SECTION 5.0

Model Application

GSWIM was calibrated to simulate hydrology, land and water use, and chloride conditions over CYs 1975 through 2005. GSWIM was developed to evaluate future site-specific hydrologic system and chloride transport behavior resulting from a variety of potential advanced treatment options at the WRPs and water uses. Although it is impossible to predict future hydrology, land use, and water use conditions with certainty, future water use and waste load allocation assumptions for CYs 2007 through 2030 were developed collaboratively by the GSWI TWG for this study. Modeling results described in this section will aid the Regional Board with implementation of the Upper SCR Chloride TMDL and, if necessary, facilitate constructive dispute resolution on the basis of an objective scientific analysis.

5.1 Description of Scenarios of Future Conditions

Table 1-3 summarizes the scenarios of future conditions that were developed by SCVSD and the Regional Board. Table 5-1 summarizes the eight scenarios that were evaluated by CH2M HILL-HGL and described in this section. Results from the remaining nine scenarios are described in a supplemental Task 2B-1 report (Geomatrix Consultants, 2008) and are not discussed further in this report. A Task 2B-2 report will also be prepared by Geomatrix Consultants that will describe results from simulating the AWRM alternatives for the future simulation period.

The scenarios of future conditions listed in Table 5-1 fall into the following three general categories:

- **Water Reuse.** Scenarios with identifiers (ID) that begin with 1 assume that recycled water is applied for outdoor use in selected areas at 100 percent of the total quantities designated in the *Draft Recycled Water Master Plan* (Kennedy/Jenks Consultants, 2002). Scenarios with IDs that begin with 3 assume that recycled water is applied at quantities actually used in CY 2006 at the Westridge Golf Course and nearby roadway medians. All water reuse scenarios also assume that recycled water is applied for outdoor use within Newhall Ranch at 100 percent of the total quantities described in the *Newhall Ranch Specific Plan* (Forma, 2003).
- **Reverse Osmosis (RO) Wastewater Treatment.** Scenario IDs designated with a and b assume different levels of RO wastewater treatment at the Saugus and Valencia WRPs. The a- and b-series scenarios assume that RO wastewater treatment renders constant chloride concentrations of 100 and 120 mg/L in discharge from these WRPs. All scenarios assume a constant chloride concentration of 100 mg/L in the discharge and 150 mg/L for the applied recycled water from the Newhall Ranch WRP.
- **SRWS Removal.** Use of SRWS systems adds chloride to the influent wastewater entering the Saugus and Valencia WRPs. Installation of SRWS systems at residences and

commercial and industrial facilities was banned in 2003 in the Santa Clarita Valley to reduce influent wastewater chloride concentrations entering these WRPs. Since that time, SCVSD and other entities have implemented public outreach programs in an attempt to encourage compliance with the 2003 ordinance[9]. Scenario IDs designated with f and g are related to these outreach efforts. The f-series scenarios assume 50 percent effectiveness for public outreach efforts compared to the District's full-outreach program, with complete removal of SRWS systems in the Santa Clarita Valley by CY 2013. The g-series scenarios assume that the District's full-outreach program is 100 percent effective, with complete removal of SRWS systems in the Santa Clarita Valley by CY 2011. The monthly time-series chloride addition in influent wastewater entering the Saugus and Valencia WRPs, in accordance with the assumptions of the f- and g-series scenarios, were provided in *Projected Monthly Chloride Loading Above Water Supply Chloride Concentration for the Saugus and Valencia WRPs* (SCVSD, 2007). Similar datasets were also provided by SCVSD for the f- and g-series scenarios that assume additional wastewater treatment using an ultraviolet (UV) treatment process. The results of the f- and g-series scenarios presented in this section used the monthly time-series data that include UV treatment as input to GSWIM.

5.2 Model Development for Scenarios of Future Conditions

The following subsections describe changes that were implemented in GSWIM to allow for appropriate conceptualization and simulation of the scenarios of future conditions.

5.2.1 Initial Conditions

Initial flow, soil moisture, and chloride conditions for the scenarios of future conditions were based on results from the end of the calibration simulation (i.e., post-2005 conditions). Figures 5-1 through 5-9 show the initial chloride conditions used in Model Layers 1 through 9 for the scenarios of future conditions.

5.2.2 Time Discretization

Transient parameter values were discretized using monthly stress periods for the WSS variables (e.g., groundwater pumping and applied water) and daily stress periods for the remaining transient parameter values (e.g., rainfall, ET, and boundary inflows). GSWIM was programmed to output results at the daily time scale to facilitate evaluation of results for the TMDL study.

5.2.3 Land Use Assumptions

Initial land use for CY 2007 was based on 2005 Southern California Association of Governments (SCAG) land use mapping (see Figure 5-10). Build-out land use mapping incorporated information from the following sources:

- Santa Clarita Valley Area Plan
- City of Santa Clarita General Plan

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[9]For additional information on the SRWS public outreach program, see http://www.lacsd.org/chloride.

- *Newhall Ranch Specific Plan* (Forma, 2003)
- 2007 cropping data for Ventura County
- City of Fillmore Plan

Figure 5-11 shows the assumed build-out land use mapping and also illustrates the modeled location of the Newhall Ranch WRP. GSWIM was programmed to linearly interpolate between these starting and ending land use distributions on an annual basis. For modeling purposes, it was assumed that full build-out would occur on January 1, 2027. Annual land use distributions in GSWIM remained constant from CYs 2027 through 2030 for the scenarios of future conditions. For modeling purposes, build-out of the Newhall Ranch communities was assumed to occur linearly from CY 2010 to 2027.

Cropping patterns in the Ventura County portion of the domain from CY 2007 remained constant throughout the scenarios of future conditions. On April 2, 2007, members of the GSWI Modeling Team, SCVSD, Farm Bureau of Ventura County, Ventura County Agricultural Association, and University of California Cooperative Extension, along with a few local growers, participated in a meeting to gain consensus regarding how land uses might evolve over the next few decades in the Piru Valley. Although the meeting was useful in providing a collaborative forum for participants to voice their insights into potential future growth, the only consensus on future growth was that urbanization would be insignificant because of Save Open-Space & Agricultural Resources (SOAR)[10] limitations. The Ventura County SOAR measure requires a vote of the people for future changes to the open space, agricultural, and rural policies and land use designations in lands located outside city boundaries, which are governed by Ventura County's General Plan. The stated purpose of the measure is "to ensure that agricultural, open space and rural lands are not prematurely or unnecessarily converted to other more intensive development uses." The measure's provisions will remain in effect until CY 2021, unless repealed by the voters at a general election before CY 2021. After December 31, 2020, general plan changes could be made without a vote of the people[11].

Because of the uncertainty associated with future agricultural growth in the Piru Valley, the GSWI Modeling Team reviewed current agricultural land use maps to evaluate how much developable agricultural land (i.e., land that is not already cultivated) is left in the Piru Valley. Figure 5-12 illustrates the 2007 agricultural land uses (Calderwood, 2007, pers. comm.) and Figure 5-13 illustrates the estimated remaining developable agricultural land in the Piru Valley. The remaining developable agricultural land in the Piru Valley that is outside the 100-year flood zone is limited (see yellow stippled pattern outside the 100-year flood zone on Figure 5-13). Thus, even if there is a local desire to expand agriculture in the Piru Valley, current land use mapping suggests that there is limited undeveloped land available for agricultural expansion on the valley floor outside the 100-year floodplain. Given the SOAR measure and space limitations, significant expansion of municipal and industrial (M&I) and agricultural land uses will not likely occur within the future scenario period in the Piru Valley.

[10] http://www.soarusa.org/.

[11] http://www.soarusa.org/pdfs/SOAR-VenturaCounty.pdf.

5.2.4 Assumed Hydrologic Sequence for Scenarios of Future Conditions

The future hydrologic conditions simulated with GSWIM were designed to follow historically observed variations in local hydrology. The future simulation period, which includes CYs 2007 through 2030, was assumed to have the same local and SWP hydrologic sequences as historically occurred from CYs 1975 through 1998. This historical period contains the following hydrologic characteristics:

- Dry conditions locally and wet conditions in the SWP system in CY 1975
- A 2-year critically dry period in the SWP system from CYs 1976 through 1977
- Wet conditions from CYs 1978 through 1983
- Mostly dry conditions locally and in the SWP system from CYs 1984 through 1991
- Variable conditions from CY 1992 through 1994
- Normal to wet conditions from CYs 1995 through 1998

Because CYs 1975 through 1998 contained a wide variety of local and SWP hydrologic conditions (critically dry to wet), the use of this historical period for the future scenario period is considered appropriate for the GSWI Study. Furthermore, by linking these periods, historical and future leap years coincide (e.g., CYs 1976 and 2008 are both leap years). Table 5-2 summarizes the linkage between future simulation years and the associated hydrology years.

5.2.5 Basis of Water Demand and Supply Assumptions

It is anticipated that water demands in the East Subbasin will increase gradually through the future simulation period in response to population growth and new development. During this period, agricultural uses of groundwater are anticipated to gradually transition to M&I uses, and additional water supplies will likely be imported for consumptive use in the East Subbasin. Projected water demands and supplies were calculated for each of the Upper Basin Water Purveyors in the East Subbasin, using information from the following sources:

- The *2005 Urban Water Management Plan* (2005 UWMP) (CLWA et al., 2005)
- The *Draft Recycled Water Master Plan* (Kennedy/Jenks Consultants, 2002)
- *The State Water Project Delivery Reliability Report 2005* (DWR, 2006)
- Water demand and supply plans for the future Newhall Ranch development (Impact Sciences, 2001; CH2M HILL, 2002)
- The *Groundwater Management Plan: Santa Clara River Valley Groundwater Basin, East Subbasin, Los Angeles County, California* (CLWA, 2003), which describes the operating plan for the two aquifer systems in the East Subbasin
- Previous numerical modeling studies for the East Subbasin groundwater system (CH2M HILL, 2004a, 2004b, 2005b; CH2M HILL and Luhdorff and Scalmanini Consulting Engineers [LSCE], 2005)
- Recent water use records (LSCE, 2006 and 2007)

It is anticipated that water demands in the Piru and Eastern Fillmore Subbasins will not increase significantly over the future simulation period. This is largely due to the following factors:

- Most of the water demand in the Piru Valley is related to applied water requirements for local agriculture (i.e., irrigation demand) rather than indoor use.
- Cropping patterns could change over the next few decades in the Piru Valley. However, the types of crops that are locally grown are not likely to deviate significantly from existing crop types.
- The Piru Valley is predominantly an agricultural community that is home to residents wanting to limit urban sprawl and protect open space and agricultural lands.
- Availability of land that is not already farmed, but could be cultivated to expand local agriculture, is limited outside the 100-year flood zone of the SCR in the Piru Valley. Given the SOAR measure and limited availability of land that is not already farmed, significant expansion of M&I and agricultural land uses will not likely occur within the future scenario period in the Piru and Eastern Fillmore Subbasins.

5.2.6 Assumed Water Supplies

It is assumed that water demands in the GSWI Study area will be met with a combination of the following supplies:

- **Groundwater.** The Alluvial Aquifer, Saugus Formation, and San Pedro Formation are the primary sources of groundwater supply in the GSWI Study area.
- **Imported Water.** Water stored in Castaic Lake and Lagoon and Lake Piru is a blend of local runoff and imported water from the SWP and other sources. DWR owns, operates, and manages releases from Castaic Lake and Lagoon. UWCD owns, operates, and manages the conservation releases from Lake Piru (UWCD and CLWA, 1996).
- **Surface Water.** Streamflows entering the GSWI Study area are sources of water for groundwater recharge and growers in the Piru Valley who divert streamflow for irrigation use. Water that is diverted in the Piru Valley is a blend of local runoff, groundwater discharge, imported water, and effluent from upstream dischargers (primarily the Saugus and Valencia WRPs in the Santa Clarita Valley; it is assumed that this will eventually include discharges from the future Newhall Ranch WRP).
- **Recycled Water.** A portion of the effluent from the Valencia WRP is currently reused within the East Subbasin. It is assumed that reuse will become an increasingly important source of supply in the Santa Clarita Valley. It is also assumed that the source of recycled water will be the Valencia WRP and future Newhall Ranch WRP for the scenarios of future conditions (see Figure 5-11 for locations of WRPs).

5.2.7 Projected Water Use in the East Subbasin

Table 5-3 summarizes annual water use in the East Subbasin for Scenarios 1a, 1b, 1f, and 1g (i.e., high reuse) (see Table 5-1 and Section 5.1 of this report for descriptions of scenarios). Table 5-4 summarizes annual water use in the East Subbasin for Scenarios 3a, 3b, 3f, and 3g (i.e., low reuse). Water demands in the East Subbasin were defined according to information presented in the 2005 UWMP (CLWA et al., 2005). Minor adjustments were made to pumping rates and pumping locations presented in the 2005 UWMP (CLWA et al., 2005) to account for recent changes in the current or planned operations of specific wells, or the replacement of certain wells. Figures 5-14a through 5-14e show the locations of simulated groundwater pumping for the scenarios of future conditions. Estimates of imported water quantities were evaluated, in terms of SWP reliability and availability of alternative imported water supplies, to make sure these quantities were reasonable on an annual basis for the scenarios of future conditions. Estimates of recycled water for the low-reuse scenarios were obtained from the *2006 Santa Clarita Valley Water Report* (LSCE, 2007); estimates of recycled water for the high-reuse scenarios were provided by the Upper Basin Water Purveyors at 5-year increments beginning in CY 2010.

Figure 5-15 shows the monthly water supply quantities assumed for the scenarios of future conditions. The two plots on the top of Figure 5-15 show the simulated monthly groundwater supply quantities in the GSWIM domain, both by county and combined, for reference. Simulated monthly groundwater pumping was assumed to range from approximately 2,800 to 12,700 acre-feet in the GSWIM domain. The simulated monthly groundwater supply depicted on Figure 5-15 was used for all scenarios of future conditions. Simulated monthly imported water under the high-reuse scenarios (i.e., 1a, 1b, 1f, and 1g) and low-reuse scenarios (i.e., 3a, 3b, 3f, and 3g) was assumed to range from approximately 1,600 to 8,200 acre-feet and 1,600 to 7,400 acre-feet, respectively. Simulated recycled water under the high-reuse scenarios (i.e., 1a, 1b, 1f, and 1g) and low-reuse scenarios (i.e., 3a, 3b, 3f, and 3g) was assumed to range from approximately 15 to 1,300 acre-feet and 15 to 3,200 acre-feet, respectively. The sources of recycled water were assumed to be the Valencia and future Newhall Ranch WRPs.

5.2.7.1 Groundwater

Water management practices of the Upper Basin Water Purveyors call for maximizing the use of local Alluvial Aquifer groundwater and SWP water during years of normal and wet SWP water supply availability. Groundwater pumping from the Saugus Formation is minimized, except during years when SWP water allocations are below normal. These water management practices are based, in part, on observations about the historical hydrology of the subbasin and form the groundwater operating plan for the subbasin. The historical hydrology of the East Subbasin is described in the *Calibration Update of the Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California* (CH2M HILL, 2005b), *Literature Review and Data Acquisition. Task 1A – Evaluate Existing Models, Literature, and Data. Upper Santa Clara River Chloride TMDL Collaborative Process* (CH2M HILL-HGL, 2006a), and *Task 2A – Conceptual Model Development, East and Piru Subbasins. Upper Santa Clara River Chloride TMDL Collaborative Process* (CH2M HILL-HGL, 2006b).

