TECHNICAL MEMORANDUM

DATE: December 19, 2025 **PROJECT #:** 9100

TO: Dwight Smith, McGinley & Associates, on behalf of the Salinas Valley Water Coalition (SVWC)
Bob Abrams, Aquilogic, on behalf of the Salinas Basin Water Alliance (SBWA)

CC: Piret Harmon and Emily Gardner, Salinas Valley Basin Groundwater Sustainability Agency (SVBGSA)
Amy Woodrow, Monterey County Water Resources Agency (MCWRA)

FROM: Hanni Blair; Kayla Bicknell, Abby Ostovar, Ph.D.; Staffan Schorr; and Derrik Williams, P.G., C.Hg.

PROJECT: Computer Modeling Agreement

SUBJECT: Results of Computer Modeling Agreement for the Salinas Valley Water Coalition (SVWC) and the Salinas Basin Water Alliance (SBWA)

INTRODUCTION

The Salinas Valley Water Coalition (SVWC) and Salinas Basin Water Alliance (SBWA) jointly requested that the Salinas Valley Basin Groundwater Sustainability Agency (SVBGSA) complete groundwater model runs that would enable them to conduct a superposition analysis of pumping effects on intersubbasin flow. At the time of the request, the Salinas Valley Integrated Hydrologic Model (SVIHM) was provisional and under development by the U.S. Geological Survey (USGS). Montgomery & Associates (M&A) had permission to run the model through the SVBGSA Cooperation Agreement with the USGS. Although USGS published the SVIHM in April 2025, SBWA and SVWC decided to continue to have M&A run the modeling simulations with the published version.

SVBGSA, SVWC, and SBWA developed the Computer Modeling Agreement, under which the modeling was completed. Aquilogic, Inc. (Aquilogic)—on behalf of SBWA—and McGinley & Associates (now UES)—on behalf of SVWC—detailed the requested modeling in a memorandum to SVBGSA, *Assessment of Groundwater Flows between Subbasins of the Salinas Valley Groundwater Basin (SVGB)*, dated June 21, 2022.

On behalf of SVBGSA, Montgomery & Associates (M&A) completed the modeling simulations. Working closely with Aquilogic and McGinley & Associates, Phase I of this project consisted of developing the modeling approach, which is outlined in the *Summary of Modeling Approach Technical Memorandum* (Approach TM) dated June 16, 2023. Phase II consisted of running the simulations and summarizing the results in this memorandum. After an executive summary of the results, the memorandum briefly describing the SVIHM and relevant changes made to conduct the simulations, documents the modeling approach, and presents the requested results for each set of simulations. Aquilogic and McGinley & Associates are responsible for interpreting the significance of the results; however, the summary section includes notes and cautions to guide that interpretation.

SUMMARY OF RESULTS

M&A completed the 10 model simulations according to the approaches defined by Aquilogic and McGinley & Associates in their June 21, 2022 memorandum. The first approach used the existing historical model simulation as the baseline condition and then turned off pumping in each of the Upper Valley Aquifer (Upper Valley), Forebay Aquifer (Forebay), Eastside Aquifer (Eastside), and 180/400-Foot Aquifer (180/400) Subbasins in 4 separate model simulations. The second approach was to develop a no-pumping baseline condition simulation for the Valley and then turn pumping on for the same 4 subbasins, each in a separate model simulation. Including the baseline simulations, each approach consisted of 5 model simulations for a total of 10 simulations. This memorandum relays the results requested by Aquilogic and McGinley & Associates, which provide the basis for Aquilogic and McGinley & Associates to complete a superposition analysis of intersubbasin subsurface flow.

For clarity, the results are separated into sections for each group of model simulations:

Pumping Turned Off by Subbasin	**Pumping Turned On by Subbasin**
Compared to the historical SVIHM baseline, pumping is turned off one subbasin at a time	*Compared to a no-pumping baseline scenario, pumping is turned on by one subbasin at a time*
Upper Valley Off	Upper Valley On
Forebay Off	Forebay On
180/400 Off	180/400 On
Eastside Off	Eastside On

All model simulations were completed with the published version of the SVIHM. Reservoir releases are specified according to historical releases and do not change based on basin conditions. The Langley, Monterey, and Seaside Subbasins are not well calibrated in this model version. While all subbasins and boundary segments are included in the results, these simulations focus on the 4 agricultural subbasins in the Salinas Valley.

Table 1 summarizes the net subsurface flows between the 4 agricultural subbasins for all simulations for the historical period of 1980 to 2022. In addition, it shows the difference between each simulation and either the pumping baseline or no pumping baseline. Simulations are listed in the rows, and each column corresponds with a subbasin boundary segment. Columns are also included for the subsurface flow across the coastal boundary from the Monterey Bay. This is not indicative of the advancement of seawater intrusion, as measured by the 500 mg/L chloride isocontour, as the SVIHM does not simulate chloride movement.

Figures showing the groundwater level difference for each simulation compared to the corresponding baseline are included in the results sections of this memorandum for the historical period of 1980 to 2022. Attachments 1 and 2 also include figures for the recent period of 2018 to 2022. Figures in the attachments include average groundwater level differences for the summer, winter, and entire year. Attachment 1 shows figures zoomed in to the subbasin where pumping is turned on or off, and Attachment 2 shows the same set of figures for the entire Valley.

Groundwater typically flows from the Upper Valley Subbasin to the Forebay Subbasin and then to the 180/400 and Eastside Subbasins. In the first set of simulations, when pumping is turned off in a subbasin, groundwater levels are higher there than in the baseline. This decreases the groundwater gradient from the up-valley subbasin, which reduces inflow from the up-valley subbasin to the subbasin where pumping was turned off. It also increases the gradient with the down-valley subbasin, which increases outflow to other subbasins from the subbasin where pumping was turned off. Conversely, in the second set of simulations, when pumping is turned on in a subbasin, groundwater levels are lower there than in the no-pumping baseline. This increases the gradient from the up-valley subbasin, which increases inflow into the subbasin where pumping was turned on. It also decreases the gradient to the down-valley subbasin, which reduces outflow from the subbasin where pumping was turned off. In general, the largest magnitude flow differences from baseline occur between subbasins immediately adjacent to the subbasin where pumping is turned on or off.

In the pumping on baseline, groundwater flows from the 180/400 Subbasin into the Eastside Subbasin. When pumping is turned off in the 180/400 Subbasin, 180/400 Subbasin groundwater levels are higher than in the baseline, the groundwater gradient with the Eastside Subbasin increases, and the subsurface flow to the Eastside Subbasin increases. When the Eastside Subbasin pumping is turned off, Eastside Subbasin groundwater levels rise enough above the baseline to reverse the groundwater gradient so that the net subsurface flow is from the Eastside to 180/400 Subbasin. In the no pumping baseline, groundwater flows from the Eastside to the 180/400 Subbasin. When pumping is turned on in the 180/400 Subbasin, its groundwater levels are lower than in the baseline, the groundwater gradient from the Eastside Subbasin becomes steeper, and the inflow from the Eastside Subbasin into the 180/400 Subbasin is greater than in the baseline. When pumping is turned on in the Eastside Subbasin, groundwater levels in the

Eastside Subbasin are lower than in the baseline, the groundwater gradient reverses relative to the no pumping baseline, and groundwater flows from the 180/400 Subbasin into the Eastside Subbasin.

The simulations that show the greatest magnitude of difference in intersubbasin groundwater flow is when pumping in either the 180/400 or Eastside Subbasin is turned on or off; the subsurface flow that changes the most is between those 2 subbasins. Pumping affects the groundwater levels the most in the subbasin where pumping is turned off or on, and then other subbasins to a lesser extent. Pumping changes in the 180/400 and Eastside Subbasins appear to result in the greatest impact on groundwater levels to the adjacent subbasin.

Net subsurface flow across the 180/400 Subbasin coastal boundary changes the most with the 180/400 Subbasin pumping off scenario. In the pumping on scenarios, turning pumping on in either the 180/400 or Eastside Subbasin affect subsurface flow across the coastal boundary to approximately the same magnitude.

MONTGOMERY & ASSOCIATES

Table 1. Summary of Net Subsurface Flow and Differences from Baseline

Simulation	Net Subbasin Subsurface Flows[3]					Net Difference from Baseline[4]				
	Upper Valley to Forebay	Forebay to Eastside	Forebay to 180/400	180/400 to Eastside	Net Flow from Monterey Bay to 180/400[5]	Upper Valley to Forebay	Forebay to Eastside	Forebay to 180/400	180/400 to Eastside	Net Flow from Monterey Bay to 180/400[5]
Pumping Baseline	5,000	6,400	8,400	27,300	8,600	--	--	--	--	--
Upper Valley Pumping Off[1]	10,100	6,412	8,400	28,900	8,200	5,000	0	0	1,600	-400
Forebay Pumping Off[1]	922	8,400	10,300	28,600	8,200	-4,200	2,000	1,900	1,300	-400
180/400 Pumping Off[1]	5,000	5,300	5,800	52,300	500	-100	-1,100	-2,700	25,000	-8,000
Eastside Pumping Off[1]	5,000	3,800	6,800	-8,500	6,600	-100	-2,600	-1,600	-35,800	-2,000
No Pumping Baseline	4,500	1,800	5,100	-22,000	-4,500	--	--	--	--	--
Upper Valley Pumping On[2]	1,100	1,800	5,400	-22,100	-4,400	-3,400	0	-100	-100	-500
Forebay Pumping On[2]	9,300	100	3,900	-21,400	-4,400	4,800	-1,800	-1,600	500	-700
180/400 Pumping On[2]	4,500	2,500	6,800	-36,700	0	0	700	1,300	-14,700	-6,000
Eastside Pumping On[2]	4,500	4,300	6,600	16,900	-3,500	0	2,400	1,100	38,900	-5,900

Notes:
[1] Pumping in all other subbasins
[2] No pumping in all other subbasins
[3] Positive value indicates net positive flow; Negative value indicates net negative flow (e.g., net flow is in the opposite direction as listed)
[4] Positive value indicates value is greater than baseline flow; Negative value indicates value is less than baseline flow
[5] Positive value indicates net inflow from Monterey Bay into 180/400 Subbasin across coastal boundary. Negative value indicates net outflow from 180/400 Subbasin into Monterey Bay across coastal boundary. Values are not indicative of the advancement of seawater intrusion, as measured by the 500 mg/L chloride isocontour, as this model does not simulate chloride.

Table 2 summarizes the annual average Salinas River surface water flow at the Chualar stream gage for each simulation, as well as the difference from the pumping or no-pumping baseline simulation. It shows that in both the pumping off and pumping on sets of simulations, the pumping changes in Forebay Subbasin have the greatest effect on Salinas River surface water flow, followed closely by the Upper Valley Subbasin. The 180/400 Subbasin has greater effect than the Eastside Subbasin on Salinas River surface water flows because the Salinas River does not flow through the subbasin.

Table 2. Summary of Surface Water Flows

Baseline Pumping Status	Simulation	Chualar Gage Annual Flow (AF/yr)	Chualar Gage Change in Annual Flow (AF/yr)
Pumping On	Simulated Flow with all Historical Pumping	244,400.00	-
	Simulated Flow with Upper Valley Pumping Off[1]	277,600.00	33,200.00
	Simulated Flow with Forebay Pumping Off[1]	282,600.00	38,200.00
	Simulated Flow with 180/400 Pumping Off[1]	254,000.00	9,600.00
	Simulated Flow with Eastside Pumping Off[1]	248,800.00	4,400.00
Pumping Off	Simulated Flow with all Historical Pumping	376,800.00	-
	Simulated Flow with Upper Valley Pumping On[2]	336,700.00	-40,100
	Simulated Flow with Forebay Pumping On[2]	333,000.00	-43,700
	Simulated Flow with 180/400 Pumping On[2]	366,800.00	-10,000
	Simulated Flow with Eastside Pumping On[2]	370,700.00	-6,000

Notes:
1 Pumping in all other subbasins
2 No pumping in other subbasins

Figure 1 provides a visual representation of the difference between the baseline simulations for both surface water and groundwater. The river flow at the Soledad gage is included as a proxy for the Upper Valley to Forebay surface water flows, and the river flow at the Chualar gage is used as a proxy for Forebay to 180/400 flows, although neither is located exactly on the subbasin boundary. This shows that turning pumping on in any of the 4 subbasins have approximately the same magnitude of effect in the opposite direction as turning pumping off in the same subbasin, although exact values vary. When the Upper Valley or Forebay pumping is turned on or off, surface water is affected to a greater extent than groundwater flows. Turning pumping on or off in the 180/400 Subbasin affects both surface water and groundwater flows. Turning off pumping in the Eastside affects primarily groundwater flows.

