Supplement to Task 2B-1 – Numerical Model Development and Scenario Results, East and Piru Subbasins
Upper Santa Clara River Chloride TMDL Collaborative Process

Upper Santa Clara River Valley

Los Angeles and Ventura Counties California

Prepared for:

Sanitation Districts of Los Angeles County and
Los Angeles Regional Water Quality Control Board

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Development and Scenario Results, East and Piru Subbasins
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Upper Santa Clara River Valley
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INTRODUCTION

This supplement to the Task 2B-1 Report (CH2M HILL-HGL, 2008) describes the preparation and results of nine applications of the numerical Groundwater/Surface-water Interaction Model (GSWIM) conducted by Geomatrix Consultants Inc to assess potential impacts of future water management and treatment options on the fate and transport of chloride in surface water and groundwater basins of the Santa Clara River (SCR) watershed. CH2M HILL, with support from HydroGeoLogic (HGL) conducted eight simulations assessing future water management and treatment options as discussed in the main body of the report. These activities are a portion of the larger Groundwater/Surface-water Interaction (GSWI) Study being jointly conducted by the Santa Clarita Valley Sanitation District of Los Angeles County (SCVSD) and the Los Angeles Regional Water Quality Control Board (LARWQCB) in support of the Upper Santa Clara River Chloride TMDL project.

MODEL OBJECTIVES

As described in the Task 2B-1 Report (CH2M HILL-HGL, 2008), GSWIM was developed to simulate potential impacts to chlorides in groundwater and surface water under a variety of potential future water management and advanced treatment options. Several scenarios were developed by the SCVSD and LARWQCB to assess the impact of various water management and treatment options on chloride concentrations within the USCR watershed. Results from these and other model simulations will support development of the chloride TMDL for the USCR watershed.

The model scenarios simulated by Geomatrix are outlined in Table 1. Development of the model input files for these scenarios are described in detail in Section 5.2 of the Task 2-B1 Report (CH2M HILL-HGL, 2008). Detailed results of the simulations and observations related to those results are provided in Section 5.3 of the Task 2B-1 Report (CH2M HILL-HGL, 2008). Because the assumptions inherent in the nine model scenarios conducted by Geomatrix are generally bounded by the assumptions inherent in the eight simulations conducted by CH2M HILL-HGL, results of Geomatrix's simulations are similar to and encompassed by those presented in the Task 2-B1 Report (CH2M HILL-HGL, 2008) and will not be repeated here.

The following discussion provides for a general context of development of the nine scenarios, and includes additional observations related to the results specific to the Blue Cut area.

The scenarios conducted by both CH2M HILL-HGL and Geomatrix represented potential conditions during calendar years (CY) 2007 through 2030 based on different future water use and treatment strategies. The first strategy tested in these scenarios was the potential impact of three different levels of recycled water use from Valencia Water Reclamation Plant (WRP). The second strategy tested was the potential impact of different levels of reverse osmosis (RO) treatment of wastewater discharges from the Saugus and Valencia WRPs. The third strategy was to assess the impact of the removal of self-regenerating water softener (SRWS) systems from homes and commercial and industrial facilities within the Santa Clarita Valley. Installation of SRWS systems was banned in the SCVSD service area in 2003, and the systems are assumed to have a useful life of approximately twelve years (SCVSD, 2007). SCVSD has utilized public outreach efforts to encourage removal of these systems from service before end of useful life because SRWS systems add chloride to the influent wastewater entering SCVSD's WRPs. These strategies are combined into the scenarios shown in Table 1 (based on Table 1-3 of the Task 2B-1 Report, CH2M HILL-HGL, 2008).

MODEL DEVELOPMENT

GSWIM implemented each of these strategies using the Water Supply System (WSS) Package of MODHMS (HGL, 2006). For the high and low recycled water use strategies, CH2M HILL-HGL developed detailed estimates of total monthly recycled water use by each water purveyor (see Section 5.2 of the Task 2B-1 Report [CH2M HILL-HGL, 2008]). Geomatrix modified these estimates to produce the intermediate monthly recycled water use estimates for water use in the East Subbasin. Table 2 summarizes annual water use estimates for the intermediate reuse options. HGL supported Geomatrix through development of the appropriate changes to the WSS Package input files for these simulations. Locations where recycled water is anticipated to be used under the high-reuse strategy were delineated by Geomatrix based on the Castaic Lake Water Agency Draft Recycled Water Master Plan (RWMP) (Kennedy/Jenks, 2002). For scenarios using the RO treatment strategy, the discharge concentrations from the Saugus and Valencia WRPs were set to the desired level in the WSS Package input files (Table 1). For the SRWS removal strategies, the MODHMS code was modified to calculate the discharge concentrations from Saugus and Valencia WRPs as the blended concentrations of the water supply systems serving the WRPs' service areas, including an estimated chloride addition from indoor water use which includes additions from SRWS systems. Three levels of removal of SRWS systems before end of useful life were considered, 0%, 50% and 100%. For each level of SRWS removal, the estimated chloride addition from indoor water use through time was reduced based on the removal of SRWS systems as estimated in SCVSD, 2007.

MODEL RESULTS

Results of the nine simulations performed by Geomatrix were generally consistent with the results of the other eight scenarios presented in the Task 2B-1 Report (CH2M HILL-HGL, 2008). Graphs showing model output at key observation locations across the USCR watershed are included as Appendices A through D. The results in the appendices supplement those provided by CH2M Hill for the other eight scenarios (see Section 5.3 of the Task 2B-1 Report [CH2M HILL-HGL, 2008]), and the detailed observations provided in the Task 2B-1 Report are not repeated here. A general description of the results of the nine scenarios, focused on predicted chloride concentrations at Blue Cut, and is provided below.

Water Reuse Scenarios

Model results were generally similar between the high, intermediate, and low water reuse scenarios, with some minor differences between the scenarios evident during later time periods. Per the CLWA Draft RWMP (Kennedy/Jenks, 2002), recycled water demand was assumed to increase with time; therefore, the differences between the high, intermediate and low recycled water strategies were also assumed to increase with time (Figure 1). As such, differences in GSWIM results between these strategies also increased with time, as shown on Figure 2. The greatest differences in results between the recycled water strategies occurred during the summer growing seasons when the demand for recycled water application was greatest (Figures 1 and 2). As shown on Figure 3, predicted chloride concentration differences of up to 24 mg/L were simulated in the SCR at Blue Cut between the high and low recycled water strategies.

Differences in predicted chloride concentrations in the SCR were not always consistent between the high and low reuse scenarios. The high reuse strategy produced lower SCR concentrations during periods when application of reuse water to the land surface reduced the discharge of high chloride waters to the SCR. However, higher SCR concentrations were predicted during periods when chloride was later mobilized from the surface by precipitation and run off into the SCR. As recycled water demand decreased during the fall months, the results of implementing the different recycled water use strategies generally converged.

GSWIM predicts increased SCR chloride concentrations during the fall months due to generally decreased precipitation, providing less dilution and greater potential for evapoconcentration of chloride in surface water and the vadose zone.

Reverse Osmosis Wastewater Treatment Scenarios

In the scenarios that include the strategy of implementing RO treatment at the Saugus and Valencia WRPs, the simulated concentration of discharged RO-treated wastewater dominated the model predicted concentrations in the SCR directly downstream of each WRP, as shown on Figure 4 at a location immediately downstream of the Valencia WRP. The selected concentration of wastewater discharges in each scenario also strongly controls model predicted concentrations in the SCR at Blue Cut (Figure 5); however, the concentration fluctuations were larger than at a location immediately downstream of the discharge location. Further, the concentrations at Blue Cut occasionally exceeded the discharge concentrations at the WRPs during drought conditions. This indicates that chloride loading from other sources occasionally contributed larger chloride loads to Blue Cut than the WRP releases. It is noted that at certain times in the model during wet periods, the selected concentration of discharged RO-treated wastewater (in particular, the "c" scenarios with a discharge concentration of 150 mg/L) was greater than the influent concentrations to the WRPs, and thus the simulation added chloride to the WRP discharges during these periods.

SRWS Removal Scenarios

Similar to the results of the RO-treatment scenarios, in the SRWS-removal scenarios the model predicted that the WRP discharge chloride concentrations were a dominant control on SCR concentrations directly downstream, and that these concentrations were variable as they depended on the influent concentrations to the WRPs (Figure 6). The WRP discharge concentrations were also predicted to be a strong control on SCR concentrations at Blue Cut, as shown on Figure 7. Among the different SRWS-removal scenarios, the model predicted only minor differences, primarily because the removal strategy was only effective between 2008 and 2015. It was assumed that SRWS systems installed in 2003 before the current ban would have reached end of useful life by 2015 and thus all removal scenarios simulated the same chloride levels after that date. Figure 8 shows the differences between the 0% and 100% SRWS removal strategies in chloride concentrations discharged from the WRPs. These differences in concentrations between the SRWS removal strategies were predicted by the model to be less downstream in the SCR, as shown on Figures 9 and 10.

Scenario 3e (Table 1, low recycled water use, 0% SRWS removal) can be considered a "minimal future action" scenario in that it represents the scenario that carries forward the currently applied management options (aside from NHR operations). These results were used to assess the impact of various management options simulated in the other simulations. As shown on Figure 11, the model predicted that with the minimal future actions of Scenario 3e, concentrations were predicted to generally increase over modeled historic values. During the most significant drought period in the model from CY 2021 through 2023 (simulated using hydrology from 1989 through 1991), the model predicted peak concentrations of nearly 160 mg/L in the SCR at Blue Cut (Figure 12).

Predicted Attainment of Chloride Concentration Thresholds

The Task 2B-1 Report (CH2M HILL-HGL, 2008) presents a discussion of predicted attainment of general chloride water quality objectives (WQOs) for the eight scenarios simulated by CH2M HILL. Figure 13 presents the predicted frequencies for which each of the nine scenarios simulated by Geomatrix meet general threshold chloride concentrations for Blue Cut streamflow, and average groundwater concentrations in wells in the Piru subbasin both east and west of Piru Creek. The RO-treatment scenarios exhibit the broadest range of attainment frequencies of chloride WQOs. The "a" scenarios (wastewater discharges with concentrations of 100 mg/L) had the highest attainment frequencies, while the "c" scenarios (wastewater discharges with concentrations of 150 mg/L) had the lowest attainment frequencies. The SRWS removal scenarios predicted little difference in attainment frequencies, though the 100% SRWS removal attainment frequencies were consistently higher than the 0% SRWS removal scenarios. The water reuse scenarios also predicted little variability in attainment frequencies. For Blue Cut, the high water reuse scenarios predicted greater attainment frequencies and the low water reuse scenarios predicted the least attainment frequencies. For Piru subbasin groundwater east of Piru Creek the low water reuse scenarios predicted the highest attainment frequencies and the intermediate water reuse scenarios predicted the lowest. None of the scenarios presented here attained all the WQOs all the time.

References

CH2M HILL and HydroGeoLogic (CH2M HILL-HGL), 2008, Task 2B –1 Numerical Model Development and Scenario Results East and Piru Subbasins. Upper Santa Clara River Chloride TMDL Collaborative Process. Draft Report. Prepared for the Groundwater/Surface-water Interaction (GSWI) Technical Working Group. February.

HydroGeoLogic, Inc. (HGL), 2006, MODHMS: A Comprehensive Modflow-based Hydrologic Modeling System, Version 3.0, Documentation and Users Guide.

Kennedy/Jenks Consultants, 2002, Draft Recycled Water Master Plan. Prepared for Castaic Lake Water Agency.

Santa Clarita Valley Sanitation District of Los Angeles County (SCVSD), 2007, Projected Monthly Chloride Loading above Water Supply Chloride Concentration for the Saugus and Valencia WRPs, Draft Memorandum, May 14.

TABLES

Table 1

GSWIM Initial Scenarios Matrix
Upper Santa Clara River Chloride TMDL
Santa Clara River Valley, California

GSWIM Scenarios			
Compliance Option	**Reuse Scenario 1 High Water Reuse**	**Reuse Scenario 2 Intermediate Water Reuse**	**Reuse Scenario 3 Low Water Reuse**
MF/RO at 100 mg/L (Saugus and Valencia WRPs)	1a	***2a***	3a
MF/RO at 120 mg/L (Saugus and Valencia WRPs)	1b	***2b***	3b
MF/RO at 150 mg/L (Saugus and Valencia WRPs)	***1c***	***2c***	***3c***
MF/RO at 160 mg/L (Saugus and Valencia WRPs)	*1d*	*2d*	*3d*
Chloride Loading Above Water Softeners (0% SRWS removal)	1e	***2e***	3e
Chloride Loading Above Water Softeners (50% SRWS removal)	1f	2f	3f
Chloride Loading Above Water Softeners (100% SRWS removal)	1g	***2g***	3g

Notes:

Scenarios performed by Geomatrix Inc. are shown in ***bold italics.*** Scenarios that were not performed are shown in *italics*. The remaining scenarios were performed by CH2M HILL.

Scenarios 2e and 2g were conducted using chloride loadings computed by assuming additional wastewater treatment using an ultraviolet (UV) treatment process.

SRWS refers to Self Regenerating Water Softeners.

Table 2

Annual Water Use in the East Subbasin Under Scenarios 2a, 2b, 2c, 2e, 2g
Upper Santa Clara River Chloride TMDL
Santa Clara River Valley, California

Simulation Year	Hydrology Year	Local Climate Year[1]	SWP Climate Year[2]	Saugus Pumping Plan[3,4]	Total Water Demand[3]	Groundwater Pumping[3]	Recycled Water[5]	Imported Water[6]	Total Water Supply
2007	1975	Dry	Wet	Normal	97,809	41,208	419	56,184	97,811
2008	1976	Normal	Critical	Dry Year 1	89,758	50,323	419	39,017	89,759
2009	1977	Normal	Critical	Dry Year 2	90,599	55,659	419	34,522	90,600
2010	1978	Normal	Above Normal	Normal	91,440	49,741	1,004	40,696	91,441
2011	1979	Normal	Below Normal	Normal	93,090	49,795	1,571	41,722	93,088
2012	1980	Normal	Above Normal	Normal	94,740	49,854	2,138	42,747	94,739
2013	1981	Normal	Dry	Normal	96,390	49,911	2,705	43,773	96,390
2014	1982	Normal	Wet	Normal	98,040	49,969	3,272	44,798	98,040
2015	1983	Normal	Wet	Normal	99,690	50,026	3,839	45,824	99,690
2016	1984	Normal	Wet	Normal	101,052	50,084	4,632	46,336	101,052
2017	1985	Dry	Dry	Normal	112,655	47,175	5,424	60,058	112,656
2018	1986	Normal	Wet	Normal	103,776	50,198	6,216	47,363	103,777
2019	1987	Normal	Dry	Normal	105,138	50,257	7,008	47,875	105,140
2020	1988	Normal	Critical	Dry Year 1	106,500	55,889	7,800	42,811	106,500
2021	1989	Dry	Dry	Normal	119,415	47,276	8,657	63,480	119,413
2022	1990	Dry	Critical	Dry Year 1	121,575	52,881	9,514	59,182	121,577
2023	1991	Dry	Critical	Dry Year 2	123,736	60,487	10,371	52,878	123,736
2024	1992	Normal	Critical	Dry Year 3	114,468	64,308	11,228	38,932	114,468
2025	1993	Normal	Above Normal	Normal	116,460	50,599	12,333	53,528	116,461
2026	1994	Dry	Critical	Dry Year 1	130,018	53,332	13,183	63,502	130,018
2027	1995	Normal	Wet	Normal	120,024	51,373	14,191	54,461	120,025
2028	1996	Normal	Wet	Normal	121,806	51,374	14,702	55,731	121,807
2029	1997	Normal	Wet	Normal	123,588	51,373	15,402	56,814	123,589
2030	1998	Normal	Wet	Normal	125,370	51,373	16,102	57,896	125,371

Notes:

[1] Dry = 12 in/yr or less and Normal = greater than 12 in/yr at rain gage 32c located in the City of Santa Clarita. An exception to this should be noted for Hydrology Year 1991, which had over 12 in/yr of rainfall after two years of very low rainfall.

[2] Defined using DWR's Sacramento Valley Unimpaired Runoff Index; wet = wettest; critical = driest.

