Santa Cruz Water Commission

ASR Investigation Update
and
Modeling Workshop

City of Santa Cruz Water Department

October 2, 2017

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water resources

ASR Investigation Update
and
Modeling Workshop

- **Brief Review of ASR Scope**
  - **Strategy 1: Elements 1 and 2 of the WSAC Recommendations**
  - **WSAC Infrastructure Components**
  - **ASR Implementation Plan**
  - **ASR Implementation Timeline**

WSAC Recommendations

- **Strategy1/Element 1 (In-Lieu):** Passively recharge the regional aquifers or basins (Santa Margarita Groundwater Basin and Mid-County Groundwater Basin) by delivering surface waters as an in-lieu supply to the districts utilizing these basins so they can rest their wells, help the aquifers recover, and effectively store water for use by the City in drought years.
- **Strategy1/Element 2 (ASR):** Actively recharge the regional aquifers or basins by using existing infrastructure (wells, pipelines, and treatment capacity) and potential new infrastructure (wells, pipelines and treatment capacity) to store water that can be available for use by the City in drought years.

WSAC Strategy 1, Elements 1 & 2

(source WSAC final report, App 8)

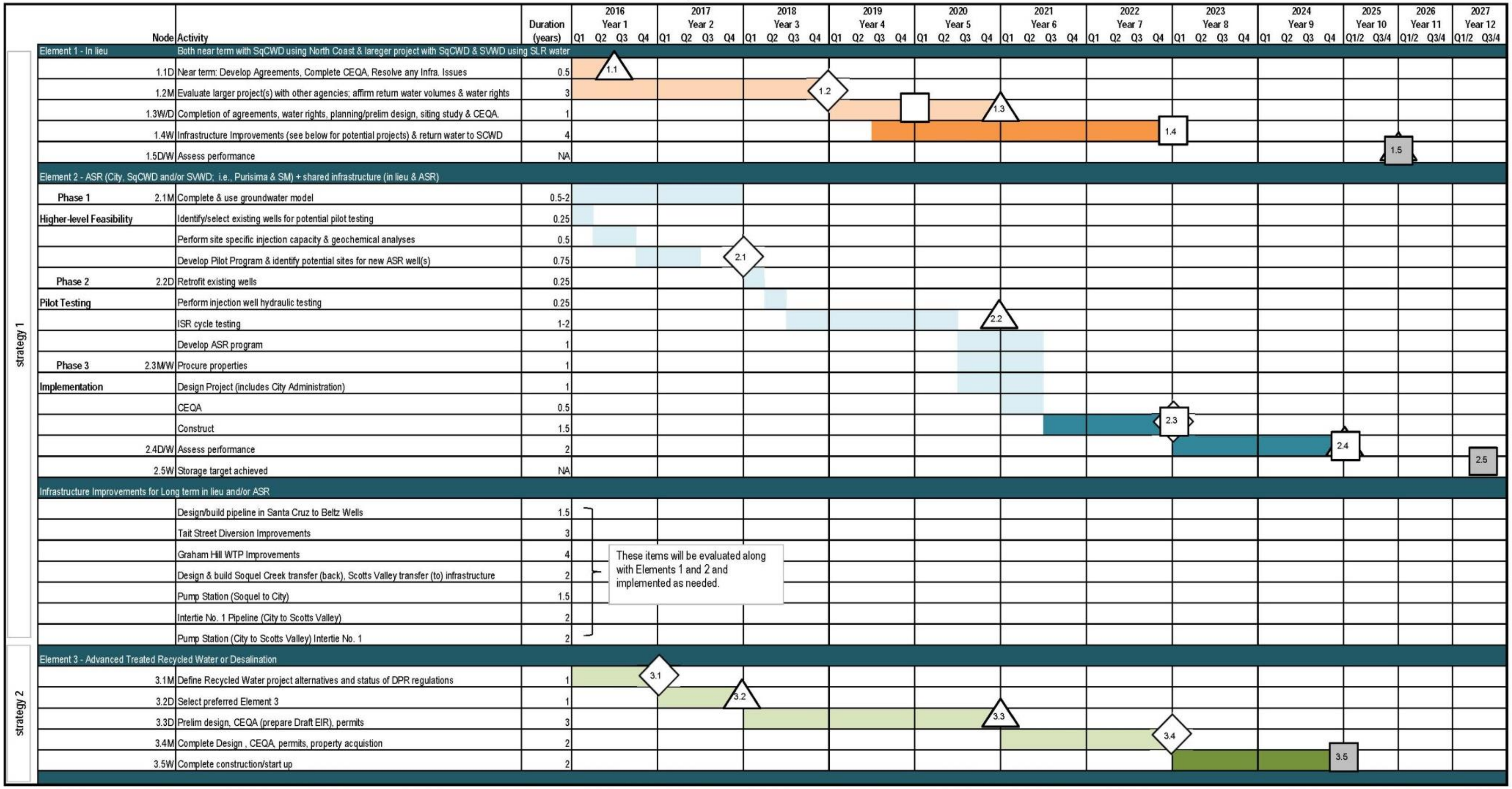
Element Number/Type	Capital Cost Components	Basis for Assumptions
1 – In lieu	Existing Infrastructure Improvements • Tait Street Diversion Improvements • Graham Hill WTP Improvements Pumps and Pipelines • 3,600 gpm Pump Station (City to Scotts Valley)at Intertie No. 1 • 16-inch Intertie 1 Pipeline (City to Scotts Valley), 3,600 linear feet (LF) • 3,600 gpm Pump Station (Soquel to City) at SqCWD Intertie • 16-inch Intertie Pipeline (City to Soquel Creek), 25,000 LF Wells • 4 350-gpm extraction wells in SVWD • 4 350-gpm extraction wells in SqCWD • Iron & manganese treatment, 8 wells • Land acquisition for wells, 4 sites in SqCWD and 4 sites in SVWD	• In lieu is based on winter demands for SqCWD and SVWD. • Water could be transferred to wells within the City, to SqCWD, and to SVWD. • Infrastructure is sized to accommodate 2.5-mgd (million gallons per day) peak flow between the City and SVWD and between the City and SqCWD. This sizing is to allow inclusion additional flows for ASR in the future. • The ultimate number and distribution of wells between agencies will be determined during project development. • The Tait Street and GHWTP improvements are based on current information that indicates that these facility upgrades are needed to treat a larger volume of higher turbidity water. This will be better defined moving forward. • It is assumed that the wells will all have a peak extraction flow rate of 350 gpm. • It is assumed that on-site iron and manganese treatment will be needed at each well. • Well footprints are estimated at 0.1 acre each. •
2 – ASR	Pumps and Pipelines • In-City pipeline to Beltz Wells, 4,000 LF Wells • 2 350-gpm Wells in SVWD) • 2 350-gpm Wells in SqCWD • 4 350-gpm Wells in Santa Cruz • Iron & manganese treatment, 4 wells • Land acquisition, 0.1 ac. each in SVWD and SqCWD	• ASR is based on the assumption that there is adequate capacity in the basin to store and produce water as supplied from available winter flows. It is also assumed that early project activities will include field work to evaluate the validity of these initial assumptions (i.e., how well ASR is likely to work in terms of both storage capacity and future yield). • The project elements for the ASR program build on the project elements already developed in Element 1. • Water could be transferred to wells within the City, to SqCWD, and to SVWD. • Infrastructure is sized to accommodate 2.5-mgd peak flow between the City and SVWD and between the City and SqCWD. • The ultimate number and distribution of wells between agencies will be determined during project development. • It is assumed that the wells will all have a peak injection flow rate of 250 gpm and a peak extraction flow rate of 350 gpm. • It is assumed that on-site iron and manganese treatment will be needed at each well. • Well footprints are estimated at 0.1 acre each.

WSAC ASR Implementation Plan

- **Phase 1 – Technical Feasibility Analysis**
- **Phase 2 – Pilot Testing**
- **Phase 3 – Permanent Project Implementation**

Estimated time to complete all 3 phases is 6 – 12 years

ASR Program Implementation Timeline



	Node	Activity	Duration (years)
Element 1 - In lieu		Both near term with SqCWD using North Coast & lareger project with SqCWD & SVWD using SLR water	
	1.1D	Near term: Develop Agreements, Complete CEQA, Resolve any Infra. Issues	0.5
	1.2M	Evaluate larger project(s) with other agencies; affirm return water volumes & water rights	3
	1.3W/D	Completion of agreements, water rights, planning/prelim design, siting study & CEQA.	1
	1.4W	Infrastructure Improvements (see below for potential projects) & return water to SCWD	4
	1.5D/W	Assess performance	NA
Element 2 - ASR (City, SqCWD and/or SVWD; i.e., Purisima & SM) + shared infrastructure (in lieu & ASR)			
Phase 1	2.1M	Complete & use groundwater model	0.5-2
Higher-level Feasibility		Identify/select existing wells for potential pilot testing	0.25
		Perform site specific injection capacity & geochemical analyses	0.5
		Develop Pilot Program & identify potential sites for new ASR well(s)	0.75
Phase 2	2.2D	Retrofit existing wells	0.25
Pilot Testing		Perform injection well hydraulic testing	0.25
		ISR cycle testing	1-2
		Develop ASR program	1
Phase 3	2.3M/W	Procure properties	1
Implementation		Design Project (includes City Administration)	1
		CEQA	0.5
		Construct	1.5
	2.4D/W	Assess performance	2
	2.5W	Storage target achieved	NA
Infrastructure Improvements for Long term in lieu and/or ASR			
		Design/build pipeline in Santa Cruz to Beltz Wells	1.5
		Tait Street Diversion Improvements	3
		Graham Hill WTP Improvements	4
		Design & build Soquel Creek transfer (back), Scotts Valley transfer (to) infrastructure	2
		Pump Station (Soquel to City)	1.5
		Intertie No. 1 Pipeline (City to Scotts Valley)	2
		Pump Station (City to Scotts Valley) Intertie No. 1	2
Element 3 - Advanced Treated Recycled Water or Desalination			
	3.1M	Define Recycled Water project alternatives and status of DPR regulations	1
	3.2D	Select preferred Element 3	1
	3.3D	Prelim design, CEQA (prepare Draft EIR), permits	3
	3.4M	Complete Design , CEQA, permits, property acquistion	2
	3.5W	Complete construction/start up	2

These items will be evaluated along with Elements 1 and 2 and implemented as needed.

Table Notes & Select Assumptions

This table approximates activities, costs, durations and sequencing of each element, all of which are subject to change.
Elements are shown to start in Q1 - 2016. This may or may not occur depending upon agreements, contracts, etc.
Rehab/replacement of the Newell Creek Pipeline is part of the existing CIP and not shown here.
Some infrastructure improvements may not be required if other pursuits are successful. E.g., evaluation of Ranney collectors may substitute GHWTP Improvements.
CEQA is used generically; implies compliance with Califorina Environmental Quality Act.
Pilot ASR work assumes major infrastructure not required. E.g., intertie to Scotts Valley or new well(s).
Element 2 includes 8 wells for in lieu plus 8 additional wells for ASR.

