Dublin San Ramon Services District
Water, wastewater, recycled water

Board of Directors

AGENDA

NOTICE OF REGULAR MEETING
TIME: 6 p.m.
PLACE: Regular Meeting Place
7051 Dublin Boulevard, Dublin, CA

DATE: Tuesday, May 15, 2018

Our mission is to provide reliable and sustainable water, recycled water, and wastewater services in a safe, efficient, and environmentally responsible manner.

1. CALL TO ORDER

2. PLEDGE TO THE FLAG

3. ROLL CALL – Members: Duarte, Halket, Howard, Misheloff, Vonheeder-Leopold

4. SPECIAL ANNOUNCEMENTS/ACTIVITIES
   - Contra Costa County Science & Engineering Fair – Excellence in Water Research Award Winners

5. PUBLIC COMMENT (MEETING OPEN TO THE PUBLIC)
   At this time those in the audience are encouraged to address the Board on any item of interest that is within the subject matter jurisdiction of the Board and not already included on tonight's agenda. Comments should not exceed five minutes. Speaker cards are available from the District Secretary and should be completed and returned to the Secretary prior to addressing the Board. The President of the Board will recognize each speaker, at which time the speaker should proceed to the lectern, introduce him/herself, and then proceed with his/her comment.

6. REPORTS

   6.A. Reports by Staff
   - Event Calendar
   - Correspondence to and from the Board

   6.B. Joint Powers Authority and Committee Reports

   6.C. Agenda Management (consider order of items)

7. CONSENT CALENDAR
   Matters listed under this item are considered routine and will be enacted by one Motion, in the form listed below. There will be no separate discussion of these items unless requested by a Member of the Board or the public prior to the time the Board votes on the Motion to adopt.

   7.A. Approve Regular Meeting Minutes of April 17, 2018
   Recommended Action: Approve by Motion

   7.B. Approve Proclamation Honoring May 20-26, 2018 as National Public Works Week
   Recommended Action: Approve by Motion

7.C. Accept the Following Regular and Recurring Reports: Warrant List and Unexpected Asset Replacement
Recommended Action: Accept by Motion

7.D. Adopt the January 2018 Tri-Valley Hazard Mitigation Plan
Recommended Action: Adopt by Resolution

7.E. Adopt Revised Apportioning Planning Costs Policy and Rescind Resolution No. 65-09
Recommended Action: Adopt Policy by Resolution

8. BOARD BUSINESS

8.A. Receive Presentation on the Joint Tri-Valley Joint Potable Reuse Technical Feasibility Study
Recommended Action: Receive Presentation and Provide Direction

8.B. Hold Public Hearing: Adopt Resolution Establishing Miscellaneous Fees and Charges and Rescind Resolution No. 13-16
Recommended Action: Hold Public Hearing and Adopt by Resolution

8.C. Hold Public Hearing: Adopt Resolution Establishing Industrial Waste Program User Fees and Charges and Rescind Resolution No. 14-16
Recommended Action: Hold Public Hearing and Adopt by Resolution

8.D. Receive Presentation on District Water Supply Outlook for 2018-2022
Recommended Action: Receive Presentation

9. BOARD MEMBER ITEMS
- Submittal of Written Reports from Travel and Training Attended by Directors
- Request New Agenda Item(s) Be Placed on a Future Board or Committee Agenda

10. CLOSED SESSION

10.A. Conference with Legal Counsel – Anticipated Litigation
Significant Exposure to Litigation Pursuant to Paragraph (2) of Subdivision (d) of Government Code Section 54956.9: One Potential Case

11. REPORT FROM CLOSED SESSION

12. ADJOURNMENT

All materials made available or distributed in open session at Board or Board Committee meetings are public information and are available for inspection at the front desk of the District Office at 7051 Dublin Blvd., Dublin, during business hours, or by calling the District Secretary at (925) 828-0515. A fee may be charged for copies. District facilities and meetings comply with the Americans with Disabilities Act. If special accommodations are needed, please contact the District Secretary as soon as possible, but at least two days prior to the meeting.

DUBLIN SAN RAMON SERVICES DISTRICT
MINUTES OF A REGULAR MEETING OF THE BOARD OF DIRECTORS

April 17, 2018

1. CALL TO ORDER

A regular meeting of the Board of Directors was called to order at 6:09 p.m. by President Vonheeder-Leopold.

2. PLEDGE TO THE FLAG

3. ROLL CALL

Boardmembers present at start of meeting:
President Georgean M. Vonheeder-Leopold, Vice President Madelyne A. (Maddi) Misheloff, Director D.L. (Pat) Howard, Director Edward R. Duarte, and Director Richard M. Halket.

District staff present: Dan McIntyre, General Manager; Carol Atwood, Administrative Services Manager/Treasurer; Judy Zavadil, Engineering Services Manager/District Engineer; Dan Martin, Water/Wastewater Systems Operations and Maintenance Supervisor; Carl P.A. Nelson, General Counsel; and Nicole Genzale, Executive Services Supervisor/District Secretary.

4. SPECIAL ANNOUNCEMENTS/ACTIVITIES

New Employee Introductions:
Jeremy Maines, Maintenance Work II
Manuel Barcellos, Mechanic I
Joshua Sanchez, Construction Inspector I

5. PUBLIC COMMENT (MEETING OPEN TO THE PUBLIC) – 6:11 p.m. No public comment was received.

6. REPORTS

6.A. Reports by General Manager and Staff

Event Calendar – General Manager McIntyre reported on the following:

- City of Pleasanton staff will propose a new water supply policy to its City Council at an upcoming meeting. DSRSD staff will attend to express support for its approval.
- The State of the City Address by Dublin Mayor Haubert will be held at the Shannon Community Center in Dublin on Wednesday, April 18.
- Zone 7 Water Agency (Zone 7) will host a groundbreaking ceremony for the Del Valle Water Treatment Plant Ozonation Project at the Del Valle Water Treatment Plant in Livermore on Wednesday, May 2 at 4 p.m. Valerie Pryor, the new Zone 7 General Manager, will be in attendance.
- The draft Potable Reuse Feasibility Study will be presented to DSRSD and Pleasanton at their respective Board/Council meetings on May 15.
- The May 1 Board meeting will be cancelled due to a lack of items.

- Correspondence to and from the Board on an Item not on the Agenda

Date	Format	From	To	Subject	Response
Various	Email/Verbal	Various invitees	DSRSD	Congratulations and comments for DSRSD's 65th Birthday	N/A

6.B. Joint Powers Authority and Committee Reports – None

6.C. Agenda Management (consider order of items) – General Manager McIntyre reported Closed Session Item 10.A will not be needed.

7. CONSENT CALENDAR

Vice President Misheloff MOVED for approval of the items on the Consent Calendar. Director Howard SECONDED the MOTION, which CARRIED with FIVE AYES.

7.A. Regular Meeting Minutes of April 3, 2018 – Approved

7.B. Accept the Following Regular and Recurring Reports: Warrant List, Quarterly Financial Reports, and Unexpected Asset Replacement – Approved

8. BOARD BUSINESS

8.A. Approve Proclamation Celebrating Dublin San Ramon Services District's 65 Years of Service

Vice President Misheloff MOVED to Approve a Proclamation Celebrating Dublin San Ramon Services District's 65 Years of Service. Director Duarte SECONDED the MOTION, which CARRIED with FIVE AYES.

8.B. Approve Master Agreement for Consulting Services with Michael Baker International, Inc. and Authorize Execution of Task Order No. 1 for the Reservoir 10A Replacement Project (CIP 17-W003)

Engineering Services Manager Zavadil reviewed the item for the Board. The Board and staff briefly discussed the project and the reservoir's role within the District's water system. They also discussed the consultant selection process, as this will be the firm's first District project.

Director Duarte MOVED to adopt Resolution No. 21-18, Approving Master Agreement for Consulting Services with Michael Baker International, Inc. for Design of Reservoir 10A Replacement Project (CIP 17-W003), and to Authorize Execution of Task Order No. 1 for Reservoir 10A Replacement Project (CIP 17-W003). Director Halket SECONDED the MOTION, which CARRIED with FIVE AYES.

8.C. Receive Presentation on the Risks and Current State of the Cybersecurity Threat Landscape

Information Services Supervisor Bob Treppa gave a presentation to the Board explaining prevalent cybersecurity risks, cybersecurity standards, and the District's risk-management approach. The Board and staff further discussed the various types of breaches, the District's security planning, and the importance of consistent monitoring and awareness training.

8.D. Receive Update Presentation on California WaterFix Project

General Manager McIntyre reported to the Board that the "twin tunnel" project is in the approval and permitting process. The economic viability was uncertain due to some agencies declining to participate in the project financing, however, last week, the State Water Project's (SWP) largest contractor, Metropolitan Water District of Southern California, approved to fully fund the project and will sell capacity to other agencies. While financing has been resolved, the WaterFix still faces legal and permitting challenges and could take 16 years to complete. Mr. McIntyre also reviewed the SWP maximum "Table A" allocations for the Tri-Valley since 2005, noting its continued downward trend in the absence of long-term water reliability solutions, and future scenarios with or without the WaterFix. So far, in the Tri-Valley, only Zone 7 has endorsed the WaterFix. The Zone 7 Urban Water Management Plan suggests two major projects (potable reuse and desalination) would be necessary in absence of the WaterFix because the SWP will continue to deteriorate. He suggested the agencies keep their options open and not rush to judgment on any potential solutions. He made clear that any solutions selected will be expensive. The Board and staff discussed the uncertainty of the WaterFix project and the hope that it either comes to fruition or is definitively taken off the table so other solutions can be pursued.

9. BOARDMEMBER ITEMS

- Submittal of Written Reports from Travel and Training Attended by Directors

  Vice President Misheloff and Director Halket thanked staff for planning a great DSRSD 65th birthday celebration.

  Director Duarte submitted a written report to Executive Services Supervisor Genzale. He reported he attended the Contra Costa Special Districts Association meeting on April 16 at the Central Contra Costa Sanitary District in Martinez. He summarized the activities and discussions at the meeting.

  President Vonheeder-Leopold submitted a written report to Executive Services Supervisor Genzale. She reported she attended the California Association of Sanitation Agencies Board of Directors teleconference meeting on April 16. She summarized the activities and discussions at the meeting.

- Request New Agenda Item(s) Be Placed on a Future Board of Committee Agenda – None

10. NOT HELD - CLOSED SESSION

10.A. Conference with Legal Counsel – Anticipated Litigation. Significant exposure to litigation pursuant to paragraph (2) of subdivision (d) of Government Code Section 54956.9: (One case)

11. NOT HELD - REPORT FROM CLOSED SESSION

12. ADJOURNMENT

President Vonheeder-Leopold adjourned the meeting at 7:08 p.m. in the memory of Carl Morrison who passed away unexpectedly on April 6. He was a highly respected environmental consultant who worked with several water agencies and led the District's Clean Water initiative many years ago.

Submitted by,

Nicole Genzale, CMC
Executive Services Supervisor/District Secretary

Dublin San Ramon Services District
Summary & Recommendation

Item 7.B.
Meeting Date: May 15, 2018

TITLE: Approve Proclamation Honoring May 20-26, 2018 as National Public Works Week

RECOMMENDATION:

Staff recommends the Board of Directors approve, by Motion, a Proclamation honoring May 20-26, 2018 as National Public Works Week.

SUMMARY:

National Public Works Week is a celebration of the tens of thousands of men and women in North America who provide and maintain the infrastructure and services collectively known as public works.

National Public Works Week is observed each year during the third full week of May. Instituted as a public education campaign by the American Public Works Association (APWA) in 1960, National Public Works Week seeks to energize and educate the public on the importance of public works to their daily lives.

This year's National Public Works Week theme is "The Power of Public Works" to give voice to the impact the many facets of public works have on modern civilization from providing clean water to disposing of solid waste, to building roads and bridges, and devising emergency management strategies. Public works services determine a society's quality of life.

The District has a $66 million budget in infrastructure and other capital improvement projects planned for its Capital Improvement Program for Fiscal Years Ending 2018 and 2019.

Originating Department: Office of the General Manager	**Contact: D. McIntyre**	**Legal Review: Not Required**
Cost: $0	**Funding Source: N/A**	
Attachments: ☐ None ☐ Staff Report ☐ Resolution ☐ Ordinance ☐ Task Order ☒ Proclamation ☐ Other (see list on right)		

Proclamation of

Dublin San Ramon Services District

Water, wastewater, recycled water

To Honor National Public Works Week: May 20-26, 2018

WHEREAS, Dublin San Ramon Services District celebrates National Public Works Week with a $66 million budget in infrastructure and other capital improvement projects planned in its Capital Improvement Program for Fiscal Years Ending 2018 and 2019; and

WHEREAS, public works services provided by the District in its service areas are an integral part of the citizens' everyday lives; and

WHEREAS, the support of an understanding and informed citizenry is vital to the efficient and effective operation of public works systems and programs such as water, recycled water, and sewers; and

WHEREAS, the quality and effectiveness of these facilities, as well as their planning, design, and construction, is vitally dependent upon the efforts and skill of public works officials, engineers, managers, and employees; and

WHEREAS, the efficiency and effectiveness of qualified and dedicated public works personnel is materially influenced by the people's attitude and understanding of the importance of the work they perform; and

WHEREAS, this year's National Public Works Week theme is "The Power of Public Works" to give voice to the impact the many facets of public works have on modern civilization from providing clean water to disposing of solid waste, to building roads and bridges, and devising emergency management strategies. Public works services determine a society's quality of life.

NOW, THEREFORE, BE IT PROCLAIMED BY THE BOARD OF DIRECTORS OF DUBLIN SAN RAMON SERVICES DISTRICT, a public agency in the State of California, Counties of Alameda and Contra Costa:

May 20-26, 2018 is National Public Works Week.

Dublin San Ramon Services District calls upon all citizens and civic organizations to acquaint themselves with the issues involved in providing our public works and to recognize the contributions which public works officials make every day to our health, safety, comfort, and quality of life.

ADOPTED at the regular meeting held on the 15th day of May, 2018.

Georgean M. Vonheeder-Leopold, President	Madelyne A. Misheloff, Vice President
Edward R. Duarte, Director	Dwight L. Howard, Director
Richard M. Halket, Director	Nicole Genzale, District Secretary

Dublin San Ramon Services District
Summary & Recommendation

Item 7.C.
Meeting Date: May 15, 2018

TITLE: Accept the Following Regular and Recurring Reports: Warrant List and Unexpected Asset Replacement

RECOMMENDATION:

Staff recommends the Board of Directors accept, by Motion, the attached regular and recurring reports.

SUMMARY:

To maximize openness and transparency and to allow the Board to be informed about key aspects of District business, the Board directed that various regular and recurring reports be presented for Board acceptance at regular intervals. This item is routinely presented to the Board at the second meeting of each calendar month.

Reports presented this month for acceptance are noted below and are submitted as part of Attachment 1:

Ref item A: Warrant List

Ref item L: Unexpected Asset Replacement

Originating Department: Administrative Services	**Contact: K. Vaden**	**Legal Review: Not Required**
Cost: $0	**Funding Source: N/A**	
Attachments: ☐ None ☐ Staff Report ☐ Resolution ☐ Ordinance ☐ Task Order ☐ Proclamation ☒ Other (see list on right)	**Attachment 1 – Summary of Regular and Recurring Reports**	

SUMMARY OF REGULAR AND RECURRING REPORTS

Ref.	Description	Frequency	Authority	Last Acceptance	Acceptance at this Meeting?	Next Acceptance
A	Warrant List	Monthly	Board Direction	April 2018	Yes	June 2018
B	District Financial Statements [1]	Quarterly	Board Direction	April 2018		July 2018
C	Low Income Assistance Program Report	Annually – Fiscal Year	Resolution 41-10	July 2017		July 2018
D	Strategic Work Plan Accomplishments Report	Annually – Fiscal Year	Resolution 24-17	July 2017		July 2018
E	Outstanding Receivables Report	Annually – Fiscal Year	District Code 1.50.050	July 2017		July 2018
F	Employee and Director Reimbursements greater than $100 [2]	Annually – Fiscal Year	CA Government Code 53065.5	July 2017		July 2018
G	Utility Billing Adjustments[3]	Annually – Fiscal Year	Utility Billing Adjustment Policy	August 2017		August 2018
H	Annual Rate Stabilization Fund Transfer Calculation	Annually – After Audit	Financial Reserves Policy	Nov 2018		Dec 2019
I	"No Net Change" Operating Budget Adjustments	As they occur but not more frequently than monthly	Board Direction Budget Accountability Policy (See table below)	Nov 2017		Before end of month after occurrence
J	Capital Outlay Budget Adjustments			May 2016		
K	Capital Project Budget Adjustments			Oct 2014		
L	Unexpected Asset Replacements			Apr 2018	Yes	

For the fiscal year ending 2018, the totals for these reports are as follows:

Category	YTD	This Meeting	Total
Capital Outlay Budget Adjustments	$0	$0	$0
Capital Project Budget Adjustments	$0	$0	$0
Unexpected Asset Replacements	$38,000	$18,000	$56,000

[1] Financial statement reporting changed from monthly to quarterly reporting.

[2] Reimbursements also reported monthly in the Warrant List (Item B). Presented to Board as separate agenda item.

[3] Per the policy a report will be presented to the Board if total credits in preceding fiscal year exceeded $25,000

apCkHistDesc

Check History Description Listing

Dublin San Ramon Services District

Printed on: 05/03/2018 12:55PM

From: 4/6/2018 To: 5/6/2018

Bank code: apbank

Date	Check #	Vendor	Description	Amount Paid	Check Total
04/06/2018	96366	00710 AAI TERMITE & PEST CONTROL I	MAR 2018: DO MONTHLY PEST CONTROL	147.00	
			03/13/18: DO PEST CONTROL RODENT SERVICE	68.00	215.00
04/06/2018	96367	07499 MAYETTE BAILEY	BAILEY TUITION REIMB 01/02 - 03/18/18	4,696.00	4,696.00
04/06/2018	96368	01013 BARRETT BUSINESS SERVICES	S. MONTAGUE: W/E 3/11/18	799.50	
			N. POON: WE 03/11/18	437.76	
			J. HAYES: WE 03/11/18	281.91	1,519.17
04/06/2018	96369	03614 CAROLLO ENGINEERS INC.	18-W019 TO NO. OC-14 FEB 1 - FEB 28	5,289.00	5,289.00
04/06/2018	96370	05875 BRETT CASTELLO	CASTELLO TUITION REIMB 06/24 - 08/14/17	3,116.00	
			CASTELLO TUITION REIMB 09/18 - 12/08/17	2,134.00	5,250.00
04/06/2018	96371	01381 JOYCE CHANG	CHANG REIMB EXP AT DO REDESIGN PROJECT M	47.09	47.09
04/06/2018	96372	00216 DAIOHS U.S.A. INC.	FY 2018 HOT BEVERAGE SERVICE DO- APRIL 2	299.09	299.09
04/06/2018	96373	00937 GRAINGER, INC.	CHARGER FOR D-7	108.74	108.74
04/06/2018	96374	04424 GRAYBAR ELECTRIC COMPANY	ELE MATLS FOR BLDG Q LIGHTING UPGRADE; C	612.53	
			ELE MATERIALS FOR SHOP STOCK	429.40	
			(3QTY) WIRE STRIPPER-CUTTER	67.22	1,109.15
04/06/2018	96375	03976 JMB CONSTRUCTION, INC	16-A002 PP 5 JAN 1 - FEB 28	261,010.12	261,010.12
04/06/2018	96376	04594 MCCAMPBELL ANALYTICAL INC	METAL SAMPLES FOR FOD	144.00	144.00
04/06/2018	96377	01171 MCGUIRE & HESTER	SERVICE REPAIRS, HYDRANT REPAIRS, PATCH	86,159.95	86,159.95
04/06/2018	96378	01078 STEFANIE OLSON	OLSON REIMB EXP AT WATEREUSE CONF. 03/25	263.56	263.56
04/06/2018	96379	00762 TESTAMERICA LABORATORIES I	LAB ANALYSES	27.50	27.50
04/06/2018	96380	00843 THE COVELLO GROUP INC	16-R014 TO NO. 1 FEB 1 - 28, 2018	84,582.78	
			07-3203 TO NO. OC-9 FEB 1 - 28, 2018	46,953.26	131,536.04
04/06/2018	96381	05026 UNIVAR USA INC.	SODIUM HYPOCHLORITE FOR WWTP OPERATIONS	2,597.54	

Bank code: apbank

Date	Check #	Vendor	Description	Amount Paid	Check Total
			WWTP SODIUM HYPO 4800.00 GL 3-14-18	2,469.93	5,067.47
04/06/2018	96382	03831 JACLYN YEE	YEE REIMB EXP AT 2018 NASTT'S NO-DIG SHO	194.00	194.00
04/06/2018	96383	03622 JUDY ZAVADIL	ZAVADIL REIMB MILEAGE FOR W/E 03/19/2018	90.47	90.47
04/09/2018	4092018	03718 HR SIMPLIFIED	IRS 125 2018 DCA/FSA/POS	957.08	957.08
04/09/2018	1001052235	00494 PERS	RETIREMENT: 2018 REPLACEMENT CHARGES	285.48	285.48
04/10/2018	1001049921	01111 CALPERS	APRIL 2018 - ER CODE 0740 (PERS)	206,411.03	206,411.03
04/10/2018	1001049923	01111 CALPERS	APRIL 2018 - ER CODE 7316 (NON-PERS)	2,087.57	2,087.57
04/12/2018	96384	03536 U S BANK/ CORP PMT SYSTEMS	DSRSD BICYCLES AND EQUIPMENT	3,519.97	
			16-P023 LIGHT FIXTURES FOR BLDG Q	2,451.46	
			LAB STAFF CWEA ANNUAL CONFERENCE REGISTR	2,205.00	
			16-P023 BLDG D HIGH BAY LIGHTS	1,817.81	
			TOOL CABINET	1,189.43	
			CRWA EXPO J. CHALK R. LAWRENCE 4-24 - 4-	1,050.00	
			FOD BOX & FACILITIES SUPPLIES	859.74	
			BJOHNSON: REG FEE FOR APP 101 TRAINING O	850.00	
			MATENDIDO: REG FEE FOR APP 101 TRAINING	850.00	
			LAVWMA: FLOW SWITCH FOR SLSS THIOSULFATE	723.24	
			TOOLS SERVICED	570.63	
			07-3203 48X48 SIGN	567.01	
			PPE: LIFE JACKETS, DRY BAG FOR FSL WORK	540.22	
			CITIZENS WATER ACADEMY - SESSION #1 3/14	533.13	
			KHAW - REGISTRATION CWEA AC18 ANNUAL CON	525.00	
			PAPER ORDER FOR THE DO	517.74	
			BREAKFAST FOR 2/23/18 WATER REUSE MEETIN	505.40	
			FYE2017 CAFR AWARD APPLICATION	505.00	
			KOEHLER - WORKPLACE INVESTIGATIONS CONFE	495.00	
			REPLT STARTING BATTERIES FOR 1250 GENERA	489.97	

Bank code: apbank

Date	Check #	Vendor	Description	Amount Paid	Check Total
			MMANC - 2018 WOMENS LEADERSHIP SUMMIT EX	480.00	
			QTY (5) MS 900 WIRELESS KB/MOUSE QTY (5)	474.90	
			PPE: HEAD LAMPS FOR SUPERVISOR GO BAGS	436.90	
			FLASHLIGHTS & LED HEADLAMPS FOR SUPERVIS	404.11	
			SUPPLIES TO CLEAN FACILITIES	398.35	
			BLOHMAN: FLAME-RESISTANT WORK CLOTHES	382.33	
			TEMP TRANSMITTER FOR CO-GEN #3	380.16	
			SUPERVISOR PPE "GO BAGS"	359.91	
			LAVWMA: PARTS FOR THIOSULFATE FLOW SWITC	359.22	
			EMBROIDERY FOR UNIFORM	340.21	
			SUPPLIES FOR FACILITIES SHOP	307.89	
			CITIZENS WATER ACADEMY -TOUR TRANSPORTAT	307.69	
			WOOD FOR FACILITIES WORK BENCH	306.56	
			HIGH PRESSURE VENTS FOR BLDG D GLYCOL LO	289.35	
			CWEA RENEWAL C. SANCHEZ	280.00	
			DHIGARES: MEMBERSHIP RNWL, EXP 04/30/18	270.00	
			D. GRIFFIN AWWA MEMBERSHIP RENEWAL	269.00	
			FLASHLIGHT & CHARGER FOR TRUCK #109	246.79	
			FLASHLIGHT & CHARGER FOR TRUCK #110	246.79	
			RODRIGUEZ: DRINKING WATER ERP TRAINING	245.00	
			DUBLIN STATE OF THE CITY LUNCHEON 4/18/1	225.00	
			INK CARTRIDGES FOR FACILITIES	221.01	
			ANKER 4-PORT USB & STANDING DESK X-ELITE	218.47	
			OFFICE SUPPLIES: RULERS, SCISSORS, PENS,	213.65	
			PLATE FOR TRUCK #109	209.51	
			RBAKER: PRESCRIPTION SAFETY GLASSES	205.00	
			RODRIGUEZ: CWEA (PROF) MEMBERSHIP	204.00	
			SUPPLIES FOR BLDG S LOCKER ROOM	203.20	
			OFFICE SUPPLIES: LAMINATING SHEETS, KEYB	200.76	

Bank code: apbank

Date	Check #	Vendor	Description	Amount Paid	Check Total
			CCAC 2018 NUTS & BOLTS WORKSHOP - M. NAR	200.00	
			FUEL FOR TRUCK #110	200.00	
			STORAGE BINS FOR FLEET SHOP	196.56	
			POLLARDWATER	190.54	
			PARTS FOR REPAIRS	189.78	
			OPERATOR'S SUPPLIES	186.46	
			ILOPEZ: MEMBERSHIP RENEWAL, EXP 03/31/18	180.00	
			CWEA S KOZANDA RENEWAL	180.00	
			OFFICE SUPPLIES: SELF-INK STAMP, PENS, S	172.72	
			FLOOR MATS FOR NEW TRUCK #124	158.76	
			LAVWMA: DC CURRENT TRANSDUCER FOR CATHOD	154.00	
			EXCEL PIVOT TABLE TRAINING FOR ROPER MAC	150.00	
			FUEL FOR TRUCK #110	130.00	
			FUEL FOR TRUCK #110	130.00	
			BATTERY SWITCH	121.21	
			FUEL FOR TRUCK #110	120.00	
			OPERATING SUPPLIES FOR FACILITIES	111.77	
			FUEL FOR TRUCK #110	110.00	
			PPE: RAINCOAT R. BAKER	107.22	
			TEAM BUILDING LUNCH 03/01/18	106.80	
			WATER PUMP FOR TV TRUCK	106.64	
			SUPPLIES FOR BLDG S LOCKER ROOM	105.03	
			PPE: ERGONOMIC KEYBOARD R. BIAGTAN	103.78	
			FUEL FOR TRUCK #109	100.00	
			LOG CODE FEE FOR GEOTRACKER DATA UPLOAD	100.00	
			QTY (10) MINI DP TO HDMI CABLES FOR IT S	97.80	
			TRAINING WEBINARS FOR C. ATWOOD	90.00	
			LLANTIN: E/I-2 CERTIFICATE RENEWAL, EXP	90.00	
			CWEA RENEWAL R.ROBLES	90.00	

Bank code: apbank

Date	Check #	Vendor	Description	Amount Paid	Check Total
			DREMEL TOOLS AND BITS	88.46	
			LIGHT BULBS FOR DO EXTERIOR LIGHT FIXTUR	88.06	
			SUPPLIES BREAKROOM/PI/EXEC	87.77	
			TOOLS FOR DERWA SUMP PUMP PROJECT	85.18	
			FUEL FOR TRUCK #109	85.00	
			MISC SUPPLIES	79.08	
			DO BREAKROOM SUPPLIES	78.79	
			OFFICE SUPPLIES: DRY-ERASE MARKERS, SCIS	76.05	
			PPE: REARM KIT FOR LIFE JACKETS	74.81	
			STAPLES	73.00	
			DO AND BREAKROOM SUPPLIES	72.69	
			OFFICE SUPPLIES - HEADSET AND SPEAKER FO	70.53	
			REFILL PROPANE TANKS FOR FORKLIFT	67.86	
			FUEL FOR TRUCK #119	65.83	
			QTY (1) LINKSYS USB WIRELESS AC ADAPTER	65.54	
			SHOP REORG SUPPLIES	64.47	
			FUEL FOR DISTRICT VEHICLE. DID NOT GET	64.46	
			OFFICE SUPPLIES: CALCULATOR, MONITOR STA	63.66	
			REFRESHMENTS FOR D. MARTIN WELCOME GATHE	61.38	
			NAMEPLATE - CHIU, NARCISCO, SANCHEZ	59.00	
			OFFICE SUPPLIES FOR DO	58.56	
			CABLE ENDS FOR 1250 GEN STARTING BATTERI	58.24	
			MISC BATTERIES FOR STOCK	57.48	
			SUPPLIES FOR BLDG S LOCKER ROOM	57.44	
			WIRELESS KEYBOARD AND MOUSE SET	52.30	
			OFFICEWORLD - SUPPLIES FOR EXEC 02 27 20	51.60	
			SEALS FOR TRUCK #124	49.90	
			GAS FOR IT TRUCK	48.03	
			TUBE/CONDUIT CUTTER & COPPER COUPLING FO	46.05	

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Date	Check #	Vendor	Description	Amount Paid	Check Total
			8-INCH BUNDT CAKE FOR ACSDA RAFFLE PRIZE	43.50	
			RECYCLING BINS FOR FACILITIES	43.44	
			QTY (1) BELKIN IPHONE CHARGER QTY (1) LO	42.91	
			EBDA NEW GM TOUR / REFRESHMENTS	42.16	
			FUEL FOR TRUCK #112	41.00	
			REPLT LAPTOP BATTERIES FOR SCADA LAPTOPS	39.98	
			FUEL FOR TRUCK #72	39.68	
			ICE MACHINE CLEANER	39.64	
			PLATES, TABLECLOTHS FOR FOD WELCOME GATH	39.40	
			QTY (1) MICROSOFT 4000 ERGO KB FOR STEPH	39.38	
			PLUG GNDS FOR NEW LED LIGHTS IN BLDG D	38.88	
			ATWOOD SUBSCRIPTION FEBRUARY 2018	34.89	
			WOOD FOR SIGNAGE	34.82	
			MISC SUPPLIES	34.41	
			PPE: WIRELESS KEYBOARD	32.76	
			GASOLINE - DISTRICT POOL VEHICLE	31.68	
			FUEL FOR TRUCK #76	30.00	
			PRO SUBSCRIPTION (MARCH 2018)	29.00	
			DO SUPPLIES: YEAR STICKERS FOR FILES	28.90	
			TOOLS: BUCKET, SOCKET & BACKER WRENCHES	28.86	
			BLUETOOTH HOOKUPS FOR WIRELESS HEADSETS/	28.00	
			FOD SUPPLIES	23.90	
			PARTS FOR FOD	22.90	
			STEPHENSON - ACWA BOARD MEETING 02/22/18	20.84	
			LAVWMA: POWER SUPPLY FOR CATHODIC PROTEC	17.46	
			SUPPLIES FOR BLDG S LOCKER ROOM	17.14	
			COFFEE FOR 2/23 WATER REUSES MEETING	16.95	
			GASOLINE - DISTRICT POOL VEHICLE	14.69	
			WIRELESS SPEAKER FOR COMPUTER	14.60	

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Date	Check #	Vendor	Description	Amount Paid	Check Total
			DRINKS FOR 2/23 WATER REUSE MEETING	14.48	
			PARKING FOR JUDY - POTABLE REUSE WORKSHO	14.35	
			FEB 2018 PRIME MEMBERSHIP MONTHLY FEE	14.19	
			CITIZENS ACADEMY: GLUTEN FREE ITEMS FOR	13.97	
			CITIZENS WATER ACADEMY SESSION 1 3/14/18	13.08	
			SHIMS & BRACKETS FOR LIFT STATION 1 PART	10.80	
			SUPPLIES FOR DO BREAKROOM	9.38	
			REPLT TWEAKER SCREWDRIVER	8.71	
			DERWA: U-BOLTS FOR SF HOSE BIB JOB	8.19	
			NETWORK SOLUTIONS PREMIUM DNS	4.99	
			EBOOK SOC MEDIA & LOCAL GOVERNMENT	4.95	
			RETURN SPEAKER FOR COMPUTER	-10.32	
			REFUND:M. BAILEY REGISTRATION	-225.00	
			REFUND: WATER REUSE 2-23-18	-750.00	35,425.34
04/12/2018	96385	08340 AIR FILTER SUPPLY, INC.	AIR FILTERS FOR CO-GEN, BLOWER & WASHER	303.01	303.01
04/12/2018	96386	01076 ALSCO INC	FOD TOWEL & MAT SERVICE - MAR' 18	422.80	
			WWTP TOWEL & MAT SERVICE MAR' 18	419.28	
			DO MAR' 18 TOWELS & MAT SERVICE	153.44	995.52
04/12/2018	96387	02158 AMADOR VALLEY INDUSTRIES	DO GARBAGE SVC - FOR MARCH 2018	363.06	363.06
04/12/2018	96388	01954 ANDERSON'S UNIFORMS	UNIFORM ITEMS - J. CHALK	1,133.60	
			UNIFORM ITEMS - J. MAINES	813.64	
			UNIFORM ITEMS FOR S. ROBERSON	271.54	2,218.78
04/12/2018	96389	00058 ARROWHEAD MOUNTAIN SPRIN	BLDG T BOTTLED WATER MAR' 18	231.05	
			BLDG T BOTTLED WATER SERVICE FEB' 18	117.52	348.57
04/12/2018	96390	00058 ARROWHEAD MOUNTAIN SPRIN	BOTTLED WATER LAB MAR' 18	193.94	
			LAB BOTTLED WATER FEB' 18	135.96	
			LAB BOTTLED WATER JAN' 18	113.97	443.87

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Date	Check #	Vendor	Description	Amount Paid	Check Total
04/12/2018	96391	06211 ASSOCIATED SERVICES CO.	PEETS COFFEE FOR APRIL 18 - 8 CASES	421.28	
			OPS COFFEE - 3 CASES PREMIUM FRENCH ROAS	81.40	502.68
04/12/2018	96392	00622 AT&T	MANAGED INTERNET SERVICES 3/1/18 - 3/31/	2,259.43	
			AT&T VIOP SERVICE 3/1/18 - 3/31/18	102.80	
			AT&T VIOP SERVICE 3/1/18 - 3/31/18	97.91	2,460.14
04/12/2018	96393	08537 AUBURN CONSTRUCTORS, INC.	WAUKESHA ENGINE/BLOWER	2,000.00	2,000.00
04/12/2018	96394	08530 VIJAY BALASUBRAMANIAN	REFUND FOR 2001 TARRAGON ROSE CT	19.10	19.10
04/12/2018	96395	00091 BOLD, POLISNER, MADDOW, NEI	MONTHLY LEGAL SERVICES - 03/2018	14,199.00	14,199.00
04/12/2018	96396	02217 BSK ASSOCIATES INC.	SLSS DISCHARGE	241.25	241.25
04/12/2018	96397	08045 FE MARIE BUSTOS	2017 ALAMEDA COUNTY SEF - TEACHER AWARD	100.00	100.00
04/12/2018	96398	01085 CALPERS LONG-TERM CARE PR	LONG-TERM CARE: PAYMENT	68.12	68.12
04/12/2018	96399	00105 CAL-STEAM	PARTS FOR ARV RES 200A	126.45	
			SINK REPAIR PARTS	84.77	211.22
04/12/2018	96400	08536 DEL CONTE'S LANDSCAPING, IN	MAR 2018: MONTHLY LANDSCAPE MAINTENANCE	3,860.00	
			MAR 2018: MONTHLY LANDSCAPE MAINTENANCE	75.00	3,935.00
04/12/2018	96401	00237 DERWA	DERWA OPERATING MAR 2018	924,267.94	924,267.94
04/12/2018	96402	00280 ECOWATER SYSTEMS	OPS LAB 6 TANKS 4-18	217.20	
			MECH 2 TANKS APR' 18	21.00	238.20
04/12/2018	96403	00307 FAIRWAY EQUIPMENT & SUPPLY	STEEL FOR BLDG S LOCKER STAND & FACILITI	1,483.20	
			SS FITTINGS FOR ACTIFLOW SEAL WATER	810.93	
			STEEL FOR BLDG S LOCKERS STANDS	250.69	2,544.82
04/12/2018	96404	02914 STATE OF CALIFORNIA FRANCHI	FRANCHISE TAX BOARD: PAYMENT	150.00	150.00
04/12/2018	96405	06640 GOLDEN GATE TRUCK CENTER	VEHICLE #110 CHECK ENGINE LIGHT	395.16	
			STOK CAMEL WIPER BLADES-VEH #109	176.58	571.74

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04/12/2018	96406	00368 HACH COMPANY	MISC CHEM PACKS	1,910.10	1,910.10
04/12/2018	96407	00376 HARRINGTON INDUSTRIAL PLAS	LAVWMA: VALVE FOR SAMPLE LINE @ SLSS	448.67	448.67
04/12/2018	96408	08516 HARVARD KENNEDY SCHOOL	SENIOR EXECUTIVES PRGM JUNE 2018 - M GAL	16,100.00	16,100.00
04/12/2018	96409	03149 HDS WHITE CAP CONST SUPPLY	PPE: RAINGEAR S. SARGIOTTO	101.58	101.58
04/12/2018	96410	08532 NICOLE HERRERO	REFUND FOR 3356 MIDDLEBROOK WAY	51.96	51.96
04/12/2018	96411	07652 HUNT & SONS, INC.	DIESEL FUEL BULK 1500	3,775.23	3,775.23
04/12/2018	96412	06074 INSIGHT PUBLIC SECTOR	EPSON LIGHT PROJ & ZOOM LENSE QUOTE 2198	5,193.75	
			BUSINESS NETWORK VEEAM RENEWAL 3/29/18	3,720.00	8,913.75
04/12/2018	96413	03758 JDH CORROSION CONSULTANTS	15-W004 ONSITE TESTING, SUBMITTAL REVIEW	1,200.00	1,200.00
04/12/2018	96414	08522 XIAO DONG LIN	REFUND FOR 7947 DIANA LN	190.94	190.94
04/12/2018	96415	07614 MAHLER CONSULTING SERVICE	DEVELOPMENT INSP SUPPORT MARCH 1-15, 201	13,195.00	
			TASK ORDER NO. OC-5 2/16 - 3/2	10,365.00	23,560.00
04/12/2018	96416	07264 MANPOWERGROUP US INC.	M. ZAKAN: WE 03/18/18	498.94	498.94
04/12/2018	96417	05897 MERIT RESOURCE GROUP	A. MCCAFFERY: WE 03/18/18	1,926.25	1,926.25
04/12/2018	96418	08521 JOSE MUNOS HERNANDEZ	REFUND FOR 7988 CAROLINE CT	166.99	166.99
04/12/2018	96419	04796 NAPA AUTO PARTS	FUEL FILTER FOR DREDGE	26.80	
			30/40 AMP RELAY & HARNES	14.19	40.99
04/12/2018	96420	08527 WEN-CHUN NI	REFUND FOR 3231 VITTORIA LOOP	305.38	305.38
04/12/2018	96421	02109 ONE HOUR DELIVERY SERVICE,	ONE HOUR DELIVERY - BOARD PACKETS 3/16/1	51.00	51.00
04/12/2018	96422	00620 P G & E	WWTP ELECTRICITY - MAR 2018	20,073.37	
			DISTRICT OFFICE ELECTRICITY - MAR 2018	4,183.41	
			PUMP STATION R200B ELECTRIC - APR 2018	1,200.51	
			DISTRICT OFFICE GAS CHARGES - MAR 2018	921.33	
			DO UTILITY BUILDING ELEC - MAR 2018	83.30	

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			RESERVOIR R100 ELEC - APR 2018	33.99	
			DO UTILITY BUILDING GAS CHARGES - MAR 20	19.29	
			ALAMO TRUNK SEWER ELEC - MAR 2018	12.80	
			JOHNSON DRIVE STREETSCAPE ELEC - MAR 201	12.28	26,540.28
04/12/2018	96423	00663 PLEASANTON GARBAGE SVC IN	MAR' 18 WWTP GARBAGE SERVICE & BOX RENT	5,009.83	5,009.83
04/12/2018	96424	01195 POWERSTRIDE BATTERY CO., IN	BATTERY VEHICLE #115	92.27	92.27
04/12/2018	96425	07727 PURE HEALTH SOLUTIONS, INC.	WWTP: OPS WATER FILTRATION SERVICE MAR'	131.10	131.10
04/12/2018	96426	04105 R & B COMPANY	PARTS FOR TURNOUT #1	402.53	402.53
04/12/2018	96427	06284 RELIANT TECHNOLOGY	CX4-120 SAN DO MAINTENANCE RENEWAL 1 YR	4,937.50	4,937.50
04/12/2018	96428	04044 SCOTT VALLEY BANK	07-3203 PP#7 - FEB. 2018	31,908.80	31,908.80
04/12/2018	96429	02698 SHAMROCK OFFICE SOLUTIONS	OVERAGE USAGE COLOR COPIES 01/01/18 - 03	2,443.41	2,443.41
04/12/2018	96430	08529 RUBY SHIN	REFUND FOR 218 CANDYTUFT CT	104.42	104.42
04/12/2018	96431	08523 BARBARA J SITES	REFUND FOR 11593 LADERA CT	22.86	22.86
04/12/2018	96432	00786 SNAP-ON INDUSTRIAL	TOOLS FOR FACILITIES SHOP	190.15	190.15
04/12/2018	96433	01470 TRI-VALLEY HOSE	HOSES FOR 402G LV PUMP LAVWMA GENERATOR	28.81	28.81
04/12/2018	96434	01222 UNITED STATES TREASURY	GARNISHMENT - IRS: PAYMENT	420.50	420.50
04/12/2018	96435	00556 UNITED WAY OF THE BAY AREA	UNITED WAY: PAYMENT	207.40	207.40
04/12/2018	96436	06004 VANGUARD CLEANING SYSTEMS	MAR 2018: WWTP - JANITORIAL SERVICES	3,045.00	
			MAR 2018: DO - JANITORIAL SERVICES	2,675.00	
			MAR 2018: FOD - JANITORIAL SERVICES	1,895.00	
			LAVWMA: PRE-CLEAN ON 03/03/18	150.00	7,765.00
04/12/2018	96437	08531 NAGA VELAVERTHIPATI	REFUND FOR 2017 TARRAGON ROSE CT	36.12	36.12
04/12/2018	96438	00933 VWR INTERNATIONAL, INC.	COLOR STD RICCA	125.81	
			LAB CHEMICALS AND SUPPLIES	63.39	189.20

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04/12/2018	96439	08423 WATERTALENT LLC	J. BALLOU: WE 03/18/18	6,264.00	6,264.00
04/12/2018	96440	00957 WEST YOST & ASSOCIATES	17-P004 TO NO. 1 2/10/18 TO 3/9/18	61,141.59	
			LAVWMA ENG SERVICES - PUMP SEAL ISSUES	1,475.00	62,616.59
04/12/2018	96441	08524 YONGMEI WU	REFUND FOR 7685 RIDGELINE DR	186.83	186.83
04/12/2018	96442	08528 DONGLING YAO	REFUND FOR 6012 KINGSMILL TER	170.52	170.52
04/12/2018	96443	08526 MICHAEL ZACHARKO	REFUND FOR 2212 SUNSET VIEW CT	124.36	124.36
04/12/2018	96444	08525 WEN ZHOU	REFUND FOR 1659 N TERRACINA DR	178.20	178.20
04/12/2018	96445	00987 ZONE 7 WATER AGENCY	MARCH 2018 CONNECTION FEES	3,061,543.05	3,061,543.05
04/12/2018	96446	01013 BARRETT BUSINESS SERVICES	S. MONTAGUE: W/E 3/18/18	994.50	994.50
04/12/2018	96447	01013 BARRETT BUSINESS SERVICES	N. POON: WE 03/18/18	437.76	437.76
04/12/2018	96448	07954 BENEFIT COORDINATORS CORF	4/18 - EE LIFE & DISABILITY INSURANCE PR	11,422.73	11,422.73
04/12/2018	96449	00099 BUCKLES-SMITH ELECTRIC CO	POWER SUPPLY FOR SOFT START @ PS4B	443.97	443.97
04/12/2018	96450	00937 GRAINGER, INC.	ABSORBENT ROLL FOR SHOP	228.39	
			SHRINK WRAP FOR SHOP	69.96	298.35
04/12/2018	96451	04424 GRAYBAR ELECTRIC COMPANY	INTERPOSING RELAYS & SOCKETS FOR NEW FSL	445.47	
			(2QTY) PLIER-TYPE CRIMPING TOOL; (2QTY)	211.57	657.04
04/12/2018	96452	00362 GSE CONSTRUCTION CO., INC.	07-3203 - PP#7 FEB. 2018	606,237.20	606,237.20
04/12/2018	96453	01242 INFO SEND, INC	BILL INSERT MAILING: NO DRUGS-DRUG DROP	178.51	
			BILL INSERT MAILING: CITIZENS WATER ACAD	153.67	332.18
04/12/2018	96454	06850 BRIAN JOHNSON	JOHNSON REIMB EXP FOR SEL APP 101 INTRO	10.00	10.00
04/12/2018	96455	07109 DANIEL MCINTYRE	MCINTYRE REIMB MILEAGE FOR MAR. 2018	70.96	70.96
04/12/2018	96456	02076 NORTHERN TOOL & EQUIPMENT	(3QTY) PNEUMATIC SHOP STOOL FOR FLEET &	89.97	89.97
04/12/2018	96457	01403 PRAXAIR DISTRIBUTION INC 186	CYLINDER RENTAL	77.73	77.73

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04/12/2018	96458	04973 NATERCIA SAUCEDA	CASE ID FL364781: PAYMENT	111.23	111.23
04/12/2018	96459	00762 TESTAMERICA LABORATORIES I	SAG MEDIA TESTING - 03/13/18	272.50	272.50
04/12/2018	96460	00762 TESTAMERICA LABORATORIES I	LAB ANALYSES	27.50	27.50
04/16/2018	8111	05511 CALIFORNIA STATE	CHILD SUPPORT GARNISHMENT: PAYMENT	690.46	690.46
04/16/2018	4162018	03718 HR SIMPLIFIED	IRS 125 2018 POS	221.80	221.80
04/16/2018	8881113	00591 NEOPOST USA INC.	POSTAGE ADVANCE 04/16/2018	500.00	500.00
04/16/2018	607041618	01098 NATIONWIDE RETIREMENT SOLI	NATIONAL DEFERRED COMPENSATION: PAYMENT	51,188.66	51,188.66
04/16/2018	1001053985	00494 PERS	RETIREMENT: PAYMENT	99,992.51	99,992.51
04/17/2018	30821877	00558 IRS - PAYROLL TAXES	FEDERAL WITHHOLDING TAXES: PAYMENT	147,394.62	147,394.62
04/17/2018	1389425216	00559 EDD - PAYROLL	CALIFORNIA STATE TAXES: PAYMENT	30,217.48	30,217.48
04/19/2018	96461	00008 ACME FIRE EXTINGUISHER	WWTP FIRE EXTINGUISHER SERVICE	594.15	
			FOF FIRE EXTINGUISHER SERVICE	417.00	
			WWTP FIRE EXTINGUISHER SERVICE	345.19	
			WWTP BLDG T FIRE EXTINGUISHER SERVICE	223.33	
			WWTP BLDG D FIRE EXTINGUISHER SERVICE	202.37	
			FOD FIELD SITES FIRE EXTINGUISHER RECHAR	187.65	
			DISTRICT OFFICE FIRE EXTINGUISHER SERVIC	175.50	
			WWTP BLDG D FIRE EXTINGUISHER SERVICE	171.19	
			LAVWMA FACILITIES ANNUAL FIRE EXTINGUISH	166.00	2,482.38
04/19/2018	96462	00009 ACWA	SB623 - NO DRINKING WATER TAX CAMPAIGN	10,000.00	10,000.00
04/19/2018	96463	01180 ADS REPROGRAPHICS, INC.	TONER FOR HP LARGE SCALE PRINTER	243.75	243.75
04/19/2018	96464	00058 ARROWHEAD MOUNTAIN SPRIN	LAVWMA BOTTLED WATER RENTAL APR' 18	8.73	8.73
04/19/2018	96465	03049 BABBITT BEARING CO, INC	RECONDITIONING OF (2) 9 SERIES PUMP STAT	1,837.00	1,837.00
04/19/2018	96466	04536 BICKMORE	GASB 75 INFORMATION FOR FYE 2018	1,350.00	1,350.00

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04/19/2018	96467	08552 CINDY CAI	REFUND FOR 11182 BRITTANY LN	63.33	63.33
04/19/2018	96468	07138 CALIFORNIA WATER TECHNOLO	FERROUS CHLORIDE WWTP 3-26-18 41,720.	3,882.38	3,882.38
04/19/2018	96469	00105 CAL-STEAM	LAVWMA: FITTINGS FOR PUMP INSTALL @ SAMP	5.64	5.64
04/19/2018	96470	00118 CALTEST ANALYTICAL LAB	LAB ANALYSES	184.30	184.30
04/19/2018	96471	08548 MIRASOL CASTRO	REFUND FOR 5656 W COG HILL TER	150.71	150.71
04/19/2018	96472	07919 COMTEL SYSTEMS TECHNOLOG	SECURITY SYSTEM: LNVR RELOCATION PROJEC	2,072.00	2,072.00
04/19/2018	96473	00014 COUNTY OF ALAMEDA	FY 2017 FUELING - FOD/INSP/CFRS - FEB. 2	2,611.68	2,611.68
04/19/2018	96474	08399 CROSSPOINT GENERAL ENGINE	17-A007 PP#1 - MARCH 2018	143,141.24	143,141.24
04/19/2018	96475	00229 DELL MARKETING LP	QTY (10) DELL P2417H 24" MONITORS FOR IT	2,687.05	2,687.05
04/19/2018	96476	03760 DOSH - ERT UNIT DEPT. OF INDU	ELEVATOR: BLDG S PERMIT FEE	225.00	
			ELEVATOR: BLDG A PERMIT FEE	225.00	450.00
04/19/2018	96477	00260 DUBLIN CHAMBER OF COMMER	DUBLIN CHAMBER OF COMMERCE - 2018 MEMBER	945.00	945.00
04/19/2018	96478	01559 EATON CORPORATION	TRI-ANNUAL MEDIUM VOLTAGE PM SERVICE FOR	11,107.00	11,107.00
04/19/2018	96479	02656 FASTENAL COMPANY	PPE: FOF VENDING MACHINE RESTOCK	221.03	
			PPE: BLDG S VENDING MACHINE RESTOCK	155.14	
			PPE: DISTRICT OFFICE NITRILE GLOVES	142.96	
			PPE: BLDG S VENDING MACHINE RESTOCK	136.82	
			PPE: BLDG S VENDING MACHINE RESTOCK	93.83	
			PPE: FOF VENDING MACHINE RESTOCK	65.67	
			PPE: BLDG A VENDING MACHINE RESTOCK	54.57	
			EPOXY FOR GENERAL SHOP USE	38.23	
			PPE: BLDG A VENDING MACHINE RESTOCK	27.60	
			2 WD-40 FOD SUPPLIES	18.15	
			PPE: BLDG A VENDING MACHINE RESTOCK	2.99	956.99
04/19/2018	96480	00313 FASTSIGNS	FOF SIGN ABOVE FRONT DOOR	1,042.79	1,042.79

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04/19/2018	96481	08544 SULXIN HUANG	REFUND FOR 7481 HANSEN DR	146.37	146.37
04/19/2018	96482	00468 KAMAN INDUSTRIAL TECHNOLO	ALIGNMENT TOOL FOR BELT & CHAIN DRIVES	1,981.68	1,981.68
04/19/2018	96483	00468 KAMAN INDUSTRIAL TECHNOLO	(2QTY) BALL BEARING FLANGE UNIT FOR DRED	385.09	385.09
04/19/2018	96484	06166 KBA	COPIER FOD/ENGR/MAINT 3/01/18 - 3/31/18	475.64	475.64
04/19/2018	96485	00525 RAQUEL MADARANG	R. MADARANG - PERSONAL VEHICLE DAMAGE CL	2,079.21	2,079.21
04/19/2018	96486	07614 MAHLER CONSULTING SERVICE	2017-2018 DEVELOPMENT PROJECT INSPECTION	7,665.00	7,665.00
04/19/2018	96487	07264 MANPOWERGROUP US INC.	M. ZAKLAN: WE 03/25/18	498.94	498.94
04/19/2018	96488	05897 MERIT RESOURCE GROUP	A. MCCAFFERY: WE 03/25/18	1,859.25	1,859.25
04/19/2018	96489	00545 BERT MICHALCZYK	MICHALCZYK COBRA REIMB - DENTAL SEPT. -	119.22	119.22
04/19/2018	96490	01650 MICROSOFT	QTY (5) COMPLETE SURFACE PRO SYSTEMS	10,874.84	10,874.84
04/19/2018	96491	04796 NAPA AUTO PARTS	505E PARTS	36.88	
			505E AIR FILTER	36.65	
			AIR BLOW GUN FOR FLEET	18.20	91.73
04/19/2018	96492	08545 GABRIELA NASSAR	REFUND FOR 11849 DUBLIN GREEN DR	87.90	87.90
04/19/2018	96493	00589 NCL OF WISCONSIN, INC.	LAB SUPPLIES AND CHEMICALS	170.16	170.16
04/19/2018	96494	00620 P G & E	MISC PUMP STNS; DUB LIFT STN; COMM CIR E	16,063.83	
			FSL AERATORS; LAB HVAC; FLEET - MAR 2018	1,903.42	
			LAVWMA PIPELINE & LIVERMORE LINE - APR 2	817.64	18,784.89
04/19/2018	96495	04211 PLATT ELECTRIC SUPPLY	DPG ATC-600 UPGRADE TO ATC-900 INCLUDING	9,924.25	
			NEW POWERXPERT GATEWAY INCLUDING LABOR T	8,533.50	18,457.75
04/19/2018	96496	04105 R & B COMPANY	CLOW HYDRANTS	20,429.75	20,429.75
04/19/2018	96497	08339 SAN FRANCISCO ELEVATOR INC	EALS ELEVATOR REPAIR WORK 3/12/18	624.00	
			EALS ELEVATOR SERVICE CALL 03132018	624.00	
			ELEVATOR MAINTENANCE APRIL	475.00	1,723.00

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04/19/2018	96498	08550 LAM SHIAU	REFUND FOR 1170 ARROWFIELD WAY	127.72	127.72
04/19/2018	96499	08546 YU SHITAO	REFUND FOR 5386 CAMPUS DR	48.13	48.13
04/19/2018	96500	08551 RAVINDER SINGH	REFUND FOR 1909 LAMBETH WAY	54.68	54.68
04/19/2018	96501	00800 STATE BOARD OF EQUALIZATIOI	2018 1ST QRT USE TAX RETURN (3Q FY 2018)	776.00	776.00
04/19/2018	96502	00804 STATE WATER RESOURCES CON	F. KELLY: WWTP OP CERT RENEWAL	150.00	
			S. KOZANDA WWTP OP CERT RENEWAL (DUAL)	110.00	
			J. CHALK SWRCB G3 CERTIFICATION RENEWAL	90.00	350.00
04/19/2018	96503	08547 KRISHNAMURTI SUBRAMANIAN	REFUND FOR 4644 CENTRAL PKY	11.27	11.27
04/19/2018	96504	06948 TECHNICAL SAFETY SERVICES,	ANNUAL LAB FUME HOOD TESTING & CERTIFICA	979.00	979.00
04/19/2018	96505	08543 THE RANCH AT LITTLE HILLS	EMPLOYEE RECOGNITION EVENT 2018 1ST PAYM	4,199.00	4,199.00
04/19/2018	96506	05417 TNT ENTERPRISES	TRAFFIC & FLAGER TRAINING CLASS	1,000.00	1,000.00
04/19/2018	96507	07568 TOLL BROTHERS	REFUND FOR METER #63832495	456.72	456.72
04/19/2018	96508	02017 TOLL BROTHERS, INC	REFUND FOR METER #65492100	164.05	
			REFUND FOR 6136 ALPINE BLUE DR	23.70	
			REFUND FOR 5125 ROWAN DR	10.38	198.13
04/19/2018	96509	08549 CATHERINE TRINH	REFUND FOR 2292 MAGNOLIA BRIDGE DR	56.52	56.52
04/19/2018	96510	01552 TRI-VALLEY PROMOTIONAL PRO	MOOD PENCILS	1,418.68	1,418.68
04/19/2018	96511	07880 TRUMARK HOMES	REFUND FOR 7993 REGIONAL CMN	39.78	39.78
04/19/2018	96512	01806 U.S. BANK	COPIER LEASE LAB/CUST SVC/ EXEC - 4/1/18	947.20	947.20
04/19/2018	96513	00912 VALLEY CARE HEALTH SYSTEM	J. BAGAKIS: DOT MEDICAL EXAM	85.00	
			R. FREITAS: DOT MEDICAL EXAM	85.00	
			R. ROBLES: DOT MEDICAL EXAM	85.00	255.00
04/19/2018	96514	00920 VASCO ROAD LANDFILL	GRIT/SEWER BAG SCREEN MAR' 18	1,055.58	1,055.58

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04/19/2018	96515	00924 VERIZON WIRELESS	CELL PHN SVC AND EQUPTMNT CHARGES 3/4/1	5,130.58	5,130.58
04/19/2018	96516	00928 VINCENT ELEC MOTOR CO., INC	LAVWMA: REPLT FILTERS AND HEATERS FOR 60	2,256.64	
			VIBRATION ANALYSIS & BUMP TEST FOR PS R2	945.50	
			REPLT MOTOR FOR REO PRESSURIZATION @ ORT	451.42	3,653.56
04/19/2018	96517	04489 WATER ENVIRONMENT FEDERA	J. CARSON WEF MEMBERSHIP RENEWAL	310.00	310.00
04/19/2018	96518	08423 WATERTALENT LLC	J. BALLOU: WE 03/25/18	6,264.00	6,264.00
04/19/2018	96519	05785 WAUKESHA-PEARCE INDUSTRIE	(6QTY) GASKET FOR CO-GEN SPARE	473.25	473.25
04/19/2018	96520	00957 WEST YOST & ASSOCIATES	PFPA134 AT DUBLIN WTR/SWR CAP EVAL PROF	39,009.50	
			16-S001 COLLECT SYS MASTER PLAN PROF SVC	27,214.48	
			16-R014 DERWA SRF PROF SVCS THROUGH 03/0	2,054.00	
			PFPA134 AT DUBLIN WSA SVCS THROUGH MARCH	840.00	69,117.98
04/19/2018	96521	08528 DONGLING YAO	6012 KINGSMILL TER	36.45	36.45
04/19/2018	96522	08525 WEN ZHOU	REFUND FOR 1659 N TERRACINA DR	36.45	36.45
04/19/2018	96524	04074 MAURICE ATENDIDO	ATENDIDO REIMB EXP AT ROCKWELL ATUOMATIO	119.90	
			ATENDIDO REIMB EXP AT SEL UNIVERSITY APP	86.30	206.20
04/19/2018	96525	01013 BARRETT BUSINESS SERVICES	S. MONTAGUE: W/E 3/25/18	780.00	780.00
04/19/2018	96526	01013 BARRETT BUSINESS SERVICES	N. POON: WE 03/25/18	437.76	437.76
04/19/2018	96527	00085 RHODORA BIAGTAN	BIAGTAN REIMB EXP AT WATEREUSE CONF. 03/	735.00	735.00
04/19/2018	96528	04691 INC. EQUIFAX INFORMATION SV	EQUIFAX	449.94	449.94
04/19/2018	96529	07205 GLENMOUNT GLOBAL SOLUTIOI	09-6101 RELEASE RETENTION	202,015.80	202,015.80
04/19/2018	96530	00937 GRAINGER, INC.	TABLE SAW FOR FACILITIES SHOP	746.76	
			(4QTY) SINK DRAIN FOR LAB SINK	354.14	
			(10QTY) NEW RELAYS FOR FSL BUCKETS FOR N	142.46	
			CEILING TILES FOR FACILITIES SHOP	142.26	

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			LABEL TAPE CARTDRIDGES	97.45	
			LAVWMA: HOOK FOR CHAIN FALL @ LAVWMA SHO	23.43	1,506.50
04/19/2018	96531	03976 JMB CONSTRUCTION, INC	16-A002 PP #6 - MARCH 2018	44,585.87	44,585.87
04/19/2018	96532	05026 UNIVAR USA INC.	WWTP SOD HYPO 4800.00 GL 3-23-18	2,469.93	2,469.93
04/23/2018	4232018	03718 HR SIMPLIFIED	IRS 125 2017 & 2018 DCA/FSA/POS	2,607.46	2,607.46
04/26/2018	96533	00710 AAI TERMITE & PEST CONTROL I	LAVWMA PEST CONTROL FOR MARCH 18	74.00	74.00
04/26/2018	96534	00031 ALLIED FLUID PRODUCTS CORP	SEALS & BUSHINGS FOR INFLUENT PUMPS	18,413.11	18,413.11
04/26/2018	96535	01013 BARRETT BUSINESS SERVICES	N. POON: WE 04/01/18	437.76	437.76
04/26/2018	96536	01013 BARRETT BUSINESS SERVICES	S. MONTAGUE: W/E 4/01/18	253.50	253.50
04/26/2018	96537	03614 CAROLLO ENGINEERS INC.	16-A002 TO NO. OC-10 3/1/18 TO 3/31/18	13,345.49	
			07-3203 TO NO. 2 3/1/18 TO 3/31/18	11,022.50	
			16-R014 TO NO. OC-12 3/1/18 TO 3/31/18	5,948.75	
			16-S034 TO NO. OC-2 3/1/18 TO 3/31/18	1,008.00	31,324.74
04/26/2018	96538	01623 EAST BAY DISCHARGERS AUTH(	O&M ASSESSMENT - APRIL 1, 2018 QTR	174,076.72	174,076.72
04/26/2018	96539	00299 ENVIRONMENTAL RESOURCE AS	2018 PT SAMPLES, QC STDS	4,298.87	4,298.87
04/26/2018	96540	04424 GRAYBAR ELECTRIC COMPANY	ELE MATLS/PARTS FOR FSL ACTUATOR UPGRADE	1,332.01	
			ELE MATLS FOR BLDG Q CAMERA INSTALL PROJ	580.35	
			JBOXES FOR CAMERAS ON BLDG Q	34.18	1,946.54
04/26/2018	96541	00439 IUOE LOCAL 39	LOCAL 39 UNION DUES: PAYMENT	5,111.09	5,111.09
04/26/2018	96542	04973 NATERCIA SAUCEDA	CASE ID FL364781: PAYMENT	111.23	111.23
04/26/2018	96543	00843 THE COVELLO GROUP INC	16-R014 TO NO. 1 3/1/18 - 3/31/18	81,307.95	
			07-3203 TO NO. OC-9 3/1/18 - 3/31/18	44,643.86	
			16-S021 TO NO. OC-8 CONSTRUCTION MANAGEM	3,549.00	
			18-P012 AND 17-P004 TO OC-11 PROJECT AND	2,190.00	
			16-P028 AND 18-P010 TO OC-10 3/1/18 - 3/	1,072.50	132,763.31

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04/26/2018	96544	03733 SARA TOM	TOM REIMB - RETIREMENT CARDS	21.37	21.37
04/26/2018	96545	05026 UNIVAR USA INC.	WWTP SOD HYPO 5000. GL 4-6-18	2,572.84	
			WWTP 3-31-18 SODIUM HYPO 4799.00 GL	2,469.41	
			RESERVOIR 1A MINI BULK DELIVERY 110.00 G	373.43	5,415.68
04/26/2018	96546	01719 A & M PRINTING, INC.	BUSINESS CARDS - JOYCE CHANG & JOSHUA SA	87.40	
			BUSINESS CARDS - DAN MARTIN	38.24	125.64
04/26/2018	96547	00019 A-1 ENTERPRISES	LAVWMA MAR' 18 STREET SWEEPING	220.00	220.00
04/26/2018	96548	02120 ALAMEDA COUNTY CLERK	18-W019 NOTICE OF EXEMPTION	50.00	50.00
04/26/2018	96549	06552 BILLING SOLUTIONS INC. AMERI	AQUAHAWK CUSTOMER PORTAL 5/1/18 - 6/1/18	2,421.00	2,421.00
04/26/2018	96550	00622 AT&T	LAVWMA AT&T 925-463-1337 APR' 18	388.32	388.32
04/26/2018	96551	00622 AT&T	C3 - TELE SVCS 3/13/18 - 4/12/18	363.16	
			C3 - CC DO T1 X 2 THRU 3/13/18 - 4/12/1	330.26	
			C3 - T1 WWTP TO PS300 DV THRU 3/13/18 -	242.48	935.90
04/26/2018	96552	03813 AT&T CONFERENCING	16-A002 TELECONFERENCE SVCS MARCH 2018	45.02	45.02
04/26/2018	96553	08519 BATTERY SYSTEMS OF SAN JOS	BATTERIES FOR CART 326	1,489.40	1,489.40
04/26/2018	96554	00079 BAY AREA AIR QUALITY MGMT.	PERMIT TO OPERATE - PLANT #15890 6/1/18-	687.00	687.00
04/26/2018	96555	04042 BAY AREA NEWS GROUP	BAY AREA NEWS GROUP - 2018 CHEMICAL BIDS	1,448.10	1,448.10
04/26/2018	96556	01085 CALPERS LONG-TERM CARE PR	LONG-TERM CARE: PAYMENT	68.12	68.12
04/26/2018	96557	08447 CHEMTRADE CHEMICALS US LL	DERWA ACTIFLOW ALUMINUM SULFATE	3,263.49	3,263.49
04/26/2018	96558	05534 CSAC EXCESS INS. AUTHORITY	EE ASSISTANCE: APRIL - JUNE 2018 CHARGES	1,028.10	1,028.10
04/26/2018	96559	00222 DATCO SERVICES CORP.	APR/MAY/JUN 2018 - MONTHLY CHARGES	546.00	546.00
04/26/2018	96560	08536 DEL CONTE'S LANDSCAPING, IN	APR 2018: MONTHLY LANDSCAPE MAINTENANCE	75.00	75.00
04/26/2018	96561	00241 DGS OFS SVC REVOLVING FUNI	NATURAL GAS SERVICE @ WWTP - 03/18	29,727.74	29,727.74

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04/26/2018	96562	02656 FASTENAL COMPANY	FASTENERS FOR BAR SCREEN	42.71	42.71
04/26/2018	96563	00314 FEDEX	FEDEX DELIVERY SERVICES FOR OPS 3/30 & 4	55.09	55.09
04/26/2018	96564	08514 FIBERGRATE COMPOSITE	LADDER FOR FLOWMETER VAULT @ TURNOUT 1	898.34	898.34
04/26/2018	96565	02914 STATE OF CALIFORNIA FRANCHI	FRANCHISE TAX BOARD: PAYMENT	150.00	150.00
04/26/2018	96566	00352 GOLDEN STATE FLOW MEASURE	120 1" SENSUS METERS	23,712.06	23,712.06
04/26/2018	96567	03149 HDS WHITE CAP CONST SUPPLY	WWTP GRIT LINES: FABRIC ROLL FILTER	602.83	602.83
04/26/2018	96568	00394 HILTI, INC.	SHOP TOOLS: CORDLESS ROTARY HAMMER & HAM	844.93	844.93
04/26/2018	96569	06732 HIRERIGHT, INC.	EMPLOYMENT BACKGROUND SCREENING SERVICES	157.36	157.36
04/26/2018	96570	07652 HUNT & SONS, INC.	DIESEL 1449 & GAS 497	6,116.42	6,116.42
04/26/2018	96571	07017 HYDROSCIENCE ENGINEERS, IN	CLEAN WATER PROGRAM ASSISTANCE THROUGH 3	640.00	640.00
04/26/2018	96572	07848 LLP JARVIS, FAY, DOPORTO & GI	GENERAL COUNSEL SVCS - MARCH 2018	1,372.50	1,372.50
04/26/2018	96573	01225 KAESER COMPRESSORS, INC	DERWA: REPLT FUSES FOR REFRIGERATED DRYE	451.66	
			OIL SEPARATOR CARTRIDGE & AIR FILTER CAR	405.49	857.15
04/26/2018	96574	08020 KELLEHER, HELMRICH AND ASS	SDS MANAGEMENT 4/1/2018 - 3/31/2019	1,800.00	1,800.00
04/26/2018	96575	07193 LAI & ASSOCIATES	FIELD DENSITY TESTING 11681 SOLANA DR.,	968.64	
			FIELD DENSITY TESTING 3/10/18 11506 BLOO	768.21	1,736.85
04/26/2018	96576	00509 LIEBERT CASSIDY WHITMORE	GENERAL LEGAL FEES (03/18)	561.00	561.00
04/26/2018	96577	07614 MAHLER CONSULTING SERVICE	DEVELOPMENT INSPECTION SUPPORT 3/16 - 3/	12,045.00	12,045.00
04/26/2018	96578	07264 MANPOWERGROUP US INC.	M. ZAKLAN: WE 04/01/18	498.94	498.94
04/26/2018	96579	05897 MERIT RESOURCE GROUP	A. MCCAFFERY: WE 04/01/18	1,381.88	1,381.88
04/26/2018	96580	04231 MSC INDUSTRIAL SUPPLY CO	PPE: HARD HATS	268.17	
			SHOP SUPPLIES	112.05	380.22
04/26/2018	96581	04796 NAPA AUTO PARTS	FILTERS FOR SLUDGE/SCUM DRIVE UNITS; BEL	62.61	62.61

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04/26/2018	96582	02109 ONE HOUR DELIVERY SERVICE,	09-6101 RECORD NOTICE OF COMPLETION	116.64	
			ONE HOUR DELIVERY - BOARD PACKETS 3/30/1	43.00	159.64
04/26/2018	96583	00620 P G & E	LAVWMA PS FEEDER A - APR 2018	84,950.06	
			LAVWMA PS FEEDER B - APR 2018	50,138.12	
			MISC PUMP STNS, RESERVOIRS, TO'S ELEC -	32,253.50	
			RESERVOIR 3A ELECTRICITY - 2018	44.92	167,386.60
04/26/2018	96584	04211 PLATT ELECTRIC SUPPLY	REPLT LAMPS FOR PS3A	148.58	148.58
04/26/2018	96585	01195 POWERSTRIDE BATTERY CO., IN	BATTERIES FOR D7	340.28	340.28
04/26/2018	96586	05543 ADMINISTRATORS (PBIA) PREFE	APRIL 2018 - DENTAL	23,505.50	23,505.50
04/26/2018	96587	05475 PRESIDIO SYSTEMS, INC.	CCTV WORK FOR DEVELOPMENT PROJECTS - TAS	2,030.40	
			CCTV WORK FOR DEVELOPMENT PROJECTS - BOU	1,781.20	3,811.60
04/26/2018	96588	04698 SAMPLE TRAPS, LLC	LAB SUPPLIES	165.19	165.19
04/26/2018	96589	00754 SCP SCIENCE	DIGITUBES, SCREW CAPS	270.78	270.78
04/26/2018	96590	06861 SIGNA MECHANICAL	LIFT STN 2: PUMP IMPELLER, GRINDER CUTTE	4,136.18	4,136.18
04/26/2018	96591	06650 TOKAY SOFTWARE	TOKAY WEB TEST ENTRIES MARCH 2018	414.00	414.00
04/26/2018	96592	01806 U.S. BANK	COPIER LEASE LAB/CUST SVC/ EXEC - MAY 20	444.04	444.04
04/26/2018	96593	01222 UNITED STATES TREASURY	GARNISHMENT - IRS: PAYMENT	420.50	420.50
04/26/2018	96594	00556 UNITED WAY OF THE BAY AREA	UNITED WAY: PAYMENT	207.40	207.40
04/26/2018	96595	07140 USA FLEET SOLUTIONS	APR 2018: FLEET GPS TRACKING SYSTEM	1,638.35	1,638.35
04/26/2018	96596	07290 V. W. HOUSEN & ASSOCIATES, IN	15-W017 TO OC-3 ESDC 2/1/18-2/28/18	607.50	607.50
04/26/2018	96597	06004 VANGUARD CLEANING SYSTEMS	APR 2018: WWTP - JANITORIAL SERVICES	3,045.00	
			APR 2018: DO - JANITORIAL SERVICES	2,675.00	
			APR 2018: FOD - JANITORIAL SERVICES	1,895.00	
			LAVWMA: APR 2018 JANITORIAL SERVICES	275.00	7,890.00

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04/26/2018	96598	00928 VINCENT ELEC MOTOR CO., INC	REDESIGN SHAFT & RECONDITION CHLOROVAC P	3,483.77	3,483.77
04/26/2018	96599	00933 VWR INTERNATIONAL, INC.	BEAKER, CULTURE TUBES, CAP,	1,080.50	
			PAO, COND STD, EDTA, BEAKER	179.22	
			E. AEROGENES	126.82	
			STERIKON BIOINDICATOR CHECK	106.45	
			PIPET SEROLOGICAL	41.82	1,534.81
04/26/2018	96600	00943 WATER EDUCATION FOUNDATIO	5TH GRADE RECYCLED WATER BOOKLETS	2,635.63	2,635.63
04/26/2018	96601	08423 WATERTALENT LLC	J. BALLOU: WE 04/01/18	6,264.00	6,264.00
04/26/2018	96602	00957 WEST YOST & ASSOCIATES	SSMP UPDATE PROF SVCS FROM JAN 6 - FEB 9	5,204.79	5,204.79
04/30/2018	8112	05511 CALIFORNIA STATE	CHILD SUPPORT GARNISHMENT: PAYMENT	690.46	690.46
04/30/2018	4302018	01098 NATIONWIDE RETIREMENT SOLI	NATIONAL DEFERRED COMPENSATION: PAYMENT	51,087.57	51,087.57
04/30/2018	43020180	03718 HR SIMPLIFIED	IRS 125 2017 & 2018 POS	1,110.41	1,110.41
04/30/2018	43937983	00558 IRS - PAYROLL TAXES	FEDERAL WITHHOLDING TAXES: PAYMENT	143,079.00	143,079.00
04/30/2018	1001061934	00494 PERS	RETIREMENT: PAYMENT	99,406.73	99,406.73
04/30/2018	1525131840	00559 EDD - PAYROLL	CALIFORNIA STATE TAXES: PAYMENT	28,593.63	28,593.63
05/01/2018	5012018	01098 NATIONWIDE RETIREMENT SOLI	NATIONAL DEFERRED COMPENSATION: PAYMENT	40.00	40.00
05/01/2018	82351199	00558 IRS - PAYROLL TAXES	FEDERAL WITHHOLDING TAXES: PAYMENT	411.47	411.47
05/01/2018	1813310016	00559 EDD - PAYROLL	CALIFORNIA STATE TAXES: PAYMENT	40.00	40.00
05/03/2018	96603	03460 ACCO ENGINEERED SYSTEMS I	FOF AIR HANDLER #2 SERVICE CALL (SC #188	815.50	815.50
05/03/2018	96604	07832 CAROL ATWOOD	ATWOOD REIMB EXP FOR W/E 04/24/2018	58.26	58.26
05/03/2018	96605	01013 BARRETT BUSINESS SERVICES	N. POON: WE 04/08/18	264.96	264.96
05/03/2018	96606	00085 RHODORA BIAGTAN	BIAGTAN REIMB EXP FOR DISTRICT VEHICLE	50.00	50.00
05/03/2018	96607	03614 CAROLLO ENGINEERS INC.	16-R014 TO NO. 1 ESDC 3/1/18 TO 3/31/18	17,058.50	

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			TO NO. OC-13 FOR PROF SERVICES 03/01/18	7,183.50	24,242.00
05/03/2018	96608	00216 DAIOHS U.S.A. INC.	FY 2018 HOT BEVERAGE SERVICE DO- MAY 201	307.21	307.21
05/03/2018	96609	00299 ENVIRONMENTAL RESOURCE AS	PT SAMPLES, QC FOR UV254, CN, VOLATILES	399.71	399.71
05/03/2018	96610	00937 GRAINGER, INC.	DERWA: WIRE FOR UVI SENSORS	316.70	
			CONCRETE REPAIR FOR DO SIDEWALK	139.23	455.93
05/03/2018	96611	04424 GRAYBAR ELECTRIC COMPANY	ELE SHOP PARTS/MATERIALS FOR STOCK	1,083.76	
			ELE SHOP PARTS/MATERIALS FOR STOCK	496.06	
			(10QTY) LIGHT FIXTURE BALLAST FOR STOCK	113.33	
			PRESSURE SWITCH FOR ORT TOWER ODORANT PU	40.41	
			PRESSURE SWITCH FOR ORT TOWER ODORANT PU	40.04	
			RETURN: PRESSURE SWITCH FOR ORT TOWER OD	-40.41	1,733.19
05/03/2018	96612	01242 INFO SEND, INC	UB BILLING PRINTING/MAILING SERVICES MAR	5,198.59	
			UB BILLING PRINTING/MAILING SERVICES MAR	301.78	5,500.37
05/03/2018	96613	00478 FLORENCE KHAW	KHAW REIMB EXP AT 2018 CWEA ANNUAL CONFE	300.70	300.70
05/03/2018	96614	04722 STEPHAN KOZANDA	KOZANDA CERT REIMB FOR WATER DISTRIBUTIO	60.00	60.00
05/03/2018	96615	02470 SHRED-IT USA LLC	SHREDDING SERVICE - APRIL 2018 INVOICE	212.94	212.94
05/03/2018	96616	05905 CAMNGA THACH-DALLABETTA	THACH REIMB MILEAGE FOR W/E 03/08/2018	96.90	96.90
05/03/2018	96617	05490 JESSIE VALDEZ	VALDEZ EDEN USER CONF BOSTON 04/22 - 04/	1,297.79	1,297.79
05/03/2018	96618	05127 VISION SERVICE PLAN - CA (VSF	MAY 2018 - VISION	2,934.30	2,934.30
05/03/2018	96619	03831 JACLYN YEE	YEE REIMB EXP FOR DISTRICT VEHICLE	59.28	59.28
05/03/2018	96620	01738 3T EQUIPMENT COMPANY INC.	SEWER PARTS	529.81	
			MISC PARTS - FOD	529.81	1,059.62
05/03/2018	96621	01719 A & M PRINTING, INC.	BUSINESS CARDS: KEN PETERSON	49.16	
			GEMMA LATHI'S BUSINESS CARDS	49.16	98.32

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05/03/2018	96622	07554 AIRGAS USA, LLC	MAR 2018: CYLINDER RENTAL - ACETYLENE, A	84.44	84.44
05/03/2018	96623	02120 ALAMEDA COUNTY CLERK	16-S034 NOTICE OF EXEMPTION ALAMEDA	50.00	50.00
05/03/2018	96624	00058 ARROWHEAD MOUNTAIN SPRIN	BOTTLED WATER FOD 3/17/18 THRU 4/16/18	30.55	30.55
05/03/2018	96625	01697 B & C TRUCK PARTS, INC	WIRING FOR #521E GROVE LIGHTING	13.46	13.46
05/03/2018	96626	08428 CAL ENGINEERING & GEOLOGY,	17-A006 TO NO. OC-1 PROGRESS BILLING THR	6,491.75	6,491.75
05/03/2018	96627	07138 CALIFORNIA WATER TECHNOLO	FERROUS CHLORIDE 4-7-18	3,913.75	3,913.75
05/03/2018	96628	02639 CITY OF SAN RAMON	ENCROACHMENT PERMIT VARIOUS LOCATIONS -	120.00	120.00
05/03/2018	96629	01140 CONTRA COSTA COUNTY COUN	16-S034 SEWER COLLECTION SYSTEM	50.00	50.00
05/03/2018	96630	08536 DEL CONTE'S LANDSCAPING, IN	APR 2018: MONTHLY LANDSCAPE MAINTENANCE	3,860.00	3,860.00
05/03/2018	96631	02656 FASTENAL COMPANY	PPE: BLDG S VENDING MACHINE RESTOCK	83.89	83.89
05/03/2018	96632	00314 FEDEX	MISC SHIPMENTS FOR OPS	26.10	26.10
05/03/2018	96633	00424 INDUSTRIAL SAFETY SUPPLY	SPILL KITS FOR TURNOUTS	360.21	
			PPE: CUT RESISTANT GLOVES FOR FOD STAFF	117.99	478.20
05/03/2018	96634	07481 J.N. ABBOTT DISTRIBUTOR, INC.	CO-GEN OIL: (450QTY) D-A BLUE FLAME HB5	4,803.18	4,803.18
05/03/2018	96635	01225 KAESER COMPRESSORS, INC	DERWA: COMPRESSED AIR TEMP TOO LOW IN BL	512.34	512.34
05/03/2018	96636	00468 KAMAN INDUSTRIAL TECHNOLO	BELTS FOR PLANT STOCK	116.92	116.92
05/03/2018	96637	07264 MANPOWERGROUP US INC.	M. ZAKLAN: WE 04/08/18	498.94	498.94
05/03/2018	96638	05897 MERIT RESOURCE GROUP	A. MCCAFFERY: WE 04/08/18	1,340.00	1,340.00
05/03/2018	96639	04231 MSC INDUSTRIAL SUPPLY CO	CUSHIONED LOOP CLAMPS FOR GROVE CRANE RE	20.21	20.21
05/03/2018	96640	04796 NAPA AUTO PARTS	BOLT FOR CART #326	14.71	14.71
05/03/2018	96641	00620 P G & E	PUMP STATION R200A ELEC - APRIL 2018	1,252.62	
			RESERVOIR R200 DERWA TANK 2 ELEC - APR 2	36.68	1,289.30
05/03/2018	96642	00649 PERKIN ELMER HEALTH SCIENC	QUARTZ PIPE	632.99	632.99

Check History Description Listing

Printed on: 05/03/2018 12:55PM

Dublin San Ramon Services District

From: 4/6/2018 To: 5/6/2018

Bank code: apbank

Date	Check #	Vendor	Description	Amount Paid	Check Total
05/03/2018	96643	04951 PLEASANTON TRUCKING	DERWA: CRANE RENTAL FOR PS R200B PUMP &	1,700.00	1,700.00
05/03/2018	96644	05543 ADMINISTRATORS (PBIA) PREFE	MAY 2018 - DENTAL	23,235.70	23,235.70
05/03/2018	96645	05475 PRESIDIO SYSTEMS, INC.	CCTV WORK FOR DEVELOPMENT PROJECT - LUCK	500.00	500.00
05/03/2018	96646	06345 RON DUPRATT FORD	SEAT BELT FOR VEHICLE #60	849.25	849.25
05/03/2018	96647	08117 SOLVAY FLUORIDES, LLC	HYDROFLUOSILICIC ACID AT $2.72 PER	8,652.16	8,652.16
05/03/2018	96648	00804 STATE WATER RESOURCES CON	J. HOLGUIN WWTP OP CERT GRADE III RENEWA	150.00	150.00
05/03/2018	96649	08538 TMI CONSULTING INC.	ERGONOMIC EVALUATION - J. RODRIGUEZ	450.00	450.00
05/03/2018	96650	00903 UNITED RENTALS, INC.	SCISSOR LIFT RENTAL FOR LIGHTS & SECURIT	781.68	781.68
05/03/2018	96651	04112 CONSULTING VINNEDGE ENVIRO	16-R018 TO OC-6 3/1/18 TO 4/1/18	600.00	
			18-W019 TO OC-7 3/1/18 TO 4/1/18	600.00	1,200.00
05/03/2018	96652	00933 VWR INTERNATIONAL, INC.	POLYSEED	344.47	344.47
05/03/2018	96653	08423 WATERTALENT LLC	J. BALLOU: WE 04/08/18	6,264.00	6,264.00
05/03/2018	1001067439	01111 CALPERS	CALPERS PENALTY NOTICE	200.00	200.00
309 checks in this report				Total Checks:	7,685,178.08

Karen Vaden 05/03/18

UNEXPECTED ASSET REPLACEMENT REQUEST

Unexpected Asset Replacement: The budget contains funding for capital outlay items that are expected to be replaced due to age or obsolescence. Occasionally, items in the replacement program fail unexpectedly and need to be replaced. If this happens during a budget cycle, replacement funds may be used for the replacement of the item if the General Manager determines that it is advantageous to the District to replace rather than repair said item, and if the Finance Officer determines that the replacement program has sufficient funds for the item.

Instructions: This form must be completed PRIOR to the purchase of the item. Contact the Accountant to assist you with completing sections two through five. After completing sections one through eight, obtain your Department Manager's signature, then route to the Accountant. Once the Finance Officer and General Manager's approvals are obtained, the Accountant will forward you a copy of the approved form. You may then purchase your replacement item following the normal purchasing guidelines. If this is an URGENT or mission critical replacement, please note that on the form so we can expedite your request.

1. Item Description	WAS mixed liquor pump #1
2. Asset Number	30-334-4801-PMP-0
3. Original Cost	
4. Depreciation (funding) to date	
5. Funding Source	
6. Estimated Cost of New Item	16360.00 Total with tax approximately $18,000
7. Requestor's Name / Date	Russ Baker 04/20/2018
8. Reason for Replacement	Existing pump experienced internal failure causing extensive damage. Pump does not match newer units that have already been replaced with new style pump with chopper type impeller and glycol cooling therefore rebuilding existing pump does not make sense for equipment continuity. Recommend replacement with newer replacement.

Department Manager Approval / Date	4/20/18
Finance Officer Approval / Date	4/24/18
General Manager Approval / Date	Carol Atwood for Dan McIntyre 4/24/18

SHAPE INCORPORATED

QUOTATION

PLEASANTON

5115-A Johnson Drive
Pleasanton, CA 94588
Phone (925) 485-9720
Fax (925) 485-6085

STOCKTON

119-2 Val Dervin Parkway
Stockton, CA 95206
Phone (209) 234-5909
Fax (209) 234-5913

TO: **Dublin San Ramon Sanitation District**

BID DATE: **4/12/18**
QUOTE #: **097926**
JOB: **3152 Rebuild/Replacement**
LOCATION: **Dublin, CA**

ATTN: Russell Baker **PHONE: (925) 875-2348** **Email: baker@dsrsd.com**
FAX:

WE ARE PLEASED TO QUOTE SUBJECT TO CONDITIONS PRINTED ON THE BACK HEREOF, THESE CONDITIONS MAY BE CHANGED ONLY BY A WRITTEN STATEMENT SIGNED BY AN OFFICER OF SHAPE, INCORPORATED.

☐ F.O.B. DESTINATION
☐ F.F.A.

QTY	ITEM	UNIT PRICE	TOTAL
	Rebuild NP3152.091-5577 445-6, 20/230/3 FLS 35' SN: S0150055 Inspection found water intrusion into stator housing causing direct short to stator. Water intrusion due to seal failure. Bearing failure. Motor shaft has grooves. Needs impeller and insert replaced along with FLS.		
1	Parts needed: repair kit (includes seals, bearing and o-rings), compression springs, screws, washer, cable unit, rotor unit, FLS detector, impeller, insert ring and stator.		
1	Estimated Labor 9 hours @ $100.00/hr		
	Parts Total:		**$11,485.20**
	Labor, Haz Mat and Prep:		**$1,023.00**
	Rebuild Total:		**$12,508.20** Plus Tax
	Replacement Pump Option:		
1	NP3153.095 434-6, 20HP-230-3-60, FM Motor, 6" discharge, hard iron impeller & insert, close cooling system, FLS sensor, 50' power cable. *Lead time – 10 weeks.*		**$16,360.00** Plus Tax
	NOTES: **Accepted As Purchase Order** **1 Price includes freight.** **2. Price does not include taxes.** **3. Price does not include: installation, equipment unloading, guide bars, pipe, valves, conduit, anchor bolts, or any other items not listed.** **4. Estimated delivery of rebuild equipment: 3 weeks.**		

Authorized Signature/Printed Name **Date**

SHAPE INC.

Jessica Tabch jtabch@shapecal.com

Company Name **PO/Job#**

QUOTATION DOES NOT INCLUDE ANY SALES OR USE TAX PAYABLE UNDER ANY STATE OR FEDERAL STATURE. THIS QUOTATION PRICE IS FOR MATERIAL LISTED ABOVE. ANY ADDITIONS OR MODIFICATIONS THAT BECOME NECESSARY FOR APPROVED SUBMITTALS, UPON AWARDING OF THIS CONTRACT, MAY RESULT IN NECESSARY PRICE CHANGES.

NOTE: ITEMS NOT SPECIFIED ON THIS QUOTATION ARE NOT INCLUDED IN OUR PRICE AND ARE TO BE SUPPLIED BY OTHERS. PRICES ARE FOR IMMEDIATE ACCEPTANCE AND SUBJECT TO CHANGE WITHOUT NOTICE.
Rev. 08/03
SALE SUBJECT TO MANUFACTURERS STANDARD TERMS AND CONDITIONS.

Dublin San Ramon Services District
Summary & Recommendation

Item 7.D.
Meeting Date: May 15, 2018

TITLE: Adopt the January 2018 Tri-Valley Hazard Mitigation Plan

RECOMMENDATION:

Staff recommends the Board of Directors adopt, by Resolution, the *January 2018 Tri-Valley Hazard Mitigation Plan*.

SUMMARY:

The Federal Disaster Mitigation Act of 2000 (DMA) required local governments to develop hazard mitigation plans as a condition of federal grant assistance. Local Hazard Mitigation Plans must be updated every five years. The District's previous Local Hazard Mitigation Plan was developed with the Association of Bay Area Governments (ABAG) on a regional basis. However, the previous Local Hazard Mitigation Plan expired in 2015, and ABAG declined to develop a successor plan for Bay Area local governments.

The development of Local Hazard Mitigation Plans must follow a rigorous federal guideline, must use federal hazard databases (earthquake seismic activity, previous flood damage, etc.), must be approved by the California Office of Emergency Services (CalOES) and by the Federal Emergency Management Agency (FEMA), and must be approved by the governing body of the local government.

In March 2017, the Cities of Dublin, Livermore, and Pleasanton, and the Dublin San Ramon Service District embarked on a planning process to prepare for and lessen the impacts of specified natural hazards by creating the *January 2018 Tri-Valley Hazard Mitigation Plan (Plan)*. The partnership was formed to pool resources and create a uniform hazard mitigation strategy that can be consistently applied to the defined planning area and used to ensure eligibility for specified grant funding success. The result of the organizational effort will be a multi-jurisdictional, multi-hazard mitigation plan approved by FEMA and CalOES.

Mitigation is defined in this context as any sustained action taken to reduce or eliminate long-term risk to life and property from a future hazard event. Mitigation encourages long-term reduction of hazard vulnerability and can decrease the enormous cost of disasters to property owners and all levels of government. Mitigation can also protect critical community facilities, lessen exposure to liability, and minimize post-disaster community disruption.

Once the Plan is adopted by all jurisdictional partners and approved by FEMA, the partnership will collectively and individually become eligible to apply for hazard mitigation project funding from both the Pre-Disaster Mitigation Grant Program and the Hazard Mitigation Grant Program. The Plan is also considered a living document. As awareness of additional hazards develops and new strategies and projects are conceived to offset or prevent losses due to natural disasters, the document will be evaluated and revised on a continual five-year time frame.

The executive summary of the *January 2018 Tri-Valley Local Hazard Mitigation Plan* is included as Attachment 1. By adopting the Plan, the District commits to a mid-term evaluation of the Plan's effectiveness with the partners. The District's part of the Plan notes and incorporates certain ongoing District efforts such as emergency generators for the water system pump stations and the emergency response trailer kept at the Field Operations Facility as hazard mitigation actions. No capital spending is authorized by the Resolution.

Originating Department: Engineering Services	**Contact: S. Kolodzie**	**Legal Review: Not Required**
Cost: $0	**Funding Source: N/A**	
Attachments: ☐ None ☐ Staff Report ☒ Resolution ☐ Ordinance ☐ Task Order ☐ Proclamation ☐ Other (see list on right)	**Attachment 1 – Executive Summary, *Tri-Valley Local Hazard Mitigation Plan***	

LIVERMORE CALIFORNIA

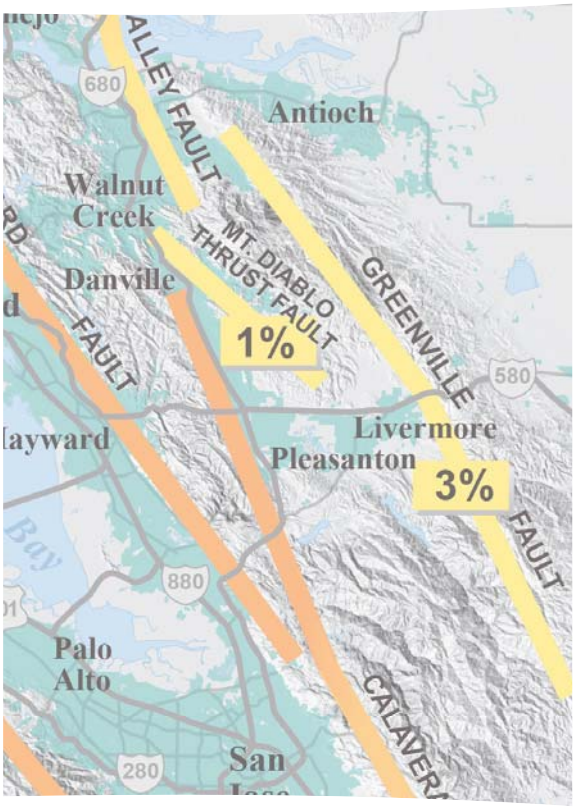
DUBLIN CALIFORNIA

THE CITY OF PLEASANTON

TRI-VALLEY LOCAL HAZARD MITIGATION PLAN

Volume 1—Planning Area-Wide Elements







Submittal Draft
January 2018

TETRA TECH

Tri-Valley Local Hazard Mitigation Plan

Volume 1—Planning-Area-Wide Elements

January 2018

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Tetra Tech Project #103S4859

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ACKNOWLEDGMENTS

Planning Team

- Hazel Wetherford, Assistant to the City Manager, City of Dublin
- Adam Weinstein, Planning Manager, City of Pleasanton
- Shweta Bonn, Senior Planner, Advanced Planning; City of Pleasanton
- Susan Frost, Special Projects Coordinator, City of Livermore
- Stanley Kolodzie, Associate Engineer, Dublin San Ramon Services District
- Brian Fritz, Maintenance and Operations Supervisor, Dublin Unified School District
- Chris Van Schaack, Deputy Superintendent, Livermore Valley Joint Unified School District

Consultants

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- Carol Bauman, GISP, Tetra Tech, Inc., Risk Assessment Lead
- Jessica Cerutti, CFM, Tetra Tech, Inc., Planner
- Tommie-Jean Valmassy, Tetra Tech, Inc., Planner
- Kari Valentine, CFM, Tetra Tech, Inc., Planner
- Stephen Veith, MUP, Tetra Tech, Inc., GIS/Hazus Analyst
- Dan Portman, Tetra Tech, Inc., Technical Editor

Stakeholders

- Colter Anderson, Production Manager, Zone 7 Water Agency
- Marla Blagg, Emergency Manager, Bay Area Rapid Transit
- Caryn Thornburg, SEMS Officer, Stanford Health Care – Valley Care
- Lincoln Cashmere, Emergency Manager, Alameda County Fire Department
- Tracy Hein, Disaster Preparedness Coordinator, Livermore Pleasanton Fire Department
- John Lawrence, Assistant General Manager, Livermore Area Recreation & Park District
- Scott Ratay, President/CEO, Pleasanton Chamber of Commerce
- John Richards, Emergency Management Expert, Lawrence Livermore National Laboratory
- Joe Testa, Deputy Chief, Livermore Pleasanton Fire Department
- Cary Fukada, Community Emergency Response Teams.

Special Acknowledgments

The development of this plan would not have been possible without the dedication and commitment to this process by the Hazard Mitigation Plan Steering Committee. The dedication of the volunteer members of this committee to allocate their time to this process is greatly appreciated. Also, local citizens are commended for their participation in planning outreach activities. The success of the outreach effort will set the course for the successful implementation of this plan.

EXECUTIVE SUMMARY

HAZARD MITIGATION OVERVIEW

Hazard mitigation is the use of policies, programs, projects, and other activities to alleviate the death, injury, and property damage that can result from a disaster. The Cities of Dublin, Livermore and Pleasanton, along with the Dublin San Ramon Services District (the Tri-Valley Planning Partnership), have collaborated to develop a hazard mitigation plan to reduce risks from natural disasters that complies with federal requirements for hazard mitigation planning.

In 2004, the Association of Bay Area Governments (ABAG) led a regional hazard mitigation planning effort for jurisdictions within its area of responsibility. Numerous Bay-area counties and cities used ABAG's template to meet federal hazard mitigation planning requirements. In 2010, ABAG conducted its second regional planning effort. The Tri-Valley planning partners used the 2010 updated ABAG tools to meet federal hazard mitigation planning requirements.

Federal regulations require periodic updates of hazard mitigation plans. A jurisdiction covered by a plan that has expired is ineligible for certain federal natural disaster assistance funding. In 2017, the Tri-Valley Planning Partnership formed to prepare an updated multi-jurisdiction hazard mitigation plan that best suits local needs and capabilities. The planning partners developed a new plan from scratch, using lessons learned from the earlier ABAG planning efforts. The 2017 plan is an update for each member of the Tri-Valley Planning Partnership. It differs from previous plans in the following ways:

- The updated plan is not a subset of a larger regional effort. It focuses on the geographic region of Dublin, Livermore, Pleasanton and the jurisdictional boundaries for the Dublin/San Ramon Services District (the Tri-Valley planning area).
- The focus of this plan is for the hazards of concern that impact the Tri-Valley planning area.
- Newly available data and tools provide for a more detailed and accurate risk assessment.
- The risk assessment has been formatted to provide information on risk and vulnerability that will allow a measurement of cost-effectiveness, as required under Federal Emergency Management Agency (FEMA) mitigation grant programs.
- The update gave the planning partners an opportunity to engage local citizens and gauge their perception of risk and support for risk reduction through mitigation.

PLAN DEVELOPMENT APPROACH

Organize, Review and Engage the Public

A planning team assembled for the plan update conducted outreach to invite the participation of local planning partners. A 20-member steering committee was assembled to oversee the plan update, consisting of staff from each of the planning partners, citizens, and other stakeholders in the defined planning area. Coordination with other county, state, and federal agencies involved in hazard mitigation occurred throughout the plan update process.

The planning team implemented a public involvement strategy developed by the Steering Committee. The strategy included public meetings to present the risk assessment and the draft plan, a hazard mitigation survey, a project website, and multiple media releases. The planning team and Steering Committee also reviewed the existing hazard mitigation plan, the California statewide hazard mitigation plan, and existing programs that may support hazard mitigation actions.

Assemble, Adopt and Maintain the Plan

The planning team and Steering Committee assembled a document to meet federal hazard mitigation planning requirements. A mitigation plan review crosswalk included in the hazard mitigation plan demonstrates its compliance with all requirements. The planning partners will formally adopt the plan once the State of California Governor's Office of Emergency Services and FEMA Region IX have granted pre-adoption approval.

The plan includes a schedule for monitoring and evaluating plan progress periodically and producing a revised plan every five years. This maintenance strategy also includes processes for continuing public involvement and integrating with other programs that can support or enhance hazard mitigation.

RISK ASSESSMENT

Risk assessment is the process of measuring the potential loss of life resulting from natural hazards, as well as personal injury, economic injury and property damage. It is used to define the vulnerability of people, buildings, and infrastructure to natural hazards. For this update, risk assessment models were enhanced with new data and technologies that have become available since the ABAG planning effort in 2010. The Steering Committee used the risk assessment to rank risk and to gauge the potential impacts of each hazard of concern in the Tri-Valley planning area. The risk assessment included the following:

- Hazard identification and profiling
- Assessment of the impact of hazards on physical, social, and economic assets
- Identification of particular areas of vulnerability
- Estimates of the cost of potential damage.

Based on the risk assessment, hazards were ranked for the risk they pose to the overall planning area, as shown in Table ES-1. Each planning partner also ranked hazards for its own area. Table ES-2 summarizes all jurisdictions' numerical ratings of high, medium and low. The results indicate the following general patterns:

- The earthquake hazard was most commonly ranked as high.
- The severe weather, wildfire and landslide hazards were most commonly ranked as medium.
- The dam failure, flood and drought hazards were most commonly ranked as low.

Table ES-1. Hazard Risk Ranking for the Overall Planning Area

Hazard Ranking	Hazard Event	Category
1	Earthquake	High
2	Severe Weather	High
3	Landslide	High
3	Wildfire	High
4	Flood	Medium
4	Dam Failure	Medium
5	Drought	Low

Table ES-2. Summary of Hazard Ranking Result by Individual Planning Partners

	Number of Jurisdictions Assigning Ranking to Hazard		
	High	Medium	Low
Dam Failure	0	1	3
Drought	0	1	3
Earthquake	4	0	0
Flood	0	1	3
Landslide	2	2	0
Severe weather	0	4	0
Wildfire	1	3	0

MITIGATION PRINCIPLE, GOALS AND OBJECTIVES

The Steering Committee developed the following guiding principle for the 2017 planning effort:

> Through community partnerships, establish a plan to reduce the vulnerability to hazards in order to protect the health, safety, welfare, environment and economy of the planning area.

The Steering Committee established the following goals for the plan update:

1. Ensure that hazards are identified and considered in land use decisions.
2. Improve local emergency management capability.
3. Promote community awareness, understanding, and interest in hazard mitigation policies and programs.
4. Incorporate hazard mitigation as an integrated public policy and standard practice.
5. Reduce community exposure and vulnerability to hazards where the greatest risk exists.
6. Increase resilience of infrastructure and critical facilities.
7. Promote an adaptive and resilient planning area that responds proactively to future conditions.
8. Develop and implement mitigation strategies that identify the best alternative to protect natural resources, promote equity, and use public funds in an efficient and cost-effective manner.

The objectives listed in Table ES-3 were identified to meet multiple goals, helping to establish priorities for recommended mitigation actions.

MITIGATION ACTION PLAN

The planning partnership selected a range of mitigation actions to work toward achieving the goals set forth in this plan update. The recommended mitigation actions are activities designed to reduce or eliminate losses resulting from natural hazards. The update process resulted in the identification of 73 mitigation actions for implementation by individual planning partners, as presented in Volume 2 of the hazard mitigation plan. In addition, the Steering Committee identified planning-area-wide actions benefiting the whole partnership, as listed in Table ES-4.

Table ES-3. Objectives for 2017 Hazard Mitigation Plan

Number	Objective	Applicable Goals
1	Develop and provide updated information to improve the understanding of the locations, potential impacts, and linkages among threats, hazards, vulnerability, and measures needed to protect life safety health, property and the environment.	3, 5, 7
2	Use local general plan, zoning, and subdivision requirements to help establish resilient and sustainable communities.	1, 3, 4, 5, 7, 8
3	Improve systems that provide warning and emergency communications.	2, 3
4	Encourage the retrofit of vulnerable structures in the planning area.	5, 6
5	Consider programs that incentivize risk reduction.	3, 4, 5
6	Reduce repetitive property losses due to all hazards by updating land use, design, and construction policies.	3, 4, 5, 6
7	Continually build linkages and promote dialog about emergency management within the public and private sectors.	2, 3, 4
8	Incorporate risk reduction considerations in new and updated infrastructure and development plans to reduce the impacts of natural hazards.	4, 5, 6
9	Inform the public, including underrepresented community groups, on the risk of exposure to natural hazards and ways to increase the public's capability to prepare for, respond to, recover from, and mitigate the impacts of these events.	3, 4, 5
10	Identify projects that simultaneously reduce risk while increasing planning area resilience and sustainability.	5, 6, 7
11	Where feasible and cost-effective, research, develop, and promote adoption of building and development laws, regulations, and ordinances exceeding the minimum levels needed for life safety.	1.4.8
12	Encourage hazard mitigation measures that promote and enhance natural processes, minimize adverse impacts on the ecosystem, and promote social equity.	3, 5, 8

Table ES-4. Planning-Area-Wide Hazard Mitigation Actions

Action Number and Description	Priority
Action AW-1— Continue to maintain a planning area-wide hazard mitigation website that will store the hazard mitigation plan and provide the public an opportunity to monitor plan implementation progress. Each planning partner can support this action by including an action in its own action plan of creating a link to the planning-area-wide hazard mitigation website.	High
Action AW-2— Leverage public outreach partnering capabilities in the planning area (such as Community Emergency Response Teams) to promote a uniform and consistent message on the importance of proactive hazard mitigation.	High
Action AW-3— Coordinate mitigation planning and project efforts in the planning area to leverage all resources available to the planning partnership.	High
Action AW-4— Where appropriate, support retrofitting, purchase, or relocation of structures in hazard-prone areas to protect the structures from future damage, with repetitive loss and severe repetitive loss properties as a priority. Seek opportunities to leverage partnerships in the planning area in these pursuits.	Medium
Action AW-5— Continue to update hazard mapping with best available data and science as it evolves, within the capabilities of the partnership. Support FEMA's RiskMAP initiative.	High
Action AW-6— To the extent possible based on available resources, provide coordination and technical assistance in applying for grant funding.	High
Action AW-7— Maintain a steering committee as a working body over time to monitor progress of the hazard mitigation plan, provide technical assistance to planning partners, manage data, and oversee the update of the plan according to schedule. This body will continue to operate under the ground rules established at its inception.	High
Action AW-8— All planning partners will collaborate and share information to support the development of debris management plans for the planning area. While each planning partner will be responsible for the development of their own plans, they will attempt to standardize the content and format based on a regional template.	High

IMPLEMENTATION

The Steering Committee developed a plan implementation and maintenance strategy that includes mid-term progress reporting, a strategy for continued public involvement, a commitment to plan integration with other relevant plans and programs, and a recommitment from the planning partners to actively maintain the plan over the five-year performance period.

Full implementation of the recommendations of this plan will require time and resources. The measure of the plan's success will be its ability to adapt to changing conditions. The Tri-Valley Planning Partnership will assume responsibility for adopting the recommendations of this plan and committing resources toward implementation. The framework established by this plan commits all planning partners to pursue actions when the benefits of a project exceed its costs. The planning partnership developed this plan with extensive public input, and public support of the actions identified in this plan will help ensure the plan's success.

RESOLUTION NO. _____

RESOLUTION OF THE BOARD OF DIRECTORS OF DUBLIN SAN RAMON SERVICES DISTRICT ADOPTING THE JANUARY 2018 TRI-VALLEY HAZARD MITIGATION PLAN

WHEREAS, the Tri-Valley Area, made up of the Cities of Dublin, Pleasanton, Livermore, and San Ramon, and the Dublin San Ramon Services District (DSRSD) Service Area, has exposure to natural hazards that increase the risk to life, property, environment and economy of Alameda County and Contra Costa County economy; and

WHEREAS, proactive mitigation of known hazards before a disaster event can reduce or eliminate long-term risk to life and property; and

WHEREAS, the Disaster Mitigation Act of 2000 (Public Law 106-390) established new requirements for pre- and post-disaster hazard mitigation programs; and

WHEREAS, a coalition of Tri-Valley Area cities consisting of the Cities of Dublin, Pleasanton, and Livermore, and DSRSD with common planning objectives has been formed to pool resources and create consistent mitigation strategies within the Tri-Valley Area; and

WHEREAS, the Cities of Dublin, Pleasanton, and Livermore, and DSRSD have completed a planning process that engages the public, assesses the risk and vulnerability to the impacts of natural hazards, develops a mitigation strategy consistent with a set of uniform goals and objectives, and creates a plan for implementing, evaluating and revising this strategy; and

WHEREAS, the Cities of Dublin, Pleasanton, and Livermore, and DSRSD, have completed the preparation of the *January 2018 Tri-Valley Hazard Mitigation Plan*, a local hazard mitigation plan, attached as Exhibit "A," *a copy of which is available for inspection in the District Office,* in conformance with Disaster Mitigation Act of 2000.

NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF DUBLIN SAN RAMON SERVICES DISTRICT, a public agency located in the Counties of Alameda and Contra Costa, California, as follows:

1. Dublin San Ramon Services District adopts the *January 2018 Tri-Valley Hazard Mitigation Plan*, referenced herein and incorporated as Exhibit "A."
2. Dublin San Ramon Services District shall use the approved *January 2018 Tri-Valley Hazard Mitigation Plan* to guide pre- and post-disaster mitigation of the hazards identified.
3. Dublin San Ramon Services District shall coordinate the strategies identified in the *January 2018 Tri-Valley Hazard Mitigation Plan* with other planning programs and mechanisms

under its jurisdictional authority.

4. Dublin San Ramon Services District shall assist to promote and support the mitigation successes of all *January 2018 Tri-Valley Hazard Mitigation Plan* partners, including the Cities of Dublin, Pleasanton, and Livermore.

ADOPTED by the Board of Directors of Dublin San Ramon Services District, a public agency in the State of California, Counties of Alameda and Contra Costa, at its regular meeting held on the 15th day of May, 2018, and passed by the following vote:

AYES:

NOES:

ABSENT:

_____
Georgean M. Vonheeder-Leopold, President

ATTEST: _____
Nicole Genzale, District Secretary

LIVERMORE CALIFORNIA

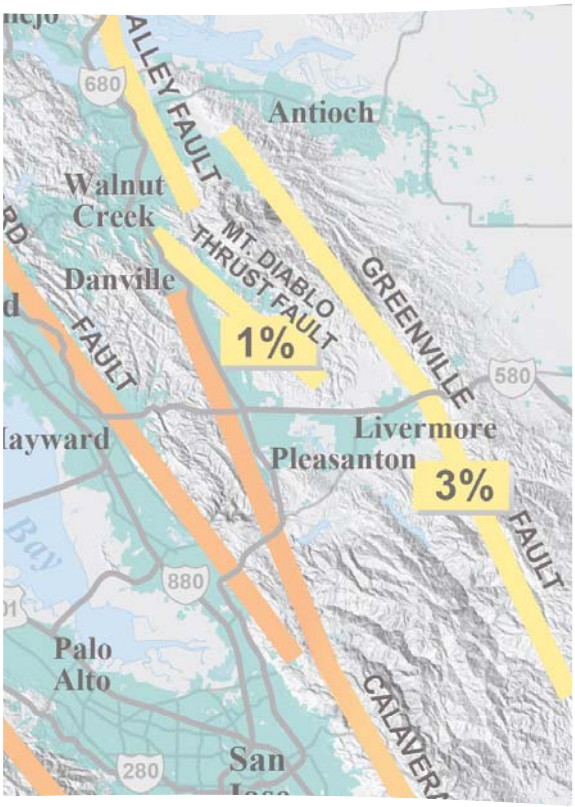
DUBLIN CALIFORNIA

THE CITY OF PLEASANTON

TRI-VALLEY LOCAL HAZARD MITIGATION PLAN

Volume 1—Planning Area-Wide Elements







Submittal Draft
January 2018

TETRA TECH

Tri-Valley Local Hazard Mitigation Plan

Volume 1—Planning-Area-Wide Elements

January 2018

PREPARED FOR

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Dublin, CA 94568

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Tetra Tech Project #103S4859

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- John Lawrence, Assistant General Manager, Livermore Area Recreation & Park District
- Scott Ratay, President/CEO, Pleasanton Chamber of Commerce
- John Richards, Emergency Management Expert, Lawrence Livermore National Laboratory
- Joe Testa, Deputy Chief, Livermore Pleasanton Fire Department
- Cary Fukada, Community Emergency Response Teams.

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EXECUTIVE SUMMARY

HAZARD MITIGATION OVERVIEW

Hazard mitigation is the use of policies, programs, projects, and other activities to alleviate the death, injury, and property damage that can result from a disaster. The Cities of Dublin, Livermore and Pleasanton, along with the Dublin San Ramon Services District (the Tri-Valley Planning Partnership), have collaborated to develop a hazard mitigation plan to reduce risks from natural disasters that complies with federal requirements for hazard mitigation planning.

In 2004, the Association of Bay Area Governments (ABAG) led a regional hazard mitigation planning effort for jurisdictions within its area of responsibility. Numerous Bay-area counties and cities used ABAG's template to meet federal hazard mitigation planning requirements. In 2010, ABAG conducted its second regional planning effort. The Tri-Valley planning partners used the 2010 updated ABAG tools to meet federal hazard mitigation planning requirements.

Federal regulations require periodic updates of hazard mitigation plans. A jurisdiction covered by a plan that has expired is ineligible for certain federal natural disaster assistance funding. In 2017, the Tri-Valley Planning Partnership formed to prepare an updated multi-jurisdiction hazard mitigation plan that best suits local needs and capabilities. The planning partners developed a new plan from scratch, using lessons learned from the earlier ABAG planning efforts. The 2017 plan is an update for each member of the Tri-Valley Planning Partnership. It differs from previous plans in the following ways:

- The updated plan is not a subset of a larger regional effort. It focuses on the geographic region of Dublin, Livermore, Pleasanton and the jurisdictional boundaries for the Dublin/San Ramon Services District (the Tri-Valley planning area).
- The focus of this plan is for the hazards of concern that impact the Tri-Valley planning area.
- Newly available data and tools provide for a more detailed and accurate risk assessment.
- The risk assessment has been formatted to provide information on risk and vulnerability that will allow a measurement of cost-effectiveness, as required under Federal Emergency Management Agency (FEMA) mitigation grant programs.
- The update gave the planning partners an opportunity to engage local citizens and gauge their perception of risk and support for risk reduction through mitigation.

PLAN DEVELOPMENT APPROACH

Organize, Review and Engage the Public

A planning team assembled for the plan update conducted outreach to invite the participation of local planning partners. A 20-member steering committee was assembled to oversee the plan update, consisting of staff from each of the planning partners, citizens, and other stakeholders in the defined planning area. Coordination with other county, state, and federal agencies involved in hazard mitigation occurred throughout the plan update process.

The planning team implemented a public involvement strategy developed by the Steering Committee. The strategy included public meetings to present the risk assessment and the draft plan, a hazard mitigation survey, a project website, and multiple media releases. The planning team and Steering Committee also reviewed the existing hazard mitigation plan, the California statewide hazard mitigation plan, and existing programs that may support hazard mitigation actions.

Assemble, Adopt and Maintain the Plan

The planning team and Steering Committee assembled a document to meet federal hazard mitigation planning requirements. A mitigation plan review crosswalk included in the hazard mitigation plan demonstrates its compliance with all requirements. The planning partners will formally adopt the plan once the State of California Governor's Office of Emergency Services and FEMA Region IX have granted pre-adoption approval.

The plan includes a schedule for monitoring and evaluating plan progress periodically and producing a revised plan every five years. This maintenance strategy also includes processes for continuing public involvement and integrating with other programs that can support or enhance hazard mitigation.

RISK ASSESSMENT

Risk assessment is the process of measuring the potential loss of life resulting from natural hazards, as well as personal injury, economic injury and property damage. It is used to define the vulnerability of people, buildings, and infrastructure to natural hazards. For this update, risk assessment models were enhanced with new data and technologies that have become available since the ABAG planning effort in 2010. The Steering Committee used the risk assessment to rank risk and to gauge the potential impacts of each hazard of concern in the Tri-Valley planning area. The risk assessment included the following:

- Hazard identification and profiling
- Assessment of the impact of hazards on physical, social, and economic assets
- Identification of particular areas of vulnerability
- Estimates of the cost of potential damage.

Based on the risk assessment, hazards were ranked for the risk they pose to the overall planning area, as shown in Table ES-1. Each planning partner also ranked hazards for its own area. Table ES-2 summarizes all jurisdictions' numerical ratings of high, medium and low. The results indicate the following general patterns:

- The earthquake hazard was most commonly ranked as high.
- The severe weather, wildfire and landslide hazards were most commonly ranked as medium.
- The dam failure, flood and drought hazards were most commonly ranked as low.

Table ES-1. Hazard Risk Ranking for the Overall Planning Area

Hazard Ranking	Hazard Event	Category
1	Earthquake	High
2	Severe Weather	High
3	Landslide	High
3	Wildfire	High
4	Flood	Medium
4	Dam Failure	Medium
5	Drought	Low

Table ES-2. Summary of Hazard Ranking Result by Individual Planning Partners

	Number of Jurisdictions Assigning Ranking to Hazard		
	High	Medium	Low
Dam Failure	0	1	3
Drought	0	1	3
Earthquake	4	0	0
Flood	0	1	3
Landslide	2	2	0
Severe weather	0	4	0
Wildfire	1	3	0

MITIGATION PRINCIPLE, GOALS AND OBJECTIVES

The Steering Committee developed the following guiding principle for the 2017 planning effort:

> Through community partnerships, establish a plan to reduce the vulnerability to hazards in order to protect the health, safety, welfare, environment and economy of the planning area.

The Steering Committee established the following goals for the plan update:

1. Ensure that hazards are identified and considered in land use decisions.
2. Improve local emergency management capability.
3. Promote community awareness, understanding, and interest in hazard mitigation policies and programs.
4. Incorporate hazard mitigation as an integrated public policy and standard practice.
5. Reduce community exposure and vulnerability to hazards where the greatest risk exists.
6. Increase resilience of infrastructure and critical facilities.
7. Promote an adaptive and resilient planning area that responds proactively to future conditions.
8. Develop and implement mitigation strategies that identify the best alternative to protect natural resources, promote equity, and use public funds in an efficient and cost-effective manner.

The objectives listed in Table ES-3 were identified to meet multiple goals, helping to establish priorities for recommended mitigation actions.

MITIGATION ACTION PLAN

The planning partnership selected a range of mitigation actions to work toward achieving the goals set forth in this plan update. The recommended mitigation actions are activities designed to reduce or eliminate losses resulting from natural hazards. The update process resulted in the identification of 73 mitigation actions for implementation by individual planning partners, as presented in Volume 2 of the hazard mitigation plan. In addition, the Steering Committee identified planning-area-wide actions benefiting the whole partnership, as listed in Table ES-4.

Table ES-3. Objectives for 2017 Hazard Mitigation Plan

Number	Objective	Applicable Goals
1	Develop and provide updated information to improve the understanding of the locations, potential impacts, and linkages among threats, hazards, vulnerability, and measures needed to protect life safety health, property and the environment.	3, 5, 7
2	Use local general plan, zoning, and subdivision requirements to help establish resilient and sustainable communities.	1, 3, 4, 5, 7, 8
3	Improve systems that provide warning and emergency communications.	2, 3
4	Encourage the retrofit of vulnerable structures in the planning area.	5, 6
5	Consider programs that incentivize risk reduction.	3, 4, 5
6	Reduce repetitive property losses due to all hazards by updating land use, design, and construction policies.	3, 4, 5, 6
7	Continually build linkages and promote dialog about emergency management within the public and private sectors.	2, 3, 4
8	Incorporate risk reduction considerations in new and updated infrastructure and development plans to reduce the impacts of natural hazards.	4, 5, 6
9	Inform the public, including underrepresented community groups, on the risk of exposure to natural hazards and ways to increase the public's capability to prepare for, respond to, recover from, and mitigate the impacts of these events.	3, 4, 5
10	Identify projects that simultaneously reduce risk while increasing planning area resilience and sustainability.	5, 6, 7
11	Where feasible and cost-effective, research, develop, and promote adoption of building and development laws, regulations, and ordinances exceeding the minimum levels needed for life safety.	1.4.8
12	Encourage hazard mitigation measures that promote and enhance natural processes, minimize adverse impacts on the ecosystem, and promote social equity.	3, 5, 8

Table ES-4. Planning-Area-Wide Hazard Mitigation Actions

Action Number and Description	Priority
Action AW-1— Continue to maintain a planning area-wide hazard mitigation website that will store the hazard mitigation plan and provide the public an opportunity to monitor plan implementation progress. Each planning partner can support this action by including an action in its own action plan of creating a link to the planning-area-wide hazard mitigation website.	High
Action AW-2— Leverage public outreach partnering capabilities in the planning area (such as Community Emergency Response Teams) to promote a uniform and consistent message on the importance of proactive hazard mitigation.	High
Action AW-3— Coordinate mitigation planning and project efforts in the planning area to leverage all resources available to the planning partnership.	High
Action AW-4— Where appropriate, support retrofitting, purchase, or relocation of structures in hazard-prone areas to protect the structures from future damage, with repetitive loss and severe repetitive loss properties as a priority. Seek opportunities to leverage partnerships in the planning area in these pursuits.	Medium
Action AW-5— Continue to update hazard mapping with best available data and science as it evolves, within the capabilities of the partnership. Support FEMA's RiskMAP initiative.	High
Action AW-6— To the extent possible based on available resources, provide coordination and technical assistance in applying for grant funding.	High
Action AW-7— Maintain a steering committee as a working body over time to monitor progress of the hazard mitigation plan, provide technical assistance to planning partners, manage data, and oversee the update of the plan according to schedule. This body will continue to operate under the ground rules established at its inception.	High
Action AW-8— All planning partners will collaborate and share information to support the development of debris management plans for the planning area. While each planning partner will be responsible for the development of their own plans, they will attempt to standardize the content and format based on a regional template.	High

IMPLEMENTATION

The Steering Committee developed a plan implementation and maintenance strategy that includes mid-term progress reporting, a strategy for continued public involvement, a commitment to plan integration with other relevant plans and programs, and a recommitment from the planning partners to actively maintain the plan over the five-year performance period.

Full implementation of the recommendations of this plan will require time and resources. The measure of the plan's success will be its ability to adapt to changing conditions. The Tri-Valley Planning Partnership will assume responsibility for adopting the recommendations of this plan and committing resources toward implementation. The framework established by this plan commits all planning partners to pursue actions when the benefits of a project exceed its costs. The planning partnership developed this plan with extensive public input, and public support of the actions identified in this plan will help ensure the plan's success.

PART 1—PLANNING PROCESS AND COMMUNITY PROFILE

1. INTRODUCTION TO HAZARD MITIGATION PLANNING

1.1 WHY PREPARE THIS PLAN?

1.1.1 The Big Picture

Hazard mitigation is defined as any action taken to reduce or alleviate the loss of life, personal injury, and property damage that can result from a disaster. It involves long- and short-term actions implemented before, during and after disasters. Hazard mitigation activities include planning efforts, policy changes, programs, studies, improvement projects, and other steps to reduce the impacts of hazards.

For many years, federal disaster funding focused on relief and recovery after disasters occurred, with limited funding for hazard mitigation planning in advance. The Disaster Mitigation Act (DMA; Public Law 106-390), passed in 2000, shifted the federal emphasis toward planning for disasters before they occur. The DMA requires state and local governments to develop hazard mitigation plans and update them every five years as a condition for federal disaster grant assistance. Regulations developed to fulfill the DMA's requirements are included in Title 44 of the Code of Federal Regulations (44 CFR).

The responsibility for hazard mitigation lies with many, including private property owners, commercial interests, and local, state and federal governments. The DMA encourages cooperation among state and local authorities in pre-disaster planning. The enhanced planning network called for by the DMA helps local government's articulate accurate needs for mitigation, resulting in faster allocation of funding and more cost-effective risk-reduction projects.

The DMA also promotes sustainability in hazard mitigation. To be sustainable, hazard mitigation needs to incorporate sound management of natural resources and address hazards and mitigation in the largest possible social and economic context.

1.1.2 Purposes for Planning

In response to the requirements of the DMA, the cities of Dublin, Livermore and Pleasanton, California and the Dublin San Ramon Services District have developed this multi-jurisdiction hazard mitigation plan. The three cities make up the incorporated area of the Alameda County portion of California's Tri-Valley region, on the east side of the San Francisco Bay area. This multi-jurisdiction plan represents an update to each city's component of the Association of Bay Area Governments (ABAG) 2010 *Multi-Jurisdictional Local Hazard Mitigation Plan for the San Francisco Bay Area*. The three cities prepared annexes for the ABAG 2010 hazard mitigation plan that were approved and adopted from 2011 to 2012.

The *Tri-Valley Local Hazard Mitigation Plan* fulfills the five-year plan update requirement for these planning partners. It identifies resources, information, and strategies for reducing risk from natural hazards in the Tri-Valley planning area. Components of the hazard mitigation plan were selected because they meet a program requirement and because they best meet the needs of the planning partners (the cities and participating special districts) and their citizens. One benefit of multi-jurisdictional planning is the ability to pool resources and eliminate redundant activities within a planning area that has uniform risk exposure and vulnerabilities. The

Federal Emergency Management Agency (FEMA) encourages multi-jurisdictional planning under its guidance for the DMA. Local special districts that participated with the cities to develop this hazard mitigation plan are the Dublin San Ramon Services District, the Livermore Valley Joint Unified School District, and the Dublin Unified School District.

The plan will help guide and coordinate mitigation activities throughout the planning area. It was developed to meet the following objectives:

- Meet or exceed requirements of the DMA.
- Enable all planning partners to continue using federal grant funding to reduce risk through mitigation.
- Meet the needs of each planning partner as well as state and federal requirements.
- Create a risk assessment that focuses on local hazards of concern.
- Meet the planning requirements of the Federal Emergency Management Agency's (FEMA's) Community Rating System (CRS), allowing planning partners that participate in the CRS program to maintain or enhance their CRS classifications.
- Coordinate existing plans and programs so that high-priority projects to mitigate possible disaster impacts are funded and implemented.

The long-term benefits of mitigation planning include the following:

- An increased understanding of hazards faced by all planning partners
- A more sustainable and disaster-resistant community
- Financial savings through partnerships that support planning and mitigation efforts
- Focused use of limited resources on hazards that have the biggest impact on the communities
- Reduced long-term impacts and damage to human health and structures, and reduced repair costs.

1.2 WHO WILL BENEFIT FROM THIS PLAN?

All citizens and businesses of the planning area are the ultimate beneficiaries of this hazard mitigation plan. The hazard mitigation plan reduces risk for those who live in, work in, and visit the planning area. It provides a viable planning framework for all foreseeable natural hazards. Participation in development of the hazard mitigation plan by key stakeholders helped ensure that outcomes will be mutually beneficial. The resources and background information in the plan are applicable across the planning area, and the plan's goals and recommendations can lay groundwork for the development and implementation of local mitigation activities and partnerships.

1.3 CONTENTS OF THIS PLAN

This plan has been set up in two volumes so that jurisdiction-specific elements may be easily distinguished from those that apply to the whole planning area:

- **Volume 1**—Volume 1 includes all federally required elements of a disaster mitigation plan that apply to the entire planning area. This includes the description of the planning process, public involvement strategy, goals and objectives, planning area hazard risk assessment, planning area mitigation actions, and a plan maintenance strategy.
- **Volume 2**—Volume 2 includes all federally required jurisdiction-specific elements in annexes for each participating jurisdiction. It includes a description of the participation requirements established by the Steering Committee, as well as instructions and templates that the partners used to complete their annexes. Volume 2 also includes "linkage" procedures for eligible jurisdictions that did not participate in development of this plan but wish to adopt it in the future.

Both volumes include elements required under federal guidelines. DMA compliance requirements are cited at the beginning of subsections as appropriate to demonstrate compliance.

The following appendices provided at the end of Volume 1 include information or explanations to support the main content of the plan:

- Appendix A—Public outreach information used in preparation of this update
- Appendix B—Data sources and methods used for hazard mapping
- Appendix C—Plan adoption resolutions from Planning Partners
- Appendix D—A template for progress reports to be completed as this plan is implemented.

All planning partners will adopt Volume 1 in its entirety, including the appendices, and at least the following parts of Volume 2: Part 1, and each partner's jurisdiction-specific annex.

2. PLAN UPDATE—WHAT HAS CHANGED

2.1 THE PREVIOUS PLAN

In 2004, ABAG led a regional effort to address hazard mitigation planning for jurisdictions in the San Francisco Bay Area. The ABAG process equipped local governments with a template and tools to complete individual planning processes for their jurisdictions, while pooling resources and eliminating redundant planning efforts. Alameda County's first annex to the ABAG hazard mitigation plan was developed and adopted in 2007. In 2010, ABAG conducted its second regional planning effort. Dublin, Livermore and Pleasanton participated in the 2010 planning process, along with Alameda County, other cities, and the Alameda County Water District including the Zone 7 Water Agency; these jurisdictions used the ABAG tools to achieve DMA compliance. The single-jurisdiction annexes in the previous hazard mitigation, developed using the ABAG template and tools, contained the following components:

- Introduction
- Description of the local planning process
- Hazards and risk assessment
- Summary of the National Flood Insurance Program and repetitive loss properties
- Mitigation goals, activities and priorities
- Regional mitigation strategies
- Incorporation of the plan into existing planning mechanisms
- Description of the plan update process
- Exhibits to illustrate the planning process.

The Dublin Unified School District and the Livermore Valley Joint Unified School District have not previously participated in a hazard mitigation plan.

2.2 WHY UPDATE?

In 2015, ABAG again provided tools for counties and cities in the Bay Area to revise their previous plans and annexes, but decided not to revise the regional 2010 ABAG hazard mitigation plan. As a result, multiple counties and cities that participated in the previous ABAG hazard mitigation plan needed to undertake a planning process independently, or as part of a new partnership, in order to remain eligible for federal hazard mitigation assistance. Alameda County set out to develop a stand-alone plan focusing on unincorporated areas; Dublin, Livermore and Pleasanton pooled resources to develop this multi-jurisdictional hazard mitigation plan. The following factors are the basis for the Tri-Valley hazard mitigation planning effort:

- The planning area has significant exposure to numerous natural hazards.
- Limited local resources make it difficult to be pre-emptive in risk reduction actions. Being able to leverage federal financial assistance is paramount to successful hazard mitigation in the area.
- The planning partners want to be proactive in preparedness for the probable impacts of natural hazards.

2.2.1 Federal Eligibility

Title 44 of the Code of Federal Regulations (44 CFR) stipulates that hazard mitigation plans must present a schedule for monitoring, evaluating, and updating the plan. This provides an opportunity to reevaluate recommendations, monitor the impacts of actions that have been accomplished, and determine if there is a need to change the focus of mitigation strategies. A jurisdiction covered by a plan that has expired is not able to pursue funding under the Robert T. Stafford Act that requires a current hazard mitigation plan.

2.2.2 Changes in Development

Hazard mitigation plan updates must be revised to reflect changes in development in the planning area since the previous plan was completed (44 CFR Section 201.6(d)(3)). The plan must describe changes in development in hazard-prone areas that increased or decreased vulnerability for each jurisdiction since the last plan was approved. If no changes in development impacted the jurisdiction's overall vulnerability, plan updates may validate the information in the previously approved plan. The intent of this requirement is to ensure that the mitigation strategy continues to address the risk and vulnerability of existing and potential development and takes into consideration possible future conditions that could impact vulnerability.

The planning area experienced an 18.1 percent increase in population from 2000 to 2010, an average growth of 1.81 percent per year. Between 2010 and 2017, the California Department of Finance estimates that the total populations of Dublin, Livermore and Pleasanton grew an additional 14.17 percent, to 225,250 (CA DOF, 2017).

This plan update assumes that some new development triggered by the increase in population occurred in hazard areas. Because all such new development would have been regulated pursuant to local programs and codes, it is assumed that vulnerability did not increase, even if exposure did. Participating planning partners have adopted general plans, strategic plans, and emergency plans that govern land-use decisions and policy-making, as well as building codes and specialty ordinances based on state and federal mandates. A detailed analysis of development patterns in the planning area is provided in Section 4.5 and in the individual partner annexes in Volume 2.

2.3 THE UPDATED PLAN—WHAT IS DIFFERENT?

The Cities of Dublin, Livermore and Pleasanton are the primary partners in developing this hazard mitigation plan. The three jurisdictions acquired contractor support to facilitate the development of this plan. The plan is a revision of the 2010 ABAG hazard mitigation plan annexes, but it represents the initial plan for the combined Tri-Valley planning area. This plan differs from the 2010 annexes in a variety of ways:

- This plan has been re-structured to focus on the Tri-Valley planning area. The risk assessment is not a part of a larger regional effort. It addresses only the Tri-Valley planning area, focusing on hazards of concern specific to that planning area.
- This updated hazard mitigation plan includes the Dublin San Ramon Services District and the Dublin Unified School District as planning partners.
- The risk assessment has been formatted to best support future grant applications by providing risk and vulnerability information directly supportive of the cost-effectiveness measurement required under FEMA mitigation grant programs.
- Newly available data (such as FEMA's countywide Digital Flood Insurance Rate Maps) and tools (such as FEMA's Hazus computer model) provide for a more detailed and accurate risk assessment.
- The process of updating the 2010 ABAG annexes gave the planning partners an opportunity to engage local citizens and gauge their perception of risk and support for risk reduction through mitigation. This plan update demonstrates that engagement process.

Table 2-1 indicates the major changes between the two plans as they relate to 44 CFR planning requirements.

Table 2-1. Plan Changes Crosswalk

44 CFR Requirement	Previous Plan	Updated Plan
§201.6(b): In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include: • 1. An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval; • 2. An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process; and • 3. Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.	Appendix A of the ABAG Plan includes a description of the planning process. It includes detail of coordination with other agencies and review of the previous plan.	The plan development process deployed for this update differed significantly from that of the ABAG plan. Volume 1 Chapters 2, 3, and 5 describe the planning process for the 2017 updated plan.
§201.6(c)(2): The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.	Appendix C of the ABAG plan includes a risk assessment for nine hazards (earthquake, tsunami, flood, landslide, wildfire, drought, climate change, dam failure, and delta levee failure) for the nine-county regional area.	Volume 1 Part 2 presents a risk assessment of 10 hazards of concern: dam failure, drought, earthquake, flood, landslide, severe weather, wildfire, human caused hazards, health hazards, and climate change. These hazards are profiled as they impact the Tri-Valley planning area. Including a qualitative assessment of human caused hazards and health hazards provides a more complete picture of the hazards facing the planning area.
§201.6(c)(2)(i): [The risk assessment shall include a] description of the … location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.	Appendix C of the ABAG plan includes a risk assessment for nine hazards (earthquake, tsunami, flood, landslide, wildfire, drought, climate change, dam failure, and delta levee failure) for the nine-county regional area.	Volume 1 Part 2 presents a risk assessment of each hazard of concern. Each hazard chapter includes the following components: • Hazard profile, including maps of extent and location, historical occurrences, frequency, severity, and warning time • Secondary hazards • Climate change impacts • Exposure of people, property, critical facilities and environment • Vulnerability of people, property, critical facilities and environment • Future trends in development • Scenarios • Issues

44 CFR Requirement	Previous Plan	Updated Plan
§201.6(c)(2)(ii): [The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i). This description shall include an overall summary of each hazard and its impact on the community	Utilizing existing studies and documents, the ABAG plan discussed vulnerability with an emphasis on exposure and land use. There was extensive discussion on the vulnerability to the earthquake hazard. The ABAG risk assessment attempts to estimate potential damage from future events. ABAG concluded that Hazus was not an adequate tool for planning purposes.	Vulnerability was assessed for all hazards of concern. The Hazus computer model was used for the dam failure, earthquake, and flood hazards, incorporating local data sets. Site-specific data on Steering Committee-identified critical facilities were entered into the Hazus model. Vulnerability was assessed for other hazards by applying varying damage percentages to an asset inventory extracted from Hazus.
§201.6(c)(2)(ii): [The risk assessment] must also address National Flood Insurance Program insured structures that have been repetitively damaged floods	The ABAG plan includes summary information by county on identified repetitive losses. The plan includes a link to a website with more information on repetitive losses, but the site is no longer maintained. The plan provides inventories of structures in repetitive loss areas, but there is no description of the causes of repetitive flooding.	Dublin, Livermore and Pleasanton have no identified Repetitive Loss or Severe Repetitive Loss structures insured through the National Flood Insurance Program.
§201.6(c)(2)(ii)(A): The plan should describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area.	The focus of the ABAG plan is on existing land use without detailed discussion on future land use. There is no consistent inventory of the number and types of structures exposed to each hazard of concern. The plan does provide an inventory of identified critical facilities.	A complete inventory of the numbers and types of buildings exposed was generated for each hazard of concern. The Steering Committee defined and identified "critical facilities" for the planning area, and these facilities were inventoried by exposure. Each hazard chapter provides a discussion on future development trends.
§201.6(c)(2)(ii)(B): [The plan should describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) and a description of the methodology used to prepare the estimate.	The ABAG plan relied on creating regional correlations from past observed damage to create estimates of future losses from the hazards of concern. Appendix F assesses vulnerability by providing private building exposure estimates for earthquake, landslide, wildfire, dam failure, and 100-year flood.	Loss estimations in terms of dollar loss were generated for all hazards of concern. These estimates were generated by Hazus for the dam failure, earthquake, and flood hazards. For the other hazards, loss estimates were generated by applying varying damage percentages to an asset inventory extracted from Hazus.
§201.6(c)(2)(ii)(C): [The plan should describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.	A strong component of the ABAG plan is its look at existing land use in hazard areas, especially for earthquake. Appendix E provides additional detail on existing land use, with a brief discussion of future land use (through 2030) by county.	There is a discussion on future development trends as they pertain to each hazard of concern. This discussion looks predominantly at the existing land use and the current regulatory environment that dictates this land use.

44 CFR Requirement	Previous Plan	Updated Plan
§201.6(c)(3): The plan shall include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.	The ABAG plan identified a comprehensive list of mitigation strategies for each planning partner to consider when creating annexes to the plan. These strategies were created via a facilitated process chronicled in the plan.	The plan contains a guiding principle, goals, objectives, and actions. The actions are jurisdiction-specific and strive to meet multiple objectives. The objectives of this plan are broad, similar to the strategies identified in the ABAG plan. All objectives meet multiple goals and stand alone as components of the plan. Each planning partner was asked to complete a capability assessment that looks at its regulatory, technical and financial capabilities.
§201.6(c)(3)(i): [The hazard mitigation strategy shall include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.	The ABAG plan has identified one overall goal and basic "commitments" for the plan.	The Steering Committee developed a new overall guiding principle for the plan, and developed eight goals and 12 objectives, as described in Chapter 17. The goals and objectives are specifically for this hazard mitigation plan and are completely new. They were identified based upon the capabilities of the Planning Partnership.
§201.6(c)(3)(ii): [The mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.	The ABAG plan contains a discussion on the process used to generate the mitigation strategies, and includes an alternatives review.	Volume I, Part 3 includes a hazard mitigation catalog that was developed through a facilitated process. This catalog identifies actions that manipulate the hazard, reduce exposure to the hazard, reduce vulnerability, and increase mitigation capability. The catalog further segregates actions by scale of implementation. A table in the action plan chapter analyzes each action by mitigation type to illustrate the range of actions selected.
§201.6(c)(3)(ii): [The mitigation strategy] must also address the jurisdiction's participation in the National Flood Insurance Program, and continued compliance with the program's requirements, as appropriate.	Strategy GOVT-c-5 deals with maintaining compliance and good standing in the National Flood Insurance Program. Strategies HSNG-h-1, LAND-c-4, and ECON-f-1 encourage participation in the CRS program.	Dublin, Livermore and Pleasanton participate in the National Flood Insurance Program and have identified an action stating their commitment to maintain compliance and good standing under the National Flood Insurance Program.
§201.6(c)(3)(iii): [The mitigation strategy shall describe] how the actions identified in Section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.	Under the ABAG plan, priorities are organized based on the following categories: • Existing • Existing/underfunded • Very High • High • Moderate • Under study • Not applicable • Not yet considered	Each of the recommended actions is prioritized using a qualitative methodology that looked at the objectives the project will meet, the timeline for completion, how the project will be funded, the impact of the project, the benefits of the project and the costs of the project. This prioritization scheme is detailed in Chapter 19.

44 CFR Requirement	Previous Plan	Updated Plan
§201.6(c)(3)(iii): [The mitigation strategy shall describe] how the actions identified in Section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.	Under the ABAG plan, priorities are organized based on the following categories: • Existing • Existing/underfunded • Very High • High • Moderate • Under study • Not applicable • Not yet considered	Each of the recommended actions is prioritized using a qualitative methodology that looked at the objectives the project will meet, the timeline for completion, how the project will be funded, the impact of the project, the benefits of the project and the costs of the project. This prioritization scheme is detailed in Chapter 19. Since this planning effort was the 1st for all the Tri-Valley planning partners working together on a plan, this was an entirely new prioritization concept than what was applied in the ABAG planning effort. Since each planning partner was asked to review all risks and prior actions, any action that was carried over to this plan from the prior plan had the opportunity to have its priority reviewed and if necessary, changed. So therefore, every risk and action in this plan, whether new of carried over from the prior plan was prioritized as described in the introduction section of volume 2.
§201.6(c)(4)(i): [The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.	Appendix B of the ABAG plan contains a plan maintenance and update process.	Volume I, Part 3 presents a plan maintenance strategy that contains additional detail to address deficiencies observed during the 2010 update process. This update includes a more defined role and vehicle for facilitating the annual review of the plan.
§201.6(c)(4)(ii): [The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.	Appendix B of the ABAG plan contains a brief discussion on incorporation of the plan into other planning mechanisms.	Volume I, Part 3 details recommendations for incorporating the plan into other planning mechanisms, such as: • General plans • Emergency response plans • Capital improvement programs • Municipal codes Specific current and future plan and program integration activities are detailed in each participating jurisdiction's annex in Volume 2.
§201.6(c)(4)(iii): [The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.	The ABAG plan does not contain a process for how each jurisdiction will continue public participation in the plan maintenance process. However, some of the local government annexes contain this discussion.	Volume I, Part 3 details a comprehensive strategy for continuing public involvement.
§201.6(c)(5): [The local hazard mitigation plan shall include] documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval of the plan (e.g., City Council, County Commission, Tribal Council).	All agencies utilizing the ABAG tools submitted to the state and FEMA individually.	An appendix in Volume 1 contains the resolutions of all planning partners that adopted this plan.

3. PLAN UPDATE APPROACH

This chapter describes the planning process used to develop the *Tri-Valley Local Hazard Mitigation Plan*, including how it was prepared, who was involved, and how the public participated. The process was broadly defined by the following objectives and activities:

- Form a planning team
- Defining stakeholders
- Establish a steering committee
- Establish a planning partnership
- Define the planning area
- Coordinate with other agencies
- Review existing programs
- Engage the public.

These objectives and activities ensure that the plan meets requirements of the DMA and has the broad and effective support of the participating jurisdictions, regional and local stakeholders and the public. They are discussed in the following sections.

3.1 FORMATION OF THE PLANNING TEAM

Project management has been the joint responsibility of staff members from the Cities of Dublin, Livermore, and Pleasanton. A contract planning consultant (Tetra Tech, Inc.) was tasked with the following:

- Assist with organization of a steering committee and planning team
- Assist with development and implementation of a public and stakeholder outreach program
- Collect data
- Facilitate and attend meetings (steering committee, planning team, stakeholder, public and other)
- Review and update the hazards of concern, hazard profiles and risk assessment
- Assist with review and update of mitigation planning goals and objectives
- Assist with review of progress of past mitigation strategies
- Assist with the screening, identification and prioritization of mitigation actions
- Author the draft and final hazard mitigation plan documents.

The Tetra Tech project manager assumed the role of the lead planner, reporting directly to the planning team. In addition to the Tetra Tech project team, the main planning team consisted of the following members:

- Tracy Hein, Disaster Preparedness Coordinator, Livermore-Pleasanton Fire Department
- Hazel Wetherford, Assistant to the City Manager, City of Dublin
- Adam Weinstein, Planning Manager, City of Pleasanton
- Shweta Bonn, Senior Planner, Advanced Planning; City of Pleasanton
- Steve Stewart, Planning Manager, City of Livermore.

3.2 DEFINING STAKEHOLDERS

At the beginning of the planning process, the planning team identified a list of stakeholders to engage during the update of the Tri-Valley Hazard Mitigation Plan. "Stakeholder" was defined as any person or public or private entity that owns or operates facilities that would benefit from the mitigation actions of this plan, and/or has an authority or capability to support mitigation actions identified by this plan. Stakeholders were separated into two categories:

- **Participatory Stakeholders**—Stakeholders that actively participated in the planning process as planning partners or members of the Steering Committee.
- **Coordinating Stakeholders**—Stakeholders that were not able to commit to actively participating in the process but were kept apprised of plan development milestones or were able to provide data that was used in the plan development.

The following stakeholders played a role in the planning process:

- **Federal Agencies—**FEMA Region IX
- **State Agencies—The** California Governor's Office of Emergency Services (Cal OES)
- **Regional and Local Stakeholders—**The following regional and local organizations received information about the planning process and invitations to provide input and participated in the planning process as full members of the Steering Committee:

  - Alameda County Fire Department
  - Alameda County Voluntary Organizations Active in Disaster
  - Zone 7 Water Agency
  - Bay Area Rapid Transit
  - Lawrence Livermore National Laboratory
  - Livermore Area Recreation & Park District
  - Livermore-Pleasanton Fire Department
  - Pleasanton Chamber of Commerce
  - Stanford Health Care – ValleyCare.

3.3 THE STEERING COMMITTEE

A Steering Committee provided guidance to the hazard mitigation plan effort and ensured that the document will be accepted by agencies and the public. For a project kickoff meeting on March 7, 2017, the planning team assembled a list of planning area candidates who could have recommendations for the plan or be impacted by its recommendations. The planning team requested these candidates' participation in the planning process. The planning team confirmed a committee of 20 members. Table 3-1 lists the Steering Committee members.

Leadership roles and ground rules were established during the Steering Committee's meeting on March 7, 2017. The Steering Committee agreed to meet once a month as needed throughout the course of the plan's development. The planning team facilitated each Steering Committee meeting to address a set of objectives based on an established work plan. The Steering Committee met nine times from March 2017 through November 2017. All Steering Committee meetings were open to the public and agendas and meeting notes were posted to the hazard mitigation plan website. Steering Committee meeting summaries are included in Appendix A of this volume.

The Steering Committee included key planning partner staff, citizens, and other stakeholders from within the planning area. Members combined expertise in preventive measures, property protection, natural resource protection, emergency services, structural flood control projects, public safety, and public information. They applied their expertise on behalf of all planning partners participating in the plan process.

Table 3-1. Steering Committee Members

Name	Title	Jurisdiction/Agency
Julie Carter	Human Resources Director	City of Dublin
Hazel Wetherford[a]	Assistant to the City Manager	City of Dublin
Susan Frost	Special Projects Coordinator	City of Livermore, Community Development Department
Steve Stewart	Planning Manager	City of Livermore
Shweta Bonn	Senior Planner, Advanced Planning	City of Pleasanton
Adam Weinstein[b]	Planning Manager	City of Pleasanton
Stanley Kolodzie	Associate Engineer	Dublin San Ramon Services District
Brian Fritz	Maintenance and Operations Supervisor	Dublin Unified School District
Lincoln Casimere	Emergency Manager	Alameda County Fire Department
Marla Blagg	Emergency Manager	Bay Area Rapid Transit
Cary Fukada	Citizen	Community Emergency Response Teams
John Richards	Emergency Management Expert	Lawrence Livermore National Laboratory
John Lawrence	Assistant General Manager	Livermore Area Recreation & Park District
Mike Trudeau	Lieutenant	Livermore Police Department
Chris Van Schaack	Assistant Superintendent	Livermore Valley Joint Unified School District
Joe Testa	Deputy Chief	Livermore-Pleasanton Fire Department
Tracy Hein	Disaster Preparedness Coordinator	Livermore-Pleasanton Fire Department
Scott Ratay	President/CEO	Pleasanton Chamber of Commerce
Caryn Thornburg	Safety, Emergency Management, and Sustainability Officer	Stanford Health Care – Valley Care
Colter Anderson	Production Manager	Zone 7 Water Agency

a. Chairperson
b. Vice-Chairperson

3.4 ESTABLISHMENT OF THE PLANNING PARTNERSHIP

Hazard mitigation planning enhances collaboration among diverse parties whose interests can be affected by hazard losses. In June 2016, the Cities of Dublin, Livermore and Pleasanton identified eligible special districts within the planning area of the pending planning process and invited them to formally participate. All special districts were asked to identify planning points of contact to serve as planning partners and represent the interests of their district.

During the first Steering Committee meeting on March 7, 2017, the planning team introduced the opportunity for special districts to participate as planning partners. A follow-up to the Steering Committee meeting was sent via email on April 17, 2017, listing potential special purpose district planning partners. This follow-up outlined planning partner expectations and sought commitment.

The municipal planning partners covered under this plan are shown in Table 3-2. The special purpose district planning partners are shown in Table 3-3. Together these jurisdictions make up the Planning Partnership for the hazard mitigation plan. While all participating jurisdictions authorized the Steering Committee to carry out certain activities on their behalf, all planning partners were invited to attend and participate in all aspects of the plan update process. Linkage procedures have been established (see Volume 2 of this plan) for any jurisdiction wishing to link to the *Tri-Valley Local Hazard Mitigation Plan* in the future.

Table 3-2. Municipal Planning Partners

Jurisdiction	Point of Contact	Title
Dublin	Hazel Wetherford	Assistant to the City Manager
Livermore	Steve Stewart Steve Reily	Planning Manager Principle Planner
Pleasanton	Adam Weinstein	Planning Manager
	Shweta Bonn	Senior Planner, Advanced Planning

Table 3-3. Special District Planning Partners

Special District	Point of Contact	Title
Dublin San Ramon Services District	Stanley Kolodzie	Associate Engineer

3.5 DEFINING THE PLANNING AREA

The planning area was defined to consist of the jurisdictional area of the Cities of Dublin, Livermore, and Pleasanton within Alameda County as well as the service area for the Dublin San Ramon Services District that extends in to Contra Costa County. The planning area is surrounded by unincorporated Alameda County. All partners to this plan have jurisdictional authority within this planning area. A map showing the geographic boundary of the defined planning area for this plan update is provided in Chapter 4, along with a description of planning area characteristics.

3.6 COORDINATION WITH OTHER AGENCIES

Opportunities for involvement in the planning process must be provided to neighboring communities, local and regional agencies involved in hazard mitigation, agencies with authority to regulate development, businesses, academia, and other private and nonprofit interests (44 CFR, Section 201.6(b)(2)). The planning team accomplished this task as follows:

- **Steering Committee Involvement**—Agency representatives were invited to participate on the Steering Committee.
- **Agency Notification**—The following agencies were invited to participate in the plan development process from the beginning and were kept apprised of plan development milestones:

  - Alameda County Fire Department, Emergency Management Division
  - Alameda County Voluntary Organizations Active in Disaster (ALCO VOAD)
  - Alameda County Emergency Management Association (ALCO-EMA)
  - American Red Cross Bay Area Chapter
  - Association of Bay Area Governments, Resilience Program Coordinator
  - Bay Area Rapid Transit
  - California Department of Water Resources, National Flood Insurance Program Coordinator
  - Cal OES
  - Contra Costa County Office of Emergency Services
  - East Bay Parks and Recreation District
  - FEMA Region IX, Lead Community Planner
  - Lawrence Livermore National Laboratory
  - Livermore Area Recreation & Park District
  - Livermore-Pleasanton Fire Department
  - Pleasanton Chamber of Commerce

- San Ramon Valley Fire District
- Stanford Health Care – Valley Care
- Zone 7 Water Agency

These agencies received meeting announcements, meeting agendas, and meeting minutes by e-mail throughout the plan development process. They supported the effort by attending meetings or providing feedback on issues.

- **Pre-Adoption Review**— All the agencies listed above were provided an opportunity to review and comment on this plan, primarily through the hazard mitigation plan website (see Section 3.8). All were sent an e-mail message informing them that draft portions of the plan were available for review. Upon completion of a public comment period, a complete draft plan was sent to Cal OES for a pre-adoption review to ensure program compliance.

Special involvement in and assistance with the planning process was provided by the following federal and state agencies:

- FEMA Region IX provided updated planning guidance, provided summary and detailed data for the planning area from the National Flood Insurance Program (NFIP) (including repetitive loss information), and conducted plan review.
- The U.S. Geological Survey (USGS) provided earthquake event mapping to support the earthquake risk assessment.
- Cal OES facilitated FEMA review, provided updated planning guidance, and reviewed the draft and final versions of the plan prior to FEMA review.
- The California Department of Forestry and Fire Protection (CAL FIRE) provided fire severity mapping to support the wildfire risk assessment.
- The California Department of Water Resources provided information on NFIP compliance for local cities.

3.7 REVIEW OF EXISTING PROGRAMS

Hazard mitigation planning must include review and incorporation, if appropriate, of existing plans, studies, reports and technical information (44 CFR, Section 201.6(b)(3)). Section 4.8 provides a review of laws and ordinances in effect within the planning area that can affect hazard mitigation actions. In addition, the following programs can affect mitigation within the planning area:

- California Fire Code
- 2013 California Building Code
- California State Hazard Mitigation Forum
- Five-year and biennial capital improvement programs
- Local emergency operations plans
- Local general plans
- Local strategic plans
- Housing elements
- Safety elements
- Local zoning ordinances
- Climate action plans.

An assessment of all planning partners' regulatory, technical and financial capabilities to implement hazard mitigation actions is presented in the jurisdiction-specific annexes in Volume 2.

3.8 PUBLIC INVOLVEMENT

Broad public participation in the planning process helps ensure that diverse points of view about the planning area's needs are considered and addressed. The public must have opportunities to comment on disaster mitigation plans during the drafting stages and prior to plan approval (44 CFR, Section 201.6(b)(1)). This section details the outreach to, and involvement of, the many agencies, departments, organizations, non-profit organizations, districts, authorities and other entities that have a stake in managing hazard risk and mitigation, commonly referred to as stakeholders.

3.8.1 Strategy

The strategy for involving the public in this plan emphasized the following elements:

- Include members of the public on the Steering Committee.
- Engage the public in two phases during the planning effort:
  - Phase 1—Gauge the public's perception of risk by sharing the results of the risk assessment.
  - Phase 2—Provide opportunity for the public to comment on a draft of the plan.
- Use a survey to determine if the public's perception of risk and support of hazard mitigation has changed since the initial planning process.
- Attempt to reach as many planning area citizens as possible using multiple media.
- Identify and involve planning area stakeholders.

Diligent efforts were made to ensure broad regional, county, and local representation in this planning process. Stakeholder outreach was performed early and throughout the planning process. In addition to mass media notification efforts, identified stakeholders were invited to attend meetings and provide input on draft documents. Information and input provided by these stakeholders has been included throughout this plan where appropriate.

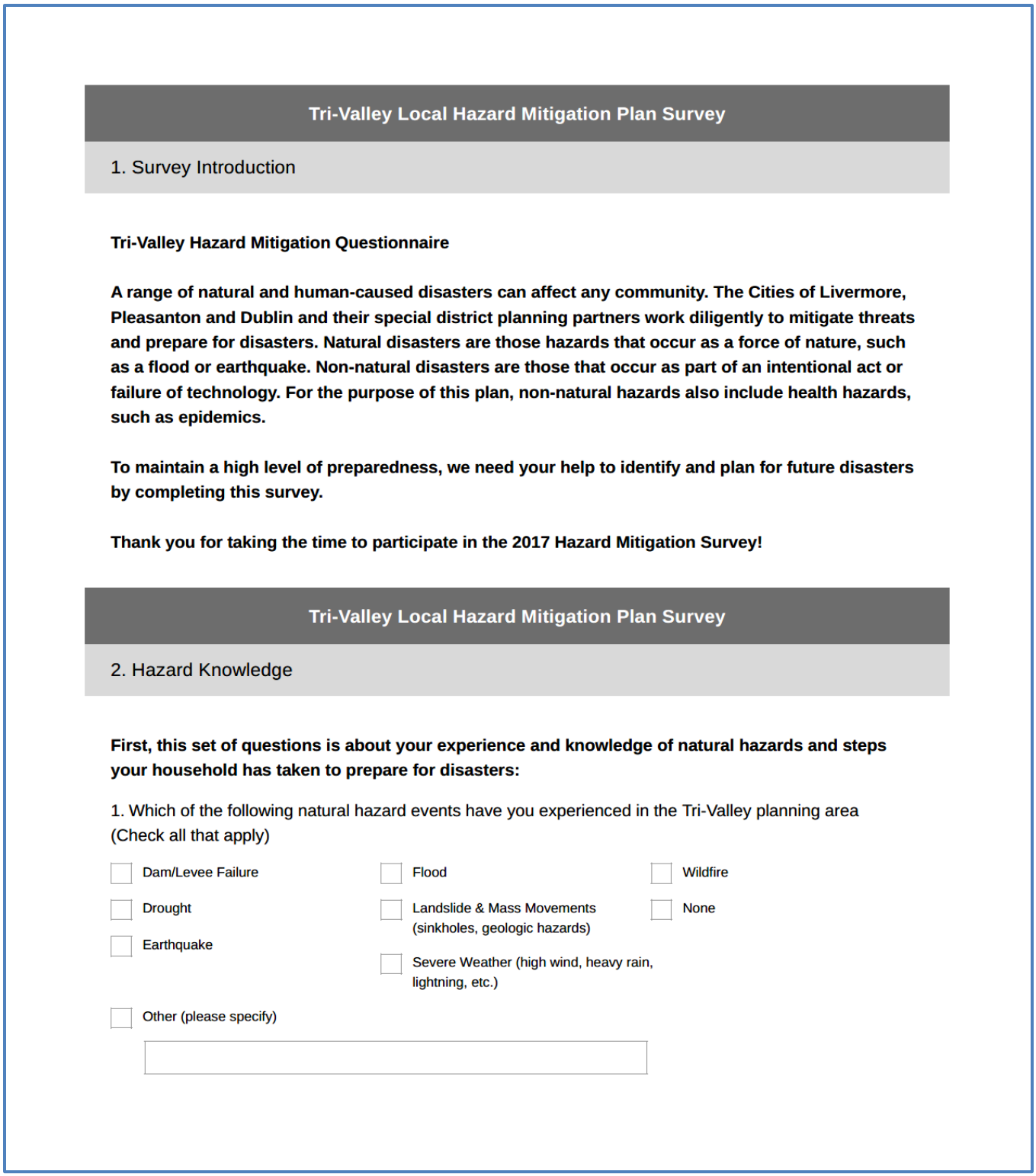
The sections below describe Steering Committee and planning team efforts toward public outreach throughout the development and review of the hazard mitigation plan.

Survey

A hazard mitigation plan survey (see Figure 3-1) was developed for this planning process. The survey was used to gauge household preparedness for natural hazards and the level of knowledge of tools and techniques that assist in reducing risk and loss from natural hazards. This survey was designed to help identify areas vulnerable to one or more natural hazards. The answers to its questions helped guide the Steering Committee in selecting goals, objectives, and mitigation strategies. The survey was made available on the hazard mitigation plan website and was distributed to citizens of the planning area as follows:

- Via social media outlets, including Facebook, Twitter and NextDoor
- At public meetings as hard copies and via QR code access with smart phones
- On the City of Dublin's platform, "Open City Hall."

Over 500 surveys were completed during the course of this planning process. The complete survey and a summary of its findings can be found in Appendix A of this volume.



Tri-Valley Local Hazard Mitigation Plan Survey

1. Survey Introduction

Tri-Valley Hazard Mitigation Questionnaire

A range of natural and human-caused disasters can affect any community. The Cities of Livermore, Pleasanton and Dublin and their special district planning partners work diligently to mitigate threats and prepare for disasters. Natural disasters are those hazards that occur as a force of nature, such as a flood or earthquake. Non-natural disasters are those that occur as part of an intentional act or failure of technology. For the purpose of this plan, non-natural hazards also include health hazards, such as epidemics.

To maintain a high level of preparedness, we need your help to identify and plan for future disasters by completing this survey.

Thank you for taking the time to participate in the 2017 Hazard Mitigation Survey!

Tri-Valley Local Hazard Mitigation Plan Survey

2. Hazard Knowledge

First, this set of questions is about your experience and knowledge of natural hazards and steps your household has taken to prepare for disasters:

1. Which of the following natural hazard events have you experienced in the Tri-Valley planning area (Check all that apply)

- ☐ Dam/Levee Failure
- ☐ Drought
- ☐ Earthquake
- ☐ Flood
- ☐ Landslide & Mass Movements (sinkholes, geologic hazards)
- ☐ Severe Weather (high wind, heavy rain, lightning, etc.)
- ☐ Wildfire
- ☐ None
- ☐ Other (please specify)

Figure 3-1. Hazard Mitigation Survey

Phase 1 Public Outreach—Informational Booths

Informational booths were staffed at the following events:

- July 27, 2017 in Dublin as part of the Dublin Farmers' Market
- September 16, 2017 in Pleasanton as part of the Pleasanton Farmers' Market.
- September 21, 2017 in Livermore as part of the Livermore Farmers' Market

During these events (see Figure 3-2 through Figure 3-5), project team members spoke with members of the public about the project and invited them to take the survey and visit the project website. Members of the public were invited to receive a personalized risk assessment based on the project risk assessment results. A Hazus workstation allowed citizens to see information on their property, including exposure and damage estimates for earthquake and flood hazard events. Participating property owners were provided printouts of this information for their properties.



Figure 3-2. Dublin Farmer's Market



Figure 3-3. Pleasanton Farmers Market



Figure 3-4. A Resident Receives a Risk Assessment

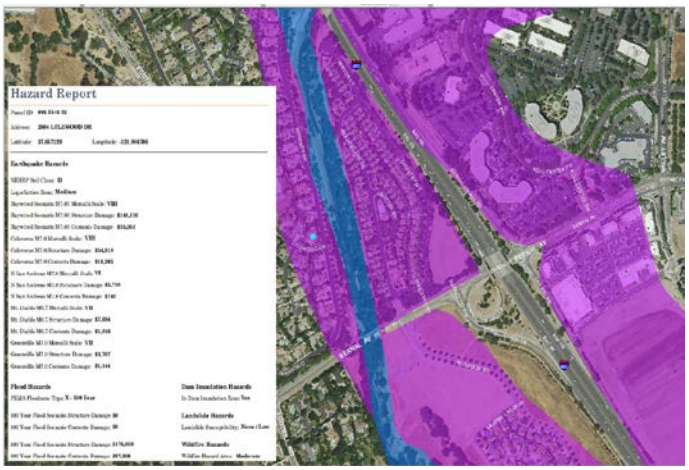


Figure 3-5. Example "Workstation" Report

Press Releases

The planning team distributed press releases over the course of the plan's development as key milestones were achieved and prior to each public meeting. All planning partners were also encouraged to distribute press releases on the project. Press releases and resulting press coverage included the following:

- May 4, 2017—The Independent: Valley Roundup article on commencement of the planning project and invitation to the public to visit the project website (copy of article provided in Appendix A).
- May 18, 2017—Dublin Patch: Announcement of commencement of the planning project and invitation to the public to visit the project website (copy of article provided in Appendix A).
- June 28, 2017—Press release regarding Tri-Valley hazard mitigation plan survey.
- December 8, 2017—Press release announcing the final public comment period for the Draft Plan.
- December 20, 2017— Pleasanton Weekly: Article announcing the final public comment meeting on 12/22/2017 (copy of article provided in Appendix A)

Internet

At the beginning of the plan development process, a website was created to keep the public posted on plan development milestones and to solicit relevant input (see Figure 3-6). The site's address (https://www.tri-valley-hmp.com/) was publicized in all press releases, mailings, surveys and public meetings. Information on the plan development process, the Steering Committee, the survey and phased drafts of the plan was made available to the public on the site throughout the process. The planning partners intend to keep a website active after the plan's completion to keep the public informed about successful mitigation projects and future plan updates.

As part of this website, visitors were encouraged to sign up for project update emails. Two members of the public signed up for continued information through this mailing list. These members received notices of upcoming public meetings and scheduled changes.

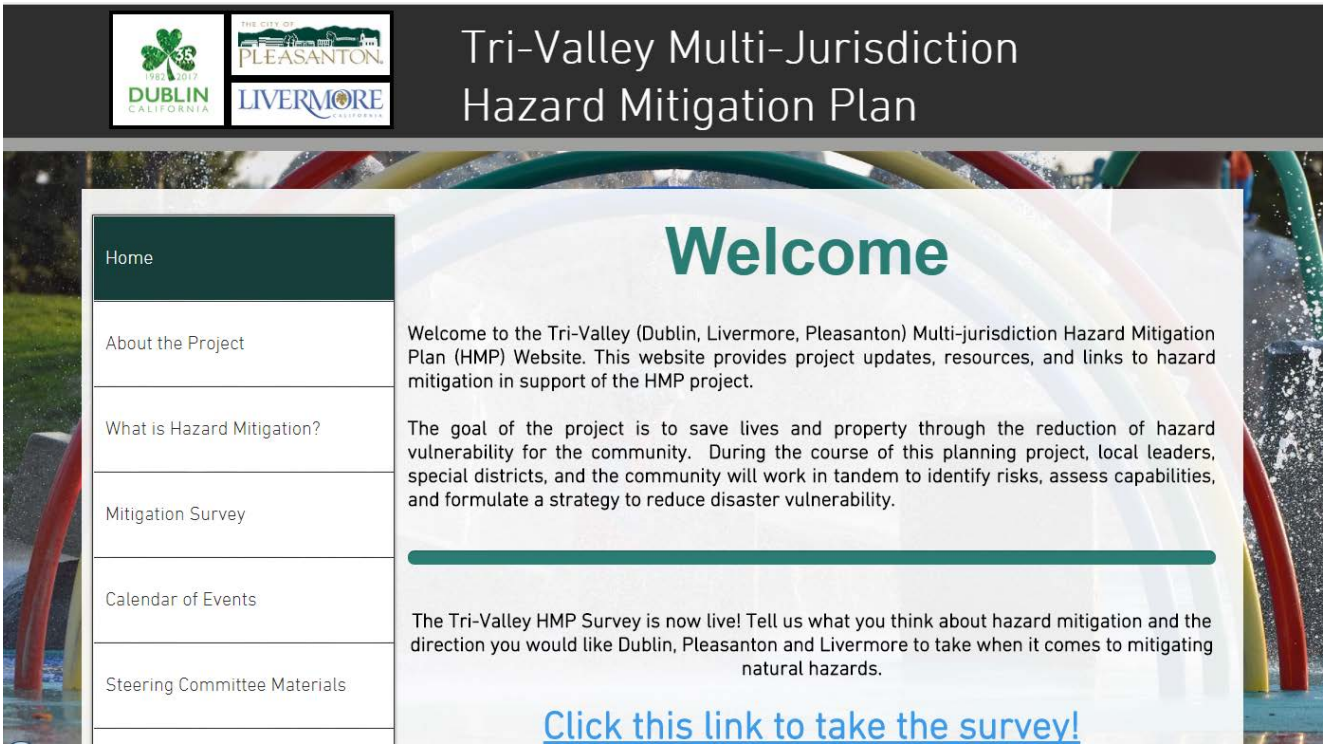


Figure 3-6. Hazard Mitigation Plan Web Site Homepage

Phase 2 Public Outreach—Final Public Comment Process

A 30-day public comment period, from December 12, 2017 to January 11, 2018, provided the public an opportunity to comment on the draft plan update prior to its submittal to Cal OES. The principle mechanism for public comment on the draft plan was the website established for this plan update. Additionally, a public meeting held on Friday, December 22, 2017 to allow an opportunity to provide comment on the draft plan update. This meeting was advertised via an area-wide press release distributed by the City of Pleasanton Public Information Office and received press coverage from the Pleasanton Weakly on December 20, 2017. At the public meeting, a 30-minute presentation was given, followed by a period for questions and answers by those in attendance. Comments received on the draft plan are available upon request. Additionally, a presentation on the draft plan was presented to the Livermore City County on January 8, 2018 (Agenda Item 6.01). This meeting was open to the public.

All comments received during the Phase 2 public outreach were reviewed by the planning team and incorporated into the draft plan as appropriate.

3.8.2 Public Involvement Results

The public involvement strategy used for this hazard mitigation plan update introduced the concept of mitigation to the public and provided the Steering Committee with feedback to use in developing the plan. All citizens of the planning area were provided opportunities to participate and give feedback during all phases of the planning process. Details of attendance and comments received from the public meetings during the public comment period are provided in Appendix A. Table 3-4 provides a summary of public meetings held in support of this project.

Table 3-4. Summary of Public Meetings

Date	Location	Number of Public Contacts	Number of Written Comments Received
July 27, 2017	Dublin Farmers' Market	100	None
September 16,2017	Pleasanton Farmer's Market	85	None
September 21, 2017	Livermore Farmer's Market	45	None
December 22, 2017	Dublin San Ramon Services District Office	3	None
January 8, 2018	Livermore City Council Meeting	20	None
Total		253	None

3.8.3 Continued Public Involvement

The planning partners are committed to the continued involvement of the public in hazard mitigation. Therefore, the draft hazard mitigation plan will be made available for review on the mitigation website. After the hazard mitigation plan has been completed, implementation and ongoing maintenance will become a function of the Planning Partnership. The Planning Partnership will be responsible for reviewing the hazard mitigation plan and accepting public comment as part of an annual review and as part of the five-year mitigation plan update process.

3.9 PLAN DEVELOPMENT CHRONOLOGY/MILESTONES

A summary of Planning Partnership activities, including Steering Committee meetings held during development of this hazard mitigation plan, is included in Table 3-5.

Table 3-5. Plan Development Chronology/Milestones

Date	Event	Description	Attendance
2016			
11/18	Planning Process	Contract executed with Tetra Tech, Inc. to facilitate the plan update process	N/A
12/1	Planning Process	Planning team Conference Call #1, project organization	9
2017			
1/17	Planning Process	Planning Team Conference Call #2	8
1/30	Planning Process	Planning Team Conference Call #3, Confirm Steering Committee and initiate invitation process.	6
3/7	Steering Committee Meeting #1	Planning Partners convened to kickoff planning project with a project overview, Steering Committee's role, previous plan, and public involvement strategy.	16
4/11	Steering Committee Meeting #2	Discussed the hazards of concern, public involvement strategy, and plan mission statement and goals.	12
5/5	Public Outreach	Press coverage on the planning process in The Independent's Valley Roundup.	N/A
5/16	Steering Committee Meeting #3	Discussed plan mission statement and goals, public involvement, hazards of concern, critical facilities, and national policy briefing.	11
5/18	Public Outreach	Announcement in Dublin Patch of commencement of the planning project and invitation to the public to visit the project website	N/A
6/13	Steering Committee Meeting #4	Discussed the planning process, risk assessment update, finalized plan goals, and public involvement.	10
6/28	Pres Release – Hazard Mitigation Plan Survey	Coordinated jurisdictional release of the public survey. Planning partners were encouraged to link to the survey from their jurisdictional webpages	NA
7/11	Steering Committee Meeting #5	Planning process, risk assessment update, objective setting, jurisdictional annex process, public involvement, and plan maintenance schedule discussed.	11
7/27	Dublin's Farmer's Market	Hazard mitigation information booth as part of Farmer's Market. Residents were provided with a mitigation flier that provided information on the project and advertised the project website and survey, property risk assessment, and general preparedness materials.	100+
8/8	Steering Committee Meeting #6	Risk assessment update, draft plan maintenance strategy, jurisdictional annex process, and public involvement.	13
9/12	Steering Committee Meeting #7	Risk assessment update, jurisdictional annex process, public involvement, and strengths, weaknesses, obstacles and opportunities of mitigation actions.	14
9/16	Pleasanton Farmer's Market	Hazard mitigation information booth as part of Farmer's Market. Residents were provided with a mitigation flier that provided information on the project and advertised the project website and survey, property risk assessment, and general preparedness materials.	85+
9/21	Livermore Farmer's Market	Hazard mitigation information booth as part of Farmer's Market. Residents were provided with a mitigation flier that provided information on the project and advertised the project website and survey, property risk assessment, and general preparedness materials.	45+
10/10	Steering Committee Meeting #8	Confirm catalog of hazard mitigation best management practices, Phase 3, jurisdictional annex process, initiate plan review process	14
11/14	Steering Committee Meeting #9	Go over SC comments on Volume 1, finalize phase 2 public engagement strategy, confirm area wide actions, and phase 3 of the Jurisdictional annex status.	
12/8	Public Outreach	Press release announcing final public comment period disseminated by PIO	N/A
12/12 to 1/11	Public Outreach	Final Public Comment Period	N/A
12/22	Phase 2 Public Meeting	Public meeting held at Dublin San Ramon Services District for public comment	3

Date	Event	Description	Attendance
2018			
1/8	Phase 2 Public Meeting	Presentation on draft plan presented to the Livermore City Council. This was an open public meeting	20
1/16	Plan submittal	Pre-adoption review draft of the plan submitted to Cal OES.	N/A
TBD	APA	Approval Pending Adoption (APA) provided by FEMA	N/A
TBD	Adoption	Adoption Window opens for planning partnership	N/A
TBD	Approval	Final Plan approval issued by FEMA region IX	N/A

4. COMMUNITY PROFILE

4.1 GEOGRAPHIC OVERVIEW

The Tri-Valley planning area is in north-central Alameda County in the San Francisco Bay area, east of San Francisco and north of San Jose. The cities of Dublin, Livermore and Pleasanton are located along Interstate 580, which runs east-west through the county. The City of Dublin is north of the intersection of Interstates 580 and 680 and is generally bounded by the City of San Ramon to the north, Castro Valley to the west, the City of Pleasanton to the south, and the City of Livermore to the east. The City of Livermore is north and south of Interstate 580. The Livermore Valley is edged to the north, south, and east by rolling hills, with the cities of Pleasanton and Dublin to the west. The City of Pleasanton extends south of Interstate 580 along Interstate 680, bounded by the City of Dublin on the north, the City of Livermore to the east, the Sunol Valley to the south, and the steep, rugged Pleasanton and main ridges on the west. Figure 4-1 shows the 66.2-square-mile planning area.

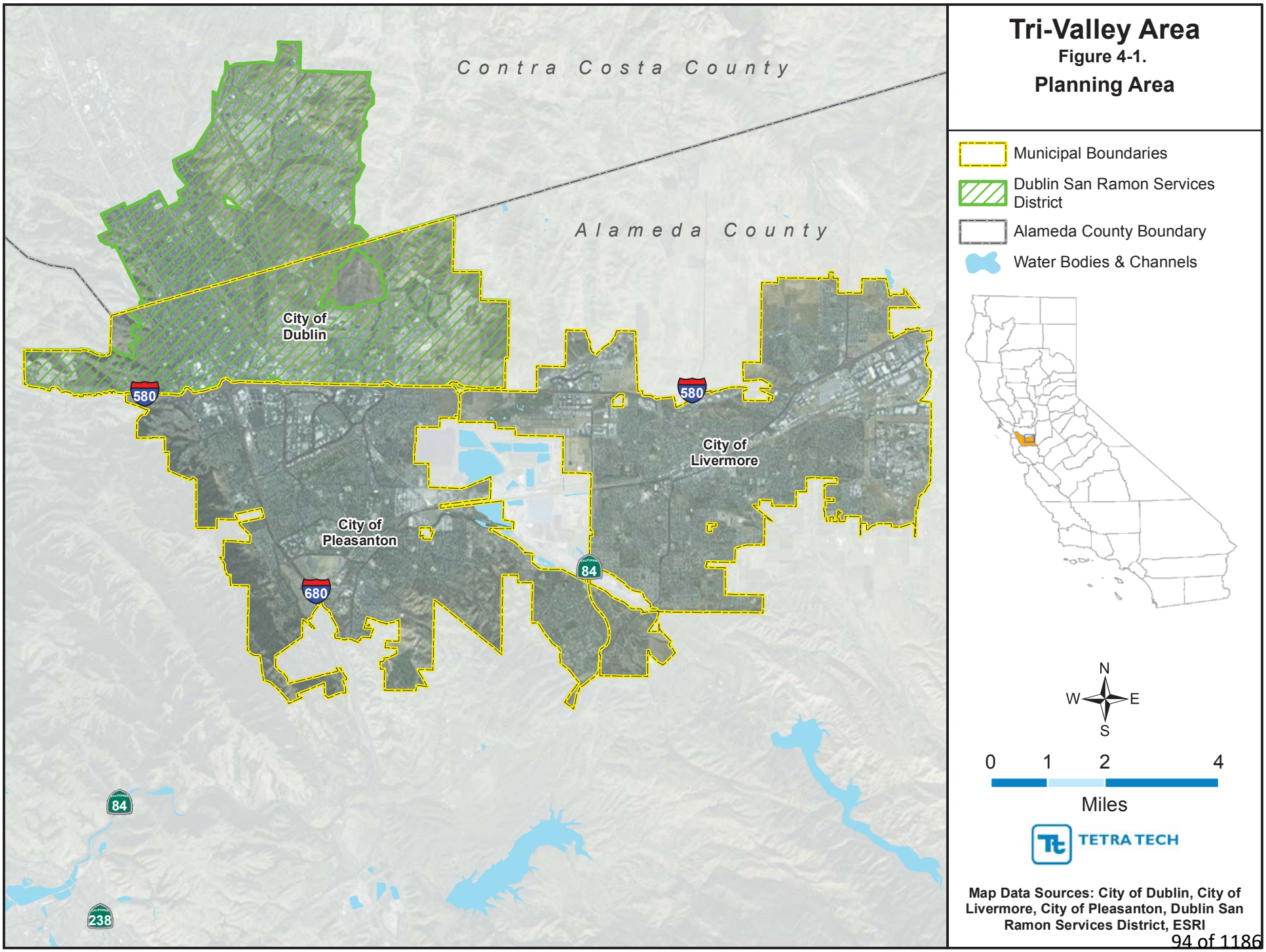
4.2 HISTORICAL OVERVIEW

For thousands of years until the arrival of Spanish settlers in the late 1700s, the Ohlone people, also referred to as Costanoans (the Spanish word for "coast"), lived in and around the Bay Area. Living in small villages, they survived on the abundance of natural resources, including acorns from oak trees and shellfish in the bay. Mission San Jose was founded on June 11, 1797, by Father Fermín Francisco de Lasuén. It was the 14th of the 21 Spanish missions in what is now the western United States. The missionaries required the Indians to move to the mission, and this disruption, as well as new diseases the Spanish brought, destroyed the Indian way of life even before the influx of gold seekers in the mid-1800s (Alameda County Library, 2017).

The Amador-Livermore Valley was first sighted by a Spanish solder in 1772 while on an expedition searching for new mission sites. After 1822, Mexico succeeded Spain in jurisdiction over Alta California. Beginning in 1839, the former mission lands were secularized and broken up into large ranchos as the result of grants to citizens by Mexico. It was a half-century after the initial discovery that Jose Amador, in 1826, brought the first settlement to the valley and Spanish families were awarded large tracts of land.

California became part of the United States after the Mexican War of 1846–1847. The territory was formally ceded in the treaty of Guadalupe Hidalgo in 1848 and was admitted as a state in 1850. Pressure from the United States was a major factor leading to the disintegration of Mexican control in California. The first American settler in the tri-valley area arrived in 1850 and settlement continued. The area was on one of the main routes to the gold fields and became a mercantile stopover for miners on their way to those fields.

Ranchers and thoroughbred horse breeders, also came to the area, attracted to the favorable climate and abundance of water, and were followed by dairy farms, hop fields, and vineyards. The Central Pacific Railroad was completed in 1869, resulting in the establishment of more towns.


Contra Costa County
Alameda County
City of Dublin
City of Livermore
City of Pleasanton
580
580
680
84
84
238
Tri-Valley Area
Figure 4-1.
Planning Area
Municipal Boundaries
Dublin San Ramon Services District
Alameda County Boundary
Water Bodies & Channels
N
W
E
S
0
1
2
4
Miles
TETRA TECH
Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, Dublin San Ramon Services District, ESRI

In 1925, the section of the Lincoln Highway through the area (by 1874 known as Dublin Road) was incorporated into the U.S. Highway system as U.S. Highway 50. In 1928, it was also designated State Route 84. By 1953, U.S. Highway 50 had become a divided four-lane road; Interstate 680 was completed in 1967. By 1973, U.S. Highway 50 had become Interstate 580. Prior to the 1950s, small agricultural towns history and economy were integrated with those of the agricultural areas around them. Since the 1950s, urbanization of the area has grown across former agricultural land, and urban development now dominate the area (Alameda County CDA, 2005).

4.3 MAJOR PAST HAZARD EVENTS

Presidential disaster declarations are typically issued for hazard events that cause more damage than state and local governments can handle without assistance from the federal government, although no specific dollar loss threshold has been established for these declarations. A presidential disaster declaration puts federal recovery programs into motion to help disaster victims, businesses and public entities. Some of the programs are matched by state programs. Since 1953, 18 presidential disaster declarations have been issued for Alameda County, which includes the cities of Dublin, Livermore, and Pleasanton as listed in Table 4-1.

Table 4-1. Presidential Disaster Declarations

Type of Event	FEMA Disaster Number	Declaration Date
Severe Winter Storms, Flooding, Mudslides	DR-4308	April 1, 2017
Severe Winter Storms, Flooding, Mudslides	DR-4305	March 16, 2017
Severe Winter Storms, Flooding, Mudslides	DR-4301	February 14, 2017
Severe Winter Storms, Flooding, Landslides, Mud Flows	DR-1646	June 5, 2006
Severe Winter Storms, Flooding, Landslides, Mud Flows	DR-1628	February 3, 2006
Severe Winter Storms, Flooding	DR-1203	February 9, 1998
Severe Winter Storms, Flooding	DR-1155	January 4, 1997
Severe Winter Storms, Flooding, Landslides, Mud Flows	DR-1046	March 12, 1995
Severe Winter Storms, Flooding, Landslides, Mud Flows	DR-1044	January 10, 1995
Oakland Hills Fire	DR-919	October 22, 1991
Severe Freeze	DR-894	February 11, 1991
Loma Prieta Earthquake	DR-845	October 17, 1989
Severe Storms, Flooding	DR-758	February 12, 1986
Coastal Storms, Floods, Slides, Tornadoes	DR-677	January 21, 1983
Severe Storms, Flood, Mudslides, High Tide	DR-651	January 7, 1982
Drought	EM-3023	January 20, 1977
Forest, Brush Fires	DR-295	September 29, 1970
Severe Storms, Flooding	DR-283	February 16, 1970

Source: FEMA, 2017

Review of these events helps identify targets for risk reduction and ways to increase a community's capability to mitigate damage from large-scale events in the future. Still, many natural hazard events do not trigger federal disaster declaration protocol but have significant impacts on their communities. These events are also important to consider in establishing recurrence intervals for hazards of concern.

4.4 PHYSICAL SETTING

4.4.1 Topography and Geology

The planning area is in the east-central part of the California Coast Range Province that is characterized by elongated ranges and narrow valleys parallel to the coast. It lies in a depression within the Diablo Range where there are three valleys: Amador Valley, Livermore Valley, and San Ramon Valley. The Livermore and Amador Valleys, which are adjacent in an east-west orientation, make up the major part of the basin. San Ramon is a smaller valley that trends northwest from the northwest edge of Amador Valley. Elevations in the planning area range from approximately 300 feet above sea level at the drainage exit of Amador Valley southwest of Pleasanton, to approximately 700 feet above sea level along Livermore Valley's eastern margin. The mean elevation above sea level is 486 feet in the City of Livermore and 354 feet in the City of Dublin. North and east of the Tri-Valley area, the Diablo Range rises to elevations between approximately 1,000 and 2,000 feet above sea level, with Mount Diablo reaching an elevation of 3,849 feet above sea level.

Geologic conditions are controlled by the planning area's location along the complex boundary between the North American and Pacific Plates and the interaction of these two plates. The Pacific Plate moves northwestward relative to the North American Plate at a rate of about 5 centimeters per year. Much of this relative movement at the latitude of the San Francisco Bay Area is accommodated primarily by strike-slip motion along a number of major faults, including the San Gregorio, San Andreas, Hayward, Calaveras, and Greenville faults. Countless other faults in the region accommodate relative motion between major faults and relieve compression stress along the plate boundary.

4.4.2 Hydrology

The Tri-Valley area consists of sub-watersheds of the Alameda Creek Watershed. Arroyo Las Positas, Arroyo Seco, and Arroyo Mocho drain the northeastern and southeastern hills, and Arroyo del Valle drains the southern hills. These drainages converge and flow through the central Tri-Valley area, collecting the flow of Cayetano, Collier, Cottonwood, Tassajara, and Alamo Creeks from the northern hills. These streams join San Ramon Creek, which flows south through the San Ramon Valley and exits the basin along Arroyo de la Laguna. Figure 4-2 shows the entire Alameda Creek Watershed and major water bodies around the Tri-Valley area.

4.4.3 Climate

The climate of the planning area is moderated by its proximity to the San Francisco Bay, with average annual temperatures ranging from 46.7°Fahrenheit (F) to 72.1°F. Climate records from the NOAA National Weather Service Forecast Office describe the region's climate as Mediterranean type. This classification is characterized by sharply contrasting wet and dry seasons, with the wet season from November through March bringing more than 80 percent of the total annual precipitation. Rainfall is sparse from May through September. Mean precipitation in June, July and August in Livermore normally totals only 0.14 inches. Wet seasons are cool but mild, with mean monthly temperatures of 47.2°F in January to 53.1°F in March. Dry season weather is very consistent, with warm sunny days and average temperatures reaching 85.9°F in June, July, August, and September. Average temperature and precipitation across the planning area are shown in Table 4-2.

Source: Alameda Creek Alliance, 2017

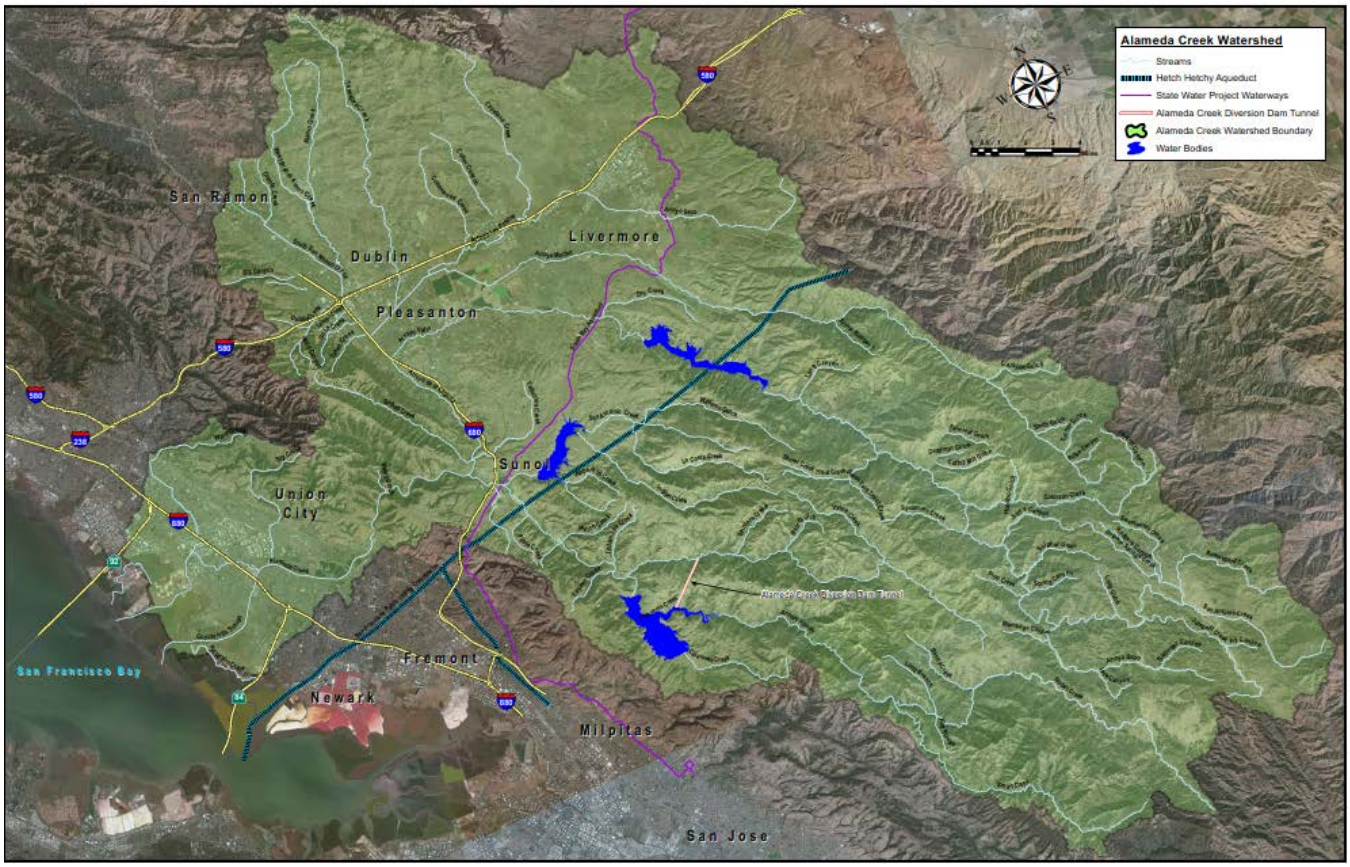


Figure 4-2. Watersheds and Water Bodies in the Planning Area

Table 4-2. Normal Precipitation and Temperatures in Planning Area, 1998-2016

	Precipitation (inches)	Minimum Temperature (ºF)	Maximum Temperature (ºF)
January	2.22	37.3	57.0
February	2.72	39.4	60.1
March	1.92	41.5	64.7
April	1.14	44.0	68.0
May	0.57	48.9	75.0
June	0.13	53.4	81.8
July	0.0	56.6	87.1
August	0.01	56.5	87.4
September	0.08	54.8	85.4
October	0.93	49.1	76.2
November	1.41	41.9	64.6
December	2.82	37.5	57.6
Annual	13.94	46.7	72.1

Source: Western U.S. Climate Historical Summaries, 2017

4.5 DEVELOPMENT PROFILE

4.5.1 Land Use

Dublin

The City of Dublin, located north of Interstate 580, covers 15.51 square miles, or 9,923.6 acres. As of 2017, the city accommodates 20,931 housing units. The City has defined the following planning areas:

- The Primary Planning Area consists of the original city boundaries and annexations completed through 1991. It covers roughly 3,100 acres.
- The Eastern Extended Planning Area is east of the Primary Planning Area and south and east of the U.S. Army's Parks Reserve Forces Training Area (Camp Parks). It covers roughly 4,300 acres.
- The Western Extended Planning Areas is west of the Primary Planning Area. It consists of 3,200 acres, mostly outside Dublin's urban limit line, which encompasses the city areas with access to city utilities and road maintenance services.
- The Dublin Crossing Planning Area, a portion of Camp Parks, covers 189 acres in the center of the city where existing buildings are scheduled for demolition to be replaced with a residential mixed-use project.

The city's land use includes a mixture of public open space, commercial/industrial, and residential. Development guidelines for the Eastern Extended Planning Area consider visually sensitive ridge lands and biologically sensitive habitat areas to preserve key elements of the area's physical character. A development elevation cap keeps growth within the 770-foot elevation that is the highest serviceable elevation for water service. Development is allowed in only a small portion of the Western Extended Planning Area; that area is out of view from the major ridgelines so it can be developed without disrupting scenic values (General Plan, 2014).

Livermore

The City of Livermore, on the eastern side of the Tri-Valley planning area, covers 26.46 square miles, or 16,931.3 acres. As of 2017, the city accommodates 31,848 housing units. Single-family residential development is the predominant land use within the city limits, with residential subdivisions scattered throughout the city. Other land uses are agriculture, open space and parks, industry, retail and office space, and community facilities. The city has a defined urban growth boundary to protect agricultural uses and natural resources outside the city from future urban development (General Plan, 2014).

Pleasanton

The City of Pleasanton covers 24.24 square miles, or 15,513.8 acres, and he City designates future land use for an additional 75-square-mile area. A 42-square-mile sphere-of-influence area represents the probable ultimate physical boundary and service area of the city. As of 2017, the City accommodates 27,176 housing units. City land use policy allows for well-planned neighborhoods and a separation between residential and non-residential uses. As of 2017, there are 77 residential neighborhoods and 17 commercial, office, and industrial development sub-areas. The City's growth management ordinance regulates the location and rate of new residential growth. (General Plan, 2015).

Summary

Table 4-3 summarizes current land use across the Tri-Valley planning area. Land use information is analyzed in this plan for each identified hazard that has a defined spatial extent and location. For hazards that lack this spatial reference, the information in Table 4-3 serves as a baseline estimate of land use and exposure for the planning area. The distribution of land uses within the planning area will change over time.

Table 4-3. Present Land Use in Planning Area

Present Use Classification	Area (acres)	% of total
Residential	14,343	33.9%
Commercial	3,737	8.8%
Industrial	1,599	3.8%
Agriculture	99	0.2%
Religion / Assembly	567	1.3%
Government / Institutional	2,576	6.1%
Education	952	2.2%
Vacant / Rights-of-Way / Water / Open Space	18,496	43.7%
Total	42,369	100.0%

4.5.2 Critical Facilities and Infrastructure

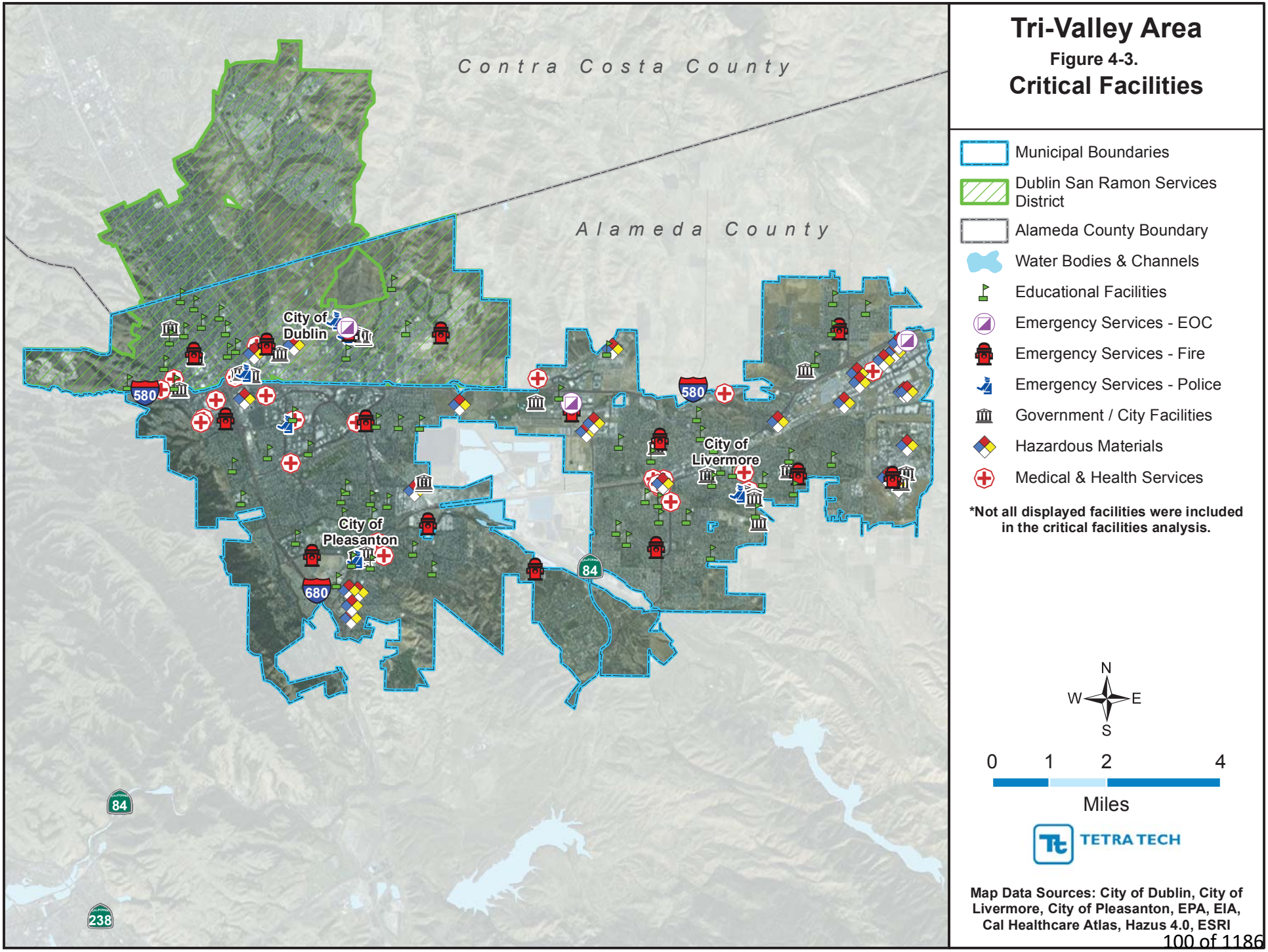
Facilities and infrastructure that are essential to the health and welfare of the population are designated as critical facilities and infrastructure. These are especially important after a hazard event. Critical facilities typically include police and fire stations, schools and emergency operations centers. Critical infrastructure can include the roads and bridges that provide ingress and egress and allow emergency vehicles access to those in need, as well as the utilities that provide water, electricity and communication services to the community. Also included are facilities and railroads that hold or carry significant amounts of hazardous materials with a potential to impact public health and welfare in a hazard event. For this hazard mitigation plan, a critical facility is defined as follows:

> *A structure or other improvement that, because of its function, size, service area, or uniqueness, has the potential to cause serious bodily harm, extensive property damage, or disruption of vital socioeconomic activities if it is destroyed or damaged or if its functionality is impaired. Critical facilities include potential shelters, transportation facilities, potential morgue facilities, private facilities, levees, health and safety facilities, utilities, government facilities, and hazardous materials facilities.*

Figure 4-3 and Figure 4-4 show the location of critical facilities and infrastructure in the planning area. Due to the sensitivity of this information, a detailed list of facilities is not provided. Table 4-4 provides summaries of the general types of critical facilities and infrastructure. All critical facilities/infrastructure were analyzed in Hazus to help rank risk and identify mitigation actions. The risk assessment for each hazard qualitatively discusses critical facilities with regard to that hazard.

Table 4-4. Planning Area Critical Facilities

	Number of Facilities								
	Medical and Health Services	Emergency Services	Educational Facilities	Government	Utilities	Transportation Infrastructure	Hazardous Materials	Other Assets	Total
Dublin	5	10	16	11	3	26	2	0	73
Livermore	11	9	26	11	28	61	16	0	162
Pleasanton	9	7	20	7	101	62	7	0	213
Total	25	26	62	29	132	149	25	0	448



Tri-Valley Area

Figure 4-3.

Critical Facilities

- Municipal Boundaries
- Dublin San Ramon Services District
- Alameda County Boundary
- Water Bodies & Channels
- Educational Facilities
- Emergency Services - EOC
- Emergency Services - Fire
- Emergency Services - Police
- Government / City Facilities
- Hazardous Materials
- Medical & Health Services

***Not all displayed facilities were included in the critical facilities analysis.**

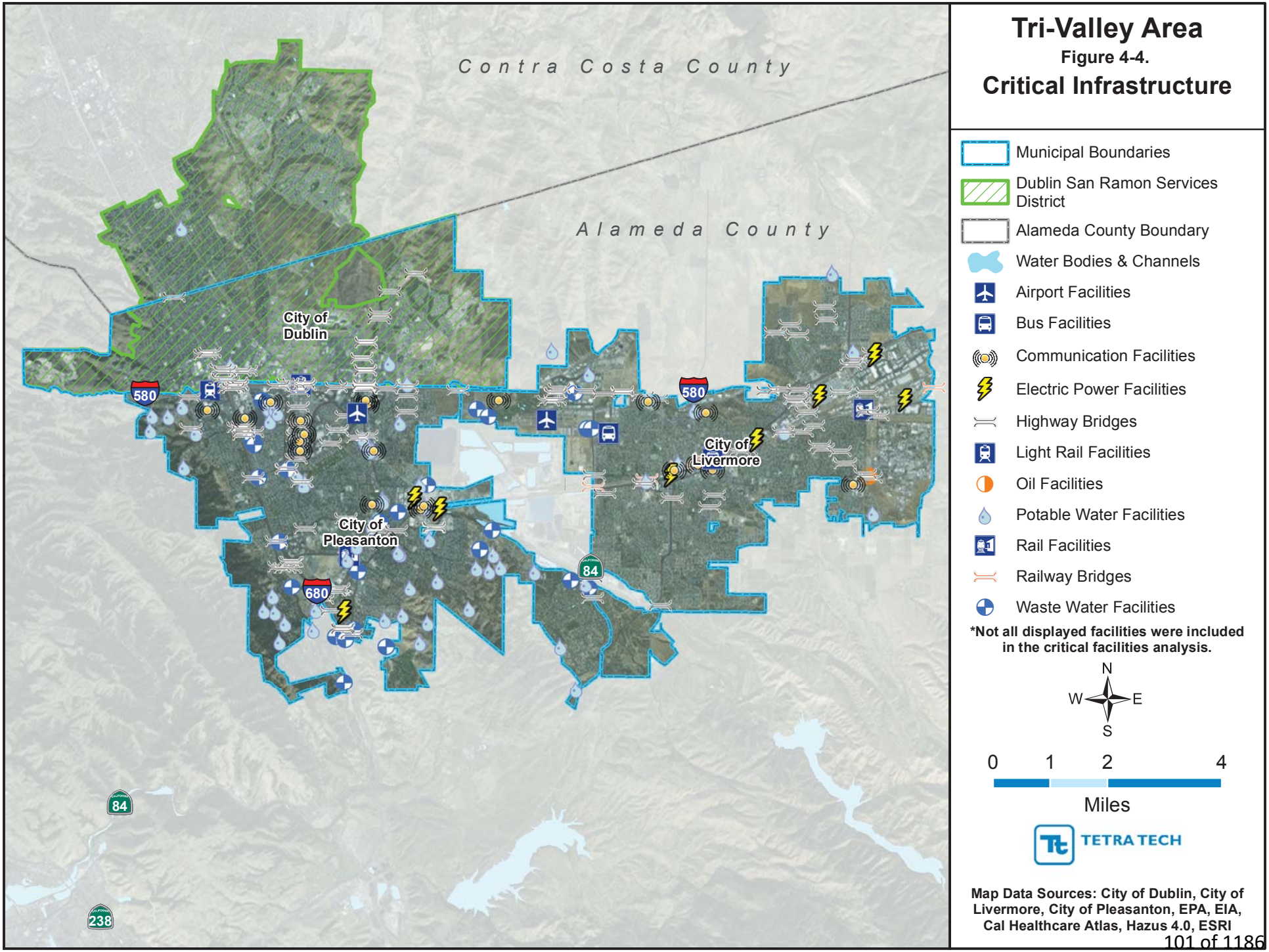
N
W E
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Miles

TETRA TECH

Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, EPA, EIA, Cal Healthcare Atlas, Hazus 4.0, ESRI



Tri-Valley Area

Figure 4-4.

Critical Infrastructure

- Municipal Boundaries
- Dublin San Ramon Services District
- Alameda County Boundary
- Water Bodies & Channels
- Airport Facilities
- Bus Facilities
- Communication Facilities
- Electric Power Facilities
- Highway Bridges
- Light Rail Facilities
- Oil Facilities
- Potable Water Facilities
- Rail Facilities
- Railway Bridges
- Waste Water Facilities

***Not all displayed facilities were included in the critical facilities analysis.**

N
W E
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Miles

TETRA TECH

Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, EPA, EIA, Cal Healthcare Atlas, Hazus 4.0, ESRI

4.5.3 Future Trends in Development

The planning area municipal partners have adopted general and economic development strategic plans to guide future growth, both local and area-wide, and ensure the orderly development of the communities. Development forecasts and development trends assist in providing a long-term vision for the planning area's future and a strategy for achieving the desired vision. This plan aligns with these development programs and provides vital information on the risk associated with natural hazards in the planning area to support wise land use in the future.

Tracking building permit volume can be a way of looking at the potential increase in exposure within the planning area. Weather a permit is issued for new construction or improvement to existing construction, the permit volume can be associated with an increase in exposed value. The number of residential building permits reported in the planning area has fluctuated significantly from a high of 965 permits in 2014 to a low of 227 permits in 2007. The permit number jumped in 2012 and stayed steady through 2014. In 2014, the City of Dublin issued residential building permits for 816 buildings, which was significantly higher than the City of Livermore with 71 and the City of Pleasanton with 78 (City-Data.com, 2017).

Figure 4-5 shows the trends in residential development projects in the planning area since 2005. Additional city-specific development trend information is provided in the city-specific annexes in Volume 2 of this plan.

Source: City-Data.com, 2017

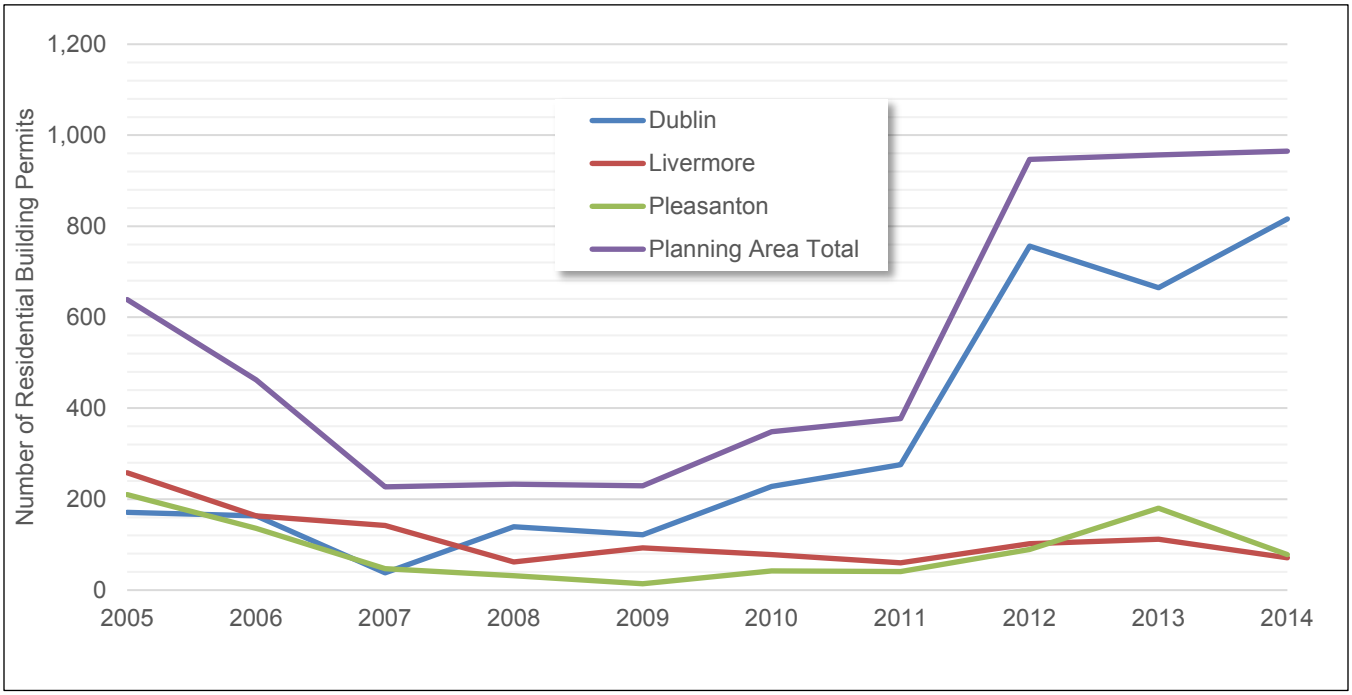


Figure 4-5. Residential Building Permit Trends, 2005 to 2014

The municipal partners will incorporate this hazard mitigation plan in their general plans by reference. This will ensure that future development trends can be established with the benefits of the information on risk and vulnerability to natural hazards identified in this plan. The planning partners intend to pursue the following:

- Discourage development within vulnerable areas, areas with the potential for high population density, and Special Flood Hazard Areas.
- Encourage higher regulatory standards at the local level.

Future development is expected to focus on infill as identified through current land use practices. Dublin, Livermore and Pleasanton are largely built out, and with sustainability practices and urban growth boundaries in place, there is little opportunity for new growth.

4.6 DEMOGRAPHICS

In general, the functional and access needs populations are at greater risk from hazard events because of decreased resources or physical abilities. Elderly people, for example, may be more likely to require additional assistance. Research has shown that people living near or below the poverty line, the elderly (especially older single men), people with disabilities, women, children, ethnic minorities and renters all experience, to some degree, more severe effects from disasters than the general population. These vulnerable populations may vary from the general population in risk perception, living conditions, access to information before, during and after a hazard event, capabilities during an event, and access to resources for post-disaster recovery. Indicators of vulnerability—such as disability, age, poverty, and minority race and ethnicity—often overlap spatially and often in the geographically most vulnerable locations. Detailed spatial analysis to locate areas where there are higher concentrations of vulnerable community members would help to extend focused public outreach and education to these most vulnerable citizens.

4.6.1 Population Characteristics

Knowledge of the composition of the population and how it has changed in the past and how it may change in the future is needed for making informed decisions about the future. Information about population is a critical part of planning because it directly relates to land needs such as housing, industry, stores, public facilities and services, and transportation. The California Department of Finance (CA DOF) estimated the planning area population at 225,250 as of January 1, 2017.

Population changes are useful socio-economic indicators. A growing population generally indicates a growing economy, while a decreasing population signifies economic decline. Figure 4-6 shows the planning area and Alameda County population change from 1970 to 2017 according to the California Department of Finance. Between 1970 and 2017, Alameda County's population grew by 53.32 percent and the planning area's population increased by 223.30 percent. Much of the growth in the planning area occurred between 1970 and 1990, though double-digit growth continues and the local growth still exceeds that of the county. The population of the planning area increased 72.55 percent from 1990 to 2017, with Dublin gaining 36,457 residents, Livermore gaining 32,907, and Pleasanton gaining 25,346. Table 4-5 shows population in the planning area from 2010 to 2017 (CA DOF, 2017a).

4.6.2 Age Distribution

As a group, the elderly are more apt to lack the physical and economic resources necessary for response to hazard events and are more likely to suffer health-related consequences making recovery slower. They are more likely to be vision, hearing, and/or mobility impaired, and more likely to experience mental impairment or dementia. Additionally, the elderly are more likely to live in assisted-living facilities where emergency preparedness occurs at the discretion of facility operators. These facilities are typically identified as "critical facilities" by emergency managers because they require extra notice to implement evacuation. Elderly residents living in their own homes may have more difficulty accessing information or evacuating their homes and could be stranded in dangerous situations. This population group is more likely to need individualized medical attention, which may not be readily available during natural disasters due to isolation caused by the event. Specific planning attention for the elderly is an important consideration given the current aging of the American population.

Source: CA DOF, 2017a

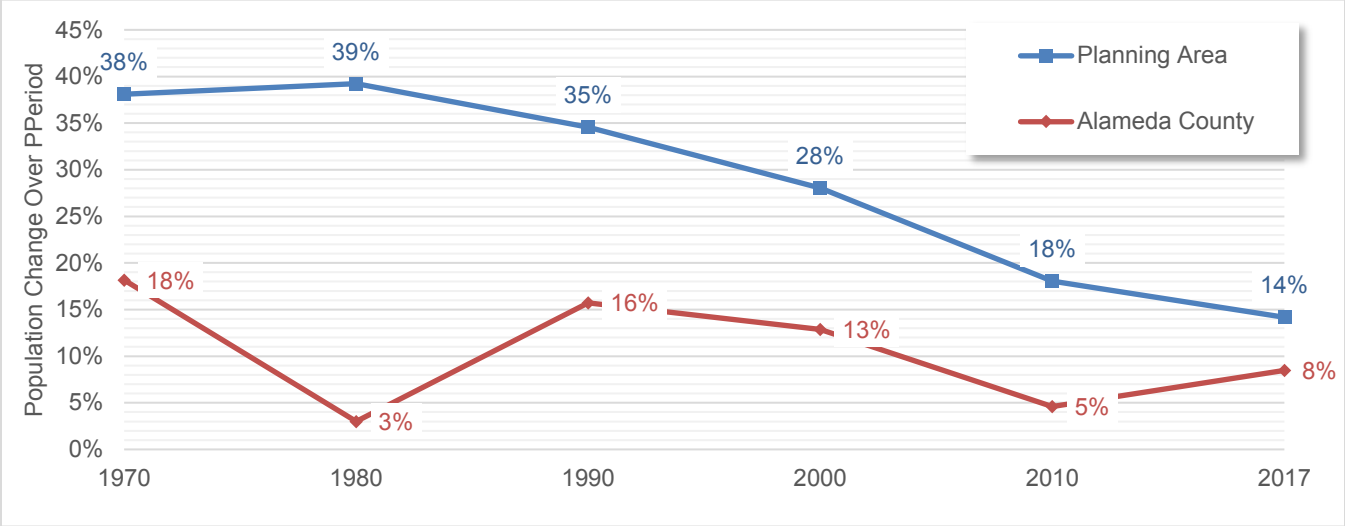


Figure 4-6. Alameda County vs. Planning Area Population Growth

Table 4-5. Annual Population Data

	Population			
	Dublin	Livermore	Pleasanton	**Tri-Valley Planning Area**
2010	46,036	80,968	70,285	197,289
2011	46,408	81,948	70,813	199,169
2012	46,956	82,772	71,117	200,845
2013	50,079	83,768	71,153	205,000
2014	53,512	85,049	71,990	210,551
2015	56,014	86,368	73,776	216,158
2016	57,349	88,138	74,982	220,469
2017	59,686	89,648	75,916	225,250

Source: CA DOF, 2017a

Children under 14 are particularly vulnerable to disaster events because of their young age and dependence on others for basic necessities. Very young children may additionally be vulnerable to injury or sickness; this vulnerability can be worsened during a natural disaster because they may not understand the measures that need to be taken to protect themselves from hazards.

The overall age distribution for the planning area is shown in Figure 4-7. Based on the U.S. Census 2011-2015 American Community Survey (ACS) 5-year estimates, 11.41 percent of the planning area's population is 65 or older, compared to Alameda County's average of 12.1 percent. The Census data also show that 4.23 percent of the under-65 population has disabilities of some kind and 4.7 percent have incomes below the poverty line. It is also estimated that 26.8 percent of the population is 18 or younger, compared to Alameda County's average of 21.7 percent (U.S. Census, 2016).

Source: U.S. Census, 2016

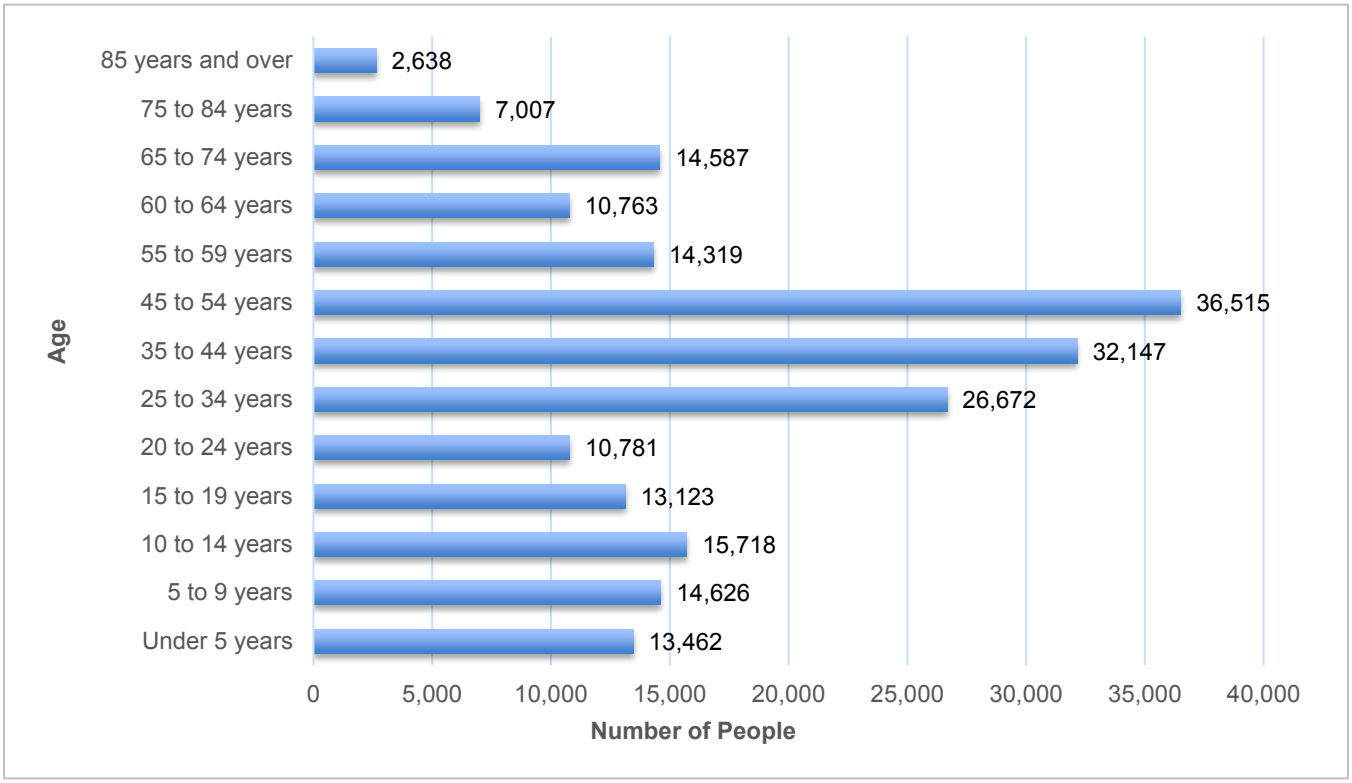


Figure 4-7. Planning Area Age Distribution

4.6.3 Race, Ethnicity and Language

Research shows that minorities are less likely to be involved in pre-disaster planning and experience higher mortality rates during a disaster event. Post-disaster recovery can be ineffective and is often characterized by cultural insensitivity. Since higher proportions of ethnic minorities live below the poverty line than the majority white population, poverty can compound vulnerability. According to the U.S. Census 2011-2015 ACS 5-year estimates, the racial composition of the planning area is predominantly white, at 67 percent, with 22 percent Asian and 3 percent black or African American. Figure 4-8 shows the racial distribution in the planning area. Census data also indicate that 15 percent of individuals in the planning area are Hispanic or Latino (of any race) and that 24.33 percent of the planning area population is foreign-born.

4.6.4 Individuals with Disabilities and Others with Access and Functional Needs

The 2010 U.S. Census estimates that 54 million non-institutionalized people with disabilities and others with access and functional needs live in the U.S. This equates to about one-in-five persons. This population is more likely to have difficulty responding to a hazard event than the general population. Local government is the first level of response to assist these individuals, and coordination of efforts to meet their needs is paramount to life safety efforts. Knowing the percentage of population with a disability or access and functional need will allow emergency management personnel and first responders to have personnel available who can provide services needed by this population. According to the 2011-2015 ACS 5-year estimates, there are 15,044 individuals with some form of disability, access, or functional need within the planning area (U.S. Census, 2016a).

Source: U.S. Census, 2016

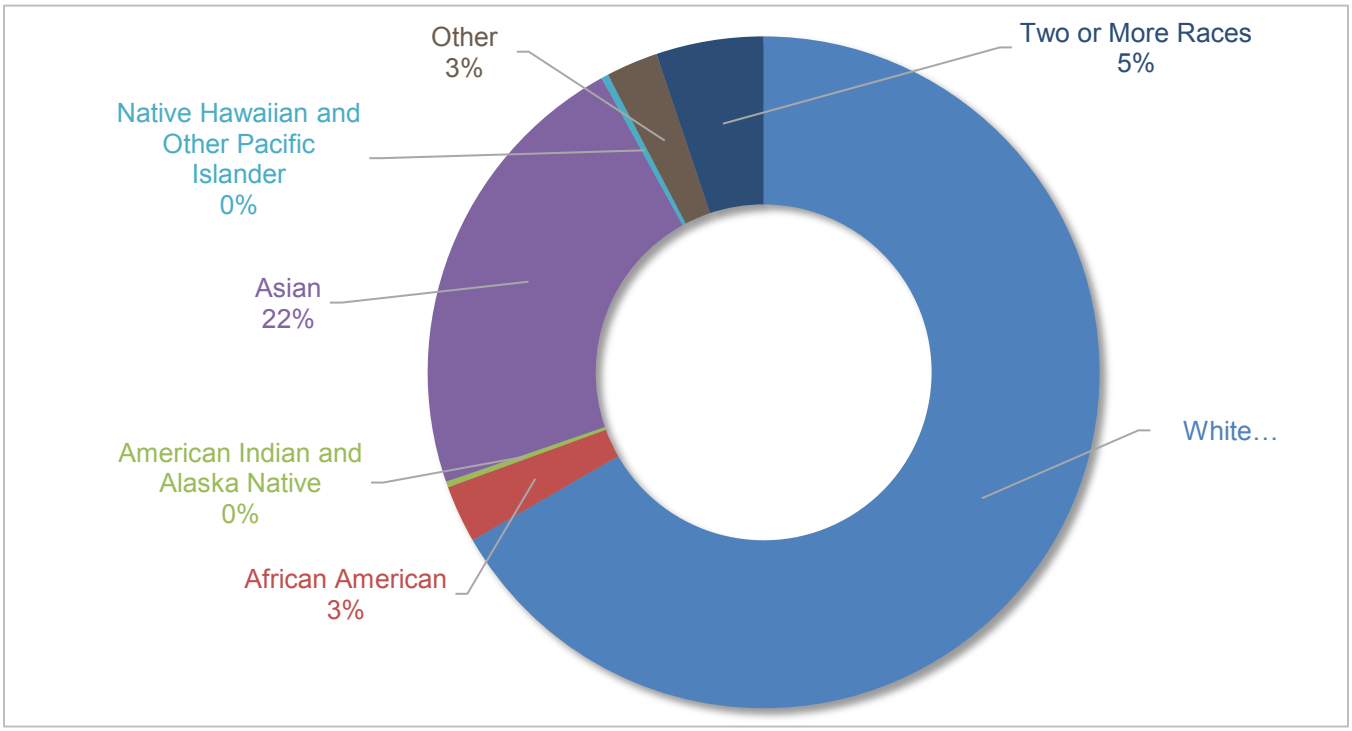


Figure 4-8. Planning Area Race Distribution

4.7 ECONOMY

4.7.1 Income

In the United States, individual households are expected to use private resources to prepare for, respond to and recover from disasters to some extent. This expectation means that households living in poverty are automatically disadvantaged when confronting hazards. Additionally, the economically disadvantaged typically occupy more poorly built and inadequately maintained housing. Mobile or modular homes, for example, are more susceptible to damage in earthquakes and floods than other types of housing. In urban areas, the economically disadvantaged often live in older houses and apartment complexes, which are more likely to be made of unreinforced masonry, a building type that is particularly susceptible to damage during earthquakes. Furthermore, residents below the poverty level are less likely to have insurance to compensate for losses incurred from natural disasters. This means that residents below the poverty level have a great deal to lose during an event and are the least prepared to deal with potential losses. The events following Hurricane Katrina in 2005 illustrated that personal household economics significantly impact people's decisions on evacuation. Individuals who cannot afford gas for their cars will likely decide not to evacuate.

Based on 2011-2015 ACS 5-year estimates, average per capita income in the planning area in 2015 was $47,658 and the median household income was $114,841. As defined by the Office of Management and Budget and U.S. Census Bureau, the poverty threshold in 2015 was $24,257 for a household with two adults and two children, and $12,082 for one person (unrelated individual) (U.S. Census, 2016b).

2011-2015 ACS 5-year estimates showed that roughly 22.45 percent of households in the planning area receive an income between $100,000 and $149,999 per year and over 34.50 percent of household incomes are above $150,000 annually. About 8.10 percent of the households in the planning area make less than $25,000 per year.

4.7.2 Industry, Businesses and Institutions

Figure 4-9 shows the planning area breakdown of employment by U.S. Census-defined industry types from 2011-2015 ACS 5-year estimates. Professional, scientific, and management, and administrative and waste management services has the highest percentage of employees with 15.5 percent. Followed by educational services, and health care and social assistance with 13.3 percent.

Source: U.S. Census, 2016c

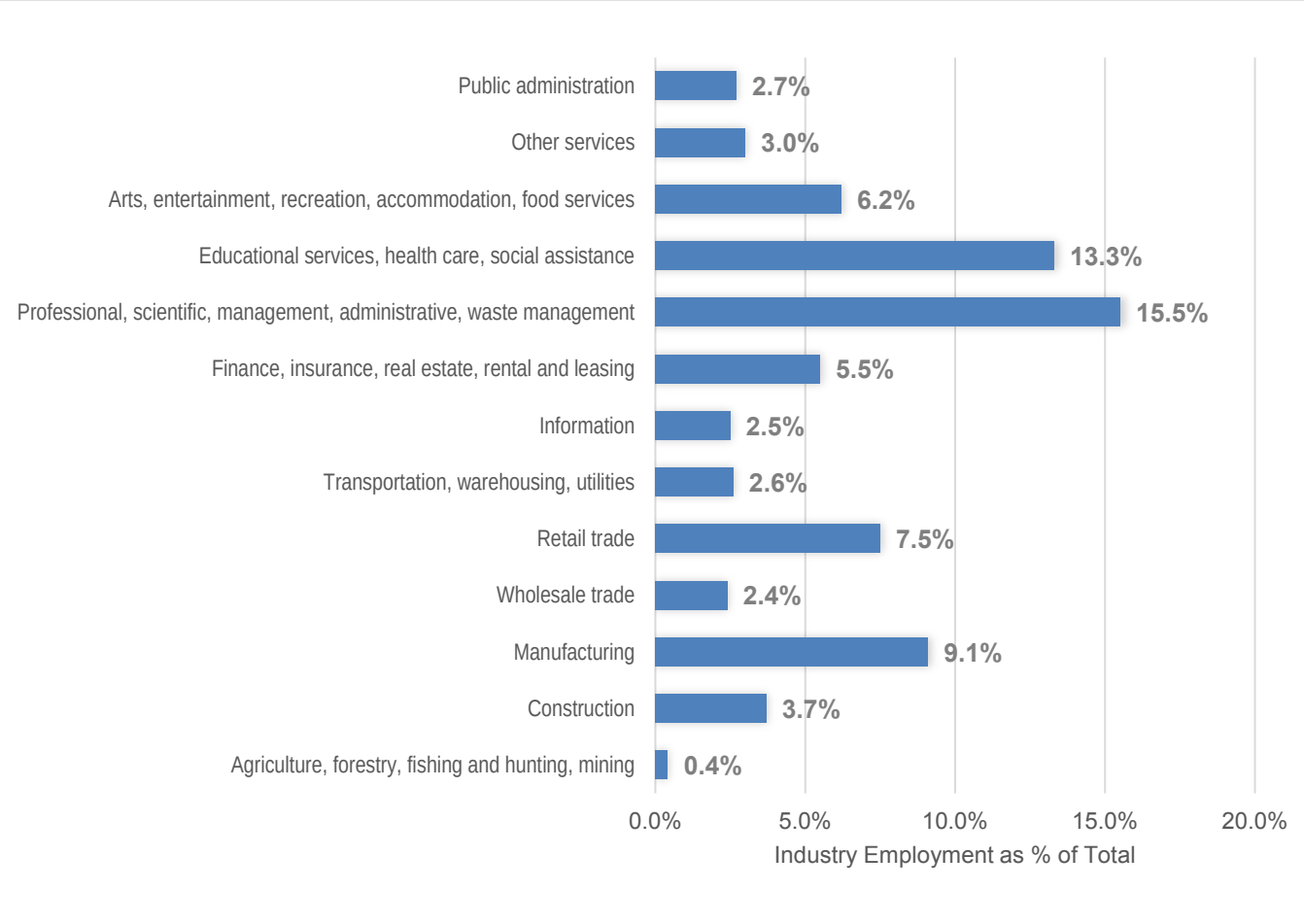


Figure 4-9. Industry in the Planning Area by Population Employed

The planning area benefits from a variety of business activity. Major businesses with headquarters in Dublin include Ross Stores, Challenge Dairy, Tria Beauty and DeSilva Gates Construction. Technology firms in Dublin include Micro Dental Laboratories, Callidues Cloud, Carl Zeiss Meditec, and Epicor. Top employers in City of Livermore include Lawrence Livermore National Laboratory, Valley Care Health System Lifestyle Rx Fitness Center, Livermore Valley Joint Unified School District, Comcast Cable, and Sandia National Laboratory, and Form Factor, Inc., Gillig Bus, and Tesla warehouse. Top employers in City of Pleasanton include Kaiser Permanente, Safeway, Oracle, Workday Inc., Pleasanton Unified School District, Macy's, and Valley Care Medical Center.

4.7.3 Employment Trends and Occupations

According to the 2011-2015 ACS 5-year estimates, about 50 percent of the planning area's population is in the labor force. Of the working-age population group (ages 18 – 64), 48 percent of the population in the labor force are employed. Figure 4-10 shows the distribution of workers by occupation category.

Source: U.S. Census, 2016d

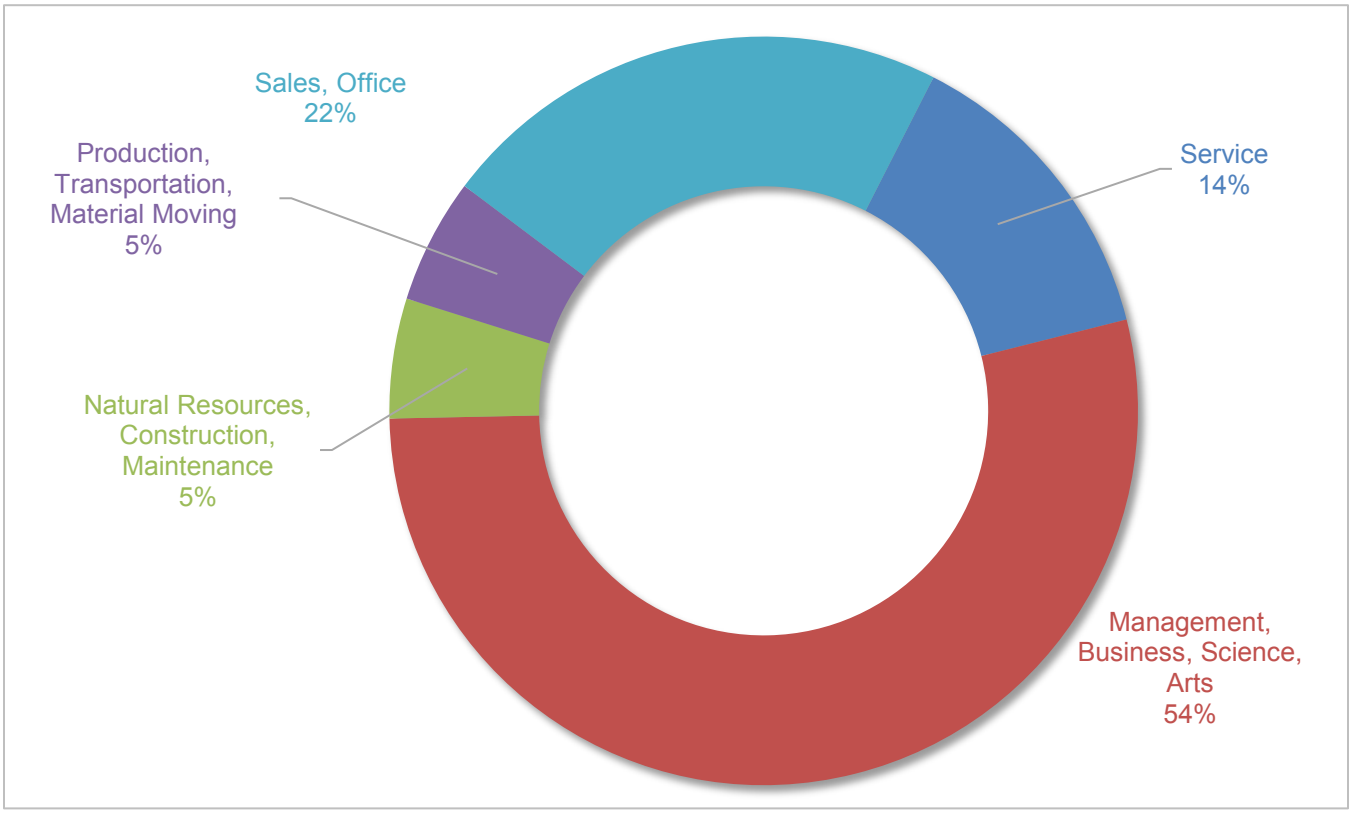


Figure 4-10. Occupations in the Planning Area

Figure 4-11 compares California and planning area unemployment trends from 2010 through 2016. Unemployment in the planning area has remained lower than the state average, and is lowest in 2016, at 4.20 percent. Unemployment rates have been on the decline since until 2010 in both the state and the planning area.

The 2011-2015 ACS 5-year estimates show that over 70 percent of the employed population 16 years and older in the planning area, or 97,722 individuals, commute to work. Of those, 80.90 percent drove alone (by car, truck or van) to work, and 8.18 percent carpooled (by car, truck or van). The mean travel time to work in the planning area is 32 minutes; the state average is 27.6 minutes (U.S. Census, 2016e).

Source: CA EDD, 2017

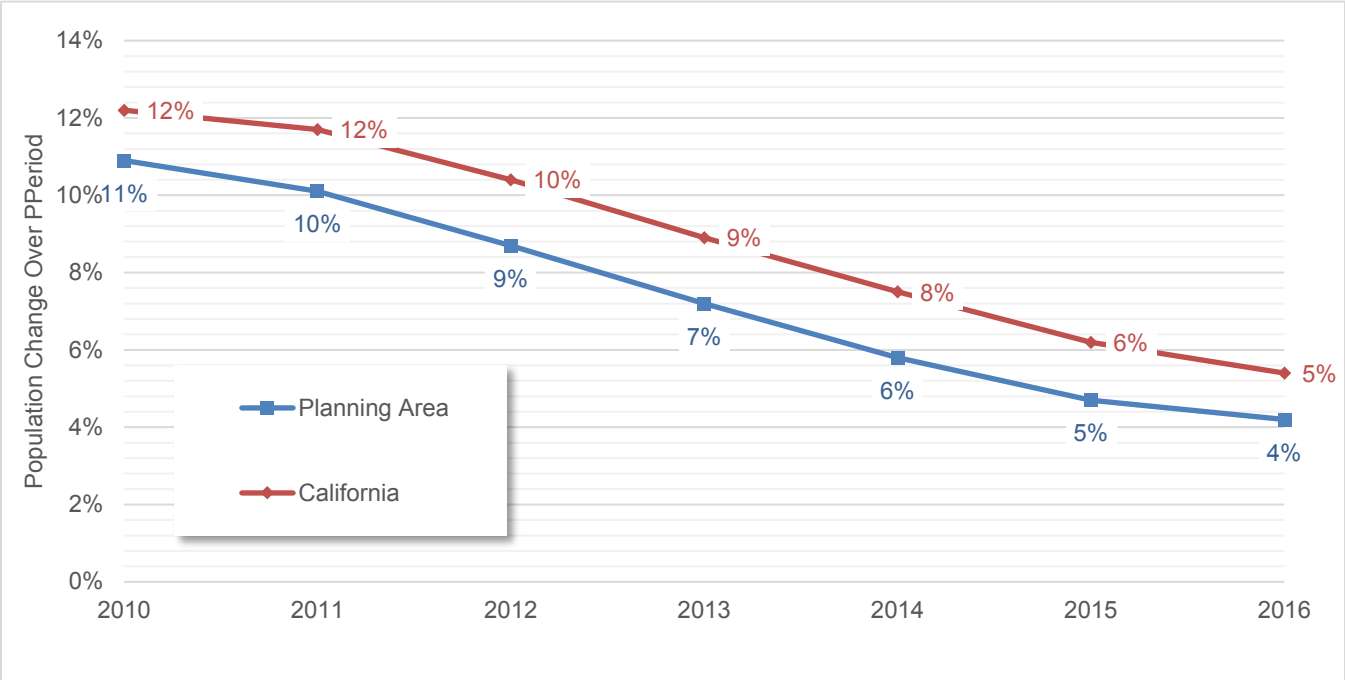


Figure 4-11. California State and Planning Area Unemployment Rate

4.8 LAWS AND ORDINANCES

Existing laws, ordinances, plans and programs at the federal, state and local level can support or impact hazard mitigation actions identified in this plan. Hazard mitigation plans are required to include a review and incorporation, if appropriate, of existing plans, studies, reports, and technical information as part of the planning process (44 CFR, Section 201.6(b)(3)). The following federal and state programs have been identified as programs that may interface with the actions identified in this plan. Each program enhances capabilities to implement mitigation actions or has a nexus with a mitigation action in this plan. Information presented in this section can be used in the review of local capabilities to implement the actions found in the jurisdictional annexes of Volume 2. Each planning partner has individually reviewed existing local plans, studies, reports, and technical information in its jurisdictional annex, presented in Volume 2.

4.8.1 Federal

Disaster Mitigation Act

The DMA is the current federal legislation addressing hazard mitigation planning. It emphasizes planning for disasters before they occur, specifically addressing planning at the local level, and requiring plans to be in place before Hazard Mitigation Grant Program funds are available to communities. This plan is designed to meet the requirements of DMA, improving eligibility for future hazard mitigation funds.

National Environmental Policy Act

The National Environmental Policy Act (NEPA) requires federal agencies to consider the environmental impacts of proposed actions and reasonable alternatives to those actions, alongside technical and economic considerations. NEPA established the Council on Environmental Quality (CEQ), whose regulations (40 CFR Parts 1500-1508) set standards for NEPA compliance. Consideration and decision-making regarding environmental impacts must be

documented in an environmental impact statement or environmental assessment. Environmental impact assessment requires the evaluation of reasonable alternatives to a proposed action, solicitation of input from organizations and individuals that could be affected, and an unbiased presentation of direct, indirect, and cumulative environmental impacts. FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

Endangered Species Act

The federal Endangered Species Act (ESA) was enacted in 1973 to conserve species facing depletion or extinction and the ecosystems that support them. The act sets forth a process for determining which species are threatened and endangered and requires the conservation of the critical habitat in which those species live. The ESA provides broad protection for species of fish, wildlife and plants that are listed as threatened or endangered. Provisions are made for listing species, as well as for recovery plans and the designation of critical habitat for listed species. The ESA outlines procedures for federal agencies to follow when taking actions that may jeopardize listed species and contains exceptions and exemptions. It is the enabling legislation for the Convention on International Trade in Endangered Species of Wild Fauna and Flora. Criminal and civil penalties are provided for violations of the ESA and the Convention.

Federal agencies must seek to conserve endangered and threatened species and use their authorities in furtherance of the ESA's purposes. The ESA defines three fundamental terms:

- **Endangered** means that a species of fish, animal or plant is "in danger of extinction throughout all or a significant portion of its range." (For salmon and other vertebrate species, this may include subspecies and distinct population segments.)
- **Threatened** means that a species "is likely to become endangered within the foreseeable future." Regulations may be less restrictive for threatened species than for endangered species.
- **Critical habitat** means "specific geographical areas that are…essential for the conservation and management of a listed species, whether occupied by the species or not."

Five sections of the ESA are of critical importance to understanding it:

- **Section 4: Listing of a Species**—The National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries) is responsible for listing marine species; the U.S. Fish and Wildlife Service is responsible for listing terrestrial and freshwater aquatic species. The agencies may initiate reviews for listings, or citizens may petition for them. A listing must be made "solely on the basis of the best scientific and commercial data available." After a listing has been proposed, agencies receive comment and conduct further scientific reviews for 12 to 18 months, after which they must decide if the listing is warranted. Economic impacts cannot be considered in this decision, but it may include an evaluation of the adequacy of local and state protections. Critical habitat for the species may be designated at the time of listing.
- **Section 7: Consultation**—Federal agencies must ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed or proposed species or adversely modify its critical habitat. This includes private and public actions that require a federal permit. Once a final listing is made, non-federal actions are subject to the same review, termed a "consultation." If the listing agency finds that an action will "take" a species, it must propose mitigations or "reasonable and prudent" alternatives to the action; if the proponent rejects these, the action cannot proceed.
- **Section 9: Prohibition of Take—**It is unlawful to "take" an endangered species, including killing or injuring it or modifying its habitat in a way that interferes with essential behavioral patterns, including breeding, feeding or sheltering.

- **Section 10: Permitted Take**—Through voluntary agreements with the federal government that provide protections to an endangered species, a non-federal applicant may commit a take that would otherwise be prohibited as long as it is incidental to an otherwise lawful activity (such as developing land or building a road). These agreements often take the form of a "Habitat Conservation Plan."
- **Section 11: Citizen Lawsuits**—Civil actions initiated by any citizen can require the listing agency to enforce the ESA's prohibition of taking or to meet the requirements of the consultation process.

FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

The Clean Water Act

The federal Clean Water Act (CWA) employs regulatory and non-regulatory tools to reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. These tools are employed to achieve the broader goal of restoring and maintaining the chemical, physical, and biological integrity of the nation's surface waters so that they can support "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water."

Evolution of CWA programs over the last decade has included a shift from a program-by-program, source-by-source, pollutant-by-pollutant approach to more holistic watershed-based strategies. Under the watershed approach, equal emphasis is placed on protecting healthy waters and restoring impaired ones. A full array of issues are addressed, not just those subject to CWA regulatory authority. Involvement of stakeholder groups in the development and implementation of strategies for achieving and maintaining water quality and other environmental goals is a hallmark of this approach.

FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

Emergency Relief for Federally Owned Roads Program

The U.S. Forest Service's Emergency Relief for Federally Owned Roads Program was established to assist federal agencies with repair or reconstruction of tribal transportation facilities, federal lands transportation facilities, and other federally owned roads that are open to public travel and have suffered serious damage by a natural disaster over a wide area or by a catastrophic failure. The program funds both emergency and permanent repairs (Office of Federal Lands Highway, 2016). Eligible activities under this program meet some of the goals and objectives for this plan and the program is a possible funding source for actions identified in this plan.

National Flood Insurance Program

The National Flood Insurance Program (NFIP) provides federally backed flood insurance in exchange for communities enacting floodplain regulations. Participation and good standing under NFIP are prerequisites to grant funding eligibility under the Robert T. Stafford Act. Dublin, Livermore and Pleasanton participate in the NFIP and have adopted regulations that meet the NFIP requirements. At the time of the preparation of this plan, all municipal jurisdictions were in good standing with NFIP requirements.

National Incident Management System

The National Incident Management System (NIMS) is a systematic approach for government, nongovernmental organizations, and the private sector to work together to manage incidents involving hazards. The NIMS provides a flexible but standardized set of incident management practices. Incidents typically begin and end locally, and they are managed at the lowest possible geographical, organizational, and jurisdictional level. In other instances, success depends on the involvement of multiple jurisdictions, levels of government, functional agencies, and

emergency-responder disciplines. These instances necessitate coordination across the spectrum of organizations. Communities using NIMS follow a comprehensive national approach that improves the effectiveness of emergency management and response personnel across the full spectrum of potential hazards (including natural hazards, terrorist activities, and other human-caused disasters) regardless of size or complexity. Although participation is voluntary, federal departments and agencies are required to make adoption of NIMS by local and state jurisdictions a condition to receive federal preparedness grants and awards.

Americans with Disabilities Act and Amendments

The Americans with Disabilities Act (ADA) seeks to prevent discrimination against people with disabilities in employment, transportation, public accommodation, communications, and government activities. The most recent amendments became effective in January 2009 (P.L. 110-325). Title II of the ADA deals with compliance with the act in emergency management and disaster-related programs, services, and activities. It applies to state and local governments as well as third parties, including religious entities and private nonprofit organizations.

The ADA has implications for sheltering requirements and public notifications. During an emergency alert, officials must use a combination of warning methods to ensure that all residents have any necessary information. Those with hearing impairments may not hear radio, television, sirens, or other audible alerts, while those with visual impairments may not see flashing lights or visual alerts. Two stand-alone technical documents have been issued for shelter operators to meet the needs of people with disabilities. These documents address physical accessibility as well as medical needs and service animals.

The ADA also intersects with disaster preparedness programs in regards to transportation, social services, temporary housing, and rebuilding. Persons with disabilities may require additional assistance in evacuation and transit (such as vehicles with wheelchair lifts or paratransit buses). Evacuation and other response plans should address the unique needs of residents. Local governments may be interested in implementing a special-needs registry to identify the home addresses, contact information, and needs for residents who may require more assistance.

FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

Civil Rights Act of 1964

The Civil Rights Act of 1964 prohibits discrimination based on race, color, religion, sex or nation origin and requires equal access to public places and employment. The Act is relevant to emergency management and hazard mitigation in that it prohibits local governments from favoring the needs of one population group over another. Local government and emergency response must ensure the continued safety and well-being of all residents equally, to the extent possible. FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

Community Development Block Grant Disaster Resilience Program

In response to disasters, Congress may appropriate additional funding for the U.S. Department of Housing and Urban Development Community Development Block Grant programs to be distributed as Disaster Recovery grants (CDBG-DR). These grants can be used to rebuild affected areas and provide seed money to start the recovery process. CDBG-DR assistance may fund a broad range of recovery activities, helping communities and neighborhoods that otherwise might not recover due to limited resources. CDBG-DR grants often supplement disaster programs of FEMA, the Small Business Administration, and the U.S. Army Corps of Engineers. Housing and Urban Development generally awards noncompetitive, nonrecurring CDBG-DR grants by a formula that

considers disaster recovery needs unmet by other federal disaster assistance programs. To be eligible for CDBG-DR funds, projects must meet the following criteria:

- Address a disaster-related impact (direct or indirect) in a presidentially declared county for the covered disaster
- Be a CDBG-eligible activity (according to regulations and waivers)
- Meet a national objective.

Incorporating preparedness and mitigation into these actions is encouraged, as the goal is to rebuild in ways that are safer and stronger.

Emergency Watershed Program

The USDA Natural Resources Conservation Service administers the Emergency Watershed Protection Program, which responds to emergencies created by natural disasters. Eligibility for assistance is not dependent on a national emergency declaration. The program is designed to help people and conserve natural resources by relieving imminent hazards to life and property caused by floods, fires, wind-storms, and other natural occurrences. The Emergency Watershed Protection is an emergency recovery program. Financial and technical assistance are available for the following activities (NRCS, 2005):

- Remove debris from stream channels, road culverts, and bridges.
- Reshape and protect eroded banks.
- Correct damaged drainage facilities.
- Establish cover on critically eroding lands.
- Repair levees and structures.
- Repair conservation practices.

This federal program could be a possible funding source for actions identified in this plan.

Presidential Executive Orders 11988 and 13690

Executive Order 11988 requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. It requires federal agencies to provide leadership and take action to reduce the risk of flood loss, minimize the impact of floods on human safety, health, and welfare, and restore and preserve the natural and beneficial values of floodplains. The requirements apply to the following activities (FEMA, 1977):

- Acquiring, managing, and disposing of federal lands and facilities
- Providing federally undertaken, financed, or assisted construction and improvements
- Conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing.

Executive Order 13690 expands Executive Order 11988 and acknowledges that the impacts of flooding are anticipated to increase over time due to the effects of climate change and other threats. It mandates a federal flood risk management standard to increase resilience against flooding and help preserve the natural values of floodplains. This standard expands management of flood issues from the current base flood level to a higher vertical elevation and corresponding horizontal floodplain when federal dollars are involved in a project. The goal is to address current and future flood risk and ensure that projects funded with taxpayer dollars last as long as intended (FEMA, 2015). All actions identified in this plan will seek full compliance with all applicable presidential executive orders.

The Federal Flood Risk Management Standards established by EO 13690 were revoked on August 15, 2017.

Presidential Executive Order 11990

Executive Order 11990 requires federal agencies to provide leadership and take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands. The requirements apply to the following activities (FEMA, 1977):

- Acquiring, managing, and disposing of federal lands and facilities
- Providing federally undertaken, financed, or assisted construction and improvements
- Conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing.

All actions identified in this plan will seek full compliance with all applicable presidential executive orders.

U.S. Army Corps of Engineers Programs

The U.S. Army Corps of Engineers has several civil works authorities and programs related to flood risk and flood hazard management:

- Floodplain Management Services are 100-percent federally funded technical services such as development and interpretation of site-specific data related to the extent, duration and frequency of flooding. Special studies may be conducted to help a community understand and respond to flood risk. These may include flood hazard evaluation, flood warning and preparedness, or flood modeling.
- For more extensive studies, the Corps of Engineers offers a cost-shared program called Planning Assistance to States and Tribes. Studies under this program generally range from $25,000 to $100,000, with the local jurisdiction providing 50 percent of the cost.
- The Corps of Engineers has several cost-shared programs (typically 65 percent federal and 35 percent non-federal) aimed at developing, evaluating and implementing structural and non-structural capital projects to address flood risks at specific locations or within a specific watershed:

    - The Continuing Authorities Program for smaller-scale projects includes Section 205 for Flood Control, with a $7 million federal limit and Section 14 for Emergency Streambank Protection with a $1.5 million federal limit. These can be implemented without specific authorization from Congress.
    - Larger scale studies, referred to as General Investigations, and projects for flood risk management, for ecosystem restoration or to address other water resource issues, can be pursued through a specific authorization from Congress and are cost-shared, typically at 65 percent federal and 35 percent non-federal.
    - Watershed Management planning studies can be specifically authorized and are cost-shared at 50 percent federal and 50 percent non-federal.

- The Corps of Engineers provides emergency response assistance during and following natural disasters. Public Law 84-99 enables the Corps to assist state and local authorities in flood fight activities and cost share in the repair of flood protective structures. Assistance afforded under PL 84-99 is broken down in to the following categories:

    - **Preparedness—**The Flood Control and Coastal Emergency Act establishes an emergency fund for preparedness for emergency response to natural disasters; for flood fighting and rescue operations; for rehabilitation of flood control and hurricane protection structures. Funding for Corps of Engineers emergency response under this authority is provided by Congress through the annual Energy and Water Development Appropriation Act. Disaster preparedness activities include coordination, planning, training and conduct of response exercises with local, state and federal agencies.
    - **Response Activities—**PL 84-99 allows the Corps of Engineers to supplement state and local entities in flood-fighting for urban and other non-agricultural areas under certain conditions (Engineering

Regulation 500-1-1 provides specific details). All flood-fight efforts require a Project Cooperation Agreement (PCA) signed by the public sponsor and a requirement for the sponsor to remove all flood-fight material after the flood has receded. PL 84-99 also authorizes emergency water support and drought assistance in certain situations and allows for "advance measures" assistance to prevent or reduce flood damage conditions of imminent threat of unusual flooding.

- **Rehabilitation—**Under PL 84-99, an eligible flood protection system can be rehabilitated if damaged by a flood event. The flood system would be restored to its pre-disaster status at no cost to the federal system owner, and at 20-percent cost to the eligible non-federal system owner. All systems eligible for PL 84-99 rehabilitation assistance have to be in the Rehabilitation and Inspection Program prior to the flood event. Acceptable operation and maintenance by the public levee sponsor are verified by levee inspections conducted by the Corps on a regular basis. The Corps has the responsibility to coordinate levee repair issues with interested federal, state, and local agencies following natural disaster events where flood control works are damaged.

All of these authorities and programs are available to the planning partners to support any intersecting mitigation actions.

4.8.2 State

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act was enacted in 1972 to mitigate the hazard of surface faulting to structures for human occupancy. The Alquist-Priolo Earthquake Fault Zoning Act's main purpose is to prevent construction of buildings used for human occupancy on the surface trace of active faults. Before a new project is permitted, cities and counties require a geologic investigation to demonstrate that proposed buildings will not be constructed on active faults. The act addresses only the hazard of surface fault rupture and is not directed toward other earthquake hazards, such as liquefaction or seismically induced landslides. The law requires the State of California Geologist to establish regulatory zones around the surface traces of active faults and to issue appropriate maps. The maps are distributed to all affected cities, counties, and state agencies for their use in planning and controlling new or renewed construction. Local agencies must regulate most development projects within the zones. Projects include all land divisions and most structures for human occupancy (California Department of Conservation, 2010). All seismic hazard mitigation actions identified in this plan will seek full compliance with the Alquist-Priolo Earthquake Fault Zoning Act.

California General Planning Law

California state law requires that every county and city prepare and adopt a comprehensive long-range plan to serve as a guide for community development. The general plan expresses the community's goals, visions, and policies relative to future land uses, both public and private. The general plan is mandated and prescribed by state law (Cal. Gov. Code §65300 et seq.), and forms the basis for most local government land use decision-making.

The plan must consist of an integrated and internally consistent set of goals, policies, and implementation measures. In addition, the plan must focus on issues of the greatest concern to the community and be written in a clear and concise manner. City actions, such as those relating to land use allocations, annexations, zoning, subdivision and design review, redevelopment, and capital improvements, must be consistent with the plan.

All municipal planning partners to this plan have general plans that are currently compliant with this law and have committed to integrating this mitigation plan with their general plans through provisions referenced below (AB-2140 and SB-379)

California Environmental Quality Act

The California Environmental Quality Act (CEQA) was passed in 1970, shortly after the federal government passed the National Environmental Policy Act, to institute a statewide policy of environmental protection. CEQA requires state and local agencies in California to follow a protocol of analysis and public disclosure of the potential environmental impacts of development projects. CEQA makes environmental protection a mandatory part of every California state and local agency's decision making process.

CEQA establishes a statewide environmental policy and mandates actions all state and local agencies must take to advance the policy. Jurisdictions conduct analyses on projects to determine if there are potentially significant environmental impacts, identify mitigation measures, and propose possible project alternatives by preparing environmental reports for projects that require CEQA review. This environmental review is required before an agency takes action on any policy, program, or project.

Dublin, Livermore and Pleasanton have all sought exemption from CEQA for this hazard mitigation plan, using the 15300 Categorical Exemption section of the CEQA guidelines:

- **Section 15300:** "...CEQA applies only to projects which have the potential for causing a significant effect on the environment. Where it can be seen with certainty that there is no possibility that the activity in question may have a significant effect on the environment, the activity is not subject to CEQA."

AB 162: Flood Planning

This California State Assembly bill passed in 2007 requires cities and counties to address flood-related matters in the land use, conservation, and safety and housing elements of their general plans. The land use element must identify and annually review the areas covered by the general plan that are subject to flooding as identified in floodplain mapping by either FEMA or the California Department of Water Resources (DWR). Upon the next revision of the housing element on or after January 1, 2009, the conservation element of the general plan must identify rivers, creeks, streams, flood corridors, riparian habitat, and land that may accommodate floodwater for the purposes of groundwater recharge and stormwater management. The safety element must identify information regarding flood hazards including:

- Flood hazard zones
- Maps published by FEMA, DWR, the U.S. Army Corps of Engineers, the Central Valley Flood Protection Board, Cal OES, etc.
- Historical data on flooding
- Existing and planned development in flood hazard zones.

The general plan must establish goals, policies and objectives to protect from unreasonable flooding risks including:

- Avoiding or minimizing the risks of flooding new development
- Evaluating whether new development should be located in flood hazard zones
- Identifying construction methods to minimize damage.

AB 162 establishes goals, policies and objectives to protect from unreasonable flooding risks. It establishes procedures for the determination of available land suitable for urban development, which may exclude lands where FEMA or DWR has determined that the flood management infrastructure is not adequate to avoid the risk of flooding.

AB 2140: General Plans—Safety Element

This bill provides that the state may allow for more than the standard 75 percent cost share for public assistance funding under the California Disaster Assistance Act only if the local agency is in a jurisdiction that has adopted a local hazard mitigation plan as part of the safety element of its general plan. The local hazard mitigation plan needs to include elements specified in this legislation. In addition this bill requires Cal OES to give federal mitigation funding preference to cities and counties that have adopted local hazard mitigation plan. The intent of the bill is to encourage cities and counties to create and adopt hazard mitigation plans.

AB 70: Flood Liability

This bill provides that a city or county may be required to contribute a fair and reasonable share to compensate for property damage caused by a flood to the extent that it has increased the state's exposure to liability for property damage by unreasonably approving new development in a previously undeveloped area that is protected by a state flood control project, unless the city or county meets specified requirements.

AB 32: The California Global Warming Solutions Act

This bill addresses greenhouse gas emissions. It identifies the following potential adverse impacts of global warming:

> "… the exacerbation of air quality problems, a reduction in the quality and supply of water to the state from the Sierra snowpack, a rise in sea levels resulting in the displacement of thousands of coastal businesses and residences, damage to marine ecosystems and the natural environment, and an increase in the incidences of infectious diseases, asthma, and other human health-related problems."

AB 32 establishes a state goal of reducing greenhouse gas emissions to 1990 levels by 2020 (a reduction of approximately 25 percent from forecast emission levels) with further reductions to follow. The law requires the state Air Resources Board to do the following:

- Establish a program to track and report greenhouse gas emissions.
- Approve a scoping plan for achieving the maximum technologically feasible and cost-effective reductions from sources of greenhouse gas emissions.
- Adopt early reduction measures to begin moving forward.
- Adopt, implement and enforce regulations—including market mechanisms such as "cap and-trade" programs—to ensure that the required reductions occur.

The Air Resources Board recently adopted a statewide greenhouse gas emissions limit and an emissions inventory, along with requirements to measure, track, and report greenhouse gas emissions by the industries it determined to be significant sources of greenhouse gas emissions.

AB 2800: Climate Change—Infrastructure Planning

This California State Assembly bill, in effect through July 1, 2020, requires state agencies to take into account the current and future impacts of climate change when planning, designing, building, operating, maintaining, and investing in state infrastructure. The bill requires the agency to establish a climate-safe infrastructure working group by July 1, 2017, to examine how to integrate scientific data concerning projected climate change impacts into state infrastructure engineering.

Senate Bill 97: Guidelines for Greenhouse Gas Emissions

Senate Bill 97, enacted in 2007, amended the California Environmental Quality Act (CEQA) to clearly establish that greenhouse gas emissions and the effects of greenhouse gas emissions are appropriate subjects for CEQA

analysis. It directed the Governor's Office of Planning and Research to develop draft CEQA guidelines for the mitigation of greenhouse gas emissions or their effects and directed the California Natural Resources Agency to certify and adopt the CEQA Guidelines by January 1, 2010.

Senate Bill 1241: General Plans: Safety Element—Fire Hazard Impacts

In 2012, Senate Bill 1241 passed requiring that all future general plans address fire risk in state responsibility areas and very high fire hazard severity zones in their safety element. In addition, the bill requires cities and counties to make certain findings regarding available fire protection and suppression services before approving a tentative map or parcel map.

Senate Bill 1000 General Plan Amendments: Safety and Environmental Justice Elements

In 2016, Senate Bill 1000 amended California's Planning and Zoning Law in two ways:

- The original law established requirements for initial revisions of general plan safety elements to address flooding, fire, and climate adaptation and resilience. It also required subsequent review and revision as necessary based on new information. Senate Bill 1000 specifies that the subsequent reviews and revision based on new information are required to address only flooding and fires (not climate adaptation and resilience).
- Senate Bill 1000 adds a requirement that, upon adoption or revision of any two other general plan elements on or after January 1, 2018, an environmental justice element be adopted for the general plan or environmental justice goals, policies and objectives be incorporated into other elements of the plan.

Senate Bill 379: General Plans: Safety Element—Climate Adaptation

Senate Bill 379 builds upon the flood planning inclusions into the safety and housing elements and the hazard mitigation planning safety element inclusions in general plans outlined in AB 162 and AB 2140, respectively. SB 379 focuses on a new requirement that cities and counties include climate adaptation and resiliency strategies in the safety element of their general plans beginning January 1, 2017. In addition, this bill requires general plans to include a set of goals, policies and objectives, and specified implementation measures based on the conclusions drawn from climate adaptation research and recommendations.

California State Building Code

California Code of Regulations Title 24 (CCR Title 24), also known as the California Building Standards Code, is a compilation of building standards from three sources:

- Building standards that have been adopted by state agencies without change from building standards contained in national model codes
- Building standards that have been adopted and adapted from the national model code standards to meet California conditions
- Building standards authorized by the California legislature that constitute extensive additions not covered by the model codes adopted to address particular California concerns.

The state Building Standards Commission is authorized by California Building Standards Law (Health and Safety Code Sections 18901 through 18949.6) to administer the processes related to the adoption, approval, publication, and implementation of California's building codes. These building codes serve as the basis for the design and construction of buildings in California. The national model code standards adopted into Title 24 apply to all occupancies in California except for modifications adopted by state agencies and local governing bodies. Since 1989, the Building Standards Commission has published new editions of Title 24 every three years.

On January 1, 2014, California Building Code Accessibility Standards found in Chapter 11B incorporated the 2010 Americans with Disabilities Act (ADA) Standards as the model accessibility code for California. The purpose for this incorporation was to ensure consistency with federal guidelines. As a result of this incorporation, the California standards will fully implement and include 2010 ADA Standards within the California Building Code while maintaining enhanced levels of accessibility already provided by existing California accessibility regulations.

Standardized Emergency Management System

CCR Title 19 establishes the Standardized Emergency Management System (SEMS) to standardize the response to emergencies involving multiple jurisdictions. SEMS is intended to be flexible and adaptable to the needs of all emergency responders in California. It requires emergency response agencies to use basic principles and components of emergency management. Local governments must use SEMS by December 1, 1996 in order to be eligible for state funding of response-related personnel costs under CCR Title 19 (Sections 2920, 2925 and 2930). Individual agencies' roles and responsibilities contained in existing laws or the state emergency plan are not superseded by these regulations.

State of California Multi-Hazard Mitigation Plan

Under the DMA, California must adopt a federally approved statewide hazard mitigation plan in order to be eligible for certain disaster assistance and mitigation funding. The intent of the *State of California Multi-Hazard Mitigation Plan* is to reduce or prevent injury and damage from hazards in the state through the following:

- Documenting statewide hazard mitigation planning in California
- Describing strategies and priorities for future mitigation activities
- Facilitating the integration of local and tribal hazard mitigation planning activities into statewide efforts
- Meeting state and federal statutory and regulatory requirements.

The plan is an annex to the *State Emergency Plan*. It identifies past and present mitigation activities, current policies and programs, and mitigation strategies for the future. It also establishes hazard mitigation goals and objectives. The plan will be reviewed and updated annually to reflect changing conditions and new information, especially information on local planning activities.

Governor's Executive Order S-13-08

Governor's Executive Order S-13-08 enhances the state's management of climate impacts from sea level rise, increased temperatures, shifting precipitation and extreme weather events. It required the following key actions:

- Initiate California's first statewide climate change adaptation strategy to assess expected climate change impacts, identify where California is most vulnerable, and recommend adaptation policies by early 2009. This effort will improve coordination within state government so that better planning can more effectively address climate impacts on human health, the environment, the state's water supply and the economy.
- Request that the National Academy of Science establish an expert panel to report on sea level rise impacts in California, to inform state planning and development efforts.
- Issue interim guidance to state agencies for how to plan for sea level rise in designated coastal and floodplain areas for new projects.
- Initiate a report on critical infrastructure projects vulnerable to sea level rise.

California Residential Mitigation Program

The California Residential Mitigation Program was established in 2011 to help Californians strengthen their homes against damage from earthquakes. The program is a joint powers authority created by Cal OES and the

California Earthquake Authority, which is a not-for-profit, publicly managed, privately funded provider of home earthquake insurance to California homeowners and renters.

Earthquake Brace + Bolt was developed to help homeowners lessen the potential for damage to their houses during an earthquake. A residential seismic retrofit strengthens an existing older house, making it more resistant to earthquake activity such as ground shaking and soil failure. The seismic retrofitting involves bolting the house to its foundation and adding bracing around the perimeter of the crawl space. Most homeowners hire a contractor to do the retrofit work, and owners of houses in ZIP codes with house characteristics suitable for this type of retrofit are eligible for up to $3,000 toward the cost. A typical retrofit by a contractor may cost between $3,000 and $7,000, depending on the location and size of the house, contractor fees, and the amount of materials and work involved. If the homeowner is an experienced do-it-yourselfer, a retrofit can cost less than $3,000.

Geologic Abatement Districts

Geologic Hazard Abatement Districts (GHAD) enabled by the Beverly Act of 1979 (SB 1195), are potentially useful financial mechanisms for reducing hillslope hazards. The enabling statute, (Division 17 of the Public Resources Code, Sections 26500 - 26654) provides for the formation of local assessment districts for the purpose of prevention, mitigation, abatement, or control of geologic hazards. The Act broadly defines "geologic hazard" as "an actual or threatened landslide, land subsidence, soil erosion, earthquake, or any other natural or unnatural movement of land or earth." Currently, there are over 35 GHADs in California working to prevent, mitigate and abate geologic hazards.

4.8.3 Local

Plans, reports and other technical information were identified and provided directly by participating jurisdictions and stakeholders or were identified through independent research by the planning consultant. These documents were reviewed to identify the following:

- Existing jurisdictional capabilities.
- Needs and opportunities to develop or enhance capabilities, which may be identified within the local mitigation strategies.
- Mitigation-related goals or objectives, considered during the development of the overall goals and objectives.
- Proposed, in-progress, or potential mitigation projects and actions to be incorporated into the updated jurisdictional mitigation strategies.

Local regulations, codes, ordinances and plans were reviewed for the following capabilities, in order to develop complementary and mutually supportive goals, objectives, and mitigation strategies that are consistent across local and regional planning and regulatory mechanisms:

- **Legal and regulatory—**Jurisdictions have the ability to develop policies and programs and to implement rules and regulations to protect and serve residents. Local policies are typically identified in a variety of community plans, implemented via a local ordinance, and enforced through a governmental body. Jurisdictions regulate land use through the adoption and enforcement of zoning, subdivision and land development ordinances, building codes, building permit ordinances, floodplain, and stormwater management ordinances. When effectively prepared and administered, these regulations can lead to hazard mitigation.
- **Fiscal—**Assessing a jurisdiction’s fiscal capability provides local governance with an understanding of the ability to fulfill the financial needs associated with hazard mitigation projects. This assessment

identifies both outside resources, such as grant-funding eligibility, and local jurisdictional authority to generate internal financial capability, such as through impact fees.

- **Administrative and technical—**Legal, regulatory, and fiscal capabilities are needed to provide the backbone for successfully developing a mitigation strategy, but without appropriate personnel the strategy may not be implemented. The administrative and technical capability assessment focuses on the availability of personnel resources for implementing hazard mitigation. These personnel resources include technical experts, such as engineers and scientists, as well as capabilities that may be found in multiple departments, such as grant writers.
- **Development and permitting—**The ability to track previous and future growth in potential hazard areas provides an overview of increased exposure to a hazard within a community. Maintaining an inventory of buildable lands allows better estimation of potential future growth and resulting hazard exposure.
- **Public education and outreach—**Assessing outreach and education capability identifies the connection between government and community members, which opens a two-way dialogue and results in a more resilient community based on education and public engagement.
- **NFIP compliance—**Community participation in the NFIP lowers flood insurance premiums and opens up opportunity for grant funding to address flooding issues. Assessment of current NFIP status and compliance provides understanding about local flood management programs and opportunities for improvement.
- **Adaptive capacity for climate change**—Given the uncertainties associated with how hazard risk may change with a changing climate, a community's ability to track such changes and adapt as needed is an important component of ongoing hazard mitigation.
- **Classification under national community mitigation programs—**Community mitigation programs—such as the Community Rating System, Storm Ready and Firewise—enhance a jurisdiction's ability to mitigate, prepare for, and respond to natural hazards. These programs indicate a jurisdiction's desire to go beyond minimum requirements set forth by local, state, and federal regulations for the purpose of creating a more resilient community. They complement each other by focusing on communication, mitigation, and community preparedness to save lives and minimize the impact of natural hazards.

PART 2—RISK ASSESSMENT

5. IDENTIFIED HAZARDS OF CONCERN AND RISK ASSESSMENT METHODOLOGY

Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from natural hazards. It allows emergency management personnel to establish early response priorities by identifying potential hazards and vulnerable assets. The process focuses on the following elements:

- **Hazard identification**—Use all available information to determine what types of disasters may affect a jurisdiction, how often they can occur, and their potential severity.
- **Exposure identification—**Estimate the total number of people and properties in the jurisdiction that are likely to experience a hazard event if it occurs.
- **Vulnerability identification and loss estimation**—Assess the impact of hazard events on the people, property, environment, economy and lands of the region, including estimates of the cost of potential damage or cost that can be avoided by mitigation.

The risk assessment for this hazard mitigation plan update evaluates the risk of natural hazards prevalent in the planning area and meets requirements of the DMA (44 CFR, Section 201.6(c)(2)). To protect individual privacy and the security of critical facilities, information on properties assessed is presented in aggregate, without details about specific individual personal or public properties.

5.1 IDENTIFIED HAZARDS OF CONCERN

The Steering Committee considered the full range of natural hazards that could impact the planning area and then listed hazards that present the greatest concern. The process incorporated review of state and local hazard planning documents, as well as information on the frequency, magnitude and costs associated with hazards that have impacted or could impact the planning area. Anecdotal information regarding natural hazards and the perceived vulnerability of the planning area's assets to them was also used. Based on the review, this plan presents complete risk assessment for the following hazards of concern (presented in alphabetical order; the order of listing does not indicate the hazards' relative severity):

- Climate change
- Dam failure
- Drought
- Earthquake
- Flood
- Landslide
- Severe weather
- Wildfire

In addition to the hazards of concern for which full risk assessments were performed, other hazards of interest were identified for inclusion in this plan: intentional human-caused hazards, technological hazards, and public

health hazards. These hazards are of interest because they present risk to the planning area. However, no methodologies are currently available to perform risk assessments on them that are equivalent to those used for the natural hazards of concern addressed in detail in this plan.

5.2 RISK ASSESSMENT TOOLS

5.2.1 Mapping

National, state and local databases were reviewed to locate spatially based data relevant to this planning effort. Maps were produced using GIS software to show the spatial extent and location of identified hazards when such data was available. These maps are included in the hazard profile sections of this document. Information regarding the data sources and methodologies employed in these mapping efforts is located in Appendix B.

5.2.2 Hazus

Overview

In 1997, FEMA developed the standardized Hazards U.S., or Hazus, model to estimate losses caused by earthquakes and identify areas that face the highest risk and potential for loss. Hazus was later expanded into a multi-hazard methodology with new models for estimating potential losses from hurricanes and floods.

Hazus is a GIS-based software program used to support risk assessments, mitigation planning, and emergency planning and response. It provides a wide range of inventory data, such as demographics, building stock, critical facility, transportation and utility lifeline, and multiple models to estimate potential losses from natural disasters. The program maps and displays hazard data and the results of damage and economic loss estimates for buildings and infrastructure. Its advantages include the following:

- Provides a consistent methodology for assessing risk across geographic and political entities.
- Provides a way to save data so that it can readily be updated as population, inventory, and other factors change and as mitigation planning efforts evolve.
- Facilitates the review of mitigation plans because it helps to ensure that FEMA methodologies are incorporated.
- Supports grant applications by calculating benefits using FEMA definitions and terminology.
- Produces hazard data and loss estimates that can be used in communication with local stakeholders.
- Is administered by the local government and can be used to manage and update a hazard mitigation plan throughout its implementation.

Levels of Detail for Evaluation

Hazus provides default data for inventory, vulnerability and hazards; this default data can be supplemented with local data to provide a more refined analysis. The model can carry out three levels of analysis, depending on the format and level of detail of information about the planning area:

- **Level 1**—All of the information needed to produce an estimate of losses is included in the software's default data. This data is derived from national databases and describes in general terms the characteristic parameters of the planning area.
- **Level 2**—More accurate estimates of losses require more detailed information about the planning area. Level 2 estimates of losses require detailed information on local geology, hydrology, hydraulics, building inventory, utilities, and critical facilities. This information is needed in a GIS format.
- **Level 3**—This level of analysis generates the most accurate estimate of losses. It requires detailed engineering and geotechnical information to customize it for the planning area.

5.3 RISK ASSESSMENT APPROACH

The risk assessments in this plan describe the risks associated with each hazard of concern identified. The following steps were used to define the risk of each hazard:

- **Identify and profile each hazard**—The following information is given for each hazard:
  - Geographic areas most affected by the hazard
  - Event frequency estimates
  - Severity estimates
  - Warning time likely to be available for response.
- **Determine exposure to each hazard**—Exposure was assessed by overlaying hazard maps with an inventory of structures, facilities, and systems to decide which of them would be exposed to each hazard.
- **Assess the vulnerability of exposed facilities**—Vulnerability of exposed structures and infrastructure was evaluated by interpreting the probability of occurrence of each event and assessing structures, facilities, and systems that are exposed to each hazard. Tools such as GIS and FEMA's hazard-modeling program Hazus were used for this assessment for the dam failure, earthquake, and flood hazards. Outputs similar to those from Hazus were generated for other hazards, using data generated through GIS.

5.3.1 Earthquake, Dam Failure, and Flood

The following hazards were evaluated using Hazus:

- **Flood**—A Level 2 user-defined analysis was performed for general building stock in flood zones and for critical facilities and infrastructure. Current flood mapping for the planning area was used to delineate flood hazard areas and estimate potential losses from the 1-percent-annual-chance, 0.2-percent-annual-chance, and 10-percent-annual-chance flood events. To estimate damage that would result from a flood, Hazus uses pre-defined relationships between flood depth at a structure and resulting damage, with damage given as a percent of total replacement value. Curves defining these relationships have been developed for damage to structures and for damage to typical contents within a structure. By inputting flood depth data and known property replacement cost values, dollar-value estimates of damage were generated.
- **Dam Failure**—A Level 2 analysis was run using the flood methodology described above.
- **Earthquake**—A Level 2 analysis was performed to assess earthquake exposure and vulnerability for five scenario events:
  - Calaveras (North Central South) Fault Scenario—A Magnitude-7.0 event with a depth of 7 km and epicenter 1 mile west of the City of Dublin.
  - Greenville Fault Scenario—A Magnitude-7.0 event with a depth of 12 km and epicenter 24 miles southeast of the City of Pleasanton.
  - Haywired Fault Scenario—This is the name given by the USGS to the fault scenario used in a 2014-2015 of Bay Area impacts from an earthquake on the Hayward Fault; it is a Magnitude-7.05 event with a depth of 8 km and epicenter 10 miles northwest of the City of Dublin.
  - Mount Diablo Fault Scenario—A Magnitude-6.7 event with a depth of 14 km and epicenter 10 miles north of the City of Livermore.
  - North San Andreas Fault Scenario—A Magnitude-7.8 event with a depth of 9.8 km and epicenter 75 miles northwest of the City of Dublin.

5.3.2 Drought

The risk assessment methodologies used for this plan focus on damage to structures. The risk assessment for drought was more limited and qualitative than the assessment for the other hazards of concern because drought does not affect structures.

5.3.3 Landslide, Severe Weather, Wildfire

Historical datasets were not adequate to model future losses for most of the hazards of concern. However, areas and inventory susceptible to some of the hazards of concern were mapped by other means and exposure was evaluated. A qualitative analysis was conducted for other hazards using the best available data and professional judgment.

5.4 SOURCES OF DATA USED IN HAZUS MODELING

5.4.1 Building, Land Use and Cost Data

Replacement cost values and detailed structure information derived from parcel and tax assessor data provided by Alameda County were loaded into Hazus. When available, an updated inventory was used in place of the Hazus defaults for critical facilities and infrastructure. Land use areas were calculated using the County's parcel data and Hazus general occupancy classes.

Replacement cost is the cost to replace the entire structure with one of equal quality and utility. Replacement cost is based on industry-standard cost-estimation models published in *RS Means Square Foot Costs* (RS Means, 2017). It is calculated using the RS Means square foot cost for a structure, which is based on the Hazus occupancy class (i.e., multi-family residential or commercial retail trade), multiplied by the square footage of the structure from the tax assessor data. The construction class and number of stories for single-family residential structures also factor into determining the square foot costs.

5.4.2 Hazus Data Inputs

The following hazard datasets were used for the Hazus Level 2 analysis conducted for the risk assessment:

- **Flood**—The effective Digital Flood Insurance Rate Map (DFIRM) for the planning area was used to delineate flood hazard areas and estimate potential losses from the 1-percent-annual-chance, 0.2-percent-annual-chance, and 10-percent-annual-chance flood events. Using the DFIRM floodplain boundaries and base flood elevation information, and the U.S. Geological Survey's (USGS) 3-meter digital elevation model data, flood depth grids were generated and integrated into the Hazus model.
- **Dam Failure**—Dam inundation area data provided by the County and the USGS 3-meter digital elevation model were used to develop depth grids that were integrated into the Hazus model.
- **Earthquake**—Earthquake mapping prepared by the USGS was used for the analysis of this hazard. A National Earthquake Hazard Reduction Program (NEHRP) soils map from the California Department of Conservation, the Association of Bay Area Governments' (ABAG) liquefaction susceptibility data, and the California Geological Survey's landslide susceptibility data were also integrated into the Hazus model.

5.4.3 Other Local Hazard Data

Locally relevant information on hazards was gathered from a variety of sources. Frequency and severity indicators include past events and the expert opinions of geologists, emergency management specialists, and others. Data sources for specific hazards were as follows:

- **Landslide**—Susceptibility to deep-seated landslide data were provided by the California Geological Survey. Areas categorized as moderate (susceptibility classes V and VI), high (classes VII, VIII, and IX), and very high (class X) were used in the exposure analysis.
- **Wildfire**—Fire severity data were acquired from the California Department of Forestry and Fire Protection (CAL FIRE).
- **Climate Change**—Climate change related projections, data and visualization tools were provided by Cal-Adapt, an online resource that provides information on how climate change might affect local communities in California, unless otherwise indicated. The data available on Cal-Adapt is from a variety of organizations in the scientific community and represents peer-reviewed science.

5.4.4 Data Source Summary

Table 5-1 summarizes the data sources used for the risk assessment for this plan.

Table 5-1. Risk Assessment Data Sources

Data	Source	Date	Format
Property parcel data including use code, year built, number of stories, and area	Alameda County	2017	Digital (GIS) format
Building replacement cost	RS Means	2017	Paper format
Demographic data	FEMA Hazus version 4.0 (U.S. Census)	2010	Digital (GIS and tabular) format
Flood hazard data	FEMA	2016	Digital (GIS) format
Earthquake mapping	USGS Earthquake Hazards Program website	2012-2014	Digital (GIS) format
Liquefaction susceptibility	ABAG (from USGS)	2006	Digital (GIS) format
Susceptibility to deep-seated landslides	CA Geological Survey	2011	Digital (GIS) format
NEHRP soils	California Department of Conservation	2008	Digital (GIS) format
Dam inundation areas	City of Pleasanton	Unknown	Digital (GIS) Format
Fire hazard severity zones	CAL FIRE	2008	Digital (GIS) format
National elevation data 3m	USGS	Unknown	Digital (GIS) format
Future Land Use, General Plan Land Use & Zoning Districts	City of Pleasanton, City of Livermore, ABAG	Various	Digital (GIS) format
Critical Facilities and Assets			
Critical Facilities and Assets: EOCs; fire stations; medical care facilities; police stations; schools; hazardous material facilities; airports and helipads; bus facilities; highway bridges; light rail facilities; railway bridges; rail facilities; communications facilities; electric power facilities; petroleum facilities; potable water facilities; wastewater facilities; government / city facilities	City of Dublin, City of Livermore, City of Pleasanton, Hazus 4.0 Database, EPA Toxic Reporter Inventory, EIA, California HealthCare Atlas, Caltrans	Various	Digital (GIS) format

5.5 LIMITATIONS

Loss estimates, exposure assessments, and hazard-specific vulnerability evaluations rely on the best available data and methodologies. Uncertainties are inherent in any loss estimation methodology and arise in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from the following:

- Approximations and simplifications necessary to conduct a study

- Incomplete or outdated inventory, demographic or economic parameter data
- The unique nature, geographic extent, and severity of each hazard
- Mitigation measures already employed
- The amount of advance notice residents have to prepare for a specific hazard event
- The uncertain spatial accuracy of the dam inundation area data.
- Lack of a standardized model for assessing sea level rise impacts. Multiple models provide multiple results. Not all models were run in the development of the sea level rise analysis.

These factors can affect loss estimates by a factor of two or more. Therefore, potential exposure and loss estimates are approximate and should be used only to understand relative risk. Over the long term, the planning partners will collect additional data to assist in estimating potential losses associated with other hazards.

6. DAM FAILURE

6.1 GENERAL BACKGROUND

A dam is an artificial barrier that has the ability to store water, wastewater, or liquid-borne materials for many reasons (flood control, human water supply, irrigation, livestock water supply, energy generation, containment of mine tailings, recreation, or pollution control). Many dams fulfill a combination of the stated functions. Dams provide a life-sustaining resource to people in all regions of the United States. They are an important resource in the United States.

Man-made dams can be classified according to the type of construction material used, the methods used in construction, the slope or cross-section of the dam, the way the dam resists the forces of the water pressure behind it, the means used for controlling seepage, and, occasionally, according to the purpose of the dam. The materials used for construction of dams include earth, rock, tailings from mining or milling, concrete, masonry, steel, timber, miscellaneous materials (plastic or rubber), and any combination of these materials (Association of State Dam Safety Officials, 2013).

More than a third of the country's dams are 50 or more years old. Approximately 14,000 of those dams pose a significant hazard to life and property if failure occurs. There are also about 2,000 unsafe dams in the United States, located in almost every state.

DEFINITIONS

Dam—Any artificial barrier, together with appurtenant works, that does or may impound or divert water, and that either (a) is 25 feet or more in height from the natural bed of the stream or watercourse at the downstream toe of the barrier (or from the lowest elevation of the outside limit of the barrier if it is not across a stream channel or watercourse) to the maximum possible water storage elevation; or (b) has an impounding capacity of 50 acre-feet or more. (CA Water Code, Division 3.)

Dam failure—An uncontrolled release of impounded water due to structural deficiencies in a dam.

Emergency action plan—A formal document that identifies potential emergency conditions at a dam and specifies actions to be followed to minimize property damage and loss of life. The plan specifies actions the dam owner should take to alleviate problems at a dam. It contains procedures and information to assist the dam owner in issuing early warning and notification messages to responsible downstream emergency management authorities of the emergency situation. It also contains inundation maps to show emergency management authorities the critical areas for action in case of an emergency. (FEMA 2013a)

High hazard dam—Dams where failure or improper operation will probably cause loss of human life. (FEMA 2004)

Significant hazard dam—Dams where failure or improper operation will result in no probable loss of human life but can cause economic loss, environmental damage or disruption of lifeline facilities, or can impact other concerns. Significant hazard dams are often located in rural or agricultural areas but could be located in areas with population and significant infrastructure. (FEMA 2004)

6.1.1 Causes of Dam Failure

The failure of a dam can allow stored water to inundate areas downstream. Dam failures typically occur when spillway capacity is inadequate and excess flow overtops the dam, or when internal erosion (piping) through the dam or foundation occurs. Complete failure occurs if internal erosion or overtopping results in a complete structural breach, releasing a high-velocity wall of debris-filled waters that rush downstream damaging and/or destroying anything in its path.

Dam failures can be catastrophic to human life and property downstream. Dam failures in the United States typically occur in one of four primary ways:

- Overtopping of the primary dam structure, which accounts for 34 percent of all dam failures, can occur due to inadequate spillway design, settlement of the dam crest, blockage of spillways, and other factors.
- Foundation defects due to differential settlement, slides, slope instability, uplift pressures, and foundation seepage account for 30 percent of all dam failures.
- Piping and seepage account for 20 percent of all failures. These result from internal erosion, erosion along hydraulic structures such as spillways, erosion due to animal burrows, and cracks in the dam structure.
- Failure due to problems with conduits and valves, typically caused by the piping of embankment material into conduits through joints or cracks, constitutes 10 percent of all failures.

The remaining six percent of dam failures are due to other miscellaneous causes. Many of the historical dam failures in the United States have been secondary results of other disasters. The prominent causes are earthquakes, landslides, extreme storms, and massive snowmelt.

The most likely causes of dam failure in the planning area are age of dams, earthquakes, excessive rainfall, and landslides. Poor construction, lack of maintenance and repair, and deficient operational procedures are preventable or correctable by a program of regular inspections. Terrorism and vandalism are serious concerns that all operators of public facilities must plan for; these threats are under continuous review by public safety agencies.

6.1.2 Regulatory Oversight

National Dam Safety Act

Potential for catastrophic flooding due to dam failures led to passage of the National Dam Safety Act (Public Law 92-367). The National Dam Safety Program requires a periodic engineering analysis of the majority of dams in the country, with exceptions for the following:

- Dams under jurisdiction of the Bureau of Reclamation, Tennessee Valley Authority, or International Boundary and Water Commission
- Dams constructed pursuant to licenses issued under the Federal Power Act
- Dams that the Secretary of the Army determines do not pose any threat to human life or property.

The goal of this FEMA-monitored effort is to identify and mitigate the risk of dam failure so as to protect lives and property of the public. The National Dam Safety Program is a partnership among the states, federal agencies, and other stakeholders that encourages individual and community responsibility for dam safety. Under FEMA's leadership, state assistance funds have allowed all participating states to improve their programs through increased inspections, emergency action planning, and purchases of needed equipment. FEMA has also expanded existing and initiated new training programs. Grant assistance from FEMA provides support for improvement of dam safety programs that regulate most of the dams in the United States (FEMA, 2013).

California Division of Safety of Dams

California DWR's Division of Safety of Dams monitors dam maintenance and safety at the state level through all of the following procedures (DWR, 2017):

- When a new dam is proposed, Division engineers and geologists inspect the site and the subsurface.
- Upon submittal of an application, the Division reviews the plans and specifications prepared by the owner to ensure that the dam is designed to meet minimum requirements and that the design is appropriate for the known geologic conditions.
- After approval of the application, the Division inspects all aspects of the construction to ensure that the work accords with the approved plans and specifications.

- After construction, the Division inspects each dam annually to ensure performance as intended and to identify developing problems. Roughly a third of these inspections include in-depth reviews of instrumentation.
- The Division periodically reviews stability of dams and their major appurtenances in light of improved design approaches, requirements, and new findings regarding earthquake hazards and hydrologic estimates in California.

U.S. Army Corps of Engineers Dam Safety Program

The Army Corps of Engineers is responsible for safety inspections of some federal and non-federal dams in the United States that meet size and storage limitations specified in the National Dam Safety Act. The Corps has inventoried dams; surveyed each state and federal agency's capabilities, practices, and regulations regarding design, construction, operation, and maintenance of dams; and developed guidelines for inspection and evaluation of dam safety (U.S. Army Corps of Engineers, 2017). The Corps of Engineers' National Inventory of Dams provides the most recent inspection dates for 26 Alameda County dams, as listed in Table 6-1. It is important to note that this data base is updated only periodically, and therefore the dates reflected may not be reflective of the most recent inspection dates for each facility listed.

Table 6-1. Alameda County Dam Inspection Dates

Alameda County Dam	Inspection Date	Alameda County Dam	Inspection Date
Almond	January 26, 2012	New U San Leandro	December 20, 2011
Bethany Forebay	November 2, 2011	Patterson	March 8, 2012
Calaveras	January 24, 2012	Patterson	November 3, 2011
Central	January 26, 2012	Piedmont	February 9, 2012
Chabot	December 20, 2011	Quarry Pits	March 9, 2012
Cull Creek	August 24, 2011	Rubber Dam 3	March 9, 2012
Decoto Reservoir	March 8, 2012	San Lorenzo Creek	August 24, 2011
Del Valle	November 3, 2011	Seneca	January 26, 2012
Dunsmuir Reservoir	January 26, 2012	Shinn	March 9, 2012
Dyer	February 10, 2012	South	January 26, 2012
Estates	February 9, 2012	Summit	February 7, 2012
James H Turner	January 23, 2012	Temescal, Lake	March 2, 2012
Middlefield Res	March 8, 2012	Ward Creek	August 24, 2011

Source: *U.S. Army Corps of Engineers, 2017*

Federal Energy Regulatory Commission Dam Safety Program

The Federal Energy Regulatory Commission (FERC) has the largest dam safety program in the United States. FERC cooperates with a large number of federal and state agencies to ensure and promote dam safety and, more recently, homeland security. Approximately 3,036 dams that are part of regulated hydroelectric projects are in the FERC program. Two-thirds of these dams are more than 50 years old. As dams age, concern about their safety and integrity grows, and oversight and a regular inspection program are extremely important. FERC staff inspects hydroelectric projects on an unscheduled basis to investigate the following:

- Potential dam safety problems
- Complaints about constructing and operating a project
- Safety concerns related to natural disasters
- Issues concerning compliance with the terms and conditions of a license.

Every five years, an independent consulting engineer, approved by the FERC, must inspect and evaluate projects with dams higher than 32.8 feet, or with a total storage capacity of more than 2,000 acre-feet.

FERC staff monitors and evaluates seismic research in geographic areas such as California where there are concerns about possible seismic activity. This information is applied in investigating and performing structural analyses of hydroelectric projects in these areas. FERC staff also evaluates the effects of potential and actual large floods on the safety of dams. During and following floods, FERC staff visits dams and licensed projects, determines the extent of damage, if any, and directs any necessary studies or remedial measures the licensee must undertake. The FERC publication *Engineering Guidelines for the Evaluation of Hydropower Projects* guides the FERC engineering staff and licensees in evaluating dam safety. The publication is frequently revised to reflect current information and methodologies.

FERC requires licensees to prepare emergency action plans, and conducts training sessions on how to develop and test these plans. The plans outline an early warning system pertaining to actual or potential sudden release of water from a dam due to failure or accident. The plans include operational procedures that may be applied, such as reducing reservoir levels and downstream flows, or notifying affected residents and agencies responsible for emergency management. Updates and tests of these plans occur frequently to ensure that everyone knows what to do in emergency situations (FERC, 2016).

6.2 HAZARD PROFILE

6.2.1 Past Events

Even under normal operating conditions, dam failures can occur suddenly, without warning (referred to as a "sunny-day" failure). Dam failures may also occur during a large storm event. Significant rainfall can quickly inundate an area and cause floodwaters to overwhelm a reservoir. If the dam spillway cannot safely pass the resulting flows, water will begin flowing in areas not designed for such flows, and a failure may occur.

No dam failures have been recorded in the planning area. According to the *Alameda County Multi-Hazard Mitigation Plan*, there have been two failures in the county:

- **1918 Calaveras Dam Failure**—The San Francisco Public Utilities Commission-owned Calaveras Dam, located in Alameda County, failed during construction in 1918. A landslide damaged the upstream shell of the dam and destroyed the dam's outlet tower.
- **2015 Rubber Dam 3 Failure**—In 2015, the inflatable dam on Alameda Creek (Rubber Dam 3) failed due to vandalism, releasing nearly 50 million gallons of water from the community's water into the San Francisco Bay. The water was supposed to go into the Niles Cone Groundwater Basin where residents and businesses from the Cities of Newark, Union City and Fremont could access drinking water.

There is a possibility that the planning area experienced the direct or indirect impacts of these events, though no specific information on local impact is available.

6.2.2 Location

According to the Corps of Engineers' National Inventory of Dams, there are over 87,000 dams in the country; however, this inventory only covers dams that meet minimum height and impoundment requirements; numerous small dams are not identified. According to the California Division of Safety of Dams (DSOD), as of 2017, there were 24 dams in Alameda County of which 20 were classified as high or extremely high hazard according the DSOD Downstream Hazard Classification guidelines. Of these, the Del Valle and Patterson Dams described in Table 6-2 and Table 6-3, have the potential to impact the planning area if a failure were to occur. Dam failure inundation mapping in support of emergency action planning is available for both dams, but have not been included in this plan for security purposes.

Table 6-2. Del Valle Dam Characteristics

Hazard Class[a]	Extremely High
Water Course	Arroyo Valle
Owner	California Department of Water Resources
Year Built	1968
Dam Type	Earth
Crest Length (feet)	880
Height (feet)	222
Storage Capacity (acre-feet)	77,100
Drainage area (sq. mi.)	146
Inundation Area (sq. mi.)	97.98

a. Hazard classification as identified in the National Performance of Dams Program:
Low Hazard—Downstream hazard classification for dams in which no lives are in jeopardy and minimal economic loss would occur as a result of failure of the dam.
Significant Hazard—Downstream hazard classification for dams in which one to six lives are in jeopardy and appreciable economic loss would occur as a result of failure of the dam.
High Hazard—Downstream hazard classification for dams in which more than six lives would be in jeopardy and excessive economic loss would occur as a direct result of dam failure.

Sources: California Department of Water Resources, 2017

Table 6-3. Patterson Dam Characteristics

Hazard Class[a]	High
Water Course	Off stream
Owner	California Department of Water Resources
Year Built	1962
Dam Type	Earth
Crest Length (feet)	1,275
Height (feet)	39
Storage Capacity (acre-feet)	104
Drainage area (sq. mi.)	0
Inundation Area (sq. mi.)	Information not available

a. Hazard classification as identified in the National Performance of Dams Program:
Low Hazard—Downstream hazard classification for dams in which no lives are in jeopardy and minimal economic loss would occur as a result of failure of the dam.
Significant Hazard—Downstream hazard classification for dams in which one to six lives are in jeopardy and appreciable economic loss would occur as a result of failure of the dam.
High Hazard—Downstream hazard classification for dams in which more than six lives would be in jeopardy and excessive economic loss would occur as a direct result of dam failure.

Sources: California Department of Water Resources, 2017

The Del Valle dam was constructed in 1968 to create Lake Del Valle, which provides water storage, Alameda Creek flood control, and regulatory storage for a portion of water delivered through the South Bay Aqueduct. The dam is in satisfactory condition as of September 2017, which means it has no recognized safety deficiencies. It is the only flood control dam in the Livermore Valley. The dam has a storage capacity of 77,100 acre-feet of water (California Department of Water Resources, 2017).

There are two dams listed as Patterson Dam in the DSOD inventory of dams. One of the 2 dams is listed as high hazard is owned by the California Department of Water Resources, and was built in 1962 and was constructed as part of the California State Water Project. The California State Water Project is a water storage and delivery system of reservoirs, aqueducts, power plants and pumping plants. Its main purpose is to store water and distribute it to 29 urban and agricultural water suppliers in Northern California, the San Francisco Bay Area, the San Joaquin Valley, the Central Coast, and Southern California. Of the contracted water supply, 70 percent goes to urban users and 30 percent goes to agricultural users. The Project makes deliveries to two-thirds of California's population. It is maintained and operated by the California Department of Water Resources. The Project is also operated to improve water quality in the Delta, control Feather River flood waters, provide recreation, and enhance fish and wildlife.

6.2.3 Frequency

Dam failures are infrequent and usually coincide with the events that cause them, such as earthquakes, landslides, and excessive rainfall and snowmelt. There is a "residual risk" associated with dams; residual risk is the risk that remains after safeguards have been implemented. The residual risk is associated with events beyond those that the facility was designed to withstand. However, the probability of occurrence of any type of dam failure event is considered to be low in today's regulatory and dam safety oversight environment.

6.2.4 Severity

Dam failure can be catastrophic to all life and property downstream. The U.S. Army Corps of Engineers developed the classification system shown in Table 6-4 for the hazard potential of dam failures.

Table 6-4. Hazard Potential Classification

Hazard Category[a]	Direct Loss of Life[b]	Lifeline Losses[c]	Property Losses[d]	Environmental Losses[e]
Low	None (rural location, no permanent structures for human habitation)	No disruption of services (cosmetic or rapidly repairable damage)	Private agricultural lands, equipment, and isolated buildings	Minimal incremental damage
Significant	Rural location, only transient or day-use facilities	Disruption of essential facilities and access	Major public and private facilities	Major mitigation required
High	Certain (one or more) extensive residential, commercial, or industrial development	Disruption of essential facilities and access	Extensive public and private facilities	Extensive mitigation cost or impossible to mitigate

a. Categories are assigned to overall projects, not individual structures at a project.
b. Loss of life potential based on inundation mapping of area downstream of the project. Analyses of loss of life potential should take into account the population at risk, time of flood wave travel, and warning time.
c. Indirect threats to life caused by the interruption of lifeline services due to project failure or operational disruption; for example, loss of critical medical facilities or access to them.
d. Damage to project facilities and downstream property and indirect impact due to loss of project services, such as impact due to loss of a dam and navigation pool, or impact due to loss of water or power supply.
e. Environmental impact downstream caused by the incremental flood wave produced by the project failure, beyond what would normally be expected for the magnitude flood event under which the failure occurs.

Source: *U.S. Army Corps of Engineers, 1996*

6.2.5 Warning Time

Warning time for dam failure varies depending on the cause of the failure. In events of extreme precipitation, evacuations can be planned with sufficient time. In the event of a structural failure due to earthquake, it is possible that there would be no warning time.

A dam's structural type also affects warning time. Earthen dams do not tend to fail completely or instantaneously. Once a breach is initiated, discharging water erodes the breach until either the reservoir water is depleted or the breach resists further erosion. Concrete gravity dams also tend to have a partial breach as one or more monolith sections formed during dam construction are forced apart by the escaping water. The time for breach formation ranges from a few minutes to a few hours.

Alameda County and the Cities of Dublin, Livermore and Pleasanton have established protocols for emergency warning and response through adopted emergency operations plans. These protocols are tied to the emergency action plans created by the dam owners.

6.3 SECONDARY HAZARDS

Dam failure can cause severe downstream flooding depending on the magnitude of the failure. Other potential secondary hazards of dam failure include landslides around the reservoir perimeter, bank erosion on the rivers, and destruction of downstream habitat.

6.4 EXPOSURE

Exposure to dam failure hazard was assessed by use of spatial analysis. While 2 dams, Del Valle and Patterson could impact the planning area, digital dam failure inundation mapping was only available for the Del Valle Dam. Therefore, the following exposure and vulnerability sections only look at the Del Valle inundation areas based on the best available data. The inundation area for the Del Valle Dam was overlaid with planning area general building stock and critical facility databases. The Hazus flood module was used to assess damage from the dam failure. Hazus uses census data at the block level, which has a level of accuracy acceptable for planning purposes. Where possible, the Hazus default data was enhanced using GIS data from local, state and federal sources.

6.4.1 Population

All populations living in a dam failure inundation zone are exposed to the risk of a dam failure. The estimated population living in the Del Valle Dam inundation area is 57,666, or 25.6 percent of the planning area's population.

6.4.2 Property

The Hazus model estimated that there are 17,555 structures within the inundation area. The value of exposed buildings in the planning area was generated using Hazus and is summarized in Table 6-5. This methodology estimated $17 billion worth of building-and-contents exposure to the inundation area, representing 33.2 percent of the total replacement value of the planning area. Table 6-6 shows the general land use of planning area parcels exposed to the Del Valle Dam Inundation Area.

Table 6-5. Value of Property Exposed to Dam Failure

	Number of Buildings Exposed	Value Exposed			% of Total Replacement Value
		Building	Contents	Total	
Dublin	442	$639,600,057	$533,654,000	$1,173,254,056	9.6%
Livermore	1,688	$818,547,256	$509,556,562	$1,328,103,818	6.5%
Pleasanton	15,425	$8,709,927,283	$6,595,801,497	$15,305,728,780	72.8%
Total Planning Area	17,555	$10,168,074,596	$7,639,012,059	$17,807,086,655	33.2%

Table 6-6. Dam Inundation Present Land Use

	Present Land Use Within the Del Valle Dam Inundation Area	
	Area (acres)	% of total
Residential	3,374	32.8%
Commercial	1,653	16.1%
Industrial	303	2.9%
Agriculture	73	0.7%
Religion / Assembly	161	1.6%
Government / Institutional	82	0.8%
Education	253	2.5%
Vacant / Rights-of-Way / Water / Open Space	4,381	42.6%
Total	10,281	100.0%

Source: Alameda County, 2016

6.4.3 Critical Facilities

GIS analysis was used to determine the number of critical facilities in the mapped dam failure inundation areas. As Table 6-7 shows, 173 of the planning area's critical facilities and critical infrastructure (41 percent) are in the inundation areas.

Table 6-7. Critical Facilities/Infrastructure in Dam Failure Inundation Areas in the Planning Area

	Medical & Health Services	Emergency Services	Educational Facilities	Government	Utilities	Transportation Infrastructure	Hazardous Materials	Other Assets	Total
Dublin	1	1	0	3	2	12	0	0	19
Livermore	0	0	1	0	1	4	0	0	6
Pleasanton	6	5	16	7	58	51	5	0	148
Total	7	6	17	10	61	67	5	0	173

6.4.4 Environment

The environment would be exposed to a number of risks in the event of dam failure. The inundation could introduce many foreign elements into local waterways. This could result in destruction of downstream habitat and could have detrimental effects on many species of animals, especially endangered species such as salmon.

6.5 VULNERABILITY

6.5.1 Population

Vulnerable populations are all populations downstream from dam failures that are incapable of escaping the area within the allowable time frame. This population includes the elderly and young who may be unable to get themselves out of the inundation area. The vulnerable population also includes those who would not have adequate warning from a television or radio emergency warning system. The potential for loss of life is affected by the capacity and number of evacuation routes available to populations living in areas of potential inundation.

6.5.2 Property

Vulnerable properties are those closest to the dam failure inundation area. These properties would experience the largest, most destructive surge of water. Low-lying areas are also vulnerable since they are where the dam waters would collect. Transportation routes are vulnerable to dam failure inundation and have the potential to be wiped

out, creating isolation issues. This includes all roads, railroads and bridges in the path of the dam failure inundation. Those that are most vulnerable are those that are already in poor condition and would not be able to withstand a large water surge. Utilities such as overhead power lines, cable and phone lines could also be vulnerable. Loss of these utilities could create additional isolation issues for the inundation areas.

It is estimated that there could be up to $8.8 billion of loss from a dam failure affecting the planning area. This represents 49 percent of the total exposure within the inundation area, or 16.3 percent of the total assessed value of the planning area. Table 6-8 summarizes the loss estimates for dam failure.

Table 6-8. Loss Estimates for Dam Failure

	Value Exposed			% of Total
	Building Loss	Contents Loss	Total Loss	Replacement Value
Dublin	$54,263,652	$134,358,432	$188,622,085	1.6%
Livermore	$249,974,304	$232,863,515	$482,837,819	2.4%
Pleasanton	$3,995,994,142	$4,100,811,972	$8,096,806,114	38.5%
Total Planning Area	$4,300,232,098	$4,468,033,919	$8,768,266,017	16.3%

6.5.3 Critical Facilities

Hazus was used to estimate the flood loss potential to critical facilities exposed to dam failure risk. Using depth/damage function curves to estimate the percent of damage to the building and contents of critical facilities, Hazus correlates these estimates into an estimate of functional down-time (the estimated time it will take to restore a facility to 100 percent of its functionality). This helps to gauge how long the planning area could have limited usage of facilities deemed critical to flood response and recovery. The Hazus critical facility results for dam failure are shown in Table 6-9.

Table 6-9. Estimated Damage to Critical Facilities and Infrastructure from Dam Failure

	Number of Facilities Affected	Average % of Total Value Damaged		Days to 100% Functionality
		Structure	Content	
Medical and Health Services	6	35.48	81.59	730
Emergency Services	5	57.03	81.08	816
Educational Facilities	13	65.93	91.33	801
Government / City Facilities	7	55.08	86.22	N/A
Utilities	55	33.56	67.62	N/A
Transportation Infrastructure	51	3.78	70.38	N/A
Hazardous Materials	4	26.28	41.00	N/A
Total/Average	141	39.59	74.18	782

6.5.4 Environment

The environment would be vulnerable to a number of risks in the event of dam failure. The inundation could introduce foreign elements into local waterways, resulting in destruction of downstream habitat and detrimental effects on many species of animals, especially endangered species. The extent of the vulnerability of the environment is the same as the exposure of the environment.

6.6 FUTURE TRENDS IN DEVELOPMENT

All land use decision-making is guided by the goals, policies and implementation measures contained in the land use elements of Dublin, Livermore and Pleasanton's general plans. The Dublin general plan's environmental

resources management element, Livermore general plan's public safety element, and Pleasanton's general plan's public safety element establish standards and plans for protecting the community from hazards. Most of the areas vulnerable to the worst impacts from a dam failure correspond to the flood hazard areas. Flood-related policies in the general plans will help to reduce the risk associated with the dam failure hazard for all future development in the planning area. Table 6-10 shows the future land use within the Del Valle Dam Inundation Area.

Table 6-10. Dam Inundation Future Land Use

	Future Land Use Within the Del Valle Dam Inundation Area	
	Area (acres)	% of total
Residential	4,062	39.5%
Commercial	1,356	13.2%
Industrial	265	2.6%
Agriculture	378	3.7%
Religion / Assembly	954	9.3%
Government / Institutional	838	8.2%
Education	2,427	23.6%
Vacant / Rights-of-Way / Water / Open Space	10,281	100.0%
Total	4,062	39.5%

Source: Alameda County, 2016

6.7 SCENARIO

An earthquake within the region could lead to liquefaction of soils around the dams. This could occur without warning during any time of the day. A human-caused failure such as a terrorist attack also could trigger a catastrophic failure of a dam that impacts the planning area. The worst-case scenario for the dam failure hazard would be a full failure of the Del Valle Dam. Such a failure would result in a large portion of Pleasanton being inundated and a smaller portion of Dublin and Livermore. Critical facilities located in the dam inundation area would likely experience failure, resulting in a severe disruption of essential services.

6.8 ISSUES

The most significant issue associated with dam failure involves the properties and populations in the inundation zones. Flooding as a result of a dam failure would significantly impact these areas. There is often limited warning time for dam failure. These events are frequently associated with other natural hazard events such as earthquakes, landslides or severe weather, which limits their predictability and compounds the hazard. Other important issues associated with dam failure include the following:

- Federally regulated dams have an adequate level of oversight and sophistication in the development of emergency action plans for public notification in the unlikely event of failure. However, the protocol for notification of downstream citizens of imminent failure needs to be tied to local emergency response planning.
- Mapping for federally regulated dams is already required and available; however, mapping that estimates inundation depths is needed for dams that are not federally regulated, in order to better assess the risk associated with failure of these facilities.
- Most dam failure mapping required at federal levels requires determination of the probable maximum flood. While the probable maximum flood represents a worst-case scenario, it is generally the event with the lowest probability of occurrence. For dams that are not federally regulated, mapping of failure scenarios that are less extreme than the probable maximum flood but have a higher probability of

occurrence can be valuable to downstream community officials and emergency managers. This type of mapping can illustrate areas potentially impacted by more frequent events to support emergency response and preparedness actions.

- The concept of residual risk associated with structural flood control projects should be considered in the design of capital projects and the application of land use regulations.
- Addressing security concerns and the need to inform the public of the risk associated with dam failure is a challenge for public officials.

7. DROUGHT

7.1 GENERAL BACKGROUND

Most of California's precipitation comes from storms moving across the Pacific Ocean. The path followed by the storms is determined by the position of an atmospheric high-pressure belt that normally shifts southward during the winter, allowing low pressure systems to move into the state. On average, 75 percent of California's annual precipitation occurs between November and March, with 50 percent occurring between December and February. If a persistent Pacific high-pressure zone takes hold over California mid-winter, there is a tendency for the water year to be dry.

A typical water year produces about 100 inches of rainfall over the North Coast, 50 inches of precipitation (combination of rain and snow) over the Northern Sierra, 18 inches in the Sacramento area, and 15 inches in the Los Angeles area. In extremely dry years, precipitation can be as little as a third of these amounts.

DEFINITIONS

Drought—The cumulative impacts of several dry years on water users. It can include deficiencies in surface and subsurface water supplies and generally impacts health, wellbeing, and quality of life.

Meteorological drought—Precipitation's departure from normal over some period of time. Meteorological measurements are the first indicators of drought and are usually region-specific.

Agricultural drought—Insufficient soil moisture to meet the needs of a particular crop at a particular time.

Hydrological drought—Deficiencies in surface and subsurface water supplies, measured as stream flow or as lake, reservoir, or groundwater level.

Socioeconomic drought—Drought impacts on people's health, well being, or quality of life.

Determination of when drought begins requires knowledge of drought impacts on water users, including supplies available to local water users and stored water available to them in surface reservoirs or groundwater basins. Different local water agencies have different criteria for defining drought conditions within their jurisdictions. Some agencies issue drought watch or drought warning announcements to their customers. Determinations of regional or statewide drought conditions are usually based on a combination of hydrologic and water supply factors (DWR, 2017). The California water code does not have a statutory definition of drought; however, analysis of text in the code indicates that legal matters most frequently focus on drought conditions during times of water shortages (California Code of Regulations (CCR), 2017). The Sierra Nevada snowpack is the primary agent for replenishing water for much of California, including the planning area. A reduction in spring snowpack runoff, whether due to drier winters or to increasing temperatures that lead to more rain instead of snow, can increase the risk of summer or fall water shortages throughout the region (California Water Action Plan, 2013).

7.1.1 Types of Drought

As defined by the National Weather Service (NWS), drought is a deficiency in precipitation over an extended period, usually a season or more, resulting in a water shortage causing adverse impacts on vegetation, animals, and/or people. It is a normal, recurrent feature of climate that occurs in virtually all climate zones, from very wet to very dry. If the weather pattern lasts a short time (a few weeks or a couple months), the drought is considered short-term. If the weather pattern becomes entrenched and the precipitation deficits last for several months or years, the drought is considered to be a long-term drought. It is possible for a region to experience a long-term circulation pattern that produces drought, and to have short-term changes in this long-term pattern that result in short-term wet spells. Likewise, it is possible for a long-term wet circulation pattern to be interrupted by short-term weather spells that result in short-term drought. There are four ways that drought can be defined:

- Meteorological drought is a measure of departure of precipitation from normal. It is defined solely on the relative degree of dryness. Due to climatic differences, what might be considered a drought in one location of the country may not be a drought in another location.
- Agricultural drought links various characteristics of meteorological (or hydrological) drought to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evapotranspiration, soil water deficits, reduced ground water or reservoir levels, and other parameters. It occurs when there is not enough water available for a particular crop to grow at a particular time. Agricultural drought is defined in terms of soil moisture deficiencies relative to water demands of plant life, primarily crops.
- Hydrological drought is associated with the effects of periods of precipitation shortfalls (including snowfall) on surface or subsurface water supply. It occurs when these water supplies are below normal. It is related to the effects of precipitation shortfalls on stream flows and reservoir, lake, and groundwater levels.
- Socioeconomic drought is associated with the supply and demand of an economic good with elements of meteorological, hydrological, and agricultural drought. This differs from the aforementioned types of drought because its occurrence depends on the processes of supply and demand to identify or classify droughts. The supply of many economic goods depends on weather (for example water, forage, food grains, fish, and hydroelectric power). Socioeconomic drought occurs when the demand for an economic good exceeds supply as a result of a weather-related shortfall in water supply (Wilhite & Glantz, 1985).

7.1.2 Monitoring Drought

The National Oceanic and Atmospheric Administration (NOAA) has developed several indices to measure drought impacts and severity and to map their extent and locations.

- The **Palmer Crop Moisture Index** measures short-term drought on a weekly scale and is used to quantify drought's impacts on agriculture during the growing season. Figure 7-1 shows this index for week ending May 20, 2017.
- The **Palmer Z Index** measures short-term drought on a monthly scale. Figure 7-2 shows this index for April 2017.
- The **Palmer Drought Index** measures the duration and intensity of long-term drought-inducing circulation patterns. Long-term drought is cumulative, so the intensity of drought during a given month is dependent on the current weather patterns plus the cumulative patterns of previous months. Weather patterns can change quickly from a long-term drought pattern to a long-term wet pattern, and the Palmer Drought Severity Index can respond fairly rapidly. Figure 7-3 shows this index through May 20, 2017.
- The hydrological impacts of drought (e.g., reservoir levels, groundwater levels, etc.) take longer to develop and it takes longer to recover from them. The **Palmer Hydrological Drought Index**, another long-term index, was developed to quantify hydrological effects. The Palmer Hydrological Drought Index responds more slowly to changing conditions than the Palmer Drought Index. Figure 7-4 shows this index for April 2017.
- While the Palmer indices consider precipitation, evapotranspiration and runoff, the **Standardized Precipitation Index** considers only precipitation. In the Standardized Precipitation Index, an index of zero indicates the median precipitation amount; the index is negative for drought and positive for wet conditions. The SPI is computed for time scales ranging from one month to 24 months. Figure 7-5 shows the 12-month SPI map for May 2016 through April 2017.

Source: NOAA, NWS, 2017

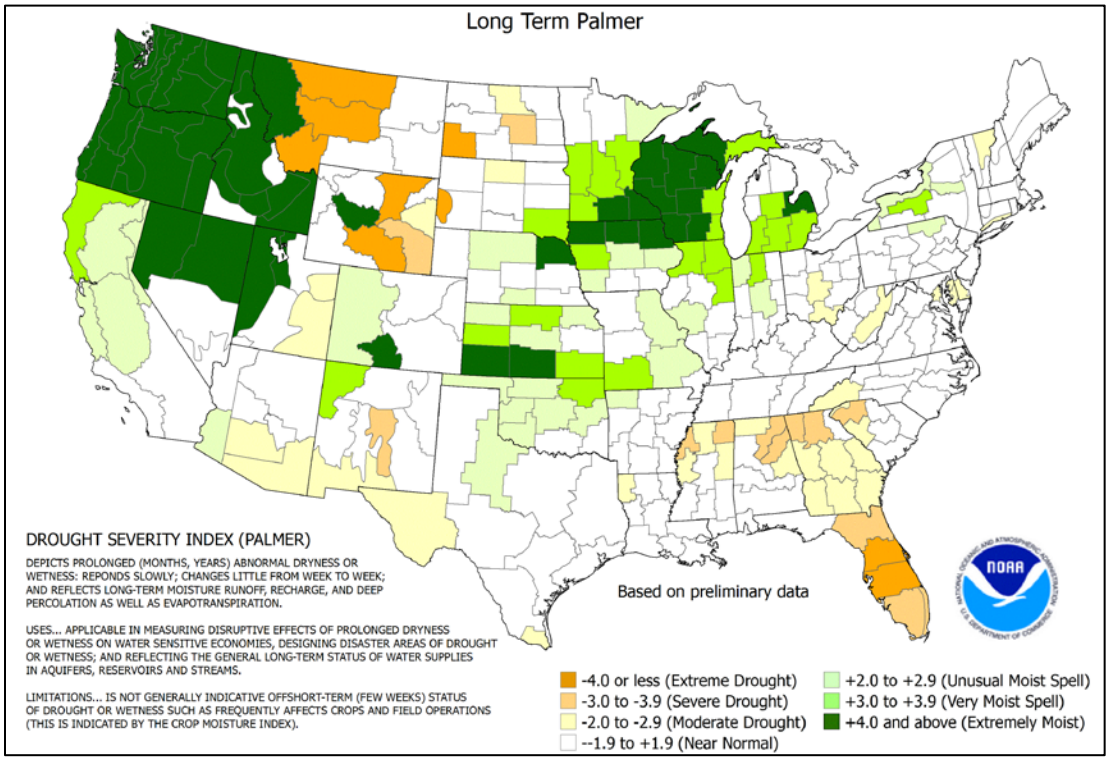


Figure 7-1. Palmer Crop Moisture Index for Week Ending May 20, 2017

Source: NOAA, NWS, 2017a

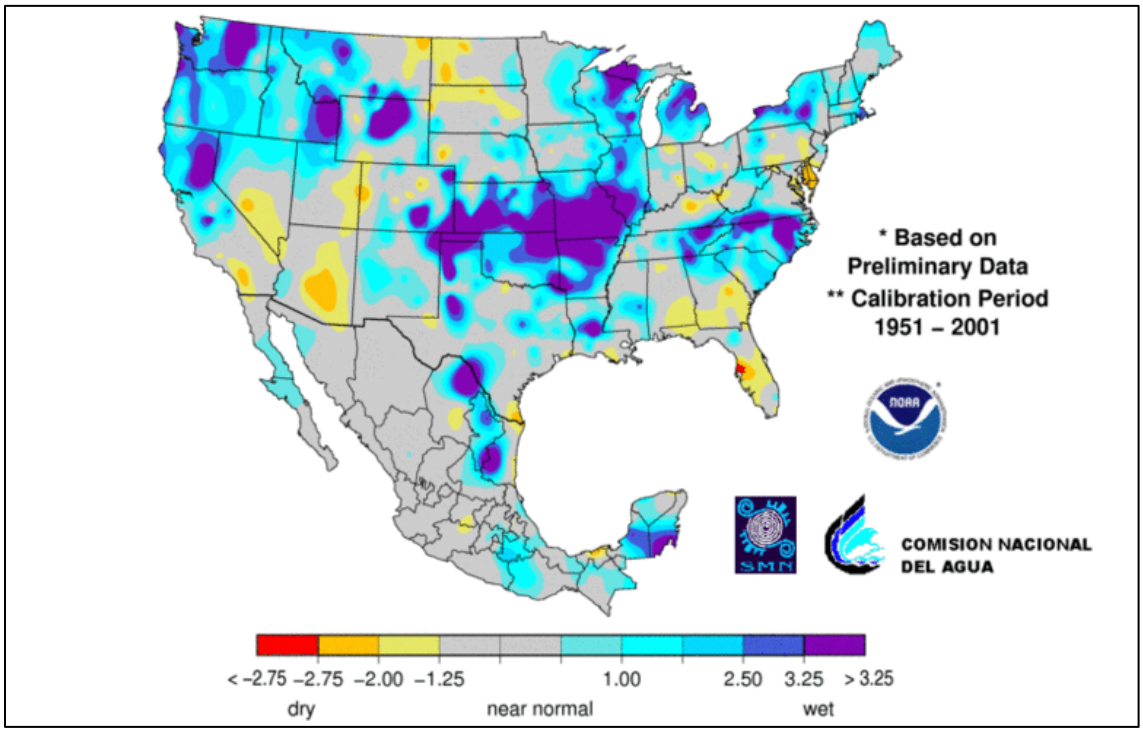


Figure 7-2. Palmer Z Index (April 2017)

Source: NOAA, NWS, 2017b

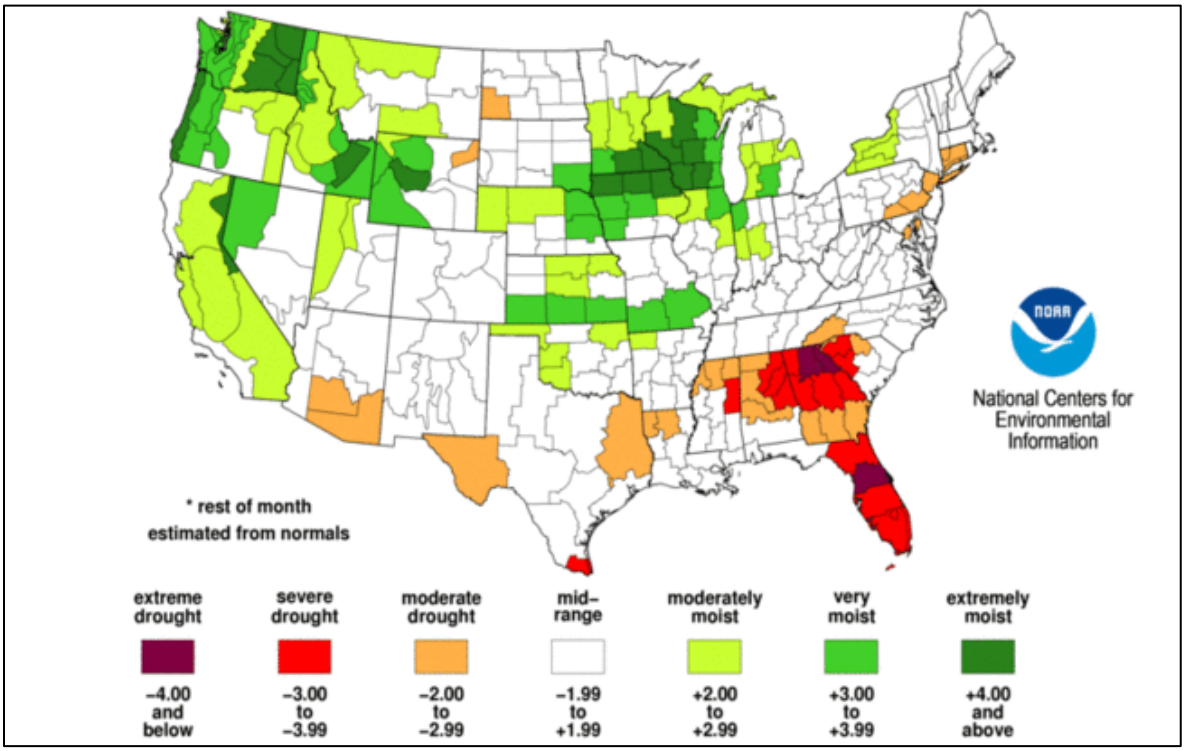


Figure 7-3. Palmer Drought Index through May 20, 2017

Source: NOAA, NWS, 2017c

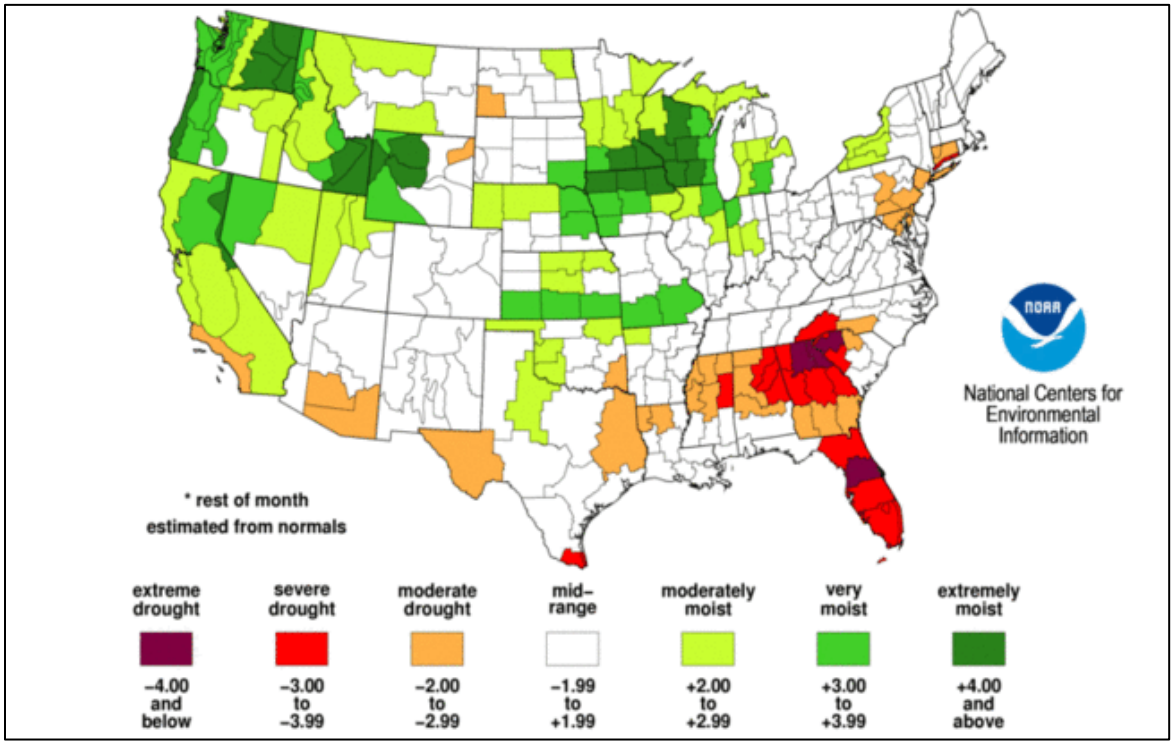


Figure 7-4. Palmer Hydrological Drought Index through May 20, 2017

Source: NOAA, NWS, 2017d

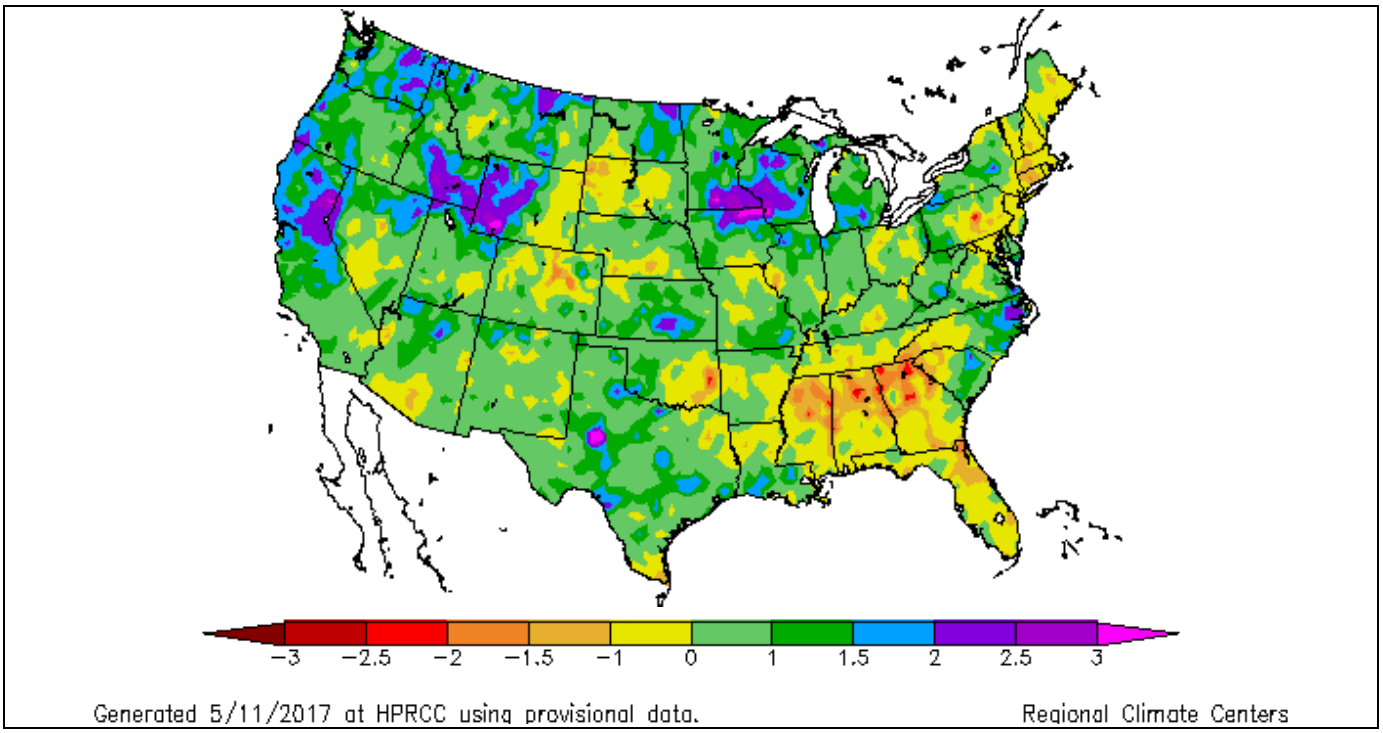


Figure 7-5. 12-Month Standardized Precipitation Index (May 1, 2016 – April 30, 2017)

7.1.3 Water Demand

Drought produces a complex web of impacts that span many sectors of the economy and reach well beyond the area experiencing physical drought. This complexity exists because water is integral to the ability to produce goods and provide services. Drought can affect a wide range of economic, environmental and social activities. The vulnerability of an activity to the effects of drought usually depends on its water demand, how the demand is met, and what water supplies are available to meet the demand.

California's 2005 Water Plan (DWR, 2005) and subsequent updates indicate that water demand in the state will increase through 2030. Although the Department of Water Resources predicts a modest decrease in agricultural water use, the agency anticipates that urban water use will increase by 1.5 to 5.8 million acre-feet per year (DWR, 2005). The 2013 update to the Water Plan explores measures, benchmarks, and successes in increasing agricultural and urban water use efficiency. Between 1996 and 2005, the average amount of water use in the San Francisco Bay area (including the planning area for this hazard mitigation plan) was 155 gallons per capita per day (gpcd); the statewide average was 198 gpcd. The state established a 20-percent water use reduction goal to be achieved by 2020. Although regional estimates were not available, the state average for water use reduction by 2010 was 16 percent (or 166 gpcd) (DWR, 2013).

7.1.4 Local Water Supply

Water Supply System

The Zone 7 Water Agency (Zone 7), a water wholesaler, provides treated drinking water to four major retailers in the planning area that serve approximately 240,000 people and businesses. The wholesale water has three sources (Figure 7-6): South Bay Aqueduct that originates from the California State Water Project; Lake Del Valle storage reservoir that is approximately 10 miles from Livermore; and groundwater from local wells (Zone 7, 2017).

Source: Zone 7, 2015

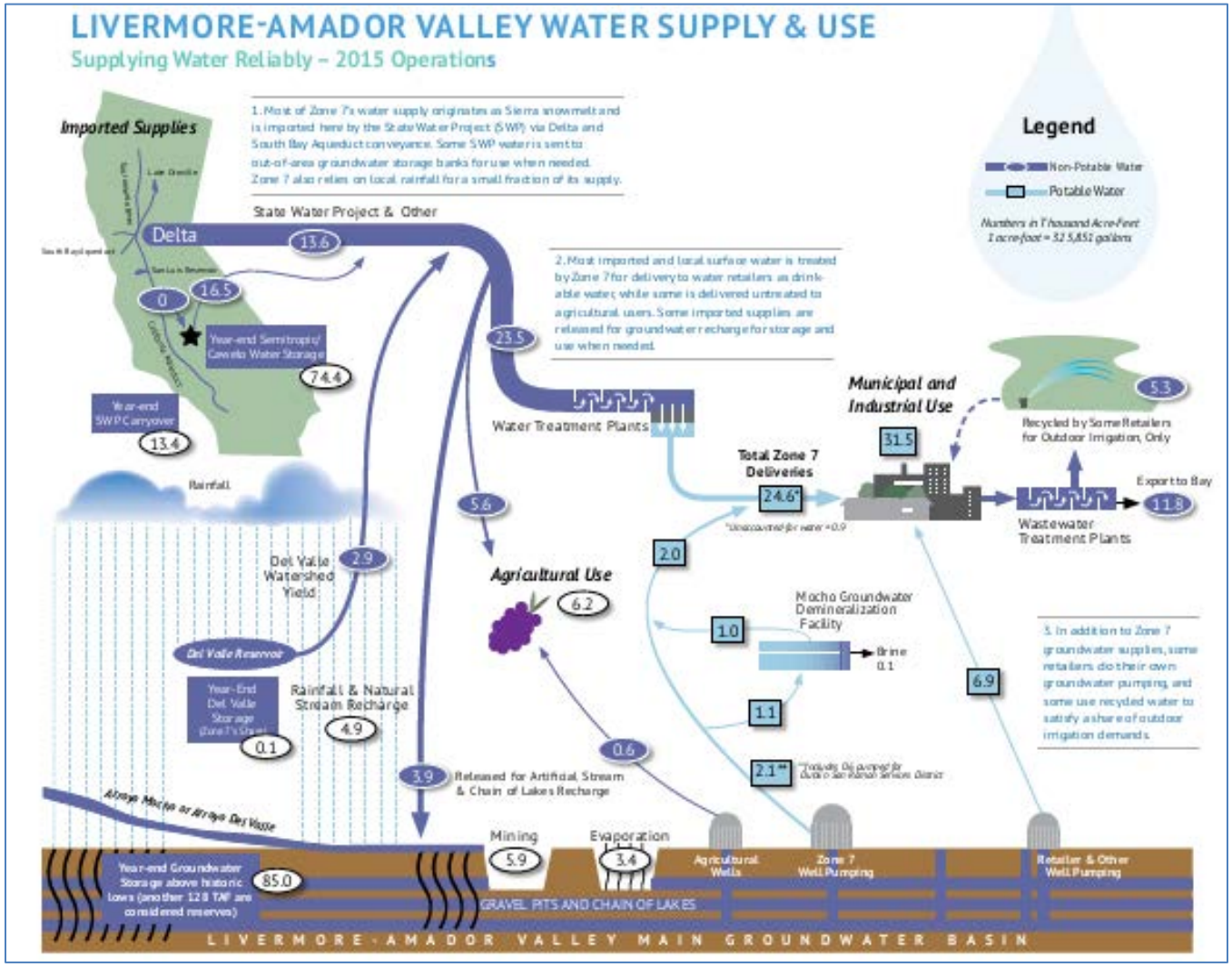


Figure 7-6. Zone 7 Water Agency Supply and Use

The following retail water purveyors in the Tri-Valley planning purchase water from Zone 7:

- **City of Dublin**—Dublin San Ramon Services District is a public agency that distributes water and recycled water, and collects, treats and disposes of wastewater for 173,000 people in Dublin, southern San Ramon, Dougherty Valley, and Pleasanton. It provides water services only to Dougherty Valley and Dublin (Dublin San Ramon Services District, 2017).
- **City of Livermore—** Livermore Municipal Water purchases potable water from Zone 7 Water agency and provides water to more than 28,800 Livermore residents in addition to significant industrial and commercial areas. The balance of residents are served by the California Water Service Company (Cal Water) and with 18,600 customers (including residential and commercial) are within their Livermore system (City of Livermore, 2017).
- **City of Pleasanton**—The City of Pleasanton Utilities Division provides potable water to Pleasanton residents and businesses. The City purchases approximately 80 percent of the water from the Zone 7 Water Agency; the remaining 20 percent comes from local groundwater pumped from City-owned and operated wells (City of Pleasanton, 2017).

Water Supply Strategy

Zone 7 includes a water supply strategy in its 2015 *Urban Water Management Plan* to meet its planning objectives for water supply reliability, cost, water quality, environmental protection and risk. It evaluates a range of water supply and water conservation options and recommended a strategy that includes desalination, recycled water, conservation, groundwater management and off-site banking/transfers.

Zone 7 has projected water supply and demand through 2035 for normal-year, single-dry-year, and multiple-dry-year conditions. Table 7-1 and Table 7-2 show the normal-year and single-dry-year projections. Under normal-year conditions, the agency will have sufficient supply to meet the projected demand and to increase groundwater storage for later use in the service area (Zone 7, 2015).

Table 7-1. Projected Normal Year Water Supply and Demand Comparison

	Supply Projections by Year (acre-feet per year)			
Supply/Demand	2020	2025	2030	2035
Supply Component				
State Water Project (Existing Conveyance-Early Long-Term)	50,000	50,000	50,000	50,000
Yuba Accord	145	145		
Byron Bethany Irrigation District	2,000	2,000	2,000	2,000
Arroyo Valle	7,300	7,300	10,300	10,300
California Water Fix			8,000	8,000
Possible desalination and/or potable reuse[a]		10,000	10,000	10,000
Groundwater	9,200	9,200	9,200	9,200
State Water Project - Carryover	10,000	10,000	10,000	10,000
TOTAL SUPPLY	78,645	88,645	99,500	99,500
Demand Component				
Retail Demand	41,300	44,700	46,600	47,600
Untreated Water Demand	6,200	6,600	7,800	8,300
Direct Retail Demand	300	300	300	300
Local Groundwater Basin	9,200	9,200	9,200	9,200
Kern County Groundwater Banking Program	0	300	7,300	9,000
Surface Water Storage – SWP Carryover or Other Storage	10,000	10,000	10,000	10,000
Transmission System	2,100	2,200	2,300	2,400
Storage Losses	3,000	4,000	6,000	6,000
TOTAL DEMAND	72,100	77,300	89,500	92,800
Supply & Demand Comparison				
Supply Totals	78,645	88,645	99,500	99,500
Demand Totals	72,100	77,300	89,500	92,800
Difference	6,545	11,345	10,000	6,700
Difference as % of Supply	8%	13%	10%	6%
Difference as % of Demand	9%	15%	11%	7%

a. Per Water Supply Evaluation Update

Table 7-2. Projected Single-Dry-Year Water Supply and Demand Comparison

Supply/Demand	Supply Projections (by year) (acre-feet per year) 2018	2023	2028	2033
Supply Component				
State Water Project (Existing Conveyance-Early Long-Term)	21,800	21,800	21,800	21,800
State Water Project - Carryover	10,000	10,000	10,000	10,000
Yuba Accord	676	676		
Byron Bethany Irrigation District	2,000	2,000	2,000	2,000
Arroyo Valle	350	350	350	350
California Water Fix			0	0
Possible desalination and/or potable reuse[a]		10,000	10,000	10,000
Groundwater	12,400	12,400	12,400	12,400
Semitropic	10,400	10,400	10,400	10,400
Cawelo	10,000	10,000	10,000	10,000
TOTAL SUPPLY	67,626	77,626	76,950	76,950
Demand Component				
Retail Demand	39,500	43,400	46,100	47,300
Untreated Water Demand	6,200	6,200	7,300	8,300
Direct Retail Demand	300	300	300	300
Local Groundwater Basin	0	0	0	0
Kern County Groundwater Banking Program	0	0	0	0
Surface Water Storage – SWP Carryover or Other Storage	0	0	0	0
Transmission System Losses	2,000	2,200	2,300	2,400
Storage Losses	0	0	0	0
TOTAL DEMAND	48,000	52,100	56,000	58,300
Supply & Demand Comparison				
Supply Totals	67,626	77,626	76,950	76,950
Demand Totals	48,000	52,100	56,000	58,300
Difference	19,626	25,526	20,950	18,650
Difference as % of Supply	29%	33%	27%	24%
Difference as % of Demand	40%	49%	37%	32%

a. Per Water Supply Evaluation Update
Source: Zone 7, 2015

7.1.5 Drought Response Planning

California Drought Contingency Plan

The *California Drought Contingency Plan* defines the following drought levels, which can serve as a reference for determining the need for response (DWR, 2010):

- When the state's precipitation, snowpack, or runoff is lower than normal, or reservoir levels are below average, conservation measures should be increased voluntarily, to help manage the state's current water supply. General response types are as follows:
  - Level 1, Abnormally Dry—Actions to raise awareness of drought

  - Level 2, First-Stage Drought—Voluntary conservation, heightened awareness, increased preparation

- When reservoirs are low; precipitation, snowpack, and runoff are all well below normal and forecasted to remain so, mandatory conservation may need to be enacted in communities that do not have adequate water supplies. General response types are as follows:

  - Level 3, Severe Drought—Mandatory conservation, emergency actions
  - Level 4, Extreme Drought—Maximum mandatory conservation

- When extremely dry conditions persist across the state, water safety, supply, and quality are all at risk due to shortages, and all sectors of water usage are facing hardship as a result of inadequate supply and dry conditions, general response types are as follows:

  - Level 5, Exceptional Drought—Water supplies cut off, maximum response.

Drought recovery begins when water conditions throughout the state are at normal levels. No drastic water conservation measures are necessary in this period, although water conservation should always be practiced. The state's reservoirs are full or nearly full and runoff across the state is at normal levels.

Zone 7 Water Management Plan

Zone 7's *2015 Urban Water Management Plan* will be enacted at the appropriate level to address a water supply shortage up to 50 percent (Chapter 8, Water Shortage Contingency Plan). Zone 7 Water District has sufficient water supply to meet demand in most years, but shortages can occur as a result of dry weather or an extended interruption of imported supplies. Voluntary water restrictions may also be initiated by an executive order from the governor due to state-level water conditions. The water shortage stages and associated actions Zone 7 will take to implement a water shortage contingency plan in response to a water supply shortfall are as follows (Zone 7, 2015):

- Stage 1, Minimal Shortage

  - Zone 7 Board declaration based on findings from the Annual Sustainability Report to determine voluntary vs. mandatory reductions (Stage 1 vs. Stage 2).
  - Public outreach to support voluntary conservation.
  - Retailers asked to voluntarily reduce demand up to 20 percent.

- Stage 2, Moderate Shortage

  - Zone 7 Board declaration based on findings from the Annual Sustainability Report to determine voluntary vs. mandatory reductions (Stage 1 vs. Stage 2), and retailers required to reduce demand accordingly up to 20 percent.
  - Water shortage surcharge may be implemented as determined by the board.
  - Expanded public outreach to support conservation.
  - Specific practices may be prohibited as determined by the board.

- Stage 3, Severe Shortage

  - Zone 7 Board declaration based on findings from the Annual Sustainability Report with mandatory demand reduction between 20 and 35 percent and retailers asked to reduce demand accordingly.
  - Water shortage surcharge may be implemented as determined by the board.
  - Intensified public outreach to support conservation.
  - Specific practices are prohibited as determined by the board.

- Stage 4, Critical Shortage
    - Zone 7 Board declaration based on findings from the Annual Sustainability Report with mandatory demand reduction greater than 35 percent and retailers asked to reduce demand accordingly.
    - Water shortage surcharge may be implemented as determined by the board.
    - Intensified public outreach to support conservation.
    - Specific practices are prohibited as determined by the board.

Since Zone 7 is a wholesale water agency, it has not adopted ordinances that set or enforce consumption limits at the customer level.

Local Retail Water Purveyors

Local retail water purveyors in the Tri-Valley planning area (Dublin San Ramon Services District, Livermore Municipal Water, California Water Service Company, and City of Pleasanton Utilities Division) have prepared for water supply interruptions with water shortage contingency plans. The plans consist of four stages of water conservation and give guidelines to residential and commercial users' conservation action ideas. These plans also include per capita allotment, penalties and customer incentives for conservation.

7.2 HAZARD PROFILE

7.2.1 Past Events

In California, droughts typically occur after two or three years of below-average rainfall for the period from November to March, when about 75 percent of the State's average annual precipitation falls. December, January, and February are when approximately 50 percent of the rainfall occurs in California.

Drought has affected nearly every county in California at one time, causing more than $2.6 million in damages. They are a cyclic part of the climate of the State and occur at any time of the year, with an average recurrence interval between three and 10 years (Cal OES, 2013a; Alameda County, 2016a). This section provides information regarding drought events that occurred in California and Alameda County.

State of California

The California Department of Water Resources has state hydrologic data back to the early 1900s. The hydrologic data show multi-year droughts from 1912 to 1913, 1918 to 1920 and 1922 to 1924, and 1928 to 1934 (DWR, 2013a). Since then, four prolonged periods of drought occurred in California:

- **2012 to 2016 Drought**—California's drought has set several records for the state. The period from 2012 to 2014 ranked as the driest three consecutive years for statewide precipitation. Calendar year 2014 set new climate records for statewide average temperatures and for record-low water allocations from State Water Project and federal Central Valley Project contractors. Calendar year 2013 set minimum annual precipitation records for many communities. The state has detailed executive orders and regulations concerning water conservation and management. Total impacts of the drought cannot be determined until after its conclusion. Based on a wet winter, Governor Brown declared an end to the drought emergency on April 7, 2017 in Executive Order B-40-17, except in four counties (Fresno, Kings Tulare, and Tuolumne) (CA.gov, 2017).
- **2007 to 2009 Drought**—The Governor issued an Executive Order that proclaimed a statewide drought emergency on June 4, 2008 after spring 2008 was the driest spring on record and low snowmelt runoff. On February 27, 2009, the Governor proclaimed a state of emergency for the entire state as the severe

drought conditions continued widespread impacts and the largest court-ordered water restriction in state history (at the time).

- **1987 to 1992 Drought** —California received precipitation well below average levels for four consecutive years. While the Central Coast was most affected, the Sierra Nevadas in Northern California and the Central Valley counties were also affected. During this drought, only 56 percent of average runoff for the Sacramento Valley was received, totaling just 10 million acre-feet. In 1991, the State Water Project sharply decreased deliveries to water suppliers including the San Francisco Bay Area. By February 1991, all 58 counties in California were suffering from drought conditions, and urban areas as well as rural and agricultural areas were impacted.
- **1976 to 1977 Drought**—California had one of its most severe droughts due to lack of rainfall during the winters of 1976 and 1977. 1977 was the driest period on record in California, with the previous winter recorded as the fourth driest in California's hydrological history. The cumulative impact led to widespread water shortages and severe water conservation measures throughout the state. Only 37 percent of the average Sacramento Valley runoff was received, with just 6.6 million acre-feet recorded. Over $2.6 billion in crop damage was recorded in 31 counties. Alameda County was included in FEMA-3023-EM-CA declaration on January 20, 1977.

Alameda County

The 2010 ABAG Annex to Local Hazard Mitigation Plan (ABAG, 2010) identified the following drought events that impacted Alameda County:

- **2007 to 2009**—This event affected the entire state, particularly the central coast. It was a three year drought due to below average rainfall, low snowmelt runoff, and the largest court ordered water restriction in state history. The dry conditions damaged crops, deteriorated water quality, and caused extreme fire danger. California proclaimed a state disaster in 2008 and 2009. Damages included $300 million in agricultural revenue loss and potential $3 billion in economic losses over time.
- **1987 to 1992**—This event affected the entire state.
- **1976 to 1977**—This event affected the entire state with the exception of southwestern deserts. These were the two driest years in California's history. The drought was most severe in the northern two-thirds of the State. California proclaimed a statewide disaster that did not include Alameda County, but the federal disaster declaration in 1977 did include Alameda County. Damage totaled $2.664 billion ($888.5 million in 1976 and $1.775 billion in 1977).
- **1959 to 1962**—This event affected the entire state.
- **1943 to 1951**—This event affected the entire state.
- **1928 to 1937**—This event affected the entire state.
- **1922 to 1926**—This event affected the entire state with the exception of central Sierra Nevada.
- **1917 to 1921**—This event affected the entire state with the exception of central Sierra Nevada and the north coast.

The National Drought Mitigation Center (NDMC) developed the Drought Impact Reporter in response to the need for a national drought impact database for the United States. Information comes from a variety of sources: on-line, drought-related news stories and scientific publications, members of the public who visit the website and submit a drought-related impact for their region, members of the media, and members of relevant government agencies. The database is being populated beginning with the most recent impacts and working backward in time. The Drought Impact Reporter contains information on 173 impacts from droughts that specifically affected Alameda County from 2006 through May 1, 2017 (NDMC Drought Impact Reporter, 2017). The following are the categories and reported number of impacts (some impacts are assigned to more than one category):

- Agriculture—38

- Business and Industry—8
- Energy—4
- Fire—14
- Plants and Wildlife—33
- Relief, Response, and Restrictions—96
- Society and Public Health—65
- Tourism and Recreation—7
- Water Supply and Quality—109

Between 1954 and 2016, the State of California experienced one FEMA declared drought-related major disaster (DR) or emergency (EM) classified as a drought. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. Alameda County was included in the declaration (FEMA 2017a) (see Table 7-3).

Table 7-3. FEMA Declarations for Drought Events in Alameda County

FEMA Declaration Number	Event Date	Event Type	Location
EM-3023	1977	Drought	58 counties including Alameda County

Agriculture-related disasters and disaster declarations are common in the United States. The U.S. Department of Agriculture (USDA) Farm Service Agency provides assistance for natural disaster losses resulting from drought, flood, fire, freeze, tornadoes, pest infestation, and other natural disasters. The Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses. Between 2012 and 2016, California has been included in 61 drought-related USDA disaster declarations and Alameda County has been included in 11 (USDA, 2017):

- S3952 in 2016
- S3784 and S3943 in 2015
- S3626, S3637, and S3743 in 2014
- S3547, S3558 and S3569 in 2013
- S3248 and S3930 in 2012.

7.2.2 Location

Droughts can occur anywhere in California and are typically regional in nature. If a drought is occurring in Alameda County, then the planning area is most likely being impacted as well. The entire planning area is susceptible to droughts and impacts brought on by such events.

7.2.3 Frequency

Historical drought data for the Alameda County region indicate there have been four significant droughts in the last 40 years (1976 to 2016). The Tri-Valley planning area has been included in various drought stages during 12 of the last 40 years. This equates to a drought about every three years on average, or a 30 percent chance of a drought in any given year. As temperatures increase, the probability of future droughts will likely increase.

7.2.4 Severity

General Drought Impacts

Drought can have a widespread impact on the environment and the economy, although it typically does not result in direct loss of life or damage to property, as do other natural disasters. Nationwide, the impacts of drought occur primarily in the agriculture, transportation, recreation and tourism, forestry, and energy sectors. Social and

environmental impacts are also significant, although it is difficult to put a precise cost on these impacts. The National Drought Mitigation Center uses three categories to describe likely drought impacts:

- Economic Impacts—Drought can cost people and businesses money: farmers' crops are destroyed; low water supply requires spending money on irrigation or to drill new wells; water-related businesses see drops in sales; water companies must spend money on new or additional water supplies.
- Environmental Impacts—Plants and animals depend on water, just like people. When a drought occurs, their food supply can shrink and their habitat can be damaged
- Social Impacts—These impacts affect people's health and safety. Social impacts include public safety, health, conflicts between groups when there is not enough water to go around, and changes in lifestyle.

The severity of a drought depends on the degree of moisture deficiency, the duration, and the size and location of the affected area. The longer the duration of the drought and the larger the area impacted, the more severe the potential impacts.

Drought generally does not affect groundwater sources as quickly as surface water supplies, but groundwater supplies generally take longer to recover. Reduced precipitation during a drought means that groundwater supplies are not replenished at a normal rate. This can lead to a reduction in groundwater levels and problems such as reduced pumping capacity or wells going dry. Shallow wells are more susceptible than deep wells. Reduced replenishment of groundwater affects streams. Much of the flow in streams comes from groundwater, especially during the summer when there is less precipitation and after snowmelt ends. Reduced groundwater levels mean that even less water will enter streams when steam flows are lowest.

Local Impacts of the 2012-2016 Drought

The Cities of Dublin, Livermore and Pleasanton all initiated water shortage contingency plans during the most recent drought. Each city carried out public education campaigns about water conservation and took steps to conserve water. Zone 7 and its retailers developed a website for Tri-Valley residents with information on water-wise gardening www.trivalleywaterwise.com (Water-Wise Gardening Tri-Valley, 2017). The following are examples of how local proprietors dealt with the drought.

Zone 7

In 2014, Zone 7 had to establish mandatory minimum guidelines for its service area to achieve a needed 25-percent reduction in water use over the course of the year by cutting back on outdoor watering by 50 to 60 percent. During this time, Zone 7 only received a 5 percent allocation from the State Water Project, but Zone 7 was able to fulfill 75 percent of retail requests. Zone 7 relied on its out-of-valley storage, groundwater banking programs, and its local groundwater basin management operations (Zone 7 Water Agency, 2014).

Dublin San Ramon Services District and City of Dublin

On May 19, 2015, the Dublin San Ramon Services District declared that a State of Community Drought Emergency existed since February 2014 as there was insufficient water to meet ordinary demand of water consumers in the service area. An updated Drought Response Act Plan adopted on May 19, 2015 was to run through February 2, 2016 and was later revised to continue until October 31, 2016.

In May 2015, Dublin San Ramon Services District issued Water Use Limitations Urgency Ordinance No. 336, which adopted water use limitations during the drought Emergency, and Water Shortage Enforcement Ordinance No. 337, which adopted penalties and provisions for the enforcement of water use limitations. In March 2016, the Board adopted Urgency Ordinance No. 338 to revise the water use limitations during the Community Drought Emergency.

Customers responded positively to Dublin San Ramon Services District's water conservation program and the ongoing drought statewide by saving water that exceeded water use reduction goals. From June 2015 through January 2016, Dublin San Ramon Services District's cumulative water savings was 37 percent compared to 2013 water use, exceeding Dublin San Ramon Services District's conservation standard of 12 percent.

The City of Dublin has taken steps to reduce its consumption of potable water. Nearly all of its parks and landscaped medians now use recycled water; recycled water use is approximately 90 percent of total usage for municipal operations. The City instituted several water-saving practices for businesses, residents, and City departments (City of Dublin, 2017).

City of Livermore

The City of Livermore first adopted a Water Shortage Contingency Plan in 1991 and updated the plan in 1996, 2005 and 2011. The Plan includes water conservation strategies in response to shortages. In response to the drought emergency declared by Governor Brown in January 17, 2014, the Livermore City Council declared a water shortage emergency on February 24, 2014 and enacted Stage 1 Voluntary Water Conservation Measures to achieve a 20% reduction in water consumption. On April 28, 2014, the City Council enacted Stage 2 mandatory conservation measures at a 35% level. Due to the community's positive response in achieving conservation targets and updated evaluation of water availability, the City Council on June 27, 2016 was able to repeal the mandated Stage 3 conservation measures and enacted Stage 1 voluntary conservation of 10%. On May 22, 2017, the City Council repealed the Stage 1 conservations measures following Governor Brown's declaration of the end of the drought emergency. During the drought, Livermore Municipal Water customers were able to achieve conservation of 25% in 2014, 32% in 2015 and 28% in 2016 as compared to 2013 water use. (City of Livermore, 2017a).

City of Pleasanton

In April 2014, the City moved into Stage 3 water restrictions, mandating a 25-percent reduction in use by all water customers. This continued into 2015. City staff organized a public education program to inform residents and businesses on ways to conserve water with more efficient and reduced landscape irrigation, repairing leaks, and eliminating non-necessary water usage from their routines. In under 6 months, Pleasanton water users reduced their water consumptions by 27 percent from the previous year.

In 2015, the City secured almost $17 million in low-interest loans and incentive grants from the state to build infrastructure to deliver more recycled water. As a result, approximately 450 million gallons a year of recycled water was projected to be delivered to commercial users. In 2016, 10 miles of purple lines (recycled water infrastructure) were installed, saving the City 10 percent of potable water (City of Pleasanton, 2017a).

7.2.5 Warning Time

Droughts are climatic patterns that occur over long periods of time. Only generalized warning can take place due to the numerous variables that scientists have not pieced together well enough to make accurate and precise predictions.

Empirical studies conducted over the past century have shown that meteorological drought is never the result of a single cause. It is the result of many causes, often synergistic in nature; these include global weather patterns that produce persistent, upper-level high-pressure systems along the West Coast with warm, dry air resulting in less precipitation.

Scientists at this time do not know how to predict drought more than a month in advance for most locations. Predicting drought depends on the ability to forecast precipitation and temperature. Anomalies of precipitation and temperature may last from several months to several decades; California is currently experiencing a several-

year-long drought, while other areas in the United States may experience droughts as short as one or two months. How long droughts last depends on interactions between the atmosphere and the oceans, soil moisture and land surface processes, topography, internal dynamics, and the accumulated influence of weather systems on the global scale.

7.3 SECONDARY HAZARDS

The secondary hazard most commonly associated with drought is wildfire. A prolonged lack of precipitation dries out vegetation, which becomes increasingly susceptible to ignition as the duration of the drought extends. Millions of board feet of timber have been lost, and in many cases erosion occurred, which caused serious damage to aquatic life, irrigation, and power production by heavy silting of streams, reservoirs, and rivers.

Drought also is often accompanied by extreme heat, exposing people to the risk of sunstroke, heat cramps and heat exhaustion. Pets and livestock are also vulnerable to heat-related injuries. Crops can be vulnerable as well.

Environmental losses are the result of damage to plants, animals, wildlife habitat, and air and water quality; forest and range fires; degradation of landscape quality; loss of biodiversity; and soil erosion. Some of the effects are short-term and conditions quickly return to normal following the end of the drought. Other environmental effects linger for some time or may even become permanent. Wildlife habitat, for example, may be degraded through the loss of wetlands, lakes, and vegetation. However, many species will eventually recover from this temporary aberration. The degradation of landscape quality, including increased soil erosion, may lead to a more permanent loss of biological productivity.

Drought-induced subsidence is a potential secondary hazard, although it is not as common as wildfire or extreme heat. If subsidence does occur, it can significantly impact the local environment, floodplain/wetlands, and water supply.

7.4 EXPOSURE

All people, property and environments within the Tri-Valley planning area would be exposed to some degree to the impacts of moderate to extreme drought conditions.

7.5 VULNERABILITY

7.5.1 Population

The entire population of the planning area is vulnerable to drought events. Drought conditions can affect people's health and safety, including health problems related to low water flows and poor water quality, and health problems related to dust. Droughts can also lead to the loss of human life (NDMC, 2017a). Other possible impacts on health from drought include increased recreational risks; effects on air quality; diminished living conditions related to energy, air quality, and sanitation and hygiene; compromised food and nutrition; and increased incidence of illness and disease. Health implications of drought—both short-term and long-term—are numerous (Centers for Disease Control and Prevention, 2012). Drought conditions can cause shortages of water for human consumption. Droughts can also lead to reduced local firefighting capabilities.

Alameda County, the Cities of Dublin, Livermore and Pleasanton, regional water purveyors, and other regional stakeholders have spent considerable effort to protect life, safety, and health during times of consecutive dry years, such as the current drought. Provisions and measures have been taken to analyze and account for anticipated water shortages. With the actions implemented by the Cities of Dublin, Livermore and Pleasanton and the coordination with Alameda County, the planning area has the ability to minimize and reduce impacts on

residents and water consumers in the planning area. No significant life or health impacts as a result of drought are anticipated in the planning area.

7.5.2 Property

No structures will be directly affected by drought conditions in the Tri-Valley planning area, though some structures may become vulnerable to wildfires, which are more likely following years of drought. Risk to life and property is greatest in the wildland-urban interface, where forested areas adjoin urbanized areas (high density residential, commercial and industrial). All assets in and adjacent to the wildland-urban interface zone, including population, structures, critical facilities, lifelines, and businesses are considered vulnerable to wildfire. Specific vulnerability regarding wildfire is described in Chapter 12.

7.5.3 Critical Facilities

Critical facilities as defined for this plan will continue to be operational during a drought. Critical facility elements such as landscaping may not be maintained due to limited resources, but the risk to the planning area's critical facilities inventory will be largely aesthetic impacts that are not considered significant.

7.5.4 Environment

Environmental losses from drought are associated with damage to plants, animals, wildlife habitat, and air and water quality; forest and range fires; degradation of landscape quality; loss of biodiversity; and soil erosion. Some of the effects are short-term and conditions quickly return to normal following the end of the drought. Other environmental effects linger for some time or may even become permanent. Wildlife habitat, for example, may be degraded through the loss of wetlands, lakes and vegetation. However, many species will eventually recover from this temporary condition. The degradation of landscape quality, including increased soil erosion, may lead to a more permanent loss of biological productivity. Environmental losses are difficult to quantify, but growing public awareness and concern for environmental quality have forced public officials to focus greater attention on these effects.