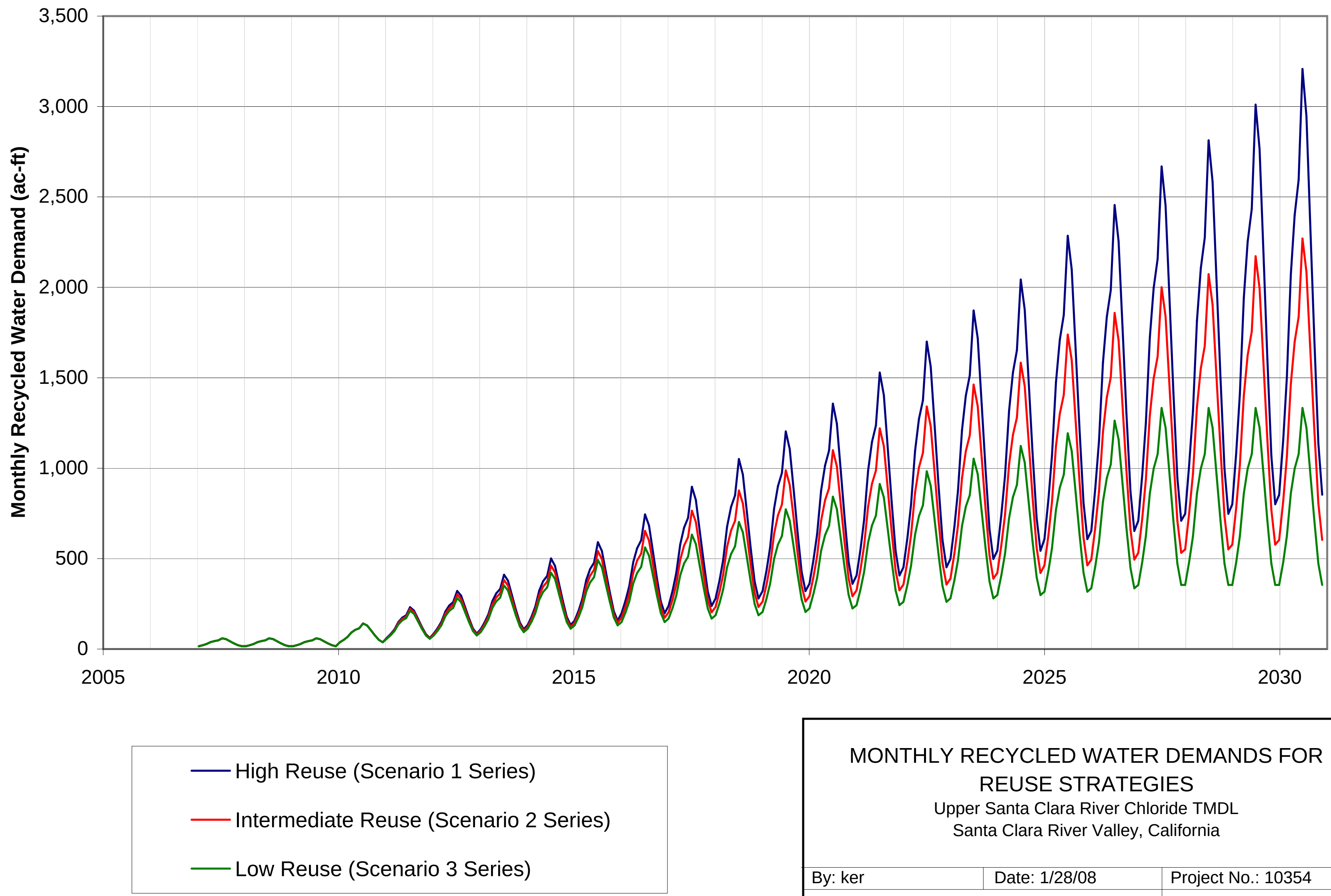
[3] Defined according to the 2005 United Water Master Plan.

[4] Defined according to SWP Hydrology.

[5] Provided by the Upper Basin Water Purveyors at five-year increments starting in 2010 and linearly interpolated annually. The 2007 through 2009 value was set based on recycled water use reported in 2006. Values account for reuse inside and outside of Newhall Ranch.

[6] Used to balance the remaining supply to meet demands.

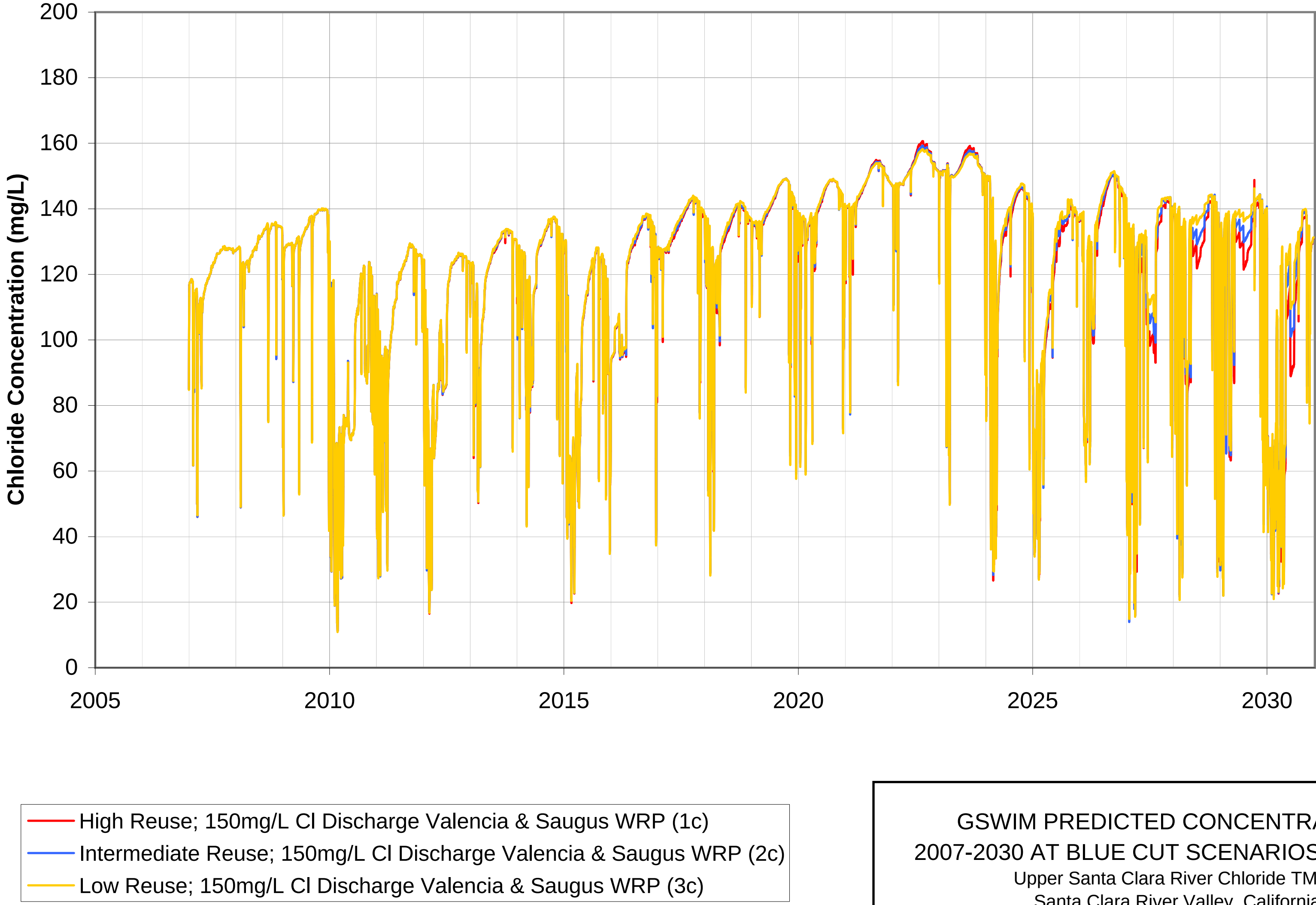
FIGURES



MONTHLY RECYCLED WATER DEMANDS FOR REUSE STRATEGIES

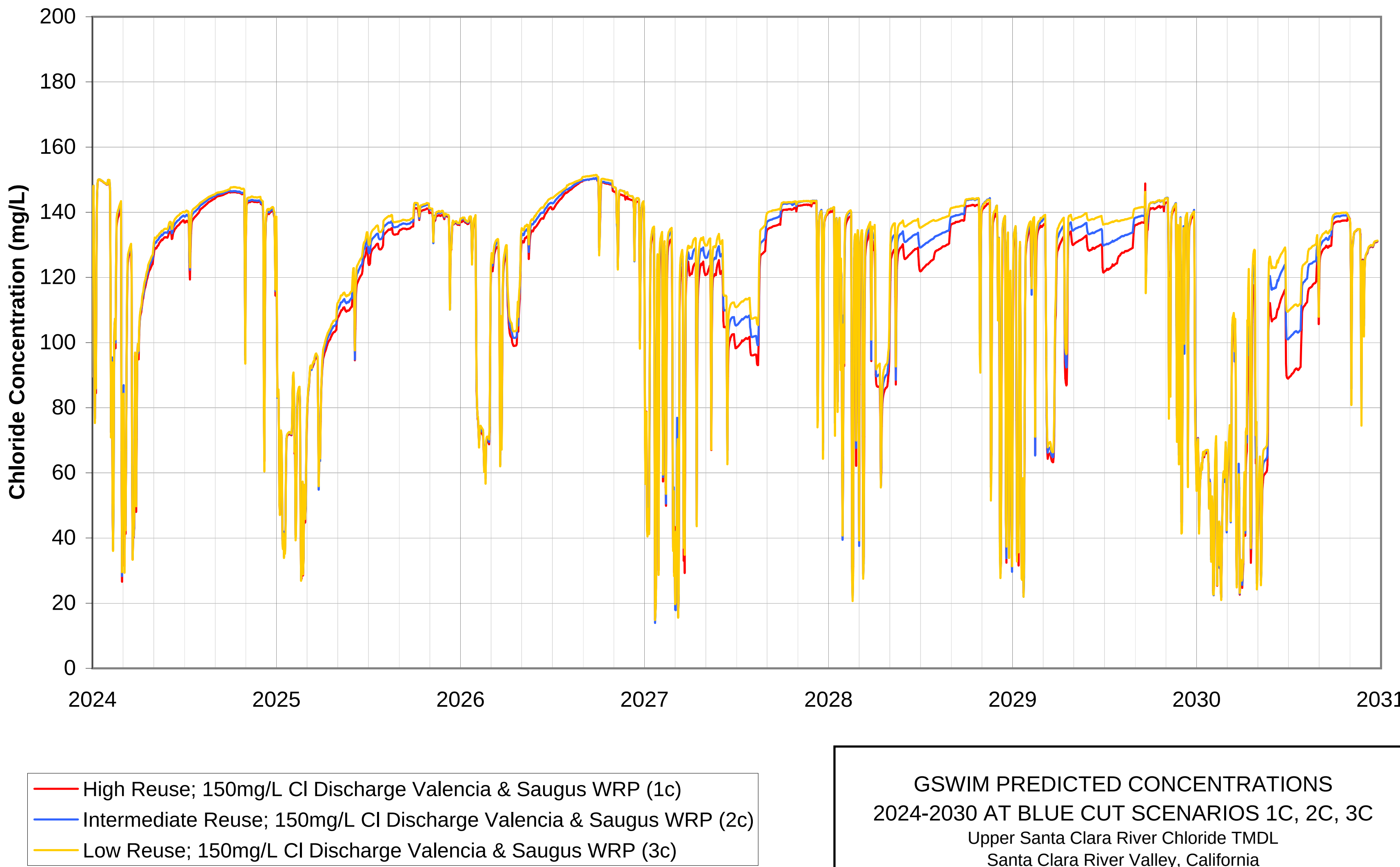
Upper Santa Clara River Chloride TMDL
Santa Clara River Valley, California

By: ker	Date: 1/28/08	Project No.: 10354
Geomatrix		Figure 1



GSWIM PREDICTED CONCENTRATIONS
2007-2030 AT BLUE CUT SCENARIOS 1C, 2C, 3C
Upper Santa Clara River Chloride TMDL
Santa Clara River Valley, California

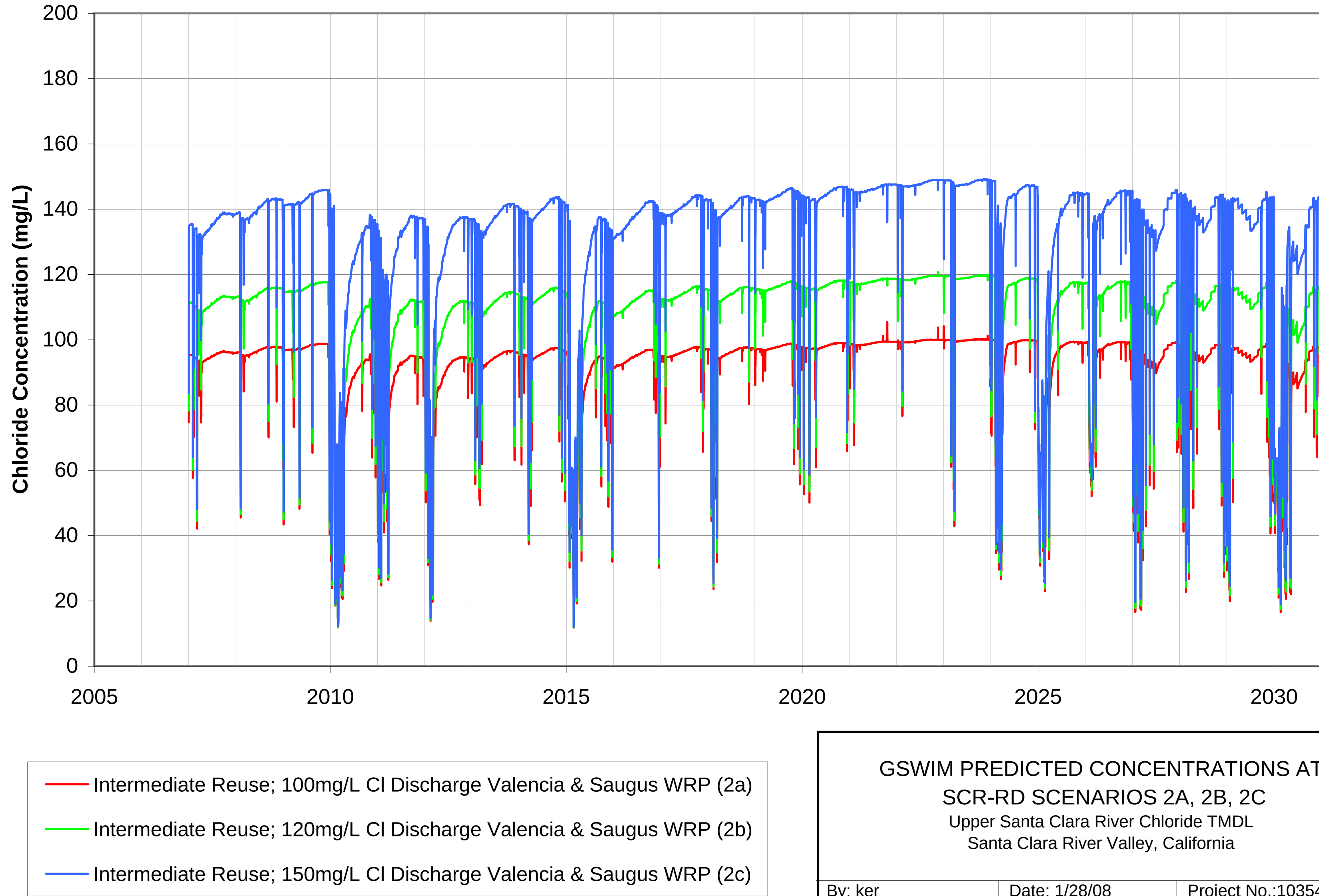
By: ker	Date: 1/28/08	Project No.: 10354
Geomatrix		Figure **2**



GSWIM PREDICTED CONCENTRATIONS
2024-2030 AT BLUE CUT SCENARIOS 1C, 2C, 3C

Upper Santa Clara River Chloride TMDL
Santa Clara River Valley, California

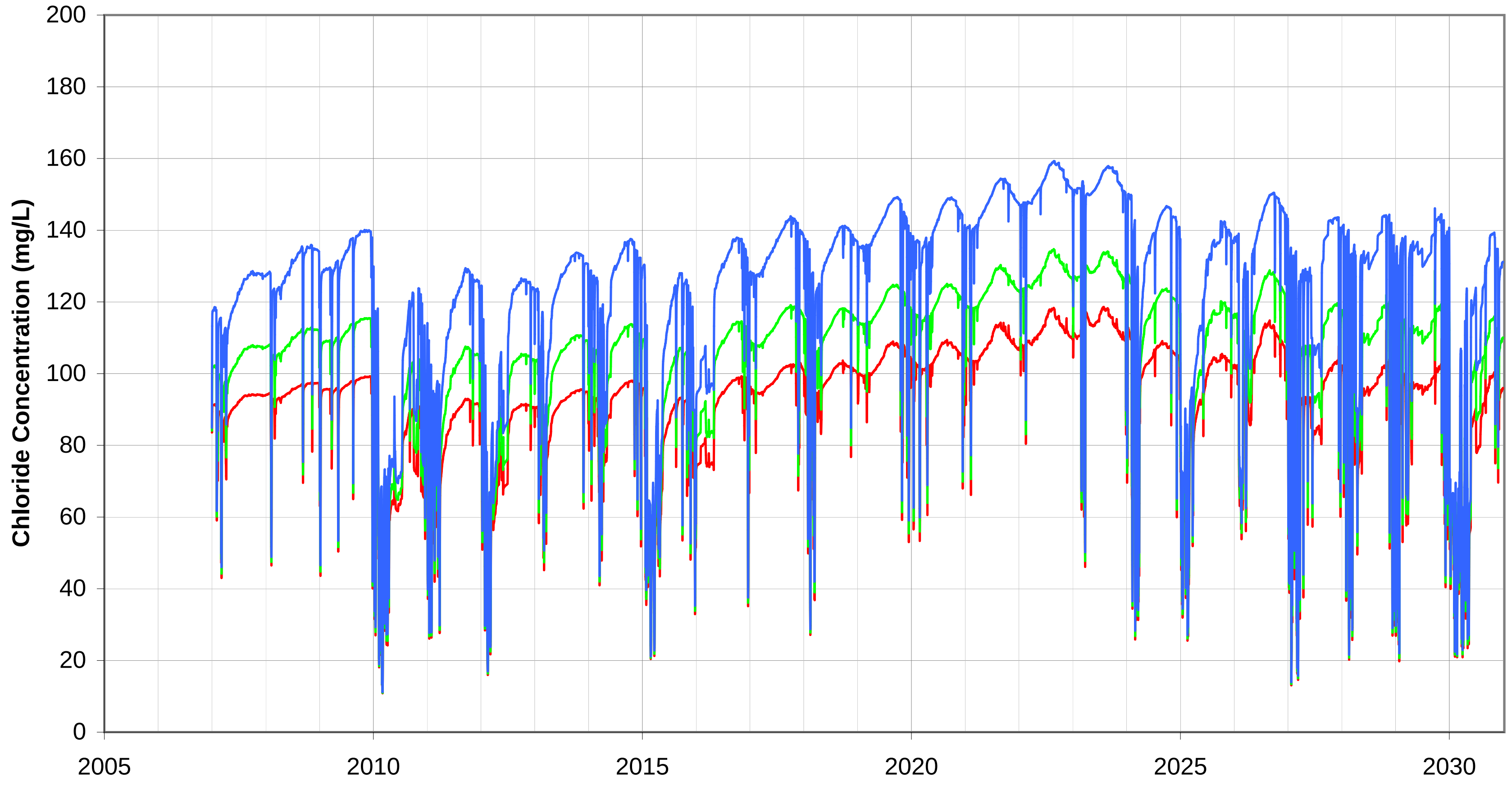
By: ker	Date: 1/28/08	Project No.: 10354
Geomatrix		Figure **3**