Legend

ASR = Aquifer Storage and Recovery
CEQA = California Environmental Quality Act
DDW = Division of Drinking Water
DPR = Direct Potable Reuse
EIR = Environmental Impact Report
GHWTP = Graham Hill Water Treatment Plant
IPR = Indirect Potable Reuse
ISR = Injection, Storage, Recovery
SCWD = Santa Cruz Water Department
SqCWD = Soquel Creek Water District
SVWD = Scotts Valley Water District

△ Decision Node
◇ Milestone Node
☐ Some amount of water returned to SCWD
▨ Full required amount of water returned to SCWD

Outline

- **Phase 1 Overview**
  - **Primary Purpose**
  - **Technical Feasibility Studies**
  - **Groundwater Modeling**
- **Update on Geochemical Interaction Analysis**
- **Well Siting Study Results**
- **Groundwater Modeling Discussion**
  - **Overview of GW Models Being Used**
  - **How Confluence Model Data are Translated**
  - **Descriptions of Initial GW Model Scenarios**
  - **WSAC Assumptions Being Validated / Overall Objective of GW Modeling**
  - **Preliminary Results**
  - **Potential Scenario Iterations**
- **Next Steps**
- **Q & A / Discussion**

ASR Implementation Plan

Phase 1 - Technical Feasibility Analysis

Primary Purposes:

1. **Validate / Refine WSAC Recon-Study Findings**
    a. **Per Well Injection Capacities**
    b. **Geochemical Interaction Potentials**
    c. **Aquifer Storage and Losses**
2. **Develop Information Needed to Scope and Budget Phase 2 Pilot Testing**

❖**OVERALL GOAL:**
Allow "GO, NO-GO" Decision to Proceed with Phase 2

ASR Implementation Plan

Phase 1 – Technical Feasibility Analysis

1. **Technical Feasibility Studies:**
   - i. **ID Existing Wells for ASR Pilot Testing**
   - ii. **Site-Specific Injection Capacity Analyses**
   - iii. **Geochemical Interaction Modeling**
   - iv. **Develop Phase 2 Pilot Testing Program**
2. **Groundwater Modeling**
   - i. **New ASR Well Siting Studies**
   - ii. **Preliminary Groundwater Modeling**

Geochemical Interaction Analysis Update

Initial Geochemical Interaction Analysis recommendation for supplemental pH sampling:

- Beltz 9 and 12 sites
- GHWTP
- Revised Geochemical Interaction Modeling

➢ RESULTS

- pH ranged between 7.1 – 7.2 at the well sites
- pH at GHWTP was 7.3
- Revised Geochemical Interaction Modeling indicates that GHWTP with pH < 7.6 should not result in Calcite precipitation.

Well Siting Study

- **Purpose:** Identify and Evaluate Potential ASR Well Sites to be used in Phase 1 GW Model Simulations

- **Siting Criteria:**
  - Hydrogeologic Factors
  - Site Considerations
  - Construction Logistics
  - Regulatory Requirements
  - Environmental Constraints

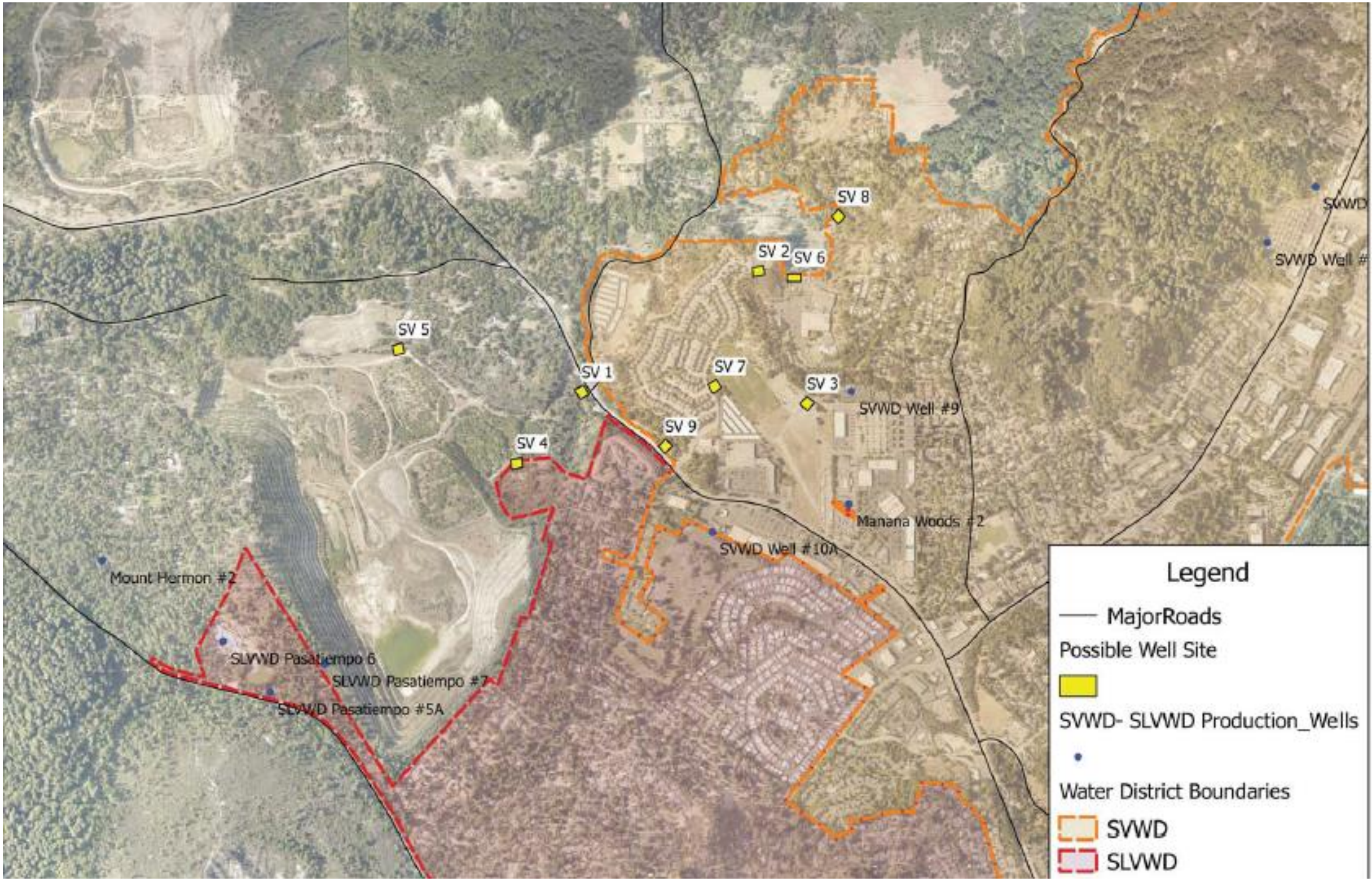
❖Note: Site Acquisition details not evaluated at this stage.

Well Siting Study

- Findings:
  - SMGB
    - Total of 9 potential sites identified
    - Estimated injection rates ranging between ~0.1 to 0.6 mgd

❖ NOTE: Area may be able to accommodate several additional sites (e.g., Hanson Quarry, needs further evaluation)

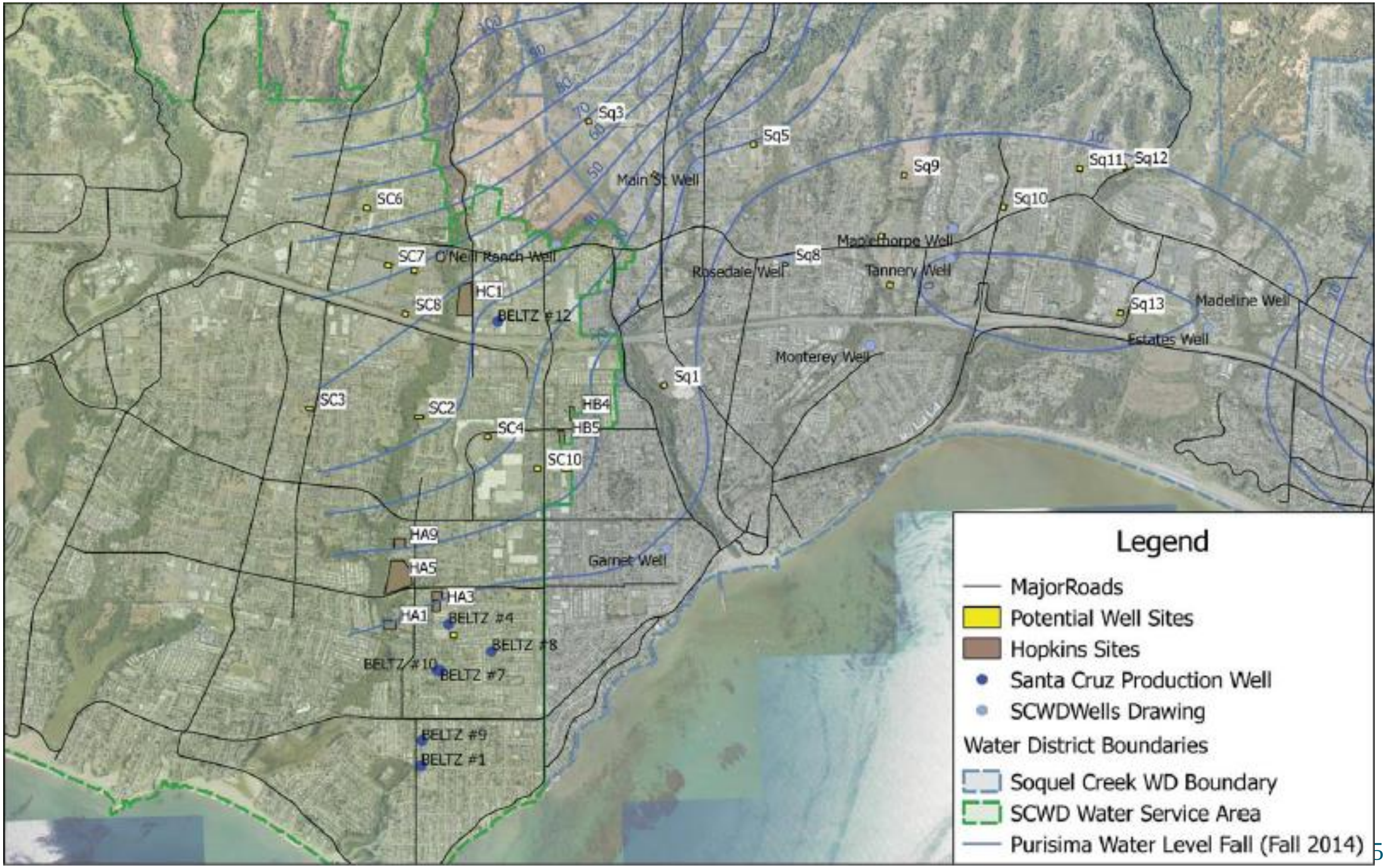
Well Siting Study
SMGB Potential ASR Well Sites