The operating plan for the Santa Clarita Valley’s groundwater resources has been defined in the 2005 UWMP (CLWA et al., 2005) and in annual water reports that discuss the valley’s water demands, water supplies, and surface-water and groundwater resources (including CH2M HILL and LSCE, 2005, and LSCE, 2007). These reports provide ranges of values for groundwater extractions from the Alluvial Aquifer and the Saugus Formation during normal, wet, and dry years. The Upper Basin Water Purveyors have developed the operating plan by considering the water supply needs of the valley, the availability of imported water supplies, and knowledge of the historical recovery of both aquifers. The Upper Basin Water Purveyors developed this operating plan as part of an overall water supply strategy designed to meet increasing water demands in the Santa Clarita Valley while assuring a reasonable degree of water supply reliability and not exceeding the operational yield of the local aquifer systems on a long-term basis. Maintaining the substantial volume of water in the Saugus Formation is an important part of this strategy, to help maintain local groundwater supplies on a long-term basis.

5.2.7.2 Imported Water

In implementing the operating plan, the Upper Basin Water Purveyors blend groundwater and imported water for area residents to ensure consistent quality and reliability of service. The actual blend of imported water and groundwater in any given year and any given location in the valley is an operational decision that varies over time according to source availability and the operational capacities of purveyor-owned facilities. In years when SWP supplies are reduced, the water demands in the Santa Clarita Valley are met through a combination of the following alternative supplies:

- Local groundwater pumping (increased short-term Saugus Formation pumping)
- Deliveries from the Buena Vista/Rosedale-Rio Bravo groundwater banking program
- Deliveries from CLWA’s other groundwater banking programs, such as the Semitropic Groundwater Storage Program in Kern County
- Deliveries from CLWA’s and Ventura County’s flexible storage accounts
- Participation in DWR’s dry-year water purchase programs
- Short-term water exchanges

The Upper Basin Water Purveyors have emphasized developing water supplies that add diversity in water supply options. This is especially important in years of dry conditions in the Santa Clarita Valley, which can reduce Alluvial Aquifer supplies.

5.2.7.3 Recycled Water

Figures 3-52 and 5-16 show the areas outside Newhall Ranch that received recycled water for outdoor use under the low-reuse (i.e., 3a, 3b, 3f, and 3g) and high-reuse scenarios (i.e., 1a, 1b, 1f, and 1g), respectively. Reuse locations shown on Figure 5-16 were delineated by Geomatrix Consultants using information presented in the *Draft Recycled Water Master Plan* (Kennedy/Jenks Consultants, 2002). Irrigated LUCs shown in the Newhall Ranch area on Figure 5-11 received recycled water for outdoor use under each of the eight scenarios listed in Table 5-1. It was assumed that only recycled (i.e., nonpotable) water will be applied for outdoor use at Newhall Ranch, whereas other areas in the East Subbasin will receive both potable and nonpotable water for outdoor use.

5.2.8 Projected Water Use in the Piru and Eastern Fillmore Subbasins

Groundwater pumping data for CYs 1975 through 2005 for the Piru and Eastern Fillmore Subbasins were provided by UWCD for use in calibrating GSWIM. Most of the water demand in the Piru Valley is related to irrigation rather than indoor use. Irrigation demand is driven by crop type and climatic conditions, such as precipitation and ET. Because the future simulation period was assumed to have the local hydrologic sequences that historically occurred from CYs 1975 through 1998, the GSWI Modeling Team repeated the reported groundwater pumping rates from this period for the future simulation period.

To evaluate the relationship between reported groundwater pumping and local hydrology in the Piru Subbasin, rainfall data were compiled from Rain Gage 25 and compared with reported groundwater pumping in the Piru Subbasin over the GSWIM calibration period. Rain Gage 25 is located near the SCR between Blue Cut and the Las Brisas Bridge in western Ventura County (see Figure 3-47 for rain gage locations). Figure 5-17 illustrates the inverse historical relationship between annual groundwater pumping and rainfall in the Piru Subbasin. When annual rainfall was low, reported groundwater pumping was generally high, and vice versa. In addition, reported annual groundwater pumping rates over the last few decades do not indicate an increasing or decreasing trend. Thus, given the lines of evidence presented in this section, the GSWI Modeling Team used reported groundwater pumping rates from CYs 1975 through 1998 in the Piru and Eastern Fillmore Subbasins for the scenarios of future conditions.

5.2.9 Wastewater Generation Assumptions

Treated wastewater was assumed to be an increasingly important source of supply under the scenarios of future conditions. Tertiary-treated wastewater is currently discharged to the SCR in the Santa Clarita Valley from the Saugus and Valencia WRPs. Under the scenarios of future conditions, it was assumed that the Newhall Ranch WRP discharged water to the SCR near the county line when discharge quantities exceeded the nonpotable water demand (i.e., irrigation demand) in the Newhall Ranch communities from CY 2010 through 2030. The simulated combined WRP discharge flowed downstream into Ventura County, where it infiltrated and became a source of groundwater supply.

Secondary-treated wastewater is currently discharged to percolation ponds adjacent to the SCR in the Piru Valley from the Piru WWTP, which is operated by Ventura County Waterworks District No. 16. The locations of the Saugus, Valencia, and Newhall Ranch WRPs and the Piru WWTP are depicted on Figure 5-11. The following subsections describe the basis for the wastewater discharge projections for the scenarios of future conditions.

5.2.9.1 Saugus and Valencia Water Reclamation Plants

Projected wastewater discharges from the Saugus and Valencia WRPs for the future scenario period were estimated by SCVSD (Guerrero, 2007). Historical influent flow data from the Saugus and Valencia WRPs and long-term population projections developed by the SCAG were initially used to estimate combined annual influent flows for the future scenario period. To project annual effluent flow rates for each WRP, the historical ratio of combined effluent-to-influent flow rates was calculated. An effluent-to-influent ratio of 0.90 was used to estimate combined effluent flow rates according to projected rates of influent flows estimated from the 2004 SCAG data.

The average Saugus WRP effluent flow rates for CYs 1996 through 2002 were used as the baseline Saugus WRP effluent flow rate for projected flows through CY 2030[12]. For future projections associated with leap years, the average value of 5.50 mgd[13] was used as the baseline flow for each leap year day through CY 2030. The projected effluent flow for the Valencia WRP was estimated as the difference between the projected combined effluent flow and the baseline Saugus WRP effluent flow through CY 2030, as summarized in Table 5-5. The future WRP discharge locations in the SCR in the Santa Clarita Valley were assumed to be identical to those from the historical period.

5.2.9.2 Newhall Ranch Water Reclamation Plant

Projected wastewater discharges from the Newhall Ranch WRP for the future scenario period were estimated from information presented in the *Newhall Ranch Draft Additional Analysis* (Impact Sciences, Inc., 2002) and the *Newhall Ranch Specific Plan* (Forma, 2003), recycled water delivery projections provided by the Upper Basin Water Purveyors (DiPrimio, 2007, pers. comm.), and discussions among consultants and design engineers from GeoSyntec Consultants and CH2M HILL (Steets and Whitaker, 2007, pers. comm.). For the GSWI Study, the Newhall Ranch WRP was assumed to begin operation in CY 2010, with full build-out operations by CY 2027. Full reclamation of the tertiary-treated effluent was assumed during the drier months of April through September. Discharge to the SCR was simulated during October through March of each year, when effluent supply was assumed to exceed reclaimed water demand (for outdoor nonpotable irrigation use). This discharge amount varied depending on actual hydrologic conditions, but was simulated to be a monthly maximum of approximately 2.5 mgd at full build-out conditions. For modeling purposes, it was assumed that the point of discharge for the Newhall Ranch WRP was located just upstream from the county line in the SCR, in Los Angeles County (see Figure 5-11 for the modeled location of the future Newhall Ranch WRP). Table 5-6 summarizes the projected annual average effluent flows (i.e., combined discharge and recycled flows) for the Newhall Ranch WRP for the GSWI Study.

5.2.9.3 Piru Wastewater Treatment Plant

Projected wastewater discharges from the Piru WWTP for the future scenario period were estimated by Ventura County Waterworks District No. 16. Current dry-weather wastewater discharges from the Piru WWTP average approximately 0.24 mgd (Pakala, 2007, pers. comm.). Planning efforts are underway for an expansion to 0.5 mgd by CY 2027, with 80 percent of the build-out capacity achieved by CY 2017 (Pakala, 2007, pers. comm.). Using this information, projected daily discharges were interpolated through CY 2027, with the discharge rate of 0.5 mgd remaining constant from CYs 2027 through 2030, as summarized in Table 5-7.

The percolation ponds to which effluent from the Piru WWTP is discharged have adequate percolation capacity for the planned expansion at the existing site. Thus, treated wastewater disposal by percolation was simulated for the Piru WWTP under the scenarios of future conditions (Pakala, 2007, pers. comm.).

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[12] CYs 1996 through 2002 were considered the baseline flow period for the Saugus WRP because effluent flow rates during this time were consistent. The effluent flow rates were consistent at that time because no operational changes were required to accommodate facility expansions and upgrades (Guerrero, 2007).

[13] According to leap-year flows on February 29, 1996, and February 29, 2000 (Guerrero, 2007).

5.2.10 Chloride Assumptions

Assumptions related to the chloride concentration in the effluent of the Saugus and Valencia WRPs over the future scenario period are summarized on Figure 5-18. Values presented on Figure 5-18 were provided by SCVSD. Details of the process by which GSWIM routed water and chloride within WSSs are discussed in Section 5.2.11. The following additional water quality assumptions were implemented for the scenarios of future conditions:

1. Measured chloride concentrations in Castaic Lake and Lagoon and Lake Piru, and calibrated chloride concentrations in Bouquet Reservoir, from CYs 1975 through 1998 were repeated for CYs 2007 through 2030.
2. Chloride concentrations in inflows (surface and subsurface) at Lang, resulting from the GSWIM calibration to conditions from CYs 1975 through 1998, were repeated for CYs 2007 through 2030.
3. Average chloride effluent concentrations from industrial dischargers other than the Saugus and Valencia WRPs over the last few years were extended into the future scenario period. These flows represent a small component of the overall water budget, as described in Sections 5.0 through 7.0 of the Task 2A Report (CH2M HILL-HGL, 2006b).
4. The Newhall Ranch WRP is being designed with RO capabilities to remove chloride and other salts to meet the National Pollutant Discharge Elimination System permit limit of 100 mg/L (as a monthly average) in discharged effluent. Thus, chloride levels in the Newhall Ranch WRP effluent were simulated at a constant value of 100 mg/L during months of discharge to the SCR (i.e., October through March). It was assumed that effluent generated during months of full reclamation (i.e., April through September) would not undergo RO treatment. The chloride concentration of this applied water, for outdoor use within Newhall Ranch, was assumed to be a constant 150 mg/L (i.e., the groundwater chloride WQO for the local groundwater basin described in the Basin Plan [Regional Board, 1994]).

The most significant of these four assumptions is related to the future water quality of Castaic Lake and Lagoon and Lake Piru, because these reservoirs have historically contributed significant water supply and chloride to the GSWI Study area.

Chloride concentration data for the historical calibration period were compiled to evaluate whether there were long-term trends in chloride concentrations in the local reservoirs. Figure 5-19 compares historical chloride concentrations at Check 41 of the California Aqueduct, Pyramid Lake, Castaic Lake, and Lake Piru. Check 41 is located north of the GSWI Study area at the Tehachapi Afterbay, which is north of the split of the West Branch Aqueduct from the main California Aqueduct (see Figure 1-1 for the location of Check 41). As illustrated on Figure 5-19, no obvious long-term trend in chloride concentrations exists at any of the plotted locations. Rather, chloride concentrations increased and decreased in response to Northern California hydrology. During drier periods of the late 1980s and early 1990s in Northern California, chloride concentrations increased, but concentrations have since become similar to those in the mid- to late 1970s. Because no obvious long-term trend in chloride concentrations existed in local reservoirs, the GSWI Modeling Team assumed that repeating measured historical chloride concentrations from CYs 1975 through 1998 was reasonable for the future scenario period.

5.2.11 Boundary Conditions

Most of the boundary condition assignments that were used for GSWIM calibration were also used for the scenarios of future conditions (see Table 5-8). However, the following changes were made:

- Additional WSSs were created to simulate the application of recycled water in areas shown on Figure 5-16 under the high-reuse scenarios (i.e., 1a, 1b, 1f, and 1g), as well as water and chloride routing from the Newhall Ranch WRP.
- The conceptualization of the way WSSs routed water and chloride throughout the domain was changed to simulate the SRWS removal (i.e., f and g) scenarios.

Implementation of the first item was straightforward. However, implementation of the last item required modification of the MODHMS source code. With the calibration simulation, water supplies were not internally linked to WRPs in GSWIM. Instead, historical input data for WRP discharges that were provided by SCVSD were entered into GSWIM as specified-flux and inflow solute concentration boundary conditions (see Table 3-11). However, the blended chloride concentration of the future water supply cannot be known a priori, but is a very important consideration for the scenarios of future conditions. These blended chloride concentrations in the water supply in the East Subbasin are important because the SRWS removal scenarios designed by the SCVSD and Regional Board (i.e., 1f, 3f, 1g, and 3g) assumed various levels of indoor chloride loading to the water supply for the future scenario period.

To simulate the f- and g-series scenarios, the WSS conceptualization in MODHMS was modified to allow for more rigorous tracking of water and chlorides in supply terms. Figure 5-20 illustrates how the WSSs in GSWIM routed water and chloride with the new conceptualization. Figure 5-18 shows the chloride concentration input data that were used for the f- and g-series scenarios. GSWIM added the chloride concentrations (shown on the bottom two plots on Figure 5-18) to the blended water supply chloride concentrations (also computed by GSWIM internally) and computed the effluent chloride concentrations from the Saugus and Valencia WRPs.

5.3 Scenario Results

This section presents results from the eight scenarios of future conditions that were simulated by CH2M HILL-HGL. Results for all eight scenarios are plotted on individual graphs to facilitate evaluation of the differences in results. The locations of model output were focused on the primary areas of interest in the Piru Subbasin, as well as at a few locations in the East Subbasin for reference. Daily time-series results for the eight scenarios are provided for review as follows:

- Simulated groundwater elevations are shown for selected locations on Figures 5-21 through 5-24.

- Simulated streamflows in the SCR are shown for Blue Cut and other selected locations in the Piru Subbasin on Figure 5-25.
- Simulated groundwater chloride concentrations are shown for selected locations on Figures 5-26 through 5-29.
- Simulated surface-water chloride concentrations are shown for selected locations on Figures 5-30 and 5-31.
- Simulated daily SCR C/Co results are shown for selected location pairs on Figures 5-32 through 5-34.

Results are discussed in the following subsections according to the general scenario categories that were described in Section 5.1.

5.3.1 Water Reuse Scenario Results

Results of the water reuse scenarios, including the 1- and 3-series (i.e., high- and low-reuse) scenarios, are discussed in the following subsections.