7.5.5 Economic Impact

A prolonged drought can have a serious economic impact on a community. Increased demand for water and electricity may result in shortages and higher costs for these resources. Industries that rely on water for business may be impacted the most (e.g., landscaping businesses). Although most businesses will still be operational, they may be impacted aesthetically. These aesthetic impacts are most significant within the recreation and tourism industry. Moreover, droughts in another area could impact the food supply/price of food for residents of the planning area. While the planning area is not considered highly agricultural, it is important to note that ranching, vineyards and the winery business are an important part of the Tri-Valley economy.

7.6 FUTURE TRENDS IN DEVELOPMENT

Land use planning is directed by general plans adopted under California's General Planning Law. Municipal planning partners are encouraged to establish general plans with policies directing land use and dealing with issues of water supply and the protection of water resources. These plans provide the capability at the local municipal level to protect future development from the impacts of drought. Dublin, Livermore and Pleasanton reviewed their general plans under the capability assessments performed for this effort. Deficiencies identified by these reviews can be identified as mitigation actions to increase the capability to deal with future trends in development.

7.7 SCENARIO

Continuation or exacerbation of the current drought across California—an extreme, multiyear drought with record-breaking rates of low precipitation and high temperatures—is the worst-case scenario for the planning area. Low precipitation and high temperatures intensify the possibility of wildfires throughout the planning area, increasing the need for water, when water is already in limited supply. Surrounding regions, also in drought conditions, could increase their demand for the water supplies also relied upon in the planning area, causing social and political conflicts. The high-density population of the Bay Area increases the likelihood of such conflicts, despite the existence of the Bay Area Water Supply and Conservation Agency *Water Conservation Implementation Plan*. The longer drought conditions last in the planning area, the more impacted the local economy becomes; water-dependent industries especially will experience setbacks.

7.8 ISSUES

The planning team has identified the following drought-related issues:

- Identification of the availability and reliability of new water supplies
- Monitoring of the implementation and benefits of the long-term reliable water supply strategy projects, Bay Area Water Supply and Conservation Agency *Water Conservation Implementation Plan* projects, and water system upgrades
- Application of alternative techniques (groundwater recharge, water recycle, local capture and reuse, desalination, and transfer) to stabilize and offset Sierra Nevada snowpack water supply shortfalls
- Regular occurrence of drought or multiyear droughts that may limit the planning area's ability to successfully recover from or prepare for more occurrences-particularly noteworthy due to longevity of the current ongoing drought.
- The probability of increased drought frequencies and durations due to climate change
- The promotion of active water conservation even during non-drought periods.

8. EARTHQUAKE

8.1 GENERAL BACKGROUND

An earthquake is the vibration of the earth's surface that follows a release of energy in the earth's crust. Most destructive quakes are caused by dislocations of the crust. The crust may first bend and then, when the stress exceeds the strength of the rocks, break and snap to a new position. Vibrations called "seismic waves" are generated in the process of breaking. These waves travel outward from the source of the earthquake along the surface and through the earth at varying speeds, depending on the material they move through.

California is seismically active because of movement of the North American Plate, on which everything east of the San Andreas Fault sits, and the Pacific Plate, which includes coast communities west of the fault. The movement of the tectonic plates creates stress released as energy that moves through the earth as waves called earthquakes.

DEFINITIONS

Earthquake—The shaking of the ground caused by an abrupt shift of rock along a fracture in the earth or a contact zone between tectonic plates.

Epicenter—The point on the earth's surface directly above the hypocenter of an earthquake. The location of an earthquake is commonly described by the geographic position of its epicenter and by its focal depth.

Fault—A fracture in the earth's crust along which two blocks of the crust have slipped with respect to each other.

Hypocenter—The region underground where an earthquake's energy originates

Liquefaction—Loosely packed, water-logged sediments losing their strength in response to strong shaking, causing major damage during earthquakes.

8.1.1 Earthquake Classifications

Earthquakes are typically classified in one of two ways: by the amount of energy released, measured as magnitude; or by the impact on people and structures, measured as intensity.

Magnitude

An earthquake's magnitude is a measure of the energy released at the source of the earthquake. It is commonly expressed by ratings on either of two scales (USGS, 1989):

- The **Richter scale** measures magnitude of earthquakes based on the amplitude of the largest energy wave released by the earthquake. Richter scale readings are suitable for smaller earthquakes; however, because it is a logarithmic scale, the scale does not distinguish clearly the magnitude of large earthquakes above a certain level. Richter scale magnitudes and corresponding earthquake effects are as follows:

  - 2.5 or less—Usually not felt, but can be recorded by seismograph
  - 2.5 to 5.4—Often felt, but causes only minor damage
  - 5.5 to 6.0—Slight damage to buildings and other structures
  - 6.1 to 6.—May cause a lot of damage in very populated areas
  - 7.0 to 7.9—Major earthquake; serious damage
  - 8.0 or greater—Great earthquake; can totally destroy communities near the epicenter

- A more commonly used magnitude scale today is the **moment magnitude (M_w) scale**. The moment magnitude scale is based on the total moment release of the earthquake (the product of the distance a fault moved and the force required to move it). Moment magnitude roughly matches the Richter scale but provides more accuracy for larger magnitude earthquakes. The scale is as follows:

- Great—$M_w \geq 8$
- Major—$M_w = 7.0 - 7.9$
- Strong—$M_w = 6.0 - 6.9$
- Moderate—$M_w = 5.0 - 5.9$
- Light—$M_w = 4.0 - 4.9$
- Minor—$M_w = 3.0 - 3.9$
- Micro—$M_w < 3$

Intensity

Currently the most commonly used intensity scale is the modified Mercalli intensity scale, with ratings defined as follows (USGS, 2014):

- I (Not Felt). Not felt except by a very few under especially favorable conditions
- II (Weak). Felt only by a few persons at rest, especially on upper floors of buildings.
- III (Weak). Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it is an earthquake. Standing cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
- IV (Light). Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like a heavy truck striking building. Standing cars rocked noticeably.
- V (Moderate). Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
- VI (Strong). Felt by all; many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
- VII (Very Strong). Damage negligible in buildings of good design and construction; slight in well-built ordinary structures; considerable in poorly built or badly designed structures. Some chimneys broken.
- VIII (Severe). Damage slight in specially designed structures; considerable damage in ordinary buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
- IX (Violent). Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
- X (Extreme). Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.

8.1.2 Ground Motion

Earthquake hazard assessment is also based on expected ground motion. During an earthquake when the ground is shaking, it also experiences acceleration. The peak acceleration is the largest increase in velocity recorded by a particular station during an earthquake. Estimates are developed of the annual probability that certain ground motion accelerations will be exceeded; the annual probabilities can then be summed over a time period of interest.

The most commonly mapped ground motion parameters are horizontal and vertical peak ground accelerations (PGA) for a given soil type. PGA is a measure of how hard the earth shakes, or accelerates, in a given geographic area. Instruments called accelerographs record levels of ground motion due to earthquakes at stations throughout a region. PGA is measured in g (the acceleration due to gravity) or expressed as a percent acceleration force of gravity (%g). These readings are recorded by state and federal agencies that monitor and predict seismic activity.

Maps of PGA values form the basis of seismic zone maps that are included in building codes such as the International Building Code. Building codes that include seismic provisions specify the horizontal force due to lateral acceleration that a building should be able to withstand during an earthquake. PGA values are directly related to these lateral forces that could damage "short period structures" (e.g. single-family dwellings). Longer period response components determine the lateral forces that damage larger structures with longer natural periods (apartment buildings, factories, high-rises, bridges). Table 8-1 lists damage potential and perceived shaking by PGA factors, compared to the Mercalli scale.

Table 8-1. Mercalli Scale and Peak Ground Acceleration Comparison

Modified Mercalli Scale	Perceived Shaking	Potential Structure Damage		Estimated PGA[a] (%g)
		Resistant Buildings	Vulnerable Buildings	
I	Not Felt	None	None	<0.17%
II-III	Weak	None	None	0.17% – 1.4%
IV	Light	None	None	1.4% – 3.9%
V	Moderate	Very Light	Light	3.9% – 9.2%
VI	Strong	Light	Moderate	9.2% – 18%
VII	Very Strong	Moderate	Moderate/Heavy	18% – 34%
VIII	Severe	Moderate/Heavy	Heavy	34% – 65%
IX	Violent	Heavy	Very Heavy	65% – 124%
X – XII	Extreme	Very Heavy	Very Heavy	>124%

a. PGA measured in percent of g, where g is the acceleration of gravity
Sources: USGS, 2008; USGS, 2010

8.1.3 USGS Earthquake Mapping Programs

ShakeMaps

The USGS Earthquake Hazards Program produces maps called ShakeMaps that provide near-real-time mapping of ground motion and shaking intensity following significant earthquakes. ShakeMaps focus on the ground shaking resulting from the earthquake, rather than on characteristics of the earthquake source, such as magnitude and epicenter. An earthquake has only one magnitude and one epicenter, but it produces a range of ground shaking at sites throughout the region, depending on the distance from the earthquake, the rock and soil conditions at sites, and variations in the propagation of seismic waves from the earthquake due to complexities in the structure of the earth's crust. A ShakeMap shows the extent and variation of ground shaking immediately following significant earthquakes.

Such mapping is derived from peak ground motion amplitudes recorded on seismic sensors, with interpolation where data are lacking based on estimated amplitudes. Color-coded instrumental intensity maps are derived from empirical relations between peak ground motions and Modified Mercalli intensity.

National Seismic Hazard Map

National maps of earthquake shaking hazards have been produced since 1948. They provide information essential to creating and updating seismic design requirements for building codes, insurance rate structures, earthquake loss studies, retrofit priorities and land use planning used in the U.S. Scientists frequently revise these maps to reflect new information and knowledge. Buildings, bridges, highways and utilities built to meet modern seismic design requirements are typically able to withstand earthquakes better, with less damage and disruption. After thorough review of the studies, professional organizations of engineers update the seismic-risk maps and seismic design requirements contained in building codes (Brown et al., 2001).

The USGS updated its National Seismic Hazard Map in 2014, incorporating the best available seismic, geologic, and geodetic information on earthquake rates and associated ground shaking. Figure 8-1 shows the peak ground acceleration with 10 percent probability of exceedance in 50 years. For Dublin, Livermore and Pleasanton, this PGA is 0.4 or greater.

Source: USGS, 2014a

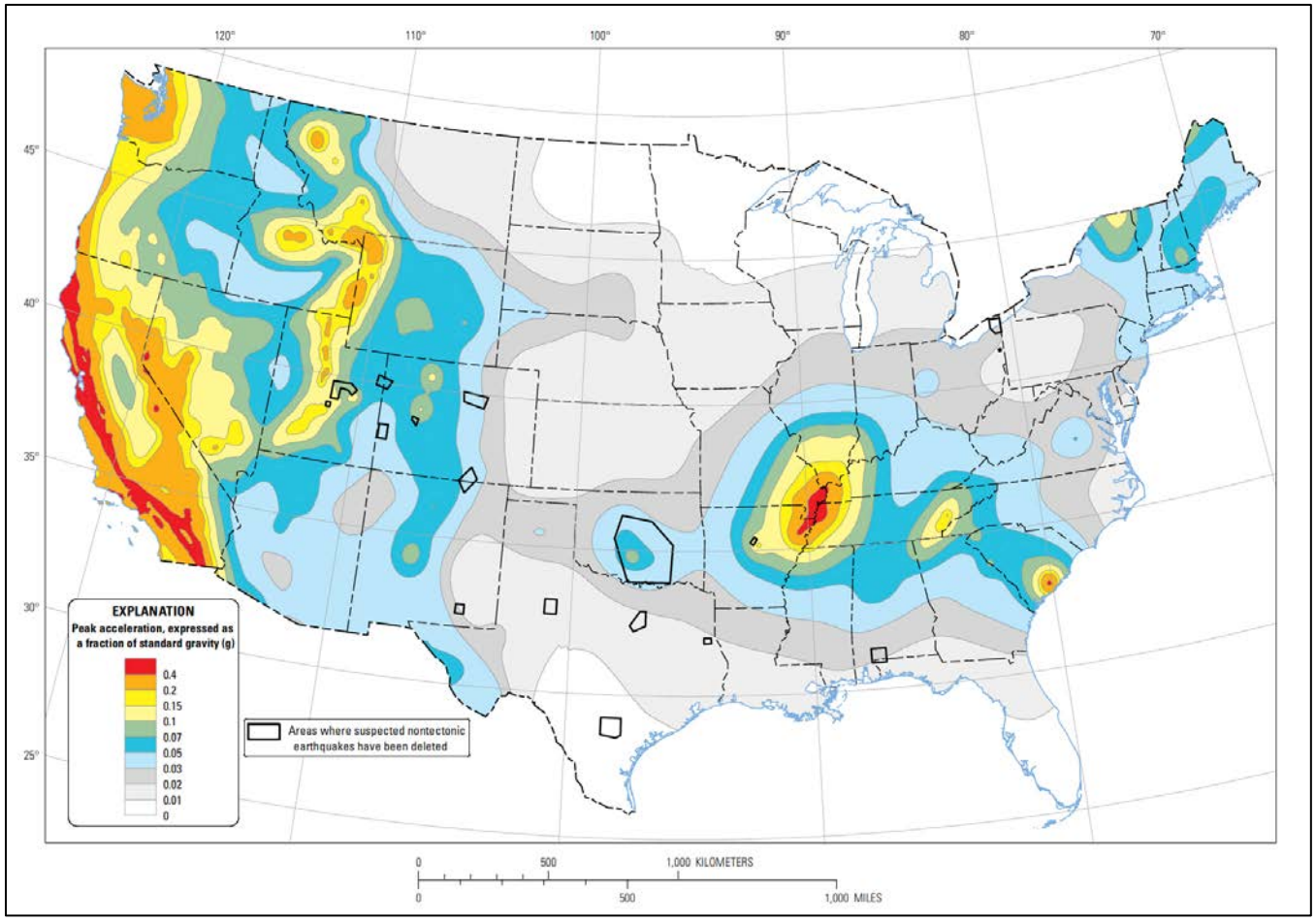


Figure 8-1. Peak Acceleration (%g) with 10% Probability of Exceedance in 50 Years

8.1.4 Effect of Soil Types

The impact of an earthquake on structures and infrastructure is largely a function of ground shaking, distance from the source of the quake, and liquefaction, a secondary effect of an earthquake in which soils lose their shear strength and flow or behave as liquid, thereby damaging structures that derive their support from the soil. Liquefaction generally occurs in soft, unconsolidated sedimentary soils. A program called the National Earthquake Hazard Reduction Program (NEHRP) creates maps based on soil characteristics to help identify locations subject to liquefaction. Table 8-2 summarizes NEHRP soil classifications. NEHRP Soils B and C typically can sustain ground shaking without much effect, dependent on the earthquake magnitude. The areas that are commonly most affected by ground shaking have NEHRP Soils D, E and F. In general, these areas are also most susceptible to liquefaction.

Table 8-2. NEHRP Soil Classification System

NEHRP Soil Type	Description	Mean Shear Velocity to 30 m (m/s)
A	Hard Rock	1,500
B	Firm to Hard Rock	760-1,500
C	Dense Soil/Soft Rock	360-760
D	Stiff Soil	180-360
E	Soft Clays	< 180
F	Special Study Soils (liquefiable soils, sensitive clays, organic soils, soft clays >36 m thick)	

The USGS has created a soil type map for the San Francisco Bay area that provides rough estimates of site effects based on surface geology. NEHRP soil types were assigned to a geologic unit based on the average velocity of that unit; USGS notes that this approach can lead to some inaccuracy. For instance, a widespread unit consisting of Quaternary sand, gravel, silt, and mud has been assigned as Class C soil types; however, some of the slower soil types in this unit fall under Class D. USGS does not have any way of differentiating units for slower-velocity soils in its digital geologic dataset (USGS, 2017).

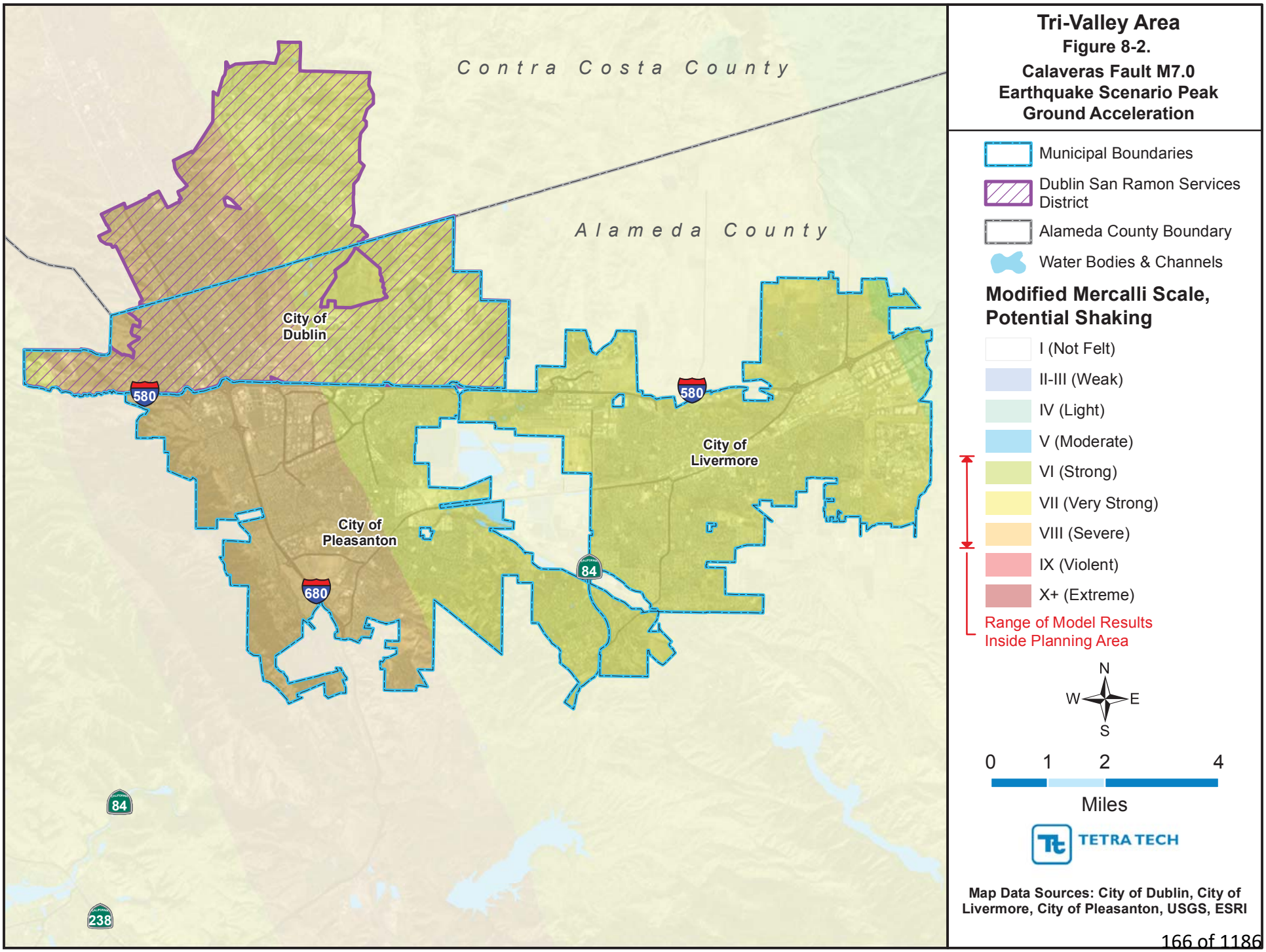
8.1.5 Earthquake Scenarios for Risk Assessment

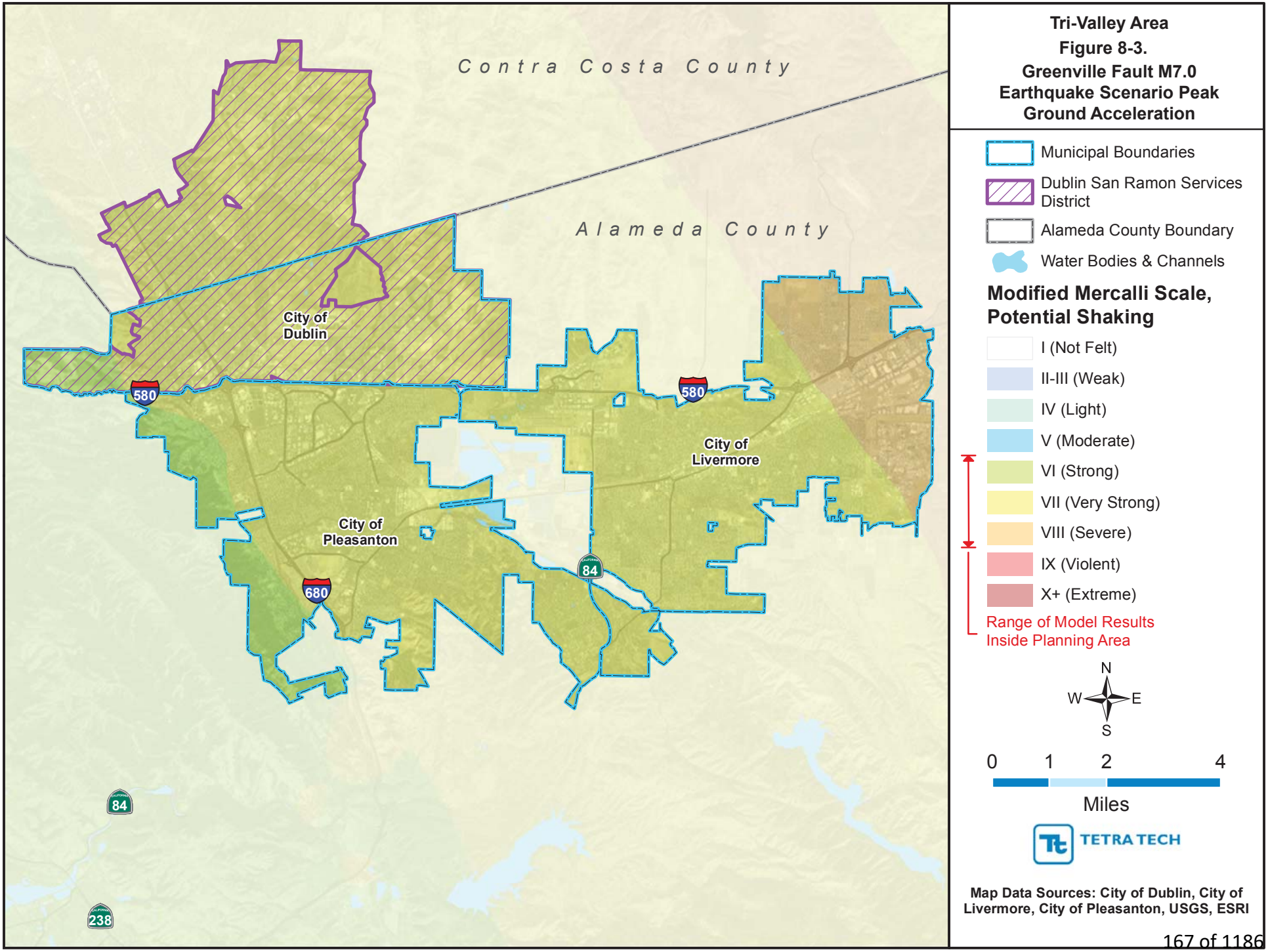
The USGS Earthquake Hazards Program creates scenarios of potential earthquakes for use in earthquake hazard planning. Hypothetical ShakeMaps of these scenarios depict the expected ground motions and effects of the scenario across the surrounding region. The following USGS scenarios were used in the risk assessment for this plan:

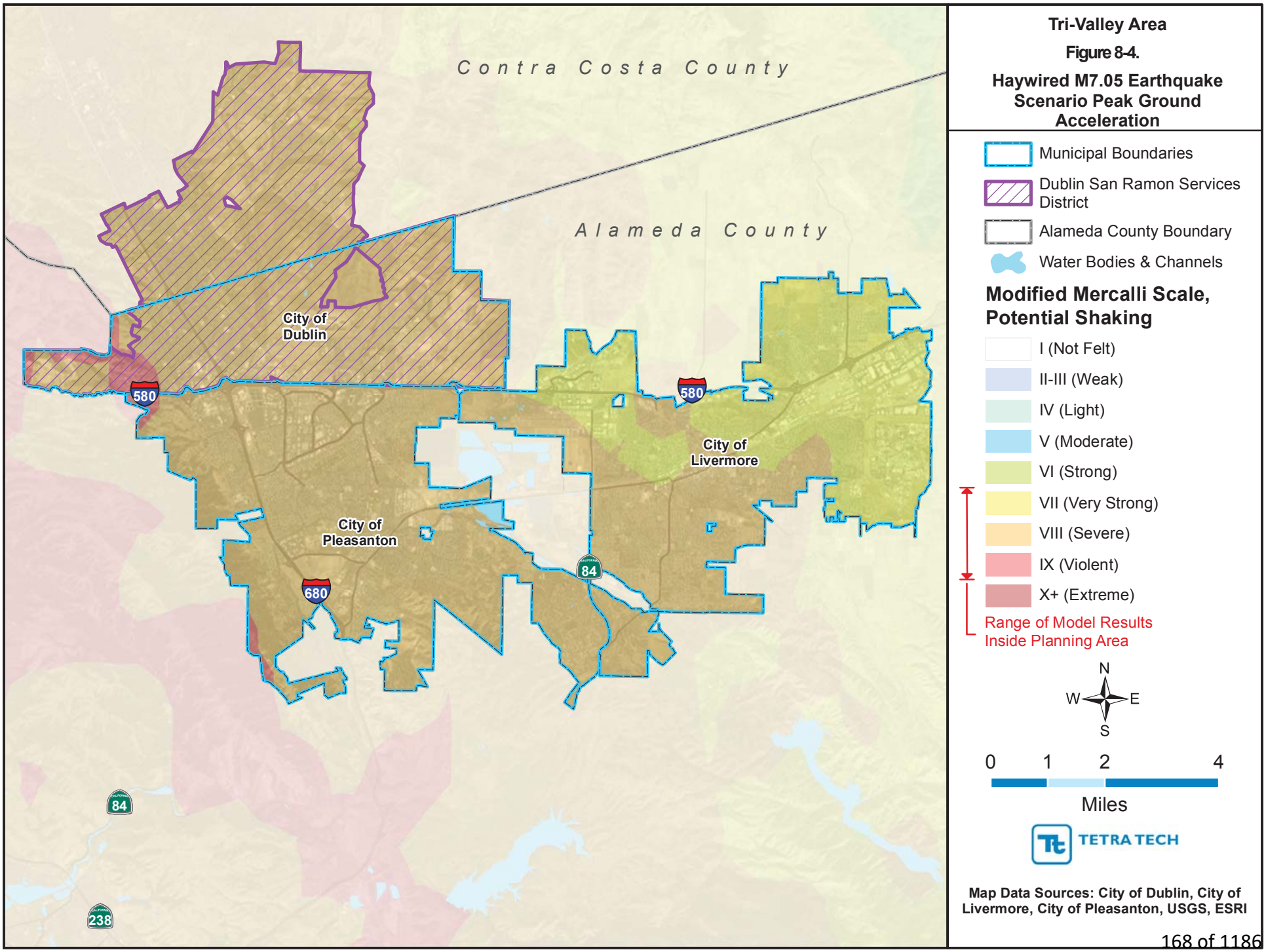
- Calaveras (North + Central + South) Fault Scenario—A Magnitude-7.0 event with a depth of 7 km and epicenter one mile west of the City of Dublin. (See Figure 8-2)
- Greenville Fault Scenario—A Magnitude-7.0 event with a depth of 12 km and epicenter 24 miles southeast of the City of Pleasanton. (See Figure 8-3)
- Haywired Fault Scenario—A Magnitude-7.05 event with a depth of 8 km epicenter 9 miles northwest of the City of Dublin. (See Figure 8-4)
- Mount Diablo Fault Scenario—A Magnitude-6.7 event with a depth of 14 km and epicenter 9 miles north of the City of Livermore. (See Figure 8-5).
- North San Andreas (North Coast + Peninsula + Santa Cruz Mountain) Fault Scenario—A Magnitude-7.8 event with a depth of 9.8 km and epicenter 140 miles northwest of the City of Dublin. (See Figure 8-6).

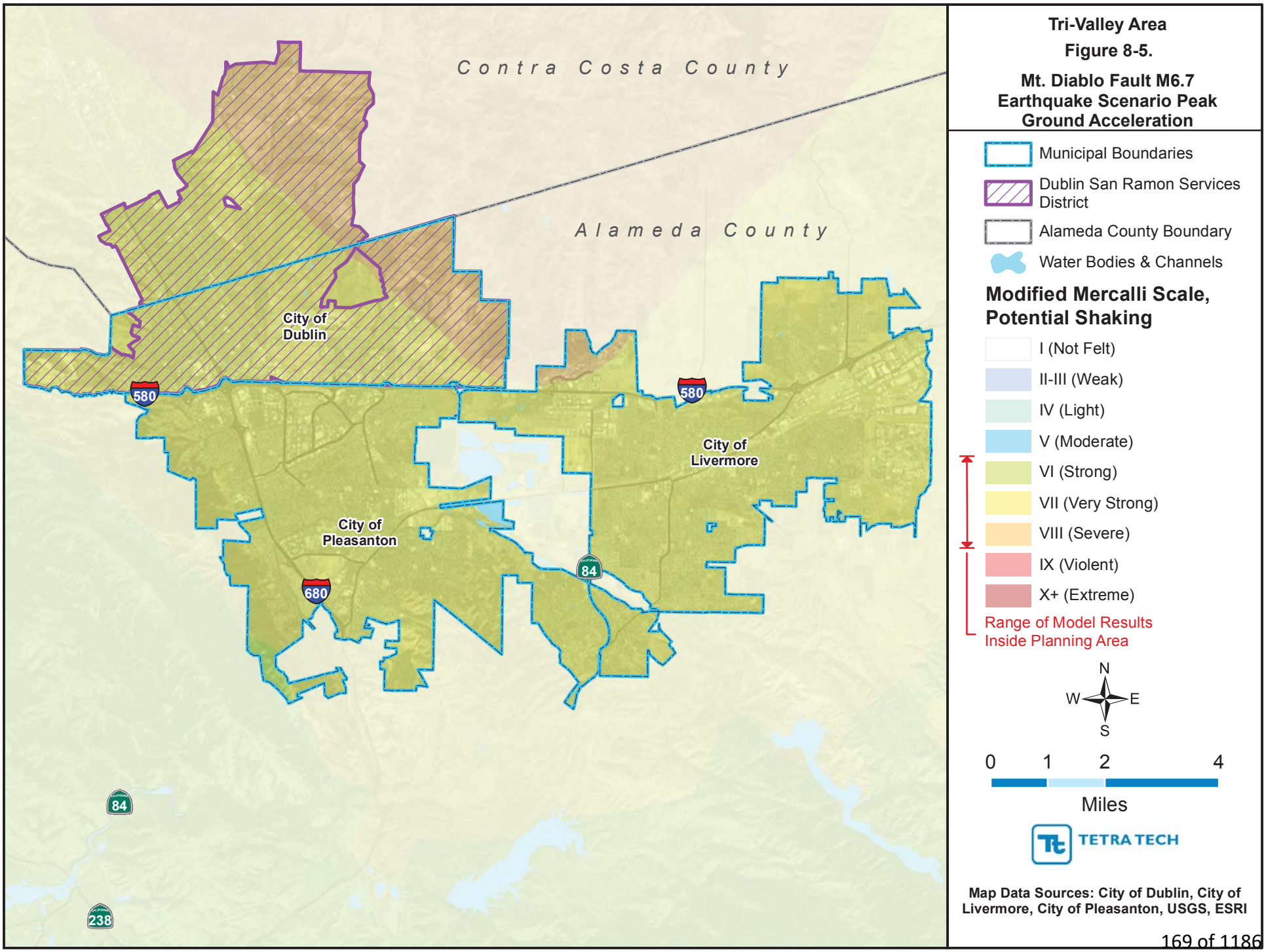
8.2 HAZARD PROFILE

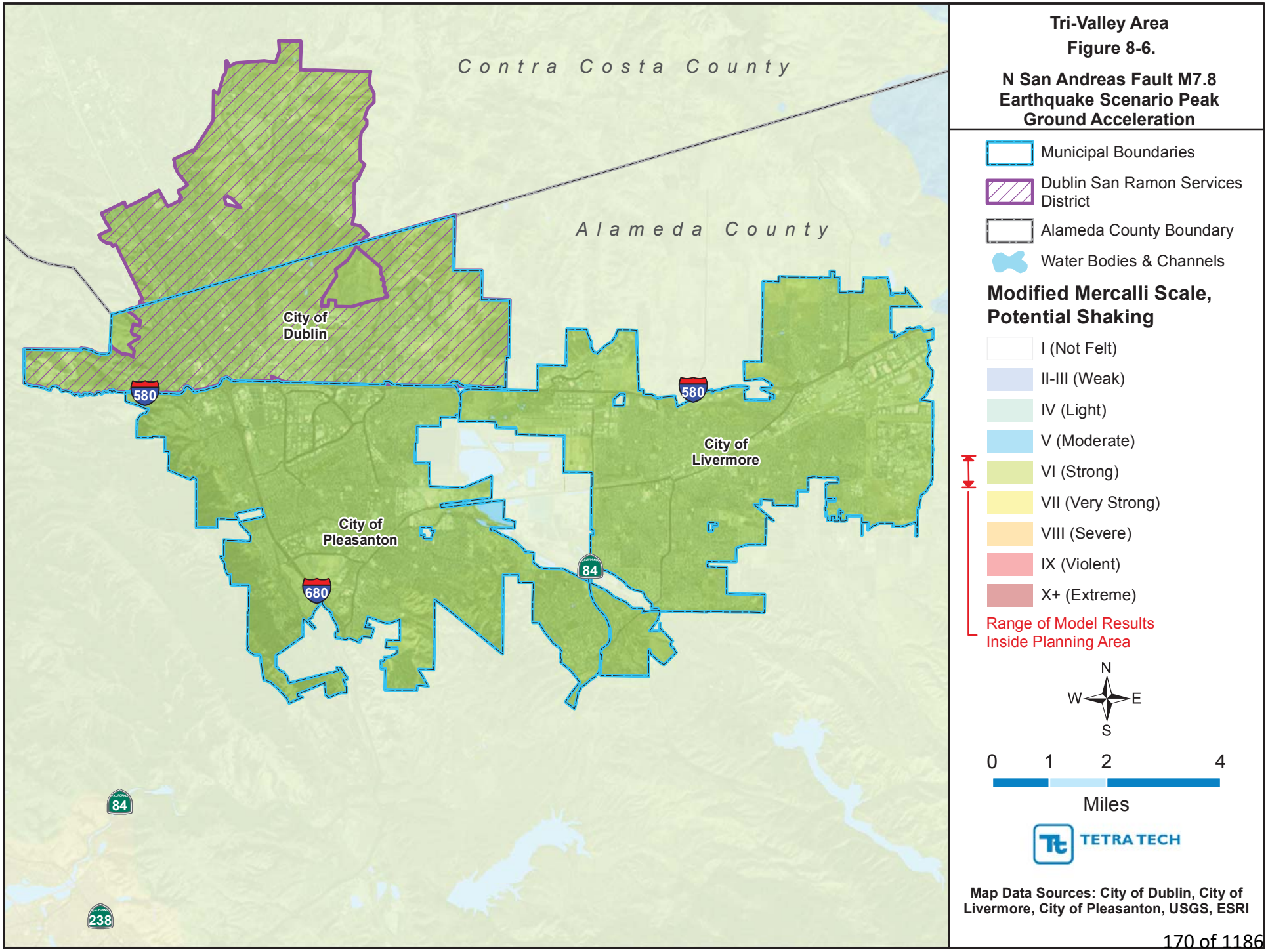
California is seismically active because it sits on the boundary between two of the earth's tectonic plates. Most of the state—everything east of the San Andreas Fault—is on the North American Plate. Coastal cities from Monterey to San Diego are on the Pacific Plate, which is constantly moving northwest past the North American Plate. The relative rate of movement is about 2 inches (50 millimeters) per year (Cal OES, 2013b). Earthquakes in the San Francisco Bay region result from strain energy constantly accumulating across the region because of the northwestward motion of the Pacific Plate relative to the North American Plate.


Contra Costa County
Alameda County
City of Dublin
City of Livermore
City of Pleasanton
580
580
680
84
84
238
Tri-Valley Area
Figure 8-2.
Calaveras Fault M7.0 Earthquake Scenario Peak Ground Acceleration
Municipal Boundaries
Dublin San Ramon Services District
Alameda County Boundary
Water Bodies & Channels
Modified Mercalli Scale, Potential Shaking
I (Not Felt)
II-III (Weak)
IV (Light)
V (Moderate)
VI (Strong)
VII (Very Strong)
VIII (Severe)
IX (Violent)
X+ (Extreme)
Range of Model Results Inside Planning Area
N
W
E
S
0 1 2 4
Miles
TETRA TECH
Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, USGS, ESRI


Contra Costa County
Alameda County
City of Dublin
City of Livermore
City of Pleasanton
580
580
680
84
84
238
Tri-Valley Area
Figure 8-3.
Greenville Fault M7.0 Earthquake Scenario Peak Ground Acceleration
Municipal Boundaries
Dublin San Ramon Services District
Alameda County Boundary
Water Bodies & Channels
Modified Mercalli Scale, Potential Shaking
I (Not Felt)
II-III (Weak)
IV (Light)
V (Moderate)
VI (Strong)
VII (Very Strong)
VIII (Severe)
IX (Violent)
X+ (Extreme)
Range of Model Results Inside Planning Area
N
W
E
S
0 1 2 4
Miles
TETRA TECH
Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, USGS, ESRI


Contra Costa County
Alameda County
City of Dublin
City of Livermore
City of Pleasanton
580
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680
84
84
238
Tri-Valley Area
Figure 8-4.
Haywired M7.05 Earthquake Scenario Peak Ground Acceleration
Municipal Boundaries
Dublin San Ramon Services District
Alameda County Boundary
Water Bodies & Channels
Modified Mercalli Scale, Potential Shaking
I (Not Felt)
II-III (Weak)
IV (Light)
V (Moderate)
VI (Strong)
VII (Very Strong)
VIII (Severe)
IX (Violent)
X+ (Extreme)
Range of Model Results Inside Planning Area
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Miles
TETRA TECH
Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, USGS, ESRI


Contra Costa County
Alameda County
City of Dublin
City of Livermore
City of Pleasanton
580
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84
84
238
Tri-Valley Area
Figure 8-5.
Mt. Diablo Fault M6.7 Earthquake Scenario Peak Ground Acceleration
Municipal Boundaries
Dublin San Ramon Services District
Alameda County Boundary
Water Bodies & Channels
Modified Mercalli Scale, Potential Shaking
I (Not Felt)
II-III (Weak)
IV (Light)
V (Moderate)
VI (Strong)
VII (Very Strong)
VIII (Severe)
IX (Violent)
X+ (Extreme)
Range of Model Results Inside Planning Area
N
W
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0 1 2 4
Miles
TETRA TECH
Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, USGS, ESRI


Contra Costa County
Alameda County
City of Dublin
City of Livermore
City of Pleasanton
580
580
680
84
84
238
Tri-Valley Area
Figure 8-6.
N San Andreas Fault M7.8 Earthquake Scenario Peak Ground Acceleration
Municipal Boundaries
Dublin San Ramon Services District
Alameda County Boundary
Water Bodies & Channels
Modified Mercalli Scale, Potential Shaking
I (Not Felt)
II-III (Weak)
IV (Light)
V (Moderate)
VI (Strong)
VII (Very Strong)
VIII (Severe)
IX (Violent)
X+ (Extreme)
Range of Model Results Inside Planning Area
N
W
E
S
0
1
2
4
Miles
TETRA TECH
Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, USGS, ESRI

8.2.1 Past Events

The last significant (> 6.0 M) seismic event in the Tri-Valley vicinity was the 2014 Magnitude-6.0 earthquake that originated 6 miles southwest of Napa. The previous large event was the 1989 M-7.1 Loma Prieta Earthquake that originated 10 miles northeast of Santa Cruz. No significant seismic events in the planning area vicinity have been recorded since these two events. Other significant earthquakes in California include the 1906 earthquake in San Francisco, the 1971 San Fernando Earthquake, and the 1994 Northridge earthquake. Recent earthquakes of magnitude of 5.0 or greater near the planning area are listed in Table 8-3 and their locations are shown on Figure 8-7.

Table 8-3. Recent Earthquakes Magnitude 5.0 or Larger Near Planning Area

Date	Magnitude	Epicenter Location
8/24/2014, South Napa Earthquake	6.0	South Napa
10/31/2007, Alum Rock Earthquake	5.6	San Francisco Bay area, California
5/14/2002, Gilroy Earthquake	5	Northern California
9/3/2000, Yountville Earthquake	5	Northern California
8/12/1998, San Juan Bautista Earthquake	5.2	Central California
4/18/1990, Northern California	5.4	Near Aromas, Northern California
10/18/1989, Loma Prieta Earthquake	7.1	10 miles northeast of Santa Cruz
8/8/1989, Santa Cruz County Earthquake	5.2	Central California
6/27/1989	5.3	Northern California
6/13/1988	5.3	San Francisco Bay area, California
2/20/1988	5.1	Central California
3/31/1986	5.6	Northern California
1/26/1986	5.4	Central California

Source: USGS, 2017a

The State of California has been included in 12 FEMA major disaster (DR) or emergency (EM) declarations for earthquake events; however, Alameda County was included in only one: DR-845 for the October 17, 1989 Loma Prieta Earthquake; this declaration applied to the Counties of Alameda, Contra Costa, Marin, Monterey, Sacramento, San Benito, San Francisco, San Joaquin, San Mateo, Santa Clara, Santa Cruz, and Solano (FEMA, 2017).

8.2.2 Location

Faults

Geologists have found that earthquakes tend to reoccur along faults, which are zones of weakness in the earth's crust. Even if a fault zone has recently experienced an earthquake, there is no guarantee that all the stress has been relieved. Another earthquake could still occur. In fact, relieving stress along one part of a fault may increase it in another part.

Active faults have experienced displacement in historical time. Inactive faults, where no such displacements have been recorded, also have the potential to reactivate or experience displacement along a branch sometime in the future. The State Division of Mines and Geology indicates that increased earthquake activity throughout California may cause tectonic movement along currently inactive fault systems. An example of a fault zone that has been reactivated is the Foothills Fault Zone in the Sierra Nevada, which was considered inactive until evidence was found near Spenceville, California, of an earthquake 1.6 million years ago. Then, in 1975, an earthquake occurred on another branch of the zone near Oroville, California.

Source: USGS, 2016a



Figure 8-7. Recent Earthquakes Near Planning Area

A direct relationship exists between a fault's length and location and its ability to generate damaging ground motion at a given site. Small, local faults produce lower magnitude quakes, but ground shaking can be strong and damage can be significant in areas close to the fault. In contrast, large regional faults can generate earthquakes of great magnitudes but, because of their distance and depth, they may result in only moderate shaking in an area.

The Cities of Dublin, Livermore and Pleasanton are located in a seismically active region in California, with exposure to major regional faults: Calaveras, Greenville, Hayward, Mount Diablo, and San Andreas. The primary seismic hazard for the planning area is potential ground shaking from these five large faults. Figure 8-8 shows the location of these fault lines and the probability of a major earthquake on each.

Calaveras Fault

The Calaveras Fault is a major branch of the San Andreas Fault, located east of the Hayward Fault. It extends 76 miles from the San Andreas Fault near Hollister to Danville at its northern end. The Calaveras Fault is one of the most geologically active and complex faults in the San Francisco Bay Area (USGS, 2017b). The probability of a M-6.7 or greater earthquake along the Calaveras Fault within the next 30 years is 26 percent.

Greenville

The Greenville Fault is in the eastern Bay Area in Contra Costa and Alameda Counties. This dextral strike-slip fault zone borders the eastern side of Livermore Valley and is considered to be part of the larger San Andreas fault system in the central Coast Ranges. The fault zone extends from northwest of Livermore Valley along the Marsh Creek and Clayton Faults toward Clayton Valley.

Hayward Fault

The Hayward Fault is a 45-mile-long, right lateral slip fault that runs parallel to the San Andreas Fault through densely populated areas on the East Bay. The Hayward Fault is increasingly becoming a hazard priority in the Bay Area because of its increased chance for activity and its proximity to critical infrastructure and multiple highly populated areas. The probability of a M-6.7 or greater earthquake along the Hayward Fault within the next 30 years is 33 percent (USGS, 2016b).

Mount Diablo

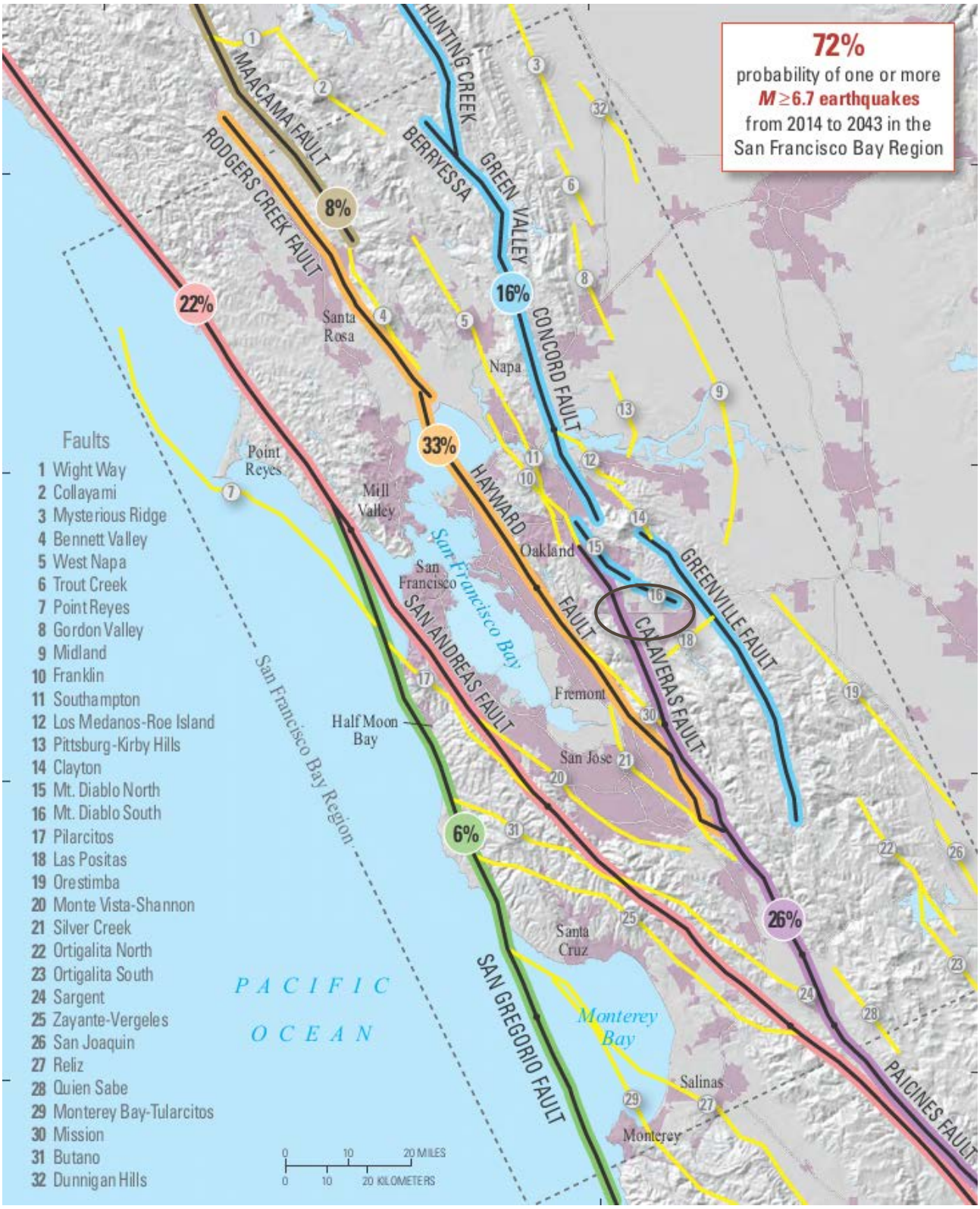
The Mount Diablo thrust fault is in the vicinity of Mount Diablo in Contra Costa County. The fault lies between the Calaveras Fault, the Greenville Fault, and the Concord Fault, all right-lateral strike slip faults, and appears to transfer movement from the Calaveras and Greenville Faults to the Concord Fault, while continuing to uplift Mount Diablo.

San Andreas Fault

The San Andreas Fault extends 810 miles from the East Pacific rise in the Gulf of California through the Mendocino fracture zone off the shore of northern California. The fault is estimated to be 28 million years old. It is an example of a transform boundary exposed on a continent. The fault forms the tectonic boundary between the Pacific Plate and the North American Plate, and its motion is right-lateral strike-slip.

The San Andreas Fault is typically referenced in three segments. The southern segment extends from its origin at the East Pacific Rise to Parkfield, California, in Monterey County. The central segment extends from Parkfield to Hollister, California. The northern segment extends northwest from Hollister, through the Bay Area, to its ultimate junction with the Mendocino fracture zone and the Cascadia subduction zone in the Pacific Ocean. The probability of a M-6.7 or greater earthquake along the San Andreas Fault within the next 30 years is 22 percent (USGS, 2016d).

Source: USGS, 2016c



Note: Oval shows the approximate location of Tri-Valley planning area.

Figure 8-8. Significant Known Faults in the Bay Area

Maps of Earthquake Impact in the Planning Area

Identifying the extent and location of an earthquake is not as simple as it is for other hazards such as flood, landslide or wildfire. The impact of an earthquake is largely a function of the following components:

- Ground shaking (ground motion accelerations)
- Liquefaction (soil instability)
- Distance from the source (both horizontally and vertically).

Mapping that shows the impacts of these components was used to assess the risk of earthquakes in the planning area. While the impacts from each of these components can build upon each other during an earthquake event, the mapping looks at each component individually. The mapping used in this assessment is described below.

National Earthquake Hazard Reduction Program (NEHRP) Soil Maps

NEHRP soil types define the locations that will be significantly impacted by an earthquake. NEHRP Soils B and C typically can sustain low-magnitude ground shaking without much effect. The areas that are most commonly affected by ground shaking have NEHRP Soils D, E and F. Figure 8-9 shows NEHRP soil classifications in the planning area.

Liquefaction Maps

Soil liquefaction maps are useful tools to assess potential damage from earthquakes. When the ground liquefies, sandy or silty materials saturated with water behave like a liquid, causing pipes to leak, roads and airport runways to buckle, and building foundations to be damaged. In general, areas with NEHRP Soils D, E and F are also susceptible to liquefaction. If there is a dry soil crust, excess water will sometimes come to the surface through cracks in the confining layer, bringing liquefied sand with it, creating sand boils. Figure 8-10 shows the liquefaction susceptibility in the planning area.

Alquist-Priolo Zone Maps

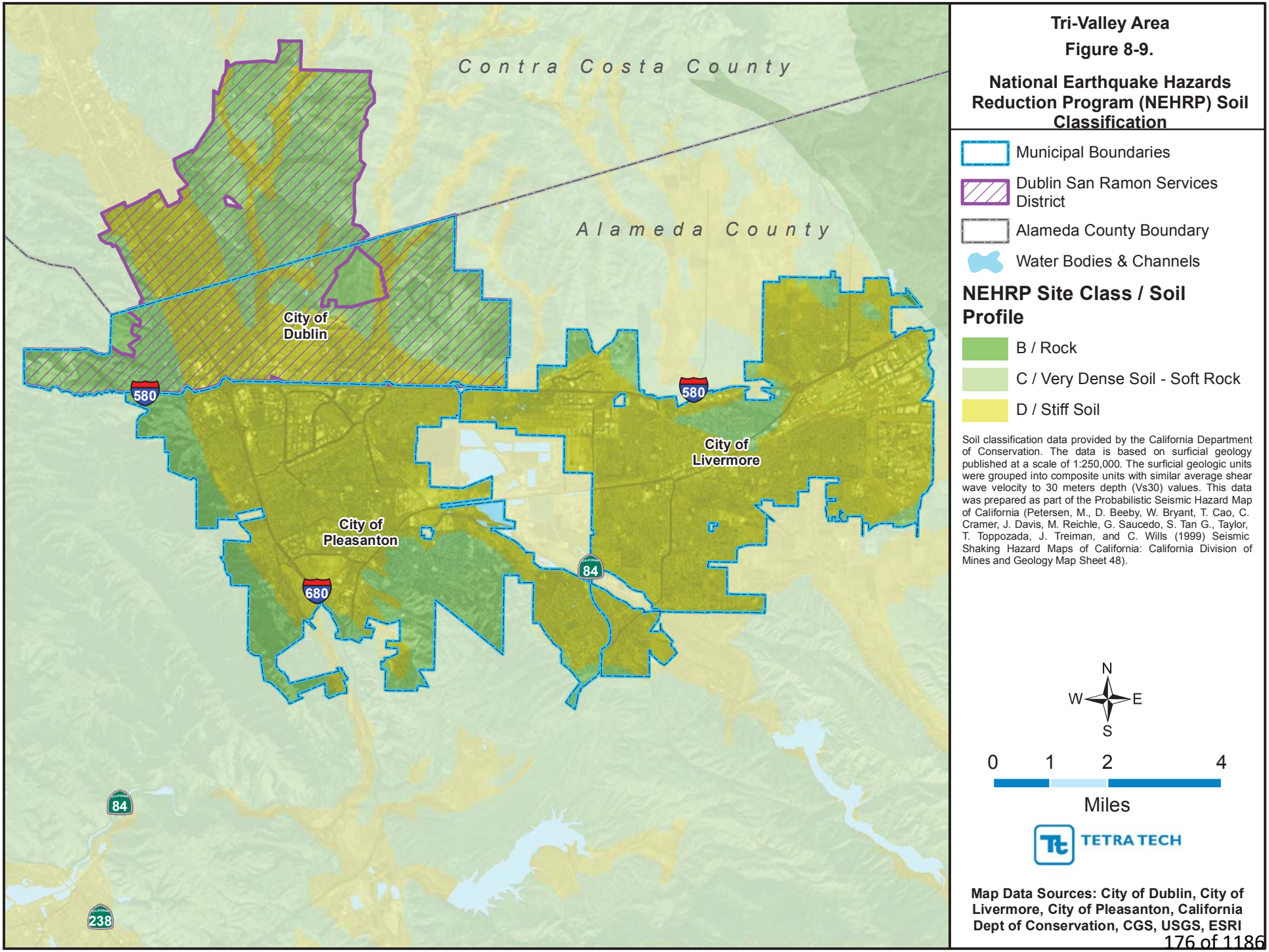
The sudden sliding of one part of the earth's crust past another releases the vast store of elastic energy in the rocks as an earthquake. The resulting fracture is a fault, and the sliding movement of earth on either side of a fault is called fault rupture. Fault rupture begins below the ground surface at the earthquake hypocenter, typically between 3 and 10 miles below the ground surface in California. If an earthquake is large enough, the fault rupture will travel to the ground surface, potentially destroying structures built across its path (Cal OES, 2013).

California's Alquist-Priolo Zone Maps provide regulatory zones for potential surface fault rupture where fault lines intersect with future development and populated areas. The purpose of these maps is to assist in the geologic investigation before construction begins to ensure that the resulting structure will not be located on an active fault. The Tri-Valley planning area is located in a designated Alquist-Priolo Zone (California DOC, 2010a).

Alquist-Priolo maps were referenced, but not specifically used, in the assessment of risk for this plan. This plan assumes that the studies conducted and information provided by the State of California are the best available data for surface rupture risk and could not be improved through a separate assessment for this plan. Alquist-Priolo maps are available to the public on the California Department of Conservation website.

8.2.3 Frequency

California experiences hundreds of earthquakes each year, most with minimal damage and magnitudes below 3.0 on the Richter Scale. Earthquakes that cause moderate damage to structures occur several times a year. According to the USGS, a strong earthquake measuring greater than 5.0 occurs every 2 to 3 years and major earthquakes of more than 7.0 occur once a decade.



Tri-Valley Area

Figure 8-9.

National Earthquake Hazards Reduction Program (NEHRP) Soil Classification

Municipal Boundaries

Dublin San Ramon Services District

Alameda County Boundary

Water Bodies & Channels

NEHRP Site Class / Soil Profile

B / Rock

C / Very Dense Soil - Soft Rock

D / Stiff Soil

Soil classification data provided by the California Department of Conservation. The data is based on surficial geology published at a scale of 1:250,000. The surficial geologic units were grouped into composite units with similar average shear wave velocity to 30 meters depth (Vs30) values. This data was prepared as part of the Probabilistic Seismic Hazard Map of California (Petersen, M., D. Beeby, W. Bryant, T. Cao, C. Cramer, J. Davis, M. Reichle, G. Saucedo, S. Tan G., Taylor, T. Toppozada, J. Treiman, and C. Wills (1999) Seismic Shaking Hazard Maps of California: California Division of Mines and Geology Map Sheet 48).

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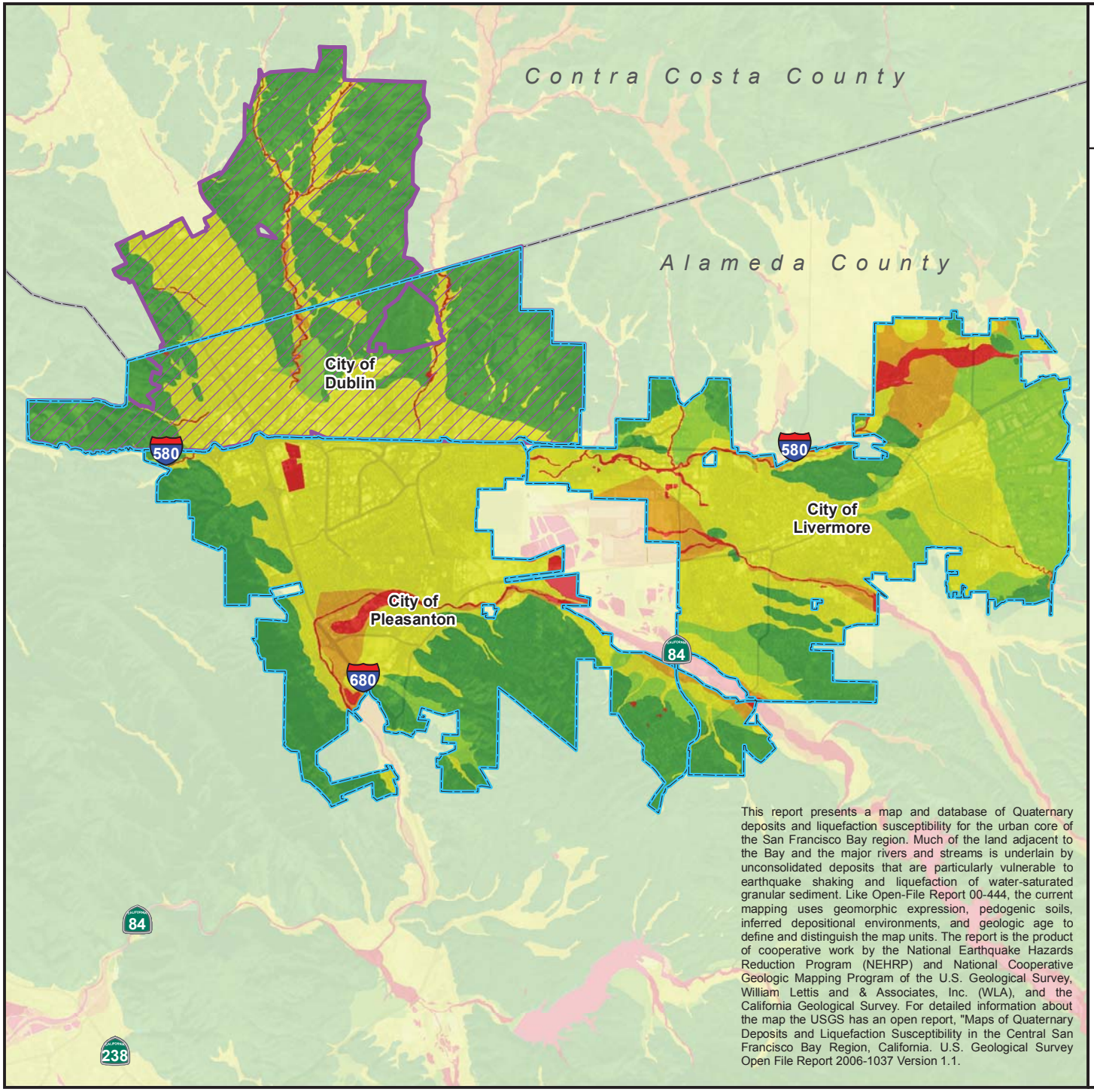
TETRA TECH

Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, California Dept of Conservation, CGS, USGS, ESRI

Tri-Valley Area

Figure 8-10.

Liquefaction Susceptibility



Municipal Boundaries

Dublin San Ramon Services District

Alameda County Boundary

Water Bodies & Channels

No Liquefaction Data Available

Susceptibility to Liquefaction

- Very Low
- Low
- Medium
- High
- Very High

This report presents a map and database of Quaternary deposits and liquefaction susceptibility for the urban core of the San Francisco Bay region. Much of the land adjacent to the Bay and the major rivers and streams is underlain by unconsolidated deposits that are particularly vulnerable to earthquake shaking and liquefaction of water-saturated granular sediment. Like Open-File Report 00-444, the current mapping uses geomorphic expression, pedogenic soils, inferred depositional environments, and geologic age to define and distinguish the map units. The report is the product of cooperative work by the National Earthquake Hazards Reduction Program (NEHRP) and National Cooperative Geologic Mapping Program of the U.S. Geological Survey, William Lettis and & Associates, Inc. (WLA), and the California Geological Survey. For detailed information about the map the USGS has an open report, "Maps of Quaternary Deposits and Liquefaction Susceptibility in the Central San Francisco Bay Region, California. U.S. Geological Survey Open File Report 2006-1037 Version 1.1.

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Miles

TETRA TECH

Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, California Geological Survey, USGS, ESRI

Both the San Andreas and the Hayward Faults have the potential for major to great events. The USGS estimated in 2016 that there is a 72 percent probability of at least one 6.7 or greater magnitude earthquake before 2043 that could cause widespread damage in the San Francisco Bay area (USGS, 2016e). The 2013 *State of California Multi-Hazard Mitigation Plan* cites projections that there is more than a 99-percent probability of a Magnitude-6.7 earthquake in California in the next 30 years and a 94-percent probability of a Magnitude-7.0 earthquake in California in the next 30 years. Probabilities for earthquakes on major fault lines in the San Francisco Bay Area were estimated by the USGS in a 2016 report, as summarized in Table 8-4.

Table 8-4. Earthquake Probabilities for the San Francisco Bay Area, 2014-2043

Fault	Probability of One or More ≥6.7 Quake, 2014-2043	Fault	Probability of One or More ≥6.7 Quake, 2014-2043
Hunting Creek	16%	Maacama	8%
Green Valley	16%	Rodgers Creek Fault	33%
Concord	16%	Hayward	33%
Greenville	16%	San Andreas	22%
Berryessa	16%	San Gregorio	6%
Calaveras	26%		

Source: USGS, 2016e

8.2.4 Severity

Earthquakes can last from a few seconds to over five minutes; they may also occur as a series of tremors over a period of several days. The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Casualties generally result from falling objects and debris, because the shocks shake, damage or demolish buildings and other structures. Disruption of communications, electrical power supplies and gas, sewer and water lines should be expected. Earthquakes may trigger fires, dam failures, landslides or releases of hazardous material, compounding their disastrous effects.

The USGS has created ground motion maps based on current information about several fault zones. These maps show the PGA that has a certain probability (2 percent or 10 percent) of being exceeded in a 50-year period. The PGA is measured in numbers of g's (the acceleration associated with gravity). Figure 8-11 shows the PGAs with a 2-percent exceedance chance in 50 years in the planning area. The planning area is located within a high risk area.

8.2.5 Warning Time

There is no current reliable way to predict the day or month that an earthquake will occur at any given location. Research is being done with warning systems that use the low energy waves that precede major earthquakes. These potential warning systems would give approximately 40 seconds notice that a major earthquake is about to occur. The warning time is very short, but it could allow for someone to get under a desk, step away from a hazardous material, or shut down a computer system.

8.3 SECONDARY HAZARDS

Earthquakes can cause large and sometimes disastrous landslides and mudslides. River valleys are vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction occurs when water-saturated sands, silts, or gravelly soils are shaken so violently that the individual grains lose contact with one another and "float" freely in the water, turning the ground into a pudding-like liquid. Building and road foundations lose load-bearing strength and may sink quicksand-like into what was previously solid ground. Unless properly secured, hazardous materials can be released, causing significant damage to the environment and people.

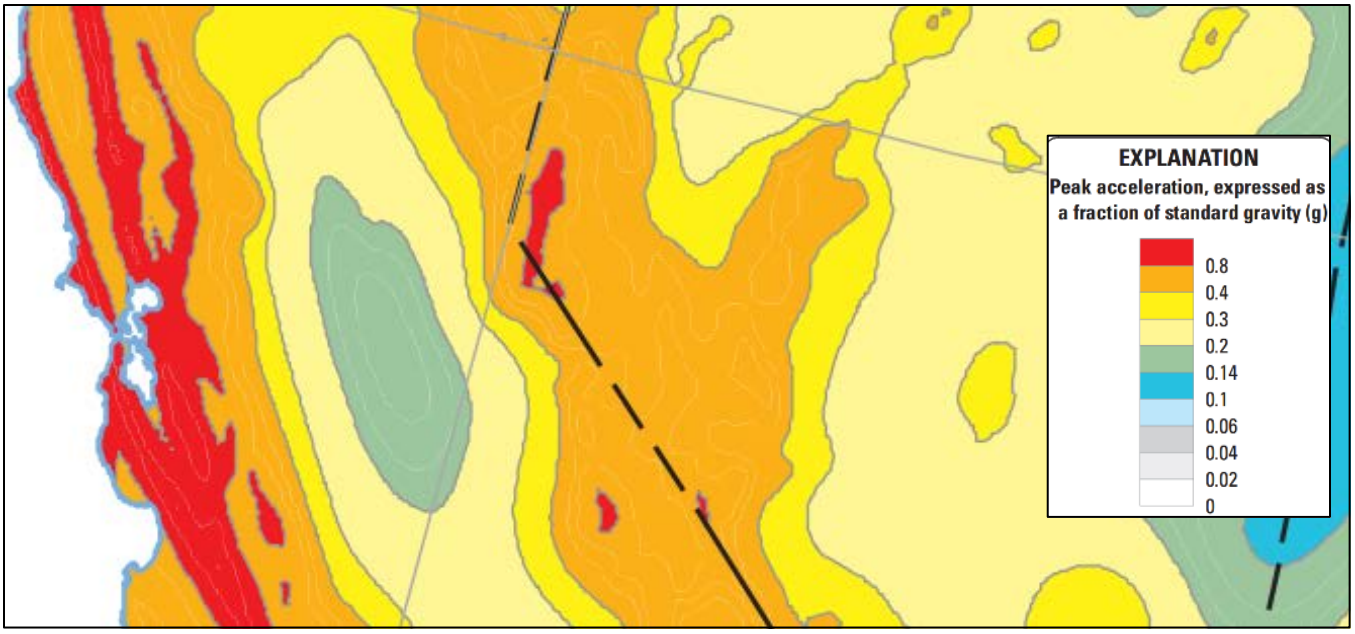


Figure 8-11. PGA with 2-Percent Probability of Exceedance in 50 Years

Earthen dams and levees are highly susceptible to seismic events, and the impacts of their eventual failures can be considered secondary hazards of earthquakes. Additionally, fires can result from gas lines or power lines that are broken or downed during the earthquake. It may be difficult to control a fire, particularly if the water lines feeding fire hydrants are also broken.

8.4 EXPOSURE

8.4.1 Population

The entire population of the planning area is potentially exposed to direct and indirect impacts from earthquakes. Whether directly impacted or indirectly impact, the entire population will have to deal with the consequences of earthquakes to some degree. Business interruption could keep people from working, road closures could isolate populations, and loss of functions of utilities could impact populations that suffered no direct damage from an event itself.

8.4.2 Property

According to Alameda County Assessor records, there are 66,760 buildings in the planning area, with a total replacement value of $53 billion. Since all structures in the planning area are susceptible to earthquake impacts to varying degrees, this total represents the property exposure to seismic events. Most of the buildings (96 percent) are residential. Table 8-5 shows the exposure value breakdown by municipality.

Table 8-5. Earthquake Exposure by Municipality

Jurisdiction	Total # of Buildings	Total Building Value—Structure and Contents
Dublin	16,588	$12,164,354,419
Livermore	27,539	$20,508,103,666
Pleasanton	22,633	$21,028,153,157
Total	66,760	$53,700,611,242

8.4.3 Critical Facilities and Infrastructure

All critical facilities and infrastructure in the planning area (see Table 4-4) are exposed to the earthquake hazard. Hazardous materials releases can occur during an earthquake from fixed facilities or transportation-related incidents. Transportation corridors can be disrupted during an earthquake, leading to the release of materials to the surrounding environment. Facilities holding hazardous materials are of particular concern because of possible isolation of neighborhoods surrounding them. During an earthquake, structures storing these materials could rupture and leak into the surrounding area or an adjacent waterway, having a disastrous effect on the environment.

8.4.4 Environment

Environmental problems as a result of an earthquake can be numerous. Secondary hazards will likely have some of the most damaging effects on the environment. Earthquake-induced landslides in landslide-prone areas can significantly damage surrounding habitat. It is also possible for streams to be rerouted after an earthquake. Rerouting can change the water quality, possibly damaging habitat and feeding areas. There is a possibility that streams fed by groundwater wells will dry up because of changes in underlying geology.

8.5 VULNERABILITY

Earthquake vulnerability data was generated using a Hazus analysis. Once the location and size of a hypothetical earthquake are identified, Hazus estimates the intensity of the ground shaking, the number of buildings damaged, the number of casualties, the damage to transportation systems and utilities, the number of people displaced from their homes, and the estimated cost of repair and clean up.

8.5.1 Population

Residents of High Risk Areas

The degree of vulnerability is dependent on many factors, including the age and construction type of the structures people live in, the soil type their homes are constructed on, and their proximity to fault locations. There are estimated to be 146,510 people in over 53,075 households living on soils with moderate to very high liquefaction potential in the planning area. This is about 74 percent of the total population.

Susceptible Population Groups

Two groups are particularly vulnerable to earthquake hazards:

- **Population Below Poverty Level**—An estimated 11,500 households in areas with moderate to very high liquefaction potential soils have household incomes less than $50,000 per year. This is about 22 percent of all households located on moderate to very high liquefaction potential soils. These households may lack the financial resources to improve their homes to prevent or mitigate earthquake damage. Economically disadvantaged residents are also less likely to have insurance to compensate for losses in earthquakes.
- **Population Over 65 Years Old**—An estimated 14,611 residents in areas with moderate to very high liquefaction potential soils are over 65 years old. This is about 28 percent of all residents in those areas. This population group is vulnerable because they are more likely to need special medical attention, which may not be available due to isolation caused by earthquakes. Elderly residents also have more difficulty leaving their homes during earthquake events and could be stranded in dangerous situations.

Estimated Impacts on Persons and Households

Impacts on persons and households in the planning area were estimated for the five selected earthquake scenarios through the Hazus analysis. Table 8-6 summarizes the results.

Table 8-6. Estimated Earthquake Impact on Persons and Households

	Number of Displaced Households	Number of Persons Requiring Short-Term Shelter
Calaveras	758	375
Greenville	89	49
Haywired	2,071	1,039
Mount Diablo	292	143
North San Andreas	4	2

8.5.2 Property

Liquefaction Potential

Table 8-7 shows the estimated number of buildings on moderate to very high liquefiable soils. There are estimated to be 45,568 buildings, or 70 percent of the total building stock, on these soils.

Table 8-7. Number of Buildings on Moderate to Very High Liquefiable Soils

Jurisdiction	Number of Buildings
Dublin	9,696
Livermore	19,542
Pleasanton	16,330
Total	45,568

Building Age

Table 8-8 identifies significant milestones in building and seismic code requirements that directly affect the structural integrity of development. Using these time periods, the planning team used Hazus to identify the number of structures in the planning area by date of construction.

Table 8-8. Age of Structures in Planning Area

Time Period	Number of Current Structures Built in Period	Significance of Time Frame
Pre-1933	618	Before 1933, there were no explicit earthquake requirements in building codes. State law did not require local governments to have building officials or issue building permits.
1933-1940	169	In 1940, the first strong motion recording was made.
1941-1960	3,635	In 1960, the Structural Engineers Association of California published guidelines on recommended earthquake provisions.
1961-1975	20,087	In 1975, significant improvements were made to lateral force requirements.
1976-1994	19,562	In 1994, the Uniform Building Code was amended to include provisions for seismic safety.
1994 – present	22,689	Seismic code is currently enforced.
Total	66,760	

The number of structures does not reflect the number of total housing units, as many multi-family units are reported as one structure. Approximately 34 percent of the planning area's structures were constructed after the Building Code was amended in 1994 to include seismic safety provisions. Approximately 1 percent were built before 1933 when there were no building permits, inspections, or seismic standards.

Loss Potential

Property losses were estimated through the Hazus analysis for the five scenario events. Table 8-9 through Table 8-13 show the results for structural loss, representing damage to building structures, and non-structural loss, representing the value of lost contents and inventory, relocation, income loss, rental loss, and wage loss.

Table 8-9. Loss Estimates for Calaveras Fault Scenario Earthquake

	Estimated Loss Associated with Earthquake			% of Total
	Structure	Contents	Total	Replacement Value
Dublin	$564,146,058	$162,144,441	$726,290,499	6.0%
Livermore	$183,024,116	$77,605,970	$260,630,086	1.3%
Pleasanton	$899,391,183	$289,707,975	$1,189,099,158	5.7%
Total Planning Area	$1,646,561,357	$529,458,386	$2,176,019,743	4.1%

Table 8-10. Loss Estimates for Greenville Fault Scenario Earthquake

	Estimated Loss Associated with Earthquake			% of Total
	Structure	Contents	Total	Replacement Value
Dublin	$83,206,165	$34,160,786	$117,366,951	1.0%
Livermore	$503,487,581	$163,105,087	$666,592,668	3.3%
Pleasanton	$102,370,262	$49,355,172	$151,725,435	0.7%
Total Planning Area	$689,064,008	$246,621,046	$935,685,054	1.7%

Table 8-11. Loss Estimates for Haywired Fault Scenario Earthquake

	Estimated Loss Associated with Earthquake			% of Total
	Structure	Contents	Total	Replacement Value
Dublin	$1,460,638,578	$479,691,784	$1,940,330,362	16.0%
Livermore	$1,370,533,128	$455,789,010	$1,826,322,138	8.9%
Pleasanton	$2,650,641,204	$980,362,472	$3,631,003,677	17.3%
Total Planning Area	$5,481,812,910	$1,915,843,266	$7,397,656,177	13.8%

Table 8-12. Loss Estimates for Mt. Diablo Fault Scenario Earthquake

	Estimated Loss Associated with Earthquake			% of Total
	Structure	Contents	Total	Replacement Value
Dublin	$303,165,849	$86,701,274	$389,867,123	3.2%
Livermore	$373,545,048	$127,640,591	$501,185,639	2.4%
Pleasanton	$274,380,720	$95,288,012	$369,668,732	1.8%
Total Planning Area	$951,091,617	$309,629,877	$1,260,721,494	2.3%

Table 8-13. Loss Estimates for North San Andreas Fault Scenario Earthquake

	Estimated Loss Associated with Earthquake			% of Total
	Structure	Contents	Total	Replacement Value
Dublin	$30,230,952	$14,295,720	$44,526,672	0.4%
Livermore	$34,240,275	$21,438,354	$55,678,629	0.3%
Pleasanton	$51,698,029	$25,378,231	$77,076,260	0.4%
Total Planning Area	$116,169,256	$61,112,305	$177,281,561	0.3%

A summary of the property-related losses is as follows:

- For the Calaveras Scenario, the estimated damage potential is $2.17 billion, or 4.1 percent of the total replacement value for the planning area.
- For the Greenville Scenario, the estimated damage potential is $935 million, or 1.7 percent of the total replacement value for the planning area.
- For the Haywired Scenario, the estimated damage potential is $7.39 billion, or 13.8 percent of the total replacement value for the planning area.
- For the Mount Diablo Scenario, the estimated damage potential is $1.26 billion, or 2.3 percent of the total replacement value for the planning area.
- For the North San Andreas Scenario, the estimated damage potential is $177 million, or 0.3 percent of the total replacement value for the planning area.

Debris Estimates

The Hazus analysis also estimated the amount of earthquake-caused debris in the planning area for the five scenario events, as summarized in Table 8-14.

Table 8-14. Estimated Earthquake-Caused Debris

	Debris to Be Removed (tons)
Calaveras	723.42
Greenville	287.84
Haywired	2,499.41
Mount Diablo	413.29
North San Andreas	26.19

8.5.3 Critical Facilities and Infrastructure

Level of Damage

Hazus classifies the vulnerability of critical facilities to earthquake damage in five categories: no damage, slight damage, moderate damage, extensive damage, or complete damage. The model was used to assign a vulnerability category to each critical facility in the planning area, which was then averaged across the facility category. The results for the five fault scenario events are summarized in Table 8-15 through Table 8-19.

Time to Return to Functionality

Hazus estimates the time to restore critical facilities to fully functional use. Results are presented as probability of being functional at specified time increments: 1, 3, 7, 14, 30 and 90 days after the event. For example, Hazus may estimate that a facility has 5 percent chance of being fully functional at Day 3, and a 95-percent chance of being fully functional at Day 90. The analysis was performed for the five fault scenarios. Results are summarized in Table 8-20 through Table 8-24.

8.5.4 Environment

The environment vulnerable to earthquake hazard is the same as the environment exposed to the hazard.

Table 8-15. Estimated Damage to Critical Facilities from the Calaveras Fault Scenario Earthquake

	Percent of Facilities Experiencing Defined Damage Level				
Category	No Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage
Medical and Health Services	62.73%	26.71%	0.82%	0.04%	9.68%
Emergency Services	56.62%	32.71%	4.09%	0.04%	6.52%
Educational Facilities	56.18%	30.98%	4.80%	0.17%	7.85%
Government	15.52%	17.46%	38.40%	17.15%	11.44%
Utilities	30.28%	25.41%	27.74%	5.52%	11.03%
Transportation Infrastructure	53.13%	18.57%	7.10%	10.40%	10.79%
Hazardous Materials	47.14%	17.46%	22.80%	8.10%	4.48%
Overall	45.9%	24.2%	15.1%	5.9%	8.8%

Table 8-16. Estimated Damage to Critical Facilities from the Greenville Fault Scenario Earthquake

	Percent of Facilities Experiencing Defined Damage Level				
Category	No Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage
Medical and Health Services	90.76%	3.08%	0.13%	0.44%	5.56%
Emergency Services	79.34%	15.95%	1.00%	0.09%	3.59%
Educational Facilities	77.12%	16.37%	1.11%	0.19%	5.18%
Government	57.32%	23.07%	12.62%	1.58%	5.37%
Utilities	80.56%	11.18%	2.69%	0.64%	4.90%
Transportation Infrastructure	70.88%	14.95%	3.91%	6.09%	4.14%
Hazardous Materials	29.48%	19.36%	35.30%	9.95%	5.89%
Overall	69.4%	14.9%	8.1%	2.7%	4.9%

Table 8-17. Estimated Damage to Critical Facilities from the Haywired Fault Scenario Earthquake

	Percent of Facilities Experiencing Defined Damage Level				
Category	No Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage
Medical and Health Services	39.61%	46.51%	2.46%	0.01%	11.40%
Emergency Services	24.90%	51.46%	15.62%	0.31%	7.68%
Educational Facilities	24.63%	49.03%	15.93%	0.32%	10.06%
Government	0.36%	1.32%	8.16%	25.04%	65.11%
Utilities	4.78%	14.66%	27.08%	24.09%	29.36%
Transportation Infrastructure	20.47%	15.40%	9.56%	15.80%	38.74%
Hazardous Materials	1.01%	3.74%	28.60%	30.86%	35.76%
Overall	16.5%	26.0%	15.3%	13.8%	28.3%

Table 8-18. Estimated Damage to Critical Facilities from the Mt. Diablo Fault Scenario Earthquake

	Percent of Facilities Experiencing Defined Damage Level				
Category	No Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage
Medical and Health Services	82.95%	9.37%	0.09%	0.16%	7.40%
Emergency Services	64.18%	28.76%	2.01%	0.07%	4.95%
Educational Facilities	66.51%	25.49%	1.49%	0.07%	6.42%
Government	22.96%	33.88%	32.02%	3.78%	7.33%
Utilities	64.53%	21.43%	6.53%	0.71%	6.76%
Transportation Infrastructure	61.92%	19.26%	5.16%	8.63%	5.01%
Hazardous Materials	41.53%	26.33%	25.77%	2.98%	3.36%
Overall	57.8%	23.5%	10.4%	2.3%	5.9%

Table 8-19. Estimated Damage to Critical Facilities from the San Andreas Fault Scenario Earthquake

Category	Percent of Facilities Experiencing Defined Damage Level				
	No Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage
Medical and Health Services	96.90%	0.37%	0.47%	0.80%	1.43%
Emergency Services	97.89%	1.46%	0.11%	0.12%	0.40%
Educational Facilities	97.51%	1.67%	0.10%	0.11%	0.59%
Government	90.39%	8.13%	1.07%	0.18%	0.21%
Utilities	94.76%	1.94%	0.54%	0.62%	2.11%
Transportation Infrastructure	91.11%	5.80%	0.81%	1.97%	0.28%
Hazardous Materials	91.62%	6.33%	1.90%	0.07%	0.05%
Overall	94.3%	3.7%	0.7%	0.6%	0.7%

Table 8-20. Functionality of Critical Facilities for Calaveras Fault Scenario Earthquake

Planning Unit	# of Critical Facilities	Probability of Being Fully Functional (%)					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Medical and Health Services	20	62.7	63.3	88.8	89.4	90.2	90.2
Emergency Services	24	56.6	57.3	88.5	89.3	93.4	93.4
Educational Facilities	62	56.1	56.8	86.4	87.1	91.9	92.0
Government	23	15.5	16.3	32.9	33.0	71.4	88.5
Utilities	120	53.9	72.8	84.1	86.9	90.9	97.5
Transportation Infrastructure	147	70.1	76.7	79.3	79.8	80.7	86.6
Hazardous Materials	27	47.1	47.9	64.5	64.5	87.4	95.4
Total/Average	423	51.7	55.9	74.9	75.7	86.5	91.9

Table 8-21. Functionality of Critical Facilities the Greenville Fault Scenario Earthquake

Planning Unit	# of Critical Facilities	Probability of Being Fully Functional (%)					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Medical and Health Services	20	90.7	90.7	93.7	93.8	93.9	94.2
Emergency Services	24	79.3	79.6	94.9	95.3	96.3	96.3
Educational Facilities	62	77.1	77.4	93.1	93.5	94.6	94.7
Government	23	57.3	58.4	80.3	80.3	93.0	94.6
Utilities	120	88.3	93.5	94.7	95.3	96.3	98.8
Transportation Infrastructure	147	83.8	88.5	90.0	90.3	90.8	94.1
Hazardous Materials	27	29.4	30.4	48.7	48.8	84.1	94.0
Overall	423	72.3	74.1	85.1	85.3	92.7	95.2

Table 8-22. Functionality of Critical Facilities for the Haywired Fault Scenario Earthquake

Planning Unit	# of Critical Facilities	Probability of Being Fully Functional (%)					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Medical and Health Services	20	39.6	40.6	85.0	86.1	88.5	88.5
Emergency Services	24	24.9	26.0	75.1	76.3	92.0	92.1
Educational Facilities	62	24.6	25.7	72.5	73.6	89.5	89.7
Government	23	0.3	0.4	1.6	1.6	9.8	34.8
Utilities	120	27.4	41.8	52.3	59.0	71.6	91.7
Transportation Infrastructure	147	36.9	43.4	46.8	47.7	49.2	59.7
Hazardous Materials	27	1.0	1.2	4.7	4.7	33.3	64.2
Total/Average	423	22.1	25.6	48.3	49.9	62.0	74.4

Table 8-23. Functionality of Critical Facilities from the Mt. Diablo Fault Scenario Earthquake

Planning Unit	# of Critical Facilities	Probability of Being Fully Functional (%)					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Medical and Health Services	20	82.9	83.1	92.1	92.3	92.4	92.4
Emergency Services	24	64.2	64.8	92.2	92.9	94.9	94.9
Educational Facilities	62	66.5	67.0	91.4	92.0	93.4	93.4
Government	23	22.9	24.5	56.7	56.8	88.8	92.6
Utilities	120	80.0	90.2	92.9	93.6	95.0	98.5
Transportation Infrastructure	147	78.8	84.7	86.7	87.1	87.8	92.4
Hazardous Materials	27	41.5	42.7	67.7	67.8	93.6	96.6
Total/Average	423	62.4	65.3	82.8	83.2	92.3	94.4

Table 8-24. Functionality of Critical Facilities from the San Andreas Fault Scenario Earthquake

Planning Unit	# of Critical Facilities	Probability of Being Fully Functional (%)					
		at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Medical and Health Services	20	96.9	96.9	97.2	97.2	97.7	98.1
Emergency Services	24	97.8	97.9	99.3	99.3	99.4	99.5
Educational Facilities	62	97.5	97.5	99.1	99.1	99.2	99.3
Government	23	90.3	90.7	98.4	98.4	99.6	99.7
Utilities	120	96.2	97.2	97.4	97.7	98.2	99.3
Transportation Infrastructure	147	95.7	97.4	97.7	97.8	98.0	99.0
Hazardous Materials	27	91.5	91.9	97.9	97.9	99.8	99.9
Total/Average	423	95.1	95.6	98.2	98.2	98.8	99.2

8.6 FUTURE TRENDS IN DEVELOPMENT

Land use in the planning area will be directed by general plans adopted under California's General Planning Law. The safety elements of the general plans establish standards and plans for the protection of the cities from hazards. The information in this plan provides a tool to ensure that there is no increase in exposure in areas of high seismic risk. Development in the planning area will be regulated through building standards and performance measures so that the degree of risk will be reduced. The geologic hazard portions of the planning area are heavily regulated under California's General Planning Law. The International Building Code establishes provisions to address seismic risk. Table 8-25 summarizes developable land by land use in areas with high and very high susceptibility to liquefaction.

8.7 SCENARIO

With the abundance of fault exposure in the Bay Area, the potential scenarios for earthquake activity are many. An earthquake does not have to occur within the planning area to have a significant impact on the people, property and economy of the planning area.

Any seismic activity of 6.0 or greater on faults within the planning area would have significant impacts throughout the planning area. Potential warning systems could give approximately 40 seconds notice that a major earthquake is about to occur. This would not provide adequate time for preparation. Earthquakes of this magnitude or higher would lead to massive structural failure of property on NEHRP C, D, E, and F soils. Dams and revetments built on these poor soils would likely fail, representing a loss of critical infrastructure. These events could cause secondary hazards, including landslides and mudslides that would further damage structures. Soil liquefaction would occur in water-saturated sands, silts or gravelly soils.

Table 8-25. Developable Land in High and Very High Liquefaction Susceptibility Areas

	High Liquefaction Susceptibility Areas		Very High Liquefaction Susceptibility Areas	
	Area (acres)	% of total	Area (acres)	% of total
Residential	919	38.9%	329	25.1%
Commercial	141	6.0%	37	2.8%
Industrial	200	8.5%	45	3.4%
Agriculture	41	1.7%	40	3.1%
Religion / Assembly	247	10.5%	243	18.6%
Government / Institutional	0	0.0%	0	0.0%
Education	812	34.4%	616	47.0%
Vacant / Rights-of-Way / Water / Open Space	2,361	100.0%	1,310	100.0%
Total	919	38.9%	329	25.1%

Source: Alameda County, 2016

8.8 ISSUES

Important issues associated with an earthquake include the following:

- More information is needed on the exposure and performance of soft-story construction within the planning area.
- Based on the modeling of critical facility performance performed for this plan, a high number of facilities in the planning area are expected to have complete or extensive damage from scenario events. These facilities are prime targets for structural retrofits.
- Critical facility owner should be encouraged to create or enhance continuity of operations plans using the information on risk and vulnerability contained in this plan.
- Geotechnical standards should be established that take into account the probable impacts from earthquakes in the design and construction of new or enhanced facilities.
- There are a few dams that could affect a portion of the planning area. Dam failure warning and evacuation plans and procedures should be reviewed and updated to reflect the dams' risk potential associated with earthquake activity in the region.
- Earthquakes could trigger other natural hazard events such as dam failures and landslides, which could severely impact the planning area.
- A worst-case scenario would be the occurrence of a large seismic event during a flood or high-water event. Dam failures would happen at multiple locations, increasing the impacts of the individual events.
- Citizens are expected to be self-sufficient for up to three days after a major earthquake without government response agencies, utilities, private-sector services, and infrastructure components. Education programs are currently in place to facilitate development of individual, family, neighborhood, and business earthquake preparedness. Government alone can never make this region fully prepared. It takes individuals, families, and communities working in concert with one another to be fully prepared for disaster.
- After a major seismic event, the Tri-Valley planning area is likely to experience disruptions in the flow of goods and services resulting from the destruction of major transportation infrastructure across the broader region.

9. FLOOD

9.1 GENERAL BACKGROUND

A floodplain is the area adjacent to a river, creek or lake that becomes inundated during a flood. Floodplains may be broad, as when a river crosses an extensive flat landscape, or narrow, as when a river is confined in a canyon.

When floodwaters recede after a flood event, they leave behind layers of rock and mud. These gradually build up to create a new floor of the floodplain. Floodplains generally contain unconsolidated sediments (accumulations of sand, gravel, loam, silt, and/or clay), often extending below the bed of the stream. These sediments provide a natural filtering system, with water percolating back into the ground and replenishing groundwater. These are often important aquifers, the water drawn from them being filtered compared to the water in the stream. Fertile, flat reclaimed floodplain lands are commonly used for agriculture, commerce and residential development.

Connections between a river and its floodplain are most apparent during and after major flood events. These areas form a complex physical and biological system that not only supports a variety of natural resources but also provides natural flood and erosion control. When a river is separated from its floodplain with levees and other flood control facilities, natural, built-in benefits can be lost, altered, or significantly reduced.

DEFINITIONS

Flood—The inundation of normally dry land resulting from the rising and overflowing of a body of water.

Floodplain—The land area along the sides of a river that becomes inundated with water during a flood.

1-percent annual chance (1oo-Year) floodplain—The area flooded by the flood that has a 1-percent chance of being equaled or exceeded each year. The 1-percent annual chance flood is the standard used by most federal and state agencies.

0.2-Percent-Annual-Chance (500-Year) Floodplain—The area flooded by the flood that has a 0.2-percent chance of being equaled or exceeded in a given year.

Regulatory Floodway—Channel of a river or other water course and adjacent land areas that must be reserved for discharge of the base flood without cumulatively increasing water surface elevation more than a designated height. Communities must regulate development in these floodways to ensure no increases in upstream flood elevations.

Return Period—The average number of years between occurrences of a hazard (equal to the inverse of the annual likelihood of occurrence).

9.1.1 Measuring Floods and Floodplains

The frequency and severity of flooding are measured using a discharge probability, which is the probability that a certain river discharge (flow) level will be equaled or exceeded in a given year. Flood studies use historical records to determine the probability of occurrence for the different discharge levels. The flood frequency equals 100 divided by the discharge probability. For example, the 100-year discharge has a 1-percent chance of being equaled or exceeded in any given year. The "annual flood" is the greatest flood event expected to occur in a typical year. These measurements reflect statistical averages only; it is possible for two or more floods with a 100-year or higher recurrence interval to occur in a short time period. The same flood can have different recurrence intervals at different points on a river.

The extent of flooding associated with a 1-percent annual change flood (also called the base flood) is used as a regulatory boundary by many agencies. The area flooded by the base flood is called the special flood hazard area (SFHA). Many communities have maps that show the extent and likely depth of flooding for the base flood.

Corresponding water-surface elevations describe the elevation of water that will result from a given discharge level, which is one of the most important factors used in estimating flood damage.

9.1.2 Floodplain Ecosystems and the Effects of Human Activities

Floodplains can support ecosystems that are rich in plant and animal species. A floodplain can contain 100 or even 1,000 times as many species as a river. Wetting of the floodplain soil releases an immediate surge of nutrients: those left over from the last flood, and those that result from the rapid decomposition of organic matter that has accumulated since then. Microscopic organisms thrive and larger species enter a rapid breeding cycle. Opportunistic feeders (particularly birds) move in to take advantage. The production of nutrients peaks and falls away quickly, but the surge of new growth endures for some time. This makes floodplains valuable for agriculture. Species growing in floodplains are markedly different from those that grow outside floodplains. For instance, riparian trees (trees that grow in floodplains) tend to be very tolerant of root disturbance and very quick-growing compared to non-riparian trees.

Because they border water bodies, floodplains have historically been popular sites to establish settlements. Human activities tend to concentrate in floodplains for a number of reasons: water is readily available; land is fertile and suitable for farming; transportation by water is easily accessible; and land is flatter and easier to develop. But human activity in floodplains frequently interferes with the natural function of floodplains. It can affect the distribution and timing of drainage, thereby increasing flood problems. Human development can create local flooding problems by altering or confining drainage channels. This increases flood potential in two ways: it reduces the stream's capacity to contain flows, and it increases flow rates or velocities downstream during all stages of a flood event. Human activities can interface effectively with a floodplain as long as steps are taken to mitigate the activities' adverse impacts on floodplain functions.

9.1.3 Federal Flood Programs

National Flood Insurance Program

The NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in participating communities. For most participating communities, FEMA has prepared a detailed Flood Insurance Study (FIS). The study presents water surface elevations for floods of various magnitudes, including the 1-percent annual chance flood and the 0.2-percent annual chance flood (the 500-year flood). Base flood elevations and the boundaries of the 1-percent annual chance and 0.2-percent annual chance floodplains are shown on Flood Insurance Rate Maps (FIRMs), which are the principle tool for identifying the extent and location of the flood hazard. FIRMs are the most detailed and consistent data source available, and for many communities they represent the minimum area of oversight under their floodplain management program. In recent years, FIRMs have been digitized as Digital Flood Insurance Rate Maps (DFIRMs), which are more accessible to residents, local governments and stakeholders.

Table 9-1 lists each municipal jurisdiction's date of entrance into the NFIP and the effective date of its current FIRM. As participants in the NFIP, the cities must, at a minimum, regulate development in their floodplain areas in accordance with NFIP criteria. Before a permit to build in a floodplain area is issued, the cities must ensure that two basic criteria are met:

- All new construction, substantial improvements, and repairs of substantial damage will be protected from damage by the base flood.
- New floodplain development will not aggravate existing flood problems or increase damage to other properties.
- New floodplain development must exercise a reasonable and prudent effort to reduce its adverse impacts on threatened salmonid species.

Table 9-1. Jurisdictions and Date Joined NFIP

Jurisdiction	NFIP Community #	NFIP Entry Date	Current Effective FIRM
Dublin	060705	April 14, 1981	August 3, 2009
Livermore	060008	July 5, 1977	August 3, 2009
Pleasanton	060012	December 16, 1980	August 3, 2009

Source: FEMA, 2017c

In participating communities, structures permitted or built in the planning area before NFIP and related building code regulations went into effect are called "pre-FIRM" structures, and structures built afterwards are called "post-FIRM." The insurance rate is different for the two types of structures. Communities participating in the NFIP may adopt regulations that are more stringent than those contained in 44 CFR 60.3, but not less stringent.

Properties constructed after a FIRM has been adopted are eligible for reduced flood insurance rates. Such structures are less vulnerable to flooding since they were constructed after regulations and codes were adopted to decrease vulnerability. Properties built before the FIRM was adopted may be more vulnerable to flooding and related damage because they do not meet code or are located in hazardous areas. The first FIRMs in the planning area were available in 1977 to 1983. The date of the current effective FIRM for all three cities is August 3, 2009. FEMA has developed a preliminary new DFIRM for these three cities dated April 16, 2015. Although the preliminary data is the most recent data available, until is it officially approved and adopted, it can only be used for review and guidance purposes. Preliminary data is subject to change until that point, and as such, it is not used to rate flood insurance policies or enforce the federal mandatory purchase requirement.

The Cities of Dublin, Livermore and Pleasanton are all in good standing with the NFIP. In California, the Department of Water Resources is the coordinating agency for floodplain management. DWR works with FEMA and local governments by providing grants and technical assistance, evaluating community floodplain management programs, reviewing local floodplain ordinances, participating in statewide flood hazard mitigation planning, and facilitating annual statewide workshops. Compliance is monitored by FEMA regional staff and by DWR. Maintaining compliance under the NFIP is an important component of flood risk reduction.

FEMA Regulatory Flood Zones

FEMA defines flood hazard areas as areas expected to be inundated by a flood of a given magnitude. These areas are determined via statistical analyses of records of river flow, storm tides, and rainfall; information obtained through consultation with the community; floodplain topographic surveys; and hydrologic and hydraulic analyses. Flood hazard areas are delineated on DFIRMs, which provide the following information:

- Locations of specific properties in relation to SFHAs
- Base flood elevations (1-percent annual chance) at specific sites
- Magnitudes of flood in specific areas
- Undeveloped coastal barriers where flood insurance is not available
- Regulatory floodways and floodplain boundaries (1-percent and 0.2-percent annual chance floodplain boundaries).

On a DFIRM, the SFHA is the land area covered by floodwaters of the base flood—an area where NFIP floodplain management regulations must be enforced, and where mandatory purchase of flood insurance applies. This regulatory boundary is a convenient tool for assessing vulnerability and risk in flood-prone communities, because many communities have maps showing the extent of the base flood and likely depths that will occur.

The base flood elevation (the water elevation of a flood that has a 1-percent chance of occurring in any given year) is one of the most important factors in estimating potential damage from flooding. A structure within a

1-percent annual chance floodplain has a 26-percent chance of undergoing flood damage during the term of a 30-year mortgage. The 1-percent annual chance flood is used by the NFIP as the basis for insurance requirements nationwide. DFIRMs also depict 0.2-percent annual chance flood designations (500-year events).

DFIRM, FIRMs, and other flood hazard information can be used to identify the expected extent of flooding from a 1-percent and 0.2-percent annual chance event. DFIRMS and FIRMS depict SFHAs, defined as follows:

- **Zones A1-30 and AE—**SFHAs that are subject to inundation by the base flood, determined using detailed hydraulic analysis. Base flood elevations are shown within these zones. There are mandatory flood insurance purchase requirements, and floodplain management standards apply.
- **Zone A (also known as Unnumbered A-zones)—**SFHAs where no base flood elevations or depths are shown because detailed hydraulic analyses have not been performed. There are mandatory flood insurance purchase requirements, and floodplain management standards apply.
- **Zone AH—**Areas subject to inundation by the base flood (shallow flooding), usually areas of ponding, where average depths are between 1 and 3 feet. Base flood elevations derived from detailed hydraulic analyses are shown in this zone. There are mandatory flood insurance purchase requirements, and floodplain management standards apply.
- **Zone AO—**SFHAs subject to inundation by types of shallow flooding (usually sheet flow or sloping terrain) where average depths are between 1 and 3 feet. Average flood depths derived from detailed hydraulic analyses are shown in this zone. There are mandatory flood insurance purchase requirements, and floodplain management standards apply.
- **Zone VE, V1-30—**Areas subject to inundation by the base flood event, with additional hazards due to storm-induced velocity wave action. Base flood elevations derived from detailed hydraulic analyses are shown. There are mandatory flood insurance purchase requirements, and floodplain management standards apply.
- **Zone V—**SFHAs along the coast that are subject to inundation by the base flood event with additional hazards associated with storm-induced waves. No base flood elevations or flood depths are shown because detailed hydraulic analyses have not been performed. There are mandatory flood insurance purchase requirements, and floodplain management standards apply.
- **Zone B and X (shaded)—**Areas of moderate flood hazard and areas between the limits of the base flood and 0.2 percent annual change flood. These zones are not SFHAs.
- **Zones C and X (unshaded)—**Areas of minimal flood hazard located outside the SFHA and higher than the elevation of the 0.2-percent annual chance flood.

On the current DFIRM for Dublin, most of the city is shown as Zone X (unshaded). There are small areas of the 1-percent annual chance floodplain and 0.2-percent annual chance floodplain. On the current DFIRM for Livermore, there are large portions of Zone X (unshaded) and only small portions within the 1- percent annual chance floodplain and 0.2-percent annual chance floodplain. For Pleasanton, most of the city is shown as Zone X (unshaded). The 1-percent annual chance floodplain covers only minor areas in Pleasanton; Pleasanton has more 0.2-percent annual chance floodplain than Dublin and Livermore

The Community Rating System

The CRS is a voluntary program within the NFIP that encourages floodplain management activities that exceed the minimum NFIP requirements. Flood insurance premiums are discounted to reflect the reduced flood risk resulting from community actions meeting the following three goals of the CRS:

- Reduce flood losses.
- Facilitate accurate insurance rating.
- Promote awareness of flood insurance.

For participating communities, flood insurance premium rates are discounted in increments of 5 percent. For example, a Class 1 community would receive a 45 percent premium discount, and a Class 9 community would receive a 5 percent discount. (Class 10 communities are those that do not participate in the CRS; they receive no discount.) The CRS classes for local communities are based on 18 creditable activities in the following categories:

- Public information
- Mapping and regulations
- Flood damage reduction
- Flood preparedness.

Figure 9-1 shows the nationwide number of CRS communities by class as of October 2016, when there were 1,391 communities receiving flood insurance premium discounts under the CRS program.

Source: FEMA, 2016

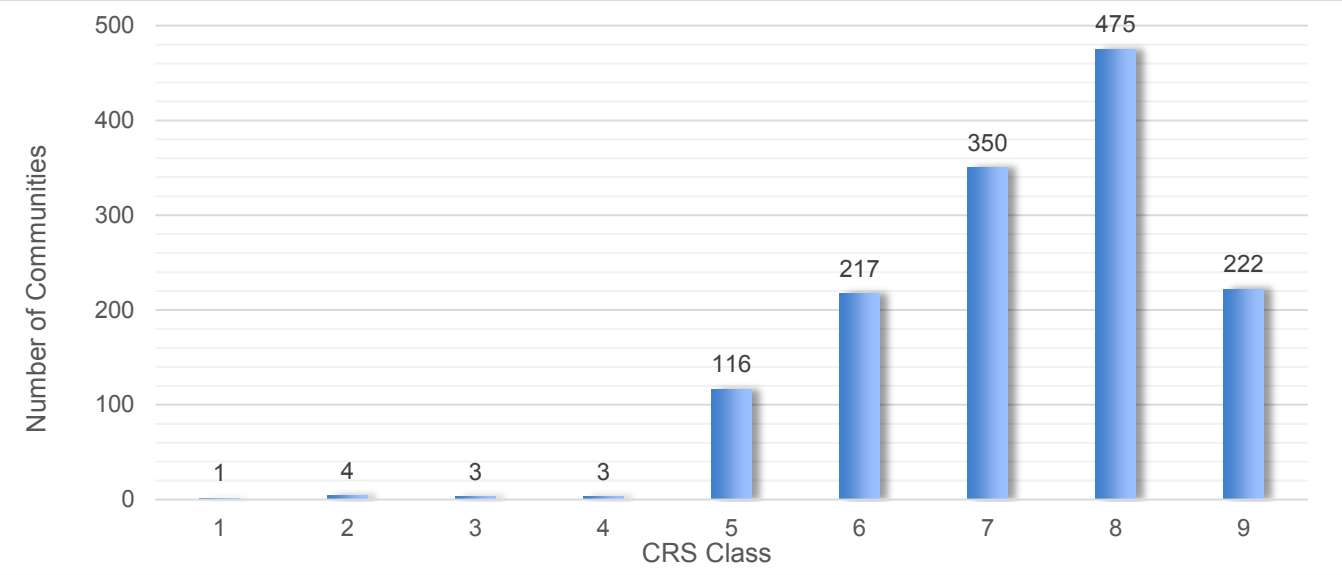


Figure 9-1. CRS Communities by Class Nationwide as of October 2016

Although insurance premiums are one benefit of participation in the CRS, more important benefits result from activities that save lives and reduce property damage. Communities participating in the CRS represent a significant portion of the nation's flood risk, as evidenced by the fact that over 68 percent of the NFIP's policy base is located in these communities. Communities receiving premium discounts through the CRS range from small to large and represent a broad mixture of flood risks, including both coastal and riverine flood risks.

The Cities of Livermore and Pleasanton currently participate in the CRS program. Their CRS status is summarized in Table 9-2. The total annual savings on flood insurance premiums within the planning area is over $20,000. Many of the mitigation actions identified in Volume 2 of this plan are creditable activities under the CRS program. Therefore, successful implementation of this plan offers the potential for these communities to enhance their CRS classifications and for currently non-participating communities to join the program.

Table 9-2. CRS Community Status in the Planning Area

Community	NFIP Community #	CRS Entry Date	Current CRS Classification	% Premium Discount, SFHA/non-SFHA	Total Premium Savings
Livermore	060008	05/01/2015	9	5/5	$5,112
Pleasanton	060012	10/1/1992	7	15/5	$15,423
Total					$20,535

Source: FEMA, 2017

9.2 HAZARD PROFILE

9.2.1 Types of Flooding Affecting the Planning Area

Flooding in the planning area typically occurs during the rainy season, between November and April. Three types of flooding primarily affect the planning area: stormwater flooding, riverine flooding and flash floods.

Stormwater Runoff Flooding

Urban drainage systems are designed to remove surface water from developed areas as quickly as possible to prevent flooding on streets and in other urban areas. These closed conveyance systems channel water away from an urban area to surrounding streams, bypassing natural processes of water filtration through the ground, containment, and evaporation of excess water. Urban drainage systems can play a role in flooding in two ways:

- Because drainage systems reduce the amount of time surface water takes to reach surrounding streams, flooding in those streams can occur more quickly and reach greater depths than prior to development in the area (FEMA, 2008).
- If stormwater runoff exceeds the capacity of the drainage system, then stormwater runoff flooding can result throughout the system's service area.

Stormwater runoff flooding can occur in areas other than delineated floodplains or along recognizable channels. It generally occurs in flat areas, and generally increases with urbanization, which speeds accumulation of floodwaters because of impervious areas. Shallow street flooding can occur unless channels have been improved to account for increased flows (FEMA, 1997).

Riverine Flooding

Riverine flooding is the overbank flooding of rivers and streams. Flooding in large river systems typically results from large-scale weather systems that generate prolonged rainfall over a wide geographic area, causing flooding in hundreds of smaller streams, which then drain into major rivers. Shallow area flooding is a special type of riverine flooding. FEMA defines shallow flood hazards as areas that are inundated by the 1-percent annual chance flood with flood depths of only 1 to 3 feet. These areas are generally flooded by low velocity sheet flows of water. Two types of flood hazards are generally associated with riverine flooding:

- **Inundation**—Inundation occurs when there is floodwater and debris flowing through an area that is not normally covered by water. Such events cause minor to severe damage, depending on the velocity and depth of flows, the duration of the flood event, the quantity of logs and other debris carried by the flows, and the amount and type of development and personal property along the floodwater's path.
- **Channel Migration**—Channel migration is erosion that results from the wearing away of banks and soils due to flowing water. This erosion, combined with sediment deposition, causes the migration or lateral movement of a river channel across a floodplain. A channel can also move by abrupt change in location, called avulsion, which can shift the channel location a large distance in as short a time as one flood event.

Flash Flooding

The National Weather Service defines flash flooding as follows (NWS, 2009):

> "[A] rapid and extreme flow of high water into a normally dry area, or a rapid water level rise in a stream or creek above a predetermined flood level, beginning within 6 hours of the causative event (e.g., intense rainfall, dam failure). However, the actual time threshold may vary in different parts of the country. Ongoing flooding can intensify to flash flooding in cases where intense rainfall results in a rapid surge of rising flood waters."

Flash floods are capable of tearing out trees, undermining buildings and bridges, and scouring new channels. In urban areas, flash flooding is an increasingly serious problem due to the removal of vegetation and replacement of ground cover with impermeable surfaces such as roads, driveways, and parking lots. The greatest risk from flash floods is that they occur with little to no warning. The major factors in predicting potential damage are the intensity and duration of rainfall and watershed and stream steepness.

9.2.2 Past Events

Sources that provide historical information regarding previous occurrences and losses associated with flooding events in Alameda County and the planning area include FEMA, NWS, and NOAA's National Centers for Environmental Information (NCEI). Between 1954 and April 2017, FEMA issued disaster (DR) declarations for the State of California for 48 flood-related events, classified as one or a combination of the following: winter storms, debris and mud flows, severe winter storms, severe storms, mudslides, landslides, heavy rains, and high tides. Alameda County was included in 13 declarations, as listed in Table 9-3. Little recorded information is available regarding previous flooding occurrences in the Cities of Dublin, Livermore and Pleasanton. Table 9-4 lists known flood events that impacted the planning area between 1970 and April 2017.

Table 9-3. FEMA Disaster Declarations for Flood Events in Alameda County

FEMA Declaration Number	Event Date	Event Type	Location
DR-4308	February 1 – February 23, 2017	Severe Winter Storms, Flooding, Mudslides	43 counties including Alameda County
DR-4305	January 18 – January 23, 2017	Severe Winter Storms, Flooding, Mudslides	23 counties including Alameda County
DR-4301	January 3 – January 12, 2017	Severe Winter Storms, Flooding, Mudslides	34 counties including Alameda County
DR-1646	March 29 – April 16, 2006	Severe Storms, Flooding, Landslides, and Mudslides	17 counties including Alameda County
DR-1628	December 17 – January 3, 2006	Severe Storms, Flooding, Mudslides, and Landslides	31 counties including Alameda County
DR-1155	December 28, 1996 – April 1, 1997	Severe Storms, Flooding, Mud and Landslides	48 counties including Alameda County
DR-1046	February 13 – April 19, 1995	Severe Winter Storms, Flooding, Landslides, Mud Flows	57 counties including Alameda County
DR-1044	January 3 – February 10, 1995	Severe Winter Storms, Flooding, Landslides, Mud Flows	42 counties including Alameda County
DR-758	February 12-March 10, 1986	Severe Storms & Flooding	39 counties including Alameda County
DR-677	January 21 – March 30, 1983	Coastal Storms, Floods, Slides & Tornadoes	40 counties including Alameda County
DR-1203	February 2 – April 30, 1998	Severe Winter Storms and Flooding	41 counties including Alameda County
DR-651	December 19, 1981 – January 8, 1983	Severe Storms, Flood, Mudslides & High Tide	10 counties including Alameda County
DR-283	February 16, 1970	Severe Storms & Flooding	17 counties including Alameda County

Source: FEMA, 2017d

Table 9-4. Flood Events in the Tri-Valley Planning Area

Event Date	Event Type	FEMA Declaration Number	Location	Description
February 21, 2017	Atmospheric River	DR-4308	Countywide	Widespread rain caused flooding, debris flow, accidents, and overtopping of reservoir spillways. In Livermore and Pleasanton, there were multiple road closures including westbound 580, westbound Stanley Blvd, Happy Valley Road. Ten people were stranded by flash flood in Livermore along Collier Canyon Road.
February 9, 2017	Atmospheric River	DR-4308	Countywide	Strong wind and heavy rain produced road flooding and debris flows.
November 30,2014	Rain and wind	N/A	Tri-Valley area	Rain and wind brought a few downed trees and minor urban flooding. Heavy rain produced flooding on Interstate 580 onramp in Dublin and two westbound lanes were flooded in Livermore.
October 13, 2009	Heavy Rain and wind	N/A	Northern and Central CA	Heavy rain and wind downed numerous trees and power lines. Heavy rain caused major flooding on Bernal Avenue at Valley Avenue
March 29 – April 16, 2006	Severe Storms, Flooding, Landslides, and Mudslides	DR-1646	Countywide	Strong storms brought heavy rain to most of Alameda County causing landslides, eroding hillsides and cracked pavement. Oversaturated earth also caused landslide and/or erosion problems to private properties, which spilled over onto public rights-of-way.
December 17, 2005 – January 12, 2006	Winter Storms (Severe Storms, Flood, Mudslides, Landslides)	DR-1628	Bay Area including Alameda County	Storms were blamed for two deaths from falling trees, around 50 businesses were declared damaged, and three homes were nearly wiped out by mudslides. The event included severe storms, flooding, mudslides, and landslides. Estimated damage was over $100 million.
February 3, 1998	Flash Flood	N/A	Tri-Valley area	A levee breach along Arroyo Mocha damage roads and property in Dublin and Livermore. Estimated damage was $100,000.
December 28, 1996 – April 1, 1997	Severe Storms, Flooding, Mud and Landslides	DR-1155	48 counties including Alameda County	300 square miles in northern California were flooded and over 12,000 people were evacuated. Levee breaks were reported across the Sacramento and San Joaquin Valleys. Over 23,000 homes, business, agricultural lands, bridges, and roads were damaged. Eight deaths resulted from this event. Overall, the state had $1.8 billion in damage.
January 3 – February 10, 1995; and February 13 – April 19, 1995	Severe Winter Storms, Flooding, Landslides, Mud Flows	DR-1044 and DR-1046	42 counties including Alameda County	Winter storms, flooding and landslides impacted a large area of the state. Storms in the Sacramento River Basin resulted in small stream flooding due to drainage system failures. Over 100 stations recorded their greatest one-day rainfall in history. Overall, there were 38 deaths, damage to homes and over $1.7 billion in damage.
February 12 – March 10, 1986	Severe Storms & Flooding	DR-758	Bay Area including Alameda County	The event damaged over 12,000 homes, destroyed over 1,300 homes, and caused 13 deaths and 67 injuries in California. Damage totaled over $407.5 million.
January 21 – March 30, 1983	Coastal Storms, Floods, Slides & Tornadoes	DR-677	40 counties including Alameda County	The state had over $500 million in damage from this event due to heavy rains, high winds, flooding, and levee breaks.
February 10, 1970	Severe Storms & Flooding	DR-283	Bay Area including Alameda County	Heavy winds, storms and flooding impacted the Bay Area, including Alameda County. Impacted areas had over $27 million in damage.

Sources: NOAA NCEI, 2017; SPC 2016; ABAG Regional Hazard Mitigation Plan 2011; State of California 2013

9.2.3 Location

Primary Flood Sources

The factors that induce flooding in Alameda County are winter storms with heavy rainfall, steep topography, and constricted floodways. Storms of wide-area distribution originate over the Pacific Ocean in winter and develop with the frontal lifting of air masses along the hills of the coastal range.

City of Dublin

According to the effective 2009 FEMA Flood Insurance Study for Alameda County, the City of Dublin has flood problems similar to those of Alameda County, with heavy winter rainfall, a steep topography, and constricted floodways.

City of Livermore

According to the effective 2009 FEMA Flood Insurance Study for Alameda County, the principal flooding problems in the City occur during winter. Storm runoff is concentrated rapidly by the network of tributaries that discharge through the hills into the major streams. The tributaries have carved well-defined courses through the hills, but upon reaching the flat Livermore Valley, the channels become shallow and inadequate for lower return-frequency flows. Constriction of Arroyo Seco flows at the Western Pacific and Southern Pacific Railroad crossing of the creek forces lower-frequency flood flows to spread out from these points. Another constricting hydraulic factor is a length of channel along Arroyo Las Positas upstream from Airway Boulevard. Rapid runoff rates, inadequate channels, and constricting structures combined with the development of some floodplain areas, make Livermore susceptible to damage when large rainstorms occur.

City of Pleasanton

According to the effective 2009 FEMA Flood Insurance Study for Alameda County, the main flooding problem is caused by the low capacity of the lower reaches of Arroyo De La Laguna, which causes backwater flooding in its tributary channels.

According to the City of Pleasanton's annex in the 2010 ABAG Local Hazard Mitigation Plan, when above-normal rain falls over a short duration, the increased runoff and flooding is at Arroyo Las Positas, Arroyo Mocho, Altamont Creek, and in areas with poor drainage.

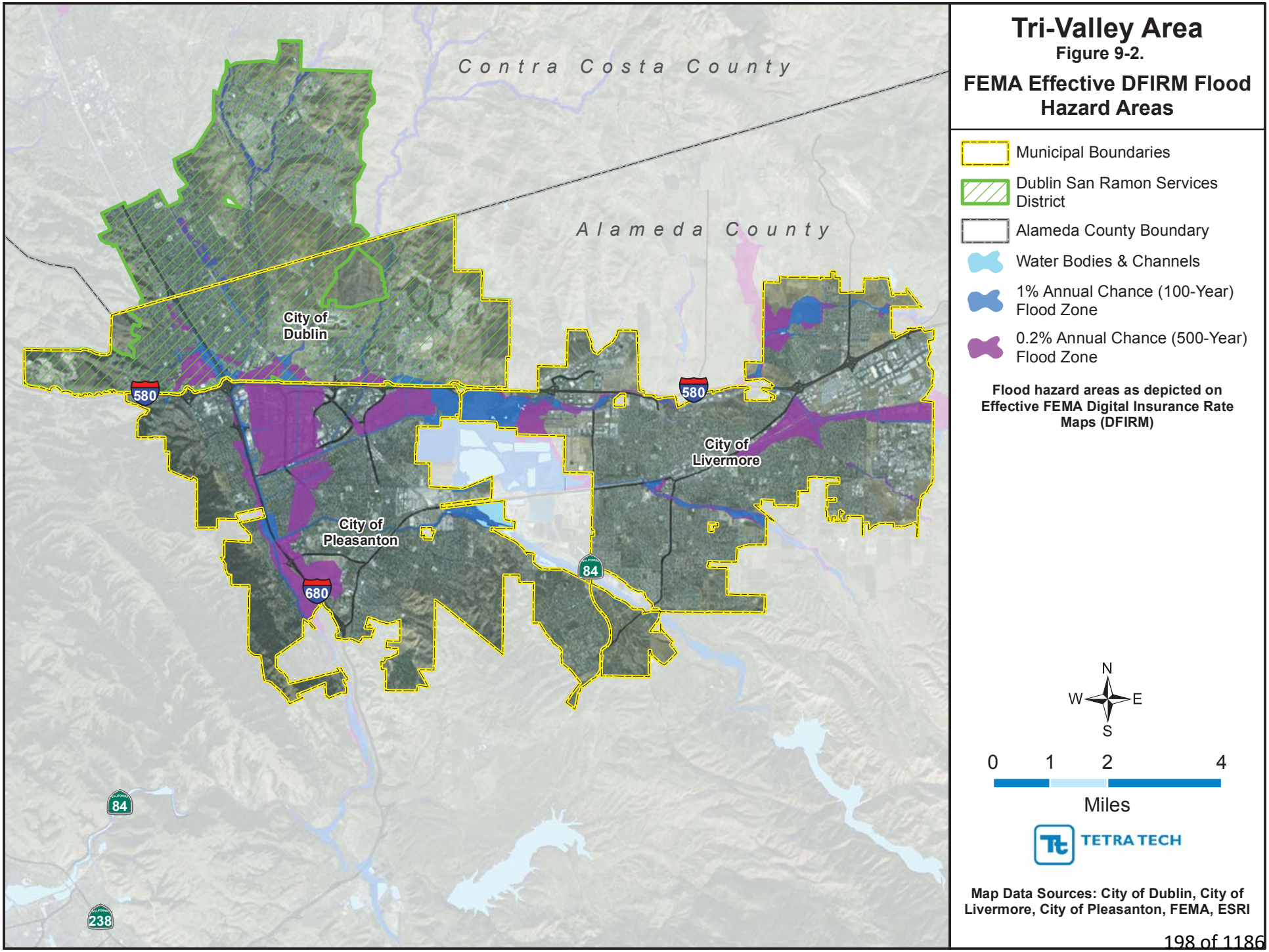
Regulatory Floodplain

Flooding in the planning area has been documented by gage records, high water marks, damage surveys, and personal accounts. This documentation was the basis for the FEMA's Alameda County FIRM. Less than 5 percent of the planning area is within the FIRM's mapped 1-percent annual chance floodplain, as shown on Figure 9-2 and listed in Table 9-5.

All principal flooding sources are incorporated in the currently effective FIRMs. The FIRMs are the most detailed and consistent data source available for determining flood extent. The effective 2009 Flood Insurance Study was used in this risk assessment to map the extent and location of the flood hazard, along with map revisions prepared through July 2016.

9.2.4 Frequency

According to NOAA NCEI, Alameda County has experienced 33 flood and flash flood events since 1996. Table 9-6 shows these statistics, as well as the annual average number of events and the percent chance of each flood hazard occurring in Alameda County in any given year.



Tri-Valley Area

Figure 9-2.

FEMA Effective DFIRM Flood Hazard Areas

- Municipal Boundaries
- Dublin San Ramon Services District
- Alameda County Boundary
- Water Bodies & Channels
- 1% Annual Chance (100-Year) Flood Zone
- 0.2% Annual Chance (500-Year) Flood Zone

Flood hazard areas as depicted on Effective FEMA Digital Insurance Rate Maps (DFIRM)

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0 1 2 4

Miles

TETRA TECH

Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, FEMA, ESRI

Table 9-5. Area in the 1-Percent Annual Chance Flood Floodplain

	1-Percent Annual Chance Floodplain	
	Area (acres)	% of total acreage
Dublin	368	3.70
Livermore	922	5.45
Pleasanton	557	3.59
Total	1,847	4.36

Table 9-6. Probability of Future Occurrences of Flood Events

Hazard Type	Number of Occurrences Between 1996 and April 2017	Rate of Occurrence	Recurrence Interval (in years)	% Chance of Occurrence in Any Given Year
Flash Flood	15	0.70	2.5	70%
Flood	18	0.84	2.14	84%
TOTAL	33			Over 100%

Source: NOAA NCEI, 2017a

Smaller floods may occur on a more frequent basis and be categorized under a different hazard event type, most typically severe weather or severe storms. It is estimated that the planning area will experience the direct and indirect impacts of flooding each year, including urban flooding and smaller floods in identified flood-prone areas. These events may induce secondary hazards such as erosion, infrastructure deterioration or failure, utility failures, power outages, water quality and supply concerns, and transportation delays, accidents and inconveniences.

Statistically, a structure within a 1-percent annual chance flood area has a 26-percent chance of suffering flood damage during the term of a 30-year mortgage.

9.2.5 Severity

The principal factors affecting flood damage are flood depth and velocity. The deeper and faster flood flows become, the more damage they can cause. Shallow flooding with high velocities can cause as much damage as deep flooding with slow velocity. This is especially true when a channel migrates over a broad floodplain, redirecting high velocity flows and transporting debris and sediment. Flood severity is often evaluated by examining peak flow; Table 9-7 lists peak flows used by FEMA to map the floodplains of the planning area.

9.2.6 Warning Time

The potential warning time a community has to respond to a flooding threat is a function of the time between the first measurable rainfall and the first occurrence of flooding. The time it takes to recognize a flooding threat reduces the potential warning time for a community that has to take actions to protect lives and property. Another element that characterizes a community's flood threat is the length of time floodwaters remain above flood stage.

Due to the sequential pattern of weather conditions needed to cause serious flooding, it is unusual for a flood to occur without warning. Warning times for floods can be between 24 and 48 hours. Flash flooding can be less predictable, but potential hazard areas can be warned in advanced of potential flash flooding danger. The NWS issues watches and warnings when forecasts indicate rivers may approach bank-full levels.

Table 9-7. Summary of Peak Discharges within the Planning Area

Source/Location	Peak Flow (cubic feet/second)			
	10-Percent Annual Chance	2-Percent Annual Chance	1-Percent Annual Chance	0.2-Percent Annual Chance
ARROYO DE LA LAGUNA				
Downstream of Arroyo Del Valle	7,000	13,500	17,000	28,000
Downstream of Arroyo Mocho	6,000	12,000	15,000	25,000
ARROYO DEL VALLE				
Upstream of Arroyo De La Laguna	1,860	4,150	7,000	9,080
ARROYO LAS POSITAS				
Upstream of confluence with Arroyo Mocho'	1,800	1,800	1,800	1,800
At Gage (USGS No. 11176145)	2,000	4,200	5,000	6,700
ARROYO MOCHO				
Upstream of Arroyo De La Laguna	4,520	11,500	13,700	20,600
Upstream of Chabot Canal	4,450	11,450	13,600	20,300
Upstream of Tassajara Creek	5,300	10,300	12,400	16,700
Downstream of Arroyo Las Positas	5,200	10,200	12,300	16,500
At USGS Gage No. 11176000	2,100	3,800	4,500	5,900
Upstream of Arroyo	1,900	1,900	1,900	1,900
Las Positas Near Garden Circlet	5,000	7,800	9,100[a]	11,900
Upstream of Tassajara Creeks	5,100	7,900	9,200[a]	12,100
CHABOT CANAL				
At confluence with Arroyo Mocho	730	1,260	1,560	2,430
COLLIER CANYON CREEK				
Near North Canyon Parkway	470	990	1,200	1,600
Downstream of Tributary	470	990	1,200	1,600
Upstream of Tributary	390	810	980	1,300
COLLIER CANYON TRIBUTARY	180	410	500	680
HEWLETT CANAL				
At confluence with Chabot Canal	186	331	400	614
LINE B-2-1				
At Interstate Highway 680	830	1,500	1,840	2,850
Upstream of Western Pacific RR	680	1,210	1,500	2,060
Upstream of confluence with Line B-2-3	230	420	520	800
LINE G-3				
At confluence with Arroyo Mocho	540	970	1,190	1,800
LINE J (ZONE 6) (CANADA DEL ALISO)				
At confluence with Line E (Zone 6) (Laguna Creek)	160	380	550	1,000
PLEASANTON CANAL				
At confluence with Arroyo Del La Laguna	280	480	580	850
TASSAJARA CREEK				
At confluence with Arroyo Mocho	1,540	3,200	4,140	6,900

a. Base flood elevations in the improved reach of Arroyo Mocho between Santa Rita and El Charro Roads are based on peak flows of 12,400 cubic feet per second at Santa Rita Road and 12,300 cubic feet per second at Garden Circle. These flows do not reflect overbank losses. The design flow for this reach of Arroyo Mocho is 12,500 cubic feet per second.

Source: FEMA FIS, 2009

The flood extent or severity categories used by the NWS include minor flooding, moderate flooding, and major flooding. Each category has a definition based on property damage and public threat (NWS, 2009a):

- **Minor Flooding**—Minimal or no property damage, but possibly some public threat or inconvenience.
- **Moderate Flooding**—Some inundation of structures and roads near streams. Some evacuations of people and/or transfer of property to higher elevations are necessary.
- **Major Flooding**—Extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations.

9.3 SECONDARY HAZARDS

The most problematic secondary hazard for flooding is bank erosion, which in some cases can be more harmful than actual flooding. This is especially true in the upper courses of rivers with steep gradients, where floodwaters may pass quickly and without much damage, but scour the banks, edging properties closer to the floodplain or causing them to fall in. Flooding is also responsible for hazards such as landslides when high flows over-saturate soils on steep slopes, causing them to fail. Hazardous materials spills are also a secondary hazard of flooding if storage tanks rupture and spill into streams, rivers or storm sewers.

9.4 EXPOSURE

Hazus was used to assess the risk and vulnerability to flooding in the planning area. The model used census data at the block level and FEMA floodplain data, which has a level of accuracy acceptable for planning purposes. Where possible, the Hazus default data was enhanced using local GIS data from local, state and federal sources.

9.4.1 Population

Population counts of those living in the floodplain in the planning area were generated by estimating percent of residential buildings in each jurisdiction within the 10-percent, 1-percent and 0.2-percent annual chance floodplains and multiplying this by total population in the planning area. Table 9-8 shows the results of this analysis.

9.4.2 Property

Structures in the Floodplain

Table 9-9, Table 9-10 and Table 9-11 summarize the total area of the 10-, 1-, and 0.2-percent-annual-chance flood hazard areas and the number of structures in each. The Hazus model determined that there are 300 structures within the 10-percent-annual-chance flood hazard area, 830 structures within the 1-percent-annual-chance flood hazard area, and 8,077 structures within the 0.2-percent-annual-chance flood hazard area. In the 1-percent-annual-chance flood hazard area, about 90 percent are residential, and 9 percent are commercial and industrial.

Exposed Value

Table 9-12, Table 9-13 and Table 9-14 summarize the estimated value of exposed buildings in the planning area. This methodology estimated $717 million worth of building-and-contents exposure to the 10-percent-annual-chance flood, representing 1.3 percent of the total replacement value of the planning area, $1.169 billion worth of exposure to the 1-percent-annual-chance flood, representing 2.2 percent of the total replacement value of the planning area, and $10.2 billion worth of exposure to the 0.2-percent-annual-chance flood, representing 19.1 percent of the total.

Table 9-8. Population Within the 10-Percent, 1-Percent and 0.2-Percent Annual Chance Flood Hazard Areas

	10-Percent Annual Chance Flood Hazard Area		1-Percent Annual Chance Flood Hazard Area		0.2-Percent Annual Chance Flood Hazard Area	
	Population Exposed[a]	% of Total Population	Population Exposed[a]	% of Total Population	Population Exposed[a]	% of Total Population
Dublin	254	0.4%	1,183	2.0%	3,804	6.4%
Livermore	212	0.2%	212	0.2%	5,340	6.0%
Pleasanton	409	0.5%	1,276	1.7%	17,354	22.9%
Total	875	0.4%	2,671	1.2%	26,498	11.8%

a. Represents percent of residential buildings exposed multiplied by estimated January 1, 2017 population from California Department of Finance.

Table 9-9. Area and Structures in the 10-Percent Annual Chance Floodplain

	Area in Floodplain (acres)	Number of Structures in Floodplain							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Dublin	181	69	24	0	1	2	1	0	97
Livermore	839	62	15	0	0	2	1	0	80
Pleasanton	337	116	3	2	0	2	0	0	123
Total	1,357	247	42	2	1	6	2	0	300

Table 9-10. Area and Structures in the 1-Percent Annual Chance Floodplain

	Area in Floodplain (acres)	Number of Structures in Floodplain							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Dublin	368	321	54	1	1	2	1	1	381
Livermore	922	62	15	0	0	2	1	0	80
Pleasanton	557	362	3	2	0	2	0	0	369
Total	1,847	745	72	3	1	6	2	1	830

Table 9-11. Area and Structures in the 0.2-Percent Annual Chance Floodplain

	Area in Floodplain (acres)	Number of Structures in Floodplain							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Dublin	854	1,032	140	6	1	11	1	4	1,195
Livermore	2,088	1,563	60	67	0	7	1	0	1,698
Pleasanton	2,958	4,924	224	18	0	10	2	6	5,184
Total	5,901	7,519	424	91	1	28	4	10	8,077

Table 9-12. Value of Structures in the 10-Percent Annual Chance Floodplain

	Estimated Value within the Floodplain			
	Structure	Contents	Total	% of Total Replacement Value
Dublin	$132,074,724	$125,014,291	$257,089,014	2.1%
Livermore	$176,253,263	$162,236,748	$338,490,011	1.7%
Pleasanton	$68,141,755	$53,967,801	$122,109,556	0.6%
Total	$376,469,741	$341,218,840	$717,688,582	1.3%

Table 9-13. Value of Structures in the 1-Percent Annual Chance Floodplain

	Estimated Value within the Floodplain			
	Structure	Contents	Total	% of Total Replacement Value
Dublin	$319,871,666	$281,906,825	$601,778,490	4.9%
Livermore	$176,253,263	$162,236,748	$338,490,011	1.7%
Pleasanton	$139,691,444	$89,742,646	$229,434,090	1.1%
Total	$635,816,373	$533,886,219	$1,169,702,592	2.2%

Table 9-14. Value of Structures in the 0.2-Percent Annual Chance Floodplain

	Estimated Value within the Floodplain			
	Structure	Contents	Total	% of Total Replacement Value
Dublin	$1,253,666,919	$985,964,915	$2,239,631,834	18.4%
Livermore	$1,005,046,299	$894,841,929	$1,899,888,229	9.3%
Pleasanton	$3,397,453,405	$2,707,341,684	$6,104,795,089	29.0%
Total	$5,656,166,624	$4,588,148,528	$10,244,315,151	19.1%

Land Use in the Floodplain

Some land uses are more vulnerable to flooding, such as single-family homes, while others are less vulnerable, such as agricultural land or parks. Table 9-15 shows the existing land use of all parcels in the 1-percent annual chance and 0.2-percent annual chance floodplain, including those in public/open space uses. About 56 percent of the parcels in the 1-percent annual chance floodplain are zoned for vacant/rights-of-way/water/open space. These are favorable, lower-risk uses for the floodplain. This would be valuable information for gauging the future development potential of the floodplain.

Table 9-15. Land Use Within the Floodplain

	1-Percent Annual Chance Floodplain		0.2-Percent Annual Chance Floodplain	
	Area (acres)	% of total	Area (acres)	% of total
Residential	404	20.7%	1,122	27.6%
Commercial	321	16.4%	972	23.9%
Industrial	7	0.4%	155	3.8%
Agriculture	1	0.0%	0	0.0%
Religion / Assembly	43	2.2%	55	1.4%
Government / Institutional	58	3.0%	68	1.7%
Education	11	0.6%	80	2.0%
Vacant / Rights-of-Way / Water / Open Space	1,106	56.7%	1,620	39.8%
Total	1,950	100.0%	4,070	100.0%

9.4.3 Critical Facilities and Infrastructure

Table 9-16, Table 9-17 and Table 9-18 summarize the critical facilities and infrastructure in the 10-, 1-, and 0.2-percent annual chance flood hazard areas. Details are provided in the following sections.

Table 9-16. Critical Facilities/Infrastructure in the 10-Percent Annual Chance Floodplain

	Medical and Health Services	Emergency Services	Educational Facilities	Government / City Facilities	Utilities	Transportation Infrastructure	Hazardous Materials	Other Assets	Total
Dublin	0	0	0	1	0	10	0	0	11
Livermore	0	0	0	1	1	13	0	0	15
Pleasanton	0	1	0	0	1	20	1	0	23
Total	0	1	0	2	2	43	1	0	49

Table 9-17. Critical Facilities/Infrastructure in the 1-Percent Annual Chance Floodplain

	Medical and Health Services	Emergency Services	Educational Facilities	Government / City Facilities	Utilities	Transportation Infrastructure	Hazardous Materials	Other Assets	Total
Dublin	1	0	0	1	1	12	0	0	15
Livermore	0	0	0	1	1	14	0	0	16
Pleasanton	0	1	0	0	2	21	2	0	26
Total	1	1	0	2	4	47	2	0	57

Table 9-18. Critical Facilities/Infrastructure in the 0.2-Percent Annual Chance Floodplain

	Medical and Health Services	Emergency Services	Educational Facilities	Government / City Facilities	Utilities	Transportation Infrastructure	Hazardous Materials	Other Assets	Total
Dublin	1	2	0	5	1	16	0	0	25
Livermore	2	1	0	1	1	26	4	0	35
Pleasanton	4	3	6	0	19	31	2	0	65
Total	7	6	6	6	21	73	6	0	125

Toxic Release Inventory Facilities

Toxic Release Inventory facilities are known to manufacture, process, store, or otherwise use certain chemicals above minimum thresholds. If damaged by a flood, these facilities could release chemicals that cause cancer or other human health effects, significant adverse acute human health effects, or significant adverse environmental effects (U.S. Environmental Protection Agency, 2015). Two businesses in the 1-percent annual chance floodplain and six businesses in the 0.2-percent annual chance floodplain report having Toxic Release Inventory hazardous materials. During a flood event, containers holding these materials can rupture and leak into the surrounding area, having a disastrous effect on the environment as well as residents.

Utilities and Infrastructure

Roads or railroads that are blocked or damaged can isolate residents and can prevent access throughout the planning area, including for emergency service providers needing to get to vulnerable populations or to make repairs. Bridges washed out or blocked by floods or debris also can cause isolation. Water and sewer systems can be flooded or backed up, causing health problems. Underground utilities can be damaged. Dikes can fail or be overtopped, inundating the land that they protect. The following sections describe specific types of critical infrastructure.

Roads

The following major roads in the planning area pass through the 1-percent annual chance floodplain:

- Interstate 580
- Interstate 680

- State Highway 84 / Isabel Ave (Livermore)
- West Las Positas Blvd (Pleasanton)
- East Stanley Blvd (Livermore)
- Santa Rita Road (Pleasanton)
- 1st Street (Pleasanton)
- First Street (Livermore)
- Hopyard Road (Pleasanton)
- Murietta Blvd (Livermore)
- Livermore Ave (Livermore)
- Holmes Street (Livermore)
- P Street (Livermore)
- East Avenue (Livermore)
- Vasco Road (Livermore)
- Jack Londond Blvd (Livermore)

Some of these roads are built above the flood level, and others function as levees to prevent flooding. Still, in severe flood events these roads can be blocked or damaged, preventing access to some areas.

Bridges

Flooding events can significantly impact road bridges. These are important because often they provide the only ingress and egress to some neighborhoods. An analysis showed that there are 73 bridges that are in or cross over the 1-percent annual chance and 0.2-percent annual chance floodplain.

Water and Sewer Infrastructure

Water and sewer systems can be affected by flooding. Floodwaters can back up drainage systems, causing localized flooding. Culverts can be blocked by debris from flood events, also causing localized urban flooding. Floodwaters can get into drinking water supplies, causing contamination. Sewer systems can be backed up, causing wastewater to spill into homes, neighborhoods, rivers and streams.

9.4.4 Environment

Flooding is a natural event, and floodplains provide many natural and beneficial functions. Nonetheless, flooding can impact the environment in negative ways. Migrating fish can wash into roads or over dikes into flooded fields, with no possibility of escape. Pollution from roads, such as oil, and hazardous materials can wash into rivers and streams. During floods, these can settle onto normally dry soils, polluting them for agricultural uses. Human development such as bridge abutments and levees, and logjams from timber harvesting can increase stream bank erosion, causing rivers and streams to migrate into non-natural courses.

9.5 VULNERABILITY

Many of the areas exposed to flooding may not experience serious flooding or flood damage. This section describes vulnerabilities in terms of population, property, infrastructure and environment.

9.5.1 Population

Estimated Impacts on Persons and Households

Impacts on persons and households in the planning area were estimated for the 10-, 1-, and 2-percent annual chance flood events through a Hazus analysis. Table 9-19 summarizes the results.

Table 9-19. Estimated Flood Impact on Persons and Households

	Displaced Population[a]	People Requiring Short-Term Shelter[a]
10-Percent Annual Chance Flood	109	79
1-Percent Annual Chance Flood	386	309
0.2-Percent Annual Chance Flood	11,531	10,770

a. Calculated using a Census-block level, general building stock analysis in Hazus, adjusted to reflect the estimated population.

Public Health and Safety

Floods and their aftermath present numerous threats to public health and safety:

- **Unsafe food**—Floodwaters contain disease-causing bacteria, dirt, oil, human and animal waste, and farm and industrial chemicals. Their contact with food items, including food crops in agricultural lands, can make that food unsafe to eat. Refrigerated and frozen foods are affected during power outages caused by flooding. Foods in cardboard, plastic bags, jars, bottles, and paper packaging may be unhygienic with mold contamination.
- **Contaminated drinking and washing water and poor sanitation**—Flooding impairs clean water sources with pollutants. The pollutants also saturate into the groundwater. Flooded wastewater treatment plants can be overloaded, resulting in backflows of raw sewage. Private wells can be contaminated by floodwaters. Private sewage disposal systems can become a cause of infection if they or overflow.
- **Mosquitoes and animals**—Floods provide new breeding grounds for mosquitoes in wet areas and stagnant pools. The public should dispose of dead animals that can carry viruses and diseases only in accordance with guidelines issued by local animal control authorities. Leptospirosis—a bacterial disease associated predominantly with rats—often accompanies floods in developing countries, although the risk is low in industrialized regions unless cuts or wounds have direct contact with disease-contaminated floodwaters or animals.
- **Mold and mildew**—Excessive exposure to mold and mildew can cause flood victims—especially those with allergies and asthma—to contract upper respiratory diseases, triggering cold-like symptoms. Molds grow in as short a period as 24 to 48 hours in wet and damp areas of buildings and homes that have not been cleaned after flooding, such as water-infiltrated walls, floors, carpets, toilets and bathrooms. Very small mold spores can be easily inhaled by human bodies and, in large enough quantities, cause allergic reactions, asthma episodes, and other respiratory problems. Infants, children, elderly people and pregnant women are considered most vulnerable to mold-induced health problems.
- **Carbon monoxide poisoning**—In the event of power outages following floods, some people use alternative fuels for heating or cooking in enclosed or partly enclosed spaces, such as small gasoline engines, stoves, generators, lanterns, gas ranges, charcoal or wood. Built-up carbon monoxide from these sources can poison people and animals.
- **Hazards when reentering and cleaning flooded homes and buildings**—Flooded buildings can pose significant health hazards to people entering them. Electrical power systems can become hazardous. Gas leaks can trigger fire and explosion. Flood debris—such as broken bottles, wood, stones and walls—may cause injuries to those cleaning damaged buildings. Containers of hazardous chemicals may be buried under flood debris. Hazardous dust and mold can circulate through a building and be inhaled by those engaged in cleanup and restoration.
- **Mental stress and fatigue**—People who live through a devastating flood can experience long-term psychological impact. The expense and effort required to repair flood-damaged homes places severe financial and psychological burdens on the people affected. Post-flood recovery can cause, anxiety, anger, depression, lethargy, hyperactivity, and sleeplessness. There is also a long-term concern among the affected that their homes can be flooded again in the future.

Current loss estimation models such as Hazus are not equipped to measure public health impacts such as these. The best preparation for these effects includes awareness that they can occur, education of the public on prevention, and planning to deal with them during responses to flood events.

9.5.2 Property

Structures and Contents

Hazus calculates losses to structures from flooding by looking at depth of flooding and type of structure. Impacted structures are those with finished floor elevations below the flood event water surface elevation. These structures are the most likely to receive significant damage in a flood event. Using historical flood insurance claim data, Hazus estimates the percentage of damage to structures and their contents by applying established damage functions to an inventory. For this analysis, local data on facilities was used instead of the default inventory data provided with Hazus. The analysis is summarized in Table 9-20, Table 9-21, and Table 9-22 for the 10-, 1-, and 0.2-percent-annual-chance flood events, respectively.

Table 9-20. Loss Estimates for 10-Percent Annual Chance Floodplain

	Buildings Impacted	Estimated Loss Associated with Flood			% of Total Replacement Value
		Structure	Contents	Total	
Dublin	32	$590,797	$2,169,503	$2,760,300	0.02%
Livermore	9	$1,869,180	$5,121,677	$6,990,857	0.03%
Pleasanton	4	$101,385	$292,115	$393,500	0.002%
Total	45	$2,561,361	$7,583,295	$10,144,656	0.02%

Note: Values shown are accurate for comparison of results in this plan. See Section 5.5 for discussion of data limitations.

Table 9-21. Loss Estimates for 1-percent Annual Chance Flood

	Buildings Impacted	Estimated Loss Associated with Flood			% of Total Replacement Value
		Structure	Contents	Total	
Dublin	103	$2,918,583	$4,516,967	$7,435,549	0.06%
Livermore	9	$1,869,180	$5,121,677	$6,990,857	0.03%
Pleasanton	202	$5,563,985	$2,250,544	$7,814,529	0.04%
Total	314	$10,351,747	$11,889,188	$22,240,935	0.04%

Note: Values shown are accurate for comparison of results in this plan. See Section 5.5 for discussion of data limitations.

Table 9-22. Loss Estimates for 0.2-percent Annual Chance Flood

	Buildings Impacted	Estimated Loss Associated with Flood			% of Total Replacement Value
		Structure	Contents	Total	
Dublin	381	$219,729,360	$284,954,257	$504,683,618	4.1%
Livermore	80	$95,941,930	$205,932,827	$301,874,756	1.5%
Pleasanton	369	$167,384,587	$200,293,920	$367,678,508	1.7%
Total	830	$483,055,877	$691,181,005	$1,174,236,882	2.2%

Note: Values shown are accurate for comparison of results in this plan. See Section 5.5 for discussion of data limitations.

Key results are as follows:

- There would be up to $10 million of flood loss from a 10-percent-annual-chance flood event in the planning area. This represents 1.4 percent of the total exposure to that level of flood and less than 0.1 percent of the total replacement value for the planning area.
- There would be up to $22 million of flood loss from a 1-percent-annual-chance flood event in the planning area. This represents 1.9 percent of the total exposure to that level of flood and less than 0.1 percent of the total replacement value for the planning area.
- There would be $1.2 billion of flood loss from a 0.2-percent-annual-chance flood event in the planning area. This represents 11.5 percent of the total exposure to that level of flood and 2.2 percent of the total replacement value.

Flood-Caused Debris

The Hazus analysis estimated the amount of flood-caused debris within the planning area generated by flooding, as summarized in Table 9-23.

Table 9-23. Estimated Flood-Caused Debris

Jurisdiction	10% Annual-Chance Flood		1% Annual-Chance Flood		0.2% Annual-Chance Flood	
	Debris to Be Removed (tons)[a]	Estimated Number of Truckloads[b]	Debris to Be Removed (tons)[a]	Estimated Number of Truckloads[b]	Debris to Be Removed (tons)[a]	Estimated Number of Truckloads[b]
Dublin	87	3	539	22	15,997	640
Livermore	538	22	538	22	11,914	477
Pleasanton	133	5	6,722	269	26,476	1,059
Total	758	30	7,799	312	54,387	2,175

a. Debris generation estimates were based on updated general building stock dataset at a Census Block analysis level.
b. Hazus assumes 25 tons/trucks.
Note: Values shown are accurate for comparison of results in this plan. See Section 5.5 for discussion of data limitations.

National Flood Insurance Program

Table 9-24 lists flood insurance statistics that help identify vulnerability in the planning area. Dublin, Livermore and Pleasanton participate in the NFIP, with a combined 368 flood insurance policies providing $125.7 million in insurance coverage. According to FEMA statistics, only 8 flood insurance claims were paid between January 1, 1978 and March 31, 2017, for a total of $154 thousand, an average of $19,250 per claim.

Table 9-24. Flood Insurance Statistics

	Date of Entry Initial FIRM Effective Date	# of Flood Insurance Policies as of 3/31/2017	Insurance In Force	Total Annual Premium	Claims Closed 11/1978 to 3/31/2017	
					Number	Value
Dublin	08/18/1983	121	$39,537,400	$210,497	0	0
Livermore	07/05/1977	107	$35,273,900	$104,078	0	0
Pleasanton	12/16/1980	140	$50,932,000	$104,558	8	$154,583.37
Total		368	$125,743,300	$419,133	8	$154,583.37

Repetitive Loss

A repetitive loss property is defined by FEMA as an NFIP-insured property that has experienced any of the following since 1978, regardless of any changes in ownership:

- Four or more paid losses in excess of $1,000

- Two paid losses in excess of $1,000 within any rolling 10-year period
- Three or more paid losses that equal or exceed the current value of the insured property.

Repetitive loss properties make up only 2 percent of flood insurance policies in force nationally, yet they account for 40 percent of the nation's flood insurance claim payments. A report on repetitive losses by the National Wildlife Federation found that 20 percent of these properties are outside any mapped 1-percent annual chance floodplain.

The government has instituted programs encouraging communities to identify and mitigate the causes of repetitive losses. FEMA-sponsored programs, such as the CRS, require participating communities to identify repetitive loss areas. The key identifiers for repetitive loss properties are the existence of flood insurance policies and claims paid by the policies. A repetitive loss area is the portion of a floodplain holding structures that FEMA has identified as meeting the definition of repetitive loss. Identifying repetitive loss areas helps to identify structures that are at risk but are not on FEMA's list of repetitive loss structures because no flood insurance policy was in force at the time of loss.

Based on information provided by FEMA Region IX, there are no repetitive loss structures within the city limits of Dublin, Livermore, or Pleasanton as of July 2017.

9.5.3 Critical Facilities and Infrastructure

Hazus was used to estimate the flood loss potential to critical facilities exposed to the flood risk. Using depth/damage function curves to estimate the percent of damage to the building and contents of critical facilities, Hazus correlates these estimates into an estimate of functional down-time (the estimated time it will take to restore a facility to 100 percent of its functionality). This helps to gauge how long the planning area could have limited usage of facilities deemed critical to flood response and recovery. The Hazus critical facility results for 10-, 1-, and 0.2-percent-annual-chance flood events are as follows (see: Table 9-25, Table 9-26, and Table 9-27).

- **10-percent annual chance flood event**—12 facilities would be affected and on average the facilities would receive 4.12 percent damage to the structure and 27.03 percent damage to the contents.
- **1-percent annual chance flood event**—21 facilities would be affected an on average, critical facilities would receive 7.33-percent damage to the structure and 27.78-percent damage to the contents during a 1-percent annual chance flood event.
- **0.2-percent annual chance flood event**—66 facilities would be affected an on average, critical facilities would receive 15.18-percent damage to the structure and 39.94-percent damage to the contents during a 1 percent annual chance flood event..

Table 9-25. Estimated Damage to Critical Facilities and Infrastructure from 10-Percent-Annual-Chance Flood

Types of Critical Facilities and Infrastructure	Number of Facilities Affected	Average % of Total Value Damaged	
		Structure	Content
Medical and Health Services	0	N/A	N/A
Emergency Services	0	N/A	N/A
Educational Facilities	0	N/A	N/A
Government / City Facilities	1	3.86	23.16
Utilities	1	11.26	57.35
Transportation Infrastructure	9	0.03	N/A
Hazardous Materials	1	1.35	0.58
Total/Average	12	4.12	27.03

Table 9-26. Estimated Damage to Critical Facilities and Infrastructure from 1-Percent-Annual-Chance Flood

Types of Critical Facilities and Infrastructure	Number of Facilities Affected	Average % of Total Value Damaged	
		Structure	Content
Medical and Health Services	0	N/A	N/A
Emergency Services	0	N/A	N/A
Educational Facilities	0	N/A	N/A
Government / City Facilities	1	4.24	25.44
Utilities	3	23.20	57.17
Transportation Infrastructure	16	0.43	N/A
Hazardous Materials	1	1.43	0.72
Total/Average	21	7.33	27.78

Table 9-27. Estimated Damage to Critical Facilities and Infrastructure from 0.2-Percent-Annual-Chance Flood

Types of Critical Facilities and Infrastructure	Number of Facilities Affected	Average % of Total Value Damaged	
		Structure	Content
Medical and Health Services	1	22.53	15.06
Emergency Services	1	5.21	5.96
Educational Facilities	3	11.39	57.56
Government / City Facilities	4	11.82	71.03
Utilities	7	28.79	52.95
Transportation Infrastructure	47	0.82	N/A
Hazardous Materials	3	25.67	37.07
Total/Average	66	15.18	39.94

9.5.4 Environment

The environment vulnerable to flood hazard is the same as the environment exposed to the hazard. Loss estimation platforms such as Hazus are not currently equipped to measure environmental impacts of flood hazards. The best gauge of vulnerability of the environment would be a review of damage from past flood events. Loss data that segregates damage to the environment was not available at the time of this plan. Capturing this data from future events could be beneficial in measuring the vulnerability of the environment for future updates.

While the vulnerability assessment focuses on human vulnerability to flood events, the impact of human activities on flooding is also worth noting. Due to negative impacts of floods, many structural and other measures have been devised to limit how far a floodplain can extend. However, floodplains have many natural and beneficial functions, and disruption of natural systems can have long-term consequences for entire regions. Some well-known, water-related functions of floodplains (noted by FEMA) include:

- Natural flood and erosion control
- Provide flood storage and conveyance
- Reduce flood velocities
- Reduce flood peaks
- Reduce sedimentation
- Surface water quality maintenance
- Filter nutrients and impurities from runoff
- Process organic wastes
- Moderate temperatures of water
- Groundwater recharge
- Promote infiltration and aquifer recharge
- Reduce frequency and duration of low surface flows.

Areas in the floodplain that typically provide these natural functions are wetlands, riparian areas, sensitive areas, and habitats for rare and endangered species.

9.6 FUTURE TRENDS IN DEVELOPMENT

The planning partners are equipped to handle future growth within flood hazard areas. All three cities have general plans that address frequently flooded areas in their safety elements and have committed to linking their general plans to this hazard mitigation plan. This will create an opportunity for wise land use decisions as future growth impacts flood hazard areas. Additionally, the three cities participant in the NFIP and have adopted flood damage prevention ordinances in response to its requirements. They have committed to maintaining their good standing under the NFIP through actions identified in this plan. Table 9-28 shows the future land use within the 1-percent and 0.2-percent annual chance floodplain.

Table 9-28. Future Land Use Within the Floodplain

	1-Percent Annual Chance Floodplain		0.2-Percent Annual Chance Floodplain	
	Area (acres)	% of total	Area (acres)	% of total
Residential	251	12.9%	1,429	35.1%
Commercial	170	8.7%	581	14.3%
Industrial	145	7.5%	274	6.7%
Agriculture	16	0.8%	3	0.1%
Religion / Assembly	88	4.5%	454	11.2%
Government / Institutional	62	3.2%	510	12.5%
Education	1,217	62.4%	818	20.1%
Vacant / Rights-of-Way / Water / Open Space	1,950	100.0%	4,070	100.0%
Total	251	12.9%	1,429	35.1%

9.7 SCENARIO

The primary water courses in the planning area have the potential to flood at irregular intervals, generally in response to a succession of intense winter rainstorms. Storm patterns of warm, moist air usually occur between early November and late March. A series of such weather events can cause severe flooding in the planning area. The worst-case scenario is a series of storms that flood numerous drainage basins in a short time. This could overwhelm the response and floodplain management capability within the planning area. Major roads could be blocked, preventing critical access for many residents and critical functions. High in-channel flows could cause water courses to scour, possibly washing out roads and creating more isolation problems.

9.8 ISSUES

The planning team has identified the following flood-related issues relevant to the planning area:

- The accuracy of the existing flood hazard mapping produced by FEMA in reflecting the true flood risk within the planning area is questionable. This is most prevalent in areas protected by privately owned levees and levees not accredited by the FEMA mapping process.
- The extent of the flood-protection currently provided by flood control facilities (dams, dikes and levees) is not known due to the lack of an established national policy on flood protection standards.
- Older levees are subject to failure or do not meet current building practices for flood protection.

- The risk associated with the flood hazard overlaps the risk associated with other hazards such as earthquake, landslide and wildfire. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.
- More information is needed on flood risk to support the concept of risk-based analysis of capital projects.
- There needs to be a sustained effort to gather historical damage data, such as high water marks on structures and damage reports, to measure the cost-effectiveness of future mitigation projects.
- Ongoing flood hazard mitigation will require funding from multiple sources.
- There needs to be a coordinated hazard mitigation effort between jurisdictions affected by flood hazards within and outside of the planning area.
- Floodplain residents need to continue to be educated about flood preparedness and the resources available during and after floods.
- The concept of residual risk should be considered in the design of future capital flood control projects and should be communicated with residents living in the floodplain.
- The promotion of flood insurance as a means of protecting private property owners from the economic impacts of frequent flood events should continue.
- Existing floodplain-compatible uses such as agricultural and open space need to be maintained. There is constant pressure to convert these existing uses to more intense uses within the planning area during times of moderate to high growth.

10. LANDSLIDE

10.1 GENERAL BACKGROUND

Landslides and mudslides can be initiated by storms, earthquakes, fires, volcanic eruptions or human modification of the land. They can move rapidly down slopes or through channels, and can strike with little or no warning at avalanche speeds.

According to the USGS, the term landslide includes a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over-steepened slope is the primary reason for a landslide, there are other contributing factors. Landslide hazard areas exist where characteristics such as the following indicate a risk of downhill movement of material (USGS, 2017c):

- A slope greater than 33 percent
- A history of landslide activity during the last 10,000 years
- Stream or wave activity that has caused erosion or cut into a bank to cause the surrounding land to be unstable
- The presence or potential for snow avalanches
- The presence of an alluvial fan, which indicates vulnerability to the flow of debris or sediments
- The presence of impermeable soils, such as silt or clay, mixed with granular soils such as sand and gravel.

DEFINITIONS

Landslide—The movement of masses of loosened rock and soil down a hillside or slope. Slope failures occur when the strength of the soils forming the slope is exceeded by the pressure, such as weight or saturation, acting upon them.

Mass movement—A collective term for landslides, debris flows, falls and sinkholes.

Mudslide (or debris flow)—A river of rock, earth, organic matter and other materials saturated with water. Mudslides develop in the soil overlying bedrock on sloping surfaces when water rapidly accumulates in the ground, such as during heavy rainfall or rapid snowmelt. Water pressure in the pore spaces of the material increases to the point that the internal strength of the soil is drastically weakened. The soil's reduced resistance can then easily be overcome by gravity, changing the earth into a flowing river of mud or "slurry."

USGS scientists also monitor stream flow, noting changes in sediment load in rivers and streams that may result from landslides. All of these types of landslides are considered aggregately in USGS landslide mapping.

10.1.1 Landslide Types

Landslides are commonly categorized by the type of initial ground failure. Common types of slides are shown on Figure 10-1 through Figure 10-4 (WDOE, 2014). The most common is the shallow colluvial slide, occurring particularly in response to intense, short-duration storms. The largest and most destructive are deep-seated slides, although they are less common than other types.

Mudslides (or debris flows) are rivers of rock, earth, organic matter and other soil materials saturated with water. They develop in the soil overlying bedrock on sloping surfaces when water rapidly accumulates in the ground, such as during heavy rainfall or rapid snowmelt. Water pressure in the pore spaces of the material increases to the point that the internal strength of the soil is drastically weakened. The soil's reduced resistance can then easily be overcome by gravity, changing the earth into a flowing river of mud.

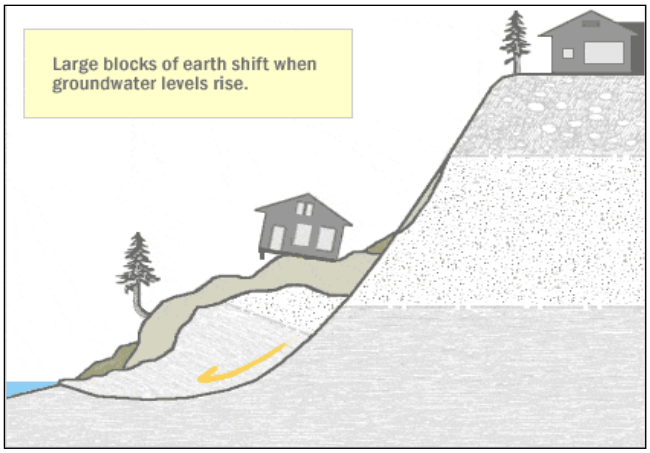


Figure 10-1. Deep Seated Slide

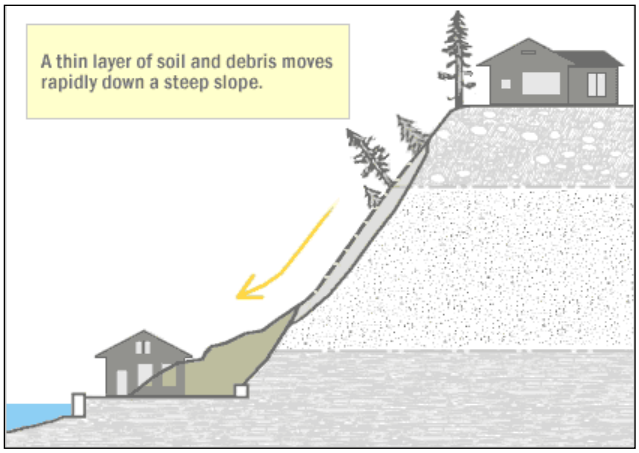


Figure 10-2. Shallow Colluvial Slide

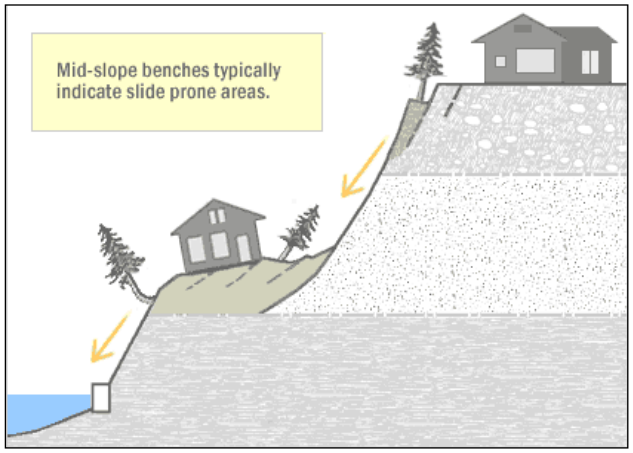


Figure 10-3. Bench Slide

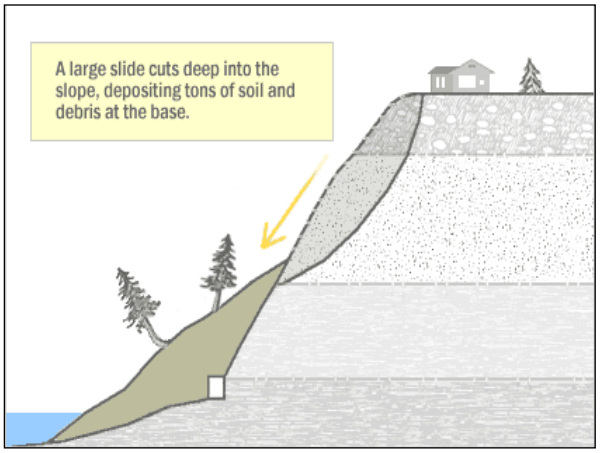


Figure 10-4. Large Slide

A debris avalanche (Figure 10-5) is a fast-moving debris flow that travels faster than about 10 miles per hour (mph). Speeds in excess of 20 mph are not uncommon, and speeds in excess of 100 mph, although rare, can occur. The slurry can travel miles from its source, growing as it descends, picking up trees, boulders, cars, and anything else in its path. Although these slides behave as fluids, they pack many times the hydraulic force of water due to the mass of material included in them. They can be among the most destructive events in nature.

Landslides also include the following:

- Rock Falls—blocks of rock that fall away from a bedrock unit without a rotational component
- Rock Topples—blocks of rock that fall away from a bedrock unit with a rotational component
- Rotational Slumps—blocks of fine-grained sediment that rotate and move down slope
- Transitional Slides—sediments that move along a flat surface without a rotational component
- Earth Flows—fine-grained sediments that flow downhill and typically form a fan structure
- Creep—a slow-moving landslide often only noticed through crooked trees and disturbed structures
- Block Slides—blocks of rock that slide along a slip plane as a unit down a slope.

Source: (Smith, n.d.)

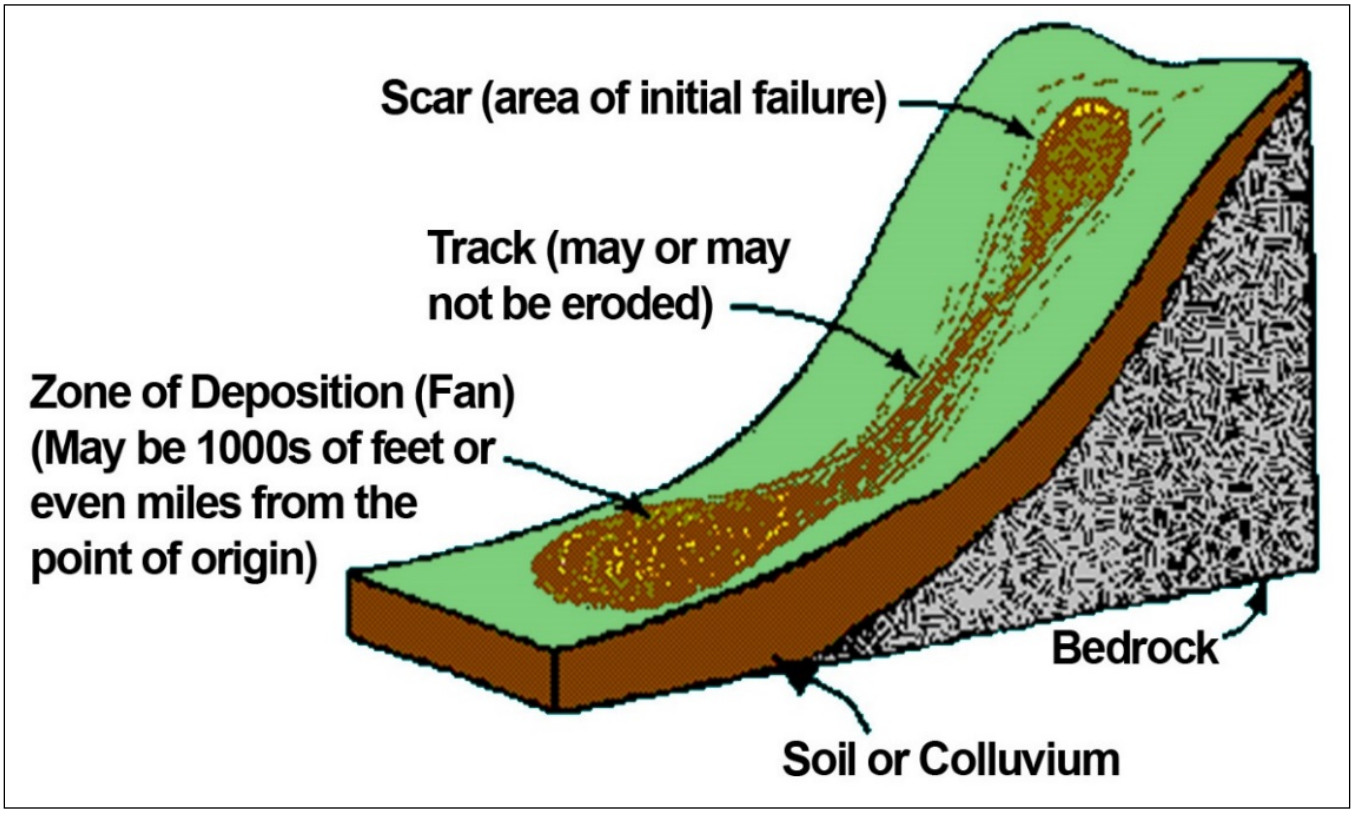


Figure 10-5. Typical Debris Avalanche Scar and Track

10.1.2 Landslide Modeling

Two characteristics are essential to conducting an accurate risk assessment of the landslide hazard:

- The type of initial ground failure that occurs, as described above
- The post-failure movement of the loosened material ("run-out"), including travel distance and velocity.

All current landslide models—those in practical applications and those more recently developed—use simplified hypothetical descriptions of mass movement to simulate the complex behavior of actual flow. The models attempt to reproduce the general features of the moving mass of material through measurable factors, such as base shear, that define a system and determine its behavior. Due to the lack of experimental data and the limited current knowledge about the behavior of the moving flows, landslide models use simplified parameters to account for complex aspects that may not be defined. These simplified parameters are not related to specific physical processes that can be directly measured, and there is a great deal of uncertainty in their definition. Some, but not all, models provide estimates of the level of uncertainty associated with the modeling approach.

Run-out modeling is complicated because the movement of materials may change over the course of a landslide event, depending on the initial composition, the extent of saturation by water, the ground shape of the path traveled and whether there is additional material incorporated during the event.

10.1.3 Landslide Causes

Mass movements are caused by a combination of geological and climate conditions, as well as encroaching urbanization. Vulnerable natural conditions are affected by human residential, agricultural, commercial and industrial development and the infrastructure that supports it. The following factors can contribute to landslide:

- Change in slope of the terrain
- Increased load on the land, shocks and vibrations
- Change in water content
- Groundwater movement
- Frost action
- Weathering of rocks
- Removing or changing the type of vegetation covering slopes.

Excavation and Grading

Slope excavation is common in the development of home sites or roads on sloping terrain. Grading can result in some slopes that are steeper than the pre-existing natural slopes. Since slope steepness is a major factor in landslides, these steeper slopes can be at an increased risk for landslides. The added weight of fill placed on slopes can also result in an increased landslide hazard. Small landslides can be fairly common along roads, in either the road cut or the road fill. Landslides occurring below new construction sites are indicators of the potential impacts stemming from excavation.

Drainage and Groundwater Alterations

Water flowing through or above ground is often the trigger for landslides. Any activity that increases the amount of water flowing into landslide-prone slopes can increase landslide hazards. Broken or leaking water or sewer lines can be especially problematic, as can water retention facilities that direct water onto slopes. However, even lawn irrigation and minor alterations to small streams in landslide prone locations can result in damaging landslides. Ineffective stormwater management and excess runoff can also cause erosion and increase the risk of landslide hazards. Drainage can be affected naturally by the geology and topography of an area. Development that results in an increase in impervious surface impairs the ability of the land to absorb water and may redirect water to other areas. Channels, streams, flooding, and erosion on slopes all indicate potential slope problems.

Road and driveway drains, gutters, downspouts, and other constructed drainage facilities can concentrate and accelerate flow. Ground saturation and concentrated velocity flow are major causes of slope problems and may trigger landslides.

Changes in Vegetation

Removing vegetation from very steep slopes can increase landslide hazards. Areas that have experienced wildfire and land clearing for development may have long periods of increased landslide hazard. In addition, woody debris in stream channels (both natural and man-made from logging) may cause the impacts from debris flows to be more severe.

10.1.4 Landslide Management

While small landslides are often a result of human activity, the largest landslides are often naturally occurring phenomena with little or no human contribution. The sites of large landslides are typically areas of previous landslide movement that are periodically reactivated by significant precipitation or seismic events. Such naturally occurring landslides can disrupt roadways and other infrastructure lifelines, destroy private property, and cause flooding, stream bank erosion and rapid stream channel migration.

Landslides can create immediate, critical threats to public safety. Engineering solutions to protect structures on or adjacent to large active landslides are often extremely or prohibitively expensive. In spite of their destructive potential, landslides can serve beneficial functions to the natural environment. They supply sediment and large wood to stream channel networks and can contribute to stream complexity and dynamic channel behavior critical for aquatic and riparian ecological diversity. Effective landslide management should include the following elements:

- Continuing investigation to identify natural landslides, understand their mechanics, assess their risk to public health and welfare, and understand their role in ecological systems
- Regulation of development in or near existing landslides or areas of natural instability through the cities' codes and ordinances and Alameda County code.
- Preparation for emergency response to landslides to facilitate rapid, coordinated action among Alameda County, the planning area, and state and federal agencies, and to provide emergency assistance to affected or at-risk citizens
- Evaluation of options including landslide stabilization or structure relocation where landslides are identified as a threat to critical public structures or infrastructure

10.2 HAZARD PROFILE

10.2.1 Past Events

Landslides in the Bay Area typically occur either as a result of an earthquake or during heavy and sustained rainfall events. Urbanized areas, like the Cities of Dublin, Livermore and Pleasanton, and especially hilly areas of Alameda County, have sustained damage from landslides caused by storms. Between 1980 and April 2017, FEMA issued disaster (DR) declarations for the State of California for 10 landslide hazard-related events, classified as one or a combination of the following events: severe winter storms, flooding, debris flow, mud flows, landslides and mudslides, as listed in Table 10-1.

Table 10-1. FEMA Landslide Disaster Declarations in Alameda County

FEMA Declaration	Event Date	Event Type	Location
DR-4308	February 1 – February 23, 2017	Severe Winter Storms, Flooding, Mudslides	43 counties including Alameda County
DR-4305	January 18 – January 23, 2017	Severe Winter Storms, Flooding, Mudslides	23 counties including Alameda County
DR-4301	January 3 – January 12, 2017	Severe Winter Storms, Flooding, Mudslides	34 counties including Alameda County
DR-1646	March 29 – April 16, 2006	Severe Storms, Flooding, Landslides, and Mudslides	17 counties including Alameda County
DR-1628	December 17 – January 3, 2006	Severe Storms, Flooding, Mudslides, and Landslides	31 counties including Alameda County
DR-1155	December 28, 1996 – April 1, 1997	Severe Storms, Flooding, Mud and Landslides	48 counties including Alameda County
DR-1046	February 13 – April 19, 1995	Severe Winter Storms, Flooding, Landslides, Mudslides	57 counties including Alameda County
DR-1044	January 3 – February 10, 1995	Severe Winter Storms, Flooding, Landslides, Mudslides	42 counties including Alameda County
DR-677	January 21 – March 30, 1983	Coastal Storms, Floods, Slides & Tornadoes	40 counties including Alameda County
DR-651	December 19, 1981 – January 8, 1983	Severe Storms, Flood, Mudslides & High Tide	10 counties including Alameda County

Source: FEMA, 2017e

Little recorded information is available regarding previous landslide occurrences in the Cities of Dublin, Livermore and Pleasanton. Table 10-2 lists known landslide events that have impacted the planning area between 1980 and April 2017.

Table 10-2. Landslide Events in the Tri-Valley Planning Area

Event Date	Event Type	FEMA Declaration Number	Location	Description
March 8, 2017	Landslide	N/A	Pleasanton	The backyards of three homes along Foothill Road slid/eroded into Arroyo De La Laguna Creek in Pleasanton.
February 20, 2017	Slide	DR-4308	Livermore	Slide blocked at least one land east bound 84 just west of Vallecitos and Tesla Road closed from mudslide in Livermore.
January 19, 2017	Mudslides	DR-4305	Tri-Valley area/ unincorporated county	Mudslide debris covered Palomares Road, Tesla Road, Mines Road, and Old Altamont Pass Road.
November 2, 2015	Mudslide	N/A	Livermore/ unincorporated county	Heavy rain caused mudslide on Patterson Pass Road, Tesla Road and Corall Hollow Road, east of Livermore
April 6-20, 2006	Heavy Rain and Debris Flows	DR-1646	Alameda County	Heavy rains caused landslides, eroding hillsides and cracked pavement. Landslide or erosion problems on private properties spilled over onto county rights-of-way. Overall, the County had approximately $10 million in damage to county roadways.
December 17, 2005 – January 12, 2006	Winter Storms	DR-1628	Alameda County	Severe storms brought flooding, mudslides, and landslides to most of Alameda County.
February 1995	Late Winter Storms (Severe Winter Storms, Flood, Landslide, Mudflows)	DR-1046	Statewide	All California counties except Del Norte were included in this declaration. In total, the state recorded 17 deaths; $190.6 million in public property damage, $122.4 million in individual damage, $46.9 million in business damage, $79 million in highway damage, and $651.6 million in agricultural damage; with 1,322 homes recording major damage, 267 listed as destroyed, and 2,299 recording minor damage.

Sources: NOAA NCEI, 2017b; FEMA, 2017e; Alameda County Local Hazard Mitigation Plan, 2016b

10.2.2 Location

The best available predictor of where movement of slides and earth flows might occur is the location of past movements. Past landslides can be recognized by their distinctive topographic shapes, which can remain in place for thousands of years. Most landslides recognizable in this fashion range from a few acres to several square miles. Most show no evidence of recent movement and are not currently active. A small proportion of them may become active in any given year, with movements concentrated within all or part of the landslide masses or around their edges.

The recognition of ancient dormant mass movement sites is important in the identification of areas susceptible to flows and slides because they can be reactivated by earthquakes or by exceptionally wet weather. Also, because they consist of broken materials and frequently involve disruption of groundwater flow, these dormant sites are vulnerable to construction-triggered sliding.

In 2011, the California Geological Survey conducted a statewide analysis of landslide susceptibility using a combination of regional rock strength and slope data to create classes of susceptibility. The methodology used for the analysis assumed, in general, that landslide susceptibility is low on very low slopes in all rock materials, and that susceptibility increases with slope and in weak rocks. The analysis also factored in locations of past landslides. Figure 10-6 shows the susceptibility classes—low, moderate, high, and very high/existing landslide—in the planning area. Most of the planning area is shown as having low susceptibility, though portions of all the cities' boundaries are shown as having moderate to high susceptibility. The City of Pleasanton has very high susceptibility near its western boundary.

10.2.3 Frequency

Landslides are often triggered by other natural hazards such as earthquakes, heavy rain, floods or wildfires, so landslide frequency is often related to the frequency of these other hazards. In the planning area, landslides typically occur during and after major storms, so the potential for landslides largely coincides with the potential for sequential severe storms that saturate steep, vulnerable soils. As shown in Figure 10-6, the Cities of Dublin and Livermore have a range of low to high susceptibility to deep-seated landslides; therefore, the frequency of landslide events in these areas is considered moderate to high. The western portion of Pleasanton has a high to very high susceptibility to deep-seated landslides; therefore having a high frequency of landslide occurrence.

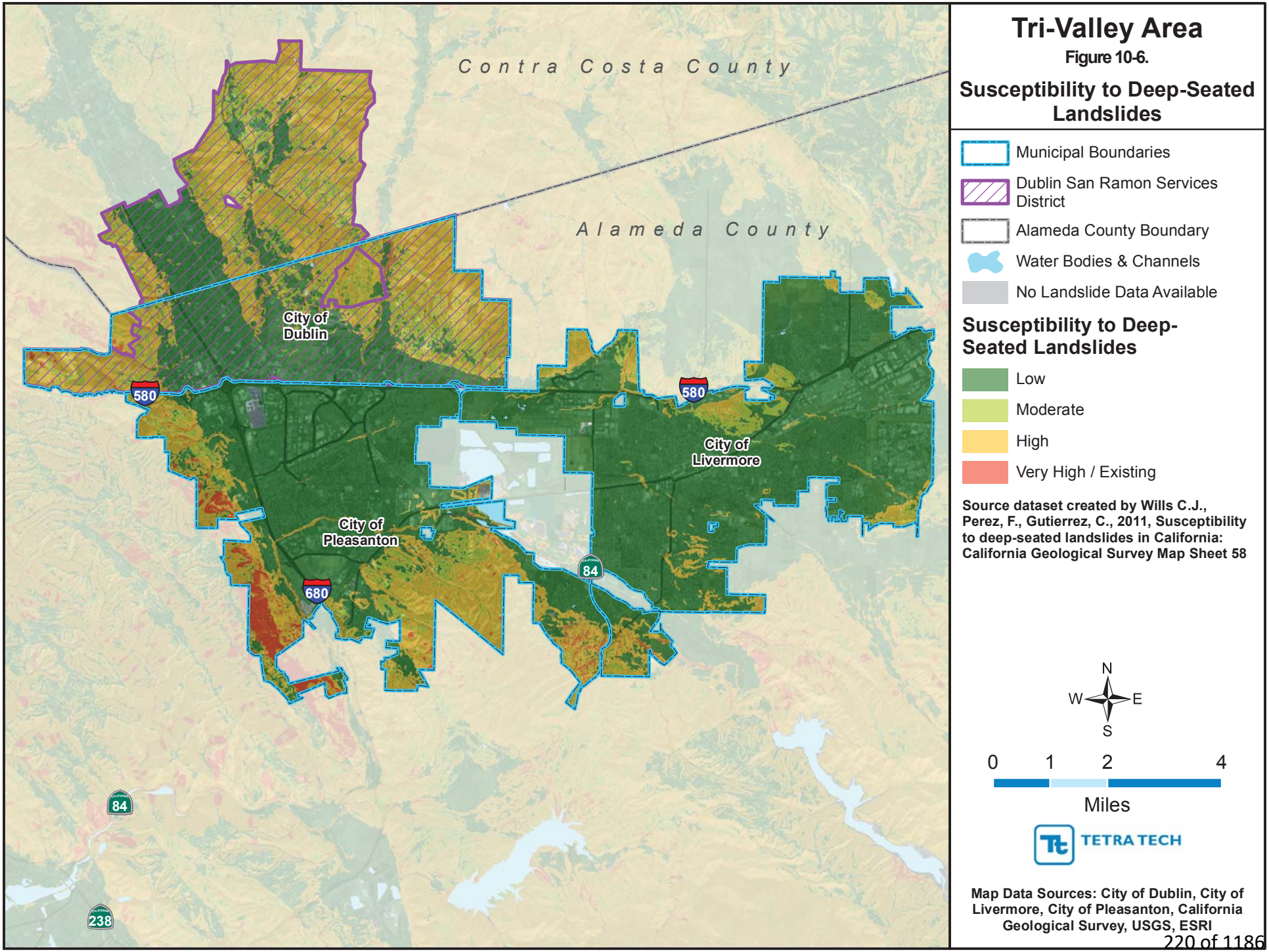
10.2.4 Severity

Landslides destroy property and infrastructure and can take human lives. Slope failures in the United States result in an average of 25 lives lost per year and an annual cost of about $1.5 billion. Landslides can pose a serious hazard to properties on or below hillsides. When landslides occur — in response to such changes as increased water content, earthquake shaking, addition of load, or removal of downslope support — they deform and tilt the ground surface. The result can be destruction of foundations, offset of roads, breaking of underground pipes, or overriding of downslope property and structures. In the planning area, landslides and mudslides are a common occurrence and have caused damage to homes, public facilities, roads, parks, and sewer lines in particular.

10.2.5 Warning Time

Mass movements can occur suddenly or slowly. The velocity of movement may range from a slow creep of inches per year to many feet per second, depending on slope angle, material and water content. Generally accepted warning signs for landslide activity include the following:

- Springs, seeps, or saturated ground in areas that have not typically been wet before
- New cracks or unusual bulges in the ground, street pavements or sidewalks
- Soil moving away from foundations
- Ancillary structures such as decks and patios tilting and/or moving relative to the main house
- Tilting or cracking of concrete floors and foundations
- Broken water lines and other underground utilities
- Leaning telephone poles, trees, retaining walls or fences
- Offset fence lines
- Sunken or down-dropped road beds
- Rapid increase in creek water levels, possibly accompanied by increased turbidity (soil content)
- Sudden decrease in creek water levels though rain is still falling or just recently stopped
- Sticking doors and windows, and visible open spaces indicating frames out of plumb
- A faint rumbling sound that increases in volume as the landslide nears
- Unusual sounds, such as trees cracking or boulders knocking together.



Tri-Valley Area

Figure 10-6.

Susceptibility to Deep-Seated Landslides

- Municipal Boundaries
- Dublin San Ramon Services District
- Alameda County Boundary
- Water Bodies & Channels
- No Landslide Data Available

Susceptibility to Deep-Seated Landslides

- Low
- Moderate
- High
- Very High / Existing

Source dataset created by Wills C.J., Perez, F., Gutierrez, C., 2011, Susceptibility to deep-seated landslides in California: California Geological Survey Map Sheet 58

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TETRA TECH

Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, California Geological Survey, USGS, ESRI

Some methods used to monitor mass movements can provide an idea of the type of movement and the amount of time prior to failure. Assessing the geology, vegetation and amount of predicted precipitation for an area can help in predictions of what areas are at risk during general time periods. Currently, there is no practical warning system for individual landslides. The standard operating procedure is to monitor situations on a case-by-case basis and respond after an event has occurred.

10.3 SECONDARY HAZARDS

Landslides can cause several types of secondary effects, such as blocking access to roads, which can isolate residents and businesses and delay commercial, public and private transportation. This could result in economic losses for businesses. Other potential problems resulting from landslides are power and communication failures. Vegetation or poles on slopes can be knocked over, resulting in possible losses to power and communication lines. Landslides also have the potential of destabilizing the foundation of structures, which may result in monetary loss for residents. They also can damage rivers or streams, potentially harming water quality, fisheries and spawning habitat.

10.4 EXPOSURE

10.4.1 Population

Population could not be examined by landslide hazard area because census block group areas do not coincide with the hazard areas. Population was estimated using the number of residential buildings in each mapped landslide hazard area multiplied by the 2016 estimated population per household. Using this approach, the estimated population living in each landslide susceptibility zone is as shown in Table 10-3.

Table 10-3. Population Exposure to the Landslide Hazard

	Low Landslide Susceptibility Zone[a]		Moderate Landslide Susceptibility Zone[b]		High Landslide Susceptibility Zone[c]		Very High Landslide Susceptibility Zone[d]	
	Population	% of Total	Population	% of Total	Population	% of Total	Population	% of Total
Dublin	36,175	60.6%	9,343	15.7%	14,072	23.6%	96	0.2%
Livermore	84,093	93.8%	2,911	3.2%	2,641	2.9%	3	0.0%
Pleasanton	61,748	81.3%	5,068	6.7%	8,790	11.6%	310	0.4%
Total	182,016	80.8%	17,322	7.7%	25,503	11.3%	409	0.2%

a. Categories 0 and III zones.
b. Categories V and VI zones.
c. Categories VII, VIII and IX zones.
d. Category X zone; includes existing landslides.
Source: CA DOF, 2017; California Geologic Survey (CGS), 2011

10.4.2 Property

Table 10-4 through Table 10-7 shows the number and replacement value of structures exposed to the landslide risk, based on the California Geological Survey (CGS) definitions of landslide susceptibility. Table 10-8 shows the general land use of planning area parcels exposed to landslides.

10.4.3 Critical Facilities and Infrastructure

Critical facilities exposed to the landslide hazard are summarized in Table 10-9 through Table 10-11.

Table 10-4. Number and Value of Exposed Structures in Very High Landslide Susceptibility Zone

	Buildings Exposed	Estimated Value within the Very High Landslide Risk Area[a]			% of Total Replacement Value
		Structure	Contents	Total	
Dublin	26	$8,128,552	$4,064,276	$12,192,829	0.1%
Livermore	2	$788,088	$691,595	$1,479,683	0.0%
Pleasanton	89	$58,799,278	$29,926,859	$88,726,137	0.4%
Total	117	$67,715,918.52	$34,682,729.95	$102,398,648	0.2%

a. Category X zone; includes existing landslides.
Source: Alameda County, 2016; California Geologic Survey (CGS), 2011

Table 10-5. Number and Value of Exposed Structures in High Landslide Susceptibility Zone

	Buildings Exposed	Estimated Value within the High Landslide Risk Area[a]			% of Total Replacement Value
		Structure	Contents	Total	
Dublin	3,836	$1,489,524,312	$808,744,220	$2,298,268,532	18.9%
Livermore	876	$369,425,486	$272,196,585	$641,622,072	3.1%
Pleasanton	2,547	$1,228,283,787	$704,352,337	$1,932,636,124	9.2%
Total	7,259	$3,087,233,586.22	$1,785,293,141.96	$4,872,526,728	9.1%

a. Categories VII, VIII and IX zones.
Source: Alameda County, 2016; California Geologic Survey (CGS), 2011

Table 10-6. Number and Value of Exposed Structures in Moderate Landslide Susceptibility Zone

	Buildings Exposed	Estimated Value within the Moderate Landslide Risk Area[a]			% of Total Replacement Value
		Structure	Contents	Total	
Dublin	2,546	$1,000,800,694	$541,216,387	$1,542,017,081	12.7%
Livermore	871	$269,402,436	$151,387,931	$420,790,366	2.1%
Pleasanton	1,445	$522,514,587	$292,911,879	$815,426,465	3.9%
Total	4,862	$1,792,717,716.19	$985,516,195.87	$2,778,233,912	5.2%

a. Categories V and VI zones.
Source: Alameda County, 2016; California Geologic Survey (CGS), 2011

Table 10-7. Exposure and Value of Structures in Low Landslide Susceptibility Zone

	Buildings Exposed	Estimated Value within the Low Landslide Risk Area[a, b]			% of Total Replacement Value
		Structure	Contents	Structure & Contents	
Dublin	10,180	$4,916,181,363	$3,395,694,614	$8,311,875,977	68.3%
Livermore	25,790	$11,139,242,238	$8,304,969,307	$19,444,211,545	94.8%
Pleasanton	18,552	$10,412,338,932	$7,779,025,499	$18,191,364,431	86.5%
Total	54,522	$26,467,762,532.92	$19,479,689,420.42	$45,947,451,953	85.6%

a. Categories 0 and III zones.
Source: Alameda County, 2016; California Geologic Survey (CGS), 2011

Table 10-8. Land Use in Landslide Risk Areas

Land Use	Moderate Area		High Area		Very High Area	
	Area (acres)	% of total	Area (acres)	% of total	Area (acres)	% of total
Residential	1,174	34.5%	2,820	30.3%	256	32.4%
Commercial	52	1.5%	150	1.6%	1	0.2%
Industrial	18	0.5%	83	0.9%	1	0.1%
Agriculture	6	0.2%	17	0.2%	0	0.0%
Religion / Assembly	45	1.3%	92	1.0%	2	0.2%
Government / Institutional	263	7.7%	427	4.6%	2	0.2%
Education	96	2.8%	97	1.0%	1	0.1%
Vacant / Rights-of-Way / Water / Open Space	1,746	51.4%	5,624	60.4%	528	66.8%
Total	3,400	100.0%	9,309	100.0%	791	100.0%

Table 10-9. Critical Facilities and Infrastructure in Moderate Landslide Risk Areas

Jurisdiction	Medical and Health Services	Emergency Services	Educational Facilities	Government / City Facilities	Utilities	Transportation Infrastructure	Hazardous Materials	Other Assets	Total
Dublin	0	1	3	0	0	0	0	0	4
Livermore	0	0	1	0	1	1	0	0	3
Pleasanton	1	0	0	0	10	2	0	0	13
Total	1	1	4	0	11	3	0	0	20

Table 10-10. Critical Facilities and Infrastructure in High Landslide Risk Areas

Jurisdiction	Medical and Health Services	Emergency Services	Educational Facilities	Government / City Facilities	Utilities	Transportation Infrastructure	Hazardous Materials	Other Assets	Total
Dublin	2	0	1	2	0	8	0	0	13
Livermore	0	0	0	0	0	6	0	0	6
Pleasanton	0	0	1	0	24	17	2	0	44
Total	2	0	2	2	24	31	2	0	63

Table 10-11. Critical Facilities and Infrastructure in Very High Landslide Risk Areas

Jurisdiction	Medical and Health Services	Emergency Services	Educational Facilities	Government / City Facilities	Utilities	Transportation Infrastructure	Hazardous Materials	Other Assets	Total
Dublin	0	0	0	0	0	0	0	0	0
Livermore	0	0	0	0	0	0	0	0	0
Pleasanton	0	0	0	0	2	0	0	0	2
Total	0	0	0	0	2	0	0	0	2

A significant amount of infrastructure can be exposed to mass movements:

- **Roads**—Access to major roads is crucial to life-safety after a disaster event and to response and recovery operations. Landslides can block roads, causing isolation for neighborhoods, traffic problems and delays for public and private transportation. This can result in economic losses for businesses.
- **Bridges**—Landslides can significantly impact road bridges. Mass movements can knock out bridge abutments or significantly weaken the soil supporting them, making them hazardous for use.
- **Power Lines**—Power lines are generally elevated above steep slopes; but the towers supporting them can be subject to landslides. A landslide could trigger failure of the soil underneath a tower, causing it to collapse and ripping down the lines. Power and communication failures due to landslides can create problems for vulnerable populations and businesses.

10.4.4 Environment

Environmental problems as a result of mass movements can be numerous. Landslides that fall into streams may significantly impact fish and wildlife habitat and affect water quality. Hillsides that provide wildlife habitat can be lost for prolonged periods of time due to landslides.

10.5 VULNERABILITY

10.5.1 Population

Due to the nature of census block group data, it is difficult to determine demographics of populations vulnerable to mass movements. In general, all of the estimated 24,799 persons exposed to high risk landslide areas are considered to be vulnerable. Increasing population and the fact that many homes are built on view property atop or below bluffs and on steep slopes subject to mass movement, increases the number of lives endangered by this hazard.

10.5.2 Property

Loss estimations for the landslide hazard are not based on damage functions, because none have been generated. Instead, estimates of potential loss were developed representing 10 percent, 30 percent and 50 percent of the assessed value of exposed structures. This allows emergency managers to select a range of economic impacts based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 10-12 shows the general building stock loss estimates in landslide risk areas.

Table 10-12. Loss Potential for Landslide

		Estimated Loss Potential from Landslide		
	Exposed Value[a]	10% Damage	30% Damage	50% Damage
Dublin	$12,164,354,419	$1,216,435,441	$3,649,306,325	$6,082,177,209
Livermore	$20,508,103,666	$2,050,810,366	$6,152,431,099	$10,254,051,833
Pleasanton	$21,028,153,157	$2,102,815,315	$6,308,445,947	$10,514,076,578
Total	$53,700,611,242	$5,370,061,124	$16,110,183,372	$26,850,305,621

a. Exposed value based on cumulative of exposed total value in low, medium, high, and very high susceptibility

10.5.3 Critical Facilities and Infrastructure

There are 85 critical facilities exposed to the landslide hazard to some degree. A more in-depth analysis of the mitigation measures taken by these facilities to prevent damage from mass movements should be done to determine if they could withstand impacts of a mass movement.

Several types of infrastructure are exposed to mass movements, including transportation, water and sewer and power infrastructure. Highly susceptible areas of the planning area include mountain and coastal roads and transportation infrastructure. At this time all infrastructure and transportation corridors identified as exposed to the landslide hazard are considered vulnerable until more information becomes available.

10.5.4 Environment

The environment vulnerable to landslide hazard is the same as the environment exposed to the hazard.

10.6 FUTURE TRENDS IN DEVELOPMENT

The planning partners are equipped to handle future growth within landslide hazard areas. Landslide risk areas are addressed in the safety elements of local general plans. All three cities have committed to linking their general plans to this hazard mitigation plan. This will create an opportunity for wise land use decisions as future growth impacts landslide hazard areas.

Additionally, the State of California has adopted the International Building Code (IBC) by reference in its California Building Standards Code. The IBC includes provisions for geotechnical analyses in steep slope areas that have soil types considered susceptible to landslide hazards. These provisions assure that new construction is built to standards that reduce the vulnerability to landslide risk. Table 10-13 shows the future land use in the moderate, high, and very high landslide risk areas.

Table 10-13. Future Land Use in Landslide Risk Areas

	Moderate Area		High Area		Very High Area	
Land Use	Area (acres)	% of total	Area (acres)	% of total	Area (acres)	% of total
Residential	1,491	43.8%	3,340	35.9%	257	32.6%
Commercial	36	1.1%	127	1.4%	2	0.2%
Industrial	45	1.3%	121	1.3%	1	0.1%
Agriculture	36	1.1%	352	3.8%	28	3.5%
Religion / Assembly	552	16.2%	832	8.9%	8	1.0%
Government / Institutional	25	0.7%	105	1.1%	2	0.2%
Education	1,216	35.7%	4,440	47.6%	494	62.5%
Vacant / Rights-of-Way / Water / Open Space	3,400	100.0%	9,317	100.0%	791	100.0%
Total	1,491	43.8%	3,340	35.9%	257	32.6%

10.7 SCENARIO

Major landslides in the planning area occur as a result of soil conditions that have been affected by severe storms, groundwater or human development. The worst-case scenario for landslide hazards in the planning area would generally correspond to a severe storm that had heavy rain and caused flooding. Landslides are most likely during late winter when the water table is high. After heavy rains from November to December, soils become saturated with water. As water seeps downward through upper soils that may consist of permeable sands and gravels and accumulates on impermeable silt, it will cause weakness and destabilization in the slope. A short intense storm

could cause saturated soil to move, resulting in landslides. As rains continue, the groundwater table rises, adding to the weakening of the slope. Gravity, poor drainage, a rising groundwater table and poor soil exacerbate hazardous conditions.

Mass movements are becoming more of a concern as development moves outside of city centers into less-developed areas. It is probable that private and public property, including infrastructure, will be affected. Mass movements could affect bridges that pass over landslide-prone ravines and knock out rail service through the planning area. Road obstructions caused by mass movements would create isolation problems for residents and businesses in sparsely developed areas. Property owners exposed to steep slopes may suffer damage to property or structures. Landslides carrying vegetation such as shrubs and trees may cause a break in utility lines, cutting off power and communication access to residents.

10.8 ISSUES

Important issues associated with landslides in the planning area include the following:

- There are existing homes in landslide risk areas throughout the planning area. The degree of vulnerability of these structures depends on the codes and standards the structures were constructed to. Information to this level of detail is not currently available.
- Future development could lead to more homes in landslide risk areas.
- Mapping and assessment of landslide hazards are constantly evolving. As new data and science become available, assessments of landslide risk should be reevaluated.
- The impact of climate change on landslides is uncertain. If climate change impacts atmospheric conditions, then exposure to landslide risks is likely to increase.
- The risk associated with the landslide hazard overlaps the risk associated with other hazards such as earthquake, flood and wildfire. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.

11. SEVERE WEATHER

11.1 GENERAL BACKGROUND

Severe weather refers to any dangerous meteorological phenomena with the potential to cause damage, serious social disruption, or loss of human life. It includes thunderstorms, downbursts, tornadoes, waterspouts, snowstorms, ice storms, and dust storms. Severe weather can be categorized into two groups: systems that form over wide geographic areas are classified as general severe weather; those with a more limited geographic area are classified as localized severe weather. Severe weather, technically, is not the same as extreme weather, which refers to unusual weather events at the extremes of the historical distribution for a given area.

Severe weather conditions with the greatest potential to impact the planning area are described in the following sections. Flooding and landslides associated with severe weather are discussed as separate hazards in Chapters 9 and 10. In this risk assessment, the "severe weather" hazard refers in aggregate to the various weather conditions profiled—severe storms, extreme heat, damaging winds and space weather. These conditions are treated as a single hazard a for the following reasons:

- Each condition has impacted the planning area, with similar frequencies of occurrence, based on weather records.
- Each condition impacts the entire planning area, with no clearly mapped or defined extent. Without a mapped or defined extent, quantitative, geospatial analysis to assess exposure or vulnerability is not available. Therefore, the risk assessment for severe weather is qualitative and is based on the aggregate exposure and vulnerability to all weather conditions.

11.1.1 Severe Storms

Severe storm conditions in the planning area include heavy rain (atmospheric rivers and thunderstorms), lightning and hail. Heavy rain refers to events where the amount of rain exceeds normal levels. The amount of precipitation needed to qualify as heavy rain varies with location and season. Heavy rain is distinct from climate change analyses on increasing precipitation. It does not mean that the total amount of precipitation at a location has increased, just that the rain is occurring in a more intense event. More frequent heavy rain events,

DEFINITIONS

Atmospheric River—A long, narrow region in the atmosphere that transports most of the water vapor outside of the tropics. These columns of vapor move with the weather, carrying large amounts of water vapor and strong winds. When atmospheric rivers make landfall, they release this vapor in the form of rain or snow, causing flooding and mudslide vents.

Extreme Heat—Temperatures that hover 10ºF or more above the average high temperature for a region and last for several weeks. Humid or muggy conditions occur when a "dome" of high atmospheric pressure traps hazy, damp air near the ground. Extremely dry and hot conditions can provoke dust storms and low visibility.

Thunderstorm—Typically 15 miles in diameter and lasting about 30 minutes, thunderstorms are marked by lightning, heavy rain and strong winds. Lightning, which occurs with all thunderstorms, is a serious threat to human life. Heavy rains over a small area in a short time can lead to flash flooding. Strong winds, hail and tornadoes are also dangers associated with thunderstorms.

Tornado—Funnel clouds of varying sizes that generate winds more than 300 miles per hour. A tornado is formed by the turbulent mixing of layers of air with contrasting temperature, moisture, density and wind flow. Tornadoes can affect an area up to a mile wide, with a path of varying length. They can come from lines of cumulonimbus clouds or from a single storm cloud. They are measured using the Fujita Scale ranging from F0 to F6.

Windstorm—A storm featuring violent winds. Windstorms tend to damage ridgelines that face into the winds.

however, can serve as indicators of changing precipitation levels. Heavy rain is most frequently measured by tracking the frequency of events, analyzing the mean return period, and measuring the amount of precipitation in a certain period (most typically inches of rain within a 24-hour period) (EPA, 2016).

Atmospheric River

An atmospheric river is a common weather pattern that brings southwest winds and heavy rain to California. Atmospheric rivers are long, narrow regions in the atmosphere that transport water vapor carried away from the tropics. These columns of vapor move with the weather, carrying large amounts of water vapor and strong winds. When they make landfall, they often release the water vapor in the form of heavy rain or snow.

Thunderstorms

A thunderstorm is a heavy rain event that includes thunder and lightning. A thunderstorm is classified as "severe" when it contains one or more of the following: hail with a diameter of three-quarter inch or greater, winds gusting in excess of 50 knots (57.5 mph), or tornado. Tornadoes are not common in the planning area; only four have been recorded in the County since 1950. All were F0-rated tornadoes except one rated EF1.

Three factors cause thunderstorms to form: moisture, rising unstable air (air that keeps rising when disturbed), and a lifting mechanism to provide the disturbance. The sun heats the surface of the earth, which warms the air above it. If this warm surface air is forced to rise (hills or mountains can cause rising motion, as can the interaction of warm air and cold air or wet air and dry air) it will continue to rise as long as it weighs less and stays warmer than the air around it. As the air rises, it transfers heat from the surface of the earth to the upper levels of the atmosphere (the process of convection). The water vapor it contains begins to cool and it condenses into a cloud. The cloud eventually grows upward into areas where the temperature is below freezing. Some of the water vapor turns to ice and some of it turns into water droplets. Both have electrical charges. Ice particles usually have positive charges, and rain droplets usually have negative charges. When the charges build up enough, they are discharged in a bolt of lightning, which causes the sound waves we hear as thunder. Thunderstorms have three stages:

- The developing stage of a thunderstorm is marked by a cumulus cloud that is being pushed upward by a rising column of air (updraft). The cumulus cloud soon looks like a tower (called towering cumulus) as the updraft continues to develop. There is little to no rain during this stage but occasional lightning. The developing stage lasts about 10 minutes.
- The thunderstorm enters the mature stage when the updraft continues to feed the storm, but precipitation begins to fall out of the storm, and a downdraft begins (a column of air pushing downward). When the downdraft and rain-cooled air spread out along the ground, they form a gust front, or a line of gusty winds. The mature stage is the most likely time for hail, heavy rain, frequent lightning, strong winds, and tornadoes. The storm occasionally has a black or dark green appearance.
- Eventually, a large amount of precipitation is produced and the updraft is overcome by the downdraft beginning the dissipating stage. At the ground, the gust front moves out a long distance from the storm and cuts off the warm moist air that was feeding the thunderstorm. Rainfall decreases in intensity, but lightning remains a danger.

There are four types of thunderstorms:

- **Single-Cell Thunderstorms—**Single-cell thunderstorms usually last 20 to 30 minutes. A true single-cell storm is rare, because the gust front of one cell often triggers the growth of another. Most single-cell storms are not usually severe, but a single-cell storm can produce a brief severe weather event. When this happens, it is called a pulse severe storm.

- **Multi-Cell Cluster Storm—**A multi-cell cluster is the most common type of thunderstorm. The multi-cell cluster consists of a group of cells, moving as one unit, with each cell in a different phase of the thunderstorm life cycle. Mature cells are usually found at the center of the cluster and dissipating cells at the downwind edge. Multi-cell cluster storms can produce moderate-size hail, flash floods and weak tornadoes. Each cell in a multi-cell cluster lasts only about 20 minutes; the multi-cell cluster itself may persist for several hours. This type of storm is usually more intense than a single cell storm.
- **Multi-Cell Squall Line**—A multi-cell line storm, or squall line, consists of a long line of storms with a continuous well-developed gust front at the leading edge. The line of storms can be solid, or there can be gaps and breaks in the line. Squall lines can produce hail up to golf-ball size, heavy rainfall, and weak tornadoes, but they are best known as the producers of strong downdrafts. Occasionally, a strong downburst will accelerate a portion of the squall line ahead of the rest of the line. This produces what is called a bow echo. Bow echoes can develop with isolated cells as well as squall lines. Bow echoes are easily detected on radar but are difficult to observe visually.
- **Super-Cell Storm—**A super-cell is a highly organized thunderstorm that poses a high threat to life and property. It is similar to a single-cell storm in that it has one main updraft, but the updraft is extremely strong, reaching speeds of 150 to 175 miles per hour. Super-cells are rare. The main characteristic that sets them apart from other thunderstorms is the presence of rotation. The rotating updraft of a super-cell (called a mesocyclone when visible on radar) helps the super-cell to produce extreme weather events, such as giant hail (more than 2 inches in diameter), strong downbursts of 80 miles an hour or more, and strong to violent tornadoes.

NOAA classifies a thunderstorm as a storm with lightning and thunder produced by cumulonimbus clouds, usually producing gusty winds, heavy rain, and sometimes hail. Thunderstorms are usually short in duration (seldom more than two hours). Heavy rains associated with thunderstorms can lead to flash flooding during the wet or dry season. According to the American Meteorological Society *Glossary of Meteorology*, thunderstorms are reported as light, medium, or heavy according to the following characteristics:

- Nature of the lightning and thunder
- Type and intensity of the precipitation, if any
- Speed and gustiness of the wind
- Appearance of the clouds
- Effect on surface temperature.

Lighting

Lightning is an electrical discharge that results from the buildup of positive and negative charges within a thunderstorm. When the buildup becomes strong enough, lightning appears as a "bolt." This flash of light usually occurs within the clouds or between the clouds and the ground. A bolt of lightning reaches temperatures approaching 50,000ºF instantaneously. The rapid heating and cooling of air near the lightning causes thunder. Lightning is a major threat during a thunderstorm. In the United States, between 75 and 100 Americans are struck and killed by lightning each year.

Hail Storms

Hail occurs when updrafts in thunderstorms carry raindrops upward into extremely cold areas of the atmosphere where they freeze into ice. Super-cooled water may accumulate on frozen particles near the back-side of a storm as they are pushed forward across and above the updraft by the prevailing winds near the top of the storm. Eventually, the hailstones encounter downdraft air and fall to the ground.

Hailstones grow two ways: by wet growth or dry growth. In wet growth, a tiny piece of ice is in an area where the air temperature is below freezing, but not super-cooled. When the ice collides with a super-cooled drop, the water

does not freeze on the ice immediately. Instead, liquid water spreads across tumbling hailstones and slowly freezes. Since the process is slow, air bubbles can escape, resulting in a layer of clear ice. Dry-growth hailstones grow when the air temperature is well below freezing and the water droplet freezes immediately as it collides with the ice particle. The air bubbles are "frozen" in place, leaving cloudy ice.

Hailstones can have layers if they travel up and down in an updraft, or they can have few or no layers if they are "balanced" in an updraft. The number of layers in a hailstone indicates how many it traveled to the top of the storm. Hailstones can begin to melt and then re-freeze together, forming large and very irregularly shaped hail.

11.1.2 Extreme Heat

Extreme heat is unexpected, unusual, or unseasonable hot weather that can create dangerous situations. It is defined as temperatures that hover 10ºF or more above the average high temperatures for the region for several weeks. According to the *California Climate Adaptation Strategy*, heat waves have claimed more lives in California than all other declared disaster events combined. Despite this history, not a single heat emergency was proclaimed at the state or federal level between 1960 and 2016. Heat emergencies are often slow to develop and usually hurt vulnerable populations. It could take a number of days of oppressive heat for a heat wave to have a significant or quantifiable impact in planning area. Heat waves do not strike victims immediately; rather, their cumulative effects slowly take the lives of vulnerable populations.

The NWS is producing experimental forecasts called Heat Risks to assess the local heat risk in California, Nevada, Utah, and Arizona (see Figure 11-1). The numeric (0-4) and color (green, yellow, orange, red and magenta) scales are similar to the NWS air quality index.

11.1.3 Damaging Winds

Damaging winds are classified as those exceeding 60 mph. Damage from such winds accounts for half of all severe weather reports in the lower 48 states and is more common than damage from tornadoes. Wind speeds can reach up to 100 mph and can produce a damage path extending for hundreds of miles. There are seven types of damaging winds:

- Straight-line winds—Any thunderstorm wind that is not associated with rotation; this term is used mainly to differentiate from tornado winds. Most thunderstorms produce some straight-line winds as a result of outflow generated by the thunderstorm downdraft.
- Downdrafts—A small-scale column of air that rapidly sinks toward the ground.
- Downbursts—A strong downdraft with horizontal dimensions larger than 2.5 miles resulting in an outward burst or damaging winds on or near the ground. Downburst winds may begin as a microburst and spread out over a wider area, sometimes producing damage similar to a strong tornado. Although usually associated with thunderstorms, downbursts can occur with showers too weak to produce thunder.
- Microbursts—A small concentrated downburst that produces an outward burst of damaging winds at the surface. Microbursts are generally less than 2.5 miles across and short-lived, lasting only 5 to 10 minutes, with maximum wind speeds up to 168 mph. There are two kinds of microbursts: wet and dry. A wet microburst is accompanied by heavy precipitation at the surface. Dry microbursts, common in places like the high plains and the intermountain west, occur with little or no precipitation reaching the ground.
- Gust front—A gust front is the leading edge of rain-cooled air that clashes with warmer thunderstorm inflow. Gust fronts are characterized by a wind shift, temperature drop, and gusty winds out ahead of a thunderstorm. Sometimes the winds push up air above them, forming a shelf cloud or detached roll cloud.

Source: NWS, 2017e

Numerical Value	Meaning	Who/What is at Risk?	How Common is this Heat?	For those at risk, what actions can be taken?
0	• Level of heat poses **little to no risk**	• No elevated risk	Very Common	• No additional preventative actions should be necessary.
1	• Heat of this type is **tolerated by most**; however there is a **low risk for sensitive groups** to experience health effects	• Primarily those who are extremely sensitive to heat	Very Common	• Increase hydration • Reduce time spent outdoors or stay in the shade when the sun is strongest • Open windows at night and use fans to bring cooler air inside buildings
2	• **Moderate risk for members of heat sensitive groups** to experience health effects • **Some risk for the general population who are exposed to the sun and are active** • For those without air conditioning, **living spaces can become uncomfortable during the day**, but should cool below dangerous levels at night	• Primarily heat sensitive groups, especially those without effective cooling or hydration • Some transportation and utilities sectors	• Fairly common most locations • Very common in southern regions of country	• Reduce time in the sun between 10 a.m. and 4 p.m. • Stay hydrated • Stay in a cool place during the heat of the day • Move outdoor activities to cooler times of the day • Open windows at night and use fans to bring cooler air inside buildings and circulate air
3	• **High Risk for much of the population who are 1) exposed to the sun and active or 2) are in a heat sensitive group** • **Dangerous to anyone without proper hydration or adequate cooling** • **Poor air quality** is possible • **Power interruptions may occur** as electrical demands increase	• Much of the population, especially those who are heat sensitive and anyone without effective cooling or hydration • Most transportation and utilities sectors	• Uncommon most northern locations • Fairly common in southern regions of country	• Try to avoid being outdoors in the sun between 10 a.m. and 4 p.m. • Stay hydrated • Stay in a cool place especially during the heat of the day • If you have access to air conditioning, use it. Fans may not be adequate • Cancel outdoor activities during the heat of the day
4	• **Very High Risk for entire population** • **Very dangerous to anyone without proper hydration or adequate cooling.** • **This is a multi-day excessive heat event.** Prolonged heat is dangerous to anyone not prepared. • **Poor air quality** is likely. • **Power outages are increasingly likely** as electrical demands may reach critical levels.	• Entire population is at risk. • For heat sensitive groups, especially people without effective cooling, **this level of heat can be deadly**. • Most transportation and utilities sectors	• Rare most locations • Occurs up to a few times a year in southern regions of country, especially the Desert Southwest	• Avoid being outdoors in the sun between 10 a.m. and 4 p.m. • Stay hydrated • Stay in a cool place, including overnight • If you have access to air conditioning, use it. Fans will not be adequate • Cancel outdoor activities during the heat of the day

Figure 11-1. NWS Experimental Potential Heat Risks

- Derecho—A derecho is a widespread thunderstorm wind caused when new thunderstorms form along the leading edge of an outflow boundary (the boundary formed by horizontal spreading of thunderstorm-cooled air). The word "derecho" is of Spanish origin and means "straight ahead." Thunderstorms feed on the boundary and continue to reproduce. Derechos typically occur in summer when complexes of thunderstorms form over plains, producing heavy rain and severe wind. The damaging winds can last a long time and cover a large area.
- Bow Echo—A bow echo is a linear wind front bent outward in a bow shape. Damaging straight-line winds often occur near the center of a bow echo. Bow echoes can be 200 miles long, last for several hours, and produce extensive wind damage at the ground.

Windstorms are generally short-duration events involving straight-line winds or gusts of over 50 mph, strong enough to cause property damage. Windstorms are especially dangerous in areas with significant tree stands and areas with exposed property, poorly constructed buildings, mobile homes (manufactured housing units), major infrastructure, and above-ground utility lines. A windstorm can topple trees and power lines, cause damage to residential, commercial and critical facilities, and leave tons of debris in its wake.

11.1.4 Space Weather

Space weather refers to variations in the space environment between the sun and earth. It includes phenomena that impact systems and technologies in orbit and on earth. Space weather can occur anywhere from the surface of the sun to the surface of the earth. As a space weather storm leaves the sun, it passes through the sun's corona and into the solar wind. When it reaches earth, it energizes earth's magnetosphere and accelerates electrons and protons down to earth's magnetic field lines where they collide with the atmosphere and ionosphere, particularly at high latitudes. Each component of space weather impacts a different technology (NOAA SWPC, 2017c). Figure 11-2 illustrates several types of space weather phenomena.

Source: NOAA, SWPC; 2017c

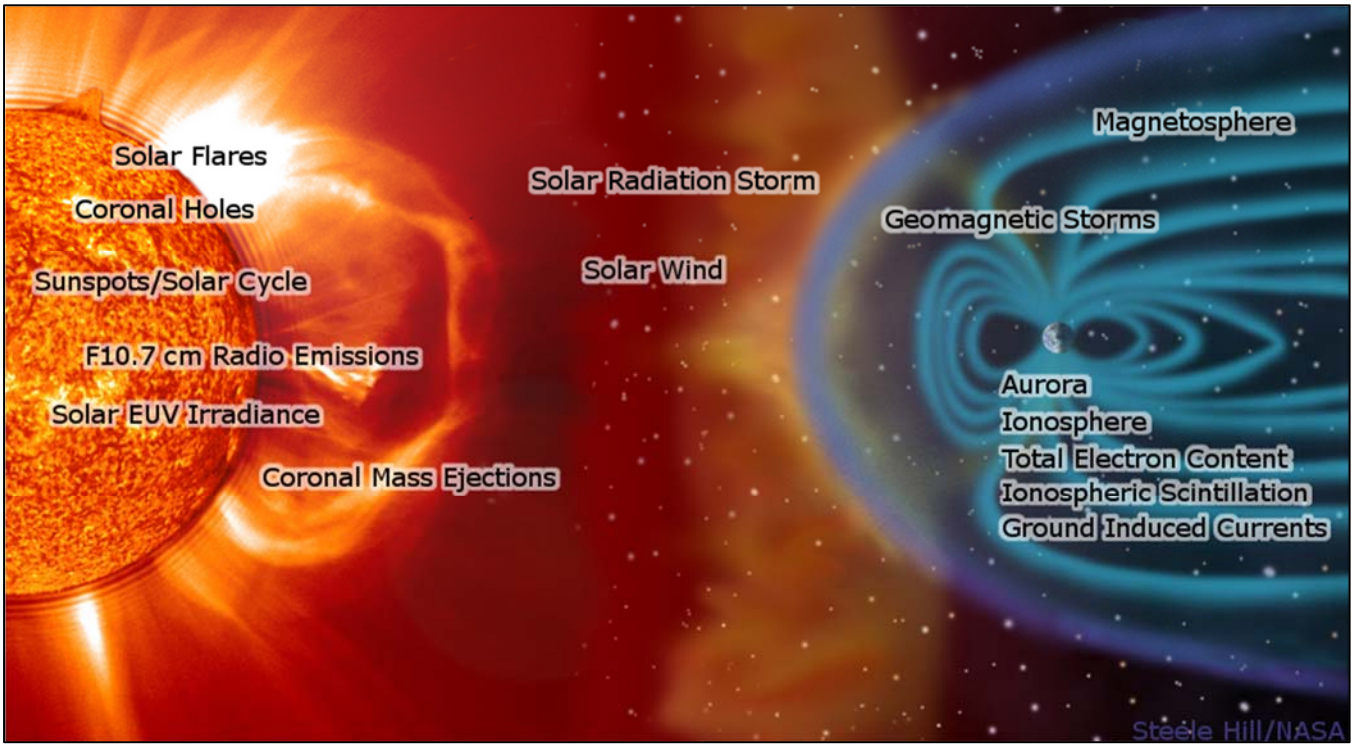


Figure 11-2. Space Weather Phenomena

A solar flare occurs when magnetic energy that has built up in the solar atmosphere is suddenly released. The flare ejects clouds of electrons, ions, and atoms through the corona of the sun into space. These clouds typically reach earth a day or two after the event. Solar flares last from minutes to hours. Radiation is emitted across virtually the entire electromagnetic spectrum, from radio waves at the long wavelength end, through optical emission to X-rays and gamma rays at the short wavelength end (NOAA SWPC, 2017c; NASA, 2016). Solar flares only impact the earth when they occur on the side of the sun that faces the earth (NASA, 2016a). If the energy from a solar flare reaches the earth, it has the potential to affect global positioning system (GPS) signals, television and radio transmissions, and telecommunications.

11.2 HAZARD PROFILE

11.2.1 Past Events

Sources that provide historical information regarding previous occurrences and losses associated with severe weather events in Alameda County and the planning area include FEMA, NWS, and NOAA NCEI. Between 1970 and April 2017, Alameda County was included in 12 FEMA disaster declarations for severe storms, severe winter storms, mudslides, landslides and flooding as listed in Table 11-1. Impacts on the planning area were not identified in the sources reviewed.

Table 11-1. FEMA Disasters for Severe Weather Events in Alameda County

FEMA Declaration	Event Date	Event Type	Location
DR-4308	February 1 – February 23, 2017	Severe Winter Storms, Flooding, Mudslides	43 counties including Alameda County
DR-4305	January 18 – January 23, 2017	Severe Winter Storms, Flooding, Mudslides	23 counties including Alameda County
DR-4301	January 3 – January 12, 2017	Severe Winter Storms, Flooding, Mudslides	39 counties including Alameda County
DR-1646	March 29 – April 16, 2006	Severe Winter Storms, Flooding, Landslides, Mudflows	17 counties including Alameda County
DR-1628	December 17, 2005 to January 3, 2006	Severe Winter Storms, Flooding, Landslides, Mudflows	30 counties including Alameda County
DR-1203	February 2 – Aril 30, 1998	Severe Winter Storms, Flooding	41 counties including Alameda County
DR-1155	December 28, 1996 – April 1, 1997	Severe Winter Storms, Flooding	48 counties including Alameda County
DR-1046	February 13 to April 19, 1995	Severe Winter Storms, Flooding, Landslides, Mudflows	57 counties including Alameda County
DR-1044	January 3 to February 10, 1995	Severe Winter Storms, Flooding, Landslides, Mudflows	42 counties including Alameda County
DR-758	February 12 – March 10, 1986	Severe Storms & Flooding	39 counties including Alameda County
DR-651	December 19, 1981 – January 8, 1983	Severe Storms, Flood, Mudslides & High Tide	10 counties including Alameda County
DR-283	February 16, 1970	Severe Storms & Flooding	17 counties including Alameda County

Source: FEMA, 2017b

According to NOAA NCEI, between 1996 and April 2017, no extreme heat nor tornado events were recorded in Alameda County. Three hail events occurred in the county, but not in the Tri-Valley planning area. Alameda County recorded 30 high wind events in this timeframe with wind magnitude ranging between 44 knots and 96 knots, 39 strong wind events with wind magnitude between 30 knots and 48 knots, and five thunderstorm wind events. Table 11-2 lists known severe weather events that impacted the planning area between 1970 and April 2017, along with solar flare events that occurred in North America.

Table 11-2. Severe Weather Events in the Tri-Valley Planning Area

Event Date	Event Type	FEMA Declaration	Location	Description
February 7, 2017	Atmospheric River	DR- 4308	Alameda County, planning area, Bay Area	An atmospheric river produced widespread roadway flooding, debris flows, strong winds, and overtopping of reservoir spillways in the Bay Area. Pleasanton recorded 2.45 inches of rain on Feb. 20.
January 20, 2017	Atmospheric River	DR- 4305	Alameda County, planning area, Bay Area	
January 10, 2017	Atmospheric River	DR- 4301	Alameda County, planning area, Bay Area	An atmospheric river produced widespread roadway flooding, debris flows, and strong winds in the Bay Area. Pleasanton recorded 2.15 inches of rain on Jan 10.
December 10 – 11, 2014	Heavy Rains and High Winds	N/A	Alameda County, planning area, and Bay Area	An atmospheric river brought heavy rains and gusty winds to the Bay Area for several days. Rainfall of 1.5 to 2 inches an hour was reported. A flash flood warning was issued for Dublin, Livermore and Pleasanton. Wind gusts were recorded up to 83 mph. Rainfall totals ranged from 5.78 to 7.24 inches. Power outages occurred across the Bay Area. Total rainfall in Pleasanton was 3.27 inches.
December 2006	Geomagnetic Storms and Solar Flares	N/A	United States	This event disabled GPS signal acquisition over the United States.
April 6-20, 2006	Heavy Rain and Debris Flows	DR-1646	Alameda County and planning area	Storms brought heavy rain causing landslides, eroding hillsides and cracked pavement. Landslides or erosion on private properties spilled over onto county rights-of-way. Overall, the County had approximately $10 million in damage to county roadways.
December 17, 2005 – January 12, 2006	Winter Storms (Severe Storms, Flood, Mudslides, Landslides)	DR-1628	Alameda County, planning area, Bay Area	Damage estimates for the region were over $100 million. Storms were blamed for two deaths from falling trees, around 50 businesses declared damage, and three homes were nearly wiped out by mudslides.
October 2003	Space Weather ("Halloween Storms of 2003")	N/A	Parts of the Europe and the United States	Solar flares impacted satellite-based systems and communications. A one-hour-long power outage resulted in Sweden. Aurorae were observed as far south as Texas.
December 28, 1996 – April 1, 1997	Severe Storms, Flooding, Mud and Landslides	DR-1155	48 counties including Alameda County	Over 12,000 people were evacuated in northern California. Levee breaks were reported across the Sacramento and San Joaquin Valleys. Over 23,000 homes and business, agricultural lands, bridges, and roads were damaged. The event caused eight deaths and $1.8 billion in damage.
March 13, 1989	Space Weather Storm	N/A	Quebec, Canada	A space weather storm disrupted the hydroelectric power grid in Quebec, Canada. This system-wide outage lasted for 9 hours and left 6 million people without power.
February 12 – March 10, 1986	Severe Storms & Flooding	DR-758	Bay Area including Alameda County	This event damaged over 12,000 homes, destroyed over 1,300 homes, and caused 13 deaths and 67 injuries in California. Damage totaled over $407.5 million.
January 3 – 5, 1982	Landslides, Floods, and Marine Effects	DR-651	Bay Area including Alameda County	A major storm caused widespread and catastrophic landslide damage throughout the Bay Area, resulting in numerous deaths and over $60 million in direct costs. In Alameda County, damage was concentrated in Oakland, Piedmont, and Berkeley. The County had approximately $3.5 million in damage.
February 10, 1970	Severe Storms & Flooding	DR-283	Bay Area including Alameda County	Heavy winds, storms and flooding impacted the Bay Area, including Alameda County. Impacted areas had over $27 million in damage.

Source: FEMA, 2017b; NOAA NCEI, 2017b

11.2.2 Location

All severe weather conditions profiled in this chapter have the potential to happen anywhere in the planning area. No extent mapping is currently available.

11.2.3 Frequency

The planning area can expect to experience some type of severe weather event at least annually. Figure 11-3 shows that the planning area can experience around five thunderstorms each year (NWS, 2016). The frequency of solar flares is difficult to estimate, and prediction of a specific future event is nearly impossible (Riley, 2012).

Source: NWS, 2016

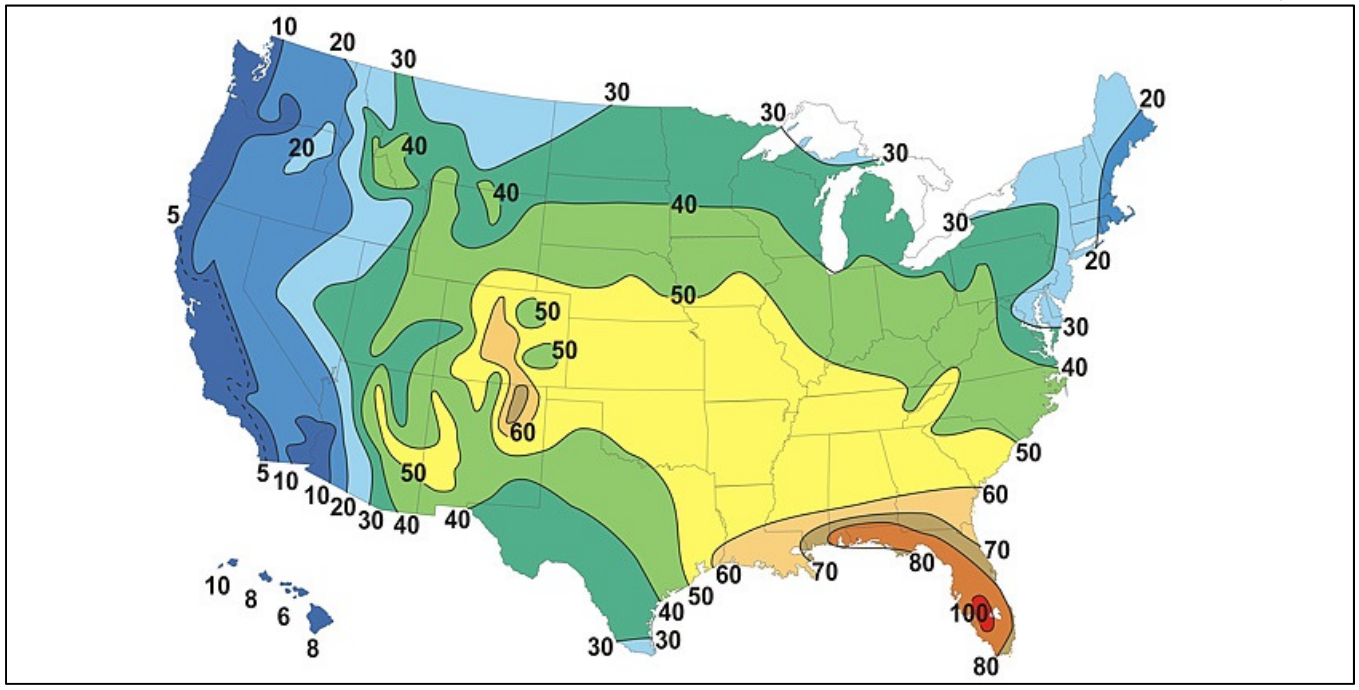


Figure 11-3. Annual Number of Thunderstorms in the United States

11.2.4 Severity

The most common problems associated with the severe weather conditions profiled in this assessment are immobility and loss of utilities. Fatalities are uncommon, but can occur. Roads may become impassable due to flooding, downed trees, or a landslide. Power lines may be downed due to high winds, and services such as water or phone may not be able to operate without power. Lightning can cause severe damage and injury. Physical damage to homes and facilities can be caused by wind or flooding.

Atmospheric rivers or heavy precipitation, which in the planning area almost always takes the form of rain, can have significant impacts, including crop damage, soil erosion, and increased risk of flood. These events can drop up to 12 inches of rain over a few days and cause widespread flooding and disruption to road and air travel. Stormwater runoff from heavy rains can also impair water quality by washing pollutants into water bodies. Thunderstorms carry the same risks as heavy precipitation events, and depending on the type of storm, they can also result in tornados, lightning, and heavy winds, increasing risk of injury and property damage (Keller, 2008).

Lightning severity is typically associated with both property damage and life safety (injuries and fatalities). The number of reported injuries from lightning is likely to be low, but planning area infrastructure losses can be up to thousands of dollars each year. Lightning also is associated with wildfire ignitions in the planning area.

Extreme heat is the primary weather-related cause of death in the U.S over a 30-year average from 1987 through 2016. In 2016, heat claimed 94 lives, though none of them were in California (NWS, 2016). Air-conditioning is the number one protective factor against heat-related illness and death. If a home is not air-conditioned, people can reduce their risk for heat-related illness by spending time in public facilities that are air-conditioned. Extreme heat is a concern to people, animals and pets as well as local nursery crops, cut flowers, and vegetable crops.

Windstorms can be a frequent problem in the planning area and have been known to cause damage to utilities. Strong, hot, dry offshore winds locally known as "diablo winds" can be particularly dangerous. These winds can occur at any time of year, but are especially dangerous in the driest months of summer and fall when vegetation is at its driest. The wind speed given in wind warnings issued by the NWS is for a one-minute average; gusts may be 25 to 30 percent higher. The FEMA *Winds Zones of the United States* map (Figure 11-4) indicates the strength of windstorms in the United States and the general location of the most wind activity, based on 40 years of tornado data and 100 years of hurricane data collected by FEMA. The planning area, along with most of the Western United States, is in Wind Zone I, where wind speeds can reach up to 130 mph.

Source: FEMA, 2010

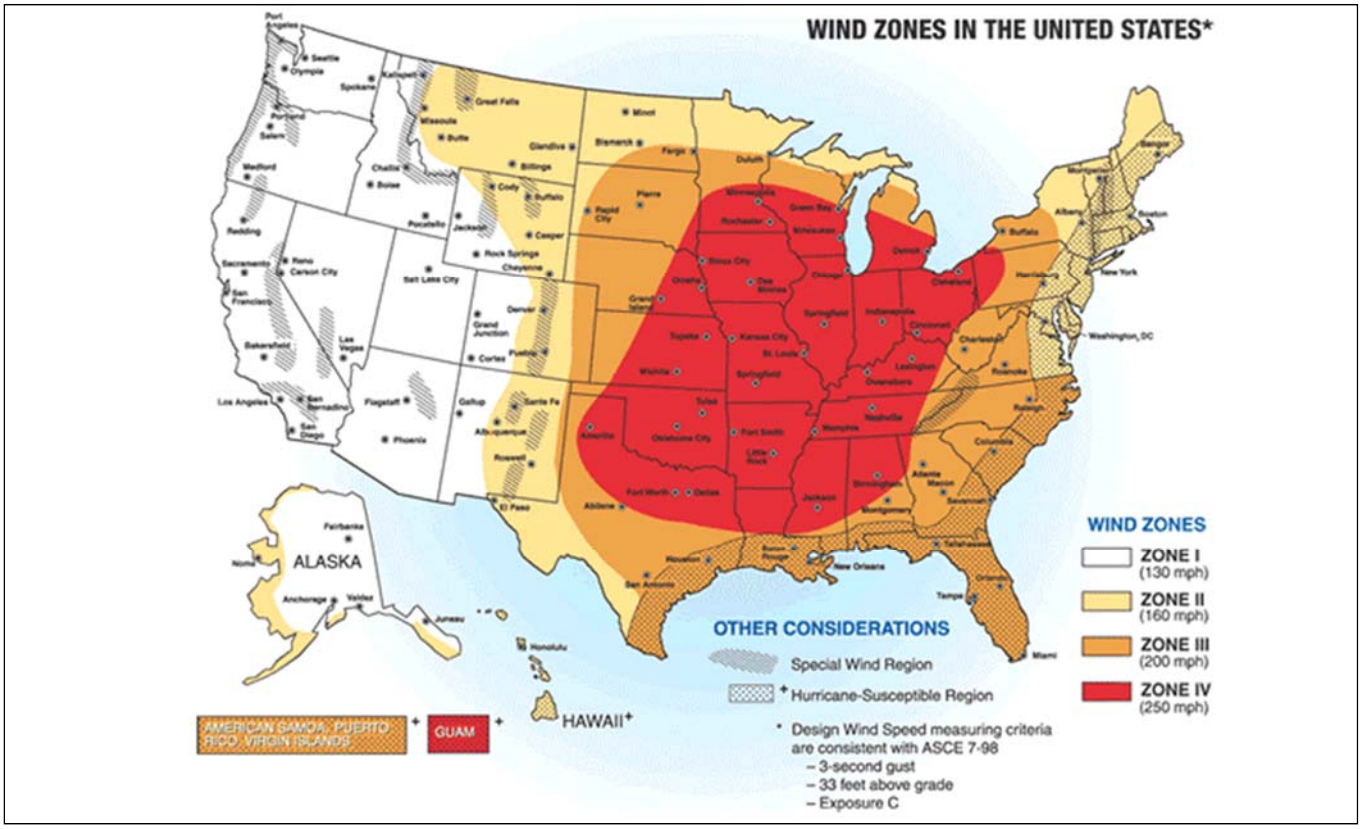


Figure 11-4. Wind Zones in the United States

Solar flares can lead to long-term power grid outages. Moderate solar storms have affected transformers as they are not very resilient to long electromagnetic pulses (Global Resilience Network, 2016). Recent events impacting the United States have disrupted the power grid, shut down satellites and air traffic precision navigation, and

disabled GPS signals. Power outages induced by space weather can be life-threatening to those dependent on electricity for life support.

11.2.5 Warning Time

Meteorologists can often predict the likelihood of a severe weather event. This can give several days of warning time. However, meteorologists cannot predict the exact time of onset or severity of the storm. Some storms may come on more quickly and have only a few hours of warning time. The San Francisco Bay Area Weather Forecast Office of the NWS monitors weather stations and issues watches and warnings when appropriate to alert government agencies and the public of possible or impending weather events. The watches and warnings are broadcast over NOAA weather radio and are forwarded to the local media for retransmission using the Emergency Alert System.

Space weather prediction in the United States is provided primarily by the Space Weather Prediction Center and the U.S. Air Force's Weather Agency. The Space Weather Prediction Center draws on a variety of data sources, both space- and ground-based, to provide forecasts, watches, warnings, alerts, and summaries to civilian and commercial users.

11.3 SECONDARY HAZARDS

The most significant secondary hazards associated with severe weather are floods, falling and downed trees, mudslides, landslides and downed power lines. Rapidly melting snow combined with heavy rain can overwhelm both natural and man-made drainage systems, causing overflow and property destruction. Landslides occur when the soil on slopes becomes oversaturated and fails.

11.4 EXPOSURE

11.4.1 Population

A lack of clearly defined extent mapping for the severe weather conditions profiled in this chapter prevents a detailed analysis of exposure and vulnerability. However, it can be assumed that the entire planning area is exposed to some extent to all severe weather conditions profiled. Certain areas are more exposed due to geographic location and local weather patterns. Populations living at higher elevations with large stands of trees or power lines may be more susceptible to wind damage and black out, while populations in low-lying areas are at risk for possible flooding.

11.4.2 Property

According to the County Assessor, there are 66,760 buildings within the census tracts that define the planning area. Most of these buildings are residential. It is estimated that 36 percent of the residential structures were built without the influence of a structural building code that would mitigate the severe weather conditions profiled in this assessment. All of these buildings are considered to be exposed to the severe weather hazard, but structures in poor condition or in particularly vulnerable locations (located on hilltops or exposed open areas) may risk the most damage. The frequency and degree of damage will depend on specific locations.

11.4.3 Critical Facilities and Infrastructure

All critical facilities exposed to flooding (Section 9.4.3) are also likely exposed to severe weather. Additional facilities on higher ground may also be exposed to wind damage or damage from falling trees. The most common problems associated with severe weather are loss of utilities. Downed power lines can cause blackouts, leaving

large areas isolated. Phone, water and sewer systems may not function. Roads may become impassable from secondary hazards such as mudslides and landslides.

11.4.4 Environment

The environment is highly exposed to severe weather events. Natural habitats such as streams and trees are exposed to the elements during a severe storm and risk major damage and destruction. Prolonged rains can saturate soils and lead to slope failure. Flooding events caused by severe weather or snowmelt can produce river channel migration or damage riparian habitat. Storm surges can erode beachfront bluffs and redistribute sediment loads.

11.5 VULNERABILITY

11.5.1 Population

Vulnerable populations are the elderly, low income or linguistically isolated populations, people with life-threatening illnesses, and residents living in areas that are isolated from major roads. Power outages can be life threatening to those dependent on electricity for life support. Isolation of these populations is a significant concern. These populations face isolation and exposure during severe weather events and could suffer more secondary effects of the hazard. Population vulnerabilities to specific severe weather conditions are as follows:

- **Damaging Winds**—Debris carried by extreme winds and trees felled by gusty conditions can contribute directly to loss of life as well as increase the vulnerability of people by damaging buildings where people take shelter. Utility lines brought down by winds have been known to cause fires and create the possibility of lethal electric shock.
- **Extreme Heat**—Individuals with physical or mobility constraints, cognitive impairments, economic constraints, or social isolation are typically at greater risk to the adverse effects of extreme heat. Some medical conditions, such as heat stroke, are directly attributable to extreme heat, while others may be exacerbated by it, resulting in medical emergencies.
- **Severe Storms**—Nationally, lighting is one of the leading causes of weather-related fatalities, though lightning strikes are less common in the west than in other areas of the country. The majority of injuries and deaths associated with lighting occur when people are outdoors; however, almost one-third of lightning-related injuries occur indoors. Males are five times more likely than females to be struck by lighting and people between the ages of 15 and 34 account for 41 percent of all lightning strike victims.
- **Space Weather —**The sun's activities cause extreme space weather events that can affect the City's population, mainly by power black-out events

11.5.2 Property

All property is vulnerable during the severe weather conditions profiled in this chapter, but properties in poor condition or in particularly vulnerable locations may risk the most damage. Those in higher elevations and on ridges may be more prone to wind damage. Those that are located under or near overhead lines or near large trees may be vulnerable to falling ice or may be damaged in the event of a collapse.

Loss estimations for the severe weather hazard are not based on damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the assessed value of exposed structures. This allows emergency managers to select a range of potential economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 11-3 lists the loss estimates.

Table 11-3. Loss Estimates for Severe Weather

	Exposed Value (Structure and Contents)	Estimated Loss Potential from Severe Weather		
		10% Damage	30% Damage	50% Damage
Dublin	$12,164,354,419	$1,216,435,442	$3,649,306,326	$6,082,177,209
Livermore	$20,508,103,666	$2,050,810,367	$6,152,431,100	$10,254,051,833
Pleasanton	$21,028,153,157	$2,102,815,316	$6,308,445,947	$10,514,076,578
Total	$53,700,611,242	$5,370,061,124	$16,110,183,373	$26,850,305,621

11.5.3 Critical Facilities and Infrastructure

Incapacity and loss of roads are the primary transportation failures resulting from severe weather, mostly associated with secondary hazards. Landslides caused by heavy prolonged rains can block roads. High winds can cause significant damage to trees and power lines, blocking roads with debris, incapacitating transportation, isolating populations, and disrupting ingress and egress. Snowstorms in higher elevations can significantly impact the transportation system and the availability of public safety services. Of particular concern are roads providing access to isolated areas and to the elderly.

Prolonged obstruction of major routes due to landslides, snow, debris or floodwaters can disrupt the shipment of goods and other commerce. Large, prolonged storms can have negative economic impacts for an entire region.

Severe windstorms, downed trees, and ice can create serious impacts on power and above-ground communication lines. Freezing of power and communication lines can cause them to break, disrupting electricity and communication. Loss of electricity and phone connection would leave certain populations isolated because residents would be unable to call for assistance.

Electric power losses caused by severe weather can be estimated using standard values for loss of service for utilities published in FEMA's *2009 Benefit Cost Analysis Reference Guide*. These figures provide estimated costs associated with the loss of power in relation to the populations in planning area (Table 11-4). The loss-of-use estimates for power failure associated with severe weather are presented as a cost per person per day of loss. The estimated loss of use provided for each jurisdiction represents the loss of service of the indicated utility for one day for 10 percent of the population. These figures do not take into account physical damage to utility equipment and infrastructure.

Table 11-4. Loss of Use Estimates for Power Failure

Jurisdiction	2016 Population Estimate[a]	Estimated Affected Population 10%	Electric Loss of Use Estimate ($126 per person per day)[b]
Dublin	57,349	5,735	$722,597
Livermore	88,138	8,814	$1,110,539
Pleasanton	74,982	7,498	$944,773
Total	220,469	22,047	$2,777,909

a. CA DOF, 2016
b. FEMA, 2009

11.5.4 Environment

The vulnerability of the environment to severe weather is the same as the exposure.

11.6 FUTURE TRENDS IN DEVELOPMENT

All future development will be affected by severe storms. The ability to withstand impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction. The planning partners have adopted the International Building Code in response to California mandates. This code is equipped to deal with the impacts of severe weather events. Land use policies identified in general plans within the planning area also address many of the secondary impacts (flood and landslide) of the severe weather hazard. With these tools, the planning partners are well equipped to deal with future growth and the associated impacts of severe weather.

11.7 SCENARIO

Severe weather impacts can be significant, particularly when secondary hazards occur. A worst-case event would involve prolonged high winds during a winter storm caused by an atmospheric river event. Such an event would have both short-term and longer-term effects. Initially, schools and roads would be closed due to power outages caused by high winds and downed tree obstructions. Prolonged rain could produce flooding, overtopped culverts with ponded water on roads. Flooding and debris could further obstruct roads and bridges, further isolating residents.

11.8 ISSUES

Important issues associated with a severe weather in the planning area include the following:

- Older building stock in the planning area is built to low code standards. These structures could be highly vulnerable to severe weather events such as windstorms.
- The cities may need to open cooling centers during extreme heat events.
- Redundancy of power supply and communications equipment must be evaluated.
- The capacity for backup power generation is limited.
- Dead or dying trees as a result of drought conditions are more susceptible to falling during severe storm events.
- Public education on dealing with the impacts of severe weather needs to continue to be provided so that citizens can be better informed and prepared for severe weather events.
- Debris management (downed trees, etc.) must be addressed, because debris can impact the severity of severe weather events, requires coordination efforts, and may require additional funding.
- The effects of climate change may result in an increase of heavy rain or more atmospheric storm events, and will likely lead to increased temperatures and changes in overall precipitation amounts.

12. WILDFIRE

NOTE: "In October, 2017 Mendocino, Napa and Sonoma Counties experienced simultaneous wildland-urban interface fires that spread into suburban residential and commercial occupancies. There were over 7000 structures destroyed and 42 lives lost. These fires are currently under investigation, and conclusive information is not available to support the wildfire risk assessment for this plan. While these fires did not directly impact the planning area for this plan, they are likely to influence the understanding and assessment best management practices for wildfire in California and abroad in the future. Future updates to this chapter will utilize bets available data and science that is likely to be influenced by conclusions and observations from these events.

12.1 GENERAL BACKGROUND

A wildfire is any uncontrolled fire occurring on undeveloped land that requires fire suppression. Wildfires can be ignited by lightning or by human activity such as smoking, campfires, equipment use, and arson. The potential for wildfire is primarily influenced by the following factors:

- Fuel, which may include living and dead vegetation on the ground, along the surface as brush and small trees, and above the ground in tree canopies.
- Topography, which includes both slope and elevation.
- Air conditions, including temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount and duration, and the stability of the atmosphere.

DEFINITIONS

Wildfire—Fires that result in uncontrolled destruction of forests, brush, field crops, grasslands, and real and personal property in non-urban areas. Because of their distance from firefighting resources, they can be difficult to contain and can cause a great deal of destruction.

Wildland urban interface area—An area susceptible to wildfires and where wildland vegetation and urban or suburban development occur together. An example would be smaller urban areas and dispersed rural housing in forested areas.

Fire hazards present a considerable risk to vegetation and wildlife habitats. Short-term loss caused by a wildfire can include the destruction of timber, wildlife habitat, scenic vistas, and watersheds. Long-term effects include smaller timber harvests, reduced access to affected recreational areas, and destruction of cultural and economic resources and community infrastructure. Vulnerability to flooding increases due to the destruction of watersheds. The potential for significant damage to life and property exists in areas designated as "wildland urban interface (WUI) areas," where development is adjacent to densely vegetated areas.

12.1.1 Local Conditions Related to Wildfire

According to *Alameda County Community Wildfire Protection Plan* (CWPP, 2012), the planning area has a Mediterranean-like climate with no summer rains and potential high winds. Non-native and invasive weedy vegetation has replaced more fire resistant and ecologically stable native species in many places. In addition, highly flammable homes are located in high fire hazard zones

"Red flag" weather in the planning area features the strong, hot, dry offshore winds locally known as "diablo winds." These winds carry extremely dry air at high velocity and can push a fire down or up a slope quickly. They can occur at any time of year, but are especially dangerous in the driest months of summer and fall.

12.1.2 Wildfire Protection Responsibility in California

Hundreds of agencies have fire protection responsibility for wildland and WUI fires in California, and primary legal (and financial) responsibility for wildfire protection is divided by local, state, tribal, and federal organizations. In many instances, two fire organizations have dual primary responsibility on the same parcel of land—one for wildfire protection, and the other for structural or "improvement" fire protection. According to the *2013 California Multi-Hazard Mitigation Plan*, this layering of responsibility and resulting dual policies, rules, practices, and legal ordinances can cause conflict or confusion. To address wildfire jurisdictional responsibilities, the California state legislature in 1981 adopted Public Resource Code Section 4291.5 and Health and Safety Code Section 13108.5 establishing the following responsibility areas:

- **Federal Responsibility Areas (FRAs)**—FRAs are fire-prone wildland areas that are owned or managed by a federal agency such as the U.S. Forest Service, National Park Service, Bureau of Land Management, U.S. Fish and Wildlife Service, or U.S. Department of Defense. Primary financial and rule-making jurisdictional authority rests with the federal land agency. In many instances, FRAs are interspersed with private land ownership or leases. Fire protection for developed private property is usually not the responsibility of the federal land management agency; structural protection responsibility is that of a local government agency.
- **State Responsibility Areas (SRAs)**—SRAs are lands in California where California Department of Forestry and Fire Protection (CAL FIRE) has legal and financial responsibility for wildfire protection and where CAL FIRE administers fire hazard classifications and building standard regulations. SRAs are defined as lands that meet the following criteria:
  - Are county unincorporated areas
  - Are not federally owned
  - Have wildland vegetation cover rather than agricultural or ornamental plants
  - Have watershed or range/forage value
  - Have housing densities not exceeding three units per acre.

  Where SRAs contain built environment or development, the responsibility for fire protection of those improvements (non-wildland) is that of a local government agency.

- **Local Responsibility Areas (LRAs)**—LRAs include land in cities, cultivated agriculture lands, non-flammable areas in unincorporated areas, and lands that do not meet the criteria for SRA or FRA. LRA fire protection is typically provided by city fire departments, fire protection districts, and counties, or by CAL FIRE under contract to local governments. The Cities of Dublin, Livermore and Pleasanton are located in incorporated LRAs. LRAs may include flammable vegetation and WUI areas where the financial and jurisdictional responsibility for improvement and wildfire protection is that of a local government agency.

SRAs were originally mapped in 1985, and LRAs were originally mapped in 1996. During that time, many local governments made similar designations under their own authority. CAL FIRE recognized the need to remap both SRAs and LRAs with more recent data and technology to create more accurate zone designations.

California's SB 1241 (adopted in 2012) requires local governments to update the safety elements in their general plans to recognize wildfire risks in SRAs and "Very High Fire Hazard Severity Zones" (based on consistent statewide criteria and the severity of fire hazard that is expected to prevail in those areas). SB 1241 correlates strongly with AB 2140, which requires local jurisdictions to adopt a federally approved hazard mitigation plan through reference in the safety elements of their general plans. This bill also notes the requirement for the safety element to include information and policies on unreasonable risk from potential hazards, including fire. These bills are both designed to encourage integration within and between jurisdictions to enhance mitigation and

prevention efforts. Information from a local general plan safety element should be considered with the development of a hazard mitigation plan, response procedures, evacuation planning, and long-term development.

12.2 HAZARD PROFILE

The 2013 *California Multi-Hazard Mitigation Plan* describes wildfire hazard and risk as follows:

> "The diversity of WUI settings and disagreement about alternative mitigation strategies has led to confusion and different methods of defining and mapping WUI areas. One major disagreement has been caused by terms such as "hazard" and "risk" being used interchangeably. Hazard is the physical condition that can lead to damage to a particular asset or resource. The term "fire hazard" is related to those physical conditions related to fire and its ability to cause damage, specifically how often a fire burns a given locale and what the fire is like when it burns (its fire behavior). Thus, fire hazard only refers to the potential characteristics of the fire itself.
>
> Risk is the likelihood of a fire occurring at a given site (burn probability) and the associated mechanisms of fire behavior that cause damage to assets and resources (fire behavior). This includes the impact of fire brands (embers) that may be blown some distance igniting fires well away from the main fire".

12.2.1 Past Events

According to the 2016 Alameda County Local Hazard Mitigation Plan, wildfires are common in the Bay Area, with large wildfires recorded in 1961, 1962, 1964, 1965, 1970, 1981, 1985, 1988, and 1991. However, none of these fires occurred in the Tri-Valley planning area. Between 1954 and April 2017, Alameda County was included in two FEMA major disaster (DR) fire management assistance declarations (DR-919 Oakland Hills Fire in 1991 and DR-295 Buckingham Norfolk Fire in 1970) but neither of these affected the planning area. With drought conditions in recent years, wildfires have occurred near the planning area, though none have caused sufficient damage to trigger a state or federal disaster declaration. The following wildfires of over 10 acres were recorded near the planning area in recent years (CAL FIRE, 2017):

- August 22, 2015—Burned 2,700 acres off Tesla Road near Correll Hollow between Livermore and Tracy. This fire took four days to contain with 18 fire personnel and five fire engines.
- June 25, 2015—Burned 53 acres off Tesla Road, southeast of Livermore.
- October 4, 2013—Burned 150 acres along Highland Road near Livermore.
- July 6, 2013, Fallon Fire—Burned 38 acres off Fallon Road and Camino Tasaajara near Dublin. The fire was contained within one day by Alameda County Fire Department.
- June 8, 2013, Vasco Fire—Burned 240 acres off Vasco Road and North Vasco Road, north of Livermore. The fire was contained within one day.

12.2.2 Location

CAL FIRE's Fire and Resource Assessment Program has modeled and mapped wildfire hazard zones using a science-based and field-tested computer model that designates moderate, high or very high fire hazard severity zones (FHSZ). The FHSZ model is built from existing CAL FIRE data and hazard information based on factors such as the following (CAL FIRE, 2017a):

- **Fuel**—Fuel may include living and dead vegetation on the ground, along the surface as brush and small trees, and above the ground in tree canopies. Lighter fuels such as grasses, leaves and needles quickly

expel moisture and burn rapidly, while heavier fuels such as tree branches, logs and trunks take longer to warm and ignite. Trees killed or defoliated by forest insects and diseases are more susceptible to wildfire.

- **Weather**—Relevant weather conditions include temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount and duration, and the stability of the atmosphere. Of particular importance for wildfire activity are wind and thunderstorms:
  - Strong, dry winds produce extreme fire conditions. Such winds generally reach peak velocities during the night and early morning hours.
  - The thunderstorm season typically begins in June with wet storms, and turns dry with little or no precipitation reaching the ground as the season progresses into July and August.
- **Terrain**—Topography includes slope and elevation. The topography of a region influences the amount and moisture of fuel; the impact of weather conditions such as temperature and wind; potential barriers to fire spread, such as highways and lakes; and elevation and slope of land forms (fire spreads more easily uphill than downhill).

The model also is based on frequency of fire weather, ignition patterns, and expected rate-of spread. It accounts for flying ember production, which is the principal driver of the wildfire hazard in densely developed areas. A related concern in built-out areas is the relative density of vegetative fuels that can serve as sites for new spot fires within the urban core and spread to adjacent structures. The model refines the zones to characterize fire exposure mechanisms that cause ignitions to structures. Significant land-use changes need to be accounted for through periodic model updates. Figure 12-1 shows the FHSZ mapping for Alameda County. Table 12-1 lists the total area mapped in each zone.

Table 12-1. Record of Fire Affecting Planning Area

FHSZ Category	Total Area in Zone (acres)	Area Burned, 1878 – 2016	
		Acres	Percent of Total
Moderate	10,564	115	1.09%
High	9,455	498	5.26%
Very High	472	0	0.00%

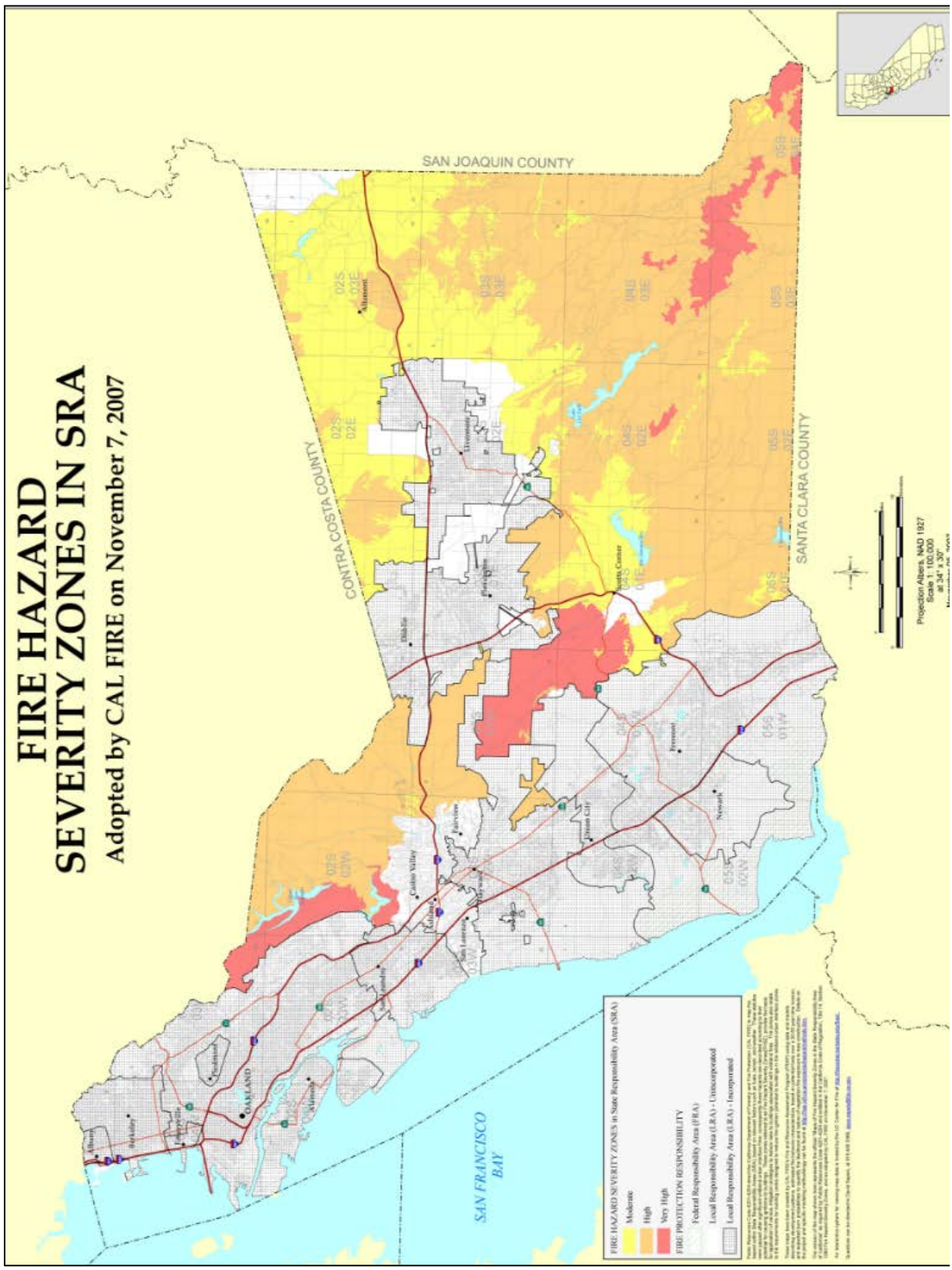
Source: CAL FIRE, 2016

12.2.1 Frequency

Wildfire frequency can be assessed through review of the percent of a given area that has been burned in previous wildfire events. Table 12-1 summarizes CAL FIRE records of fires from 1878 to 2016. About 3 percent of the mapped wildfire risk zones in the planning area have burned in that 138-year period.

12.2.2 Severity

Potential losses from wildfire include human life, structures and other improvements, and natural resources. Given the immediate response times to reported fires, the likelihood of injuries and casualties is minimal. Smoke and air pollution from wildfires can be a health hazard, especially for children, the elderly and those with respiratory and cardiovascular diseases. First responders are exposed to dangers from the initial incident and after-effects from smoke inhalation and heat stroke. In addition, wildfire can lead to ancillary impacts such as landslides in steep ravine areas and flooding due to the impacts of silt in local watersheds.



Source: CAL FIRE, 2007

Figure 12-1. CAL FIRE FRAP Map for Alameda County

The largest WUI fire in the Bay Area, and one of the worst wildland fires in the United States, occurred in 1991 in the Oakland Hills of Alameda County. The fire resulted in $1.7 billion in losses and received a FEMA disaster declaration. The fire spread across 1,520 acres, destroyed 3,354 homes and 456 apartments, injured 150 people and took the lives of 25 people (Alameda County, 2016a). There are no recorded incidents of loss of life from wildfires in the planning area.

CAL FIRE's mapped fire hazard severity zones define the application of mitigation strategies to reduce risk associated with wildfires. Figure 12-2 shows fire hazard severity zones for the Tri-Valley planning area.

12.2.3 Warning Time

Wildfires are often caused by humans, intentionally or accidentally. There is no way to predict when one might break out. Since fireworks often cause brush fires, extra diligence is warranted around the Fourth of July when the use of fireworks is highest. Dry seasons and droughts are factors that greatly increase fire likelihood. Dry lightning may trigger wildfires. Severe weather can be predicted, so special attention can be paid during weather events that may include lightning. Reliable National Weather Service lightning warnings are available on average 24 to 48 hours prior to a significant electrical storm.

If a fire does break out and spread rapidly, residents may need to evacuate within days or hours. A fire's peak burning period generally is between 1 p.m. and 6 p.m. Once a fire has started, fire alerting is reasonably rapid in most cases. The rapid spread of cellular and two-way radio communications in recent years has further contributed to a significant improvement in warning time.

12.3 SECONDARY HAZARDS

Wildfires can in some cases generate secondary effects that cause more widespread and prolonged damage than the fire itself. Fires can cause direct economic losses in the reduction of harvestable timber and indirect economic losses in reduced tourism. Wildfires can contaminate reservoirs, destroy transmission lines and contribute to flooding. They strip slopes of vegetation, exposing them to greater amounts of runoff, which can weaken soils and cause slope failures. Major landslides can occur several years after a wildfire. Most wildfires burn hot and for long durations that can bake soils, especially those high in clay content, thus increasing the imperviousness of the ground. This increases the runoff generated by storm events, thus increasing the chance of flooding.

12.4 EXPOSURE

12.4.1 Population

Population could not be examined by FHSZ because the boundaries of census block groups do not coincide with the zone boundaries. However, population was estimated using the structure count of buildings in each mapped FHSZ and multiplying by the 2016 estimated average population per household (CA DOF, 2016). Table 12-2 presents the results.

12.4.2 Property

The number of homes in the various wildfire hazard zones within the planning area and their values are summarized in Table 12-3 through Table 12-5. Table 12-6 shows the general land use of parcels exposed to the wildfire hazard in the planning area.

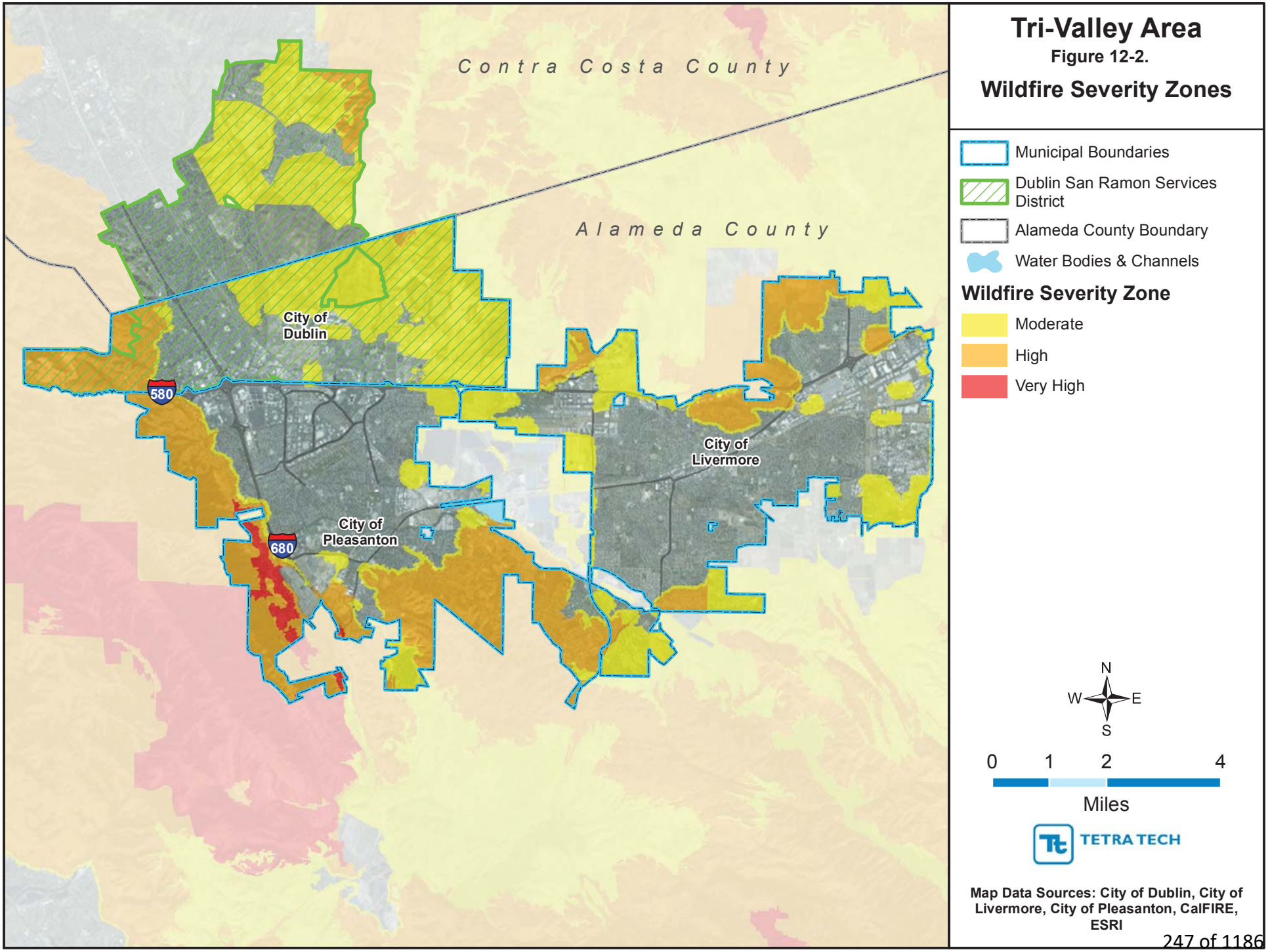

Contra Costa County
Alameda County
City of Dublin
City of Livermore
City of Pleasanton
580
680
Tri-Valley Area
Figure 12-2.
Wildfire Severity Zones
Municipal Boundaries
Dublin San Ramon Services District
Alameda County Boundary
Water Bodies & Channels
Wildfire Severity Zone
Moderate
High
Very High
N
W
E
S
0
1
2
4
Miles
TETRA TECH
Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, CalFIRE, ESRI

Table 12-2. Population within Wildfire Hazard Areas

	Moderate FHSZ		High FHSZ		Very High FHSZ	
	Population Exposed[a]	% of Total Population Exposed	Population Exposed[a]	% of Total Population Exposed	Population Exposed[a]	% of Total Population Exposed
Dublin	23,087	38.7%	6,402	10.7%	0	0.0%
Livermore	7,140	8.0%	6,642	7.4%	0	0.0%
Pleasanton	5,942	7.8%	11,528	15.2%	2,492	3.3%
Total	36,170	16.1%	24,572	10.9%	2,492	1.1%

a. Exposed population calculated as percent of residential buildings exposed multiplied by estimated population on January 1, 2017, from California Department of Finance.

Table 12-3. Exposure and Value of Structures in Very High Wildfire Hazard Areas

	Buildings Exposed[a]	Value Exposed			
		Structure	Contents	Total	% of Total Replacement Value
Dublin	0	$0	$0	$0	0.0%
Livermore	0	$0	$0	$0	0.0%
Pleasanton	708	$255,482,500	$129,473,890	$384,956,390	1.8%
Total	708	$255,482,500	$129,473,890	$384,956,390	0.7%

a. Fire hazard severity data downloaded from CAL FIRE website in May 2016.

Table 12-4. Exposure and Value of Structures in High Wildfire Hazard Areas

	Buildings Exposed[a]	Value Exposed			
		Structure	Contents	Total	% of Total Replacement Value
Dublin	1,744	$631,760,619	$341,680,204	$973,440,823	8.0%
Livermore	2,038	$863,648,160	$655,619,139	$1,519,267,300	7.4%
Pleasanton	3,313	$1,749,485,861	$1,018,950,914	$2,768,436,776	13.2%
Total	7,095	$3,244,894,640	$2,016,250,257	$5,261,144,898	9.8%

a. Fire hazard severity data downloaded from CAL FIRE website in May 2016.

Table 12-5. Exposure and Value of Structures in Moderate Wildfire Hazard Areas

	Buildings Exposed[a]	Value Exposed			
		Structure	Contents	Total	% of Total Replacement Value
Dublin	6,300	$2,650,676,069	$1,451,005,773	$4,101,681,842	33.7%
Livermore	2,234	$1,267,065,382	$1,011,668,475	$2,278,733,857	11.1%
Pleasanton	1,705	$755,916,113	$459,120,197	$1,215,036,310	5.8%
Total	10,239	$4,673,657,564	$2,921,794,444	$7,595,452,009	14.1%

a. Fire hazard severity data downloaded from CAL FIRE website in May 2016.

Table 12-6. Land Use Within the Wildfire Hazard Areas

Land Use	Moderate FHSZ		High FHSZ		Very High FHSZ	
	Area (acres)	% of total	Area (acres)	% of total	Area (acres)	% of total
Residential	2,189	20.7%	3,496	37.0%	332	70.4%
Commercial	363	3.4%	450	4.8%	0	0.0%
Industrial	236	2.2%	56	0.6%	0	0.0%
Agriculture	24	0.2%	25	0.3%	0	0.0%
Religion / Assembly	133	1.3%	59	0.6%	5	1.1%
Government / Institutional	1,314	12.4%	0	0.0%	0	0.0%
Education	248	2.3%	85	0.9%	3	0.7%
Vacant / Rights-of-Way / Water / Open Space	6,056	57.3%	5,284	55.9%	131	27.8%
Total	10,564	100.0%	9,455	100.0%	472	100.0%

12.4.3 Critical Facilities and Infrastructure

Table 12-7 identifies critical facilities exposed to the wildfire hazard in the planning area.

Table 12-7. Critical Facilities and Infrastructure in Wildfire Hazard Areas

	Medical and Health Services	Emergency Services	Educational Facilities	Government / City Facilities	Utilities	Transportation Infrastructure	Hazardous Materials	Other Assets	Total
Moderate Hazard Zone									
Dublin	0	5	2	3	0	8	0	0	18
Livermore	0	0	3	0	6	12	3	0	24
Pleasanton	1	0	4	0	4	5	2	0	16
High Hazard Zone									
Dublin	2	0	1	0	0	0	0	0	3
Livermore	1	0	1	0	1	6	0	0	9
Pleasanton	1	1	0	0	33	9	1	0	45
Very High Hazard Zone									
Dublin	0	0	0	0	0	0	0	0	0
Livermore	0	0	0	0	0	0	0	0	0
Pleasanton	0	0	0	0	5	2	0	0	7
Total	5	6	11	3	49	42	6	0	122

Currently there are six registered Toxic Release Inventory hazardous material containment sites in wildfire risk zones. During a wildfire event, these materials could rupture due to excessive heat and act as fuel for the fire, causing rapid spreading and escalating the fire to unmanageable levels. In addition they could leak into surrounding areas, saturating soils and seeping into surface waters, and have a disastrous effect on the environment.

In the event of wildfire, there would likely be little damage to the majority of infrastructure. Most roads and railroads would be without damage except in the worst scenarios. Power lines are the most at risk to wildfire because most are made of wood and susceptible to burning. In the event of a wildfire, pipelines could provide a source of fuel and lead to a catastrophic explosion.

12.4.4 Environment

Fire is a natural and critical ecosystem process in most terrestrial ecosystems, dictating in part the types, structure, and spatial extent of native vegetation. However, wildfires can cause severe environmental impacts:

- Damaged Fisheries—Critical fisheries can suffer from increased water temperatures, sedimentation, and changes in water quality.
- Soil Erosion—The protective covering provided by foliage and dead organic matter is removed, leaving the soil fully exposed to wind and water erosion. Accelerated soil erosion occurs, causing landslides and threatening aquatic habitats.
- Spread of Invasive Plant Species—Non-native woody plant species frequently invade burned areas. When weeds become established, they can dominate the plant cover over broad landscapes, and become difficult and costly to control.
- Disease and Insect Infestations—Unless diseased or insect-infested trees are swiftly removed, infestations and disease can spread to healthy forests and private lands. Timely active management actions are needed to remove diseased or infested trees.
- Destroyed Endangered Species Habitat—Catastrophic fires can have devastating consequences for endangered species.
- Soil Sterilization—Topsoil exposed to extreme heat can become water repellant, and soil nutrients may be lost. It can take decades or even centuries for ecosystems to recover from a fire. Some fires burn so hot that they can sterilize the soil.

Many ecosystems are adapted to historical patterns of fire occurrence. These patterns, called “fire regimes,” include temporal attributes (e.g., frequency and seasonality), spatial attributes (e.g., size and spatial complexity), and magnitude attributes (e.g., intensity and severity), each of which have ranges of natural variability. Ecosystem stability is threatened when any of the attributes for a given fire regime diverge from its range of natural variability.

12.5 VULNERABILITY

Structures, above-ground infrastructure, critical facilities and natural environments are all vulnerable to the wildfire hazard. There is currently no validated damage function available to support wildfire mitigation planning. Except as discussed in this section, vulnerable populations, property, infrastructure and environment are assumed to be the same as described in the section on exposure.

12.5.1 Population

There are no recorded incidents of loss of life from wildfires within the planning area. Given the immediate response times to reported fires, the likelihood of injuries and casualties is minimal; therefore, injuries and casualties were not estimated for the wildfire hazard.

Smoke and air pollution from wildfires can be a severe health hazard, especially for sensitive populations, including children, the elderly and those with respiratory and cardiovascular diseases. Smoke generated by wildfire consists of visible and invisible emissions that contain particulate matter (soot, tar, water vapor, and minerals), gases (carbon monoxide, carbon dioxide, nitrogen oxides), and toxics (formaldehyde, benzene). Emissions from wildfires depend on the type of fuel, the moisture content of the fuel, the efficiency (or temperature) of combustion, and the weather. Public health impacts associated with wildfire include difficulty in breathing, odor, and reduction in visibility.

Wildfire may also threaten the health and safety of those fighting the fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke.

12.5.2 Property

Loss estimations for wildfire are not based on damage functions, because no such functions have been generated. Instead, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the assessed value of exposed structures. This allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 12-8 lists the loss estimates for the general building stock for jurisdictions that have an exposure to a fire hazard severity zone.

Table 12-8. Wildfire Loss Potential

	Exposed Value (Structure and contents)	Loss Potential from Wildfire		
		10% Damage	30% Damage	50% Damage
Dublin	$5,075,122,665	$507,512,266	$1,522,536,799	$2,537,561,332
Livermore	$3,798,001,157	$379,800,115	$1,139,400,347	$1,899,000,578
Pleasanton	$4,368,429,476	$436,842,947	$1,310,528,842	$2,184,214,737
Total	$13,241,553,297	$1,324,155,329	$3,972,465,989	$6,620,776,648

12.5.3 Critical Facilities and Infrastructure

Critical facilities of wood frame construction are especially vulnerable to wildfire. In the event of wildfire, there would likely be little damage to most infrastructure. Most roads and railroads would be without damage except in the worst scenarios. Power lines are the most at risk from wildfire because most poles are made of wood and susceptible to burning. Fires can create conditions that block or prevent access and can isolate residents and emergency service providers. Wildfire typically does not have a major direct impact on bridges, but it can create conditions in which bridges are obstructed. Many bridges in areas of high to moderate fire risk are important because they provide the only ingress and egress to large areas and in some cases to isolated neighborhoods.

12.6 FUTURE TRENDS IN DEVELOPMENT

The highly urbanized portions of the planning area have little or no wildfire risk exposure. Urbanization tends to alter the natural fire regime, and can create the potential for the expansion of urbanized areas into wildland areas. The expansion of the wildland urban interface can be managed with strong land use and building codes. The planning area is well equipped with these tools and this planning process has assessed capabilities with regards to the tools. As the planning area experiences future growth, it is anticipated that the exposure to this hazard will remain as assessed or even decrease over time due to these capabilities. Table 12-9 shows the future land use within the moderate, high, and very high FHSZ.

12.7 SCENARIO

A major wildfire in the planning area might begin with a wet spring, adding to fuels already present on the forest floor. Flashy fuels would build throughout the spring. A dry summer could follow the wet spring, exacerbated by diablo winds. Carelessness with combustible materials or a tossed lit cigarette, or a sudden lighting storm could trigger a multitude of small isolated fires.

The embers from these smaller fires could be carried miles by hot, dry winds. The deposition zone for these embers would be deep in the forests and interface zones. Fires that start in flat areas move slower, but wind still pushes them. It is not unusual for a wildfire pushed by wind to burn the ground fuel and later climb into the crown and reverse its track. This is one of many ways that fires can escape containment, typically during periods when response capabilities are overwhelmed. These new small fires would most likely merge. Suppression resources would be redirected from protecting the natural resources to saving more remote subdivisions.

Table 12-9. Future Land Use Within the Wildfire Hazard Areas

Land Use	Moderate FHSZ		High FHSZ		Very High FHSZ	
	Area (acres)	% of total	Area (acres)	% of total	Area (acres)	% of total
Residential	2,409	22.8%	4,077	43.1%	408	86.4%
Commercial	298	2.8%	284	3.0%	7	1.4%
Industrial	940	8.9%	141	1.5%	0	0.0%
Agriculture	644	6.1%	313	3.3%	0	0.0%
Religion / Assembly	2,333	22.1%	159	1.7%	4	0.9%
Government / Institutional	167	1.6%	19	0.2%	0	0.0%
Education	3,774	35.7%	4,468	47.2%	53	11.2%
Vacant / Rights-of-Way / Water / Open Space	10,566	100.0%	9,462	100.0%	472	100.0%
Total	2,409	22.8%	4,077	43.1%	408	86.4%

While local fire districts would be extremely useful in the urban interface areas, they have limited wildfire capabilities or experience, and they would have a difficult time responding to the ignition zones. Even though the existence and spread of the fire is known, it may not be possible to respond to it adequately, so an initially manageable fire can become out of control before resources are dispatched.

12.8 ISSUES

The major issues for wildfire are the following:

- Public education and outreach to people living in or near the fire hazard zones should include information about and assistance with mitigation activities such as defensible space, and advance identification of evacuation routes and safe zones.
- Wildfires could cause multiple secondary natural hazards.
- Climate change could affect the wildfire hazard.
- Future growth into interface areas should continue to be managed, particularly in the western hillside area of Pleasanton.
- Area fire districts need to continue to train on wildland-urban interface events.
- Vegetation management activities. This would include enhancement through expansion of the target areas as well as additional resources.
- Regional consistency of higher building code standards such as residential sprinkler requirements and prohibitive combustible roof standards.

13. CLIMATE CHANGE

13.1 GENERAL BACKGROUND

13.1.1 What Is Climate Change?

Climate, consisting of patterns of temperature, precipitation, humidity, wind and seasons, plays a fundamental role in shaping natural ecosystems and the human economies and cultures that depend on them. "Climate change" refers to changes over a long period of time. Worldwide, average temperatures have increased 1.7ºF since 1880 (NASA, 2017). Although this change may seem small, it can lead to large changes in climate and weather.

The warming trend and its related impacts are caused by increasing concentrations of carbon dioxide and other greenhouse gases in the earth's atmosphere. Greenhouse gases are gases that trap heat in the atmosphere, resulting in a warming effect. Carbon dioxide is the most commonly known greenhouse gas, but methane, nitrous oxide and fluorinated gases also contribute to warming. Emissions of these gases come from a variety of sources, such as the combustion of fossil fuels, agricultural production, changes in land use and volcanic eruptions. According to the U.S. Environmental Protection Agency (EPA), carbon dioxide concentration measured about 280 parts per million (ppm) before the industrial era began in the late 1700s and reached 401 ppm in 2015 (EPA, 2016) (see Figure 13-1). In addition, the concentration of methane has almost doubled, and nitrous oxide is being measured at a record high of 328 parts per billion (ppb) (EPA, 2016a). In the United States, electricity generation is the largest source of these emissions, followed by transportation (EPA, 2016b).

Scientists are able to place this rise in carbon dioxide in a longer historical context through the measurement of carbon dioxide in ice cores. According to these records, carbon dioxide concentrations in the atmosphere are the highest that they have been in 650,000 years. According to NASA, this trend is of particular significance "because most of it is very likely human-induced and [it is] proceeding at a rate that is unprecedented in the past 1,300 years". There is broad scientific consensus (97 percent of scientists) that climate-warming trends are very likely due to human activities (NASA, 2017). Unless emissions of greenhouse gases are substantially reduced, this warming trend and its associated impacts are expected to continue.

Climate change will affect the people, property, economy and ecosystems of the planning area in a variety of ways. Climate change impacts are most frequently associated with negative consequences, such as increased flood vulnerability or increased heat-related illnesses/public health concerns; however, other changes may present opportunities. The most important effect for the development of this plan is that climate change will have a measurable impact on the occurrence and severity of natural hazards.

13.1.2 How Climate Change Affects Hazard Mitigation

An essential aspect of hazard mitigation is predicting the likelihood of hazard events in a planning area. Typically, predictions are based on statistical projections from records of past events. This approach assumes that the likelihood of hazard events remains essentially unchanged over time. Thus, averages based on the past frequencies of, for example, floods are used to estimate future frequencies: if a river has flooded an average of once every 5 years for the past 100 years, then it can be expected to continue to flood an average of once every 5 years.

Source: EPA, 2016

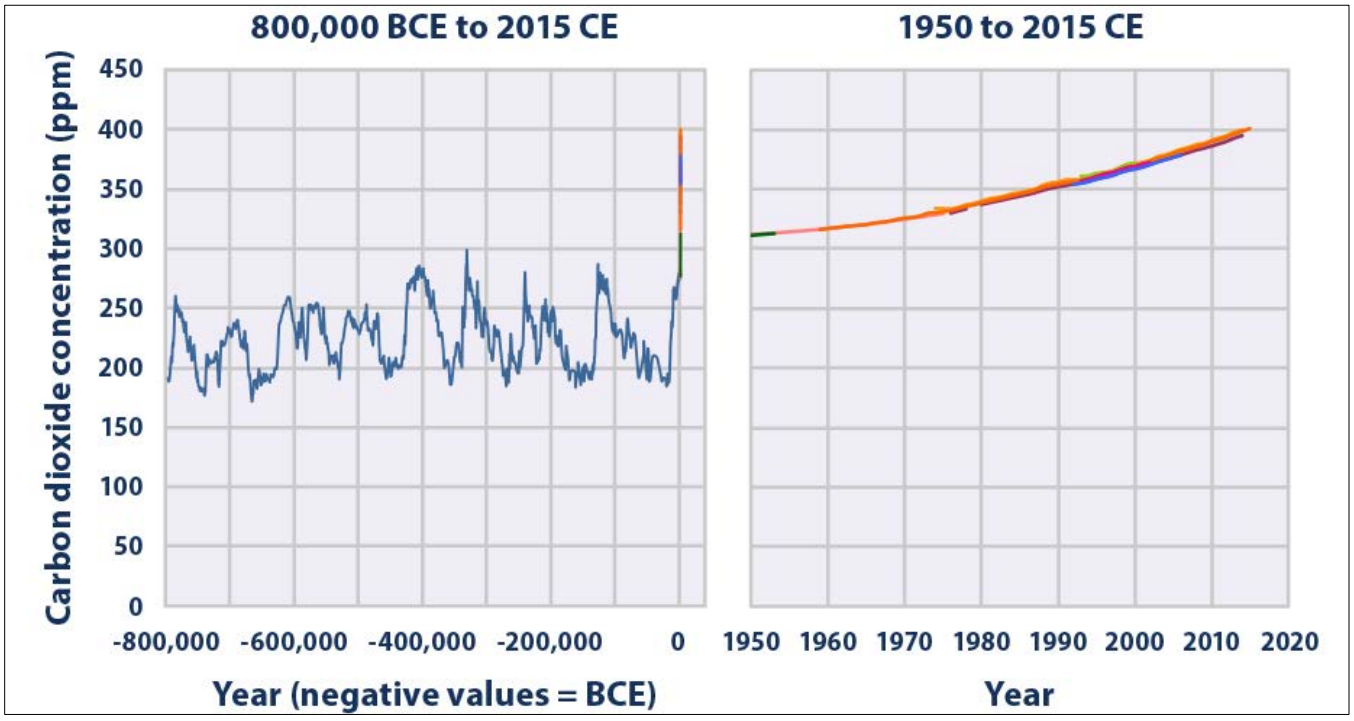


Figure 13-1. Global Carbon Dioxide Concentrations over Time

For hazards that are affected by climate conditions, the assumption that future behavior will be equivalent to past behavior is not valid if climate conditions are changing. As flooding is generally associated with precipitation frequency and quantity, for example, the frequency of flooding will not remain constant if broad precipitation patterns change over time. Specifically, as hydrology changes, storms currently considered to be a 1-percent-annual-chance event might strike more often, leaving many communities at greater risk. The risks of, landslide, severe storms, extreme heat and wildfire are all affected by climate patterns as well. For this reason, an understanding of climate change is pertinent to efforts to mitigate natural hazards. Information about how climate patterns are changing provides insight on the reliability of future hazard projections used in mitigation analysis. This chapter summarizes current understandings about climate change in order to provide a context for the recommendation and implementation of hazard mitigation measures.

13.1.3 Current Indicators of Climate Change

The major scientific agencies of the United States and the world—including NASA, NOAA and the Intergovernmental Panel on Climate Change (IPCC)—agree that climate change is occurring. Multiple temperature records from all over the world have shown a warming trend. The IPCC has stated that the warming of the climate system is unequivocal (IPCC, 2014). Sixteen of the 17 warmest years on record occurred since 2001, and 2016 was the warmest year on record (NASA, 2016b).

Rising global temperatures have been accompanied by other changes in weather and climate. Many places have experienced changes in rainfall resulting in more intense rain, as well as more frequent and severe heat waves (IPCC, 2014). The planet's oceans and glaciers have also experienced changes: oceans are warming and becoming more acidic, ice caps are melting, and sea levels are rising. Global sea level has risen approximately 6.7 inches, on average, in the last 100 years (NASA, 2017). This has already put some coastal homes, beaches, roads, bridges, and wildlife at risk (USGCRP, 2009).

NASA currently maintains information on the vital signs of the planet. At the time of the development of this plan, the following trends and status of these signs are as follows (NASA, 2017a):

- Carbon Dioxide—Increasing trend, currently at 406.17 parts per million
- Global Temperature—Increasing trend, increase of 1.7 ºF since 1880
- Arctic Ice Minimum—Decreasing trend, 13.3 percent per decade
- Land Ice—Decreasing trend, 287.0 gigatonnes per year
- Sea Level—Increasing trend, 3.4 millimeters (0.04 inches) per year.

13.1.4 Projected Future Impacts

The *Third National Climate Assessment Report for the United States* indicates that impacts resulting from climate change will continue through the 21st century and beyond. Although not all changes are understood at this time and the impacts of those changes will depend on global emissions of greenhouse gases and sensitivity in human and natural systems, the following impacts are expected in the United States:

- Temperatures will continue to rise
- Growing seasons will lengthen
- Precipitation patterns will change
- Droughts and heat waves will increase
- Hurricanes will become stronger and more intense
- Sea level will rise 1-4 feet by 2100
- The Arctic may become ice free.

The *California Climate Adaptation Planning Guide* outlines the following climate change impact concerns for Bay Area communities (Cal EMA et al., 2012):

- Increased temperature
- Reduced precipitation
- Sea level rise—coastal inundation and erosion
- Public health—heat and air pollution
- Reduced agricultural productivity
- Inland flooding
- Reduced tourism.

Some of these changes are direct or primary climatic changes, such as increased temperature, while others are indirect climatic changes or secondary impacts, such as heat wave frequency, resulting from these direct changes. Some direct changes may interact with one another to create unique secondary impacts. These primary and secondary impacts may then result in impacts on human and natural systems. The primary and secondary impacts likely to affect the planning area are summarized in Table 13-1.

Climate change projections contain inherent uncertainty, largely derived from the fact that they depend on future greenhouse gas emission scenarios. Generally, the uncertainty in greenhouse gas emissions is addressed by the presentation of differing scenarios: low-emissions or high-emissions scenarios. In low-emissions scenarios, greenhouse gas emissions are reduced substantially from current levels. In high-emissions scenarios, greenhouse gas emissions generally increase or continue at current levels. Uncertainty in outcomes is generally addressed by averaging a variety of model outcomes.

Table 13-1. Summary of Primary and Secondary Impacts

Primary Impact	Secondary Impact	Example Human and Natural System Impacts
Increased temperature	Heat wave	• Increased frequency of illness and death • Increased stress on mechanical systems, such as HVAC systems
Increased temperature and changes in precipitation	Changed seasonal patterns	• Reduced agricultural productivity • Reduced tourism
Increased temperature and/or reduced precipitation	Drought	• Reduced agricultural productivity • Decreased water supply
	Reduced Snowpack	• Decreased water supply • Reduced tourism
	Wildfire	• Increased incidence of landslide or mudslide • Reduced tourism • Increase in air pollution and related health impacts
Sea level rise	Permanent inundation of previously dry land	• Loss of assets and tax base • Loss of coastal habitat
	Larger area impacted by extreme high tide	• More people and structures impacted by storms • Increased incidence of loss of utilities and lifeline systems
	Increased coastal erosion	• Loss of assets and tax base
	Saltwater intrusion into freshwater systems	• Decreased water supply • Ecosystem disruption Sea level rise
Changes in wind patterns	Increased extreme events, including severe storms and fires	• More frequent disruption to systems resulting from severe storms
Ocean acidification		• Decreased biodiversity in marine ecosystems

Source: Adapted and expanded from *California Adaptation Planning Guide: Planning for Adaptive Communities*

Despite this uncertainty, climate change projections present valuable information to help guide decision-making for possible future conditions. The following sections summarize information developed for the planning area by Cal-Adapt, a resource for public information on how climate change might impact local communities, based on the most current data available. The projections are averaged across Alameda County and include information from two emissions scenarios, which were developed by the IPCC (Cal-Adapt, 2017):

- Low Emissions Scenario—Emissions peak around 2040 and then decline (this was designated Scenario B1 in previous IPCC analyses but is Scenario RCP 4.5 under more recent IPCC analyses)
- High Emissions Scenario—Emissions continue to rise strongly through 2050 and plateau around 2100 (this was designated Scenario A2 in previous IPCC analyses but is Scenario RCP 8.5 under more recent IPCC analyses).

Temperature

The historical (1961-1990) average maximum temperature in Tri-Valley planning area was 69.9ºF and the average minimum temperature was 44.6ºF. While average temperatures may fluctuate from year-to-year, and may differ from one municipality to the next, the trend for the planning area indicates that average temperatures are increasing (see Figure 13-2). The annual average maximum temperature increased by 7.7ºF when comparing 1961 to 1990 and 2070 to 2099 records. Average temperatures are expected to continue to rise. Table 13-2 shows the estimated average temperatures for 2050 and 2099 under the low and high emission scenario.

Source: Cal-Adapt, 2017

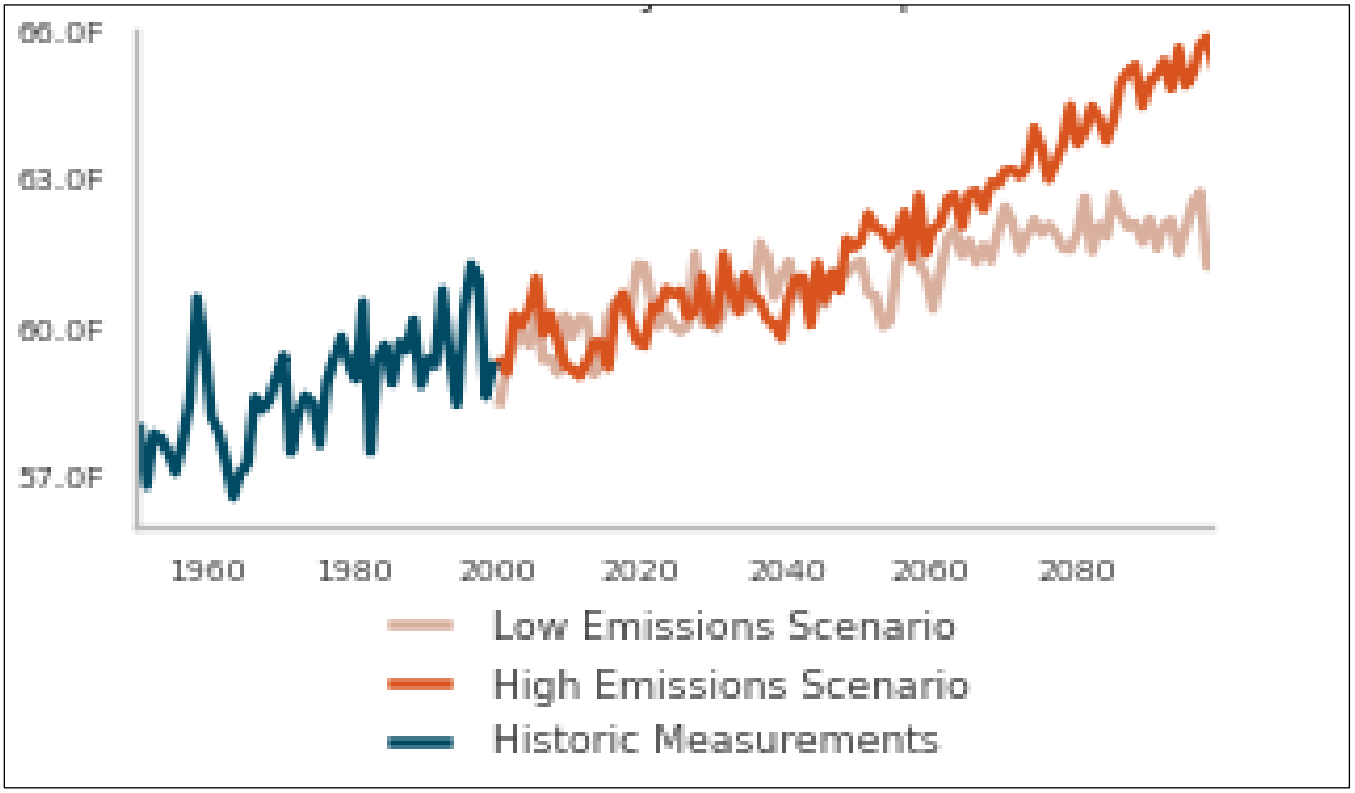


Figure 13-2. Observed and Projected Average Temperatures in Tri-Valley planning area

Table 13-2. Average Temperature Projections in Tri-Valley planning area

	2050 Projection (°F)				2099 Projection (°F)			
	Average Temperature		Difference from Historical Average		Average Temperature		Difference from Historical Average	
Emission Scenario	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
Low Emissions (RCP 4.5)	73.9	50.1	+4.0	+5.5	76.23	49.3	+6.3	+4.7
High Emissions (RCP 8.5)	74.8	51.0	+4.9	+6.4	80.6	56.4	+10.7	+11.8

Extreme Heat

The extreme heat day temperature threshold for the planning area is 98.3°F. The historical average (1961-1990) number of extreme heat days is 4.3 days. In the low emissions scenario, there are projected to be an annual average of 13 days with temperatures over the extreme heat day threshold between 2017 and 2050 and between 2051 and 2099. In the high emissions scenario, there are projected to be an annual average of 20 days with temperatures over the extreme heat day threshold between 2017 and 2050 and an average of 19 days per year between 2051 and 2099 (see Figure 13-3).

Source: Cal-Adapt, 2017

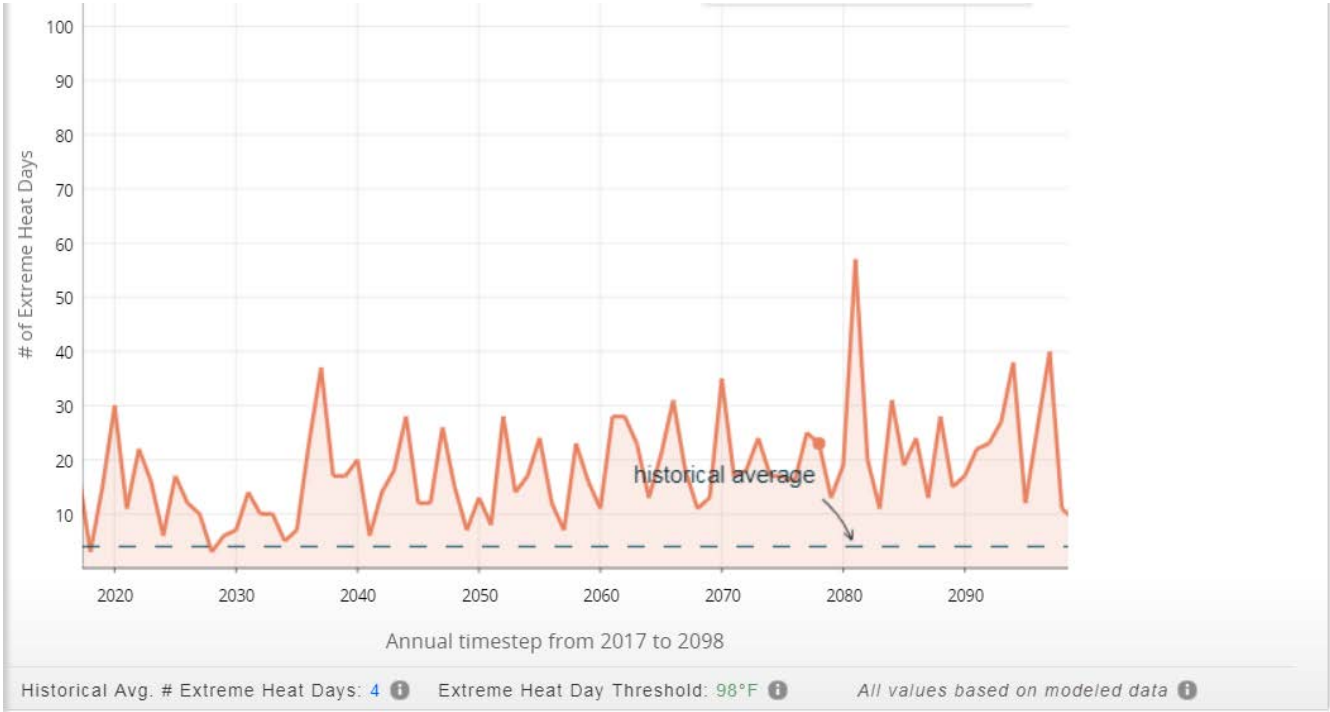


Figure 13-3. Projected Number of Extreme Heat Days by Year

Precipitation

Cal-Adapt shows that the historical annual mean precipitation (1961-1990) for the Tri-Valley planning area was 21.1 inches. Under the low and high emission scenario, annual precipitation is expected to average 22.75 inches from 2017 to 2050 and 29.22 inches from 2051 to 2099. In general, most precipitation is expected to continue to fall during the winter. Small changes in precipitation patterns in the state will have the potential to cause significant disruption to built and natural systems.

Snowpack

While there are no snow-water equivalency measurements for the planning area, Cal-Adapt indicates that changes in precipitation patterns may result in a reduction in snowpack. For example, Sierra Nevada snowpack may be reduced by as much as 70 to 90 percent.

Wildfire

Wildfire risk is expected to change in the coming decades (see Figure 13-4). Under both high- and low-emissions scenarios, the change in area burned in planning area decreases by 10 to 20 percent by 2050.

Sea Level Rise

Sea levels have been rising over the past several decades and are expected to continue to rise. Sea level rise is mostly attributed to two factors: the expansion of water as it warms (thermal expansion) and the melting of ice sheets and glaciers. As average ocean temperatures continue to increase, thermal expansion will continue and can be projected with some degree of certainty. Less certain is how quickly ice sheets will melt, accounting for most of the uncertainty in projections.

Source: Cal-Adapt, 2017

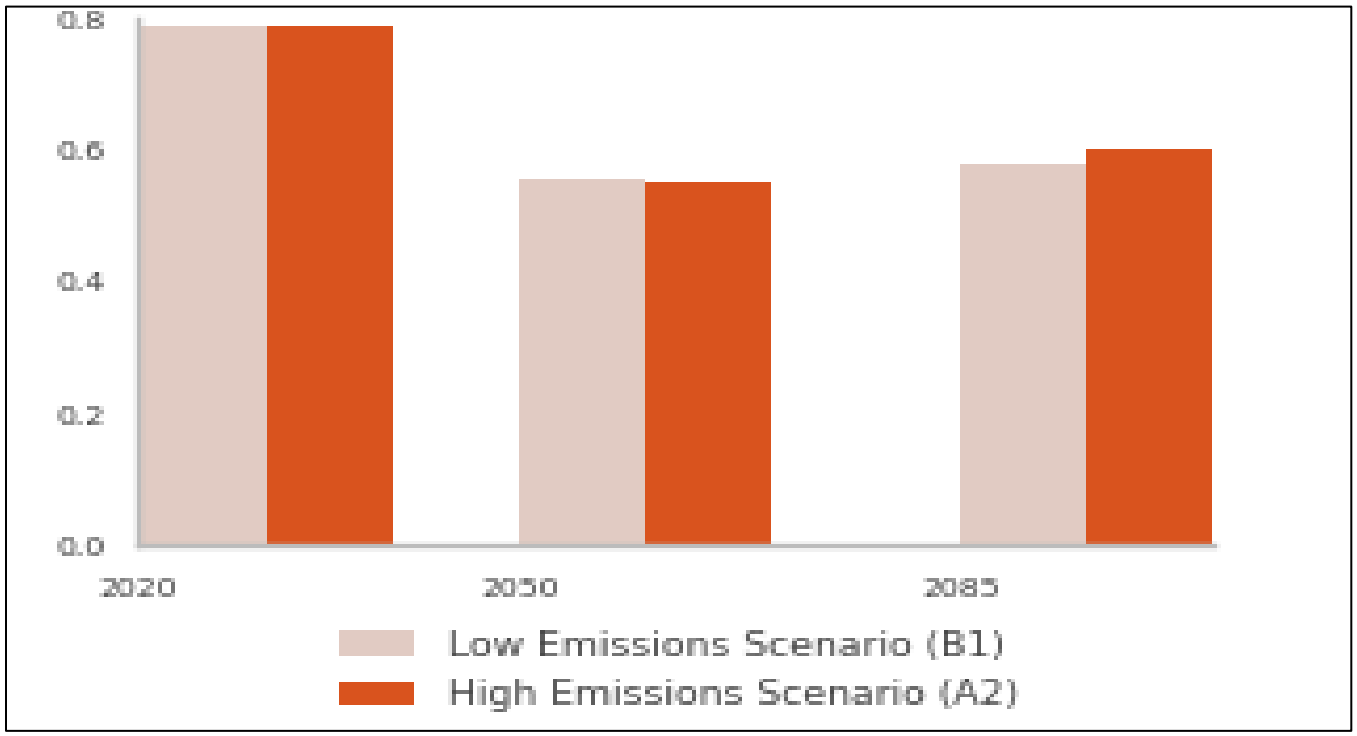


Figure 13-4. Projected Changes in Fire Risk, Relative to 2010 Levels

Sea level rise will cause currently dry areas to be permanently or chronically inundated. Temporary inundation from extreme tide events and storm surge also will change. Unlike many other impacts resulting from climate change, sea level rise will have a defined extent and location. This allows for a more-detailed risk assessment to be conducted for this climate change impact. Although the extent and timing of sea level rise is still uncertain, conducting an assessment of potential areas at risk provides information appropriate for planning purposes.

13.1.5 Responses to Climate Change

Communities and governments worldwide are working to address, evaluate and prepare for climate changes that are likely to impact communities in coming decades. Generally, climate change discussions encompass two separate but inter-related considerations: mitigation and adaptation. The term "mitigation" can be confusing, because it's meaning changes across disciplines:

- Mitigation in restoration ecology and related fields generally refers to policies, programs or actions that are intended to reduce or to offset the negative impacts of human activities on natural systems. Generally, mitigation can be understood as avoiding, minimizing, rectifying, reducing or eliminating, or compensating for known impacts (CEQ, 1978).
- Mitigation in climate change discussions is defined as "a human intervention to reduce the impact on the climate system." It includes strategies to reduce greenhouse gas sources and emissions and enhance greenhouse gas sinks (EPA, 2013).
- Mitigation in emergency management is typically defined as the effort to reduce loss of life and property by lessening the impact of disasters (FEMA, 2013).

In this chapter, mitigation is used as defined by the climate change community. In the other chapters of this hazard mitigation plan, mitigation is primarily used in an emergency management context.

The IPCC defines adaption as "the process of adjustment to actual or expected climate and its effects." Mitigation and adaptation are related, as the world's ability to reduce greenhouse gas emissions will affect the degree of adaptation that will be necessary. Some actions can both reduce greenhouse gas emissions and support adaptation to likely future conditions. Some adaptation actions also help communities reach other community goals (referred to as co-benefits). The ability to adapt to changing conditions is often referred to as adaptive capacity, which is "the ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences" (IPCC, 2014).

Societies across the world are facing the need to adapt to changing conditions and to identify ways to increase their adaptive capacity. Some efforts are already underway. Farmers are altering crops and agricultural methods to deal with changing rainfall and rising temperature; architects and engineers are redesigning buildings; planners are looking at managing water supplies to deal with droughts or flooding.

Adaptive capacity goes beyond human systems, as some ecosystems show a remarkable ability to adapt to change and to buffer surrounding areas from the impacts of change. Forests can bind soils and hold large volumes of water during times of plenty, releasing it through the year; floodplains can absorb vast volumes of water during peak flows; coastal ecosystems can hold out against storms, attenuating waves and reducing erosion. Other ecosystem services—such as food provision, timber, materials, medicines and recreation—can provide a buffer to societies in the face of changing conditions. Ecosystem-based adaptation is the use of biodiversity and ecosystem services as part of an overall strategy to help people adapt to the adverse effects of climate change. This includes the sustainable management, conservation and restoration of specific ecosystems that provide key services.

Assessment of the current efforts and adaptive capacity of the planning partners participating in this hazard mitigation plan are included in the jurisdiction-specific annexes in Volume 2.

13.2 VULNERABILITY ASSESSMENT

The following sections provide information on how each natural hazard of concern for this planning process may be impacted by climate change and how these impacts may alter current exposure and vulnerability for the people, property, critical facilities and the environment in the planning area.

13.2.1 Dam Failure

Climate Change Impacts on the Hazard

On average, changes in California's annual precipitation levels are not expected to be dramatic; however, small changes may have significant impacts for water resource systems, including dams. Dams are designed partly based on assumptions about a river's flow behavior, expressed as hydrographs. Changes in weather patterns can have significant effects on the hydrograph used for the design of a dam. If the hygrograph changes, it is conceivable that the dam can lose some or all of its designed margin of safety, also known as freeboard. If freeboard is reduced, dam operators may be forced to release increased volumes earlier in a storm cycle in order to maintain the required margins of safety. Such early releases of increased volumes can increase flood potential downstream.

According to the California Department of Water Resources, flood flows on many California rivers have been record setting since the 1950s. This means that water infrastructure, such as dams, have been forced to manage flows for which they were not designed. The California Division of Safety of Dams has indicated that climate change may result in the need for increased safety precautions to address higher winter runoff, frequent fluctuations of water levels, and increased potential for sedimentation and debris accumulation from changing erosion patterns and increases in wildfires. According to the Division, climate change also will impact the ability of dam operators to estimate extreme flood events (DWR, 2017b).

Dams are constructed with safety features known as "spillways." Spillways are put in place on dams as a safety measure in the event of the reservoir filling too quickly. Spillway overflow events, often referred to as "design failures," result in increased discharges downstream and increased flooding potential. Although climate change will not increase the probability of catastrophic dam failure, it may increase the probability of design failures. These types of conditions were observed during the emergency spillway failure of Oroville dam in California in the spring of 2017 (see Figure 13-5).



Figure 13-5. Oroville Dam Emergency Spillway Failure in Spring 2017

Exposure, Sensitivity and Vulnerability

Population

Population exposure and vulnerability to the dam failure hazard are unlikely to change as a result of climate change. However, if areas previously protected by accredited levees are mapped in a special flood hazard area, the number of people residing in flood hazard areas may increase.

Property

Property exposure and vulnerability to the dam failure hazard are unlikely to change as a result of climate change. However, if areas previously protected by accredited levees are mapped in a special flood hazard area, the assets considered to be exposed to the flood hazard may increase.

Critical facilities

The exposure and vulnerability of critical facilities are unlikely to change as result of climate change. Dam owners and operators are sensitive to the risk and may need to alter maintenance and operations to account for changes in the hydrograph and increased sedimentation.

Environment

The exposure and vulnerability of the environment to dam failure are unlikely to change as a result of climate change. Ecosystem services may be used to mitigate some factors that could increase the risk of design failures, such as increasing the natural water storage capacity in watersheds above dams.

Economy

Changes in the dam failure hazard related to climate change are unlikely to affect the local economy.

13.2.2 Drought

Climate Change Impacts on the Hazard

The long-term effects of climate change on regional water resources are unknown, but global water resources are already experiencing the following stresses without climate change:

- Growing populations
- Increased competition for available water
- Poor water quality
- Environmental claims
- Uncertain reserved water rights
- Groundwater overdraft
- Aging urban water infrastructure.

With a warmer climate, droughts could become more frequent, more severe, and longer-lasting. According to the National Climate Assessment, "higher surface temperatures brought about by global warming increase the potential for drought. Evaporation and the higher rate at which plants lose moisture through their leaves both increase with temperature. Unless higher evapotranspiration rates are matched by increases in precipitation, environments will tend to dry, promoting drought conditions" (NCA, 2014a).

Because future changes in precipitation patterns are still uncertain, the potential impacts and likelihood of drought are uncertain. That being said, DWR has already noted the impact of climate change on statewide water resources by charting changes in snowpack and river flow. As temperatures rise and more precipitation comes in the form of rain instead of snow, these changes will likely continue or grow even more significant. DWR estimates that the Sierra Nevada snowpack, which provides a large amount of the water supply for the planning area and other parts of the state, will experience a 48- to 65-percent reduction from historic April 1 averages by the end of the century (DWR, 2017b). Increasing temperatures may also increase net evaporation from reservoirs by 15 to 37 percent (DWR, 2013). The planning area's water supply is also derived from groundwater resources. Increased incidence of drought may cause a drawdown in these resources without allowing opportunity for aquifer recharge.

Exposure, Sensitivity and Vulnerability

Population

Population exposure and vulnerability to drought are unlikely to increase as a result of climate change. While greater numbers of people may need to engage in behavior change, such as water saving efforts, significant life or health impacts are unlikely.

Property

Property exposure and vulnerability may increase as a result of increased drought resulting from climate change, although this would most likely occur in non-structural property such as landscaping. It is unlikely that structure exposure and vulnerability would increase as a direct result of drought, although secondary impacts of drought, such as wildfire, may increase and threaten structures.

Critical facilities

Critical facility exposure and vulnerability are unlikely to increase as a result of increased drought resulting from climate change; however, critical facility operators may be sensitive to changes and need to alter standard management practices and actively manage resources, particularly in water-related service sectors.

Environment

The vulnerability of the environment may increase as a result of increased drought resulting from climate change. Ecosystems and biodiversity in the Bay Area are already under stress from development and water diversion activities. Prolonged or more frequent drought resulting from climate change may further stress the ecosystems in the region, which include many special status species.

Economy

Increased incidence of drought could increase the potential for impacts on the local economy. Increased drought may impact the wine industry and related tourism activities.

13.2.3 Earthquake

Climate Change Impacts on the Hazard

The impacts of global climate change on earthquake probability are unknown. Some scientists say that melting glaciers could induce tectonic activity. As ice melts and water runs off, tremendous amounts of weight are shifted on the earth's crust. As newly freed crust returns to its original, pre-glacier shape, it could cause seismic plates to slip and stimulate volcanic activity, according to research into prehistoric earthquakes and volcanic activity. NASA and USGS scientists found that retreating glaciers in southern Alaska may be opening the way for future earthquakes (NASA, 2004).

Secondary impacts of earthquakes could be magnified by climate change. Soils saturated by repetitive storms or heavy precipitation could experience liquefaction or an increased propensity for slides during seismic activity due to the increased saturation. Dams storing increased volumes of water due to changes in the hydrograph could fail during seismic events.

Exposure, Sensitivity and Vulnerability

Because impacts on the earthquake hazard are not well understood, increases in exposure and vulnerability of the local resources are not able to be determined.

13.2.4 Flood

Climate Change Impacts on the Hazard

Use of historical hydrologic data has long been the standard of practice for designing and operating water supply and flood protection projects. For example, historical data are used for flood forecasting models and to forecast snowmelt runoff for water supply. This method of forecasting assumes that the climate of the future will be similar to that of the period of historical record. However, the hydrologic record cannot be used to predict changes in frequency and severity of extreme climate events such as floods. Scientists project greater storm intensity with climate change, resulting in more direct runoff and flooding. High frequency flood events (e.g. 10-year floods) in particular will likely increase with a changing climate. What is currently considered a 1-percent-annual-chance flood may strike more often, leaving many communities at greater risk. Going forward, model calibration must happen more frequently, new forecast-based tools must be developed, and a standard of practice that explicitly considers climate change must be adopted.

Climate change is already impacting water resources, and resource managers have observed the following:

- Historical hydrologic patterns can no longer be solely relied upon to forecast the water future.
- Precipitation and runoff patterns are changing, increasing the uncertainty for water supply and quality, flood management and ecosystem functions.
- Extreme climatic events will become more frequent, necessitating improvement in flood protection, drought preparedness and emergency response.

The amount of snow is critical for water supply and environmental needs, but so is the timing of snowmelt runoff into rivers and streams. Rising snowlines caused by climate change will allow more mountain areas, such as the Sierra Nevada watersheds, to contribute to peak storm runoff. Changes in watershed vegetation and soil moisture conditions will likewise change runoff and recharge patterns. As stream flows and velocities change, erosion patterns will also change, altering channel shapes and depths, possibly increasing sedimentation behind dams, and affecting habitat and water quality. With potential increases in the frequency and intensity of wildfires due to climate change, there is potential for more floods following fire, which increase sediment loads and water quality impacts.

Exposure, Sensitivity and Vulnerability

Population and Property

Population and property exposure and vulnerability may increase as a result of climate change impacts on the flood hazard. Runoff patterns may change, resulting in flooding in areas where it has not previously occurred.

Critical Facilities

Critical facility exposure and vulnerability may increase as a result of climate change impacts on the flood hazard. Runoff patterns may change, resulting in risk to facilities that have not historically been at risk from flooding. Additionally, changes in the management and design of flood protection critical facilities may be needed as additional stress is placed on these systems. Planners will need to factor a new level of safety into the design, operation, and regulation of flood protection facilities such as dams and bypass channels, as well as the design of local sewers and storm drains.

Environment

The exposure and vulnerability of the environment may increase as a result of climate change impacts on the flood hazard. Changes in the timing and frequency of flood events may have broader ecosystem impacts that alter the ability of already stressed species to survive.

Economy

If flooding becomes more frequent, there may be impacts on the local economy. More resources may need to be directed to response and recovery efforts, and businesses may need to close more frequently due to loss of service or access during flood events.

13.2.5 Landslide

Climate Change Impacts on the Hazard

Climate change may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration. Increase in global temperature is likely to affect the snowpack and its ability to hold and store water. Warming temperatures also could increase the occurrence and duration of droughts, which would increase the probability of wildfire, reducing the vegetation that helps to support steep slopes. All of these factors would increase the probability for landslide occurrences.

Exposure, Sensitivity and Vulnerability

Population and Property

Population and property exposure and vulnerability would be unlikely to increase as a result of climate change impacts on the landslide hazard. Landslide events may occur more frequently, but the extent and location should be contained within mapped hazard areas or recently burned areas.

Critical facilities

Critical facility exposure and vulnerability would be unlikely to increase as a result of climate change impacts on the landslide hazard; however, critical facility owners and operators may experience more frequent disruption to service provision as a result of landslide hazards. For example, transportation systems may experience more frequent delays if slides blocking these systems occur more frequently. In addition, increased sedimentation resulting from landslides may negatively impact flood control facilities, such as dams.

Environment

Exposure and vulnerability of the environment would be unlikely to increase as a result of climate change, but more frequent slides in river systems may impact water quality and have negative impacts on stressed species.

Economy

Changes to the landslide hazard resulting from climate change are unlikely to result in impacts on the local economy.

13.2.6 Severe Weather

Climate Change Impacts on the Hazard

Climate change presents a challenge for risk management associated with severe weather. The number of weather-related disasters during the 1990s was four times that of the 1950s, and cost 14 times as much in

economic losses. The science for linking the severity of specific severe weather events to climate change is still evolving; however, a number of trends have been recorded that indicate how climate change may be impacting these events. According to the U.S. National Climate Change Assessment (2014), there were more than twice as many high temperature records as low temperatures records broken between 2001 and 2012, and heavy rainfall events are becoming more frequent and more severe.

The increase in average surface temperatures can also lead to more intense heat waves that can be exacerbated in urbanized areas by what is known as urban heat island effect. The evidence suggests that heat waves are already increasing, especially in western states. According to information on Cal-Adapt provided above, extreme heat days are likely to increase in the planning area.

Climate change impacts on other severe weather events such as thunderstorms and high winds are still not well understood.

Exposure, Sensitivity and Vulnerability

Population and Property

Population and property exposure and vulnerability would be unlikely to increase as a direct result of climate change impacts on the severe weather hazard. Severe weather events may occur more frequently, but exposure and vulnerability will remain the same. Secondary impacts, such as the extent of localized flooding, may increase, impacting greater numbers of people and structures.

Critical Facilities

Critical facility exposure and vulnerability would be unlikely to increase as a result of climate change impacts on the severe weather hazard; however, critical facility owners and operators may experience more frequent disruption to service provision. For example, more frequent and intense storms may cause more frequent disruptions in power service.

Environment

Exposure and vulnerability of the environment would be unlikely to increase; however, more frequent storms and heat events and more intense rainfall may place additional stress on already stressed systems.

Economy

Climate change impacts on the severe weather hazard may impact the local economy through more frequent disruption to services, such as power outages.

13.2.7 Wildfire

Climate Change Impacts on the Hazard

Wildfire is determined by climate variability, local topography, and human intervention. Climate change has the potential to affect multiple elements of the wildfire system: fire behavior, ignitions, fire management, and vegetation fuels. Hot dry spells create the highest fire risk. Increased temperatures may intensify wildfire danger by warming and drying out vegetation.

Changes in climate patterns may impact the distribution and perseverance of insect outbreaks that create dead trees (increase fuel). When climate alters fuel loads and fuel moisture, forest susceptibility to wildfires changes. Climate change also may increase winds that spread fires. Faster fires are harder to contain, and thus are more likely to expand into residential neighborhoods.

Exposure, Sensitivity and Vulnerability

Population

According to Cal-Adapt projections, wildfire risk in the vicinity of the planning area may actually decrease over the next century. Other areas of California and the western United States are expected to have increased risk to wildfire, with increases in annual acres burned. Although planning area residents may not experience increased risk to wildfire directly, secondary impacts, such as poor air quality may increase.

Property and Critical Facilities

If wildfire risk decreases, the exposure and vulnerability of property and critical facilities would remain the same.

Environment

It is possible that the exposure and vulnerability of the environment will be impacted by changes in wildfire risk due to climate change. Natural fire regimes may change, resulting in more or less frequent or higher intensity burns. These impacts may alter the composition of the ecosystems in areas in and surrounding planning area.

Economy

As the risk from wildfire is currently projected to decrease, direct impacts on the economy would not be likely.

13.3 ISSUES

The major issues for climate change are the following:

- Planning for climate change related impacts can be difficult due to the inherent uncertainty in projected future impacts.
- Average temperatures are expected to continue to increase in the planning area, which may lead to a host of primary and secondary impacts, such as an increased incidence of heat waves.
- Expected changes in precipitation patterns are poorly understood and could have significant impacts on the water supply and flooding in the planning area.
- Some impacts of climate change are poorly understood, such as potential impacts on the frequency and severity of earthquakes and thunderstorms.
- Atmospheric river events may result in stormwater flooding after stormwater management systems are overwhelmed.

14. PUBLIC HEALTH EMERGENCY

14.1 GENERAL BACKGROUND

An outbreak or an epidemic exists when there are more cases of a particular disease than expected in a given area, or among a specific group of people, over a particular period of time. In an outbreak or epidemic, it is presumed that the cases are related to one another or that they have a common cause (CDC, 2011). This chapter describes commonly recognized public health hazards that are a concern to the planning area.

DEFINITIONS

Epidemic—The spread of an infectious disease beyond a local population, reaching people in a wider geographical area. Several factors determine whether an outbreak will become an epidemic: the ease with which the disease spreads from vectors, such as animals, to people and the ease with which it spreads from person to person.

Influenza—A viral infection that attacks the respiratory system; commonly called flu.

Infectious diseases—Diseases caused by pathogenic microorganisms, such as bacteria, viruses, parasites or fungi, that can be spread, directly or indirectly, from one person to another.

Pandemic—A worldwide epidemic.

Vector—An organism (such as an insect or rodent) that transmits pathogens that cause disease

Vector-borne illness—Diseases transmitted to people from insects and other animals. These include, but are not limited to, Hanta Virus, Plague, Tularemia, Lyme Disease, West Nile Virus and the Zika Virus.

Zoonotic diseases—Infectious diseases of animals that can cause disease when transmitted to humans.

14.1.1 Vector-Borne

Tick-Borne Illnesses

Ticks are small, insect-like creatures most often found in naturally vegetated areas. They feed by attaching to animals and humans, sticking their mouthparts into the skin, and sucking blood for up to several days. Ticks do not fall from trees, jump or fly. Most species are found on wild grasses and low plants. Adult ticks wait at the ends of grass or other foliage for a host to brush by so they may attach. Sometimes ticks carry bacteria or viruses that can be transmitted to a person while the tick is attached and feeding. There are 47 species of ticks in California, but only eight are known to commonly bite humans:

- Western blacklegged tick (*Ixodes pacificus*)
- American dog tick (*Dermacentor variabilis*)
- Pacific Coast tick (*Dermacentor occidentalis*)
- Wood tick (*Dermacentor andersoni*)
- Brown dog tick (*Rhipicephalus sanguineus*)
- *Ornithodoros hermsi*
- *Ornithodoros parkeri*
- *Ornithodoros coriaceus.*

Tularemia

Tularemia, named after Tulare County in California where it was first described in 1911, is a tick-borne disease of animals and humans caused by the bacterium *Francisella tularensis*. Tularemia is similar to plague, but is typically spread differently. While plague is usually spread to humans by fleas, humans usually become infected with Tularemia by tick and deer fly bites, skin contact with infected animals, ingestion of contaminated water or meat, or inhalation of contaminated dusts or aerosols. Symptoms vary depending upon the route of infection.

Rabbits, hares, and rodents are especially susceptible and often die in large numbers during outbreaks. Although Tularemia can be life-threatening, most infections can be treated successfully with antibiotics. Steps to prevent Tularemia include use of insect repellent, wearing gloves when handling sick or dead animals, and not mowing over dead animals. Naturally occurring infections have been reported in all U.S. states except Hawaii.

Lyme Disease

Lyme disease, named after the city in Connecticut where it was first identified in 1975, is a tick-borne disease caused by the bacterium *Borrelia burgdorferi,* which normally lives in mice, squirrels and other small animals. It is transmitted among these animals and to humans through the bites of certain species of ticks. In the northeastern and north-central United States, the black-legged tick (or deer tick, *Ixodes scapularis*) transmits Lyme disease. In the Pacific coastal United States, the disease is spread by the western black-legged tick (*Ixodes pacificus*). Other major tick species found in the United States have not been shown to transmit the disease.

Typical symptoms include fever, headache, fatigue, and a skin rash. If left untreated, infection can spread to joints, the heart, and the nervous system. Lyme disease is diagnosed based on symptoms, physical findings (e.g., rash), and the possibility of exposure to infected ticks. Laboratory testing is helpful in later stages of the disease. Most cases of Lyme disease can be treated successfully with a few weeks of antibiotics. Steps to prevent Lyme disease include using insect repellent, removing ticks promptly, landscaping, and integrated pest management. The ticks that transmit Lyme disease can occasionally transmit other tick-borne diseases as well.

Rocky Mountain Spotted Fever

Rocky Mountain spotted fever is a potentially fatal tick-borne disease caused by the bacterium *Rickettsia rickettsii*. It is transmitted to humans by the bite of an infected American dog tick (*Dermacentor variabilis*), Rocky Mountain wood tick (*Dermacentor andersoni*), or brown dog tick (*Rhipicephalus sanguineus)*.

Typical symptoms include fever, headache, abdominal pain, vomiting, and muscle pain. A rash may also develop, but is often absent in the first few days, and in some patients, never develops. Rocky Mountain spotted fever can be a severe or even fatal illness if not treated in the first few days of symptoms. It can be treated successfully with a few weeks of antibiotics. Steps to prevent the disease include using insect repellent, removing ticks promptly, landscaping, and integrated pest management. The ticks that transmit Rocky Mountain spotted fever can occasionally transmit other tick-borne diseases as well.

Mosquito-Borne Illnesses

Mosquito-borne diseases are diseases that are spread through the bite of an infected female mosquito. There are approximately 48 species of mosquitos in California that can carry disease. West Nile Virus and Zika Virus are a concern for the planning area and described below.

West Nile Virus

West Nile virus (WNV) is a potentially serious mosquito-borne disease that may affect residents in the planning area. Experts believe WNV is established as a seasonal epidemic in North America that flares up in the summer and continues into the fall. As of January 2017, human-infection cases of the virus had been reported in all states of the continental U.S. except Maine; Delaware and New Hampshire reported only non-human infections.

According to the Centers for Disease Control and Prevention (CDC), about 80 percent of people infected with WNV show no symptoms. The remainder have symptoms such as fever, headache, and body aches, nausea, vomiting, and sometimes swollen lymph glands or a skin rash on the chest, stomach and back. Symptoms can last for as short as a few days, though even healthy people have become sick for several weeks. About 1 percent of people infected with WNV will develop severe illness, with symptoms that can include high fever, headache, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, vision loss, numbness and paralysis. These symptoms may last several weeks, and neurological effects may become permanent. There is no specific treatment for WNV infection. In more severe cases, people may need to go to the hospital where they can receive supportive treatment including intravenous fluids, help with breathing and nursing care.

WNV is a recent disease to affect California. Mosquitoes transmit the virus to birds, livestock and humans. WNV season is between June and November in the planning area. During WNV season, Alameda County's mosquito abatement program works to limit risks to residents by monitoring ponds and other possible mosquito breeding sites; trapping to detect high numbers of mosquitoes; treating sewer catch-basins to prevent breeding; collecting birds for testing; and educating residents and owners about removing standing water from private property to limit mosquito breeding and mosquito bites (Alameda County Public Health Department, 2017).

Zika Virus

Zika is a mosquito-borne disease transmitted by yellow fever mosquito (*Aedes aegypti)* and the Asian tiger mosquito *(Aedes albopictus)*. An *Aedes* mosquito can only transmit Zika virus after it bites a person who has this virus in their blood. The most common symptoms of Zika are fever, rash, joint pain, and conjunctivitis (red eyes). The illness is usually mild, with symptoms lasting for several days to a week after being bitten by an infected mosquito. People usually do not get sick enough to go to the hospital, and they rarely die of Zika. For this reason, many people might not realize they have been infected. However, Zika virus infection during pregnancy can cause a serious birth defect called microcephaly (abnormally small head and brain), as well as other severe fetal brain defects. Once a person has been infected, he or she is likely to be protected from future infections. Zika virus is not spread through casual contact, but can be spread by infected men to their sexual partners. There is a growing association between Zika and Guillain-Barré Syndrome, a disease affecting the nervous system.

The mosquitos that carry Zika are not native to California, but infestations have been reported in multiple counties in California, but not in Alameda County or the Tri-Valley planning area (CDPH, 2017). Thus far in California, Zika virus infections have been documented only in people who were infected while traveling outside the United States or through sexual contact with an infected traveler. From 2015 to the publishing of this document there has been no local mosquito-borne transmission of Zika virus in California.

14.1.2 Infectious Diseases

Influenza

Influenza, commonly called flu, is a viral infection that attacks the respiratory system. This disease is capable of claiming thousands of lives and adversely affecting critical infrastructure and key resources. An influenza pandemic has the ability to reduce the health, safety, and welfare of the essential services workforce; immobilize core infrastructure; and induce fiscal instability. The risk of a global influenza pandemic has increased over the last several years.

Pandemic influenza is different from seasonal influenza (or "the flu") because outbreaks of seasonal flu are caused by viruses that are already among people. Pandemic influenza is caused by an influenza virus that is new to people and is likely to affect many more people than seasonal influenza. In addition, seasonal flu occurs every year, usually during the winter season, while the timing of an influenza pandemic is difficult to predict. Pandemic influenza is likely to affect more people than the seasonal flu, including young adults. A severe pandemic could change daily life for a time, including limitations on travel and public gatherings.

The CDC's Influenza Division of the Centers for Disease Control and Prevention supports the World Health Organization's global network of National Influenza Centers (NIC). The Influenza Division also conducts epidemiologic research, including vaccine studies and serologic assays and provides international outbreak investigation assistance (CDC, 2011).

Seasonal Influenza

Seasonal epidemics of the flu typically occur in the fall and winter. The CDC estimates that the 2015-2016 flu season for California was moderate compared to previous years; however, more influenza-associated deaths were

reported than the 2014-2015 season. Laboratory-confirmed influenza-associated deaths among patients under 65 have been reportable in California since the 2009 influenza pandemic. For the 2015-2016 flu season, there were 144 fatal cases of influenza-related illness statewide among those under 65, well below the 404 fatal cases during the 2013-2014 influenza season (CDPH, 2017).

Swine Flu (H1N1)

In April 2009, the World Health Organization (WHO) issued a health advisory on an outbreak of influenza-like illness caused by a new subtype of influenza A (A/H1N1) in Mexico and the United States. The disease spread rapidly, with the number of confirmed cases rising to 2,099 by May 7, despite aggressive measures taken against the disease by the Mexican government. On June 11, the WHO declared an H1N1 pandemic, marking the first global pandemic since the 1968 Hong Kong flu. On October 25, the U.S. declared H1N1 a national emergency. On August 10, 2010, the WHO declared an end to the 2009 H1N1 pandemic globally. The pandemic was mild compared to the Spanish Flu pandemic of 1918, which caused 100 million deaths worldwide—a total of 3 percent of the world's total population.

H1N1 viruses and seasonal influenza viruses are co-circulating in many parts of the world. It is likely that the 2009 H1N1 virus will continue to spread for years to come, like a regular seasonal influenza virus.

Avian Flu (H5N1/H7N9)

The highly pathogenic H5N1 avian influenza virus is an influenza A subtype that occurs mainly in birds, causing high mortality among birds and domestic poultry. Outbreaks of highly pathogenic H5N1 among poultry and wild birds are ongoing in a number of countries such as Cambodia, China, Indonesia, Thailand, and Vietnam.

H5N1 virus infections of humans are rare and most cases have been associated with direct poultry contact during poultry outbreaks. Rare cases of limited human-to-human spread of H5N1 virus may have occurred, but there is no evidence of sustained human-to-human transmission. Nonetheless, because all influenza viruses have the ability to change and mutate, scientists are concerned that H5N1 viruses one day could be able to infect humans more easily and spread more easily from one person to another, potentially causing another pandemic.

While the H5N1 virus does not now infect people easily, infection in humans is much more serious when it occurs than is infection with H1N1. More than half of people reported infected with H5N1 have died.

Infections in humans and poultry by a new avian influenza A virus (H7N9) continue to be reported in China. While mild illness in human cases has been seen, most patients have had severe respiratory illness and some have died. The only case identified outside of China was recently reported in Malaysia. Source investigation by Chinese authorities is ongoing. Many of the people infected with H7N9 are reported to have had contact with poultry. However, some cases reportedly have not had such contact. Close contacts of confirmed H7N9 patients are being followed to determine whether any human-to-human spread of H7N9 is occurring. No sustained person-to-person spread of the H7N9 virus has been found at this time. However, based on previous experience with avian flu viruses, some limited human-to-human spread of this the virus would not be surprising.

As of the publication of this document, H5N1 and the new H7N9 virus have not been detected in people or birds in the United States.

Viral Hemorrhagic Fevers

Viral hemorrhagic fevers (VHFs) are a group of illnesses caused by four families of viruses (Ebola, Marburg, Lassa fever, and yellow fever). VHF describes a multisystem syndrome (multiple systems in the body are affected). Characteristically, the overall vascular system is damaged and the body's ability to regulate itself is impaired. These symptoms are often accompanied by hemorrhage (bleeding); however, the bleeding itself is

rarely life-threatening. While some types of hemorrhagic fever viruses can cause relatively mild illnesses, many cause severe, life-threatening disease.

The viruses that cause VHFs are distributed over much of the globe. However, because each virus is associated with one or more particular host species, the virus and the disease it causes are usually seen only where the host species live. Some hosts, such as the rodent species carrying several of the New World arenaviruses, live in geographically restricted areas. Therefore, the risk of getting VHFs caused by these viruses is restricted to those areas. Other hosts range over continents, such as the rodents that carry viruses that cause the hantavirus pulmonary syndrome in North and South America, or the rodents that carry viruses that cause hemorrhagic fever with renal syndrome in Europe and Asia.

The only VHF discussed in detail for this hazard mitigation plan is Ebola.

Ebola

The 2014 Ebola virus outbreak was unprecedented in geographical reach and impact on health care systems across the globe. This was the largest and deadliest Ebola virus outbreak ever recorded. It was the first time the West African countries of Guinea, Liberia, Sierra Leone, Nigeria, Mali, and Senegal saw the virus. Ebola is more common in Central African countries, such as the Democratic Republic of Congo and Sudan, where it was first discovered in 1976. It was also the first time that Ebola made it to the United States and Europe, prompting world-wide preparedness and response efforts. Figure 14-1 shows areas that ultimately were affected. The outbreak was closely monitored and traveler screenings were developed for those returning from West Africa.

Source: World Health Organization

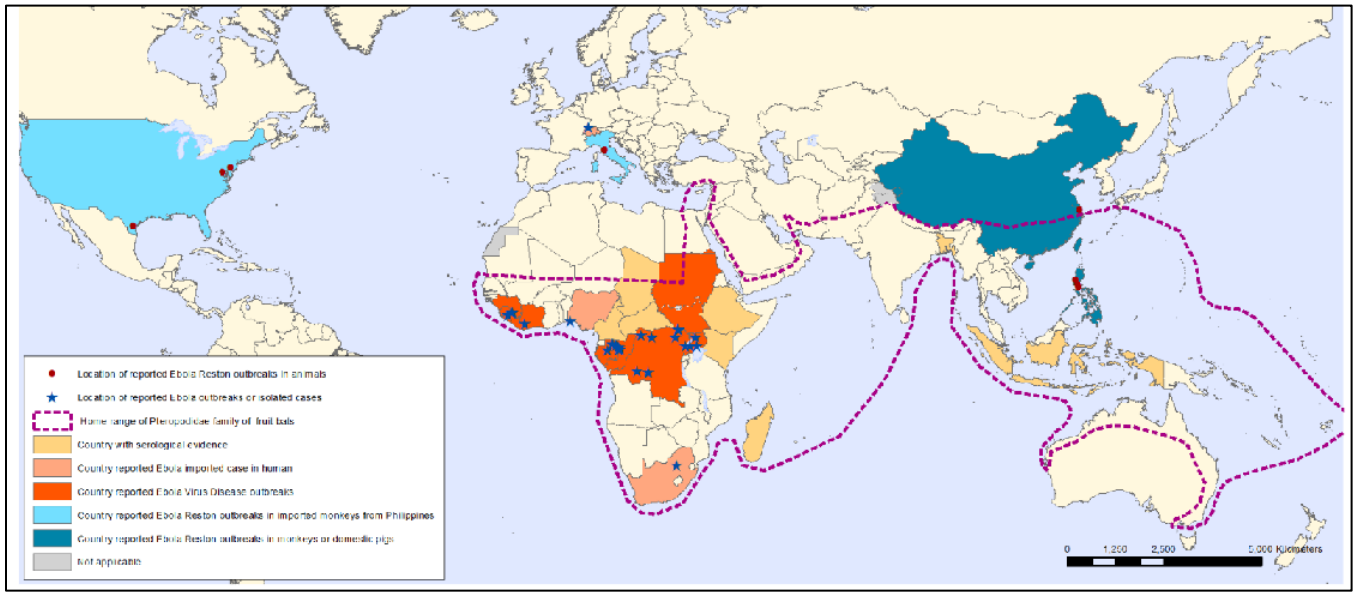


Figure 14-1. 2014 Distribution of Ebola Virus Outbreaks in Humans and Animals

In August 2014, two U.S. healthcare workers returned to the United States for treatment for Ebola. The case that most impacted the health care system in the United States was a patient diagnosed with Ebola in Dallas, Texas who died due to Ebola in October 2014. The nurse who provided care for him later tested positive for Ebola. This caused responses across the country from hospitals, emergency medical teams, fire departments and public health agencies to enhance isolation precautions, develop emergency policies, train with personal protective equipment and conduct multi-agency emergency exercises in case the spread of Ebola became a pandemic.

Before the 2014 outbreak, only 2,200 cases of Ebola had been recorded and 68 percent were fatal. Twenty percent of new Ebola infections were linked to burial traditions in which family and community members wash and touch dead bodies before burial. In Guinea, 60 percent of Ebola infections were linked to traditional burial practices. As of the date of this plan, there have been no reported Ebola cases in California.

Enterovirus

Non-polio enteroviruses are very common. There are more than 100 non-polio enteroviruses. One of the more common types is Enterovirus D68 (EV-D68). First identified in California in 1962, it causes about 10 to 15 million infections and tens of thousands of hospitalizations each year in the United States. Most people who get infected with this virus do not get sick or they only have mild illness, like the common cold. This virus spreads from person-to-person when an infected person coughs, sneezes, or touches a surface that is then touched by others (CDC, 2016).

In the summer and fall of 2014, the United States experienced a nationwide outbreak of EV-D68 associated with severe respiratory illness. From mid-August 2014 to January 15, 2015, 1,153 people in 49 states and the District of Columbia were diagnosed with respiratory illness caused by EV-D68. Almost all of the confirmed cases were among children, many of whom had asthma or a history of wheezing. There likely were many thousands of mild EV-D68 infections for which people did not seek medical treatment/or get tested (CDC, 2016a).

Norovirus

Norovirus is a highly contagious virus that causes acute gastroenteritis (inflammation of the stomach and intestines). It can spread quickly in closed and crowded environments such as hospitals, nursing homes, daycare centers, schools and cruise ships. Norovirus is the most common cause of acute gastroenteritis in the United States. Every year, it causes an estimated 19 to 21 million cases of acute gastroenteritis. While it is possible to become infected with norovirus year-round, norovirus infection happens most often from November to April. There can be a higher incidence of norovirus illnesses in years when a new strain of the virus is going around (CDPH, 2016).

Norovirus is found in the feces and vomit of infected people and can spread easily from person to person. People can become infected in several ways, including:

- Having direct contact with another person who is infected (for example, caring for or sharing foods or eating utensils with someone who is ill)
- Eating food or drinking liquids contaminated with norovirus, such as food touched by an ill food handler or undercooked seafood that has been harvested from contaminated waters
- Touching contaminated surfaces or objects and then touching the mouth before hand washing.

The CDPH and local health departments monitor norovirus outbreaks. Although healthcare providers are not required to report individual cases of norovirus to the local health department, outbreaks are reportable. When outbreaks are reported, CDPH and local health departments investigate to confirm and identify the strain of norovirus, find the cause of the outbreak, prevent further infections, and educate the public (CDPH, 2016).

14.2 HAZARD PROFILE

The severity of human health hazards is dependent upon the hazard and the population exposed to it. As the population increases, so does the risk of exposure to hazards. The key to reducing the disease hazard is isolation so that the exposed population does not continue to spread the hazard to the uninfected population. For disease and weather-related human health hazards, promoting education and personal preparedness will help to mitigate and reduce the severity of the hazard.

14.2.1 Past Events

Vector-Borne

The following is a summary of recent vector-borne disease outbreak events:

- In Alameda County, between 2006 and 2015, there were 35 confirmed cases of Lyme disease and six reported cases of West Nile Virus (CDPH, 2015).
- As of September 16, 2016, 18 Zika cases were reported in Alameda County, all from returning travelers.

Infectious Diseases

- In the United States during the 2009 H1N1 influenza pandemic, there were 60 million confirmed cases of the disease, 270,000 people hospitalized due to the illness and 12,000 deaths. In California, there were 4,134 people hospitalized due to the illness and 596 deaths. In Alameda County, there were 243 confirmed cases, with 29 deaths (CDPH, 2011).
- The most recent data for influenza in the State of California is for the 2015-2016 flu season. The CDPH recorded 144 fatal and 355 non-fatal ICU cases of influenza. In Alameda County, there were 5 fatal and 19 non-fatal ICU cases recorded for the same period. Overall, the influenza season was more moderate than the previous three seasons (CDPH, 2016a).
- California was impacted by the Enterovirus D68 outbreak in 2014. By October 2014, there were 32 reported cases in the state. Two of those cases were reported in Alameda County (Seipel, 2014).
- In 2015, California experienced a norovirus outbreak. Between October and December, there were 32 confirmed cases of norovirus (CDPH, 2015).

14.2.2 Location

All of the planning area is susceptible to the human health hazards discussed in this chapter. While some hazards, such as Lyme disease, can have a geographic presence within the planning area, other diseases can cause exposure to the planning area from outside the local region. Planning area residents who travel can become exposed to diseases while abroad and bring the diseases back with them, potentially placing the region at risk for exposure. Extreme weather poses an equal human health hazard across the planning area.

14.2.3 Frequency

Predicting the future occurrences of disease outbreaks is difficult; however, based on the history of past occurrences, it is likely that the planning area will be impacted in the future. An increase in population and population density in the planning area have the potential to increase residents' exposure and susceptibility to outbreaks. Infected mosquitos and ticks will continue to inhabit and impact the planning area.

14.2.4 Severity

The severity of the human health hazard varies from individual to individual. Typically, young children and older adults are more susceptible to acquiring communicable diseases due to developing or diminishing immune systems. These populations often experience the most severe of symptoms, as their immune systems are not capable of fighting off infection or efficiently regulating temperature. In general, severity varies depending on the pathology of the disease, the health of the infected, and the availability of treatments for alleviating symptoms or curing the disease.

14.3 SECONDARY HAZARDS

The largest secondary impact caused by human health hazards is economic. Large outbreaks of any human health hazard could reduce the work force significantly, causing businesses and agencies to close or be greatly impacted.

Another secondary impact is stigmatization. The fear of the human health hazard and fear of the unknown can lead to isolation, violence and self-inflicted injury. Hospitals and health care providers can be overwhelmed with the "worried well" seeking care and comfort. Providing key and critical information can reduce and mitigate this secondary risk.

14.4 EXPOSURE AND VULNERABILITY

14.4.1 Population

All citizens in the planning area could be susceptible to the human health hazards discussed in this chapter. A large outbreak or epidemic, a pandemic or a use of biological agents as a weapon of mass destruction could have devastating effects on the population of the planning area. The young and the elderly, those with compromised immune systems, and those with specialized medical needs are considered the most vulnerable.

14.4.2 Property

None of the health hazards discussed in this chapter would have significant measurable impact on the structural environment or property of the planning area.

14.4.3 Critical Facilities and Infrastructure

None of the health hazards discussed in this chapter would have significant measurable impact on the critical facilities or infrastructure of the planning area.

14.4.4 Environment

None of the health hazards discussed in this chapter would have significant measurable impact on the environment of the planning area. While many of the vectors of the health hazards discussed in this chapter rely on local or regional environments for their survival, the human health hazard that they carry or potentially transmit would have no significant measurable impact on the environment.

14.4.5 Economy

The economic impact of a human health hazard could be localized to a single region or population, or could be widespread. The impact could be significant, depending on the hazard, number of cases and the availability of resources to care for those affected by the hazard. Other financial impacts could be absorbed or managed by the organization affected.

14.5 FUTURE TRENDS IN DEVELOPMENT

The potential for communicable diseases, vector-borne diseases or extreme weather in the planning area is not likely to lessen or prohibit growth or development.

14.6 SCENARIO

A worst-case human health scenario for the planning area would be an epidemic or large-scale incident of any of the human health hazards discussed in this chapter. Medical treatment facilities in the planning area would be overwhelmed and taxed beyond their capabilities as the numbers of patients escalates. Impacts on the work force could have acute and long-term economic impacts on the planning area's primary employers. First responders would be exposed to the human health hazards, which could deplete the medical work force and could have profound impact on the potential escalation of the scenario.

14.7 ISSUES

Important issues associated with the human health hazards include but are not limited to the following:

- Prevention through vaccination and personal emergency and disaster preparation will help to reduce the impacts of human health hazards.
- Medical and response personnel need to be integrated in a unified command to provide care when needed in response to human health hazards.
- Medical and response personnel must be adequately trained and supplied.
- Up-to-date and functional all-hazard contingency planning should be carried out.
- A system needs to be in place to inform the public with a unified message about the human health hazard.
- Health agencies and facilities require surge capacity management and adaptation to the rising number and needs of the region.

15. HUMAN-CAUSED HAZARDS

15.1 GENERAL BACKGROUND

Although the DMA does not require an assessment of human-caused hazards, this plan includes human-caused hazards for the following reasons:

- The planning partners take a proactive approach to disaster preparedness in order to protect the public safety of all citizens.
- Preparation for and response to a human-caused disaster will involve much of the same staff training, critical decision-making, and commitment of resources as for a natural hazard.
- The hazard mitigation planning effort is an opportunity to inform the public about all hazards, including human-caused hazards.
- The likelihood of a human-caused hazard in the planning area is greater than several of the identified natural hazards in this plan.

Human-caused hazards fall into the following categories:

- Intentional, criminal, malicious acts, including acts of terrorism, cyber threats, civil unrest, riots, and active threats.
- Technological incidents that arise accidentally from human activities such as the manufacture, transportation, storage and use of hazardous materials; pipeline failure and release; and transportation.

DEFINITIONS

Active threats—Shootings, secondary explosives, and/or chemical or biological threats.

Acts of terrorism—The unlawful use or threatened use of force or violence against people or property with the intention of intimidating or coercing societies or governments. Terrorism is either foreign or domestic, depending on the origin, base, and objectives of the terrorist or organization.

Civil unrest—Groups of people purposely choosing not to observe a law, regulation or rule, usually to bring attention to a cause, concern or agenda.

Cyber threat—An intentional and malicious action to compromise the digital infrastructure of a person or organization, often for financial or terror-related reasons.

Hazardous material—A substance or combination of substances that, because of quantity, concentration, physical, chemical, or infectious characteristics, may cause or contribute to an increase in mortality or an increase in serious irreversible or incapacitating reversible illness, or pose a present or potential hazard to human life, property, or the environment.

Technological hazards—Hazards from accidents associated with human activities such as the manufacture, transportation, storage and use of hazardous materials.

Weapons of mass destruction—Chemical, biological, radiological, nuclear, and explosive weapons associated with terrorism.

15.1.1 Intentional Hazards

In dealing with intentional human-caused hazards, the unpredictability of human beings must be considered. People with a desire to perform criminal acts may seek out targets of opportunity that may not fall into established lists of critical areas or facilities. First responders train not only to respond to organized terrorism events, but also to respond to random acts by individuals who, for a variety of reasons ranging from fear to emotional trauma to mental instability, may choose to harm others and destroy property.

While education, heightened awareness, and early warning of unusual circumstances may deter crime and terrorism, intentional acts that harm people and property are possible at any time. Public safety entities must react to the incident, locate, isolate and neutralize further damage, and conduct investigate to bring criminals to justice.

Terrorism

The Federal Bureau of Investigation (FBI) categorizes terrorism in the United States as one of two types:

- Domestic terrorism involves groups or individuals acting without foreign direction against the government or population, such as the 1995 bombing of the Alfred P. Murrah federal building in Oklahoma City. The FBI is the primary response agency for domestic terrorism. The FBI coordinates domestic preparedness activities of the United States to limit acts posed by terrorists.
- International terrorism involves groups or individuals whose terrorist activities are foreign-based and/or directed by countries or groups outside the United States, or whose activities transcend national boundaries. Examples include the 1997 bombing of Mobil Oil's headquarters, the 1983 bombing of the U.S. Capitol, the 1993 bombing of the World Trade Center, and the September 11, 2001 attacks at the World Trade Center and the Pentagon.

The three key elements to defining a terrorist event are as follows:

- Actions involve the use of illegal force.
- Actions are intended to intimidate or coerce.
- Actions are committed in support of political or social objectives.

Terrorism evokes strong emotional reactions, ranging from anxiety to fear to anger to depression. Those involved with terrorism response are trained to deal with the public's emotional reaction swiftly as response to the event occurs. The area of the event must be clearly identified in all emergency alert messages to prevent those not affected by the incident from overwhelming local emergency rooms and response resources, thereby reducing service to those actually affected. The public will be informed clearly and frequently about what government agencies are doing to mitigate the impacts of the event. The public will also be given clear directions on how to protect the health of individuals and families.

Terrorism involves the use of weapons of mass destruction, including biological, chemical, nuclear and radiological weapons; arson, incendiary, explosive and armed attacks; industrial sabotage and intentional hazardous materials releases; agro-terrorism; and cyberterrorism (FEMA 386-7). In the case of chemical, biological and radioactive agents, their presence may not be immediately obvious, making it difficult to determine when and where they may have been released, who has been exposed, and what danger is present for first responders and emergency medical technicians. The following are potential methods used by terrorists that could affect the Alameda County and the planning area as a direct target or collaterally:

- Conventional bomb
- Biological agent
- Chemical agent
- Nuclear bomb
- Radiological agent
- Arson/incendiary attack
- Armed attack
- Cyber-terrorism
- Agro-terrorism
- Intentional hazardous material release.

Table 15-1 provides a hazard profile summary for terrorism-related hazards. Most terrorist events in the United States have been bombing attacks, involving detonated or undetonated explosive devices, tear gas, pipe bombs, and firebombs.

The effects of terrorism can vary from loss of life and injuries to property damage and disruptions in services such as electricity, water supplies, transportation, or communications. Terrorist acts may have an immediate effect or a delayed effect. Terrorists often choose targets that offer limited danger to themselves and areas with relatively easy public access. Foreign terrorists look for visible targets where they can avoid detection before and after an attack such as international airports, large cities, major special events, and high-profile landmarks.

Table 15-1. Event Profiles for Terrorism

Hazard	Application Mode[a]	Hazard Duration[b]	Static/Dynamic Characteristics[c]	Mitigating and Exacerbating Conditions[d]
Conventional Bomb	Detonation of explosive device on or near target; delivery via person, vehicle, or projectile.	Instantaneous; additional secondary devices, or diversionary activities may be used, lengthening the duration of the hazard until the attack site is clear.	Extent of damage is determined by type and quantity of explosive. Effects generally static other than cascading consequences, incremental structural failure, etc.	Over-pressure at a given location is inversely proportional to the cube of the distance from the blast; thus, each extra length of distance provides progressively more protection. Terrain, forestation, structures, etc. can absorb and/or deflect energy and debris. Exacerbating conditions include ease of access to target; lack of barriers and shielding; poor construction; and ease of concealment of device.
Chemical Agent	Liquid/aerosol contaminants dispersed using sprayers or other aerosol generators; liquids vaporizing from puddles/ containers; or munitions.	Hours to weeks, depending on the agent and the conditions in which it exists.	Contamination can be carried out of the initial target area by persons, vehicles, water, and wind. Chemicals may be corrosive or otherwise damaging over time if not remediated.	Air temperature can affect evaporation of aerosols. Ground temperature affects evaporation of liquids. Humidity can enlarge aerosol particles, reducing inhalation hazard. Precipitation can dilute and disperse agents but can spread contamination. Wind can disperse vapors but also cause target area to be dynamic. The micro-meteorological effects of buildings and terrain can alter travel and duration of agents. Shielding in the form of sheltering in place can protect people and property from harmful effects.
Arson/ Incendiary Attack	Initiation of fire or explosion on or near target via direct contact or remotely via projectile.	Generally minutes to hours.	Extent of damage is determined by type and quantity of device, accelerant, and materials present at or near target. Effects generally static other than incremental structural failure, etc.	Mitigation includes fire detection and protection systems and fire-resistive construction. Inadequate security can allow easy access to target, easy concealment of an incendiary device, and undetected initiation of a fire. Non-compliance with fire and building codes or failure to maintain fire protection systems can increase the effectiveness of a fire weapon.
Armed Attack	Tactical assault or sniping from remote location, or random attack in response to fear, emotion or mental instability.	Generally minutes to days.	Varies based on the perpetrators' intent and capabilities.	Inadequate security can allow easy access to target, easy concealment of weapons, and undetected initiation of an attack.
Radiological Agent	Radioactive contaminants dispersed using sprayers/ aerosol generators, or by point or line sources such as munitions.	Seconds to years, depending on material used.	Initial effects will be localized to site of attack; depending on meteorological conditions, subsequent behavior of radioactive contaminants may be dynamic.	Duration of exposure, distance from source of radiation, and the amount of shielding between source and target determine exposure to radiation.

Hazard	Application Mode[a]	Hazard Duration[b]	Static/Dynamic Characteristics[c]	Mitigating and Exacerbating Conditions[d]
Biological Agent	Liquid or solid contaminants dispersed with sprayers or by point or line sources such as munitions, covert deposits, and moving sprayers.	Hours to years, depending on the agent and the conditions in which it exists.	Contamination can be spread via wind and water, depending on the agent used and the effectiveness with which it is deployed. Infection can spread via humans or animals.	Altitude of release above ground can affect dispersion; sunlight is destructive to many bacteria and viruses; light to moderate wind will disperse agents but higher winds can break up aerosol clouds; the micro-meteorological effects of buildings and terrain can influence aerosolization and travel of agents.
Agro-terrorism	Direct, generally covert contamination of food supplies or introduction of pests and/or disease agents to crops and livestock.	Days to months.	Varies by type of incident. Food contamination events may be limited to specific distribution sites, whereas pests and diseases may spread widely. Generally no effects on built environment.	Inadequate security can facilitate adulteration of food and introduction of pests and disease agents to crops and livestock.
Nuclear Bomb	Detonation of nuclear device underground, at the surface, in the air, or at high altitude.	Light/heat flash and shock wave last for seconds; radiation and fallout can last for years. Electromagnetic pulse from a high-altitude detonation lasts for seconds and affects only unprotected electronic systems.	Initial light, heat, and blast effects of a subsurface, ground or air burst are static and determined by the device's characteristics and employment; fallout of radioactive contaminants may be dynamic, depending on meteorological conditions.	Harmful effects of radiation can be reduced by minimizing the time of exposure. Light, heat, and blast energy decrease logarithmically as a function of distance from seat of blast. Terrain, forestation, structures, etc. can provide shielding by absorbing and/or deflecting radiation and radioactive contaminants.
Intentional Hazardous Material Release (fixed facility or transportation)	Solid, liquid, and/or gaseous contaminants released from fixed or mobile containers	Hours to days.	Chemicals may be corrosive or otherwise damaging over time. Explosion and/or fire may be subsequent. Contamination may be carried out of the incident area by persons, vehicles, water and wind.	Weather conditions directly affect how the hazard develops. The micro-meteorological effects of buildings and terrain can alter travel and duration of agents. Shielding in the form of sheltering in place can protect people and property from harmful effects. Non-compliance with fire and building codes, as well as failure to maintain existing fire protection and containment features, can substantially increase the damage from a hazardous materials release.

a. Application Mode—The human acts or unintended events necessary to cause the hazard to occur.
b. Duration—The length of time the hazard is present. For example, the duration of a tornado may be just minutes, but a chemical warfare agent such as mustard gas, if un-remediated, can persist for hours or weeks under the right conditions.
c. Dynamic or Static Characteristics—The tendency of a hazard or its effects to expand, contract, or remain confined in time, magnitude, and space. For example, the physical destruction caused by an earthquake is generally confined to the place in which it occurs, and it does not usually get worse unless aftershocks or other cascading failures occur; in contrast, a cloud of chlorine gas leaking from a storage tank can change location by drifting with the wind and can diminish in danger by dissipating over time.
d. Mitigating and Exacerbating Conditions—Mitigating conditions are characteristics of the target and its physical environment that can reduce the effects of a hazard. For example, earthen berms can provide protection from bombs; exposure to sunlight can render some biological agents ineffective; and effective perimeter lighting and surveillance can minimize the likelihood of someone approaching a target unseen. In contrast, exacerbating conditions are characteristics that can enhance or magnify the effects of a hazard. For example, depressions or low areas in terrain can trap heavy vapors, and a proliferation of street furniture (trash receptacles, newspaper vending machines, mail boxes, etc.) can provide hiding places for explosive devices.

Source: FEMA 386-7 (2003a)

The effects of terrorism can include injuries, loss of life, property damage, or disruption of services such as electricity, water supplies, transportation, or communications. Effects may be immediate or delayed. Terrorists often choose targets that offer limited danger to themselves and areas with relatively easy public access. Foreign terrorists look for visible targets where they can avoid detection before and after an attack, such as international airports, large cities, major special events, and high-profile landmarks.

In dealing with terrorism, the unpredictability of human beings must be considered. People with a desire to perform such acts may seek out targets of opportunity that do not fall into established lists of critical areas or facilities. First responders train to respond not only to organized terrorism events, but also to random acts by individuals who, for a variety of reasons—ranging from fear to emotional trauma to mental instability—choose to harm others and destroy property. While education, heightened awareness, and early warning of unusual circumstances may deter terrorism, intentional acts that harm people and property are possible at any time. Public safety entities must react to the threat, locating, isolating, and neutralizing further damage and investigating potential scenes and suspects to bring criminals to justice.

Active Threats

Active threats may include active shootings, secondary explosives, and/or chemical or biological threats.

Active Shooter

Active shooter attacks are typically motivated by the desire to maximize human casualties. They are differentiated from other attack types by the indiscriminate nature of the victim's targets of opportunity rather than actions directed toward a specific target. Active shooter attacks have evolved over the last decade ranging from "lone wolf" shooters who act alone and without any organizational affiliation to organized groups acting in concert to achieve a specific objective. Current active shooter threat force tactics commonly employ a blend of lone shooters and multi-person teams as part of a larger assault.

Active shooters may use small arms, light weapons, or a combination of the two depending on the type of attack. Small arms refers to revolvers, automatic pistols, rifles, shotguns, assault rifles, light machine guns, etc. Light weapons refer to medium caliber and explosive ordinance, grenade launchers, rocket propelled grenades, etc. With additional planning and preparation, attackers can increase their likelihood of success in also including a wider array of weapons, to include improvised explosive devices.

Biological Threats

Biological hazards include disease-causing microorganisms and pathogens, such as bacteria and viruses. The distinguishing characteristic of these substances is their ability to multiply within a host and cause an infection. Some bacteria and viruses can spread from one individual to another. Infections typically occur as a result of airborne exposure, skin contact, or ingestion. In general, exposure to bacteria and viruses can occur through inhalation (as is the case with airborne *B. anthracis* spores, which cause anthrax), ingestion of contaminated food or water (the case with *E. coli*, which causes gastrointestinal infection), contact with infected individuals, or contact with contaminated surfaces (which may be harboring, for example, viruses that cause influenza). As a result, domestic and transnational threat groups have considered targeting heating, ventilation, and air conditioning systems of large commercial buildings.

Anthrax has been used as a weapon for nearly 100 years and is one of the most likely agents to be used in a biological threat. Its spores are easily found in nature, can be produced in a lab, and can last for a long time. It can be released quietly and without anyone knowing. Microscopic spores can be put into powders, sprays, food, and water. Due to their size, one may not be able to see, smell or taste them (CDC, 2016b). Terrorists may release anthrax spores in public places. In 2001, letters containing powdered anthrax spores were sent through the U.S. mail, causing skin and lung anthrax in 22 people. Five people died, all due to lung anthrax.

If a biological attack were to occur within the planning area, a large number of personnel could be impacted. Buildings in the impacted area and transportation infrastructure might be closed for investigation and cleanup. These areas would not be accessible until cleanup is completed, which would impact the businesses. Hospitals could become overwhelmed with people coming in fearing contamination. Residents and businesses may need to shelter in place in the area of the attack.

Chemical Threats

Chemical weapons are often classified according to their effect on the body, based on the primary organ system affected by exposure. They are poisonous vapors, aerosols, liquids, and solids that have toxic effects on humans, animals, and plants. Exposure pathways include inhalation, skin contact, ingestion or injection. Depending on the severity of exposure, impacts may include temporary illness or injury, permanent medical conditions, or death. An attack using chemical threats can come without warning. Signs of a chemical release include difficulty breathing; eye irritation; losing coordination; nausea; or a burning sensation in the nose, throat and lungs (Ready.gov, 2016). Harmful chemicals that could be used in an attack include the following:

- Chemical weapons developed for military use (warfare agents)
- Toxic industrial and commercial chemicals that are produced, transported, and stored in the making of petroleum, textiles, plastics, fertilizers, paper, foods, pesticides, household cleaners, and other products
- Chemical toxins of biological origin such as ricin (U.S. Department of Homeland Security, 2004).