Well Siting Study

- Findings:
  - MGB
    - Total of 29 potential sites identified (17 in SCWD, 12 in SqCWD)
    - Estimated injection rates ranging between ~0.2 to 0.6 mgd

Well Siting Study
MGB Potential ASR Well Sites



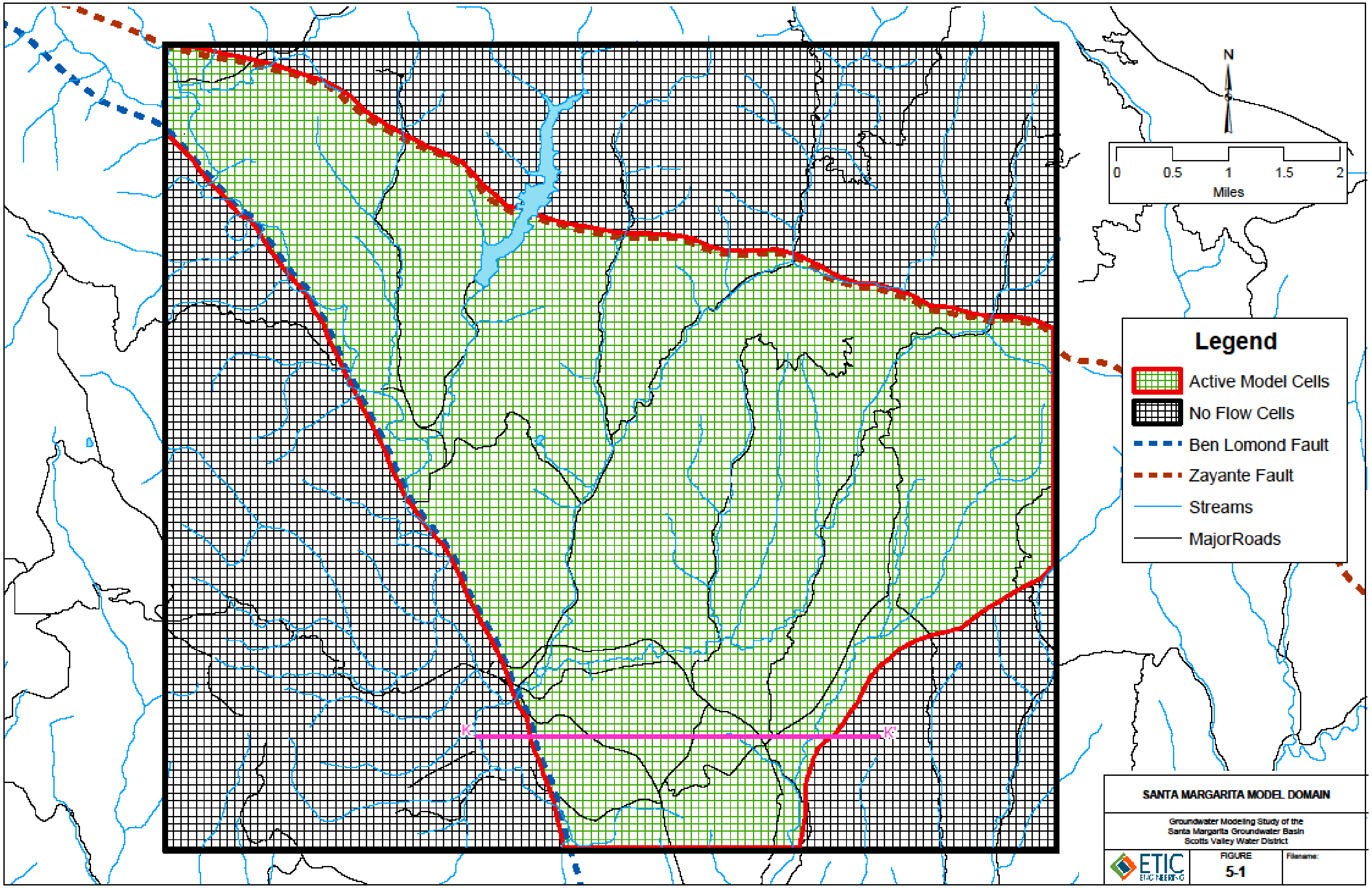
Groundwater Modeling

- Two independent models:
  1. Santa Margarita Groundwater Basin (SMGB)
  2. Santa Cruz Mid-County Groundwater Basin (MGB)
- Both utilize USGS MODFLOW code
- 3-D numerical models of physical groundwater systems
- Simulate occurrence and movement of groundwater
- Calibrated against historical based periods of 1985 – 2015

T1.5.2 – Groundwater Modeling

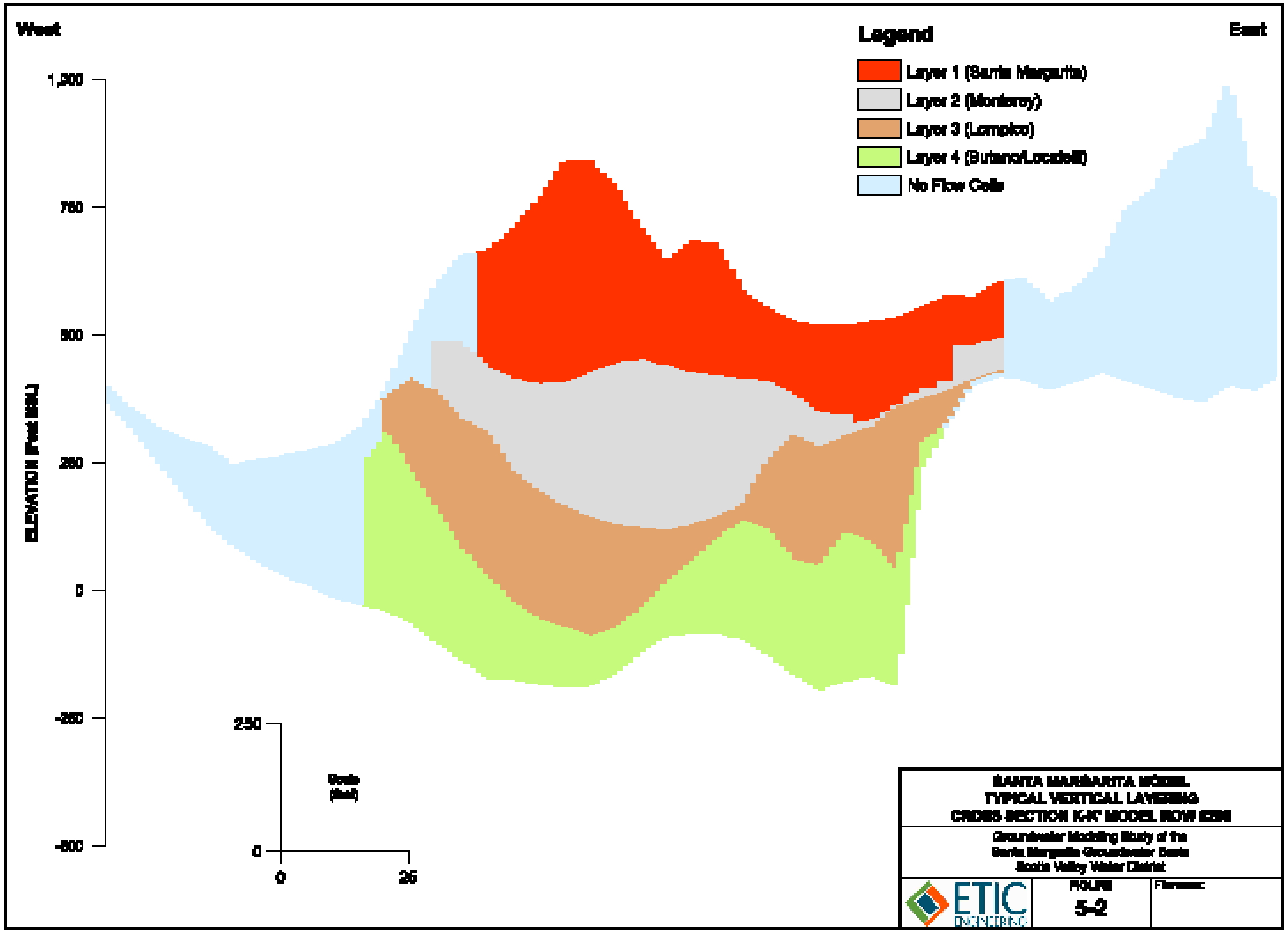
- Model Inputs
  1. Initial groundwater level conditions (starting heads)
  2. Boundary conditions
  3. Rainfall percolation
  4. Streambed percolation
  5. Well pumping
  6. Return flows
- Model Outputs
  1. Basin water balance (In – Out = Change in Storage)
  2. Water levels
     - Hydrographs
     - Contours