GSWIM PREDICTED CONCENTRATIONS AT
SCR-RD SCENARIOS 2A, 2B, 2C

Upper Santa Clara River Chloride TMDL
Santa Clara River Valley, California

By: ker	Date: 1/28/08	Project No.:10354
Geomatrix		Figure 4



Intermediate Reuse; 100mg/L Cl Discharge Valencia & Saugus WRP (2a)

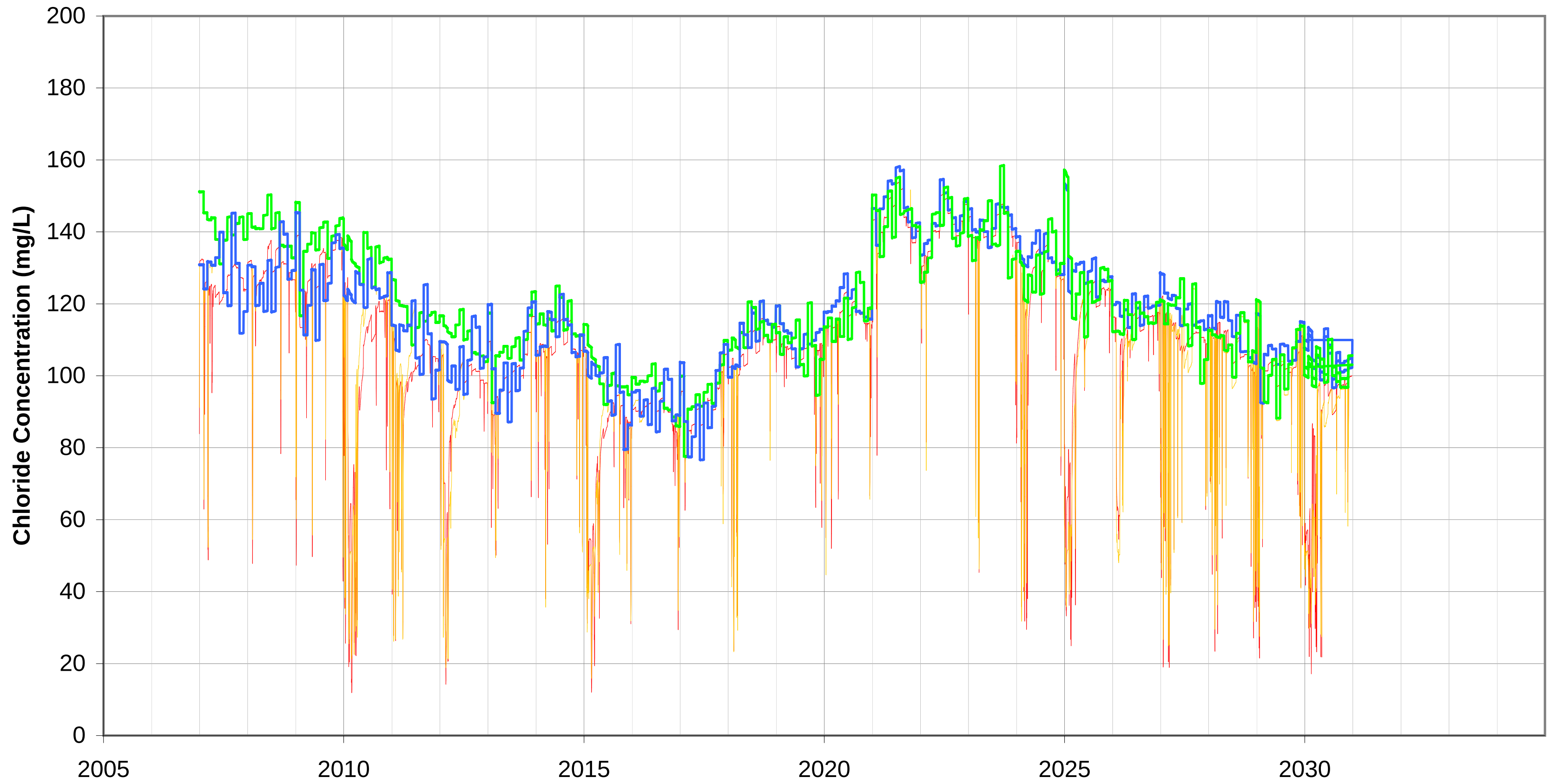
Intermediate Reuse; 120mg/L Cl Discharge Valencia & Saugus WRP (2b)

Intermediate Reuse; 150mg/L Cl Discharge Valencia & Saugus WRP (2c)

GSWIM PREDICTED CONCENTRATIONS AT BLUE CUT SCENARIOS 2A, 2B, 2C

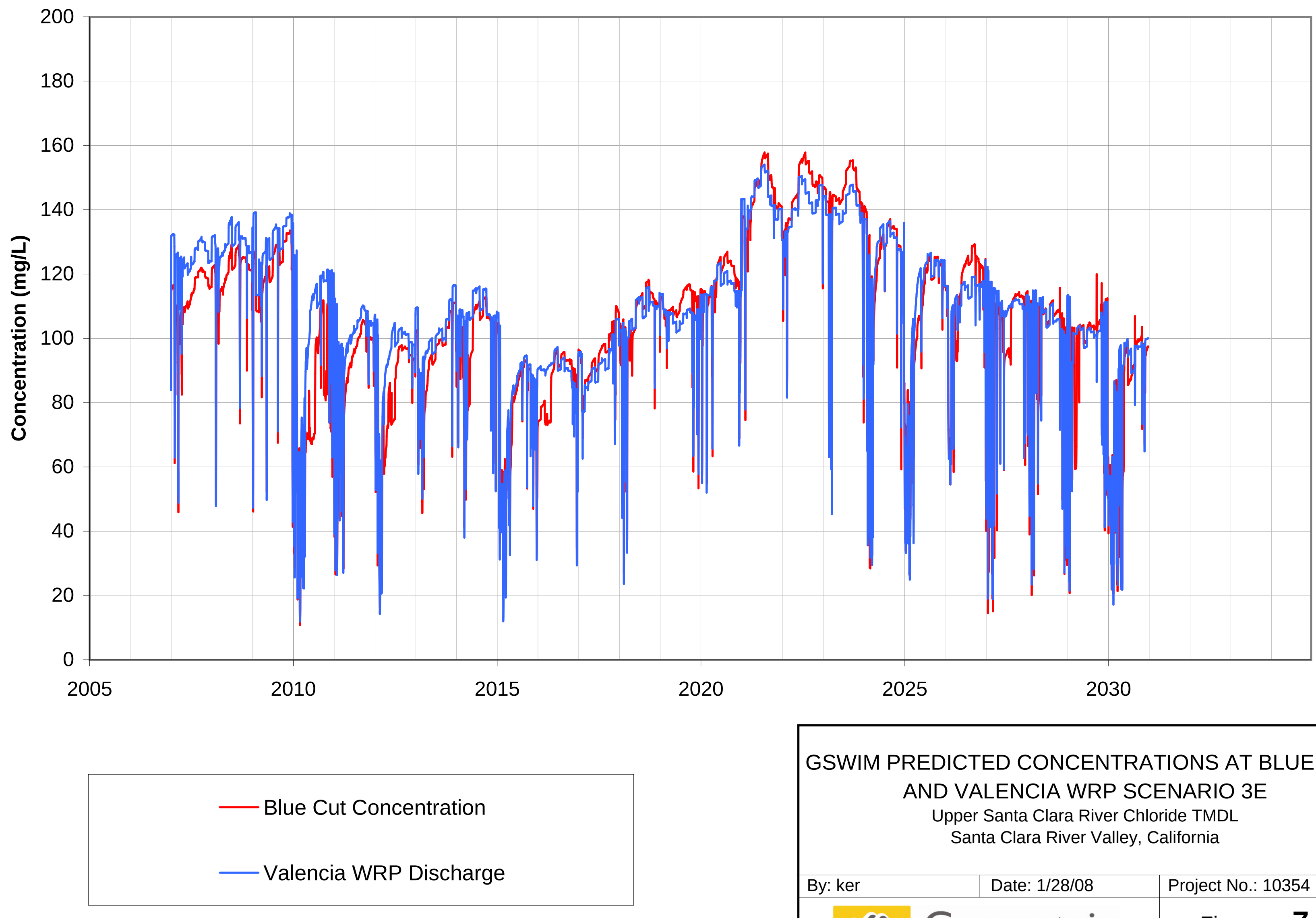
Upper Santa Clara River Chloride TMDL
Santa Clara River Valley, California

By:ker	Date: 1/28/08	Project No.:10354
Geomatrix		Figure **5**



GSWIM PREDICTED CONCENTRATIONS AT WRPs AND DOWNSTREAM LOCATIONS
SCENARIO 3E
Upper Santa Clara River Chloride TMDL
Santa Clara River Valley, California

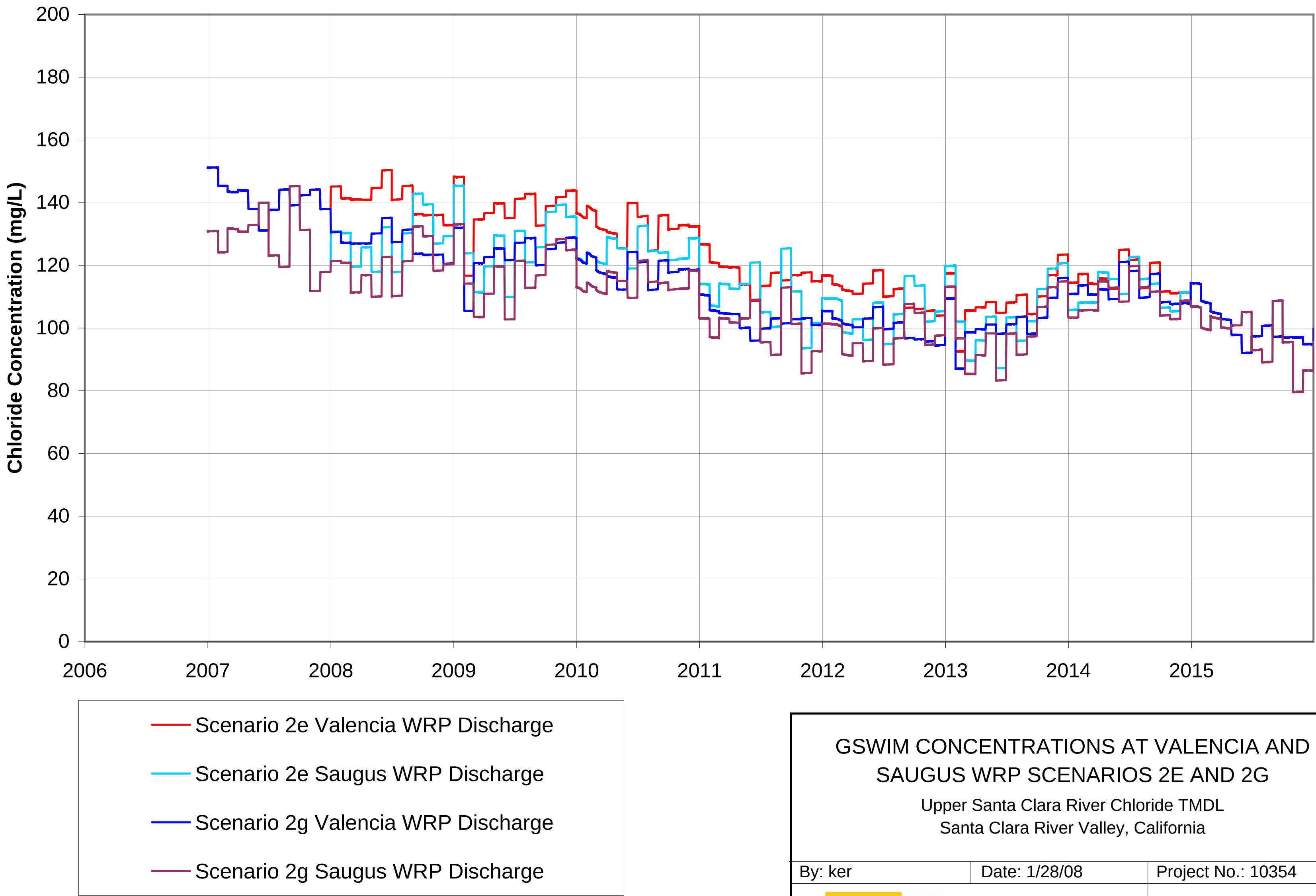
By: ker	Date:1/28/2008	Project No.: 10354
Geomatrix		Figure 6



GSWIM PREDICTED CONCENTRATIONS AT BLUE CUT AND VALENCIA WRP SCENARIO 3E

Upper Santa Clara River Chloride TMDL
Santa Clara River Valley, California

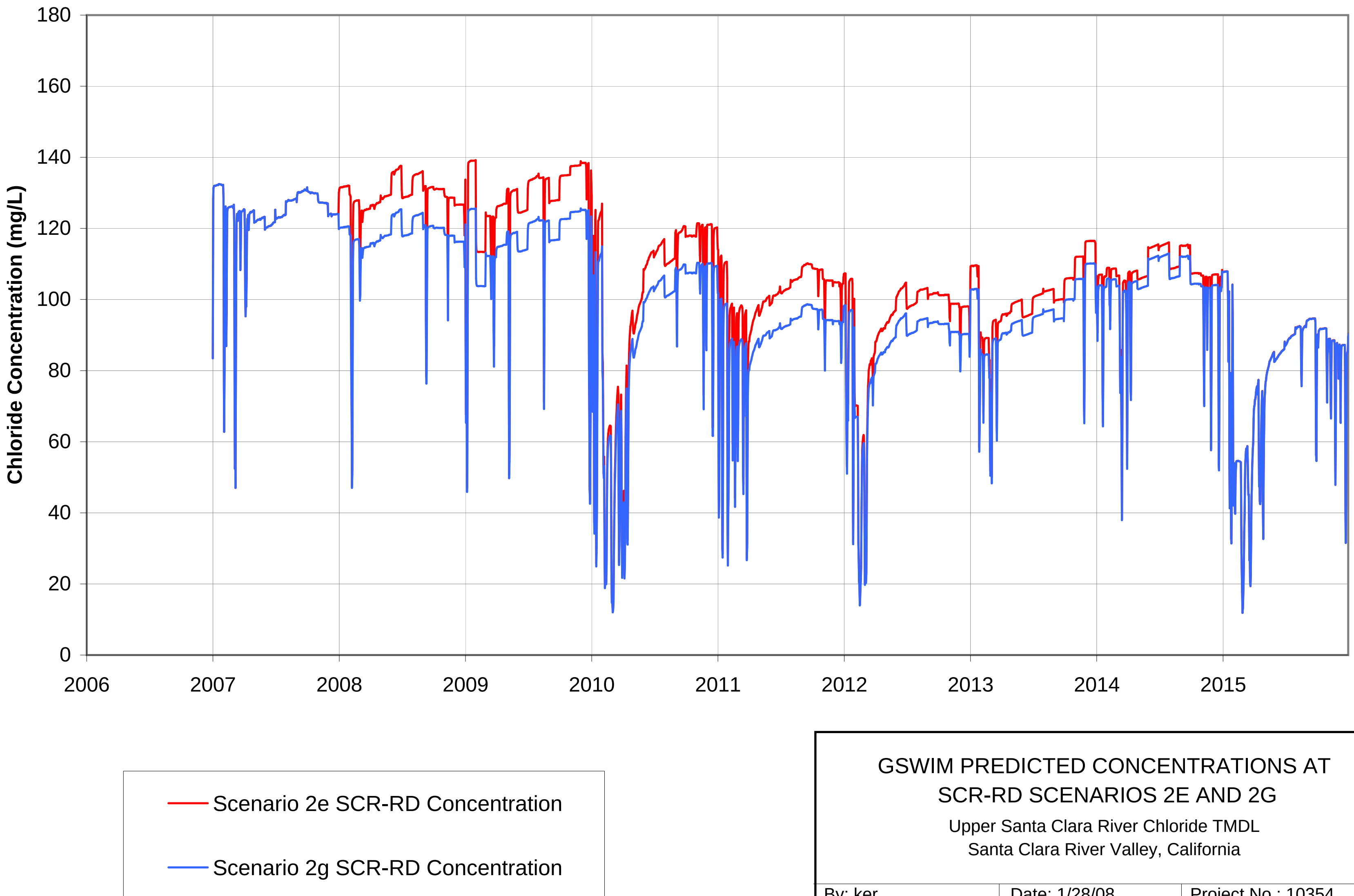
By: ker	Date: 1/28/08	Project No.: 10354
Geomatrix		Figure 7