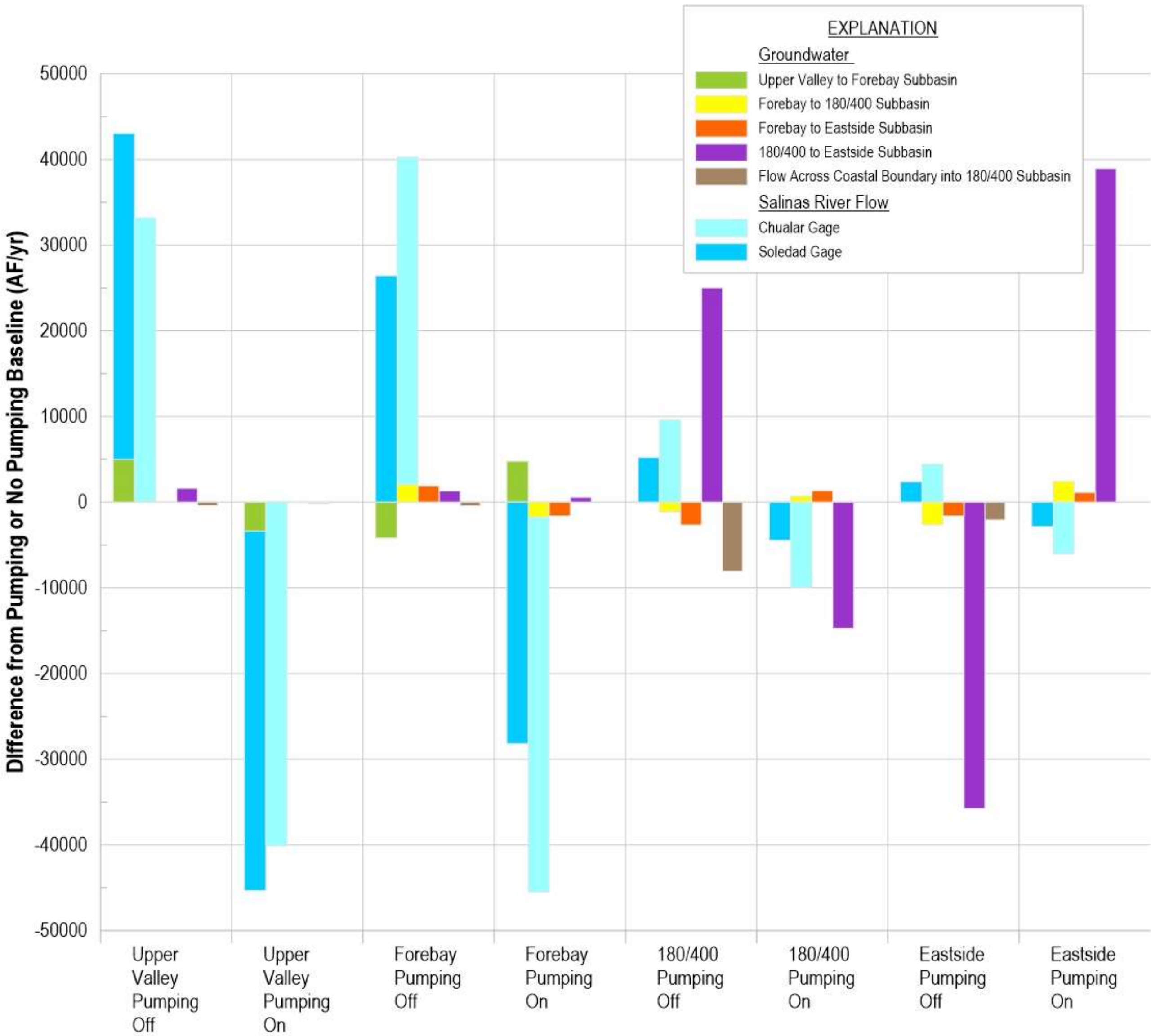


Figure 1. Summary of Salinas River Surface Water and Groundwater Flows Between Subbasin

GROUNDWATER FLOW MODEL

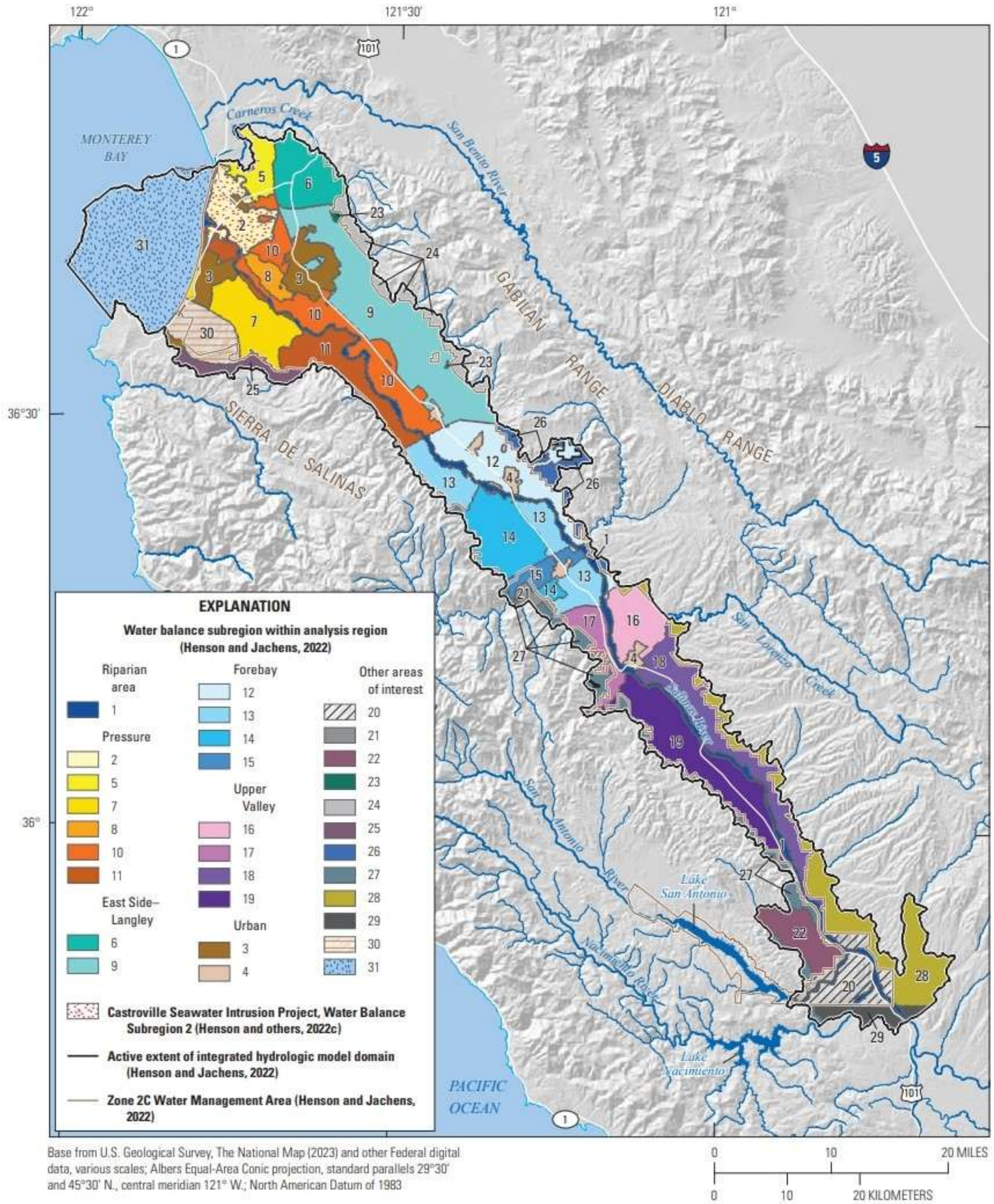
The SVIHM is a numerical groundwater flow model developed to simulate groundwater and surface water conditions in the Salinas Valley under historical conditions. It is part of a larger suite of models that includes a geologic model and a watershed model. The SVIHM is built using the most recent version of the USGS MODFLOW One Water Hydrologic Flow Model (OWHM) code.

MONTGOMERY & ASSOCIATES

The SVIHM has 9 layers representing principal aquifers and aquitards in the Salinas Valley. The Farm Process in the SVIHM—which is unique to MODFLOW OWHM—estimates demand-based agricultural pumping. Municipal, industrial, and domestic pumping are specified based on historical records and estimates. Reclaimed water supply, diversions to the Castroville Seawater Improvement Project (CSIP) from the Salinas River Diversion Facility, and surface water flows including releases from the Nacimiento and San Antonio Dams, are specified based on historical records. Runoff, agricultural return flows, and recharge are simulated flows that vary in time and space in the SVIHM in response to climate, land use, and groundwater elevations. Further description of the SVIHM can be found in the USGS model summary report by Henson and others (2025 [pre-print]).

The USGS made a few notable changes in the final version of the SVIHM, as compared to the version reviewed when developing the modeling approach for this project:

1. **Temporal Update:** The final SVIHM was updated to run from 1967 to 2022.
2. **Flooding of Layer 1:** The USGS added a layer of drain cells across layer 1 to address simulated water levels above the ground surface (flooding). With the addition of drains, any groundwater flow into model cells that would increase the head above the top elevation of the cell is routed to nearby streamflow. This computer modeling task was previously paused in 2024 due to observed simulated flooding of layer 1, for which the USGS added the drain later in 2024 as a preventative measure.
3. **Water Balance Subregion (WBS) Adjustment:** The SVIHM is divided into WBSs, or farms, as shown on Figure 2, which is reproduced from the USGS model report (Henson and others, 2025 [pre-print]). The agricultural water demand and supply are calculated by the SVIHM at the WBS level. When the approach to this project was developed, the WBS boundaries specified in the SVIHM did not correspond with Bulletin 118 subbasin boundaries used for groundwater sustainability plans (GSPs), and they were not necessarily contiguous. In the final version of the SVIHM, the USGS adjusted those boundaries to align better with the subbasin boundaries.



(reproduced from Henson and others, 2025 [pre-print])

Figure 2. Water Balance Subregion Grouping for Results

MODELING APPROACH

The proposed superposition analysis requires that groundwater pumping be removed from or turned off in individual subbasins in the SVIHM, or be turned on again after being turned off for the no-pumping baseline. Wells were turned off by subbasin through the following methods:

- **Urban wells,** which have specified pumping rates (municipal, industrial, and domestic wells), were turned off by specifying a rate of zero for the affected wells in the MNW package input files.

- **Agricultural wells** have pumping rates calculated internally in the SVIHM Farm Process according to land use and crop demand. Groundwater pumping was eliminated as a potential source of water that the model can use to meet demand. Wells were "turned off" by setting the maximum pumping rate of the wells located within the subbasin of interest to zero in the farm package input files. Historical surface water deliveries continue for irrigation. Without additional water sources, demand was partially met (deficit irrigation). Land use demand remained unchanged. This approach, selected by the SBWA and SVWC hydrologists, also eliminated any recharge from return flow of excess agricultural irrigation sourced from groundwater since there was no groundwater supplied for irrigation.

CSIP deliveries are determined based on demand in the CSIP area: first, the model attempts to meet CSIP crop demand using natural sources (precipitation and groundwater root uptake); second, it uses prescribed non-routed delivery of recycled water; third, it attempts to divert surface water at the SRDF; and finally, it pumps groundwater to make up any demand shortfall. At Clark Colony, it follows the same progression without recycled water. The model simulates the historical diversion amounts as a specified diversion from the main channel (Salinas River for CSIP and Arroyo Secco for Clark Colony). The specified diversion goes into a side channel from which the associated farm (water balance subregion) is allowed to draw to meet its demand. In the public release version of the SVIHM from the USGS, any diverted water that is not used by the farm is returned to the main channel. This allows the farm to use up to the historical diversion but does not guarantee that the historical diversion will be completely removed from the system.

For the stream diversions to be consistent between the model runs, a change was implemented to the stream flow routing package to disconnect the return of the diversion side channels from the main channel. With this change, the historical diversion amount is always diverted from the main channel and if there is any unused portion it disappears from the model domain. Without groundwater as a water supply, irrigation decreases and deficit irrigation results in reduced evapotranspiration from crops. The other anticipated impacts on the water budget from this approach are reduced return flows and reduced deep percolation from farms.

This memorandum provides model simulation outputs according to the Summary of Modeling Approach Technical Memorandum. In addition, M&A shared the raw output files with the SBWA and SVWC hydrologists. These include the model input files (discretization data), the groundwater elevation difference outputs compared to the baseline model, groundwater cell-by-cell flow budget files, and modeled Salinas River flow output.

MODEL RESULTS FOR TURNING OFF PUMPING BY SUBBASIN

For this set of simulations, M&A used the historical model with the stream diversion modifications noted above as the pumping baseline. Pumping was turned off for each of the Upper Valley, Forebay, Eastside, and 180/400 Subbasins in 4 separate model simulations. The results for the individual subbasin "off" simulations are compared to the pumping baseline simulation. This section focuses on the first set and organizes results by the key outputs.

Groundwater Level Changes

Groundwater level change is calculated as the difference between the pumping baseline simulation and each subbasin pumping off scenario. The difference is averaged over 2 periods: 1980-2022 for the historical period and 2018-2022 for the recent period. Dry cells were excluded from the calculation. The average difference was calculated for the water table, 180-Foot Aquifer or equivalent (model layer 3), and the 400-Foot Aquifer or equivalent (model layer 5). In the Upper Valley, only the results for the water table are presented because the aquifer is unconfined and model layers 3 and 5 pinch out near the Forebay and Upper Valley border. Note that the water table crosses multiple layers, especially near the valley margins, and is represented as the simulated groundwater elevation in the topmost partially saturated cell. The FloPy python water table function was used to calculate the water table elevation. These average water level differences are presented spatially as color-flooded maps.

Figure 3 through Figure 6 show examples of groundwater level change differences between the pumping baseline and pumping off scenarios for key aquifers in each subbasin for the historical period. Each figure is focused on the subbasin of the adjustments; figures with groundwater level changes across the entire Valley are included in Attachment 2.

Maps were also prepared to represent average groundwater level changes over time for either the wet (December to March) or dry (June to August) season. The water level difference between the pumping baseline and each scenario was calculated for only the months defined in the wet or dry season. It was then averaged across the same 2 periods mentioned above.