Groundwater Modeling
SMGB Model Domain



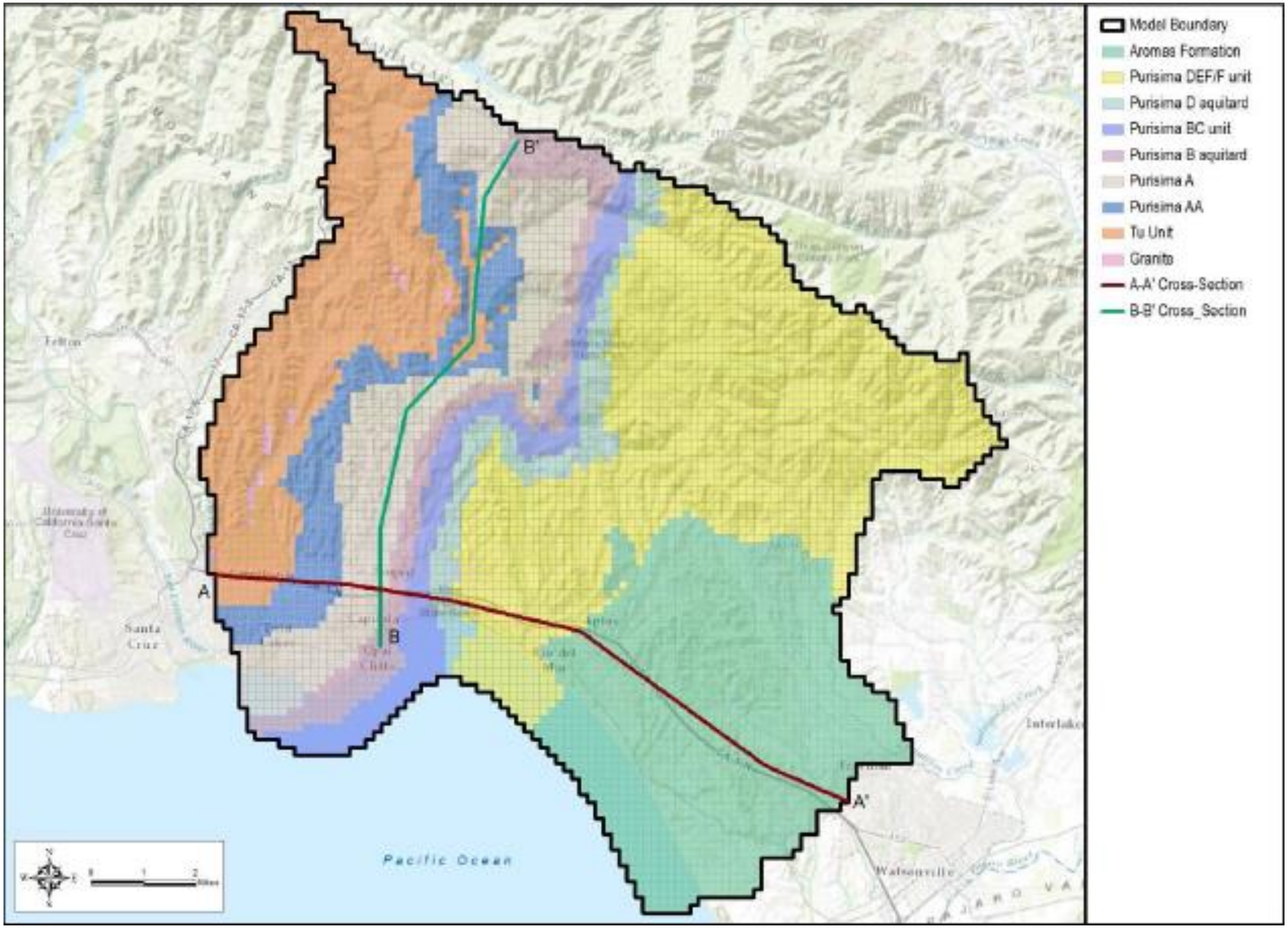
Source: ETIC 2006

Groundwater Modeling
SMGB Model Layers



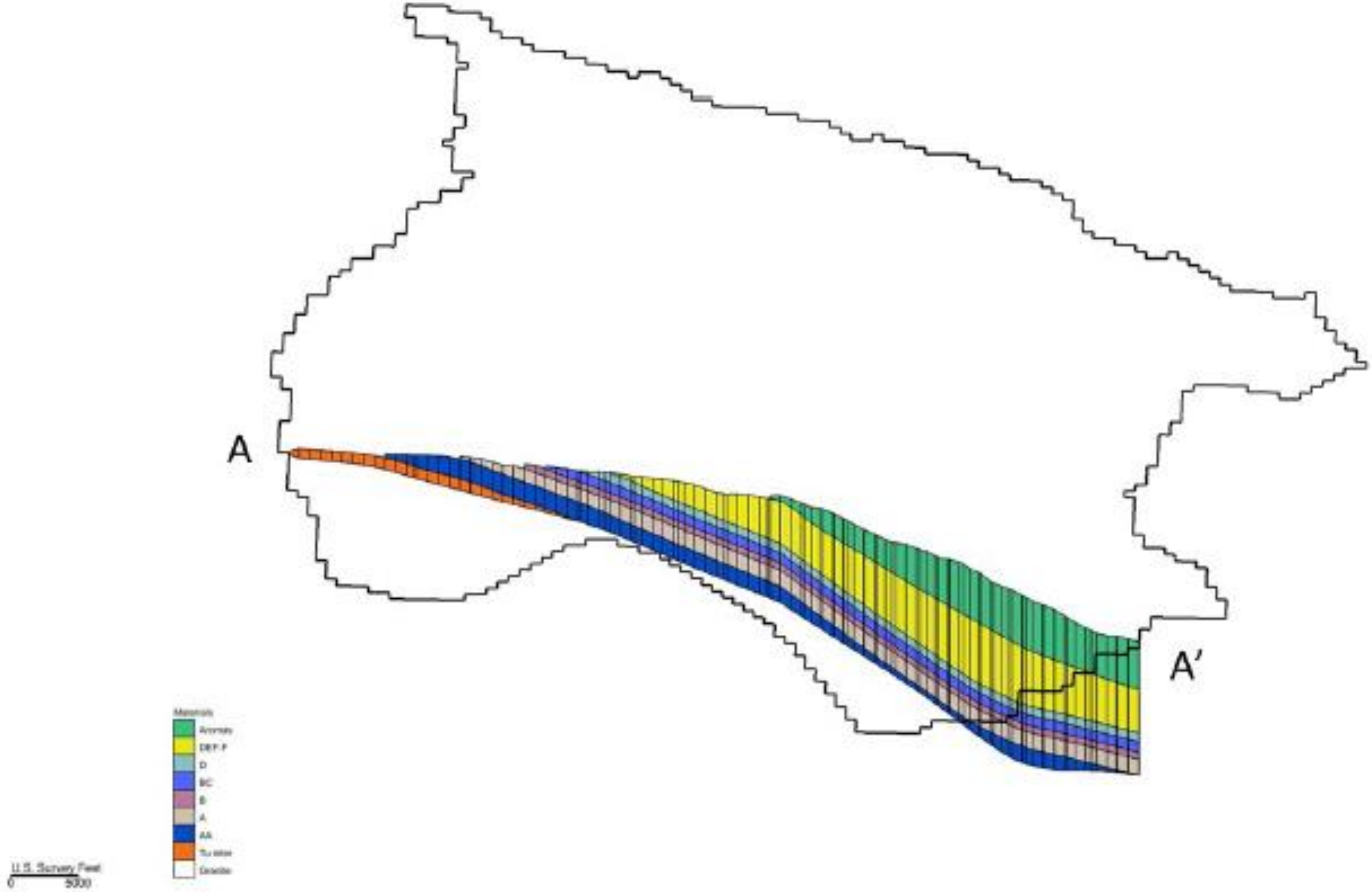
Source: ETIC 2006

Groundwater Modeling
MGB Model Domain



Source: HMWRI 2015

Groundwater Modeling
MBG Model Layers



Source: HMWRI 2015

Groundwater Modeling Planned Simulations

		Infrastructure		Worst Yr.	
	Project	Capacity (mgd)		Shortfall	Scoped
Climate	Scenario	Injection	Extraction	(mg)	Iterations
Historical	No Project	0	0	1380	1
	In-Lieu Only	0	4	400	3
	ASR Only	5.5	4	0	3
	In-Lieu plus ASR	1.5	4	0	3
Future Climate Change	No Project	0	0	1230	1
	In-Lieu Only	0	4	470	3
	ASR Only	6	6	0	3
	In-Lieu plus ASR	2	6.5	0	3
				Scenarios Per Basin	20
				Total Scenarios	40

Development of GW Model Scenarios from Confluence Model Output

- Confluence Model results provide as MG per month
  1. Recharge
  2. Recovery
- Translated in GW Model Scenarios
  1. Unit Conversion (mgm – cfd)
  2. Recharge and Recovery flows split between ea GW basin
  3. Flows assigned to specific wells
     - Existing District-owned wells to idle for In-Lieu
     - City ASR wells for injection
     - City ASR wells for recovery pumping

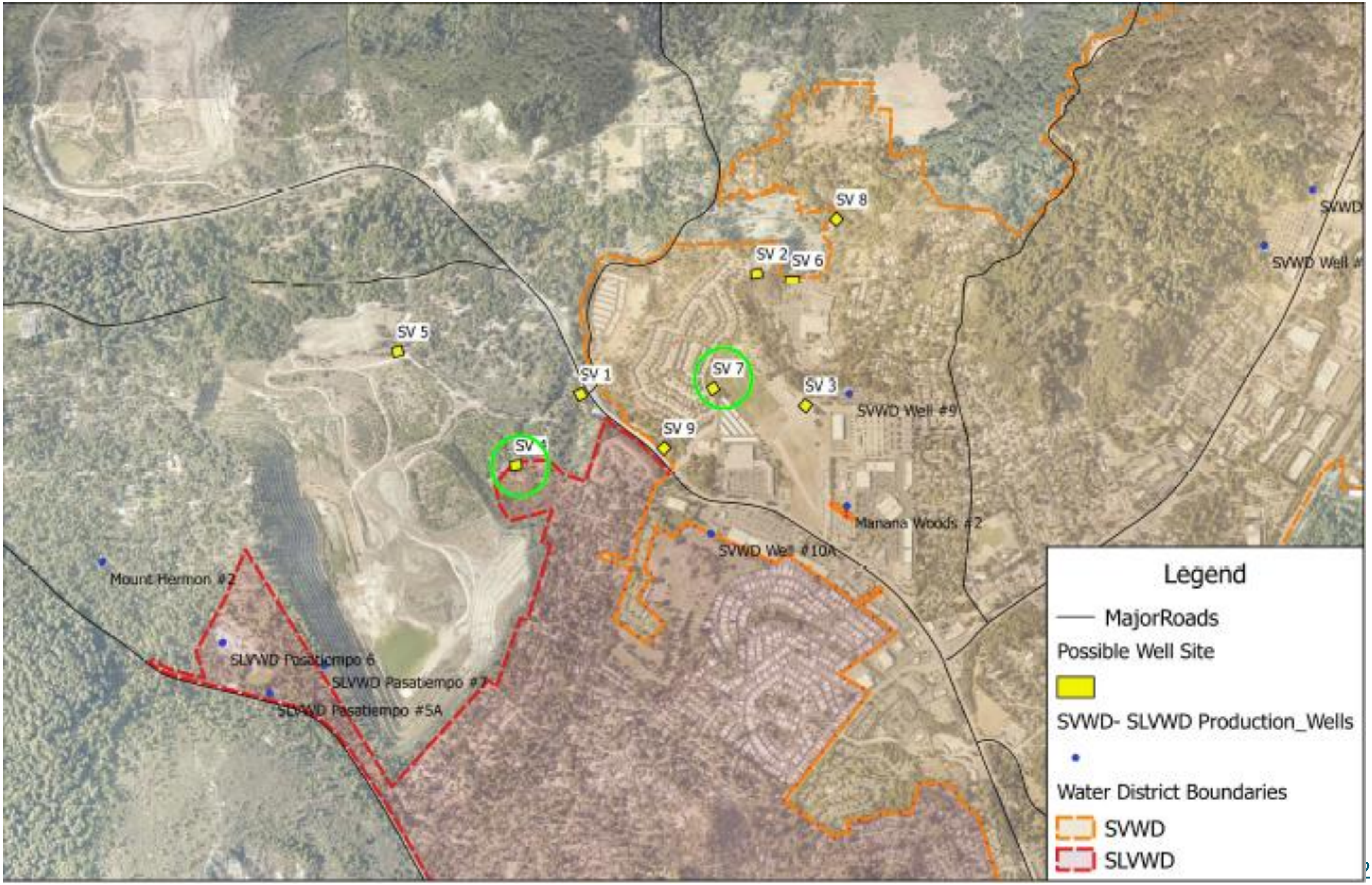
Validation of WSAC Assumptions

- GW Basin Storage Capacities (3 bg combined)
- Storage Losses (20% - 40% range)
- Per-Well Injection Rates (0.3 - 0.5 mgd avg)