5.3.1.1 Groundwater Elevations and Streamflows

As shown in Table 5-1, CH2M HILL-HGL conducted scenario simulations related to water reuse for two flow conditions, high and low reuse (i.e., the 1- and 3-series scenarios). Recycled water demand was assumed to increase through time under both water reuse scenarios, because Newhall Ranch was assumed to be built-out from CYs 2010 through 2027 under both scenarios. Thus, the only difference between these scenarios from a flow perspective was the level of water reuse assumed for the CLWA service areas located outside Newhall Ranch (see Figure 5-16 for these areas). Figure 5-35 shows the projected additional annual recycled water supply under high-reuse and low-reuse conditions. As shown on Figure 5-35, there was no difference in recycled water supply between these two scenarios until CY 2011. This difference increased steadily through CY 2015 and then increased more rapidly through the rest of the future scenario period. As a result, the simulated groundwater elevations and streamflows shown on Figures 5-21 through 5-25 were not different until after CY 2015; the difference in results was more evident in later simulation years.

The main observations of groundwater elevation and streamflow under the water reuse scenarios are as follows:

- In the western portion of the East Subbasin, the groundwater elevations shown on Figure 5-21 under both water reuse scenarios were similar throughout the future scenario period.
- In the Piru Subbasin, the difference in groundwater elevations shown on Figures 5-22 through 5-24 under both water reuse scenarios slightly increased in a westerly (i.e., downgradient) direction until reaching the Piru Narrows. This indicates that larger differences in simulated groundwater elevations occurred in groundwater recharge areas than in groundwater discharge areas.

- Groundwater elevations under the high-reuse scenario were generally lower than those under the low-reuse scenario by approximately 5 to 10 feet during droughts. This is because there was less simulated WRP discharge to the SCR under the high-reuse scenario (see Figure 5-25); therefore, less streamflow was available for groundwater recharge in the Piru Subbasin.
- The largest differences in groundwater elevations and streamflows occurred during the summer months, when the irrigation demands were at seasonal highs.
- The ranges of simulated groundwater elevations and streamflows at the locations shown on Figures 5-21 through 5-25 were similar to those simulated under historical calibration conditions (see Figures 4-4 through 4-6 for historical groundwater elevations).

5.3.1.2 Groundwater Chloride Concentrations

The main observations of simulated groundwater chloride concentrations under the water reuse scenarios are as follows:

- Near the Saugus WRP in the East Subbasin, the differences in simulated groundwater chloride concentrations on Figure 5-26 (see VWC-Q2 and VWC-S6) between both water reuse scenarios increased throughout the future scenario period to a maximum difference of approximately 5 to 15 mg/L. The simulated groundwater chloride concentrations under the high-reuse scenario were generally higher than those under the low-reuse scenario.
- In the western portion of the East Subbasin, the simulated groundwater chloride concentrations shown on Figure 5-26 under both water reuse scenarios were similar throughout the future scenario period.
- In the Piru Subbasin, the differences in simulated groundwater chloride concentrations shown on Figures 5-27 through 5-29 between both water reuse scenarios increased throughout the future scenario period to a maximum difference less than approximately 5 mg/L.
- In the eastern portion of Piru Subbasin, the simulated groundwater chloride concentrations at V-0013, V-0031, and V-0036 did not fluctuate over as large a range as the concentrations at wells located in the area more influenced by Piru Creek (see V-0042, V-0053, and V-0060), as shown on Figure 5-27. This indicates that wells along the flowpath of water leaving Piru Canyon are influenced by releases and spills from Lake Piru. Further, the largest differences in simulated groundwater chloride concentrations in the eastern Piru Subbasin area occurred during drought periods (as much as an approximately 30-mg/L difference between water reuse scenarios). When wetter conditions returned after the drought periods, the differences in simulated groundwater chloride concentrations were small at wells located along the flowpath of water leaving Piru Creek.
- Simulated groundwater chloride concentrations under the b-series water reuse scenarios were as much as 20 mg/L larger than those under the a-series water reuse scenarios when comparing Scenarios 1a to 1b and 3a to 3b. However, comparison of the same

results from Scenarios 1f to 1g and 3f to 3g shows little difference between simulated groundwater chloride concentrations.

- Simulated groundwater chloride concentrations under the low-reuse scenarios were no more than approximately 5 mg/L larger than those under the high-reuse scenarios when comparing results from Scenarios 1a to 3a, 1b to 3b, 1f to 3f, and 1g to 3g.
- Differences in simulated groundwater chloride concentrations were not consistent between the high- and low-reuse scenarios through time. For example, scenarios that produced the highest groundwater chloride concentrations during earlier years of the future scenario period did not necessarily produce the highest groundwater chloride concentrations throughout the future scenario period. The cause for these inconsistent outcomes between water reuse scenarios likely relates to differences in monthly irrigation demand, timing and quality of discharge from the WRPs, climatic conditions, and transient effects related to chloride evapoconcentration of applied water.
- Simulated groundwater chloride concentrations at V-0108 indicate an increasing trend over the simulation period (see Figure 5-28). Simulated groundwater chloride concentrations at many of the other well locations in the Piru Subbasin fluctuated in response to wet and dry conditions, but did not show consistently upward or downward trends.
- The ranges of simulated groundwater chloride concentrations at the locations shown on Figures 5-26 through 5-29 are within those simulated from the historical calibration simulation (see Figures 4-17 through 4-22 for historical groundwater chloride concentrations). However, because the initial chloride conditions used for CY 2007 were generally higher than those used for the beginning of the calibration simulation (i.e., CY 1975), the maximum concentrations are higher under the scenarios of future conditions by as much as approximately 20 mg/L at several locations as compared with those under historical conditions.

5.3.1.3 Surface-water Chloride Concentrations

The main observations of simulated surface-water chloride concentrations under the water reuse scenarios are as follows:

- Near the Saugus WRP, the differences in simulated surface-water chloride concentrations shown on Figure 5-30 (see SCR-RA and SCR-RB) between both water reuse scenarios were as much as approximately 60 mg/L (see differences between Scenarios 1a and 3f during dry periods).
- Near the Valencia WRP to the confluence with Castaic Creek, the differences in simulated surface-water chloride concentrations shown on Figure 5-30 (see SCR-RC, SCR-RD, and SCR-RE) between both water reuse scenarios were as much as approximately 50 mg/L (see differences between Scenarios 1a and 3f during dry periods). However, the cause for the 50 mg/L difference is not the high-versus low-reuse conditions, but rather the assumptions related to the end-of-pipe chloride concentrations at the Saugus and Valencia WRPs.

- In the western portion of the East Subbasin in Potrero Creek, the differences in simulated surface-water chloride concentrations shown on Figure 5-30 between both water reuse scenarios were as much as approximately 20 mg/L (see differences between Scenarios 1a and 3f during dry periods).
- In the Blue Cut area of the Piru Subbasin, the differences in simulated surface-water chloride concentrations shown on Figure 5-31 between both water reuse scenarios were as much as approximately 45 mg/L (see differences between Scenarios 1a and 3f during dry periods at 04N17W29SW1, 04N18W25SW2, and 04N18W25SW1). Simulated surface-water chloride concentrations in Salt and Tapo Creeks were less sensitive to assumptions related to the specific scenarios and were more variable than in other locations because streamflow was not consistently simulated at these locations.
- In the rest of the Piru Subbasin, the differences in simulated surface-water chloride concentrations shown on Figure 5-31 between both water reuse scenarios were as much as approximately 40 mg/L near the Camulos Diversion (see differences between Scenarios 1a and 3f during dry periods at SCR-RF). Simulated surface-water chloride concentrations in Piru Creek (see 04N18W20SW1) were not sensitive to assumptions related to the specific scenarios, but instead responded to chloride conditions in Lake Piru releases and spills. The spike in simulated chloride concentrations in Piru Creek in CY 2023 is a numerical anomaly. Results near Torrey Road at 04N18W30SW1 were variable because streamflow was not consistently simulated at this location. Near the Fillmore Fish Hatchery, differences in results were as much as approximately 10 mg/L (see differences between Scenarios 1a and 3f during dry periods at 04N19W33SW1).
- Differences in simulated surface-water chloride concentrations were not consistent between the high- and low-reuse scenarios through time. For example, the scenarios that produced the highest surface-water chloride concentrations during earlier years of the future scenario period did not necessarily produce the highest groundwater chloride concentrations throughout the future scenario period. The cause for the inconsistent outcomes between water reuse scenarios likely relates to differences in monthly irrigation demand, timing and quality of discharge from the WRPs, climatic conditions, and transient effects related to chloride evapoconcentration of applied water.
- Generally, the b-series simulated surface-water chloride concentrations dominated during wetter periods, whereas the concentrations in the f-series scenarios tended to dominate during drought periods (see Figures 5-30 and 5-31). During wet periods, simulated surface-water chloride concentrations of the a- or b-series scenarios occasionally exceeded those of the f or g series. This is because the a- and b-series scenarios occasionally added chloride concentrations to the system that were greater than the chloride concentrations in the water supply and indoor loading.

5.3.2 Reverse Osmosis Wastewater Treatment Scenario Results

Results of the RO scenarios, including the a- and b-series scenarios, are discussed in the following subsections.

5.3.2.1 Groundwater Elevations and Streamflows

Because scenarios related to RO wastewater treatment were simulated under the same two water reuse flow assumptions, these scenario results for groundwater elevations and streamflows were identical to those described in Section 5.3.1.1.

5.3.2.2 Groundwater Chloride Concentrations

The main observations of simulated groundwater chloride concentrations under the RO scenarios are as follows:

- Near the Saugus WRP in the East Subbasin, the differences in simulated groundwater chloride concentrations on Figure 5-26 (see VWC-Q2 and VWC-S6) between the RO scenarios increased throughout the future scenario period under the high-reuse scenarios to a maximum difference of approximately 5 mg/L. Comparisons of these results under the low-reuse scenarios indicate similar differences during drought periods, but less difference during nondrought periods.
- In the western portion of the East Subbasin, the differences in simulated groundwater chloride concentrations shown on Figure 5-26 under both RO scenarios were as much as 5 mg/L higher under the b-series scenarios during the seasonally wet months.
- In the eastern Piru Subbasin, the differences in simulated groundwater chloride concentrations shown on Figures 5-27 through 5-29 between the RO scenarios were as much as 15 mg/L, with the b-series producing the highest concentrations.
- Simulated groundwater chloride concentrations at V-0042, V-0060, V-0070, V-0105, V-0109, V-0121, and V-0233 occasionally exceeded the groundwater chloride WQO of 100 mg/L west of Piru Creek in the Piru Subbasin (see Figures 5-27 through 5-29).
- In the eastern Piru Subbasin, the simulated groundwater chloride concentrations at V-0013, V-0031, and V-0036 did not fluctuate over as large a range as concentrations in the area more influenced by Piru Creek (see V-0042, V-0053, and V-0060), as shown on Figure 5-27. This indicates that wells that lie along the flowpath of water leaving Piru Canyon are influenced by releases and spills from Lake Piru. Further, the largest differences in simulated groundwater chloride concentrations in the eastern Piru Subbasin occurred during drought periods (as much as approximately 15 mg/L difference between RO scenarios). When wetter conditions returned after the drought periods, the differences in simulated groundwater chloride concentrations were small at wells located along the flowpath of water leaving Piru Creek.
- Differences in simulated groundwater chloride concentrations were not consistent between the RO scenarios when considering different water reuse assumptions, as described in Section 5.3.1.2. However, for individual water reuse scenarios, the b-series groundwater chloride concentrations were consistently higher than those of the a series.
- Simulated groundwater chloride concentrations at V-0108 indicate an increasing trend over the simulation period (see Figure 5-28). Simulated groundwater chloride concentrations at many other well locations in the Piru Subbasin fluctuated in response to wet and dry conditions, but did not show consistently upward or downward trends.

- The RO scenarios occasionally simulated unrealistically high chloride concentrations in the Saugus and Valencia WRP effluent, as compared with influent chloride concentration estimates under the SRWS removal scenarios (see Figure 5-36).

5.3.2.3 Surface-water Chloride Concentrations

The main observations of simulated surface-water chloride concentrations under the RO scenarios are as follows:

- Near the Saugus WRP, the differences in simulated surface-water chloride concentrations shown on Figure 5-30 (see SCR-RA and SCR-RB) between the RO scenarios were approximately 20 mg/L, as expected.
- From near the Valencia WRP to the confluence with Castaic Creek, the differences in simulated surface-water chloride concentrations shown on Figure 5-30 (see SCR-RC, SCR-RD, and SCR-RE) between the RO scenarios were as much as approximately 20 mg/L, as expected.
- In the western portion of the East Subbasin in Potrero Creek, the differences in simulated surface-water chloride concentrations shown on Figure 5-30 between the RO scenarios were as much as approximately 10 mg/L (see differences between Scenarios 1a and 1b and 3a and 3b during dry periods).
- In the Blue Cut area of the Piru Subbasin, the differences in simulated surface-water chloride concentrations shown on Figure 5-31 between the RO scenarios were as much as approximately 15 mg/L (see differences between Scenarios 1a and 1b, and 3a and 3b at 04N17W29SW1, 04N18W25SW2, and 04N18W25SW1). Simulated surface-water chloride concentrations in Salt and Tapo Creeks were less sensitive to assumptions related to the specific scenarios and were more variable than in other locations because streamflow was not consistently simulated at these locations (see Figure 5-25 for streamflow plots).
- In the rest of the Piru Subbasin, the differences in simulated surface-water chloride concentrations shown on Figure 5-31 between both water reuse scenarios were as much as approximately 15 mg/L near the Camulos Diversion (see differences between Scenarios 1a and 1b, and 3a and 3b at SCR-RF). Simulated surface-water chloride concentrations in Piru Creek (see 04N18W20SW1) were not sensitive to assumptions related to the specific scenarios, but instead responded to chloride conditions in Lake Piru releases and spills. The spike in simulated chloride concentrations in Piru Creek in CY 2023 is a numerical anomaly. Results near Torrey Road at 04N18W30SW1 were variable because streamflow was not consistently simulated at this location. Near the Fillmore Fish Hatchery, differences in results were as much as approximately 5 mg/L (see differences between Scenarios 1a and 1b, and 3a and 3b at 04N19W33SW1).
- Differences in simulated surface-water chloride concentrations were not consistent between the RO scenarios when considering different water reuse assumptions, as described in Section 5.3.1.3. However, for individual water reuse scenarios, the b-series surface-water chloride concentrations were consistently higher than those of the a series. Simulated surface-water chloride concentrations at Blue Cut were directly affected by the simulated chloride concentrations at the Saugus and Valencia WRPs. However, the

ranges of surface-water chloride concentrations at Blue Cut and other downstream locations in the SCR were larger than those near the WRP discharge points.

- Simulated surface-water chloride concentrations at Blue Cut under the RO scenarios exceeded those near the points of discharge at the Saugus and Valencia WRPs during drought conditions. This indicates that chloride loading from other sources located between the WRPs and Blue Cut occasionally contributed more to the simulated chloride concentrations at Blue Cut. Figures 5-32 through 5-34 show model-derived daily C/Co comparisons for downstream and upstream location pairs on the SCR as well as model-derived daily C/Co exceedance plots. These comparisons indicate that downstream surface-water chloride concentrations (i.e., where C/Co values are greater than a value of 1.0) were higher than chloride concentrations in the WRP effluent approximately 30 percent of the time. Similar comparisons indicate that downstream surface-water chloride concentrations were higher than chloride concentrations at SCR-RE approximately 70 percent of the time.

5.3.3 Self-regenerating Water Softener Removal Results

Results of the SRWS removal scenarios, including the f- and g-series scenarios, are discussed in the following subsections.