![Montgomery & Associates logo]

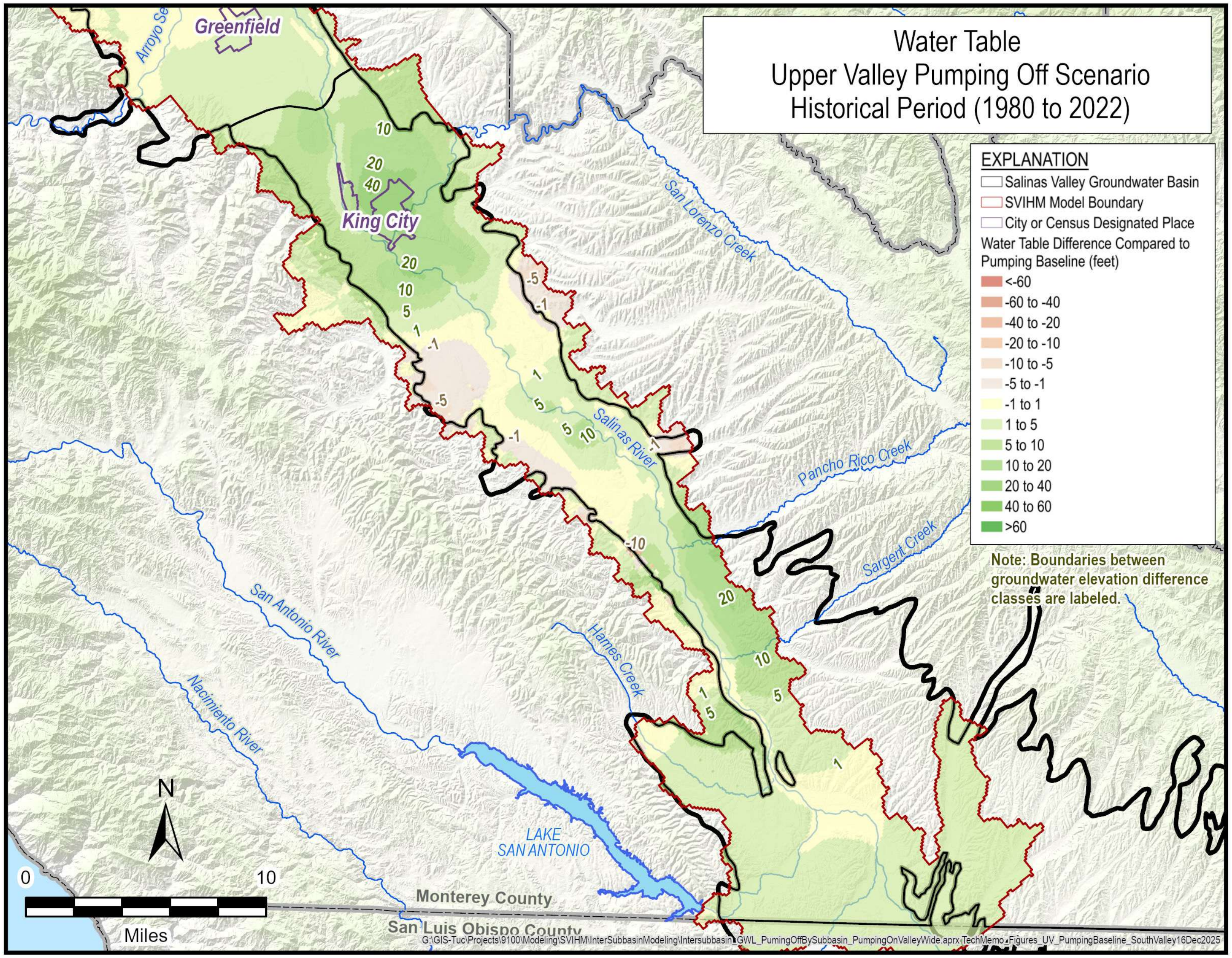


Figure 3. Upper Valley Pumping Off Scenario Compared to Pumping Baseline – Average Groundwater Level Difference for 1980-2022 Focused on Upper Valley Subbasin for the Water Table

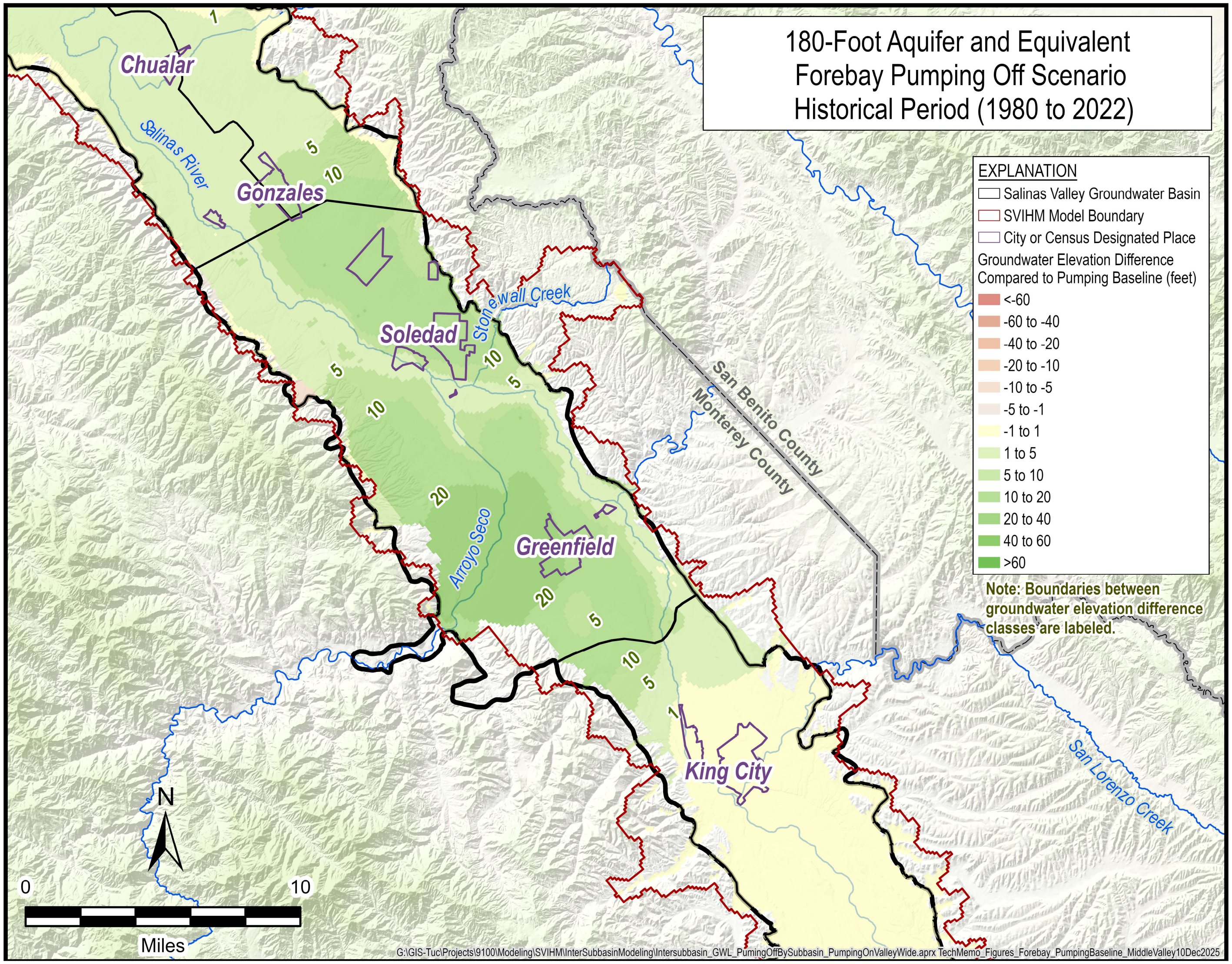


Figure 4. Forebay Pumping Off Scenario Compared to Pumping Baseline – Average Groundwater Level Difference for 1980-2022 Focused on Forebay Subbasin for the 180-Foot Aquifer and Equivalent

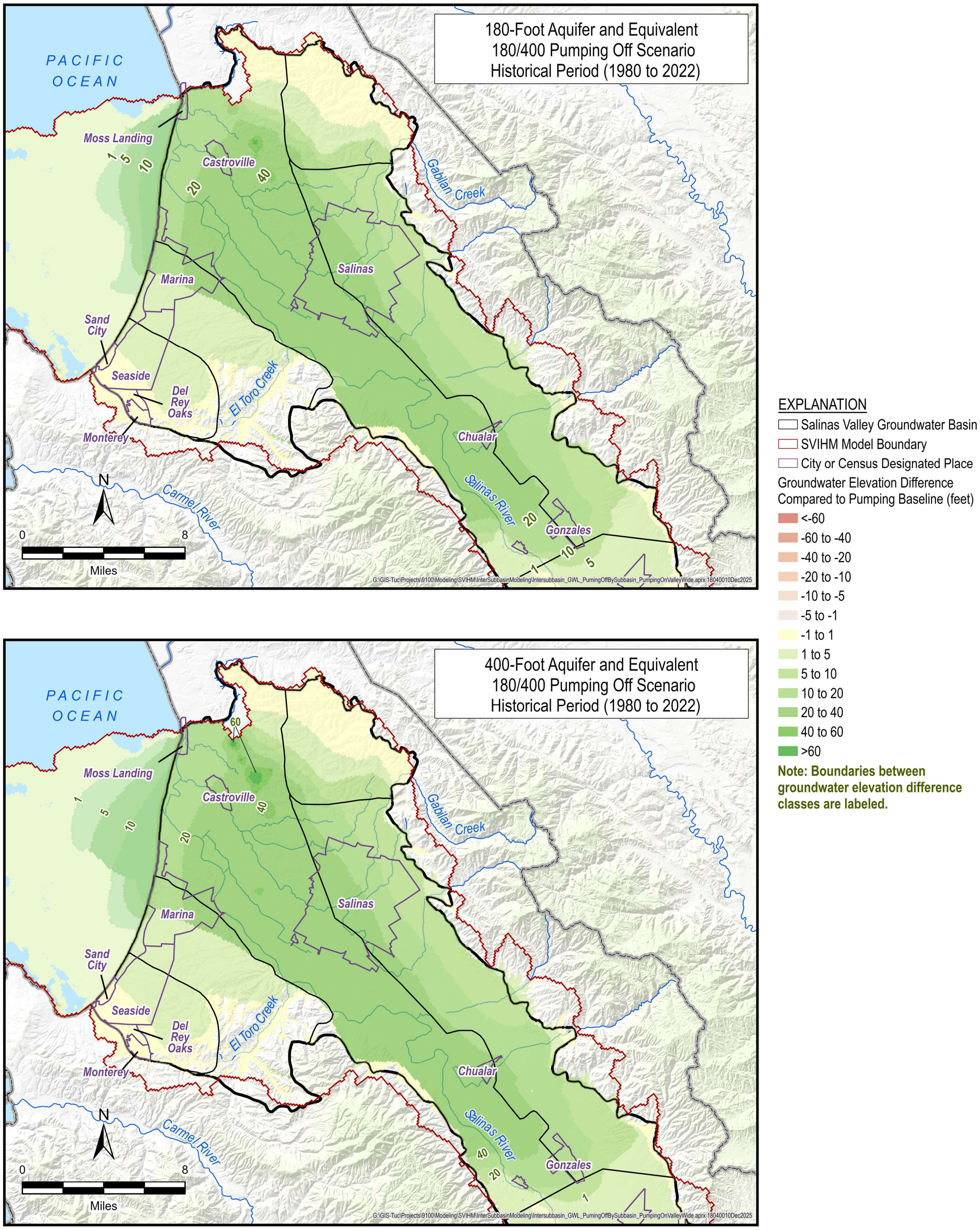
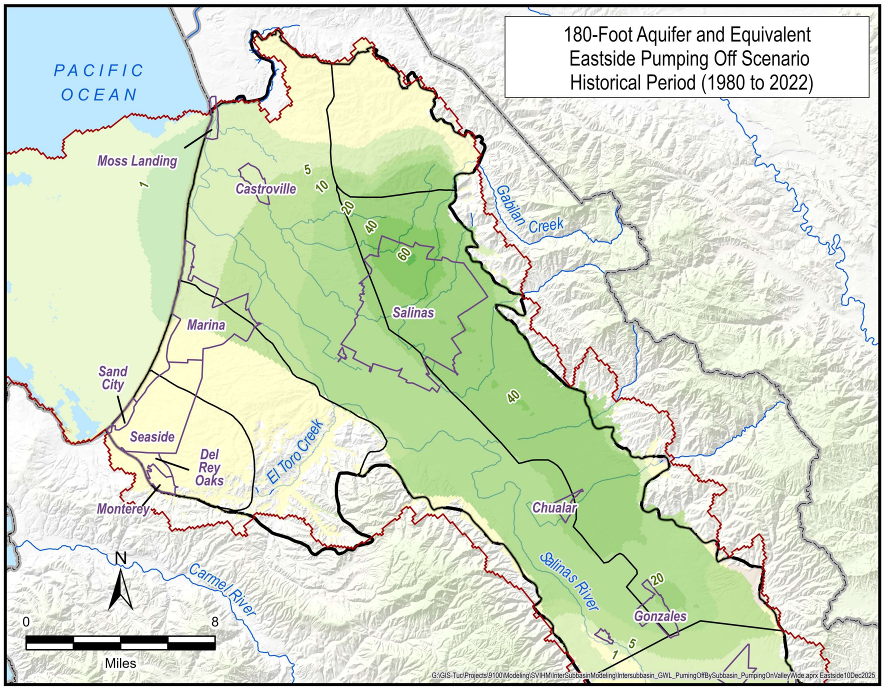
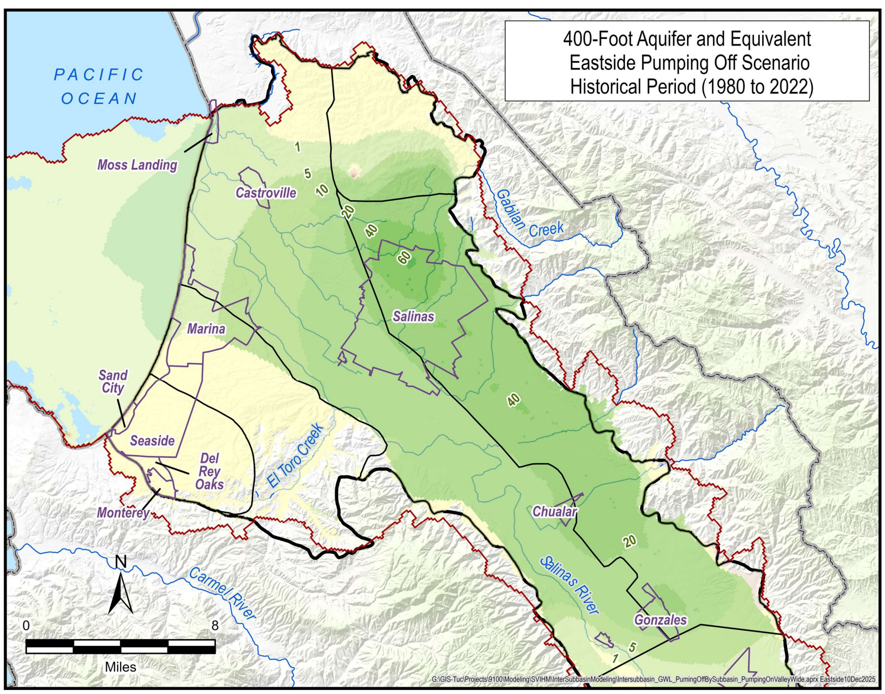