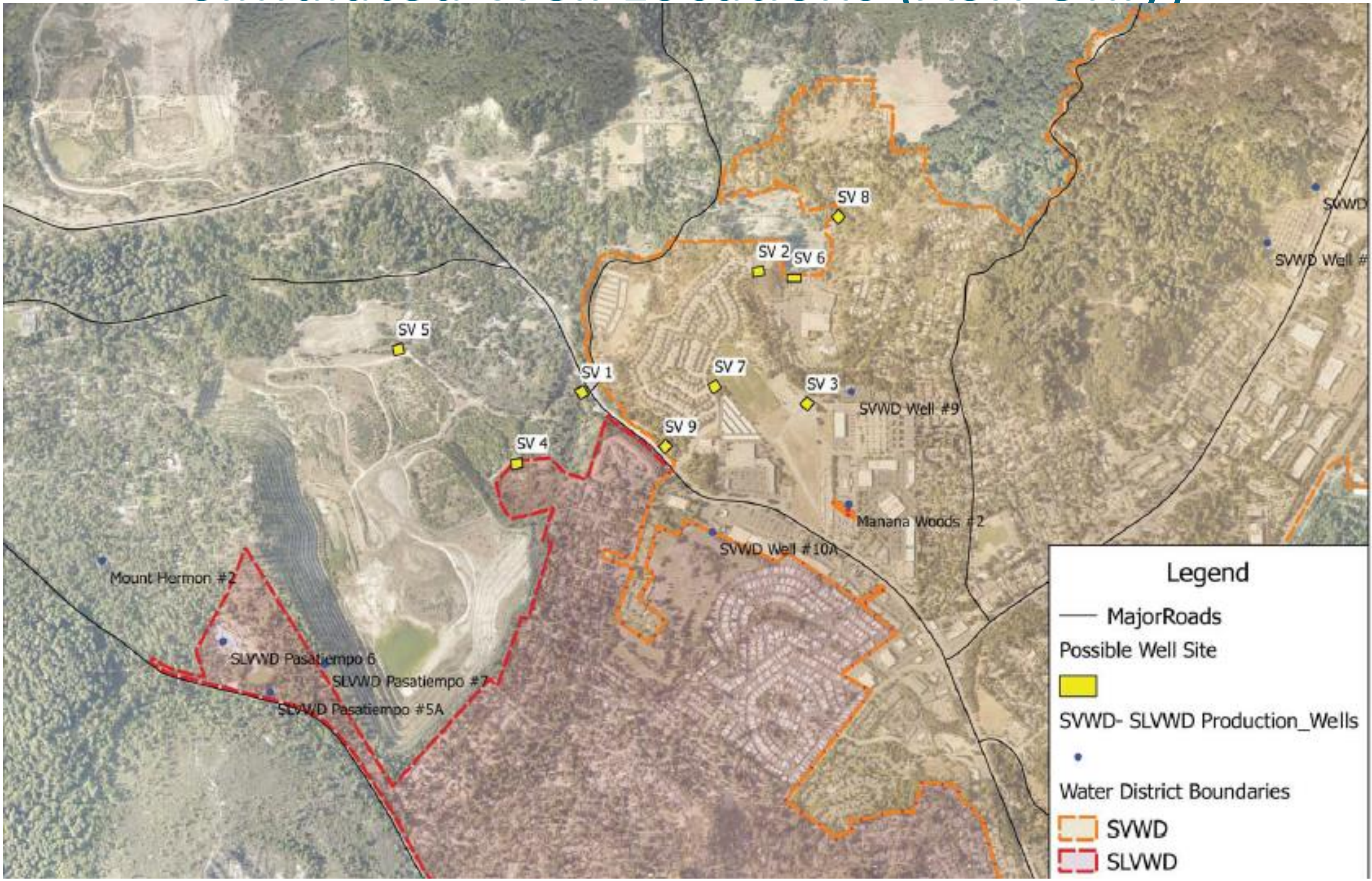
Preliminary GW Model Scenarios Parameters

- Historical Climate (calibration period of 1985 – 2015)
- Future Projected Pumping
- City Project Scenarios:
    1. In-Lieu Only: maximize recharge and recovery
    2. ASR Only: 50% of recharge and recovery
    3. In-Lieu plus ASR: 50% of recharge and recovery

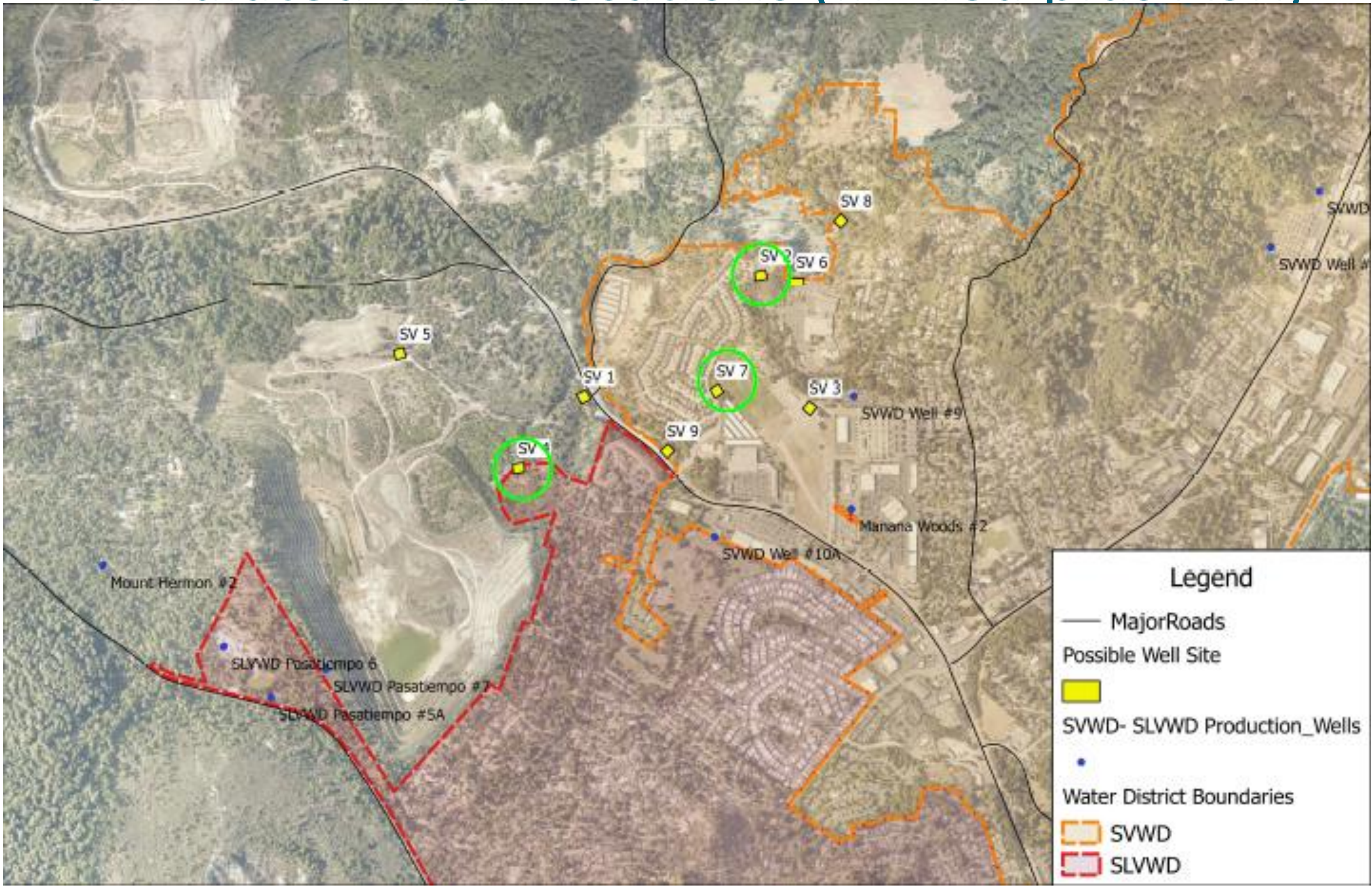
Preliminary GW Model Scenarios
SMGB Simulated Well Locations (In-Lieu Only)



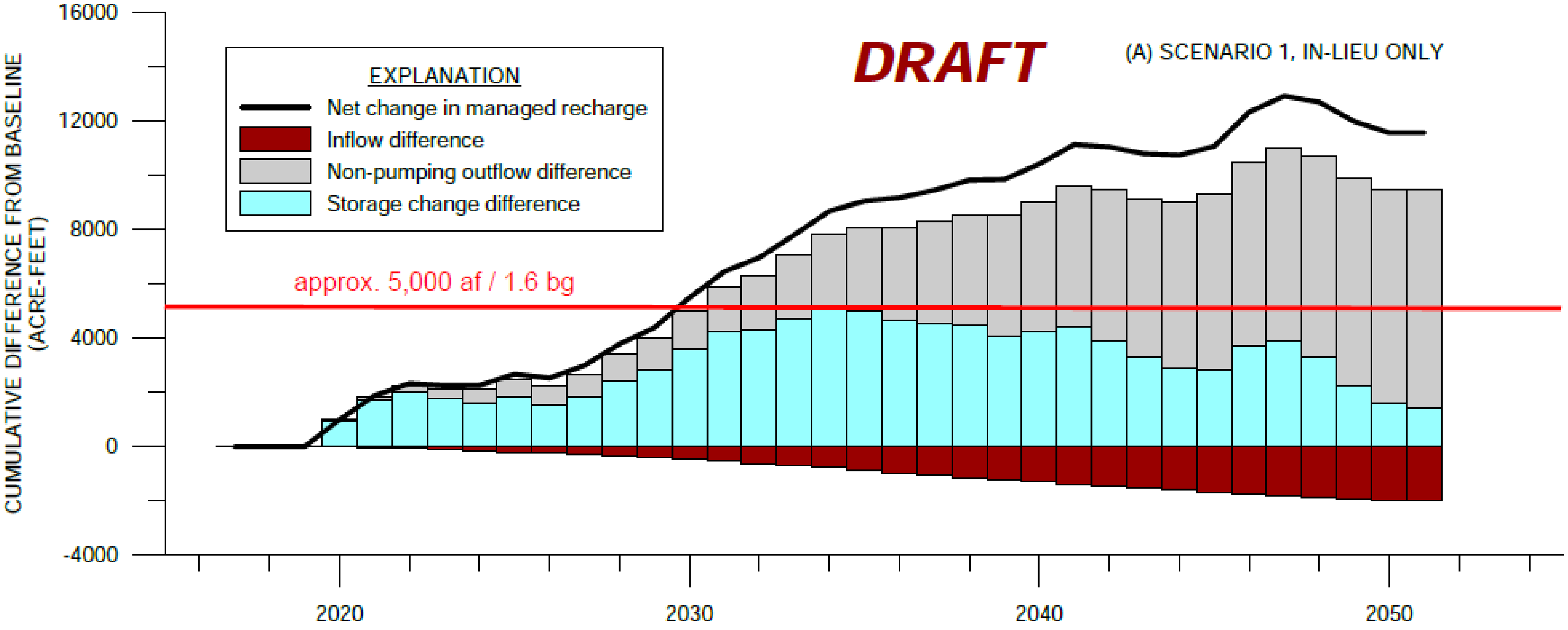
Preliminary GW Model Scenarios
Simulated Well Locations (ASR Only)