There have been reports of chlorine found in explosive devices, mortars, rockets, and missiles. Chlorine has been used in the past, mainly in blunt, terrorist-style attacks. Some experts believe that groups are trying to advance their technology for deploying the chemical in combat operations (Tilghman, 2015). Chlorine is an acutely toxic industrial compound that can cause severe coughing, pulmonary, eye and skin irritation, and even death at higher concentrations (USACHPPM, 2015).

A chemical release in the planning area could lead to closed down streets and major transportation routes (including bridges) for extended periods of time, causing transportation delays and traffic. Many homes and businesses would also be impacted as they would need to be evacuated for an extended period of time. There could also be impact on the environment and/or natural resources that would require cleanup. Hazardous material response teams and fire-rescue would be needed to respond to the incident and coordinate cleanup efforts.

Explosive Devices

Improvised explosive device (IED) attacks are the favored method of terrorist groups around the world. The evolution in explosive materials, firing devices, and their ease of concealment and delivery has increased the effectiveness of this hazard. IED attacks are typically motivated by the desire to maximize human casualties. Explosive incidents account for 70 percent of all terrorist attacks worldwide. These types of attacks range from small-scale letter bombs to large- scale attacks on specific buildings. According to the FBI, 172 improvised explosive devices were reported in the United States between October 2012 and April 2013.

IEDs generally consist of TNT equivalent explosives (e.g. black or smokeless powder) in a container (e.g. galvanized pipe, paint can, etc.). These propellants are easily purchased on the commercial market. IEDs may also contain added shrapnel to induce greater casualties or shaped charges that direct the force of the explosive towards the target. Devices may be hidden in everyday objects such as briefcases, flowerpots or garbage cans, or on the person of the attacker in the case of suicide bombers. The most commonly used container is galvanized pipe, followed by PVC pipe. When shrapnel is added to the device, the type of shrapnel varies; BBs and other small pieces of hardware are common, as is glass or gravel.

An attack using IEDs or other explosive devices within the planning area has potential large-scale consequences that may require multi-agency and multi-jurisdictional coordination. Depending on the location of the attack,

businesses and other venues may be closed for investigation and due to damage. If the attack occurred in or near residences, evacuations and/or sheltering may occur.

Fire as a Weapon

The use of fire for criminal, gang, and terrorist activities, as well as targeting first responders, is not new. The World Health Organization estimates that 195,000 people die each year from fire, while according to the Global Terrorism Database an average of 7,258 people die annually from terrorism, and that includes deaths in conflict zones such as Afghanistan and Iraq (Stewart, 2013).

Cyber Threats

A cyber threat is an intentional and malicious crime that compromises the digital infrastructure of a person or organization, often for financial or terror-related reasons. Such attacks vary in nature and are perpetrated using digital mediums or sometimes social engineering to target human operators. Generally, attacks last minutes to days, but large-scale events and their impacts can last much longer. As information technology continues to grow in capability and interconnectivity, cyber threats become increasingly frequent and destructive.

Cyber threats differ by motive, attack type and perpetrator profile. Motives range from the pursuit of financial gain to political or social aims. Cyber threats are difficult to identify and comprehend. Types of threats include using viruses to erase entire systems, breaking into systems and altering files, using someone's personal computer to attack others, or stealing confidential information. The spectrum of cyber risks is limitless, with threats having a wide-range of effects on the individual, community, organization, and nation.

Cyber-Attacks

Public and private computer systems are likely to experience a variety of cyber-attacks, from blanket malware infection to targeted attacks on system capabilities. Cyber-attacks specifically seek to breach computer security measures designed to protect an individual or organization. The initial attack is followed by more severe attacks for the purpose of causing harm, stealing data, or financial gain. Organizations are prone to different types of attacks that can be either automated or targeted in nature. Table 15-2 describes the most common cyber-attack mechanisms faced by organizations today.

With millions of threats created each day, the importance of protection against cyber-attacks becomes a necessary function of everyday operations for individuals, government facilities, and businesses. The increasing dependency on technology for vital information storage and the often automated method of infection means higher stakes for the success of measurable protection and education. Cyber-attacks may lead to widespread business interruptions and likely considerable repair and response costs. A cyber-attack could cause sewage pump stations to fail, which could result in contaminated beaches, unsanitary conditions and/or potentially unsafe water supply.

Since 2013, a new type of cyber-attack is becoming increasingly common against individuals and small- and medium-sized organizations. This attack is called cyber ransom. Cyber ransom occurs when an individual downloads ransom malware, or ransomware, often through phishing or drive-by download, and the subsequent execution of code results in encryption of all data and personal files stored on the system. The victim then receives a message that demands a fee in the form of electronic currency or cryptocurrency, such as Bitcoin, for the decryption code (Figure 15-1). In October 2015, the FBI said that commonly used ransomware is so difficult to override, that victims should pay the ransom to retrieve their data (Danielson, 2015).

Table 15-2. Common Mechanisms for Cyber-attacks

Type	Description
Socially Engineered Trojans	Programs designed to mimic legitimate processes (e.g. updating software, running antivirus software). When the victim runs the fake process, the Trojan is installed on the system.
Unpatched Software	Nearly all software has weak points that may be exploited by malware. Most common software exploitations occur with Java, Adobe Reader, and Adobe Flash. These vulnerabilities are often exploited as small amounts of malicious code are often downloaded via drive-by download.
Phishing	Malicious email messages that ask users to click a link or download a program. Phishing attacks may appear as legitimate emails from trusted third parties.
Password Attacks	Third party attempts to crack a user's password and gain access to a system. Password attacks do not typically require malware, but rather stem from software applications on the attacker's system. These applications may use a variety of methods to gain access, including generating large numbers of generated guesses, or dictionary attacks, in which passwords are systematically tested against all of the words in a dictionary.
Drive-by Downloads	Malware is downloaded unknowingly by the victims when they visit an infected site.
Denial of Service Attacks	Attacks that focus on disrupting service to a network in which attackers send high volumes of data until the network becomes overloaded and can no longer function.
Man in the Middle	Man-in-the-Middle attacks mirror victims and endpoints for online information exchange. In this type of attack, the attacker communicates with the victims, who believe they are interacting with a legitimate endpoint website. The attacker is also communicating with the actual endpoint website by impersonating the victim. As the process goes through, the attacker obtains entered and received information from both the victim and endpoint.
Malvertising	Malware downloaded to a system when the victim clicks on an affected ad.
Advanced Persistent Threat	An attack in which the attacker gains access to a network and remains undetected. Advanced Persistent Threat attacks are designed to steal data instead of cause damage.

Source: Danielson, 2015



Figure 15-1. Pop-Up Message Indicating Ransomware Infection

If an attack were to occur that impacted the planning area, multi-jurisdictional response would need to be coordinated, in accordance with local and county emergency operations plans. To reduce the planning area's vulnerability, cyber security should be improved by providing network defense intelligence and conducting regular evaluations of network security posture and readiness. Additionally, the planning area should provide education on cyber threats and cyber-attack measurements.

Cyberterrorism

Cyberterrorism is the use of computers and information, particularly over the Internet, to recruit others to an organization's cause, cause physical or financial harm, or cause a severe disruption of infrastructure service. Such disruptions can be driven by religious, political, or other motives. Like traditional terrorism tactics, cyberterrorism seeks to evoke very strong emotional reactions, but it does so through information technology rather than a physically violent or disruptive action. Cyberterrorism has three main types of objectives (Kostadinov, 2012):

- **Organizational**—Cyberterrorism with an organizational objective includes specific functions outside of or in addition to a typical cyber-attack. Terrorist groups today use the internet on a daily basis. This daily use may include recruitment, training, fundraising, communication, or planning. Organizational cyberterrorism can use platforms such as social media as a tool to spread a message beyond country borders and instigate physical forms of terrorism. Additionally, organizational goals may use systematic attacks as a tool for training new members of a faction in cyber warfare.
- **Undermining**—Cyberterrorism with undermining as an objective seeks to hinder the normal functioning of computer systems, services, or websites. Such methods include defacing, denying, and exposing information. While undermining tactics are typically used due to high dependence on online structures to support vital operational functions, they typically do not result in grave consequences unless undertaken as part of a larger attack. Undermining attacks on computers include the following (Waldron, 2011):
  - Directing conventional kinetic weapons against computer equipment, a computer facility, or transmission lines to create a physical attack that disrupts the reliability of equipment.
  - Using electromagnetic energy, most commonly in the form of an electromagnetic pulse, to create an electronic attack against computer equipment or data transmissions. By overheating circuitry or jamming communications, an electronic attack disrupts the reliability of equipment and the integrity of data.
  - Using malicious code directed against computer processing code, instruction logic, or data. The code can generate a stream of malicious network packets that disrupt data or logic by exploiting vulnerability in computer software, or a weakness in computer security practices. This type of cyber-attack can disrupt the reliability of equipment, the integrity of data, and the confidentiality of communications (Wilson, 2008)
- **Destructive**—The destructive objective for cyberterrorism is what organizations fear most. Through the use of computer technology and the Internet, the terrorists seek to inflict destruction or damage on tangible property or assets, and even death or injury to individuals.

Civil Unrest

Civil disturbance refers to groups of people purposely choosing not to observe a law, regulation or rule, usually in order to bring attention to their cause, concern or agenda. Disturbances may take the form of small gatherings or large groups blocking or impeding access to planning area municipality facilities or businesses to actions directed at intimidating staff, visitors, and causing property damage. Civil disturbances can arise from a number of causes for a variety of reasons. Protests intended to be a peaceful demonstration to the public and the government can escalate into general chaos.

The circumstances surrounding civil disturbance may be spontaneous or may result from escalating tensions within an institutional facility, community or the larger society. This was the case in Ferguson, MO and other recent national examples, where local police activities resulted in a massive community response that began as protest but evolved into less controlled, potentially violent response from community members. Civil disorder can erupt anywhere, but the most likely locations are areas with large population groupings or gatherings. Civil disorder can also occur near locations where a "trigger event" occurred, as was the case in Ferguson.

The following types of large gatherings are typically associated with civil disturbances:

- **Crowds**:
  - A casual crowd is identified as individuals or small groups with nothing in common to bind them together. If they have an agenda, it is their own. Casual crowds are made up of individuals or small groups occupying the same common place.
  - Sighting crowds are people gathering for an event. People migrating to sporting events, gathering to observe a fire or accident, and those that attend music concerts are all types of sighting crowds. Individuals or small groups gather at these events for the same purpose. It is the event and/or one's curiosity that compels a crowd to come together.
  - Agitated crowds have responses based on the elements (people, space, and event). Individuals with strong emotional feelings within a crowd can quickly spread and influence the rest of the crowd. As more people within the crowd become emotionally involved, a sense of unity may develop, causing changes in the overall demeanor of the crowd. Yelling, screaming, and name-calling are all associated with an agitated crowd.

- **Mobs—**Mobs have all the elements found in the crowd types described above, but also display aggressive, physical, and sometimes violent actions. Under these conditions, individuals within a crowd will often say or do things they usually would not do. Extreme acts of violence and property damage are often part of mob activities. They consist of, or involve, the elements of people and groups being mixed together and becoming fluid. Mobs are usually emotional, loud, tumultuous, violent, and lawless. There are different levels of mobs (Alvarez and Bachman, 2007):
  - An aggressive mob is one that attacks, riots, and terrorizes. The object of violence may be a person, property, or both. An aggressive mob is distinguished from an aggressive crowd only by lawless activity. Examples of aggressive mobs are the inmate mobs in prisons and jails, mobs that act out their frustrations after political defeat, or violent mobs at political protests or rallies.
  - An escape mob is attempting to flee from something such as a fire, bomb, flood, or other catastrophe. Members of escape mobs are generally difficult to control and can be characterized by unreasoning terror.
  - An acquisitive mob is one motivated by a desire to acquire something. Riots caused by other factors often turn into looting sprees. This mob exploits an authority's lack of control in safeguarding property.
  - An expressive mob is one that expresses fervor or revelry following some sporting event, religious activity, or celebration. Members experience a release of pent up emotions in highly charged situations.
  - A flash mob is a large group of people who gather in some predetermined location, perform some brief action, and then quickly disperse. Youth flash mobs in Boston, Philadelphia, Brooklyn, New York, Kansas City, Missouri, Orange, New Jersey, and elsewhere in the United States have resulted in violence, vandalism, injuries, and arrests.

- **Riots**—A riot is form of civil disorder characterized by a group lashing out in a violent public disturbance against authority, property, or people. Riots typically involve vandalism and the destruction of property,

public or private. The property targeted varies depending on the riot and the inclinations of those involved. Targets can include shops, cars, restaurants, government institutions, and religious buildings.

Civil disorders can result in numerous secondary hazards. Depending on the size and scope of the incident, civil disturbance may lead to widespread urban fire, utility failure, transportation interruption, and environmental hazards. Civil disorders can be a secondary hazard after a severely destructive disaster. This may include looting, blocking of roadways, which may impact emergency response vehicles, and demonstrations.

15.1.2 Technological Hazards

Technological hazards are associated with human activities such as the manufacture, transportation, storage and the use of hazardous materials. Incidents related to these hazards are assumed to be accidental, with unintended consequences. Technological hazards in the planning area can be categorized as follows:

- Hazardous materials incidents
- Pipeline and utility failure
- Transportation accidents.

Hazardous Materials Incidents

Hazardous materials are substances that are considered severely harmful to human health and the environment, as defined by the U.S. Environmental Protection Agency (EPA) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Many hazardous materials are commonly used substances that are harmless in their normal uses but dangerous if released. The EPA designates more than 800 substances as hazardous and identifies many more as potentially hazardous due to their characteristics and the circumstances of their release.

If released or misused, hazardous substances can cause death, serious injury, long-lasting health effects, and damage to structures, other properties, and the environment. Many products containing hazardous substances are used and stored in homes, and these products are shipped daily on highways, railroads, waterways, and pipelines. The following are the most common type of hazardous material incidents:

- **Fixed-Facility Hazardous Materials Incident**—This is the uncontrolled release of materials from a fixed site capable of posing a risk to health, safety and property. It is possible to identify and prepare for a fixed-site incident because federal and state laws require those facilities to notify state and local authorities about what is being used or produced at the site.
- **Hazardous Materials Transportation Incident**— A hazardous materials transportation incident is any event resulting in uncontrolled release of materials during transport that can pose a risk to health, safety, and property as defined by Department of Transportation Materials Transport regulations. Transportation incidents are difficult to prepare for because there is little if any notice about what materials could be involved should an accident happen. Hazardous materials transportation incidents can occur at any place within the country, although most occur on the interstate highways or major federal or state highways, or on the major rail lines. In addition to materials such as chlorine that are shipped throughout the country by rail, thousands of shipments of radiological materials, mostly medical materials and low-level radioactive waste, take place via ground transportation across the United States. Many incidents occur in sparsely populated areas and affect very few people.
- **Interstate Pipeline Hazardous Materials Incident**—A significant number of interstate natural gas, heating oil, and petroleum pipelines run through California. These are used to provide natural gas to the utilities in California and to transport these materials from production facilities to end-users.

CERCLA, the Emergency Planning and Community Right-to-Know Act, and California law require responsible parties to report hazardous material releases if certain criteria is met. CERCLA requires that all releases of hazardous substances (including radionuclides) exceeding reportable quantities be reported by the responsible party to the National Response Center. If an accidental chemical release exceeds the Right-to-Know Act applicable minimal reportable quantity, the facility must notify state emergency response commissions and local emergency planning committees for any area likely to be affected by the release, and provide a detailed written follow-up as soon as practicable. Information about accidental chemical releases must be made available to the public.

Pipeline and Utility Failure

Raw Materials Pipelines

Transmission and distribution pipelines provide two differing services. Transmission pipelines transport raw material for further refinement. These pipes are large and far reaching, operating under high pressure. Distribution pipelines provide processed materials to end users. These are smaller in diameter, some as small as a half an inch, and operate under lower pressure.

Although pipelines are the safest and most reliable way to transport natural gas, crude oil, liquid petroleum products, and chemical products, there is still an inherent risk due to the nature of the hazardous materials. Pipelines are regulated by the Office of the State Fire Marshal. The Pipeline and Hazardous Materials Safety Administration enforces oil and gas pipeline safety regulations. The federal government enforces hazardous material transport pursuant to its interstate commerce regulation authority. Pipelines are also monitored by system control and data acquisition (SCADA) systems that measuring flow rate, temperature and pressure. The SCADA system transfers real-time data via satellite from the pipelines to a control center where the valves, pumps, and motors are remotely operated. If tampering with the pipeline occurs, an alarm sounds. The ensuing valve reaction is instantaneous, with the alarm system isolating any rupture and setting off a chain reaction that shuts down pipeline pumps and alerts pipeline operators within seconds.

Failures of distribution and transmission pipelines can occur when pipes corrode, are damaged during excavation, are incorrectly operated, or are damaged by other forces. More serious accidents occur on distribution pipelines than on any other type due to their number, intricate networking, and location in highly populated areas.

Water

Water disruption is a secondary impact from a natural disaster or intentional act. A breach in the pipelines that carry water through the planning area would have significant temporary impacts on the cities until alternative water sources are pumped and treated. Long-term disruption would have significant impacts on residences and businesses in the planning area if demand exceeds secondary supplies and water conservation measures do not provide enough relief to reduce demand to equal the secondary supplies.

Wastewater

Disruption of the planning area's wastewater collection and wastewater treatment plants would have significant citywide and regional impacts. Such disruption could result if the system were to be overwhelmed by a significant storm or discharge of materials in such quantities that the treatment plant could not adequately treat the waste. Natural hazards such as earthquake or flood, major power outages, or terrorism directed at the facilities and systems could disrupt the process of collecting and treating millions of gallons of sewage. Wastewater treatment plants may also have emergencies internal to the plant such as oxygen deficiencies that render them incapable of treating waste. The disruption of service may also have significant environmental impacts on the waterways adjacent to the treatment plants.

Petroleum Refineries

A petroleum refinery's main job is to separate crude oil into its many parts, which are then reprocessed into products. The type, number, and size of process units at a particular refinery depends on factors such as the type of crude oil and the products made. The units making up a refinery are tanks, furnaces, distillation towers, reactors, heat exchangers, pumps, pipes, fittings, and valves. Products include the following:

- Fuels, such as gasoline, diesel, heating oil, kerosene, jet fuel, bunker fuel oil, and liquefied petroleum gas
- Solvents, including benzene, toluene, xylene, hexane, and heptane, which are used in paint thinners, dry-cleaning solvents, degreasers, and pesticide solvents
- Lubricating oils and insulating, hydraulic, and medicinal oils
- Petroleum wax
- Greases, which are primarily a mixture of various fillers
- Asphalt.

These products can be hazardous not only in their final state but as they are being processed and refined. The principal hazards at refineries are fire and explosion. Refineries process a multitude of products with low flash points. Although systems and operating practices are designed to prevent such catastrophes, they can occur. In a refinery, hazardous chemicals can come from many sources and in many forms. In crude oil, there are not only the components sought for processing, but impurities such as sulfur, vanadium, and arsenic compounds. The oil is split into many component streams that are further altered and refined to produce the final product range. Most, if not all, of these component stream chemicals are inherently hazardous to humans, as are the other chemicals added during processing. Hazards include fire, explosion, toxicity, corrosiveness, and asphyxiation.

At refineries, the potential for fires, explosions, releases of flammable or toxic materials, or other accidents that could cause injuries, fatalities, or spills could occur and would be primarily associated with the flammable vapors and other flammable materials transported as cargo by tankers visiting the marine terminal. Damage prevention measures include routine inspection and maintenance, corrosion protection, continuous monitoring and control technologies, public awareness programs, and integrity management and emergency response plans.

Transportation Accidents

Transportation accidents are incidents involving air, road or rail travelers resulting in death or serious injury. The potential for transportation accidents that block ingress, egress, and movement through the planning area is significant, as is the likelihood of hazardous material incidents resulting from a traffic or rail accident.

15.2 HAZARD PROFILE

15.2.1 Past Events

Intentional Hazards

Terrorism Events

The Bay Area has not experienced a regional terrorism event. However, the 2016 hosting of the Super Bowl in Santa Clara County increased mainstream exposure of the Bay Area for potential future terrorist events. The 2012 Alameda County Emergency Operations Plan (EOP) identifies two incidents in the county (Alameda County EOP, 2012):

- September 9, 2003—A bombing at Shaklee Corp in Pleasanton was attributed to a faction of the Animal Liberation Front.

- August 8, 2003—Two bombings at the Chiron Corp in Emeryville were attributed to a faction of the Animal Liberation Front.

Cyber Threats

In December 2015, University of California at Berkeley experienced a massive cyber-attack that left upwards of 80,000 people exposed to cyber-crime. The university is one of the largest employers in the Bay Area, and this cyber-attack reached beyond jurisdictional and county lines to affect the entire Bay Area.

On December 1, 2014, a global cyber-attack shut down web access to agenda, minutes, and video for many Bay Area government agencies, including Alameda County. The San Francisco-based company Granicus, which provides web services for government agencies nationwide, reported the outage (Johnson, 2014).

Civil Unrest

The 2012 Alameda County EOP and other resources identify the following civil unrest incidents (Alameda County EOP, 2012):

- November 24 – December 10, 2014—After a grand jury decision in the Michael Brown case in Ferguson, MO, there was a 17-day revolt in Oakland that resulted in marches, blocked roadways, looting of businesses, destruction of property, and arrests.
- October 20, 2011— Occupy Oakland protesters took to the streets in Oakland over economic inequality, corporate excess, and homelessness. Hundreds of participants set up tents in Frank Ogawa Plaza. Some arrests were made for disruptive behavior; however, for the most part, the protest remained peaceful.
- January 7, 2009—This was the most notorious civil disturbance in Alameda County and occurred as a response to shooting by a Bay Area Rapid Transit police officer. It began as a peaceful protest but turned into a destructive riot resulting in trash can fires, multiple cars set on fire, broken storefront windows, and looting of stores.

Over the years, fights and lock-downs occur and some develop into full-scale threatening riots at the Alameda County Jail, Santa Rita, in Dublin. One occasion was August 26, 2010, when an inmate was killed. Security measures have not completely stopped the violence perpetrated on inmates and staff. The Federal Correctional Facility in Dublin is a low security federal correctional institution for female inmates that has not had recorded riots or fatalities.

In Pleasanton on September 9, 2016, hundreds of protesters gathered and 23 were arrested for civil disobedience at the Alameda County Fairgrounds. They gathered to protest the "militarization of police" at an event called Urban Shield, an annual law enforcement preparedness training.

Technological Hazards

Hazardous Materials

Although hazardous material incidents can happen almost anywhere, certain areas are at higher risk. Jurisdictions near roadways that are frequently used for transporting hazardous materials and jurisdictions with industrial facilities that use, store, or dispose of such materials all have an increasing potential for major incidents, as do jurisdictions crossed by certain railways, waterways, airways and pipelines. Hazardous materials are transported through the planning area via highways and pipelines. The planning area's level of exposure to hazardous materials can be understood by examining the type of businesses, commercial traffic routes, and highway exposure.

Alameda County and its incorporated cities have experienced many accidental hazardous materials incidents. On November 7, 2007, a container ship struck a pier bumper at the western span of the Bay Bridge, which caused 58,000 gallons of bunker fuel to be released into the water. Oil slicks, oil globs, and oiled and dead wildlife were reported around the Bay and Pacific coastline. Beaches, marines and other shoreline areas were closed for cleanup in Alameda County and surrounding areas. In 2009, an oil tanker, located south of the Bay Bridge, was being fueled when human errors caused the tanks to overflow. This released 400 gallons of fuel into the bay and led to birds being oiled and approximately 6 miles of East Bay being oiled, specifically Bay Farm Island and Alameda Island (Alameda County EOP, 2012).

Table 15-3 lists the number of hazardous material incidents reported to Cal OES Warning Center by year and spill site type between 2012 through 2016. Additional historical hazardous material spill report data is available on Cal OES website. The records show that a total of 166 hazardous materials spills occurred over 5-year timeframe in Tri-Valley planning area.

Table 15-3. Hazard Materials Spills in Tri-Valley Planning Area Reported to Cal OES (2012-2016)

Spill Site	2012	2013	2014	2015	2016	Total
Airport	0	0	0	0	0	0
Industrial Plant	0	2	0	2	0	4
Merchant/Business	3	5	3	6	6	23
Military Base	0	0	0	0	0	0
Oil Field	0	0	0	1	0	1
Other	3	5	2	2	5	17
Pipeline	0	0	0	2	1	3
Rail Road	0	1	2	2	1	6
Refinery	0	1	0	0	0	1
Residence	2	1	1	0	7	11
Road	15	11	18	14	10	68
School	0	0	0	0	0	0
Service Station	5	6	9	7	1	28
Treatment/Sewage Facility	0	1	0	0	0	1
Utilities/Substation	0	0	1	0	0	1
Waterways	1	0	0	0	1	2
Total	29	33	36	36	32	166

Source: Cal OES, 2017

Pipeline Incidents

Accidents involving underground pipelines in Alameda County have caused injury, fatalities and property damage. Recent events have involved natural gas lines in Oakland, Union City, Berkeley, and Livermore. In particular, on September 9, 2010 a natural gas pipeline explosion in San Bruno (San Mateo County) killed eight people and reduced the Crestmoor neighborhood to ashes. There have been incidents involving hazardous liquids as well, including an event on May 20, 2016 involving crude oil in Tracy (PHSMA, 2016).

According to Pipeline and Hazardous Materials Safety Administration (PHSMA), between 2010 to July 2017, there was one reported natural gas pipeline incident in the planning area. The incident occurred on June 11, 2012 in Livermore, when Pacific Gas & Electric had an unintentional release of gas (PHSMA, 2016).

Transportation Accidents

According to the 2012 Alameda County EOP, the County has not experienced an incident of a commercial flight or large plane. However, a number of general aviation aircraft incidents have occurred. These types of incidents are typically localized and somewhat contained.

Alameda County has experienced train derailments in the past. Recent events have been small, with minimal damage. In August 2004, a non-hazmat car derailed and two tank cars carrying methanol were damaged. Material release was not reported. In July 2005, a train derailed near a Kinder Morgan pipeline, which had to be shut down in case of any release (Alameda County EOP, 2012).

Between 1990 and 2016, there have been two aviation fatality incidents in Livermore, none in Dublin and Pleasanton as reported by the National Transportation Safety Board (NTSB). The following is information regarding recent incidents in the planning area (NTSB, 2017):

- May 9, 2010, Livermore—A Piper PA-280235 pilot used visual flight into instrument meteorological conditions which resulted in a collision with obstacles and terrain. Two fatalities occurred.
- May 1, 2007, Livermore—A Beech 36 collided with terrain nine miles from the Livermore airport. It resulted in two fatalities.

The California Office of Traffic Safety provides the total number of fatal and injury collisions on local city streets between 2010 through 2014 (see Table 15-4). Over this five-year period, 3,744 fatal and injury collisions have occurred in the Tri-Valley planning area.

Table 15-4. Total Fatal and Injury Collision Data for Tri-Valley Planning Area

Jurisdiction	2010	2011	2012	2013	2014	Total
Dublin	103	94	112	87	131	527
Livermore	271	275	267	268	472	1,553
Pleasanton	305	216	283	320	540	1,664
Total	679	585	662	675	1,143	3,744

Source: California Office of Traffic Safety, 2017

The only railway accident reported in recent years occurred on March 8, 2016 when a commuter train detailed after it struck a downed tree on the tracks. The incident occurred in Niles Canyon, south of the City of Pleasanton, where two train cars derailed and one plunged into a creek. It occurred at night and only nine people were injured (San Francisco CBS Local, 2016).

15.2.2 Location

Intentional Hazards

Terrorism, Civil Unrest, and Active Threats

The State of California and Office of Homeland Security have identified numerous high-profile targets for potential terrorists in California. Large population centers, high-visibility tourist attractions, and critical infrastructure accessible to the public present security challenges of an ongoing nature in California. The network of highways, railways, ports, and airports used to transport significant amounts of hazardous materials poses a significant technological hazards threat. Multiple incidents may happen simultaneously, and all typically require a multi-agency, multi-jurisdictional response.

In particular, the Santa Rita County Jail and Federal Correctional Facility, both in Dublin, are locations where civil unrest may occur. Also, the Lawrence Livermore National Laboratory and Sandia National Laboratory are U.S. Department of Energy national labs are critical facilities that may have active threats.

Cyber Threats

Both public and private operations in the Cities of Dublin, Livermore and Pleasanton are threatened on a near-daily basis by the millions of currently engineered cyber-attacks developed to automatically seek technological vulnerabilities. Possible cyberterrorist targets include the banking industry, power plants, air traffic control centers, and water systems; especially facilities that rely on computers, computer systems, and programs for their operations.

Technological Hazards

Hazardous Materials Release

Hazardous materials are stored before and after they are transported to their intended use. This may include service stations that store gasoline and diesel fuel in underground storage tanks; hospitals that store radioactive materials, flammable materials and other hazardous substances; or manufacturers, processors, distributors, and recycling plants for chemical industries that store a variety of chemicals on site (FEMA, 2013). For the purpose of this plan, fixed sites include buildings or property where hazardous materials are manufactured or stored, and are regulated under various programs by the EPA.

The Toxic Substances Control Act of 1976 (TSCA) provides the EPA with authority to require reporting, record-keeping and testing requirements, and restrictions relating to chemical substances and/or mixtures. Certain substances are generally excluded from TSCA, including food, drugs, cosmetics, and pesticides. TSCA addresses the production, importation, use, and disposal of specific chemicals, including polychlorinated biphenyls (PCBs), asbestos, radon, and lead-based paint. According to TSCA, there are no facilities with these substances in the planning area (EPA, 2017a).

Facilities identified in the Resource Conservation and Recovery Act Information databases (RCRA Info) were also reviewed for this plan. Hazardous waste information is contained in RCRA Info, a national program management and inventory system about hazardous waste handlers. In general, entities that generate, transport, treat, store, and dispose of hazardous waste are required to provide information about their activities to state environmental agencies. These agencies pass on the information to regional and national EPA offices. This regulation is governed by the RCRA, as amended by the Hazardous and Solid Waste Amendments of 1984. There are 73 RCRA facilities in Dublin, 162 facilities in Livermore, and 132 facilities in Pleasanton (EPA, 2017b).

Petroleum Refineries

There are five petroleum refinery operations along the Bay Area's Contra Costa-Solano refinery belt.

Pipelines and Utilities

Distribution pipelines run through highly populated areas providing refined materials for public use and consumption. Large gas distribution lines, called "mains," along with much smaller service lines that travel to homes and businesses, account for the vast majority of underground pipeline system.

Figure 15-2 shows gas transmission and hazardous liquid pipelines as well as the locations of accidents and incidents within the planning area. Both natural gas and hazardous liquid pipelines traverse the planning area. The primary operator of the gas transmission pipelines is Northern California Power Agency and Pacific Gas & Electric. The primary operator for the hazardous liquid pipeline is Shell Pipeline Company (PHMSA, 2017a).

Source: PHMSA National Pipeline Mapping System, 2017

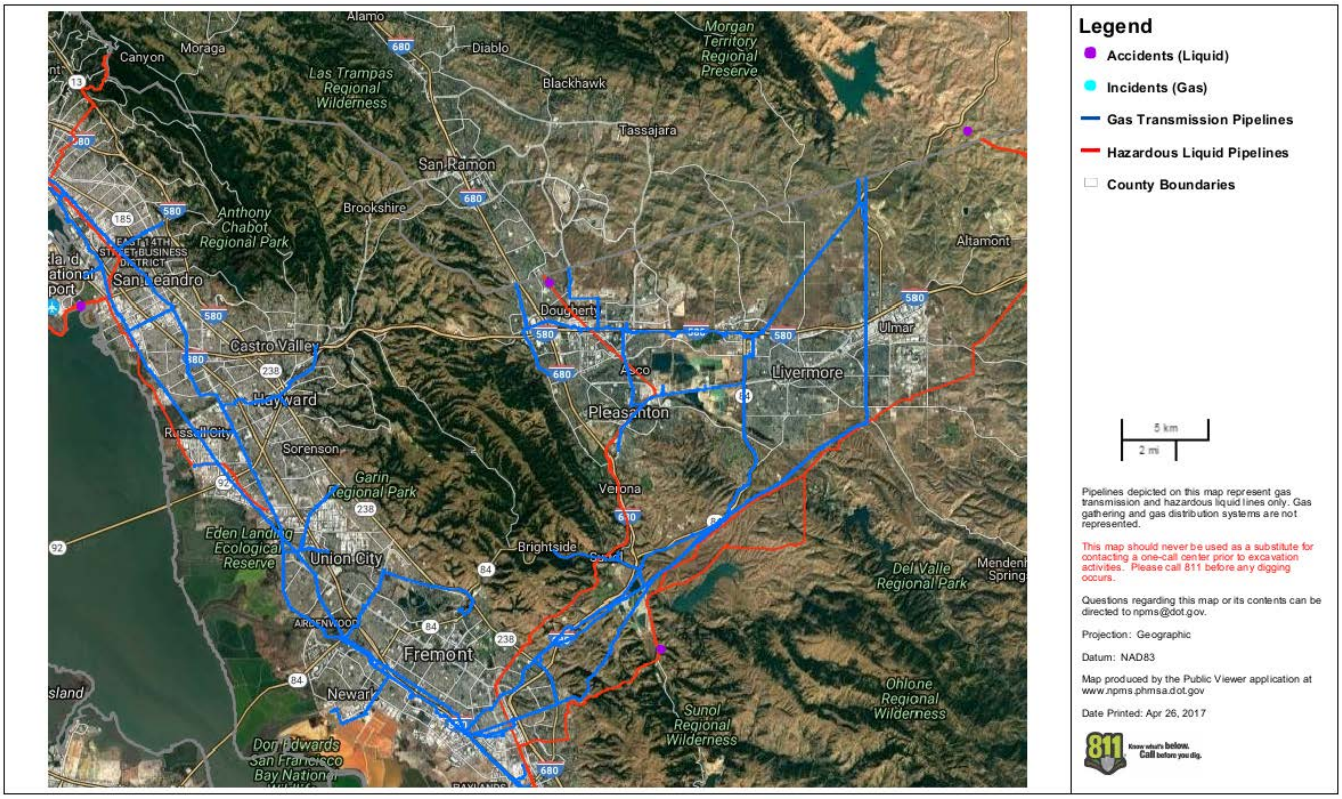


Figure 15-2. Gas Transmission and Hazardous Liquid Pipelines Near the Planning Area

Zone 7 Water Agency (Zone 7), a water wholesaler, provides treated drinking water to four major retailers in the Valley area that serve approximately 240,000 people and businesses. The wholesale water has three sources: South Bay Aqueduct that originates from the California State Water Project; Lake Del Valle storage reservoir that is approximately 10 miles from Livermore; and groundwater from local wells (Zone 7, 2017) (see Figure 7-6).

Transportation Incidents

Incidents involving hazardous materials in transit or incidents occurring on roads and rail can occur through a variety of vehicles in and around the planning area. In the City of Dublin, there are 193 miles of road and no commuter train or transportation rails. In the City of Livermore, there are 348 miles of roadway, 12 miles of railroad and the Altamont Commuter express commuter train. In the City of Pleasanton, there are 340 miles of roadway, 6 miles of commuter train, and 8 miles of transportation rail (ABAG Local HMP Annex, 2010).

The Tri-Valley planning area is serviced by the Livermore Municipal Airport. It was a 5,255-foot main paved runway and a second 2,700-foot unlighted training runway. The nearest airports with scheduled airline service are Oakland, San Jose, and Stockton.

The main artery through the planning area is Interstate 580, which feeds traffic from the Bay Area to the Central Valley of California.

Union Pacific Railroad freight line traverses the Cities of Livermore and Pleasanton and Amtrak passenger train has a station in Livermore. The Altamont Commuter Express commuter train stops in Livermore and Pleasanton. It extends from Stockton to San Jose.

15.2.3 Frequency

Intentional Hazards

Terrorism, Civil Unrest, and Active Threats

As of 2016, California's economy was the largest of any state in the United States. The planning area's proximity to San Francisco and Silicon Valley presents unique conditions for terrorist attacks. The transportation, energy, and communications systems that cross the planning area have impacts on the local, regional, and even national economy. In general, the risks of a terrorist event involving a WMD are as follows:

- **Chemical**—The risk of a chemical event is present in the Cities of Dublin, Livermore and Pleasanton. The agricultural community in Alameda County uses and stores significant amounts of chemicals for peaceful and productive means that could be used in destructive ways.
- **Explosives**—Pipe bomb and suspicious package events have occurred in Alameda County in the past. While none of the events has been specifically identified as a WMD-related attack, the elements necessary to construct a WMD are readily available. Additionally, the agricultural communities maintain sufficient products and quantities for use in explosive events.
- **Radiological/Nuclear**—The major transportation arteries for vehicles or rail that cross through the planning area contribute to the risk of a radiological event. Such products can unknowingly pass through any one of the regional transportation corridors.
- **Biological**—Anthrax incidents that occurred in the United States in October 2001 demonstrate the potential for spreading terror through biological WMDs. The introduction of Newcastle disease in the United States demonstrates how an agent can be introduced to livestock, causing harm to public health and the economy.
- **Combined Hazards**—WMD agents can be combined to have a greater total effect. When combined, the impacts of the event can be immediate and longer-term. Casualties will likely suffer from both immediate and long-term burns and contamination. Given the risks associated with chemical agents in Alameda County, the possibility exists for such a combined event to occur.

Cyber Threats

Cyber-attacks are experienced on a daily basis, often without being noticed. Up-to-date virus protection software used in both public and private sectors prevent most cyber-attacks from becoming successful. Programs that promote public education to that end are also an effective way in which to mitigate cyber threats.

Cyberterrorism is much less common than cyber-attacks, and the frequency is unknown.

Technological Hazards

Hazardous material incidents may occur at any time in the Cities of Dublin, Livermore and Pleasanton, given the presence of transportation routes bisecting the planning area, the location of businesses and industry that use hazardous materials, the presence of scattered illegitimate businesses such as clandestine drug laboratories at any given time, and the improper disposal of hazardous waste.

15.2.4 Severity

The severity of human-caused hazards could range from a minor transportation accident or power outage to a full-scale terrorist attack.

The term mass casualty incident (MCI) is often applied to transportation accidents involving air and rail travel, as well as multi-vehicle highway accidents. However, MCIs may also result from hazardous materials incidents or

acts of violence, such as shootings or hostage situations. Effects may include serious injuries, loss of life, and associated property damage. Because large numbers of patients may be involved, significant MCIs may tax local emergency medical and hospital resources, and therefore require a regional response. MCIs may occur throughout the planning area, day or night, at any time of the year: Interstate 580 offer the potential for MCIs because of the heavy volume of traffic, although no highway or surface street in the City is exempt from this hazard.

The railroad tracks traversing Alameda County, carrying Amtrak passengers as well as freight, also face the risk of an MCI, as do the air corridors above the county. Severe weather may play a role in roadway, air, or rail accidents. MCIs may also result from acts of violence or terrorism, which could include a chemical, biological or radiological incident, contaminating persons and requiring mass decontamination.

Hazardous Materials

Table 15-5 shows the number of injuries and fatalities associated with hazardous material spills reported to Cal OES Warning Center between 2012 through 2016. Additional historical hazardous material spill report data is available on the Cal OES website. The records show that eight people were injured and five fatalities occurred in a 5-year timeframe in planning area.

Table 15-5. Injuries and Fatalities from Hazardous Materials Spills in Tri-Valley Planning Area

Severity	2012	2013	2014	2015	2016	Total
Number of Injuries	2	1	3	0	2	8
Number of Fatalities	0	1	3	1	0	5
Total	2	2	6	1	2	13

Source: Cal OES, 2017

Hazardous material releases also affect the environment through contamination of soil, but data are not available on the area that has been affected by such contamination.

15.2.5 Warning Time

Very few terrorism incidents—fewer than 5 percent—are preceded by a warning. Technological accidents occur without predictability under circumstances that give responders little time to prepare.

15.3 SECONDARY HAZARDS

The largest secondary impact caused by human-caused hazards would be economic, and could be significant:

- The cost of a terrorist act would be felt in terms of loss of life and property, disruption of business activity and long-term emotional impacts. Recovery would take significant resources and expense at the local level.
- Computer security breaches associated with data and telecommunications losses can have significant economic impact.
- Pipeline and tank failure impacts can include both the cost of community recovery for the area surrounding the failure site and the cost of disruption of services for the transported material.
- Hazardous materials releases have the potential to cause major disruptions to local businesses that house hazardous materials. Additionally, a hazardous materials release could cause businesses to close if they are located in the path of the hazardous materials flow.
- The economic impacts should a transportation facility be rendered impassable would be significant. The loss of a roadway or railway would have serious effects on the local economy and ability to provide services. Loss of major travel routes would result in loss of commerce, and could impact the ability to

provide emergency services to citizens by delaying response times or limiting routes for equipment such as fire apparatus, police vehicles, and ambulances. The ability to receive fuel deliveries would also be impacted. The effects of re-routed traffic could have a serious impact on local roadways.

15.4 EXPOSURE

15.4.1 Population

A human-caused hazard event could range from an isolated accident to a highly coordinated attack by multiple agents upon multiple targets. Large-scale incidents have the potential to kill or injure many citizens in the immediate vicinity, and may also affect people a relative distance from the initial event. Variables affecting exposure for a WMD attack and a hazardous material accident include the physical and chemical properties of the WMD, the ambient temperature, wind speed, wind direction, barometric pressure, and humidity.

Computer models can provide general data to first responders to advise evacuations or sheltering in place. With so many variables to determine "toxic endpoints" as defined by the California Environmental Protection Agency, distances are difficult to forecast. In general, those close to transportation corridors or businesses with acutely hazardous materials are more at risk for some sort of effect. Each chemical incident will be different and the scenarios are too numerous to describe in this plan.

Hazardous materials pose a significant risk to emergency response personnel. All potential first responders and follow-on emergency personnel must be properly trained to the level of emergency response actions required of their individual position at the response scene. Hazardous materials also pose a serious long-term threat to public health and safety, property and the environment.

15.4.2 Property

The planning area is located in Alameda County, among the fastest growing counties in California, making it a higher profile target for terrorism. Additionally, the planning area's proximity to San Francisco and Silicon Valley make it vulnerable to secondary and cascading effects of a possible terrorist threat.

15.4.3 Critical Facilities and Infrastructure

Terrorism events can pose a serious long-term threat to damaging critical facilities and infrastructure. In particular, the industrial corridor along the northern and northwestern portions of the county are highly visible targets. The high-profile buildings in the planning area include the Federal Correctional Facility, the Alameda County Jail - Santa Rita, and Camp Parks, which are all in Dublin. Additionally, Lawrence Livermore National Laboratory and Sandia National Laboratory are considered high profile critical facilities within the planning area. Critical facilities are limited to City facilities, Alameda County facilities, and other government facilities, private utility infrastructure and administrative offices, and medical facilities.

Critical facilities may house hazardous materials and rail, highways, and interstates transport hazardous materials on a daily basis. The exposure of critical facilities and infrastructure to a terrorism event or hazardous material incident is based on the facility's criticality and physical vulnerability:

- Criticality is a measure of the potential consequence of an accidental or terrorist event as well as the attractiveness of the facility to a potential adversary or threat. The criticality for each critical facility is based on the factors shown in Table 15-6.
- Vulnerability is a measure of the physical opportunity for an accident or an adversarial attack. This assessment takes into consideration physical design, existing countermeasures, and site layout. The vulnerability for each critical facility is based on the criteria shown in Table 15-7.

Table 15-6. Criticality Factors

Criterion	Low Criticality	Medium Criticality	High Criticality
Awareness[a]	Not known/Neighborhood	City/Region/County	State/National
Hazardous Materials[b]	None / limited and secure	Moderate to large and secure	Large, minimum or no security
Collateral Damage Potential[c]	None or low	Moderate/immediate area or within 1 mile radius	High/immediate area or within 1 mile radius
Site Population[d]	0 – 300	301 – 1,000	1,001 or greater
Public/ Emergency Function[e]	No emergency function, or could be used for emergency function in the future	Support emergency function—redundant site	Emergency function—critical service with or without redundancy

a. Awareness—How aware is the public of the existence of the facility, site, system, or location?
b. Hazardous Materials—Are flammable, explosive, biological, chemical and/or radiological materials present on site?
c. Collateral Damage Potential—What are the potential consequences for the surrounding area if the asset is attacked or damaged?
d. Site Population—What is the potential for mass causalities, based on the capacity of the facility.
e. Public or Emergency Functions—Does the facility perform a function during an emergency? Is this facility or function capable of being replicated elsewhere?

Table 15-7. Vulnerability Criteria

Criterion	Low Vulnerability	Medium Vulnerability	High Vulnerability
Accessibility[a]	Remote location, secure perimeter, tightly controlled access	Controlled access, protected or unprotected entry	Open access, unrestricted, patrolling security, sign restrictions
Automobile Proximity[b]	Not within 75' – 100'	Not within 25' – 50'	Adjacent or not within 10'
Asset Mobility[c]	Moves or is relocated frequently	Moves or is relocated occasionally	Permanent/Fixed
Proximity to other Critical Facilities[d]	Greater than 1.5 – 2 miles	Greater than 3/4 - 1 mile	Within 1/2 – 3/4 mile
Secure Design[e]	No areas for concealment of packages, air intakes are on roof, access ways are not under the structure.	Area of concealment present, greater than 25' from the structure; Air intakes located at least 10' above ground, may have under structure access drives.	Areas of concealment within 25', air intakes at ground level, under structure access drives.

a. Accessibility—How accessible is the facility or site to the public?
b. Automobile Proximity—How close can an automobile get to the facility? How vulnerable is the facility to a car bomb attack?
c. Asset Mobility—Is the facility or asset's location fixed or mobile? If mobile, how often is it moved, relocated, or repositioned?
d. Proximity to other critical facilities—If the facility is close to other critical facilities then there could be an increased probability of the facility receiving collateral damage.
e. Secure design—General evaluation of areas of obstruction, air intake locations, parking lot and road design and locations and other site design aspects.

15.4.4 Environment

The risk of human-caused hazards to the environment is considerable. Hazardous materials spilled along roads or railways could easily pollute rivers, streams, wetlands, riparian areas and adjoining fields. Other hazardous materials released into the air could severely impact plant and animal species. Reducing the risk exposure to the built environment can also mitigate potential losses to the natural environment.

15.5 VULNERABILITY

15.5.1 Population

Although human-caused hazards have not resulted in a large number of deaths in this area, this type of hazard can be deadly and widespread. Injuries and casualties were not estimated for this hazard. Any individuals exposed to human-caused hazards are considered to be at risk, particularly those working as first responder professionals.

15.5.2 Property

All structures in the planning area are physically vulnerable to a human-caused hazard. The emphasis on accessibility, the opportunity for roof access, driveways underneath some structures, unmonitored areas, the proximity of many structures to transportation corridors and underground pipelines, and the potential for a terrorist to strike any structure randomly all have an impact on the vulnerability of structures.

15.5.3 Critical Facilities and Infrastructure

The U.S Office of Homeland Security's 2003 *National Strategy for the Physical Protection of Critical Infrastructure of Critical Infrastructure and Key Assets* lays a foundation to work together to prepare and protect critical infrastructure and key assets nationwide from terrorist events. Critical facilities and infrastructure entities know their vulnerabilities to terrorism. They have executed numerous preparedness plans and exercises for years and fortified their facilities to minimize their vulnerability.

The impact of a hazardous material spill or transportation incident will likely be localized to the particular facility, hospital, airport, railroad, road, or highway. The potential losses to existing development vary because of the variable nature of the hazardous material spill, but costs from product loss, property damage and decontamination and other costs can add up to millions of dollars.

15.5.4 Environment

The environment vulnerable to a human-caused hazard is the same as the environment exposed to the hazard. While human-caused disasters have caused significant damage to the environment, estimating damage can be difficult. Loss estimation platforms such as Hazus are not equipped to measure environmental impacts of these types of hazards. The best gauge of vulnerability of the environment would be a review of damage from past human-caused hazard events. Loss data for damage to the environment were not available at the time of this plan update. Capturing this data from future events could be beneficial in measuring the vulnerability of the environment for future updates.

Most hazardous materials incidents are localized and are quickly contained or stabilized. Depending on the characteristic of the hazardous material or the volume of product involved, the affected area can be as small as a room in a building or as large as many square miles that require soil remediation. More widespread effects occur when a product contaminates the municipal water supply or water system such as a river, lake, or aquifer. Such environmental damage can linger for decades.

15.5.5 Economic impacts

Economic impacts from human-caused hazards could be significant. The cost of a terrorist act would be felt in terms of loss of life and property, disruption of business activity and long-term emotional impacts. Recovery would take significant resources at the local level.

Utility losses could cause a reduction in employment, wholesale and retail sales, utility repairs, and increased medical risks. The planning area may lose sales tax and property taxes, and the finances of private utility companies and the businesses that rely on them would be disrupted.

The economic impact of data and telecommunications losses can be great, as computer security breaches, crime conducted via the world wide web such as identify theft, and many more forms of human-caused economic losses occur daily. Millions of dollars are lost each year as criminals and cyberterrorists steal sensitive information and funds from individuals and organizations.

The economic impacts would be significant if a transportation facility were rendered impassable. The loss of a roadway or railway would have serious effects on the planning area's economy and ability to provide services. Loss of travel routes on Interstate 580 would result in loss of commerce, and may impact the planning area's ability to provide emergency services to its citizens by delaying response times or limiting routes for egress to critical healthcare facilities or ingress of equipment such as fire apparatus, police vehicles, and ambulances. Fuel deliveries would also be impacted. The effects of re-routed traffic could also have a serious impact on local roadways. Heavy traffic on routes through the planning area already occur at peak commute times when Interstate 580 is congested.

15.6 FUTURE TRENDS IN DEVELOPMENT

The potential for human-caused hazards is not likely to lessen or prohibit development in the planning area. The threat of human-caused hazards and the availability of Homeland Security Funds will influence future development of critical facilities.

15.7 SCENARIO

Two human-caused hazard scenarios could have a significant impact on the planning area:

- The first scenario would involve hazardous materials being transported via rail, pipeline, or highway (Interstate 580) across the planning area. The release of hazardous materials via intentional or unintentional means could impact large population centers within the planning area. Advance knowledge of these shipments and their contents would play a role in preparedness for this scenario, thus reducing its potential impact. The biggest issue in response to hazardous material is material identification and containment.
- The second scenario would be a large-scale cyber-attack on Dublin, Livermore, and Pleasanton city servers. Such an attack would require the planning area governments to revert to non-network based operations and put a strain on daily operations. If such an attack would last for an extended period of time, fiscal operations may be impacted.

15.8 ISSUES

Future actions needed at the local level to address human-caused hazards include but are not limited to the following:

- Continue all facets of emergency preparedness training for police, fire, public works, and city manager/public information staff in order to respond quickly in the event of a human-caused disaster. Enhance awareness training for all employees to recognize threats or suspicious activity in order to prevent an incident from occurring.
- Work with the private sector to enhance and create business continuity plans in the event of an emergency.

- Encourage local businesses to adopt information technology and telecommunications recovery plans.
- Prepare and present the human-caused hazard risk and preparedness program to the public through meetings, town hall gatherings, and preparedness fairs and outreach.
- Maintain any and all citizen advisory groups and periodically e-mail emergency preparedness information including human-caused hazard preparedness instructions and reminders.
- Work proactively with hazardous materials facilities to follow best management practices:

  - Placards and labeling of containers
  - Emergency plans and coordination
  - Standardized response procedures
  - Notification of the types of materials being transported through the planning area at least annually
  - Random inspections of transporters as allowed by each company
  - Installation of mitigating techniques along critical locations
  - Routine hazard communication initiatives
  - Consideration of using safer alternative products.

- Continue all facets of the hazardous materials team training and response through commitment of resources from the Fire Department budget.
- Work with the private sector to enhance and create business continuity plans in the event of an emergency.
- Coordinate with planning area school districts to ensure that their emergency preparedness plans include preparation for human-caused incidents.

16. RISK RANKING

A risk ranking was performed for the natural hazards of concern described in this plan. This risk ranking assesses the probability of each hazard's occurrence as well as its likely impact on the people, property, and economy of the planning area, using methodologies promoted by FEMA. The results are used in establishing mitigation priorities.

When available, estimates of risk were generated with data from Hazus or GIS using methodologies promoted by FEMA, based on the hazard profiles and exposure and vulnerability evaluations presented in Chapters 6 through 14. For hazards of concern with less quantitative datasets, qualitative assessments were used. As appropriate, results were adjusted based on local knowledge and other information not captured in the quantitative assessments. The hazards of interest were not ranked for the following reasons:

- A key component of risk as defined for the planning effort is probability of occurrence. While it is possible to assign a recurrence interval for natural hazards because of historical occurrence, it is not feasible to assign recurrence intervals for the other hazards of interest, which lack such historical precedent.
- Federal hazard mitigation planning regulations do not require the assessment of non-natural hazards (44 CFR, 201.6). It is FEMA's position that this is a local decision.

All planning partners used the same methodology to rank risk for impacts on their jurisdictions (see Volume 2 for these rankings). The risk ranking at the planning partner scale was used to inform the action plan development process for each partner. Planning partners were directed to identify mitigation actions addressing hazards that, at a minimum, had a "high" risk ranking (see Section 16.3). Actions that address hazards with a "medium", "low" or no hazard ranking are considered optional by this planning process.

This chapter summarizes the planning-area-wide risk ranking prepared by the planning team using aggregate results of the risk assessment. The risk ranking methodology and results were reviewed, discussed and approved by the Steering Committee via facilitated brainstorming sessions.

16.1 PROBABILITY OF OCCURRENCE

The probability of occurrence of a hazard is indicated by a probability factor based on likelihood of annual occurrence:

- High—Hazard event is likely to occur within 25 years (Probability Factor = 3)
- Medium—Hazard event is likely to occur within 100 years (Probability Factor =2)
- Low—Hazard event is not likely to occur within 100 years (Probability Factor =1)
- No exposure—There is no probability of occurrence (Probability Factor = 0)

The assessment of hazard frequency is generally based on past hazard events in the area. Table 16-1 summarizes the probability assessment for each hazard of concern for this plan.

Table 16-1. Probability of Hazards

Hazard Event	Probability (high, medium, low)	Probability Factor
Dam Failure	Low	1
Drought	High	3
Earthquake	High	3
Flood	High	3
Landslide	Medium	2
Severe Weather	High	3
Wildfire	High	3

16.2 IMPACT

Hazard impacts were assessed in three categories: impacts on people, impacts on property and impacts on the local economy. Numerical impact factors were assigned as follows:

- **People**—Values were assigned based on the percentage of the total ***population exposed*** to the hazard event. The degree of impact on individuals will vary and is not measurable, so the calculation assumes for simplicity and consistency that all people exposed to a hazard because they live in a hazard zone will be equally impacted when a hazard event occurs. It should be noted that planners can use an element of subjectivity when assigning values for impacts on people. Impact factors were assigned as follows:

  - High—50 percent or more of the population is exposed to a hazard (Impact Factor = 3)
  - Medium—25 percent to 49 percent of the population is exposed to a hazard (Impact Factor = 2)
  - Low—25 percent or less of the population is exposed to the hazard (Impact Factor = 1)
  - No impact—None of the population is exposed to a hazard (Impact Factor = 0)

- **Property**—Values were assigned based on the percentage of the total ***property value exposed*** to the hazard event:

  - High—30 percent or more of the total assessed property value is exposed to a hazard (Impact Factor = 3)
  - Medium—15 percent to 29 percent of the total assessed property value is exposed to a hazard (Impact Factor = 2)
  - Low—14 percent or less of the total assessed property value is exposed to the hazard (Impact Factor = 1)
  - No impact—None of the total assessed property value is exposed to a hazard (Impact Factor = 0)

- **Economy**—Values were assigned based on the percentage of the total ***property value vulnerable*** to the hazard event. Values represent estimates of the loss from a major event of each hazard in comparison to the total assessed value of the property exposed to the hazard. For some hazards, such as wildfire, landslide and severe weather, vulnerability was considered to be the same as exposure due to the lack of loss estimation tools specific to those hazards. Loss estimates separate from the exposure estimates were generated for the earthquake and flood hazards using Hazus.

  - High—Estimated loss from the hazard is 20 percent or more of the total exposed property value (Impact Factor = 3)
  - Medium—Estimated loss from the hazard is 10 percent to 19 percent of the total exposed property value (Impact Factor = 2)
  - Low—Estimated loss from the hazard is 9 percent or less of the total exposed property value (Impact Factor = 1)
  - No impact—No loss is estimated from the hazard (Impact Factor = 0)

The impacts of each hazard category were assigned a weighting factor to reflect the significance of the impact. These weighting factors are consistent with those typically used for measuring the benefits of hazard mitigation actions: impact on people was given a weighting factor of 3; impact on property was given a weighting factor of 2; and impact on the economy was given a weighting factor of 1.

Table 16-2, Table 16-3 and Table 16-4 summarize the impacts for each hazard.

Table 16-2. Impact on People from Hazards

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (3)
Dam Failure	High	3	9
Drought	No impact	0	0
Earthquake	High	3	9
Flood	Low	1	3
Landslide	Medium	2	6
Severe Weather	Medium	2	6
Wildfire	Medium	2	6

Table 16-3. Impact on Property from Hazards

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (2)
Dam Failure	High	3	6
Drought	No Impact	0	0
Earthquake	High	3	6
Flood	Low	1	2
Landslide	Medium	2	4
Severe Weather	Medium	2	4
Wildfire	Medium	2	4

Table 16-4. Impact on Economy from Hazards

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (1)
Dam Failure	High	3	3
Drought	Medium	2	2
Earthquake	High	3	3
Flood	Low	1	1
Landslide	High	3	3
Severe Weather	Low	1	1
Wildfire	Medium	2	2

16.3 RISK RATING AND RANKING

The risk rating for each hazard was determined by multiplying the probability factor by the sum of the weighted impact factors for people, property and operations, as summarized in Table 16-5.

Based on these ratings, a category of high, medium or low was assigned to each hazard. The hazards ranked as being of highest concern are the earthquake and wildfire hazards. Hazards ranked as being of medium concern are dam failure, flood, landslide and severe weather. The hazard ranked as being of lowest concern is drought. Table 16-6 shows the hazard risk ranking.

Table 16-5. Hazard Risk Rating

Hazard Event	Probability Factor	Sum of Weighted Impact Factors	Total (Probability x Impact)
Dam Failure	1	9+6+3 =18	18
Drought	3	0+0+2 = 2	6
Earthquake	3	9+6+3 = 18	54
Flooding	3	3+2+1 = 6	18
Landslide	2	6+4+3 = 13	26
Severe Weather	3	6+4+1 = 11	33
Wildfire	3	6+4+2 = 12	36

Table 16-6. Hazard Risk Ranking

Hazard	Rating Number	Category
Earthquake	54	High
Wildfire	36	High
Severe Weather	33	Medium
Landslide	26	Medium
Flood	18	Medium
Dam Failure	18	Medium
Drought	6	Low

PART 3—MITIGATION STRATEGY

17. GOALS AND OBJECTIVES

Hazard mitigation plans must identify goals for reducing long-term vulnerabilities to identified hazards (44 CFR Section 201.6(c)(3)(i)). The Steering Committee established a guiding principle, a set of goals and measurable objectives for this plan, based on data from the preliminary risk assessment and the results of the public involvement strategy. The guiding principle, goals, objectives and actions in this plan all support each other. Goals were selected to support the guiding principle. Objectives were selected that met multiple goals. Actions were prioritized based on the action meeting multiple objectives.

17.1 GUIDING PRINCIPLE

A guiding principle focuses the range of objectives and actions to be considered. This is not a goal because it does not describe a hazard mitigation outcome. The Steering Committee selected the following guiding principle for the 2017 planning effort:

> Through community partnerships, establish a plan to reduce the vulnerability to hazards in order to protect the health, safety, welfare, environment and economy of the planning area.

17.2 GOALS

The following are the eight mitigation goals for this plan:

9. Ensure that hazards are identified and considered in land use decisions.
10. Improve local emergency management capability.
11. Promote community awareness, understanding, and interest in hazard mitigation policies and programs.
12. Incorporate hazard mitigation as an integrated public policy and standard practice.
13. Reduce community exposure and vulnerability to hazards where the greatest risk exists.
14. Increase resilience of infrastructure and critical facilities.
15. Promote an adaptive and resilient planning area that responds proactively to future conditions.
16. Develop and implement mitigation strategies that identify the best alternative to protect natural resources, promote equity, and use public funds in an efficient and cost effective manner.

The effectiveness of a mitigation strategy is assessed by determining how well these goals are achieved.

17.3 OBJECTIVES

Each selected objective meets multiple goals, serving as a stand-alone measurement of the effectiveness of a mitigation action, rather than as a subset of a goal. The objectives also are used to help establish priorities. The objectives are as follows:

1. Develop and provide updated information to improve the understanding of the locations, potential impacts, and linkages among threats, hazards, vulnerability, and measures needed to protect life safety health, property and the environment.

2. Use local general plan, zoning, and subdivision requirements to help establish resilient and sustainable communities.
3. Improve systems that provide warning and emergency communications.
4. Encourage the retrofit of vulnerable structures in the planning area.
5. Consider programs that incentivize risk reduction.
6. Reduce repetitive property losses due to all hazards by updating land use, design, and construction policies.
7. Continually build linkages and promote dialog about emergency management within the public and private sectors.
8. Incorporate risk reduction considerations in new and updated infrastructure and development plans to reduce the impacts of natural hazards.
9. Inform the public, including underrepresented community groups, on the risk of exposure to natural hazards and ways to increase the public's capability to prepare for, respond to, recover from, and mitigate the impacts of these events.
10. Identify projects that simultaneously reduce risk while increasing planning area resilience and sustainability.
11. Where feasible and cost-effective, research, develop, and promote adoption of building and development laws, regulations, and ordinances exceeding the minimum levels needed for life safety.
12. Encourage hazard mitigation measures that promote and enhance natural processes, minimize adverse impacts on the ecosystem, and promote social equity.

18. MITIGATION BEST PRACTICES AND ADAPTIVE CAPACITY

18.1 MITIGATION BEST PRACTICES

Catalogs of hazard mitigation alternatives were developed that present a broad range of alternatives to be considered for use in the planning area, in compliance with 44 CFR (Section 201.6(c)(3)(ii)). One catalog was developed for each hazard of concern evaluated in this plan. The catalogs present alternatives that are categorized in two ways:

- By who would have responsibility for implementation:
  - Individuals (personal scale)
  - Businesses (corporate scale)
  - Government (government scale).
- By what the alternative would do:
  - Manipulate the flooding hazard
  - Reduce exposure to the flooding hazard
  - Reduce vulnerability to the flooding hazard
  - Increase the ability to respond to or be prepared for the flooding hazard.

Hazard mitigation actions recommended in this plan were selected from among the alternatives presented in the catalogs. The catalogs provide a baseline of mitigation alternatives that are backed by a planning process, are consistent with the established goals and objectives, and are within the capabilities of the planning partners to implement. Some of these actions may not be feasible based on the selection criteria identified for this plan. The purpose of the catalog was to provide a list of what could be considered to reduce risk of the flood hazard within the planning area. Actions in the catalog that are not included for the partnership's action plan were not selected for one or more of the following reasons:

- The action is not feasible.
- The action is already being implemented.
- There is an apparently more cost-effective alternative.
- The action does not have public or political support.

The catalogs for each hazard are presented in Table 18-1 through Table 18-7.

Table 18-1. Alternatives to Mitigate the Dam Failure Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• Manipulate the hazard: ❖ None • Reduce exposure to the hazard: ❖ Relocate out of dam failure inundation areas. • Reduce vulnerability to the hazard: ❖ Elevate home to appropriate levels. • Increase the ability to respond to or be prepared for the hazard: ❖ Learn about risk reduction for the dam failure hazard. ❖ Learn the evacuation routes for a dam failure event. ❖ Educate yourself on early warning systems and the dissemination of warnings.	• Manipulate the hazard: ❖ Remove dams. ❖ Remove levees. ❖ Harden dams. • Reduce exposure to the hazard: ❖ Replace earthen dams with hardened structures. • Reduce vulnerability to the hazard: ❖ Flood-proof facilities within dam failure inundation areas. • Increase the ability to respond to or be prepared for the hazard: ❖ Educate employees on the probable impacts of a dam failure. ❖ Develop a continuity of operations plan.	• Manipulate the hazard: ❖ Remove dams. ❖ Remove levees. ❖ Harden dams. • Reduce exposure to the hazard: ❖ Replace earthen dams with hardened structures ❖ Relocate critical facilities out of dam failure inundation areas. ❖ Consider open space land use in designated dam failure inundation areas. • Reduce vulnerability to the hazard: ❖ Adopt higher regulatory floodplain standards in mapped dam failure inundation areas. ❖ Retrofit critical facilities within dam failure inundation areas. • Increase the ability to respond to or be prepared for the hazard: ❖ Map dam failure inundation areas. ❖ Enhance emergency operations plan to include a dam failure component. ❖ Institute monthly communications checks with dam operators. ❖ Inform the public on risk reduction techniques ❖ Adopt real-estate disclosure requirements for the re-sale of property located within dam failure inundation areas. ❖ Consider the probable impacts of climate in assessing the risk associated with the dam failure hazard. ❖ Establish early warning capability downstream of listed high hazard dams. ❖ Consider the residual risk associated with protection provided by dams in future land use decisions. ❖ Develop comprehensive planning policies that encourage wise land use in hazard prone areas. ❖ Develop a post-disaster recovery plan that addresses the dam failure hazard. ❖ Develop a debris management plan.

Table 18-2. Alternatives to Mitigate the Drought Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• Manipulate the hazard: ❖ None • Reduce exposure to the hazard: ❖ None • Reduce vulnerability to the hazard: ❖ Drought-resistant landscapes ❖ Reduce water system losses ❖ Modify plumbing systems (through water saving kits) • Increase the ability to respond to or be prepared for the hazard: ❖ Practice active water conservation	• Manipulate the hazard: ❖ None • Reduce exposure to the hazard: ❖ None • Reduce vulnerability to the hazard: ❖ Drought-resistant landscapes ❖ Reduce private water system losses • Increase the ability to respond to or be prepared for the hazard: ❖ Practice active water conservation	• Manipulate the hazard: ❖ Groundwater recharge through stormwater management • Reduce exposure to the hazard: ❖ Identify and create groundwater backup sources • Reduce vulnerability to the hazard: ❖ Reduce water system losses ❖ Distribute water saving kits ❖ Increase use of recycled water ❖ Diversify water supply diversion points ❖ Develop recycled water projects • Increase the ability to respond to or be prepared for the hazard: ❖ Enhance hazard mapping based on data and science ❖ Public education on drought resistance ❖ Identify alternative water supplies for times of drought; mutual aid agreements with alternative suppliers ❖ Implement drought contingency plan ❖ Develop criteria "triggers" for drought-related actions ❖ Improve accuracy of water supply forecasts ❖ Prioritize groundwater projects for competitive funding ❖ Develop a post-disaster recovery plan that addresses the drought hazard ❖ Develop a debris management plan

Table 18-3. Alternatives to Mitigate the Earthquake Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• Manipulate the hazard: ❖ None • Reduce exposure to the hazard: ❖ Locate outside of hazard area (off soft soils) • Reduce vulnerability to the hazard: ❖ Retrofit structure (anchor house structure to foundation) ❖ Secure household items that can cause injury or damage (such as water heaters, bookcases, and other appliances) ❖ Build to higher design • Increase the ability to respond to or be prepared for the hazard: ❖ Practice "drop, cover, and hold" ❖ Develop household mitigation plan, such as creating a retrofit savings account, communication capability with outside, 72-hour self-sufficiency during an event ❖ Keep cash reserves for reconstruction ❖ Become informed on the hazard and risk reduction alternatives available. ❖ Develop a post-disaster action plan for your household	• Manipulate the hazard: ❖ None • Reduce exposure to the hazard: ❖ Locate or relocate mission-critical functions outside hazard area where possible • Reduce vulnerability to the hazard: ❖ Build redundancy for critical functions and facilities ❖ Retrofit critical buildings and areas housing mission-critical functions • Increase the ability to respond to or be prepared for the hazard: ❖ Adopt higher standard for new construction; consider "performance-based design" when building new structures ❖ Keep cash reserves for reconstruction ❖ Inform your employees on the possible impacts of earthquake and how to deal with them at your work facility. ❖ Develop a continuity of operations plan	• Manipulate the hazard: ❖ None • Reduce exposure to the hazard: ❖ Locate critical facilities or functions outside hazard area where possible • Reduce vulnerability to the hazard: ❖ Harden infrastructure ❖ Provide redundancy for critical functions ❖ Adopt higher regulatory standards ❖ Identify projects that limit transportation downtime • Increase the ability to respond to or be prepared for the hazard: ❖ Enhance hazard mapping based on data and science ❖ Provide technical information and guidance ❖ Enact tools to help manage development in hazard areas (e.g., tax incentives, information) ❖ Include retrofitting and replacement of critical system elements in capital improvement plan ❖ Develop strategy to take advantage of post-disaster opportunities ❖ Warehouse critical infrastructure components such as pipe, power line, and road repair materials ❖ Develop and adopt a continuity of operations plan ❖ Initiate triggers guiding improvements (such as <50% substantial damage or improvements) ❖ Further enhance seismic risk assessment to target high hazard buildings for mitigation opportunities. ❖ Develop a post-disaster action plan that includes grant funding and debris removal components. ❖ Identify food security strategies, including distribution priorities ❖ Develop comprehensive planning policies that encourage wise land use in hazard prone areas. ❖ Develop a post-disaster recovery plan that addresses the earthquake hazard. ❖ Develop a debris management plan.

Table 18-4. Alternatives to Mitigate the Flooding Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• Manipulate the hazard: ❖ Clear storm drains and culverts ❖ Use low-impact development techniques • Reduce exposure to the hazard: ❖ Locate outside of hazard area ❖ Elevate utilities above base flood elevation ❖ Use low-impact development techniques • Reduce vulnerability to the hazard: ❖ Raise structures above base flood elevation ❖ Elevate items within house above base flood elevation ❖ Build new homes above base flood elevation ❖ Flood-proof structures • Increase the ability to respond to or be prepared for the hazard: ❖ Buy flood insurance ❖ Develop household plan, such as retrofit savings, communication with outside, 72-hour self-sufficiency during and after an event	• Manipulate the hazard: ❖ Clear storm drains and culverts ❖ Use low-impact development techniques • Reduce exposure to the hazard: ❖ Locate critical facilities or functions outside hazard area ❖ Use low-impact development techniques • Reduce vulnerability to the hazard: ❖ Build redundancy for critical functions or retrofit critical buildings ❖ Provide flood-proofing when new critical infrastructure must be located in floodplains • Increase the ability to respond to or be prepared for the hazard: ❖ Keep cash reserves for reconstruction ❖ Support and implement hazard disclosure for sale of property in risk zones. ❖ Solicit cost-sharing through partnerships with others on projects with multiple benefits.	• Manipulate the hazard: ❖ Maintain drainage system ❖ Institute low-impact development techniques on property ❖ Dredging, levee construction, and providing regional retention areas ❖ Structural flood control, levees, channelization, or revetments. ❖ Stormwater management regulations and master planning ❖ Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff • Reduce exposure to the hazard: ❖ Locate or relocate critical facilities outside of hazard area ❖ Acquire or relocate identified repetitive loss properties ❖ Promote open space uses in identified high hazard areas via techniques such as: planned unit developments, easements, setbacks, greenways, sensitive area tracks. ❖ Adopt land development criteria such as planned unit developments, density transfers, clustering ❖ Institute low impact development techniques on property ❖ Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff • Reduce vulnerability to the hazard: ❖ Harden infrastructure, bridge replacement program ❖ Provide redundancy for critical functions and infrastructure ❖ Adopt higher regulatory standards. ❖ Stormwater management regulations and master planning. ❖ Adopt “no-adverse impact” floodplain management policies that strive to not increase the flood risk on downstream communities. ❖ Preserve natural spaces that serve as buffers against flood • Increase the ability to respond to or be prepared for the hazard: ❖ Enhance hazard mapping based on data and science ❖ Provide technical information and guidance ❖ Enact tools to help manage development in hazard areas (stronger controls, tax incentives, and information) ❖ Incorporate retrofitting or replacement of critical system elements in capital improvement plan ❖ Develop strategy to take advantage of post-disaster opportunities ❖ Warehouse critical infrastructure components ❖ Develop and adopt a continuity of operations plan ❖ Consider participation in the Community Rating System ❖ Maintain and collect data to define risks and vulnerability ❖ Train emergency responders ❖ Create an elevation inventory of structures in the floodplain ❖ Develop and implement a public information strategy ❖ Charge a hazard mitigation fee ❖ Integrate floodplain management policies into other planning mechanisms within the planning area. ❖ Consider the probable impacts of climate change on the flood hazard ❖ Consider the residual risk associated with structural flood control in future land use decisions ❖ National Flood Insurance Program compliance ❖ Adopt a Stormwater Management Master Plan ❖ Comprehensive planning policies-Wise land use in hazard prone areas ❖ Develop a post-disaster recovery plan that addresses the flood hazard ❖ Develop a debris management plan

Table 18-5. Alternatives to Mitigate the Landslide Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• Manipulate the hazard: ❖ Stabilize slope (dewater, armor toe) ❖ Reduce weight on top of slope ❖ Minimize vegetation removal and the addition of impervious surfaces. • Reduce exposure to the hazard: ❖ Locate structures outside of hazard area (off unstable land and away from slide-run out area) • Reduce vulnerability to the hazard: ❖ Retrofit home • Increase the ability to respond to or be prepared for the hazard: ❖ Institute warning system, and develop evacuation plan ❖ Keep cash reserves for reconstruction ❖ Educate yourself on risk reduction techniques for landslide hazards	• Manipulate the hazard: ❖ Stabilize slope (dewater, armor toe) ❖ Reduce weight on top of slope • Reduce exposure to the hazard: ❖ Locate structures outside of hazard area (off unstable land and away from slide-run out area) • Reduce vulnerability to the hazard: ❖ Retrofit at-risk facilities • Increase the ability to respond to or be prepared for the hazard: ❖ Institute warning system, and develop evacuation plan ❖ Keep cash reserves for reconstruction ❖ Develop a continuity of operations plan ❖ Educate employees on the potential exposure to landslide hazards and emergency response protocol.	• Manipulate the hazard: ❖ Stabilize slope (dewater, armor toe) ❖ Reduce weight on top of slope • Reduce exposure to the hazard: ❖ Acquire properties in high-risk landslide areas. ❖ Adopt land use policies that prohibit the placement of habitable structures in high-risk landslide areas. • Reduce vulnerability to the hazard: ❖ Adopt higher regulatory standards for new development within unstable slope areas. ❖ Armor/retrofit critical infrastructure against the impact of landslides. • Increase the ability to respond to or be prepared for the hazard: ❖ Enhance hazard mapping based on data and science ❖ Provide technical information and guidance ❖ Enact tools to help manage development in hazard areas: better land controls, tax incentives, information ❖ Develop strategy to take advantage of post-disaster opportunities ❖ Warehouse critical infrastructure components ❖ Develop and adopt a continuity of operations plan ❖ Educate the public on the landslide hazard and appropriate risk reduction alternatives. ❖ Develop comprehensive planning policies that encourage wise land use in hazard prone areas. ❖ Develop a post-disaster recovery plan that addresses the landslide hazard. ❖ Develop a debris management plan.

Table 18-6. Alternatives to Mitigate the Severe Weather Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• Manipulate the hazard: ❖ None • Reduce exposure to the hazard: ❖ None • Reduce vulnerability to the hazard: ❖ Insulate house ❖ Provide redundant heat and power ❖ Insulate structure ❖ Plant appropriate trees near home and power lines ("Right tree, right place" National Arbor Day Foundation Program) • Increase the ability to respond to or be prepared for the hazard: ❖ Trim or remove trees that could affect power lines ❖ Promote 72-hour self-sufficiency ❖ Obtain a NOAA weather radio. ❖ Obtain an emergency generator.	• Manipulate the hazard: ❖ None • Reduce exposure to the hazard: ❖ None • Reduce vulnerability to the hazard: ❖ Relocate critical infrastructure (such as power lines) underground ❖ Reinforce or relocate critical infrastructure such as power lines to meet performance expectations ❖ Install tree wire • Increase the ability to respond to or be prepared for the hazard: ❖ Trim or remove trees that could affect power lines ❖ Create redundancy ❖ Equip facilities with a NOAA weather radio ❖ Equip vital facilities with emergency power sources. ❖ Prioritize utility recovery based on safety and critical infrastructure needs	• Manipulate the hazard: ❖ None • Reduce exposure to the hazard: ❖ None • Reduce vulnerability to the hazard: ❖ Harden infrastructure such as locating utilities underground ❖ Trim trees back from power lines ❖ Designate snow routes and strengthen critical road sections and bridges • Increase the ability to respond to or be prepared for the hazard: ❖ Enhance hazard mapping based on data and science ❖ Support programs such as "Tree Watch" that proactively manage problem areas through use of selective removal of hazardous trees, tree replacement, etc. ❖ Establish and enforce building codes that require all roofs to withstand snow loads ❖ Increase communication alternatives ❖ Modify land use and environmental regulations to support vegetation management activities that improve reliability in utility corridors. ❖ Modify landscape and other ordinances to encourage appropriate planting near overhead power, cable, and phone lines ❖ Provide NOAA weather radios to the public ❖ Develop a post-disaster recovery plan that addresses the severe weather hazards ❖ Develop a debris management plan

Table 18-7. Alternatives to Mitigate the Wildfire Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• Manipulate the hazard: ❖ Clear potential fuels on property such as dry overgrown underbrush and diseased trees • Reduce exposure to the hazard: ❖ Create and maintain defensible space around structures ❖ Locate outside of hazard area ❖ Mow regularly • Reduce vulnerability to the hazard: ❖ Create and maintain defensible space around structures and provide water on site ❖ Use fire-retardant building materials ❖ Create defensible spaces around home • Increase the ability to respond to or be prepared for the hazard: ❖ Employ techniques from the National Fire Protection Association's Firewise Communities program to safeguard home ❖ Identify alternative water supplies for fire fighting ❖ Install/replace roofing material with non-combustible roofing materials.	• Manipulate the hazard: ❖ Clear potential fuels on property such as dry underbrush and diseased trees • Reduce exposure to the hazard: ❖ Create and maintain defensible space around structures and infrastructure ❖ Locate outside of hazard area • Reduce vulnerability to the hazard: ❖ Create and maintain defensible space around structures and infrastructure and provide water on site ❖ Use fire-retardant building materials ❖ Use fire-resistant plantings in buffer areas of high wildfire threat. • Increase the ability to respond to or be prepared for the hazard: ❖ Support Firewise community initiatives. ❖ Create /establish stored water supplies to be utilized for firefighting.	• Manipulate the hazard: ❖ Clear potential fuels on property such as dry underbrush and diseased trees ❖ Implement best management practices on public lands. • Reduce exposure to the hazard: ❖ Create and maintain defensible space around structures and infrastructure ❖ Locate outside of hazard area ❖ Enhance building code to include use of fire resistant materials in high hazard area. • Reduce vulnerability to the hazard: ❖ Create and maintain defensible space around structures and infrastructure ❖ Use fire-retardant building materials ❖ Use fire-resistant plantings in buffer areas of high wildfire threat. ❖ Consider higher regulatory standards (such as Class A roofing) ❖ Establish biomass reclamation initiatives • Increase the ability to respond to or be prepared for the hazard: ❖ Enhance hazard mapping based on data and science ❖ More public outreach and education efforts, including an active Firewise program ❖ Possible weapons of mass destruction funds available to enhance fire capability in high-risk areas ❖ Identify fire response and alternative evacuation routes ❖ Seek alternative water supplies ❖ Become a Firewise community ❖ Use academia to study impacts/solutions to wildfire risk ❖ Establish/maintain mutual aid agreements between fire service agencies. ❖ Create/implement fire plans ❖ Consider the probable impacts of climate change on the risk associated with the wildfire hazard in future land use decisions ❖ Develop comprehensive planning policies that encourage wise land use in hazard prone areas. ❖ Develop a post-disaster recovery plan that addresses the wildfire hazard. ❖ Develop a debris management plan.

18.2 ADAPTIVE CAPACITY

Adaptive capacity is defined as "the ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences" (IPCC, 2014b). This term is typically used while discussing climate change adaptation; however, it is similar to the alternatives presented in the tables for building local capacity. In addition to hazard-specific capacity building, the following list provides general alternatives that planning partners considered to build capacity for adapting to both current and future risks (Cal EMA, et al., 2012a and 2012b):

- Incorporate climate change adaptation into relevant local and regional plans and projects.
- Establish a climate change adaptation and hazard mitigation public outreach and education program.
- Build collaborative relationships between regional entities and neighboring communities to promote complementary adaptation and mitigation strategy development and regional approaches.
- Establish an ongoing monitoring program to track local and regional climate impacts and adaptation strategy effectiveness.
- Increase participation of low-income, immigrant, non-English-speaking, racially and ethnically diverse, and special-needs residents in planning and implementation.
- Ask local employers and business associations to participate in local efforts to address climate change and natural hazard risk reduction.
- Conduct a communitywide assessment and develop a program to address health, socioeconomic, and equity vulnerabilities.
- Focus planning and intervention programs on neighborhoods that currently experience social or environmental injustice or bear a disproportionate burden of potential public health impacts.
- Use performance metrics and data to evaluate and monitor the impacts of climate change and natural hazard risk reduction strategies on public health and social equity.
- Develop coordinated plans for mitigating future flood, landslide, and related impacts through concurrent adoption of updated general plan safety elements and local hazard mitigation plans.
- Implement general plan safety elements through zoning and subdivision practices that restrict development in floodplains, landslide, and other natural hazard areas.
- Identify and protect locations where native species may shift or lose habitat due to climate change impacts (sea level rise, loss of wetlands, warmer temperatures, and drought).
- Collaborate with agencies managing public lands to identify, develop, or maintain corridors and linkages between undeveloped areas.
- Promote economic diversity.
- Incorporate consideration of climate change impacts as part of infrastructure planning and operations.
- Conduct a climate impact assessment on community infrastructure.
- Identify gaps in legal and regulatory capabilities and develop ordinances or guidelines to address those gaps.
- Identify and pursue new sources of funding for mitigation and adaptation activities.
- Hire new staff or provide training to current staff to ensure an adequate level of administrative and technical capability to pursue mitigation and adaptation activities.

19. AREA-WIDE ACTION PLAN AND IMPLEMENTATION

19.1 ACTIONS INCLUDED IN PLAN

The Steering Committee reviewed the catalogs of hazard mitigation alternatives and selected area-wide actions to be included in a hazard mitigation action plan. The selection of area-wide actions was based on the risk assessment of identified hazards of concern and the defined hazard mitigation goals and objectives. Table 19-1 lists the recommended hazard mitigation actions that make up the action plan. The timeframe indicated in the table is defined as follows:

- Short Term = to be completed in 1 to 5 years
- Long Term = to be completed in greater than 5 years
- Ongoing = currently being funded and implemented under existing programs.

19.2 BENEFIT-COST REVIEW

The action plan must be prioritized according to a benefit/cost analysis of the proposed projects and their associated costs (44 CFR, Section 201.6(c)(3)(iii)). The benefits of proposed projects were weighed against estimated costs as part of the project prioritization process. The benefit/cost analysis was not of the detailed variety required by FEMA for project grant eligibility under the Hazard Mitigation Grant Program (HMGP) and Pre-Disaster Mitigation (PDM) grant program. A less formal approach was used because some projects may not be implemented for up to 10 years, and associated costs and benefits could change dramatically in that time. Therefore, a review of the apparent benefits versus the apparent cost of each project was performed. Parameters were established for assigning subjective ratings (high, medium, and low) to the costs and benefits of these projects.

Cost ratings were defined as follows:

- **High**—Existing funding will not cover the cost of the project; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).
- **Medium**—The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.
- **Low**—The project could be funded under the existing budget. The project is part of or can be part of an ongoing existing program.

Benefit ratings were defined as follows:

- **High—**Project will provide an immediate reduction of risk exposure for life and property.
- **Medium—**Project will have a long-term impact on the reduction of risk exposure for life and property, or project will provide an immediate reduction in the risk exposure for property.
- **Low—**Long-term benefits of the project are difficult to quantify in the short term.

Table 19-1. Action Plan

Applies to New or Existing Assets	Hazards Mitigated	Objectives Met	Lead Agencies	Estimated Cost	Sources of Funding	Timeline[a]
Action AW-1—Continue to maintain a planning area-wide hazard mitigation website that will store the hazard mitigation plan and provide the public an opportunity to monitor plan implementation progress. Each planning partner can support this action by including an action in its own action plan of creating a link to the planning-area-wide hazard mitigation website.						
New and Existing	All Hazards	1,7,9	City of Pleasanton	Low	General Funds	Ongoing
Action AW-2— Leverage public outreach partnering capabilities in the planning area (such as Community Emergency Response Teams) to promote a uniform and consistent message on the importance of proactive hazard mitigation.						
New and Existing	All Hazards	1,7,9	Livermore Pleasanton Fire	Low	District Funds	Ongoing
Action AW-3— Coordinate mitigation planning and project efforts in the planning area to leverage all resources available to the planning partnership.						
New and Existing	All Hazards	7,10	Designated POC for each Planning Partner	Low	General Funds for each planning partner	Short Term
Action AW-4— Where appropriate, support retrofitting, purchase, or relocation of structures in hazard-prone areas to protect the structures from future damage, with repetitive loss and severe repetitive loss properties as a priority. Seek opportunities to leverage partnerships in the planning area in these pursuits.						
Existing	All Hazards	4,5,11	Designated POC for each Planning Partner	High	FEMA Grant Funding	Long Term
Action AW-5— Continue to update hazard mapping with best available data and science as it evolves, within the capabilities of the partnership. Support FEMA's RiskMAP initiative.						
New and Existing	All Hazards	1,7,9	Designated POC for each Planning Partner	Medium	FEMA mitigation grant funding, FEMA's Cooperating Technical Partners program, Planning Partner capital improvement program funding	Long term
Action AW-6— To the extent possible based on available resources, provide coordination and technical assistance in applying for grant funding.						
New and Existing	All Hazards	7,10	Alameda County OES, ALCOEMA	Low	General Funds, FEMA Grant Funding (eligible pre-award costs)	Short term
Action AW-7— Maintain a steering committee as a working body over time to monitor progress of the hazard mitigation plan, provide technical assistance to planning partners, manage data, and oversee the update of the plan according to schedule. This body will continue to operate under the ground rules established at its inception.						
New and Existing	All Hazards	7,10	Designated POC for each Planning Partner	Low	General Funds	Ongoing
Action AW-8— All planning partners will collaborate and share information to support the development of debris management plans for the planning area. While each planning partner will be responsible for the development of their own plans, they will attempt to standardize the content and format based on a regional template.						
New and Existing	All Hazards	1,7,10,12	Designated POC for each Planning Partner	Medium	General Funds	Short term

a. Ongoing indicates continuation of an action that is already in place. Short-term indicates implementation within five years. Long-term indicates implementation after five years.

Using this approach, projects with positive benefit versus cost ratios (such as high over high, high over medium, medium over low, etc.) are considered cost-beneficial and are prioritized accordingly.

For many of the strategies identified in this action plan, financial assistance may be available through the HMGP or PDM programs, both of which require detailed benefit/cost analyses. These analyses will be performed on projects at the time of application using the FEMA benefit-cost model. For projects not seeking financial

assistance from grant programs that require detailed analysis, "benefits" can be defined according to parameters that meet the goals and objectives of this plan.

19.3 AREA-WIDE ACTION PLAN PRIORITIZATION

Table 19-2 lists the priority of each area-wide action. A qualitative benefit-cost review was performed for each of these actions. The priorities are defined as follows:

- **High Priority**—A project that meets multiple objectives (i.e., multiple hazards), has benefits that exceed cost, has funding secured or is an ongoing project and meets eligibility requirements for the HMGP or PDM grant program. High priority projects can be completed in the short term (1 to 5 years).
- **Medium Priority**—A project that meets goals and objectives, that has benefits that exceed costs, and for which funding has not been secured but that is grant eligible under HMGP, PDM or other grant programs. Project can be completed in the short term, once funding is secured. Medium priority projects will become high priority projects once funding is secured.
- **Low Priority**—A project that will mitigate the risk of a hazard, that has benefits that do not exceed the costs or are difficult to quantify, for which funding has not been secured, that is not eligible for HMGP or PDM grant funding, and for which the time line for completion is long term (1 to 10 years). Low priority projects may be eligible for other sources of grant funding from other programs.

Table 19-2. Prioritization of Area-Wide Mitigation Actions

Action #	# of Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is project Grant Eligible?	Can Project Be Funded under Existing Programs/ Budgets?	Priority (High, Medium, Low)
AW-1	3	Medium	Low	Yes	No	Yes	High
AW-2	3	Medium	Low	Yes	No	Yes	High
AW-3	2	Medium	Low	Yes	No	Yes	High
AW-4	3	High	High	Yes	Yes	No	Medium
AW-5	3	Medium	Medium	Yes	Yes	Yes	High
AW-6	2	Medium	Low	Yes	Yes	Yes	High
AW-7	2	Medium	Low	Yes	No	Yes	High
AW-8	4	Medium	Medium	Yes	No	Yes	High

19.4 PLAN ADOPTION

A hazard mitigation plan must document that it has been formally adopted by the governing bodies of the jurisdictions requesting federal approval of the plan (44 CFR Section 201.6(c)(5)). For multi-jurisdictional plans, each jurisdiction requesting approval must document that is has been formally adopted. This plan will be submitted for a pre-adoption review to Cal OES and FEMA Region IX prior to adoption. Once pre-adoption approval has been provided, all planning partners will formally adopt the plan. DMA compliance and its benefits cannot be achieved until the plan is adopted. Copies of the resolutions adopting this plan for all planning partners can be found in Appendix C of this volume.

19.5 ANALYSIS OF AREA-WIDE MITIGATION ACTIONS

Each recommended action was classified based on the hazard it addresses and the type of mitigation it involves. Table 19-3 shows the classification based on this analysis. Mitigation types used for this categorization are as follows:

Table 19-3. Analysis of Mitigation Actions

Hazard	Planning Area Actions That Address the Hazard, by Mitigation Type					
	Prevention	Property Protection	Public Education and Awareness	Natural Resource Protection	Emergency Services	Structural Projects
Dam Failure	3,5,6	4	1,2,5,7	-	8	-
Drought	3,5,6	4	1,2,5,7	-	8	-
Earthquake	3,5,6	4	1,2,5,7	-	8	-
Flooding	3,5,6	4	1,2,5,7	-	8	-
Landslide	3,5,6	4	1,2,5,7	-	8	-
Severe Weather	3,5,6	4	1,2,5,7	-	8	-
Wildfire	3,5,6	4	1,2,5,7	-	8	-

- **Prevention**—Government, administrative or regulatory actions that influence the way land and buildings are developed to reduce hazard losses. Includes planning and zoning, floodplain laws, capital improvement programs, open space preservation, and stormwater management regulations.
- **Property Protection**—Modification of buildings or structures to protect them from a hazard or removal of structures from a hazard area. Includes acquisition, elevation, relocation, structural retrofit, storm shutters, and shatter-resistant glass.
- **Public Education and Awareness**—Actions to inform citizens and elected officials about hazards and ways to mitigate them. Includes outreach projects, real estate disclosure, hazard information centers, and school-age and adult education.
- **Natural Resource Protection**—Actions that minimize hazard loss and preserve or restore the functions of natural systems. Includes sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, and wetland restoration and preservation.
- **Emergency Services**—Actions that protect people and property during and immediately after a hazard event. Includes warning systems, emergency response services, and the protection of essential facilities.
- **Structural Projects**—Actions that involve the construction of structures to reduce the impact of a hazard. Includes dams, setback levees, floodwalls, retaining walls, and safe rooms.

19.6 PLAN MAINTENANCE STRATEGY

A hazard mitigation plan must present a plan maintenance process that includes the following (44 CFR Section 201.6(c)(4)):

- A section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan over a five-year cycle
- A process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms, such as general or capital improvement plans, when appropriate
- A discussion on how the community will continue public participation in the plan maintenance process.

The plan maintenance strategy is the formal process that will ensure that the Tri-Valley Hazard Mitigation Plan remains an active and relevant document and that the planning partners maintain their eligibility for applicable funding sources. It includes the following:

- A process for monitoring and evaluating the plan and producing an updated plan every five years. The plan's format allows sections to be reviewed and updated when new data become available, resulting in a plan that will remain current and relevant.

- A plan for how public participation will be integrated throughout the plan maintenance and implementation process.
- Guidance for incorporating the mitigation strategies outlined in this plan into existing planning mechanisms and programs, such as comprehensive land-use planning processes, capital improvement planning, and building code enforcement and implementation.

Pursuant to 44CFR 201.6(c)(4)(i), the plan maintenance matrix shown in Table 19-4 provides a synopsis of responsibilities for plan monitoring, evaluation, and update, which are discussed in further detail in the sections below.

19.6.1 Plan Monitoring and Implementation

The effectiveness of the hazard mitigation plan depends on its monitoring, implementation, and incorporation of its action items into partner jurisdictions' existing plans, policies and programs. Together, the action items in the plan provide a framework for activities that the Planning Partnership can implement over the next 5 years. The planning team and the Steering Committee have established goals and objectives and have prioritized mitigation actions that will be implemented through existing plans, policies, and programs. The planning partners will have individual responsibility for overseeing the plan monitoring and implementation strategy, with primary responsibility identified in each jurisdictional annex plans (see planning partner annexes in Volume 2) and summarized in Table 19-4. At a minimum, the planning partners will track and report the status of the jurisdiction-specific hazard mitigation actions for inclusion into the Midterm Progress Report, described in Section 19.6.3.

19.6.2 Plan Evaluation

Evaluating how well a plan achieves intended goals and objectives ensures that the Planning Partnership remains cognizant of the continued short- to long-term efforts to reduce hazard impacts. Establishing a schedule for monitoring ensures that the hazard mitigation plan will remain a living document that provides benchmarks for building more resilient communities. Plan evaluation will be achieved through the assessment of the status of actions as submitted by planning partners for the development of the Midterm Progress Report described in Section 19.6.3.

19.6.3 Midterm Progress Report

Each planning partner will evaluate the progress of its individual action plan at the midterm of the period between the completion of this plan and the next update. This progress report should be completed within two and a half years of plan approval, or upon initiation of an accelerated plan update as described under Section 19.6.4, whichever occurs first. The review will include the following:

- Summary of any hazard events that occurred during the performance period and the impact these events had on the planning area
- Review of mitigation success stories
- Review of continuing public involvement
- Brief discussion about why targeted strategies were not completed
- Re-evaluation of the action plan to determine if the timeline for identified projects needs to be amended (such as changing a long-term project to a short-term one because of new funding)
- Recommendations for new projects
- Changes in or potential for new funding options (grant opportunities)
- Impact of any other planning programs or actions that involve hazard mitigation.

Table 19-4. Plan Maintenance Matrix

Task	Approach	Timeline	Lead Responsibility[a]		Support Responsibility
Monitoring	Preparation of status updates and action implementation tracking as part of submission for Midterm Progress Report.	2-1/2 years after the adoption and final approval of the plan by FEMA. Actual reporting period TBD	Dublin	City Manager	Jurisdictional points of contact identified in Volume 2 annexes
			Livermore	City Manager	
			Pleasanton	General Manager	
			DSRDS	General Manager	
			Dublin USD	Maintenance and Operations Supervisor	
			Livermore Valley JUSD	Deputy Superintendent	
Evaluation	Review the status of previous actions as submitted by the monitoring task lead and support to assess the effectiveness of the plan; compile the Midterm Progress Report; assess appropriate action for preparing 2021/2022 hazard mitigation plan update.	2-1/2 years after final plan approval by FEMA, or upon comprehensive update to General Plan or major disaster	City of Dublin City of Livermore City of Pleasanton Dublin/San Ramon Services District Dublin Unified School District Livermore Valley Joint Unified School District		Jurisdictional points of contacts identified in Volume 2 annexes
Update [b]	The Tri-Valley partnership will reconvene the planning partners, at a minimum, every 5 years to guide a comprehensive update to review and revise the plan.	Every 5 years or upon comprehensive update to General Plan or major disaster	The governing body for all planning partners covered by this plan		Jurisdictional point of contacts identified in Volume 2 annexes
Grant Monitoring and Coordination	As grant opportunities present themselves, the Tri-Valley planning partners will consider options to pursue grants to fund actions identified in this plan	As grants become available	ALCOEMA provides a regional platform for grant notification and coordination		Jurisdictional point of contacts identified in Volume 2 annexes
Continuing Public Involvement	The principle means for providing the public access to the implementation of this plan will be the Tri-Valley HMP website: https://www.tri-valley-hmp.com/	Annually	Livermore-Pleasanton Fire District		All planning partners will provide a link to LHMP website on their jurisdictional websites
Plan Integration	Integrate relevant information from LHMP into other plans and programs where viable and opportunities arise	Ongoing	The governing body for all planning partners covered by this plan		Jurisdictional point of contacts identified in Volume 2 annexes

a. Responsible lead party may designate an alternate
b. The approach to the plan update process may change based on partnership decisions made during the evaluation phase and the preparation of the midterm progress report as described in Section 19.6.2 and Section 19.6.3.

The Steering Committee has created a template to guide the planning partners in preparing a progress report (see Appendix D). The progress report template may be used as a tool for annual progress reporting at the discretion of the planning partners and based on available jurisdictional resources. The completed report should be distributed as follows:

- Posted on the hazard mitigation website dedicated to the hazard mitigation plan
- Provided to the local media through a press release
- Presented to planning partner governing bodies to inform them of the progress of actions implemented during the reporting period.

Progress reporting is not a federal requirement. However, it may enhance the Planning Partnership's opportunities for funding. While failure to implement this component of the plan maintenance strategy will not jeopardize a planning partner's compliance under the DMA, it may jeopardize its opportunity to partner and leverage funding opportunities with other partners. Upon completion, the mid-term progress report will be posted to the hazard mitigation plan website which will invite the public to provide to provide comment on its content.

19.6.4 Plan Update

Local hazard mitigation plans must be reviewed, revised if appropriate, and resubmitted for approval in order to remain eligible for benefits under the DMA (44 CFR, Section 201.6(d)(3)). The planning partners intend to update the hazard mitigation plan on a five-year cycle from the date of initial plan adoption. This cycle may be accelerated to less than five years based on the following triggers:

- A presidential disaster declaration that impacts the planning area
- A hazard event that causes loss of life
- A comprehensive update of a planning partner's general plan.

The update will, at a minimum, include the following elements:

- The update process will be convened through a steering committee.
- The hazard risk assessment will be reviewed and, if necessary, updated using best available information and technologies.
- The action plans will be reviewed and revised to account for any actions completed, dropped, or changed and to account for changes in the risk assessment or new policies identified under other planning mechanisms (such as the comprehensive plan).
- The draft update will be sent to appropriate agencies and organizations for comment.
- The public will be given an opportunity to comment on the update prior to adoption.
- Planning partner governing bodies will adopt the updated plan.

When developing the Midterm Progress Report, jurisdictional partners will evaluate the appropriate course of action for a plan update. The progress report will recommend a process for updating the plan based on available resources, regional initiatives, and overall timing. Options for updating this plan include the following:

- Development of an updated multi-jurisdictional plan similar to the current plan
- Development of single jurisdictional plans
- Participation in development of an operational-area initiative led by Alameda County.

19.6.5 Grant Monitoring and Coordination

The Alameda County Emergency Managers' Association (ALCO EMA) provides an opportunity to maintain awareness of current and future grant opportunities. Currently, Dublin, Livermore, Pleasanton and Dublin/San Ramon Services District participate in ALCO EMA through the Alameda County Fire Department's contracted emergency management services. All planning partners have agreed to continue to coordinate with each other as grant opportunities arise.

19.6.6 Continuing Public Involvement

The public will continue to be apprised of the plan's progress through the hazard mitigation website and by distribution of the midterm progress report to the media. The website will house the final plan and become the central source of information about the plan, the partnership, plan implementation and the platform for the public to provide comment on plan directive and initiatives. This website will also house the mid-term progress report as

discussed under section 19.6.3 and will be set up such that the public can provide comment on the reports content and conclusions. All planning partners have agreed to provide links to the website on their individual websites. The Livermore-Pleasanton Fire District has agreed to maintain the hazard mitigation plan website. Copies of the plan will be distributed to local libraries. Upon initiation of future update processes, a new public involvement strategy will be initiated based on guidance from a new steering committee. This strategy will be based on the needs and capabilities of the Planning Partnership at the time of the update.

The public outreach strategy used during development of the current update, as described in Section 3.8.1, provides a framework for public engagement through the planning process. It can be adapted for continued public outreach through the plan performance period.

19.6.7 Integration with Other Planning Mechanisms

The information on hazard, risk, vulnerability, and mitigation contained in this plan is based on the best science and technology available at the time this plan was prepared. The comprehensive plans of the planning partners are considered to be integral parts of this plan. The planning partners, through adoption of comprehensive plans and zoning ordinances, have planned for the impact of natural hazards. The plan development process provided them with the opportunity to review and expand on policies contained within these planning mechanisms. The planning partners used their comprehensive plans and the hazard mitigation plan as complementary documents that work together to achieve the goal of reducing risk exposure to the citizens of the planning area. An update to a comprehensive plan may trigger an update to the hazard mitigation plan.

All municipal planning partners committed to linking the hazard mitigation plan to their comprehensive plans by identifying a mitigation action as such and giving that action a high priority. Other planning processes and programs to be coordinated with the recommendations of the hazard mitigation plan include the following:

- Emergency response plans
- Capital improvement programs
- Municipal codes
- Community design guidelines
- Water-efficient landscape design guidelines
- Stormwater management programs
- Water system vulnerability assessments
- Master fire protection plans.

Specific activities identified for incorporating mitigation into other planning mechanisms can be found in each jurisdictional annex located in Volume 2 of this hazard mitigation plan. Some action items in this plan can be implemented through creation of new educational programs, continued interagency coordination, or improved public participation. As information becomes available from other planning mechanisms that can enhance this plan, that information will be incorporated via the update process.

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GLOSSARY

ACRONYMS

ABAG—Association of Bay Area Governments

CCR—California Code of Regulations

CDBG-DR—Community Development Block Grant Disaster Recovery

CEQA—California Environmental Quality Act

CFR—Code of Federal Regulations

CIP—Capital Improvement Plan

CRS—Community Rating System

DFIRM—Digital Flood Insurance Rate Maps

DHS—Department of Homeland Security

DMA —Disaster Mitigation Act

DTSC—Department of Toxic Substances Control

DWR—Department of Water Resources

EMA—Emergency Management Agency (California state)

EPA—U.S. Environmental Protection Agency

ESA—Endangered Species Act

FEMA—Federal Emergency Management Agency

FERC—Federal Energy Regulatory Commission

FIRM—Flood Insurance Rate Map

FIS—Flood Insurance Study

FRA—Federal Responsibility Area

GIS—Geographic Information System

Hazus—Hazards, United States

HMA—Hazard Mitigation Assistance

HMGP—Hazard Mitigation Grant Program

IBC—International Building Code

IRC—International Residential Code

LRA—Local Responsibility Area

MM—Modified Mercalli Scale

NCA—National Climate Assessment

NEHRP—National Earthquake Hazards Reduction Program

NFIP—National Flood Insurance Program

NIMS—National Incident Management System

NOAA—National Oceanic and Atmospheric Administration

NWS—National Weather Service

OES—Office of Emergency Services

PDM—Pre-Disaster Mitigation Grant Program

PDI—Palmer Drought Index

PGA—Peak Ground Acceleration

PHMSA—Pipeline and Hazardous Materials Safety Administration

PHDI—Palmer Hydrological Drought Index

SEMS—Standardized Emergency Management System

SFHA—Special Flood Hazard Area

SPI—Standardized Precipitation Index

SRA—State Responsibility Area

USGCRP—U.S. Global Change Research Program

USGS—U.S. Geological Survey

WNV—West Nile virus

DEFINITIONS

Acre-Foot: An acre-foot is the amount of water it takes to cover 1 acre to a depth of 1 foot. This measure is used to describe the quantity of storage in a water reservoir. An acre-foot is a unit of volume. One acre foot equals 7,758 barrels; 325,829 gallons; or 43,560 cubic feet. An average household of four will use approximately 1 acre-foot of water per year.

Asset: An asset is any man-made or natural feature that has value, including people; buildings; infrastructure, such as bridges, roads, sewers, and water systems; lifelines, such as electricity and communication resources; and environmental, cultural, or recreational features such as parks, wetlands, and landmarks.

Base Flood: The flood having a 1% chance of being equaled or exceeded in any given year, also known as the "100-year" or "1% chance" flood. The base flood is a statistical concept used to ensure that all properties subject to the National Flood Insurance Program (NFIP) are protected to the same degree against flooding.

Basin: A basin is the area within which all surface water—whether from rainfall, snowmelt, springs, or other sources—flows to a single water body or watercourse. The boundary of a river basin is defined by natural topography, such as hills, mountains, and ridges. Basins are also referred to as "watersheds" and "drainage basins."

Benefit: A benefit is a net project outcome and is usually defined in monetary terms. Benefits may include direct and indirect effects. For the purposes of benefit-cost analysis of proposed mitigation measures, benefits are limited to specific, measurable, risk reduction factors, including reduction in expected property losses (buildings, contents, and functions) and protection of human life.

Benefit/Cost Analysis: A benefit/cost analysis is a systematic, quantitative method of comparing projected benefits to projected costs of a project or policy. It is used as a measure of cost effectiveness.

Building: A building is defined as a structure that is walled and roofed, principally aboveground, and permanently fixed to a site. The term includes manufactured homes on permanent foundations on which the wheels and axles carry no weight.

Capability Assessment: A capability assessment provides a description and analysis of a community's current capacity to address threats associated with hazards. The assessment includes two components: an inventory of an agency's mission, programs, and policies, and an analysis of its capacity to carry them out. A capability assessment is an integral part of the planning process in which a community's actions to reduce losses are identified, reviewed, and analyzed, and the framework for implementation is identified. The following capabilities were reviewed under this assessment:

- Legal and regulatory capability
- Administrative and technical capability
- Fiscal capability

Community Rating System (CRS): The CRS is a voluntary program under the NFIP that rewards participating communities (provides incentives) for exceeding the minimum requirements of the NFIP and completing activities that reduce flood hazard risk by providing flood insurance premium discounts.

Critical Area: An area defined by state or local regulations as deserving special protection because of unique natural features or its value as habitat for a wide range of species of flora and fauna. A sensitive/critical area is usually subject to more restrictive development regulations.

Critical Facility: Facilities and infrastructure that are critical to the health and welfare of the population. These become especially important after any hazard event occurs. For the purposes of this plan, critical facilities include:

- Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic and/or water reactive materials;
- Hospitals, nursing homes, and housing likely to contain occupants who may not be sufficiently mobile to avoid death or injury during a hazard event.
- Police stations, fire stations, vehicle and equipment storage facilities, and emergency operations centers that are needed for disaster response before, during, and after hazard events, and
- Public and private utilities, facilities and infrastructure that are vital to maintaining or restoring normal services to areas damaged by hazard events.
- Government facilities.

Dam: Any artificial barrier or controlling mechanism that can or does impound 10 acre-feet or more of water.

Dam Failure: Dam failure refers to a partial or complete breach in a dam (or levee) that impacts its integrity. Dam failures occur for a number of reasons, such as flash flooding, inadequate spillway size, mechanical failure of valves or other equipment, freezing and thawing cycles, earthquakes, and intentional destruction.

Debris Flow: Dense mixtures of water-saturated debris that move down-valley; looking and behaving much like flowing concrete. They form when loose masses of unconsolidated material are saturated, become unstable, and

move down slope. The source of water varies but includes rainfall, melting snow or ice, and glacial outburst floods.

Debris Slide: Debris slides consist of unconsolidated rock or soil that has moved rapidly down slope. They occur on slopes greater than 65 percent.

Disaster Mitigation Act of 2000 (DMA); The DMA is Public Law 106-390 and is the latest federal legislation enacted to encourage and promote proactive, pre-disaster planning as a condition of receiving financial assistance under the Robert T. Stafford Act. The DMA emphasizes planning for disasters before they occur. Under the DMA, a pre-disaster hazard mitigation program and new requirements for the national post-disaster hazard mitigation grant program (HMGP) were established.

Drainage Basin: A basin is the area within which all surface water- whether from rainfall, snowmelt, springs or other sources- flows to a single water body or watercourse. The boundary of a river basin is defined by natural topography, such as hills, mountains and ridges. Drainage basins are also referred to as **watersheds** or **basins**.

Drought: Drought is a period of time without substantial rainfall or snowfall from one year to the next. Drought can also be defined as the cumulative impacts of several dry years or a deficiency of precipitation over an extended period of time, which in turn results in water shortages for some activity, group, or environmental function. A hydrological drought is caused by deficiencies in surface and subsurface water supplies. A socioeconomic drought impacts the health, well-being, and quality of life or starts to have an adverse impact on a region. Drought is a normal, recurrent feature of climate and occurs almost everywhere.

Earthquake: An earthquake is defined as a sudden slip on a fault, volcanic or magmatic activity, and sudden stress changes in the earth that result in ground shaking and radiated seismic energy. Earthquakes can last from a few seconds to over 5 minutes, and have been known to occur as a series of tremors over a period of several days. The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Casualties may result from falling objects and debris as shocks shake, damage, or demolish buildings and other structures.

Exposure: Exposure is defined as the number and dollar value of assets considered to be at risk during the occurrence of a specific hazard.

Extent: The extent is the size of an area affected by a hazard.

Fire Behavior: Fire behavior refers to the physical characteristics of a fire and is a function of the interaction between the fuel characteristics (such as type of vegetation and structures that could burn), topography, and weather. Variables that affect fire behavior include the rate of spread, intensity, fuel consumption, and fire type (such as underbrush versus crown fire).

Fire Frequency: Fire frequency is the broad measure of the rate of fire occurrence in a particular area. An estimate of the areas most likely to burn is based on past fire history or fire rotation in the area, fuel conditions, weather, ignition sources (such as human or lightning), fire suppression response, and other factors.

Flash Flood: A flash flood occurs with little or no warning when water levels rise at an extremely fast rate

Flood Insurance Rate Map (FIRM): FIRMs are the official maps on which the Federal Emergency Management Agency (FEMA) has delineated the Special Flood Hazard Area (SFHA).

Flood Insurance Study: A report published by the Federal Insurance and Mitigation Administration for a community in conjunction with the community's Flood Insurance Rate Map. The study contains such background data as the base flood discharges and water surface elevations that were used to prepare the FIRM. In most cases, a community FIRM with detailed mapping will have a corresponding flood insurance study.

Floodplain: Any land area susceptible to being inundated by flood waters from any source. A flood insurance rate map identifies most, but not necessarily all, of a community's floodplain as the Special Flood Hazard Area (SFHA).

Floodway: Floodways are areas within a floodplain that are reserved for the purpose of conveying flood discharge without increasing the base flood elevation more than 1 foot. Generally speaking, no development is allowed in floodways, as any structures located there would block the flow of floodwaters.

Floodway Fringe: Floodway fringe areas are located in the floodplain but outside of the floodway. Some development is generally allowed in these areas, with a variety of restrictions. On maps that have identified and delineated a floodway, this would be the area beyond the floodway boundary that can be subject to different regulations.

Freeboard: Freeboard is the margin of safety added to the base flood elevation.

Frequency: For the purposes of this plan, frequency refers to how often a hazard of specific magnitude, duration, and/or extent is expected to occur on average. Statistically, a hazard with a 100-year frequency is expected to occur about once every 100 years on average and has a 1 percent chance of occurring any given year. Frequency reliability varies depending on the type of hazard considered.

Fujita Scale of Tornado Intensity: Tornado wind speeds are sometimes estimated on the basis of wind speed and damage sustained using the Fujita Scale. The scale rates the intensity or severity of tornado events using numeric values from F0 to F5 based on tornado wind speed and damage. An F0 tornado (wind speed less than 73 miles per hour (mph)) indicates minimal damage (such as broken tree limbs), and an F5 tornado (wind speeds of 261 to 318 mph) indicates severe damage.

Goal: A goal is a general guideline that explains what is to be achieved. Goals are usually broad-based, long-term, policy-type statements and represent global visions. Goals help define the benefits that a plan is trying to achieve. The success of a hazard mitigation plan is measured by the degree to which its goals have been met (that is, by the actual benefits in terms of actual hazard mitigation).

Geographic Information System (GIS): GIS is a computer software application that relates data regarding physical and other features on the earth to a database for mapping and analysis.

Hazard: A hazard is a source of potential danger or adverse condition that could harm people and/or cause property damage.

Hazard Mitigation Grant Program (HMGP): Authorized under Section 202 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, the HMGP is administered by FEMA and provides grants to states, tribes, and local governments to implement hazard mitigation actions after a major disaster declaration. The purpose of the program is to reduce the loss of life and property due to disasters and to enable mitigation activities to be implemented as a community recovers from a disaster

Hazards U.S. Multi-Hazard Loss Estimation Program (Hazus): Hazus is a GIS-based program used to support the development of risk assessments as required under the DMA. The Hazus software program assesses risk in a quantitative manner to estimate damage and losses associated with natural hazards. Hazus is FEMA's nationally applicable, standardized methodology and software program and contains modules for estimating potential losses from earthquakes, floods, and wind hazards. Hazus has also been used to assess vulnerability (exposure) for other hazards.

Hydraulics: Hydraulics is the branch of science or engineering that addresses fluids (especially water) in motion in rivers or canals, works and machinery for conducting or raising water, the use of water as a prime mover, and other fluid-related areas.

Hydrology: Hydrology is the analysis of waters of the earth. For example, a flood discharge estimate is developed by conducting a hydrologic study.

Intensity: For the purposes of this plan, intensity refers to the measure of the effects of a hazard.

Inventory: The assets identified in a study region comprise an inventory. Inventories include assets that could be lost when a disaster occurs and community resources are at risk. Assets include people, buildings, transportation, and other valued community resources.

Landslide: Landslides can be described as the sliding movement of masses of loosened rock and soil down a hillside or slope. Fundamentally, slope failures occur when the strength of the soils forming the slope exceeds the pressure, such as weight or saturation, acting upon them.

Lightning: Lightning is an electrical discharge resulting from the buildup of positive and negative charges within a thunderstorm. When the buildup becomes strong enough, lightning appears as a "bolt," usually within or between clouds and the ground. A bolt of lightning instantaneously reaches temperatures approaching 50,000ºF. The rapid heating and cooling of air near lightning causes thunder. Lightning is a major threat during thunderstorms. In the United States, 75 to 100 Americans are struck and killed by lightning each year (see http://www.fema.gov/hazard/thunderstorms/thunder.shtm).

Liquefaction: Liquefaction is the complete failure of soils, occurring when soils lose shear strength and flow horizontally. It is most likely to occur in fine grain sands and silts, which behave like viscous fluids when liquefaction occurs. This situation is extremely hazardous to development on the soils that liquefy, and generally results in extreme property damage and threats to life and safety.

Local Government: Any county, municipality, city, town, township, public authority, school district, special district, intrastate district, council of governments (regardless of whether the council of governments is incorporated as a nonprofit corporation under State law), regional or interstate government entity, or agency or instrumentality of a local government; any Indian tribe or authorized tribal organization, or Alaska Native village or organization; and any rural community, unincorporated town or village, or other public entity.

Magnitude: Magnitude is the measure of the strength of an earthquake, and is typically measured by the Richter scale. As an estimate of energy, each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value.

Mass movement: A collective term for landslides, debris flows, sinkholes and lahars.

Mitigation: A preventive action that can be taken in advance of an event that will reduce or eliminate the risk to life or property.

Mitigation Actions: Mitigation actions are specific actions to achieve goals and objectives that minimize the effects from a disaster and reduce the loss of life and property.

Objective: For the purposes of this plan, an objective is defined as a short-term aim that, when combined with other objectives, forms a strategy or course of action to meet a goal. Unlike goals, objectives are specific and measurable.

Peak Ground Acceleration: Peak Ground Acceleration (PGA) is a measure of the highest amplitude of ground shaking that accompanies an earthquake, based on a percentage of the force of gravity.

Preparedness: Preparedness refers to actions that strengthen the capability of government, citizens, and communities to respond to disasters.

Presidential Disaster Declaration: These declarations are typically made for events that cause more damage than state and local governments and resources can handle without federal government assistance. Generally, no specific dollar loss threshold has been established for such declarations. A Presidential Disaster Declaration puts into motion long-term federal recovery programs, some of which are matched by state programs, designed to help disaster victims, businesses, and public entities.

Probability of Occurrence: The probability of occurrence is a statistical measure or estimate of the likelihood that a hazard will occur. This probability is generally based on past hazard events in the area and a forecast of events that could occur in the future. A probability factor based on yearly values of occurrence is used to estimate probability of occurrence.

Repetitive Loss Property: Any NFIP-insured property that, since 1978 and regardless of any changes of ownership during that period, has experienced:

- Four or more paid flood losses in excess of $1000.00; or
- Two paid flood losses in excess of $1000.00 within any 10-year period since 1978 or
- Three or more paid losses that equal or exceed the current value of the insured property.

Return Period (or Mean Return Period): This term refers to the average period of time in years between occurrences of a particular hazard (equal to the inverse of the annual frequency of occurrence).

Riverine: Of or produced by a river. Riverine floodplains have readily identifiable channels. Floodway maps can only be prepared for riverine floodplains.

Risk: Risk is the estimated impact that a hazard would have on people, services, facilities, and structures in a community. Risk measures the likelihood of a hazard occurring and resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a high, moderate, or low likelihood of sustaining damage above a particular threshold due to occurrence of a specific type of hazard. Risk also can be expressed in terms of potential monetary losses associated with the intensity of the hazard.

Risk Assessment: Risk assessment is the process of measuring potential loss of life, personal injury, economic injury, and property damage resulting from hazards. This process assesses the vulnerability of people, buildings, and infrastructure to hazards and focuses on (1) hazard identification; (2) impacts of hazards on physical, social, and economic assets; (3) vulnerability identification; and (4) estimates of the cost of damage or costs that could be avoided through mitigation.

Risk Ranking: This ranking serves two purposes, first to describe the probability that a hazard will occur, and second to describe the impact a hazard will have on people, property, and the economy. Risk estimates are based on the methodology used to prepare the risk assessment for this plan. The following equation shows the risk ranking calculation:

$$\text{Risk Ranking} = \text{Probability} + \text{Impact (people} + \text{property} + \text{economy)}$$

Robert T. Stafford Act: The Robert T. Stafford Disaster Relief and Emergency Assistance Act (Public Law 100-107) was signed into law on November 23, 1988. This law amended the Disaster Relief Act of 1974

(Public Law 93-288). The Stafford Act is the statutory authority for most federal disaster response activities, especially as they pertain to FEMA and its programs.

Special Flood Hazard Area: The base floodplain delineated on a Flood Insurance Rate Map. The SFHA is mapped as a Zone A in riverine situations and zone V in coastal situations. The SFHA may or may not encompass all of a community's flood problems

Stakeholder: Business leaders, civic groups, academia, non-profit organizations, major employers, managers of critical facilities, farmers, developers, special purpose districts, and others whose actions could impact hazard mitigation.

Stream Bank Erosion: Stream bank erosion refers to the erosion, sloughing or undercutting of a river, stream or drain. It is natural for streams to meander through erosion processes. Generally, stream bank erosion is a problem where development has limited meandering, where streams have been channelized, or where stream bank structures (bridges, culverts, etc.) are in places where they can cause damage to downstream areas. Stabilizing these areas can help protect watercourses from sedimentation, prevent damage to adjacent lands, control unwanted meander, and improve fish and wildlife habitat.

Steep Slope: Different communities and agencies define it differently, depending on what it is being applied to, but generally a steep slope is a slope in which the percent slope equals or exceeds 25%. For this study, steep slope is defined as slopes greater than 33 percent.

Sustainable Hazard Mitigation: This concept includes the sound management of natural resources, local economic and social resiliency, and the recognition that hazards and mitigation must be understood in the largest possible social and economic context.

Thunderstorm: A thunderstorm is a storm with lightning and thunder produced by cumulonimbus clouds. Thunderstorms usually produce gusty winds, heavy rains, and sometimes hail. Thunderstorms are usually short in duration (seldom more than 2 hours). Heavy rains associated with thunderstorms can lead to flash flooding during the wet or dry seasons.

Tornado: A tornado is a violently rotating column of air extending between and in contact with a cloud and the surface of the earth. Tornadoes are often (but not always) visible as funnel clouds. On a local scale, tornadoes are the most intense of all atmospheric circulations, and winds can reach destructive speeds of more than 300 mph. A tornado's vortex is typically a few hundred meters in diameter, and damage paths can be up to 1 mile wide and 50 miles long.

Vulnerability: Vulnerability describes how exposed or susceptible an asset is to damage. Vulnerability depends on an asset's construction, contents, and the economic value of its functions. Like indirect damage, the vulnerability of one element of the community is often related to the vulnerability of another. For example, many businesses depend on uninterrupted electrical power. Flooding of an electric substation would affect not only the substation itself but businesses as well. Often, indirect effects can be much more widespread and damaging than direct effects.

Watershed: A watershed is an area that drains downgradient from areas of higher land to areas of lower land to the lowest point, a common drainage basin.

Wildfire: These terms refer to any uncontrolled fire occurring on undeveloped land that requires fire suppression. The potential for wildfire is influenced by three factors: the presence of fuel, topography, and air mass. Fuel can include living and dead vegetation on the ground, along the surface as brush and small trees, and in the air such as tree canopies. Topography includes both slope and elevation. Air mass includes temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount, duration, and the stability of the atmosphere at the

time of the fire. Wildfires can be ignited by lightning and, most frequently, by human activity including smoking, campfires, equipment use, and arson.

Windstorm: Windstorms are generally short-duration events involving straight-line winds or gusts exceeding 50 mph. These gusts can produce winds of sufficient strength to cause property damage. Windstorms are especially dangerous in areas with significant tree stands, exposed property, poorly constructed buildings, mobile homes (manufactured housing units), major infrastructure, and aboveground utility lines. A windstorm can topple trees and power lines; cause damage to residential, commercial, critical facilities; and leave tons of debris in its wake.

Zoning Ordinance: The zoning ordinance designates allowable land use and intensities for a local jurisdiction. Zoning ordinances consist of two components: a zoning text and a zoning map.

Appendix A. Public Outreach Materials

SURVEY, SURVEY RESULTS

Tri-Valley Local Hazard Mitigation Plan Survey

1. Survey Introduction

Tri-Valley Hazard Mitigation Questionnaire

A range of natural and human-caused disasters can affect any community. The Cities of Livermore, Pleasanton and Dublin and their special district planning partners work diligently to mitigate threats and prepare for disasters. Natural disasters are those hazards that occur as a force of nature, such as a flood or earthquake. Non-natural disasters are those that occur as part of an intentional act or failure of technology. For the purpose of this plan, non-natural hazards also include health hazards, such as epidemics.

To maintain a high level of preparedness, we need your help to identify and plan for future disasters by completing this survey.

Thank you for taking the time to participate in the 2017 Hazard Mitigation Survey!

2. Hazard Knowledge

First, this set of questions is about your experience and knowledge of natural hazards and steps your household has taken to prepare for disasters:

1. Which of the following natural hazard events have you experienced in the Tri-Valley planning area? (Check all that apply)

- [ ] Dam/Levee Failure
- [ ] Drought
- [ ] Earthquake
- [ ] Flood
- [ ] Landslide & Mass Movements (sinkholes, geologic hazards)
- [ ] Severe Weather (high wind, heavy rain, lightning, etc.)
- [ ] Wildfire
- [ ] None
- [ ] Other (please specify)

2. How concerned are you about the following natural hazards in the Tri-Valley planning area? (Please check one for each hazard)

	Not concerned	Somewhat concerned	Concerned	Very concerned	Extremely concerned
Dam/Levee Failure	○	○	○	○	○
Drought	○	○	○	○	○
Earthquake	○	○	○	○	○
Flood	○	○	○	○	○
Landslide & Other Earth Movements (sinkholes,geologic hazard)	○	○	○	○	○
Severe Weather (wind, lightning, fog, heavy rains, solar flare, etc.)	○	○	○	○	○
Wildfire	○	○	○	○	○
Other Natural Hazard	○	○	○	○	○

If you are concerned about a natural hazard not listed above, please specify.

3. How would you expect to be notified in case of an immediate threat caused by a local hazard.

Select all that apply.

- [ ] Television
- [ ] Radio
- [ ] Facebook
- [ ] Other (please specify)
- [ ] Twitter
- [ ] Nextdoor
- [ ] Nixle
- [ ] Public Notification System
- [ ] Alameda County Alert

4. Which of the following steps has your household taken to prepare for a local hazard event? (Check all that apply)

- [ ] Received first aid/CPR training
- [ ] Made a fire escape plan
- [ ] Designated a meeting place
- [ ] Identified utility shutoffs
- [ ] Prepared a disaster supply kit
- [ ] Other (please specify)
- [ ] Installed smoke detectors on each leve of the house
- [ ] Stored food and water
- [ ] Stored flashlights and batteries
- [ ] Stored a battery-powered radio
- [ ] Stored a fire extinguisher
- [ ] Stored medical supplies (first aid kit, medications)
- [ ] Registered to receive emergency alerts
- [ ] Purchased additional Insurance

5. How prepared is your household to get along without electricity or natural gas for one to five days?

- ◯ Not at all prepared
- ◯ Somewhat prepared
- ◯ Very prepared

3. Location

Please tell us about where you live and work:

* 6. Where do you live?

- ◯ Dublin
- ◯ Pleasanton
- ◯ I do not live in the Tri-Valley Planning area
- ◯ Livermore
- ◯ Alameda County (Unincorporated)

If you live in Unincorporated County, please provide the name of your community.

7. Where do you work?

- ◯ Dublin
- ◯ Pleasanton
- ◯ I work outside of the Tri-Valley planning area
- ◯ Livermore
- ◯ Alameda County (Unincorporated)
- ◯ I am unemployed/retired

4. Location (continued)

Please tell us about where you live and if the potential impacts of natural or human-caused hazards influenced your decision:

8. Do you own or rent your place of residence?

- ◯ Own
- ◯ Rent

9. When you moved into your home, did you consider the impact a disaster could have on your home?

- ◯ Yes
- ◯ No

10. If you received real estate disclosure information when you moved into your current residence, did your real estate agent or landlord explain the implications of living in a hazard risk zone and did you understand the information presented?

- ◯ Yes
- ◯ No

11. Is your home located in any of the following hazard areas (check all that apply):

- ☐ FEMA Designated Floodplain
- ☐ Near an Active Fault (within 1 mile)
- ☐ Dam Failure Zone
- ☐ Wildfire Prone Area
- ☐ High Liquefaction Zone
- ☐ Landslide/Sinkhole Area
- ☐ Other (please specify)

12. Do you have hazard- specific insurance (check all that apply)?

- ☐ Flood Insurance
- ☐ Earthquake Insurance
- ☐ Not Sure
- ☐ Other Insurance (please specify)

5. About You

Please tell us about yourself. This information will aid the Local Hazard Mitigation Plan Workgroup in evaluating the responses to this questionnaire. The answers will be used only for the preparation of this Plan and will not be provided to any other group or interest.

13. Is English the primary language spoken in your home?

- ◯ Yes
- ◯ No (please specify)

14. Which of the following digital media outlets do you use and/or subscribe to receive news and information about the Tri-Valley Planning Area?

Select all that apply.

- ☐ Facebook
- ☐ Twitter
- ☐ Nextdoor
- ☐ E-mail and/or text messages
- ☐ Nixle
- ☐ Local News
- ☐ Other (please specify)

15. Please indicate how you feel about the following statement:

It is the responsibility of government (local, state and federal) to provide education and programs that promote citizen actions that will reduce exposure to the risks associated with natural hazards.

◯ Strongly Disagree ◯ Somewhat Disagree ◯ Neutral ◯ Somewhat Agree ◯ Strongly Agree

16. Please provide any additional comments you would like to share with the LHMP Steering Committee.

17. If you would like to receive information regarding upcoming public events, other participatory opportunities regarding hazard mitigation, or general preparedness information, please provide your email address below.

STEERING COMMITTEE MEETING SUMMARIES

MEETING SUMMARY

Date/Time of Meeting:	Tuesday – March 7, 2017; 9:00am to 11:00am
Location:	Regional Meeting Room, 100 Civic Dr., Dublin, CA 94568
Subject:	Steering Committee No.1
Project Name:	Tri-Valley Multi-Jurisdiction Hazard Mitigation Plan
In Attendance (See Attachment):	**Attendees:** Susan Frost, Cary Fukada, John Richards, Hazel Wetherford, Dan Stevenson, Mike Benzien, Julie Carter, John Lawrence, Tracy Hein, Lincoln Casimere, Shweta Bonn, Adam Weinstein Phoned in: Marla Blagg, Joe Testa, Bruce Bird **Planning Team:** Rob Flaner
Not Present:	N/A
Summary Prepared by:	Rob Flaner (3/20/2017)
Quorum – Yes or No	N/A – Steering Committee not finalized

Item	Action

Welcome and Introductions, Review Agenda

- Mr. Rob Flaner opened the meeting and facilitated group introductions.
- Distributed handouts included: Agenda; Draft Steering Committee Charter; Work Plan and timeline, Planning Partner expectations document
- The agenda was reviewed and no modifications were made.

Project Overview

After introductions, Mr. Flaner went through a PowerPoint presentation that provided an overview of the Disaster Mitigation Act (DMA) of 2000. He noted that per DMA 2000 requirements, hazard mitigation plans (HMP) are needed to be eligible for certain types of federal grant funding opportunities. He provided a history of hazard mitigation planning in the 3 cities and noted that this process represent a functional reset for the Cities and their planning partners. The presentation provided an overview of the 7-phase work plan that will follow the Community Rating System (CRS) planning script to maximize the CRS credit potential for participating Cities (Pleasanton and Livermore). The presentation concluded by introducing the role of the

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Steering Committee and identified the next planning steps to be conducted.

Should We expand the Partnership?

Under the next segment of the agenda, Mr. Flaner presented to the SC the options for expansion of the coverage of the plan to include special purpose districts within the planning area. Mr. Flaner explained that section 201.4 of 44CFR redefined the definition of "local government" to include special purpose districts that have junior taxing authority. This puts districts in the same position as municipal governments in that they must have participated in the development of, and adopted a hazard mitigation plan to be eligible for pre/post disaster hazard mitigation grant funding.

The topic of discussion transition to what special purpose districts would be likely candidates to participate in the Tri-Valley effort. Mr. Flaner explained the Dublin/San Ramon CSD had already expressed interest in this effort based on a referral from Contra Costa County. Mr. Flaner also explained that there would be no extra cost to the current contracts for this planning effort to expand, that responsibility to meet planning partner expectations would lie with each committed district. It was the general consensus of the group that the planning partnership should be expanded with the most like candidates being: the school districts, water/waste water service providers and the Livermore Area Parks and Recreation District. Mr. Flaner asked for members of the SC to provide him with contact information for the targeted districts so that he can send them an introductory e-mail along with the planning partner expectations package prior to the next SC meeting. This dissemination will establish a turn-around time for the Districts to commit to the process.

Planning Team to send out e-mail to districts targeted for expansion explaining the options available to participate in the Tri-Valley planning effort prior to next SC meeting.

The Steering Committee's Role

Mr. Flaner turned attention to establishing the ground rules for the Steering Committee. He provided the group with a proposed draft Charter which they reviewed. Mr. Flaner requested that the group discuss the specific composition and rules of the HMP SC. He began by discussing who should be the Chair and Vice Chair. Ms. Hazel Wetherford from the City of Dublin volunteered to be the Chair and Mr. Adam Weinstein from the City of Pleasanton volunteered as Vice-chair.

Other key components of the Charter approved by the SC include:

- Hazel Wetherford will act as the spokesperson for the process
- The quorum was established as 50%+1, or 12 members.

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• The proxy protocol will be followed for alternates • The reoccurring meeting date will be the 2nd Tuesday of every month from 9:00 AM to 11:00 AM • The meeting Location will be the Reginal Meeting Room at Dublin City Hall, 100 Civic Plaza, Dublin, CA 94568 • A public comment protocol will be followed that mirrors standard process for city council meetings. Mr. Flaner will finalize the Charter and will make available for public review via the website discussed below.	Planning Team to finalize the Charter based on direction from this meeting, and will post on the TVLHMP website.
Plan Review Mr. Flaner reiterated that this planning process was being viewed as a "functional reset" for those local governments that had prior coverage under the ABAG plan. Many planning components such as goals, objectives, public outreach strategy will be developed from scratch as hazard mitigation planning moves from a Bay Area regional focus to one specifically focused on the Tri-Valley panning area. The principal starting point for this process will be a review of The CA State Hazard Mitigation Plan. Section 2501.6 44CFR requires that Local Hazard Mitigation Plans integrate and be consistent with key planning goals identified in the State Hazard Mitigation Plan. The State mitigation plan should be used to frame the hazards of concern to be addressed by the Tri-Valley plan and the goals and objectives. To prepare for the next SC meeting that will be dedicated to goal setting and hazard identification, Mr. Flaner assigned homework to the SC. The homework involved a review of the CA State Hazard Mitigation Plan to gain a better understanding of: • The State's identified goals for Hazard mitigation • The hazards the State plan identifies the Tri-Valley Planning area is susceptible to.	The SC to review the CA State Hazard mitigation plan to identify: •The State's identified goals for Hazard mitigation •The hazards the State plan identifies the Tri-Valley Planning area is susceptible to.
Public Involvement Strategy Mr. Flaner expanded on earlier discussion regarding the requirement for public engagement throughout the entire planning process. This will be accomplished for this effort by the identification of a comprehensive public engagement strategy that will utilize multiple media within the existing capabilities of the assembled planning partnership. This strategy will be identified and approved by the SC via the panning process. The cornerstone of this strategy will be the development of a website that will house the plan and its support document. The website will be the "one-	

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stop-shop" for all things hazard mitigation within the Tri-Valley planning area. The Planning team has already developed a site framework on the "WIX" platform that will become activated as soon as information becomes available to post.

Action Items for Next Meeting

Action items identified for the next meeting include the following:

- Confirm hazards of Concern
- Identify a Vision/Mission
- Goal Setting
- Phase 1 Public Outreach

Attachment: Sign-in Sheet

Tri-Valley Hazard Mitigation Plan-Update
March 7, 2017

Name	Representing	E-mail
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Adam Weinstein	"	aweinstein@"

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Tri-Valley Hazard Mitigation Plan-Update
March 7, 2017

Name	Representing	E-mail
MARL BLAGG	BOART	PLEASE IN
JOE TESTA	LPPD	" "
BRUCE BIRD	VOAD	" "

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MEETING SUMMARY

Date/Time of Meeting:	Tuesday – April 11, 2017; 9:00am to 11:00am
Location:	Regional Meeting Room, 100 Civic Dr., Dublin, CA 94568
Subject:	Steering Committee No.2
Project Name:	Tri-Valley Multi-Jurisdiction Hazard Mitigation Plan
In Attendance (See Attachment):	**Attendees:** Susan Frost, Cary Fukada, John Richards, Hazel Wetherford, Dan Stevenson, Tracy Hein, Shweta Bonn, Adam Weinstein, Stan Kolodzie, Steve Stewart, Joe Testa Phoned in: None **Planning Team:** Rob Flaner
Not Present:	N/A
Summary Prepared by:	Rob Flaner (4/14/2017)
Quorum – Yes or No	Yes

Item	Action

Welcome and Introductions, Review Agenda

- Mr. Rob Flaner opened the meeting and facilitated group introductions.
- Distributed handouts included: Agenda; Meeting Summary, Final SC Charter, SB-379 Summary, Draft Press release, example survey, example vision/mission statements
- The agenda was reviewed and no modifications were made.
- The meeting summary was approved as amended.
- There were no members of the public present
- The final Charter was approved as amended.

Hazards of Concern

Rob Flaner facilitated discussion on which hazards of concern the plan should address. At the last SC meeting, the committee was asked to review the CA State Hazard mitigation Plan to see:

a. What hazards the state plan assessed
b. What hazards the state plan said the Tri-Valley planning area was susceptible to.

Rob explained that the first order of business was to decide whether the plan should include non-natural/human caused hazards. Section 201.6

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44CFR states that local hazard mitigation plans "***shall"*** assess the risk from natural hazards within a planning area, and they ***"may***" assess other hazards of interest. So it is considered optional to include non-natural/human caused hazards in the risk assessments for local hazard mitigation plans. So Rob asked the committee to share their thoughts on this question.

Rob explained that he had done plans both ways over the years, but it is important to note that you cannot assess the 2 types of hazards in the same context. FEMA has defined "risk" as Probability x Impact. The probability of an event is the possible recurrence of an event based on historical record. The impact is based on the impact of a hazard on the people, property and economy of a planning area. The fundamental difference between assess risk on natural vs. non-natural hazards following this definition is probability. There is sufficient historical record of natural hazards events to assign recurrence intervals or probabilities based on historical record. These type of records do not exist for non-natural hazards. We know that a 100-year flood event is a flood that has a 1% chance of occurring in any given year. There is no such thing as a 100-year terrorism event.

So after discussion, there was consensus among the SC that the plan should include non-natural/human caused hazards. The principle driver for this decision was to acknowledge the potential exposure to these type events and to acknowledge the other plans and programs within the planning area that are specific to these type hazards. The plan will fully assess and rank the risk to the natural hazards of concern and will profile the other non-natural/human caused hazards of interest.

Next, the discussion shifted to which hazards the plan will include. For the natural hazards, the plan will assess and rank the following hazards:

- Dam Failure
- Drought
- Earthquake
- Flood
- Landslide
- Severe Weather
- Wildfire

Hazus will be used to model the impacts from the Dam Failure, Earthquake and Flood hazards. Multiple event scenarios will be modeled for each of these hazards as follows:

- Dam Failure- Del Valle and san Antonio reservoirs

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- Earthquake- a “Haywired”, Greenville, Southern Calaveras, Mt. Diablo and San Andreas fault scenarios from shakemaps provided by USGS.
- Flood-10, 100 and 500-year flood events.

For non-natural/human caused hazards, the SC determined that the plan should profile the following hazards:

- Terrorism-Including Cyber and Agricultural terrorism
- Hazardous Materials- both rail and Highway
- Pipeline hazards (oil and gas, natural gas)
- Oil and Gas mining
- Human Health-including pandemic
- Jails- both County and federal
- Transportation- Airport

Public Involvement Strategy

Rob in formed the SC that the website was up and running. The website address is: https://www.tri-valley-hmp.com/ . Rob previewed the site and asked all jurisdictions to link to the site on their individual web sites. Rob also stated that he would like to get a press release out ASAP to advertise the planning process and the website. Rob asked the group who would be good public information offices to work through. Hazel Weatherford from Dublin recommended their PIO, Lori Taylor, and Stan Kolodzie from DSRCSD recommended their PIO, Sue Stevenson. It was recommended by the group that Lori had a well-established network of PIO’s within the planning area and that she would be able to lead the coordination of all press releases. Hazel asked Rob if he could provide a “word” version of the draft press release so that it could be put in to the proper city format.

Planning partners to link to the LHMP website on their individual websites

Rob to send copy of “word” version of the press release to Hazel

Next, Rob presented a draft copy of a hazard mitigation survey that is currently being used in the Contra Costa County planning effort. Rob explained to the EC that surveys are a good way to gauge the public’s perception of risk and will be an integral part of the public engagement strategy for the Tri-Valley planning effort. As homework, Rob asked for the SC to review the draft survey and to mark up any changes the SC would like to see made. The SC will finalize a Tri-Valley survey as an action item at their May SC meeting

Homework: SC to review draft survey and be prepared to finalize a Tri-Valley survey at the next SC meeting.

Goal Setting

Rob explained to the SC that it is required under section 201.6 44CFR for LHMP’s to have a clearly defined set of goals. Rob explained that many planning efforts expand on this requirement and include a vision or

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mission statement and a set of measurable objectives. While not required, these planning components can add depth and versatility to a LHMP. Rob explained that it is Tetra Tech's recommendation that the Tri-Valley plan include: a vision/mission statement, goals and objectives. These would be linear planning components that each would stand on their own merit and would be selected based upon their ability to support the upper tier component. So, for example, once a vision/mission statement was determined, goals would be identified that define that vision/mission. Then objectives would be identified on the basis of their ability to support multiple goals. Then actions would be identified and prioritized based on their ability to meet multiple objectives. The SC agreed with this approach for the Tri-Valley plan.	
Rob provided the SC with a handout that provided 11 example vision/mission statements from other planning efforts around the country. The SC was asked to review the statements to identify what type of vision/mission statement they wanted for the Tri-Valley Plan. It was determined that there was not sufficient time at this meeting to confirm a vision/mission statement for the plan, so the SC was given homework to review and refine recommendations for a vision/mission statement. It was also suggested that these statements be reviewed for consistency with to vision/mission statements of the general plans for the 3 cities. To expedite this process, Rob asked for the SC to provide their recommendations to Rob via e-mail by close of business, Friday April 21, 2017.	SC to provide Rob their recommendations for vision/mission statements via e-mail by Friday April 21, 2017.
Rob explained that the next step after confirming a vision/mission statement would be to identify to goals for the plan. This will be done by the completion of a goal setting exercise using Survey Monkey, where the SC will review a catalog of goals statements and each member of the SC will chose 5 statements they feel should be in the plan. Those goal statements that receive the most votes will be the basis for the goals selected for the plan. Rob explained that it is imperative that all SC members complete the exercise so that the goals selected for consideration can be based on a quorum consensus.	
Rob stated that he would really like to have goals identified for the plan before the phase 1 public meetings. So to meet this objective, Rob will	Rob to deploy the goal setting exercise prior to May SC meeting

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deploy the goal setting exercise prior to the May SC meeting so that the goals can be confirmed at that meeting.

Action Items for Next Meeting

Action items identified for the next meeting include the following:

- Confirm hazard mitigation survey
- Confirm vision/mission statement
- Confirm Goals
- Define critical facilities/infrastructure
- Introduce objectives exercise

MEETING SUMMARY

Attachment: Sign-in Sheet

Tri-Valley Hazard Mitigation Plan-Update
April 11, 2017

Name	Representing	E-mail
John Richards ✓	LLNL	richards6@llnl.gov ✓
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FINAL MEETING SUMMARY

Date/Time of Meeting:	Tuesday – May 16, 2017; 9:00am to 11:00am
Location:	Regional Meeting Room, 100 Civic Dr., Dublin, CA 94568
Subject:	Steering Committee No.3
Project Name:	Tri-Valley Multi-Jurisdiction Hazard Mitigation Plan
In Attendance (See Attachment):	**Attendees:** Susan Frost, John Richards, Julie Carter, Shweta Bonn, Adam Weinstein, Stan Kolodzie, Joe Testa, Marla Blagg (phone in), Lincoln Casimere (phone in) Phoned in: None **Planning Team:** Rob Flaner
Not Present:	N/A
Summary Prepared by:	Rob Flaner (6/1/2017)
Quorum – Yes or No	No

Item	Action

Welcome and Introductions, Review Agenda

- Mr. Rob Flaner opened the meeting and facilitated group introductions.
- There was not sufficient attendance for a quorum.
- Distributed handouts included: Agenda; Meeting Summary, example mission/vision statements, sample critical facility definitions, goal setting exercise
- The agenda was reviewed and no modifications were made.
- Approval of meeting summary was tabled until the next meeting due to lack of a quorum.
- There were no members of the public present
- Lori Taylor from the City of Dublin is retiring and will need to be replaced as PIO for this planning effort. It was recommended by the SC that Lori Dunne from the City of Pleasanton would assume the role as public information coordinator for this process.

Goal Setting

The confirmation of a vision mission statement for the plan was tabled at the last meeting for further discussion at this meeting. The SC reviewed the example statements and recommended the following:

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Through community partnerships, establish a plan to reduce the vulnerability to hazards in order to protect the health, safety, welfare, environment and economy of the planning area. Due to the lack of a quorum, confirmation of this mission/vision statement was tabled until the June meeting. Prior to the meeting, Rob had sent out a goal setting exercise to the Committee. Hard copies of the exercise were provided at the meeting. Rob explained that the purpose of the exercise was to review a catalog of goal statements. The SC was asked to identify at least 5 of the goal statements that they feel best support the mission/vision that had been identified for the plan. Members in attendance that had not completed the exercise on-line were given time to complete the exercise at the meeting. Six surveys were completed at the meeting the results of the survey will be presented at the next meeting with the intent to finalize the goals for the plan by a quorum vote. Rob then explained that the next step after goal confirmation would be to identify a series of objectives that will meet multiple goals. This will be done by survey in the same context as goal setting. **Public Involvement Strategy** Rob reiterated that the website was up and running and asked if the individual planning partners had in fact created links to the website. Not all planning partners had yet established links to the website. Rob ask that this be confirmed before the next meeting. A press release on the planning process had been distributed and there was some response to the release. The "Independent" published a piece on the planning process on May 4th as did the Dublin Patch on May 18th. Rob stressed that any and all press coverage of the plan and the process is a good thing and asked that the SC continue to get the word out. The proposed hazard survey was reviewed once again by the committee and additional edits were made. However, due to the lack of a quorum, the final survey could not be approved. Approval and deployment of the final survey was tabled until the next meeting in June. **Critical Facilities** Rob explained that one of the principle objectives for the Disaster Mitigation acts is to make the nation's critical facilities and infrastructure more resilient. He explained that it is a principle objective for hazard mitigation grants to show how a proposed project will benefit identified critical facilities and infrastructure. The planning requirements for DMA compliant plans specify that planning efforts "define" what are	Planning team to tabulate goal setting exercise results for review at next meeting. Planning team to revise survey prior to next SC meeting and distribute to SC prior to next meeting for their review.

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critical facilities and infrastructure specific to a defined planning area. So the next step for the SC is to define critical facilities and infra-structure for the planning area. Rob provided a handout that provided examples of critical facility/infrastructure definitions from across the country. Discussion then ensued on variations of the examples that best suited the Tri-Valley planning area. It was decided that the following definition would be appropriate for this planning effort:

A Critical Facility is infrastructure or a facility that is critical to the health and welfare of the population. These become especially important after any hazard/natural disaster event occurs. For the purposes of the Tri-Valley Planning Area Hazard Mitigation Plan, Critical Facilities include:

- ***Essential Facilities:***
    - *Medical and Shelter Facilities—Facilities likely to be used as a sheltering or community assembly location, and structures likely to contain occupants who may not be sufficiently mobile to avoid death or injury during and after a hazard/natural disaster event including but not limited to: Hospitals, schools, skilled nursing facilities, board and care homes, pharmacies, clinics, fairgrounds, community centers, ambulance services, and veterinary hospitals.*
    - *Emergency Response—Public and private facilities that are needed for response and recovery activities before, during, and after a hazard/natural disaster event including but not limited to: Emergency Operations Centers, public safety answering points, police stations, fire stations, local, state and federal resource agencies, and emergency response staging sites.*
    - *Recovery facilities—debris clearing and disposal, car rentals, buses, financial institutions, survival and building supplies*
    - *Utilities and Infrastructure—Public and private utility facilities and essential services that are vital to maintaining or restoring normal services to impacted areas before, during, and after a hazard/natural disaster event including but not limited to: All transportation infrastructure, municipal water pumps and wells, water treatment plants, water storage, sewage treatment facilities, lift stations, water and sewer mainlines, substations, electric power*

generating and transmission infrastructure, retail and wholesale fuel transmission infrastructure and transport and storage facilities, telecommunications, repeater stations, radio stations and towers, airport services, standby power-generating equipment, public works corporation yards and grocery stores.

- ***Hazardous Facilities:***
  - *Major Dams and Levees*
  - *Risk Management Plan (RMP) Hazmat Sites—Hazmat sites are structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic and/or water-reactive materials. This includes all RMP Hazmat sites including but not limited to facilities that use, or store acutely hazardous materials as defined by California Code of Regulations Title 19, Division 2, Chapter 4.5, Section 2770.5.*
  - *Additional Hazmat Sites—Hazmat sites may additionally include: Nuclear materials storage sites, wholesale fuel facilities, hazardous materials yards, industrial facilities .*

Once again, this definition could not be approved due to the lack of a quorum and its approval was tabled until the next meeting.

National Policy Briefing

Rob provide the SC a briefing on some national policy changes that he had learned about at a national flood conference he attended 2 week prior to this meeting. These points are summarized as follows:

- *FMA Hazard Mitigation Assistance program*: Due to the continuing resolution extending the national budget, there will be congressional appropriations for the Pre-disaster mitigation grant program (PDM and the Flood Mitigation Assistance (FMA) grant programs. PDM has been authorized for $100 million and FMA was authorized for $175 million. This is good news as both of these programs had been cut in the President's proposed budget. This may be the last time these programs are funded for a while.
- *Disaster deductible concept for Public Assistance*: There is a lot of political support for a major overhaul of the "Public Assistance (PA) program. The current model is based on a damage threshold that is population based. There is a lot of support for a "disaster deductible" concept that established a deductible for each state that

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can be bought down by tracking successful mitigation actions that have reduced risk. This concept puts a premium on being able to identify and track successful mitigation projects. This would have a large impact on states like CA that would have very high deductibles due to its population.

- *NFIP reauthorization*: Reauthorization of the National Flood Insurance Program (NFIP) is slated for October 2017. The current administration is very heavily supporting of the concept of privatizing the NFIP. The NFIP in is current state is significantly flawed. There are many who feel that these flaws could be corrected by privatizing the program. But what about the programmatic aspects of the NFIP? Is the private sector going to monitor compliance with the programmatic aspects of the NFIP? Are those programmatic aspects even needed? The answers to these questions could have a significant impact on the way the nation's floodplains and managed.
- *Moonshots 2023*: The Flood Insurance and Mitigation Administration (a branch of FEMA referred to as FIMA) has a new mission. It has been termed "Moonshots 2023". The ultimate goal of Moonshots 2013 is to double the flood insurance coverage of the nation by 2023, regardless of who is managing the program. This program will built upon innovation with 3 cornerstones, explore, build and finish. It has established very ambitious goals for flood risk management and mitigation as a whole over the next 6 years.

Action Items for Next Meeting

Action items identified for the next meeting include the following:

- Approve Mission/Vision
- Approve Goals
- Approve Critical Facilities definition
- Approve final survey
- Introduce objectives exercise
- Set round 1 public meeting schedule

Attachment: Sign-in Sheet

Tri-Valley Hazard Mitigation Plan-Update
May 16, 2017

Name	Representing	E-mail
John Richards ✓	LLNL	richards6@llnl.gov
Susan Frost ✓	Livermore	simfrost@cityoflivermore.net
Julie Carter ✓	Dublin	Julie.carter@dublin.ca.gov
Joe Testa	LPFD	jtesta@lpfd.org
Adam Weinstein ✓	Pleasanton	aweinstein@cityofpleasanton.ca.gov ✓
Shweta Bonn ✓	Pleasanton	sbonn@...
MARLA BLAGG	BART	PHONED IN
LINCOLN	ACFD	PHONE IN
STAN KOCODZIE	DSRSD	

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FINAL MEETING SUMMARY

Date/Time of Meeting:	Tuesday – June 13, 2017; 9:00am to 11:00am
Location:	Regional Meeting Room, 100 Civic Dr., Dublin, CA 94568
Subject:	Steering Committee No. 4
Project Name:	Tri-Valley Multi-Jurisdiction Hazard Mitigation Plan
In Attendance: **(See Attachment):**	Shweta Bonn, Susan Frost, Cary Fukada, Tracy Hein, Stan Kolodzie, John Richards, Adam Weinstein, Hazel Wetherford Phoned in: None **Planning Team:** Rob Flaner, Tommie Jean Valmassy
Summary Prepared by:	Tommie Jean Valmassy
Quorum – Yes or No	Yes

Item	Action
Welcome and Introductions, Review Agenda • Rob Flaner opened the meeting and facilitated group introductions. • There were not enough steering committee members present for a quorum. • Distributed handouts included: Agenda, Meeting Summary #3, Risk Assessment Data Dictionary for Spatial Analysis, Goal Exercise Results, Draft Community Survey. • The agenda was reviewed and no modifications were made.	
Planning Process There was not sufficient attendance for a quorum. There have been several meetings without a quorum, preventing approval and progress on project milestones. Mr. Flaner said the quorum was established as 50% of planning members plus 1, which means 10 attendees are needed for a quorum. This is the fourth meeting and some members have yet to attend. It was determined that the quorum should be 50% plus 1 jurisdictional member. There are four jurisdictions, so a quorum is now three of the four jurisdictions. Based on the change, there is now a quorum for the meeting.	New Quorum is set at three.
Since a quorum was established, the group provided some minor edits to the notes from Meeting No. 3, and approved them as final pending incorporation of edits.	Update and finalize the notes from meeting No. 3.

Item	Action
Once a quorum was established, the group voted to approve the Mission and Vision statements, as presented in the notes from meeting No. 3.	Mission and Vision are approved for the plan. A clean copy will be provided to the group.
Risk Assessment Update Mr. Flaner reviewed the Risk Assessment Data Dictionary for Spatial Analysis. This includes a description and data source for general building stock, critical facilities, flood, earthquake, landslide, dam and reservoir failure, wildfire, demographics, and current/future land use.	
The costs associated with hazards will be costs to repair or replace, not a current assessed value. There is a formula that includes square footage and occupancy, and factors in anticipated down time for a building or structure.	
Mr. Flaner said the risk assessment will include five different earthquake scenarios because fault and magnitude variances will make a difference in risk.	
For wildfire scenarios, Tetra Tech is using Cal Fire Fire and Resource Assessment Program (FRAP) data, which is limited because it focuses on resource planning areas. Mr. Flaner asked Tracy Hein if she is aware of a community wildfire protection plan (CWPP). Ms. Hein is not aware of one but will ask.	Tracy Hein will find out if there is a CWPP
In relation to flood data, FEMA tracks repetitive losses. A repetitive loss is a property with two or more losses worth over $1,000 since 1978. Because the Tri-Valley does not have a lot of flood issues, there likely are not repetitive loss properties.	
For landslides, Tetra Tech will use data from the Association of Bay Area Governments (ABAG), unless any communities have their own landslide data.	If your jurisdiction has landslide data provide it to Mr. Flaner.
Demographic data will be gathered through the American Community Survey (ACS). The U.S. Census Bureau only completes a full census every ten years, so the most recent data is 2010. Tetra Tech will use ACS data because it is more recent.	
Mr. Flaner said Buildable Lands is vacant land that, based on zoning, could be built. He asked if any of the Tri-Valley planning departments have	

Item	Action
buildable lands data. Vacant land is also easy to define. More ambiguous is "underutilized land." Mr. Flaner said Tetra Tech needs whatever data is available, but will not do an analysis to confirm the correct category of land.	
Goal Setting See handout for the top ten goals, established based on steering committee members completing a survey. Typically plans have five to seven goals. The team went through the goals and created the following final list: 1.) Ensure that hazards are identified and considered in land use decisions. 2.) Improve local emergency management capability. 3.) Promote community awareness, understanding, and interest in hazard mitigation policies and programs. 4.) Incorporate hazard mitigation as an integrated public policy and standard practice. 5.) Reduce community exposure and vulnerability to hazards where the greatest risk exists. 6.) Increase resilience of infrastructure and critical facilities. 7.) Promote an adaptive and resilient planning area that responds proactively to future conditions. 8.) Develop and implement mitigation strategies that identify the best alternative to protect natural resources, promote equity, and use public funds in an efficient and cost-effective manner.	Goals are approved as final and will be included in the plan.
Critical Facilities A definition was prepared during the May meeting. The team reviewed the text and made minor adjustments. The definition was approved. Mr. Flaner shared a copy of the HAZUS hazard zone data. This is default data and not accurate. He will email the spreadsheet to the committee and needs responses with updated information about hazard zones. This data will be combined with the critical facilities inventory so the plan can focus on critical facilities within hazard zones.	The definition for critical facilities was approved as final pending incorporation of minor edits, and will be included in the plan.
Public Involvement Strategy Mr. Flaner provided a draft community survey. This is a key element in FEMA required public involvement. Surveys should be completed before phase I outreach meetings are held later this summer.	

Item	Action
The team reviewed the survey and provided minor edits. Mr. Flaner will finalize the survey today and distribute a weblink to the steering committee. It is important that the group get as many survey responses as possible. Each city and agency should share the link through all of their social network accounts and share with anyone they know who lives or works in the Tri-Valley. Other public involvement will include meetings or workshops. If there are established meetings taking place in late July or early August, it will be beneficial to get on their docket or agenda.	Mr. Flaner will email a link to the final community survey. All cities and agencies should share the survey with the community as broadly as possible, as soon as possible.
Next Steps The next meeting will be Tuesday, July 11, 2017. The meeting was adjourned at 11:00 a.m.	Identify opportunities to hold a workshop in conjunction with an established meeting, or get on the agenda of an established meeting. Report back at the July steering committee meeting.

FINAL MEETING SUMMARY

Attachment: Sign-in Sheet

Tri-Valley Hazard Mitigation Plan-Update
June 13, 2017

Name	Representing	E-mail
Tommie Jean Valmassy	Tetra Tech	tommie.jean.valmassy@tetratech.com
Susan Frost	Livermore	smfrost@cityoflivermore.net
Shweta Bonn	Pleasanton	sbonn@cityofpleasantonca.gov
Tracy Hein	LPFD	[illegible]
Stan Kolodzie	OSRSD	kolodzie@OSRSD.com
John Richards	LLNL	richards6@llnl.gov
Adam Weinstein	Pleasanton	aweinstein@cityofpleasantonca.gov
Hazel Wetherford	City of Dublin	hazel.wetherford@dublin.ca.gov
Rob Flaner	Tt	rob.flaner@tetratech.com
CARY FUKADA	Citizen	cfukada@hotmail.com

MEETING SUMMARY

Date/Time of Meeting:	Tuesday – July 11, 2017; 9:00am to 11:00am
Location:	Dublin Public Library Program Room, 200 Civic Dr., Dublin, CA 94568
Subject:	Steering Committee No. 5
Project Name:	Tri-Valley Multi-Jurisdiction Hazard Mitigation Plan
In Attendance: **(See Attachment):**	Shweta Bonn, Brian Fritz, Cary Fukada, Stan Kolodzie, John Richards, Joe Testa, Adam Weinstein, Hazel Wetherford Phoned in: Lincoln Casimere **Planning Team:** Rob Flaner, Tommie Jean Valmassy
Summary Prepared by:	Tommie Jean Valmassy
Quorum – Yes or No	Yes

Item	Action

Welcome and Introductions, Review Agenda

- Rob Flaner opened the meeting and facilitated group introductions.
- Distributed handouts included: Agenda; Meeting Summary #4; Objectives Exercise Results; Risk Rankings for floods, wildfires, and landslides; and Instructions for Completing Municipality Annex.
- The agenda was reviewed and no modifications were made.

Planning Process

Notes from meeting #4 were approved pending incorporation of comments provided prior to this meeting by Ms. Wetherford.

Update and finalize the notes from meeting No. 4.

Risk Assessment Update

Mr. Flaner presented the risk data for risks including 100 year flood, 500 year flood, wildfire, and landslides. The earthquake risk data are still being run. A new "shake map" from the US Geological Survey was recently made available, so that will be used to run scenarios for five scenarios, including the Hayward fault. This risk data will be used to rank risk hazards in each jurisdiction. Mr. Flaner said risk is a calculation of probability multiplied by impact. This data estimates the impact to people and the economy.

Ms. Valmassy will email the spreadsheet with full risk data to the planning committee.

Item	Action
It was noted the flood data does not include dam failure scenarios, and is based on the Federal Emergency Management Agency (FEMA) floodplain areas. Mr. Flanner said wildfire hazard data will need to be updated. For example, Tilden Park is a park so it is not included in the Fire Resources and Assessment Program (FRAP) data. However, wildland urban interface (WUI) can be added to FRAP data to ensure such areas are considered. Mr. Flaner said there are no standards for landslide risk, so that is difficult to map and model. There can be some significant possible impacts from landslides, so he will likely recommend including actions related to that hazard in the hazard mitigation plan.	
Objective Setting Mr. Flaner presented the results of the survey about objectives. He noted only five people took the survey. Meeting attendees went through the draft list of objectives. They were removed, combined, and reduced to a final list of 12 objectives. The updated list was emailed to the steering committee during the meeting, and will be voted on during the August meeting.	Review the updated objectives list and be prepared to vote on it at the next meeting.
Jurisdictional Annex Process An email was sent with the template for the jurisdictional annex section of the plan. Please review the instructions and complete the section for your jurisdiction.	Complete the jurisdictional template that was emailed on July 11, 2017. Send completed form to Mr. Flaner.
Public Involvement Strategy To-date, 211 surveys have been completed, primarily from Pleasanton residents. There is currently no end date for the survey. The goal is to gather as many completed surveys as possible before the team starts preparing their plans. The team requested Mr. Flaner resend the link for the survey so they can share it on social media outlets. The Tetra Tech team will be at the Dublin Farmer's Market on July 27 to conduct outreach and encourage participation in the survey. A press release about the plan and the public survey should be issued. Mr. Flaner will coordinate that with Tracy Hein. Cary Fukada suggested Tetra Tech attend the First Wednesday event in Pleasanton. His Community Emergency Response Team (C.E.R.T.) has a table with space that can be made available.	Mr. Flaner will re-send the public survey link. Committee members will share it broadly.

Item	Action

Plan Maintenance Schedule

Progress reporting is not required, however, you will received credit for conducting progress reports during your next required update of the hazard mitigation plan. Mr. Flanner said many jurisdictions conduct annual updates, while others conduct mid-term updates, typically during year three of the plan.

Mr. Flaner said updates can include reviewing the action list and making updates on a website or to a city council about what has been accomplished. The benefits to updating the plan including identifying grant opportunities while conducting the update, keeping communication open between various jurisdictions, making the mandatory 5-year full updates easier, and keeping the play dynamic.

Committee members said annual progress reports are not feasible for their resources, but mid-term updates make sense. Mr. Flaner will write the plan maintenance strategy to include a mid-term update.

Next Steps

The next meeting will be Tuesday, August 8, 2017. The meeting was adjourned at 11:00 a.m.

MEETING SUMMARY

Attachment: Sign-in Sheet

Tri-Valley Hazard Mitigation Plan - Update

Tuesday, July 11, 2017

Name	Representing	Email
Tammie Jean Valmassy	Tt	tammiejean.valmassy@tetratech.com
John Richards	CCWC	richards6@cwl.sav
Joe Testa	LPFD	N. A
Stan Kolodzie	DSRSD	kolodzie@DSRSD.com
Hazel Wetherford	City of Dublin	hazel.wetherford@dublin.ca.gov
Adam Weinstein	city of Pleasanton	aweinstein@cityofpleasantonca.gov
BRIAN FRITZ	Dublin Unified	fritzbrian@dublinusd.org
Shweta Bonn	City of Pleasanton	sbonn@cityofpleasantonca.gov
Steve Stewart	City of Livermore	sestewart@cityoflivermore.net
CARY FUKADA	CITIZEN	cfukada@hotmail.com

FINAL MEETING SUMMARY

Date/Time of Meeting:	Tuesday – August 8, 2017; 9:00am to 11:00am
Location:	Dublin Public Library Program Room, 200 Civic Dr., Dublin, CA 94568
Subject:	Steering Committee No. 6
Project Name:	Tri-Valley Multi-Jurisdiction Hazard Mitigation Plan
In Attendance:	Colter Andersen, Shweta Bonn, Brian Fritz, Cary Fukada, Tracy Hein, Stan Kolodzie, Steve Riley, Joe Testa, Adam Weinstein, Hazel Wetherford Phoned in: Caryn Thornburg, Stanford Health Care **Planning Team:** Rob Flaner, Tommie Jean Valmassy
Summary Prepared by:	Tommie Jean Valmassy
Quorum – Yes or No	Yes

Item	Action

Welcome and Introductions, Review Agenda

- Rob Flaner opened the meeting and facilitated group introductions.
- Distributed handouts included: Agenda; Meeting Summary #5; Risk Assessment Update; Plan Maintenance Strategy; Instructions for Completing Municipality Annex and District Annex; Loss matrix.
- The agenda was reviewed and no modifications were made.

Planning Process

Approval of notes from meeting #5 was postponed until the next meeting. The objectives for the plan were sent out after the previous meeting, and there was no further input. The committee voted to approve the objectives as final.

Risk Assessment Update

Mr. Flaner said the risk assessment is complete. For the earthquake data, results are presented as an aggregate. The full spreadsheet was emailed to the steering committee, and each fault has a separate tab so you can view each scenario separately. The information for all of the risks will be put into a risk ranking model, and presented in the hazard mitigation plan

Item	Action
by ranking. This will help you focus on developing actions to mitigate the hazards that pose the greatest risk to your city or district. Mr. Flaner said many actions in the plan will be multi-objective, meaning they address multiple risk scenarios. Theoretically, when the plan is updated in five years, the risks should be lower because of mitigation activities. Cary Fukada (citizen) asked if it is possible to make future improvements to the model that is used for the risk ranking. Mr. Flaner said his team will give the model to someone selected by the steering committee and show them how to use it. Mr. Flaner said the plan must be dynamic to capture actions taken. FEMA will move to a system where you can buy-down your deductible for FEMA funding by quantifying the impact of your actions. All FEMA-approved actions must include a cost/benefit analysis, and the benefit must outweigh the cost.	
Draft Plan Maintenance Strategy Mr. Flaner presented a draft of the plan maintenance strategy, to be included in the hazard mitigation plan, based on the discussion at the last steering committee meeting. He noted that Pleasanton and Livermore are part of the "Community Ready" system, which requires annual progress reporting. So regardless of what is in this hazard mitigation plan, they must complete annual progress reports. However, for this plan, the steering committee agreed to mid-term progress reporting. What is currently missing is language about who will coordinate the mid-term progress reporting. After some discussion, it was agreed that the Livermore/Pleasanton Fire District will be responsible for initiating the progress report. However, actually completing the report will be the responsibility of the partners. A progress report template will be included in the plan. Other events may trigger an update of the plan, such as a large disaster. Those will also be noted in the plan. The progress reports are reviewed by the state and by FEMA. One requirement of the plan is ongoing public involvement. A mechanism to meet that requirement is to talk about the plan with your city council. Include the plan on the city council agenda so the public is aware of the topic, and provide updates on progress during your meetings. Another way to include public outreach is maintaining and updating the website that has been created for this project. After some discussion, Adam Weinstein said the City of Pleasanton will coordinate the website.	Complete the jurisdictional template that was emailed on July 11, 2017. Send completed form to Mr. Flaner. Mr. Flaner will re-send the public survey link. Committee members will share it broadly. Review your capital improvement plans. If any of the projects mitigate risks identified in this plan, make sure to include them in the action list. The plan maintenance strategy will be finalized and included in the hazard mitigation plan.

Item	Action
There were some other minor edits to the plan maintenance strategy, and it was approved pending incorporation of those updates and edits. Mr. Flaner noted FEMA provides disaster funding for pre-disaster actions as well as post-disaster actions. The purpose of the plan is pre-disaster actions to mitigate a disaster before it happens. Your capital improvement plans (CIP) are likely already funded. However, they should be included in the plan because they may mitigate risks we have identified. If a CIP repairs something that is vulnerable, make sure you include it in your action list. You will be completing some actions even if you do not receive a FEMA grant for them. But you should still track them as part of the plan, because they are mitigating risk. For post-disaster actions, the event does not necessarily have to have directly impacted your area. If an event has impacted the state, then you may be able to receive funding. California has declared a disaster for the past eleven years running. Each of those declarations comes with funding for the state.	
Jurisdictional Annex Process The hazard mitigation plan will be two volumes. Volume I is applicable to all of the partners. Volume II is separated into sections for each jurisdiction. It is the individual risk rankings, assessment of core capabilities, and actions. The instructions for preparing Volume II were distributed at this meeting. When you are preparing your section of Volume II, do NOT do it alone! Work with other departments, carefully read the instructions, and reach out to the Tetra Tech contact provide on the instructions, Kristin Gelino, with any questions you have. Mr. Flaner noted that to be eligible for a FEMA grant, you must be compliant with the National Flood Insurance Program (NFIP). If your flood prevention code is older than 2004, you are likely not in compliance. Work with your planning department to get this information. Updating your flood prevention code may be one of the key actions you include in this plan.	Complete your jurisdictional annex for Volume II. Work with as many departments as possible to ensure good information, staff familiarity with the plan, and ease the workload.
Public Involvement Strategy To date, 413 surveys have been completed: 119 for Dublin; 27 for Livermore; 267 for Pleasanton. Push it out on social media as much as possible. The goal is to have a total of at least 1,000 surveys completed. The link is: https://www.surveymonkey.com/r/Tri-ValleyHMP	Share the survey via social media. Encourage co-workers, family, and friends in your

Item	Action
	jurisdiction to complete it as well.
The Tetra Tech team was at the Dublin Farmer's Market on July 27 to conduct outreach and encourage participation in the survey. A HAZUS station to run earthquake risk was run for individuals who provided their address. The team ran approximately 13 HAZUS reports and handed out information the on survey to 93 people. Mr. Flaner said his team may be able to attend another event between now and the end of September. The event would ideally have a power source so a HAZUS station could be run. Ideas offered included the Livermore Farmer's Market or a station at the library; the Pleasanton Farmer's Market, the Dublin Splatter event, and the Pleasanton Fire Expo (held in October). Mr. Flaner will work to confirm two of the events for his team.	The Tetra Tech team will work to support outreach at two additional community events before the end of September.
Next Steps The committee needs to determine how this plan falls under the California Environmental Quality Act (CEQA). Several planning partners said they prefer categorical exemption. Mr. Flaner said that is what he would recommend, as well. Partners should confer with the CEQA decision-makers in their jurisdiction and confirm categorical exemption is acceptable.	Discuss CEQA categorical exemption with your decision-makers and let Mr. Flaner know if that is acceptable for this hazard mitigation plan.
The timeline includes plan submittal by the end of October; public comment needs to begin in early October. It should be taken to the city councils for approval AFTER it is conditionally approved by FEMA. Share information with your city council in advance; do whatever leg work is necessary now to make approval easy.	Discuss the plan with your city council now so they know what to expect and can easily approve it.
The next meeting will focus on the strengths, weaknesses, opportunities, obstacles (SWOO) analysis. Invite your planning and public works department representatives, or anyone else who can help with the SWOO brainstorming. The meeting will be Tuesday, September 12, 2017.	Invite other departments to the next steering committee meeting to help brainstorm strengths, weaknesses, opportunities, obstacles.
The meeting was adjourned at 11:00 a.m.	

Attachment: Sign-in Sheet

Tri-Valley Hazard Mitigation Plan-Update Steering Committee Sign-in Sheet
August 8, 2017

Name	Representing	E-mail
Tammie Jean Valmassy	Tetra Tech	
Colter Andersen	Zone 7	Candersen@zone7water.com
Tracy Hein	LPFD	thein@lpfire.org
CARY FUKADA	CITIZEN	cfukada@hotmail.com
JE TESLA	LPFD	
Hazel Wetherford	City of Dublin	hazel.wetherford@dublin.ca.gov
Stan Kolodzie	DSRSD	kolodzie@dsrsd.com
BRIAN FRITZ	Dublin Unified School Dist.	fritzbrian@dublinusd.org
Shweta Bonn	City of Pleasanton	sbonn@cityofpleasantonca.gov
Adam Weinstein	" "	aweinstein...
Steve Riley	City of Livermore	sriley@cityoflivermore.net

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FINAL

MEETING SUMMARY

Date/Time of Meeting:	Tuesday – September 12, 2017; 9:00am to 11:00am
Location:	Dublin Civic Center Regional Meeting Room, 200 Civic Dr., Dublin, CA 94568
Subject:	Steering Committee No. 7
Project Name:	Tri-Valley Multi-Jurisdiction Hazard Mitigation Plan
In Attendance:	Martha Battaglia, Shweta Bonn, Susan Frost, Cary Fukada, Pamela Lung, John Richards, Cheri Sheets, Joe Testa, Caryn Thornburg, Adam Weinstein, Hazel Wetherford, Shannon Young
	Planning Team: Rob Flaner, Tommie Jean Valmassy
Summary Prepared by:	Tommie Jean Valmassy
Quorum – Yes or No	Yes

Item	Action

Welcome and Introductions, Review Agenda

- Rob Flaner opened the meeting and facilitated group introductions.
- Distributed handouts included: Agenda; Meeting Summary #6.
- The agenda was reviewed and no modifications were made.
- There were no public comments.

Planning Process

Meeting notes from meeting #5 and meeting #6 were approved as final.

Minutes for meetings #5 and #6 will be finalized.

Risk Assessment Update

Mr. Flaner said his team is still compiling the critical facilities data. Technical difficulties require the team to re-run the facility hazards data for multiple scenarios. Mr. Flaner will email it, but noted it is protected information and is confidential and for internal use only.

Mr. Flaner will email the updated risk assessment data, which should be kept confidential, when it is available.

Cary Fukada (citizen) asked about the capability to update information in the future. Mr. Flaner said projects in the plan require a benefit/cost analysis (BCA) that can include things like avoiding lost time. Because the BCA has to be done using FEMA's software, it requires expertise to ensure your project shows a benefit. Mr. Flaner noted that Contra Costa County has several individuals trained to do BCA with FEMA software, and they support the entire county. It may be advisable to do the same in the Tri-Valley. Mr. Flaner added that the state of California may provide BCA

Item	Action
assistances, and BCA preparation costs are often reimbursable when applying for a grant. Mr. Flaner noted that new information about risk and vulnerability can be added to the plan via plan maintenance. For example, the FEMA flood maps are outdated, but they were the best available data at the time. Zone 7 is paying to have maps updated, but they will not be ready for use in this plan.	Livermore will share its draft updated flood map information when it is available.
Jurisdictional Annex Process While all three cities participating in the plan have provided their information for Volume II, Tetra Tech has not received any updates from the districts. Please reach out to Kristin Gelino (Tetra Tech, not present) if you have questions about how to complete the information. Mr. Flaner noted the information that is being requested and the comments Tetra Tech provides are based on recent FEMA reviews. He added that their reviews can be inconsistent, so Mr. Flaner's team are doing their best to address everything to avoid numerous FEMA comments on the draft hazard mitigation plan.	
Public Involvement Strategy Tommie Jean Valmassy (Tetra Tech) will attend the Pleasanton and Livermore Farmer's markets in September. She will host a Hazus station, which is a FEMA program that estimates potential losses from earthquakes, floods, and other disasters. In addition, the community will be encouraged to take the public survey. To date, 472 surveys have been completed. The goal is to have a total of at least 1,000 surveys completed. The survey will be available through the public comment period on the draft plan, and the survey link is: https://www.surveymonkey.com/r/Tri-ValleyHMP	Continue to share the survey via social media. Encourage co-workers, family, and friends in your jurisdiction to complete it as well.
Strengths, Weaknesses, Obstacles, Opportunities (SWOO) The committee discussed and prepared a SWOO list. The list will be presented in the hazard mitigation plan under mitigation actions.	
Next Steps The meeting will be Tuesday, October 10, 2017. The meeting was adjourned at 11:00 a.m.	

Item	Action

Tri-Valley Hazard Mitigation Plan-Update Steering Committee Sign-in Sheet
September 12, 2017

Name	Representing	E-mail
Tommie Jean Valmassy	Tetra Tech	tommie.jean.valmassy@tetratech.com
Caryn Thornburg	Stanford HealthCare ValleyCare	cthornbu@stanfordhealthcare.org
Susan Frost	City of Livermore	smfrost@cityoflivermore.net
CARY FUKADA	Citizen	cfukada@hotmail.com
Martha Battaglia	City of Dublin	martha.battaglia@dublin.ca.gov
Cheri Sheets	City of Livermore	crsheets@cityoflivermore.net
Joe Testa	LPFD	No Δ
John Richard	LLNL	Richards6@llnl.gov
Shannon Young	City of Dublin	shannon.young@dublin.ca.gov
Hazel Wetherford	City of Dublin	hazel.wetherford@dublin.ca.gov
Shweta Bonn	City of Pleasanton	sbonn@cityofpleasantonca.gov
Adam Weinstein	" "	aweinstein@ " "
Pamela Lung	City of Livermore	pglung@cityoflivermore.net

FINAL MEETING SUMMARY

Date/Time of Meeting:	Tuesday – October 10, 2017; 9:00am to 11:00am
Location:	Dublin Civic Center Regional Meeting Room, 200 Civic Dr., Dublin, CA 94568
Subject:	Steering Committee No. 8
Project Name:	Tri-Valley Multi-Jurisdiction Hazard Mitigation Plan
In Attendance:	Shweta Bonn, Susan Frost, Cary Fukada, Obaird Khan, Stan Kolodzie, John Richards, Cheri Sheets, Joe Testa, Caryn Thornburg, Adam Weinstein, Hazel Wetherford, Shannon Young **Planning Team:** Rob Flaner, Tommie Jean Valmassy
Summary Prepared by:	Tommie Jean Valmassy
Quorum – Yes or No	Yes

Item	Action
Welcome and Introductions, Review Agenda • Hazel Wetherford called the meeting to order and initiated group introductions. • Distributed handouts included: Agenda; Meeting Summary #7, Mitigation Best Practices Catalog, Risk Ranking Results, and Survey Results Data. • The agenda was reviewed and no modifications were made. • There were no public comments.	
Planning Process Meeting notes from meeting #7 were approved as final.	Minutes for meeting #7 will be finalized and put on the website.
Strengths, Weaknesses, Obstacles, Opportunities (SWOO) Rob Flaner reviewed the Mitigation Best Practices Catalog, which contains the SWOO results from the previous steering committee meeting. This catalog will be presented in Chapter 18 of the Hazard Mitigation Plan. If you identify a risk and need an action to address it, look at the SWOO list. It is organized by who can take the action (government, private sector, individuals.) This list provides broad-scale actions that can be taken; you can make them more specific for your plan.	Review the SWOO list and contact Mr. Flaner if you have additions.

Item	Action
Jurisdictional Annex Process It is time to begin phase 3. You need to have completed phases 1 and 2. Kristin Gelino (Tetra Tech) will send you your phase 3 template, and it will include all of the information you provided for phases 1 and 2. Please address any yellow highlighted items. The level of detail that Mr. Flaner and his team request from you is based on direct experience trying to get other plans approved by the state of California and by FEMA. There are embedded comments in the Word file you will get that instruct that you MUST add information, or you SHOULD add information. If you must, it is required by the state or FEMA. If it is suggested, please try. Use the comment box to let Mr. Flaner and his team know if you addressed a comment. Mr. Flaner reviewed the phase 3 template for jurisdictions and for municipalities. The instructions are long, but will answer most questions so review them thoroughly before you reach out for help. However, definitely reach out for help if you are having difficulties. Some specific details to include: • For hazard event history, you will have to do some investigating. Google the local newspaper to find out dates and impact of events. • If you had to close a road or respond in any way to an event, that was an impact. • Do NOT send back an empty Natural Events table. • If you had an active fire season do not list the date of each fire. You can do a calendar year line item, such as 13 fires in 2014. • Damage assessment is an optional field, but if you can complete it, please do. You should have numbers for recent events that were declared. Mr. Flaner reviewed the risk ranking portion of the hazard mitigation plan. The ranking uses a formula defined by FEMA and includes quantitative data. The highest possible risk is 54. The data is weighted, such that risk to people and life safety is multiplied by a factor of 3. If you have evidence that an event has happened more frequently than is modeled here, then you can change the risk. However, you need to note why you changed the risk and be prepared to show backup. Sometimes events in other jurisdictions can cause impact to you. For example, if a dam fails, that could cause flooding. However, if the dam is not in your area, you cannot show risk from dams. You can show potential flooding or landslides as a risk if that is relevant.	Complete Phase 3 when you receive it. Use the full instructions and toolkit provided and see the tips in these notes. Start right away and identify those who will help you with different sections and input. This must be a team effort for your city/jurisdiction.

Item	Action
Mr. Flaner reviewed the Mitigation Action Plan portion of the document. For any risk that is ranked as medium or high, you must show at least 1 action and list what hazards it addresses. DO NOT COMPLETE THIS ALONE. Use your planners, police and fire, public works, and even reach out to citizens and homeowners groups if applicable. Keep track of all of your resources and information sources.	Assess the status of your phase 3 document by November 3, 2017. Report to Mr. Flaner how far you are and how you will complete it by November 17, 2017.
Public Involvement Strategy Since the last meeting, Tommie Jean Valmassy (Tetra Tech) attended two public events: • 9/16 Pleasanton Farmers Market: Ran 40 Hazus Reports, Handed out 85 survey flyers • 9/21 Livermore Farmers Market: Ran 35 Hazus Reports, Handed out 45 survey flyers	
Start comment period Monday, November 27 at the latest. That will allow for submittal to the state by December 15. Comment period would end December 8. There will be 2 public meetings during that time. ACTION: Check your council meeting dates. Susan Frost and Stan Kolodzie each said they may be able to get a plan presentation on their agendas. Mr. Flaner handed out the survey results. These will be included in the plan.	Check your council meeting dates to see if there will be a meeting between November 27 and December 8.
Volume 1 Internal Draft Review Volume 1 of the plan will be ready for internal review on October 20, 2017. Please review it by November 14. It is almost 400 pages long, so review the parts you are most interested in. Many of the sections you have already seen because they have been crafted and shared at these steering committee meetings. You will receive a Word file so you can easily review and track changes. This one will not include maps.	
Next Steps The next meeting will be Tuesday, November 14, 2017. This is Ms. Wetherford's last meeting before she is on maternity leave. The committee thanked her for her hard work. She will have a replacement attending meetings in her absence.	
The meeting was adjourned at 11:05 a.m.	

October 10, 2017

Name	Representing	E-mail
Tommie Jean Valmassy	Tetra Tech	
Caryn Thornburg	Stanford Health Care Valley Care	cthornbu@stanfordhealthcare.org
CARY FUKADA	CITIZEN	cfukada@hotmail.com
Cheri Sheets	Livermore	crsheets@cityofLivermore.net
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John Richard	LLNL	richards6@llnl.gov
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Shannan Young	Dublin	shannan.young@Dublin.ca.gov
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1

Hazel Wetherford	City of Dublin	hazel.wetherford@dublin.ca.gov

MEETING SUMMARY

Date/Time of Meeting:	Tuesday – November 14, 2017; 9:00am to 11:00am
Location:	Dublin Civic Center Regional Meeting Room, 200 Civic Dr., Dublin, CA 94568
Subject:	Steering Committee No. 8
Project Name:	Tri-Valley Multi-Jurisdiction Hazard Mitigation Plan
In Attendance:	Shweta Bonn, Julie Carter, Susan Frost, Cary Fukada, Joe Testa, Caryn Thornburg, **Planning Team:** Rob Flaner, Tommie Jean Valmassy
Summary Prepared by:	Tommie Jean Valmassy
Quorum – Yes or No	Yes

Item	Action
Welcome and Introductions, Review Agenda • Julie Carter called the meeting to order and initiated group introductions. • Distributed handouts included: Agenda; Meeting Summary #8, and the template for the Area-Wide Action Plan and Implementation. • The agenda was reviewed and no modifications were made. • There were no public comments. • Meeting notes from meeting #8 were approved as final.	Minutes for meeting #8 will be finalized and put on the website.
Planning Process Rob Flaner said the deadline for participants to submit Phase III for incorporation into the Hazard Mitigation Plan is this Friday, November 17. He noted several districts, including two school districts, submitted letters of intent to participate, but have yet to turn in phase I or phase II. Mr. Flaner has reached out to designated contacts, but has had no response. If someone does not turn in their sections, the steering committee will have to decide whether to move forward without them. It was agreed that if those districts do not submit their portions of the plan on time, the group will move forward without them to avoid unnecessary delay in the process.	Review the SWOO list and contact Mr. Flaner if you have additions.

Item	Action
When preparing actions a debris management plan is a great action and is applicable to most hazards. Consider adding this to your action plan if you do not already have it included. Talk to your public works department about their plans; roads, bridges, stormwater projects are all eligible. With the recent wildfires, it is worth considering projects related to that as well.	Incomplete Volume I figures will be updated and resent for review.
Volume I Review Rob Flaner said Volume I was delivered for review via Dropbox. There are two files; one is in Microsoft Word, and reviewers should provide edits in track changes, then save the file with your last name at the end. The second file is a PDF and includes figures. It was noted that some of the figures in Volume I are incomplete. They will be updated and resent for review. Any comments must be sent by November 24.	Submit comments on Volume 1 no later than November 24.
Area Wide Actions Mr. Flaner provide a template of area-wide actions from another jurisdiction. The committee used those to determine the following area-wide actions summarized below. 1. Maintain a project website. [To be hosted by City of Pleasanton on the Wix platform.] 2. Support Livermore/Pleasanton Community Emergency Response Team (C.E.R.T.) 3. Coordinate mitigation planning, and designation a point of contact (POC) for each partner. 4. [Item 4 in the template will not be part of the Tri-Valley area-wide actions because it is in the individual action plans.] 5. Continue to update hazard mapping. Designate a POC for each partner. 6. Coordinate on hazard mitigation planning. The team would like to list Alameda County Office of Emergency Services (OES) as the lead for this action. Ms. Carter will ask their permission. 7. Maintain this steering committee outside of plan maintenance. 8. Create an action that each jurisdiction will coordinate and share information as the plan is being prepared. Can give you a regionalized concept that can be deployed individually.	Mr. Flaner will determine the final public comment period on the draft Hazard Mitigation Plan once the status of phase III submittals is assessed. Julie Carter will ask Alameda County OES to be the lead on coordinating hazard mitigation efforts between jurisdictions.
Public Involvement Strategy The public survey is still open, but there have been no additional responses since the last meeting.	

Item	Action

Mr. Flaner reviewed the timeline, which is to begin the public comment period Monday, November 27 at the latest. That will allow for submittal to the state by December 15. Comment period would end December 8. There will be 2 public meetings during that time. If participants need more time to complete their phase III submittals, those dates may slip. It was determined that everyone will submit what they have on November 17, and Mr. Flaner will determine whether it is adequate for state approval, or if the deadline needs to be extended in order to gather more information.

Susan Frost said she has presentation of the plan on her City Council meeting for December 11. If the dates for public comment period slips, presenting to her council may not be possible within an adjusted public comment period. For any meeting, Mr. Flaner will provide a PowerPoint presentation and talking points.

Next Steps

Mr. Flaner said this is the final scheduled Steering Committee meeting. This Hazard Mitigation Plan will be regionalized and specific, and a useful document. He thanked all of the members for their participation and cooperation, and noted his team will continue to work with them until the plan reaches final state and FEMA approval. Please reach out to the team with any questions.

The meeting was adjourned at 11:00 a.m.

PUBLIC MEETING SUMMARIES

PUBLIC COMMENT SESSION

DUBLIN SAN RAMON SERVICES DISTRICT BUILDING

DEC. 22, 2017 6:00 – 7:00 PM

1 Comment was received and is summarized below:

Respondent was Mike Grant of Dublin CA

This Tri-Valley resident was concerned that the Plan did not list the Nielsen Elementary School at 7500 Amarillo Blvd. as a post-disaster shelter. He suggested that the Nielsen Elementary School be retrofit to strengthen the structure for post-disaster shelter. This resident said he was involved in task forces doing post-disaster planning for human-caused disasters throughout Alameda County. The gentleman also asked which agency was responsible for the prevention of floods from the creek through Dublin.

Rob Flaner of Tetratech responded that the LHMP is a pre-disaster mitigation tool that identifies risk from natural disasters; and reduces losses in property damage and human lives through identifying and funding projects to correct deficiencies before natural disasters. As such, listing post-disaster emergency shelters is somewhat outside the boundaries of the LHMP. However, the suggestion to use Nielsen Elementary School as a post-disaster emergency shelter will be included in the public comments. In response to the question which agency responsible for flood protection in Dublin; Zone 7 Water Agency of Alameda County is responsible for maintaining the stream beds and stream banks in Dublin to prevent floods.

Livermore City Council, January 8, 2017 regular meeting.

Agenda Item 6.01. Discussion and Direction regarding the update to the 2017 Tri-Valley Hazard Mitigation Plan

There we about 20 members of the public present.

Susan Frost, Special Projects Coordinator, gave a presentation on the draft 2017 TVHMP. There were no questions from the Council regarding the draft plan. The Council commented that we should be encouraging other agencies in the planning area, such as the school district and park district, to participate in the plan since it provides greater opportunities for coordination and grant eligibility. This is important given the damage the City experienced from flooding last winter of almost $12 million. However, there are fewer FEMA grant opportunities than previously. The information provided in Volume 1, Planning Process and Community Profile, provides a lot of interesting and useful information about the area.

No comments were received from the public.

Motion to accept the 2017 Tri-Valley Hazard Mitigation Plan by Councilmember Carling, seconded by Councilmember Spedowfski, approved 5-0.

ARTICLES PUBLISHED BASED ON PRESS RELEASES

VALLEY ROUNDUP

Modernize Congress

U.S. Representatives Eric Swalwell (CA-15), with Republicans Steve Pearce (NM-02), and Rick Crawford (AR-01), have reintroduced a resolution aimed at modernizing congressional committee and voting procedures to bring Congress into the 21st Century and allow Members more time to connect with their constituents. The bipartisan H. Res. 278, Members Operating to Be Innovative and Link Everyone (MOBILE) Resolution would strengthen the ability of Members to participate virtually in committee hearings and vote remotely on suspension bills.

The MOBILE Resolution would require that Members and invited witnesses be allowed to participate in committee hearings remotely, via video conferencing or related technologies, which would count toward rules on quorum. It also would direct the creation of a secure voting system that would allow Members to vote remotely on suspension bills, which are generally less-controversial legislation requiring a two-thirds vote to pass.

Swalwell, Pearce, and Crawford also reintroduced a resolution directing the House Administration Committee to investigate best practices and establish procedures and rules for conducting House of Representatives business in a virtual setting, such as the consideration of legislation.

"Across the nation we see the development of new, innovative ways of conducting business to improve communication and connectedness. It's time for Congress to learn to be more mobile and adapt to the times in which we live," said Swalwell. "The American people want to see an efficient Congress that works directly for the people. Letting Members of Congress participate in committee hearings and vote on some items remotely is an essential step toward giving constituents more time with their elected representatives and forcing Congress to work more efficiently on consequential legislation."

Freeze on Tuition

In the wake of the Auditor's report on the University of California Office of the President, Assemblywoman Catharine Baker requested an immediate freeze of any increases in UC tuition, and UC Office of the President's salaries and benefits. She also requested a legislative subpoena for all financial records and correspondence related to the undisclosed $175 million maintained by the University of California Office of the President.

Additionally, the Assemblywoman requested an independent forensic audit to determine if UC administrators engaged in criminal activity in interfering with the audit.

"It is unfair to increase student tuition and ask again for California families to pay more in UC when the Office of the President holds this kind of money," said Assembly Higher Education Committee Vice Chair Catharine Baker (R-San Ramon). "An independent review to unearth what really happened is the only way to restore people's trust in the UC. California families deserve no less."

Hazard Mitigation Planning

The Cities of Dublin, Livermore, and Pleasanton, Dublin San Ramon Services District, and other local government stakeholders in the TriValley planning area are collaborating on the development of the Tri-Valley Hazard Mitigation Plan, pursuant to State and Federal requirements.

Responding to Federal mandates in the Disaster Mitigation Act of 2000, the planning partnership was formed to pool resources and create a uniform hazard mitigation strategy that can be consistently applied to the Tri-Valley planning area.

During this process, citizens will be asked to contribute by sharing local knowledge of an area's vulnerability to hazards based on past occurrences. Public involvement will be solicited via a multi-media campaign that will include public meetings, web-based information, questionnaires, and updates on the plan's progress via the news media. This process will be overseen by a Steering Committee made up of stakeholders from within the planning area. This Steering Committee will meet as needed on the 2nd Tuesday of every month throughout the planning process. These meetings will typically run from 9:00 a.m. to 11:00 a.m. and are open to the public. Meetings will be held at Dublin City Hall - Regional Meeting Room, 100 Civic Plaza, Dublin, California.

An informational website on the plan and the purposes for planning has been established at www.tri-valley-hmp.com/. This website will serve as the primary means for the public to gain information on the plan and ways that they can participate in the planning process. Information on the public meetings and the Steering Committee meetings can also be found on this website.

Any questions or comments regarding this process are encouraged and can be directed to Hazel Wetherford at (925) 833-6650 or hazel.wetherford@dublin.ca.gov.

Transportation Survey

Beginning May 8, Pleasanton residents may be contacted via telephone to participate in the City's 2017 residential commute survey. Approximately every three or four years, the City of Pleasanton conducts an employer and residential transportation survey to monitor the successes of and any challenges related to the City's transportation systems management program.

The survey provides the City with up-to-date information to assist with ongoing efforts that help shape the strategies and programs to encourage alternative commute habits, which may result in improved traffic flow and air quality.

In addition to residents, Pleasanton companies will also be surveyed later in May. The results will be provided to the Alameda County Transportation Commission to support annual funding requests under the Bay Area Air Quality Management District's Transportation Fund for Clean Air.

The final report will be available later this summer. To view the 2013 Employer and Residential Transportation Survey report, visit the Employer Commute Services section on the City's Economic Development department page of the City's website at cityofpleasantonca.gov





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Bomb Threat At Dublin High Under Investigation


Meet Dublin's New Police Chief


Military, Vets Eat Free At Applebee's On Vets Day


California Wow Houses


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Community Corner

Tri-Valley Planning Area Collaborates For Hazard Mitigation Plan

In response to Federal mandates, the partnership was formed to create a hazard mitigation plan that is consistent with the planning area.

By Damita Thomas (Patch Staff) - Updated May 18, 2017 12:07 pm ET

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From The City of Dublin: The Cities of Dublin, Livermore, and Pleasanton, Dublin San Ramon Services District, and other local government stakeholders in the Tri-Valley planning area are collaborating on the development of the Tri-Valley Hazard Mitigation Plan, pursuant to State and Federal requirements.

Chegg
Exam stress getting real?
USE CHEGG STUDY

Responding to Federal mandates in the Disaster Mitigation Act of 2000 (Public Law 106- 390), the planning partnership was formed to pool resources and create a uniform hazard mitigation strategy that can be consistently applied to the Tri-Valley planning area.

During this process, citizens will be asked to contribute by sharing local knowledge of an area's vulnerability to hazards based on past occurrences. Public involvement will be solicited via a multi-media campaign that will include public meetings, web-based information, questionnaires and updates on the plan's progress via the news media. This process will be overseen by a steering committee made up of stakeholders from within the planning area. This Steering Committee will meet as needed on the 2nd Tuesday of every month throughout the planning process. These meetings will typically run from 9:00 a.m. to 11:00 a.m. and are open to the public. Meetings will be held at Dublin City Hall - Regional Meeting Room, 100 Civic Plaza, Dublin, California.

An informational website on the plan and the purposes for planning has been established at: https://www.tri-valley-hmp.com/. This website will serve as the primary means for the public to gain information on the plan and ways that they can participate in the planning process. Information on the public meetings and the steering committee meetings can also be found on this website. The public is encouraged to provide input on all phases of the plan's development.

Any questions or comments regarding this process are encouraged and can be directed to Hazel Wetherford at (925) 833-6650 or hazel.wetherford@dublin.ca.gov.

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NEWS

Uploaded: Wed, Dec 20, 2017, 2:21 pm

Comments sought for draft Tri-Valley hazard mitigation plan

Pleasanton teaming with Dublin, Livermore, DSRSD on regional preparation

by Jeremy Walsh / Pleasanton Weekly

Pleasanton officials, along with those in Dublin and Livermore, are working to gather public input on the region's draft Tri-Valley Multi-Jurisdictional Hazard Mitigation Plan.

Now is the time to submit comments, as the 14-day review period closes on Tuesday. There is also a public meeting to solicit feedback Friday evening from 6-7 p.m. at the Dublin San Ramon Services District (7051 Dublin Blvd.), which is also a partner in the planning effort.



The draft plan aims to help the Tri-Valley agencies prepare for and lessen the impacts of specified natural hazards within the region.

People can comment via the plan's website, www.tri-valley-hmp.com. Comments and questions can also be sent to Rob Flaner of Tetra Tech, Inc., at rob.flaner@tetratech.com or 208-939-4391.

TOP BLOGS

GE's re-organization reaches San Ramon digital headquarters
By Tim Hunt | 3 comments | 1,709 views

Sound and Fury over Vile and Slur-ry
By Tom Cushing | 56 comments | 912 views

New state housing requirements could affect Pleasanton
By Jeb Bing | 0 comments | 285 views

View all local blogs







Appendix B. Risk Assessment Mapping Methodology

B. RISK ASSESSMENT MAPPING METHODOLOGY

DAM INUNDATION MAPPING

The Del Valle dam inundation area data are provided by the City of Pleasanton, GIS Division. These data originate from the California Office of Emergency Services.

EARTHQUAKE MAPPING

Liquefaction Susceptibility

Liquefaction susceptibility data are provided by the Association of Bay Area Governments and originate from the U.S. Geological Survey as Open-File Report 2006-1037. The report presents a map and database of Quaternary deposits and liquefaction susceptibility for the urban core of the San Francisco Bay region. Much of the land adjacent to the Bay and the major rivers and streams is underlain by unconsolidated deposits that are particularly vulnerable to earthquake shaking and liquefaction of water-saturated granular sediment. The mapping uses geomorphic expression, pedogenic soils, inferred depositional environments, and geologic age to define and distinguish the map units. The report is the product of cooperative work by the National Earthquake Hazards Reduction Program (NEHRP) and National Cooperative Geologic Mapping Program of the U.S. Geological Survey, William Lettis and & Associates, Inc. (WLA), and the California Geological Survey. (USGS, 2006)

National Earthquake Hazard Reduction Program (NEHRP) Soils

Soil classification data provided by the California Department of Conservation. The data is based on surficial geology published at a scale of 1:250,000. The surficial geologic units were grouped into composite units with similar average shear wave velocity to 30 meters depth (Vs30) values. This data was prepared as part of the Probabilistic Seismic Hazard Map of California (Petersen et. al., 1999)

Susceptibility to Deep-Seated Landslides

Landslide susceptibility data provided by the California Geological Survey.

The map, and associated data, show the relative likelihood of deep-seated landsliding based on regional estimates of rock strength and steepness of slopes. On the most basic level, weak rocks and steep slopes are most likely to generate landslides. The map uses detailed information on the location of past landslides, the location and relative strength of rock units, and steepness of slope to estimate susceptibility to deep-seated landsliding (0 to X, low to high). The USGS 2009 National Elevation Dataset (NED) with 10-m grid size was used as the basemap. This landslide susceptibility map is intended to provide infrastructure owners, emergency planners and the public with a general overview of where landslides are more likely to occur. (Wills, et. al., 2011)

Shake Maps

A shake map is designed as a rapid response tool to portray the extent and variation of ground shaking throughout the affected region immediately following significant earthquakes. Ground motion and intensity maps are derived

from peak ground motion amplitudes recorded on seismic sensors (accelerometers), with interpolation based on both estimated amplitudes where data are lacking, and site amplification corrections. Color-coded instrumental intensity maps are derived from empirical relations between peak ground motions and Modified Mercalli intensity. For this plan, shake maps were prepared for five earthquake scenarios:

- An earthquake on the Calaveras (North Central South) fault with the following characteristics:
  - Magnitude: 7.0
  - Epicenter: N37.74 W121.95
  - Depth: 6 km
- An earthquake on the Northern San Andreas fault with the following characteristics:
  - Magnitude: 7.8
  - Epicenter: N39.16 W123.83
  - Depth: 10 km
- An earthquake on the Greenville fault with the following characteristics:
  - Magnitude: 7.0
  - Epicenter: N37.51 W121.55
  - Depth: 12 km
- An earthquake on the Hayward fault with the following characteristics:
  - Magnitude: 7.05
  - Epicenter: N37.81 W122.18
  - Depth: 8 km
- An earthquake on the Mount Diablo fault with the following characteristics:
  - Magnitude: 6.7
  - Epicenter: N37.82 W121.81
  - Depth: 14 km

FLOOD MAPPING

Flood hazard areas are mapped as depicted on the effective FEMA Digital Flood Insurance Rate Maps published March 8th, 2016 (effective date August 3rd, 2009) with last Letter of Map Revision incorporated December 11, 2015. There were no repetitive loss claims for the Tri-Valley area, so no data were acquired.

LANDSLIDE MAPPING

See Susceptibility to Deep-Seated Landslides data description under earthquake mapping.

WILDFIRE MAPPING

Fire Hazard Severity Zones in State Responsibility Areas data were provided by the California Department of Forestry and Fire Protection. Public Resources Code 4201-4204 direct the CAL FIRE to map fire hazard within State Responsibility Areas, based on relevant factors such as fuels, terrain, and weather. These statutes were passed after significant wildland-urban interface fires; consequently these hazards are described according to their potential for causing ignitions to buildings. These zones referred to as Fire Hazard Severity Zones(FHSZ),

provide the basis for application of various mitigation strategies to reduce risks to buildings associated with wildland fires. The zones also relate to the requirements for building codes designed to reduce the ignition potential to buildings in the wildland-urban interface zones. These maps have been created by CAL FIRE's Fire and Resource Assessment Program (FRAP) using data and models describing development patterns, estimated fire behavior characteristics based on potential fuels over a 30-50 year time horizon, and expected burn probabilities to quantify the likelihood and nature of vegetation fire exposure to new construction. The zones were adopted by CAL FIRE on November 7, 2007.

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USGS. 2006. Maps of Quaternary Deposits and Liquefaction Susceptibility in the Central San Francisco Bay Region, California. Open-File Report 2006-1037. Version 1.1. U.S. Geological Survey in cooperation with the California Geological Survey.

Wills C.J., Perez, F., Gutierrez, C. 2011. Susceptibility to deep-seated landslides in California: California Geological Survey Map Sheet 58.

Appendix C. Plan Adoption Resolutions from Planning Partners

C. Plan Adoption Resolutions from Planning Partners

Appendix D. Progress Report Template

D. PROGRESS REPORT TEMPLATE

Reporting Period: *(Insert reporting period)*

Background: The Cities of Dublin, Livermore and Pleasanton, and participating local jurisdictions, developed a hazard mitigation plan to reduce risk from all hazards by identifying resources, information, and strategies for risk reduction. The federal Disaster Mitigation Act of 2000 requires state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. To prepare the plan, the participating planning partners organized resources, assessed risks from natural hazards, developed planning goals and objectives, reviewed mitigation alternatives, and developed an action plan to address probable impacts from natural hazards. By completing this process, these jurisdictions maintained compliance with the Disaster Mitigation Act, achieving eligibility for mitigation grant funding opportunities afforded under the Robert T. Stafford Act. The plan can be viewed on-line at:

INSERT LINK

Summary Overview of the Plan's Progress: The performance period for the Hazard Mitigation Plan became effective on ____, 2017, with the final approval of the plan by FEMA. The initial performance period for this plan will be 5 years, with an anticipated update to the plan to occur before _____, 2022. As of this reporting period, the performance period for this plan is considered to be __% complete. The Hazard Mitigation Plan has targeted __ hazard mitigation actions to be pursued during the 5-year performance period. As of the reporting period, the following overall progress can be reported:

- __ out of __ actions (__%) reported ongoing action toward completion.
- __ out of __ actions (__%) were reported as being complete.
- __ out of __ actions (___%) reported no action taken.

Purpose: The purpose of this report is to provide an annual update on the implementation of the action plan identified in the Hazard Mitigation Plan. The objective is to ensure that there is a continuing and responsive planning process that will keep the Hazard Mitigation Plan dynamic and responsive to the needs and capabilities of the planning partners. This report discusses the following:

- Natural hazard events that have occurred within the last year
- Changes in risk exposure within the planning area
- Mitigation success stories
- Review of the action plan
- Changes in capabilities that could impact plan implementation
- Recommendations for changes/enhancement.

The Hazard Mitigation Plan Steering Committee: The Hazard Mitigation Plan Steering Committee, made up of planning partners and other stakeholders within the planning area, reviewed and approved this progress report at its annual meeting held on _____, 2018. It was determined through the plan's development process that a steering committee would remain in service to oversee maintenance of the plan. At a minimum, the Steering Committee will provide technical review and oversight on the development of the annual progress report.

It is anticipated that there will be turnover in the membership annually, which will be documented in the progress reports. For this reporting period, the Steering Committee membership is as indicated in Table 1.

Table 1. Steering Committee Members

Name	Title	Jurisdiction/Agency

Natural Hazard Events within the Planning Area: During the reporting period, there were __ natural hazard events in the planning area that had a measurable impact on people or property. A summary of these events is as follows:

- _____
- _____

Changes in Risk Exposure in the Planning Area: *(Insert brief overview of any natural hazard event in the planning area that changed the probability of occurrence or ranking of risk for the hazards addressed in the hazard mitigation plan)*

Mitigation Success Stories: *(Insert brief overview of mitigation accomplishments during the reporting period)*

Review of the Action Plan: Table 2 reviews the action plan, reporting the status of each action. Reviewers of this report should refer to the Hazard Mitigation Plan for more detailed descriptions of each action and the prioritization process.

Address the following in the "status" column of the following table:

- Was any element of the action carried out during the reporting period?
- If no action was completed, why?
- Is the timeline for implementation for the action still appropriate?
- If the action was completed, does it need to be changed or removed from the action plan?

Table 2. Action Plan Matrix

Action Taken? (Yes or No)	Time Line	Priority	Status	Status (X, O,✓)
Action #__—_____[description]				
Action #__—_____[description]				
Action #__—_____[description]				
Action #__—_____[description]				
Action #__—_____[description]				
Action #__—_____[description]				
Action #__—_____[description]				
Action #__—_____[description]				
Action #__—_____[description]				
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Action #__—_____[description]				
Action #__—_____[description]				

Completion status legend:
✓= Project Completed
O = Action ongoing toward completion
X = No progress at this time

Changes That May Impact Implementation of the Plan: *(Insert brief overview of any significant changes in the planning area that would have a profound impact on the implementation of the plan. Specify any changes in technical, regulatory and financial capabilities identified during the plan's development)*

Recommendations for Changes or Enhancements: Based on the review of this report by the Hazard Mitigation Plan Steering Committee, the following recommendations will be noted for future updates or revisions to the plan:

- _____
- _____
- _____
- _____
- _____
- _____

Public review notice: *The contents of this report are considered to be public knowledge and have been prepared for total public disclosure. Copies of the report have been provided to the governing boards of all planning partners and to local media outlets. The report is posted on the Tri-Valley Hazard Mitigation Plan website. Any questions or comments regarding the contents of this report should be directed to:*

Insert Contact Info Here

LIVERMORE CALIFORNIA

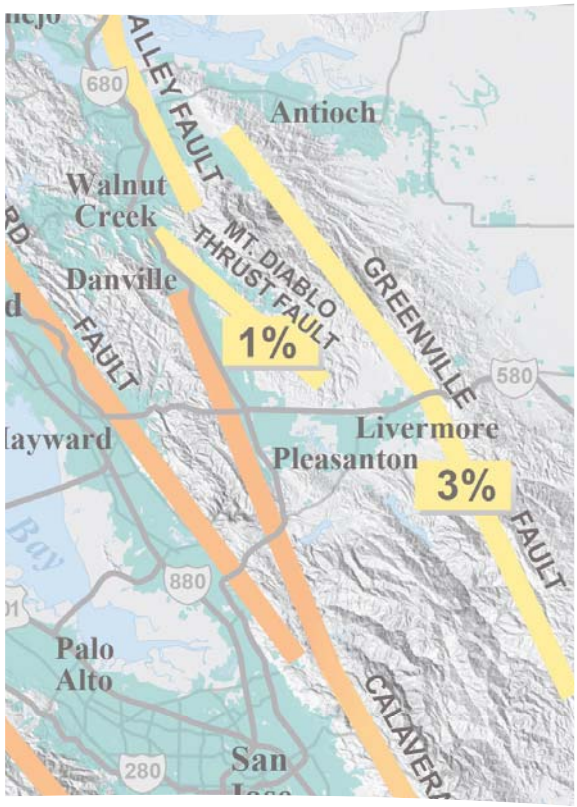
DUBLIN CALIFORNIA

THE CITY OF PLEASANTON

TRI-VALLEY LOCAL HAZARD MITIGATION PLAN

Volume 2—Planning Partner Annexes







Submittal Draft
January 2018

TETRA TECH

Tri-Valley Local Hazard Mitigation Plan

Volume 2—Planning Partner Annexes

December 2017

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INTRODUCTION

BACKGROUND

The Federal Emergency Management Agency (FEMA) encourages multi-jurisdictional planning for hazard mitigation. All participating jurisdictions must meet the requirements of Chapter 44 of the Code of Federal Regulations (44 CFR):

> "Multi-jurisdictional plans (e.g. watershed plans) may be accepted, as appropriate, as long as each jurisdiction has participated in the process and has officially adopted the plan." (Section 201.6.a(4))

For the Tri-Valley Local Hazard Mitigation Plan, a Planning Partnership was formed to leverage resources and to meet requirements of the federal Disaster Mitigation Act (DMA) for as many eligible local governments as possible. The DMA defines a local government as follows:

> "Any county, municipality, city, town, township, public authority, school district, special district, intrastate district, council of governments (regardless of whether the council of governments is incorporated as a nonprofit corporation under State law), regional or interstate government entity, or agency or instrumentality of a local government; any Indian tribe or authorized tribal organization, or Alaska Native village or organization; and any rural community, unincorporated town or village, or other public entity."

There are two types of Planning Partners that participated in this process, with distinct needs and capabilities:

- Incorporated municipalities
- Special purpose districts.

Each participating planning partner has prepared a jurisdiction-specific annex to this plan. These annexes, as well as information on the process by which they were created, are contained in this volume.

THE PLANNING PARTNERSHIP

Initial Solicitation and Letters of Intent

The planning team solicited the participation of all eligible municipalities and special purpose districts at the outset of this project. In June 2016, the Cities of Dublin, Livermore and Pleasanton identified eligible special districts within the planning area of the pending planning process and invited them to formally participate in the process. During the first Steering Committee meeting on March 7, 2017, the planning team introduced the opportunity for special purpose districts to participate as planning partners. A follow-up to the Steering Committee meeting was sent via email on April 17, 2017, listing potential special purpose district planning partners. This follow-up outlined planning partner expectations and sought commitment.

From these efforts, six interested local governments were provided with a list of planning partner expectations developed by the planning team outlining the obligations required for participation. Local governments wishing to

join the planning effort were asked to provide the planning team with a "notice of intent to participate" that agreed to the planning partner expectations and designated a point of contact for their jurisdiction. The planning team received formal commitment from all six invited planning partners.

Maps for each participating city are provided in the individual annex for that city in this volume. The regional maps in Volume 1 of this plan show the jurisdictional area of special purpose districts participating in this planning effort.

Planning Partner Expectations

The planning team developed the following list of planning partner expectations, which were confirmed by participating planning partners (see Appendix A for details):

- Complete administrative tasks:
  - Complete a letter of intent.
  - Designate points of contact.
  - Approve the steering committee.
- Participate, as able, in additional opportunities:
  - Attend steering committee meetings.
  - Attend or host public meetings or open houses.
  - Participate in and advertise the public review and comment period prior to adoption.
- Support the steering committee.
- Support the public involvement strategy.
- Complete the jurisdictional annex template:
  - Attend the mandatory workshop.
  - Perform a capability assessment.
  - Review the risk assessment.
  - Review area-wide mitigation recommendations.
  - Develop a mitigation action plan.
- Adopt the plan.

By adopting this plan, each planning partner also agrees to the plan implementation and maintenance protocol established in Volume 1. Failure to meet these criteria may result in a partner being dropped from the partnership by the Steering Committee, and thus losing eligibility under the scope of this plan.

Linkage Procedures

Eligible local jurisdictions that did not participate in development of this multi-jurisdictional plan may comply with DMA requirements by linking to this plan following the procedures outlined in Appendix B.

ANNEX-PREPARATION PROCESS

Templates

Templates were created to help the Planning Partners prepare their jurisdiction-specific annexes. Since special purpose districts operate differently from incorporated municipalities, separate templates were created for the two

types of jurisdictions. The templates were created so that all criteria of Section 201.6 of 44 CFR would be met, based on the partners' capabilities and mode of operation. Templates available for the planning partners' use were specific as to whether the partner's annex is an update to a previous hazard mitigation plan or a first-time hazard mitigation plan. The templates were set up to lead each partner through a series of steps that would generate the DMA-required elements that are specific for each partner. Detailed instructions on the completion of these templates include key definitions of required jurisdictional specific components were provided to all participating planning partners. Reviewers of this plan seeking to "cross-walk" plan content to the section 201.6 44CFR requirements are encouraged to review these instructions in conjunction with the content of this volume. The templates and their instructions can be found in Appendix C to this volume.

Jurisdictional annexes were completed in three phases. Phase 1 was initiated in July 2017 and Phase 3 concluded in December 2017. At the October 10, 2017, steering committee meeting, the planning team reviewed instructions for completing the Phase 3 portion of the annexes, which focuses on action plan development. All planning partners seeking DMA compliance under this plan attended the meeting. The following topics were discussed:

- Jurisdiction-specific natural events history
- Risk ranking
- Action plan development.

In the risk-ranking discussion, each planning partner was asked to review the ranked risk specifically for its jurisdiction, based on the impact on its population and/or facilities. Municipalities based this ranking on probability of occurrence and the potential impact on people, property and the economy. Special purpose districts based this ranking on probability of occurrence and the potential impact on their constituency, their vital facilities and the facilities' functionality after an event. The methodology followed that used for the area-wide risk ranking presented in Volume 1. The objectives of this exercise were to familiarize the partnership with how to use the risk assessment as a tool to support other planning and hazard mitigation processes and to help prioritize types of mitigation actions that should be considered. Hazards that were ranked as "high" or "medium" for each jurisdiction as a result of this exercise were considered to be priorities for identifying appropriate mitigation actions, although jurisdictions also identified actions to mitigate "low" ranked hazards as appropriate.

Tool Kit

Each planning partner was provided with a tool kit to assist in completing the annex template and developing an action plan. The tool kits contained the following:

- Previous hazard mitigation plan annexes for those jurisdictions who are updating existing plans
- A catalog of mitigation best practices
- The goals and objectives developed for the update to the plan
- Information on the FEMA Hazard Mitigation Assistance grant program
- Information on past hazard events that have impacted the planning area
- County-wide and jurisdiction-specific maps for hazards of concern
- The risk assessment results developed for this plan
- Jurisdiction-specific annex templates, with instructions for completing them
- FEMA guidance on plan integration
- The results of the public survey conducted as part of the public involvement strategy

The toolkit provided each planning partner with resources to develop a mitigation action plan. Planning partners were asked to review the following to assist in the identification of actions:

- **The jurisdiction's capability assessment**—Reviewed to identify capabilities that the jurisdiction does not currently have but should consider pursuing, or capabilities that should be revisited and updated to

include best available information. Reviewed to determine how existing capabilities can be leveraged to increase or improve hazard mitigation in the jurisdiction. Additionally, planning partners used this capability assessment to identify existing capabilities that may be expanded or enhanced to better support the mitigation goals and objectives of this plan.

- **The jurisdiction's National Flood Insurance Program compliance table**—Reviewed to identify opportunities to increase floodplain management capabilities.
- **The jurisdiction's review of its adaptive capacity for climate change**—Reviewed to identify ways to leverage or continue to improve existing capacities and to improve understanding of other capacities.
- **The jurisdiction's identified opportunities for future integration**—Reviewed to identify specific integration actions to be included in the mitigation strategy.
- **Jurisdiction-specific vulnerabilities**—Reviewed to identify actions that will help reduce known vulnerabilities.
- **The mitigation best practices catalog**—Reviewed to identify actions that the jurisdiction should consider including in its action plan.
- **Public input**—Reviewed to identify potential actions and community priorities.

Prioritization

44 CFR requires actions identified in the action plan to be prioritized (Section 201.c.3.iii). The planning team and steering committee developed a methodology for prioritizing the action plans that meets the needs of the partnership and the requirements of 44 CFR. All identified actions were prioritized in two categories—implementation and grant pursuit—as defined by the following criteria:

- Implementation priority
  - **High Priority**—An action that meets multiple objectives, has benefits that exceed costs, and has a designated source of funding. Action can be completed in the short term (1 to 5 years). The key factors for high-priority actions are that they have designated funding sources and can be completed in the short term.
  - **Medium Priority**—An action that meets multiple objectives, has benefits that exceed costs, and does not have a designated source of funding but is eligible for funding. Action can be completed in the short term (1 to 5 years), once funding is secured. The key factors for medium-priority actions are that they are eligible for funding though no specific funding source has been designated, and they can be completed within the short term. Medium-priority actions become high-priority actions once funding is secured.
  - **Low Priority**—An action that will mitigate the risk of a hazard, has benefits that do not exceed the costs or are difficult to quantify, has no designated source of funding, and is not eligible for any known grant funding. Action can be completed in the long term (1 to 10 years). Low-priority actions are generally "wish-list" actions. Their financing is unknown and they have a long-term timeframe for completion. These actions may be eligible for grant funding from programs that have not yet been identified.

- Grant pursuit priority
  - **High Priority**—An action that meets identified grant eligibility requirements, has high benefits, and is listed as high or medium priority; local funding options are unavailable or available local funds could be used instead for actions that are not eligible for grant funding.
  - **Medium Priority**—An action that meets identified grant eligibility requirements, has medium or low benefits, and is listed as medium or low priority; local funding options are unavailable.
  - **Low Priority**—An action that has not been identified as meeting any grant eligibility requirements.

These priority definitions are dynamic and can change from one category to another based on changes to a parameter such as availability of funding. For example, a project might be assigned a medium priority because of the uncertainty of a funding source, but be changed to high priority once a funding source has been identified. The prioritization schedule for this plan will be reviewed and updated as needed annually through the plan maintenance strategy.

Benefit/Cost Review

44 CFR requires the prioritization of the action plan to emphasize a benefit/cost analysis of the proposed actions. Because some actions may not be implemented for up to 10 years, benefit/cost analysis was qualitative and not of the detail required by FEMA for project grant eligibility under the Hazard Mitigation Assistance (HMA) grant program. A review of the apparent benefits versus the apparent cost of each project was performed. Parameters were established for assigning subjective ratings (high, medium, and low) to benefits and costs as follows:

- Benefit ratings:
  - **High—**The action will have an immediate impact on the reduction of risk exposure to life and property.
  - **Medium**—The action will have a long-term impact on the reduction of risk exposure to life and property or will provide an immediate reduction in the risk exposure to property.
  - **Low—**Long-term benefits of the action are difficult to quantify in the short term.
- Cost ratings:
  - **High—**Existing funding levels are not adequate to cover the costs of the proposed action; implementation would require an increase in revenue through an alternative source (for example, bonds, grants, and fee increases).
  - **Medium—**The action could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the action would have to be spread over multiple years.
  - **Low—**The action could be funded under the existing budget. The action is part of or can be part of an existing, ongoing program.

Using this approach, projects with positive benefit versus cost ratios (such as high over high, high over medium, medium over low, etc.) are considered cost-beneficial and are prioritized accordingly.

For many of the strategies identified in this action plan, funding might be sought under FEMA's HMA program. This program requires detailed benefit/cost analysis as part of the application process. These analyses will be performed on projects at the time of application preparation. The FEMA benefit-cost model will be used to perform this review. For projects not seeking financial assistance from grant programs that require this sort of analysis, the Partners reserve the right to define "benefits" according to parameters that meet their needs and the goals and objectives of this plan.

Analysis of Mitigation Actions

All planning partners reviewed their recommended actions to classify each action based on the hazard it addresses and the type of mitigation it involves. Mitigation types used for this categorization are as follows:

- **Prevention**—Government, administrative or regulatory actions that influence the way land and buildings are developed to reduce hazard losses. Includes planning and zoning, floodplain laws, capital improvement programs, open space preservation, and stormwater management regulations.

- **Property Protection**—Modification of buildings or structures to protect them from a hazard or removal of structures from a hazard area. Includes acquisition, elevation, relocation, structural retrofit, storm shutters, and shatter-resistant glass.
- **Public Education and Awareness**—Actions to inform citizens and elected officials about hazards and ways to mitigate them. Includes outreach projects, real estate disclosure, hazard information centers, and school-age and adult education.
- **Natural Resource Protection**—Actions that minimize hazard loss and preserve or restore the functions of natural systems. Includes sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, and wetland restoration and preservation.
- **Emergency Services**—Actions that protect people and property during and immediately after a hazard event. Includes warning systems, emergency response services, and the protection of essential facilities.
- **Structural Projects**—Actions that involve the construction of structures to reduce the impact of a hazard. Includes dams, setback levees, floodwalls, retaining walls, and safe rooms.
- **Climate Resilient**—Actions that incorporate methods to mitigate and/or adapt to the impacts of climate change. Includes aquifer storage and recovery activities, incorporating future-conditions projections in project design or planning, or actions that specifically address jurisdiction-specific climate change risks, such as sea level rise or urban heat island effect.
- **Community Capacity Building**—Actions that increase or enhance local capabilities to adjust to potential damage, to take advantage of opportunities, or to respond to consequences. Includes staff training, memorandums of understanding, development of plans and studies, and monitoring programs.

These categories include categories identified in the Community Rating System (CRS) 2017 *CRS Coordinators Manual* (OMB No. 1660-0022, Figure 510-4). The CRS categories expand on the four categories in FEMA's 2013 *Local Mitigation Handbook*. They provide a more comprehensive range of options, thus increasing integration opportunities. The use of CRS guidance enhances the CRS credit potential for this plan, for the benefit of planning partners who participate in the CRS program.

In addition to the CRS categories, two other categories were included in the analysis. The climate resilient category was added to facilitate the incorporation of climate adaptation planning into hazard mitigation plans in accordance with California Senate Bill 379 (see Section 4.8.2 in Volume 1 of this plan). Community capacity building was added to clearly identify opportunities for expanding on existing capabilities.

COMPATIBILITY WITH PREVIOUS APPROVED PLANS

Of the six initially identified potential planning partners, four were covered by the FEMA-approved 2010 Association of Bay Area Governments hazard mitigation planning effort. Table 1 lists all the initial partners, the role this multi-jurisdictional plan will play in achieving compliance, and CRS status.

FINAL COVERAGE UNDER THE PLAN

Of the six planning partners that submitted letters of intent to participate, four fully met the participation requirements specified by the Steering Committee. The principal requirement not met by the other partners was completion of the jurisdictional annex template. Only the four partners that submitted completed templates are included in this volume and will seek DMA compliance under this plan. The remaining jurisdictions will need to follow the linkage procedures described in Appendix B of this volume in order to achieve DMA compliance. Table 2 lists the jurisdictions that submitted letters of intent and their ultimate status in this plan.

Table 1. Prior Plan Status

	Prior Plan Adoption Date	Will Be Covered by This Hazard Mitigation Plan?	CRS Community	This Hazard Mitigation Plan Will Become CRS Plan of Record?
City of Dublin	03/06/2012	Yes	No	N/A
City of Livermore	02/27/2012	Yes	Yes	Yes
City of Pleasanton	02/21/2012	Yes	Yes	Yes
Dublin San Ramon Services District	09/18/2012	Yes	N/A	N/A
Dublin Unified School District	N/A	No	N/A	N/A
Livermore Valley Joint Unified School District	N/A	No	N/A	N/A

Table 2. Planning Partner Status

	Letter of Intent Date	Attended Steering Committee Annex Completion Discussion?	Completed Template?	Covered by This Plan?
City of Dublin	4/11/2017	Yes	Yes	Yes
City of Livermore	4/11/2017	Yes	Yes	Yes
City of Pleasanton	4/11/2017	Yes	Yes	Yes
Dublin San Ramon Services District	4/11/2017	Yes	Yes	Yes
Dublin Unified School District	4/11/2017	No	No	No
Livermore Valley Joint Unified School District	4/11/2017	No	No	No

1. CITY OF DUBLIN

1.1 HAZARD MITIGATION PLAN POINT OF CONTACT

Primary Point of Contact
Hazel L. Wetherford, Assistant to the City Manager
100 Civic Plaza
Dublin, CA 94568
Telephone: 925-833-6650
e-mail Address: hazel.wetherford@dublin.ca.gov

Alternate Point of Contact
Julie E. Carter, Human Resources Director
100 Civic Plaza
Dublin, CA 94568
Telephone: 925-833-6650
e-mail Address: julie.carter@dublin.ca.gov

1.2 JURISDICTION PROFILE

The following is a summary of key information about the jurisdiction and its history:

- **Date of Incorporation—**February 2, 1982
- **Current Population**—59,686 as of May 2017 (2017 Department of Finance estimates)
- **Population Growth**—According the California Department of Finance, the City of Dublin's population increased by 4% between January of 2016 and January of 2017. The City population has steadily increased over the past decade, averaging 15% per year since 2010.
- **Location and Description**—Dublin is a suburban city of the East Bay Area (San Francisco) and Tri-Valley regions of Alameda County, California, United States. Located along the north side of Interstate 580 and at the intersection of Interstate 680, roughly 35 miles (56 km) east of downtown San Francisco, 23 miles (37 km) east of downtown Oakland, and 31 miles (50 km) north of downtown San Jose. According to the United States Census Bureau, the city has a total area of 15.23 square miles (40 km2) of which 0.03% is water. The City of Dublin is generally bounded by the City of San Ramon to the north, Castro Valley to the west, the City of Pleasanton to the south, and the City of Livermore to the east.
- **Brief History**—Dublin has long been known as the Crossroads of the Bay Area. Dublin now sits at the crossroads of two major freeways: Interstate 580 and Interstate 680. However, the significance of the crossroads dates back more than 200 years when Dublin served as the crossroads of two important stage routes - one from the Bay Area to Stockton and the other from Martinez to San Jose. The Alamilla Spring, located in the Dublin area, provided a place for travelers to change horses and freshen up before continuing their journey. Dublin has a rich history dating back to 1772 when Pedro Fages led an expedition of 16 mounted men on a journey in search of a land route to Drake's Bay, now known as San Francisco Bay. Their return journey brought them through the Amador Valley.
  During the past 20 years, the rapidly expanding Tri-Valley area has become renowned as a place of prosperity, a center for internationally acclaimed business parks, and home to some of the world's largest corporations. The City of Dublin, located at the crossroads of the Tri-Valley, has contributed to the planned growth and forward thinking of the area. The City continues to look ahead to expand and enhance the quality of life for members of the community.
- **Climate**—Dublin enjoys a relatively mild climate, with an average rainfall of 15 inches and an average maximum temperature of 89º Fahrenheit in July and an average minimum temperature of 37ºF in

December. At its most extreme, winter temperatures can drop below freezing a few days each year, and summer temperatures hover around 100 degrees Fahrenheit during July and August. The temperate weather allows residents year-round opportunities to take advantage of outdoor activities such as hiking, cycling, and shopping in a robust downtown corridor.

- **Governing Body Format**—The City of Dublin is a general law city operating under a City Council / City Manager form of local government. This form of government combines an elected mayor and council and an appointed local government administrator. The City Council elections are nonpartisan. The Mayor serves a two-year term, and Council members serve four-year terms. The Mayor and City Council, as a collegial body, are responsible for setting policy, setting/prioritizing goals and objectives, and approving the budget. The Mayor, with confirmation by the City Council, makes appointments to the City's advisory commissions and committees.
  The Council appoints the City Manager, who is responsible for the day-to-day administrative operation of the City, including: delivery of services, hiring of personnel, implementation of capital projects and preparation. The City Council assumes responsibility for the adoption of this plan; the City Manager will oversee its implementation.

1.3 DEVELOPMENT TRENDS

The Planning Division coordinates the City's review of residential, commercial, office, and industrial development projects. This includes working with property owners, developers, business owners, and residents to ensure that their development proposals conform to City policies and guidelines.

Table 1-1 summarizes development trends in the performance period since development of the previous hazard mitigation plan and expected future development trends.

1.4 CAPABILITY ASSESSMENT

The City of Dublin has performed an inventory and analysis of existing capabilities, plans, programs and policies that enhance its ability to implement mitigation strategies. The introduction at the beginning of this volume of the hazard mitigation plan describes the components included in the capability assessment and their significance for hazard mitigation planning. This section summarizes the following findings of the assessment:

- An assessment of legal and regulatory capabilities is presented in Table 1-2.
- Development and permitting capabilities are presented in Table 1-3.
- An assessment of fiscal capabilities is presented in Table 1-4.
- An assessment of administrative and technical capabilities is presented in Table 1-5.
- An assessment of education and outreach capabilities is presented in Table 1-6.
- Information on National Flood Insurance Program (NFIP) compliance is presented in Table 1-7.
- Classifications under various community mitigation programs are presented in Table 1-8.
- The community's adaptive capacity for the impacts of climate change is presented in Table 1-9.

The capability assessment was reviewed in order to identify opportunities to expand, initiate or integrate capabilities to further hazard mitigation goals and objectives. Where such opportunities were identified and determined to be feasible, they are included in the action plan and are identified as Community Capacity Building mitigation actions in the Analysis of Mitigation Actions table in Section 1.10.

Table 1-1. Recent and Expected Future Development Trends

Criterion	Response
Has your jurisdiction annexed any land since the development of the previous hazard mitigation plan? • If yes, give the estimated area annexed and estimated number of parcels or structures.	No N/A
Is your jurisdiction expected to annex any areas during the performance period of this plan? • If yes, please describe land areas and dominant uses. • If yes, who currently has permitting authority over these areas?	No N/A N/A
Are any areas targeted for development or major redevelopment in the next five years? • If yes, please briefly describe, including whether any of the areas are in known hazard risk areas	Yes Downtown Dublin is experiencing ongoing reinvestment and revitalization. Portions of that area lie within the Alquist-Priolo Earthquake Fault Zone and FEMA flood zones. There are undeveloped parcels along I-580 in the Eastern Dublin Specific Plan area located within a FEMA flood zone that are anticipated for future development
How many permits for new construction were issued in your jurisdiction since the development of the previous hazard mitigation plan?	

	2012	2013	2014	2015	2016
Single Family	656	616	473	369	428
Multi-Family	29	10	60	29	33
Other (commercial, mixed use, etc.)	6	6	13	12	2

Please provide the number of new-construction permits for each hazard area or provide a qualitative description of where development has occurred.	• Special Flood Hazard Areas: 0 • Wildfire Risk Areas: 0 as defined by the CA Building Code; and 558 as defined by the City of Dublin. Development has occurred throughout the city during the performance period for this plan. For the landslide and liquefaction hazards, the city does not track the specific number of building permits issued. It is important to note, however, that all new development was consistent with General Plan policies and municipal code standards.
Please describe the level of buildout in the jurisdiction, based on your jurisdiction's buildable lands inventory. If no such inventory exists, provide a qualitative description.	Approximately 21,000 existing housing units with approximately 6,600 remaining to reach buildout. Remaining commercial/industrial sites are located along I-580 between Tassajara Road and the eastern City Limits boundary.

Table 1-2. Legal and Regulatory Capability

	Local Authority	Other Jurisdiction Authority	State Mandated	Integration Opportunity?
Codes, Ordinances, & Requirements				
Note: The Dublin Municipal Code is current through Ordinance 6-17, passed July 18, 2017.				
Building Code	Yes	No	Yes	No
Comment: Title 7, Chapter 7.32 DMC adopts The 2016 California Building Code, Part 2, Title 24 of the California Code of Regulations, a portion of the California Building Standards Code, as defined in the California State Health and Safety Code Section 18901 et seq. (hereinafter referred to as the "state code"), and any rules and regulations promulgated pursuant thereto including the International Building Code, 2015 Edition, including Appendix Chapters C, F, G, H, and I, as published by the International Code Council, and as referenced in and adopted pursuant to California State Health and Safety Code Sections 17922 and 18935, (hereinafter referred to as the "IBC") are hereby adopted and incorporated by reference herein.				
Zoning Code	Yes	No	Yes	No
Comment: Title 8, DMC, Chapters 8.04 to 8.144. The purpose of this Ordinance is to promote and protect the public health, safety, peace, comfort, convenience and general welfare and to preserve and enhance the aesthetic quality of the City by providing regulations to ensure an appropriate mix of land uses, and that each land use relates properly to adjacent land uses in an orderly manner, and for the following more particularly specified purposes.				
Subdivisions	Yes	No	Yes	No
Comment: Title 9, DMC, Chapters 9.04 to 9.56. This title shall regulate and control the design and improvement of subdivisions of land within the city and supplement the provisions of the Subdivision Map Act of the State of California set forth at Government Code Section 66410 et seq. concerning the design, improvement and survey data of subdivisions, the form and content of all maps provided for by the Subdivision Map Act, and the procedure to be followed in securing the official approval of the city regarding the maps.				
Stormwater Management	Yes	No	No	Yes
Comment: Title 7, Chapter 7.74 DMC. The purpose of this chapter is to ensure the future health, safety and general welfare of city of Dublin citizens by: (1) Eliminating non-stormwater discharges to the municipal separate storm sewer; (2) Controlling the discharge to municipal separate storm sewers from spills, dumping or disposal of materials other than stormwater; and (3) Reducing pollutants in stormwater discharges to the maximum extent practicable. The intention of this chapter is to protect and enhance the water quality of our watercourses, water bodies and wetlands, in a manner pursuant to and consistent with the Clean Water Act. Integration Opportunity: Pursue mitigation opportunities through green infrastructure planning.				
Post-Disaster Recovery	No	No	No	Yes
Comment: City currently does not have a code or ordinance that dictates its recovery operations following a disaster. This could be a core capability the City may consider as a mitigation action for this plan.				
Real Estate Disclosure	No	Yes	Yes	Yes
Comment: California State Civil Code 1102 requires full disclosure on natural hazard exposure of the sale/re-sale of any and all real property. To be implemented by sellers and realtors. Integration Opportunity: The information of hazards and risk contained in this plan could be used to support enforcement of this law.				
Growth Management	Yes	No	Yes	Yes
Comment: California state law requires that every county and city prepare and adopt a comprehensive long-range plan to serve as a guide for community development. The General Plan for the City of Dublin was adopted February 11, 1985 and most recently amended November 14, 2016. The General Plan contains 12 elements that address many aspects of the community including: land use, housing, parks and open space, community design, infrastructure, safety, sustainability and conservation of resources. The General Plan is the City's overarching policy document. All City policies and ordinances must be consistent with the General Plan. The Planning Division is responsible for maintaining the General Plan and preparing amendments to the document as directed by the City Council. Integration Opportunity: Integrate the hazard mitigation plan in to the General Plan pursuant to CA AB2140 and SB 379.				
Site Plan Review	Yes	No	No	No
Comment: Title 9, Chapter 9.08 DMC. The form and contents, submittal and approval of tentative tract maps for the subdivision of five (5) or more parcels and tentative parcel maps for the subdivision of four (4) or fewer parcels shall be governed by the provisions of this chapter.				

	Local Authority	Other Jurisdiction Authority	State Mandated	Integration Opportunity?
Environmental Protection	Yes	No	No	No
Comment: *Title 7, Chapter 7.20, DMC: WATERCOURSE PROTECTION* *Title 7, Chapter 7.30, DMC: WASTE MANAGEMENT PLAN* *Title 7, Chapter 7.56, DMC: TREES* *Title 7, Chapter 7.94, DMC: GREEN BUILDING* *Title 5, Chapter 5.56, DMC. GREEN BUILDING PRACTICES FOR CITY PROJECTS*				
Flood Damage Prevention	Yes	No	No	Yes
Comment: *Title 7, Chapter 7.24, DMC. It is the purpose of this chapter to promote the public health, safety, and general welfare, and to minimize public and private losses due to flood conditions in specific areas by provisions*				
Emergency Management	Yes	No	No	Yes
Comment: *Title 2, Chapter 2.44, DMC. The declared purposes of this chapter are to provide for the preparation and carrying out of plans for the protection of persons and property within this city in the event of an emergency; the direction of the emergency organization; and the coordination of the emergency functions of this city with all other public agencies, corporations, organizations, and affected private persons. Integration Opportunity: This plan should fully support and integrate in to the City's Emergency Management program.*				
Climate Change	Yes	No	Yes	Yes
Comment: *The City Council adopted the Climate Action Plan in November 2010, and updated the plan in 2013. The City's Climate Action Plan outlines measures to reduce the City's greenhouse gas (GHG) emissions to 15% below 2010 GHG levels by 2020. The City will update the Climate Action Plan to meet 2030 and 2050 goals in fiscal year 2017-2018.*				
Other:	Yes	No	Yes	No
Comment: *The California Environmental Quality Act (CEQA) requires state and local agencies to identify the significant environmental impacts of their actions and to avoid or mitigate those impacts, if feasible. California Senate Bill 379 requires that local government incorporate climate adaptation and resiliency strategies in the safety element of their general plans.*				
Planning Documents				
General Plan	Yes	No	Yes	No
Is the plan compliant with Assembly Bill 2140? *Yes* *Comment:* *The General Plan for the City of Dublin was adopted February 11, 1985 and most recently amended November 14, 2016. Chapter 8, section 8.3 of the General Plan includes the Safety Element. This section includes an emergency preparedness policy that states: In 2010 the City adopted a Local Hazard Mitigation Plan as an annex to the Comprehensive Emergency Management Plan to assess hazards and mitigate risks prior to a disaster event. The City will periodically review the Plan to prepare for emergencies.*				
Capital Improvement Plan	Yes	No	No	Yes
How often is the plan updated? *Every 5-years.* *Comment:* *Current CIP in effect for the City Covers Fiscal Year 2016-2017 through Fiscal Year 2020-2021. The projects as proposed in this document have been prioritized based on the need for infrastructure preservation, repair and safety, and critical planning for future city service delivery. Program Funding is allocated under the following categories: general improvements, community improvements, parks and streets. Integration opportunity: FEMA grant eligible projects within the CIP that will reduce risk from hazards assessed by this plan could be included in the City's action plan.*				
Floodplain or Watershed Plan	No	No	No	Yes
Comment: *The City is a participating community in the National Flood Insurance Program and implements the program thorough the Dublin Municipal Code, Chapter 7.24. The City does not currently have a stand-alone flood hazard management plan or watershed management plan. Integration Opportunity: If the City feels that the flood risk is sufficient to warrant a detailed look at causes and solutions to the flood problems identified, the City could consider the development of a Comprehensive Flood Hazard Management Plan as a mitigation action for this plan.*				
Stormwater Management Plan	Yes	Yes	Yes	Yes
Comment: *The City of Dublin Municipal code contains regulations pertaining to watercourse protection, flood control and stormwater management in Chapters 7.20, 7.24, and 7.74. The City is a permittee under the California Regional Water Quality Control Board, San Francisco Bay Region, Municipal Regional Stormwater NPDES Permit, Order No. R2-2015-0049, NPDES Permit No. CAS612008.*				

	Local Authority	Other Jurisdiction Authority	State Mandated	Integration Opportunity?
Urban Water Management Plan	No	Yes	No	No
Comment: *The City receives retail water services from Dublin San Ramon Services District (DSRSD) and DSRSD receives wholesale water services from Zone 7 Water Agency (Zone 7). Both DSRSD and Zone 7 have collaborated together on their respective Urban Water Management Plans.*				
Habitat Conservation Plan	No	No	No	No
Comment: *N/A for the City of Dublin*				
Economic Development Plan	Yes	No	No	No
Comment: *The City's general plan includes an economic development element which was most recently amended on November 14, 2016.*				
Shoreline Management Plan	No	No	No	No
Comment: *N/A for the City of Dublin*				
Community Wildfire Protection Plan	Yes	No	No	Yes
Comment: *City of Dublin Wildfire Management Plan. Adopted July 9, 1996; revised March 5, 2002. Integration Opportunity: future updates to this plan should reference the wildfire risk assessment of this hazard mitigation plan. This plan is now considered to be integrated in to the Tri-Valley Hazard Mitigation plan by reference.*				
Forest Management Plan	No	No	No	No
Comment: *N/A for the City of Dublin*				
Climate Action Plan	Yes	No	Yes	Yes
Comment: *The City Council adopted the Climate Action Plan in November 2010, and updated the plan in 2013. The City's Climate Action Plan outlines measures to reduce the City's GHG emissions 20% below a business-as-usual scenario by 2020. Integration Opportunity: Pursuant to CA SB379, the city will integrate.*				
Comprehensive Emergency Management Plan	Yes	No	Yes	No
Comment: *The City Council adopted a Comprehensive Emergency Management Plan in January 2004, and has since approved Updates to the Plan in February 2004, August 2009, and June 2011.*				
Threat & Hazard Identification & Risk Assessment (THIRA)	Yes	Yes	Yes	Yes
Comment: *This is identified in the City's Comprehensive Emergency Management Plan, section 12.1.4.*				
Post-Disaster Recovery Plan	Yes	Yes	Yes	Yes
Comment: *This is identified in the City's Comprehensive Emergency Management Plan, Annex H.*				
Continuity of Operations Plan	Yes	No	Yes	Yes
Comment: *This is identified in the City's Comprehensive Emergency Management Plan, Annex G.*				
Public Health Plan	No	Yes	No	No
Comment: *Alameda County Health Care Services Agency: mission of Health Care Services Agency is to provide fully integrated health care services through a comprehensive network of public and private partnerships that ensure optimal health and well-being and respect the diversity of all residents.*				
Other:	No	No	No	No
Comment:				

Table 1-3. Development and Permitting Capability

Criterion	Response
Does your jurisdiction issue development permits? • If no, who does? If yes, which department?	Yes Building and Safety Division of the Community Development Department
Does your jurisdiction have the ability to track permits by hazard area?	No, the City does not currently track building permits issued by hazard area.
Does your jurisdiction have a buildable lands inventory?	Chapter 2, section 2.2 of the City's General Plan includes a "Land Use Development Potential Analysis." However, a traditional buildable lands analysis has not been performed at the time of this plan update.

Table 1-4. Fiscal Capability

Financial Resource	Accessible or Eligible to Use?
Community Development Block Grants	Yes
Capital Improvements Project Funding	Yes
Authority to Levy Taxes for Specific Purposes	Yes
User Fees for Water, Sewer, Gas or Electric Service	No, none of these services are city sponsored
Incur Debt through General Obligation Bonds	Yes
Incur Debt through Special Tax Bonds	Yes
Incur Debt through Private Activity Bonds	No
Withhold Public Expenditures in Hazard-Prone Areas	No
State-Sponsored Grant Programs	Yes
Development Impact Fees for Homebuyers or Developers	Yes, Surface Water Utility
Other	N/A

Table 1-5. Administrative and Technical Capability

Staff/Personnel Resource	Available?	Department/Agency/Position
Planners or engineers with knowledge of land development and land management practices	Yes	Community Development Department
Engineers or professionals trained in building or infrastructure construction practices	Yes	Public Works Department
Planners or engineers with an understanding of natural hazards	Yes	Community Development Department, Public Works Department; Geological Hazard Abatement Districts (GHAD)
Staff with training in benefit/cost analysis	Yes	Finance/Administrative Services Department
Surveyors	Yes	Can contract for these services
Personnel skilled or trained in GIS applications	Yes	Information Services Division
Scientist familiar with natural hazards in local area	Yes	Community Development Department
Emergency Manager	Yes	City Manager's Office
Grant writers	Yes	Finance/Administrative Services Department
Other	N/A	N/A

Table 1-6. Education and Outreach Capability

Criterion	Response
Do you have a Public Information Officer or Communications Office?	Yes
Do you have personnel skilled or trained in website development?	Yes
Do you have hazard mitigation information available on your website? • If yes, please briefly describe.	Yes Links to the Tri-Valley hazard mitigation plan web site are provided on the City's Disaster preparedness page: http://www.dublin.ca.gov/94/Disaster-Preparedness
Do you utilize social media for hazard mitigation education and outreach? • If yes, please briefly describe.	Yes City utilizes "Next-door," Twitter and Facebook options for social media
Do you have any citizen boards or commissions that address issues related to hazard mitigation? • If yes, please briefly describe.	No N/A
Do you have any other programs already in place that could be used to communicate hazard-related information? • If yes, please briefly describe.	Yes CERT, Alameda County Fire Department
Do you have any established warning systems for hazard events? • If yes, please briefly describe.	Yes The City has partnered with Alameda County on a new emergency notification system, "AC Alert," powered by EverBridge. It is an ultra-high-speed telephonic communication service used for emergency notifications.

Table 1-7. National Flood Insurance Program Compliance

Criterion	Response
What local department is responsible for floodplain management?	Community Development Department, Building and Safety Division
Who is your floodplain administrator? (department/position)	Building Official
Are any certified floodplain managers on staff in your jurisdiction?	No
What is the date that your flood damage prevention ordinance was last amended?	1996
Does your floodplain management program meet or exceed minimum requirements? • If exceeds, in what ways?	Meets
When was the most recent Community Assistance Visit or Community Assistance Contact?	Visit was in 2014. Last contact 2016.
Does your jurisdiction have any outstanding NFIP compliance violations that need to be addressed? • If so, please state what they are.	No N/A
Do your flood hazard maps adequately address the flood risk within your jurisdiction? • If no, please state why.	Yes N/A
Does your floodplain management staff need any assistance or training to support its floodplain management program? • If so, what type of assistance/training is needed?	No N/A
Does your jurisdiction participate in the Community Rating System (CRS)? • If yes, is your jurisdiction interested in improving CRS Classification? • Is your jurisdiction interested in joining the CRS program?	No N/A Yes
How many flood insurance policies are in force in your jurisdiction?[a] • What is the insurance in force? • What is the premium in force?	123 $40,114,900 $217,765
How many total loss claims have been filed in your jurisdiction?[a] • How many claims are still open/were closed without payment? • What were the total payments for losses?	3 0/3 $0

a. According to FEMA statistics as of June 30, 2017

Table 1-8. Community Classifications

	Participating?	Classification	Date Classified
Community Rating System	No	N/A	N/A
Building Code Effectiveness Grading Schedule	Yes	2	4/22/2014
Public Protection	Yes	Unknown	Unknown
Storm Ready	No	N/A	N/A
Firewise	No	N/A	N/A

Table 1-9. Adaptive Capacity for Climate Change

Criterion	Jurisdiction Rating[a]
Technical Capacity	
Jurisdiction-level understanding of potential climate change impacts	Low
Comment: None provided	
Jurisdiction-level monitoring of climate change impacts	Low
Comment: None provided	
Technical resources to assess proposed strategies for feasibility and externalities	Medium
Comment: The City of Dublin has a professional staff with the capabilities to assess strategies. In addition, the State of California offers a variety of planning guidance and resources to assist local communities with climate change strategies.	
Jurisdiction-level capacity for development of greenhouse gas emissions inventory	High
Comment: The City of Dublin adopted a Climate Action Plan (CAP) to reduce GHG emissions in 2010 and adopted an updated CAP in 2013. The updated CAP includes a detailed emissions inventory for both community and municipal emissions. City staff is currently working on the 2015 GHG inventory.	
Capital planning and land use decisions informed by potential climate impacts	Low
Comment: The CAP contains a number of GHG emission reduction strategies pertaining to land use and the General Plan includes policies and actions related to reducing risk from natural hazard events, such as flood and wildfire, in the Safety Element; however, these strategies do not account for impacts from climate change. The City has a Capital Improvement Program in which all projects conform to the General Plan and the California Environmental Quality Act.	
Participation in regional groups addressing climate risks	Medium
Comment: The City joined the Alameda County Climate Protection Project in 2007 and is part of the Bay Area Air Quality Management District. City staff participates in regional committees such as the Bay Area Energy Resource Network, the goal of which is to develop successful climate, resource and sustainability programs.	
Implementation Capacity	
Clear authority/mandate to consider climate change impacts during public decision-making processes	Medium
Comment: There are a number of state actions and regulations that require local governments to consider climate change in public decision-making processes such as Senate Bill 379 (SB379), which requires that the impacts of climate change be addressed in local general plans. The CAP sets forth a number of areas where GHG emissions are considered in decision-making and development processes.	
Identified strategies for greenhouse gas mitigation efforts	High
Comment: The City's 2013 CAP sets a GHG emissions reduction target of 15 percent below the 2010 inventory levels by 2020. The CAP identifies 45 reduction measures for community and/or municipal activities. The CAP includes a plan to implement, monitor and review the CAP to determine progress. City staff will update the CAP to meet the 2030/2050 goals in fiscal year 2017-2018.	
Identified strategies for adaptation to impacts	Medium
Comment: Although the CAP is focused on GHG reduction strategies rather than climate change adaptation, it identifies strategies that support co-benefits such as the Bay-Friendly Landscaping Policy to decrease heat island effect and control stormwater runoff and the City's Green Building Ordinance. In addition, the City's General Plan includes a sustainability element that includes policies related to drought tolerant landscaping, reduction of heat island effect and stormwater retention.	

Criterion	Jurisdiction Rating[a]
Champions for climate action in local government departments	Low
Comment: *As part of the 2030 Climate Action Plan process, the City will select champions from the various City departments.*	
Political support for implementing climate change adaptation strategies	Low
Comment: *The City Council has a long history of supporting efforts related to climate change including the endorsement of the US Mayors' Climate Protection Agreement in 2005 and the adoption of the CAP in 2010 and 2013; however, a clear set of climate change adaptation strategies and directives have not yet been developed.*	
Financial resources devoted to climate change adaptation	Medium
Comment: *The City has allocated $70,000 for the update of the City's Climate Action Plan. This Plan will evaluate the climate change impacts on the City's operations and infrastructure.*	
Local authority over sectors likely to be negative impacted	Medium
Comment: *Dublin San Ramon Services District is the water utility for the City. The City shares responsibility for stormwater facilities with private property owners and the Alameda County Flood Control and Water Conservation District. The City is a participant in the NFIP and enforces the provisions of its flood damage prevention ordinance. The city maintains more than 40 acres of landscaping that may be vulnerable to drought. Fire protection services are contracted through the Alameda County Fire Department.*	
Public Capacity	
Local residents' knowledge of and understanding of climate risk	Medium
Comment: *The City is a leader in environmental stewardship and has placed emphasis on conservation efforts and the establishment of renewable energy resources. The CAP includes a number of strategies to increase the public's awareness of climate change and GHG reduction strategies; however, no public outreach program focused on climate change impacts and adaptation currently exists.*	
Local residents support of adaptation efforts	Low
Comment: *The City is a leader in environmental stewardship and has placed emphasis on conservation efforts and the establishment of renewable energy resources. The CAP includes a number of strategies to increase the public's awareness of climate change and GHG reduction strategies; however, no public outreach program focused on climate change impacts and adaptation currently exists.*	
Local residents' capacity to adapt to climate impacts	Medium
Comment: *The City of Dublin's population would be expected to be able to adapt to many climate impacts as residents are well educated with more than 54 percent of the adult population holding a bachelor's degree or higher, relatively well off with a median household income almost double the state average, relatively young with only 7 percent of the population 65 years and over, and relatively healthy with about 4 percent of residents under age 65 reporting a disability, which is less than half the national average. However, residents may not know what actions to take to adapt to climate change impacts.*	
Local economy current capacity to adapt to climate impacts	High
Comment: *The majority of the employed population in the City works in management, business, science and the arts, which would be likely to be able to adapt to the impacts of climate change. Only a very small portion of the population is employed in natural resource based industries such as farming or forestry.*	
Local ecosystems capacity to adapt to climate impacts	Unsure
Comment: *Local ecosystems ability to adapt to climate impacts at this time is unclear. The western hills are ecologically important and part of an area of regional significance identified by the National Park Service. Riparian areas, particularly in western Dublin, are important wildlife habitat. The General Plan identified policies for the conservation of these areas.*	

a. High = Capacity exists and is in use; Medium = Capacity may exist, but is not used or could use some improvement; Low = Capacity does not exist or could use substantial improvement; Unsure= Not enough information is known to assign a rating.

1.5 INTEGRATION WITH OTHER PLANNING INITIATIVES

The information on hazards, risk, vulnerability and mitigation contained in this hazard mitigation plan is based on the best available data. Plan integration is the incorporation of this information into other relevant planning mechanisms, such as general planning and capital facilities planning. It includes the integration of natural hazard information and mitigation policies, principles and actions into local planning mechanisms and vice versa. Additionally, plan integration is achieved though the involvement of key staff and community officials in collaboratively planning for hazard mitigation.

1.5.1 Existing Integration

In the performance period since adoption of the previous hazard mitigation plan, The City of Dublin made progress on integrating hazard mitigation goals, objectives and actions into other planning initiatives. The following plans and programs currently integrate components of the hazard mitigation strategy:

- **City of Dublin General Plan**— the November 14, 2016 amendment to the City's General Plan includes an emergency preparedness policy that integrates the City's hazard mitigation plan.
- **City of Dublin Comprehensive Emergency Management Plan (CEMP)**— In 2010 the City adopted a Local Hazard Mitigation Plan as an annex to the Comprehensive Emergency Management Plan to assess hazards and mitigate risks prior to a disaster event.
- **Post-Disaster Recovery Program**—Future updates to the City's General Plan, CEMP or the Tri-Valley Hazard Mitigation Plan should consider the inclusion of a post-disaster recovery component. Since these three programs are already fully integrated, only one of these programs would need to include this component.
- **Flood Damage Prevention Ordinance**—The City should consider the inclusion of higher regulatory flood protection standards appropriate for the flood risk within the City as mitigation actions for this plan.
- **Climate Change**—Pursuant to CA SB379, all future updates to the City's General Plan and Climate Action Plan should address the adaptive capacity requirements of SB379 which includes full integration of the hazard mitigation plan.

Resources listed in Section 1.11 were used to provide information for this annex on hazard events and local capabilities within the jurisdiction.

1.5.2 Opportunities for Future Integration

As this hazard mitigation plan is implemented, the City of Dublin will use information from the plan as the best available science and data on natural hazards. The capability assessment presented in this annex identifies codes, plans and programs that provide opportunities for integration. The area-wide and local action plans developed for this hazard mitigation plan in actions related to plan integration, and progress on these actions will be reported through the progress reporting process described in Volume 1. New opportunities for integration also will be identified as part of the midterm progress report. The capability assessment identified the following plans and programs that do not currently integrate goals or recommendations of the hazard mitigation plan but provide opportunities to do so in the future:

- **City of Dublin General Plan**—Since this 2017 hazard mitigation planning effort differs substantially from the prior hazard mitigation plan of record for the City of Dublin, all future amendments to the General Plan should revisit hazard mitigation plan integration opportunities by adopting relevant policies in its safety element.
- **City of Dublin Comprehensive Emergency Management Plan (CEMP)**— All future updates to the City's CEMP should look to the 2017 Tri-Valley hazard mitigation plan as a major source of information on exposure and vulnerability to natural hazards of concern for the City.

- **Post-Disaster Recovery Program**—Future updates to the City's General Plan, CEMP or the Tri-Valley Hazard Mitigation Plan should consider the inclusion of a post-disaster recovery component. Since these three programs are already fully integrated, only one of these programs would need to include this component.
- **Flood Damage Prevention Ordinance**—The City should consider the inclusion of higher regulatory flood protection standards appropriate for the flood risk within the City as mitigation actions for this plan.
- **Climate Change**—Pursuant to CA SB379, all future updates to the City's General Plan and Climate action plan should address the adaptive capacity requirements of SB379 which includes full integration of the hazard mitigation plan.
- **Capital Improvements Program (CIP)**—The City should look to the Hazard Mitigation Plan as a possible source to grant funding that could leverage City's funding for grant eligible capital projects. This plan has the ability to fold in new capital projects through the plan maintenance strategy of the plan.
- **City of Dublin Wildfire Management Plan**—This document has been incorporated by reference in to this plan. However, should the City ever decide to update this plan, they should look to the 2017 Tri-Valley Hazard Mitigation Plan and its future updates as the source of risk information to the wildfire hazard.
- **City of Dublin Green Infrastructure Plan—**This plan is required by the Municipal Regional Stormwater NPDES Permit (MRP) and mandates the inclusion of low impact development drainage design into storm drain infrastructure. The intent of the plan is to describe how permittees under the MRP will shift their impervious surfaces and storm drain infrastructure from traditional storm drain infrastructure to a more resilient, sustainable system that slows runoff by dispersing it and/or infiltrating it. The goals, objectives and actions identified in this plan and the hazard mitigation plan should be coordinated and complementary, as appropriate.

1.6 JURISDICTION-SPECIFIC NATURAL HAZARD EVENT HISTORY

Table 1-10 lists past occurrences of natural hazards for which specific damage was recorded in the City of Dublin. Other hazard events that broadly affected the entire planning area, including the City of Dublin, are listed in the risk assessments in Volume 1 of this hazard mitigation plan.

Table 1-10. Past Natural Hazard Events

Type of Event	FEMA Disaster #	Date	Damage Assessment
Wildfire	N/A	10/17/2017	50-acre wildfire requiring automated alert system notification to 150 residents to evacuated to City sponsored Shelter. No Damage $0
Wildfire	N/A	8/22/2017	75-acre wildfire on Camp PARKS requiring road closures and automated alert system notification residents directed to City sponsored reunification center. No Damage $0
Drought	N/A	Years 2014-2015	CA Governor declared a state of emergency based on drought conditions in California; City proclaimed Local Emergency and mandatory conservation efforts to show support to water purveyors.
Gas Line Leak	N/A	June, 2006	Private undergrounded jet fuel gas line traversing City of Dublin sustained a leak.
Gasoline Spill	N/A	May, 2009	Privately operated gasoline tanker spill in neighboring jurisdiction leaked into City of Dublin storm-drain system. City had partial emergency operation center activation, provided temporary lodging vouchers and animal sheltering services to impacted neighborhoods.
Flash Flood	N/A	February, 1999	Weeks of severe winter weather and horizontal rain caused significant damage to public facilities.

1.7 JURISDICTION-SPECIFIC VULNERABILITIES

Volume 1 of this hazard mitigation plan provides complete risk assessments for each identified hazard of concern. This section provides information on a few key vulnerabilities for the jurisdiction.

Repetitive loss records are as follows:

- Number of FEMA-identified Repetitive-Loss Properties: 0
- Number of FEMA-identified Severe-Repetitive-Loss Properties: 0
- Number of Repetitive-Loss Properties or Severe-Repetitive-Loss Properties that have been mitigated: 0

Other noted vulnerabilities include the following:

- Storm drain conditions citywide need to be assessed and updated, as appropriate.

1.8 HAZARD RISK RANKING

Table 1-11 presents a local ranking for the City of Dublin of all hazards of concern for which Volume 1 of this hazard mitigation plan provides complete risk assessments. This ranking summarizes how hazards vary for this jurisdiction. As described in detail in Volume 1, the ranking process involves an assessment of the likelihood of occurrence for each hazard, along with its potential impacts on people, property and the economy.

Table 1-11. Hazard Risk Ranking

Rank	Hazard Type	Risk Rating Score (Probability x Impact)	Category
1	Landslide[e]	54	High
2	Earthquake[a]	36	High
3	Severe weather[b]	33	Medium
4	Wildfire[c]	18	Medium
5	Flood[d]	12	Low
6	Drought[f]	9	Low
7	Dam failure[g]	6	Low

a. Based on the "Haywired" (Hayward Fault Scenario M7.05)
b. Severe weather is assessed more qualitatively than other hazards. Assumptions for risk ranking include high probability, medium impact on people, medium impact on property and low impact on economy.
c. Based on Very High and High Fire Severity Zones.
d. Based on 1 percent-annual-chance flood zone (otherwise known as the special flood hazard area)
e. Based on Very High, High, and Moderate Landslide Susceptibility Zones
f. Drought is assessed more qualitatively than other hazards. Generally, drought does not cause injury or death to people or result in property damage. Assumptions for risk ranking include high probability, no impact on people, low impact on property and low impact on economy for those jurisdictions with limited agriculture.
g. Based on the Del Valle Dam inundation scenario.

1.9 STATUS OF PREVIOUS PLAN ACTIONS

Table 1-12 summarizes the actions that were recommended in the previous version of the hazard mitigation plan and their implementation status at the time this update was prepared.

Table 1-12. Status of Previous Plan Actions

Action Item	Completed	Removed; No Longer Feasible	Carried Over to Plan Update: Check if Yes	Carried Over to Plan Update: Enter Action #
The City will continue annual sponsorship of Community Emergency Response Team (CERT) training (INFR-g-6, HSNG-k-6, ECON-j-5, GOVT-c-3, EDUC-c-3). The Fire Department is the lead agency for this activity. The City will accomplish this task with existing resources. This is an annual project.	Completed; Ongoing			N/A
Comment: The City works in partnership with Alameda County Fire Department to perform emergency preparedness services and increase community capability and self-sufficiency during a disaster.				
The City will continue to recruit community volunteers on an annual basis to remove litter and debris from the City's storm drain system (Econ-J-8). The City Manager's Office is the lead agency for this project. The City will accomplish this task with existing resources. This is an annual project.	Completed; Ongoing			N/A
Comment: The City holds a semi-annual creek cleanup as part of Dublin Pride activities and Creek Clean Up Day.				
The City will install, where appropriate, trash capture devices at storm drain inlets (INFR-d-7). The Public Works Department is the lead agency for this project. The City will seek grant funding to offset the cost of installation. Possible grant opportunities exist with ABAG also with the State of California's Used Oil Recycling Program. This is a five-year project.	Completed; Ongoing			N/A
Comment: The City adheres to the Municipal Regional NPDES permit which requires trash load reduction. Through this effort, the City installs trash capture devices and maintains them three times a year.				
The City will consider adoption of the 2010 California Building Code. The code will become effective January 1, 2011 and will apply to all construction activity within the City boundaries (HSNG-f-1, HSNG-g-6, ECON-e-3). The Community Development Department is the lead agency for this project. The City will accomplish this task with existing resources.	Completed			N/A
Comment:				
The City Council will consider adoption of a Climate Action Plan, which includes an inventory of community and municipal greenhouse gas emissions and sets a greenhouse gas reduction target (ENVI-b-2). The City Manager's Office is the lead agency for this project. The City will accomplish this task with existing resources and will be completed by 2011.	Completed			N/A
Comment: The City currently has a Climate Action Plan through 2020.				

1.10 HAZARD MITIGATION ACTION PLAN AND EVALUATION OF RECOMMENDED ACTIONS

Table 1-13 lists the actions that make up the City of Dublin hazard mitigation action plan. Table 1-14 identifies the priority for each action. Table 1-15 summarizes the mitigation actions by hazard of concern and mitigation type.

Table 1-13. Hazard Mitigation Action Plan Matrix

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline
D-1—Where appropriate, support retrofitting or relocation of structures in high hazard areas, prioritizing structures that have experienced repetitive losses.							
Existing	Dam failure, Earthquake, Flood, Landslide, Severe weather, Wildfire	4, 6, 8, 10, 11, 12	City of Dublin Public Works	N/A	High	HMGP, PDM, FMA	Short-term
D-2— Integrate the hazard mitigation plan into other plans, ordinances and programs that dictate land use decisions in the community as feasible.							
New and Existing	Dam failure, Drought, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 2, 6, 8, 10, 11	City of Dublin Community Development	N/A	Low	Staff Time, General Funds	Ongoing
D-3— Actively participate in the plan maintenance protocols outlined in Volume 1 of this hazard mitigation plan.							
New and Existing	Dam failure, Drought, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	City of Dublin, Assistant to the City Manager	All City of Dublin departments identified as lead or support agencies	Low	Staff Time, General Funds	Short-term
D-4—Continue to maintain good standing and compliance under the NFIP through implementation of floodplain management programs that, at a minimum, meet the NFIP requirements: • Enforce the flood damage prevention ordinance. • Participate in floodplain identification and mapping updates. • Provide public assistance/information on floodplain requirements and impacts.							
New and Existing	Flood, Dam failure	1, 4, 6, 9	City of Dublin Public Works/ Environmental Services	N/A	Low	Staff Time, General Funds	Ongoing
D-5—Identify and pursue strategies to increase adaptive capacity to climate change including but not limited to the following: Conduct a Climate Adaptation Evaluation and Develop a Climate Adaptation Plan.							
New and Existing	Dam failure, Drought, Flood, Landslide, Severe weather, Wildfire	1, 2, 5, 7, 8, 9, 10, 12	City of Dublin Public Works / Environmental Services	N/A	Low	Staff Time, General Funds	Short-term
D-6—Integrate flood protection mechanisms into the City's Green Infrastructure Plan.							
New and Existing	Drought, Flood, Severe weather	8, 10, 12	City of Dublin Public Works / Environmental Services	Zone 7	High	Staff time, general funds, HMGP, PDM, FMA, other grants	Short-term integration, long-term implement ation
D-7—Develop a Regional Catastrophic Debris Management Plan to minimize recovery time post-disaster.							
Existing	Dam failure, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 12	City of Dublin Public Works	Tri-Valley Agencies, Alameda County, City Franchised Waste Hauler, Other Waste Haulers	Low	Staff time, general funds	Short-term
D-8—Coordinate with existing GHADs, as applicable, on the mitigation of geological hazards, including landslides.							
New and Existing	Landslide, Earthquake	1, 7	City of Dublin Public Works	GHADs	Low	Staff time, GHAD and HMGP, PDM and other grants	Ongoing

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline
D-9—Complete a Citywide Street Storm Drain Condition Assessment.							
Existing	Flood, Severe weather	1, 8	City of Dublin Public Works	N/A	High	Staff time, Capital Project with general funds	Short-term
D-10—Update City's Flood Damage Prevention Ordinance in accordance with State of California model.							
Existing	Dam failure, flood, severe weather	6, 8, 11	City of Dublin CDD/ Public Works	State of CA	Low	Staff time	Short-term
D-11—Utilize vegetation management to reduce risks in existing development and open space land.							
Existing	Wildfire, flood, severe weather, landslide	10, 12	City of Dublin Fire Prevention Bureau &Public Works Dept.	Alameda County Fire Department, Private Property Owners, East Bay Regional Park District	Low	Staff time	Ongoing
D-12—Reduce hazard vulnerabilities for non-City owned building throughout Dublin. Continually update and adopt building standard codes to incorporate the latest knowledge and design standard to protect people and property against know seismic, fire, flood and landslide risk in both structural and non-structural building and site components.							
Existing	Flood, Earthquake, Wildfire, Severe Weather, Landslide	1, 6, 11	City of Dublin CDD/Building	Alameda County Fire Department International Code Council	Low	Staff time	Ongoing
D-13—Streamline the permitting process to rebuild residential and commercial structures following disaster; prepare an informational handout for property owner and contractors on steps to rebuild following a major disaster.							
New and Existing	Dam failure, Earthquake, Flood, Landslide, Severe weather, Wildfire	4, 6, 7, 9	City of Dublin/CDD Building & Planning	Private Property & Landowners	Low	Staff Time	Short-term
D-14—Improve the disaster-resistance of natural gas delivery system to increase public safety and to minimize damage and service disruption following a disaster. Educate private property owners about gas line shut off procedures.							
New and Existing	Earthquake, Flood, Wildfire	1, 4, 9	City of Dublin/CDD	Alameda County Fire (CERT) PG&E Kinder Morgan Pipeline & Hazardous Material Safety Administration	Medium	Staff Time for education; HMGP, PDM	Short-term
D-15—Provide outreach activities related to hazard mitigation and disaster preparedness. Revitalize and maintain Tri-Valley Hazard Mitigation Plan website, create printed materials for public and business owners.							
New and Existing	Dam failure, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 9	Tri-Valley Cities; City of Dublin	Alameda County Fire Department, Alameda County Sheriff	Low	Staff Time & General Funds	Short-term

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline
D-16—Establish cooling centers and encourage landscaping improvement to reduce Dublin's residents' vulnerability to extreme heat events, severe storms, and associated hazards. Integrate extreme heat readiness in to City operations, services and best practices.							
Existing	Severe weather, flood	8, 10, 12	City of Dublin Public Works & Parks and Community Services Departments	CA Office of Emergency Services	Low	Staff Time	Short-term
D-17—Coordinate disaster preparation and mitigation practices with private sector, public institutions and other public bodies. Maintain an emergency notification system (reverse 9-1-1) to deliver community alerts. Seek guidance from Cal OES and Alameda County OES how best to work and educate private sector about business resilience.							
New and Existing	Dam failure, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 3, 7	City of Dublin City Manager's Office/ PIO/ Disaster Preparedness	County of Alameda CAL OES	Low	Staff Time	Short-term
D-18—Explore local legislation to regulate the storage of hazardous materials to be protected from flood zones. Continue to assess the potential impact from hazardous material stored and transported through Dublin.							
New and Existing	Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 2, 4, 10	City of Dublin City Manager's Office	EPA, Alameda County OES, Ca OES, Alameda County Fire Dept.	Low	Staff Time	Short-term
D-19—Reduce hazard vulnerabilities for City owned building and public facilities throughout Dublin. Continue City's Injury and Illness Prevention Program and Safety Plan of Action including regular facility inspections including office spaces to eliminate hazards.							
Existing	Earthquake	4, 8	City of Dublin City Manager's Office / Disaster Preparedness	Safety Consultant, Alameda County Fire	Medium	Staff time, general funds	Short-term
D-20—Collaborate with Dublin San Ramon Services District (DSRSD), Zone 7, local, state, regional and federal partners to increase the security of Dublin's water supply from climate change impacts. Continue to encourage private and public water recycling, gray water use, and ensure compliance with State's Water Efficient Landscape Ordinance and Bay Friendly Landscaping Guidelines.							
New and Existing	Severe Weather, Drought	1, 2, 7	City of Dublin Public Works Dept. and City Manager's Office	DSRSD Zone 7 CA Dept. of Water Resources	Low	Staff Time	Short-term
D-21—Protect vulnerable electric systems and facilities and build resiliency so disruption to the system is minimized during and following disasters. Ensure adequate redundancy in the form of photovoltaic generation, battery storage systems, energy efficiency, and mobile generators including fuel is available to maintain critical facilities.							
New and Existing	Dam failure, Earthquake, Flood, Landslide, Severe weather, Wildfire	3, 4, 10	City of Dublin City Manager's Office, Public Works Dept., Facilities Development	Alameda County Offices of Emergency Services, Fire, Sheriff, and PG&E,	Low	Staff time, Capital Project with general funds	Short-term

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline
D-22—Conduct ongoing training for City Personnel to ensure they have necessary training and equipment to deal with a hazard (including natural and man-made disasters); Test and train City Disaster Service Workers and those assigned to Emergency Operations Center (R.A.C.E.S); pre-screen, train and educate Disaster Services Volunteers for same.							
New and Existing	Dam failure, Earthquake, Flood, Landslide, Severe weather, Wildfire	3, 7, 9	City of Dublin City Manager's Office	Alameda County Office of Emergency Services, Emergency Managers' Association, and General Public	Low	Staff time, Capital Project for new emergency operation center, general funds	Short-term

Table 1-14. Mitigation Action Priority

Action #	# of Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is Project Grant-Eligible?	Can Project Be Funded Under Existing Programs/ Budgets?	Implementation Priority[a]	Grant Pursuit Priority[a]
D-1	6	High	High	Yes	Yes	No	Medium	High
D-2	6	Medium	Low	Yes	No	Yes	High	Low
D-3	12	Low	Low	Yes	No	Yes	High	Low
D-4	4	Medium	Low	Yes	No	Yes	High	Low
D-5	8	Medium	Low	Yes	No	Yes	High	Medium
D-6	3	High	High	Yes	Yes	Yes	High	High
D-7	2	Medium	Low	Yes	No	Yes	High	Low
D-8	3	Medium	Low	Yes	Yes	Yes	High	High
D-9	2	High	High	Yes	No	Yes	High	Low
D-10	3	Medium	Low	Yes	No	Yes	High	Low
D-11	2	Medium	Low	Yes	No	Yes	High	Low
D-12	3	High	Low	Yes	No	Yes	High	Low
D-13	4	Low	Low	Yes	No	Yes	High	Low
D-14	3	High	Medium	Yes	Yes	Yes	High	High
D-15	2	Medium	Low	Yes	No	Yes	High	Low
D-16	3	Medium	Low	Yes	No	Yes	High	Low
D-17	3	High	Low	Yes	No	Yes	High	Low
D-18	4	Medium	Low	Yes	No	Yes	High	Low
D-19	2	High	Medium	Yes	No	Yes	High	Low
D-20	3	Medium	Low	Yes	No	Yes	High	Low
D-21	3	Medium	Low	Yes	No	Yes	High	Low
D-22	3	Medium	Low	Yes	No	Yes	High	Low

a. See the introduction to this volume for explanation of priorities.

Table 1-15. Analysis of Mitigation Actions

Hazard Type	Action Addressing Hazard, by Mitigation Type[a]							
	Prevention	Property Protection	Public Education and Awareness	Natural Resource Protection	Emergency Services	Structural Projects	Climate Resilient	Community Capacity Building
Landslide	2, 12, 18	1, 8, 11, 12	15		7, 17, 21	8		2, 3, 5, 8, 13, 21, 22
Earthquake	2, 12, 18	1, 8, 12, 19	14, 15		7, 17, 21			3, 8, 13, 14, 21, 22
Severe weather	2, 10, 12, 16, 18, 20	1, 11, 12	15	6	7, 17, 21		6, 16, 20	3, 5, 6, 13, 21, 22
Wildfire	2, 12, 18	1, 11, 12	14, 15		7, 17, 21			3, 5, 13, 14, 21, 22
Flood	2, 4, 9, 10, 12, 16, 18	1, 4, 9, 11, 12	4, 14, 15	6	7, 17, 21		6, 16	3, 5, 6, 9, 13, 14, 21, 22
Drought	2, 20		15	6			6, 20	3, 5, 6
Dam failure	2, 4, 10	1, 4	4, 15		7, 17, 21			3, 5, 13, 21, 22

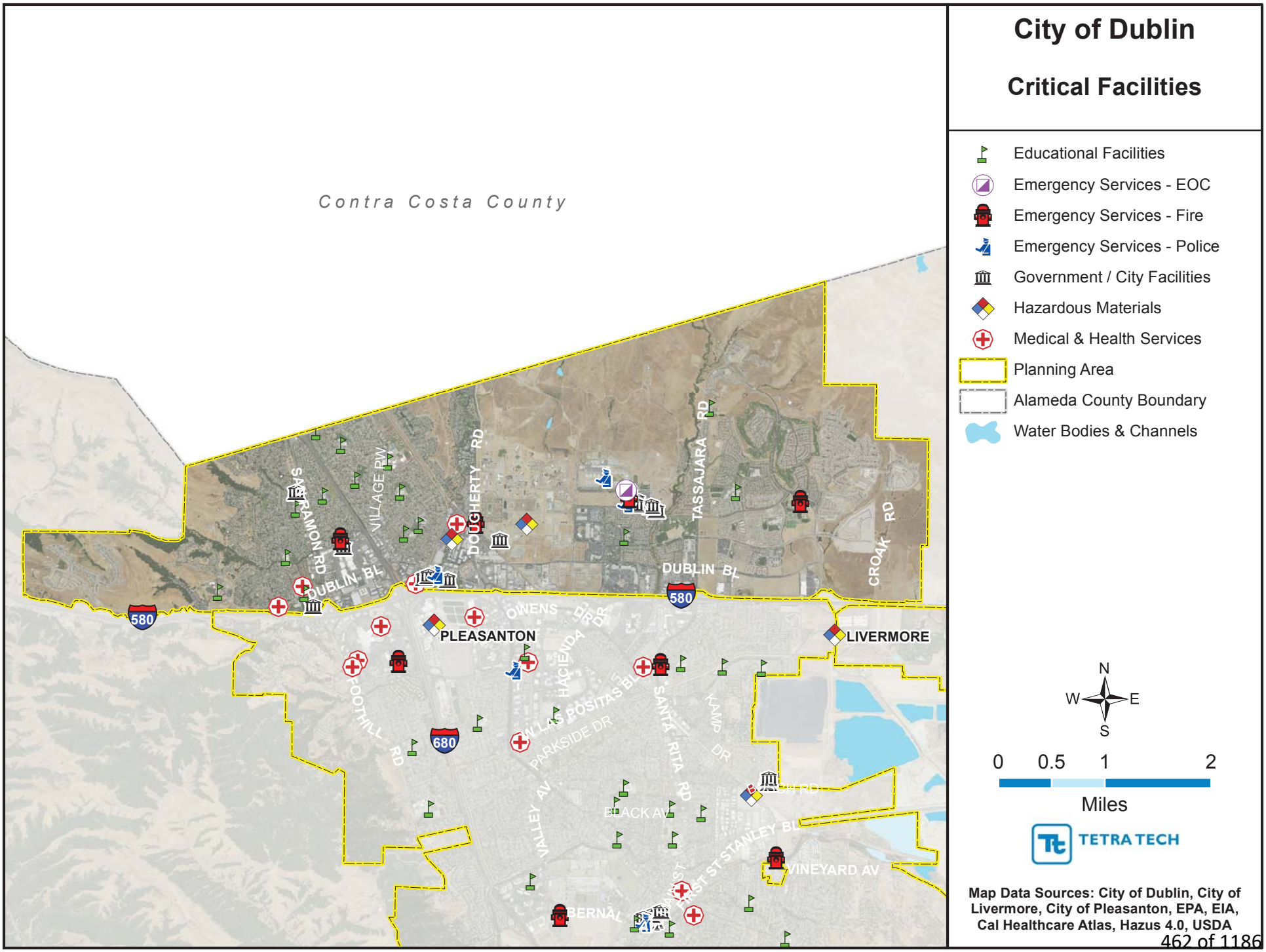
a. See the introduction to this volume for explanation of mitigation types.

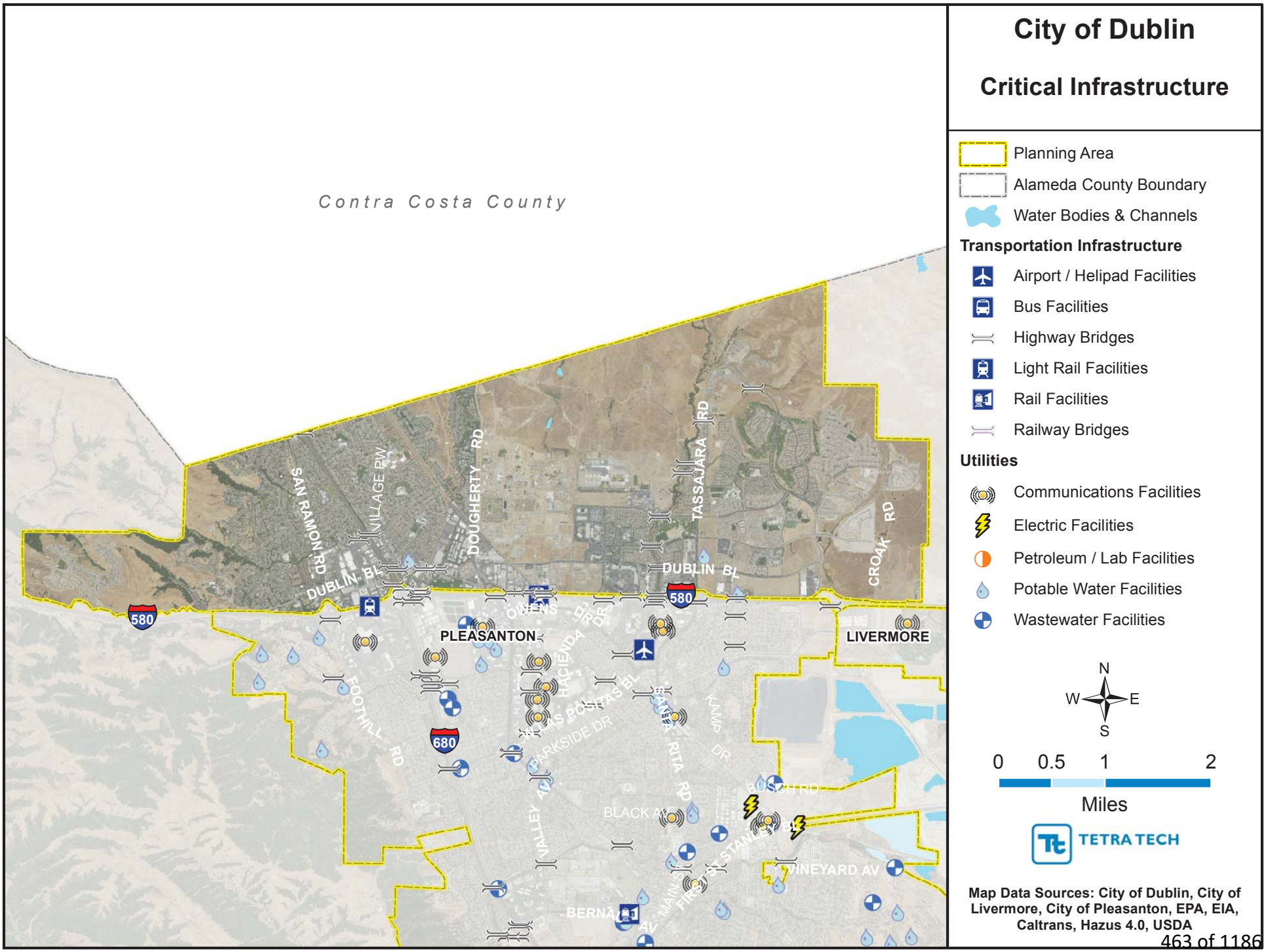
1.11 REVIEW AND INCORPORATION OF RESOURCES FOR THIS ANNEX

The following technical reports, plans, and regulatory mechanisms were reviewed to provide information for this annex.

- **City of Dublin Municipal Code**—The municipal code was reviewed for the full capability assessment and for identifying opportunities for action plan integration.
- **City of Dublin Flood Damage Prevention Ordinance**—The flood damage prevention ordinance was reviewed for compliance with the National Flood Insurance Program.
- **Climate Action Plan (2013)**—The Climate Action Plan was used to develop ratings for the adaptive capacity assessment conducted as part of the capability assessment.
- **General Plan**—The General Plan was used to develop ratings for the adaptive capacity assessment conducted as part of the capability assessment.
- **Technical Reports and Information—**The following **o**utside resources and references were reviewed:

  - **Hazard Mitigation Plan Annex Development Tool-kit**—The tool-kit was used to support the development of this annex including past hazard events, noted vulnerabilities, risk ranking and action development.
  - **American FactFinder**—Information obtained via the American FactFinder website was used to develop ratings for the adaptive capacity assessment conducted as part of the capability assessment.
  - **Community and Economic Profile**—Information on the City of Dublin's website regarding the City's business profile was used to develop ratings for the adaptive capacity assessment conducted as part of the capability assessment.


City of Dublin
Critical Facilities
Contra Costa County
Educational Facilities
Emergency Services - EOC
Emergency Services - Fire
Emergency Services - Police
Government / City Facilities
Hazardous Materials
Medical & Health Services
Planning Area
Alameda County Boundary
Water Bodies & Channels
SAN RAMON RD
VILLAGE PW
DOUGHERTY RD
TASSAJARA RD
CROAK RD
DUBLIN BL
580
PLEASANTON
OWENS DR
HACIENDA
LIVERMORE
FOOTHILL RD
680
VALLEY AV
PARKSIDE DR
SANTA RITA RD
KAMP DR
BLACK AV
FIRST ST
STANLEY BL
VINEYARD AV
N
W
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Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, EPA, EIA, Cal Healthcare Atlas, Hazus 4.0, USDA



City of Dublin

Critical Infrastructure

- Planning Area
- Alameda County Boundary
- Water Bodies & Channels

Transportation Infrastructure

- Airport / Helipad Facilities
- Bus Facilities
- Highway Bridges
- Light Rail Facilities
- Rail Facilities
- Railway Bridges

Utilities

- Communications Facilities
- Electric Facilities
- Petroleum / Lab Facilities
- Potable Water Facilities
- Wastewater Facilities

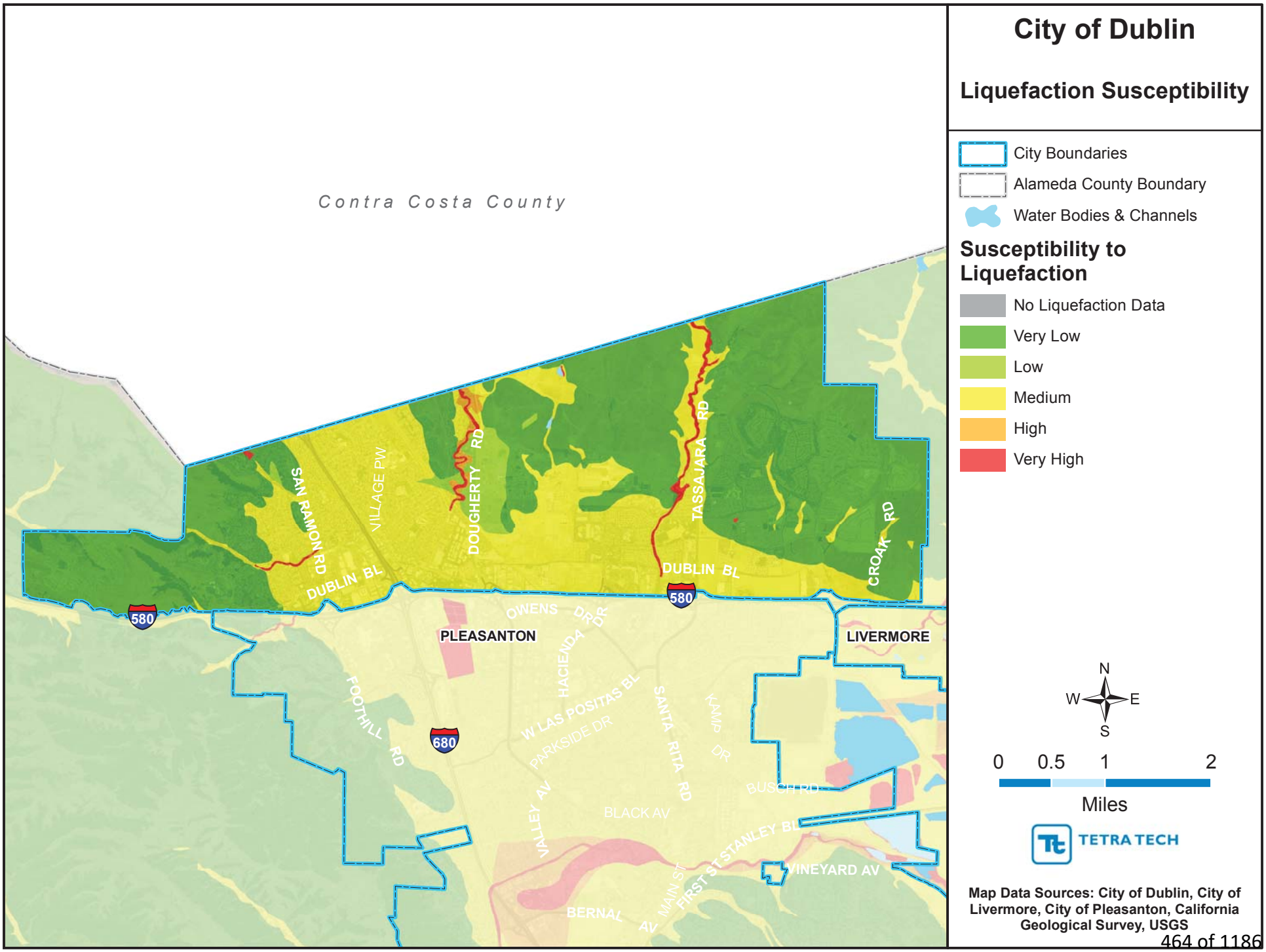
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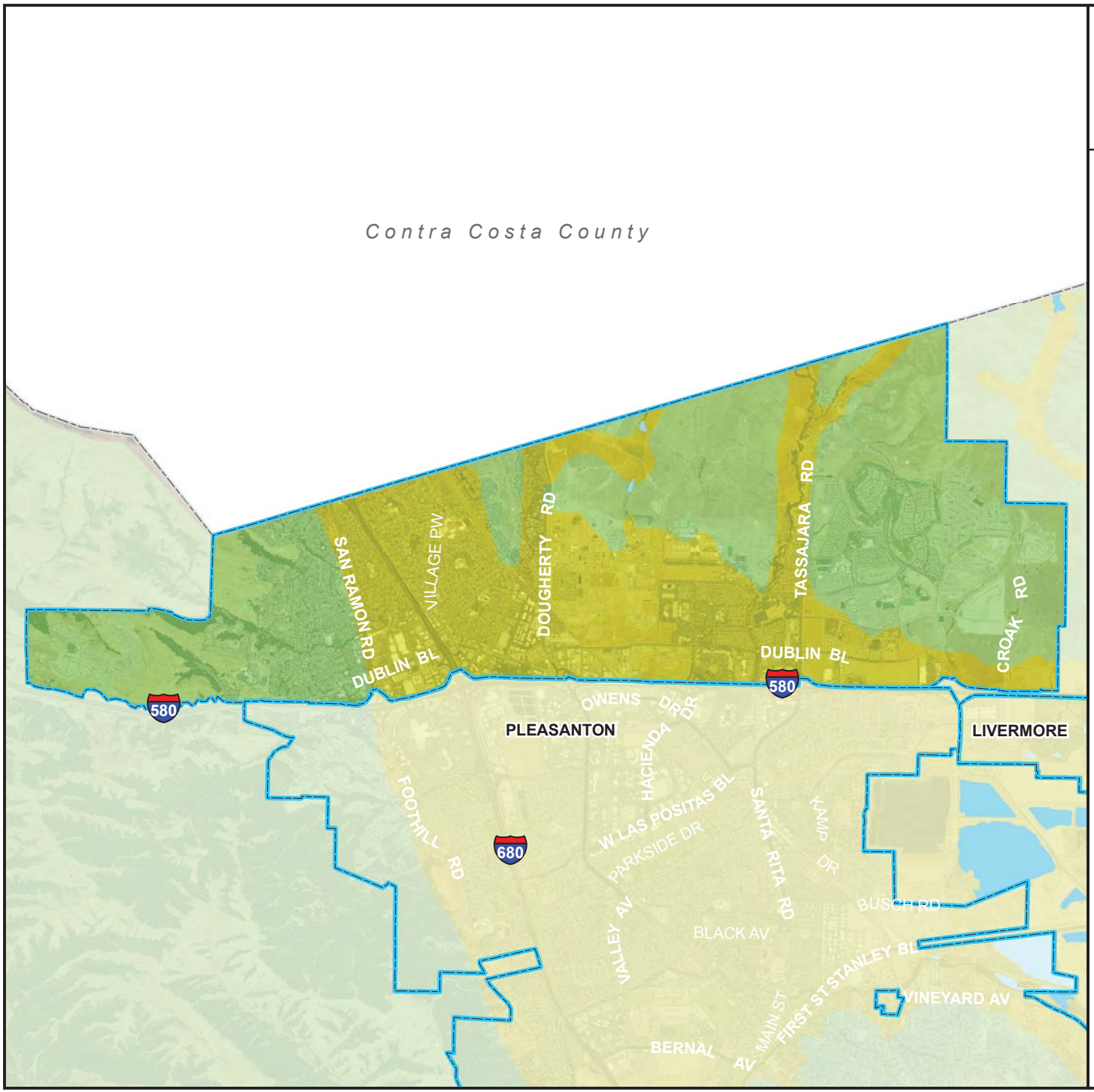
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Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, EPA, EIA, Caltrans, Hazus 4.0, USDA


City of Dublin
Liquefaction Susceptibility
City Boundaries
Alameda County Boundary
Water Bodies & Channels
Susceptibility to Liquefaction
No Liquefaction Data
Very Low
Low
Medium
High
Very High
Contra Costa County
SAN RAMON RD
VILLAGE PW
DOUGHERTY RD
TASSAJARA RD
CROAK RD
DUBLIN BL
580
PLEASANTON
LIVERMORE
OWENS DR
HACIENDA DR
FOOTHILL RD
680
W LAS POSITAS BL
PARKSIDE DR
SANTA RITA RD
KAMP DR
BUSCH RD
VALLEY AV
BLACK AV
STANLEY BL
VINEYARD AV
MAIN ST
FIRST ST
BERNAL AV
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Miles
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Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, California Geological Survey, USGS

City of Dublin

National Earthquake Hazards Reduction Program (NEHRP) Soil Classification



City Boundaries

Alameda County Boundary

Water Bodies & Channels

NEHRP Site Class / Soil Profile

- B / Rock
- C / Very Dense Soil - Soft Rock
- D / Stiff Soil
- E / Soft Soil

Soil classification data provided by the California Department of Conservation. The data is based on surficial geology published at a scale of 1:250,000. The surficial geologic units were grouped into composite units with similar average shear wave velocity to 30 meters depth (Vs30) values. This data was prepared as part of the Probabilistic Seismic Hazard Map of California (Petersen, M., D. Beeby, W. Bryant, T. Cao, C. Cramer, J. Davis, M. Reichle, G. Saucedo, S. Tan G., Taylor, T. Toppozada, J. Treiman, and C. Wills (1999) Seismic Shaking Hazard Maps of California: California Division of Mines and Geology Map Sheet 48).

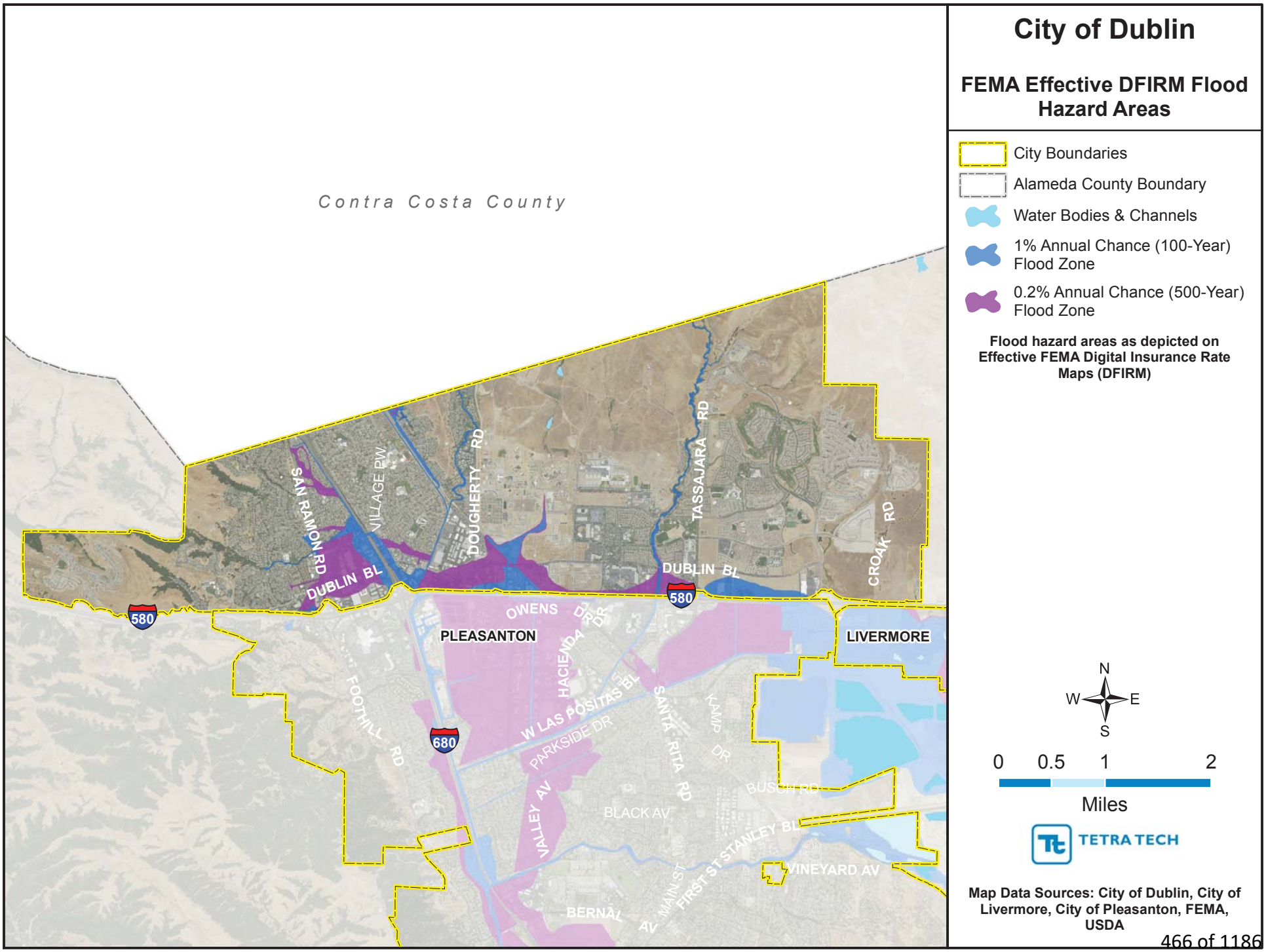
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Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, California Dept of Conservation, CGS, USGS



City of Dublin

FEMA Effective DFIRM Flood Hazard Areas

- City Boundaries
- Alameda County Boundary
- Water Bodies & Channels
- 1% Annual Chance (100-Year) Flood Zone
- 0.2% Annual Chance (500-Year) Flood Zone

Flood hazard areas as depicted on Effective FEMA Digital Insurance Rate Maps (DFIRM)

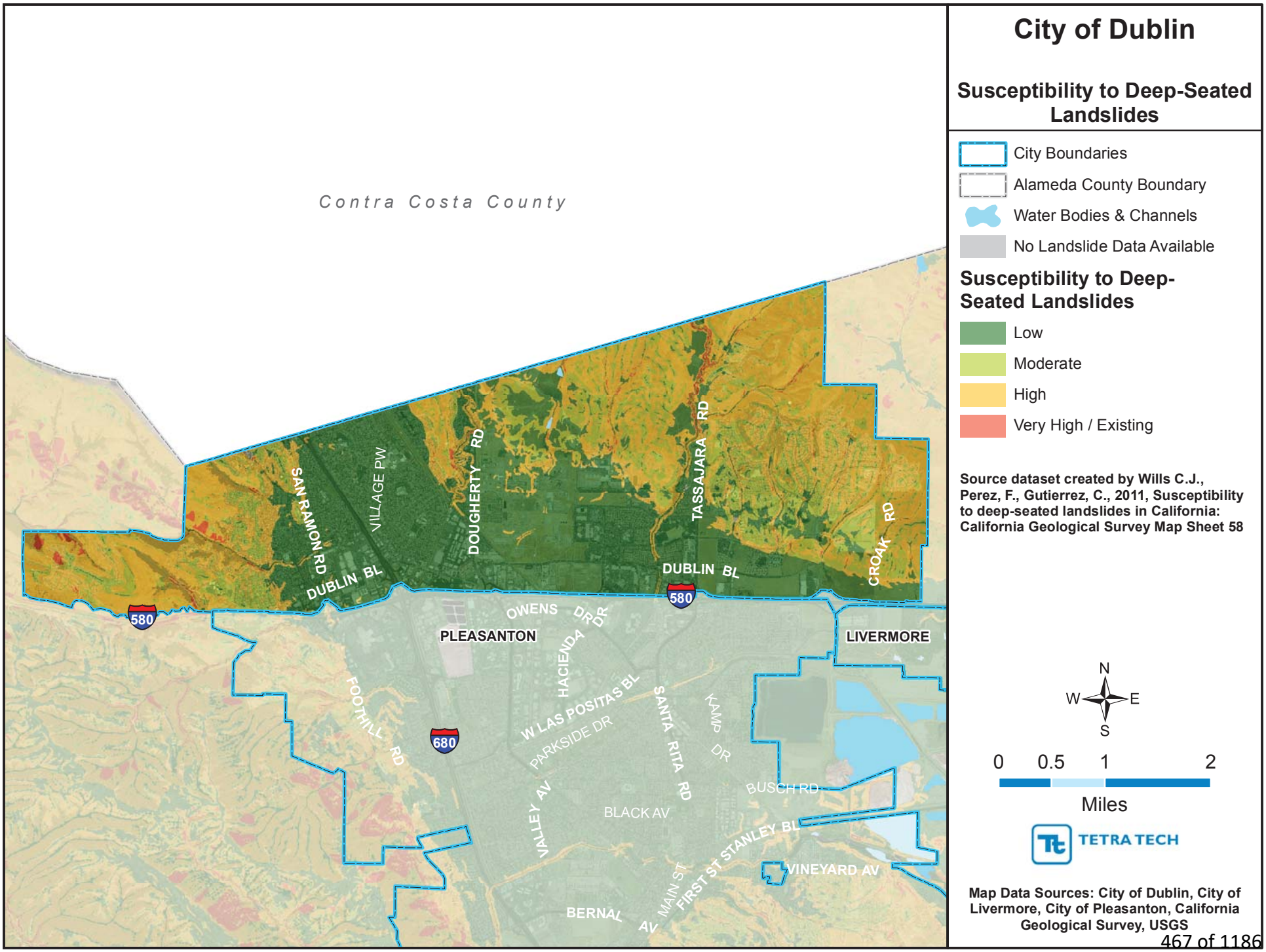
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Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, FEMA, USDA



City of Dublin

Susceptibility to Deep-Seated Landslides

City Boundaries

Alameda County Boundary

Water Bodies & Channels

No Landslide Data Available

Susceptibility to Deep-Seated Landslides

Low

Moderate

High

Very High / Existing

Source dataset created by Wills C.J., Perez, F., Gutierrez, C., 2011, Susceptibility to deep-seated landslides in California: California Geological Survey Map Sheet 58

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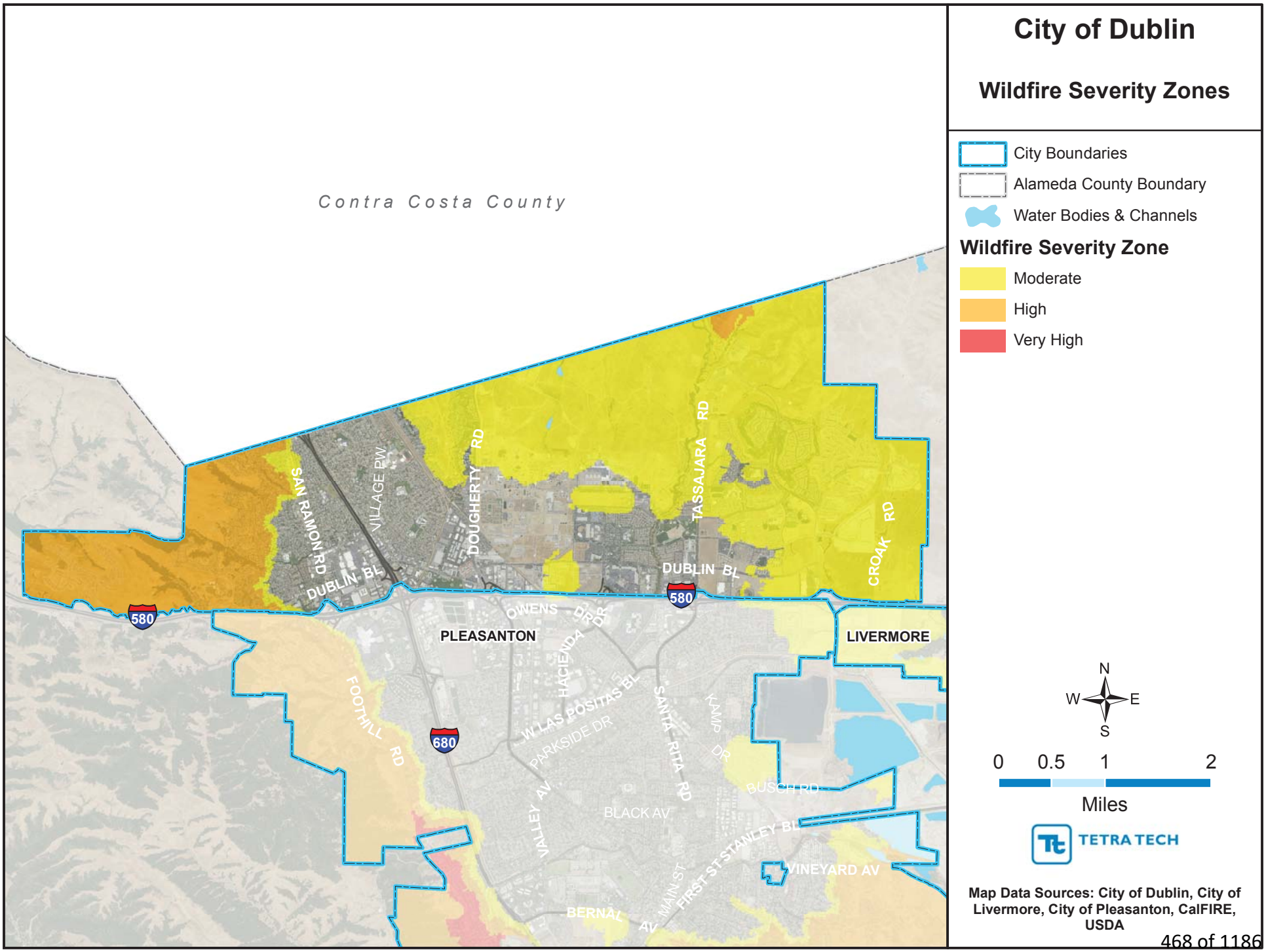
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Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, California Geological Survey, USGS

City of Dublin

Wildfire Severity Zones



City Boundaries

Alameda County Boundary

Water Bodies & Channels

Wildfire Severity Zone

Moderate

High

Very High

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Miles

TETRA TECH

Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, CalFIRE, USDA

2. CITY OF LIVERMORE

2.1 HAZARD MITIGATION PLAN POINT OF CONTACT

Primary Point of Contact
Marc Roberts, City Manager
City Manager's Office
1052 S. Livermore Avenue
Livermore, CA 94550
Telephone: 925-960-4040
e-mail Address: citymanager@cityoflivermore.net

Alternate Point of Contact
Paul Spence, Community Development Director
Livermore Community Development Department
1052 S. Livermore Ave.
Livermore, CA 94550
Telephone: 925-960-4400
e-mail Address: cedd@cityoflivermore.net

2.2 JURISDICTION PROFILE

The following is a summary of key information about the jurisdiction and its history:

- **Date of Incorporation**— April 1, 1876
- **Current Population**— 89,648 as of January 1, 2017, per the State of California Department of Finance
- **Population Growth**— Based on data provided by the state Department of Finance, Livermore's annual population growth is about 1.5% per year since 2010.
- **Location and Description**—Livermore is located in the Livermore Valley in eastern Alameda County about 43 miles southeast of San Francisco, 30 miles southeast of Oakland, and 29 miles northeast of San Jose. The Livermore Valley is edged to the north, south and east by rolling hills within which the urbanized area is located. Several creeks and arroyos traverse the city including Altamont Creek, Arroyo Seco, Arroyo Mocho, Arroyo Las Positas, Collier Canyon Creek and Arroyo del Valle. Livermore is bisected by Interstate 580 which runs east-west through Alameda County. The Union Pacific Railroad, which also serves the ACE train commuter rail service, roughly parallels the freeway to the south. The Livermore Municipal Airport, located on the western edge of the city, is a general aviation airport which primarily serves the Tri-Valley Area.
- **Brief History**—The City of Livermore was founded in 1869 by William Mendenhall. In the years leading up to incorporation in 1876, the Livermore Valley was used mainly for grazing land for cattle and sheep. Mendenhall named the city in honor of his friend Robert Livermore, a prominent rancher in the valley. Livermore's development as a city was based on the Western Pacific Railroad and the commerce the railroad brought with it, as well as cattle ranches and vineyards. Since its incorporation, Livermore has grown from its agricultural roots to a thriving suburban community. While retaining much of its agricultural heritage, Livermore now provides a variety of housing and employment opportunities. Major employers include Lawrence Livermore and Sandia National Laboratories, Valley Care Health Systems, US Foods and several local public agencies, including the City of Livermore, Livermore Area Recreation and Park District and the Livermore Valley Joint Unified School District.
- **Climate**—Livermore's climate is typical for inland Bay Area valleys with warm to hot, dry summers and mild to cool, wet winters. Summer daytime temperatures range from 75 to 85º F, sometimes reaching 100º F and higher. Summer nighttime temperatures average in the 50 to 60º F range. Winter daytimes

temperatures range 50 to 60º F with nighttime temperatures averaging in the 35 to 40º F range. Average annual rainfall is 14.6 inches occurring mainly from September to May.

- **Governing Body Format**—The City of Livermore operates under the Council/Manager form of government. The Council, as the legislative body, represents the entire community and is empowered under the General Law of California to formulate city-wide policy. The City Council is comprised of four Councilmembers and the Mayor. They are elected at-large by city voters. Councilmembers serve four-year terms and the Mayor serves a two-year term. The City Manager is appointed by the Council and serves as the chief executive officer responsible for day-to-day administration of city affairs and implementation of Council policies. The City Council assumes responsibility for the adoption of this plan; the City Manager will oversee its implementation.

2.3 DEVELOPMENT TRENDS

Under General Plan policies, residential development is limited to an average range between 140 to 700 units per year. Due to the Urban Growth Boundary, residential development has primarily been infill in recent years. Jobs have increased almost 10% between 2010 and 2015, with about 42,300 jobs in 2015. The Livermore General Plan anticipates about 41,000 residential units and 86,000 jobs at buildout.

Table 2-1 summarizes development trends in the performance period since development of the previous hazard mitigation plan and expected future development trends.

2.4 CAPABILITY ASSESSMENT

The City of Livermore has performed an inventory and analysis of existing capabilities, plans, programs and policies that enhance its ability to implement mitigation strategies. The introduction at the beginning of this volume of the hazard mitigation plan describes the components included in the capability assessment and their significance for hazard mitigation planning. This section summarizes the following findings of the assessment:

- An assessment of legal and regulatory capabilities is presented in Table 2-2.
- Development and permitting capabilities are presented in Table 2-3.
- An assessment of fiscal capabilities is presented in Table 2-4.
- An assessment of administrative and technical capabilities is presented in Table 2-5.
- An assessment of education and outreach capabilities is presented in Table 2-6.
- Information on National Flood Insurance Program (NFIP) compliance is presented in Table 2-7.
- Classifications under various community mitigation programs are presented in Table 2-8.
- The community's adaptive capacity for the impacts of climate change is presented in Table 2-9.

The capability assessment was reviewed in order to identify opportunities to expand, initiate or integrate capabilities to further hazard mitigation goals and objectives. Where such opportunities were identified and determined to be feasible, they are included in the action plan and are identified as Community Capacity Building mitigation actions in the Analysis of Mitigation Actions table in Section 2.10.

Table 2-1. Recent and Expected Future Development Trends

Criterion	Response
Has your jurisdiction annexed any land since the development of the previous hazard mitigation plan? • If yes, give the estimated area annexed and estimated number of parcels or structures.	Yes 1,022 acres including Lawrence Livermore National Laboratory (627 acres), Sandia National Laboratory (390 acres) and two rural parcels (5 acres total).
Is your jurisdiction expected to annex any areas during the performance period of this plan? • If yes, please describe land areas and dominant uses. • If yes, who currently has permitting authority over these areas?	Yes Pending annexation applications: 0.62-acre vacant parcel for proposed single family dwelling and secondary unit; 9.34 acres with 19 existing single family units and 4 vacant lots; 79.4 acres with existing winery and vineyard; 0.1-acre vacant parcel for fast food restaurant; 2.53-acre vacant parcel for car wash/gas station/fast food; 21 acres for residential and park uses Alameda County
Are any areas targeted for development or major redevelopment in the next five years? • If yes, please briefly describe, including whether any of the areas are in known hazard risk areas	Yes • Isabel Neighborhood Plan – Proposed neighborhood plan covering 1,138 acres including 4,095 dwelling units and 2 million square feet of commercial and office space. Areas of low to medium liquefaction susceptibility and moderate wildfire risks are within the plan area. • Arroyo Vista Neighborhood Plan – Approved neighborhood plan covering 28 acres and 456 dwelling units. Plan includes area of medium liquefaction risk. • Rincon/Pine Plan – Proposed plan for mixed use including 91 dwelling units and 15,000-square-foot commercial. Plan includes area of medium liquefaction risk. • First Street Corridor Plan – Approved neighborhood plan covering 24 acres for up to 350 units; first phase project of 100 units approved. Plan includes areas of low to medium liquefaction risk and 500-year flood zone.
How many permits for new construction were issued in your jurisdiction since the development of the previous hazard mitigation plan?	

	2012	2013	2014	2015	2016
Single Family	110	96	71	272	140
Multi-Family	20	8	4	22	40
Other (commercial, mixed use, etc.)	8	7	15	13	4

Please provide the number of new-construction permits for each hazard area or provide a qualitative description of where development has occurred.	• Special Flood Hazard Areas: No new residential development permits were located within the 100 or 500-year flood zones. Approximately 13 new commercial permits were issued for development located in the 100-year flood zone. All commercial structures are part of Conditional Letter of Map Revision Case No. 08-09-1228R. The application will be submitted December 2017 to show the area out of the floodplain. • Landslide: The majority of the city is areas of low landslide susceptibility. No new development has occurred in areas of moderate, high or very high landslide susceptibility. • High Liquefaction Areas: The majority of the city is located in areas of very low to moderate liquefaction susceptibility. New industrial development has occurred in an area of high liquefaction south of the Airport. • Wildfire Risk Areas: Areas of moderate to high wildfire severity are located primarily on the edges of the city where urban development abuts agriculture/open space areas. New residential, commercial and industrial development has occurred in areas of moderate wildfire severity. No new development has occurred in areas of high wildfire severity. There are no areas of very high wildfire severity in the city limits.
Please describe the level of buildout in the jurisdiction, based on your jurisdiction's buildable lands inventory. If no such inventory exists, provide a qualitative description.	The Livermore General Plan anticipates approximately 41,000 dwelling units and 86,000 jobs at buildout. Buildout estimates include not only development of vacant parcels, but also redevelopment of underdeveloped parcels and intensification of uses in existing buildings

Table 2-2. Legal and Regulatory Capability

	Local Authority	Other Jurisdiction Authority	State Mandated	Integration Opportunity?
Codes, Ordinances, & Requirements				
Building Code	Yes	No	Yes	Yes
Comment: Livermore Building Code adopted in 2016				
Zoning Code	Yes	No	Yes	Yes
Comment: Livermore Development Code adopted in 2010; updated through July 2017				
Subdivisions	Yes	No	Yes	Yes
Comment: Livermore Development Code adopted in 2010; updated through July 2017				
Stormwater Management	Yes	Yes	Yes	Yes
Comment: City Stormwater Master Plan for city-owned property; Zone 7 Stream Management Master Plan for Zone 7 owned facilities/property.				
Post-Disaster Recovery	No	No	No	Yes
Comment: Preparation of plan proposed.				
Real Estate Disclosure	Yes	No	Yes	Yes
Comment: City uses real estate disclosure to provide notice regarding special conditions and requirements on properties; Cal. Civ. Code §1102 et seq.				
Growth Management	Yes	No	Yes	Yes
Comment: General Plan includes policies and programs for residential growth management; Cal. Gov. Code §65300 et seq.				
Site Plan Review	Yes	No	No	Yes
Comment: Site Plan Approval required in Development Code for all new development and redevelopment projects.				
Environmental Protection	Yes	Yes	Yes	Yes
Comment: The City conforms to the requirements of the California Environmental Quality Act for development review as well as applicable environmental protection requirements for businesses. City coordinates with other agencies including Regional Water Quality Control Board, Bay Area Air Quality Management District, California Department of Fish and Wildlife, US Fish and Wildlife Service, and Alameda County Health Department.				
Flood Damage Prevention	Yes	Yes	Yes	Yes
Comment: The City has agreements with Zone 7 for stream management and flood protection projects. The city's floodplain ordinance implements NFIP requirements, plus 1' of freeboard and elevation certificates of new buildings adjacent to creeks.				
Emergency Management	Yes	Yes	Yes	Yes
Comment: Water Resources Division has a Water System Emergency Plan which needs to be updated. Livermore Emergency Management Plan adopted in 2005; Plan conforms with the state-mandated Standardized Emergency Management System and the National Incident Management System				
Climate Change	Yes	No	Yes	Yes
Comment: General Plan Climate Change Element adopted in 2009; Climate Action Plan adopted in 2012; California Senate Bill 379 requires cities to include climate adaptation and resiliency strategies in their general plans				
Other:	N/A	N/A	N/A	N/A
Comment: None identified				
Planning Documents				
General Plan	Yes	No	Yes	Yes
Is the plan compliant with Assembly Bill 2140? No				
Comment: Livermore General Plan was adopted in 2004. Comprehensive update scheduled for 2019. General plans required under Government Code Sec. 65300.				
Capital Improvement Plan	Yes	No	Yes	Yes
How often is the plan updated? Every 2 Years				
Comment: FY 2017-2019 CIP adopted in June 2017. The CIP is coordinated with Zone 7 and Livermore Area Recreation & Park District improvement plans.				

	Local Authority	Other Jurisdiction Authority	State Mandated	Integration Opportunity?
Floodplain or Watershed Plan	No	Yes	No	Yes
Comment: City coordinates with Zone 7 who is responsible for flood control. The city regulates the watershed by enforcing the Municipal Regional Permit and the NFIP requirements plus 1' freeboard and elevation certificates for all new buildings next to creeks. The city has a Stream Maintenance Program which allows the city to maintain all creeks within city limits including creeks owned by Livermore Area Recreation & Park District and Zone 7.				
Stormwater Plan	Yes	Yes	Yes	Yes
Comment: City Stormwater Master Plan adopted in 2004; Zone 7 Stream Management Master Plan adopted in 2006				
Urban Water Management Plan	Yes	Yes	Yes	Yes
Comment: 2015 Urban Water Management Plan applies in area served by city. California Water Service provides water to remaining areas of the city.				
Habitat Conservation Plan	No	Yes	No	No
Comment: City participates in the Eastern Alameda County Conservation Strategy.				
Economic Development Plan	Yes	No	No	Yes
Comment: General Plan includes an Economic Development and Fiscal Element.				
Shoreline Management Plan	No	No	No	No
Comment: Not applicable				
Community Wildfire Protection Plan	No	Yes	No	Yes
Comment: Alameda County				
Forest Management Plan	No	No	No	No
Comment: Not applicable				
Climate Action Plan	Yes	No	No	Yes
Comment: City CAP adopted in 2012. Update scheduled for 2018.				
Comprehensive Emergency Management Plan	Yes	Yes	Yes	Yes
Comment: Livermore Emergency Management Plan adopted in 2005. Plan conforms to the state-mandated Standardized Emergency Management System and the National Incident Management System.				
Threat & Hazard Identification & Risk Assessment (THIRA)	No	No	No	Yes
Comment: THIRA may be developed within the performance period of this plan				
Post-Disaster Recovery Plan	No	No	No	Yes
Comment:				
Continuity of Operations Plan	Yes	No	No	Yes
Comment: 2017 Livermore Municipal Code; Annex on the Livermore Emergency Management Plan adopted in 2005				
Public Health Plan	No	Yes	Yes	Yes
Comment: Alameda County Public Health Department prepares a Community Health Improvement Plan				
Other:	N/A	N/A	N/A	N/A
Comment: None identified				

Table 2-3. Development and Permitting Capability

Criterion	Response
Does your jurisdiction issue development permits? • If no, who does? If yes, which department?	Yes Building, Planning and Engineering Divisions of the Community Development Department (CDD); Water Resources Division of Public Works Department
Does your jurisdiction have the ability to track permits by hazard area?	Yes
Does your jurisdiction have a buildable lands inventory?	Yes Buildable lands inventory included in the 2015 Housing Element for residential development. Inventory of non-residential lands not available.

Table 2-4. Fiscal Capability

Financial Resource	Accessible or Eligible to Use?
Community Development Block Grants	Yes
Capital Improvements Project Funding	Yes
Authority to Levy Taxes for Specific Purposes	Yes
User Fees for Water, Sewer, Gas or Electric Service	Yes – Water and Sewer services
Incur Debt through General Obligation Bonds	Yes
Incur Debt through Special Tax Bonds	Yes
Incur Debt through Private Activity Bonds	No
Withhold Public Expenditures in Hazard-Prone Areas	Yes
State-Sponsored Grant Programs	Yes
Development Impact Fees for Homebuyers or Developers	Yes
Other	Yes – Landscape Maintenance Districts

Table 2-5. Administrative and Technical Capability

Staff/Personnel Resource	Available?	Department/Agency/Position
Planners or engineers with knowledge of land development and land management practices	Yes	CDD/ Planning/Assistant, Associate, Senior Planners; Engineering/Assistant and Associate Engineers
Engineers or professionals trained in building or infrastructure construction practices	Yes	CDD; Building and Engineering
Planners or engineers with an understanding of natural hazards	Yes	CDD/ Planning/Assistant, Associate, Senior Planners; Engineering/Assistant and Associate Engineers
Staff with training in benefit/cost analysis	Yes	CDD/Engineering/ Assistant and Associate Engineers
Surveyors	Yes	CDD/Engineering/Contract
Personnel skilled or trained in GIS applications	Yes	Information Technology/Contract; CDD/Planning/ Assistant, Associate, Senior Planners; Engineering/Engineering Tech
Scientist familiar with natural hazards in local area	Yes	CDD/Planning/Contract
Emergency Manager	Yes	City Manager's Office/Management Analyst-Disaster Preparedness; LPFD/Disaster Preparedness Coordinator
Grant writers	Yes	CDD/ Planning/Assistant, Associate, Senior Planners; Engineering/Assistant and Associate Engineers
Other	-	-

Table 2-6. Education and Outreach Capability

Criterion	Response
Do you have a Public Information Officer or Communications Office?	Yes
Do you have personnel skilled or trained in website development?	Yes
Do you have hazard mitigation information available on your website? • If yes, please briefly describe.	Yes 2012 Hazard Mitigation Plan on LPFD website.
Do you utilize social media for hazard mitigation education and outreach? • If yes, please briefly describe.	Yes Advertise CERT trainings; post family disaster preparedness tips
Do you have any citizen boards or commissions that address issues related to hazard mitigation? • If yes, please briefly describe.	No N/A
Do you have any other programs already in place that could be used to communicate hazard-related information? • If yes, please briefly describe.	Yes Living Arroyos Program LPFD Public Education Program
Do you have any established warning systems for hazard events? • If yes, please briefly describe.	Yes Next Door, Nixle, AC Alert

Table 2-7. National Flood Insurance Program Compliance

Criterion	Response
What local department is responsible for floodplain management?	Community Development/Engineering
Who is your floodplain administrator? (department/position)	CDD/Senior Civil Engineer
Are any certified floodplain managers on staff in your jurisdiction?	Yes
What is the date that your flood damage prevention ordinance was last amended?	2015
Does your floodplain management program meet or exceed minimum requirements? • If exceeds, in what ways?	Exceeds 1 ft. freeboard requirement, requires elevation certificates for new construction next to creeks
When was the most recent Community Assistance Visit or Community Assistance Contact?	2017
Does your jurisdiction have any outstanding NFIP compliance violations that need to be addressed? • If so, please state what they are.	No N/A
Do your flood hazard maps adequately address the flood risk within your jurisdiction? • If no, please state why.	No Inundation due to storm drains.
Does your floodplain management staff need any assistance or training to support its floodplain management program? • If so, what type of assistance/training is needed?	Yes Training additional staff in duties of floodplain management
Does your jurisdiction participate in the Community Rating System (CRS)? • If yes, is your jurisdiction interested in improving CRS Classification? • Is your jurisdiction interested in joining the CRS program?	Yes (Class 9) Yes N/A
How many flood insurance policies are in force in your jurisdiction?[a] • What is the insurance in force? • What is the premium in force?	108 $36,407,900 $104,928
How many total loss claims have been filed in your jurisdiction?[a] • How many claims are still open/were closed without payment? • What were the total payments for losses?	0 0 $0

a. According to FEMA statistics as of June 30, 2017

Table 2-8. Community Classifications

	Participating?	Classification	Date Classified
Community Rating System	Yes	9	05/1/15
Building Code Effectiveness Grading Schedule	Yes	2	2012
Public Protection	No	N/A	N/A
Storm Ready	Yes[a]	N/A	N/A
Firewise	No	N/A	N/A

a. At the time of this plan update, the City is in the process of verification for StormReady classification.

Table 2-9. Adaptive Capacity for Climate Change

Criterion	Jurisdiction Rating[a]
Technical Capacity	
Jurisdiction-level understanding of potential climate change impacts	High
Comment: *A greenhouse gas inventory was conducted in 2008 using 2005 data. This supported the preparation and adoption of the Climate Change Element of the General Plan in 2009. The adoption of the Climate Action Plan followed in 2012.*	
Jurisdiction-level monitoring of climate change impacts	Medium
Comment: *The City has adopted a Climate Action Plan and the General Plan includes climate change policies. While climate change impacts are not specifically monitored, hazards are monitored via the local hazard mitigation plan.*	
Technical resources to assess proposed strategies for feasibility and externalities	Medium
Comment: *City staff and/or consultants are available to assess strategies for feasibility.*	
Jurisdiction-level capacity for development of greenhouse gas emissions inventory	High
Comment: *City planning staff, with assistance from ICLEI, is conducting an update to the greenhouse gas inventory which will be completed by early 2018.*	
Capital planning and land use decisions informed by potential climate impacts	Medium
Comment: *Impacts relating to GHG emissions evaluated during environmental review*	
Participation in regional groups addressing climate risks	Medium
Comment: *Staff tracks discussions of regional (e.g. ABAG, MTC) and local (e.g. Stop Waste) agencies*	
Implementation Capacity	
Clear authority/mandate to consider climate change impacts during public decision-making processes	Low
Comment: *While CEQA requires consideration of GHG emissions during environmental review there is no clear authority to otherwise consider climate change impacts during the decision-making process.*	
Identified strategies for greenhouse gas mitigation efforts	High
Comment: *Climate Action Plan outlines strategies for reducing GHG emissions within the community and city operations.*	
Identified strategies for adaptation to impacts	Medium
Comment: *The GHG emissions inventory completed for the Climate Action Plan identified sectors with the greatest potential to reduce emissions. The city is also working with Stop Waste on identification of climate adaptation strategies available for further consideration.*	
Champions for climate action in local government departments	Low
Comment: *While some city staff has experience with climate action planning, there is not a coordinated program to address climate action planning.*	
Political support for implementing climate change adaptation strategies	Medium
Comment: *The city is supportive of resilient infrastructure projects but there is no specific program to identify climate adaptation projects.*	
Financial resources devoted to climate change adaptation	Low
Comment: *While many capital improvement projects can address climate adaption, there is no specific program to identify climate adaptation projects.*	

Criterion	Jurisdiction Rating[a]
Local authority over sectors likely to be negative impacted	Medium
Comment: *The city has authority over local public streets and infrastructure and coordinates with other public agencies, such as Zone 7, Regional Water Quality Control Board, CalTrans, Livermore Area Recreation and Park District, regarding hazard mitigation.*	
Public Capacity	
Local residents' knowledge of and understanding of climate risk	High
Comment: *Livermore residents are highly educated and aware of the issues and science relating to climate change.*	
Local residents support of adaptation efforts	Low
Comment: *Support of adaptation efforts is unknown as the city has not specifically addressed this issue.*	
Local residents' capacity to adapt to climate impacts	Low
Comment: *Unsure.*	
Local economy current capacity to adapt to climate impacts	Low
Comment: *Unsure.*	
Local ecosystems capacity to adapt to climate impacts	Low
Comment: *Unsure.*	

a. High = Capacity exists and is in use; Medium = Capacity may exist, but is not used or could use some improvement; Low = Capacity does not exist or could use substantial improvement; Unsure= Not enough information is known to assign a rating.

2.5 INTEGRATION WITH OTHER PLANNING INITIATIVES

The information on hazards, risk, vulnerability and mitigation contained in this hazard mitigation plan is based on the best available data. Plan integration is the incorporation of this information into other relevant planning mechanisms, such as general planning and capital facilities planning. It includes the integration of natural hazard information and mitigation policies, principles and actions into local planning mechanisms and vice versa. Additionally, plan integration is achieved though the involvement of key staff and community officials in collaboratively planning for hazard mitigation.

2.5.1 Existing Integration

In the performance period since adoption of the previous hazard mitigation plan, Livermore made progress on integrating hazard mitigation goals, objectives and actions into other planning initiatives. The following plans and programs currently integrate components of the hazard mitigation strategy:

- **Capital Improvement Program—**Incorporates hazard mitigation projects consistent with other adopted plans and programs
- **Living Arroyos Program—**Regional volunteer program for hands-on stream maintenance and restoration. Apprenticeship program for students at Las Positas Community College.
- **Zone 7 Stream Management Master Plan—** Multi-objective master plan addressing flood control, water quality, recycled water, and recreation.
- **Livermore Storm Management Plan—**City-wide program for maintaining creeks and outfalls.
- **Storm Drain Master Plan—**City master plan prioritizing capital improvements to storm drains.
- **Livermore General Plan**—The General Plan includes a Safety Element that addresses natural hazards.
- **Livermore Development Code—**The Development Code includes development requirements that can address hazard mitigation.
- **Livermore Municipal Code**—The Municipal Code includes development requirements that can address hazard mitigation.
- **Livermore Building Code—**The Building Code includes related State codes for hazard mitigation.

Resources listed in Section 2.12 were used to provide information for this annex on hazard events and local capabilities within the jurisdiction.

2.5.2 Opportunities for Future Integration

As this hazard mitigation plan is implemented, Livermore will use information from the plan as the best available science and data on natural hazards. The capability assessment presented in this annex identifies codes, plans and programs that provide opportunities for integration. The area-wide and local action plans developed for this hazard mitigation plan in actions related to plan integration, and progress on these actions will be reported through the progress reporting process described in Volume 1. New opportunities for integration also will be identified as part of the midterm progress report. The capability assessment identified the following plans and programs that do not currently integrate goals or recommendations of the hazard mitigation plan but provide opportunities to do so in the future. Information from the risk assessment as well as goals, objectives and actions will be integrated into these plans and programs as appropriate at the time of their next update:

- **Design Standards and Guidelines—**The Design Standards and Guidelines provide design guidance for private and public developments. Acknowledgement of information from the hazard mitigation plan, including identification of potential hazards and mitigation requirements, will be incorporated into the next update of the Design Standards and Guidelines. The update will include identification of additional design elements that can address hazard mitigation.
- **Climate Action Plan—**The CAP provides an assessment of greenhouse gas emissions by the community and identifies strategies for reducing emissions. Discussion of climate change resiliency and adaptation and identification of appropriate community actions to address resiliency will be included in the next update of the CAP.
- **Capital Improvement Program—**Incorporates hazard mitigation projects consistent with other adopted plans and programs. Improvement plans and projects that address hazard mitigation will be identified.
- **Living Arroyos Program—**Regional volunteer program for hands-on stream maintenance and restoration. This is an apprenticeship program for students at Las Positas Community College. The City will work with the Community College to incorporate identification of natural hazards and mitigation opportunities in the curriculum of this program.
- **Livermore Storm Management Plan—** This is a city-wide program for maintaining creeks and outfalls. Information from the hazard mitigation plan will be incorporated into the plan including identification of projects that address hazard mitigation.
- **Storm Drain Master Plan—** This is the city master plan prioritizing capital improvements to storm drains. Information from the hazard mitigation plan will be incorporated into the plan including identification of projects that address hazard mitigation.
- **Livermore General Plan**—The General Plan includes a Safety Element that addresses natural hazards. The proposed General Plan update will be consistent with the requirements of AB 2140 and SB 379.
- **Livermore Development Code—**The Development Code includes zoning and subdivision regulations. Information from the hazard mitigation plan will be incorporated into the Development Code that addresses hazard mitigation.
- **Livermore Municipal Code—**The Municipal Code includes ordinances regarding city operations and other regulations. The Municipal Code will be updated, as appropriate, to incorporate the information from the hazard mitigation plan.
- **Urban Water Management Plan—**Consistent with the California Water Code, this plan provides long-term water supply and resource planning. The plan will be updated to include information from the hazard mitigation plan and identify appropriate hazard mitigation strategies and projects.
- **Threat and Hazard Identification and Risk Assessment**—The THIRA process helps to identify capability targets and resource requirements necessary to address anticipated and unanticipated risks. The THIRA will include information from and be consistent with the hazard mitigation plan.

- **Continuity of Operations Plan**—This plan ensures that agencies are able to perform essential functions during emergencies. Update to the plan will incorporate information from the hazard mitigation plan.
- **Continuity of Government Plan**—This plan ensures that government continues its essential functions during emergencies. Update to the plan will incorporate information from the hazard mitigation plan.
- **Post Disaster Recovery Plan**— This plan provides policies and actions for rebuilding and recovery after disasters. Update to the plan will incorporate information from the hazard mitigation plan.
- **Comprehensive Emergency Management Plan**—This plan ensures the city's ability to function during and after events including measures that provide for the safety of personnel and, if possible, of property and facilities. Update to the plan will incorporate information from the hazard mitigation plan.

2.6 JURISDICTION-SPECIFIC NATURAL HAZARD EVENT HISTORY

Table 2-10 lists past occurrences of natural hazards for which specific damage was recorded in the City of Livermore. Other hazard events that broadly affected the entire planning area, including the City of Livermore, are listed in the risk assessments in Volume 1 of this hazard mitigation plan.

Table 2-10. Past Natural Hazard Events

Type of Event	FEMA Disaster # (if applicable)	Date	Damage Assessment
Severe winter storms, flooding and mudslides	DR-4308	4/1/2017	$11,715,000
Winter storm, Doolan Road tree damage	—	4/18/15	$5,000
Severe winter storms, flooding, landslides and mudslides	DR-1646	6/5/2006	Minor damage in the community
Flash Flood	DR-1203	2/2/1998	$28,052
Flash Flood	DR-1044	1/3/1995-2/10/1995	$13,796
Flash Flood	DR-1046	2/13/1995-4/19/1995	$147,737
Tornado	—	4/25/1994	Minor damage in the community
Earthquake – Greenville Fault	—	1/12/1980	Moderate structural damage in the community

2.7 JURISDICTION-SPECIFIC VULNERABILITIES

Volume 1 of this hazard mitigation plan provides complete risk assessments for each identified hazard of concern. This section provides information on a few key vulnerabilities for the jurisdiction.

Repetitive loss records are as follows:

- Number of FEMA-identified Repetitive-Loss Properties: 0
- Number of FEMA-identified Severe-Repetitive-Loss Properties: 0
- Number of Repetitive-Loss Properties or Severe-Repetitive-Loss Properties that have been mitigated: 0

Other noted vulnerabilities include the following:

- Storm drain pumps at road and railroad undercrossings (Isabel Ave., Murietta Blvd., P Street, L Street, Livermore Ave.) require back-up pumps and back-up power to ensure functions during storms.
- Road undercrossings (Isabel Ave./Stanley Blvd., Greenville Rd./Railroad overcrossing, Greenville Rd./I-580, Livermore Ave./Railroad overcrossing) need to be assessed to determine vulnerability during earthquakes.

- Bridge/Culverts over creeks (Arroyo Mocho at Concannon, Holmes, Arroyo Rd., Stanley Blvd.; Arroyo Las Positas at Vasco Rd., Central Ave., Heather Lane, Bluebell Ave.) need to be assessed to determine vulnerability during earthquakes.
- Doolan Road, which provides the sole access to rural properties and city-owned properties, could be blocked by falling trees due to high winds and heavy windfall. The health and stability of adjacent trees need to assessed.
- Cottonwood Creek along Doolan Road is severely incised and could be destabilized during heavy rainfall threatening the roadway and culvert. Stabilization measures for creek bank and roadway need to be identified.

2.8 HAZARD RISK RANKING

Table 2-11 presents a local ranking for the City of Livermore of all hazards of concern for which Volume 1 of this hazard mitigation plan provides complete risk assessments. This ranking summarizes how hazards vary for this jurisdiction. As described in detail in Volume 1, the ranking process involves an assessment of the likelihood of occurrence for each hazard, along with its potential impacts on people, property and the economy.

Table 2-11. Hazard Risk Ranking

Rank	Hazard Type	Risk Rating Score (Probability x Impact)	Category
1	Earthquake[a]	36	High
2	Severe weather[b]	33	Medium
3	Wildfire[c]	18	Medium
4	Flood[d]	12	Low
4	Landslide[e]	12	Low
5	Drought[f]	9	Low
6	Dam failure[g]	6	Low

a. Based on the "Haywired" (Hayward Fault Scenario M7.05)
b. Severe weather is assessed more qualitatively than other hazards. Assumptions for risk ranking include high probability, medium impact on people, medium impact on property and low impact on economy.
c. Based on Very High and High Fire Severity Zones.
d. Based on 1 percent-annual-chance flood zone (otherwise known as the special flood hazard area)
e. Based on Very High, High, and Moderate Landslide Susceptibility Zones
f. Drought is assessed more qualitatively than other hazards. Generally, drought does not cause injury or death to people or result in property damage. Assumptions for risk ranking include high probability, no impact on people, low impact on property and low impact on economy for those jurisdictions with limited agriculture.
g. Based on the Del Valle Dam inundation scenario.

2.9 STATUS OF PREVIOUS PLAN ACTIONS

Table 2-12 summarizes the actions that were recommended in the previous version of the hazard mitigation plan and their implementation status at the time this update was prepared.

Table 2-12. Status of Previous Plan Actions

Action Item	Completed	Removed; No Longer Feasible	Carried Over to Plan Update: Check if Yes	Carried Over to Plan Update: Enter Action #
Pre-position emergency power generation capacity (or have rental/lease agreements for these generators) in critical buildings of cities, counties, and special districts to maintain continuity of government and services. Water Resources Division. Have generators in water pump stations; need back-up power to keep entire Livermore Water Resources Plant running. On CIP. INFRA-a- (8)	No		X	L-20
Comment: Emergency generator for Water Resources in 2017-2019 CIP				
Tie public education on defensible space and a comprehensive defensible space ordinance to a field program of enforcement. LPFD. (HSNG-g-(2). Funding and resources unavailable.	Yes; Ongoing		X	L-12, 30
Comment: Annual education provided				
Provide retrofit classes or workshops for homeowners. Community Development. HSNG-b-(7). Funding unavailable.	No	X		
Comment: Classes are available at local home improvement stores				
Offer the 20-hour basic CERT training to teachers and after-school personnel. LPFD Emergency Preparedness and Livermore School District. This strategy moved from category "existing" to deferred" due to resources on both sides of the partnership. EDUC-c-(3)	Yes; Ongoing		X	L-12, 30
Comment: Classes are offered multiple times annually to the general public.				
Offer the 20-hour basic CERT training course through the Adult School system and/or through the Community College system. LPFD Emergency Preparedness. This strategy moved from the category "existing" to "deferred" because there was a fee to utilize registration through the Adult School which was not acceptable when the program was granted U.S. Dept. of Homeland Security funding. EDUC-c-(5)	Yes; Ongoing		X	L-12, 30
Comment: Classes are offered multiple times annually to the general public.				
Explore ways to require that hazardous materials stored in the flood zone be elevated or otherwise protected from flood waters. Public Works. ENVI-a-(10)	No		X	L-1, L-8
Comment: This action was not implemented due to lack of funding.				
Assess the vulnerability of critical facilities (such as city halls, fire stations, community service centers, seaports, and airports) to damage in natural disasters and make recommendations for appropriate mitigation. Unfunded. Maintenance Division. GOVT-a-(1)	No		X	L-1, 8
Comment: Expand on work completed for the Asset Management Program				
Retrofit or replace critical facilities that are shown to be vulnerable to damage in natural disasters. Unfunded. Maintenance Division. GOVT-a-(2)	No		X	L-1, 8
Comment: Lack of funding				
Install micro and/or surveillance cameras around critical public assets tied to web-based software, and develop a surveillance protocol to monitor these cameras. Unfunded. Maintenance Division. GOVT-a-(6)	No		X	L-1, 8
Comment: Lack of funding				
Develop unused or new pedestrian rights-of-way as walkways to serve as additional evacuation routes (such as fire roads in park lands). Public Works/Maintenance Division. INFRA-a-10.	No		X	L-12
Comment: This action was not implemented due to lack of funding.				

Action Item	Completed	Removed; No Longer Feasible	Carried Over to Plan Update: Check if Yes	Carried Over to Plan Update: Enter Action #
Encourage the cooperation of utility system providers and cities, counties, and other special districts to develop strong and effective mitigation strategies for infrastructure systems and facilities. Not implemented; unfunded. INFRA-a-(3)	Yes; Ongoing			
Comment: *Water system maintains interties with neighboring agencies; City participates in CalWARN mutual aid network for wastewater agencies.*				
Assist residents in the development of defensible space through the use of, for example, "tool libraries" for weed abatement tools, roadside collection and/or chipping services (for brush, weeds, and tree branches) in wildland-urban-interface fire-threatened communities or in areas exposed to high-to-extreme fire threat. LPFD. HSNG-k-(9)	No	X		
Comment: This is not feasible given the liability of loaning power tools; start up and personnel costs of a new waste collection and chipper program prohibitive.				
Encourage the formation of a community- and neighborhood-based approach to wildfire education and action through local Fire Safe Councils and the Fire Wise Program. LPFD. HSNG-k-(9) Previously moderate priority.	Yes		X	L-18
Comment: Information is offered through social media and public outreach. Weed abatement program includes wildfire safety approach.				
Assist businesses in the development of defensible space through the use of, for example, "tool libraries" for weed abatement tools, roadside collection and/or chipping services (for brush, weeds, and tree branches) in wildland-urban-interface fire-threatened communities or in areas exposed to high-to-extreme fire threat. LPFD. ECON-j-(6)	No	X		
Comment: See explanation above				
Conduct comprehensive programs to identify and mitigate problems with facility contents, architectural components, and equipment that will prevent critical buildings from being functional after major natural disasters. Public Works. GOVT-a-(4)	No		X	L-1, 8
Comment: Expand on work completed for the Asset Management Program				
Be aware of past problems of inadequate hazard disclosure and work with real estate agents to improve enforcement of real estate disclosure requirements for those hazards covered by this plan, for example, by making those agents and the disclosure firms aware of the hazard maps incorporated in this plan and available on the ABAG web site at http://quake.abag.ca.gov/mitigation, as well as locally developed maps. Community Development. HSNG-a-(1)	No		X	L-11
Comment: *Lack of funding*				

2.10 HAZARD MITIGATION ACTION PLAN AND EVALUATION OF RECOMMENDED ACTIONS

Table 2-13 lists the actions that make up the City of Livermore hazard mitigation action plan. Table 2-14 identifies the priority for each action. Table 2-15 summarizes the mitigation actions by hazard of concern and mitigation type.

Table 2-13. Hazard Mitigation Action Plan Matrix

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline
L-1— Where appropriate, support retrofitting or relocation of structures in high hazard areas, prioritizing structures that have experienced repetitive losses.							
Existing	Dam failure, Earthquake, Flood, Landslide, Severe weather, Wildfire	4, 6, 8, 10, 11, 12	Public Works	Community Development	High	HMGP, PDM, FMA	Long-term
L-2— Integrate the hazard mitigation plan into other plans, ordinances and programs that dictate land use decisions in the community, including General Plan, Development Code, Municipal Code, Design Standards and Guidelines, Specific Plans.							
New and Existing	Dam failure, Drought, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 2, 6, 8, 10, 11	Community Development	Public Works, Community Development, City Manager	Low	Staff Time, General Funds	Ongoing
L-3— Actively participate in the plan maintenance protocols outlined in Volume 1 of this hazard mitigation plan.							
New and Existing	Dam failure, Drought, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	Community Development	Livermore Pleasanton Fire Dept., City Manager	Low	Staff Time, General Funds	Short-term
L-4—Continue to maintain good standing and compliance under the NFIP through implementation of floodplain management programs that, at a minimum, meet the NFIP requirements: • Enforce the flood damage prevention ordinance. • Participate in floodplain identification and mapping updates. • Provide public assistance/information on floodplain requirements and impacts.							
New and Existing	Flood, Dam failure	1, 4, 6, 9	Community Development	Public Works, City Manager	Low	Staff Time, General Funds	Ongoing
L-5—Identify and pursue strategies to increase adaptive capacity to climate change including, but not limited to, updates of the General Plan and Climate Action Plan.							
New and Existing	Dam failure, Drought, Flood, Landslide, Severe weather, Wildfire	1, 2, 5, 7, 8, 9, 10, 12	Community Development	City Manager	Low	Staff Time, General Funds	Short-term
L-6—Develop/update Continuity of Operations (COO) and Continuity of Government (COG) Plans to support organizational resiliency in the event of a disaster.							
New and Existing	Earthquake, Flood, Dam Failure, Wildfire, Severe Weather	1, 3, 5, 7, 9, 10	City Manager	Livermore Pleasanton Fire Dept., Police Dept.	Low	Staff Time, General Funds	Short-term
L-7—Develop a Post Disaster Recovery Plan that addresses all potential hazards and supports the efficient, timely and effective recovery of the community and public services and facilities. Ensure that Post Disaster Recovery Plan complies with U.S. Army Corps of Engineers, NRCS, FEMA, and state and local regulatory requirements to repair damage and receive public assistance in a timely manner.							
New and Existing	Earthquake, Flood, Dam Failure, Wildfire, Landslide, Severe Weather	7, 9, 12	City Manager	Community Development, Public Works	Medium	Staff time, General Funds	Short-Term

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline
L-8—Consider hazard mitigation when designing the new construction, rehabilitation, retrofitting and/or replacement of projects identified in the CIP, particularly critical facilities.							
New and Existing	Dam failure, Drought, Earthquake, Flood, Landslide, Severe weather, Wildfire	9, 12	Community Development	Public Works	Low	Staff Time, General Funds	Ongoing
L-9—Update and maintain GIS mapping to include information for all mapped hazards that may affect properties in the community.							
New and Existing	Flood, Dam Failure, Landslide, Wildfire	1, 3, 4	Community Development	City Manager	Medium	Staff Time, General Funds	Ongoing
L-10—Support the area-wide initiatives identified in Volume 1 of the hazard mitigation plan.							
New and Existing	Dam failure, Drought, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 2, 3, ,4, 5, 6, 7, 8, 9, 10	Community Development	City Manager	Low	Staff-Time, General Funds	Short-term
L-11—Continue and expand public information and education activities for residents and businesses regarding hazard mitigation, emergency preparation, emergency response, and real estate disclosures.							
New and Existing	Earthquake, Flood, Dam Failure, Wildfire, Landslide, Severe Weather	3, 7, 9	Livermore Pleasanton Fire Dept., Community Development	City Manager	Low	Staff time, General Funds	Ongoing
L-12—Develop evacuation plan that addresses all members of the community including special needs populations including, but not limited to, seniors, low-income households, disabled, and non-English speaking households.							
New and Existing	Earthquake, Flood, Dam Failure, Wildfire, Severe Weather	1, 3, 5, 7, 8, 9, 10, 12	City Manager	Livermore Pleasanton Fire Dept.	Low	Staff time, General Funds	Short-term
L-13—Provide staff training as needed to support plan implementation, plan maintenance and reporting requirements. Coordinate training with plan partners.							
New and Existing	Dam failure, Drought, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 3, 5, 7, 10	City Manager	All	Low	Staff time, General Funds	Ongoing
L-14—Develop and implement a program to capture perishable data after significant events (e.g. high watermarks, preliminary damage estimates, and damage photos) to support future mitigation efforts including implementation and maintenance of the hazard mitigation plan.							
Existing	Earthquake, Severe Weather, Wildfire, Flood, Landslide, Dam Failure	1, 3, 5, 7, 9	City Manager	Livermore Pleasanton Fire Dept., Police Dept., Public Works	Medium	Staff time, General Funds	Ongoing
L-15—Participate in programs such as Firewise, StormReady and the Community Rating System.							
New and Existing	Dam Failure, Flood, Severe weather, Wildfire	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	City Manager	Livermore Pleasanton Fire Dept., Community Development	Low	Staff time, General Funds	Short-term

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline
L-16—Implement programs such as "Tree Watch" that proactively manage problem areas through use of selective removal of hazardous trees, tree replacement, trimming, etc.							
New and Existing	Severe Weather	5, 8, 10, 11, 12	Public Works	City Manager	Medium	Staff time, General Funds	Ongoing
L-17—Amend existing landscape and other related ordinances to encourage appropriate planting near overhead power, cable, and phone lines.							
New and Existing	Severe Weather	5, 8, 10, 11, 12	Community Development	Public Works	Low	Staff time, General Funds	Short-term
L-18—Continue Annual Weed Abatement program.							
New and Existing	Wildfire	5, 9, 10, 12	Livermore-Pleasanton Fire Dept.	City Manager	Low	Staff time, General Funds	Ongoing
L-19—Install emergency generators, or secure lease/rental agreements, in critical facilities, as identified in the CIP, including the Water Reclamation Plant, Fire Stations, and Airport facilities.							
Existing	Earthquake, Severe Weather, Wildfire, Flood	3, 4, 8, 10, 12	Public Works	Livermore Pleasanton Fire Dept.	Low	Staff time, General Funds, Airport funds	Short-term
L-20—Install backup battery systems for traffic signals as identified in the CIP.							
Existing	Earthquake, Severe Weather, Wildfire, Flood	3, 4, 8, 10, 12	Public Works	City Manager	Low	Staff time, General Funds	Short-Term
L-21—As part of the approved Civic Center Meeting Hall, include facilities for an Emergency Operations Center.							
New	Earthquake, Severe Weather, Wildfire, Flood, Dam Failure, Landslide	3, 4, 5, 9	City Manager	Community Development	Medium	Staff time, General Funds	Short-Term
L-22—Develop a Floodplain Management Plan to describe how city will maintain CRS Classification 9 and work towards Classification 8 and integrate flood damage reduction into public information, development and capital improvement processes.							
New and Existing	Flood	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	Community Development	Public Works	Medium	Staff time, General Funds	Short-term
L-23—Develop a Climate Resiliency Plan as part of an update to the Climate Action Plan to identify weather trends and infrastructure subject to damage in increasingly severe weather events and identify mitigation projects.							
New and Existing	Flood, Severe Weather, Drought	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	Community Development	Public Works	Medium	Staff time, General Funds	Short-Term
L-24—Maintain annual inspection records and update GIS and cost tracking process to reflect accurate city facility data.							
New and Existing	Earthquake, Flood, Severe Weather, Wildfire, Dam Failure	1, 9, 10	Public Works	Community Development	Low	Staff time, General Funds	Short-Term
L-25—Develop a Debris Management Plan that is coordinated with other regional agencies, addresses all potential hazards and supports the efficient, timely and effective recovery of the community and public services and facilities.							
New and Existing	Earthquake, Severe weather, Wildfire, Flood, Landslide, Dam Failure	1, 5, 7, 9, 10	Public Works	Community Development	Low	Staff time, General Funds	Short-term
L-26—Complete an inundation study to develop flood data for 2-year to 100-year storms that is integrated with the updated Zone 7 flood study.							
New and Existing	Flood	1, 2, 5, 7, 9, 10, 12	Community Development	City Manager	Low	Staff time, General Funds	Short-term

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline
L-27—Incorporate grant eligible capital improvement projects into the hazard mitigation plan annually.							
New	Earthquake, Severe weather, wildfire, flood, dam failure	8, 10, 12	Community Development	City Manager	Low	Staff time, General Funds	Short-term
L-28—Mitigate for landslide and flood damage on Collier Creek by adding to the CIP projects to design and construct a debris basin upstream of Collier Canyon Road and to grade and plant creek banks to restore capacity of Arroyo Las Positas through the Las Positas Golf Course.							
New and Existing	Flood, Landslide	8, 10, 12	Public Works	City Manager	High	HMGP	Short-Term
L-29—Continue and expand public education and outreach programs, including CERT, to provide consistent and accessible information regarding hazards and mitigation for residents and businesses.							
New and Existing	Dam failure, Drought, Earthquake, Flood, Landslide, Severe weather, Wildfire	5, 7, 9, 12	City Manager	Livermore Pleasanton Fire Dept.	Low	Staff time, General funds	Short-term
L-30—Develop a restoration plan to preserve and restore Cottonwood Creek on the city owned property along Doolan Road. Plan would restore the drainage function of Cottonwood Creek and minimize loss to Doolan Road, public utilities and private property threatened by eucalyptus tree grove at the top of the creek bank.							
Existing	Flood, Landslide, Severe weather, wildfire	4, 6, 10, 12	Community Development	Public Works	Medium	Staff time, General Funds	Short-term
L-31— Complete the update to the Emergency Operations Plan.							
New and Existing	Earthquake, Flood, Dam failure, Landslide, Severe weather, Wildfire	1, 3, 7	City Manager	Livermore-Pleasanton Fire Dept., Police Dept.	Low	Staff Time, General Fund	Short-term
L-32— Develop a Threat & Hazard Identification & Risk Assessment (THIRA).							
New and Existing	Earthquake, Flood, Dam Failure, Landslide, Severe Weather, Wildfire	1, 3, 5, 7, 9, 10	City Manager	Livermore-Pleasanton Fire Dept., Police Dept.	Low	Staff Time, General Funds	Short-term
L-33— Install storm drain back-up pumps and back-up power at road and railroad undercrossings (Isabel Ave., Murietta Blvd., P Street, L Street, Livermore Avenue).							
Existing	Flood, Dam Failure	4, 10, 12	Public Works	City Manager	High	HMGP, PDM, FMA	Long-term
L-34— Assess the earthquake vulnerability of existing road undercrossings (Isabel Ave., Murietta Blvd., P Street, Livermore Avenue, Greenville Rd.) and overcrossings (First St./railroad, Mines Road/railroad, Vasco Road/railroad) and existing culverts and bridges over creeks(Arroyo Mocho at Concannon Blvd., Holmes St., Arroyo Rd., Stanley Blvd.; Arroyo Las Positas at Vasco Rd., Central Ave., Heather Lane, Bluebell Ave.) .							
New and Existing	Earthquake	4, 10, 12	Community Development	City Manager	High	HMGP, PDM, FMA	Long-term

Table 2-14. Mitigation Action Priority

Action #	# of Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is Project Grant-Eligible?	Can Project Be Funded Under Existing Programs/ Budgets?	Implementation Priority[a]	Grant Pursuit Priority[a]
L-1	6	High	High	Yes	Yes	No	Medium	High
L-2	6	Medium	Low	Yes	No	Yes	High	Low
L-3	12	Low	Low	Yes	No	Yes	High	Low
L-4	4	Medium	Low	Yes	No	Yes	High	Low
L-5	8	Medium	Low	Yes	No	Yes	High	Medium
L-6	6	Medium	Low	Yes	No	Yes	Medium	Low
L-7	3	Low	Low	Yes	No	No	Medium	Low
L-8	2	Medium	Low	Yes	No	Yes	Medium	Low
L-9	4	Medium	Medium	Yes	No	No	Medium	Low
L-10	10	Medium	Low	Yes	No	No	High	Low
L-11	3	High	Low	Yes	No	Yes	High	Low
L-12	8	Medium	Low	Yes	No	No	Medium	Low
L-13	5	Low	Low	Yes	No	No	Low	Low
L-14	5	Medium	Low	Yes	No	No	Medium	Low
L-15	12	High	Low	Yes	No	Yes	High	Low
L-16	5	Medium	Low	Yes	No	Yes	Medium	Low
L-17	5	Medium	Low	Yes	No	Yes	Medium	Low
L-18	4	High	Low	Yes	No	Yes	High	Low
L-19	5	High	Medium	Yes	Yes	Yes	Medium	Medium
L-20	5	High	Medium	Yes	Yes	Yes	Medium	Medium
L-21	4	High	Medium	Yes	No	Yes	Medium	Low
L-22	12	High	Low	Yes	Yes	No	High	High
L-23	12	Medium	Medium	Yes	No	No	Medium	Low
L-24	3	Low	Low	Yes	No	No	Low	Low
L-25	5	High	Low	Yes	No	Yes	High	Low
L-26	7	High	Medium	Yes	No	Yes	Medium	Low
L-27	3	Medium	Low	Yes	No	Yes	Medium	Low
L-28	3	High	Medium	Yes	Yes	No	High	High
L-29	4	High	Low	Yes	No	Yes	High	Low
L-30	4	Medium	Medium	Yes	Yes	No	Medium	Medium
L-32	6	High	Medium	Yes	No	Yes	Medium	Low
L-33	3	High	Medium	Yes	Yes	No	Medium	Medium
L-34	3	High	Medium	Yes	Yes	No	Medium	Medium

a. See the introduction to this volume for explanation of priorities.