Figure 5. 180/400 Pumping Off Scenario Compared to Pumping Baseline - Average Groundwater Level Difference for 1980-2022
Focused on North Valley for the 180-Foot Aquifer, 400-Foot Aquifers, and Equivalents





EXPLANATION

- Salinas Valley Groundwater Basin
- SVIHM Model Boundary
- City or Census Designated Place

Groundwater Elevation Difference Compared to Pumping Baseline (feet)

- <-60
- -60 to -40
- -40 to -20
- -20 to -10
- -10 to -5
- -5 to -1
- -1 to 1
- 1 to 5
- 5 to 10
- 10 to 20
- 20 to 40
- 40 to 60
- >60

Note: Boundaries between groundwater elevation difference classes are labeled.

Figure 6. Eastside Pumping Off Scenario Compared to Pumping Baseline -
Average Groundwater Level Difference for 1980-2022
Focused on North Valley for the 180-Foot Aquifer, 400-Foot Aquifers, and Equivalents

Intersubbasin Subsurface Flows

Annual subsurface flows between each subbasin are averaged over the historical period (1980-2022). Results for the pumping baseline are presented in Table 3. Results for each model scenario and the difference between the scenarios and baseline are presented in Table 4 through Table 7. In addition, annual intersubbasin subsurface flows will be provided to the hydrologists as part of model outputs.

Table 3. Annual Intersubbasin Subsurface Flows Pumping Baseline

	NET FLOW[1]						
	PUMPING BASELINE						
PUMPING BASELINE	Upper Valley	Forebay	180/400	Eastside	Langley	Monterey	Seaside
From Upper Valley to	0	5,071	0	0	0	0	0
From Forebay to	-5,071	0	8,431	6,385	0	0	0
From 180/400 to	0	-8,431	0	27,292	-449	2,270	0
From Eastside to	0	-6,385	-27,292	0	-4,489	0	0
From Langley to	0	0	449	4,489	0	0	0
From Monterey to	0	0	-2,270	0	0	0	290
From Pajaro Valley to	0	0	-229	0	-360	0	0
From Paso Robles to	-93	0	0	0	0	0	0

[1] Positive value indicates positive net flow from the subbasin in the rows to the subbasin in the columns; negative value indicates negative net flow.

Table 4. Annual Intersubbasin Subsurface Flows – Upper Valley Pumping Off Scenario

	NET FLOW[1]						NET FLOW DIFFERENCE FROM PUMPING BASELINE[2]					
	UPPER VALLEY OFF						UPPER VALLEY OFF					
UPPER VALLEY OFF	**Upper Valley**	**Forebay**	**180/400**	**Eastside**	**Langley**	**Monterey**	**Upper Valley**	**Forebay**	**180/400**	**Eastside**	**Langley**	**Monterey**
From Upper Valley to	0	10,050	0	0	0	0	0	4,979	0	0	0	0
From Forebay to	-10,050	0	8,434	6,412	0	0	-4,979	0	3	26	0	0
From 180/400 to	0	-8,434	0	28,890	-444	2,918	0	-3	0	1,598	6	648
From Eastside to	0	-6,412	-28,890	0	-4,479	0	0	-26	-1,598	0	10	0
From Langley to	0	0	444	4,479	0	0	0	0	-6	-10	0	0
From Monterey to	0	0	-2,918	0	0	0	0	0	-648	0	0	0
From Pajaro Valley to	0	0	-241	0	-360	0	0	0	-11	0	0	0
From Paso Robles to	-152	0	0	0	0	0	-59	0	0	0	0	0

[1] Positive value (red) indicates positive net flow from the subbasin in the rows to the subbasin in the columns; negative value indicates negative net flow. Dark red indicates the greatest positive number in the specified simulation; dark blue indicates the greatest negative number.

[2] Positive value (red) indicates increase in net flow from the subbasin in the rows to the subbasin in the columns; negative value (blue) indicates decrease in net flow. Dark red indicates the greatest positive number in the specified simulation; dark blue indicates the greatest negative number.

Table 5. Annual Intersubbasin Subsurface Flows – Forebay Pumping Off Scenario

	NET FLOW[1]						NET FLOW DIFFERENCE FROM PUMPING BASELINE[2]					
	FOREBAY OFF						FOREBAY OFF					
FOREBAY OFF	Upper Valley	Forebay	180/400	Eastside	Langley	Monterey	Upper Valley	Forebay	180/400	Eastside	Langley	Monterey
From Upper Valley to	0	887	0	0	0	0	0	-4,185	0	0	0	0
From Forebay to	-887	0	10,339	8,407	0	0	4,185	0	1,908	2,022	0	0
From 180/400 to	0	-10,339	0	28,588	-443	2,991	0	-1,908	0	1,296	6	721
From Eastside to	0	-8,407	-28,588	0	-4,472	0	0	-2,022	-1,296	0	16	0
From Langley to	0	0	443	4,472	0	0	0	0	-6	-16	0	0
From Monterey to	0	0	-2,991	0	0	0	0	0	-721	0	0	0
From Pajaro Valley to	0	0	-245	0	-360	0	0	0	-16	0	0	0
From Paso Robles to	-105	0	0	0	0	0	-12	0	0	0	0	0

[1] Positive value (red) indicates positive net flow from the subbasin in the rows to the subbasin in the columns; negative value indicates negative net flow. Dark red indicates the greatest positive number in the specified simulation; dark blue indicates the greatest negative number.

[2] Positive value (red) indicates increase in net flow from the subbasin in the rows to the subbasin in the columns; negative value (blue) indicates decrease in net flow. Dark red indicates the greatest positive number in the specified simulation; dark blue indicates the greatest negative number.

Table 6. Annual Intersubbasin Subsurface Flows – 180/400 Pumping Off Scenario

	NET FLOW[1]						NET FLOW DIFFERENCE FROM PUMPING BASELINE[2]					
	180/400 OFF						180/400 OFF					
180/400 OFF	Upper Valley	Forebay	180/400	Eastside	Langley	Monterey	Upper Valley	Forebay	180/400	Eastside	Langley	Monterey
From Upper Valley to	0	5,005	0	0	0	0	0	-67	0	0	0	0
From Forebay to	-5,005	0	5,766	5,251	0	0	67	0	-2,665	-1,134	0	0
From 180/400 to	0	-5,766	0	52,324	-238	8,892	0	2,665	0	25,031	211	6,622
From Eastside to	0	-5,251	-52,324	0	-3,612	0	0	1,134	-25,031	0	876	0
From Langley to	0	0	238	3,612	0	0	0	0	-211	-876	0	0
From Monterey to	0	0	-8,892	0	0	0	0	0	-6,622	0	0	0
From Pajaro Valley to	0	0	-501	0	-363	0	0	0	-272	0	-3	0
From Paso Robles to	-97	0	0	0	0	0	-4	0	0	0	0	0

[1] Positive value (red) indicates positive net flow from the subbasin in the rows to the subbasin in the columns; negative value indicates negative net flow. Dark red indicates the greatest positive number in the specified simulation; dark blue indicates the greatest negative number.

[2] Positive value (red) indicates increase in net flow from the subbasin in the rows to the subbasin in the columns; negative value (blue) indicates decrease in net flow. Dark red indicates the greatest positive number in the specified simulation; dark blue indicates the greatest negative number.

Table 7. Annual Intersubbasin Subsurface Flows – Eastside Pumping Off Scenario

	NET FLOW[1]						NET FLOW DIFFERENCE FROM PUMPING BASELINE[2]					
	EASTSIDE OFF						EASTSIDE OFF					
EASTSIDE OFF	**Upper Valley**	**Forebay**	**180/400**	**Eastside**	**Langley**	**Monterey**	**Upper Valley**	**Forebay**	**180/400**	**Eastside**	**Langley**	**Monterey**
From Upper Valley to	0	5,013	0	0	0	0	0	-58	0	0	0	0
From Forebay to	-5,013	0	6,815	3,751	0	0	58	0	-1,616	-2,635	0	0
From 180/400 to	0	-6,815	0	-8,483	-658	4,279	0	1,616	0	-35,776	-208	2,009
From Eastside to	0	-3,751	8,483	0	-1,305	0	0	2,635	35,776	0	3,183	0
From Langley to	0	0	658	1,305	0	0	0	0	208	-3,183	0	0
From Monterey to	0	0	-4,279	0	0	0	0	0	-2,009	0	0	0
From Pajaro Valley to	0	0	-403	0	-364	0	0	0	-174	0	-4	0
From Paso Robles to	-95	0	0	0	0	0	-2	0	0	0	0	0

[1] Positive value (red) indicates positive net flow from the subbasin in the rows to the subbasin in the columns; negative value indicates negative net flow. Dark red indicates the greatest positive number in the specified simulation; dark blue indicates the greatest negative number.

[2] Positive value (red) indicates increase in net flow from the subbasin in the rows to the subbasin in the columns; negative value (blue) indicates decrease in net flow. Dark red indicates the greatest positive number in the specified simulation; dark blue indicates the greatest negative number.

Subsurface Outflow To and Inflow From Monterey Bay

Subsurface outflow to and inflow from Monterey Bay is averaged over the historical period in Table 8 for the pumping baseline and each pumping off scenario. In addition, the annual outflows and inflows are provided as part of model outputs.

Table 8. Net Average Annual Flows To/From Monterey Bay for WY 1980-2022 (AF/WY)

	Net Average Annual Flow		
Subbasin	**180/400**	**Monterey**	**Seaside**
Pumping Baseline	8,603	2,967	1,660
Upper Valley Pumping Off	8,221	2,682	1,629
Forebay Pumping Off	8,183	2,664	1,629
180/400 Pumping Off	456	-64	1,546
Eastside Pumping Off	6,555	2,139	1,633
	Difference Compared to Pumping Baseline		
	180/400	**Monterey**	**Seaside**
Upper Valley Pumping Off	-381	-285	-31
Forebay Pumping Off	-420	-303	-31
180/400 Pumping Off	-8,147	-3,031	-114
Eastside Pumping Off	-2,047	-828	-27

Note: Positive value indicates inflow into subbasin.

Simulated Salinas River Streamflow Changes

Changes in simulated Salinas River streamflow at Soledad (USGS gage 11151700), Chualar (USGS gage 11152300), and Spreckels (USGS gage 11152500) are summarized in Table 9. Results for each model simulation are presented for comparison between scenarios. In addition, Figure 7, Figure 8, and Figure 9 show the Salinas River flow over time at the Soledad, Chualar, and Spreckels gages, respectively, for each model run.