Preliminary GW Model Scenarios
Simulated Well Locations (In-Lieu plus ASR)



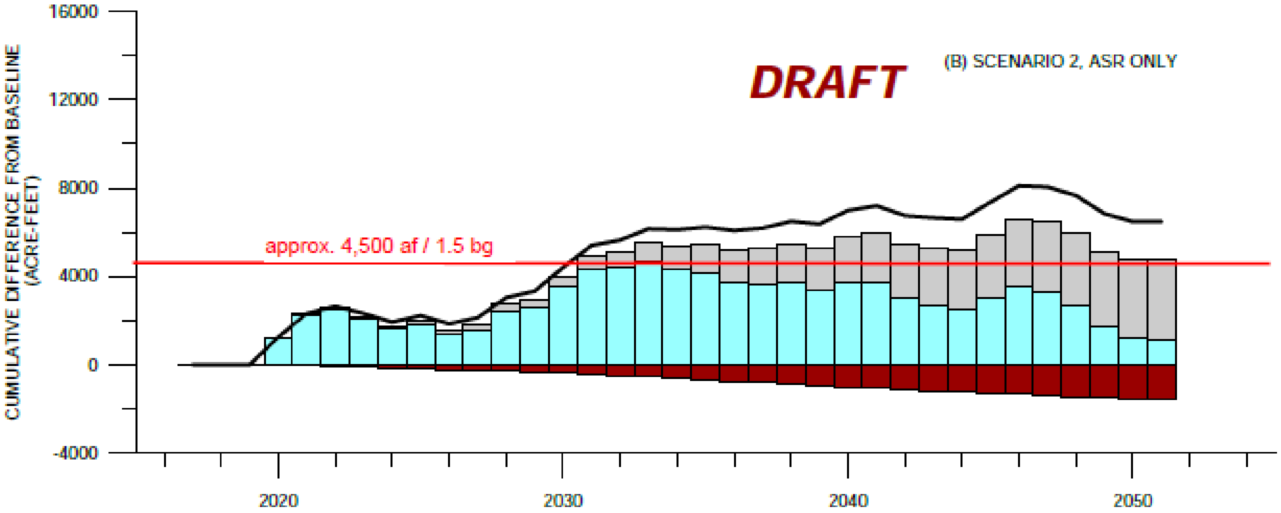
Preliminary GW Model Scenarios Results (Storage Changes – In-Lieu Only)

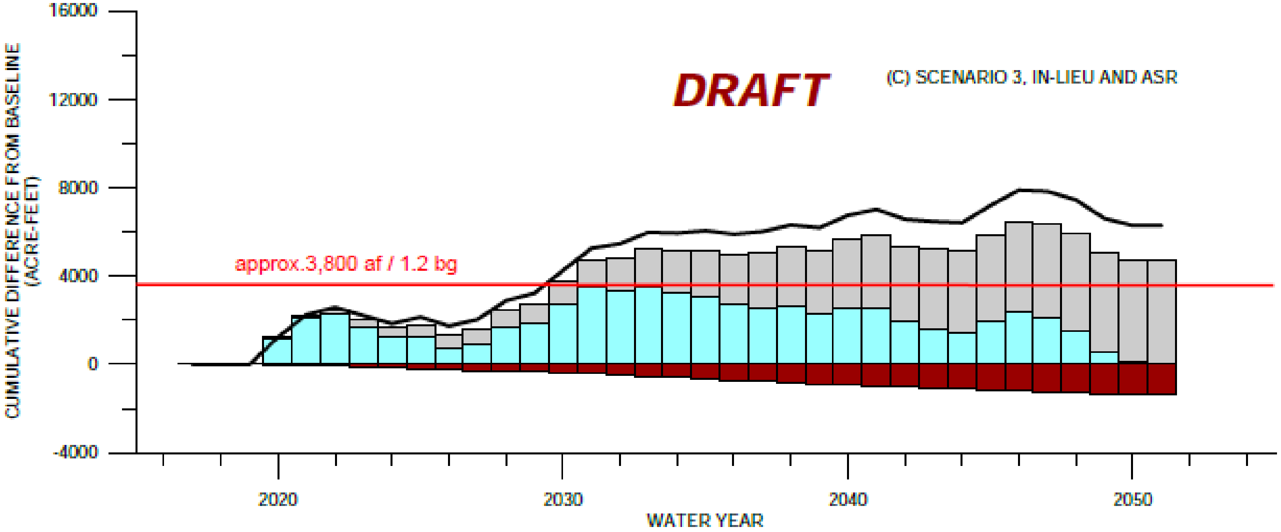


Source: HMWRI 2017

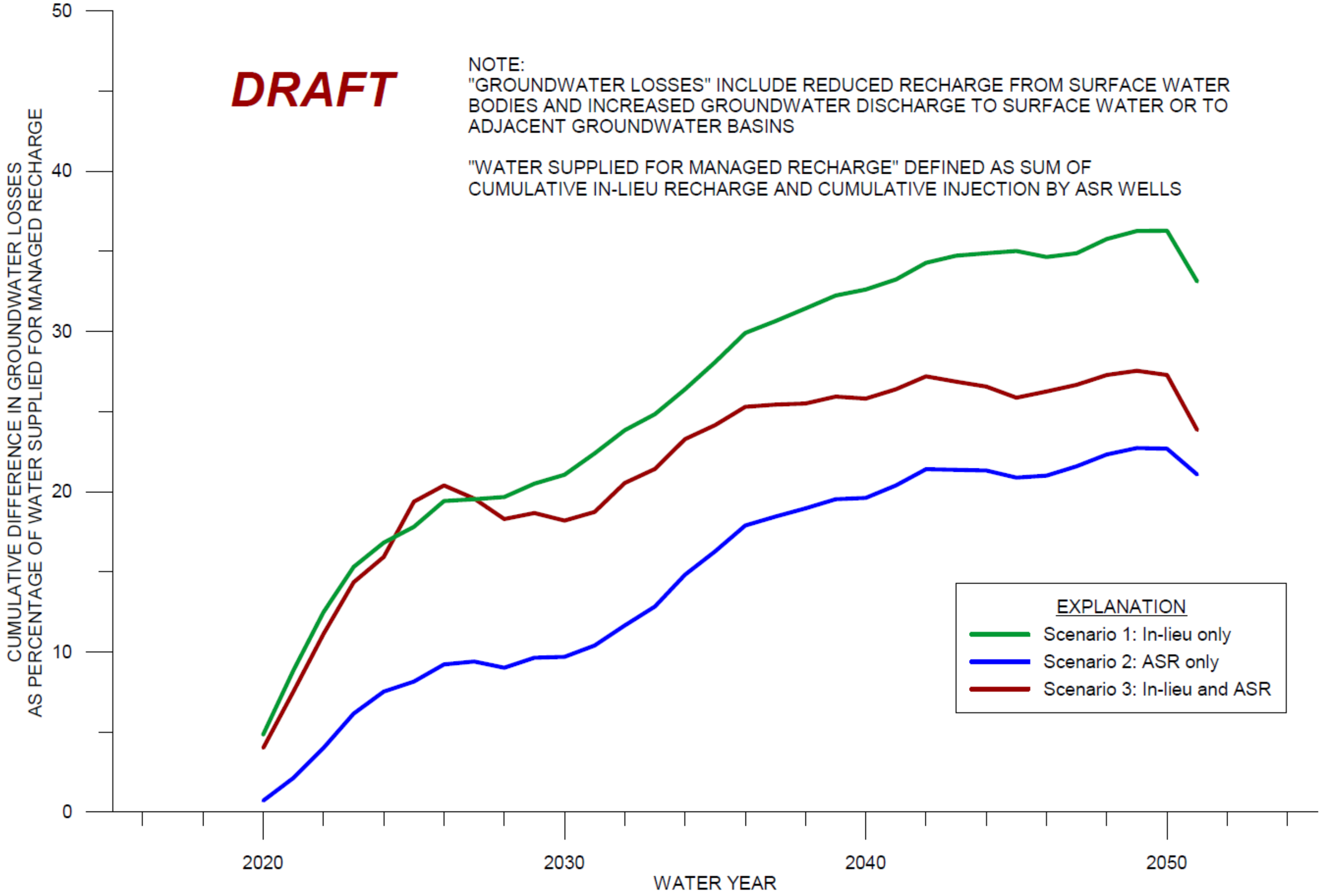
Preliminary GW Model Scenarios

Results (Storage Changes – ASR Only and In-Lieu plus ASR)