GSWIM CONCENTRATIONS AT VALENCIA AND SAUGUS WRP SCENARIOS 2E AND 2G

Upper Santa Clara River Chloride TMDL
Santa Clara River Valley, California

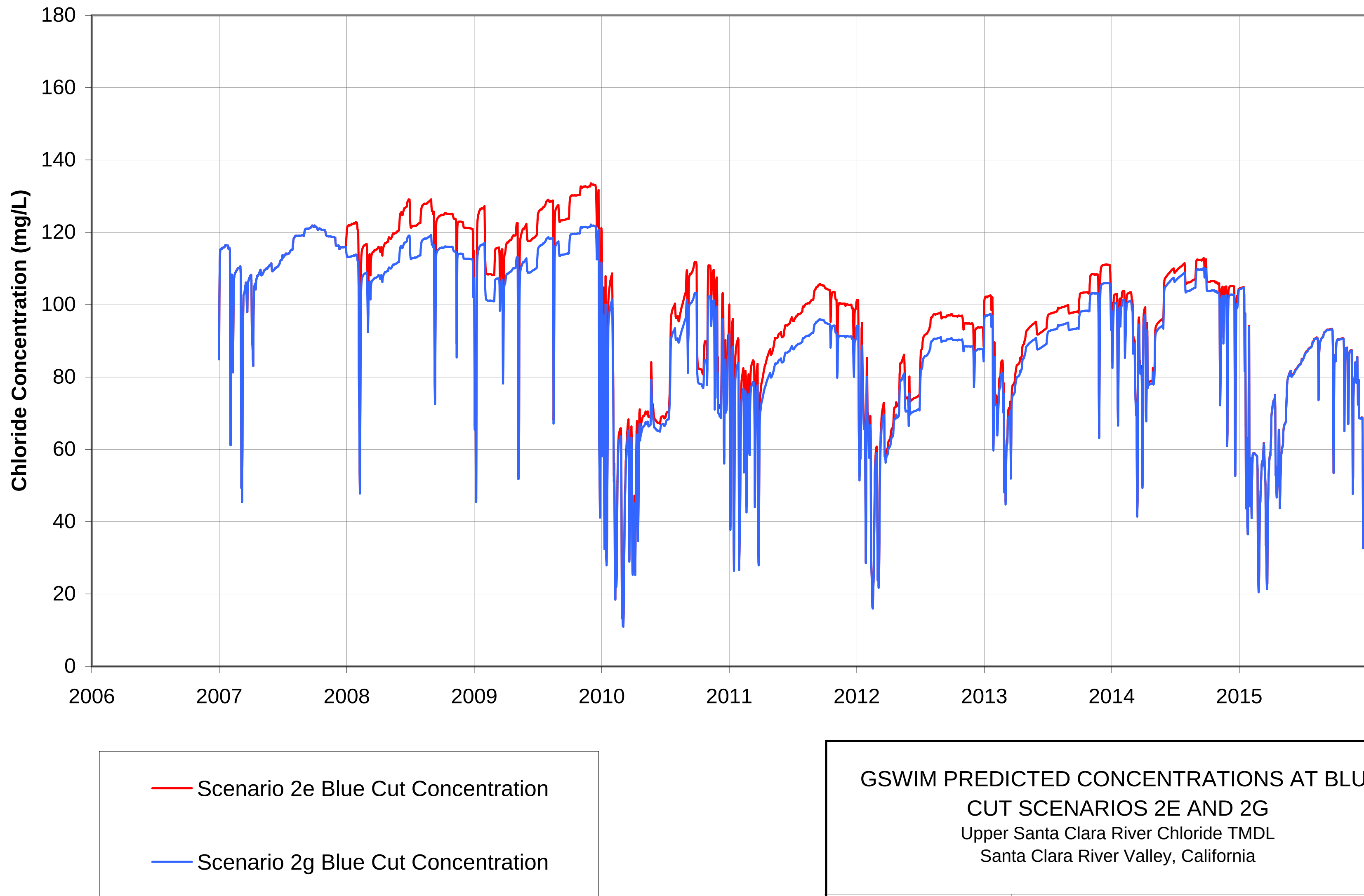
By: ker	Date: 1/28/08	Project No.: 10354
Geomatrix		Figure **8**



GSWIM PREDICTED CONCENTRATIONS AT
SCR-RD SCENARIOS 2E AND 2G

Upper Santa Clara River Chloride TMDL
Santa Clara River Valley, California

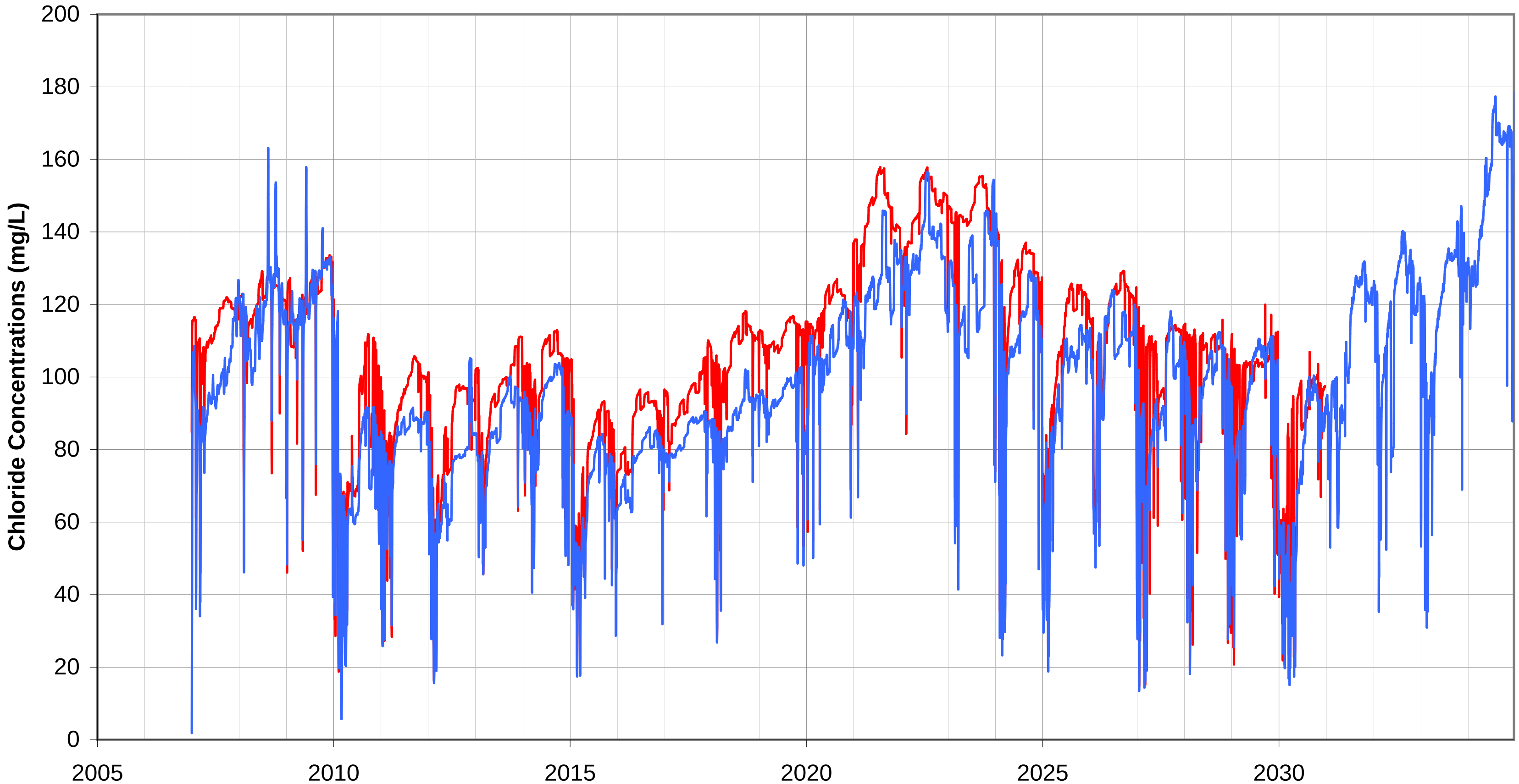
By: ker	Date: 1/28/08	Project No.: 10354
Geomatrix		Figure **9**



GSWIM PREDICTED CONCENTRATIONS AT BLUE CUT SCENARIOS 2E AND 2G

Upper Santa Clara River Chloride TMDL
Santa Clara River Valley, California

By: ker	Date: 1/28/08	Project No.: 10354
Geomatrix		Figure **10**



Scenario 3e Blue Cut Concentrations

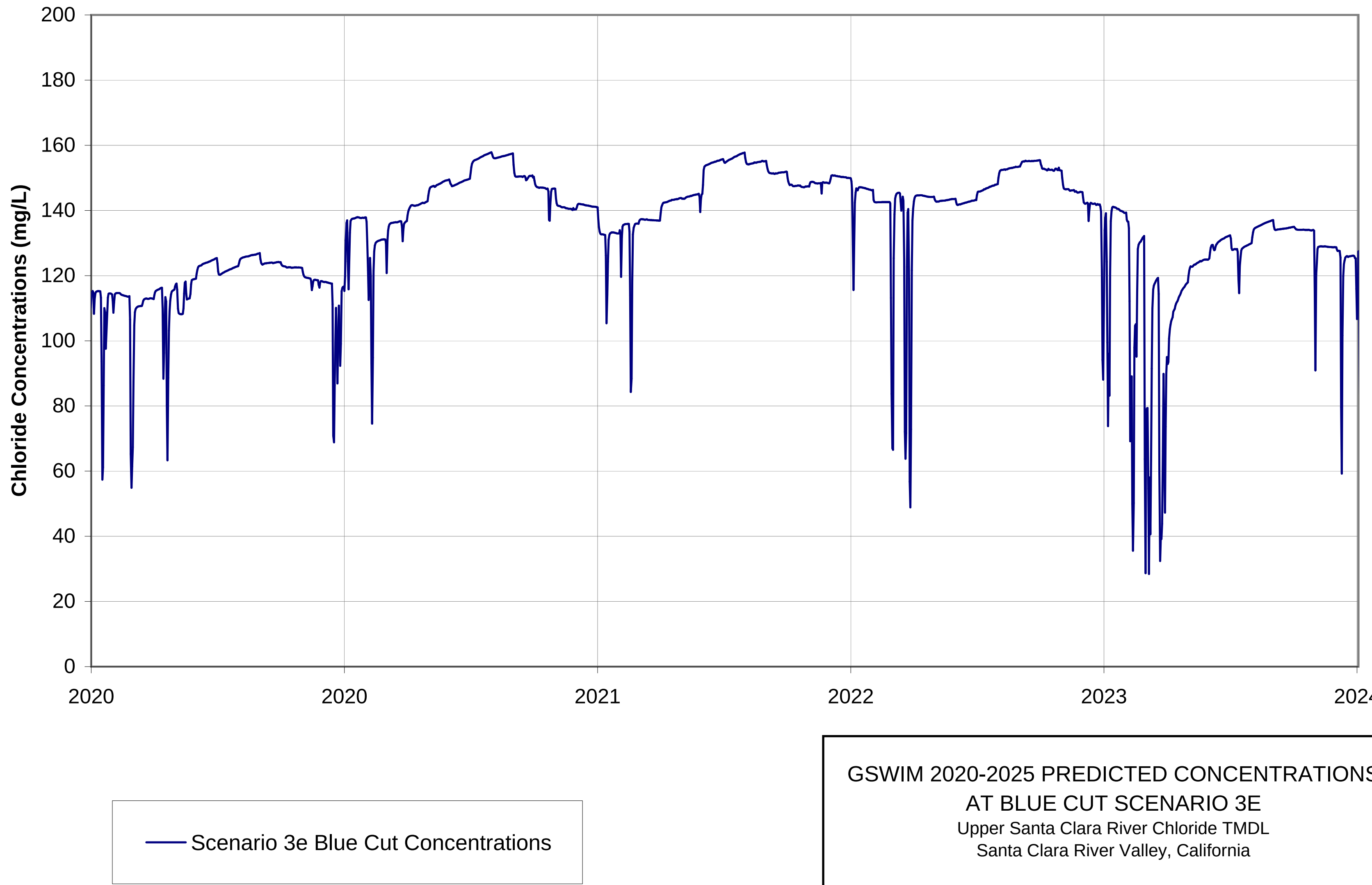
Historical Blue Cut Concentrations

GSWIM HISTORIC AND PREDICTED CONCENTRATIONS AT BLUE CUT SCENARIO 3E

Upper Santa Clara River Chloride TMDL

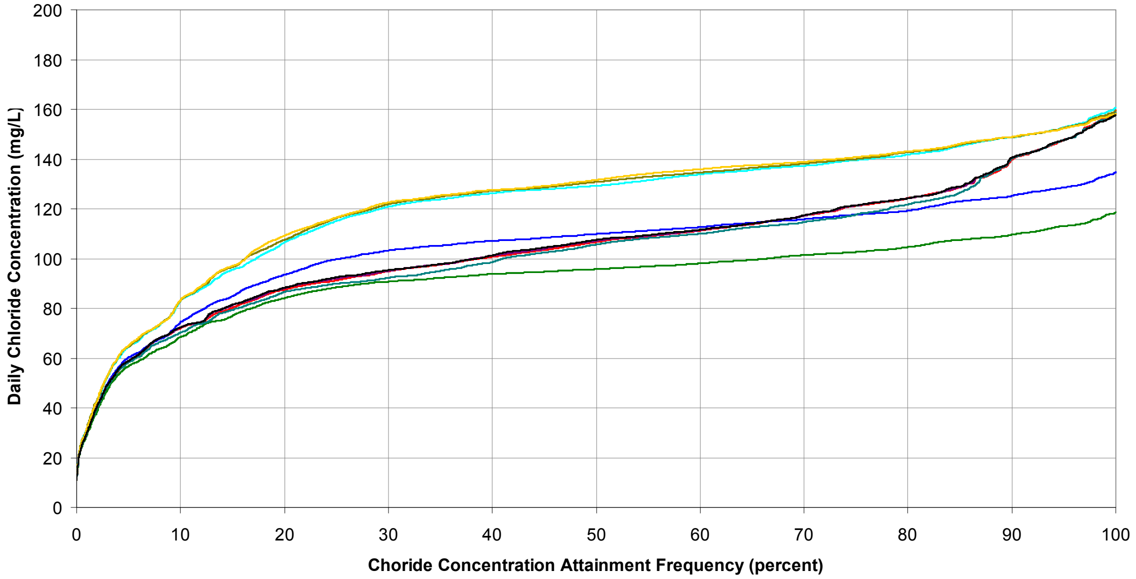
Santa Clara River Valley, California

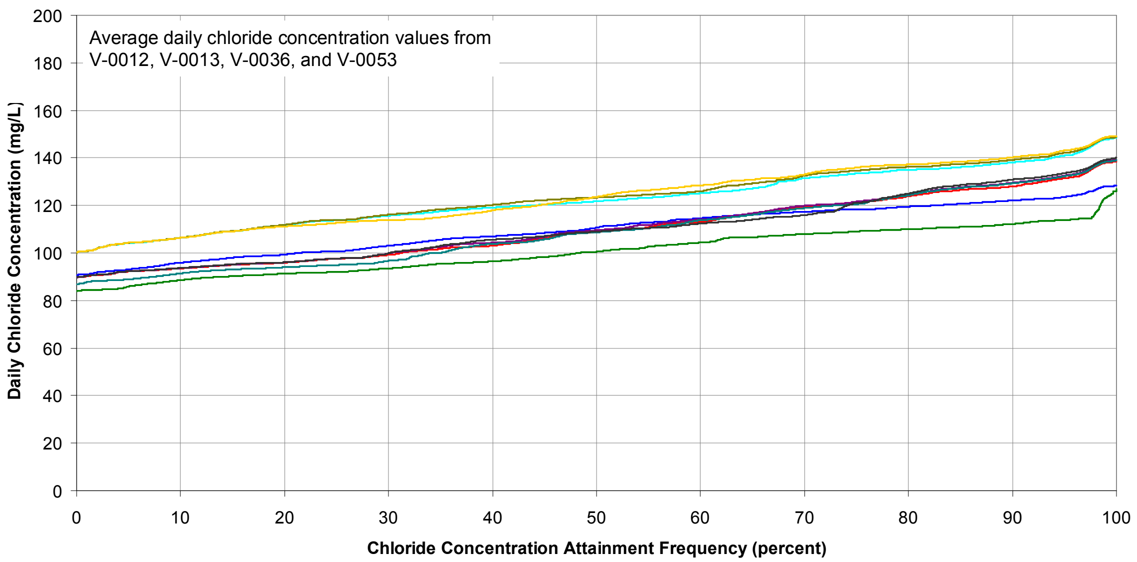
By: ker	Date: 1/28/08	Project No.: 10354
Geomatrix		Figure **11**