Table 9. Pumping Off Scenarios - Average Annual Salinas River Flow at the Soledad, Chualar, and Spreckels Gages

	Average Annual Flow (AF/yr)			Change in Average Annual Flow from Baseline to Model Run (AF/yr)		
	Soledad Gage	**Chualar Gage**	**Spreckels Gage**	**Soledad Gage**	**Chualar Gage**	**Spreckels Gage**
Pumping Baseline	264,850	244,388	246,536			
Upper Valley Off	302,883	277,554	282,461	38,033	33,166	35,904
Forebay Off	291,262	282,624	285,866	26,412	38,236	39,310
180/400 Off	270,062	254,028	266,920	5,212	9,640	20,364
Eastside Off	267,216	248,811	254,677	2,366	4,423	8,121

MONTGOMERY & ASSOCIATES

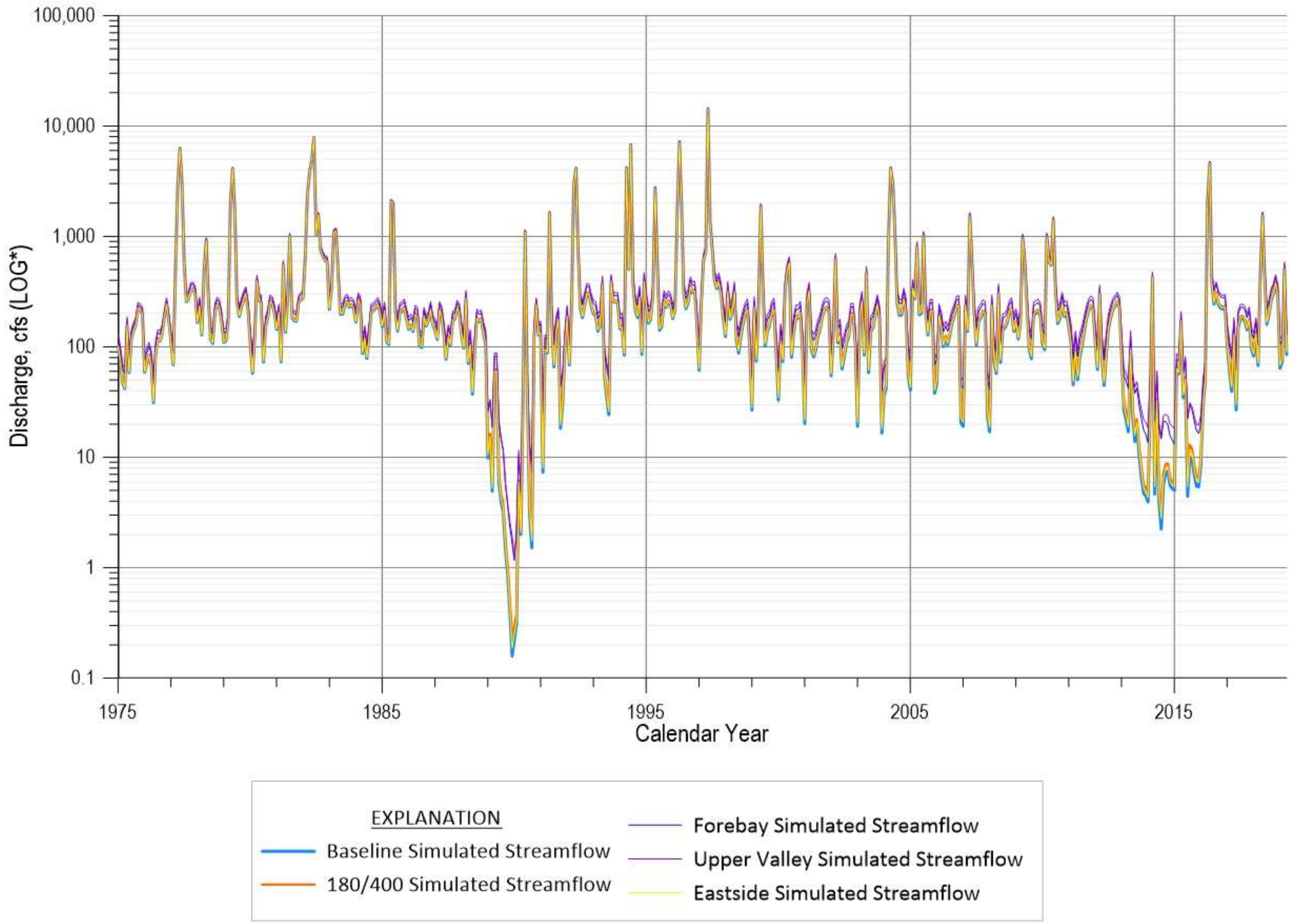


Figure 7. Pumping Off Scenarios – Simulated Salinas River Streamflow at the Soledad Gage

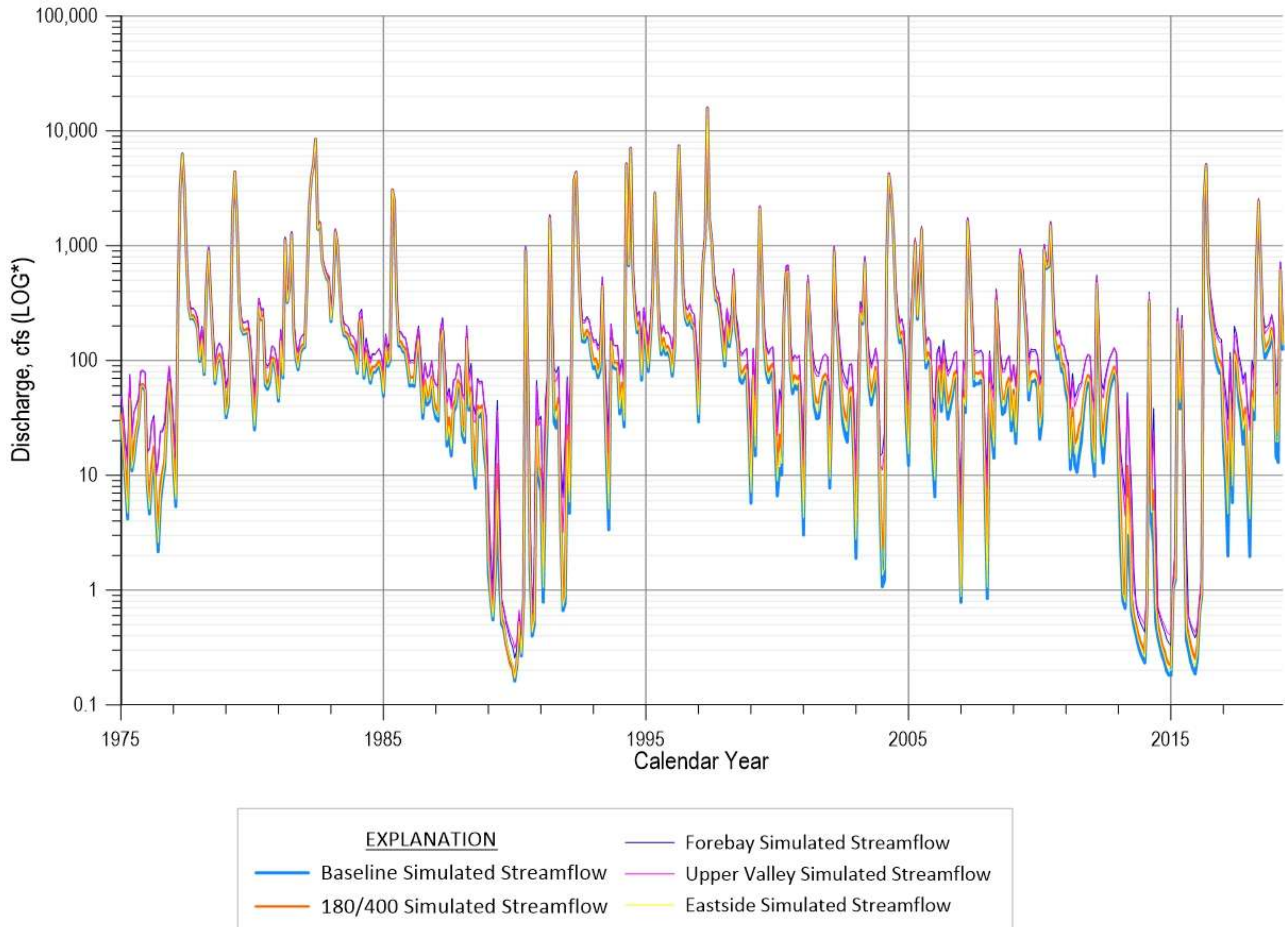


Figure 8. Pumping Off Scenarios – Simulated Salinas River Streamflow at the Chualar Gage

MONTGOMERY & ASSOCIATES

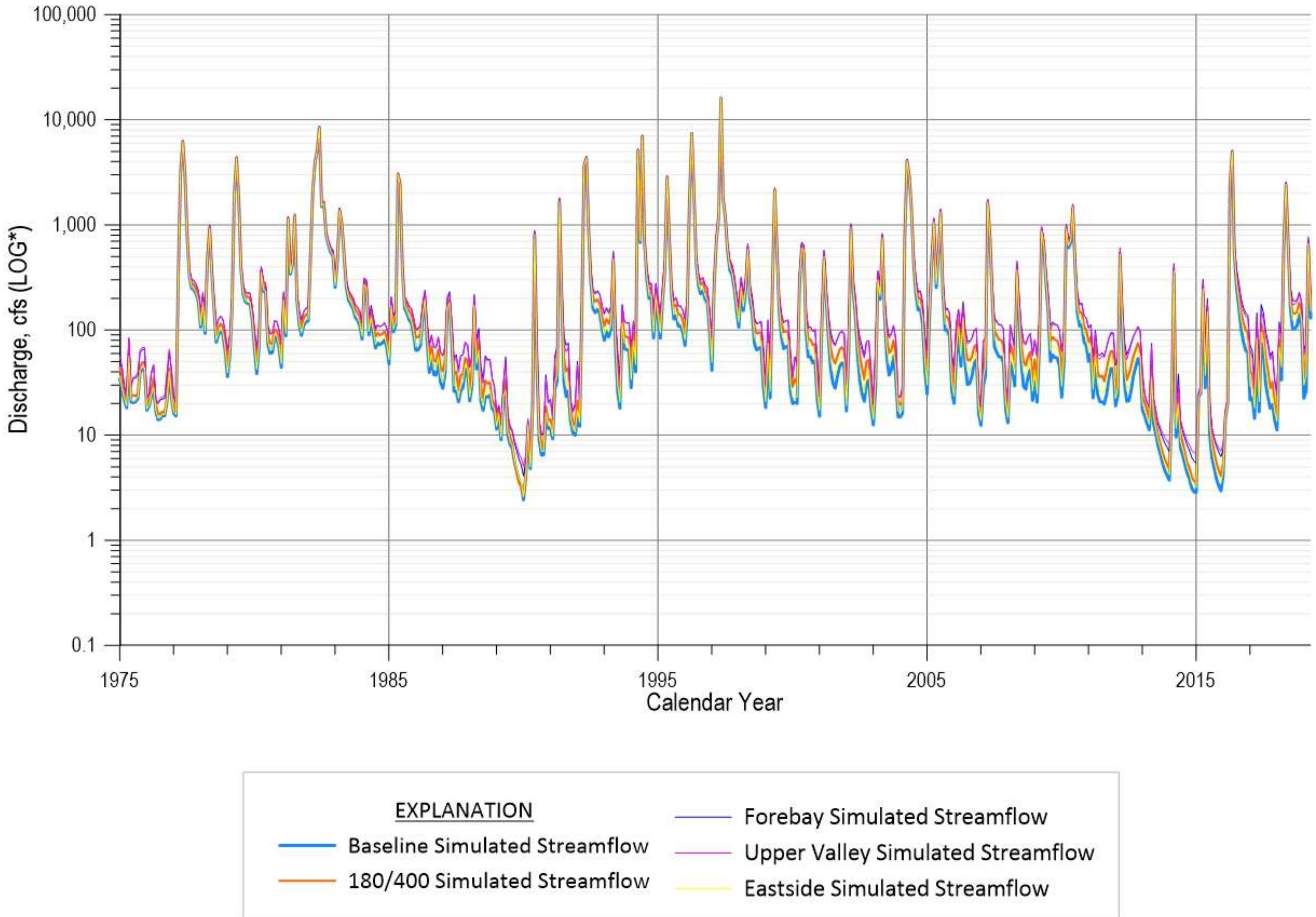


Figure 9. Pumping Off Scenarios – Simulated Salinas River Streamflow at the Spreckels Gage

MODEL RESULTS FOR TURNING ON PUMPING BY SUBBASIN

For this set of scenarios, M&A developed a no-pumping baseline as the baseline condition and then added and allowed for pumping for each of the Upper Valley, Forebay, Eastside, and 180/400 Subbasins in 4 separate model simulations. The no-pumping baseline consisted of the historical period of the model running 6 times. Each time, the final stress period heads from 2022 were used as the initial heads for the next iteration. Heads increased following each iteration. After the first iteration, heads in Eastside subbasin increased by up to approximately 50 feet. By the end of the second iteration heads in Eastside increased by up to 20 feet and the groundwater gradient switched directions and started flowing from the Eastside subbasin toward the 180/400 Subbasin. In the following iteration, the head difference was less than 10 feet and the difference diminished with subsequent iterations. By the sixth iteration, groundwater levels had equilibrated.

Groundwater Level Changes

Groundwater level change is calculated using the same method as previously described for the pumping baseline set of simulations. The difference between the no-pumping baseline model and each subbasin pumping on scenario is calculated first. Then, the difference is averaged over the historical period (1980-2022) and the recent period (2018-2022). Dry cells were excluded from the calculation. The average difference was calculated for the water table, 180-Foot Aquifer or equivalent (model layer 3), and the 400-Foot Aquifer or equivalent (model layer 5). The 180-Foot and 400-Foot Aquifers are not present in Upper Valley; therefore, only the results for the water table are presented. These average water level differences are presented spatially as color-flooded maps.

As an example, Figure 9 shows groundwater level change differences between the Upper Valley pumping on scenario compared to the no-pumping baseline for the water table. Figure 10, Figure 11, and Figure 12 show similar figures for the pumping on scenarios in Forebay, 180/400, and Eastside Subbasin, respectively. Each figure is focused on the subbasin of the adjustments; figures with groundwater level changes across the whole Valley are included in Attachment 2. Average water level differences for the wet season and dry season were also prepared for the same 2 periods mentioned above. Attachment 1 includes all figures.