Table 2-15. Analysis of Mitigation Actions

Hazard Type	Action Addressing Hazard, by Mitigation Type[a]							
	Prevention	Property Protection	Public Education and Awareness	Natural Resource Protection	Emergency Services	Structural Projects	Climate Resilient	Community Capacity Building
Earthquake	L-2, 3, 8, 10, 11, 14, 27, 32, 34	L-1, 8, 19, 20	L-2, 3, 10, 11, 12, 29, 32		L-6, 7, 11, 12, 19, 20, 21, 25, 31	L-21, 27, 28	L-2, 3	L-2, 3, 6, 10, 13, 14, 24
Severe weather	L-2, 3, 5, 8, 10, 11, 14, 15, 16, 17, 27	L-1, 8, 19, 20, 30	L-2, 3, 5, 10, 11, 12, 15, 29	L-16, 17, 30	L-6, 7, 11, 12, 19, 20, 21, 25	L-27, 30	L-2, 3, 5, 14, 23	L-2, 3, 5, 6, 10, 13, 14, 24
Wildfire	L-2, 3, 5, 8, 9, 10, 11, 14, 15, 18, 27, 32	L-1, 8, 19, 20, 30	L-2, 3, 5, 9, 10, 11, 12, 15, 29, 32	L-18, 30	L-6, 7, 11, 12, 19, 20, 21, 25, 31	L-27, 30	L-2, 3, 5, 14	L-2, 3, 5, 6, 10, 13, 14, 24
Flood	L-2, 3, 4, 5, 8, 9, 10, 11, 14, 15, 22, 26, 27, 28, 32	L-1, 8, 19, 20, 28, 30	L-2, 3, 4, 5, 9, 10, 11, 12, 15, 26, 29, 32	L-22, 28, 30	L-6, 7, 11, 12, 19, 20, 21, 25, 31	L-22, 27, 30, 33	L-2, 3, 5, 14, 23	L-2, 3, 5, 6, 10, 13, 14, 24
Landslide	L-2, 3, 5, 8, 9, 10, 11, 14, 28, 32	L-1, 8, 28, 30	L-2, 3, 5, 9, 10, 11, 29, 32	L-28, 30	L-7, 11, 21, 25, 31	L-28, 30	L-2, 3, 5, 14	L-2, 3, 5, 9, 10, 13, 14
Drought	L-2, 3, 5, 8, 10, 11	L-8	L-2, 3, 5, 10, 29				L-2, 3, 5, 14, 24	L-2, 3, 5, 10, 13, 14
Dam failure	L-2, 3, 5, 8, 9, 10, 11, 14, 15, 27, 32	L-1, 8	L-2, 3, 5, 9, 10, 11, 12, 29, 32		L-6, -7, 11, 12, 21, 25, 31	L-27, 33	L-2, 3, 5, 14	L-2, 3, 5, 6, 9, 10, 13, 14, 24

a. See the introduction to this volume for explanation of mitigation types.

2.11 FUTURE NEEDS TO BETTER UNDERSTAND RISK/VULNERABILITY

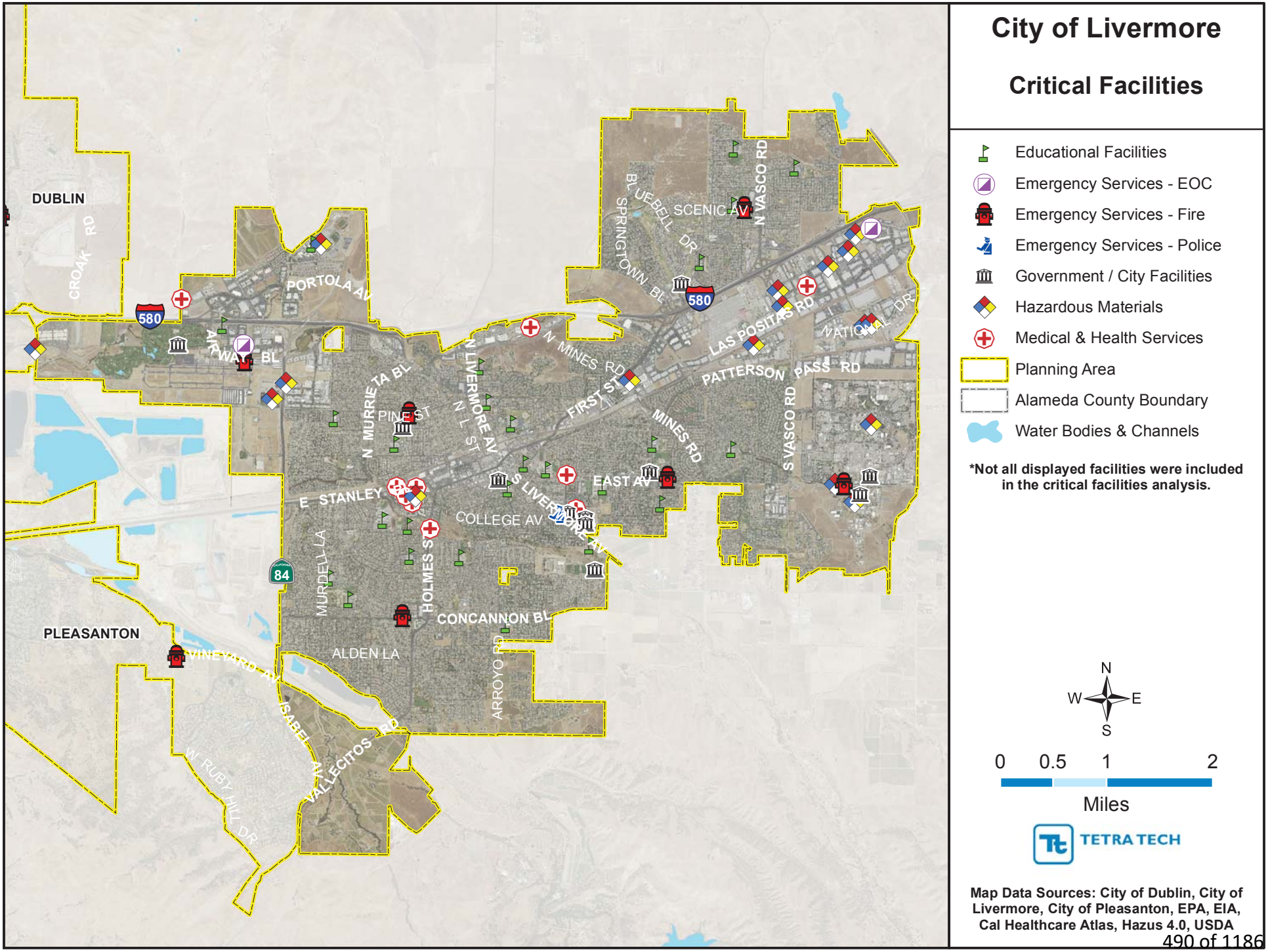
Recent disasters experienced in California and elsewhere in the Country (e.g. North Bay wildfires and hurricanes with associated flooding) provide extreme examples of the affects that natural disasters can have on emergency preparation, response and recovery actions. Lessons learned from these events will provide valuable information for future programs and actions to better protect and prepare our community against natural disasters.

2.12 REVIEW AND INCORPORATION OF RESOURCES FOR THIS ANNEX

The following technical reports, plans, and regulatory mechanisms were reviewed to provide information for this annex.

- **Livermore Municipal Code**—The municipal code was reviewed for the full capability assessment and for identifying opportunities for action plan integration.
- **Livermore Flood Damage Prevention Ordinance**—The flood damage prevention ordinance was reviewed for compliance with the National Flood Insurance Program.
- **Capital Improvement Program—**The CIP was reviewed for capital improvements that address hazard mitigation.
- **Livermore Storm Master Plan—**Reviewed plan for projects that address hazard mitigation.
- **Storm Drain Master Plan—**Reviewed plan for projects that address hazard mitigation.
- **Livermore General Plan—**The General Plan was reviewed for goals, objectives and policies supporting hazard mitigation.
- **Livermore Development Code**—The Development Code was reviewed for requirements supporting hazard mitigation.

- **Livermore Building Code**—The Building Code was reviewed for requirements supporting hazard mitigation.
- **Technical Reports and Information—**The following **o**utside resources and references were reviewed:
  - **Hazard Mitigation Plan Annex Development Tool-kit**—The tool-kit was used to support the development of this annex including past hazard events, noted vulnerabilities, risk ranking and action development.
  - **Living Arroyos Program—**The program was reviewed for opportunities to address hazard mitigation.
  - **Zone 7 Draft Hazard Mitigation Plan—**Reviewed draft plan for opportunities for coordination.
  - **2016 Alameda County Hazard Mitigation Plan—**Plan reviewed for opportunities for coordination.
  - **2013 California State Hazard Mitigation Plan—**Plan reviewed for opportunities for coordination.



City of Livermore

Critical Facilities

- Educational Facilities
- Emergency Services - EOC
- Emergency Services - Fire
- Emergency Services - Police
- Government / City Facilities
- Hazardous Materials
- Medical & Health Services
- Planning Area
- Alameda County Boundary
- Water Bodies & Channels

***Not all displayed facilities were included in the critical facilities analysis.**

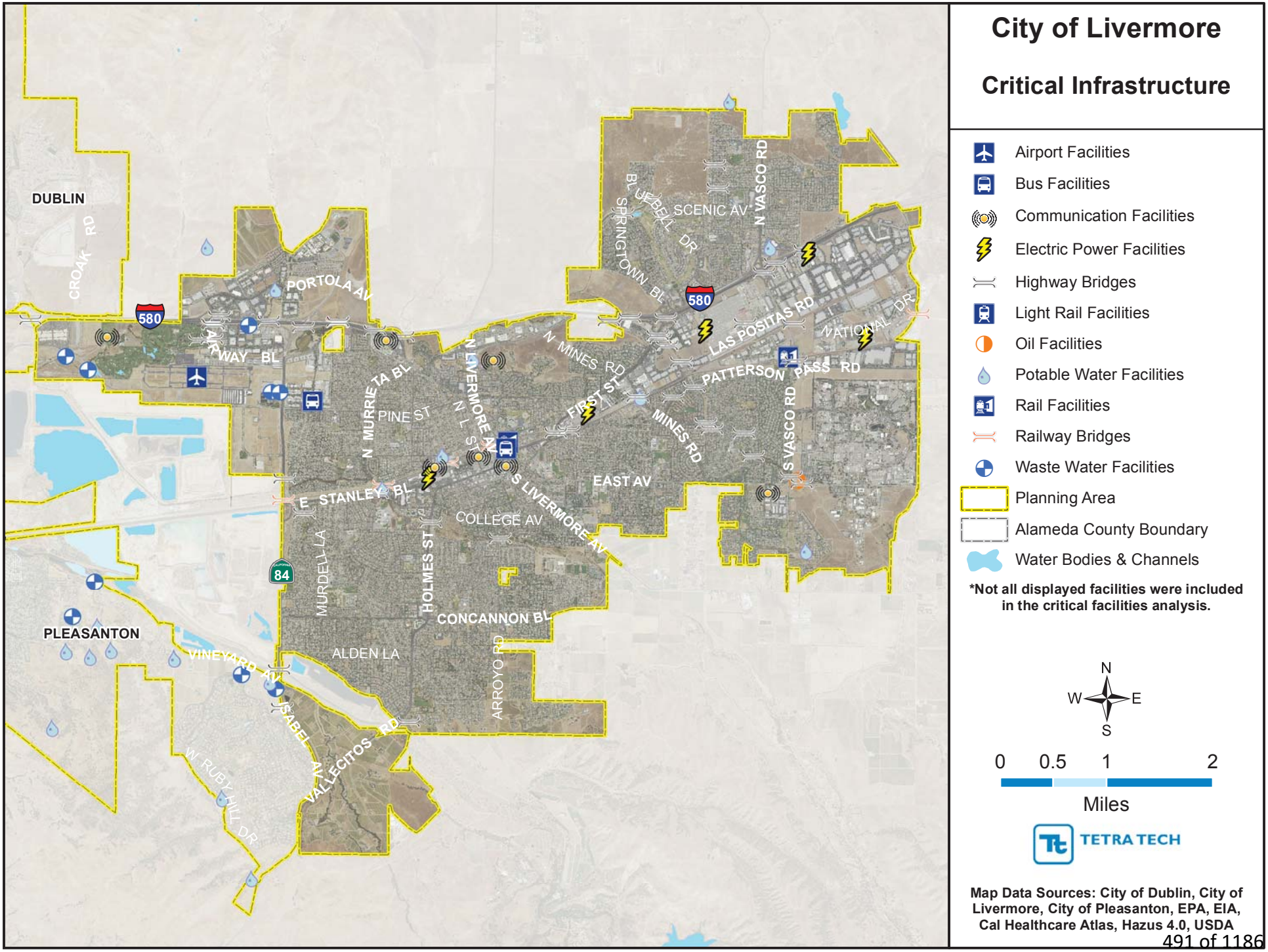
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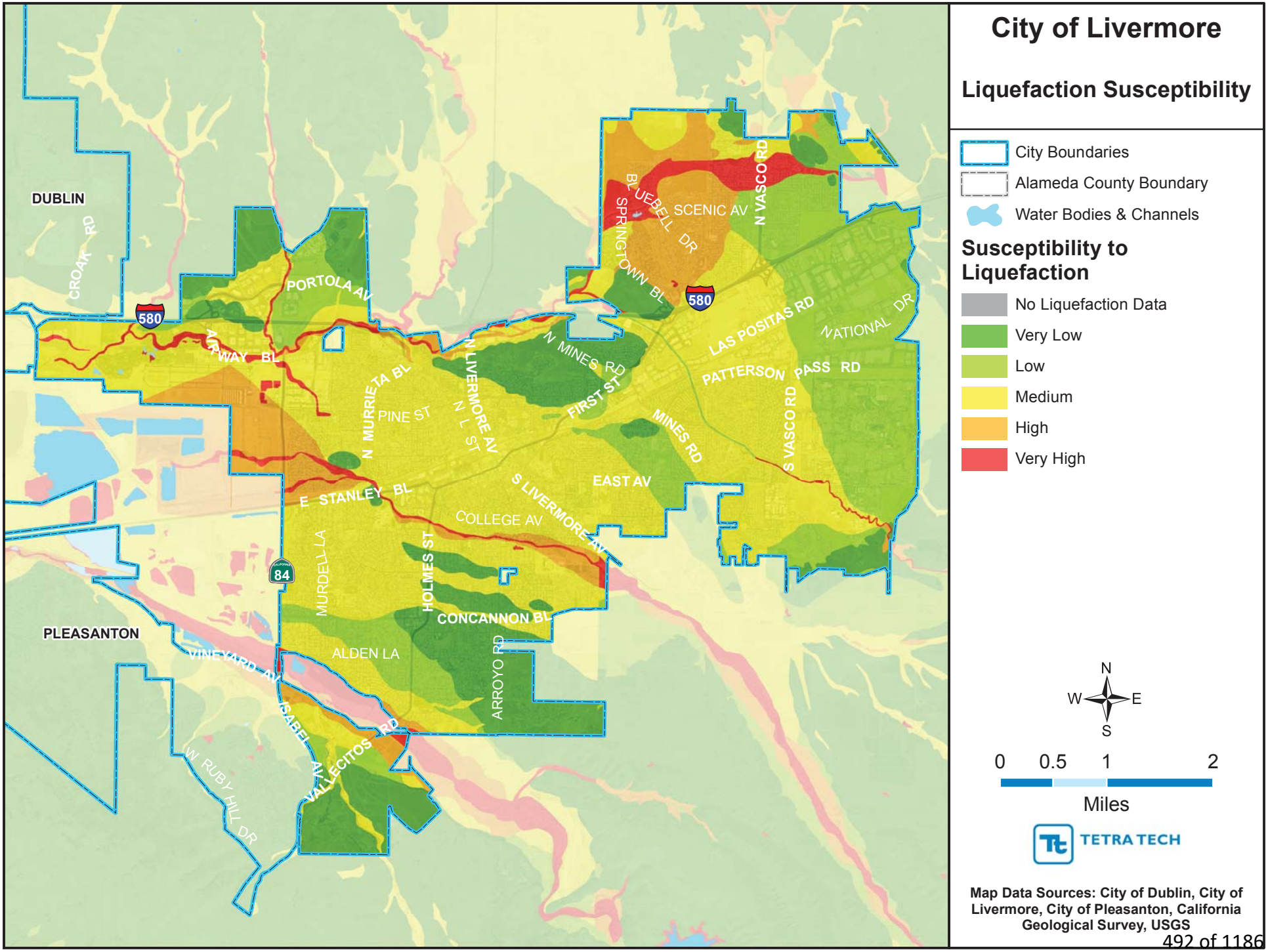
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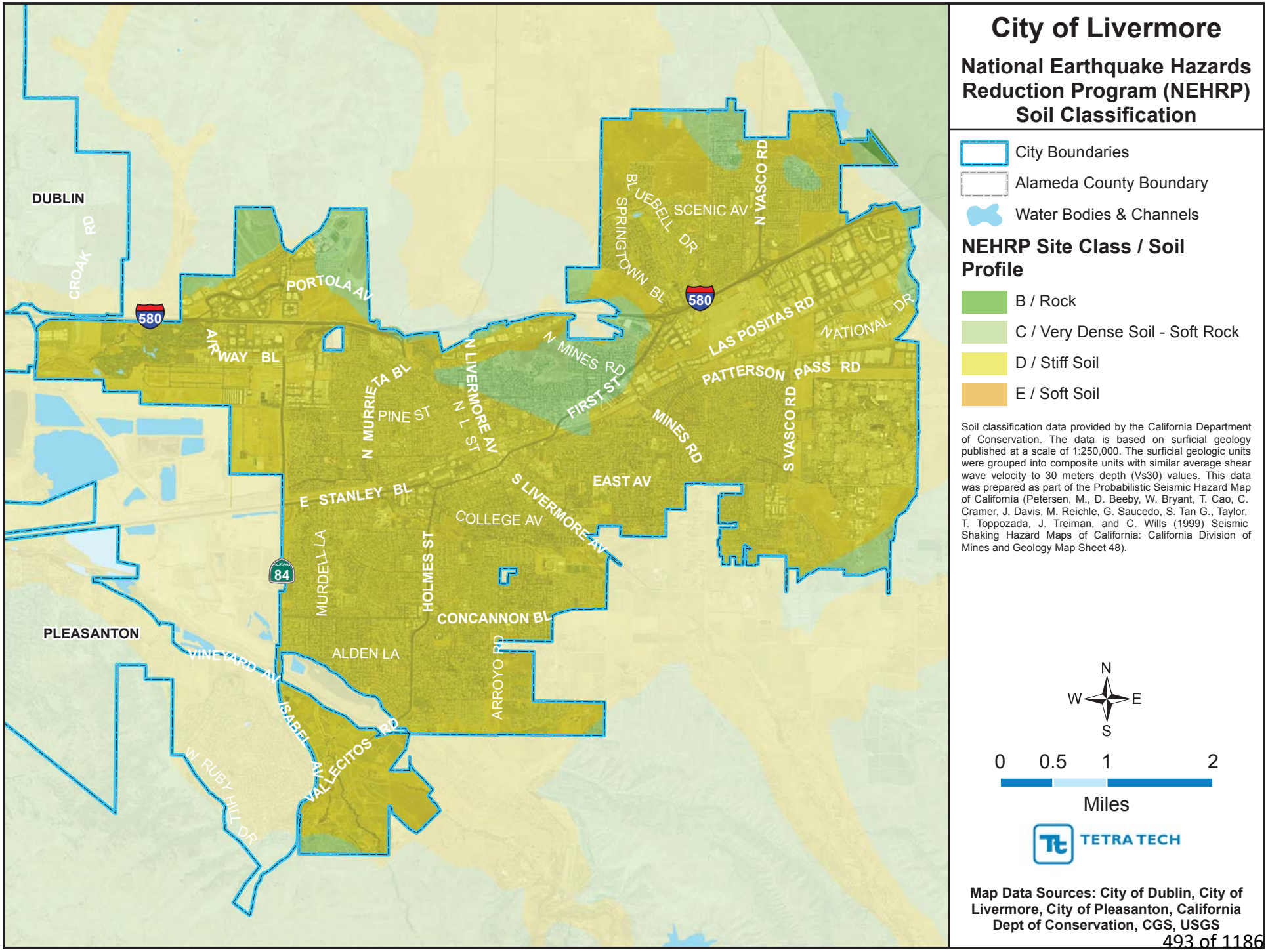
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Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, EPA, EIA, Cal Healthcare Atlas, Hazus 4.0, USDA


City of Livermore
Critical Infrastructure
Airport Facilities
Bus Facilities
Communication Facilities
Electric Power Facilities
Highway Bridges
Light Rail Facilities
Oil Facilities
Potable Water Facilities
Rail Facilities
Railway Bridges
Waste Water Facilities
Planning Area
Alameda County Boundary
Water Bodies & Channels
*Not all displayed facilities were included in the critical facilities analysis.
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Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, EPA, EIA, Cal Healthcare Atlas, Hazus 4.0, USDA
DUBLIN
CROAK RD
580
PORTOLA AV
AIRWAY BL
N MURRIETA BL
PINE ST
N LIVERMORE AV
N L ST
N MINES RD
FIRST ST
MINES RD
SPRINGTOWN BL
BLUEBELL DR
SCENIC AV
N VASCO RD
LAS POSITAS RD
NATIONAL DR
PATTERSON PASS RD
S VASCO RD
EAST AV
E STANLEY BL
COLLEGE AV
S LIVERMORE AV
84
MURDELL LA
HOLMES ST
CONCANNON BL
ALDEN LA
ARROYO RD
PLEASANTON
VINEYARD AV
ISABEL AV
VALLECITOS RD
W RUBY HILL DR


City of Livermore
Liquefaction Susceptibility
City Boundaries
Alameda County Boundary
Water Bodies & Channels
Susceptibility to Liquefaction
No Liquefaction Data
Very Low
Low
Medium
High
Very High
DUBLIN
PLEASANTON
580
84
CROAK RD
PORTOLA AV
ARROWAY BL
N MURRIETA BL
PINE ST
N LIVERMORE AV
N L ST
N MINES RD
FIRST ST
BLUEBELL DR
SCENIC AV
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Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, California Geological Survey, USGS



City of Livermore

National Earthquake Hazards Reduction Program (NEHRP) Soil Classification

City Boundaries

Alameda County Boundary

Water Bodies & Channels

NEHRP Site Class / Soil Profile

- B / Rock
- C / Very Dense Soil - Soft Rock
- D / Stiff Soil
- E / Soft Soil

Soil classification data provided by the California Department of Conservation. The data is based on surficial geology published at a scale of 1:250,000. The surficial geologic units were grouped into composite units with similar average shear wave velocity to 30 meters depth (Vs30) values. This data was prepared as part of the Probabilistic Seismic Hazard Map of California (Petersen, M., D. Beeby, W. Bryant, T. Cao, C. Cramer, J. Davis, M. Reichle, G. Saucedo, S. Tan G., Taylor, T. Toppozada, J. Treiman, and C. Wills (1999) Seismic Shaking Hazard Maps of California: California Division of Mines and Geology Map Sheet 48).

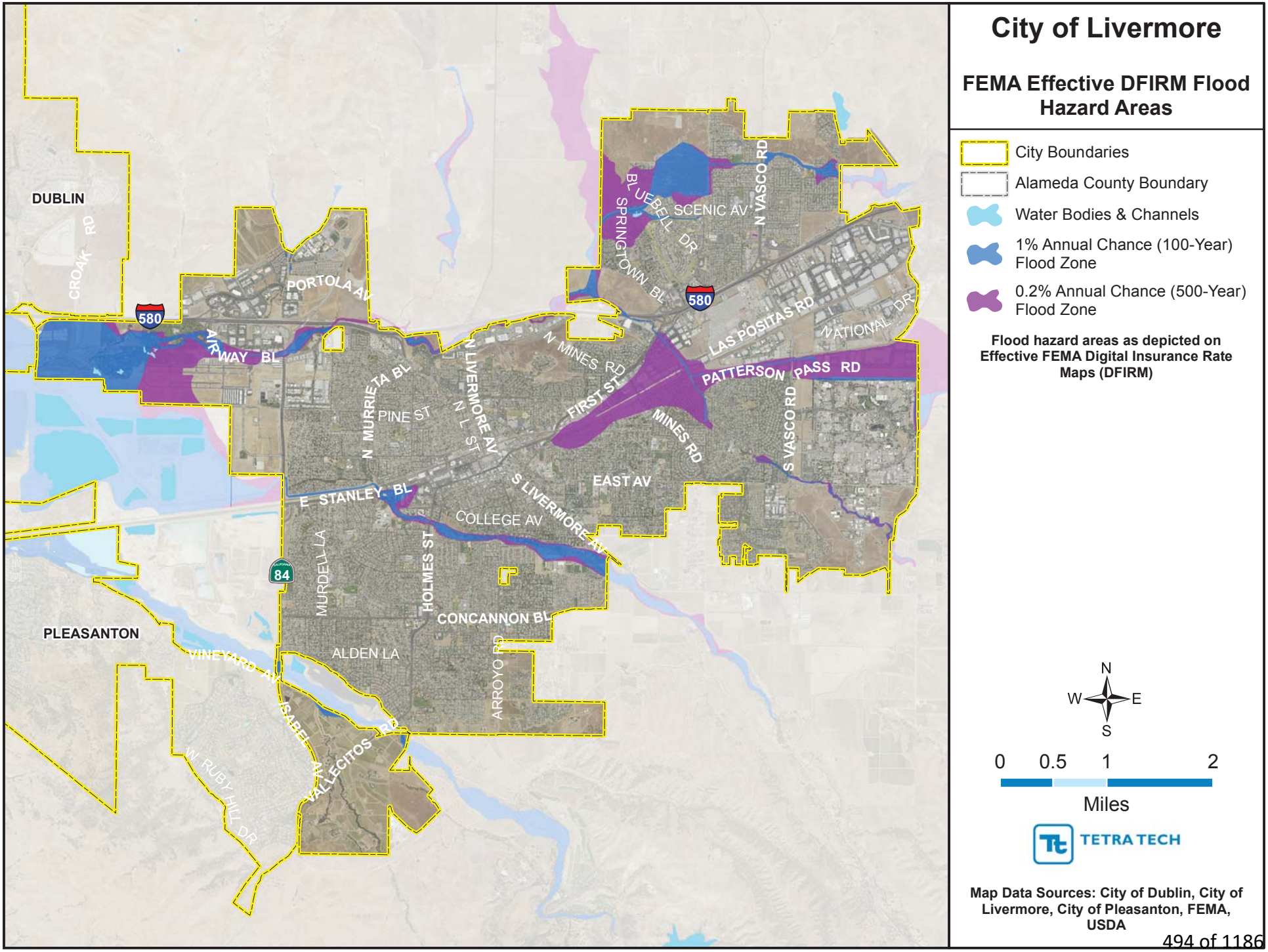
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Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, California Dept of Conservation, CGS, USGS



City of Livermore

FEMA Effective DFIRM Flood Hazard Areas

- City Boundaries
- Alameda County Boundary
- Water Bodies & Channels
- 1% Annual Chance (100-Year) Flood Zone
- 0.2% Annual Chance (500-Year) Flood Zone

Flood hazard areas as depicted on Effective FEMA Digital Insurance Rate Maps (DFIRM)

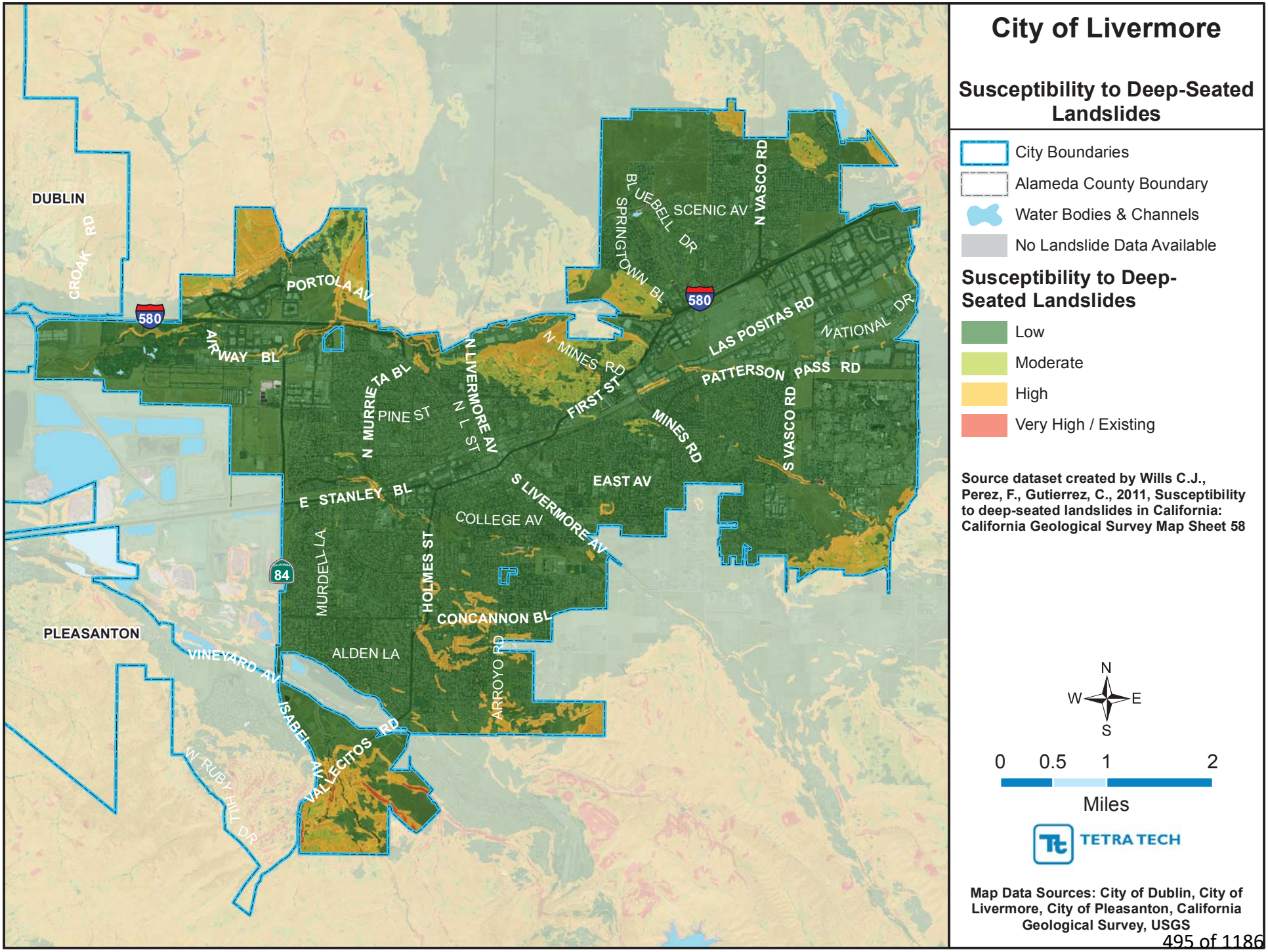
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Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, FEMA, USDA



City of Livermore

Susceptibility to Deep-Seated Landslides

City Boundaries

Alameda County Boundary

Water Bodies & Channels

No Landslide Data Available

Susceptibility to Deep-Seated Landslides

Low

Moderate

High

Very High / Existing

Source dataset created by Wills C.J., Perez, F., Gutierrez, C., 2011, Susceptibility to deep-seated landslides in California: California Geological Survey Map Sheet 58

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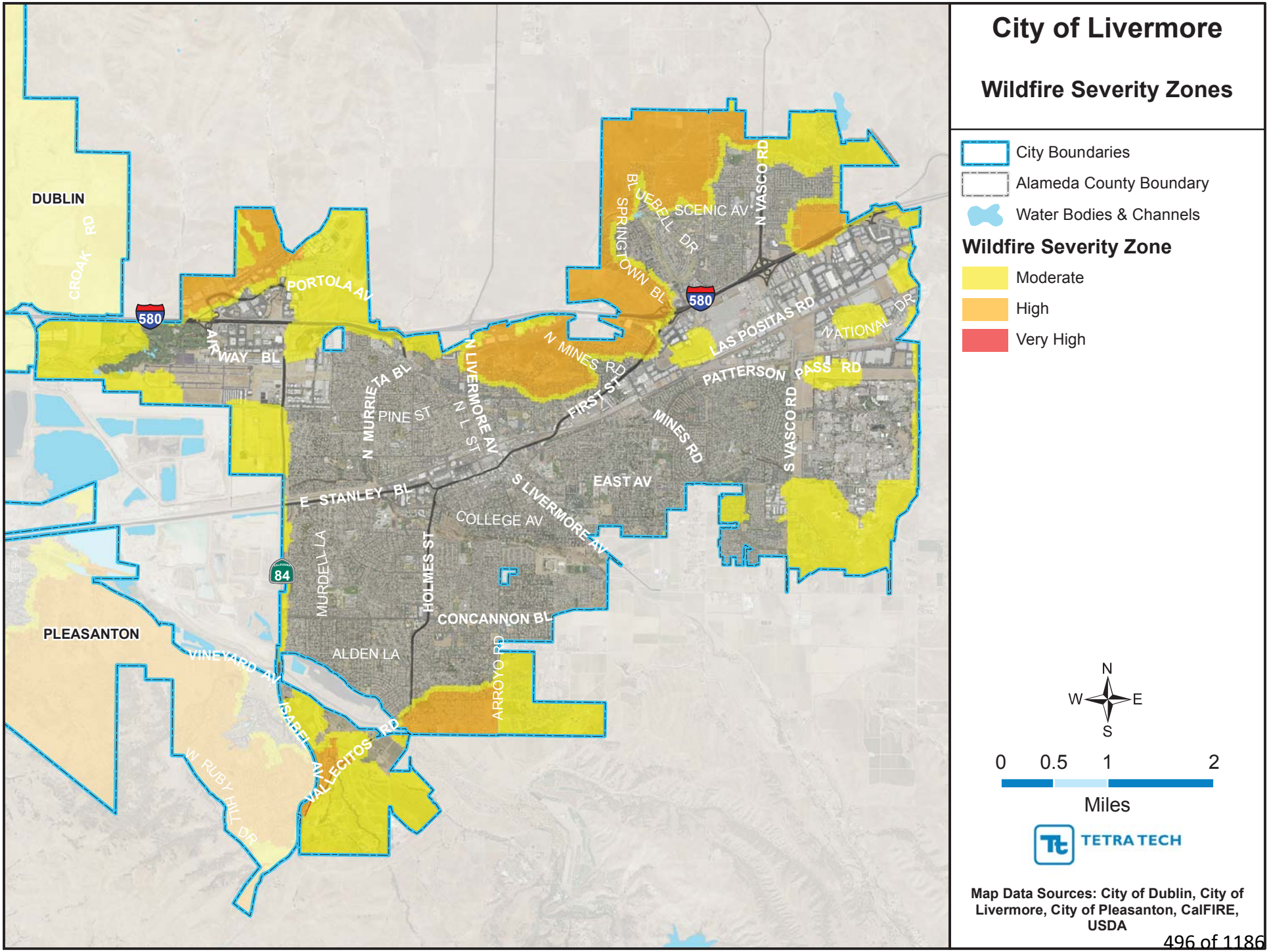
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Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, California Geological Survey, USGS


City of Livermore
Wildfire Severity Zones
City Boundaries
Alameda County Boundary
Water Bodies & Channels
Wildfire Severity Zone
Moderate
High
Very High
DUBLIN
PLEASANTON
580
84
PORTOLA AV
AIRWAY BL
N MURRIETA BL
PINE ST
N LIVERMORE AV
N L ST
N MINES RD
FIRST ST
LAS POSITAS RD
PATTERSON PASS RD
NATIONAL DR
SPRINGTOWN BL
BLUEBELL DR
SCENIC AV
N VASCO RD
S VASCO RD
MINES RD
EAST AV
E STANLEY BL
COLLEGE AV
S LIVERMORE AV
MURDELL LA
HOLMES ST
CONCANNON BL
ALDEN LA
ARROYO RD
VINEYARD AV
ISABEL AV
VALLECITOS RD
N RUBY HILL DR
CROAK RD
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Miles
TETRA TECH
Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, CalFIRE, USDA

3. CITY OF PLEASANTON

3.1 HAZARD MITIGATION PLAN POINT OF CONTACT

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3.2 JURISDICTION PROFILE

The following is a summary of key information about the jurisdiction and its history:

- **Date of Incorporation**—1894
- **Current Population**—75,916 as of January 2017 (CA Department of Finance, May 2017)
- **Population Growth**— Based on data tracked by the state Department of Finance, Pleasanton experienced an approximate 6.6 percent increase in the five years between January 2012 and January 2017 (an increase of 4,703 persons).
- **Location and Description**— Pleasanton is located within Alameda County, one of nine Bay Area counties bordering the San Francisco Bay. Within city limits, Pleasanton comprises generally flat land that was once covered with native vegetation and agriculture, and is now mostly developed with urban land uses. To the east of city limits lie sand and gravel quarries – a result of alluvial deposits from prehistoric streams flowing through the Tri-Valley – which in the future will convert to water conservation and recreational uses. To the south are vineyards along Vineyard Avenue and a series of gently to steeply sloping hills – the Southeast Hills – which sustain grazing lands and cattle. Finally, to the west, the seismically active Pleasanton and Main Ridges rise sharply, providing recreational and grazing areas. Downtown Pleasanton boasts some buildings from the late 1890s, and is generally the center of community activities.
- **Brief History**— Although the area around Pleasanton was long inhabited by people before settlement by Europeans in 1769, the City's population remained modest in the four decades after the City's incorporation in 1894. By the late 1930s and early 1940s the population in Pleasanton was about 1,200 people. However, World War II triggered growth, and the City's population doubled between 1940 and 1950. The National Highway Act passed in 1956 brought Interstates 580 and 680 to the Tri-Valley, allowing for new economic activity. Also contributing to the rapid regional population growth was the federal government's sponsorship of the establishment of what is now Lawrence Livermore National Laboratory in 1950. This time period saw the development of tract neighborhoods outside the immediate downtown area, including: Amaral Acres on Kottinger Avenue, Jensen Tract on Santa Rita Road across from Amador Valley High School, Pleasanton Valley Estates near Santa Rita Road and Black Avenue, Heritage Valley, Pleasanton Heights, and Vintage Hills. The decades subsequent to the 1950s would see rapid population growth and expansion of the city limits to the north and east. The population of the City

in the 1960s was estimated to be 4,200 people. Growth in Pleasanton was further supported by the construction of Hacienda – a major business park – which began in 1982, and construction of Stoneridge Shopping Center.

- **Climate**— Pleasanton enjoys a relatively mild climate, with an average rainfall of 15 inches and average maximum temperature of 89º Fahrenheit in July and average minimum temperature of 37º in December. At its most extreme, winter temperatures can drop below freezing a few days each year, and summer temperatures hover around 100 degrees Fahrenheit during July and August. The temperate weather allows residents year-round opportunities to take advantage of outdoor activities such as hiking the Pleasanton Ridge, cycling along trails and roadways, shopping in the historic downtown district and patio dining at restaurants.
- **Governing Body Format**— The City Council, comprising the Mayor and four City Councilmembers, is the governing body of the city, with all the regulatory and corporate powers of a municipal corporation provided under California State Law. In general, the Council supervises the operations of the City government by establishing policies and programs and appropriating funds for each service function. Members of the City Council are elected at-large. Councilmembers are elected for a term of four-years, and the Mayor is elected to a term of two-years. A Vice Mayor is selected by the Mayor each calendar year. The Mayor and Council are subject to term limits of eight years. The City has 10 committees, commissions, and task forces, which report to the City Council, and 13 departments (inclusive of the City Manager's and City Attorney's Office). The City Council would review and adopt this plan, and the City Council would oversee its implementation.

3.3 DEVELOPMENT TRENDS

The number of housing permits issued in 2016 is 287, which is significantly lower than the 891 permits issued in 2015 (for reference, 332 permits were issued in 2014). Housing production, as regulated by the City's Growth Management Ordinance, is expected to continue as a result of an improved economic climate, recent development activity, interest in sites rezoned for high density development, and the City's efforts to encourage housing through implementation of the Housing Element's new policies and programs. New commercial development is located in various areas of Pleasanton. Examples of large scale projects include Workday, which is currently constructing a six-story, approximately 410,000 square foot office building, parking garage, and other improvements near Stoneridge Mall; and an approximately 112,000 square foot new shopping center located in the eastern part of the City near the intersection of Stoneridge Drive and El Charro Road. The City of Pleasanton adopted its General Plan in 2009, and City actions, such as those relating to land use allocations, annexations, zoning, subdivision, design review, redevelopment, and others must be consistent with the General Plan.

Table 3-1 summarizes development trends in the performance period since development of the previous hazard mitigation plan and expected future development trends.

Table 3-1. Recent and Expected Future Development Trends

Criterion	Response
Has your jurisdiction annexed any land since the development of the previous hazard mitigation plan? • If yes, give the estimated area annexed and estimated number of parcels or structures.	Yes Since February 2012 (date of City Council adoption of resolution of previous hazard mitigation plan), the City has processed 2 annexations (Balch and Linfoot-Mix-Marks), resulting in a total of 22 acres annexed to the City. This consists of 5 parcels.
Is your jurisdiction expected to annex any areas during the performance period of this plan? • If yes, please describe land areas and dominant uses. • If yes, who currently has permitting authority over these areas?	Yes Yes, the City is expecting to annex areas on the outskirts of Pleasanton over the next 5 years. These areas are primarily in the Happy Valley and West of Foothill area, and are generally occupied by lower-density residential units. The County currently has permitting authority in these areas.
Are any areas targeted for development or major redevelopment in the next five years? • If yes, please briefly describe, including whether any of the areas are in known hazard risk areas	Yes Redevelopment activities are focused around transit stations, with few hazard risks other than geotechnical and dam inundation hazards.
How many permits for new construction were issued in your jurisdiction since the development of the previous hazard mitigation plan?	

	2012	2013	2014	2015	2016
Single Family	83	62	68	87	74
Multi-Family	5	3	8	33	23
Other (commercial, mixed use, etc.)	5	5	6	12	12

Please provide the number of new-construction permits for each hazard area or provide a qualitative description of where development has occurred.	Development has occurred throughout the city during the performance period for this plan. The city does not have the ability to track the specific number of building permits issued by hazard area. It is important to note, however, that all new development was consistent with General Plan policies and municipal code standards.
Please describe the level of buildout in the jurisdiction, based on your jurisdiction's buildable lands inventory. If no such inventory exists, provide a qualitative description.	The City of Pleasanton is substantially built out; however, several in-fill lots have not been developed, both with potential residential and non-residential uses.

3.4 CAPABILITY ASSESSMENT

The City of Pleasanton has performed an inventory and analysis of existing capabilities, plans, programs and policies that enhance its ability to implement mitigation strategies. The introduction at the beginning of this volume of the hazard mitigation plan describes the components included in the capability assessment and their significance for hazard mitigation planning. This section summarizes the following findings of the assessment:

- An assessment of legal and regulatory capabilities is presented in Table 3-2.
- An assessment of fiscal capabilities is presented in Table 3-3.
- Development and permitting capabilities are presented in Table 3-4.
- An assessment of administrative and technical capabilities is presented in Table 3-5.
- An assessment of education and outreach capabilities is presented in Table 3-6.
- Information on National Flood Insurance Program (NFIP) compliance is presented in Table 3-7.
- Classifications under various community mitigation programs are presented in Table 3-8.
- The community's adaptive capacity for the impacts of climate change is presented in Table 3-9.

Table 3-2. Legal and Regulatory Capability

	Local Authority	Other Jurisdiction Authority	State Mandated	Integration Opportunity?
Codes, Ordinances, & Requirements				
Building Code	Yes	Yes	Yes	Yes
Comment: Pleasanton Building Code, last amended in 2016, (PMC § 20.08, Building Code)				
Zoning Code	Yes	No	Yes	Yes
Comment: Pleasanton Municipal Code, last amended in 2016 (PMC Title 18, Zoning)				
Subdivisions	Yes	No	Yes	Yes
Comment: Pleasanton Municipal Code, last amended in 2016 (PMC Title 19 Subdivisions)				
Stormwater Management	Yes	Yes	Yes	Yes
Comment: Pleasanton Municipal Code, last amended in 2016 (PMC § 9.14, Stormwater Management and Discharge Control)				
Post-Disaster Recovery	Yes	Yes	No	Yes
Comment: Preparation of subject plan in process				
Real Estate Disclosure	Yes	Yes	Yes	Yes
Comment: Cal. Civ. Code §1102 et seq.				
Growth Management	Yes	Yes	No	No
Comment: Cal. Gov. Code §65300 et seq.; (PMC § 17.36, Growth Management Program)				
Site Plan Review	Yes	No	No	Yes
Comment: Site Plan Review is completed with entitlements such as Design Review and/or Planned Unit Development review for new development projects				
Environmental Protection	Yes	Yes	Yes	Yes
Comment: California Environmental Quality Act (CEQA)				
Flood Damage Prevention	Yes	Yes	Yes	Yes
Comment: The City coordinates with Zone 7 Water Agency for stream management and flood protection.				
Emergency Management	Yes	Yes	Yes	Yes
Comment: Pleasanton Municipal Code, last updated 2016 (PMC § 2.44 Emergency Organization)				
Climate Change	Yes	Yes	Yes	Yes
Comment: California SB 379 requires cities to include climate adaptation and resiliency strategies in their general plans.				
Other:	N/A	N/A	N/A	N/A
Comment: None identified				
Planning Documents				
General Plan	Yes	Yes	Yes	Yes
Is the plan compliant with Assembly Bill 2140? No				
Comment: Pleasanton's General Plan was adopted in 2009.				
Capital Improvement Plan	Yes	Yes	No	Yes
How often is the plan updated? Every 2 years				
Comment: The CIP was last updated in May 2017 for fiscal years 2017-18 through 2020-21				
Floodplain or Watershed Plan	No	Yes	Yes	Yes
Comment: The City coordinates with Zone 7 Water Agency for stream management and flood protection.				
Stormwater Plan	Yes	Yes	Yes	Yes
Comment: Pleasanton Municipal Code, last amended in 2016				
Urban Water Management Plan	Yes	Yes	Yes	Yes
Comment: Pleasanton Municipal Code, last amended in 2016 (PMC § 9.30 Water Management Plan)				
Habitat Conservation Plan	No	Yes	No	No
Comment: Pleasanton participates in the Eastern Alameda County Conservation Strategy				
Economic Development Plan	Yes	No	No	No
Comment: Pleasanton's General Plan includes an Economic and Fiscal Element				

	Local Authority	Other Jurisdiction Authority	State Mandated	Integration Opportunity?
Shoreline Management Plan	No	No	No	No
Comment: Not applicable				
Community Wildfire Protection Plan	No	Yes	Yes	Yes
Comment: Alameda County				
Forest Management Plan	No	No	No	No
Comment: Not applicable				
Climate Action Plan	Yes	Yes	Yes	Yes
Comment: General Plan Air Quality and Climate Change Element adopted in 2009; Climate Action Plan adopted in 2012 and is scheduled to be updated in 2018				
Comprehensive Emergency Management Plan	Yes	Yes	Yes	Yes
Comment: The City is in the process of updating its Emergency Management Plan, which will include the critical elements of the Standardized Emergency Management System (SEMS), the National Incident Management System, the National Response Framework and the Incident Command System.				
Threat & Hazard Identification & Risk Assessment (THIRA)	No	Yes	No	No
Comment: Bay Area Urban Areas Security Initiative				
Post-Disaster Recovery Plan	No	Yes	No	Yes
Comment: ABAG, Bay Area Regional Disaster Resilience Action Plan Initiative				
Continuity of Operations Plan	No	No	No	No
Comment: None identified				
Public Health Plan	No	Yes	No	Yes
Comment: Alameda County Public Health Department				
Other:	N/A	N/A	N/A	N/A
Comment: None identified				

Table 3-3. Fiscal Capability

Financial Resource	Accessible or Eligible to Use?
Community Development Block Grants	No – the City uses Community Development Block Grants to fund NPOs
Capital Improvements Project Funding	Yes – eligible but requires City Council approval
Authority to Levy Taxes for Specific Purposes	No
User Fees for Water, Sewer, Gas or Electric Service	Yes, Water and Sewer funds can be used for eligible projects & fees can be increased with City Council approval for that purpose.
Incur Debt through General Obligation Bonds	Yes – requires 2/3 voter approval
Incur Debt through Special Tax Bonds	Yes – requires 2/3 voter approval
Incur Debt through Private Activity Bonds	Yes – requires either City Council or voter approval
Withhold Public Expenditures in Hazard-Prone Areas	Yes – requires City Council action
State-Sponsored Grant Programs	Yes
Development Impact Fees for Homebuyers or Developers	Yes, if the project was included in fee study as required to mitigate full build-out of the City's General Plan
Other	No

Table 3-4. Development and Permitting Capability

Criterion	Response
Does your jurisdiction issue development permits? • If no, who does? If yes, which department?	Yes Community Development
Does your jurisdiction have the ability to track permits by hazard area?	No
Does your jurisdiction have a buildable lands inventory?	Yes

Table 3-5. Administrative and Technical Capability

Staff/Personnel Resource	Available?	Department/Agency/Position
Planners or engineers with knowledge of land development and land management practices	Yes	Community Development Department
Engineers or professionals trained in building or infrastructure construction practices	Yes	Community Development Department and Engineering Department
Planners or engineers with an understanding of natural hazards	Yes	Community Development Department
Staff with training in benefit/cost analysis	Yes	Finance Department
Surveyors	Yes	Engineering Department
Personnel skilled or trained in GIS applications	Yes	Information technology
Scientist familiar with natural hazards in local area	No	N/A
Emergency Manager	Yes	LPFD
Grant writers	Yes	Various Departments
Other	No	N/A

Table 3-6. Education and Outreach Capability

Criterion	Response
Do you have a Public Information Officer or Communications Office?	Yes
Do you have personnel skilled or trained in website development?	Yes
Do you have hazard mitigation information available on your website? • If yes, please briefly describe.	Yes Hazard Mitigation Plan website
Do you utilize social media for hazard mitigation education and outreach? • If yes, please briefly describe.	No N/A
Do you have any citizen boards or commissions that address issues related to hazard mitigation? • If yes, please briefly describe.	No N/A
Do you have any other programs already in place that could be used to communicate hazard-related information? • If yes, please briefly describe.	Yes City newsletter
Do you have any established warning systems for hazard events? • If yes, please briefly describe.	Yes Social media

Table 3-7. National Flood Insurance Program Compliance

Criterion	Response
What local department is responsible for floodplain management?	Engineering/Building
Who is your floodplain administrator? (department/position)	Adam Nelkie, Senior Civil Engineer
Are any certified floodplain managers on staff in your jurisdiction?	Yes
What is the date that your flood damage prevention ordinance was last amended?	January 1, 2014, Ord No. 2083
Does your floodplain management program meet or exceed minimum requirements?	Meets
• If exceeds, in what ways?	N/A
When was the most recent Community Assistance Visit or Community Assistance Contact?	February 2016
Does your jurisdiction have any outstanding NFIP compliance violations that need to be addressed?	No
• If so, please state what they are.	N/A
Do your flood hazard maps adequately address the flood risk within your jurisdiction?	Yes
• If no, please state why.	N/A
Does your floodplain management staff need any assistance or training to support its floodplain management program?	Yes
• If so, what type of assistance/training is needed?	Additional staff trained.
Does your jurisdiction participate in the Community Rating System (CRS)?	Yes (Class 8)
• If yes, is your jurisdiction interested in improving CRS Classification?	Yes
• Is your jurisdiction interested in joining the CRS program?	N/A
How many flood insurance policies are in force in your jurisdiction?[a]	139
• What is the insurance in force?	$50,728,000
• What is the premium in force?	$101,768
How many total loss claims have been filed in your jurisdiction?[a]	22
• How many claims are still open/were closed without payment?	1/13
• What were the total payments for losses?	$154,583

a. According to FEMA statistics as of June 30, 2017

Table 3-8. Community Classifications

	Participating?	Classification	Date Classified
Community Rating System	Yes	8	10/1/97
Building Code Effectiveness Grading Schedule	Yes	3	March 2012
Public Protection	No	N/A	N/A
Storm Ready	No	N/A	N/A
Firewise	No	N/A	N/A

Table 3-9. Adaptive Capacity for Climate Change

Criterion	Jurisdiction Rating[a]
Technical Capacity	
Jurisdiction-level understanding of potential climate change impacts	Medium
Comment: *A greenhouse gas inventory was conducted for 2005 data. This analysis supported preparation and adoption of the Climate Action Plan (CAP) in 2012. The Air Quality and Climate Change Element of the General Plan was modified concurrently with adoption of the CAP.*	
Jurisdiction-level monitoring of climate change impacts	Low
Comment: *The City has adopted a Climate Action Plan and the General Plan includes climate change policies. While climate change impacts are not specifically monitored, hazards are monitored via the local hazard mitigation plan.*	
Technical resources to assess proposed strategies for feasibility and externalities	Medium
Comment: *City staff and if needed, consultants are available to assess strategies for feasibility.*	
Jurisdiction-level capacity for development of greenhouse gas emissions inventory	Low
Comment: *The City is planning an update to its Climate Action Plan. This effort is expected to commence in 2018.*	
Capital planning and land use decisions informed by potential climate impacts	Medium
Comment: *Impacts related to air quality and greenhouse gas emissions are evaluated on a project-by-project basis during environmental review.*	
Participation in regional groups addressing climate risks	Low
Comment: *The City would participate in regional groups that are initiated for this effort.*	
Implementation Capacity	
Clear authority/mandate to consider climate change impacts during public decision-making processes	Medium
Comment: *Impacts related to air quality and greenhouse gas emissions are evaluated on a project-by-project basis during environmental review.*	
Identified strategies for greenhouse gas mitigation efforts	High
Comment: *The CAP provides strategies and implementation measures to reduce greenhouse gas emissions.*	
Identified strategies for adaptation to impacts	Low
Comment: *These strategies could be incorporated into an update to the Climate Action Plan.*	
Champions for climate action in local government departments	Low
Comment: *At this time, there is no dedicated staff to climate action planning. However, with the planned update to the CAP commencing in 2018, the City anticipates setting up a* city-wide Green Team comprised of representatives from various departments.	
Political support for implementing climate change adaptation strategies	High
Comment: *The city is supportive of measures outlined in the CAP and their strategic implementation.*	
Financial resources devoted to climate change adaptation	Medium
Comment: *While funds have not been specifically dedicated to climate change adaptation, implementation of such measures are carried forward on an as feasible basis for city projects.*	
Local authority over sectors likely to be negative impacted	Medium
Comment: *The city has authority over local public streets and related infrastructure.*	
Public Capacity	
Local residents' knowledge of and understanding of climate risk	Medium
Comment: *Local residents are well-informed and aware of local, regional, state-wide, and greater issues relating to climate change.*	
Local residents support of adaptation efforts	Low
Comment: *Local residents are generally supportive of measures to address climate change, but the city has not recently specifically solicited public feedback on this topic.*	
Local residents' capacity to adapt to climate impacts	Low
Comment: *This is not known at this time.*	

Criterion	Jurisdiction Rating[a]
Local economy current capacity to adapt to climate impacts	Low
Comment: This is not known at this time.	
Local ecosystems capacity to adapt to climate impacts	Low
Comment: This is not known at this time.	

a. High = Capacity exists and is in use; Medium = Capacity may exist, but is not used or could use some improvement; Low = Capacity does not exist or could use substantial improvement; Unsure= Not enough information is known to assign a rating.

3.5 INTEGRATION WITH OTHER PLANNING INITIATIVES

The information on hazards, risk, vulnerability and mitigation contained in this hazard mitigation plan is based on the best available data. Plan integration is the incorporation of this information into other relevant planning mechanisms, such as general planning and capital facilities planning. It includes the integration of natural hazard information and mitigation policies, principles and actions into local planning mechanisms and vice versa. Additionally, plan integration is achieved though the involvement of key staff and community officials in collaboratively planning for hazard mitigation.

3.5.1 Existing Integration

In the performance period since adoption of the previous hazard mitigation plan, the City of Pleasanton made progress on integrating hazard mitigation goals, objectives and actions into other planning initiatives. The following plans and programs currently integrate components of the hazard mitigation strategy:

- **General Plan**—Includes policies related to flooding, geotechnical concerns, wildfire, and other hazards
- **Capital Improvement Plan**—Includes infrastructure that incorporates climate change adaptation strategies
- **Climate Action Plan**—Increases resilience to climate change
- **Emergency Operations Plan—**Addresses operational needs and procedures during an emergency
- **Pleasanton Municipal Code—**The Pleasanton Municipal Code includes development requirements that can address hazard mitigation.

Resources listed in Section 3.12 were used to provide information for this annex on hazard events and local capabilities within the jurisdiction.

3.5.2 Opportunities for Future Integration

As this hazard mitigation plan is implemented, the City of Pleasanton will use information from the plan as the best available science and data on natural hazards. The capability assessment presented in this annex identifies codes, plans and programs that provide opportunities for integration. The area-wide and local action plans developed for this hazard mitigation plan in actions related to plan integration, and progress on these actions will be reported through the progress reporting process described in Volume 1. New opportunities for integration also will be identified as part of the midterm progress report. The capability assessment identified the following plans and programs that do not currently integrate goals or recommendations of the hazard mitigation plan but provide opportunities to do so in the future:

- **Capital Improvement Program**—Incorporate hazard mitigation projects consistent with other adopted plans and programs.
- **Pleasanton General Plan**—Enhance to address hazard mitigation policies, including climate adaptation and resiliency as required by State law
- **Climate Action Plan**—Enhance to increase local resiliency to climate change

- **Emergency Operations Plan**—Update to better address operational needs and procedures during an emergency
- **Pleasanton Municipal Code –** The Pleasanton Municipal Code includes development requirements that can address hazard mitigation, including site plan review completed with entitlements such as Design Review and Planned Unit Development review. Continue to look for opportunities to further integrate hazard mitigation goals and objectives into the Municipal Code.
- **Continuity of Operations Plan—**Plan to ensure that agencies are able to perform essential functions during emergencies.
- **Continuity of Government Plan—**Plan to ensure that government continues its essential functions during emergencies
- **Post Disaster Recovery Plan**—Develop plan and policies for rebuilding and recovery after disasters

3.6 JURISDICTION-SPECIFIC NATURAL HAZARD EVENT HISTORY

Table 3-10 lists past occurrences of natural hazards for which specific damage was recorded in the City of Pleasanton. Other hazard events that broadly affected the entire planning area, including the City of Pleasanton, are listed in the risk assessments in Volume 1 of this hazard mitigation plan.

Table 3-10. Past Natural Hazard Events

Type of Event	FEMA Disaster # (if applicable)	Date	Damage Assessment
Drought	-	2013-2016	N/A
Severe Winter Storms, Flooding	DR-1155	11/17/96	N/A
Loma Prieta Earthquake	DR-845	10/17/89	N/A

3.7 JURISDICTION-SPECIFIC VULNERABILITIES

Volume 1 of this hazard mitigation plan provides complete risk assessments for each identified hazard of concern. This section provides information on a few key vulnerabilities for the jurisdiction.

Repetitive loss records are as follows:

- Number of FEMA-identified Repetitive-Loss Properties: 0
- Number of FEMA-identified Severe-Repetitive-Loss Properties: 0
- Number of Repetitive-Loss Properties or Severe-Repetitive-Loss Properties that have been mitigated: 0

Other noted vulnerabilities include the following:

- Areas of Pleasanton are likely to experience flooding and effects of climate change.
- Petroleum product and natural gas pipelines, as well as PG&E transmission lines traverse through Pleasanton.
- The Union Pacific / Southern Pacific and Western Pacific Railroads consult rail operations through Pleasanton, which includes cargoes of electronics, fabricated metals, plastics, precision machinery, agricultural chemicals, construction materials, rock/sand/gravel aggregates, and other hazardous materials. A spill of bulk hazardous materials could result in fire, explosion, toxic cloud, or direct contamination of people and property.
- Although not located within the Pleasanton Planning Area boundary, the Livermore Municipal Airport affects land uses in Pleasanton in the form of noise and safety. These concerns are addressed by the Alameda County Airport Land Use Commission (ALUC) in its *Airport Land Use Compatibility Plan*

(ALUCP). As part of the ALUCP, the ALUC has adopted seven safety compatibility zones. Three of the zones, 4, 6, and 7, extend into Pleasanton.

3.8 HAZARD RISK RANKING

Table 3-11 presents a local ranking for the City of Pleasanton of all hazards of concern for which Volume 1 of this hazard mitigation plan provides complete risk assessments. This ranking summarizes how hazards vary for this jurisdiction. As described in detail in Volume 1, the ranking process involves an assessment of the likelihood of occurrence for each hazard, along with its potential impacts on people, property and the economy.

Table 3-11. Hazard Risk Ranking

Rank	Hazard Type	Risk Rating Score (Probability x Impact)	Category
1	Wildfire[c]	39	High
2	Earthquake[a]	36	High
3	Severe weather[b]	33	Medium
4	Landslide[e]	26	Medium
5	Dam failure[g]	18	Medium
6	Flood[d]	12	Low
7	Drought[f]	9	Low

a. Based on the "Haywired" (Hayward Fault Scenario M7.05)
b. Severe weather is assessed more qualitatively than other hazards. Assumptions for risk ranking include high probability, medium impact on people, medium impact on property and low impact on economy.
c. Based on Very High and High Fire Severity Zones.
d. Based on 1 percent-annual-chance flood zone (otherwise known as the special flood hazard area)
e. Based on Very High, High, and Moderate Landslide Susceptibility Zones
f. Drought is assessed more qualitatively than other hazards. Generally, drought does not cause injury or death to people or result in property damage. Assumptions for risk ranking include high probability, no impact on people, low impact on property and low impact on economy for those jurisdictions with limited agriculture.
g. Based on the Del Valle Dam inundation scenario.

3.9 STATUS OF PREVIOUS PLAN ACTIONS

Table 3-12 summarizes the actions that were recommended in the previous version of the hazard mitigation plan and their implementation status at the time this update was prepared.

3.10 HAZARD MITIGATION ACTION PLAN AND EVALUATION OF RECOMMENDED ACTIONS

Table 3-13 lists the actions that make up the City of Pleasanton hazard mitigation action plan. Table 3-14 identifies the priority for each action. Table 3-15 summarizes the mitigation actions by hazard of concern and mitigation type.

Table 3-12. Status of Previous Plan Actions

Action Item	Completed	Removed; No Longer Feasible	Carried Over to Plan Update: Check if Yes	Carried Over to Plan Update: Enter Action #
Tie public education on defensible space and a comprehensive defensible space ordinance to a field program of enforcement. LPFD Fire Prevention. Resource shortage. (HSNG-g-2)	Yes; Ongoing		Yes	P6
Comment: This is completed annually.				
Install micro and/or surveillance cameras around critical public assets tied to web-based software, and develop a surveillance protocol to monitor these cameras. Pleasanton Police Dept., (GOVT-a-6).	No	Yes	No	
Comment: Unfunded.				
Ongoing Activities	X			
Comment: The 2010 plan included an extensive list of ongoing activities as part of the mitigation strategy. Based upon review, these strategies are addressed by the objectives identified as part of this plan update and/or are identified in the core capability assessment for the City of Pleasanton.				

Table 3-13. Hazard Mitigation Action Plan Matrix

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline
P-1— Where appropriate, support retrofitting or relocation of structures in high hazard areas, prioritizing structures that have experienced repetitive losses.							
Existing	Dam failure, Earthquake, Flood, Landslide, Severe weather, Wildfire	4, 6, 8, 10, 11, 12	City of Pleasanton, Community Development Department, Engineering Department	LPFD	High	HMGP, PDM, FMA	Short-term
P-2— Integrate the hazard mitigation plan into other plans, ordinances and programs that dictate land use decisions in the community, including the City's General Plan.							
New and Existing	Dam failure, Drought, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 2, 6, 8, 10, 11	City of Pleasanton, Community Development Department, Engineering Department	LPFD	Low	Staff Time, General Funds	Ongoing
P-3— Actively participate in the plan maintenance protocols outlined in Volume 1 of this hazard mitigation plan.							
New and Existing	Dam failure, Drought, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	City of Pleasanton-All Departments	LPFD	Low	Staff Time, General Funds	Short-term
P-4—Continue to maintain good standing and compliance under the NFIP through implementation of floodplain management programs that, at a minimum, meet the NFIP requirements: • Enforce the flood damage prevention ordinance. • Participate in floodplain identification and mapping updates. • Provide public assistance/information on floodplain requirements and impacts.							
New and Existing	Flood, Dam failure	1, 4, 6, 9	City of Pleasanton, Engineering Department	LPFD	Low	Staff Time, General Funds	Ongoing

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline
P-5—Identify and pursue strategies to increase adaptive capacity to climate change including but not limited to the following: update and implementation of the Climate Action Plan and update the General Plan to address recent legislation and establish policies related to climate change adaptability.							
New and Existing	Dam failure, Drought, Flood, Landslide, Severe weather, Wildfire	1, 2, 5, 7, 8, 9, 10, 12	City of Pleasanton-All Departments	Adjacent cities/County	Low	Staff Time, General Funds	Short-term
P-6— Tie public education on defensible space and a comprehensive defensible space ordinance to a field program of enforcement.							
New and Existing	Wildfire	1, 2, 5, 6, 11, 12	LPFD	City of Pleasanton	Medium	Staff Time, General Funds	Ongoing
P7— Prohibit construction of habitable structures within at least 50 feet of an identified active fault trace where the fault has been specifically located in site-specific geologic studies							
New	Landslide, Earthquake	2, 4, 5, 6, 11	City of Pleasanton Community Development Department, Engineering Department	None	Low	General Funds, Staff Time	Ongoing
P8— Prohibit new development of sites with structures intended for human occupancy in any landslide-prone areas unless the landslide risk can be eliminated. Permit development in landslide prone areas only when sites can be shown to be stable during adverse conditions such as saturated soils, ground shaking, and during grading of the site for roads, installation of infrastructure, and creation of building pads. Engineering studies shall demonstrate that structures in landslide prone areas would sustain no more damage due to slope instabilities than damage sustained by a similar building in the Pleasanton Planning Area constructed to current CBC standards and located on soils with a low susceptibility to failure when exposed to moderate ground shaking.							
New	Landslide, Earthquake	2, 4, 5, 6, 11	City of Pleasanton Community Development Department, Engineering Department	None	Low	General Funds, Staff Time	Ongoing
P9—Require fire mitigation measures in new and existing developments that reduce the fire threat to the structure and occupants. Require development outside the five-minute travel time and in Special Fire Protection Areas to provide effective fire prevention measures.							
New	Wildfire	2, 3, 7	LPFD	City of Pleasanton	Medium	General Funds, Staff Time, Private Development Investment	Ongoing
P10—Continue to conduct public meetings and issue press releases regarding Del Valle Dam evacuation.							
Existing	Dam failure	3, 7, 9	City of Pleasanton Community Development Department, Engineering Department	None	Low	General Funds	Ongoing
P11—Encourage replacing aboveground electric and phone wires and other structures with underground facilities, and use the planning-approval process to ensure that, on a case-by-case basis, all new phone and electrical lines are installed underground.							
New and Existing	Severe weather, Landslide, dam failure, flood, wildfire	4, 8	City of Pleasanton Community Development	None	Low	General Funds; Possible PG&E Underground Fund; HMGP, PDM	Ongoing

Table 3-14. Mitigation Action Priority

Action #	# of Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is Project Grant-Eligible?	Can Project Be Funded Under Existing Programs/ Budgets?	Implementation Priority[a]	Grant Pursuit Priority[a]
P-1	6	High	High	Yes	Yes	No	Medium	High
P-2	6	Medium	Low	Yes	No	Yes	High	Low
P-3	12	Low	Low	Yes	No	Yes	High	Low
P-4	4	Medium	Low	Yes	No	Yes	High	Low
P-5	8	Medium	Low	Yes	No	Yes	High	Medium
P-6	6	Medium	Low	Yes	No	Yes	High	Low
P-7	5	Medium	Low	Yes	No	Yes	High	Low
P-8	5	Medium	Low	Yes	No	Yes	High	Low
P-9	3	High	Medium	Yes	No	Yes	High	Low
P-10	3	High	Low	Yes	No	Yes	High	Low
P-11	2	Medium	Low	Yes	Yes	Yes	High	High

a. See the introduction to this volume for explanation of priorities.

Table 3-15. Analysis of Mitigation Actions

Hazard Type	Action Addressing Hazard, by Mitigation Type[a]							
	Prevention	Property Protection	Public Education and Awareness	Natural Resource Protection	Emergency Services	Structural Projects	Climate Resilient	Community Capacity Building
Wildfire	2	1, 6, 9, 11	6		9		5	2, 3, 5, 6
Earthquake	2, 7	1						2, 3, 5
Severe weather	2	1, 11					5	2, 3, 5
Landslide	2, 7, 8	1, 8, 11					5	2, 3, 5
Dam failure	2, 4	1, 4, 11	4, 10				5	2, 3, 4, 5
Flood	2, 4	1, 4, 11	4				5	2, 3, 4, 5
Drought	2						5	2, 3, 5

a. See the introduction to this volume for explanation of mitigation types.

3.11 FUTURE NEEDS TO BETTER UNDERSTAND RISK/VULNERABILITY

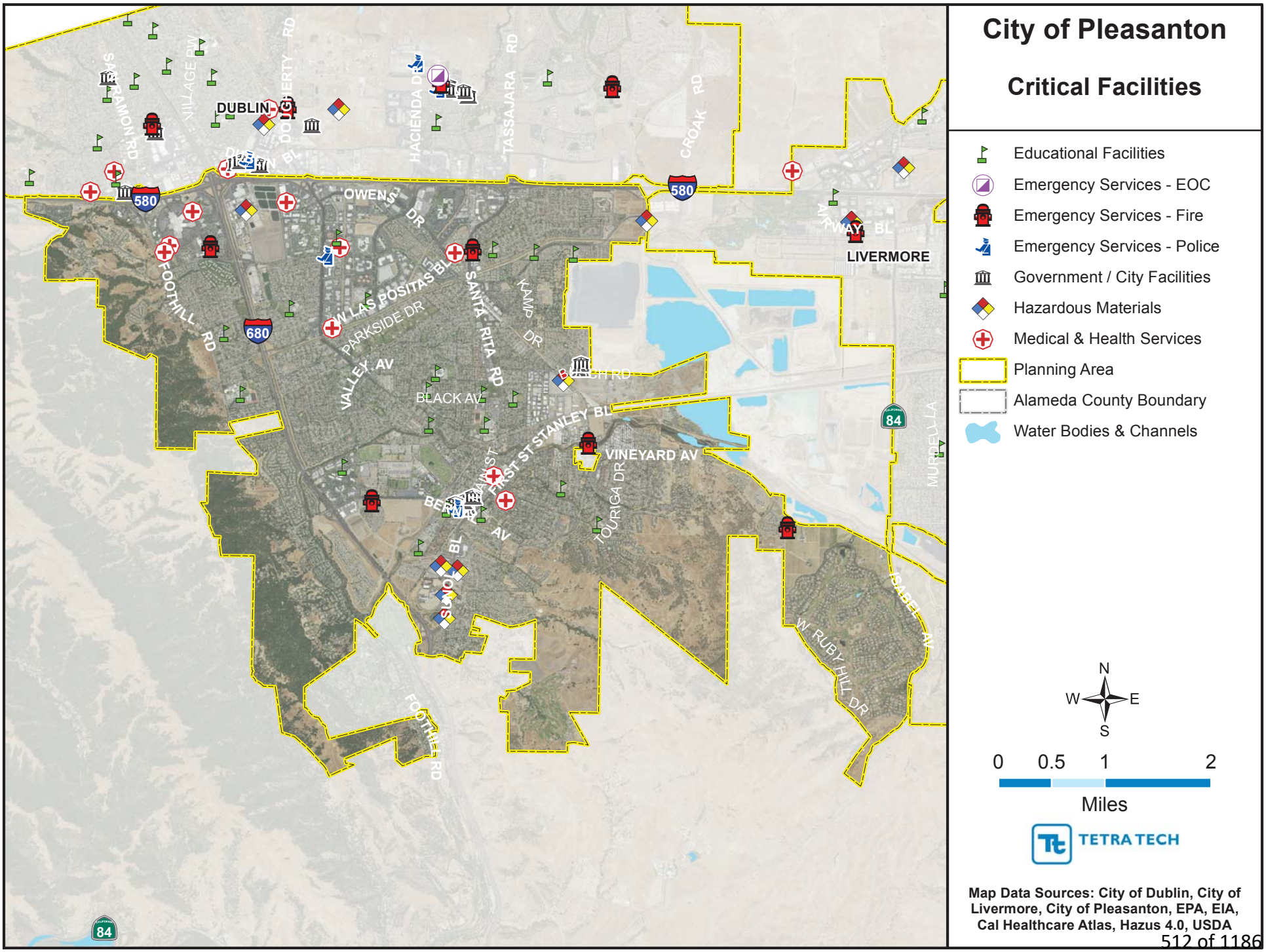
The City could benefit from a multi-disciplinary plan identifying ways in which climate change will affect Pleasanton in the future, and ways to address/mitigate this change.

3.12 REVIEW AND INCORPORATION OF RESOURCES FOR THIS ANNEX

The following technical reports, plans, and regulatory mechanisms were reviewed to provide information for this annex.

- **City of Pleasanton Municipal Code**—The municipal code was reviewed for the full capability assessment and for identifying opportunities for action plan integration.

- **City of Pleasanton Flood Damage Prevention Ordinance**—The flood damage prevention ordinance was reviewed for compliance with the National Flood Insurance Program.
- **City of Pleasanton General Plan—**The General Plan was reviewed to identify applicable policies that promote hazard mitigation.
- **City of Pleasanton Climate Action Pla**n—The Climate Action Plan was reviewed to ascertain approaches to achieving climate change resilience.
- **Technical Reports and Information—**The following outside resources and references were reviewed:
  - **Hazard Mitigation Plan Annex Development Tool-kit**—The tool-kit was used to support the development of this annex including past hazard events, noted vulnerabilities, risk ranking and action development.
  - **Current State Law**—State law (e.g., SB 379, SB 1241) was reviewed regarding recent requirements that relate to hazards and hazard mitigation.
  - **State Office Department of Planning and Research, General Plan Guidelines**—The Guidelines were reviewed to identify new approaches to integrating hazard planning into General Plans.



City of Pleasanton

Critical Facilities

- Educational Facilities
- Emergency Services - EOC
- Emergency Services - Fire
- Emergency Services - Police
- Government / City Facilities
- Hazardous Materials
- Medical & Health Services
- Planning Area
- Alameda County Boundary
- Water Bodies & Channels

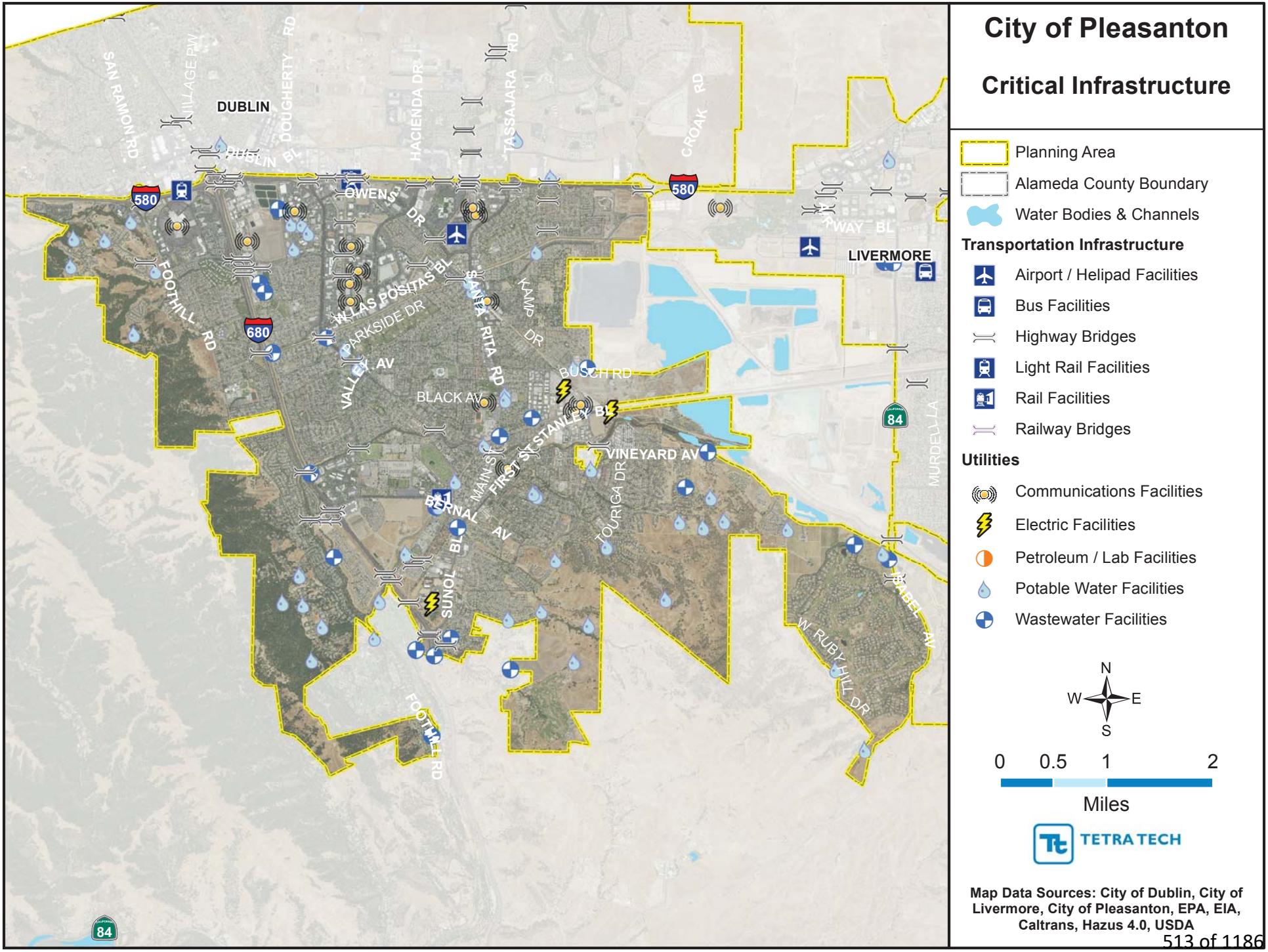
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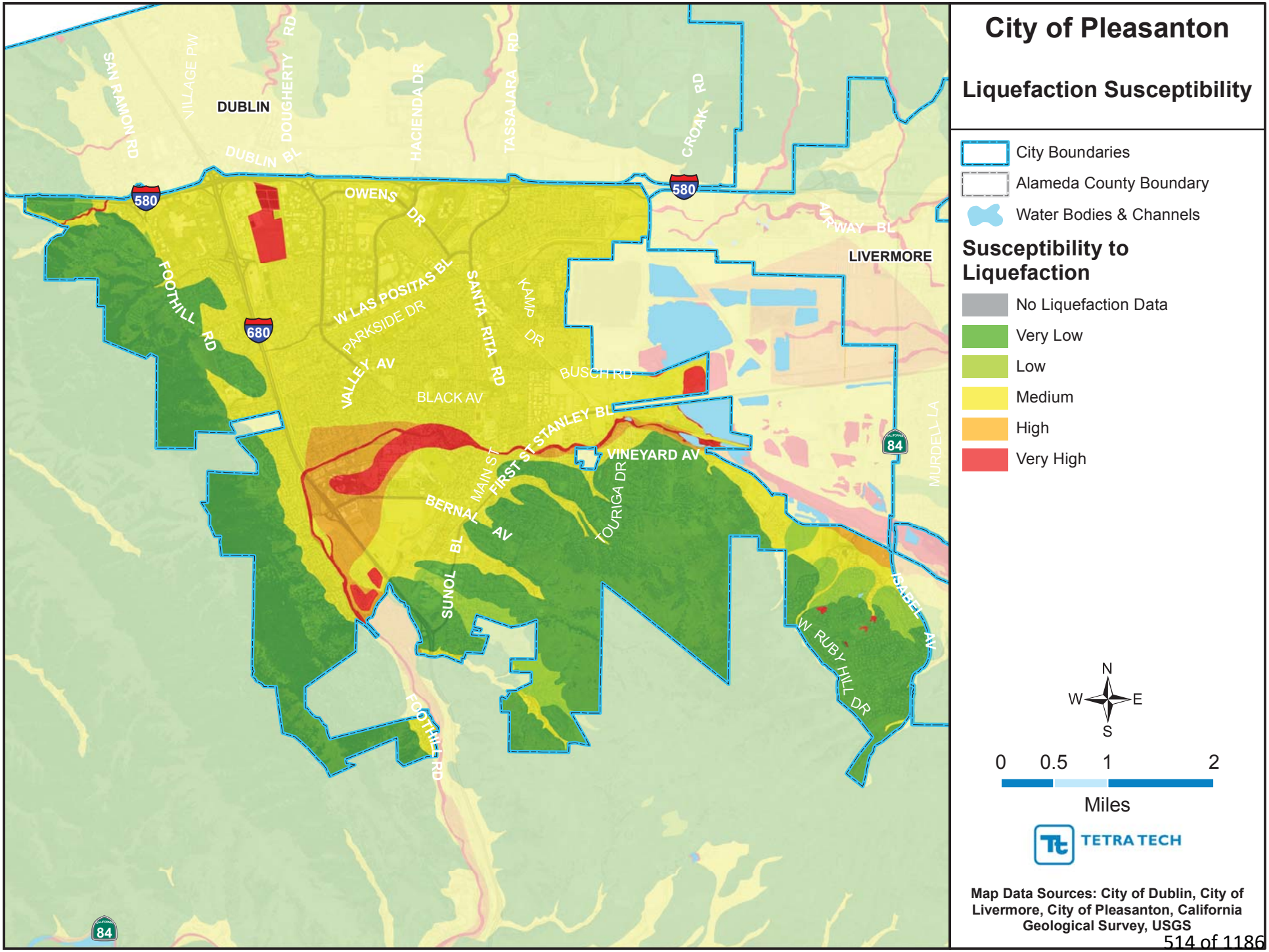
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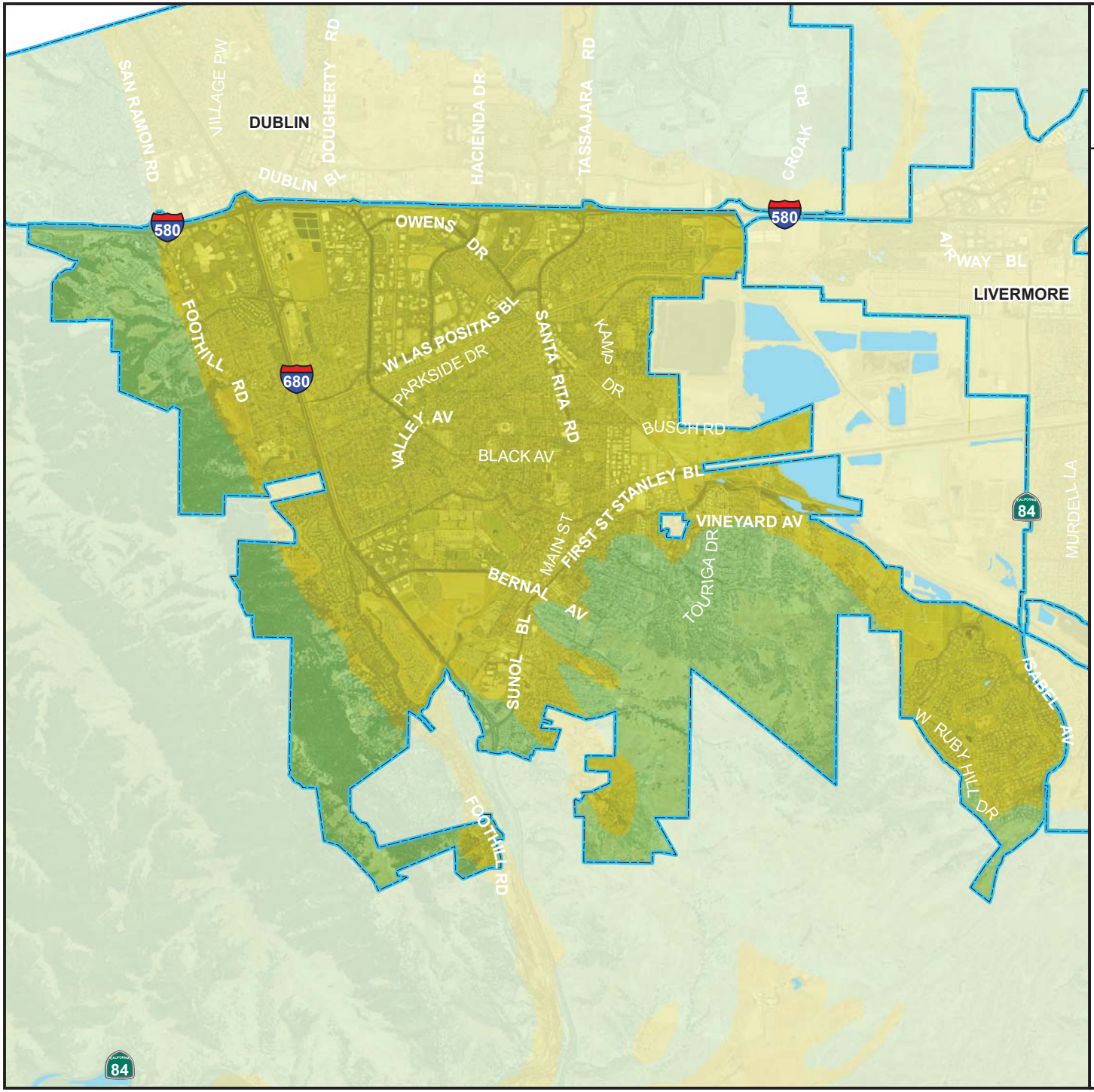
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Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, EPA, EIA, Cal Healthcare Atlas, Hazus 4.0, USDA


City of Pleasanton
Critical Infrastructure
Planning Area
Alameda County Boundary
Water Bodies & Channels
Transportation Infrastructure
Airport / Helipad Facilities
Bus Facilities
Highway Bridges
Light Rail Facilities
Rail Facilities
Railway Bridges
Utilities
Communications Facilities
Electric Facilities
Petroleum / Lab Facilities
Potable Water Facilities
Wastewater Facilities
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TETRA TECH
Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, EPA, EIA, Caltrans, Hazus 4.0, USDA
DUBLIN
LIVERMORE
SAN RAMON RD
VILLAGE PW
DOUGHERTY RD
DUBLIN BL
HACIENDA DR
TASSAJARA RD
CROAK RD
OWENS DR
N LIVERMORE AV
FOOTHILL RD
W LAS POSITAS BL
PARKSIDE DR
SANTA RITA RD
KAMP DR
VALLEY AV
BLACK AV
BUSCH RD
STANLEY BL
VINEYARD AV
MAIN ST
FIRST ST
BERNAL AV
TOURIGA DR
MURRIETA LA
SUNOL BL
ISABEL AV
W RUBY HILL DR
FOOTHILL RD
580
680
84


City of Pleasanton
Liquefaction Susceptibility
City Boundaries
Alameda County Boundary
Water Bodies & Channels
Susceptibility to Liquefaction
No Liquefaction Data
Very Low
Low
Medium
High
Very High
DUBLIN
LIVERMORE
SAN RAMON RD
VILLAGE PW
DOUGHERTY RD
HACIENDA DR
TASSAJARA RD
CROAK RD
DUBLIN BL
OWENS DR
AIRWAY BL
FOOTHILL RD
W LAS POSITAS BL
PARKSIDE DR
SANTA RITA RD
KAMP DR
VALLEY AV
BLACK AV
BUSCH RD
FIRST ST
STANLEY BL
VINEYARD AV
MAIN ST
BERNAL AV
TOURIGA DR
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MURDELL LA
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Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, California Geological Survey, USGS



City of Pleasanton

National Earthquake Hazards Reduction Program (NEHRP) Soil Classification

City Boundaries

Alameda County Boundary

Water Bodies & Channels

NEHRP Site Class / Soil Profile

- B / Rock
- C / Very Dense Soil - Soft Rock
- D / Stiff Soil
- E / Soft Soil

Soil classification data provided by the California Department of Conservation. The data is based on surficial geology published at a scale of 1:250,000. The surficial geologic units were grouped into composite units with similar average shear wave velocity to 30 meters depth (Vs30) values. This data was prepared as part of the Probabilistic Seismic Hazard Map of California (Petersen, M., D. Beeby, W. Bryant, T. Cao, C. Cramer, J. Davis, M. Reichle, G. Saucedo, S. Tan G., Taylor, T. Toppozada, J. Treiman, and C. Wills (1999) Seismic Shaking Hazard Maps of California: California Division of Mines and Geology Map Sheet 48).

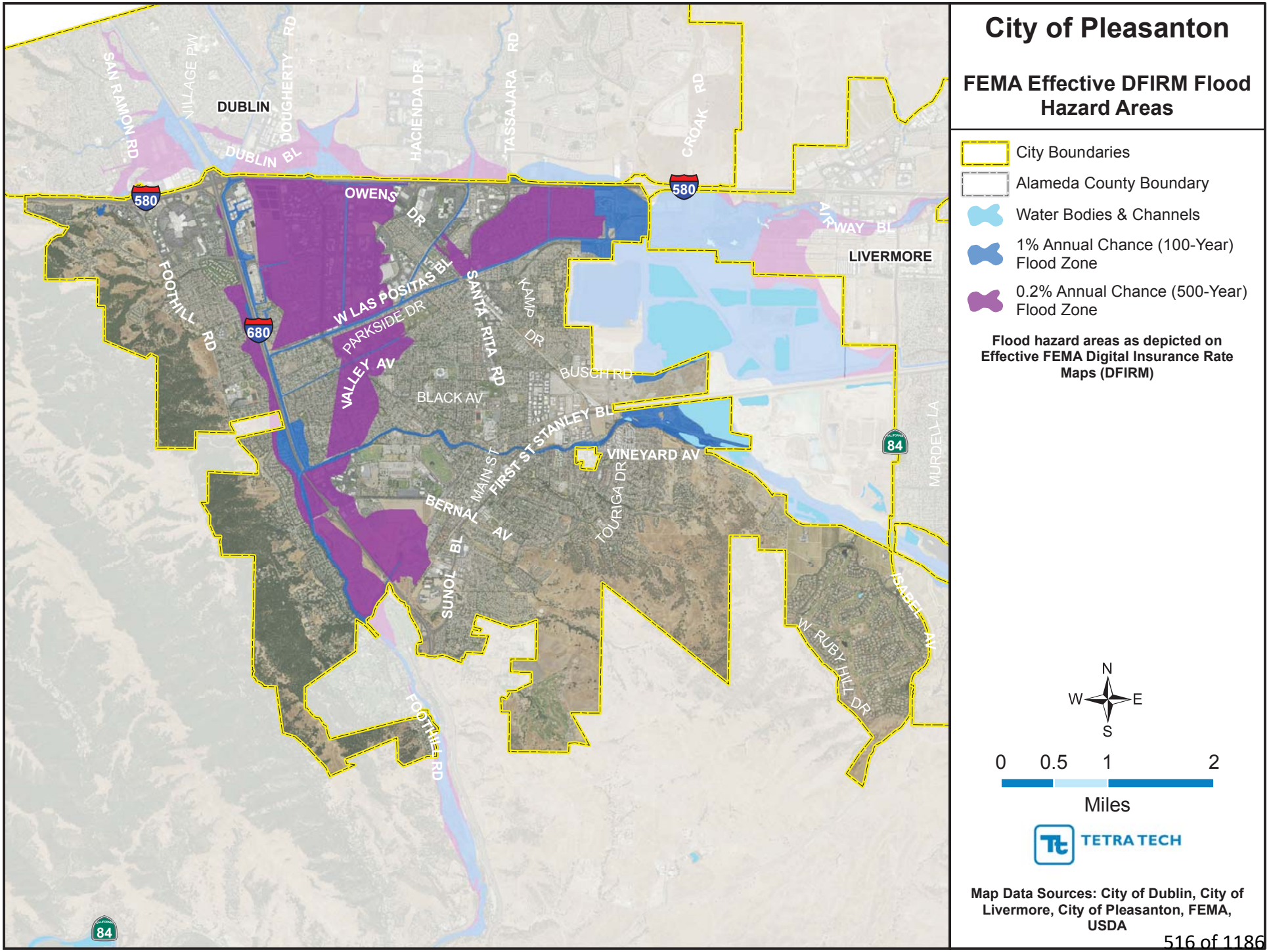
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Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, California Dept of Conservation, CGS, USGS



City of Pleasanton

FEMA Effective DFIRM Flood Hazard Areas

- City Boundaries
- Alameda County Boundary
- Water Bodies & Channels
- 1% Annual Chance (100-Year) Flood Zone
- 0.2% Annual Chance (500-Year) Flood Zone

Flood hazard areas as depicted on Effective FEMA Digital Insurance Rate Maps (DFIRM)

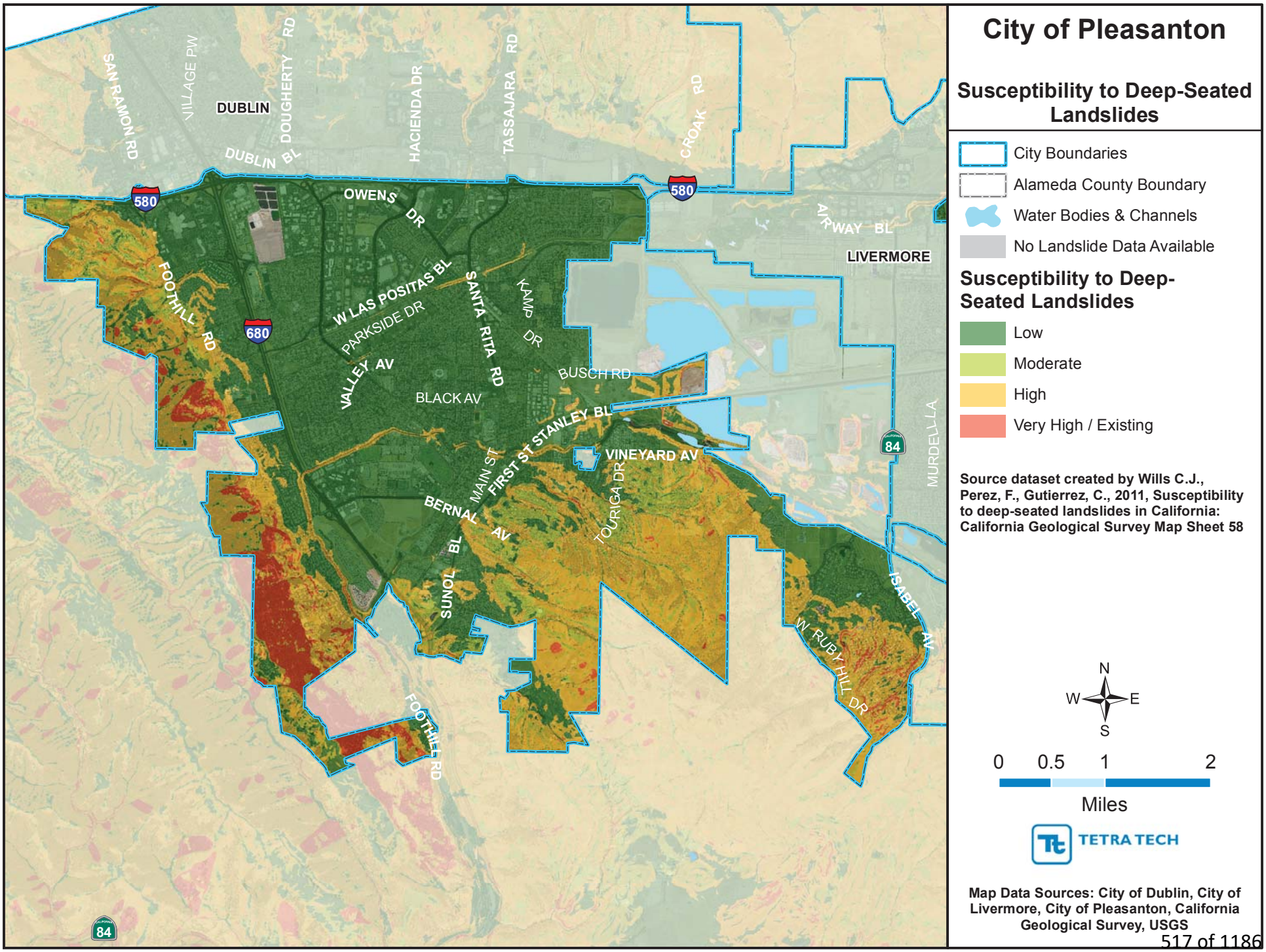
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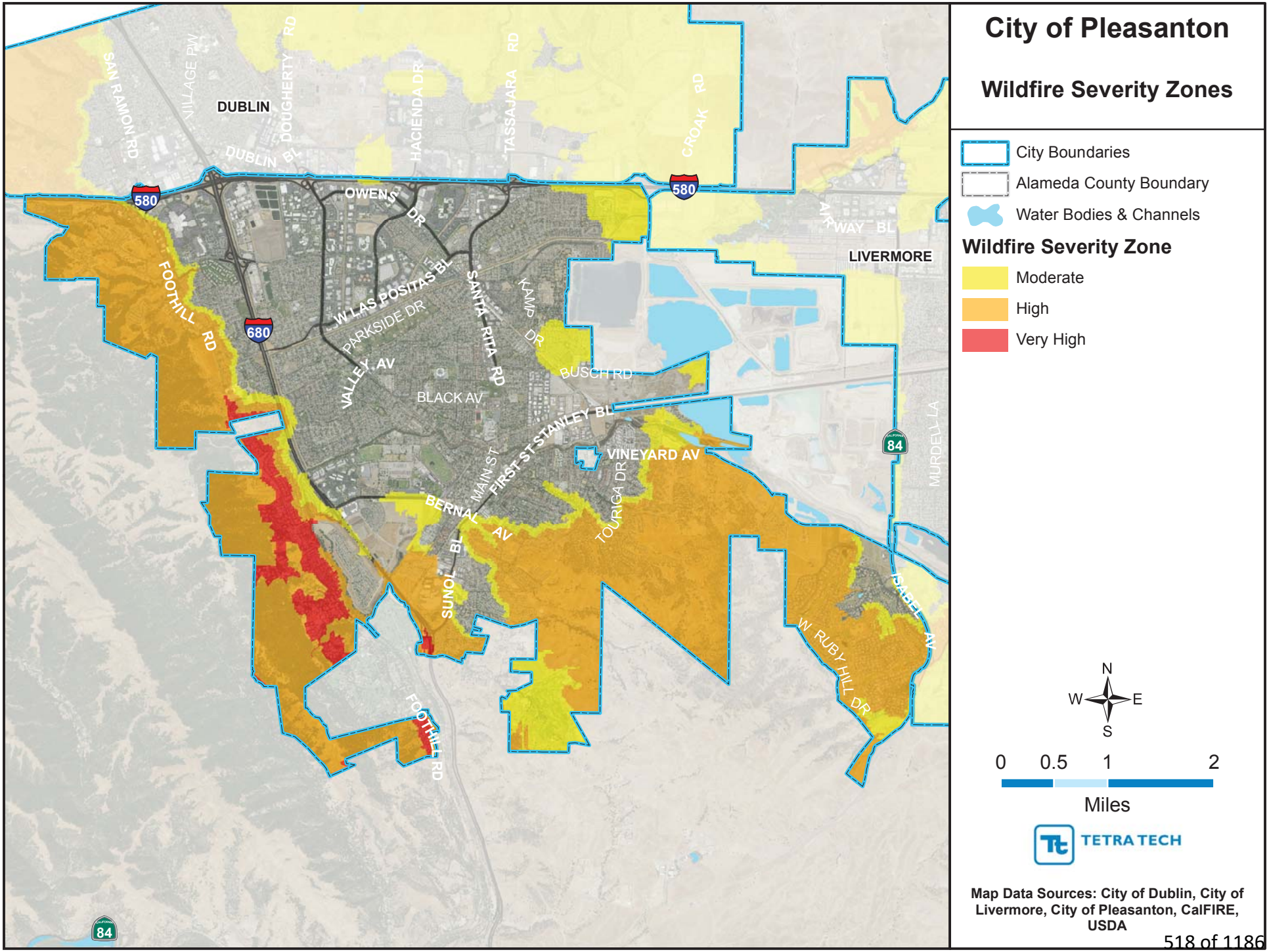
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Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, FEMA, USDA


City of Pleasanton
Susceptibility to Deep-Seated Landslides
City Boundaries
Alameda County Boundary
Water Bodies & Channels
No Landslide Data Available
Susceptibility to Deep-Seated Landslides
Low
Moderate
High
Very High / Existing
Source dataset created by Wills C.J., Perez, F., Gutierrez, C., 2011, Susceptibility to deep-seated landslides in California: California Geological Survey Map Sheet 58
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Miles
TETRA TECH
Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, California Geological Survey, USGS
DUBLIN
LIVERMORE
SAN RAMON RD
VILLAGE PW
DOUGHERTY RD
HACIENDA DR
TASSAJARA RD
CROAK RD
DUBLIN BL
OWENS DR
AIRWAY BL
FOOTHILL RD
W LAS POSITAS BL
PARKSIDE DR
SANTA RITA RD
KAMP DR
VALLEY AV
BLACK AV
BUSCH RD
FIRST ST
STANLEY BL
VINEYARD AV
MAIN ST
BERNAL AV
TOURIGA DR
SUNOL BL
MURDELLA
ISABEL AV
W RUBY HILL DR
FOOTHILL RD
580
680
84


City of Pleasanton
Wildfire Severity Zones
City Boundaries
Alameda County Boundary
Water Bodies & Channels
Wildfire Severity Zone
Moderate
High
Very High
DUBLIN
LIVERMORE
SAN RAMON RD
VILLAGE PW
DOUGHERTY RD
HACIENDA DR
TASSAJARA RD
CROAK RD
DUBLIN BL
OWENS DR
AIRWAY BL
580
680
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FOOTHILL RD
W LAS POSITAS BL
PARKSIDE DR
VALLEY AV
SANTA RITA RD
KAMP DR
BUSCH RD
BLACK AV
FIRST ST
STANLEY BL
VINEYARD AV
MAIN ST
BERNAL AV
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TOURIGA DR
MURDELL LA
ISABEL AV
W RUBY HILL DR
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Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, CalFIRE, USDA

4. DUBLIN SAN RAMON SERVICES DISTRICT

4.1 HAZARD MITIGATION PLAN POINT OF CONTACT

Primary Point of Contact
Stanley Kolodzie, Associate Engineer
7051 Dublin Blvd.
Dublin, California 94568
Telephone: 925-875-2253
e-mail Address: kolodzie@dsrsd.com

Alternate Point of Contact
Rhodora Biagtan, Principal Engineer
7051 Dublin Blvd.
Dublin, California 94568
Telephone: 925-875-2255
e-mail Address: biagtan@dsrsd.com

4.2 JURISDICTION PROFILE

4.2.1 Overview

The Dublin San Ramon Services District is a special district created in 1953 to provide water and sewer service to an unincorporated area of Contra Costa County and Alameda County. The name of the District was originally the Parks Community Service District and eventually became Dublin San Ramon Services District. The unincorporated area of Contra Costa County eventually became part of the city of San Ramon, and the unincorporated area of Alameda County eventually became part of the city of Dublin. The District's service area expanded throughout the years to include the Dougherty Valley area of San Ramon in Contra Costa County; the entirety of the city of Dublin in Alameda County, and the sites of the Wastewater Treatment Plant and Dedicated Land Disposal in the city of Pleasanton in Alameda County.

A five-member elected Board of Directors governs the District. The Board assumes responsibility for adoption of this plan, the General Manager will oversee its implementation.

4.2.2 Service Area and Trends

As of January 1, 2017, the District serves 21,837 potable water accounts, 421 recycled water accounts and 20,934 single family residential wastewater tax roll assessments (excludes commercial, industrial and institutional accounts), with a current staff of 115. Funding comes primarily through water, recycled water and wastewater capacity charges for new development, rate charges and revenue bonds.

The District distributes drinking water to approximately 80,000 people and provides wastewater collection and treatment for approximately 150,000 people in Dublin, southern San Ramon and the city of Pleasanton. Since 1999 the District produced and distributed recycled water for landscape irrigation and construction to the cities of Dublin and San Ramon. The District distributes 5.22 million gallons per day of potable water, 2.7 million gallons per day of recycled water and treats an average of 9.96 million gallons of day of wastewater. The District anticipates increased demand for potable water and recycled water; and increased flows of wastewater to be treated as additional development occurs in eastern Dublin. The District's service area has reached its expected limits and is approximately 26 square miles.

4.2.3 Assets

Table 4-1 summarizes the critical assets of the district and their value.

Table 4-1. Special Purpose District Assets

Asset	Value
Property	
203 acres of land	$50,000,000
Critical Infrastructure and Equipment	
308 miles of potable water pipe and 3,256 hydrants	$187,052,000
16 potable water pump stations	$10,335,000
64 miles of recycled water pipe and 20 hydrants	$38,868,000
4 recycled water pump stations	$3,612,000
206 miles of wastewater pipes	$201,595,000
2 sanitary sewer lift stations	$144,000
14 potable water reservoirs capable of storing 27 million gallons	$28,029,000
2 recycled water reservoirs capable of storing 2 million gallons	$12,080,000
Wastewater Treatment Plant capable of processing 17 million gallons per day	$85,637,000
Recycled Water Plant capable of producing 12.7 million gallons per day	$16,100,000
5 Potable Water Turnout Delivery Facilities	$1,935,000
6 Emergency Interconnect Facilities	$775,000
Total:	$586,164,000
Critical Facilities	
Administrative Building – District Offices	$6,588,000
Administrative Building – Field Operations Center	$5,500,000
Total:	$12,088,000

4.3 CAPABILITY ASSESSMENT

Upon completion, the capability assessment was reviewed to identify opportunities to expand, initiate or integrate capabilities to further hazard mitigation goals and objectives. Where such opportunities were identified and determined to be feasible, they are included in the action plan and are identified as Community Capacity Building mitigation actions in the Analysis of Mitigation Actions table in Section 4.9.

4.3.1 Planning and Regulatory Capabilities

Jurisdictions develop plans and programs and implement rules and regulations to protect and serve residents. When effectively prepared and administered, these plans, programs and regulations can support the implementation of mitigation actions. Table 4-2 summarizes existing codes, ordinances, policies, programs or plans that are applicable to this hazard mitigation plan.

Table 4-2. Planning and Regulatory Capability

	Recent Update	Comment
District Code of the Dublin San Ramon Services District (District Code)	11/2/2010; effective 12/1/2010	The District Code is modified with new ordinances adopted by the Board from time to time as needed.
Dublin San Ramon Services District Standard Procedures, Specifications and Drawings	12/2016	The Standard Specs contain the required specifications for DSRSD infrastructure and equipment. The Standard Specs are update as needed by DSRSD staff.
Dublin San Ramon Services District Emergency Response Plan (ERP)	5/1/2012	This policy is P300-16-2 and it designates the District Emergency Manager and authorizes that person to manage emergency operations.
Dublin San Ramon Services District Risk Management for District Agreements with Contractors and Consultants	8/19/2014	This is policy P100-14-4 and it determines the risk management system that provides for the required types of insurance, limits of coverage and other provisions for agreements with contractors and consultants who do business with the District.
Dublin San Ramon Services District Construction Project Acceptance by the General Manager	10/21/2014	This is policy P200-14-3 and it allows the General Manager to accept construction projects.
Dublin San Ramon Services District Green Business Policy	7/17/2017	This is policy P200-07-1 and it includes directions for environmental compliance, pollution prevention, energy conservation and solid waste reduction.
Dublin San Ramon Services District Water Recycling Policy	9/7/2010	This is policy P300-10-3 and it includes directions for provision of Recycled Water service both within and outside the District.
Dublin San Ramon Services District Water Supply, Storage, Conveyance, Quality and Conservation Policy	10/20/2015	This is policy P300-15-1 and it provides guidance for addressing water supply challenges.
Dublin San Ramon Services District Infrastructure Responsibilities and Funding Policy	1/19/2010	This is policy P600-15-3 and it defines responsibility for major and non-major infrastructure planning design and construction.
Dublin San Ramon Services District Security Policy	4/6/2010	This is policy P700-14-2 and its intent is to ensure security of District facilities to provide safe and reliable water and wastewater services.
Dublin San Ramon Services District Safety Programs	8/16/2016	This is policy P700-16-1 and its intent is to provide a safe work environment for all employees; regular, part-time, limited-term, interns, temporary, contract, consultant, and elected officials.
Dublin San Ramon Services District Recycled Water Use Guidelines and Requirements	8/16/2016	These guidelines contain DSRSD regulations and guidelines for the design, installation, operation and maintenance of on-site recycled water facilities for irrigation and water features, transport and use of recycled water for dust control and surface cleaning; and use of recycled water in dual-plumbed buildings and industrial facilities.
Dublin San Ramon Services District Capital Improvement Program	6/2/2015	This is a ten-year Capital Plan for fiscal years ending 2016 through 2025 and a two-year Budget for fiscal years ending 2016 and 2017. The District's CIP defines the projects to: 1) protect human health and the environment, 2) maintain and rehabilitate existing assets, 3) respond to regulatory requirements, 4) accommodate planed future growth.
Dublin San Ramon Services District Asset Management Plan	Continuously updated	The District maintains a Computerized Maintenance and Management System (CMMS) which inventories all the District assets, their date of installation and asset condition information. The District maintains rehabilitation and replacement models for the sewer collection system, water system and wastewater treatment plant. These models identify critical assets and indicate when they should be replaced.
Dublin San Ramon Services District Geographic Information System	Continuously updated	The District maintains a Geographic Information System that maps the location of the District's infrastructure as aligned with the local transportation system (streets, highways); water features (creeks, canals, streams); and fault lines. This system assists the District in determining the infrastructure most vulnerable to hazards such as flooding or earthquakes.

4.3.2 Fiscal, Administrative and Technical Capabilities

Fiscal capability is an indicator of a jurisdiction's ability to fulfill the financial needs associated with hazard mitigation projects. An assessment of fiscal capabilities is presented in Table 4-3. Administrative and technical capabilities represent a jurisdiction's staffing resources for carrying out the mitigation strategy. An assessment of administrative and technical capabilities is presented in Table 4-4.

Table 4-3. Fiscal Capability

Financial Resource	Accessible or Eligible to Use?
Capital Improvements Project Funding	Yes
Authority to Levy Taxes for Specific Purposes	No
User Fees for Water, Sewer, Gas or Electric Service	Yes
Incur Debt through General Obligation Bonds	Yes
Incur Debt through Special Tax Bonds	No
Incur Debt through Private Activity Bonds	No
State-Sponsored Grant Programs	Yes
Development Impact Fees for Homebuyers or Developers	Yes
Federal Grant Programs	Yes
Other	No

Table 4-4. Administrative and Technical Capability

Staff/Personnel Resource	Available?	Department/Agency/Position
Planners or engineers with knowledge of land development and land management practices	Yes	Engineering / Assistant-Associate Civil Engineer – SME Engineering / Principal Engineer - Supervisory
Engineers or professionals trained in building or infrastructure construction practices	Yes	Engineering / Assistant-Associate Civil Engineer – SME Engineering / Principal Engineer - Supervisory
Planners or engineers with an understanding of natural hazards	No	
Staff with training in benefit/cost analysis	Yes	Engineering / Assistant-Associate Civil Engineer – SME Engineering-Operations / Administrative Analyst II
Surveyors	No	
Personnel skilled or trained in GIS applications	Yes	Engineering / GIS Analyst II Engineering / Engineering/GIS Technician II
Scientist familiar with natural hazards in local area	No	
Emergency manager	No	
Grant writers	Yes	Engineering-Operations / Administrative Analyst II
Other	No	

4.3.3 Education and Outreach Capabilities

Outreach and education capability identifies the connection between government and community members, which opens a dialogue needed for a more resilient community. An assessment of education and outreach capabilities is presented in Table 4-5.

Table 4-5. Education and Outreach

Criterion	Response
Do you have a Public Information Officer or Communications Office?	Yes
Do you have personnel skilled or trained in website development?	Yes
Do you have hazard mitigation information available on your website? • If yes, please briefly describe	Yes District has an "Emergency" button on its home page that opens a portal to information about emergencies.
Do you utilize social media for hazard mitigation education and outreach? • If yes, please briefly describe	No N/A
Do you have any citizen boards or commissions that address issues related to hazard mitigation? • If yes, please briefly specify	No N/A
Do you have any other programs already in place that could be used to communicate hazard-related information? • If yes, please briefly describe	No N/A
Do you have any established warning systems for hazard events? • If yes, please briefly describe	No N/A

4.3.4 Adaptive Capacity for Climate Change

Given the uncertainties associated with how hazard risk may change with a changing climate, a jurisdiction's ability to track such changes and adapt as needed is an important component of the mitigation strategy. Table 4-6 summarizes the District's adaptive capacity for climate change.

4.4 INTEGRATION WITH OTHER PLANNING INITIATIVES

The information on hazards, risk, vulnerability and mitigation contained in this hazard mitigation plan is based on the best available data. Plan integration is the incorporation of this information into other relevant planning mechanisms, such as general planning and capital facilities planning. It includes the integration of natural hazard information and mitigation policies, principles and actions into local planning mechanisms and vice versa. Additionally, plan integration is achieved though the involvement of key staff and community officials in collaboratively planning for hazard mitigation.

4.4.1 Existing Integration

In the performance period since adoption of the previous hazard mitigation plan, the Dublin San Ramon Services District made progress on integrating hazard mitigation goals, objectives and actions into other planning initiatives. The following plans and programs currently integrate components of the hazard mitigation strategy:

- **Dublin San Ramon Services District Water Supply, Storage, Conveyance, Quality and Conservation Policy**—Last updated October 20, 2015. This is policy P300-15-1. During its last review, District staff included consideration of water demands during water supply disruptions such as droughts and strategies to meet the water demands in the service area during the periods of disruption.
- **Dublin San Ramon Services District Recycled Water Use Guidelines and Requirements**—Last updated August 16, 2016. The District has always regarded recycled water as a valuable replacement for potable water now used as outdoor irrigation. The implementation of recycled water irrigation programs thus helps mitigate shortages of potable water whether caused by as drought or other natural disasters.

Table 4-6. Adaptive Capacity for Climate Change

Criterion	Jurisdiction Rating
Technical Capacity	
Jurisdiction-level understanding of potential climate change impacts	Medium
Comments/Additional Information: None provided	
Jurisdiction-level monitoring of climate change impacts	Low
Comments/Additional Information: None provided	
Technical resources to assess proposed strategies for feasibility and externalities	Low
Comments/Additional Information: None provided	
Jurisdiction-level capacity for development of greenhouse gas emissions inventory	Low
Comments/Additional Information: None provided	
Capital planning and land use decisions informed by potential climate impacts	Low
Comments/Additional Information: None provided	
Participation in regional groups addressing climate risks	Medium
Comments/Additional Information: Operations Manager is member of Alameda County Coastal Hazards Adaptation Resiliency Group.	
Implementation Capacity	
Clear authority/mandate to consider climate change impacts during public decision-making processes	Low
Comments/Additional Information: District has no formal policy on planning fees	
Identified strategies for greenhouse gas mitigation efforts	Low
Comments/Additional Information: None provided	
Identified strategies for adaptation to impacts	Medium
Comments/Additional Information: District's Urban Water Management Plan considers effect of Climate Change on Water Supply.	
Champions for climate action in local government departments	Low
Comments/Additional Information: None provided	
Political support for implementing climate change adaptation strategies	Medium
Comments/Additional Information: None provided	
Financial resources devoted to climate change adaptation	Low
Comments/Additional Information: None provided	
Local authority over sectors likely to be negative impacted	Low
Comments/Additional Information: None provided	
Public Capacity	
Local residents' knowledge of and understanding of climate risk	Low
Comments/Additional Information: None provided	
Local residents support of adaptation efforts	Low
Comments/Additional Information: None provided	
Local residents' capacity to adapt to climate impacts	Medium
Comments/Additional Information: None provided	
Local economy current capacity to adapt to climate impacts	Medium
Comments/Additional Information: None provided	
Local ecosystems capacity to adapt to climate impacts	Medium
Comments/Additional Information: None provided	

a. High = Capacity exists and is in use; Medium = Capacity may exist, but is not used or could use some improvement; Low = Capacity does not exist or could use substantial improvement; Unsure= Not enough information is known to assign a rating.

- **Dublin San Ramon Services District Capital Improvement Program**—Last updated June 2, 2015. This is a ten-year Capital Plan for fiscal years ending 2016 through 2025 and a two-year budget for fiscal years ending 2016 and 2017. The District's CIP defines the projects to: 1) protect human health and the environment, 2) maintain and rehabilitate existing assets, 3) respond to regulatory requirements, 4) accommodate planed future growth. Pertinent projects in the CIP program that deal with public health issues of wastewater collection and treatment and water supply were reviewed for facility reliability, diversifying the District's potable water supply and the prospects of extending potable water supply by creating and using additional recycled water.

Resources listed in Section 4.10 were used to provide information on hazard events and local capabilities within the jurisdiction.

4.4.2 Opportunities for Future Integration

As this hazard mitigation plan is implemented, the Dublin San Ramon Services District will use information from the plan as the best available science and data on natural hazards. The capability assessment presented in this annex identifies codes, plans and programs that provide opportunities for integration. The area-wide and local action plans developed for this hazard mitigation plan include actions related to plan integration, and progress on these actions will be reported through the progress reporting process described in Volume 1. New opportunities for integration also will be identified as part of the mid-term progress report. The capability assessment identified the following plans and programs that do not currently integrate goals or recommendations of the hazard mitigation plan but provide opportunities to do so in the future:

- **Dublin San Ramon Services District Standard Procedures, Specifications and Drawings**—latest update was December 2016. The Standard Specs contain the required specifications for DSRSD infrastructure and equipment. The Standard Specs will be reviewed and update with a strategy of rehabilitating or rebuilding District facilities as quickly as necessary following damage during a disaster.
- **Dublin San Ramon Services District Emergency Response Plan (ERP)** —Last updated May 1, 2012. This policy will be reviewed and updated with a strategy to coordinate response to a disaster with other entities. This will mitigate damage to specific facilities as much as possible and minimize harmful effects to public health from future disasters.
- **Dublin San Ramon Services District Asset Management Plan** —Now under development. This plan will include provisions for prioritizing the rehabilitation of District facilities that are disabled by various hazards. The goal will be to maintain public health during and after an emergency.

4.5 JURISDICTION-SPECIFIC NATURAL HAZARD EVENT HISTORY

Table 4-7 lists past occurrences of natural hazards for which specific damage was recorded in the Dublin San Ramon Services District. Other hazard events that broadly affected the entire planning area, including the Dublin San Ramon Services District, are listed in the risk assessments in Volume 1 of this hazard mitigation plan.

Table 4-7. Natural Hazard Events

Type of Event	FEMA Disaster #	Date	Damage Assessment
Severe winter storm	DR-4308	Feb. 7 thru Feb. 21, 2017	Per FEMA Disaster Designation 4308, this storm and resultant mudslides caused damage in the affected area. DSRSD monitored potential flooding and disruption to operations at the wastewater treatment plant.
Severe winter storm	DR-4305	Jan 22, 2017	Per FEMA Disaster Designation 4305, this storm and resultant mudslides caused damage in the affected area. DSRSD monitored potential flooding and disruption to operations at the wastewater treatment plant.
Severe winter storm	DR-4301	Jan 3 thru Jan 7, 2017	Per FEMA Disaster Designation 4301, this storm and resultant mudslides caused damage in the affected area. DSRSD monitored potential flooding and disruption to operations at the wastewater treatment plant.
Severe Drought	N/A	2014 thru 2016	This drought required water conservation and severe water restrictions. DSRSD suffered severe loss of revenue. Landscaping including turf and trees in the DSRSD area died or were removed.
Severe winter storm	N/A	February 6, 2015	This storm brought 0.96 inches of rain in13 hours, with wind gusts of 32 mph. DSRSD monitored potential flooding and disruption to wastewater treatment plant operations.
Severe winter storm	N/A	December 30-31, 2014	This storm brought 0 inches of rain over 19 hrs. with wind gusts of 43 mph. DSRSD monitored potential flooding and disruption to wastewater treatment plant operations.
Severe winter storm	N/A	December 2, 2014	This storm brought 1.41 inches of rain over 16 hrs. with wind gusts of 23 mph. DSRSD monitored potential flooding and disruption to wastewater treatment plant operations.
Severe winter storm	N/A	October 13, 2009	Per 6-hour rainfall intensity, this storm was a 17-year storm. DSRSD monitored potential flooding and disruption to operations at the wastewater treatment plant.
Severe winter storm	N/A	January 3-5, 2008	Per 6-hour rainfall intensity, this storm was a 12-year storm. DSRSD monitored potential flooding and disruption to operations at the wastewater treatment plant.
Drought	N/A	September 2007	N/A

4.6 JURISDICTION-SPECIFIC VULNERABILITIES

Volume 1 of this hazard mitigation plan provides complete risk assessments for each identified hazard of concern. Noted vulnerabilities within the district include the following:

- Pump Station Vulnerability—Two of the District's potable water pump stations, PS 4A and PS 4B, are located in less developed area with high wildfire severity. During a high wind and wildfire event these two pump stations could be damaged and hinder potable water transfer to areas of western Dublin.
- Sewer Trunk Main Vulnerability—A major sewer trunk main crosses above Alamo Creek in an area susceptible to a 1 percent annual chance flood. A severe flood might damage this sewer main from debris flows in Alamo Creek.
- Wastewater Treatment Plant Vulnerability—The District's Wastewater Treatment Plant is located adjacent to Alamo Creek in Pleasanton. A severe flood in Alamo Creek could hinder operations of the Wastewater Treatment Plant.

4.7 HAZARD RISK RANKING

Table 4-8 presents a local ranking for the Dublin San Ramon Services District of all hazards of concern for which Volume 1 of this hazard mitigation plan provides complete risk assessments. This ranking summarizes how hazards vary for this jurisdiction. As described in detail in Volume 1, the ranking process involves an assessment of the likelihood of occurrence for each hazard, along with its potential impacts on people, property and the economy.

Table 4-8. Hazard Risk Ranking

Rank	Hazard Type	Risk Rating Score (Probability x Impact)	Category
1	Earthquake[a]	36	High
1	Landslide[e]	36	High
2	Severe weather[b]	33	Medium
3	Drought[f]	27	Medium
3	Wildfire[c]	27	Medium
4	Flood[d]	12	Low
5	Dam failure[g]	6	Low

a. Based on the "Haywired" (Hayward Fault Scenario M7.05)
b. Severe weather is assessed more qualitatively than other hazards. Assumptions for risk ranking include high probability, medium impact on people, medium impact on property and low impact on economy.
c. Based on Very High and High Fire Severity Zones.
d. Based on 1 percent-annual-chance flood zone (otherwise known as the special flood hazard area)
e. Based on Very High, High, and Moderate Landslide Susceptibility Zones
f. Drought is assessed more qualitatively than other hazards. Generally, drought does not cause injury or death to people or result in property damage. Assumptions for risk ranking include high probability, no impact on people, low impact on property and low impact on economy for those jurisdictions with limited agriculture.
g. Based on the Del Valle Dam inundation scenario.

4.8 STATUS OF PREVIOUS PLAN ACTIONS

Table 4-9 summarizes the actions that were recommended in the previous version of the hazard mitigation plan and their implementation status at the time this update was prepared.

Table 4-9. Status of Previous Plan Actions

Action Item	Completed	Removed; No Longer Feasible	Carried Over to Plan Update	
			Check if Yes	Enter Action #
Complete Potable Water Emergency Interties with East Bay Municipal Utility District, City of Pleasanton and City of Livermore			X	DSRSD-6
Comment:				
Retrofit DSRSD Pumping Stations for Portable Emergency Power			X	DSRSD-7
Comment:				
Stockpile Necessary Treating Chemical and Repair Equipment for Local Shortages			X	DSRSD-8
Comment:				
Central Dublin Recycled Water Retrofit	June 1, 2013			
Comment:				

4.9 HAZARD MITIGATION ACTION PLAN AND EVALUATION OF RECOMMENDED ACTIONS

Table 4-10 lists the actions that make up the Dublin San Ramon Services District hazard mitigation action plan. Table 4-11 identifies the priority for each action. Table 4-12 summarizes the mitigation actions by hazard of concern and mitigation type.

Table 4-10. Hazard Mitigation Action Plan Matrix

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline
DSRSD-1—Where appropriate, support retrofitting or relocation of structures in high hazard areas, prioritizing Wastewater Treatment Plant structures and other structures which have experienced repetitive losses.							
Existing	Dam failure, Drought, Earthquake, Flood, Landslide, Severe weather, Wildfire	4, 6, 8, 10, 11, 12	DSRSD - Engineering	N/A	High	HMGP, PDM, FMA	Short-term
DSRSD-2—Integrate the hazard mitigation plan into other plans, ordinances and programs within the District.							
New and Existing	Dam failure, Drought, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 2, 6, 8, 10, 11	DSRSD – Planning Division	N/A	Low	Staff Time, General Funds	Short-term
DSRSD-3—Develop and implement a program to capture perishable data after significant events (e.g. high water marks, preliminary damage estimates, damage photos) to support future mitigation efforts including the implementation and maintenance of the hazard mitigation plan.							
Existing	Dam failure, Drought, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 9	Emergency Management	N/A	Medium	Staff Time, General Funds	Short-term
DSRSD-4—Support the Tri-Valley Area –wide initiatives identified in Volume I of the hazard mitigation plan.							
New and Existing	Dam failure, Drought, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	Lead Contact Department for Plan	Any Supporting Departments	Low	Staff Time, General Funds	Short-term
DSRSD-5—Actively participate in the plan maintenance protocols outlined in Volume 1 of the hazard mitigation plan.							
New and Existing	Dam failure, Drought, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	Lead Contact Department for Plan	Any Supporting Departments	Low	Staff Time, General Funds	Short-term
DSRSD-6—Complete Potable Water Emergency Interties with East Bay Municipal Utility District, City of Pleasanton and City of Livermore.							
New and Existing	Dam failure, Drought, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 4, 6, 8, 10, 11	DSRSD - Engineering	East Bay Municipal Utility District, City of Pleasanton, and City of Livermore	Medium	HMGP, PDM, FMA, Staff Time, General Funds	Short-term
DSRSD-7—Retrofit DSRSD Pumping Stations for Potable Emergency Power.							
Existing	Dam failure, Drought, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 4, 6, 8, 10, 11,	DSRSD - Engineering	Any Supporting Departments	Medium	HMGP, PDM, Staff Time, General Funds	Short-term
DSRSD-8—Stockpile Necessary Treating Chemical and Repair Equipment for Local Shortages.							
Existing	Dam failure, Earthquake, Flood, Wildfire	1, 4, 6, 8, 10, 11	DSRSD – Field Operations	N/A	Low	HMGP, Staff Time, General Funds	Short-term
DSRSD-9—Require subdivision water mains to be “looped” to maintain water supplies after landslides and earthquakes							
Existing	Earthquake, Landslide, Wildfire	1, 4, 6, 8, 10, 11,	DSRSD - Engineering	Any Supporting Departments	Medium	Staff Time, General Funds	Short-term
DSRSD-10—Map and Assess DSRSD Facilities Vulnerable to Landslides.							
Existing	Landslides, Wildfire	1, 4, 6, 8, 10, 11	DSRSD – Field Operations	N/A	Low	HMGP, Staff Time, General Funds	Short-term

Table 4-11. Mitigation Action Priority

Action #	# of Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is Project Grant-Eligible?	Can Project Be Funded Under Existing Programs/ Budgets?	Implementation Priority[a]	Grant Pursuit Priority[a]
DSRSD-1	6	High	High	Yes	Yes	No	Medium	High
DSRSD-2	6	Low	Low	Yes	No	Yes	High	Low
DSRSD-3	2	Medium	Medium	Yes	No	No	Medium	Low
DSRSD-4	12	Medium	Low	Yes	No	No	Medium	Low
DSRSD-5	12	High	Low	Yes	No	Yes	High	Low
DSRSD-6	6	Medium	Medium	Yes	Yes	Yes	Medium	Medium
DSRSD-7	6	Medium	Medium	Yes	Yes	Yes	High	Medium
DSRSD-8	6	Medium	Low	Yes	Yes	Yes	High	Medium
DSRSD-9	6	Medium	Low	Yes	Yes	Yes	High	Low
DSRSD-10	6	Low	Low	Yes	Yes	Yes	High	Medium

a. See the introduction to this volume for explanation of priorities.

Table 4-12. Analysis of Mitigation Actions

Hazard Type	Action Addressing Hazard, by Mitigation Type[a]							
	Prevention	Property Protection	Public Education and Awareness	Natural Resource Protection	Emergency Services	Structural Projects	Climate Resilient	Community Capacity Building
Dam Failure	DSRSD-2, 3, 4, 5, 10	DSRSD-1	DSRSD-4		DSRSD-6, 7, 8, 9			DSRSD-3, 4, 6, 8, 9, 10
Drought	DSRSD-2, 3, 4, 5	DSRSD-1	DSRSD-4		DSRSD-6, 7, 8			DSRSD-3, 4, 6
Earthquake	DSRSD-2, 3, 4, 5, 10	DSRSD-1	DSRSD-4		DSRSD-6, 7, 8, 9			DSRSD-3, 4, 6, 8, 9, 10
Flood	DSRSD-2, 3, 4, 5	DSRSD-1	DSRSD-4		DSRSD-6, 7, 8			DSRSD-3, 4, 6, 8
Landslide	DSRSD-2, 3, 4, 5, 9, 10	DSRSD-1	DSRSD-4		DSRSD-6, 7, 8, 9			DSRSD-3, 4, 6, 9, 10
Severe Weather	DSRSD-2, 3, 4, 5	DSRSD-1	DSRSD-4		DSRSD-6, 7, 8			DSRSD-3, 4, 6
Wildfire	DSRSD-2, 3, 4, 5, 10	DSRSD-1	DSRSD-4		DSRSD-6, 7, 8, 9, 10			DSRSD-3, 4, 6, 8, 9, 10

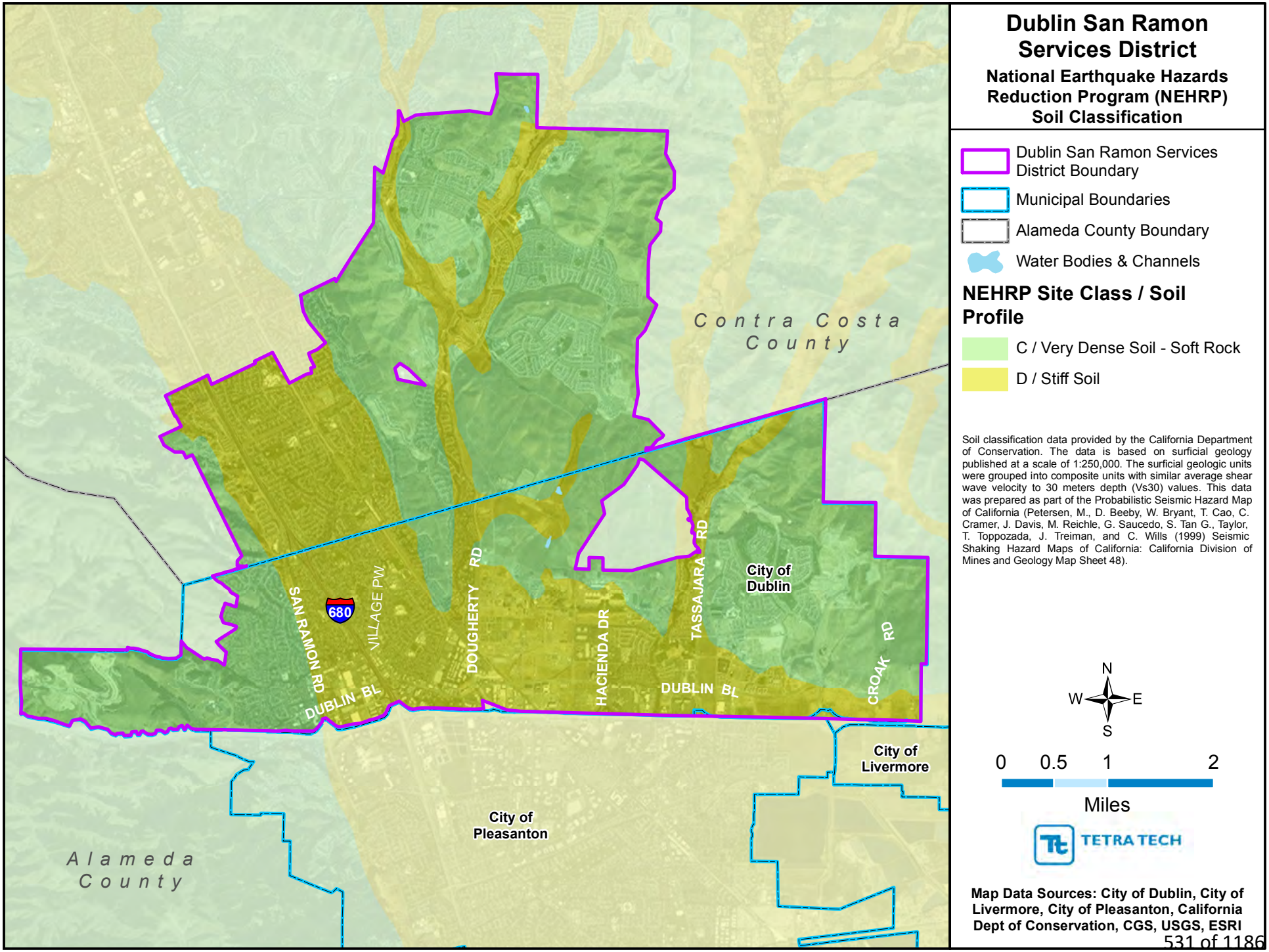
a. See the introduction to this volume for explanation of mitigation types.

4.10 REVIEW AND INCORPORATION OF RESOURCES FOR THIS ANNEX

The following technical reports, plans, and regulatory mechanisms were reviewed to provide information for this annex.

- **Dublin San Ramon Services District Emergency Response Plan (ERP)** —Reviewed to identify possible mitigation actions.
- **Dublin San Ramon Services District Asset Management Program**—update in progress. This program designates the critical infrastructure for continued DSRSD operations and prioritizes the facilities for rehabilitating the facilities to be repaired after a disaster. The Asset Management Program was used to identify the critical infrastructure.

- **Dublin San Ramon Services District 2016 Urban Water Management Plan**—last update June 2016. Reviewed as part of the capability assessment.
- **Dublin San Ramon Services District Wastewater Collection System Master Plan Update**—last update June 2005. Reviewed to identify possible mitigation actions.
- **Hazard Mitigation Plan Annex Development Tool-kit**—The tool-kit was used to support the development of this annex including past hazard events, noted vulnerabilities, risk ranking and action development.



Dublin San Ramon Services District

National Earthquake Hazards Reduction Program (NEHRP) Soil Classification

- Dublin San Ramon Services District Boundary
- Municipal Boundaries
- Alameda County Boundary
- Water Bodies & Channels

NEHRP Site Class / Soil Profile

- C / Very Dense Soil - Soft Rock
- D / Stiff Soil

Soil classification data provided by the California Department of Conservation. The data is based on surficial geology published at a scale of 1:250,000. The surficial geologic units were grouped into composite units with similar average shear wave velocity to 30 meters depth (Vs30) values. This data was prepared as part of the Probabilistic Seismic Hazard Map of California (Petersen, M., D. Beeby, W. Bryant, T. Cao, C. Cramer, J. Davis, M. Reichle, G. Saucedo, S. Tan G., Taylor, T. Toppozada, J. Treiman, and C. Wills (1999) Seismic Shaking Hazard Maps of California: California Division of Mines and Geology Map Sheet 48).

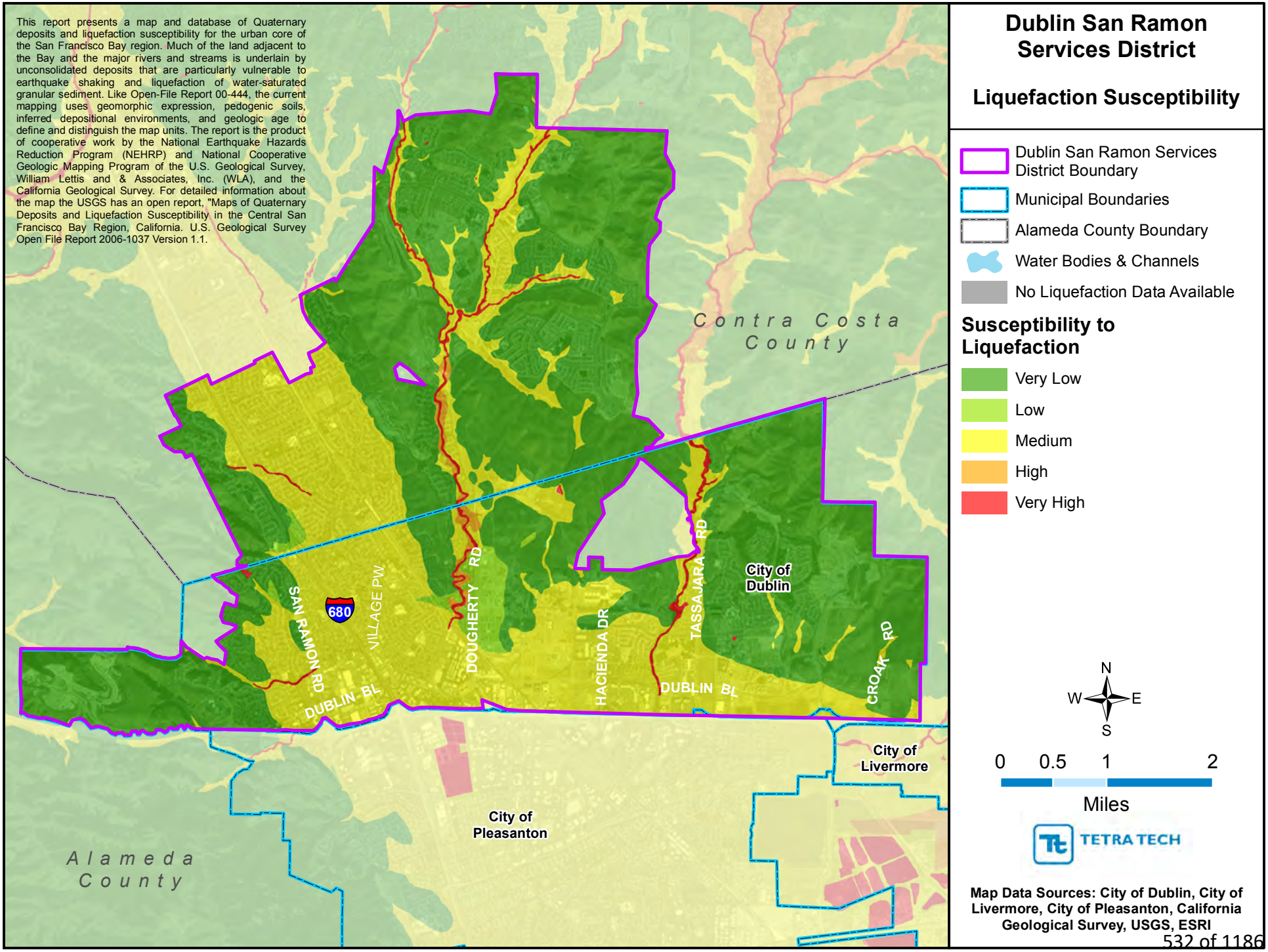
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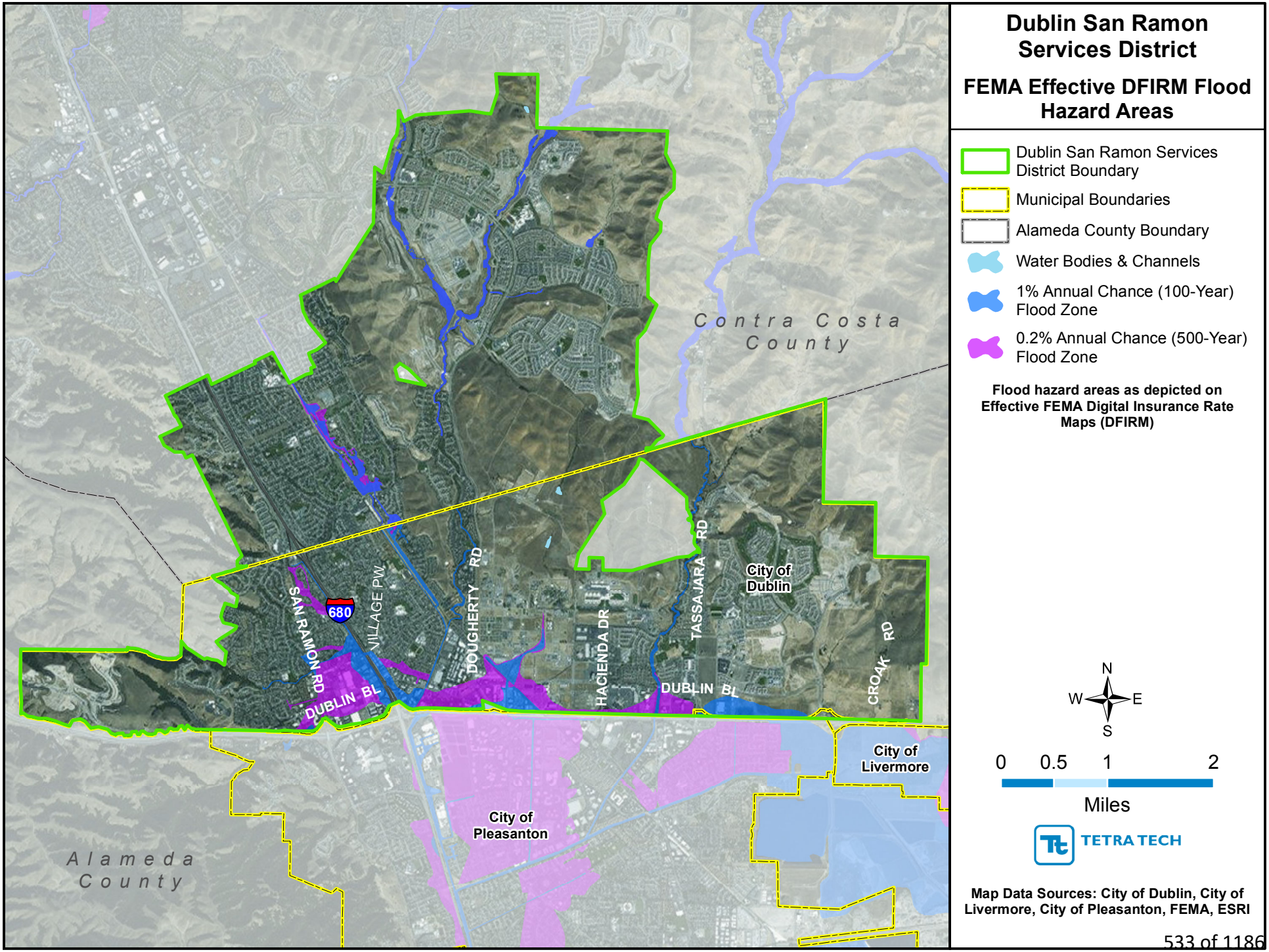
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Miles

TETRA TECH

Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, California Dept of Conservation, CGS, USGS, ESRI


This report presents a map and database of Quaternary deposits and liquefaction susceptibility for the urban core of the San Francisco Bay region. Much of the land adjacent to the Bay and the major rivers and streams is underlain by unconsolidated deposits that are particularly vulnerable to earthquake shaking and liquefaction of water-saturated granular sediment. Like Open-File Report 00-444, the current mapping uses geomorphic expression, pedogenic soils, inferred depositional environments, and geologic age to define and distinguish the map units. The report is the product of cooperative work by the National Earthquake Hazards Reduction Program (NEHRP) and National Cooperative Geologic Mapping Program of the U.S. Geological Survey, William Lettis and & Associates, Inc. (WLA), and the California Geological Survey. For detailed information about the map the USGS has an open report, "Maps of Quaternary Deposits and Liquefaction Susceptibility in the Central San Francisco Bay Region, California. U.S. Geological Survey Open File Report 2006-1037 Version 1.1.
Dublin San Ramon Services District
Liquefaction Susceptibility
Dublin San Ramon Services District Boundary
Municipal Boundaries
Alameda County Boundary
Water Bodies & Channels
No Liquefaction Data Available
Susceptibility to Liquefaction
Very Low
Low
Medium
High
Very High
Contra Costa County
Alameda County
City of Dublin
City of Livermore
City of Pleasanton
SAN RAMON RD
VILLAGE PW
680
DOUGHERTY RD
HACIENDA DR
TASSAJARA RD
CROAK RD
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Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, California Geological Survey, USGS, ESRI



Dublin San Ramon Services District

FEMA Effective DFIRM Flood Hazard Areas

- Dublin San Ramon Services District Boundary
- Municipal Boundaries
- Alameda County Boundary
- Water Bodies & Channels
- 1% Annual Chance (100-Year) Flood Zone
- 0.2% Annual Chance (500-Year) Flood Zone

Flood hazard areas as depicted on Effective FEMA Digital Insurance Rate Maps (DFIRM)

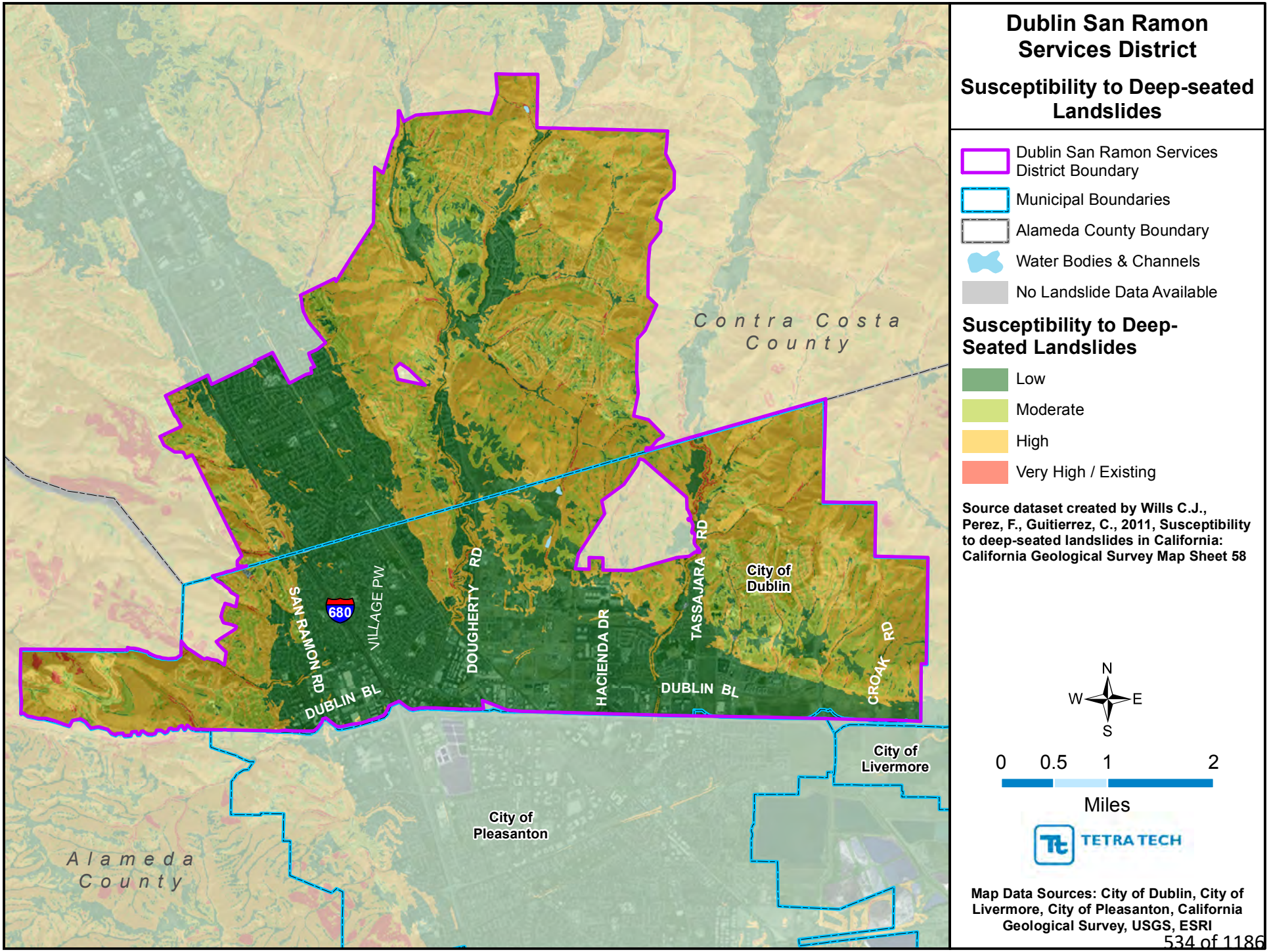
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TETRA TECH

Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, FEMA, ESRI



Dublin San Ramon Services District

Susceptibility to Deep-seated Landslides

- Dublin San Ramon Services District Boundary
- Municipal Boundaries
- Alameda County Boundary
- Water Bodies & Channels
- No Landslide Data Available

Susceptibility to Deep-Seated Landslides

- Low
- Moderate
- High
- Very High / Existing

Source dataset created by Wills C.J., Perez, F., Guitierrez, C., 2011, Susceptibility to deep-seated landslides in California: California Geological Survey Map Sheet 58

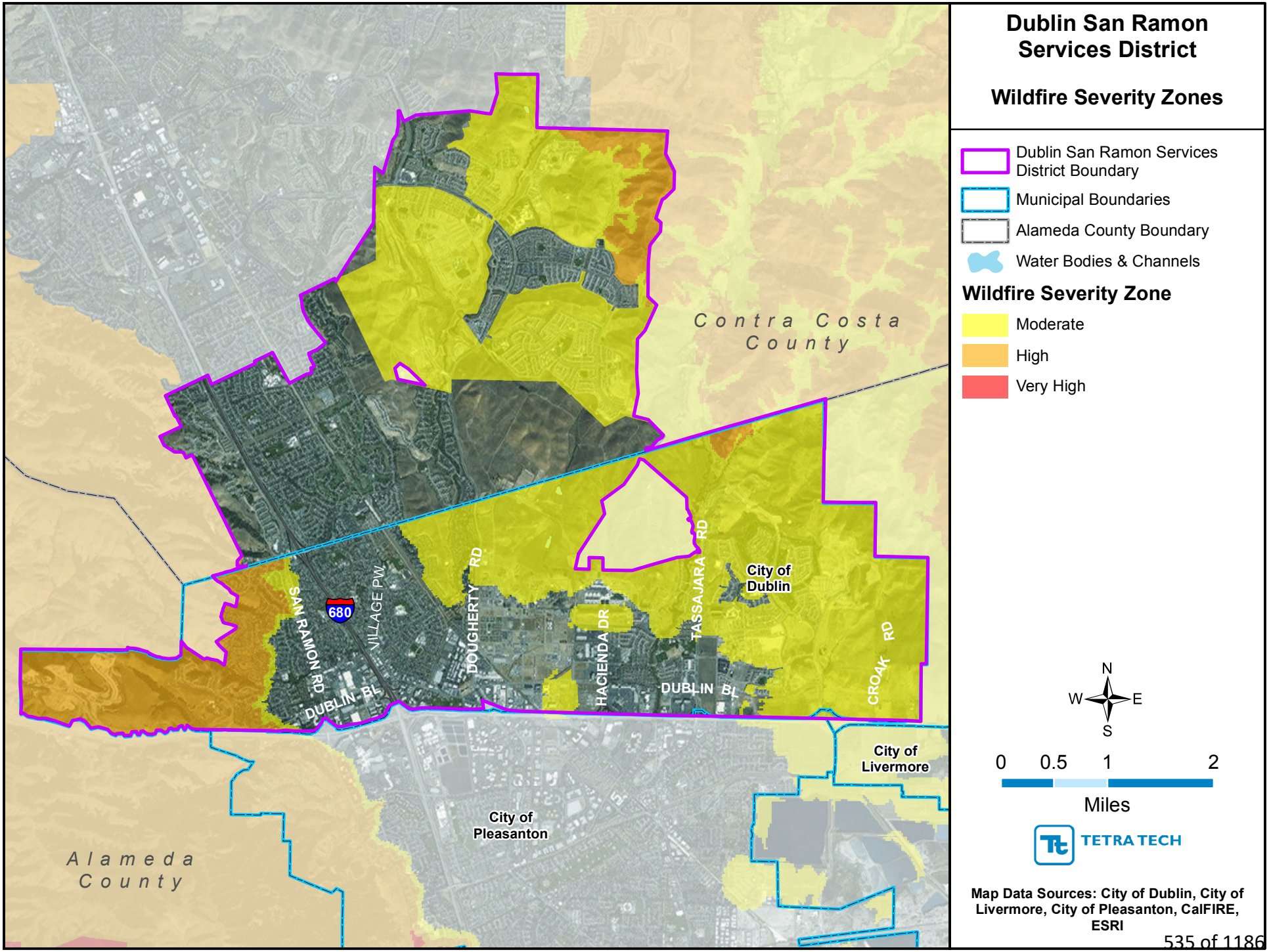
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TETRA TECH

Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, California Geological Survey, USGS, ESRI


Dublin San Ramon Services District
Wildfire Severity Zones
Dublin San Ramon Services District Boundary
Municipal Boundaries
Alameda County Boundary
Water Bodies & Channels
Wildfire Severity Zone
Moderate
High
Very High
Contra Costa County
Alameda County
City of Dublin
City of Livermore
City of Pleasanton
680
SAN RAMON RD
VILLAGE PW
DOUGHERTY RD
HACIENDA DR
TASSAJARA RD
CROAK RD
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Map Data Sources: City of Dublin, City of Livermore, City of Pleasanton, CalFIRE, ESRI

Appendix A. Planning Partner Expectations

A. PLANNING PARTNER EXPECTATIONS

Achieving DMA Compliance for All Planning Partners

The federal Disaster Mitigation Act (DMA) of 2000 (Public Law 106-390), commonly known as the 2000 Stafford Act amendments, was approved by Congress on October 10, 2000. This act required state and local governments to develop hazard mitigation plans as a condition for federal grant assistance. Among other things, this legislation reinforces the importance of pre-disaster infrastructure mitigation planning to reduce disaster losses nationwide. DMA 2000 is aimed primarily at the control and streamlining of the administration of federal disaster relief and programs to promote mitigation activities. Prior to 2000, federal legislation provided funding for disaster relief, recovery, and some hazard mitigation planning. The DMA improves upon the planning process by emphasizing the importance of communities planning for disasters before they occur.

The Disaster Mitigation Act defines a "local government" as:

Any county, municipality, city, town, public authority, school district, special district, intrastate district, council of governments (regardless of whether the council of governments is incorporated as a nonprofit corporation under State law), regional or interstate government entity, or agency or instrumentality of a local government; any Indian tribe or authorized tribal organization, or Alaska Native village or organization; and any rural community, unincorporated town or village, or other public entity.

Any local government wishing to pursue funding afforded under FEMA Hazard Mitigation Grant Programs must have an approved hazard mitigation plan in order to be eligible to apply for these funds.

One of the goals of the multi-jurisdictional approach to hazard mitigation planning is to achieve compliance with the DMA for all participating members in the planning effort. DMA compliance must be certified for each member in order to maintain eligibility for the benefits under the DMA. Whether a planning process generates 10 individual plans or one large plan that has a chapter for each partner jurisdiction, the following items must be addressed by each planning partner to achieve DMA compliance:

- **Participate in the process.** It must be documented in the plan that each planning partner "participated" in the process that generated the plan. There is flexibility in defining "participation." Participation can vary based on the type of planning partner (i.e.: City vs. a Special Purpose District). However, the level of participation must be defined and the extent for which this level of participation has been met for each partner must be contained in the plan context.
- **Consistency Review.** Review existing documents pertinent to each jurisdiction to identify policies or recommendations that are not consistent with documents reviewed in producing the "parent" plan or that have policies and recommendations that complement the hazard mitigation initiatives selected (i.e.: comp plans, basin plans or hazard specific plans).
- **Action Review.** For plan updates, review the strategies from the prior action plan to determine those that have been accomplished and how they were accomplished; and why those that have not been accomplished were not completed.

- **Update Localized Risk Assessment.** Personalize the risk assessment for each jurisdiction by removing hazards not associated with the defined jurisdictional area or redefining vulnerability based on a hazard's impact to a jurisdiction. This phase will include:

  - A ranking of the risk
  - A description of the number and type of structures at risk
  - An estimate of the potential dollar losses to vulnerable structures
  - A general description of land uses and development trends within the community, so that mitigation options can be considered in future land use decisions.

- **Capability assessment.** Each planning partner must identify and review their individual regulatory, technical and financial capabilities with regards to the implementation of hazard mitigation actions.
- **Personalize mitigation recommendations.** Identify and prioritize mitigation recommendations specific to each jurisdiction's defined area.
- **Create an Action Plan.**
- **Incorporate Public Participation.** Each jurisdiction must present the plan to the public for comment at least once, within two weeks prior to adoption.
- **Plan must be adopted by each jurisdiction.**

One of the benefits to multi-jurisdictional planning is the ability to pool resources. This means more than monetary resources. Resources such as staff time, meeting locations, media resources, and technical expertise will all need to be utilized to generate a successful plan. In addition, these resources can be pooled such that decisions can be made by a peer group applying to the whole and thus reducing the individual level of effort of each planning partner. This will be accomplished by the formation of a steering committee made up of planning partners and other "stakeholders" within the planning area. The size and makeup of this steering committee will be determined by the planning partnership. This body will assume the decision-making responsibilities on behalf of the entire partnership. This will streamline the planning process by reducing the number of meetings that will need to be attended by each planning partner. The assembled Steering Committee for this effort will meet monthly on an as needed basis as determined by the planning team, and will provide guidance and decision making during all phases of the plan's development.

With the above participation requirements in mind, each partner is expected to aid this process by being prepared to develop its section of the plan. To be an eligible planning partner in this effort, each Planning Partner shall provide the following:

A. A "Letter of Intent to participate" or resolution to participate submitted to the Planning Team (see Exhibit A).

B. Designate a lead point of contact for this effort. This designee will be listed as the hazard mitigation point of contact for your jurisdiction in the plan.

C. Support and participate in the selection and function of the Steering Committee selected to oversee the development of this plan.

D. Provide support in the form of a mailing list, a possible meeting space, and public information materials, such as newsletters, newspapers or direct mailed brochures, required to implement the public involvement strategy developed by the Steering Committee.

E. Participate in the process. There will be many opportunities as this plan evolves to participate. Opportunities such as:

a. Steering Committee meetings

b. Public meetings or open houses

c. Workshops/ Planning Partner specific training sessions

d. Public review and comment periods prior to adoption

At each and every one of these opportunities, attendance will be recorded. Attendance records will be used to document participation for each planning partner. No thresholds will be established as minimum levels of participation. However, each planning partner should attempt to attend all possible meetings and events.

F. There will be one ***mandatory*** workshop that all planning partners will be required to attend. This workshop will cover the proper completion of the jurisdictional annex template, which is the basis for each partner's jurisdictional chapter in the plan. Failure to have a representative at this workshop will disqualify the planning partner from participation in this effort. The schedule for this workshop will be such that all committed planning partners will be able to attend.

G. After participation in the mandatory template workshop, each partner will be required to complete a template and provide it to the planning team in the time frame established by the Steering Committee. Failure to complete your template in the required time frame may lead to disqualification from the partnership.

H. Each partner will be expected to perform a "consistency review" of all technical studies, plans, ordinances specific to hazards to determine the existence of any not consistent with the same such documents reviewed in the preparation of the parent plan.

I. Each partner will be expected to review the risk assessment and identify hazards and vulnerabilities specific to its jurisdiction. Contract resources will provide the jurisdiction specific mapping and technical consultation to aid in this task, but the determination of risk and vulnerability will be up to each partner.

J. Each partner will be expected to review and determine if the mitigation recommendations chosen in the parent plan will meet the needs of its jurisdiction. Projects within each jurisdiction consistent with the parent plan recommendations will need to be identified and prioritized, and reviewed to determine their benefits vs. costs.

K. Each partner will be required to create its own action plan that identifies each project, who will oversee the task, how it will be financed and when it is estimated to occur.

L. Each partner will be required to sponsor at least one public meeting to present the draft plan to its constituents at least 2 weeks prior to adoption.

M. Each partner will be required to formally adopt the plan.

Templates and instructions to aid in the compilation of this information will be provided to all committed planning partners. Each partner will be expected to complete their templates in a timely manner and according to the timeline specified by the Steering Committee.

**** Note**: Once this plan is completed, and DMA compliance has been determined for each partner, maintaining that eligibility will be dependent upon each partner implementing the plan implementation-maintenance protocol identified in the plan. At a minimum, this means completing the ongoing plan**

maintenance protocol identified in the plan. Partners that do not participate in this plan maintenance strategy may be deemed ineligible by the partnership, and thus lose their DMA eligibility.

Eligible entities that do not wish to participate in the 2016 multi-jurisdictional planning process or fail to meet the requirements contained in this document may choose to link to the plan in pursuit of future adoption after the completion of the 2016 effort.

Exhibit A.
Example Letter of Intent to Participate

Tri-Valley Multi-Jurisdiction Hazard Mitigation Planning Partnership
C/O Jessica Cerutti, Tetra Tech, Inc.
1999 Harrison St.
Oakland, CA 94612

Dear Tri-Valley Planning Team,

Please be advised that the _____ (***insert district name***) is committed to participating in the update to the Tri-Valley Multi-Jurisdiction Hazard Mitigation Plan. As the jurisdictional representative tasked with this planning effort, I certify that we will commit all necessary resources in order to meet Partnership expectations as outlined in the "Planning Partners expectations" document provided by the planning team, in order to obtain Disaster Mitigation Act (DMA) compliance for our jurisdiction.

Mr./Ms. _____ will be our jurisdiction's point of contact for this process and they can be reached at ***(insert: address, phone number and e-mail address)***.

Sincerely,

Name _____

Title _____

Exhibit B.
Planning Team Contact information

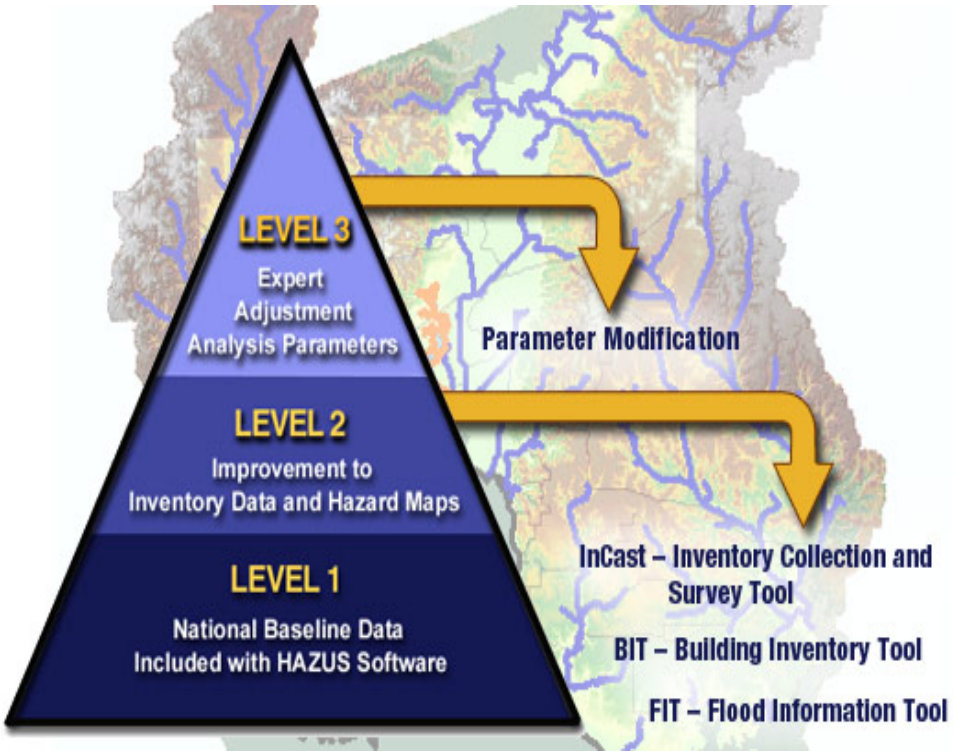
Name	Representing	Address	e-mail
Tracy Hein	Livermore-Pleasanton Fire Department	3560 Nevada St, Pleasanton, CA 94566	THein@lpfire.org
Hazel Wetherford	Dublin	100 Civic Plaza, Dublin, CA 94568	hazel.wetherford@dublin.ca.gov
Shweta Bonn	Pleasanton	P.O. Box 520 Pleasanton, CA 94566	sbonn@cityofpleasantonca.gov
Janice Stern	Pleasanton	P.O. Box 520 Pleasanton, CA 94566	jstern@cityofpleasantonca.gov
Stephen Reilly	Livermore	1052 S Livermore Ave, Livermore, CA 94550	spriley@cityoflivermore.net
Jessica Cerutti	Tetra Tech, Inc.	1999 Harrison St., Ste. 500 Oakland, CA 94612	jessica.cerutti@tetratech.com
Rob Flaner	Tetra Tech, Inc.	90 S. Blackwood Ave Eagle, ID 83616	rob.flaner@tetratech.com
Stephen Veith	Tetra Tech, Inc.	1020 SW Taylor St., Ste. 530 Portland, Oregon 97205	stephen.veith@tetratech.com

Exhibit C.
Overview of HAZUS

Overview of HAZUS-MH (Multi-Hazard)



http://www.fema.gov/hazus/dl_mhpres.shtm**HAZUS-MH**, is a nationally applicable standardized methodology and software program that contains models for estimating potential losses from earthquakes, floods, and hurricane winds. HAZUS-MH was developed by the Federal Emergency Management Agency (FEMA) under contract with the National Institute of Building Sciences (NIBS). NIBS maintains committees of wind, flood, earthquake and software experts to provide technical oversight and guidance to HAZUS-MH development. Loss estimates produced by HAZUS-MH are based on current scientific and engineering knowledge of the effects of hurricane winds, floods, and earthquakes. Estimating losses is essential to decision-making at all levels of government, providing a basis for developing mitigation plans and policies, emergency preparedness, and response and recovery planning.



HAZUS-MH uses state-of-the-art geographic information system (GIS) software to map and display hazard data and the results of damage and economic loss estimates for buildings and infrastructure. It also allows users to estimate the impacts of hurricane winds, floods, and earthquakes on populations. The latest release, HAZUS-MH MR1, is an updated version of HAZUS-MH that incorporates many new features which improve both the speed and functionality of the models. For information on software and hardware requirements to run HAZUS-MH MR1, see HAZUS-MH Hardware and Software Requirements.

HAZUS-MH Analysis Levels

HAZUS-MH provides for three levels of analysis:

- A Level 1 analysis yields a rough estimate based on the nationwide database and is a great way to begin the risk assessment process and prioritize high-risk communities.

- A Level 2 analysis requires the input of additional or refined data and hazard maps that will produce more accurate risk and loss estimates. Assistance from local emergency management personnel, city planners, GIS professionals, and others may be necessary for this level of analysis.
- A Level 3 analysis yields the most accurate estimate of loss and typically requires the involvement of technical experts such as structural and geotechnical engineers who can modify loss parameters based on to the specific conditions of a community. This level analysis will allow users to supply their own techniques to study special conditions such as dam breaks and tsunamis. Engineering and other expertise is needed at this level.

Three data input tools have been developed to support data collection. The Inventory Collection Tool (InCAST) helps users collect and manage local building data for more refined analyses than are possible with the national level data sets that come with HAZUS. InCAST has expanded capabilities for multi-hazard data collection. HAZUS-MH includes an enhanced Building Inventory Tool (BIT) allows users to import building data and is most useful when handling large datasets, such as tax assessor records. The Flood Information Tool (FIT) helps users manipulate flood data into the format required by the HAZUS flood model. All Three tools are included in the HAZUS-MH MR1 Application DVD.



HAZUS-MH Models

The **HAZUS-MH Hurricane Wind Model** gives users in the Atlantic and Gulf Coast regions and Hawaii the ability to estimate potential damage and loss to residential, commercial, and industrial buildings. It also allows users to estimate direct economic loss, post-storm shelter needs and building debris. In the future, the model will include the capability to estimate wind effects in island territories, storm surge, indirect economic losses, casualties, and impacts to utility and transportation lifelines and agriculture. Loss models for other severe wind hazards will be included in the future. Details about the Hurricane Wind Model.

The **HAZUS-MH Flood Model** is capable of assessing riverine and coastal flooding. It estimates potential damage to all classes of buildings, essential facilities, transportation and utility lifelines, vehicles, and agricultural crops. The model addresses building debris generation and shelter requirements. Direct losses are estimated based on physical damage to structures, contents, and building interiors. The effects of flood warning are taken into account, as are flow velocity effects. Details about the Flood Model.

The **HAZUS-MH Earthquake Model**, The HAZUS earthquake model provides loss estimates of damage and loss to buildings, essential facilities, transportation and utility lifelines, and population based on scenario or probabilistic earthquakes. The model addresses debris generation, fire-following, casualties, and shelter requirements. Direct losses are estimated based on physical damage to structures, contents, inventory, and building interiors. The earthquake model also includes the Advanced Engineering Building Module for single- and group-building mitigation analysis. Details about the Earthquake Model.

The updated earthquake model released with HAZUS-MH includes:

- The (September 2002) National Hazard Maps
- Project ‘02 attenuation functions
- Updated historical earthquake catalog (magnitude 5 or greater)
- Advanced Engineering Building Module for single and group building mitigation analysis

Additionally, HAZUS-MH can perform multi-hazard analysis by providing access to the average annualized loss and probabilistic results from the hurricane wind, flood, and earthquake models and combining them to provide integrated multi-hazard reports and graphs. HAZUS-MH also contains a third-party model integration capability that provides access and operational capability to a wide range of natural, man-made, and technological hazard models (nuclear and conventional blast, radiological, chemical, and biological) that will supplement the natural hazard loss estimation capability (hurricane wind, flood, and earthquake) in HAZUS-MH.

Appendix B. Procedures for Linking to Hazard Mitigation Plan

B. Procedures for Linking to Hazard Mitigation Plan

Not all eligible local governments are included in the Tri-Valley Local Hazard Mitigation Plan. Some or all of these non-participating local governments may choose to "link" to the Plan at some point to gain eligibility for programs under the federal Disaster Mitigation Act (DMA). The following "linkage" procedures define the requirements established by the planning team for dealing with an increase in the number of planning partners linked to this plan. No currently non-participating jurisdiction within the defined planning area is obligated to link to this plan. These jurisdictions can choose to do their own "complete" plan that addresses all required elements of Section 201.6 of Chapter 44 of the Code of Federal Regulations (44 CFR).

INCREASING THE PARTNERSHIP THROUGH LINKAGE

Eligibility

Eligible jurisdictions located in the planning area may link to this plan at any point during the plan's performance period (5 years after final approval). Eligibility will be determined by the following factors:

- The linking jurisdiction is a local government as defined by the Disaster Mitigation Act.
- The boundaries or service area of the linking jurisdiction is completely contained within the boundaries of the planning area established during the 2016 hazard mitigation plan development process.
- The linking jurisdiction's critical facilities were included in the critical facility and infrastructure risk assessment completed during the 2016 plan development process.

Requirements

It is expected that linking jurisdictions will complete the requirements outlined below and submit their completed template to the Livermore-Pleasanton Fired District for review within six months of beginning the linkage process:

- The eligible jurisdiction requests a "Linkage Package" by contacting the plan point of contact (POC):

  Tracy Hein, Disaster Preparedness Coordinator
  Livermore Pleasanton Fire Department
  3560 Nevada Street
  Pleasanton, CA 94566
  (925) 454-2317
  THein@lpfire.org

- The POC will provide a linkage procedure package that includes linkage information and a linkage tool-kit:

  - Linkage Information

  - Procedures for linking to the multi-jurisdictional hazard mitigation plan
  - Planning partner's expectations for linking jurisdictions
  - A sample "letter of intent" to link to the multi-jurisdictional hazard mitigation plan
  - A copy of Section 201.6 of 44 CFR, which defines the federal requirements for a local hazard mitigation plan.

- Linkage Tool-Kit

  - Copy of Volume 1 and 2 of the plan
  - A special purpose district or municipality template and instructions
  - A catalog of hazard mitigation alternatives
  - A sample resolution for plan adoption

- The new jurisdiction will be required to review both volumes of the Tri-Valley Local Hazard Mitigation Plan, which include the following key components for the planning area:

  - Goals and objectives
  - The planning area risk assessment
  - Comprehensive review of alternatives
  - Area-wide actions
  - Plan implementation and maintenance procedures.

  Once this review is complete, the jurisdiction will complete its specific annex using the template and instructions provided by the POC.

- The development of the new jurisdiction's annex must not be completed by one individual in isolation. The jurisdiction must develop, implement and describe a public involvement strategy and a methodology to identify and vet jurisdiction-specific actions. The original partnership was covered under a uniform public involvement strategy and a process to identify actions that covered the planning area described in Volume 1 and Volume 2 of this plan. Since new partners were not addressed by these strategies, they will have to initiate new strategies and describe them in their annex. For consistency, new partners are encouraged to develop and implement strategies similar to those described in this plan.
- The public involvement strategy must ensure the public's ability to participate in the plan development process. At a minimum, the new jurisdiction must solicit public opinion on hazard mitigation at the onset of the linkage process and hold one or more public meetings to present the draft jurisdiction-specific annex for comment at least two weeks prior to adoption by the governing body. The POC will have resources available to aid in the public involvement strategy, including:

  - The questionnaire utilized in the plan development
  - Presentations from public meeting workshops and the public comment period
  - Press releases used throughout the planning process
  - The plan website.

- The methodology to identify actions should include a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard and a description of the process by which chosen actions were identified. As part of this process, linking jurisdictions should coordinate the selection of actions amongst the jurisdiction's various departments.
- Once their public involvement strategy and template are completed, the new jurisdiction will submit the completed package to the POC for a pre-adoption review to ensure conformance with the multi-jurisdictional plan format and linkage procedure requirements.
- The POC will review for the following:

  - Documentation of public involvement and action plan development strategies
  - Conformance of template entries with guidelines outlined in instructions
  - Chosen actions are consistent with goals, objectives and mitigation catalog of the Tri-Valley Local Hazard Mitigation Plan
  - A designated point of contact
  - A completed FEMA plan review crosswalk.

- Plans will be reviewed by the POC and submitted to California Governor's Office of Emergency Services (Cal OES) for review and approval.
- Cal OES will review plans for state compliance. Non-compliant plans are returned to the lead agency for correction. Compliant plans are forwarded to FEMA for review with annotation as to the adoption status.
- FEMA reviews the linking jurisdiction's plan in association with the approved plan to ensure DMA compliance. FEMA notifies the new jurisdiction of the results of review with copies to Cal OES and the approved plan lead agency.
- Linking jurisdiction corrects plan shortfalls (if necessary) and resubmits to Cal OES through the approved plan lead agency.
- For plans with no shortfalls from the FEMA review that have not been adopted, the new jurisdiction governing authority adopts the plan and forwards adoption resolution to FEMA with copies to lead agency and Cal OES.
- FEMA regional director notifies the new jurisdiction's governing authority of the plan's approval.

The new jurisdiction plan is then included with the multi-jurisdiction hazard mitigation plan and the linking jurisdiction is committed to participate in the ongoing plan maintenance strategy identified in Section 19.5 of Volume 1 of the hazard mitigation plan.

DECREASING THE PARTNERSHIP

The eligibility afforded under this process to the planning partnership can be rescinded in two ways. First, a participating planning partner can ask to be removed from the partnership. This may be done because the partner has decided to develop its own plan or has identified a different planning process for which it can gain eligibility. A partner that wishes to voluntarily leave the partnership shall inform the POC of this desire in writing. This notification can occur any time during the calendar year. A jurisdiction wishing to pursue this avenue is advised to make sure that it is eligible under the new planning effort, to avoid any period of being out of compliance with the Disaster Mitigation Act.

After receiving this notification, the POC shall immediately notify both Cal OES and FEMA in writing that the partner in question is no longer covered by the Tri-Valley Local Hazard Mitigation Plan, and that the eligibility afforded that partner under this plan should be rescinded based on this notification.

The second way a partner can be removed from the partnership is by failure to meet the participation requirements specified in the "Planning Partner Expectations" package provided to each partner at the beginning of the process, or the plan maintenance and implementation procedures specified in Volume 1 of the plan. Each partner agreed to these terms by adopting the plan.

Eligibility status of the planning partnership will be monitored by the POC. The determination of whether a partner is meeting its participation requirements will be based on the following parameters:

- Are progress reports being submitted by the specified time frames?
- Are partners notifying the POC of changes in designated points of contact?

- Are the partners supporting the Steering Committee by attending designated meetings or responding to needs identified by the body?
- Are the partners continuing to be supportive as specified in the Planning Partners expectations package provided to them at the beginning of the process?

Participation in the plan does not end with plan approval. This partnership was formed on the premise that a group of planning partners would pool resources and work together to strive to reduce risk within the planning area. Failure to support this premise lessens the effectiveness of this effort. The following procedures will be followed to remove a partner due to the lack of participation:

- The POC will advise the Steering Committee of this pending action and provide evidence or justification for the action. Justification may include: multiple failures to submit annual progress reports, failure to attend meetings determined to be mandatory by the Steering Committee, failure to act on the partner's action plan, or inability to reach designated point of contact after a minimum of five attempts.
- The Steering Committee will review information provided by POC, and determine action by a vote. The Steering Committee will invoke the voting process established in the ground rules established during the formation of this body.
- Once the Steering Committee has approved an action, the POC will notify the planning partner of the pending action in writing via certified mail. This notification will outline the grounds for the action, and ask the partner if it is their desire to remain as a partner. This notification shall also clearly identify the ramifications of removal from the partnership. The partner will be given 30 days to respond to the notification.
- Confirmation by the partner that they no longer wish to participate or failure to respond to the notification shall trigger the procedures for voluntary removal discussed above.
- Should the partner respond that they would like to continue participation in the partnership, they must clearly articulate an action plan to address the deficiencies identified by the POC. This action plan shall be reviewed by the Steering Committee to determine whether the actions are appropriate to rescind the action. Those partners that satisfy the Steering Committee's review will remain in the partnership, and no further action is required.
- Automatic removal from the partnership will be implemented for partners where these actions have to be initiated more than once in a 5-year planning cycle.

Appendix C. Annex Instructions and Templates

INSTRUCTIONS FOR COMPLETING MUNICIPAL ANNEX TEMPLATE

The jurisdictional annex templates for the 2017 Tri-Valley Hazard Mitigation Plan update will be completed in three phases. **This document provides instructions for completing all phases of the template for municipalities.**

If your jurisdiction completed and submitted Phase 1 and/or Phase 2, Phase 3 has been added to the end of your document. Any planning team comments, questions or suggestions have been included as blue highlighted notes and/or comments. Any text edits were made with changes tracked for review. Any yellow highlights indicate areas where missing information should be filled in.

If your jurisdiction did not complete Phase 1 or Phase 2, please complete all phases at this time.

The target timeline for phase completion is as follows:

- **Phase 1** – Jurisdictional profile
  - Deployed: early July
  - Due: early August
- **Phase 2** – Capability assessment
  - Deployed: late August
  - Due: September 26, 2017
- **Phase 3** – Risk ranking and action plan development
  - Deployed: Mid-October
  - Workshop: October steering committee meeting
  - Due: November 17, 2017

Any questions on completing the template should be directed to:

Kristen Gelino
Tetra Tech, Inc.
(917) 426-4594 or (646) 576-4029
E-mail: kristen.gelino@tetratech.com

Municipality Annex:

This document provides instructions for completing **all phases** of the jurisdictional annex template for municipalities. **Templates should be completed by Friday, November 17, 2017.** Your completed template should be submitted to:

Kristen Gelino
Tetra Tech, Inc.
(917) 426-4594 or (646) 576-4029
E-mail: kristen.gelino@tetratech.com

A Note About Formatting:

The template for the annex is a Microsoft Word document in a format that will be used in the final plan. Partners are asked to use this template so that a uniform product will be completed for each partner.

Content should be entered within the yellow, highlighted text that is currently in the template, rather than creating text in another document and pasting it into the template. Text from another source will alter the style and formatting of the document.

The numbering in the document will be updated when completed annexes are combined into the final document. Please do not adjust any of this numbering.

PHASE 1 INSTRUCTIONS

CHAPTER TITLE

In the chapter title at the top of Page 1, type in the complete official name of your municipality (City of Pleasantville, West County, etc.). Please do not change the chapter number. Revise only the jurisdiction name.

HAZARD MITIGATION PLAN POINT OF CONTACT

Provide the name, title, mailing address, telephone number, and e-mail address for the primary point of contact for your jurisdiction. This should be the person responsible for monitoring, evaluating and updating the annex for your jurisdiction. This person should also be the principle liaison between your jurisdiction and the Steering Committee overseeing development of this plan.

In addition, designate an alternate point of contact. This would be a person to contact should the primary point of contact be unavailable or no longer employed by the jurisdiction.

Note: Both of these contacts should match the contacts that were designated in your jurisdiction's letter of intent to participate in this planning process. If you have changed the primary or secondary contact, please let the planning team know by inserting a comment into the document.

JURISDICTION PROFILE

Provide information specific to your jurisdiction as indicated, in a style similar to the example provided in the box below. This should be information that will not be provided in the overall mitigation plan document. For population data, use the most current population figure for your jurisdiction based on an official means of tracking (e.g., the U.S. Census or state office of financial management).

Example Jurisdiction Profile:

- **Date of Incorporation**—1858
- **Current Population**—17,289 as of July 2014 (2014 Department of Finance estimates)
- **Population Growth**—Based on state Department of Finance data, Smithburg has experienced a flat rate of growth. The population increased only 3.4% since 2010 and growth averaged 0.74% per year from 2000 to 2014.
- **Location and Description—**The City of Smithburg is on the Pacific coast, 760 miles north of Los Angeles and 275 miles north of San Francisco. The nearest seaport is Eureka, five miles south on Humboldt Bay. Smithburg is the home of Smithburg State University and is situated between the communities of Murphy to the north and Blue Lake to the east. It sits at the intersection of US Highway 101 and State Route 299.
- **Brief History**—The Smithburg area was settled during the gold rush in the 1850s as a supply center for miners. As the gold rush died down, timber and fishing became the area's major economic resource. Smithburg was incorporated in 1858 and by 1913 the Smithburg Teachers College, a predecessor to today's Smithburg State University was founded. Recently, the presence of the college has come to shape Smithburg's population into a young, liberal, and educated crowd. In 1981 Smithburg developed the Smithburg Marsh and Wildlife sanctuary, an environmentally friendly sewage treatment enhancement system.
- **Climate**—Smithburg's weather is typical of the Northern California coast, with mild summers and cool, wet winters. It rarely freezes in the winter and it is rarely hot in the summer. Annual average rainfall is over 40 inches, with 80% of that falling from November through April. The average year-round temperature is 59ºF. Humidity averages 72 to 87 percent. Prevailing winds are from the north, and average 5 mph.
- **Governing Body Format**—The City of Smithburg is governed by a five-member city council. The City consists of six departments: Finance, Environmental Services, Community Development, Public Works, Police and the City Manager's Office. The City has 13 commissions and task forces, which report to the City Council. The City Council assumes responsibility for the adoption of this plan; the City Manager will oversee its implementation.

Phase 2 Instructions

DEVELOPMENT TRENDS

Please note that we have made some modifications to the template based on our most current feedback from the State and FEMA. You may have already completed a portion of the development trends section during Phase 1. If so, we have moved the information you provided into the appropriate section of the document.

In the yellow-highlighted text that says "Describe trends in general," provide a brief description of your jurisdiction's recent development trends similar to the following example:

> Anticipated development levels for Smithburg are low to moderate, consisting primarily of residential development. The majority of recent development has been infill. Residentially, there has been a focus on affordable housing and a push for more secondary mother-in-law units on properties. The City of Smithburg adopted its general plan in July 2000. The plan focuses on issues of the greatest concern to the community. City actions, such as those relating to land use allocations, annexations, zoning, subdivision and design review, redevelopment, and capital improvements, must be consistent with the plan. Future growth and development in the City will be managed as identified in the general plan.

Complete the table titled "Recent and Expected Future Development Trends" to demonstrate the development that occurred during the past 5 years, including a description of any development which may be located within a hazard zone. Provide additional information on any anticipated development**. Please note that we are specifically looking for development permits for new construction.** If your jurisdiction does not have the ability to differentiate between permit types, please list the total number of permits and include a note or comment in the document indicating what you have provided.

If your jurisdiction does not have the ability to track the number of permits for each hazard area, please insert a qualitative description of where development has occurred similar to the following:

> Development has occurred throughout the city during the performance period for this plan. For those hazards with a clearly defined extent and location, the City cannot estimate specific development impacts. For those hazards with impacts city-wide, it is safe to assume that this new development could be subject to impacts from those hazards. However, it is important to note that all new development was consistent with General Plan policies and municipal code standards and as a result most development has occurred outside of identified hazard zones.

CAPABILITY ASSESSMENT

Please note that it is unlikely that you will be able to complete all sections of the capability assessment on your own. You will likely need to reach out to other departments within your local government, such as planning, finance, public works, etc. It may be beneficial to provide these individuals with background information about this planning process, as you will want input from them again during Phase 3 of your annex development.

Legal and Regulatory Capability

In the table titled "Legal and Regulatory Capability," indicate "Yes" or "No" for each listed code, ordinance, requirement or planning document in each of the following columns:

- **Local Authority**—Enter "Yes" if your jurisdiction has prepared or adopted the identified item; otherwise, enter "No." If yes, then enter the code, ordinance number, or plan name and its date of adoption in the

comments column. ***Note: If you are entering yes, please be sure that you are providing a comment with the appropriate code, ordinance or plan.***

- **Other Jurisdiction Authority**—Enter "Yes" if there are any regulations that may impact your jurisdiction that are enforced or administered by another agency (e.g., a state agency or special purpose district) or if you know that there are any state or federal regulations or laws that would prohibit local implementation of the identified item; otherwise, enter "No." ***Note: If you answer yes, please indicate the other agency in the comments.***
- **State Mandated**—Enter "Yes" if state laws or other requirements enable or require the listed item to be implemented at the local level; otherwise, enter "No." ***Note: If you are entering yes, please be sure that you are providing a comment.***
- **Integration Opportunity**—Enter "Yes" if your jurisdiction has opportunities for integration of the code, ordinance or plan with the hazard mitigation plan. Consider entering "Yes" in the Integration Opportunity column if you answer "yes" to any of the following:

  - If you answered "Yes" in the Local Authority column for this code, ordinance or plan:

    - Does the code, ordinance or plan already address hazards and their potential impacts?
      - If so, should it be updated or revised to reflect new information about risk?
      - If not, will (or should) the code, ordinance or plan be updated over the performance period of the hazard mitigation plan (5 years)?
    - Does the code, ordinance or plan include specific projects that should be reviewed to incorporate hazard mitigation goals?
    - Does the code, ordinance or plan include specific projects that should be included as action items in the hazard mitigation action plan?

  - If you answered "No" in the Local Authority column for this code, ordinance or plan:

    - Will your jurisdiction develop the code, ordinance or plan during the performance period of the hazard mitigation plan?

  Note: Each capability with a "Yes" answer to Integration Opportunity will be discussed in more detail later in the annex. You may wish to keep notes when assessing the Integration Opportunity or review the "Integration with Other Planning Initiatives" section below.

- **Comments**—Enter the code number and adoption date for any local code indicated as being in place; provide other comments as appropriate to describe capabilities for each entry.
- For the categories "General Plan" and "Capital Improvement Plan," answer the specific questions shown, in addition to completing the four columns indicating level of capability.

Development and Permit Capabilities

Complete the table titled "Development and Permitting Capabilities." Examples of qualitative descriptions of buildout in the jurisdiction are as follows:

- The Town is close to being built out. Most new projects involve the demolition of an existing residence and construction of a new replacement residence. A few subdivisions are processed each year.
- There are five parcels of underdeveloped land within the city limits. According to the General Plan, the total potential units for these parcels is 33 units.

Fiscal Capability

Complete the table titled "Fiscal Capability" by indicating whether each of the listed financial resources is accessible to your jurisdiction. Enter "Yes" if the resource is fully accessible to your jurisdiction. Enter "No" if there are limitations or prerequisites that may hinder your eligibility for this resource.

Administrative and Technical Capability

Complete the table titled "Administrative and Technical Capability" by indicating whether your jurisdiction has access to each of the listed personnel resources. Enter "Yes" or "No" in the column labeled "Available?". If yes, then enter the department and position title in the right-hand column. If you have contract support staff with these capabilities, you can still answer "Yes." Indicate in the department column that this resource is provided through contract support.

Education and Outreach Capabilities

Complete the table titled "Education and Outreach" to indicate your jurisdiction's capabilities and existing efforts regarding natural hazard mitigation education and outreach.

National Flood Insurance Program Compliance

Complete the table titled "National Flood Insurance Program Compliance" by indicating your jurisdiction's capabilities related to each question in the table.

Classification in Hazard Mitigation Programs

Complete the table titled "Community Classifications" to indicate your jurisdiction's participation in various national programs related to natural hazard mitigation. For each program enter "Yes" or "No" in the second column to indicate whether your jurisdiction participates. If yes, then enter the classification that your jurisdiction has earned under the program in the third column and the date on which that classification was issued in the fourth column; enter "N/A" in the third and fourth columns if your jurisdiction is not participating.

Tetra Tech has completed this table for classification programs that have classification information available online:

- **Community Rating System**— https://www.fema.gov/media-library/assets/documents/15846
- **Storm Ready**— https://www.weather.gov/stormready/communities
- **Firewise**— http://www.firewise.org/usa-recognition-program/map-of-active-participants.aspx

For two of the programs, we are not able to access information pertaining to your jurisdiction. If you are unfamiliar with the programs, please visit the websites below:

- **Building Code Effectiveness Grading Schedule (BCEGS)**— https://www.isomitigation.com/bcegs/iso-s-building-code-effectiveness-grading-schedule-bcegs.html
- **Public Protection Classification**— https://firechief.iso.com/FCWWeb/mitigation/ppc0001.jsp

Adaptive Capacity for Climate Change

Consider the climate change impact concerns identified for the planning area:

- Increased temperature
- Reduced precipitation
- Sea level rise – coastal inundation and erosion

- Public health – heat and air pollution
- Reduced agricultural productivity
- Inland flooding
- Reduced tourism.

With those impacts in mind, complete the table titled "Adaptive Capacity for Climate Change" by indicating that your jurisdiction's capacity for each listed criterion as follows:

- **High**—The capacity exists and is in use.
- **Medium**—The capacity may exist, but is not used or could use some improvement.
- **Low**—The capacity does not exist or could use substantial improvement.
- **Unsure**—Not enough information is known to assign a rating.

This is a subjective assessment, but providing a few words of explanation is useful. It is highly recommended that you complete this table with an internal planning team and that you review the results of the other capability assessment tables before completing.

INTEGRATION WITH OTHER PLANNING INITIATIVES

The goal of plan integration is to ensure that the potential impact of hazards is considered in planning for future development. FEMA recommends integration as follows:

- Integrate hazard mitigation plan goals with community objectives (e.g. incorporate the goals for risk reduction and safety into the policies of other plans).
- Use the risk assessment to inform plans and policies (e.g. incorporate risk assessment findings into land use plans, site plan review, emergency operations plans).
- Implement mitigation actions through existing mechanisms (e.g. include mitigation projects in the capital improvement plan).
- Think about mitigation before and after a disaster (e.g. build recovery planning on existing mitigation plans and goals).

After reviewing the plans, programs and ordinances identified in the capability assessment tables, identify all plans and programs that have already been integrated with the goals and recommendations of the hazard mitigation plan, and those that offer opportunities for future integration. The simplest way to do this is to review the Legal and Regulatory Capabilities table to see which items were marked as "Yes" under the Integration Opportunity column.

Existing Integration

List the items for which you entered "Yes" under the Integration Opportunity column because the plan or ordinance already addresses potential impacts or includes specific projects that should be included as action items in the mitigation action plan. Provide a brief description of how the plan or ordinance is integrated. For plan updates, it is required that at least one item be listed or that you explicitly state that no integration occurred. Examples are as follows:

- **Capital Improvement Plan**—The capital improvement plan includes projects can help mitigate potential hazards. The City will act to ensure consistency between the hazard mitigation plan and the current and future capital improvement plans. The hazard mitigation plan may identify new possible funding sources for capital improvement projects and may result in modifications to proposed projects based on results of the risk assessment.

- **Building Code and Fire Code**—The City's adoption of the 2016 California Building and Fire codes incorporated local modifications to account for the climatic, topographic and geographic conditions that exist in the City.
- **General Plan 2030**—The general plan includes a "Safety, Services, and Infrastructure" element to protect the community from unreasonable risk by establishing policies and actions to avoid or minimize the following hazards:

  - Geologic and seismic hazards
  - Fire hazards
  - Hazardous materials
  - Flood control
  - Impacts from climate change.

- **Climate Action Plan**—The City's Climate Action Plan includes projects for reducing greenhouse gas emissions and adapting to likely impacts of climate change. These projects were reviewed to identify cross-planning initiates that serve both adaptation and mitigation objectives. ***Note: Any plans that fall into this category should be reviewed during the development of the mitigation strategy in Phase 3 and included as appropriate.***

Opportunities for Future Integration

List any remaining items that say "Yes" in the Integration Opportunity column in the Legal and Regulatory Capabilities and explain the process by which integration will occur. Examples follow:

- **Zoning Code**—The City of Smithburg is conducting a comprehensive update to its zoning code. The opportunity to incorporate additional mitigation and abatement measures will be contemplated for inclusion into the Code.
- **Capital Improvement Projects**—Capital improvement project proposals may take into consideration hazard mitigation potential as a means of evaluating project prioritization.
- **Post-Disaster Recovery Plan**—Smithburg does not have a recovery plan and intends to develop one as a mitigation planning action during the next five years. The plan will build on the mitigation goals and objectives identified in the mitigation plan.

After you have accounted for all items marked as "Yes" under the Integration Opportunity column, consider other programs you may have in place in your jurisdiction that include routine consideration and management of hazard risk. Examples of such programs may include: tree pruning programs, right-of-way mowing programs, erosion control or stream maintenance programs, etc. Please add any such programs to the integration discussion and provide a brief description of how these program manage (or could be adapted to manage) risk from hazards.

Phase 3 Instructions

JURISDICTION-SPECIFIC NATURAL EVENT HISTORY

In the table titled "Past Natural Hazard Events," list in chronological order (most recent first) any natural hazard event that has caused damage to your jurisdiction. Include the date of the event and the estimated dollar amount of damage it caused. You are welcome to include any events, but special attention should be made to include major storms and federally declared disasters. Please refer to the table below that lists Presidential Disaster Declarations for the County. We recommend including most large-scale disasters, unless you know that there were no impacts to your jurisdiction. Specifically, we recommend that you include these events if you have damage estimate information or can provide a brief description of impacts that occurred within your community. In addition to these events, please refer to the NOAA storm events database included in the tool kit. We recommend conducting

a search for the name of your jurisdiction in order to identify events with known impacts. Other potential sources of damage information include:

- Preliminary damage estimates your jurisdiction filed with the county or state
- Insurance claims data
- Newspaper archives
- Other plans/documents that deal with emergency management (safety element of a comprehensive plan, emergency response plan, etc.)
- Resident input.

If you do not have estimates for dollars of damage caused, please list "Not Available" in the appropriate column or simply list a brief description of the damages (e.g. Main Street closed as a result of flooding, downed trees and residential damages). Please note that tracking such damages is a valid and useful mitigation action if your jurisdiction does not currently track such information.

Presidential Disaster Declarations for Alameda County

Type of Event	FEMA Disaster #	Declaration Date
Severe Winter Storms, Flooding, and Mudslides	DR-4308	4/1/2017
Severe Winter Storms, Flooding, and Mudslides	DR-4305	3/16/2017
Severe Winter Storms, Flooding, and Mudslides	DR-4301	2/14/2017
Severe Storms, Flooding, Landslides, and Mudslides	DR-1646	6/5/2006
Severe Storms, Flooding, Mudslides, and Landslides	DR-1628	2/3/2006
Hurricane Katrina Evacuation	EM-3248	9/13/2005
Severe Winter Storms and Flooding	DR-1203	2/9/1998
Severe Storms, Flooding, Mud and Landslides	DR-1155	1/4/1997
Severe Winter Storms, Flooding Landslides, Mud Flow	DR-1046	3/12/1995
Severe Winter Storms, Flooding, Landslides, Mud Flows	DR-1044	1/10/1995
Oakland Hills Fire	DR-919	10/22/1991
Severe Freeze	DR-894	2/11/1991
Loma Prieta Earthquake	DR-845	10/18/1989
Severe Storms & Flooding	DR-758	2/21/1986
Coastal Storms, Floods, Slides & Tornadoes	DR-677	2/9/1983
Severe Storms, Flood, Mudslides & High Tide	DR-651	1/7/1982
Drought	EM-3023	1/20/1977
Forest & Brush Fires	DR-295	9/29/1970
Severe Storms & Flooding	DR-283	2/16/1970

Note: EM = Emergency Declaration; DR = Disaster Declaration

JURISDICTION-SPECIFIC VULNERABILITIES

Repetitive Loss Properties

A repetitive loss property is any property for which FEMA has paid two or more flood insurance claims in excess of $1,000 in any rolling 10-year period since 1978. In the space provided, Tetra Tech will insert the following information based on data provided by FEMA:

- The number of any FEMA-identified repetitive-loss properties in your jurisdiction.

- The number of any FEMA-identified severe-repetitive-loss properties in your jurisdiction.
- The number (if any) of repetitive-loss or severe-repetitive-loss properties in your jurisdiction that have been mitigated. Mitigated for this exercise means that flood protection has been provided to the structure.

Please note that if your jurisdiction has any repetitive loss properties, we would strongly encourage you to include a mitigation action that addresses mitigating these properties.

Other Vulnerabilities

We would strongly encourage you to review the results of the risk assessment included in the tool kit, your jurisdiction's natural events history, and any relevant public comments/input and develop a few sentences that discuss specific risks. You do not need to develop a sentence for every single parameter, but review the results and identify a few issues you would like to highlight. For example:

- Only about 2 percent of the jurisdiction's population is estimated to reside in the 1 percent annual chance flood hazard area; however, 45 percent of the population is estimated to reside in the 0.2 percent annual chance flood hazard area where flood insurance is generally not required.
- A magnitude 7.5 earthquake on the Smithburg Fault may produce nearly 1 million tons of structure debris.
- Over the past 10 years, the jurisdiction has experienced more than $6 million in estimated damages from severe storm events.
- More than 50 buildings are located in areas that will be permanently inundated with 12 inches of sea level rise.
- The results of the public survey indicated that 40 percent of Smithburg residents would not be able to be self-sufficient for 5 days following a major event.

In addition, please list any noted vulnerabilities in your jurisdiction related to hazard mitigation that may not be apparent from the risk assessment and other information provided. This may include things such as the following:

- An urban drainage issue that results in localized flooding every time it rains.
- An area of the community that frequently loses power due to a lack of tree maintenance.
- A critical facility, such as a police station, that is not equipped with a generator.
- A neighborhood that has the potential to have ingress and egress cut off as the result of a hazard event, such as a flood or earthquake (e.g. bridge only access).
- Substantial number of buildings in one area of the community are unreinforced masonry or soft-story construction.
- An area along the river is eroding and threatening public and/or private property.
- A large visitor population that may not be aware of tsunami risk.

Spending some time thinking about the results of the risk assessment and other noted vulnerabilities will be a big help in the development of your mitigation strategy. The items you list in this section should cross-walk back to the mitigation action that you have selected. Two examples are shown in the table below.

Noted Vulnerability	Example Mitigation Action
Only about 2 percent of the jurisdiction's population is estimated to reside in the 1 percent annual chance flood hazard area; however, 45 percent of the population is estimated to reside in the 0.2 percent annual chance flood hazard area where flood insurance is generally not required.	Develop and implement an annual public information initiative that targets residents in the 0.2 percent annual chance flood hazard area. Provide information on the availability of preferred risk flood insurance policies.

Noted Vulnerability	Example Mitigation Action
An urban drainage issue that results in localized flooding every time it rains.	Replace undersized culverts that are contributing to localized flooding. Priority areas include: • The corner of Main Street and 1st Street • Old Oak subdivision.

HAZARD RISK RANKING

The risk ranking performed for the overall planning area is presented in the risk assessment section of the overall hazard mitigation plan. However, each jurisdiction has differing degrees of risk exposure and vulnerability and, therefore, needs to rank risk for its own area, using the same methodology as used for the overall planning area. The risk-ranking exercise assesses two variables for each hazard: its probability of occurrence; and its potential impact on people, property and the economy.

The risk ranking for each jurisdiction is included in the Risk Ranking Summary tab in the Loss Matrix included in the toolkit. Tetra Tech has filled in the results for each jurisdiction. If this risk ranking exercise generates results other that what you know based on substantiated data and documentation, you may alter the ranking based on this knowledge. If this is the case, please note this fact in your template and include what you believe the rank should be and why. For example, drought was ranked as low; however, the jurisdiction's economy is heavily reliant on water using industries, such as agriculture or manufacturing, so you believe it should be ranked as medium.

Also keep in mind that one of the purposes of this exercise is to support the selection and prioritization of actions in your plan. If you identify an action with a high priority that mitigates the risk of a hazard you have ranked low, that project may not be as competitive in the grant arena. On the other hand, **you will need to have at least one true mitigation action for each hazard ranked as "high" or "medium."** This is discussed in more detail in the Hazard Mitigation Action Plan section of these instructions.

The instructions below describe the methodology for how these rankings were derived. Please review before providing any comments.

Risk Ranking Methodology

Review Risk Ranking in Template

Review the hazard risk ranking information that Tetra Tech has provided. The hazard with the highest risk rating is listed at the top of table titled "Hazard Risk Ranking" in your template and was given a rank of 1; the hazard with the second highest rating is listed second with a rank of 2; and so on. Two hazards with equal risk ratings were given the same rank. "High," Medium," and "Low" assignments were given for each hazard of concern based on the total score (probability x impact). It is important to note, that this is determined by the scores rather than assigning a certain number of hazards to each category.

When reviewing the risk ranking results, it is important to remember that this exercise is about categorizing hazards into broad levels of risk (e.g. high, medium, low). It is not an exercise in precision.

Review Risk Ranking in Loss Matrix

The following sections discuss the methodology used to develop the results included in your template. Please refer to the Loss Matrix provided in your tool kit in order to follow along.

Probability of Occurrence for Each Hazard

A probability factor is assigned based on how often a hazard is likely to occur. The probability of occurrence of a hazard event is generally based on past hazard events in an area, although weight can be given to expected future probability of occurrence based on established return intervals and changing climate conditions. For example, if your jurisdiction has experienced two damaging floods in the last 25 years, the probability of occurrence is high for flooding and scores a 3 under this category. If your jurisdiction has experienced no damage from landslides in the last 100 years, your probability of occurrence for landslide is low, and scores a 1 under this category. Each hazard was assigned a probability factor as follows:

- High—Hazard event is likely to occur within 25 years (Probability Factor = 3)
- Medium—Hazard event is likely to occur within 100 years (Probability Factor = 2)
- Low—Hazard event is not likely to occur within 100 years (Probability Factor = 1)
- None—If there is no exposure to a hazard, there is no probability of occurrence (Probability Factor = 0)

Potential Impacts of Each Hazard

The impact of each hazard is divided into three categories: impacts on people, impacts on property, and impacts on the economy. These categories are also assigned weighted values. Impact on people was assigned a weighting factor of 3, impact on property was assigned a weighting factor of 2 and impact on the economy was assigned a weighting factor of 1.

Impact factors for each category (people, property, economy) are described below:

- **People**—Values are assigned based on the percentage of the total ***population exposed*** to the hazard event. The degree of impact on individuals will vary and is not measurable, so the calculation assumes for simplicity and consistency that all people exposed to a hazard because they live in a hazard zone will be equally impacted when a hazard event occurs. Impact factors were assigned as follows:
  - High—25 percent or more of the population is exposed to a hazard (Impact Factor = 3)
  - Medium—10 percent to 24 percent of the population is exposed to a hazard (Impact Factor = 2)
  - Low—9 percent or less of the population is exposed to the hazard (Impact Factor = 1)
  - No impact—None of the population is exposed to a hazard (Impact Factor = 0)
- **Property**—Values are assigned based on the percentage of the total ***property value exposed*** to the hazard event:
  - High—25 percent or more of the total replacement value is exposed to a hazard (Impact Factor = 3)
  - Medium—10 percent to 24 percent of the total replacement value is exposed to a hazard (Impact Factor = 2)
  - Low—9 percent or less of the total replacement value is exposed to the hazard (Impact Factor = 1)
  - No impact—None of the total replacement value is exposed to a hazard (Impact Factor = 0)
- **Economy**—Values were assigned based on the percentage of the total ***property value vulnerable*** to the hazard event. Values represent estimates of the loss from a major event of each hazard in comparison to the total replacement value of the property exposed to the hazard. For some hazards, such as wildfire and landslide, vulnerability may be considered to be the same or a portion of exposure due to the lack of loss estimation tools specific to those hazards.
  - High—Estimated loss from the hazard is 10 percent or more of the total replacement value (Impact Factor = 3)

- Medium—Estimated loss from the hazard is 5 percent to 9 percent of the total replacement value (Impact Factor = 2)
- Low—Estimated loss from the hazard is 4 percent or less of the total replacement value (Impact Factor = 1)
- No impact—No loss is estimated from the hazard (Impact Factor = 0).

The following sections provide information on completing the risk ranking for your jurisdiction.

Impacts on People

The percent of the total population exposed to each hazard of concern with a defined extent and location (e.g. floodplain) can be found in the loss estimate matrix in the **green highlighted column.** For those hazards that do not have a defined extent and location (e.g. severe weather) the entire population is generally considered to be exposed. For the drought hazard, it is common for jurisdictions to list "low" or "none," because all people in the planning area would be exposed to drought, but impacts to the health and safety of individuals are expected to be minimal.

Impacts on Property

The percent of the total value exposed to each hazard of concern with a defined extent and location (e.g. floodplain) can be found in the loss estimate matrix in the **blue highlighted column.** For those hazards that do not have a defined extent and location (e.g. severe weather) the entire building stock is generally considered to be exposed. For the drought hazard, it is common for jurisdictions to list "low" or "none," because all structures in the planning area would be exposed to drought, but impacts to structures are expected to be minimal.

Impacts on the Economy

The loss estimates for each hazard of concern that was modeled (i.e. dam failure, flood, earthquake) can be found in the loss estimate matrix in the **purple highlighted column.** For those hazards that have a defined extent and location, but do not have modelled loss results, loss estimates can be the same as exposure or a portion thereof. For example, a large percentage of the building stock may be exposed to landslide or wildfire risk, but it would not be expected that one event that resulted in loss to all exposed structures would occur. For those hazards that do not have a defined extent and location (e.g. severe weather) the entire building stock is generally considered to be exposed, but impacts are generally considered to be "low."

Risk Rating for Each Hazard

A risk rating for each hazard was determined by multiplying the assigned probability factor by the sum of the weighted impact factors for people, property and the economy:

Risk Rating = Probability Factor x Weighted Impact Factor {people + property + economy}

This is the number that is shown in the risk ranking table in your template.

STATUS OF PREVIOUS PLAN ACTIONS

Please note that this section only applies to jurisdictions that are conducting updates to previously approved hazard mitigation plans. If your jurisdiction has not previously participated in an approved plan, this section will not appear in your annex template. Also, please note that if you completed the Phase 2 annex, you likely already filled out this table. You will need to revisit this section to fill in the Action # section after competing your action plan in the following section.

All action items identified in prior mitigation planning efforts must be reconciled in this plan update. Action items must all be marked as ONE of the following; check the appropriate box (place an X) and provide the following information:

- **Completed—**If an action was completed during the performance period of the prior plan, please check the appropriate box and provide a date of completion in the comment section. If an action has been initiated and is an ongoing program (e.g. annual outreach event), you may mark it as completed and note that it is ongoing in the comments. When removing such actions from your action plan, please consider including them in the existing integration section above. If you have an action that addresses an ongoing program you would like to continue to include it in your action plan, please see the Carried Over to Plan Update section below.
- **Removed—**If action items are to be removed because they are no longer feasible, a reason must be given. Lack of funding does not mean that it is no longer feasible, unless the sole source of funding for an action is no longer available. Place a comment in the comment section explaining why the action is no longer feasible (e.g., "Action no longer considered feasible due to lack of political support."). If the wording and/or intent of a previously identified action is unclear, this can be a reason for removal. A change in community priorities may also be a reason for removal and should be discussed in the comments.
- **Carried Over to Plan Update—**If an action is in progress, ongoing or has not been initiated and you would like to carry it over to the plan update, please check the "Check if Yes" column under "Carried Over to Plan Update." Selecting this option indicates that the action will be included in the mitigation action plan for the 2017 plan. The last column "Enter Action #" will be addressed when you develop your actions plan in the following sections. You will need to revisit it after completing the action plan.

HAZARD MITIGATION ACTION PLAN AND EVALUATION OF RECOMMENDED ACTIONS

This section is the heart of your jurisdictional annex. This is where you will identify the actions your jurisdiction would like to pursue with this plan. All of the work that you have done thus far should provide you with a plethora of ideas for actions. With this in mind, we recommend that you review the following and develop a list of potential actions:

- **Capability Assessment Section of Annex—**Review the Legal and Regulatory Capability table, the Development and Permitting Capability table, the Fiscal Capability table, the Administrative and Technical Capability table, the Education and Outreach table, and the Community Classification table.
  - For any capability that you indicated that you did not have, ask yourself – should we have this capability? If yes, consider including an action to develop/acquire the capability.
  - Example: Ensure a staff person from public works and planning are trained in the use of FEMA's benefit-cost analysis software.

Wording Your Action Descriptions:

Descriptions of your actions need not provide great detail. That will come when you apply for a project grant. Provide enough information to identify the project's scope and impact. The following are typical descriptions for an action plan action:

- **Action 1—**Address repetitive-loss properties. Through targeted mitigation, acquire, relocate or retrofit the five repetitive loss structures in the County as funding opportunities become available.
- **Action 2—**Perform a non-structural, seismic retrofit of City Hall.
- **Action 3—**Acquire floodplain property in the Smith subdivision.
- **Action 4—**Enhance the County flood warning capability by joining the NOAA "Storm Ready" program.

- Review the Legal and Regulatory capabilities. If any have not been reviewed and updated a capability in more than 10 years, consider an action to review and update the capability and, as appropriate, incorporate hazard mitigation principles or information obtained in the risk assessment (Note: actions such as this should also be identified in the opportunities for future integration section). Also, consider including projects or actions that have been identified in other plans and programs such as Capital Improvement Plans, Strategic Plans, etc. as actions in this plan.
- For any capability that you indicated you do have, consider how this capability can be leveraged to increase or improve hazard mitigation in the jurisdiction.

- **National Flood Insurance Program Compliance Table of this Annex**—Review the table and consider the following:

  - If you have no certified floodplain managers and you have flood risk, consider adding an action to provide key staff members with training appropriate to obtain certification.
  - If your flood damage prevention was last updated in or before 2004, you should identify an action to update your ordinance to ensure it is compliant with NFIP requirements.
  - If you have any outstanding NFIP compliance issues, be sure to add an action to address them.
  - If flood hazard maps do not adequately address the flood risk within your jurisdiction, consider actions to request new mapping or conduct studies.
  - If you don't participate in CRS or you would like to improve your classification, consider this as an action.
  - If the number of flood insurance polices in your jurisdiction is low relative to the number of structures in the floodplain, consider an action that will promote flood insurance in your jurisdiction.

- **Adaptive Capacity for Climate Change Section of this Annex**—Consider your responses to this section. For those criterion that you listed as medium or low, think of ways you could improve this rating (see adaptive capacity portion of the mitigation best practices catalog). For those criterion you listed as high, think about how you can leverage this capacity to improve or enhance mitigation or continue to improve this capacity. For those criterion that you were unable to provide responses for, consider ways you could improve your understanding of this capacity (see mitigation best practices and adaptive capacity catalog).
- **Opportunities for Future Integration Section in this Annex**—Review the items you identified in this section. For those items that address land use include them in the prepopulated Action in your template that reads as follows: Integrate the hazard mitigation plan into other plans, ordinances and programs that dictate land use decisions in the community, including _____. For other items listed in this section, consider an action that specifically says what the plan, code, ordinance etc. is and how it will be integrated.
- **Jurisdiction-Specific Vulnerabilities Section in this Annex—**Review the items that you have identified in this section and consider actions that will help reduce these vulnerabilities (see mitigation best practices catalog).
- **Mitigation Best Practices Catalog**—A catalog that includes FEMA and other agency identified best practices, steering committee and other stakeholder recommendations was developed as part of the plan development process and included in your tool kit. Review the catalog and identify those actions that your jurisdiction should consider including in its action plan.
- **Public Input**—Review input received during the process, specifically the public survey results included in your toolkit.
- **Prior Mitigation Planning Efforts**—If your jurisdiction participated in a previous hazard mitigation plan, please be sure to remember to include any actions that were identified as "carry over" actions. Once you have carried them over, return to the Status of Previous Actions table and record the new action number (see discussion below).

Be sure to consider the following factors in your selection of actions:

- Select actions that are consistent with the overall purpose, goals, and objectives of the hazard mitigation plan.
- Identify actions where benefits exceed costs.
- Include any action that your jurisdiction has committed to pursuing regardless of grant eligibility.
- Know what is and is not grant-eligible under the Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation (PDM) and Flood Mitigation Assistance (FMA) grants (see fact sheet provided in toolkit). If you have actions that are not HMGP, PDM or FMA grant eligible, but do mitigate part or all of the hazard and may be eligible for other grant programs sponsored by other agencies, include them in this section.
- **You must identify at least one true mitigation action (i.e. not a preparedness or response action) that is clearly defined and actionable for hazards ranked as "high" or medium."**

Recommended Actions

We recommend that every planning partner strongly consider the following actions. The specifics of these actions should be adjusted as needed for the particulars of each community. You will note that five of these actions have been prepopulated in your annex template. These five actions should be included in every annex and should not be removed.

- Where appropriate, support retro-fitting, purchase or relocation of structures located in high hazard areas and prioritize those structures that have experienced repetitive losses.
- Integrate the hazard mitigation plan into other plans, ordinances and programs that dictate land use decisions within the community.
- Actively participate in the plan maintenance protocols outlined in Volume I of the hazard mitigation plan.
- Continue to maintain good standing and compliance under the NFIP through implementation of floodplain management programs that, at a minimum, meet the NFIP requirements:

  - Enforce the flood damage prevention ordinance.
  - Participate in floodplain identification and mapping updates.
  - Provide public assistance/information on floodplain requirements and impacts.

- Identify and pursue strategies to increase adaptive capacity to climate change.
- Develop and implement a program to capture perishable data after significant events (e.g. high water marks, preliminary damage estimates, damage photos) to support future mitigation efforts including the implementation and maintenance of the hazard mitigation plan.
- Support the County-wide initiatives identified in Volume I of the hazard mitigation plan.
- Consider the development of a post-disaster recovery plan and a debris management plan.
- Develop and/or update plans that support or enhance continuity of operations following disasters.

Complete the Table

Complete the table titled "Hazard Mitigation Action Plan Matrix" for all the actions you have identified and would like to include in the plan:

Action Item Numbering:

- Please use the following action item numbering conventions:
  - Dublin—D-1
  - Livermore—L-1
  - Pleasanton—P-1

- Enter the action number and description .
- Indicate whether the action mitigates hazards for new and/or existing assets.
- Identify the specific hazards the action will mitigate (note: you must list the hazards, simply indicating all hazards is not deemed acceptable).
- Identify by number the mitigation plan objectives that the action addresses (see toolkit).
- Indicate who will be the lead in administering the action. This will most likely be a department within your jurisdiction (e.g. planning or public works). If you wish to indicate more than one department, please ensure that it is clear who the lead agency will be (i.e. note with an *)
- Enter an estimated cost in dollars if known; otherwise, enter "High," "Medium" or "Low" as determined for the prioritization process described in the following section.
- Identify funding sources for the action. If it is a grant, include the funding sources for the cost share. Refer to your fiscal capability assessment to identify possible sources of funding and refer to the table below for project eligibility for FEMA's hazard mitigation assistance grant program.
- Indicate the time line as "short-term" (1 to 5 years) or "long-term" (5 years or greater) or ongoing (a continual program)

Eligible Activities	HMGP	PDM	FMA
Mitigation Projects			
Property Acquisition and Structure Demolition	√	√	√
Property Acquisition and Structure Relocation	√	√	√
Structure Elevation	√	√	√
Mitigation Reconstruction	√	√	√
Dry Floodproofing of Historic Residential Structures	√	√	√
Dry Floodproofing of Non-residential Structures	√	√	√
Generators	√	√	
Localized Flood Risk Reduction Projects	√	√	√
Non-Localized Flood Risk Reduction Projects	√	√	
Structural Retrofitting of Existing Buildings	√	√	√
Non-structural Retrofitting of Existing Buildings and Facilities	√	√	√
Safe Room Construction	√	√	
Wind Retrofit for One- and Two-Family Residences	√	√	
Infrastructure Retrofit	√	√	√
Soil Stabilization	√	√	√
Wildfire Mitigation	√	√	
Post-Disaster Code Enforcement	√		
Advance Assistance	√		
5 Percent Initiative Projects*	√		
Aquifer and Storage Recovery**	√	√	√
Flood Diversion and Storage**	√	√	√

Eligible Activities	HMGP	PDM	FMA
Floodplain and Stream Restoration**	√	√	√
Green Infrastructure**	√	√	√
Miscellaneous/Other**	√	√	√
Hazard Mitigation Planning	√	√	√
Technical Assistance			√
Management Costs	√	√	√

Notes: HMGP = Hazard Mitigation Grant Program; PDM = Pre-Disaster Mitigation; FMA = Flood Mitigation Assistance

* FEMA allows increasing the 5% Initiative amount up to 10% for a Presidential major disaster declaration under HMGP. The additional 5% Initiative funding can be used for activities that promote disaster-resistant codes for all hazards. As a condition of the award, either a disaster-resistant building code must be adopted or an improved Building Code Effectiveness Grading Schedule is required.

**Indicates that any proposed action will be evaluated on its own merit against program requirements. Eligible projects will be approved provided funding is available.

Source: https://www.fema.gov/hazard-mitigation-assistance-mitigation-activity-chart

Please see the table below for examples of some of the recommended actions above:

Example Action Plan Matrix

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline
EX-1—Where appropriate, support retro-fitting, purchase or relocation of structures located in high hazard areas and prioritize those structures that have experienced repetitive losses.							
Existing	Dam failure, Earthquake, Flood, Landslide, Severe weather, Wildfire	4, 6, 8, 10, 11, 12	Planning		High	HMGP, PDM, FMA	Short-term
EX-2—Integrate the hazard mitigation plan into other plans, ordinances and programs that dictate land use decisions within the community.							
New and Existing	Dam failure, Drought, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 2, 6, 8, 10, 11	Planning		Low	Staff Time, General Funds	Ongoing
EX-3—Develop and implement a program to capture perishable data after significant events (e.g. high water marks, preliminary damage estimates, damage photos) to support future mitigation efforts including the implementation and maintenance of the hazard mitigation plan.							
Existing	Dam failure, Drought, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 9	Emergency Management		Medium	Staff Time, General Funds	Short-term
EX-4—Support the County-wide initiatives identified in Volume I of the hazard mitigation plan.							

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline
New and Existing	Dam failure, Drought, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	Lead Contact Department for Plan	Any Supporting Departments	Low	Staff Time, General Funds	Short-term
EX-5—Actively participate in the plan maintenance protocols outlined in Volume I of the hazard mitigation plan.							
New and Existing	Dam failure, Drought, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	Lead Contact Department for Plan	Any Supporting Departments	Low	Staff Time, General Funds	Short-term
EX-6—Continue to maintain good standing and compliance under the NFIP through implementation of floodplain management programs that, at a minimum, meet the NFIP requirements: • Enforcement of the flood damage prevention ordinance • Participate in floodplain identification and mapping updates • Provide public assistance/information on floodplain requirements and impacts.							
New and Existing	Flood, Dam Failure	1, 4, 6, 9	Floodplain Administration Department		Low	Staff Time, General Funds	Ongoing
EX-7—Work with building officials to identify ways to improve the jurisdictions' BCEGS classification.							
New	Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 10, 11	Building and Development Services		Low	Staff Time, General Funds	Short-term
EX-8—Develop a post-disaster recovery plan and a debris management plan.							
Existing	Dam failure, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 3, 7, 10	Emergency Management		Medium	EMPG	Long-term
EX-9—Participate in programs such as Firewise, StormReady and the Community Rating System.							
New and Existing	Dam Failure, Flood, Severe weather, Wildfire	5, 7, 9	Emergency Management	Public Works	Low	Staff Time, General Funds	Short-term
EX-10—Identify and pursue strategies to increase adaptive capacity to climate change.							
New and Existing	Dam failure, Drought, Flood, Landslide, Severe weather, Wildfire	1, 2, 5, 7, 8, 9, 10, 12	Planning		Low	Staff Time, General Funds	Short-term

Prioritization of Mitigation Actions

Complete the information in the table titled "Mitigation Strategy Priority Schedule" as follows:

- **Action #**—Indicate the action number from the previous annex table (Hazard Mitigation Action Plan Matrix).
- **# of Objectives Met**—Enter the number of objectives the action will meet.
- **Benefits**—Enter "High," "Medium" or "Low" as follows:

  - High: Action will have an immediate impact on the reduction of risk exposure to life and property.
  - Medium: Action will have a long-term impact on the reduction of risk exposure to life and property, or action will provide an immediate reduction in the risk exposure to property.
  - Low: Long-term benefits of the action are difficult to quantify in the short term.

- **Costs**—Enter "High," "Medium" or "Low" as follows:

  - High: Would require an increase in revenue via an alternative source (i.e., bonds, grants, fee increases) to implement. Existing funding levels are not adequate to cover the costs of the proposed action.
  - Medium: Could budget for under existing work-plan, but would require a reapportionment of the budget or a budget amendment, or the cost of the action would have to be spread over multiple years.
  - Low: Possible to fund under existing budget. Action is or can be part of an existing ongoing program.

  If you know the estimated cost of an action because it is part of an existing, ongoing program, indicate the amount.

- **Do Benefits Exceed the Cost?**—Enter "Yes" or "No." This is a qualitative assessment. Enter "Yes" if the benefit rating (high, medium or low) is the same as or higher than the cost rating (high benefit/high cost; high benefit/medium cost; medium benefit/low cost; etc.). Enter "No" if the benefit rating is lower than the cost rating (medium benefit/high cost, low benefit/medium cost; etc.)
- **Is the Action Grant-Eligible?**—Enter "Yes" or "No." Refer to the fact sheet on HMGP, PDM and FMA and the table above.
- **Can Action Be Funded Under Existing Program Budgets?**—Enter "Yes" or "No." In other words, is this action currently budgeted for, or would it require a new budget authorization or funding from another source such as grants?
- **Implementation Priority**— Enter "High," "Medium" or "Low" as follows:

  - High Priority—An action that meets multiple objectives, has benefits that exceed cost, has funding secured or is an ongoing action and meets eligibility requirements for a grant program. High priority actions can be completed in the short term (1 to 5 years). The key factors for high priority actions are that they have funding secured and can be completed in the short term.
  - Medium Priority—An action that meets multiple objectives, that has benefits that exceed costs, and for which funding has not yet been secured, but is eligible for funding. Action can be completed in the short term, once funding is secured. Medium priority actions will become high priority actions once funding is secured. The key factors for medium priority actions are that they are eligible for funding, but do not yet have funding secured, and they can be completed within the short term.
  - Low Priority—An action that will mitigate the risk of a hazard, that has benefits that do not exceed the costs or are difficult to quantify, for which funding has not been secured, that is not eligible for grant funding, and for which the time line for completion is long term (1 to 10 years). Low priority actions may be eligible for grant funding from other programs that have not yet been identified. Low priority actions are generally "blue-sky" or "wish-list." actions. Financing is unknown, and they can be completed over a long term.

- **Grant Pursuit Priority**— Enter "High," "Medium" or "Low" as follows:

- High Priority—An action that has been identified as meeting grant eligibility requirements, assessed to have high benefits, is listed as high or medium priority, and where local funding options are unavailable or where dedicated funds could be utilized for actions that are not eligible for grant funding.
- Medium Priority—An action that has been identified as meeting grant eligibility requirements, assessed to have medium or low benefits, is listed as medium or low priority, and where local funding options are unavailable.
- Low Priority—An action that has not been identified as meeting grant eligibility requirements, or has low benefits.

This prioritization is a simple way to determine that your identified actions meet one of the primary objectives of the Disaster Mitigation Act. It is not the detailed benefit/cost analysis required for HMGP/PDM /FMA action grants. The prioritization will identify any actions whose probable benefits will not exceed the probable costs. Those actions identified as high-priority grant funding actions should be closely reviewed for consideration when grant funding opportunities arise.

Note: If a jurisdiction wishes to identify an action as high priority that is outside of the prioritization scheme for high priorities. A note indicting so should be inserted and a rationale should be provided.

Please see the example below based off the recommended actions:

Table 0-9. Mitigation Strategy Priority Schedule

Action #	# of Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is Action Grant-Eligible?	Can Action Be Funded Under Existing Programs/ Budgets?	Implementation Priority[a]	Grant Pursuit Priority[a]
EX-1	6	High	High	Yes	Yes	No	Medium	High
EX-2	6	Medium	Low	Yes	No	Yes	High	Low
EX-3	2	Low	Medium	No	No	Maybe	Low	Low
EX-4	12	Low	Low	Yes	No	Yes	High	Low
EX-5	12	Low	Low	Yes	No	Yes	High	Low
EX-6	4	Medium	Low	Yes	No	Yes	High	Low
EX-7	3	Medium	Low	Yes	No	Yes	High	Low
EX-8	4	Medium	Medium	Yes	Yes	No	Medium	High
EX-9	3	Medium	Low	Yes	No	Yes	High	Low
EX-10	8	Medium	Low	Yes	No	Yes	High	Medium

Analysis of Mitigation Actions

Complete the table titled “Analysis of Mitigation Actions” summarizing the mitigation actions by hazard of concern and the following eight mitigation types. Please note that an action can be more than one mitigation type:

- **Prevention**—Government, administrative or regulatory actions that influence the way land and buildings are developed to reduce hazard losses. Includes planning and zoning, floodplain laws, capital improvement programs, open space preservation, and stormwater management regulations.

- **Property Protection**—Modification of buildings or structures to protect them from a hazard or removal of structures from a hazard area. Includes acquisition, elevation, relocation, structural retrofit, storm shutters, and shatter-resistant glass.
- **Public Education and Awareness**—Actions to inform residents and elected officials about hazards and ways to mitigate them. Includes outreach projects, real estate disclosure, hazard information centers, and school-age and adult education.
- **Natural Resource Protection**—Actions that minimize hazard loss and preserve or restore the functions of natural systems. Includes sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, wetland restoration and preservation, and green infrastructure.
- **Emergency Services**—Actions that protect people and property during and immediately after a hazard event. Includes warning systems, emergency response services, and the protection of essential facilities.
- **Structural Projects**—Actions that involve the construction of structures to reduce the impact of a hazard. Includes dams, setback levees, floodwalls, retaining walls, and safe rooms.
- **Climate Resilient**—Actions that incorporate methods to mitigate and/or adapt to the impacts of climate change. Includes aquifer storage and recovery activities, incorporating future conditions projections in project design or planning, or actions that specifically address jurisdiction-specific climate change risks, such as sea level rise or urban heat island effect.
- **Community Capacity Building**—Actions that increase or enhance local capabilities to adjust to potential damage, to take advantage of opportunities, or to respond to consequences. Includes staff training, memorandums of understanding, development of plans and studies, and monitoring programs.

This exercise demonstrates that the jurisdiction has selected a comprehensive range of actions.

Please see the example below based off the recommended actions, but please note that these recommendations are heavy on generalized actions on the prevention spectrum and light in other areas and specificity. Planning partners should aim to identify at least one action in each category (although this is not required) and should make sure there is at least one action to address "high" ranked hazards:

Analysis of Mitigation Actions

Hazard Type	Action Addressing Hazard, by Mitigation Type[a]							
	Prevention	Property Protection	Public Education and Awareness	Natural Resource Protection	Emergency Services	Structural Projects	Climate Resilient	Community Capacity Building
Dam Failure	EX-2, 3, 4, 5, 6	EX-1, 6	EX-4, 6		EX-8			EX-3, 4, 8, 9, 10
Drought	EX-2	EX-1	EX-4					EX-3, 4, 8, 9, 10
Earthquake	EX-2, 3, 4, 5, 7	EX-1, 7	EX-4		EX-8			EX-3, 4, 8, 9
Flood	EX-2, 3, 4, 5, 6, 7	EX-1, 6, 7	EX-4, 6	EX-9	EX-8			EX-3, 4, 8, 9, 10
Landslide	EX-2, 3, 4, 5, 7	EX-1, 7	EX-4		EX-8			EX-3, 4, 8, 9, 10

Hazard Type	Action Addressing Hazard, by Mitigation Type[a]							
	Prevention	Property Protection	Public Education and Awareness	Natural Resource Protection	Emergency Services	Structural Projects	Climate Resilient	Community Capacity Building
Severe weather	EX-2, 3, 4, 5, 7	EX-1, 7, 9	EX-4		EX-8, 9			EX-3, 4, 8, 9, 10
Wildfire	EX-2, 3, 4, 5, 7	EX-1, 7, 9	EX-4, 9	EX-9	EX-8			EX-3, 4, 8, 9, 10

FUTURE NEEDS TO BETTER UNDERSTAND RISK/VULNERABILITY

In this section, identify any future studies, analyses, reports, or surveys your jurisdiction needs to better understand its vulnerability to identified or currently unidentified risks. These could be needs based on federal or state agency mandates. Please note that this section is optional.

ADDITIONAL COMMENTS

Use this section to add any additional information pertinent to hazard mitigation and your jurisdiction not covered in this template. Please note that this section is optional.

REVIEW AND INCORPORATION OF RESOURCES FOR THIS ANNEX

This section should describe what resources you used to complete the annex and how you used them. Several items are started for you, but please be sure to update and enhance any descriptions. This may seem trivial or unimportant, but it is a requirement to pass the state and FEMA review process.

NEXT STEPS

After all jurisdictions have submitted their annexes, the draft plan will be submitted for public comment. Following the public comment period and any revisions responsive to public comment, the plan will be submitted to the California Governor's Office of Emergency Services (Cal OES) for review. After their review and approval, Cal OES will submit the plan to FEMA Region IX for plan review and approval. At that point planning partners will be asked to begin making preparations to formally adopt the plan. Each participating planning partner must have the governing board of their jurisdiction adopt via resolution or ordinance. Once FEMA has reviewed the plan and issued an approved pending adoption (APA) notice, planning partners will be asked to go forth and adopt the plan. Once adopted, planning partners will submit adoption information to Tetra Tech, who will submit the proof of adoption to FEMA. Once such adoption has been received, FEMA will issue final approval via a letter for those planning partners who have adopted the plan. It is very important to understand that approval is not final until proof of adoption has been received by FEMA and they have issued a letter specifically naming your jurisdiction. More information on the review and approval process, along with adoption support materials, will be provided at a later date.

1. JURISDICTION NAME

1.1 HAZARD MITIGATION PLAN POINT OF CONTACT

Primary Point of Contact
Name, Title
Street Address
City, State ZIP
Telephone: xxx-xxx-xxxx
e-mail Address: xxx@xxx.xxx

Alternate Point of Contact
Name, Title
Street Address
City, State ZIP
Telephone: xxx-xxx-xxxx
e-mail Address: xxx@xxx.xxx

1.2 JURISDICTION PROFILE

The following is a summary of key information about the jurisdiction and its history:

- **Date of Incorporation**—
- **Current Population**—
- **Population Growth**—
- **Location and Description**—
- **Brief History**—
- **Climate**—
- **Governing Body Format**—___[general description]___. The __[name of adopting body]___ assumes responsibility for the adoption of this plan; __[name of oversight agency]__ will oversee its implementation.

1.3 DEVELOPMENT TRENDS

_DESCRIBE TRENDS IN GENERAL__.

Table 1-1 summarizes development trends in the performance period since development of the previous hazard mitigation plan and expected future development trends.

Table 1-1. Recent and Expected Future Development Trends

Criterion	Response					
Has your jurisdiction annexed any land since the development of the previous hazard mitigation plan? • If yes, give the estimated area annexed and estimated number of parcels or structures.	Yes/No _____					
Is your jurisdiction expected to annex any areas during the performance period of this plan? • If yes, please describe land areas and dominant uses. • If yes, who currently has permitting authority over these areas?	Yes/No _____ _____					
Are any areas targeted for development or major redevelopment in the next five years? • If yes, please briefly describe, including whether any of the areas are in known hazard risk areas	Yes/No _____					
How many permits for new construction were issued in your jurisdiction since the development of the previous hazard mitigation plan?		2011	2012	2013	2014	2015
	Single Family	__	__	__	__	__
	Multi-Family	__	__	__	__	__
	Other (commercial, mixed use, etc.)	__	__	__	__	__
Please provide the number of new-construction permits for each hazard area or provide a qualitative description of where development has occurred.	• Special Flood Hazard Areas: # • Landslide: # • High Liquefaction Areas: # • Tsunami Inundation Area: # • Wildfire Risk Areas: #					
Please describe the level of buildout in the jurisdiction, based on your jurisdiction's buildable lands inventory. If no such inventory exists, provide a qualitative description.	_____					

1.4 CAPABILITY ASSESSMENT

Jurisdiction Name has performed an inventory and analysis of existing capabilities, plans, programs and policies that enhance its ability to implement mitigation strategies. The introduction at the beginning of this volume of the hazard mitigation plan describes the components included in the capability assessment and their significance for hazard mitigation planning. This section summarizes the following findings of the assessment:

- An assessment of legal and regulatory capabilities is presented in Table 1-2.
- Development and permitting capabilities are presented in Table 1-3.
- An assessment of fiscal capabilities is presented in Table 1-4.
- An assessment of administrative and technical capabilities is presented in Table 1-5.
- An assessment of education and outreach capabilities is presented in Table 1-6.
- Information on National Flood Insurance Program (NFIP) compliance is presented in Table 1-7.
- Classifications under various community mitigation programs are presented in Table 1-8.
- The community's adaptive capacity for the impacts of climate change is presented in Table 1-9.

The capability assessment was reviewed in order to identify opportunities to expand, initiate or integrate capabilities to further hazard mitigation goals and objectives. Where such opportunities were identified and determined to be feasible, they are included in the action plan and are identified as Community Capacity Building mitigation actions in the Analysis of Mitigation Actions table in Section 1.10.

Table 1-2. Legal and Regulatory Capability

	Local Authority	Other Jurisdiction Authority	State Mandated	Integration Opportunity?
Codes, Ordinances, & Requirements				
Building Code *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No
Zoning Code *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No
Subdivisions *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No
Stormwater Management *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No
Post-Disaster Recovery *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No
Real Estate Disclosure *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No
Growth Management *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No
Site Plan Review *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No
Environmental Protection *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No
Flood Damage Prevention *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No
Emergency Management *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No
Climate Change *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No
Other: *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No
Planning Documents				
General Plan *Is the plan compliant with Assembly Bill 2140?* *Yes/No* *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No
Capital Improvement Plan *How often is the plan updated?* _____ *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No
Floodplain or Watershed Plan *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No
Stormwater Plan *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No
Urban Water Management Plan *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No
Habitat Conservation Plan *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No
Economic Development Plan *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No
Shoreline Management Plan *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No

	Local Authority	Other Jurisdiction Authority	State Mandated	Integration Opportunity?
Community Wildfire Protection Plan *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No
Forest Management Plan *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No
Climate Action Plan *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No
Comprehensive Emergency Management Plan *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No
Threat & Hazard Identification & Risk Assessment (THIRA) *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No
Post-Disaster Recovery Plan *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No
Continuity of Operations Plan *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No
Public Health Plan *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No
Other: *Comment:*	Yes/No	Yes/No	Yes/No	Yes/No

Table 1-3. Development and Permitting Capability

Criterion	Response
Does your jurisdiction issue development permits? • If no, who does? If yes, which department?	Yes/No _____
Does your jurisdiction have the ability to track permits by hazard area?	Yes/No
Does your jurisdiction have a buildable lands inventory?	Yes/No

Table 1-4. Fiscal Capability

Financial Resource	Accessible or Eligible to Use?
Community Development Block Grants	Yes/No
Capital Improvements Project Funding	Yes/No
Authority to Levy Taxes for Specific Purposes	Yes/No
User Fees for Water, Sewer, Gas or Electric Service	Yes/No- If yes, please specify
Incur Debt through General Obligation Bonds	Yes/No
Incur Debt through Special Tax Bonds	Yes/No
Incur Debt through Private Activity Bonds	Yes/No
Withhold Public Expenditures in Hazard-Prone Areas	Yes/No
State-Sponsored Grant Programs	Yes/No
Development Impact Fees for Homebuyers or Developers	Yes/No
Other	Yes/No (if yes, please specify)

Table 1-5. Administrative and Technical Capability

Staff/Personnel Resource	Available?	Department/Agency/Position
Planners or engineers with knowledge of land development and land management practices	Yes/No	Insert appropriate information
Engineers or professionals trained in building or infrastructure construction practices	Yes/No	Insert appropriate information
Planners or engineers with an understanding of natural hazards	Yes/No	Insert appropriate information
Staff with training in benefit/cost analysis	Yes/No	Insert appropriate information
Surveyors	Yes/No	Insert appropriate information
Personnel skilled or trained in GIS applications	Yes/No	Insert appropriate information
Scientist familiar with natural hazards in local area	Yes/No	Insert appropriate information
Emergency Manager	Yes/No	Insert appropriate information
Grant writers	Yes/No	Insert appropriate information
Other	Yes/No	Insert appropriate information

Table 1-6. Education and Outreach Capability

Criterion	Response
Do you have a Public Information Officer or Communications Office?	Yes/No
Do you have personnel skilled or trained in website development?	Yes/No
Do you have hazard mitigation information available on your website? • If yes, please briefly describe.	Yes/No Insert appropriate information
Do you utilize social media for hazard mitigation education and outreach? • If yes, please briefly describe.	Yes/No Insert appropriate information
Do you have any citizen boards or commissions that address issues related to hazard mitigation? • If yes, please briefly describe.	Yes/No Insert appropriate information
Do you have any other programs already in place that could be used to communicate hazard-related information? • If yes, please briefly describe.	Yes/No Insert appropriate information
Do you have any established warning systems for hazard events? • If yes, please briefly describe.	Yes/No Insert appropriate information

Table 1-7. National Flood Insurance Program Compliance

Criterion	Response
What local department is responsible for floodplain management?	Insert appropriate information
Who is your floodplain administrator? (department/position)	Insert appropriate information
Are any certified floodplain managers on staff in your jurisdiction?	Yes/No
What is the date that your flood damage prevention ordinance was last amended?	Insert appropriate information
Does your floodplain management program meet or exceed minimum requirements? • If exceeds, in what ways?	Meets/Exceeds Insert appropriate information
When was the most recent Community Assistance Visit or Community Assistance Contact?	Insert appropriate information
Does your jurisdiction have any outstanding NFIP compliance violations that need to be addressed? • If so, please state what they are.	Yes/No Insert appropriate information
Do your flood hazard maps adequately address the flood risk within your jurisdiction? • If no, please state why.	Yes/No Insert appropriate information

Criterion	Response
Does your floodplain management staff need any assistance or training to support its floodplain management program? • If so, what type of assistance/training is needed?	Yes/No Insert appropriate information
Does your jurisdiction participate in the Community Rating System (CRS)? • If yes, is your jurisdiction interested in improving CRS Classification? • Is your jurisdiction interested in joining the CRS program?	Yes/No Yes/No Yes/No
How many flood insurance policies are in force in your jurisdiction?[a] • What is the insurance in force? • What is the premium in force?	Insert appropriate information $_____ $_____
How many total loss claims have been filed in your jurisdiction?[a] • How many claims are still open/were closed without payment? • What were the total payments for losses?	Insert appropriate information Insert appropriate information $_____

a. According to FEMA statistics as of MONTH XX, 201X

Table 1-8. Community Classifications

	Participating?	Classification	Date Classified
Community Rating System	Yes/No	_____	Date
Building Code Effectiveness Grading Schedule	Yes/No	_____	Date
Public Protection	Yes/No	_____	Date
Storm Ready	Yes/No	_____	Date
Firewise	Yes/No	_____	Date

Table 1-9. Adaptive Capacity for Climate Change

Criterion	Jurisdiction Rating[a]
Technical Capacity	
Jurisdiction-level understanding of potential climate change impacts	High/Medium/Low
Comment:	
Jurisdiction-level monitoring of climate change impacts	High/Medium/Low
Comment:	
Technical resources to assess proposed strategies for feasibility and externalities	High/Medium/Low
Comment:	
Jurisdiction-level capacity for development of greenhouse gas emissions inventory	High/Medium/Low
Comment:	
Capital planning and land use decisions informed by potential climate impacts	High/Medium/Low
Comment:	
Participation in regional groups addressing climate risks	High/Medium/Low
Comment:	
Implementation Capacity	
Clear authority/mandate to consider climate change impacts during public decision-making processes	High/Medium/Low
Comment:	
Identified strategies for greenhouse gas mitigation efforts	High/Medium/Low
Comment:	
Identified strategies for adaptation to impacts	High/Medium/Low
Comment:	

Criterion	Jurisdiction Rating[a]
Champions for climate action in local government departments	High/Medium/Low
Comment:	
Political support for implementing climate change adaptation strategies	High/Medium/Low
Comment:	
Financial resources devoted to climate change adaptation	High/Medium/Low
Comment:	
Local authority over sectors likely to be negative impacted	High/Medium/Low
Comment:	
Public Capacity	
Local residents knowledge of and understanding of climate risk	High/Medium/Low
Comment:	
Local residents support of adaptation efforts	High/Medium/Low
Comment:	
Local residents' capacity to adapt to climate impacts	High/Medium/Low
Comment:	
Local economy current capacity to adapt to climate impacts	High/Medium/Low
Comment:	
Local ecosystems capacity to adapt to climate impacts	High/Medium/Low
Comment:	

a. High = Capacity exists and is in use; Medium = Capacity may exist, but is not used or could use some improvement; Low = Capacity does not exist or could use substantial improvement; Unsure= Not enough information is known to assign a rating.

1.5 INTEGRATION WITH OTHER PLANNING INITIATIVES

The information on hazards, risk, vulnerability and mitigation contained in this hazard mitigation plan is based on the best available data. Plan integration is the incorporation of this information into other relevant planning mechanisms, such as general planning and capital facilities planning. It includes the integration of natural hazard information and mitigation policies, principles and actions into local planning mechanisms and vice versa. Additionally, plan integration is achieved though the involvement of key staff and community officials in collaboratively planning for hazard mitigation.

1.5.1 Existing Integration

In the performance period since adoption of the previous hazard mitigation plan, Jurisdiction Name made progress on integrating hazard mitigation goals, objectives and actions into other planning initiatives. The following plans and programs currently integrate components of the hazard mitigation strategy:

- **Plan or Program Name**—Description
- **Plan or Program Name**—Description
- **Plan or Program Name**—Description
- **Plan or Program Name**—Description
- **Plan or Program Name**—Description
- **Plan or Program Name**—Description

Resources listed in Section 1.13 were used to provide information for this annex on hazard events and local capabilities within the jurisdiction.

1.5.2 Opportunities for Future Integration

As this hazard mitigation plan is implemented, Jurisdiction Name will use information from the plan as the best available science and data on natural hazards. The capability assessment presented in this annex identifies codes, plans and programs that provide opportunities for integration. The area-wide and local action plans developed for this hazard mitigation plan in actions related to plan integration, and progress on these actions will be reported through the progress reporting process described in Volume 1. New opportunities for integration also will be identified as part of the annual progress report. The capability assessment identified the following plans and programs that do not currently integrate goals or recommendations of the hazard mitigation plan but provide opportunities to do so in the future:

- **Plan or Program Name**—Description
- **Plan or Program Name**—Description
- **Plan or Program Name**—Description
- **Plan or Program Name**—Description
- **Plan or Program Name**—Description
- **Plan or Program Name**—Description

1.6 JURISDICTION-SPECIFIC NATURAL HAZARD EVENT HISTORY

Table 1-10 lists past occurrences of natural hazards for which specific damage was recorded in Jurisdiction Name. Other hazard events that broadly affected the entire planning area, including Jurisdiction Name, are listed in the risk assessments in Volume 1 of this hazard mitigation plan.

Table 1-10. Past Natural Hazard Events

Type of Event	FEMA Disaster # (if applicable)	Date	Damage Assessment
Insert event type	_____	Date	$_____
Insert event type	_____	Date	$_____
Insert event type	_____	Date	$_____
Insert event type	_____	Date	$_____
Insert event type	_____	Date	$_____
Insert event type	_____	Date	$_____
Insert event type	_____	Date	$_____
Insert event type	_____	Date	$_____
Insert event type	_____	Date	$_____
Insert event type	_____	Date	$_____
Insert event type	_____	Date	$_____
Insert event type	_____	Date	$_____
Insert event type	_____	Date	$_____
Insert event type	_____	Date	$_____
Insert event type	_____	Date	$_____

1.7 JURISDICTION-SPECIFIC VULNERABILITIES

Volume 1 of this hazard mitigation plan provides complete risk assessments for each identified hazard of concern. This section provides information on a few key vulnerabilities for the jurisdiction.

Repetitive loss records are as follows:

- Number of FEMA-identified Repetitive-Loss Properties: XX
- Number of FEMA-identified Severe-Repetitive-Loss Properties: XX
- Number of Repetitive-Loss Properties or Severe-Repetitive-Loss Properties that have been mitigated: XX

Other noted vulnerabilities include the following:

- Insert as appropriate.
- Insert as appropriate.
- Insert as appropriate.

1.8 HAZARD RISK RANKING

Table 1-11 presents a local ranking for Jurisdiction Name of all hazards of concern for which Volume 1 of this hazard mitigation plan provides complete risk assessments. This ranking summarizes how hazards vary for this jurisdiction. As described in detail in Volume 1, the ranking process involves an assessment of the likelihood of occurrence for each hazard, along with its potential impacts on people, property and the economy.

Table 1-11. Hazard Risk Ranking

Rank	Hazard Type	Risk Rating Score (Probability x Impact)	Category
1	_____	_____	High/Medium/Low
2	_____	_____	High/Medium/Low
3	_____	_____	High/Medium/Low
4	_____	_____	High/Medium/Low
5	_____	_____	High/Medium/Low
6	_____	_____	High/Medium/Low
7	_____	_____	High/Medium/Low
8	_____	_____	High/Medium/Low
9	_____	_____	High/Medium/Low

a. Based on the "Haywired" (Hayward Fault Scenario M7.05)
b. Severe weather is assessed more qualitatively than other hazards. Assumptions for risk ranking include high probability, medium impact on people, medium impact on property and low impact on economy.
c. Based on Very High and High Fire Severity Zones.
d. Based on 1 percent-annual-chance flood zone (otherwise known as the special flood hazard area)
e. Based on Very High, High, and Moderate Landslide Susceptibility Zones
f. Drought is assessed more qualitatively than other hazards. Generally, drought does not cause injury or death to people or result in property damage. Assumptions for risk ranking include high probability, no impact on people, low impact on property and low impact on economy for those jurisdictions with limited agriculture.
g. Based on the Del Valle Dam inundation scenario.

1.9 STATUS OF PREVIOUS PLAN ACTIONS

Table 1-12 summarizes the actions that were recommended in the previous version of the hazard mitigation plan and their implementation status at the time this update was prepared.

Table 1-12. Status of Previous Plan Actions

Action Item	Completed	Removed; No Longer Feasible	Carried Over to Plan Update: Check if Yes	Carried Over to Plan Update: Enter Action #
Insert Action Text *Comment:*				Action#
Insert Action Text *Comment:*				Action#
Insert Action Text *Comment:*				Action#
Insert Action Text *Comment:*				Action#
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Insert Action Text *Comment:*				Action#
Insert Action Text *Comment:*				Action#

1.10 HAZARD MITIGATION ACTION PLAN AND EVALUATION OF RECOMMENDED ACTIONS

Table 1-13 lists the actions that make up the Jurisdiction Name hazard mitigation action plan. Table 1-14 identifies the priority for each action. Table 1-15 summarizes the mitigation actions by hazard of concern and mitigation type.

Table 1-13. Hazard Mitigation Action Plan Matrix

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline
Action #— Where appropriate, support retrofitting or relocation of structures in high hazard areas, prioritizing structures that have experienced repetitive losses.							
Existing	Dam failure, Earthquake, Flood, Landslide, Severe weather, Wildfire	4, 6, 8, 10, 11, 12	TBD	TBD	High	HMGP, PDM, FMA	Short-term

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline
Action #— Integrate the hazard mitigation plan into other plans, ordinances and programs that dictate land use decisions in the community, including _____							
New and Existing	Dam failure, Drought, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 2, 6, 8, 10, 11	TBD	TBD	Low	Staff Time, General Funds	Ongoing
Action #— Actively participate in the plan maintenance protocols outlined in Volume 1 of this hazard mitigation plan.							
New and Existing	Dam failure, Drought, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	TBD	TBD	Low	Staff Time, General Funds	Short-term
Action #—Continue to maintain good standing and compliance under the NFIP through implementation of floodplain management programs that, at a minimum, meet the NFIP requirements: • Enforce the flood damage prevention ordinance. • Participate in floodplain identification and mapping updates. • Provide public assistance/information on floodplain requirements and impacts.							
New and Existing	Flood, Dam failure	1, 4, 6, 9	TBD	TBD	Low	Staff Time, General Funds	Ongoing
Action #—Identify and pursue strategies to increase adaptive capacity to climate change including but not limited to the following _____.							
New and Existing	Dam failure, Drought, Flood, Landslide, Severe weather, Wildfire	1, 2, 5, 7, 8, 9, 10, 12	TBD	TBD	Low	Staff Time, General Funds	Short-term
Action #—Description							
Action #—Description							
Action #—Description							
Action #—Description							
Action #—Description							
Action #—Description							
Action #—Description							
Action #—Description							
Action #—Description							
Action #—Description							
Action #—Description							

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline
Action #—Description							

Table 1-14. Mitigation Action Priority

Action #	# of Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is Project Grant-Eligible?	Can Project Be Funded Under Existing Programs/ Budgets?	Implementation Priority[a]	Grant Pursuit Priority[a]
TBD	6	High	High	Yes	Yes	No	Medium	High
TBD	6	Medium	Low	Yes	No	Yes	High	Low
TBD	12	Low	Low	Yes	No	Yes	High	Low
TBD	4	Medium	Low	Yes	No	Yes	High	Low
TBD	8	Medium	Low	Yes	No	Yes	High	Medium

a. See the introduction to this volume for explanation of priorities.

Table 1-15. Analysis of Mitigation Actions

Hazard Type	Action Addressing Hazard, by Mitigation Type[a]							
	Prevention	Property Protection	Public Education and Awareness	Natural Resource Protection	Emergency Services	Structural Projects	Climate Resilient	Community Capacity Building
_____								
_____								
_____								
_____								
_____								
_____								
_____								

Hazard Type	Action Addressing Hazard, by Mitigation Type[a]							
	Prevention	Property Protection	Public Education and Awareness	Natural Resource Protection	Emergency Services	Structural Projects	Climate Resilient	Community Capacity Building
_____								
_____								

a. See the introduction to this volume for explanation of mitigation types.

1.11 FUTURE NEEDS TO BETTER UNDERSTAND RISK/VULNERABILITY

Insert text, if any; otherwise, delete section

1.12 ADDITIONAL COMMENTS

Insert text, if any; otherwise, delete section

1.13 REVIEW AND INCORPORATION OF RESOURCES FOR THIS ANNEX

The following technical reports, plans, and regulatory mechanisms were reviewed to provide information for this annex.

- **Jurisdiction Name Municipal Code**—The municipal code was reviewed for the full capability assessment and for identifying opportunities for action plan integration.
- **Jurisdiction Name Flood Damage Prevention Ordinance**—The flood damage prevention ordinance was reviewed for compliance with the National Flood Insurance Program.
- <INSERT PLAN/PROGRAM AND DESCRIPTION OF HOW IT WAS USED>
- <INSERT PLAN/PROGRAM AND DESCRIPTION OF HOW IT WAS USED>
- <INSERT PLAN/PROGRAM AND DESCRIPTION OF HOW IT WAS USED>
- <INSERT PLAN/PROGRAM AND DESCRIPTION OF HOW IT WAS USED>
- **Technical Reports and Information—**The following **o**utside resources and references were reviewed:
  - **Hazard Mitigation Plan Annex Development Tool-kit**—The tool-kit was used to support the development of this annex including past hazard events, noted vulnerabilities, risk ranking and action development.
  - <INSERT DOCUMENT AND DESCRIPTION OF HOW IT WAS USED>

Tetra Tech Will Insert Jurisdiction-Specific Hazard Maps Prepared for This Plan

INSTRUCTIONS FOR COMPLETING SPECIAL PURPOSE DISTRICT ANNEX TEMPLATE

The jurisdictional annex templates for the 2017 Tri-Valley Hazard Mitigation Plan will be completed in three phases. **This document provides instructions for completing all phases of the template for special purpose districts.**

If your jurisdiction completed and submitted Phase 1 and/or Phase 2, Phase 3 has been added to the end of your document. Any planning team comments, questions or suggestions have been included as blue highlighted notes and/or comments. Any text edits were made with changes tracked for review. Any yellow highlights indicate areas where missing information should be filled in.

If your jurisdiction did not complete Phase 1 or Phase 2, please complete all phases at this time.

The target timeline for phase completion is as follows:

- **Phase 1** – Jurisdictional profile
  - Deployed: early July
  - Due: early August
- **Phase 2** – Capability assessment
  - Deployed: late August
  - Due: September 26, 2017
- **Phase 3** – Risk ranking and action plan development
  - Deployed: Mid-October
  - Workshop: October steering committee meeting
  - Due: November 17, 2017

Any questions on completing the template should be directed to:

Kristen Gelino
Tetra Tech, Inc.
(917) 426-4594 or (646) 576-4029
E-mail: kristen.gelino@tetratech.com

Special Purpose District Annex:

This document provides instructions for completing **all phases** of the jurisdictional annex template for special purpose districts. **Templates should be completed by Friday, November 17, 2017.** Your completed template should be submitted to:

Kristen Gelino
Tetra Tech, Inc.
(917) 426-4594 or (646) 576-4029
E-mail: kristen.gelino@tetratech.com

A Note About Formatting:

The template for the annex is a Microsoft Word document in a format that will be used in the final plan. Partners are asked to use this template so that a uniform product will be completed for each partner.

Content should be entered within the yellow, highlighted text that is currently in the template, rather than creating text in another document and pasting it into the template. Text from another source will alter the style and formatting of the document.

The numbering in the document will be updated when completed annexes are combined into the final document. Please do not adjust any of this numbering.

Phase 1 Instructions

CHAPTER TITLE

In the chapter title at the top of Page 1, type in the complete official name of your district (e.g. West County Fire Protection District #1, Johnsonville Flood Protection District, etc.). Please do not change the chapter number. Revise only the jurisdiction name.

HAZARD MITIGATION PLAN POINT OF CONTACT

Please provide the name, title, mailing address, telephone number, and e-mail address for the primary point of contact for your jurisdiction. This should be the person responsible for monitoring, evaluating and updating the annex for your jurisdiction. This person should also be the principle liaison between your jurisdiction and the Steering Committee overseeing development of this plan.

In addition, designate an alternate point of contact. This would be a person to contact should the primary point of contact be unavailable or no longer employed by the jurisdiction.

Note: Both of these contacts should match the contacts that were designated in your jurisdiction's letter of intent to participate in this planning process. If you have changed the primary or secondary contact, please let the planning team know by inserting a comment into the document.

JURISDICTION PROFILE

Overview

Please provide a brief summary description of your jurisdiction. Please be sure to include:

- the purpose of the jurisdiction,
- the date of inception,
- the type of organization,
- the number of employees,
- the mode of operation (i.e., how operations are funded),
- a description of who the district's customers are,
- an overview of current service area trends, including an approximation of current users/subscribers,
- a summary description of previous growth trends in service area, and anticipated future increase/decrease in services (if applicable),
- an approximation of area served in square miles,
- a geographical decription of the service area, and
- the type of governing body, and who has adoptive authority.

Example Jurisdiction Narrative Profile:

The Johnsonville Community Services District is a special district created in 1952 to provide water and sewer service to the unincorporated area east of the City of Smithburg known as Johnsonville. The District's designated service area expanded throughout the years to include other unincorporated areas of Jones County: Creeks Corner, Jones Hill, Fields Landing, King Salmon, and Freshwater. A five-member elected Board of Directors governs the District. The Board assumes responsibility for the adoption of this plan; the General Manager will oversee its implementation. As of April 30, 2016, the District serves 7,305 water connections and 6,108 sewer connections, with a current staff of 21. Funding comes primarily through rates and revenue bonds.

Provide information similar to the example provided in the box above. This should be information that is specific to your jurisdiction and will not be provided in the overall, planning area-wide mitigation plan document.

Fire Districts should complete the yellow highlighted portions of the following sentence that is included in the annex: The District participates/does not participate in the Public Protection Class Rating System and currently has a rating of #.

All other types of special purpose districts should delete this sentence.

ASSETS

Please provide an approximate value for the noted areas within the table. Include the sum total value for identified assets for each section in the "Total" line for the section.

Property

Provide an approximate value for the land owned by the District.

Critical Infrastructure and Equipment

List types of equipment an infrastructure owned by the District that are used in times of emergency or, if incapacitated, has the potential to severely impact the service area. Provide an approximate **aggregate replacement value** for each type. For water and sewer, include mileage of pipeline under this category.

Critical Facilities

List types of district structures vital to maintain services to the designated service area. Provide an approximate **aggregate replacement value** for each line. The Steering Committee has decided upon the following definition of Critical Facilities for this planning process:

> Critical facilities and infrastructure are those assets, systems, and networks, whether physical or virtual, considered so vital to the United States that the incapacity or destruction of such systems and assets would have a debilitating impact on security, national economic security, national public health or safety, or any combination, per the Department of Homeland Security. For this hazard mitigation plan, the 16 critical infrastructure sectors as defined by the Department of Homeland Security will be used. The 16 sectors are:
>
> - Chemical
> - Commercial Facilities
> - Communications
> - Critical Manufacturing
> - Dams
> - Defense Industrial Base
> - Emergency Services
> - Energy
> - Financial Services
> - Food and Agriculture
> - Government Facilities
> - Healthcare and Public Health
> - Information Technology
> - Nuclear Reactors, Materials, and Waste
> - Transportation Systems
> - Water and Wastewater Systems.

Please use this definition as a guideline when selecting critical facilities.

SAMPLE COMPLETED TABLE – SPECIAL DISTRICT ASSETS	
Asset	Value
Property	
11.5 Acres	$5,750,000
Critical Infrastructure and Equipment	
Total length of pipe 40 miles ($1.32 million per mile X 40 miles)	$52,800,000
4 Emergency Generators	$250,000
Total:	**$53,050,000**
Critical Facilities	
2 Administrative Buildings	$2,750,000
4 Pump Station Buildings	$377,000
Total:	**$3,127,000**

Phase 2 Instructions

CAPABILITY ASSESSMENT

Planning and Regulatory Capability

List any federal, state, local or district laws, ordinances, codes and policies that govern your jurisdiction that include elements related to hazard mitigation. List any other plans, studies or other documents that address hazard mitigation issues for your jurisdiction. Please provide the date of last update. A few examples follow:

- **District Design Standards**—Last updated 2010.
- **Capital Improvement Program**—Updated and approved annually, covers 5 year timeframe.
- **Emergency Operations Plan**—Last updated 2000.
- **Facility Maintenance Manual**—Last updated 1990.
- **California Building Code**—Last updated 2016.
- **California State Division of State Architects—**Review and approval of all building and site design features is required prior to construction.
- **Habitat Conservation Plan**—All development impacting critical habitat must meet federal and state requirements pertaining to the protection of endangered species.

Fiscal, Administrative and Technical Capabilities

Fiscal Capability

Complete the table titled "Fiscal Capability" by indicating whether each of the listed financial resources is accessible to your jurisdiction. Enter "Yes" if the resource is fully accessible to your jurisdiction. Enter "No" if there are limitations or prerequisites that may hinder your eligibility for this resource.

Administrative and Technical Capability

Complete the table titled "Administrative and Technical Capability" by indicating whether your jurisdiction has access to each of the listed personnel resources. Enter "Yes" or "No" in the column labeled "Available?". If yes, then enter the department and position title in the right-hand column. If you have contract support staff with these capabilities, you can still answer "Yes." Indicate in the department column that this resource is provided through contract support.

Education and Outreach Capabilities

Complete the table titled "Education and Outreach" to indicate your jurisdiction's capabilities and existing efforts regarding natural hazard mitigation education and outreach.

Adaptive Capacity for Climate Change

Consider the climate change impact concerns identified for the planning area:

- Increased temperature
- Reduced precipitation
- Sea level rise – coastal inundation and erosion
- Public health – heat and air pollution
- Reduced agricultural productivity
- Inland flooding
- Reduced tourism.

With those impacts in mind, complete the table titled "Adaptive Capacity for Climate Change" by indicating that your jurisdiction's capacity for each listed criterion as follows:

- **High**—The capacity exists and is in use.
- **Medium**—The capacity may exist, but is not used or could use some improvement.
- **Low**—The capacity does not exist or could use substantial improvement.
- **Unsure**—Not enough information is known to assign a rating.

This is a subjective assessment, but providing a few words of explanation is useful. It is highly recommended that you complete this table with an internal planning team and that you review the results of the other capability assessment tables before completing.

INTEGRATION WITH OTHER PLANNING INITIATIVES

The goal of plan integration is to ensure that the potential impact of hazards is considered in planning for future development. FEMA recommends integration as follows:

- Integrate hazard mitigation plan goals with community objectives (e.g. incorporate the goals for risk reduction and safety into the policies of other plans).
- Use the risk assessment to inform plans and policies (e.g. incorporate risk assessment findings into land use plans, site plan review, emergency operations plans).
- Implement mitigation actions through existing mechanisms (e.g. include mitigation projects in the capital improvement plan).
- Think about mitigation before and after a disaster (e.g. build recovery planning on existing mitigation plans and goals).

After reviewing the plans, programs and ordinances identified in the capability assessment, identify all plans and programs that have already been integrated with the goals and recommendations of the hazard mitigation plan, and those that offer opportunities for future integration.

Existing Integration

Provide a brief description of how the plan or ordinance is integrated. For plan updates, it is required that at least one item be listed or that you explicitly state that no integration occurred. Examples are as follows:

- **Capital Improvement Plan**—The capital improvement plan includes projects that can help mitigate potential hazards. The District will act to ensure consistency between the hazard mitigation plan and the current and future capital improvement plans. The hazard mitigation plan may identify new possible funding sources for capital improvement projects and may result in modifications to proposed projects based on results of the risk assessment.
- **Emergency Operations Plan**—The results of the risk assessment were used in the development of the emergency operations plan.
- **Facilities Plan**—The results of the risk assessment and mapped hazard areas are used in facility planning for the district. Potential sites are reviewed for hazard risks and appropriate mitigation measures are considered in building and site design.

Opportunities for Future Integration

List any plans or program that offer the potential for future integration and describe the process by which integration will occur. Examples follow:

- **Capital Improvement Projects**—Capital improvement project proposals may take into consideration hazard mitigation potential as a means of evaluating project prioritization.
- **Post-Disaster Recovery Plan**—The District does not have a recovery plan and intends to develop one as a mitigation planning action during the next five years. The plan will build on the mitigation goals and objectives identified in the mitigation plan.

Consider other programs you may have in place in your jurisdiction that include routine consideration and management of hazard risk. Examples of such programs may include: tree pruning programs, right-of-way mowing programs, erosion control or stream maintenance programs, etc. Please add any such programs to the integration discussion and provide a brief description of how these program manage (or could be adapted to manage) risk from hazards.

Phase 3 Instructions

If your jurisdiction participated in a previously approved hazard mitigation plan, we have transferred relevant content to the Phase 3 portion of your annex. All pre-populated content should be reviewed for accuracy and completeness.

JURISDICTION-SPECIFIC NATURAL EVENT HISTORY

In the table titled "Past Natural Hazard Events," list in chronological order (most recent first) any natural hazard event that has caused damage to your jurisdiction. Include the date of the event and the estimated dollar amount of damage it caused. You are welcome to include any events, but special attention should be made to include major storms and federally declared disasters. Please refer to the table below that lists Presidential Disaster Declarations for the County. We recommend including most large-scale disasters, unless you know that there were no impacts to your jurisdiction. Specifically, we recommend that you include these events if you have damage estimate information or can provide a brief description of impacts that occurred within your community. In addition to these events, please refer to the NOAA storm events database included in the tool kit. We recommend conducting a search for the name of your jurisdiction or those jurisdictions in your service area in order to identify events with known impacts. Other potential sources of damage information include:

- Preliminary damage estimates your jurisdiction filed with the county or state
- Insurance claims data

- Newspaper archives
- Other plans/documents that deal with emergency management (safety element of a comprehensive plan, emergency response plan, etc.)
- Resident input.

If you do not have estimates for dollars of damage caused, please list "Not Available" in the appropriate column or simply list a brief description of the damages (e.g. Power out to 35,000 customers for 24 hours). Please note that tracking such damages, is a valid and useful mitigation action if your jurisdiction does not currently track such information.

Presidential Disaster Declarations for Alameda County

Type of Event	FEMA Disaster #	Declaration Date
Severe Winter Storms, Flooding, and Mudslides	DR-4308	4/1/2017
Severe Winter Storms, Flooding, and Mudslides	DR-4305	3/16/2017
Severe Winter Storms, Flooding, and Mudslides	DR-4301	2/14/2017
Severe Storms, Flooding, Landslides, and Mudslides	DR-1646	6/5/2006
Severe Storms, Flooding, Mudslides, and Landslides	DR-1628	2/3/2006
Hurricane Katrina Evacuation	EM-3248	9/13/2005
Severe Winter Storms and Flooding	DR-1203	2/9/1998
Severe Storms, Flooding, Mud and Landslides	DR-1155	1/4/1997
Severe Winter Storms, Flooding Landslides, Mud Flow	DR-1046	3/12/1995
Severe Winter Storms, Flooding, Landslides, Mud Flows	DR-1044	1/10/1995
Oakland Hills Fire	DR-919	10/22/1991
Severe Freeze	DR-894	2/11/1991
Loma Prieta Earthquake	DR-845	10/18/1989
Severe Storms & Flooding	DR-758	2/21/1986
Coastal Storms, Floods, Slides & Tornadoes	DR-677	2/9/1983
Severe Storms, Flood, Mudslides & High Tide	DR-651	1/7/1982
Drought	EM-3023	1/20/1977
Forest & Brush Fires	DR-295	9/29/1970
Severe Storms & Flooding	DR-283	2/16/1970

Note: EM = Emergency Declaration; DR = Disaster Declaration

JURISDICTION-SPECIFIC VULNERABILITIES

We would strongly encourage you to review the results of the risk assessment included in the tool kit, your jurisdiction's natural events history, and any relevant public comments/input and develop a few sentences that discuss specific risks. You do not need to develop a sentence for every single parameter, but review the results and identify a few issues you would like to highlight. For example:

- One of the District's wastewater treatment plants is located in an area likely to be permanently inundated by sea level rise by 2030.
- Three of the District's five fire stations are located in very high landslide risk areas.

- The vast majority of the service area for the district is located on high liquefaction potential soils, which has the potential to severely disrupt service for an extended period following even a moderate earthquake event.
- The District headquarters is more likely than not to be extensively damaged during a Smithburg fault M7.0 event.

In addition, please list any noted vulnerabilities in your jurisdiction related to hazard mitigation that may not be apparent from the risk assessment and other information provided. This may include things such as the following:

- An area of the community that frequently loses power due to a lack of tree maintenance.
- A critical facility, such as a police station, that is not equipped with a generator.
- A neighborhood that has the potential to have ingress and egress cut off as the result of a hazard event, such as a flood or earthquake (e.g. bridge only access).

Spending some time thinking about the results of the risk assessment and other noted vulnerabilities will be a big help in the development of your mitigation strategy. The items you list in this section should cross-walk back to the mitigation action that you have selected. Two examples are shown in the table below.

Noted Vulnerability	Example Mitigation Action
One of the District's wastewater treatment plants is located in an area likely to be permanently inundated by sea level rise by 2030.	Conduct a detailed assessment of the wastewater treatment plant vulnerability to sea level rise. Determine adaptation actions that can be implemented in the near- and long-term.
A critical facility, such as a police station, that is not equipped with a generator.	Unsure all critical facilities within the District have backup power generation capabilities. Priority facilities include: • Main street pump station • Old Oak subdivision pump station.

HAZARD RISK RANKING

The risk ranking performed for the overall planning area is presented in the risk assessment section of the overall hazard mitigation plan. However, each jurisdiction has differing degrees of risk exposure and vulnerability and, therefore, needs to rank risk for its own area, using the same methodology as used for the overall planning area. The risk-ranking exercise assesses two variables for each hazard: its probability of occurrence; and its potential impact on people, property and the economy.

Tetra Tech has brought forward the risk ranking results from the 2011 plan for each jurisdiction that participated in that planning effort. For those jurisdictions that did not participate in the 2011 planning effort, a draft risk ranking using the parameters outlined below has been developed for each planning partner. If this risk ranking exercise generates results other that what you know based on substantiated data and documentation, you may alter the ranking based on this knowledge. If this is the case, please note this fact in your template and include what you believe the rank should be and why. For example, drought was ranked as low; however, the jurisdiction is a water supply district, so you believe it should be ranked as high.

Also keep in mind that one of the purposes of this exercise is to support the selection and prioritization of actions in your plan. If you identify an action with a high priority that mitigates the risk of a hazard you have ranked low, that action may not be as competitive in the grant arena. On the other hand, you will need to have at least one true mitigation action for each hazard ranked as "high."

The instructions below describe the methodology for how these rankings were derived. Please review before providing any comments.

Risk Ranking Methodology

Review Risk Ranking in Template

Review the hazard risk ranking information that Tetra Tech has provided. The hazard with the highest risk rating is listed at the top of table titled "Hazard Risk Ranking" in your template and was given a rank of 1; the hazard with the second highest rating is listed second with a rank of 2; and so on. Two hazards with equal risk ratings were given the same rank. "High," Medium," and "Low" assignments were given for each hazard of concern based on the total score (probability x impact). It is important to note, that this is determined by the scores rather than assigning a certain number of hazards to each category.

When reviewing the risk ranking results, it is important to remember that this exercise is about categorizing hazards into broad levels of risk (e.g. high, medium, low). It is not an exercise in precision.

Review Risk Ranking in Loss Matrix

The following sections discuss the methodology used to develop the results included in your template. Please refer to the risk assessment results provided for more information.

Probability of Occurrence for Each Hazard

A probability factor is assigned based on how often a hazard is likely to occur. The probability of occurrence of a hazard event is generally based on past hazard events in an area, although weight can be given to expected future probability of occurrence based on established return intervals and changing climate conditions. For example, if your jurisdiction has experienced two damaging floods in the last 25 years, the probability of occurrence is high for flooding and scores a 3 under this category. If your jurisdiction has experienced no damage from landslides in the last 100 years, your probability of occurrence for landslide is low, and scores a 1 under this category. Each hazard was assigned a probability factor as follows:

- High—Hazard event is likely to occur within 25 years (Probability Factor = 3)
- Medium—Hazard event is likely to occur within 100 years (Probability Factor = 2)
- Low—Hazard event is not likely to occur within 100 years (Probability Factor = 1)
- None—If there is no exposure to a hazard, there is no probability of occurrence (Probability Factor = 0)

Potential Impacts of Each Hazard

The impact of each hazard is divided into three categories: impacts on people, impacts on property, and impacts on the economy. These categories are also assigned weighted values. Impact on people was assigned a weighting factor of 3, impact on property was assigned a weighting factor of 2 and impact on the economy was assigned a weighting factor of 1.

Impact factors for each category (people, property, economy) are described below:

- **People**—Values are assigned based on the percentage of the total ***population exposed*** in your service area to the hazard event. The degree of impact on individuals will vary and is not measurable, so the calculation assumes for simplicity and consistency that all people exposed to a hazard because they live in a hazard zone will be equally impacted when a hazard event occurs. Impact factors were assigned as follows:

  - High—25 percent or more of the population is exposed to a hazard (Impact Factor = 3)

- Medium—10 percent to 24 percent of the population is exposed to a hazard (Impact Factor = 2)
- Low—9 percent or less of the population is exposed to the hazard (Impact Factor = 1)
- No impact—None of the population is exposed to a hazard (Impact Factor = 0)

- **Property**—Values are assigned based on the percentage of the total ***district assets exposed*** to the hazard event:

  - High—25 percent or more of the total replacement value of assets is exposed to a hazard (Impact Factor = 3)
  - Medium—10 percent to 24 percent of the total replacement value of assets is exposed to a hazard (Impact Factor = 2)
  - Low—9 percent or less of the total replacement value of assets is exposed to the hazard (Impact Factor = 1)
  - No impact—None of the total replacement value is exposed to a hazard (Impact Factor = 0)

- **Operations**—Impact on operations is assessed based on estimates of how long it will take your jurisdiction to become 100-percent operable after a hazard event. The estimated functional downtime for critical facilities has been estimated by Hazus (see toolkit) or subjectively assigned an impact as follows:

  - High—Functional downtime of 365 days or more (Impact Factor = 3)
  - Medium—Functional downtime of 180 to 364 days (Impact Factor = 2)
  - Low—Functional downtime of 180 days or less (Impact Factor = 1)
  - No impact—No functional downtime is estimated from the hazard (Impact Factor = 0).

Risk Rating for Each Hazard

A risk rating for each hazard was determined by multiplying the assigned probability factor by the sum of the weighted impact factors for people, property and the economy:

Risk Rating = Probability Factor x Weighted Impact Factor {people + property + economy}

This is the number that is shown in the risk ranking table in your template.

STATUS OF PREVIOUS PLAN ACTIONS

Please note that this section only applies to jurisdictions that are conducting updates to previously approved hazard mitigation plans. If your jurisdiction has not previously participated in an approved plan, this section will not appear in your annex template. Also, please note that if you completed the Phase 2 annex, you likely already filled out this table. You will need to revisit this section to fill in the Action # section after competing your action plan in the following section.

All action items identified in prior mitigation planning efforts must be reconciled in this plan update. Action items must all be marked as ONE of the following; check the appropriate box (place an X) and provide the following information:

- **Completed—**If an action was completed during the performance period of the prior plan, please check the appropriate box and provide a date of completion in the comment section. If an action has been initiated and is an ongoing program (e.g. annual outreach event), you may mark it as completed and note that it is ongoing in the comments. When removing such actions from your action plan, please consider including them in the existing integration section above. If you have an action that addresses an ongoing program you would like to continue to include it in your action plan, please see the Carried Over to Plan Update section below.

- **Removed**—If action items are to be removed because they are no longer feasible, a reason must be given. Lack of funding does not mean that it is no longer feasible, unless the sole source of funding for an action is no longer available. Place a comment in the comment section explaining why the action is no longer feasible (e.g., "Action no longer considered feasible due to lack of political support."). If the wording and/or intent of a previously identified action is unclear, this can be a reason for removal. A change in community priorities may also be a reason for removal and should be discussed in the comments.
- **Carried Over to Plan Update**—If an action is in progress, ongoing or has not been initiated and you would like to carry it over to the plan update, please check the "Check if Yes" column under "Carried Over to Plan Update." Selecting this option indicates that the action will be included in the mitigation action plan for the 2017 plan. The last column "Enter Action #" will be addressed when you develop your actions plan in the following sections. You will need to revisit it after completing the action plan.

HAZARD MITIGATION ACTION PLAN AND EVALUATION OF RECOMMENDED ACTIONS

This section is the heart of your jurisdictional annex. This is where you will identify the actions your jurisdiction would like to pursue with this plan. All of the work that you have done thus far should provide you with a plethora of ideas for actions. With this in mind, we recommend that you review the following and develop a list of potential actions:

Wording Your Action Descriptions:

Descriptions of your actions need not provide great detail. That will come when you apply for a project grant. Provide enough information to identify the action's scope and impact. The following are typical descriptions for an action plan action:

- **Action 1**—Address repetitive-loss properties. Through targeted mitigation, acquire, relocate or retrofit the nine pump stations that have been repetitively damaged.
- **Action 2**—Perform a non-structural, seismic retrofit of the administrative building.
- **Action 3**—Develop a schedule to underground overhead powerlines.

- **Capability Assessment Section of Annex**—Review the Planning and Regulatory Capability table, the Fiscal Capability table, the Administrative and Technical Capability table, and the Education and Outreach table.
  - For any capability that you indicated that you did not have, ask yourself – should we have this capability? If yes, consider including an action to develop/acquire the capability.
  - Example: Ensure a staff person is trained in the use of FEMA's benefit-cost analysis software.
  - Review the Legal and Regulatory capabilities. If you have not reviewed and updated a capability in more than 10 years, consider an action to review and update the capability and, as appropriate, incorporate hazard mitigation principles or information obtained in the risk assessment (Note: actions such as this should also be identified in the opportunities for future integration section). Also, consider including projects or actions that have been identified in other plans and programs such as Capital Improvement Plans, Strategic Plans, etc. as actions in this plan.
  - For any capability that you indicated you do have, consider how this capability can be leveraged to increase or improve hazard mitigation in the jurisdiction.

- **Adaptive Capacity for Climate Change Section of this Annex**—Consider your responses to this section. For those criterion that you listed as medium or low, think of ways you could improve this rating (see adaptive capacity portion of the mitigation best practices catalog). For those criterion you listed as high, think about how you can leverage this capacity to improve or enhance mitigation or continue to

improve this capacity. For those criterion that you were unable to provide responses for, consider ways you could improve your understanding of this capacity (see mitigation best practices).

- **Opportunities for Future Integration Section in this Annex**—Review the items you identified in this section. Consider an action that specifically says what the plan, code, ordinance etc. is and how it will be integrated.
- **Jurisdiction-Specific Vulnerabilities Section in this Annex—**Review the items that you have identified in this section and consider actions that will help reduce these vulnerabilities (see mitigation best practices catalog).
- **Mitigation Best Practices Catalog**—A catalog that includes FEMA and other agency identified best practices, steering committee and other stakeholder recommendations was developed as part of the plan development process and included in your tool kit. Review the catalog and identify those actions that your jurisdiction should consider including in its action plan.
- **Public Input**—Review input received during the process, specifically the public survey results included in your toolkit.
- **Prior Mitigation Planning Efforts**—If your jurisdiction participated in a previous hazard mitigation plan, please be sure to remember to include any actions that were identified as "carry over" actions. Once you have carried them over, return to the Status of Previous Actions table and record the new action number (see discussion below).

Be sure to consider the following factors in your selection of actions:

- Select actions that are consistent with the overall purpose, goals, and objectives of the hazard mitigation plan.
- Identify actions where benefits exceed costs.
- Include any action that your jurisdiction has committed to pursuing regardless of grant eligibility.
- Know what is and is not grant-eligible under the Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation (PDM) and Flood Mitigation Assistance (FMA) grants (see fact sheet provided in toolkit). If you have actions that are not HMGP, PDM or FMA grant eligible, but do mitigate part or all of the hazard and may be eligible for other grant programs sponsored by other agencies, include them in this section.
- **You must identify at least one true mitigation action (i.e. not a preparedness or response action) that is clearly defined and actionable for hazards ranked as "high" or medium."**

Recommended Actions

We recommend that every planning partner strongly consider the following actions. The specifics of these actions should be adjusted as needed for the particulars of each jurisdiction. You will note that two of these actions have been prepopulated in your annex template. These two actions should be included in every annex and should not be removed.

- Where appropriate, support retro-fitting, purchase or relocation of structures located in high hazard areas, prioritizing structures that have experienced repetitive losses.
- Integrate the hazard mitigation plan into other plans, ordinances and programs within the community.
- Actively participate in the plan maintenance protocols outlined in Volume I of the hazard mitigation plan.
- Develop and implement a program to capture perishable data after significant events (e.g. high water marks, preliminary damage estimates, damage photos) to support future mitigation efforts including the implementation and maintenance of the hazard mitigation plan.
- Support the County-wide initiatives identified in Volume I of the hazard mitigation plan.
- Consider the development of a post-disaster recovery plan and a debris management plan.
- Develop and/or update plans that support or enhance continuity of operations following disasters.

- Identify and pursue strategies to increase adaptive capacity to climate change.

Complete the Table

Complete the table titled "Hazard Mitigation Action Plan Matrix" for all the actions you have identified and would like to include in the plan:

Action Item Numbering:

- Please use the following action item numbering conventions:
  - Dublin Unified School District: DUSD-1
  - Dublin San Ramon Services District: DSRSD-1
  - Livermore Valley Joint Unified School District: LVJUSD-1

- Enter the action number and description .
- Indicate whether the action mitigates hazards for new and/or existing assets.
- Identify the specific hazards the action will mitigate.
- Identify by number the mitigation plan objectives that the action addresses (see toolkit).
- Indicate who will be the lead in administering the action. This will most likely be a department within your jurisdiction (e.g. planning or public works). If you wish to indicate more than one department, please ensure that it is clear who the lead agency will be (i.e note with an *)
- Enter an estimated cost in dollars if known; otherwise, enter "High," "Medium" or "Low" as determined for the prioritization process described in the following section.
- Identify funding sources for the action. If it is a grant, include the funding sources for the cost share. Refer to your fiscal capability assessment to identify possible sources of funding and refer to the table below for project eligibility for FEMA's hazard mitigation assistance grant program.
- Indicate the time line as "short-term" (1 to 5 years) or "long-term" (5 years or greater) or ongoing (a continual program)

Eligible Activities	HMGP	PDM	FMA
Mitigation Projects			
Property Acquisition and Structure Demolition	√	√	√
Property Acquisition and Structure Relocation	√	√	√
Structure Elevation	√	√	√
Mitigation Reconstruction	√	√	√
Dry Floodproofing of Historic Residential Structures	√	√	√
Dry Floodproofing of Non-residential Structures	√	√	√
Generators	√	√	
Localized Flood Risk Reduction Projects	√	√	√
Non-Localized Flood Risk Reduction Projects	√	√	
Structural Retrofitting of Existing Buildings	√	√	√
Non-structural Retrofitting of Existing Buildings and Facilities	√	√	√
Safe Room Construction	√	√	
Wind Retrofit for One- and Two-Family Residences	√	√	
Infrastructure Retrofit	√	√	√
Soil Stabilization	√	√	√
Wildfire Mitigation	√	√	
Post-Disaster Code Enforcement	√		
Advance Assistance	√		
5 Percent Initiative Projects*	√		

Eligible Activities	HMGP	PDM	FMA
Aquifer and Storage Recovery**	√	√	√
Flood Diversion and Storage**	√	√	√
Floodplain and Stream Restoration**	√	√	√
Green Infrastructure**	√	√	√
Miscellaneous/Other**	√	√	√
Hazard Mitigation Planning	√	√	√
Technical Assistance			√
Management Costs	√	√	√

Notes: HMGP = Hazard Mitigation Grant Program; PDM = Pre-Disaster Mitigation; FMA = Flood Mitigation Assistance

* FEMA allows increasing the 5% Initiative amount up to 10% for a Presidential major disaster declaration under HMGP. The additional 5% Initiative funding can be used for activities that promote disaster-resistant codes for all hazards. As a condition of the award, either a disaster-resistant building code must be adopted or an improved Building Code Effectiveness Grading Schedule is required.

**Indicates that any proposed action will be evaluated on its own merit against program requirements. Eligible projects will be approved provided funding is available.

Source: https://www.fema.gov/hazard-mitigation-assistance-mitigation-activity-chart

Please see the table below for an examples of some of the recommended actions above:

Example Action Plan Matrix							
Applies to new or existing assets	**Hazards Mitigated**	**Objectives Met**	**Lead Agency**	**Support Agency**	**Estimated Cost**	**Sources of Funding**	**Timeline**
EX-1— Where appropriate, support retro-fitting, purchase or relocation of structures located in high hazard areas, prioritizing structures that have experienced repetitive losses.							
Existing	Dam failure, Earthquake, Flood, Landslide, Severe weather, Wildfire	4, 6, 8, 10, 11, 12			High	HMGP, PDM, FMA	Short-term
EX-2—Integrate the hazard mitigation plan into other plans, ordinances and programs within the community.							
New and Existing	Dam failure, Drought, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 2, 6, 8, 10, 11			Low	Staff Time, General Funds	Ongoing
EX-3—Develop and implement a program to capture perishable data after significant events (e.g. high water marks, preliminary damage estimates, damage photos) to support future mitigation efforts including the implementation and maintenance of the hazard mitigation plan.							
Existing	Dam failure, Drought, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 9	Emergency Management		Medium	Staff Time, General Funds	Short-term

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline
EX-4—Support the County-wide initiatives identified in Volume I of the hazard mitigation plan.							
New and Existing	Dam failure, Drought, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	Lead Contact Department for Plan	Any Supporting Departments	Low	Staff Time, General Funds	Short-term
EX-5—Actively participate in the plan maintenance protocols outlined in Volume I of the hazard mitigation plan.							
New and Existing	Dam failure, Drought, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	Lead Contact Department for Plan	Any Supporting Departments	Low	Staff Time, General Funds	Short-term
EX-6—Develop a post-disaster recovery plan and a debris management plan.							
Existing	All Hazards	6, 13	Emergency Management		Medium	EMPG	Long-term

Prioritization of Mitigation Actions

Complete the information in the table titled "Mitigation Strategy Priority Schedule" as follows:

- **Action #**—Indicate the action number from the previous annex table (Hazard Mitigation Action Plan Matrix).
- **# of Objectives Met**—Enter the number of objectives the action will meet.
- **Benefits**—Enter "High," "Medium" or "Low" as follows:
  - High: Action will have an immediate impact on the reduction of risk exposure to life and property.
  - Medium: Action will have a long-term impact on the reduction of risk exposure to life and property, or action will provide an immediate reduction in the risk exposure to property.
  - Low: Long-term benefits of the action are difficult to quantify in the short term.
- **Costs**—Enter "High," "Medium" or "Low" as follows:
  - High: Would require an increase in revenue via an alternative source (i.e., bonds, grants, fee increases) to implement. Existing funding levels are not adequate to cover the costs of the proposed action.
  - Medium: Could budget for under existing work-plan, but would require a reapportionment of the budget or a budget amendment, or the cost of the action would have to be spread over multiple years.
  - Low: Possible to fund under existing budget. Action is or can be part of an existing ongoing program.

  If you know the estimated cost of a action because it is part of an existing, ongoing program, indicate the amount.
- **Do Benefits Exceed the Cost?**—Enter "Yes" or "No." This is a qualitative assessment. Enter "Yes" if the benefit rating (high, medium or low) is the same as or higher than the cost rating (high benefit/high cost; high benefit/medium cost; medium benefit/low cost; etc.). Enter "No" if the benefit rating is lower than the cost rating (medium benefit/high cost, low benefit/medium cost; etc.)

- **Is the Action Grant-Eligible?**—Enter "Yes" or "No." Refer to the fact sheet on HMGP, PDM and FMA.
- **Can Action Be Funded Under Existing Program Budgets?**—Enter "Yes" or "No." In other words, is this action currently budgeted for, or would it require a new budget authorization or funding from another source such as grants?
- **Implementation Priority**— Enter "High," "Medium" or "Low" as follows:

  - High Priority—An action that meets multiple objectives, has benefits that exceed cost, has funding secured or is an ongoing action and meets eligibility requirements for a grant program. High priority actions can be completed in the short term (1 to 5 years). The key factors for high priority actions are that they have funding secured and can be completed in the short term.
  - Medium Priority—An action that meets multiple objectives, that has benefits that exceed costs, and for which funding has not yet been secured, but is eligible for funding. Action can be completed in the short term, once funding is secured. Medium priority actions will become high priority actions once funding is secured. The key factors for medium priority actions are that they are eligible for funding, but do not yet have funding secured, and they can be completed within the short term.
  - Low Priority—An action that will mitigate the risk of a hazard, that has benefits that do not exceed the costs or are difficult to quantify, for which funding has not been secured, that is not eligible for grant funding, and for which the time line for completion is long term (1 to 10 years). Low priority actions may be eligible for grant funding from other programs that have not yet been identified. Low priority actions are generally "blue-sky" or "wish-list." actions. Financing is unknown, and they can be completed over a long term.

- **Grant Pursuit Priority**— Enter "High," "Medium" or "Low" as follows:

  - High Priority—An action that has been identified as meeting grant eligibility requirements, assessed to have high benefits, is listed as high or medium priority, and where local funding options are unavailable or where dedicated funds could be utilized for actions that are not eligible for grant funding.
  - Medium Priority—An action that has been identified as meeting grant eligibility requirements, assessed to have medium or low benefits, is listed as medium or low priority, and where local funding options are unavailable.
  - Low Priority—An action that has not been identified as meeting grant eligibility requirements, or has low benefits.

This prioritization is a simple way to determine that your identified actions meet one of the primary objectives of the Disaster Mitigation Act. It is not the detailed benefit/cost analysis required for HMGP/PDM /FMA action grants. The prioritization will identify any actions whose probable benefits will not exceed the probable costs. Those actions identified as high-priority grant funding actions should be closely reviewed for consideration when grant funding opportunities arise.

Note: If a jurisdiction wishes to identify a action as high priority that is outside of the prioritization scheme for high priorities. A note indicting so should be inserted and a rationale should be provided.

Please see the example below based off the recommended actions:

Table 0-9. Mitigation Strategy Priority Schedule

Action #	# of Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is Action Grant-Eligible?	Can Action Be Funded Under Existing Programs/ Budgets?	Implementation Priority[a]	Grant Pursuit Priority[a]
EX-1	6	High	High	Yes	Yes	No	Medium	High
EX-2	6	Medium	Low	Yes	No	Yes	High	Low
EX-3	2	Low	Medium	No	No	Maybe	Low	Low
EX-4	12	Low	Low	Yes	No	Yes	High	Low
EX-5	12	Low	Low	Yes	No	Yes	High	Low
EX-8	4	Medium	Medium	Yes	Yes	No	Medium	High

Analysis of Mitigation Actions

Complete the table titled "Analysis of Mitigation Actions" summarizing the mitigation actions by hazard of concern and the following eight mitigation types. Please note that an action can be more than one mitigation type:

- **Prevention**—Government, administrative or regulatory actions that influence the way land and buildings are developed to reduce hazard losses. Includes planning and zoning, floodplain laws, capital improvement programs, open space preservation, and stormwater management regulations.
- **Property Protection**—Modification of buildings or structures to protect them from a hazard or removal of structures from a hazard area. Includes acquisition, elevation, relocation, structural retrofit, storm shutters, and shatter-resistant glass.
- **Public Education and Awareness**—Actions to inform residents and elected officials about hazards and ways to mitigate them. Includes outreach projects, real estate disclosure, hazard information centers, and school-age and adult education.
- **Natural Resource Protection**—Actions that minimize hazard loss and preserve or restore the functions of natural systems. Includes sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, wetland restoration and preservation, and green infrastructure.
- **Emergency Services**—Actions that protect people and property during and immediately after a hazard event. Includes warning systems, emergency response services, and the protection of essential facilities.
- **Structural Projects**—Actions that involve the construction of structures to reduce the impact of a hazard. Includes dams, setback levees, floodwalls, retaining walls, and safe rooms.
- **Climate Resilient**—Actions that incorporate methods to mitigate and/or adapt to the impacts of climate change. Includes aquifer storage and recovery activities, incorporating future conditions projections in project design or planning, or actions that specifically address jurisdiction-specific climate change risks, such as sea level rise or urban heat island effect.
- **Community Capacity Building**—Actions that increase or enhance local capabilities to adjust to potential damage, to take advantage of opportunities, or to respond to consequences. Includes staff training, memorandums of understanding, development of plans and studies, and monitoring programs.

This exercise demonstrates that the jurisdiction has selected a comprehensive range of actions.

Please see the example below based off the recommended actions, but please note that these recommendations are heavy on generalized actions on the prevention spectrum and light in other areas and specificity. Planning partners should aim to identify at least one action in each category (although this is not required) and should make sure there is at least one action to address "high" ranked hazards:

Analysis of Mitigation Actions

Hazard Type	Action Addressing Hazard, by Mitigation Type[a]							
	Prevention	Property Protection	Public Education and Awareness	Natural Resource Protection	Emergency Services	Structural Projects	Climate Resilient	Community Capacity Building
Dam Failure	EX-2, 3, 4, 5	EX-1	EX-4					EX-3, 4, 6
Drought	EX-2	EX-1	EX-4					EX-3, 4, 6
Earthquake	EX-2, 3, 4, 5	EX-1	EX-4					EX-3, 4, 6
Flood	EX-2, 3, 4, 5	EX-1	EX-4					EX-3, 4, 6
Landslide	EX-2, 3, 4, 5	EX-1	EX-4					EX-3, 4, 6
Severe weather	EX-2, 3, 4, 5	EX-1	EX-4		EX-6			EX-3, 4, 6
Wildfire	EX-2, 3, 4, 5	EX-1	EX-4					EX-3, 4, 6

FUTURE NEEDS TO BETTER UNDERSTAND RISK/VULNERABILITY

In this section, identify any future studies, analyses, reports, or surveys your jurisdiction needs to better understand its vulnerability to identified or currently unidentified risks. These could be needs based on federal or state agency mandates. Please note that this section is optional.

ADDITIONAL COMMENTS

Use this section to add any additional information pertinent to hazard mitigation and your jurisdiction not covered in this template. Please note that this section is optional.

REVIEW AND INCORPORATION OF RESOURCES FOR THIS ANNEX

This section should describe what resources you used to complete the annex and how you used them. Several items are started for you, but please be sure to update and enhance any descriptions. This may seem trivial or unimportant, but it is a requirement to pass the state and FEMA review process.

NEXT STEPS

After all jurisdictions have submitted their annexes, the draft plan will be submitted for public comment. Following the public comment period and any revisions responsive to public comment, the plan will be submitted to the California Governor's Office of Emergency Services (Cal OES) for review. After their review and approval, Cal OES will submit the plan to FEMA Region IX for plan review and approval. At that point planning partners will be asked to begin making preparations to formally adopt the plan. Each participating planning partner must have the governing board of their jurisdiction adopt via resolution or ordinance. Once FEMA has

reviewed the plan and issued an approved pending adoption (APA) notice, planning partners will be asked to go forth and adopt the plan. Once adopted, planning partners will submit adoption information to Tetra Tech, who will submit the proof of adoption to FEMA. Once such adoption has been received, FEMA will issue final approval via a letter for those planning partners who have adopted the plan. It is very important to understand that approval is not final until proof of adoption has been received by FEMA and they have issued a letter specifically naming your jurisdiction. More information on the review and approval process, along with adoption support materials, will be provided at a later date.

1. DISTRICT NAME

1.1 HAZARD MITIGATION PLAN POINT OF CONTACT

Primary Point of Contact
Name, Title
Street Address
City, State ZIP
Telephone: xxx-xxx-xxxx
e-mail Address: xxx@xxx.xxx

Alternate Point of Contact
Name, Title
Street Address
City, State ZIP
Telephone: xxx-xxx-xxxx
e-mail Address: xxx@xxx.xxx

1.2 JURISDICTION PROFILE

1.2.1 Overview

Insert Narrative Profile Information, per Instructions. The __[name of adopting body]___ assumes responsibility for the adoption of this plan; __[name of oversight agency]__ will oversee its implementation.

For fire districts please be sure to include the following sentence (Non-fire Special Purpose Districts may delete the sentence):

The District participates/does not participate in the Public Protection Class Rating System and currently has a rating of #.

1.2.2 Service Area and Trends

The district serves a population of _ population_. Its service area covers an area of _area_.

Insert summary description of service trends.

1.2.3 Assets

Table 1-1 summarizes the critical assets of the district and their value.

Table 1-1. Special Purpose District Assets

Asset	Value
Property	
number acres of land	$_value_
Critical Infrastructure and Equipment	
description	$_value_
description	$_value_
description	$_value_
description	$_value_
description	$_value_
Total:	*$_value_*
Critical Facilities	
description	$_value_
description	$_value_
description	$_value_
description	$_value_
description	$_value_
description	$_value_
Total:	*$_value_*

1.3 CAPABILITY ASSESSMENT

Upon completion, the capability assessment was reviewed to identify opportunities to expand, initiate or integrate capabilities to further hazard mitigation goals and objectives. Where such opportunities were identified and determined to be feasible, they are included in the action plan and are identified as Community Capacity Building mitigation actions in the Analysis of Mitigation Actions table in Section 1.9.

1.3.1 Planning and Regulatory Capabilities

Jurisdictions develop plans and programs and implement rules and regulations to protect and serve residents. When effectively prepared and administered, these plans, programs and regulations can support the implementation of mitigation actions. Table 1-2 summarizes existing codes, ordinances, policies, programs or plans that are applicable to this hazard mitigation plan.

Table 1-2. Planning and Regulatory Capability

	Date of Most Recent Update	Comment
Name of code, ordinance, policy, program or plan	____	____
Name of code, ordinance, policy, program or plan	____	____
Name of code, ordinance, policy, program or plan	____	____
Name of code, ordinance, policy, program or plan	____	____
Name of code, ordinance, policy, program or plan	____	____

1.3.2 Fiscal, Administrative and Technical Capabilities

Fiscal capability is an indicator of a jurisdiction's ability to fulfill the financial needs associated with hazard mitigation projects. An assessment of fiscal capabilities is presented in Table 1-3. Administrative and technical

capabilities represent a jurisdiction's staffing resources for carrying out the mitigation strategy. An assessment of administrative and technical capabilities is presented in Table 1-4.

Table 1-3. Fiscal Capability

Financial Resource	Accessible or Eligible to Use?
Capital Improvements Project Funding	Yes/No
Authority to Levy Taxes for Specific Purposes	Yes/No
User Fees for Water, Sewer, Gas or Electric Service	Yes/No
Incur Debt through General Obligation Bonds	Yes/No
Incur Debt through Special Tax Bonds	Yes/No
Incur Debt through Private Activity Bonds	Yes/No
State-Sponsored Grant Programs	Yes/No
Development Impact Fees for Homebuyers or Developers	Yes/No
Federal Grant Programs	Yes/No
Other	Yes/No (if yes, please specify)

Table 1-4. Administrative and Technical Capability

Staff/Personnel Resource	Available?	Department/Agency/Position
Planners or engineers with knowledge of land development and land management practices	Yes/No	Insert appropriate information
Engineers or professionals trained in building or infrastructure construction practices	Yes/No	Insert appropriate information
Planners or engineers with an understanding of natural hazards	Yes/No	Insert appropriate information
Staff with training in benefit/cost analysis	Yes/No	Insert appropriate information
Surveyors	Yes/No	Insert appropriate information
Personnel skilled or trained in GIS applications	Yes/No	Insert appropriate information
Scientist familiar with natural hazards in local area	Yes/No	Insert appropriate information
Emergency manager	Yes/No	Insert appropriate information
Grant writers	Yes/No	Insert appropriate information
Other	Yes/No	Insert appropriate information

1.3.3 Education and Outreach Capabilities

Outreach and education capability identifies the connection between government and community members, which opens a dialogue needed for a more resilient community. An assessment of education and outreach capabilities is presented in Table 1-5.

Table 1-5. Education and Outreach

Criterion	Response
Do you have a Public Information Officer or Communications Office?	Yes/No
Do you have personnel skilled or trained in website development?	Yes/No
Do you have hazard mitigation information available on your website? • If yes, please briefly describe	Yes/No Insert appropriate information
Do you utilize social media for hazard mitigation education and outreach? • If yes, please briefly describe	Yes/No Insert appropriate information

Criterion	Response
Do you have any citizen boards or commissions that address issues related to hazard mitigation? • If yes, please briefly specify	Yes/No Insert appropriate information
Do you have any other programs already in place that could be used to communicate hazard-related information? • If yes, please briefly describe	Yes/No Insert appropriate information
Do you have any established warning systems for hazard events? • If yes, please briefly describe	Yes/No Insert appropriate information

1.3.4 Adaptive Capacity for Climate Change

Given the uncertainties associated with how hazard risk may change with a changing climate, a jurisdiction's ability to track such changes and adapt as needed is an important component of the mitigation strategy. Table 1-6 summarizes the District's adaptive capacity for climate change.

Table 1-6. Adaptive Capacity for Climate Change

Criterion	Jurisdiction Rating[a]
Technical Capacity	
Jurisdiction-level understanding of potential climate change impacts	High/Medium/Low
Comment:	
Jurisdiction-level monitoring of climate change impacts	High/Medium/Low
Comment:	
Technical resources to assess proposed strategies for feasibility and externalities	High/Medium/Low
Comment:	
Jurisdiction-level capacity for development of greenhouse gas emissions inventory	High/Medium/Low
Comment:	
Capital planning and land use decisions informed by potential climate impacts	High/Medium/Low
Comment:	
Participation in regional groups addressing climate risks	High/Medium/Low
Comment:	
Implementation Capacity	
Clear authority/mandate to consider climate change impacts during public decision-making processes	High/Medium/Low
Comment:	
Identified strategies for greenhouse gas mitigation efforts	High/Medium/Low
Comment:	
Identified strategies for adaptation to impacts	High/Medium/Low
Comment:	
Champions for climate action in local government departments	High/Medium/Low
Comment:	
Political support for implementing climate change adaptation strategies	High/Medium/Low
Comment:	
Financial resources devoted to climate change adaptation	High/Medium/Low
Comment:	
Local authority over sectors likely to be negative impacted	High/Medium/Low
Comment:	

Criterion	Jurisdiction Rating[a]
Public Capacity	
Local residents knowledge of and understanding of climate risk	High/Medium/Low
Comment:	
Local residents support of adaptation efforts	High/Medium/Low
Comment:	
Local residents' capacity to adapt to climate impacts	High/Medium/Low
Comment:	
Local economy current capacity to adapt to climate impacts	High/Medium/Low
Comment:	
Local ecosystems capacity to adapt to climate impacts	High/Medium/Low
Comment:	

a. High = Capacity exists and is in use; Medium = Capacity may exist, but is not used or could use some improvement; Low = Capacity does not exist or could use substantial improvement; Unsure= Not enough information is known to assign a rating.

1.4 INTEGRATION WITH OTHER PLANNING INITIATIVES

The information on hazards, risk, vulnerability and mitigation contained in this hazard mitigation plan is based on the best available data. Plan integration is the incorporation of this information into other relevant planning mechanisms, such as general planning and capital facilities planning. It includes the integration of natural hazard information and mitigation policies, principles and actions into local planning mechanisms and vice versa. Additionally, plan integration is achieved though the involvement of key staff and community officials in collaboratively planning for hazard mitigation.

1.4.1 Existing Integration

In the performance period since adoption of the previous hazard mitigation plan, District Name made progress on integrating hazard mitigation goals, objectives and actions into other planning initiatives. The following plans and programs currently integrate components of the hazard mitigation strategy:

- **Plan or Program Name**—Description
- **Plan or Program Name**—Description
- **Plan or Program Name**—Description
- **Plan or Program Name**—Description
- **Plan or Program Name**—Description

Resources listed in Section 1.12 were used to provide information on hazard events and local capabilities within the jurisdiction.

1.4.2 Opportunities for Future Integration

As this hazard mitigation plan is implemented, District Name will use information from the plan as the best available science and data on natural hazards. The capability assessment presented in this annex identifies codes, plans and programs that provide opportunities for integration. The area-wide and local action plans developed for this hazard mitigation plan include actions related to plan integration, and progress on these actions will be reported through the progress reporting process described in Volume 1. New opportunities for integration also will be identified as part of the annual progress report. The capability assessment identified the following plans and programs that do not currently integrate goals or recommendations of the hazard mitigation plan but provide opportunities to do so in the future:

- **Plan or Program Name**—Description
- **Plan or Program Name**—Description
- **Plan or Program Name**—Description
- **Plan or Program Name**—Description
- **Plan or Program Name**—Description

1.5 JURISDICTION-SPECIFIC NATURAL HAZARD EVENT HISTORY

Table 1-7 lists past occurrences of natural hazards for which specific damage was recorded in District Name. Other hazard events that broadly affected the entire planning area, including District Name, are listed in the risk assessments in Volume 1 of this hazard mitigation plan.

Table 1-7. Natural Hazard Events

Type of Event	FEMA Disaster # (if applicable)	Date	Damage Assessment
Insert event type	_____	Date	$_____
Insert event type	_____	Date	$_____
Insert event type	_____	Date	$_____
Insert event type	_____	Date	$_____
Insert event type	_____	Date	$_____
Insert event type	_____	Date	$_____
Insert event type	_____	Date	$_____
Insert event type	_____	Date	$_____
Insert event type	_____	Date	$_____
Insert event type	_____	Date	$_____
Insert event type	_____	Date	$_____
Insert event type	_____	Date	$_____
Insert event type	_____	Date	$_____
Insert event type	_____	Date	$_____
Insert event type	_____	Date	$_____

1.6 JURISDICTION-SPECIFIC VULNERABILITIES

Volume 1 of this hazard mitigation plan provides complete risk assessments for each identified hazard of concern. Noted vulnerabilities within the district include the following:

- Insert as appropriate.
- Insert as appropriate.
- Insert as appropriate.

1.7 HAZARD RISK RANKING

Table 1-8 presents a local ranking for District Name of all hazards of concern for which Volume 1 of this hazard mitigation plan provides complete risk assessments. This ranking summarizes how hazards vary for this jurisdiction. As described in detail in Volume 1, the ranking process involves an assessment of the likelihood of occurrence for each hazard, along with its potential impacts on people, property and the economy.

Table 1-8. Hazard Risk Ranking

Rank	Hazard Type	Risk Rating Score (Probability x Impact)	Category
1	_____	_____	High/Medium/Low
2	_____	_____	High/Medium/Low
3	_____	_____	High/Medium/Low
4	_____	_____	High/Medium/Low
5	_____	_____	High/Medium/Low
6	_____	_____	High/Medium/Low
7	_____	_____	High/Medium/Low
8	_____	_____	High/Medium/Low
9	_____	_____	High/Medium/Low

a. Based on the "Haywired" (Hayward Fault Scenario M7.05)
b. Severe weather is assessed more qualitatively than other hazards. Assumptions for risk ranking include high probability, medium impact on people, medium impact on property and low impact on economy.
c. Based on Very High and High Fire Severity Zones.
d. Based on 1 percent-annual-chance flood zone (otherwise known as the special flood hazard area)
e. Based on Very High, High, and Moderate Landslide Susceptibility Zones
f. Drought is assessed more qualitatively than other hazards. Generally, drought does not cause injury or death to people or result in property damage. Assumptions for risk ranking include high probability, no impact on people, low impact on property and low impact on economy for those jurisdictions with limited agriculture.
g. Based on the Del Valle Dam inundation scenario.

1.8 STATUS OF PREVIOUS PLAN ACTIONS

Table 1-9 summarizes the actions that were recommended in the previous version of the hazard mitigation plan and their implementation status at the time this update was prepared.

Table 1-9. Status of Previous Plan Actions

Action Item	Completed	Removed; No Longer Feasible	Carried Over to Plan Update: Check if Yes	Carried Over to Plan Update: Enter Action #
Insert Action Text *Comment:*				Action#
Insert Action Text *Comment:*				Action#
Insert Action Text *Comment:*				Action#
Insert Action Text *Comment:*				Action#
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Insert Action Text *Comment:*				Action#
Insert Action Text *Comment:*				Action#
Insert Action Text *Comment:*				Action#

Action Item	Completed	Removed; No Longer Feasible	Carried Over to Plan Update: Check if Yes	Carried Over to Plan Update: Enter Action #
Insert Action Text				Action#
Comment:				
Insert Action Text				Action#
Comment:				
Insert Action Text				Action#
Comment:				
Insert Action Text				Action#
Comment:				

1.9 HAZARD MITIGATION ACTION PLAN AND EVALUATION OF RECOMMENDED ACTIONS

Table 1-10 lists the actions that make up the District Name hazard mitigation action plan. Table 1-11 identifies the priority for each action. Table 1-12 summarizes the mitigation actions by hazard of concern and mitigation type.

Table 1-10. Hazard Mitigation Action Plan Matrix

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline
Action #—Where appropriate, support retrofitting or relocation of structures in high hazard areas, prioritizing structures that have experienced repetitive losses.							
Existing	Dam failure, Drought, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 2, 6, 8, 10, 11	TBD	TBD	High	HMGP, PDM, FMA	Short-term
Action #—Actively participate in the plan maintenance protocols outlined in Volume 1 of this hazard mitigation plan.							
New and Existing	Dam failure, Drought, Earthquake, Flood, Landslide, Severe weather, Wildfire	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	TBD	TBD	Low	Staff Time, General Funds	Short-term
Action #—Description							
Action #—Description							
Action #—Description							
Action #—Description							
Action #—Description							
Action #—Description							

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline
Action #—Description							
Action #—Description							
Action #—Description							
Action #—Description							
Action #—Description							
Action #—Description							
Action #—Description							
Action #—Description							
Action #—Description							

Table 1-11. Mitigation Action Priority

Action #	# of Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is Project Grant-Eligible?	Can Project Be Funded Under Existing Programs/ Budgets?	Implementation Priority[a]	Grant Pursuit Priority[a]
TBD	6	High	High	Yes	Yes	No	Medium	High
TBD	12	Low	Low	Yes	No	Yes	High	Low

a. See the introduction to this volume for explanation of priorities.

Table 1-12. Analysis of Mitigation Actions

Hazard Type	Action Addressing Hazard, by Mitigation Type[a]							
	Prevention	Property Protection	Public Education and Awareness	Natural Resource Protection	Emergency Services	Structural Projects	Climate Resilient	Community Capacity Building
_____								
_____								
_____								
_____								
_____								
_____								
_____								
_____								
_____								

a. See the introduction to this volume for explanation of mitigation types.

1.10 FUTURE NEEDS TO BETTER UNDERSTAND RISK/VULNERABILITY

Insert text, if any; otherwise, delete section

1.11 ADDITIONAL COMMENTS

Insert text, if any; otherwise, delete section

1.12 REVIEW AND INCORPORATION OF RESOURCES FOR THIS ANNEX

The following technical reports, plans, and regulatory mechanisms were reviewed to provide information for this annex.

- <INSERT PLAN/PROGRAM AND DESCRIPTION OF HOW IT WAS USED>
- <INSERT PLAN/PROGRAM AND DESCRIPTION OF HOW IT WAS USED>
- <INSERT PLAN/PROGRAM AND DESCRIPTION OF HOW IT WAS USED>
- **Hazard Mitigation Plan Annex Development Tool-kit**—The tool-kit was used to support the development of this annex including past hazard events, noted vulnerabilities, risk ranking and action development.

Dublin San Ramon Services District
Summary & Recommendation

Item 7.E.
Meeting Date: May 15, 2018

TITLE: Adopt Revised Apportioning Planning Costs Policy and Rescind Resolution No. 65-09

RECOMMENDATION:

Staff recommends the Board of Directors approve, by Resolution, the revised Apportioning Planning Costs policy and rescind Resolution No. 65-09.

SUMMARY:

All District policies are reviewed on a rotating four-year cycle to ensure that they remain current and that the Board seated at that time continues to concur with that policy. The Apportioning Planning Costs policy (Policy No. P400-13-1) was last revised in 2009 and remained status quo in 2013. Staff has reviewed the policy and recommends making minor changes in language for clarification and to be consistent with the District Code.

The proposed changes are presented in the attached red-lined version of the policy.

Originating Department: Engineering Services	**Contact: R. Biagtan**	**Legal Review: Not Required**
Cost: $0	**Funding Source: N/A**	
Attachments: ☐ None ☐ Staff Report ☒ Resolution ☐ Ordinance ☐ Task Order ☐ Proclamation ☒ Other (see list on right)	**Attachment 1 – Red-lined version of current Apportioning Planning Costs policy**	

POLICY

Dublin San Ramon Services District

Policy No.: **Type of Policy:**	P400-13-1	Finance
Policy Title:	Apportioning Planning Costs	
Policy Description:	Protects the District from claims from property owners who paid planning costs that should be collected from an adjacent property owner	

Approval Date:	~~Dec 1, 2009~~May 15, 2018	**Last Review Date:**	~~2013~~2018
Approval Resolution No.:	~~65-09~~____	**Next Review Date:**	~~2017~~2022
Rescinded Resolution No.:	~~41-94~~65-09	**Rescinded Resolution Date:**	~~Sept 20, 1994~~December 1, 2009

It is the policy of the Board of Directors of Dublin San Ramon Services District that:

Any work undertaken, and services provided by the District, pursuant to a ~~Public~~ Planning ~~Facilities Planning~~Service Agreement and the District's Policy Regarding Extension of Utility Services which is funded by or on behalf of a particular landowner or developer, shall not be subject to reimbursement by or through the District for benefits which may be derived there~~-~~from by other landowners or developers, except as may be agreed upon between or among said landowners or developers and the District and upon a finding by this Board that such reimbursement or other allocation of such costs is equitable and in the public's interest.

~~Policy is current and no changes need to be adopted by the Board of Directors.~~ ~~Status Quo Chronology~~ ~~Date Adopted December 1, 2009~~
~~Reviewed by~~ ~~Committee Finance Date April 30, 2013~~ ~~Committee Date~~ ~~Committee Date~~ ~~Committee Date~~

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RESOLUTION NO. _____

RESOLUTION OF THE BOARD OF DIRECTORS OF DUBLIN SAN RAMON SERVICES DISTRICT REVISING THE APPORTIONING PLANNING COSTS POLICY AND RESCINDING RESOLUTION NO. 65-09

WHEREAS, on September 20, 1994, the Board adopted an Apportioning Planning Costs policy for protecting the District from claims from property owners who paid planning costs that should be collected from an adjacent property owner; and

WHEREAS, on December 1, 2009, the policy was revised by Resolution No. 65-09 to eliminate reference to the District Code section number and added reference to a Public Facilities Planning Agreement; and

WHEREAS, the policy is revised to make minor changes in language for clarification and to be consistent with the District Code; and

WHEREAS, the policy now provides reference to the updated agreement title Planning Service Agreement.

NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF DUBLIN SAN RAMON SERVICES DISTRICT, a public agency located in the Counties of Alameda and Contra Costa, California, that the revised Apportioning Planning Costs policy, attached as Exhibit "A," be adopted; and Resolution No. 65-09, attached as Exhibit "B," is hereby rescinded.

ADOPTED by the Board of Directors of Dublin San Ramon Services District, a public agency in the State of California, Counties of Alameda and Contra Costa, at its regular meeting held on the 15th day of May, 2018, and passed by the following vote:

AYES:

NOES:

ABSENT:

_____
Georgean M. Vonheeder-Leopold, President

ATTEST: _____
Nicole Genzale, District Secretary

Dublin San Ramon Services District
Water, wastewater, recycled water

Policy

Policy No.: P400-13-1	**Type of Policy:** Finance
Policy Title: Apportioning Planning Costs	
Policy Description: Protects the District from claims from property owners who paid planning costs that should be collected from an adjacent property owner	
Approval Date: 5/15/2018	**Last Review Date:** 2018
Approval Resolution No.: TBD	**Next Review Date:** 2022
Rescinded Resolution No.: 65-09	**Rescinded Resolution Date:** 12/1/2009

It is the policy of the Board of Directors of Dublin San Ramon Services District that:

Any work undertaken, and services provided by the District, pursuant to a Planning Service Agreement and the District's Policy Regarding Extension of Utility Services which is funded by and on behalf of a particular landowner or developer, shall not be subject to reimbursement by or through the District for benefits which may be derived therefrom by other landowners or developers, except as may be agreed upon between or among said landowners or developers and the District and upon a finding by this Board that such reimbursement or other allocation of such costs is equitable and in the public's interest.

RESOLUTION NO. 65-09

RESOLUTION OF THE BOARD OF DIRECTORS OF DUBLIN SAN RAMON SERVICES DISTRICT REVISING THE APPORTIONING PLANNING COSTS POLICY AND RESCINDING RESOLUTION NO. 41-94

WHEREAS, on September 20, 1994, the Board adopted a Appropriating Planning Cost Policy for protecting the District from claims from property owners who paid planning costs that should be collected from an adjacent property owner; and

WHEREAS, the Policy is revised to eliminate reference to District Code Section number; and

WHEREAS, the Policy now provides reference to a Public Facilities Planning Agreement.

NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF DUBLIN SAN RAMON SERVICES DISTRICT, a public agency located in the Counties of Alameda and Contra Costa, California, that the revised Appropriating Planning Cost Policy, attached as Exhibit "A", be adopted; and Resolution No. 41-94 is hereby rescinded and attached as Exhibit "B."

ADOPTED by the Board of Directors of Dublin San Ramon Services District, a public agency in the State of California, Counties of Alameda and Contra Costa, at its regular meeting held on the 1st day of December 2009, and passed by the following vote:

AYES: 5 - Directors Jeffrey G. Hansen, D.L. (Pat) Howard, Georgean M. Vonheeder-Leopold, Richard M. Halket, Daniel J.Scannell

NOES: 0

ABSENT: 0

Daniel J. Scannell, President

ATTEST: Nancy G. Hatfield
Nancy G. Hatfield, District Secretary

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Dublin San Ramon Services District
Summary & Recommendation

Item 8.A.
Meeting Date: May 15, 2018

TITLE: Receive Presentation on the *Joint Tri-Valley Potable Reuse Technical Feasibility Study*

RECOMMENDATION:

Staff recommends the Board of Directors receive a presentation on the *Joint Tri-Valley Potable Reuse Technical Feasibility Study* and express support for proceeding with planning level studies associated with a potential potable reuse project.

SUMMARY:

In October 2015, the Board adopted the Water Supply, Storage, Conveyance, Quality and Conservation policy, under which the District is seeking to diversify water supply sources and improve water supply reliability by collaborating with other Tri-Valley water agencies. The District subsequently adopted a strategic plan that includes a goal to develop and implement an integrated recycled and potable water program that meets the objectives of the District's water supply policy. One of the tasks under the strategic plan is to complete a feasibility study for a Tri-Valley advanced purification project and implement a joint Tri-Valley strategy.

Since the beginning of the 2014-2016 drought, the District has participated in water policy roundtables and Tri-Valley Water Liaison Committee (Committee) meetings to discuss water issues in the Tri-Valley. The Committee consists of elected officials from the Tri-Valley water agencies (DSRSD, Zone 7 Water Agency, City of Livermore, City of Pleasanton, the California Water Service Company – Livermore District) and the Cities of Dublin and San Ramon. In February 2016, the Committee requested that the Tri-Valley water agencies proceed with a joint feasibility study for potable reuse in the Tri-Valley.

The *Joint Tri-Valley Joint Potable Reuse Technical Feasibility Study* (Study) is complete. At its March 1, 2018 meeting, the Committee received a high level presentation of the Study along with a presentation of the results of a 2018 community survey on water issues. The Study and the results of the community survey are discussed further in the attached staff report.

The Committee members are tasked with bringing the Study and survey information back to their agency to review in greater detail. A follow-up Liaison Committee meeting was suggested in two to three months to discuss possible next steps. Due to timing of the agencies' respective meetings and Committee members' schedules, the follow-up meeting is anticipated to be held in September 2018.

Staff recommends the Board receive a presentation of the Study and express support for proceeding with planning level studies associated with a potential potable reuse project. These studies may require task orders through the Tri-Valley Agencies Reciprocal Services Agreement in the future. Should the District's share of costs for the studies exceed staff authority or the authorized CIP project funds, staff will seek further Board approval.

Originating Department: Engineering Services	**Contact: R. Biagtan**	**Legal Review: Not Required**
Cost: $200,000 - $1M (Varies, depending on number of participating agencies)	**Funding Source:** **Water Replacement (Fund 610) - 65%** **Water Expansion (Fund 620) - 35%**	
Attachments: ☐ None ☒ Staff Report ☐ Resolution ☐ Ordinance ☐ Task Order ☐ Proclamation ☐ Other (see list on right)		

STAFF REPORT

District Board of Directors
May 15, 2018

Receive Presentation on the *Tri-Valley Water Agencies Joint Potable Reuse Feasibility Study*

BACKGROUND

District Policy and Goal

In October 2015, the Board adopted the *Water Supply, Storage, Conveyance, Quality and Conservation Policy* with the objective to diversify its water supply sources and improve water supply reliability by collaborating with other Tri-Valley water agencies. The District subsequently adopted a strategic plan that includes a goal to develop and implement an integrated recycled and potable water program that meets the objectives of the District's water supply policy. One of the tasks under the strategic plan is to complete a feasibility study for a Tri-Valley advanced purification project and implement a joint Tri-Valley strategy.

Tri-Valley Action towards Long Term Reliability

During the 2014-2016 drought, the Tri-Valley Water Liaison Committee (Liaison Committee) was formed to discuss water issues in the Tri-Valley. The Liaison Committee consists of elected officials from the Tri-Valley Water Agencies (DSRSD, Zone 7 Water Agency, City of Livermore, City of Pleasanton, the California Water Service Company – Livermore District,) and the Cities of Dublin and San Ramon. The Liaison Committee requested that the Tri-Valley Water Agencies proceed with a joint feasibility study for potable reuse in the Tri-Valley. In December 2016, a project management committee consisting of senior technical staff from the Tri-Valley Water Agencies commenced the preparation of the feasibility study with Carollo Engineers (Carollo.) The Project Management Committee received oversight from a steering committee consisting of directors and general managers of the Tri-Valley Water Agencies.

The draft *Joint Tri-Valley Potable Reuse Technical Feasibility Study* (Study) was completed in early 2018. The Study finds that potable reuse in the Tri-Valley is feasible and will improve water supply reliability. Additionally, the project may improve overall groundwater basin quality and delivered water quality.

At its March 1, 2018 meeting, the Liaison Committee received a high level presentation of the draft Study along with a presentation of the results of a 2018 community survey on water issues. The Study and the results of the community survey are discussed further below. The Committee members are tasked with bringing the Study and survey information back to their agency to review in greater detail. A follow-up Liaison Committee meeting was suggested in two to three months to discuss possible next steps. Due to timing of the agencies' respective meetings and Committee members' schedules, the follow-up meeting is anticipated to be held in September 2018. The draft minutes from the March 1 meeting are included as Attachment 1.

DISCUSSION

Potable Reuse Feasibility Study

The primary goals of the Study were: 1) to evaluate the feasibility of a wide range of potable reuse options for the Tri-Valley based on technical, financial, and regulatory considerations and 2) assuming that potable reuse is found to be feasible, to recommend next steps for the agencies. The draft Study is included as Attachment 2.

Given the numerous possibilities of potable reuse projects, with various source water, treatment locations, and end uses, a step-wise decision process was used to evaluate the potential Tri-Valley potable reuse projects. The process was designed to develop a "book-end" of options to be considered with the end goals of improving water supply reliability, protecting water quality, and being fiscally responsible. The process narrowed the number of project alternatives (including minor variations) down to six alternatives for detailed evaluation.

The Livermore Water Reclamation Plant (LWRP) and the DSRSD Wastewater Treatment Plant were the sources of water supply for a project. Both the City of Livermore and the District have existing non-potable recycled water programs. These programs limit the amount of available flow for a potable reuse project. Based on projected wastewater availability, the study found that the City of Livermore may provide up to 5,500 acre-feet per year of year-round flow. The District may provide supply on a seasonal basis, when recycled water demand for landscape irrigation is low. Based on seasonal operation, an advanced water purification facility may yield 10,000 acre-feet per year.

To provide a sense of scale, the water demand provided by the Zone 7 water system is estimated to be about 60,000 acre-feet annually at buildout. Theoretically a potable reuse project could provide another 5,500 to 10,000 acre-feet per year of water, thus adding 7% to 15% to the Tri-Valley water supply every year.

The study identified four potential sites for an advanced water purification facility:

- DSRSD – in space currently used as a dedicated land disposal (DLD)
- LWRP – in the abandoned on-site facultative sludge lagoons (FSLs)
- Mocho – near Zone 7's existing Mocho Demineralization Facility
- Pleasanton Corp Yard

The study investigated three potential end uses for purified water:

- Groundwater augmentation or recharge via injection wells at two locations - one in the eastern side of the basin in Livermore and one in the western side in Pleasanton near the Mocho Demineralization facility
- Groundwater recharge via Lake I (Chain of Lakes) surficial recharge
- Raw water augmentation via Chain of Lakes to the Zone 7 Del Valle Water Treatment Plant (DVWTP) or directly to DVWTP

The source water, treatment and end use locations are provided in Figure 1 below.



Figure 1. Source water, Treatment and End Use Locations

A summary of the selected alternatives is shown in Table 1. The six alternatives were found to be feasible, improve water supply reliability, improve overall groundwater basin quality and delivered water quality. Regulatory pathways are available for every option. Qualitative analysis shows some variability in the overall operational flexibility and constructability between alternatives.

Table 1. Alternatives for Potable Reuse Purification and End Use

Alternatives	Purification Location	End Use	Water Yield (AF/Year)	Capital Cost (million)	Unit Cost[1] ($/AF)
1	Livermore Water Reclamation Plant	Groundwater Augmentation via Chain of Lakes	5,500	$112	$2,530
2	Livermore Water Reclamation Plant	Groundwater Injection	5,500	$103	$2,420
3	DSRSD Wastewater Treatment Facility	Raw Water Augmentation via Chain of Lakes and DVWTP	10,000	$222	$2,350
4	DSRSD Wastewater Treatment Facility	Groundwater Injection	10,000	$194	$2,160
5	Zone 7 Mocho Demin Facility	Groundwater Injection	10,000	$210	$2,250

Alternatives	Purification Location	End Use	Water Yield (AF/Year)	Capital Cost (million)	Unit Cost[1] ($/AF)
6	Pleasanton Operations Service Center	Raw Water Augmentation via Chain of Lakes and DVWTP	10,000	$208	$2,240

[1]**Unit cost includes capital cost financed by debt plus annual operation and maintenance costs.**

Project Cost and Financing

A Tri-Valley potable reuse project will require funding for capital costs for construction of facilities and operational and maintenance costs. The capital cost of the six alternatives shown in Table 1 range from $112 million to $222 million. Capital cost plus operations cost can provide water in the range of $2,160 to $2,530 per acre-foot. The cost of a potable reuse project for water customers will vary, depending on the number of partner agencies participating as the project moves forward. Based on the estimated number of Tri-Valley water customers at buildout, the cost of this project (capital cost financed by debt plus operating cost) could add $10 to $15 per month to an average water bill.

Funding may be available through competitive grants and loans from state and federal programs for the capital costs, including planning, design and construction. State funding programs may include the Water Recycling Funding Program, Clean Water State Revolving Fund, Green Project Reserve, Integrated Regional Water Management Grants, and Proposition 1. Federal grant programs include Title XVI, Water Infrastructure Improvements for the Nation Act, and Water Infrastructure Finance and Innovation Act. The District has had some success in pursuing funding with both state and federal entities. However, at this time, staff anticipates that a majority of the project cost would come from resources of the partnering Tri-Valley water agencies through rates and fees.

To meet the objectives of the District's Water Supply, Storage, Conveyance, Quality and Conservation Policy (Policy No. P300-15-1), the District has included two projects, *Water Supply Reliability Project (CIP 16-W009)* and *Capital Improvements to Increase Water Supply Program - Phase 2 (CIP No. 00-W002)* in its Capital Improvement Program. The District has also planned for partial funding of a potable reuse project in the development of its water capacity reserve fees and will also be considering a potable reuse project in the upcoming water rate study.

Community Awareness and Outreach

In November 2015, the Tri-Valley agencies conducted a community survey of support for a potable reuse project. Key results indicated that 63% of the Tri-Valley supported a potable reuse project. Moreover, the results showed that 82% would be willing to pay up to $5 per month for a project that would provide water reliability, and 56% would be willing to pay $20 a month for a project that would provide water reliability. Because this survey was completed in the midst of the 2014-2015 severe drought, staff from the Tri-Valley water agencies felt that a resurvey of the community was warranted.

A second water supply reliability survey was completed in January of 2018, and the key findings showed a decrease in concerns about the use of recycled water, and a decrease in how much the Tri-Valley is willing to pay for water reliability with a potable reuse project: 55% of respondents support supplementing existing water supplies with purified recycled water and the majority would support a $5 monthly increase in their water bills, or a 5% increase, as opposed to a $20 increase three years earlier.

The surveys illustrate the need to reach out to the Tri-Valley residents and educate them about the Tri-Valley's water supply, the value of water, and the challenges that put our water supply at risk. A reliable water supply

will require additional water supply projects, regardless of whether the project is potable reuse, the CalWater Fix or any of the other projects contemplated in the Zone 7 Water Supply Evaluation. All of these projects will require investments and the water agencies will ultimately need to communicate the need for these investments to their customers.

At its February 11, 2016 meeting, the Liaison Committee members expressed an interest in a public education program proceeding concurrently with the feasibility study for potable reuse. A multi-agency staff team, the Water Outreach Workgroup (WOW), developed a joint "Tri-Valley Water 101" presentation, which some of the agencies have begun presenting to their respective communities and interest groups.

Potential Next Steps

If the partnering agencies wish to continue pursuing potable reuse, there are a number of technical studies to further define a project. In the near-term, to narrow the best end use option, further studies are needed to evaluate the best candidates for siting injection wells; to characterize the potential for contaminant mobilization in the groundwater basin using models and field test; and to determine the ability of the COL to receive, store, and recharge purified water in conjunction with other potential uses of the COL. The cost of these studies are in the range of $800,000 to $930,000. These studies may commence within a year and may take up to three years to complete.

In parallel, a broader effort to review the need for and yield of all the water supply options, including potable reuse, would provide context on how potable reuse fits within the Tri-valley water supply portfolio. This effort could include updating the Zone 7 2016 Water Supply Evaluation Update to reflect the findings from the Study as well as new data and options that have developed since 2016; conducting a conjunctive use study of the groundwater basin; and refining regional demand projections to reflect the proposed water budgets in the State water conservation framework. Staff anticipates that Zone 7 will proceed with some of these studies shortly.

A potable reuse project may take eight to twelve years, from planning studies to implementation. Attachment 3 presents the potential next steps and timeline for planning and technical efforts associated with implementation of a potable reuse project.

There are also major public outreach and institutional components to potable reuse implementation that would need to be addressed. As mentioned above, survey results show the need for public outreach, parallel to the preparation of the technical studies. The initial outreach should explain the source of the Tri-Valley's water supply, the need for long-term water supply reliability and efforts to improve long-term reliability. The Tri-Valley water agencies will need to provide coordinated messages within their service area. The estimated cost to support this preliminary effort may be up to $200,000.

Additionally, the Tri-Valley water agencies will need to develop an institutional framework for decision making, cost sharing, ownership and operations of a potable reuse facility. The estimated cost to support this effort may be up to $100,000.

RECOMMENDATION

Staff recommends the Board receive a presentation on the Study and express support for proceeding with planning level studies associated with a potential potable reuse project. These studies may require task orders through the Tri-Valley Agencies Reciprocal Services Agreement in the future. Should the District's share of costs for the studies exceed staff authority or the authorized CIP project funds, staff will seek further Board approval.

Tri-Valley Water Liaison Committee Staff Report

DATE: March 1, 2018

TO: Tri-Valley Water Liaison Committee Members

FROM: Jill Duerig, Zone 7 General Manager
Darren Greenwood, City of Livermore Public Works Director
Kathleen Yurchak, City of Pleasanton Operations Services Director
Dan McIntyre, DSRSD General Manager
Frank Vallejo, Cal Water District Manager

SUBJECT: Briefing on Tri-Valley Joint Feasibility Study for Potable Reuse

RECOMMENDATION:

Staff recommend that the Liaison Committee:

1. Receive a presentation on the results of the Tri-Valley Joint Feasibility Study for Potable Reuse
2. Receive a presentation on a re-survey of the community's support for a potable reuse project
3. Provide initial comments to staff on the results of the feasibility study and the community survey
4. Refer the Tri-Valley Joint Feasibility Study for Potable Reuse to the Tri-Valley agencies for over the next 2 to 3 months to receive direction on next steps
5. Reconvene the next Liaison meeting to jointly consider next steps on a regional potable reuse project

BACKGROUND:

Since the start of the 2014-2015 Great Drought, the water agencies and cities of the Tri-Valley and the California Water Service Company (Cal Water) have held eight meetings of elected officials to confer on Tri-Valley water issues ("Water Policy Roundtables" followed by "Water Liaison" meetings) from 2014 to 2017. At the February 11, 2016 Liaison meeting, the elected officials received a polling report showing public support for a potable reuse project, and expressed mutual interest in proceeding with a Tri-Valley Joint Feasibility Study for Potable Reuse. In late 2016, a joint project management team (consisting of

senior technical staff from the participating agencies) began work with the consultant, Carollo Engineers, on the feasibility study. This feasibility study was funded jointly by the City of Livermore, the City of Pleasanton, Zone 7 Water Agency, Dublin San Ramon Services District, and Cal Water, under the provisions of the Tri-Valley Intergovernmental Reciprocal Services Agreement. Executive oversight of the study was provided by a joint Steering Committee (department directors and general managers of the agencies, and the Cal Water District manager).

DISCUSSION:

Joint Feasibility Study for Potable Reuse

The Tri-Valley Joint Feasibility Study has been completed; staff and Carollo Engineers will provide an overview of the key findings at this Liaison meeting.

The study initially reviewed 21 preliminary concepts for a potable reuse project, and in consultation with the Steering Committee and the Project Management Committee, narrowed the number of project options (including minor variations) down to six for a more detailed evaluation. The six final options evaluated in great detail are all feasible, although some of the options require further study to better understand and resolve complicated issues and challenges. The report consolidates and develops a great deal of useful information on a project concept that is specific to the Tri-Valley.

One of the first questions the feasibility study assesses is how much additional water supply a potable reuse or purified water project could provide to the Tri-Valley. At buildout of the Tri-Valley, water demand provided by the Zone 7 water system is estimated to be about 60,000 acre-feet annually. To give a sense of scale, theoretically a potable reuse project could provide another 5,500 to 10,000 acre-feet of water, thus adding 7% to 15% to the Tri-Valley water supply every year, diversifying the water supply, and bolstering reliability during severe droughts.

The cost of various options ranges from $112 million to $222 million. When the capital cost of borrowing is combined with operational costs, a potable reuse project can provide water in the range of $2,100 to $2,500 per acre-foot.

At buildout of the Tri-Valley, the cost of this project (capital cost financed by debt plus operating cost) could add $10 to $15 per month to an average water bill.

Public Education Program

At the February 11, 2016 Liaison meeting, the elected officials expressed an interest in a public education program proceeding concurrently with the feasibility study for potable reuse. A separate multi-agency staff team, the Water Outreach Workgroup (WOW), developed a joint “Tri-Valley Water 101” presentation, which some of the agencies have begun presenting to their respective communities and interest groups. A copy of the “Tri-Valley Water 101” presentation is attached for reference. Further community presentations will be developed, depending on how a potable reuse program proceeds. General information and a sign-up list for community presentations can be found at TriValleyWater.org.

Community Survey on Potable Reuse

In November of 2015, the Tri-Valley agencies conducted a community survey of support for a potable reuse project using the groundwater injection concept. These results were presented to the Liaison Committee in November of 2016. Key results indicated that by a 63% to 29% margin, the Tri-Valley supported a potable reuse project. Moreover, the results showed that 82% would be willing to pay up to $5 per month for a project that would provide water reliability, and 56% would be willing to pay $20 for a project that would provide water reliability.

Because this community survey was completed in the midst of the Great Drought of 2014-2015 and community attitudes may be changing, staff determined that a new poll of the community was warranted. This survey was completed in January of 2018, and the results will be presented at this Liaison Committee meeting.

Potential Next Steps

The Tri-Valley Joint Feasibility Study for Potable Reuse answered a number of questions about general feasibility, but also brought to light a number of technical, regulatory, and economic challenges, as well as outstanding questions that need to be answered. Given the large scale of such a project, input from the full Board and Councils of the various agencies might be appropriate, prior to the elected officials of the Water Liaison Committee concurring on further project development.

Staff proposes a 2-3 month period for each agency's elected body to consider the findings of the Joint Feasibility Study in detail. In early summer, another Liaison meeting would be scheduled to further confer. If the agencies of the Tri-Valley are interested in further exploring a project, the following are next steps towards project development and implementation:

Phase / Activity	**Description**	**Timeline**
Tri-Valley Potable Reuse Water Master Plan	Further evaluate areas not completely studied in the Feasibility Study, including groundwater management, brine disposal, operational, financial, and institutional considerations.	2 years
Potable Water Programmatic Environmental Impact Report (EIR)	Evaluate the impacts of two or more options suggested in the Potable Reuse Water Master Plan, including 10% preliminary design.	2 years
Potable Reuse Project Design	Final design of a project (100% design)	2 years
Potable Reuse Bid/Construction	Bid and construct project	2 – 3 years
Final Commissioning	-	TBD

Although a potable reuse project offers the strong possibility of bolstering the Tri-Valley's water supply considerably, a potable reuse project is very complex and challenging. If the agencies came to consensus on developing and constructing a regional project, and moved expeditiously, a project could be operational in an 8-10 year time frame.

Attachment: Tri-Valley Water 101 Presentation



Tri-Valley Agencies

Joint Tri-Valley Potable Reuse Technical Feasibility Study

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Tri-Valley Agencies
Potable Reuse Feasibility Study



Joint Tri-Valley
Potable Reuse Feasibility Study

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Abbreviations

AC	Acre
ADWF	Average Dry Weather Flow
AF	Acre-feet
AFM	Acre-Feet Per Month
AFY	Acre-foot per year
AOP	Advanced Oxidation Processes
ASR	Aquifer Storage and Recover
ATP	Adenosine Triphosphate
AWPF	Advanced Water Purification Facilities
AWTF	Advanced Water Treatment Facility
BAC	Biological Activated Carbon
BPI	Blue Plan-it®
Bq	Becquerel
Carollo	Carollo Engineers, Inc.
CalEPA	California Environmental Protection Agency
CCCSD	Central Contra Costa Sanitary District
CDPH	California Department of Public Health
CECs	Contaminants of Emerging Concern
CFR	Code of Federal Regulations
Ci	Curie
CIP	Capital Improvement Projects
CIWQS	California Integrated Water Quality System
COLs	Chain of Lakes
CRMWD	Colorado River Municipal Water District
Ct	Contact Time
CTR	California Toxic Rule
CWS	Clean Water Services

DBPs	Disinfection byproducts
DDW	California Division of Drinking Water
DEET	N,N-Diethyl-meta-toluamide
DERWA	DSRSD-EBMUD Recycled Water Authority
DPR	Direct Potable Reuse
DSRSD	Dublin San Ramon Sanitation District
DVWTP	Del Valle Water Treatment Plant
EBDA	East Bay Dischargers Authority
EBMUD	East Bay Municipal Utility District
EC	Electrical Conductivity
EPHC	Environment Protection and Health Council
ESB	Engineered Storage Buffers
ESCP	Enhanced Source Control Program
FAT	Full Advanced Treatment
FAT+	Full advanced treatment plus additional treatment
FGF	Forest Grove Facility
FRT	Failure and Response Time
ft	Feet
GAC	Granular Activated Carbon
GMF	Granular Media Filtration
GRRP	Groundwater Replenishment Reuse Projects
GWRS	Groundwater Replenishment System
HAAs	Haloacetic acids
IPR	Indirect Potable Reuse
LACSD	Los Angeles County Sanitation District
LACDPW	Los Angeles County Department of Public Works
LASAN	Los Angeles Sanitation
LAVQAR	Livermore-Amador Valley Quarry Area Reclamation
LAVWMA	Livermore-Amador Valley Water Management Agency

LF	Lineal feet
LLNL	Lawrence Livermore National Laboratory
LRCs	Log Removal Credits
LRV	Log Removal Value
LT2	Long Term 2
LWRP	Livermore Water Reclamation Plant
MCL	Maximum Contaminant level
MF	Microfiltration
MG	Million gallons
mg/L	milligrams per liter
mgd	million gallons per day
MIT	Membrane Integrity Testing
MPN	Most Probable Number
msl	Mean sea level
O&M	Operations and maintenance
NDMA	N-Nitrosodimethylamine
NF	Nanofiltration
NL	Notification Level
NHMRC	National Health and Medical Research Council
NPDES	National Pollutant Discharge Elimination System
NRC	National Research Council
NRMMC	National Resource Management Ministerial Council
NTU	Nephelometric Turbidity Unit
OCWD	Orange County Water District
PFOA	Perfluoro-octanoic acid
PFOS	Perfluoro-octane sulfonate
POC	Pollutants of Concern
PPWTP	Patterson Path Water Treatment Plant
Q	Flow

QMRA	Quantitative Microbial Risk Assessment
RO	Reverse Osmosis
RRT	Response Retention Times
RW	Recycled Water
RWC	Recycled Water Contribution
RWPF	Raw Water Production Facility
RWQCB	Regional Water Quality Control Board
SNL	Sandia National Laboratory
SRT	Solids Retention Time
SRVRWP	San Ramon Valley Recycled Water Program
SWA	Surface Water Augmentation
SWMORs	Surface Water Monthly Operating Reports
SWP	State Water Project
SWRCB	State Water Resources Control Board
SWTP	Surface Water Treatment Plant
SWTR	Surface Water Treatment Rule
TAT	Turnaround Time
TCEP	Tris (2-chloroethyl) phosphate
TDS	Total Dissolved Solids
TEQ	Toxic Equivalents
THMs	Trihalomethanes
TI	Terminal Island
TM	Technical Memorandum
TMF	Technical, Managerial, and Financial
TOC	Total Organic Carbon
TOrC	Trace Organic Constituents
UF	Ultrafiltration
USEPA	United States Environmental Protection Agency
UV	Ultraviolet

UV AOP	Ultraviolet advanced oxidation process
WERF	Water Environment & Reuse Foundation
WHO	World Health Organization
WRD	Water Replenishment District
WRP	Water Reclamation Plant
WRRF	WateReuse Research Foundation
WSE	Water surface elevation
WTP	Water treatment plant
WWTP	Wastewater Treatment Plant Operation
µg/L	micrograms per liter
Zone 7	Zone 7 Water Agency

EXECUTIVE SUMMARY AND NEXT STEPS

Introduction and Purpose

The Water Supply Evaluation Update (2016 WSE Update) completed by Zone 7 Water Agency (Zone 7) in February 2016 underscored the need to pursue water supply options to enhance long-term water supply reliability for the Livermore-Amador Valley (Tri-Valley). Potential future water supply options identified in the WSE Update include the California WaterFix, desalination, and potable reuse. On February 11, 2016, participants in the Tri-Valley Water Policy Roundtable—including elected representatives from the cities of Dublin, Livermore, Pleasanton, San Ramon, DSRSD, and Zone 7—agreed to proceed in a more detailed study of potable reuse, which would be a local and drought-resistant supply. In response, the Tri-Valley Water Agencies, described further below, jointly funded and oversaw the effort to complete the Joint Tri-Valley Potable Reuse Technical Feasibility Study.

The primary goals of this study are: 1) to evaluate the feasibility of a wide range of potable reuse options for the Tri-Valley based on technical, financial, and regulatory considerations and 2) assuming that potable reuse is found to be technically feasible, to recommend next steps for the agencies.

Project Participants

The study is being conducted by the Tri-Valley Water Agencies. Each agency plays a role in water treatment and distribution, and/or wastewater collection and treatment, and recycled water production and distribution. The agencies and corresponding roles are as follows:

- **California Water Service (Cal Water)** – Water retailer within the Livermore District.
- **City of Livermore** – Water retailer and provider of wastewater collection/treatment services for the residents within its service area.
- **City of Pleasanton** – Water retailer and provider of wastewater collection services within its service area.
- **Dublin San Ramon Services District (DSRSD)** – Water retailer within its service area. Provider of wastewater collection and treatment services for Dublin and southern San Ramon, and wastewater treatment for Pleasanton. DSRSD and East Bay Municipal Utility District (EBMUD) formed the San Ramon Valley Recycled Water Program (SRVRWP). The program provides tertiary-treated recycled water to DSRSD, EBMUD, and Pleasanton irrigation customers at 558 locations.
- **Zone 7 Water Agency (Zone 7)** – Wholesale water provider to the Cities of Livermore, Pleasanton, Dublin, and a portion of San Ramon[1] through the water retailer agencies listed above. Zone 7 also manages the local groundwater basin as the Groundwater Sustainability Agency for the Livermore Valley Groundwater Basin. Furthermore, Zone 7 provides flood protection in eastern Alameda County.

A map showing the service areas is shown in Figure ES.1.

[1] Served through an out-of-service area agreement with DSRSD.

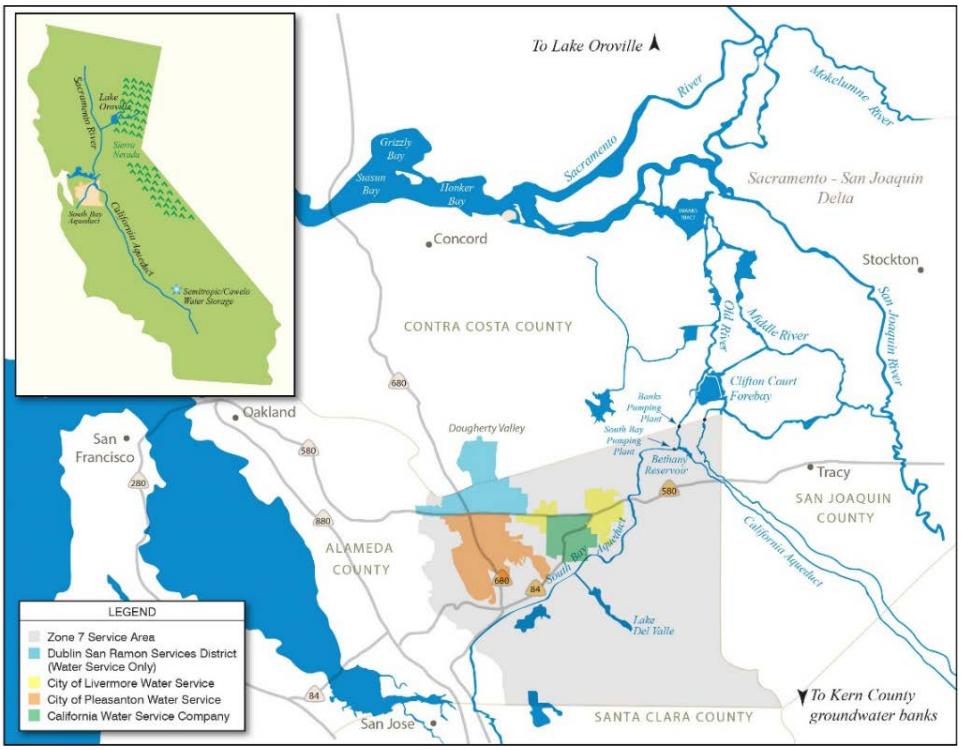


Figure ES.1 Tri-Valley Water Agencies and Service Areas

Range of Water Supply Yield

The 2016 WSE Update evaluated a number of water supply portfolios including a combination of the following potential new supplies: California WaterFix, desalination, and potable reuse. Los Vaqueros was also included as a potential new storage location. Desalination and potable reuse were assumed to have yields of 5,600 acre-feet per year (AFY) and 7,800 AFY, respectively. For the purposes of this study, an upper bookend of 10,000 AFY was assumed for potable reuse, which was also consistent with projected wastewater availability, as discussed further below. A lower bookend of 5,500 AFY was used.

Existing Facilities and Regulations

Zone 7 supplies water to the Tri-Valley using raw imported water (State Water Project), local water (Arroyo Valle), and groundwater. Raw water is treated at either the Patterson Pass Water Treatment Plant (PPWTP) or the Del Valle Water Treatment Plant (DVWTP) before distribution (locations shown in Figure ES.2). Zone 7's wells are primarily located in the western portion of the service area. Some groundwater in the Mocho Wellfield area with high total dissolved solids (TDS) is treated through a demineralization plant before distribution. Additional Zone 7 water facilities include the Chain of Lakes (COL), a series of existing or former gravel quarries that are in the process of reclamation or have been reclaimed as water storage and/or recharge lakes (Figure ES.2). Zone 7 currently owns Cope Lake and Lake I, with the rest of the ten lakes due to be transferred to Zone 7 in the future. Lake H is expected to be transferred for Zone 7's use over the next few years. Zone 7 will use the COL for a variety of water resource management activities.

Existing wastewater facilities include the DSRSD wastewater treatment plant (WWTP) and the Livermore Water Reclamation Plant (LWRP) as shown in Figure ES.2. Both DSRSD and Livermore have existing non-potable recycled water irrigation programs. Secondary effluent that is not used for producing recycled water is discharged to the San Francisco Bay through the Livermore-Amador Valley Water Management Agency (LAVWMA) and East Bay Dischargers Authority (EBDA) facilities.

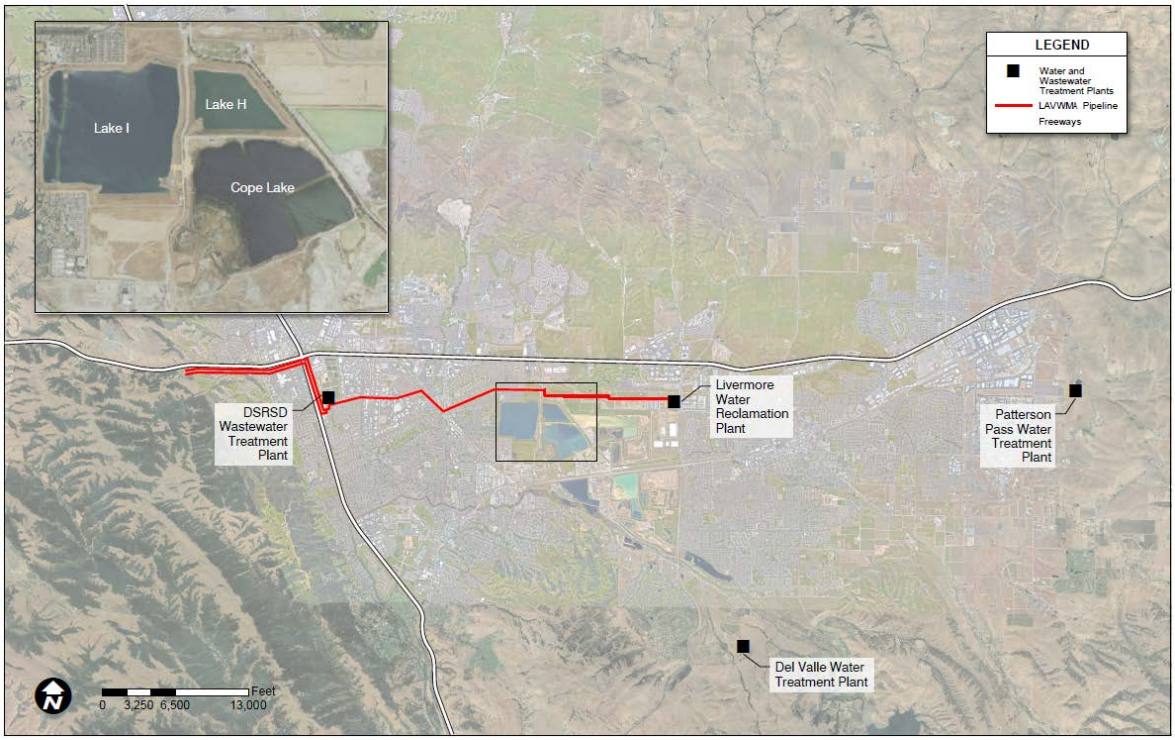


Figure ES.2 Existing Water and Wastewater Facilities

Potable Reuse Status and Regulations

Potable reuse has been utilized successfully by California agencies over 30 years as a means to extend water supplies. Other states have also successfully implemented potable reuse while being protective of public health. Project-specific permits for potable reuse have been issued in California for many years, although now regulations are clearly defined for groundwater recharge by the 2014 Groundwater Replenishment Reuse Projects (GRRPs) requirements included in Title 22 and the surface water augmentation SWA regulations were adopted following a released for public comment period in March 2018. The September 2016 draft report by the State Water Resources Control Board (SWRCB), titled "Investigation on the Feasibility of Developing Uniform Water Recycling Criteria for Direct Potable Reuse," found that it is feasible to develop uniform water recycling criteria that would incorporate a level of public health protection as good as or better than what is currently provided in California by conventional drinking water supplies (SWRCB, 2016). The state is now moving forward with developing regulations for other types of potable reuse.

The term "potable reuse" incorporates all types of reuse whereby recycled water is safely incorporated into potable water supplies. For the purposes of this study, the term "potable

reuse" refers to the practice of using purified water derived from wastewater effluent to supplement water supplies. Specific terminology that will be used in this study are:

Groundwater Augmentation or Recharge: planned use of purified recycled water for replenishment of a groundwater basin or an aquifer that has been designated as a source of water supply for a public water system.

Raw Water Augmentation (RWA): planned placement of purified recycled water into a system of pipelines or aqueducts that deliver raw water to a drinking water treatment plant that provides water to a public water system.

Treatment Technology

An advanced water purification facility (AWPF) is required for any potable reuse operation. Potable reuse uses multiple barriers for reliable purification. The multiple barriers concept was designed to ensure public health and the reliability of the process. Each treatment technology has different capabilities in removing pathogens, contaminants of emerging concern, and meeting drinking water standards so combining them adds layers of safety as shown in Figure ES.3 and Table ES.1.

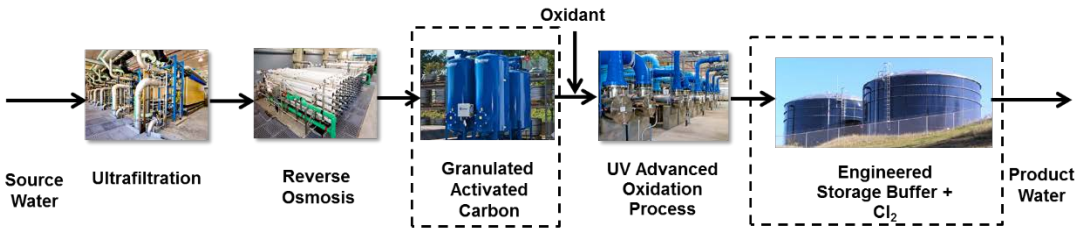


Figure ES. 3 AWPF Treatment Train (Dash lines show additional treatment assumed for RWA)

Table ES.1 Treatment Technologies Target Removal and Multiple Barrier Concept

Target	UF	RO	GAC	UV AOP	ESB + Cl_2
Protozoa	X	X		X	
Virus		X		X	X
MCLs		X	X	X	
CECs		X	X	X	

A treatment train that meets regulatory guidance for groundwater recharge has been established by Title 22, termed Full Advanced Treatment (FAT). This widely accepted and regulatory approved treatment process train for potable reuse is membrane filtration (MF/UF, micro or ultra-filtration), reverse osmosis (RO), followed by an ultraviolet light/advanced oxidation processes (UV/AOP) step. The proposed treatment train for Raw Water Augmentation involves the addition of Granular Activated Carbon (GAC) after the RO process to prevent any contaminant spikes that might pass through the RO from getting to the finished water. An engineered storage buffer (ESB) is also included at the end of the treatment train. This ESB is a series of three tanks, which provides additional monitoring time to be able to respond to any

issue in the treatment train upstream. This treatment train, called FAT+, when combined with the downstream WTPs, greatly exceeds expected regulatory goals.

Alternative Development Method

Due to the numerous possibilities of potable reuse projects, with various source water, treatment locations, and end uses, a step-wise decision process was used to evaluate the potential Tri-Valley potable reuse projects, as is shown in Figure ES.4. At key stages in the selection process, workshops with representatives from all project participants were convened to facilitate key decisions. The effort was designed to develop a "book-end" of options to be considered with the end goals of improving water supply reliability, protecting water quality, and being fiscally responsible.

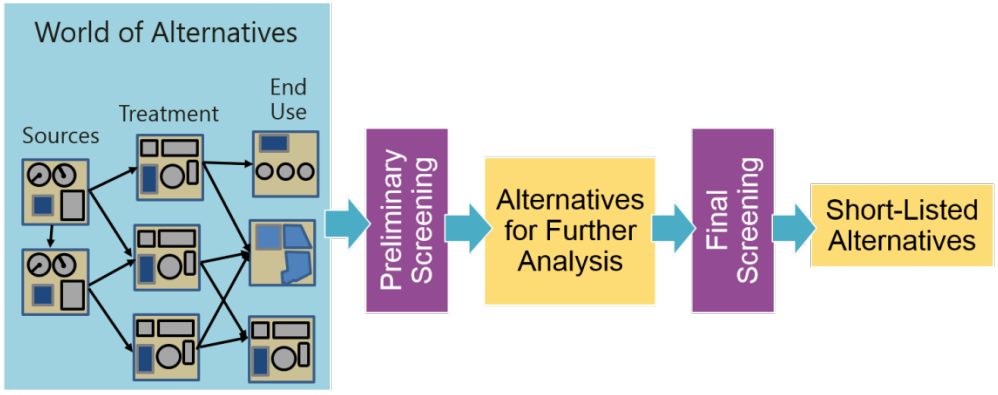


Figure ES.4 Alternative Development Process

Evaluation Criteria

The following evaluation criteria were used in the screening of project alternatives:

- Yield (measured by acre-feet per year - AFY).
- Cost (Capital and Operations & Maintenance [O&M]).
- Improved Supply Reliability.
- Improved Delivered Water Quality.
- Improved Groundwater Basin Quality.
- Clear Regulatory Pathway.
- Minimizes Neighborhood Impacts.
- Ability to Phase the Project.
- Operational Flexibility.
- Ease of Construction.

Alternatives Development

Alternatives were developed by combining source of water, treatment locations, and different end uses as discussed below.