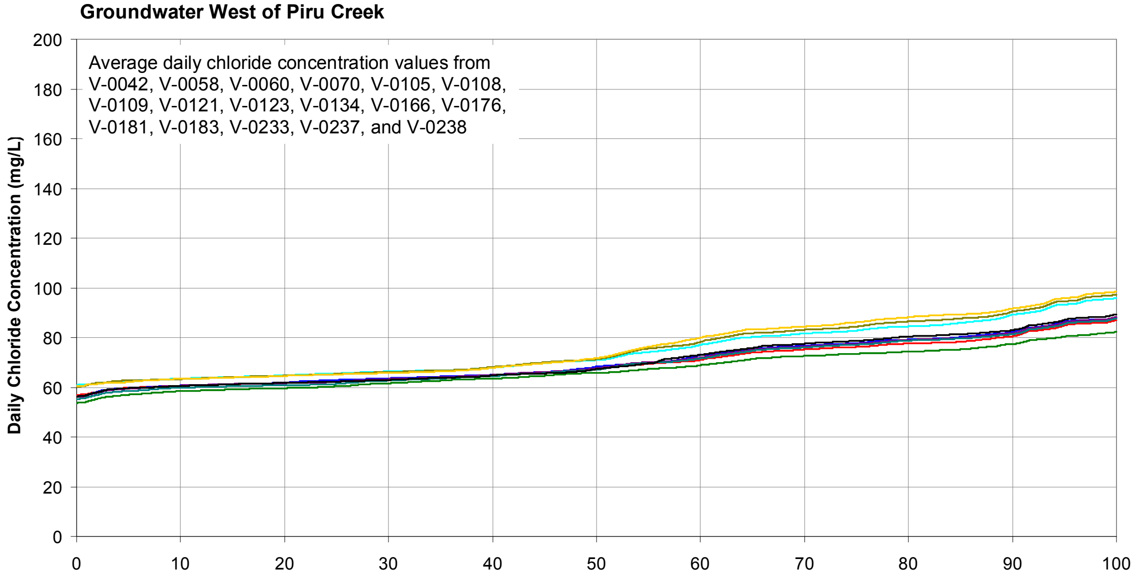


GSWIM 2020-2025 PREDICTED CONCENTRATIONS
AT BLUE CUT SCENARIO 3E
Upper Santa Clara River Chloride TMDL
Santa Clara River Valley, California

By: ker	Date: 1/28/08	Project No.: 10354
Geomatrix		Figure **12**







Daily Chloride Threshold Attainment Frequencies (percent)

Blue Cut (11108500)

Scenario	Surface Water WQO	Avocado Threshold	
	100 mg/L	100 mg/L	120 mg/L
1c	17.2	17.2	29.2
1e	38.7	38.7	73.5
2a	66.4	66.4	100.0
2b	25.4	25.4	81.1
2c	16.2	16.2	28.4
2e	38.2	38.2	73.4
2g	41.0	41.0	78.1
3c	16.2	16.2	27.9
3e	38.5	38.5	73.1

Groundwater East of Piru Creek

Scenario	Groundwater WQO	Avocado Threshold	
	200 mg/L	100 mg/L	120 mg/L
1c	100.0	0.0	43.6
1e	100.0	31.2	71.8
2a	100.0	48.3	98.4
2b	100.0	21.3	82.4
2c	100.0	0.0	39.5
2e	100.0	30.1	70.2
2g	100.0	34.5	72.9
3c	100.0	0.0	44.4
3e	100.0	30.1	74.1

Groundwater West of Piru Creek

Scenario	Groundwater WQO	Avocado Threshold	
	100 mg/L	100 mg/L	120 mg/L
1c	100.0	100.0	100.0
1e	100.0	100.0	100.0
2a	100.0	100.0	100.0
2b	100.0	100.0	100.0
2c	100.0	100.0	100.0
2e	100.0	100.0	100.0
2g	100.0	100.0	100.0
3c	100.0	100.0	100.0
3e	100.0	100.0	100.0

Explanation

- Intermediate Reuse; 100 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 2a)
- Intermediate Reuse; 120 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 2b)
- High Reuse; 150 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 1c)
- Intermediate Reuse; 150 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 2c)
- Low Reuse; 150 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 3c)
- High Reuse; 0 Percent Removal of Self Regenerating Water Softeners (Scenario 1e)
- Intermediate Reuse; 0 Percent Removal of Self Regenerating Water Softeners (Scenario 2e)
- Low Reuse; 0 Percent Removal of Self Regenerating Water Softeners (Scenario 3e)
- Intermediate Reuse; 100 Percent Removal of Self Regenerating Water Softeners (Scenario 2g)

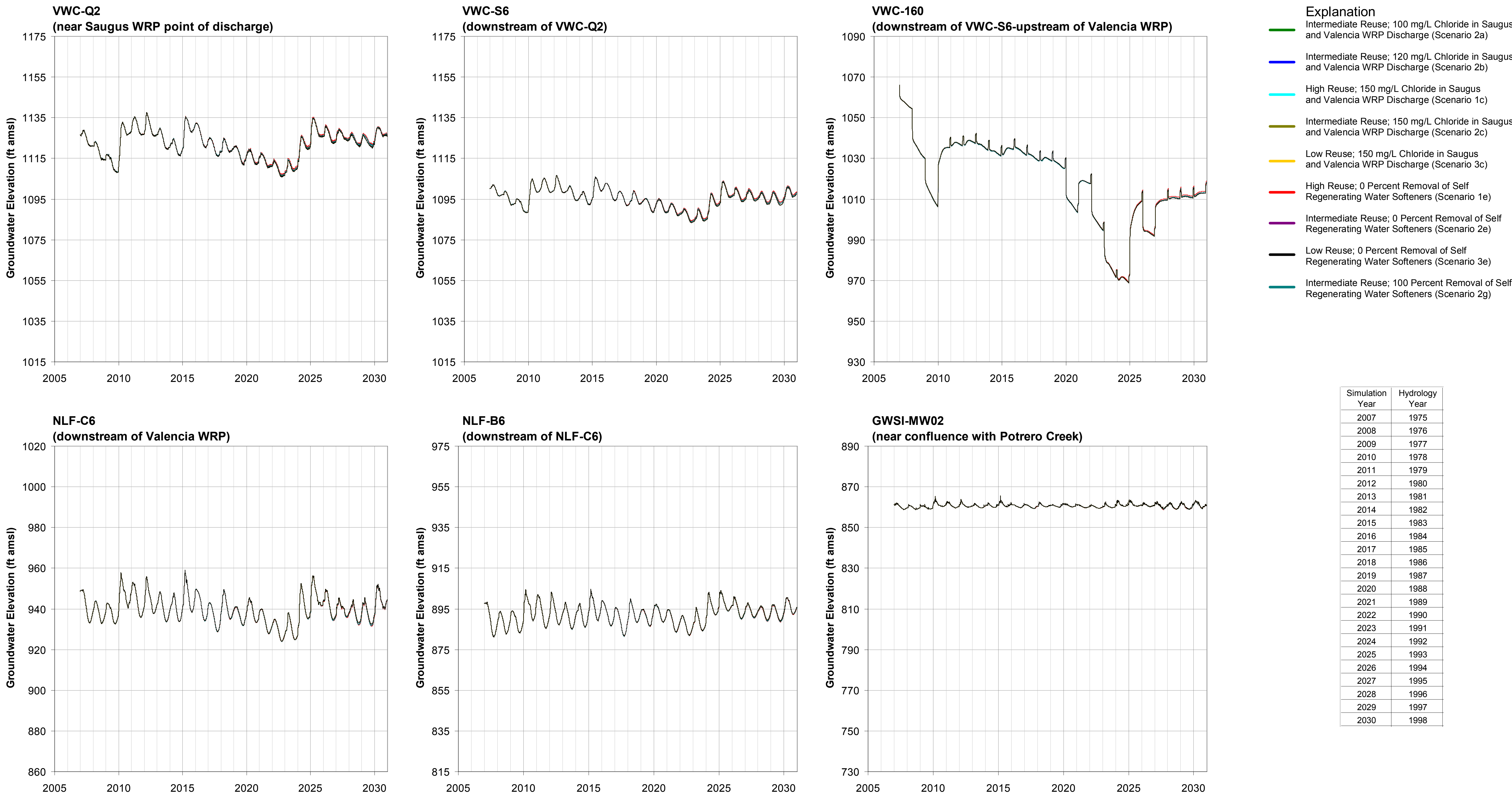
Notes:
1. See Appendices C and D for simulated daily chloride concentrations.
2. Attainment frequency represents the percent of time during the future simulation period that chloride concentrations were at or below the indicated daily chloride concentration.

SIMULATED DAILY CHLORIDE CONCENTRATION ATTAINMENT FREQUENCIES AT BLUE CUT AND THE PIRU SUBBASIN
SCENARIOS 1C/E, 2A/B/C/E/G, 3C, 3E
Upper Santa Clara River Chloride TMDL
Santa Clara River Valley, California

Geomatrix	Project No. 10354	Figure 13

APPENDIX A

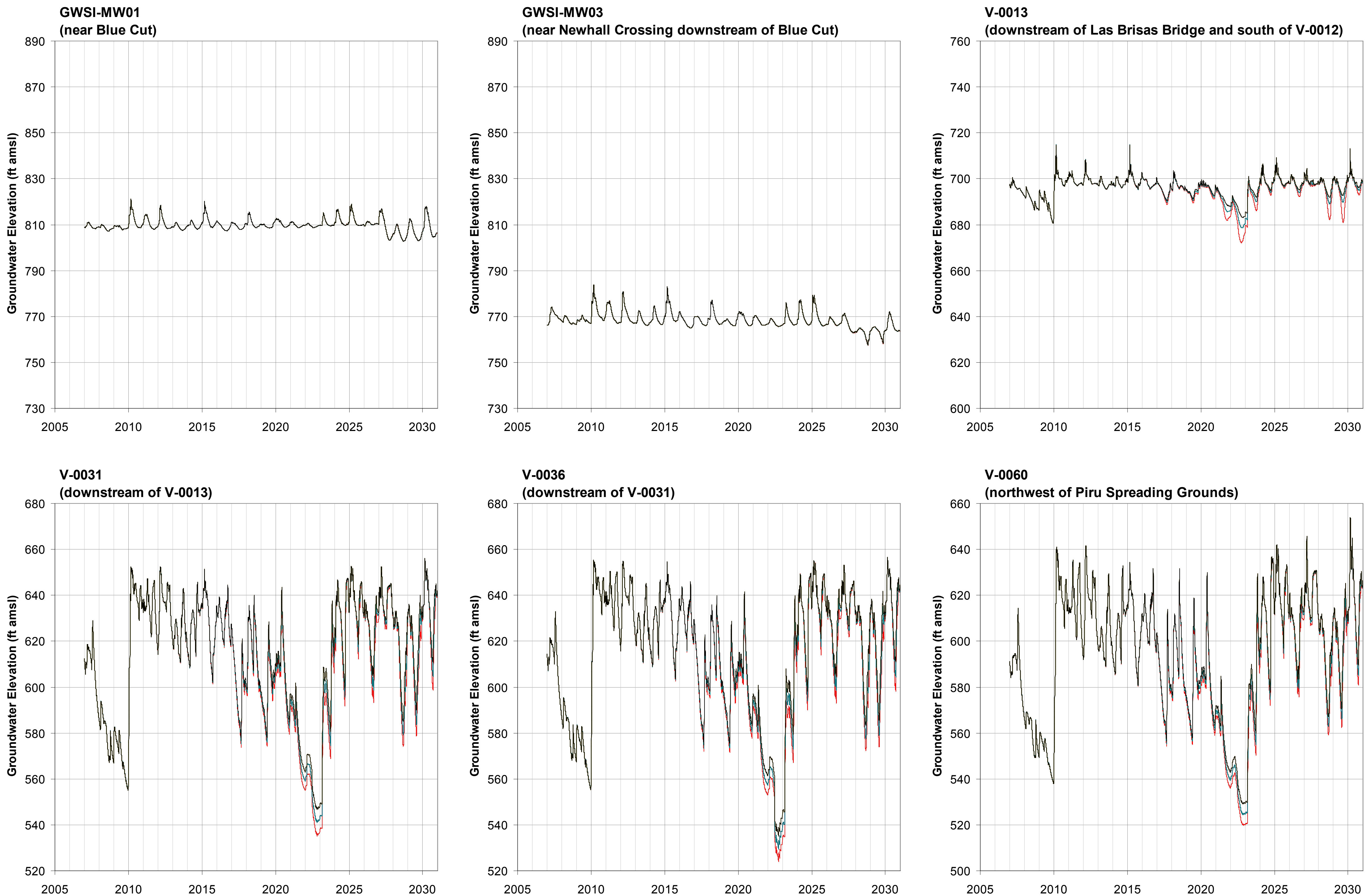
SIMULATED GROUNDWATER ELEVATIONS AT SELECTED OBSERVATION WELLS



Simulation Year	Hydrology Year
2007	1975
2008	1976
2009	1977
2010	1978
2011	1979
2012	1980
2013	1981
2014	1982
2015	1983
2016	1984
2017	1985
2018	1986
2019	1987
2020	1988
2021	1989
2022	1990
2023	1991
2024	1992
2025	1993
2026	1994
2027	1995
2028	1996
2029	1997
2030	1998

SIMULATED GROUNDWATER ELEVATIONS IN WELLS LOCATED IN THE EAST SUBBASIN
SCENARIOS 1C/E, 2A/B/C/E/G, 3C, 3E
Upper Santa Clara River Chloride TMDL
Santa Clara River Valley, California

Geomatrix | Project No. 10354 | Figure A-1



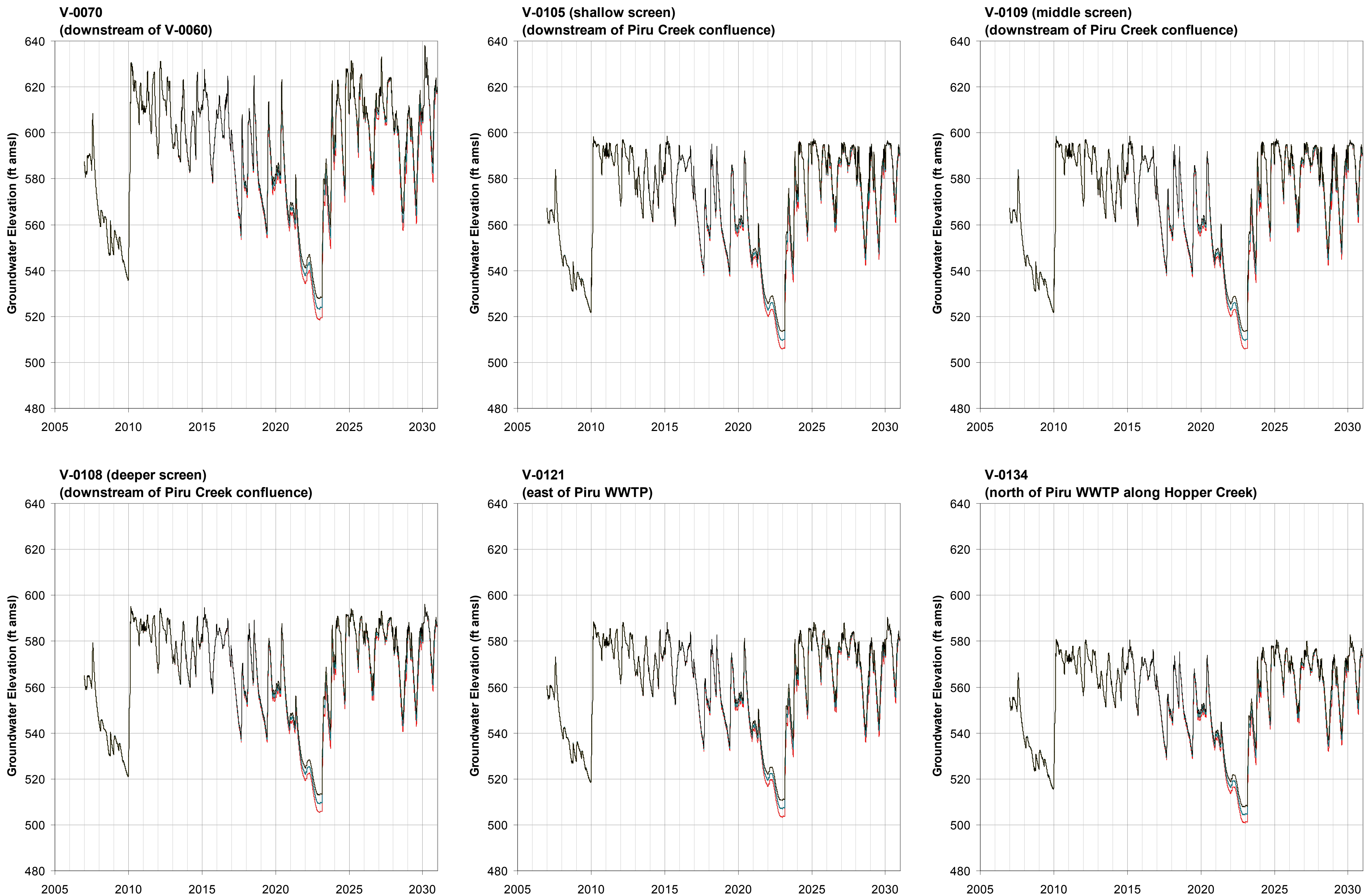
Explanation

- Intermediate Reuse; 100 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 2a)
- Intermediate Reuse; 120 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 2b)
- High Reuse; 150 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 1c)
- Intermediate Reuse; 150 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 2c)
- Low Reuse; 150 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 3c)
- High Reuse; 0 Percent Removal of Self Regenerating Water Softeners (Scenario 1e)
- Intermediate Reuse; 0 Percent Removal of Self Regenerating Water Softeners (Scenario 2e)
- Low Reuse; 0 Percent Removal of Self Regenerating Water Softeners (Scenario 3e)
- Intermediate Reuse; 100 Percent Removal of Self Regenerating Water Softeners (Scenario 2g)

Simulation Year	Hydrology Year
2007	1975
2008	1976
2009	1977
2010	1978
2011	1979
2012	1980
2013	1981
2014	1982
2015	1983
2016	1984
2017	1985
2018	1986
2019	1987
2020	1988
2021	1989
2022	1990
2023	1991
2024	1992
2025	1993
2026	1994
2027	1995
2028	1996
2029	1997
2030	1998