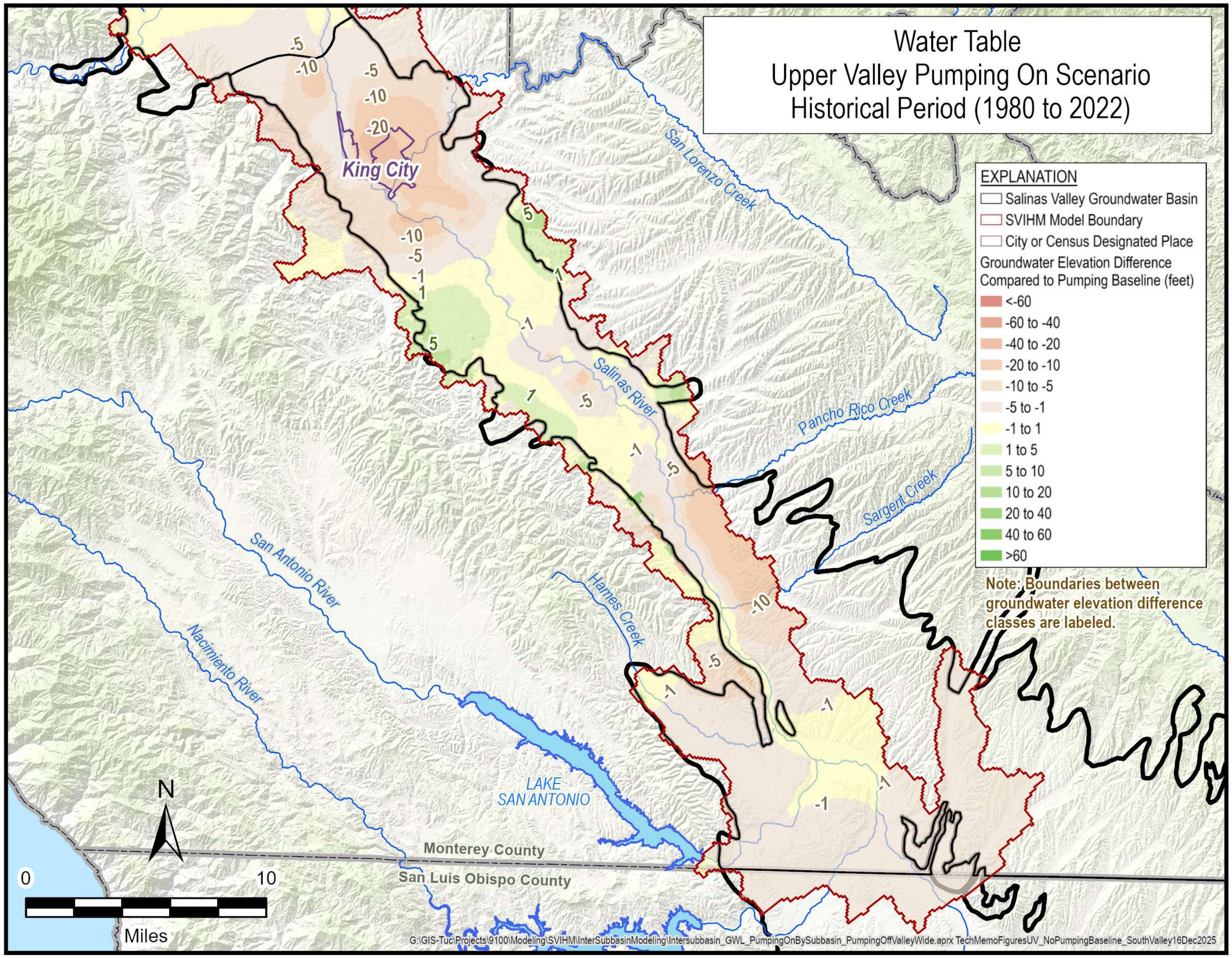


Figure 9. Upper Valley Pumping On Scenario Compared to No-pumping Baseline – Average Groundwater Level Difference for 1980-2022 Focused on Upper Valley Subbasin for the Water Table

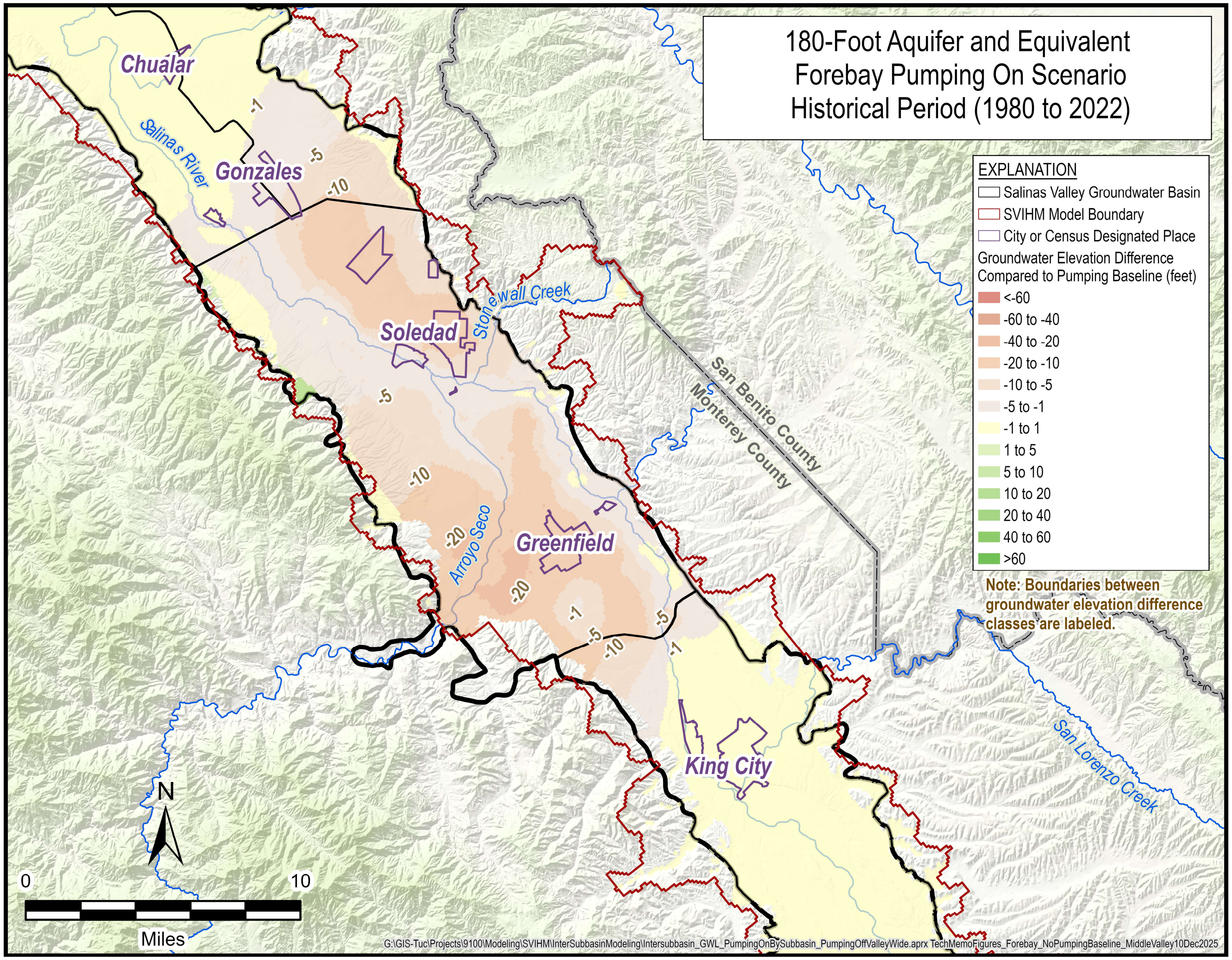
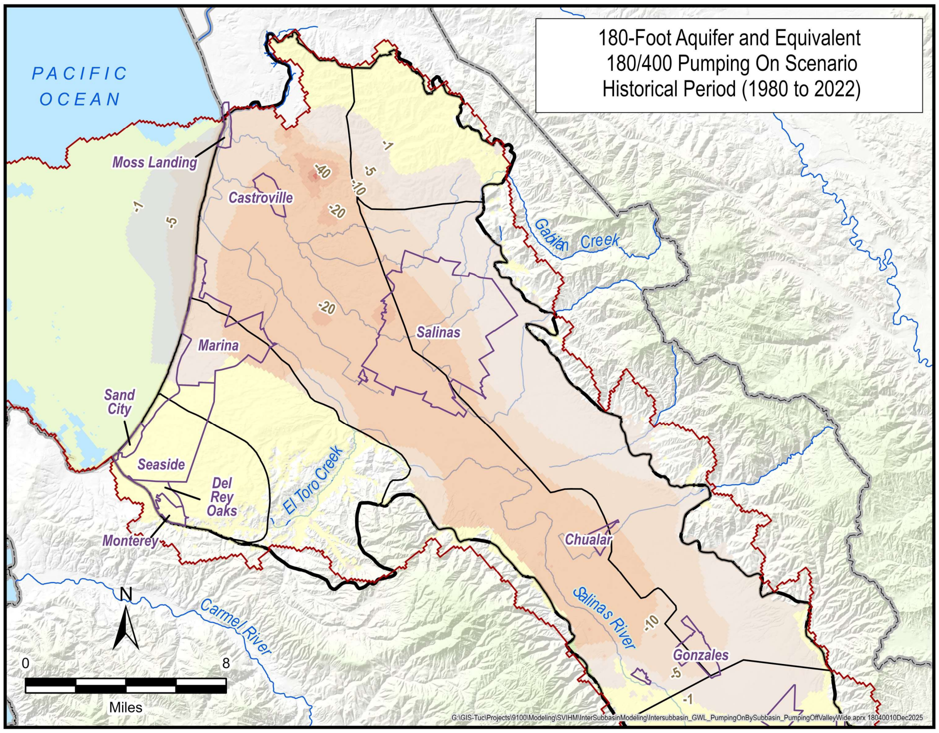
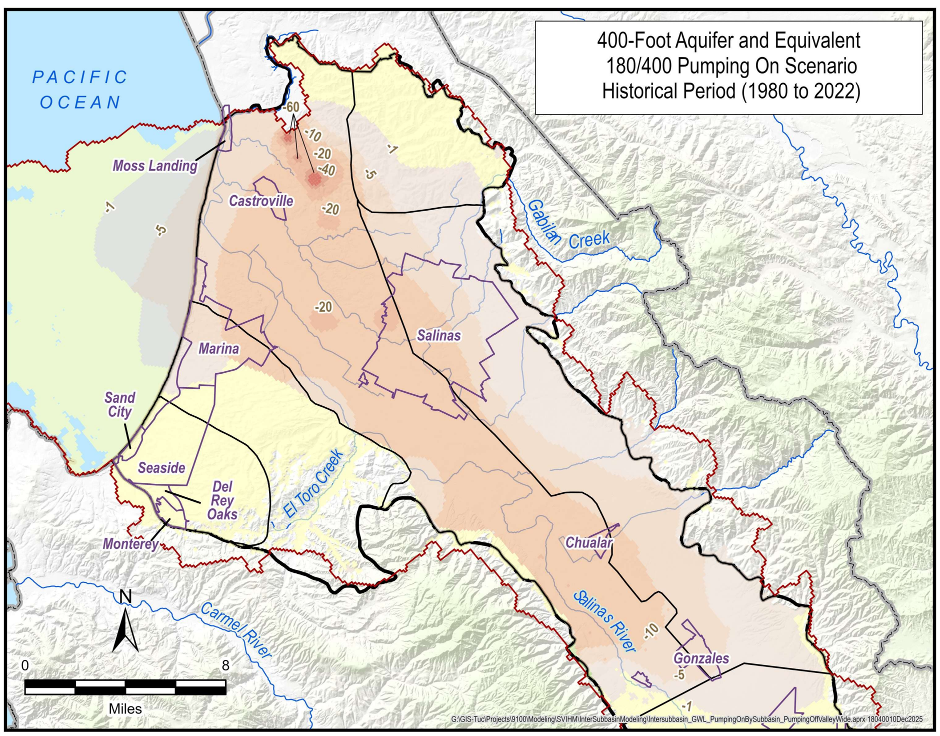


Figure 10. Forebay Pumping On Scenario Compared to No-pumping Baseline - Average Groundwater Level Difference for 1980-2022 Focused on Forebay Subbasin for the 180-Foot Aquifer and Equivalent





EXPLANATION

- Salinas Valley Groundwater Basin
- SVIHM Model Boundary
- City or Census Designated Place

Groundwater Elevation Difference Compared to Pumping Baseline (feet)

- <-60
- -60 to -40
- -40 to -20
- -20 to -10
- -10 to -5
- -5 to -1
- -1 to 1
- 1 to 5
- 5 to 10
- 10 to 20
- 20 to 40
- 40 to 60
- >60

Note: Boundaries between groundwater elevation difference classes are labeled.