Source Water and Potential Yield

There are two sources of water for the purified water projects, LWRP and DSRSD WWTP. These two WWTPs have existing non-potable recycled water programs. These programs limit the

amount of available flow for the AWPF. The available flow for potable reuse is seasonally variable and depending on the use of the source can affect the yield of the project as shown in Figure ES.5.

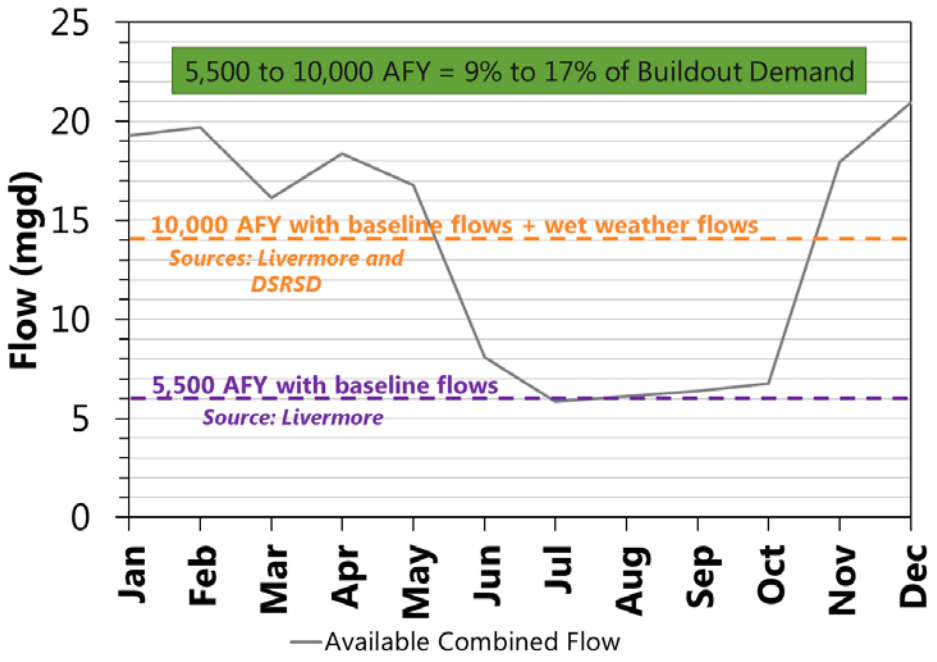


Figure ES.5 Projected Available Secondary Effluent Flows and Yields

Potential Treatment Locations and End Uses

Criteria for selecting treatment locations included available space, proximity to source water, proximity to end uses, and site accessibility. With these criteria in mind, five preliminary options were chosen for potential AWPF location as shown in Figure ES.6:

- DSRSD – in space currently used as a dedicated land disposal (DLD).
- LWRP – in the abandoned on-site facultative sludge lagoons (FSLs).
- Mocho – near Zone 7's existing Mocho Demineralization Facility.
- Chain of Lakes (COL).
- Pleasanton Corp Yard.

This study investigated three potential end uses for purified water:

- Groundwater augmentation or recharge via injection wells at two locations - one in the eastern side of the basin in Livermore and one in the western side in Pleasanton near the Mocho Demineralization facility.
- Groundwater recharge via Lake I (Chain of Lakes) surficial recharge.
- Raw water augmentation via Chain of Lakes to DVWTP (or directly to DVWTP).

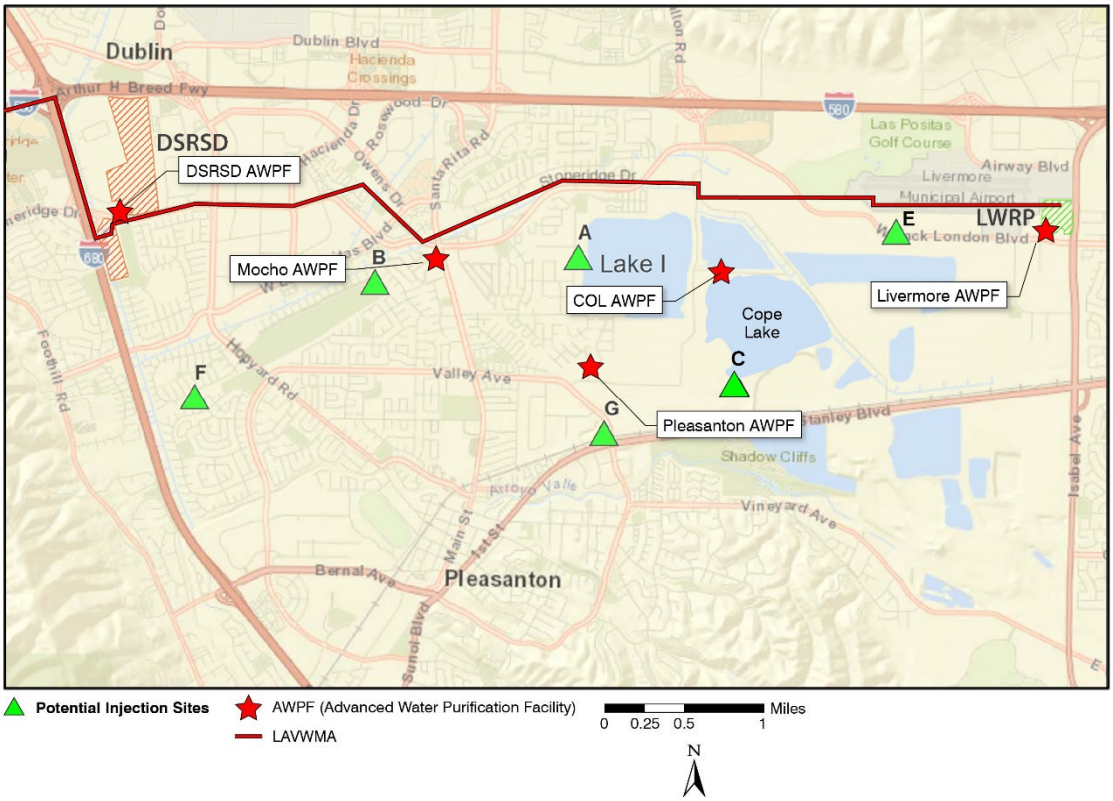


Figure ES.6 Five Potential Purification Facility Locations

The groundwater injection sites were identified based on proximity to treatment location, distance from production wells, potential to improve groundwater quality, and estimated transmissivity. These locations were evaluated using Zone 7's groundwater model to meet regulatory requirements for travel time to municipal wells.

The COL can be used in two separate ways – as a surficial recharge for the aquifer (via Lake I) or as a holding point before delivery to DVWTP (via Cope Lake and a planned COL pipeline). Since there is an existing connection between Lake I and Cope Lake, alternatives which send water to one of the lakes can, in effect, use both lakes as potential end uses. Another potential alternative is direct delivery of purified water upstream of the DVWTP, bypassing the COL.

Summary of Findings

Based on the book-end approach of considering alternatives, the major findings of this study are:

- Potable reuse for the Tri Valley is technically feasible. There were no fatal flaws identified by this technical evaluation.
- All alternatives increase water supply reliability, with the degree of benefit varying depending on yield (5,500 – 10,000 AFY) and, to a limited extent, end use (e.g., via groundwater recharge versus raw water augmentation).
- All alternatives improve drinking water quality and some improve the overall groundwater basin quality.
- There are good options available to site the AWPF facility.
- Regulatory pathways exist for all options.

- There is some variability in the overall operational flexibility and constructability depending on the option.
- Cost ranges for the book-end options:
  - Capital costs = $103 to $222 million.
  - Operations and Maintenance Costs = $6.5 to $9M/year.
  - Overall unit costs = $2,200-2,500/AF.

Recommendations/Next Steps

If the partnering agencies wish to continue pursuing potable reuse, there are a number of technical efforts necessary. In the near-term, to narrow the best end use option, further studies and other efforts are needed to evaluate the best candidates for siting injection wells; to characterize the potential for contaminant mobilization in the groundwater basin using models and field test; and to determine the ability of the COL to receive, store, and recharge purified water in conjunction with other potential uses of the COL.

A broader effort refining regional demand projections would also help determine the need for the various water supply options available to the Tri-Valley—including potable reuse—and the target yield for those options. To place potable reuse in the context of other water supply options, the 2016 WSE update should be updated to reflect the findings from this study as well as new data and options that have developed since 2016.

Figure ES. 7 presents one potential timeline for next step technical efforts and implementation of a potable reuse project showing a project could be online within 8 years if desired.

While this study focused on technical issues, there are also major institutional and public outreach components to potable reuse implementation that would need to be addressed. These components would support decision making and potential future efforts associated with a potable reuse project.

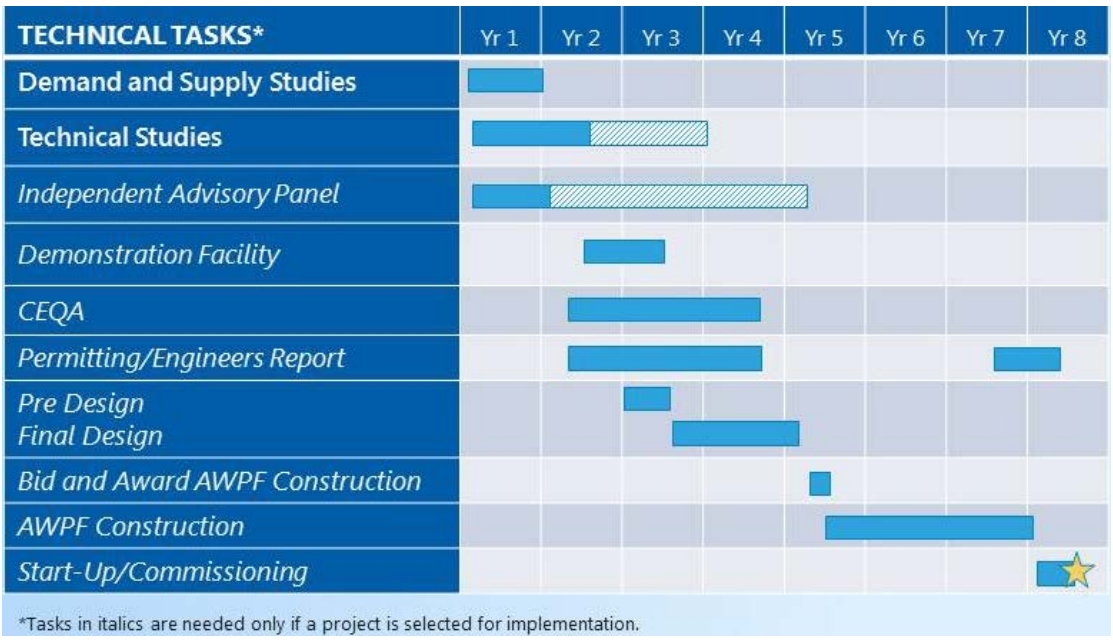


Figure ES.7 Potential Next Steps: Conceptual Timeline

Chapter 1

BACKGROUND AND INTRODUCTION

1.1 Project Purpose

The Water Supply Evaluation Update (2016 WSE Update) completed by Zone 7 Water Agency (Zone 7) in February 2016 underscored the need to pursue water supply options to enhance long-term water supply reliability for the Livermore-Amador Valley. Potential future water supply options identified in the WSE Update include the California WaterFix, desalination, and potable reuse. On February 11, 2016, participants in the Tri-Valley Water Policy Roundtable—including elected representatives from the cities of Dublin, Livermore, Pleasanton, San Ramon, Dublin San Ramon Services District (DSRSD), and Zone 7—agreed to proceed in a more detailed study of potable reuse, which would be a local and drought-resistant supply. In response, the Tri-Valley Water Agencies, described further below, jointly funded and oversaw the effort to complete the Joint Tri-Valley Potable Reuse Technical Feasibility Study.

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[1] Served through an out-of-service area agreement with DSRSD.

A map showing the overlapping service areas is shown in Figure 1.1.

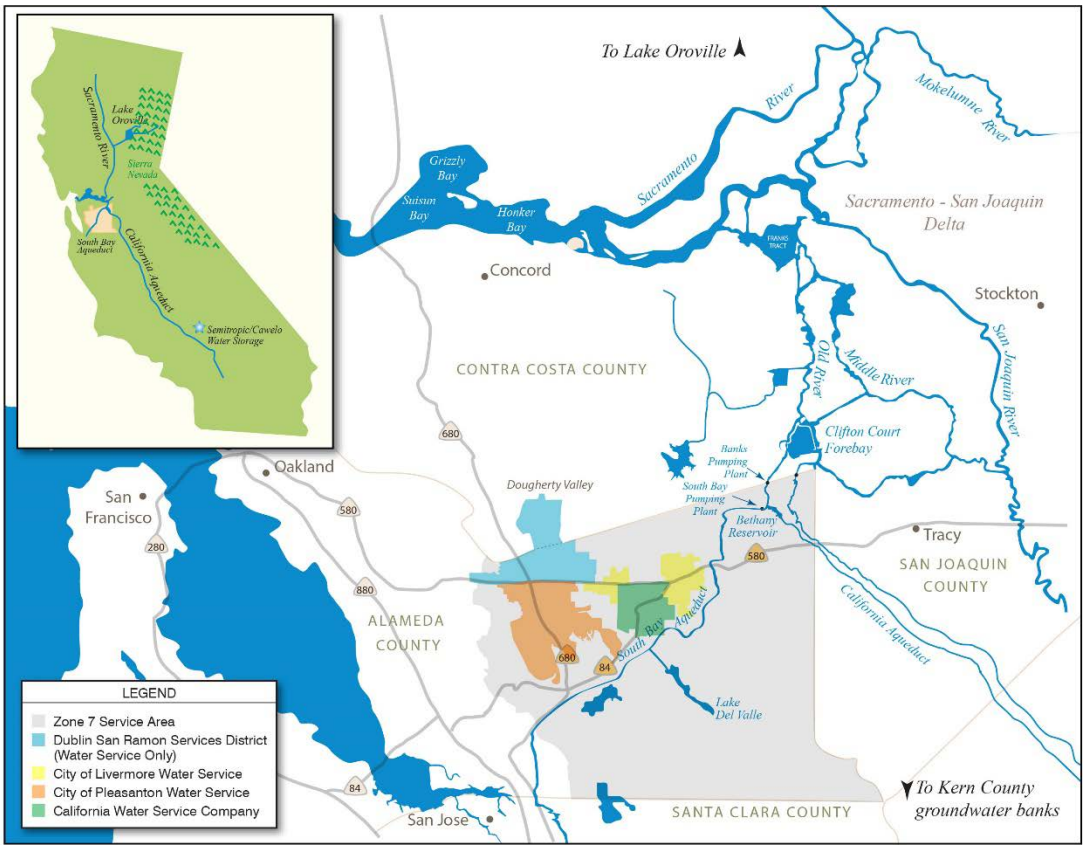


Figure 1.1 Tri-Valley Water Agencies and Service Areas

1.3 Project Location

The project is located in the Livermore-Amador Valley, also commonly referred to as the Tri-Valley, 18 miles southeast of Oakland and 33 miles from San Francisco. A vicinity map is provided in Figure 1.1.

1.4 Existing Facilities and Groundwater Basin

Figure 1.2 shows the existing water and wastewater facilities within the Tri-Valley Area, including the Zone 7 water treatment plants, the DSRSD wastewater treatment plant (WWTP), Livermore Water Reclamation Plant (LWRP), and water supply wells. Both DSRSD and Livermore have existing non-potable recycled water irrigation programs. Secondary effluent that is not used for non-potable recycled water irrigation is discharged to the San Francisco Bay through the Livermore-Amador Valley Water Management Agency (LAVWMA) and East Bay Dischargers Authority (EBDA) facilities.

Figure 1.2 also shows the boundaries of the Livermore-Amador Valley Groundwater Basin along with the major wells that draw from the basin for municipal and domestic supply.

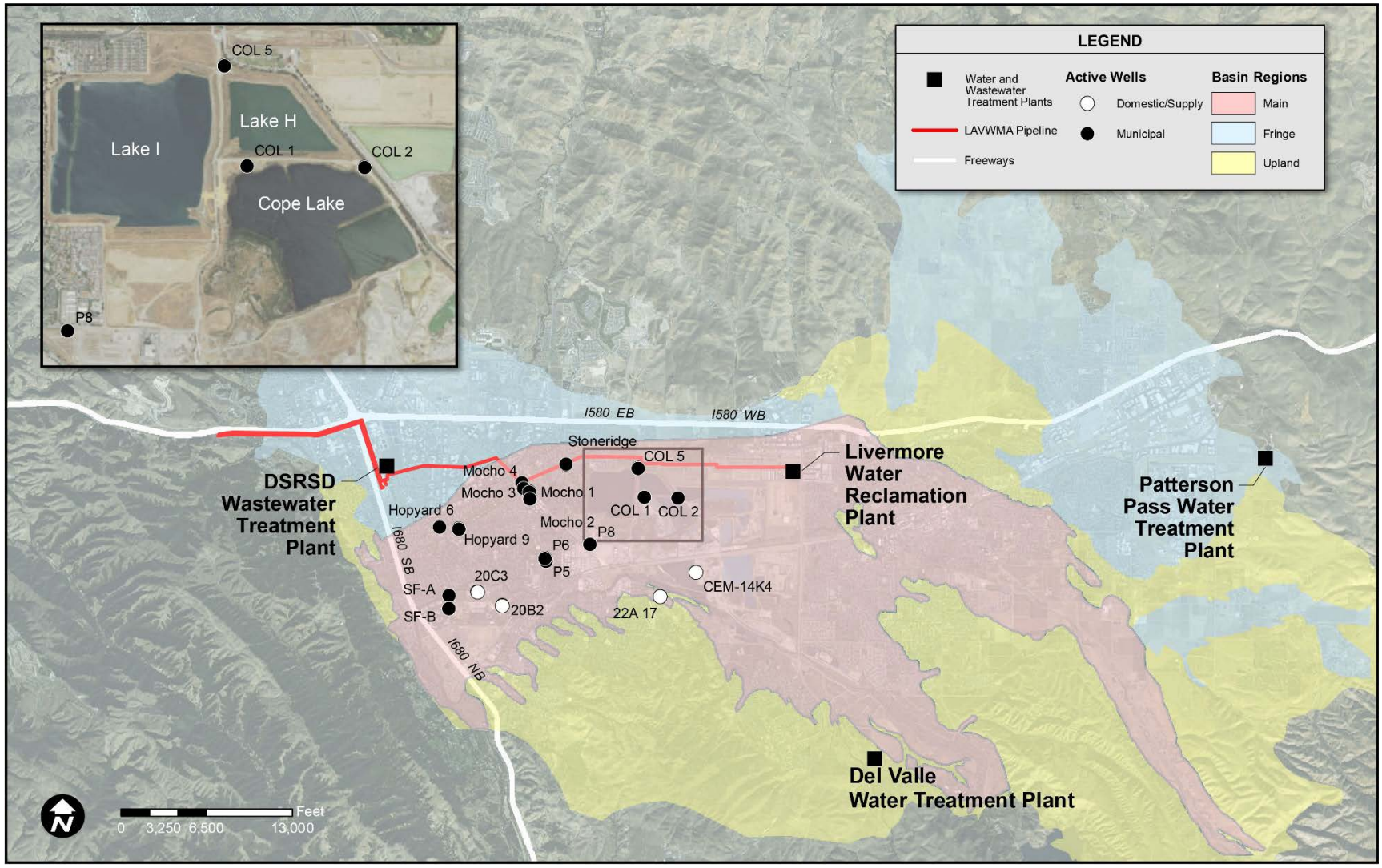


Figure 1.2 Existing Water and Wastewater Facilities

Treated wastewater from DSRSD WWTP and Livermore WRP flows to a junction box downstream of the plants and is conveyed to the LAVWMA reservoirs and export pump station adjacent to the DSRSD WWTP. The treated wastewater is pumped from the reservoirs into the LAVWMA export pipeline, over Boehmer Summit and discharged into the EBDA outfall pipeline. The EBDA pipeline conveys the effluent from LAVWMA and five other wastewater agencies (Town of Castro Valley, City of Hayward, Oro Loma Sanitary District, City of San Leandro, and Union Sanitary District) to a deep-water discharge outfall in San Francisco Bay. Under wet weather conditions and specific hydraulic conditions in the EBDA pipeline, LAVWMA can discharge to San Lorenzo Creek and Alamo Canal.

The existing water supply system for Zone 7 consists of two surface water treatment plants (WTPs) that treat State Water Project (SWP) water, local surface water (Arroyo Valle), and transfer water; and ten municipal groundwater production wells distributed over four well fields. A demineralization facility, located near the Mocho well field, uses reverse osmosis to lower total dissolved solids (TDS) in groundwater extracted from the Mocho well field prior to distribution. In addition, Zone 7 currently owns Cope Lake and Lake I, which are part of the Chain of Lakes (COL). The COL is a series of current or former gravel quarries that have been reclaimed or will be reclaimed for water management purposes. Of these ten lakes, so far Lake I and Cope Lake have been transferred over to Zone 7. Lake H will be transitioned to Zone 7 over the next few years. Zone 7 plans to use the COL for various water resource management activities such as groundwater recharge, surface water storage and conveyance, and flood management. The various Zone 7 water facilities are shown in Figure 1.3.

1.5 Risk & Reliability Tool & Project Goal

To enhance their planning studies and future projections, Zone 7 has developed a Water Supply Risk Model that assesses potential impacts to system-wide water supply reliability and water shortage risk under various water supply portfolios. The model uses Monte Carlo simulations. This model was used in the 2016 Water Supply Evaluation Update (Zone 7, 2016), and was used in this study as well. The WSE Update included analysis of Portfolio B, which included 'purified recycled water' or potable reuse. In this study, this portfolio is updated with the results of the more detailed analysis to evaluate the impacts on water supply reliability.

In the WSE Update, desalination and potable reuse were assumed to have yields of 5,600 acre-feet per year (AFY) and 7,800 AFY, respectively. For the purposes of this study, an upper bookend of 10,000 AFY was assumed for potable reuse, which was also consistent with projected wastewater availability, as discussed further below. A lower bookend of 5,500 AFY was used based on available year round supply.

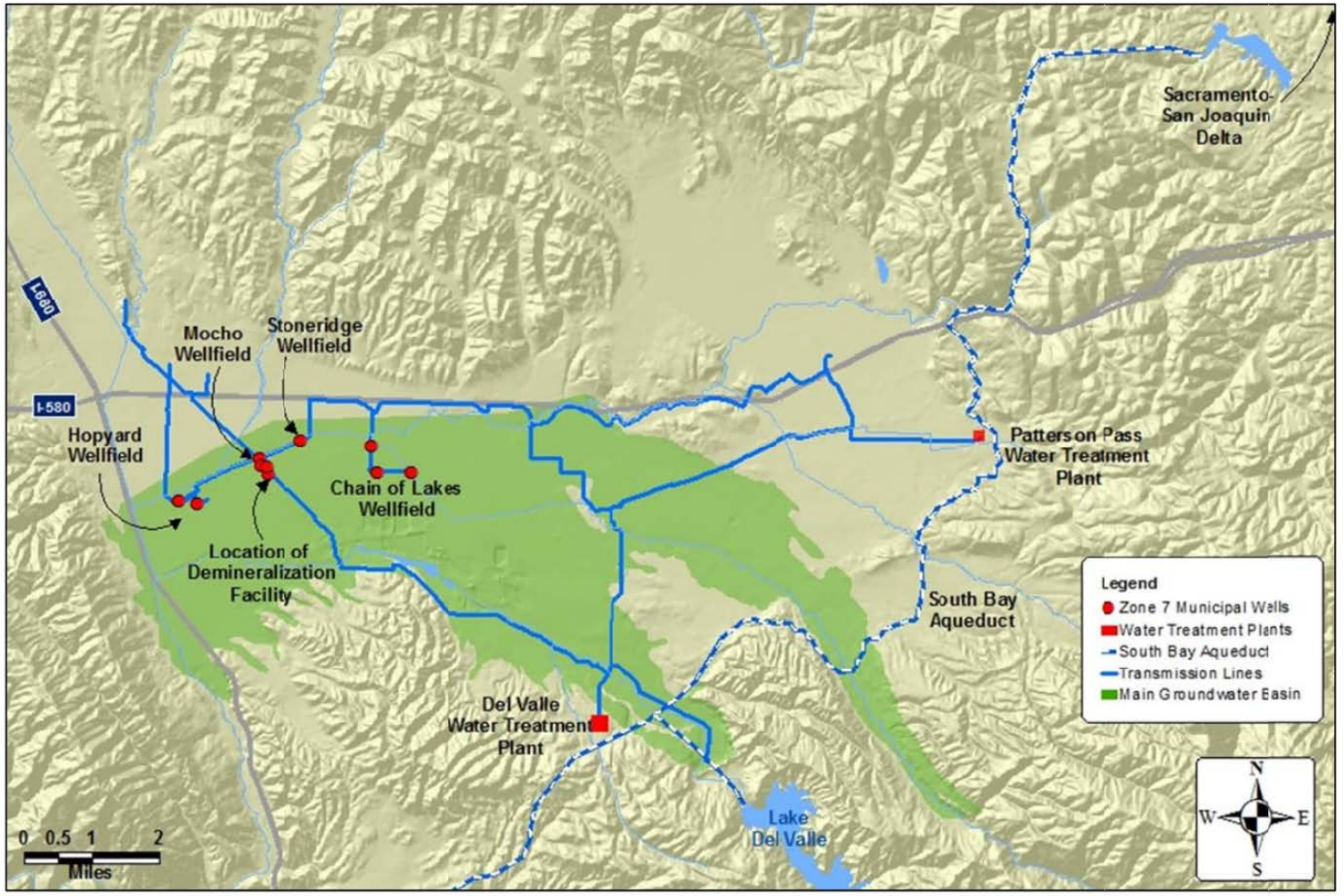


Figure 1.3 Zone 7 Water System Facilities

1.6 Alternative Development Method

Within the Tri-Valley area, there are several options for source water, treatment type, treatment location, and end use in the development of potable reuse alternatives, as will be discussed in Chapter 4. With the number of project components possible, there could be a multitude of project combinations. Selecting alternatives for detailed analysis was therefore a stepwise process, as shown in Figure 1.4. At key stages in the selection process, workshops with representatives from all project participants were convened to facilitate key decisions.

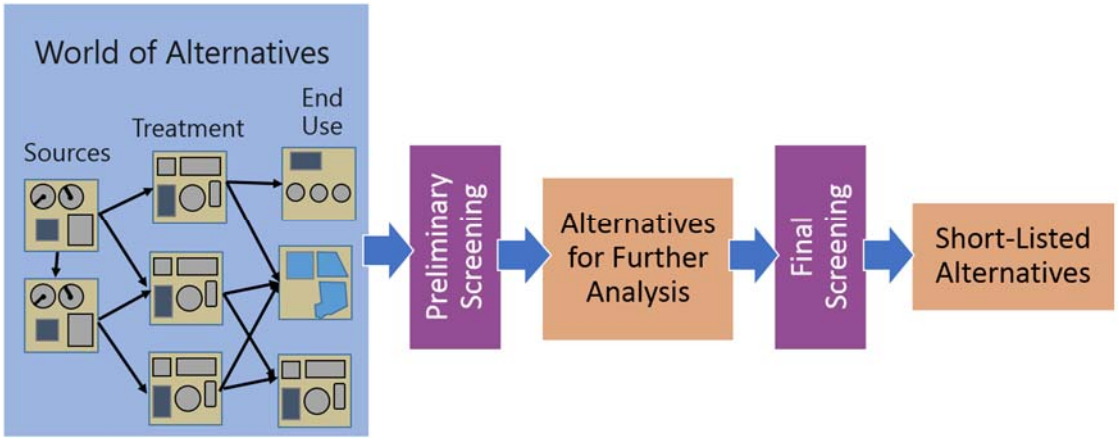


Figure 1.4 Alternative Selection Process

1.7 Evaluation Criteria

A preliminary set of evaluation criteria was developed to narrow the initial list of alternatives down for further investigation. These criteria are as follows:

- Yield (measured by acre-feet per year - AFY).
- Cost (Capital and Operations and Maintenance [O&M]).
- Improved Supply Reliability.
- Improved Delivered Water Quality.
- Improved Groundwater Basin Quality.
- Clear Regulatory Pathway.
- Minimizes Neighborhood Impacts.
- Ability to Phase the Project.
- Operational Flexibility.
- Ease of Construction.

As decided by the project management team, the main criteria for the initial screening were cost and yield. After the initial screening of alternatives, additional criteria were used in the more detailed analysis.

Ultimately, six options were chosen for the detailed analysis to serve as bookends.

1.8 Report Organization

This report is divided into 8 chapters, listed below:

1. Background and Introduction
2. Potable Reuse Regulations
3. Treatment Technology Assessment
4. Water Availability, Balance, and Quality
5. Preliminary Alternatives Evaluation
6. Hydrogeologic Feasibility
7. Short-Listed Options Detailed Analysis
8. Recommended Next Steps
9. Summary

1.9 References

Zone 7 Water Agency (2016) Water Supply Evaluation Update - Water Supply Alternatives for the Livermore-Amador Valley. URL: http://www.zone7water.com/images/pdf_docs/water_supply/wse-update_2-16.2.pdf

Chapter 2

POTABLE REUSE REGULATIONS

This chapter is intended to address the following goals:

- To document the successful application of potable reuse in California and in other states.
- To define the finished water quality goals for potable reuse. These goals will be protective of public health, surface water quality, and groundwater quality, regardless of the application/use.
- To define existing and anticipated future regulations for different types of potable reuse projects.

2.1 Summary of Findings

Potable reuse has been utilized by agencies as a means to extend water supplies for over 30 years in California. Other states have also successfully implemented potable reuse while being protective of public health. Project-specific permits for potable reuse have been issued in California for many years, although now regulations are clearly defined for groundwater recharge by the 2014 Groundwater Replenishment Reuse Projects (GRRPs) included in Title 22. Regulations are currently being developed for other types of potable reuse including the recently adopted reservoir augmentation regulations (adopted March 6, 2018) and a framework for other types of potable reuse is being considered. The December 2016 report, titled "Investigation on the Feasibility of Developing Uniform Water Recycling Criteria for Direct Potable Reuse," found that it is feasible to develop uniform water recycling criteria that would incorporate a level of public health protection as good as or better than what is currently provided in California by conventional drinking water supplies (SWRCB, 2016). In implementing potable reuse, protection of public health requires adequate treatment to remove pathogens and chemicals, a system of multiple barriers for reliability and redundancy, systematic monitoring to ensure compliance, proper operation and maintenance, careful source control, and qualified operator training.

2.2 Definitions

Terminology related to potable water reuse has evolved from the initial classification of *indirect* and *direct* potable water reuse defined in the report *Framework for Direct Potable Reuse* (WateReuse, 2015) to more specific definitions established by California Assembly Bill 574, which was passed in October 2017. This bill finds that by June 2018 the State Board should establish a framework for the regulation of potable reuse projects to encourage the development of potable reuse to mitigate the impact of long-term drought and climate change. The term "potable reuse" incorporates all types of water reuse that are safely incorporated into potable water supplies.. For the purposes of this study, the term "potable reuse" refers to the practice of using purified water derived from wastewater effluent to supplement water supplies.

The definitions below were compiled from the *Framework for Direct Potable Reuse* and the California Assembly Bill 574 to reflect the recent changes in the terminology and for the specific terminology that will be used **in this report**:

Disinfected Tertiary Recycled Water: Water that has been filtered and subsequently disinfected to "Title 22" standards for unrestricted non-potable reuse applications.

Purified Water: Water that has been treated at a wastewater treatment plant and a full advanced treatment plant (or advanced water purification facility), and has been verified through monitoring to be suitable for augmenting drinking water supplies.

Indirect Potable Reuse (IPR): The addition of recycled and/or purified water to augment groundwater or surface waters. Groundwater and surface waters are considered environmental buffers for providing public health protection benefits, such as contaminant attenuation dilution, and time to detect and respond to failures before final treatment and distribution. Indirect potable reuse can used with advanced treated water, but can also be accomplished with tertiary effluent when applied by spreading (i.e., groundwater recharge) to take advantage of soil aquifer treatment (SAT).

IPR for Groundwater Recharge: Planned used of purified recycled water for replenishment of a groundwater basin or an aquifer that has been designated as a source of water supply for a public water system.

Reservoir Water Augmentation (SWA): Planned placement of purified recycled water into a raw surface water reservoir used as a source of domestic drinking water supply for a public water or into a constructed system conveying water to such a reservoir.

Direct Potable Reuse (DPR): Planned introduction of purified recycle water either directly into a public water system, or into a raw water supply immediately upstream of a water treatment plant. DPR includes (i) raw water augmentation and (ii) treated drinking water augmentation. Additional treatment, monitoring, and/or an engineered buffer(s) would be used in place of an environmental buffer to provide equivalent protection of public health and response time in the event that the purified water does not meet specifications.

Raw Water Augmentation: Planned placement of purified recycled water into a system of pipelines or aqueducts that deliver raw water to a drinking water treatment plant that provides water to a public water system.

Treated Drinking Water Augmentation: Planned placement of purified recycled water intothe water distribution system of a public water system.

2.3 History of Successful Potable Reuse

Potable reuse projects have been successfully implemented in California and nationally using a broad range of treatment and monitoring technology to be protective of public health. Currently permitted potable reuse projects in California are shown in Table 2.1.

In addition to these operational projects, the map shown in Figure 2.1 below also includes the planned potable reuse projects in California as of February 2016. Seven long-standing examples potable reuse projects in the United States are also briefly reviewed in the following section.

Table 2.1 Operational Potable Reuse Projects in California

Agency	Project Name	Facility Start-up	Potable Reuse Type	Current Treatment	Capacity (mgd)
Los Angeles County Sanitation Districts (LACSD), Water Replenishment District (WRD), Los Angeles County Department of Public Works (LACDPW)	Montebello Forebay Groundwater Recharge Project	1962	Spreading	Tertiary (biological, GMF, disinfection)	50
Orange County Water District	Groundwater Replenishment System	1978	Spreading Injection	Purification (biological, MF, RO, UV/H_2O_2)	100
West Basin Municipal Water District	West Coast Basin Seawater Intrusion Barrier	1992	Injection	Purification (biological, MF, RO, UV/H_2O_2)	17.5
Inland Empire Utilities Agency	Chino Basin	2005	Spreading	Tertiary (biological, GMF, disinfection)	19
Water Replenishment District	Alamitos Barrier	2005	Injection	Purification (biological, MF, RO, UV/H_2O_2)	10
Los Angeles Bureau of Sanitation	Dominguez Gap Seawater Intrusion Barrier	2006	Injection	Purification (biological, MF, RO, disinfection)	10
Cambria Community Services District	Sustainable Water Facility at the San Simeon Well Field and Percolation Pond System	2016	Injection	Purification (biological, MF, RO, disinfection)	0.5
				TOTAL	207

Notes:
(1) GMF – granular media filtration.
(2) MF – microfiltration.
(3) RO – reverse osmosis.
(4) UV – ultraviolet disinfection.

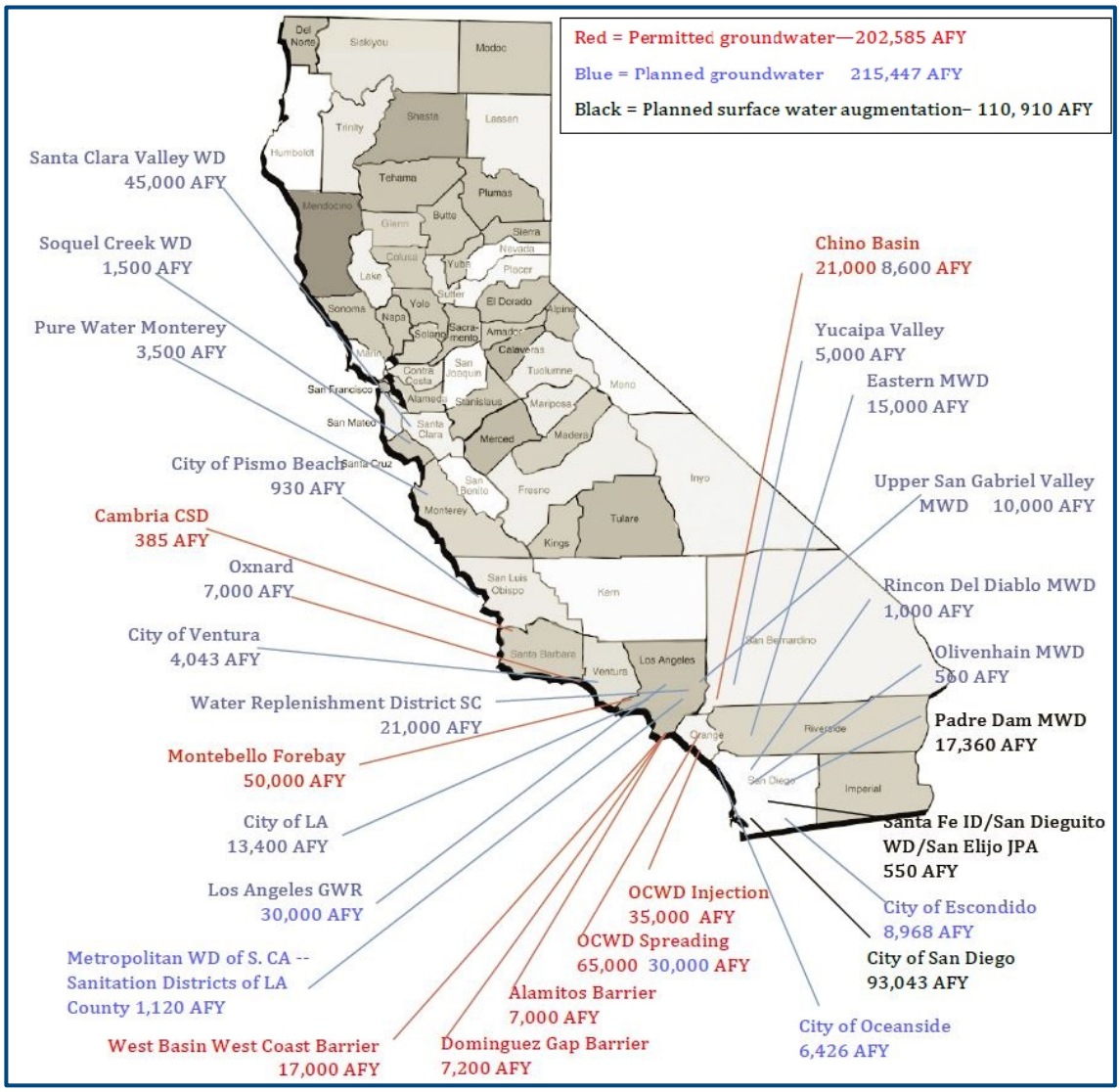


Figure 2.1 Existing and Planned Potable Reuse Projects in California (WateReuse California, February 2016)

2.3.1 Orange County Water District California (OCWD)

The Orange County Water District's Groundwater Replenishment System (GWRS) is the world's largest potable water reuse project, with a daily production of 100 million gallons of purified water, which is injected into the local groundwater basin. Since starting up in the late 1970s, this project has injected more than 188 billion gallons of purified water into the groundwater basin, later to be extracted for potable water use. Currently, OCWD is exploring the feasibility of expanding the GWRS to a total production to 130 mgd. A photo of the OCWD's reverse osmosis (RO) membranes is shown below in Figure 2.2.



Figure 2.2 OCWD RO Membranes Used to Purify Reclaimed Water for Potable Reuse

2.3.2 Terminal Island Advanced Water Purification Facility

The Los Angeles Sanitation (LASAN) Terminal Island Advanced Water Purification Facilities (TI AWPF) provides highly purified water to recharge the Dominguez Gap Barrier (Figure 2.3). Currently the facility is undergoing an expansion that will increase the plant's capacity from 6 to 12 mgd and will add UV/AOP (UV + sodium hypochlorite) for disinfection. The project's expansion will allow TI AWPF to continue supplying water to the Dominguez Gap Barrier, and to supply reclaimed water to Harbor Area industrial users and replenish the evaporation losses at Lake Machado.



Figure 2.3 City of Los Angeles Terminal Island AWPF

2.3.3 Water Replenishment District/Los Angeles County Sanitation Districts California

The Water Replenishment District (WRD) and the Los Angeles County Sanitation Districts (LACSD) are partners in the recharge of tertiary recycled water (secondary treated effluent that is then filtered and disinfected) into the local groundwater basin. Over the last 30+ years, more than 472,500 million gallons of reclaimed water have been placed into spreading basins and percolated down into the aquifer, later to be extracted for potable water use. A photo of the Rio Hondo spreading grounds is shown below in Figure 2.4.



Figure 2.4 Rio Hondo Spreading Grounds

2.3.4 VenturaWaterPure

The goal of the City of Ventura and Ventura Water's VenturaWaterPure demonstration facility was to document the high quality of purified reclaimed water through extensive water quality testing, and to understand the impact of blending this purified water with the conventional finished potable water. Additionally, this demonstration facility provided an educational opportunity for the community (Figure 2.5).

The VenturaWaterPure demonstration facility was designed to have multiple barriers for both pathogens and trace pollutants in excess of the treatment required for groundwater augmentation in anticipation of potential additional barriers needed for treated drinking water augmentation, and for direct potable water reuse. The ~20 gallon per minute (28,800 gallons per day) process train took filtered secondary effluent from the Ventura Water Reclamation Facility and treated it through pasteurization, UF, RO, and a UV light advanced oxidation process.

Moving forward, a granular activated carbon (GAC) process may be added after RO for an additional barrier to trace pollutants, and an engineered storage buffer may be added to the treatment train after the UV AOP to allow for appropriate system monitoring and water quality assurance.



Figure 2.5 Pure Water Demonstration Facility

2.3.5 Gwinnett County Georgia

Gwinnett County Georgia is responsible for the advanced treatment of wastewater prior to discharge into Lake Lanier (Figure 2.6, below). The latest treatment process modifications to the F. Wayne Hill Water Resources Center were completed in 2005, allowing the advanced treatment of secondary effluent at up to 150 million gallons per day using microfiltration (MF), pre-ozone, biofiltration, and post-ozone. Water from Lake Lanier is then treated at a conventional water treatment plant and distributed to customers throughout Gwinnett County.



Figure 2.6 Lake Lanier Georgia

2.3.6 Colorado River Municipal Water District Texas

The Colorado River Municipal Water District (CRMWD) is a regional water agency in Texas, serving the cities of Big Spring, Odessa, Snyder, and others, with a current combined population of about 500,000. Extreme drought in Texas led the CRMWD to construct the Raw Water Production Facility (RWPF) in Big Spring, Texas (Figure 2.7). The RWPF started operating in May 2013, with a steady production capacity of 2 mgd. The RWPF uses the same advanced treatment

processes as OCWD's GRWS: MF, RO, and UV advanced oxidation. After purification, the water from the RWPF is fed into a raw water supply line which blends with other raw water (up to 50 percent) and is then subjected to treatment at a standard water treatment plant (media filtration and chlorine disinfection). The City of Big Spring's surface water treatment plant (SWTP) is the first downstream user to withdraw from the pipeline. The cities of Snyder, Odessa, Stanton, and Midland also operate SWTPs that take water downstream of that pipeline.



Figure 2.7 Colorado River Municipal Water District's Raw Water Production Facility in Big Spring, TX

A two-year third-party evaluation of the water quality produced at this facility was recently completed. Water quality was tested across the treatment train at four major sample events, with test parameters including enteric virus, Giardia, Cryptosporidium, bacterial indicators, a large suite of CECs (pharmaceuticals, personal care products, consumer chemicals, flame-retardants, steroid hormones, perfluorinated alkyl substances, conventional and emerging disinfection byproducts) and many other constituents. The study concluded that the product water met public health standards and was fit to drink without the additional treatment that occurs at the downstream conventional water treatment plants, and is generally of a better quality than the conventional water supply from Moss Creek Lake; which has served the CRMWD's customers for many decades (Figure 2.8).

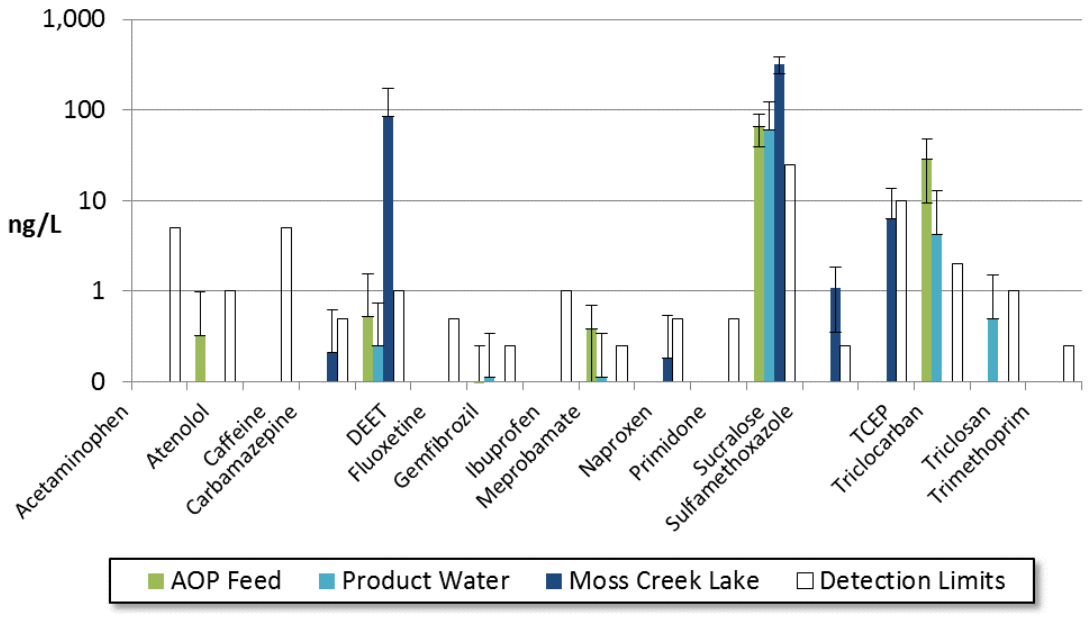


Figure 2.8 Big Spring Finished Water (AOP Feed and Product Water) and Existing Source (Moss Creek Lake) Concentrations of CECs

2.3.7 DPR High Purity Water Project Demonstration Facility, Oregon

Clean Water Services (CWS) is a water resources management utility in Washington County, Oregon. CWS has Oregon's largest water reuse program and is exploring further options to address water needs within the Tualatin River Watershed. As part of their water reuse program, CWS funded, designed and constructed a High Purity Water Project DPR Demonstration Facility to purify municipal disinfected secondary effluent to various levels which would be sufficient for use in a variety of purposes, including semiconductor processing, agriculture and food crops, product manufacturing, and human consumption (Figure 2.9). The end goal was not to immediately produce a purified water for potable use, but to elevate the discussion of water in Oregon and to allow for a future potable reuse project.

Included in the overall process design were the following advanced water treatment technologies, which, when combined, provided robust pathogen and pollutant treatment:

- Ultrafiltration.
- Reverse osmosis.
- Ultraviolet light advanced oxidation processes.
- Granular activated carbon.

These processes were used in series to purify disinfected secondary effluent from CWS's Forest Grove Facility (FGF). The testing demonstrated that the FGF effluent, when treated with UF, RO, and UV/AOP, provides a very high quality water absent of trace pollutants and/or pathogens. As a result, the purified water was deemed suitable for potable use, public consumption was confirmed, and a single use DPR permit was obtained from the Oregon Department of Environmental Quality.



Figure 2.9 Clean Water Services (Pure Water Brew) Project Demonstrated the Safety of Potable Water Reuse Using Innovative and Understandable Methods – Beer!

2.4 Chemical Pollutant and Pathogen Goals

California Division of Drinking Water (DDW, formerly the California Department of Public Health or CDPH) has been approving potable reuse projects for many years now, although regulations for groundwater recharge were only finalized in 2014. In the consideration and permitting of potable reuse, the two critical factors for protection of public health are pathogens and chemical pollutants. Many of the standards used for potable reuse are based on drinking water regulations and goals.

2.4.1 Chemical Pollutants

A large number of chemicals known to be detrimental to human health above certain concentrations are regulated through maximum contaminant levels (MCLs). The DDW has also established health-based advisory levels, called notification levels (NLs). Drinking water must be treated to meet these standards regardless of the source. Any effluent that is proposed for supply augmentation should, therefore, be tested for the full suite of these constituents. Treatment processes at the wastewater treatment, advanced treatment, and/or drinking water treatment stage can be adapted to remove these constituents.

For example, in almost all cases, inorganic nitrogen species (nitrate, nitrite) will be of particular concern. From a drinking water perspective, these are regulated with primary standards (10 mg/L as nitrogen for nitrate and nitrite combined, and 1 mg/L as nitrogen for nitrite) due the acute toxicity concerns associated with methemoglobinemia, known for causing "blue baby syndrome." These health-based standards can often be exceeded in treated wastewater effluents.

A second example is salinity, which has both primary and secondary drinking water standards. Due to the human contribution of salinity during municipal use, it is often necessary to remove

salt in order to maintain water quality with acceptable aesthetic characteristics (based on secondary standards). In some cases, it is required in order to meet primary standards. Salt removal is commonly achieved with nanofiltration (NF) or reverse osmosis (RO), though at a relatively high cost.

Most other exceedances of primary or secondary standards will vary based on the nature of the contributions to the collection system, but, generally, treated effluent of strictly municipal origin does not contain many, if any, additional chemicals at concentrations above primary standards (Trussell *et al.*, 2013). The initial treated effluent water quality assessment, ongoing source control measures, and periodic sampling requirements will serve to maintain and confirm compliance with regulatory limits on an ongoing basis.

Industrial contributions to the effluent are of significant concern with respect to metals and regulated organic constituents in particular. Concerns about contamination with industrial chemicals led the longest-operating DPR project on the globe, in Windhoek, Namibia, to segregate industrial wastewater from municipal sewage and only use the municipal stream for DPR. As part of this study, historical data for secondary effluent will provide some indication of upstream industrial source control issues.

2.4.2 Disinfection Byproducts

The formation of disinfection byproducts (DBPs) deserves special attention. Conventional DBPs, such as trihalomethanes (THMs), haloacetic acids (HAAs), bromate, and chlorate, are already regulated by the Stage 1 and Stage 2 Disinfectant and Disinfection Byproduct Rules (USEPA, 1998 and 2006a). n-Nitrosodimethylamine (NDMA) and other nitrosamines have been considered for regulation by the USEPA for over a decade (they are on the Unregulated Contaminant Monitoring Rule 2 list and the Candidate Contaminant List 3), and NDMA has a California Notification Level of 10 nanograms per liter (ng/L), which is considered the minimum treatment benchmark by the California utilities currently implementing potable reuse.

2.4.3 Unregulated Constituents

Besides the chemical (and radiological) constituents explicitly regulated through MCLs, a wealth of research has been conducted on the concentrations of unregulated trace organic constituents (TOrCs) in wastewater, their attenuation through conventional WWTPs, and their further breakdown during advanced treatment (Baronti *et al.*, 2000; Lovins *et al.*, 2002; Schäfer *et al.*, 2005; Sedlak *et al.*, 2006; Steinle-Darling *et al.*, 2010; Linden *et al.*, 2012; Salveson *et al.*, 2010; Salveson *et al.*, 2012; Snyder *et al.*, 2012; and many others). These constituents include pharmaceuticals, personal care products, consumer chemicals, coatings (perfluorinated compounds), flame retardants, and others, some of which have endocrine disrupting, carcinogenic, and/or other potentially harmful properties at sufficiently high concentrations. Due to these potential effects, combining with media interest, this group of constituents has been the cause of more public concern than the pathogens discussed below. However, the vast majority of TOrCs are present in wastewater effluent at concentrations that are not of concern for human health, if present at all. Table 2.2 (original Table 1.14 and 1.15 from Trussell *et al.*, 2013) includes a cross-section of TOrCs detection in secondary wastewater effluent as well as through an advanced treatment train. For comparative purposes, the Maximum Recommended Value is also shown in Table 2.3.

Table 2.2 Effluent Concentration of Indicator Trace Organic Compounds in Treated Secondary Effluent and in the Purified Water from Advanced Treatment per California IPR Regulations Compared to Maximum Recommended Value

Target Compound	Use of Target Compound	Secondary Wastewater Treatment[1] (ng/L)	MF-RO-UV/H_2O_2[2] (ng/L)	Maximum Recommended Value[3] (ng/L)
Atenolol	Pharmaceutical, beta blocker	710	<25	70,000
Atrazine	Herbicide	28	<10	1,000
Bisphenol A	Plastics additive	<50	<50	200,000
Carbamazepine	Pharmaceutical, anti-convulsant	140	<10	1,000
DEET	Insect repellant	54	<25	2,500,000
Diclofenac	Pharmaceutical, nonsteroidal anti-inflammatory drug	62	<25	1,800
Gemfibrozil	Pharmaceutical, lipid regulating agent	31	<10	45,000
Ibuprofen	Pharmaceutical, pain reliever	<25	<25	400,000
Meprobamate	Pharmaceutical, anti-anxiety medication	41	<10	260,000
Musk Ketone	Fragrance additive	<100	<100	350,000
Naproxen	Pharmaceutical, pain reliever	<25	<25	220,000
Phenytoin	Pharmaceutical, anti-convulsant	110	<10	6,800
Primidone	Pharmaceutical, anti-convulsant	67	<10	10,000
Sulfamethoxazole	Pharmaceutical, antibiotic	570	<25	35,000
Triclosan	Biocide	26	<25	350
Trimethoprim	Pharmaceutical, antibiotic	280	<10	70,000
Tris(2-chloroethyl)phosphate (TCEP)	Fire retardant	540	<200	1,000

Notes:
(1) Data reported by Trussell *et al.* (2013; see Table 1.14).
(2) Data reported by Trussell *et al.* (2013; see Table 1.15).
(3) As reported by Trussell *et al.* (2013).

An independent advisory panel recommended regulatory criteria for potable reuse, as part of WateReuse Research Foundation project 11-02 (NWRI, 2013). The information in Table 2.3, proposed regulatory criteria for chemicals, is adapted from Trussell *et al.* (2013). Any treatment train proposed for potable reuse for the Tri-Valley would be designed to meet or exceed these recommended regulatory criteria.

Table 2.3 Recommended Regulatory Criteria for Maximum Concentration Levels of Chemicals in Finished Water from Potable Reuse Treatment Trains (reproduced from Trussell et al., 2013 Table 2.8)

Chemical Group	Criterion	Rationale	Sources Used for Criteria
Disinfection byproducts that should be measured to evaluate treatment trains:			
Trihalomethanes (THMs)	80 ug/L	Prominent chlorination byproducts.	MCL
Halogenated acetic acids (HAA5)	60 ug/L	Polar group of chlorination byproducts.	MCL
N-nitrosodimethylamine (NDMA)	10 ng/L	Byproduct of chloramination.	DDW notification level.
Bromate	10 ug/L	Byproduct of ozonation.	MCL / WHO guideline.
Chlorate	800 ug/L	Reflective of hypochlorite use.	DDW notification level.
Non-regulated chemicals of interest from a public health stand point (if present in wastewater source):			
Perfluoro-octanoic acid (PFOA)	0.4 ug/L	Known to occur, frequency unknown.	Provisional short-term U.S. EPA Health Advisory.
Perfluoro-octane sulfonate (PFOS)	0.2 ug/L	Known to occur, frequency unknown.	Provisional short-term U.S. EPA Health Advisory.
Perchlorate	15 ug/L 6 ug/L	Of interest, same analysis as chlorate and bromate.	U.S. EPA Health Advisory California MCL.
1,4-dioxane	1 ug/L	Occurs at low frequency in wastewater, but likely to penetrate RO membranes.	DDW notification level.
Ethinyl Estradiol	None, close to detection limit if established.	Steroid hormone, should evaluate presence in source water.	Bull *et al.* (2011).

Table 2.3 Recommended Regulatory Criteria for Maximum Concentration Levels of Chemicals in Finished Water from Potable Reuse Treatment Trains (reproduced from Trussell et al., 2013 Table 2.8) (Continued)

Chemical Group	Criterion	Rationale	Sources Used for Criteria
17-ß-estradiol	None, close to detection limit if established.	Steroid hormone, should evaluate presence in source water.	Bull *et al.* (2011).
Pharmaceuticals of potential health concern that should be useful to evaluate the effectiveness of organic chemical removal by treatment trains.			
Cotinine/Primidone/ Dilantin	1/10/2 ug/L	Surrogate for low molecular weight, partially charged cyclics.	Bruce *et al.* (2010); Bull *et al.* (2011).
Meprobamate/Atenolol	200/4 ug/L	Occur frequently at the ng/L level.	Bull *et al.* (2011).
Carbamazepine	10 ug/L	Unique structure.	Bruce *et al.* (2010).
Estrone	320 ng/L	Surrogate for steroids.	Based on an increased risk of stroke in women taking the lowest dose of conjugated estrogens.
Other chemicals of potential health concern that should be useful to evaluate the effectiveness of organic chemical removal by treatment trains:			
Sucralose	150 mg/L	Surrogate for water soluble, uncharged chemicals of moderate molecular weight.	CFR Title 12, revised 4/1/12.
TCEP	5 ug/L	Chemical of interest.	Minnesota Department of Health (2011) guidance value.
N,N-diethyl-meta-toluamide (DEET)	200 ug/L	Chemical of interest.	Minnesota Department of Health (2011) guidance value.
Triclosan	2,100 ug/L	Chemical of interest.	Risk-based action level (NRC, 2012).

2.5 Pathogens

In contrast to most chemical constituents, pathogens represent an acute risk, as a single event in which concentrations leaving a treatment plant are above an illness-causing threshold can cause a public health crisis with a significant fraction of the population falling ill. Accordingly, substantial effort in purification is focused on the reduction of pathogens to below regulated levels.

2.5.1 Wastewater Pathogen Concentrations

DDW has been approving protozoa and virus reduction credits for the primary and secondary treatment processes as part of recent IPR projects (WRD, 2013). That work relied upon risk analysis data presented in Olivieri *et al*. (2007), which was developed based upon data collected by Rose *et al*. (2004).

Rose *et al*. 2004 collected and analyzed samples of raw wastewater and secondary effluent from six different full-scale WWTPs for bacteria, enterovirus, *Cryptosporidium*, and *Giardia*. Variability of up to three orders of magnitude is shown in the data for both raw wastewater and secondary effluent at some of the individual facilities, which must be accounted for in a public health analysis of potable reuse.

The statistics shown in Table 2.4 describe the distribution of the pathogen concentrations in secondary effluents from Rose *et al*. (2004). The 95th percentile data was assumed as the secondary effluent pathogen concentrations requiring further treatment.

Table 2.4 Summary Statistics for Secondary Effluent Pathogen Concentrations(1)

Statistic	*Giardia* (cysts/L)	*Cryptosporidium* (oocyts/L)	Enteric Virus (MPN/L)
Number of Samples	33	33	30
Minimum	$1.00 \times 10^{+1}$	$1.00 \times 10^{+1}$	5.00×10^{-1}
Mean	$1.28 \times 10^{+3}$	$2.27 \times 10^{+2}$	$4.01 \times 10^{+1}$
95th Percentile	$8.81 \times 10^{+3}$	$7.43 \times 10^{+2}$	$2.17 \times 10^{+2}$
Maximum	$1.40 \times 10^{+4}$	$3.33 \times 10^{+3}$	$2.70 \times 10^{+2}$

Notes:
(1) As provided by Olivieri *et al.* (2007) and Rose *et al.* (2004).

2.5.2 Pathogen Removal Goals

While different states have taken different approaches to permitting potable reuse projects, the fundamental potable water end goals are generally accepted. These goals are based on reducing annual risk of *infection* below 1 in 10,000 with each examined pathogen group (Regli *et al.*, 1991), which was also applied to the control of *Cryptosporidium* oocysts as part of USEPA Long Term 2 (LT2) (USEPA, 2006b). This method represents one additional level of conservatism in comparison to the approach taken in the EPA Surface Water Treatment Rule (SWTR), which determined *Giardia* goal concentrations on the basis of a 1 in 10,000 annual risk of *illness* (USEPA, 1989). Where *infection* represents the moment when a pathogen first enters the body, whether or not it causes symptoms, *illness* is defined by when symptoms first appear. Not all infections lead to illnesses, but all illnesses result from infections. Drinking water pathogen goal concentrations are shown in Table 2.5.

Table 2.5 Drinking Water Pathogen Goal Concentrations

Pathogen	Drinking Water Goal	Reference
Giardia	< 6.8×10^{-6} oocysts/L	Regli *et al*. (1991)
Cryptosporidium	< 3.0×10^{-5} oocysts/L	Haas *et al*. (1999)
Enteric virus	< 2.2×10^{-7} MPN/L	Regli *et al*. (1991)

Notes:
(1) Drinking water goals are identified for national potable reuse research and as implied by California regulations and cited by Trussell *et al*. (2013). These are consistent with values used in Texas based on personal communications with staff at the Texas Commission on Environmental Quality (TCEQ).
(2) The *Cryptosporidium* goal as inferred from the treatment requirements under the (LT2) Rule for Bin 3, which is the most conservative defined-boundary bin (only a lower boundary is defined for Bin 4). Bin 3 has an upper limit of 3 oocysts/L and requires 5-log treatment. The original quantitative microbial risk assessment defining this limit based on a 1 in 10,000 annual risk of *infection* was performed by Haas *et al*. (1999).
(3) MPN/L = most probable number per liter. The 10^{-4} risk level concentrations of a number of enteric viruses is provided by Regli *et al*. (1991). The most conservative value listed in Table 2 of this reference is for rotavirus (at 2.22×10^{-7} MPN/L).

2.5.3 Pathogen Removal Analysis

With a clear understanding of secondary effluent pathogen loads, the amount of reduction of pathogens to meet water quality goals can be readily determined as shown in Table 2.6.

Table 2.6 Pathogen Removal Analysis

Concentrations	*Giardia*	*Cryptosporidium*	Enteric Virus
95th Percentile estimated Concentrations in Secondary Effluent (#/L)(1)	$8.81 \times 10^{+3}$	$7.43 \times 10^{+2}$	$2.17 \times 10^{+2}$
Goal Concentration (#/L)	< 6.8×10^{-6}	< 3.0×10^{-5}	< 2.2×10^{-7}
Overall Pathogen Removal Needed by Advanced Treatment/Purification	**9.1-log**	**7.4-log**	**9.0-log**

Notes:
(1) 95th percentile value presented by Olivieri *et al.* (2007) and Rose *et al.* (2004).

Texas regulators take a tact similar to Table 2.7. The Texas Commission on Environmental Quality (TCEQ) has defined treatment goals based on a case-by-case evaluation of the specific treated effluent proposed as the source water for advanced treatment for potable reuse. The pathogen sampling requirements are in general analogous to those required for *Cryptosporidium* under LT2, but extend to sampling for *Giardia* and enteric virus as well. This process has been applied to three approved potable reuse projects and has resulted in slightly different Log Removal Value (LRV) requirements (Table 2.8).

National expert panels and California regulators approach the pathogen log reduction targets for potable reuse in a different fashion, looking first at the concentrations of pathogens in raw wastewater and then determining the log reduction requirements to attain the 1 in 10,000 risk of infection level concentrations for pathogens (CDPH, 2014; Trussell *et al.*, 2013). The log removal value (LRV) set by California in Title 22 and the values targeted in a study by Trussell *et al.*, 2013 from raw wastewater to potable water consumption are shown in Table 2.8. In both cases, the approach uses the most conservative values available in the datasets described above and applies a generous safety factor of ≥100-fold to provide a safeguard against "outbreak conditions" (Trussell *et al.*, 2013).

Table 2.7 Summary of Log Removal Value Requirements (LRV) for Approved Potable Reuse Projects in Texas

Project	*Giardia* LRV	*Cryptosporidium* LRV	Enteric Virus LRV
Raw Water Production Facility at Big Spring(1)	6.0	5.5	8.0
Wichita Falls Emergency DPR Project(2)	7.0	5.5	9.0
City of Brownwood DPR Project(3)	6.0	5.5	8.0

Notes:
(1) Operating since May 2013
(2) Started operation June 2014, no longer in operation
(3) Approved for construction but not yet built

Table 2.8 Summary of Log Removal Value Requirements for California

Parameter	Log Removal Value	
	California Title 22	Trussell *et al.*, 2013
Virus	12	12
Giardia	10	10
Cryptosporidium	10	10
Total Coliform	NS	9

Notes:
(1) NS - none specified

For this project, we recommend setting the pathogen reduction targets for purification processes based upon conservative secondary effluent values from Rose *et al.* (2004), resulting in 9-log *Giardia,* 7.4-log *Cryptosporidium,* and 9-log virus.

2.5.4 Groundwater and Surface Water Protection

Groundwater and surface water quality protection is one of the main concerns when developing a potable reuse project. As an example, addition of purified water for recharge can result in arsenic mobilization due to changes in the native geochemistry of the groundwater basin where arsenic occurs naturally. The OCWD has done extensive research at the groundwater replenishment system (GWRS) and has developed a successful formula using lime as post-treatment of the purified water to avoid metal mobilization (Fakhreddine, 2015). The lime dosing specifications developed for OCWD are shown in Table 2.9. The OCWD information provides a basis for RO permeate stabilization and cost analysis. A detailed analysis to determine the appropriate groundwater stabilization strategy should be developed for the project implementation.

Table 2.9 Lime Dosing Specifications

Product	Ultra-pure hydrate (95+% CaOH)
Supplier	Lhoist, N.A.
Dose	26 mg/L
Target pH	8 – 8.5
Target Alkalinity	40 – 45 mg/L

2.6 Potable Reuse Regulations in California

Regulations are in place for potable reuse for groundwater recharge (CDPH, 2014). In March 2018, SWA regulations were adopted following a public comment period on the draft regulations. However, they are unlikely to change significantly with respect to LRVs. The State has released the report to Legislature on the feasibility of establishing regulations for DPR. The recently enrolled AB 574 has established a deadline of December 31, 2023, for the creation of regulations governing DPR through raw water augmentation. No deadline has been set for regulations regarding treated drinking water augmentation.

2.6.1 California Water Code (CWC)

The CWC stipulates that each Regional Water Quality Control Board (RWQCB) formulate and adopt Water Quality Control Plans (Basin Plans) for all areas governed by the boards. These plans must contain water quality objectives for surface water and groundwater within the regions that provide reasonable protection of the beneficial uses of the waters. During the process of formulating such plans the RWQCBs must consult with and consider recommendations of affected state and local agencies. Such plans shall be periodically reviewed and may be revised (section 13240). In accordance with CWC Section 13260, all persons discharging waste within the region must file with the appropriate boards and provide information pertaining to their discharge. Within the region, it is not permitted for a person to construct, maintain, or use any waste well that interferes with a source for domestic water supply without proper permitting or exceptions (CWC Section 13540).

2.6.2 Regulations for Groundwater Recharge/Groundwater Augmentation

The Division of Drinking Water (DDW) has developed extensive guidelines regarding Groundwater Replenishment Reuse Projects (GRRPs) included in Title 22. The DDW revised Title 22 regulations on June 2014. There are two types of GRRPs regulated, surface and subsurface application. General requirements for groundwater recharge are listed in Table 1.10.

Table 2.10 Groundwater Recharge Criteria for Potable Reuse

Parameter	Criteria
Pathogen Microorganism Control	
Enteric Virus	12-log Reduction
Giardia Cyst	10-log Reduction
Cryptosporidium oocysts	10-log Reduction
Total Organic Carbon (TOC)	Maximum 0.25 mg/L in 95% of samples within first 20 weeks Maximum 0.5 mg/L in 20-week running average
1,4-dioxane	0.5-log Reduction
Total Nitrogen	10 mg/L

Notes:
(1) Log reductions are from the point of raw wastewater to the point of finished water for public consumption.

2.6.2.1 Surface Spreading Application

For surface spreading applications the process relies on treatment through percolation and dilution once the percolated water is in the groundwater basin. Regulations establish that spreading projects for subsurface applications can use up to 20 percent of tertiary recycled water and 80 percent of other acceptable dilution water. Per regulations, "acceptable dilution water" is water that meets drinking water standards. This percentage of recycled water (named the

recycled water contribution [RWC]) can be increased as operations proceed, with approval from DDW. It is even possible to have an RWC of 100 percent if there is sufficient travel time in the groundwater basin before the nearest drinking water well (approximately 6 months). This retention time target is based on tracer tests or conservative hydraulic modeling. Based upon discussions with DDW, secondary effluent treated with microfiltration (MF) and reverse osmosis (RO) can be an acceptable supply for dilution water. Our experience suggests that RO permeate will meet all potable water regulations with the possible exception of NDMA. Further discussion about the use of treatment technologies to meet different regulatory criteria is detailed in a subsequent TM.

2.6.2.2 Groundwater Injection Application

Subsurface application or injection of purified water directly into the groundwater basin would require full advanced treatment that includes RO and advanced oxidation processes (AOP). Additionally, a minimum of two months of subsurface travel time is required before extraction for potable use. These two months provide "Response Retention Time" (RRT) which is time to monitor water quality and respond to water quality concerns. Direct injection projects have less room for innovation due to the close connectivity between the injected water and the extraction wells. Cost savings have been realized by using alternative UV AOP systems, including the City of Los Angeles' new UV AOP that used NaOCl instead of H_2O_2 in the advanced oxidation process (12 mgd) and the Ventura Water demonstration of UV AOP using an electrode technology and thus not using any type of dosed chemical oxidant.

2.6.3 Reservoir Water Augmentation

In March 2018, the SWA regulations were adopted following a public comment period on the draft regulations. The City of San Diego completed their DDW Regional Water Quality Control Board (RWQCB) Engineering Report in early 2017, which serves as both a template for SWA across the State and for this project.

Water Code section 13561 defines Direct Potable Reuse (DPR) as "the planned introduction of recycled water either directly into a public water system, as defined in Health and Safety Code section 116275, or into a raw water supply immediately upstream of a water treatment plant." This definition provides a potential 'gap' between SWA and DPR, as certain projects may use a reservoir that is too small to qualify for the SWA regulations. According to the Expert Panel, this 'gap' was defined as projects with reservoirs that had hydraulic retention times of less than 4 months but greater than or equal to 2 months. This 'gap' is incorporated into the SWA regulations via an alternatives clause.

This section summarizes the key requirements stipulated in the SWA regulations (released in 2018). These include pathogen and chemical control at the advanced water purification facility (AWPF) and retention time and dilution requirements in the reservoir.

SWA projects use an environmental buffer (e.g., reservoir) between treatment and distribution like in GRRPs (Figure 2.10). The major difference is that the retention time in the reservoir is shorter than GRRP retention times in aquifers.



Figure 2.10 SWA Project Schematic Process Flow Diagram

The key requirements for SWA are summarized below.

- **Dilution Requirement -** the dilution requirements stipulate that *any 24-hour input of recycled water* to the reservoir must be mixed such that water withdrawn for use as drinking water will never contain more than 1 percent of this input. This is meant to provide a buffer against off-specification water that enters the reservoir; pathogen concentrations will be reduced by 2 logs, either through 100:1 dilution or 10:1 dilution with 1-log treatment. Log removal requirements and pathogenic microorganism control are discussed below.
- **Hydrodynamic modeling** - required in order to demonstrate compliance with this requirement. The modeling will verify the ability of the reservoir to meet this requirement under all conditions, as well as completion of a tracer study with added tracer prior to the end of the first six months of operation. The achievable dilution of a 24-hour input can be estimated using a simplifying assumption of complete mixing in the reservoir. Under this assumption, dilution is related to the theoretical retention time (τ) and the duration of the input (Δt):

  $$\text{dilution factor} = \tau/\Delta t$$
- **Retention Time** - The SWA regulations continue to incorporate the concept of retention time, albeit taking into account the differences in hydrodynamics between an aquifer and a reservoir. The final regulations currently available stipulate that a reservoir used for SWA must have a minimum theoretical retention time (τ) of 180 days, to be measured on a monthly basis as follows:

  $$\tau = (V_{total}/Q_{out}) \geq 180 \text{ days}$$

  where V_{total} is the volume in the reservoir at the end of the month and Q_{out} is the total outflow from the reservoir during that month. The project may apply for an alternative minimum less than 120 days, however, a 1-log reduction of pathogen is required. The alternative minimum cannot be less than 60 days.
- **Pathogenic Microorganism Control** - The treatment requirements in the draft SWA regulations look very similar to those for a GRRP, particularly with regard to pathogenic microorganism control. If at least a 100:1 dilution is achieved in the reservoir, then the log removals for enteric virus, *Cryptosporidium*, and *Giardia* are the same as in the GRRP regulations. If less than 100:1 but at least 10:1 is dilution achieved in the reservoir, then an additional 1-log of pathogen treatment is required by an additional process. If there is less than 10:1 dilution available in the reservoir, then the project will likely be considered immediately upstream of a drinking water treatment plant and will be defined as direct potable reuse (DPR). Table 2.11 illustrates the required removal criteria for enteric virus, *Cryptosporidium*, and *Giardia*.

Table 2.11 SWA Pathogenic Microorganism Control - Draft Regulations

Dilution	Enteric Virus Removal	*Cryptosporidium* Removal	*Giardia* Removal
San Diego Pure Water(1)	14-log	12-log	12-log
Dilution ≥ 100:1	8-log	7-log	8-log
100:1 ≥ Dilution ≥ 10:1	9-log	8-log	9-log
Dilution < 10:1	Not classified as surface water augmentation		

Notes:
(1) San Diego has an expected retention time of only sixty days, which is why DDW requires such high pathogen log removal credits.

- GRRPs have the benefit of receiving log removal credit from the retention time underground, whereas SWA projects do not. Instead, SWA projects allow treatment credits from the conventional drinking water treatment plant downstream of the reservoir. The original surface water treatment rule, promulgated by EPA (EPA 1989), required the water treatment plant to provide treatment to remove 4-log virus and 3-log *Giardia*. This rule has since been updated to include 2-log *Cryptosporidium* removal as well. SWA projects can combine the treatment credit achieved prior to the reservoir and at the conventional drinking water treatment plant to achieve the required pathogen reductions.
- A primary goal in the design of the treatment train will be to design an overall system that has enough credit to achieve the required log removals in the SWA regulations.
- **Regulated Contaminant Limits** - As with the GRRP regulations, the recycled water must meet all current regulatory limits. The inclusion of an RO system will ordinarily keep the product water quality well below any current regulatory limits; however, it is possible that the San Diego Regional Water Quality Control Board (SDRWQCB) may require strict nutrient limits for environmental reasons, lowering the total nitrogen discharged to as low as 1 mg/L.

2.6.4 Direct Potable Reuse

DPR projects are differentiated from IPR based on the absence of an environmental buffer. The SWRCB defines DPR as the planned introduction of recycled water either directly into a public water distribution system, or into a raw water supply immediately upstream of a water treatment plant. No uniform regulations have been established within the State of California or nationally for DPR. However, two important documents have now been completed, the Framework for Direct Potable Water Reuse and the Investigation on the Feasibility of Developing Uniform Water Recycling Criteria for Direct Potable Reuse. The Framework for Direct Potable Water Reuse provides an overview of DPR, identifies key issues that need to be addressed in the development of regulations, and provides step-by-step recommendations on how to safely implement DPR (Tchobanoglous, *et al.*, 2015). The two DPR facilities currently operated worldwide (one in Windhoek, Namibia and the other in Big Spring, Texas) have site-specific permits and treatment requirements set forth by regional regulatory agencies. A summary of the Feasibility of Developing Uniform Water Recycling Criteria for Direct Potable Reuse is presented in section 6.4.1.1.

2.6.4.1 State of California Efforts

Senate Bill (SB) 918 directed the SWRCB to investigate the feasibility of developing uniform water recycling criteria for direct potable reuse, convene an Expert Panel to study the technical and scientific issues, and provide a final report to the California State Legislature by December 31, 2016. SB 322 further required that the SWRCB convene an Advisory Group comprised of utility stakeholders to advise the SWRCB and its Expert Panel on the development of the feasibility report. SB 322 also amended the scope of the Expert Panel to include identification of research gaps that should be filled to support the development of uniform water recycling criteria for DPR.

The SWRCB DDW released their draft report on the feasibility of DPR in California on September 8, 2016. The draft report is titled "*Investigation on the Feasibility of Developing Uniform Water Recycling Criteria for Direct Potable Reuse*," and was issued pursuant to requirements set forth in SB 918.

Summary of SWRCB Report

In general, the SWRCB found that regulations for DPR projects are attainable and that a common framework across the various types of DPR will help avoid discontinuities in the risk assessment and management approach. The SWRCB clearly indicated that further quantification of reliability is necessary in order to develop criteria for DPR. The SWRCB states that the process for developing criteria for DPR can be initiated with a parallel analysis of the knowledge gaps.

The SWRCB outlines recommendations that must be addressed in order to successfully adopt uniform water recycling criteria for DPR that are protective of public health. The recommendations, which are documented in Chapter 4 and further described in Table 1 of the report (SWRCB, 2016), are summarized as follows:

1. The SWRCB recommends that the development of uniform water recycling criteria for DPR be initiated concurrently with the six Expert Panel research recommendations such that the findings from these parallel efforts can be used to inform the development of the criteria.
2. Convene a "blue ribbon" panel to review scientific literature and report on the current state of scientific knowledge regarding the potential health risks of emerging contaminants in recycled water that present serious harm to health.
3. Consider the use of probabilistic quantitative microbial risk assessment (QMRA) as part of criteria development to provide better assessment of the performance of DPR treatment trains, provide an opportunity to identify additional effective DPR treatment trains, and result in DPR criteria that ensure the protectiveness of DPR.
4. Work with the Regional Water Quality Control Boards to include monitoring requirements for pathogens (i.e., Giardia cysts, Cryptosporidium oocysts, and several human viruses) in raw wastewater feeding potable reuse systems to improve characterization methods and improved precision of concentrations to provide more information on concentrations and their variability.
5. The SWRCB will work with other agencies (DDW, local health departments, and wastewater agencies) to investigate the feasibility of collecting pathogen concentration data in raw wastewater associated with community outbreaks of disease.
6. Conduct short term research to identify treatment options for final treatment processes that can provide attenuation with respect to potential chemical peaks, particularly for chemicals

that have the potential to persist through advanced water treatment. Simple concepts could include the use of GAC to capture organic spikes.

7. Develop more comprehensive analytical methods to identify low molecular weight unknown contaminants. This includes non-targeted analysis as a screening tool and bioanalytical tools.
8. Convene technical workgroups to address the knowledge gaps regarding resiliency to assist in developing uniform water recycling criteria for DPR.
9. SWRCB will continue to work with Water Environment & Reuse Foundation (WE&RF) on its DPR Research initiative. SWRCB will serve as an advisor to prioritize projects and serve in its Project Advisory Committees.
10. The SWRCB will partner with other relevant agencies within California Environmental Protection Agency (CalEPA), to assess the technical capability in areas relevant to DPR.

The SWRCB also adopted the Expert Panel and Advisory Group recommendations for non-treatment barriers. The recommendations include:

1. Training and certification of operators for potable reuse treatment facilities.
2. Optimizing wastewater treatment plant performance to prepare for DPR.
3. Enhancing source control programs designed to prevent or minimize discharges of toxic chemicals to sewer systems that feed into DPR treatment plants.
4. Ensuring that agencies implementing DPR projects have adequate technical, managerial, and financial capacity to ensure the success and safety of the project.

The SWRCB recommendations were derived in large part from the Expert Panel report. The Expert Panel report is available in the State Water Resources Control Board website and includes the following specific findings:

The Expert Panel found that it "is technically feasible to develop uniform water recycling criteria for DPR in California, and that those criteria could incorporate a level of public health protection as good as or better than what is currently provided by conventional drinking water supplies and IPR."

The Expert Panel indicated that increasing the reliability of mechanical systems and treatment plant performance will address the absence of an environmental buffer and the level of protection that it provides in IPR projects. The Expert Panel identified several reliability features that should be incorporated into DPR projects to provide an equivalent level of health protection as IPR:

"1) providing multiple, independent barriers, 2) ensuring the independent barriers represent a diverse set of processes, 3) using parallel independent treatment trains, 4) providing diversion of inadequately-treated water, 5) providing a final treatment step to attenuate any remaining short-term chemical peaks, 6) incorporating frequent monitoring of surrogate parameters at each step to ensure treatment processes are performing properly, and 7) developing and implementing rigorous response protocols, such as a formal Hazard Analysis Critical Control Point (HACCP) system."

The Expert Panel provided six research recommendations to ensure that DPR is protective of public health and promote understanding and acceptability of DPR. However, the Expert Panel stated that the research could be undertaken either before and/or concurrently with the

development of the uniform water recycling criteria. The six research recommendations are summarized below (SWRCB, 2016):

- Improve source control and final water quality monitoring, and perform a literature review to identify new compounds that may pose health risks (especially to fetuses and children) from short-term exposures.
- Evaluate the performance and reliability of DPR treatment trains by implementing a probabilistic method (QMRA) to confirm the necessary removal values for viruses, Cryptosporidium and Giardia based on a literature review and new pathogen data collected.
- Develop better empirical data on concentrations and variability by monitoring of pathogens in raw wastewater.
- Investigate the feasibility of collecting raw wastewater pathogen concentration data associated with community outbreaks of disease, and implement where possible.
- Identify suitable options for final treatment processes that can provide some "averaging" with respect to potential chemical peaks, particularly for chemicals that have the potential to persist through advanced water treatment.
- Develop more comprehensive analytical methods to identify unknown contaminants (e.g., low molecular weight compounds) that may not be removed by advanced treatment and are not presently detectable by current regulatory monitoring approaches.

These findings and recommendations generally follow the state of the industry in terms of best practices and critical considerations for DPR. A few specific points warrant further discussion, particularly in terms of how they can impact DPR projects in California, which are either currently being considered or that could be developed in the future.

Key Findings

The SWRCB makes several statements in the report that could have implications to the path forward for DPR projects in California:

- **Timing.** The SWRCB plans to further address knowledge gaps related to reliability prior to finalizing uniform water recycling criteria for DPR. This indicates that any planned DPR projects may need to be brought before the Board for site-specific approval in the absence of a statewide framework.
- **Framework for Criteria.** The report indicates that each type of DPR project (i.e., a project delivering advanced treated recycled water directly to a surface water treatment plant or surface water reservoir with minimal retention time, or a project delivering finished water to a public water system's distribution system) will have its own unique set of criteria that are possibly captured within a common framework to avoid discontinuities in the risk assessment. The goal of any type of project is to provide identical water quality and minimal risk.
- **Raw Water Pathogen Monitoring, Including During Outbreaks and Recommendation to Consider Incorporating QMRA.** The SWRCB approach on establishing pathogen log inactivation / removal requirements will directly impact treatment requirements and costs. The language in the report suggests that rather than setting uniform values as with the groundwater replenishment requirements (Table 2.2), the log inactivation / removal requirements could be based on site-specific raw water

pathogen concentrations, or a more robust set of raw water pathogen concentrations for California that encompasses outbreak data. Those site-specific or worst case raw water pathogen data would be used to calculate the required log removal / inactivation requirements to achieve a target finished water quality, potentially derived from QMRA. Depending on the database of raw water pathogen data, this approach could result in similar or more stringent requirements for log inactivation / removal than those established for IPR using injection into the groundwater aquifer as an environmental buffer.

- **Monitoring and Control of Ongoing Projects.** The Expert Panel suggests that a new formal process be established by the SWRCB to administer periodic review of treatment performance data of permitted potable reuse projects. This proposed process is not unlike the process for ongoing monitoring and review of surface water treatment plant operation through surface water monthly operating reports (SWMORs), annual reports (e.g., consumer confidence reports), and California DDW inspections. The SWRCB also indicates a plan to review the state of the science on chemicals of emerging concern every five years. Either of these activities could have implications on permitted operation of a DPR facility, but with the benefit of providing a mechanism for continued review of whether a specific DPR facility, or DPR in general, is providing the best feasible level of protection of public health.
- **Start-up and Commissioning.** The Expert Panel cautioned that the introduction of DPR water into a public water system be staged to demonstrate reliability before contribution is increased. This language, if adopted by the SWRCB in DPR criteria, has potential implications on the approach for starting up new DPR facilities.
- **Approach to Fill Knowledge Gaps and Incorporate New Research Findings.** The SWRCB recognizes the need to consider recently completed and ongoing research through its plan to convene a blue ribbon panel and technical workgroups focused on further developing quantitative metrics and criteria that address the concept of reliability. Outcomes of ongoing research and those panel discussions will influence the criteria for DPR and should be carefully tracked by any ongoing planned DPR project to make sure that the facility design reflects any updated requirements that could be incorporated in the uniform water recycling criteria for DPR based on emerging science.
- **DPR Projects without Reverse Osmosis (RO) Treatment.** The Expert Panel recommended that the SWRCB consider proposals for DPR projects that do not employ RO. While RO provides a robust barrier for protozoa, viruses, nitrate, nitrite, TDS, and multiple metals and chemical microconstituents, it produces a concentrate stream of up to 20 percent or more of the raw water production rate that requires disposal with environmental implications. To facilitate consideration of non-RO treatment trains, the uniform water recycling criteria will need to be written in a manner that allows for these alternatives. The SWRCB highlights that "...there should be some specific reliability criteria for alternatives." The SWRCB's approach to establishing criteria for alternatives to RO will have significant ramification for the design and cost of DPR projects that do not include that unit process, and the feasibility of such an implementation.
- **Provision of a Final Treatment Step to "Average" Out Any Chemical Peaks.** The Expert Panel recommendation for research to identify suitable options for final treatment processes that can provide some "averaging" with respect to chemical peaks,

and any resulting incorporation of that language in the criteria, will have important implications to the design, cost, and operation of DPR projects.

- **Consideration and Incorporation of Non-Treatment Barriers.** The Expert Panel and the SWRCB recommend incorporation of non-treatment barriers, including optimization of wastewater treatment plant operation (WWTP), source control, technical, managerial, and financial capacity (TMF), and operator training and certification. The SWRCB approach to incorporating these non-treatment barriers in any uniform water recycling criteria for DPR could have implications to:
  - WWTP capital improvement projects (CIP) and operational costs.
  - Pre-treatment program requirements for monitoring, management, and local limits.
  - Industrial discharge options and costs.
  - Water utility investment in technical, managerial, and financial capacity.
  - Staffing and training costs for operation of a new DPR facility.
  - Generally, these non-treatment factors reflect best practices for DPR and are recommended within the potable reuse industry. However, their potential adoption within State criteria for DPR projects highlights the importance of planning in advance to ensure that they are addressed as part of a comprehensive DPR project requiring State of California approval.
- **Research on Low Molecular Weight Organics.** One of the SWRCB recommendations is that research be conducted to develop more comprehensive methods to identify low molecular weight unknown compounds for DPR, including non-targeted analysis as a screening tool. How the SWRCB proceeds with this may impact monitoring requirements at a minimum for DPR projects, but could also affect treatment requirements and incorporation of processes that address low molecular weight compounds. Low molecular weight compounds are perhaps the most challenging to remove through established treatment processes (e.g., membrane filtration, membrane desalination, advanced oxidation, granular activated carbon adsorption, biologically active filtration, and chemical disinfection). Requirements to mitigate these compounds could include source control strategies as one of the more effective approaches to reduce concentrations in DPR projects.

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Chapter 3

TREATMENT TECHNOLOGY ASSESSMENT

This chapter details the level of treatment that will be obtained through key processes, how those processes should be monitored, and the total level of treatment that results in both regulatory approval and public health protection as defined by the California Division of Drinking Water, DDW (formally known as the California Department of Public Health, CDPH). As detailed in Chapter 2, the primary acute risk for potable reuse is pathogens; therefore, this chapter focuses on pathogen removal through advanced processes.

3.1 Summary of Findings

Treatment process performance for potable reuse applications have been documented in both demonstration and full-scale applications through years of research and performance monitoring. Combining treatment processes into a series of multiple barriers provides effective pathogen and chemical pollutant reduction. While the pathogen and chemical pollutant removal goals are the same for all types of potable reuse, the actual combination of treatment processes can vary, depending on the end use.

Due to the need to protect water quality (both surface and ground water) we are evaluating treatment process trains that include reverse osmosis for reduction of salts as well as their excellent removal of pollutants and pathogens. The widely accepted and regulatory approved treatment process train for potable reuse is membrane filtration (MF/UF, micro or ultra-filtration), reverse osmosis (RO), followed by an ultraviolet light/advanced oxidation processes (UV/AOP) step. There are several types of oxidants that have proven successful, including hydrogen peroxide and sodium hypochlorite. Additional processes including granular activated carbon (GAC), soil aquifer treatment (SAT), and engineered storage buffers (ESB) may be desired for their removal capabilities in the overall treatment train. Final selection of treatment trains will be made when alternatives for end-use are determined.

3.2 Treatment Process Performance

The performance of each type of treatment process is measured by log reduction of pathogens and removal of chemical compounds (e.g. 1 log = 90 percent removal, 2 log = 99 percent removal, etc.). Because a system of multiple barriers is added up to meet the total log reduction criteria established by regulations, it is important to understand the log reductions that occur across each process, starting with primary and secondary treatment. For each process, we have summarized research findings and generally accepted removal values. The potable reuse goals to meet existing, draft, and prospective regulatory criteria are defined in Table 3.1.

Table 3.1 Potable Reuse Pathogen Reduction Goals/Requirements

Applicable Potable Reuse Form	Virus	*Giardia*	*Crypto*
Surface Water/Reservoir Augmentation (standard: Dilution ≥ 100:1)(1)	8	7	8
Surface Water/Reservoir Augmentation (reduced dilution: 100:1 ≥ Dilution ≥ 10:1) (1)	9	8	9
Groundwater Augmentation(2)	12	10	10
Raw Water Augmentation(3)	14	12	12

Notes:
(1) Surface Water/Reservoir Augmentation requires a minimum residence time of 180 days in the reservoir be calculated theoretically (volume in surface water reservoir divided by total outflow). A lower residence time may incur a proportional increase in required log removal credits.
(2) Groundwater augmentation requires a minimum of two months (60 days) of travel time in the ground before reaching a potable water extraction well.
(3) It is expected that the State will increase several Log Removal Credits (LRCs) for Raw Water Augmentation projects. This increase does not imply an increase in health protection but an increase in risk minimization due to process failure. There is no environmental buffer between the AWPF and the drinking water treatment plant.

3.2.1 Primary and Secondary Treatment

Primary treatment and secondary treatment are the basic physical and biological treatment processes required for wastewater treatment and discharge. However, these processes are also an important first step in the removal of both pathogens and chemical pollutants from a wastewater source. United States Environmental Protection Agency (USEPA) has investigated the removal of pathogens and Table 2-3 of the Design Manual for Municipal Wastewater Disinfection (1986) lists primary treatment as providing 10 to 35 percent removal of bacteria and less than 10 percent removal of viruses. Protozoa removal through primary treatment is not listed. The same table (2-3) includes bacteria and virus removal percentages for secondary treatment, showing 90 to 99 percent removal of bacteria and 76 to 99 percent removal of viruses.

Francy *et al.* (2012) indicates that secondary treatment is capable of 99 percent to 99.98 percent removal of bacteria and 88 percent to 99.9995 percent removal of various virus and coliphage. The single data set with any data below 90 percent removal, which was for adenovirus, showed removal ranging from 88 percent to 99.93 percent with a median removal of 99.8 percent.

Recent DDW approval of pathogen removal credits for combined primary and secondary treatment was obtained by the Water Replenishment District (WRD, 2013). That document relied upon risk analysis data presented in Olivieri *et al.* (2007), which was developed based upon Rose *et al.* (2004). Within Rose *et al.* (2004), the research team defined the range of bacteria, enterovirus, *Cryptosporidium*, and *Giardia* removal through 6 different full scale wastewater treatment plants. The raw data from that work is reported in Olivieri *et al.* (2007). For WRD (2013), the pathogen removal credits for their secondary process were based upon the data from 2 of the 6 tested secondary process configurations. Specifically, two of the secondary process trains (Facilities C and D, with solids retention time (SRT) of 1.6-2.7 days and 3-5 days, respectively) had SRT values less than the secondary process feeding the WRD advanced treatment system (>9 days), and thus are presumed to be conservative estimates of performance. Per CDPH request, WRD (2013) used the lower 10th percentile values calculated for each pathogen, resulting in 2.06-log reduction of enterovirus, 1.42-log reduction of

Cryptosporidium, and 2.42-log reduction of *Giardia*. Note that our analysis of the same data set found one data translation error, but the overall impact on the log reduction credits is minimal. Interpretations of the data set (Rose *et al.* 2004) suggest that longer SRT values result in increased pathogen removal. While this may be the case, the raw data from Rose *et al.* (2004) does not show this clearly (Table 3.2). For example, Facility F from that research with the longer SRT has lower protozoa reduction than most of the other facilities, but also shows the best virus removal compared to the other facilities. The lowest virus removal occurs at Facility A, which has an SRT of 6 to 8 days. This data set is limited and making projections based upon SRT is speculative. Thus, we recommend using the lower 10th percentile of the entire data set, which results in 1.9-log reduction of virus, 1.2-log reduction of *Cryptosporidium*, and 0.8-log reduction of *Giardia*.

Table 3.2 Pathogen Reduction Values Through Primary and Secondary Treatment (from Rose et al., 2004)

Lower 10th Percentile Values		Log Reduction		
SRT	**Facility**	**Enterovirus**	***Giardia***	***Crypto***
1.6 - 2.7	C	1.8	2.6	1.25
3-5	D	2.05	1.35	1.4
3.5-6	B	1.95	2.45	1.6
6-8	A	1.65	0.8	0.7
8.7-13.3	E	1.75	2.6	1.9
8-16	F	2.6	0.9	0.25
1.6-16	**ALL**	**1.85**	**0.8**	**1.2**
50th Percentile Values		**Log Reduction**		
SRT	**Facility**	**Enterovirus**	***Giardia***	***Crypto***
1.6-2.7	C	2.05	3.05	1.65
3-5	D	2.5	1.9	2.6
3.5-6	B	2.25	2.6	1.9
6-8	A	2.1	1.6	1.1
8.7-13.3	E	2.2	2.8	2.1
8-16	F	2.75	1.1	0.95
1.6-16	**ALL**	**2.3**	**2.6**	**1.6**

Overall Performance: The primary and secondary treatment should account for 1.9-log reduction of virus, 1.2-log reduction of *Cryptosporidium*, and 0.8-log reduction of *Giardia*. Primary and secondary treatment is also an important step in removing a significant portion of the chemical pollutants found in raw wastewater.

3.2.2 Membrane Filtration - Microfiltration (MF)/Ultrafiltration (UF)

MF and UF are both types of physical filtration processes. Membranes used for MF applications have a pore size that ranges from 0.1 to 10 µm, while UF membrane pore size are smaller in the range of 0.001 to 0.1 µm. MF is a robust technology that has proven to be effective in removing *Giardia* and *Cryptosporidium* cysts, algae, and some bacterial species. However, MF is not an effective barrier to viruses. On the other hand, UF has proven to be effective in removing viruses.

Recent work with Clean Water Services (CWS) (Oregon), as part of DPR demonstration testing, indicates that a well-functioning UF membrane (0.01 µm nominal pore size in this case) can attain 4.7-log reduction of seeded virus (CWS, 2014) without chemical use (such as alum or polymer) ahead of the membrane. Equivalent or greater reduction of protozoa can be assumed based upon this data because protozoa are much greater in size, and is directly supported by NSF (2012). Furthermore, MF or UF membrane integrity testing (MIT) confirms system performance and demonstrates how MIT data can be used to track and ensure continued membrane performance (CWS, 2014). The UF system at the Ventura Water Pure Demonstration Facility reliably provided at least 4-log protozoa removal and 1-log virus removal.

Overall Performance: Both MF and UF membranes can be relied upon for 4+ log reduction of protozoa. System performance monitoring (to provide regulators' confidence in the removal credit) is accomplished through the use of precise and accurate filtrate turbidity monitoring coupled with daily pressure hold tests (MIT). Innovative methods to track MF or UF performance include the use of bench-scale particle counting and the use of adenosine triphosphate (ATP) to daily verify bacteria removal. MF/UF processes have not been shown to remove a significant amount of chemical pollutants.

3.2.3 Reverse Osmosis (RO)

The RO process in a potable reuse treatment train provides for removal of salt (measured as electrical conductivity (EC)), organics (measured as total organic carbon (TOC)), and pathogens. RO removes ~95 percent of incoming salt. Depending on the feed water quality, RO product water can have a total dissolved solids (TDS) concentration as low as 50 mg/L. Along with salt and TOC removal, RO removes trace level pollutants such as hormones, pharmaceuticals, and personal care products.

Studies have found virus removal by RO to be from 3 to >6-log (Reardon *et al.*, 2005, NRMMC/EPHC/NHMRC 2008, CWS 2014). Equal or greater removal is expected for protozoa based upon size differences (protozoa being much larger than virus). RO process performance for pathogen rejection is not governed by the ability of an intact membrane to reject pathogens; it is governed by the ability to monitor process integrity (Reardon *et al.*, 2005 and Schäfer *et al.*, 2005). The monitoring tools currently used, electrical conductivity (EC) meters and total organic carbon (TOC) meters, can measure 99 percent or less removal of both parameters through the RO process. Recently, the DDW granted 1.5-log reduction credit for all pathogens for RO (WRD, 2013), based upon a requirement to continuously monitor TOC reduction across RO. The Orange County Water District (OCWD) currently attains 2-log pathogen credit through their online TOC meters.

Alternative technologies, such as online fluorescent dye monitoring, have been shown to have higher accuracy in assessing membrane efficiency (Kitis *et al.*, 2003, Henderson *et al.*, 2009, Pype *et al.*, 2013). The Trasar fluorescent dye is stable over a range of temperature and is not impacted

by pH in the range of 4 to 10. At 600 g/mole, this compound is larger than the openings in the RO membrane, but smaller than the size of any target pathogen, making the Trasar compound a potentially valuable tool for RO system performance monitoring.

The Trasar technology's efficiency to detect any flaw in a RO membrane was tested by Carollo, with the assistance of Nalco, as part of the Ventura Water Pure demonstration testing. The test included monitoring the removal of seeded virus MS2, EC, and Trasar for different RO operational conditions, including "normal" operation, a cut O-ring condition, and two chlorine oxidized RO membranes. The performance was tracked across both the first stage of RO and for the entire RO. Results from this research demonstrate the ability to conservatively monitor 3 to >4-log removal of virus using Trasar, compared to ~1.5-log removal of other monitoring surrogates.

The RO at the Ventura Water Pure demonstration facility reliably provided at least 1.5-log removal of both protozoa and virus based upon standard monitoring processes (e.g., EC). Results from Trasar testing at the Ventura Water Pure facility documented 4+ log removal of virus (and thus also 4+ log removal of protozoa) under normal operating conditions.

Overall Performance: RO provides a robust removal for all pathogens. OCWD currently attains 2-log pathogen credit trough online TOC meters. RO also provides for substantial removal of trace pollutants.

3.2.4 UV Advance Oxidation Processes (AOP)

In the event of pathogens passing through RO, the UV system provides for a high level of disinfection. A dose of 235 mJ/cm2 will result in 6+ log reductions of all target pathogens (USEPA 2006; Hijnen et al., 2006, Rochelle et al., 2005), including Cryptosporidium, Giardia, and adenovirus. Potable water reuse UV AOP systems will commonly operate at UV doses greater than 900 mJ/cm2; thus, higher reductions are theoretically possible, but DDW allows only a maximum of 6-log reduction credits per any one treatment technology (CDPH, 2014).

Adding an oxidant before the high dose UV results in the generation of hydroxyl radicals thought the UV process. This turns the treatment into an AOP, providing destruction of a range of pollutants that may pass through RO. Either hydrogen peroxide (H_2O_2) or sodium hypochlorite (NaOCl) can be used as an oxidant for this application. H_2O_2 is a more common oxidant than NaOCl for UV AOP applications. NaOCl presents benefits such as increased disinfection due to the presence of free chlorine, lower chemical cost, and operator familiarity. An additional benefit of the UV/NaOCl AOP is a more efficient generation of hydroxyl radicals at a low pH (<6), and RO permeate is typically in this pH range. Both the NaOCl and H_2O_2 UV advanced oxidation processes are controlled by oxidant dose and UV dose (UV intensity, UV Transmittance, or Power). However, the UV/NaOCl process is also controlled by the influent pH to the UV reactor and is sensitive to ammonia residual through the RO process which has a high NaOCl demand, thereby requiring a higher oxidant dose. pH and free chlorine concentration should be closely monitored to ensure the UV AOP design dose is met.

DDW requires the UV AOP to provide at least 0.5-log reduction of 1,4-dioxane, a conservative surrogate for destruction of trace pollutants (CDPH, 2014). Additionally, NDMA, with a DDW notification level (NL) of 10 ng/L, can pass through RO at low concentrations (typically 20 to 100 ng/L), requiring destruction by UV photolysis (Sharpless and Linden, 2003). Therefore, it is common to set the UV dose at 900 mJ/cm2 or higher. This high UV dose photolyzes NDMA as

well as many other smaller chemicals that may have passed through the RO train. NDMA is particularly photolabile.

Overall Performance: UV AOP (either with H_2O_2 or NaOCl) reliably provides at least 6-log disinfection of both protozoa and virus. Higher reductions are theoretically possible, but the DDW allows only a maximum of 6-log reduction credits per any one treatment technology (CDPH, 2014).The same system will reduce NDMA to <10 ng/L and destroy at least 0.5-log of 1,4-dioxane, thus also reducing other trace level pollutants. Online dose monitoring systems, using real time inputs of UV, UV intensity, flow, and oxidant dosing, is recommended for continuous confidence in UV AOP performance.

3.2.5 Granular Activated Carbon (GAC)

Granular activated carbon (GAC) and biological granular activated carbon (BAC) are able to remove a wide range of substances in solution (natural organic compounds, taste and odor compounds, and synthetic organic chemicals) via both physical (adsorption) and chemical (absorption) processes. GAC is activated carbon with a diameter greater than 0.1 mm, and a porous interior, greatly increasing the surface area for chemical removal. GAC filters can provide biological treatment of chemicals and organic matter in addition to physical removal when they are not exposed to disinfectants, and a biofilm layer is allowed to grow on the media (Crittenden, *et al*. 2012).

The State Water Resources Control Board recommended in the report to the legislature "*Investigating the Feasibility of Developing Uniform Water Recycling Criteria for Direct Potable Reuse*" that short term research be conducted to identify suitable treatment options for final treatment processes that can provide some attenuation with respect to potential chemical peaks (in particular, for chemicals that have the potential to persist through advanced water treatment)...". GAC and BAC are both options for a final barrier in an advanced treatment train, to act as a "polishing" step to remove any potential chemical peaks persisting through the processes. A polishing step can further reduce concentrations of any unlikely chemicals persisting in the water, rather than simply averaging. Public health benefits from incorporation of a final treatment step in the treatment train for attenuation of chemical peaks should be balanced with an assessment of environmental impacts (e.g., carbon generation, regeneration/disposal, and transport).

The Prairie Waters Project in Aurora, Colorado is a potable reuse augmentation project developed to alleviate the drought effects in the area. The treatment capacity is 50 million gallons per day (mgd). The project recovers the return flows discharged to the South Platte River downstream of Denver. The multi-barrier purification approach starts with riverbank filtration followed by artificial aquifer recharge with a retention time of 30 days. Once the water is recovered, the water is chemically softened before undergoing advanced oxidation (UV/H_2O_2), granular filters, and GAC as a polishing step to remove any trace organics that were not destroyed by the previous processes.

Overall Performance: GAC will readily adsorb organic compounds and provides a good option for a final barrier in a potable reuse train. However, GAC effectiveness is observed to be lower for low-molecular weight polar organic compounds.

3.2.6 Soil Aquifer Treatment (SAT)

Soil Aquifer Treatment (SAT) is a simple and effective process that has become an economical treatment alternative for water reuse applications. In SAT, water is recharged to an underlying aquifer through the unsaturated vadose zone. Physical, chemical, or biological treatment may be achieved when water infiltrates or percolates trough vadose zone.

The City of Fresno with Carollo, working with the WateReuse Research Foundation, completed leading edge research on the pathogen removal ability of spreading basins, showing 4 to 5-log reduction of virus through filtration in the upper levels of the percolation process. As protozoa are much larger than virus, equal or greater protozoa removal is also anticipated. The State of California credits the SAT process with substantial pathogen removal, but note that such pathogen removal is based upon 6+ months of travel time in the subsurface, not based upon removal in the upper levels of percolation through SAT. This new work tells another story, the robust value of filtration which would supplement pathogen die-off.

Overall Performance: The City of Fresno study showed 4 to 5-log reduction of pathogens through filtration as part of SAT. It should be noted that this work has been repeated at two locations (Fresno, Dinuba), but further soil column work is recommended until a more robust data set is completed. For this study, we are assuming a 3-log reduction of all pathogens through an SAT process. Field studies have shown that SAT process is capable of efficiently removing organic matter and estrogen (Fox, 2006).

3.2.7 Engineered Storage Buffer

For projects with short "Response Retention Time" (RRT), minimum time required for analytical procedures to be completed so that the quality and health effects can be determined, on the order of days to weeks or less, the use of an Engineered Storage Buffer (ESB) is recommended. Minimizing the environmental buffer leads to the loss of several benefits, including dilution, and, perhaps most importantly, time to detect and respond to a treatment failure. Recent potable reuse reports suggest that these are limitations that can be overcome. These studies include the WateReuse Research Foundation's 2011 report entitled "Direct Potable Reuse: A Path Forward" (Tchobanoglous *et al.*, 2011), the National Research Council's 2012 report entitled "Water Reuse: Potential for Expanding the Nation's Water Supply Through Reuse of Municipal Wastewater" (NRC, 2012), the Australian Academy of Technological Sciences and Engineering's 2013 report entitled "Drinking Water through Recycling: The benefits and costs of supplying direct to the distribution system" (ATSE 2013), and the WateReuse Research Foundation (WRRF) Project 11-10, Application of Risk Reduction Principles to Direct Potable Reuse (Salveson *et al.*, 2014). They suggest that a higher level of treatment at the Advanced Water Treatment Facility (AWTF) can compensate for the lack of treatment and dilution provided by the groundwater aquifer or surface water reservoir.

Tng *et al.* (2015) collected a cumulative 64 years' worth of operating data from seven operating advanced treatment facilities around the world to calibrate a model that simulated failure events for potable reuse. One of the significant findings of the modeling effort by Tng *et al.* (2015) is that *"the best approach to improving a plant's resilience is not by having multiple redundancies, but rather, via implementing more efficient maintenance protocols with an adequate amount of treated water storage."* This second point dovetails with the findings from WRRF 12-06 (Salveson *et al.*, 2016), which defines a framework for engineered storage buffer sizing as a function of

monitoring system characteristics and robustness as opposed to redundant treatment, essentially providing a roadmap for the approach recommended by Tng *et al.* (2015).

The ESB could hold the finished water for a duration sufficient to fully monitor the performance of each key process and respond any potential performance issue (Figure 3.1.). This hold time is the "Failure and Response Time," or FRT (Salveson *et al.*, 2016). The FRT can be minimized by not taking credit for processes that require long sampling and analysis time frames. Advanced processes such as pasteurization, RO, and UV AOP all can be rapidly monitored and maintain FRT values of ~30 minutes or less. The implication with this FRT is that the operators of the AWPF will have sufficient time to divert water or shut down the plant. A 30-minute FRT does not give enough time to necessarily address a water quality concern, but instead to identify it and prevent water from leaving the plant.

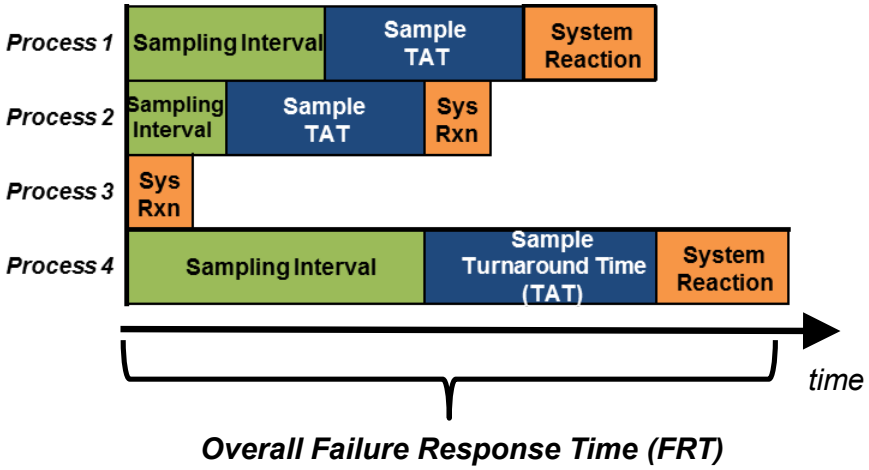


Figure 3.1 Treatment Train Failure Response Time (Salveson et al., 2016)

ESB also provides disinfection due to the maintenance of a free chlorine residual. Free chlorine contact time (Ct) values required for *Giardia* and virus inactivation are defined by the 1990 Surface Water Treatment Rule (SWTR) Guidance Manual (USEPA 1991). The Ct tables in that reference are flexible. 4-log virus credit can be obtained at a Ct of 12 mg-min/L, though higher Cts would be required for *Giardia* credit. USEPA (1991) was only designed to meet a maximum 4-log virus kill, though higher virus kill has been demonstrated. For a minimum FRT of 30 minutes and a minimum residual of 1 mg/L, the Ct of 30 mg-min/L will result in the 4+ log reduction of virus and 0.5-log reduction of *Giardia*, but no reduction of *Cryptosporidium*.

Overall Performance: The ESB would provide for 30 minutes of failure and response time, allowing the proposed online monitoring systems time to measure water quality and time for response and diversion procedures to be properly implemented in the event of a water quality or monitoring system failure. Additional, the ESB would provide for 4-log reduction of virus and a 0.5-log reduction of *Giardia*. ESB does not provide any removal of chemical pollutants.

3.2.8 Surface Water Treatment Plant (SWTP) - Filtration and Ozonation

Treatment processes at a conventional SWTP (sedimentation, coagulation, filtration, and disinfection) provide another set multiple barriers. For projects where purified water will be introduced upstream of the existing SWTPs, the treatment processes at the WTP provide

another set of multiple barriers in meeting pathogen and pollutant removal goals. Most of the WTPs have replaced the chlorine-treatment process with a combination of ozonation (O_3), ultrafiltration, and UV. This process provides faster treatment time, requires a smaller footprint, and allows enhanced performance. Sections 3.2.2 and 3.2.4 describe the UF and UV processes.

Zone 7 has two SWTPs, Del Valle Water Treatment Plant (DVWTP) and Patterson Path Water Treatment Plant (PPWTP). It also uses a demineralization facility (Mocho Demin) to treat brackish groundwater. However, the Mocho Demin is not included as part of any potable reuse treatment train. Zone 7 is planning to add O_3 at both SWTPs. The agency expects to make the addition to the DVWTP by 2019, and possibly PPWTP by 2020.

O_3 is widely used for drinking water treatment because of its disinfection and oxidation qualities. It is usually added as a pre-oxidation step before filtration to remove organic, inorganic matter, and micro-pollutants. It is also used for odor and taste control. O_3 is generated on-site due to the very short half-life of the molecule.

Overall Performance: A typical SWTP must meet a 4-log virus, 3-log *Giardia*, and 2.5-log *Cryptosporidium* requirement. Log removal credit for *Giardia* cysts and viruses by ozone (O_3) disinfection is based on contact time (Ct) per USEPA Ct tables (USEPA, 1991). According to the Long Term 2 Enhanced Surface Water Treatment Rule - Toolbox Guidance Manual, a log credit of 0.25 to 3.0-log for *Cryptosporidium* inactivation can be granted to systems with the addition of ozone, depending on the ozone dose applied. This value is determined by the Ct values. Ct values are established to provide a conservative characterization of the dose of ozone necessary to achieve a specified inactivation of *Cryptosporidium* (USEPA, 2010). O_3 can remove some trace organics like pesticides.

3.3 Overall Treatment Process Performance

The anticipated total performance of a proposed treatment train will depend upon the coupled treatment processes, which depends upon the planned type of potable reuse. The final selection of treatment trains paired with end use (types of potable reuse) will be made in later TMs that focus on alternative development and evaluation/comparison. Example potable reuse projects are listed below, including summary tables (Tables 3.3 through 3.6) of treatment performance for each listed option. For this analysis, the following considerations have been taken (i) SWTPs include sedimentation, coagulation, filtration, and disinfection, and (ii) two types of Groundwater Replenishment Reuse Projects (GRRPs) are surface spreading (SAT) and groundwater injection. Surface water spreading allows the stabilized purified water to infiltrate and percolate through the soil into the aquifer. This process is known as soil aquifer treatment(SAT). Surface spreading projects rely heavily upon treatment through the percolation process and dilution once the percolated water is in the groundwater basin. Groundwater injection of stabilized purified water directly into the groundwater basin would require full advanced treatment that includes RO and advanced oxidation processes (AOP). Additionally, a minimum of two months of subsurface travel time is required before extraction for potable use. General requirements for groundwater recharge are described in Chapter 2.

1a. Groundwater Recharge by Surface Spreading: DDW will allow for 20 percent tertiary recycled water and 80 percent approved "dilution" water. The dilution water can be reclaimed water that has gone through sufficient treatment to meet all regulatory standards; use of MF and RO should be sufficient. Thus, the process train, by regulation, could include 20 percent

tertiary recycled water (filtered and disinfected) with 80 percent MF/RO product water. Spreading projects require 6+ months of subsurface travel time to extraction wells. Given the proximity to extraction wells and the connectivity of Lake I to the shallow aquifer, which could be a potential spreading location, Option 1b, below, may be required.

Table 3.3 Treatment Option 1a. Groundwater Recharge by Surface Water Spreading (6+ months Travel Time)

Parameter	Primary/ Secondary Treatment	Tertiary Filtration and Disinfection	SAT	Subsurface Travel	Total Credits	Removal Goal
Viruses (log)	1.9	5	3	6	12+	12
Giardia (log)	0.8	0	3	*	10+	10
Crypto (log)	1.2	0	3	*	10+	10
NDMA			X			<10 ng/L
Turbidity		X				<0.2 NTU
Total Organic Carbon			X			<0.5 mg/L
Drinking Water MCLs			X			Varies

Notes:
(1) Extra log removal credits are granted by subsurface travel time. Assumes 6 months of travel time

1b. Groundwater Recharge by Surface Spreading with Short Travel Time: Option 1a must be modified in the event of a travel time of less than 6 months. The treatment train would require MF (or UF), RO, and UV AOP following a strict regulatory interpretation. However, the SAT process still provides value and the goal would be to utilize that value and reduce the purification costs through the use of low dose UV instead of UV AOP.

Table 3.4 Treatment Option 1b. Groundwater Recharge by Surface Water Spreading with Short RRT (<6 months)

Parameter	Primary/ Secondary Treatment	MF	RO	UV/ NaOCl	SAT	Subsurface Travel	Total Credits	Removal Goal
Viruses (log)	1.9	0	3	6	3	0	13.9	12
Giardia (log)	0.8	4	3	6	3	0	16.8	10
Crypto (log)	1.2	4	3	6	3	0	16.8	10
NDMA				X	X			<10 ng/L
Turbidity			X					<0.2 NTU
Total Organic Carbon		X			X			<0.5 mg/L
Drinking Water MCLs			X		X			Varies

2. Reservoir (Surface) Water Augmentation: Cope Lake could be used for Reservoir Augmentation, recognizing that the travel time is likely less than 6 months and anticipated DDW requirements for V/Q and blending may not be met. The resulting treatment and monitoring system would be MF (or UF), RO, and UV AOP, followed by the use of an ESB, and using advanced monitoring of the RO process with Trasar. Using the more conservative log removal

credits from the Pure Water San Diego project, this treatment may be appropriate for Raw Water Augmentation as well, with the water sent directly to DV WTP or PPWTP

Table 3.5 Treatment Option 2 - Reservoir Water Augmentation or Raw Water Augmentation

Parameter	Primary/ Secondary Treatment	MF	RO	UV / NaOCl	ESB+ Cl_2[(1)]	WTP	Total Credits	San Diego Pure Water Goal
Virus (log)	1.9	0	3	6	4	4	18.9	14
Giardia cysts (log)	0.8	4	3	6	0.5	3	17.3	12
Cryptos oocysts (log)	1.2	4	3	6	0	3	17.2	12
1,4-dioxane				X		X		0.5-log by AOP
NDMA			X	X				<10 ng/L
Turbidity		X				X		<0.2 NTU
Total Organic Carbon			X			X		<0.5 mg/L
Drinking Water MCLs			X	X		X		Varies

Notes:
(1) Assumes a CT (chlorine dose - contact time relationship) of 3.0.

3. Groundwater Injection: Groundwater injection, either in a conventional mode or with Aquifer Storage and Recover (ASR), would require MF (or UF), RO, and UV AOP. Use of advanced monitoring with Trasar allows the project greater flexibility in the minimum time the purified water must be stored underground.

Table 3.6 Treatment Option 3 - Groundwater Injection

Parameter	Primary/ Secondary Treatment	MF	RO	UV/NaOCl	Subsurface Travel	Total Credits	Removal Goal
Viruses (log)	1.9	0	3	6	2	12.9	12
Giardia (log)	0.8	4	3	6	0	13.8	10
Crypto (log)	1.2	4	3	6	0	13.8	10
1,4-dioxane				X			0.5-log by AOP
NDMA			X	X			<10 ng/L
Turbidity		X					<0.2 NTU
Total Organic Carbon			X				<0.5 mg/L
Drinking Water MCLs			X				Varies

3.4 References

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Chapter 4
WATER AVAILABILITY, BALANCE, AND QUALITY

This chapter presents a summary of the analysis on water availability and source water quality. Results of the following specific analyses are presented in this chapter:

- Water availability of sources both within and outside of Tri-Valley.
- Treatment process and source water evaluation.
- Water balance analysis and yields/losses.

Potential treatment, storage, conveyance, and end use options were identified to develop the components of the water balance and to assess yields and losses. As noted in the sections that follow, more detailed analysis is conducted on the options as part of the alternatives analysis and the refined results is presented in Chapter 5.

4.1 Summary of Findings

There are a number of key findings and conclusions from information presented in this chapter that impact the next step in the analysis of developing and evaluating alternatives. The flows presented in this study are based on master plan projections for buildout flows - 2020 for Livermore and 2035 for Dublin San Ramon Services District (DSRSD).

The water supply related findings and conclusions include:

- Projected summer available flows from the LWRP and DSRSD WWTP are 6.1 million gallons per day (mgd) and 0 mgd, respectively.
- Projected combined summer available flow from LWRP and DSRSD WWTP is 6.1 mgd.
- Projected maximum month flows from the LWRP and DSRSD WWTP are 8.7 mgd and 12.3 mgd, respectively.
- Projected combined maximum month available flow from LWRP and DSRSD WWTP is 20.9 mgd.
- While the EBDA pipeline provides a potential source of effluent, the cost of conveying the water to the Tri-Valley will likely exceed $60 M to reliably obtain 6 mgd of water to avoid developing a very complex system of batch processing and operation.

The water storage related findings and conclusions include:

- The available volume of storage at LWRP is not sufficient to provide an appreciable increase in year round flows to a purification process. Storage at this site is not further considered.
- The potential storage options at DSRSD present more of a potential flow benefit, although these storage options require replacement of DSRSD's existing biosolids management facilities Approximately 170 MG (605 AF) of storage is required to increase the purification flow by 1.1 mgd.
- Storage of the combined flow from DSRSD and Livermore, at DSRSD, has the potential to appreciably increase year round flow to a purification process. This storage option will

be further considered in the alternatives analysis only for alternatives with treatment at DSRSD or nearby.

The treatment, water quality, and end use related findings and conclusions include:

- FAT is assumed for all potential sites for injection wells and ASR wells, with the exception of the site adjacent to Lake I, where FAT, GAC, and engineered storage are assumed to be required.
- FAT, GAC, and engineered storage are assumed for all other end uses including Lake I recharge and surface water augmentation.
- Wastewater or concentrate treatment for ammonia removal is assumed not to be required to meet current discharge permit limitations; however this should be confirmed if a project was to move forward.
- Concentrate treatment to reduce fouling and scaling potential may be required.

While pollutants in the secondary effluent do not appear to present issues for a purification process, an Enhanced Source Control Program (ESCP) will be used as a first barrier for protecting public health. Even though an ESCP is not a specific regulatory requirement, it is expected that this will become part of the State's requirements to permit potable reuse projects. Background

4.2 Background

Figure 4.1 shows the existing facilities, including the Zone 7 water treatment plants, the DSRSD WWTP and the LWRP. Both DSRSD and Livermore have existing non-potable recycled water irrigation programs. Secondary effluent that is not used for non-potable recycled water irrigation is discharged to San Francisco Bay through the LAVWMA and EBDA facilities.

Treated wastewater from DSRSD WWTP and LWRP flows to a junction box downstream of the plants and is conveyed to the LAVWMA reservoirs and export pump station located north of the DSRSD WWTP. The effluent is then pumped from LAVWMA reservoirs into the LAVWMA export pipeline, sent over Boehmer Summit and discharged into the EBDA outfall pipeline. The EBDA pipeline conveys the effluent from LAVWMA and five other wastewater agencies (Town of Castro Valley, City of Hayward, Oro Loma Sanitary District, City of San Leandro, and Union Sanitary District) to a deep-water discharge outfall in San Francisco Bay. Under wet weather conditions and specific hydraulic conditions in the EBDA pipeline, LAVWMA can discharge to San Lorenzo Creek and Alamo Canal.

This project explores opportunities to treat the secondary effluent that is currently discharged to San Francisco Bay as potable reuse for water supply. The amount of available water for potable reuse depends upon the supply patterns, other existing uses (e.g. non-potable recycled water programs), and the projected recovery of the treatment train. The treatment trains were discussed in Chapter 3. Figure 4.2 presents a schematic of the components of the potable reuse alternatives, and additional detail is provided in Table 4.1, including identification of locations for treatment as agreed upon through discussions with staff from the Tri-Valley Water Agencies. This chapter will focus on available water supply and projected yield. A further analysis of project alternatives based on end uses and treatment location is presented in Chapter 5.

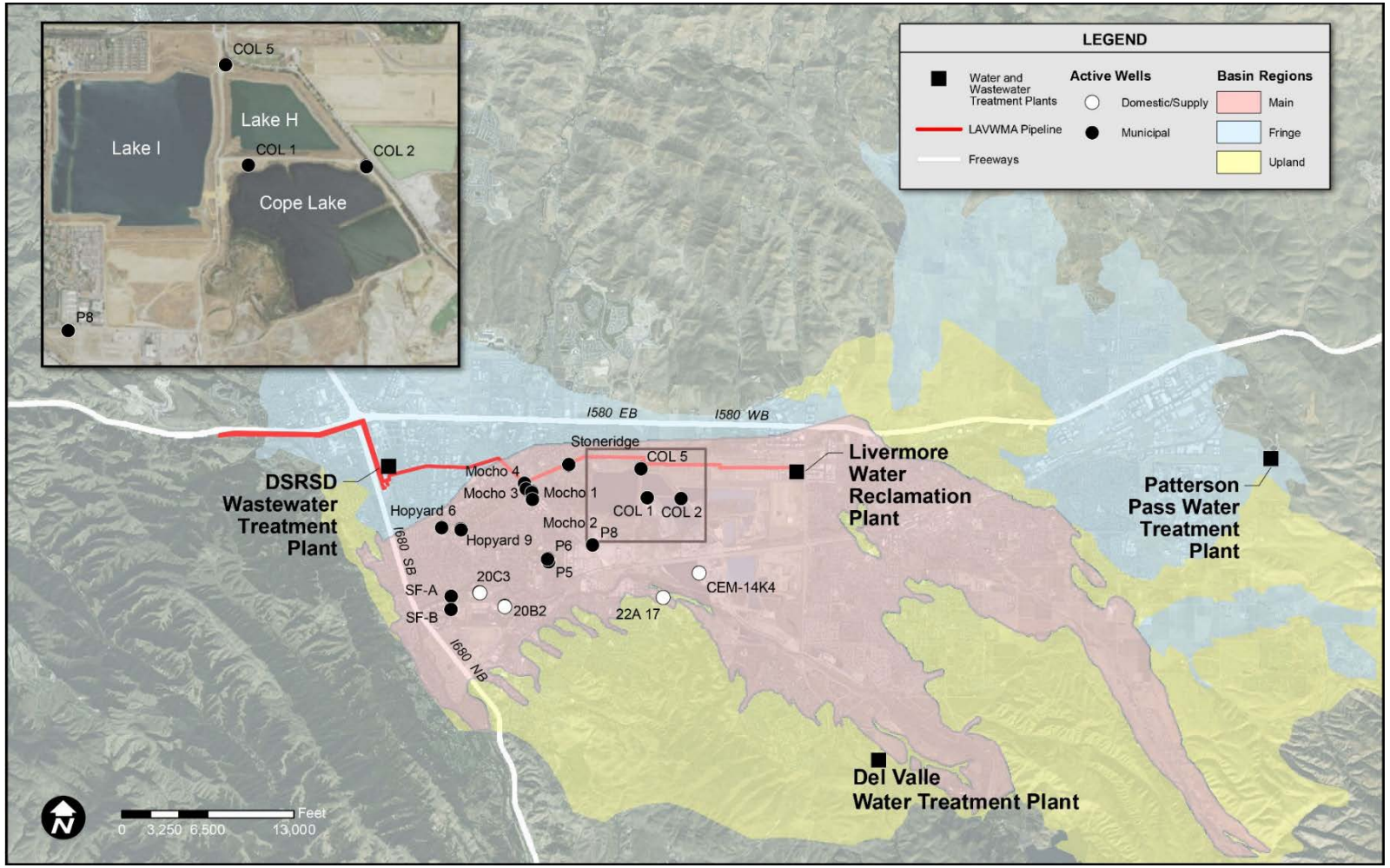


Figure 4.1 Existing Facilities

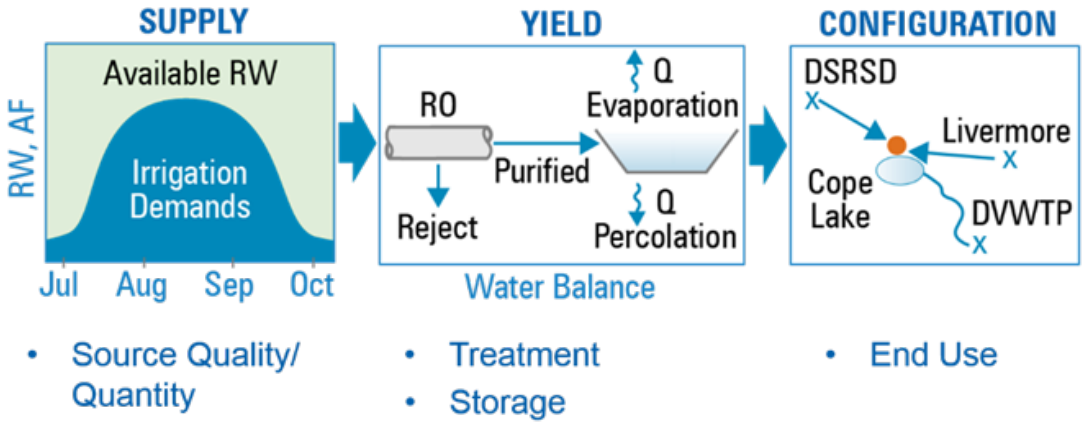


Figure 4.2 Schematic Diagram of Potable Reuse Alternatives

4.3 Water Availability

Both in-valley and out-of-valley sources of water were considered for this evaluation of flows available for potable reuse.

4.3.1 Within Tri Valley Sources

The in-valley analysis was performed for current conditions using historical data from the WWTPs from 2011 to 2015. However, during that period, California experienced a severe drought. While conservation measures have increased from the pre-drought usage there is expected to be some rebounding in per-capita water usage (and corresponding wastewater production) in non-drought conditions. Future flows were identified through review of the agencies' wastewater and recycled water master plans and used to develop the flow projections for 2035. The projections include compensation for the "bounceback" from the drought. For this study, the available water for potable reuse is defined as the secondary effluent flow from DSRSD WWTP and LWRP that is not being used to supply recycled water for non-potable uses.

Both agencies have existing and planned non-potable recycled water programs to serve irrigation customers within their service areas. Given the significant capital investment incurred, and the community support for the non-potable recycled water programs, it is highly unlikely that the agencies will discontinue these programs in the near future and divert wastewater to potable reuse instead. However, it is noted that if severe drought and water scarcity conditions persist in the future, non-potable uses may eventually be significantly reduced or eliminated (e.g. no landscape watering). Until such time that outdoor irrigation is banned, it is appropriate that recycled water be used, where feasible, to reduce demands on the potable water system for non-potable uses. This concept is termed "fit for purpose" and considers examining the best and highest use for each type of water. Clearly potable water should not be used for non-potable uses if an alternative exists.

Table 4.1 Components of Potable Reuse Alternatives

Component	Description
Potable Reuse Source Water	
Livermore Effluent	The available secondary effluent from the LWRP
DSRSD Effluent	The available secondary effluent from the DSRSD WWTP
Combined Effluent	The combined total available from the DSRSD WWTP and LWRP
Outside Tri-Valley Effluent	Any source of secondary effluent that is not generated in the Tri-Valley Area
Purification Process/Location	
LWRP	Purification treatment of available LWRP secondary effluent, located at the LWRP
DSRSD WWTP	Purification treatment of available DSRSD WWTP secondary effluent, located at the DSRSD WWTP
Regional Plant at DSRSD	Purification treatment of the combined secondary effluent, located at the DSRSD WWTP
Regional Plant at Chain of Lakes	Purification treatment of the combined secondary effluent, located at a new site in the Chain of Lakes area
Regional Plant Near Zone 7 Demineralization Facility	Purification treatment of the combined secondary effluent, located at a new site near the Zone 7 Demineralization Facility
Pleasanton AWPF to COLs/DVWTP(1)	Purification treatment of the combined secondary effluent, located at the Pleasanton Corp Yard
End Uses	
Groundwater Augmentation: Groundwater Recharge with injection wells (various locations)	Groundwater recharge of purified water through injection wells, and extraction at a downgradient location.
Groundwater Augmentation: Aquifer Storage and Recovery (ASR) wells (various locations)	Groundwater recharge of purified water through a well, followed by temporary underground storage, and extraction via the same well.
Surface Water Augmentation: Surface spreading (Lake I)	Groundwater recharge of purified water through surface spreading, and percolation into the underlying groundwater aquifer.
Raw Water Augmentation: Augmenting surface water to PPWTP or DVWTP	Augmentation of surface water supplies with purified water, followed by additional treatment at the PPWTP or DVWTP

Note:
(1) This alternative was added after Workshop #4 to provide an alternate regional location.

For the purposes of illustration, we have included a discussion in this chapter regarding the potential future flows available for potable reuse if non-potable recycled water programs were eliminated at some point in the future. However, for developing alternatives for potable reuse we will use only the flows available beyond what is planned for non-potable reuse. The flow discharged to the shared LAVWMA outfall to the San Francisco Bay is used as the available water for potable reuse. The projected 2035 combined LAVWMA discharge from DSRSD and Livermore is used as a maximum flow to size the different advanced water treatment facilities alternatives. It should be noted, that even though the values considered in this study are conservative, there is a level of uncertainty in terms of how the actual flows will vary in the future due to changes in climatic conditions, growth, and/or water use patterns.

4.3.1.1 DSRSD

DSRSD has made significant investments in non-potable recycled water over the last two decades. DSRSD's wastewater effluent is recycled at the recycled water treatment facilities, collocated at its regional wastewater treatment plant. DSRSD partnered with the East Bay Municipal Utility District (EBMUD) to form the DSRSD-EBMUD Recycled Water Authority (DERWA), a joint powers authority. DERWA acts as a recycled water wholesaler, which treats and distributes tertiary treated recycled water to DSRSD, EBMUD and the City of Pleasanton primarily for landscape irrigation. DERWA's most recent project is an $18 million recycled water treatment facilities expansion project that increases capacity to over 16 mgd to provide for projected increased demands by DSRSD, EBMUD and the City of Pleasanton. Upon completion in 2018, the facilities will essentially use all of the secondary effluent available from DSRSD during the summer irrigation season.

Historical data from October 2011 to April 2015 on DSRSD's wastewater influent flows and recycled water demands and projections for 2035 were provided by West Yost Associates developed as part of DSRSD's Wastewater Treatment and Biosolids Facilities Master Plan (West Yost Associates, 2016). Flow projection data for 2035, for the influent and recycled water demand flow rates, were only available for the months of October to April.

Figure 4.3 shows the historical data for flows discharged to LAVWMA from DSRSD that could be made available for potable reuse. The flow fluctuates seasonally with lower available flows for potable reuse during the summer months when demand for recycled water is higher. The average available flow during the summer (June, July, and August) is 3.8 mgd.

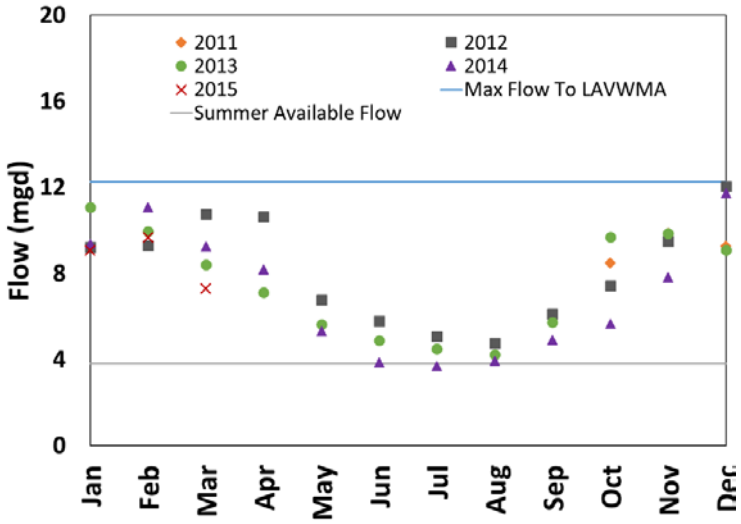


Figure 4.3 DSRSD's Historical Water Available for Potable Reuse

Figure 4.4 shows the 2035 flow projections for the available water compared to the historical data from 2012 to 2014. In 2035, based on the current plans to expand DSRSD, EBMUD, and the City of Pleasanton's non-potable system, the recycled water demand during the summer months would exceed the available wastewater influent flow. DSRSD is working on alternatives and seeking partnerships with adjacent agencies for alternatives to supplement their influent flows to meet recycled water demands. In conclusion, there is essentially no flow available from DSRSD for potable reuse during the summer months when there is the highest demand for non-potable recycled water. Potential outside source options to supplement flows are discussed in Section 4.3.2. The maximum available water flow from DSRSD during winter months is 12.3 mgd.

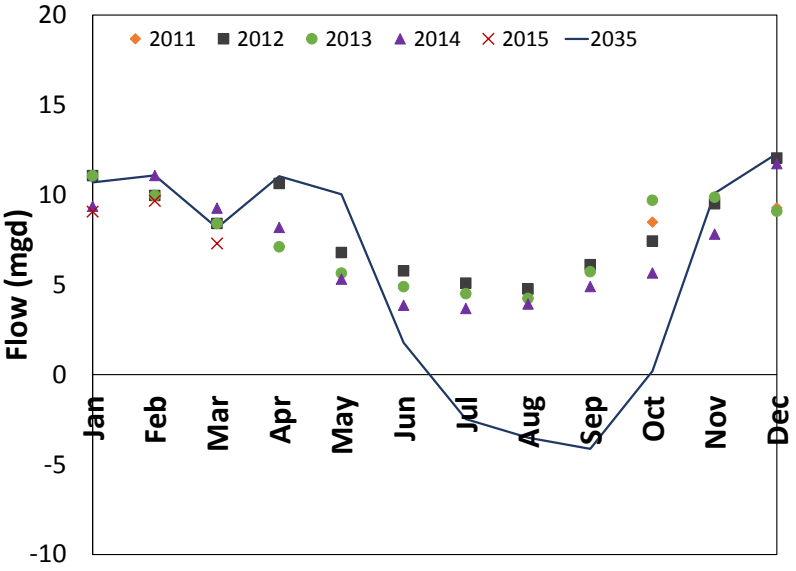


Figure 4.4 DSRSD 2035 Net Flow Projection After Recycled Water Production

4.3.1.2 Livermore

Like DSRSD, the City of Livermore has invested in a non-potable recycled water system, however, the existing and planned non-potable recycled water commitments are not expected to exceed the supply of secondary effluent throughout the year. Figure 4.5 shows historical data from 2011 to 2015 for flows discharged to LAVWMA that shows a seasonal variation with lower flows available during the peak irrigation months (summer). The maximum flow available during the winter is 6.4 mgd and the average summer flow is 3.1 mgd.

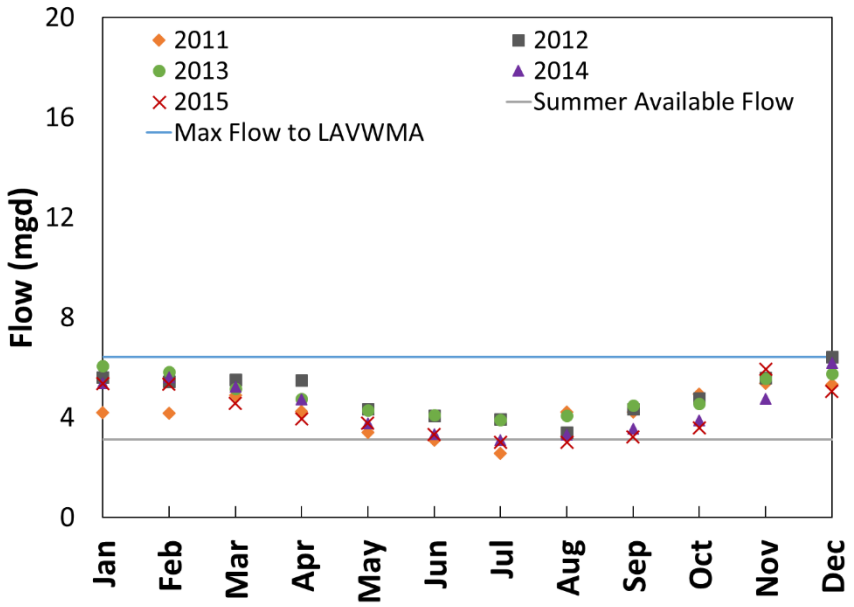


Figure 4.5 Livermore's Historical Available Flow Data

Livermore's flow projections were based on the Livermore Water Reclamation Plant 2012 Master Plan Update (Tetratech, 2013). The buildout Average Dry Weather Flow (ADWF) of 9.66 mgd was used to develop the flow projection for this study. Currently, Livermore is working on updating their master plan; however, the document was not ready for release at the time of this writing. It is expected that future flows could vary depending on the development of an extension of the Bay Area Rapid Transit (BART) to the area. This potential increase in flow would offset the decreases seen in recent years by conservation efforts during the drought. In the absence of an updated master plan, Livermore agreed to use the 2012 Master Plan's buildout value for this study. Figure 4.6 shows flow data for 2013 to 2015 along with the water available flow projection at buildout. The projection maximum flow is 8.7 mgd and the average summer flow is 6.1 mgd.

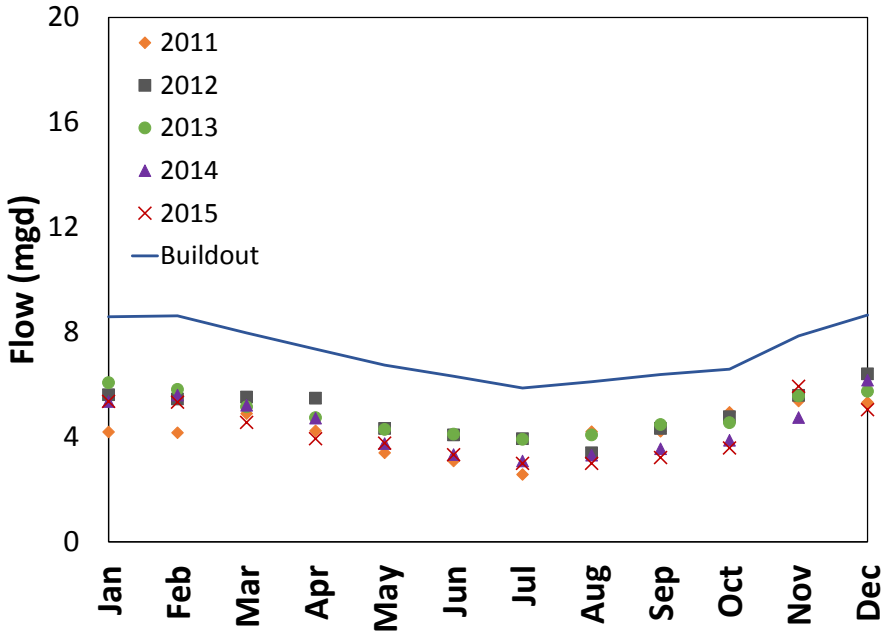


Figure 4.6 Livermore's Net Flow Projection After Recycled Water Production

4.3.1.3 Combined Flows Available

There are different approaches that could be used for considering the available supply for potable reuse. Three scenarios were analyzed for the combined flows available as summarized in Table 4.2. Based on input from the Tri-Valley agencies, it was decided that only future flows should be considered. Table 4.2 shows the available supply for: 1) after removing planned recycled water demands, 2) existing recycled water demands, and 3) eliminating recycled water altogether.

Table 4.2 Summary of Projected Summer Flows

Scenario	Projected Summer Influent Flow (mgd)			Average Summer RW Demand Flow (mgd)			Available Summer Flow for Potable Reuse (mgd)
	DSRSD	Livermore	Combined	Combined	DSRSD	Livermore	
1. Planned RW Use	12.7	9.4	22.1	19.3[(1)] (more than available	16.0	3.3	6.1[(2)] (Livermore only)
2. Existing RW Use	12.7	9.4	22.1	8.1[(3)]	5.5	2.6	14.2
3. No RW Use	12.7	9.4	22.1	None			22.1

Notes:
(1) Projected non-potable reuse demands (DSRSD/Livermore).
(2) Represents only Livermore's secondary effluent flow during the summer months. DSRSD's flow is fully diverted to recycled water use. Deficit DSRSD recycled water demands assumed to be supplied by other supplemental flow.
(3) Existing demands (DSRSD/Livermore).

Scenario 1 assumes the projected combined flows (DSRSD and Livermore) for the projected influent and the recycled water demand. Figure 4.7 shows the annual variation for the projected combined influent and recycled water with an annual average influent flow of 22.7 mgd and a summer influent combined flow of 22.1 mgd. The combined recycled water demand during peak

irrigation months is projected at 19.3 mgd, primarily made up by DSRSD's demand of 16 mgd and a smaller demand from Livermore of 3.3 mgd. The maximum available flow during the months with lower recycled water demand (winter months) is 20.9 mgd. The average available flow for potable reuse during summer months is 6.1 mgd. This available water represents only Livermore's flow since DSRSD's flow is fully diverted to recycled water use during the summer months. Water sources outside the Tri-Valley area are discussed in Section 4.3.2.

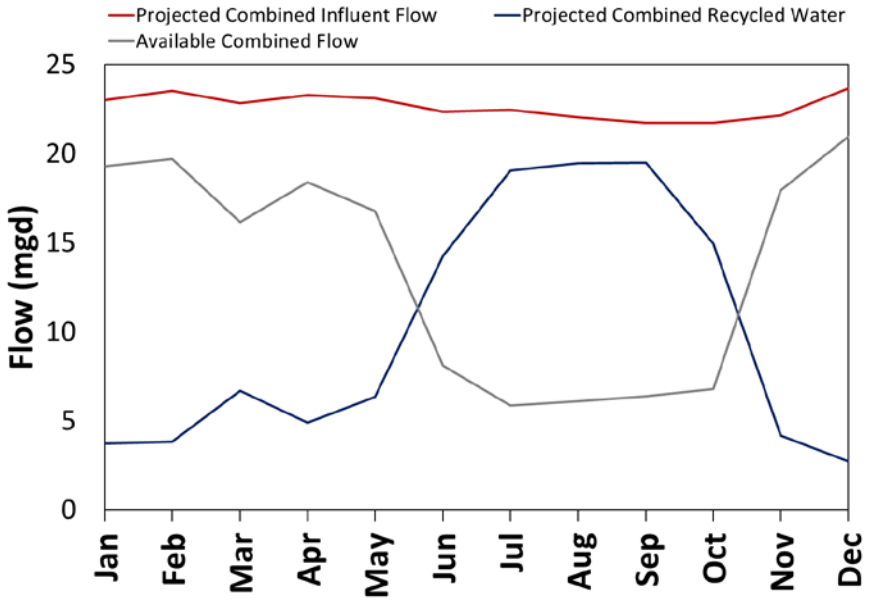


Figure 4.7 Combined Projected 2035 Available Flows for Potable Reuse with Planned RW Expansions

Scenario 2 considers the projected combined flow with the existing combined recycled water demand. In this scenario, further expansion of the non-potable recycled water system is suspended at current level. The average existing summer recycled water demand is 8.1 mgd which leaves the average summer water available for potable reuse at 14.2 mgd. This value includes both DSRSD and Livermore's flow since neither of the agencies' existing recycled water demand exceeded the influent flow. This scenario was discussed and eliminated from further discussion since there has already been a significant investment made to expand the DERWA recycled water services to Pleasanton using secondary effluent at DSRSD's wastewater treatment plant as source water. Therefore, the historical recycled water demands are not a realistic representation of future demands.

Finally, scenario 3 examines the option of the eliminating the recycled water programs for DERWA and Livermore. This would provide the maximum available flow equivalent to their combined summer influent of 22.1 mgd. However, the Tri-Valley agencies indicated a commitment to continuing to serve non-potable demands with recycled water in the foreseeable future to both offset potable uses and to provide a "fit for purpose" water supply. Therefore, this scenario is presented for informational purposes only and will not be used in developing alternatives.

4.3.2 Outside Tri-Valley Sources

Given the limitations of the wastewater available for potable reuse in the summer, the potential for treated wastewater from outside the Tri-Valley to serve as a source of water supply for potable reuse was considered.

Due to the projected deficit of available water for their non-potable recycled water program, DSRSD previously identified a number of options for augmenting flows. The following options have been considered:

- Wastewater from the Dougherty Valley area - This wastewater flow is currently exported to the Central Contra Costa Sanitary District (CCCSD) via the San Ramon Pump Station. The five-year average (2011-2015) flow recorded at the pump station was 2.75 mgd. However, this flow has been fluctuating with an average of 2.57 mgd in 2015.
- Treated effluent from the East Bay Dischargers Authority (EBDA) Pipeline - The disinfected, secondary effluent in this pipeline is from several Bay Area facilities and is currently discharged to San Francisco Bay. Use of this effluent would require conveyance from the EBDA pipeline over the Boehmer Summit and into the Tri-Valley. Alternatives for conveying 6 mgd and 25 mgd from the EBDA pipeline have been previously considered.

To increase the available wastewater supply to meet projected irrigation demands, DSRSD is exploring the possibility of receiving 2.5 mgd of wastewater from the Dougherty Valley area during the summer months and has approached CCCSD. If an agreement is reached, this outside supply would be dedicated to meeting non-potable recycled water irrigation demands. The wastewater from Dougherty Valley will therefore not be available as a supply for potable reuse.

DSRSD, EBMUD and the City of Pleasanton examined supplemental supply options for DERWA (DSRSD, EBMUD and the City of Pleasanton, 2016). Among the options explored is to use the wastewater in the EBDA pipeline as a potential source of water for potable reuse. Two different options were considered previously: 1) use existing infrastructure and add pump stations to reverse flow back into the valley; and 2) add new pipeline and pump stations to allow flow both directions. Both options were developed for importing 6 mgd and importing 25 mgd. Option 1 to use existing infrastructure may be feasible but would be operationally complex requiring storage of brine and alternating use of the pipeline between secondary effluent into the valley and RO concentrate discharges out of the valley. Option 2 of adding a new parallel line the entire length of LAVWMA outfall is costly and may have permitting and siting issues.

Preliminary analysis of these options suggests that it may be technically feasible, but that the cost of conveyance may be significant, as shown in Table 4.3. Costs shown do not include the cost of storage needed to batch process the water for brine disposal and conveyance of secondary source water. Operational complexity and perception issues of importing wastewater into the valley are also important considerations. After discussion with the Tri-Valley agencies, it was determined that there was not a sufficient water need in the Tri-Valley area to further consider importing 25 mgd. The agencies also agreed that the operational complexity of batch processing was not appealing.

Table 4.3 Advantages and Disadvantages of using Secondary Effluent from the EBDA Pipeline

	Advantages	Disadvantages
Technical Considerations	Can offset lack of available summer flows or greatly increase capacity of potable reuse project May be able to maximize use of existing infrastructure	Construction of either 61,000 feet new pipeline (parallel to existing) or 6 new pump stations to reverse flow. Siting, right of ways and permitting for pump stations and/or new pipeline may be complex.
Operational Considerations	Higher year-round flows available will allow operation of purification facilities at a steady rate (best operational scenario for membranes)	Batch storage/discharge of RO concentrate and batch import of water for purification facilities creates operational complexity
Cost Considerations (DSRSD, EBMUD and the City of Pleasanton, 2016).)	6 mgd in existing pipe = $27 M 25 mgd in existing pipe = $60 M	6 mgd in new pipe = $60 M 25 mgd in new pipe = $106 M Includes one 25 mgd pump station, and 61,000 linear feet of 36" diameter force main. Estimated costs do not include easement or property acquisition.

Due to the expense and complication of importing EBDA's effluent into the Tri-Valley, it is not recommended to include these flows into the current alternatives analysis. The Tri-Valley agencies have also recognized that for a potable reuse project to succeed, there needs to be a potable water need and incremental successes. An initial smaller project using only Tri-Valley generated flows has a greater potential to fit within the supply portfolio needs and be a first phase for implementing potable reuse.

However, the Tri-Valley agencies may wish to consider this option in the future when reviewing alternatives for additional water sources.

4.4 Effluent Storage Options

The secondary effluent available for potable reuse varies on a monthly basis, with the lowest flows available in the summer months and the highest flows available in the winter months. The variation in flow presents some operational challenge for reverse osmosis (RO) process, which is assumed to be included in all purification process treatment trains. The preferred operational approach for a RO membrane process is to provide a relatively constant feed flow with maximum variation of +/- 10%. A relatively constant flow keeps the membranes wet and provides for relatively uniform use of the individual membrane units. For this study, approaches for maintaining a constant RO feed flow and alternative options for protecting the RO membranes are considered:

- Assume that the capacity of the purification processes is equivalent to the minimum summer flow.
- Assume that the capacity of the purification processes is equivalent to a flow greater than the minimum summer flow, and operate the purification processes at capacity on a seasonal basis. This assumption requires that some portion of the RO system would not

be used on a seasonal basis, and it would be preserved over this period to maintain the integrity of the RO membranes. Alternatively, flow to the RO membranes would be cycled between membrane units during low flow periods, keeping the membranes wetted.

- Assume that the capacity of the purification processes is equivalent to a flow greater than the minimum summer flow, and utilize storage of water when it is available in the winter months to supplement the available flow in the summer months.

4.4.1 Secondary Effluent Storage

Each of the treatment facilities has onsite storage for the purpose of equalization and wet weather flow management. However, based on input from the operations and management staff, the use of these existing storage basins was confirmed to be an important piece in operating the facilities that will still be required in the future. Therefore, the existing basins are not available for seasonal equalization of the secondary supply before a purification process. Storage of the secondary effluent supply for potable reuse would require new storage facilities. Given that secondary effluent needs to be contained for public health reasons, only options for onsite storage at a WWTP were considered for secondary effluent storage. Given the limited available space onsite, the following options were identified:

- DSRSD WWTP - Conversion of sludge lagoons and/or dedicated land disposal area.
- LWRP - Conversion of sludge lagoons and/or use of additional unused space.

Conversion of the DSRSD solids areas presents a number of issues and implications. Most relevant are the significant costs that would be required for DSRSD to convert to mechanical dewatering and disposal offsite. There also may be legacy issues associated with siting a reservoir on facilities that were used for sludge disposal. These issues are incorporated in cost estimates for storage that are developed in Chapter 5.

A monthly water balance was conducted using data from October 2011 through March 2015, to quantify the constant flow of the purification process that could be achieved for various storage volume assumptions. The mass balance accounts for precipitation and evaporation, but assumes that the storage basins would be lined and therefore seepage is assumed to be negligible. This analysis was conducted for storage of LWRP secondary effluent at the LWRP, storage of DSRSD secondary effluent at the DSRSD WWTP and storage of secondary effluent from both facilities at the DSRSD WWTP.

Table 4.4 presents a summary of the storage basin assumptions and estimated constant purification process flow that could be achieved through constructing new or re-purposing storage facilities. The projected average monthly flows available for potable reuse and average net evaporation values were used for this analysis. Analysis of historical flow data showed significant variation due to varying hydrologic conditions. Therefore, the estimated amount of storage needed to achieve a constant purification process flow differs between scenarios. Results in Table 4.4 are estimated using average hydrologic conditions. Thus, under dry conditions, such as the one experienced in 2014, the storage volumes will not likely yield the purification process flows. The results suggest that purification process flow would not appreciably change with the addition of storage basins at the LWRP. The potential storage options at DSRSD present more of a potential flow benefit. Approximately 170 MG (605 AF) of storage is required to increase the purification flow by 1.1 mgd.

More detailed mass balance analysis combined with cost estimates for new/repurposing storage basins was conducted as part of future modeling tasks and alternatives analysis in Chapter 5.

4.4.2 Tertiary Storage

Storage of disinfected, tertiary treated water does not have the advantage of secondary effluent storage to equalize out tertiary facility sizing, but still may have some benefit in reducing RO sizing. There are limited locations for storage offsite from a WWTP that would not require a major rezoning or siting in an already developed area. Cope Lake is one of the few available options for the following reasons:

- Unlike some of the other existing and future lakes in the Chain of Lakes, the ownership and operation of Cope Lake has already been transferred to Zone 7.
- Due to the buildup of silt, there is limited recharge from Cope Lake to underlying groundwater.

While there are some distinct advantages of using Cope Lake for tertiary storage, this alternative was eliminated for the following reasons:

- Cope Lake is in very close proximity to some of Zone 7's municipal supply wells (Chain of Lakes wells), which would potentially present issues with requirements for setbacks between recycled water impoundments and potable supply wells, and potential issues with unplanned recharge of underlying groundwater.
- Planned uses of Cope Lake include flood management, which will require use of Cope Lake storage capacity in combination with Lake H and I (Zone 7, 2014).
- Even though, the Preliminary Lake Use Evaluation for the Chain of Lakes scored the use of Cope Lake for recycled water storage positively, this may conflict with the primary use of flood management.
- The Vulcan mining operations holds a permit to dewater groundwater and discharge it to Cope Lake, where a portion of the water is then routed to Lake I for groundwater recharge. Given the proximity to downstream wells and the connectivity of Lake I to the shallow aquifer, it is unlikely that Title 22 requirements for groundwater recharge with tertiary effluent co-mingled with the groundwater could be met for Lake I.
- Zone 7 plans to build a multi-use pipeline between the DVWTP/South Bay Aqueduct and Cope Lake. One of the potential uses for this pipeline is to convey surface water from the Cope Lake area to DVWTP for use as a supply during emergencies (e.g., outage on the South bay Aqueduct) and droughts. Water in Cope Lake therefore has to remain suitable for use as a raw water supply. Under Title 22, there has never been a tertiary effluent permitted for direct use at a WTP, even if it is co-mingled with dewatered groundwater. It is unlikely that the State would approve this type of project.

Table 4.4 Storage Evaluation Results

Facility	Storage Location	Secondary Effluent Source	Storage Facility Characteristics			Without Storage	With Storage
			Area (Acres)	Depth (ft)	Volume (AF)	Constant Purification Flow (mgd)	Constant Purification Flow (mgd)
Livermore	Converted Sludge Lagoons	Livermore Effluent	2.9	10(1)	29	6.1	6.1
	Additional Unused Space		7.1	10(2)	71		6.2
	Combined		10	10	100		6.3
DSRSD	Converted Sludge Lagoons	DSRSD Effluent	27	11(1)	286	0	0.5
	Converted Dedicated Land Disposal (DLD)		55	11(2)	605		1.1
	Combined		82	11	891		1.6
DSRSD	Converted Sludge Lagoons	Combined DSRSD + Livermore Effluent	27	11(1)	286	6.1	6.6
	Converted DLDs		55	11(2)	605		7.3
	Combined		82	11	891		7.9

Notes:
(1) Calculated from estimated volume and area.
(2) Assumed value.

4.5 Treatment Process and Source Water Evaluation

4.5.1 Discharge Requirements

Conveyance of secondary effluent from the DSRSD WWTP and the LWRP, via the LAVWMA and EBDA facilities, is regulated by the following permits:

- DSRSD WWTP NPDES permit.
- LWRP NPDES permit.
- LAVWMA NPDES permit.
- EBDA NPDES permit.

The permit limits and compliance locations for the above listed facilities have been aligned, with recognition that several facilities are involved in the overall conveyance and discharge of secondary effluent to San Francisco Bay. Table 4.5 presents a summary of the current permit requirements related to discharge to San Francisco Bay. The most stringent limit is presented for each parameter in Table 4.5.

In addition, as the LAVWMA discharge permit allows discharge to San Lorenzo Creek and Alamo Canal under certain conditions (intermittent peak wet weather flows only when EBDA capacity is exceeded), Table 4.6 presents a summary of the LAVWMA discharge permit limits.

4.5.1.1 Evaluation of Discharge Compliance

Under future potable reuse scenarios, a portion of the secondary effluent that is currently discharged to SF Bay would be diverted to purification treatment processes, and through the reverse osmosis process a concentrate waste stream would be generated. It is assumed that the RO concentrate would be discharged to SF Bay, via LAVWMA and EBDA facilities.

A high-level analysis was conducted to assess compliance with ammonia limits (due to toxicity concerns) under a future potable reuse scenario. More detailed investigation of compliance with all parameters was conducted as part of modeling analysis of potable reuse alternatives. The following data sources and assumptions were used to assess compliance with ammonia discharge limits:

- As a conservative scenario, it was assumed that all available secondary effluent from the DSRSD WWTP and LWRP would be diverted to purification treatment. This scenario generates the maximum volume of RO concentrate.
- Monthly discharge flows and ammonia concentrations for LWRP secondary effluent, DSRSD WWTP secondary effluent, and the EBDA discharge were compiled for 2014 from data provided by agencies and/or the California Integrated Water Quality System Project (CIWQS) database.
- As a conservative estimate, a high ammonia removal rate of 99% through the RO process was assumed. Anticipated ammonia removal rates from RO are closer to 80%. The higher removal efficiency value leads to a higher concentrating factor for the ammonia in the concentrate.
- It was assumed that the RO concentrate flow would be 20% of the flow diverted to purification processes, which uses an appropriate RO capture efficiency of 80%.

Table 4.5 Permit Limits Related to Discharge to SF Bay

Parameter	Units	Frequency	LWRP Compliance Location	DSRSD WWTP Compliance Location	Limit	Permit Reference
CBOD	mg/L	Monthly	Discharge to LAVWMA	Discharge to LAVWMA	25	Livermore R2-2017-0018
TSS	mg/L	Monthly			30	
pH	s.u.	Instantaneous		Discharge to LAVWMA(3)	6-9	DSRSD R2-2017-0017
Oil and Grease	mg/L	Monthly	EBDA Discharge to SF Bay	EBDA Discharge to SF Bay	10	Livermore R2-2017-0018
Chlorine residual	mg/L	Instantaneous			0.0	
Fecal Coliform	MPN/100 mL	5-sample geometric mean			500	
Fecal Coliform	MPN/100 mL	11-sample 90th percentile			1100	
Enterococci	MPN/100 mL	Monthly geometric mean			242	DSRSD R2-2017-0017
Copper, Total Recoverable	µg/L	Average Monthly			53	
Cyanide, Total	µg/L	Average Monthly			21	R2-2017-0016
Dioxin TEQ	µg/L	Average Monthly			1.4E-8	
Total Ammonia	mg/L as N	Average Monthly			93	
Whole Effluent Acute Toxicity(1)		An eleven (11)-sample median value			Not less than 90 percent survival	
Whole Effluent Acute Toxicity(1)		An eleven (11)-sample 90th percentile value			Not less than 70 percent survival.	
Whole Effluent Chronic Toxicity(1)		Based on indicator organisms and toxicity tests			No chronic toxicity	

Notes:
(1) Additional information on acute and chronic toxicity limitations are provided in the Livermore, DSRSD, and EBDA discharge permits (Livermore R2-2012-0006, DSRSD R2-2012-0005, and EBDA R2-2012-0004).
(2) Upstream of Zone 7 brine addition.
(3) Downstream of Zone 7 brine addition.

Table 4.6 LAVWMA Discharge Permit Limits

Parameter	Units	Frequency	LAVWMA Compliance Location	Limit	Permit Reference
CBOD	mg/L	Weekly	San Lorenzo Creek or Alamo Canal	40	LAVWMA R2-2016-0015
TSS	mg/L	Weekly		45	
pH	s.u.	Instantaneous		6.5-8.5	
Oil and Grease	mg/L	Daily		20	
Lead, Total	µg/L	Monthly		5.5	
Lead, Total	µg/L	Weekly		11	
Chlorine residual	mg/L	Instantaneous		0.0	
Fecal Coliform	MPN/100 mL	Maximum Daily		400	

The ammonia concentration in the EBDA discharge was calculated using mass balance relationships. Results suggested that the ammonia concentration in the EBDA discharge would increase by approximately 7 mg/L as N, with the highest concentration estimated at approximately 40 mg/L as N. This value is well below the average monthly permit limit of 93 mg/L as N. Based on this analysis, compliance with ammonia discharge limits is anticipated even under the scenario where all secondary effluent is diverted to purification processes. Potential reduction in wastewater discharges may influence this analysis, thus requiring a re-evaluation in the future.

In addition to potential water quality impacts of diverting secondary effluent to potable reuse, the potential hydraulic impacts to the LAVWMA facility were investigated. It is anticipated that there would not be any adverse hydraulic impacts on LAVWMA facilities, and that the reduction in effluent flows could be accommodated with operational adjustment (personal communication with Levi Fuller (DSRSD, 2016).

4.5.2 Concentrate Treatment Needs

As discussed in the previous section, the purification processes will generate RO concentrate that will be discharged to SF Bay via LAVWMA and EBDA facilities. Additional treatment of the brine was considered for the following two reasons:

- Potential for the concentrate to impact attainment of discharge permit limits, and
- Potential impacts to LAVWMA conveyance and discharge facilities.

As discussed in Section 4.5.2, discharge of RO concentrate via the EBDA common outfall is not expected to present issues with attainment of ammonia discharge limits. Therefore, treatment to remove ammonia, either from the concentrate or the secondary effluent wastewater that feeds the purification processes, is not expected to be needed to meet current discharge requirements and no issues are projected with continued attainment of all discharge limits. While more detailed analysis of attainment of all discharge permit limits was included in future modeling analysis, concentrate treatment for the purpose of meeting discharge limits is not

anticipated at this time. However, as nutrient limits are under discussion for future permits, removal of nutrients from either the concentrate or the secondary effluent may be required in the future. Exact nutrient standards and timelines for implementation are not known yet.

Discharge of RO concentrate has the potential to impact the existing DSRSD, Livermore and LAVWMA infrastructure. In the summer months, it is possible that all of the available secondary effluent would be diverted to purification facilities. Under this scenario, 100% of the discharge in the DSRSD WWTP effluent pipeline, the LWRP effluent pipeline, and the LAVWMA facilities will be RO concentrate. LAVWMA infrastructure includes concrete lined storage basins, pump stations, and an export pipeline with segments made from different materials including, concrete lined welded steel and HDPE. It is anticipated that additional treatment of the RO concentrate will be needed to reduce scaling and corrosion potential of the RO concentrate. More detailed investigation of concentrate treatment will be needed to be evaluated further if a project were selected to be implemented.

4.5.3 Water Quality/Source Control

In considering implementation of a potable reuse project, the source water quality is of upmost importance to protect public health. Recent regulatory discussions in CA regarding potable reuse have focused in on the need for enhanced source control programs.

Both DSRSD and Livermore have existing pretreatment (source control) programs, per regulatory requirements. Pretreatment programs are designed to protect the wastewater collection and treatment system from substances that could potentially interfere with operation of the system, pass through the treatment process, compromise work safety, or harm the public health or environment.

For both treatment facilities the current end uses of the secondary effluent include discharge to SF Bay, and source water to tertiary treatment and disinfection facilities for the purposes of landscape irrigation. Implementation of a potable reuse project would introduce the new end use of potable water supply. The end use of potable water supply triggers regulatory requirements for enhanced levels of source control.

4.5.3.1 Regulatory Requirements

The regulatory requirements for wastewater source control are defined in California's 2014 Groundwater Recharge Regulations (Title 22). The regulations require that the project owner implement and maintain a program that includes, at a minimum:

- An assessment of the fate of DDW-specified and Regional Board-specified chemicals and contaminants through the wastewater and recycled municipal wastewater treatment systems,
- Chemical and contaminant source investigations and monitoring that focuses on DDW-specified and Regional Board-specified chemicals and contaminants.
- An outreach program to industrial, commercial, and residential communities within the portions of the sewage collection agency's service area that flows into the water reclamation plant subsequently supplying the groundwater recharge project, for the purpose of managing and minimizing the discharge of chemicals and contaminants at the source, and

- A current inventory of chemicals and contaminants identified pursuant to this section, including new chemicals and contaminants resulting from new sources or changes to existing sources, that may be discharged into the wastewater collection system.

To meet the wastewater source control requirements in the groundwater recharge regulations, an ESCP will need to be developed. Some of the key differences between the existing source control program and an ESCP include more monitoring parameters (drinking water MCLs, parameters with notification levels, and unregulated contaminants), increased monitoring frequency, and increased monitoring locations.

4.5.3.2 DSRSD – Existing Source Control Program and Water Quality

DSRSD's ongoing pollution prevention program generally consists of tracking industrial users within the DSRSD WWTP service area, industrial user site inspections, monitoring and reporting, source control program implementation, and outreach/education.

DSRSD's pollution prevention program focuses on pollution minimization and control of pollutants of concern (POCs) and other pollutants. A POC is defined as a substance that exceeds the applicable water quality objectives from the California Toxic Rule (CTR), NPDES permit limits, or the water quality criteria established in the Regional Water Quality Control Board (RWQCB) Basin Plan.

Monitoring for the pretreatment program includes monthly data for the treatment plant influent and effluent. While the data were not collected with the intent of comparison to drinking water standards, this comparison is relevant for understanding the quality of the secondary effluent as source water to purification treatment. Table 4.7 presents a comparison of secondary effluent concentrations and drinking water standards.

The limited comparison of secondary effluent concentrations to drinking water standards suggests that the secondary effluent is of relatively good water quality, with exceedance of standards for only alpha-BHC and NDMA. However, it is important to recognize that this is a limited comparison and that an enhanced source control program would require monitoring of all regulated drinking water contaminants, contaminants with notification levels, and unregulated contaminants.

4.5.3.3 Livermore - Existing Source Control Program and Water Quality

Livermore has an ongoing Pollution Prevention Program that generally consists of tracking industrial users within the LWRP service area, industrial user site inspections, monitoring and reporting, source control program implementation, and outreach/education.

Similar to DSRSD's pollution prevention program, the Livermore pollution prevention program focuses on pollution minimization and control of POCs and other pollutants. Monitoring data from the pretreatment program includes treatment plant influent and effluent on a monthly basis. Similar to the analysis in the previous section, Table 4.8 presents the secondary effluent data as compared to drinking water standards.

Table 4.7 Comparison of DSRSD Secondary Effluent to Drinking Water Standards

Parameter	Units	DSRSD Secondary Effluent Concentration	Drinking Water Standard
Metals [1]			
Arsenic	µg/L	<0.8	100
Cadmium	µg/L	<0.2	5
Chromium	µg/L	<0.6	50
Copper	µg/L	8.2	1300
Lead	µg/L	<0.1	15
Mercury	µg/L	0.0028	2
Nickel	µg/L	2.4	100
Selenium	µg/L	<0.5	50
Silver	µg/L	<0.4	-
Zinc	µg/L	20.9	-
Organics [2]			
alpha-BHC	µg/L	**0.49**	0.2
Bis (2-ethylhexyl) phthalate	µg/L	0.29	-
Bromoform	µg/L	0.4	80 [3]
Chloroform	µg/L	0.65-0.8	80 [3]
NDMA	µg/L	**0.48**	0.01 [4]
Phenol	µg/L	0.75-1.1	-
Pyrene	µg/L	0.0014	--

Notes:
(1) For the metals, the average of monthly samples from 2015 is presented.
(2) For the organics, any data point within 2015 with a value greater than the method detection limits is reported. Where a range is presented, there was more than one sample with a value greater than the method detection limits.
(3) Standard is for total trihalomethanes which is the sum of chloroform, chlorodibromethane, dichlorbromomethane, and bromoform.
(4) Notification Level.

Table 4.8 Comparison of Livermore Secondary Effluent to Drinking Water Standards

Parameter[2]	Units	Livermore Secondary Effluent Concentration	Drinking Water Standard
Metals[1]			
Arsenic	µg/L	0.581	100
Cadmium	µg/L	0.097	5
Chromium	µg/L	0.6	50
Copper	µg/L	6.18	1300
Lead	µg/L	0.154	15
Mercury	µg/L	0.004	2
Nickel	µg/L	3.723	100
Silver	µg/L	0.69	-
Zinc	µg/L	17.63	-

Notes:
(1) For the metals, the average of monthly samples from 2011-2015 is presented.
(2) In addition to the metals presented above, Livermore's monitoring program includes tritium, plutonium, methyl ethyl ketone, 1,1,2-trichloroethane, 1,1,2,2,-tetrachloroethane, toluene, ethyl benzene, benzene, tetrachloroethene, trichlorethane, phenols, chloroform, methylene chloride, acetone, and Freon. The 2015 annual report indicates that concentrations of these pollutants in the influent were below levels of concern or below method detection limits.

The LWRP service area includes Lawrence Livermore National Laboratory (LLNL) and Sandia National Laboratory (SNL). Combined flow from these laboratories represented approximately 4.2% of the influent flow in 2015 but can vary year to year based on hydrologic conditions. One pollutant of concern is tritium, which has been used at LLNL since the 1950s. LLNL has developed environmental monitoring programs to monitor radioactive material releases. Annual environmental reports document LLNL's compliance with environmental standards and requirements, describe environmental protection and remediation programs, and present the results of environmental monitoring (LLNL, 2015).

LLNL determines the total radioactivity contributed by tritium, gross alpha emitters, and gross beta emitters from the measured radioactivity in the monthly effluent samples. Discharge limits and a summary of the measurements of tritium in the sanitary sewer effluent from LLNL and the LWRP are reported in LLNL monthly reports. The maximum daily concentration for tritium of 0.134 Bq/mL[1] (3.64 pCi/mL) was far below the permit discharge limit of 12 Bq/mL (333 pCi/mL) (LLNL, 2015).

[1] Becquerels are the international unit used to measure radioactivity. One Becquerel is the amount of a radioactive material that will undergo one transformation per second. Becquerels are not used to measure radiation dose or radiation exposure. The U.S. unit is the Curie (Ci). One curie is roughly the activity of one gram of Radium-226. Curies are not used to measure radiation dose. USEPA (2007). Radiation Protection Program - Radiation Glossary. Last Updated March 10, 2017.

Assuming that all beta emission is due to tritium, then the drinking water standard for beta particle emission of 4 milirem/yr[2] is equivalent to a tritium concertation of 740 Bq/L. The maximum daily concentration for tritium of 0.134 Bq/mL reported in the LLNL effluent is well below the drinking water standard. In addition, the pollution prevention and environmental programs at LLNL have been successful at reducing tritium concentrations in the LLNL discharge to the sewer. Since the 1970s, tritium concentrations in the LWRP effluent have decreased by over two orders of magnitude.

Regardless of the trend of decreasing tritium concentrations in LLNL effluent and the low levels relative to drinking water standards, tritium remains a public concern in the Tri-Valley area. This public concern should be a consideration in the development of an ESCP.

4.6 Water Balance

In order to provide detailed evaluations of multiple scenarios, Carollo's Blue Plan-it® Decision Support System (BPI) was used to simulate water flows, water qualities, and costs of various options. This planning tool is a water, pollutant, and energy balance model that simulates flow routing, treatment, distribution, and the associated costs. The model is very effective at analyzing complex and interconnected treatment and conveyance systems. The main purpose of the modeling effort for this project is to determine the most cost effective manner of implementing potable reuse. Costs in the model (developed in Chapter 5) include both treatment and infrastructure.

BPI was configured to incorporate existing wastewater and water facilities, and future facilities associated with potential potable reuse alternatives in the Tri-Valley. Figure 4.8 presents a schematic of the model. The schematic shows existing and future facilities/components in a generally left to right arrangement, from secondary effluent source to end use. The model is configured to simulate numerous options throughout the system, and includes the functionality to select options for a particular alternative. The functionality provided in the model includes:

- Sources of Secondary Effluent - Secondary effluent from the individual treatment plant or a combined source (regional).
- Storage - Storage (secondary effluent) options at both treatment facilities.
- Purification Facilities - Locations at the DSRSD WWTP, the LWRP, and other regional sites.
- Treatment Processes - Options to include FAT or FAT with additional treatment.
- Conveyance - Options to utilize natural systems (Cope Lake), existing/planned pipelines, or new pipelines.
- End use of Surface Recharge - Recharge in Lake I.
- End use of Injection Wells - Options for injection and recovery and for ASR.
- End use of Raw Water Augmentation - Options to augment PPWTP or DVWTP.

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[2] The millirem is the U.S. unit used to measure effective dose. One millirem equals 0.001 rem. The international unit is milliSievert (mSv). Sievert: An international unit used to measure effective dose. The U.S. unit is rem

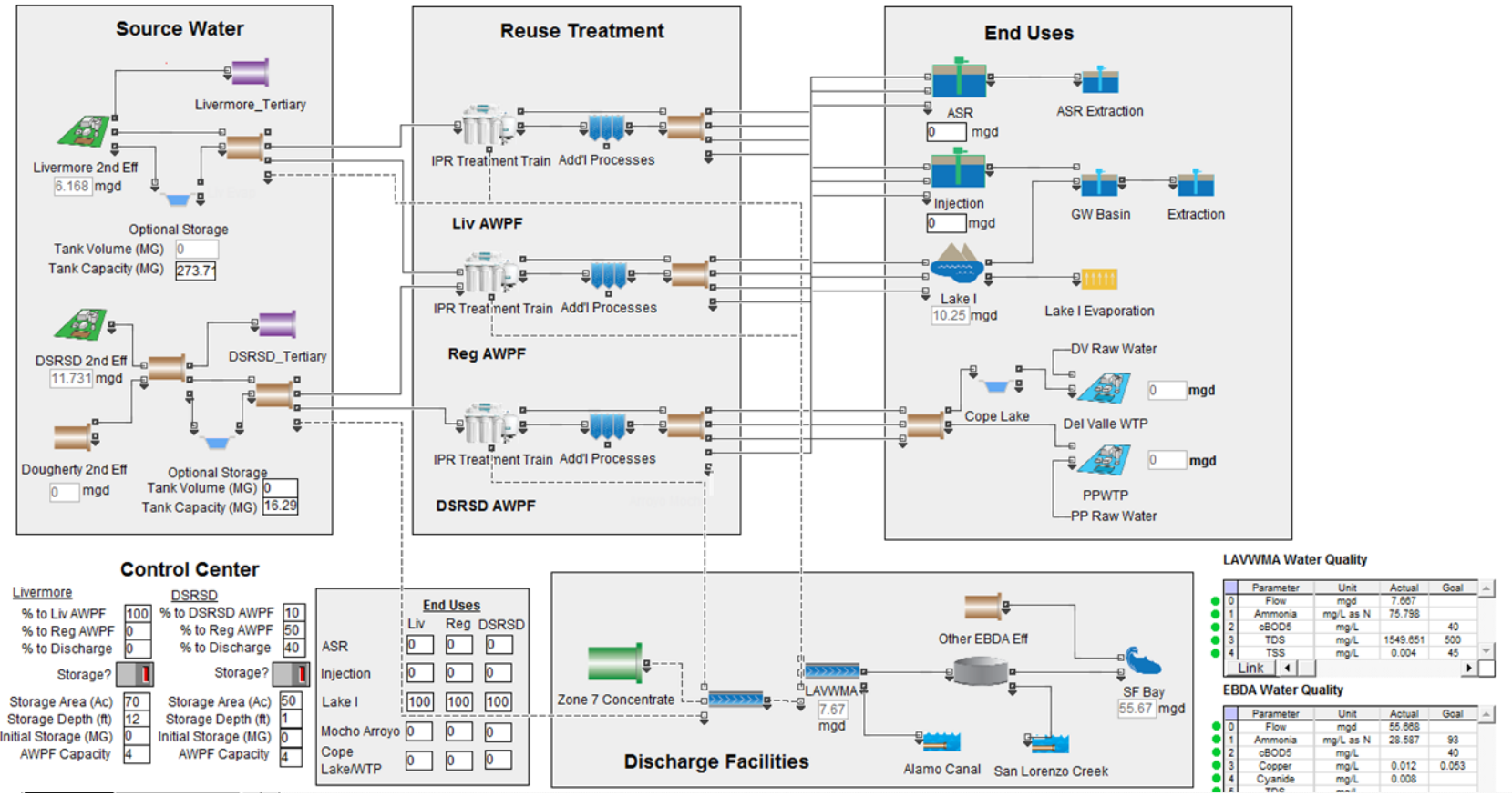


Figure 4.8 BPI Model Application

Along with this customized representation of the existing and potential future system, BPI requires input data and parameters. The BPI application to the Tri-Valley is described in detail in Chapter 5. However, the model provides a useful platform for discussing the water balance through the system, and preliminary estimates of yields and losses through various components of a potable reuse alternative. The data and assumptions presented in the following sections are used as input into the BPI model

4.6.1 Water Losses

Each alternative is evaluated based upon its modeled yield or potable water offset. Yield depends upon end use, conveyance mechanism, storage facility, and treatment technology, as there are losses through each of these components of an alternative.

4.6.1.1 Evaporation and Precipitation

For all alternatives with a portion of the storage or recharge located outdoors and uncovered, evaporation and precipitation play key roles in the determination of yield. Precipitation data for over 100 years and evaporation data measured since 1974 were compiled to create an average predicted evaporation/ precipitation trend. The precipitation was then subtracted from the evaporation to calculate a net evaporation in inches per month, and the resulting average monthly net evaporation is shown in Figure 4.9. Actual evaporative losses are calculated in BPI based upon the exposed surface area of the purified water.

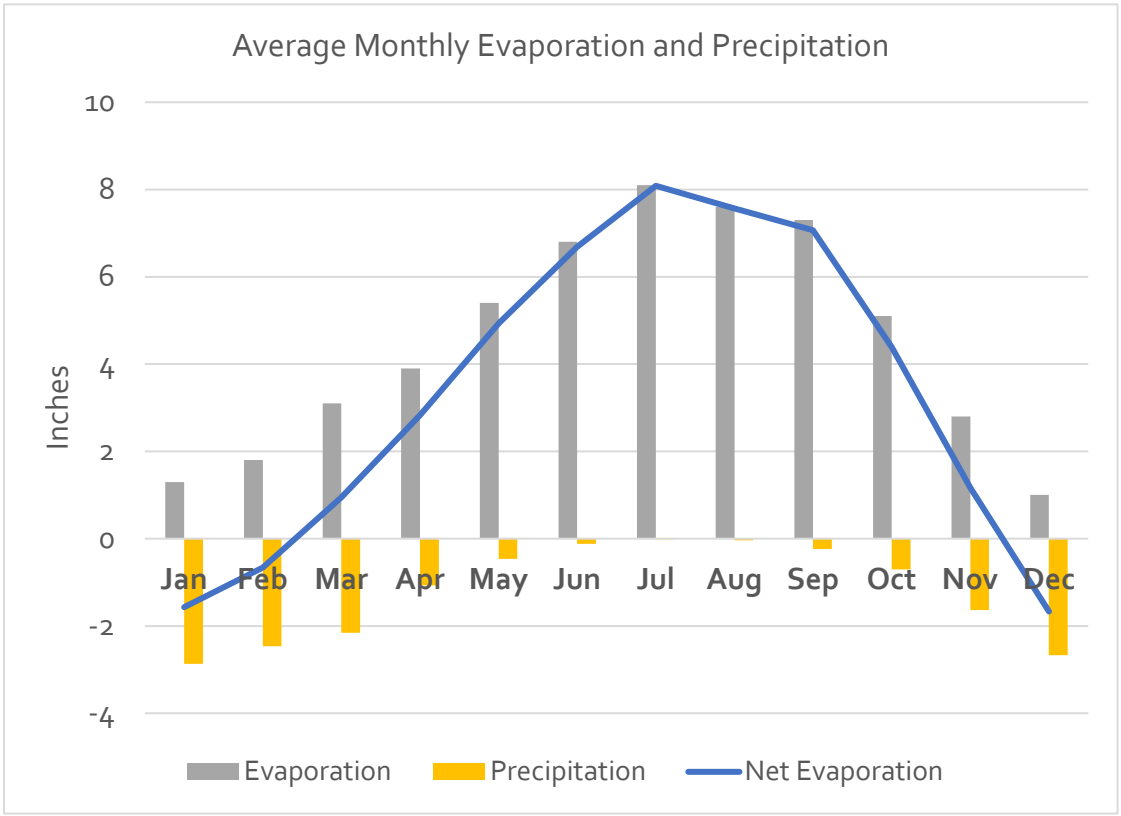


Figure 4.9 Average Monthly Evaporation and Precipitation

4.6.1.1 Seepage

For alternatives that include secondary effluent storage at Livermore and DSRSD, it is assumed that these facilities would be lined and therefore seepage loss would be negligible.

For alternatives that involve conveyance of water through Cope Lake to various end uses, there will be a seepage loss. Cope Lake was identified as being relatively isolated from the underlying groundwater basin due to accumulated silt (40 to -65 ft) at the bottom of the lake (Zone 7, 2014). However, more recent investigations suggest that there may be a more significant hydraulic connection to groundwater than previously documented (personal communication Zone 7, 2016). For this study, seepage loss through Cope Lake is estimated to range from 544 to 1,000 AFY (Stetson, 2004).

End uses include groundwater recharge by surface spreading in Lake I. In this case, the water that seeps into the underlying groundwater aquifer contributes to the yield of a groundwater recharge alternative, rather than a loss. Lake I capacity for groundwater recharge is addressed in Section 4.6.2.

4.6.1.2 Treatment Water Losses

Two main treatment processes are considered: traditional FAT and the additional processes required for a small environmental buffer (2 months or less). Traditional FAT consists of membrane filtration (MF or UF), reverse osmosis (RO), and an ultraviolet advanced oxidation process (UV AOP). Due to consistent cleaning and backwash cycles, recovery rates for MF/UF are assumed to be conservatively around 90 percent, but the backwash would be returned to the WWTP headworks. RO rejects approximately 20 percent of the feed water, creating a concentrate stream. UV AOP has no significant water loss through the process. The overall recovery rate for FAT is assumed to be 80 percent.

The additional processes required for raw water augmentation include a granular activated carbon (GAC) filter and an engineered storage buffer (ESB). Neither of these treatment processes is associated with major water losses. The assumed recovery rate through these processes is 100 percent.

4.6.1.3 Other Losses Associated with End Uses

There are losses associated with each potential end use considered within this project, including evaporative losses for Lake I recharge, groundwater losses for injection wells and ASR, and potential conveyance losses for all projects, especially those with raw water augmentation. For this preliminary yield analysis, all end uses are assumed to be 100 percent efficient. Groundwater modeling and other hydraulic modeling will unveil the losses per end use when the projects are more defined. Refer to Chapter 5 for an overview of the end uses and Chapter 6 for a detailed groundwater modeling analysis.

4.7 References

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Chapter 5

PRELIMINARY ALTERNATIVES DEVELOPMENT

5.1 Purpose

This chapter lays out the alternatives for potable reuse in the Tri-Valley Area, which include groundwater augmentation (recharge/injection), reservoir (surface) water augmentation, and raw water augmentation and are defined according to Section 13561 of the Water Code:

- Groundwater augmentation - Planned placement of [purified] recycled water for replenishment of a groundwater basin or an aquifer that has been designated as the source of water supply for a public water system.
- Reservoir augmentation - Planned placement of [purified] recycled water into a raw surface water reservoir used as a source of domestic drinking water supply for a public water system, or into a constructed system conveying water to such a reservoir.
- Raw water augmentation - Planned placement of [purified] recycled water into a system of pipelines or aqueducts that deliver raw water to a drinking water treatment plant that provides water to a public water system.

This chapter presents a summary of the potable reuse alternatives development and evaluation process. Results of the following specific analyses are presented within:

- Potential treatment and end uses for potable reuse.
- Alternatives development and analysis through Blue Plan-it®
- Short-listed options selection.

The evaluations conducted at this stage in the feasibility study are high level and developed mainly for comparison purposes. The short-listed options identified within this Chapter are further developed in Chapter 7.

5.2 Screening Process

Within the Tri-Valley area, there are several options for source water, treatment type, treatment location, and end use in the development of potable reuse alternatives. Figure 5.1 shows the range of sources, treatment, locations, and end uses being considered through the alternative development process. With the number of project components possible, there could be a multitude of project combinations. The selection of a potable reuse project is therefore a stepwise process, as shown in Figure 5.2. The alternative development and evaluation discussed within this chapter is the first step towards narrowing down the many potential alternatives to approximately three alternatives, to be considered for a more detailed analysis. At key stages in the selection process, workshops with representatives from all project participants were convened to facilitate key decisions.

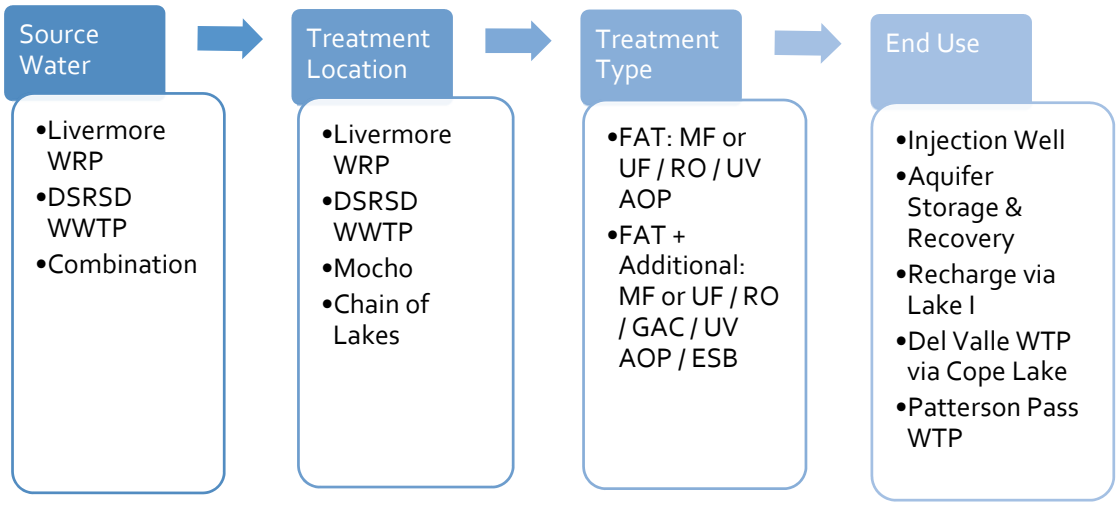


Figure 5.1 Alternative Development Process and Component Options

5.3 Evaluation Criteria

A preliminary set of evaluation criteria was developed to narrow the initial list of alternatives down to three for further investigation. These criteria are as follows:

- Yield (measured by acre-feet per year - AFY).
- Cost (Capital and Operations and Maintenance [O&M]).
- Improved Supply Reliability.
- Improved Delivered Water Quality.
- Improved Groundwater Basin Quality.
- Clear Regulatory Pathway.
- Minimizes Neighborhood Impacts.
- Ability to Phase the Project.
- Operational Flexibility.
- Ease of Construction.

As decided by the project management team, the main criteria for the initial screening were cost and yield. After the initial screening of alternatives, additional criteria were used in the more detailed analysis.

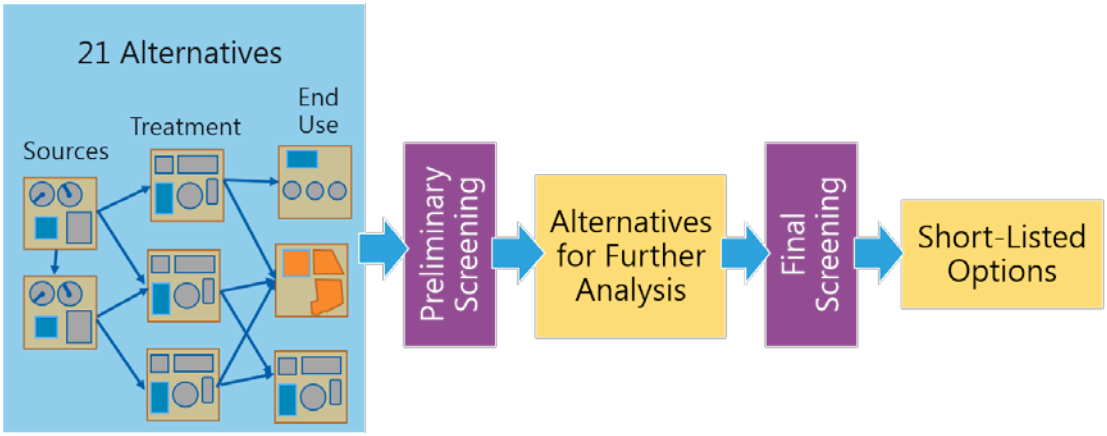


Figure 5.2 Project Selection Process

5.4 Water Availability and Source

Water for the future purification plant would come from one or both wastewater treatment facilities - DSRSD WWTP and the Livermore WRP. These facilities each have their own non-potable recycled water irrigation programs. The amount of water available from each plant for potable reuse was analyzed in detail in Chapter 4. Buildout projections for both wastewater flows and non-potable reuse growth were used to estimate the amount of available future source water for potable reuse. The amount of water available at both WWTPs is depicted graphically in Figure 5.3; the average is around 13.5 million gallons per day (mgd), with peak month flows of 20.9 mgd and average dry weather flows of approximately 6.1 mgd.

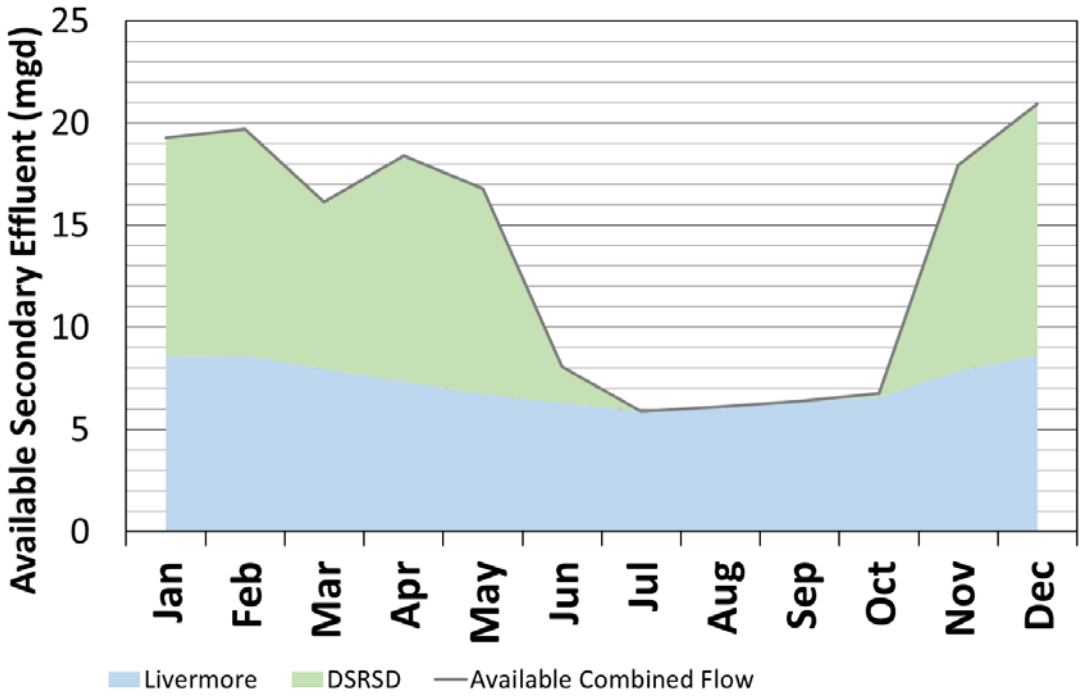


Figure 5.3 Combined Available Flow from the LWRP and DSRSD WWTP

As can be seen in Figure 5.3, due to the existing non-potable recycled water programs and natural seasonality of flow variations, there is significantly more water available in the winter and shoulder months than in the summer. Several flow/treatment strategies are considered to accommodate the variability in available flow, including:

- Limiting the flow for potable reuse to the flow available in the summer.
- Providing storage to supplement summer flows.
- Operating a treatment facility with seasonal variation of flows.

These options are further discussed in the alternatives development section.

5.5 Potable Reuse Yield Goals

As discussed in Chapter 1, Zone 7 completed the Water Supply Evaluation Update (WSE Update) in 2016. In the WSE Update, the upper end of what was estimated available from alternative future water supplies (potable reuse and desalination) was around 10,000 acre-feet per year (AFY), so this amount was used as the upper bookend for the analysis in this study. Note that there were other limiting factors (i.e., wastewater availability) to going beyond 10,000 AFY so this value is a reasonable estimate. A lower bookend value of 5,500 AFY was used as this is the amount of purified water that can be produced year-round from Livermore alone, allowing for a constant production rate.

5.6 Treatment Assumptions

The purification process train assumptions are based on end use, as described below.

- Groundwater augmentation via injection - Full advanced treatment (FAT), per the Title 22 Groundwater Recharge Regulations (Title 22) established in 2014, is assumed for groundwater augmentation via injection. FAT consists of a microfiltration or ultrafiltration membrane process (MF or UF), followed by reverse osmosis (RO), and an ultraviolet advanced oxidation disinfection process (UV AOP). The FAT assumption applies to groundwater injection scenarios where the estimated travel time to the nearest drinking water supply wells is at least 2 months.
- Groundwater augmentation via Aquifer Storage and Recovery (ASR) - ASR involves injection into an aquifer, storing that water in the aquifer for a minimum of 2 months, and then extracting the water for use. ASR is expected to be permitted under the existing Title 22 regulations, and would require FAT.
- Groundwater augmentation via Lake I - Title 22 regulations include treatment requirements for groundwater recharge via surface spreading. In the case of Lake I, there are three key conditions that influence the treatment requirements. The first condition is that Lake I is directly hydraulically connected to the groundwater aquifer. Therefore, under existing Title 22 regulations it would be considered equivalent to groundwater injection and require FAT. The second condition is that there may be minimal travel time between Lake I and the closest municipal water supply well, potentially less than the required two months. The third condition is that water in Lake I (and the connected Cope Lake and Lake H) is planned for potential use as an emergency supply for the DVWTP with the planned construction of a pipeline. Based on the last two conditions, recharge via Lake I is considered from a regulatory perspective as including both groundwater augmentation with short residence time, and reservoir augmentation. Regulations for potable reuse via reservoir augmentation and

groundwater augmentation with short travel times are under development. For this study, it is assumed that additional treatment beyond FAT, referred to in this report as "FAT+" will be required. The assumed additional treatment processes include granular activated carbon (GAC) and an engineered storage buffer (ESB). The GAC provides an extra barrier for attenuating chemical peak concentrations while also increasing reliability and redundancy. The ESB is a series of storage basins that allows for 30 minutes of monitoring time before distribution to the end use. This treatment train was developed under an assumption of certain stringent regulations. If these regulations change, the GAC and ESB may not be required, and treatment costs may be reduced.

- Reservoir augmentation - As mentioned above it is assumed that FAT+ will be required, however the treatment requirements may vary as the regulations develop.
- Raw Water Augmentation (RWA) involves a very short (if any) residence time in the raw water supply system before being delivered to the WTP. This type of potable reuse would require a FAT+ train. The alternatives which involve sending water to a WTP via Cope Lake would be labeled RWA instead of reservoir augmentation because sufficient residence time in Cope Lake is not guaranteed.

The treatment type (FAT or FAT+) selected for each end use is listed in Table 5.1.

Table 5.1 Tri-Valley Potable Reuse End Uses and Associated Required Treatment

End Use	Associated Treatment Type
Injection Wells - with greater than two months travel time to drinking water wells (1)	FAT Only
Injection Wells - less than two months travel time to drinking water wells (1)	FAT + Additional Treatment
Aquifer Storage & Recovery (ASR)	FAT Only
Groundwater Recharge via Surface Spreading - Lake I	FAT + Additional Treatment (2)
Reservoir Augmentation	FAT + Additional Treatment
Raw Water Augmentation	FAT + Additional Treatment

Notes:
(1) The regulations require 2 months travel time. A 4-month travel time is being used based on the lower credit given to groundwater modeling as a verification method.
(2) The groundwater recharge regulations do not require FAT for all surface spreading projects. However, due to the close proximity of Lake I to municipal potable water supply wells and connection with DVWTP's supply source, it is assumed that FAT and additional treatment will be required.

More information about treatment trains and performance can be found in Chapter 3. Regulatory information is detailed in Chapter 2.

5.6.1 Treatment Train Flow Recovery

The recommended treatment trains for potable reuse involve both MF or UF and RO. These treatment processes have typical water recovery rates of 90 percent and 80 percent, respectively. Overall recovery of influent to the purification facilities is 72 percent. For purification facilities located at the WWTPs, the backwash water from the MF/UF can be recovered by piping it back to the headworks, and thus the total treatment train recovery would be 80 percent. However, if the treatment facility is located at a place other than the WWTPs, the backwash water cannot be easily routed to the headworks of a treatment facility and would therefore be discharged in the waste stream to an outfall. The total recovery rate for this facility

would then be around 72 percent. These recovery assumptions will result in yield differences between the individual alternatives.

5.6.2 Yield with Summer Available Flow

The projected buildout (2035) flows from Chapter 3 were combined with the expected recovery rates described above to estimate a potential yield per flow scenario. Due to seasonal variation in available flow from diversion to the existing non-potable recycled water programs, no water is available from the DSRSD WWTP in the summer months. Flow is still available from the Livermore WRP, approximately 6.1 mgd on a consistent (year-round) basis. One approach is to assume that approximately 6.1 mgd (year-round) would be used for potable reuse. With the assumption that the purification processes would be located at the LWRP, the system recovery would be about 80 percent, and the purified water yield would be approximately 5,500 AFY, as shown in Figure 5.4.

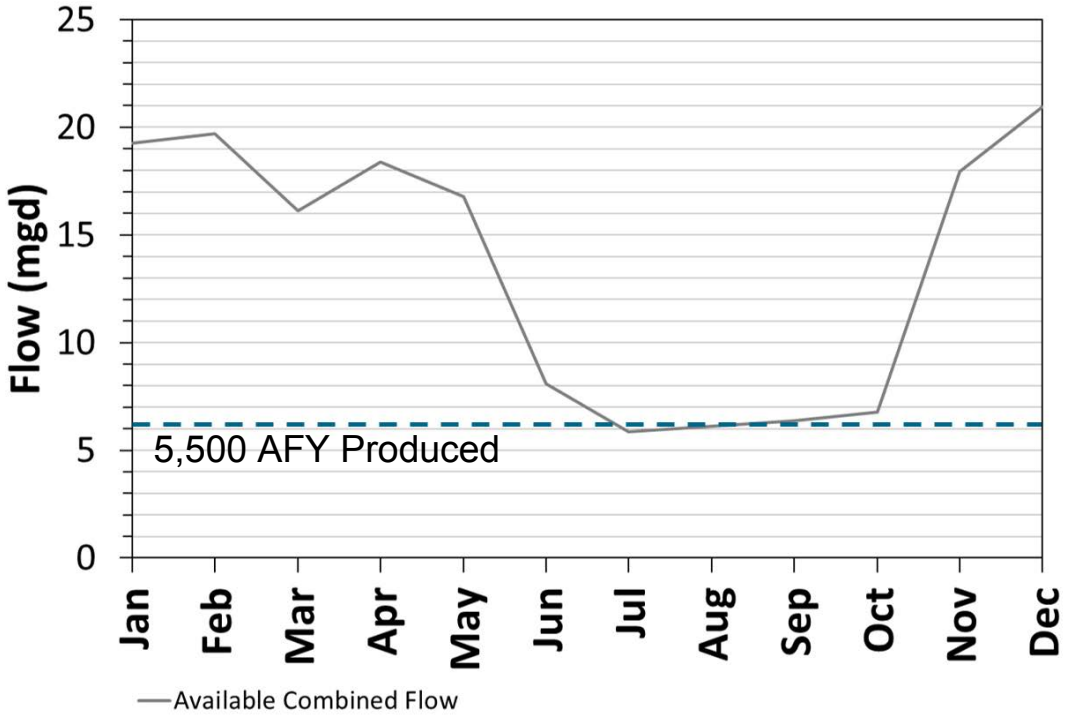


Figure 5.4 Year-Round Constant Summer Flow Strategy (2035 Projected Flows)

5.6.3 Yield with Seasonal Operation

Seasonal treatment is one approach to increasing the overall yield above 5,500-AFY. In winter months, secondary effluent from both treatment plants is estimated to be available up to 16-mgd consistently (using 2035 projected buildout flows). The seasonal operation approach involves greater production of purified water in the winter months and lower production of purified water in the summer months. The 10,000-AFY upper bookend can be achieved with seasonal operation.

Producing 10,000 AFY using seasonal variable flows would require a treatment plant sized for 15-mgd influent flow (12-mgd permeate flow). This facility would need the flexibility to turn

down to 6.1 mgd influent flow (5-mgd permeate flow) during the summer months, as illustrated in Figure 5.5. These flows assume that the AWPF is located at one of the WWTPs.

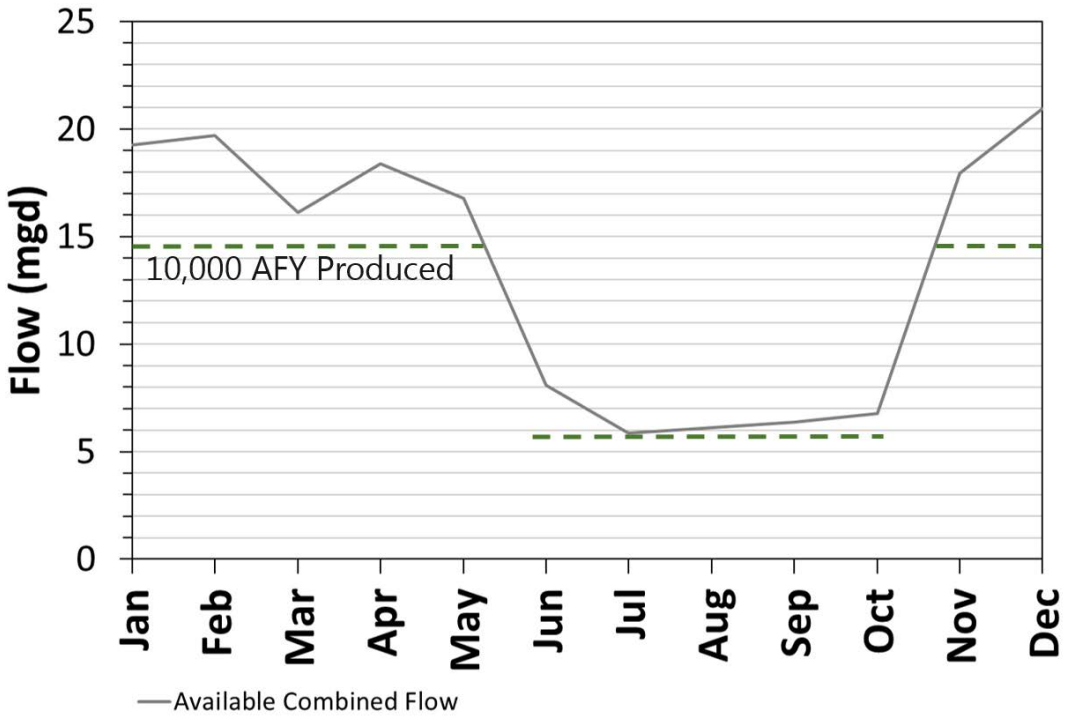


Figure 5. 5 Seasonal Treatment Flow Strategy (2035 Projected Flows)

A facility operating in a seasonal fashion would rotate through membrane trains on an hourly or daily basis to ensure that all membranes are used evenly and maintained at the same level. While this configuration is possible and being used at other facilities in the US, there is added operational complexity.

The available membrane capacity in the summer lower flow periods may have other potential uses. In future project development, it may be possible to consider supplementing summer WWTP flows through the treatment facility in order to create a higher-quality non-potable recycled water for irrigation, or aid in demineralizing groundwater. Furthermore, during a drought, available wastewater could be diverted from non-potable use towards potable use using the AWPF facility. These options are outside the scope of this effort, but may be considered in future discussions.

5.6.4 Yield with Storage

An alternate method of reaching 10,000 AFY of water with a more constant flow to treatment units is building storage. DSRSD has a dedicated land disposal (DLD) area that has been identified as a potential location for storage. If all of DSRSD's solids handling facilities (sludge lagoons and DLDs) were converted to mechanical processing, approximately 82 acres would be available. Due to the small size of Livermore's abandoned sludge lagoons when compared to the predicted amount of storage needed, it was decided that Livermore would not provide sufficient storage for the amount of effort required to convert the lagoons. Additionally, as is discussed later, if the AWPF were located at Livermore, it would likely be in the area of the sludge lagoons.

The combined area available for a storage facility at DSRSD WWTP is approximately 82 acres, less if an AWPF is located in that same area. A water balance was created using Blue Plan-it® to determine the size of storage necessary to produce a constant 10,000 AFY (8.9 mgd). The 82 acre value was used as an estimate to calculate evaporative losses. The results of the modeling showed that the storage basin would need to be approximately 450 million gallons (MG). The cost of a basin this size is approximately $65 million (total project cost), with an additional $10 million estimated for replacing the existing solids facilities with mechanical dewatering. Cost assumptions with detailed cost breakdowns are shown in Appendix A. If the AWPF must be located at the DLDs, then the storage facility would need to be deeper.

The estimated treatment cost for a FAT facility (groundwater augmentation via injection) at a flow of 8.9 mgd is approximately $110 million. With the necessary storage required to maintain the constant flow, this cost rises to $185 million. With the seasonal option discussed above, a treatment plant sized for 11.9 mgd would cost approximately $140 million. At $185 million for treatment and storage alone, an alternative requiring 450 MG of storage becomes cost-prohibitive. However, in order to investigate the option of storage fully, a breakpoint curve was created, to determine the storage - treatment combination which would be cost-competitive with the seasonal option. The breakpoint curve is shown in Figure 5.6.

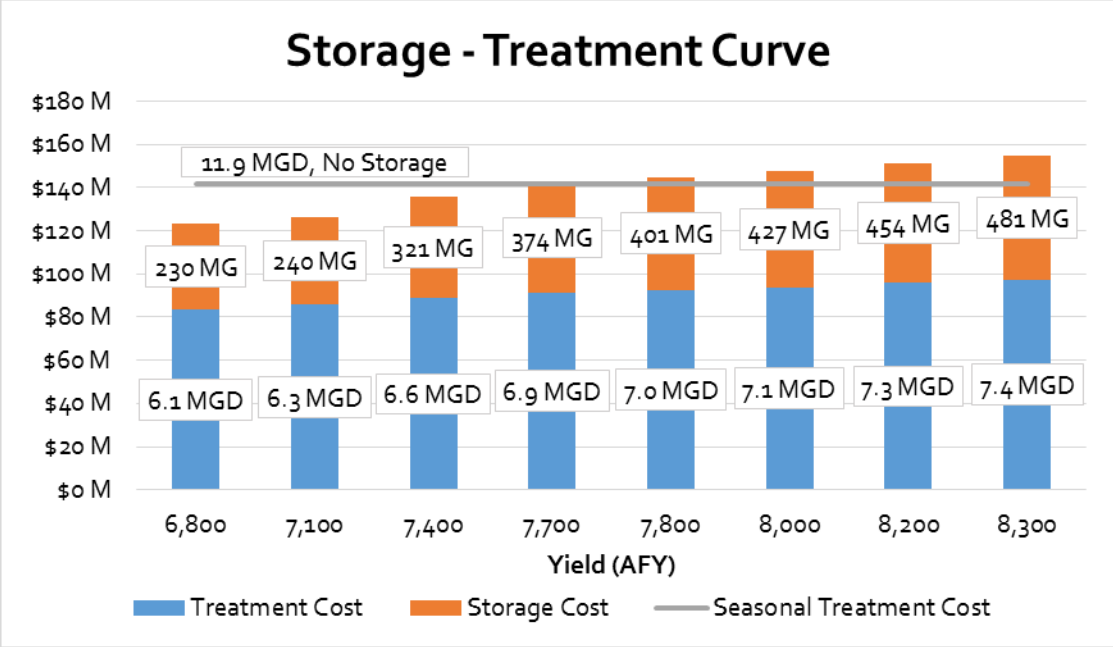


Figure 5.6 Storage and Treatment Breakpoint Calculation

With 370 MG of storage and a 7 mgd (permeate water) facility, approximately 7,700 AFY can be produced year round (see Figure 5.7). This option was chosen to represent the storage discussion in future model runs. In the project team workshop on April 18, 2017, project participants unanimously voted to remove the option of the 450-MG storage to reach 10,000 AFY in preference for the 7,700-AFY option. Table 5.2 shows the cost comparison between the seasonal treatment and both storage options.

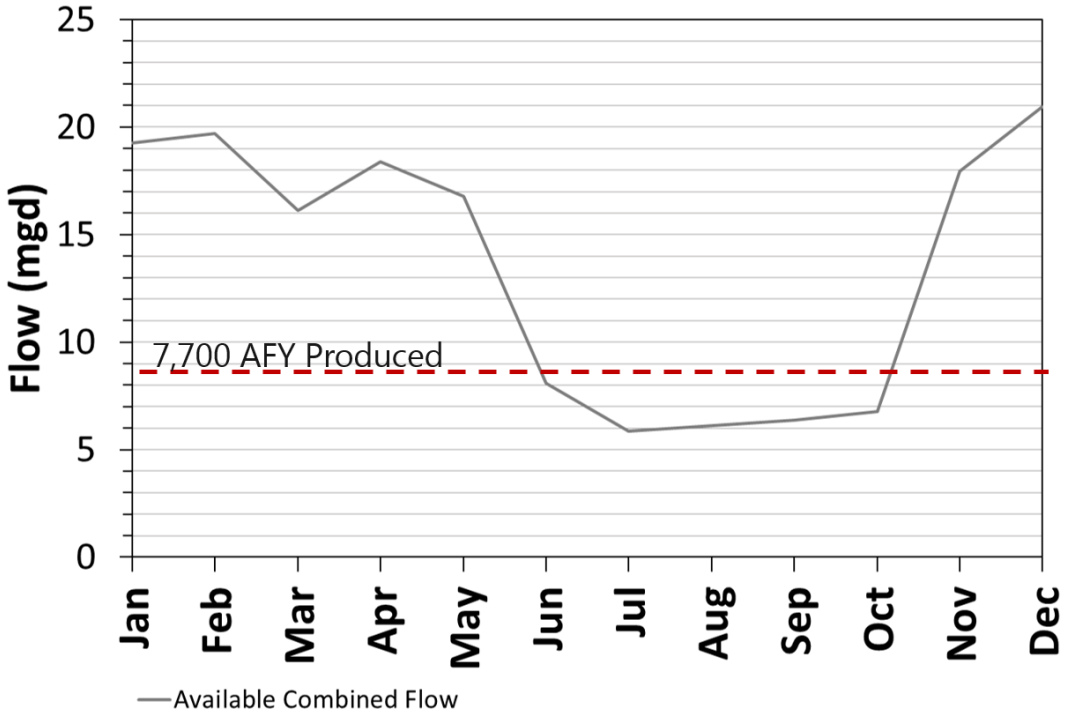


Figure 5.7 Treatment Flow Strategy with Storage (2035 Projected Flows)

Table 5.2 Storage and Treatment Cost Breakdown

Yield (AFY)	Additional Flow Option	Description	Cost for Treatment ($M)	Cost for Additional Water (Storage or EBDA) ($M)	Total Treatment and Storage Cost ($M)
10,000	Seasonal Treatment	5 months/ 7 months	$140	$0	$140
10,000	Storage at DSRSD	~450 MG	$110	$75 ($10 Solids + $65 Storage)	$185
7,700	Storage at DSRSD	~370 MG	$90	$50 ($10 Solids + $40 Storage)	$140

5.6.5 Treatment Location

Livermore secondary effluent flows through the LAVWMA pipeline to DSRSD where it is combined with DSRSD effluent and discharged to the San Francisco Bay through the EBDA pipeline. While both WWTPs have space available for a regional purification facility, treating DSRSD effluent would require pumping DSRSD effluent an additional six miles to the Livermore site.

An advanced treatment plant at DSRSD, however, could treat both Livermore and DSRSD secondary effluent with very minimal additional infrastructure because the LAVWMA pipeline already delivers Livermore flows to the DSRSD site.

Two potential additional regional locations for a purification facility have been considered. The first option is near the existing Mocho demineralization facility. The second location is a plot of land between Cope Lake and Lake I within the Chain of Lakes, near an existing Zone 7 well facility. These two locations were chosen due to the availability of land, proximity to potential end uses (discussed later), and preferred pipeline alignments. Both locations could receive Livermore effluent via the LAVWMA pipeline or a short new connection to the pipeline. DSRSD effluent would need a designated pipeline to be conveyed to each facility. The four potential purification facility locations are highlighted in Figure 5.8.

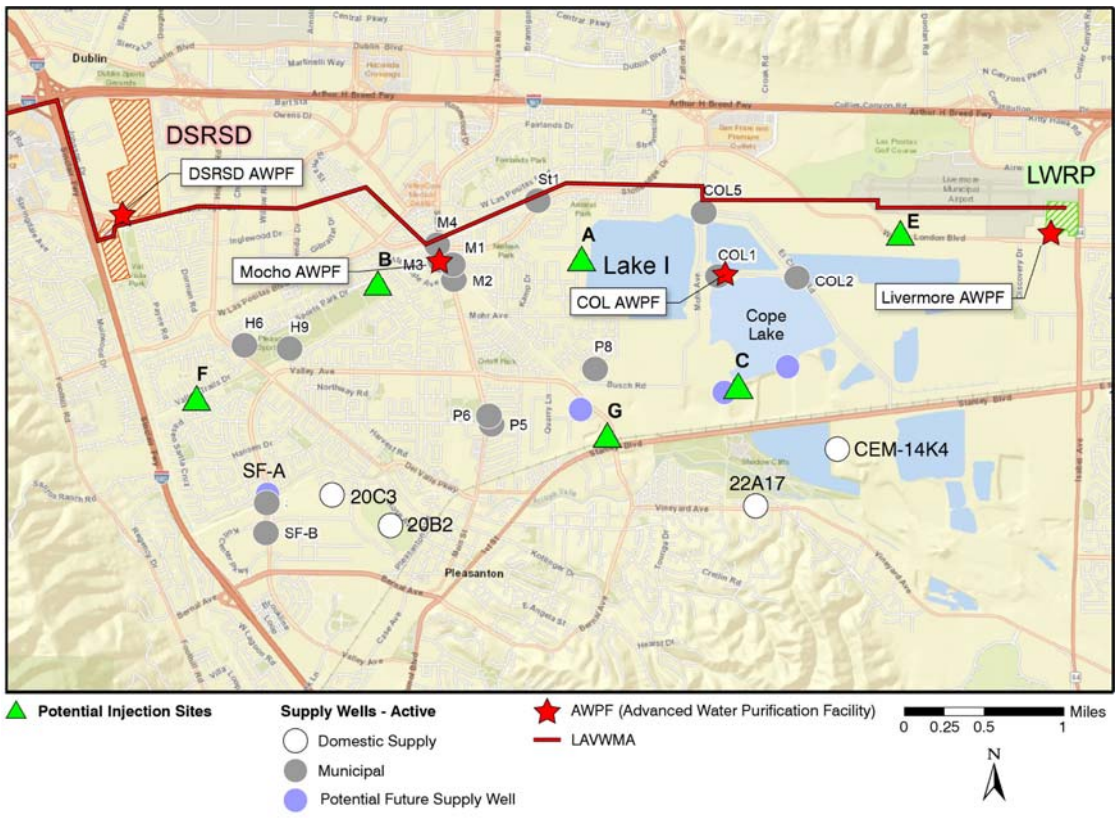


Figure 5.8 Potential Purification Facility Locations

5.6.6 Concentrate Treatment

In Chapter 4, it was determined that potable reuse, even with reverse osmosis concentrate, would not pose an issue with the EBDA Outfall effluent discharge limits. For the purposes of this study, it is assumed that concentrate treatment is not needed for the purposes of meeting existing effluent discharge limits. However, effluent discharge limits may be more stringent in the future. Other agencies that discharge to the EBDA pipeline may implement reuse projects of their own. Additional reuse upstream would concentrate the discharge stream. If other agencies pursue large recycled water programs (removing 20-40 percent of the flow from the EBDA discharge) it may still be possible to revise the EBDA discharge permit, increasing the dilution credit to a higher ratio than 80:1. This would not increase the loading of constituents into the Bay. The Basin Management Plan allows the RWQCB to increase permit limits if needed to support recycling projects. An adjusted permit is not expected or needed for the currently proposed projects.

Concentrate treatment for the short-listed options may be needed to prevent scaling on the LAVWMA line. However, since concentrate treatment is common to all alternatives, it is not a differentiator, and therefore it is not being considered within the preliminary alternative analysis.

5.6.7 Summary of Treatment Alternatives Evaluated

Table 5.3 summarizes the treatment processes and sizes that are evaluated in the alternatives analysis at each site. The location of the AWPF treatment affects the amount of water produced depending on whether it is co-located at a WWTP site or not. For those sites that are located at a satellite location (not at a WWTP), the 10 percent flow that is backwashed from the MF/UF membrane process is not recoverable and must be discharged. At this stage in the project, it is assumed that this waste could be combined with the RO concentrate and discharged to the LAVWMA line, thus lowering the total flow available for product water yield. It is assumed that this discharge can be permitted although this should be confirmed in future efforts. If not, the MF backwash would be returned to the sewer where it would remain be sent to the WWTP headworks. Sufficient capacity in the collection system must be shown before this option is pursued. The lower yield option of discharging directly to LAVWMA is assumed because it is conservative in yield projections.

Table 5.3 Treatment Alternatives Summary

Purified Water Design Flow (Permeate)	Annual Yield	Treatment Type	Seasonal or Constant Operation	Storage	Location
5 mgd	5,500 AFY	FAT, FAT+	Constant	None	Livermore WRP
6 mgd	6,900 AFY	FAT+	Constant	370 MG at DSRSD	Mocho and COL
7 mgd	7,700 AFY	FAT, FAT+	Constant	370 MG at DSRSD	DSRSD
12 mgd	10,000 AFY	FAT, FAT+	Seasonal	None	DSRSD, Mocho, and COL(1)

Notes:
(1) The regional facilities at Mocho and COL will have lower overall recovery rates through their treatment trains (72 percent assumed). This lowered rate is compensated by using a greater influent flow and enlarging the MF/UF membrane process, which is reflected in the costs.

At a WWTP, the 10 percent backwash flow would recycle back to the WWTP and be available again as influent to the AWPF. For the scenarios with storage where winter flows are stored to be used during summer months, this reduced yield phenomena occurs for the satellite locations because the AWPF is designed to run at a steady rate year round and the storage in effect limits the amount of feedwater available. However, the seasonal operation scenarios do not have a reduced yield for options at satellite locations because there is adequate winter flows to be able to account for the 10 percent backwash loss and design for higher flows in some months to meet an annual yield of 10,000 AFY.

5.7 End Use Evaluation

Five types of end uses were selected as viable options to supplement water supplies:

- Groundwater Recharge
  - Via injection wells
  - Via aquifer storage and recovery (ASR)
  - Via surface spreading in Lake I/Chain of Lakes
- Raw Water Augmentation via Cope Lake to the DVWTP
- Raw Water Augmentation of the PPWTP water supply

The assumptions in pursuing each end use option are discussed within this section.

5.7.1 Chain of Lakes

Zone 7 currently owns two former quarries or lakes (Lake I and Cope Lake), with more to be transitioned to Zone 7 through approximately 2060 to form the hydraulically-connected "Chain of Lakes". Lake H is planned for transition in the next few years. The Chain of Lakes will serve a variety of water management purposes, including groundwater recharge, surface water storage and conveyance, and flood management.

In addition to the COLs' existing and planned uses, the COL's area is being considered for potable reuse applications as discussed further below. The evaluation of these options considers the multiple existing and planned uses of Lakes H, I, and Cope; the connectivity of the lakes; future connection to DVWTP; and the connectivity of the lakes to the groundwater basin and water supply wells.

Some of the lakes are, or will be, directly connected to the Livermore Valley Groundwater Basin. Lake I, with a total storage volume of about 27,000 AF, serves as the key lake for groundwater recharge. Cope Lake (4,500 AF) has limited connectivity to the groundwater basin, while Lake H (6,000 AF) can accommodate recharge. A mining company currently discharges pumped groundwater into Cope Lake (see Section 5.7.2.3 for more detail); the water is then conveyed to Lake I for recharge via the Cope Lake-Lake I pipeline.

In the future, Cope Lake and Lake H may be used for stormwater detention. Lake H will also have a diversion structure, allowing diversions from Arroyo Mocho into Lake H. Lakes H and I are connected by a 30-inch pipeline. There are currently three water supply wells (COLs 1, 2, and 5) in the Lake H/Lake I/Cope Lake area, with two additional wells planned. A new pump station and 36-in pipeline connecting Lake H/Lake I/Cope Lake to the DVWTP and the South Bay Aqueduct is planned ("COLs pipeline", see Figure 5.9).The COLs pipeline would allow raw surface water to be brought into the COLs area for storage and recharge. It would also allow access to surface water stored in the COLs for use at the Del Valle Water Treatment Plant (DVWTP) in case of droughts and emergencies.

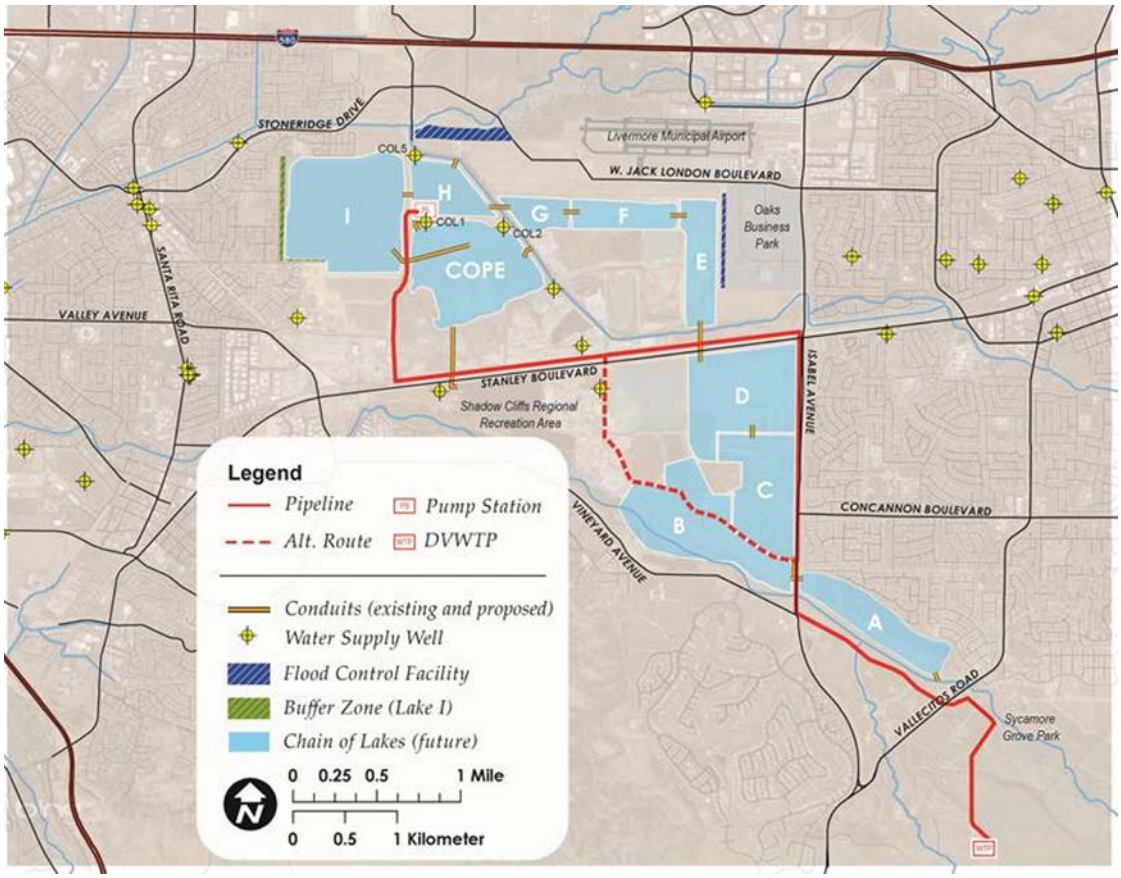


Figure 5.9 Potential Pipeline from COL to DVWTP (COLs Pipeline)

5.7.2 Groundwater Recharge

The primary goal of groundwater recharge is to replenish the groundwater aquifer for the purpose of subsequent extraction and use. The three different types of groundwater recharge discussed within this section vary based upon the method of delivering to and/or extracting water from the groundwater basin.

5.7.2.1 Injection Wells

Groundwater injection requires the use of dedicated injection wells hydraulically connected to the aquifer, recharging the aquifer through a screened casing. Groundwater is then monitored using down-gradient monitoring wells and recovered further down-gradient with extraction wells. This method of groundwater recharge has been widely used in southern California for many years. The DDW requires a minimum retention time in the aquifer of 2 months (Title 22); this retention time is equivalent to a travel time of 2 months to the nearest production well. The required retention time may increase depending on the type of verification used. For instance, if the travel time is calculated with a groundwater model, each month of travel time only gets a half credit, so a total of four months travel time is needed. A tracer study using an added tracer (not intrinsic) receives full credit.

The existing water extraction wells and potential sites investigated for groundwater recharge are shown in Figure 5.10. The potential injection sites were determined through discussions with Zone 7's Groundwater Section familiar with the existing groundwater conditions and quality.

Preliminary locations were also selected to meet the travel time requirement from existing wells using the well protection zones (2-years of estimated subsurface travel time) established in Zone 7's Drinking Water Source Assessment Reports. For wells without published assessment reports (production wells outside of Zone 7's jurisdiction), a conservative 2,000 foot radius around the well was assumed to be the protection zone, which equates to approximately 2-years of travel time. The potential injection well locations and existing wells are called out on Figure 5.10.

It is assumed that potential injections sites located outside of the delineated protection zones would have at minimum 6-month travel time to the nearest potable supply well and likely much longer.

Most of the delineated protection zones are based on the Calculated Fixed Radius method; protection zones for these wells are represented by a single red circle around the well locations shown in Figure 5.10. Protection zones for two wells, COL #1 and COL #2, were determined using the Modified Calculated Fixed Radius method, which determines an up gradient and downgradient distance from the wellhead based on the regional groundwater flow gradient. Because of seasonal changes to the groundwater flow gradient in the area of these wells, there are two potential radii that could be used, depending on the season. The larger radius is used for each well to ensure that injection sites are located outside of the protection zone.

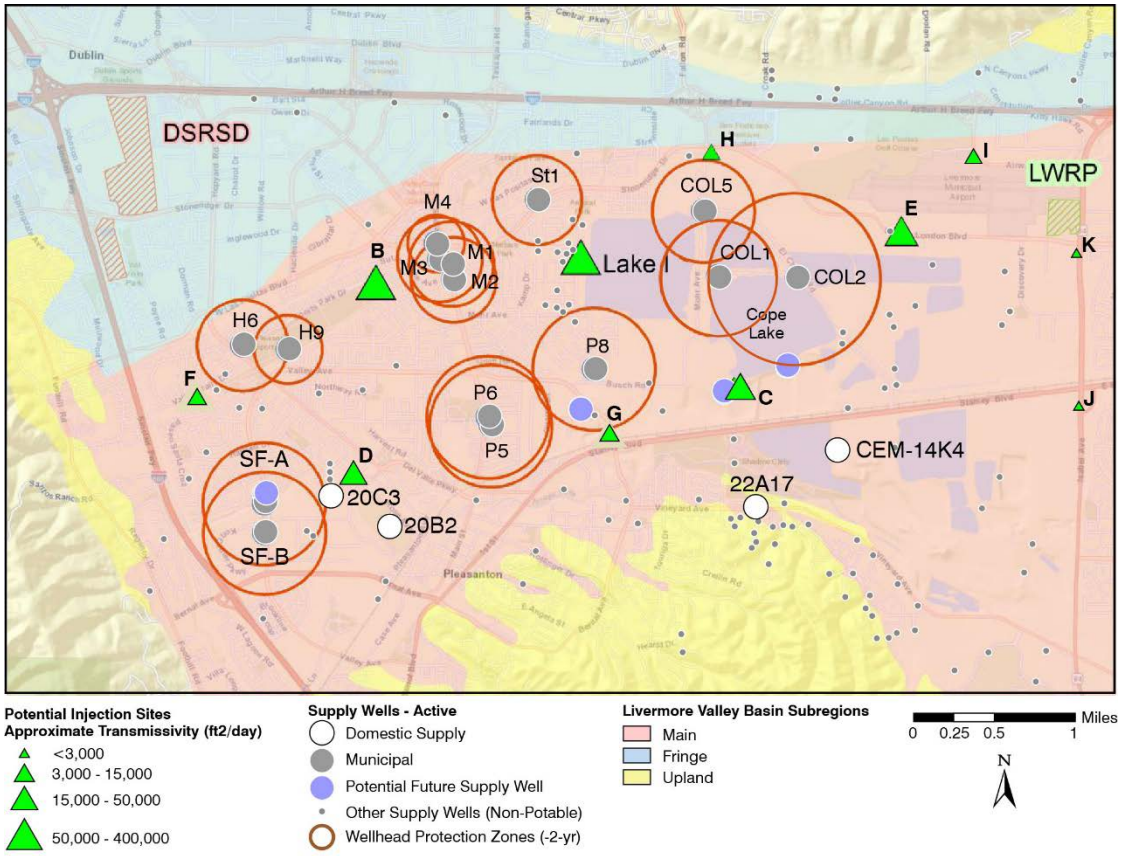


Figure 5.10 Potential Locations of Injection Wells

Transmissivity, defined as the product of hydraulic conductivity and aquifer thickness, is a hydraulic property of an aquifer that describes the water transmission capability of the entire

thickness of an aquifer. For wells screened across a substantial portion of the thickness of a confined aquifer unit, the extraction and injection capacities of the well will be related to the aquifer's transmissivity at the well location. Therefore, the estimated transmissivity of the lower aquifer zone was used as a surrogate for well injection capacity for evaluating the initially identified potential injection locations.

Hydraulic properties for the Lower Aquifer Zone were extracted from the Zone 7 Groundwater Model of the Livermore-Amador Valley, version 3.0. Layer 3 of the model represents all of the interbedded water-bearing layers below the aquiclude found in the center of the groundwater basin. Extracted data included hydraulic conductivity and top and bottom elevations of the model layer. A grid of transmissivity values was calculated from the extracted data in ArcGIS using the same 500-ft grid as used in the groundwater model. Gridded transmissivity values ranged from 1.6 to 3,200,000 ft^2/day. Because of the large variation in calculated transmissivity values (over six orders of magnitude), the logarithm of transmissivity was calculated. The grid was then smoothed using a neighborhood mean with a radius of five grid cells because the initially identified injection locations are approximate in an area larger than a single model grid cell. Finally, the mean log transmissivity values were assigned to each potential injection location as shown in Figure 5.10 where the size of the well symbol is proportional to the mean log transmissivity at the location.

Another consideration for the siting of potential injection wells is the potential to improve groundwater quality by flushing lower-quality water out of the basin. Some of the highest TDS concentrations in both the upper and lower aquifers in the main basin are found in the areas generally west of the Chain of Lakes as shown in Figures 6-2 and 6-8 of the Zone 7 Annual Report for the Groundwater Management Program for Water Year 2015. Depending on the specific injection practices used, i.e. injection only or ASR, it is possible that injection of higher quality water can, over time, push higher TDS water toward production wells where it will be extracted. Potential injection sites identified in the western basin in Figure 5.10 were identified in part with this flushing of higher TDS groundwater in mind.

Based on the screening analysis of the potential injection sites the two wells with the lowest estimated transmissivities were eliminated (sites I, J, and K along Isabel avenue). Well D, located in the southwest part of the basin closest to the San Francisco wells, was also eliminated because of its proximity to these potable supply wells.

While site specific conditions including localized hydrogeology and available space will influence injection capacities and site suitability, a preliminary analysis of injection well capacities was conducted based on known extraction capacities at wells throughout Zone 7's water supply system. In general, injection capacity can be assumed to be approximately 50 to 80 percent of extraction capacity. Using this range and averaging the extraction capacities of the existing well system, a high and low injection capacity was determined per injection well. The capacity range is 2.2 mgd to 3.5 mgd per well. The conservative value of 2.2 mgd per well was assumed for the purposes of the model. At each site the number of wells and the individual injection well capacity will define the overall injection capacity of each potential location. These potential injection locations is assessed for sufficient travel time to the nearest well in Chapter 6. The injection capacity assumption is re-visited based on further investigations in Chapter 7.

With the exception of the well adjacent to Lake I (site A in Figure 5.10), it is assumed that the wells could be sited to meet the groundwater recharge regulations through providing a minimum 2 month travel time to the nearest water supply well. Further refinement of travel time and attainment of the 6-month criteria (conservative assumption for planning purposes) is presented in Chapter 6. It is assumed that FAT will be required for injection of purified water at these sites. For the well adjacent to Lake I, it is assumed that the proximity to the Zone 7 water supply wells will require additional treatment—such as GAC and engineered storage—beyond FAT.

Groundwater modeling can show the estimated travel time between the selected injection sites and extraction wells. The 2003 Well Master Plan identified seven potential locations for future wells under the preferred alternative to increase well production capacity to meet drought period demands. While not considered in the preliminary groundwater modeling and alternatives analysis, these additional wells will be considered in the future development of alternatives. Groundwater modeling is discussed briefly within this chapter but in detail in Chapter 6.

5.7.2.2 Aquifer Storage and Recovery (ASR)

ASR is the use of a system of wells to both inject potable or purified water and later extract the water from the same location (after a minimum retention time of two months). Typical ASR wells are located in aquifers with minor lateral hydraulic velocity, or where recovery of recharged water occurs on a regular basis. An ASR system requires several injection locations (minimum 3) to provide continual injection, holding, and extraction ability. These locations can be separated by a defined horizontal distance or by a semi-permeable or impermeable layer within the aquifer. ASR is advantageous on many levels: 1) having both the recharge and recovery components located within a small well site; 2) retaining recharged water within a "bubble" around the well, which allows for better control of water quality within the well; and 3) use of in-situ equipment to maintain recharge capacity, since all recharge facilities clog and need rehabilitation. ASR wells must be located far enough away from drinking water wells to prevent interference with the ASR operations. An example ASR operation is shown in Figure 5.11.

The identified locations for groundwater injection wells could potentially be similar for ASR wells. However, costs for ASR wells are higher than conventional groundwater injection wells. This is due to the additional infrastructure required to connect the wells to the existing distribution system. Since Zone 7 has an extensive existing well system with capacity to extract additional water, there is not a capacity incentive to pursue ASR. The groundwater area around Mocho does have water quality issues (high TDS) as discussed earlier, but these could potentially be resolved with conventional groundwater injection. Since ASR is not seen as essential for groundwater recharge and it is the more expensive option, it will not be individually investigated within this round of alternatives. ASR could potentially be an option later if hydrogeological investigations show that the soils are conducive to the operations. ASR is discussed more in Chapter 6.

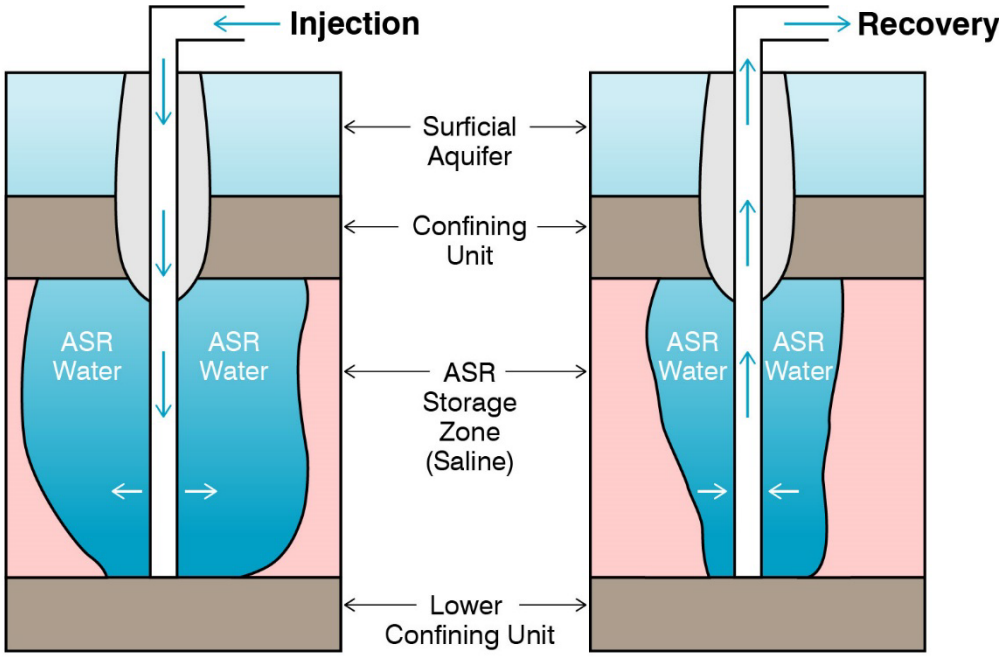


Figure 5.11 Aquifer Storage and Recovery (ASR) System (Adapted from NAP, 2005)

5.7.2.3 Surface Spreading - Lake I

Lake I is the westernmost lake in the Chain of Lakes system (COL). The COL is a series of 10 current and former quarry lakes that have been or will be turned over to Zone 7 for purposes of groundwater recharge, surface water storage, and stormwater management. Currently, Zone 7 owns Lake I and Cope Lake. The other lakes are still in the active mining or reclamation process and will be turned over to Zone 7 in future years once reclamation of lakes is complete.

In the 2014 Chain of Lakes Use Evaluation (Zone 7, 2014), Lake I was rated the highest among the COLs for groundwater recharge potential. It was designated in the 1981 Specific Plan for Livermore Amador Valley Quarry Area Reclamation (LAVQAR) as a recharge location. As a result, during mining and reclamation operations, the western sidewall was maintained as a recharge face. The bottom of the lake (average of 220 ft msl) is beneath the average groundwater surface elevation (approx. 300 ft msl). As a result, Lake I recharge rates are highly sensitive to water surface elevation (WSE), ranging from 0 to almost 18,000 AFY (16 mgd). Its total storage volume is approximately 27,000 AF. If Lake I levels are low enough, the water flow is reversed and groundwater begins to flow into the lake. Figure 5.12 shows the relationship between Lake I WSE, recharge rate, and volume. As the lake level drops, the head decreases, therefore the infiltration rate decreases.

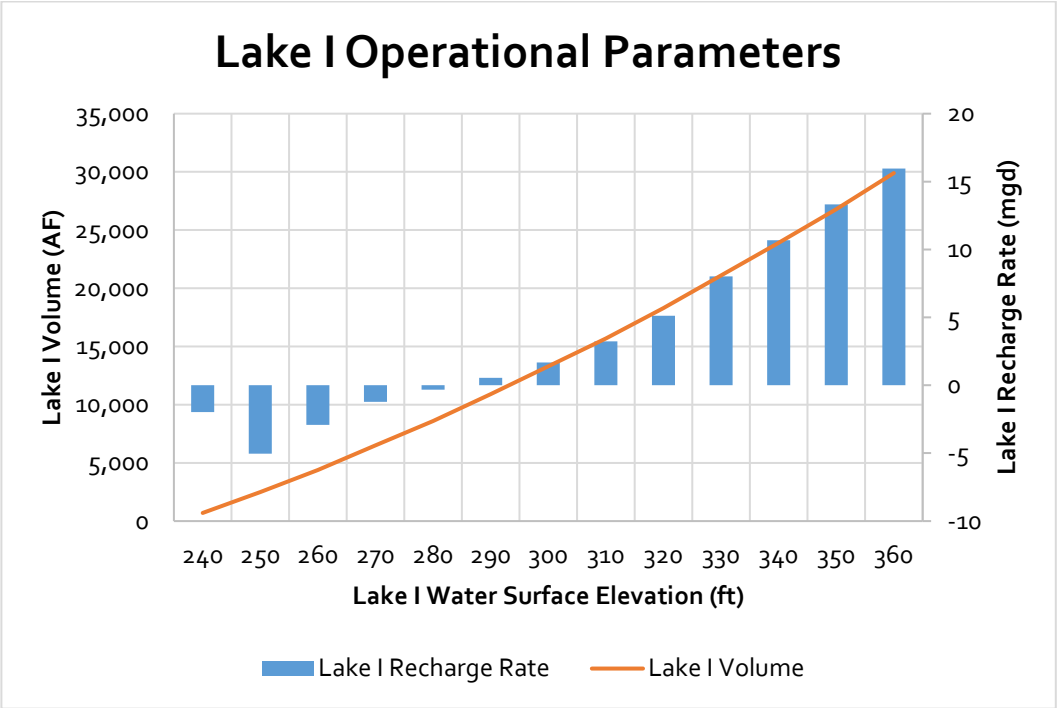


Figure 5.11 Lake I Recharge Rate, Volume, and Water Surface Elevation Relationship (Assumes Groundwater Level at 270 feet)

Vulcan Discharge

Vulcan Materials is currently using Lakes C through G - either actively mining or storing water. The company has a contract with Zone 7 to discharge dewatering and processing water into Lake I via Cope Lake.

The water is transferred through an existing Lake I-Cope Lake connecting pipeline. If Vulcan discharges the full capacity, then storage/recharge capacity in Lake I will be unavailable for purified water. Before Cope Lake or Lake I was available, Vulcan discharged to the Arroyo Mocho. Historical annual discharges are shown in Figure 5.13. The discharges vary by year depending on the mining operations. These discharges are not distributed evenly throughout the year and tend to be higher in winter months and lower in summer months. The average annual discharge volume is 2,000 AFY and the maximum amount of water that has been discharged between 1974 and 2015 in the COLs is 9,100 AFY. This discharge value was used in the alternatives analysis to model Lake I operations and the upper bookend of effects on recharge rate. The average discharge rate of 2,000 AFY was used to model operations with a lowered Vulcan discharge.

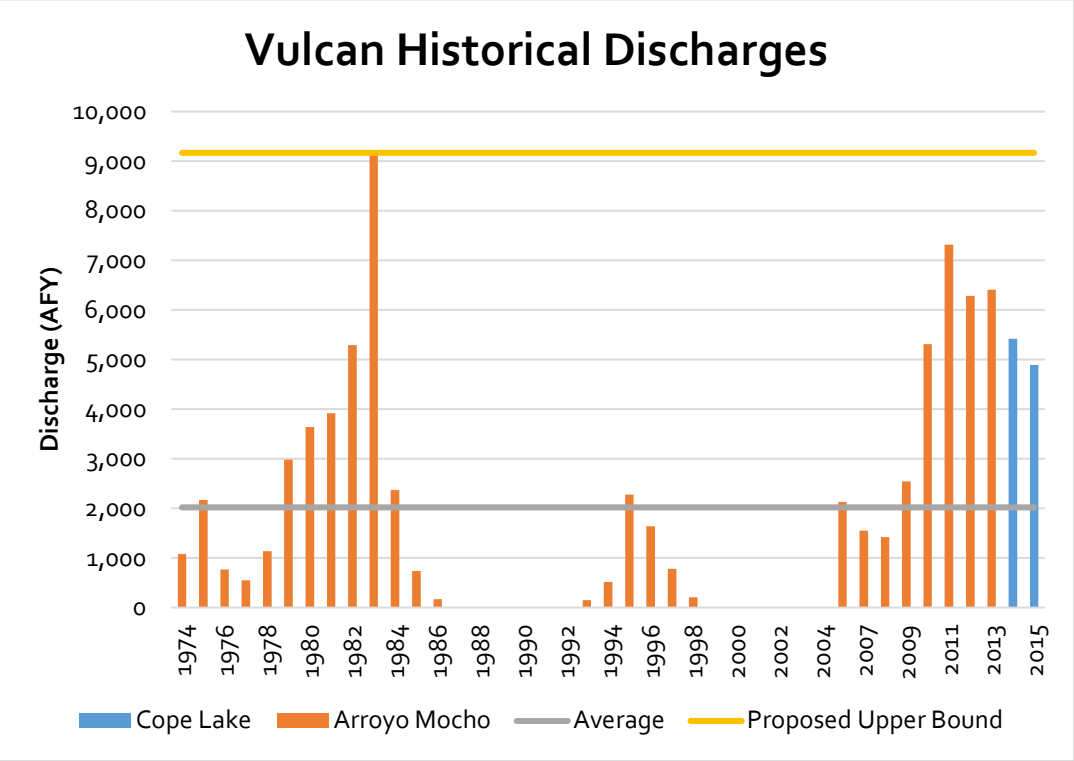


Figure 5.12 Vulcan Historical Discharges

The above section was accurate as of the publishing of the draft feasibility study in 2017. However, in water year 2017, Vulcan Materials discharged 13,500 AF. They have established a new National Pollutant Discharge Elimination System (NPDES) permit limit of 40 mgd and are considering adding a new discharge pipeline to increase capacity. If options involving Lake I discharge or even use of Cope Lake are considered in the future, future studies should investigate operational adjustments and institutional agreements that need to be made between the agencies and Vulcan Materials.

5.7.3 Reservoir and Raw Water Augmentation - DVWTP and PPWTP

Two WTPs treat surface water for distribution throughout Zone 7's service area - Del Valle WTP (DVWTP) and Patterson Pass WTP (PPWTP). DVWTP has an average capacity of 36 mgd. PPWTP has an average capacity of 19 mgd (to be expanded to 24 mgd by 2021).

5.7.3.1 Cope Lake to DVWTP

In a future potable reuse project, purified water could be sent to Cope Lake for a brief holding period before being transferred to DVWTP via the new COL pipeline. Purified water could potentially be sent directly to the pipeline to DVWTP, bypassing Cope Lake, but still utilizing a main portion of the pipeline. Since the volume of Cope Lake is so low, it may not provide enough storage time to be considered reservoir augmentation. All alternatives with delivery to DVWTP via Cope Lake or directly via the COL pipeline would be considered raw water augmentation. Note that the ability to discharge into Cope Lake allows for some flexibility in case DVWTP is unable to receive purified water (e.g., plant outage).

Cope Lake has a capacity of approximately 4,500 AF. To assess the residence time in Cope Lake, a water balance around the Cope Lake was developed. This water balance accounts for inflows and outflows from Cope Lake, including:

- Net evaporation.
- Seepage.
- Inflow from Vulcan mining operations.
- Purified water flow.
- Outflow to Lake I.

In addition, the following infrastructure limitations for flow in/out of Cope Lake were considered in this analysis:

- Outflow to Lake I - The connection between Cope Lake and Lake I is a 36-inch HDPE pipeline, starting at an elevation of 330 feet in Cope Lake and discharging into Lake I at 285 feet. Water flows from Cope Lake to Lake I at various speeds depending on the water elevation in the respective lakes. The maximum design flow between lakes is 34 mgd.
- Outflow to DVWTP - A 30-in pipeline from Cope Lake to DVWTP is currently included in the capital improvement plan for Zone 7. A 1,300-hp pump station is included in the plan as well. The planned capacity of the pump station and pipeline is 12 mgd.

The water balance was conducted on an annual basis, and assumes a steady state condition (no storage change). In recent years the Vulcan discharge has been approximately 4,900 AFY, with about 3,000 AFY conveyed to Lake I for recharge. Under this discharge condition, if an additional 4,100 AFY of purified water were conveyed through Cope Lake then the average residence time of the purified water in Cope Lake would be approximately 6 months. It is possible that future potable reuse regulations would consider a 6-month residence to be a sufficient environmental buffer and treatment requirements would be limited to FAT. However, there is some seepage from Cope Lake, and the lake is in close proximity to the Zone 7 municipal wells. Therefore, it is assumed that FAT, GAC, and engineered storage will be required.

While the residence time in Cope Lake may not provide a regulatory benefit in terms of treatment requirements, it can serve as an environmental buffer. A key variable in the residence time of purified water in Cope Lake is the volume of the Vulcan discharge into Cope Lake and subsequent outflow into Lake I. At Vulcan's permitted discharge volume of 21,000 AFY, the residence time would be on the order of 2 months. Furthermore, there would be potential issues with maintaining a steady state condition, as Lake I recharge capacity would likely be exceeded.

5.7.3.2 PPWTP Raw Water Augmentation

PPWTP has a 92-AF reservoir ahead of its facilities. At best, this reservoir would only be able to provide a few days' residence time. Therefore, alternatives considering PPWTP are also designated as raw water augmentation projects.

PPWTP is located approximately 7 miles east of Livermore WRP, the easternmost purification facility location. The infrastructure alone to distribute water from any of the other purification facilities to PPWTP could be cost prohibitive. Therefore, the only alternative that includes purified water sent to PPWTP is the 5 mgd treatment facility at Livermore WRP. As shown in Table 5.4, PPWTP has received sufficient historical flows to be able to meet the 50 percent blend requirement with flows from a purification facility at Livermore WRP.

5.7.3.3 Blending Requirement

Regulations for reservoir augmentation (also called surface water augmentation) were adopted in March 2018. Raw water augmentation regulations have not been established but are expected by December 2023. Prior to adoption of formal regulations, case by case projects may be permitted by the State. For the purposes of this evaluation, it is assumed that the blending percentage for purified water to raw water would be 50 percent for both raw water and reservoir augmentation. Historical production for each of the WTPs is shown in Table 5.4. It should be noted that 2014 was a drought year and surface water supplies were limited. DVWTP is able to meet the blend percentage with a seasonal flow of up to 12 mgd of purified water, which is the maximum potential purified water flow being investigated within this project.

Table 5.4 WTP Historical Flows

Year	PPWTP Flow (mgd)	DVWTP Flow (mgd)
2012	7.9	17.5
2013	11.2	18.5
2014	6.9	13.2
Overall Average	8.7	16.4

On a seasonal basis, the WTPs produce more water in summer months than in winter months, as is shown in Figure 5.14. With PPWTP, there may be a shortage of blending water in winter months. However, assuming that the annual allocation of water stays the same, operationally, the WTPs should be able to adjust to new flow patterns with the purified water addition.

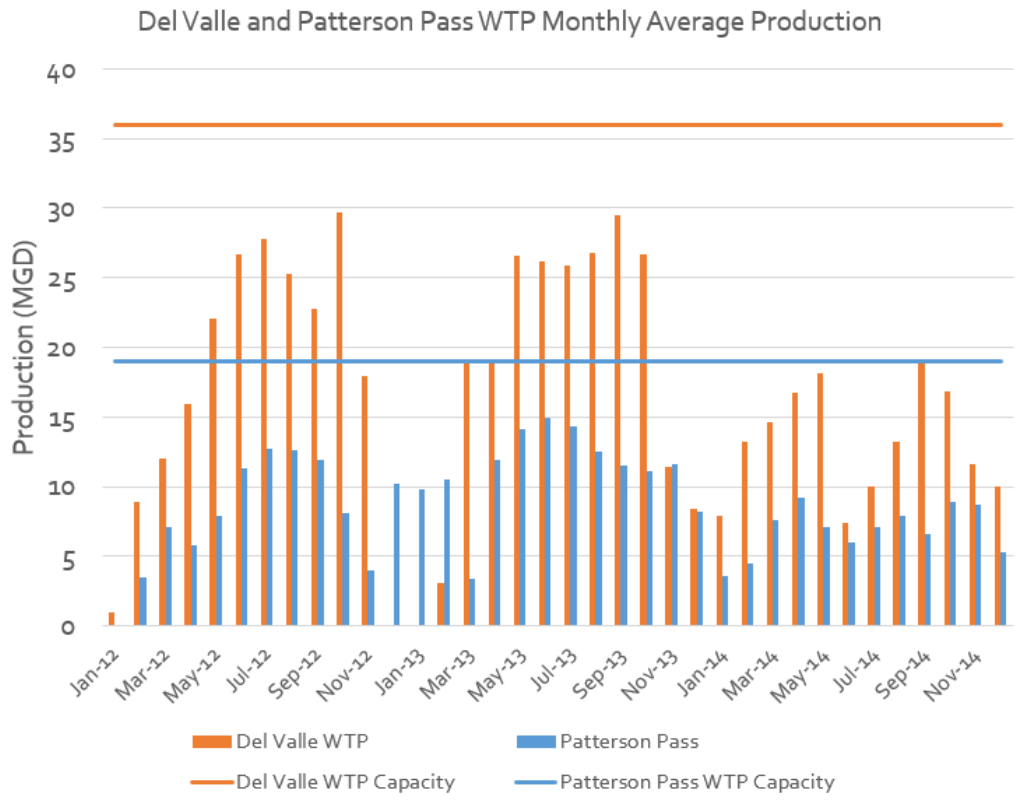


Figure 5.14 WTP Monthly Average Production

Cope Lake is sensitive to peak flows, smaller than Lake I, and (along with Lake H) may be used for stormwater detention in the future. At times when there is not enough capacity in Cope Lake or not enough source water available to meet the blend ratio, it may be necessary to divert purified water from Cope Lake to Lake I or to nearby injection wells. This flexibility must be considered in each alternative which uses Cope Lake.

5.8 Alternatives Development

In total, 21 preliminary alternatives were developed by the project management team. They are listed in Table 5.5. The intention of this initial alternatives analysis was to take a broad cross section of potential alternatives and evaluate them according to the preliminary evaluation criteria, narrowing down the group of alternatives to three short-listed options for further investigation. Alternatives developed within this section were compared in Carollo's master planning tool - Blue Plan-it® (BPI). The purpose of the BPI runs was to provide a bracket of potential costs across a range of alternatives. Not all of the 21 alternatives listed in Table 5.5 were analyzed in the BPI model because they were considered similar to other, more cost-effective alternatives.

For each alternative, preliminary pipeline alignments, treatment trains, and end use assumptions were developed to inform the cost estimate and modeling effort. Each alternative is described briefly within this section.

5.8.1 Alternatives at Livermore WRP

Four alternatives were evaluated with advanced treatment at Livermore WRP. Diversion of flow from DSRSD WWTP to Livermore WRP was briefly investigated. The diversion would require approximately 6.5 miles of pipeline adjacent to the existing LAVWMA line. The LAVWMA line would have to remain in place to convey discharge and waste streams to DSRSD. The additional infrastructure required to bring DSRSD flows was considered too extensive to consider in this round of alternatives. Therefore, all options with advanced treatment at Livermore WRP are sized only for Livermore flows. The flows are predicted to be sufficient for 5 mgd (5,500 AFY) year-round production of purified water. Alternative alignments are shown in Figure 5.15.

Treated concentrate would be discharged to the LAVWMA pipeline.

5.8.1.1 Alternative 1: Treatment at Livermore, Direct Injection at Well E

Alternative 1 includes the following components:

- 5 mgd FAT facility operating year-round.
- 6,100 LF of pipeline from the facility to Well E (alignment along Jack London Blvd).
- Three injection wells located at Well E Site.

Table 5.5 Preliminary Alternative List

ID	Source	Capacity (mgd)	Annual Yield (AFY)	Seasonal/Year Round	Purification Location	Treatment	Storage	End Use Location
1	L	5	5,500	Year Round	Livermore WRP	FAT	No	Well E
2	L	5	5,500	Year Round	Livermore WRP	FAT	No	Lake I
3	L	5	5,500	Year Round	Livermore WRP	FAT+	No	PPWTP
4	L	5	5,500	Year Round	Livermore WRP	FAT+	No	Cope Lake/ DVWTP
5	L + D	7	7,700	Year Round	Regional at DSRSD WWTP	FAT	370 MG	Well F
6	L + D	7	7,700	Year Round	Regional at DSRSD WWTP	FAT	370 MG	Well B
7	L + D	7	7,700	Year Round	Regional at DSRSD WWTP	FAT+	370 MG	Lake I
8	L + D	1212 (5 Summer)	10,000	Seasonal	Regional at DSRSD WWTP	FAT	No	Well F
9	L + D	1212 (5 Summer)	10,000	Seasonal	Regional at DSRSD WWTP	FAT	No	Well B
10	L + D	12 (5 Summer)	10,000	Seasonal	Regional at DSRSD WWTP	FAT+	No	Lake I
11	L + D	7	7,700	Year Round	Regional at DSRSD WWTP	FAT+	370 MG	Cope Lake /DVWTP
12	L + D	12 (5 Summer)	10,000	Seasonal	Regional at DSRSD WWTP	FAT+	No	Cope Lake /DVWTP
13	L + D	12 (5 Summer)	10,000	Seasonal	Regional at Mocho	FAT	No	Well B
14	L + D	12 (5 Summer)	10,000	Seasonal	Regional at Mocho	FAT+	No	Well A
15	L + D	12 (5 Summer)	10,000	Seasonal	Regional at Mocho	FAT+	No	Lake I
16	L + D	6	6,900	Year Round	Regional at Mocho	FAT+	370 MG	Cope Lake/DVWTP
17	L + D	12 (5 Summer)	10,000	Seasonal	Regional at COL	FAT	No	Well C
18	L + D	12 (5 Summer)	10,000	Seasonal	Regional at COL	FAT	No	Well H
19	L + D	12 (5 Summer)	10,000	Seasonal	Regional at COL	FAT+	No	Lake I
20	L + D	12 (5 Summer)	10,000	Seasonal	Regional at COL	FAT+	No	Well A
21	L + D	6	6,900	Year Round	Regional at COL	FAT+	370 MG	Cope Lake/DVWTP

Notes:
L = Livermore
D = DSRSD

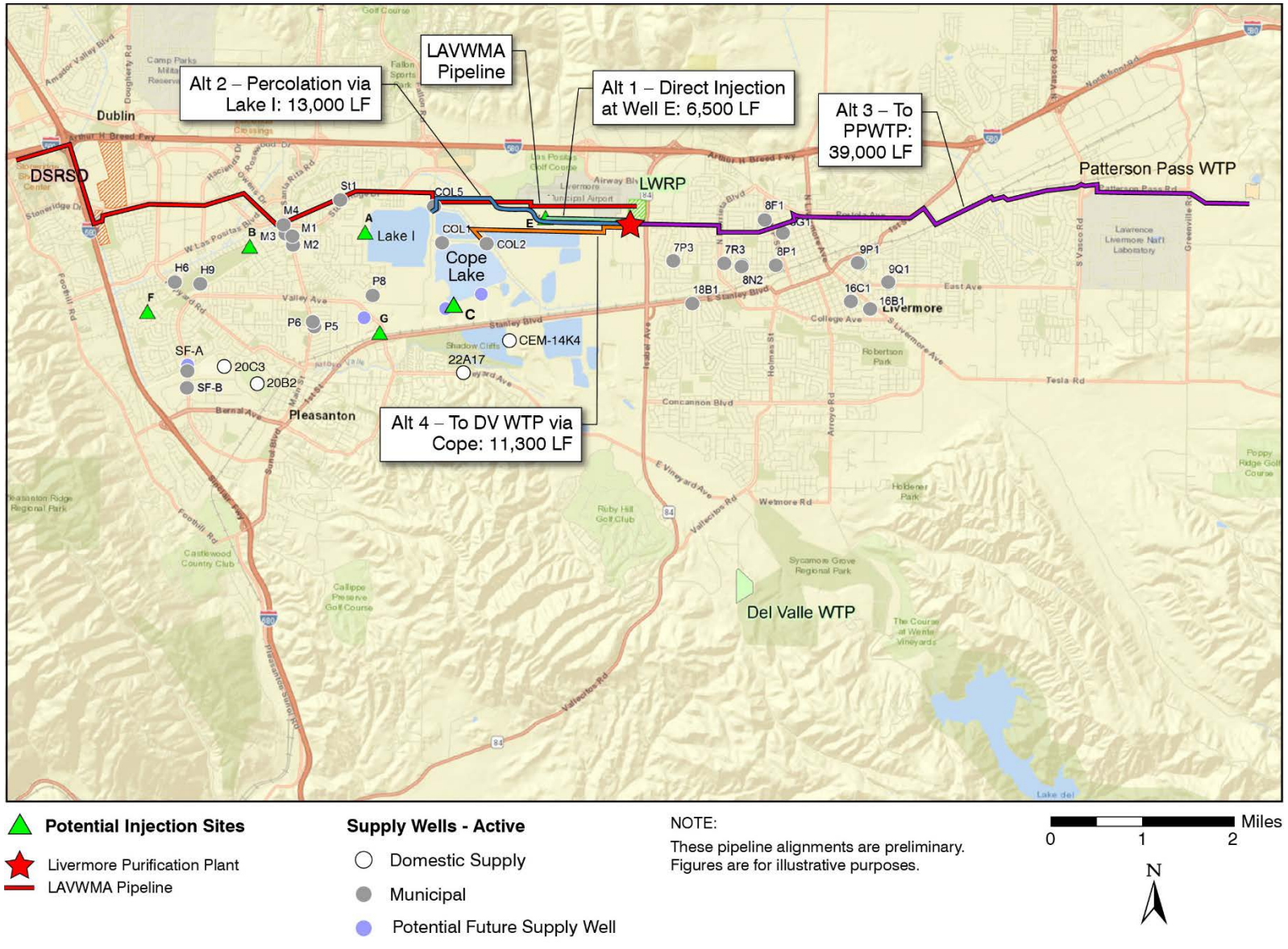


Figure 5.15 Alternative Alignments for Livermore Alternatives

5.8.1.2 Alternative 2: Treatment at Livermore, Surface Spreading via Lake I

Alternative 2 includes the following components:

- 5 mgd FAT+ facility operating year-round.
- 13,000 LF of pipeline from the facility to Lake I (alignment along Jack London Blvd).
- Flexibility to send water through Cope Lake to DVWTP.

5.8.1.3 Alternative 3: Treatment at Livermore, Blend at Patterson Pass WTP

Alternative 3 includes the following components:

- 5 mgd FAT+ facility operating year-round.
- 39,000 LF of pipeline from the facility to PPWTP (alignment follows East Jack London Blvd down to Portola Ave to Patterson Pass Road).
- Three injection wells located near the treatment facility in case of PPWTP shut down to provide flexibility.

5.8.1.4 Alternative 4: Treatment at Livermore, Blend at Del Valle WTP via Cope Lake

Alternative 4 includes the following components:

- 5 mgd FAT+ facility operating year-round.
- 11,300 LF of pipeline from the facility to Cope Lake (alignment follows Jack London Blvd).
- Additional $2 million to increase pump station capacity for diversion from Cope Lake to DVWTP.

5.8.2 Alternatives at DSRSD WWTP

A facility at DSRSD WWTP would be able to treat both Livermore and DSRSD effluent without constructing significant additional secondary effluent piping. Alternatives at DSRSD include both year-round constant production facilities as well as seasonal facilities. The year-round facilities will require 370 MG of storage and can produce up to 7 mgd. Seasonal facilities are sized to produce 12 mgd but will turn down to 5 mgd in summer months. Figure 5.16 shows alignments for all Alternatives 5 through 12.

5.8.2.1 Alternative 5: Year-Round Treatment at DSRSD, Direct Injection at Well F

Alternative 5 includes the following components:

- 7 mgd FAT facility operating year-round.
- 370 MG of storage at DSRSD.
- 4,500 LF of pipeline from facility to Well F (alignment follows the Centennial bike trail).
- Four injection wells.

Well F was chosen for this alternative due to its proximity to DSRSD and the lower water quality (high TDS) reported from production wells in that area.

5.8.2.2 Alternative 6: Year-Round Treatment at DSRSD, Direct Injection at Well B

Alternative 6 includes the following components:

- 7 mgd FAT facility operating year-round.
- 370 MG of storage at DSRSD.

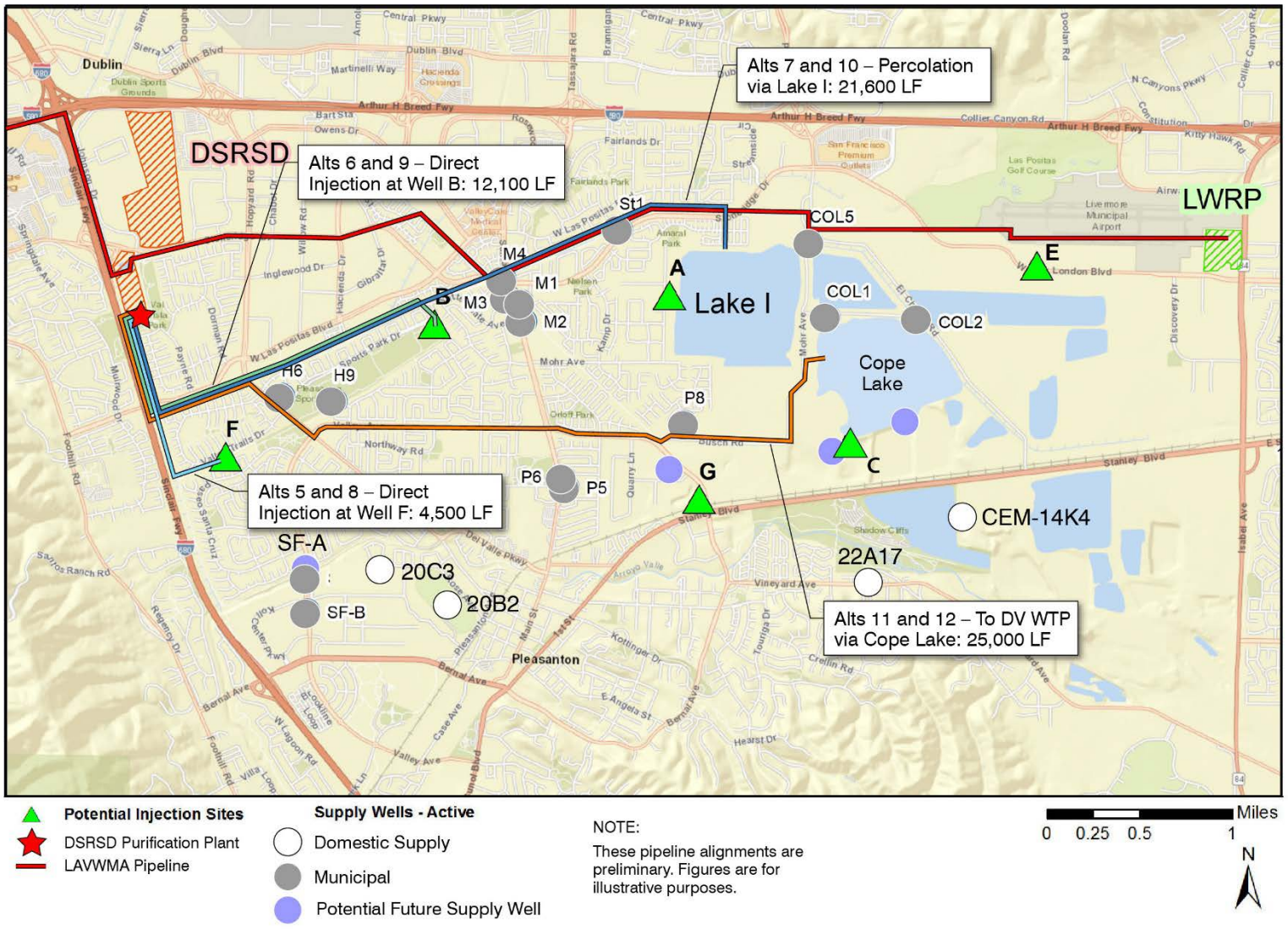


Figure 5.16 Alternative Alignments for DSRSD Alternatives

- 12,100 LF of pipeline from facility to Well B (alignment follows the Centennial and Arroyo Mocho bike trails).
- Four injection wells.

This alternative was not modeled in Blue Plan-it®, in favor of Alternative 5 which has a reduced pipeline length.

5.8.2.3 Alternative 7: Year-Round Treatment at DSRSD, Surface Spreading via Lake I

Alternative 7 includes the following components:

- 7 mgd FAT+ facility operating year-round.
- 370 MG of storage at DSRSD.
- 21,600 LF of pipeline from facility to Lake I (alignment follows the Centennial and Arroyo Mocho bike trails and turns down Trevor Parkway).
- Flexibility to send water through Cope Lake to DVWTP.

5.8.2.4 Alternative 8: Seasonal Treatment at DSRSD, Direct Injection at Well F

Alternative 8 includes the following components:

- 12 mgd FAT facility with seasonally varied flow operations (annual yield of 10,000 AFY).
- 4,500 LF of pipeline from facility to Well F (alignment follows the Centennial bike trail).
- Six injection wells.

5.8.2.5 Alternative 9: Seasonal Treatment at DSRSD, Direct Injection at Well B

Alternative 9 includes the following components:

- 12 mgd FAT facility with seasonally varied flow operations (annual yield of 10,000 AFY).
- 12,100 LF of pipeline from facility to Well B (alignment follows the Centennial and Arroyo Mocho bike trails).
- Six injection wells.

This alternative is not modeled in Blue Plan-it®.

5.8.2.6 Alternative 10: Seasonal Treatment at DSRSD, Surface Spreading via Lake I

Alternative 10 includes the following components:

- 12 mgd FAT+ facility with seasonally varied flow operations (annual yield of 10,000 AFY).
- 21,600 LF of pipeline from facility to Lake I (alignment follows the Centennial and Arroyo Mocho bike trails and turns down Trevor Parkway).
- Flexibility to send water through Cope Lake to DVWTP.

5.8.2.7 Alternative 11: Year-Round Treatment at DSRSD, Blend at Del Valle WTP via Cope Lake

Alternative 11 includes the following components:

- 7 mgd FAT+ facility operating year-round.
- 370 MG of storage at DSRSD.
- 25,000 LF of pipeline from the facility to Cope Lake (alignment follows Valley Road and El Charro Road).
- Additional $2 million to increase pump station capacity for diversion from Cope Lake to DVWTP.

5.8.2.8 Alternative 12: Seasonal Treatment at DSRSD, Blend at Del Valle WTP via Cope Lake

Alternative 12 involves the following components:

- 12 mgd FAT+ facility with seasonally varied flow operations (annual yield of 10,000 AFY).
- 25,000 LF of pipeline from the facility to Cope Lake (alignment follows Valley Road and El Charro Road).
- Additional $2 million to increase pump station capacity for diversion from Cope Lake to DVWTP.

5.8.3 Alternatives at Mocho

Zone 7 currently has a demineralization facility located at the Mocho site, at the intersection of Stoneridge Drive and Santa Rita Road (see Figure 5.17). Repurposing of the demineralization facility is not considered under these alternatives although it could be an option considered in the future. The purification facilities would be located south of the Mocho demineralization facility. DSRSD secondary effluent would be conveyed through a dedicated pipeline (14,200 LF) along the Arroyo Mocho Bike Trail as shown in Figure 5.18. Livermore effluent would come from the nearby LAVWMA line. All waste streams would be discharged into the LAVWMA line.



Figure 5.17 Mocho Regional Facility Overview

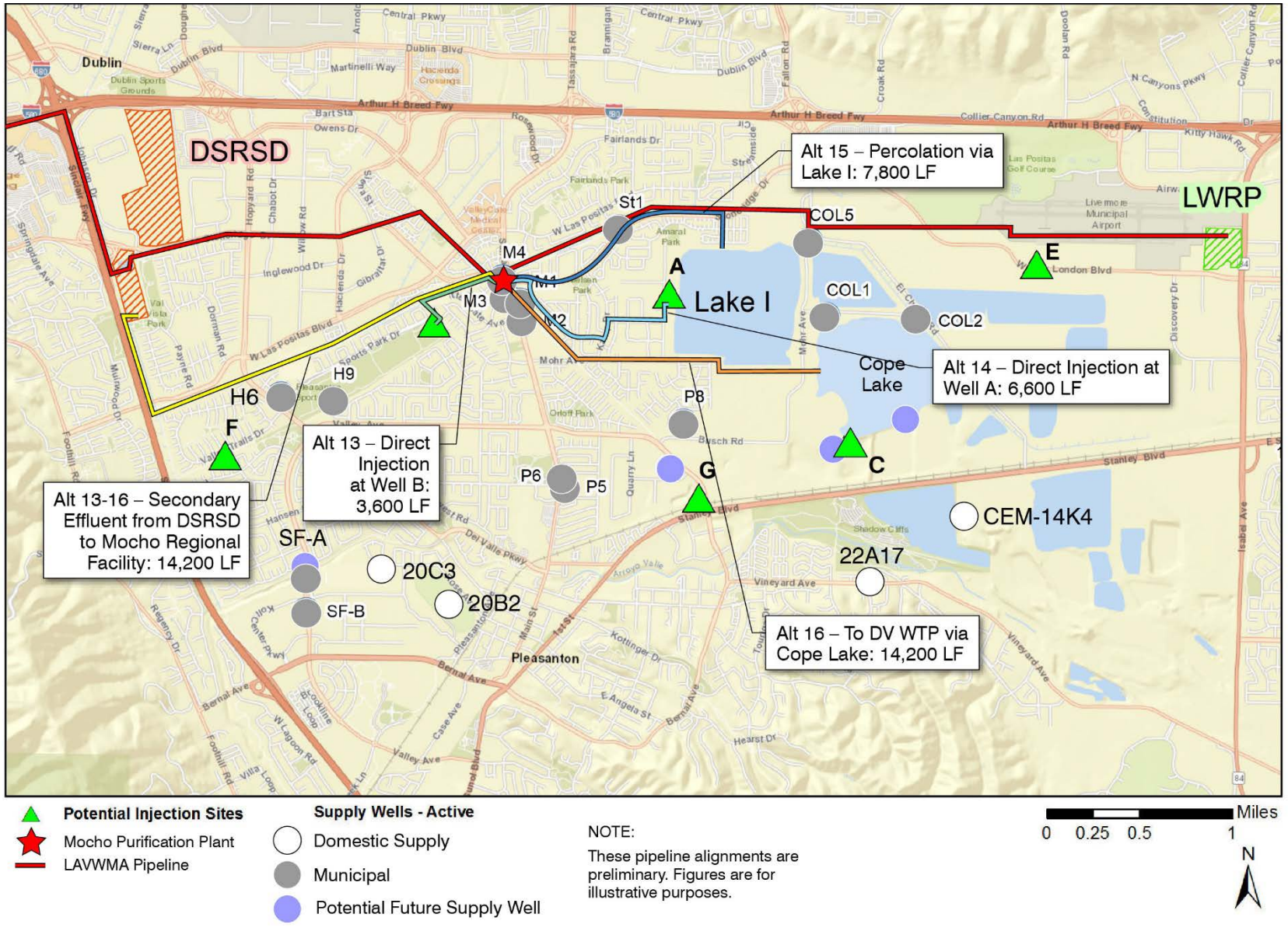


Figure 5.13 Alternative Alignments for Mocho Alternatives

The treatment train recovery rate for all facilities at Mocho will be slightly lower than those at Livermore WRP or DSRSD WWTP as discussed in Section 5.6.1 – closer to 72 percent than 80 percent, due to the inability to recapture reject flows. With the seasonal treatment options, the impact of the lower recovery rate is a slightly larger infrastructure size for transferring water to the treatment facility. With the year-round facility, however, the product flow will be reduced to 6 mgd because the amount of available year-round flow is limited by the storage size.

The total available land is estimated to be a little over 1.5 acres. Seasonal treatment facilities sized for 12 mgd at this location may need to have multiple floors in order to fit on the site. For the year-round treatment option, storage would be built at DSRSD WWTP. Figure 5.18 shows pipeline alignments for alternatives 13 through 16.

5.8.3.1 Alternative 13: Seasonal Treatment at Mocho, Direct Injection at Well B

Alternative 13 includes the following components:

- 12 mgd FAT facility with seasonally varied flow operations (annual yield of 10,000 AFY).
- 3,600 LF of pipeline to Well B.
- Six injection wells.

5.8.3.2 Alternative 14: Seasonal Treatment at Mocho, Direct Injection at Well A

Alternative 14 includes the following components:

- 12 mgd FAT+ facility with seasonally varied flow operations (annual yield of 10,000 AFY).
- 6,600 LF of pipeline to Well A.
- Six injection wells.

FAT+ is assumed to be necessary because of the proximity to Lake I and the short travel time to proximate distribution wells.

5.8.3.3 Alternative 15: Seasonal Treatment at Mocho, Surface Spreading via Lake I

Alternative 15 includes the following components:

- 12 mgd FAT+ facility with seasonally varied flow operations (annual yield of 10,000 AFY).
- 7,800 LF of pipeline from facility to Lake I.
- Flexibility to send water through Cope Lake to DVWTP.

5.8.3.4 Alternative 16: Year-Round Treatment at Mocho, Blend at Del Valle WTP via Cope Lake

Alternative 16 includes the following components:

- 6 mgd FAT+ facility operating year-round (lower production due to lower recovery rate).
- 370 MG of storage at DSRSD.
- 9,800 LF of pipeline from the facility to Cope Lake.
- Additional $2 million to increase pump station capacity for diversion from Cope Lake to DVWTP.

5.8.4 Alternatives at Chain of Lakes

A plot of land in between Lake H, Lake I, and Cope Lake was investigated as a potential site for a regional facility. The size of the available land is approximately 3.1 acres. There is an existing Zone 7 well facility near the potential facility site as shown in Figure 5.19. Since the site is

surrounded by lakes and active groundwater recharge, the COL facility would need deep foundations, like piles, to ensure structural integrity.



Figure 5.19 COL Regional Facility Overview

Secondary effluent from DSRSD WWTP would be piped through 26,000 LF of pipeline to reach the facility. Livermore water would be conveyed via a 3,100 LF-long diversion from the LAVWMA line. Concentrate and waste streams would be piped back along a parallel pipeline to the LAVWMA line for discharge. As a satellite facility, the treatment train overall recovery rate is 72 percent. Preliminary alignments for alternatives with a treatment facility at COL are shown in Figure 5.20.

5.8.4.1 Alternative 17: Seasonal Treatment at COL, Direct Injection at Well C

Alternative 17 includes the following components:

- 12 mgd FAT facility with seasonally varied flow operations (annual yield of 10,000 AFY).
- 5,400 LF of pipeline to Well C.
- Six injection wells.

This option is similar to Alternative 18, but with a slightly longer pipeline. For this reason it is not modeled in Blue Plan-it®.

5.8.4.2 Alternative 18: Seasonal Treatment at COL, Direct Injection at Well H

Alternative 18 includes the following components:

- 12 mgd FAT facility with seasonally varied flow operations (annual yield of 10,000 AFY).
- 3,000 LF of pipeline to Well H.
- Six injection wells.

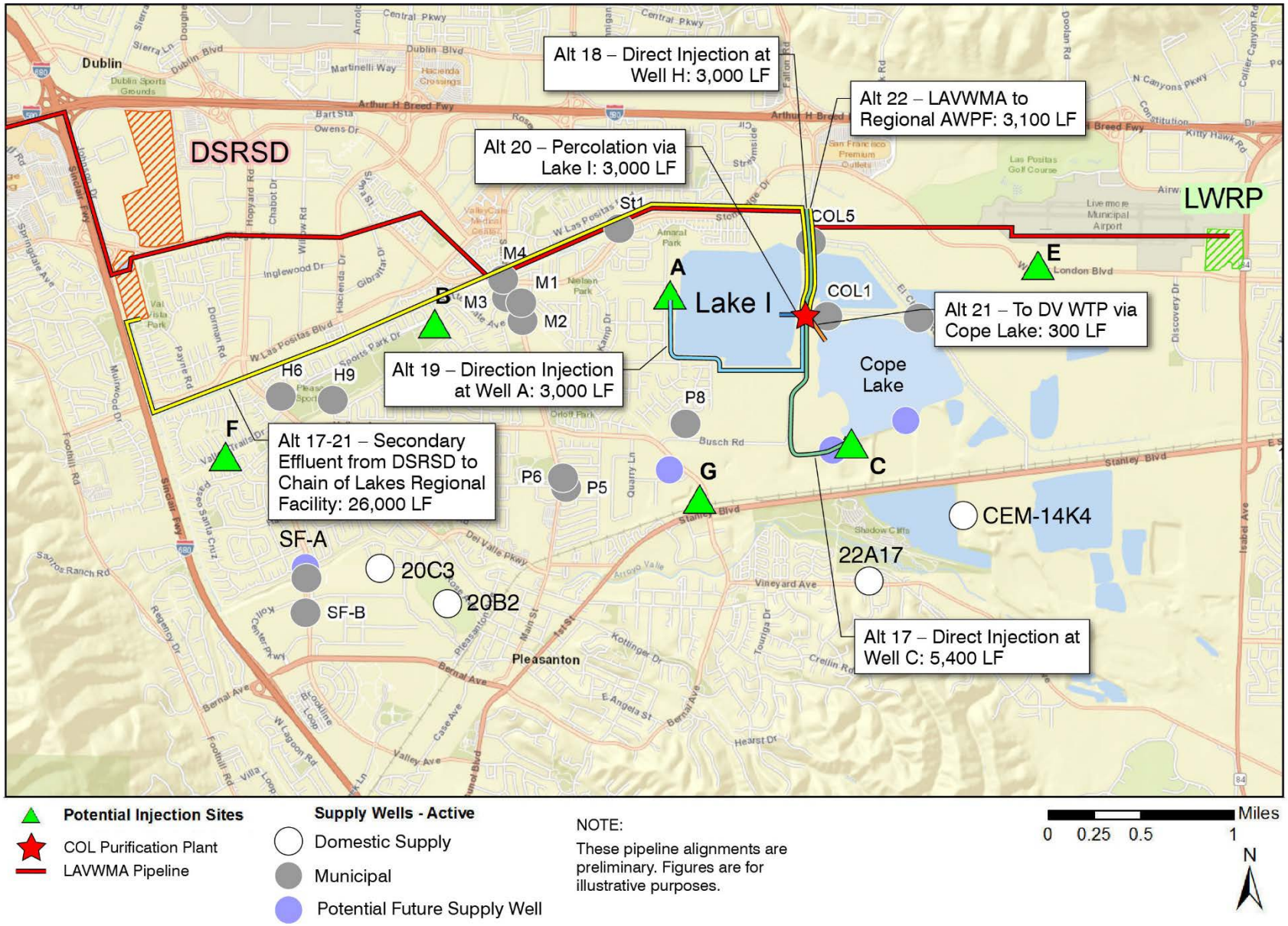


Figure 5.14 Alternative Alignments for COL Alternatives

This alternative includes potentially 4 pipelines between Lake I and Lake H, in addition to the pipelines already in that vicinity. Realignment of pipelines during a route study may be necessary if this alternative is pursued.

5.8.4.3 Alternative 19: Seasonal Treatment at COL, Direct Injection at Well A

Alternative 19 includes the following components:

- 12 mgd FAT+ facility with seasonally varied flow operations (annual yield of 10,000 AFY).
- 7,000 LF of pipeline to Well A.
- Six injection wells.

A more feasible approach to get water into Well A from the facility is to use Lake I as a conveyance and provide an intake on the west side of Lake I right near Well A. Since Alternative 19 is similar to Alternative 20, it is not modeled in Blue Plan-it®.

5.8.4.4 Alternative 20: Seasonal Treatment at COL, Surface Spreading via Lake I

Alternative 20 includes the following components:

- 12 mgd FAT+ facility with seasonally varied flow operations (annual yield of 10,000 AFY).
- 300 LF of pipeline to Lake I.
- Flexibility to send water through Cope Lake to DVWTP.
- A well on the west side of the lake (Well A) could be included to inject excess water deeper into the aquifer and relieve a capacity burden.

5.8.4.5 Alternative 21: Year-Round Treatment at COL, Blend at Del Valle WTP via Cope Lake

Alternative 21 includes the following components:

- 6 mgd FAT+ facility operating year-round (lower production due to lower recovery rate).
- 370 MG of storage at DSRSD.
- 300 LF of pipeline from the facility to Cope Lake.
- Additional $2 million to increase pump station capacity for diversion from Cope Lake to DVWTP.

5.9 Preliminary Groundwater Modeling

The Zone 7 groundwater basin model was used to evaluate high-level feasibility of several injection and/or surface spreading scenarios.

The primary objectives of the regional modeling analysis were to:

- Quantify potential *relative* impacts to the groundwater basin resulting from injection of purified recycled water based on different injection sites and rates, and
- Evaluate the potential travel time to existing potable production wells.

To simplify the evaluation, the impacts of injecting purified recycled water at each of the potential injection sites were simulated assuming operation as recharge wells (not in ASR configuration).

A total of 21 project alternatives have been described previously; however, only those alternatives with a recharge component were considered for the modeling analysis. In addition,

some project alternatives having similar recharge components, e.g., alternatives having the same end uses but different purification plant locations, can be evaluated with a single groundwater model scenario. From these 21 alternatives, a subset of five scenarios was identified for preliminary evaluation using the model, including a baseline/no recharge scenario, as shown in Table 5.6.

Table 5.6 Preliminary Groundwater Modeling Scenarios

Scenario	Recharge Site	Injection Rate
00-Baseline	None	0
01	Well E	5,500 AFY
08	Well F	10,000 AFY
13	Well B	10,000 AFY
10	Lake I	10,000 AFY

For each scenario, the Fall 2016 observed groundwater levels were used to define the initial conditions for the model. A 10-year simulation period was used for evaluating the effects of recharge. The observed water levels were interpolated to the model grid and used as initial conditions for a steady state model run. The output heads from this steady state model were used to define initial heads for the transient model. Semi-annual time steps are used in the transient model; a series of four initialization time steps are included at the beginning of the transient simulation period. Thus, the model includes 24 time steps for the simulations: 4 steady state time steps plus 20 transient time steps for 10 years.

The scenarios were based on average hydrologic conditions. Inflow and outflow components, including purified recycled water injection, are held constant throughout the simulation period, but may vary seasonally. Inflow components include natural stream recharge, Arroyo del Valle prior rights, artificial stream recharge, rainfall recharge, applied water recharge, and subsurface basin inflow.

Outflow components comprise of municipal pumping by Zone 7 and others, agricultural pumpage, mining use, and basin overflow. Zone 7 municipal pumpage is related to the volume of artificial recharge while municipal pumpage by other agencies is based on a quota derived from the basin natural sustainable yield. For this preliminary analysis, the basin water balance is not maintained, i.e., purified recycled water recharge is not offset by corresponding reductions in imports to the basin through the South Bay Aqueduct or increased municipal pumping by Zone 7. Further modeling efforts in the next phase will explore options to maintain the basin water balance.

The time of travel from an injection site to potable production wells can be evaluated by injecting a unit concentration in the recharge wells and determining the time for breakthrough to occur at the nearest affected production well. In accordance with potable reuse regulations, breakthrough is defined at a level of two percent of the injected concentration. Travel time of purified recycled water from the point of injection to a production well is evaluated through the use of a transport simulation using the Modular Transport 3-Dimensional method (MT3D). For this evaluation, the initial concentration is set to zero throughout the model domain, and a unit concentration of 100 is assigned to the injection well. Observed concentrations at the production

wells are used to determine the time at which 2 percent of the injected concentration appears at each well.

The preliminary modeling results on impacts to groundwater levels and travel time are used to help refine the list of alternatives. The next phase of work will include more detailed feasibility analysis of specific sites and refined travel time estimates, as well as evaluation of groundwater quality, potential for contaminant mobilization, and plugging potential.

5.9.1 Preliminary Modeling Results

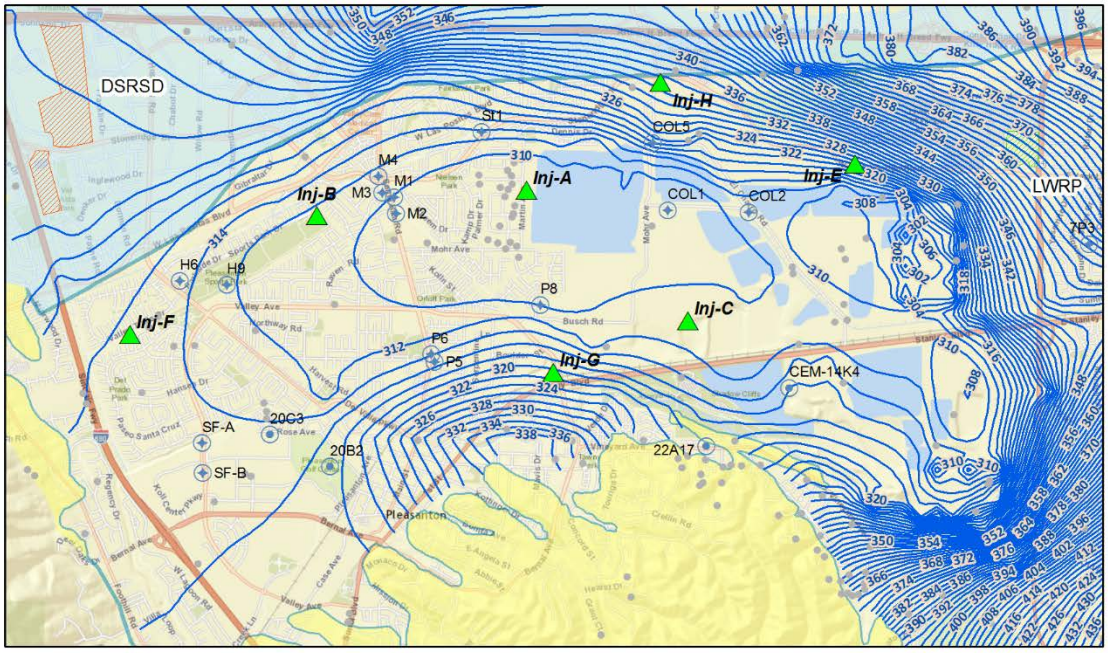
For the baseline scenario, the groundwater basin is at steady state with inflow equal to outflow. Water level contours at the end of the 10-year simulation period are shown in Figure 5.21. In the upper aquifer, layer 1 of the model, groundwater flows inward toward the center of the basin near Lake I with a minimum water level contour elevation of about 310 ft. In the lower aquifer (layer 3), groundwater flows from east to west under a head gradient that varies from about 314 ft in the east to about 298 ft in the west. Areas of localized drawdown are apparent surrounding some of the production wells shown in Figure 5.21. Results shown within this section are preliminary modeling results and are intended for comparative purposes only.

5.9.1.1 Groundwater Elevation Results

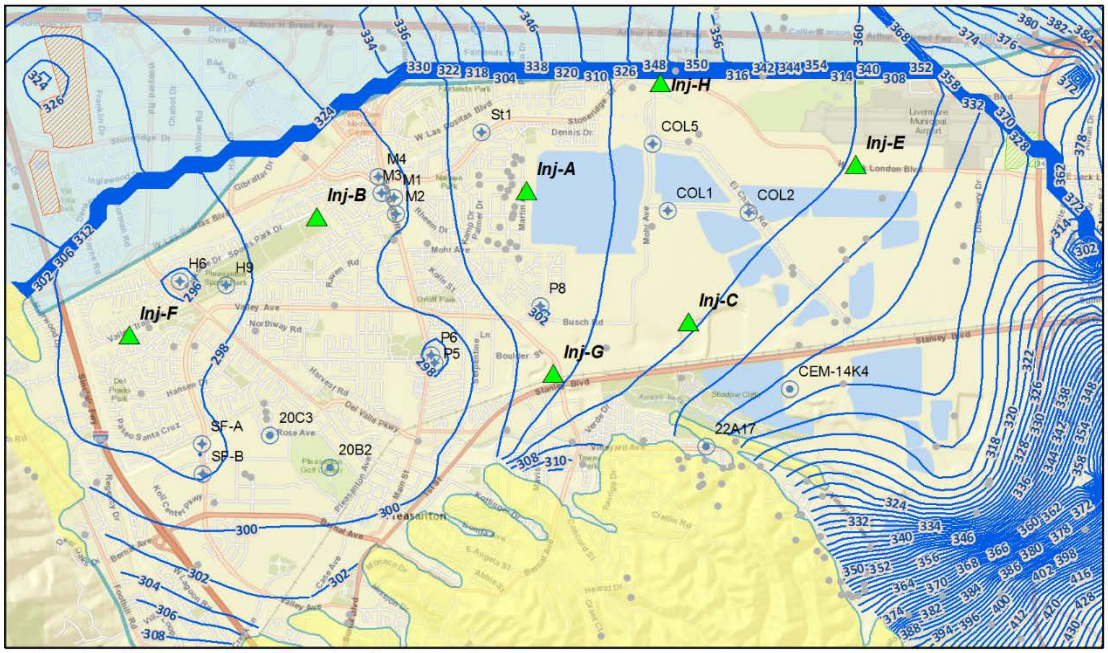
All of the injection scenarios demonstrated a significant increase in water levels throughout the basin in both aquifers. Water levels in the upper aquifer (layer 1) rose up more than 40 feet; and in the lower aquifer (layer 3) water levels increased nearly 50 feet across the basin. Figure 5.22 shows an example output after 10-years of injection for Scenario 13 with injection of 10,000 AFY at Well B. In this scenario, water levels in the upper aquifer increase up to about 44 ft, and an east-to-west flow gradient is established in the western basin. In the lower aquifer the flow gradient is maintained, but potentiometric heads increase by about 44 to 48 ft across the main basin.

Although the increase in water levels can be beneficial by increasing the volume of water in storage and improving production well yield and reliability, negative effects include impacts to mining operations in the central and eastern parts of the basin and potential flooding on some low-lying areas of the basin. For actual operations, injection of purified recycled water would need to be offset by operational changes to groundwater production and other recharge activities. The need for additional analysis of operational changes to maintain the groundwater basin balance is common across all of the groundwater recharge scenarios.

The modeling analysis of injection at Well F indicates higher groundwater elevations near well F, with decreasing elevations to the west of Well F. These results suggest that there is potential for some of the injected water to migrate out of the western edge of basin. In the alternatives evaluation, Well F is considered a relatively undesirable location for groundwater injection.



a. Simulated Water Table Elevation for Layer 1



b. Simulated Water Table Elevation for Layer 3

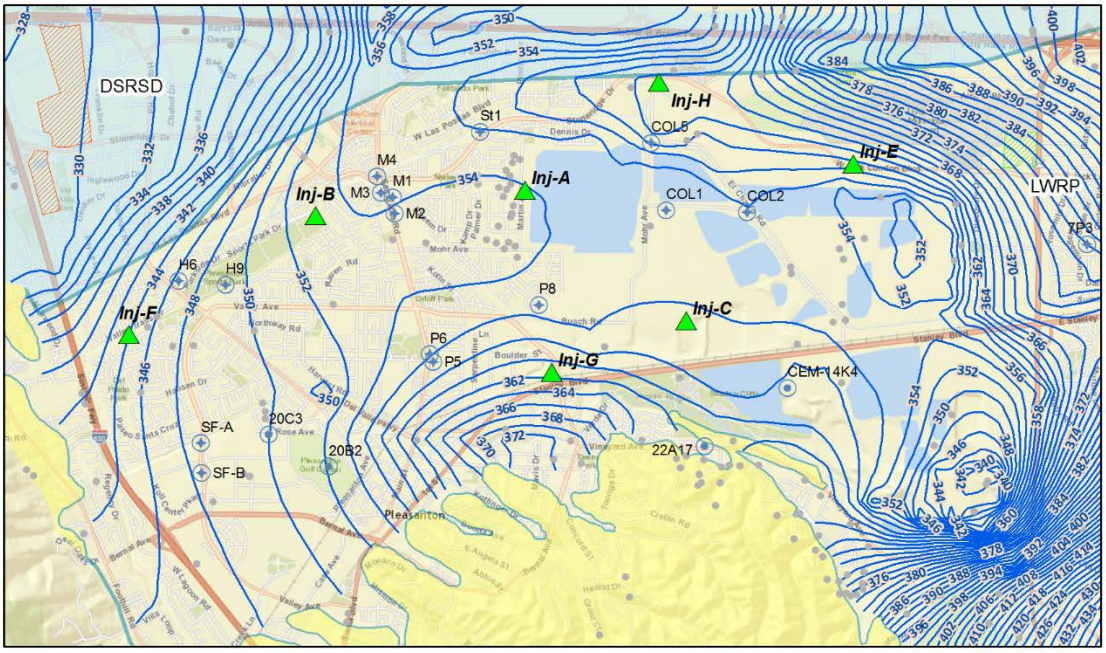
Miles
0 0.25 0.5 1

Potential Injection Sites

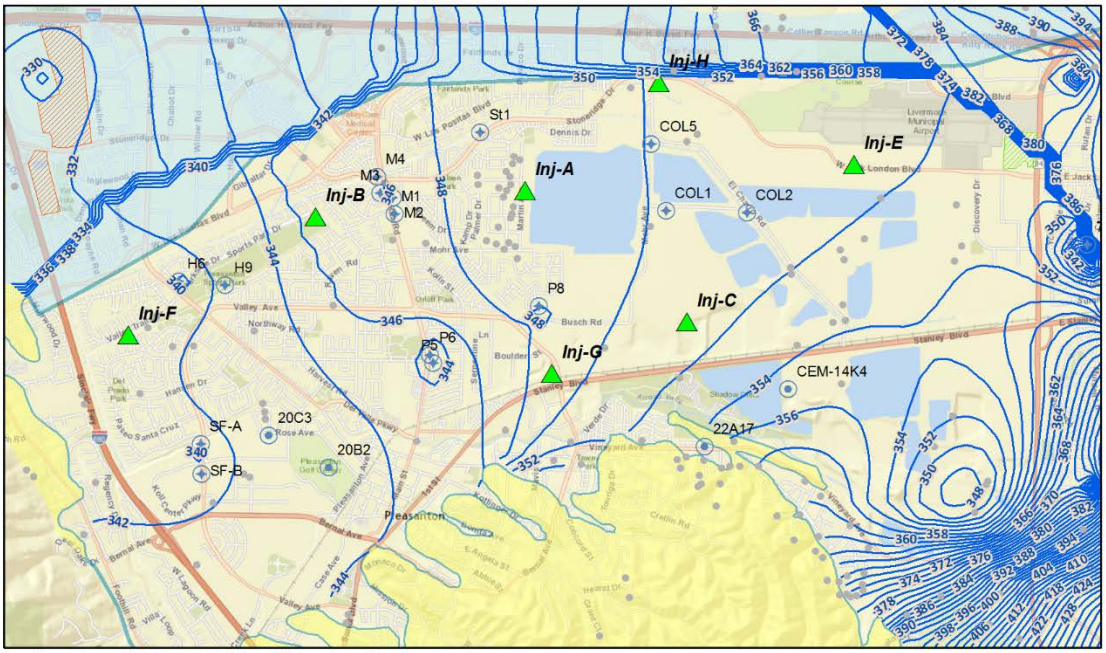
Livermore Valley Basin Subregions
- Main
- Fringe
- Upland

Supply Wells - Active
- Domestic/Supply
- Industrial
- Irrigation
- Municipal
- Other Supply Wells (non-potable)

Figure 5.15 Simulated Water Levels for the Baseline Scenario



a. Simulated Water Table Elevation for Layer 1



b. Simulated Water Table Elevation for Layer 3

Miles
0 0.25 0.5 1

Potential Injection Sites

Livermore Valley Basin Subregions
- Main
- Fringe
- Upland

Supply Wells - Active
- Domestic/Supply
- Industrial
- Irrigation
- Municipal
- Other Supply Wells (non-potable)

Figure 5.22 Simulated Water Levels for the Scenario 13 (Injection at Well B)

5.9.1.2 Travel Time Results

The preliminary travel time analysis results are presented in Table 5.7. For each injection scenario, the table provides the production well where breakthrough is first observed and the time at which 2 percent of the injected concentration appears at each well. No results are presented for Scenario 10 with recharge through Lake I because a higher level of treatment is assumed for the effluent and the retention time requirement does not apply. Based on the required retention time of 2 months and numerical model uncertainty factor of 0.5, the minimum acceptable travel time is 120 days.

Table 5.7 Travel Time Summary

Scenario	Recharge Site	Breakthrough Location	2% Breakthrough Time, days
1	Well E	COL 2	473
8	Well F	HOP 7	170
10	Lake I	NA	NA
13	Well B	MOCHO 2	114

The travel time requirement is met for the all recharge scenarios that were examined through the preliminary modeling effort, with the exception of Well B. The retention time requirement is not met for injection at Well B where the breakthrough of 2 percent occurred after only 114 days. However, Well B was not eliminated from further consideration based on this analysis because the actual site of injection could be moved further from the Mocho production wells without changing the assumptions of this alternative. For example, moving the injection site the width of one model grid cell (500 ft) to the west increases the travel time to the MOCHO 2 production well to more than 150 days.

5.10 Alternatives Evaluation Approach

The alternatives evaluation was facilitated through the Blue Plan-it® using the groundwater modeling previously discussed as well as costs developed within the software. An overview of the alternatives evaluation approach is included within this section.

5.10.1 Basis of Cost

Cost estimates for each scenario were prepared for a Class 5 cost estimate in accordance with guidelines from the Association for the Advancement of Cost Estimating (AACE). As Class 5 estimates, the accuracy ranges from -50 to +100 percent. Tables 5.8 and 5.9 summarize cost assumptions in creation of the high level cost estimate. Appendix A contains detailed cost breakdowns.

Table 5.8 Contingencies and Assumptions

Line Item	Description	% of A
Total Direct Cost	A	100%
Contingency	30% of A	30%
Subtotal	B	130%
General Conditions	10% of B	13%
Subtotal	C	143%
Contractor Overhead & Profit	15% of C	14%
Subtotal	D	157%
Sales Tax	9.5% of B/2	6%
Total Construction Cost	**E**	**163%**
Project Cost Factor	30% of E	49%
Total Project Cost	**F**	**213%**

Table 5.9 Cost Estimate Assumptions

Line Item	Description
Amortization Interest Rate	5%
Payback Period	30 years
Power Cost	$0.14/kWh
ENR-CCI (San Francisco, January 2017)	11069

Other preliminary cost assumptions include:

- All alternatives involving Cope Lake add $2 million to increase the pump station capacity in the currently planned Cope - DVWTP connection pipeline.
- Alternatives with Lake I as an end location also include the extra $2 million to provide flexibility to discharge water into Cope Lake if capacity becomes an issue.
- Alternatives which include the facility at COL include the cost of land, estimated to be approximately $184,000 for the site, based on recent land purchases by Zone 7.

5.10.2 Blue Plan-it® Modeling

All of the treatment assumptions, alternatives, pipeline alignments, treatment processes, and costs discussed within the previous sections were input into Carollo's Blue Plan-it® Decision Support System (BPI). BPI is a tool Carollo developed to help clients manage complex, interconnected treatment and conveyance systems. This BPI tool simulates the water quality from secondary effluent through product water and all waste and discharge streams. BPI was used in the Chapter 4 water balance to determine the maximum amount of reuse water that could be used while complying with permit discharge limits. Using the custom built control panel within the process flow diagram (see Figure 5.23), all relevant alternatives were analyzed to determine facility sizing, capital and O&M costs, and overall yield (factoring in evapotranspiration and precipitation). Results from the BPI model runs were presented at the project team workshop on April 18, 2017.

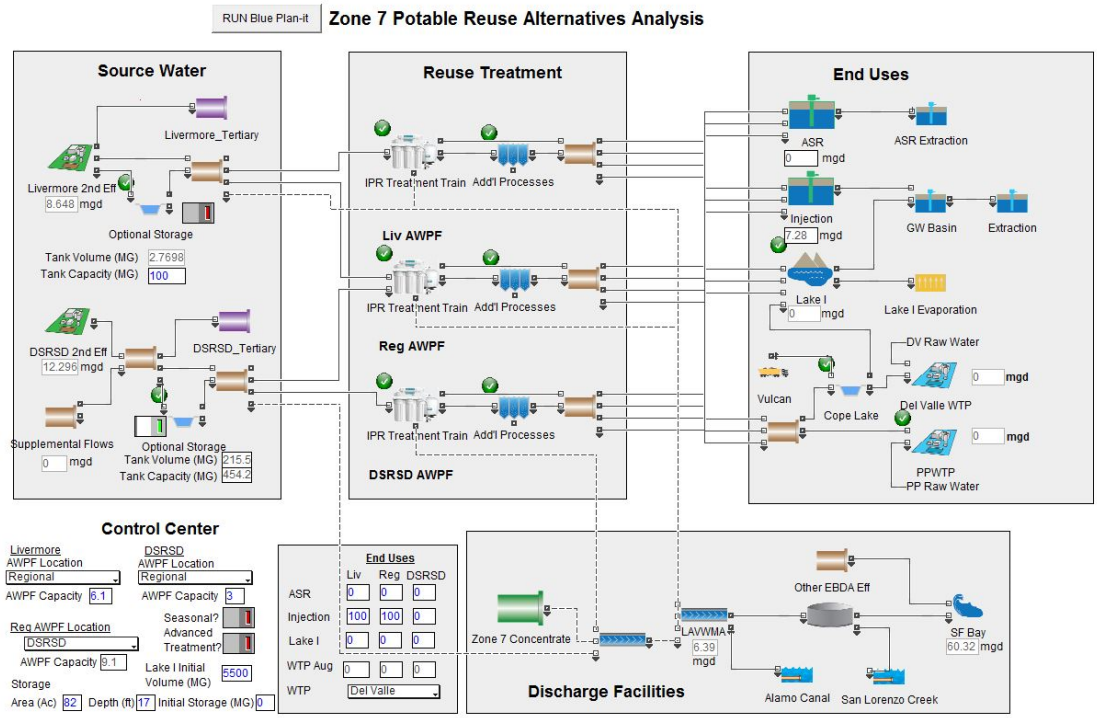


Figure 5.23 Blue Plan-it® Process Flow Diagram

5.10.2.1 Blue Plan-it® Modeling Assumptions

Many changing variables could influence the effectiveness of any future project. To aid in the decision making process, for the BPI model runs, a number of simplifying assumptions were made with regards to water availability, capacity limits, and project development. They are summarized below:

- The model was set up on a monthly time step using 2035/build out flow projections from DSRSD WWTP and Livermore WRP.
- Discharge to Lake I resulting from Vulcan mining processes was assumed to be the maximum historical annual discharge of 9,100 AFY. This flow was divided evenly throughout the year and is routed through Cope Lake before discharge to Lake I.
- Available storage near the DSRSD WWTP was assumed to be a maximum of 82 acres.
- Due to the sensitive nature of Lake I recharge, levels in the lake were iteratively increased until a steady state was reached. It is expected that, should a Lake I alternative be selected and pursued, Zone 7 would have to operate the lake accordingly to operate at a steady state. Lake levels can be increased or decreased through connections with Lake H and Cope Lake.
- For alternatives with direct injection, a single well site (with multiple wells based on the 2.2 mgd capacity per well assumption) was assumed to be sufficient for the entire flow. If groundwater modeling shows that too much mounding occurs within a specific location, it may be necessary to have multiple well sites.

5.11 Alternatives Evaluation

Table 5.10 shows the preliminary costs and yield for all alternatives evaluated in BPI. For the alternatives that were not run through the model, a comparable alternative is indicated.

5.11.1 Yield

As stated previously, the upper bookend for water supply reliability is 10,000 AFY based upon Zone 7's Water Supply Evaluation Update. While all alternatives add water to the basin, the seasonal options are the only options that provide 10,000 AFY. While achieving 10,000 AFY is not a specific objective of the project, yield is still a key evaluation criteria.

The modeling discussion reveals that not all injection or groundwater recharge alternatives benefit the basin in the same way, or in a way that is easily recoverable by Zone 7's current operations. Alternatives with Well F as the endpoint are less effective because the modeling shows that the groundwater may leave the basin or is harder to capture. Alternatives with lake discharge (Lake I or Cope Lake) are subject to minor evaporative losses. The most effective recharge options may be those with direct injection in other areas of the basin, like Wells E and B).

According to this analysis, the top yield alternatives are:

- Alternative 9: Seasonal Treatment at DSRSD, Direct Injection at Well B.
- Alternative 13: Seasonal Treatment at Mocho, Direct Injection at Well B.
- Alternative 14: Seasonal Treatment at Mocho, Direct Injection at Well A.
- Alternative 17: Seasonal Treatment at COL, Direct Injection at Well C.
- Alternative 18: Seasonal Treatment at COL, Direct Injection at Well H.
- Alternative 19: Seasonal Treatment at COL, Direct Injection at Well A.

5.11.2 Cost (Capital and O&M)

Capital, O&M, and unit costs ($/AF) are shown in Table 5.10. The highest unit costs occur with alternatives that have storage or large infrastructure requirements (Alternative 3). While seasonal treatment incurs a larger capital cost, the increased annual yield makes up for the difference. The best value alternatives (lowest unit cost) maximize the facility use, do not have storage, and have minimal infrastructure.

The lowest unit cost alternatives are:

- Alternative 1: Treatment at Livermore, Direct Injection at Well E ($1,900/AF).
- Alternative 2: Treatment at Livermore, Surface Spreading via Lake I ($1,900/AF).
- Alternative 4: Treatment at Livermore, Blend at Del Valle WTP via Cope Lake ($1,900/AF).
- Alternative 8: Seasonal Treatment at DSRSD, Direct Injection at Well F ($2,000/AF).
- Alternative 12: Seasonal Treatment at DSRSD, Blend at Del Valle WTP via Cope Lake ($2,100/AF).
- Alternative 13: Seasonal Treatment at Mocho, Direct Injection at Well B ($2,100/AF).

Table 5.10 Preliminary Alternatives Results

Alternative Number	Alternative Description	Treatment	Total Capital Cost	O&M Cost	Treatment Plant Sizing (mgd)	Yield (AF)	$/AF
1	Treatment at Livermore, Direct Injection at Well E	FAT	$93M	$4.3M	5	5,500	$1,900
2	Treatment at Livermore, Surface Spreading via Lake I	FAT	$95M	$4.3M	5	5,500	$1,900
3	Treatment at Livermore, Blend at PPWTP	FAT+	$138M	$4.8M	5	5,500	$2,500
4	Treatment at Livermore, Blend at DVWTP via Cope Lake	FAT+	$93M	$4.2M	5	5,500	$1,900
5	Year-Round Treatment at DSRSD, Direct Injection at Well F	FAT	$169M	$5.8M	7	7,700	$2,200
6	Year-Round Treatment at DSRSD, Direct Injection at Well B	FAT			Alternative 5		
7	Year-Round Treatment at DSRSD, Surface Spreading via Lake I	FAT+	$184M	$6.1M	7	7,700	$2,300
8	Seasonal Treatment at DSRSD, Direct Injection at Well F	FAT	$182M	$8.2M	12	10,000	$2,000
9	Seasonal Treatment at DSRSD, Direct Injection at Well B	FAT			Alternative 8		
10	Seasonal Treatment at DSRSD, Surface Spreading via Lake I	FAT+	$202M	$8.5M	12	10,000	$2,200
11	Year-Round Treatment at DSRSD, Blend at Del Valle WTP via Cope Lake	FAT+	$207M	$6.4M	7	7,700	$2,600
12	Seasonal Treatment at DSRSD, Blend at Del Valle WTP via Cope Lake	FAT+	$205M	$7.9M	12	10,000	$2,100
13	Seasonal Treatment at Mocho, Direct Injection at Well B	FAT	$199M	$8.4M	12	10,000	$2,100
14	Seasonal Treatment at Mocho, Direct Injection at Well A	FAT+			Alternative 15		
15	Seasonal Treatment at Mocho, Surface Spreading via Lake I	FAT+	$207 M	$8.6M	12	10,000	$2,200
16	Year-Round Treatment at Mocho, Blend at Del Valle WTP via Cope Lake	FAT+	$170M	$5.7M	6	6,900	$2,400
17	Seasonal Treatment at COL, Direct Injection at Well C	FAT			Alternative 18		
18	Seasonal Treatment at COL, Direct Injection at Well H	FAT	$227M	$8.5M	12	10,000	$2,300
19	Seasonal Treatment at COL, Direct Injection at Well A	FAT+			Alternative 20		
20	Seasonal Treatment at COL, Surface Spreading via Lake I	FAT+	$229M	$8.5M	12	10,000	$2,300
21	Year-Round Treatment at COL, Blend at Del Valle WTP via Cope Lake	FAT+	$182M	$5.6M	6	6,900	$2,500

5.11.3 Groundwater Basin Water Quality

Zone 7 distribution wells in the western edge of the basin (near the Hopyard wells) consistently have high TDS. The current mitigation measures include the demineralization facility and blending with surface water. Purified water, which is very low in TDS, would potentially improve the groundwater quality. Alternatives with direct injection can clearly provide a groundwater benefit versus raw water augmentation or surface spreading via Lake I. While surface spreading in Lake I does have an effect on groundwater quality, it is a much more subtle, diluted effect because the percolated water enters the upper aquifer and gradually migrates into the lower aquifer in contrast to injection of purified water directly into the lower aquifer.

The alternatives with the greatest potential for improving groundwater quality in the basin are:

- Alternative 1: Treatment at Livermore, Direct Injection at Well E.
- Alternative 6: Year-Round Treatment at DSRSD, Direct Injection at Well B.
- Alternative 9: Seasonal Treatment at DSRSD, Direct Injection at Well B.
- Alternative 13: Seasonal Treatment at Mocho, Direct Injection at Well B
- Alternative 14: Seasonal Treatment at Mocho, Direct Injection at Well A.
- Alternative 17: Seasonal Treatment at COL, Direct Injection at Well C.

5.11.4 Ease of Implementation

At the level of detail used in this analysis, only general implementation issues were identified, such as the small size of the site at Mocho, the saturated soils at COL, and the large infrastructure requirements to get to PPWTP. As the short-listed options are investigated in more detail, other, more critical implementation issues may arise.

Ease of implementation is also based upon the current regulations and the permitting required to execute a project plan. In that regard, alternatives with direct groundwater injection are easier to implement because the regulations are established and many similar projects across California exist or are currently underway.

The alternatives with the initial highest ease of implementation are those with established permitting procedures, minimal infrastructure requirements, and site locations without geotechnical or spatial restraints:

- Alternative 1: Treatment at Livermore, Direct Injection at Well E.
- Alternative 8: Seasonal Treatment at DSRSD, Direct Injection at Well F.
- Alternative 9: Seasonal Treatment at DSRSD, Direct Injection at Well B.

However, there is a narrow differentiation in ease of implementation between most of the alternatives at this level of analysis.

5.11.5 Alternatives Evaluation Workshop

The results of the preliminary evaluation were presented to the project team in a workshop on April 18, 2017. Representatives from Zone 7, DSRSD, Livermore, Pleasanton, and Carollo were present at the workshop. The team agreed that no additional alternatives needed to be analyzed to capture the full range of possibilities. There were several broad decisions made regarding short-listed options including: 1) do not evaluate further any storage options, 2) carry an option for each WWTP site as well as at least one regional non-WWTP site, and 3) carry a range of end-

use options. After a discussion period, the workshop participants narrowed down and combined some alternatives to develop short-listed options for more detailed analysis.

1. Do not evaluate further storage options: This option was no longer considered since the capital cost investment to include storage did not significantly increase the yield and came with significant institutional and operational challenges in constructing large storage basins on DSRSD's existing solids facilities.
2. AWPF sites: All the agencies agreed on maintaining the options of a both WWTP sites and regional AWPF as it is not yet clear who would own or operate the facility and participants felt more comfortable with a wide range of siting options still being available.
3. Range of end-use of options: All the agencies agreed on maintaining the options of a regional AWPF agreed to carry all the end-use of options since this is a book-end study.

5.11.6 Short-listed Options

The short-listed options identified in the April 2017 workshop were refined at a Steering Committee workshop held in July 2017. Final options were chosen to give a wide range of feasible projects, covering the spectrum of end uses and treatment locations.

5.11.6.1 Short-listed Option 1 - Year-Round Treatment at the Livermore WRP

This option was selected to provide a year round Livermore only option. This option was selected based on the relatively low unit cost, and the flexibility to go to different end uses. An important limitation of this option is the relatively low yield of 5,500 AFY of product water.

Option 1a) Groundwater Recharge via Lake I and Raw Water Augmentation for DVWTP via Cope Lake

This short-listed option is a combination of alternatives 2 and 4. This option involves FAT+ at the Livermore WRP and conveyance to Lake I for groundwater recharge (primary use). Because of the planned connection between the COLs and the DVWTP (via the future COLs pipeline), this alternative incorporates the flexibility to blend with water in the COLs and conveyance to the DVWTP. This option provides flexibility to incorporate both groundwater recharge and raw water augmentation.

Option 1b) Groundwater Recharge via Injection at Well E

This option is a variation of Option 1a with the end use changed for groundwater injection into Well E which is located near the Livermore WRP. This option would be relatively easy to implement based on existing regulations and precedent for permitted groundwater injection systems.

5.11.6.2 Short-listed Option 2 - Seasonal Treatment at DSRSD

This option was selected based on the high yield (10,000 AFY) and flows from both DSRSD and Livermore with the location at DSRSD. The yield is achieved through seasonal treatment. It is recognized that there is some additional operational complexity involved with seasonal treatment.

Option 2a) Groundwater Recharge via Lake I and Raw Water Augmentation for DVWTP via Cope Lake

This short-listed option is a combination of alternatives 10 and 12. This option involves FAT+ at DSRSD and conveyance to DVWTP via Cope Lake. Given the planned connectivity of the COLs, this alternative incorporates the flexibility to convey water to Lake I for groundwater recharge; this will be useful especially when DVWTP is down for maintenance or other purposes. This

option provides flexibility to incorporate both raw water augmentation and groundwater augmentation.

Option 2b) Groundwater Recharge via Injection at Well B

This option is a variation of Option 2a with the end use changed for groundwater injection into Well B. This option would be relatively easy to implement based on existing regulations and precedent for permitted groundwater injection systems.

5.11.6.3 Short-listed Option 3 - Seasonal Treatment at Mocho, Groundwater Recharge via Injection at Well B

This short-listed option involves seasonal treatment at the Mocho site and groundwater injection. This option was selected based on the high yield, relative ease of implementation (regulatory), and potential benefits of a purification treatment plant located offsite from a WWTP. While proximity to a WWTP can be convenient for staff, operations, and supplies, a satellite facility can be beneficial terms of public perception by providing distance between the wastewater plants and the purification plant at the Mocho site.

5.11.6.4 Short-listed Option 4 - Seasonal Treatment at Pleasanton, Groundwater Recharge via Lake I and Raw Water Augmentation for DVWTP via Cope Lake

This option was added after the July 2017 workshop with the intent to add an additional regional site. The Pleasanton Corp yard potentially has involves room to accommodate an AWPF. The end use for this site is conveyance to DVWTP via Cope Lake. Given the planned connectivity of the COLs, this alternative incorporates the flexibility to convey water to Lake I for groundwater recharge; this will be useful especially when DVWTP is down for maintenance or other purposes.

5.12 Next Steps for Analysis of the Short-listed Options

The short-listed options are further analyzed in more detail for hydrogeologic considerations in Chapter 6 and for general engineering and implementation considerations in Chapter 7. The additional analysis needed for these options generally includes:

- Development of site layouts.
- Revisiting the preliminary pipeline alignments.
- Detailed cost estimates.
- Groundwater modeling for travel time and injection capacity.

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Chapter 6

HYDROGEOLOGIC FEASIBILITY

This chapter details the groundwater modeling and other evaluations performed to assess the hydrogeologic feasibility of groundwater augmentation to recharge the aquifer for the purpose of subsequent extraction and use. The types of groundwater augmentation evaluated through modeling include: 1) injection by wells into the lower aquifer and 2) surface water recharge or percolation through Lake I. Groundwater augmentation end uses were previously discussed in Chapter 5.

Several aspects of the feasibility of groundwater augmentation were assessed through groundwater modeling. The model was used to quantify relative impacts to the hydraulics of groundwater flow in the basin, estimate the potential travel time to existing potable production wells, quantify relative impacts to the salt concentrations at potable productions wells, and investigate impacts on the overall basin salt balance. Modeling was conducted in phases with a preliminary phase looking at high-level feasibility of a number of scenarios, and then using a more detailed model to evaluate the impacts of groundwater augmentation once the short-listed options had been identified.

6.1 Preliminary Groundwater Modeling

For the first phase of modeling, the Zone 7 groundwater basin model was used to evaluate high-level feasibility of several injection and/or percolation scenarios. To simplify the evaluation, the impacts of injecting purified recycled water at each of the potential injection sites were simulated assuming operation as recharge wells (i.e., not in ASR configuration).

As described in Chapter 5, a total of 21 preliminary alternatives were developed by the project management team; however, only those alternatives with a recharge component were considered for the modeling analysis. In addition, some project alternatives having similar recharge components, e.g., alternatives having the same end uses but different purification plant locations could be evaluated with a single groundwater model scenario. From these 21 alternatives, a subset of five scenarios was identified for preliminary evaluation using the model, including a baseline/no recharge scenario, as shown in Table 6.1 and Figure 6.1.

Table 6.1 Preliminary Groundwater Modeling Scenarios

Scenario	Recharge Location	Recharge Volume (AFY)
0-Baseline	None	0
1	Well E	5,500
8	Well F	10,000
10	Lake I	10,000
13	Well B	10,000

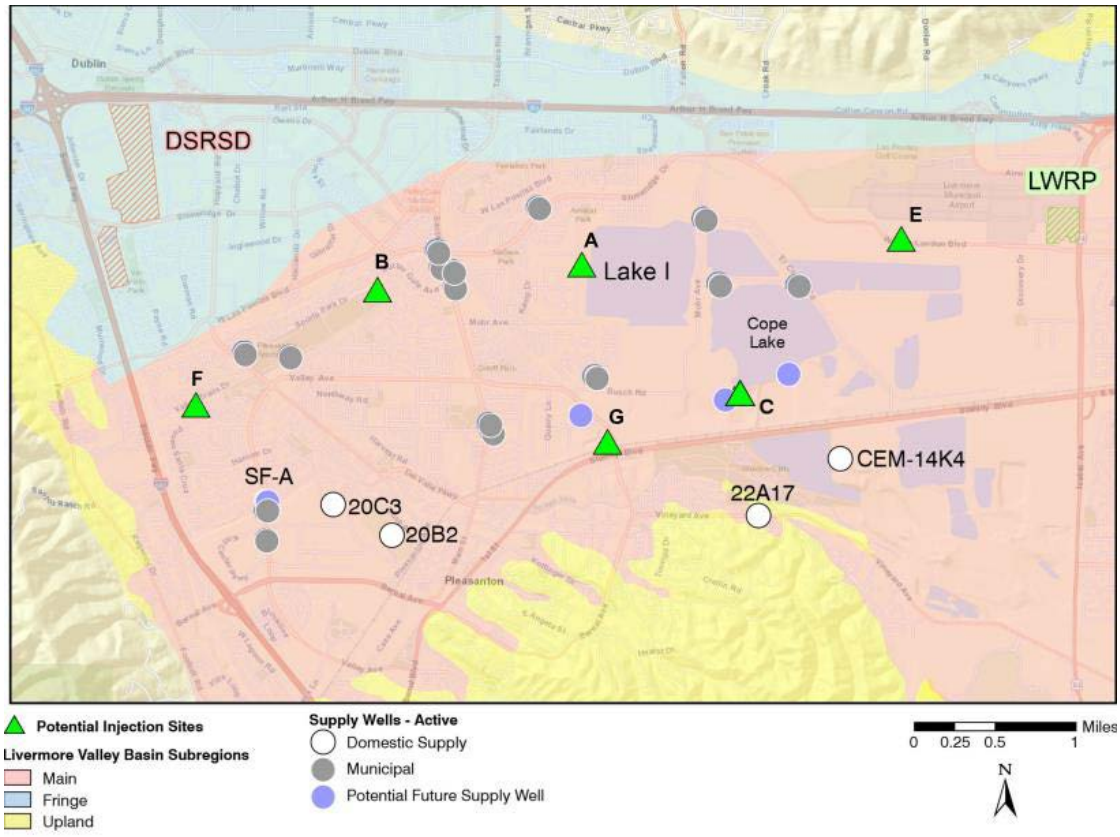


Figure 6.1 Potential Injection Locations

6.1.1 Model Description

As part of its Groundwater Basin Management Program, Zone 7 Water Agency maintains a numerical groundwater model of the basin for predicting the consequences of potential groundwater basin management actions on groundwater levels and salt concentrations in the basin. This model was recently upgraded to better meet the needs of Zone 7 for planning for conjunctive use of surface water and groundwater and for evaluating the salt balance of the basin (HydroMetrics 2016). However, this upgraded version of the model was not available at the time of the preliminary analysis (described in Chapter 5), so the previous version of the Zone 7 model was used.

In this report, the previous version of the model is referred to as the Zone 7 3-Layer Model because the model contained three active layers representing two aquifers, an upper unconfined aquifer and a lower confined aquifer that includes the many productive intervals used by local municipal wells, and an intervening aquitard. Layer thicknesses were based on mapped thicknesses of the aquifers and aquitard.

The Zone 7 3-Layer Model used MODFLOW, the U.S. Geological Survey modular finite-difference flow model, to solve the groundwater flow equation. Specifically, MODFLOW-NWT, a Newton-Raphson formulation for MODFLOW-2005 to improve solution of unconfined groundwater-flow problems, was used to simulate groundwater flow. MT3DMS, a modular three-dimensional transport model for the simulation of advection, dispersion, and chemical

reactions of dissolved constituents in groundwater systems, was used to simulate the movement of injected solute.

6.1.2 Travel Time Analysis

Under the Title 22 rules for groundwater replenishment, the Division of Drinking Water (DDW) requires a 2-month minimum retention time in the aquifer for recycled water; this retention time is equivalent to a travel time of 2 months to the nearest production well. The required retention time may increase depending on the type of verification used. For instance, if the travel time is calculated with a groundwater model, each month of travel time receives one-half credit, so a total of four months travel time is needed. A tracer study using an added tracer (not intrinsic) would receive full credit. For this analysis, a 4 month travel time requirement is assumed (based on a 2-month minimum and half credit for modeling verification) and is used for comparison with the modeled travel times for various scenarios.

The time of travel from an injection site to potable production wells can be evaluated by injecting a unit concentration in the recharge wells and determining the time for breakthrough to occur at the nearest affected production well. In accordance with potable reuse regulations, breakthrough is defined at a level of two percent of the injected concentration.

Travel time of purified recycled water from the point of injection to a production well was evaluated through the use of a solute transport simulation using MT3D. For this evaluation, the initial concentration was set to zero throughout the model domain, and a unit concentration of 100 was assigned to the injection well. Observed concentrations at the production wells were used to determine the time at which two percent of the injected concentration appears at each well.

6.1.3 Preliminary Modeling Results

As discussed in Chapter 5, the preliminary modeling results were used for comparative purposes only to narrow down the range of alternatives to "bookends" that represent feasible options for implementation. Since pumping was not increased in the preliminary model runs, all of the injection scenarios demonstrated a significant increase in water levels throughout the basin in both upper and lower aquifers. This finding was used to modify the alternatives for more detailed evaluation by adding additional pumping to keep the basin in balance.

The preliminary travel time analysis results are presented in Table 6.2. As discussed in Chapter 5, the travel time requirement of 120 days was met for the all the injection scenarios that were examined through the preliminary modeling effort with the exception of Well B. For the detailed alternatives analysis, the Well B location was moved by one model grid cell to the south and west (about 700 ft) to increase the travel time to the MOCHO 2 production well to more than 120 days.

Table 6.2 Travel Time Summary

Scenario	Injection Site	Breakthrough Location	2% Breakthrough Time (days)
1	Well E	COL 2	473
8	Well F	HOP 7	170
13	Well B	MOCHO 2	114

6.2 Detailed Modeling of Short-listed Options

The preliminary modeling results on impacts to groundwater levels and travel time were used to help refine the list of alternatives. The results of the preliminary modeling evaluation were presented to the Steering Committee in a workshop in April 2017. The field of alternatives was narrowed down to three options selected to give a wide range of feasible projects covering the spectrum of end uses and treatment locations. These three options were presented to the Steering Committee in a workshop in July 2017. Based on feedback from the workshop, the three selected options were expanded to six options with different siting locations for each.

Four of the short-listed options (1a, 1b, 2b, and 3) include an end use of groundwater recharge as shown in Table 6.3. The other two short-listed options (2a and 4) include conveyance to DVWTP via the Chain of Lakes as the end use, but incorporate flexibility for groundwater recharge via Lake I. Therefore, all six of the short-listed options were evaluated using the groundwater model. Because the recharge location (end use) and recharge volume is the same for some of the short-listed options, only four modeling scenarios were required. A baseline model scenario was also included.

Table 6.3 Project Options Selected for Detailed Modeling Evaluation

Option	Recharge Location	Recharge Volume (AFY)	Seasonal/Year Round
1a	Lake I	5,500	Year Round
1b	Well E	5,500	Year Round
2a/4	Lake I(1)	10,000	Seasonal
2b/3	Well B	10,000	Seasonal

Note:
(1) The end use for these options is conveyance to DVWTP via Cope Lake, but incorporates flexibility to convey water to Lake I for groundwater recharge.

The model was used to evaluate the travel time from the injection locations to existing production wells. Potential future production well locations identified in the Zone 7 Well Master Plan (CH2M Hill 2003) were not included; however, based on the identified future well locations the existing wells are likely to see breakthrough first from the recharge sites considered through this analysis. In addition to evaluation of travel time, the model was used to assess the overall water and salt balance within the basin and how injection of recycled water affects groundwater flow and salt concentrations. For this analysis, simulation results of the model with injection and increased groundwater production were compared to results of a baseline model without injection or increased production. The comparison included quantification and analysis of groundwater levels, flow conditions in the upper and lower aquifers, and impacts on production wells.

6.2.1 10-Layer Model Description

Another outcome of the April 2017 workshop was the decision to employ the upgraded Zone 7 groundwater model for this analysis. Revisions to the model included addition of the ability to simulate flow and transport in streams and lakes to allow for direct simulation of flow interactions between surface and ground water features and increase of the number of model layers from three to ten to improve the model's capability for simulating salt transport. Use of the upgraded model for this analysis was preferable because the additional layers in the model provided a better representation of flow in the lower aquifer and therefore provided more

accurate and reliable results, particularly with respect to assessment of travel time. The model was not used for this study to simulate surface water, only groundwater. In this report, the upgraded version of the model is referred to as the Zone 7 10-Layer Model.

Increasing the number of layers in the model improved the model's capability for simulating salt transport because layers that represent the basin's gross hydrostratigraphy were too thick to accurately represent the depth variation of salt concentrations. The refined model layers better represented clay overburden in the southwestern portion of the basin and the variability of well screen placements and TDS concentrations with respect to depth in the lower aquifer. By simulating the low conductivity overburden and aquitard layers within the upper and lower aquifer units, the model was better able to simulate delays in downward salt migration. An example cross-section and schematic of model layers are shown in Figure 6.2.

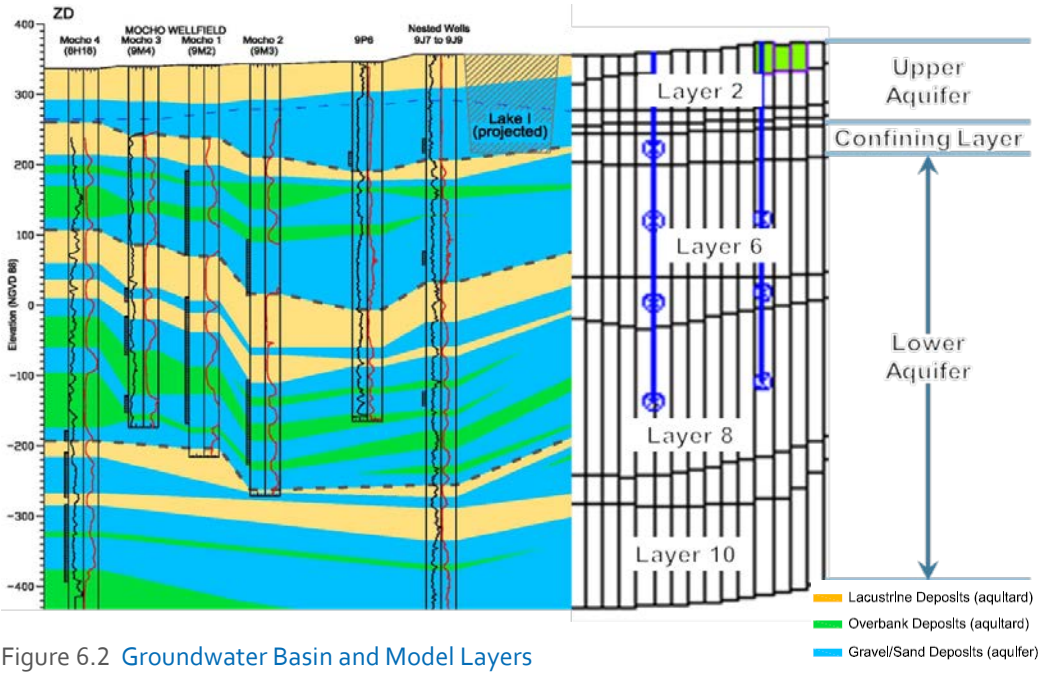


Figure 6.2 Groundwater Basin and Model Layers

Groundwater flow was modeled by the Zone 7 10-Layer Model using MODFLOW-NWT. Surface water and groundwater interactions were modeled using the SFR and LAK MODFLOW packages. Salt transport as represented by total dissolved solids (TDS) was modeled using MT3D-USGS with the LKT and SFT packages to simulate groundwater and surface water (lakes and streams) interactions. Zone 7 funded development of these recently developed packages that were included in the public release of MT3D-USGS, a USGS-updated release of MT3DMS that includes new transport modeling capabilities to accommodate flow terms calculated by MODFLOW packages that were previously unsupported by MT3DMS and to provide greater flexibility in the simulation of solute transport and reactive solute transport (Bedekar, 2016).

Limitations of the model included a recommendation to not use the transport model to predict groundwater TDS concentrations at specific wells because localized sources of salt were not included in the model (HydroMetrics, 2016). Use of surface water results from the model should also be limited because the inclusion of surface water flow and transport packages was meant only to simulate surface water effects on groundwater conditions. Furthermore, using the model to plan operation of future recharge lakes will likely require additional calibration.

Based on these stated limitations, the 10-Layer Model was used to assess general trends in TDS concentrations at locations across the basin and predicted relative differences in salt concentrations at production well locations between the baseline and purified recycled water recharge scenarios. The 10-Layer Model was also used to assess travel time from injection locations to production wells.

6.2.2 Model Revisions

The upgraded model was received from HydroMetrics on June 1, 2017, and Carollo and Zone 7 staff began working to set up the model for simulation of the short-listed options. Initial and boundary conditions and setup of stress periods from the previous simulations based on the Zone 7 3-Layer Model were used in the 10-Layer Model. For salt balance simulations, the simulation period was extended to 25 years using a total of 54 semi-annual stress periods (four initialization stress periods followed by 50 semi-annual stress periods) to better assess long-term trends.

6.2.2.1 Conjunctive Use of Surface Water and Groundwater

Zone 7 currently uses surface water, including imported water from the State Water Project, to recharge the groundwater basin via a network of streams or arroyos, and, in the future, the Chain of Lakes. The surface water supply is a critical component of Zone 7's Groundwater Management Plan for maintaining balance of the groundwater basin. When less surface water supply is available during droughts, groundwater storage is used to meet demand in the basin. Groundwater is also regularly used to meet diurnal and seasonal peak demands. Conversely, when excess surface water is available, groundwater storage is replenished through recharge. Zone 7 has well capacity to meet normal peak demands of 32 mgd, plus additional capacity of 11 mgd for use during emergency or drought conditions. These wells can provide up to 28,000 AFY. Zone 7 plans to install additional wells in the future.

For the purposes of groundwater modeling, the model input was revised to incorporate increased groundwater production to offset quantities of purified recycled water recharge directly (i.e., 10,000 AFY of recharge would be offset by 10,000 AFY of additional pumping). The increase in pumping for each recharge scenario was introduced in the model by increased pumping from existing Zone 7 production wells. Individual well production was generally increased proportionately based on the fraction of total Zone 7 pumpage (5,940 AFY) assigned to each well in the baseline scenario. The maximum amount of pumping assigned to each well was limited to 50 percent of the estimated well capacity as reported in the Zone 7 2011 Water Supply Evaluation; therefore, the production assigned to some wells was proportionally higher than for others. The annual pumping assigned to each of the Zone 7 production wells is shown in Table 6.4 for the baseline model with 5,940 AFY of total pumping and for the recharge scenario models with additional pumping to offset recycled water recharge. These assumptions were made for modeling purposes only and while are physically possible based on well capacity, operational considerations of the water supply system were not evaluated. Actual pumping operations would be modified to meet multiple objectives including maintaining groundwater elevations, maintaining system water quality and maintaining system pressure. In addition, new wells have been identified in a Well Master Plan. These new wells could be used in place of the modeled use of existing wells.

Table 6.4 Annual Pumping Assigned to Zone 7 Production Wells

Well	Estimated Capacity(1) (AFY)	Annual Withdrawal (AFY)		
		Baseline Scenario	5,500 AFY Recharge	10,000 AFY Recharge
Chain of Lakes 1	3600	40	1144	1594
Chain of Lakes 2	5100	340	1144	1594
Hopyard 6	5500	1500	1903	2651
Hopyard 9	--	200	385	537
Stoneridge	6600	400	1716	2391
Mocho 1	3300	1000	1144	1594
Mocho 2	3200	1000	1144	1594
Mocho 3	6100	1000	1716	2391
Mocho 4	5300	460	1144	1594
Total		**5,940**	**11,440**	**15,940**

Notes:
(1) From Table 4-1, Zone 7 2011 Water Supply Evaluation.

The seasonal variations in pumping and recharge showed a strong influence on model results. The model is based on six-month stress periods roughly corresponding to Winter and Summer or a wet and dry season. Groundwater pumping is greater in the dry period (April through September) to meet peak demands, while recycled water recharge is greater during the wet period for the options involving a seasonal component to recharge (i.e., 10,000 AFY options). Note that existing recharge activities were assumed to continue (assumed conservatively at about 6,000 AFY for the model); the recharge amounts shown on Figure 6.2 only reflect the additional amounts from potable reuse. Thus, the variations in pumping and recharge are seasonally opposed as illustrated in Figure 6.3. These seasonal fluctuations are exaggerated somewhat by the use of semi-annual stress periods in the model and it is expected that monthly variations would exhibit less drastic variations.

For the water quality modeling scenarios, the recycled water was assumed to have a TDS concentration of 100 mg/L. This concentration was based on recent operational data obtained from the Ventura demonstration pilot recycled water facility that showed an average TDS of 56 mg/L in the RO effluent and a maximum of 120 mg/L. The selected value of 100 mg/L is within this range but higher than the average and is conservative in the sense that simulated water quality improvements based on this value should be biased high. In addition, the 100 mg/L assumption accounts for the potential increase in TDS due to stabilization of RO permeate prior conveyance/injection into the water supply system. The OCWD Groundwater Replenishment System includes decarbonation and lime stabilization of RO permeate prior to groundwater injection. The combination of decarbonation and lime stabilization raises the pH and adds hardness and alkalinity to make the purified recycled water less corrosive and more stable (OCWD, 2017). This process adds approximately 25 mg/L of TDS to the RO permeate. Assuming an average RO TDS concentration of 56 mg/L, the addition of 25 mg/L due to stabilization results in a TDS concentration of approximately 75 mg/L, which is below the assumption of 100 mg/L.

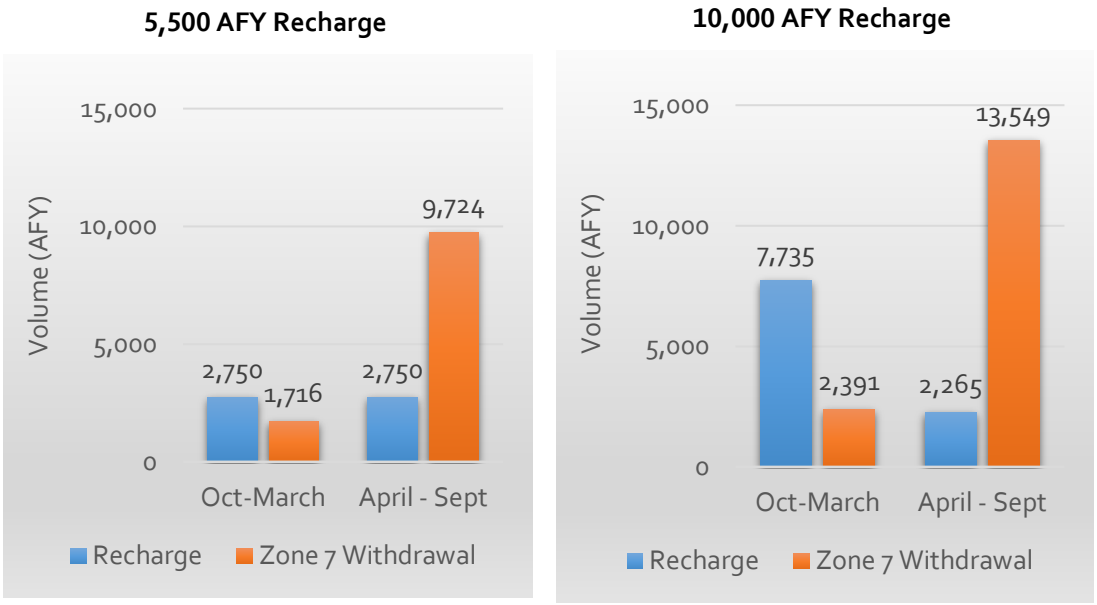


Figure 6.3 Seasonal Pumping and Recharge Volumes for Recharge Scenarios

6.2.3 Modeling Results

6.2.3.1 Baseline Simulation of Groundwater Flow

Simulated water levels for the baseline scenario from the 10-Layer model are shown in Figure 6.4. For this figure, simulated heads for the final two stress periods of the simulation, representing the Winter and Summer seasons, were extracted from model layers four and six representing the upper and lower aquifer, respectively. The simulated head values for the two stress periods were averaged for each layer and contours were generated to produce a representation of the annual average flow. The upper map shows that groundwater in the Upper Aquifer entered from the north, east, and southeast and generally flowed inward toward the Chain of Lakes in the eastern part of the basin and to the southwest in the western part of the basin. In the middle of the basin, groundwater flowed inward under the influence of a very low hydraulic gradient. This inward flow may reflect the downward movement of water into the Lower Aquifer to replenish groundwater extracted by production wells.

Flow in the Lower Aquifer was generally from east to west with a steeper hydraulic gradient east of the Chain of Lakes. Localized cones of depression were evident around some of the production wells.

6.2.3.2 Injection at Well B

Short-listed options 2b and 3 include injection of 10,000 AFY of recycled water at Well B on a seasonal basis. Well B would be screened through one or more intervals within the Lower Aquifer.

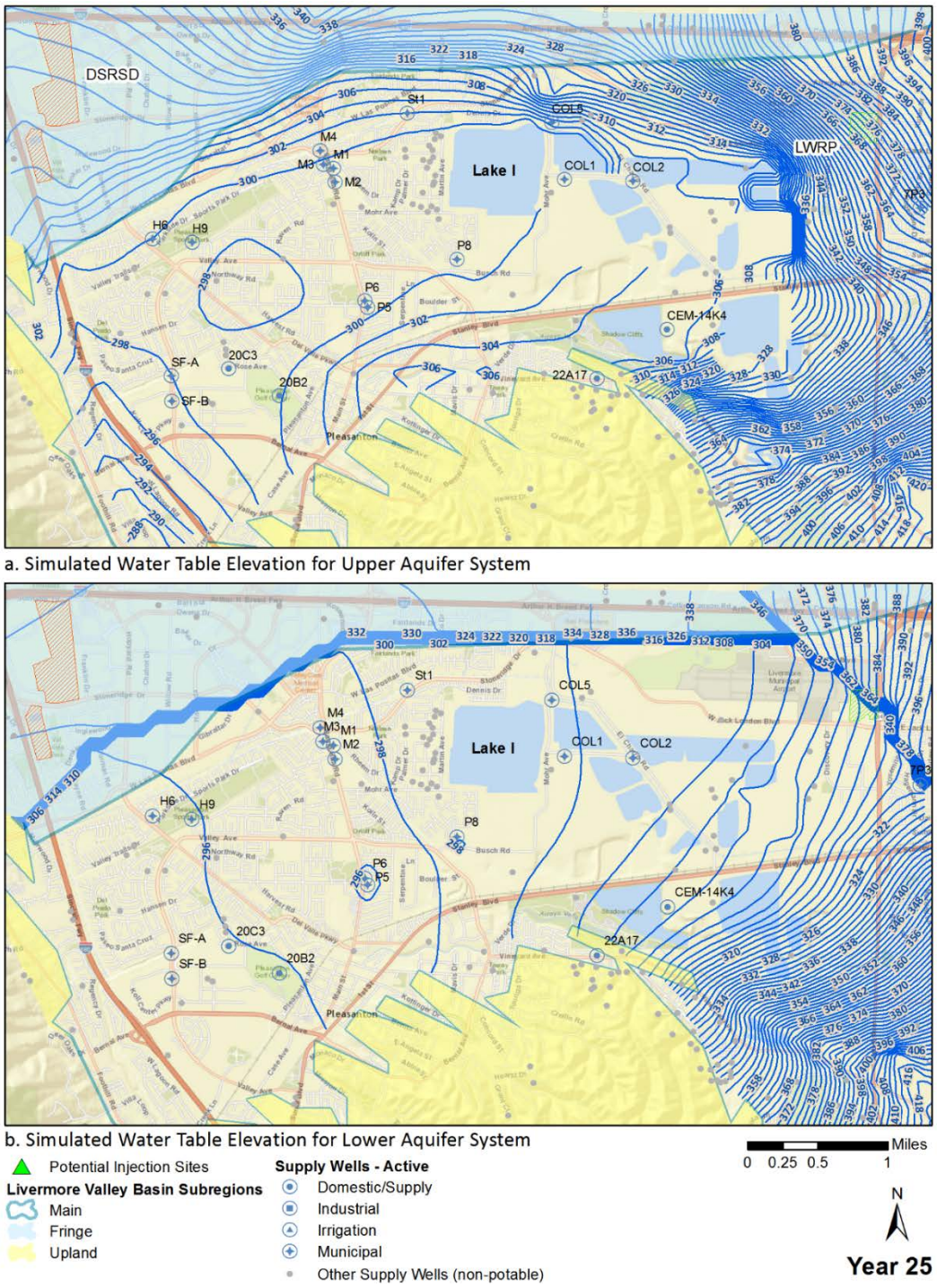


Figure 6.4 Simulated Water Levels for the Baseline Scenario, 10-Layer Model

Groundwater Flow

Simulated average water levels in the Lower Aquifer for the Well B injection scenario are shown in Figure 6.5. Compared to the baseline simulation, flows east of the Chain of Lakes were generally the same. A mound was evident near the injection site with flow away from the injection well to the east, west, and south. Localized cones of depression were evident around

the Hopyard and Pleasanton production wells. The hydraulic gradient was nearly flat between the injection site and the Chain of Lakes.

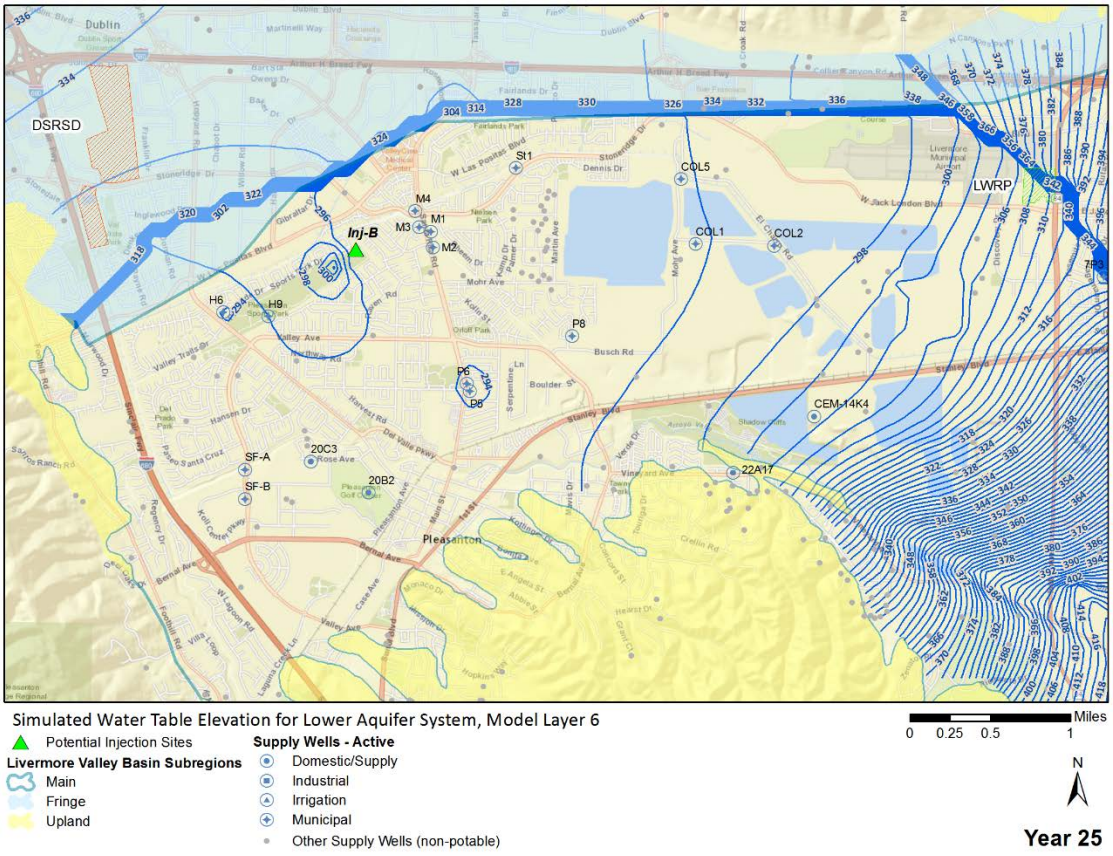


Figure 6.5 Simulated Water Levels in the Lower Aquifer, 25 Years, 10,000 AFY in Well B

Travel Time Analysis

The model was used to evaluate injection at Well B into various layers of the lower aquifer. Based on results of the preliminary travel time modeling, the location of Well B was adjusted slightly by moving the well one model cells to the south and west (about 700 feet) to increase the distance from the injection site to the Mocho well field. For the travel time analysis, a unit concentration was assigned to the injected water at Well B, and breakthrough of the concentration was observed at the production wells. Breakthrough was observed at the Mocho wells, as shown in Figure 6.6. Breakthrough of two percent of the injected concentration occurred at well Mocho 3 after 370 days of injection, exceeding the required four month travel time by more than three times. The travel time predicted by the 10-Layer Model was significantly longer than predicted by the 3-Layer Model, but the travel times simulated by both models were longer than required under Title 22.

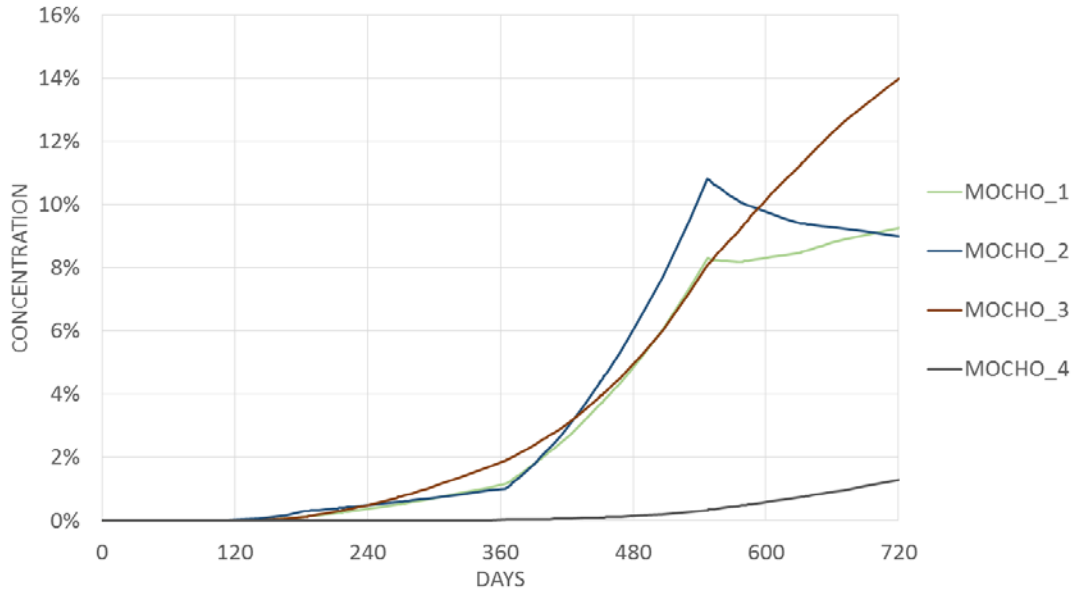


Figure 6.6 Simulated Breakthrough at Mocho Wells, 10,000 AFY Injection at Well E

The breakthrough shown in Figure 6.6 is based on the average concentration at the production wells extracted water from multiple model layers. The output from the 10-Layer Model was also checked to ensure that simulated breakthrough in a single layer was not significantly less; the simulated travel times for individual layers were similar to the average. Simulating injection into only one or two of the Lower Aquifer layers also did not significantly affect the travel time.

Impacts on Salt Balance

The effects of recycled water injection on the salt balance within the groundwater basin as assessed by looking at the predicted changes in TDS concentrations at the production wells over time and the change in TDS concentration in the lower aquifer after 25 years of injection. Trend charts showing the simulated change in TDS over time at selected production wells are shown in Figure 6.7 and Figure 6.8. Note that these figures should only be interpreted to show the relative change in concentration over time between the scenarios with and without recharge and do not indicate predictions of actual concentrations at these wells. A summary table of the net change in TDS concentrations at the end of the 25-year simulation period for all recharge scenarios is provided in Table 6.5. Charts of TDS trends for additional wells are provided in Appendix C.

Figure 6.6 shows the simulated trends in TDS concentration for the baseline and injection scenario at well Hopyard 6 west of the injection site at Well B. In the baseline model, TDS concentrations were expected to gradually increase over time by almost 300 mg/L over the 25-year simulation period. In the injection scenario, TDS at Hopyard 6 was expected to remain relatively stable over time resulting in a net reduction in TDS at this location of about 290 mg/L.

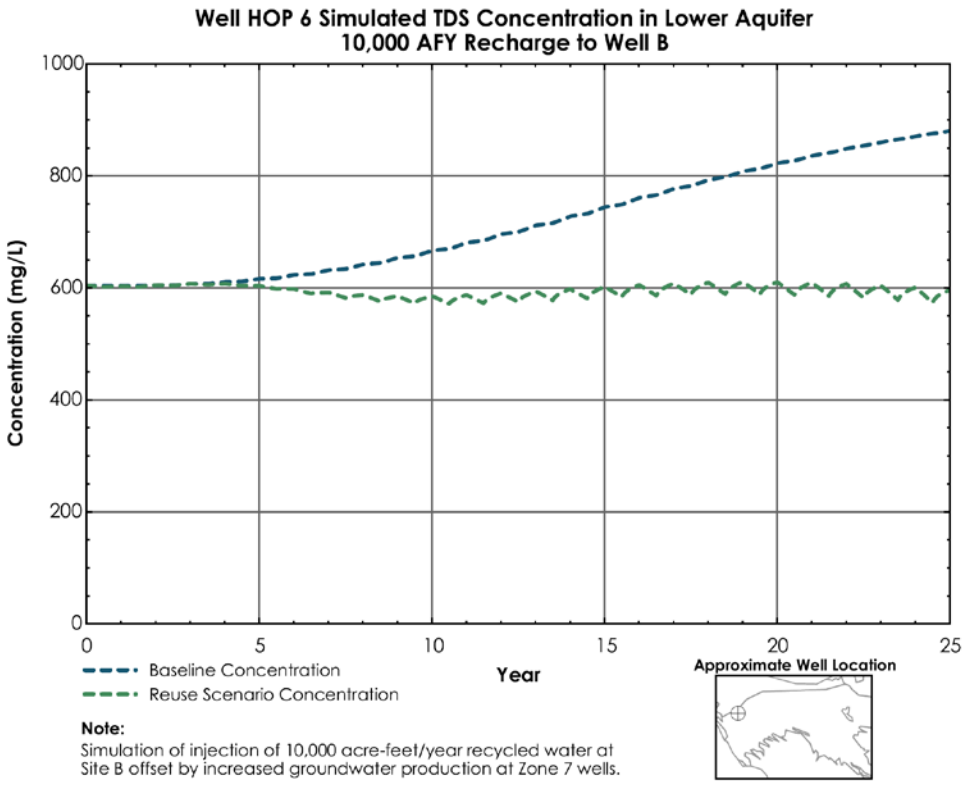


Figure 6.7 Comparison of Simulated TDS Concentrations at Well Hopyard 6, 10,000 AFY at Well B

Figure 6.8 shows the simulated trends in TDS concentration for the baseline and injection scenario at well Mocho 2 east of the injection site at Well B. In the baseline model, TDS concentrations remained relatively stable over time. In the injection scenario, TDS at Mocho 2 exhibited a strong seasonal fluctuation of about 100 mg/L because of the large seasonal difference in the volume of injection and extraction. As noted previously, this fluctuation is an artifact of the use of semi-annual stress periods in the model; although concentrations would likely vary seasonally, such drastic fluctuations would not be expected to occur if a shorter time period was used. TDS at this well was expected to decline over time for roughly the first 15 years of injection, then stabilized resulting in a net reduction in TDS at this location of about 270 mg/L.