5.3.3.1 Groundwater Elevations and Streamflows

Because scenarios related to SRWS removal were simulated under the same two water reuse flow assumptions, these scenario results for groundwater elevations and streamflows were identical to those described in Section 5.3.1.1.

5.3.3.2 Groundwater Chloride Concentrations

The main observations of simulated groundwater chloride concentrations under the SRWS removal scenarios are as follows:

- Near the Saugus WRP in the East Subbasin, the differences in simulated groundwater chloride concentrations on Figure 5-26 (see VWC-Q2 and VWC-S6) between the SRWS removal scenarios increased throughout the future scenario period to a maximum difference of approximately 10 mg/L when considering the two different water reuse assumptions. However, under the same water reuse assumption, the differences between the simulated groundwater chloride concentrations in this area were minimal.
- In the western portion of the East Subbasin, the difference in simulated groundwater chloride concentrations shown on Figure 5-26 under the SRWS removal scenarios were similar throughout the future scenario period.
- In the eastern Piru Subbasin, the differences in simulated groundwater chloride concentrations shown on Figures 5-27 through 5-29 between the SRWS removal scenarios were less than approximately 5 mg/L.
- In the eastern Piru Subbasin, the simulated groundwater chloride concentrations at V-0013, V-0031, and V-0036 did not fluctuate over as large a range as those in wells located in the area more influenced by Piru Creek (see V-0042, V-0053, and V-0060), as shown on Figure 5-27. This indicates that wells that lie along the flowpath of water

leaving Piru Canyon are influenced by releases and spills from Lake Piru. Further, the largest differences in simulated groundwater chloride concentrations in the eastern Piru Subbasin area occurred during drought periods (as much as approximately 5 mg/L difference between SRWS removal scenarios). When wetter conditions returned after the drought periods, the differences in simulated groundwater chloride concentrations were small at wells located along the flowpath of water leaving Piru Creek.

- Differences in simulated groundwater chloride concentrations were consistent between the SRWS removal scenarios in that the f-series scenarios produced higher groundwater chloride concentrations during the years of public outreach (i.e., CYs 2007 through 2013). This was expected because more chloride was introduced in the WRP discharges under the f-series scenarios than under the g-series scenarios. After CY 2013, the simulated groundwater chloride concentrations for the SRWS removal scenarios were similar under individual reuse assumptions.
- Simulated groundwater chloride concentrations at V-0108 indicate an increasing trend over the simulation period (see Figure 5-28). Simulated groundwater chloride concentrations at many other well locations in the Piru Subbasin fluctuated in response to wet and dry conditions, but did not show consistently upward or downward trends.

5.3.3.3 Surface-water Chloride Concentrations

The main observations of simulated surface-water chloride concentrations under the SRWS removal scenarios are as follows:

- Near the Saugus WRP, the differences in simulated surface-water chloride concentration shown on Figure 5-30 (see SCR-RA and SCR-RB) between the SRWS removal scenarios were minimal prior to CY 2013 and negligible thereafter.
- From the Valencia WRP to the confluence with Castaic Creek, the differences in simulated surface-water chloride concentrations shown on Figure 5-30 (see SCR-RC, SCR-RD, and SCR-RE) between the SRWS removal scenarios were as much as 5 to 10 mg/L prior to CY 2013 and negligible thereafter.
- In the western portion of the East Subbasin in Potrero Creek, the differences in simulated surface-water chloride concentrations shown on Figure 5-30 between the SRWS removal scenarios were negligible throughout the future scenario period.
- In the Blue Cut area of the Piru Subbasin, the differences in simulated surface-water chloride concentrations shown on Figure 5-31 between the SRWS removal scenarios were as much as approximately 5 mg/L prior to CY 2013 and negligible thereafter (see differences between Scenarios 1f and 1g, and 3f and 3g at 04N17W29SW1, 04N18W25SW2, and 04N18W25SW1). Simulated surface-water chloride concentrations in Salt and Tapo Creeks were less sensitive to assumptions related to the specific scenarios and were more variable than those in other locations because streamflow was not consistently simulated at these locations.
- In the rest of the Piru Subbasin, the differences in simulated surface-water chloride concentrations shown on Figure 5-31 between the SRWS removal scenarios were as much as approximately 5 mg/L near the Camulos Diversion (see differences between

Scenarios 1f and 1g, and 3f and 3g at SCR-RF). Simulated surface-water chloride concentrations in Piru Creek (see 04N18W20SW1) were not sensitive to assumptions related to the specific scenarios, but instead responded to chloride conditions in Lake Piru releases and spills. The spike in simulated chloride concentrations in Piru Creek in CY 2023 is a numerical anomaly. Results near Torrey Road at 04N18W30SW1 were variable because streamflow was not consistently simulated at this location. Near the Fillmore Fish Hatchery, differences in results were negligible (see differences between Scenarios 1f and 1g, and 3f and 3g at 04N19W33SW1).

- Differences in simulated surface-water chloride concentrations were consistent between the SRWS removal scenarios in that the f-series scenarios produced higher groundwater chloride concentrations during the years of public outreach (i.e., CYs 2007 through 2013). This was expected given that more chloride is introduced in the WRP discharges under the f-series scenarios than under the g-series scenarios. After CY 2013, the simulated groundwater chloride concentrations were similar between the SRWS removal scenarios under individual water reuse assumptions.
- Figure 5-36 shows a comparison of the model-derived chloride concentrations in the Saugus and Valencia WRP discharge under the SRWS removal scenarios with those of the RO scenarios. Figure 5-36 indicates that the RO scenarios occasionally simulated unrealistically high chloride concentrations in the Saugus and Valencia WRP effluent, as compared with influent chloride concentration estimates under the SRWS removal scenarios.

5.3.4 Chloride Threshold Evaluation

Results from simulating the scenarios of future conditions were compared against the surface-water and groundwater WQOs, as designated in the Basin Plan (Regional Board, 1994), and the lower and upper bound of the avocado threshold, as described in *Literature Review Evaluation. Upper Santa Clara River Chloride TMDL Collaborative Process* (CH2M HILL, 2005a). Figure 5-37 shows a comparison of these results for Blue Cut and selected wells located in the Piru Subbasin. Rather than individual results for each of the Piru Subbasin groundwater wells, the average simulated daily chloride concentrations from groups of these wells are presented – east of Piru Creek and west of Piru Creek. Simulated daily chloride concentrations for individual wells in the Piru Subbasin are provided on Figures 5-27 through 5-29.

5.3.4.1 Blue Cut

Simulated daily chloride concentrations at Blue Cut were equal to or less than the surface-water WQO of 100 mg/L from approximately 25 to 66 percent of the future simulation period. The lower bound of the avocado threshold is the same as the surface-water WQO; thus, attainment results for this threshold and the surface-water WQO are identical. Of the eight scenarios, only the Scenario 3a chloride concentration was less than the upper bound of the avocado threshold (120 mg/L) throughout the entire future simulation period. The remaining scenarios were less than 120 mg/L from approximately 75 to 99 percent of the future simulation period.

5.3.4.2 Groundwater East of Piru Creek

The average simulated daily chloride concentrations in wells located east of Piru Creek were consistently less than the groundwater WQO of 200 mg/L throughout the future simulation period. The average simulated daily chloride concentrations in wells located east of Piru Creek were equal to or less than the lower bound of the avocado threshold (100 mg/L) from approximately 23 to 52 percent of the future simulation period. The average of the simulated daily chloride concentrations in wells located east of Piru Creek were equal to or less than the upper bound of the avocado threshold (120 mg/L) from approximately 74 to 99 percent of the future simulation period. Thus, none of these results were consistently less than the lower or upper bound of the avocado threshold.

5.3.4.3 Groundwater West of Piru Creek

The average simulated daily chloride concentrations in wells located west of Piru Creek were consistently less than the groundwater WQO of 100 mg/L and the lower and upper bounds of the avocado threshold throughout the entire future simulation period.

5.3.5 Supplemental Simulations

Two supplemental simulations were also conducted by CH2M HILL-HGL to quantify the following:

- The relative flow contribution resulting from discharges at the Saugus and Valencia WRPs to downstream surface and subsurface locations
- The portion of the relative flow contribution from the first supplemental simulation that participates in the simulated chloride evapoconcentration process

Simulations were set up using data inputs from the a-series high-reuse scenarios (i.e., 1a and 3a), with the following modifications:

- Chloride concentrations in the Saugus and Valencia WRP discharges were left at a constant 100 mg/L, but all other inflow chloride concentration boundaries and initial chloride concentrations were set to 0 mg/L. By simulating chloride concentrations in this manner and by including the chloride evapoconcentration effects in the numerical solution of chloride concentration, the results were interpreted as follows. The relative flow contribution at the Saugus and Valencia WRP discharge points (i.e., ends of pipes) was 100 percent, because the quantity of water at these locations would only be attributed to the Saugus and Valencia WRP discharges. As these discharges entered the SCR system and flowed downstream, they mixed with other sources of water and chloride in GSWIM (e.g., tributary inflows and groundwater discharge) reducing the relative WRP flow contribution at these downstream locations. For example, if a simulated result at a downstream location equaled 40, that would indicate that approximately 40 percent of the flow present at that location would be due to a combination of discharges from the Saugus and Valencia WRPs and chloride evapoconcentration effects.
- Another set of scenarios was also simulated, with only one difference: the evapoconcentration effects were not simulated as part of the numerical solution. By simulating chloride conditions in this manner and comparing results with and without the

evapoconcentration effects, the relative flow contribution to downstream surface and subsurface locations solely from the Saugus and Valencia WRPs could be evaluated.

Figure 5-38 shows the simulated WRP flow contribution to selected downstream SCR locations, and Figures 5-39 through 5-41 show the simulated WRP flow contribution to selected downstream subsurface locations in the Piru Subbasin. As expected, the WRP flow contribution to the SCR near the Saugus and Valencia WRP discharge points approached 100 percent during drier periods. Model results indicated that streamflows at Blue Cut resulted from as much as 85 to 90 percent of the discharges from the Saugus and Valencia WRPs during drought periods. The contributions remained at these levels in the SCR to at least the NLF-NR3 location. West of the Dry Gap, WRP flow contributions to streamflows in the SCR near the Fillmore Fish Hatchery rarely exceeded 30 percent. Further, the effects of chloride evapoconcentration were more evident at this downstream location (more than a 20 percent increase in relative flow contributions). These supplemental simulations also indicated that the WRP contributions to SCR streamflows near Fillmore Fish Hatchery had not fully reached that location, as evidenced by the increasing trend in WRP flow contributions at that location (see Figure 5-38).

The simulated Saugus and Valencia WRP flow contributions to downstream subsurface locations in the Piru Subbasin decreased with increasing downgradient distance, as shown on Figures 5-39 through 5-41. The effects of chloride evapoconcentration were more discernable in the groundwater system of the Piru Subbasin than in the SCR system (as much as a 24 percent higher flow contribution). These supplemental simulations also indicated that these WRP flow contributions to groundwater in the Piru Subbasin had not fully reached all of the selected locations, as evidenced by the increasing trends in WRP flow contributions at these locations (see Figure 5-39 through 5-41).

5.4 Outcome of Scenario Evaluation

The following general observations of simulated groundwater conditions were drawn from the various scenario results:

- Simulated groundwater chloride concentrations did not ever exceed the groundwater chloride WQO of 200 mg/L east of Piru Creek.
- The groundwater chloride WQO of 100 mg/L west of Piru Creek was exceeded in some wells west of Piru Creek; however, the average of the simulated daily chloride concentrations at wells located west of Piru Creek did not ever exceed the WQO.
- Simulated chloride concentrations in both groundwater and surface water were related to simulated chloride concentrations in discharges from the Saugus and Valencia WRPs.
- Increased reuse in East Subbasin resulted in increased groundwater chloride concentrations in the Piru Subbasin during droughts.
- The b-series scenarios produced larger groundwater chloride concentrations east of the Piru Creek confluence during normal and wet periods, except during extended droughts, than compared to the f- and g-series scenarios. However, the RO scenarios occasionally simulated unrealistically high chloride concentrations in the Saugus and

Valencia WRP effluent, as compared with influent chloride concentration estimates under the SRWS removal scenarios (see Figure 5-36).

- Simulated groundwater levels during drought periods in the Piru Subbasin were approximately 5 to 10 feet lower under high-reuse scenarios than under low-reuse scenarios. This is because there was less simulated WRP discharge to the SCR under the high-reuse scenario; therefore, less streamflow was available for groundwater recharge in the Piru Subbasin.

The following general observations of simulated surface-water conditions were drawn from the various scenario results:

- The surface-water chloride WQO of 100 mg/L in Reach 5 (i.e., from Blue Cut to the west pier of the Highway 99 bridge in Los Angeles County) was exceeded in some years (especially drought years) under all scenarios.
- Scenario 3a produced surface-water chloride concentrations less than 120 mg/L at all times and close to 100 mg/L most of the time, except during droughts.
- Simulated surface-water chloride concentrations generally increased from the a- through f-series scenarios during drought periods.
- The RO scenarios occasionally simulated unrealistically high chloride concentrations in the Saugus and Valencia WRP effluent, as compared with influent chloride concentration estimates under the SRWS removal scenarios (see Figure 5-36).
- Sources of chloride loading exist between the Valencia WRP and Blue Cut. Downstream surface-water chloride concentrations were higher than chloride concentrations in the WRP effluent approximately 30 percent of the time during the future scenario period. During this same period, downstream surface-water chloride concentrations were higher than chloride concentrations at SCR-RE approximately 70 percent of the time. This suggests that the assimilative capacity in the SCR between the Valencia WRP and Blue Cut is limited.

TABLE 5-1
Summary Matrix of Future Scenarios Evaluated by CH2M HILL-HGL
Task 2B-1 – Numerical Model Development and Scenario Results, East and Piru Subbasins

Assumed Chloride Concentration in SCVSD WRP Effluent (mg/L)[a]	Scenario 1 Series[b] (High Reuse)	Scenario 3 Series[c] (Low Reuse)
100	1a	3a
120	1b	3b
Chloride Loading above Water Supply with 50 percent SRWS Removal[d]	1f	3f
Chloride Loading above Water Supply with 100 percent SRWS Removal[d]	1g	3g

[a]Chloride concentration assumptions pertain to discharge from the Saugus and Valencia WRPs only. Chloride concentrations in the discharge of the future Newhall Ranch WRP were set at a constant of 100 mg/L.

[b]High water reuse. Assumes that recycled water is applied for outdoor use at selected areas and 100 percent of the total quantities designated in Kennedy/Jenks Consultants (2002). Also assumes that recycled water is applied for outdoor use within Newhall Ranch at 100 percent of the total quantities described in the *Newhall Ranch Specific Plan* (Forma, 2003).

[c]Low water reuse. Assumes that recycled water is applied at quantities actually used in CY 2006 at the Westridge Golf Course and nearby roadway medians. Also assumes that recycled water is applied for outdoor use within Newhall Ranch at 100 percent of the total quantities described in the *Newhall Ranch Specific Plan* (Forma, 2003).

[d]Includes the assumption that discharges from the Saugus and Valencia WRPs include UV treatment.

TABLE 5-2
Simulation Years and Hydrology Years for Scenarios of Future Conditions
Task 2B-1 – Numerical Model Development and Scenario Results, East and Piru Subbasins

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

[a]Leap year.