Figure 11. 180/400 Pumping On Scenario Compared to No-pumping Baseline - Average Groundwater Level Difference for 1980-2022
Focused on North Valley for the 180-Foot Aquifer, 400-Foot Aquifers, and Equivalents

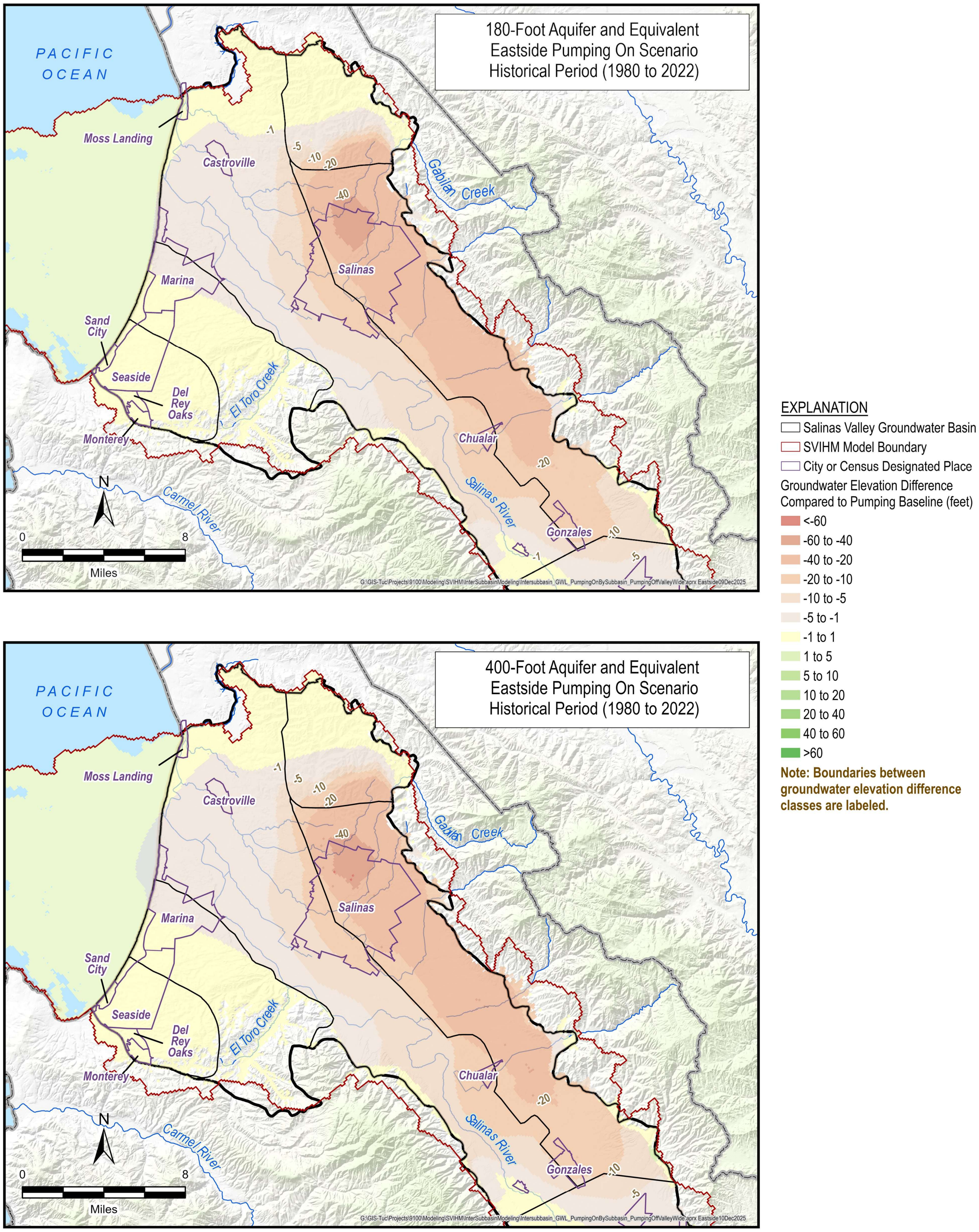


Figure 12. Eastside Pumping On Scenario Compared to No-pumping Baseline –
Average Groundwater Level Difference for 1980-2022
Focused on North Valley for the 180-Foot Aquifer, 400-Foot Aquifers, and Equivalents

Intersubbasin Subsurface Flows

Annual subsurface flows between each subbasin are averaged over the historical period (1980-2022). Results for the no-pumping baseline are presented in Table 10. Results for each model scenario and the difference between the scenarios and no-pumping baseline are presented in Table 11 through Table 14. Results for each model simulation are presented in a table for comparison between models. In addition, annual intersubbasin subsurface flows will be provided to the hydrologists as part of model outputs.

Table 10. Annual Intersubbasin Subsurface Flows for No-Pumping Baseline

	NET FLOW[1]						
	No-Pumping Baseline						
No-Pumping Baseline	Upper Valley	Forebay	180/400	Eastside	Langley	Monterey	Seaside
From Upper Valley to	0	4,478	0	0	0	0	0
From Forebay to	-4,478	0	5,492	1,822	0	0	0
From 180/400 to	0	-5,492	0	-21,973	-762	2,982	0
From Eastside to	0	-1,822	21,973	0	-822	0	0
From Langley to	0	0	762	822	0	0	0
From Monterey to	0	0	-2,982	0	0	0	-208
From Pajaro Valley to	0	0	-1,321	0	-450	0	0
From Paso Robles to	826	0	0	0	0	0	0

[1] Positive value indicates positive net flow from the subbasin in the rows to the subbasin in the columns; negative value indicates negative net flow.

MONTGOMERY & ASSOCIATES

Table 11. Annual Intersubbasin Subsurface Flows – Upper Valley Pumping On Scenario

	NET FLOW[1]						NET FLOW DIFFERENCE FROM NO-PUMPING BASELINE[2]					
	UPPER VALLEY ON						UPPER VALLEY ON					
UPPER VALLEY ON	Upper Valley	Forebay	180/400	Eastside	Langley	Monterey	Upper Valley	Forebay	180/400	Eastside	Langley	Monterey
From Upper Valley to	0	1,084	0	0	0	0	0	-3,394	0	0	0	0
From Forebay to	-1,084	0	5,440	1,815	0	0	3,394	0	-52	-7	0	0
From 180/400 to	0	-5,440	0	-22,100	-762	2,811	0	52	0	-126	0	-171
From Eastside to	0	-1,815	22,100	0	-827	0	0	7	126	0	-5	0
From Langley to	0	0	762	827	0	0	0	0	0	5	0	0
From Monterey to	0	0	-2,811	0	0	0	0	0	171	0	0	0
From Pajaro Valley to	0	0	-1,320	0	-450	0	0	0	1	0	0	0
From Paso Robles to	876	0	0	0	0	0	50	0	0	0	0	0

[1] Positive value (red) indicates positive net flow from the subbasin in the rows to the subbasin in the columns; negative value indicates negative net flow. Dark red indicates the greatest positive number in the specified simulation; dark blue indicates the greatest negative number.

[2] Positive value (red) indicates increase in net flow from the subbasin in the rows to the subbasin in the columns; negative value (blue) indicates decrease in net flow. Dark red indicates the greatest positive number in the specified simulation; dark blue indicates the greatest negative number.

MONTGOMERY & ASSOCIATES

Table 12. Annual Intersubbasin Subsurface Flows – Forebay Pumping On Scenario

	NET FLOW[1]						NET FLOW DIFFERENCE FROM NO-PUMPING BASELINE[2]					
	FOREBAY ON						FOREBAY ON					
FOREBAY ON	Upper Valley	Forebay	180/400	Eastside	Langley	Monterey	Upper Valley	Forebay	180/400	Eastside	Langley	Monterey
From Upper Valley to	0	9,256	0	0	0	0	0	4,778	0	0	0	0
From Forebay to	-9,256	0	3,884	57	0	0	-4,778	0	-1,607	-1,765	0	0
From 180/400 to	0	-3,884	0	-21,429	-762	2,801	0	1,607	0	545	0	-181
From Eastside to	0	-57	21,429	0	-827	0	0	1,765	-545	0	-6	0
From Langley to	0	0	762	827	0	0	0	0	0	6	0	0
From Monterey to	0	0	-2,801	0	0	0	0	0	181	0	0	0
From Pajaro Valley to	0	0	-1,319	0	-450	0	0	0	2	0	0	0
From Paso Robles to	832	0	0	0	0	0	6	0	0	0	0	0

[1] Positive value (red) indicates positive net flow from the subbasin in the rows to the subbasin in the columns; negative value indicates negative net flow. Dark red indicates the greatest positive number in the specified simulation; dark blue indicates the greatest negative number.

[2] Positive value (red) indicates increase in net flow from the subbasin in the rows to the subbasin in the columns; negative value (blue) indicates decrease in net flow. Dark red indicates the greatest positive number in the specified simulation; dark blue indicates the greatest negative number.

MONTGOMERY & ASSOCIATES

Table 13. Annual Intersubbasin Subsurface Flows – 180//400 Pumping On Scenario

	NET FLOW[1]						NET FLOW DIFFERENCE FROM NO-PUMPING BASELINE[2]					
	180/400 ON						180/400 ON					
180/400 ON	Upper Valley	Forebay	180/400	Eastside	Langley	Monterey	Upper Valley	Forebay	180/400	Eastside	Langley	Monterey
From Upper Valley to	0	4,484	0	0	0	0	0	6	0	0	0	0
From Forebay to	-4,484	0	6,841	2,547	0	0	-6	0	1,349	725	0	0
From 180/400 to	0	-6,841	0	-36,700	-931	125	0	-1,349	0	-14,727	-170	-2,857
From Eastside to	0	-2,547	36,700	0	-1,323	0	0	-725	14,727	0	-501	0
From Langley to	0	0	931	1,323	0	0	0	0	170	501	0	0
From Monterey to	0	0	-125	0	0	0	0	0	2,857	0	0	0
From Pajaro Valley to	0	0	-1,164	0	-448	0	0	0	156	0	2	0
From Paso Robles to	824	0	0	0	0	0	-2	0	0	0	0	0

[1] Positive value (red) indicates positive net flow from the subbasin in the rows to the subbasin in the columns; negative value indicates negative net flow. Dark red indicates the greatest positive number in the specified simulation; dark blue indicates the greatest negative number.

[2] Positive value (red) indicates increase in net flow from the subbasin in the rows to the subbasin in the columns; negative value (blue) indicates decrease in net flow. Dark red indicates the greatest positive number in the specified simulation; dark blue indicates the greatest negative number.

MONTGOMERY & ASSOCIATES

Table 14. Annual Intersubbasin Subsurface Flows – Eastside Pumping On Scenario

	NET FLOW[1]						NET FLOW DIFFERENCE FROM NO-PUMPING BASELINE[2]					
	EASTSIDE ON						EASTSIDE ON					
EASTSIDE ON	Upper Valley	Forebay	180/400	Eastside	Langley	Monterey	Upper Valley	Forebay	180/400	Eastside	Langley	Monterey
From Upper Valley to	0	4,482	0	0	0	0	0	4	0	0	0	0
From Forebay to	-4,482	0	6,632	4,266	0	0	-4	0	1,140	2,444	0	0
From 180/400 to	0	-6,632	0	16,941	-552	2,104	0	-1,140	0	38,914	209	-878
From Eastside to	0	-4,266	-16,941	0	-3,446	0	0	-2,444	-38,914	0	-2,624	0
From Langley to	0	0	552	3,446	0	0	0	0	-209	2,624	0	0
From Monterey to	0	0	-2,104	0	0	0	0	0	878	0	0	0
From Pajaro Valley to	0	0	-1,194	0	-446	0	0	0	126	0	3	0
From Paso Robles to	824	0	0	0	0	0	-2	0	0	0	0	0

[1] Positive value (red) indicates positive net flow from the subbasin in the rows to the subbasin in the columns; negative value indicates negative net flow. Dark red indicates the greatest positive number in the specified simulation; dark blue indicates the greatest negative number.

[2] Positive value (red) indicates increase in net flow from the subbasin in the rows to the subbasin in the columns; negative value (blue) indicates decrease in net flow. Dark red indicates the greatest positive number in the specified simulation; dark blue indicates the greatest negative number.

MONTGOMERY & ASSOCIATES

Subsurface Outflow To and Inflow From Monterey Bay

Subsurface outflow to and inflow from Monterey Bay is averaged over the historical period in Table 15 for the no-pumping baseline and each pumping on scenario. In addition, the annual outflows and inflows are provided as part of model outputs.

Table 15. Net Subsurface Flows To/From Monterey Bay for WY 1980-2022 (AF/yr)

	Net Average Annual Flow		
Subbasin	**180/400**	**Monterey**	**Seaside**
No-Pumping Baseline	-4,450	-8,253	-3,077
Upper Valley Pumping On	-4,399	-8,194	-3,069
Forebay Pumping On	-4,397	-8,191	-3,069
180/400 Pumping On	-3	-6,722	-3,027
Eastside Pumping On	-3,515	-7,900	-3,066
	Difference Compared to No-Pumping Baseline		
	180/400	**Monterey**	**Seaside**
Upper Valley Pumping On	51	59	8
Forebay Pumping On	53	62	8
180/400 Pumping On	4,447	1,531	50
Eastside Pumping On	935	353	11

Note: Positive value indicates inflow into subbasin.

Simulated Salinas River Streamflow Changes

Changes in simulated Salinas River streamflows at the Soledad, Chualar, and Spreckels gages are included in Table 16, and results for each model run are presented for comparison between models. In addition, Figure 10, Figure 11, and Figure 12 show the Salinas River flow over time at the Soledad, Chualar, and Spreckels gages for each model simulation, respectively.