Figure 6.9 shows the simulated change in TDS concentrations in the lower aquifer between this scenario and the baseline after 25 years of injection. On this figure, areas of net decrease in TDS are shaded green while areas of net increase in TDS are shaded orange. The shaded colors have contour intervals of approximately 25 mg/L TDS representing the general changes in water quality that are expected. The darkest green and innermost contour represents more than 500 mg/L decrease in TDS, whereas the darkest orange and innermost contour over the COLs represents a 125 mg/L increase in TDS. This figure shows that after 25 years of injection, water quality improvements occurred over an area extending from Hopyard 6 west of the injection site to the Mocho wells east of the injection site. The influence of injection on TDS was likely limited beyond these wells by the extraction of groundwater at these wells. This figure also shows that a net increase in TDS occurred in some areas of the basin beyond this extent, likely due to the displacement of higher-TDS water with lower-TDS water near the injection site. The largest net increase was observed at wells Pleasanton 5 and 6 with a net increase of 50 mg/L. Although the

difference in concentration between the baseline and injection scenarios showed a net increase, simulated TDS concentrations in the injection scenario at Pleasanton 6 are expected to decline over time relative to the baseline, as shown in Figure 6.10.

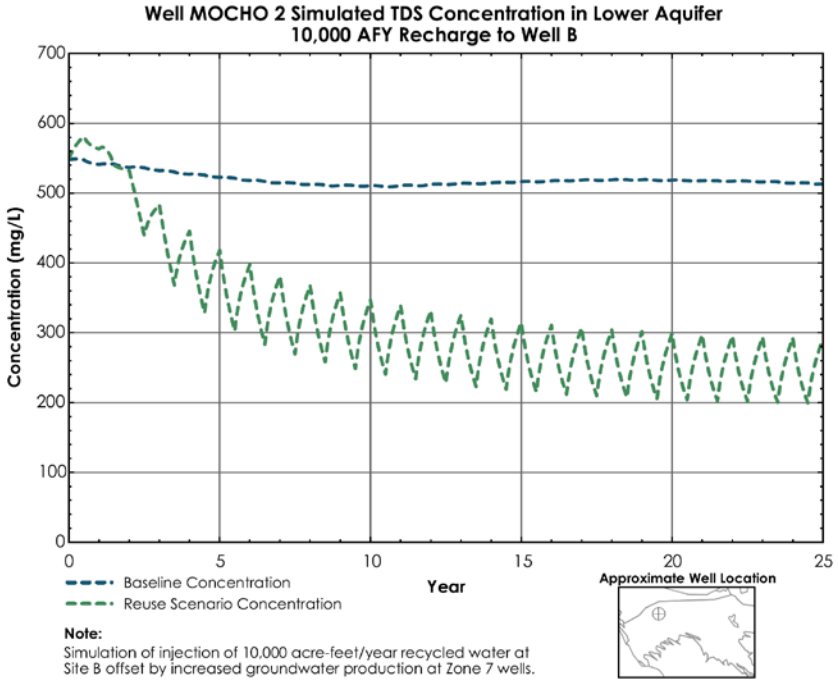


Figure 6.8 Comparison of Simulated TDS Concentrations at Well Mocho 2, 10,000 AFY at Well B

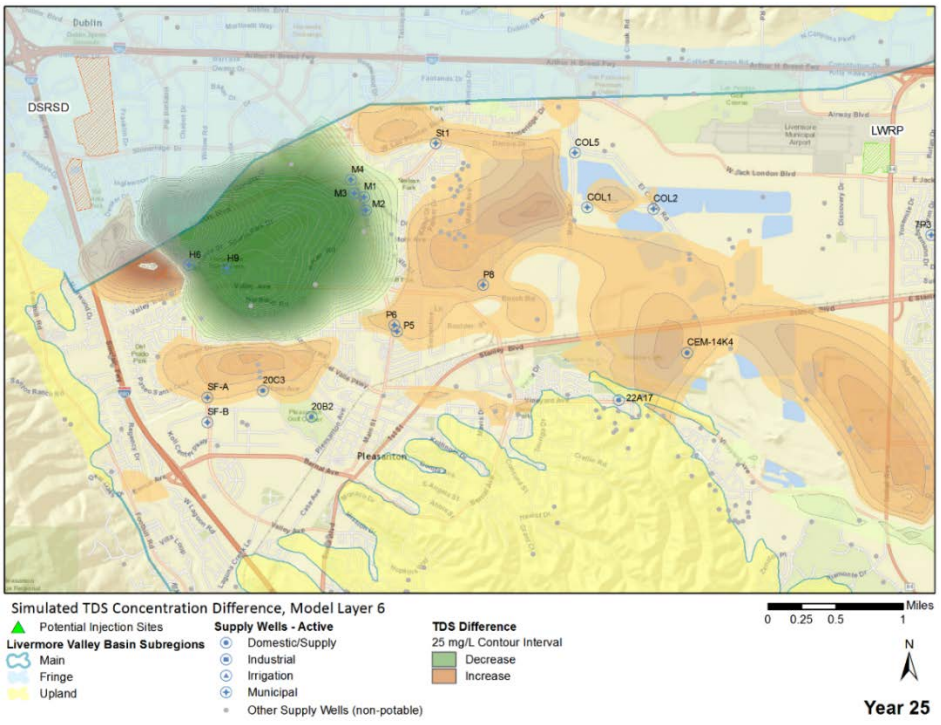


Figure 6.9 Simulated Change from Baseline TDS Concentrations in Lower Aquifer After 25 Years, 10,000 AFY in Well B Scenario

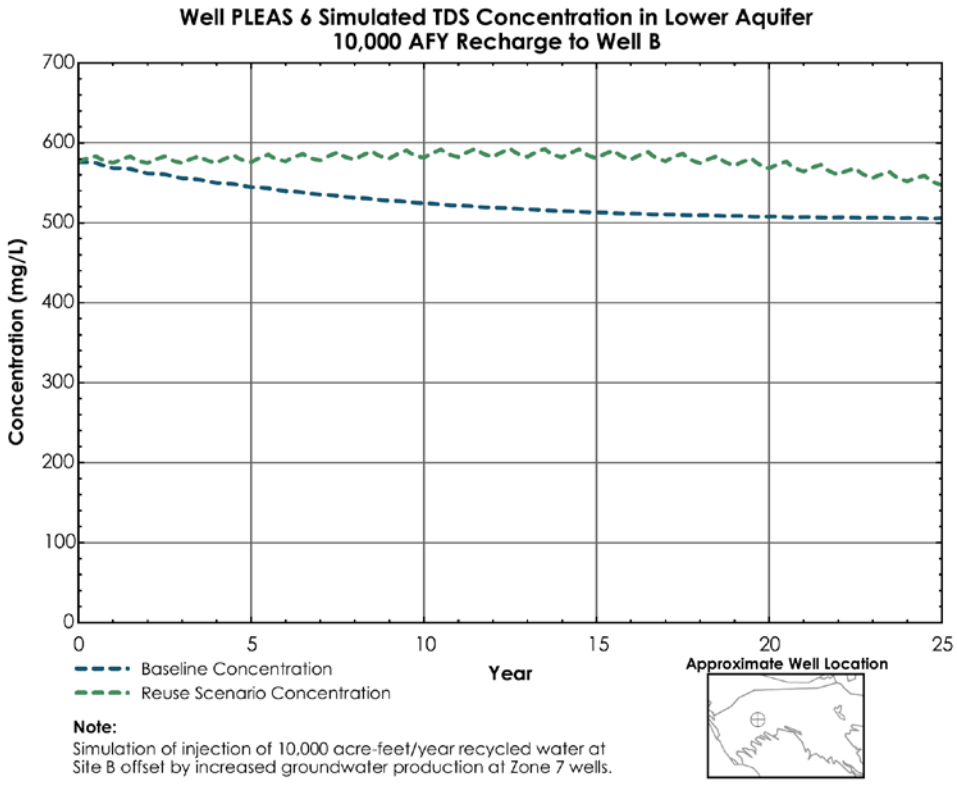


Figure 6.10 Comparison of Simulated TDS Concentrations at Well Pleasanton 6, 10,000 AFY at Well B

6.2.3.3 Injection at Well E

Short-listed option 1b includes injection of 5,500 AFY of recycled water at Well E on a year round basis. Well E would be screened through one or more intervals within the Lower Aquifer.

Groundwater Flow

Simulated average water levels between scenario and the baseline in the Lower Aquifer for the Well E injection scenario are shown in Figure 6.11. Compared to the baseline simulation, flows east of the Chain of Lakes were generally the same except for the mound evident near the injection site with flow away from the injection well primarily to the west. The hydraulic gradient from the Chain of Lakes area to west of the Mocho well field was steeper than the baseline. Localized cones of depression were evident around the Hopyard and Pleasanton production wells.

Travel Time Analysis

The model was used to evaluate injection at Well E into the lower aquifer. For the travel time analysis, a unit concentration was assigned to the injected water at Well E, and breakthrough of the concentration was observed at the production wells. Breakthrough was observed at the Chain of Lakes wells, as shown in Figure 6.11. Breakthrough of two percent of the injected concentration occurred at well COL 2 after 665 days of injection, exceeding the required four month travel time by more than five times.

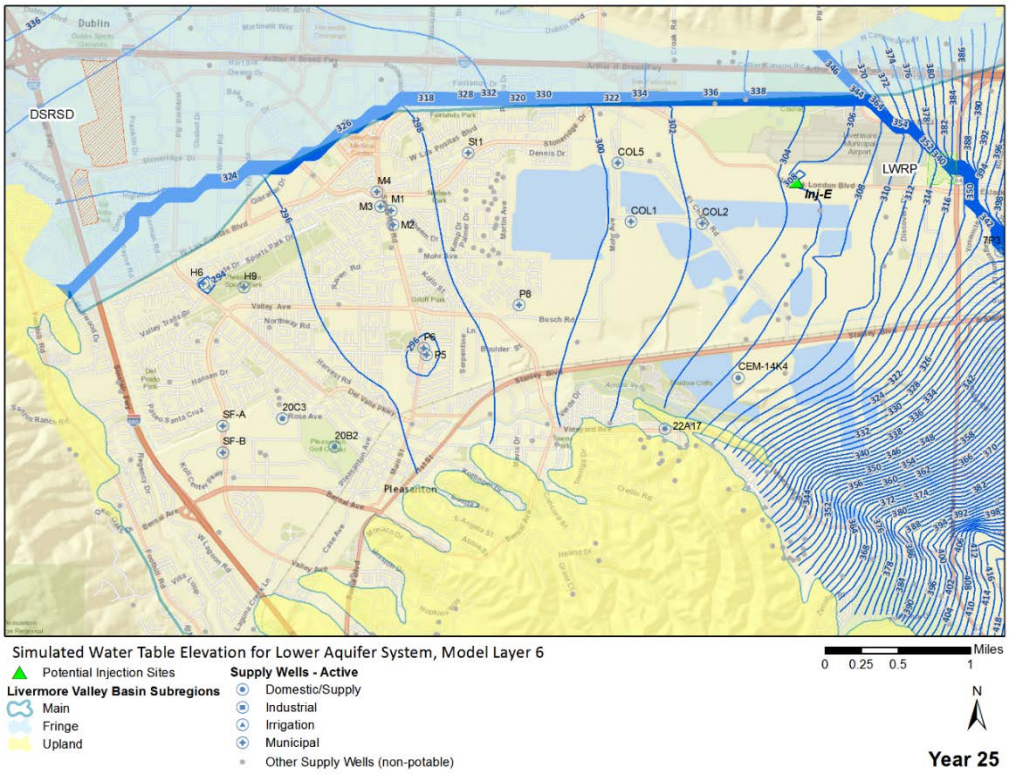


Figure 6.11 Simulated Water Levels in the Lower Aquifer, 25 Years, 5,500 AFY in Well E

The breakthrough shown in Figure 6.12 is based on the average concentration at the production wells extracted water from multiple model layers. The output from the 10-Layer Model was also checked to ensure that simulated breakthrough in a single layer was not significantly less; the simulated travel times for individual layers were similar to the average.

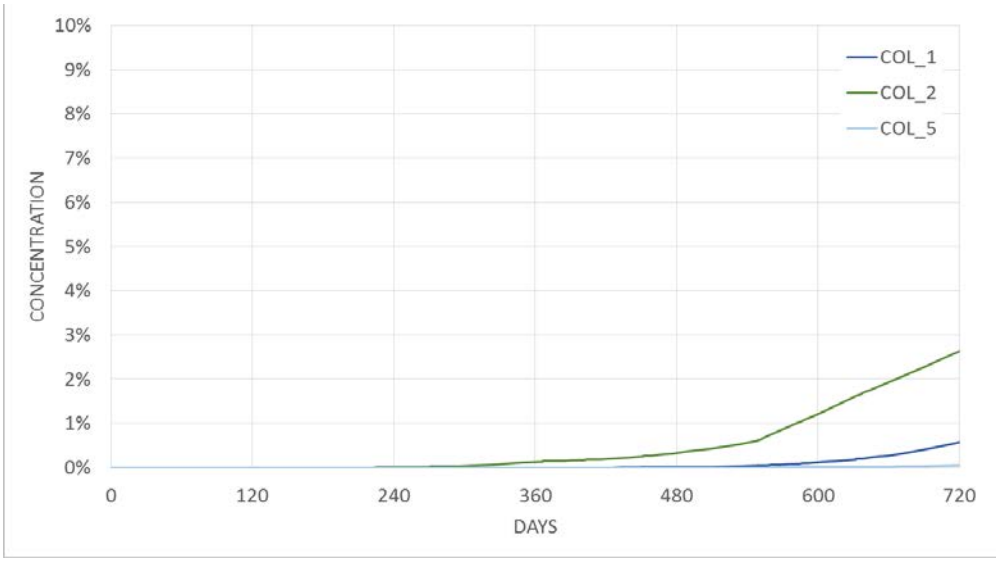


Figure 6.12 Simulated Breakthrough at Chain of Lakes Wells, 5,5000 AFY Injection at Well E

Impacts on Salt Balance

Trend charts showing the simulated change in TDS over time at selected production wells are shown in Figures 6.13 and 6.14. A summary table of the net change in TDS concentrations at the end of the 25-year simulation period for all recharge scenarios is provided in Table 6.5.

Figure 6.13 shows the simulated trends in TDS concentration for the baseline and injection scenario at well COL 1 west and slightly south of the injection site at Well E. In the baseline model, TDS concentrations declined over time with a net decline of about 100 mg/L over 25 years. In the injection scenario, TDS at COL 1 exhibited a rapid decline after about 3 years when the front of injected water reached the well location. Following this sharp decline, TDS stabilized after about 8 years and declined only slightly through the end of the simulation. A net reduction in TDS of about 90 mg/L was observed at this location, although a decline of 350 mg/L was observed at nearby COL 5 located further north and directly downgradient of the injection site.

Figure 6.14 shows the simulated trends in TDS concentration for the baseline and injection scenario at well Mocho 2 east of the injection site at Well E. In the baseline model, TDS concentrations remained relatively stable over time. In the injection scenario, TDS at Mocho 2 exhibited a declining trend after about 10 years of injection indicating when the front of injected water reached the well location. Simulated concentrations at this location continued to decline through the end of the simulation with a net reduction in TDS at this location of about 150 mg/L.

Figure 6.15 shows the simulated change in TDS concentrations between scenario and the baseline in the lower aquifer after 25 years of injection. In this scenario, water quality improvements occurred over an area extending from the injection site to beyond the Mocho wells and also south to the Pleasanton wells. Because the groundwater flowed from east to west through the basin and pumping in the central parts of the basin occurred downgradient of the site of injection, injection reduced the TDS across a much larger area of the basin as compared to the Well B scenario. No net increase greater than 10 mg/L was observed at any of the production wells, and significant declines in TDS of more than 100 mg/L were observed at several wells.

6.2.3.4 Recharge through Lake I

Short-listed option 1a includes recharge of 5,500 AFY of recycled water through Lake I on a year round basis. Short-listed options 2a and 4 include an end use of conveyance to DVWTP via Cope Lake, but incorporate flexibility to convey water to Lake I for groundwater recharge. The recharge amount for these options is 10,000 AFY on a seasonal basis. Recharge through Lake I enters the Upper Aquifer through a seepage face on the western side of the lake, and the rate of recharge is proportional to the head difference between the lake water level and groundwater levels in the aquifer. For these simulations, recycled water was added to the lake, and the actual rate of recharge to the aquifer was determined by the model.

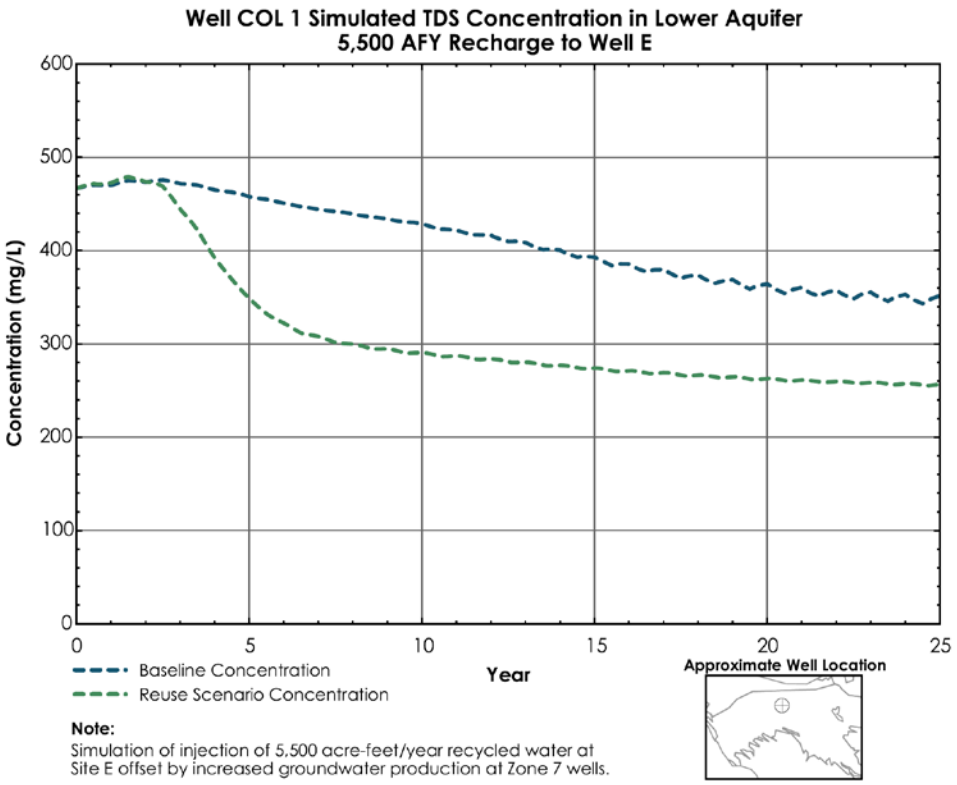


Figure 6.13 Comparison of Simulated TDS Concentrations at Well COL 1, 5,500 AFY at Well E

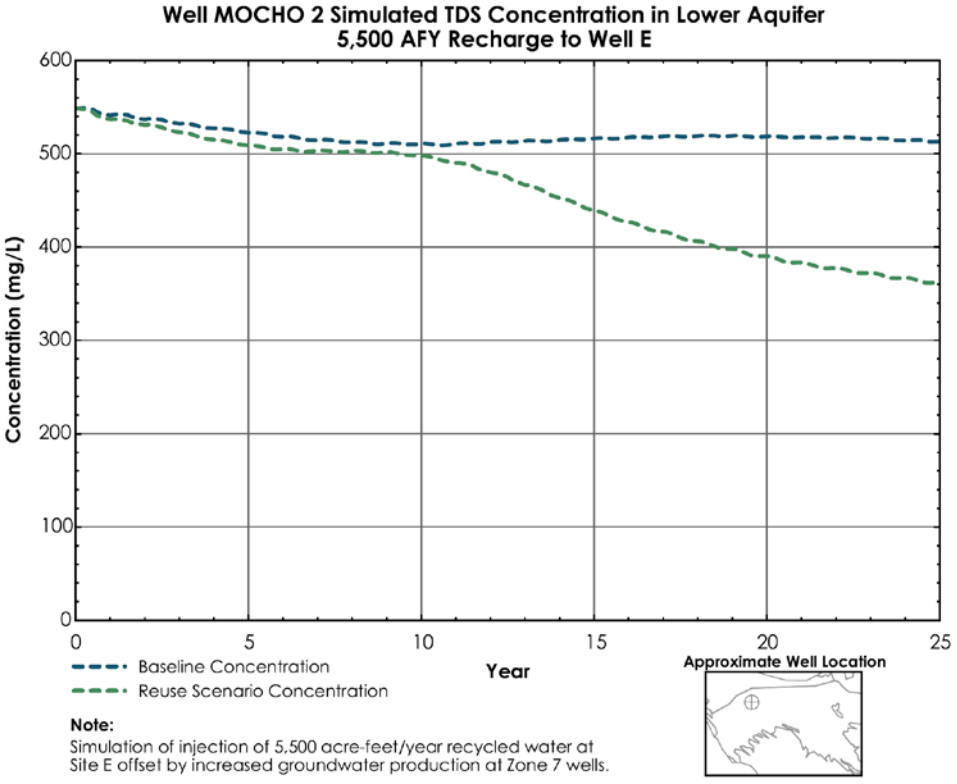


Figure 6.14 Comparison of Simulated TDS Concentrations at Well Mocho 2, 5,500 AFY at Well E

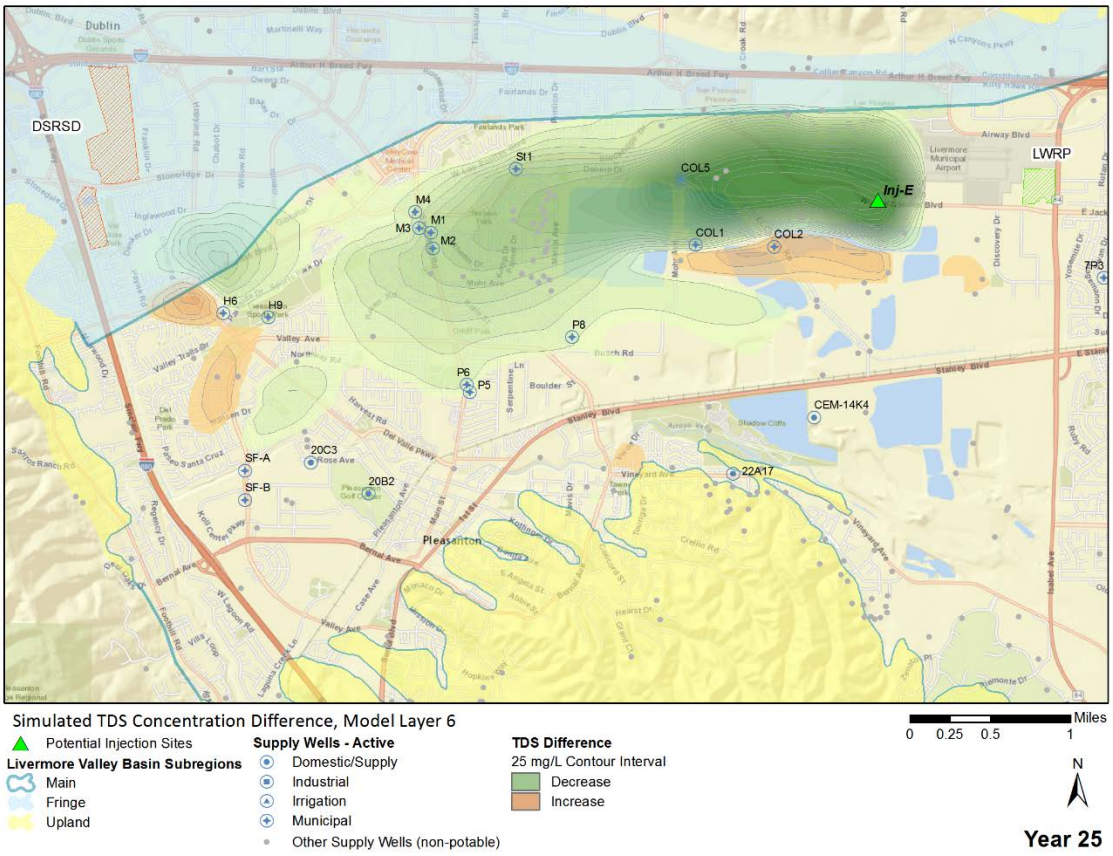
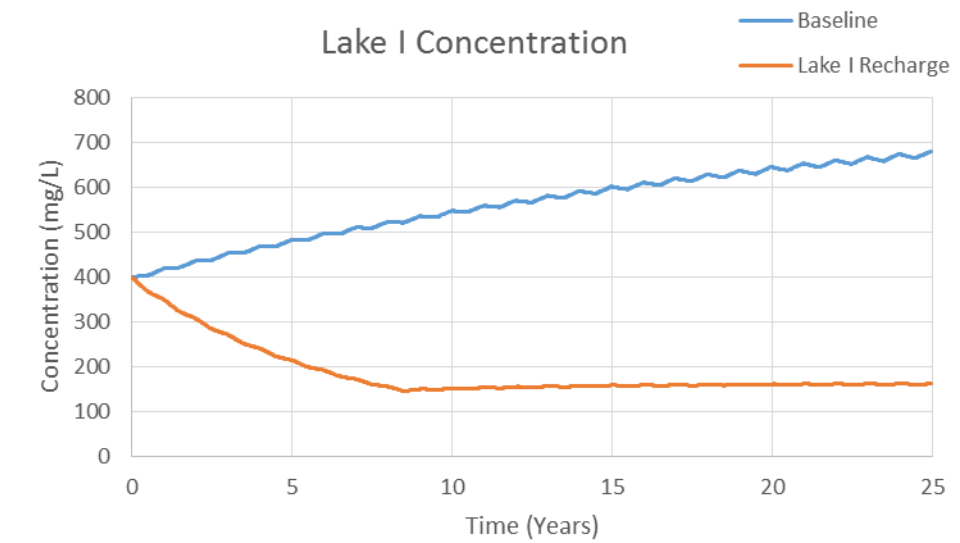


Figure 6.15 Simulated Change from Baseline TDS Concentrations in Lower Aquifer After 25 Years, 5,500 AFY in Well E Scenario

Lake I Recharge: 5,500 AFY

Figure 6.16 shows the simulated TDS concentration and change in storage volume in Lake I for the 5,500 AFY scenario. In the baseline scenario, TDS concentration in the lake increased steadily throughout the simulation. In the recharge scenario, the concentration in the lake declined for about eight years after discharge to the lake begins, then remained constant through the end of the simulation. By maintaining the TDS concentration of the lake, the simulated salt load to the groundwater basin was reduced.

The average simulated lake volume was the same for both scenarios, and both scenarios indicated that lake levels would exhibit a seasonal fluctuation in response to the seasonal variation in pumping from the groundwater basin.This seasonal fluctuaction was exaggerated in the recharge scenario because the addition of recycled water to the lake increased the lake volume during the wet season and allowed more recharge from the lake during the dry season. Note that the change in storage volume is shown in Figure 6.16 because simulated Lake I volumes are higher than the actual capacity of the lake because of the limitations of discretization of the model grid.



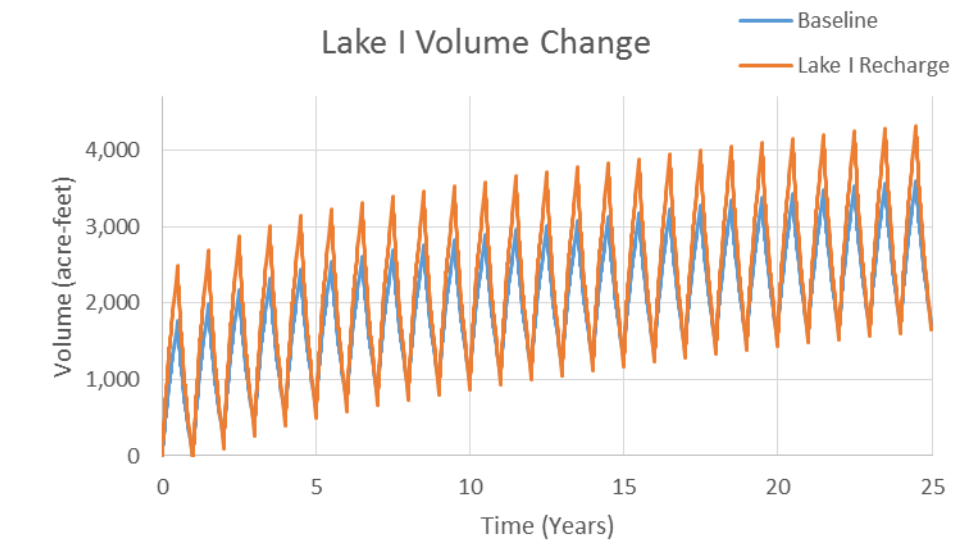
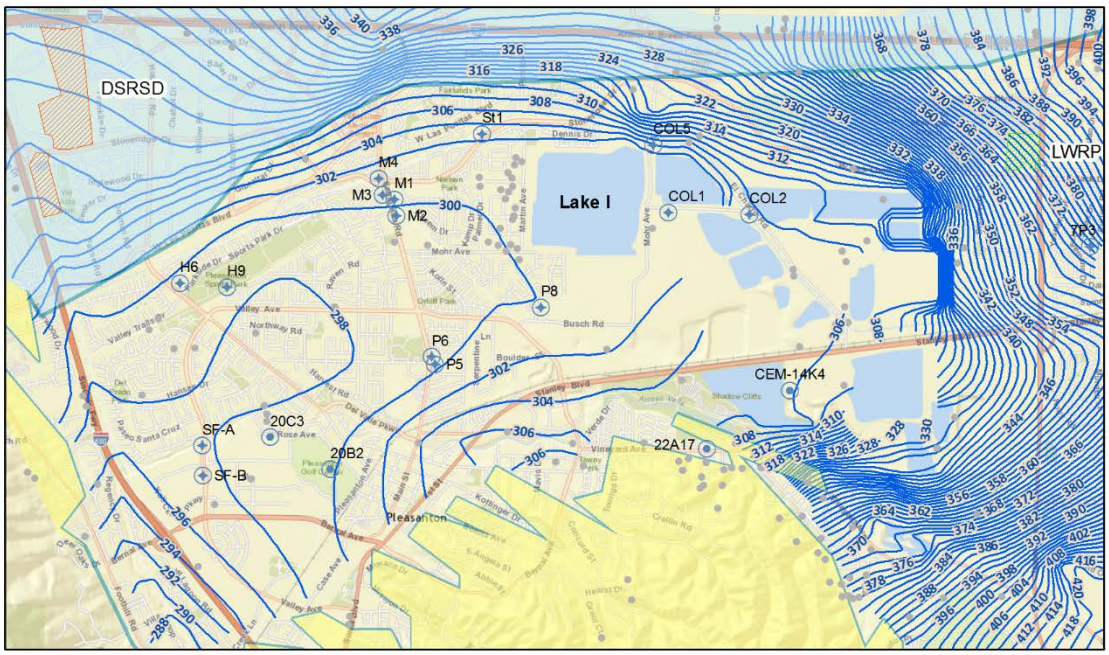


Figure 6.16 Comparison of Simulated TDS Concentration and Volume in Lake I, 5,500 AFY Recharge

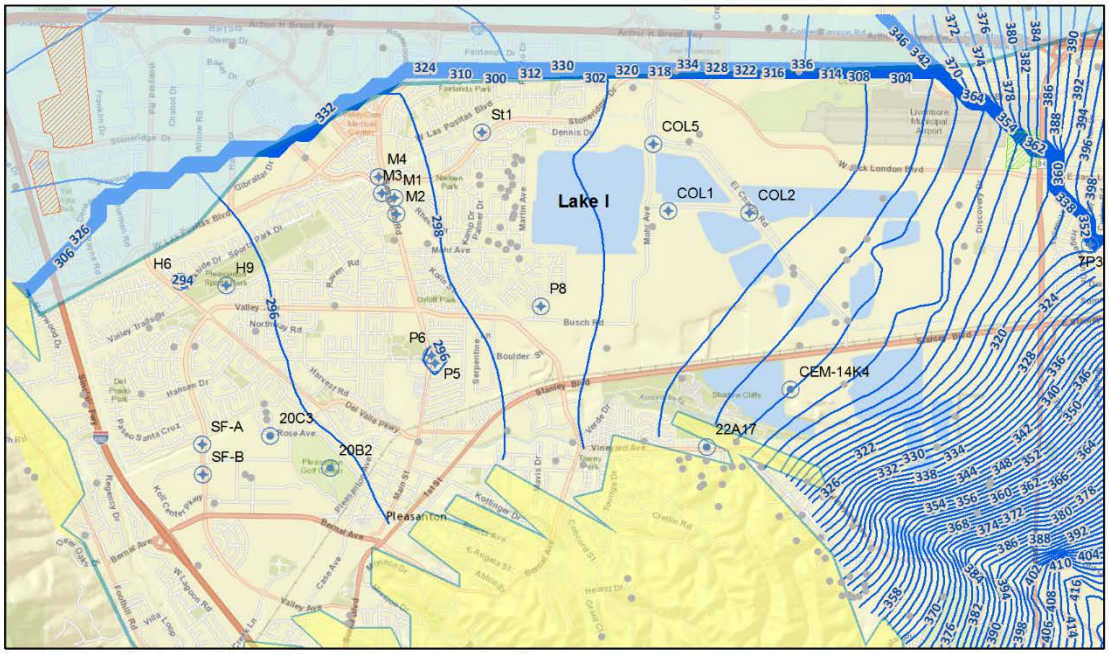
Groundwater Flow

Simulated average water levels for the 5,500 AFY recharge in Lake I scenario are shown in Figure 6.17. The upper map shows that groundwater elevations in the Upper Aquifer near Lake I and to the west were about two feet higher than in the baseline scenario, and the area of inward flow was smaller with the hydraulic gradient pushing flow to the west across the basin.

In the Lower Aquifer, groundwater levels beneath Lake I were higher than the baseline creating a stronger hydraulic gradient toward the Mocho wells and slowing incoming flow from the east upgradient of the Chain of Lakes wells.



a. Simulated Water Table Elevation for Upper Aquifer System



b. Simulated Water Table Elevation for Lower Aquifer System

Potential Injection Sites

Livermore Valley Basin Subregions
- Main
- Fringe
- Upland

Supply Wells - Active
- Domestic/Supply
- Industrial
- Irrigation
- Municipal
- Other Supply Wells (non-potable)

Miles
0 0.25 0.5 1

N

Year 25

Figure 6.17 Simulated Water Levels, 25 Years, 5,500 AFY in Lake I

Impacts on Salt Balance

Trend charts showing the simulated change in TDS over time at selected production wells are shown in Figures 6.18 and 6.19. A summary table of the net change in TDS concentrations at the end of the 25-year simulation period for all recharge scenarios is provided in Table 6.5.

Figure 6.18 shows the simulated trends in TDS concentration for the baseline and recharge scenario at well COL 1 just east of Lake I. In the baseline model, TDS concentrations declined over time with a net decline of about 115 mg/L over 25 years. In the recharge scenario, TDS at COL 1 exhibited similar behavior to the baseline scenario with a slightly smaller decrease at the end of the simulation of about 90 mg/L. A net increase in TDS of about 30 mg/L was observed at this location. Because of the proximity of this well to Lake I, one might expect a decrease in TDS; however, the well is completed in the Lower Aquifer, whereas recharge from Lake I entered the Upper Aquifer. In addition, the well is upgradient of the lake, and unlike in the injection scenarios, recharge in the lake only occurred in response to a simulated head gradient rather than under pressure when injected from a well.

Figure 6.19 shows the simulated trends in TDS concentration for the baseline and recharge scenario at well Mocho 2 west of Lake I. In the baseline model, TDS concentrations remained relatively stable over time. In the recharge scenario, TDS at Mocho 2 exhibited a strong declining trend for about the first 15 years of recharge followed by a continued more gradual decline through the end of the simulation with a net reduction in TDS at this location of about 200 mg/L. These results indicate that although recharge from the lake primarily entered the Upper Aquifer, the recycled water migrated downward through the aquitard to the Lower Aquifer relatively quickly under the influence of a downward gradient created by the extraction of groundwater from the Lower Aquifer.

Figure 6.20 shows the simulated change in TDS concentrations between scenario and the baseline in the Upper Aquifer after 25 years of recharge. In this scenario, water quality improvements occurred over an area extending from Lake I to the west and southwest following the flow gradient in this direction. This figure also shows a decrease in TDS in the Upper Aquifer west and northwest of the Shadow Cliffs Lake. This reduction in TDS was not directly related to the recharge in Lake I, but may be indirectly affected by the discharge of recycled water to Lake I. The model input files were reviewed to confirm that this was not caused by an error in the input data, but no errors were identified.

Figure 6.21 shows the simulated change in TDS concentrations between scenario and the baseline in the Lower Aquifer after 25 years of recharge. In this scenario, water quality improvements occurred over an area extending from Lake I to the west, northwest, and southwest following the flow gradient and influences of wells pumping in this aquifer. Because the groundwater flowed from east to west through the basin and pumping in the central parts of the basin occurred downgradient of the recharge site, recharge through Lake I reduced the TDS across a large area of the basin. No net increase greater than 30 mg/L was observed at any of the production wells, and significant declines in TDS of up to 250 mg/L were observed at the Mocho, and Stoneridge wells.

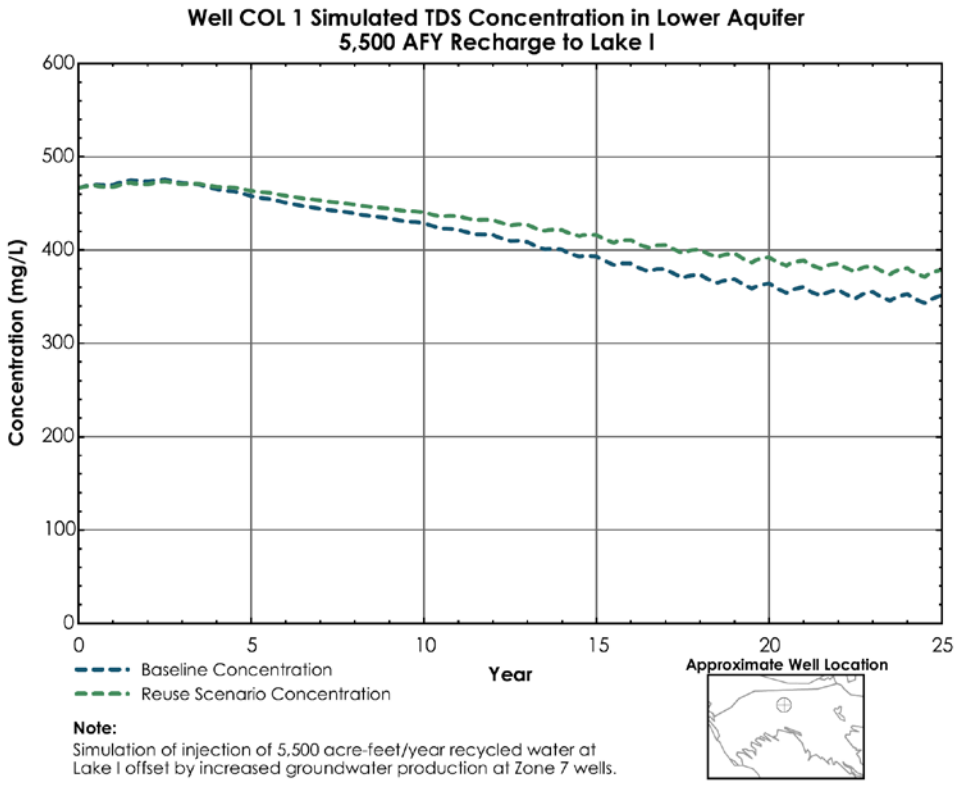


Figure 6.18 Comparison of Simulated TDS Concentrations at Well COL 1, 5,500 AFY in Lake I

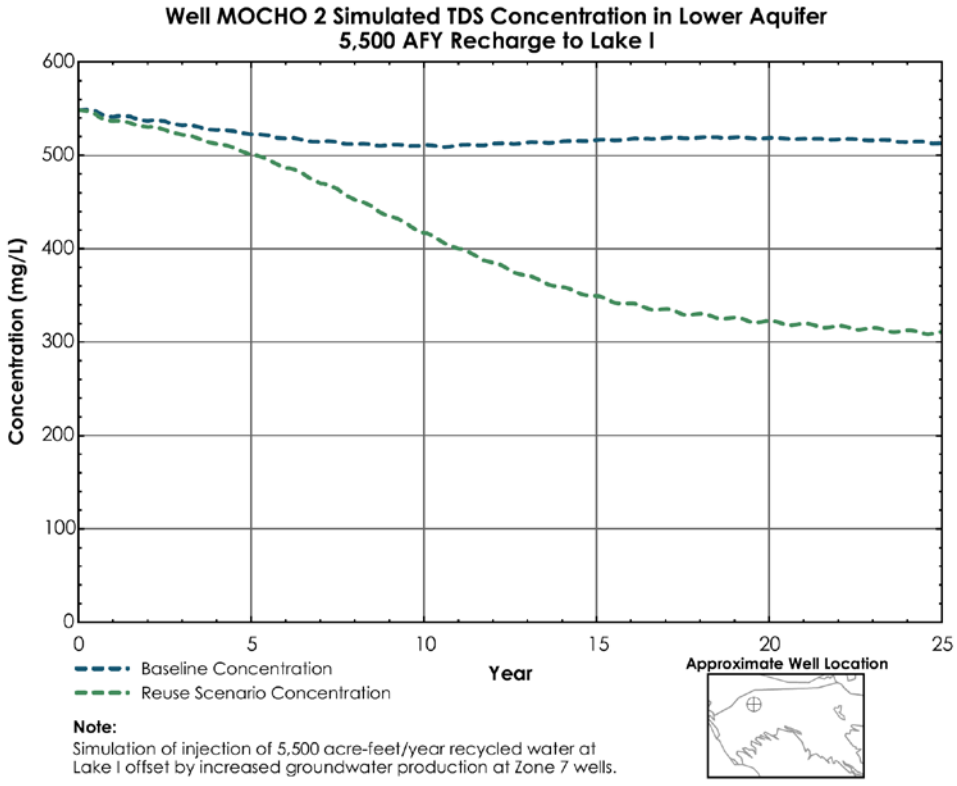


Figure 6.19 Comparison of Simulated TDS Concentrations at Well Mocho 2, 5,500 AFY in Lake I

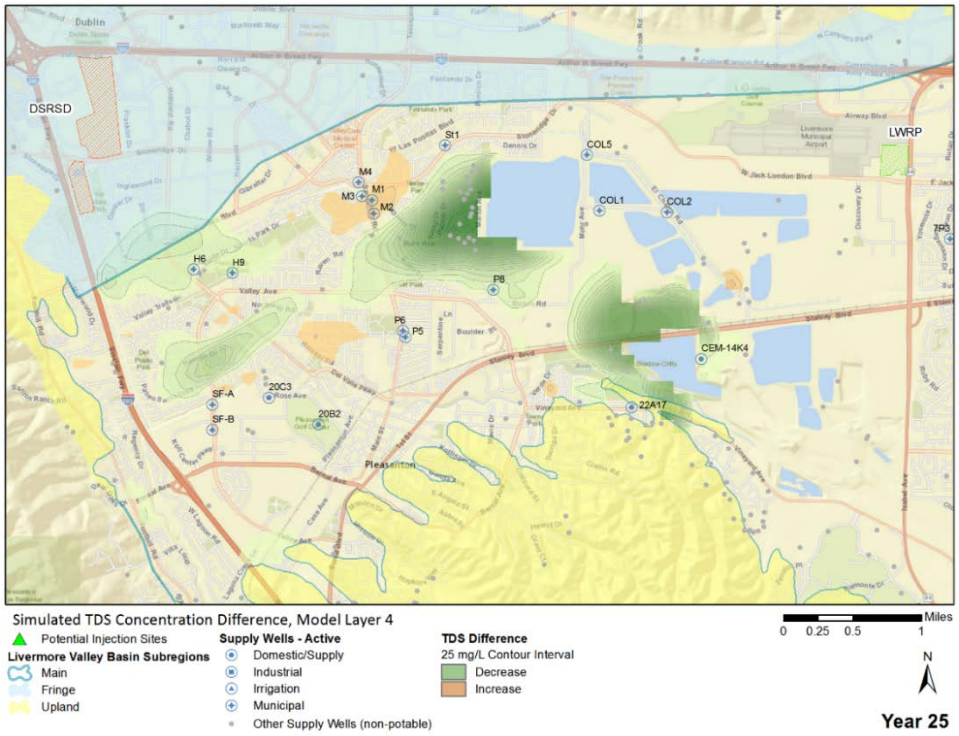


Figure 6.20 Simulated Change from Baseline TDS Concentrations in Upper Aquifer After 25 Years, 5,500 AFY in Lake I Scenario

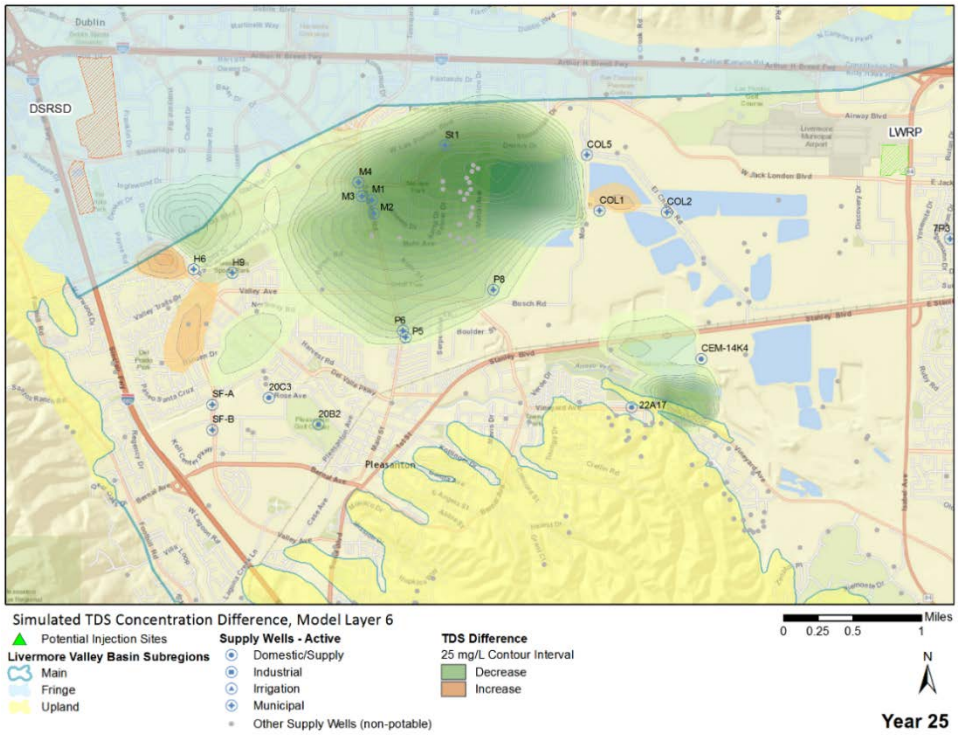
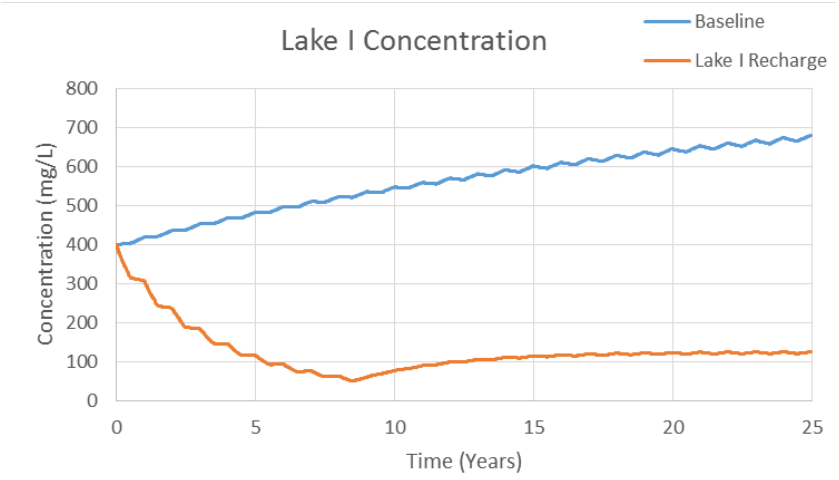


Figure 6.21 Simulated Change from Baseline TDS Concentrations in Lower Aquifer After 25 Years, 5,500 AFY in Lake I Scenario

Lake I Recharge: 10,000 AFY

Figure 6.22 shows the simulated TDS concentration and volume of storage in Lake I for the 10,000 AFY scenario. In the baseline scenario, the TDS concentration in the lake increased steadily throughout the simulation. In the recharge scenario, the concentration in the lake declined for about eight years after discharge to the lake begins, then remained constant through the end of the simulation. This simulation shows that by adding purified water the TDS concentration of the lake stays at a lower level resulting in the simulated salt load to the groundwater basin being reduced.



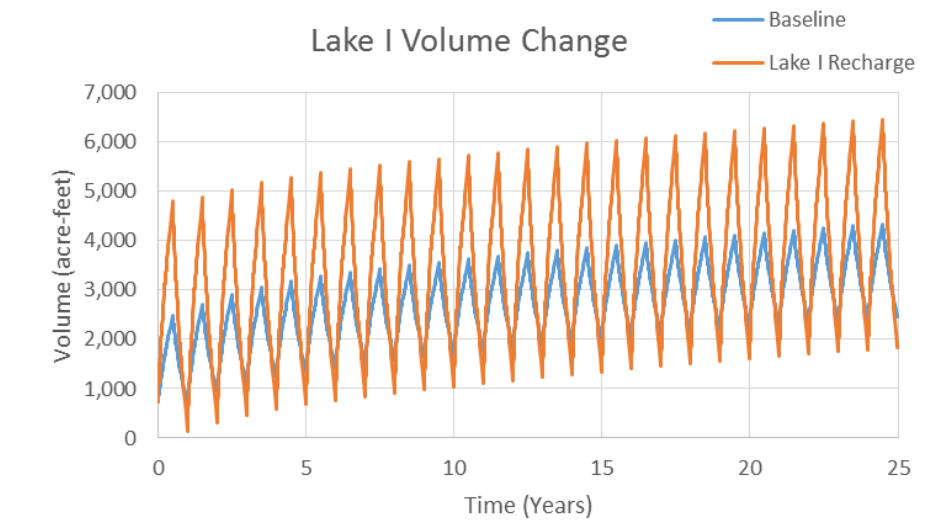


Figure 6.22 Comparison of Simulated TDS Concentration and Volume in Lake I, 10,000 AFY Recharge

The trend in average simulated lake volume was the same for both the baseline and recharge scenarios although the simulated lake volume for the recharge scenario was higher, and both scenarios indicated that lake levels would exhibit a seasonal fluctuation in response to the seasonal variation in pumping from the groundwater basin.This seasonal fluctuaction was exaggerated in the recharge scenario because of the combined effects of higer recharge during the wet season and higher pumping during the dry season. The addition of recycled water to the

lake increased the lake volume during the wet season and allowed more recharge from the lake during the dry season.

Groundwater Flow

Simulated average water levels for the 10,000 AFY recharge in Lake I scenario are shown in Figure 6.23. The upper map shows that groundwater elevations in the Upper Aquifer near Lake I and to the west were about two feet higher than in the baseline scenario, and the area of inward flow was smaller with the hydraulic gradient pushing flow to the west across the basin.

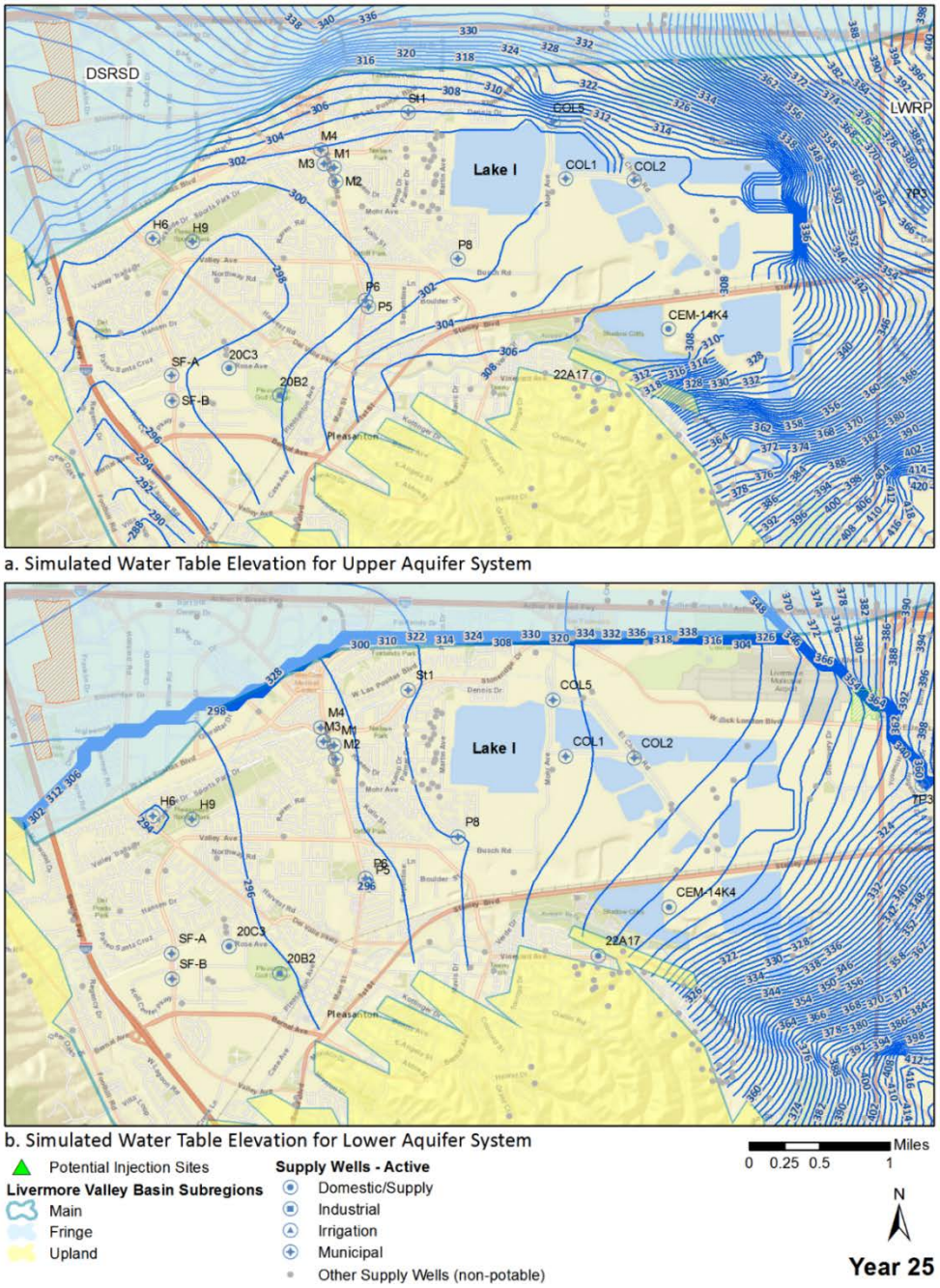


Figure 6.23 Simulated Water Levels, 25 Years, 10,000 AFY in Lake I

In the Lower Aquifer, groundwater levels beneath Lake I were about four feet higher than the baseline creating a stronger hydraulic gradient toward the Mocho and Hopyard wells and slowing incoming flow from the east upgradient of the Chain of Lakes.

Impacts on Salt Balance

Trend charts showing the simulated change in TDS over time at selected production wells are shown in Figures 6.24 and 6.25. A summary table of the net change in TDS concentrations at the end of the 25-year simulation period for all recharge scenarios is provided in Table 6.5.

Figure 6.24 shows the simulated trends in TDS concentration for the baseline and recharge scenario at well COL 1 just east of Lake I. In the baseline model, TDS concentrations declined over time with a net decline of about 115 mg/L over 25 years. In the recharge scenario, TDS at COL 1 exhibited similar behavior to the baseline scenario with a smaller decrease at the end of the simulation of about 70 mg/L. A net increase in TDS of about 45 mg/L was observed at this location. Because of the proximity of this well to Lake I, a decrease in TDS was expected. However, the well is completed in the Lower Aquifer, whereas recharge from Lake I entered the Upper Aquifer. In addition, the well is upgradient of the lake, and unlike in the injection scenarios, recharge in the lake only occurred in response to a simulated head gradient rather than under pressure when injected into a well.

Figure 6.25 shows the simulated trends in TDS concentration for the baseline and recharge scenario at well Mocho 2 west of Lake I. In the baseline model, TDS concentrations remained relatively stable over time. In the recharge scenario, TDS at Mocho 2 exhibited a strong declining trend for about the first 15 years of recharge followed by a continued more gradual decline through the end of the simulation with a net reduction in TDS at this location of about 290 mg/L. These results indicate that although recharge from the lake primarily entered the Upper Aquifer, the recycled water migrated downward through the aquitard to the Lower Aquifer relatively quickly under the influence of a downward gradient created by the extraction of groundwater from the Lower Aquifer.

Figure 6.26 shows the simulated change in TDS concentrations in the Upper Aquifer after 25 years of recharge. In this scenario, water quality improvements occurred over an area extending from Lake I to the west and southwest beyond the Mocho wells following the flow gradient in this direction. Unlike for the 5,500 AFY recharge scenario, the decrease in TDS in the Upper Aquifer west and northwest of the Shadow Cliffs lake was not observed in this scenario.

Figure 6.27 shows the simulated change in TDS concentrations in the Lower Aquifer after 25 years of recharge. In this scenario, water quality improvements occurred over an area extending from Lake I to the west, northwest, and southwest extending to the Hopyard and Pleasanton wells following the flow gradient and influences of wells pumping in this aquifer. Because the groundwater flowed from east to west through the basin and pumping in the central parts of the basin occurred downgradient of the recharge site, recharge through Lake I reduced the TDS across a large area of the basin. No net increase greater than 40 mg/L was observed at any of the production wells, and significant declines in TDS of up to levels of 340 mg/L were observed at the Mocho, Stoneridge, and Pleasanton wells.

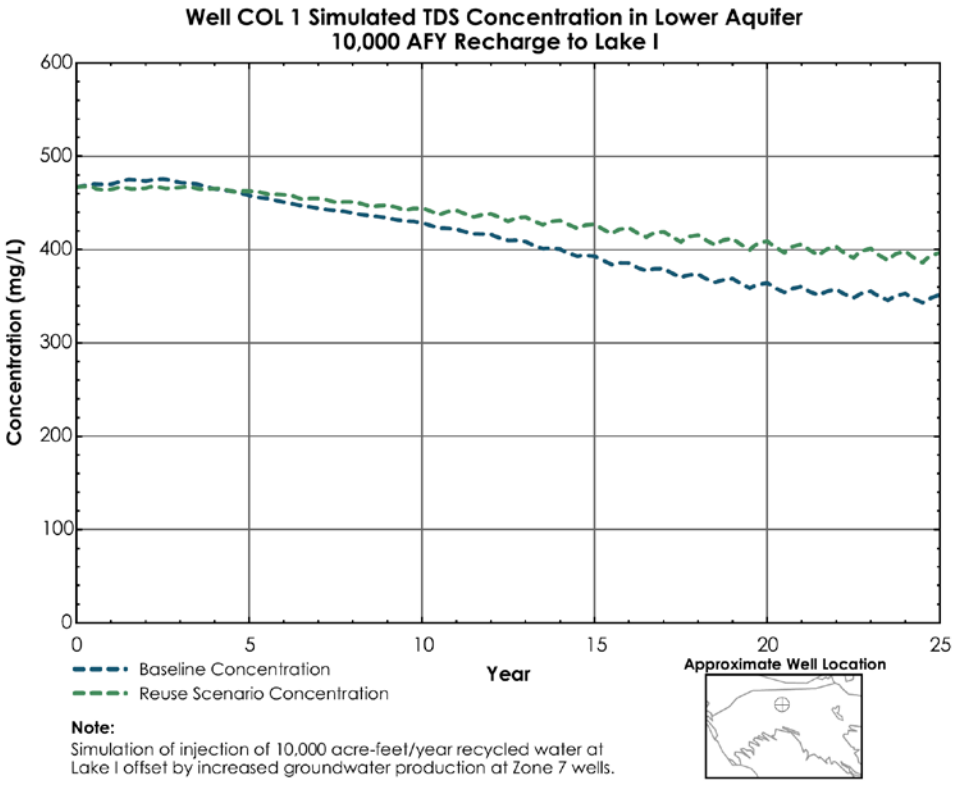


Figure 6.24 Comparison of Simulated TDS Concentrations at Well COL 1, 10,000 AFY in Lake I

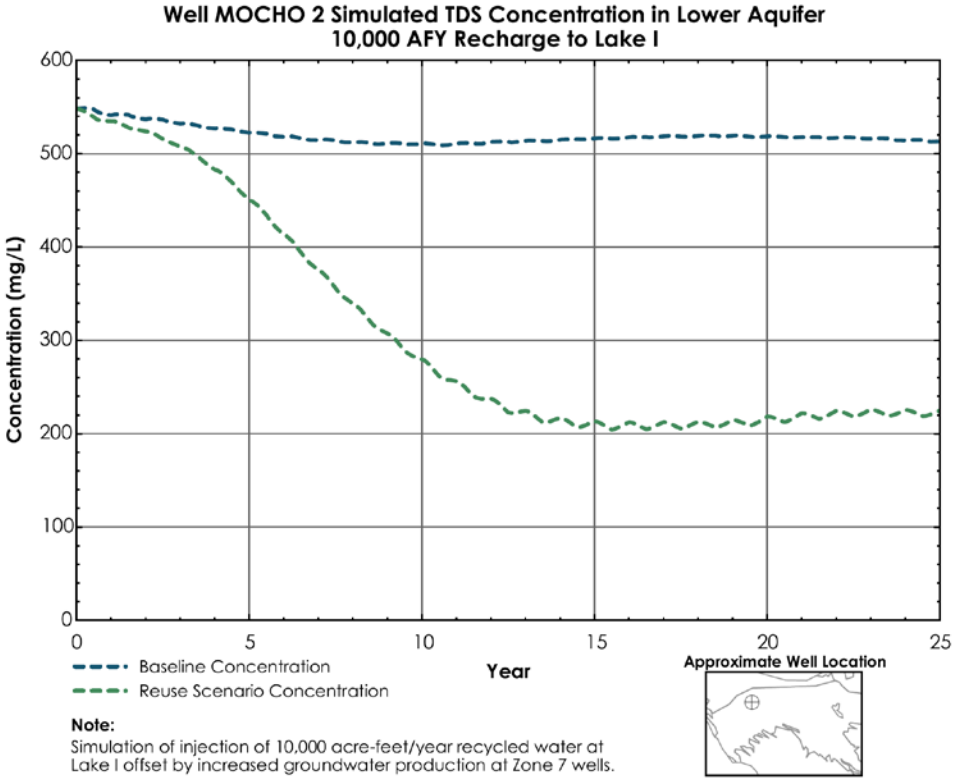


Figure 6.25 Comparison of Simulated TDS Concentrations at Well Mocho 2, 10,000 AFY in Lake I

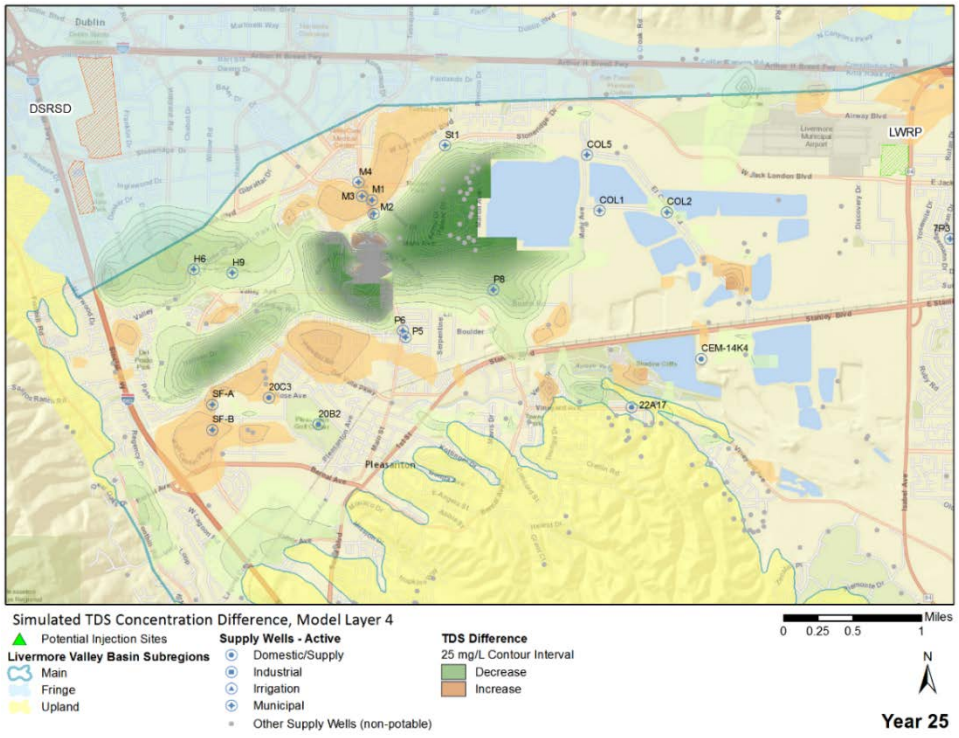


Figure 6.26 Simulated Change from Baseline TDS Concentrations in Upper Aquifer After 25 Years, 10,000 AFY in Lake I Scenario

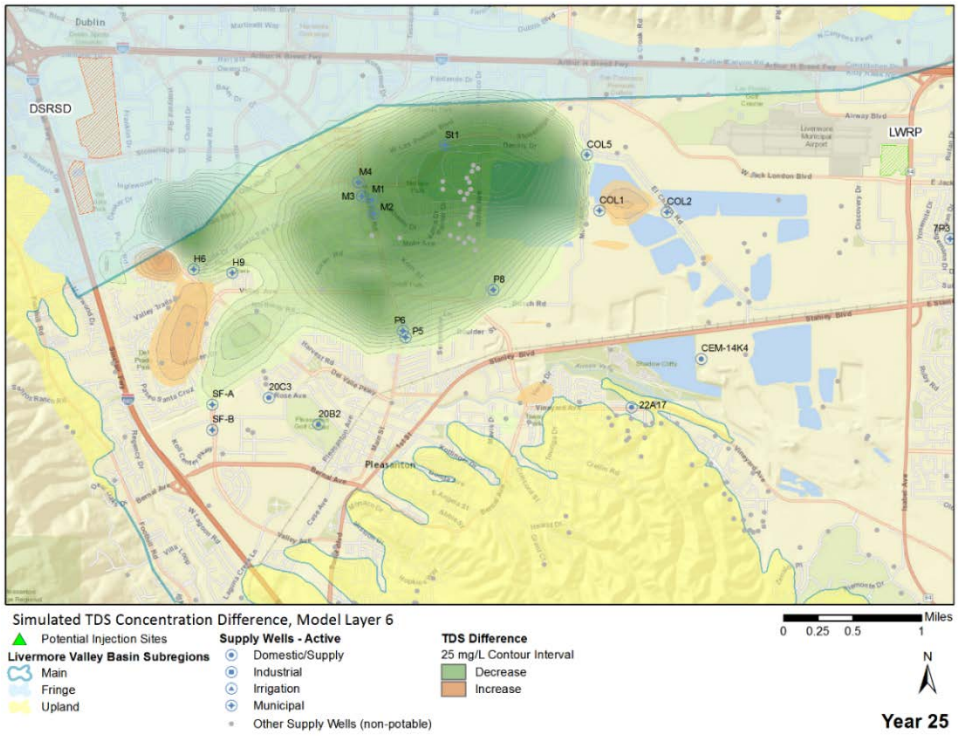


Figure 6.27 Simulated Change from Baseline TDS Concentrations in Lower Aquifer After 25 Years, 10,000 AFY in Lake I Scenario

6.3 Summary of Salt Balance Results

A summary table of the net change in TDS concentrations at the production wells at the end of the 25-year simulation period for all recharge scenarios as compared to baseline is provided in Table 6.5. Table 6.6 provides the flow-weighted average TDS concentration at the nine active Zone 7 productions wells in the simulations. Comparisons of simulated concentrations at wells COL 1 and MOCHO 2 for all five scenarios are shown in Figures 6.28 and 6.29, respectively. Production well locations are shown in Figure 6.30. Review of the modeled net change in TDS indicates that the largest increase in TDS at a production well is 50 mg/L after 25 years of injection with the Pleasanton and Chain of Lakes wells experiencing the greatest increases. For all recharge scenarios, significant water quality benefits are expected at the majority of the production wells with most benefits beginning within about 10 years after the start of recharge. Injection of 10,000 AFY at Well B produces the largest decreases in TDS at locally affected wells although due to proximity of extraction wells, this location has less basin wide benefit. In contrast, injection of 5,500 AFY at Well E produces the most widespread water quality benefits. Substantial decreases in TDS were observed in some wells for all of the recharge scenarios investigated.

The flow-weighted average concentrations shown in Table 6.6 show that, as expected, recharge of lower TDS recycled water into the groundwater basin decreases the average TDS concentrations in the basin over time. Greater decreases in TDS are observed as the annual volume of recycled water injected increases; however, Table 6.6 also shows that the location of recharge also affects the simulated changes in TDS. The largest decline in average TDS occurs with recharge of 10,000 AFY through Lake I resulting in a simulated reduction of 200 mg/L after 20 years compared to the baseline scenario. It is important to note that the TDS concentration differences shown in Tables 6.5 and 6.6 are based on modeling estimates only and are meant to illustrate relative impacts. These predictions also do not reflect changes in operations or production from each well due to new recharge projects. The concentrations of TDS may change based upon updated production. Charts of TDS trends at the production wells for all recharge scenarios are provided in Appendix C.

Localized reductions in TDS, especially near the Mocho Wells, could affect the long term efficacy of Zone 7's demineralization facility and may affect plans/need for a future second demineralization facility. While the existing demineralization facility has significant useful life left and therefore little opportunity for cost avoidance is possible, the avoidance of building the planned second demineralization facility could be a significant cost savings. The impacts to operations of these and other existing facilities need to be carefully considered when siting and implementing a project.

Table 6.5 Simulated Change from Baseline TDS Concentrations After 25 Years of Recharge

Production Well	Difference from Baseline in TDS Concentration (mg/L)			
Recharge Location	Well B	Well E	Lake I	
Recharge Volume (AFY)	10,000	5,500	5,500	10,000
COL 1	40	-90	30	40
COL 2	20	-20	10	10
COL 5	30	-350	20	30
Hopyard 6	-290	10	0	-10
Hopyard 9	-530	10	0	-10
Mocho 1	-250	-150	-230	-310
Mocho 2	-270	-150	-200	-290
Mocho 3	-310	-110	-140	-240
Mocho 4	-330	-100	-80	-170
Pleasanton 5	50	-20	-30	-80
Pleasanton 6	50	-20	-40	-100
Pleasanton 7	-400	10	10	0
Pleasanton 8	20	-20	-30	-80
Stoneridge 1	20	-200	-250	-340

Table 6.6 Flow-Weighted Average Concentrations

Scenario	Simulated TDS Concentration (mg/L)
Baseline, Initial	564
Baseline after 20 Years	588
Well B, 10,000 AFY	428
Well E, 5,500 AFY	463
Lake I, 5,500 AFY	445
Lake I, 10,000 AFY	388

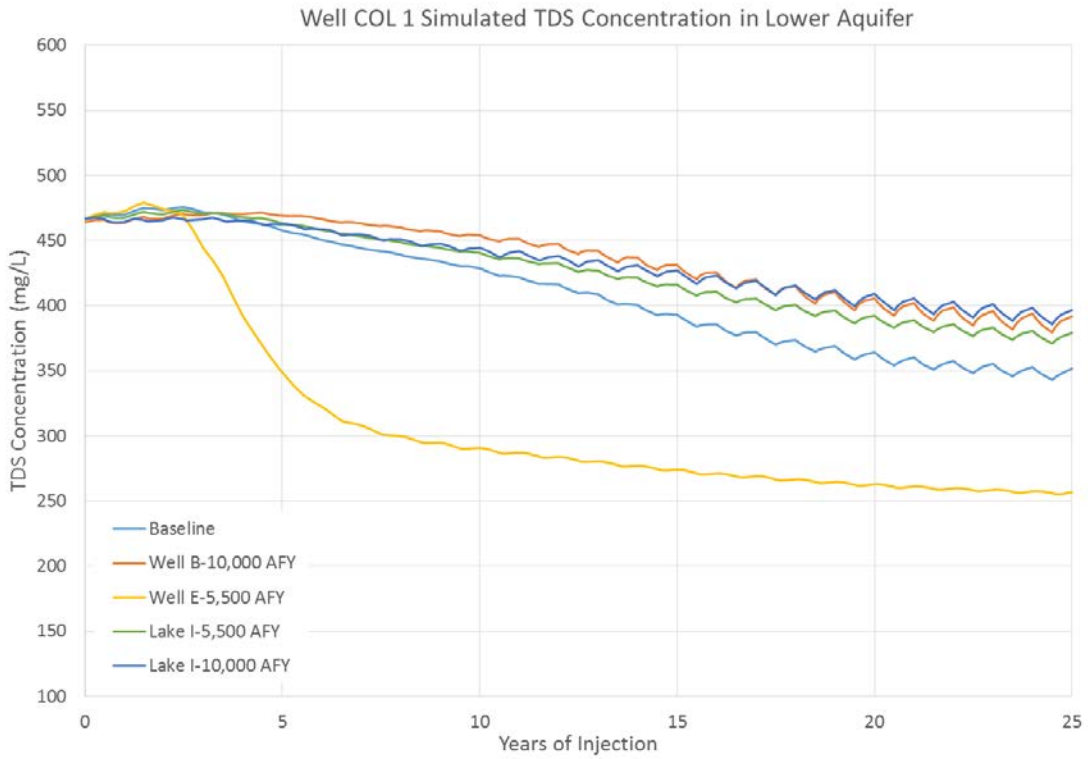


Figure 6.28 Comparison of Simulated TDS Concentrations at Well COL 1

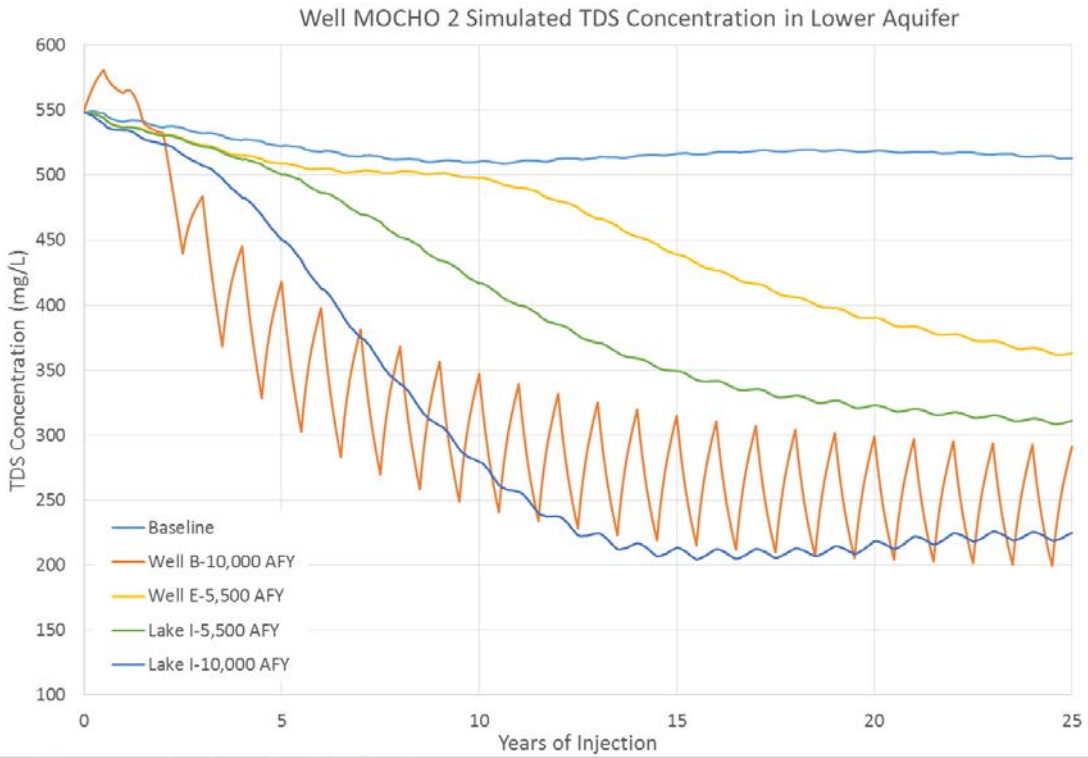


Figure 6.29 Comparison of Simulated TDS Concentrations at Well MOCHO 2

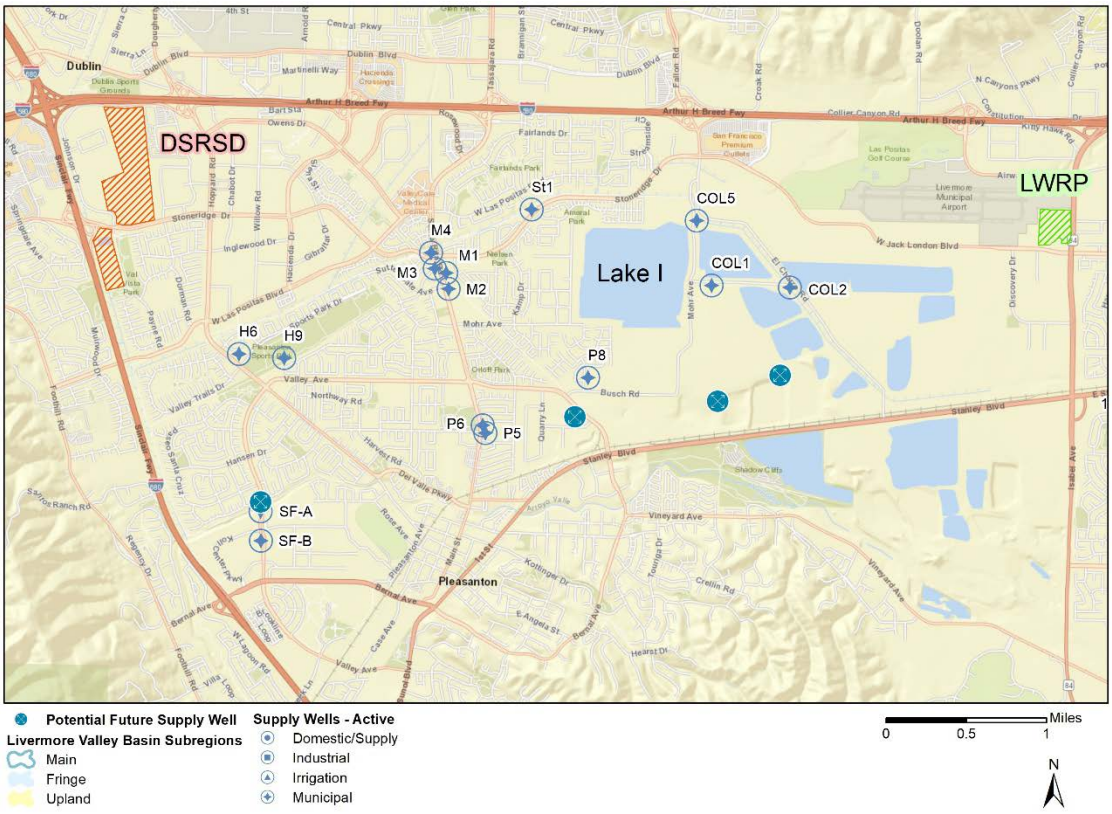


Figure 6.30 Production Well Locations

6.3.1 Basin-Average Salt Concentrations

Basin-average salt concentrations in groundwater were calculated using output from the Zone 7 Groundwater Basin Model. The model output includes simulated TDS concentrations across the groundwater basin. A basin-average concentration can be calculated from model output by calculating the total salt mass in the basin then dividing by the total volume of groundwater. The total salt mass was determined as the salt concentration in each model grid cell multiplied by the water volume in the cell, then summing the mass for all cells in the model grid. The water volume in each grid cell was calculated as the area of the cell multiplied by the layer thickness multiplied by the porosity. Similar to total salt mass, the total water volume was calculated as the sum of the water volume in all grid cells. These calculations were performed by layer, and only the primary water-bearing layers in the lower aquifer, i.e., layers 6, 8, and 10, were included. As specified in the Zone 7 Salt Management Plan, average salt concentrations were determined for the Main Basin only.

Basin-average salt concentrations are shown in Figure 6.31 for the baseline and four different groundwater augmentation scenarios. Results for all four groundwater augmentation scenarios indicate a decline in average salt concentrations relative to the baseline scenario. For the baseline scenario, the average salt concentration in the lower aquifer declines from 516 mg/L TDS to 493 mg/L after 25 years or about 4 percent decline. By comparison, declines ranged from about 7 to 9 percent for the groundwater augmentation scenarios. Figure 6.31 shows that the

greatest declines in salt concentrations were observed for the Well E injection scenario. Basin-average changes in salt concentration were substantially less than the changes observed at the Zone 7 production wells which indicated declines ranging from 19 to 36 percent. These differences are expected however because the basin-average results included the entire Main Basin whereas the production wells are more centrally located within the basin and therefore were more strongly influenced by the addition of purified water.

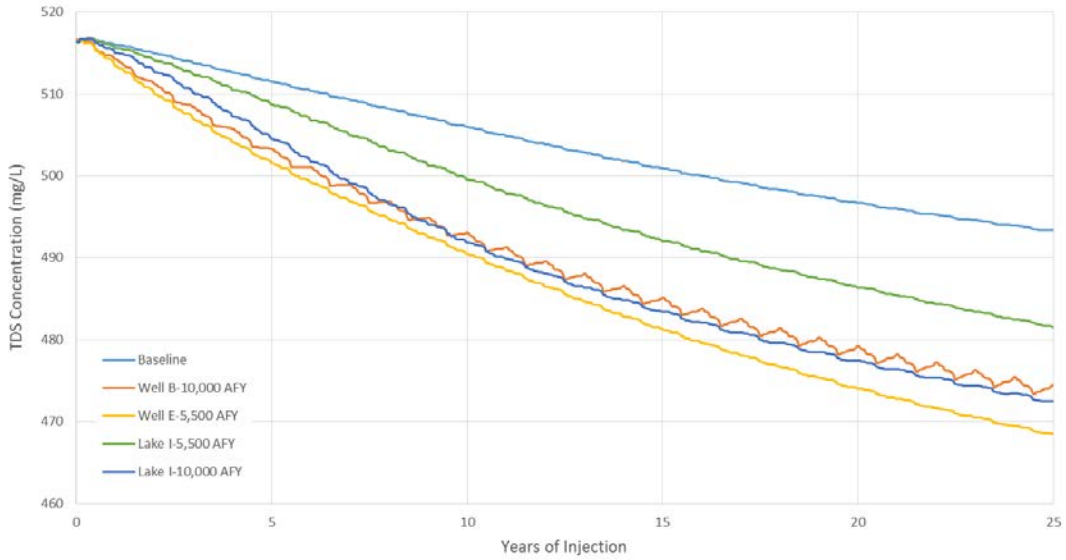


Figure 6.31 Average Salt Concentration in the Main Basin Lower Aquifer

6.4 Subsurface Water Storage Approaches

Two subsurface water storage approaches are under consideration for meeting Zone 7 goals for storage and recovery of purified water that meets all drinking water standards and other regulations for potable reuse in the state of California. One is a recharge approach in which purified recycled water would be injected into one or more sand intervals of the Lower Aquifer System. This water would then flow to downgradient production wells located at a sufficient distance so that a travel time of at least 60 to 120 days is ensured to meet potable reuse regulations. The stored water, blended with native water in the aquifer, would eventually be pumped from production wells for potable water supply. A reduction in salinity of the produced water is reasonably expected. The modeling analysis discussed previously provides an analysis of this approach.

In the other approach, known as aquifer storage and recovery or ASR, purified recycled water would be stored within one or more sand intervals of the Lower Aquifer System and recovered from the same, or adjacent, wells after storage for at least 60 to 120 days. Recovered water would then be blended with water produced from other sources for drinking water. Because of limitations of the basin-wide model, ASR was not evaluated with the model.

There are several advantages and disadvantages of each type of recharge/storage approach, as shown in Table 6.7.

Table 6.7 Recharge Project Comparisons

Recharge with Downgradient Extraction	Aquifer Storage and Recovery
Can help improve overall basin quality	Can preserve quality of injection water
Can result in mobilization of contaminants	Easier to control mobilization through formation of underground bubble of water
Can have long term clogging and maintenance of injection well	Designed to both inject and extract which may reduce clogging and allows for maintenance with in-situ equipment

As part of this study, technical input was solicited from ASR Systems. The President of ASR Systems, David Pyne, is a pioneer in ASR and groundwater recharge alternatives and has implemented groundwater recharge/ASR projects throughout the United States as well as in other countries. The following information is summarized from a Technical Memorandum prepared by ASR Systems. The complete memorandum is provided in Appendix D.

For an ASR well, the well design would likely be in one or more of the three, thick sand intervals comprising Layers 6, 8, or 10 of the Zone 7 10-layer Model. Alternatively, a cluster of three ASR wells could be constructed with one screened in each major sand interval, instead of a single ASR well in one or more sand intervals. Water stored in an ASR well would be recovered after 60 or 120 days of storage, as approved by regulatory agencies. Stored water may be recovered from the same ASR well or, depending on confining layer hydraulic characteristics, could be recovered from an adjacent layer, providing supplemental soil aquifer treatment. Recovered water would be blended as needed to meet Zone 7 needs for peak water supplies and/or for reducing salinity. Any water that is not recovered from the ASR wells, due to lateral movement of the stored water, would not be lost. It would be eventually recovered from the downgradient production wells.

For a recharge well, the well design would likely be open to all three sand intervals. Other than periodic backflushing to maintain hydraulic performance, no water would be recovered from a recharge well. Instead, it would be recovered months later at a downgradient production well. Depending on the location of recharge, the injected water may or may not reduce salinity of the produced drinking water; however it would improve the basin salinity overall.

Potential problems with either approach include well clogging and loss of injection capacity and mobilization of naturally occurring constituents in the aquifer materials into the groundwater through geochemical reactions, possibly resulting in exceedance of drinking water standards. Prior experience at Zone 7 indicates the potential for both to occur in the Livermore Valley Groundwater Basin. In 1997, arsenic, manganese, and boron were found at varying concentrations in different depth intervals in the recently constructed Hopyard 7 well, one of several planned ASR wells to be used to store surplus treated surface water. Also in 1997, Zone 7 began ASR cycle testing with surface water at well Hopyard 6. Although not originally constructed as an ASR well, the well was retrofit for ASR purposes for surface water recharge and recovery. Over a series of five ASR cycles of injection, storage, and recovery, the specific capacity (a measure of well efficiency and performance) of the well progressively declined

culminating in an acute clogging event in March 2000. Insufficient data are available to determine the cause of ASR failure. Well clogging occurred, but the reasons for that are unclear, whether physical, microbial or geochemical, or some combination of these clogging mechanisms. Physical clogging due to air entrainment is likely to have been a significant factor contributing to both the acute clogging incident that occurred during March 2000 and the chronic clogging that occurred during the cycle testing program from 1997 to 2000. Air entrainment may have had a secondary effect of contributing to geochemical clogging that probably also occurred. Regardless of the reasons for this perceived failure, the results effectively dampened local enthusiasm for ASR as a potential water management tool for achieving water supply reliability.

ASR wells and recharge wells have several unique design features that differentiate them from production wells. Equipping ASR wells and recharge wells is also different when compared to production wells. For example, downhole flow control valves are typically recommended for ASR wells where cascading of recharge water may otherwise occur. This ensures a small pressure at the wellhead, regardless of the recharge flow rate, so that air entrainment does not occur. Understanding these differences is important for ensuring ASR success and to not repeat the clogging at Hopyard 6. It is important to note that for this project, the water quality is entirely different for AWPF product water versus surface water and that any future project would be designed using equipment and procedures specific to an ASR operation rather than retrofitting an existing well.

At least 500 ASR wells and about 130 ASR wellfields are currently operational in at least 20 states, plus many more in other countries. About 18 ASR wellfields and about 63 ASR wells are currently in operation in California. If implemented today, an ASR or recharge well program for Zone 7 would most likely be successful, providing water supply reliability during droughts, meeting peak demands, and reducing salinity. The best guarantee of success would be to follow a proven procedure for successful ASR or recharge wellfield development consistent with procedures developed and implemented during the past thirty years at many ASR and recharge wellfield sites, particularly at those where there has been no prior well recharge experience. The underlying principle is to develop such a project in phases, collecting reliable data, and with "go, no-go" decision points along the way. Any project working hundreds of feet below ground has inherent risks and uncertainties, but these can be managed and minimized. Such an approach is an effective way to manage risk.

Phased implementation of an ASR or recharge well test program following a proven, logical path, with facilities designed for project purposes and a commitment to obtaining necessary, reliable data would help ensure project success. Wells would be designed based upon extensive, site-specific data to guide storage interval selection, screen design, filter pack design to maximize well efficiency, and operational procedures to efficiently achieve program goals. Wellfield design and operations, such as well spacing, would be based upon a well-informed local model, based on site-specific data regarding groundwater velocities, leakage of confining layers, and pressures in different sand intervals. Wellhead facilities would be designed to maximize flow rates and thereby minimize unit operating costs. Pretreatment would be implemented if necessary to control well clogging. Unique backflushing and well development procedures would be implemented to maximize well recharge and recovery rates.

Through appropriate equipping of the wells with use of downhole control valves, air entrainment would be eliminated as a potential cause of chronic and acute well clogging and would also further reduce the potential for geochemical clogging due to calcium carbonate precipitation.

Well casing and column pipe would avoid the use of mild steel, thereby eliminating a potential source of corrosion products that can clog a well screen while stimulating microbial activity downhole. Corrosion products from mild steel also tend to increase the duration and frequency of backflushing required to maintain well performance, and the volume of backflush water that requires disposal.

A disinfectant residual would be maintained downhole at all times, not only during recharge periods but also during extended periods of no recharge and no recovery exceeding about one week. This would be achieved through a trickle flow of disinfected water during extended storage periods. Disinfection byproduct attenuation would occur during the 60-day to 120-day storage periods underground.

If needed, pretreatment of the recharge water could be implemented to reduce well clogging. This might be through pH adjustment to eliminate calcium carbonate precipitation or to avoid destabilization of clays. If bypass filter testing indicates occasional slugs of poor quality water reaching the wellhead, such as may occur due to flow reversal in a long transmission pipeline, a simple wellhead filtration system could be installed as a supplemental pretreatment device.

ASR or recharge wells would be designed and equipped to provide for efficient backflushing and redevelopment procedures, maximizing the energy available to periodically purge particulates from around the well screens and to stabilize the filter pack material for both recharge and recovery.

Due to the highly corrosive nature of RO permeate; stabilization of the purified water would be required for protection of pipelines as well as to reduce the potential for leaching of chemicals naturally present in the soils, such as arsenic. Orange County Water District has developed a stabilization mix that has been effective and continues to do research into ways to prevent leaching of chemicals into the injected recharge water (personal communication). Recent experience with ASR wells in Florida, a state with approximately 40 ASR well fields in operation, has also demonstrated that the mobilization of arsenic and other naturally occurring metals can be controlled. Mobilization control requires a proper geochemical and mineralogical study that provides the information needed to design operational procedures to maintain the stability of aquifer minerals.

6.5 Conclusions/Summary

The hydrogeologic feasibility of developing a potable reuse project with groundwater recharge was evaluated in this chapter and found to be feasible. Major findings are:

- Both Zone 7's 3-layer model and 10-layer model were used to assess feasibility and found suitable conditions for recharge operations.
- Subsurface travel times between injection sites and existing extraction wells can meet regulatory requirements through proper selection of injection sites.
- Recharge with low TDS water from an AWPF can significantly improve water quality conditions in the groundwater basin on both a local and basin-wide scale, with varying amounts of quality improvement depending on input location.

- Aquifer Storage and Recovery has been found to be effective at many other locations and provides an option to maintain control over the water quality and quantity without migration downgradient. The agencies may want to consider this option in the future.
- Methods to control mobilization of contaminants in the groundwater include stabilization of the purified water and proper geochemical and mineralogical studies once an injection location is identified.
- System wide operational modifications would be needed if a groundwater recharge project were to be implemented. Modifications to groundwater pumping and use of the groundwater supply would be needed to manage groundwater levels. Consideration of long-term system water quality would also be required with the potential for avoiding the costs to construct the second demineralization facility and to consider the best use of the existing demineralization facility.

Specific recommendations related to future hydrogeologic studies are included in Chapter 8.

6.6 References

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Chapter 7

SHORT-LISTED OPTIONS DETAILED ANALYSIS

7.1 Background

This Chapter evaluates the feasibility of the short-listed potable reuse project option(s) for the Tri-Valley. Information gathered in the prior Chapters was used in compiling the project options presented within this Chapter.

The following work was conducted to form the body of this Chapter:

- Project option reconfiguration and selection.
- Operational impact investigations.
- Development of site layouts.
- Revision of preliminary pipeline alignments.
- Concentrate management development.
- Refinement of the capital and O&M cost estimates.

7.2 Project Component Development

The three short-listed options selected in Chapter 5 were presented to the Steering Committee in a workshop in July 2017. During the presentation of alternatives at the workshop, it became apparent that the original regional facilities (at Mocho and at COL) were highly spatially constrained and would present significant construction issues. These sites were the only available alternatives at the time. However, at the meeting, representatives from the City of Pleasanton announced that their facility could be a potential third option for a regional facility. The site at Pleasanton was added, but since there was not as in depth of a site study conducted on the Pleasanton site, the option with an AWPF at Mocho was kept to provide at least one thoroughly investigated regional option.

Additionally, it was decided that both flow-based bookends (5,500 AFY and 10,00 AFY) should incorporate both a groundwater recharge via injection well option as well as a connection to surface water through the COLs. Based on this feedback from the workshop, the three projects were expanded to six options with different siting locations for each, as listed in Table 7.1. The purpose of evaluating these options is to provide the Tri-Valley Water Agencies a range of potential projects, with variations in flow, location, end use, and their corresponding costs. ***These options "book-end" the types of potable reuse combinations that may be considered in the Tri-Valley, but do not eliminate the future consideration of other options, locations, end uses or combinations/permutations of options.***

Table 7.1 Project Options for Detailed Evaluation

Option	Location	Capacity (mgd)	Source Water	Treatment Train	End Use
1a	Livermore	5	LWRP	FAT+	COL (Lake I)
1b				FAT	Well E
2a	DSRSD	12	DSRSD WWTP + LWRP	FAT+	COL (Cope Lake)/ DVWTP
2b				FAT	Well B
3	Regional at Mocho	12	DSRSD WWTP + LWRP	FAT	Well B
4	Regional at Pleasanton	12	DSRSD WWTP + LWRP	FAT+	COL (Cope Lake)/ DVWTP

Each option involves construction of an AWPF, using secondary effluent from either LWRP or DSRSD WWTP. All alternatives include either a FAT or FAT+ process train, but vary in the end use and location of the treatment train. The regulations are not fully developed yet for the raw water augmentation options so assumptions have been conservatively made regarding treatment trains with the recognition that required treatment and associated costs may be reduced in the future as regulations are finalized. Detailed development of these alternatives is discussed in Chapter 5.

7.2.1 End Uses

Three separate end uses continue to be investigated within this project: groundwater augmentation or recharge via injection wells, groundwater augmentation or recharge via surface spreading and reservoir augmentation, and raw water augmentation as defined below:

- Groundwater recharge via injection wells is where purified water is pumped into specific layers of the groundwater basin in order to supplement later extraction of groundwater for drinking water purposes.
- Groundwater recharge via surface spreading allows purified water to percolate to the groundwater basin below through maintained recharge faces. The projects that use Lake I would be considered surface spreading, with the note that Lake I is directly hydraulically connected to the aquifer and there is no intervening vadose zone for percolation and treatment as commonly found in surface spreading applications. Therefore additional treatment processes have been added (FAT+).
- Raw water augmentation is the planned placement of (purified) recycled water into a system of pipelines or aqueducts that deliver raw water to a drinking water treatment plant that provides water to a public water system.

The key difference among these uses is the amount and type of environmental buffer between the AWPF and Zone 7's treated water transmission system. The results shown within this section are based on the preliminary groundwater modeling shown in Chapter 5 and the detailed modeling in Chapter 6. For more introductory information about the end uses shown within, refer to Chapter 5.

7.2.1.1 Groundwater Recharge using Injection Wells

Through preliminary groundwater modeling and use of Zone 7's Water Supply Risk Model, it was determined that recharge of the basin appears to be both operationally and technically feasible

and may have some water quality benefits. In Chapter 5, six potential groundwater injection sites (Figure 7.1) were evaluated. When forming the three short listed options, only Well B was initially selected to represent the injection scenario for the evaluation of book-end options. This site was chosen due to its proximity to the source waters (LWRP and DSRSD WWTP), travel time to nearest extraction wells (at least 2 months required by regulations), efficiency of recharge, and potential to improve the nearby groundwater that has high TDS values. As noted above, the three options were presented to the Steering Committee in a workshop in July 2017. Based on feedback from the workshop, the three selected options were expanded to six options with different siting locations for each. Based on feedback at the July 2017 workshop, Well E was added back in for a Livermore only injection well option to represent an injection well site in the eastern end of the basin and better book-end the injection options. Because the groundwater flows from east to west through the basin and pumping in the central parts of the basin occur downgradient of the site of injection, modeling of injection at Well E showed reduced TDS across a much larger area of the basin as compared to the Well B scenario.

In the initial alternative development, an injection capacity of 2.2 mgd was assumed. This value was based on the conservative assumption that injection capacity is approximately 50 percent of production capacity. However, in the more detailed analysis, a more aggressive recharge assumption of 80 percent is being used. This assumption is based upon the improved technology over the past few years, as exemplified by the City of Phoenix's ASR program, which has been running successfully since 2010 using an 80 percent injection to extraction ratio - with some wells operating up to 90 percent. With improved well technology and understanding of local hydrogeology, it is therefore feasible that the injection to extraction ratio can be increased to 80 percent, which means that the assumed capacity of each well in this study can be assumed to be 3.5 mgd. This new assumption will require a closer level of monitoring in order to track specific capacity and fine-tune operations.

7.2.1.2 Groundwater Augmentation through Lake I

Groundwater modeling revealed that recharging purified water through Lake I results in effective increase of levels throughout the nearby groundwater basin. This efficiency, combined with the ability to transfer water to and from Cope Lake and Lake H, makes Lake I a desirable end use. As was discussed in Chapter 5, since Lake I is hydraulically connected to the groundwater basin and has an increased risk of not meeting the minimum two months of subsurface travel time before reaching a production well, more advanced treatment would be required for this alternative.

7.2.1.3 Use of Cope Lake - Raw Water Augmentation of DVWTP or Reservoir Augmentation

Raw water augmentation involves adding purified water to the intake system of a water treatment plant; reservoir augmentation requires a minimum holding time within a reservoir upstream of the treatment plant. Purified water sent to DVWTP can be routed through Cope Lake (reservoir augmentation, if appropriate conditions are met below) or directly through the future COLs pipeline (raw water augmentation) (see Figure 7.2). In either case, the primary end use for the purified water is blending with raw water influent to the DVWTP.

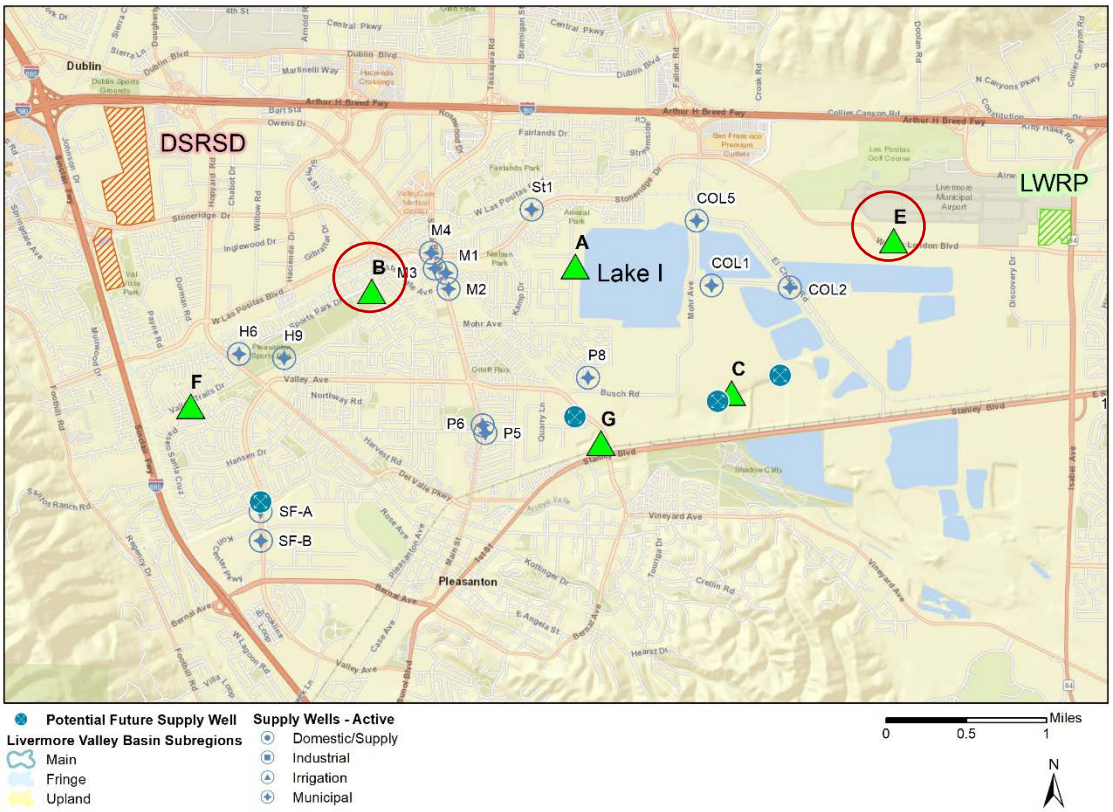


Figure 7.1 Potential Injection Locations

The final State Water Board's Surface Water Augmentation (SWA) regulations were adopted in March 2018. According to the regulations, a FAT process (instead of a more robust FAT+) is allowable if a retention time in a reservoir of 180 days can be shown. This lowered requirement would only apply to the option of an AWPF at Livermore with a product flow of 5 mgd going to Cope Lake. The following final requirements would apply to a reservoir (such as Cope Lake) in order for it to be considered in a reservoir augmentation project:

- A purified water residence time of 180 days, defined by a total volume of the reservoir divided by outflow. This value could be decreased to a minimum of 60 days. However, an additional 1-log reduction of pathogens is required.
- The reservoir must have been used as a drinking water reservoir for a recommended time of five years to establish a quality baseline before the addition of purified water. This time could be decreased to two years during discussions with the State or Regional Board.
- In operations of DVWTP, Zone 7 must ensure that the contribution of purified water within any 24-hour period to the DVWTP does not exceed 10 percent by volume. If the purified water contribution is lower than one percent consistently, then less stringent treatment requirements can be applied.

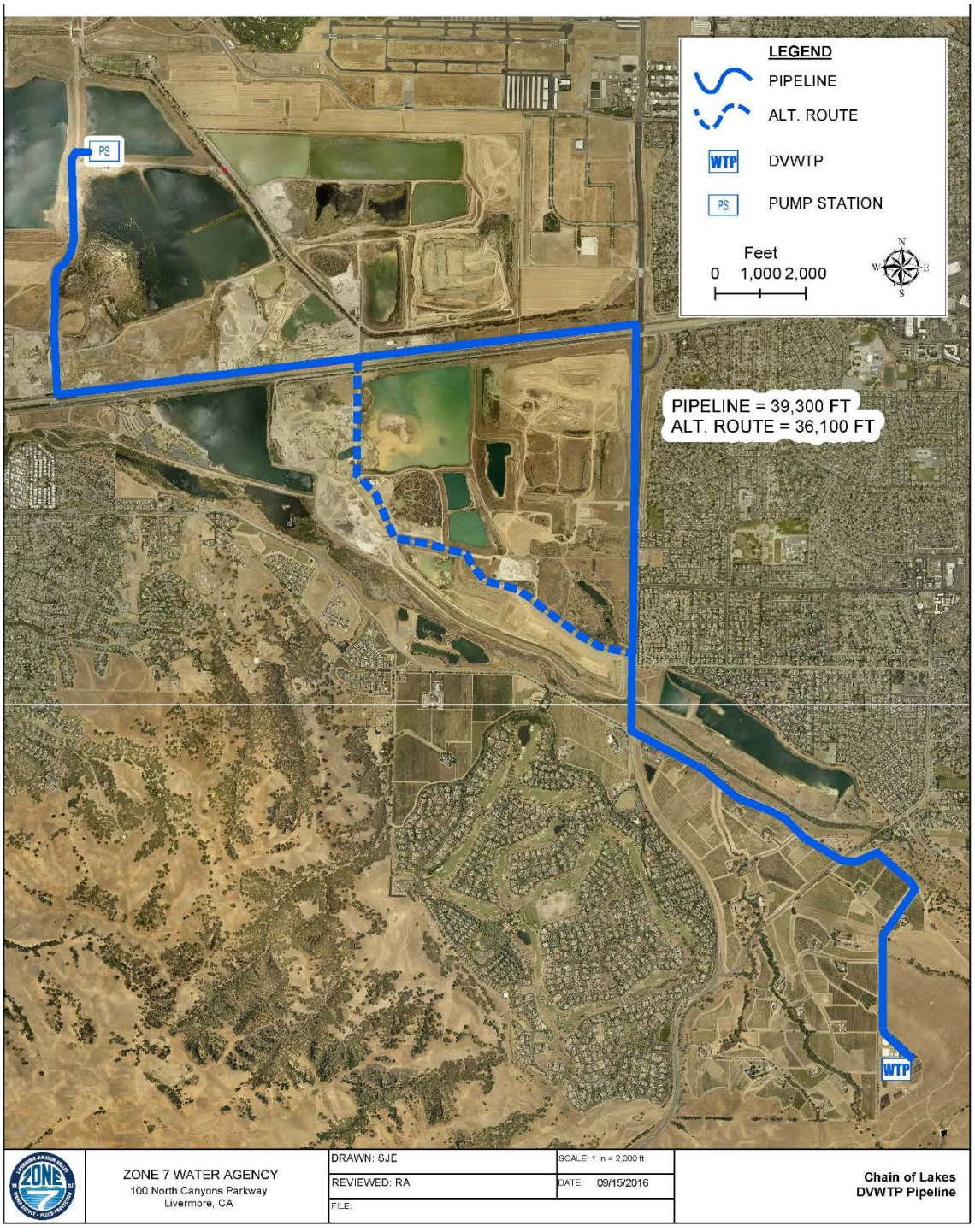


Figure 7.2 Potential Pipeline Connecting COL to DVWTP and the South Bay Aqueduct (COLs Pipeline)

Cope Lake has a capacity of approximately 4,500 AF (1,075 MG). This means that the maximum flow that it could accept and meet the 180 days minimum residence time is 6 mgd. To pursue use of Cope Lake as a reservoir, hydraulic modeling and potentially tracer studies would be needed to ensure that there is no short-circuiting in the reservoir or connectivity to wells. Additionally, all discharges and inputs into Cope Lake besides the purified water would need to be characterized to allow for calculation of the purified water contribution. If necessary, baffles might need to be installed to guarantee the residence time. Lastly, Zone 7 would need to build the COLs pipeline and operate the system for 2-5 years to establish the required baseline, or appeal to the regulatory board for an exception to this rule.

Under the current guidelines, use of Cope Lake alone would not be qualified for reservoir augmentation for flows higher than 6 mgd, unless an exception is approved by the RWQCB, in which case, additional treatment would be necessary. Use of Cope Lake is assumed to be reservoir augmentation for flows under 6 mgd and raw water augmentation for flows above 6 mgd.

Note that Cope Lake is hydraulically connected to Lake I, which has a larger storage volume; however, Lake I is directly connected to the groundwater basin. Use of the COLs for potable reuse will need to be further evaluated in the future, as other water management uses of the lakes (e.g., stormwater capture) are implemented.

7.2.2 Treatment Train Design Criteria

The treatment train requirements are based on end use and corresponding regulations. More information on technology and regulations is provided in Chapters 2 and 3. The two treatment trains being considered are:

- Full Advanced Treatment (FAT) - Microfiltration (MF), reverse osmosis (RO), and ultraviolet light advanced oxidation process (UV AOP).
- Full Advanced Treatment plus additional treatment (FAT+) - MF, RO, granular activated carbon (GAC), UV AOP, and an engineered storage buffer (ESB).

As shown in Chapter 3, these treatment trains meet the current and anticipated regulations for potable reuse in California. The process design criteria shown in this section are applicable to the selected six short-listed alternatives.

7.2.2.1 Design Flows

The amount of water available for potable reuse depends on the source water. The associated flows with each source water are shown in Table 7.2.

Table 7.2 Source Water and Design Flows

Source	Design Flow	Flow Variability
LWRP	5 mgd	Constant Year-Round
LWRP & DSRSD WWTP	12 mgd	Seasonal (12 mgd in winter months, 5 mgd in summer months)

7.2.2.2 Microfiltration (MF)

The MF system is one of the multiple barriers used in the AWPF to produce purified water. As shown in the water quality goals section the MF system is anticipated to achieve a 4-log removal of *Cryptosporidium* and *Giardia*. The MF system also serves as a pre-treatment to remove particulate matter from the feed water that would otherwise foul the RO membranes. For this study, the design criteria for the MF system for the three options are shown in the Table 7.3.

Table 7.3 Microfiltration Design Criteria

Design Criteria	5 mgd	12 mgd
Membrane Flux (gfd)	25	25
System Recovery (%)	94	94
Number of Racks	5	10
Membrane Modules Per Rack	100	100
Membrane Modules	335	814
Membrane Area per Module (ft^2)	800	800
Membrane Life (years)	5	5

7.2.2.3 Reverse Osmosis (RO)

The RO process in a potable reuse treatment train provides for removal of salt (measured as electrical conductivity (EC)), organics (measured as total organic carbon (TOC)), and pathogens. RO removes ~95 percent of incoming salt. Alongside with salt and TOC removal, RO removes trace level pollutants. Table 7.4 summarizes the RO design criteria. More detail can be found in Appendix E.

Table 7.4 Reverse Osmosis Design Criteria

Design Criteria	5 mgd	12 mgd
Membrane Flux (gfd)	12	12
System Recovery (%)	80	80
Membrane Area per Element (ft^2)	400	400
Number of Elements per Pressure Vessel	7	7
Number of Pressure Vessels per Train	54	54
Number of Pressure Vessels (Total)	145	352
Number of Trains (Total)	3	7
Membrane Life (years)	5	5

RO Concentrate Management

All potable reuse treatment trains included in this study involve RO as a key part of the process. RO is required by all current potable reuse regulations. However, RO produces a concentrate that requires treatment and/or disposal. The cost of concentrate management is not included in the cost estimate. Further studies should be developed to determine the benefits and limitations of each of the potential sites. The proposed RO concentrate disposal approach is to use the LAVWMA pipeline with final discharge via the EBDA outfall to San Francisco Bay.

RO concentrate has the potential to scale the insides of pipelines, reducing efficiency and causing extra friction. This issue can be managed with appropriate operational adjustments. While it is not anticipated to be necessary, antiscalant can be added to RO concentrate to protect the insides of pipelines. A pipe loop study would determine if antiscalant is necessary, and the appropriate doses.

Other concerns include the potential effects of discharging RO concentrate into the San Francisco Bay, specifically on the compliance of the EBDA discharge with the NPDES permit. For the discharge of RO concentrate, the critical issue for compliance is the dilution with other waters. As of 2017, enough secondary effluent from other treatment plants is being discharged within the EBDA pipeline to dilute the RO concentrate from a potential new Tri-Valley AWPF. Regardless of which Tri-Valley option is selected, as long as there is dilution from other EBDA participants' continued discharge, at the current rates the RO concentrate is not anticipated to cause an exceedance of the EBDA NPDES permit, as shown in Chapter 4. However, if other dischargers decide to pursue reuse projects or significantly reduce their effluent discharge, it may be necessary to implement a concentrate management project or update the NPDES permit (e.g., changing to mass-based limits or obtaining higher effluent limits based on higher dilution credits). There are several options for concentrate management:

- Third-stage RO to increase recovery and reduce concentrate stream moving toward a zero liquid discharge (or not using outfall but instead moving toward land disposal).
- Concentrate softening to produce calcium carbonate pellets, which can be disposed of or sold.
- Deep well injection.
- Evaporation pond.
- Land application.

Some of these options are not feasible for the Tri-Valley Area due to lack of land or an unfavorable groundwater structure. Of these alternatives, concentrate softening seems to be promising, if expensive. It has been successfully implemented with the Chino II Desalter located in Jurupa Valley, CA. These options will need to be further evaluated in the future.

7.2.2.4 Granular Activated Carbon (GAC)

GAC provides a polishing step after the RO process. It also provides an additional barrier for an FAT+ process in case of a chemical spike through the RO. It can quench the chloramines, which are added before the RO process to prevent fouling. Presence of excess chloramine could adversely affect operation of the UV/AOP system by exerting additional demand for chlorine (NaOCl). Table 7.5 shows the design criteria for the GAC system.

Table 7.5 Granular Activated Carbon Design Criteria

Design Criteria	5 mgd	12 mgd
System Configuration	Single Pass	Single Pass
Loading Rate	6 gpm/sf	6 gpm/sf
Carbon per Vessel	20,000 lbs	20,000 lbs
Number of Vessels	5	12

7.2.2.5 Ultraviolet Light / Advanced Oxidation Processes (UV AOP)

UV process provides for a high level of disinfection. Adding an oxidant before a high dose UV results in the generation of hydroxyl radicals during treatment, providing an advanced oxidation process (AOP). The UV AOP provides destruction of a range of pollutants that may pass through RO. Either hydrogen peroxide (H_2O_2) or sodium hypochlorite (NaOCl) can be used as an oxidant for this application. H_2O_2 is a more common oxidant than NaOCl for UV AOP applications. NaOCl presents benefits such as increased disinfection due to the presence of free chlorine, lower chemical cost, and operator familiarity. An additional benefit of the UV/NaOCl AOP is a more efficient generation of hydroxyl radicals at a low pH (<6), and RO permeate is typically in this pH range. Both the NaOCl and H_2O_2 UV advanced oxidation processes are controlled by oxidant dose and UV dose (UV intensity, UV Transmittance, or Power). However, the NaOCl UV process is also controlled by the influent pH to the UV reactor and is sensitive to ammonia residual through the RO process, which has a high NaOCl demand, thereby requiring a higher oxidant dose. Free chlorine concentration and pH should be closely monitored to ensure the UV AOP design dose is met. Design criteria for the UV AOP are presented in Table 7.6.

Table 7.6 UV/AOP Design Criteria

Design Criteria	5 mgd	12 mgd
Number of Reactors (1 Redundant)	3	8
UV Lamps (Duty)	408	972
UV Lamps Replaced per Year	255	608
UV Replacement Frequency (years)	1.6	1.6
UV Ballast	41	97
UV Ballast Replacement Frequency (years)	1	1
UV Sleeves	408	972
UV Sleeves Replacement Frequency (years)	20	49
Oxidant	NaOCl	NaOCl
Oxidant Dose (mg/L)	3	3

7.2.2.6 Engineered Storage Buffer (ESB)

An ESB is a series of three holding tanks which operate in a filling, holding, distributing cycle to allow time for monitoring and reacting to any potential issues in the upstream processes. The ESB not only replaces the environmental buffer with a more sterile environment but also provides additional contact time for disinfection. The design criteria for the ESBs are shown in Table 7.7.

Table 7.7 Engineered Storage Buffer Design Criteria

Design Criteria	5 mgd	12 mgd
Hold Time	30 min	30 min
Number of Tanks	3	3
Volume (each)	110,000 gal	250,000 gal
Diameter	35 ft	50 ft
Height	17 ft	19 ft
Freeboard	2 ft	2 ft

7.2.2.7 Post-Treatment

Water that is processed through an FAT or FAT+ treatment train has very low amount of minerals, TDS, and alkalinity in the water. Essentially, the water is so pure that it is aggressive or corrosive, which means that it could leach metals and minerals from the soils. It is necessary, therefore to stabilize the water after treatment, through decarbonation towers and lime addition. The decarbonation serves to remove excess dissolved carbon dioxide, increasing the pH of the water and decreasing the corrosiveness. The addition of lime helps to raise the alkalinity and hardness. These steps combine to stabilize the water and prevent corrosion of pipelines and leaching of metals in the aquifer. Soil column tests, using injection site specific cores, would be recommended to determine the appropriate level of stabilization required.

7.2.2.8 Staffing Assumptions

Due to the highly technical processes and high level of monitoring required, it is anticipated that the AWPF must be staffed 24 hours a day. An expected breakdown of the staffing requirements is shown in Table 7.8. A total of 16 full time employees or contractors are expected to be needed. O&M costs presented later on in the Chapter are based on the assumption of hiring a staff of 16. The costs associated with this value do not assume any "sharing" of staff with Livermore, DSRSD, and/or Zone 7, although this could be an option to reduce costs and should be evaluated in future evaluations. Depending on the project chosen and the amount of residence time in the environment, it may be possible to incorporate a higher amount of automation in exchange for a lower staffing requirement. This adjustment would be the result of discussions with DDW during project permitting. A detailed staffing memo is included in Appendix F.

Table 7.8 Staffing Summary

Staff Title	Number
Grade V	1
Grade III	5
Grade II	5
Mechanics	1
Electrician	1
Instrument Tech	1
Lab Tech	1
Admin	1
Total	**16**

7.2.2.9 Administrative Building

An operational/administrative building is needed to provide facilities for these staff members. In addition to an admin building, the Tri-Valley Agencies expressed interest in having a learning center or a place where members of the community could gather and learn about the AWPF. Additionally, a well-equipped laboratory would be necessary to meet the advanced monitoring requirements for the facility. This operations/administrative building was estimated to require approximately 7,000 square feet. This footprint includes office spaces, break rooms, facilities for staff, a small visitor center, as well as a small well-equipped lab. The lab would be equipped to handle the expected daily monitoring requirements, but weekly and monthly compliance samples may have to be sent to an outside lab. Future evaluations should consider whether existing labs (e.g., Zone 7's Water Quality Lab) could handle the additional workload from a potable reuse facility.

7.2.2.10 Footprint

These treatment processes are expected to require approximately 2.5 or 5 acres, for a 5 mgd and 12 mgd facility, respectively. A smaller footprint could be accommodated with a multi-story process building or creative repurposing of existing facilities.

7.2.3 Advanced Water Purification Facility Location

The proposed AWPF locations were chosen based on the ease of conveying the secondary effluent from the two water sources as well as distance to the proposed end uses. Three sites were selected from the initial set of four locations – LWRP, DSRSD WWTP, and a regional location at Mocho. A fourth site, a second regional location, was proffered in the July 2017 workshop, the City of Pleasanton Corp Yard. These locations provided a variety of potential options for consideration, supporting the book-end approach, but does not preclude consideration of other options in the future. A more detailed description of the sites and other considered sites can be found in the Site Memos delivered after the visits (Appendix G).

The four potential purification facility locations are highlighted in Figure 7.3 and are discussed in the following sections.

7.2.3.1 Alternative 1 - LWRP Site Location

The preferred location for the AWPF at the LWRP is the abandoned facultative sludge lagoons (FSLs) site located in the southwest edge of the LWRP (Figure 7.4 and Figure 7.5). Approximately 150,000 square feet (3.5 acres) of space is available if the three FSLs are drained and reclaimed. The two northern lagoons have already been dredged. However, the larger lagoon will need to be dredged and reclaimed. The solids from the smaller ponds were dewatered and hauled off without any disposal restrictions due to metals or contamination. Therefore, no restrictions are anticipated for the larger pond reclamation/solids removal. Currently, all lagoons have a reclaimed water cap, which will need to be drained. Additionally, the site should be leveled during construction.

Benefits of this site include the ability to repurpose the FSLs, visibility and ease of access for public, and the availability of utilities near the site (potable and fire water, process water, and fiber optic for SCADA system). The switchgear at the LWRP has enough electrical capacity for the predicted AWPF electrical loads. However, it is assumed that the AWPF will have its own dedicated power supply. More details about the LWRP site visit can be found in Appendix G.

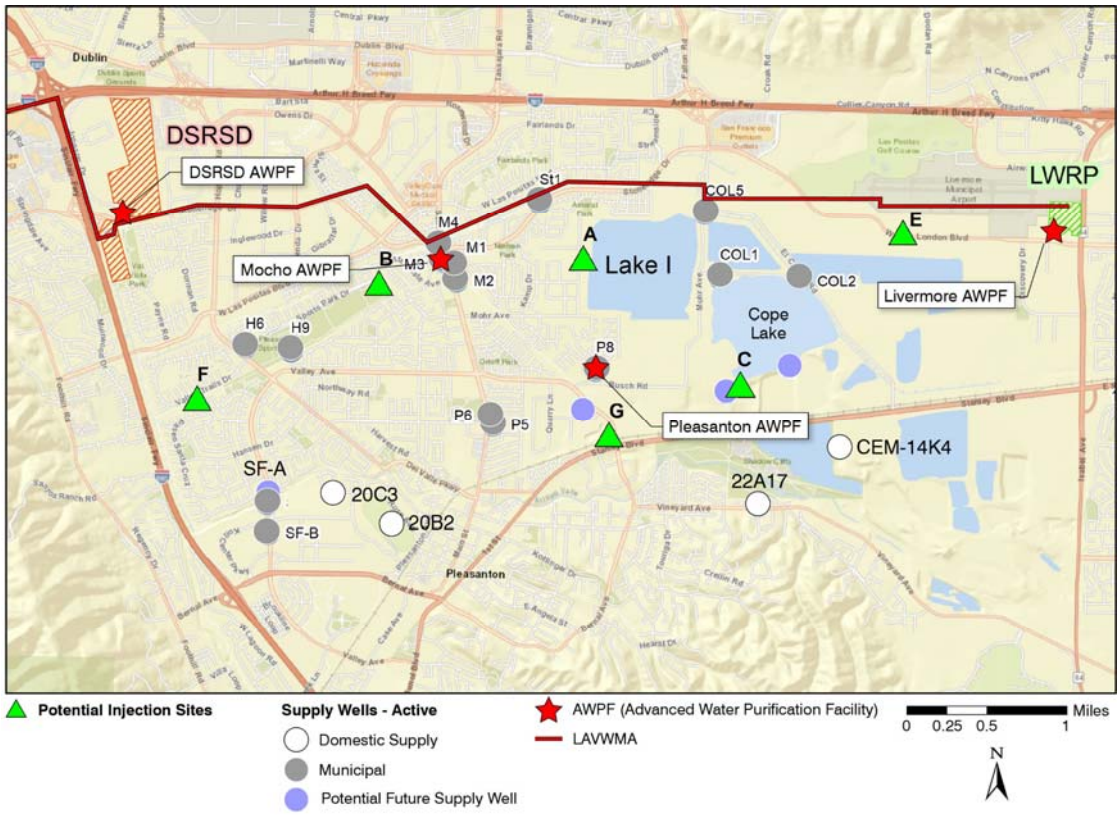


Figure 7.1 Four Potential Purification Facility Locations



Figure 7.2 Abandoned Facultative Sludge Lagoons

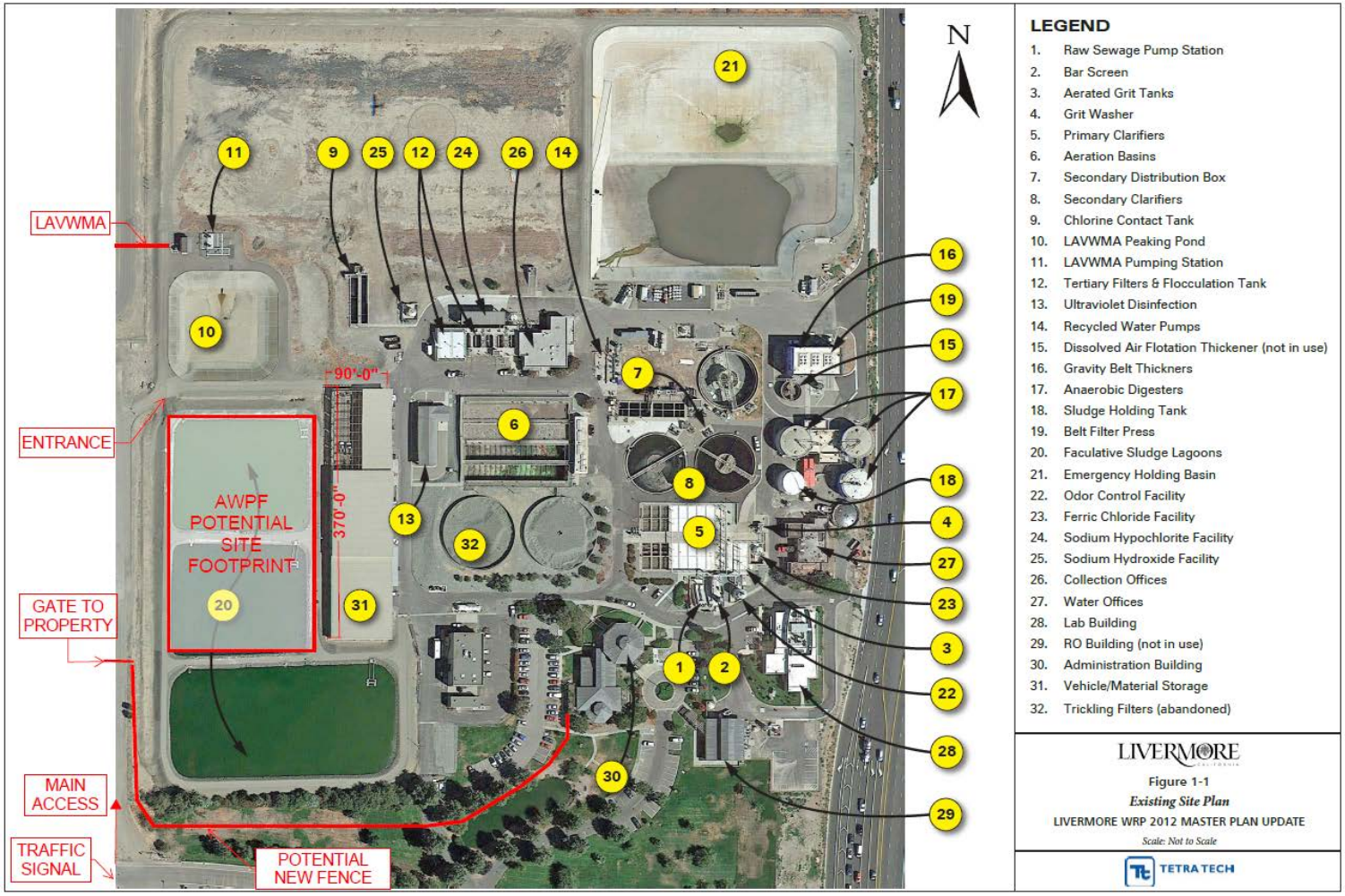


Figure 7.3 LWRP Site Map

7.2.3.2 Alternative 2 - DSRSD WWTP Location

The best location for the AWPF identified during the site visit to the DSRSD WWTP was the southwestern corner of the dedicated land disposal area (DLD, Site 3, Figure 7.6, Figure 7.7). The total DLD area is approximately 55 acres. The AWPF is anticipated to need about 5 acres. Use of this site requires decommissioning a portion of DSRSD's existing solids handling process. The site is accessible, both for visitors and deliveries. The road next to the site, Johnson Drive will be widened in the near future to accommodate planned development projects. To bring water to the site, a pump station would need to be installed at the LAVWMA facilities. This takes advantage of the equalization available in the LAVWMA ponds. Alternatively, the nearby 27-inch Livermore effluent pipeline and 42-inch DSRSD effluent pipelines could be tapped to bring water to the site; however, a new tank would be needed to provide equalization.

Since the AWPF would remove a portion of DSRSD's solids handling capacity, compensation may need to be provided to allow DSRSD to transition to mechanical dewatering or other solids handling adjustments. Mechanical dewatering could increase the solids percentage from three to six percent and therefore, reduce the area needed for land application.

To keep stormwater runoff contained on the DLDs, the entire site was constructed about 10 feet below grade. Construction of a new AWPF 10 feet below grade is not ideal for access. Solutions to this limitation could include raising the site or re-grading the site. For the purposes of this study, it is assumed the AWPF site will be raised 5 feet above the DLD levels. A new drainage plan for the site would be needed to keep runoff within the DLD boundaries for compliance with DSRSD's NPDES permit.

There is the potential to repurpose DSRSD's existing MF/RO building (Figure 7.8) for at least the MF membranes. However, splitting operations of the advanced treatment facilities is not ideal, so a cost-benefit analysis should be conducted before pursuit of this option. Layouts and costs for this option assume all treatment in one location.

A site visit was conducted by the project team. The write-up of this visit and more site details can be found in Appendix G.

7.2.3.3 Alternative 3 - Mocho Well Location

An alternate location for the AWPF is at the Mocho Well site (Figure 7.9) south of the Zone 7 Mocho Groundwater Demineralization Facility. The site contains two parcels, one owned by the City of Pleasanton, and one owned by DSRSD. In addition to the two owners, Zone 7 has several easements on the property, one of which includes a drinking water well and a disinfection building. The available space is approximately 74,000 square feet (1.7 acres). This site would provide high visibility of the project, being located on major roads. All relevant utilities are available because of the existing well facilities on the Mocho site. It should be determined if these utilities can be expanded to meet the AWPF needs. Regarding the electrical needs, an electrical power sharing agreement may potentially be arranged with Zone 7, depending on the ultimate ownership of the AWPF. Despite the convenient location from a utilities perspective, the site availability is limited to 1.7 acres (only about 70 percent of 2.5 acre site is useable). A two-story process building would be required to fit a large facility on the site.

The existing building also poses a constructability challenge; while the building could potentially be moved, Zone 7 prefers not to relocate the extraction well contained within the building.



Figure 7.4 DSRSD Site Layout with Potential AWPF Locations



Figure 7.5 View of Access Road from the Dedicated Land Disposal (DLD) area



Figure 7.6 DSRSD Microfiltration (MF) Building



Figure 7.7 Mocho Well Site Potential AWPF Location

Additionally there are several pipelines and easements which crisscross the site - one of which is a high-pressure petroleum line (Figure 7.10). Other considerations include the surrounding residential development, the presence of the Iron Horse Trial, and the park/open space that exist there presently. More information about the Mocho site is included in Appendix G.

Alternative 4 - Pleasanton Corp Yard

In the July 2017 workshop, when the short-listed options were presented, a fourth location was presented to the project team - the Pleasanton Corp Yard. Representatives from the City of Pleasanton mentioned that many buildings on the site were going to be replaced and potentially moved. If this occurred, there would be sufficient space to fit an AWPF. Additionally, the site is relatively close to the Chain of Lakes, which would reduce the purified water pumping requirement.

However, the Pleasanton site is not close to either WWTP, so source water pipelines and corresponding concentrate pumping would be necessary to bring water to and from the site.

The entire site includes both City of Pleasanton Facilities as well as a training ground for police and firefighters (Figure 7.11). The City of Pleasanton facilities could be rearranged potentially; however, the police and firefighter training ground would not be moveable.

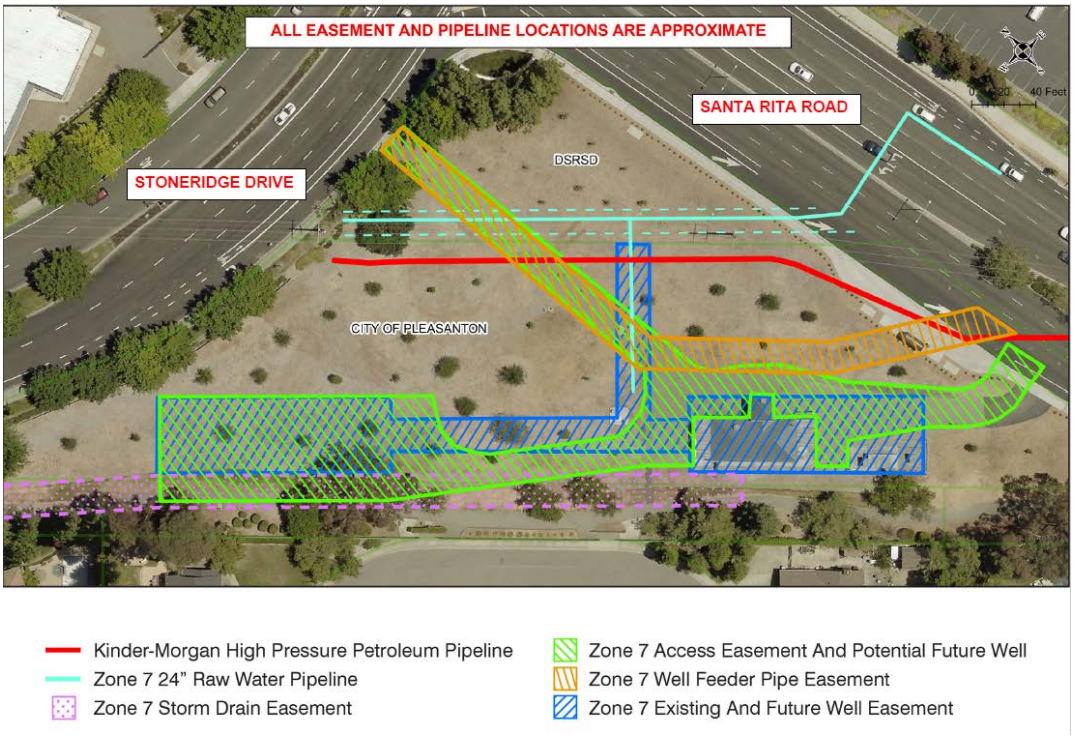


Figure 7.8 Existing Easements on Mocho Well Location



Figure 7.9 Pleasanton Corp Yard

7.3 Detailed Project Discussion

The identified alternatives were chosen to give a wide range of feasible projects, covering the spectrum of end uses and treatment locations. Six project options were selected for further investigation, including the three alternatives chosen during Workshop 3. They are listed below and in Table 5.1:

- Option 1a - Year-Round 5 mgd Livermore AWPF to COL/Lake I Recharge.
- Option 1b - Year-Round 5 mgd Livermore AWPF to Well E Injection.
- Option 2a - Seasonal 12 mgd DSRSD AWPF to COL/DVWTP.
- Option 2b - Seasonal 12 mgd DSRSD AWPF to Well B Injection.
- Option 3 - Seasonal 12 mgd Mocho AWPF to Well B Injection.
- Option 4 - Seasonal 12 mgd Pleasanton AWPF to COL/DVWTP.

7.3.1 Option 1a - Year-Round 5 mgd Livermore AWPF to COL/Lake I Recharge

This option involves FAT+ at the LWRP and conveyance to Lake I recharge. Because of the existing connection between Lake I and Cope Lake as well as the planned connection between the COLs and the DVWTP (via the future COLs pipeline), this alternative also incorporates the flexibility to route flows from Lake I to either Cope Lake or to DVWTP via the COL pipeline (costs are included for the upsized pump station for the connection to DVWTP). Option 1 was selected due to its low capital cost and relatively low unit cost. However, the low capital cost is due to the lower yield of 5,500 AFY of product water. From a regulatory perspective, recharging Lake I does not qualify as reservoir augmentation since its primary purpose is groundwater recharge. However, some water from Lake I/Cope Lake could be sent to DVWTP in emergency situations, which could be considered reservoir augmentation or raw water augmentation, depending on amount of hold time allowed; this type of use would need to be vetted with DDW and may require a special exemption. Lake I does not have enough travel time to fully qualify for the groundwater recharge regulations for potable reuse. This scenario poses an interesting regulatory issue, which could be resolved with the additional treatment explained earlier.

Another potential end use from an AWPF at Livermore, is to convey purified water to the Arroyo Mocho for groundwater recharge. As shown in Figure 7.12, this end use would require a pipeline from the Livermore AWPF to the Arroyo Mocho, with the closest location being south of the LWRP in the vicinity of Arroyo Mocho crossing and Isabel Avenue. Zone 7 conducts artificial recharge with South Bay Aqueduct (SBA) water along this reach of the Arroyo Mocho, taking advantage of available SBA water and available capacity in the Arroyo Mocho. Conveyance of purified water to the Arroyo Mocho for recharge is not considered a standalone end use because of potential capacity limitations. On a seasonal basis, Zone 7 may take advantage of all or nearly all of the Arroyo Mocho capacity for recharge of SBA water. However, by coordinating purified water recharge and recharge of SBA water, there is potential to recharge purified water via the Arroyo Mocho during some portion of the year and to utilize an alternative end use (such as Lake I recharge or Well E injection) when capacity is not available in the Arroyo Mocho. To maximize water supply, Zone 7 could also store excess SBA water in Semitropic, making the Arroyo Mocho capacity available for purified water. Combining purified water recharge via the Arroyo Mocho provides some potential advantages with respect to operational flexibility, public perception (i.e. subsurface environmental buffer) and environmental benefits (additional in-stream flow in the Arroyo Mocho when needed). Should a project move forward with an AWPF located at

Livermore, this option could be considered further; costs to discharge into the Arroyo Mocho are not included in this version of the project cost estimate.

7.3.1.1 Pipeline Alignments

The pipeline from the Livermore AWPF to Lake I is shown in Figure 7.12. It has a nominal diameter of 18 inches and is approximately 16,000 lineal feet (LF). In Workshop 3, it was mentioned that there is an unused 12-inch recycled water pipeline that also follows Jack London Boulevard. While this line is smaller than what is required, it may be possible to repurpose this pipeline. Additionally, it may be possible to use a portion of the LAVWMA line easement or pipeline to convey purified water, either repurposing the line or adding an additional pipeline within the existing LAVWMA line. A more detailed hydraulic and regulatory assessment should be conducted before determining if it is possible to use either pipeline, especially considering the need for peak wet weather flow conveyance in the LAVWMA line. Current pipeline requirements are shown in Table 7.9. These requirements assume new pipelines and no use of existing lines.

Table 7.9 Livermore AWPF to COL Infrastructure Requirements

Item	Unit	Value
Source Water Pipeline		
Diameter	in	20
Length	LF	200
Pumping Requirement	hp	0
Concentrate/Waste Pipeline		
Diameter	in	10
Length	LF	300
Pumping Requirement	hp	20
Purified Water Pipeline		
Diameter	in	18
Length	LF	16,000
Pumping Requirement	hp	190

Notes:
(1) Pumping requirement based on a 70% pump efficiency.

7.3.1.2 Layout

A layout for the Livermore AWPF is shown in Figure 7.13, and Figure 7.14.

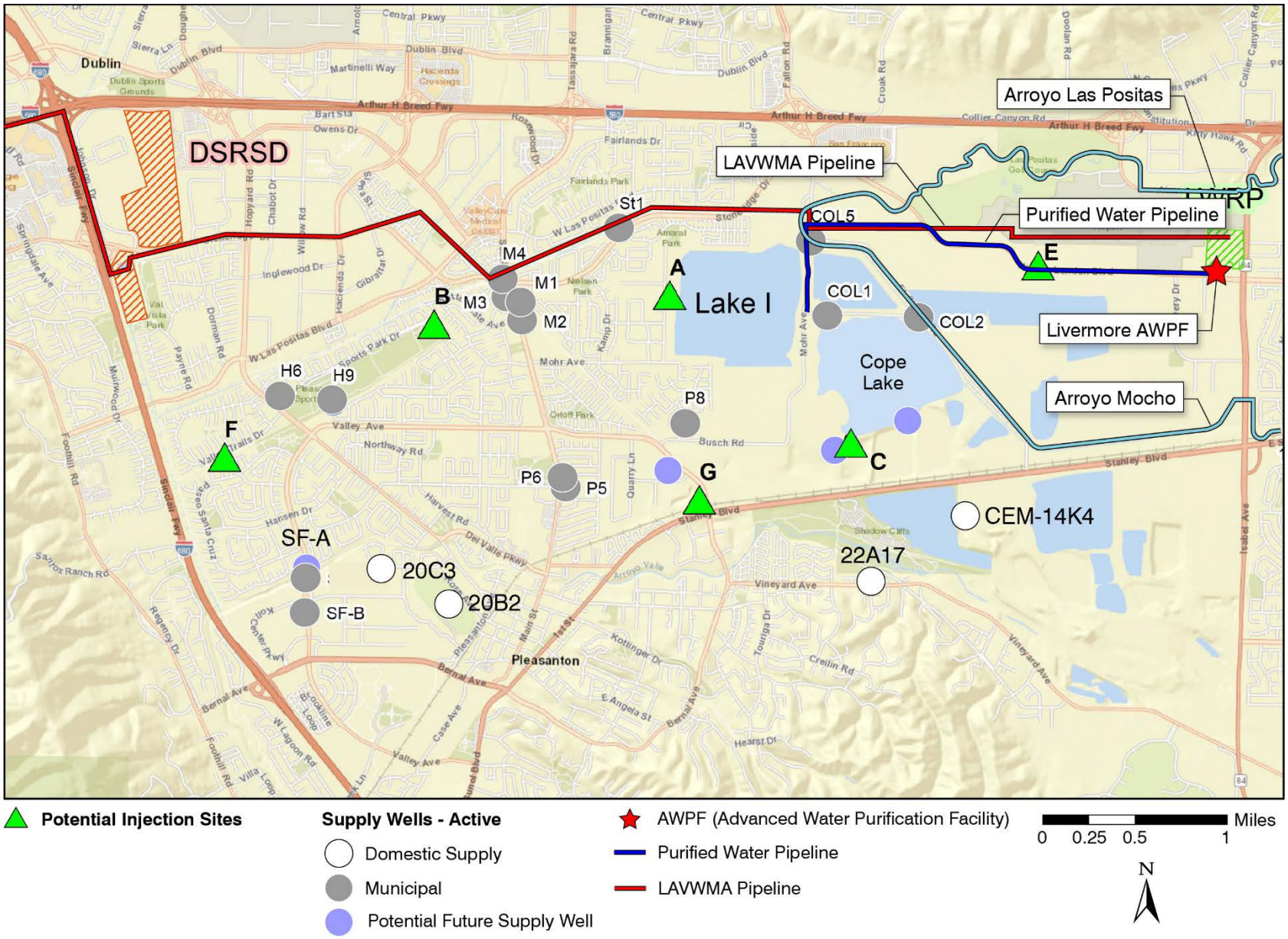


Figure 7.10 Livermore AWPF to COL

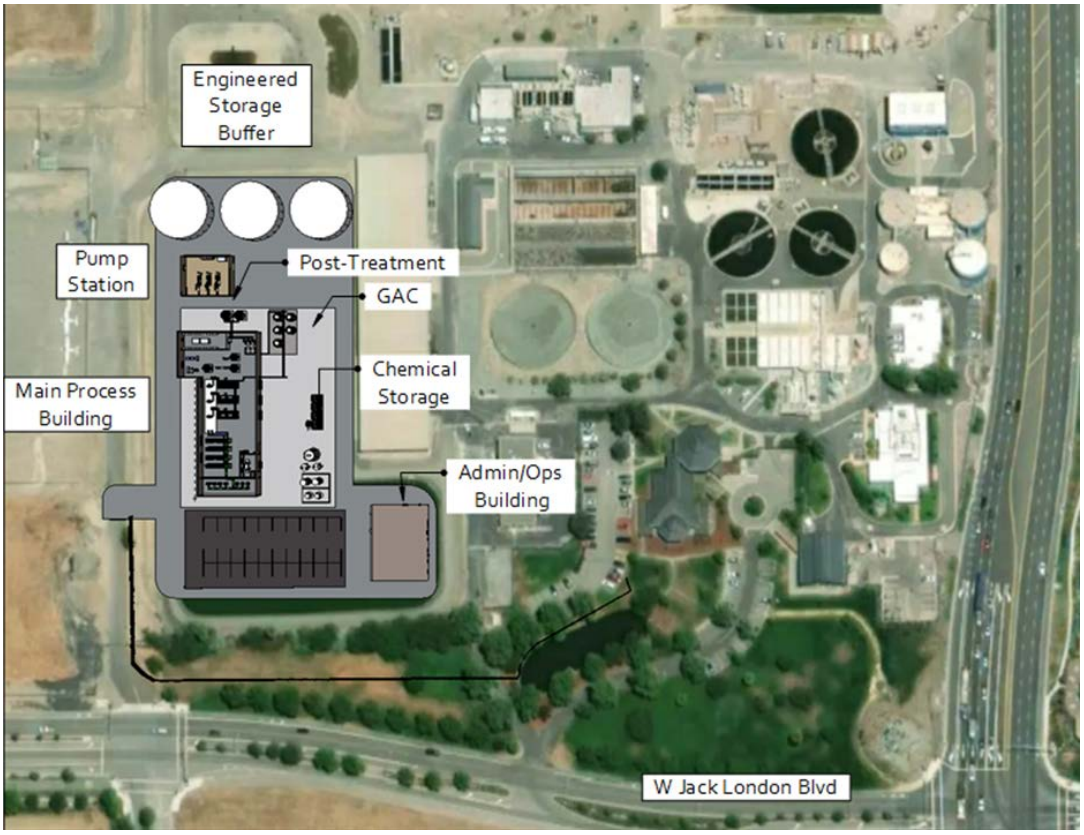


Figure 7.11 Livermore AWPF Layout - Top View

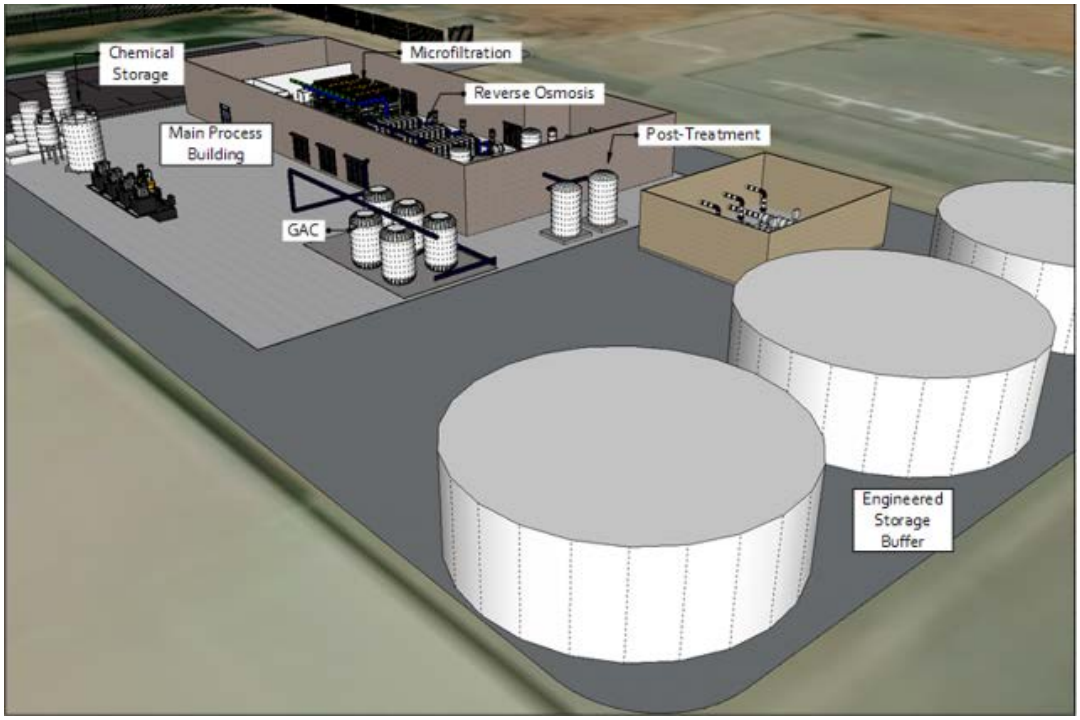


Figure 7.12 Livermore AWPF Layout (Iso View)

7.3.2 Option 1b - Year-Round 5 mgd Livermore AWPF to Well E Injection

This option involves FAT at the LWRP and conveyance to Well E Injection area (Figure 7.15). This option was added to explore a less expensive alternative due to lower treatment requirement (no ESB or GAC). Additionally, since regulations are fully in place for this type of potable reuse, the implementation process will likely be simpler and require less time. This option also provides the opportunity to evaluate impacts of injection in another part of the basin. ASR at this well injection site is a potential option in the future, if desired, depending on site conditions.

As discussed in Option 1a, another potential end use from an AWPF at Livermore, is to convey purified water to the Arroyo Mocho for groundwater recharge (see Figure 7.12). In this case, recharge purified water via the Arroyo Mocho could be conducted when capacity is available, and conveyed to Well E for groundwater injection when capacity is not available. Recharge of purified water via the Arroyo Mocho provides some potential advantages with respect to operational flexibility, public perception (i.e. subsurface environmental buffer) and environmental benefits (additional in-stream flow in the Arroyo Mocho when needed). In addition, there is potential for reduced O&M costs by eliminating injection well pumping during the portion of the year when purified water is conveyed to the Arroyo Mocho. The cost to bring a pipeline to the Arroyo Mocho is not included in the current project cost estimate.

7.3.2.1 Pipeline Alignments

The source water pipeline is approximately 200 feet, with no additional pumping necessary. The purified water pipeline is almost 10,000 LF shorter than Option 1a, although an extension to the COLs could be considered in the future. The current infrastructure requirements are shown in Table 7.10.

Table 7.10 Livermore AWPF to Well E Infrastructure Requirements

Item	Unit	Value
Source Water Pipeline		
Diameter	in	20
Length	LF	200
Pumping Requirement	hp	0
Concentrate/Waste Pipeline		
Diameter	in	10
Length	LF	300
Pumping Requirement	hp	20
Purified Water Pipeline		
Diameter	in	18
Length	LF	6,500
Pumping Requirement	hp	130
Injection Well	No.	2
Monitoring Well	No.	4

Notes:
(1) Pumping requirement based on a 70% pump efficiency.

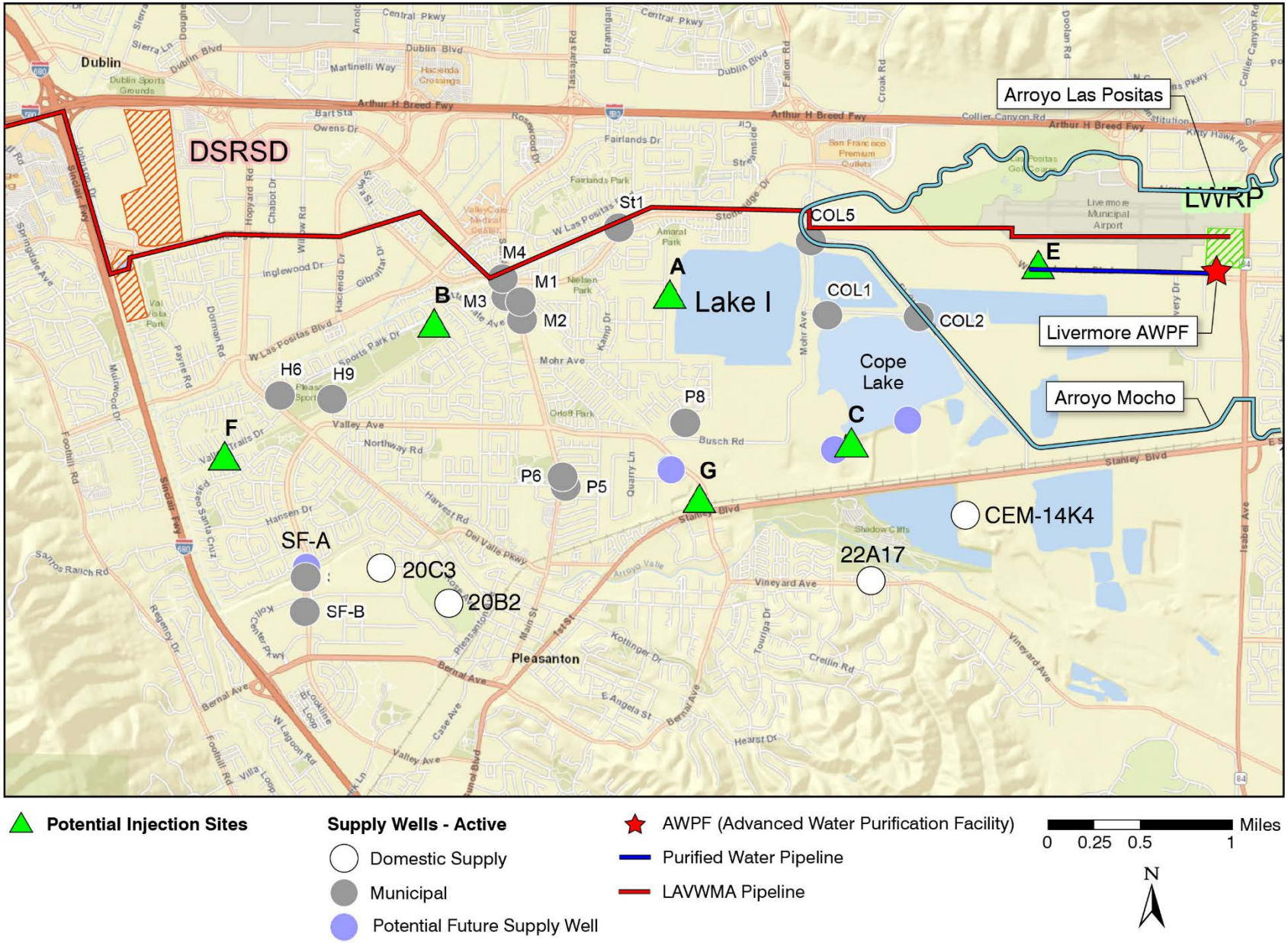


Figure 7.13 Livermore AWPF to Well E

7.3.2.2 Layout

A layout for the Livermore AWPF is shown in Figure 7.16 and Figure 7.17.



Figure 7.14 Livermore FAT AWPF Layout

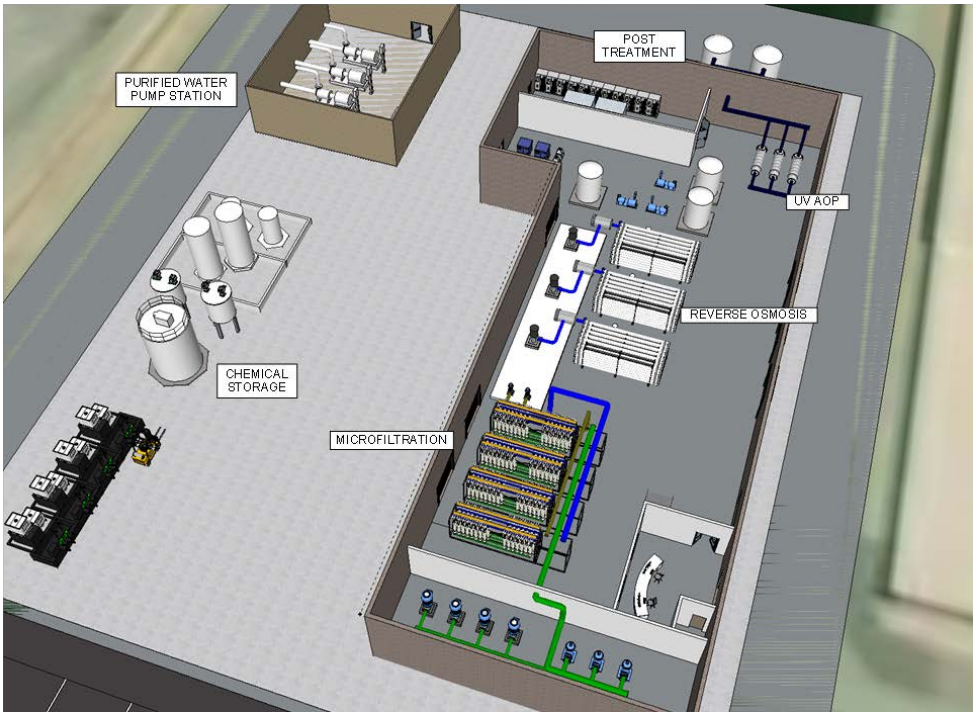


Figure 7.15 Livermore FAT AWPF Layout (Side View)

7.3.3 Option 2a - Seasonal 12 mgd DSRSD AWPF to COL/DVWTP

This option involves FAT+ at DSRSD and conveyance to DVWTP via Cope Lake for raw water augmentation, as shown in Figure 7.18. Given the connectivity of the COLs, this alternative incorporates the flexibility to convey water to Lake I for recharge as well, which will be useful to provide flexible operations. This option was selected based on the high yield (10,000 AFY), and the flexibility it provides to incorporate raw water augmentation (primarily) and groundwater recharge. The yield is achieved through seasonal treatment. However, it is recognized that there is some additional operational complexity involved with seasonal treatment.

7.3.3.1 Pipeline Alignments

Source water could be brought either from the LAVWMA system (approx. 1,000 LF away) or the two parallel wastewater effluent pipelines could be tapped to bring water to the treatment facility. In this study, it is assumed that the water comes from LAVWMA, where the ponds can provide equalization of variable flows. Concentrate would be returned to the LAVWMA effluent pump station. The 30-inch purified water pipeline to Cope Lake is approximately 23,000 LF. Infrastructure requirements are shown in Table 7.11.

Table 7.11 DSRSD AWPF to COL/DVWTP Infrastructure Requirements

Item	Unit	Value
Source Water Pipeline		
Diameter	in	30
Length	LF	1,000
Pumping Requirement	hp	275
Concentrate/Waste Pipeline		
Diameter	in	16
Length	LF	1,500
Pumping Requirement	hp	40
Purified Water Pipeline		
Diameter	in	30
Length	LF	23,000
Pumping Requirement	hp	690

Notes:
(1) Pumping requirement based on a 70% pump efficiency.

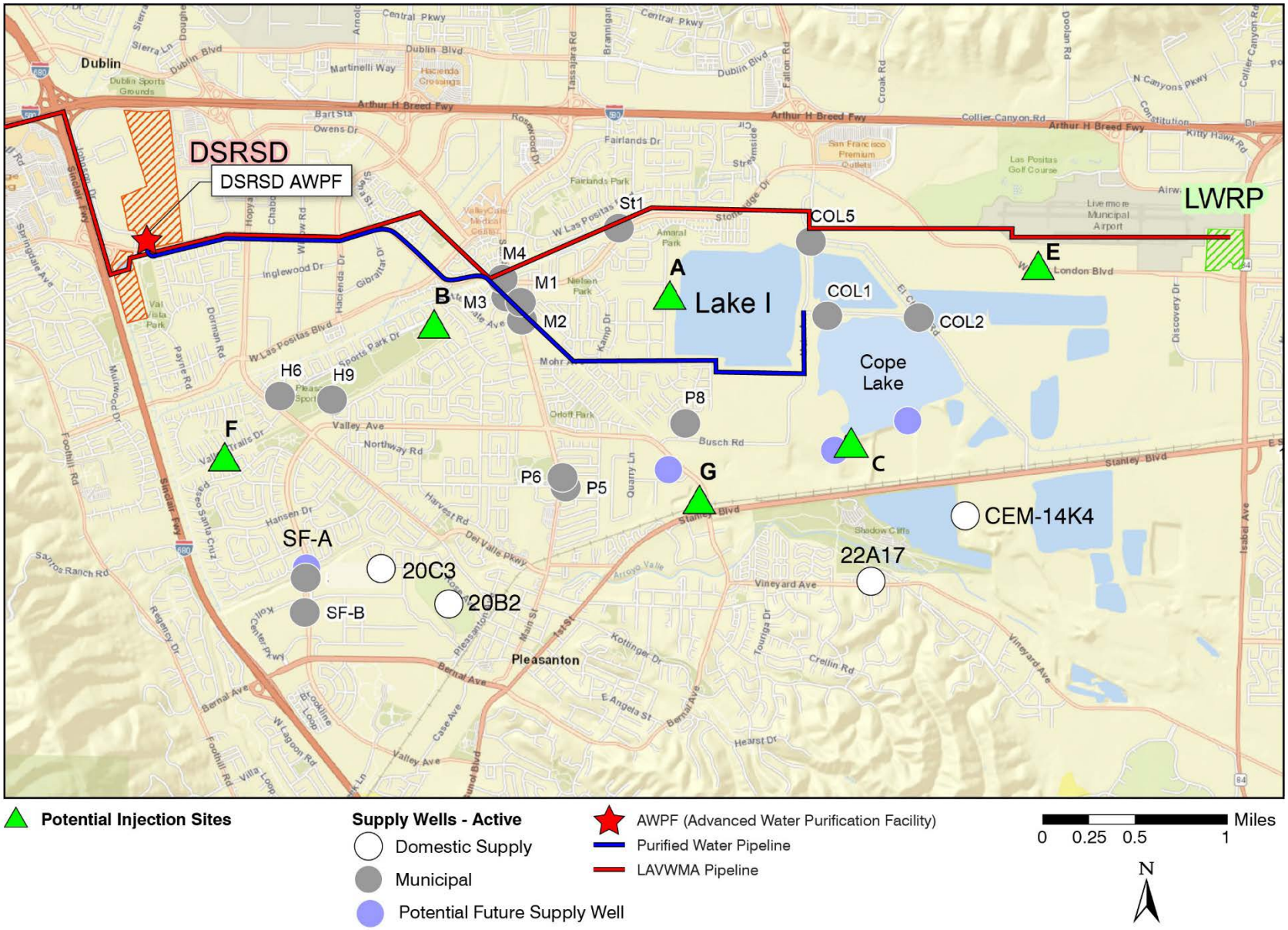


Figure 7.16 DSRSD AWPF to COL/DVWTP Overview

7.3.3.2 Layout

The layout for the potential FAT+ AWPF is shown in Figures 7.19, 7.20 and 7.21. The site occupies approximately five acres of the existing DLDs. This corresponds to about 10 percent of the DLDs. In return for use of the land, DSRSD may need to be compensated for the loss of 10 percent of their solids disposal mechanisms. In DSRSD's 2017 Wastewater Treatment and Biosolids Facilities Master Plan, several alternative solids handling and disposal alternatives were evaluated. The most promising alternative - mechanical dewatering of a portion of FSL solids for offsite disposal in winter - was chosen as the most viable option. For this analysis, the cost of using 10 percent of the DLDs includes 10 percent of the costs to implement the alternative solids handling project ($14,600,000 total construction for the whole project; a value of $1,460,000 is used for this project cost).



Figure 7.17 DSRSD AWPF Layout (Far View)

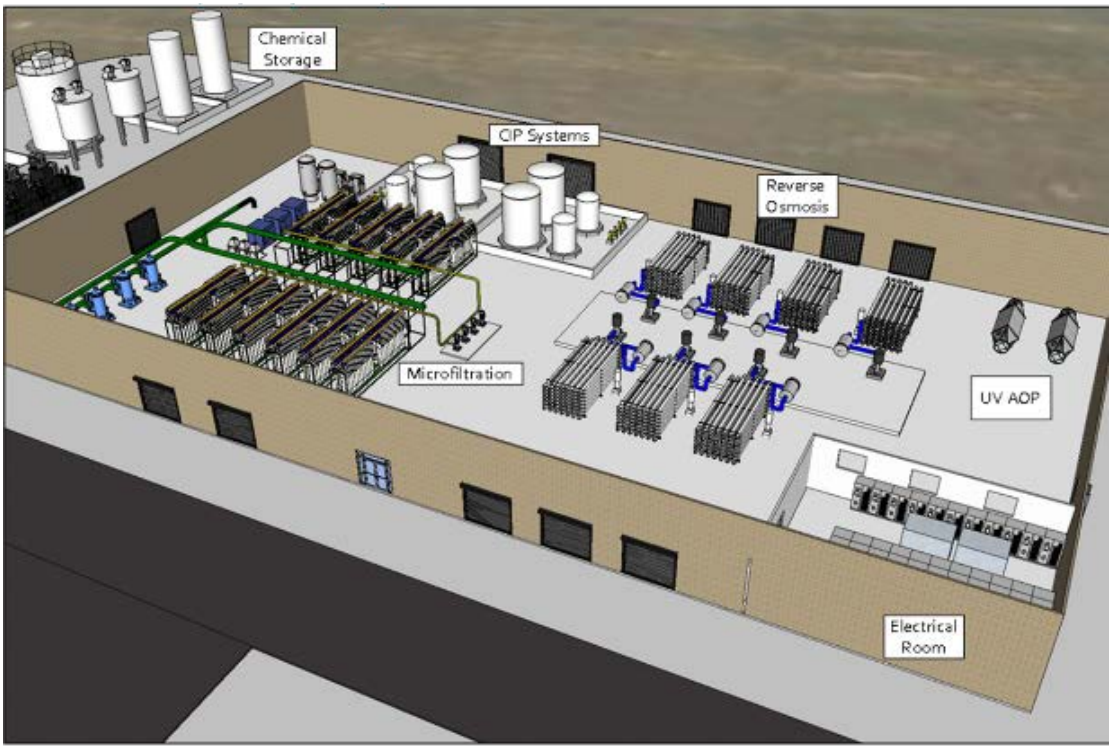


Figure 7.18 DSRSD AWPF Process Building

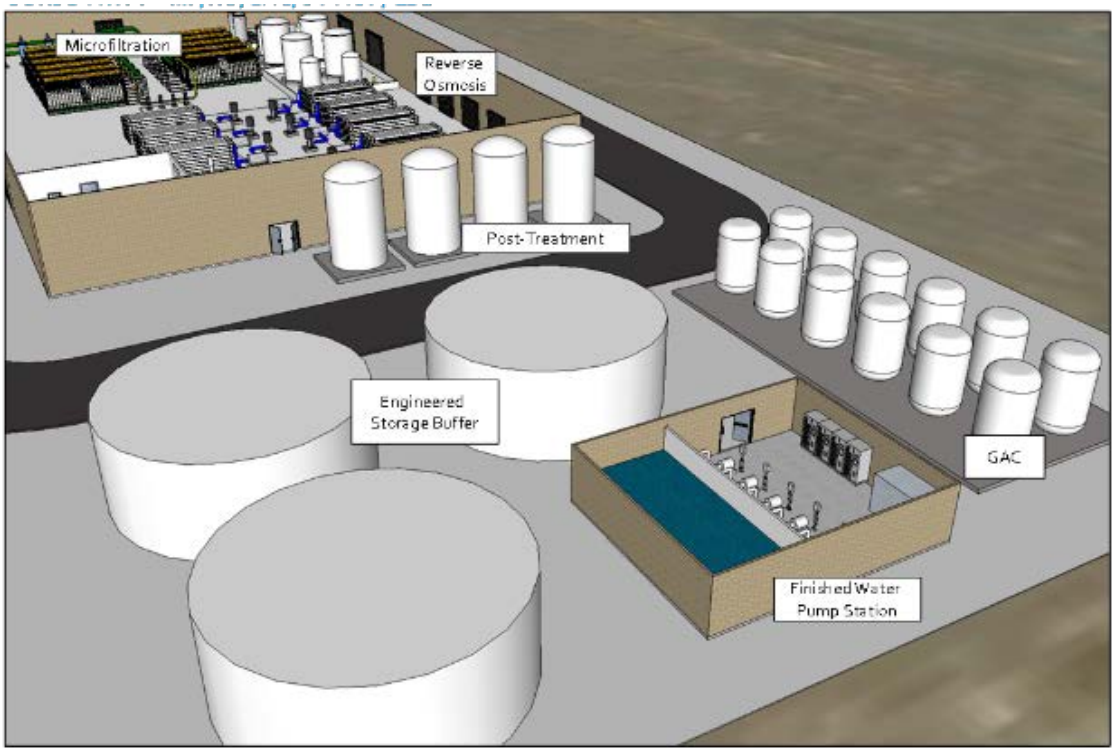


Figure 7.19 DSRSD AWPF Additional Processes

7.3.4 Option 2b - Seasonal 12 mgd DSRSD AWPF for Well B Injection

This option involves FAT at DSRSD and groundwater augmentation at Well B area. The pipeline alignment is shown in Figure 7.22. This project was added based on the lower cost due to lower treatment requirement (no ESB or GAC) and a shorter conveyance pipeline. Additionally, since regulations are fully in place for this type of potable reuse, this alternative provides the benefit of relative ease of implementation.

7.3.4.1 Pipeline Alignment

The source water pipeline is still the same as in short-listed Option 2a. However, the purified water pipeline is only 11,000 LF (12,000 LF shorter). The infrastructure requirements are shown in Table 7.12.

Table 7.12 DSRSD AWPF to Well Injection Infrastructure Requirements

Item	Unit	Value
Source Water Pipeline		
Diameter	in	30
Length	LF	1,000
Pumping Requirement(1)	hp	275
Concentrate/Waste Pipeline		
Diameter	in	16
Length	LF	1,500
Pumping Requirement(1)	hp	40
Purified Water Pipeline		
Diameter	in	31
Length	LF	11,100
Pumping Requirement(1)	hp	400
Injection Well	No.	4
Monitoring Well	No.	8

Notes:
(1) Pumping requirement based on a 70% pump efficiency.

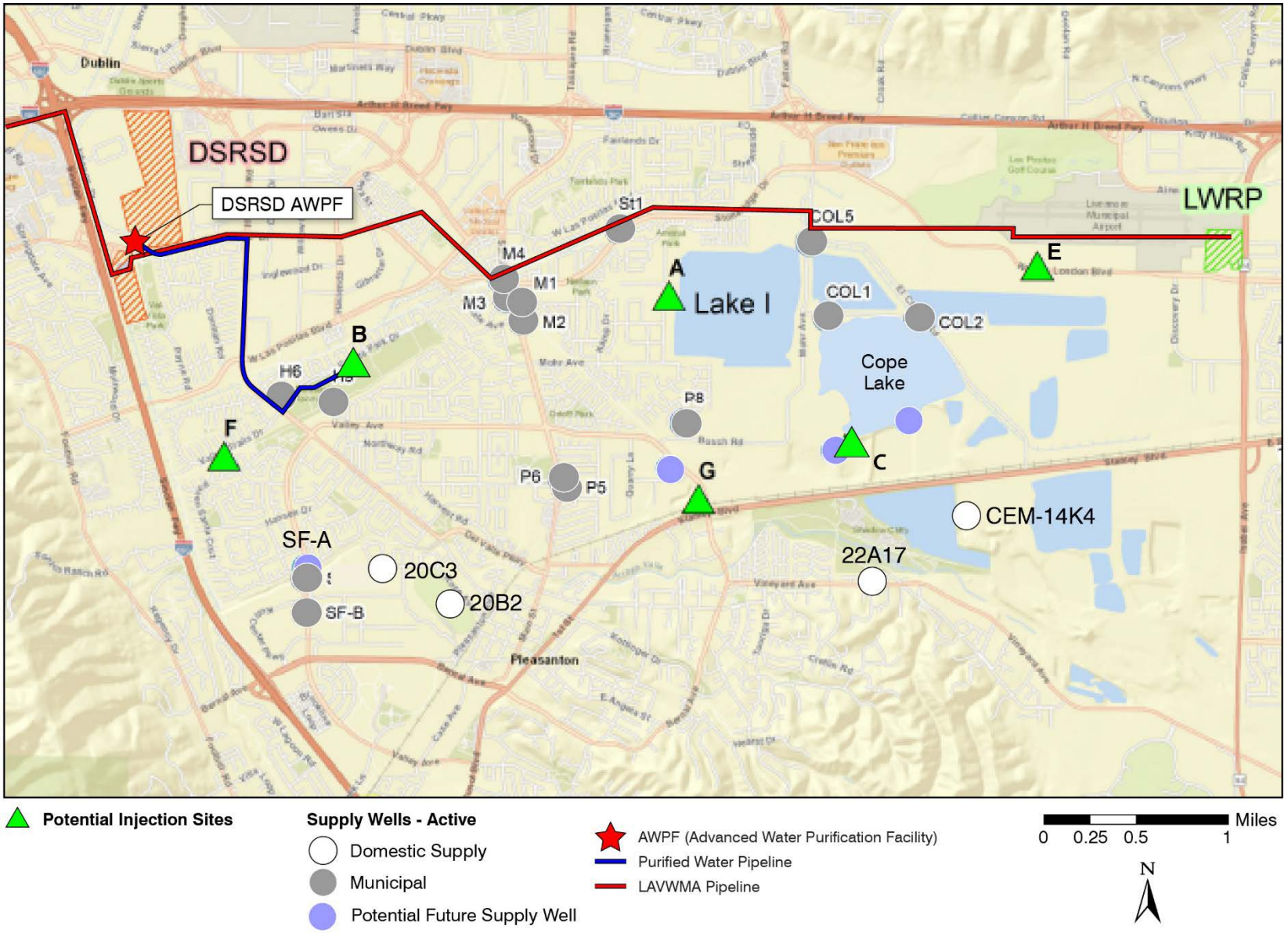


Figure 7.20 DSRSD AWPF to Injection Well Site B

7.3.4.2 Layout

Unlike short-listed Option 2a, this option does not have GAC or an ESB. As a result, the required area for the plant can be reduced to 4.3 acres, as shown in Figures 7.23 and 7.24.



Figure 7.21 DSRSD AWPF Layout (Zoomed Out)

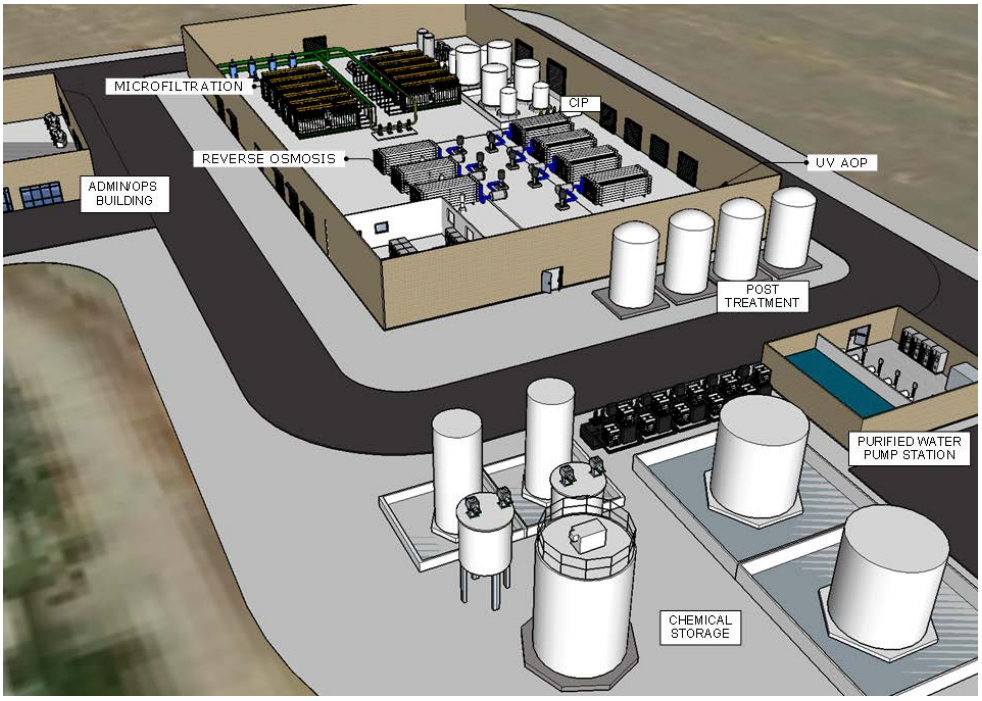


Figure 7.22 DSRSD AWPF Layout (Iso View)

7.3.5 Option 3 - 12 mgd Mocho AWPF for Well B Injection

This short-listed option involves FAT at the Mocho site and groundwater injection at Well B (see Figure 7.25. This option was selected based on the high yield (10,000 AFY seasonal operation receiving water from both LWRP and DSRSD WWTP), relative ease of implementation (regulatory), and potential benefits of a purification treatment plant located off-site from a WWTP. The relative ease of implementation is based on existing regulations and precedent for permitted groundwater injection systems. The benefits of an off-site treatment facility are related to public perception. While proximity of the AWPF to a WWTP can be convenient for staff, operations, and supplies, a satellite facility can be beneficial terms of public perception by providing distance between the wastewater plants and the purification plant. It is also easier to delineate roles and responsibilities of project participants with a regional site.

7.3.5.1 Pipeline Alignment

The 27-inch pipeline from LWRP passes almost directly through the Mocho site. It may be possible to tap into the pipeline and direct source water into the influent equalization tank for the site. Water from DSRSD would have to be pumped via a separate new 24-inch pipeline. This pipeline would be approximately 13,000 LF. Concentrate and MF backwash would be sent to the LAVWMA Pipeline downstream of the extraction of the LWRP flows. It is assumed within this report that, even though the waste stream from the facility may exceed the LAVWMA limits in terms of TSS and turbidity, the overall dilution provided by other facilities within EBDA would allow this discharge to be permitted. It may be possible to send the MF waste flows to the collection system nearby, but capacity of the collection system would need to be verified. Infrastructure requirements are shown in Table 7.13.

Table 7.13 Mocho AWPF to Injection Wells

Item	Unit	Value
Source Water Pipeline		
Diameter	in	24
Length	LF	13,000
Pumping Requirement	hp	620
Concentrate/Waste Pipeline		
Diameter	in	16
Length	LF	500
Pumping Requirement	hp	70
Purified Water Pipeline		
Diameter	in	30
Length	LF	6,300
Pumping Requirement	hp	320
Injection Well	No.	4
Monitoring Well	No.	8

Notes:
(1) Pumping requirement based on a 70% pump efficiency.

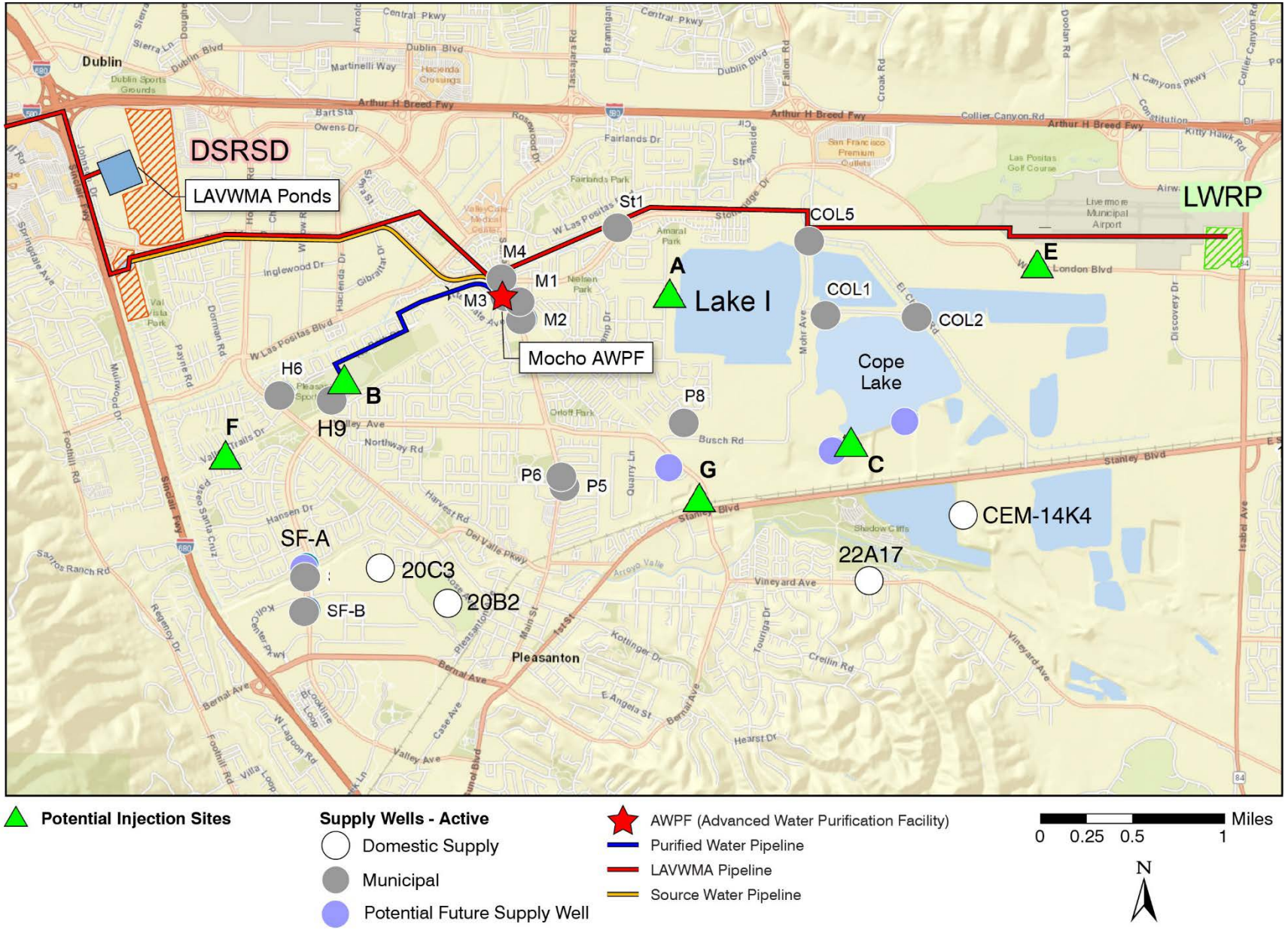


Figure 7.23 Mocho AWPF to Injection Well Site B Overview

7.3.5.2 Layout

Due to the extreme site constraints discussed earlier, it is necessary to put the processes in a two story building. All break tanks are assumed to be buried, but there may be limited space on the site to bury them due to the amount of utilities on the site. Due to the residential nature of the site, it is recommended to put the chemicals inside a building. Layouts for the Mocho site are shown in Figures 7.26, 7.27, and 7.28.



Figure 7.24 Mocho AWPF Layout

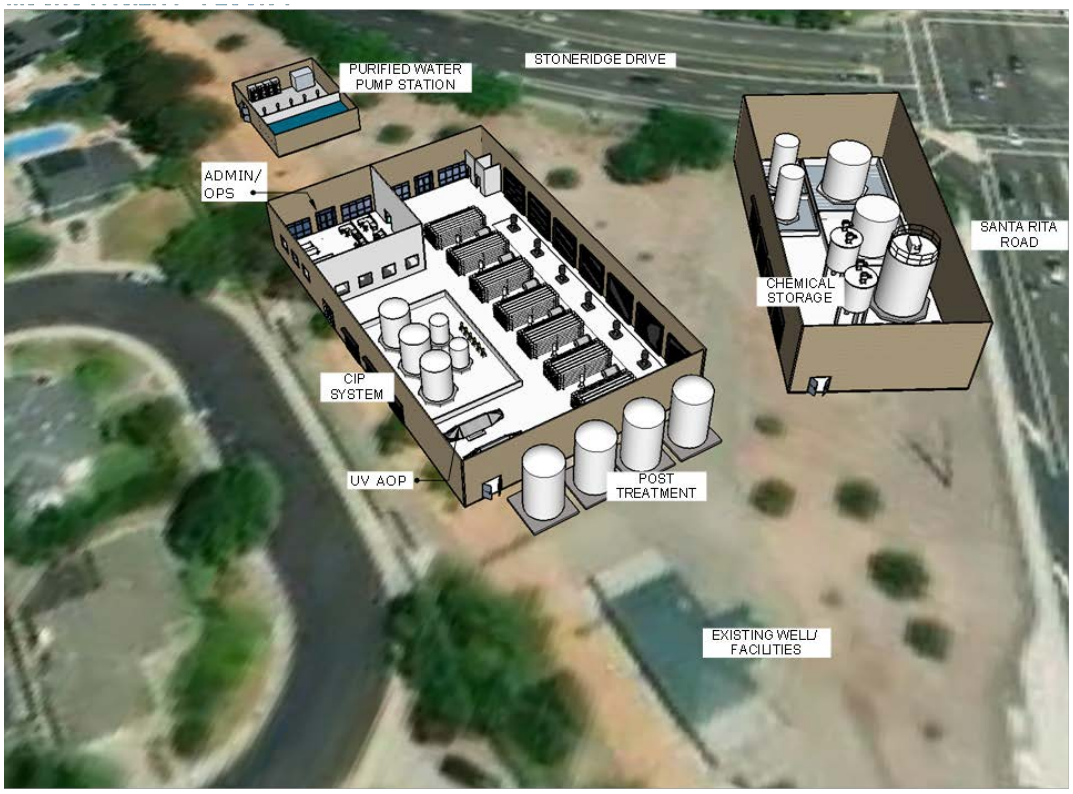


Figure 7.25 Mocho AWPF Layout (First Floor)



Figure 7.26 Mocho AWPF Layout (Second Floor)

7.3.6 Option 4 - Pleasanton AWPF to COL/DVWTP

This alternative incorporates a 12 mgd seasonally operating FAT+ AWPF and COLs/DVWTP augmentation, shown in Figure 7.29. As discussed for the other options, Lake I recharge could also be utilized. The Pleasanton AWPF was added after Workshop No. 4 to provide an alternate regional location which did not have the extreme site constraints of the Mocho site or the access difficulty of the COL location (discussed in Chapter 5). The Pleasanton Corp Yard would either need to be rearranged in order to accommodate the AWPF or the treatment processes would be separated. The City of Pleasanton has expressed that it will pursue a master plan for the site in the near future. If the project is pursued, space for the AWPF could be incorporated into future plans. Costs to relocate buildings are not included in the cost estimate.

7.3.6.1 Pipeline Alignments

The Pleasanton Corp Yard requires a 20,000 LF pipeline to bring source water from DSRSD. As the 24-inch pipeline crosses the existing LWRP effluent discharge line, it connects to that line and is then expanded to 30 inches to be able to convey the Livermore effluent as well. Concentrate and MF backwash must be returned via a separate pipeline to the LAVWMA line downstream of the intake. The same potential permitting and discharge options apply in this scenario as in Section 7.3.5.1. Infrastructure requirements are shown in Table 7.14.

Table 7.14 Pleasanton AWPF to Lake I Infrastructure Requirement

Item	Unit	Value
Source Water Pipeline Segment 1		
Diameter	in	24
Length	LF	13,000
Pumping Requirement	hp	520
Source Water Pipeline Segment 2		
Diameter	in	30
Length	LF	7,000
Concentrate/Waste Pipeline		
Diameter	in	16
Length	LF	8,900
Pumping Requirement	hp	120
Purified Water Pipeline		
Diameter	in	30
Length	LF	6,150
Pumping Requirement	hp	330

Notes:
(1) Pumping requirement based on a 70% pump efficiency.

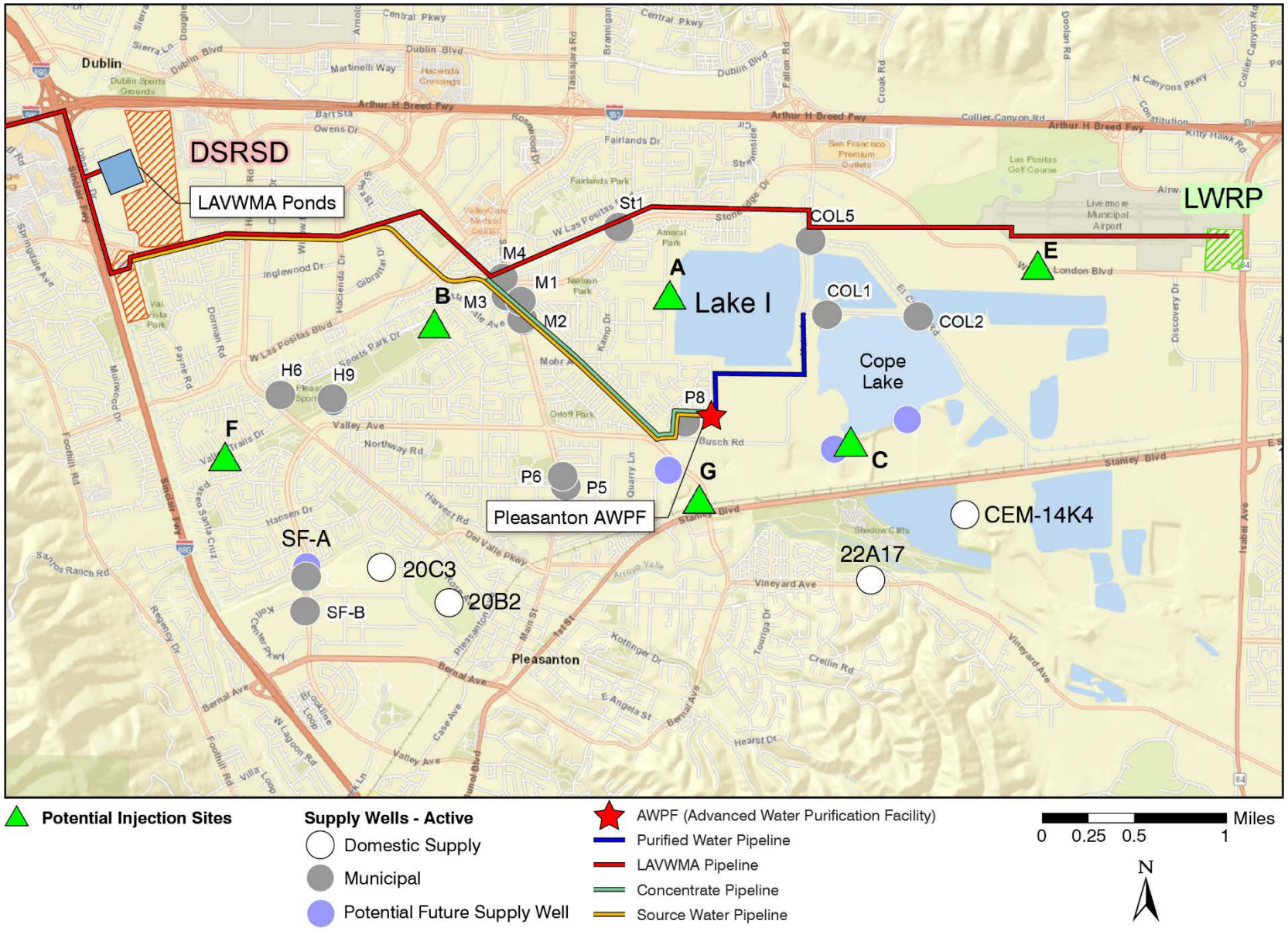


Figure 7.27 Pleasanton AWPF to COL/DVWTP

7.3.6.2 Layouts

The AWPF layout area was selected for the northeast corner of the Pleasanton Corp Yard. This layout is for planning purposes only. The City of Pleasanton will have to decide the buildings that can be re-arranged and which ones need to remain. The AWPF will require approximately 5 acres of space. Figures 7.30, and 7.31 show the AWPF layout at Pleasanton Corp Yard.

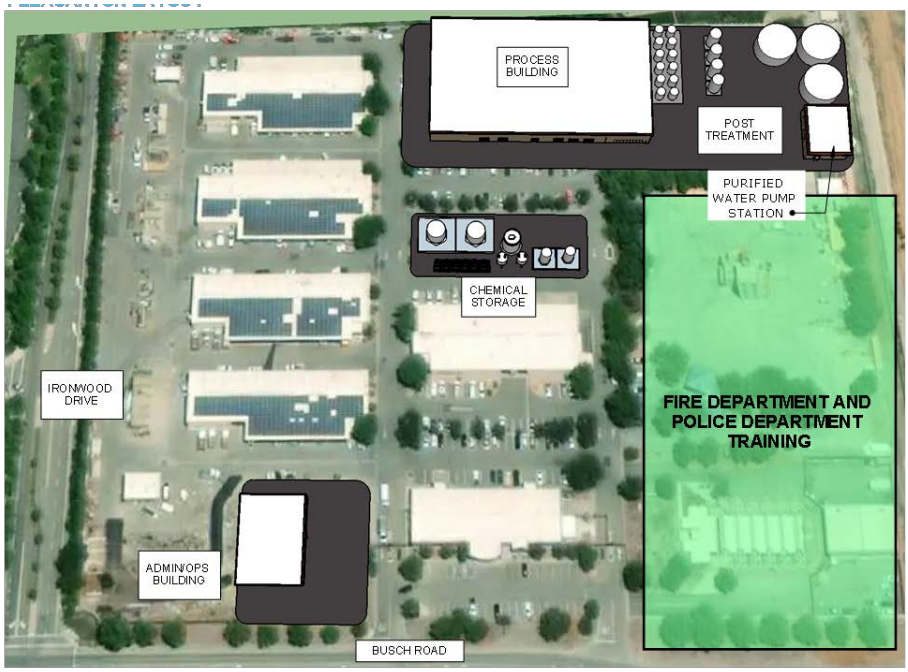


Figure 7.28 Pleasanton AWPF Layout

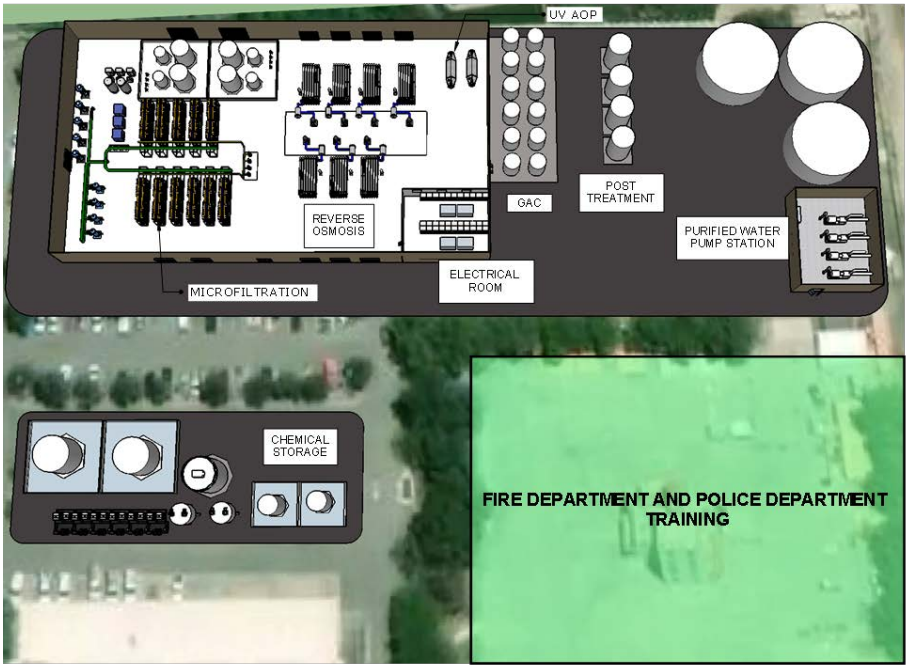


Figure 7.29 Pleasanton AWPF Process View

7.4 Cost Estimates

7.4.1 Basis of Cost

Cost estimates for each scenario were prepared for a Class 5 cost estimate in accordance with guidelines from the Association for the Advancement of Cost Estimating (AACE). As Class 5 estimates, the accuracy ranges from -50 to +100 percent. Tables 7.15 and 7.16 summarize cost assumptions in the development of the high level cost estimate. Appendix H contains detailed cost breakdowns.

Table 7.15 Cost Estimate Assumptions

Line Item	Description
Amortization Interest Rate	5%
Payback Period	30 years
Power Cost	$0.14/kWh
ENR-CCI (San Francisco, January 2017)	11069

Table 7.15 Contingencies and Assumptions

Line Item	Description	% of A
Total Direct Cost(1)	A	100%
Contingency	30% of A	30%
Subtotal	B	130%
General Conditions	10% of B	13%
Subtotal	C	143%
Contractor Overhead & Profit	15% of C	14%
Subtotal	D	157%
Sales Tax	9.5% of B/2	6%
Total Construction Cost(2)	**E**	**163%**
Project Cost Factor(3)	30% of E	49%
Total Project Cost	**F**	**213%**

Notes:
(1) Based on vendor quotes, estimating guides, and construction costs of similar facilities
(2) Sales tax is applied on 50% of the direct costs plus contingency, which is assumed, at this level to be equivalent to amount of materials/equipment purchased for this project. Sales tax is not applied on labor or overhead
(3) Project Cost Factor includes all legal, environmental, administrative, engineering, and construction management.

7.4.2 Cost Assumptions

Other identified cost assumptions include:

- All alternatives involving COL add $2 million to allow for an increase in the planned pump station capacity for the COL pipeline (as currently included in Zone 7's Capital Improvement Program), allowing flexibility to accommodate potable reuse applications.

- No land costs are included at this time. Note that all identified siting options are located on public agency owned land; cost sharing agreements to provide credits to the land owner may be considered should a project move forward.
- Converting the DLDs at DSRSD to an AWPF site requires a separate line item to allow DSRSD to pursue alternative methods of solids handling. In this study, a portion ($1,460,000) of the cost for new dewatering is added to projects at DSRSD as a proportionate amount of DLD capacity impacted.

7.4.3 Cost Comparisons

Table 7.17 presents the costs for each of the short-listed options discussed above. Detailed cost estimates are included in Appendix H.

Given a unit cost range from $2,160 to $2,530 per AF, and a cost uncertainty range of -50 to +100 percent, unit cost is not a key differentiator among the book-end options. However, capital costs range widely from $112M for Option 1a to $222M for Option 2a. While these options offer different amounts of recycled water, the capital cost is an important consideration from financial and project phasing perspectives.

7.5 Qualitative Evaluation

In addition to economic analysis many qualitative factors were considered for each short-listed option. Each factor was scored using a positive (+), negative (-), and neutral (0) sign. The number of signs implies a larger positive or negative impact. They are discussed within this section.

7.5.1 Yield (measured by acre-feet per year - AFY)

As discussed in Chapter 5, supplemental water supplies are meant to bolster the water supply reliability of the Zone 7 water portfolio. As can be expected, Zone 7's Risk Model shows that 10,000 AFY increases resiliency and reduces risk to a far better extent than a 5,500 AFY project (i.e., the greater the additional supplies, the greater the water supply reliability).

7.5.2 Improve Water Supply Reliability

All short-listed alternatives will improve water supply reliability compared to a no-project scenario. However, the impact on reliability can be differentiated based on the end use. Zone 7's Risk Model was used to consider the impact of each option on the overall water supply reliability. The methods used for evaluation are consistent with the 2016 Water Supply Evaluation Update (WSE Update) to allow for direct comparison with the results from that document. Each scenario was modeled using a Monte Carlo simulation that provided measures of water supply reliability and risk. Each Monte Carlo simulation ran 1,000 trials. In total, 48,000 separate forecasts were made to achieve the comparative results. This analysis updates the assumptions used in the WSE Update's Portfolio B, which included 'purified recycled water' or potable reuse. Every option performed better than the baseline portfolio from the WSE Update (i.e., the "Current Plan" portfolio, which includes existing planned capital improvement projects, but no potable reuse projects. Various water supply portfolios with varying amounts of potable reuse were analyzed with the model concurrent with this study. Note that the modeling reflects Zone 7's current operations, which relies largely on surface water deliveries supplemented by groundwater as needed.

Table 7.17 Cost Estimates and Unit Cost Comparison

	Livermore AWPF to COL Option 1a	Livermore AWPF to Well E Option 1b	DSRSD AWPF To COL/DVWTP Option 2a	DSRSD AWPF to Well B Option 2b	Mocho AWPF to Well B Option 3	Pleasanton AWPF to COL /DVWTP Option 4
CAPITAL COSTS						
Water Purification Facility	$72,620,000	$65,290,000	$139,530,000	$120,360,000	$121,420,000	$130,930,000
Infrastructure	$13,460,000	$13,390,000	$29,820,000	$27,670,000	$39,890,000	$28,110,000
Total Construction Cost	**$86,080,000**	**$78,680,000**	**$169,350,000**	**$148,030,000**	**$161,310,000**	**$159,040,000**
Engineering & Contract Admin (30%)	25,824,000	23,604,000	50,805,000	44,409,000	48,393,000	47,712,000
Additional Costs[1]	500,000	500,000	2,210,000	2,006,000	750,000	750,000
Total Project Cost	**$112,404,000**	**$102,784,000**	**$222,365,000**	**$194,445,000**	**$210,453,000**	**$207,502,000**
ANNUAL COSTS						
Amortized Annual Cost (5% for 30 Years) [2]	7,310,000	6,690,000	14,470,000	12,650,000	13,690,000	13,500,000
Operation and Maintenance:						
AWPF Operational Cost	6,374,000	6,374,000	8,215,000	8,215,000	8,026,000	8,079,000
Infrastructure Energy and Maintenance	256,000	256,000	840,000	693,000	764,000	851,000
Total Annual Cost	**$13,940,000**	**$13,320,000**	**$23,525,000**	**$21,558,000**	**$22,480,000**	**$22,430,000**
Available Project Yield, mgd	5.0	5.0	12	12	12	12
Actual Project Yield, AF/yr [3]	5,500	5,500	10,000	10,000	10,000	10,000
Unit Cost of Water ($ per ac-ft) [3]	$2,530	$2,420	$2,350	$2,160	$2,250	$2,240

Notes:
(1) Additional costs include costs to bring electricity to sites and additional solids handling compensation, if necessary.
(2) Costs based on a 5% interest rate and a 30-year payback period - typical of bond financing.
(3) Actual yield based upon year round operation for Livermore plants and seasonal operation for options which treat both DSRSD and Livermore effluent.

Based on the model results, while any potable reuse project would generally improve supply reliability and reduce the impact of droughts and outages, the addition of water into the system via DVWTP (raw water augmentation) had the most benefit in the worst-case supply scenario when surface water supplies are severely limited. Groundwater augmentation via well injection (Options 2b and 3) provided the highest average reliability overall as it maintained a fuller groundwater basin. As noted, these results are based on Zone 7's current operational scheme that largely relies on surface water with groundwater supplement as needed during daily and seasonal peaking, emergencies, and limited surface water conditions. If potable reuse via groundwater augmentation is implemented, Zone 7's operations could potentially be modified to optimize the benefits from this type of end use of purified water. The Risk Model results for this study are shown in Appendix I.

7.5.3 Improved Delivered Water Quality

The implementation of potable reuse has the potential to change delivered water quality. The changes in future delivered water quality, relative to the future (+25 years) baseline scenario, were estimated for the groundwater augmentation and raw water augmentation scenarios. Delivered water quality is represented by the flow weighted average TDS concentration of the combined groundwater and surface water supplies used to meet the projected demand of 51,330 AFY. The analysis is based on Zone 7's current operational scheme that largely relies on surface water with groundwater supplement as needed during daily and seasonal peaking, emergencies, and limited surface water conditions. If potable reuse via groundwater augmentation is implemented, Zone 7's operations could potentially be modified to optimize the benefits—including delivered water quality benefits—from this type of end use of purified water.

This analysis involved predicting the water supplies used to meet the projected demand and the quality of these supplies. The Zone 7 Water Supply Risk Model was used to predict the use of groundwater to meet demands under the future baseline, groundwater augmentation, and raw water augmentation scenarios. The use of surface water was assumed to be the difference between the projected demands and the groundwater supply. Table 7.18 presents the predicted use of groundwater and surface water supplies in the future condition for each of the scenarios.

Groundwater quality was estimated using the Zone 7 Groundwater Basin Model. The model output includes predicted TDS concentrations at each well. The groundwater model includes long term average production estimates from each of Zone 7's groundwater wells, and the relative production of each well to the total production was calculated. The resulting relative production of each well was assumed for the future scenarios. The flow weighted average groundwater concentrations were calculated using the projected total groundwater production, projected concentrations, and relative production of each well. Table 7.18 presents the predicted average groundwater concentrations for each scenario.

Surface water quality was estimated based on the average TDS concentrations for treated water from the DVWTP and the PPWTP, as reported in Zone 7's consumer confidence reports. Reported TDS concentrations from 2012, 2013, and 2016 were used to calculate the average TDS concentration of 298 mg/L. Years 2014 and 2015 were not used, as drought conditions influenced TDS concentrations of the treated water from DVWTP and PPWTP. The purified water used for raw water augmentation was assumed to have a TDS concentration of 100 mg/L.

Table 7.16 Water Quality Summary for the Baseline and Potable Reuse Scenarios

Future Baseline (25+ Years)			Future Groundwater Augmentation Scenarios						Future Raw Water Augmentation Scenarios	
			Options 2B, and 3		Option 1B		Option 1A		Options 2A and 4	
			DSRSD or Mocho to Well B		Livermore AWPF to Well E		Livermore AWPF to COL		DSRSD or Pleasanton to COL/DVWTP	
			10,000 AFY		5,500 AFY		5,500 AFY		10,000 AFY	
	Normal Year Supply	Simulated Concentration	Normal Year Supply	Simulated Concentration	Normal Year Supply	Simulated Concentration	Normal Year Supply	Simulated Concentration	Normal Year Supply	Simulated Concentration
Existing Supply	AFY	TDS (mg/L)	AFY	TDS (mg/L)	AFY	TDS (mg/L)	AFY	TDS (mg/L)	AFY	TDS (mg/L)
Surface Water	43,130	298	38,130	298	41,330	298	14,030	298	33,530	398
Groundwater	8,200	603	13,200	372	10,000	510	9,300	484	7,800	603
Raw Water Augmentation									10,000	100
Cumulative (Total Volume, Weighted Average TDS)	**51,330**	**346**	**51,330**	**317**	**51,330**	**339**	**51,330**	**331.**	**51,330**	**306**
Percent Change in Average TDS				**-9%**		**-2%**		**-4%**		**-12%**

The results are summarized in the Table 7.17. It is important to recognize the potential potable reuse projects contribute only 10 to 20% of the total supply. Therefore, changes in the weighted average TDS concentration of the total supply are relatively subtle. However, comparison of these relative changes can be used to evaluate difference between the scenarios.

The changes in water quality on a percentage basis were calculated relative to the baseline scenario. A negative percentage change in TDS concentration indicates a decrease in TDS concentrations. For the raw water augmentation scenarios, the purified water with a TDS of 100 mg/L is blended with existing surface water supplies, and therefore has a direct impact on average TDS concentrations. For the groundwater augmentation scenarios, the change in delivered water quality is dependent on the migration of the injected groundwater to each well and the resulting change in groundwater quality at each well. The groundwater augmentation volume and location impacts the change in TDS concentration at each well.

TDS reductions in delivered water quality range from 2 percent to 12 percent depending on the scenario, as presented below:

- 10,000 AFY raw water augmentation (Options 2a and 4) - 12% TDS reduction
- 10,000 AFY groundwater augmentation (via injection at well B) (Options 2b and 3) - 9% TDS reduction
- 5,500 AFY groundwater augmentation via recharge at the COLs (Option 1a) - 4% TDS reduction
- 5,500 AFY groundwater augmentation via injection at well E (Option 1b) - 2% TDS reduction

The estimated delivered water quality TDS concentrations are a gross estimate of potential delivered water quality impacts and would need to be evaluated in more detail in future studies, which could also incorporate potential operational modifications; however, it is reasonable to assume that the water quality benefits from the 10,000 AFY raw water augmentation and groundwater augmentation options are similar and that the benefits from the 5,500 AFY groundwater augmentation options are similar. That is, larger amounts of purified water generally lead to larger benefits to delivered water quality.

7.5.4 Improve Groundwater Basin Water Quality

There are areas of the groundwater basin with high TDS values. These values may be lowered with the injection of lower TDS water into the groundwater basin via wells or recharge through Lake I or the Arroyo Mocho. Chapter 6 showed the results of the recharge options on basin quality. The Well B area is closer to the groundwater basin area with higher TDS values and may be desirable for that reason. However, Lake I recharge and Well E injection provide a more widespread benefit to the groundwater basin.

All groundwater recharge were given a single plus (+) score recognizing that any recharge of a high quality water improves the groundwater quality. Raw Water Augmentation is scored with a neutral sign (0) since it has neither a positive or negative impact on groundwater basin quality. Water quality concerns related to leaching of metals from the soils into the groundwater would be addressed through post-treatment stabilization of the water, discussed in Section 7.2.2.7.

7.5.5 Clear Regulatory Pathway

Groundwater augmentation via injection wells has been established in many areas across the country. The regulations for these projects have been set since 2014 so there is a streamlined approach for permitting them. This category will therefore be assigned two plus (++) signs.

Surface water/reservoir augmentation regulations were finalized in early 2018. Raw water augmentation regulations have not yet been created but are mandated to be developed by 2023. However, the DDW has stated that they will permit projects on a case by case basis in the interim. The permitting process is therefore likely to be more complex for raw water augmentation compared to the other two potable reuse end use options with adopted regulations. However since there is a clear regulatory pathway, raw water augmentation is given a single plus (+) while groundwater augmentation is given a double plus (++).

7.5.6 Minimizes Neighborhood Impacts

This factor will be rated based on the amount of neighborhood impact, which depends on the zoning of the lot, existing industry or utilities nearby, and the potential visibility of the site.

The Mocho site is immediately next to a neighborhood. While it is across the street from an existing demineralization plant, the building itself will be very visible (2-stories tall) to neighbors. This location will also replace an existing park. The impact on the neighborhood is significant, therefore it is scored with a negative (-) sign.

Both Livermore and DSRSD AWPF sites would be on existing utility property in either commercial or industrial areas. These locations will have minimal impact on the surrounding neighborhood and therefore are scored with two (++) plus signs. The Pleasanton site would be within an existing corporation yard; however, there are homes that border the north and west side of the existing yard. This location is scored with one (+) plus sign. .

7.5.7 Ability to Phase the Project

The purpose of constructing a project in phases is to appropriately match facility size with available water supply. This allows for a quicker return on investment and a more immediate benefit. However, phasing a project is only practical if there is a significant difference between the initial flows and the ultimate buildout flows. The phasing considered within this project only refers to adapting one location for an AWPF to buildout flows. Other phasing options could include adjusting sources, like building a small AWPF at Livermore and then a separate site at DSRSD later to facilitate use of both sources over time, or it could involve supplementing the source water flow with existing tertiary recycled water flows in the event of a severe drought. These alternative phasing definitions should be investigated separately as they were not examined in this study. The initial to buildout phasing for each site is discussed within this section.

For projects at LWRP, the available flow is expected to reach a buildout of 6.1 mgd as shown in Figure 7.32. While current flows hover around a minimum of 3 mgd, flows are expected to reach 4.7 mgd by the time a project could be expected to come online. The phasing options for LWRP are such small increments that it is not likely to be cost-effective, so options at the LWRP are not considered favorable for phasing. In addition, the ultimate buildout capacity at LWRP is limited to 6.1 mgd, further decreasing the ability to phase the project at that site (Table 7.19). Note, however, that a future evaluation could consider a project at LWRP as Phase 1 of a larger potable reuse project should the project participants want to have multiple AWPF sites or want to consider pumping water from the west side of the valley east for treatment at Livermore. These options were not considered in this study and cost estimates were not performed; however, building two separate facilities or pumping tertiary effluent eastwards are likely to increase costs relative to the options evaluated in this study.

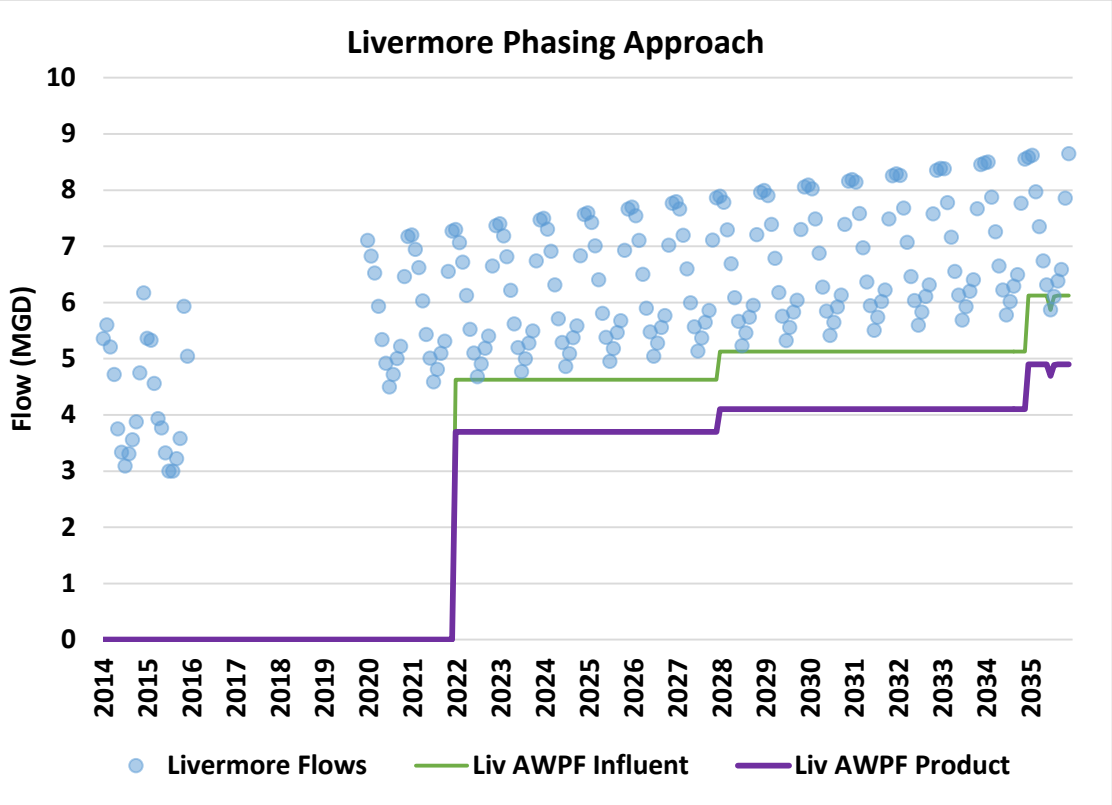


Figure 7.30 Livermore AWPF Flow Projections and Potential Phasing

Table 7.17 Livermore AWPF Potential Phasing Options

Phase	Start Date	Design Flow (mgd)
1	2022	3.7
2	2028	4.1
3	2035	5.0

Treatment plants using both LWRP effluent and DSRSD effluent can be phased first to design around a consistent flow (5 mgd effluent, expected around 2035) and then be increased in future years to provide higher winter level treatment to achieve the 10,000 AFY goal. Flow projections for DSRSD and LWRP combined are shown in Figure 7.33 and one potential phasing plan is shown in Table 7.20, although others could be considered.

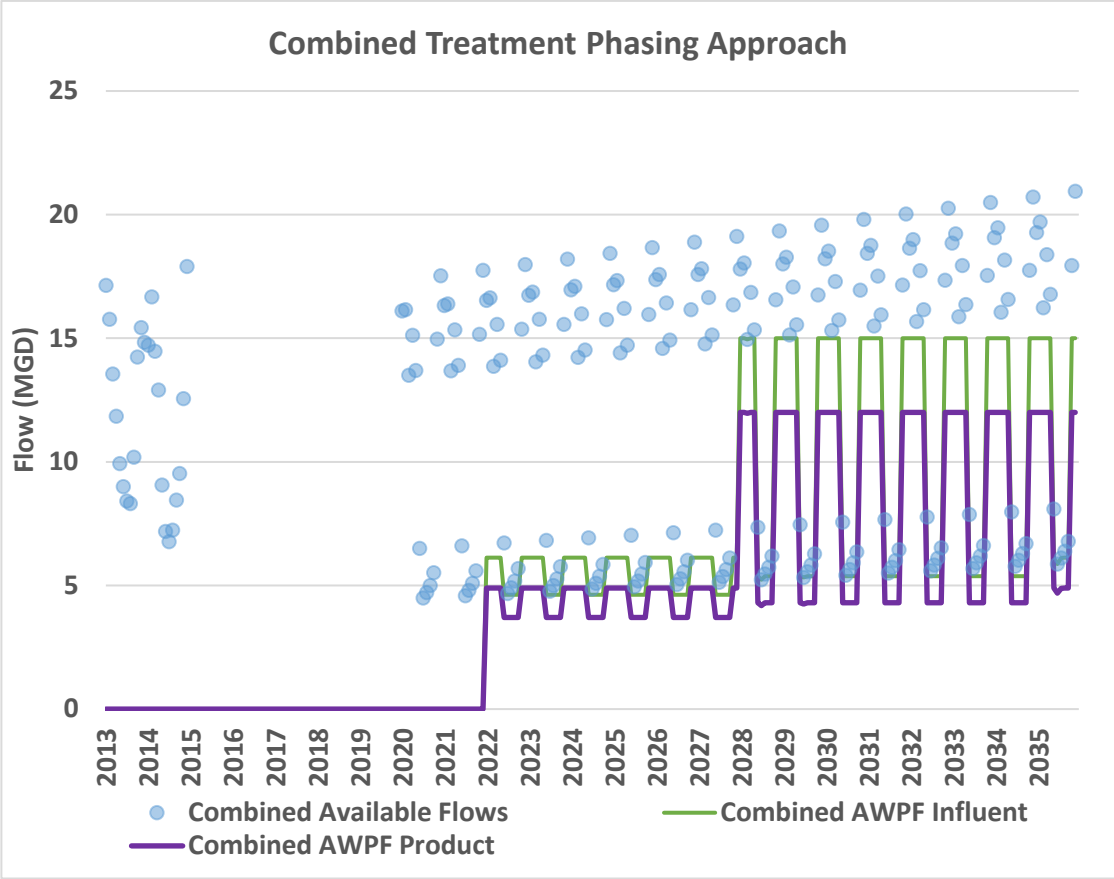


Figure 7.31 DSRSD/Mocho/Pleasanton AWPF Flow Projections and Potential Phasing

Table 7.20 Potential Combined AWPF Phasing Options

Phase	Start Date	Summer Design Flow (mgd)	Winter Design Flow (mgd)
1	2022	3.7	5
2	2028	4.3	12
3	2035	5	12

While all alternatives could start with smaller flows and expand to the buildout flow of that site, it may not be cost-effective. The larger the ultimate buildout flow for a site, the greater opportunity to phase. Livermore options were given a neutral (0) score due to minimal opportunity to phase (given the definition of phasing used in this study) while the other options with 10,000 AFY yield were given a single plus (+) for the relative ease in which design flows could start smaller (5,000 AFY) and then be increased to 10,000 AFY.

7.5.8 Operational Considerations

Operations could potentially be complicated by the following factors:

- Variances of flow - for instance, running the AWPF at two different flow setpoints would complicate chemical deliveries, equipment rotations, and pipeline usage.
- Physical separation of AWPF from support centers - while each AWPF will have an operations center, locating an AWPF nearer to an existing utility would provide an additional source of 'on-site' operators as backup.

In the scoring of alternatives, LWRP was given positive scores for both running at a constant flow and being located near an existing utility. DSRSD was given a positive score for being located near an existing utility but a negative score for seasonal operation, thereby equaling out to an overall neutral score. Both Pleasanton and Mocho options were given negative scores for both seasonal operation and location away from an existing facility.

7.5.9 Ease of Construction

Impacts to construction include:

- Amount of staging space available (physical constriction of the site).
- Ease of access for construction vehicles.
- Amount of site work required - working around existing structures vs. greenfield site.
- Sludge management

The locations that have easy access and require minimum modification or extra work are scored with double (++) plus signs. Alternatives at DSRSD are rated ++ because while the site needs filling and a berm, the soils are available locally within the DLDs. While Livermore requires lagoon draining and sludge hauling in addition to importing soil from off-site, the site is still easily accessible and unconstrained. Livermore sites were given a double (++) plus sign. The Pleasanton site was given a single plus sign as well because it is easy to access, being along main roads. However, construction at the site would require working around existing buildings or relocating buildings. Mocho received a negative (-) sign because the construction site is very small, with little to no staging area available. Additionally, several utility pipelines cross underground, which should be carefully considered during construction.

Table 7.21 qualitatively scores each alternative based on the above criteria.

Table 7.21 Qualitative Alternatives Evaluation

	Livermore AWPF to COL/Lake I	Livermore AWPF to COL/DVWTP[1]	Livermore AWPF to Well E	DSRSD AWPF To COL/DVWTP	DSRSD AWPF to Well B	Mocho AWPF to Well B	Pleasanton AWPF to COL/DVWTP
Yield	**5,500**	**5,500**	**5,500**	**10,000**	**10,000**	**10,000**	**10,000**
Cost, $million	**$112.4**	**$112.4**	**$102.8**	**$222.4**	**$194.5**	**$210.5**	**$207.5**
Unit Cost, $/AF	**$2,530**	**$2,530**	**$2,420**	**$2,350**	**$2,160**	**$2,250**	**$2,240**
Improve Supply Reliability	**+**	**++**	**+**	**+++**	**++**	**++**	**+++**
Improve Delivered Water Quality	**+**	**++**	**+**	**++**	**++**	**++**	**++**
Improve Groundwater Basin Quality	**+**	**o**	**+**	**o**	**+**	**+**	**o**
Clear Regulatory Pathway	**+**	**+**	**++**	**+**	**++**	**++**	**+**
Minimizes Neighborhood Impacts	++	++	++	++	++	-	+
Ability to Phase the Project	o	o	o	+	+	+	+
Operational Flexibility	**++**	**++**	**++**	**o**	**o**	**-**	**-**
Ease of Construction	**++**	**++**	**++**	**++**	**++**	**-**	**+**

+ positive impact **-** negative impact **o** neutral impact

Notes:

(1) This option is the same in cost and infrastructure requirement as Livermore AWPF to COL / Lake I. However, there is a higher benefit to delivered water quality overall, and no impact on groundwater quality. This option is included in the qualitative table because it may qualify as a surface water augmentation project (reservoir augmentation) under the new regulations. If Cope Lake is allowed to be used as a reservoir, the treatment requirement for the AWPF at Livermore may be decreased, which would result in a lower capital and O&M cost.

7.6 Conclusion

The analysis presented in this chapter supported 1) a more detailed evaluation of the feasibility of the options, 2) a book-ending of the potential benefits and challenges of the options and 3) a comparison of the project options based on both quantitative (e.g., cost) and qualitative (e.g., ease of construction) considerations. Given the complex nature of some of the metrics used, the qualitative assessment as presented in Table 7.21 is subjective; however, it provided a useful framework for the identification of potential benefits and challenges of the options and their relative comparison. The overall conclusion is that all of the options are found to be viable, realistic alternatives that could be implemented, with varying levels of benefits and challenges. Recommendations for next steps are summarized in Chapter 8.

Chapter 8

RECOMMENDED NEXT STEPS

8.1 Summary of Major Findings and Overall Recommendations

The Tri-Valley Water Agencies have set out to evaluate the technical feasibility of potable reuse for the Tri-Valley through this project. Options evaluated include potable reuse through groundwater augmentation (recharge/injection), reservoir augmentation, and raw water augmentation to a connection upstream of the Zone 7 DVWTP. This study has found that potable reuse in the Tri-Valley is a technically feasible method to increase water supply, improve water supply reliability and to improve water quality of the groundwater basin and/or delivered water depending on the selected end use.

This study expanded on initial evaluations conducted as part of Zone 7's 2016 Water Supply Evaluation Update (WSE Update). For that work, Zone 7 used its Water Supply Risk Model that assessed potential impacts to system-wide water supply reliability and water shortage risk. This new analysis updates the assumptions used in the WSE Update's Portfolio B, which included 'purified recycled water' or potable reuse. Every potable reuse option evaluated in this new effort provided better water supply reliability than the baseline portfolio from the WSE Update (i.e., the "Current Plan" portfolio, which includes existing planned capital improvement projects, but no potable reuse project). Various water supply portfolios with varying amounts of potable reuse were analyzed with the Risk Model concurrent with this study. In the WSE Update, the upper end of what was estimated available from future water supplies (potable reuse and desalination) was around 10,000 AFY, so this amount was used as the upper bookend for the analysis in this study. Note that there were other limiting factors (i.e. wastewater availability) to going beyond 10,000 AFY so this value is a reasonable estimate.

Working with the Project Management team and Steering Committee, both comprised of members from each water agency, a wide range of alternatives was considered in this study to develop "bookends" of feasible potable reuse options. Twenty-one alternatives were considered and evaluated in Chapter 5 and screened down to six options that were developed in more detail in Chapter 6 and Chapter 7. Table 8.1 summarizes the options evaluated at a higher level of detail.

This chapter lays out the process if the Tri-Valley Water Agencies choose to pursue a potable reuse project further, and details a number of subsequent decisions and action items necessary to successfully implement a potable reuse project. A schematic of the decision process that needs to be followed for the agencies to move forward with potable reuse is shown in Figure 8.1. The future work items required can be classified into three categories: Technical, Institutional, and Outreach. Note that this study focused on technical issues only; however, potable reuse projects are widely recognized to involve complex institutional and public outreach issues that need to be addressed early in the project implementation process. Some examples of recommended next steps for the institutional and outreach components are provided in

Appendix J for future consideration by the Tri-Valley Water Agencies should they choose to proceed with a project.

Table 8.1 Summary of Feasible Project Options Evaluated in Detail

Option	Location	Capacity (mgd)	Source Water	Treatment Train	End Use	Total Project Cost/	Annual Yield (AFY)	$/acft
1a	Livermore	5	LWRP	FAT+	COL (Lake I)/ DVWTP	$112 M	5,500	$2,530
1b				FAT	Well E	$103 M	5,500	$2,420
2a	DSRSD	12	DSRSD WWTP + LWRP	FAT+	COL (Cope Lake)/ DVWTP	$222 M	10,000	$2,350
2b				FAT	Well B	$194 M	10,000	$2,160
3	Regional at Mocho	12	DSRSD WWTP + LWRP	FAT	Well B	$210 M	10,000	$2,250
4	Regional at Pleasanton	12	DSRSD WWTP + LWRP	FAT+	Cope Lake/ DVWTP	$208 M	10,000	$2,240

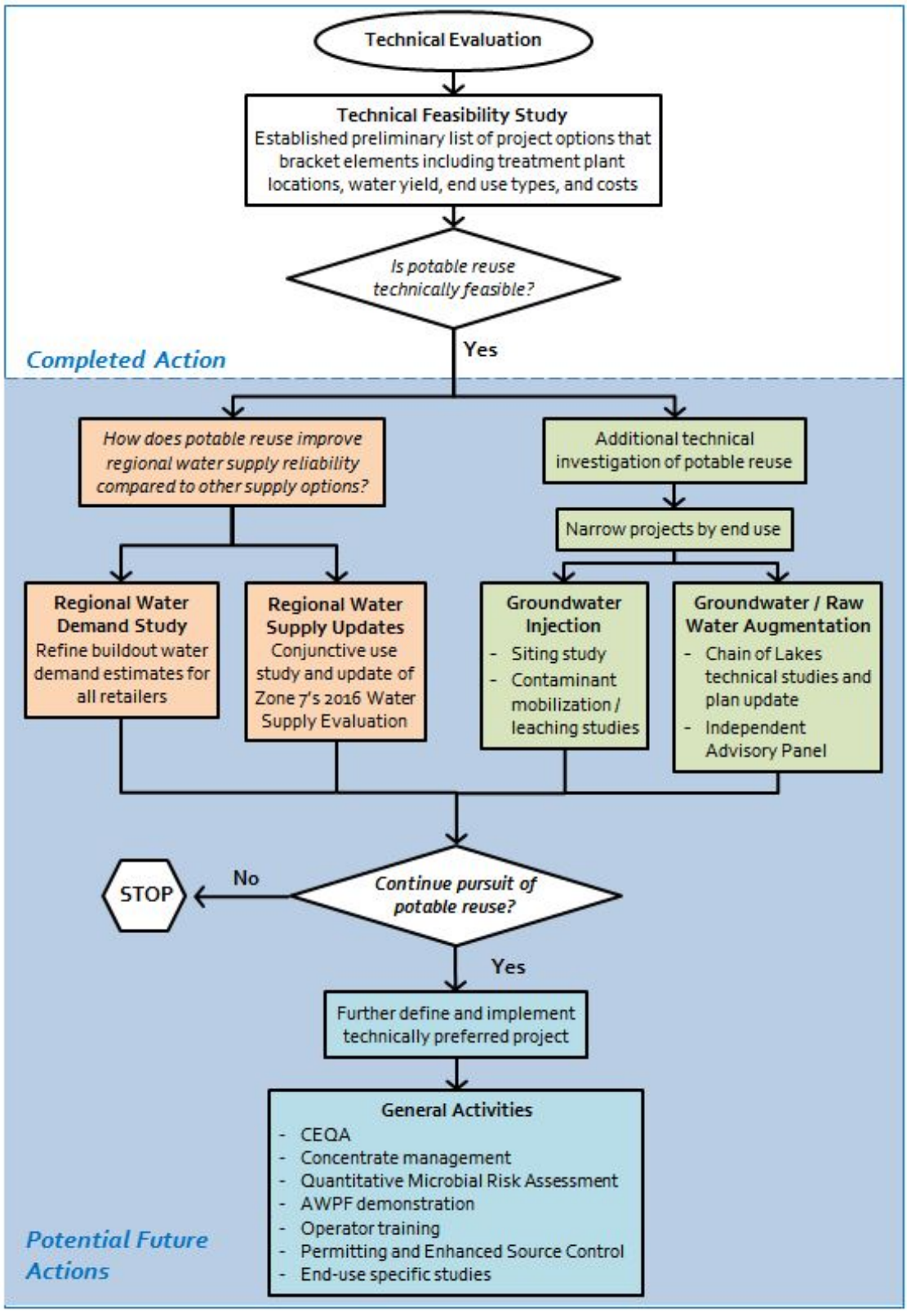


Figure 8.1 Decision Process Schematic

8.2 Technical Next Steps

There are several key technical efforts needed to move a potable reuse project forward, as summarized below.

8.2.1 All Projects

Regardless of the type of potable reuse project, there are several key next steps:

- **Regional Water Demand Study** - This study would apply a consistent land-use based method to the region that accounts for the state's long-term conservation framework. This will help determine the amount of additional water supply needed and timing for the Tri-Valley area.
- **Zone 7 Conjunctive Use Study** - Zone 7's water system was built primarily as a surface-water based system. This study would evaluate the potential shift to greater groundwater use if groundwater recharge is increased significantly (e.g., if potable reuse via groundwater augmentation is implemented). Impacts on the transmission, treatment plant, and well facilities will be evaluated, as well as on salt management and delivered water quality.
- **Zone 7's Water Supply Evaluation Update** - Zone 7 will incorporate new data and new supplies that have become available since the WSE Update was completed in 2016 (e.g., timing and yield of CA WaterFix, Sites Reservoir, results of potable reuse study). Data from the conjunctive use study would also be incorporated. This will allow comparison of potable reuse to other water supply options based on yield, cost, reliability, and other metrics.

8.2.2 Groundwater Augmentation/Recharge

There are a series of next steps required for implementing a groundwater recharge project, summarized here:

- **Siting Study -** Preferred site selection includes hydrogeological evaluation, expected travel time to adjacent production wells, infrastructure proximity and availability, and land area to support construction and operation of the injection wellfield/s. It would also consider optimization of salt management strategies, including the existing demineralization facility and plans for additional facilities as needed. Site selection should be carefully coordinated with the Conjunctive Use Study, the Contaminant Mobilization Study and the Leaching Study.
- **Contaminant Mobilization Study** - Sampling of native groundwater and prediction of water qualities of potential recharge water, including averages and variabilities of the constituents.
  - Geochemical analysis of the soil sample should be conducted. These analyses may include up to 50 proposed water quality constituents of interest for geochemical analysis.
  - Use of Geochemist's Workbench software to conduct a geochemical model analysis of mixing between the recharge water quality, the native groundwater quality, and the potential short term and long term impact of the chemical reactions (including potential contaminant mobilization) occurring between the mixture and the mineralogy of each layer.

- **Leaching Study (and Core Sampling) –** Samples taken from surface to a sufficient depth (approximately 700 feet) below the Lower Aquifer System to characterize the soils and geologic layers. Perform geochemical analysis and contaminant mobilization/leaching studies with cores. Samples can be obtained from drilling of injection and/or monitoring wells. Assume use of 2 cores, four columns (two of each site) and a minimum of a 1 month study with weekly sampling.
- **Injection and Monitoring Well Design and Construction –** Design and construction of wells for injection study (including recharge rates) as well as water quality analysis. Construct individual monitoring wells in various layers of the aquifer. The primary purpose of these monitoring wells would be to obtain water qualities for geochemical analysis, including contaminant mobilization or leaching studies with RO permeate. These wells can be used for tracer studies and permitting efforts as well as ongoing monitoring for compliance purposes.
- **Tracer Study –** Conduct tracer study using monitoring wells to verify travel time in aquifer for permitting purposes.

The above recommendations apply to groundwater recharge in general and specifically to recharge involving injection wells. For recharge involving Lake I, other steps would include:

- **COLs Water Quality Analysis** - Characterization of Lake H/I/Cope water quality throughout the year, and projected potential water quality impacts of various source waters, including purified water. The water quality from AWPFs treating municipal wastewater is relatively well characterized and predictable. However, in order to assess the effects of the blending of COL water with purified water, the new blended water quality should be predicted based on scenarios developed from the COL management scheme.
- **COLs Hydraulic Modeling/Water Balance -** Hydraulic modeling and water balance in the Lake H/I/Cope complex, incorporating recharge rates, projected Vulcan discharges, groundwater levels, Arroyo Mocho and Arroyo Valle/SBA diversions, and potentially stormwater and purified water storage.
- **COL Management Plan Update -** Incorporate scenarios and results from the COLs water quality and hydraulic modeling/water balance analyses. Consider other potential uses such as recreation and planned facilities such as the diversion structure/s and COLs pipeline.
- **Tracer Studies -** Conduct tracer studies using previously constructed monitoring wells alongside Lake I. The results from the tracer study will be used to develop permitting documents.

8.2.3 Raw Water Augmentation

A project that included delivery to DVWTP as a raw water augmentation would require a few different steps than more common potable reuse projects (i.e., groundwater augmentation).

- **Independent Advisory Panel** - While not necessary, a committee comprising experts in the area of potable reuse and regulation of projects would bring credibility to the project as well as address public concerns. This body would provide an unbiased perspective and would not have a political agenda.
- **Regulatory Criteria-** Since the regulations for raw water augmentation have not yet been developed by the State, first and foremost, the agencies should decide whether to

pursue this option, with the understanding that it could potentially (depending on the timing of the project pursuit) drive regulations. There is currently a five-utility potable reuse regulatory project underway with the National Water Research Institute focusing keenly on such action. As California regulators move ahead with raw water augmentation, these types of potable reuse projects could be required to have higher levels of analysis, potentially including:

- Quantitative Microbial Risk Assessment (QMRA)
- Additional Treatment Barriers
- Additional Monitoring Barriers
- Additional Water Quality Sampling for Emerging Pollutants

8.2.4 General Activities

- **Demonstration facility** - An AWPF demonstration project would provide an opportunity to do site specific water quality analysis on product water as well as concentrate. In addition a demonstration is an important strategy for public education and outreach.
- **Pipe Loop Studies -**
  - Purified water for raw water augmentation may not be stabilized in the same way that it would be for groundwater recharge. However, to protect piping and conveyance infrastructure, some stabilization would be necessary. Pipe loop studies would be able to provide information on the long-term effects of the purified water on pipeline infrastructure under various stabilization strategies.
  - Pipe loop studies should be conducted with both purified water as well as blended purified water and Cope Lake water.
  - These studies would ideally be done as part of a potable water reuse demonstration facility. Alternatively other sources of purified or RO water (such as from the Mocho Demin facility) could be used but may require transport costs.
- **CEQA** - Using the information currently developed in this report, environmental documentation could begin that included alternatives considered and potential impacts associated with building a project. Project-specific details would be required for CEQA compliance and may require additional engineering efforts.
- **Source Control** - A potable reuse system requires a more rigorous approach to source control with advanced monitoring and additional sampling/testing. The reason for the enhanced source control is to protect the new water supply from any illicit discharges of contaminants that could impact the drinking water supply. The wastewater agencies could begin the process of evaluating their existing source control programs now in preparation for implementing a potable reuse program.
- **Permitting** - An initial meeting with staff from the Regional Water Quality Control Board and the CA DDW to inform them of a potential project is recommended. A Report of Waste Discharge and an Engineer's Report will be needed to support development of permits for a new potable reuse facility. These permitting documents will require detailed information on treatment processes, water quality, operations, source control, groundwater protection (if applicable) and other issues.
- **Operator Training** - It will be necessary to train staff to run a new potable reuse program. A new Advanced Water Treatment operator training program is being developed by CA/NV AWWA and is being recommended by CA DDW for future system operations programs. It is anticipated that both certified water and wastewater

operators can apply for the AWT certification program. Training materials are under development by the Water Environment and Research Foundation, as well as other training providers. The operation of a demonstration treatment facility would provide the ideal opportunity for existing operations staff to train and become comfortable with the treatment processes.

- **Supplemental Studies**
  - **Concentrate Management Investigation** – While the analysis within this project documented that RO concentrate can be discharged to the EBDA outfall for release into the San Francisco Bay, this conclusion should be verified through discussions with other EBDA dischargers as well as the RWQCB. If the RWQCB or EBDA denies the discharge of untreated concentrate into the outfall, a new concentrate management study should be conducted to evaluate RO concentrate treatment and disposal options. However, this possibility is not expected based on previous water balance calculations.
  - **Pipeline Alignment Study** - the initial alignments shown within this study were chosen based on a preliminary set of criteria. A detailed pipeline alignment study would include discussion of right-of-way, existing utilities, and future capital improvement plans.
- **Standard Engineering Tasks**
  - Preliminary Design
  - Land Acquisition
  - Right-of-Way
  - Legal Risk Analysis
  - Final Design
  - Construction
  - Startup

8.2.5 Estimated Cost of Next Steps

The estimated time requirement and approximate costs for the next steps are shown in Table 8.2. Costs for design and construction activities are not shown and would be dependent on selected project.

Table 8.2 Potential Next Steps and Estimated Costs/Timing

Step	Timing	Estimated Consultant Cost
How Does Potable Reuse Improve Regional Water Supply Reliability vs. Other Supply Options?		
Regional Water Demand Study	6-9 months	$200,000-300,000
Zone 7 Conjunctive Use Study	4-6 months	$100,000-$150,000
Zone 7 Water Supply Evaluation Update	4-6 months	Zone 7
	Subtotal	**$300,000-$450,000**
Narrow Projects by End Use		
Groundwater Injection		
Siting Study	6-8 months	$100,000
Desktop Contaminant Mobilization Study	4 months	$50,000 - $70,000
Leaching Study	4 months	$250,000 - $310,000
Groundwater Augmentation and Raw Water Augmentation (COL/ DVWTP)		
Independent Advisory Panel	12 months	$50,000
COLs Water Quality Analysis	8 months	$50,000
COLs Hydraulic Modeling/Water Balance	8 months	$100,000 - $150,000
COL Management Plan Update	12-16 months	$200,000
	Subtotal	**$800,000 - $930,000**
Further Define and Implement Technically Preferred Project		
CEQA	12-24 months	$1,00,000 - $1,500,000
Concentrate Management Investigation	6-8 months	$300,000
Quantitative Microbial Risk Assessment (QMRA)	6 months	$40,000
AWPF Demonstration	12 months	$500,000 - $1,000,000
Operator Training	6 months	$100,000
Permitting and Enhanced Source Control	12 months	$300,000 - $500,000
Groundwater Injection - If GW Injection Selected		
Injection and Monitoring Well Construction (1-2000 gpm)	24 months	$3,900,000 - $4,200,000
Tracer Study / Groundwater sampling	12 months	$100,000
COL - If Lake I recharge is selected		
Lake I Tracer Studies	4 months	$50,000
	Subtotal	**$6,300,000 - $7,800,000**

8.3 Schedule for Implementation

As discussed above, there are a number of additional studies and efforts required before a decision on proceeding with potable reuse in the Tri-Valley and before a specific project can be selected. Many of the technical studies can be conducted in parallel along with additional outreach and institutional efforts. One potential implementation schedule is shown in Figure 8.2 showing a project could be online in as little as 8 years if so desired.

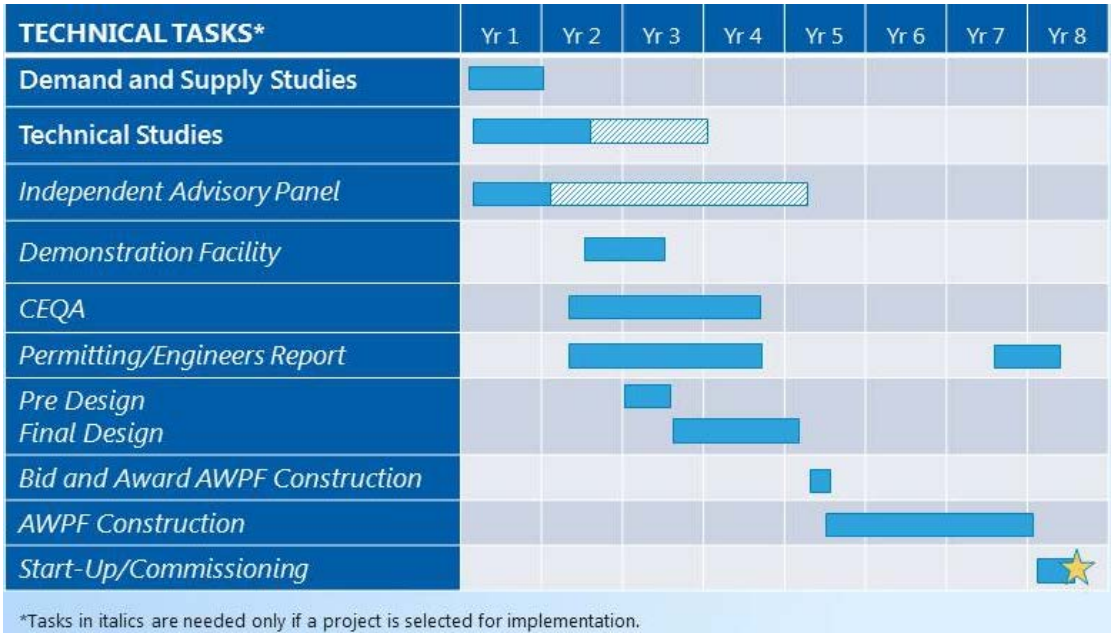


Figure 8.2 Potential Implementation Schedule

8.4 Potential Funding Opportunities

The adequate funding of capital costs is a primary constraint in implementing a major construction project. There are funding sources available, typically through competitive grants and loans from State and Federal programs that could be applied to a Tri-Valley potable reuse project. A potable reuse project would likely be eligible for funding as it meets the following general requirements and objectives:

- Consistent with the California Water Action Plan (CWAP).
- Helps meet the State Recycled Water Policy objectives.
- Protects groundwater resources.
- Demonstrates regional cooperation and partnerships with partners and stakeholders.
- Consistent with objectives of US Bureau of Reclamation Title XVI program to reclaim and reuse wastewaters and naturally impaired ground and surface water in the 17 Western States and Hawaii.

Grants and low interest loans are highly competitive. Competitive funding programs require enhanced programs to meet as many of the following objectives as possible:

- Regional Partnerships
- Integrated project benefits.

- Water conservation.
- Renewable energy improvements.
- Economic stimulus:
  - Job creation.
  - Job preservation.
- Protects and prevents the spread of contamination in an aquifer that serves as a source of drinking water.

8.4.1 Summary of Funding Options

Costs for implementing a Tri-Valley Potable Reuse Project consist of two components – (1) capital cost for construction of facilities, and (2) annual O&M expenditures for both treatment and distribution systems/end uses.

The funding sources available range from traditional funding options such as pay-as-you-go funding, bond funding, grants, and State assisted loans to non-traditional funding sources such as market-based programs. These funding options are detailed in Appendix J. The following list summarizes a sample of other California utilities that are currently working on their potable reuse programs and how they are planning to fund them:

- Soquel Creek Water District - Prop 1 Groundwater grant (for preventing seawater intrusion), Title XVI grants, and SRF loans.
- Morro Bay - WIFIA loans and SRF loans
- Santa Clara Valley Water District - Public/Private partnership

The State of California is working on another water bond, so additional grant funding may be made available should that water bond pass in the future.

8.5 Conclusions

This study has shown preliminarily from a technical basis that a potable reuse project is feasible in the Tri-Valley area. In order to pursue any of these projects, several studies would need to be finalized, including the Regional Water Demand Study, Zone 7 Conjunctive Use Study, and the Zone 7 Water Supply Evaluation Update. If those studies show that potable reuse is needed for future water supply reliability, the appropriate potable reuse project would be pursued, with project specific investigations, including water quality analyses, groundwater/reservoir modeling, and site studies. Appropriate institutional, outreach, and funding next steps (as detailed in Appendix J) should be pursued concurrently with the technical studies.

Chapter 9

SUMMARY

9.1 Introduction and Purpose

The Water Supply Evaluation Update (2016 WSE Update) completed by Zone 7 Water Agency (Zone 7) in February 2016 underscored the need to pursue water supply options to enhance long-term water supply reliability for the Livermore-Amador Valley. Potential future water supply options identified in the WSE Update include the California WaterFix, desalination, and potable reuse. On February 11, 2016, participants in the Tri-Valley Water Policy Roundtable—including elected representatives from the cities of Dublin, Livermore, Pleasanton, San Ramon, DSRSD, and Zone 7—agreed to proceed in a more detailed study of potable reuse, which would be a local and drought-resistant supply. In response, the Tri-Valley Water Agencies, described further below, jointly funded and oversaw the effort to complete the Joint Tri-Valley Potable Reuse Technical Feasibility Study.

The primary goals of this study are: 1) to evaluate the feasibility of a wide range of potable reuse options for the Tri-Valley based on technical, financial, and regulatory considerations and 2) assuming that potable reuse is found to be technically feasible, to recommend next steps for the agencies.

9.1.1 Existing Facilities

Zone 7 supplies water to the Tri-Valley using both raw imported water (State Water Project), local water (Arroyo Valle), and groundwater. Raw water is treated at either the Patterson Pass Water Treatment Plant (PPWTP) or the Del Valle Water Treatment Plant (DVWTP) before distribution (locations shown in Figure 9.1). Zone 7's wells are primarily located in the western portion of the service area. Some groundwater in the Mocho area with high total dissolved solids (TDS) is treated through a demineralization plant before distribution. Additional Zone 7 water facilities include the Chain of Lakes (COL), a series of existing or former gravel quarries that are in the process of reclamation or have been reclaimed as storage or recharge lakes. Zone 7 currently owns Cope Lake and Lake I, with the rest of the ten lakes due to be transferred to Zone 7 in the future. Lake H is expected to be transferred for Zone 7's use over the next few years. Zone 7 will use the COL for a variety of water resource management activities.

Existing wastewater facilities include the DSRSD wastewater treatment plant (WWTP) and the Livermore Water Reclamation Plant (LWRP) as shown in Figure 9.1. Both DSRSD and Livermore have existing non-potable recycled water irrigation programs. Secondary effluent that is not used for producing recycled water is discharged to the San Francisco Bay through the Livermore-Amador Valley Water Management Agency (LAVWMA) and East Bay Dischargers Authority (EBDA) facilities.

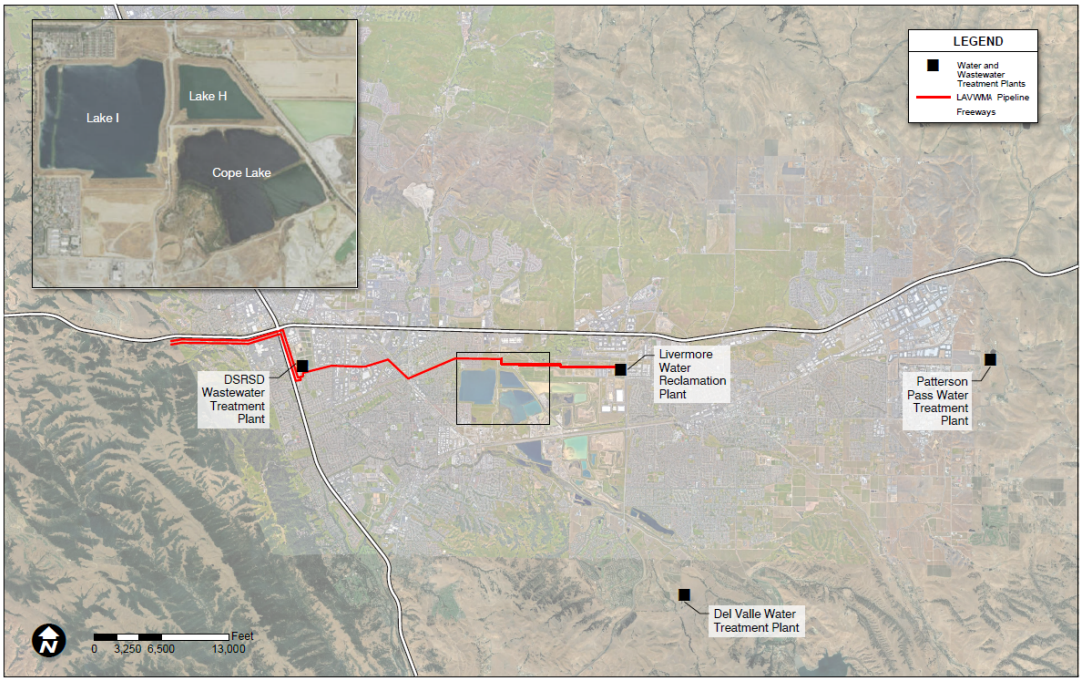


Figure 9.1 Existing Water and Wastewater Facilities

9.2 Alternative Development Method

Due to the numerous possibilities of potable reuse projects, with various source water, treatment locations, and end uses, a step-wise decision process was used to evaluate the potential Tri-Valley potable reuse projects, as is shown in Figure 9.2. At key stages in the selection process, workshops with representatives from all project participants were convened to facilitate key decisions.

9.2.1 Evaluation Criteria

A preliminary set of evaluation criteria was developed to narrow the initial list of alternatives down to three for further investigation. These criteria are as follows:

- Yield (measured by acre-feet per year - AFY).
- Cost (Capital and Operations and Maintenance [O&M]).
- Improved Supply Reliability.
- Improved Delivered Water Quality.
- Improved Groundwater Basin Quality.
- Clear Regulatory Pathway.
- Minimizes Neighborhood Impacts.
- Ability to Phase the Project.
- Operational Flexibility.
- Ease of Construction.

As decided by the project management team, the main criteria for the initial screening were cost and yield. After the initial screening of alternatives, additional criteria were used in the more detailed analysis.

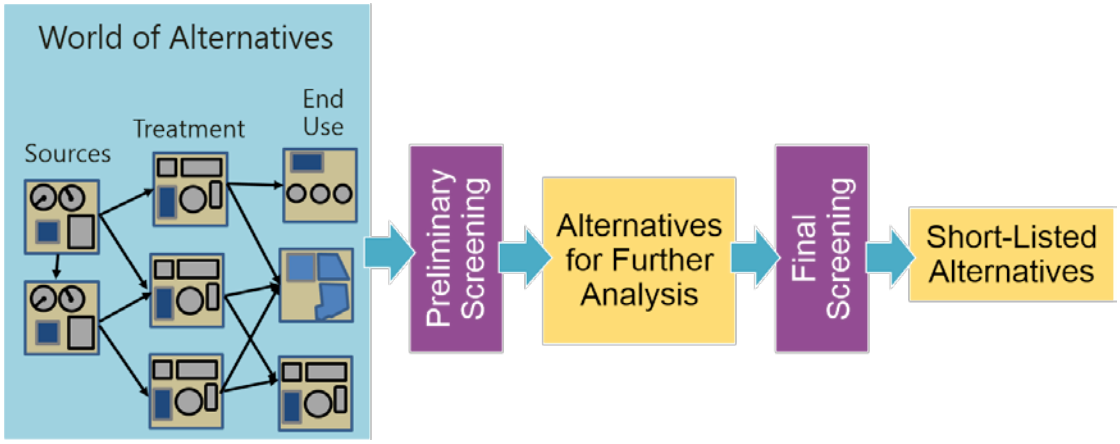


Figure 9.2 Alternative Development Process

9.3 Potable Reuse Status, Regulations and Treatment

Potable reuse has been utilized successfully by California agencies over 30 years as a means to extend water supplies. Other states have also successfully implemented potable reuse while being protective of public health. Project-specific permits for potable reuse have been issued in California for many years, although now regulations are clearly defined for groundwater recharge by the 2014 Groundwater Replenishment Reuse Projects (GRRPs) requirements included in Title 22 and the draft surface water augmentation (SWA) regulations were adopted following a public comment period in March 2018. The September 2016 draft report by the State Water Resources Control Board (SWRCB), titled "Investigation on the Feasibility of Developing Uniform Water Recycling Criteria for Direct Potable Reuse," found that it is feasible to develop uniform water recycling criteria that would incorporate a level of public health protection as good as or better than what is currently provided in California by conventional drinking water supplies (SWRCB, 2016). The state is now moving forward with developing regulations for other types of potable reuse in addition to groundwater augmentation/recharge and surface water augmentation.

9.3.1 Potable Reuse Definitions

The term "potable reuse" incorporates all types of reuse whereby recycled water is safely incorporated into potable water supplies. For the purposes of this study, the term "potable reuse" refers to the practice of using purified water derived from wastewater effluent to supplement water supplies.

The definitions below were compiled from the Framework for Direct Potable Reuse and California Assembly Bill 574 to reflect the recent changes in the terminology and for the specific terminology used in this study.

Groundwater Recharge: planned used of purified recycled water for replenishment of a groundwater basin or an aquifer that has been designated as a source of water supply for a public water system.

Raw Water Augmentation: planned placement of purified recycled water into a system of pipelines or aqueducts that deliver raw water to a drinking water treatment plant that provides water to a public water system.

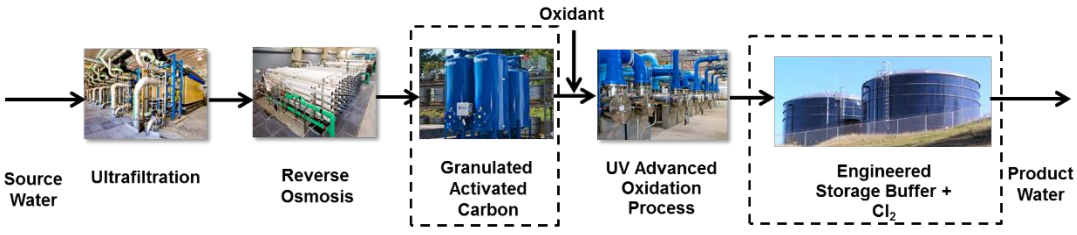
9.4 Treatment Technology

An advanced water purification facility (AWPF) is required for any potable reuse operation. Potable water reuse uses multiple barriers for reliable purification. The multiple barriers concept was designed to ensure public health and the reliability of the process. Each treatment technology has different capabilities in removing pathogens, contaminants of emerging concern (CECs), and meeting drinking water standards (Maximum Contaminant Levels [MCLs]) so combining them adds layers of safety as shown in Table 9.1. The treatment trains for Groundwater Recharge and Raw Water Augmentation are defined below using either existing regulations or industry experience and are shown in Figure 9.3.

A treatment train that meets regulatory guidance for groundwater recharge has been established by Title 22, termed Full Advanced Treatment (FAT). This widely accepted and regulatory approved treatment process train for potable reuse includes membrane filtration (MF/UF, micro or ultra-filtration), reverse osmosis (RO), followed by an ultraviolet light/advanced oxidation process (UV/AOP) step. The proposed treatment train for Raw Water Augmentation involves the addition of Granular Activated Carbon (GAC) after the RO process to prevent any contaminant spikes that might pass through the RO from getting to the finished water. An engineered storage buffer (ESB) is also included at the end of the treatment train. This ESB is a series of three tanks, which provides additional monitoring time to be able to respond to any issue in the treatment train upstream. This treatment train, called FAT+, when combined with the downstream WTPs, greatly exceeds expected regulatory goals.

Table 9.1 Treatment Technologies Target Removal and Multiple Barrier Concept

Target	UF	RO	GAC	UV AOP	ESB + Cl_2
Protozoa	X	X		X	
Virus		X		X	X
MCLs		X	X	X	
CECs		X	X	X	



Note: (Dashed lines show additional treatment technologies required for FAT+)

Figure 9.3 Advanced Water Purification Facility (AWPF) Treatment Train

9.5 Alternatives Identification

Alternatives were developed by combining various sources of water, treatment locations and different end uses as discussed below.

9.5.1 Source Water and Potential Yield

There are two sources of water for the purified water projects, LWRP and DSRSD WWTP. These two WWTPs have existing non-potable recycled water programs, which are planned to be continued even when a purified water project comes online. This limits the amount of available flow for the advanced water purification facility (AWPF). The available flow for potable reuse is seasonally variable and depending on the use of the source can affect the yield of the project as is shown in Figure 9.4.

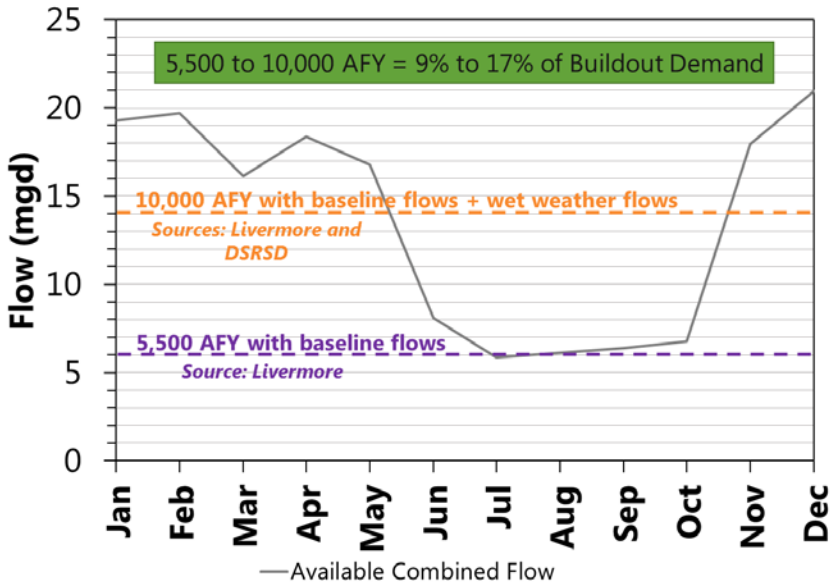


Figure 9.4 Projected Available Secondary Effluent Flows

The potential annual yield in acre-feet per year (AFY) was calculated using the proposed treatment trains described above, with an estimated 80 percent recovery rate (due to the RO recovery rate). Different possible flow scenarios and annual yields for potable reuse were created using buildout flow projections for LWRP and DSRSD WWTP:

- LWRP only flows = 5,500 AFY of purified water.
- Combination of DSRSD WWTP and LWRP flows, operating seasonally = 10,000 AFY of purified water.

A scenario to use seasonal storage to increase available flows for purified water was eliminated due to the high cost and the complication of the elimination of all of DSRSD's solids facilities to accommodate storage at the DSRSD WWTP site.

The remaining bookend scenarios of 5,500 to 10,000 AFY of purified water would provide between 9 to 17 percent of buildout potable water demands in the Tri-Valley.

9.5.2 Potential Treatment Locations

Criteria for selecting treatment locations included available space, proximity to source water, proximity to end uses, and site accessibility. Each WWTP has available space for an AWPF. Additionally, a few regional sites were proposed. With these criteria in mind, five preliminary options were chosen for potential AWPF location:

- DSRSD WWTP – in space currently used as a dedicated land disposal (DLD).
- LWRP – in the abandoned on-site facultative sludge lagoons (FSLs).
- Mocho – near Zone 7's existing Mocho Demineralization Facility.
- Chain of Lakes (COL) – between Cope Lake and Lake H.
- Pleasanton Corp Yard (added in July 2017).

All AWPF locations evaluated are shown in Figure 9.5.

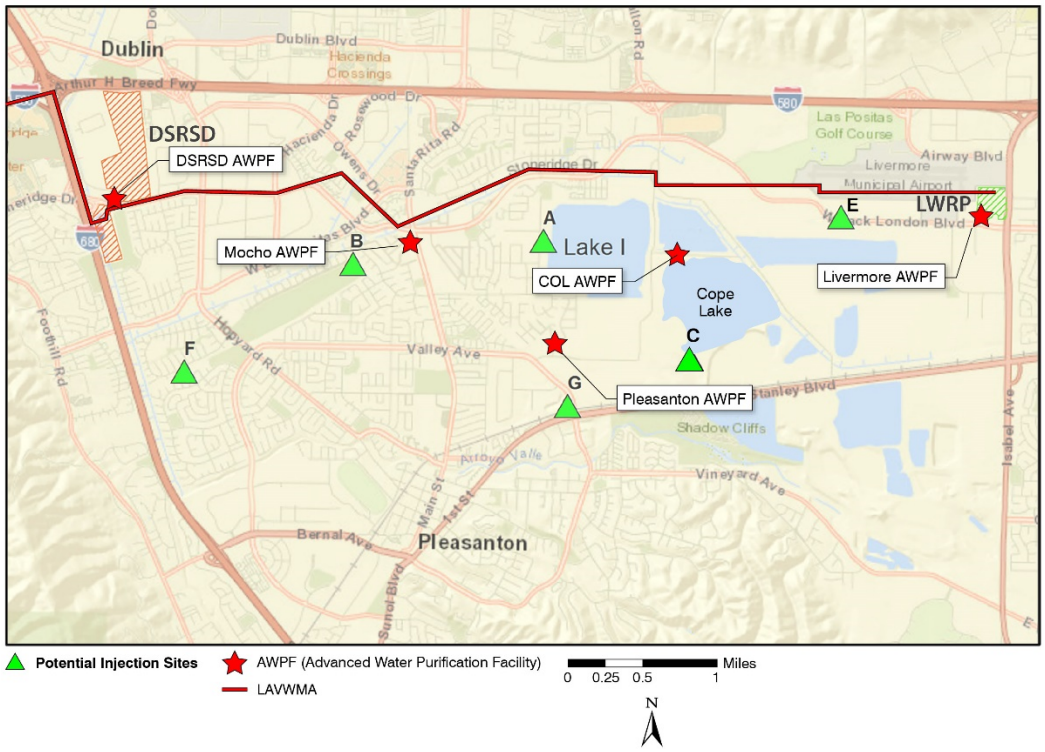


Figure 9.5 Five Potential Purification Facility Locations

9.5.3 End Use Selection

This study investigated three potential end uses for purified water:

- Groundwater augmentation or recharge via injection wells at two locations - one in the eastern side of the basin in Livermore and one in the western side in Pleasanton near the Mocho Demineralization facility
- Groundwater recharge via Lake I (Chain of Lakes) surficial recharge
- Raw water augmentation via Chain of Lakes to DVWTP (or directly to DVWTP)

Raw water augmentation via PPWTP was eliminated due to the long distance to convey purified water to the PPWTP from any of the AWPF sites evaluated.

9.5.3.1 Groundwater Injection

Several injection sites were identified based on proximity to treatment location, distance from production wells, potential to improve groundwater quality, and estimated transmissivity. These wells are shown in Figure 9.6. According to regulations, purified water must travel for a minimum of two months in an aquifer before reaching a production well. However, this travel time must be verified with a tracer study in order to receive full credit. If a tracer study cannot be conducted, six months of travel time via groundwater modeling is assumed within this study to be a minimum travel distance. Figure 9.6 shows an estimated two year travel time buffer around each production well indicating that the identified recharge well locations are outside of these buffer zones and would therefore meet the six- month travel time requirement. Placement of planned new supply wells would also need to consider the travel time requirements.

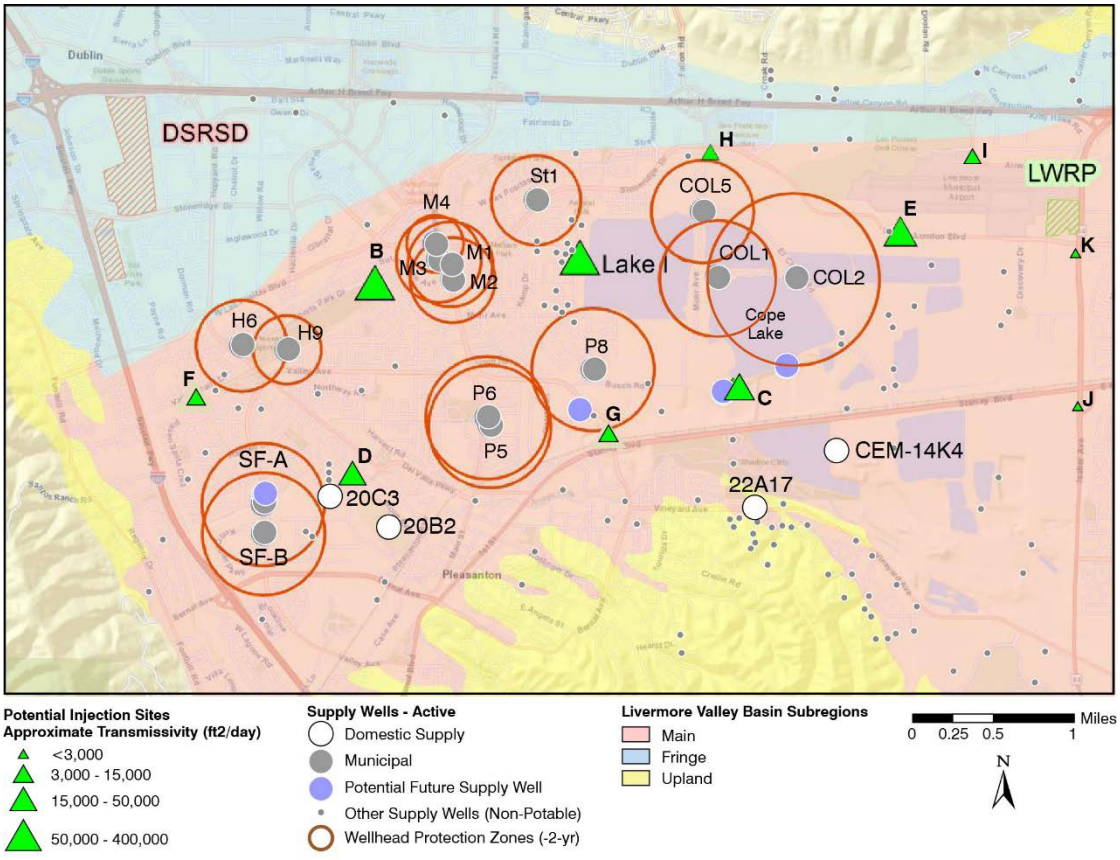


Figure 9.6 Potential Injection Well Locations

9.5.3.2 Groundwater Investigations

The hydrogeologic feasibility of developing a potable reuse project with groundwater recharge was evaluated and found to be technically feasible. Major findings are:

- Both Zone 7's 3-layer and 10-layer groundwater models were used to assess feasibility and found suitable conditions for recharge operations.
- Subsurface travel times between injection sites and existing extraction wells can meet regulatory requirements through proper selection of injection sites.

- Recharge with low TDS water from an AWPF can significantly improve water quality conditions in the groundwater basin on both a local and basin-wide scale, with varying amounts of quality improvement depending on input location.
- Aquifer storage and recovery (ASR) has been found to be effective at many other locations in the country and provides an option to maintain control over groundwater quality and quantity without migration down-gradient. It is recommended for further investigation in future studies.
- Methods to control mobilization of contaminants in the groundwater include stabilization of the purified water and proper geochemical and mineralogical studies once an injection location is identified.
- System wide operational modifications may be needed if a groundwater recharge project were to be implemented, as greater annual groundwater extraction would be required to maintain reasonable groundwater levels in the basin. Long-term groundwater and delivered water quality impacts should also be considered, as they may impact use of the existing Mocho Demineralization Facility and the need for and design of a second facility.

9.5.3.3 Raw Water Augmentation Using Chain of Lakes

The COL can be used in two separate ways – as a surficial recharge for the aquifer (via Lake I) or as a holding point before delivery to DVWTP (via Cope Lake and a planned COL pipeline). Since there is an existing connection between Lake I and Cope Lake, alternatives which send water to one of the lakes can, in effect, use both lakes as potential end uses.

Recharge Via Lake I

Lake I was identified in the 2014 Chain of Lakes Evaluation (Zone 7, 2014) as the highest among the COL for groundwater recharge potential. Lake I is hydraulically connected to the groundwater layer, so there is no vadose zone to provide separation or treatment. Recharge into Lake I would likely not meet the two month minimum travel time required by groundwater recharge regulations. Furthermore, recharge via Lake I would be considered raw water augmentation (with potential emergency use of Lake I to supplement surface water supplies) and the associated treatment train would be FAT+. Additional considerations for recharging Lake I include the existing discharge into Cope Lake (and ultimately transferred to Lake I) by Vulcan Materials Company that could take up available capacity.

Cope Lake to DVWTP

Zone 7 has identified a future capital improvement project to construct a pipeline and pump station at Cope Lake to connect the COLs to DVWTP. Alternatives sending water to Cope Lake assume the use of this connection to convey purified water to DVWTP for additional treatment and distribution. Cope Lake has a storage capacity of approximately 4,500 AF. To qualify as reservoir augmentation (per regulations), at least 180 days of storage in the reservoir must be shown. With most of the flow scenarios investigated, the hold time would be much less than 180 days. Therefore, alternatives using Cope Lake are considered Raw Water Augmentation.

9.6 Alternative Screening and Development

The flow scenarios, treatment trains, and end uses described above were analyzed through Carollo's master planning tool – Blue Plan-it®, which allows the user to investigate various alternative combinations and create potentially endless scenarios. Twenty-one viable scenarios

were produced and evaluated primarily based on overall yield, total capital cost, and unit costs to narrow down to viable scenarios for further analysis.

Based on the analysis from the Blue Plan-it® planning tool, three alternatives were recommended for further detailed analysis. These three alternatives were expanded to six options in the July 2017 workshop. During this workshop, the Pleasanton Corps Yard was offered as a potential regional location. These options are summarized in Table 9.2. ***Note: the selected options were intended to provide bookends for the analysis, allowing evaluation of a range of sources, yields, AWPF locations, and end uses. They are not intended to preclude other options for future consideration.***

Table 9.2 Short-Listed Options for Detailed Evaluation

Option	Location	Capacity (mgd)	Operational Timing	Source Water	Treatment Train	End Use
1a	Livermore	5	Year-Round	LWRP	FAT+	COL (Lake I)/ DVWTP
1b					FAT	Well E
2a	DSRSD	12	Seasonal	DSRSD WWTP + LWRP	FAT+	COL (Cope Lake)/ DVWTP
2b					FAT	Well B
3	Regional at Mocho	12	Seasonal	DSRSD WWTP + LWRP	FAT	Well B
4	Regional at Pleasanton	12	Seasonal	DSRSD WWTP + LWRP	FAT+	COL (Cope Lake)/ DVWTP

Options 1a and 1b are the only projects that involve a year-round operation at a constant flow of 5 mgd. Options 2 through 4 have larger 12-mgd AWPFs which are intended to operate at full capacity during winter months (October through April) and at a reduced flow of 5 mgd in summer months (May through September). During the reduced flow periods, unused membranes would be stored in solution and rotated in and out of operation.

In the detailed investigations, site visits were conducted to all of the potential AWPFs (except for Pleasanton) and preliminary site layouts were developed for both FAT and FAT+ treatment trains. Preliminary design criteria for each treatment process were also established. A preliminary staffing assessment showed that a minimum of sixteen full time staff may be required for continuous operation. This number could decrease with a sufficient amount of automation.

9.6.1 Alternatives Comparison

The short-listed options were evaluated based on both qualitative and quantitative criteria. Table 9.3 presents the cost estimates for each short-listed project. Table 9.4 shows a qualitative comparison of the short-listed projects using the established evaluation criteria. For the purposes of the qualitative analysis, Option 1a was broken up into end use at the COL (Lake I) and end use as raw water augmentation to DVWTP to recognize their different impacts on reliability and groundwater quality.

Table 9.3 Cost Estimate for Short-Listed Options

	Livermore AWPF to COL/DVWTP Option 1a	Livermore AWPF to Well E Option 1b	DSRSD AWPF To COL/DVWTP Option 2a	DSRSD AWPF to Well B Option 2b	Mocho AWPF to Well B Option 3	Pleasanton AWPF to COL /DVWTP Option 4
Total Capital Cost	$112M	$103M	$222M	$194M	$210M	$208M
Annualized Capital Cost(1)	$7M	$7M	$15M	$13M	$14M	$14M
Annual O&M Costs	$7M	$7M	$9M	$9M	$9M	$9M
Actual Project Yield (AFY) (2)	5,500	5,500	10,000	10,000	10,000	10,000
Unit Cost of Water ($ per acft) (2)	$2,530	$2,420	$2,350	$2,160	$2,250	$2,240

Notes:
(1) Annualized capital costs based on a 5% interest rate and a 30-year payback period - typical of bond financing. Includes O&M.
(2) Actual yield based upon year round operation for Livermore plants and seasonal operation for options which treat both DSRSD and Livermore effluent.

9.7 Summary of Findings

Based on the book-end approach of considering alternatives, the major findings of this study are:

- Potable reuse for the Tri Valley is technically feasible. There were no fatal flaws identified by this technical evaluation.
- All alternatives increase water supply reliability, with the degree of benefit varying depending on yield (5,500 – 10,000 AFY) and, to a limited extent, end use (e.g., via groundwater recharge versus raw water augmentation).
- All alternatives improve drinking water quality and some improve the overall groundwater basin quality.
- There are good options available to site the AWPF facility.
- Regulatory pathways exist for all options.
- There is some variability in the overall operational flexibility and constructability depending on the option.
- Cost ranges for the book-end options:
  - Capital costs = $103 to $222 million
  - Operations and Maintenance Costs = $6.5 to $9M/year
  - Overall unit costs = $2,200-2,500/AF

Table 9.4 Qualitative Comparison of Short-Listed Projects

	Livermore AWPF to COL(2)	Livermore AWPF to DVWTP(2)	Livermore AWPF to Well E	DSRSD AWPF To COL/ DVWTP	DSRSD AWPF to Well B	Mocho AWPF to Well B	Pleasanton AWPF to COL/DVWTP
Yield (AFY)	5,500	5,500	5,500	10,000	10,000	10,000	10,000
Capital Cost (M$)	112	112	103	222	195	210	208
Improve Supply Reliability	+	++	+	+++	++	++	+++
Improved Delivered Water Quality	+	+	+	++	++	++	++
Improve Groundwater Basin Quality	+	o	+	o	+	+	o
Clear Regulatory Pathway	+	+	++	+	++	++	+
Minimizes Neighborhood Impacts	++	++	++	++	++	-	+
Ability to Phase the Project (1)	o	o	o	+	+	+	+
Operational Flexibility	++	++	++	o	o	-	-
Ease of Construction	++	++	++	++	++	-	+
+ positive impact			**-** negative impact				**o** neutral impact

Notes:
(1) Phasing in this report only refers to the ability to expand on one site, not the potential to build in phases at two different locations.
(2) For the purposes of the qualitative analysis, Option 1a was broken up into end use at the COL (Lake I) and end use as raw water augmentation to DVWTP to recognize their different impacts on reliability and groundwater quality.

9.8 Recommendations/Next Steps

If the partnering agencies wish to continue pursuing potable reuse, there are a number of technical efforts necessary. In the near-term, to narrow the best end use option, further studies and other efforts are needed to evaluate the best candidates for siting injection wells; to characterize the potential for contaminant mobilization in the groundwater basin using models and field test; and to determine the ability of the COL to receive, store, and recharge purified water in conjunction with other potential uses of the COL.

A broader effort refining regional demand projections would also help determine the need for the various water supply options available to the Tri-Valley—including potable reuse—and the target yield for those options. To place potable reuse in the context of other water supply options, the 2016 WSE update should be updated to reflect the findings from this study as well as new data and options that have developed since 2016.

While this study focused on technical issues, there are also major institutional and public outreach components to potable reuse implementation that would need to be addressed.

Appendix A

COST ESTIMATES

ID	Source	Capacity (MGD)	Annual Yield (AFY)	Seasonal/Year Round	Purification Location	Treatment	Storage	End Use Location	Treatment Cost	Pipeline / Pumps Cost	Well Cost	Storage Cost	Total Infrastructure Cost	Total Capital Cost	O&M Cost
1	L	4.9	5,500	Year Round	Livermore WRP	FAT	No	Well E	$71.1M	$9.8M	$11.7M	$0.0M	$21.5M	$93M	$4.3M
2	L	4.9	5,500	Year Round	Livermore WRP	FAT	No	Lake I	$79.7M	$15.3M	$0.0M	$0.0M	$15.3M	$95M	$4.3M
3	L	4.9	5,500	Year Round	Livermore WRP	FAT+	No	PPWTP	$79.7M	$46.7M	$11.7M	$0.0M	$58.4M	$138M	$4.8M
4	L	4.9	5,500	Year Round	Livermore WRP	FAT+	No	Cope Lake / DVWTP	$79.7M	$13.6M	$0.0M	$0.0M	$13.6M	$93M	$4.2M
5	L + D	6.9	7,700	Year Round	Regional at DSRSD WWTP	FAT	370 MG	Well F	$91.5M	$11.6M	$15.6M	$50.7M	$77.8M	$169M	$5.8M
6	L + D	6.9	7,700	Year Round	Regional at DSRSD WWTP	FAT	370 MG	Well B							
7	L + D	6.9	7,700	Year Round	Regional at DSRSD WWTP	FAT+	370 MG	Lake I	$104.5M	$29.2M	$0.0M	$50.7M	$79.8M	$184M	$6.1M
8	L + D	11.8 (4.9 Summer)	10,000	Seasonal	Regional at DSRSD WWTP	FAT	No	Well F	$143.0M	$16.6M	$23.4M	$0.0M	$40.0M	$183M	$8.2M
9	L + D	11.8 (4.9 Summer)	10,000	Seasonal	Regional at DSRSD WWTP	FAT	No	Well B							
10	L + D	11.8 (4.9 Summer)	10,000	Seasonal	Regional at DSRSD WWTP	FAT+	No	Lake I	$166.8M	$35.3M	$0.0M	$0.0M	$35.3M	$202M	$8.5M
11	L + D	6.9	7,700	Year Round	Regional at DSRSD WWTP	FAT+	370 MG	Cope Lake / DVWTP	$104.5M	$51.5M	$0.0M	$50.7M	$102.2M	$207M	$6.4M
12	L + D	11.8 (4.9 Summer)	10,000	Seasonal	Regional at Mocho	FAT+	No	Cope Lake / DVWTP	$166.8M	$37.9M	$0.0M	$0.0M	$37.9M	$205M	$7.9M
13	L + D	11.8 (4.9 Summer)	10,000	Seasonal	Regional at Mocho	FAT	No	Well B	$145.5M	$30.5M	$23.4M	$0.0M	$53.9M	$199M	$8.4M
14	L + D	11.8 (4.9 Summer)	10,000	Seasonal	Regional at Mocho	FAT+	No	Well A							
15	L + D	11.8 (4.9 Summer)	10,000	Seasonal	Regional at Mocho	FAT+	No	Lake I	$169.9M	$37.1M	$0.0M	$0.0M	$37.1M	$207M	$8.6M
16	L + D	6.9	7,700	Year Round	Regional at Mocho	FAT+	370 MG	Cope Lake / DVWTP	$96.0M	$23.2M	$0.0M	$50.7M	$73.9M	$170M	$5.7M
17	L + D	11.8 (4.9 Summer)	10,000	Seasonal	Regional at COL	FAT	No	Well C							
18	L + D	11.8 (4.9 Summer)	10,000	Seasonal	Regional at COL	FAT	No	Well H	$152.8M	$50.8M	$23.4M	$0.0M	$74.2M	$227M	$8.5M
19	L + D	11.8 (4.9 Summer)	10,000	Seasonal	Regional at COL	FAT+	No	Lake I							
20	L + D	11.8 (4.9 Summer)	10,000	Seasonal	Regional at COL	FAT+	No	Well A	$177.2M	$51.4M	$0.0M	$0.0M	$51.4M	$229M	$8.5M
21	L + D	6.9	7,700	Year Round	Regional at COL	FAT+	370 MG	Cope Lake / DVWTP	$101.6M	$29.5M	$0.0M	$50.7M	$80.2M	$182M	$5.6M

Notes:
(1) L = Livermore; D= DSRSD
(2) Annual costs based on an interest rate of % and an expected payback period of years, consistent with bond funding.
(3) Costs are estimated based upon the January San Francisco ENR-CCI of 11069
(4) This is a class 4 budget estimate as defined by the AACEI's Revised Classification () with an expected accuracy range of + or - percent. The cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others, or economic conditions occur. Since the Engineer has no control over these factors, he or she cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at the time.

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Appendix B

WORKSHOP NO. 3 MEETING MINUTES

MEETING MINUTES

TRI-VALLEY POTABLE REUSE FEASIBILITY STUDY

Zone 7 Water Agency

Date: April 18, 2017

Project No.: 10414A.00

Purpose: Discussion of preliminary alternatives

Attendees:

Zone 7:	Carollo Team:	DSRSD:
Amparo Flores, Jill Duerig, Wes Mercado, Colter Anderson, Carol Mahoney	Lydia Holmes, Elisa Garvey, Andy Salveson, Christina Casler, Jeff Stovall, Jeff Mosher- WE&RF	Rhodora Biagtan, Dan McIntyre, Judy Zavadil
Pleasanton:	**Livermore:**	
Kathleen Yurchak, Dan Martin	Darren Greenwood	

Distribution: Attendees, Helen Ling

Discussion:

The following is our understanding of the subject matter covered in this conference. If this differs from your understanding, please notify us.

Meeting Minutes

1. **NWRI and WE&RF overview**
    a. Both Zone 7 and DSRSD have provided funding for potable reuse research.
    b. Jill - note that Zone 7 supported reuse under the WRRF not under WateReuse. We were not comfortable contributing to a project that was promoting water reuse solely and were more stating that there needs to be more research in this area.
    c. AB 574 (Quirk) bill - come up with definitions for potable reuse, not keeping the "Indirect" and "Direct" in there. Titles are more based on the application.
        i. Deadline is 2021
2. **Decisions made and background**
    a. Discussion about flexibility in Cope Lake
        i. Currently 12 mgd project planned to build pipe between Cope Lake and DVWTP. Can be used to push water in either direction for treatment or for storage.
        ii. For the alternatives, it was recommended to increase the pump station to 20 mgd (the pipeline has sufficient capacity to handle this flow). Will allow use of pipeline for potable reuse while preserving current planed uses of the pipeline for emergencies, etc.
    b. Discussion on the 10,000 AFY assumption
        i. Amparo - 10,000 AFY comes from the Water Supply Evaluation Update & UWMP, identified as potential future water supply so a good upper bracket for the analysis. Would get Zone 7 to a certain amount of reliability.

ii. Judy- is the 10,000 afy satisfying a potential discrepancy in water demand and supply?
iii. Amparo- Essentially, yes, the 10,000 AFY meets the demand and supply discrepancy. However, Zone 7's approach is not simply to look at a water demand and supply balance under normal conditions and calculate the difference. We identify possible water supply options—with their associated amounts and timing—and use those as inputs to the water supply risk model, then run the model to see if reliability goals are achieved with those options. In the WSE Update, the upper end of what was estimated available from both desal and potable reuse was around 10,000 AFY. Note that while the 10,000 AFY was used as a bookend for the analysis for this study, there were other limiting factors to going beyond 10,000 AFY so this number appeared reasonable.
iv. Carollo to solidify the rationale for the 10,000 afy number .

3. Alternatives Development Discussion

a. Seasonal vs Constant Flow
   i. Amparo - what about the operational difficulty with seasonal treatment?
      1. Jeff M - we have El Paso that operates with 4 modules that rotate in and out of use and it works fine.
   ii. Storage
      1. **Decision** - As a group decided to delete the option to get to 10,000 AFY constant flow with 450 MG of storage.
b. **Decision -** For cost estimates - switch to San Francisco ENR-CCI to be consistent with WSE Update.
c. End Use discussion - groundwater wells
   i. Jill - what was our basis for injection well locations? Well master plan has new wells that we are planning, we should incorporate these when placing well locations and calculating travel time.
      1. **Decision -** The original well placement was developed through discussion with the PM team and Zone 7 groundwater staff, but in future developments of alternatives, we should also consider the additional wells to be constructed by Zone 7.
   ii. Jill - concern about ability to inject.
   iii. Jill - did you incorporate some years when we couldn't use recharge as an option, when the basin is full?
      1. Amparo – Carollo's analysis has not included this yet. This is something that can be analyzed using the water supply risk model during the more detailed analysis of short-listed options.
   iv. Jeff M - would you not increase your groundwater production if you had excess groundwater?
      1. Jill - no we don't normally - groundwater is not as good of quality and demin facility is only a certain size.
      2. Jill - groundwater recharge with purified water may increase release of chromium, arsenic, or other metals from the soils into groundwater.
         a. *Note - next task of work will evaluate this issue.*

v. Judy - we need to balance our concerns about water quality - while injection could potentially worsen the groundwater quality due to contaminant mobilization, it could also benefit and be in line with the salt and nutrient management plan.

4. **Regional Modeling Discussion**
    a. Water level elevation - about 310 feet.
    b. Well C was not modeled in this run because of limited time.
    c. **Decision -** We would have to consider mining activities if we're bringing groundwater elevations up by 25 ft . Could affect their operations and need to dewater.
        i. They have permits to discharge going out to 2060.
    d. Operations staff has expressed preference in increasing storage and groundwater recharge in the COL area.
    e. Judy - did we have a maximum groundwater level assumption?
        i. For this preliminary modeling, no.
    f. Amparo – The WSE update may have assumed an 80% limit to groundwater operational storage until mining is done. Staff can check this. The preliminary groundwater modeling is only being used to compare impacts across the alternatives, and not to predict actual levels in the groundwater basin. The water supply risk model could be used to evaluate impacts to the groundwater basin when the detailed analysis is done for the short list of alternatives.
    g. **Decision -** for future analysis, we need to add to considerations for groundwater recharge - like modifying operations. We will likely need to modify operations with all alternatives, WTP, Lake I, Injection wells (e.g., changing groundwater/surface water blend).
5. **Alternatives Discussion and Screening**
    a. Discussion question 1 - Do we have any more alternatives we want to run?
        i. **Decision -** Group agrees no more alternatives need to be analyzed.
    b. Discussion question 2 - Any alternatives that need modification? Combined?
        i. Combinations could include modular regional approach or we could have a plant at Livermore and then a second plant at DSRSD.
    c. Discussion on question 3 - Recommended Alternatives
        i. Carry forward at least one GW well alternative and one WTP alternative.
        ii. Carry forward at least one 10,000 afy option for groundwater recharge.
        iii. **Decision -** Group agrees to remove any alternative that requires storage (Alternatives 5, 7, 11, 16, and 21).
        iv. **Decision** - Pair Lake I with Cope/DVWTP. Provides flexibility for operations.
        v. **Decision** - Team would like Alt 2 (Livermore to Lake I), combined with Alt 4 (Livermore to DVWTP).
        vi. Need to select lower capital cost alternatives and not just lower $/AF. Will be difficult for Valley to pay for project over $200M.
        vii. Location of purification facilities:
            1. There's more operations support for something at an existing facility.
            2. Zone 7 operations folks were not concerned about the location difference.
            3. Is there any public perception regarding collocating a WWTP and a purification facility?
                a. Jeff M - In El Paso, they're building a wall between the two facilities but they are on the same site.
        viii. Yield - as alternatives are refined, we don't have to get all 10,000 afy into the ground it's not a magic number. Determine what makes sense technically.

ix. **Group Decides on Recommended alternatives**
    1. **Option 1 - Alternatives 2 and 4 combined - Livermore to Lake I, Cope and DVWTP**
    2. **Option 2 - Alternative 12 - DSRSD Seasonal operation to Surface Water Augmentation (Cope/DVWTP)**
    3. **Option 3 - Alternative 13 - Mocho Seasonal operation to GW well (but adjust well location for travel time)**

6. Joint Liaison Committee meeting next week
    a. Decision: Provide an overview of potable reuse regulatory framework and projects and overview of current project status (e.g., range of end use alternatives, bookends of water supply amounts). Slide on the AB 574 would be a good backpocket slide.

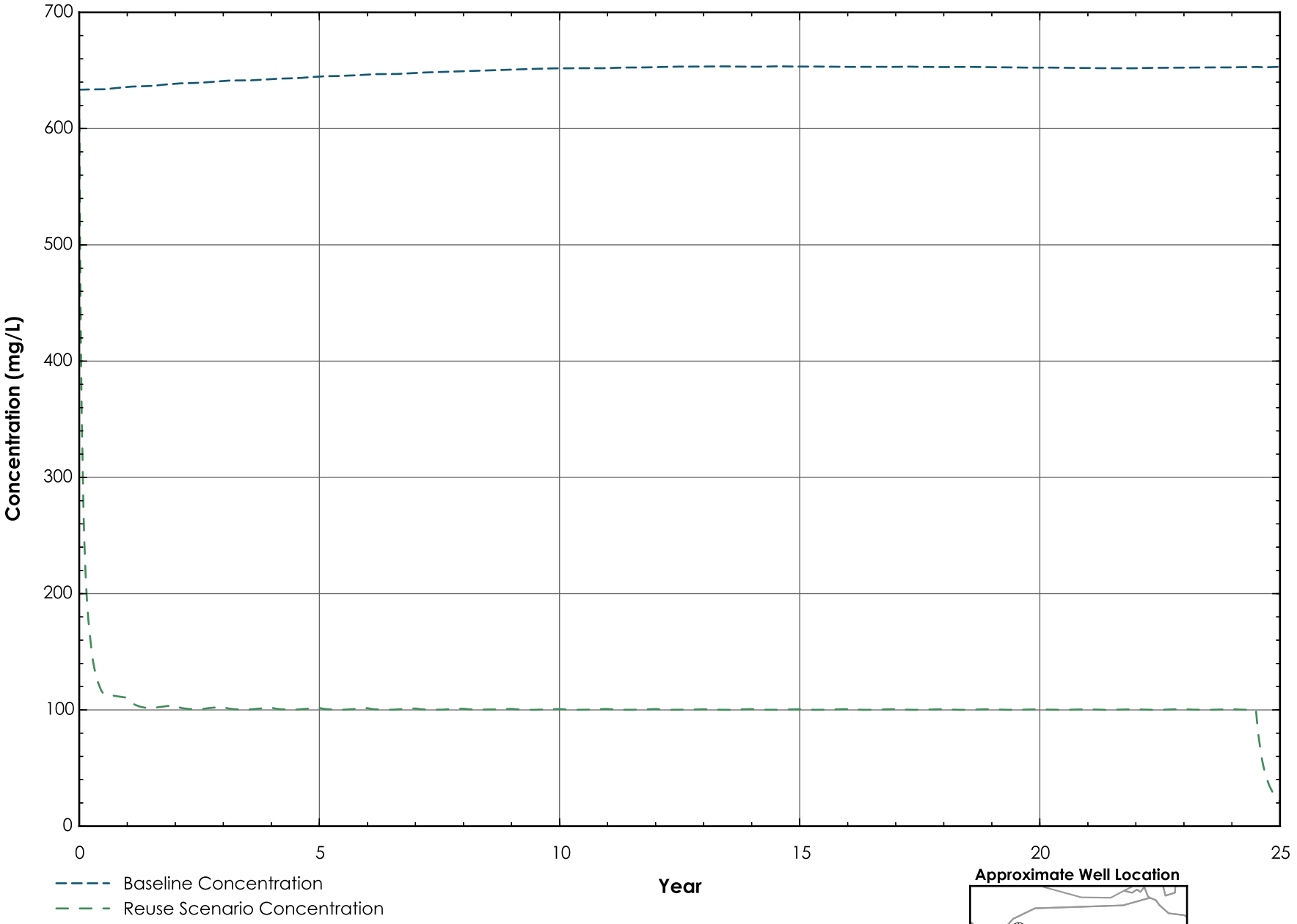
Action Items:

- Carollo/PM team
    - Adjust ENR-CCI to be SF and not 20-Cities.
    - Clarify rationale for 10,000 AFY bookend
    - Continue detailed analysis on recommended alternatives - Option 1 (Alts 2 & 4 combined), Option 2 (Alt 12) and Option 3 (Alt 13)
    - Detailed analysis needs to include the following
        - Existing and planned wells for travel time calculations
        - Impacts of groundwater levels on mining and recharge operations – confirm whether groundwater basin should only be kept at 80% full until mining is done
    - Need to evaluate operational strategies for each of the recommended alternatives. These new strategies should be incorporated into the groundwater model.
        - Zone 7 to run Risk Model to evaluate impacts of alternatives to the groundwater basin and storage options
    - Presentation/slides for meeting next week with slimmed down discussion

Appendix C

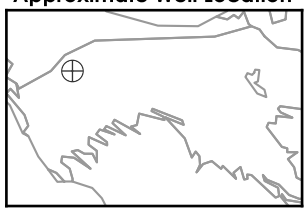
SIMULATED TDS CONCENTRATIONS IN PRODUCTION WELLS

Well Inj B Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Well B

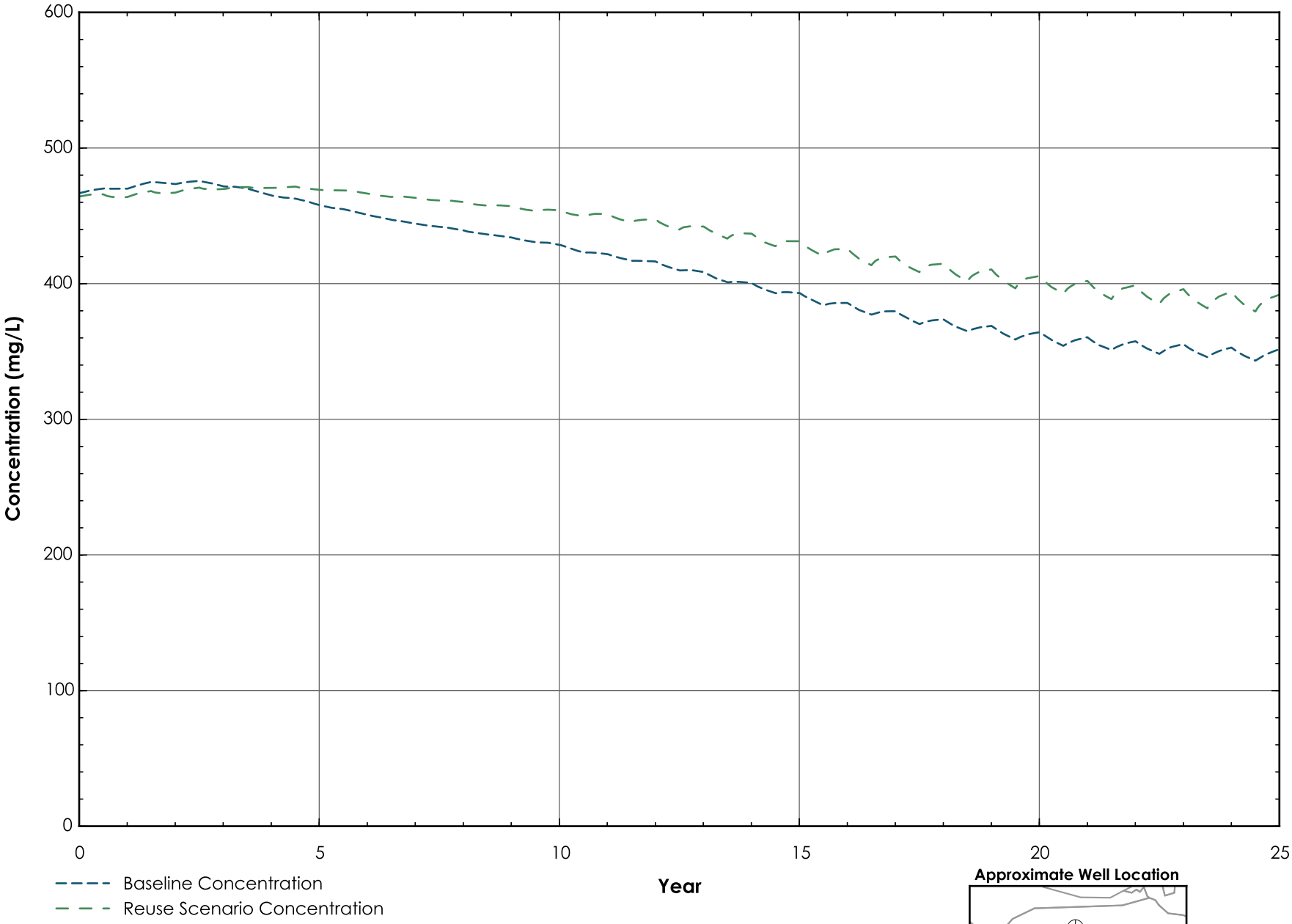


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Site B offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

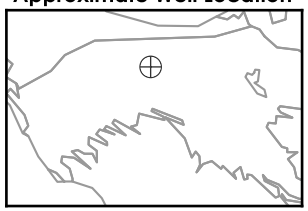


Well COL 1 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Well B

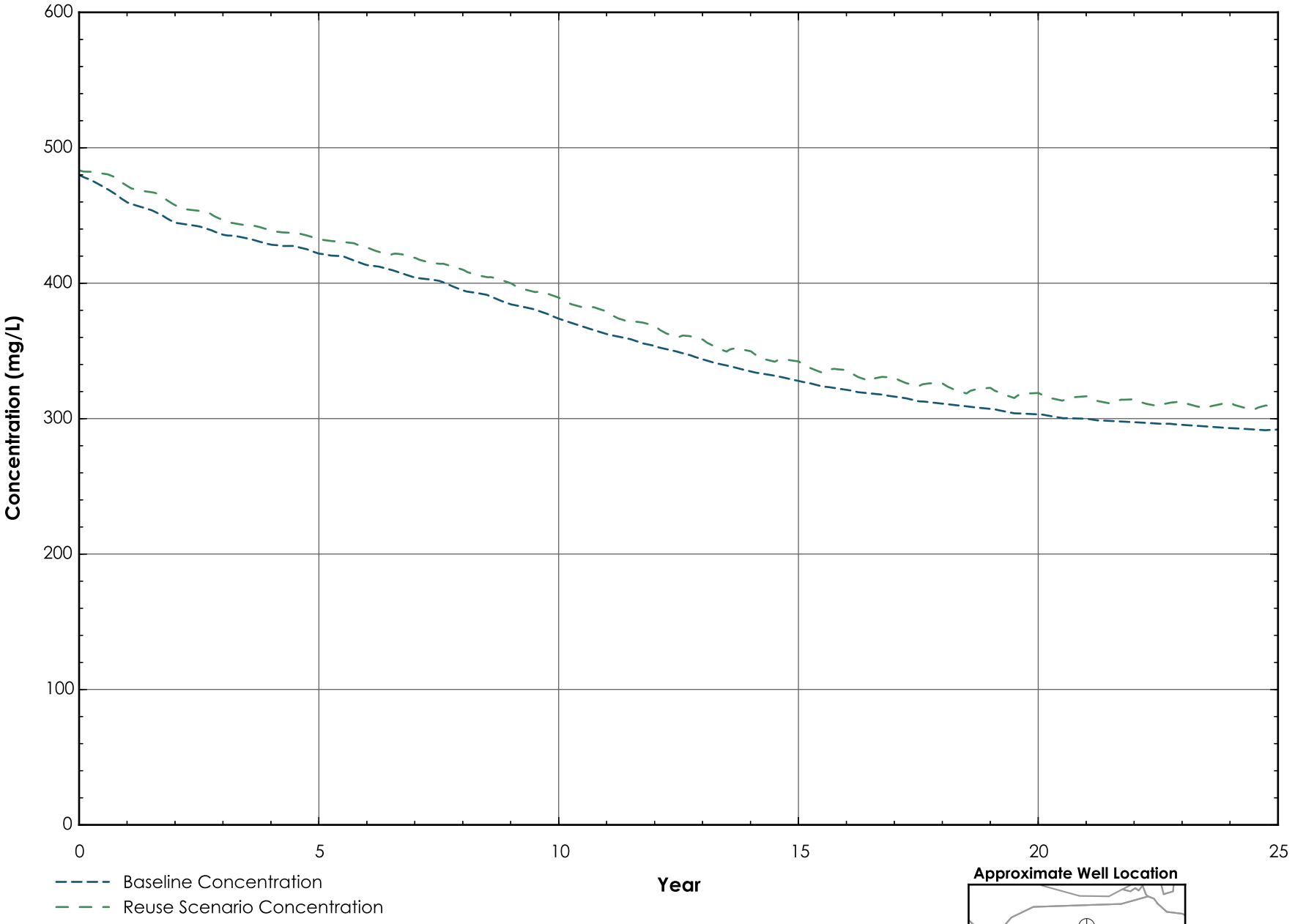


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Site B offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

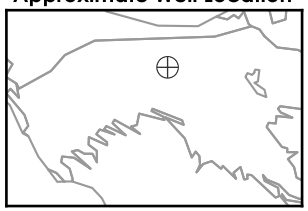


Well COL 2 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Well B

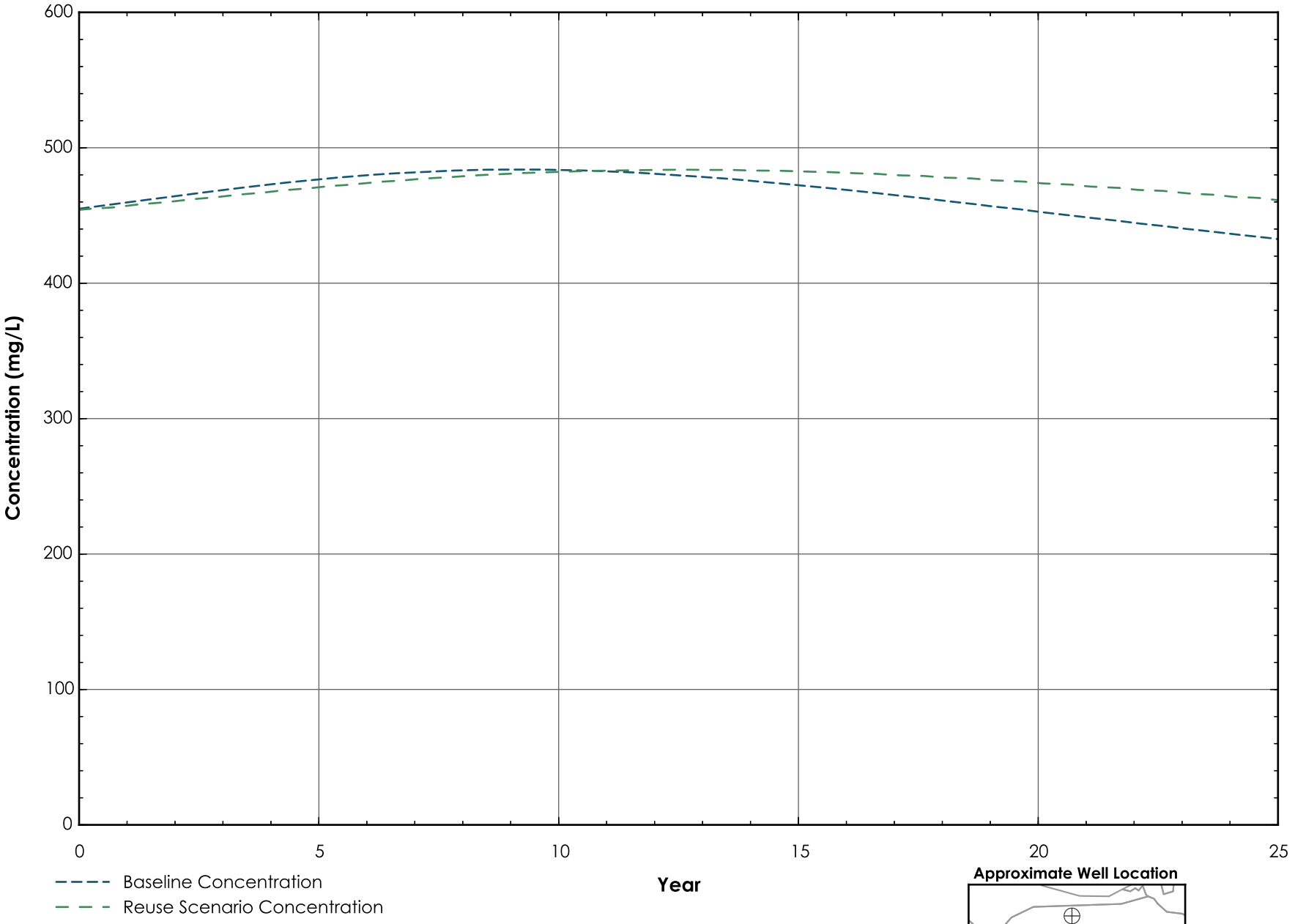


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Site B offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

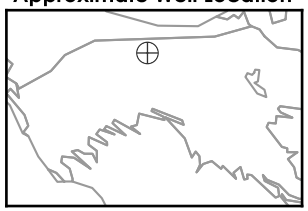


Well COL 5 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Well B

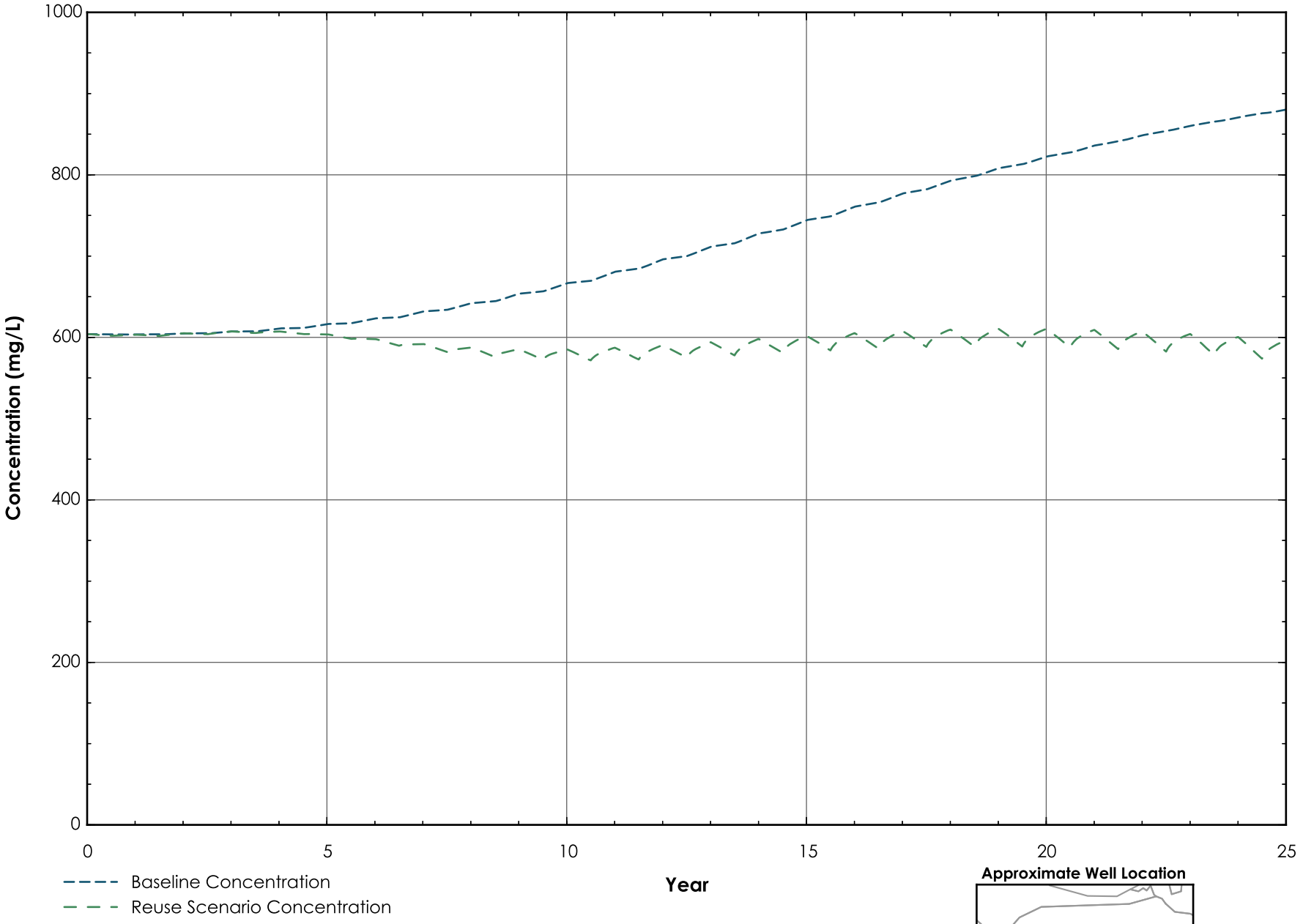


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Site B offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

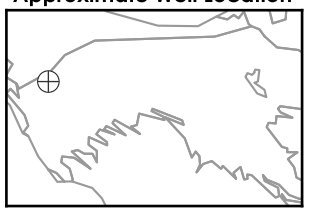


Well HOP 6 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Well B

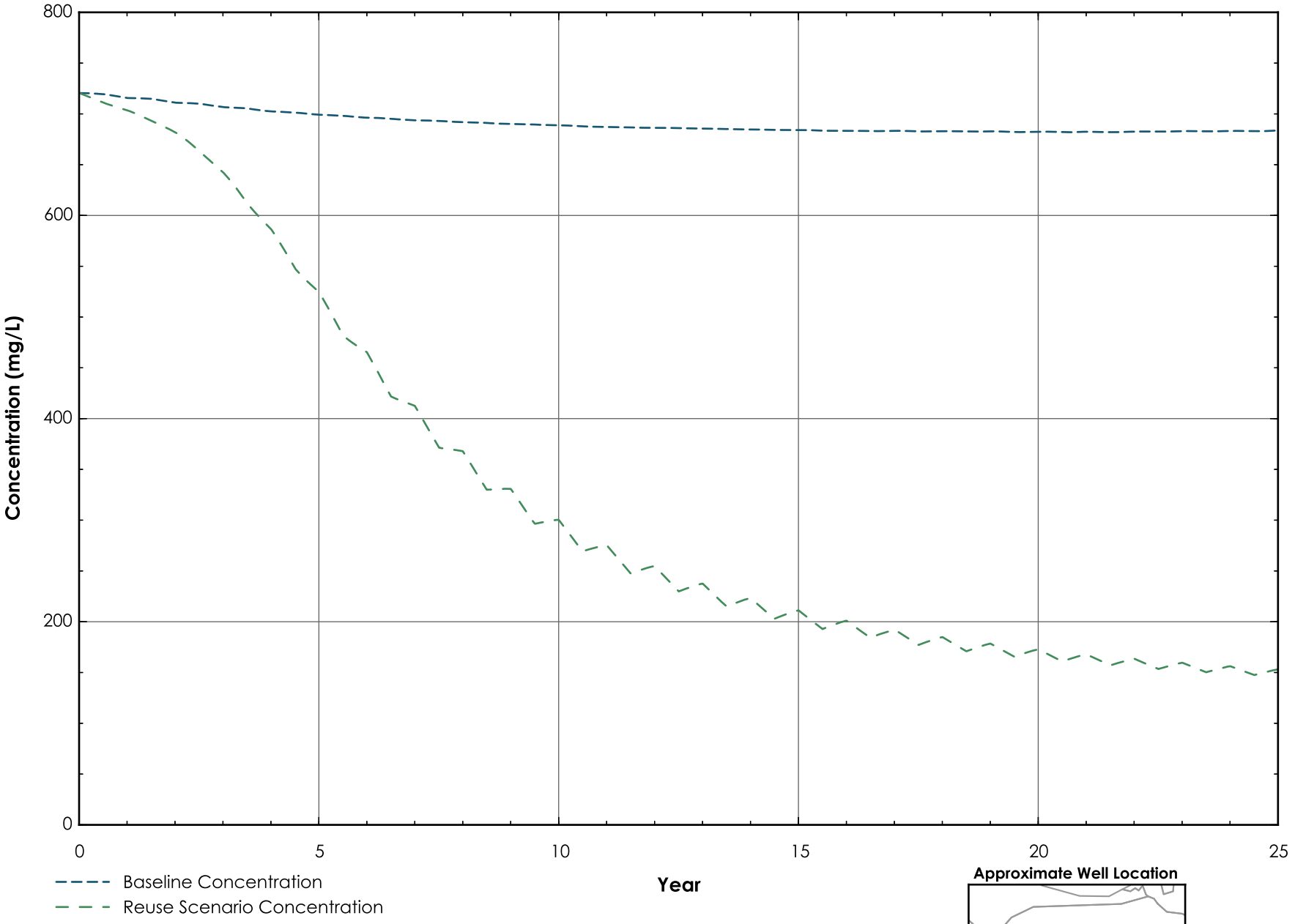


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Site B offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

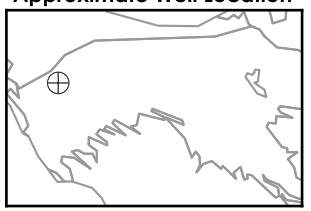


Well HOP 9 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Well B

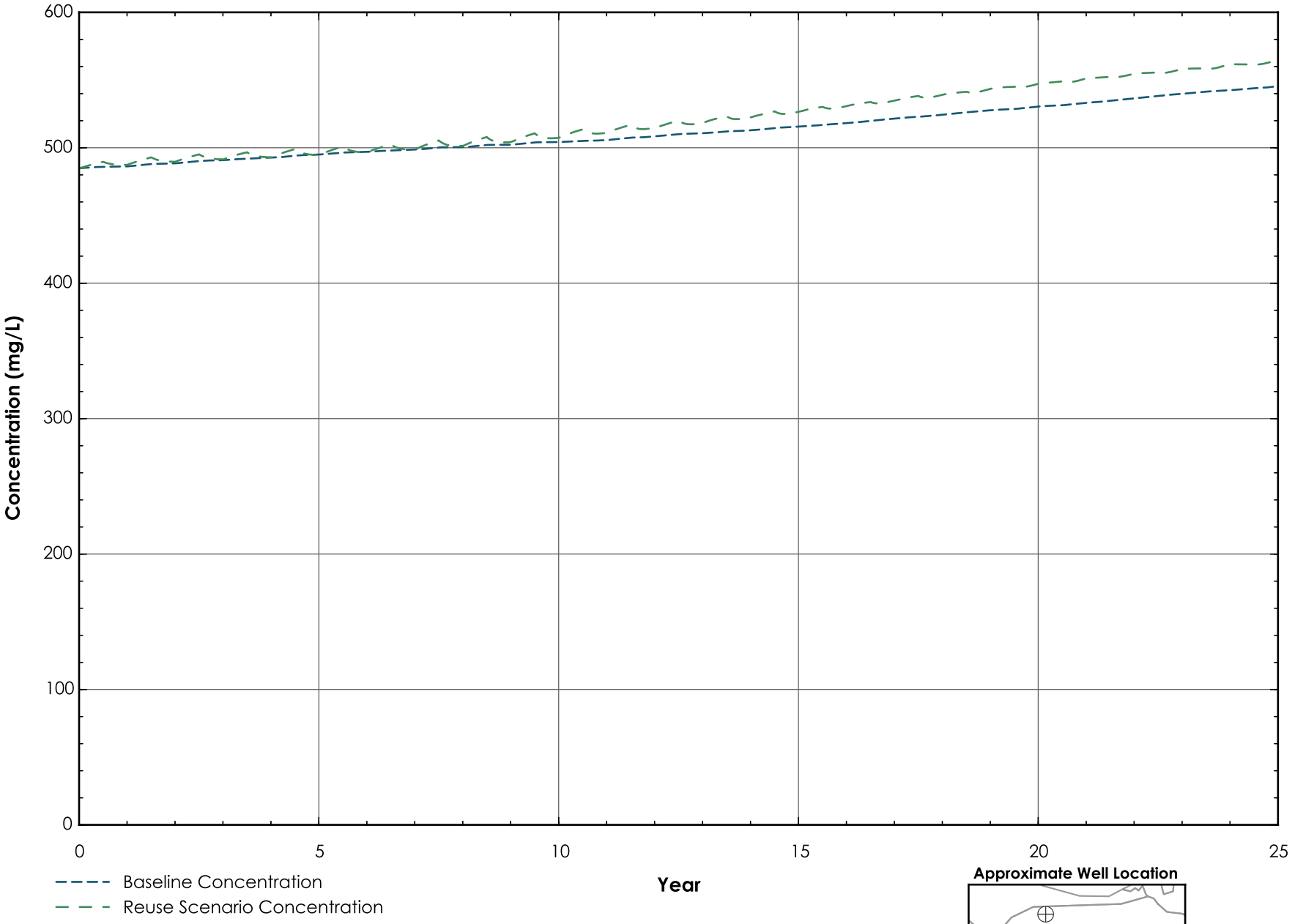


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Site B offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

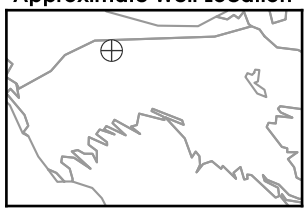


Well STONERIDGE 1 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Well B

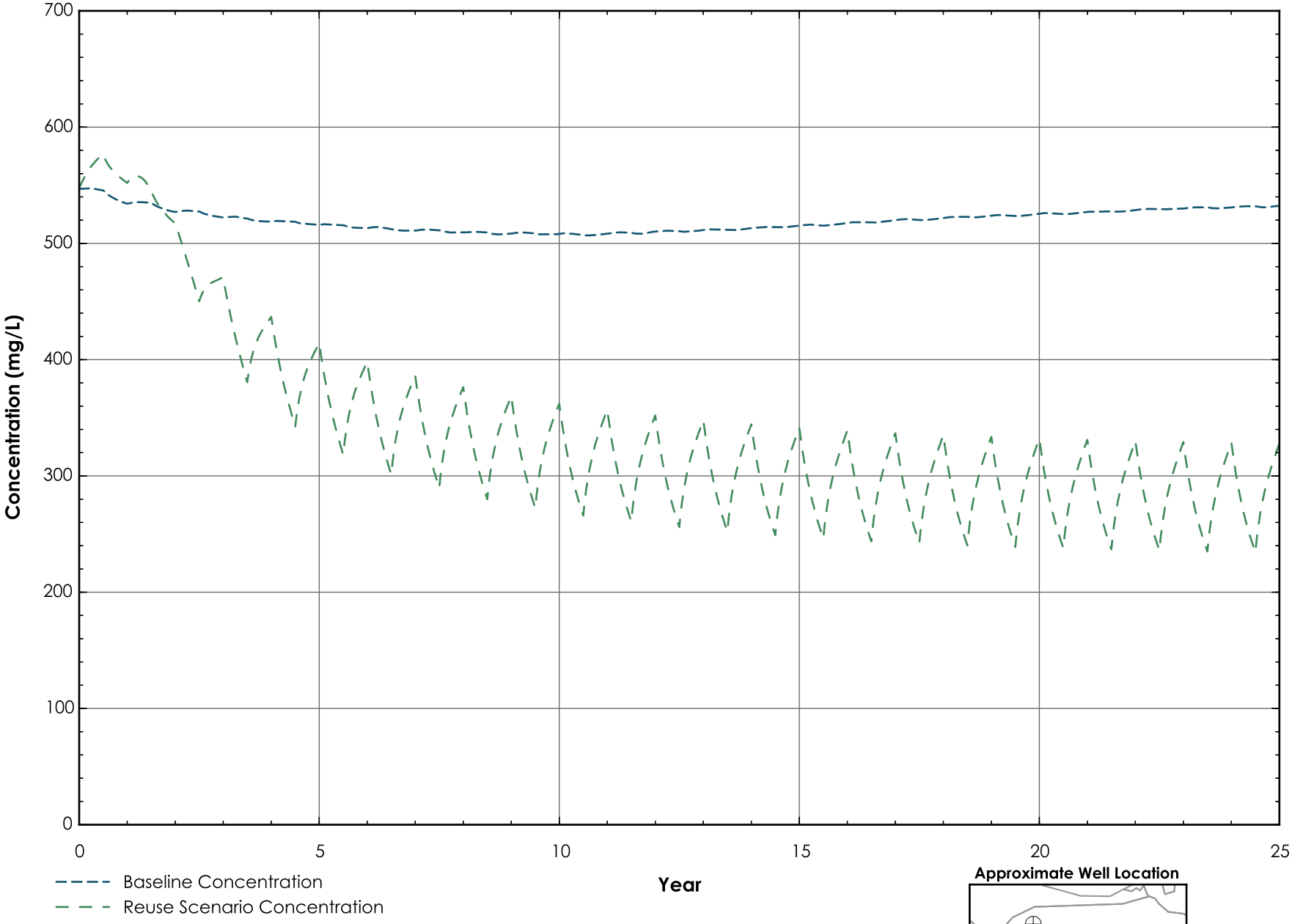


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Site B offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

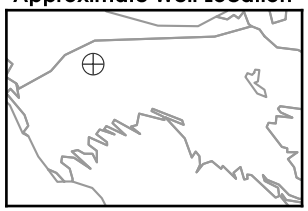


Well MOCHO 1 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Well B

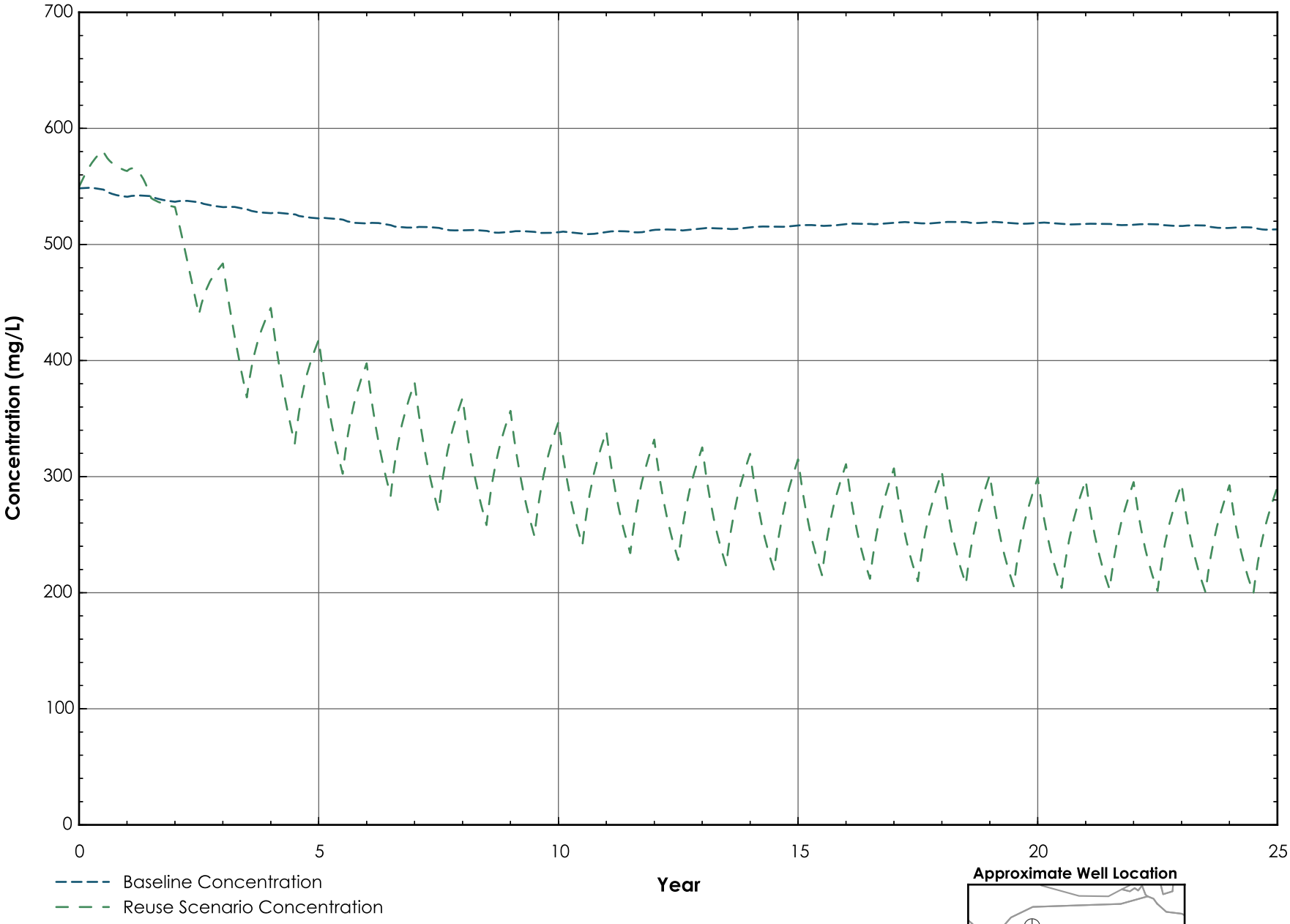


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Site B offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

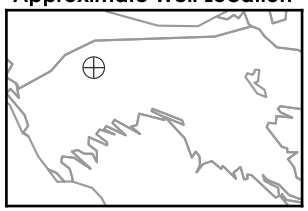


Well MOCHO 2 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Well B

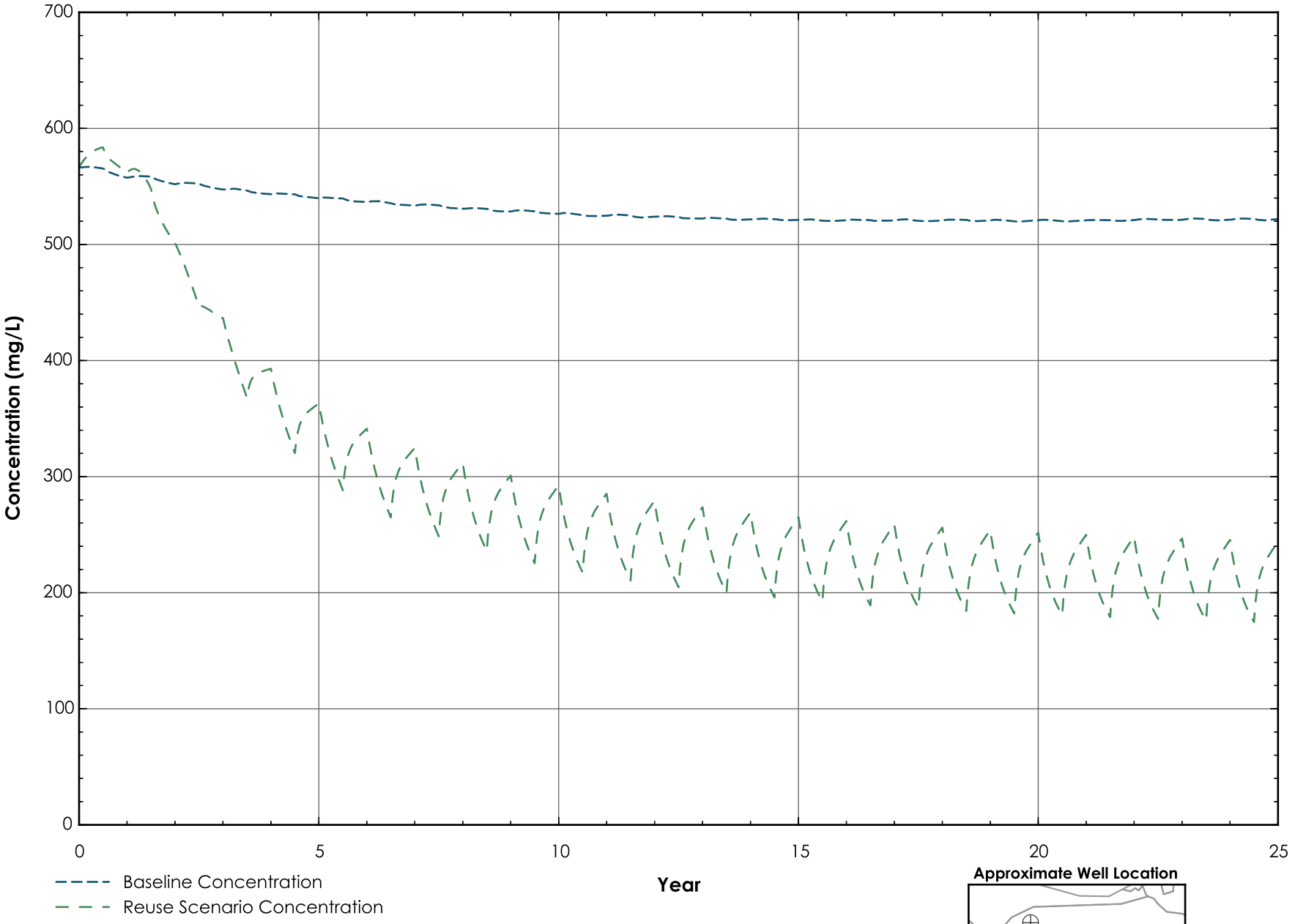


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Site B offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

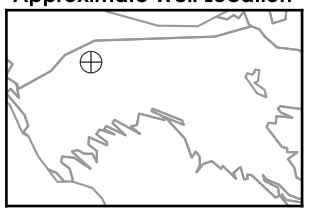


Well MOCHO 3 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Well B

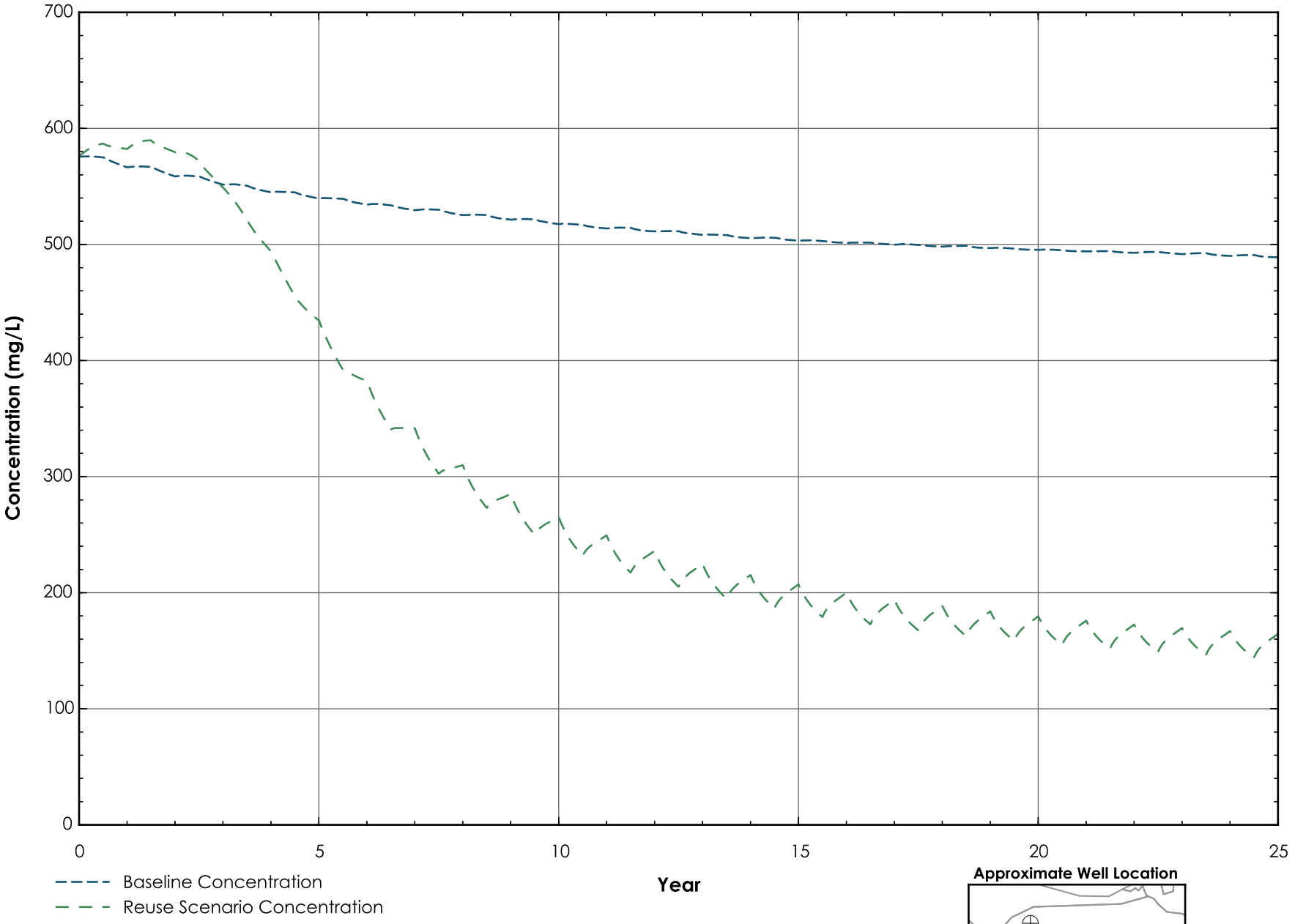


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Site B offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

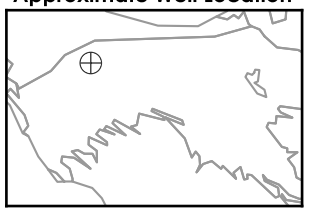


Well MOCHO 4 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Well B

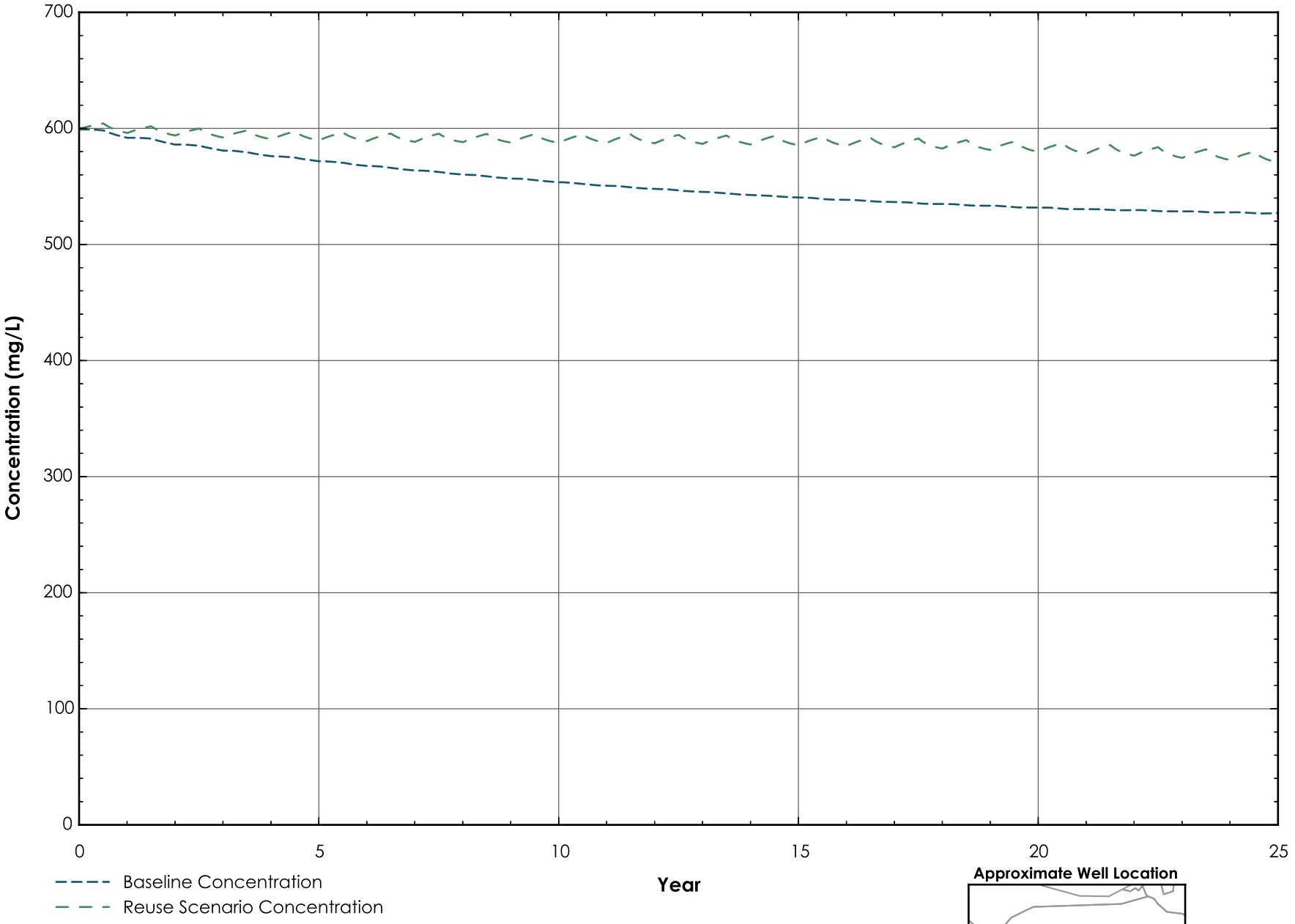


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Site B offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

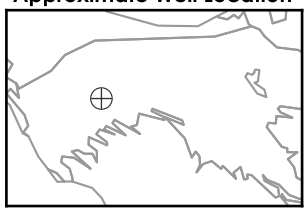


Well PLEAS 5 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Well B

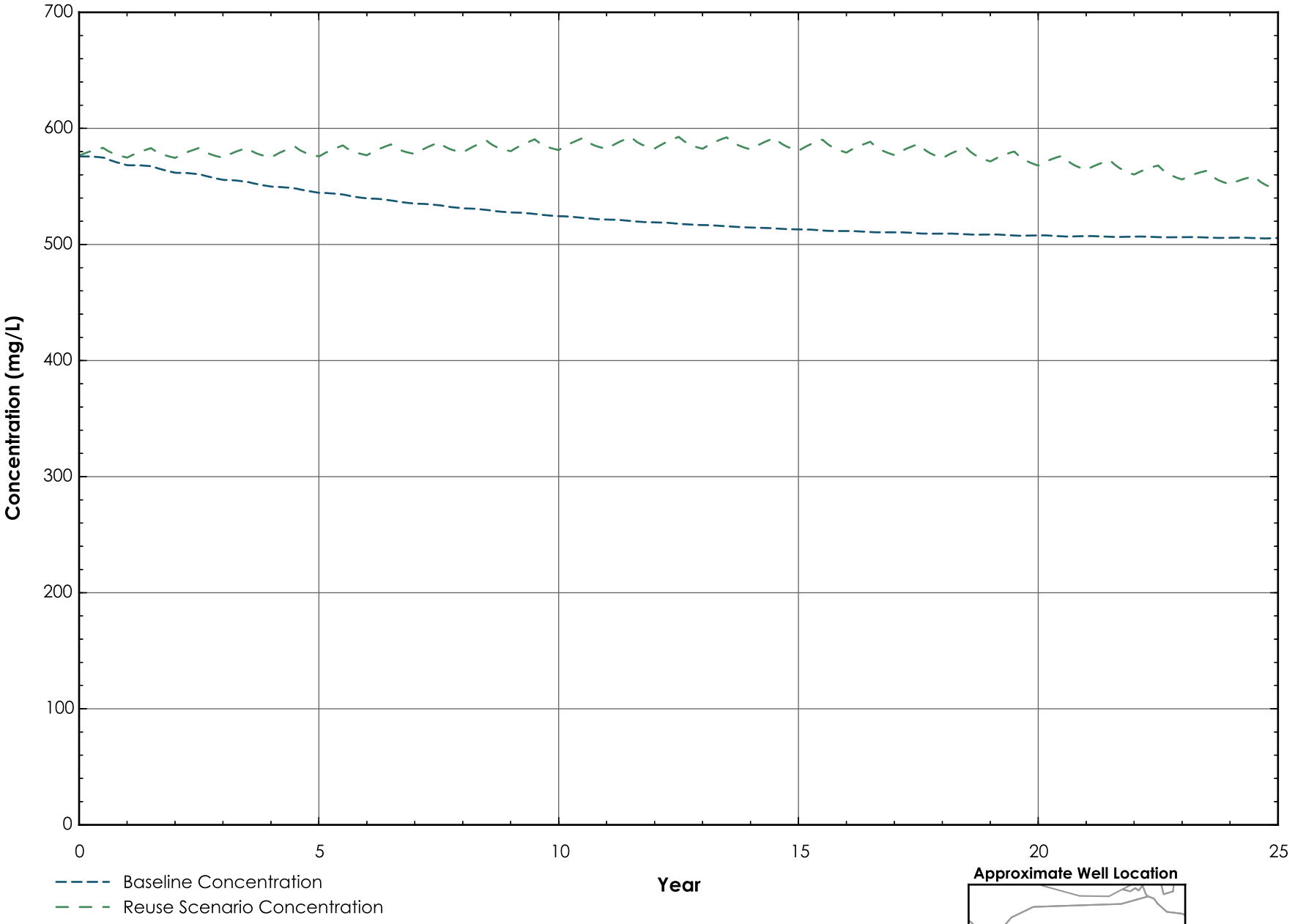


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Site B offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

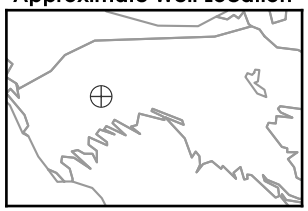


Well PLEAS 6 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Well B

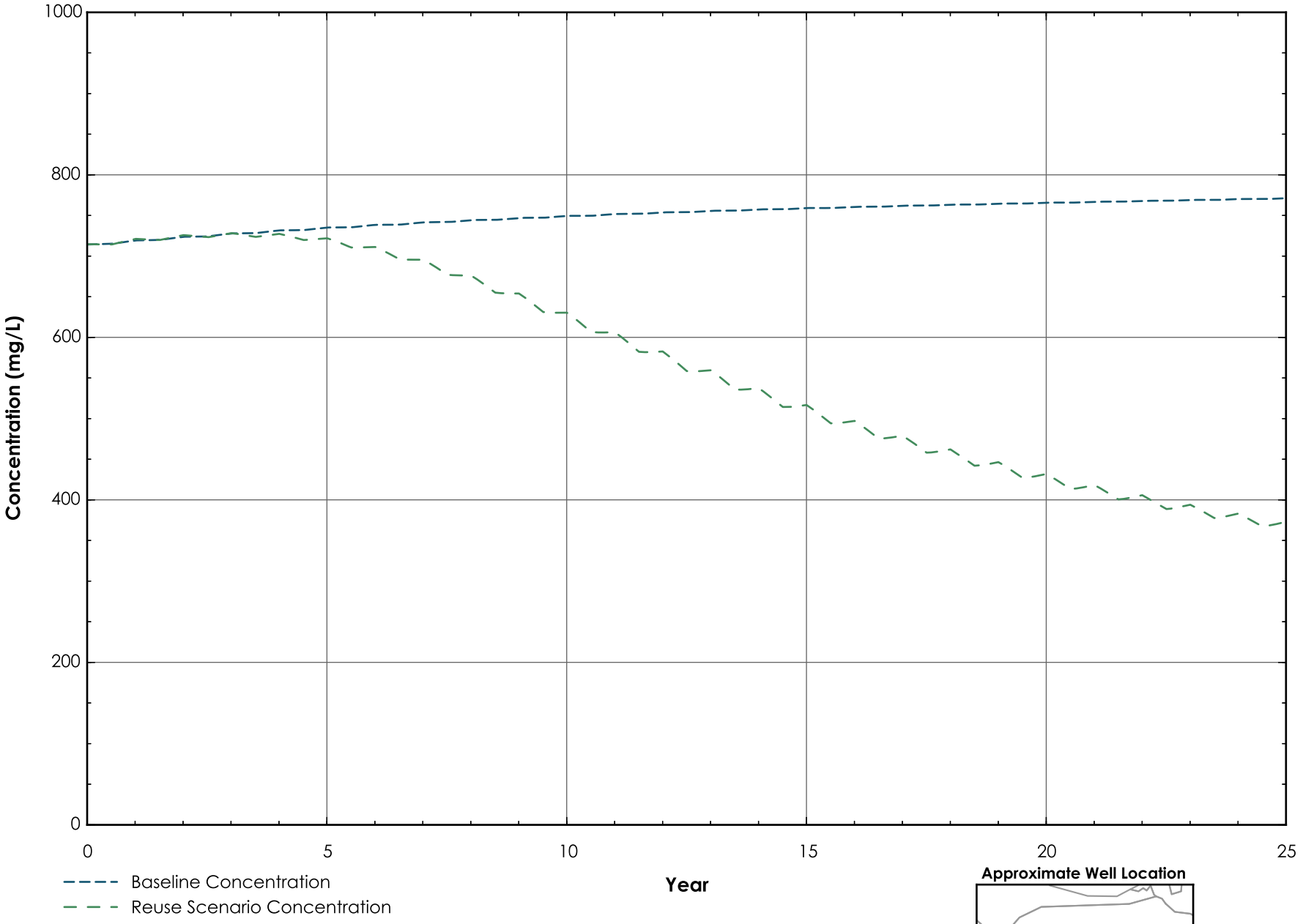


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Site B offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

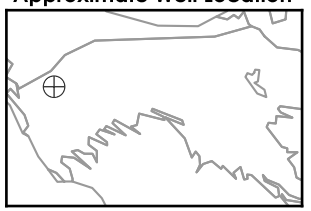


Well PLEAS 7 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Well B

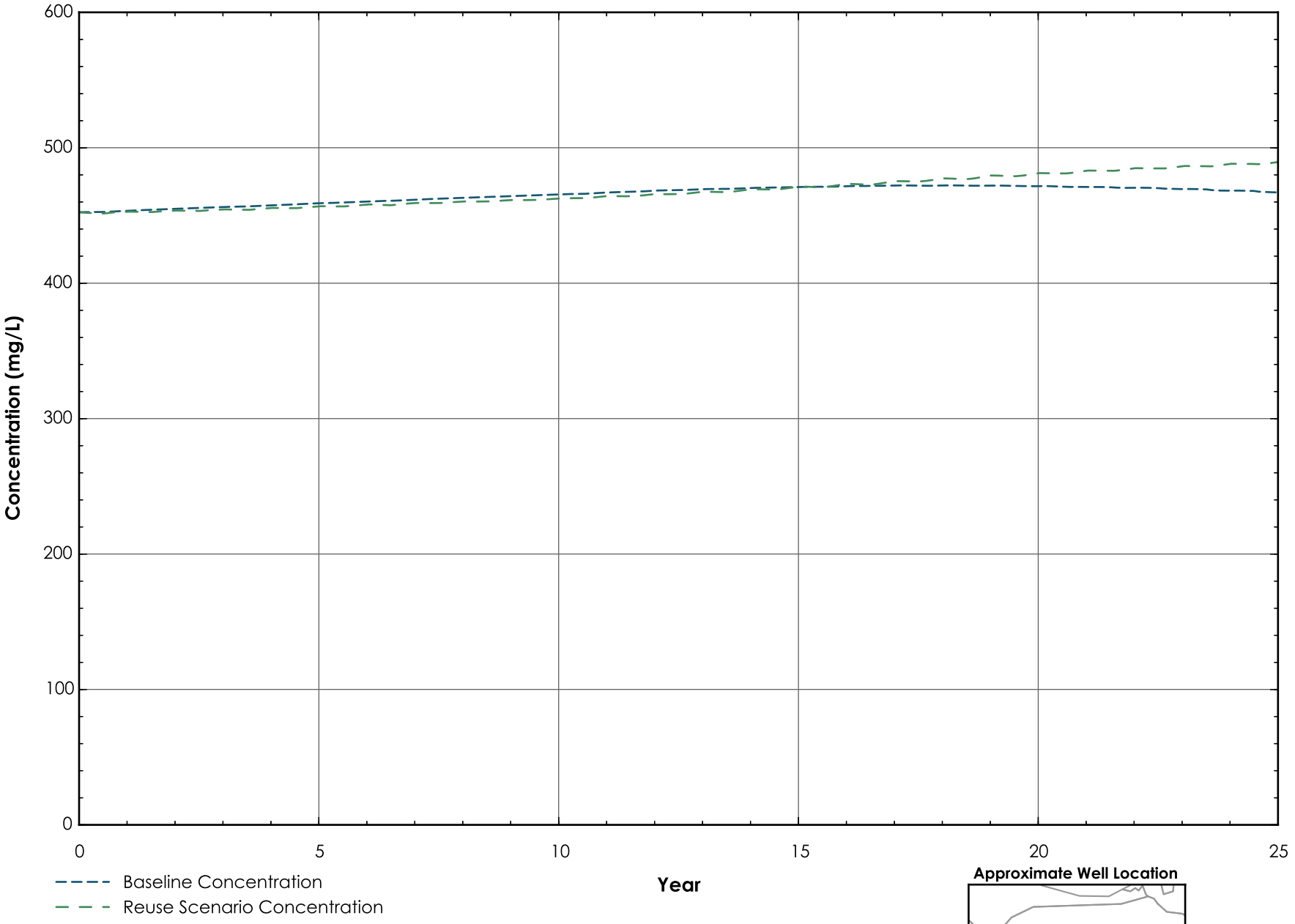


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Site B offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

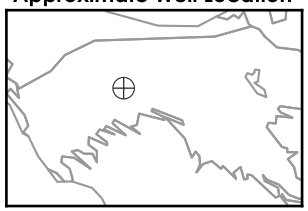


Well PLEAS 8 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Well B

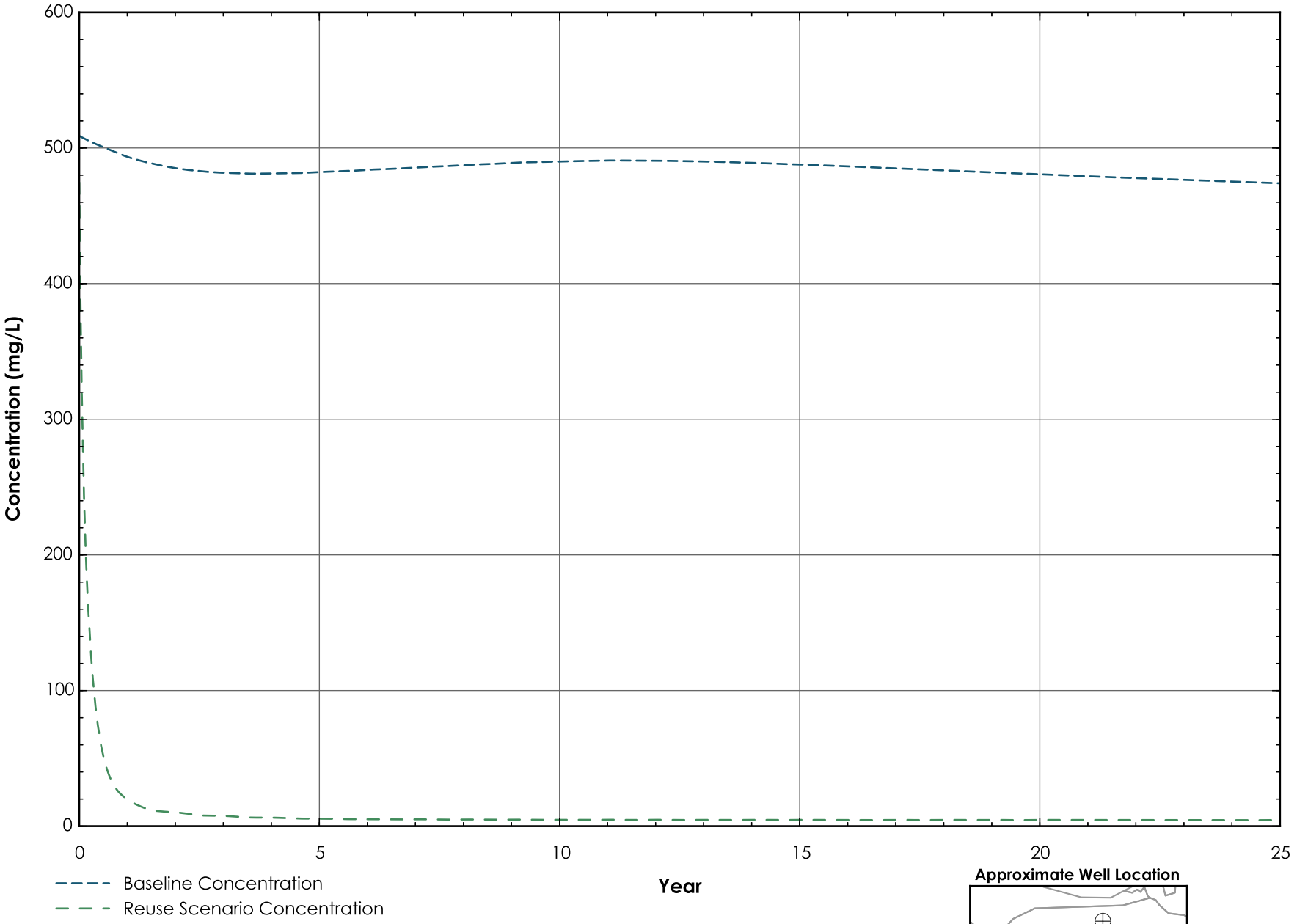


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Site B offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