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TABLE 5-3
Annual Water Use in the East Subbasin under Scenarios 1a, 1b, 1f, and 1g
Task 2B-1 – Numerical Model Development and Scenario Results, East and Piru Subbasins

Simulation Year	Hydrology Year	Local Climate Year[a]	SWP Hydrology[b]	Saugus Pumping Plan[c,d]	Water Demand[c]	Groundwater Pumping[c]	Recycled Water[e]	Imported Water[f]	Supply
2007	1975	Dry	Wet	Normal	97,809	41,207	419	56,183	97,809
2008	1976	Normal	Critical	Dry Year 1	89,758	50,322	419	39,017	89,758
2009	1977	Normal	Critical	Dry Year 2	90,599	55,658	419	34,522	90,599
2010	1978	Normal	Above Normal	Normal	91,440	49,741	1,004	40,695	91,440
2011	1979	Normal	Below Normal	Normal	93,090	49,798	1,641	41,651	93,090
2012	1980	Normal	Above Normal	Normal	94,740	49,856	2,278	42,606	94,740
2013	1981	Normal	Dry	Normal	96,390	49,912	2,915	43,563	96,390
2014	1982	Normal	Wet	Normal	98,040	49,970	3,552	44,518	98,040
2015	1983	Normal	Wet	Normal	99,690	50,027	4,189	45,474	99,690
2016	1984	Normal	Wet	Normal	101,052	50,085	5,276	45,691	101,052
2017	1985	Dry	Dry	Normal	112,655	47,175	6,363	59,117	112,655
2018	1986	Normal	Wet	Normal	103,776	50,198	7,450	46,128	103,776
2019	1987	Normal	Dry	Normal	105,138	50,256	8,537	46,345	105,138
2020	1988	Normal	Critical	Dry Year 1	106,500	55,890	9,624	40,986	106,500
2021	1989	Dry	Dry	Normal	119,415	47,279	10,841	61,295	119,415
2022	1990	Dry	Critical	Dry Year 1	121,575	52,881	12,058	56,636	121,575
2023	1991	Dry	Critical	Dry Year 2	123,735	60,488	13,275	49,972	123,735
2024	1992	Normal	Critical	Dry Year 3	114,468	64,309	14,492	35,667	114,468
2025	1993	Normal	Above Normal	Normal	116,460	50,599	16,207	49,654	116,460
2026	1994	Dry	Critical	Dry Year 1	130,018	53,333	17,410	59,275	130,018
2027	1995	Normal	Wet	Normal	120,024	51,373	18,928	49,723	120,024
2028	1996	Normal	Wet	Normal	121,806	51,374	19,950	50,482	121,806
2029	1997	Normal	Wet	Normal	123,588	51,373	21,350	50,865	123,588
2030	1998	Normal	Wet	Normal	125,370	51,373	22,750	51,247	125,370

[a]Dry = 12 inches per year or less and Normal = greater than 12 inches per year at rain Gage 32c, located in the City of Santa Clarita. An exception to this is noted for Hydrology Year 1991, which had more than 12 inches of rainfall after 2 years of very low rainfall.
[b]Defined using DWR's Sacramento Valley Unimpaired Runoff Index; wet = wettest, critical = driest.
[c]Defined according to the 2005 UWMP.
[d]Defined according to SWP hydrology.
[e]Provided by the Upper Basin Water Purveyors at 5-year increments, starting in CY 2010 and linearly interpolated annually. The CY 2007 through 2009 value was set according to recycled water use reported in 2006. Values account for reuse inside and outside Newhall Ranch.
[f]Used to balance the remaining supply to meet demands.

Note:

Units are acre-feet.

TABLE 5-4
Annual Water Use in the East Subbasin under Scenarios 3a, 3b, 3f, and 3g
Task 2B-1 – Numerical Model Development and Scenario Results, East and Piru Subbasins

Simulation Year	Hydrology Year	Local Climate Year[a]	SWP Hydrology[b]	Saugus Pumping Plan[c,d]	Water Demand[c]	Groundwater Pumping[c]	Recycled Water[e]	Imported Water[f]	Supply
2007	1975	Dry	Wet	Normal	97,809	41,207	419	56,183	97,809
2008	1976	Normal	Critical	Dry Year 1	89,758	50,322	419	39,017	89,758
2009	1977	Normal	Critical	Dry Year 2	90,599	55,658	419	34,522	90,599
2010	1978	Normal	Above Normal	Normal	91,440	49,741	1,004	40,695	91,440
2011	1979	Normal	Below Normal	Normal	93,090	49,798	1,501	41,791	93,090
2012	1980	Normal	Above Normal	Normal	94,740	49,856	1,998	42,886	94,740
2013	1981	Normal	Dry	Normal	96,390	49,912	2,495	43,983	96,390
2014	1982	Normal	Wet	Normal	98,040	49,970	2,992	45,078	98,040
2015	1983	Normal	Wet	Normal	99,690	50,027	3,489	46,174	99,690
2016	1984	Normal	Wet	Normal	101,052	50,085	3,986	46,981	101,052
2017	1985	Dry	Dry	Normal	112,655	47,175	4,483	60,997	112,655
2018	1986	Normal	Wet	Normal	103,776	50,198	4,980	48,598	103,776
2019	1987	Normal	Dry	Normal	105,138	50,256	5,477	49,405	105,138
2020	1988	Normal	Critical	Dry Year 1	106,500	55,890	5,974	44,636	106,500
2021	1989	Dry	Dry	Normal	119,415	47,279	6,471	65,665	119,415
2022	1990	Dry	Critical	Dry Year 1	121,575	52,881	6,968	61,726	121,575
2023	1991	Dry	Critical	Dry Year 2	123,735	60,488	7,465	55,782	123,735
2024	1992	Normal	Critical	Dry Year 3	114,468	64,309	7,962	42,197	114,468
2025	1993	Normal	Above Normal	Normal	116,460	50,599	8,459	57,402	116,460
2026	1994	Dry	Critical	Dry Year 1	130,018	53,333	8,956	67,729	130,018
2027	1995	Normal	Wet	Normal	120,024	51,373	9,454	59,197	120,024
2028	1996	Normal	Wet	Normal	121,806	51,374	9,454	60,978	121,806
2029	1997	Normal	Wet	Normal	123,588	51,373	9,454	62,761	123,588
2030	1998	Normal	Wet	Normal	125,370	51,373	9,454	64,543	125,370

[a]Dry = 12 inches per year or less and Normal = greater than 12 inches per year at rain Gage 32c, located in the City of Santa Clarita. An exception to this is noted for Hydrology Year 1991, which had more than 12 inches of rainfall after 2 years of very low rainfall.
[b]Defined using DWR's Sacramento Valley Unimpaired Runoff Index; wet = wettest, critical = driest.
[c]Defined according to the 2005 UWMP.
[d]Defined according to SWP hydrology.
[e]Provided by the Upper Basin Water Purveyors at 5-year increments, starting in CY 2010 and linearly interpolated annually. The CY 2007 through 2009 value was set according to recycled water use reported in 2006. Values account for reuse inside and outside Newhall Ranch.
[f]Used to balance the remaining supply to meet demands.

Note:

Units are acre-feet.

TABLE 5-5
Projected Flows for the Saugus and Valencia Water Reclamation Plants
Task 2B-1 – Numerical Model Development and Scenario Results, East and Piru Subbasins

CY	Projected Combined Saugus and Valencia WRP Influent Flow (mgd)	Projected Combined Saugus and Valencia WRP Effluent Flow (mgd)	Projected Saugus WRP Effluent Flow (mgd)	Projected Valencia WRP Effluent Flow (mgd)	Basis
2007	23.8	21.4	5.55	15.85	Interpolated
2008	24.4	21.9	5.55	16.35	Interpolated
2009	25.0	22.5	5.55	16.95	Interpolated
2010	25.6	23.0	5.55	17.45	Planning
2011	26.1	23.5	5.55	17.95	Interpolated
2012	26.7	24.0	5.55	18.45	Interpolated
2013	27.2	24.5	5.55	18.95	Interpolated
2014	27.8	25.0	5.55	19.45	Interpolated
2015	28.3	25.5	5.55	19.95	Planning
2016	28.8	25.9	5.55	20.35	Interpolated
2017	29.3	26.4	5.55	20.85	Interpolated
2018	29.9	26.9	5.55	21.35	Interpolated
2019	30.4	27.3	5.55	21.75	Interpolated
2020	30.9	27.8	5.55	22.25	Planning
2021	31.4	28.3	5.55	22.75	Interpolated
2022	31.9	28.7	5.55	23.15	Interpolated
2023	32.4	29.2	5.55	23.65	Interpolated
2024	32.9	29.6	5.55	24.05	Interpolated
2025	33.4	30.1	5.55	24.55	Planning
2026	33.8	30.5	5.55	24.95	Interpolated
2027	34.3	30.9	5.55	25.35	Interpolated
2028	34.7	31.2	5.55	25.65	Interpolated
2029	35.2	31.6	5.55	26.05	Interpolated
2030	35.6	32.0	5.55	26.45	Planning

Source: Guerrero, 2007.

TABLE 5-6
Projected Effluent Flows from the Future Newhall Ranch Water Reclamation Plant
Task 2B-1 – Numerical Model Development and Scenario Results, East and Piru Subbasins

CY	Projected Newhall Ranch WRP Effluent Flow (mgd)	Basis
2007	0	Not operational
2008	0	Not operational
2009	0	Not operational
2010	0.50	Newhall Ranch WRP operation assumed to begin
2011	0.92	Interpolated
2012	1.35	Interpolated
2013	1.77	Interpolated
2014	2.20	Interpolated
2015	2.62	Interpolated
2016	3.04	Interpolated
2017	3.47	Interpolated
2018	3.90	Interpolated
2019	4.32	Interpolated
2020	4.73	Interpolated
2021	5.17	Interpolated
2022	5.59	Interpolated
2023	6.02	Interpolated
2024	6.43	Interpolated
2025	6.87	Interpolated
2026	7.29	Interpolated
2027	7.72	Build-out assumed
2028	7.70	Build-out assumed
2029	7.72	Build-out assumed
2030	7.72	Build-out assumed

Sources: *Newhall Ranch Draft Additional Analysis* (Impact Sciences, Inc., 2002); DiPrimio, 2007, pers. comm.; and Steets and Whitaker, 2007, pers. comm.

TABLE 5-7
Projected Effluent Flows from the Piru Wastewater Treatment Plant
Task 2B-1 – Numerical Model Development and Scenario Results, East and Piru Subbasins

CY	Projected Piru WWTP Effluent Flow (mgd)	Basis
2007	0.24	Current
2008	0.26	Interpolated
2009	0.27	Interpolated
2010	0.29	Interpolated
2011	0.30	Interpolated
2012	0.32	Interpolated
2013	0.34	Interpolated
2014	0.35	Interpolated
2015	0.37	Interpolated
2016	0.38	Interpolated
2017	0.40	80 Percent of Build-out Capacity
2018	0.41	Interpolated
2019	0.42	Interpolated
2020	0.43	Interpolated
2021	0.44	Interpolated
2022	0.45	Interpolated
2023	0.46	Interpolated
2024	0.47	Interpolated
2025	0.48	Interpolated
2026	0.49	Interpolated
2027	0.50	Build-out Capacity
2028	0.50	Build-out Capacity
2029	0.50	Build-out Capacity
2030	0.50	Build-out Capacity

Source: Pakala, 2007, pers. comm.

TABLE 5-8
Summary of Boundary Conditions Used in Scenarios of Future Conditions
Task 2B-1 – Numerical Model Development and Scenario Results, East and Piru Subbasins

Hydrologic Process	Specified-head Boundary	Specified-flux Boundary	Head-dependent Flux Boundary	Inflow Solute Concentration Boundary
Stream Inflow at Lang Stream Gage		X		X
Groundwater Inflow at Lang Stream Gage		X		X
Dam Underflow		X		X
Precipitation		X		X
ET			X	
Applied Water		X[b]		X[a,b]
Saugus and Valencia WRP Discharges		X		X[a,b]
Newhall Ranch WRP		X		X
Other Industrial Point-source Discharges		X		X
Reservoir Releases and Spills		X		X
Imported Water		X[b]		X[a,b]
Groundwater Pumping		X[b]		X[a,b]
Surface-water Diversions		X[b]		X[a,b]
Discharges to Septic Systems		X		X
Stream Outflow at A Street Bridge	X[c]			
Groundwater Outflow at A Street Bridge	X			

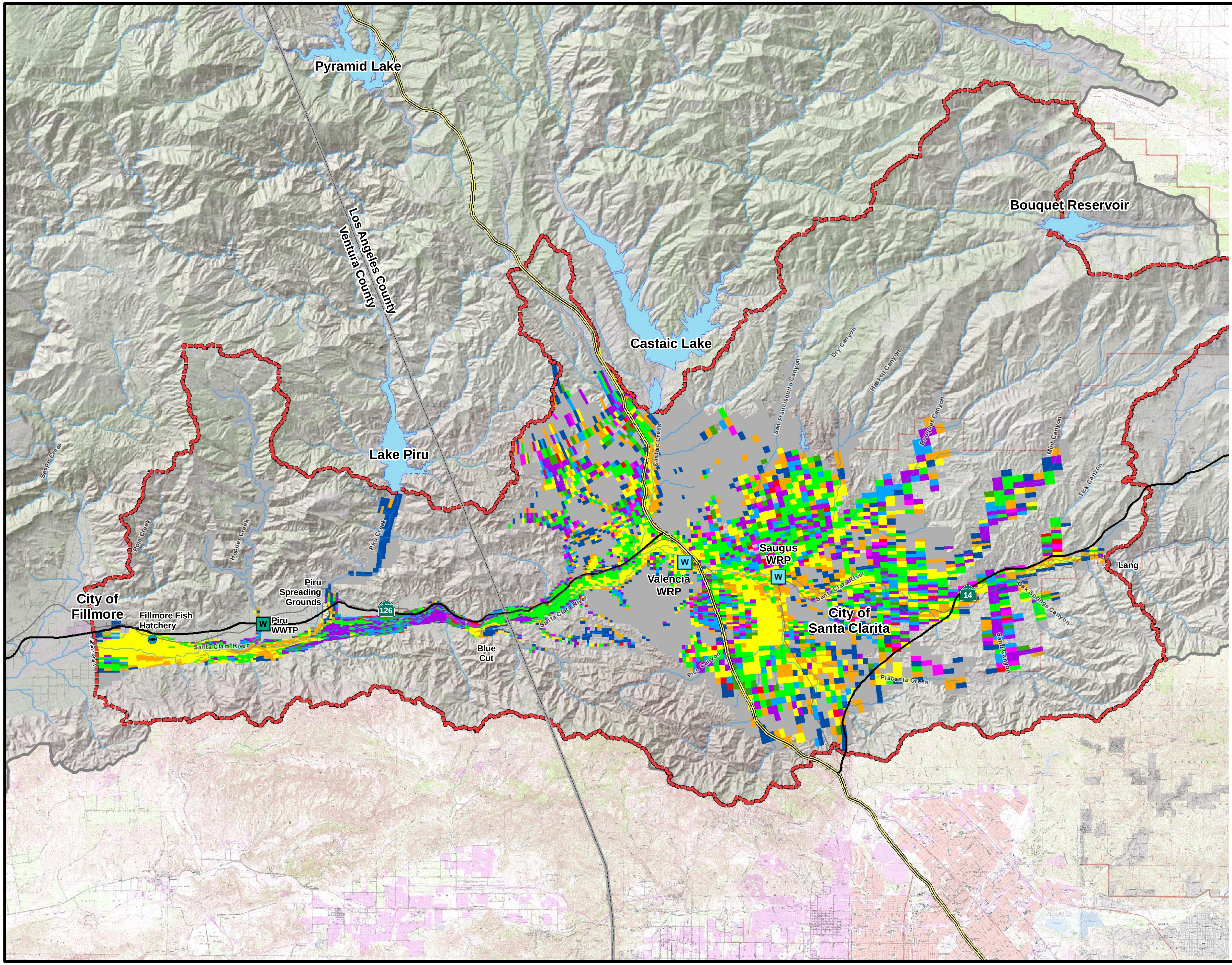
[a]Included in a WSS.