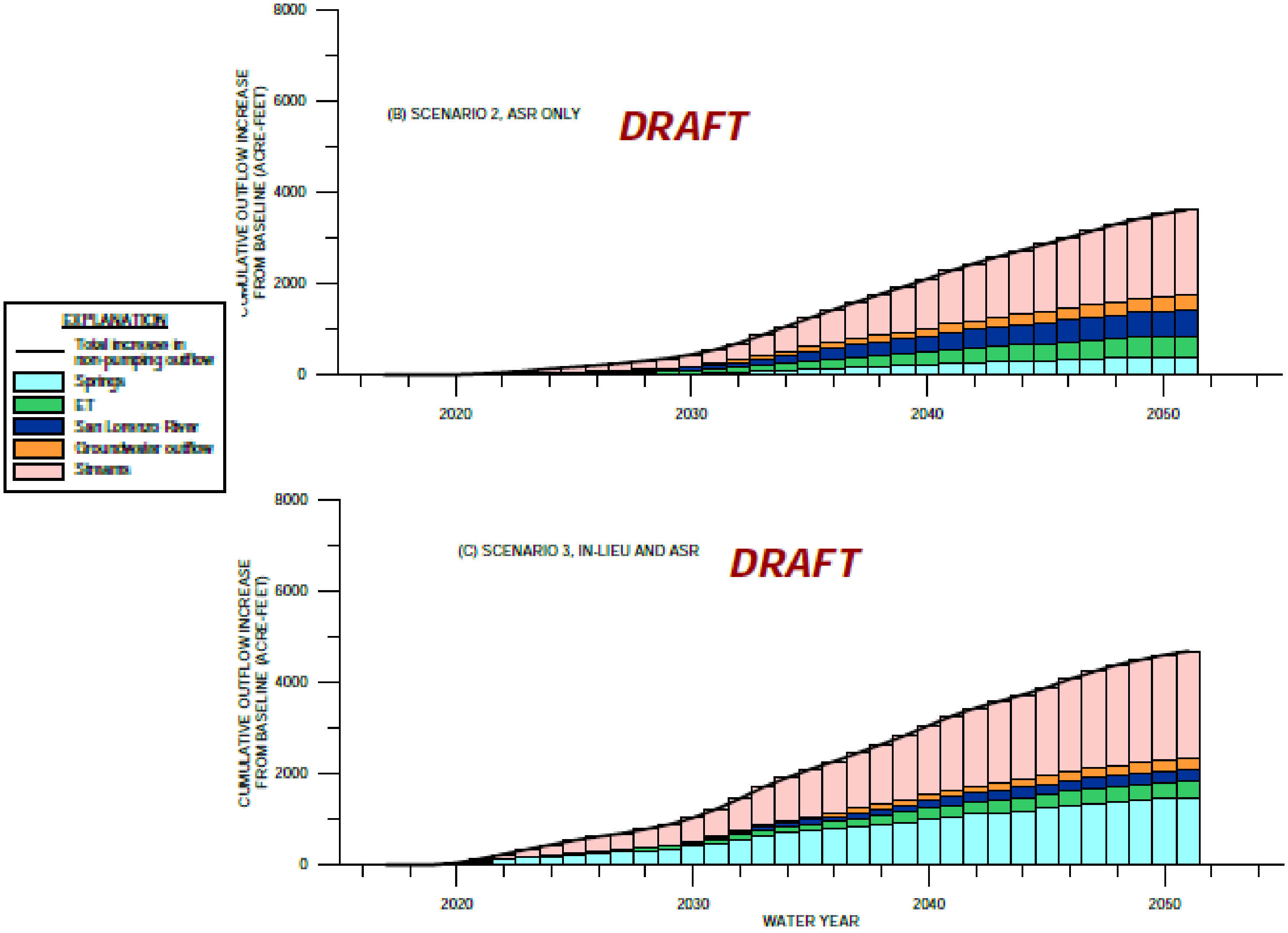




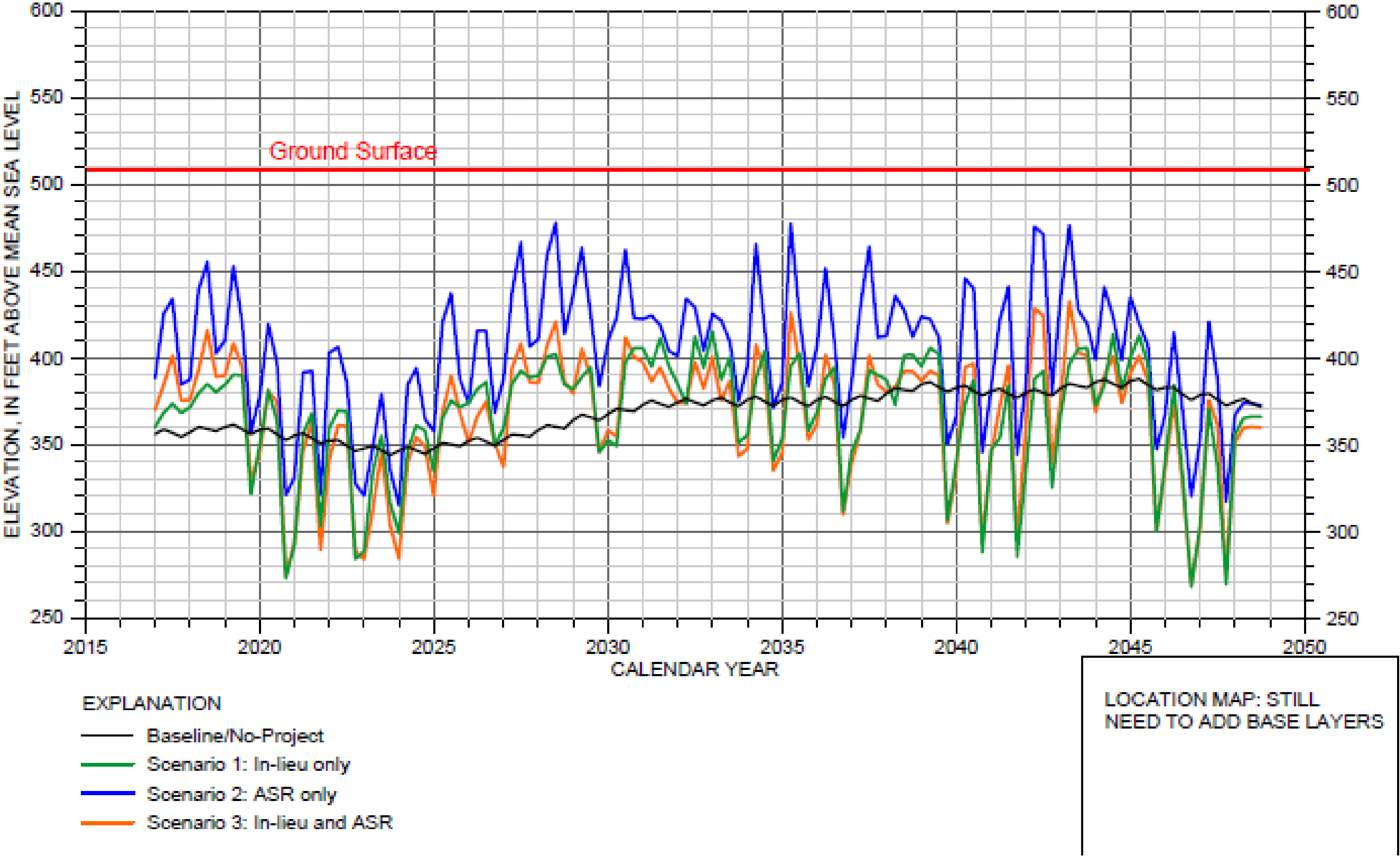
Preliminary GW Model Scenarios Results (Storage Losses)



Preliminary GW Model Scenarios Results (Storage Losses)

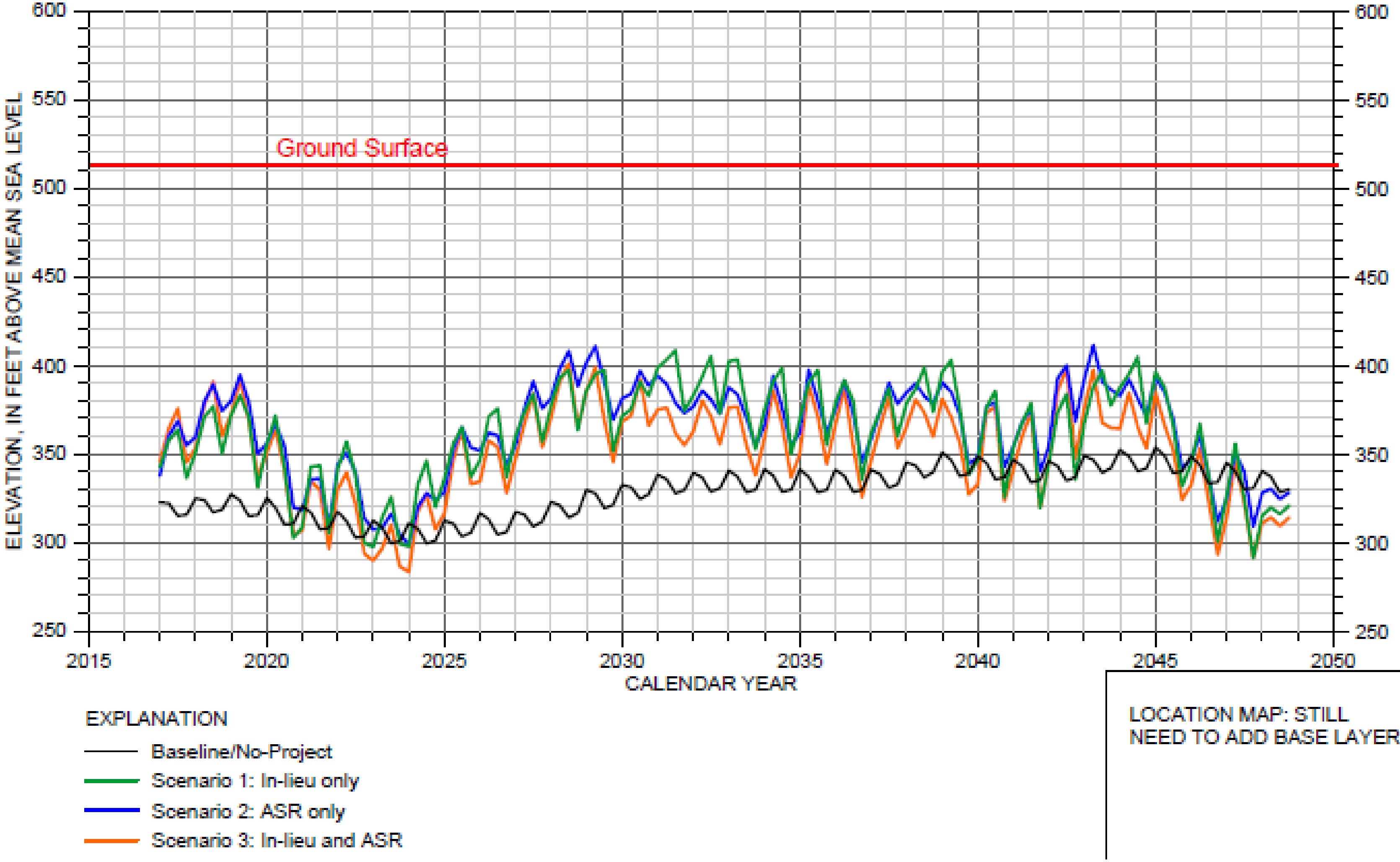


Preliminary GW Model Scenarios Results (Water Levels – SV-4)