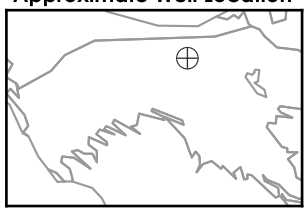


Well Inj E Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

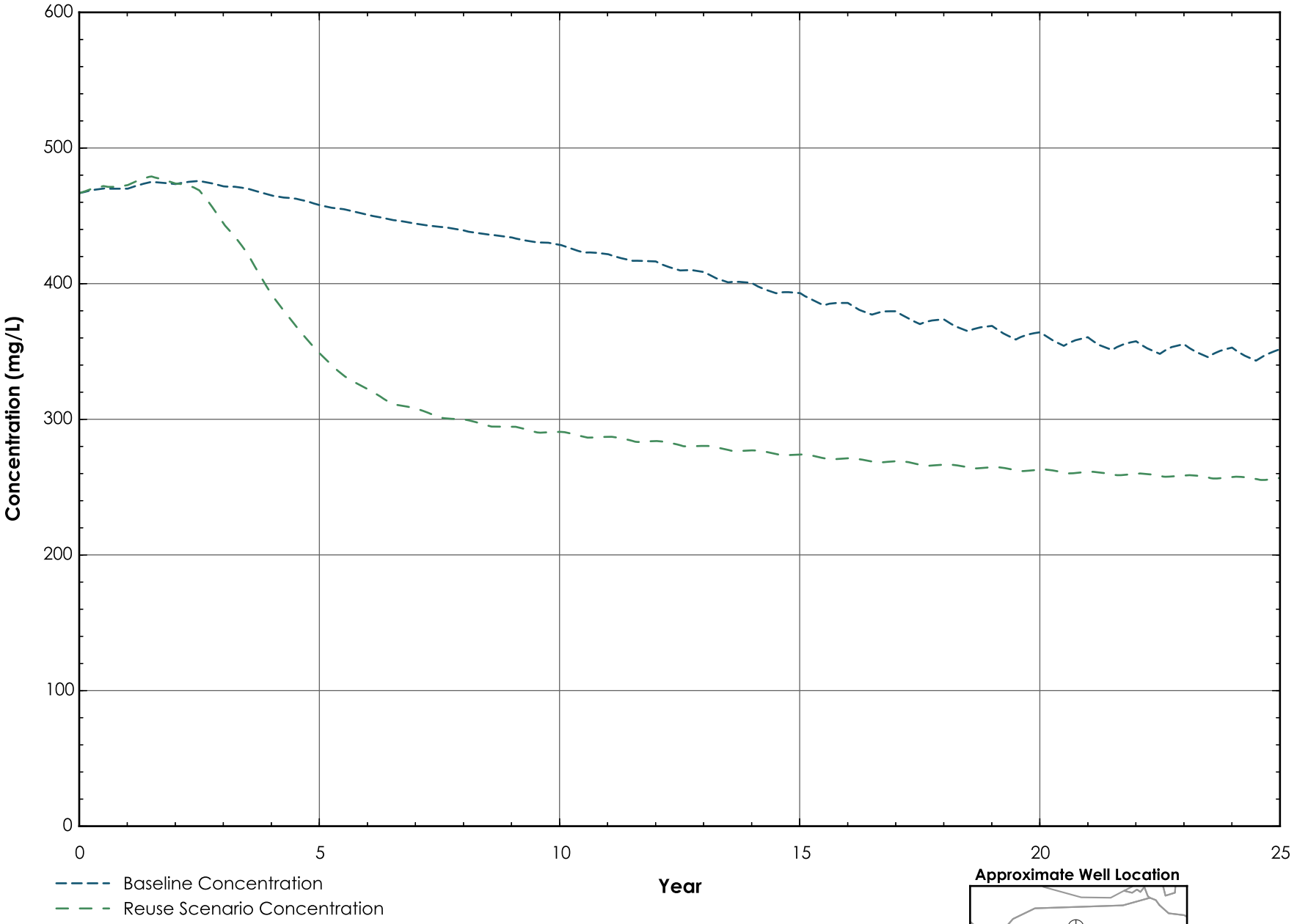


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

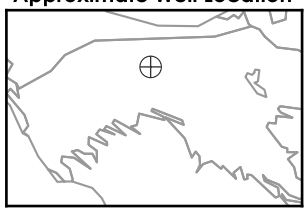


Well COL 1 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

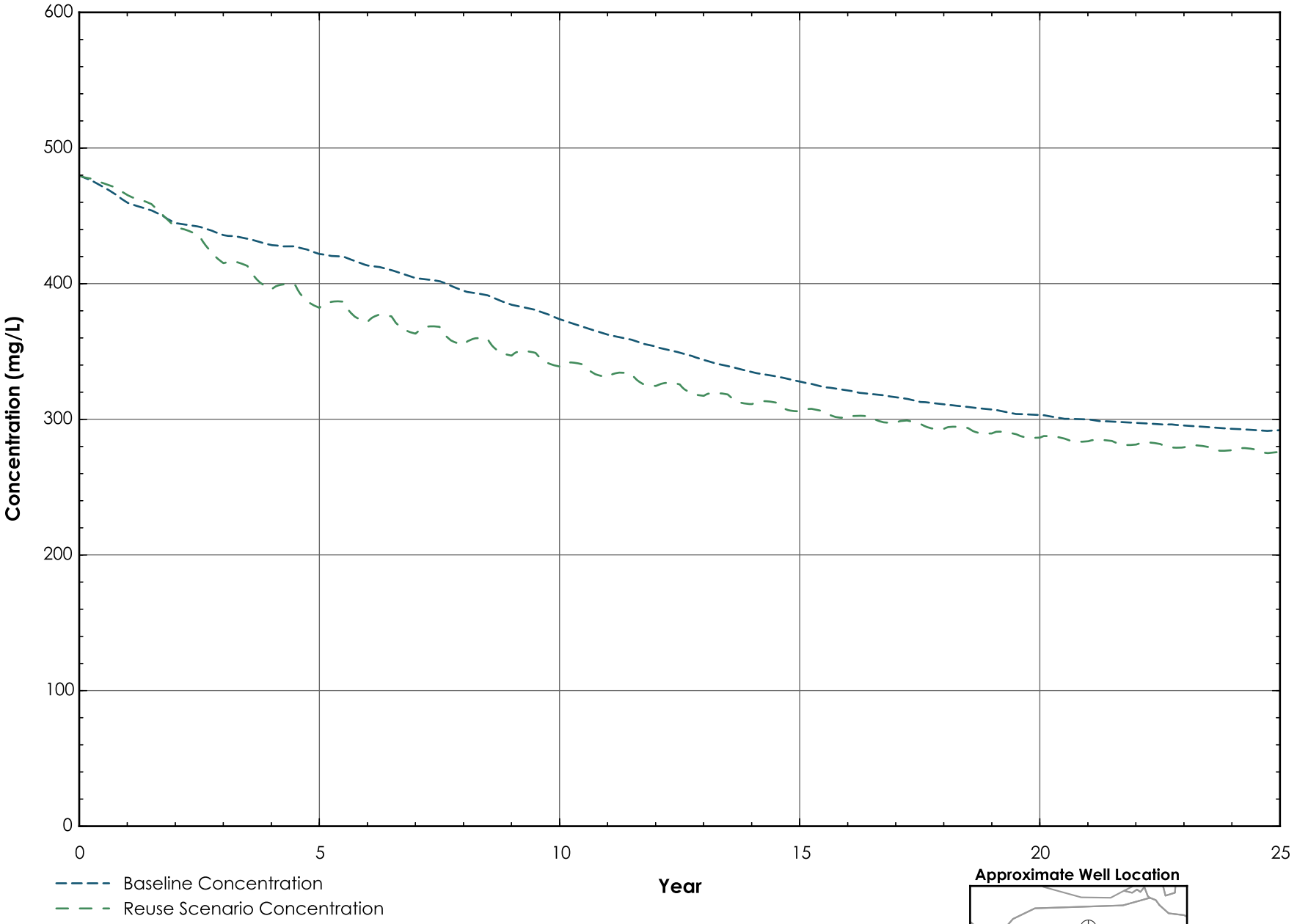


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

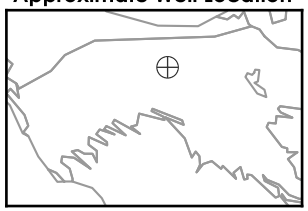


Well COL 2 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

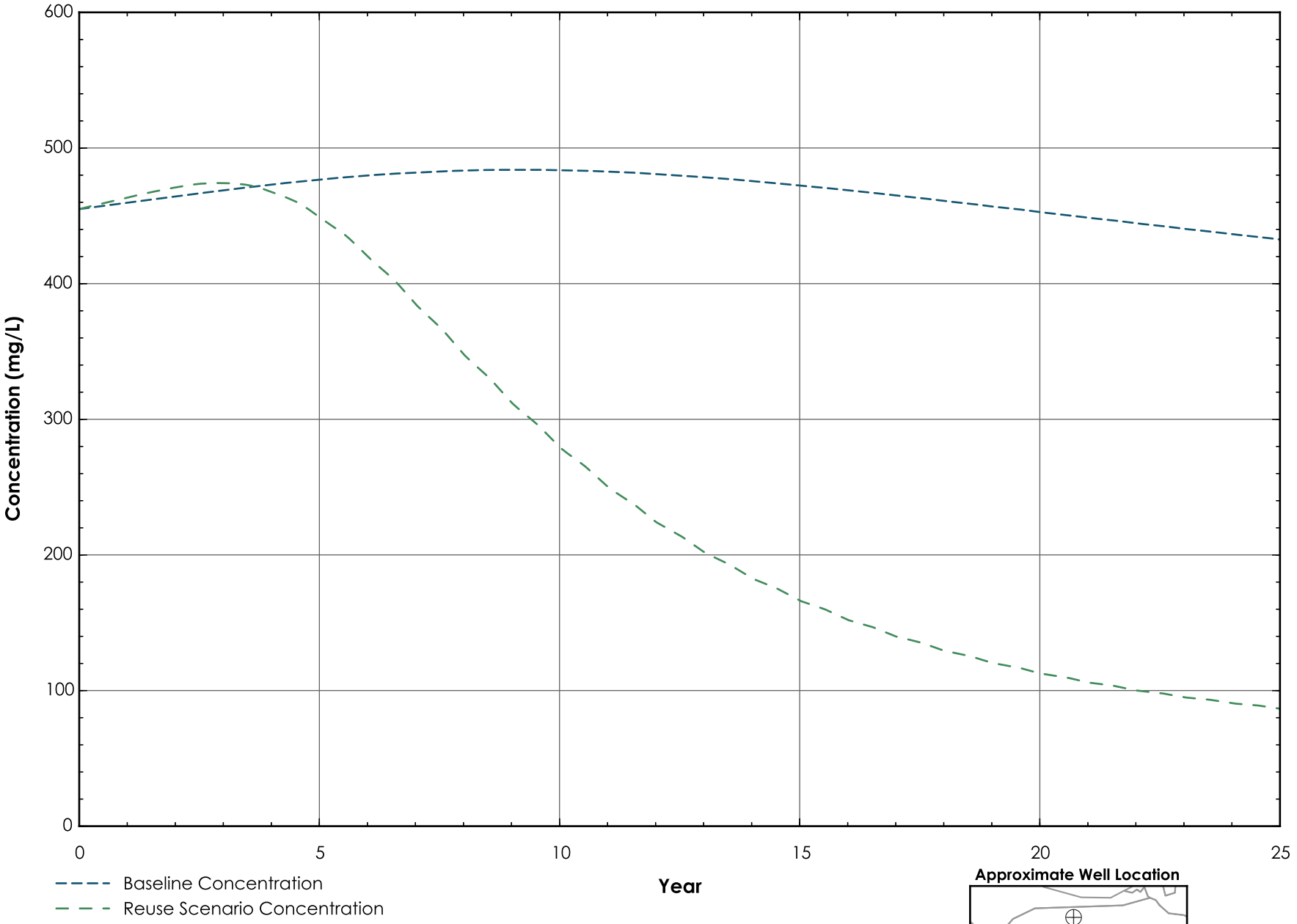


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

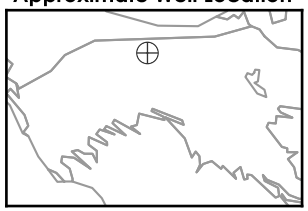


Well COL 5 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

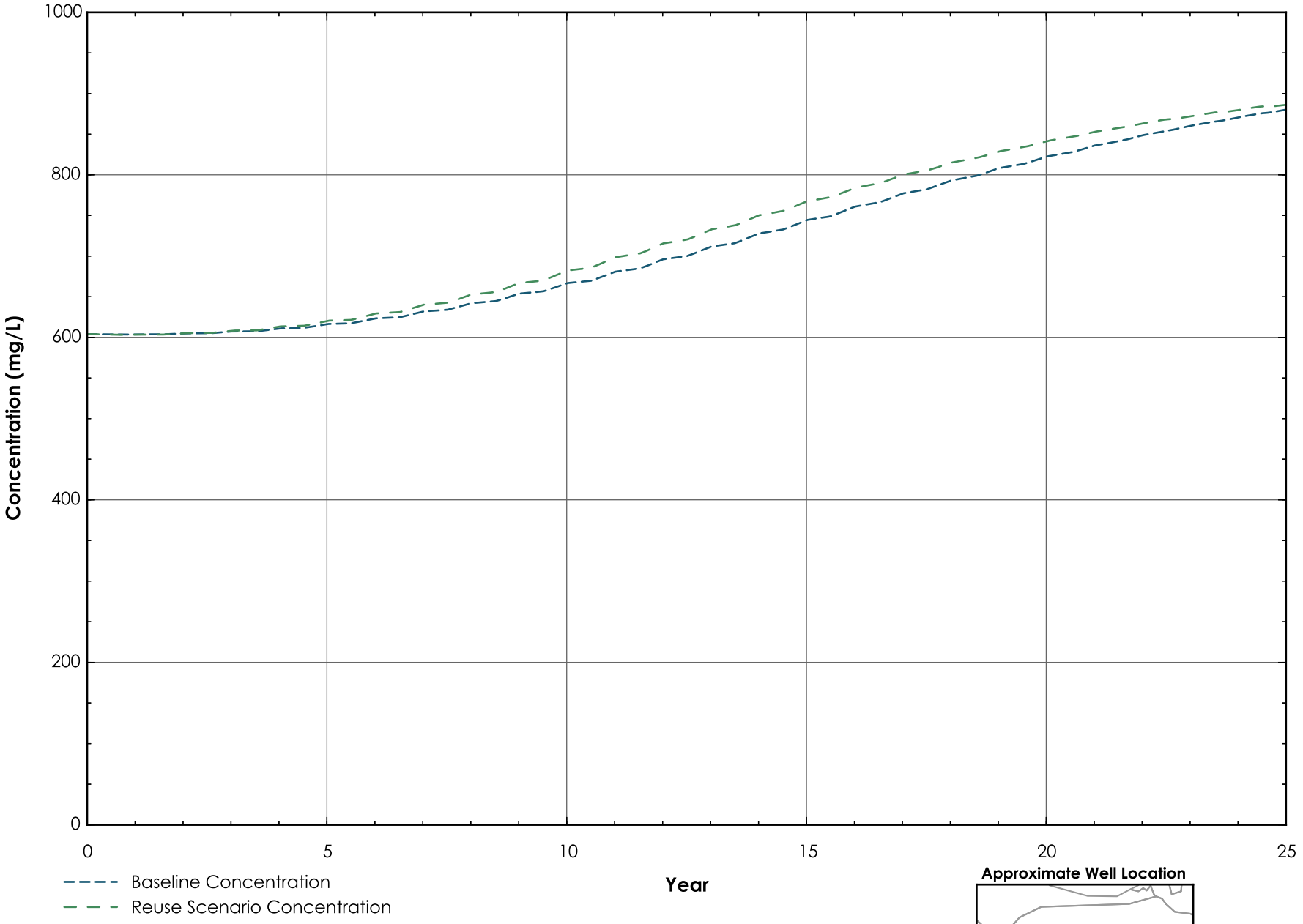


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

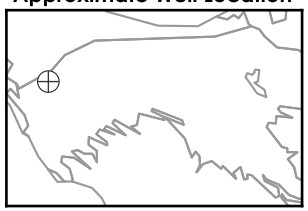


Well HOP 6 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

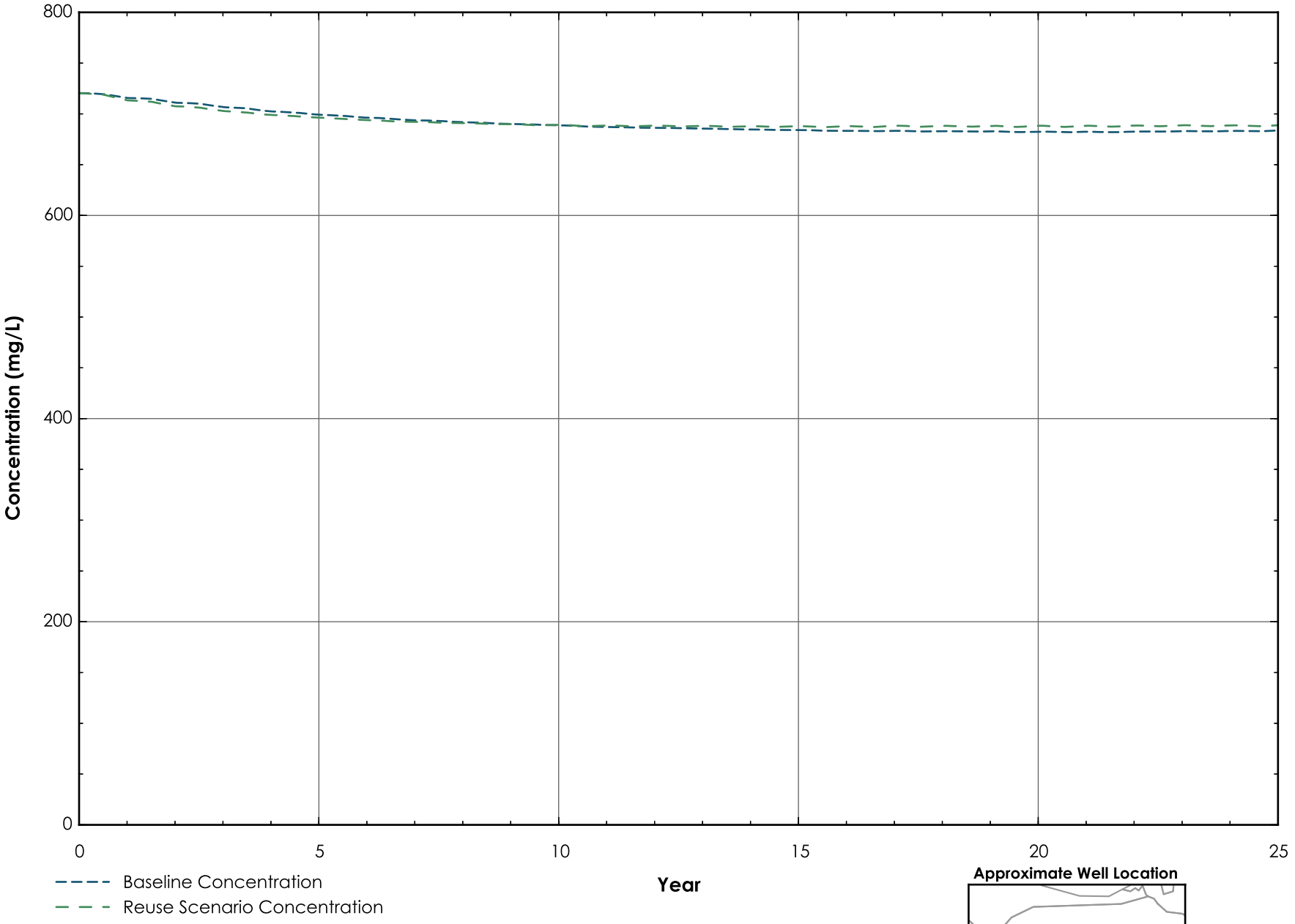


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

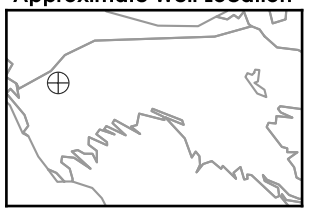


Well HOP 9 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

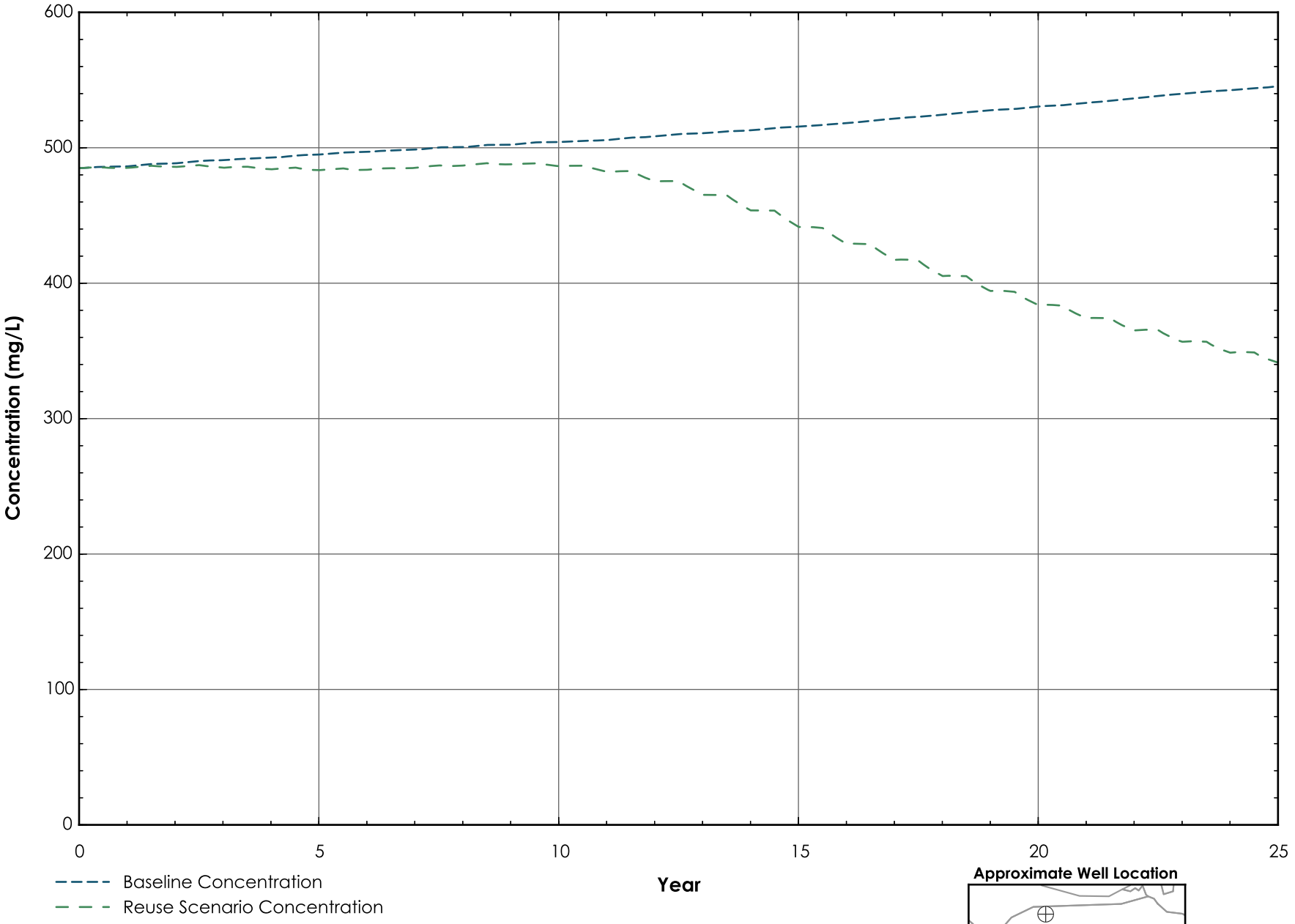


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

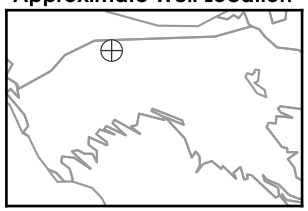


Well STONERIDGE 1 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

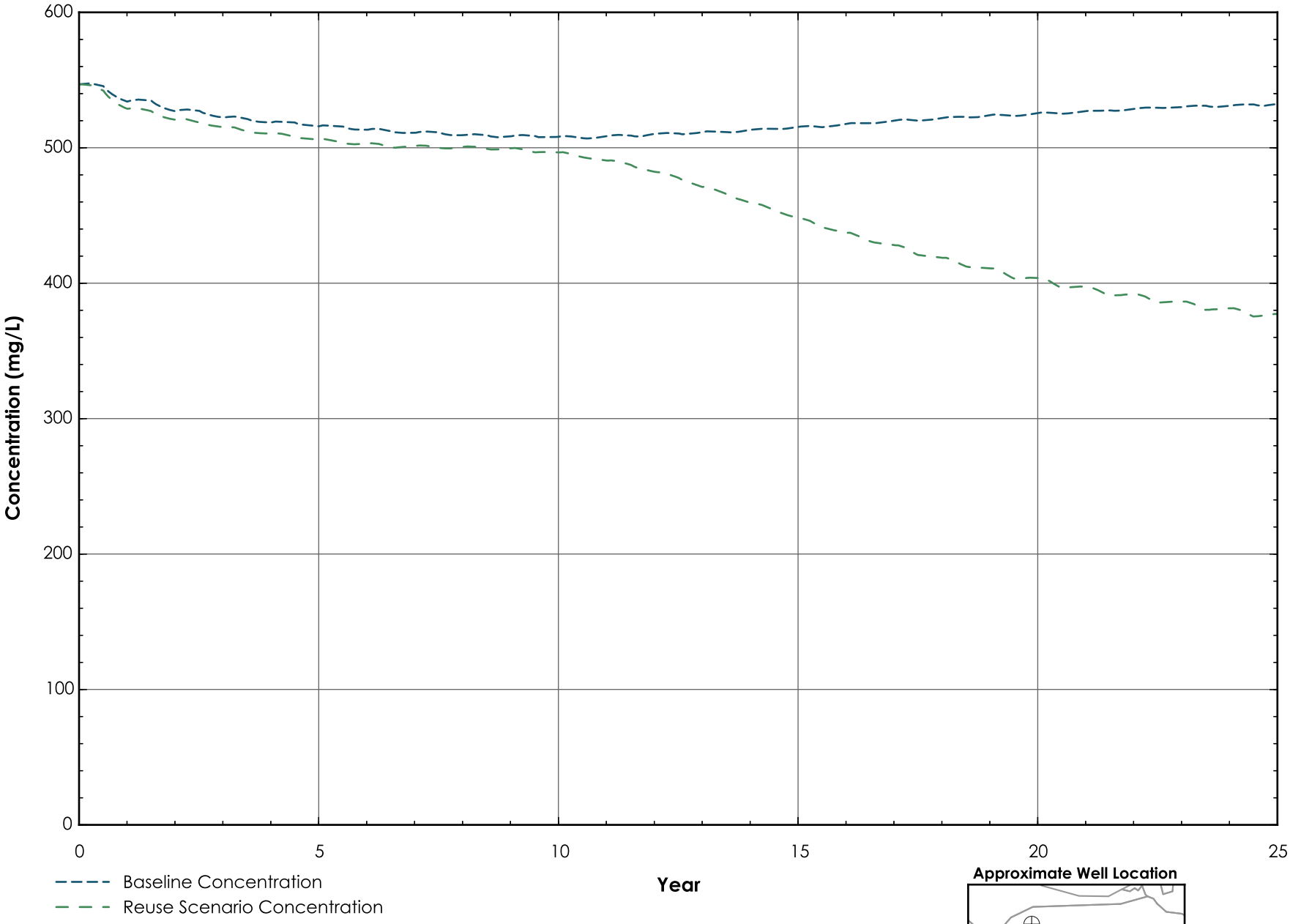


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

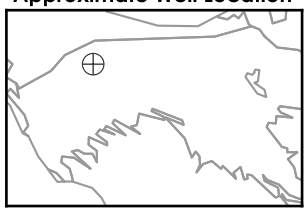


Well MOCHO 1 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

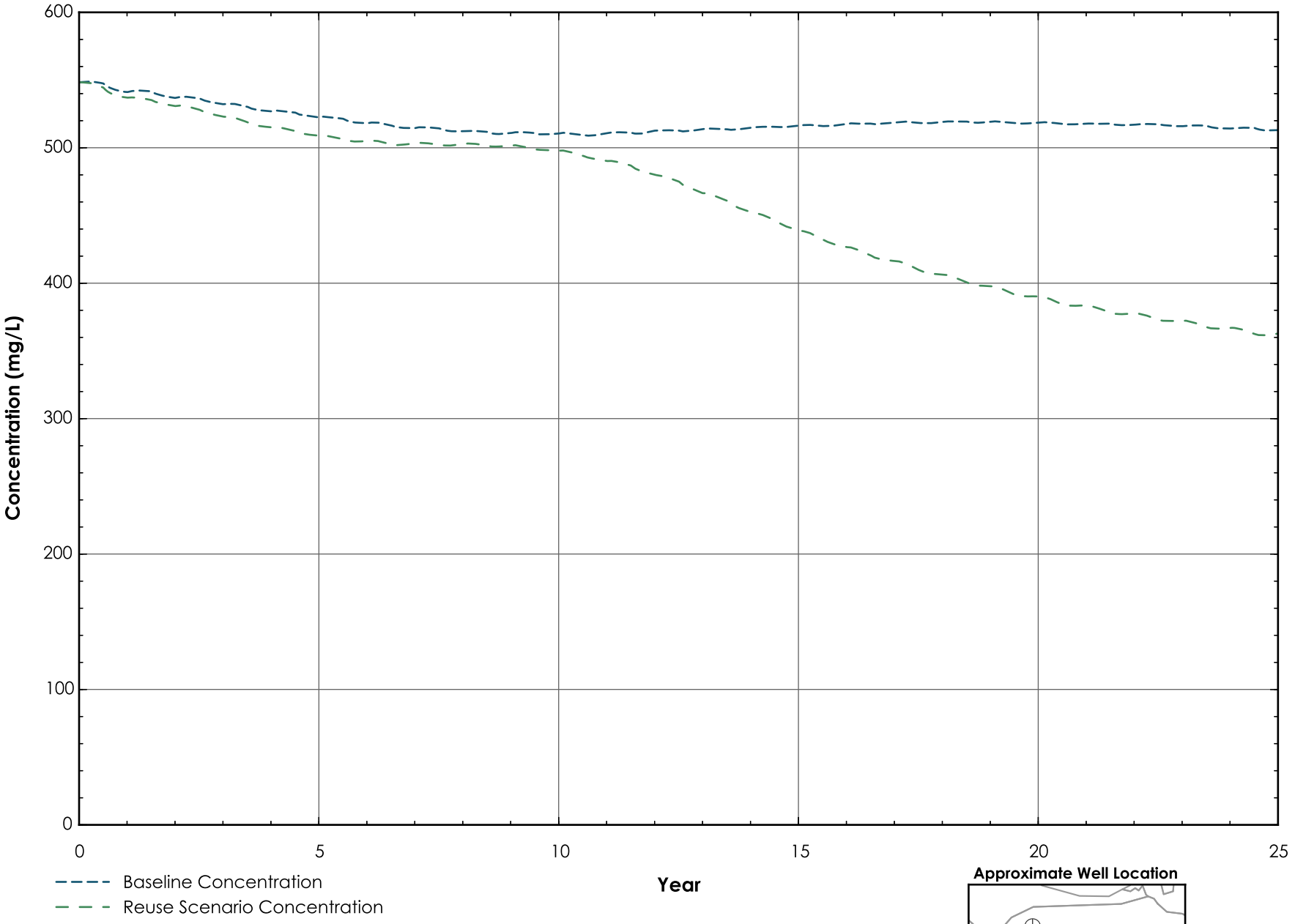


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

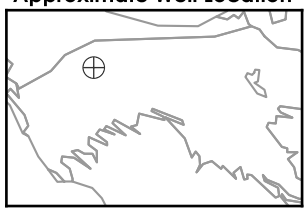


Well MOCHO 2 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

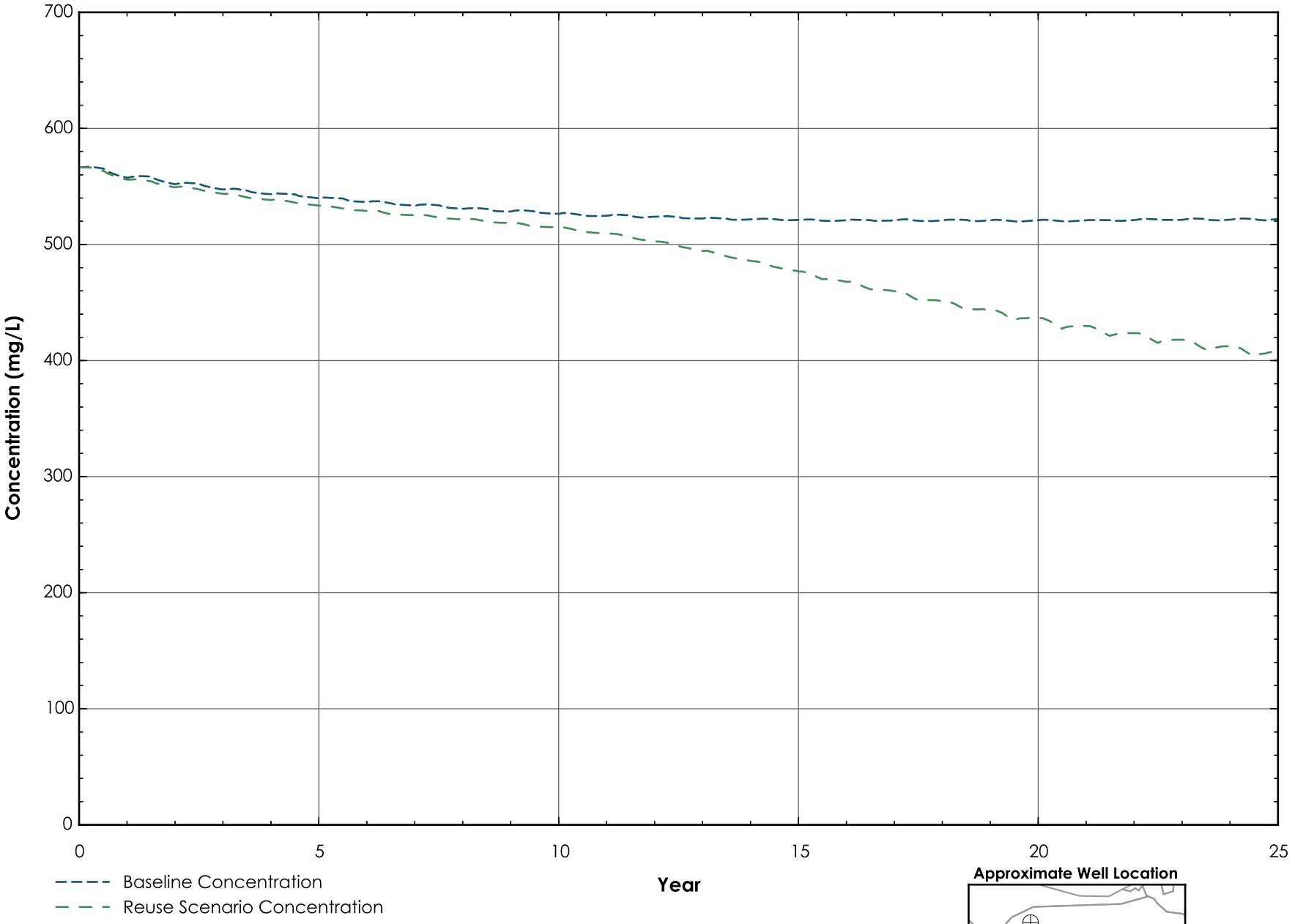


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

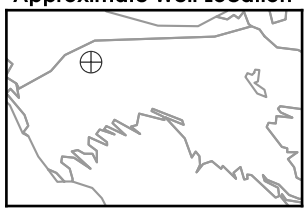


Well MOCHO 3 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

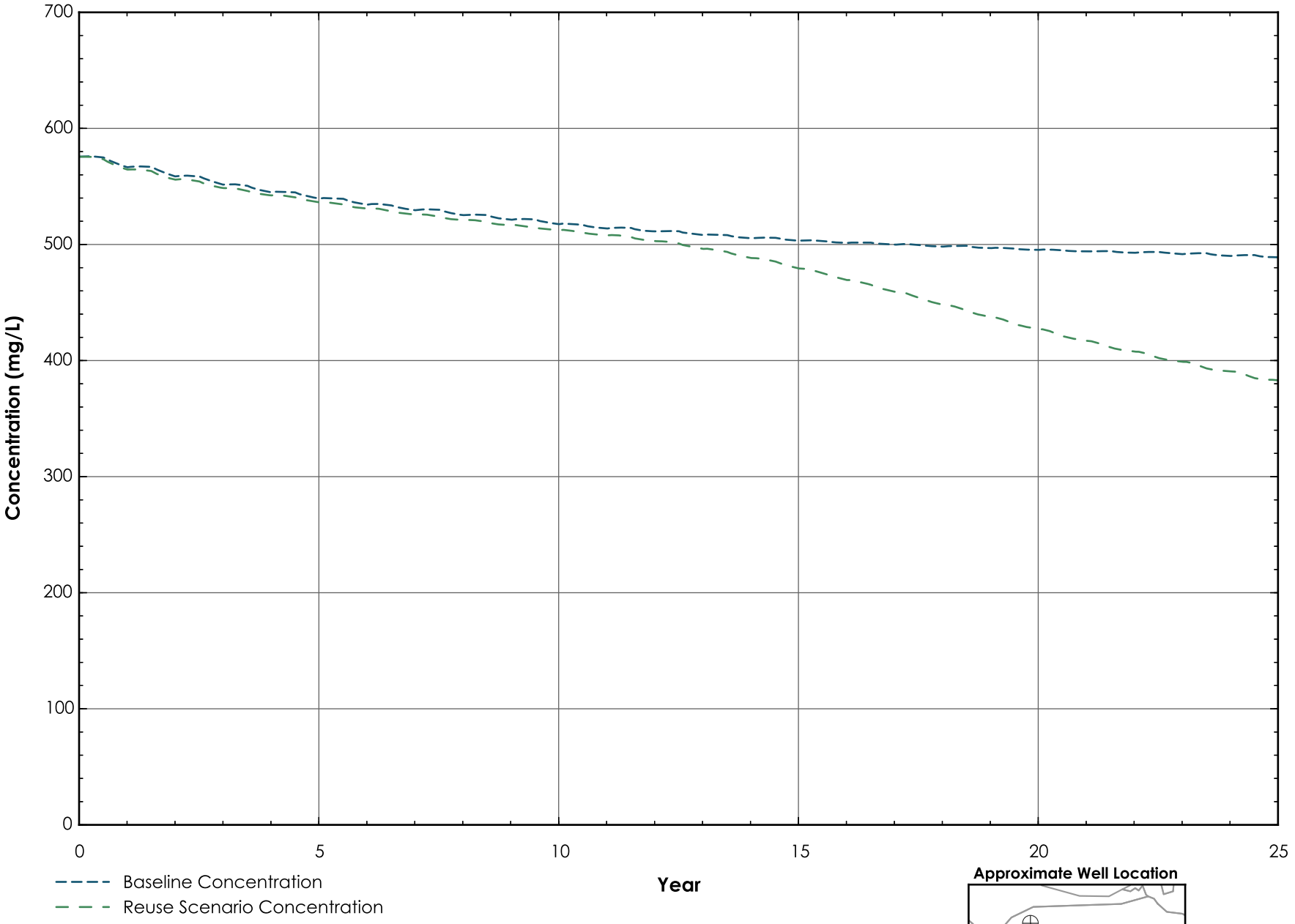


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

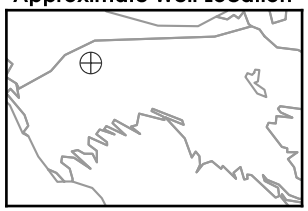


Well MOCHO 4 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

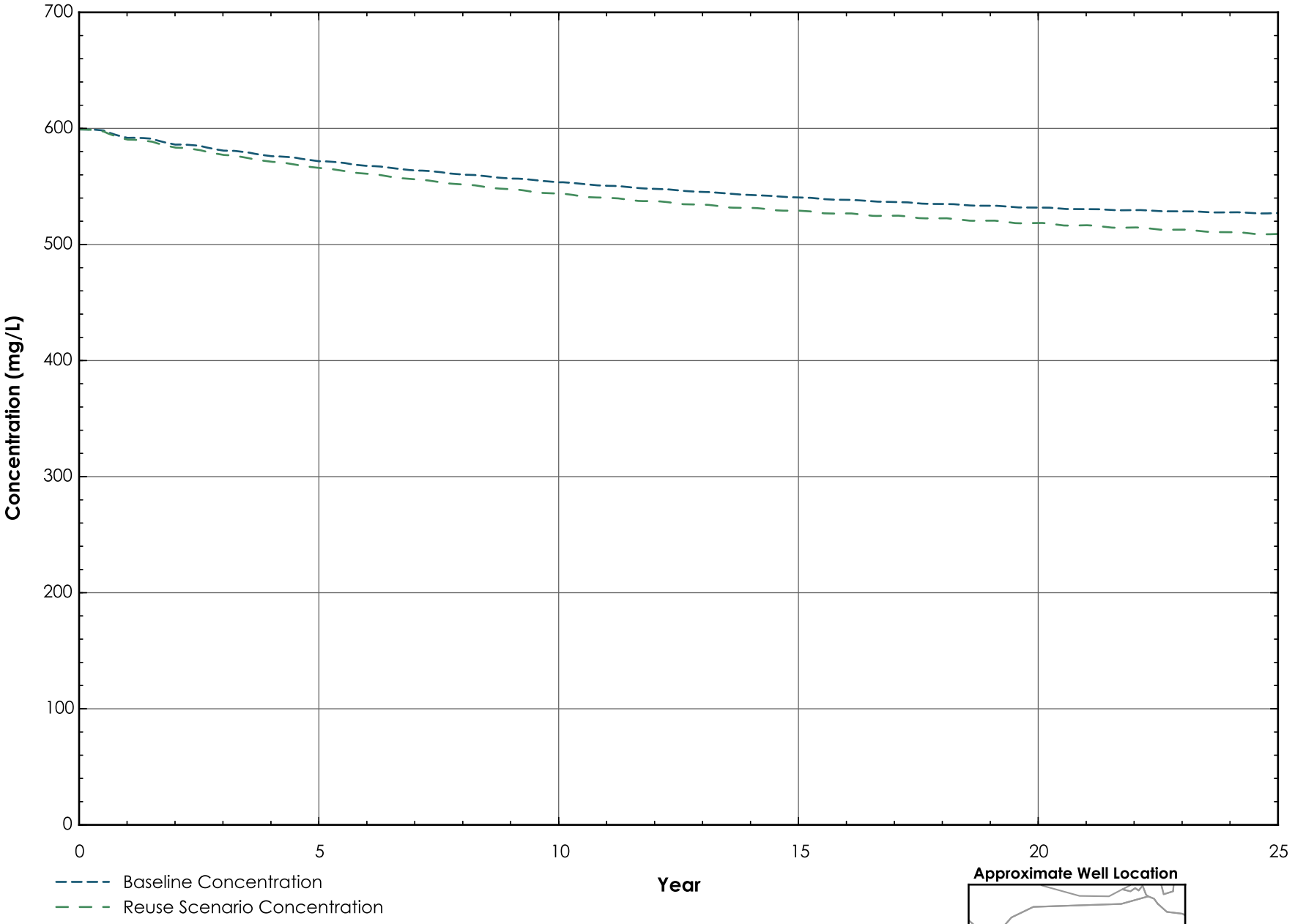


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

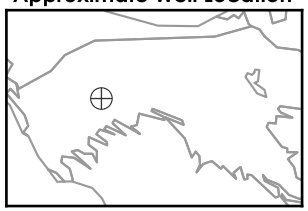


Well PLEAS 5 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

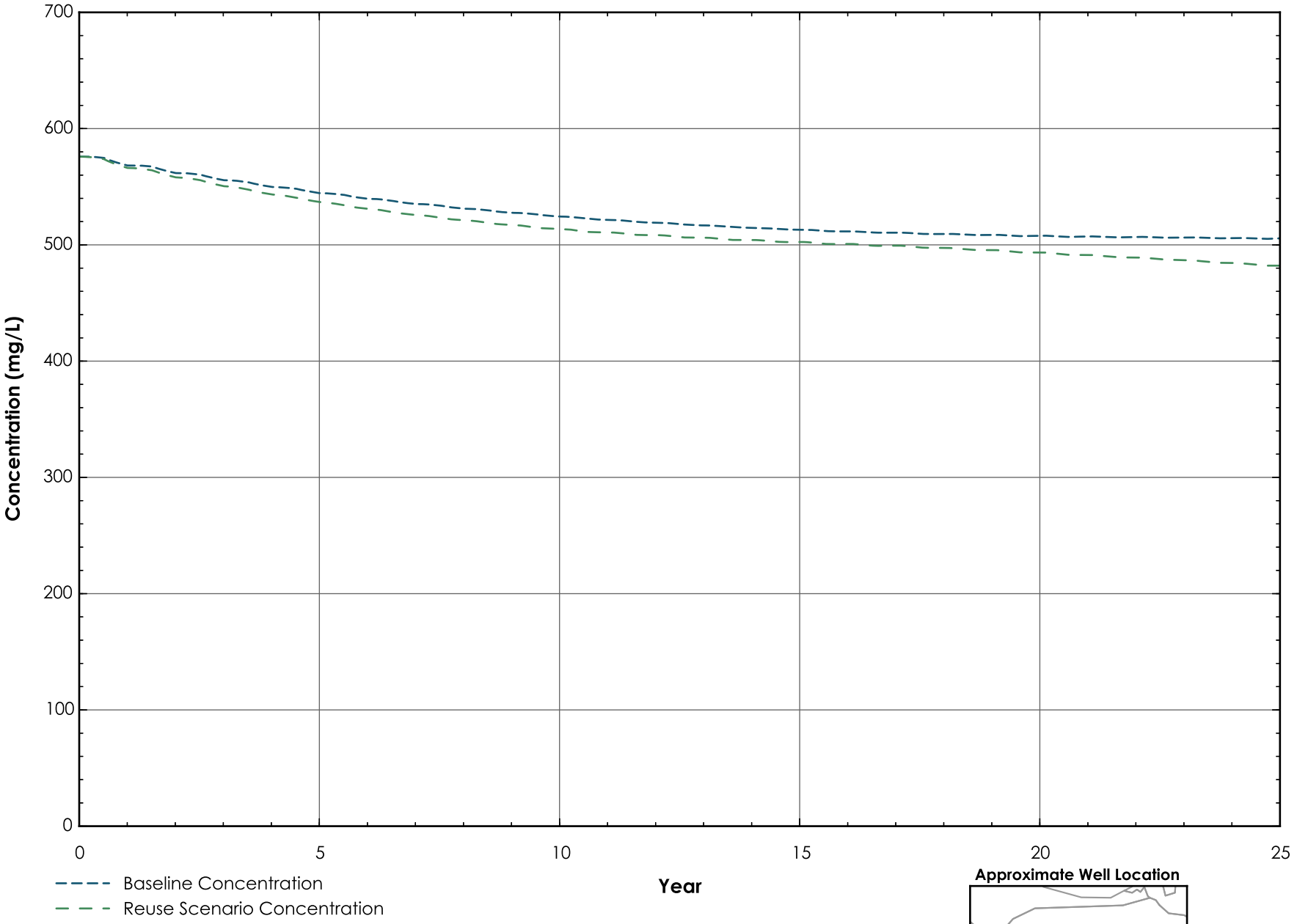


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

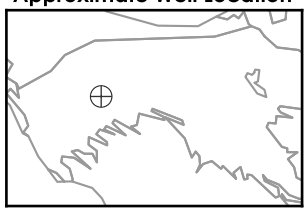


Well PLEAS 6 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

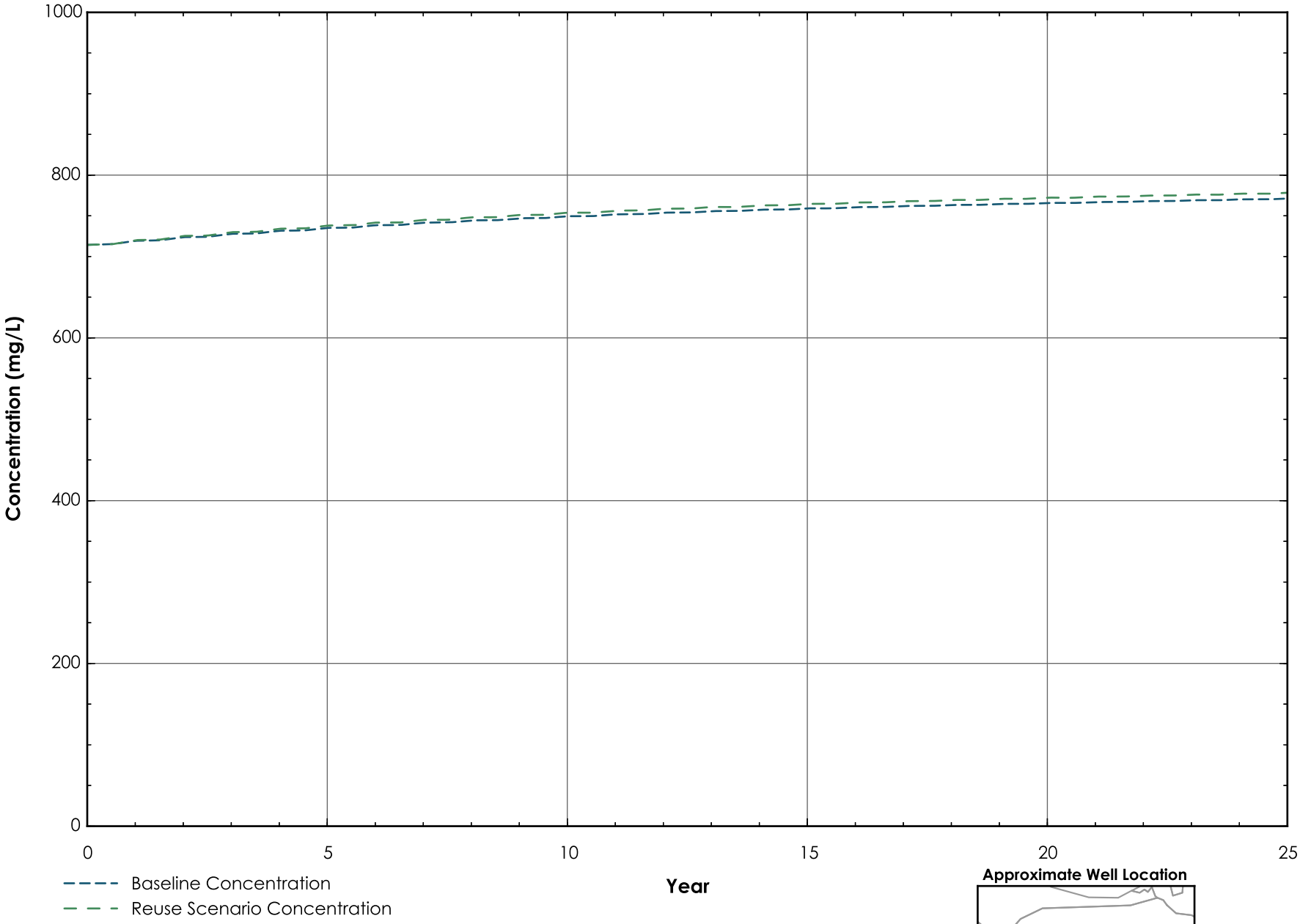


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

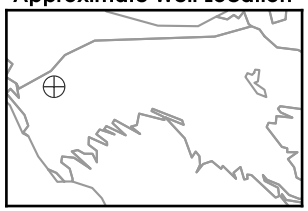


Well PLEAS 7 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

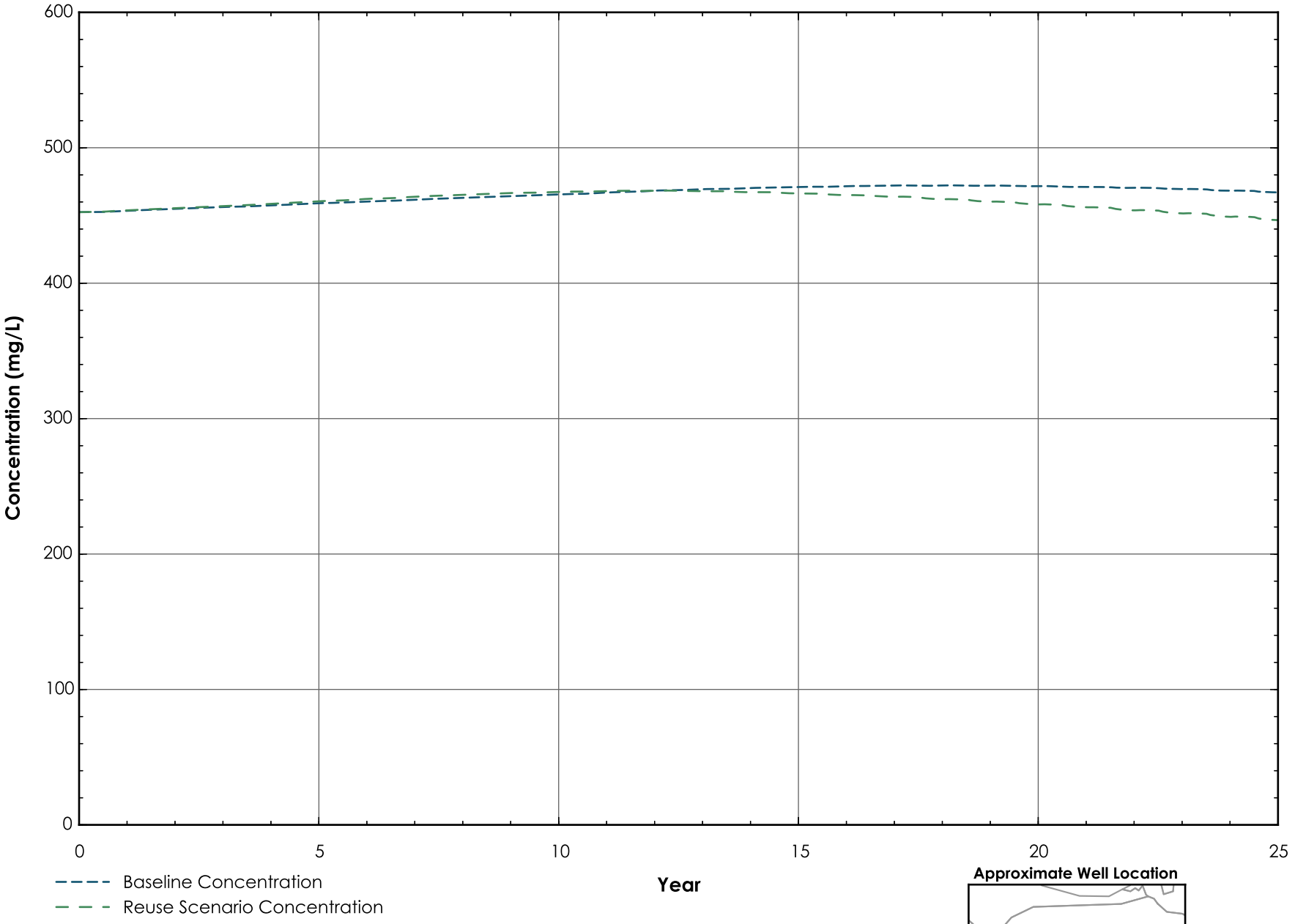


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

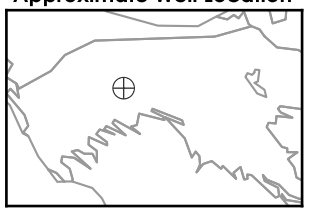


Well PLEAS 8 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

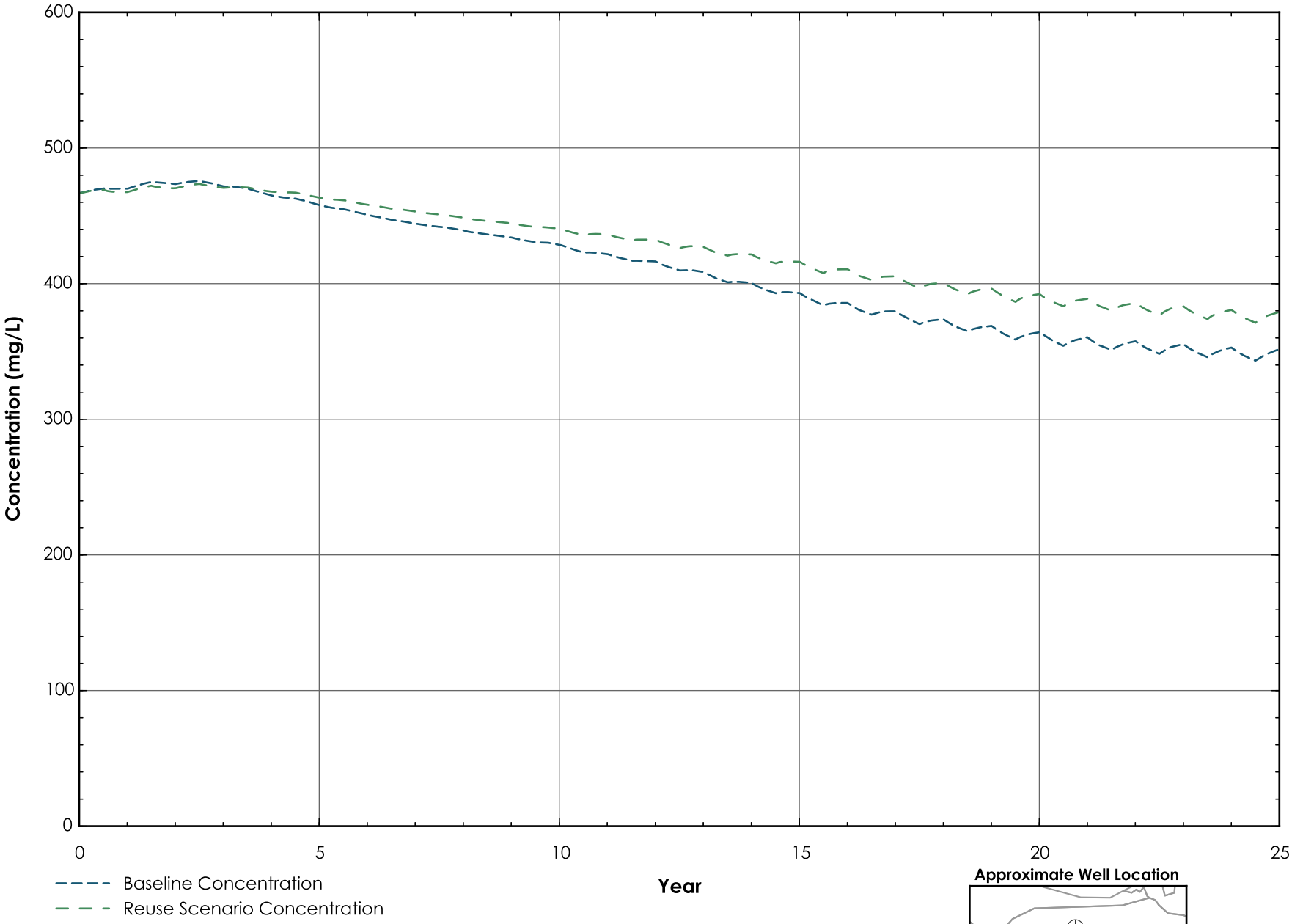


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

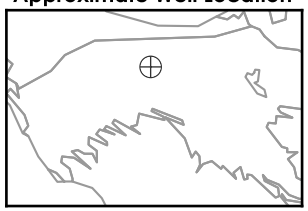


Well COL 1 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

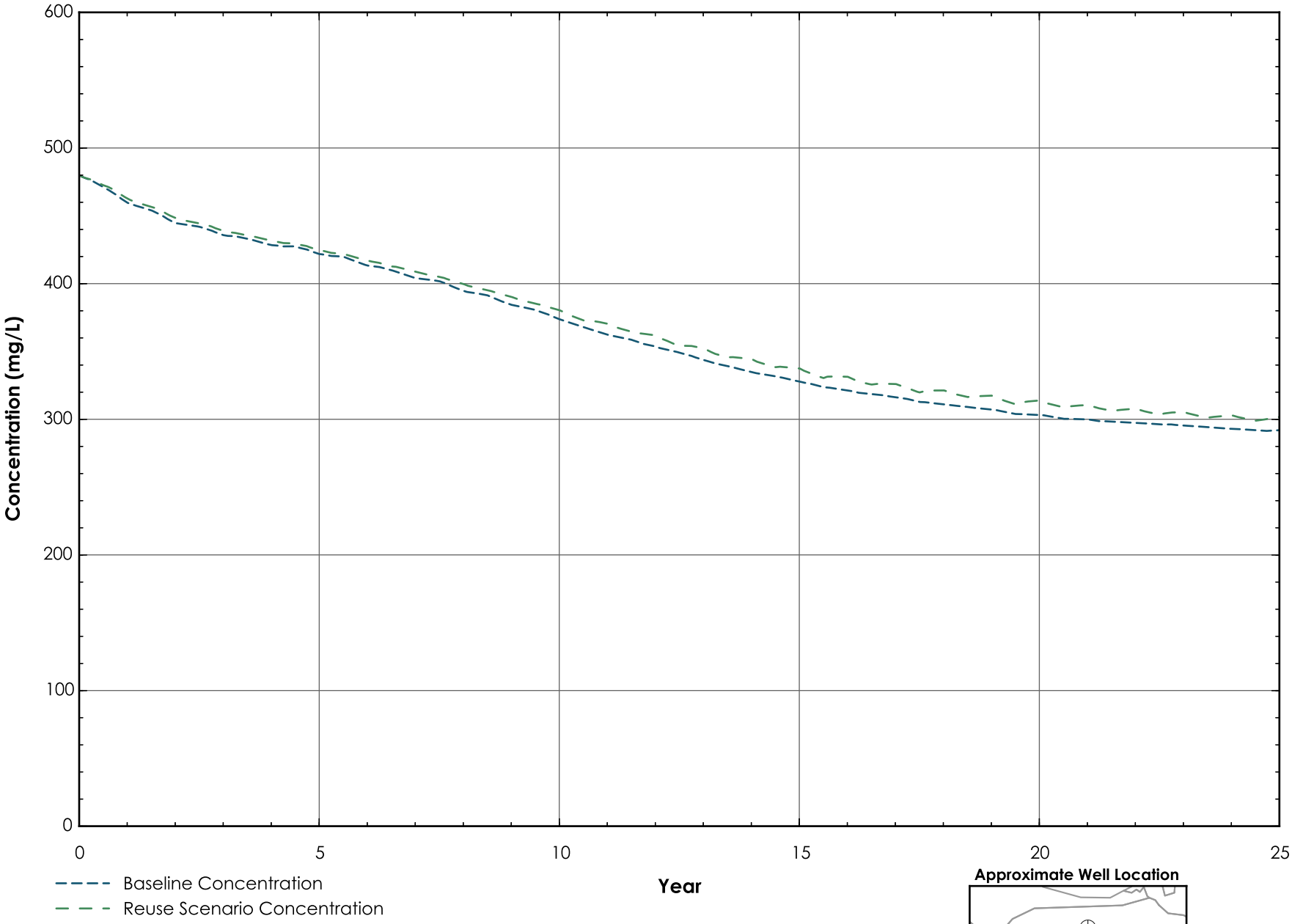


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

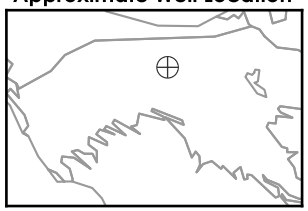


Well COL 2 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

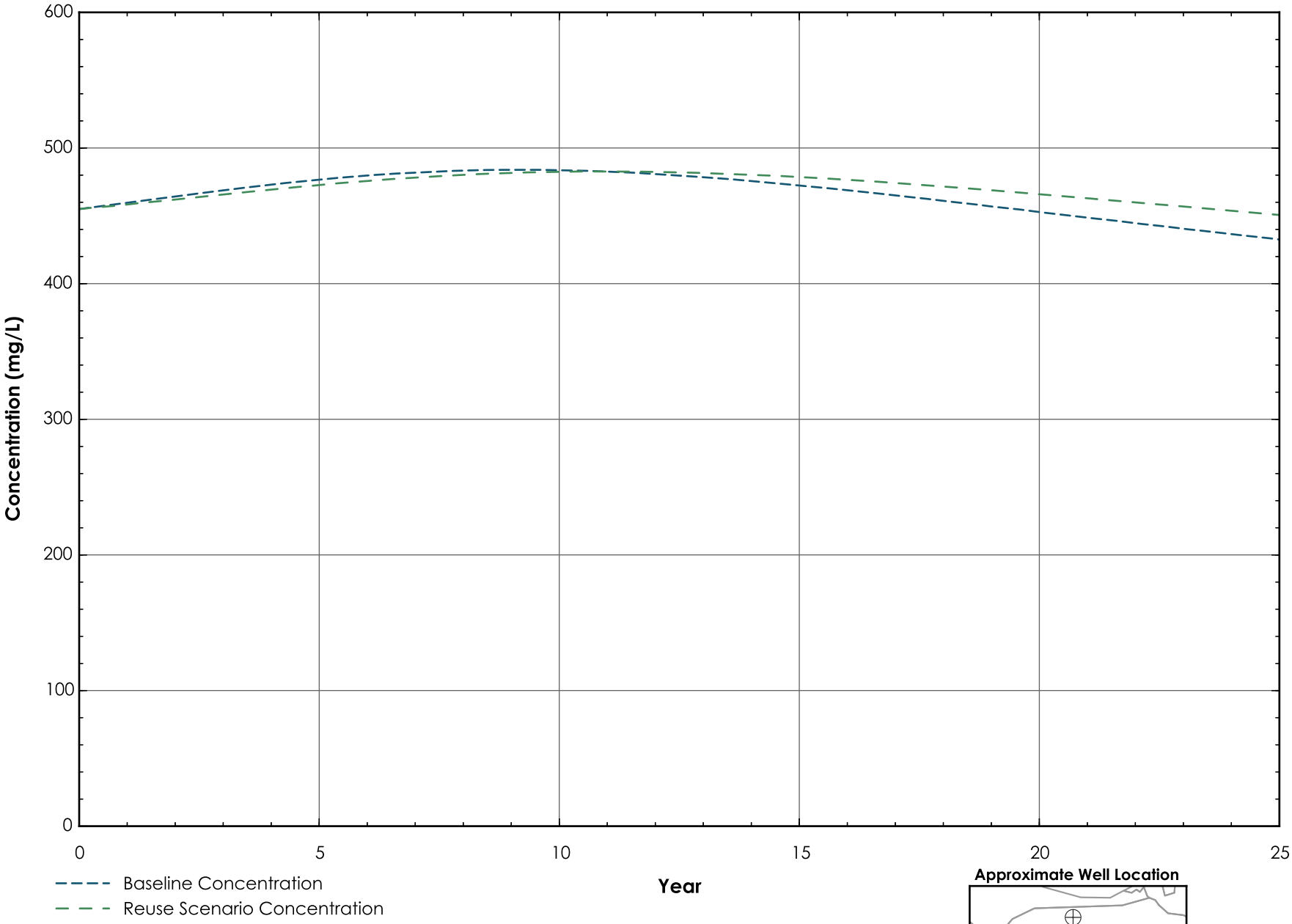


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

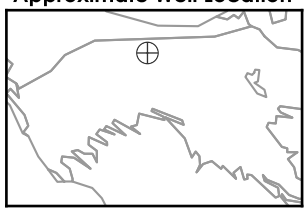


Well COL 5 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

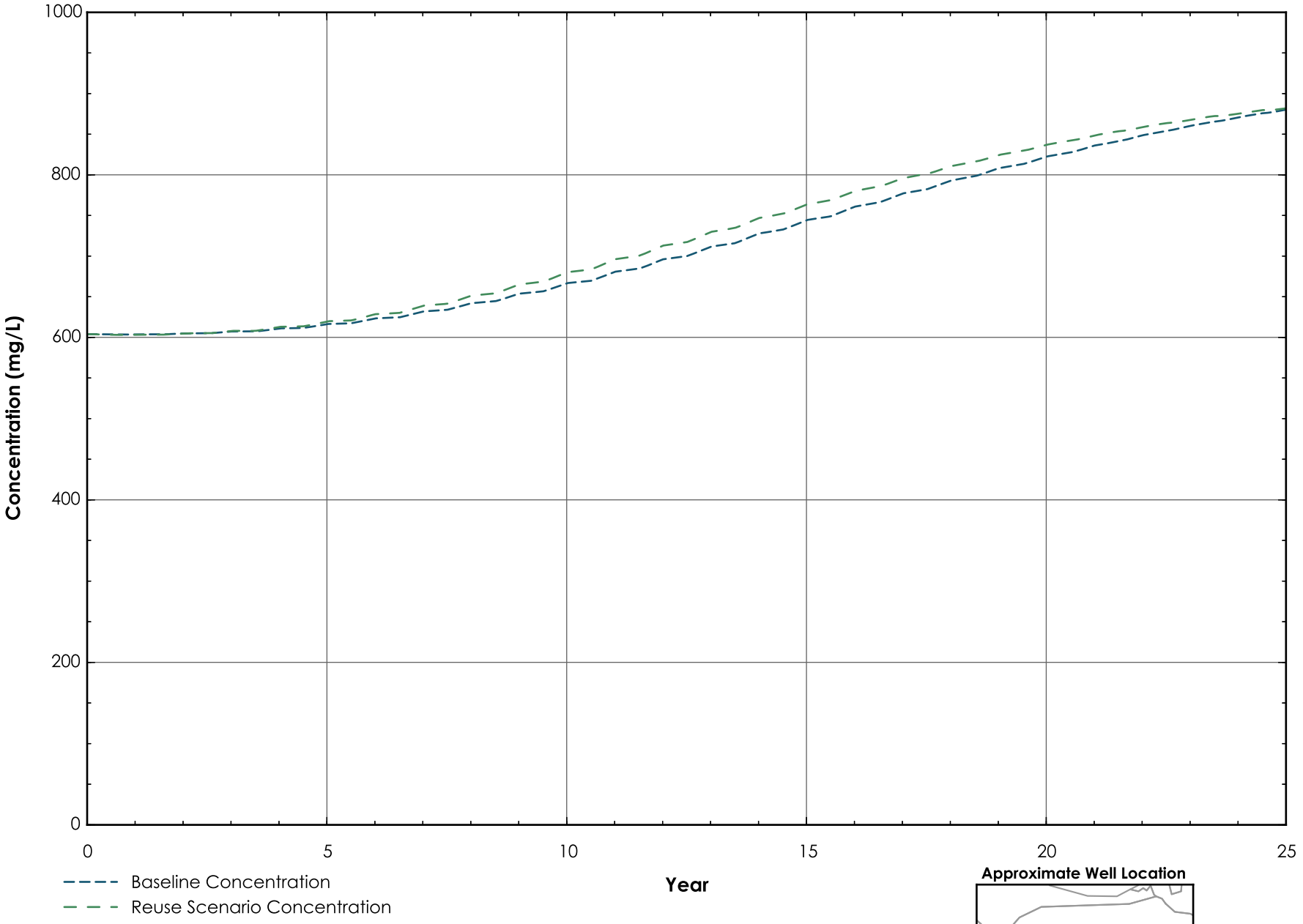


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

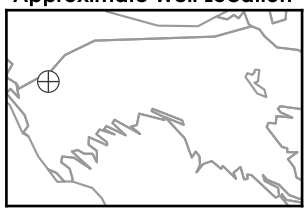


Well HOP 6 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

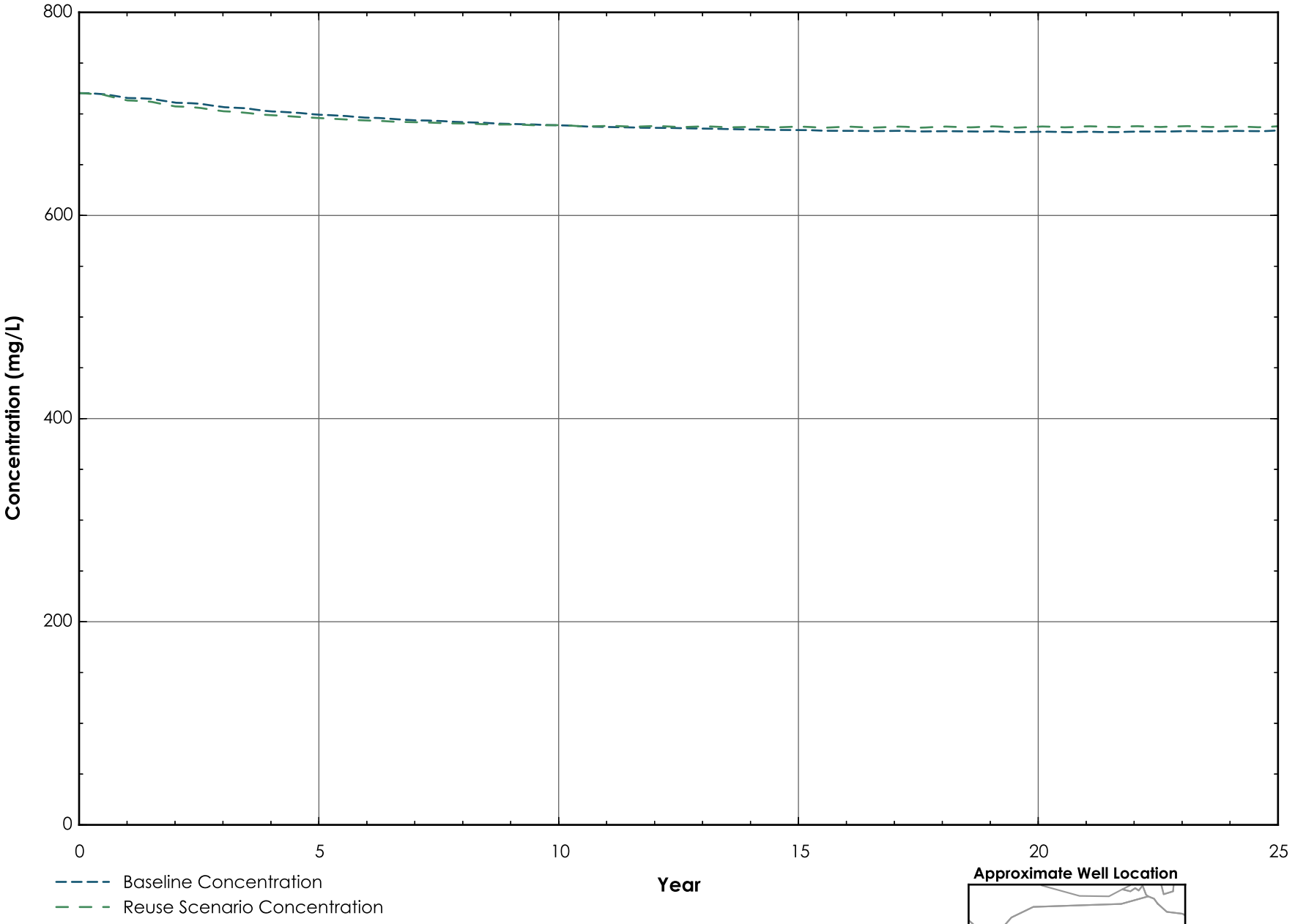


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

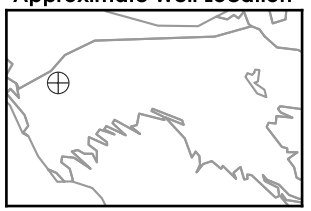


Well HOP 9 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

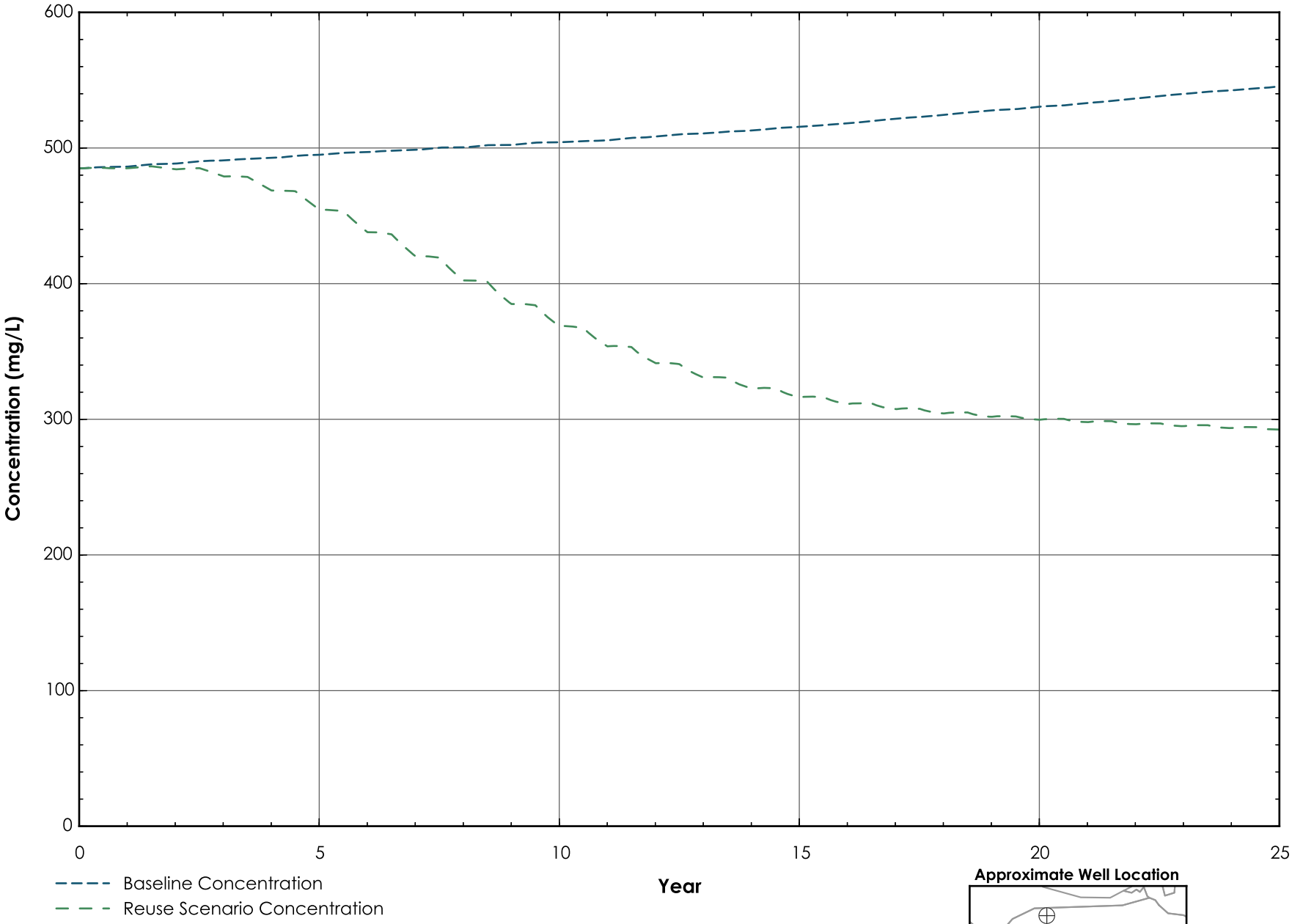


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

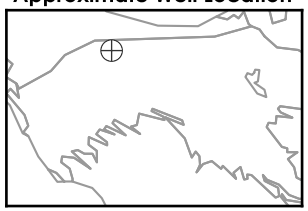


Well STONERIDGE 1 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

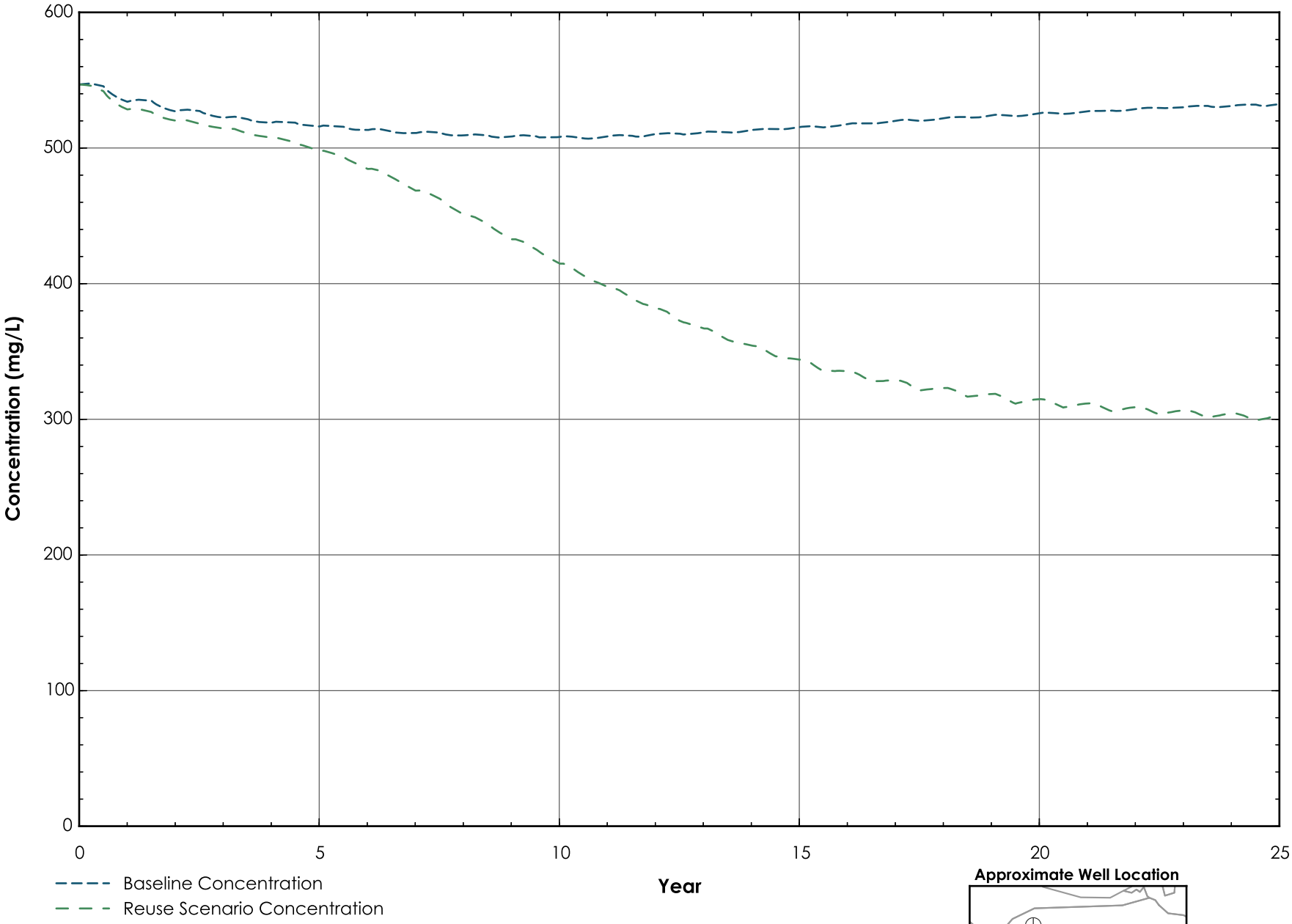


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

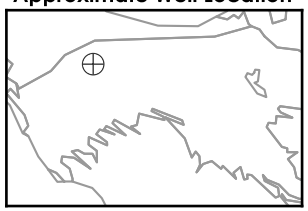


Well MOCHO 1 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

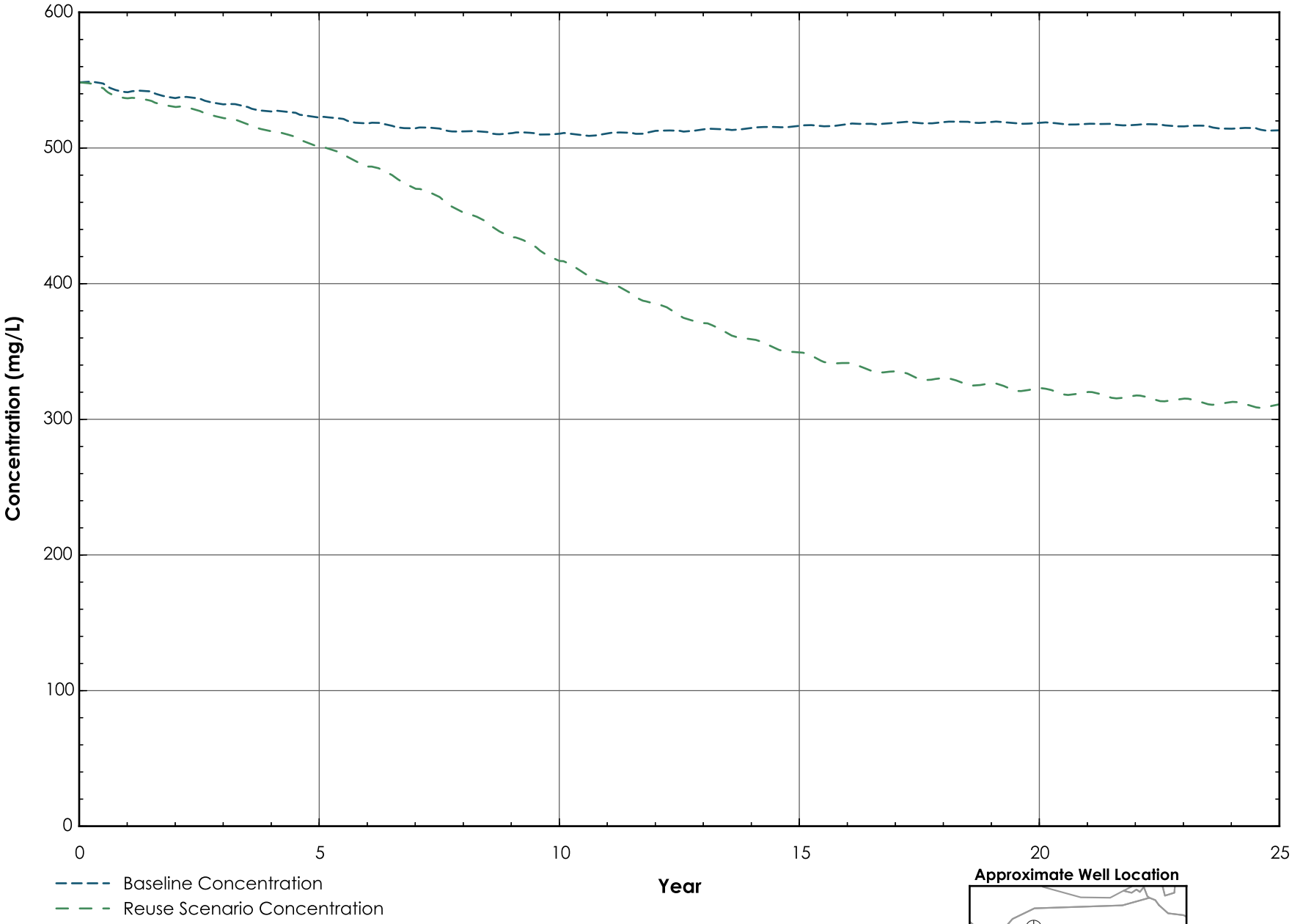


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

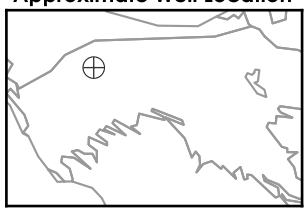


Well MOCHO 2 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

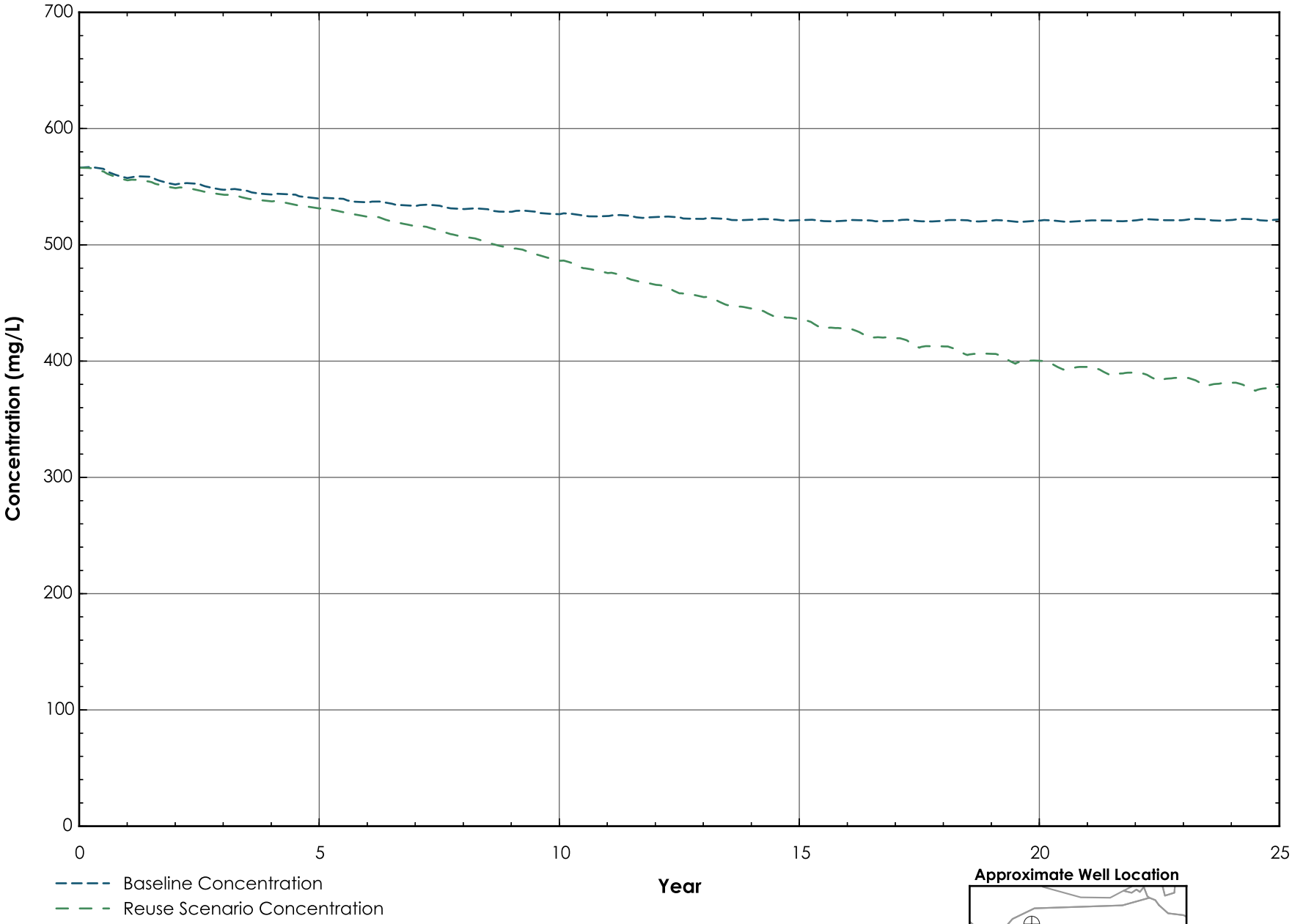


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

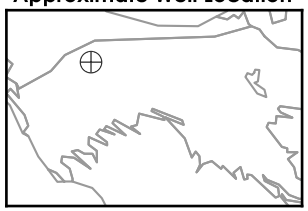


Well MOCHO 3 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

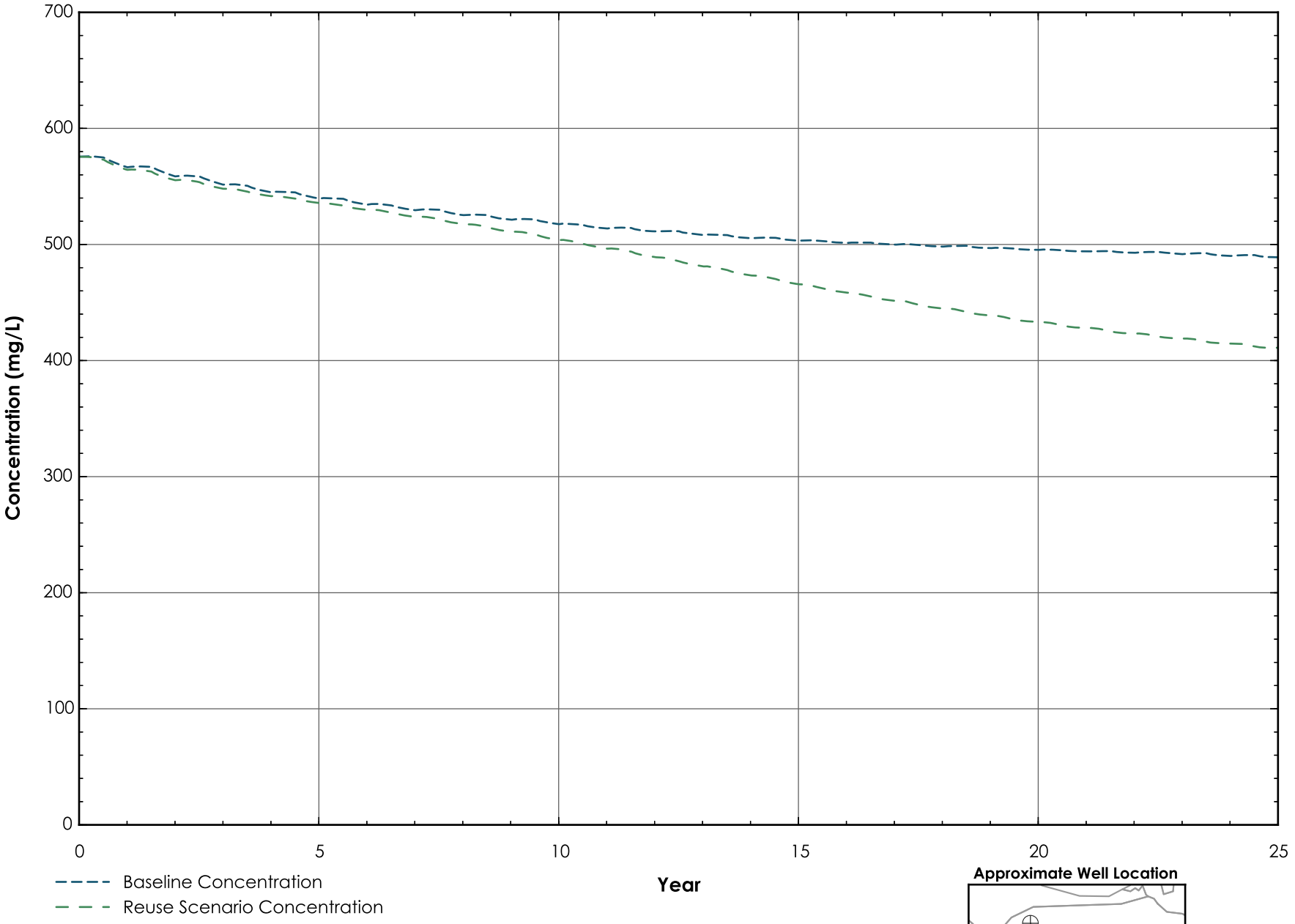


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

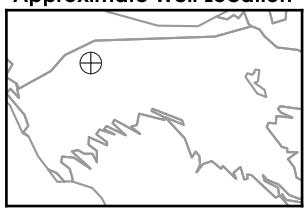


Well MOCHO 4 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

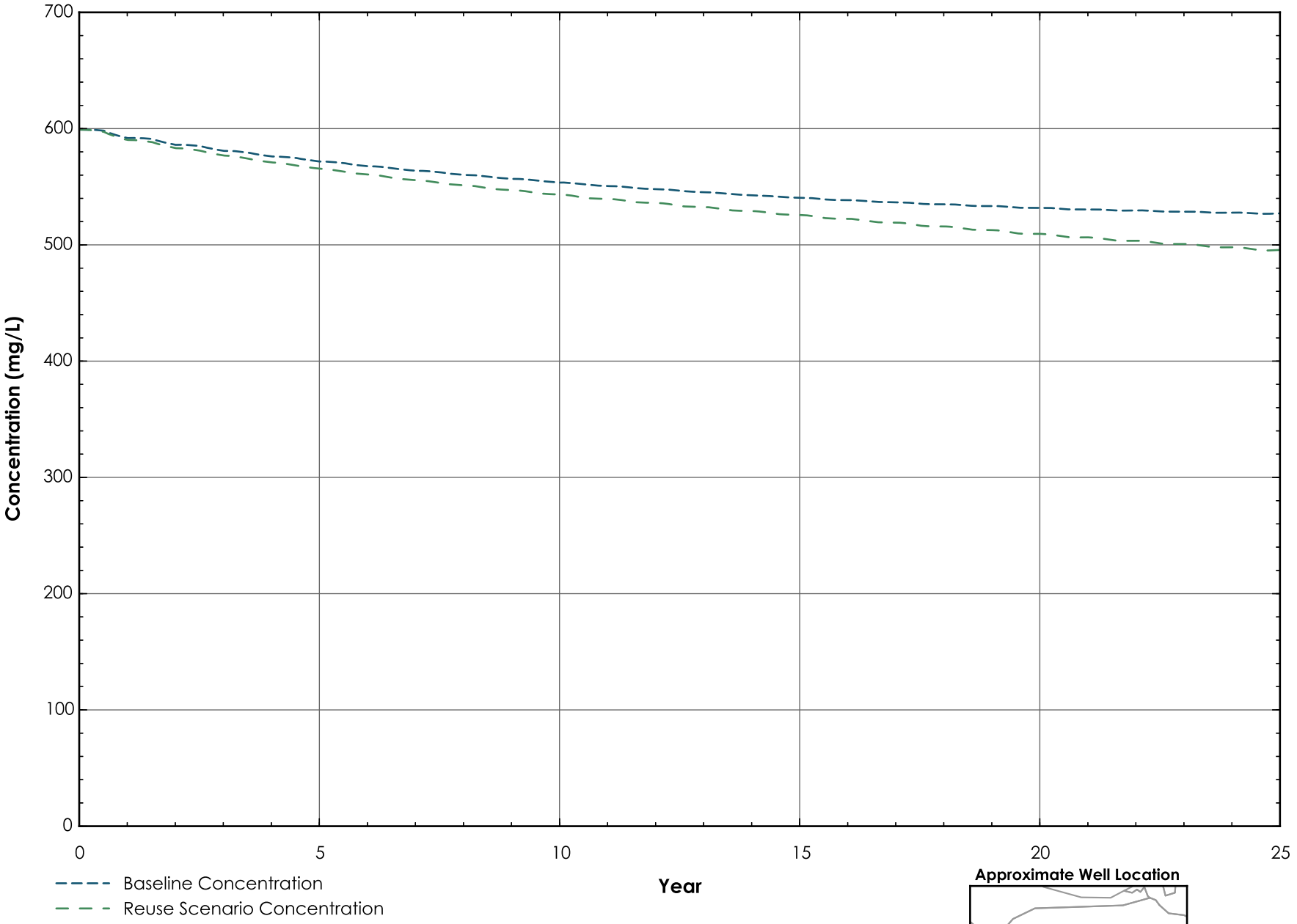


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

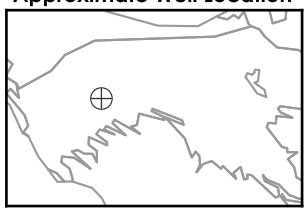


Well PLEAS 5 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

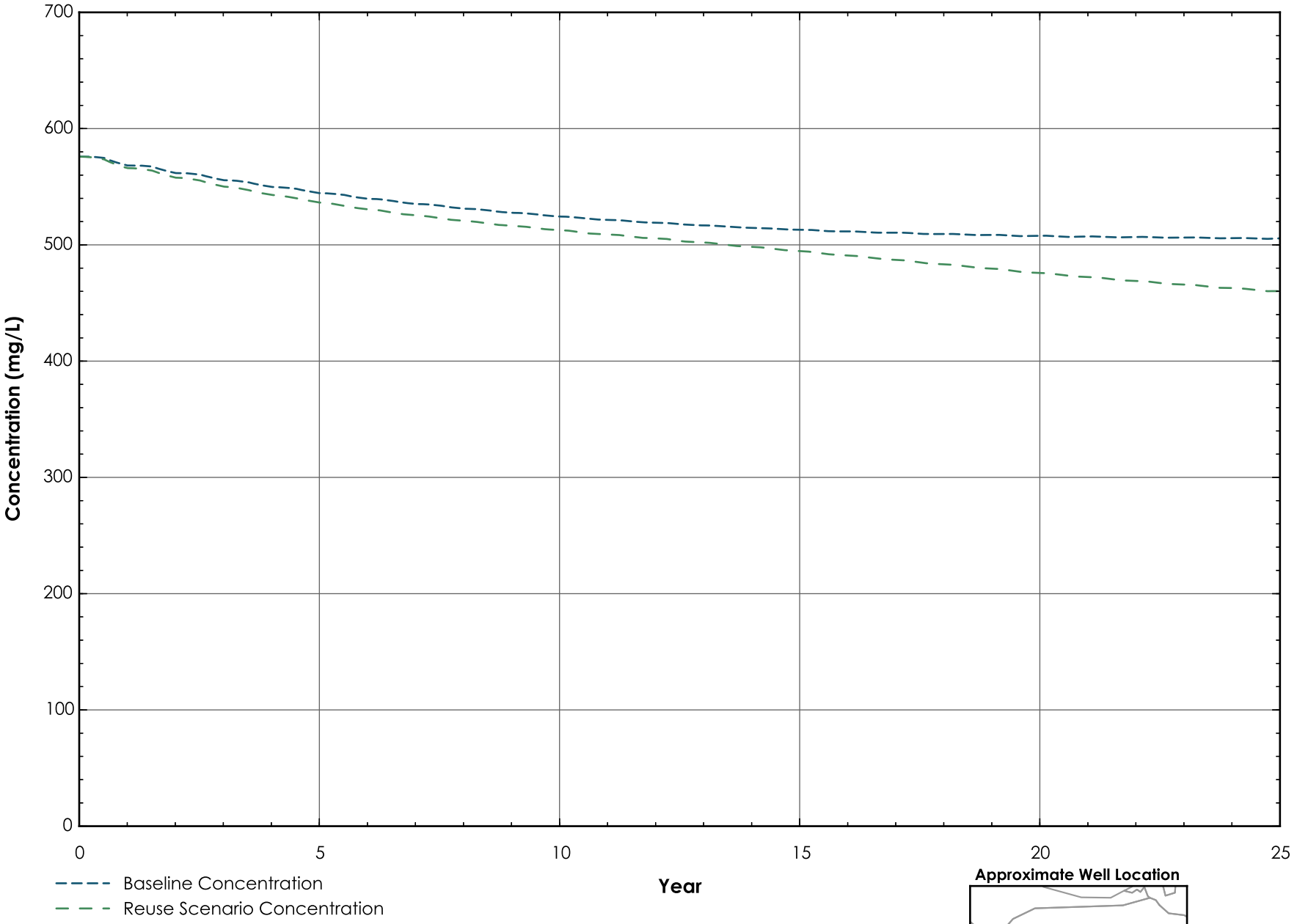


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

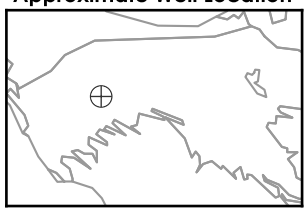


Well PLEAS 6 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

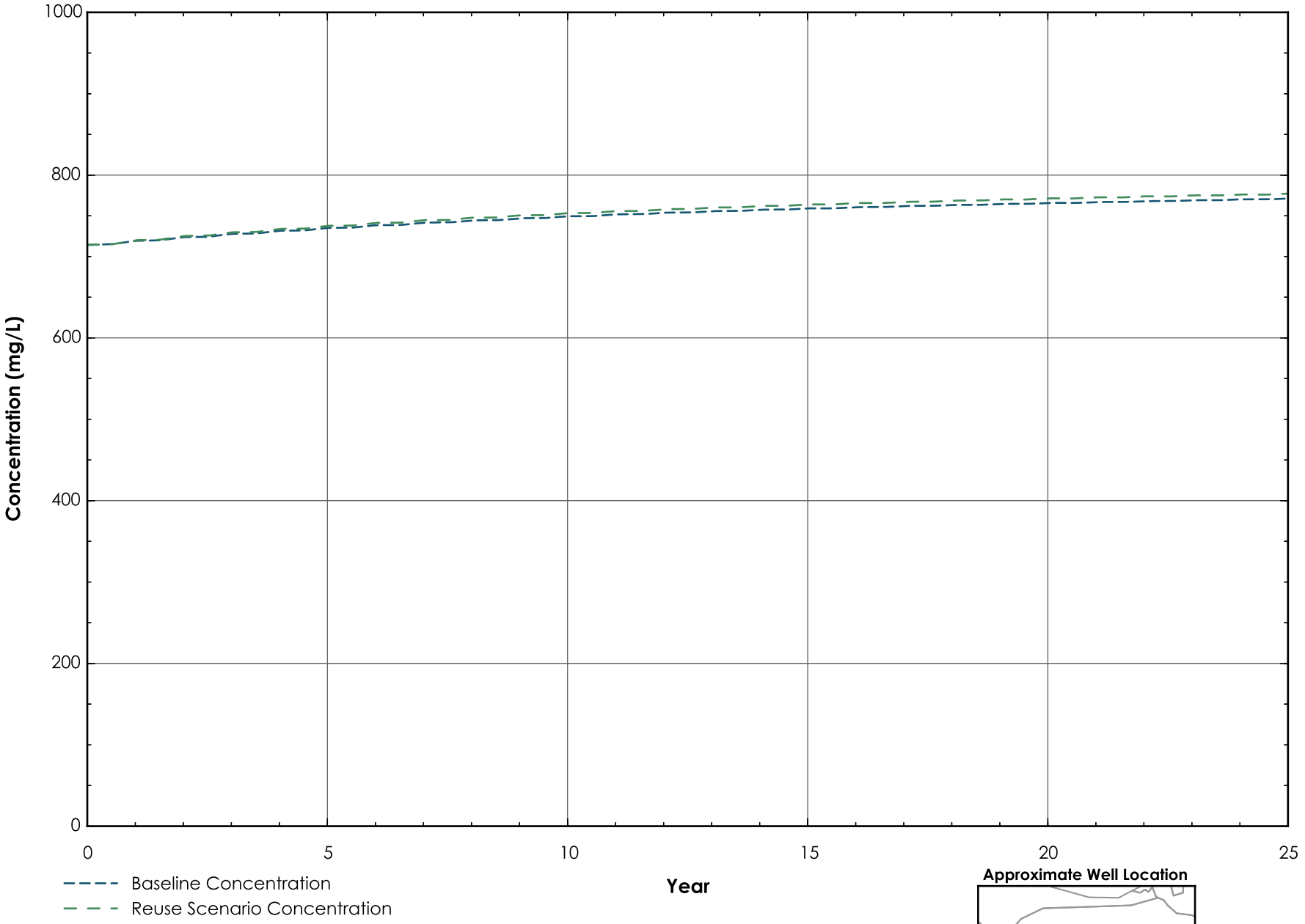


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

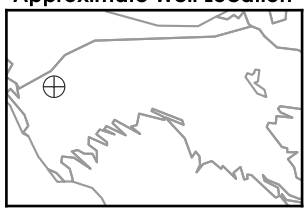


Well PLEAS 7 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

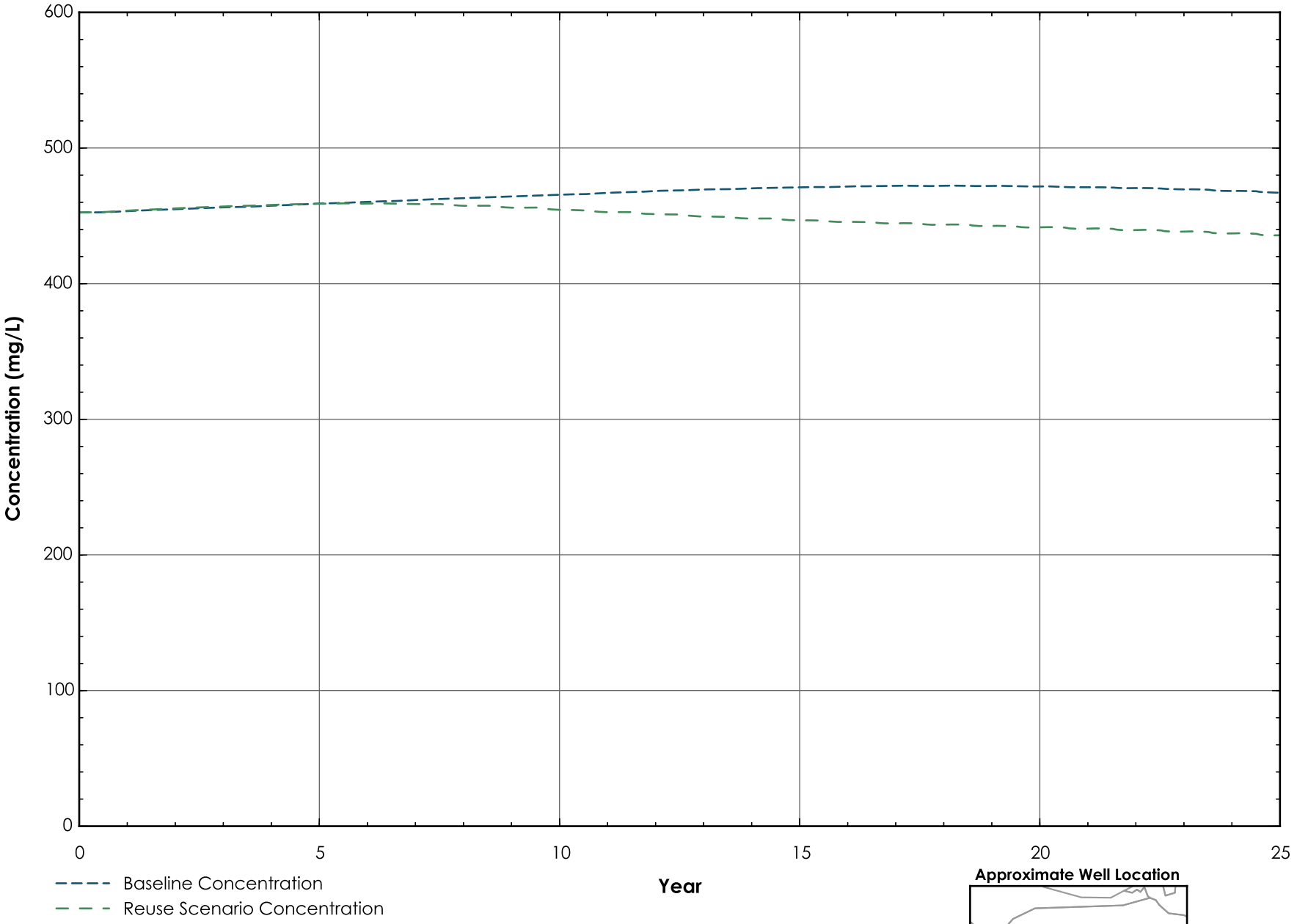


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

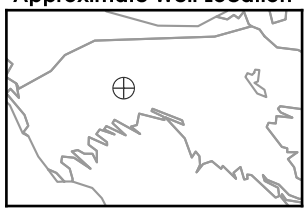


Well PLEAS 8 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

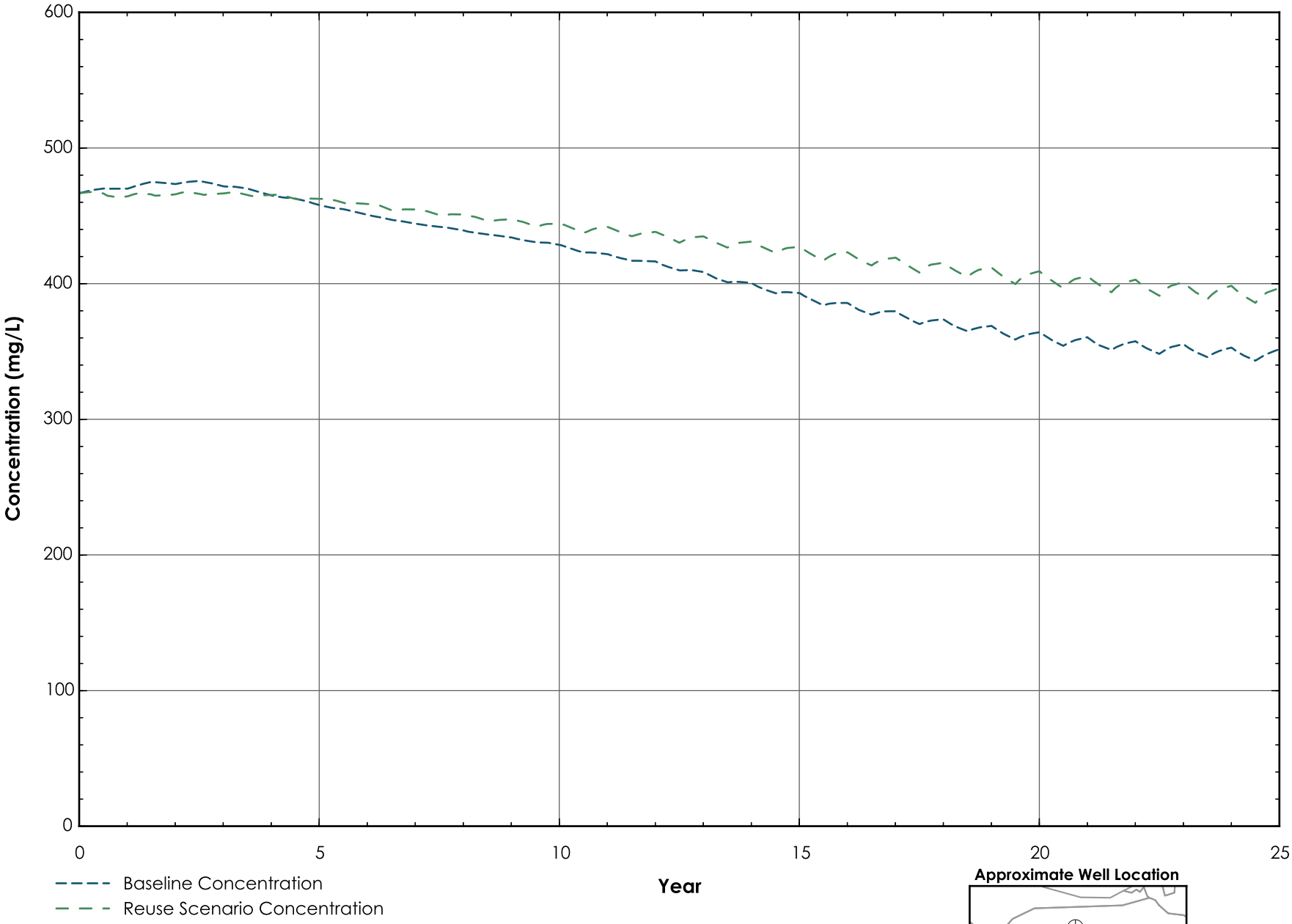


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

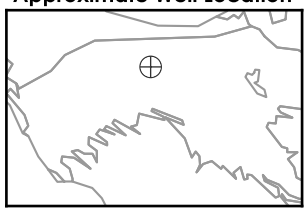


Well COL 1 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

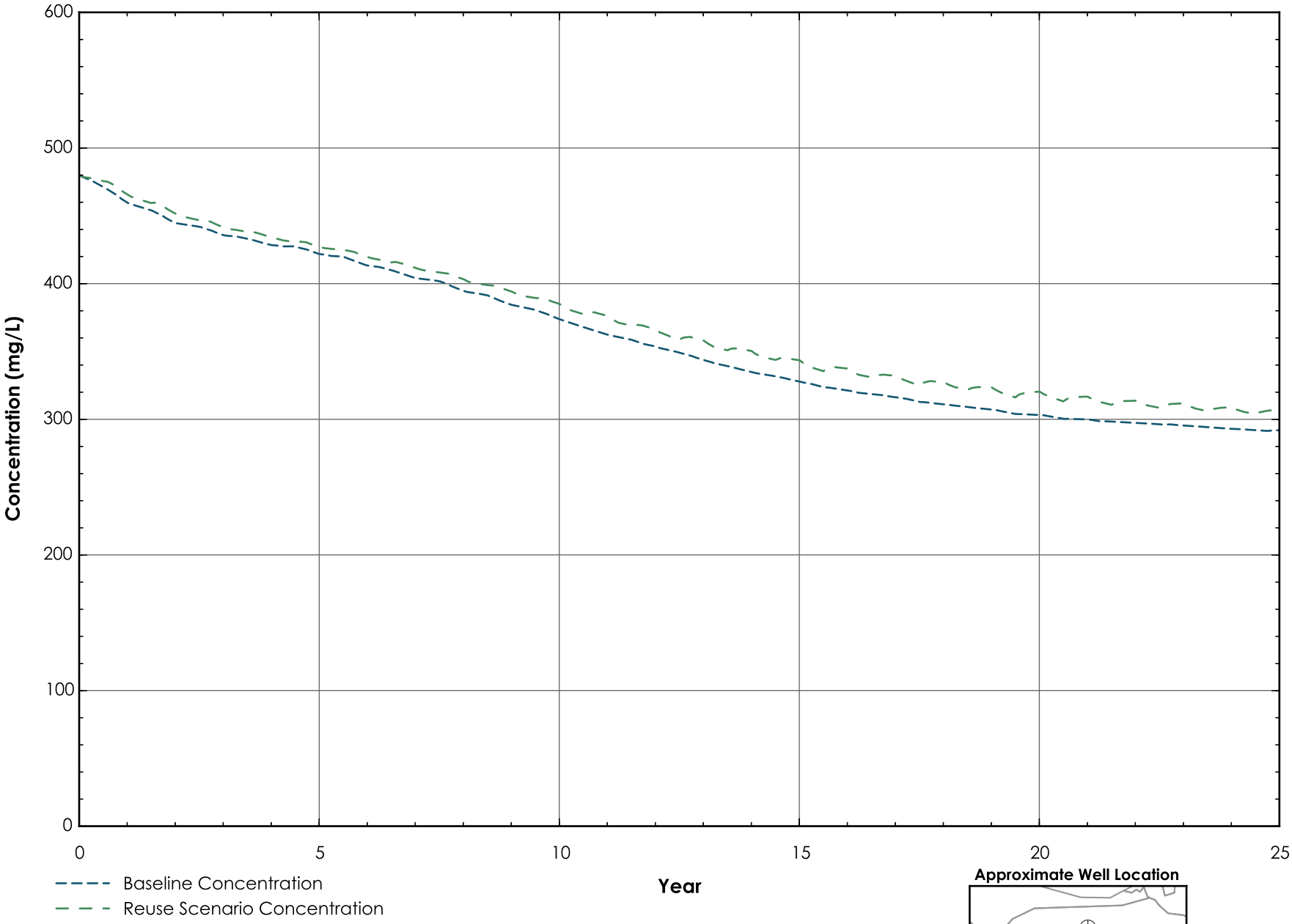


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

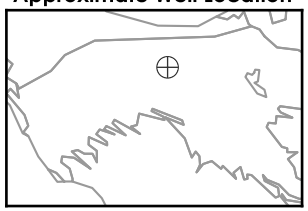


Well COL 2 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

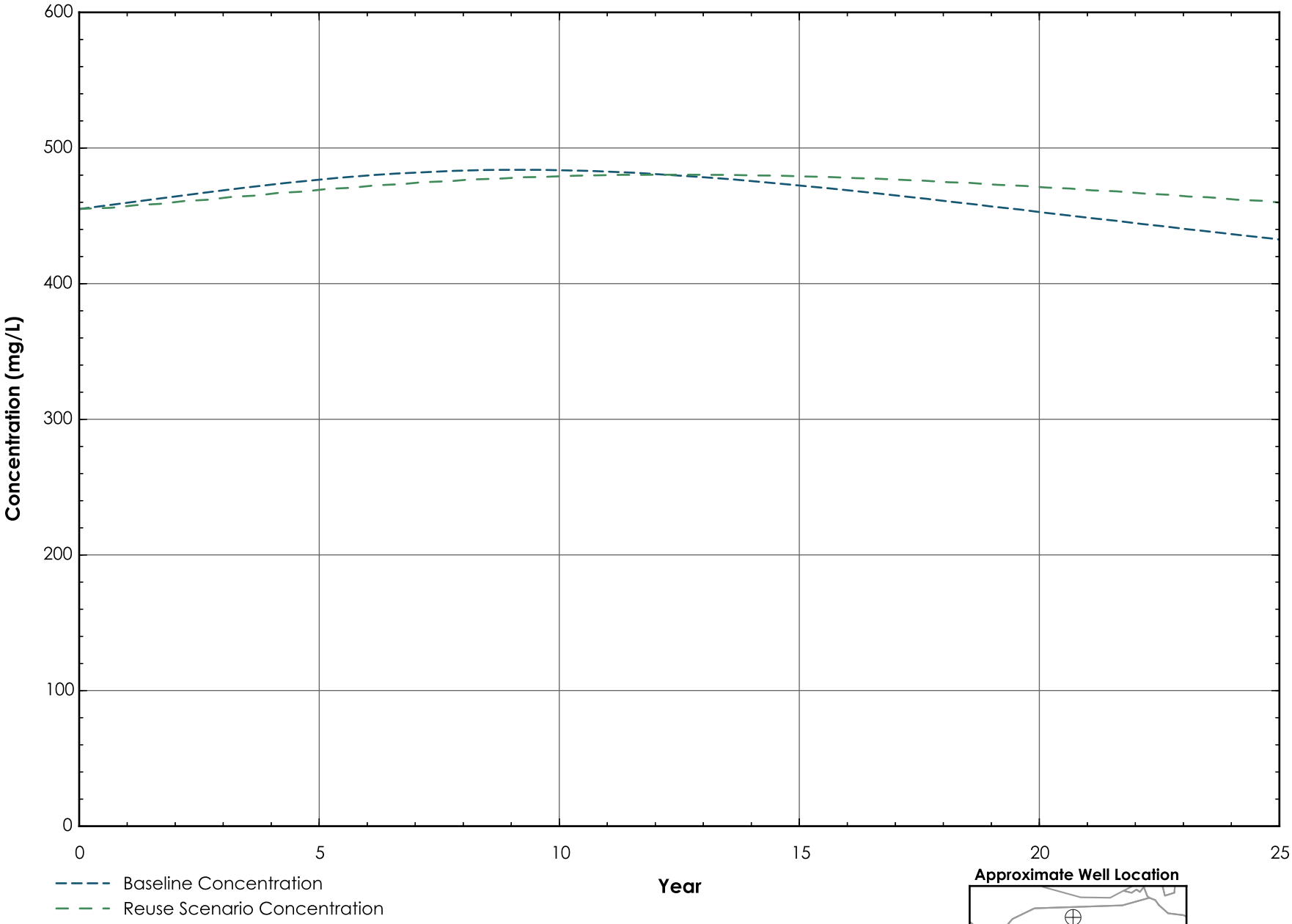


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

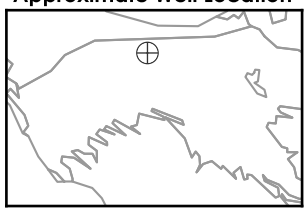


Well COL 5 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

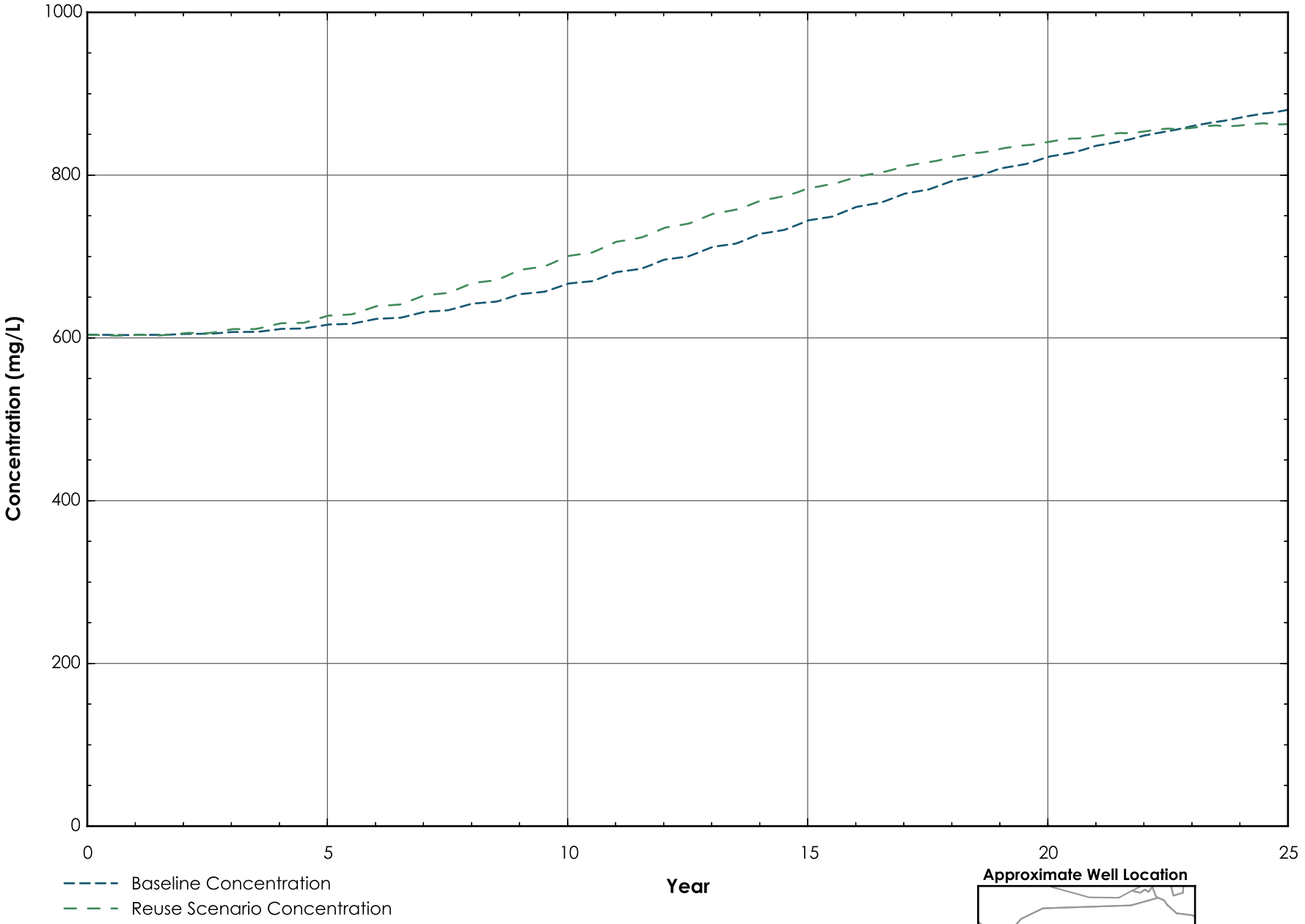


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

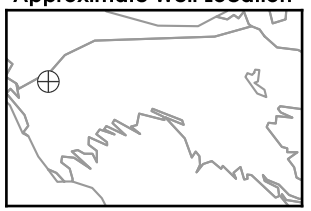


Well HOP 6 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

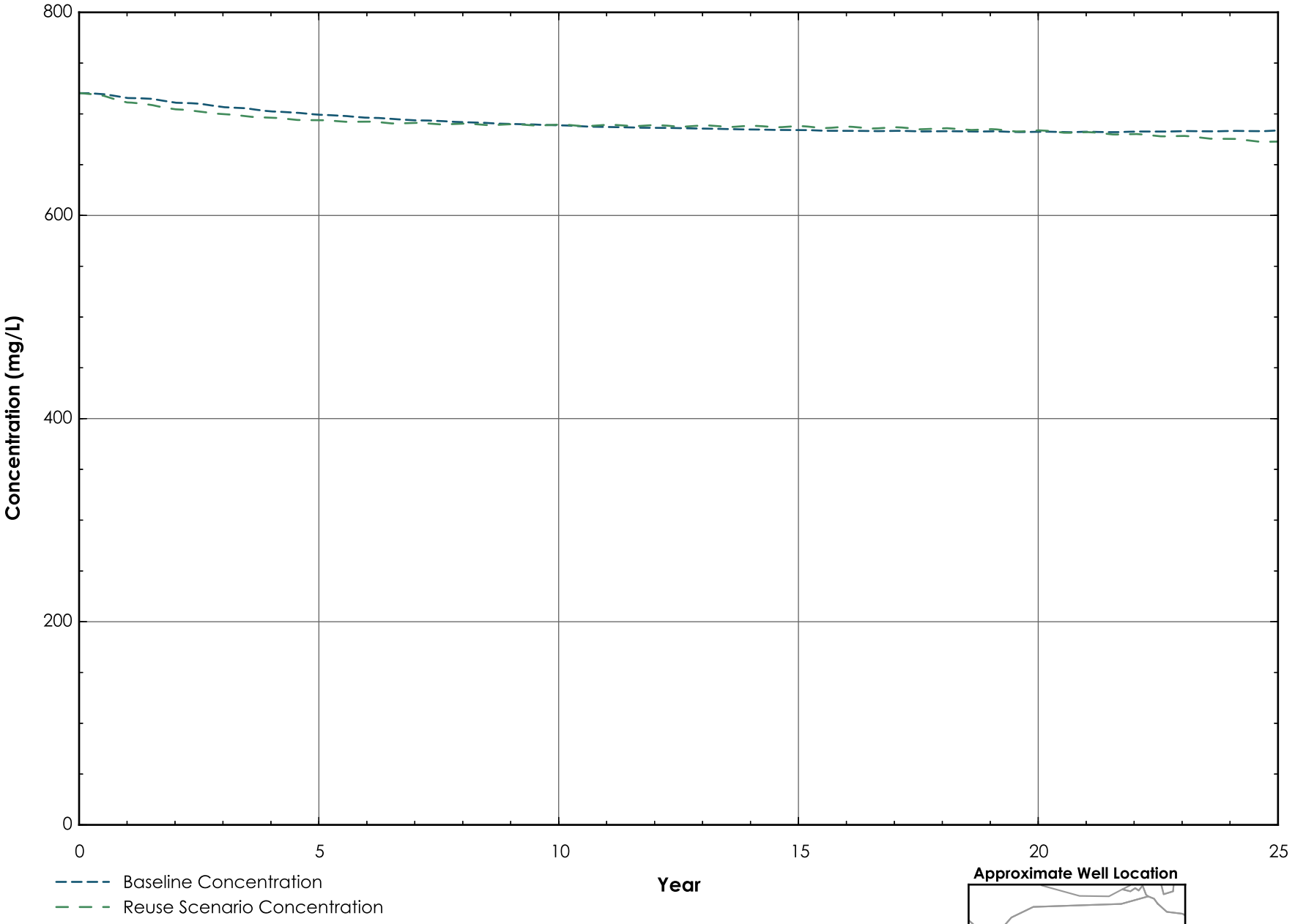


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

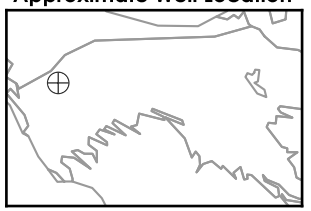


Well HOP 9 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

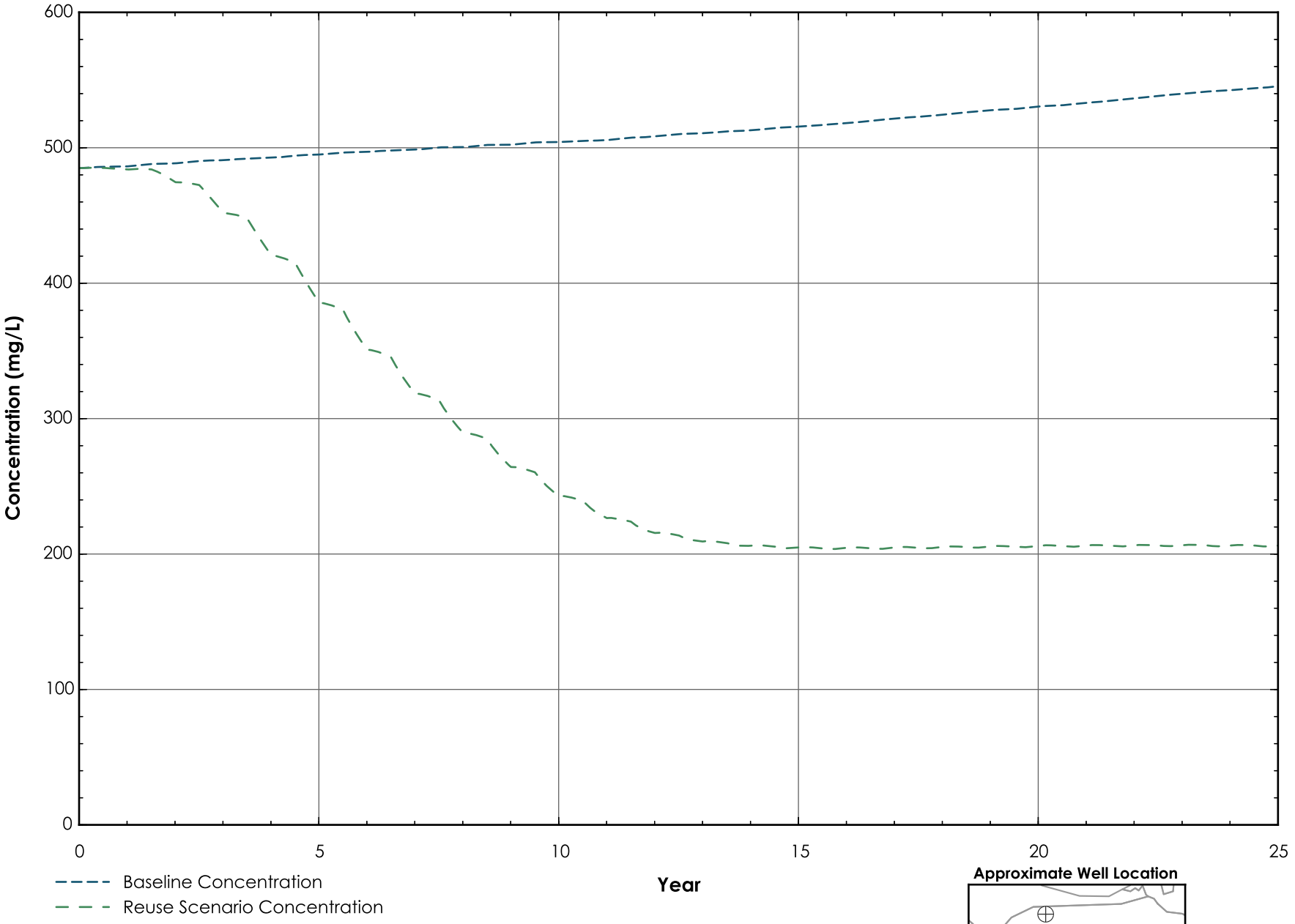


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

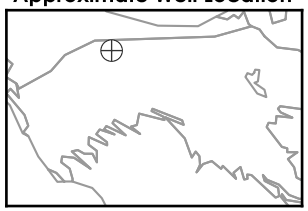


Well STONERIDGE 1 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

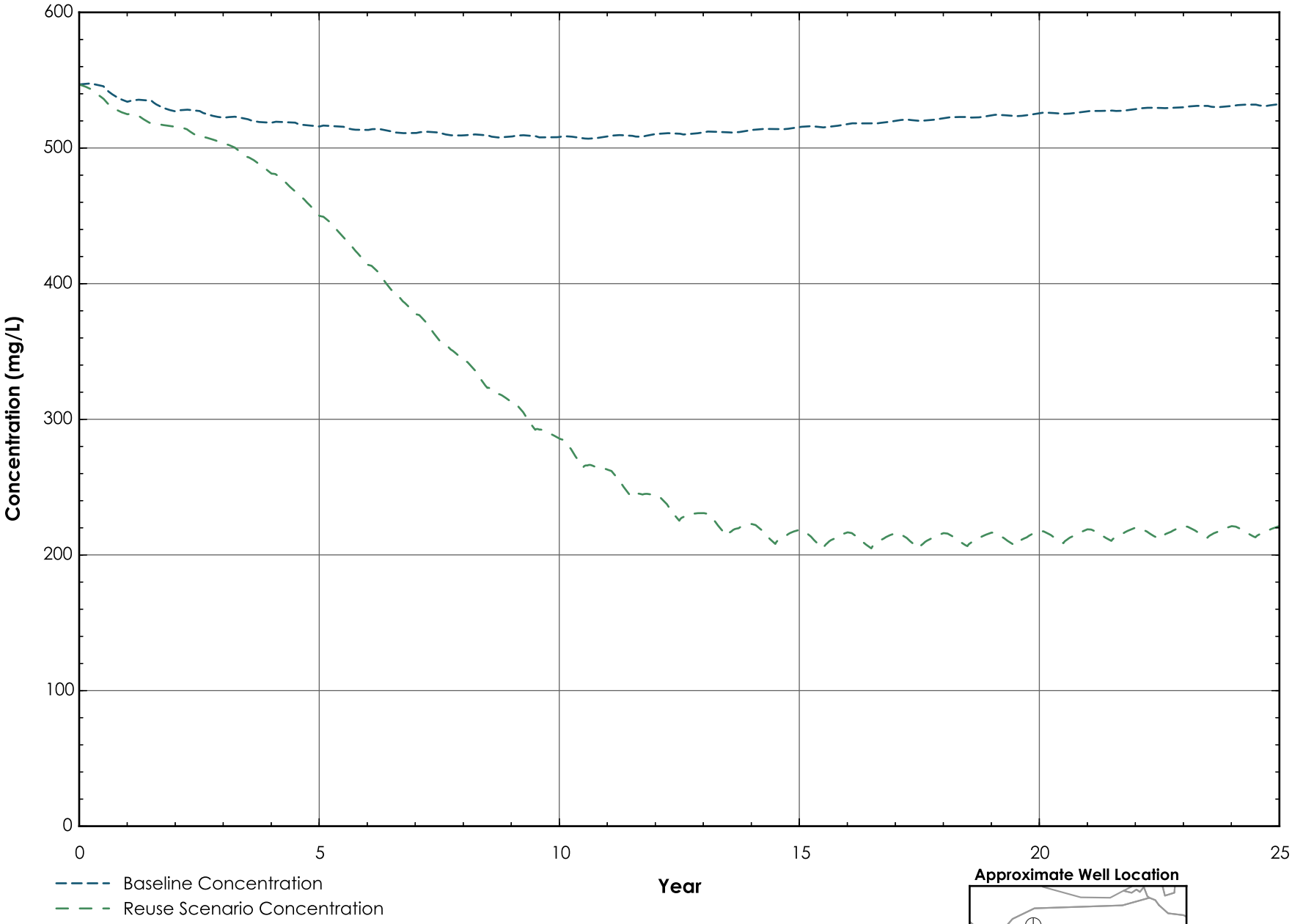


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

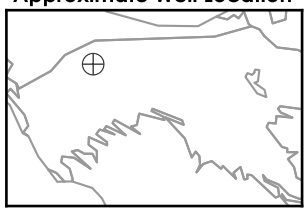


Well MOCHO 1 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

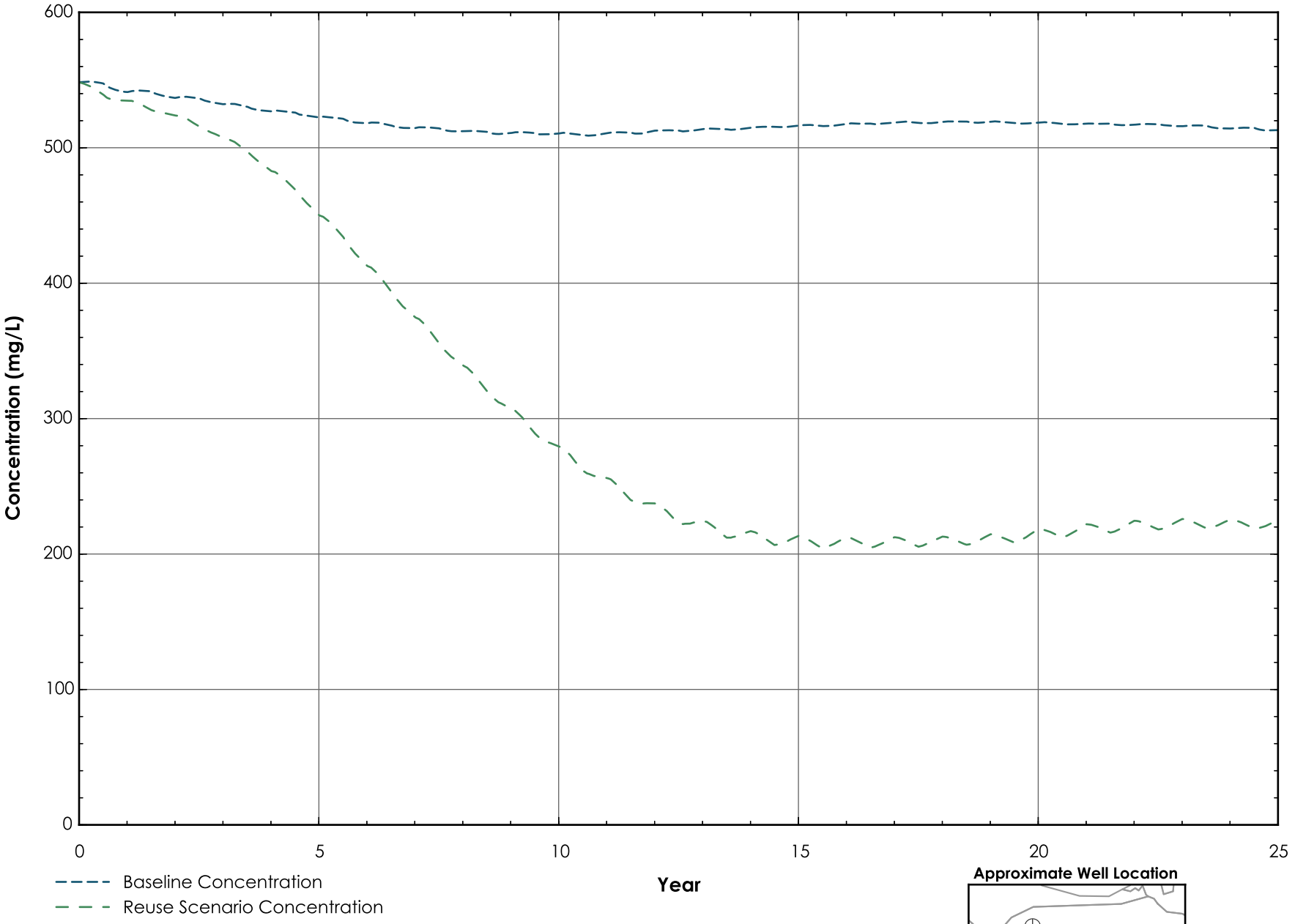


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

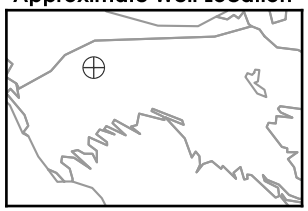


Well MOCHO 2 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

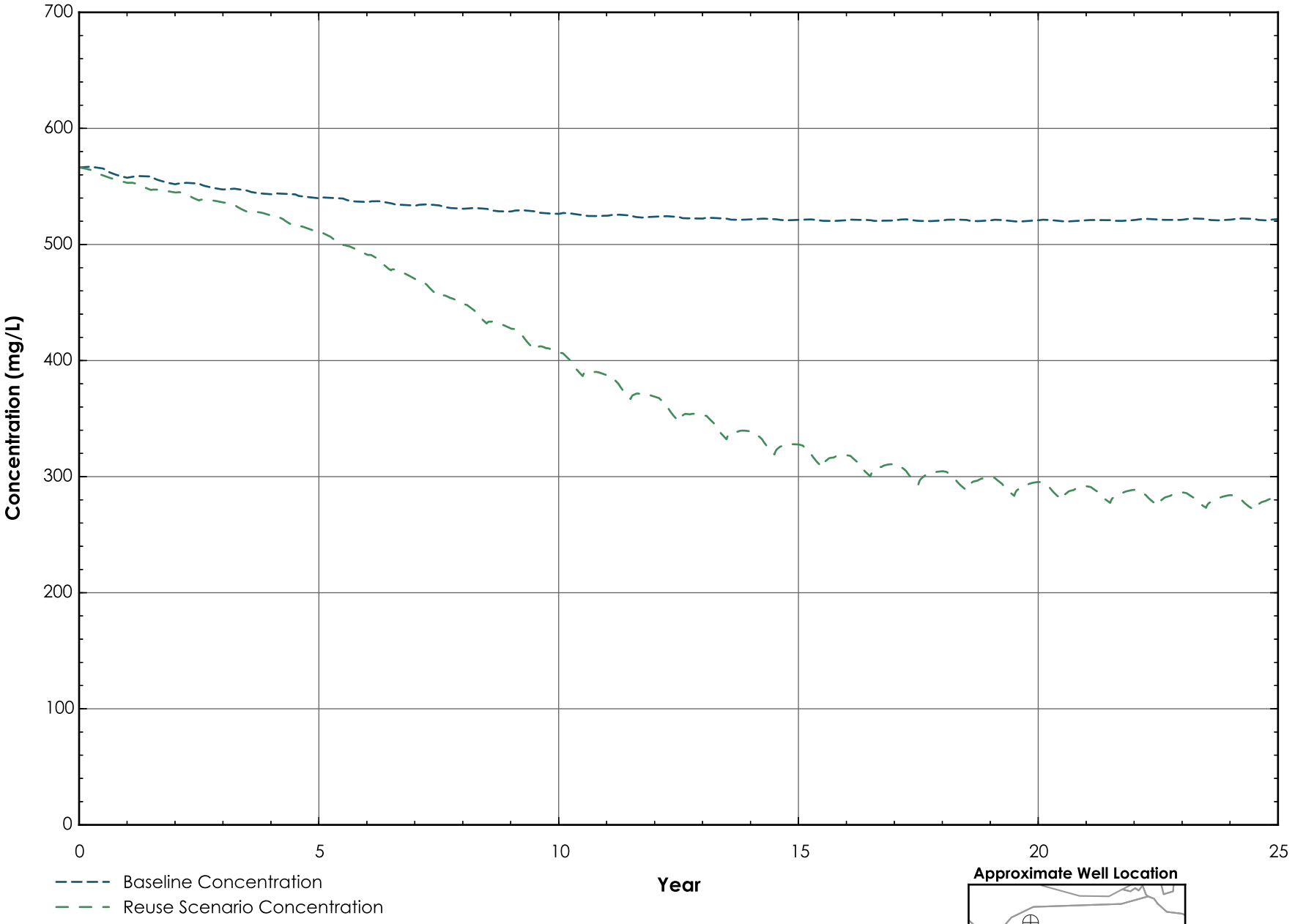


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

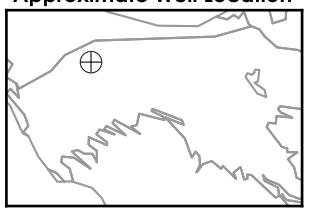


Well MOCHO 3 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

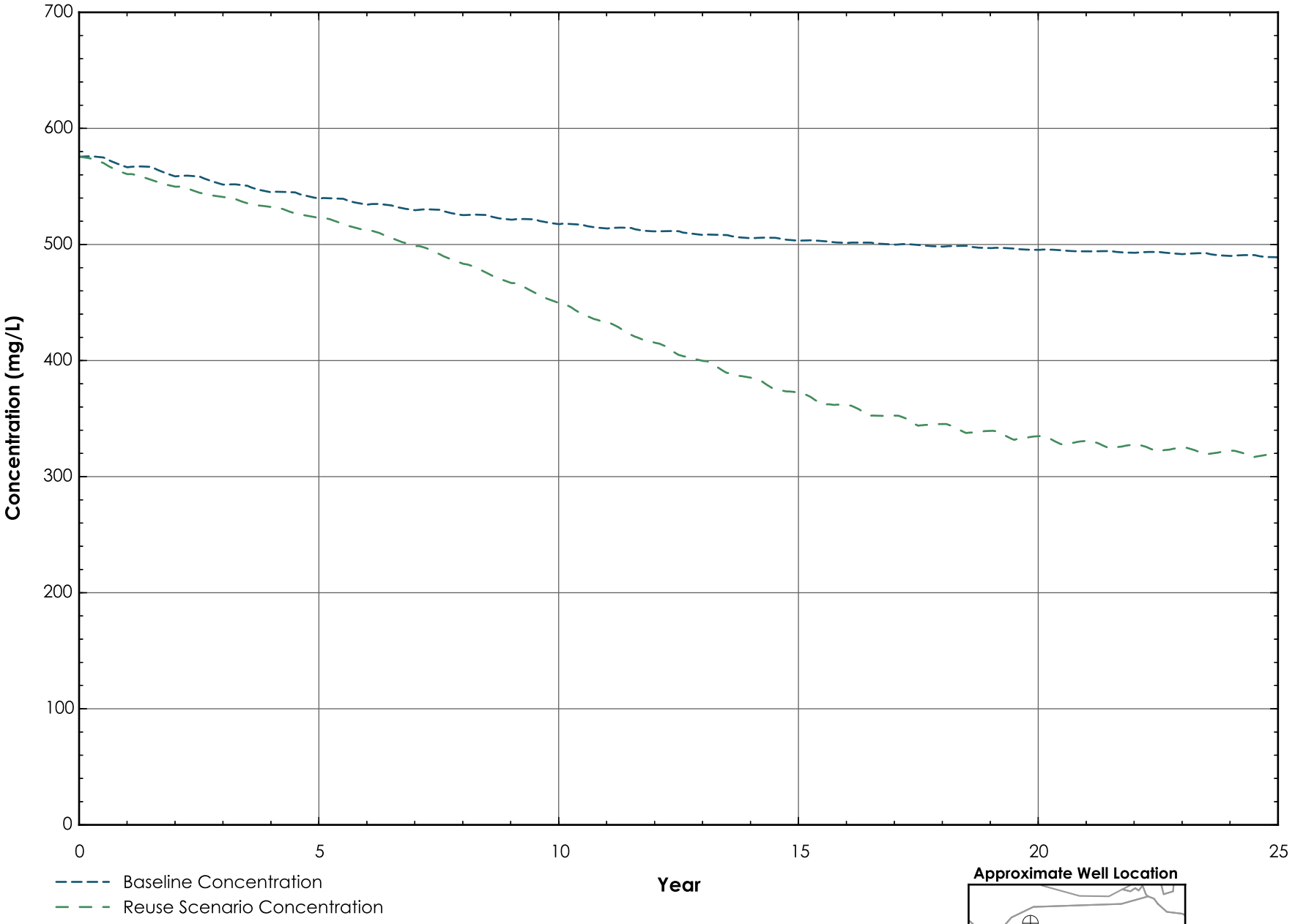


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

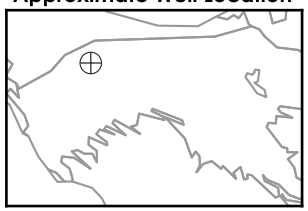


Well MOCHO 4 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

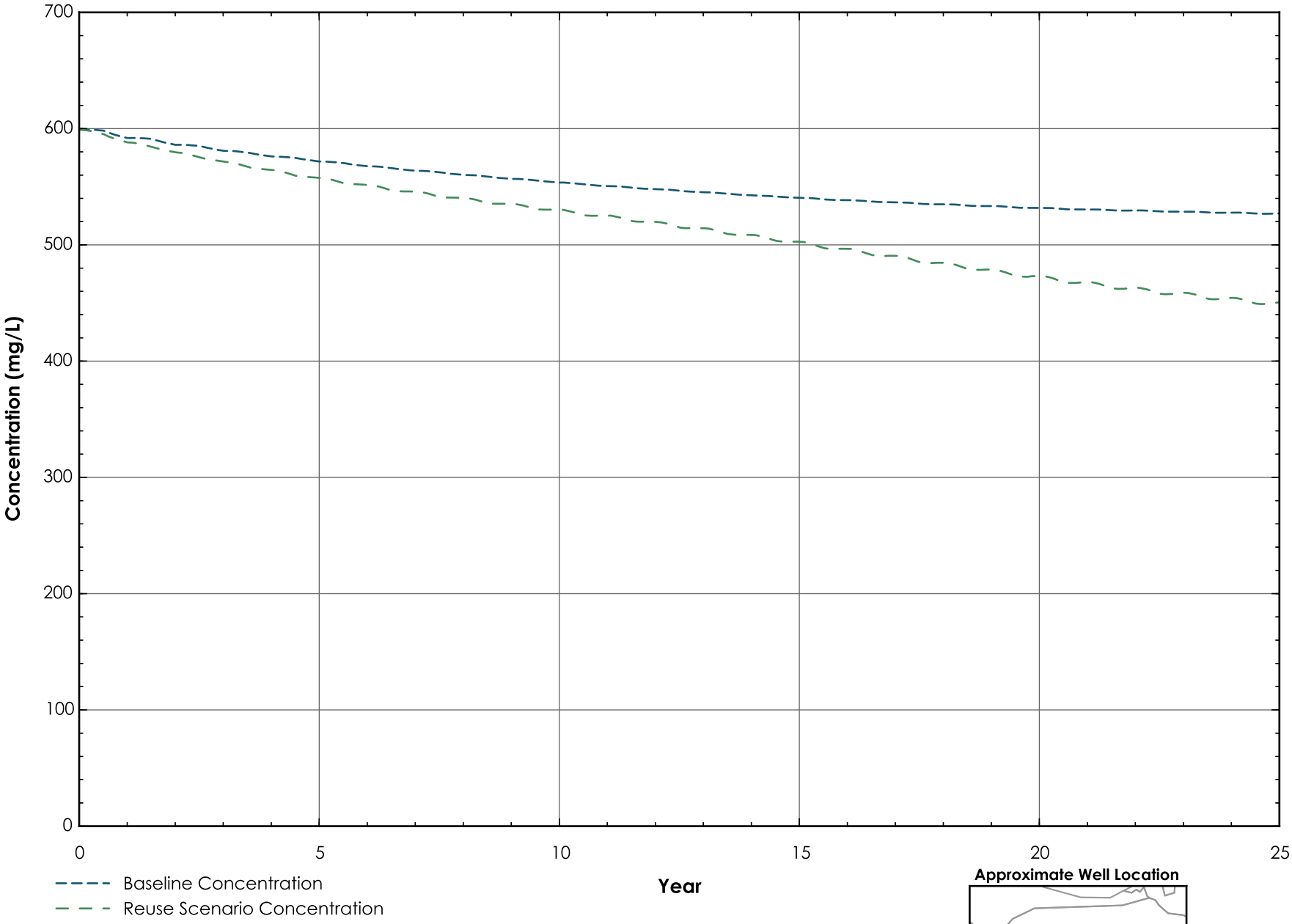


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

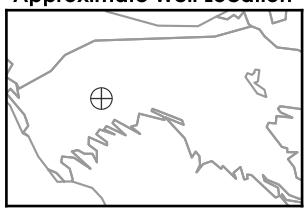


Well PLEAS 5 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

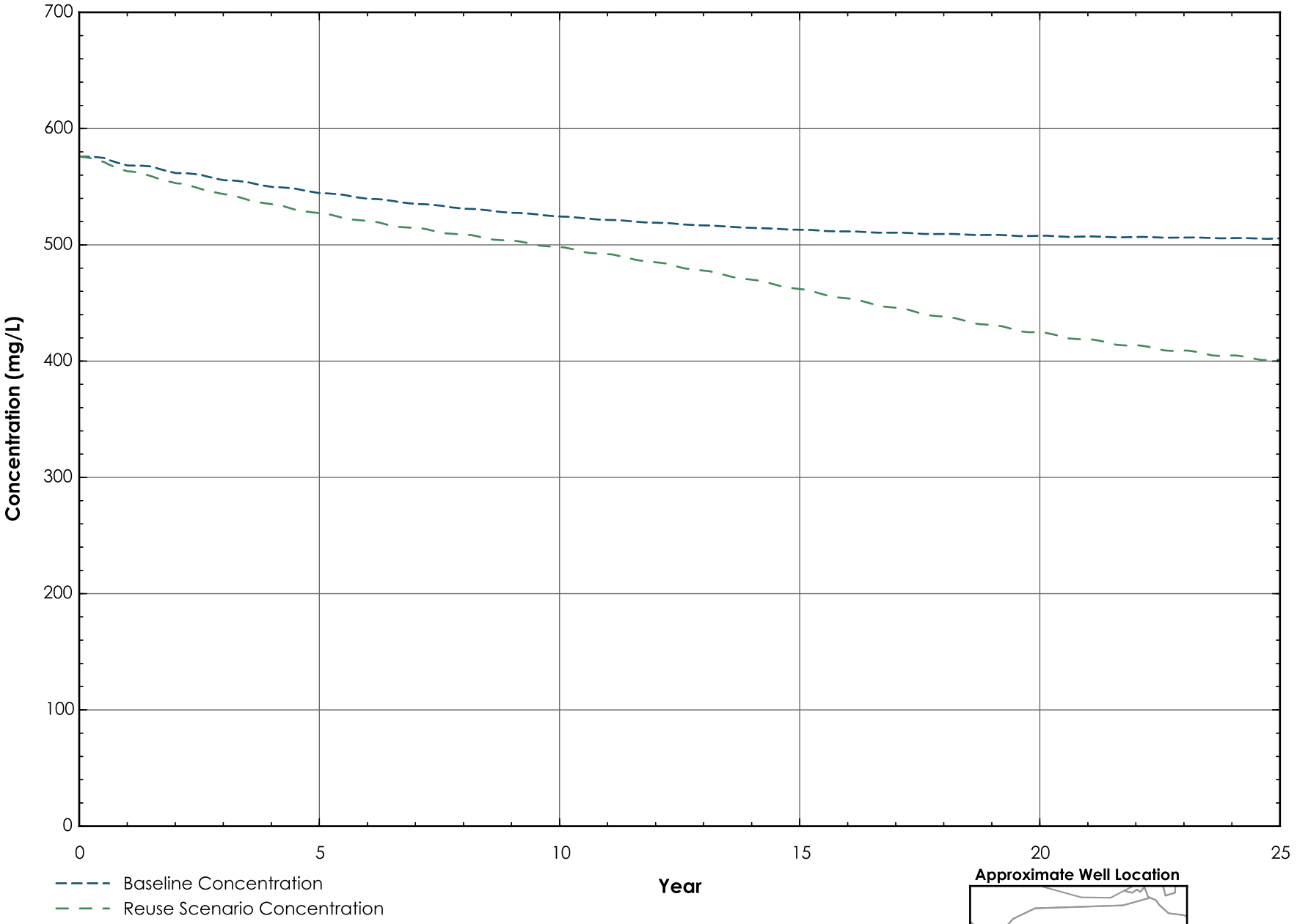


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

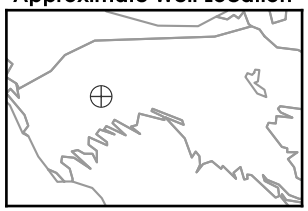


Well PLEAS 6 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

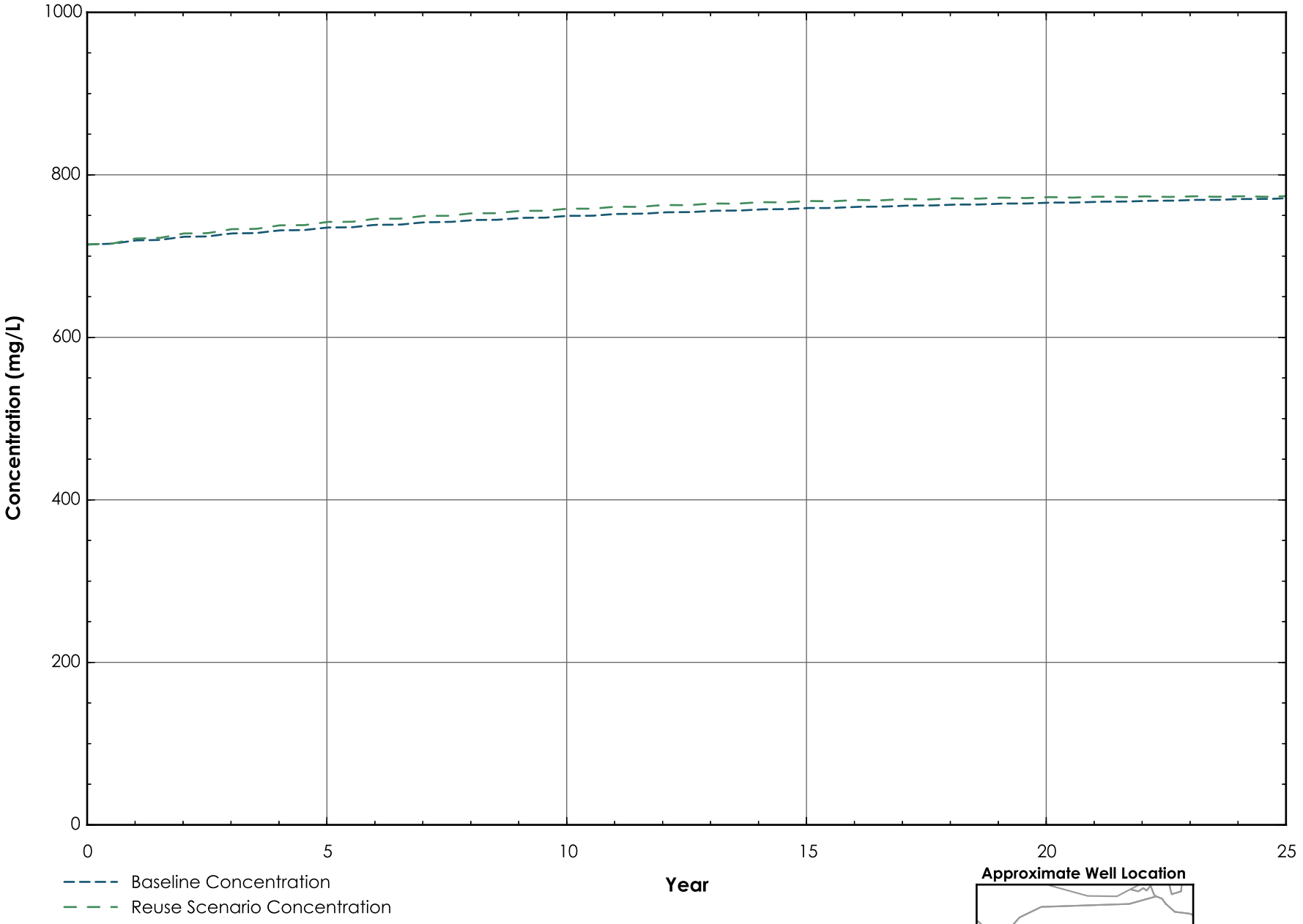


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

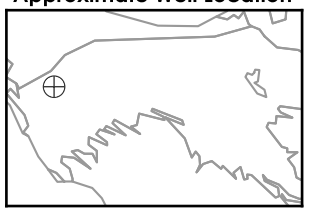


Well PLEAS 7 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

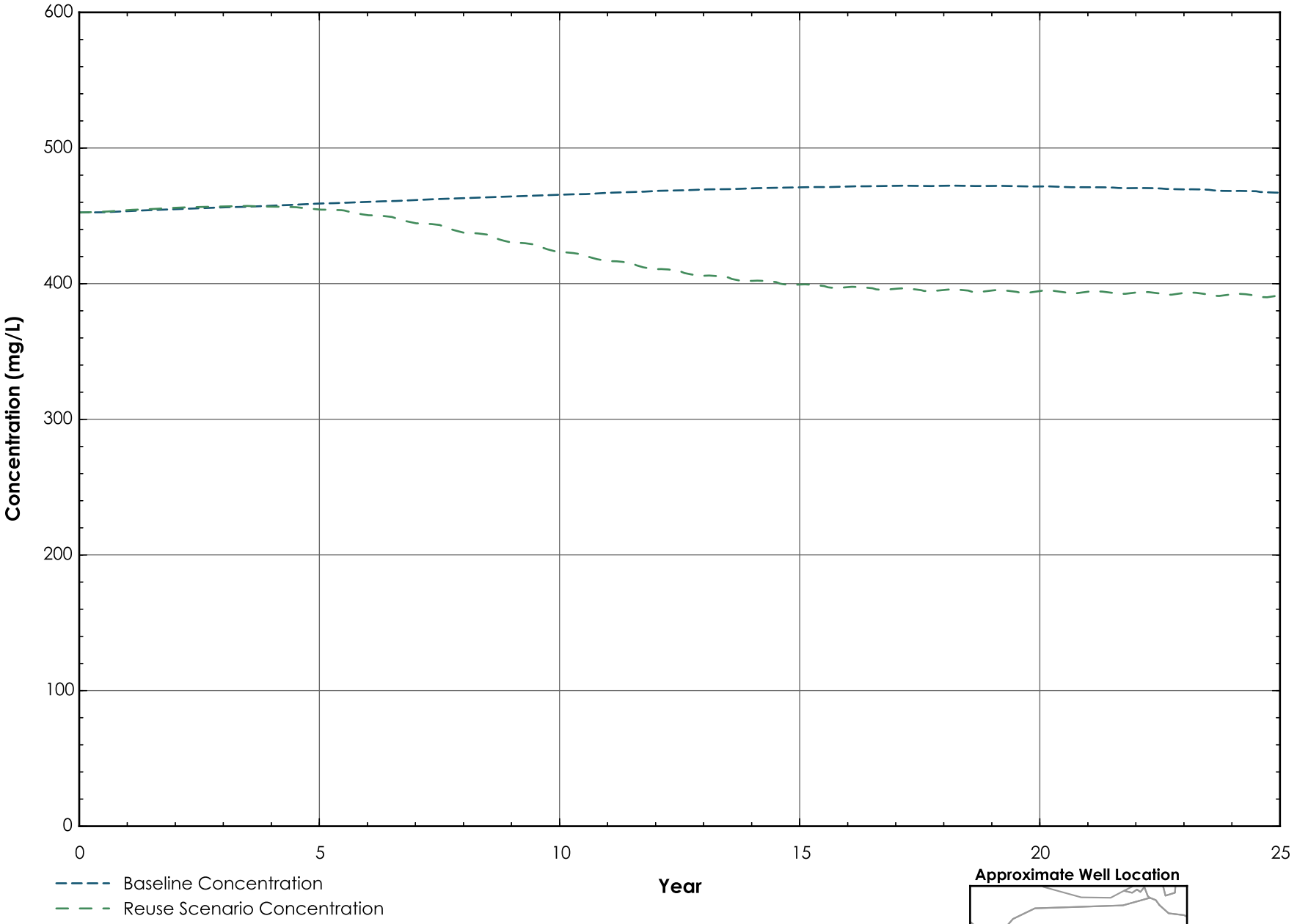


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

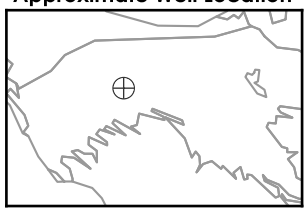


Well PLEAS 8 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

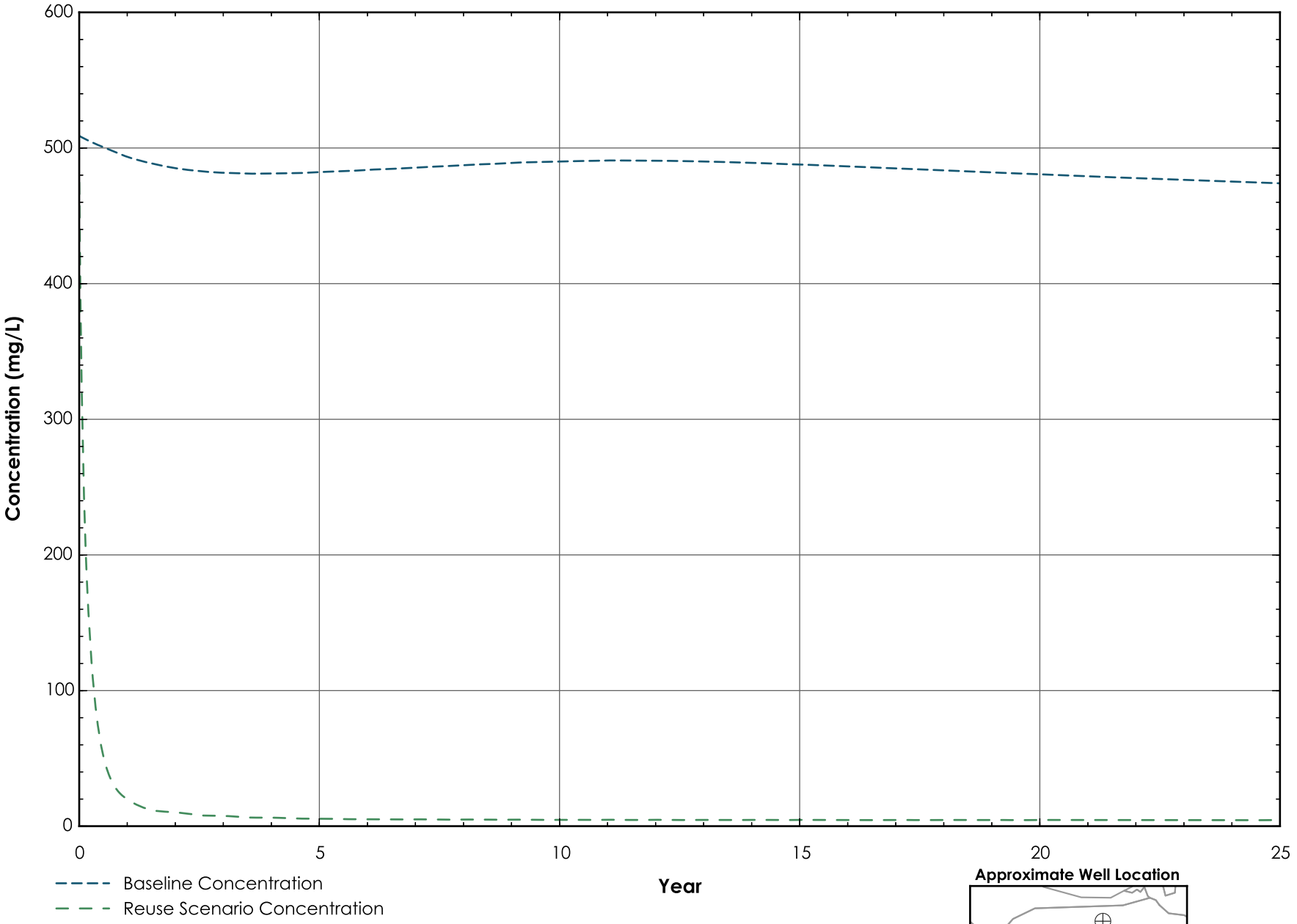


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

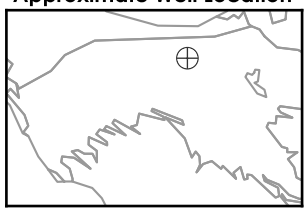


Well Inj E Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

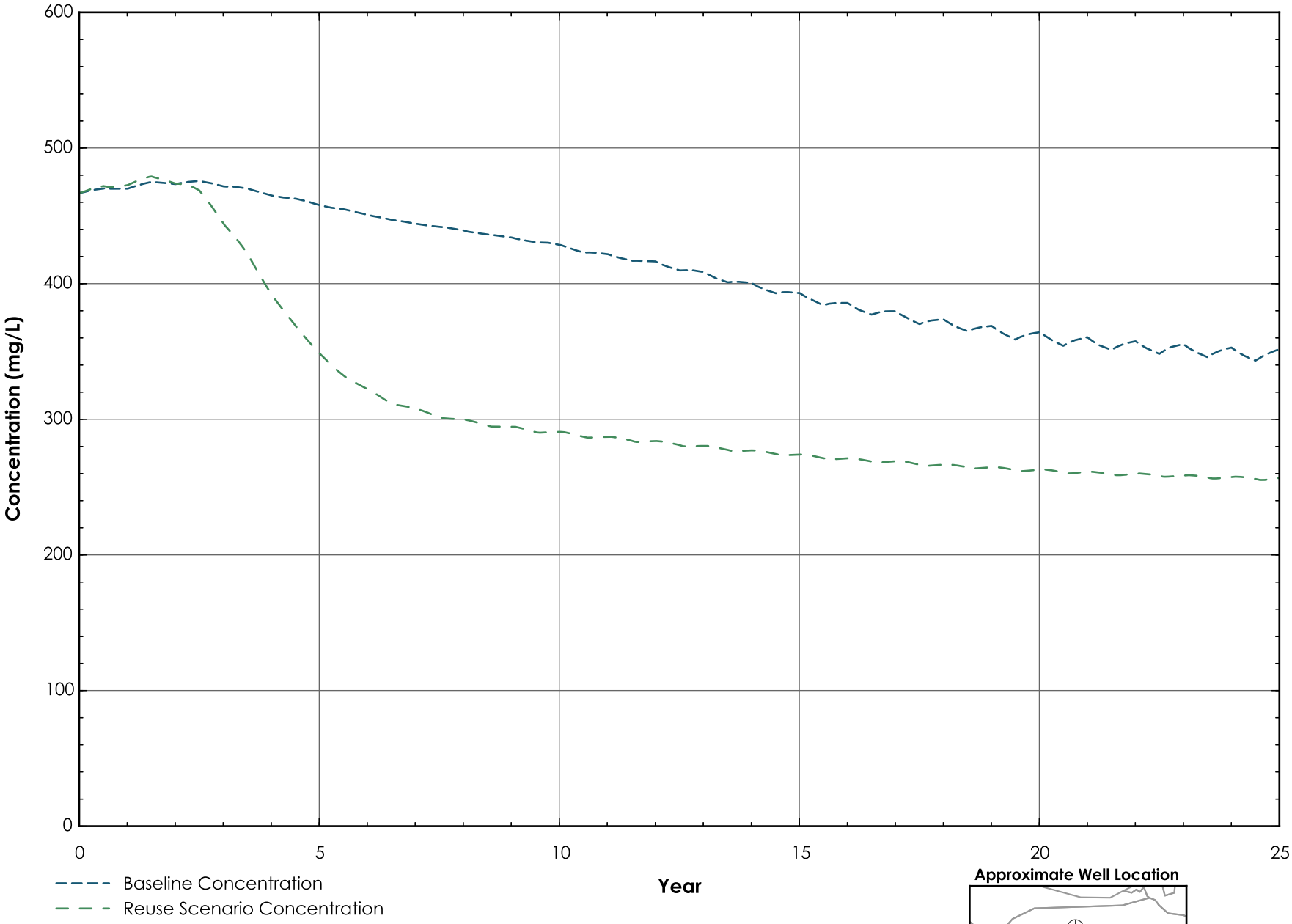


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

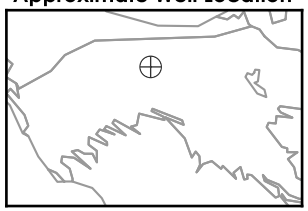


Well COL 1 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

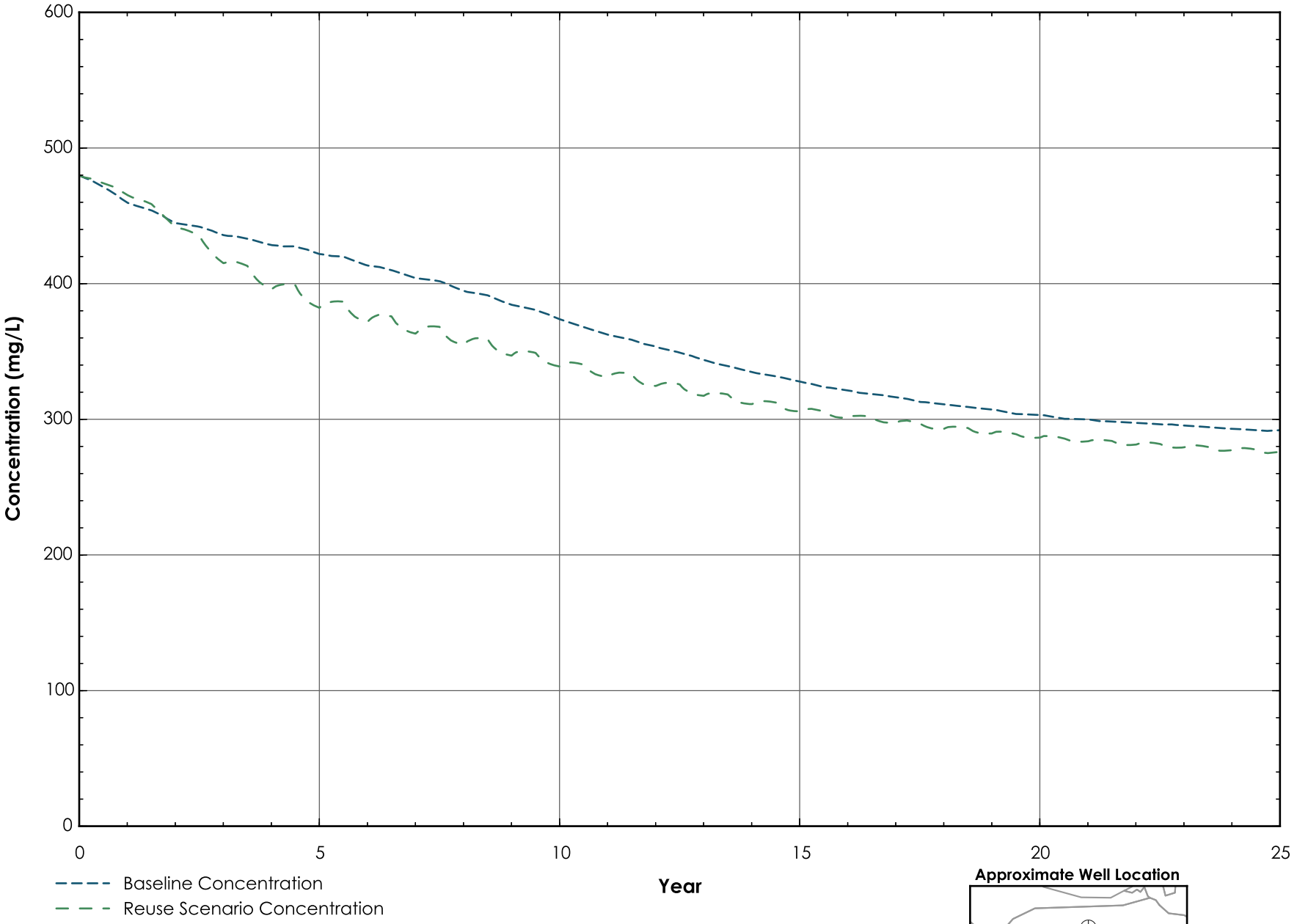


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

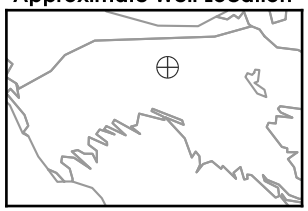


Well COL 2 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

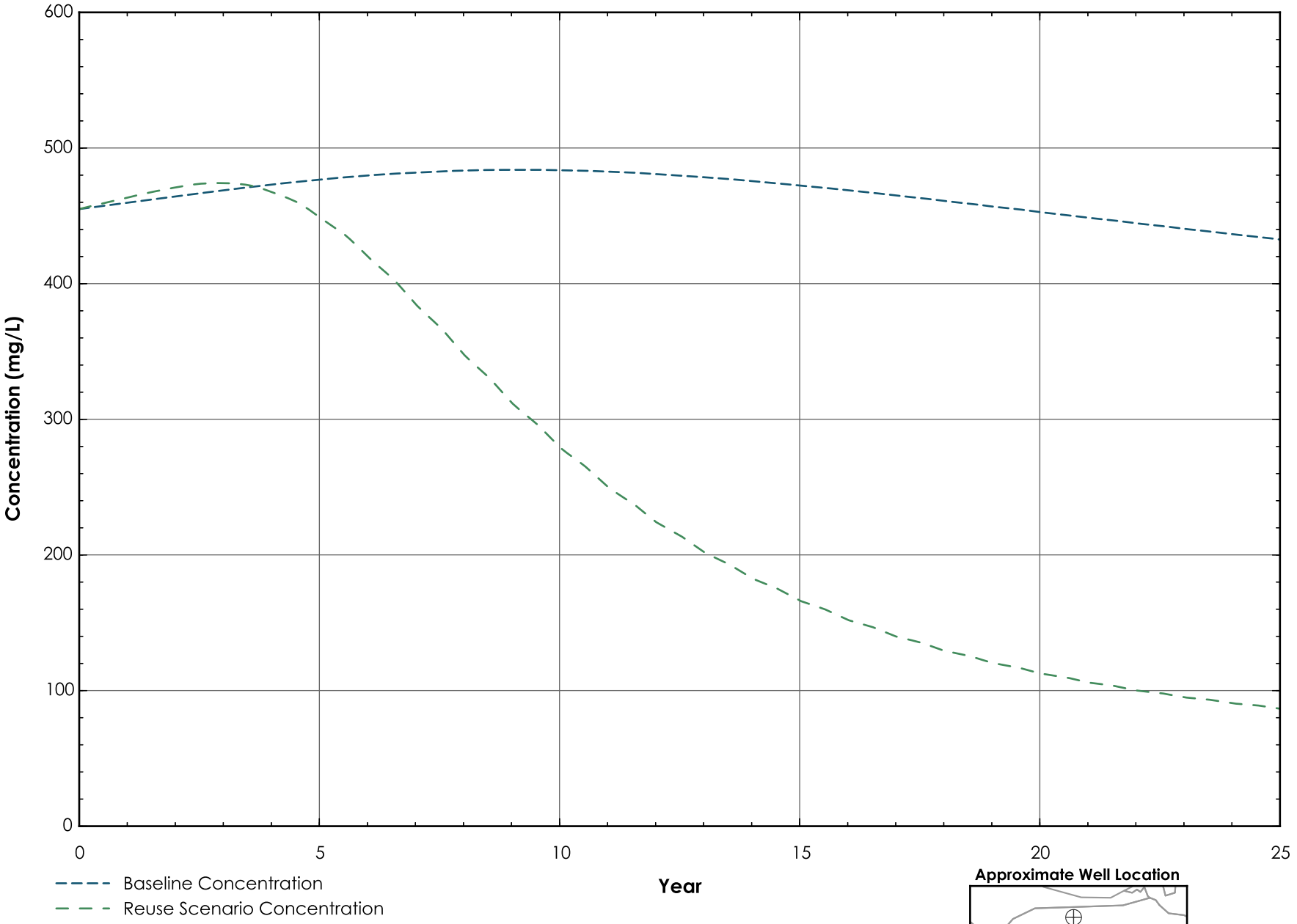


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

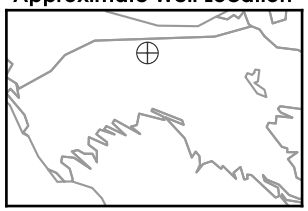


Well COL 5 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

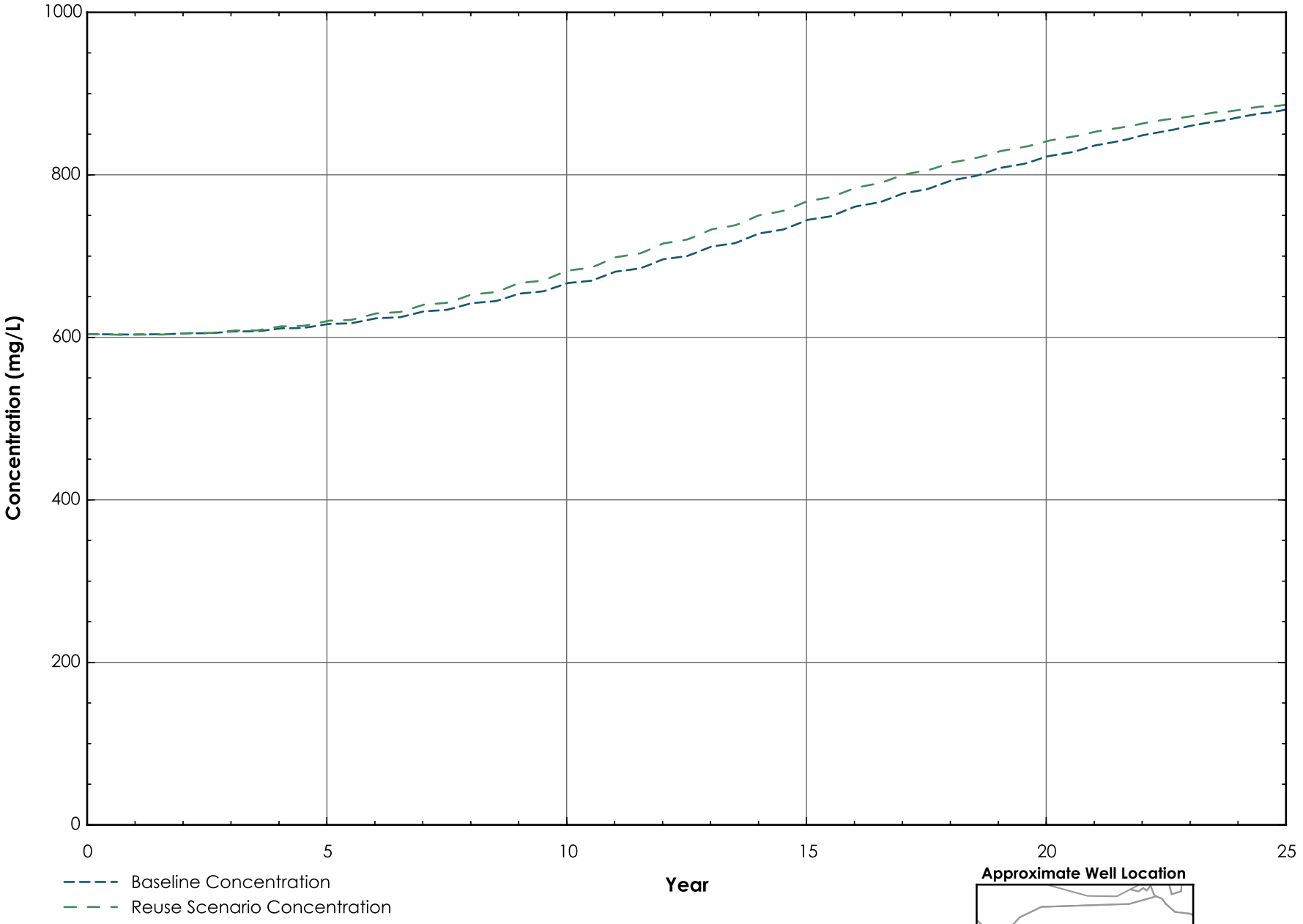


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

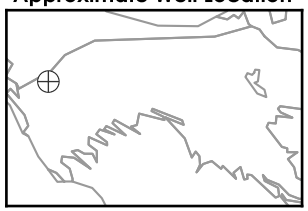


Well HOP 6 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

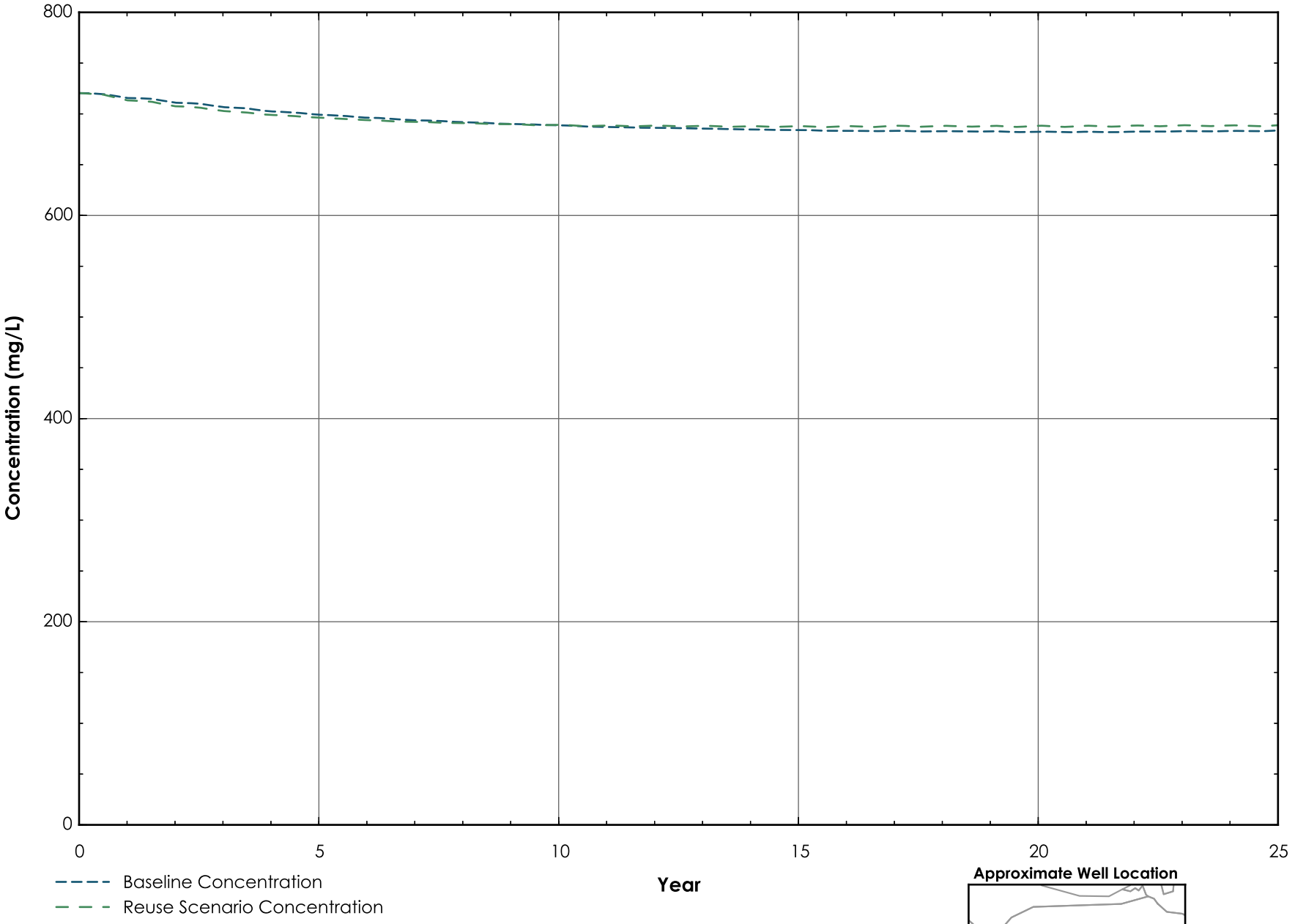


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

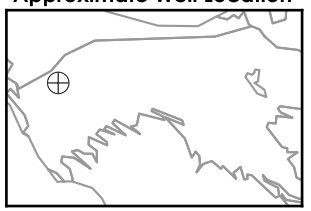


Well HOP 9 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

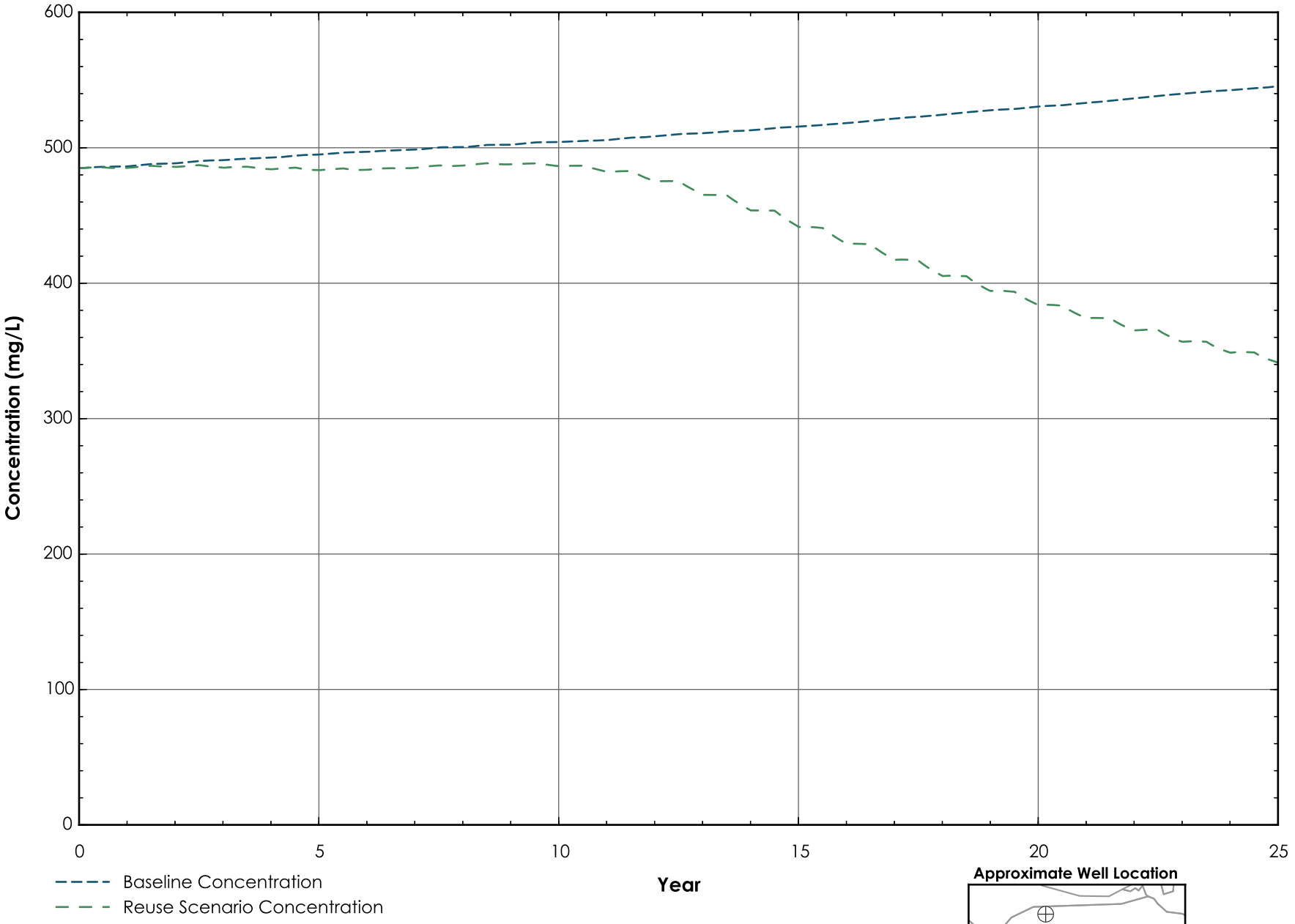


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

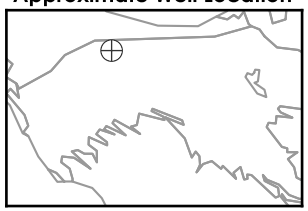


Well STONERIDGE 1 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

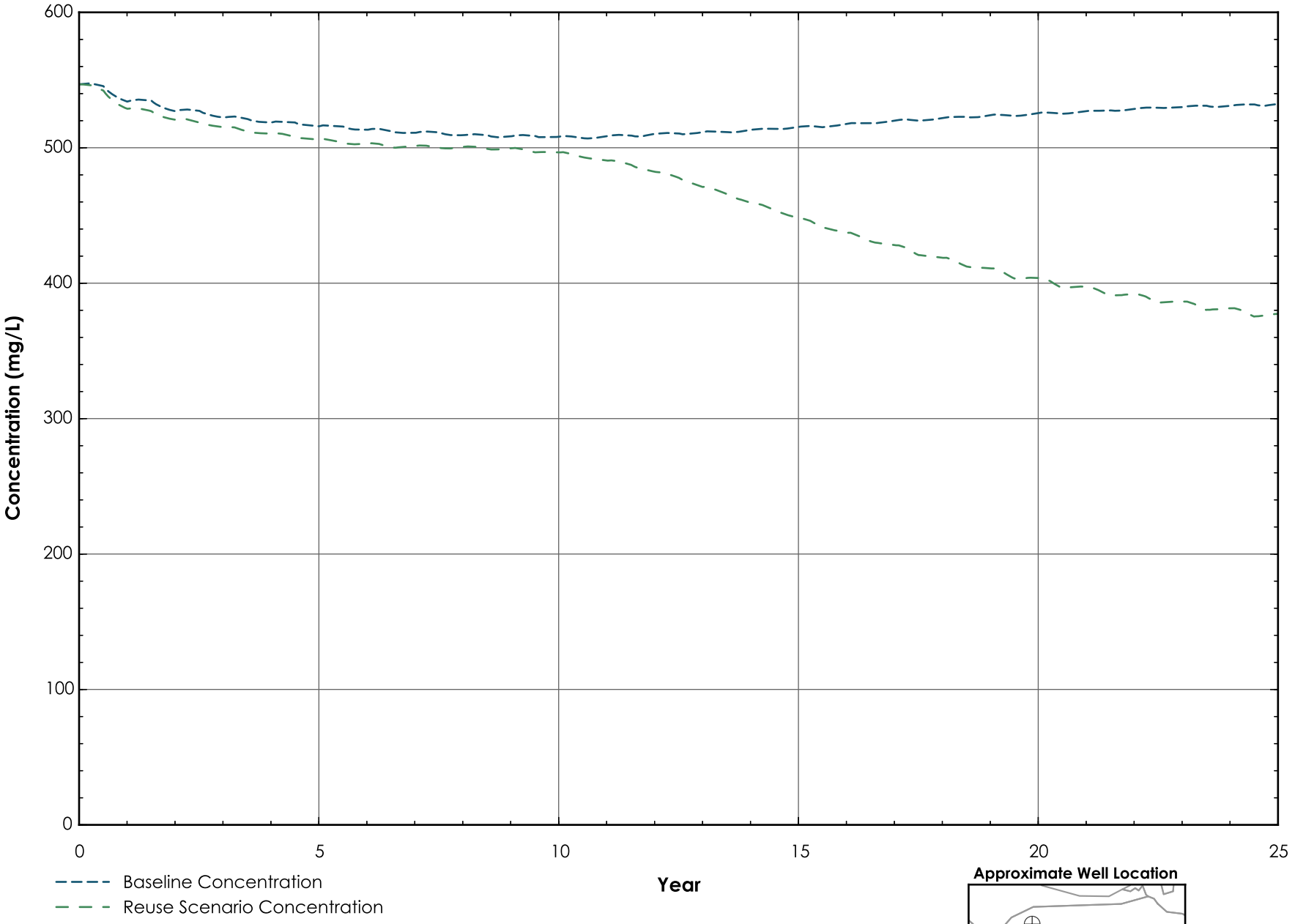


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

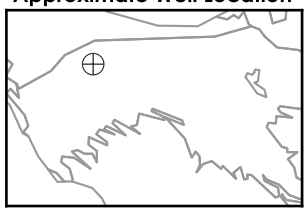


Well MOCHO 1 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

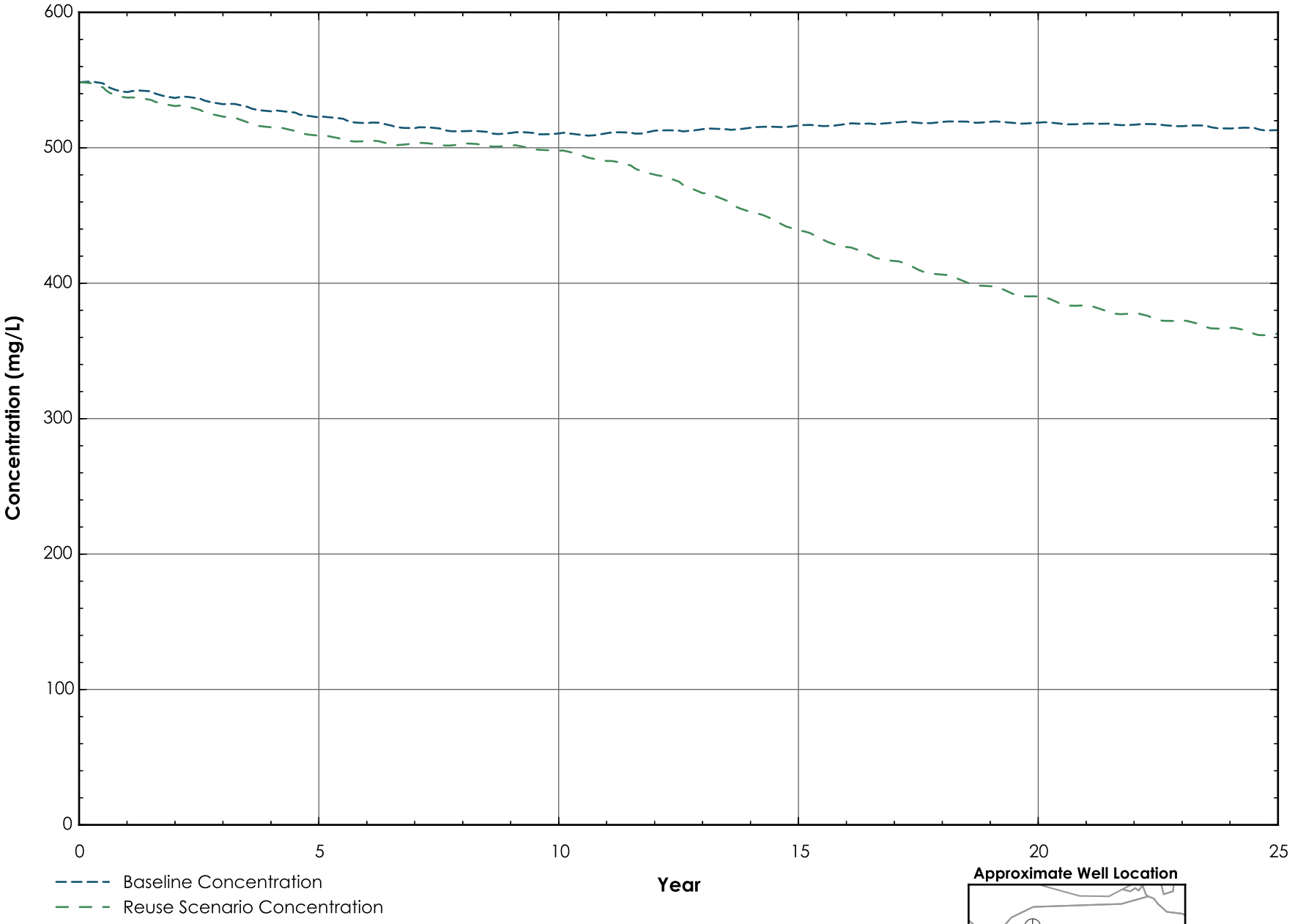


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

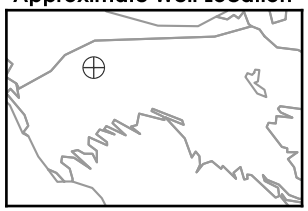


Well MOCHO 2 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

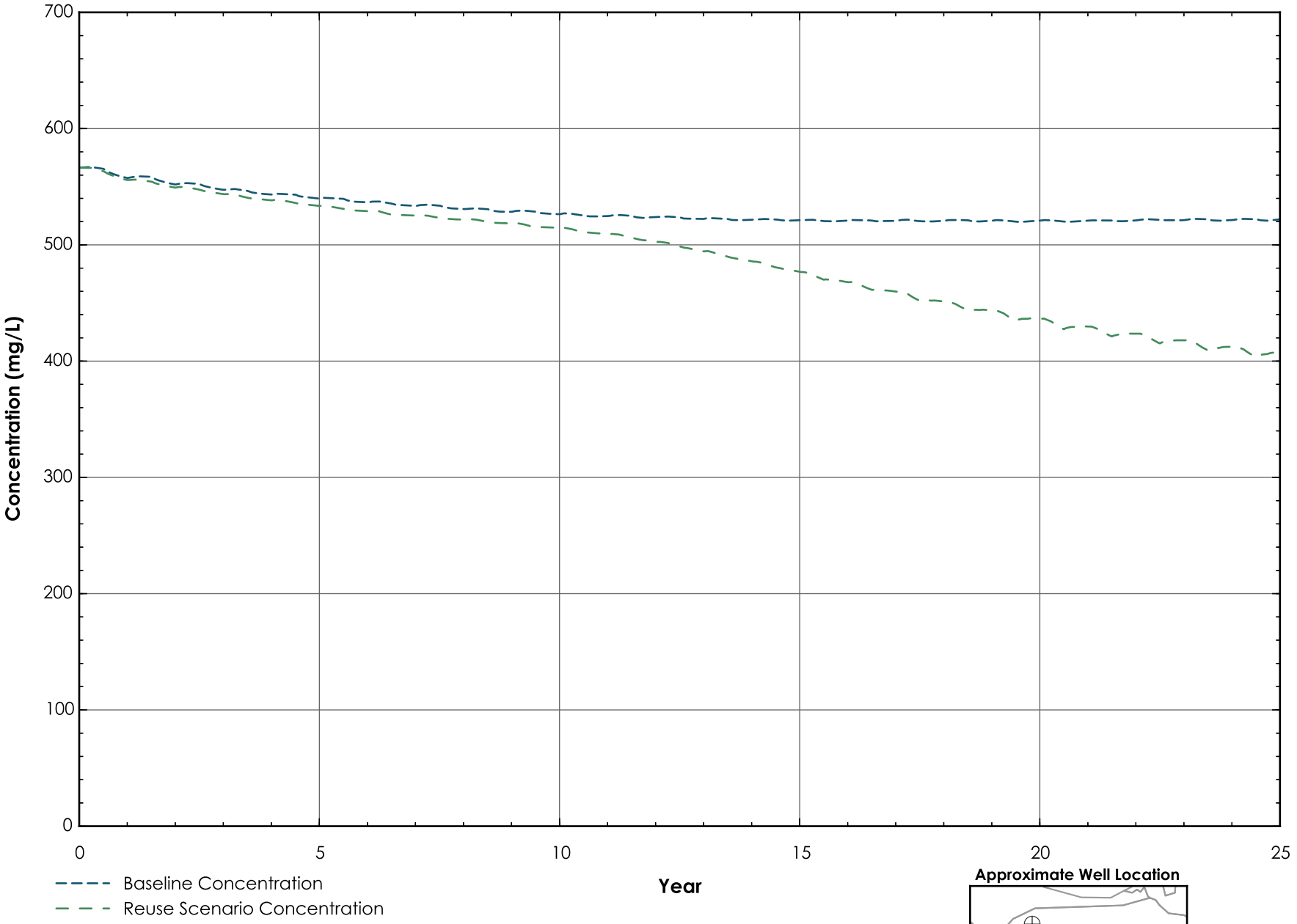


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

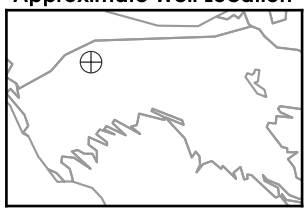


Well MOCHO 3 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

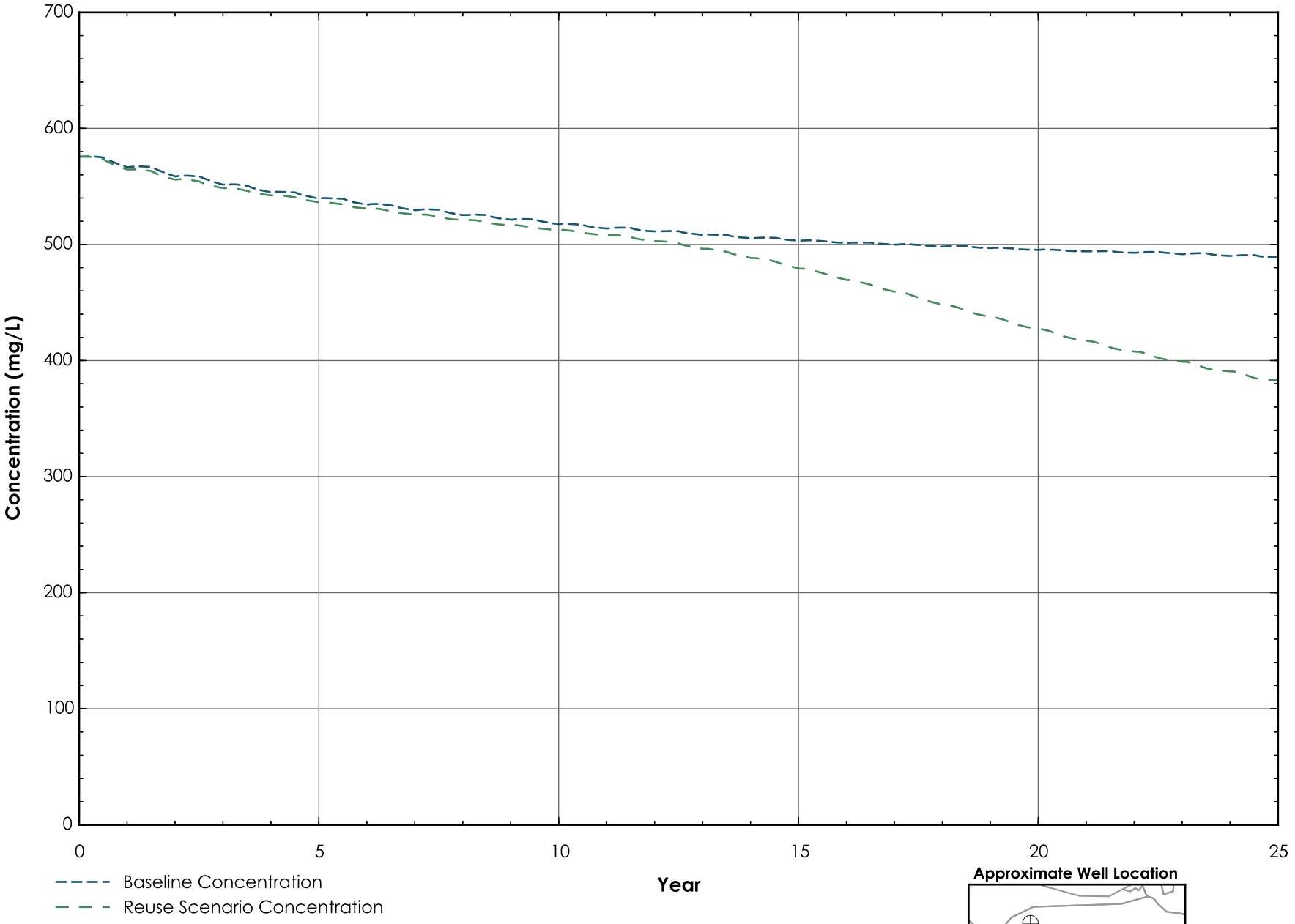


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

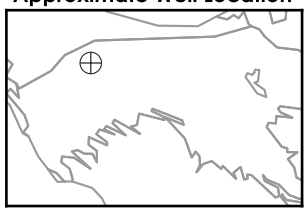


Well MOCHO 4 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

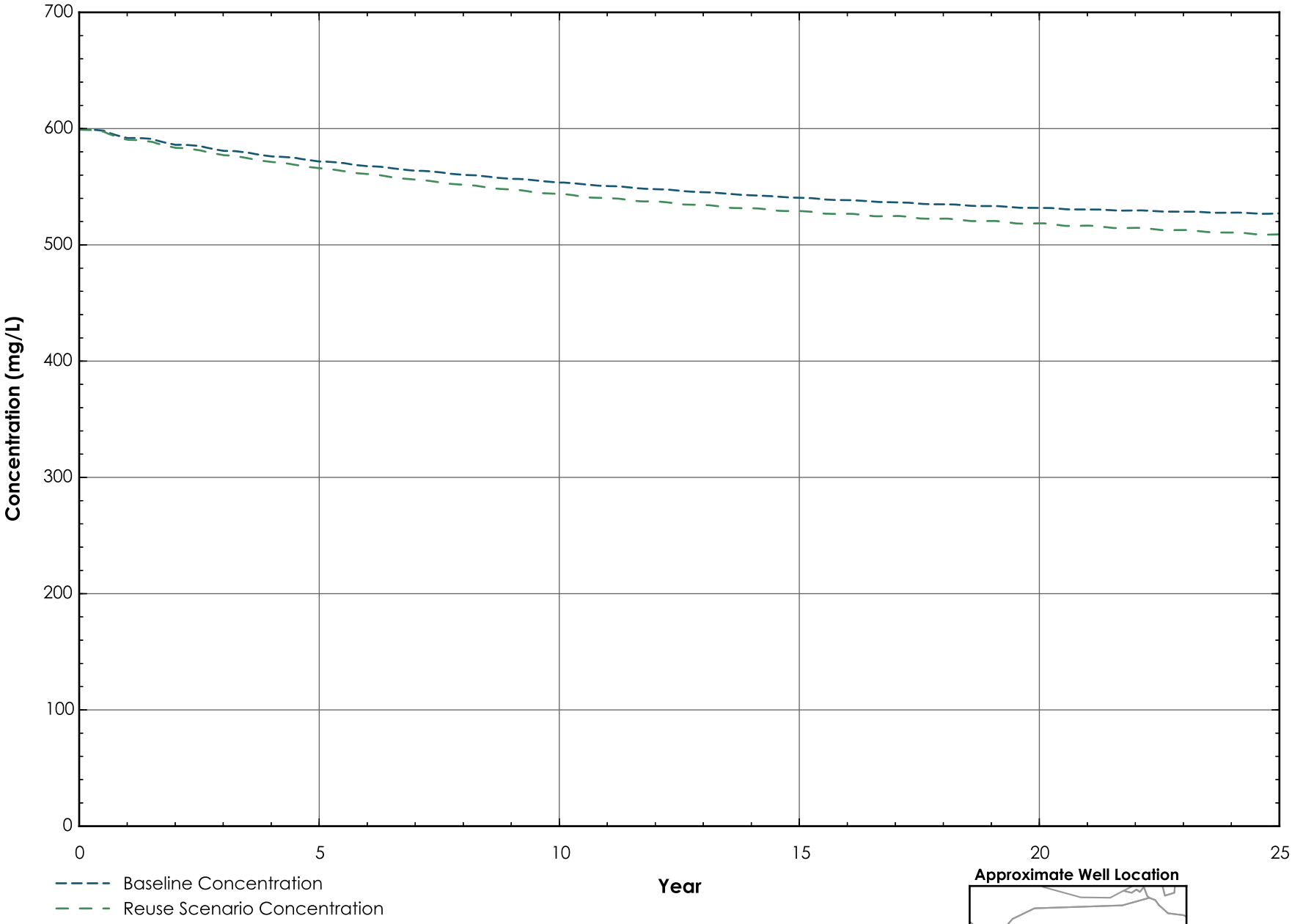


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

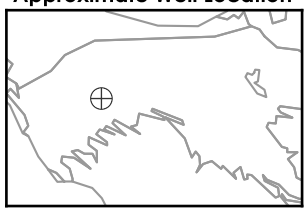


Well PLEAS 5 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

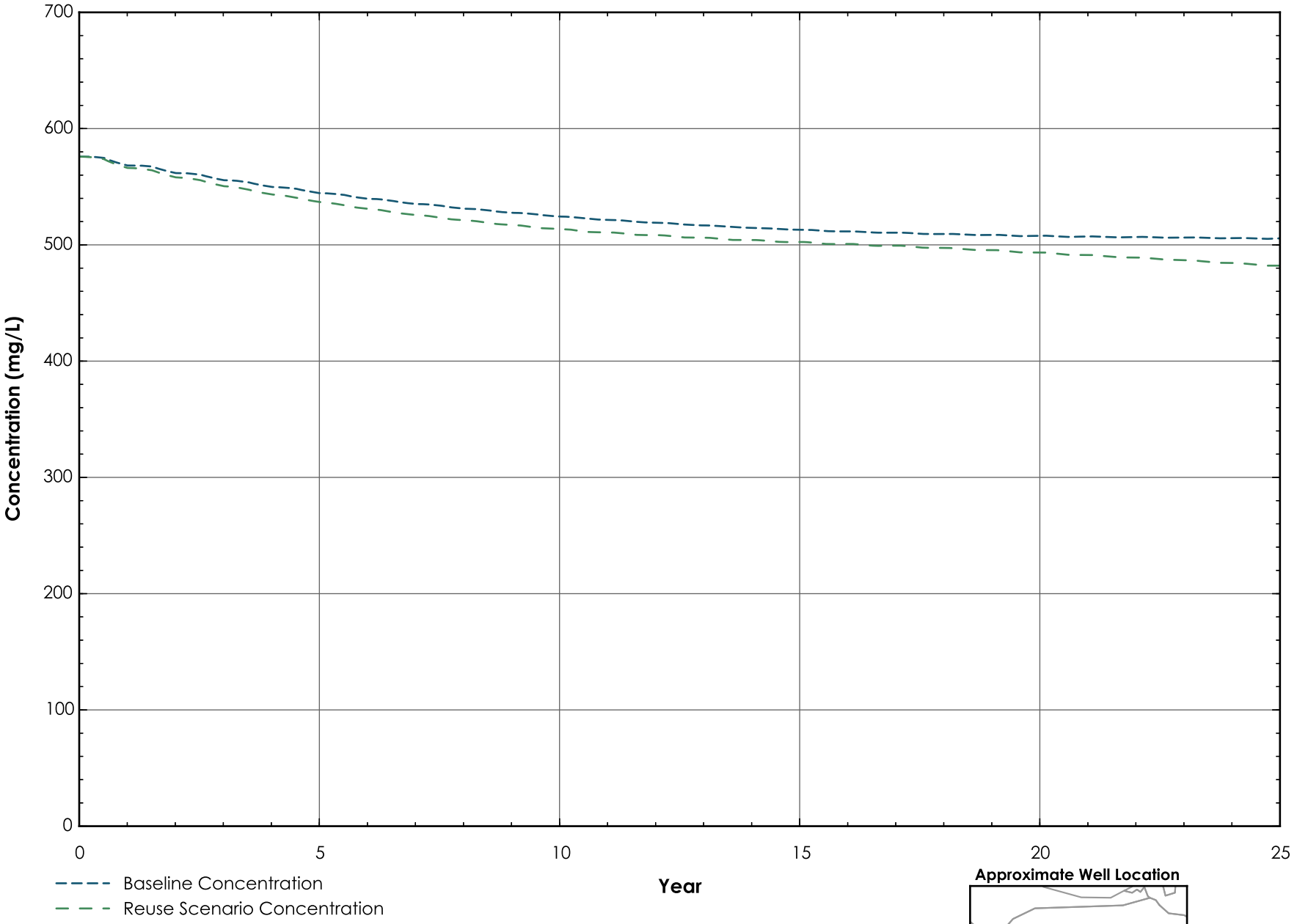


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

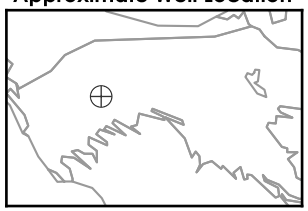


Well PLEAS 6 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

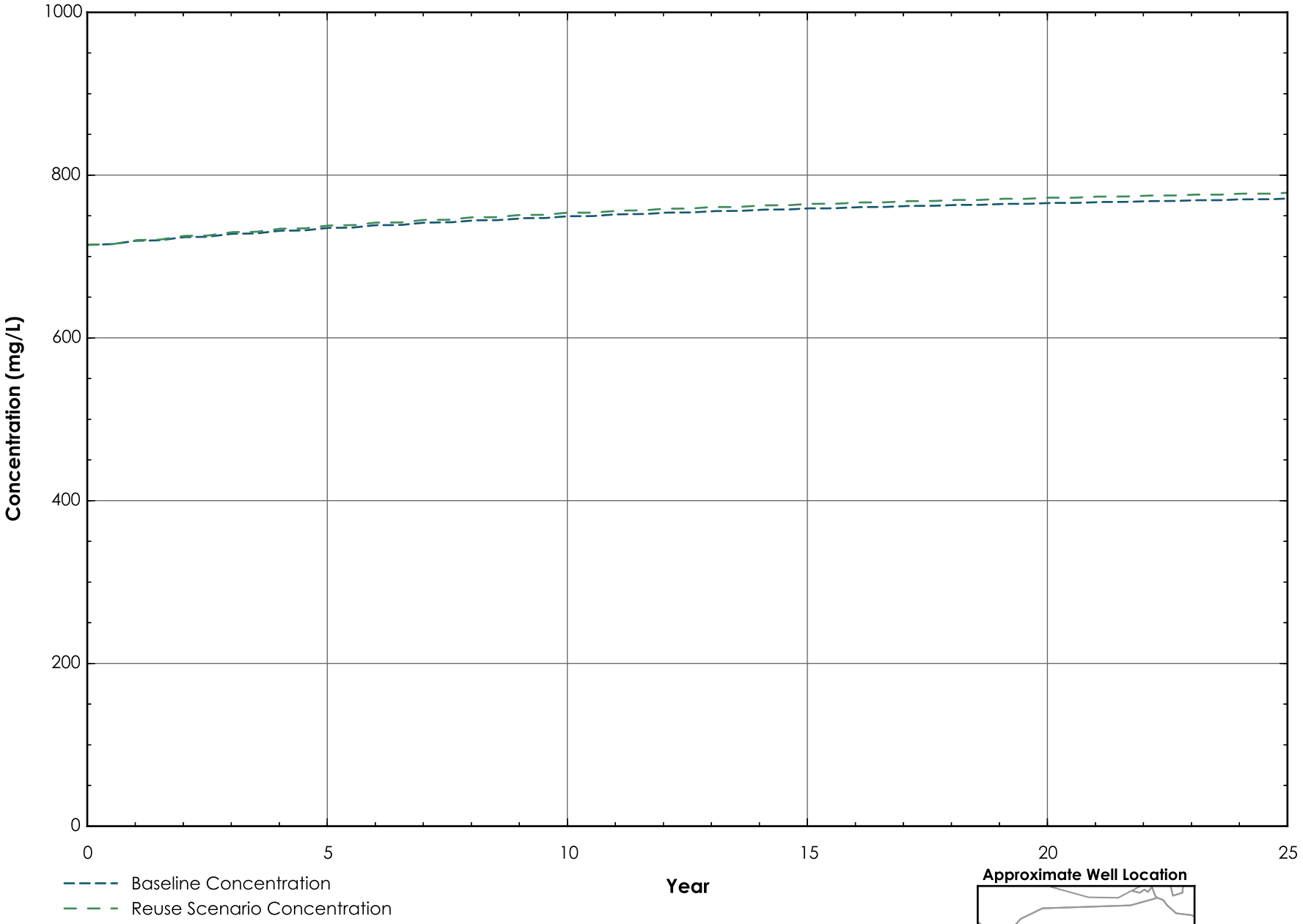


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

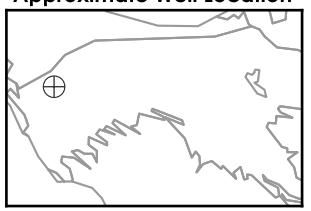


Well PLEAS 7 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

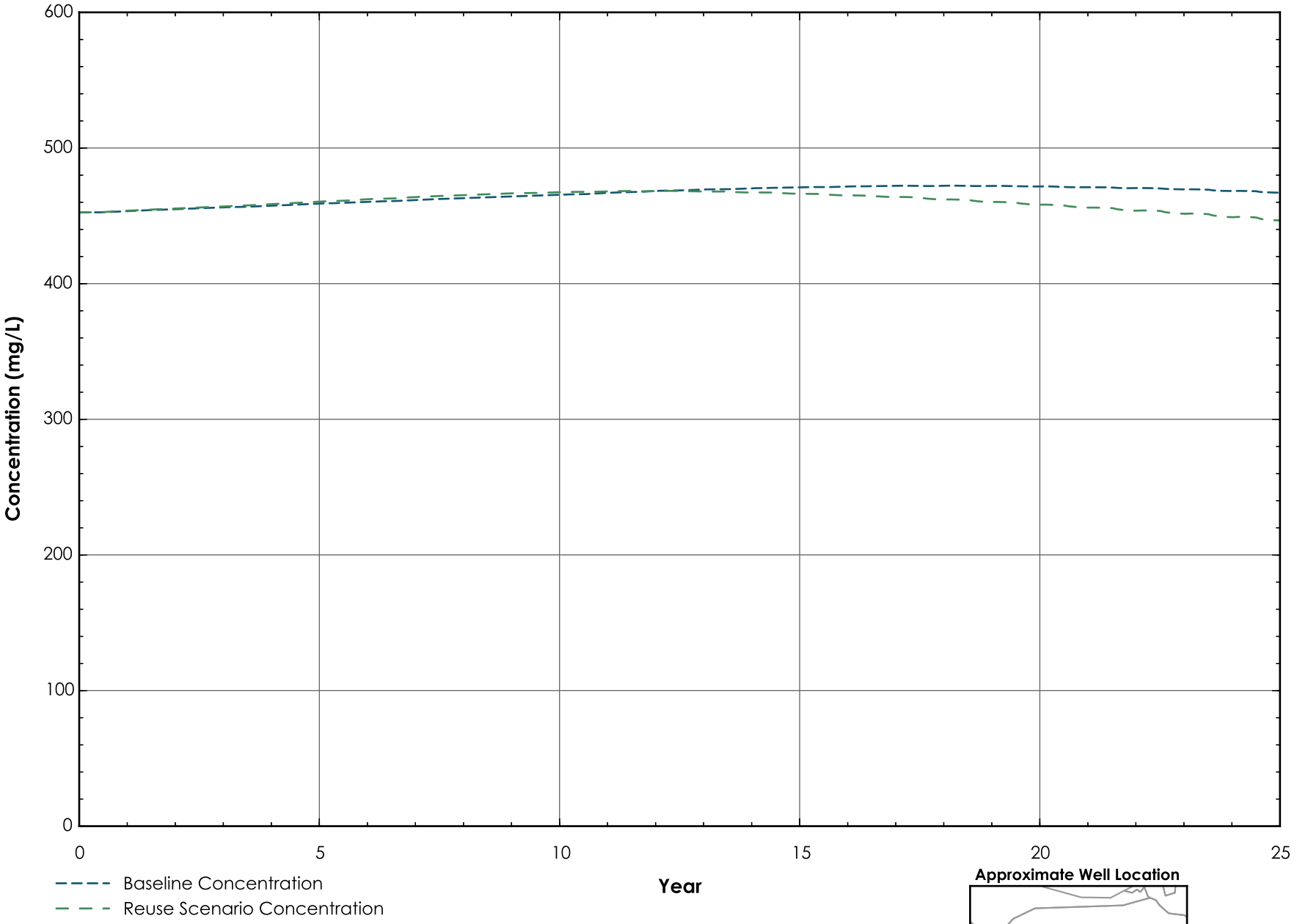


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

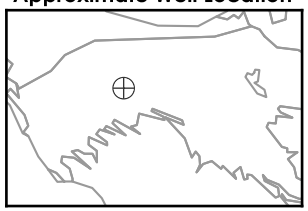


Well PLEAS 8 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

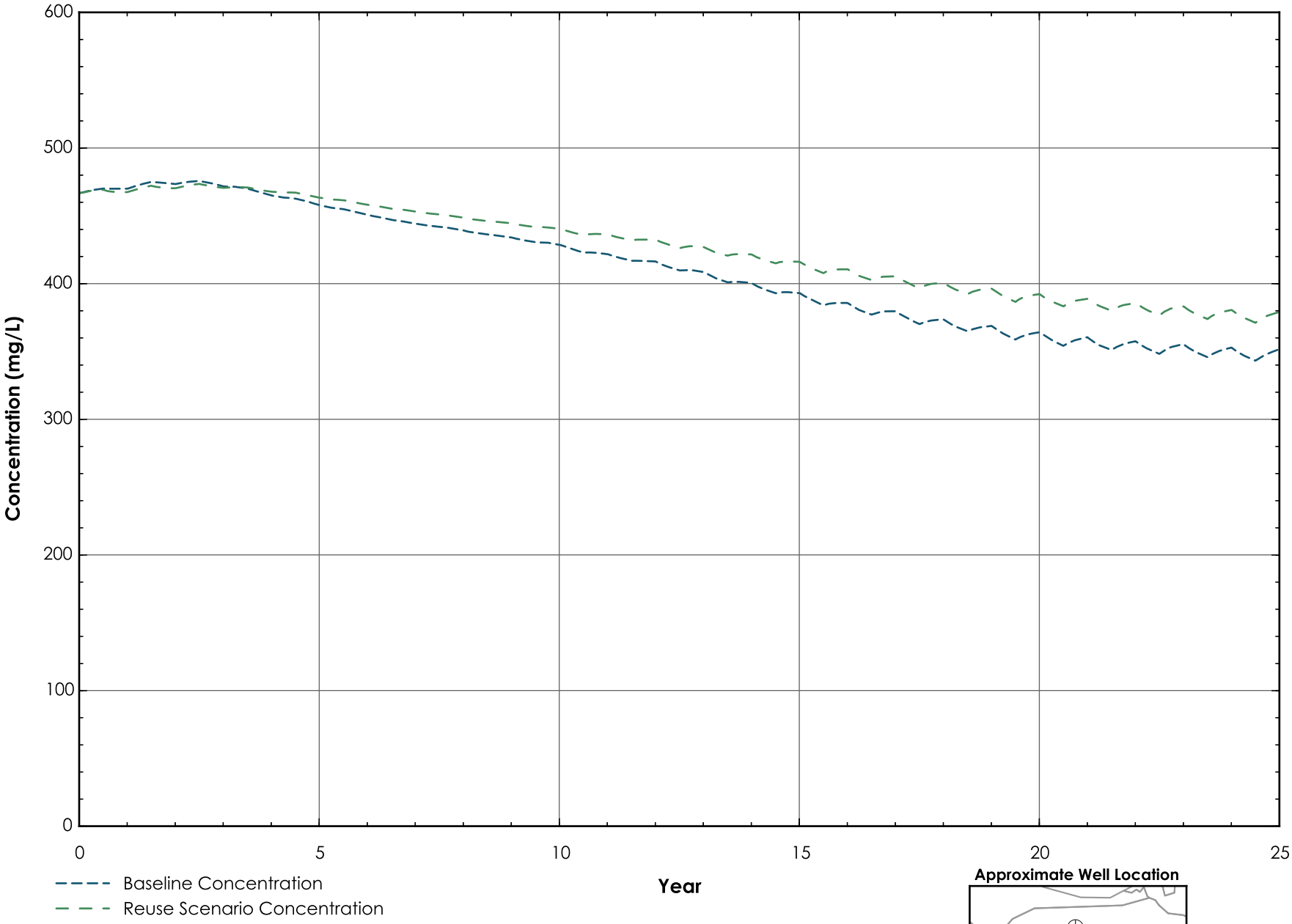


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

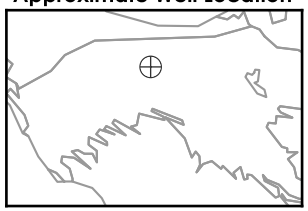


Well COL 1 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

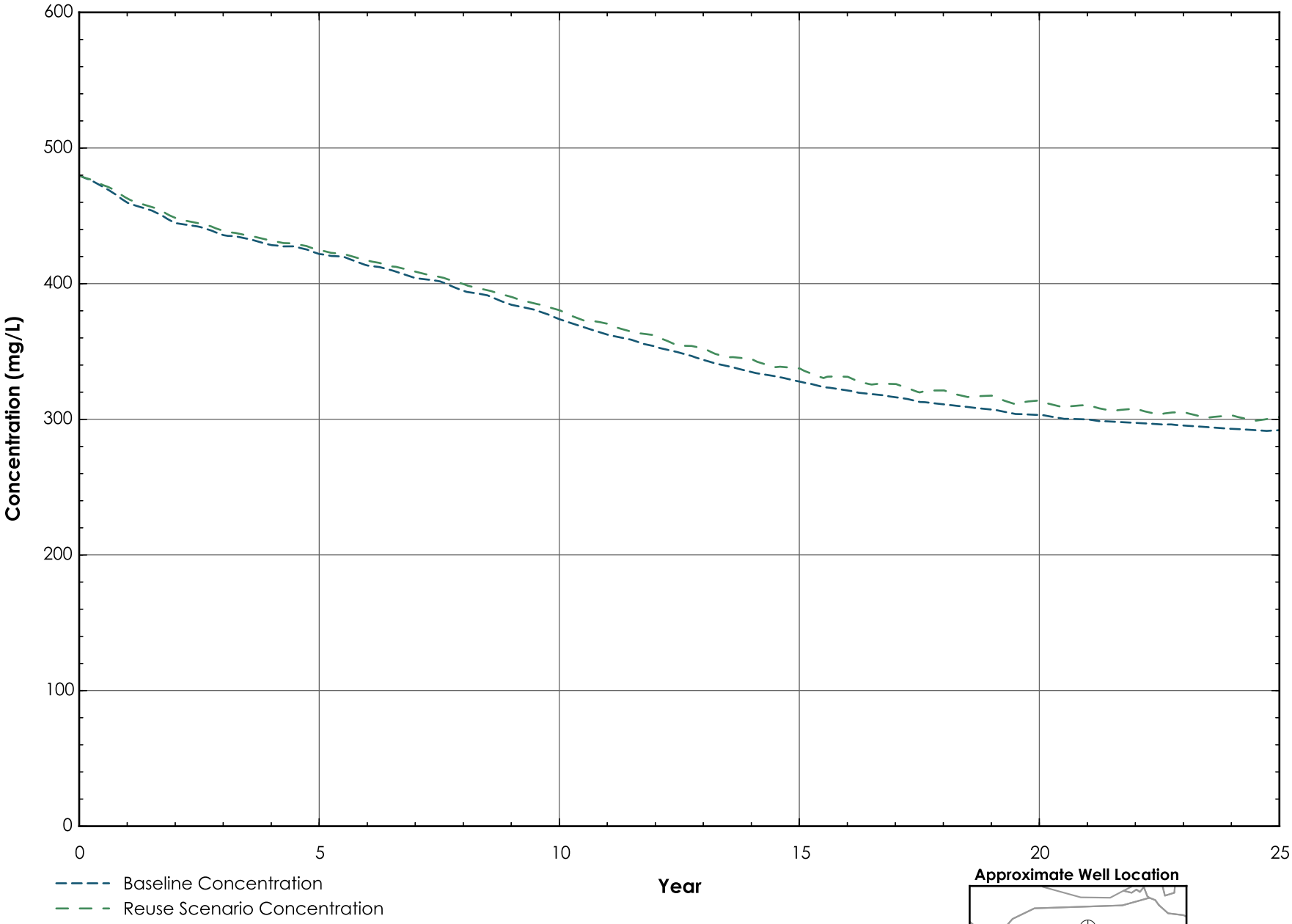


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

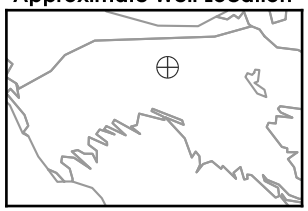


Well COL 2 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

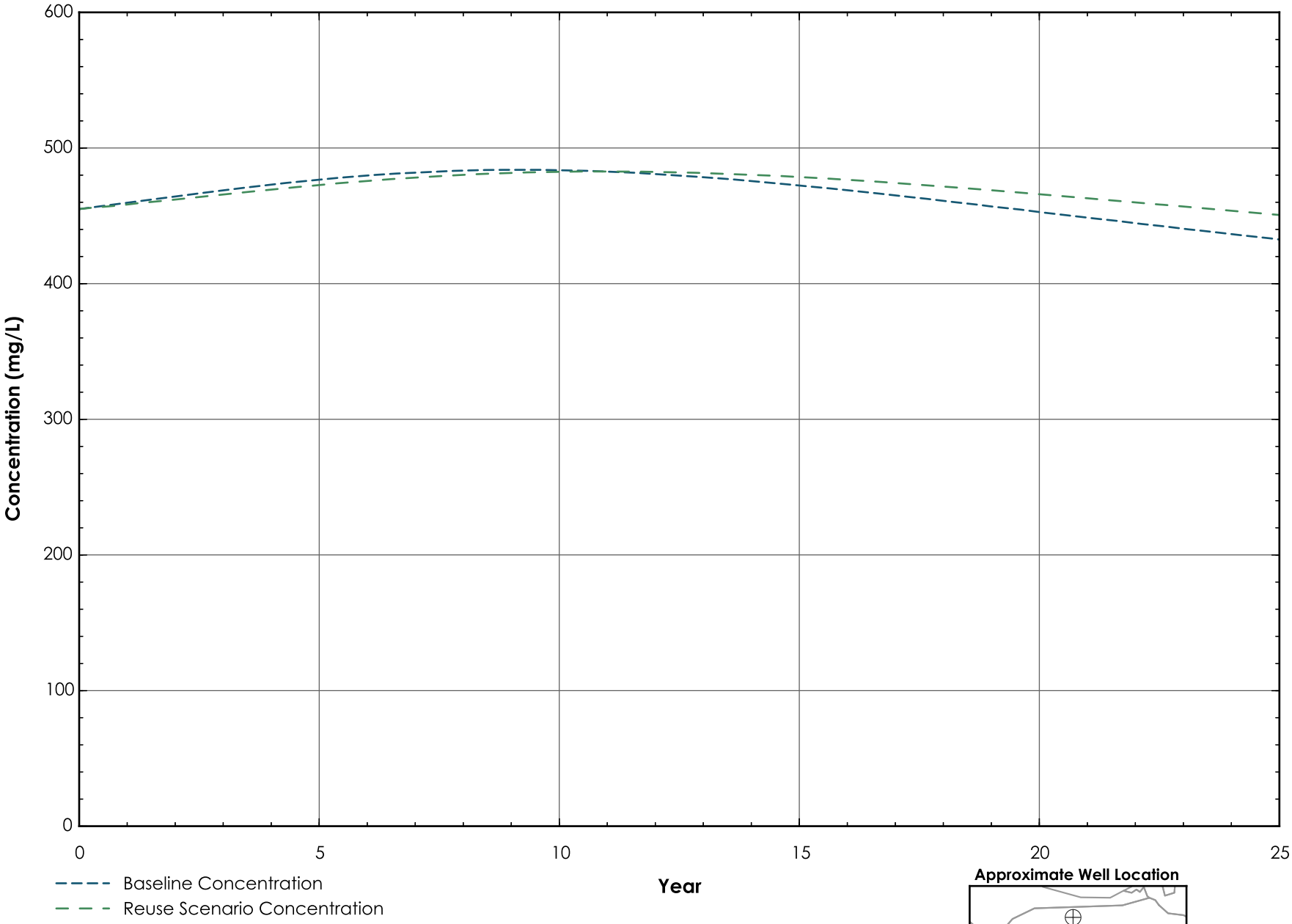


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

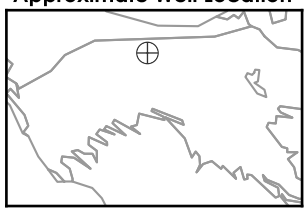


Well COL 5 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

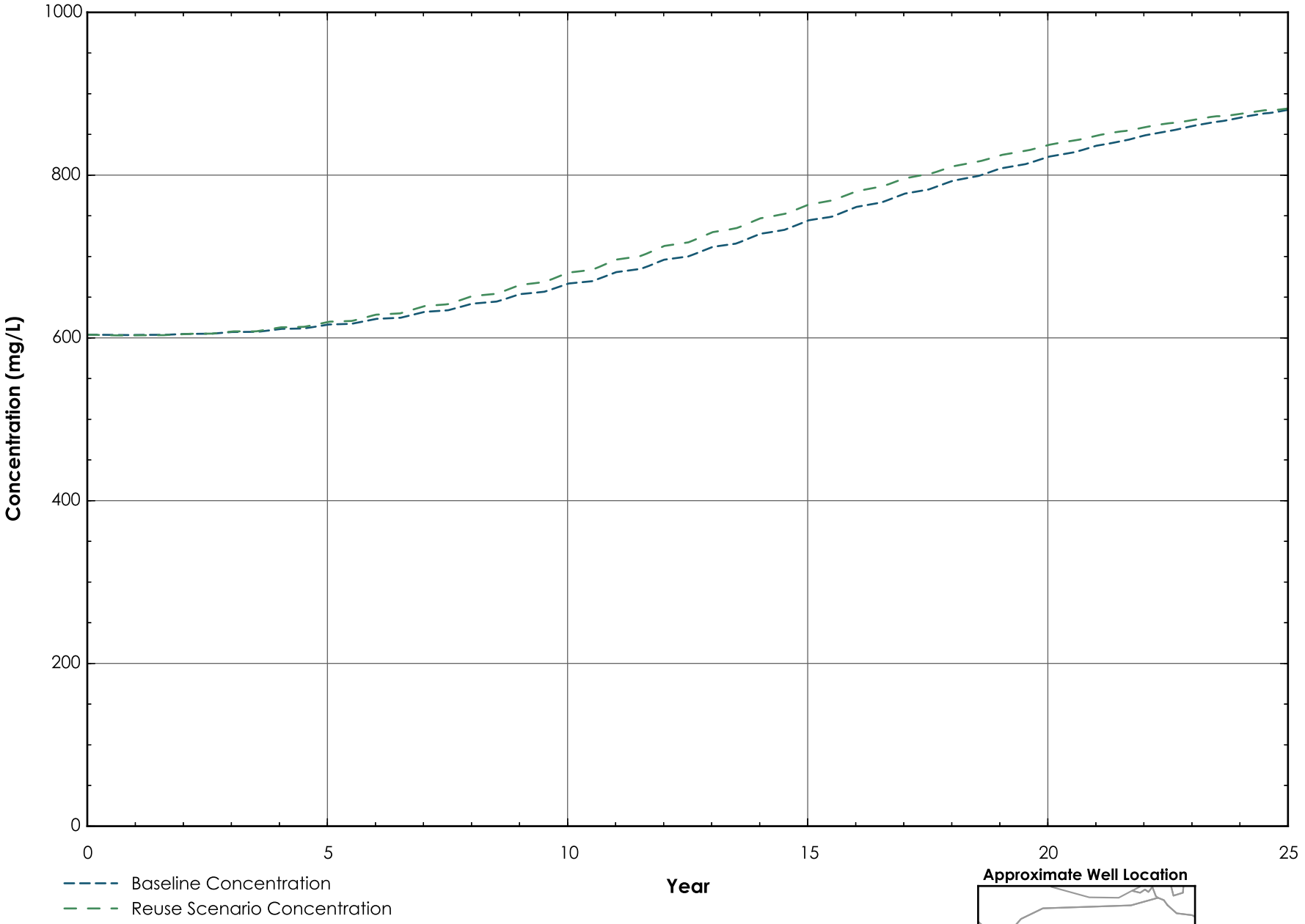


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

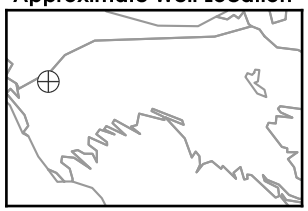


Well HOP 6 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

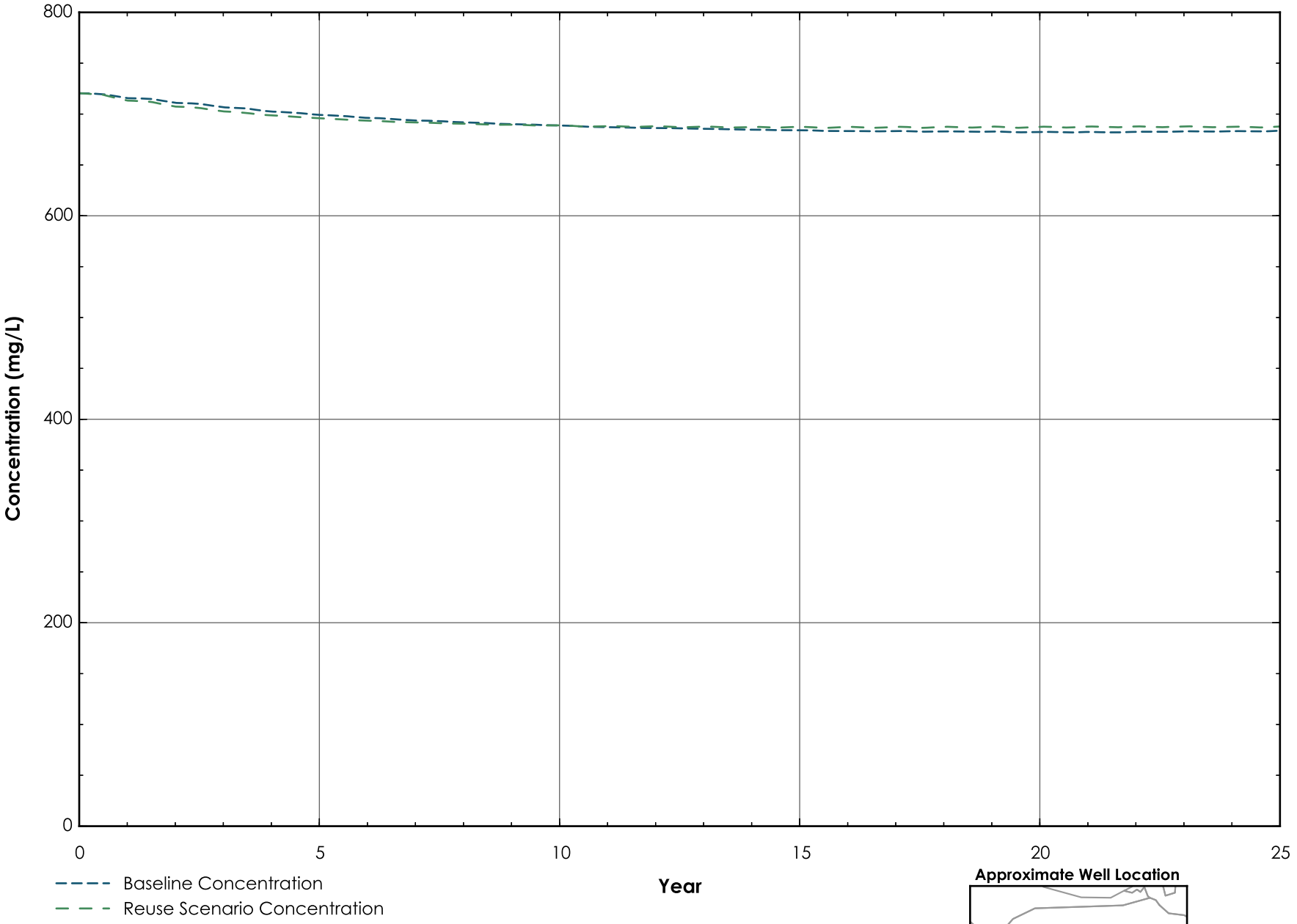


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

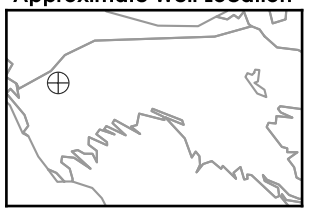


Well HOP 9 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

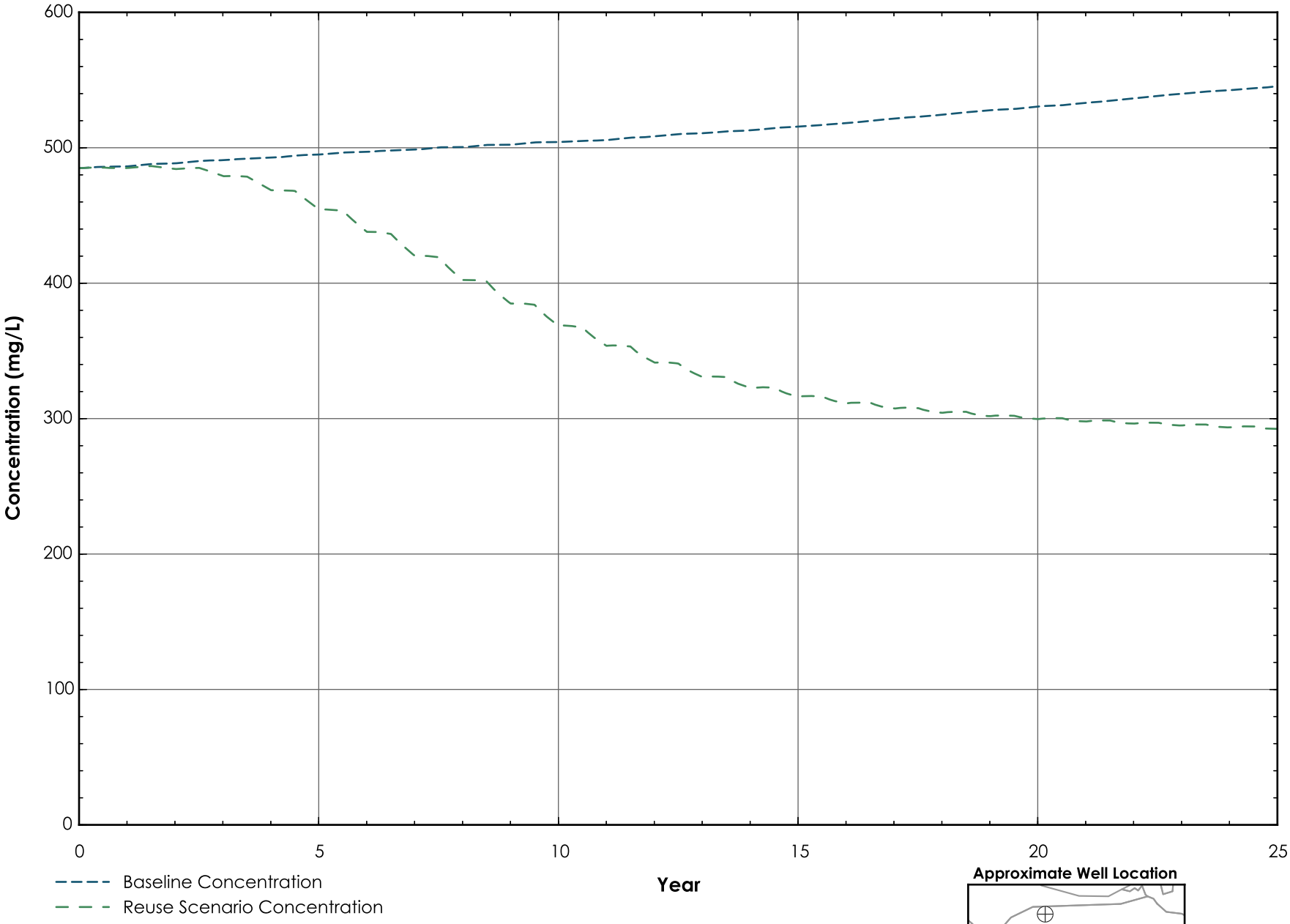


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

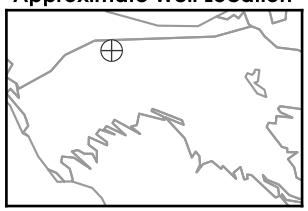


Well STONERIDGE 1 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

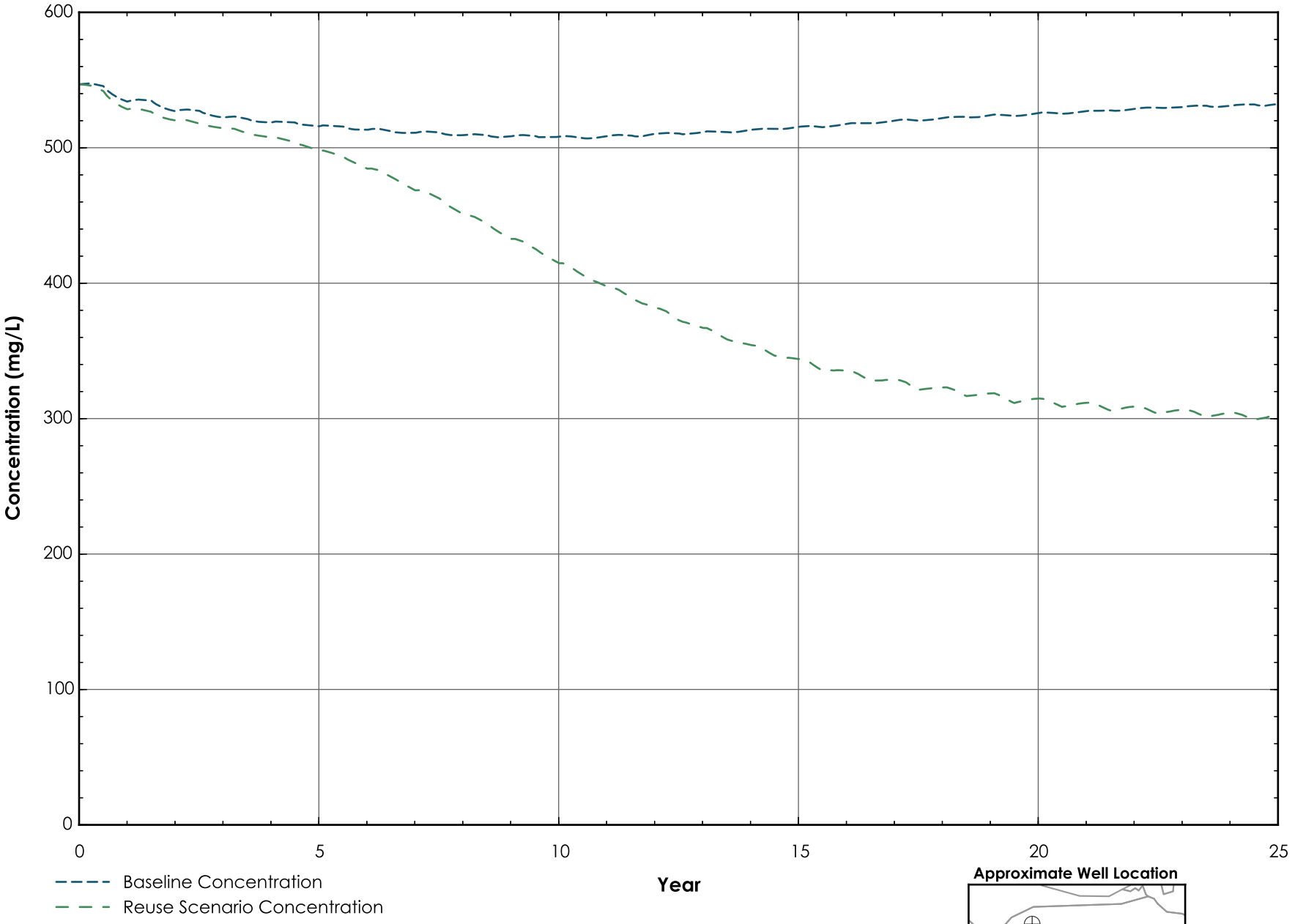


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

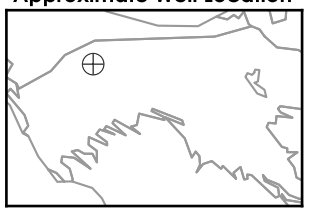


Well MOCHO 1 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

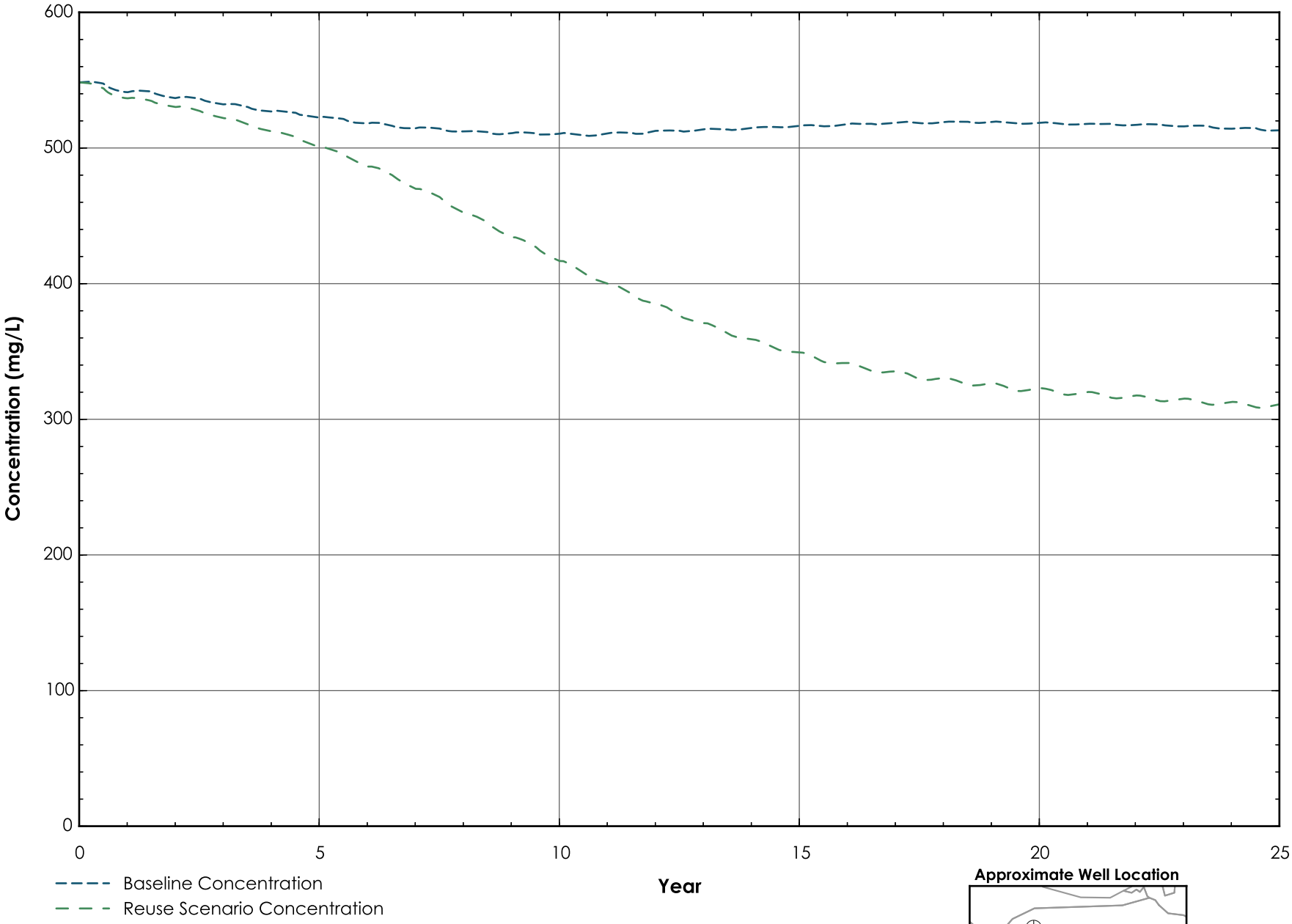


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

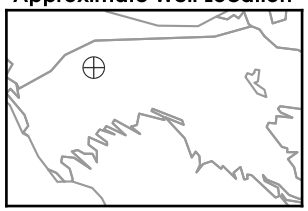


Well MOCHO 2 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

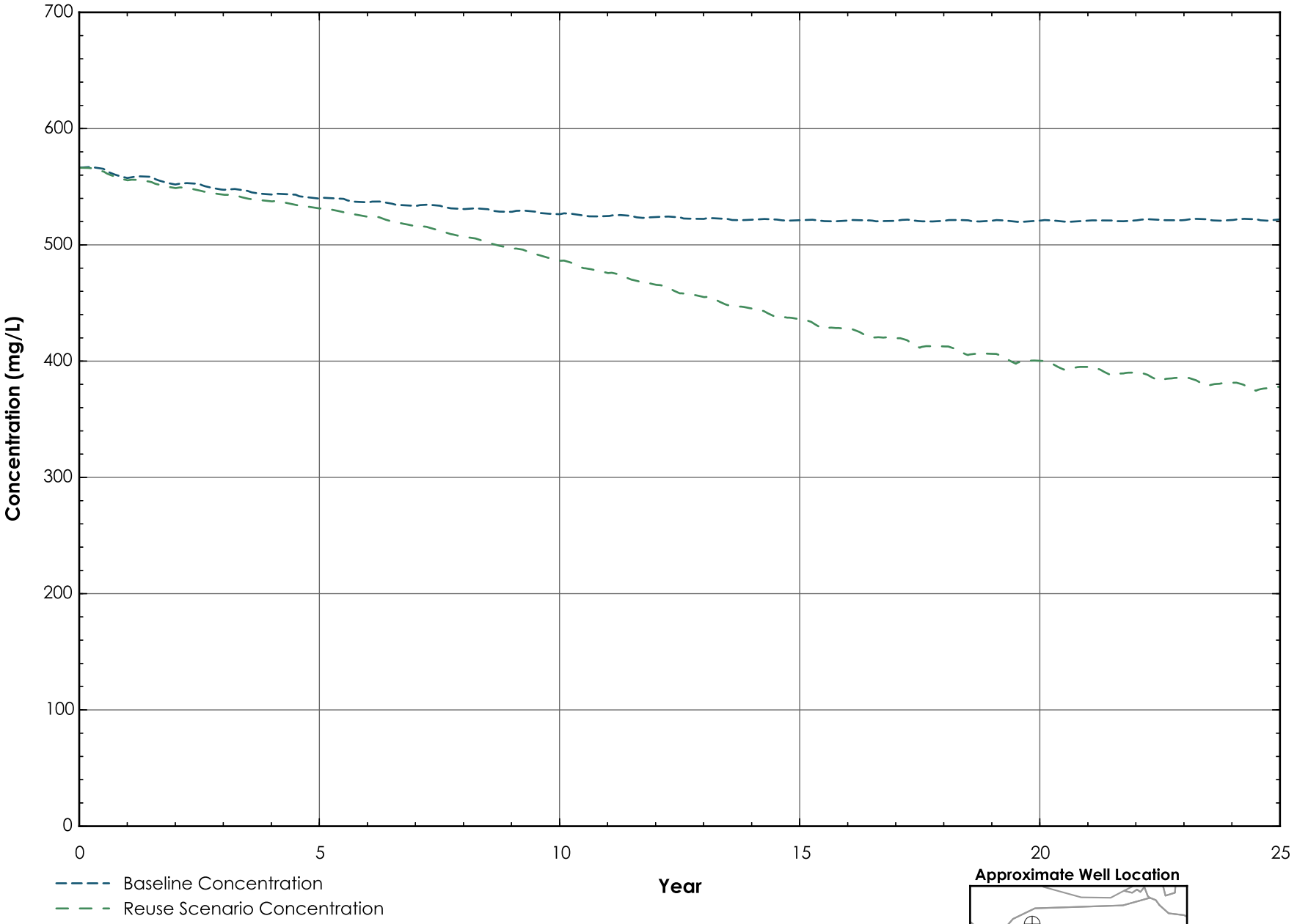


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

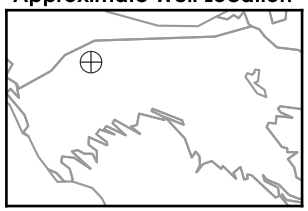


Well MOCHO 3 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

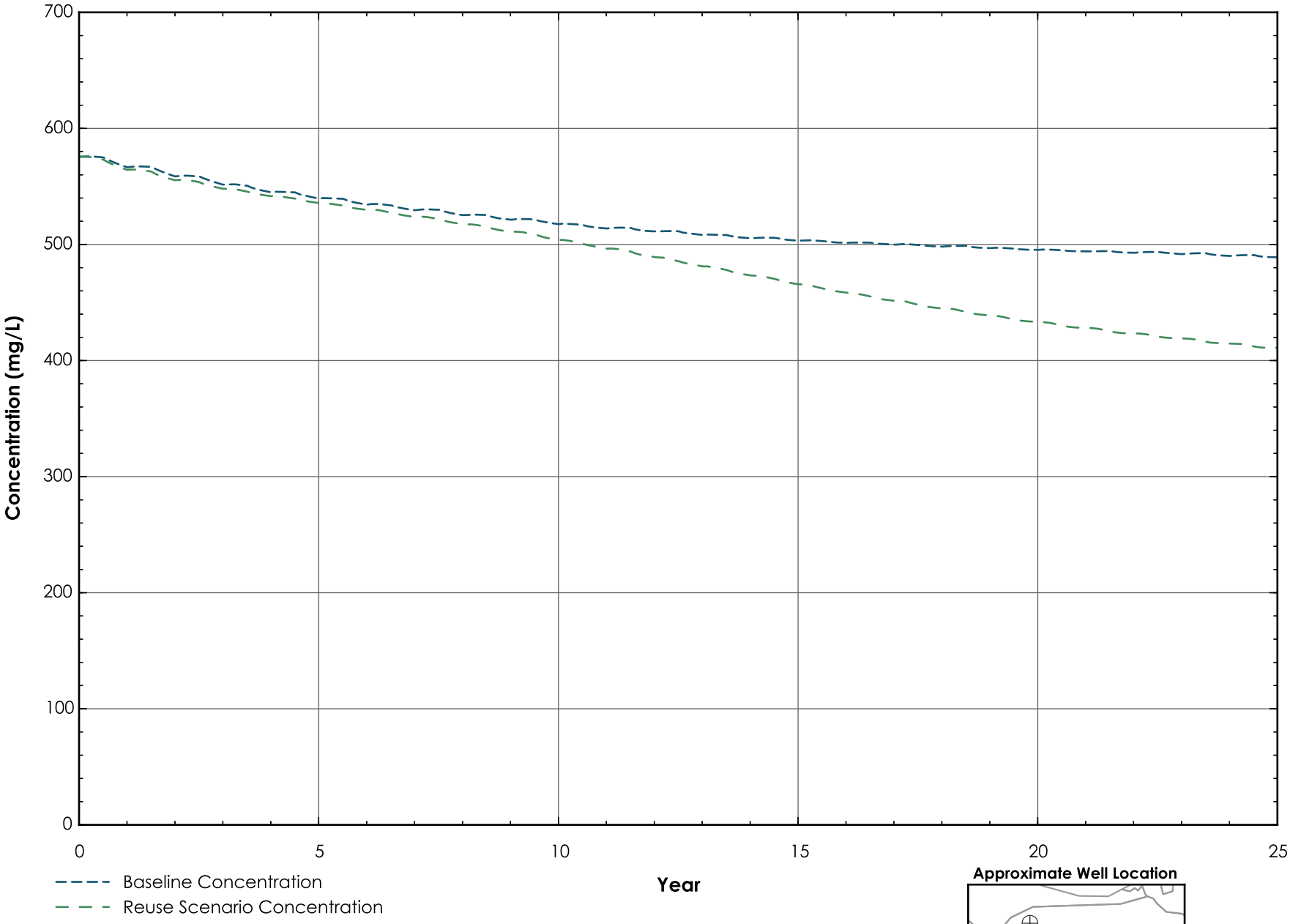


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

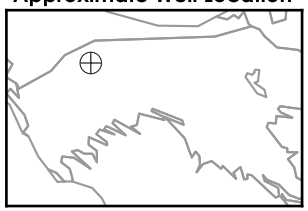


Well MOCHO 4 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

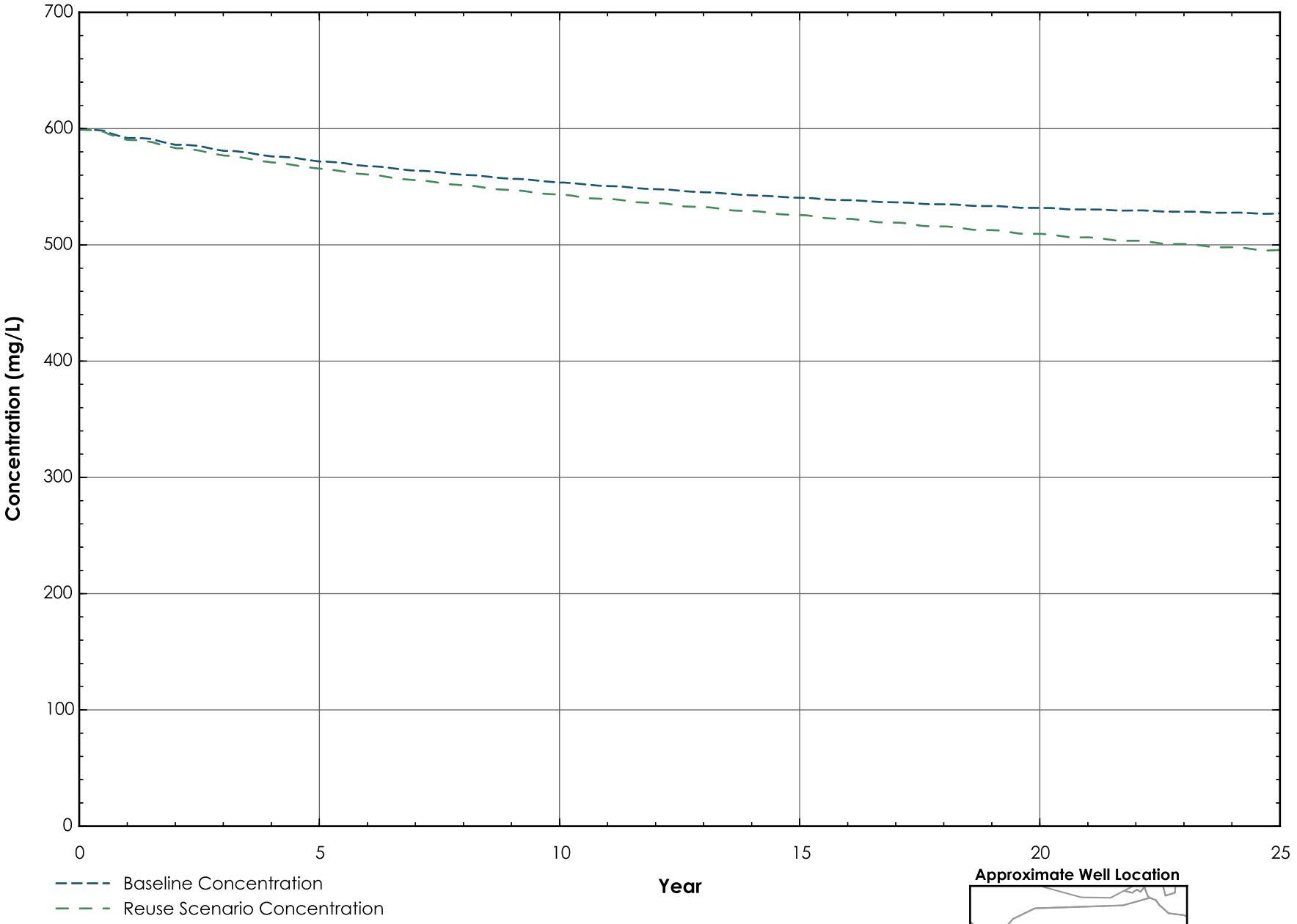


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

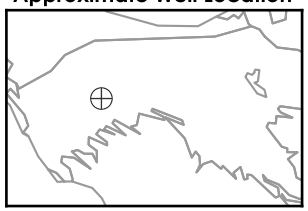


Well PLEAS 5 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

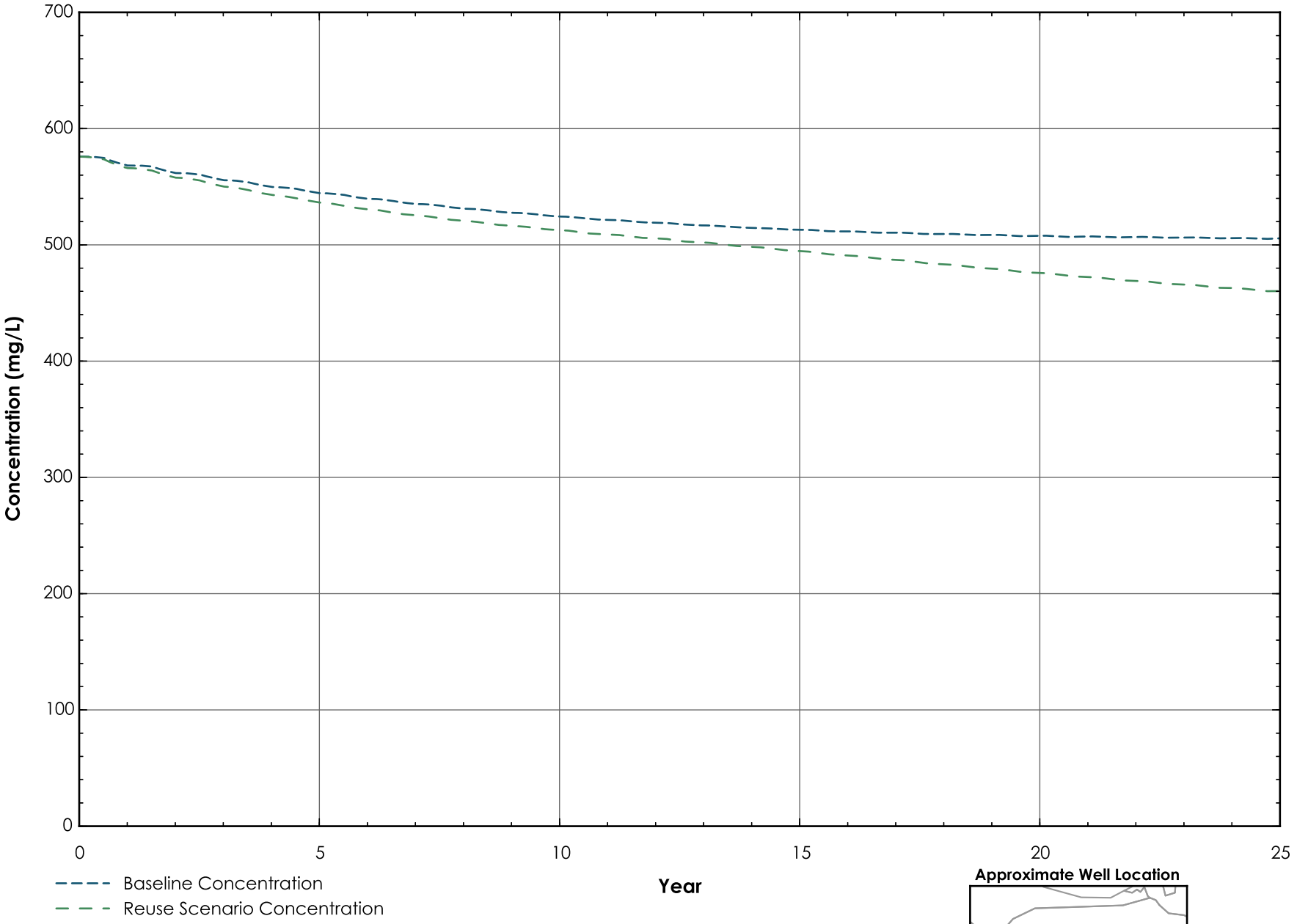


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

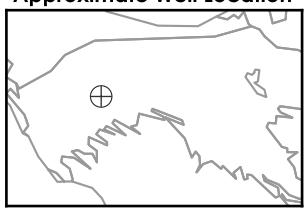


Well PLEAS 6 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

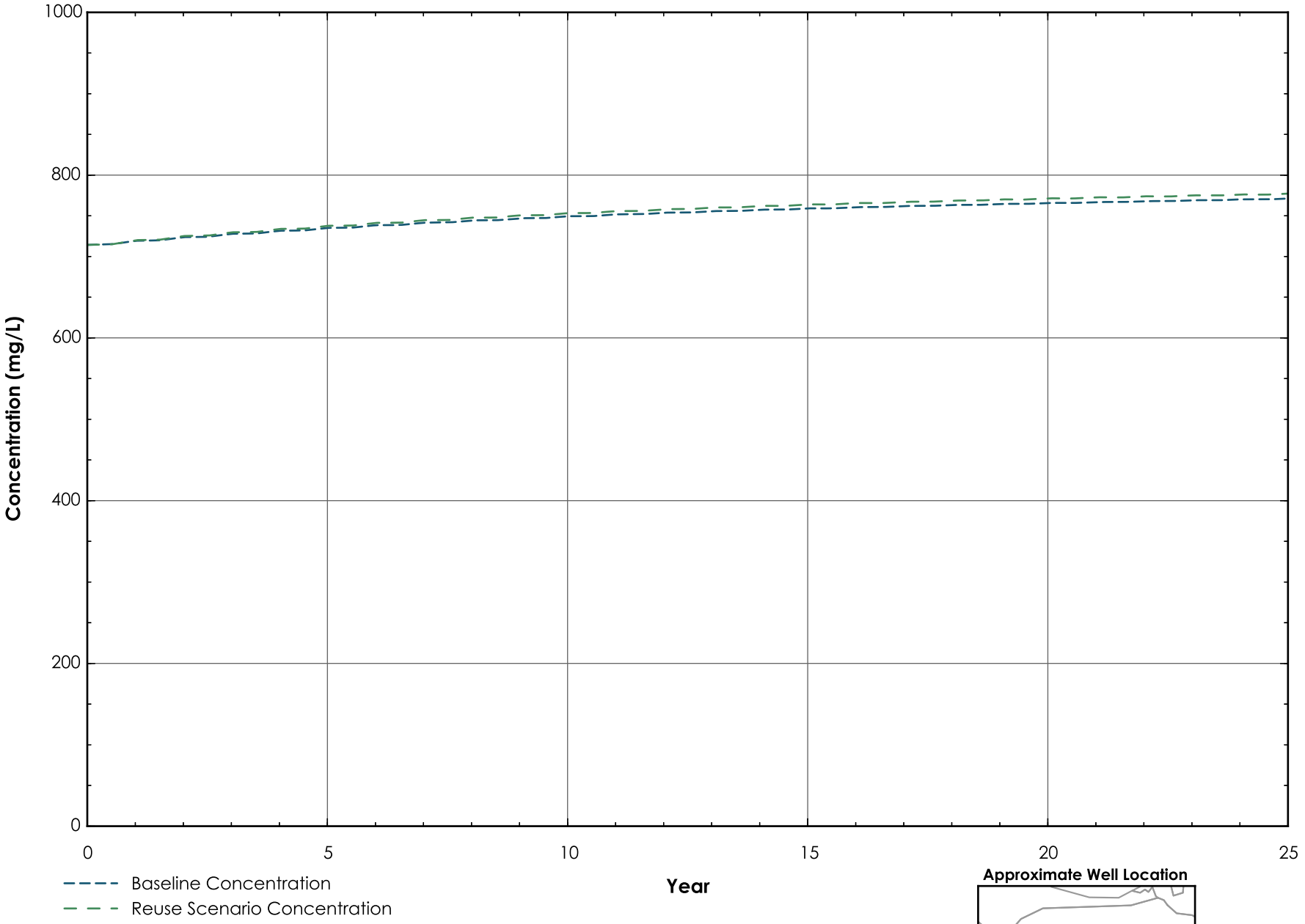


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

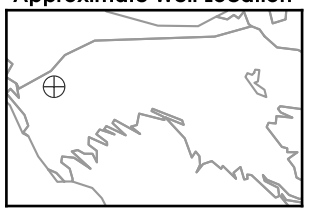


Well PLEAS 7 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

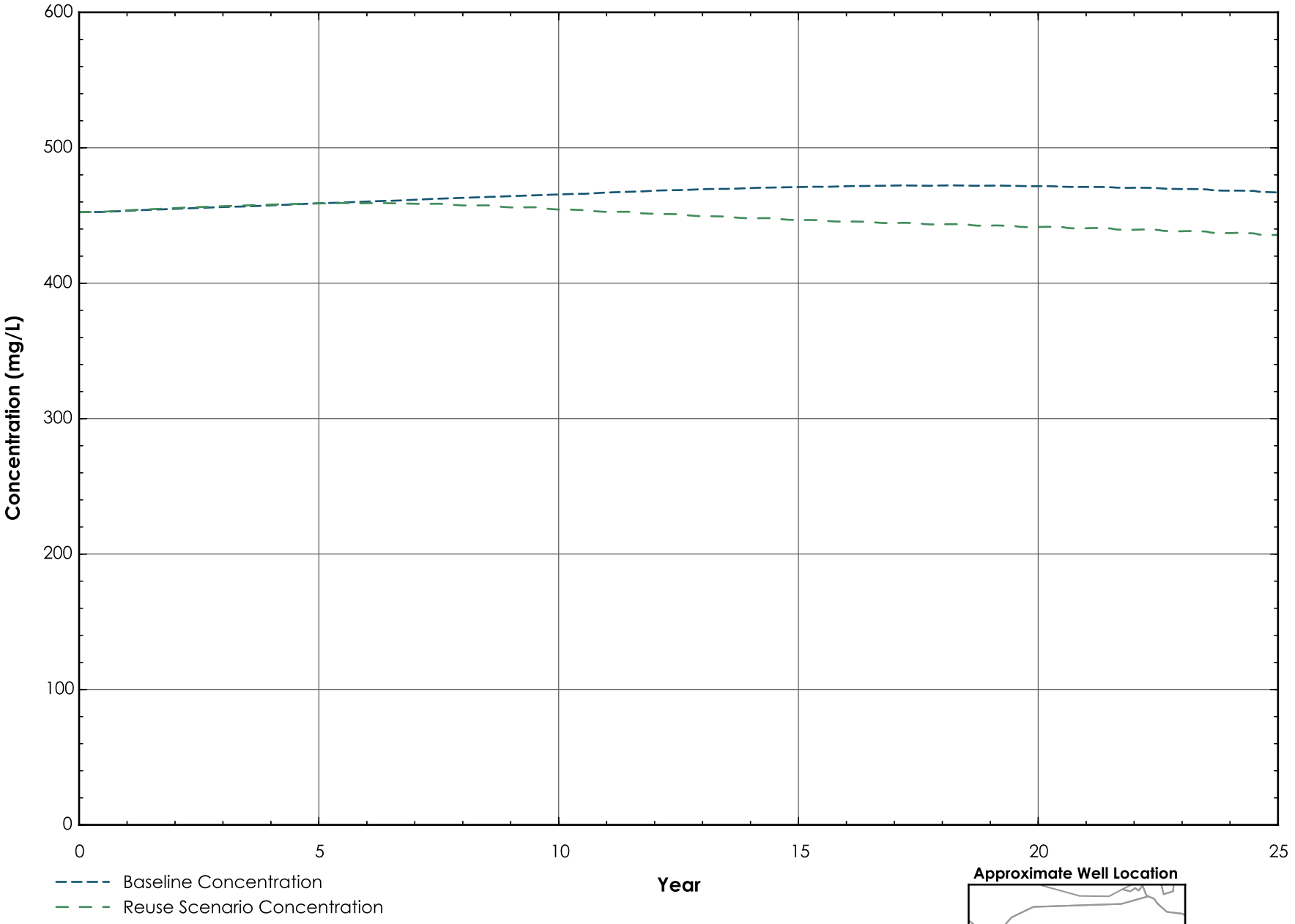


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

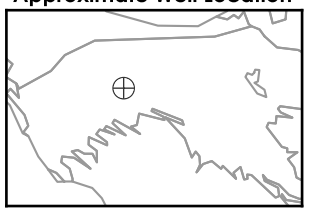


Well PLEAS 8 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

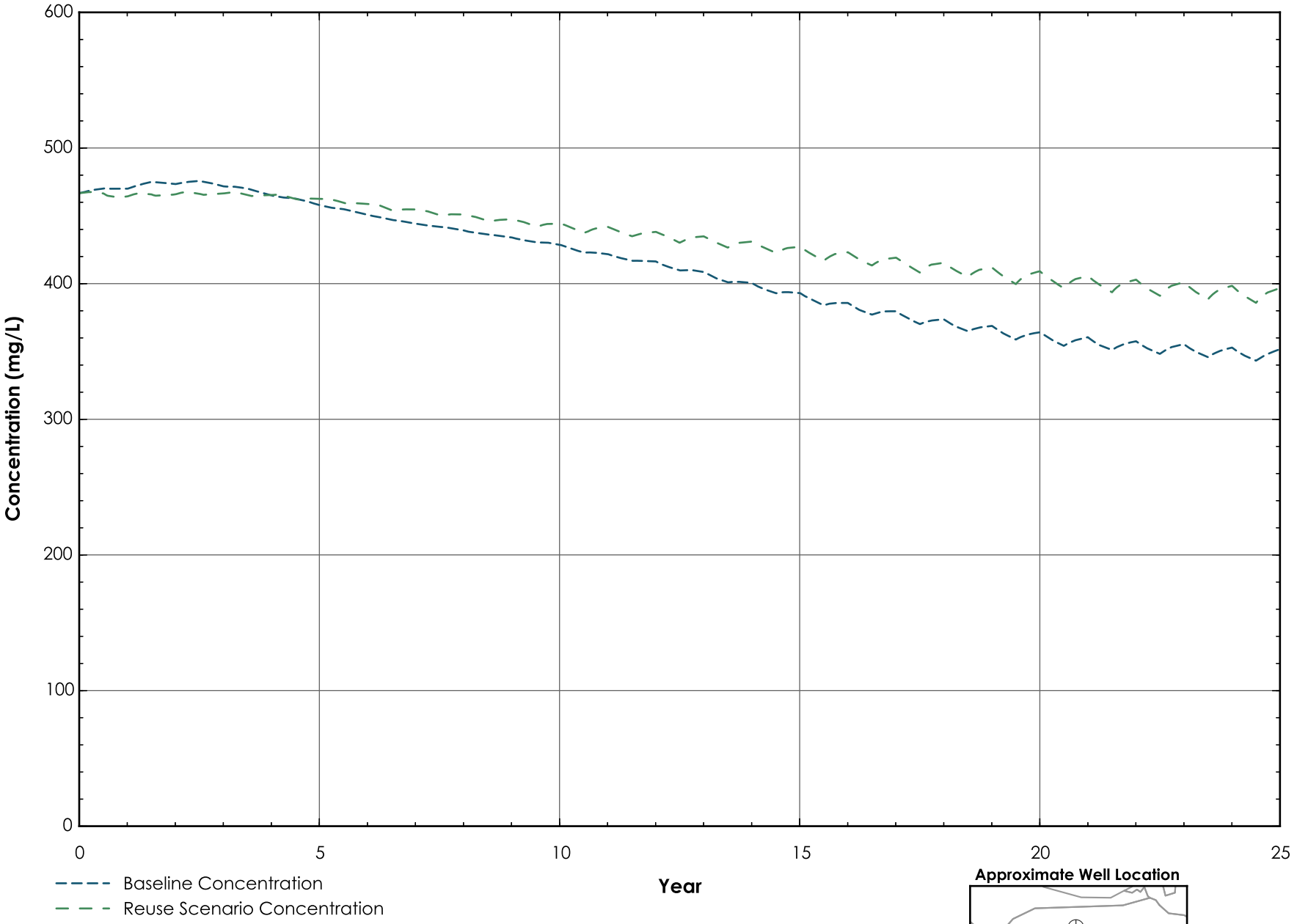


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

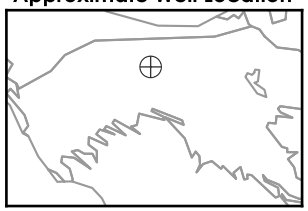


Well COL 1 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

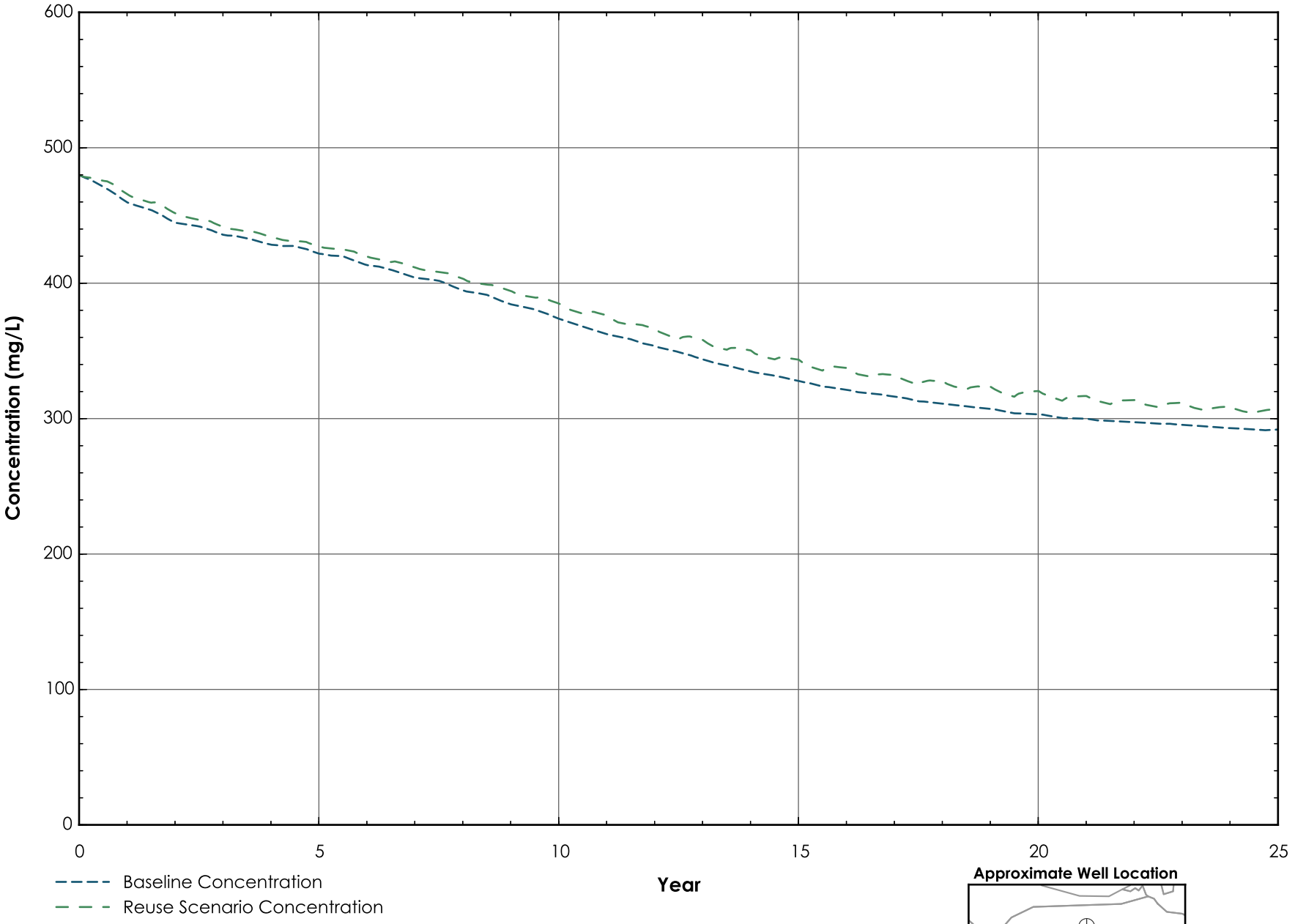


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

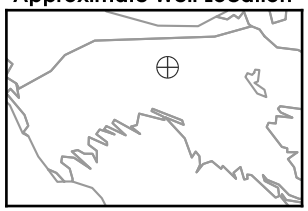


Well COL 2 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

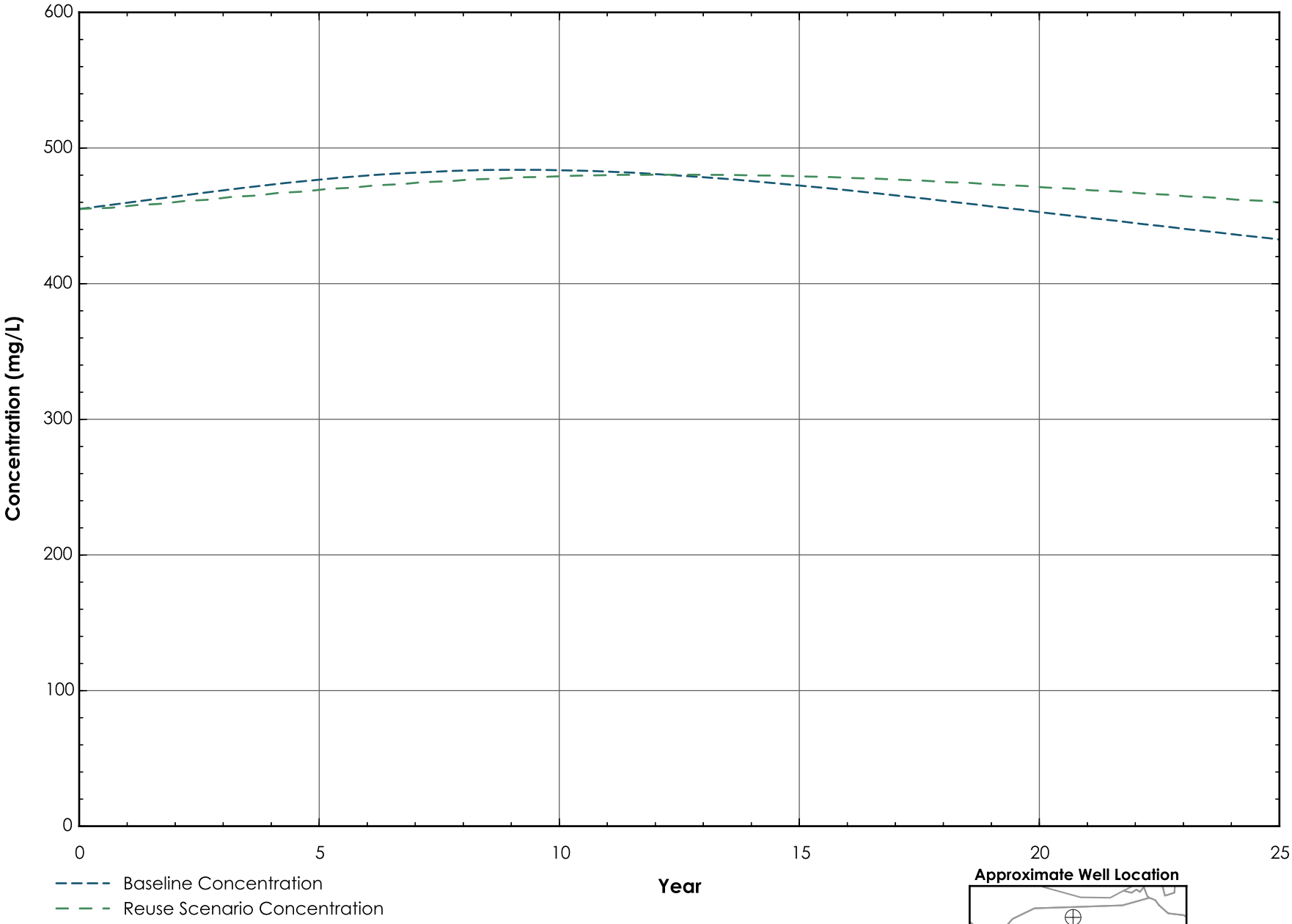


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

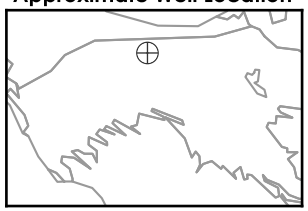


Well COL 5 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

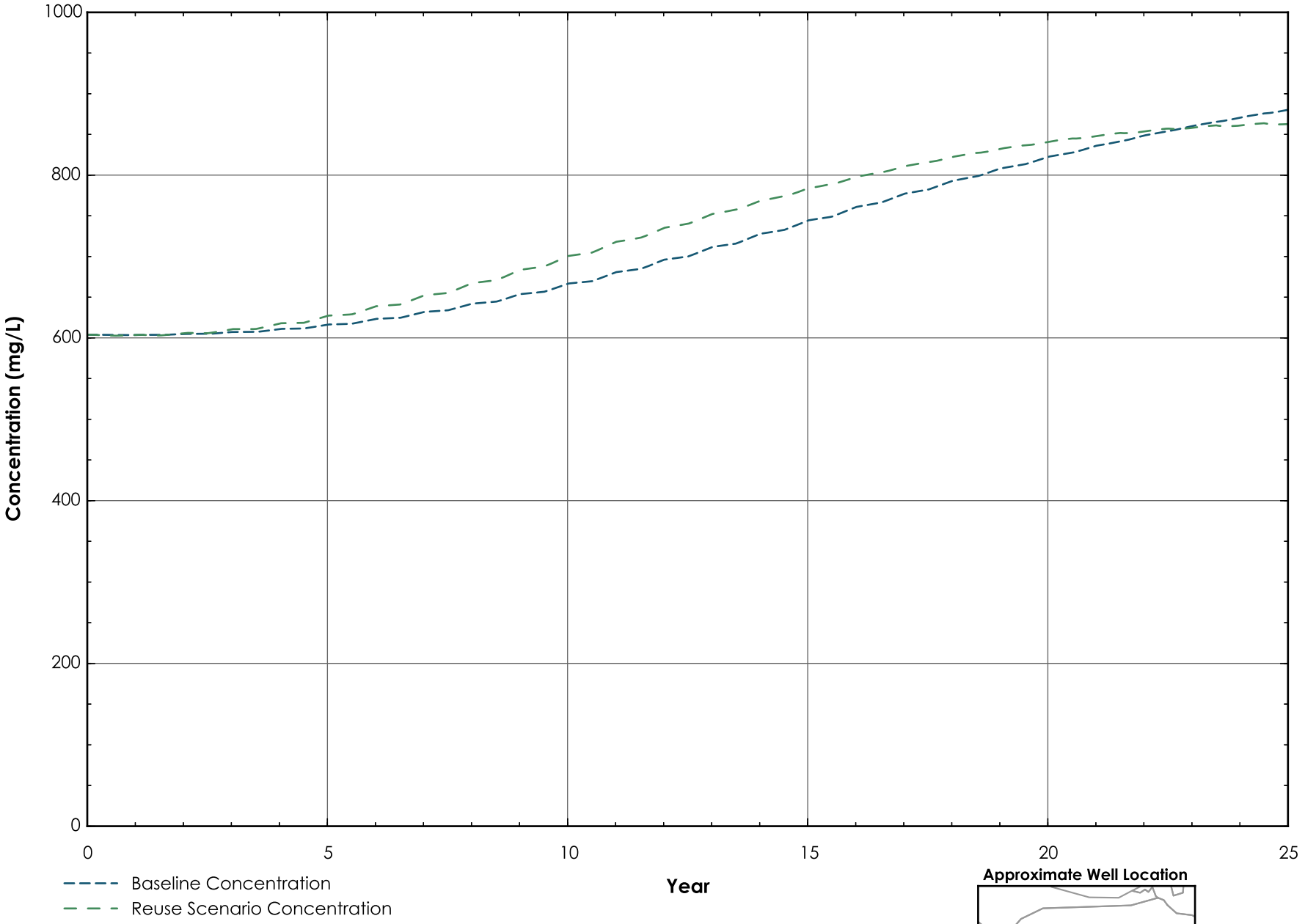


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

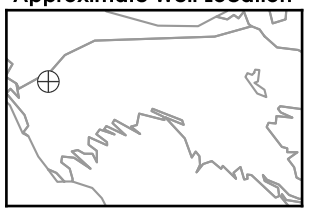


Well HOP 6 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

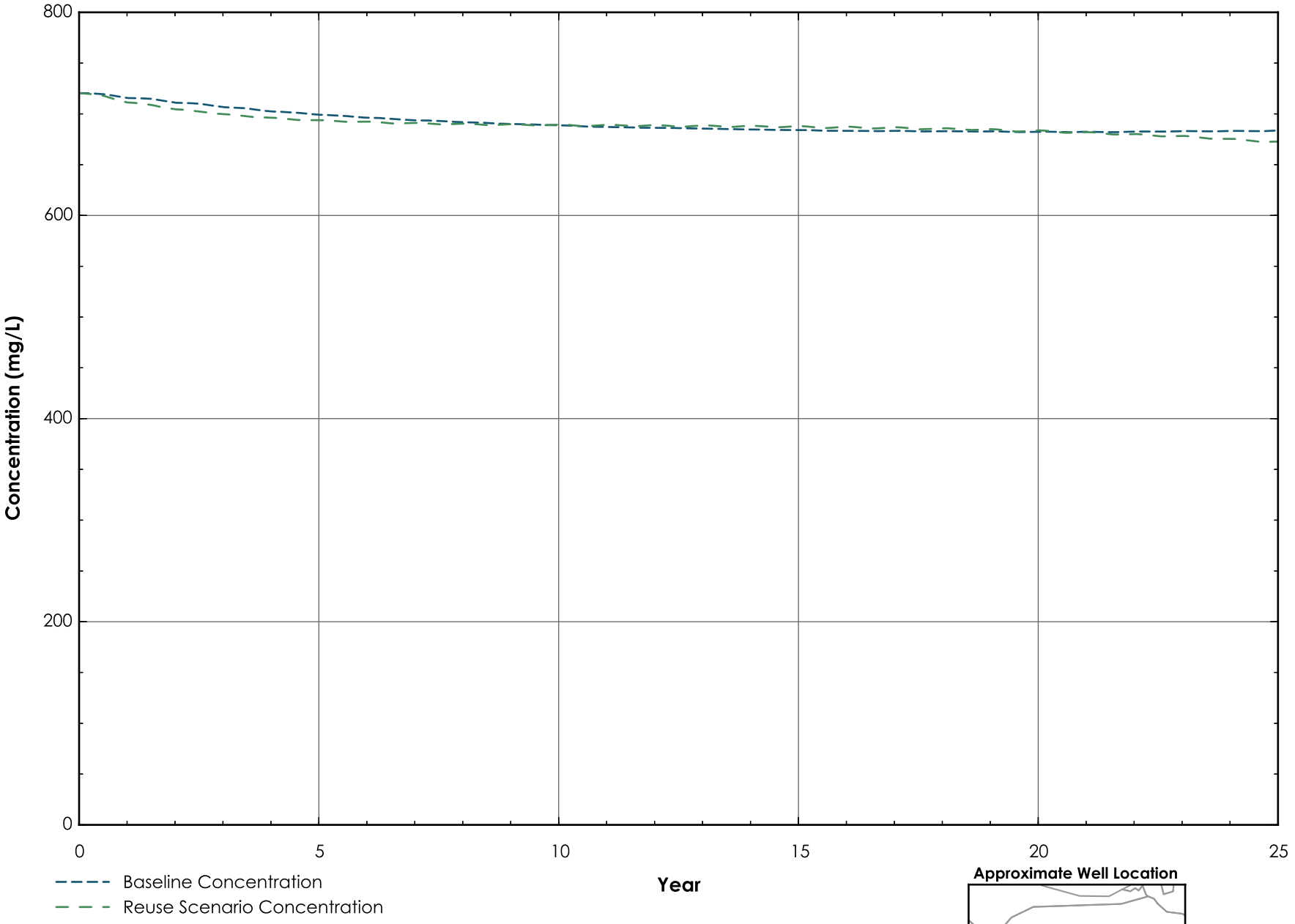


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

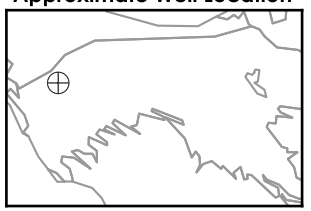


Well HOP 9 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

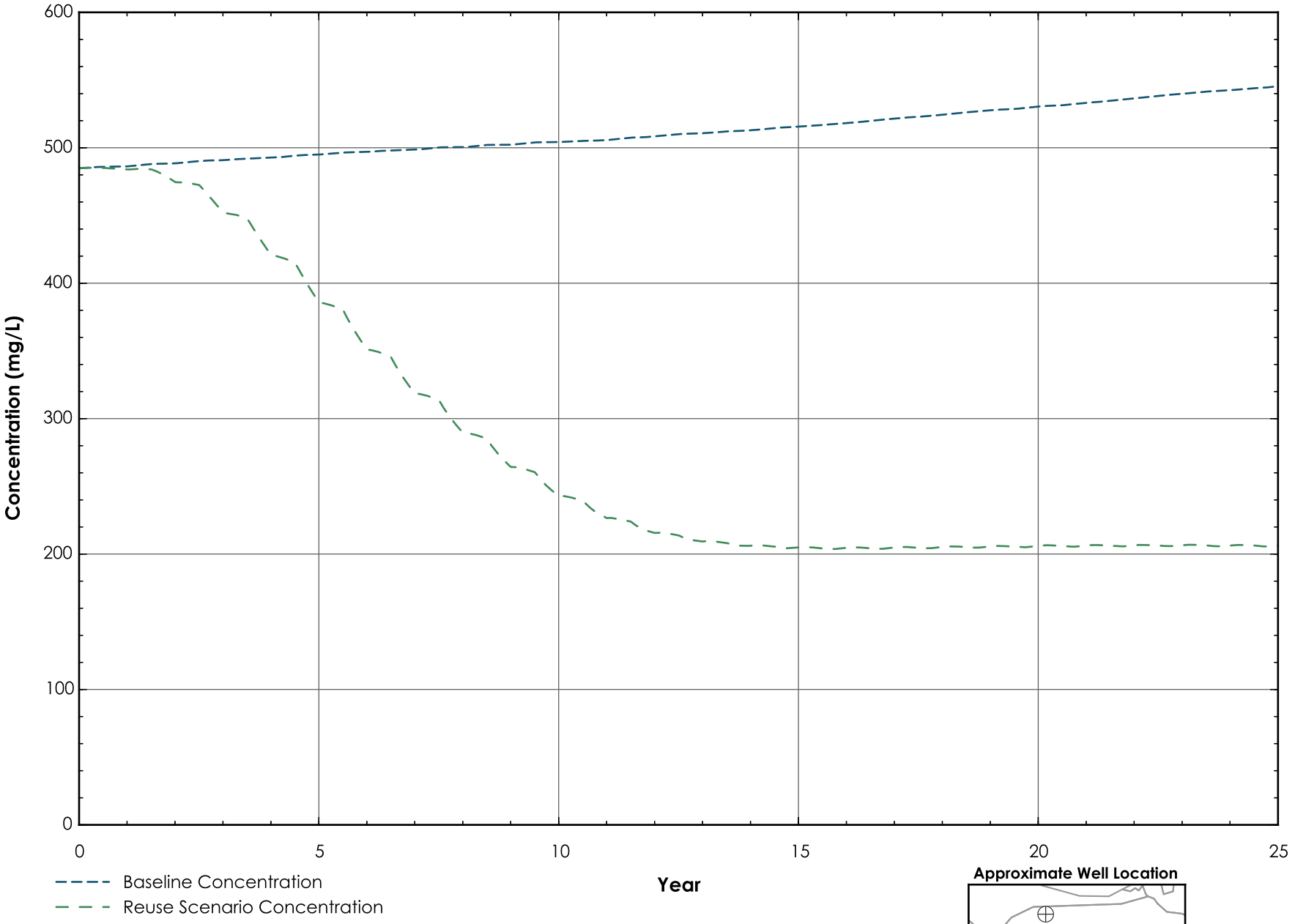


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

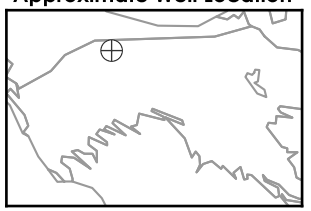


Well STONERIDGE 1 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

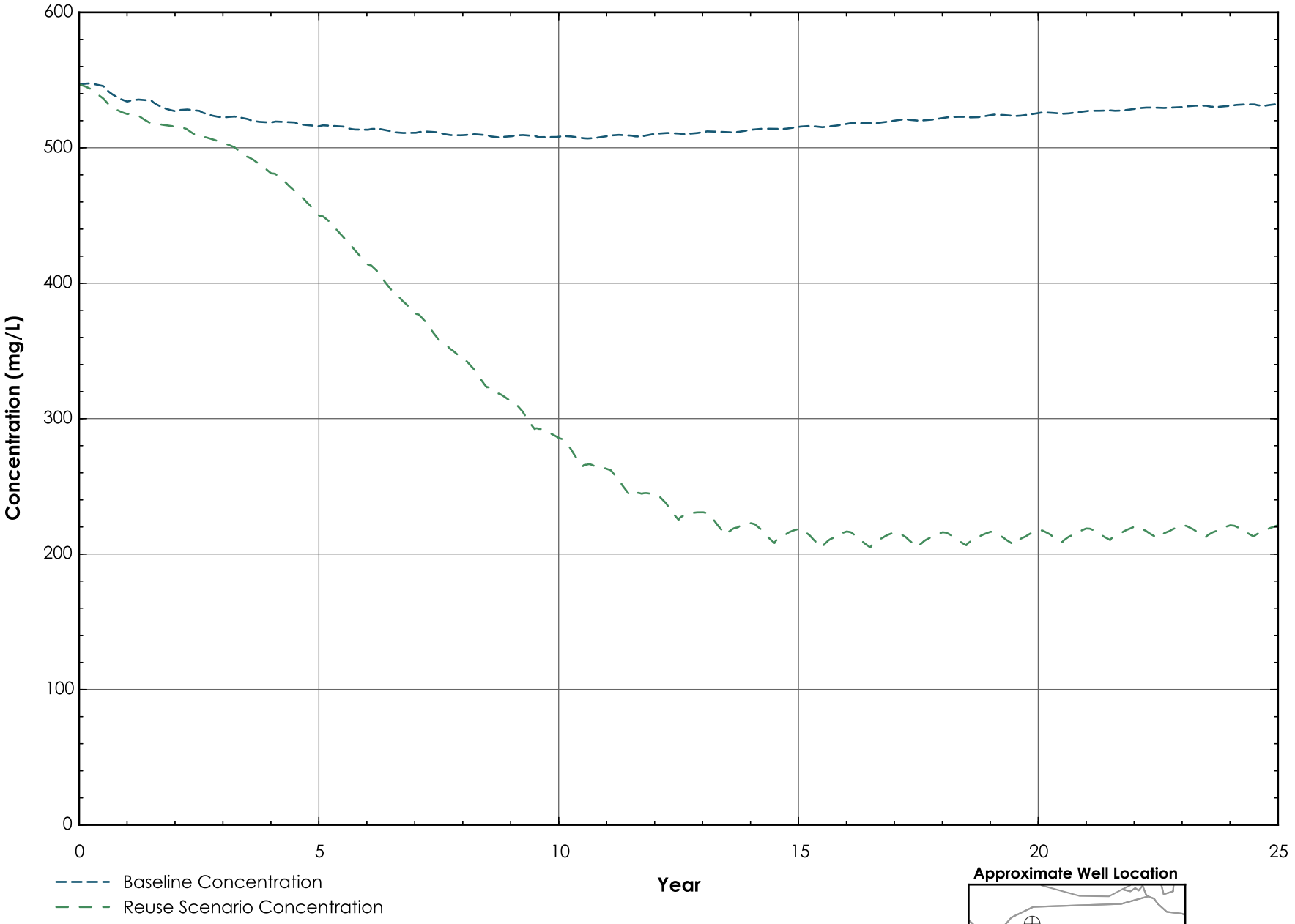


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

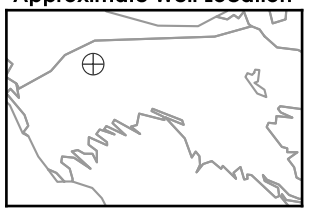


Well MOCHO 1 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

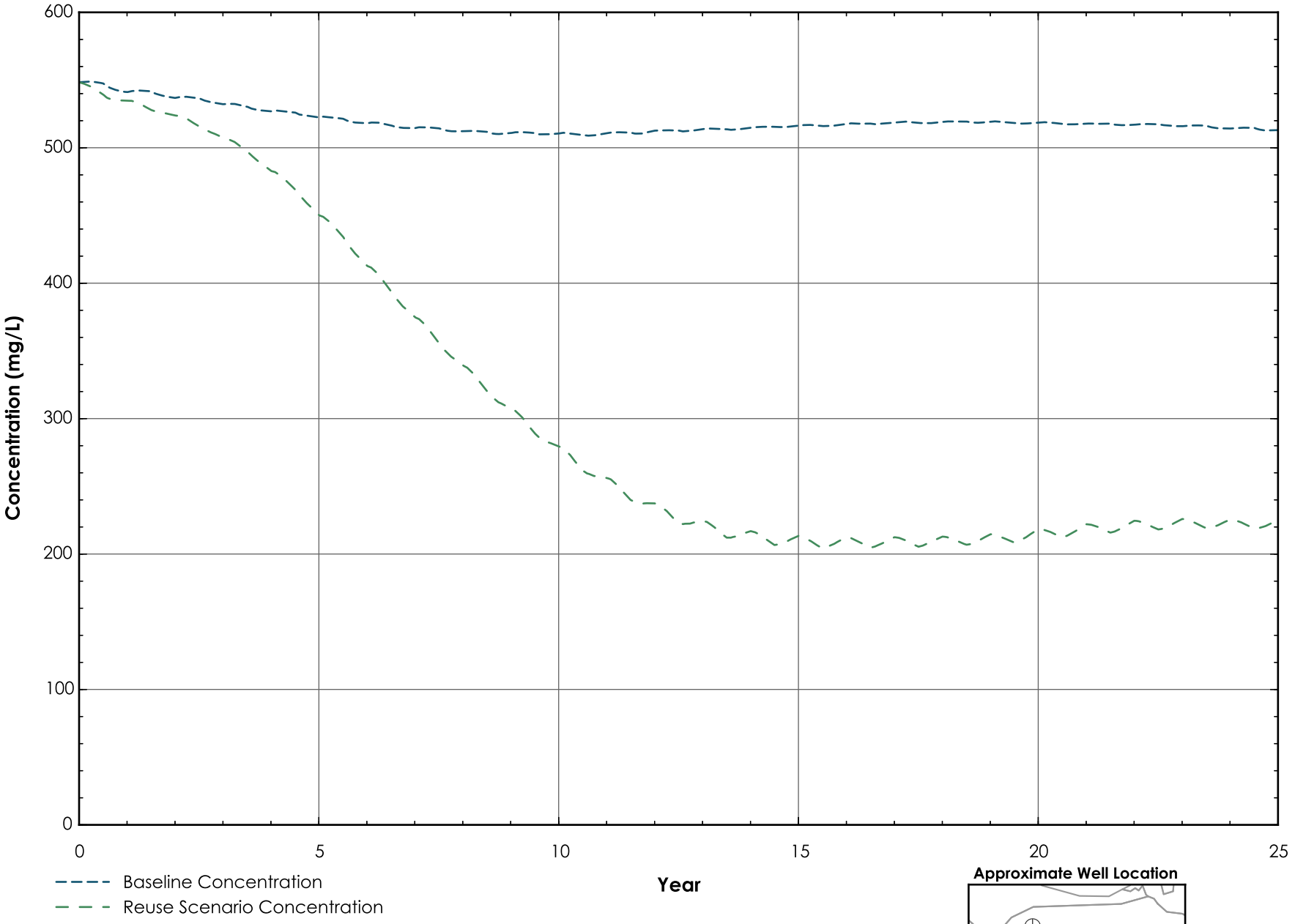


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

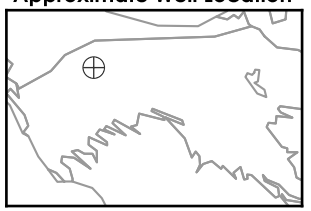


Well MOCHO 2 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

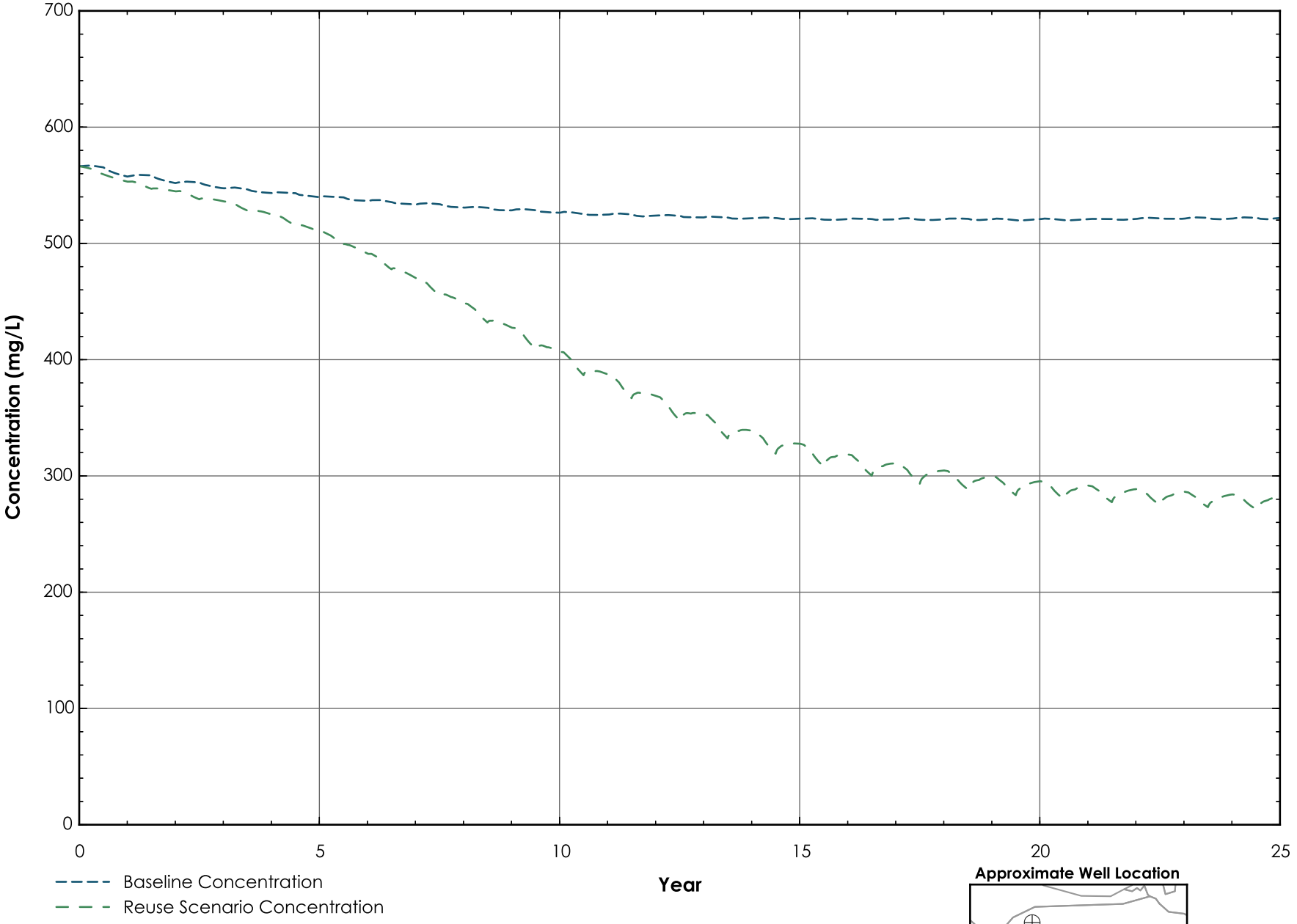


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

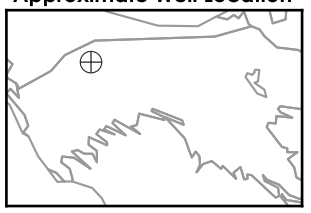


Well MOCHO 3 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

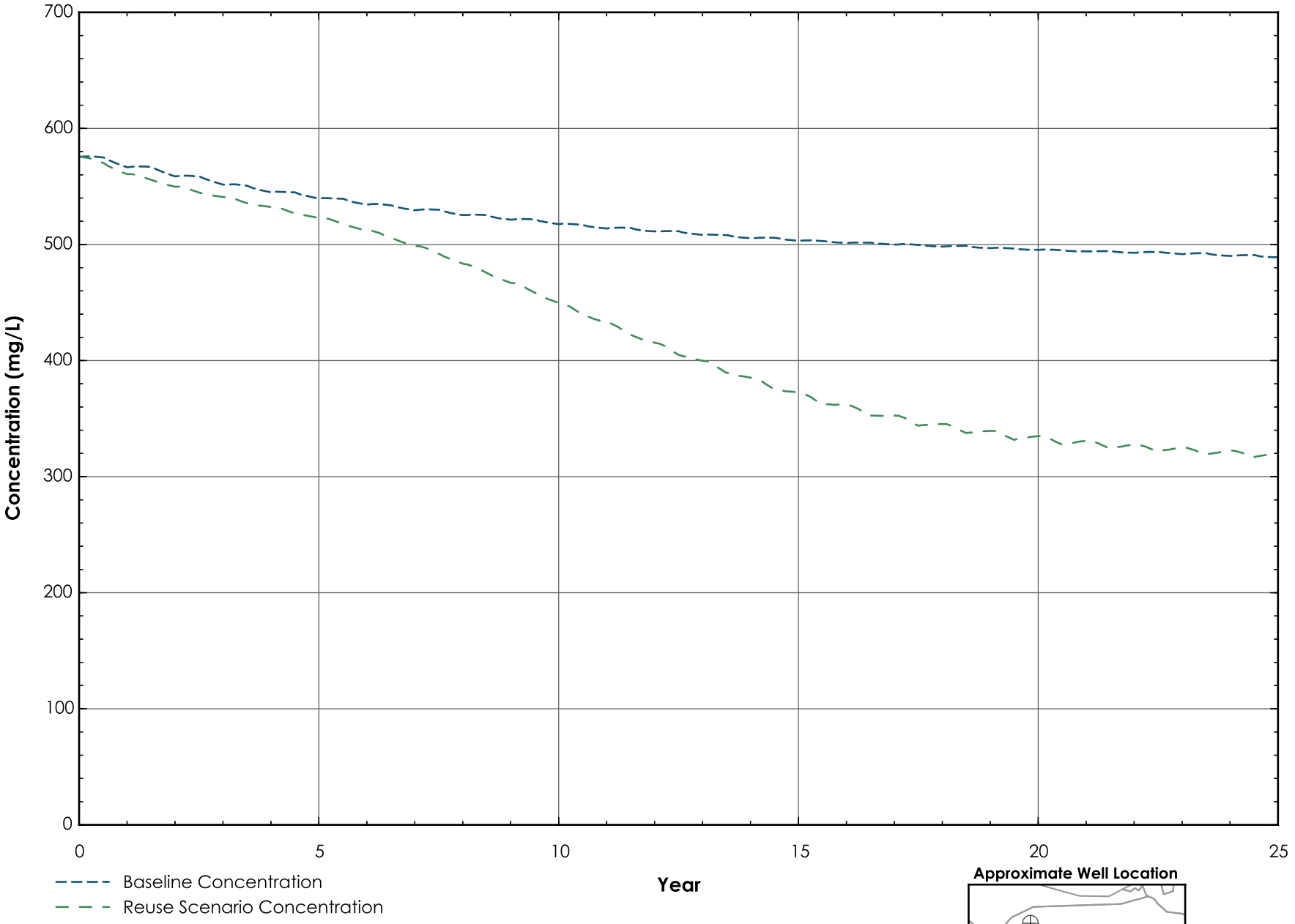


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

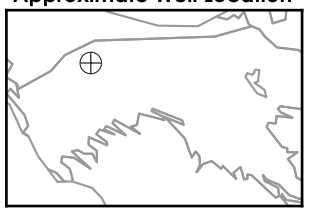


Well MOCHO 4 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

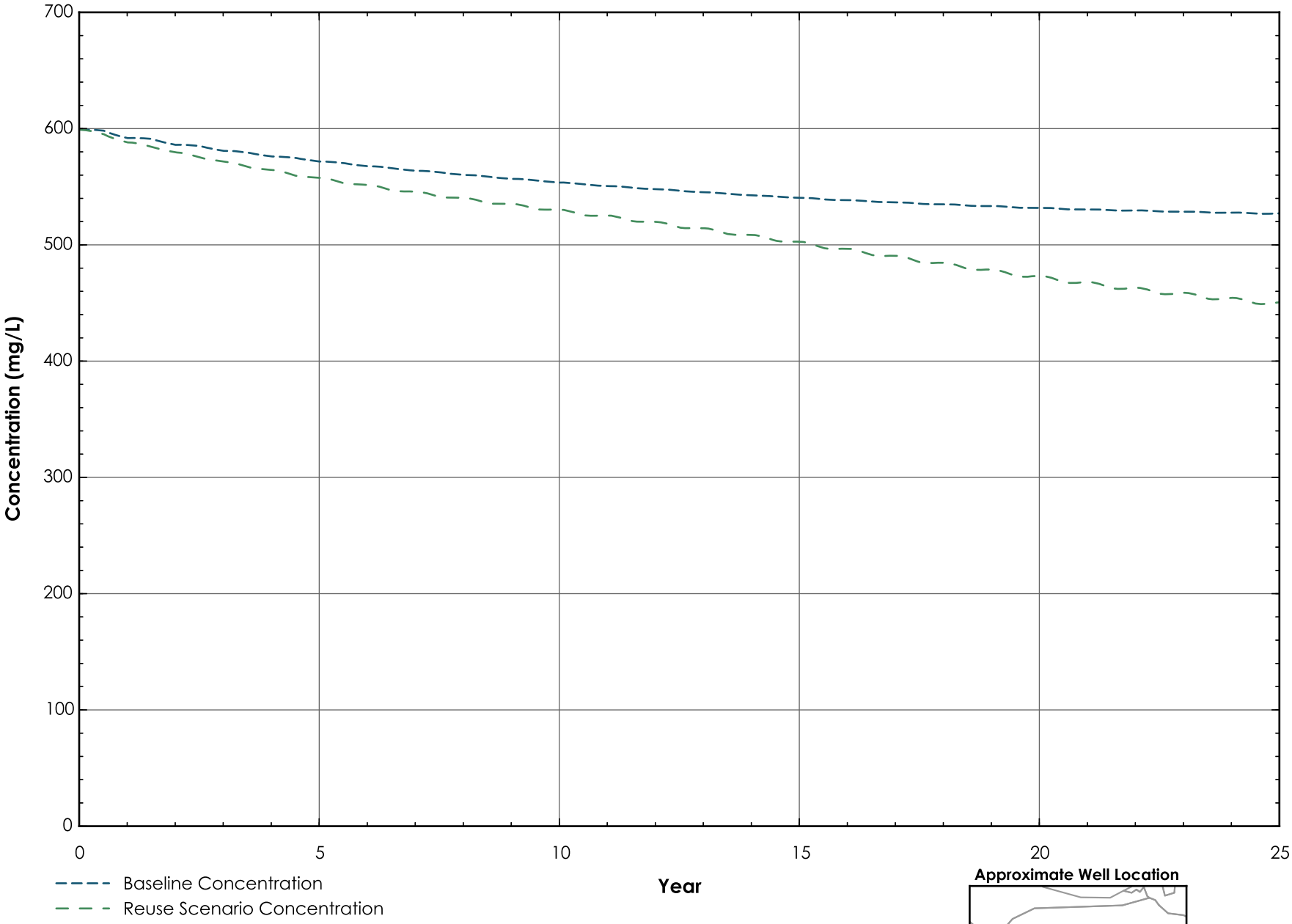


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

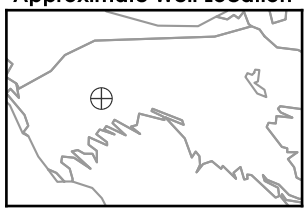


Well PLEAS 5 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

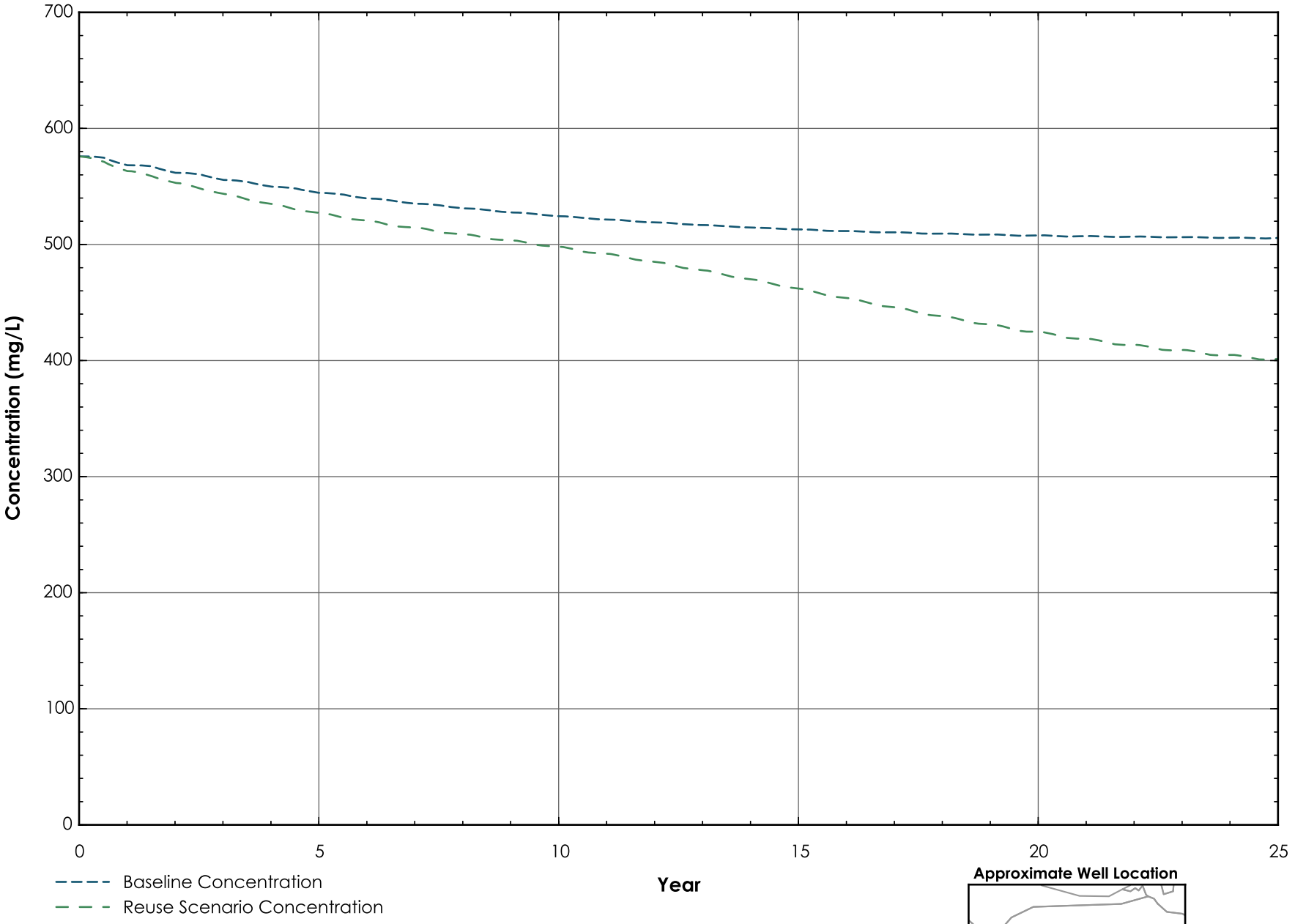


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

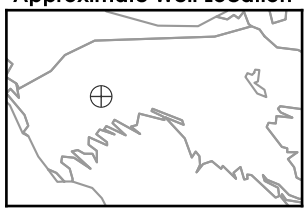


Well PLEAS 6 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

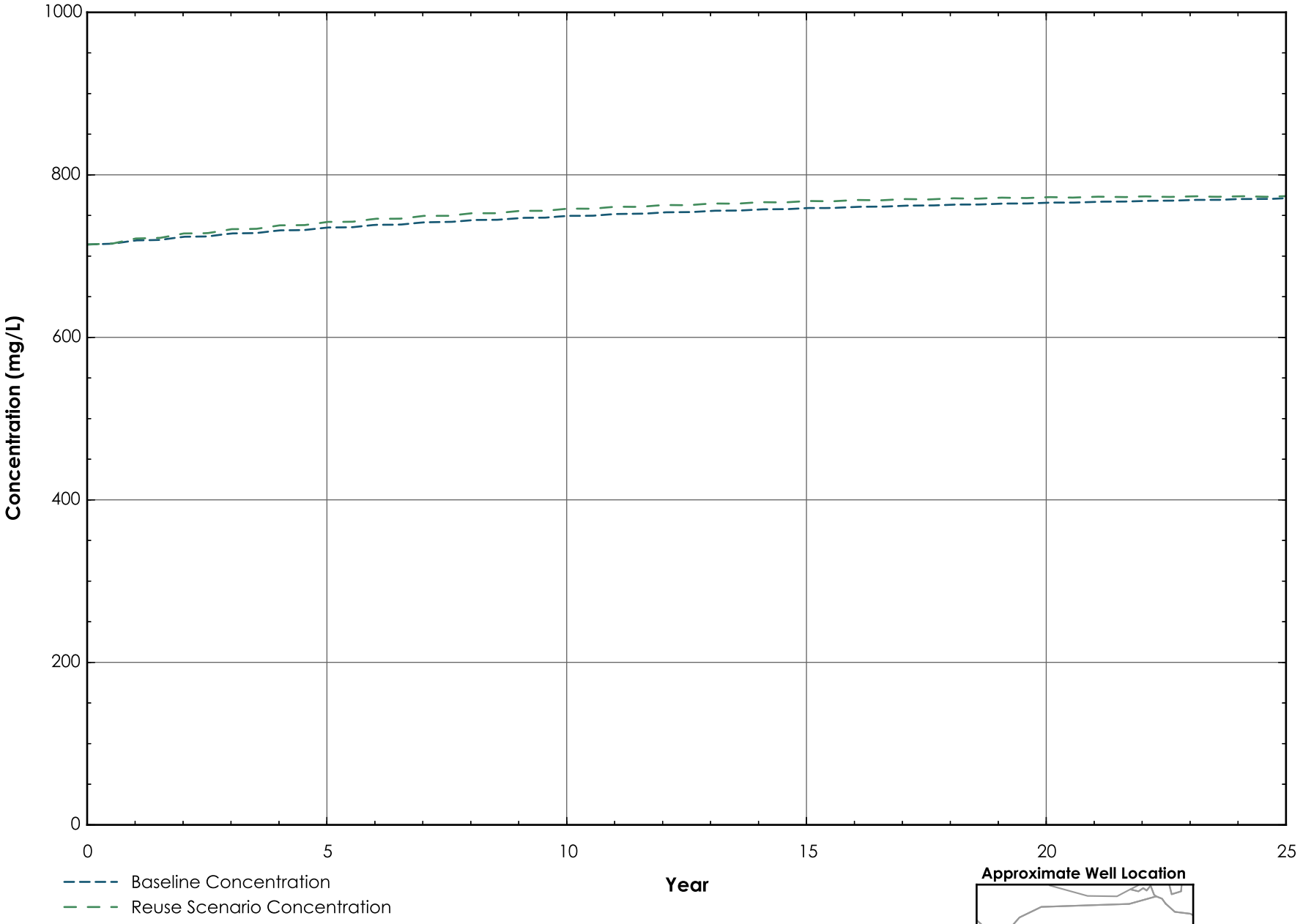


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

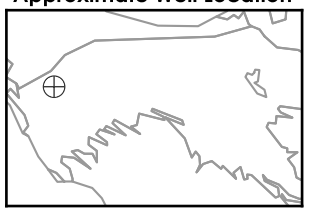


Well PLEAS 7 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

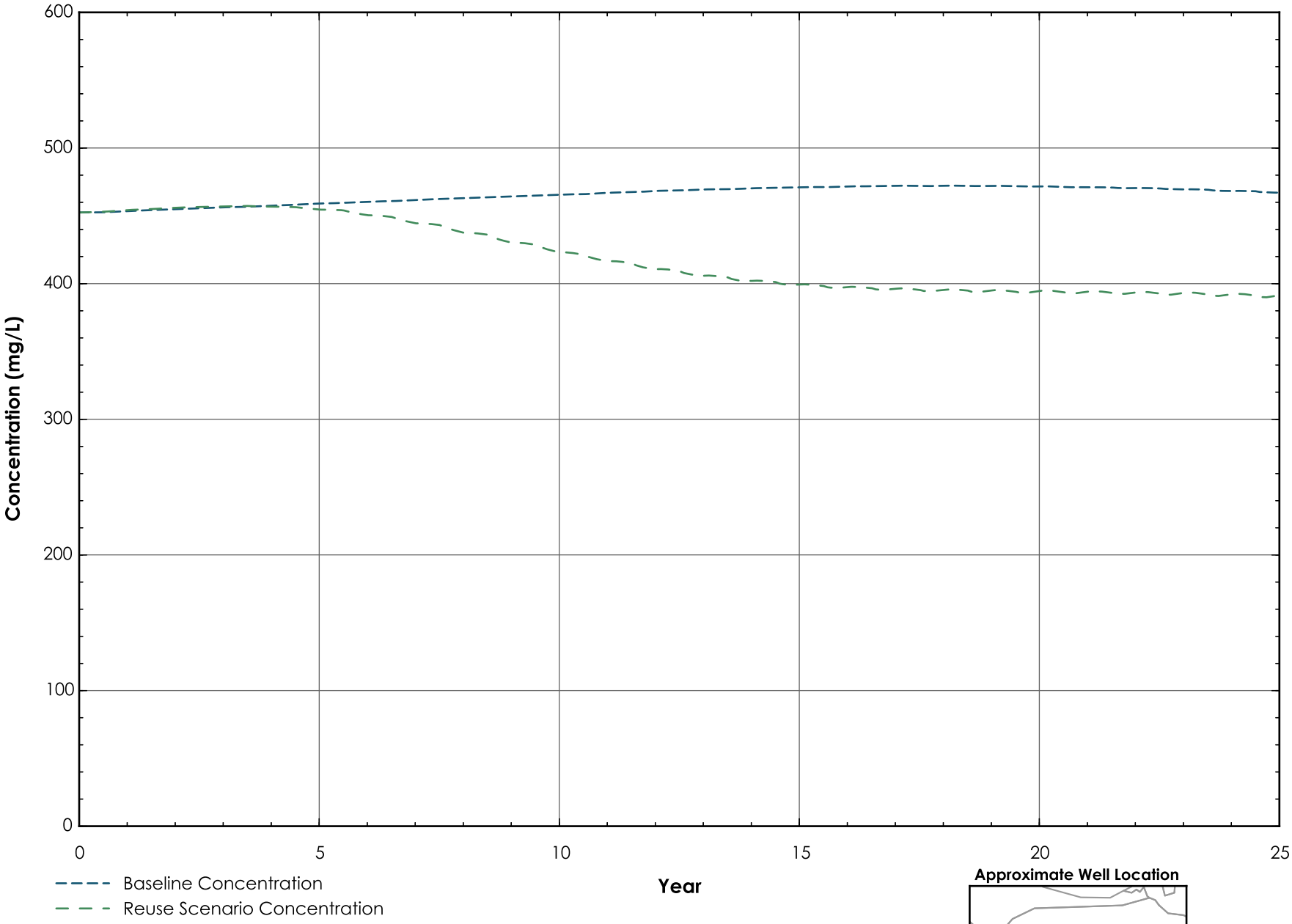


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

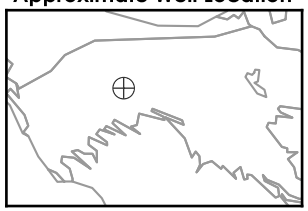


Well PLEAS 8 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

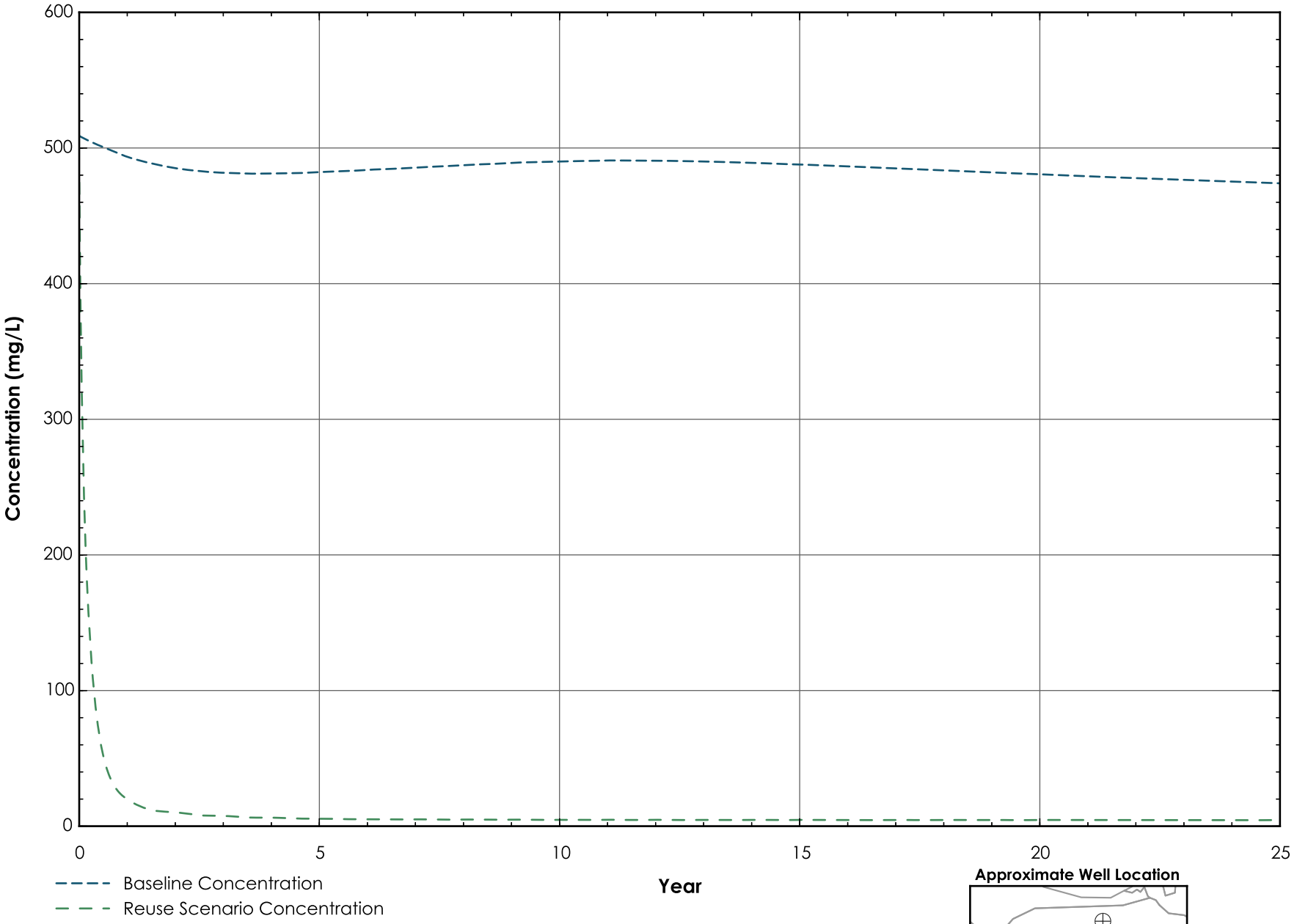


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

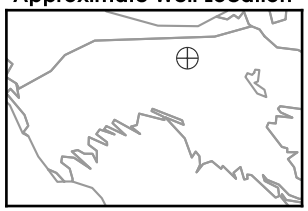


Well Inj E Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

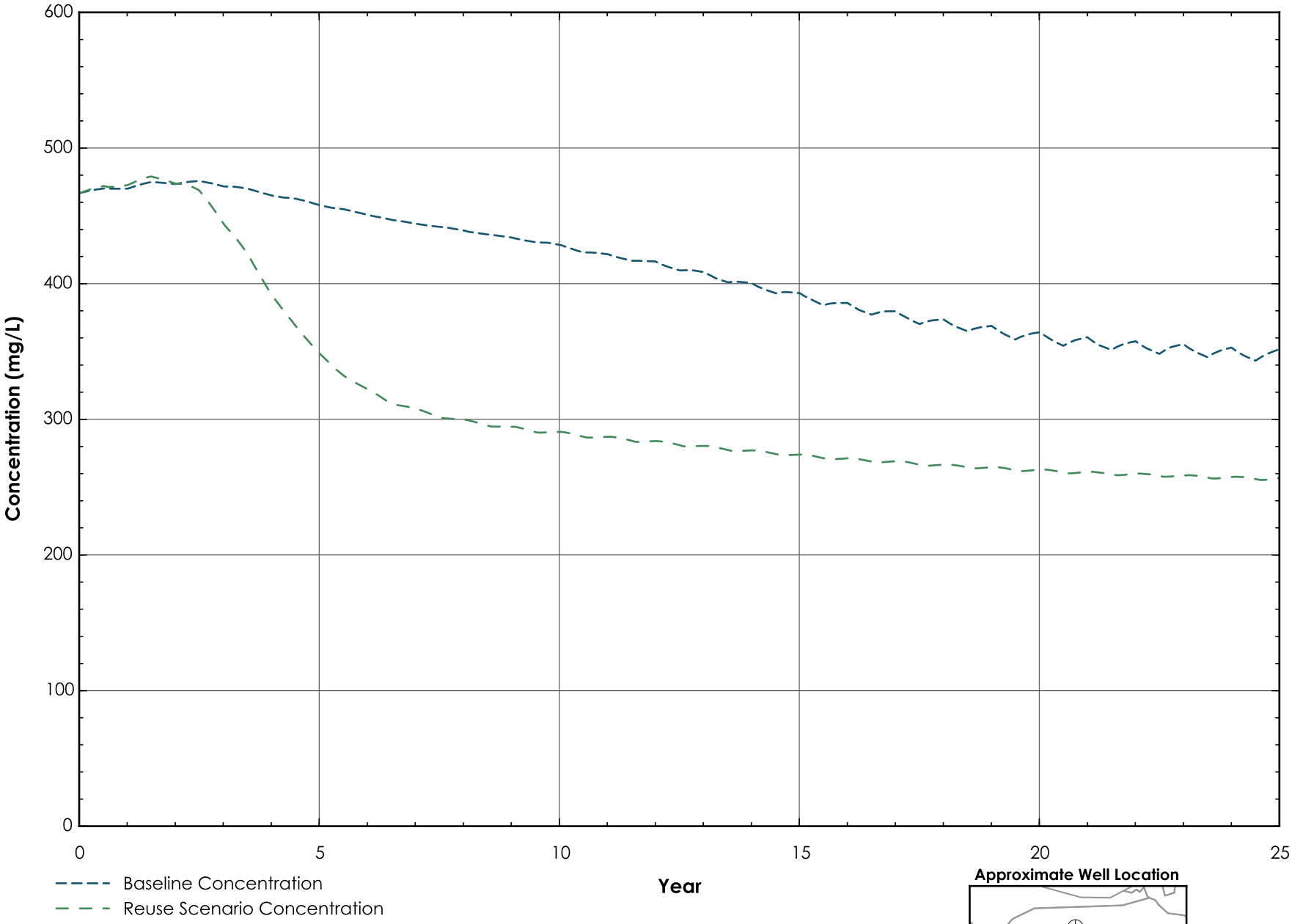


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

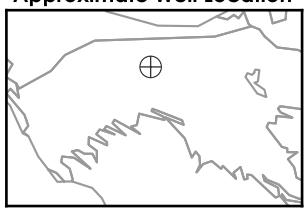


Well COL 1 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

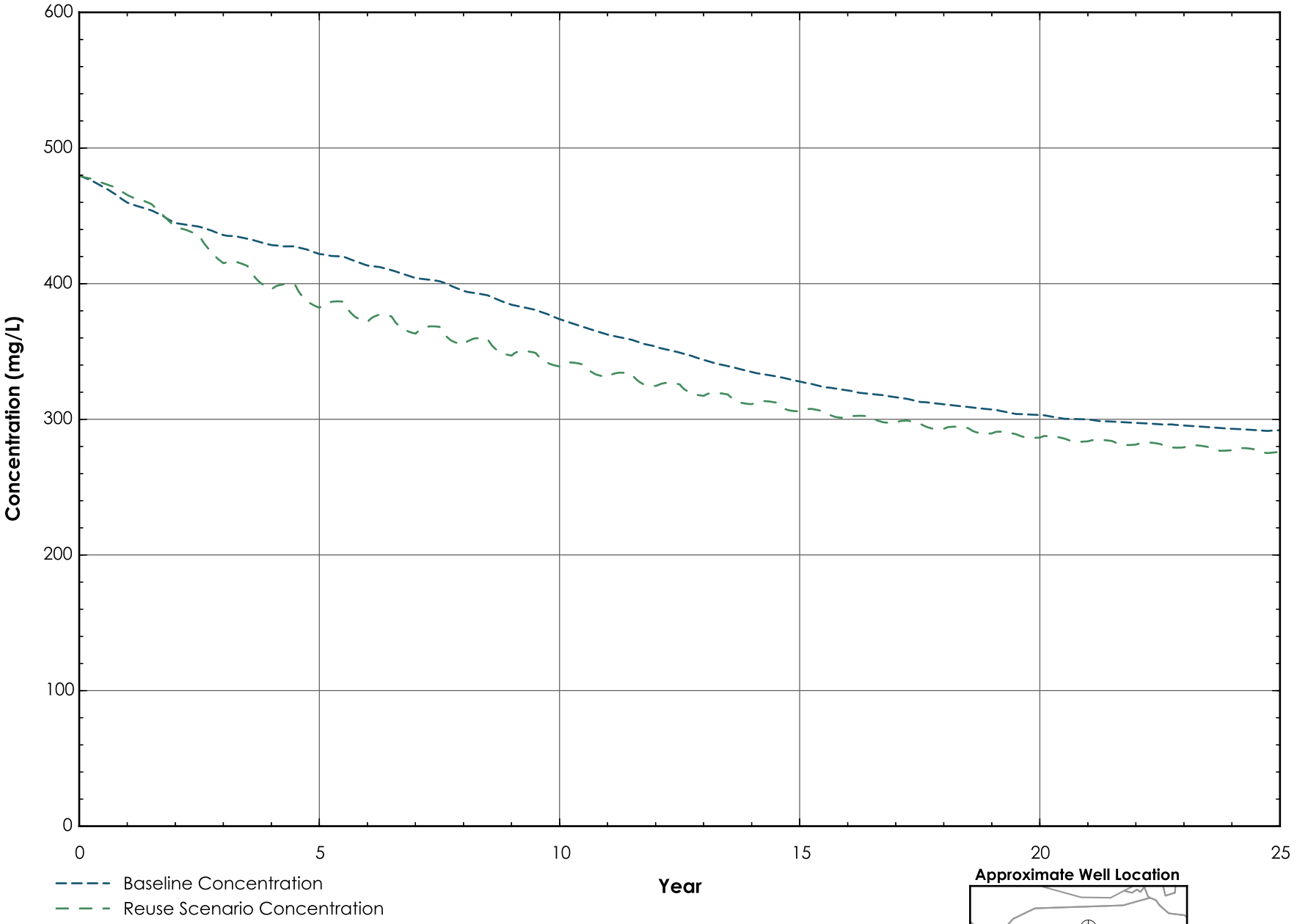


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

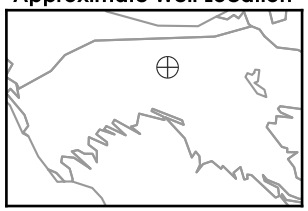


Well COL 2 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

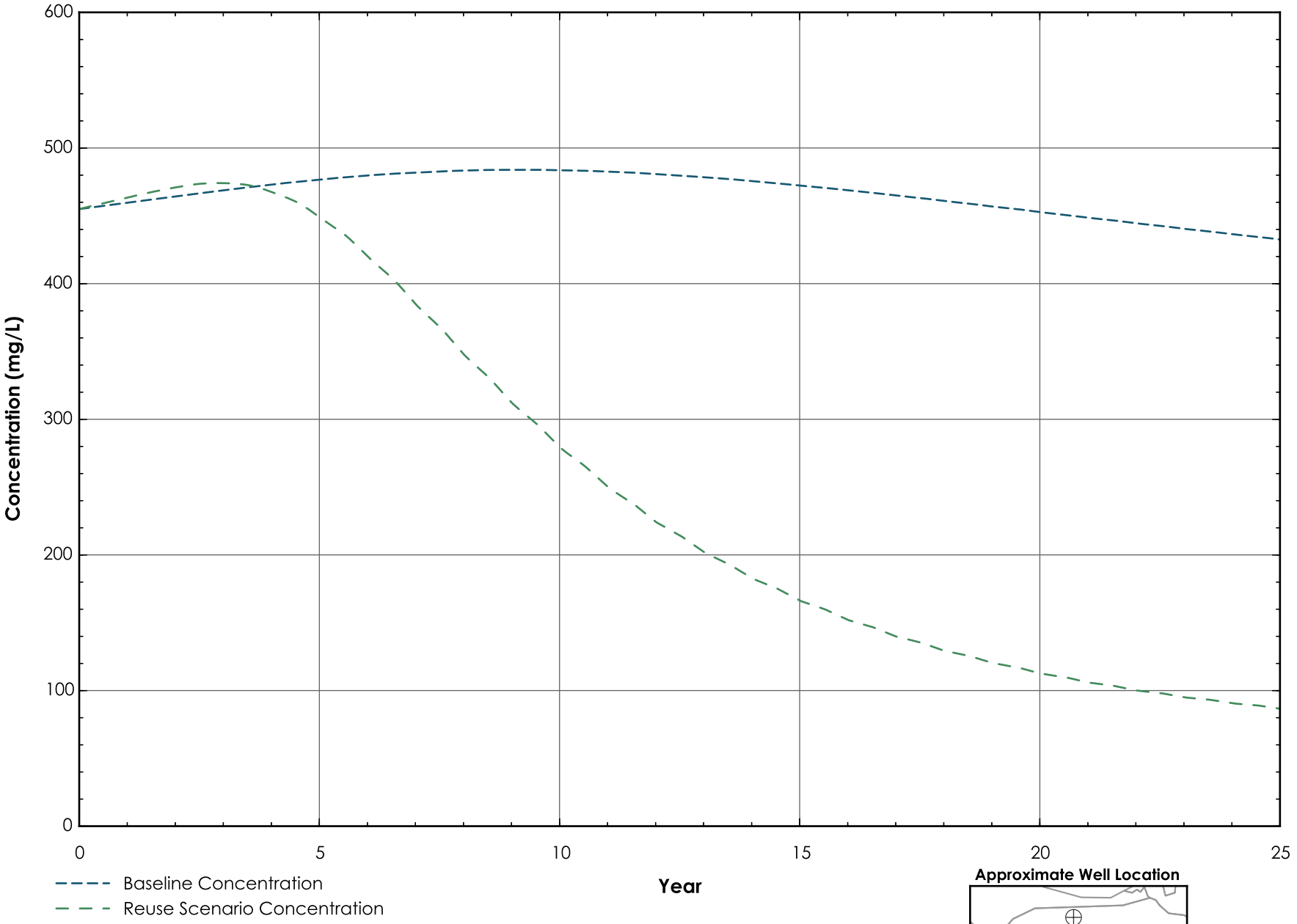


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

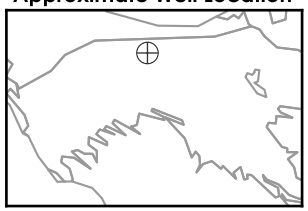


Well COL 5 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

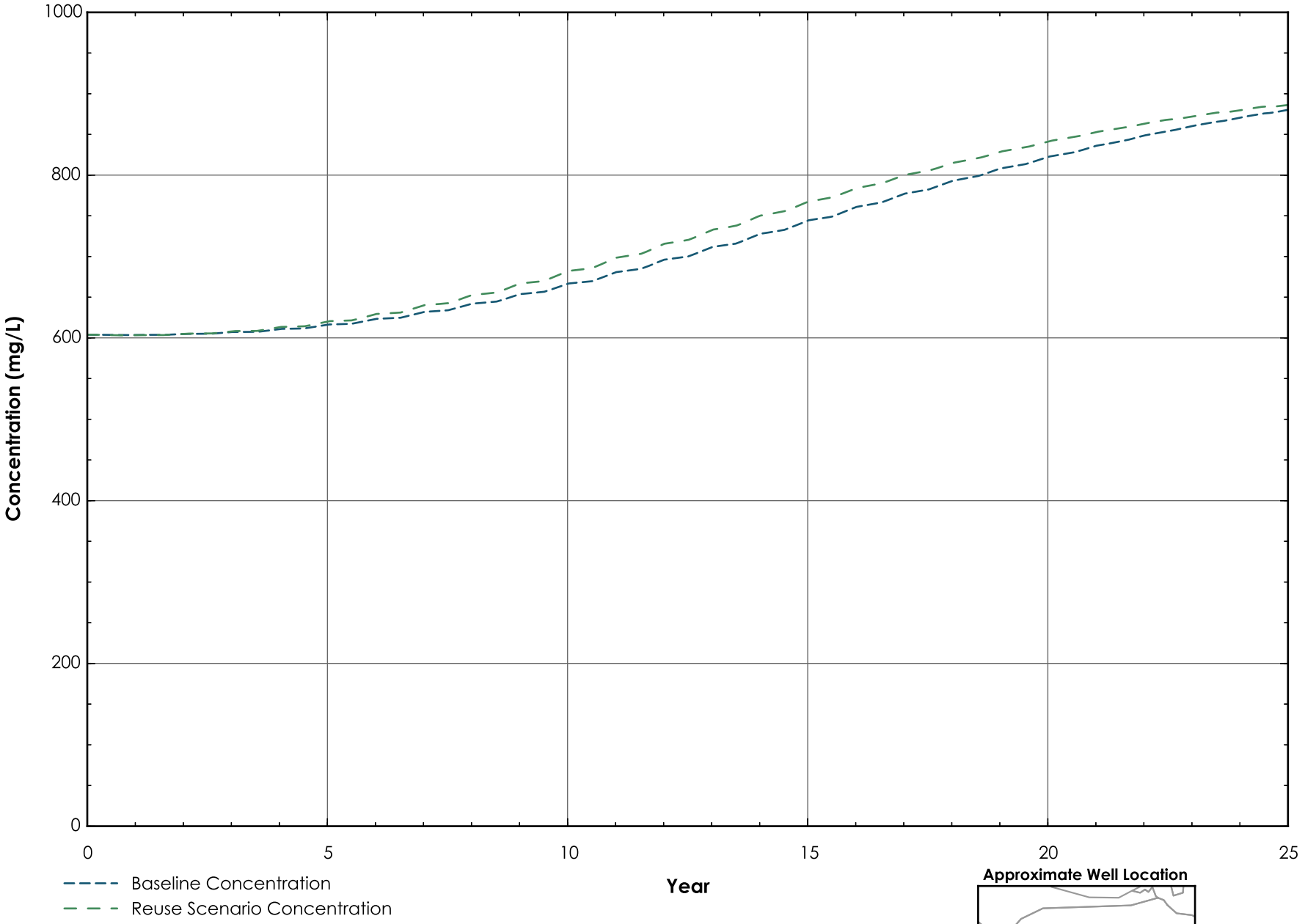


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

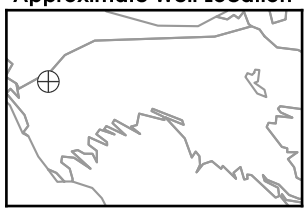


Well HOP 6 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

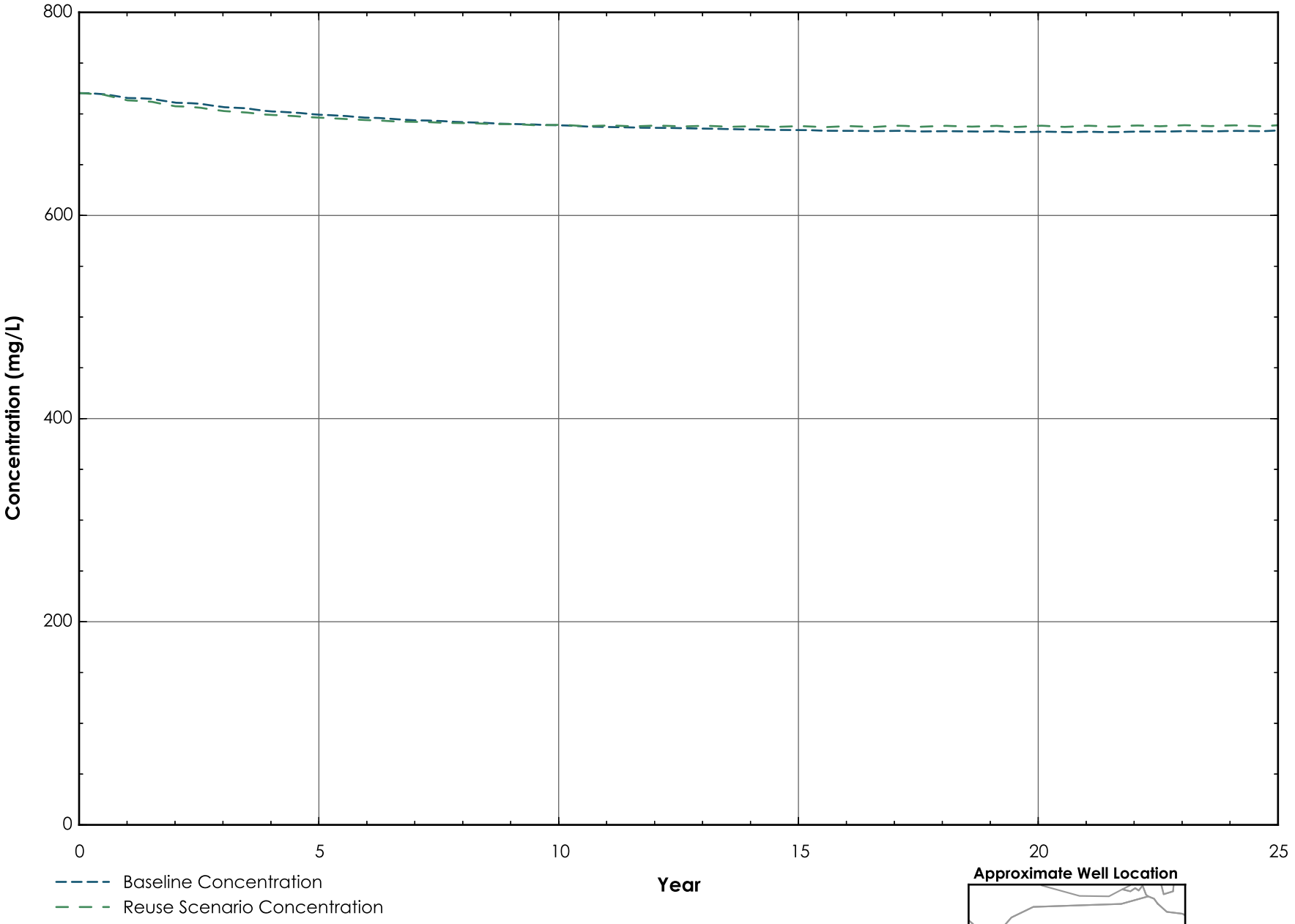


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

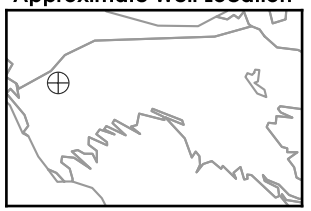


Well HOP 9 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

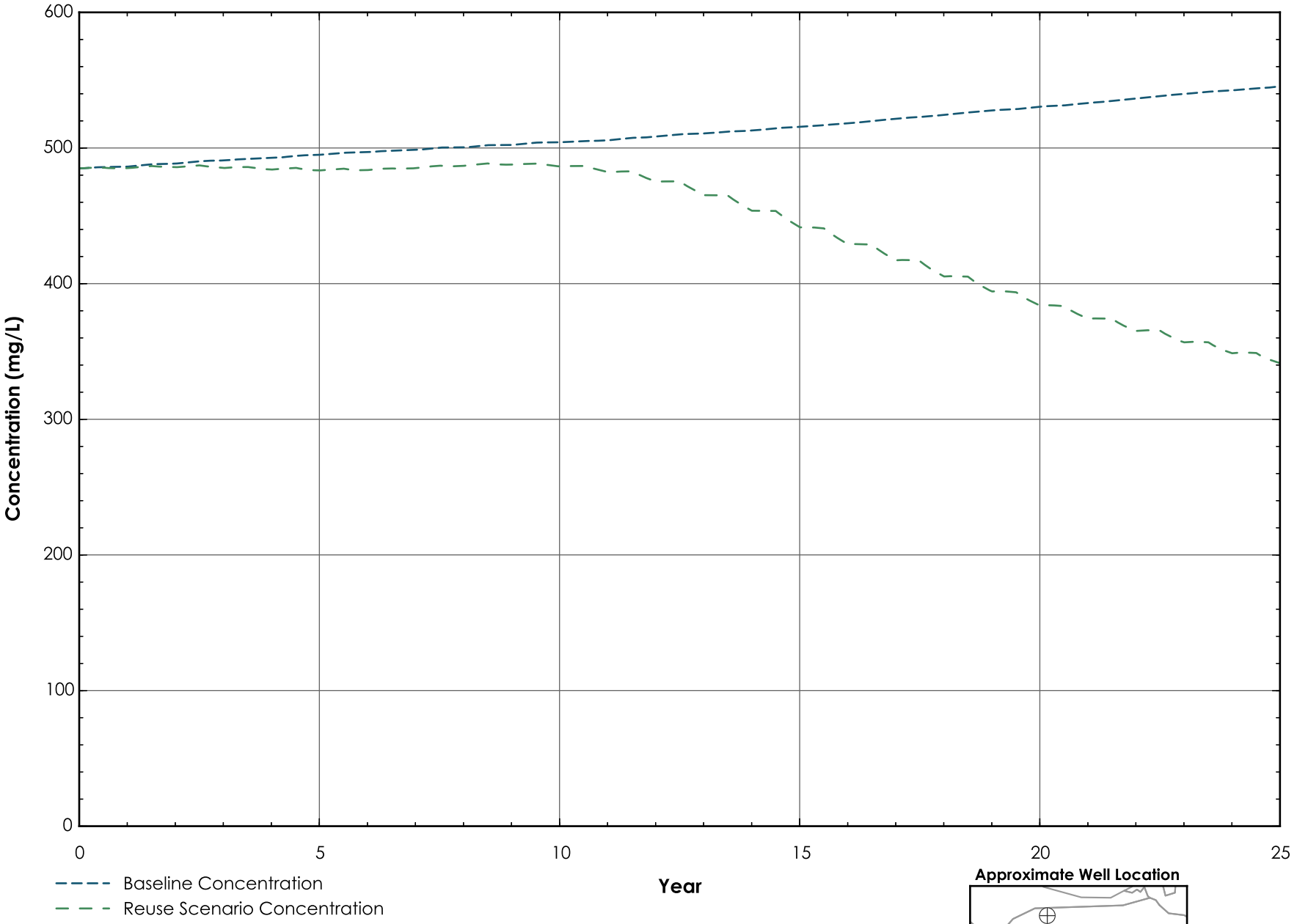


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

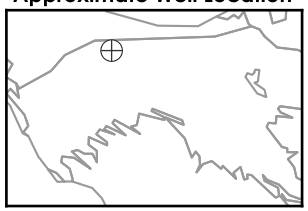


Well STONERIDGE 1 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

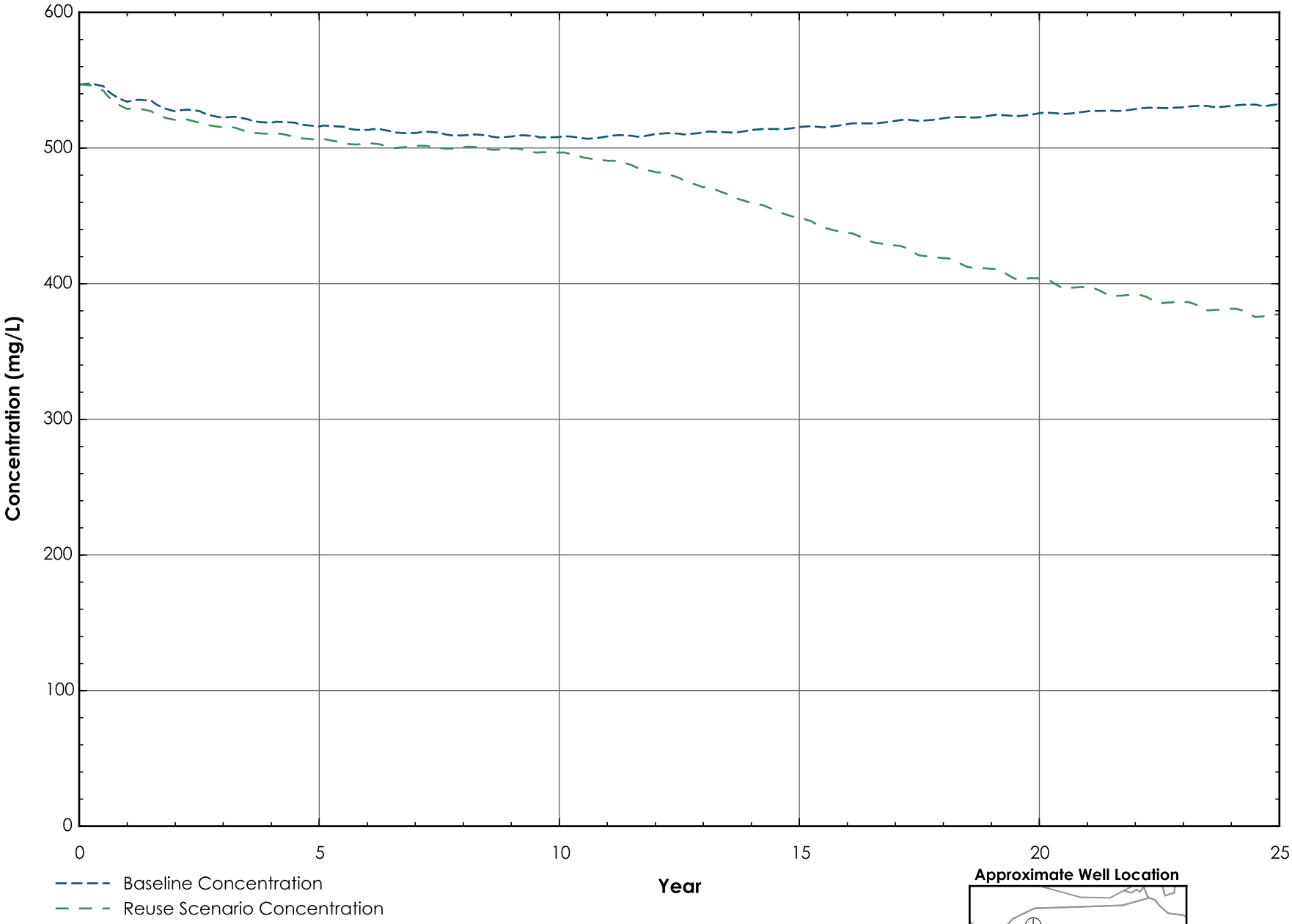


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

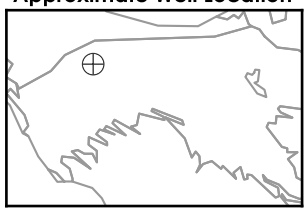


Well MOCHO 1 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

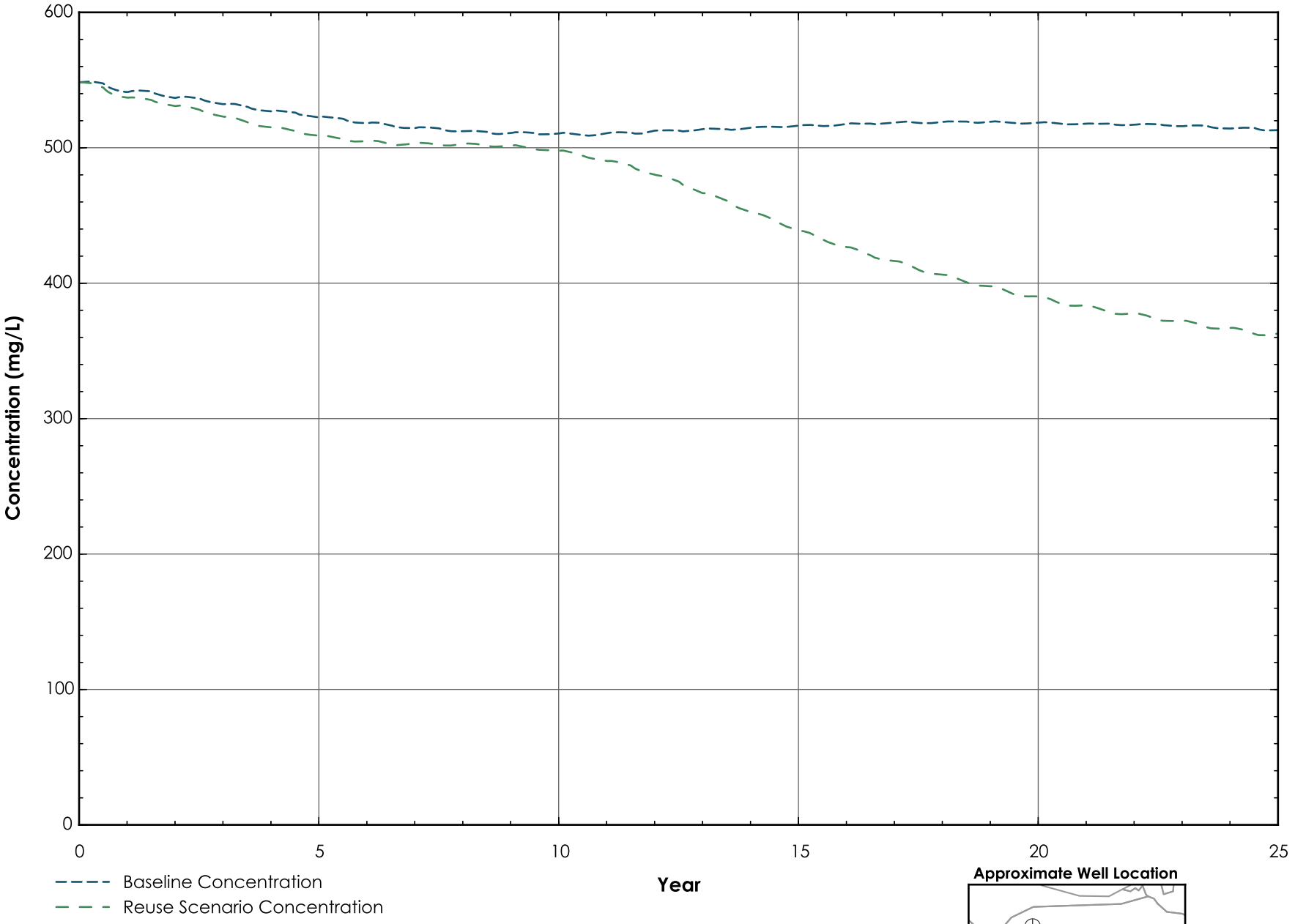


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

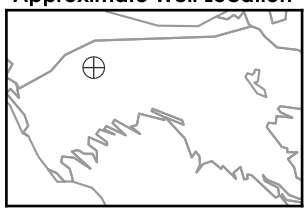


Well MOCHO 2 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

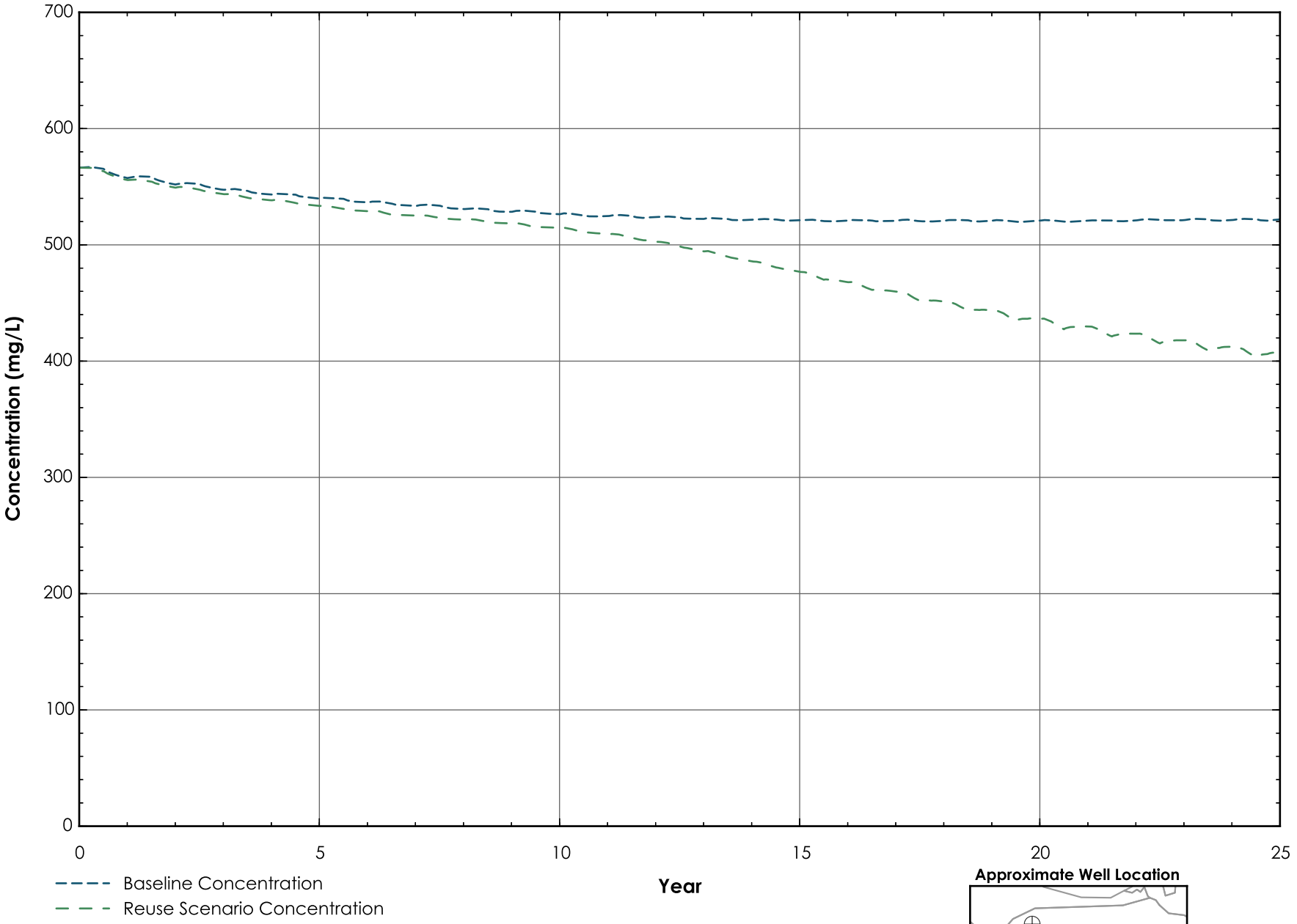


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

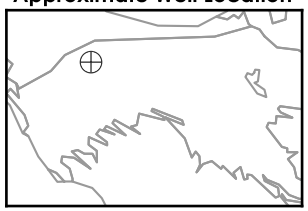


Well MOCHO 3 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

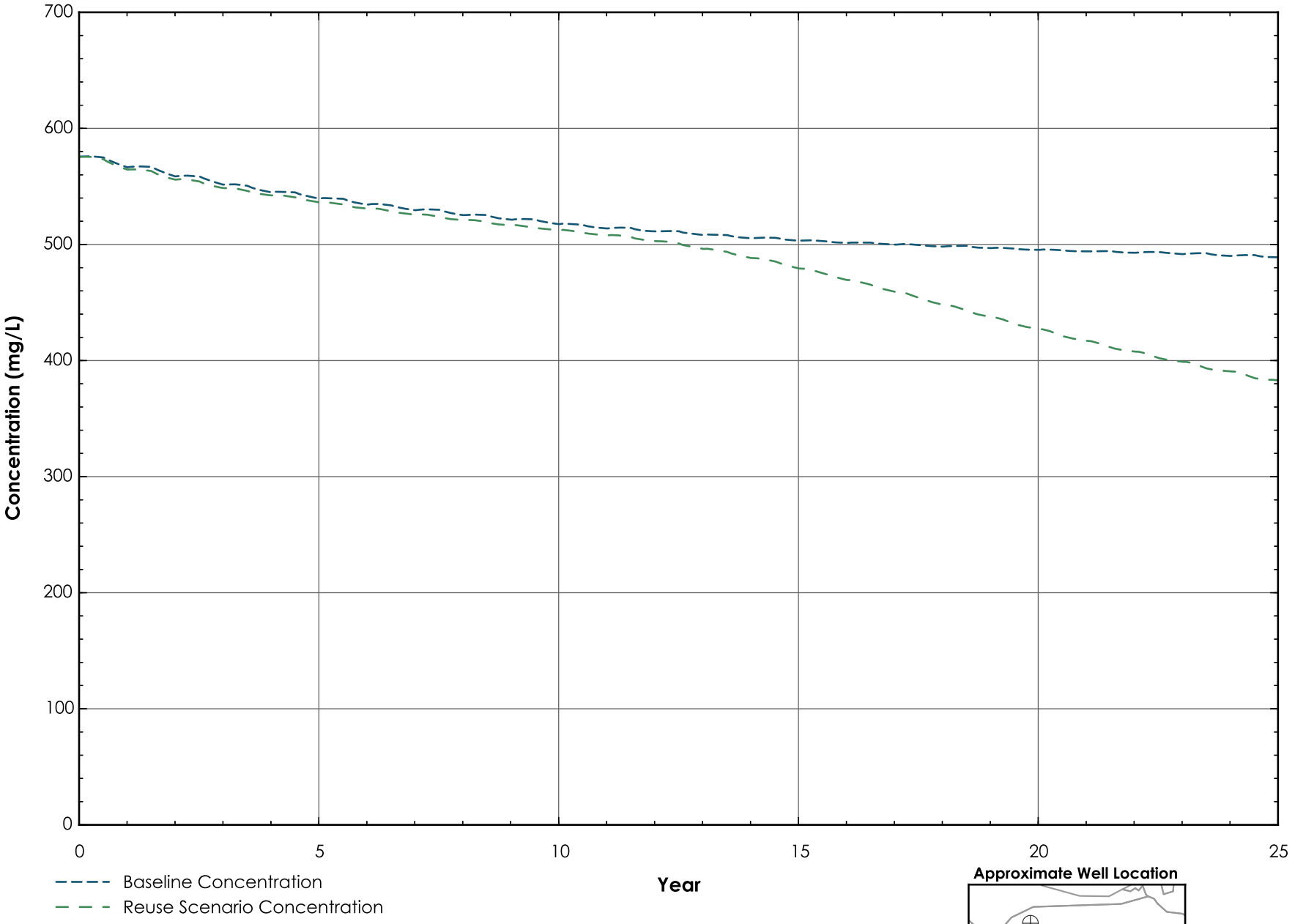


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

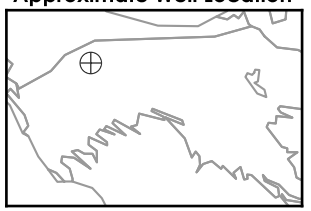


Well MOCHO 4 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

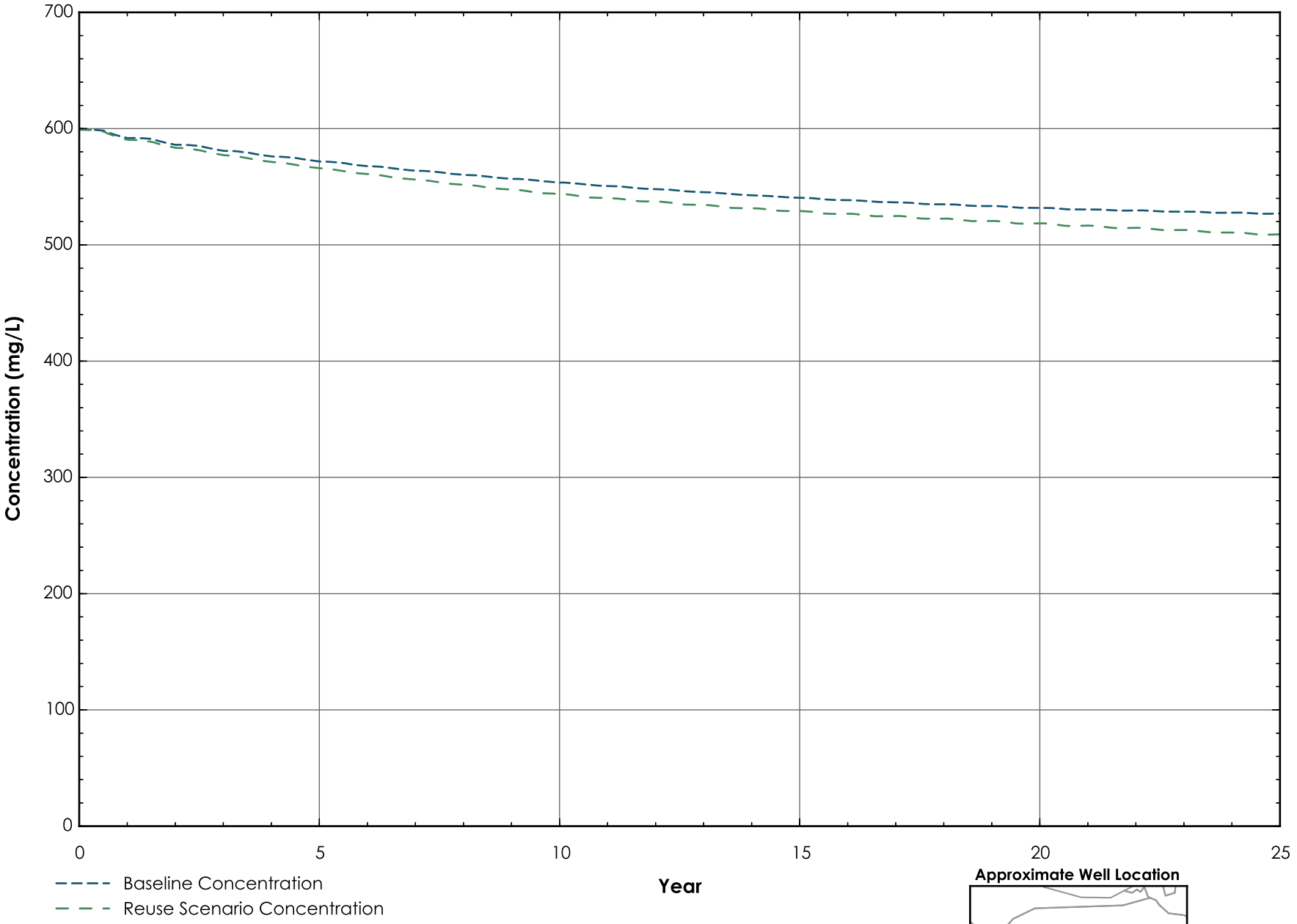


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

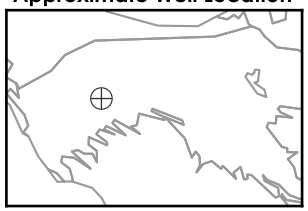


Well PLEAS 5 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

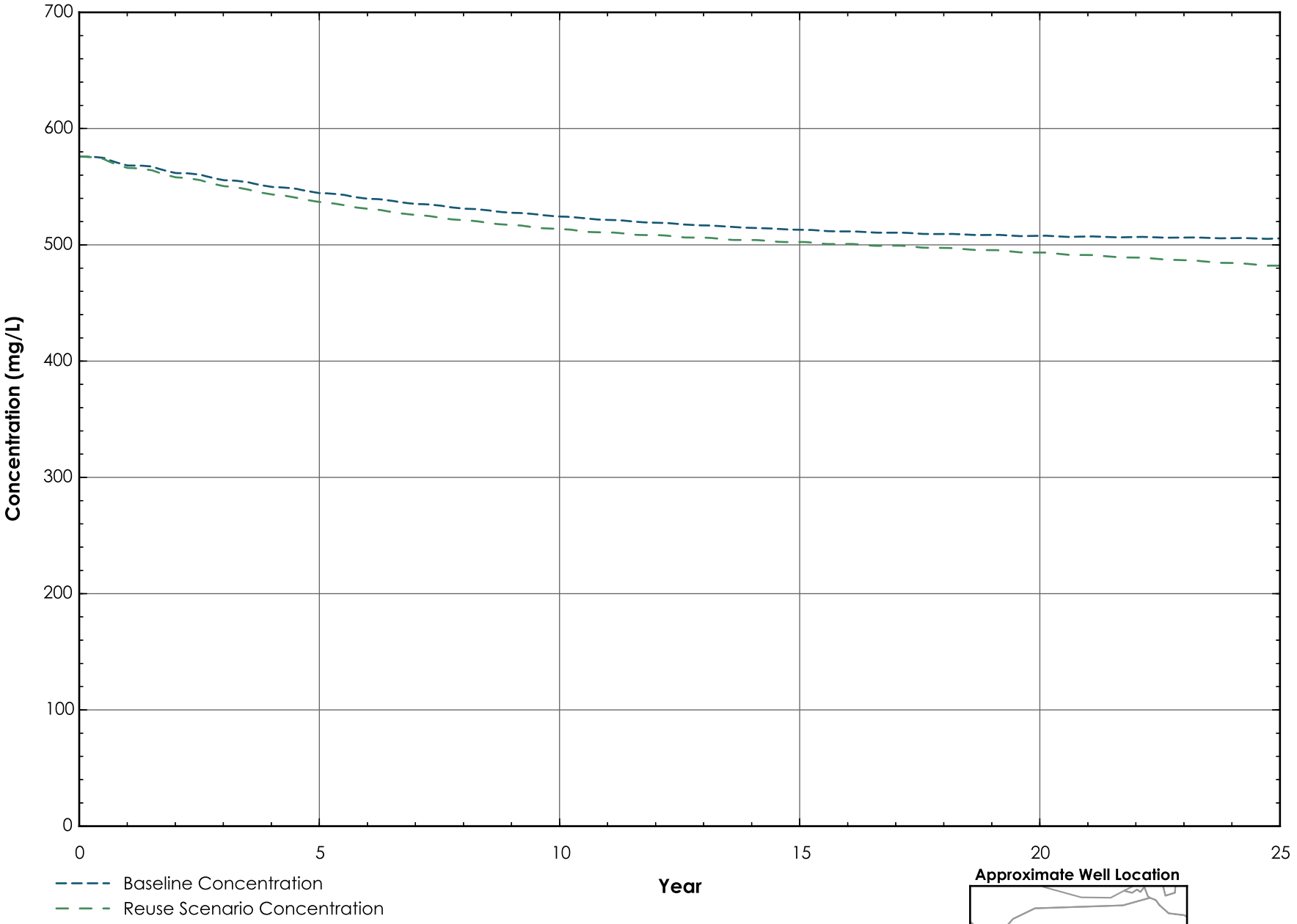


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

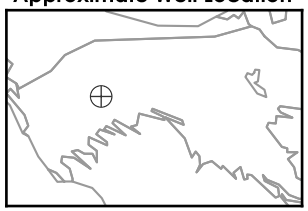


Well PLEAS 6 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

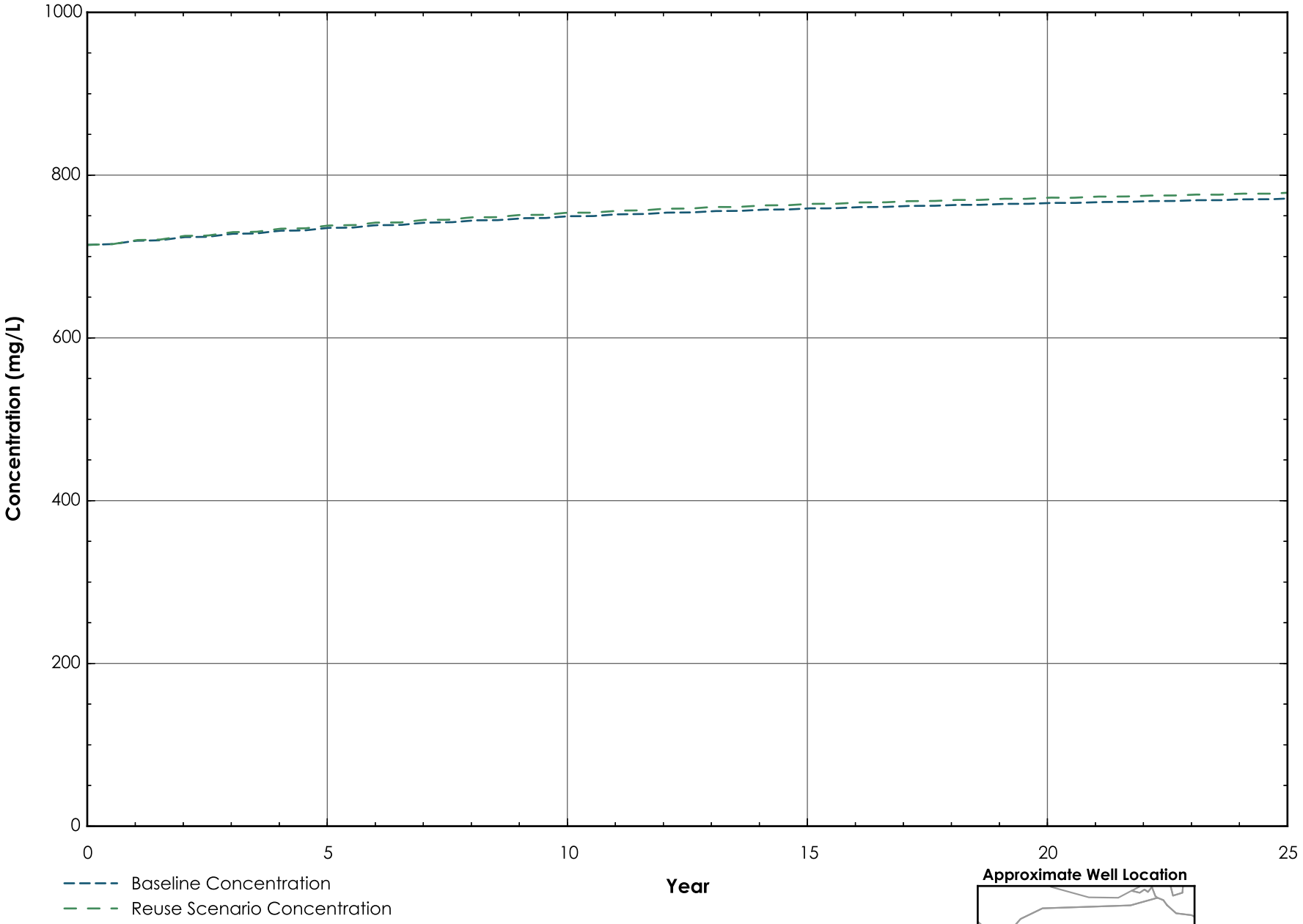


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

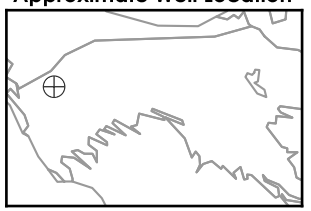


Well PLEAS 7 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

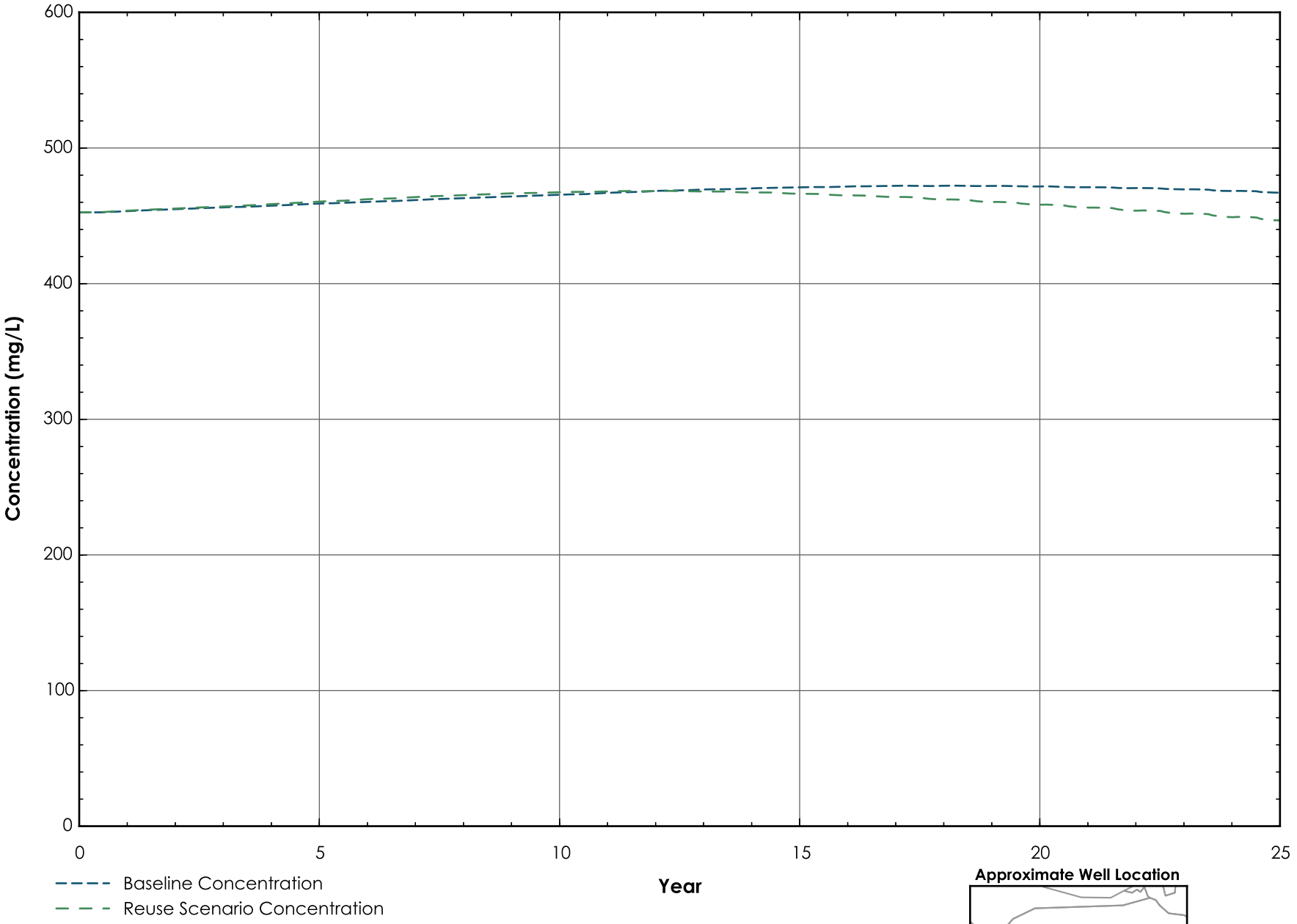


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

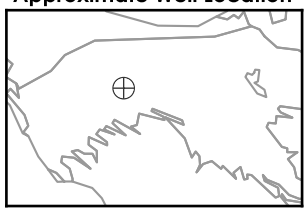


Well PLEAS 8 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Well E

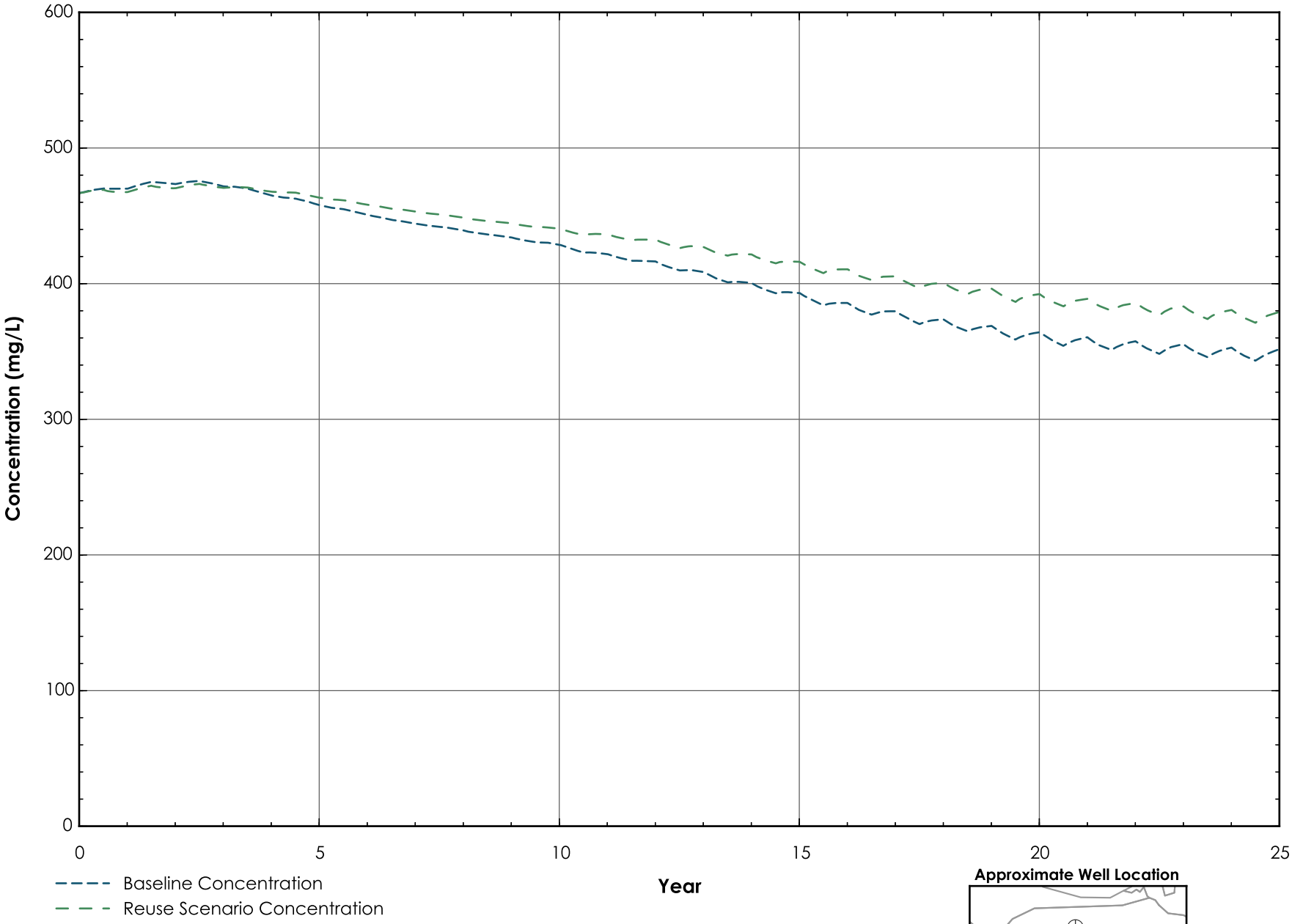


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Site E offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