[b]Chloride concentrations computed internally by GSWIM for Scenarios 1f, 3f, 1g, and 3g. Chloride concentrations for Scenarios 1a, 3a, 1b, and 3b set at constant values (see Table 5-1).

[c]More specifically, a zero-depth gradient boundary condition.

Note:

No-flow boundaries were simulated at lateral boundaries of surface and active subsurface grid-blocks and below the bottom-most model layer.



LEGEND

- GSWI STUDY AREA
- SANTA CLARA RIVER WATERSHED
- STREAM

TRANSPORTATION

- INTERSTATE
- STATE HIGHWAY
- RAILROAD

INITIAL CHLORIDE CONCENTRATION (mg/L)

- Up to 20
- 20 to 40
- 40 to 60
- 60 to 80
- 80 to 100
- 100 to 120
- 120 to 140
- 140 to 160
- 160 to 180
- 180 to 200

N

0 3 6 miles

FIGURE 5-1
INITIAL CHLORIDE CONDITIONS IN MODEL LAYER 1 USED FOR SCENARIOS OF FUTURE CONDITIONS

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL -HGL

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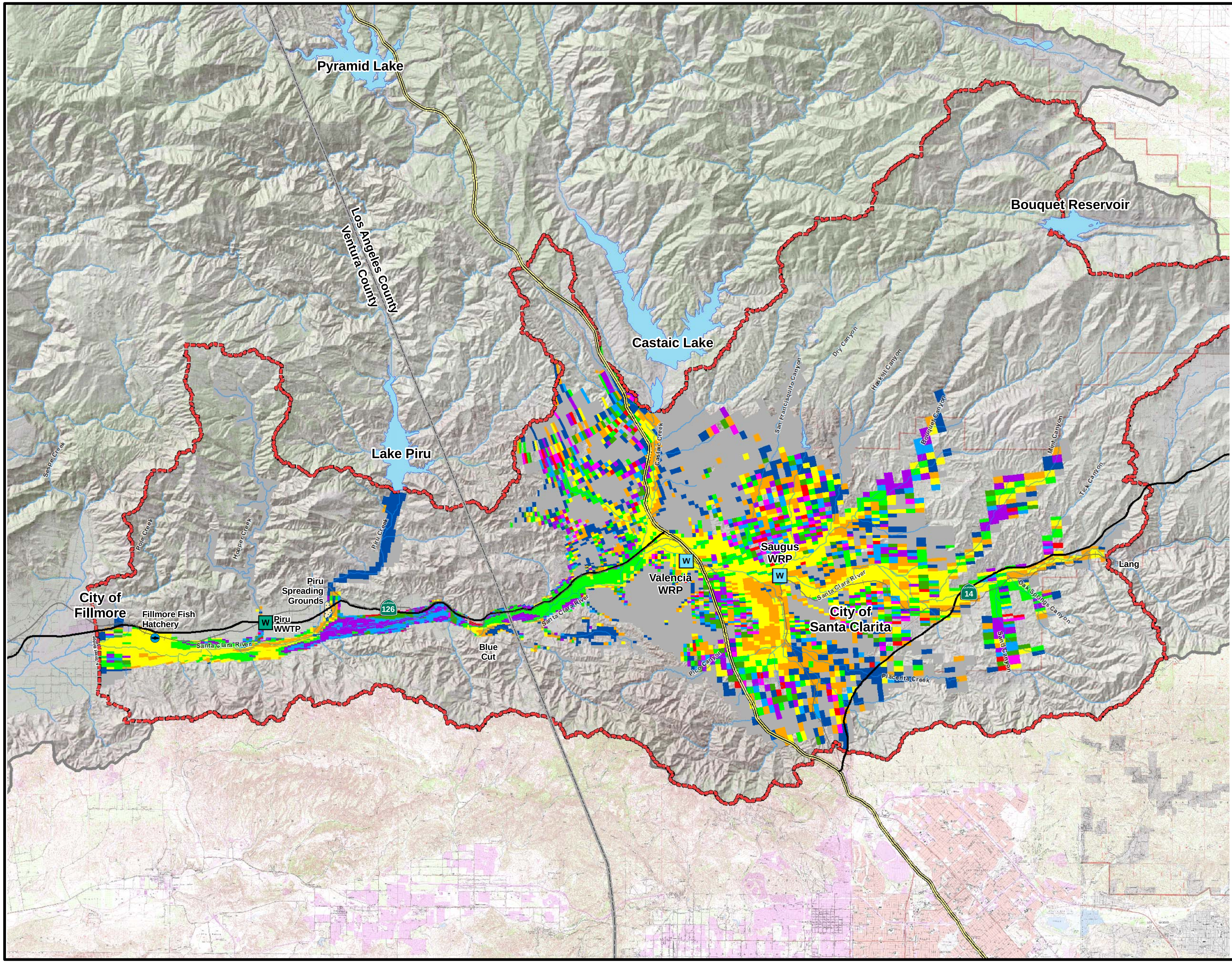

LEGEND

- GSWI STUDY AREA
- SANTA CLARA RIVER WATERSHED
- STREAM

TRANSPORTATION

- INTERSTATE
- STATE HIGHWAY
- RAILROAD

INITIAL CHLORIDE CONCENTRATION (mg/L)

- Up to 20
- 20 to 40
- 40 to 60
- 60 to 80
- 80 to 100
- 100 to 120
- 120 to 140
- 140 to 160
- 160 to 180
- 180 to 200

FIGURE 5-2
INITIAL CHLORIDE CONDITIONS IN MODEL LAYER 2 USED FOR SCENARIOS OF FUTURE CONDITIONS

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL -HGL

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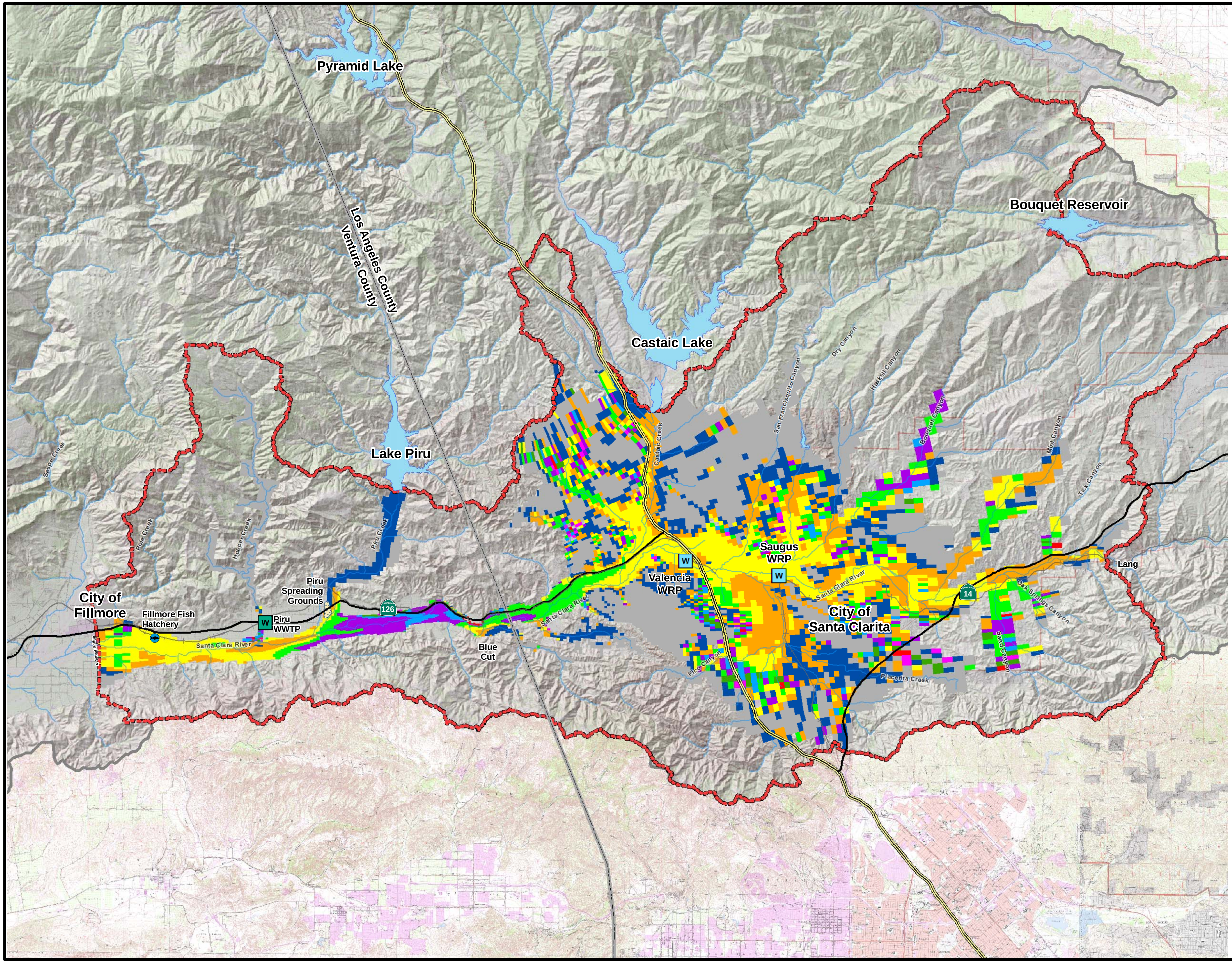

FIGURE 5-3
INITIAL CHLORIDE CONDITIONS IN MODEL LAYER 3 USED FOR SCENARIOS OF FUTURE CONDITIONS

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL -HGL

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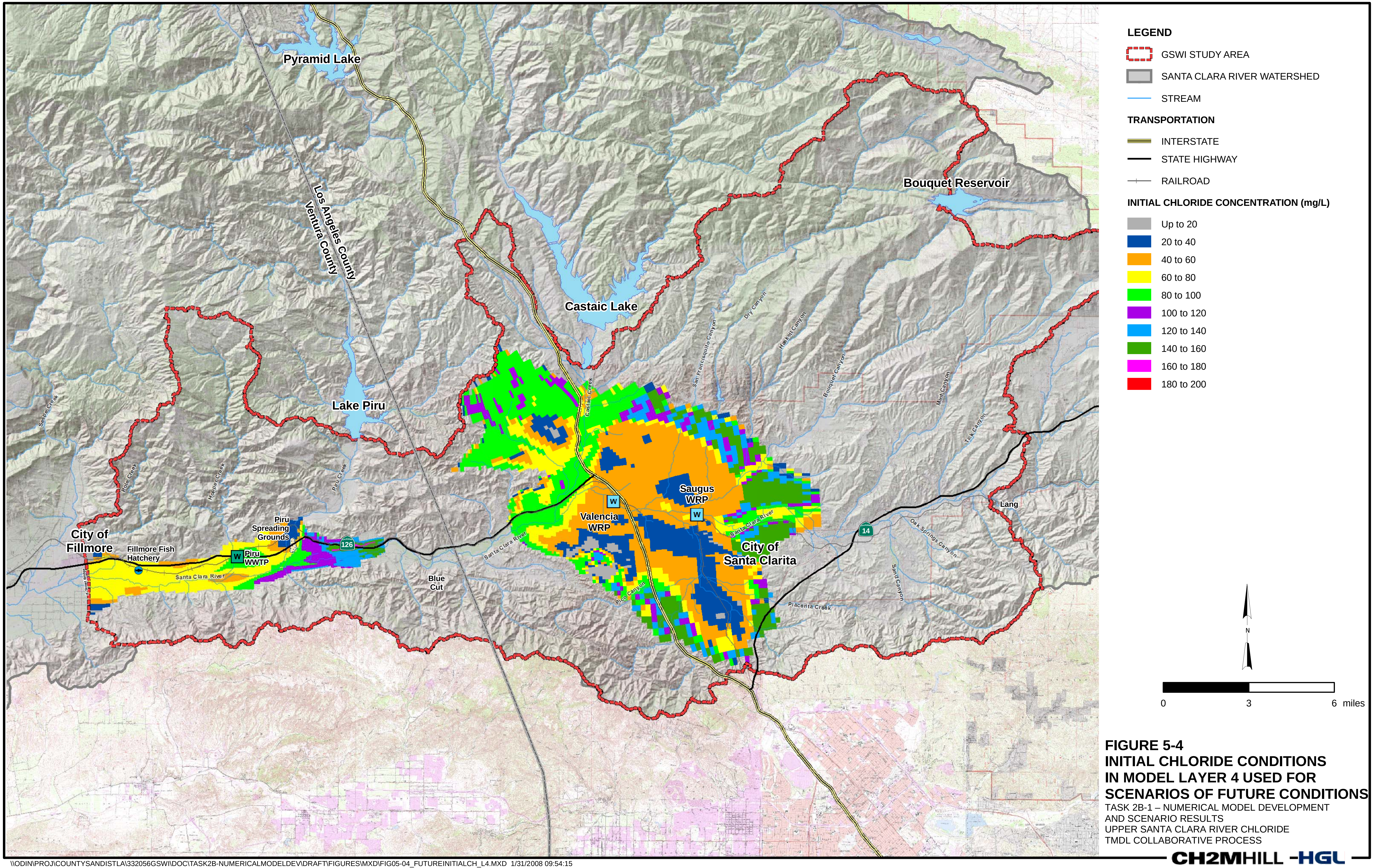