SIMULATED GROUNDWATER ELEVATIONS IN WELLS LOCATED EAST OF TORREY ROAD IN THE PIRU SUBBASIN
SCENARIOS 1C/E, 2A/B/C/E/G, 3C, 3E
Upper Santa Clara River Chloride TMDL
Santa Clara River Valley, California

Geomatrix | Project No. 10354 | Figure A-2



Simulation Year	Hydrology Year
2007	1975
2008	1976
2009	1977
2010	1978
2011	1979
2012	1980
2013	1981
2014	1982
2015	1983
2016	1984
2017	1985
2018	1986
2019	1987
2020	1988
2021	1989
2022	1990
2023	1991
2024	1992
2025	1993
2026	1994
2027	1995
2028	1996
2029	1997
2030	1998

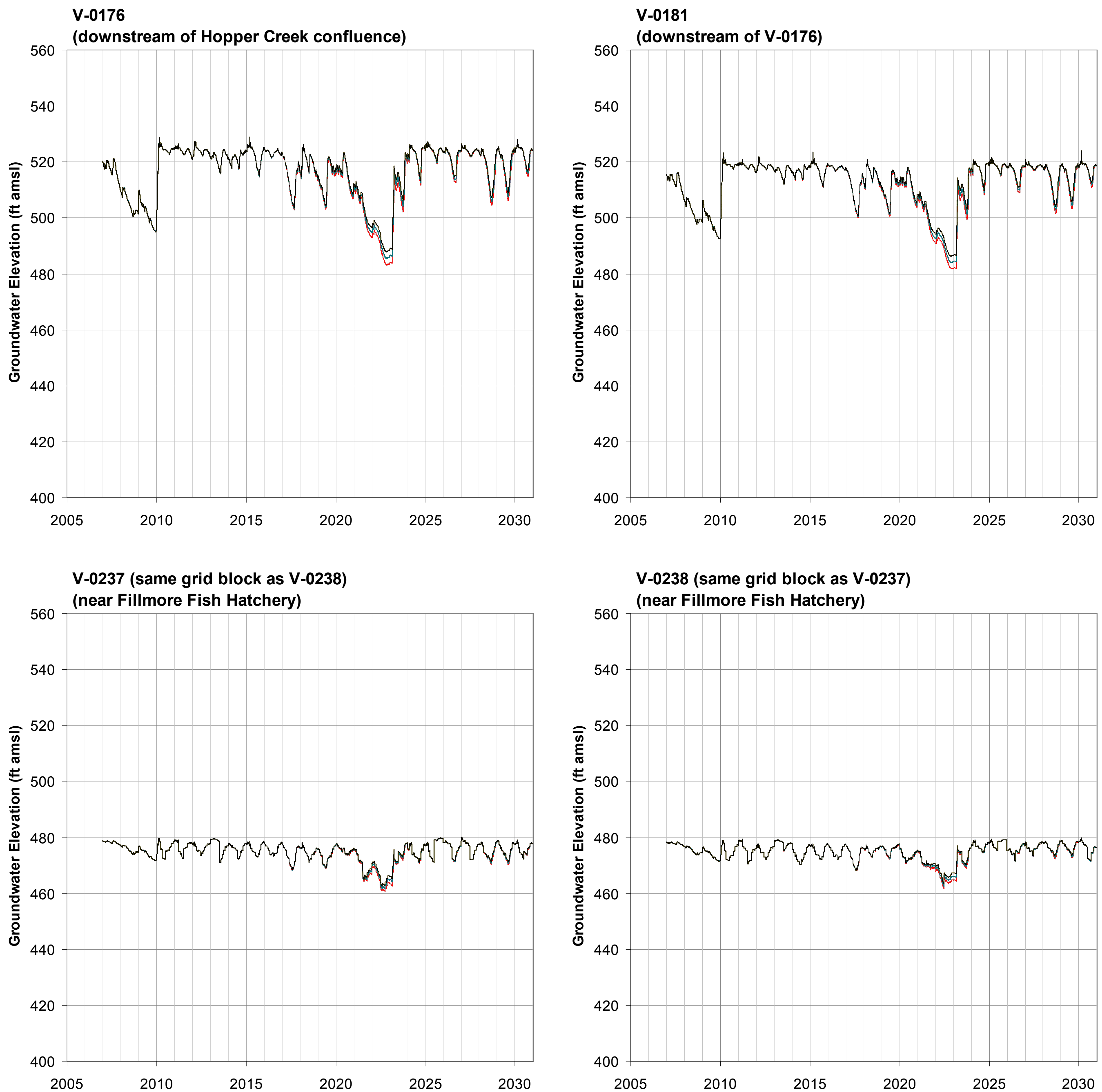
SIMULATED GROUNDWATER ELEVATIONS IN WELLS LOCATED BETWEEN HOPPER CREEK AND TORREY ROAD IN THE PIRU SUBBASIN
SCENARIOS 1C/E, 2A/B/C/E/G, 3C, 3E

Upper Santa Clara River Chloride TMDL
Santa Clara River Valley, California

Geomatrix

Project No. 10354

Figure A-3



Explanation

- Intermediate Reuse; 100 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 2a)
- Intermediate Reuse; 120 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 2b)
- High Reuse; 150 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 1c)
- Intermediate Reuse; 150 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 2c)
- Low Reuse; 150 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 3c)
- High Reuse; 0 Percent Removal of Self Regenerating Water Softeners (Scenario 1e)
- Intermediate Reuse; 0 Percent Removal of Self Regenerating Water Softeners (Scenario 2e)
- Low Reuse; 0 Percent Removal of Self Regenerating Water Softeners (Scenario 3e)
- Intermediate Reuse; 100 Percent Removal of Self Regenerating Water Softeners (Scenario 2g)

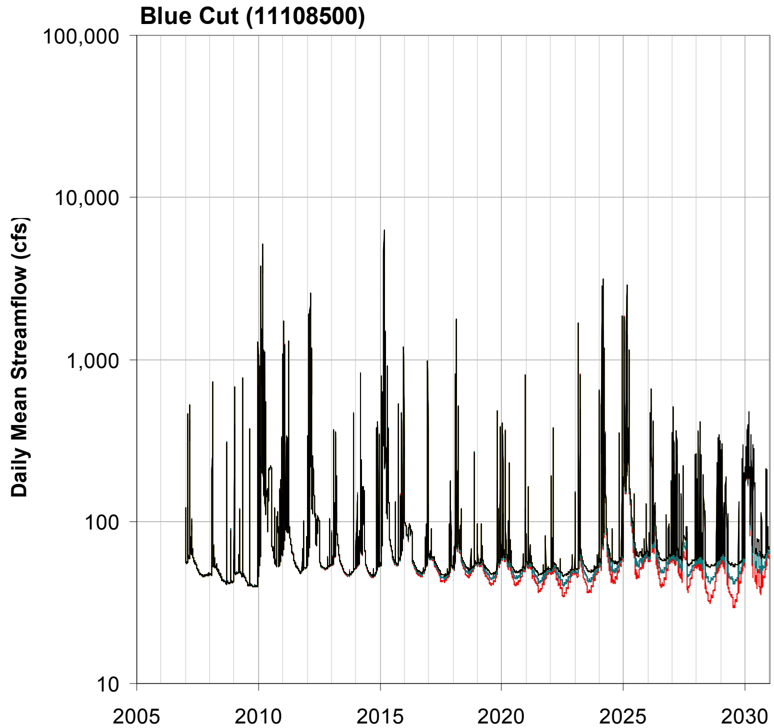
Simulation Year	Hydrology Year
2007	1975
2008	1976
2009	1977
2010	1978
2011	1979
2012	1980
2013	1981
2014	1982
2015	1983
2016	1984
2017	1985
2018	1986
2019	1987
2020	1988
2021	1989
2022	1990
2023	1991
2024	1992
2025	1993
2026	1994
2027	1995
2028	1996
2029	1997
2030	1998

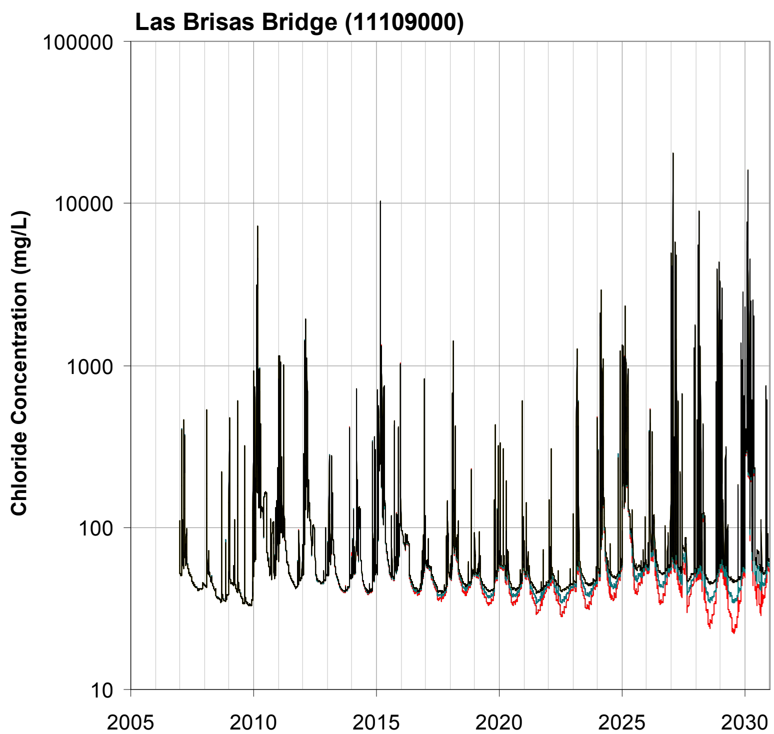
SIMULATED GROUNDWATER ELEVATIONS IN WELLS LOCATED WEST OF HOPPER CREEK IN THE PIRU SUBBASIN
SCENARIOS 1C/E, 2A/B/C/E/G, 3C, 3E
Upper Santa Clara River Chloride TMDL
Santa Clara River Valley, California

Geomatrix | Project No. 10354 | Figure A-4

APPENDIX B

SIMULATED STREAMFLOWS AT SELECTED SURFACE WATER LOCATIONS





Explanation

- Intermediate Reuse; 100 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 2a)
- Intermediate Reuse; 120 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 2b)
- High Reuse; 150 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 1c)
- Intermediate Reuse; 150 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 2c)
- Low Reuse; 150 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 3c)
- High Reuse; 0 Percent Removal of Self Regenerating Water Softeners (Scenario 1e)
- Intermediate Reuse; 0 Percent Removal of Self Regenerating Water Softeners (Scenario 2e)
- Low Reuse; 0 Percent Removal of Self Regenerating Water Softeners (Scenario 3e)
- Intermediate Reuse; 100 Percent Removal of Self Regenerating Water Softeners (Scenario 2g)

Simulation Year	Hydrology Year
2007	1975
2008	1976
2009	1977
2010	1978
2011	1979
2012	1980
2013	1981
2014	1982
2015	1983
2016	1984
2017	1985
2018	1986
2019	1987
2020	1988
2021	1989
2022	1990
2023	1991
2024	1992
2025	1993
2026	1994
2027	1995
2028	1996
2029	1997
2030	1998

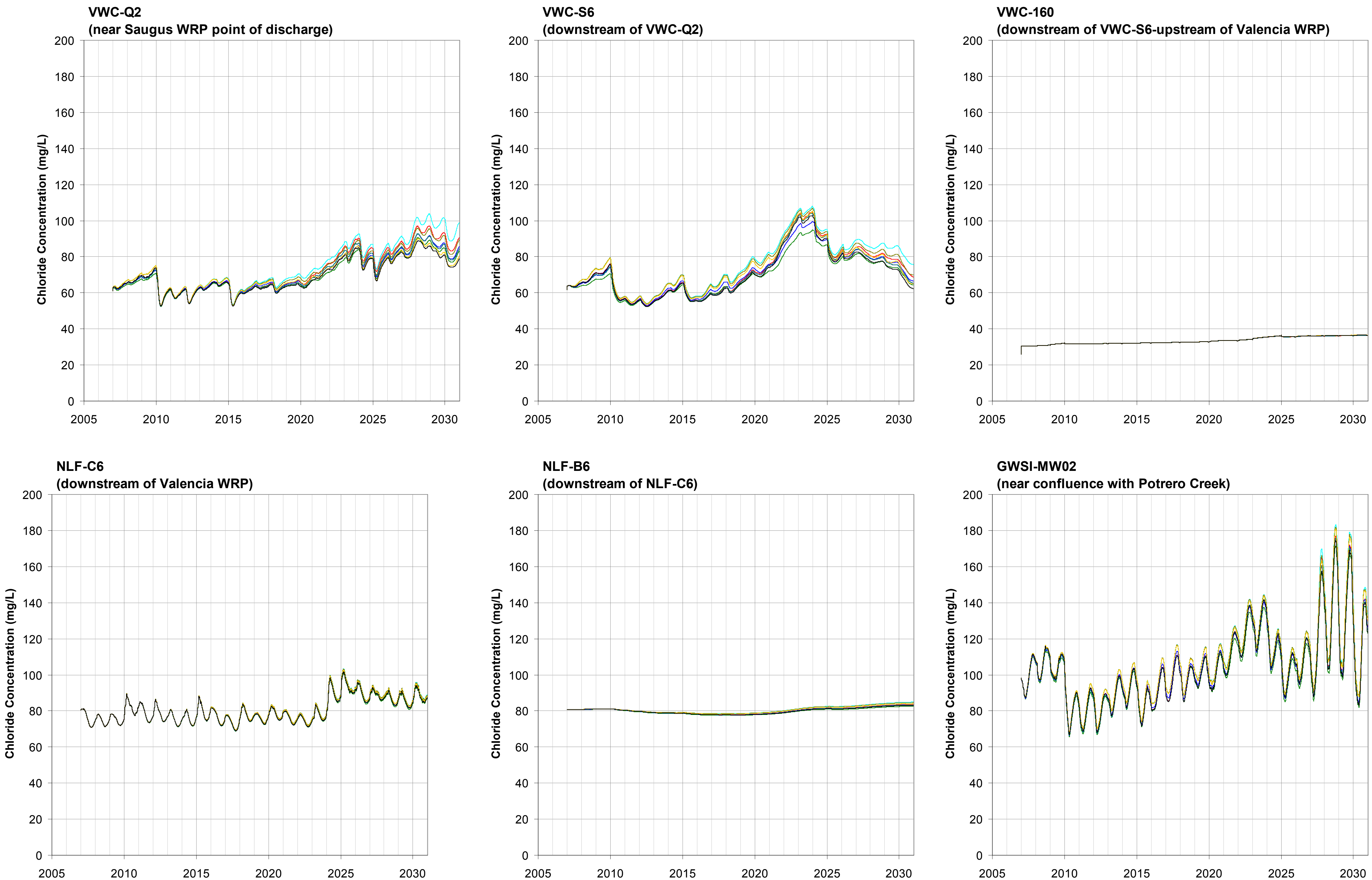
SIMULATED STREAMFLOWS AT BLUE CUT AND LAS BRISAS BRIDGE SCENARIOS 1C/E, 2A/B/C/E/G, 3C, 3E

Upper Santa Clara River Chloride TMDL
Santa Clara River Valley, California

Geomatrix	Project No. 10354	Figure **B-1**

APPENDIX C

SIMULATED GROUNDWATER CONCENTRATIONS AT SELECTED OBSERVATION WELLS



Explanation

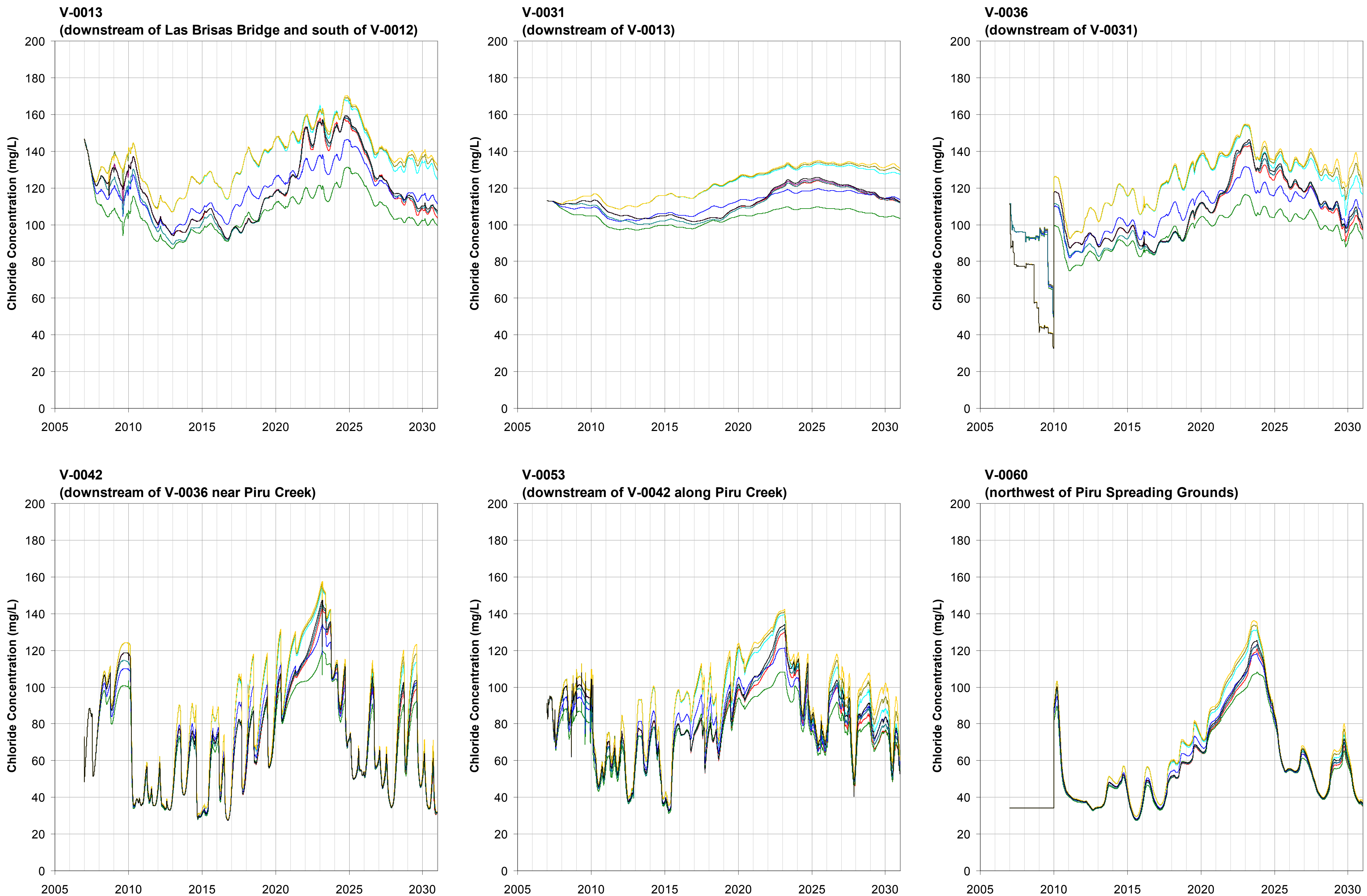
- Intermediate Reuse; 100 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 2a)
- Intermediate Reuse; 120 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 2b)
- High Reuse; 150 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 1c)
- Intermediate Reuse; 150 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 2c)
- Low Reuse; 150 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 3c)
- High Reuse; 0 Percent Removal of Self Regenerating Water Softeners (Scenario 1e)
- Intermediate Reuse; 0 Percent Removal of Self Regenerating Water Softeners (Scenario 2e)
- Low Reuse; 0 Percent Removal of Self Regenerating Water Softeners (Scenario 3e)
- Intermediate Reuse; 100 Percent Removal of Self Regenerating Water Softeners (Scenario 2g)