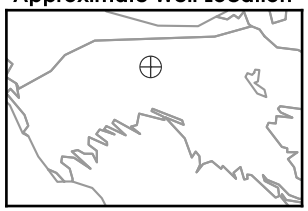


Well COL 1 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

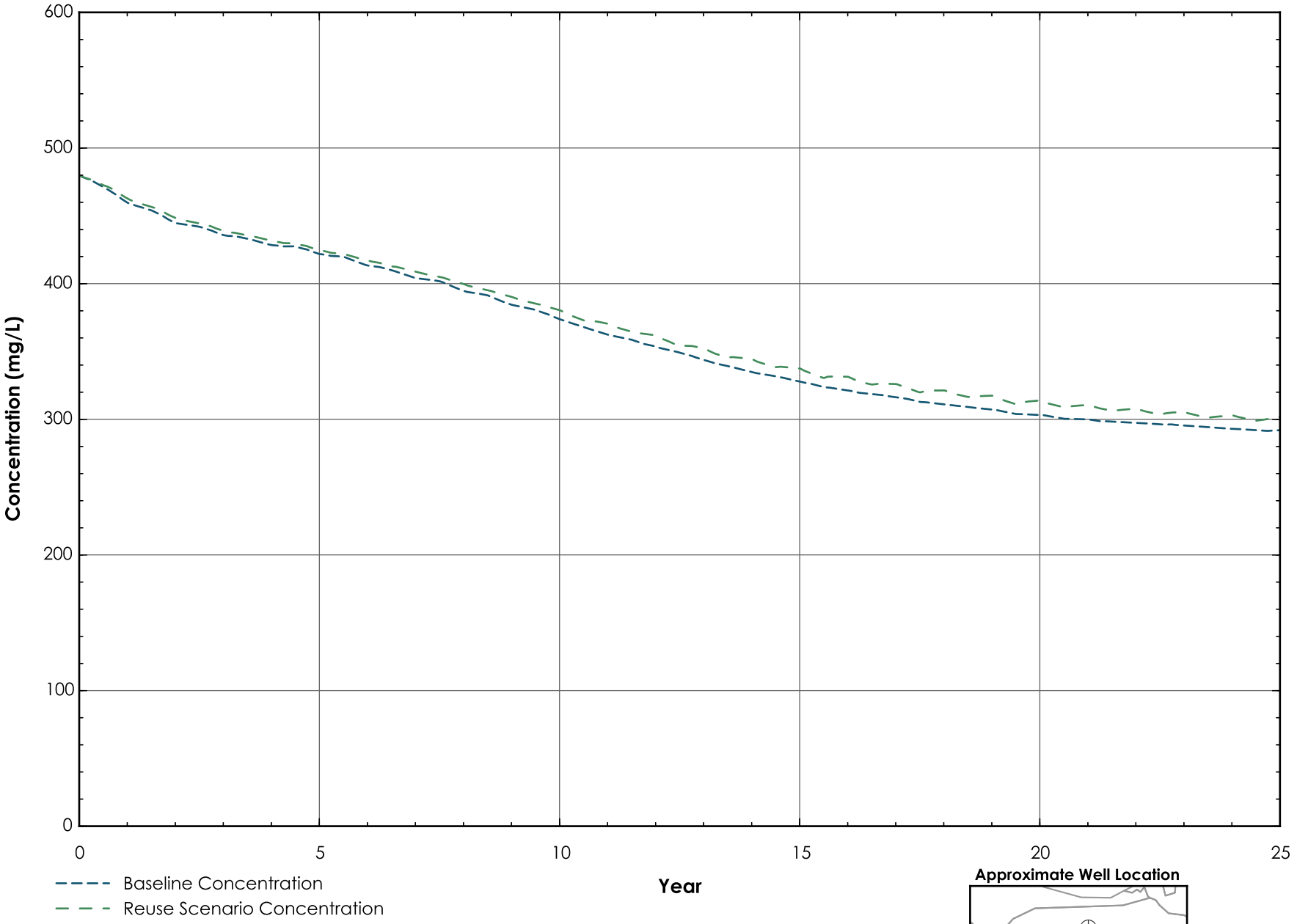


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

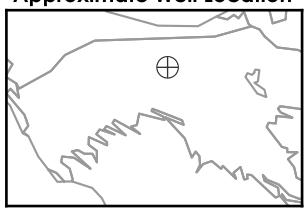


Well COL 2 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

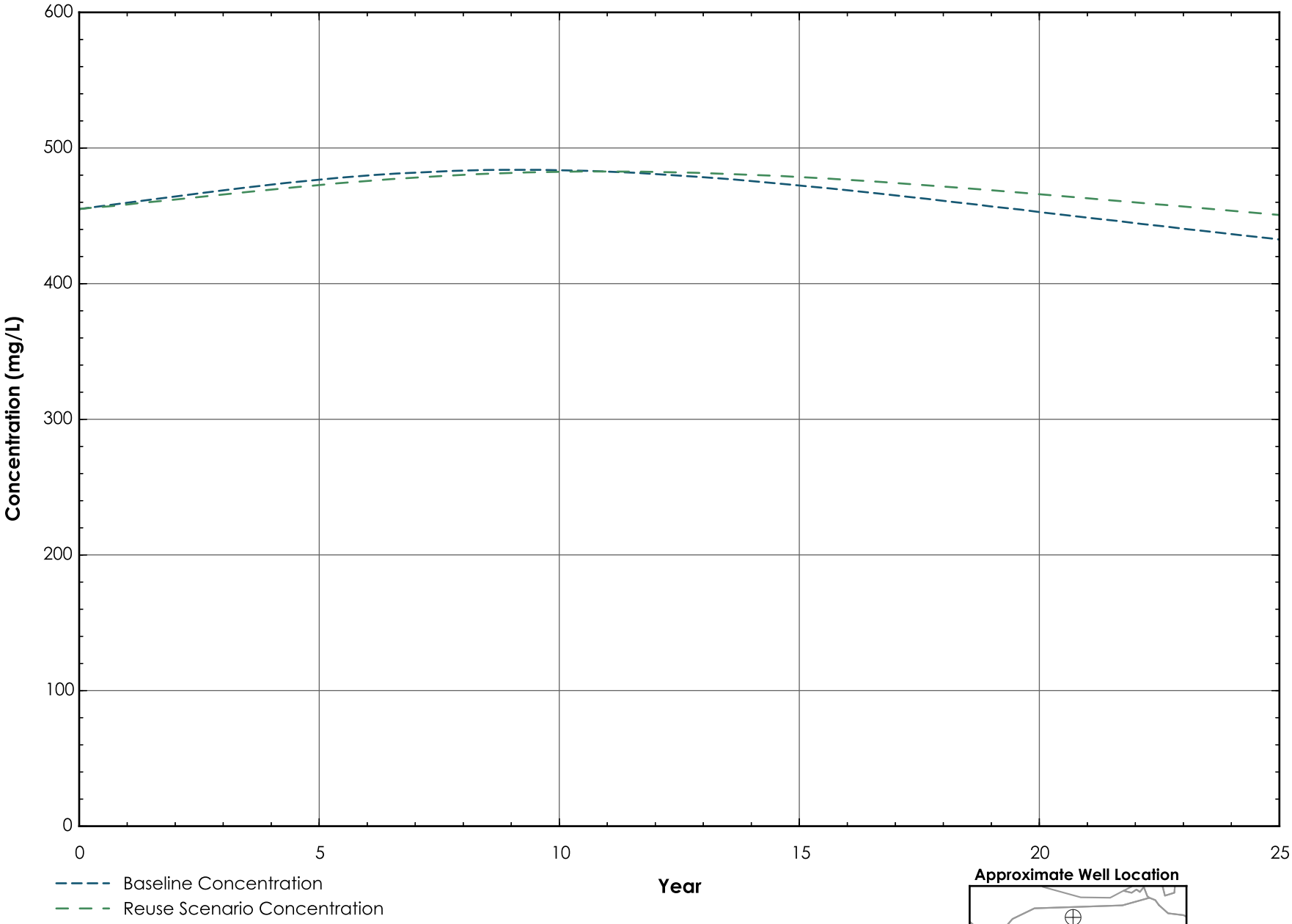


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

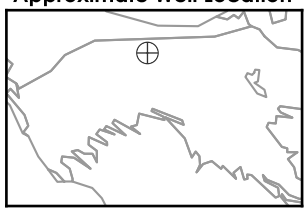


Well COL 5 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

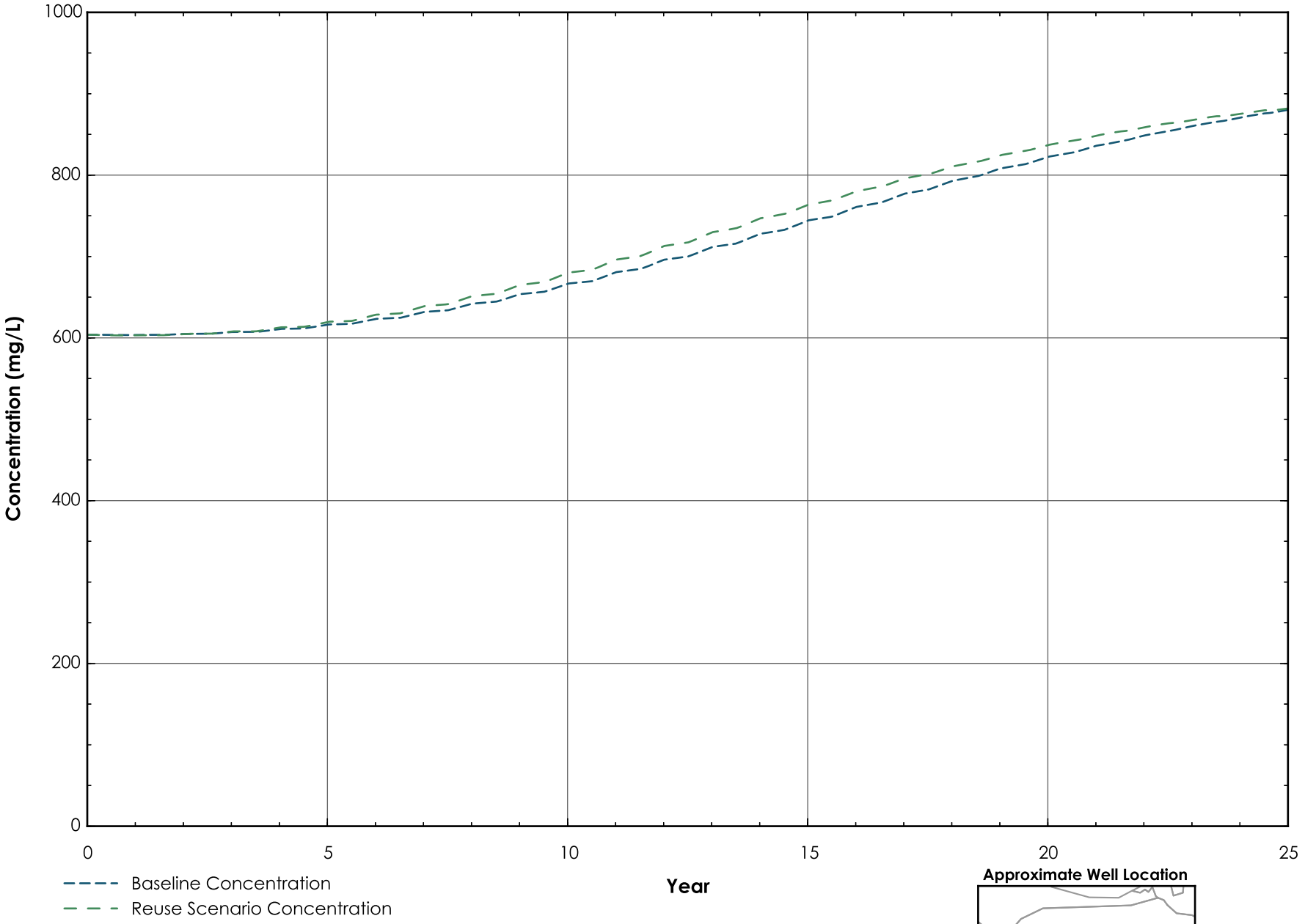


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

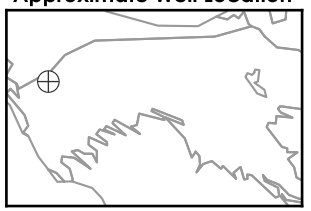


Well HOP 6 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

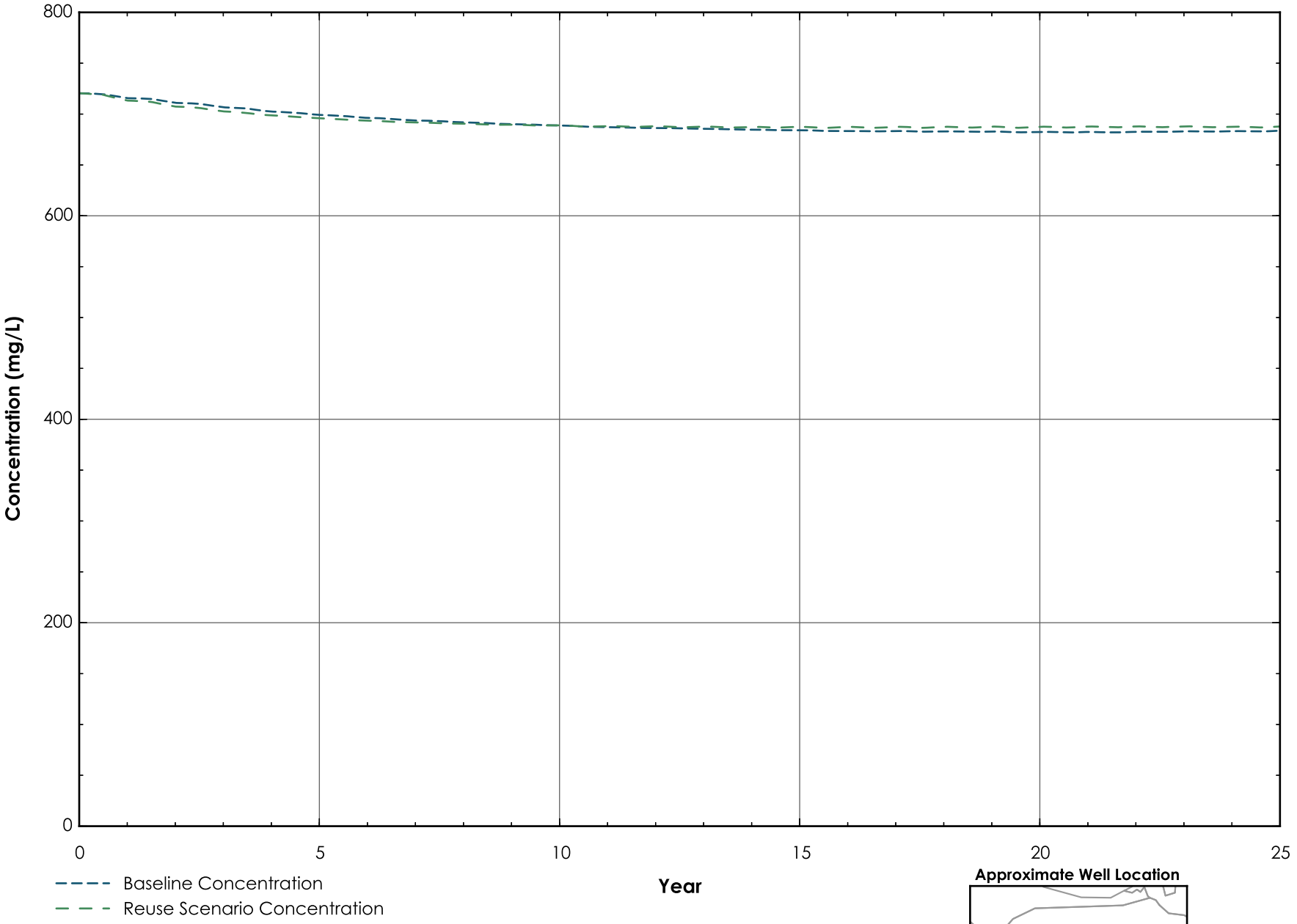


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

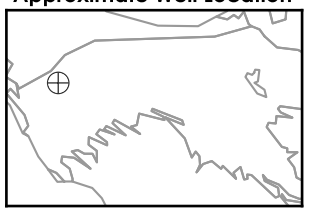


Well HOP 9 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

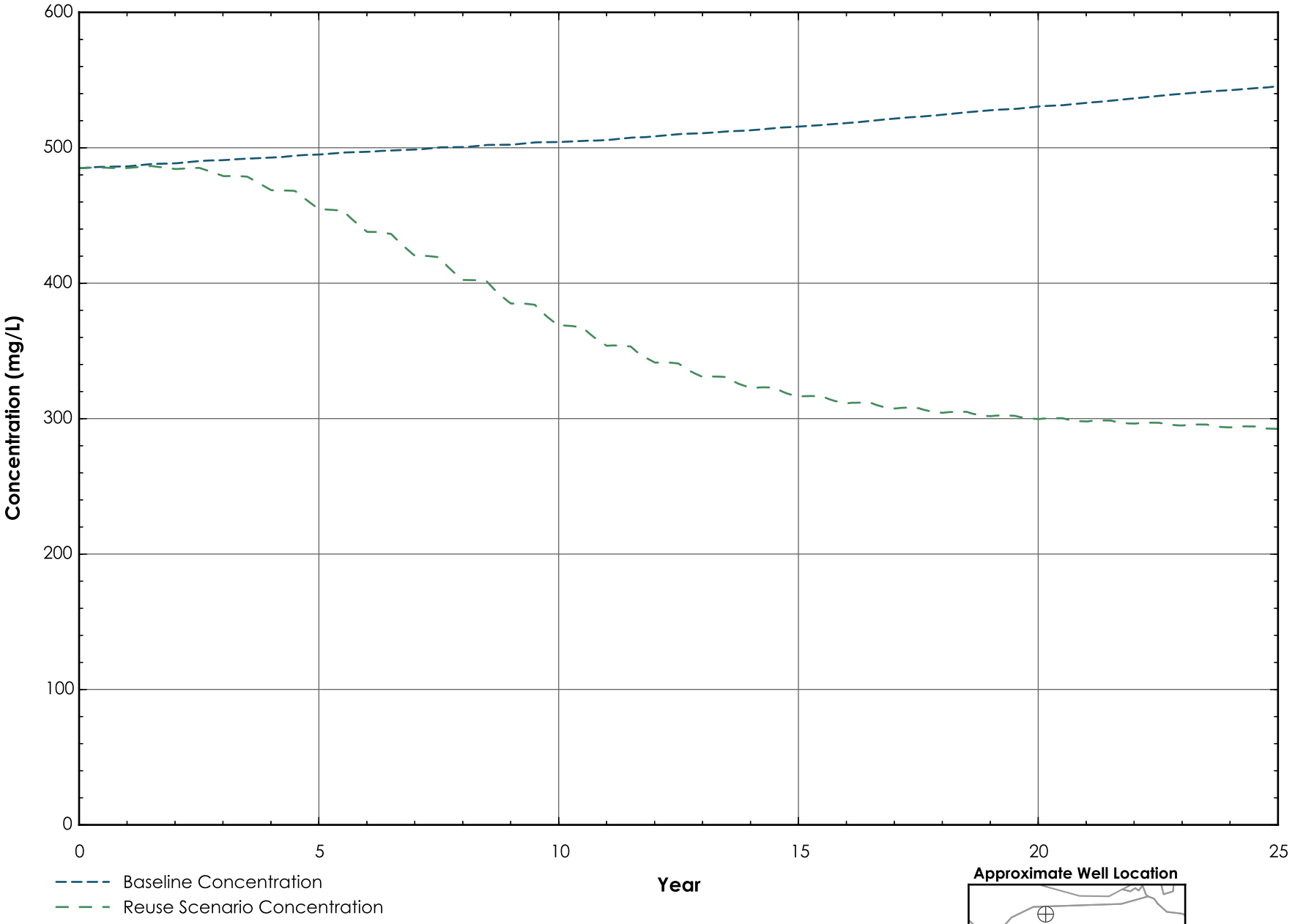


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

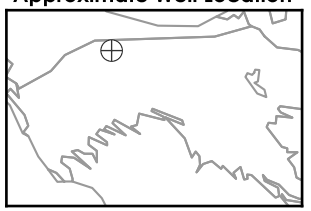


Well STONERIDGE 1 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

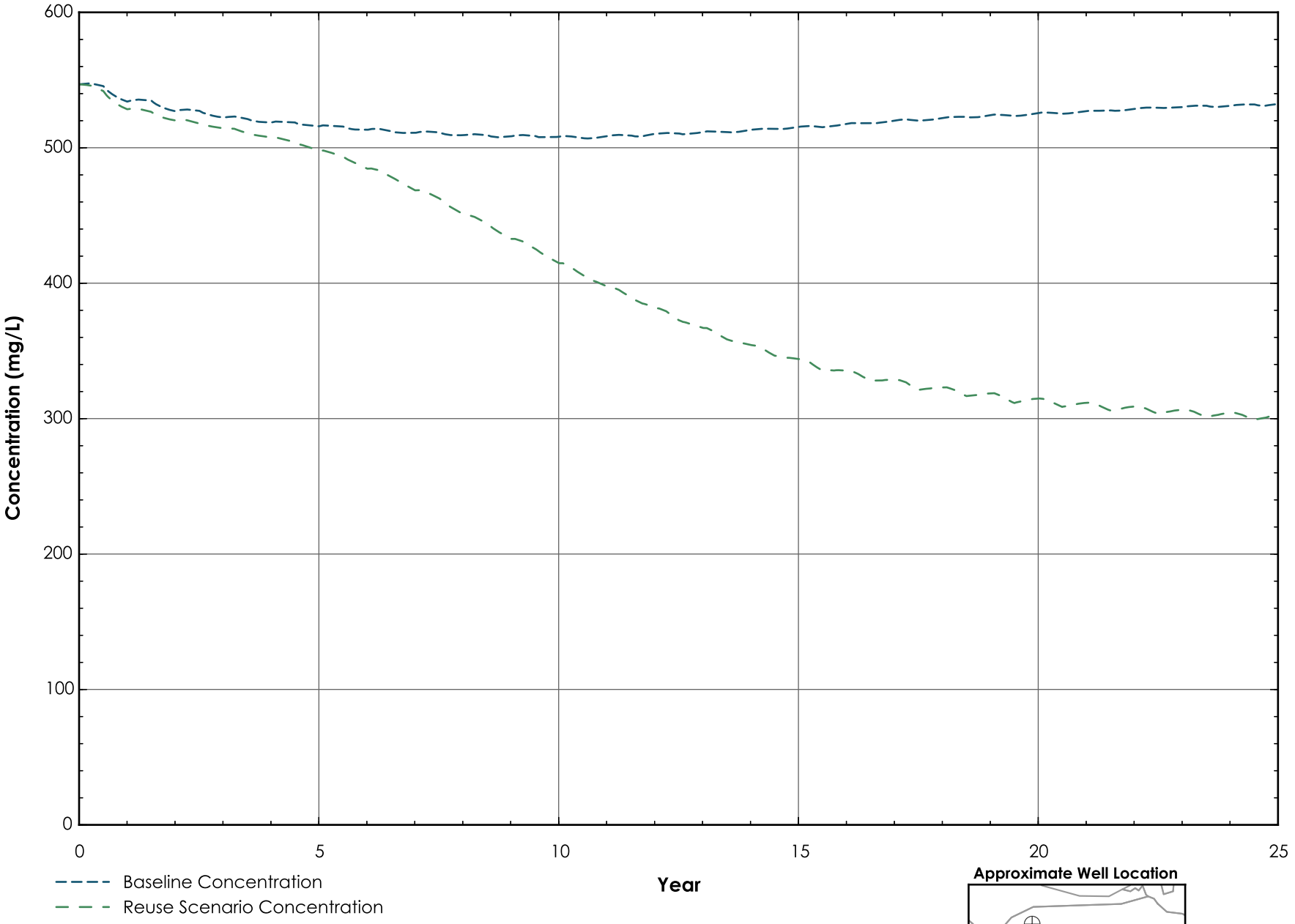


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

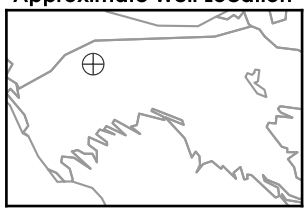


Well MOCHO 1 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

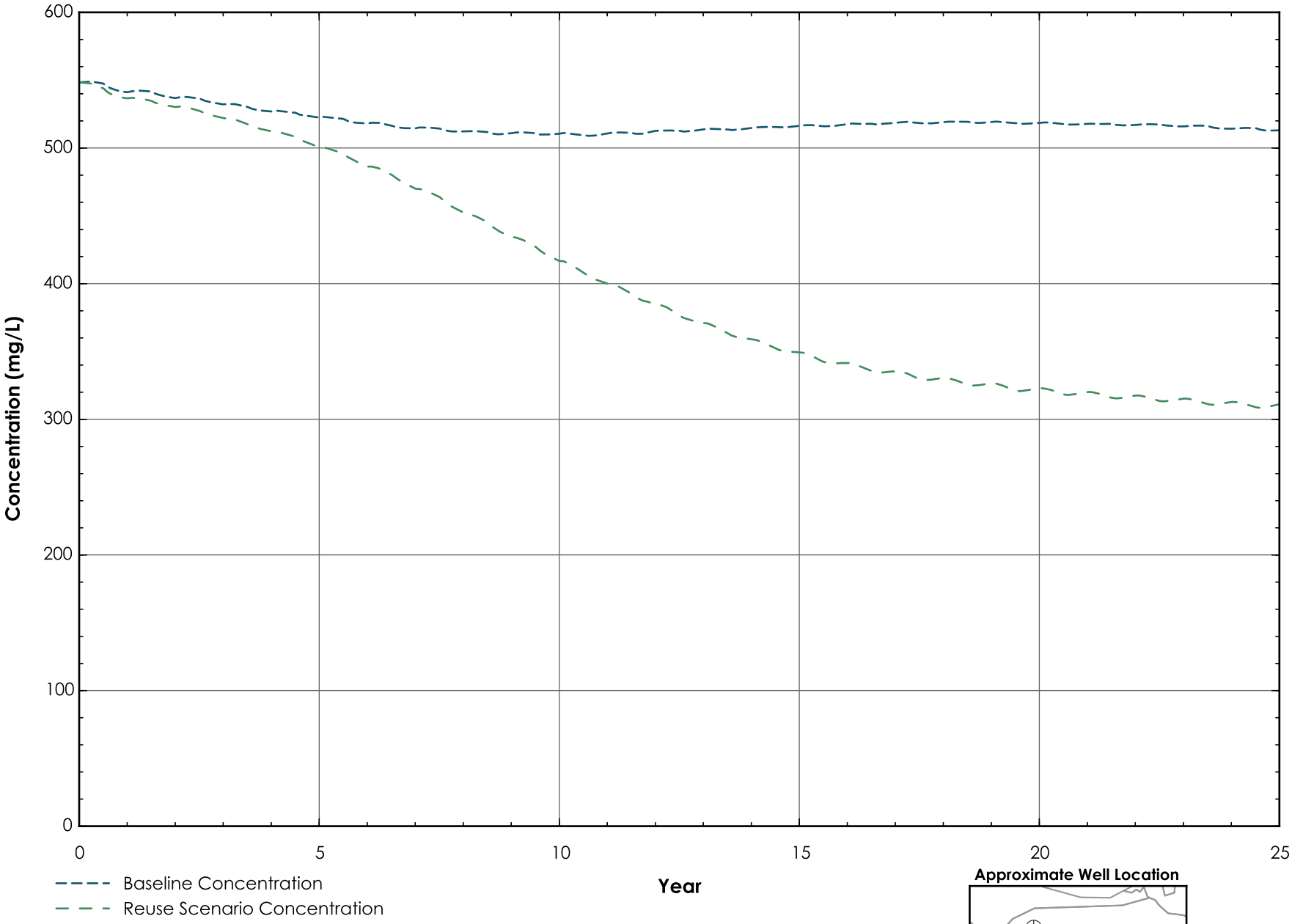


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

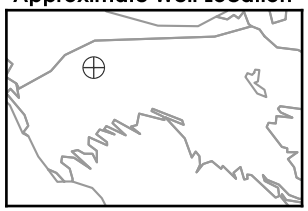


Well MOCHO 2 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

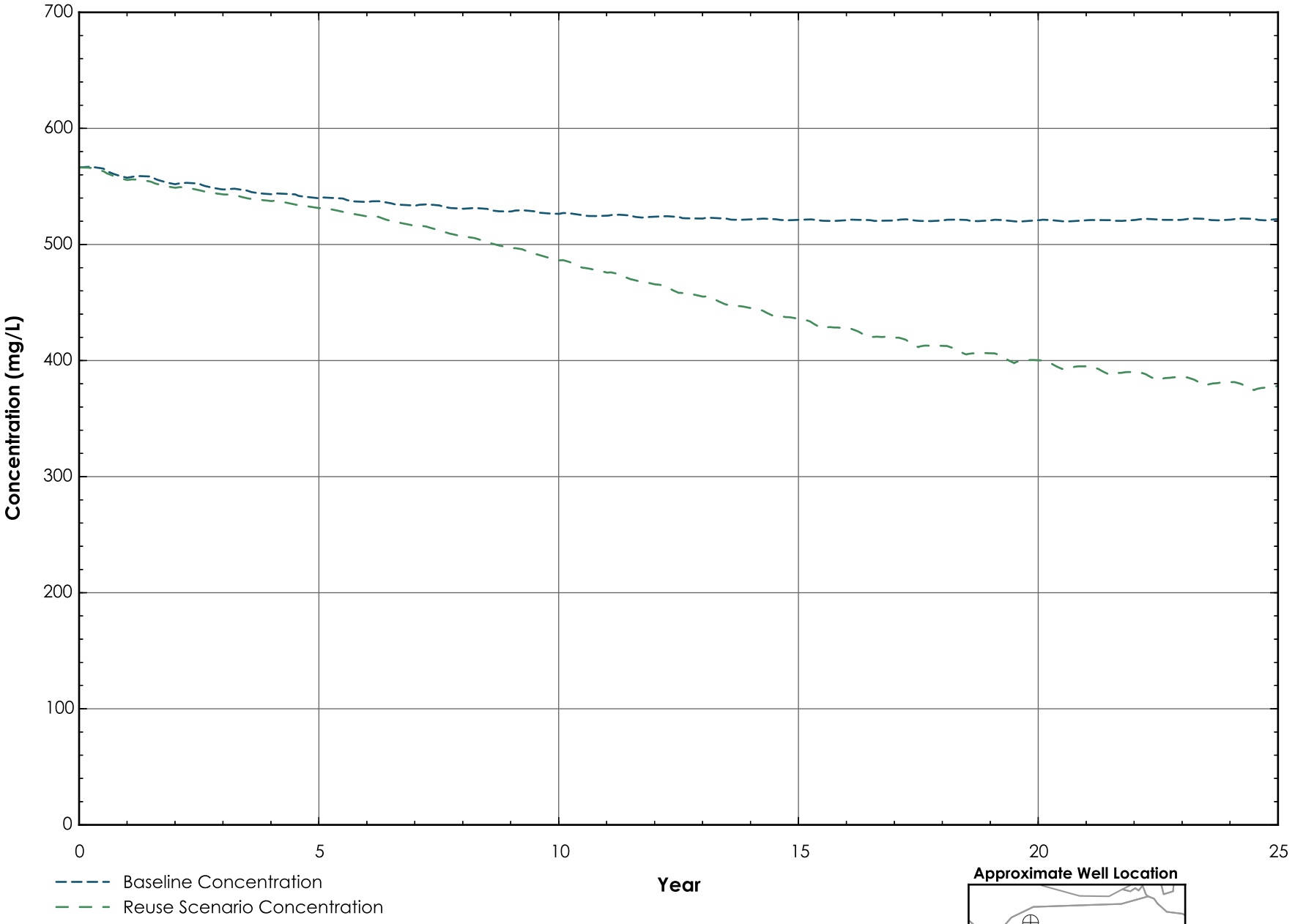


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

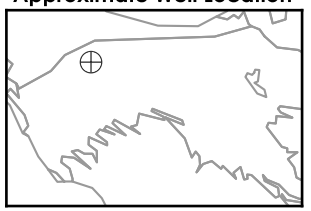


Well MOCHO 3 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

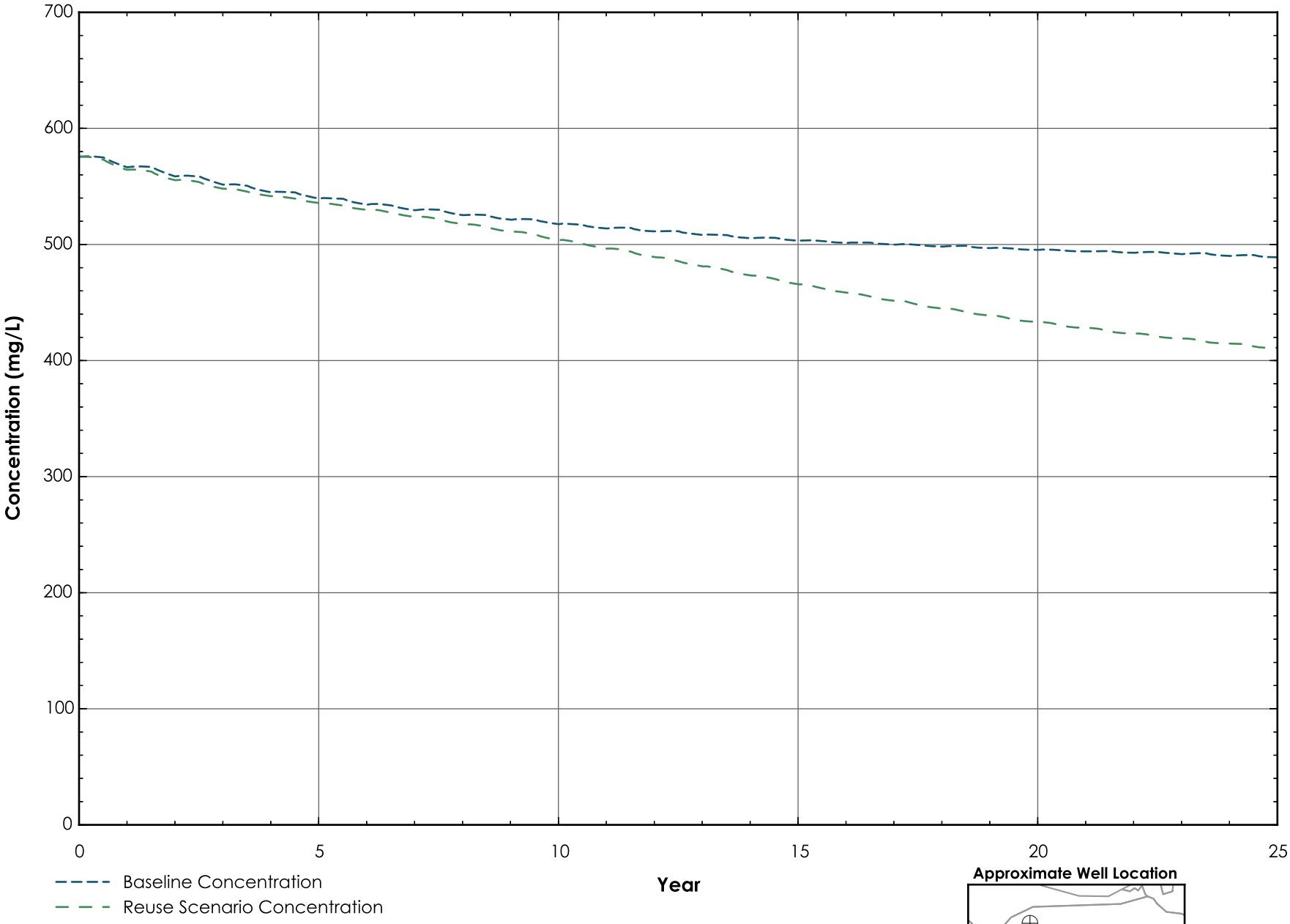


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

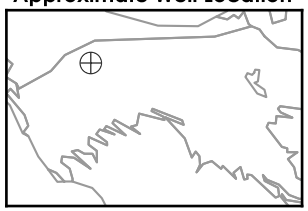


Well MOCHO 4 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

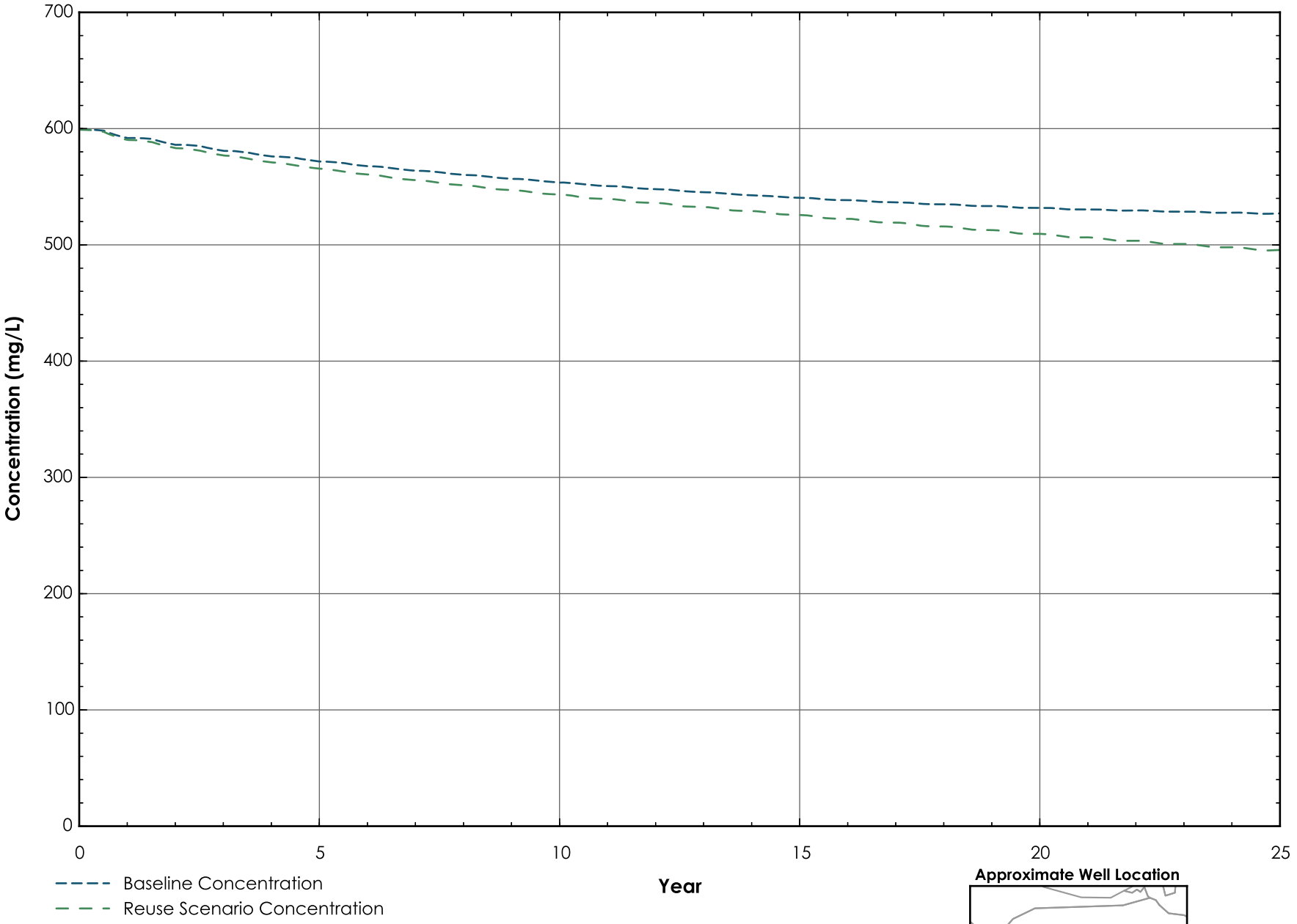


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

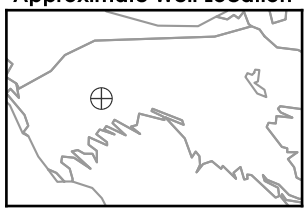


Well PLEAS 5 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

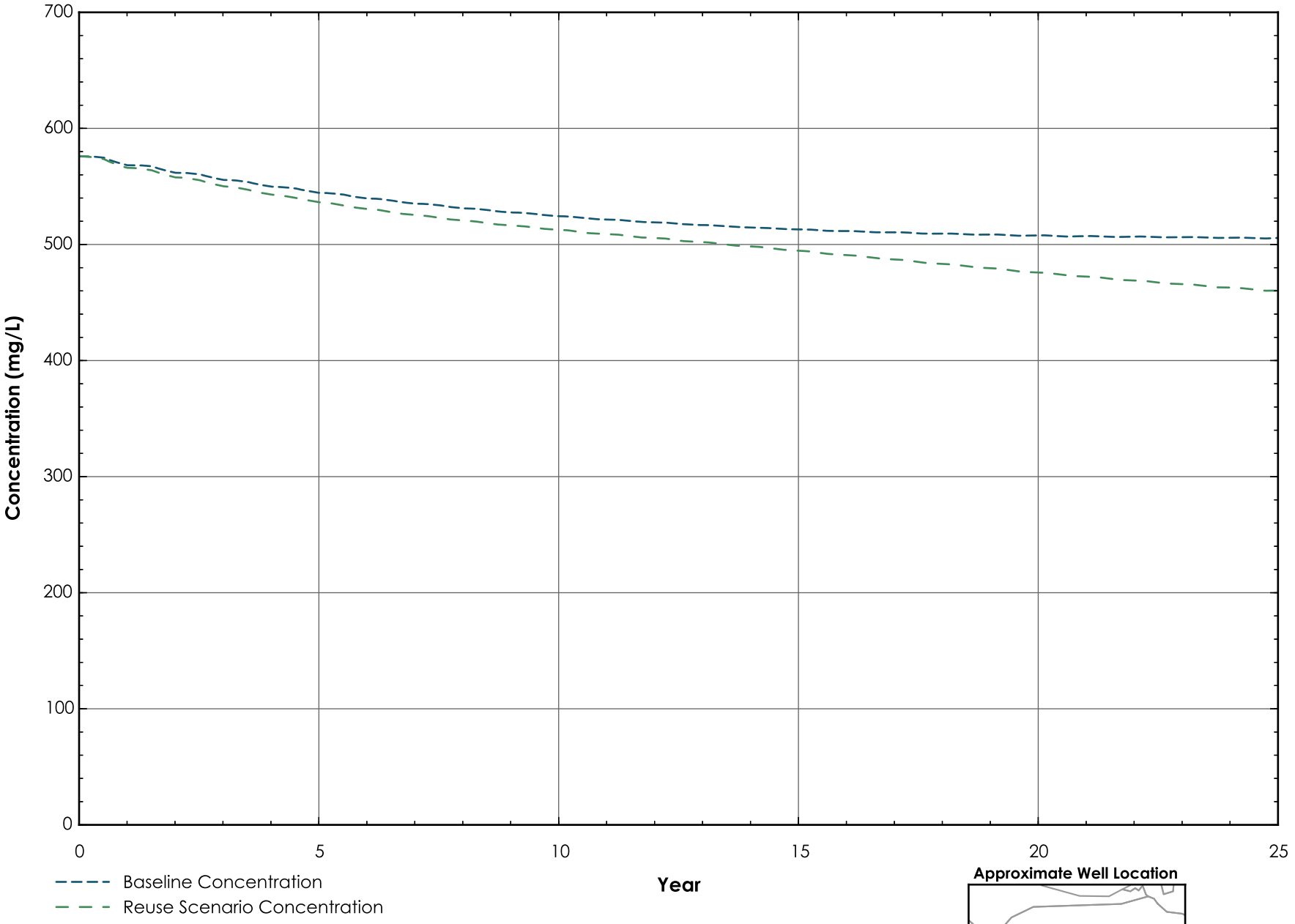


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

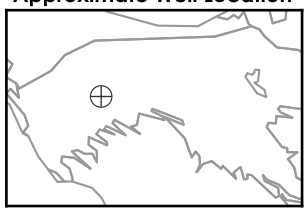


Well PLEAS 6 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

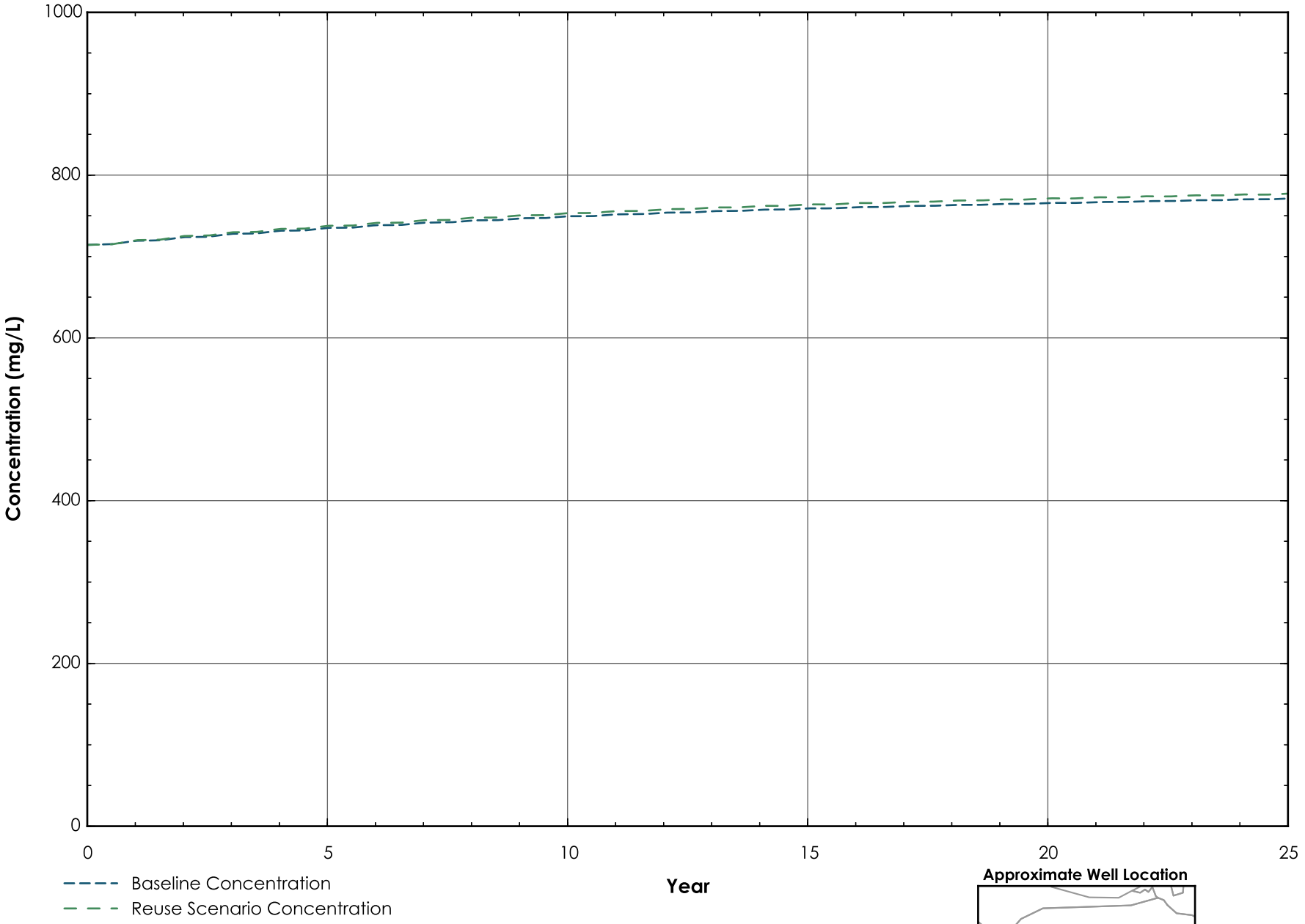


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

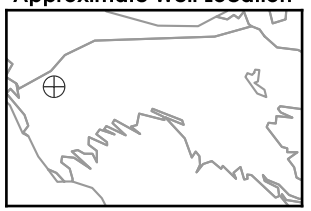


Well PLEAS 7 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

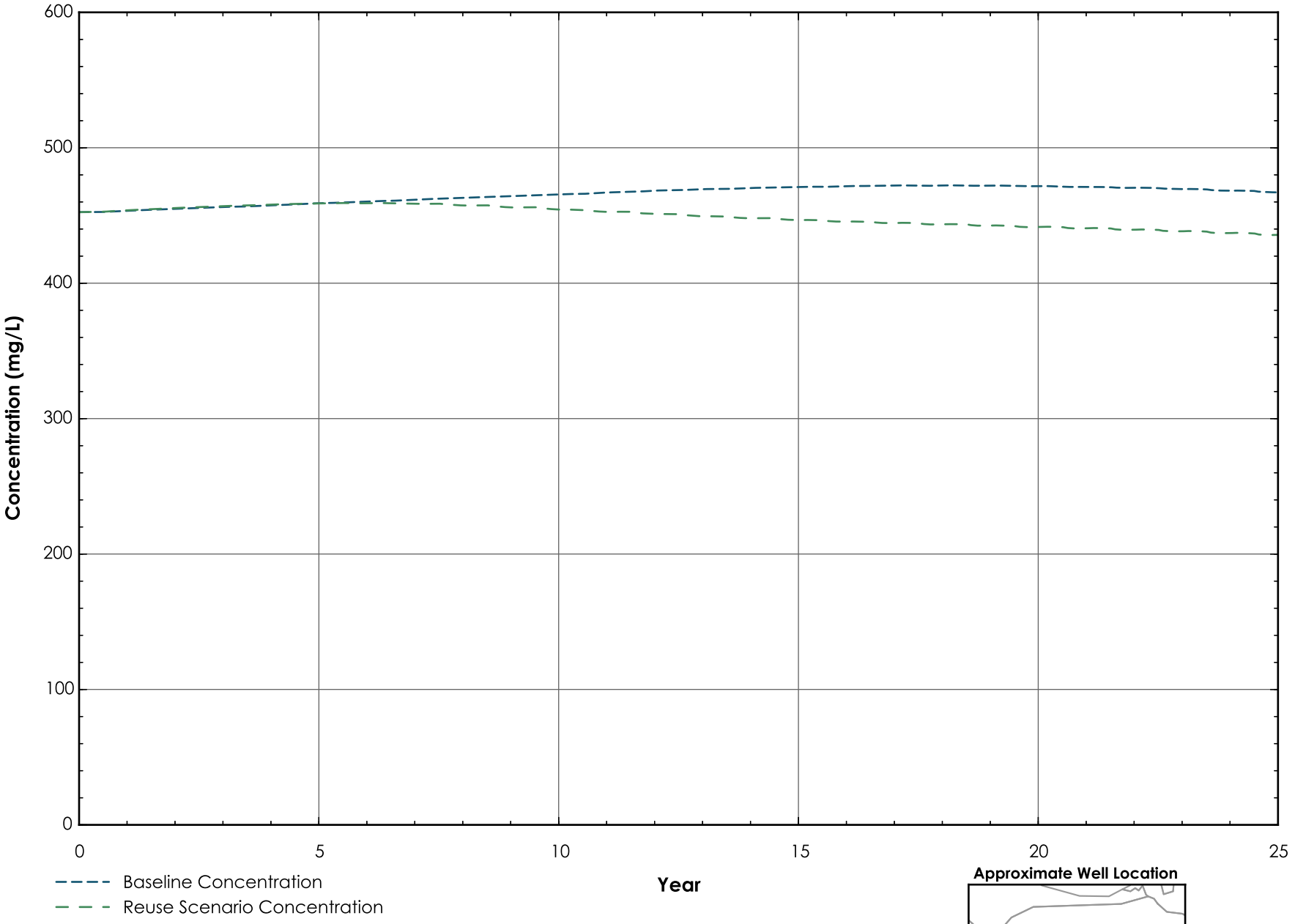


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

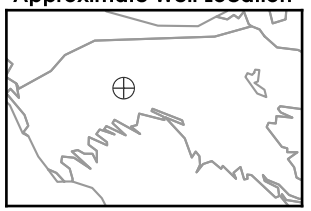


Well PLEAS 8 Simulated TDS Concentration in Lower Aquifer
5,500 AFY Recharge to Lake I

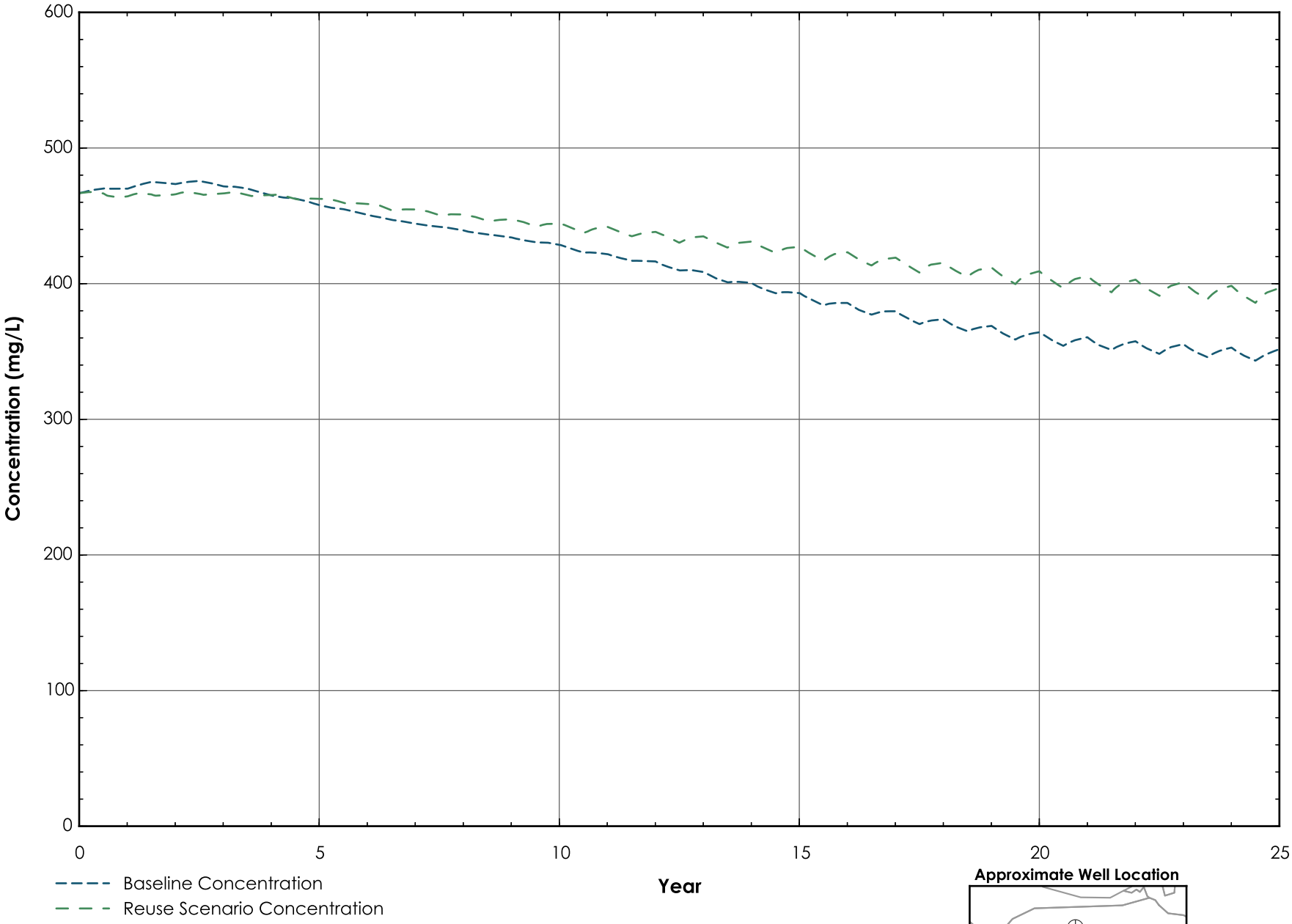


Note:
Simulation of injection of 5,500 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

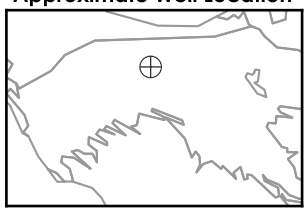


Well COL 1 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

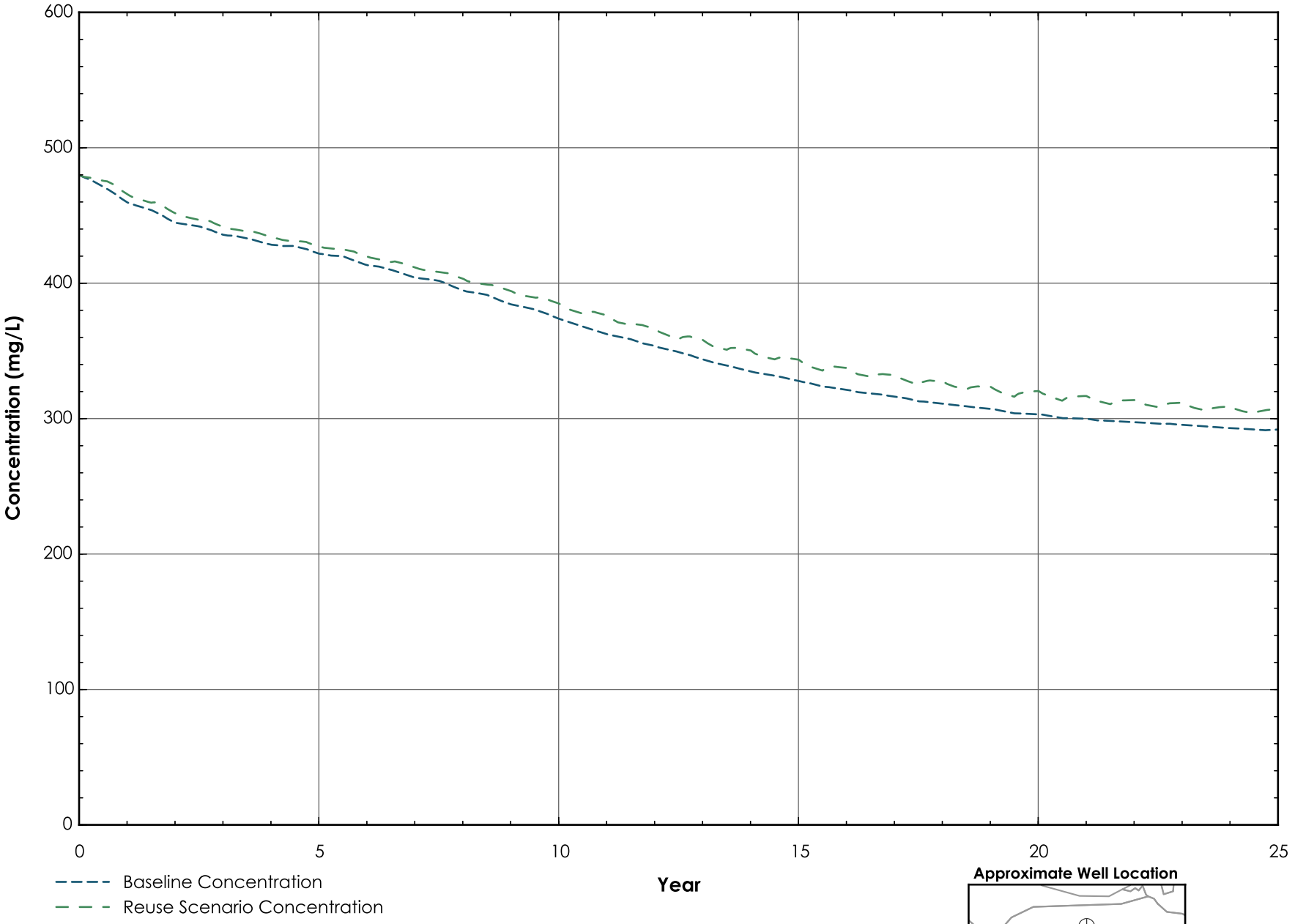


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

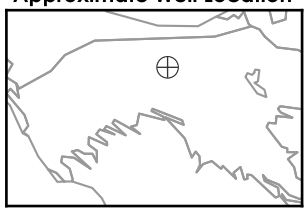


Well COL 2 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

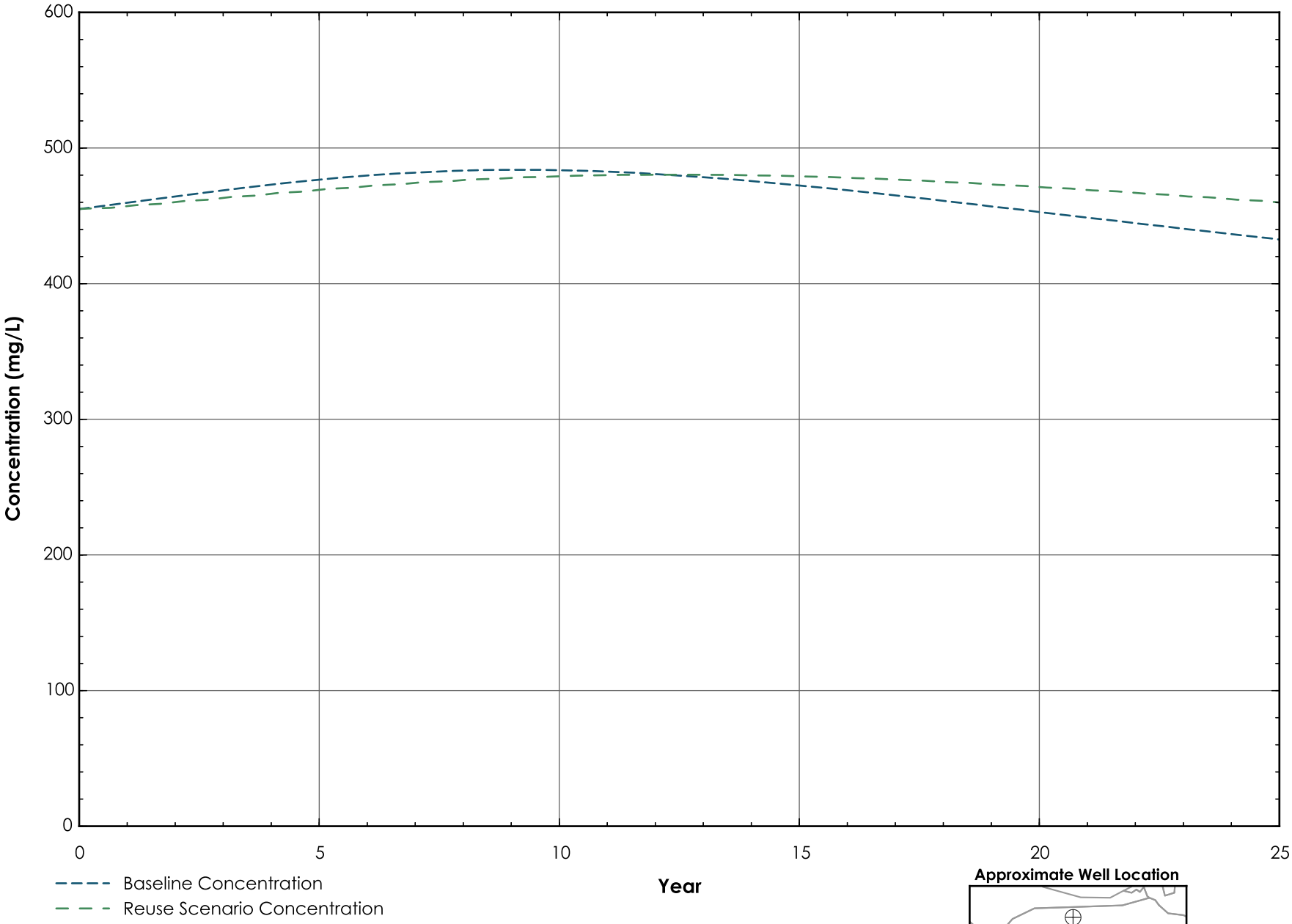


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

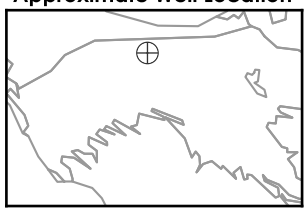


Well COL 5 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

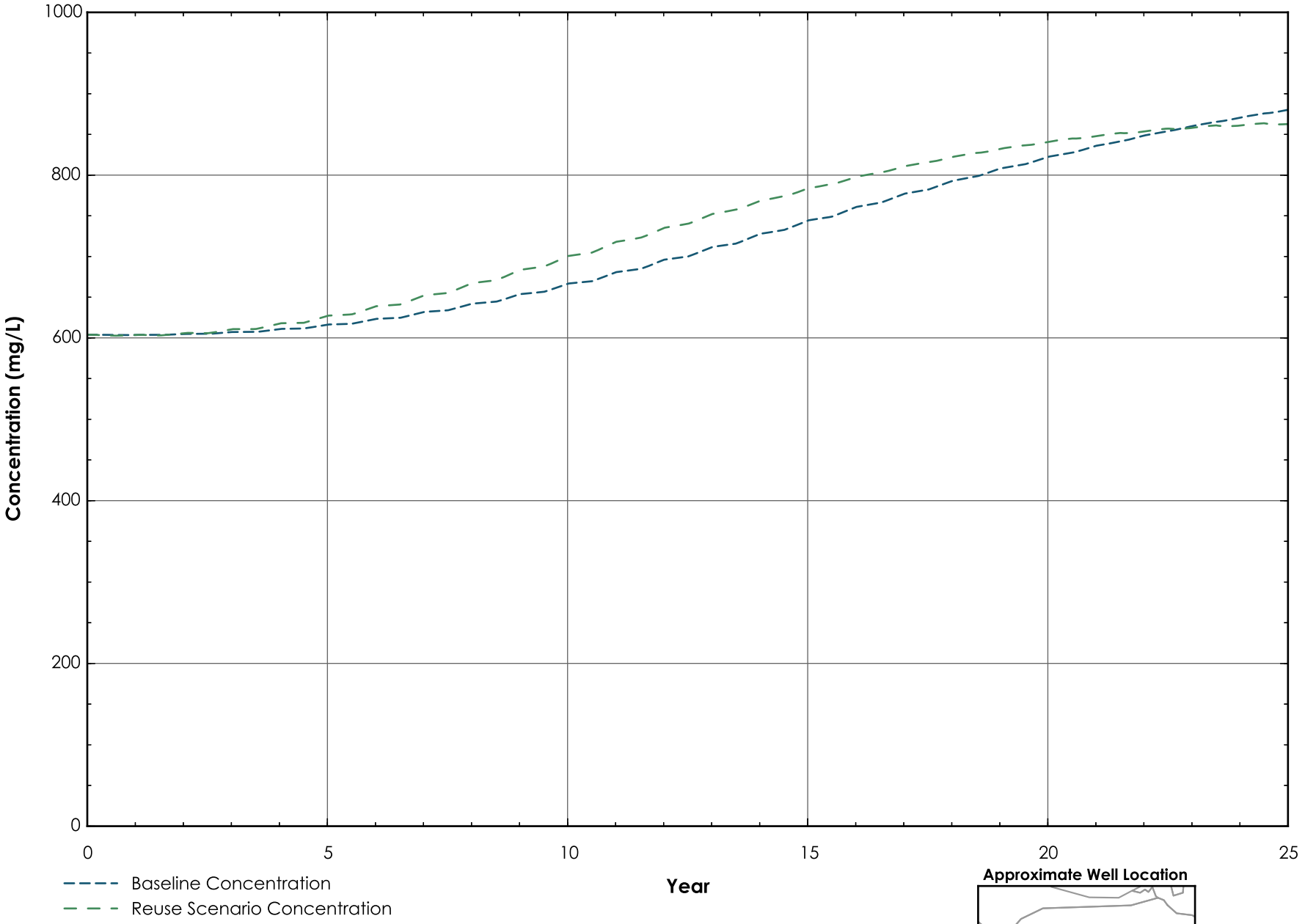


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

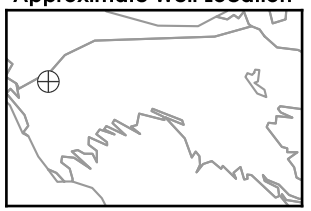


Well HOP 6 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

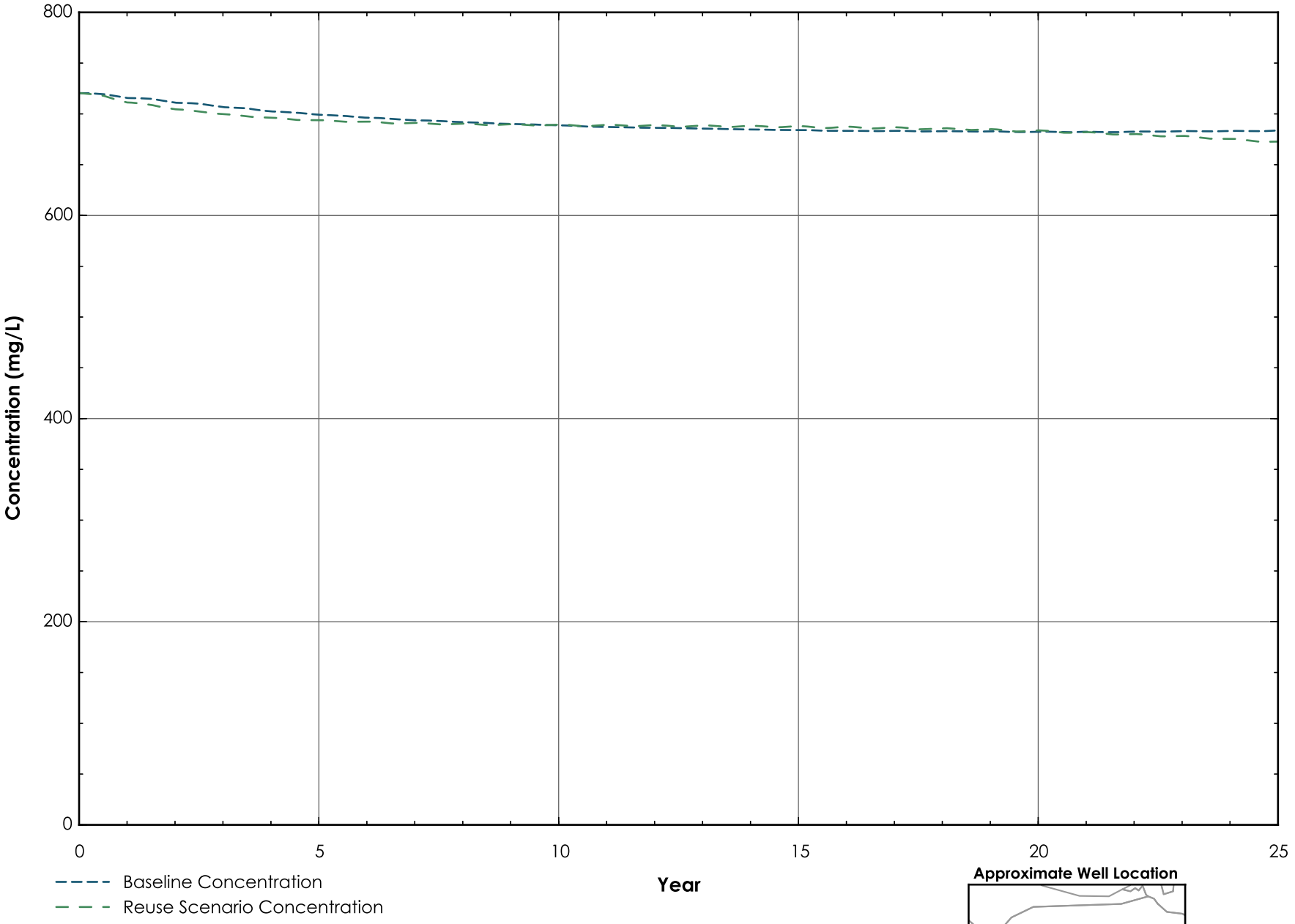


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

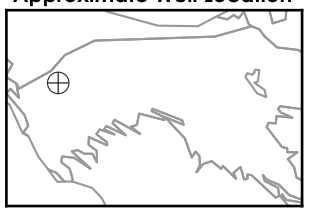


Well HOP 9 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

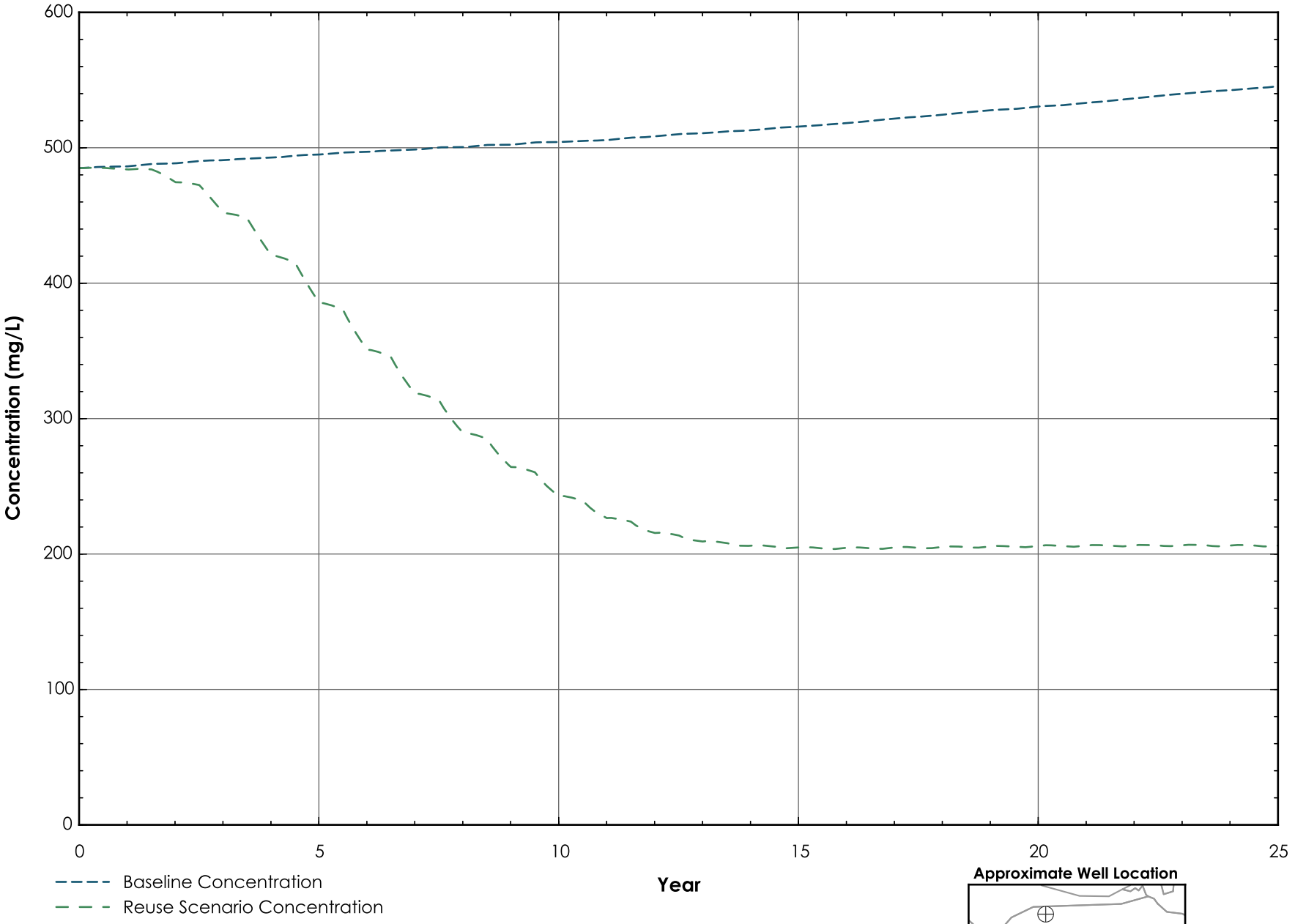


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

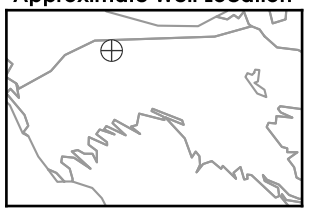


Well STONERIDGE 1 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

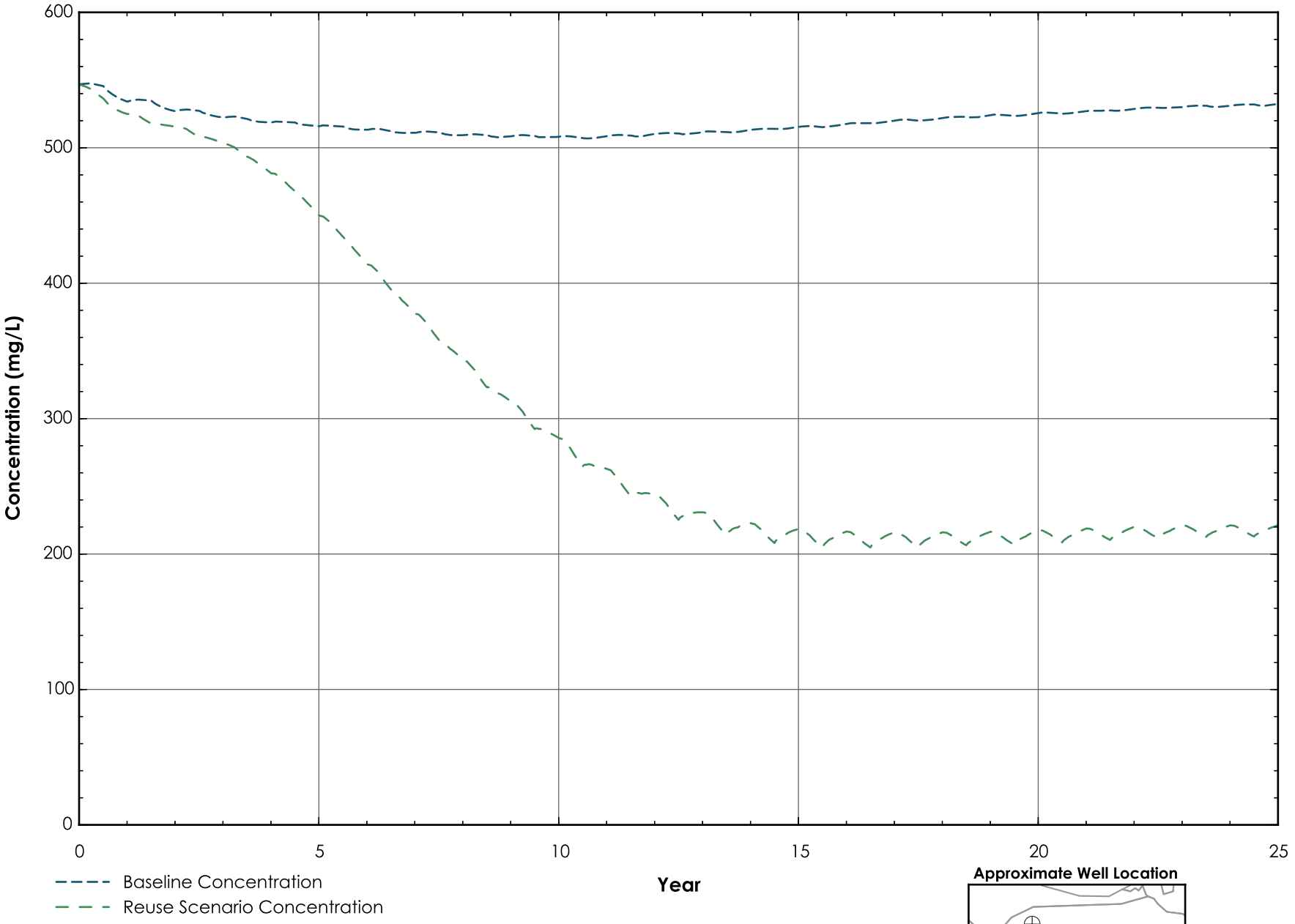


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

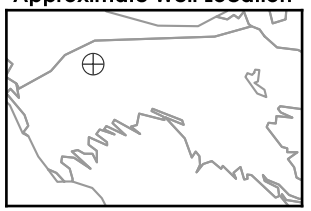


Well MOCHO 1 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

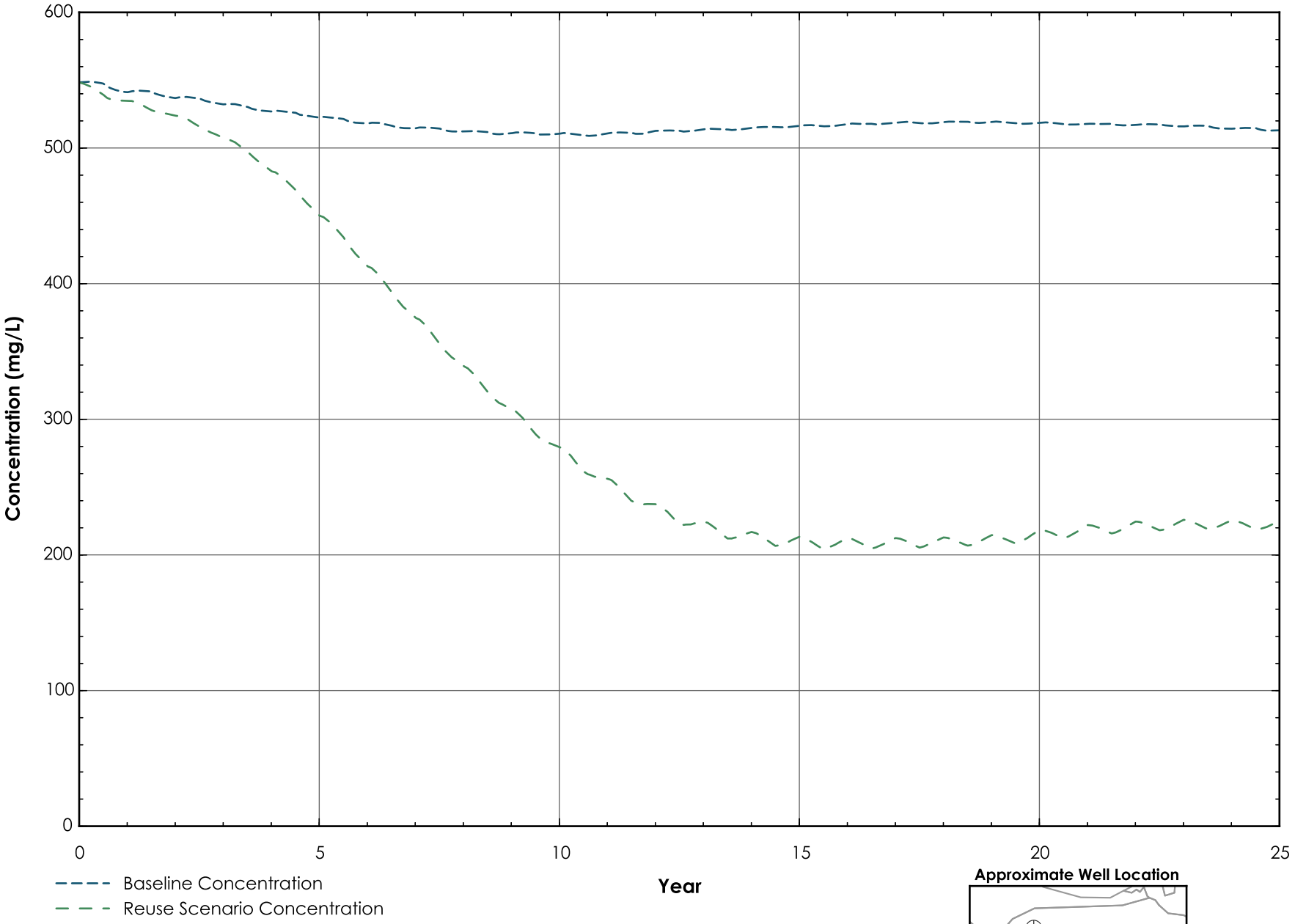


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

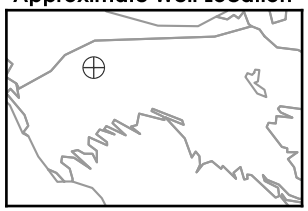


Well MOCHO 2 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

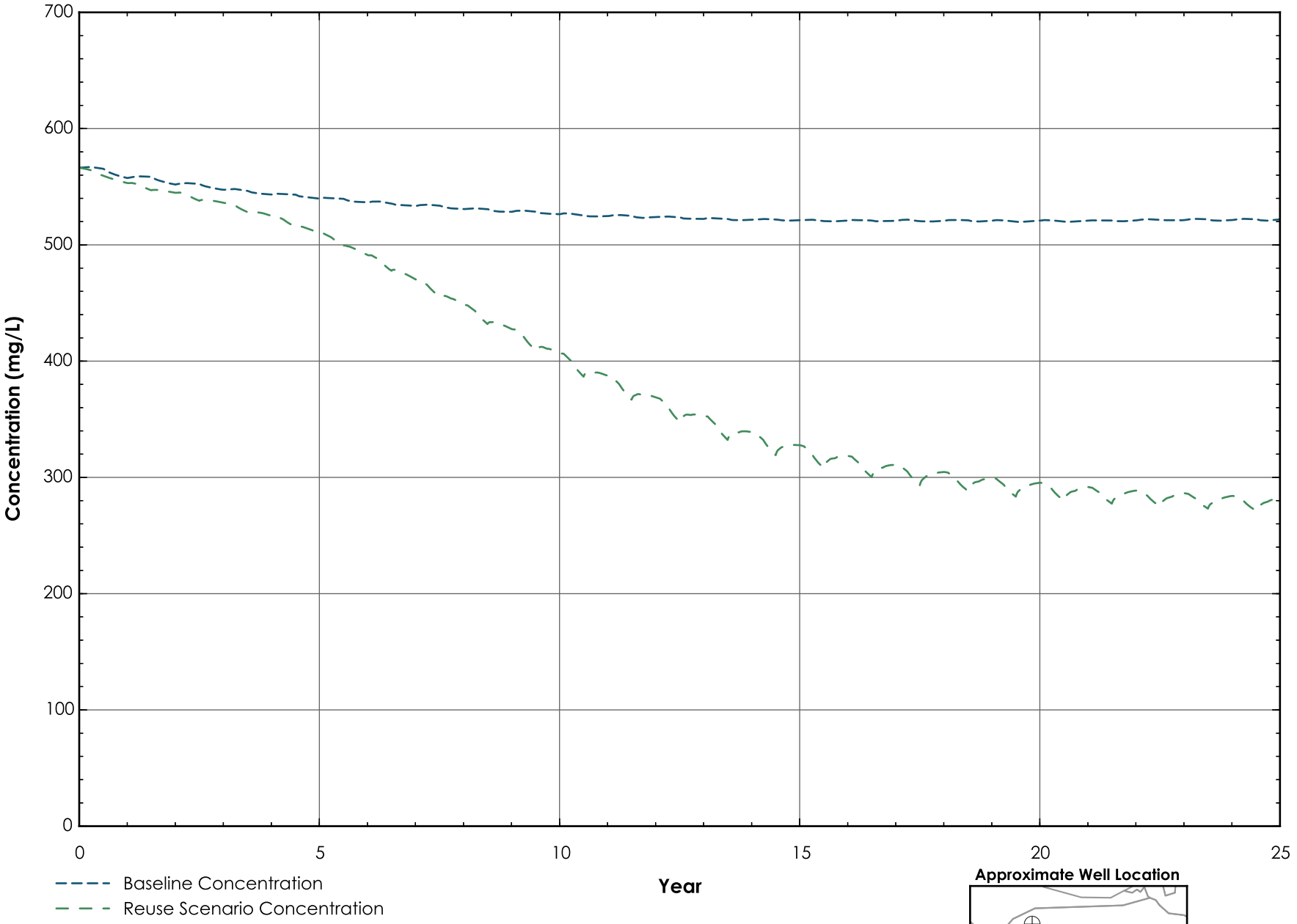


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

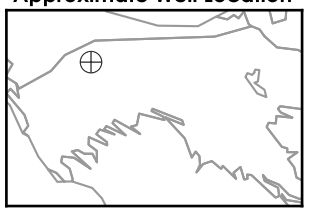


Well MOCHO 3 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

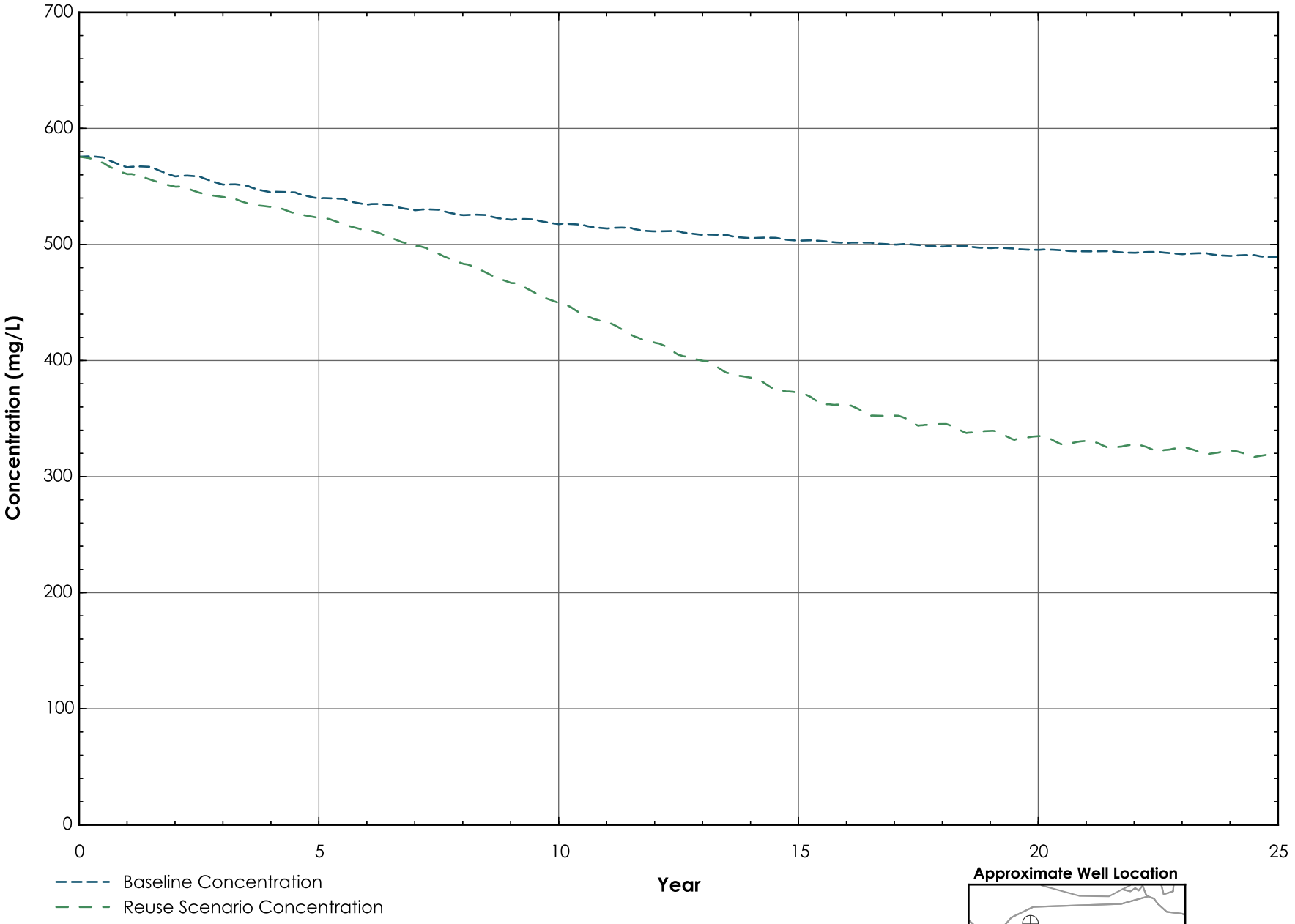


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

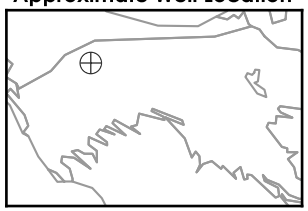


Well MOCHO 4 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

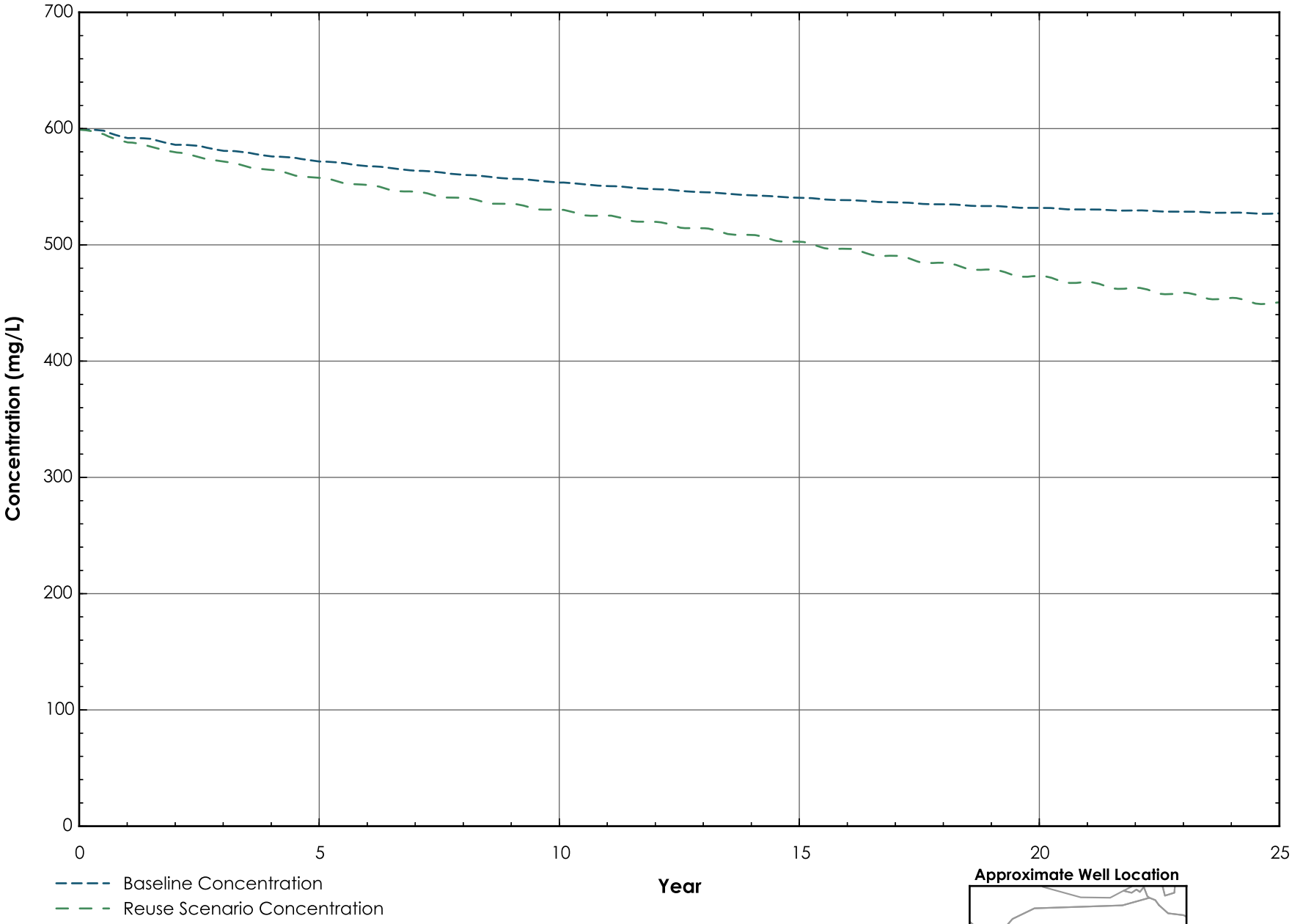


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

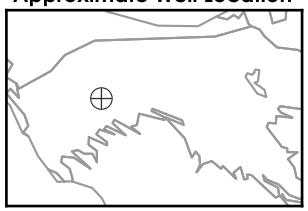


Well PLEAS 5 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

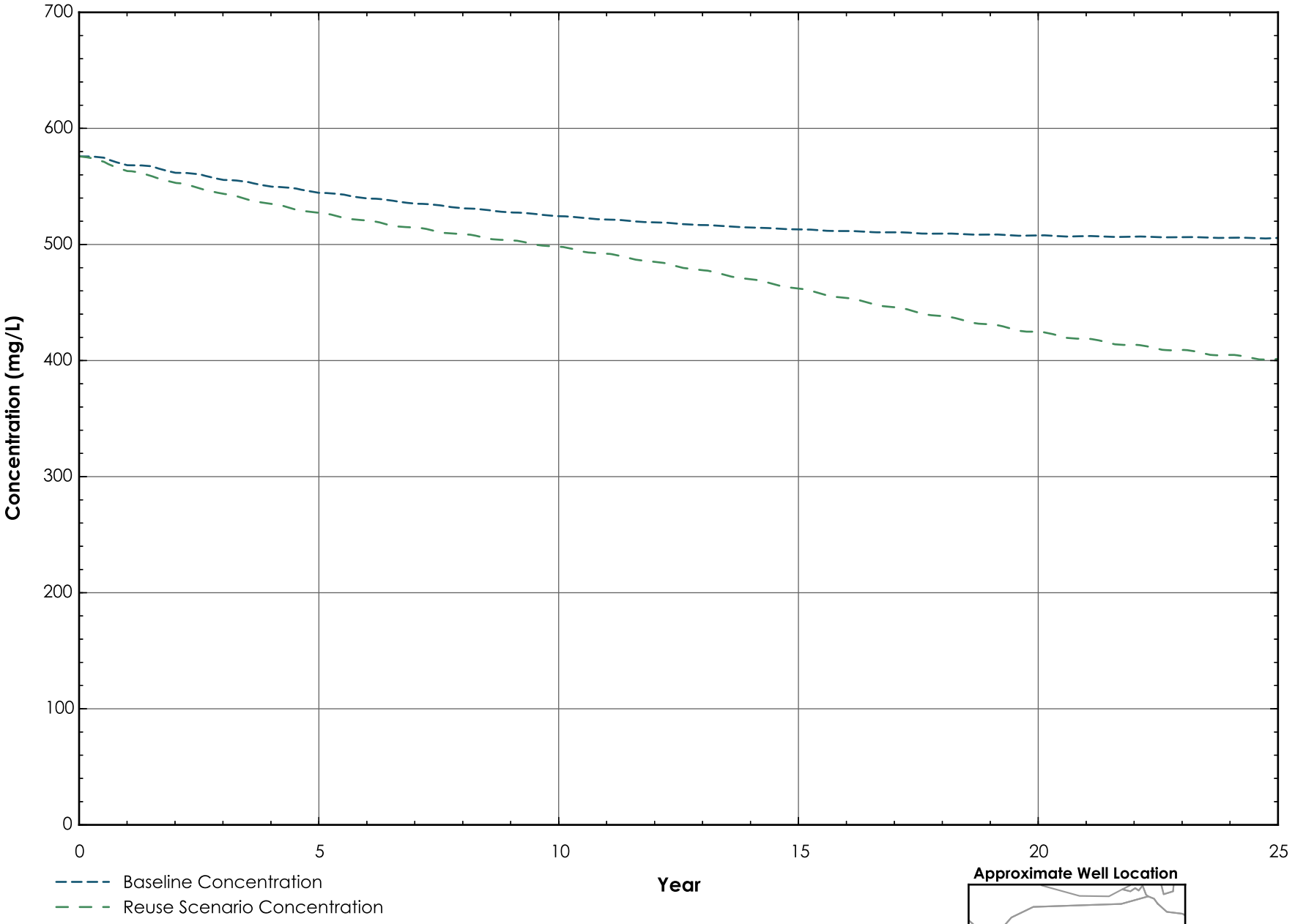


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

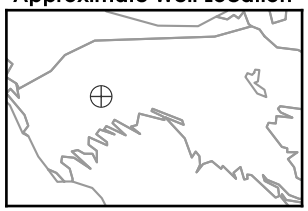


Well PLEAS 6 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

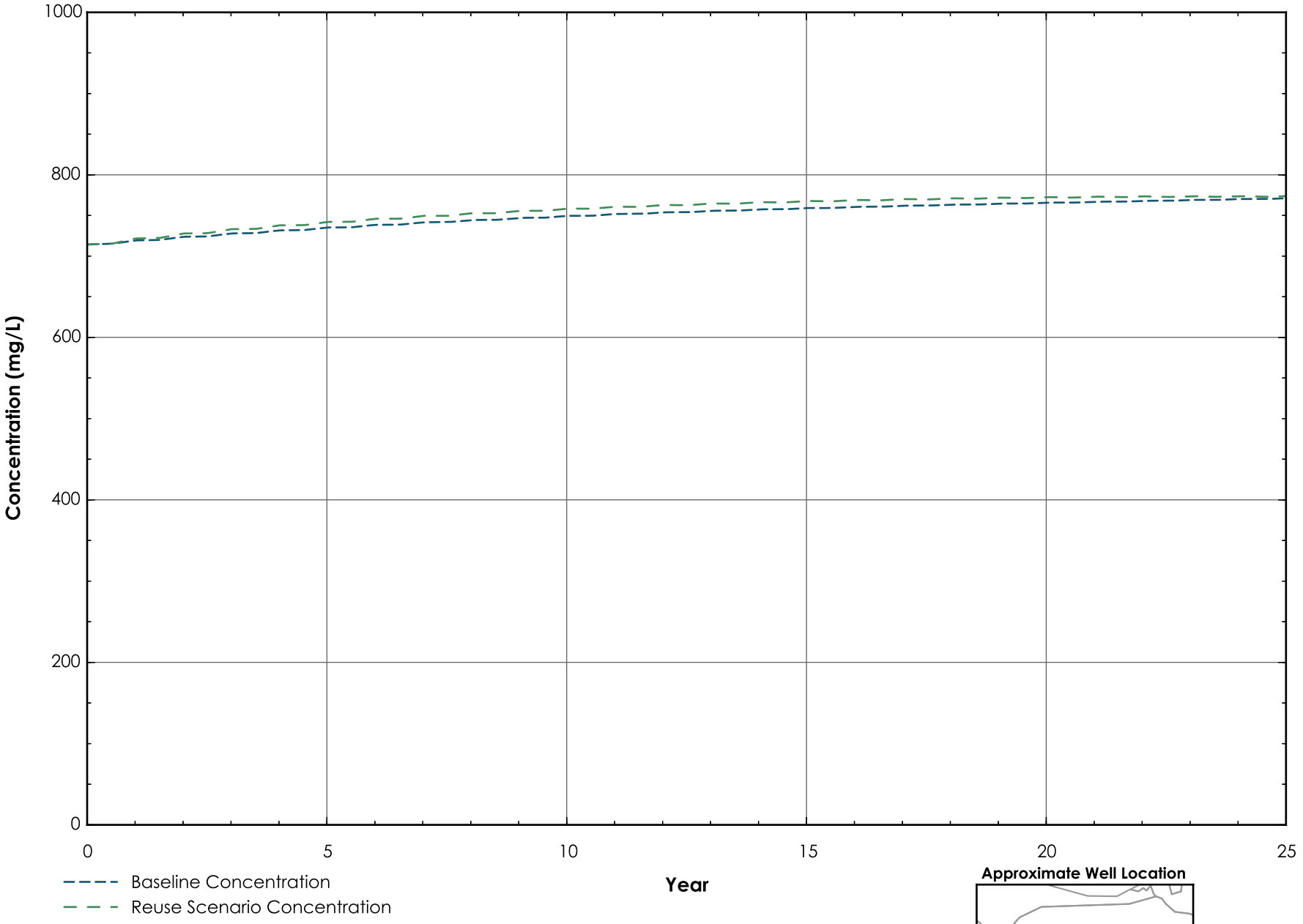


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

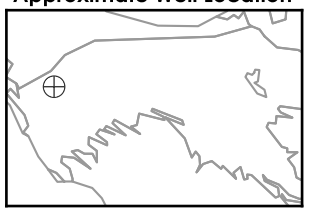


Well PLEAS 7 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I

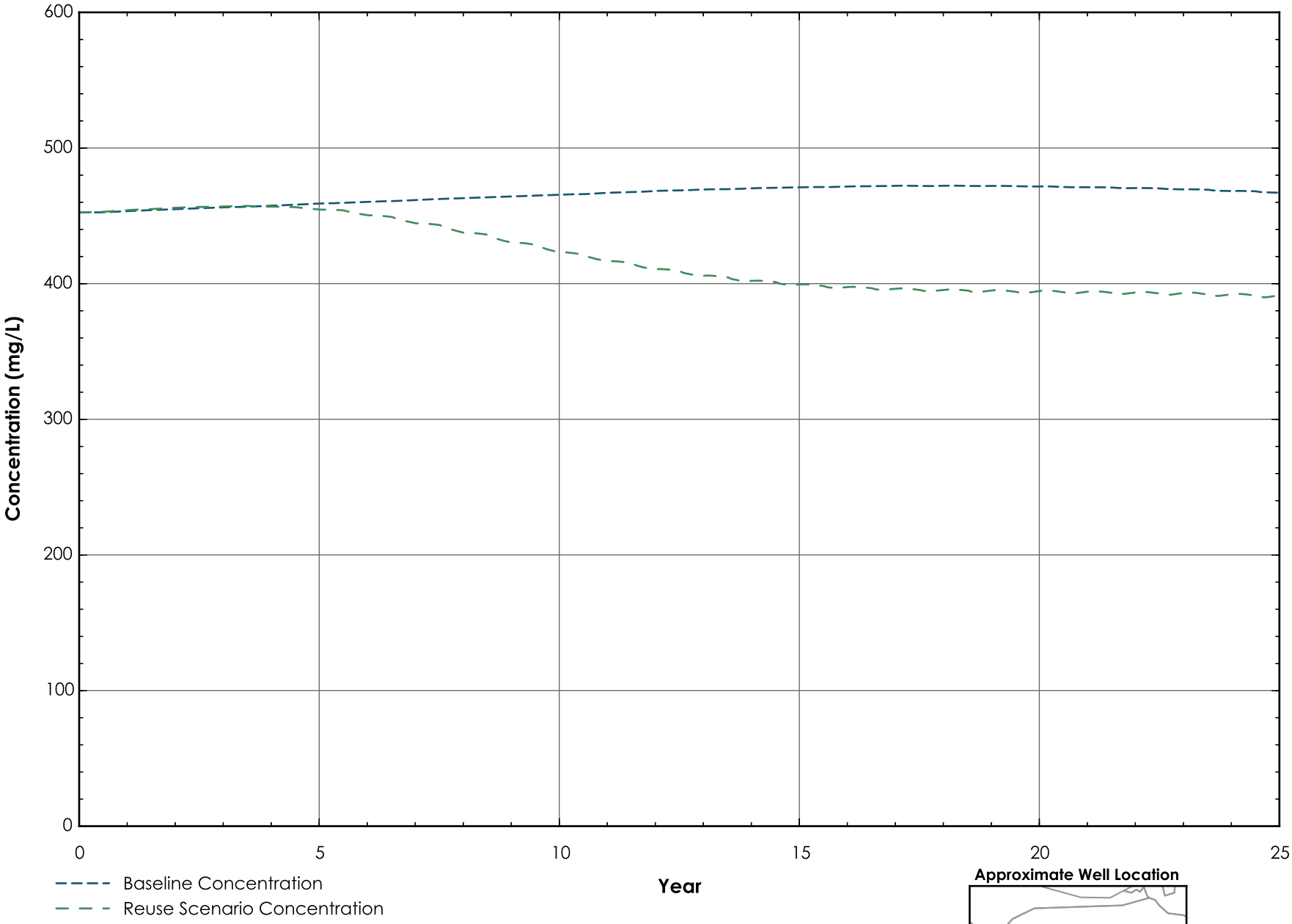


Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location

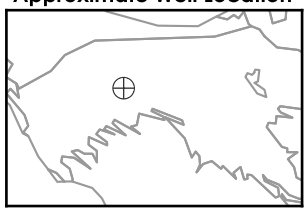


Well PLEAS 8 Simulated TDS Concentration in Lower Aquifer
10,000 AFY Recharge to Lake I



Note:
Simulation of injection of 10,000 acre-feet/year recycled water at Lake I offset by increased groundwater production at Zone 7 wells.

Approximate Well Location



Appendix D

ASR SYSTEMS TECHNICAL MEMORANDUM

ASR SYSTEMS

The Pioneer of ASR Technology

540 NE 5th Avenue, Gainesville, Florida 32601
Phone 352-336-3820
Fax 352-373-2381
www.asrsystems.ws

TECHNICAL MEMORANDUM

To: Jeff Stovall, PhD/ Carollo
From: David Pyne and Richard Glanzman, PhD
Re: Review of a Technical Memorandum for Zone 7 dated October 23, 2000, by Dan Wendell/CH2M HILL, entitled "ASR Test Results for the Hopyard-6 Well"
Date: 11 August 2017

As a subconsultant to Carollo Engineers, ASR Systems LLC is investigating the viability of Aquifer Storage Recovery (ASR) and Recharge Wells for subsurface storage and conveyance of highly purified wastewater to augment water supply reliability and reduce salinity for Zone 7 and its customers. ASR Systems was asked to review the referenced report by CH2M HILL regarding prior ASR testing at the Hopyard-6 well, and to render an opinion as to 1) why we think ASR today would turn out differently than what they did before, and 2) to come up with the next steps to move forward.

Two subsurface water storage approaches are under consideration for meeting Zone 7 goals for storage and recovery of purified water that meets all drinking water standards. The first is an "ASR Approach," under which low salinity recharge water would be stored within one or more sand intervals of the Lower Aquifer System and recovered from the same, or adjacent, wells after storage for at least 60 to 120 days. Recovered water would then be blended with water produced from other sources to immediately achieve drinking water salinity goals.

Under the second, "Recharge well" approach, recharge water would be injected into the same sand intervals of the Lower Aquifer System. It would then flow to down-gradient production wells located at a sufficient distance so that a travel time of at least 60 to 120 days is ensured. Actual travel time may be months to years. The stored water, blended with native water in the aquifer, would be eventually pumped from production wells for potable water supply. A reduction in salinity of the produced water is reasonably expected, but may or may not actually occur since there remains uncertainty regarding the source of the saline water that is currently causing a steadily increasing salinity from the Lower Aquifer System. This is presumed to be due to leakage from the more saline Upper Aquifer System, however it could also be partly due to upward leakage from below the Lower Aquifer System. This is a common issue for ASR wells storing water in saline aquifers or in fresh aquifers underlain by more saline aquifers. Resolution of this uncertainty would require further investigations.

Well B Site Information and Basis of Recommendations

This Technical Memorandum is based upon information from the previous 3-layer simulation model of the Zone 7 aquifer system, and the recently-updated 10-layer model, indicating the following pertinent characteristics at the Well B site that has been tentatively selected for subsurface storage:
Even numbered layers in the updated, 10-layer model represent coarse-grained water-bearing deposits. Layer 5 represents the main aquitard that separates the Lower Aquifer System (LAS) and the Upper Aquifer System (UAS) in the main basin. For the original, three-layer simulation model, the UAS, Aquitard and LAS were the three layers.

Well B is tentatively located at 6,160,635E, 2,074,810N, or (66,51) in the updated model. The following data from the updated model is for that location, as delineated in the table below.

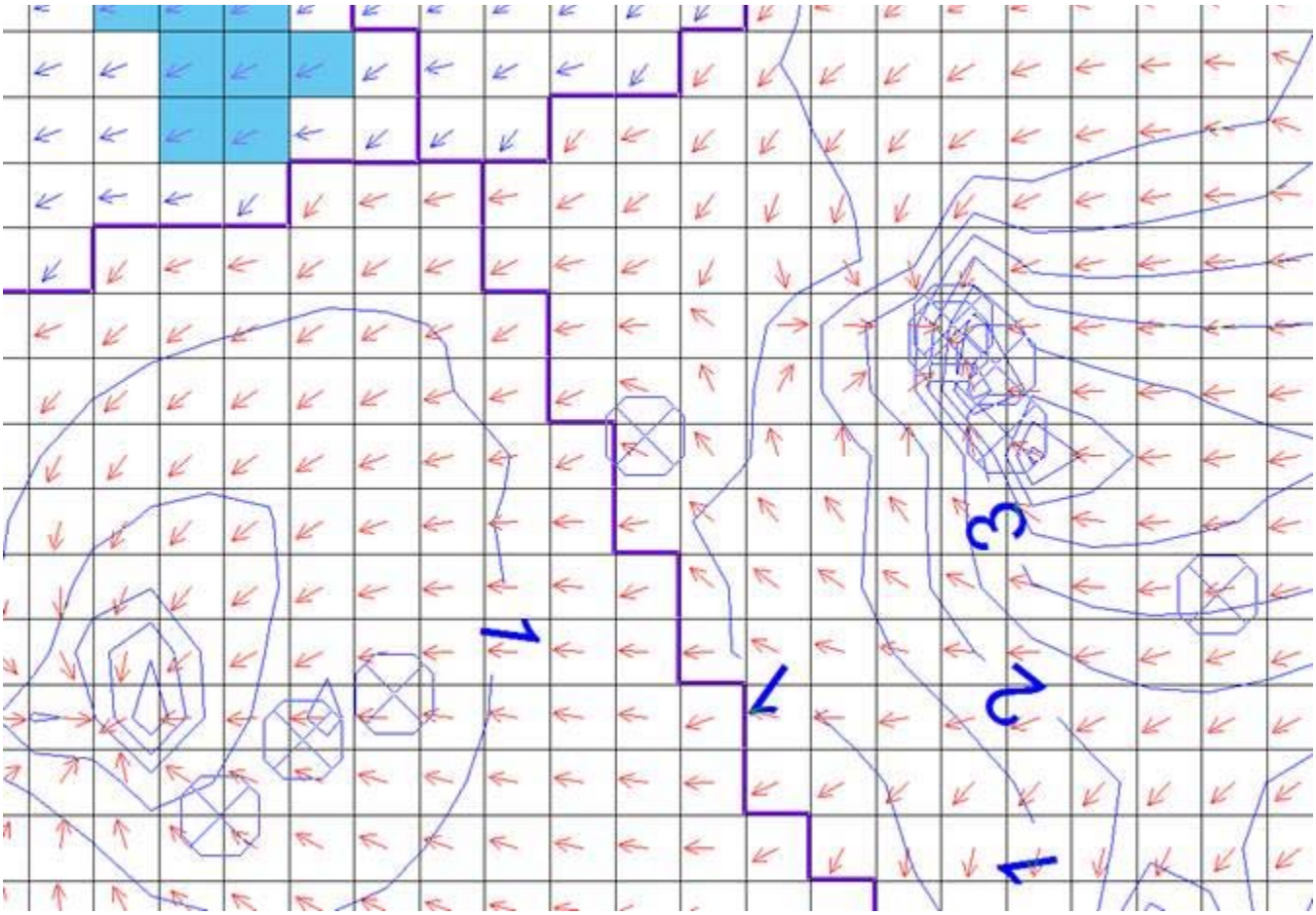
Layers 6, 8 and 10 are the sand and gravel layers of interest for ASR or Recharge well operations. The "Top of Layer" and "Bottom of Layer" columns are land surface elevations, indicating that these three layers are, respectively, 104, 174 and 161 feet thick. Confining or semi-confining layers overlying or

underlying these sand intervals are 26, 45 and 104 ft thick. Thickness of the confining layer beneath Layer 10 is unknown. The very thick sand layers each provide excellent potential storage reservoirs for purified water, laterally displacing the native groundwater around each well. ASR wells in these three sand intervals could possibly be stacked one on top of the other, achieving substantial storage volume within a relatively small radius. Kx and Kz are estimates of horizontal and vertical hydraulic conductivity. Ss and Sy are estimates of specific storage, while "n" is an estimate of effective porosity, probably based on geophysical log interpretation. It is anticipated that core analysis will indicate a higher porosity estimate such as double this amount.

Near Well B, velocities in the aquifer are in the range of 0.4 to 0.7 ft/day. The velocity through cell (66,51) is 0.43 ft/day. Flow through the aquitard between the upper and lower aquifers is downward at 0.00654 ft/day at this location in this simulation. These are very preliminary estimates pending further model development and verification. It is likely that lateral velocities will be slower in deeper sand intervals of the LAS, and higher in the UAS.

Layer	Top of Layer	Bottom of Layer	Kx	Kz	Ss	Sy	n
1	333.7	293.4	0.155	0.00276	1.03E-06	0.095	0.129
2	293.4	267.6	20.6	2.25	1.11E-06	0.133	0.171
3	267.6	262.6	0.884	0.00275	1.00E-06	0.183	0.212
4	262.6	252.6	20.6	2.25	1.11E-06	0.133	0.171
5	252.6	226.8	1.00	0.0992	1.10E-06	0.245	0.275
6	226.8	122.9	7.40	0.809	2.66E-06	0.117	0.140
7	122.9	78.1	0.992	0.03	2.42E-06	0.150	0.174
8	78.1	-95.9	7.40	0.809	2.66E-06	0.117	0.140
9	-95.9	-199.5	1.70	0.0514	2.42E-06	0.150	0.174
10	-199.5	-360.9	7.40	0.809	2.66E-06	0.117	0.140

A screenshot of the velocity vectors in layer 3 (deep aquifer, Lower Aquifer System) of the previous 3-layer model is shown below. The Well B location is the blue marker in the center.



Next Steps To Move Forward

If Zone 7 elects to move forward with either an ASR approach or a Recharge Well approach for purified water storage to provide water supply security while meeting regulatory requirements, the recommended sequence of steps is as follows:

1. Select a preferred area for construction and testing of wellfield facilities. Currently this is assumed to be the site of Well B and surrounding area. Site selection criteria would include hydrogeologic evaluation of expected aquifer and confining layer characteristics, and expected travel time to adjacent production wells; infrastructure proximity and availability (treatment facilities, transmission pipelines, drainage facilities for disposal of well backflush water; site access; power supply, etc); and land area to support construction and operation of wellfield and related facilities. Other criteria will undoubtedly impact the site selection process.

2. Construct a continuous wireline core hole from the land surface to a sufficient depth below the base of the Lower Aquifer System (LAS) (Model Layer 10) so that underlying vertical confinement can be evaluated. Tentatively this would be to a depth of about 800 ft, or about 100 ft below the estimated base of the LAS. During coring operations, provide full-time resident observation services by an experienced hydrogeologist familiar with coring and core handling, including field lithologic analysis; marking, recording, photographing, preservation and storage of the cores; geophysical logging of the core hole; shipping of selected frozen cores to a core lab for detailed geochemical and geotechnical analysis; preparation of a detailed lithologic analysis of the cores, and preparation of a coring summary report, including the results from the core lab and

associated core lab report. Grout back the core hole to land surface. Alternatively, consider completing the core hole as a monitor well for Layer 10, or possibly another potential storage interval. Also consider obtaining depth-specific water quality samples in the core hole. These are less likely to be representative of native water quality at each sample depth, as compared to samples pumped from a monitor well, however comparison of the values will be of interest.

Cores were not collected for the Hopyard-6 ASR test, resulting in the lack of sufficient information to interpret the recovered water geochemistry and understand what caused the continuous decline in the aquifer transmissivity during the five cycles of ASR testing.

3. Construct individual monitor wells completed in Layers 6, 8 and 10 at the selected site. If the core hole has been completed as a monitor well in Layer 10, a second monitor well in Layer 10 may not be needed. The primary initial purpose of these monitor wells would be to obtain reliable data on the water quality for each of the interval(s) that are potentially being screened. Water samples from a properly designed monitor well are more reliable than water quality samples from a continuous wireline core hole.

   Recovered water from the Hopyard-6 ASR cycle testing indicates that there are differences in the native groundwater chemistry of the screened depth intervals. Mixing of these native groundwaters from the screened depth intervals when the well was idled may be responsible for at least part of the continuous increase in well clogging. Mixing of the recharge water with the native groundwater did result in the precipitation of calcium carbonate. The resulting precipitation could be considerably different for depth intervals with differing native groundwater chemistry. Therefore, it is important to know the baseline chemistry of native groundwater from the three layers. Monitoring wells in the three layers would not only monitor the water level but also document the arrival and transport of the recharge water through each layer.

4. Prepare a representative estimate of recharge water chemistry and variability for each of approximately 50 constituents of interest for geochemical analysis. If more than one source may be utilized for aquifer recharge, prepare such a list for each constituent for each source. For the same water quality constituents, determine the native groundwater quality in each storage aquifer interval.

   As with the Hopyard-6 ASR tests, there may be more than one recharge water source making up the recharge water chemistry. If so, it is important to have a representative water chemistry of each source if the relative amount of each is not a constant to understand the chemical reactions occurring between the recharge water and the mineralogy of each layer affecting the recovered water chemistry and potential plugging of the individual layers.

5. Use Geochemist's Workbench software to conduct a geochemical model analysis of mixing between the recharge water quality, the native groundwater quality, and the potential short term and long term impact of chemical reactions occurring between the mixture and the mineralogy of each layer. The purpose of this analysis is to predict subsurface geochemical reactions, estimate the recovered water chemistry and provide recommendations regarding pretreatment geochemical conditioning of the aquifer and/or of the recharge water that may be necessary to provide for aquifer storage without well clogging or potential problems in the recovered water chemistry. For example, this might include pH adjustment of the recharge water to prevent chronic well clogging due to calcium carbonate precipitation.

   There was insufficient data to perform this geochemical modeling on the Hopyard-6 ASR project and help understand the chronic well clogging that occurred during the five cycles at the site. Prior geochemical modeling may have controlled or prevented well clogging during ASR cycle testing.

6. Prepare a Preliminary Design Technical Memorandum (PDTM), constituting a 30% design deliverable, providing the Basis of Design for subsequent wells and wellhead facilities, and equipping of the wells. A draft document would be reviewed and approved by Zone 7 to determine that it is consistent with evolving program goals, current understanding of the area hydrogeology, risk management, needs, constraints and opportunities. To the extent that such topics have not already been addressed in prior investigations, the PDTM would address the following issues:
    a. Project objectives, listed and prioritized
    b. Recharge water quality and variability
    c. Water demand, trends and seasonal/drought variability
    d. Recharge water supply, trends and variability
    e. Selection of an ASR approach or a Recharge well approach
    f. Target Storage Volume, including Buffer Zone Volume (for an ASR approach)
    g. Hydrogeology of the Selected Site, including geochemical considerations
    h. Conceptual design of wells, equipping of wells, and wellhead facilities
    i. Pretreatment, post-treatment and well conditioning
    j. Preliminary estimate of construction and capital costs for wellfield and related facilities
    k. Regulatory considerations and requirements
    l. Legal, environmental and institutional issues

7. Design, permit, construct and test a demonstration ASR or Recharge Well, or perhaps both. The well design may be different, but both would be equipped with a pump to provide for periodic backflushing. Backflushing frequency might range from once or twice a week to as much as once every two months, to be determined during demonstration well startup testing and during the first year of operations. Initial testing of each well would include a step drawdown test and a constant rate pumping test to establish well efficiency and aquifer hydraulic characteristics. This would be followed by a step injection test to establish recharge hydraulic characteristics. Injection testing could be accomplished with potable water if the purification treatment plant is not yet operational. Design and analysis of pump test results would be conducted to establish leakance characteristics of overlying and underlying confining layers, supplementing conclusions based upon prior analysis of the continuous wireline cores. Equipping of the well(s) would be conducted after hydraulic performance has been confirmed through initial testing. The wellhead design would provide for maintaining a small pressure at the wellhead during aquifer recharge, such as up to about 10 psi.

   For an ASR well, the well design would likely be in one or more of the three, thick sand intervals comprising Layers 6, 8 or 10 of the hydrogeologic simulation model of the selected site. Alternatively, consideration should be given to constructing a cluster of three ASR demonstration wells, one screened in each major sand interval, instead of a single ASR well in one or more sand intervals. Water stored in an ASR well would be recovered after 60 or 120 days of storage, as approved by regulatory agencies. Stored water may be recovered from the same ASR well or, depending on confining layer hydraulic characteristics, could be recovered from an adjacent layer, providing supplemental soil aquifer treatment. Water would be recovered locally at the Well B site and would be blended as needed to meet Zone 7 needs for peak water supplies and/or for reducing salinity.

   For a Recharge Well, the well design would likely be open to all three sand intervals. Other than periodic backflushing to maintain hydraulic performance, no water would be recovered from a Recharge Well. Instead it would be recovered months to years later at a down-gradient production well. At that time it may or may not reduce salinity of the produced drinking water, depending upon the source of the currently, steadily increasing salinity. Baseline TDS at the Hopyard-6 well prior to 1997 to 2000 ASR testing was in the range of 480 to 550 m/gl. Recovered water during ASR cycle testing showed a reduction in salinity. The well has been in a

production mode of operation since then, and salinity has most recently been 675 mg/l.

8. Monitor performance of the demonstration wellfield facilities. This will include regular water chemistry sampling of the recharge water and, for ASR wells, the recovered water. For Recharge wells, sampling would also occur at downgradient monitor wells and downgradient production wells. Tracer testing would be needed for the Recharge well so that arrival of the leading edge of the recharge bubble may be detected when it reaches each successive monitor well or production well. Tracer testing may also be advisable for the ASR well, establishing recovery efficiency after the water has been stored for 60 days or 120 days. Further investigation would be appropriate to determine whether an intrinsic or extrinsic tracer would be needed to differentiate between the recharge water and the native groundwater. Most ASR tracer testing to date has been conducted with intrinsic tracers such as conductivity and chloride.

   Monitoring during the first year would also include hydraulic performance, including Specific Capacity during Production (SCp) and Specific Capacity during Injection (SCi); recharge and recovery flow rates and cumulative volumes; backflushing frequency, procedures, volumes discharged to waste, and overall performance. Periodic review of monitor program results will provide a basis for adjustment of operating procedures to enhance well performance, and also an improved Basis of Design for wellfield expansion.

9. Expand wellfield facilities at the "Well B" site, whether ASR or Recharge Wells, sufficient to provide for 10,000 AFY of recovery capacity, or whatever updated goal may have been determined at that time. Expansion would include one or more monitor wells in each interval of the LAS, or possibly a multi-zone well monitoring all three sand intervals.

   If Zone 7 elects to proceed with ASR wells, construct one or more clusters of three ASR wells, each well screened in one of the three, thick, sand and gravel intervals of the LAS. Operate each well in each cluster to achieve at least 60 days of subsurface storage, then recover the stored water from the same well or possibly from an adjacent well, and blend with other water supply sources. Any water that is not recovered from the ASR wells, such as due to lateral movement of the stored water, will not be lost. It will be eventually recovered from the downgradient production wells. It is anticipated that lateral velocity of groundwater movement in deeper sand intervals of the LAS will tend to be slower than in shallower intervals, and also slower than in the UAS.

   If Zone 7 elects to proceed with Recharge Wells, recharge whenever purified water is available and recover from downgradient production wells when needed to meet drought or seasonal peak demand needs. It may be possible to interconnect all three sand intervals of the LAS in a single LAS well instead of three separate wells, depending upon the ability to manage well clogging by periodic backflushing. If more intensive well redevelopment methods are needed to maintain recharge performance, such as bringing in a well driller; removing the backflush pump; setting packers downhole and pumping each screened interval separately, then operating costs will increase, perhaps justifying the same design approach as for the ASR wells. Recovery of the stored water may occur months to years later, and may or may not reduce salinity of the drinking water provided to consumers from the production wells, depending upon the source of the currently steadily increasing salinity. The source of the increasing salinity is generally assumed to be downward movement of more saline water from the UAS, through the semi-confining layer separating the UAS from the LAS. Based upon experience at other ASR sites, it may also be partly due to upward movement of more saline water from sedimentary layers beneath the LAS.

10. Operating permits will have been issued. Monitor performance of the expanded wellfield facilities. The frequency and intensity of monitoring should be significantly reduced compared to the comparable level of effort during the demonstration period. The number of water quality constituents being monitored would be scaled back, as would the sample collection frequency.

Hydraulic performance (water levels, flows, daily and cumulative volumes) would continue to be monitored through a SCADA system with data stored on a Hiistorian, providing the opportunity for an annual performance review that should be conducted. An annual report should be prepared, including recommendations for operational enhancements that would improve overall performance.

The ten steps listed above for moving forward with an ASR or Recharge well program at Zone 7 are consistent with project development procedures developed and implemented during the past thirty years at many ASR and recharge wellfield sites, particularly at those where there has been no prior well recharge experience. At locations where ASR wells or wellfields have been in successful operation for many years, some of these steps can be scaled back or perhaps eliminated since the risk of an adverse outcome is greatly reduced. The underlying principal is to develop such a project in phases, learning as you go along, and with "go, no-go" decision points along the way. Such an approach is an effective way to manage risk.

Some water utilities and agencies make a conscious decision to bypass these recommended steps, thereby saving time and money, but accepting the higher risk associated with such a decision. Usually this is in the form of putting some water down an existing production well, often an old, abandoned one; waiting a few days, and then pumping it out to see what happens. This is similar to what Zone 7 did in 1999. With insufficient data, it is not possible to interpret the results. Well clogging occurred, but the reasons for that are unclear, whether physical, microbial or geochemical clogging occurred, or some combination of these three clogging mechanisms. As indicated elsewhere in this Technical Memorandum, physical clogging due to air entrainment is likely to have been a significant factor contributing to both the acute clogging incident that occurred during September 2000, and also the chronic clogging that occurred during the cycle testing program from 1997 to 2000. Air entrainment may have had a secondary effect of contributing to geochemical clogging that probably also occurred. Regardless of the reasons for this perceived failure, the results effectively dampened local enthusiasm for ASR as a potential water management tool for achieving water supply reliability. It has taken 16 years, and ASR success at many other locations nationwide and overseas, for Zone 7 to revisit the potential application of this subsurface water storage technology to meet evolving local needs.

ASR wells and Recharge wells have several unique design features that differentiate them from production wells. Equipping of ASR wells and Recharge wells is also different when compared to production wells. For example, downhole flow control valves are typically recommended for ASR wells where cascading of recharge water may otherwise occur, ensuring a small pressure at the wellhead, regardless of the recharge flow rate, so that air entrainment does not occur. Unlike the Hopyard-6 well, ASR wellheads are typically designed to hold pressure.

Pumping a well prior to recharge, and purging any stagnant water in wellhead piping prior to recharge, is still recommended. However, we typically do not rely on this to initiate recharge through a siphon down the pump column. If air vacuum relief valves in the wellhead piping are inadvertently left open, or are leaky, or if the well is inadvertently not pumped to waste prior to initiating recharge, air will be siphoned into the water column under the partial vacuum that often occurs at the wellhead. This can clog a well in a few minutes and is probably what happened during the acute clogging event that occurred in November 1999.

A review of the hydraulic data for the five cycles conducted in 1997 to 2000 (Figure 5) indicates that static water levels typically varied between 35 and 45 ft below ground surface (BGS). Recharge water levels were generally in a range of 5 to 25 ft BGS, with extremes ranging from 35 ft to 0 ft BGS (overflowing at the wellhead). Some head loss would have occurred during flow down the approximately 350 ft of pump column and through the pump bowls. Assuming a 14-inch pump column diameter inside the 18-inch casing, the head loss was probably less than 5 ft at a recharge flow rate of 2,000 GPM. This suggests that the wellhead was under a partial vacuum virtually all of the time during recharge periods. Any opportunity for air entry, such as through a leaky or open air relief valve or a pump shaft seal, would cause air entrainment. At 2,000 GPM, downhole velocities in the pump column and in the well casing below the pump intake would have significantly exceeded the

approximately 1 ft/sec rise rate for entrained air bubbles. Entrained air would then enter the well screens, filter pack and surrounding aquifer, causing air binding and chronic well clogging. The additional oxygen added to the water would contribute to geochemical and microbial well clogging, such as by increasing the pH and causing increased precipitation of calcium carbonate.

The acute clogging that occurred in November 1999 was probably caused by starting recharge without prior pumping to waste to purge air and particulates from the well and pump column. Perhaps closing of air/vacuum relief valves may also not have been implemented at that time. That would have pulled probably a full vacuum at the wellhead at startup, entraining a lot of air and carrying it downhole, causing the observed rapid well clogging. At other ASR sites where this has occurred, clogging has occurred in minutes from startup. Once clogged with air, it sometimes takes weeks for the air to go into solution under the increased downhole pressure. As indicated above, a recommended, better approach for equipping ASR wells is to provide a downhole flow control valve so that a small, positive pressure is maintained at the wellhead, regardless of the recharge flow rate.

Inner casing materials of construction avoid the use of mild steel since corrosion products are swept downhole during aquifer recharge, contributing to well clogging by both physical and microbial processes.

ASR well design, equipping and operation includes several unique features that are different than for production wells or injection wells. Understanding these differences is important for ensuring ASR success.

Why ASR Today Would Turn Out Differently

With phased implementation of the recommended sequence of steps outlined above, data would be available to guide the ASR or Recharge well program along a proven, logical path, with facilities designed for project purposes and a commitment to obtaining necessary, reliable data. Any project working hundreds of feet below ground has inherent risks and uncertainties, but these can be managed and minimized.

Wells would be designed based upon extensive, site-specific data to guide storage interval selection, screen design, filter pack design to maximize well efficiency, and operational procedures to efficiently achieve program goals. Wellfield design and operations, such as well spacing, would be based upon a well-informed local model, based on site-specific data regarding groundwater velocities, leakance of confining layers, and pressures in different sand intervals. Wellhead facilities would be designed to maximize flow rates and thereby minimize unit operating costs. Pretreatment would be implemented if necessary to control well clogging. Unique backflushing and well development procedures would be implemented to maximize well recharge and recovery rates. All of these key elements contribute toward ultimate project success.

Air entrainment would be eliminated as a potential cause of chronic and acute well clogging, through appropriate equipping of the well(s) with use of downhole control valves. This would also further reduce the potential for geochemical clogging due to calcium carbonate precipitation.

Well casing and column pipe would avoid the use of mild steel, thereby eliminating a potential source of corrosion products that can clog a well screen while stimulating microbial activity downhole. Corrosion products from mild steel also tend to increase the duration and frequency of backflushing required to maintain well performance, and the volume of backflush water that requires disposal.

A disinfectant residual would be maintained downhole at all times, not only during recharge periods but also during extended periods of no recharge and no recovery, exceeding about one week. This would be achieved through a trickle flow of disinfected water during extended storage periods. Disinfection byproduct attenuation would occur during the 60-day to 120-day storage periods underground.

If needed, pretreatment of the recharge water could be implemented to reduce well clogging. This might be through pH adjustment to eliminate calcium carbonate precipitation or to avoid destabilization of clays.

If bypass filter testing indicates occasional slugs of poor quality water reaching the wellhead, such as may occur due to flow reversal in a long transmission pipeline, a simple wellhead filtration system could be installed as a supplemental pretreatment device.

ASR wells or Recharge wells would be designed and equipped to provide for efficient backflushing and redevelopment procedures, maximizing the energy available to periodically purge particulates from around the well screens and to stabilize the filter pack material for both recharge and recovery.

Most importantly, Zone 7 would be guided by a consultant team that has worked together for decades, successfully implementing ASR programs for clients nationwide and in other countries. Such proven performance is the best indicator of likely success of an ASR or Recharge well program for Zone 7. Carollo and ASR Systems have worked together on numerous ASR projects nationwide since 2001, when David Pyne formed ASR Systems after leaving CH2M HILL. Prior to 2001, David Pyne and Richard Glanzman worked together at CH2M Hill on numerous ASR projects nationwide, from the initial ASR project in 1980. That teaming relationship has continued since 2001. Other team members at Carollo and at ASR Systems bring unmatched ASR experience to Zone 7.

Summary

If implemented today, an ASR or Recharge well program for Zone 7 would most likely be successful, providing water supply reliability during droughts; meeting peak demands, and reducing salinity. The best guarantee of success would be to follow a proven procedure for successful ASR or Recharge wellfield development, as described in this Technical Memorandum, working with a team of engineers, hydrogeologists, geochemists and others who have a substantial depth of ASR and Recharge well experience. At least 500 ASR wells and about 130 ASR wellfields are currently operational in at least 20 states, plus many more in other countries. Many Recharge well projects are operational or in development nationwide. California has about 18 ASR wellfields and about 63 ASR wells. Zone 7 can benefit from this experience.

Appendix E

DETAILED DESIGN CRITERIA

TableE.1 Design Criteria for AWPFs

DESIGN CRITERIA	5 mgd AWPF	12 mgd AWPF
Effluent Feed Flow, gpm	4233	10277
Interstage Boost Pump Flow, gpm	2117	5139
Total Permeate Flow, gpm	3386	8222
Total Concentrate Flow, gpm	847	2055
Finished Water Flow, gpm	3386	8222
Finished Water Average Day Flow, gpm	3386	8222
MF Feed Pump Vertical Lift, ft H2O	10	10
MF Feed Pump Discharge Pressure, psi	35	35
RO Lift Station Vertical Lift, ft H2O	10	10
RO Lift Station Discharge Pressure, psi	30	30

Table E.2 Design Criteria for AWPFs

DESIGN CRITERIA	5 mgd AWPF	12 mgd AWPF
Raw Water TDS, mg/L	1400	1400
RO Permeate Water TDS, mg/L	85	85
Temperature, deg. C	30	30
Raw Water pH	7.50	7.50
Finished Water pH	8.65	8.65
Raw Water Chloride, mg/L	500	500
Permeate Water Chloride, mg/L	30	30
Blended Water Chloride, mg/L	30	30
Raw Water Sulfate, mg/L	85	85
Permeate Water Sulfate, mg/L	2	2
Blended Water Sulfate, mg/L	2	85
Raw Water Calcium, mg/L as $CaCO_3$	53	53
Permeate Calcium, mg/L as $CaCO_3$	0.65	0.65
Blended Water Calcium, mg/L as $CaCO_3$	0.7	53.0
Finished Water Calcium, mg/L as $CaCO_3$	24	24
Raw Water Alkalinity, mg/L as $CaCO_3$	120	120
Permeate Water Alkalinity, mg/L as $CaCO_3$	10	10
Blended Water Alkalinity, mg/L as $CaCO_3$	10	120
Finished Water Alkalinity, mg/L as $CaCO_3$	37	37
Finished Water CCPP, mg/L as $CaCO_3$	9	9
Finished Water LSI	0.9	0.9
% Calcium Rejection	99%	99%
% TDS Rejection	95%	95%

Table E.3 Chemical Concentrations

DESIGN CRITERIA	5 mgd AWPF	12 mgd AWPF
RO Recovery	80%	80%
MF Recovery	100%	100%
Membrane Feed Chemicals		
Sulfuric Acid, mg/L	184	184
Scale Inhibitor, mg/L	2	2
Aqua Ammonia	1.3	1.3
Sodium Hypochlorite, mg/L	5	5
Blended Permeate Chemicals		
Caustic Soda, mg/L	0	0
Calcium Chloride, mg/L	0	0
Lime, mg/L	24	24
Carbon Dioxide, mg/L	19	19
Chlorine Gas, mg/L	0.0	0.0
Sodium Hypochlorite, mg/L	6	4.8
Hydrogen Peroxide, mg/L	0	0

Table E.4 Microfiltration Design Criteria

DESIGN CRITERIA	5 mgd AWPF	12 mgd AWPF
MF Membrane Flux, gfd	25	25
Production Cycle Duration, min	30	30
Backwash Duration, min	3	3
Filtrate Recovery, %	98	98
Feed Water Recovery, %	94	94
Square feet of MF Membrane Per Module, ft^2	800	800
Number of MF Modules, No.	335	814
Number of Modules/Rack	100	100
Number of Racks (1 Redundant)	6	11
Membrane Life, years	5	5
Hydraulic Configuration	Outside to Inside Flow	Outside to Inside Flow
MF Maintenance Clean Frequency		
Sodium Hypochlorite Solution, gallons per day	10,000	24,000
Sodium Bisulfite Solution (Neutralization), gallons per day	10,000	24,000
MF Maintenance Clean Chemical Dose		
Sodium Hypochlorite, ppm	500	500
Sodium Bisulfite (Neutralization), ppm	735	735
MF Maintenance Clean Chemical Use		

Table E.4 Microfiltration Design Criteria (continued)

DESIGN CRITERIA	5 mgd AWPF	12 mgd AWPF
Sodium Hypochlorite, lbs per year	15,197	36,472
Sodium Bisulfite (Neutralization), lbs per year	22,339	53,614
MF Clean-in-Place Frequency		
Sodium Hypochlorite Solution, gallons per month	10,000	24,000
Sodium Bisulfite Solution (Neutralization), gallons per month	10,000	24,000
Sulfuric Acid Solution, gallons per month	10,000	24,000
Citric Acid Solution, gallons per month	10,000	24,000
Sodium Hydroxide Solution (Neutralization), gallons per month	10,000	24,000
MF Clean-in-Place Dose		
Sodium Hypochlorite, ppm	500	500
Sodium Bisulfite, ppm	735	735
Sulfuric Acid, ppm	5,000	5,000
Citric Acid, ppm	5,000	5,000
Sodium Hydroxide, ppm	10,000	10,000
MF Clean-in-Place Chemical Use		
Sodium Hypochlorite, lbs per year	500	1,199
Sodium Bisulfite, lbs per year	734	1,763
Sulfuric Acid, lbs per year	4,996	11,991
Citric Acid, lbs per year	4,996	11,991
Sodium Hydroxide, lbs per year	9,992	23,982

Table E.5 Reverse Osmosis Design Criteria

DESIGN CRITERIA	5 mgd AWPF	12 mgd AWPF
RO Recovery		80%
RO Flux, gfd	12.0	12.0
RO Feed Pump Suction Pressure, psi	20	20
RO Feed Pump Discharge Pressure (ave), psi	150	150
RO Feed Pump Discharge Pressure (max), psi	165	165
Interstage Booster Pump TDH, psi	45	45
Pump Efficiency	70%	70%
Motor Efficiency	90%	90%
Maximum RO Process Power	2.41	2.41
Square Feet of RO Membrane Per Element, ft^2	400	400
Number of RO Membrane Elements, No.	1016	2466
Number of Elements per Pressure Vessel	7	7
Number of Pressure Vessels Per Train	54	54
Number of Pressure Vessels (Total)	145	352
Number of Trains (total)	3	7
Membrane Life, years	5	5
Membrane Cleaning Frequency, days	90	90
Cleaning Chemicals Consumption		
Low pH, lbs/cleaning	2660	6458
High pH, lbs/cleaning	2660	6458
Cartridge Filter Loading Rate, gpm/10-inch	2.5	2.5
Cartridge Filter Length, inches	40	40
Replacement Frequency, days	30	30
Number of Cartridge Filters, No.	420	1020

Table E.6 GAC Design Criteria

DESIGN CRITERIA	5 mgd AWPF	12 mgd AWPF
GAC Design Criteria		
Total Flow (gpm)	3386	8222
Loading Rate (gpm/ft2)	6.5	6.5
Adsorber Surface Area (SF)	56.5	56.5
Number of adsorbers	5	12
Flow per adsorber	677	685
Lbs of Carbon per Adsorber	20,000	20,000

Table E.7 UV AOP Design Criteria

DESIGN CRITERIA	5 mgd AWPF	12 mgd AWPF
UV Power Required, kW	245	583
UV Lamp Replacement Frequency years	1.60	1.60
UV Lamps (Duty), No.	408	972
UV Lamps replaced per year	255	608
UV Ballast Replacement Frequency, years	5	5
UV Ballasts, No.	204	486
UV Ballasts Replaced per year	41	97
UV Wiper Replacement Frequency, years	1	1
UV Wipers, No.	0	0
UV Wipers Replaced per Year	0	0
UV Sleeve Replacement Frequency, years	20	20
UV Sleeves, No.	408	972
UV Sleeves Replaced per year	20	49
UV Chemical Cleaning Interval, times per year	24	24
UV Chemical Cleaning, lbs/clean	300	545
UV Chemicals per year, lbs	7200	13078
Number of Reactors, (1 redundant)	3	8

Table E.8 ESB Design Criteria

DESIGN CRITERIA	5 mgd AWPF	12 mgd AWPF
Hold Time	30 min	30 min
Volume (each)	110,000 gal	250,000 gal
Diameter	35 ft	50 ft
Height	17 ft	19 ft
Freeboard	2 ft	2 ft

Appendix F

STAFFING MEMO

PROJECT MEMORANDUM

TRI-VALLEY POTABLE REUSE FEASIBILITY STUDY

Tri-Valley Agencies

To:	Rhodora Biagtan (DSRSD), Helen Ling (Livermore), Amparo Flores (Zone 7)		
Copies to:	Lydia Holmes, Elisa Garvey, Brian Graham, Andrew Salveson, Wes Mercado		
From:	Christina Casler		
Date:	8/31/2017	**Project No.:**	10414A.00
Subject:	Advanced Treatment Plant Staffing		

Purpose

The purpose of this memo is to determine the staffing requirement for a potential future advanced treatment potable water reuse facility. This need is precipitated by the ongoing Tri-Valley Potable Reuse Feasibility conducted by the Tri-Valley Agencies [California Water Service Company- Livermore District, City of Livermore, City of Pleasanton, Dublin San Ramon Services District (DSRSD), and Zone 7 Water Agency (Zone 7)].

The results of a preliminary screening revealed six optimum potable water reuse project alternatives for the Tri-Valley Area. In these alternatives, four different advanced water purification facilities (AWPFs) were identified, as described below. Each would treat secondary effluent from either Livermore Water Reclamation Plant (LWRP) or the DSRSD Wastewater Treatment Plant (WWTP). These alternatives, described in more detail in Technical Memorandum 5 - Detailed Alternatives Development, are listed below.

- A 5 million gallons per day (mgd) facility for raw water augmentation (RWA) consisting of microfiltration (MF), reverse osmosis (RO), granular activated carbon (GAC), ultraviolet advanced oxidation process (UV AOP) and an engineered storage buffer (ESB). This AWPF would be located on existing LWRP property.
- A 12 mgd facility for RWA consisting of MF, RO, GAC, UV AOP, and an ESB. This AWPF would be located on existing DSRSD WWTP property.
- A 12 mgd facility for groundwater augmentation (GWA) consisting of MF, RO, and UV AOP. This AWPF would be located at a location owned by DSRSD but not collocated with the WWTP.
- A 12 mgd facility for RWA consisting of MF, RO, GAC, UV AOP, and an ESB. This AWPF would be located on City of Pleasanton property.

For full cost accounting of each option, it is necessary to determine the staffing requirements. This memo provides a general schema and assumptions for determine staff numbers. The recommendations within this memo were based upon detailed discussions with Brian Graham (Carollo). Prior to joining Carollo as an employee of Suez, Brian was responsible for managing the operations and maintenance staff at the West Basin Municipal Water District's Edward C. Little Water Recycling Facility in El Segunda CA. That facility produces 40 mgd of new water using five different treatment trains for five different water reuse applications, including potable water reuse.

Definitions

Operations, Maintenance, Laboratory, and Maintenance staff are all necessary. The job description for each position is defined below. For small facilities, often staff will have responsibilities in more than one of the four listed areas.

- Operations Staff - The Operations Staff is responsible for the basic running of the plant, monitoring of effluent, and maintaining compliance. They are not responsible for major repairs. Many operators work 12 hour shifts (meaning they receive overtime in California). In DSRSD/Livermore, operators work 10-hour shifts, with overlapping start and end times. While this can be arranged, it would require 50 percent more staffing than is presented within this document.
  - Grade V Operator - Chief primary operator. A Grade V operator is required for permit compliance for the AWPF, but is not required on site at all times for an AWPF.
  - Grade III Operator - A lead Grade III operator is required on site at all times of AWPF plant operations.
  - Grade II Operator - The Grade II operators are support staff for the lead operators and would assist with the running of the plant.
- Maintenance Staff - Maintenance staff is at the plant about 8 hours a day, but can be on call for nights and weekends. They are responsible for keeping equipment in running shape. However, major repairs may be contracted out. Three specific types of staff are needed. Again, for a small plant, one person may be trained in multiple areas.
  - Electrician.
  - Mechanic.
  - Instrument Technologist - An instrument technologist is essential in AWPFs due to the high level of monitoring and instrumentation required.
- Lab Staff - The AWPF will require stringent testing procedures to maintain compliance. Many of these tests, at least initially, will be daily tests. It is recommended to have a fully staffed lab at the plant to prevent delays that could result from outsourcing lab testing. It may also be a long term cost saving to have in house lab versus contract work. Lab staff typically works 8 hour days.
  - Lab Supervisor.
  - Lab Technician.
- Management Staff - In addition to the working staff, a minimum layer of management is needed to provide overall direction and reporting to the Utility's General Manager.
  - Plant Manager.
  - Maintenance Supervisor.
  - Lab Manager (same as Lab Supervisor).
  - Admin.

Staffing Requirements & Assumptions

Two staffing scenarios were investigated for the future AWPFs - a fully sufficient staff, and a lean staff.

Fully Staff

The fully sufficient staff would not require significant amounts of emergency contract work and would not require as much automation. The plant would be able to be run comfortably. The estimated staff requirements are summarized in Table 1 below.

Table 1 Full Staff Requirements

Staff Title	Number
Grade V	2
Grade III	5
Grade II	6
Maintenance Supervisor	1
Mechanics	2
Electrician	1
Instrument Tech	1
Lab Supervisor	1
Lab Tech	4
Plant Manager	1
Ops Manager	1
Admin	1
Total	**26**

Lean Staff Requirements

The lean staff would require a heavily automated facility with much of the maintenance work outsourced, especially as the plant ages. The majority of the cut down in staff is in the lab. This means that much of the lab samples will have to be sent out to a contract lab for permitting. The lean staff requirement also assumes that much of the management would be handled by the existing Tri-Valley Agencies. Table 2 summarizes staffing requirements for a lean staff.

Table 2 Lean Staff Requirements

Staff Title	Number
Grade V	1
Grade III	5
Grade II	5
Mechanics	1
Electrician	1
Instrument Tech	1
Lab Tech	1
Admin	1
Total	16

Work Hours and Shifts

Operators typically will work a 12 hour shift and will work in a 3-day on, 2 day off, 2 day on rotation. All other staff are assumed to be full time 8-hour employees. Figures 1 and 2 show example two week operational shifts for the full and lean staff, respectively.

Shift teams for the full staff are shown in Table 3. Table 4 shows the lean staff shift teams. Floats are additional Grade III or V operators who can fill in for the full-time employee in case of vacation or sick-day.

Table 3 Full Staff Work Shifts

Shift Team	Number per team
Full time 8-hr staff	14
Day shift team 1	3
Day shift team 2	3
Night shift team 1	2
Night shift team 2	2
Float	2
Total	**26**

Table 4 Lean Staff Work Shifts

Shift Team	Number per team
Full time 8-hr staff	7
Day shift team 1	2
Day shift team 2	3
Night shift team 1	2
Night shift team 2	2
Float	2
Total	**18**

Certification Requirements

The State of California Division of Drinking Water (DDW) recognizes that many of the treatment systems used for potable water purification are not part of conventional water or wastewater operator training programs. To that end, DDW has pushed the CA/NV AWWA to develop a new operator certification program for "Advanced Water Treatment" (AWT) operators. DDW has requested (but not yet required) that new potable water reuse programs have one of more of their operators certified under the new AWT program, once it is in place.

The final AWT program is not solidified, but several CA/NV AWWA Expert Panels have met over the last year to develop and detail the job requirements and skill needs for the AWT operator. The same group of experts expects the program to be voluntary at first, but transition to mandatory for potable water reuse projects. Eligibility to take the AWT test is expected to be simple, requiring a minimum Grade III water or wastewater operator's license.

Appendix G

SITE VISIT MEMOS

PROJECT MEMORANDUM

TRI-VALLEY POTABLE REUSE FEASIBILITY STUDY

Date: May 20, 2017
Project No.: 10414A.00

Tri-Valley Agencies

Prepared By:	Christina Casler and Andrea F. Corral
Reviewed By:	Lydia Holmes, Paul Friedlander and Andrew Salveson
Subject:	DSRSD Regional Wastewater Treatment Plant and Mocho Site Visit

Purpose

The purpose of the May 11, 2017, site visits to DSRSD's Regional Wastewater Treatment Plant (WWTP) and Mocho site was to identify site specific conditions that related to locating an Advanced Water Treatment Facility (AWTF) at the plant site. These conditions include existing layout, electrical, piping, access, deliveries, and public impact, among others.

Advanced Water Purification Facility Location

DSRSD WWTP

The Carollo Team met with Levi Fuller (Operations Supervisor at the DSRSD's WWTP) and Rhodora Biagtan to tour possible locations at the DSRSD's WWTP and the Mocho Site.

The first option proposed for the location of the AWTF (12 mgd, 2.9 Acres area required) was the area located southwest of the existing facultative sludge lagoons (FSLs) (Site 1, Figure 1). However, this site had already been identified as a location for a potential mechanical dewatering facility. An alternative location is south of the LAVWMA diversion structure in the dedicated land disposal (DLD) (Site 2, Figure 1). The following advantages/challenges were identified for Site 2:

- Advantages:
  - Near LAVWMA facilities for ease of source water access and concentrate disposal.
  - Potential for easier staffing with proximity to future mechanical dewatering facility.
  - An electrical power sharing agreement may potentially be arranged with LAVWMA.

- Challenges:
  - Proximity of a solids handling facility close to an advanced treatment facility may pose issues from public perception and health perspectives.
  - While there may be the potential to arrange an electricity sharing deal with LAVWMA, this location will likely require to bring all utilities to the site, including electrical.
  - The site may be designated for a future SCFI solids handling project.
  - For construction, the lot will need additional site work to ensure that stormwater runoff stays on the DLDs. This could be construction of a berm around the AWPF, raising the site to a certain, or creatively grading the site. Future efforts will determine the most cost effective method of runoff management.

The best location for the AWTF identified during the visit was the southwestern corner of the DLD (Site 3, Figure 1). This location presents several advantages and challenges, listed below:

- Advantages:
  - The site provides great visibility of the project for public education and outreach.
  - Good access to the facility and for delivery of chemicals. Johnson Drive will be widened in the near future to accommodate planned development projects.
- Challenges:
  - For construction, the lot will need to be leveled and filled up to 10 feet.
  - This location will require extension all utilities to the site.
  - To bring source water to the site, a new pipeline will need to be extended from the LAVWMA pump station site. Alternatively, a new pipeline will need to be tapped off the Livermore 27" pipeline and the DSRSD 42" pipeline. A Other outcomes and considerations for the DSRSD site are as follows:
- During the site visit, the existing membrane building (both the MF and RO sections) was visited (Figure 3). This building, approximately 200 feet long and 50 feet wide, was identified as a potential housing for the new microfiltration (MF) membranes. Some of the piping could be reused and the building would be repurposed. This could potentially save up to $4 million in building costs. However, the cost savings come with extra complexity/inconvenience for the operators; they would have to drive between the MF units and other processes (crossing a road) potentially multiple times a day. This option can be investigated further in preliminary design should a project move forward.
- Use of any of the sites identified at DSRSD (sites 1, 2, 3) requires decommissioning a portion of their existing solids handling process.
  - The current solids percentage is 3 percent. At this rate, the DLDs are limited by liquids loading. If the solids percentage were raised to 6 percent (like through mechanical dewatering), the DLDs would have enough capacity even with reduced acreage to make room for an AWTF.
  - Mechanical dewatering will result in higher rates for the customer without some cost sharing with other agencies. This needs to be considered before pursuit of a project at the DLDs.
- The existing DLDs are required to have raised edges to keep rain runoff from escaping and impacting other locations. To use a portion of the DLD, berms would have to be constructed to prevent runoff from the DLDs getting into the project site. Alternatively, the entire project site could be raised to keep rain runoff contained within the DLDs. If the DLDs are be deepened, that soil could be used to raise the project site. DSRSD sent the groundwater surface elevation underneath the DLD and DLD topography information on June 14, 2017.

Mocho Well Site

An alternate location for the AWTF is at the Mocho site (Figure 4) property of DSRSD and the City of Pleasanton (Figure 5), south of the Zone 7 Mocho Groundwater Demineralization Facility. The site currently has multiple easements on it (Figure 6), including several easements to Zone 7 for a production well and pipelines. A high pressure petroleum pipeline also crosses the site. The available space is approximately 74,000 square feet (1.7 acres). The advantages and challenges of this location are presented below.

- Advantages:
  - Provides great visibility of the project.
  - Existing site appears to have all relevant utilities. It should be determined if these utilities can be expanded to meet the AWTF needs.

  - An electrical power sharing agreement may potentially be arranged with DSRSD.
- Challenges:
  - The site has public access and leads to a walking trail as shown in Figure 7.
  - There is an existing extraction well within the building onsite (Figure 8) that cannot be moved, which makes constructing in the tight site even more complex. A more detailed site layout will help determine the need to relocate the building.
  - The geometry of the site is narrow and not uniform.
  - The available area is not enough to accommodate the estimated AWTF footprint of 2.9 acres. An alternative would be a two story-building to reduce the footprint. Carollo will study the feasibility of this alternative

Action Items

- Carollo will include annual operating cost for solids disposal.
- Carollo will determine the cost to fill and level the site for construction (sites 2 and 3).
- Carollo will study the feasibility of a two story-building to reduce the footprint to accommodate the AWTF at the Mocho Site.



Figure 1 DSRSD WWTP Potential Locations



Figure 2 View of Access Road from Southwest Corner of DLD



Figure 3 DSRSD MF



Figure 4 Mocho Wells Site Potential Location



Figure 5 Mocho Site Parcel Lines

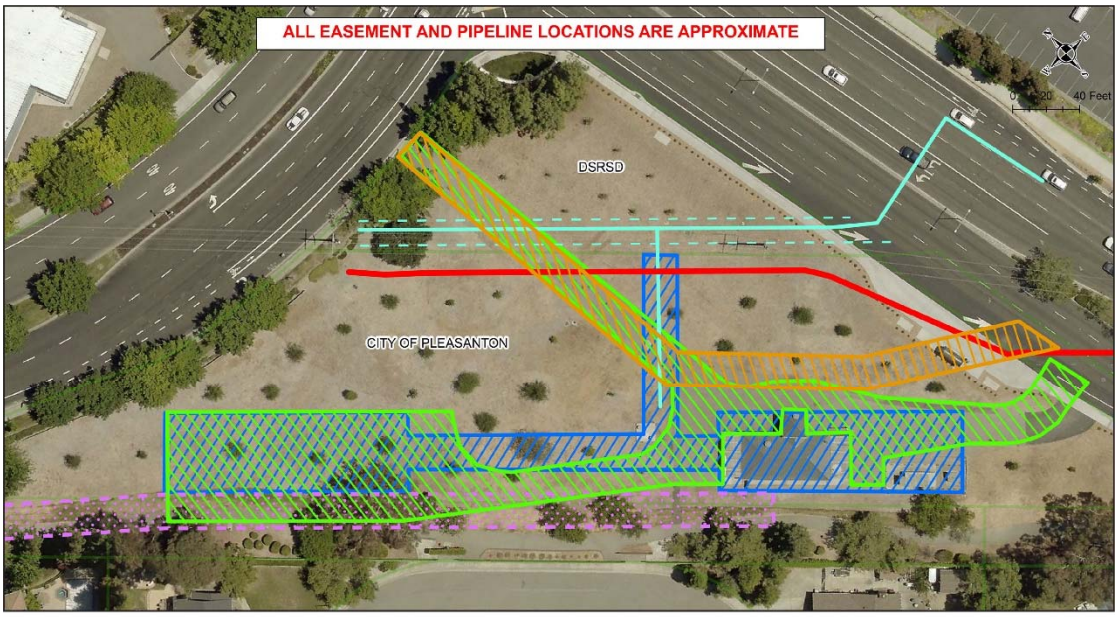


Figure 6 Existing Easements on Mocho Site



Figure 7 Public Access to the Mocho Wells Site



Figure 8 View of Zone 7 Chemical Building from West Side of Site

PROJECT MEMORANDUM

TRI-VALLEY POTABLE REUSE FEASIBILITY STUDY

Date: May 23. 2017
Project No.: 10414A.00

Tri-Valley Agencies

Prepared By:	Christina Casler and Andrea F. Corral
Reviewed By:	Lydia Holmes and Zaheer Shaikh
Subject:	Livermore Water Reclamation Plant

Purpose

The purpose of the May 23, 2017, site visit to the Livermore Water Reclamation Plant (WRP) was to identify site specific conditions that need to be considered when locating an Advanced Water Treatment Facility (AWTF) at the plant site. These conditions include existing layout, electrical, piping, access, deliveries, and public impact, among others.

Advanced Water Purification Facility Location

The Carollo Team met with Helen Ling (Water Resources Division Manager), Todd Yamello and Jimmie Truesdell to tour possible locations for the AWTF at the Livermore WRP.

The first option for the location of the AWTF was the area currently occupied by the abandoned trickling filters (Figure 1, #32). However, this area was identified in the Wastewater Master Plan as an aeration basin expansion area for future nutrient removal. The initial idea of repurposing the reverse osmosis (RO) building (Figure 1, #29) was discarded - the building is too small, it does not have enough security, and it is already being used for office space. Similarly, the vehicle/material storage building (Figure 1, #31) was also discarded because the building is still in use and, in its current condition, it would not be beneficial to repurpose it.

The preferred location for the AWTF is the abandoned facultative sludge lagoons site located in the southwest edge of the Livermore WRP (Figure 1, #20 and Figure 2). The following advantages/challenges were identified for this site. A potential layout is shown in Figure 4.

- Advantages:
  - Interest in repurposing the area where the abandoned facultative sludge lagoons are located.
  - The site provides great potential for visibility of the project for public education and outreach.
  - The new facilities for purified water can be kept separated from the current wastewater processes for better public perception and outreach opportunities.
  - Voyager Road provides an easy access to the site for chemical deliveries or potentially tours. The turn onto Voyager from Jack London Blvd is governed by a traffic light. (Figure 3).
    - A contained loop for chemical delivery should be included in layout (Figure 4).
  - Available utilities line nearby the site.
    - Potable and fire water supply (southwest corner of property, Livermore to confirm).
    - Process water.
    - Fiber for SCADA system.

- Challenges:
  - The larger lagoon will need to be dredged and reclaimed. The smaller lagoons have already been dredged. The solids were dewatered and hauled off without any restrictions due to metals or contamination. Currently, all lagoons are filled with reclaimed water.
  - For construction, all ponds will need to be leveled. The current water depth is about 10-15 feet but the berms are raised above the ground so the fill requirement is unclear.
  - While the new switchgear has the capacity to support the projected electrical demand, there would be no redundant electrical system. Therefore, a new electrical connection will be assumed for this location.

Other outcomes and considerations for the Livermore site are as follows:

- Existing Tertiary treatment system operated during off peak times of day to save energy peaking costs. Filters sized for 8 mgd. New AWTF would be running all day. If Tertiary run all day then could probably feed both non-potable and potable reuse systems. Pull off before UV system for non-potable reuse. Could potentially use the alignment of the existing UV overflow pipe to LAVWMA (not used).
- A new SCADA loop will be required for the AWTF.
- It might be possible to build the influent pipeline to the AWTF in place of the UV overflow to feed the AWTF.
- Existing laboratory space is big enough to accommodate the additional analysis for an AWTF. However, more personnel will be required to meet the new needs.
- A new electrical connection would need to be installed. Consult with PG&E requirements and availability to install the new connection.
- The current operations building for Livermore does not have much room for expansion. A new operations building should be assumed. The current administrative building can be used by the AWTF staff if it is expanded. A new visitor center for outreach and education purposes will be assumed as well.
- Livermore also suggested to increase the number of maintenance personnel, from two to three, to meet the needs of the AWTF.
- For security reasons, a fence should be built around the facility, potentially encompassing all of the purification facilities, separating it from the wastewater facilities. A fully enclosed facility may make sharing staff inconvenient.
- Further discussion with the Steering Committee should include administrative, maintenance, and operations staffing, as well as project cost sharing.

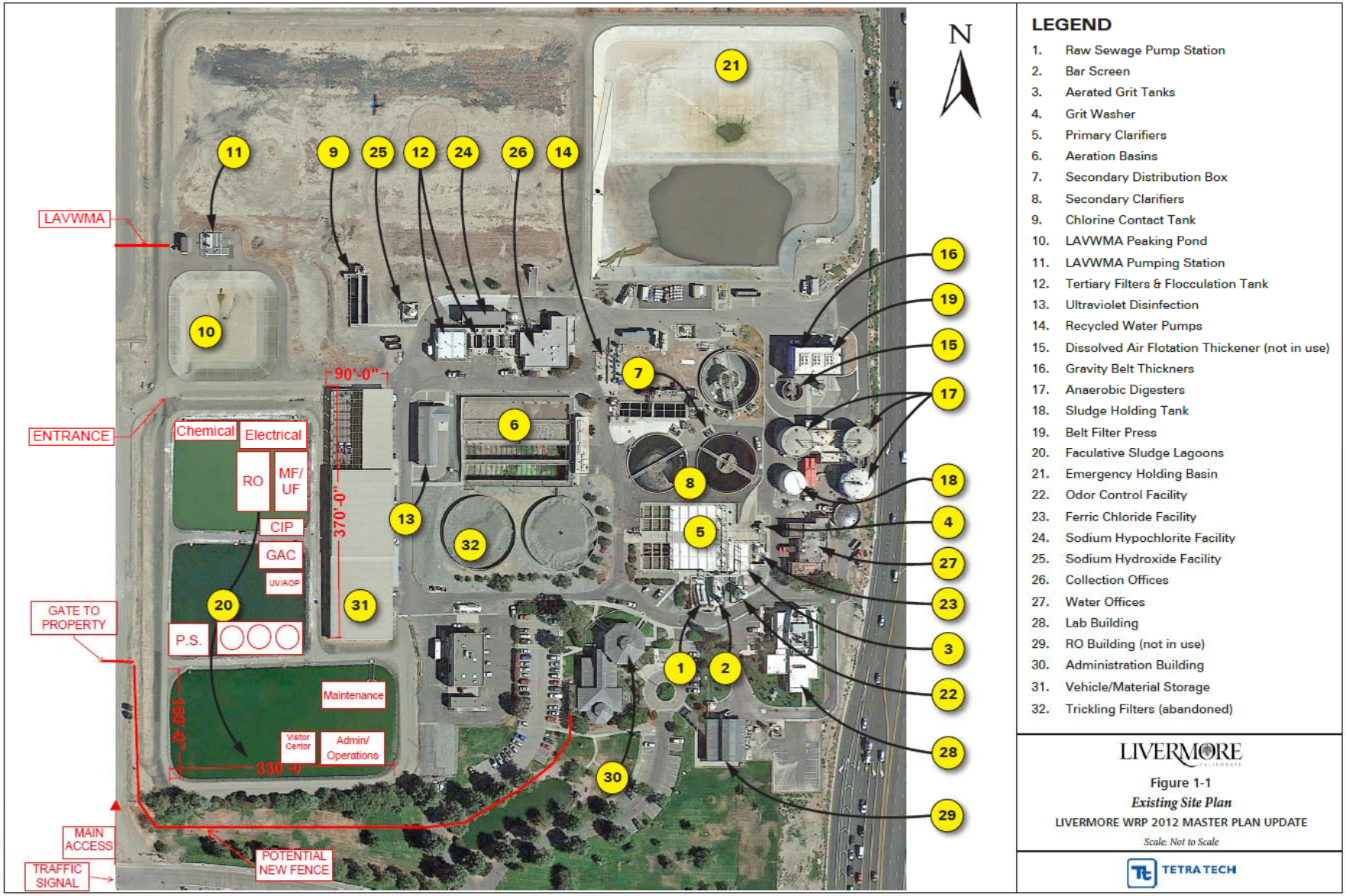


Figure 1 Livermore WRP Site Plan - Originally from 2012 Master Plan Update



Figure 2 Livermore WRP Existing Lagoons.



Figure 3 Livermore WRP Entrance Jack London Blvd. and Voyager St.

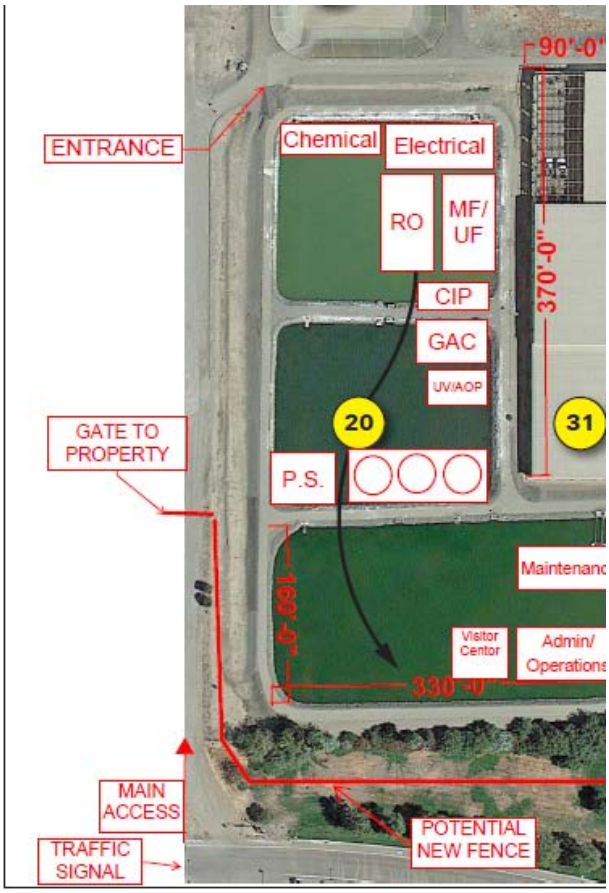


Figure 4 Example Layout of AWTF

Action Items

- Carollo will check the cost and footprint impact of using tertiary effluent as influent to the AWTF vs secondary effluent.
- Carollo will include online monitoring points and equipment in the previous TM.
- Carollo will determine the cost of cleaning the large facultative sludge lagoon.
- Carollo will determine the cost to fill and level the site for construction.
- Carollo will check on the staffing requirements for operations and maintenance
- Livermore will provide topological information of the facultative sludge lagoons.
- Livermore will provide the estimated sludge volume from the cleaning of the small facultative sludge lagoons.
- Livermore will check where the pipeline for the old RO is located. Carollo will determine if this pipeline can be used for the microfiltration backwash flow.
- Livermore will confirm location of utilities near the facultative sludge lagoons.

Appendix H

DETAILED COST ESTIMATES

PROJECT:	Tri-Valley Potable Reuse Feasibility Study
JOB NO.:	10414A.00
DATE:	12/21/2017
BY:	CYC
OPTION:	Livermore AWPF to Lake I

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Sludge Lagoon Dredging & Removal	1	LS	$900,000	$900,000
Building [1]	18,400	SF	$350	$6,440,000
Administrative Building	7,400	SF	$400	$2,960,000
MF Feed Equalization Basin [2]	130,000	Gallon	$2.0	$260,000
MF Equipment [3]	6.1	MGD	$861,000	$5,260,000
RO Feed Flow Equalization Basin [2]	130,000	Gallon	$2.0	$260,000
RO Equipment [4]	6.1	MGD	$800,000	$4,880,000
Chemical Storage/Feed System [5]				
Sodium Hypochlorite	1	LS	$200,000	$200,000
Aqua Ammonia	1	LS	$150,000	$150,000
Sulfuric Acid	1	LS	$100,000	$100,000
Scale Inhibitor	1	LS	$100,000	$100,000
Lime	1	LS	$200,000	$200,000
Sodium Bisulfite	1	LS	$70,000	$70,000
Caustic Soda	1	LS	$100,000	$100,000
Citric Acid	1	LS	$100,000	$100,000
Hydrogen Peroxide	0	LS	$150,000	$ -
Carbon Dioxide Post-Treatment System	1	EA	$650,000	$650,000
UV Equipment for UV/AOP	1	EA	$1,205,000	$1,205,000
GAC Contactor System	5.0	MGD	$270,000	$1,350,000
Engineered Storage Buffer	330,000	Gallon	$5.0	$1,650,000
Yard Piping	1	LS	$1,750,000	$1,750,000
Process Electrical [6]	1	LS	$7,000,000	$7,000,000
Process Instrumentation	1	LS	$4,500,000	$4,500,000
Site Work [7]	1	LS	$2,500,000	$2,500,000
Total Direct Cost				$42,590,000
Contingency (30%)				$12,780,000
Subtotal				$55,370,000
General Conditions (15%)				$8,310,000
Subtotal				$63,680,000
Contractor Overhead & Profit (10%)				$6,370,000
Subtotal				$70,050,000
Escalation to Midpoint (0%)				$ -
Subtotal				$70,050,000
Sales Tax (9.25%) on 50% of Direct Costs Plus Contingency				$2,570,000
TOTAL CONSTRUCTION COSTS [8]				**$72,620,000**
TOTAL TREATMENT PROJECT COST [9]				**$94,406,000**
Infrastructure				
Pipelines				
Pipeline to Cope Lake - 18 inch	16,000	LF	$269	$4,301,000
Waste Stream Pipeline	300	LS	$183	$50,000
Total				*$4,351,000*
Pumping				
Finished Water Pump Station	1	LS	$1,530,000	$1,530,000
Increase in Pump Station Size from Cope to DV WTP	1	LS	$2,000,000	$2,000,000
Total Direct Cost				$7,890,000
Contingency (30%)				$2,370,000

PROJECT:	Tri-Valley Potable Reuse Feasibility Study
JOB NO.:	10414A.00
DATE:	12/21/2017
BY:	CYC
OPTION:	Livermore AWPF to Lake I

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Subtotal				$10,260,000
General Conditions (15%)				$1,540,000
Subtotal				$11,800,000
Contractor Overhead & Profit (10%)				$1,180,000
Subtotal				$12,980,000
Escalation to Midpoint (0%)				$ -
Subtotal				$12,980,000
Sales Tax (9.25%) on 50% of Direct Costs Plus Contingency				$480,000
TOTAL CONSTRUCTION COSTS [8]				**$13,460,000**
Engineering and Contract Administration (30%)				**$4,038,000**
TOTAL INFRASTRUCTURE PROJECT COST [9]				**$17,498,000**
Cost to Bring Electrical				**$500,000**
TOTAL PROJECT COST				**$112,404,000**
Annual Yield		AF		5,500
Annual Yield		MG		1,800
Annual O&M Costs				
Treatment				$6,374,000
Infrastructure				$256,000
Total O&M				**$6,630,000**
Annualized Project Cost				$7,312,000
Total Annual Cost				**$13,942,000**
Unit Cost ($/AF)				$2,530

Notes:

(1) Includes general building HVAC, plumbing, and electrical. Unit price based on CMU block building type construction. Unit price based on usable square footage.

(2) Constructed below grade, under the building. Flow equalization is required before the MF/UF and RO feed pump stations so that MF/UF and RO trains maintain a constant flow. Sized to provide approximately 30 minutes of storage.

(3) Includes membrane trains, piping, membrane modules, CIP system, pre-strainers and on-skid instrumentation & control.

(4) Includes membrane trains, piping, RO pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.

(5) Tanks, feed pumps and piping included.

(6) Does not include stand-by power or off-site power improvements.

(7) Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.

(8) ENR Construction Cost Index (20-City average, March 2017): 10,288.

(9) This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Tri-Valley Potable Reuse Feasibility Study
JOB NO.:	10414A.00
DATE:	12/21/2017
BY:	CYC
OPTION:	Livermore AWPF to Well E

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Sludge Lagoon Dredging & Removal	1	LS	$900,000	$900,000
Building [1]	18,400	SF	$350	$6,440,000
Administrative Building	7,400	SF	$400	$2,960,000
MF Feed Equalization Basin [2]	130,000	Gallon	$2	$260,000
MF Equipment [3]	6.1	MGD	$861,000	$5,260,000
RO Feed Flow Equalization Basin [2]	130,000	Gallon	$2	$260,000
RO Equipment [4]	6.1	MGD	$800,000	$4,880,000
Chemical Storage/Feed System [5]				
Sodium Hypochlorite	1	LS	$200,000	$200,000
Aqua Ammonia	1	LS	$150,000	$150,000
Sulfuric Acid	1	LS	$100,000	$100,000
Scale Inhibitor	1	LS	$100,000	$100,000
Lime	1	LS	$200,000	$200,000
Sodium Bisulfite	1	LS	$70,000	$70,000
Caustic Soda	1	LS	$100,000	$100,000
Citric Acid	1	LS	$100,000	$100,000
Hydrogen Peroxide	0	LS	$150,000	$0
Carbon Dioxide Post-Treatment System	1	EA	$650,000	$650,000
UV Equipment for UV/AOP	1	EA	$1,205,000	$1,205,000
Yard Piping	1	LS	$1,750,000	$1,750,000
Process Electrical [6]	1	LS	$6,300,000	$6,300,000
Process Instrumentation	1	LS	$4,200,000	$4,200,000
Site Work [7]	1	LS	$2,200,000	$2,200,000
Total Direct Cost				$38,290,000
Contingency (30%)				$11,490,000
Subtotal				$49,780,000
General Conditions (15%)				$7,470,000
Subtotal				$57,250,000
Contractor Overhead & Profit (10%)				$5,730,000
Subtotal				$62,980,000
Escalation to Midpoint (0%)				$0
Subtotal				$62,980,000
Sales Tax (9.25%) on 50% of Direct Costs Plus Contingency				$2,310,000
TOTAL CONSTRUCTION COSTS [8]				**$65,290,000**
TOTAL TREATMENT PROJECT COST [9]				**$84,877,000**
Infrastructure				
Pipelines				
Pipeline to Cope Lake - 18 inch	6,500	LF	$269	$1,747,000
Waste Stream Pipeline	300	LS	$183	$50,000
Total				*$1,797,000*
Pumping				

PROJECT:	Tri-Valley Potable Reuse Feasibility Study
JOB NO.:	10414A.00
DATE:	12/21/2017
BY:	CYC
OPTION:	Livermore AWPF to Well E

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Finished Water Pump Station	1	LS	$1,040,000	$1,040,000
Injection Well	2	EA	$1,500,000	$3,000,000
Increase in Pump Station Size from Cope to DV WTP	1	LS	$2,000,000	$2,000,000
Total Direct Cost				$7,840,000
Contingency (30%)				$2,360,000
Subtotal				$10,200,000
General Conditions (15%)				$1,530,000
Subtotal				$11,730,000
Contractor Overhead & Profit (10%)				$1,180,000
Subtotal				$12,910,000
Escalation to Midpoint (0%)				$0
Subtotal				$12,910,000
Sales Tax (9.25%) on 50% of Direct Costs Plus Contingency				$480,000
TOTAL CONSTRUCTION COSTS [8]				**$13,390,000**
Engineering and Contract Administration (30%)				**$4,017,000**
TOTAL INFRASTRUCTURE PROJECT COST [9]				**$17,407,000**
Cost to Bring Electrical				**$500,000**
TOTAL PROJECT COST				**$102,784,000**
Annual Yield		AF		$5,500
Annual Yield		MG		$1,800
Annual O&M Costs				
Treatment				$6,374,000
Infrastructure				$256,000
Total O&M				**$6,630,000**
Annualized Project Cost				$6,686,000
Total Annual Cost				**$13,316,000**
Unit Cost ($/AF)				$2,420

PROJECT:	Tri-Valley Potable Reuse Feasibility Study
JOB NO.:	10414A.00
DATE:	12/21/2017
BY:	CYC
OPTION:	Livermore AWPF to Well E

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost

Notes:

(1) Includes general building HVAC, plumbing, and electrical. Unit price based on CMU block building type construction. Unit price based on usable square footage.

(2) Constructed below grade, under the building. Flow equalization is required before the MF/UF and RO feed pump stations so that MF/UF and RO trains maintain a constant flow. Sized to provide approximately 30 minutes of storage.

(3) Includes membrane trains, piping, membrane modules, CIP system, pre-strainers and on-skid instrumentation & control.

(4) Includes membrane trains, piping, RO pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.

(5) Tanks, feed pumps and piping included.

(6) Does not include stand-by power or off-site power improvements.

(7) Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.

(8) ENR Construction Cost Index (20-City average, March 2017): 10,288

(9) This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Tri-Valley Potable Reuse Feasibility Study
JOB NO.:	10414A.00
DATE:	12/21/2017
BY:	CYC
OPTION:	DSRSD AWPF To Cope Lake

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Building [1]	42,000	SF	$350	$14,700,000
Admin Building	7,200	SF	$400	$2,880,000
Cost to raise site	1	LS	$510,000	$510,000
MF Feed Equalization Basin [2]	0	Gallon	$2	$0
MF Equipment [3]	14.8	MGD	$639,000	$9,460,000
RO Feed Flow Equalization Basin [2]	310,000	Gallon	$2	$620,000
RO Equipment [4]	14.2	MGD	$775,000	$11,020,000
Chemical Storage/Feed System [5]				
Sodium Hypochlorite	1	LS	$272,000	$272,000
Aqua Ammonia	1	LS	$156,000	$156,000
Sulfuric Acid	1	LS	$156,000	$156,000
Scale Inhibitor	1	LS	$156,000	$156,000
Lime	1	LS	$311,000	$311,000
Sodium Bisulfite	1	LS	$109,000	$109,000
Caustic Soda	1	LS	$156,000	$156,000
Citric Acid	1	LS	$156,000	$156,000
Hydrogen Peroxide	0	LS	$233,000	$0
Carbon Dioxide Post-Treatment System	1	EA	$1,010,000	$1,010,000
UV Equipment for UV/AOP	1	EA	$2,723,000	$2,723,000
GAC Contactor System	12	MGD	$270,000	$3,240,000
Finished Water Pump Reservoir [5]	750,000	Gallon	$5	$3,750,000
Yard Piping	1	LS	$3,200,000	$3,200,000
Process Electrical [6]	1	LS	$13,500,000	$13,500,000
Process Instrumentation	1	LS	$9,000,000	$9,000,000
Site Work [7]	1	LS	$4,750,000	$4,750,000
Total Direct Cost				*$81,840,000*
Contingency (30%)				$24,560,000
Subtotal				$106,400,000
General Conditions (15%)				$15,960,000
Subtotal				$122,360,000
Contractor Overhead & Profit (10%)				$12,240,000
Subtotal				$134,600,000
Escalation to Midpoint (0%)				$0
Subtotal				$134,600,000
Sales Tax (9.25%) on 50% of Direct Costs Plus Contingency				$4,930,000
TOTAL CONSTRUCTION COSTS [8]				**$139,530,000**
Engineering and Contract Administration (30%)				**$41,859,000**
TOTAL PROJECT COST [9]				**$181,389,000**
Infrastructure				
Pipelines				
Source Water Pipeline - 30 inch	1,000	LF	$387	$387,000
Waste Conveyance - 16 inch	1,200	LF	$237	$284,000
Pipeline to Lake I - 30 inch	23,000	LF	$387	$8,902,000

PROJECT:	Tri-Valley Potable Reuse Feasibility Study
JOB NO.:	10414A.00
DATE:	12/21/2017
BY:	CYC
OPTION:	DSRSD AWPF To Cope Lake

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Total				$9,573,000
Pumping				
Source Water Pump Station	1	LS	$1,101,000	$1,101,000
Finished Water Pump Station	1	LS	$4,805,000	$4,805,000
Additional contingency to send to Cope Lake/DV WTP	1	LS	$2,000,000	$2,000,000
Total Direct Cost				*$17,480,000*
Contingency (30%)				$5,250,000
Subtotal				$22,730,000
General Conditions (15%)				$3,410,000
Subtotal				$26,140,000
Contractor Overhead & Profit (10%)				$2,620,000
Subtotal				$28,760,000
Escalation to Midpoint (0%)				$0
Subtotal				$28,760,000
Sales Tax (9.25%) on 50% of Direct Costs Plus Contingency				$1,060,000
TOTAL CONSTRUCTION COSTS [8]				**$29,820,000**
Engineering and Contract Administration (30%)				**$8,946,000**
TOTAL PROJECT COST [9]				**$38,766,000**
Costs to Bring Electricity				**$750,000**
Cost for Additional Solids Handling				**$1,460,000**
Total Project Cost				**$222,365,000**
Annual Yield		AF		$10,000
Annual Yield		MG		$3,300
Annual O&M Costs				
Treatment				$8,215,000
Infrastructure				$840,000
Total O&M				$9,055,000
Annualized Project Cost				$14,465,000
Total Annual Cost				**$23,520,000**
Unit Cost ($/AF)				$2,350

PROJECT:	Tri-Valley Potable Reuse Feasibility Study
JOB NO.:	10414A.00
DATE:	12/21/2017
BY:	CYC
OPTION:	DSRSD AWPF To Cope Lake

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost

Notes:

(1) Includes general building HVAC, plumbing, and electrical. Unit price based on CMU block building type construction. Unit price based on usable square footage.

(2) Constructed below grade, under the building. Flow equalization is required before the MF/UF and RO feed pump stations so that MF/UF and RO trains maintain a constant flow. Sized to provide approximately 30 minutes of storage.

(3) Includes membrane trains, piping, membrane modules, CIP system, pre-strainers and on-skid instrumentation & control.

(4) Includes membrane trains, piping, RO pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.

(5) Tanks, feed pumps and piping included.

(6) Does not include stand-by power or off-site power improvements.

(7) Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.

(8) ENR Construction Cost Index (20-City average, March 2017): 10,288.

(9) This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Tri-Valley Potable Reuse Feasibility Study
JOB NO.:	10414A.00
DATE:	12/21/2017
BY:	CYC
OPTION:	DSRSD AWPF to Wells

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Building [1]	42,000	SF	$350	$14,700,000
Admin Building	7,200	SF	$400	$2,880,000
Cost to raise site	1	LS	$510,000	$510,000
MF Feed Equalization Basin [2]	0	Gallon	$2	$0
MF Equipment [3]	14.8	MGD	$639,000	$9,460,000
RO Feed Flow Equalization Basin [2]	310,000	Gallon	$2	$620,000
RO Equipment [4]	14.2	MGD	$775,000	$11,020,000
Chemical Storage/Feed System [5]				
Sodium Hypochlorite	1	LS	$272,000	$272,000
Aqua Ammonia	1	LS	$156,000	$156,000
Sulfuric Acid	1	LS	$156,000	$156,000
Scale Inhibitor	1	LS	$156,000	$156,000
Lime	1	LS	$311,000	$311,000
Sodium Bisulfite	1	LS	$109,000	$109,000
Caustic Soda	1	LS	$156,000	$156,000
Citric Acid	1	LS	$156,000	$156,000
Hydrogen Peroxide	0	LS	$233,000	$0
Carbon Dioxide Post-Treatment System	1	EA	$1,010,000	$1,010,000
UV Equipment for UV/AOP	1	EA	$2,723,000	$2,723,000
Yard Piping	1	LS	$2,500,000	$2,500,000
Process Electrical [6]	1	LS	$11,500,000	$11,500,000
Process Instrumentation	1	LS	$8,000,000	$8,000,000
Site Work [7]	1	LS	$4,200,000	$4,200,000
Total Direct Cost				*$70,600,000*
Contingency (30%)				$21,180,000
Subtotal				$91,780,000
General Conditions (15%)				$13,770,000
Subtotal				$105,550,000
Contractor Overhead & Profit (10%)				$10,560,000
Subtotal				$116,110,000
Escalation to Midpoint (0%)				$0
Subtotal				$116,110,000
Sales Tax (9.25%) on 50% of Direct Costs Plus Contingency				$4,250,000
TOTAL CONSTRUCTION COSTS [8]				**$120,360,000**
Engineering and Contract Administration (30%)				**$36,108,000**
TOTAL PROJECT COST [9]				**$156,468,000**
Infrastructure				
Pipelines				
Source Water Pipeline - 30 inch	1,000	LF	$387	$387,000
Waste Conveyance - 16 inch	1,500	LF	$237	$355,000
Pipeline to Lake I - 30 inch	11,100	LF	$387	$4,296,000

PROJECT:	Tri-Valley Potable Reuse Feasibility Study
JOB NO.:	10414A.00
DATE:	12/21/2017
BY:	CYC
OPTION:	DSRSD AWPF to Wells

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Total				*$5,038,000*
Pumping				
Source Water Pump Station	1	LS	$1,101,000	$1,101,000
Finished Water Pump Station	1	LS	$3,181,000	$3,181,000
Total				*$3,181,000*
Injection Wells	4	EA	$1,500,000	$6,000,000
Additional contingency to send to Cope Lake/DV WTP	1	LS	$2,000,000	$2,000,000
Total Direct Cost				*$16,220,000*
Contingency (30%)				$4,870,000
Subtotal				$21,090,000
General Conditions (15%)				$3,170,000
Subtotal				$24,260,000
Contractor Overhead & Profit (10%)				$2,430,000
Subtotal				$26,690,000
Escalation to Midpoint (0%)				$0
Subtotal				$26,690,000
Sales Tax (9.25%) on 50% of Direct Costs Plus Contingency				$980,000
TOTAL CONSTRUCTION COSTS [8]				**$27,670,000**
Engineering and Contract Administration (30%)				**$8,301,000**
TOTAL PROJECT COST [9]				**$35,971,000**
Costs to Bring Electricity				**$750,000**
Cost for Additional Solids Handling				**$1,256,000**
Total Project Cost				**$194,445,000**
Annual Yield		AF		$10,000
Annual Yield		MG		$3,300
Annual O&M Costs				
Treatment				$8,124,000
Infrastructure				$693,000
Total O&M				$8,817,000
Annualized Project Cost				$12,649,000
Total Annual Cost				**$21,466,000**
Unit Cost ($/AF)				$2,150

PROJECT:	Tri-Valley Potable Reuse Feasibility Study
JOB NO.:	10414A.00
DATE:	12/21/2017
BY:	CYC
OPTION:	DSRSD AWPF to Wells

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost

Notes:

(1) Includes general building HVAC, plumbing, and electrical. Unit price based on CMU block building type construction. Unit price based on usable square footage.

(2) Constructed below grade, under the building. Flow equalization is required before the MF/UF and RO feed pump stations so that MF/UF and RO trains maintain a constant flow. Sized to provide approximately 30 minutes of storage.

(3) Includes membrane trains, piping, membrane modules, CIP system, pre-strainers and on-skid instrumentation & control.

(4) Includes membrane trains, piping, RO pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.

(5) Tanks, feed pumps and piping included.

(6) Does not include stand-by power or off-site power improvements.

(7) Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.

(8) ENR Construction Cost Index (20-City average, March 2017): 10,288.

(9) his is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Tri-Valley Potable Reuse Feasibility Study
JOB NO.:	10414A.00
DATE:	12/21/2017
BY:	CYC
OPTION:	Mocho AWPF to Wells

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
AWPF Costs				
Building [1]	36,000	SF	$400	$14,400,000
Chemical Building	10,500	SF	$350	$3,680,000
MF Feed Equalization Basin [2]	310,000	Gallon	$2	$620,000
MF Equipment [3]	14.8	MGD	$639,000	$9,460,000
RO Feed Flow Equalization Basin [2]	310,000	Gallon	$2	$620,000
RO Equipment [4]	14.2	MGD	$775,000	$11,020,000
Chemical Storage/Feed System [5]				
Sodium Hypochlorite	1	LS	$272,000	$272,000
Aqua Ammonia	1	LS	$156,000	$156,000
Sulfuric Acid	1	LS	$156,000	$156,000
Scale Inhibitor	1	LS	$156,000	$156,000
Lime	1	LS	$311,000	$311,000
Sodium Bisulfite	1	LS	$109,000	$109,000
Caustic Soda	1	LS	$156,000	$156,000
Citric Acid	1	LS	$156,000	$156,000
Hydrogen Peroxide	0	LS	$233,000	$0
Carbon Dioxide Post-Treatment System	1	EA	$1,010,000	$1,010,000
UV Equipment for UV/AOP	1	EA	$2,723,000	$2,723,000
Yard Piping	1	LS	$2,600,000	$2,600,000
Process Electrical [6]	1	LS	$11,500,000	$11,500,000
Process Instrumentation	1	LS	$8,000,000	$8,000,000
Site Work [7]	1	LS	$4,000,000	$4,000,000
Relocation of existing monitoring well	1	EA	$110,000	$110,000
Total Direct Costs				$71,220,000
Contingency (30%)				$21,370,000
Subtotal				$92,590,000
General Conditions (15%)				$13,890,000
Subtotal				$106,480,000
Contractor Overhead & Profit (10%)				$10,650,000
Subtotal				$117,130,000
Escalation to Midpoint (0%)				$0
Subtotal				$117,130,000
Sales Tax (9.25%) on 50% of Direct Costs Plus Contingency				$4,290,000
TOTAL CONSTRUCTION COSTS [8]				**$121,420,000**
Engineering and Contract Administration (30%)				**$36,426,000**
TOTAL PROJECT COST [9]				**$157,846,000**
Infrastructure				

PROJECT:	Tri-Valley Potable Reuse Feasibility Study
JOB NO.:	10414A.00
DATE:	12/21/2017
BY:	CYC
OPTION:	Mocho AWPF to Wells

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Pipelines				
Source Water Pipeline - 24 inch	13,000	LF	$323	$4,193,000
Waste Conveyance - 16 inch	500	LF	$237	$118,000
Pipeline to Well - 30 inch	6,300	LF	$387	$2,438,000
Total				*$6,749,000*
Pumping				
Source Water Pump Station	1	LS	$3,095,000	$3,095,000
Concentrate Pump Station	1	LS	$735,000	$735,000
Finished Water Pump Station	1	LS	$4,805,000	$4,805,000
Total				*$8,635,000*
Injection Wells	4	EA	$1,500,000	$6,000,000
Additional contingency to send to Cope Lake/DV WTP	1	LS	$2,000,000	$2,000,000
Subtotal				$23,390,000
Contingency (30%)				$7,020,000
Subtotal				$30,410,000
General Conditions (15%)				$4,570,000
Subtotal				$34,980,000
Contractor Overhead & Profit (10%)				$3,500,000
Subtotal				$38,480,000
Escalation to Midpoint (0%)				$0
Subtotal				$38,480,000
Sales Tax (9.25%) on 50% of Direct Costs Plus Contingency				$1,410,000
TOTAL CONSTRUCTION COSTS [8]				**$39,890,000**
Engineering and Contract Administration (30%)				**$11,967,000**
TOTAL INFRASTRUCTURE PROJECT COST [9]				**$51,857,000**
Cost to Bring Electrical				**$750,000**
Total Project Cost				**$210,453,000**
Annual Yield		AF		$10,000
Annual Yield		MG		$3,300
Annual O&M Costs				
Treatment				$8,026,000
Infrastructure				$764,000
Total O&M				**$8,790,000**
Annualized Project Cost				$13,690,000
Total Annual Cost				**$22,480,000**
Unit Cost ($/AF)				$2,250

PROJECT:	Tri-Valley Potable Reuse Feasibility Study
JOB NO.:	10414A.00
DATE:	12/21/2017
BY:	CYC
OPTION:	Mocho AWPF to Wells

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost

Notes:

(1) Includes general building HVAC, plumbing, and electrical. Unit price based on CMU block building type construction. Unit price based on usable square footage.

(2) Flow equalization is required before the MF/UF and RO feed pump stations so that MF/UF and RO trains maintain a constant flow. Sized to provide approximately 30 minutes of storage.

(3) Includes membrane trains, piping, membrane modules, CIP system, pre-strainers and on-skid instrumentation & control.

(4) Includes membrane trains, piping, RO pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.

(5) Tanks, feed pumps and piping included.

(6) Does not include stand-by power or off-site power improvements.

(7) Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.

(8) ENR Construction Cost Index (20-City average, March 2017): 10,288.

(9) This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Tri-Valley Potable Reuse Feasibility Study
JOB NO.:	10414A.00
DATE:	12/21/2017
BY:	CYC
OPTION:	Pleasanton AWPF to Cope Lake

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
AWPF Costs				
Building [1]	36,000	SF	$350	$12,600,000
Administration Building	7,200	SF	$400	$2,880,000
MF Feed Equalization Basin [2]	310,000	Gallon	$2.0	$620,000
MF Equipment [3]	14.8	MGD	$639,000	$9,460,000
RO Feed Flow Equalization Basin [2]	310,000	Gallon	$2.0	$620,000
RO Equipment [4]	14.2	MGD	$775,000	$11,020,000
Chemical Storage/Feed System [5]				
Sodium Hypochlorite	1	LS	$272,000	$272,000
Aqua Ammonia	1	LS	$156,000	$156,000
Sulfuric Acid	1	LS	$156,000	$156,000
Scale Inhibitor	1	LS	$156,000	$156,000
Lime	1	LS	$311,000	$311,000
Sodium Bisulfite	1	LS	$109,000	$109,000
Caustic Soda	1	LS	$156,000	$156,000
Citric Acid	1	LS	$156,000	$156,000
Hydrogen Peroxide	0	LS	$233,000	$ -
Carbon Dioxide Post-Treatment System	1	EA	$1,010,000	$1,010,000
UV Equipment for UV/AOP	1	EA	$2,723,000	$2,723,000
GAC Contactor System	12	MGD	$270,000	$3,240,000
Finished Water Pump Reservoir [5]	750,000	Gallon	$5.0	$3,750,000
Yard Piping	1	LS	$2,700,000	$2,700,000
Process Electrical [6]	1	LS	$12,000,000	$12,000,000
Process Instrumentation	1	LS	$8,500,000	$8,500,000
Site Work [7]	1	LS	$4,200,000	$4,200,000
Total Direct Costs				$76,800,000
Contingency (30%)				$23,040,000
Subtotal				$99,840,000
General Conditions (15%)				$14,980,000
Subtotal				$114,820,000
Contractor Overhead & Profit (10%)				$11,490,000
Subtotal				$126,310,000
Escalation to Midpoint (0%)				$ -
Subtotal				$126,310,000
Sales Tax (9.25%) on 50% of Direct Costs Plus Contingency				$4,620,000
TOTAL CONSTRUCTION COSTS [8]				**$130,930,000**
Engineering and Contract Administration (30%)				**$39,279,000**
TOTAL PROJECT COST [9]				**$170,209,000**
Infrastructure				
Pipelines				

PROJECT:	Tri-Valley Potable Reuse Feasibility Study
JOB NO.:	10414A.00
DATE:	12/21/2017
BY:	CYC
OPTION:	Pleasanton AWPF to Cope Lake

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Source Water Pipeline - 24 inch	13,000	LF	$323	$4,193,000
Source Water Pipeline - 30 inch	7,000	LF	$387	$2,709,000
Waste Conveyance - 16 inch	8,900	LF	$237	$2,105,000
Pipeline to Lake I - 30 inch	6,150	LF	$387	$2,380,000
Total				*$7,194,000*
Pumping				
Source Water Pump Station	1	LS	$3,633,000	$3,633,000
Concentrate Pump Station	1	LS	$997,000	$997,000
Finished Water Pump Station	1	LS	$2,637,000	$2,637,000
Total				*$7,267,000*
Additional contingency to send to Cope Lake/DV WTP	1	LS	$2,000,000	$2,000,000
Subtotal				$16,470,000
Contingency (30%)				$4,950,000
Subtotal				$21,420,000
General Conditions (15%)				$3,220,000
Subtotal				$24,640,000
Contractor Overhead & Profit (10%)				$2,470,000
Subtotal				$27,110,000
Escalation to Midpoint (0%)				$ -
Subtotal				$27,110,000
Sales Tax (9.25%) on 50% of Direct Costs Plus Contingency				$1,000,000
TOTAL CONSTRUCTION COSTS [8]				**$28,110,000**
Engineering and Contract Administration (30%)				**$8,433,000**
TOTAL INFRASTRUCTURE PROJECT COST [9]				**$36,543,000**
Cost to Bring Electrical				**$750,000**
Total Project Cost				**$207,502,000**
Annual Yield		AF		10,000
Annual Yield		MG		3,300
Annual O&M Costs				
Treatment				$8,079,000
Infrastructure				$851,000
Total O&M				**$8,930,000**
Annualized Project Cost				$13,498,000
Total Annual Cost				**$22,428,000**
Unit Cost ($/AF)				$2,240

PROJECT:	Tri-Valley Potable Reuse Feasibility Study
JOB NO.:	10414A.00
DATE:	12/21/2017
BY:	CYC
OPTION:	Pleasanton AWPF to Cope Lake

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost

Notes:

(1) Includes general building HVAC, plumbing, and electrical. Unit price based on CMU block building type construction. Unit price based on usable square footage.

(2) Constructed below grade, under the building. Flow equalization is required before the MF/UF and RO feed pump stations so that MF/UF and RO trains maintain a constant flow. Sized to provide approximately 30 minutes of storage.

(3) Includes membrane trains, piping, membrane modules, CIP system, pre-strainers and on-skid instrumentation & control.

(4) Includes membrane trains, piping, RO pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.

(5) Tanks, feed pumps and piping included.

(6) Does not include stand-by power or off-site power improvements.

(7) Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.

(8) ENR Construction Cost Index (20-City average, March 2017): 10,288.

(9) his is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the engineer's professional opinion of accurate costs at this time.

Appendix I

ZONE 7 RISK MODEL

Joint Tri-Valley Potable Reuse Feasibility Study

Water Supply Risk Model Evaluation of Project Options

The potable reuse project options considered in Chapter 7 were analyzed using Zone 7's Water Supply Risk Model, in order to evaluate potential impacts to system-wide water supply reliability and water shortage risk. The methods used for evaluation were consistent with the 2016 Water Supply Evaluation Update (WSE Update) to allow for direct comparison with the results from that document. A total of 48 separate scenarios were evaluated, a combination of:

- 6 potable reuse project options, with the available potable reuse supply increasing with time until 2035 buildout conditions are reached,
- 2 potential trends for future State Water Project reliability (static/declining),
- 2 alternative years for the beginning of California WaterFix operations (2028 and 2040), and
- 2 potential trends in future water demand (baseline growth/faster growth).

Each scenario was modeled using a Monte Carlo simulation that provided measures of water supply reliability and risk. Each Monte Carlo simulation ran 1,000 trials. In total, 48,000 separate forecasts were made to achieve the comparative results. This analysis updates the assumptions used in the WSE Update's Portfolio B, which included portable reuse.

The results were as one would expect: when more water supplies were available, there was a lower probability of water shortages. A summary of each project option and its model results is presented in Table 1. Every option performed better than the baseline portfolio from the WSE Update (i.e., the "Current Plan" portfolio). The WSE Update also featured a portfolio that included potable reuse supply, Portfolio B, and a summary of its risk model results is also included in Table 1 for comparison (note that Portfolio B made the assumption of producing a full 7,700 AFY starting in 2022, which the options in this analysis made a more conservative assumption of increasing production with time until expected buildout in 2035. This difference in timing drove the result that no single option outperformed Portfolio B in all categories. Both the current analysis and the WSE Update used the years 2022 through 2040 for the statistics describing the overall results.

Options 2b and 3 had the best results in terms of improving overall reliability, raising the 2022-2040 average to 99.7%, up from the baseline 98.0%. In addition, these options maintained the highest average groundwater level at 84% of total capacity, where the baseline was 75%. Option 2a had the highest water supply during a worst-case scenario: 75 gpcd, or 55% of typical demand, where the worst-case scenario in the baseline was 39 gpcd or 35%. Options 1a, 1b, and 5 had the least beneficial results, which was largely driven by the smaller buildout yield of 5,500 AFY instead of the 10,000 AFY supplied by the other options.

The gradual phasing-in of the potable reuse supply to buildout made any patterns in the results less noticeable than if the buildout yield were available from the outset. For example, the 10,000 AFY option for raw water augmentation (Option 2a) provided a base supply of surface water to the water treatment plants, and during simulated State Water Project shortages, the plants had capacity to treat the available raw water augmentation supply. Alternatively, the high-yield options for groundwater augmentation (Options 2b, 3, and 4) provided a base supply to groundwater, and while the wells increased production during simulated SWP shortages, they lacked the capacity to take full advantage of the potable reuse supply in addition to the existing groundwater supply. On a related note, groundwater pumping in the Risk Model is based on the amount required for peaking and to make up for any deficits in surface water supply. If

instead the average groundwater pumping is increased to match the purified water injection, as it was in the Zone 7 Groundwater Model, then the long-term change in average basin levels might be less pronounced between the various options. If needed, additional modeling might help evaluate the difference. These patterns were more apparent during initial analyses which omitted supply growth and phasing over time; with phasing included as the more conservative approach, these differences have less of an impact on final results.

It should be noted that the choice of location for the advanced water purification plant is not a factor in the model simulations; therefore, the project options that differed only by plant location produced identical results in the risk model. Specifically, Option 2b and Option 3 had identical results, because both yielded 10,000 AFY of purified water used for groundwater injection. Summaries of the modeled project option results are presented in Table 1.

Table 1: Water Supply Risk Model results for Chapter 7 project options are compared along with results from the 2016 Water Supply Evaluation Update. The best results in each metric are highlighted in green. Options 2b and 3 achieve the best outcomes in terms of increasing reliability and maintaining high groundwater storage levels, Option 2a achieved the best results for mitigating the effects of a worst-case water shortage.

Potable Reuse Option	**Yield (AFY)**	**Yield (MGD)**	**End Use**	**Average Reliability**, % of Demand	**Worst-Case Supply**, gpcd	**Worst-Case Supply**, % of Demand	**Average Groundwater Storage**, % of Basin Capacity
1a	5,500	5	Groundwater Augmentation via COL Recharge	99.2%	60	47%	79%
1b	5,500	5	Groundwater Augmentation via Well Injection	99.4%	61	47%	82%
2a	10,000	12 (winter) 5 (summer) 9 (average)	Raw Water Augmentation to DVWTP	99.6%	75	55%	81%
2b, 3	10,000	12 (winter) 5 (summer) 9 (average)	Groundwater Augmentation via Well Injection	99.7%	66	50%	84%
4	10,000	12 (winter) 5 (summer) 9 (average)	Groundwater Augmentation via COL Recharge	99.5%	71	53%	81%
5	5,500	5	Raw Water Augmentation to DVWTP	99.3%	60	47%	77%
WSE Update "Current Plan"	0	0		98.0%	39	35%	75%
WSE Update "Portfolio B" (Potable Reuse)	7,700	7	Raw Water Augmentation to DVWTP	99.5%	72	54%	84%

Appendix J

INSTITUTIONAL, OUTREACH, AND FUNDING NEXT STEPS AND OPPORTUNITIES

The Joint Tri-Valley Potable Reuse Technical Feasibility Study focused only on the technical aspects of implementing a potable reuse project. Chapter 8 enumerated some key next steps to proceed with the technical and permitting portion of the projects. However, projects are rarely that one-dimensional. For true project success, a multi-pronged approach, including institutional, outreach, and funding projects, should be implemented. Potential recommendations in each of these areas are described below.

Potential Institutional Next Steps

Any project within the Tri-Valley area will require coordination between multiple agencies. Depending on the type of project, end use, and location of treatment, various entities may be involved.

Institutional agreements and additional studies could include:

- Developing cost sharing agreements for future work:
  - Contracting a third-party mediator for developing cost sharing agreements may be helpful.
- Identify location for future Advanced Water Purification Facility (AWPF):
  - All potential treatment locations are owned by at least one of the partner agencies in the Tri-Valley area. The location selection process would include lease/ownership/operation discussions.
- Develop operational and ownership agreements:
  - Determination of how decisions are made (e.g., democratic decisions by a collective board or a lead agency with supporting advisors).
  - Clear determination of cost sharing.
  - Clear determination of capacity allocation/rights to expanded supply.
  - Agreements to document system operations and maintenance responsibilities by agency, hiring and training of staff, and legal responsibilities for new water production, distribution, and use. All such costs, including salaries for staff, would be discussed in the cost sharing agreement.
- Conduct a comprehensive rate study to determine impacts on rates for each agency
  - The split of funding for the project would be determined by the ownership and cost sharing agreement.
- Seek and apply for funding opportunities to offset rate payer impacts.
  - Funding opportunities for potable reuse are discussed in Section 8.5.

Potential Outreach and Education Next Steps

A comprehensive outreach and education program is critical for implementation of a successful potable reuse program. The last potable reuse project attempted in the Tri-Valley area (1990s) was not implemented, largely due to public resistance. It is therefore recommended to begin outreach efforts as soon as possible, explaining the concept of potable reuse even before a project is selected. These outreach efforts could include speaking engagements, surveys, educational tours, school outreach, and assemblies with community leaders.

An important component of other successful outreach programs has been treatment demonstrations. While not required for permitting or for design, a demonstration facility helps educate the public and elected officials by being able to actually see and taste the purified water

that is produced. A demonstration facility also allows for site specific water quality testing and data collection to address questions about water quality and how it compares to the existing drinking water supply.

Funding Source Identification

Costs of the Tri-Valley Potable Reuse Project consist of two components – (1) capital cost for construction of the facilities and associated components, and (2) O&M costs of the project, including the treatment and distribution systems.

The funding sources available range from traditional funding options such as pay-as-you-go funding, bond funding, grants, and State assisted loans to non-traditional funding sources such as market-based programs.

The main instruments available for funding the capital costs include:

- Pay-as-you-go financing or upfront collection of project costs from existing and/or new users for future capital improvement projects.
- Debt financing or the acquisition of funds through borrowing mechanisms.
- Grants and loans or alternate source of funds at no or minimal interest cost. Examples include federal, state, and local grant programs that provide funding at zero interest for projects that meet select criteria or loan programs that provide funding at a lower rate (estimated currently around 2.5 percent).
- Market-based programs that refer to financing through funds obtained from tax credits, purchase agreements, voluntary programs, trading and offset programs, and public-private partnerships.
- Public/Private Partnerships where the financing is by a private party whereby design, construction and operation is all by a private entity and the utilities would purchase the water at an agreed upon price for a set term. This is the model currently being considered by Santa Clara Valley Water District to expand their AWPF and develop their potable reuse program.

The Tri-Valley agencies would develop a specific financial and funding plan should a project move forward. Only grant and loan opportunities are discussed herein.

Grants and Loans

Table J.1 provides a summary of some of the available state and federal funding sources available for potable reuse projects. Please refer to the contact or website for the most up to date information for each of these grants and loans.

There are numerous factors that should be considered in the pursuance of grant funding. Several factors that should be noted in pursuance of grant funding include:

- Grant applications require demonstration of the ability to construct, operate, and maintain the project without grant funding.
- Grant award or funding authorization is not a promise of grant reimbursement.
- Most grants are reimbursements and not cash up front. This requires that a source of funding be available for the construction of the project.
- Grant reimbursements are subject to annual budget and appropriations process and thus disbursement of grant funds on schedule is not guaranteed.

  - It may take several years after project completion to receive reimbursements, especially in difficult economic times.
  - Most grants require a minimum cost share by project sponsor.
- Federal grants typically require investment of additional resources to obtain lobbying support.

Despite the competitive nature of alternative funding, available funding sources should be considered to maximize ratepayer financial benefits. The following sections summarize available state and federal funding options.

State Funding

Several state funding sources are applicable to potable reuse projects. These grants and loans require environmental documents such as CEQA or CEQA-Plus. Note that grant programs may change over time depending on fund availability; grant programs should be reviewed as a project moves toward construction.

Water Recycling Funding Program

One option for financing a potable reuse project is the Water Recycling Funding Program administered by the State Water Resources Control Board. The program offers funding for research, feasibility studies, planning, and construction. The program is financed through Propositions 1, 13, 50, and the State Revolving Fund (SRF):

Recycling projects are categorized by their potential benefits to state and local communities, which in turn determine which funding sources are applicable.

- Category I projects will offset state water supplies and increase water to the Delta.
- Category II projects will offset state water use, but do not provide benefits to the Delta.
- Category III projects use recycled water to supplement local water supplies but have no impact on the state water supply or the Delta.
- Category IV projects will treat and reuse groundwater contaminated by human activity.
- Category V projects will treat and dispose wastewater to meet waste discharge regulations.
- Category VI captures miscellaneous projects that do not fall into other categories and have no benefits to state or local water supplies.

The recycled water projects fall into Category III although a potable reuse project in the Tri-Valley could be used as a Category I project to offset state water use. The source of available funding varies with the category in which the project is classified. The maximum award for construction grants for Category I through IV projects is the lesser value of $5 million per project or 25 percent of construction costs.

Category V and VI projects are only eligible for SRF loans. Loans are capped at $50 million per agency per year. The SRF interest rate is set at one-half of the state General Obligation bond rate and has historically averaged around 2.5 percent.

Table J.1 Grant and Loan Funding Summary

Program	Agency	Type	Description
State			
Water Recycling Funding Program	State Water Resources Control Board	Loan/ Grant	Funding is available for projects in the following categories: 1. Category I projects will offset state water supplies and increase water to the Delta. 2. Category II projects will offset state water use, but do not provide benefits to the Delta. 3. Category III projects use recycled water to supplement local water supplies but have no impact on the state water supply or the Delta. 4. Category IV projects will treat and reuse groundwater contaminated by human activity. 5. Category V projects will treat and dispose wastewater to meet waste discharge regulations. 6. Category VI captures miscellaneous projects that do not fall into other categories and have no benefits to state or local water supplies. The maximum award for construction grants for Category I through IV projects is the lesser value of $5 million per project or 25 percent of construction costs. Category V and VI projects are only eligible for SRF loans. Loans are capped at $50 million/agency/year.
Clean Water State Revolving Fund (CWSRF)	State Water Resources Control Board	Loan	Low interest loan for a 30-year payment period (same as Water Recycling Funding Program). Rolling application period. No limit to funding amounts, but depends on available funding.
Green Project Reserve (GPR)	State Water Resources Control Board	Grant	Grant program to fund water efficient components of a project in the form of loan forgiveness for the principal amount, up to 50 percent of GPR eligible construction and 75 percent of GPR eligible planning costs. The maximum amount of funding for recycled water projects is $2.5 million. Applications are on a rolling basis with a business case along with the CWSRF application.
Integrated Regional Water Management Grants Program (Prop 84 and Prop 1)	Department of Water Resources	Grant	Grants are available for projects that support integrated water resources management (IWRM) plans and are related to water supply reliability, groundwater recharge, water quality enhancement, etc.
Proposition 1	State Water Resources Control Board	Grant	Funding is available for recycled water projects as well as groundwater sustainability projects. The recycled water grants are being run through the SRF program (application is the same as an SRF application). Grant award is up to 35 percent of construction costs or a maximum of $15 million (for recycled water projects). The Proposition 1 Groundwater Sustainability Grants funds up to 50 percent of the construction costs with a maximum cap of $50 million. Funds are available on a first-come, first-served basis. Projects must have a groundwater sustainability focus, either through prevention or cleanup of contaminated groundwater.

Table J.1 Grant and Loan Funding Summary (Continued)

Program	Agency	Type	Description
Federal			
Title XVI	U.S. Bureau of Reclamation	Grants	Eligible projects include recycled water feasibility study, demonstration, and construction projects. The program provides as much as 25 percent of construction costs with a maximum of $20 million. To meet eligibility requirements a project must have a Bureau of Reclamation approved feasibility study, comply with federal environmental regulations (NEPA), and demonstrate the ability to pay the remainder of the construction costs. Once the project feasibility study is approved, the project must be authorized by Congress to be eligible for a Title XVI grant. This process has been streamlined through Water Infrastructure Improvements for the Nation (WIIN) Act.
WIFIA	EPA	Loan	Minimum project cost is $20 million for communities over 25,000 people. Total federal assistance may not exceed 80% of the project's eligible costs. Low interest rate loan.

The SWRCB provides one application package for both construction grants and SRF recycled water loans. The application package consists of:

- Financial Assistance Application.
- Facilities Plan composed of:
  - Project report.
  - Environmental documents including CEQA documents.
  - Construction Financing Plan.
  - Recycled Water Market Assurances documenting user participation in the project.
  - Authorized Representative Resolution (Legal Authority).
- Water Conservation Plan demonstrating that the applicant has a water conservation program in effect.

The SWRCB will review the application package and assess eligibility. Once the SWRCB receives and reviews the final plans and specs, it will issue project performance standards. Once performance standards are agreed to and the applicant chooses a contractor, the parties sign a funding agreement. The applicant must also have an Urban Water Management Plan filed with the Department of Water Resources to receive funds. Passed in 2014, Proposition 1 allocated $625 million for funding of recycled water projects through the Water Recycling Funding Program. At this time, these funds have been largely depleted. In January 2016, the SWRCB added $1.2 billion to the funds available for SRF. Unlike the Prop 1 funds that included grant funding, the program has returned to primarily issuing water recycling loan applications. Due to the long drought from 2012 to 2016, many recycled water projects have been submitted for funding. The SWRCB has indicated that in the future there may be competitive criteria for funding as opposed to first-come, first-served.

Clean Water State Revolving Fund

The Clean Water State Revolving Fund (CWSRF) is the umbrella funding program for the Water Recycling Fund. The benefits and application process are the same. The allocated money differs depending on the project. CWSRF is more focused on wastewater projects - for example lift station rehabilitation, wastewater treatment plant upgrades, and infrastructure. From July 2016 to April 2017, the CWSRF program applicants received $1.016 billion while the Water Recycling Funding Program projects received $89 million.

The application for both SRF programs is the same and therefore it is possible to apply for both programs with the same application.

Green Project Reserve

Within the Clean Water SRF program, there is an additional funding source called the Green Project Reserve (GPR). Projects with greater than 10 percent of GPR eligible components are prioritized above others without a GPR component. This program allows up to 50 percent of GPR eligible components of loan forgiveness for projects which have received CWSRF funding. In order to qualify, projects must fit into one of the following four categories:

- Green infrastructure.
- Water efficiency.
- Energy efficiency.

- Environmentally innovative activities.

All projects must also qualify for the CWSRF program in order to receive loan forgiveness. The maximum award amount for the GPR is 50 percent of GPR eligible costs and 75 percent of GPR eligible planning costs, with a cap of $2.5 million for recycled water projects. A business case must be presented within the CWSRF application explaining the GPR components of the program and note on the CWSRF application the portion of the project that is GPR eligible.

Integrated Regional Water Management Implementation Grant Program

Grants are available for projects that support Integrated Regional Water Management (IRWM) Plans and are related to water supply reliability, groundwater recharge, water quality enhancement etc.

In transitioning from Prop 50 funding to Prop 84 funding, the Department of Water Resources (DWR) altered several of the standards it uses to evaluate regions including governance requirements, acknowledgement of water conflicts, and potential climate change requirements. To facilitate this change, DWR has allowed regions with standing IRWM plans to also receive funds under Prop 84 to comply with the new standards and to develop new projects. Projects seeking funding through this grant process generally submit a project summary to the respective local IRWM management group to review and assess the merits of a project and its ability to fulfill the intent of the IRWM plan. Once approved through this process, a project may be included in the region's implementation grant application.

The IRWM program was also allocated an additional $510 million of funds from Proposition 1. The initial release of funds from this program has been focused on providing assistance to disadvantaged communities. However, grant money is expected to be available and advertised for all other qualified projects that are included in their own regional IRWM Plans is expected in 2018. Therefore, any potable reuse project must be a part of the Bay Area IRWMP to qualify for this grant.

Proposition 1

Proposition 1 was approved by California voters in November, 2014 and allocates a total of $7.5 billion to water projects and programs as part of a statewide water plan for California. There are six main funding areas defined:

- Regional Water Reliability.
- Water Storage Capacity.
- Water Recycling.
- Groundwater Sustainability.
- Safe Drinking Water.
- Watersheds and Flood Management.

Proposition 1 allocated $625 million for funding of recycled water projects. As discussed above these funds were routed through the SWRCB Water Recycling Funding Program. At this time, these funds have been largely depleted.

Proposition 1 also allocated funds for preventing groundwater contamination or cleaning up groundwater that serves as a source for drinking water. The SWRCB will administer $800 million of these funds. In March 2017 the SWRCB awarded $20 million in an initial round of grant funds. There is a minimum grant amount of $100,000 and a maximum grant amount of $2 million for

planning projects that are designed to lead to implementation projects that prevent or clean up contamination of an aquifer. There is a minimum grant amount of $500,000 and a maximum grant amount of $50 million for implementation projects that prevent or clean up contamination of an aquifer.

The Budget Act of 2015 appropriates Proposition 1 funds and makes the funding available for expenditure (i.e., encumbered in a funding agreement) until June 30, 2018, and available for liquidation (i.e., funds encumbered in funding agreements have been invoiced and paid) until June 30, 2021. The applicant is required to provide a minimum local cost share of fifty (50) percent of the total project cost. Other state funds (regardless of the issuing state agencies) cannot be used for the required match funds. Match funds may include, but are not limited to: federal grants and loans; or "in-kind" services provided by the applicant. The projects help achieve the goals of California's Water Action Plan, which serves as California's road map toward sustainable water management and calls for accelerating the cleanup of contaminated groundwater and preventing future contamination.

Federal Funding

In addition to local and State grants and loans, there are several highly competitive Federal grant and loan programs that provide financial resources to purified recycled water projects.

Title XVI

The U.S. Bureau of Reclamation administers funds for recycled water feasibility, demonstration, and construction projects through the Water Reclamation and Reuse Program authorized by the Reclamation Wastewater and Groundwater Study and Facilities Act of 1992 (Title XVI) and its amendments. The program provides as much as 25 percent of construction costs with a maximum of $20 million. To meet eligibility requirements a project must have a feasibility study meeting federal standards through compliance with USBR feasibility study guidelines, comply with environmental regulations, and demonstrate the ability to pay the remainder of the construction costs. Projects are authorized by Congress and recommended in the President's annual budget request by the Bureau of Reclamation. Congress then appropriates funds and the Bureau ranks and prioritizes projects and disburses the money on a competitive grant basis each year. Prioritized projects are those that postpone the development of new water supplies, reduce diversions from natural watercourses, and reduce demand on federal water supply facilities, or that have a regional or watershed perspective.

Water Infrastructure Improvements for the Nation (WIIN) Act

In July 2017, the Bureau of Reclamation released a new funding opportunity for the Title XVI water recycling projects under the Water Infrastructure Improvement for the Nation (WIIN) Act. This funding opportunity is for sponsors of water recycling projects that have completed a Title XVI Feasibility Study that has been reviewed by Reclamation, found to meet all the requirements of Reclamation Manual Release WTR 11-01 and been transmitted to Congress by Reclamation. For this first funding opportunity under the WIIN Act, only $10 million was allocated and the Bureau accepted applications during a one month window (July 17-August 17, 2017) to fund up to 25 percent of the total cost of planning, design and /or construction that would be conducted before September 30, 2019. No other restriction on funding is explicitly stated. It is anticipated that future Title XVI funding opportunities will include allocations under WIIN.

Water Infrastructure Finance and Innovation Act (WIFIA) Program

The EPA's Water Infrastructure Finance and Innovation Act (WIFIA) establishes a new financing mechanism for water and wastewater infrastructure projects. WIFIA provides low interest rate financing for large dollar-value water and wastewater projects. The interest rate will be equal to or greater than the U.S. Treasury rate of a similar maturity at the date of execution of the Financial Agreement. Projects must cost no less than $20 million (large communities) or $5 million (small communities <25,000 people), however projects can be combined and submitted as a group of projects with the maximum amount of the loan not exceeding 49 percent of the total eligible project costs. Total federal assistance may not exceed 80% of the project's eligible costs. The WIFIA loan term is 35 years, with a 5 year maximum repayment deferment after substantial completion of the project. Project selection is competitive.

Eligible projects include:

- CWSRF eligible projects.
- Drinking Water State Revolving Fund (DWSRF) eligible projects.
- Projects for enhanced energy efficiency at drinking water and wastewater facilities.
- Brackish or seawater desalination project, an aquifer recharge project, water recycling project.
- Acquisition of property if it is integral to the project or will mitigate the environmental impact of a project.
- Bundled State Revolving Fund (SRF) projects submitted under one application by an SRF program.
- A combination of projects secured by a common security pledge.

The WIFIA application process includes a two-step application process with the first step including the submittal of a Letter of Interest (LOI). Based upon a review of the LOI, Agencies may be Invited to Apply, upon which a more comprehensive WIFIA Application will need to be developed and submitted within 6 months of notification. The WIFIA application process can take 1 to 1.5 years to complete. The WIFIA program charges an application fee for the submittal of the WIFIA Application ($25,000 for small agencies and $100,000 for large agencies) and upon closing of the Financial Agreement, the EPA will provide an invoice to the applicant reconciling all application costs (anticipated to range from $250,000-$700,000 pending the size of the loan and agency negotiations).

The next round of WIFIA funding is anticipated in early 2018.

Summary of Funding Options

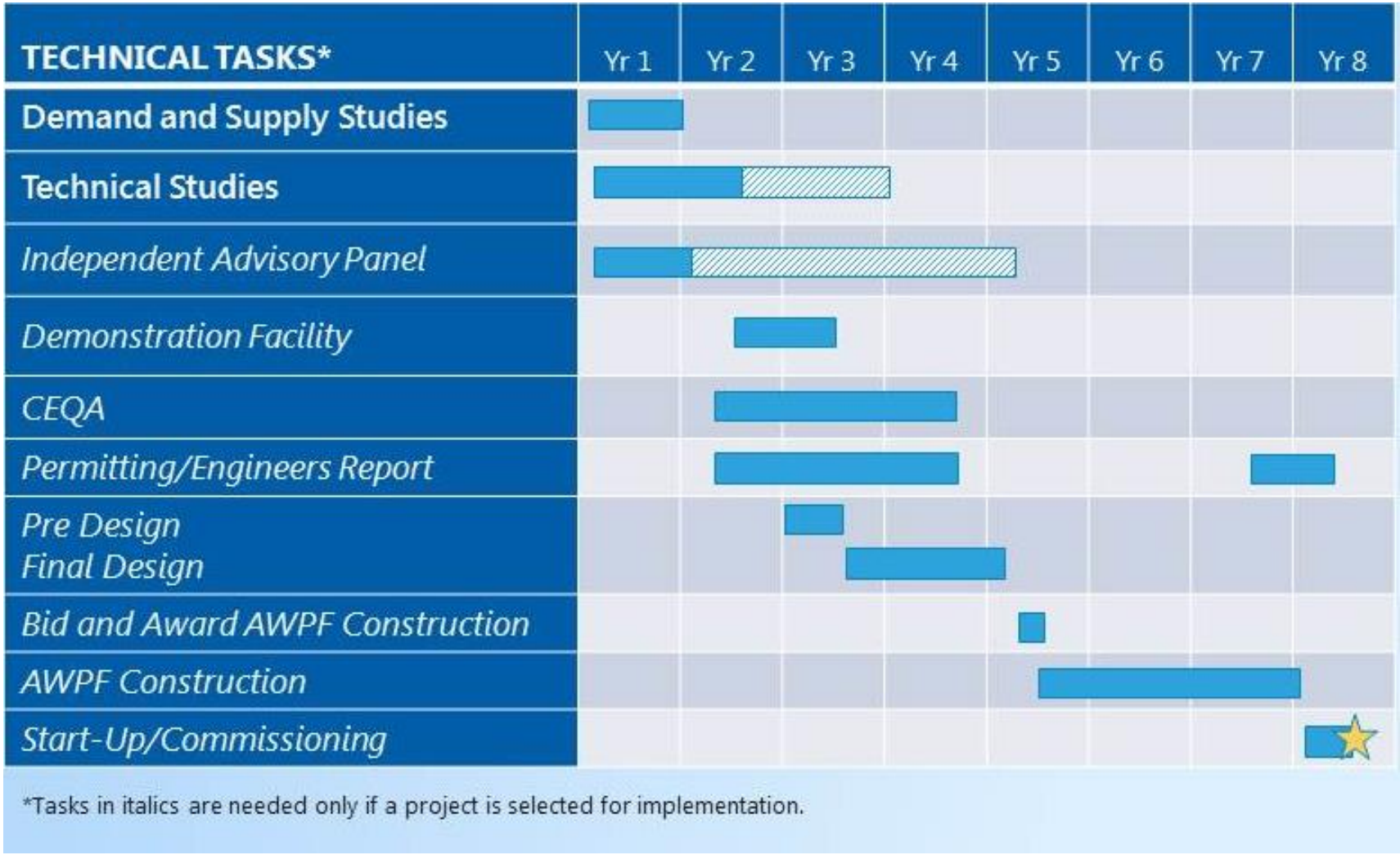
Costs of the Tri-Valley Potable Reuse Project consist of two components – (1) capital cost for construction of the facilities and associated components, and (2) O&M costs of the project, including the treatment and distribution systems.

The funding sources available range from traditional funding options such as pay-as-you-go funding, bond funding, grants, and State assisted loans to non-traditional funding sources such as market-based programs. These funding options are detailed in Appendix J. The following list summarizes a sample of other California utilities that are currently working on their potable reuse programs and how they are planning to fund them:

- Soquel Creek Water District - Prop 1 Groundwater grant (for preventing seawater intrusion), Title XVI grants, and SRF loans.
- Morro Bay - WIFIA loans and SRF loans
- Santa Clara Valley Water District - Public/Private partnership

The State of California is working on another water bond, so additional grant funding may be made available should that water bond pass in the future.

POTENTIAL NEXT STEPS FOR JOINT TRIVALLEY POTABLE REUSE PROJECT



Dublin San Ramon Services District
Summary & Recommendation

Item 8.B.
Meeting Date: May 15, 2018

TITLE: Hold Public Hearing: Adopt Resolution Establishing Miscellaneous Fees and Charges and Rescind Resolution No. 13-16

RECOMMENDATION:

Staff recommends the Board of Directors hold a Public Hearing and adopt, by Resolution, miscellaneous fees and charges and rescind Resolution No. 13-16.

SUMMARY:

Miscellaneous fees and charges are reviewed and updated every two years to ensure that the cost of specific services provided to customers is recovered. Miscellaneous fees were last updated in 2016. In fiscal year ending 2017, revenue generated from miscellaneous fees was over $4.3 million.

The departments prepared an analysis for each miscellaneous fee which lists the staff position(s) that typically provides the service, the staff's 2018 billing rate, the amount of time required to provide the service, and any miscellaneous costs incurred to provide the service (materials, postage, printing, etc.). A comprehensive review of the current process has been performed to ensure that the proposed fees capture the current level of service provided.

Attachment 1 to this report recaps all of the miscellaneous fees. The table compares the current and proposed fees including the dollar and percentage change. Many fees have increased by 7%, which is primarily due to the increase in salary and benefits over the past two years. Some fees increased more due to a reassessment of the time required to complete the work, and some fees have decreased because of process efficiencies that were developed. Other considerations included supplier costs of materials. Notes are provided for those fees that are increasing or decreasing beyond adjustments to salary and benefit rates.

No new miscellaneous fees are recommended at this time.

Originating Department: Administrative Services	**Contact: C. Atwood**	**Legal Review: Not Required**
Cost: $0	**Funding Source: N/A**	
Attachments: ☐ None ☐ Staff Report ☒ Resolution ☐ Ordinance ☐ Task Order ☐ Proclamation ☒ Other (see list on right)	**Attachment 1 – Miscellaneous Fees**	

Miscellaneous Fees - Administrative

TYPE OF FEE	DISTRICT CODE	FEE DESCRIPTION	2018 FEE	CURRENT FEE	CHANGE	% CHANGE	LAST UPDATE	NOTES
General Penalty - Code Infraction	1.30.010(B)	First violation.	$250.00	$250.00	$0.00	0%	Jul-04	CA Penal Code Section 19.8
		Second violation of the same provision or ordinance within one year.	$500.00	$500.00	$0.00	0%	Jul-04	CA Water Code Section 377
		Each additional violation of the same provision or ordinance within one year.	$1,000.00	$1,000.00	$0.00	0%	Jul-04	CA Water Code Section 377
Copies of Public Records Fee	1.40.040	Per page.	$0.10	$0.10	$0.00	0%	Jul-04	CA Gov. Code Section 6253(b)
Assessment of Late Charges	1.50.010	Shall be assessed on the overdue amount outstanding.	10%	10%	0%	0%	Jul-04	CA Gov. Code Section 61115(a)(3)(C)
Additional Late Charges	1.50.010	Shall be assessed for each 30 day period during which the overdue bill remains unpaid.	1%	1%	0%	0%	Jul-04	CA Gov. Code Section 61115(a)(3)(C)
Charge for Unpaid Returned Checks	1.50.070	First occurrence.	$25.00	$25.00	$0.00	0%	Aug-03	CA Civil Code 1719
		Each additional occurrence.	$35.00	$35.00	$0.00	0%		CA Civil Code 1719
Escrow Account - Set-up Fee	1.100.010	Fee to establish an escrow account requested by contractor.	$405.00	$ 375.00	$30.00	8%	Apr-16	
Escrow Account - Handling Fee	1.100.010	Fee for each escrow account transaction will be deducted from the contractor's regular progress payment.	$35.00	$30.00	$5.00	17%	Apr-16	
Regional Sewer Capacity Reserve Fee - Installment Plan - 10 year	3.70.070(B)	Initial set-up of 10 year installment plan.	$3,110.00	$ 3,100.00	$10.00	0%	Apr-16	Staff performing task changed from Associate Engineer to Junior Planner

Miscellaneous Fees - Customer Service

TYPE OF FEE	DISTRICT CODE	FEE DESCRIPTION	2018 FEE	CURRENT FEE	CHANGE	% CHANGE	LAST UPDATE	NOTES
Backflow Prevention Administrative Fee - Reduced Pressure Device	4.40.070	Bi-monthly backflow prevention device maintenance administrative fee for reduced pressure device.	$ 13.00	$ 15.00	($2.00)	-13%	Apr-16	Customer Service staff no longer involved in performing tasks, removed staff time cost and reduced time for all other staff.
Backflow Prevention Administrative Fee - Double check/Detector check	4.40.070	Bi-monthly backflow prevention device maintenance administrative fee for double check/detector check devices.	$ 19.00	$ 24.50	($5.50)	-22%	Apr-16	Customer Service staff no longer involved in performing tasks, removed staff time cost and reduced time for all other staff.
New Accounts Set-up Fee	4.40.040(A)	New Utility Billing Account Set Up Fee. Charged when establishing a new account.	$ 20.00	$ 19.00	$1.00	5%	Apr-16	
Service Reconnection Fee	4.40.040(B)	For each occasion.	$ -	$ 52.00	($52.00)	-100%	Apr-16	Have been combined with Service Termination fee to improve efficiency and customer communications.
Service Termination Fee	4.40.040(B)	For each occasion.	$ -	$ 52.00	($52.00)	-100%	Apr-16	Have been combined with Service Reconnection fee to improve efficiency and customer communications.
Service Reconnection and Termination Fee	4.40.040(B)	For each occasion.	$ 109.00	$ -	$109.00	100%	N-A	Previously two separate fees; have been combined into one fee to improve efficiency and customer communications.
Service Reinstatement Fee-OT	4.40.040(B)	Performed during non-regular business hours.	$ 360.00	$ 282.00	$78.00	28%	Apr-16	Updated overtime billing rate.
Curb Stop Repair Fee	4.40.040(B)	For repair of damaged curb stop.	$ 399.00	$ 384.00	$15.00	4%	Apr-16	
Trim Charge	4.40.040(B)	For trimming around meter box after customer failed to do trimming after being notified.	$ 141.00	$ 133.00	$8.00	6%	Apr-16	
Hand Delivered Notification Fee	4.40.040(B)	Hand delivery, to service location as required by law, to notify resident of pending service disconnect.	$ 29.00	$ 27.00	$2.00	7%	Apr-16	
Broken Lock Fee	4.40.040(B)	Fee to cover the hardware and staff time costs resulting from a cut lock.	$ 70.00	$ 67.00	$3.00	4%	Apr-16	

Miscellaneous Fees - Customer Service

TYPE OF FEE	DISTRICT CODE	FEE DESCRIPTION	2018 FEE	CURRENT FEE	CHANGE	% CHANGE	LAST UPDATE	NOTES
Meter Reinstall Fee	4.40.040(B)	Time and materials to remove and reinstall meter based on customer need	$ -	$ 133.00	($133.00)	-100%	Apr-16	Have been combined with Meter Removal fee to improve efficiency.
Meter Removal Fee	4.40.040(B)	Time and materials to remove and reinstall meter based on customer need	$ -	$ 133.00	($133.00)	-100%	Apr-16	Have been combined with Meter Reinstall fee to improve efficiency.
Meter Removal and Reinstall Fee	4.40.040(B)	Time and materials to remove and reinstall meter based on customer need	$ 166.00	$ -	$166.00	100%	N-A	Previously two separate fees; have been combined into one fee to improve efficiency.
Site Visit	4.40.080(A)	Unsupported Site visit.	$ 83.00	$ 79.00	$4.00	5%	Apr-16	
Temporary Meter - Charge for Breaking Seal	4.40.080(A)	Customer will be charged for actual time and materials	Actual Cost	$ 630.00	($630.00)	-100%	Apr-16	Time and Materials vary too much to have a set fee for every circumstance.
Field Tracing Charge - Non-Residential Construction Water Meter Fee	4.40.090(B)	Field tracing charge each time a meter user fails to present the meter for reading.	$ 240.00	$ 226.00	$14.00	6%	Apr-16	

Miscellaneous Fees - Engineering

Attachment 1 to S&R

TYPE OF FEE	DISTRICT CODE	FEE DESCRIPTION	2018 FEE	CURRENT FEE	CHANGE	% CHANGE	LAST UPDATE	NOTES ON VARIANCE
Planning Agreement Application Fee	2.30.050	Minimum processing fee for planning agreement application.	**$3,205.00**	**$ 3,425.00**	($220.00)	-6%	Apr-16	Staff performing tasks changed from General Manager to Engineering Services Manager.
Water Main Installation Inspection	3.70.070(A)	Inspection of repair of water main line with no bacteriological testing required.	**$1,045.00**	**$ 980.00**	$65.00	7%	Apr-16	
		Minimum for inspection of installation or repair of water main line with bacteriological testing required. (Laboratory testing charges billed separately.)	**$4,625.00**	**$ 4,330.00**	$295.00	7%		
		Additional cost per linear foot over 300 ft. for inspection of installation or repair of water main line with bacteriological testing required.	**$8.35**	**$ 7.82**	$0.53	7%		
Chlorination/Bacti retest	3.70.070	Fee for Chlorination/Bacti retest when initial testing fails.	**$760.00**	**$710.00**	$50.00	7%	Apr-16	
Water Pressure retest	3.70.070	Fee for water pressure retest when initial testing fails.	**$340.00**	**$320.00**	$20.00	6%	Apr-16	
Fire Hydrant Inspection Fee	3.70.070(A)	Per unit fee for inspection of fire hydrant installation.	**$420.00**	**$ 390.00**	$30.00	8%	Apr-16	
Building Service Line Inspection Fee	3.70.070(A)	Per unit fee for inspection of water service line installation.	**$555.00**	**$ 520.00**	$35.00	7%	Apr-16	
Blow-off Valve or Air Relief Valve Inspection Fee	3.70.070(A)	Per unit fee for inspection of blow-offs and air relief valves.	**$280.00**	**$ 260.00**	$20.00	8%	Apr-16	
Backflow Prevention Device Inspection Fee	3.70.070(A)	Per unit fee for inspection of backflow prevention - domestic and irrigation service lines.	**$205.00**	**$ 260.00**	($55.00)	-21%	Apr-16	Reduced staff time from 2hrs to 1.5hrs
Fire Service Installation and Backflow Prevention Device Inspection Fee	3.70.070(A)	Per unit fee for fire service installation and inspection of backflow prevention device.	**$830.00**	**$ 800.00**	$30.00	4%	Apr-16	
Service Assembly and Service Connection Inspection Fee	3.70.070(A)	Per unit fee for inspection of service assembly and service connection (water tap)	**$555.00**	**$ 520.00**	$35.00	7%	Apr-16	

TYPE OF FEE	DISTRICT CODE	FEE DESCRIPTION	2018 FEE	CURRENT FEE	CHANGE	% CHANGE	LAST UPDATE	NOTES ON VARIANCE
Inspection Conducted Outside Regular Working Hours.	3.70.070(A)	Hourly rate for inspection conducted other than during regular working hours (8:30-4:30 weekdays).	**$225.00**	**$ 210.00**	$15.00	7%	Apr-16	
Inspection Conducted on Weekends or Holidays	3.70.070(A)	Minimum for inspections conducted on weekends or holidays.	**$725.00**	**$ 680.00**	$45.00	7%	Apr-16	
		For each hour in excess of four hours.	**$225.00**	**$ 210.00**	$15.00	7%		
Project Planning and Review Fees (for potable water and/or recycled water plans)	3.70.070(A)	Single family home	**$410.00**	**$385.00**	$25.00	6%	Apr-16	
		Commercial Unit Improvement/Expansion	**$2,170.00**	**$2,035.00**	$135.00	7%		
		New Single commercial unit/building	**$4,340.00**	**$4,070.00**	$270.00	7%		
		Additional commercial unit/building	**$1,695.00**	**$1,520.00**	$175.00	12%		Staff performing task changed from GIS Analyst to Assoc. Engr. & Included staff time costs for WWW System Lead Operator involved in plan reviews.
All Project Planning and Review Fees assume a maximum of two plan submittal reviews; all additional reviews will be billed at the staff's actual burdened hourly rate. Fee includes staff time for project support during construction and project acceptance.		Additional fee per linear foot for water service over 300ft	**$5.18**	**$4.77**	$0.41	9%		
		Minimum new water system installation for residential subdivision - up to 5 units (incl. offsite or backbone improvements)	**$4,340.00**	**$4,070.00**	$270.00	7%		
		Additional per residential unit over 5	**$155.00**	**$145.00**	$10.00	7%		
		Additional fee per linear foot for new main installation over 300ft	**$5.18**	**$4.77**	$0.41	9%		
		Variance review	**$1,440.00**	**$1,275.00**	$165.00	13%		Staff performing task changed from GIS Analyst to Assoc. Engr. & Included staff time costs for WWW System Lead Operator involved in plan reviews.
Project Planning and Review Fees (Minimum for any **two** combination of potable water, recycled water and/or sewer plans submitted on the same sheet(s) of the plan (1)).	3.70.070(A)	Single family home	**$615.00**	**$580.00**	$35.00	6%	Apr-16	
		Commercial Unit Improvement/Expansion	**$3,625.00**	**$3,400.00**	$225.00	7%		
		New Single commercial unit/building	**$7,245.00**	**$6,795.00**	$450.00	7%		
		Additional commercial unit/building	**$2,280.00**	**$2,035.00**	$245.00	12%		Staff performing task changed from GIS Analyst to Assoc. Engr. & Included staff time costs for WWW System Lead Operator involved in plan reviews.

Miscellaneous Fees - Engineering

Attachment 1 to S&R

TYPE OF FEE	DISTRICT CODE	FEE DESCRIPTION	2018 FEE	CURRENT FEE	CHANGE	% CHANGE	LAST UPDATE	NOTES ON VARIANCE
Project Planning and Review Fees (Minimum for any **two** combination of potable water, recycled water and/or sewer plans submitted on the same sheet(s) of the plan (1)).	3.70.070(A)	Additional fee per linear foot for new main installation over 300ft	**$7.45**	**$6.85**	$0.60	9%		
		Minimum new water system installation for residential subdivision - up to 5 units (incl. offsite or backbone improvements)	**$6,100.00**	**$5,620.00**	$480.00	9%		
		Additional per residential unit over 5	**$190.00**	**$175.00**	$15.00	9%		
		Additional fee per linear foot for new main installation over 300ft	**$7.45**	**$6.85**	$0.60	9%		
(1) Project Planning and Review fees also appear among the fees authorized by Section 3.70.070(B) of the District code, fee for the first two plan submittals. It is the District's intent to charge one fee for the first two plan submittals. If two or more plans are included in one submittal, one fee would apply, and shall be based upon the greater of the length of potable water, recycled water, or sewer line submitted.								
Project Planning and Review Fees (Minimum for any **three** combination of potable water, recycled water and/or sewer plans submitted on the same sheet(s) of the plan (1)).	3.70.070(A)	Single family home	**$615.00**	**$580.00**	$35.00	6%	Apr-16	
		Commercial Unit Improvement/Expansion	**$4,710.00**	**$4,415.00**	$295.00	7%		
		New Single commercial unit/building	**$9,415.00**	**$8,830.00**	$585.00	7%		
		Additional commercial unit/building	**$2,865.00**	**$2,550.00**	$315.00	12%		Sewer portion of fee increased due to staff performing task changed from GIS Analyst to Assoc. Engr. & Included staff time costs for WWW System Lead Operator involved in plan reviews.
		Additional fee per linear foot for new main installation over 300ft	**$9.72**	**$8.94**	$0.78	9%		
		Minimum new water system installation for residential subdivision - up to 5 units (incl. offsite or backbone improvements)	**$7,855.00**	**$7,165.00**	$690.00	10%		Sewer portion of fee increased due to staff performing task changed from GIS Analyst to Assoc. Engr. & Included staff time costs for WWW System Lead Operator involved
		Additional per residential unit over 5	**$220.00**	**$205.00**	$15.00	7%		
		Additional fee per linear foot for new main installation over 300ft	**$9.72**	**$8.94**	$0.78	9%		
Recycled Water - Irrigation System Plan Review Fees	3.70.070(A)	Minimum for recycled water irrigation system plan review.	**$4,105.00**	**$ 3,850.00**	$255.00	7%	Apr-16	
		Additional cost per acre for recycled water irrigation system plan review over 2 acres.	**$510.00**	**$ 475.00**	$35.00	7%		

Miscellaneous Fees - Engineering

TYPE OF FEE	DISTRICT CODE	FEE DESCRIPTION	2018 FEE	CURRENT FEE	CHANGE	% CHANGE	LAST UPDATE	NOTES ON VARIANCE
Recycled Water - Irrigation System Inspection Fees (includes one zero pressure test for one building and one irrigation system)	3.70.070(A)	Minimum for recycled water irrigation system inspection.	**$3,640.00**	**$ 3,410.00**	$230.00	7%	Apr-16	
		Additional cost per acre for recycled water irrigation system inspection over 2 acres.	**$635.00**	**$ 595.00**	$40.00	7%		
		Additional zero pressure test	**$635.00**	**$ 595.00**	$40.00	7%		
Recycled Water - Irrigation System License Fee	3.70.070(A)	Recycled water irrigation system license fee.	**$875.00**	**$ 820.00**	$55.00	7%	Apr-16	
Meter Assembly Installation Fee (including meter and meter spud)	3.70.060 & 4.40.050	5/8" Meter assembly installation fee.	**$ 545.00**	**$ 531.00**	$14.00	3%	Apr-16	Positive displacements (PD) meters are being phased out by manufacturers. Assembly fees for positive displacement meters includes materials that would replicate the capacity of positive displacement meters and labor associated with putting the assembly together.
		3/4" Meter assembly installation fee.	**$ 564.00**	**$ 551.00**	$13.00	2%		
		1" Meter assembly installation fee.	**$ 612.00**	**$ 599.00**	$13.00	2%		
		1-1/2" PD meter assembly installation fee.	**$ 2,568.00**	**n/a - new**	n/a	n/a		
		1-1/2" Compound meter assembly installation fee.	**$ 1,685.00**	**n/a - new**	n/a	n/a		
		1-1/2" Turbine meter assembly installation fee.	**$ 1,342.00**	**$ 1,611.00**	($269.00)	-17%		
		2" PD meter assembly installation fee	**$ 2,761.00**	**n/a - new**	n/a	n/a		
		2" Compound meter assembly installation fee	**$ 1,877.00**	**n/a - new**	n/a	n/a		
		2" Turbine meter assembly installation fee	**$ 1,510.00**	**n/a - new**	n/a	n/a		
Sewer Main Installation Inspection	3.70.070(B)	Inspection of single reach sewer main installation without TV Inspection.	**$1,045.00**	**$ 980.00**	$65.00	7%	Apr-16	
		Minimum for inspection of single or multiple reach sewer main installation with TV inspection. *Additional Fees may include services performed by outside contractors.*	**$5,340.00**	**$ 5,010.00**	$330.00	7%		
		Additional cost per linear foot over 350 ft. for inspection of single or multiple reach sewer main installation with TV inspection. *Additional Fees may include services performed by outside contractors.*	**$9.18**	**$ 8.61**	$0.57	7%		
Sewer air retest	3.70.070	Fee for sewer air retest when initial testing fails.	**$340.00**	**$320.00**	$20.00	6%	Apr-16	
Saddle or Manhole Connection Inspection	3.70.070(B)	Inspection of Saddle installation or Manhole connection.	**$415.00**	**$ 390.00**	$25.00	6%	Apr-16	
Sewer manhole vacuum retest	3.70.070	Fee for sewer manhole vacuum retest when initial testing fails.	**$205.00**	**$ 190.00**	$15.00	8%	Apr-16	

TYPE OF FEE	DISTRICT CODE	FEE DESCRIPTION	2018 FEE	CURRENT FEE	CHANGE	% CHANGE	LAST UPDATE	NOTES ON VARIANCE
Sewer Lateral Installation Inspection Fee	3.70.070(B)	Inspection of sewer lateral installation.	**$280.00**	**$ 260.00**	$20.00	8%	Apr-16	
House Sewer Installation Inspection Fee	3.70.070(B)	Inspection of house sewer installation.	**$280.00**	**$ 260.00**	$20.00	8%	Apr-16	
Fees for Grease Traps/Interceptors	3.70.070(B)	Annual maintenance inspection - grease trap/ interceptor	**$120.00**	**$ 120.00**	$0.00	0%	Apr-16	
		Annual maintenance inspection for additional grease trap/interceptors for same customer at the same location	**$40.00**	**$ 45.00**	($5.00)	-11%	Apr-16	Staff time for EC Insp II reduced from 0.33 to 0.25 hours.
		New installation inspection.	**$355.00**	**$ 325.00**	$30.00	9%	Apr-16	
Fees for Grease Traps/Interceptors - Reinspections	3.70.070(B)	Reinspection - grease trap/ interceptor	**$120.00**	**$ 120.00**	$0.00	0%	Apr-16	
		Reinspection for additional grease trap/interceptors for same customer at the same location	**$40.00**	**$ 45.00**	($5.00)	-11%	Apr-16	Staff time for EC Insp II reduced from 0.33 to 0.25 hours.
Repairs or Minor Alteration Inspection Fee	3.70.070(B)	Inspection of repairs or minor alterations.	**$280.00**	**$ 260.00**	$20.00	8%	Apr-16	
Automotive Pollution Prevention Inspection	3.70.070(B)	Inspection of vehicle service and wash facilities every other year .	**$165.00**	**$ 145.00**	$20.00	14%	Apr-16	Staff performing task changed from EC Insp II in Engineering Division to EC Insp II in Lab Division
Fees for Inspection of Special or Single Structure (e.g., manholes) Appurtenant Projects	3.70.070(B)	Per structure less than 350 lineal feet of sewer main.	**$485.00**	**$ 455.00**	$30.00	7%	Apr-16	
		Additional per structure over 350 lineal feet of sewer main.	**$210.00**	**$ 195.00**	$15.00	8%		
Inspection Conducted Outside Regular Working Hours.	3.70.070(B)	Hourly rate for inspection conducted other than during regular working hours (8:30-4:30 weekdays).	**$220.00**	**$ 210.00**	$10.00	5%	Apr-16	
Inspection Conducted on Weekends or Holidays	3.70.070(B)	Minimum for inspection conducted on weekends or holidays.	**$725.00**	**$ 680.00**	$45.00	7%	Apr-16	
		For each hour in excess of four hours.	**$220.00**	**$ 210.00**	$10.00	5%		

TYPE OF FEE	DISTRICT CODE	FEE DESCRIPTION	2018 FEE	CURRENT FEE	CHANGE	% CHANGE	LAST UPDATE	NOTES ON VARIANCE
Sewer Flushing Fee	3.70.070(B)	Sewer flushing to be billed at hourly rate per staff and equipment billing rates in effect at time of request.(2 hour minimum).						
Project Planning and Review Fees (for sewer system plans) All fees assume a maximum of two plan reviews; all additional reviews will be billed at the staff's actual burdened hour rate. Fee includes staff time for project support during construction and project acceptance.	3.70.070(B)	Single family home	**$410.00**	**$385.00**	$25.00	6%	Apr-16	
		Commercial Unit Improvement/Expansion	**$2,540.00**	**$2,380.00**	$160.00	7%		
		New Single commercial unit/building	**$5,075.00**	**$4,760.00**	$315.00	7%		
		Additional commercial unit/building	**$1,170.00**	**$1,030.00**	$140.00	14%		Staff performing task changed from GIS Analyst to Assoc. Engr. Included staff time costs for WWW System Lead Operator involved in plan reviews.
		Additional fee per linear foot for sewer service over 300ft	**$4.53**	**$4.16**	$0.37	9%		
		Minimum new sewer main installation for residential subdivision - up to 5 units (incl. offsite or backbone improvements)	**$3,515.00**	**$3,095.00**	$420.00	14%		Staff performing task changed from GIS Analyst to Assoc. Engr. Included staff time costs for WWW System Lead Operator involved in plan reviews.
		Additional per residential unit over 5	**$65.00**	**$60.00**	$5.00	8%		
		Additional fee per linear foot for sewer service over 300ft	**$4.53**	**$4.16**	$0.37	9%		
		Variance review	**$1,440.00**	**$1,275.00**	$165.00	13%		Staff performing task changed from GIS Analyst to Assoc. Engr. Included staff time costs for WWW System Lead Operator involved in plan reviews.
Project Planning and Review Fees (Minimum for any **two** combination of potable water, recycled water and/or sewer plans submitted on the same sheet(s) of the plan (1)).	3.70.070(B)	Single family home	**$615.00**	**$580.00**	$35.00	6%	Apr-16	
		Commercial Unit Improvement/Expansion	**$3,625.00**	**$3,400.00**	$225.00	7%		
		New Single commercial unit/building	**$7,245.00**	**$6,795.00**	$450.00	7%		
		Additional commercial unit/building	**$2,280.00**	**$2,035.00**	$245.00	12%		Staff performing task changed from GIS Analyst to Assoc. Engr. Included staff time costs for WWW System Lead Operator involved in plan reviews.

TYPE OF FEE	DISTRICT CODE	FEE DESCRIPTION	2018 FEE	CURRENT FEE	CHANGE	% CHANGE	LAST UPDATE	NOTES ON VARIANCE
Project Planning and Review Fees (Minimum for any **two** combination of potable water, recycled water and/or sewer plans submitted on the same sheet(s) of the plan (1)).	3.70.070(B)	Additional fee per linear foot for new main installation over 300ft	**$7.45**	**$6.85**	$0.60	9%		
		Minimum new sewer main installation for residential subdivision - up to 5 units (incl. offsite or backbone improvements)	**$6,100.00**	**$5,620.00**	$480.00	9%		
		Additional per residential unit over 5	**$190.00**	**$175.00**	$15.00	9%		
		Additional fee per linear foot for new main installation over 300ft	**$7.45**	**$6.85**	$0.60	9%		
Project Planning and Review Fees (Minimum for any **three** combination of potable water, recycled water and/or sewer plans submitted on the same sheet(s) of the plan (1)).	3.70.070(B)	Single family home	**$615.00**	**$580.00**	$35.00	6%	Apr-16	
		Commercial Unit Improvement/Expansion	**$4,710.00**	**$4,415.00**	$295.00	7%		
		New Single commercial unit/building	**$9,415.00**	**$8,830.00**	$585.00	7%		
		Additional commercial unit/building	**$2,865.00**	**$2,550.00**	$315.00	12%		Staff performing task changed from GIS Analyst to Assoc. Engr. Included staff time costs for WWW System Lead Operator involved in plan reviews.
		Additional fee per linear foot for new main installation over 300ft	**$9.72**	**$8.94**	$0.78	9%		
		Minimum new sewer main installation for residential subdivision - up to 5 units (incl. offsite or backbone improvements)	**$7,855.00**	**$7,165.00**	$690.00	10%		Staff performing task changed from GIS Analyst to Assoc. Engr. Included staff time costs for WWW System Lead Operator involved in plan reviews.
		Additional per residential unit over 5	**$220.00**	**$205.00**	$15.00	7%		
		Additional fee per linear foot for new main installation over 300ft	**$9.72**	**$8.94**	$0.78	9%		

Miscellaneous Fees - Engineering

Attachment 1 to S&R

TYPE OF FEE	DISTRICT CODE	FEE DESCRIPTION	2018 FEE	CURRENT FEE	CHANGE	% CHANGE	LAST UPDATE	NOTES ON VARIANCE
(1) Project Planning and Review fees also appear among the fees authorized by Section 3.70.070(A) of the District code, fee for the first two plan submittals. It is the District's intent to charge one fee for the first two plan submittals. If two or more plans are included in one submittal, one fee would apply, and shall be based upon the greater of the length of potable water, recycled water, or sewer line submitted.								
Recycled Water Fill Station - Annual Permit Fee	4.30.070	Annual Permit fee for water trucks to fill with recycled water at the wastewater treatment plant	**$99.00**	**$79.00**	$20.00	25%	Apr-16	Added staff time costs for Clean Water Specialist involved in permitting and increased staff time for Sr. Acctg. Tech. from 0.15 to 0.25. Decreased staff time for Environmental Compliance Inspector from 0.50 to 0.25
Recycled Water Fill Station	4.30.070	Fee Per Truck Load	**$14.00**	**$10.00**	$4.00	40%		Added staff time costs for Env. Comp. Insp. II-PreTrmt for metering data and staff time cost for Sr. Acctg. Tech. to perform billing task.
Construction Water Meter Fee - Residential (Jumper Fee)	4.40.090(A)	Flat rate fee per 3/4-inch residential service line. Rate is for 54.5 CCF of water	**230.00**	**$ 240.00**	($10.00)	-4%	Apr-16	

RESOLUTION NO. _____

RESOLUTION OF THE BOARD OF DIRECTORS OF DUBLIN SAN RAMON SERVICES DISTRICT ESTABLISHING FEES AND CHARGES UNDER DISTRICT CODE SECTIONS 1.30.010 (B) (GENERAL PENALTY – INFRACTION), 1.40.040 (COPIES OF PUBLIC RECORDS - FEES), 1.50.010 (ASSESSMENT OF LATE CHARGES), 1.50.070 (CHARGE FOR UNPAID RETURNED CHECKS), 2.30.050 (PROCESSING FEE [PLANNING SERVICES AGREEMENTS]), 1.100.010 (ESCROW FEES), 3.70.070 (A) & (B) (INSPECTION AND PROJECT REVIEW FEES – MISCELLANEOUS FEES), 3.70.060 (METER ASSEMBLY INSTALLATION FEE - WATER), 4.30.070 (SALE OF RECYCLED WATER AT RECYCLED WATER TREATMENT FACILITIES), 4.40.040 (A) & (B) (OTHER FEES AND CHARGES FOR WATER SERVICE), 4.40.050 (METER ASSEMBLY AND INSTALLATION FEES), 4.40.070 (BACKFLOW PREVENTION ADMINISTRATION FEE), 4.40.080 (A) & (C) (FEES AND CHARGES FOR USE OF TEMPORARY METERS), AND 4.40.090 (A) & (B) (FEES AND CHARGES FOR USE OF CONSTRUCTION WATER METER) AND RESCINDING RESOLUTION NO. 13-16

WHEREAS, the above referenced sections of the District Code allow the Board of Directors to establish the respective fees and charges by ordinance or resolution; and

WHEREAS, these fees and charges, which are not assessed as an incident of property ownership, but are instead imposed based upon the nature of the use of the property, not by virtue of the landowner's ownership of the property, and are therefore not subject to Proposition 218 notification procedures, have been reviewed and require adjustment; and

WHEREAS, these fees and charges are imposed for specific services provided by the District directly to the customer required to pay them, which services are not provided to those not charged, and the amounts of the fees and charges have each been calculated using an accepted methodology of allocating costs to the customers who benefit from the services provided such that the fee or charge does not exceed the reasonable costs of providing the service; and

WHEREAS, some of the fees and charges are imposed for the reasonable regulatory costs for issuing licenses and permits, performing investigations, inspections, and audits, and the administrative enforcement and adjudication thereof, based on an accepted methodology of allocating the reasonable regulatory costs to those whose activities give rise to the need for regulation; and

WHEREAS, some of the fees and charges comprise monetary charges imposed by the District for violations of law, and

WHEREAS, the rates, as adopted by this resolution, once operative, will supersede those previously established in Resolution No. 13-16.

NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF DUBLIN SAN RAMON SERVICES DISTRICT, a public agency in the Counties of Alameda and Contra Costa, California, as follows:

Res. No. _____

1. The charges authorized under Sections 1.30.010 (B), 1.40.040, 1.50.010, 1.50.070, 1.100.010, 2.30.050, 3.70.060, 3.70.070 (A) & (B), 4.30.070, 4.40.040 (A) & (B), 4.40.050, 4.40.070, 4.40.080 (A) & (C), and 4.40.090 (A) & (B), of Dublin San Ramon Services District Code are established in the respective amounts set forth in Exhibit "A," attached.

2. This resolution will be effective immediately upon its adoption, provided that the charges as shown on Exhibit "A" shall be operative from and after July 1, 2018.

3. Resolution No. 13-16, attached as Exhibit "B," is rescinded effective July 1, 2018.

ADOPTED by the Board of Directors of Dublin San Ramon Services District, a public agency in the State of California, Counties of Alameda and Contra Costa, at its regular meeting held on the 15th day of May, 2018, and passed by the following vote:

AYES:

NOES:

ABSENT:

_____
Georgean M. Vonheeder-Leopold, President

ATTEST: _____
Nicole Genzale, District Secretary

Miscellaneous Fees - Administrative Exhibit A to Reso

TYPE OF FEE	DISTRICT CODE	FEE DESCRIPTION	2018 FEE
General Penalty - Code Infraction	1.30.010(B)	First violation. Second violation of the same provision or ordinance within one year. Each additional violation of the same provision or ordinance within one year.	**$250.00** **$500.00** **$1,000.00**
Copies of Public Records Fee	1.40.040	Per page.	**$0.10**
Assessment of Late Charges	1.50.010	Shall be assessed on the overdue amount outstanding.	**10%**
Additional Late Charges	1.50.010	Shall be assessed for each 30 day period during which the overdue bill remains unpaid.	**1%**
Charge for Unpaid Returned Checks	1.50.070	First occurrence. Each additional occurrence.	**$25.00** **$35.00**
Escrow Account - Set-up Fee	1.100.010	Fee to establish an escrow account requested by contractor.	**$405.00**
Escrow Account - Handling Fee	1.100.010	Fee for each escrow account transaction will be deducted from the contractor's regular progress payment.	**$35.00**
Regional Sewer Capacity Reserve Fee - Installment Plan - 10 year	3.70.070(B)	Initial set-up of 10 year installment plan.	**$3,110.00**

Miscellaneous Fees - Customer Service

Exhibit A to Reso

TYPE OF FEE	DISTRICT CODE	FEE DESCRIPTION	2018 FEE
Backflow Prevention Administrative Fee - Reduced Pressure Device	4.40.070	Bi-monthly backflow prevention device maintenance administrative fee for reduced pressure device.	**$ 13.00**
Backflow Prevention Administrative Fee - Double check/Detector check	4.40.070	Bi-monthly backflow prevention device maintenance administrative fee for double check/detector check devices.	**$ 19.00**
New Accounts Set-up Fee	4.40.040(A)	New Utility Billing Account Set Up Fee. Charged when establishing a new account.	**$ 20.00**
Service Reconnection and Termination Fee	4.40.040(B)	For each occasion.	**$ 109.00**
Service Reinstatement Fee-OT	4.40.040(B)	Performed during non-regular business hours.	**$ 360.00**
Curb Stop Repair Fee	4.40.040(B)	For repair of damaged curb stop.	**$ 399.00**
Trim Charge	4.40.040(B)	For trimming around meter box after customer failed to do trimming after being notified.	**$ 141.00**
Hand Delivered Notification Fee	4.40.040(B)	Hand delivery, to service location as required by law, to notify resident of pending service disconnect.	**$ 29.00**
Broken Lock Fee	4.40.040(B)	Fee to cover the hardware and staff time costs resulting from a cut lock.	**$ 70.00**
Meter Removal and Reinstall Fee	4.40.040(B)	Time and materials to remove and reinstall meter based on customer need	**$ 166.00**
Site Visit	4.40.080(A)	Unsupported Site visit.	**$ 83.00**
Temporary Meter - Charge for Breaking Seal	4.40.080(A)	Customer will be charged for actual time and materials	**Actual Cost**
Field Tracing Charge - Non-Residential Construction Water Meter Fee	4.40.090(B)	Field tracing charge each time a meter user fails to present the meter for reading.	**$ 240.00**

Miscellaneous Fees - Engineering Exhibit A to Reso

TYPE OF FEE	DISTRICT CODE	FEE DESCRIPTION	2018 FEE
Planning Agreement Application Fee	2.30.050	Minimum processing fee for planning agreement application.	**$3,205.00**
Water Main Installation Inspection	3.70.070(A)	Inspection of repair of water main line with no bacteriological testing required.	**$1,045.00**
		Minimum for inspection of installation or repair of water main line with bacteriological testing required. (Laboratory testing charges billed separately.)	**$4,625.00**
		Additional cost per linear foot over 300 ft. for inspection of installation or repair of water main line with bacteriological testing required.	**$8.35**
Chlorination/Bacti retest	3.70.070	Fee for Chlorination/Bacti retest when initial testing fails.	**$760.00**
Water Pressure retest	3.70.070	Fee for water pressure retest when initial testing fails.	**$340.00**
Fire Hydrant Inspection Fee	3.70.070(A)	Per unit fee for inspection of fire hydrant installation.	**$420.00**
Building Service Line Inspection Fee	3.70.070(A)	Per unit fee for inspection of water service line installation.	**$555.00**
Blow-off Valve or Air Relief Valve Inspection Fee	3.70.070(A)	Per unit fee for inspection of blow-offs and air relief valves.	**$280.00**
Backflow Prevention Device Inspection Fee	3.70.070(A)	Per unit fee for inspection of backflow prevention - domestic and irrigation service lines.	**$205.00**
Fire Service Installation and Backflow Prevention Device Inspection Fee	3.70.070(A)	Per unit fee for fire service installation and inspection of backflow prevention device.	**$830.00**
Service Assembly and Service Connection Inspection Fee	3.70.070(A)	Per unit fee for inspection of service assembly and service connection (water tap)	**$555.00**
Inspection Conducted Outside Regular Working Hours.	3.70.070(A)	Hourly rate for inspection conducted other than during regular working hours (8:30-4:30 weekdays).	**$225.00**
Inspection Conducted on Weekends or Holidays	3.70.070(A)	Minimum for inspections conducted on weekends or holidays.	**$725.00**
		For each hour in excess of four hours.	**$225.00**

TYPE OF FEE	DISTRICT CODE	FEE DESCRIPTION	2018 FEE
Project Planning and Review Fees (for potable water and/or recycled water plans) All Project Planning and Review Fees assume a maximum of two plan submittal reviews; all additional reviews will be billed at the staff's actual burdened hourly rate. Fee includes staff time for project support during construction and project acceptance.	3.70.070(A)	Single family home	**$410.00**
		Commercial Unit Improvement/Expansion	**$2,170.00**
		New Single commercial unit/building	**$4,340.00**
		Additional commercial unit/building	**$1,695.00**
		Additional fee per linear foot for water service over 300ft	**$5.18**
		Minimum new water system installation for residential subdivision - up to 5 units (incl. offsite or backbone improvements)	**$4,340.00**
		Additional per residential unit over 5	**$155.00**
		Additional fee per linear foot for new main installation over 300ft	**$5.18**
		Variance review	**$1,440.00**
Project Planning and Review Fees (Minimum for any **two** combination of potable water, recycled water and/or sewer plans submitted on the same sheet(s) of the plan (1)).	3.70.070(A)	Single family home	**$615.00**
		Commercial Unit Improvement/Expansion	**$3,625.00**
		New Single commercial unit/building	**$7,245.00**
		Additional commercial unit/building	**$2,280.00**
		Additional fee per linear foot for new main installation over 300ft	**$7.45**
		Minimum new water system installation for residential subdivision - up to 5 units (incl. offsite or backbone improvements)	**$6,100.00**
		Additional per residential unit over 5	**$190.00**
		Additional fee per linear foot for new main installation over 300ft	**$7.45**
(1) Project Planning and Review fees also appear among the fees authorized by Section 3.70.070(B) of the District code, fee for the first two plan submittals. It is the District's intent to charge one fee for the first two plan submittals. If two or more plans are included in one submittal, one fee would apply, and shall be based upon the greater of the length of potable water, recycled water, or sewer line submitted.			
Project Planning and Review Fees (Minimum for any **three** combination of potable water, recycled water and/or sewer plans submitted on the same sheet(s) of the plan (1)).	3.70.070(A)	Single family home	**$615.00**
		Commercial Unit Improvement/Expansion	**$4,710.00**
		New Single commercial unit/building	**$9,415.00**
		Additional commercial unit/building	**$2,865.00**
		Additional fee per linear foot for new main installation over 300ft	**$9.72**
		Minimum new water system installation for residential subdivision - up to 5 units (incl. offsite or backbone improvements)	**$7,855.00**
		Additional per residential unit over 5	**$220.00**
		Additional fee per linear foot for new main installation over 300ft	**$9.72**

Miscellaneous Fees - Engineering Exhibit A to Reso

TYPE OF FEE	DISTRICT CODE	FEE DESCRIPTION	2018 FEE
Recycled Water - Irrigation System Plan Review Fees	3.70.070(A)	Minimum for recycled water irrigation system plan review.	**$4,105.00**
		Additional cost per acre for recycled water irrigation system plan review over 2 acres.	**$510.00**
Recycled Water - Irrigation System Inspection Fees (includes one zero pressure test for one building and one irrigation system)	3.70.070(A)	Minimum for recycled water irrigation system inspection.	**$3,640.00**
		Additional cost per acre for recycled water irrigation system inspection over 2 acres.	**$635.00**
		Additional zero pressure test	**$635.00**
Recycled Water - Irrigation System License Fee	3.70.070(A)	Recycled water irrigation system license fee.	**$875.00**
Meter Assembly Installation Fee (including meter and meter spud)	3.70.060 & 4.40.050	5/8" Meter assembly installation fee.	**$545.00**
		3/4" Meter assembly installation fee.	**$564.00**
		1" Meter assembly installation fee.	**$612.00**
		1-1/2" PD meter assembly installation fee.	**$2,568.00**
		1-1/2" Compound meter assembly installation fee.	**$1,685.00**
		1-1/2" Turbine meter assembly installation fee.	**$1,342.00**
		2" PD meter assembly installation fee	**$2,761.00**
		2" Compound meter assembly installation fee	**$1,877.00**
		2" Turbine meter assembly installation fee	**$1,510.00**
Sewer Main Installation Inspection	3.70.070(B)	Inspection of single reach sewer main installation without TV Inspection.	**$1,045.00**
		Minimum for inspection of single or multiple reach sewer main installation with TV inspection. *Additional Fees may include services performed by outside contractors.*	**$5,340.00**
		Additional cost per linear foot over 350 ft. for inspection of single or multiple reach sewer main installation with TV inspection. *Additional Fees may include services performed by outside contractors.*	**$9.18**
Sewer air retest	3.70.070	Fee for sewer air retest when initial testing fails.	**$340.00**
Saddle or Manhole Connection Inspection	3.70.070(B)	Inspection of Saddle installation or Manhole connection.	**$415.00**
Sewer manhole vacuum retest	3.70.070	Fee for sewer manhole vacuum retest when initial testing fails.	**$205.00**
Sewer Lateral Installation Inspection Fee	3.70.070(B)	Inspection of sewer lateral installation.	**$280.00**
House Sewer Installation Inspection Fee	3.70.070(B)	Inspection of house sewer installation.	**$280.00**

Miscellaneous Fees - Engineering Exhibit A to Reso

TYPE OF FEE	DISTRICT CODE	FEE DESCRIPTION	2018 FEE
Fees for Grease Traps/Interceptors	3.70.070(B)	Annual maintenance inspection - grease trap/ interceptor	**$120.00**
		Annual maintenance inspection for additional grease trap/interceptors for same customer at the same location	**$40.00**
		New installation inspection.	**$355.00**
Fees for Grease Traps/Interceptors - Reinspections	3.70.070(B)	Reinspection - grease trap/ interceptor	**$120.00**
		Reinspection for additional grease trap/interceptors for same customer at the same location	**$40.00**
Repairs or Minor Alteration Inspection Fee	3.70.070(B)	Inspection of repairs or minor alterations.	**$280.00**
Automotive Pollution Prevention Inspection	3.70.070(B)	Inspection of vehicle service and wash facilities every other year .	**$165.00**
Fees for Inspection of Special or Single Structure (e.g., manholes) Appurtenant Projects	3.70.070(B)	Per structure less than 350 lineal feet of sewer main.	**$485.00**
		Additional per structure over 350 lineal feet of sewer main.	**$210.00**
Inspection Conducted Outside Regular Working Hours.	3.70.070(B)	Hourly rate for inspection conducted other than during regular working hours (8:30-4:30 weekdays).	**$220.00**
Inspection Conducted on Weekends or Holidays	3.70.070(B)	Minimum for inspection conducted on weekends or holidays.	**$725.00**
		For each hour in excess of four hours.	**$220.00**
Sewer Flushing Fee	3.70.070(B)	Sewer flushing to be billed at hourly rate per staff and equipment billing rates in effect at time of request.(2 hour minimum).	**Actual Cost**
Project Planning and Review Fees (for sewer system plans) All fees assume a maximum of two plan reviews; all additional reviews will be billed at the staff's actual burdened hour rate. Fee includes staff time for project support during construction and project acceptance.	3.70.070(B)	Single family home	**$410.00**
		Commercial Unit Improvement/Expansion	**$2,540.00**
		New Single commercial unit/building	**$5,075.00**
		Additional commercial unit/building	**$1,170.00**
		Additional fee per linear foot for sewer service over 300ft	**$4.53**
		Minimum new sewer main installation for residential subdivision - up to 5 units (incl. offsite or backbone improvements)	**$3,515.00**
		Additional per residential unit over 5	**$65.00**
		Additional fee per linear foot for sewer service over 300ft	**$4.53**
		Variance review	**$1,440.00**

Miscellaneous Fees - Engineering Exhibit A to Reso

TYPE OF FEE	DISTRICT CODE	FEE DESCRIPTION	2018 FEE
Project Planning and Review Fees (Minimum for any **two** combination of potable water, recycled water and/or sewer plans submitted on the same sheet(s) of the plan (1)).	3.70.070(B)	Single family home	**$615.00**
		Commercial Unit Improvement/Expansion	**$3,625.00**
		New Single commercial unit/building	**$7,245.00**
		Additional commercial unit/building	**$2,280.00**
		Additional fee per linear foot for new main installation over 300ft	**$7.45**
		Minimum new sewer main installation for residential subdivision - up to 5 units (incl. offsite or backbone improvements)	**$6,100.00**
		Additional per residential unit over 5	**$190.00**
		Additional fee per linear foot for new main installation over 300ft	**$7.45**
Project Planning and Review Fees (Minimum for any three combination of potable water, recycled water and/or sewer plans submitted on the same sheet(s) of the plan (1)).	3.70.070(B)	Single family home	**$615.00**
		Commercial Unit Improvement/Expansion	**$4,710.00**
		New Single commercial unit/building	**$9,415.00**
		Additional commercial unit/building	**$2,865.00**
		Additional fee per linear foot for new main installation over 300ft	**$9.72**
		Minimum new sewer main installation for residential subdivision - up to 5 units (incl. offsite or backbone improvements)	**$7,855.00**
		Additional per residential unit over 5	**$220.00**
		Additional fee per linear foot for new main installation over 300ft	**$9.72**
(1) Project Planning and Review fees also appear among the fees authorized by Section 3.70.070(A) of the District code, fee for the first two plan submittals. It is the District's intent to charge one fee for the first two plan submittals. If two or more plans are included in one submittal, one fee would apply, and shall be based upon the greater of the length of potable water, recycled water, or sewer line submitted.			
Recycled Water Fill Station - Annual Permit Fee	4.30.070	Annual Permit fee for water trucks to fill with recycled water at the wastewater treatment plant	**$99.00**
Recycled Water Fill Station	4.30.070	Fee Per Truck Load	**$14.00**
Construction Water Meter Fee - Residential (Jumper Fee)	4.40.090(A)	Flat rate fee per 3/4-inch residential service line. Rate is for 54.5 CCF of water	**$230.00**

RESOLUTION NO. 13-16

RESOLUTION OF THE BOARD OF DIRECTORS OF DUBLIN SAN RAMON SERVICES DISTRICT ESTABLISHING FEES AND CHARGES UNDER DISTRICT CODE SECTIONS 1.30.010 (B) (GENERAL PENALTY – INFRACTION), 1.40.040 (COPIES OF PUBLIC RECORDS - FEES), 1.50.010 (ASSESSMENT OF LATE CHARGES), 1.50.070 (CHARGE FOR UNPAID RETURNED CHECKS), 2.30.050 (PROCESSING FEE [PLANNING SERVICES AGREEMENTS]), 1.100.010 (ESCROW FEES), 3.70.070 (A) & (B) (INSPECTION AND PROJECT REVIEW FEES – MISCELLANEOUS FEES), 3.70.060 (METER ASSEMBLY INSTALLATION FEE - WATER), 4.40.070 (BACKFLOW PREVENTION ADMINISTRATION FEE), 4.40.040 (A) & (B) (OTHER FEES AND CHARGES FOR WATER SERVICE), 4.40.080 (A) (FEES AND CHARGES FOR USE OF TEMPORARY METERS), 4.40.080 (C) (FEES AND CHARGES FOR USE OF TEMPORARY METERS - DEPOSIT), AND 4.40.090 (A) & (B) (FEES AND CHARGES FOR USE OF CONSTRUCTION WATER METER) AND RESCINDING RESOLUTION NO. 14-14

WHEREAS, the above referenced sections of the District Code allow the Board of Directors to establish the respective fees and charges by ordinance or resolution; and

WHEREAS, these fees and charges, which are not assessed as an incident of property ownership, but are imposed upon and due to the nature of the use of the property, and not by virtue of the landowner's ownership of the property and are therefore not subject to Proposition 218 notification, have been reviewed and require adjustment, and

WHEREAS, these fees and charges are imposed for specific services provided by the District directly to the customer required to pay them, which services are not provided to those not charged, and the amount of the fees and charges have each been calculated using an accepted methodology of allocating costs to the customers that benefit from the services provided such that the fee or charge does not exceed the reasonable costs of providing the service, and

WHEREAS, some of the fees and charges are imposed for the reasonable regulatory costs for issuing licenses and permits, performing investigations, inspections, and audits, and the administrative enforcement and adjudication thereof, based on an accepted methodology of allocating the reasonable regulatory costs to those whose activities give rise to the need for regulation, and

WHEREAS, some of the fees and charges comprise monetary charges imposed by the District for violations of law, and

WHEREAS, the rates, as adopted by this resolution, once operative, will supersede those previously established in Resolution No. 14-14.

NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF DUBLIN SAN RAMON SERVICES DISTRICT, a public agency in the counties of Alameda and Contra Costa, California, as follows:

1. The charges authorized under Sections 1.30.010 (B), 1.40.040, 1.50.010, 1.50.070, 2.30.050, 1.100.010, 3.70.070 (A) & (B), 3.70.060, 4.40.040 (A) & (B), 4.40.070, 4.40.080 (A), 4.40.080 (C), and 4.40.090 (A) & (B) of Dublin San Ramon Services District Code are established in the respective amounts set forth in Exhibit "A," attached.

Res. No. 13-16

2. This resolution will be effective immediately upon its adoption; provided that the charges as shown on Exhibit "A" shall be operative from and after April 4, 2016.

3. Resolution No. 14-14 is Rescinded, attached as Exhibit "B," effective April 4, 2016.

ADOPTED by the Board of Directors of Dublin San Ramon Services District, a public agency in the State of California, counties of Alameda and Contra Costa, at its regular meeting held on the 1st day of March 2016, and passed by the following vote:

AYES: 4 - Directors Richard M. Halket, Madelyne A. Misheloff, Edward R. Duarte, D.L. (Pat) Howard

NOES: 0

ABSENT: 1 - Director Georgean M. Vonheeder-Leopold

D. L. (Pat) Howard, President

ATTEST:

Nicole Genzale, District Secretary

CERTIFIED AS A TRUE AND CORRECT COPY OF THE ORIGINAL ON FILE IN THE OFFICE OF DUBLIN SAN RAMON SERVICES DISTRICT
Secretary

MAR 0 2 2016

Dublin San Ramon Services District
Summary & Recommendation

Item 8.C.
Meeting Date: May 15, 2018

TITLE: Hold Public Hearing: Adopt Resolution Establishing Industrial Waste Program User Fees and Charges and Rescind Resolution No. 14-16

RECOMMENDATION:

Staff recommends the Board of Directors hold a Public Hearing and adopt, by Resolution, Industrial Waste Program user fees and charges and rescind Resolution No. 14-16.

SUMMARY:

The District reviews and updates its fees biennially to ensure that the cost of providing a service is fully covered by the fee. The Industrial Waste Program user fees and laboratory analysis fees were last reviewed in 2016. In fiscal year ending 2017, revenue generated from Industrial Waste Program user fees was just under $250,000.

The departments prepare an analysis for each type of Industrial Waste Program user fee and a listing of all laboratory analysis tests that our lab can provide. The worksheets list the staff position(s) that typically provide the service, staff's 2018 billing rate, the amount of time required to provide the service, and any miscellaneous costs incurred to provide the service (postage, printing, etc.). A comprehensive review of the process has been performed to ensure that the proposed fees capture the current level of service provided.

Attachment 1 to this report recaps the Industrial Waste Program user fees and lists all laboratory analysis tests. The table compares the current and proposed fees including the dollar and percentage change. When reviewing these fees you will notice the majority of the fees have increased in the range of 4% to 14% due to increases in personnel costs and overhead rates, as well as changes in the assignment of staff performing inspections and lab analyses. There is a notable decrease of 58% to the dental amalgam inspections because of process efficiencies. Dental amalgam inspections go hand in hand with the three-year permits, so inspections are only done every three years and as needed.

No new Industrial Waste Program user fees are recommended at this time.

Originating Department: Administrative Services	**Contact: C. Atwood**	**Legal Review: Not Required**
Cost: $0	**Funding Source: N/A**	
Attachments: ☐ None ☐ Staff Report ☒ Resolution ☐ Ordinance ☐ Task Order ☐ Proclamation ☒ Other (see list on right)	**Attachment 1 – Industrial Waste Fees**	

TYPE OF FEE	DISTRICT CODE	FEE DESCRIPTION	2018 FEE	CURRENT FEE	CHANGE	% CHANGE	LAST UPDAT	NOTES ON VARIANCE
Sampling	5.30.090	Composite Sampler set-up	$395.00	$ 345.00	$50.00	13%	Apr-16	Staff performing task changed from Env. Insp. II-PreTrmt in Engr. Division to Env. Insp. II-PreTrmt in Lab Division
		Sampling, each site per day	$250.00	$220.00	$30.00	12%	Apr-16	"
Inspections and Permitting - Significant Industrial User	5.30.090	Inspection, initial (Significant Industrial User (SIU)	$1,550.00	$1,350.00	$200.00	13%	Apr-16	"
		Inspection, compliance (SIU)	$910.00	$795.00	$115.00	13%	Apr-16	"
		Permit Issuance, includes application review (SIU)	$1,160.00	$1,015.00	$145.00	13%	Apr-16	"
		Permit Renewal, includes application review (SIU)	$690.00	$605.00	$85.00	12%	Apr-16	"
		Permit Amendments (SIU)	$385.00	$340.00	$45.00	12%	Apr-16	"
Inspections and Permitting - Intermediate Industrial User	5.30.090	Inspection, initial (Intermediate Industrial User (IIU)	$775.00	$675.00	$100.00	13%	Apr-16	"
		Inspection, compliance (IIU)	$455.00	$400.00	$55.00	12%	Apr-16	"
		Permit Issuance, includes application review (IIU)	$775.00	$675.00	$100.00	13%	Apr-16	"
		Permit Renewal, includes application review (IIU)	$345.00	$300.00	$45.00	13%	Apr-16	"
		Permit Amendments (IIU)	$235.00	$205.00	$30.00	13%	Apr-16	"
Hearings and Enforcement	5.30.090	Show Cause Hearing, each hearing, hours	$935.00	$815.00	$120.00	13%	Apr-16	"
		Enforcement Hearing, each hearing, hours	$1,245.00	$1,085.00	$160.00	13%	Apr-16	"
Dental Amalgam Program	5.30.090	Permit fee - 3 year permit for dental offices with amalgam separator devices	$ 105.00	$ 120.00	($15.00)	14%	Apr-16	Reduced staff time forAdmin. Asst. II from 1 hour to 0.5 hour
		Inspection fee - inspection of amalgam separator devices	$ 95.00	$ 150.00	($55.00)	-58%	Apr-16	Insp II-PreTrmt from 1 hour to 0.5 hour
		Penalty for past due self-monitoring report submittal	$ 105.00	$ 100.00	$5.00	5%	Apr-16	Staff performing task changed from Env. Insp. II-PreTrmt in Engr. Division to Env. Insp. II-PreTrmt in Lab Division

Calculated User Charges:	Lab Supervisor	Sr. Env. Chemist	Env. Chemist II	Env. Chemist I	Lab Technician	Total Cost per					
Laboratory Analysis	**$213.06**	**$178.96**	**$163.84**	**$150.05**	**$131.30**	**Analysis**	**2018 Fee**	**Current Fee**	**Increase**	**% Change**	**Comments**
Alkalinity Bicarbonate, HCO3					0.25	$32.83	$ 33.00	$ 31.00	$ 2.00	6%	Shifted level of effort from Supervisor to Sr. Env. Chemist since Lab Supervisor doesn't perform any lab analysis.
Alkalinity Carbonate, CO3					0.25	$32.83	$ 33.00	$ 31.00	$ 2.00	6%	"
Alkalinity Hydroxide, OH					0.25	$32.83	$ 33.00	$ 31.00	$ 2.00	6%	"
Alkalinity Total					0.25	$32.83	$ 33.00	$ 31.00	$ 2.00	6%	"
Ammonia					1.00	$131.30	$ 132.00	$ 124.00	$ 8.00	6%	"
Antimony		0.03	0.40			$70.90	$ 71.00	$ 68.00	$ 3.00	4%	"
Arsenic (included in Metals)		0.03	0.40			$70.90	$ 71.00	$ 68.00	$ 3.00	4%	"
Barium		0.03	0.40			$70.90	$ 71.00	$ 68.00	$ 3.00	4%	"
Beryllium		0.03	0.40			$70.90	$ 71.00	$ 68.00	$ 3.00	4%	"
Biochemical Oxygen Demand (BOD)					0.75	$98.48	$ 99.00	$ 93.00	$ 6.00	6%	"
Boron		0.03	0.60			$103.67	$ 104.00	$ 99.00	$ 5.00	5%	"
Cadmium (included in Metals)		0.03	0.40			$70.90	$ 71.00	$ 68.00	$ 3.00	4%	"
Calcium & Calcium Hardness					0.30	$39.39	$ 40.00	$ 37.00	$ 3.00	8%	"
Chemical Oxygen Demand (COD)					0.30	$39.39	$ 40.00	$ 37.00	$ 3.00	8%	"
Chloride			0.60			$98.30	$ 99.00	$ 93.00	$ 6.00	6%	"
Chlorine					0.75	$98.48	$ 99.00	$ 93.00	$ 6.00	6%	"
Chromium (included in Metals)		0.03	0.40			$70.90	$ 71.00	$ 68.00	$ 3.00	4%	"
Cobalt		0.03	0.40			$70.90	$ 71.00	$ 68.00	$ 3.00	4%	"
Coliform, Total, MPN Method					1.50	$196.95	$ 197.00	$ 185.00	$ 12.00	6%	"
Coliform, Total, P/A Method					0.50	$65.65	$ 66.00	$ 62.00	$ 4.00	6%	"
Color					0.15	$19.70	$ 20.00	$ 19.00	$ 1.00	5%	"
Conductivity					0.25	$32.83	$ 33.00	$ 31.00	$ 2.00	6%	"
Copper (included in Metals		0.03	0.40			$70.90	$ 71.00	$ 68.00	$ 3.00	4%	"
Cyanide		0.03	1.00			$169.21	$ 170.00	$ 160.00	$ 10.00	6%	"
Dissolved Oxygen					0.20	$26.26	$ 27.00	$ 25.00	$ 2.00	8%	"
E-Coli, P/A Method					0.50	$65.65	$ 66.00	$ 62.00	$ 4.00	6%	"
Enterococcus					0.70	$91.91	$ 92.00	$ 87.00	$ 5.00	6%	"
Fecal Coliform, MPN Method					1.50	$196.95	$ 197.00	$ 185.00	$ 12.00	6%	"
Fluoride			0.50			$81.92	$ 82.00	$ 77.00	$ 5.00	6%	"
HaloAcetic Acids (HAAs)		0.03	1.25			$210.17	$ 211.00	$ 198.00	$ 13.00	6%	"
Hardness, Total					0.30	$39.39	$ 40.00	$ 37.00	$ 3.00	8%	"
Langelier Index					1.25	$164.13	$ 165.00	$ 154.00	$ 11.00	7%	"
Lead (included in Metals)		0.03	0.40			$70.90	$ 71.00	$ 68.00	$ 3.00	4%	"
Manganese		0.03	0.40			$70.90	$ 71.00	$ 68.00	$ 3.00	4%	"
Mercury		0.03	0.80			$136.44	$ 137.00	$ 129.00	$ 8.00	6%	"
Metals		0.15	2.25			$395.48	$ 396.00	$ 376.00	$ 20.00	5%	"
Nickel (included in Metals)		0.03	0.40			$70.90	$ 71.00	$ 68.00	$ 3.00	4%	"
Nitrate, NO3			0.50			$81.92	$ 82.00	$ 77.00	$ 5.00	6%	"
Nitrate, NO3, Hach Method					0.25	$32.83	$ 33.00	$ 31.00	$ 2.00	6%	"
Nitrite and Nitrate, Total			0.50			$81.92	$ 82.00	$ 77.00	$ 5.00	6%	"
Nitrite, NO2			0.50			$81.92	$ 82.00	$ 77.00	$ 5.00	6%	"
Nitrite, NO2, Hach Method					0.25	$32.83	$ 33.00	$ 31.00	$ 2.00	6%	"
pH					0.25	$32.83	$ 33.00	$ 31.00	$ 2.00	6%	"
Phenol		0.03	1.00			$169.21	$ 170.00	$ 160.00	$ 10.00	6%	"
Potassium		0.03	0.40			$70.90	$ 71.00	$ 68.00	$ 3.00	4%	"
Selenium (included in Metals)		0.03	0.40			$70.90	$ 71.00	$ 68.00	$ 3.00	4%	"
Silica			0.50			$81.92	$ 82.00	$ 77.00	$ 5.00	6%	"
Silver (included in Metals)		0.03	0.40			$70.90	$ 71.00	$ 68.00	$ 3.00	4%	"
Sodium		0.03	0.40			$70.90	$ 71.00	$ 68.00	$ 3.00	4%	"
Sulfate			0.50			$81.92	$ 82.00	$ 77.00	$ 5.00	6%	"
Sulfide					0.25	$32.83	$ 33.00	$ 31.00	$ 2.00	6%	"
Temperature					0.10	$13.13	$ 14.00	$ 13.00	$ 1.00	8%	"
Thallium		0.03	0.40			$70.90	$ 71.00	$ 68.00	$ 3.00	4%	"
Total Dissolved Solids, TDS					0.60	$78.78	$ 79.00	$ 74.00	$ 5.00	7%	"
Total Solids, TS					0.60	$78.78	$ 79.00	$ 74.00	$ 5.00	7%	"
Total Suspended Solids, TSS					0.60	$78.78	$ 79.00	$ 74.00	$ 5.00	7%	"
Total Trihalomethanes (TTHMs)		0.03	0.90			$152.82	$ 153.00	$ 145.00	$ 8.00	5%	"
Turbidity					0.25	$32.83	$ 33.00	$ 31.00	$ 2.00	6%	"
UV 254					0.25	$32.83	$ 33.00	$ 31.00	$ 2.00	6%	"
Vanadium		0.03	0.40			$70.90	$ 71.00	$ 68.00	$ 3.00	4%	"
Volatile Acids, VA					0.75	$98.48	$ 99.00	$ 93.00	$ 6.00	6%	"
Volatile Organics, EPA 624		0.03	0.90			$152.82	$ 153.00	$ 145.00	$ 8.00	6%	"
Volatile Solids, VS					0.70	$91.91	$ 92.00	$ 87.00	$ 5.00	6%	"
Zinc (included in Metals		0.03	0.40			$70.90	$ 71.00	$ 68.00	$ 3.00	4%	"

Any lab analysis not specifically identified will be billed at Time & Materials

Outside Contract Laboratory Analysis -billed at cost + staff time

RESOLUTION NO. _____

RESOLUTION OF THE BOARD OF DIRECTORS OF DUBLIN SAN RAMON SERVICES DISTRICT ESTABLISHING FEES AND CHARGES UNDER DISTRICT CODE SECTION 5.30.090, INDUSTRIAL WASTE PROGRAM USER FEES AND CHARGES AND RESCINDING RESOLUTION NO. 14-16

WHEREAS, the above referenced section of the District Code allows the Board of Directors to establish the respective fees and charges by ordinance or resolution; and

WHEREAS, these fees and charges, which are not assessed as an incident of property ownership, but are instead imposed based upon the nature of the use of the property, not by virtue of the landowner's ownership of the property, and are therefore not subject to Proposition 218 notification procedures, have been reviewed and require adjustment; and

WHEREAS, these fees and charges are imposed for specific services provided by the District directly to the customer required to pay them, which services are not provided to those not charged, and the amount of the fees and charges have each been calculated using an accepted methodology of allocating costs to the customers that benefit from the services provided such that the fee or charge does not exceed the reasonable costs of providing the service; and

WHEREAS, some of the fees and charges are imposed for the reasonable regulatory costs for issuing licenses and permits, performing investigations, inspections, and audits, and the administrative enforcement and adjudication thereof, based on an accepted methodology of allocating the reasonable regulatory costs to those whose activities give rise to the need for regulation; and

WHEREAS, the rates, as adopted by this resolution, once operative, will supersede those previously established in Resolution No. 14-16.

NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF DUBLIN SAN RAMON SERVICES DISTRICT, a public agency in the Counties of Alameda and Contra Costa, California, as follows:

1. The charges authorized under Section 5.30.090 of Dublin San Ramon Services District Code are established in the respective amounts set forth in Exhibit "A," attached.

2. This resolution will be effective immediately upon its adoption, provided that the charges as shown on Exhibit "A" shall be operative from and after July 1, 2018.

3. Resolution No. 14-16, attached as Exhibit "B," is rescinded effective July 1, 2018.

Res. No. _____

ADOPTED by the Board of Directors of Dublin San Ramon Services District, a public agency in the State of California, Counties of Alameda and Contra Costa, at its regular meeting held on the 15th day of May, 2018, and passed by the following vote:

AYES:

NOES:

ABSENT:

_____
Georgean M. Vonheeder-Leopold, President

ATTEST: _____
Nicole Genzale, District Secretary

TYPE OF FEE	DISTRICT CODE	FEE DESCRIPTION	2018 FEE
Sampling	5.30.090	Composite Sampler set-up	$395.00
		Sampling, each site per day	$250.00
Inspections and Permitting - Significant Industrial User	5.30.090	Inspection, initial (Significant Industrial User (SIU)	$1,550.00
		Inspection, compliance (SIU)	$910.00
		Permit Issuance, includes application review (SIU)	$1,160.00
		Permit Renewal, includes application review (SIU)	$690.00
		Permit Amendments (SIU)	$385.00
Inspections and Permitting - Intermediate Industrial User	5.30.090	Inspection, initial (Intermediate Industrial User (IIU)	$775.00
		Inspection, compliance (IIU)	$455.00
		Permit Issuance, includes application review (IIU)	$775.00
		Permit Renewal, includes application review (IIU)	$345.00
		Permit Amendments (IIU)	$235.00
Hearings and Enforcement	5.30.090	Show Cause Hearing, each hearing, hours	$935.00
		Enforcement Hearing, each hearing, hours	$1,245.00
Dental Amalgam Program	5.30.090	Permit fee - 3 year permit for dental offices with amalgam separator devices	$ 105.00
		Inspection fee - inspection of amalgam separator devices	$ 95.00
		Penalty for past due self-monitoring report submittal	$ 105.00

Calculated User Charges:	
Laboratory Analysis	**2018 Fee**
Alkalinity Bicarbonate, HCO3	$ 33.00
Alkalinity Carbonate, CO3	$ 33.00
Alkalinity Hydroxide, OH	$ 33.00
Alkalinity Total	$ 33.00
Ammonia	$ 132.00
Antimony	$ 71.00
Arsenic (included in Metals)	$ 71.00
Barium	$ 71.00
Beryllium	$ 71.00
Biochemical Oxygen Demand (BOD)	$ 99.00
Boron	$ 104.00
Cadmium (included in Metals)	$ 71.00
Calcium & Calcium Hardness	$ 40.00
Chemical Oxygen Demand (COD)	$ 40.00
Chloride	$ 99.00
Chlorine	$ 99.00
Chromium (included in Metals)	$ 71.00
Cobalt	$ 71.00
Coliform, Total, MPN Method	$ 197.00
Coliform, Total, P/A Method	$ 66.00
Color	$ 20.00
Conductivity	$ 33.00
Copper (included in Metals	$ 71.00
Cyanide	$ 170.00
Dissolved Oxygen	$ 27.00
E-Coli, P/A Method	$ 66.00
Enterococcus	$ 92.00
Fecal Coliform, MPN Method	$ 197.00
Fluoride	$ 82.00
HaloAcetic Acids (HAAs)	$ 211.00
Hardness, Total	$ 40.00
Langelier Index	$ 165.00
Lead (included in Metals)	$ 71.00
Manganese	$ 71.00
Mercury	$ 137.00
Metals	$ 396.00
Nickel (included in Metals)	$ 71.00
Nitrate, NO3	$ 82.00
Nitrate, NO3, Hach Method	$ 33.00
Nitrite and Nitrate, Total	$ 82.00
Nitrite, NO2	$ 82.00
Nitrite, NO2, Hach Method	$ 33.00
pH	$ 33.00
Phenol	$ 170.00
Potassium	$ 71.00
Selenium (included in Metals)	$ 71.00
Silica	$ 82.00
Silver (included in Metals)	$ 71.00
Sodium	$ 71.00
Sulfate	$ 82.00
Sulfide	$ 33.00
Temperature	$ 14.00
Thallium	$ 71.00
Total Dissolved Solids, TDS	$ 79.00
Total Solids, TS	$ 79.00
Total Suspended Solids, TSS	$ 79.00
Total Trihalomethanes (TTHMs)	$ 153.00
Turbidity	$ 33.00
UV 254	$ 33.00
Vanadium	$ 71.00
Volatile Acids, VA	$ 99.00
Volatile Organics, EPA 624	$ 153.00
Volatile Solids, VS	$ 92.00
Zinc (included in Metals	$ 71.00

Any lab analysis not specifically identified will be billed at Time & Materials.

Outside Contract Laboratory Analysis - billed at cost + staff time

Notes: all hours shown are estimates based on typical tasks and normal

(typically tests are run in batches of 5-8; time adjusted by 1/5.)

RESOLUTION NO. 14-16

RESOLUTION OF THE BOARD OF DIRECTORS OF DUBLIN SAN RAMON SERVICES DISTRICT ESTABLISHING FEES AND CHARGES UNDER DISTRICT CODE SECTION 5.30.090, INDUSTRIAL WASTE PROGRAM USER FEES AND CHARGES AND RESCINDING RESOLUTION NO. 15-14

WHEREAS, the above referenced section of the District Code allows the Board of Directors to establish the respective fees and charges by ordinance or resolution; and

WHEREAS, these fees and charges, which are not assessed as an incident of property ownership, but are imposed upon and due to the nature of the use of the property, and not by virtue of the landowner's ownership of the property and are therefore not subject to Proposition 218 notification, have been reviewed and require adjustment, and

WHEREAS, these fees and charges are imposed for specific services provided by the District directly to the customer required to pay them, which services are not provided to those not charged, and the amount of the fees and charges have each been calculated using an accepted methodology of allocating costs to the customers that benefit from the services provided such that the fee or charge does not exceed the reasonable costs of providing the service, and

WHEREAS, some of the fees and charges are imposed for the reasonable regulatory costs for issuing licenses and permits, performing investigations, inspections, and audits, and the administrative enforcement and adjudication thereof, based on an accepted methodology of allocating the reasonable regulatory costs to those whose activities give rise to the need for regulation, and

WHEREAS, the rates, as adopted by this resolution, once operative, will supersede those previously established in Resolution No. 15-14.

NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF DUBLIN SAN RAMON SERVICES DISTRICT, a public agency in the counties of Alameda and Contra Costa, California, as follows:

1. The charges authorized under Section 5.30.090 of Dublin San Ramon Services District Code are established in the respective amounts set forth in Exhibit "A," attached.

2. This resolution will be effective immediately upon its adoption; provided that the charges as shown on Exhibit "A" shall be operative from and after April 4, 2016.

3. Resolution No. 15-14 is Rescinded, attached as Exhibit "B," effective April 4, 2016.

ADOPTED by the Board of Directors of Dublin San Ramon Services District, a public agency in the State of California, counties of Alameda and Contra Costa, at its regular meeting held on the 1st day of March 2016, and passed by the following vote:

AYES: 4 - Directors Edward R. Duarte, Madelyne A. Misheloff, Richard M. Halket, D.L. (Pat) Howard

NOES: 0

ABSENT: 1 - Director Georgean M. Vonheeder-Leopold

D. L. (Pat) Howard, President

ATTEST:

Nicole Genzale, District Secretary

CERTIFIED AS A TRUE AND CORRECT COPY OF THE ORIGINAL ON FILE IN THE OFFICE OF DUBLIN SAN RAMON SERVICES DISTRICT
Secretary

MAR 0 2 2016

Dublin San Ramon Services District
Summary & Recommendation

Item 8.D.
Meeting Date: May 15, 2018

TITLE: Receive Presentation on District Water Supply Outlook for 2018-2022

RECOMMENDATION:

Staff recommends the Board of Directors receive a presentation on the District's water supply outlook for 2018 to 2022.

SUMMARY:

The Zone 7 Water Agency (Zone 7) supplies 100% of the District's potable water supply. Zone 7 annually reviews the reliability and sustainability of the water supply in meeting the Tri-Valley water retailers projected five-year demands. At its April 18, 2018 meeting, Zone 7's Board of Directors received the *2018 Annual Review of Sustainable Water Supply for Zone 7 Water Agency*.

As of April 1, 2018, the statewide Sierra snowpack was estimated at 54% of average and the Northern Sierra precipitation was 78% of average. Zone 7's State Water Project allocation is 30% as of April 24, 2018, reflecting dry hydrologic conditions statewide and the operational conditions at Oroville Reservoir. The previous Water Year (October 1, 2016-September 30, 2017) was one of the wettest years on record in a number of watersheds in the State. The wet conditions, along with residual water conservation associated with the drought, allowed Zone 7 to boost its storage both locally and in Kern County Water Banks for use in the current year and future years.

The Tri-Valley region continues to conserve at a high level. For example, Zone 7 water demand in 2017 was 25% less than the demand in 2013. Water supply conservation helps Zone 7 meet delivery requests made by the retailers. Zone 7's water supply review shows that the District will receive 100% of its projected potable water demands from 2018 to 2022, even if one of those years is a critical dry year.

The DSRSD-EBMUD Recycled Water Authority (DERWA) produces recycled water at its recycled water treatment facility, which is completing construction for expansion. DERWA provides recycled water to the District, East Bay Municipal Utility District, and the City of Pleasanton. DERWA annually updates its five-year demand projections and determines recycled water availability.

The recycled water demand is surpassing the supply and in 2018 DSRSD and EBMUD will need to implement demand management or supplement the recycled water supply with potable water to meet peak day demands.

Additional details regarding both potable water and recycled water supply availability to serve the District's customers are discussed in the attached staff report.

Originating Department: Engineering Services	**Contact: R. Biagtan**	**Legal Review: Not Required**
Cost: $0	**Funding Source: N/A**	
Attachments: ☐ None ☒ Staff Report ☐ Resolution ☐ Ordinance ☐ Task Order ☐ Proclamation ☐ Other (see list on right)		

STAFF REPORT

District Board of Directors
May 15, 2018

Receive Presentation on District Water Supply Outlook for 2018-2022

BACKGROUND

The Zone 7 Water Agency (Zone 7) provides 100% of DSRSD's potable water supply. Zone 7 annually reviews the reliability and sustainability of the water supply in meeting the Tri-Valley Water Retailers' projected five year demands. The DSRSD-EBMUD Recycled Water Authority (DERWA) provides recycled water to DSRSD, East Bay Municipal Utility District (EBMUD), and the City of Pleasanton. DERWA annually updates its five-year demand projections and determines recycled water availability.

This report provides a summary of DSRSD's potable and recycled water supply outlook based on the *2018 Annual Review of Sustainable Water Supply for Zone 7 Water Agency* presented at Zone 7's April 18, 2018 Board meeting and the 2018 projected DERWA recycled water projected demands and available supply.

DISCUSSION

Potable Water Supply

Because Zone 7 receives more than 80% of its water supply from the State Water Project (SWP), DSRSD's water supply condition is linked to the state's water supply condition. The snowpack level in northern California, the main source of supply for the SWP during the spring and summer, is at 54% of the April 1st average. The Northern Sierra precipitation, which is a strong constituent in SWP allocation, was 85% of average as of April 1, 2018.

Oroville and San Luis Reservoir, the main reservoirs for the SWP are 60% and 87% of historical average as of April 1, 2018. The SWP project on April 1, 2018 announced contractors would receive 20% of their allocation in 2018, reflecting dry hydrologic conditions and operational constraints for spillway repairs. Repairs are underway to restore the Oroville spillway to full capacity in 2018.

Local precipitation is at 85% of average for April 1, 2018 at the Livermore Rainfall Station. The runoff into Lake Del Valle, as of April 1, 2018, is 9% of average. Local runoff into the lake has been minimal due to dry conditions until the March storms, which brought most of this year's runoff to-date into Lake Del Valle. In addition, the local groundwater basin is currently at 96% of operational storage as of May 1, 2018.

Zone 7's potential surface water supplies in the next five years include: water from its contract with DWR for imported SWP water, local runoff into Lake Del Valle, and its agreement with DWR for Yuba Accord Water and other water (e.g., SWP multi-year pool). Additional water transfers, when available, also add to Zone 7's water supply. Table 1 presents Zone 7's expected water supply in 2018, an estimate for 2019 assuming 1977 critically dry year, followed by normal or average years from 2020 through 2022. While Zone 7 requested water from Byron Bethany Irrigation District in 2018, no water was assumed available as the Byron Bethany Irrigation District agreement is being re-evaluated. Zone 7 is planning a water transfer from River Garden Farms (RGF) this summer.

It should be noted that since the Zone 7 review was published the Department of Water resources announced that SWP allocation would increase from 20% to 30%. Therefore, the water available from the SWP is 24,100 acre-feet as opposed to 16,100 as assumed in Tables 1, 2 and 3.

Table 1. Zone 7 Projected Yields from Existing Contracted Water Supplies, acre-feet

Source[a]	2018	2019 *(1977)*	2020 *(Average)*	2021 *(Average)*	2022 *(Average)*
Table A[b]	16,100	8,100	50,000	50,000	50,000
Byron Bethany Irrigation District[c]	0	0	0	0	0
LDV Yield[d]	1,200	0	7,300	7,300	7,300
Yuba Accord	1000	1,500	1,000	1,000	1,000
Turnback Pool Program	0	0	200	200	200
River Garden Farms[e]	750	0	0	0	0
Projected Yields	19,050	9,600	58,500	58,500	58,500
Carryover into Following Year	-10,000	0	-10,000	-10,000	-10,000
Contracted Supply for Direct Use	**9,050**	**9,600**	**48,500**	**48,500**	**48,500**

[a] See Zone 7's 2015 Urban Water Management Plan for more details about Zone 7 supplies: http://www.zone7water.com/images/pdf_docs/water_supply/uwmp_2015.pdf.

[b] 2018 yield is based on 20% (current 2018 allocation) of 80,619 AF. Long-term average yield is 62% of Zone 7's Table A amount (80,619 AF) per DWR's Final 2015 Delivery Capability Report. Critically dry year is 10% yield.

[c] For conservative planning purposes, no water was assumed to be available under this contract.

[d] Water stored in the lake is currently 6,800 AF and expected to increase to approximately 8,000 AF by the end of December 2018. Water captured in 2018 is currently 1,200 AF. The current long-term yield is 7,300 AF.

[e] In 2018, Zone 7 plans to obtain a one-time transfer from River Garden Farms of 1,000 AF. After a 25% carriage loss, the net available to Zone & is 750 AF.

[f] Operational losses associated with unaccounted-for water.

Water Supply Storage

To help meet water demands during dry years, Zone 7 stores surplus surface water in various facilities including Del Valle Reservoir, the SWP San Luis Reservoir, the local ground water basin, and the Kern County ground water banks. Table 2 summarizes the total accrued water in storage available to Zone 7 as of April 1, 2018, and the estimated water supply to be provided from storage between 2018 and 2022 assuming 2019 is a critical dry year followed by average years from 2020 to 2022. As shown in Table 2, Zone 7 planned to recover banked water from Kern County in 2018. Given that Zone 7 received notice that they will receive 30% instead of 20% allocation from the State Water Project in April 24, 2018, Zone 7 will forgo storage recovery from Kern County groundwater banks. This will allow Zone 7 to maintain Kern Banks storage levels, keep about 10,000 AF in SWP storage for 2019, and manage the groundwater basin which is currently at about 96% of operational capacity.

Table 2. Available Storage, acre-feet

Source	Total Water in Storage[a]	Water Supply from Storage Planned for Use				
		2018	2019 *(1977)*	2020 *(Average)*	2021 *(Average)*	2022 *(Average)*
Main Groundwater Basin[b]	113,000	10,000	14,000	5,000	5,000	5,000
LDV Carryover[c]	5,600	5,600	2,300	3,100	7,300	7,300
SWP Carryover[d]	10,100	10,100	10,000	0	10,000	10,000
Semitropic[e]	79,200	8,950	9,100	0	0	0
Cawelo[f]	24,900	0	3,000	0	0	0
Total	232,800	34,650	38,400	8,100	22,300	22,300

[a] Storage as of January 1, 2018. Groundwater was at 90% of operational storage capacity.

[b] Slightly above average pumping is required in 2018 due to the low SWP allocation of 20% (10,000 AF vs. 9,200 AF). This still allows for greater pumping in 2019 if needed because the groundwater basin is nearly full. In 2019, Zone 7 staff estimates that approximately 14,000 acre-feet can be accessed via groundwater pumping if needed. A conservative pumping amount of 5,000 acre-feet was used for years classified as normal or average.

(c) Zone 7 carried over 5,600 AF into 2018 from 2017. Future LDV carryover available for use is estimated based on excess supplies from the previous year available for storage in LDV.

(d) Zone 7's total SWP carryover from 2017 into 2018 is 10,000 acre-feet and will be used up by June. Zone 7 typically carries over about 10,000 acre-feet from year to year during average conditions.

(e) On an annual basis, Zone 7 can recover up to 9,100 acre-feet from Semitropic via pumpback, and depending on the SWP allocation, also recover additional water via exchange.

(f) Cawelo can produce up to 10,000 AF per year between September and March once requested.

Potable Water Demand

A comparison of available water supply and the Tri-Valley's water demands is shown in Table 3. This table shows that Zone 7 will be able to deliver 100% of the Tri-Valley's water demand from 2018 to 2022 based on current projected demands. Additional conservation would result in higher excess supplies placed in storage, while higher demands than currently projected could be met through use of excess supplies shown in Table 3.

Table 3. Comparison of Supply and Demand: Next Five Years

Source	2018	2019 (1977)	2020 *(Average)*	2021 *(Average)*	2022 *(Average)*
Contracted Supply for Direct Use[a]	9,050	9,600	48,500	48,500	48,500
Water Supply from Storage Planned for Use[b]	34,650	38,400	8,100	22,300	22,300
Total Water Supply	43,700	48,000	56,600	70,800	70,800
Water Demand	41,400	44,900	46,400	47,200	48,200
Excess Supplies[c]	2,300	3,100	10,200	23,600	22,600
% of Demand Delivered	100%	**100%**	**100%**	**100%**	**100%**

(a) This amount reflects 10,000 AF reserved as SWP carryover into subsequent years when available.

(b) Excess supplies are stored in LDV as carryover, as well as in the local groundwater basin and Kern County banks.

Programs Necessary to Meet Long Term Water Demands

As presented in Zone 7's 2015 Urban Water Management Plan and 2016 Water Supply Evaluation Update, Zone 7 is evaluating several potential future water supply and storage options to bolster long-term water supply reliability. Future water supply and storage alternatives being evaluated include:

- California WaterFix,
- Sites Reservoir,
- Potable Reuse,
- Bay Area Regional Desalination,
- Los Vaqueros Reservoir Expansion,
- Lake Del Valle Expansion of Storage Capacity,
- Spot Market Water.

The District continues to coordinate with Zone 7 and the other Tri-Valley water agencies to support long term water supply reliability efforts.

Recycled Water

Annually, DERWA requests a five year demand projection from its customers— the District, East Bay Municipal Utility District (EBMUD), and the City of Pleasanton. The average annual and peak day demands are then compared to the projected available recycled water supply. The projected recycled water demands are shown in Table 4 below.

Table 4. DERWA Average and Peak Demands (2018 – 2022)

Year	Demand (MGD)							
	Pleasanton		DSRSD		EBMUD		**TOTAL**	
	Annual	**Peak***	**Annual**	**Peak***	**Annual**	**Peak***	**Annual**	**Peak***
2018	1.00	2.50	2.49	6.23	0.90	2.25	4.39	10.98
2019	1.37	3.43	2.66	6.65	1.30	3.25	5.33	13.33
2020	1.77	4.43	2.78	6.94	1.30	3.25	5.85	14.61
2021	1.77	4.43	2.89	7.22	1.30	3.25	5.96	14.89
2022	1.77	4.43	3.02	7.54	1.30	3.25	6.09	15.21

*Daily Peak Factor = 2.5

Daily production of recycled water is limited by incoming wastewater flow to the Regional Wastewater Treatment Facility and the recycled water treatment plant capacity. DERWA will be able to meet normal daily recycled water demands, however there will not be sufficient wastewater effluent to meet the projected peak day recycled water demands. The peak demand days typically occur in the month of July when the wastewater treatment plan inflow is lowest. DSRSD's projected WWTP inflow for July 2018 is 10 million gallons per day (MGD) while the peak demand is projected to be 11 MGD. Therefore, DERWA may have a recycled water supply shortfall of 1.0 MGD on peak days. For the 2018 recycled water season DERWA plans to implement demand management and supplement recycled water with potable water during peak demand days. DERWA is currently exploring other recycled water supply sources.

The capacity of the recycled water treatment process has varied considerably based on the quality of the effluent from wastewater treatment plant. With the completion of the DERWA Recycled Water Treatment Plant Expansion Project, which added a process ahead of the sand filtration to provide higher quality water going into the recycled water treatment process, the District will now be able to reliably treat all of the available wastewater treatment plant effluent.

CONCLUSION

Zone 7's water supply review indicates the District will receive 100% of its projected potable water demands from 2018 to 2022, even if next year is a critically dry year and there is minimal water conservation. The recycled water demand is surpassing the supply and in 2018, DSRSD and EBMUD will need to implement demand management or supplement the recycled water supply with potable water to meet peak day demands.