FIGURE 5-4
INITIAL CHLORIDE CONDITIONS IN MODEL LAYER 4 USED FOR SCENARIOS OF FUTURE CONDITIONS

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL -HGL

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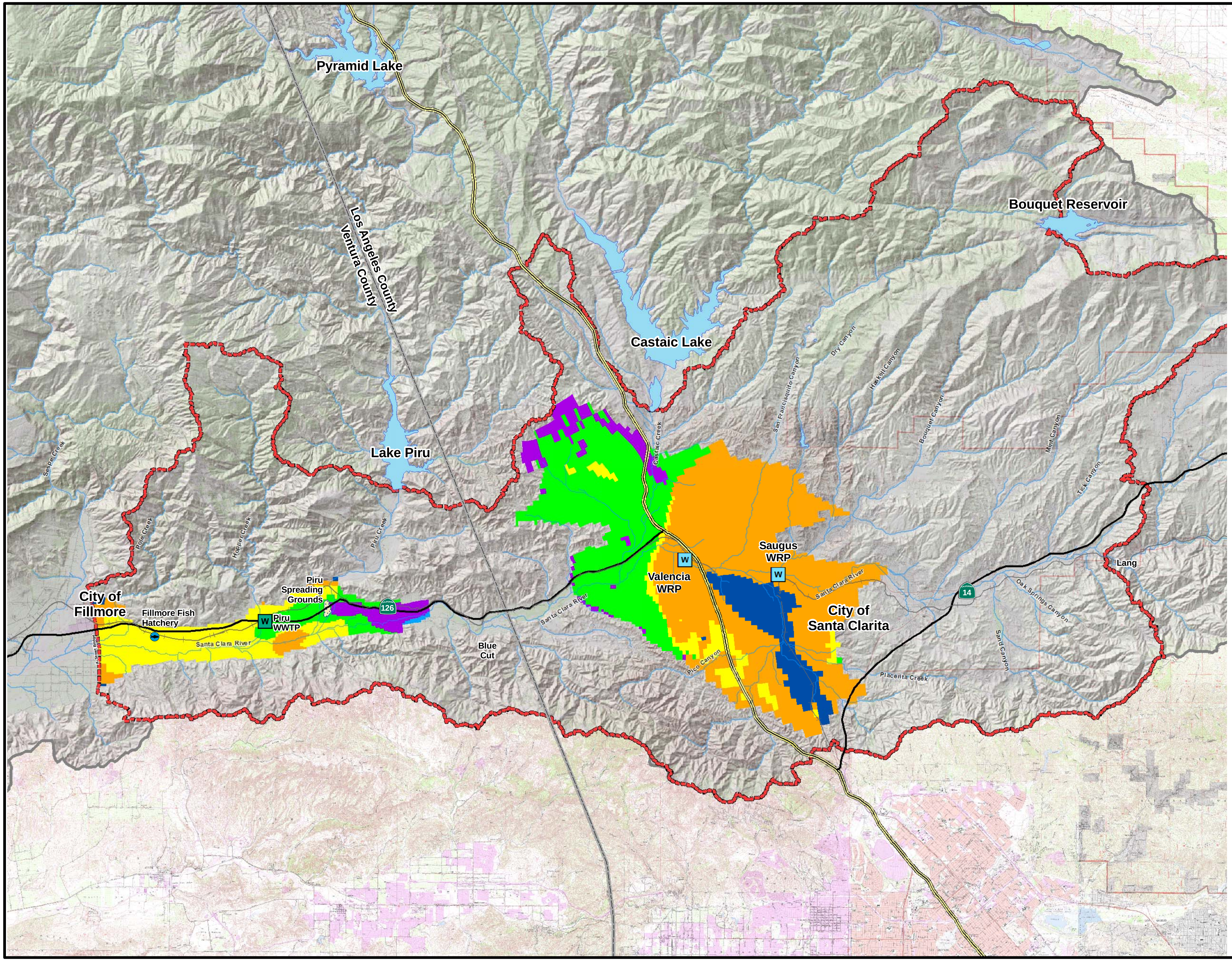

FIGURE 5-5
INITIAL CHLORIDE CONDITIONS IN MODEL LAYER 5 USED FOR SCENARIOS OF FUTURE CONDITIONS

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL -HGL

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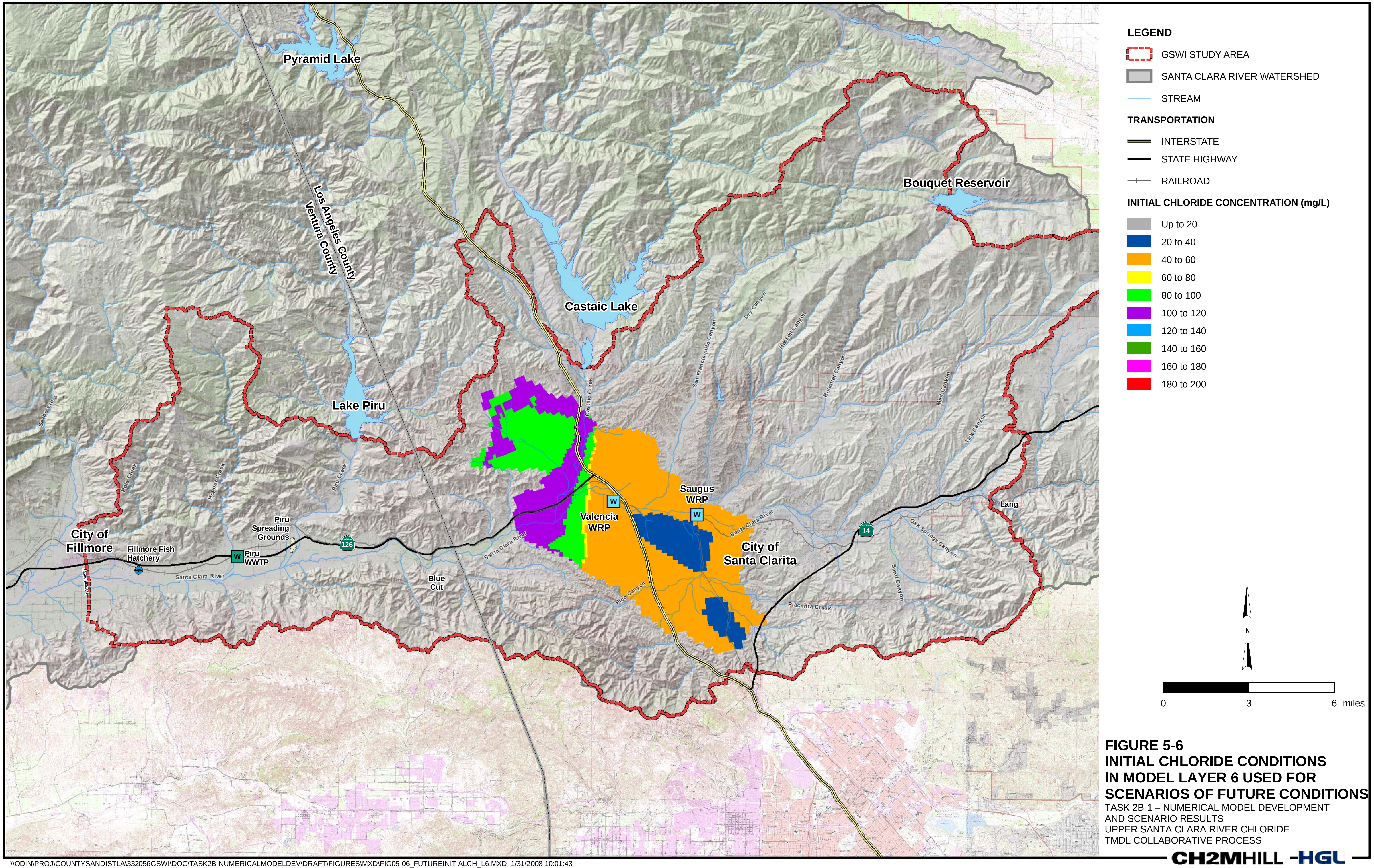

FIGURE 5-6
INITIAL CHLORIDE CONDITIONS IN MODEL LAYER 6 USED FOR SCENARIOS OF FUTURE CONDITIONS
TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL -HGL

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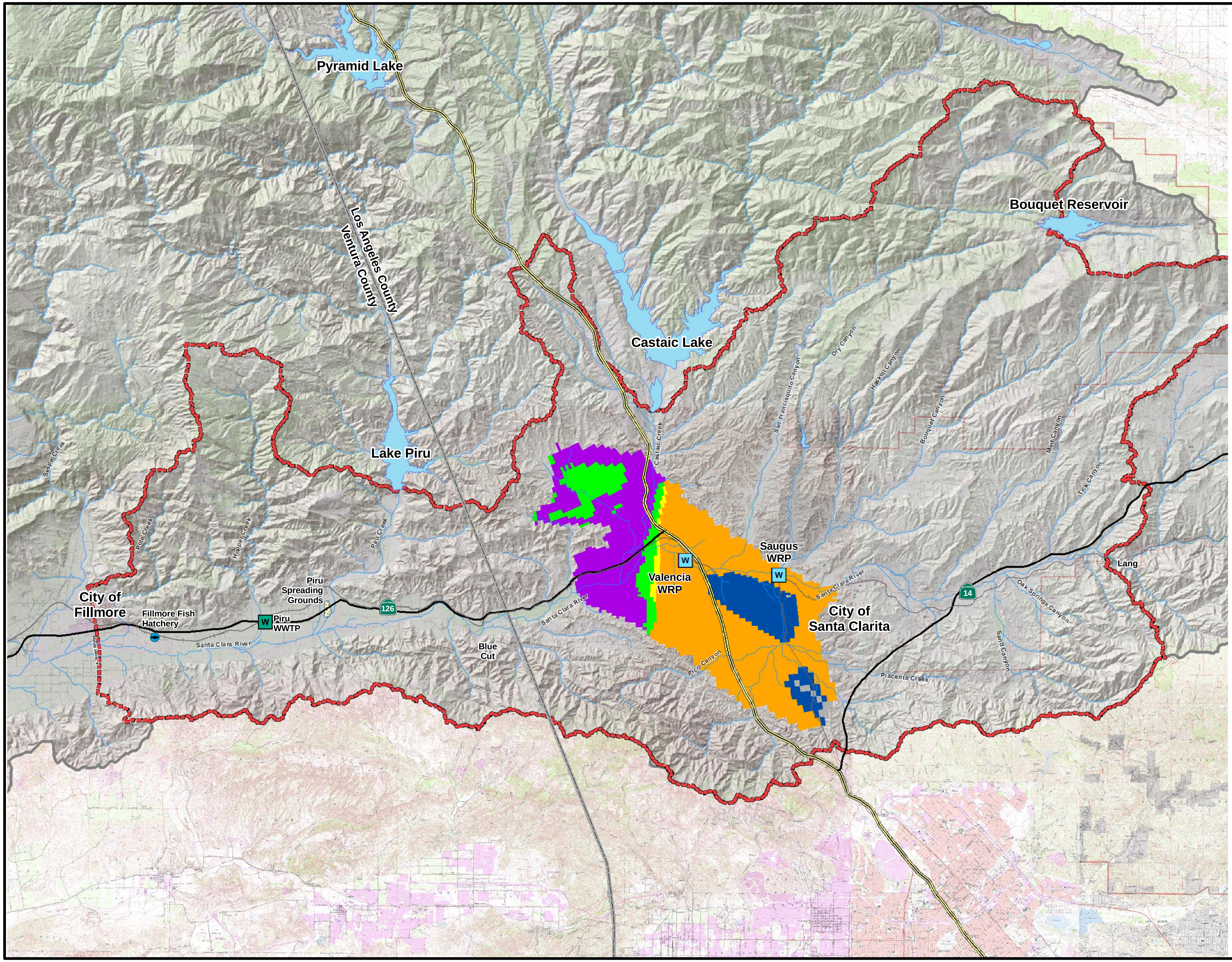

FIGURE 5-7
INITIAL CHLORIDE CONDITIONS IN MODEL LAYER 7 USED FOR SCENARIOS OF FUTURE CONDITIONS

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL -HGL

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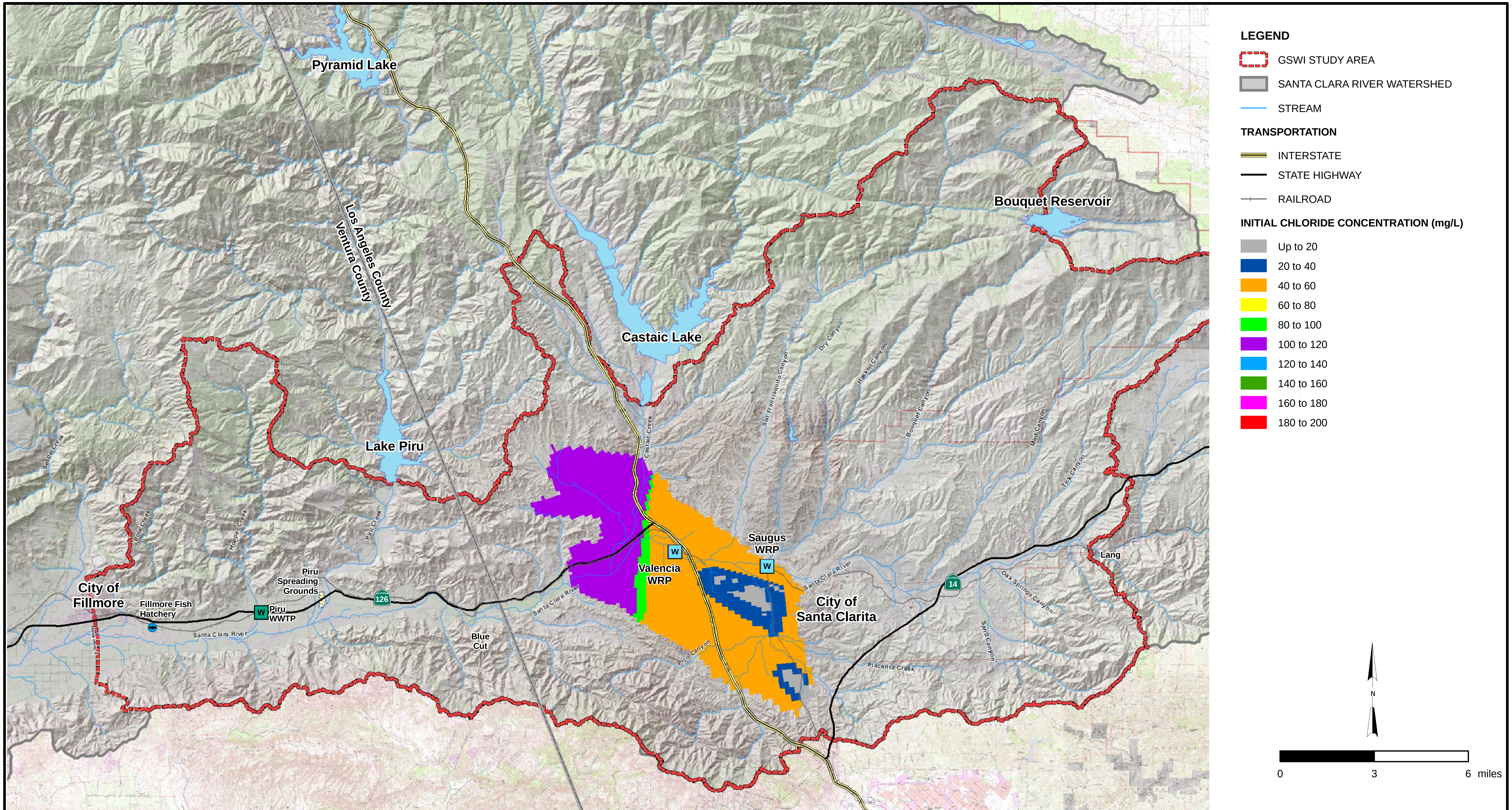