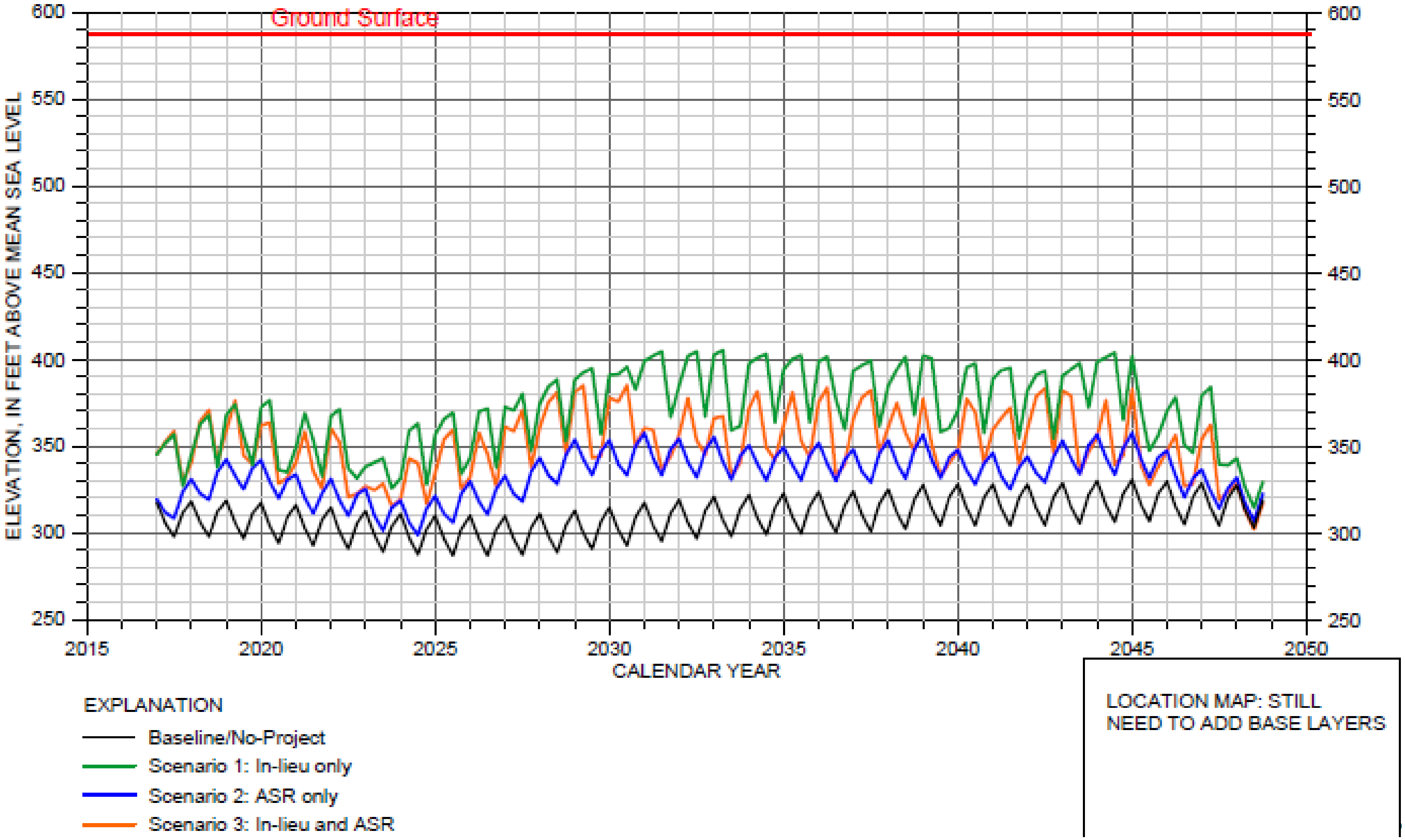
LOCATION MAP: STILL
NEED TO ADD BASE LAYERS

Preliminary GW Model Scenarios Results (Water Levels – SVWD 10A)

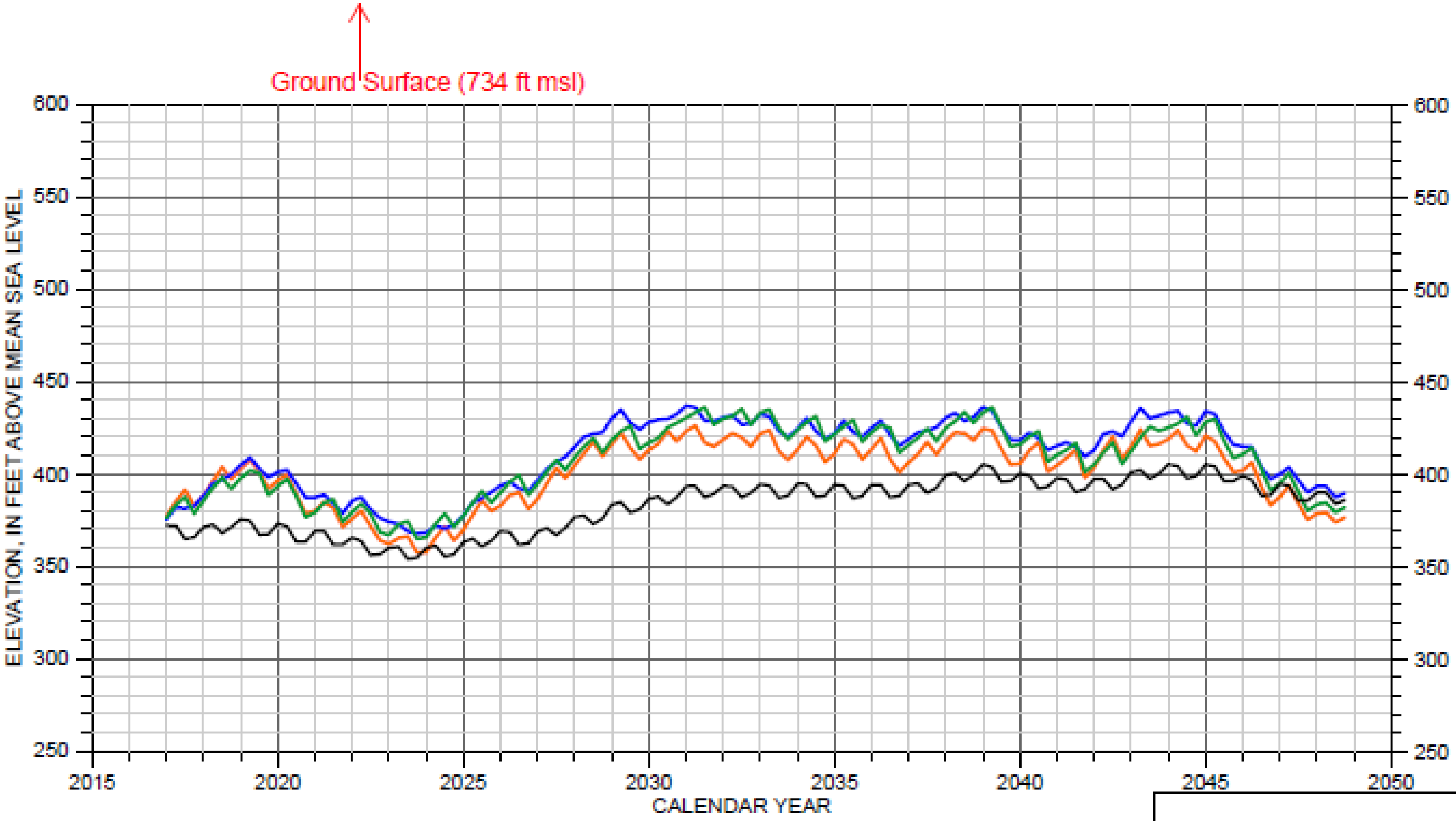


LOCATION MAP: STILL NEED TO ADD BASE LAYERS

Preliminary GW Model Scenarios Results (Water Levels – SVWD 11B)



Preliminary GW Model Scenarios Results (Water Levels – SLVWD Pasatiempo 7)



EXPLANATION

- Baseline/No-Project
- Scenario 1: In-lieu only
- Scenario 2: ASR only
- Scenario 3: In-lieu and ASR

LOCATION MAP: STILL
NEED TO ADD BASE LAYERS

Preliminary GW Model Scenarios Summary of Key Findings (tentative)

1. Storage capacity range of ~ 4000 – 5000 af (1.3 – 1.6 bg)
   - About 50% of needed 2.4 bg
   - WSAC Recon-Study estimated ~5,400 af / 1.8 bg
2. Hydraulic losses at peak storage volume range between ~20% - 40%
   - ASR Only ~20%
   - In-Lieu plus ASR (~30% losses)
   - In-Lieu Only (~40% losses)
   - WSAC Assumed 20% - 40%
3. Most of the storage losses are to creeks, streams and springs
   - Increased surface water flows – potential environmental benefits

Preliminary GW Model Scenarios Key Findings (tentative – con't)

4. Impacts to other District's wells overall net positive
   - Limited negative impacts to some wells at peak recovery
5. Per-well injection rates in range of ~0.2 – 0.4 mgd
   - WSAC Recon-Study estimated 0.5 mgd avg
   - T1.2 Site-Specific Injection Capacity Analysis indicated 0.3 mgd avg.

GW Model Scenarios
Potential Simulation Iterations

1. Manage Recharge to Maintain TSV
   - Once TSV is achieved, recharge only enough to keep “topped off”
2. Redistributed / Additional In-Lieu Recovery Wells
   - Add recovery wells to Tsm and/or Tlo aquifers
   - Reduce losses via more efficient capture of recharge
3. Hanson Quarry ASR Only
   - Simulate 6 – 12 ASR wells
   - Evaluate capacity of injection/storage/recovery
4. Others?

ASR Performance Measures

Phase 1

Task	Potential Performance Measures	Findings To Date
1.1 - Existing Wells Screening	Suitable Existing Wells for Pilot Testing in Target Aquifers do not exist	**Satisfied**
1.2 - Site-Specific Injection Capacity Analysis	Results show that avg. Injection Capacity of 250 gpm (+/- 10%) is unrealistic	**Satisfied**
1.3 - Geochemical Interaction Modeling	Results show that undesirable geochemical interactions are likely	**Satisfied**
1.5 - Groundwater Modeling	Results show that target aquifers cannot sustain needed injection or recovery rates or unacceptable hydraulic losses occur	**Pending (initial results favorable)**

Summary and Next Steps

- Phase 1 Investigation essentially on schedule and budget to date (GW modeling currently delayed by 1-2 months)
- The following tasks have been substantially completed:
  - T1.1 – Existing Well Screening
  - T1.2 – Site Specific Injection Capacity Analysis
  - T1.3 – Geochemical Interaction Analysis
  - T1.5.1 – Well Siting Study
- **No Fatal Flaws** have emerged thus far
- Preliminary GW modeling results for SMGB appear favorable and generally consistent with WSAC assumptions
- **NEXT STEPS** - Pending Phase 1 tasks include:
  - T1.4 – Development of Phase 2 ASR Pilot Test Work Plans
  - T1.5.2 – Complete Groundwater Modeling
  - ➢ **Make "GO, NO-GO" Decision to Proceed with Phase 2**

Questions / Discussion