Simulation Year	Hydrology Year
2007	1975
2008	1976
2009	1977
2010	1978
2011	1979
2012	1980
2013	1981
2014	1982
2015	1983
2016	1984
2017	1985
2018	1986
2019	1987
2020	1988
2021	1989
2022	1990
2023	1991
2024	1992
2025	1993
2026	1994
2027	1995
2028	1996
2029	1997
2030	1998

SIMULATED CHLORIDE CONCENTRATIONS IN WELLS LOCATED IN THE EAST SUBBASIN SCENARIOS 1C/E, 2A/B/C/E/G, 3C, 3E

Upper Santa Clara River Chloride TMDL
Santa Clara River Valley, California

Geomatrix | Project No. 10354 | Figure C-1



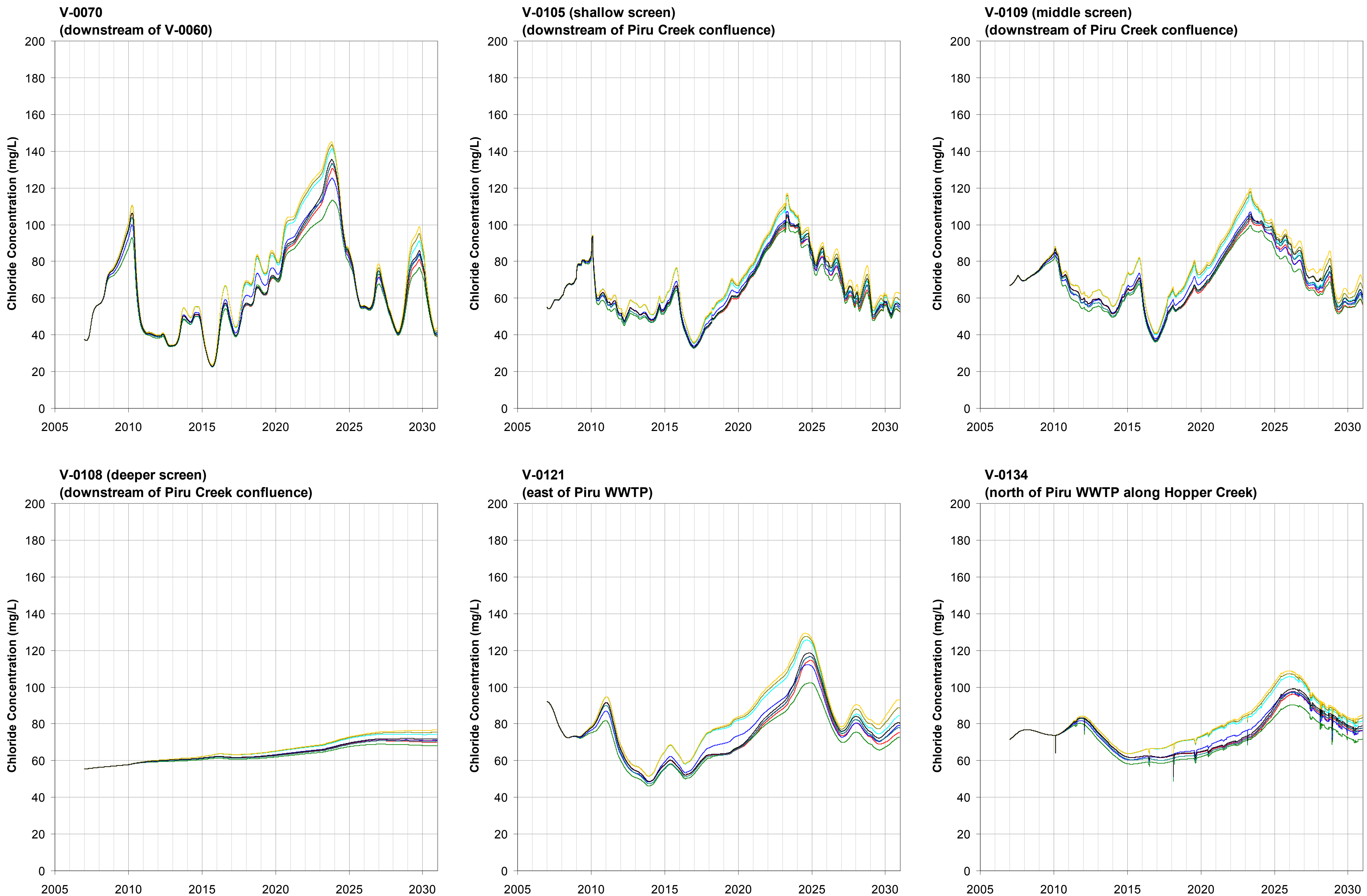
Explanation

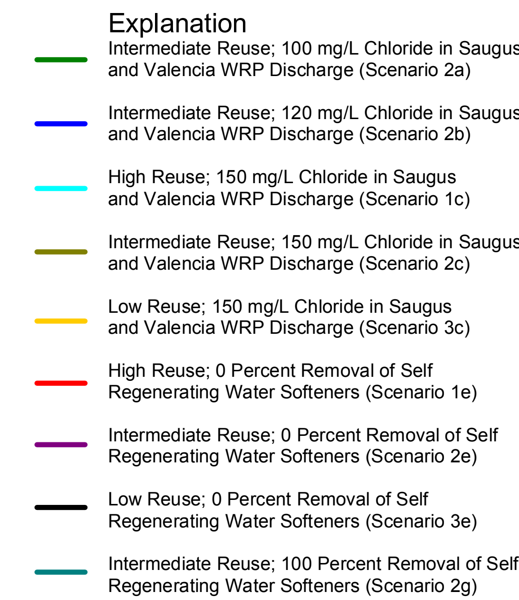
- Intermediate Reuse; 100 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 2a)
- Intermediate Reuse; 120 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 2b)
- High Reuse; 150 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 1c)
- Intermediate Reuse; 150 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 2c)
- Low Reuse; 150 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 3c)
- High Reuse; 0 Percent Removal of Self Regenerating Water Softeners (Scenario 1e)
- Intermediate Reuse; 0 Percent Removal of Self Regenerating Water Softeners (Scenario 2e)
- Low Reuse; 0 Percent Removal of Self Regenerating Water Softeners (Scenario 3e)
- Intermediate Reuse; 100 Percent Removal of Self Regenerating Water Softeners (Scenario 2g)

Simulation Year	Hydrology Year
2007	1975
2008	1976
2009	1977
2010	1978
2011	1979
2012	1980
2013	1981
2014	1982
2015	1983
2016	1984
2017	1985
2018	1986
2019	1987
2020	1988
2021	1989
2022	1990
2023	1991
2024	1992
2025	1993
2026	1994
2027	1995
2028	1996
2029	1997
2030	1998

SIMULATED CHLORIDE CONCENTRATIONS IN WELLS LOCATED EAST OF TORREY ROAD IN THE PIRU SUBBASIN
SCENARIOS 1C/E, 2A/B/C/E/G, 3C, 3E
Upper Santa Clara River Chloride TMDL
Santa Clara River Valley, California

Geomatrix | Project No. 10354 | Figure C-2





Simulation Year	Hydrology Year
2007	1975
2008	1976
2009	1977
2010	1978
2011	1979
2012	1980
2013	1981
2014	1982
2015	1983
2016	1984
2017	1985
2018	1986
2019	1987
2020	1988
2021	1989
2022	1990
2023	1991
2024	1992
2025	1993
2026	1994
2027	1995
2028	1996
2029	1997
2030	1998

SIMULATED CHLORIDE CONCENTRATIONS IN WELLS LOCATED BETWEEN HOPPER CREEK AND TORREY ROAD IN THE PIRU SUBBASIN SCENARIOS 1C/E, 2A/B/C/E/G, 3C, 3E

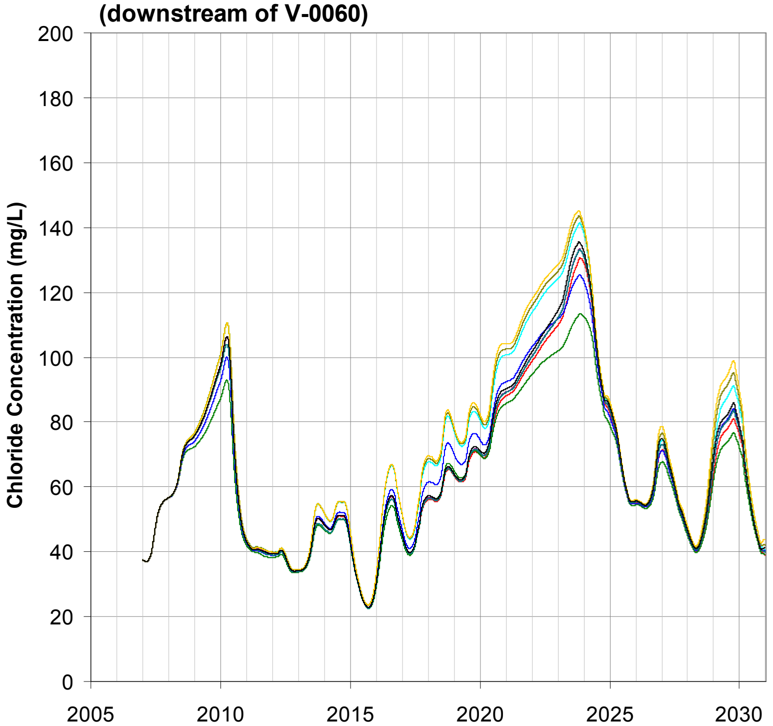
Upper Santa Clara River Chloride TMDL
Santa Clara River Valley, California

Geomatrix

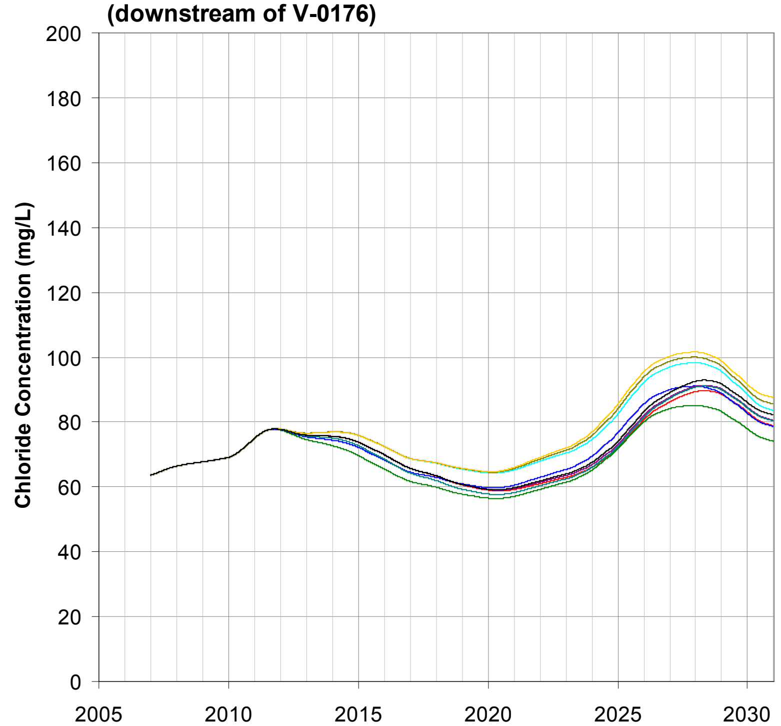
Project No. 10354

Figure C-3

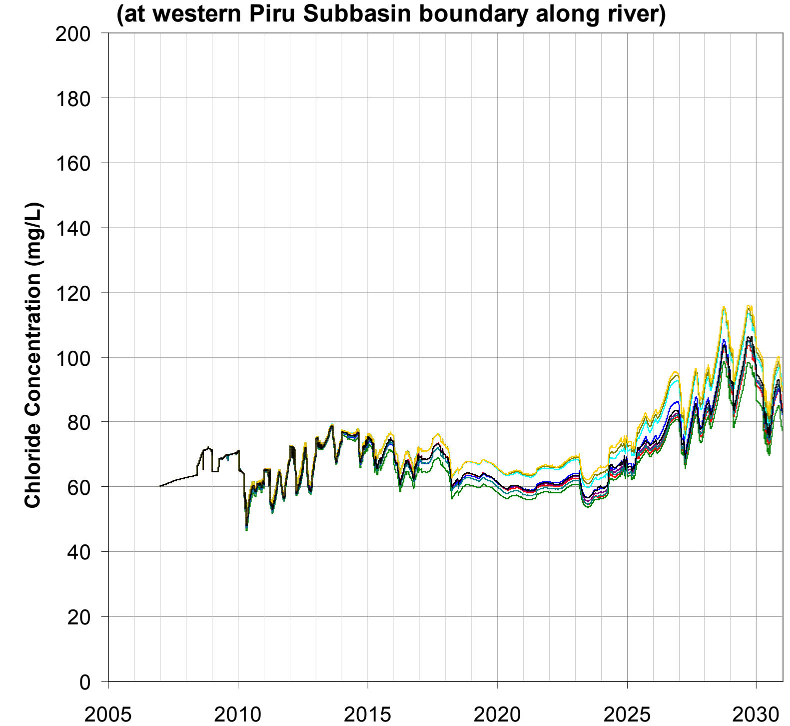
V-0070
(downstream of V-0060)



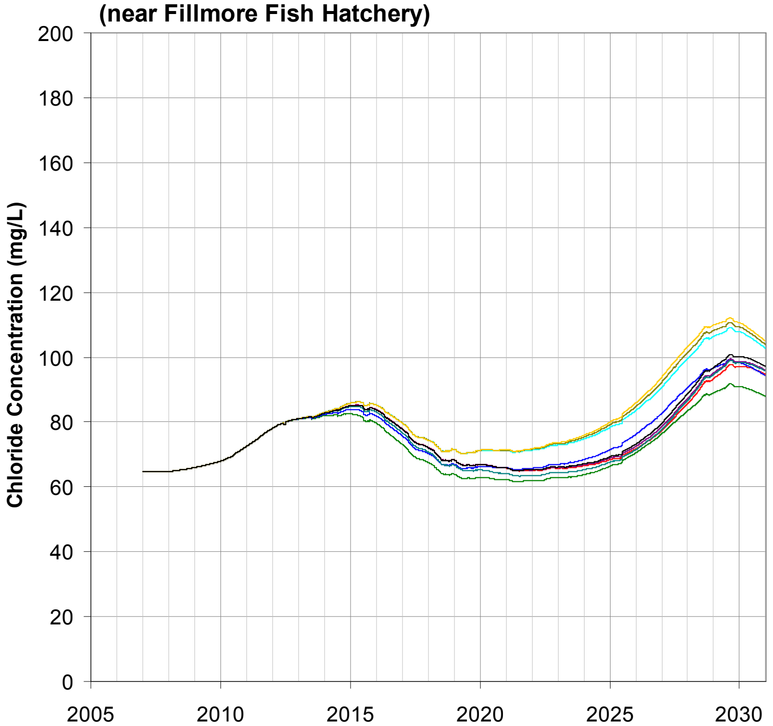
V-0181
(downstream of V-0176)