Table 16. Pumping On Scenarios - Average Annual Salinas River Flow at the Soledad, Chualar, and Spreckels Gages

	Average Annual Flow (AF/yr)			Change in Average Annual Flow from Baseline to Model Run (AF/yr)		
	Soledad Gage	**Chualar Gage**	**Spreckels Gage**	**Soledad Gage**	**Chualar Gage**	**Spreckels Gage**
No-Pumping Baseline	366,511	376,775	423,519			
Upper Valley On	324,569	336,658	378,498	-41,942	-40,117	-45,020
Forebay On	338,343	333,028	376,506	-28,169	-43,747	-47,013
180/400 On	362,037	366,819	397,481	-4,474	-9,956	-26,038
Eastside On	363,652	370,749	409,221	-2,860	-6,026	-14,298

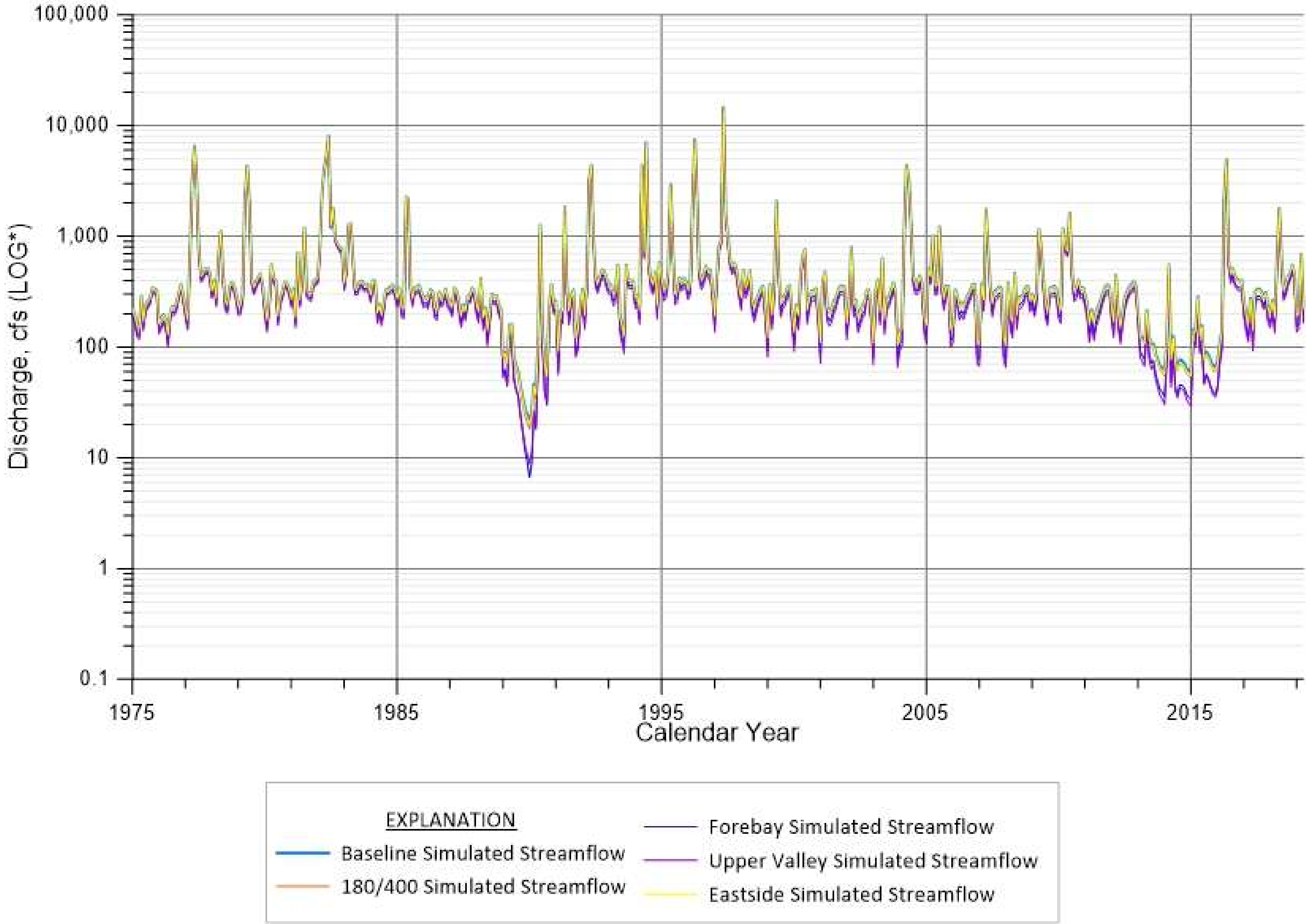


Figure 10. Pumping On Scenarios – Simulated Salinas River Streamflow at the Soledad Gage

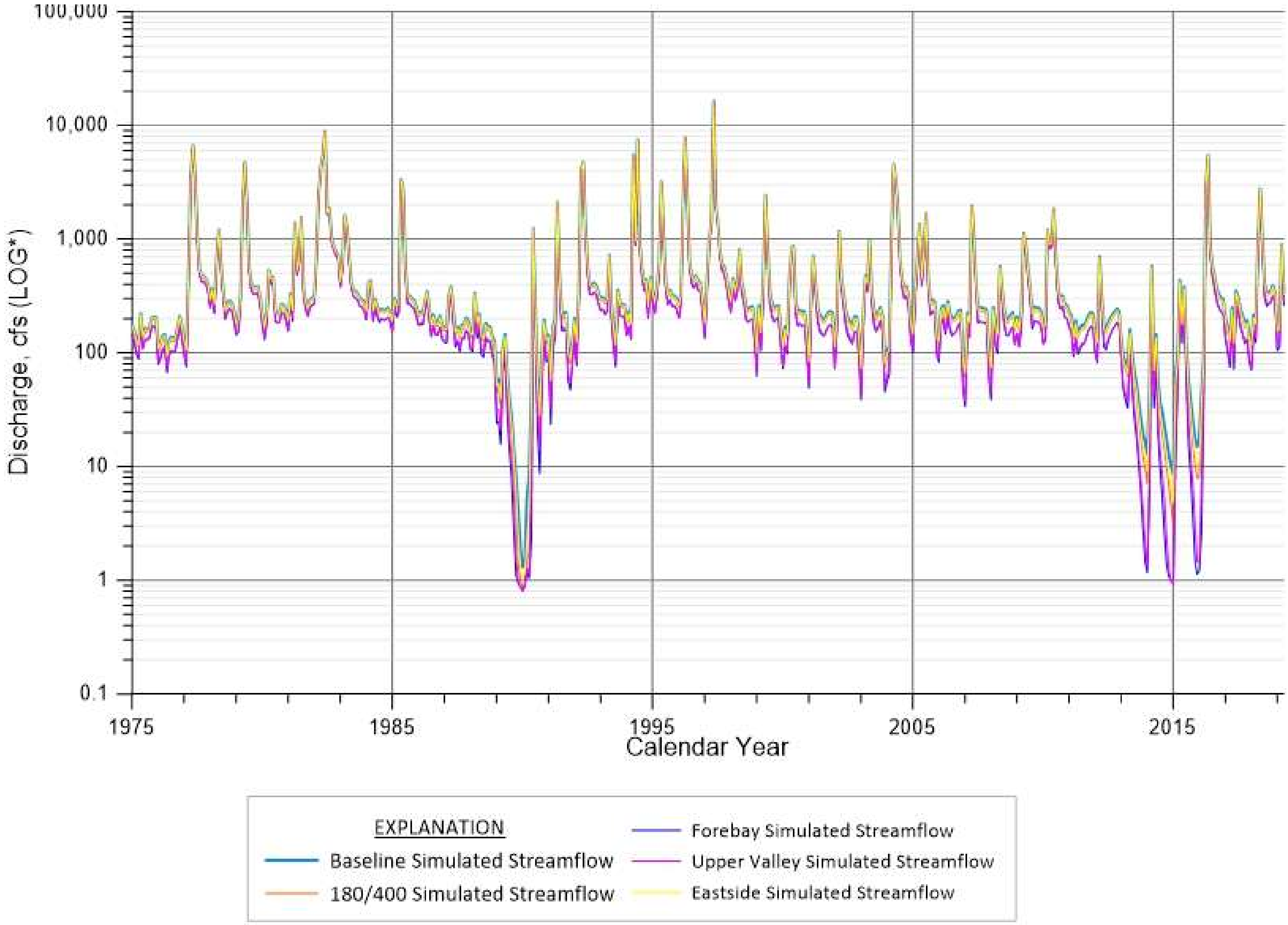


Figure 11. Pumping On Scenarios – Simulated Salinas River Streamflow at the Chualar Gage

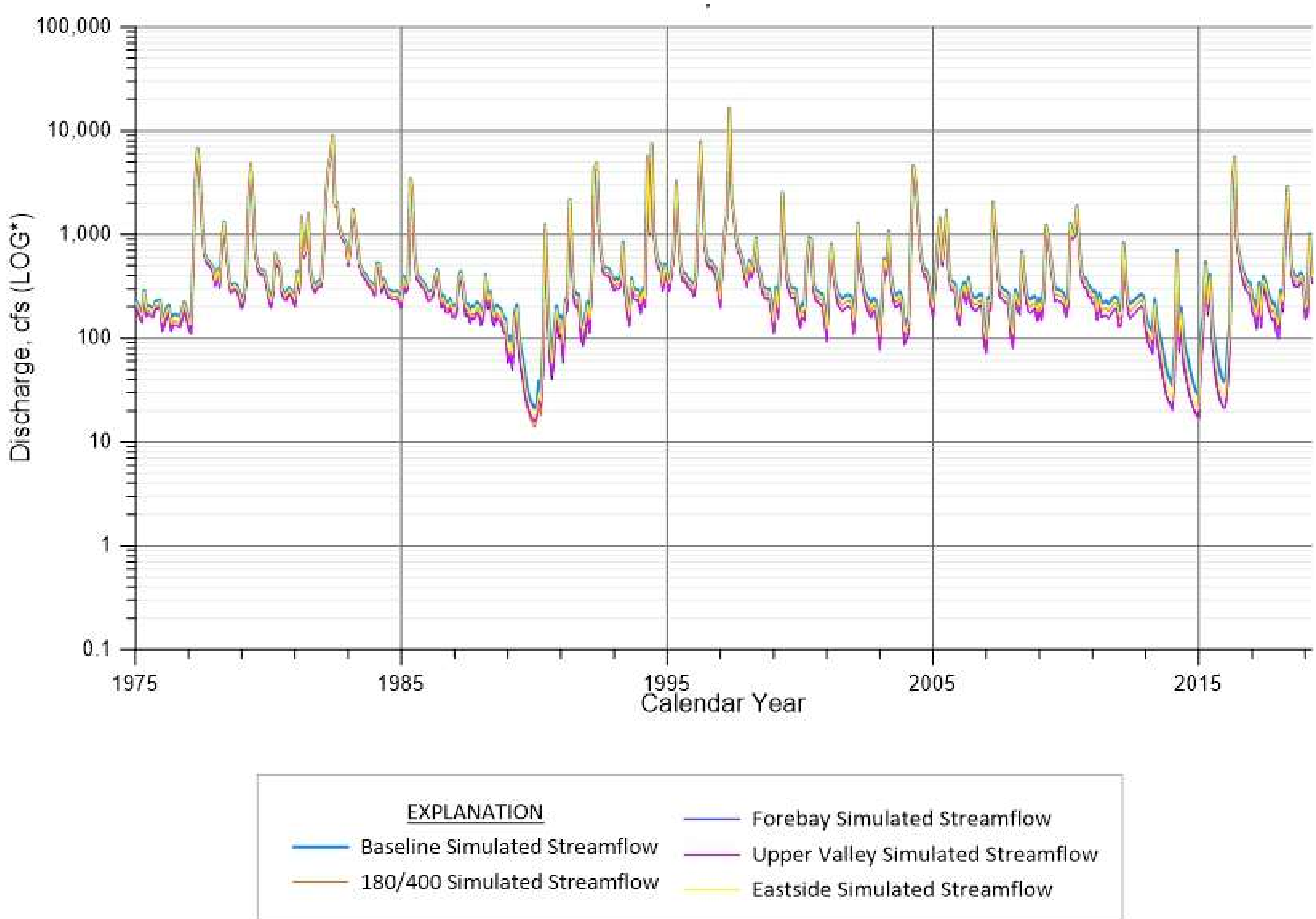


Figure 12. Pumping On Scenarios – Simulated Salinas River Streamflow at the Spreckels Gage

SUMMARY NOTES

As noted in the Approach TM, modifications to the SVIHM beyond those explicitly outlined in this project were outside the scope of work. Therefore, the resulting model outputs and interpretations presented herein should be considered with caution.

The Approach TM noted that the no pumping scenarios had the potential to flood large portions of the model area. The addition of drains to layer 1 by the USGS in the public release version of the SVIHM prevented flooding of layer 1. The water budgets indicate drain flows increased from minus 256,012 acre-feet per year (AF/yr) to minus 610,967 AF/yr between the pumping baseline and no-pumping baseline.

In general, turning off pumping in the pumping baseline scenarios resulted in an increase in water levels compared to the baseline. Turning on pumping in the no-pumping baseline scenarios generally resulted in a decrease in water levels compared to the baseline. In some localized areas the opposite trend was observed (i.e., water levels decreased in the subbasin when the pumping was turned off, and vice versa). Nuances of the Farm Process may be the cause of the counterintuitive simulated water level changes. In the SVIHM Farm Process, any active well assigned to the WBS can supply water to meet the aggregate crop demand of the entire WBS. Groundwater pumping in one part of a WBS may be used to meet crop demand in another part of the WBS. This can exacerbate spatial differences between groundwater pumping and deep percolation during the summer from irrigation. Additionally, it was observed that in the public release version of the SVIHM a small number of groundwater wells were assigned to supply water for a WBS in which it was not physically located.

As outlined in the Approach TM, reservoir releases were kept specified at historical rates. Therefore, the simulations do not reflect that when pumping is turned off, stream infiltration may decrease, resulting in less water needing to be released from the reservoirs to achieve the same diversion at the Salinas River Diversion Facility. In predictive modeling with the Salinas Valley Operational Model, the Surface Water Operations package accounts for this by changing reservoir releases according to the Nacimiento Dam Operation Policy.

M&A is currently undertaking an update and recalibration of the SVIHM. This effort includes revising the model layering to align with recent updates to the basin’s hydrogeologic conceptual model, which will improve the accuracy of future simulations and analyses. The update also includes revising the distribution of groundwater pumping based on the revised layering and updated well locations. These updates may result in different simulated results than presented in this memorandum.

REFERENCES

Henson, W.R., R. Hanson, S. Boyce, J. Hevesi, and E.R. Jachens. 2025 [pre-print]. Salinas Valley Integrated Hydrologic and Reservoir Operations Models, Monterey and San Luis Obispo Counties, California; prepared by United States Geological Survey in cooperation with Monterey County Resources Agency, Monterey County and the Salinas Valley Basin Groundwater Sustainability Agency, preprint version released April 2, 2025.