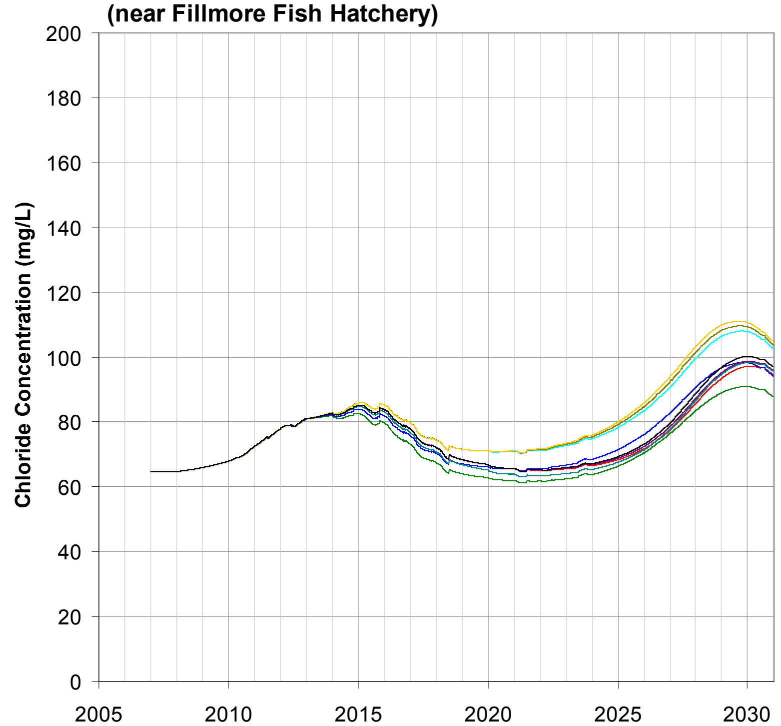
V-0233
(at western Piru Subbasin boundary along river)



V-0237 (same grid block as V-0238)
(near Fillmore Fish Hatchery)



V-0238 (same grid block as V-0237)
(near Fillmore Fish Hatchery)



Explanation

- Intermediate Reuse; 100 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 2a)
- Intermediate Reuse; 120 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 2b)
- High Reuse; 150 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 1c)
- Intermediate Reuse; 150 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 2c)
- Low Reuse; 150 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 3c)
- High Reuse; 0 Percent Removal of Self Regenerating Water Softeners (Scenario 1e)
- Intermediate Reuse; 0 Percent Removal of Self Regenerating Water Softeners (Scenario 2e)
- Low Reuse; 0 Percent Removal of Self Regenerating Water Softeners (Scenario 3e)
- Intermediate Reuse; 100 Percent Removal of Self Regenerating Water Softeners (Scenario 2g)

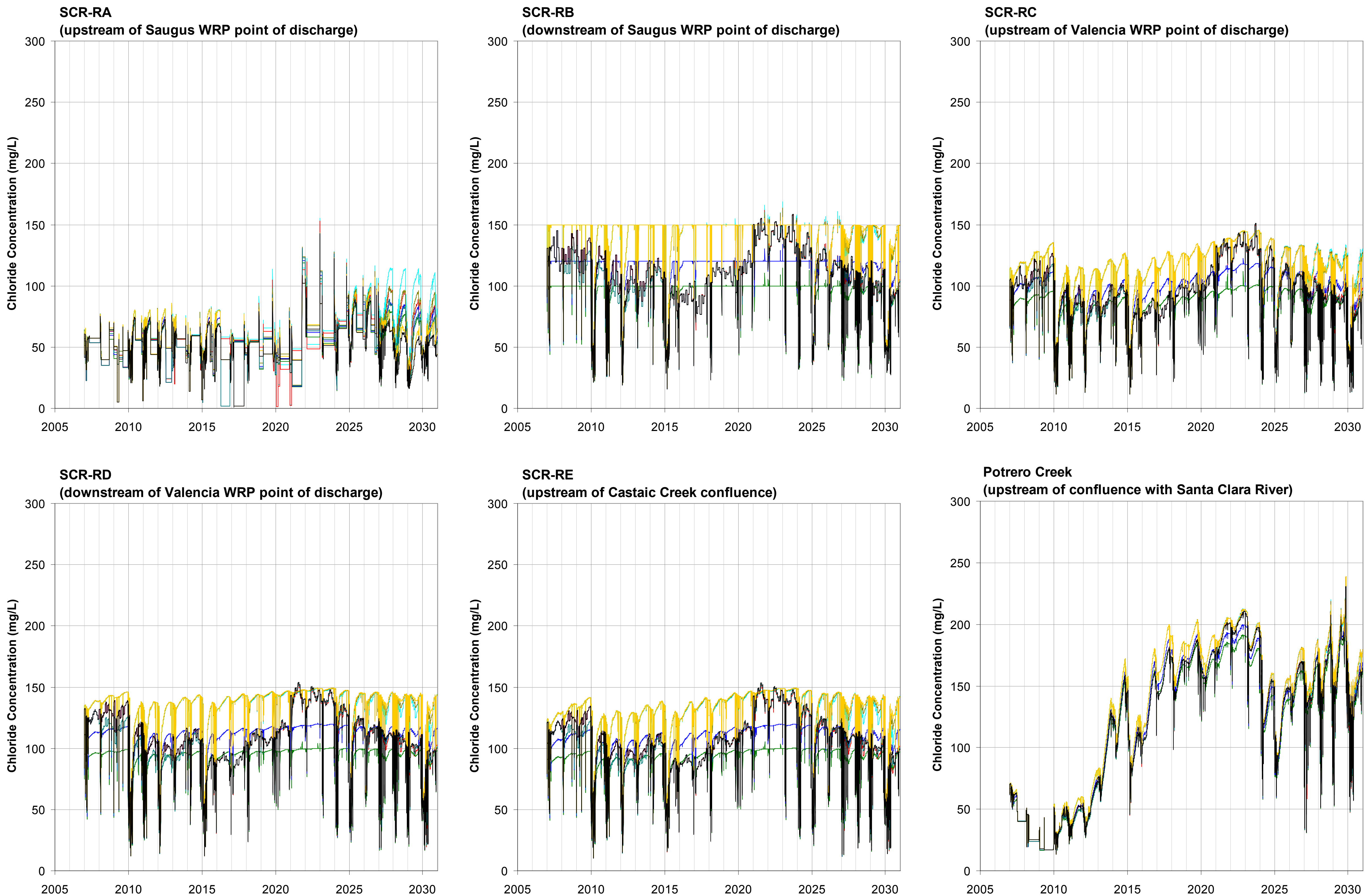
Simulation Year	Hydrology Year
2007	1975
2008	1976
2009	1977
2010	1978
2011	1979
2012	1980
2013	1981
2014	1982
2015	1983
2016	1984
2017	1985
2018	1986
2019	1987
2020	1988
2021	1989
2022	1990
2023	1991
2024	1992
2025	1993
2026	1994
2027	1995
2028	1996
2029	1997
2030	1998

SIMULATED CHLORIDE CONCENTRATIONS IN WELLS LOCATED WEST OF HOPPER CREEK IN THE PIRU SUBBASIN
SCENARIOS 1C/E, 2A/B/C/E/G, 3C, 3E
Upper Santa Clara River Chloride TMDL
Santa Clara River Valley, California

Geomatrix	Project No.	Figure
	10354	C-4

APPENDIX D

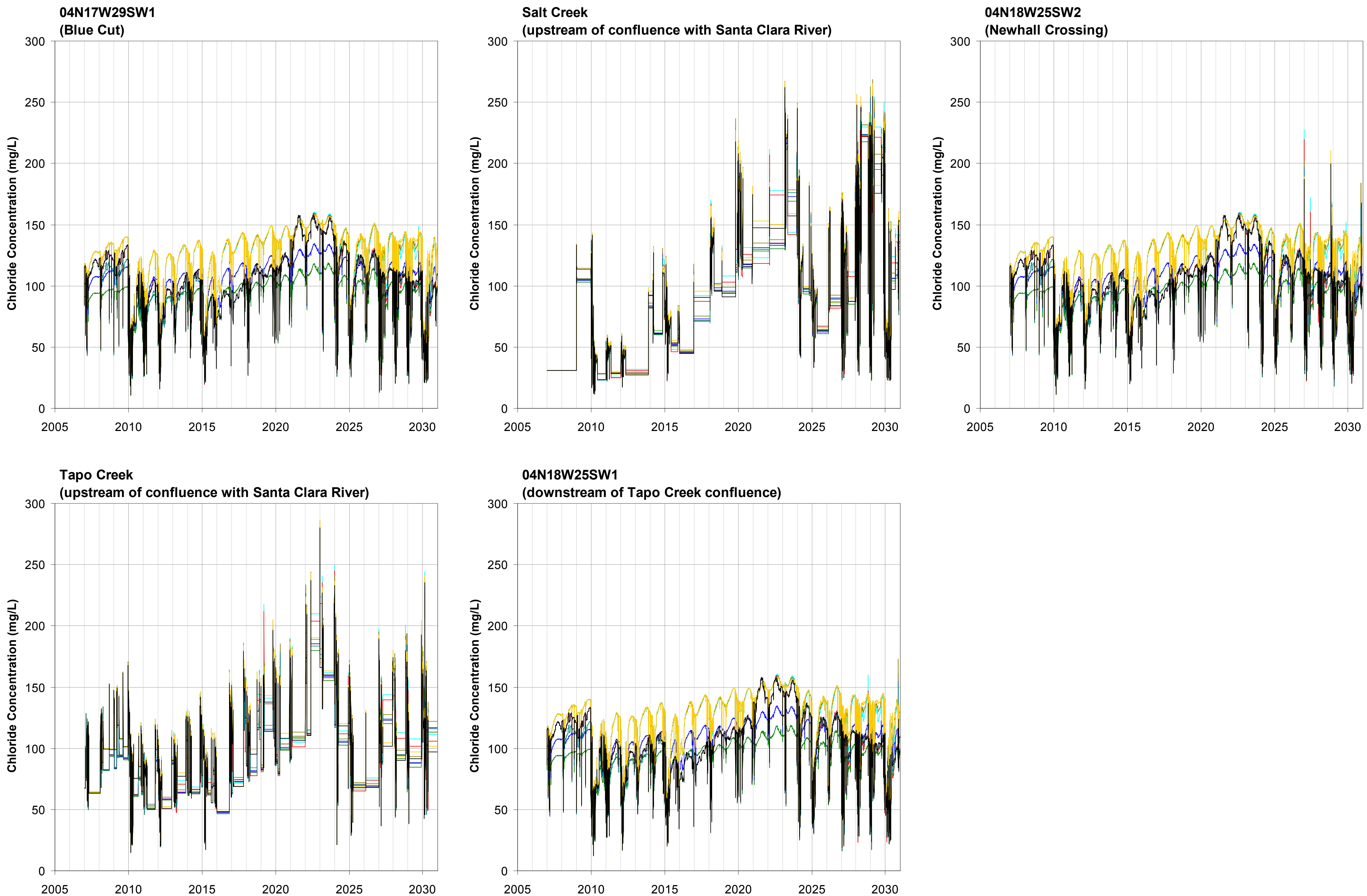
SIMULATED CONCENTRATIONS AT SELECTED SURFACE WATER LOCATIONS



Simulation Year	Hydrology Year
2007	1975
2008	1976
2009	1977
2010	1978
2011	1979
2012	1980
2013	1981
2014	1982
2015	1983
2016	1984
2017	1985
2018	1986
2019	1987
2020	1988
2021	1989
2022	1990
2023	1991
2024	1992
2025	1993
2026	1994
2027	1995
2028	1996
2029	1997
2030	1998

SIMULATED CHLORIDE CONCENTRATIONS
IN THE SANTA CLARA RIVER AND SELECTED
TRIBUTARIES IN THE EAST SUBBASIN
SCENARIOS 1C/E, 2A/B/C/E/G, 3C, 3E
Upper Santa Clara River Chloride TMDL
Santa Clara River Valley, California

Geomatrix | Project No. 10354 | Figure D-1



Explanation

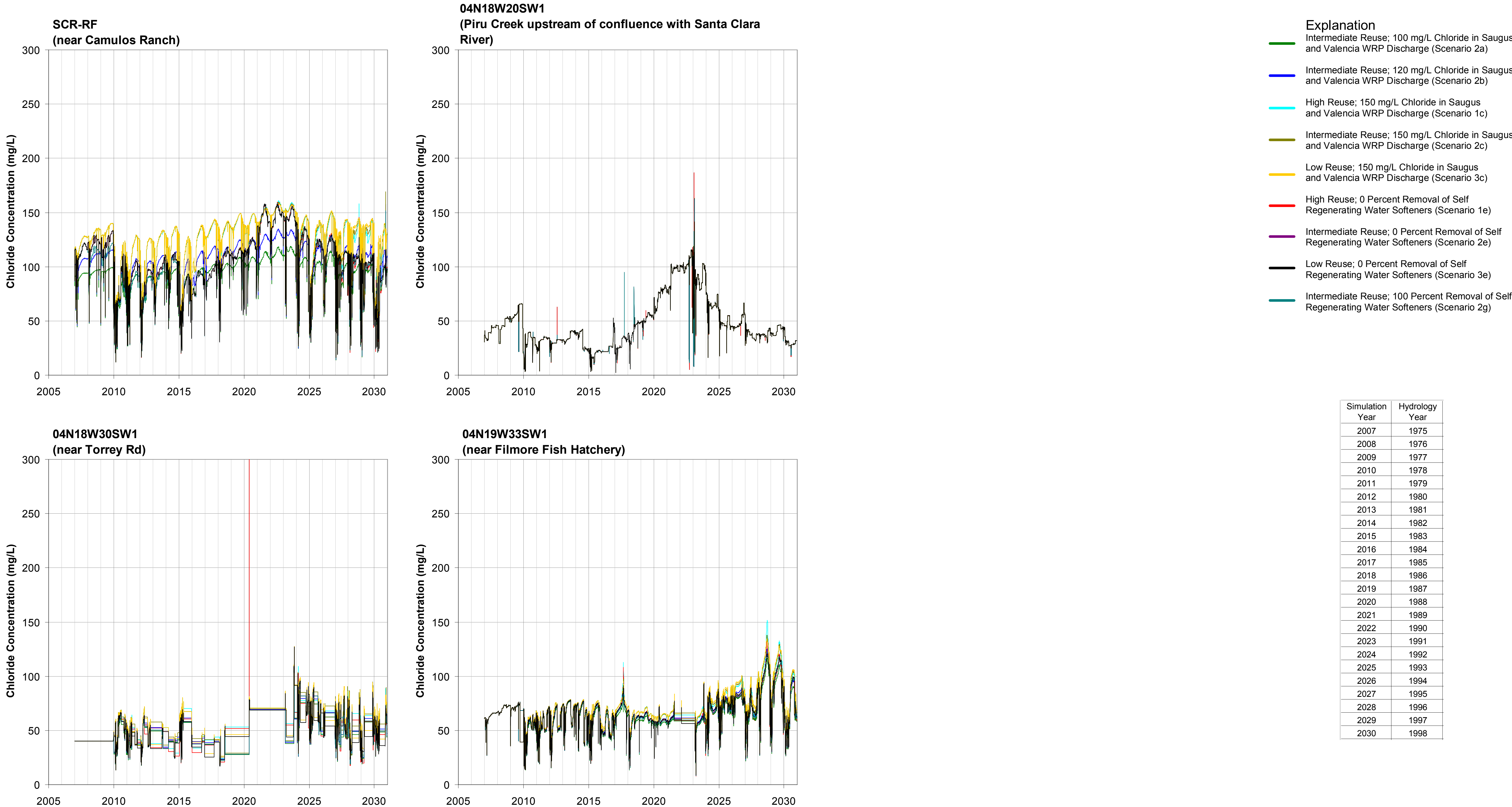
- Intermediate Reuse; 100 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 2a)
- Intermediate Reuse; 120 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 2b)
- High Reuse; 150 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 1c)
- Intermediate Reuse; 150 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 2c)
- Low Reuse; 150 mg/L Chloride in Saugus and Valencia WRP Discharge (Scenario 3c)
- High Reuse; 0 Percent Removal of Self Regenerating Water Softeners (Scenario 1e)
- Intermediate Reuse; 0 Percent Removal of Self Regenerating Water Softeners (Scenario 2e)
- Low Reuse; 0 Percent Removal of Self Regenerating Water Softeners (Scenario 3e)
- Intermediate Reuse; 100 Percent Removal of Self Regenerating Water Softeners (Scenario 2g)

Simulation Year	Hydrology Year
2007	1975
2008	1976
2009	1977
2010	1978
2011	1979
2012	1980
2013	1981
2014	1982
2015	1983
2016	1984
2017	1985
2018	1986
2019	1987
2020	1988
2021	1989
2022	1990
2023	1991
2024	1992
2025	1993
2026	1994
2027	1995
2028	1996
2029	1997
2030	1998

SIMULATED CHLORIDE CONCENTRATIONS IN THE SANTA CLARA RIVER AND SELECTED TRIBUTARIES IN THE PIRU SUBBASIN SCENARIOS 1C/E, 2A/B/C/E/G, 3C, 3E

Upper Santa Clara River Chloride TMDL
Santa Clara River Valley, California

Geomatrix | Project No. 10354 | Figure **D-2a**



Simulation Year	Hydrology Year
2007	1975
2008	1976
2009	1977
2010	1978
2011	1979
2012	1980
2013	1981
2014	1982
2015	1983
2016	1984
2017	1985
2018	1986
2019	1987
2020	1988
2021	1989
2022	1990
2023	1991
2024	1992
2025	1993
2026	1994
2027	1995
2028	1996
2029	1997
2030	1998

SIMULATED CHLORIDE CONCENTRATIONS IN THE SANTA CLARA RIVER AND SELECTED TRIBUTARIES IN THE PIRU SUBBASIN SCENARIOS 1C/E, 2A/B/C/E/G, 3C, 3E

Upper Santa Clara River Chloride TMDL
Santa Clara River Valley, California

Geomatrix

Project No. 10354

Figure D-2b