FIGURE 5-8
INITIAL CHLORIDE CONDITIONS IN MODEL LAYER 8 USED FOR SCENARIOS OF FUTURE CONDITIONS

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL -HGL

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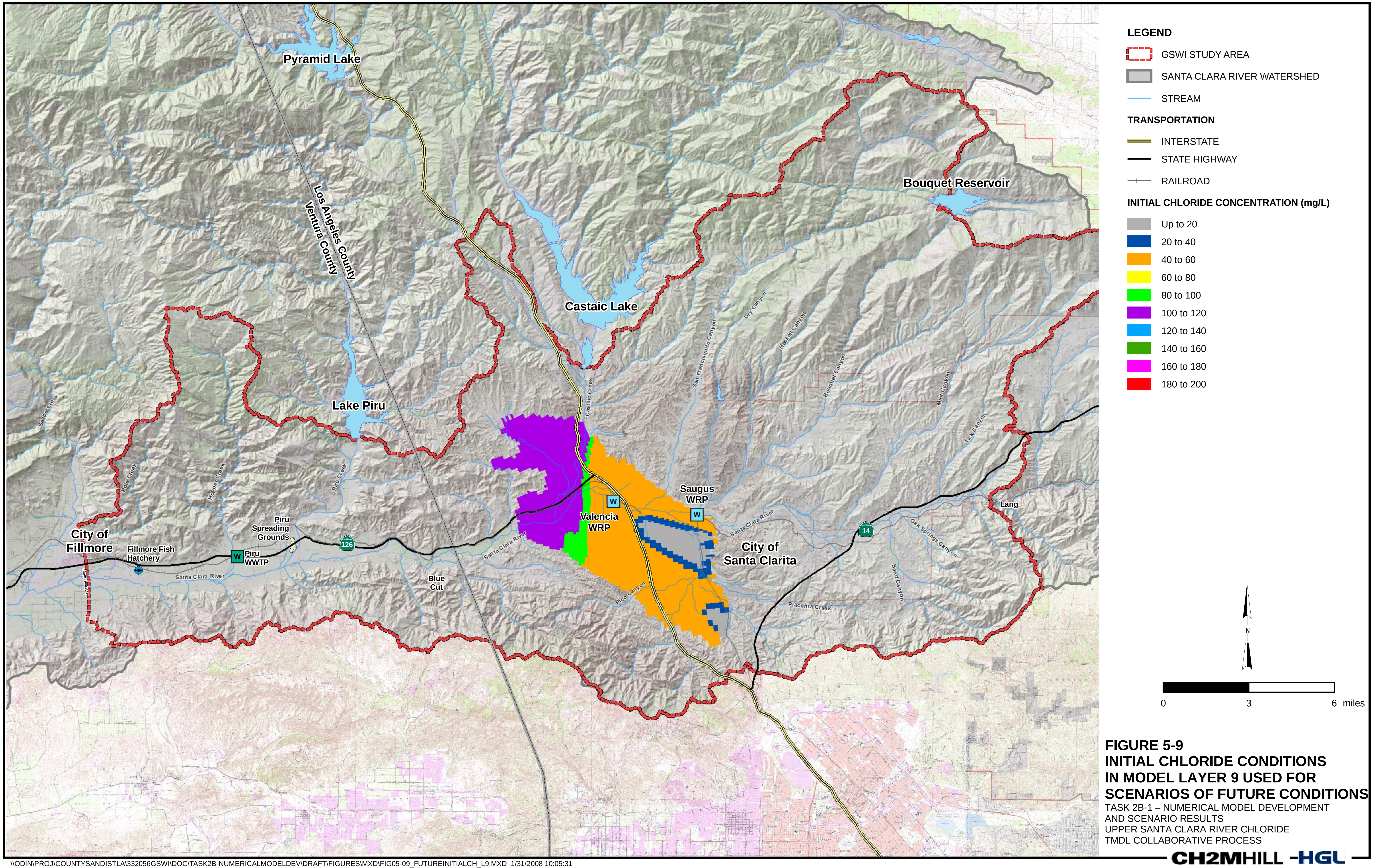

FIGURE 5-9
INITIAL CHLORIDE CONDITIONS IN MODEL LAYER 9 USED FOR SCENARIOS OF FUTURE CONDITIONS

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL -HGL

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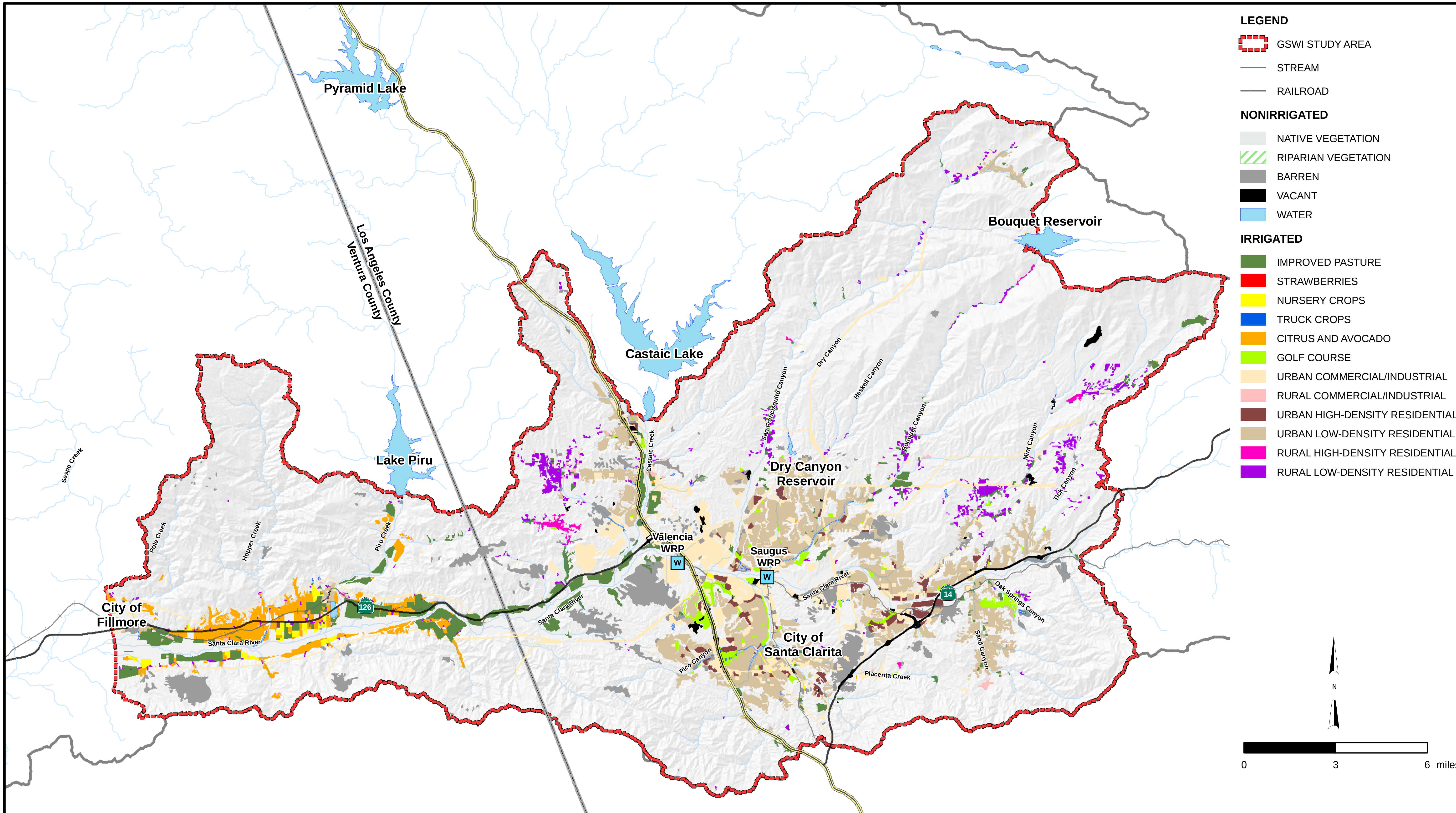

FIGURE 5-10
LAND USE 2005 – SCAG
TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

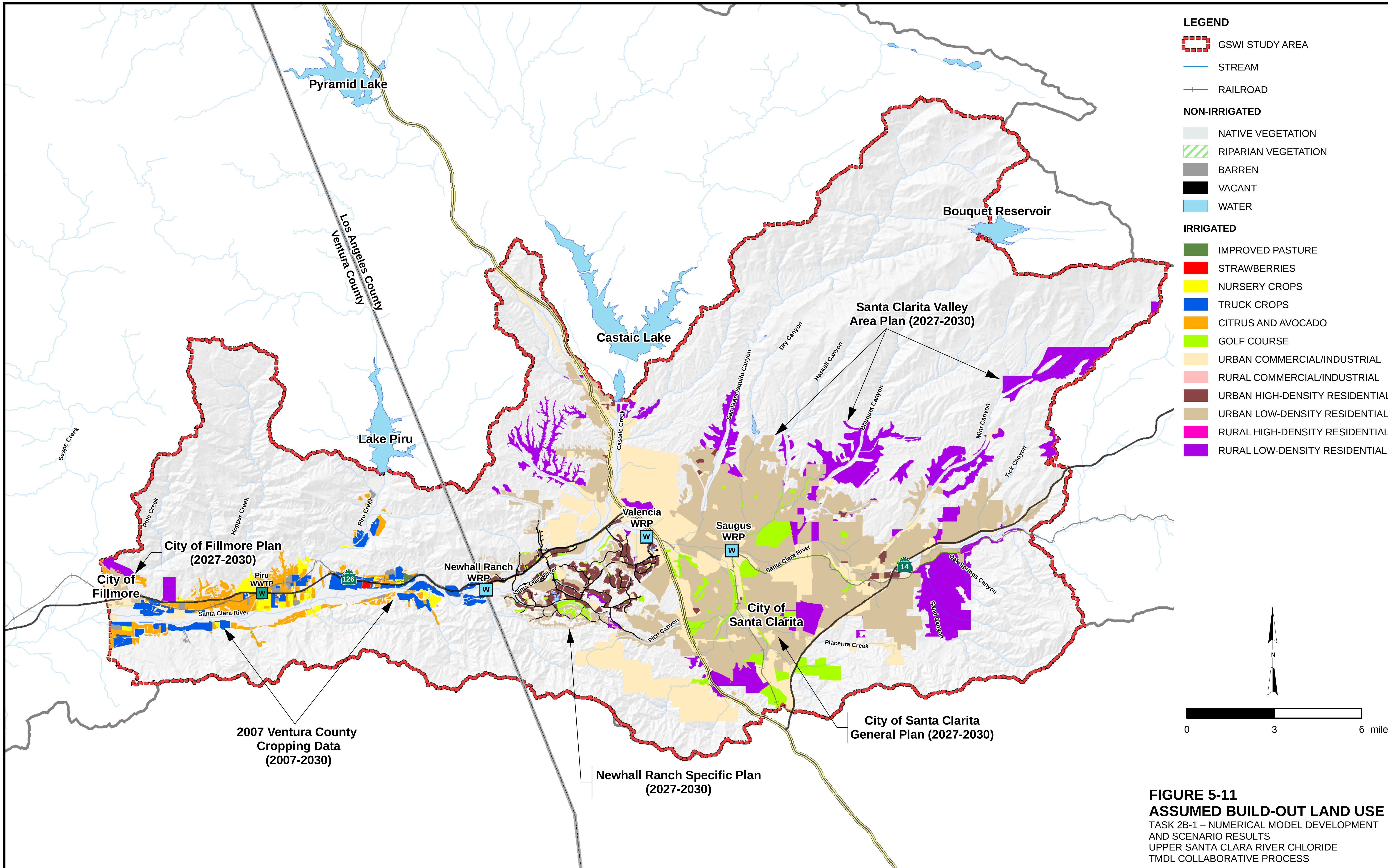

FIGURE 5-11
ASSUMED BUILD-OUT LAND USE
TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

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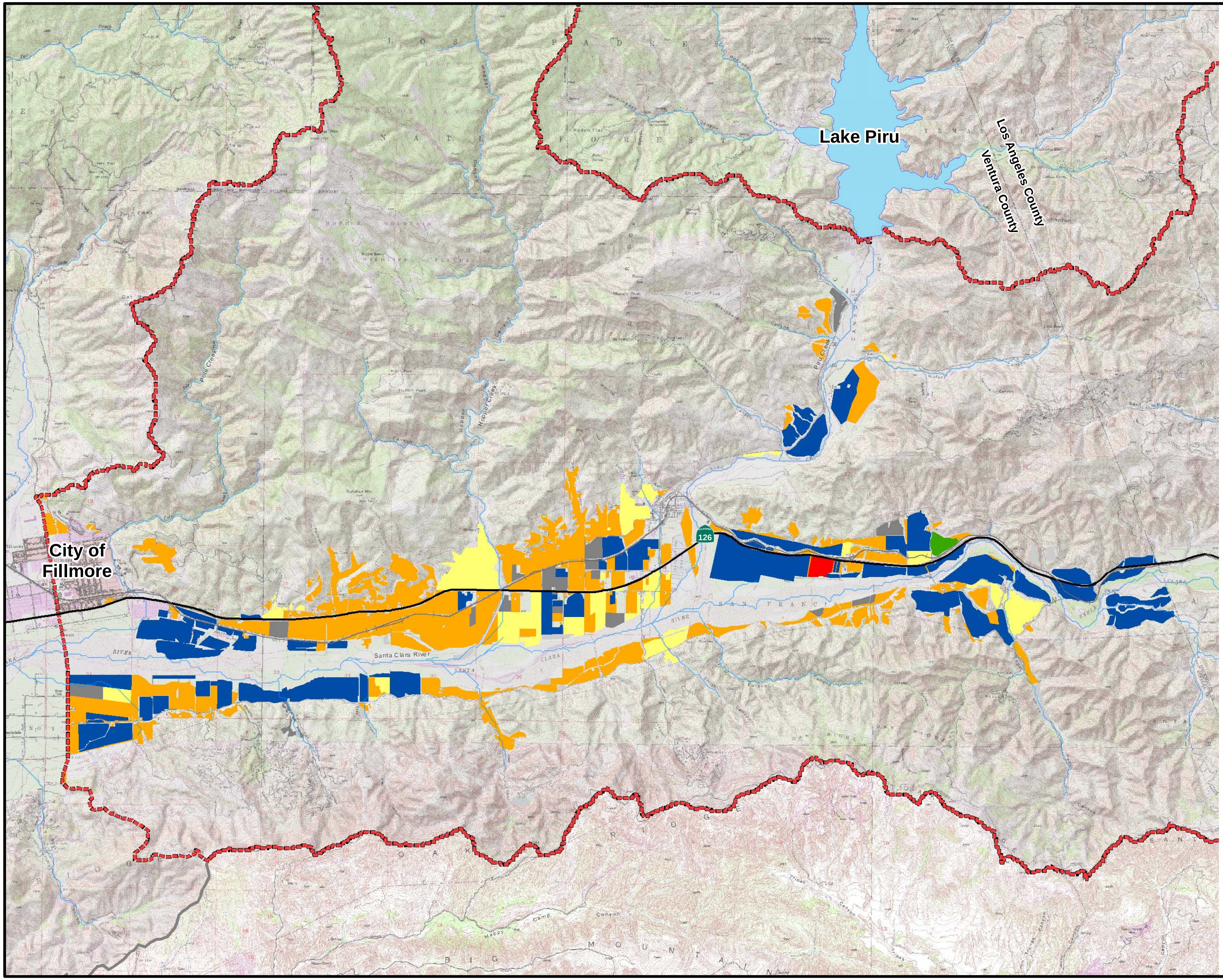

LEGEND

GSWI STUDY AREA
STREAM
RAILROAD

STANDARDIZED LAND USE

BARREN
CITRUS AND AVOCADO
IMPROVED PASTURE
NATIVE VEGETATION
NURSERY CROPS
STRAWBERRIES
TRUCK CROPS

N

0 6,000 12,000 feet

FIGURE 5-12
2007 AGRICULTURAL CROPPING IN VENTURA COUNTY

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL - HGL

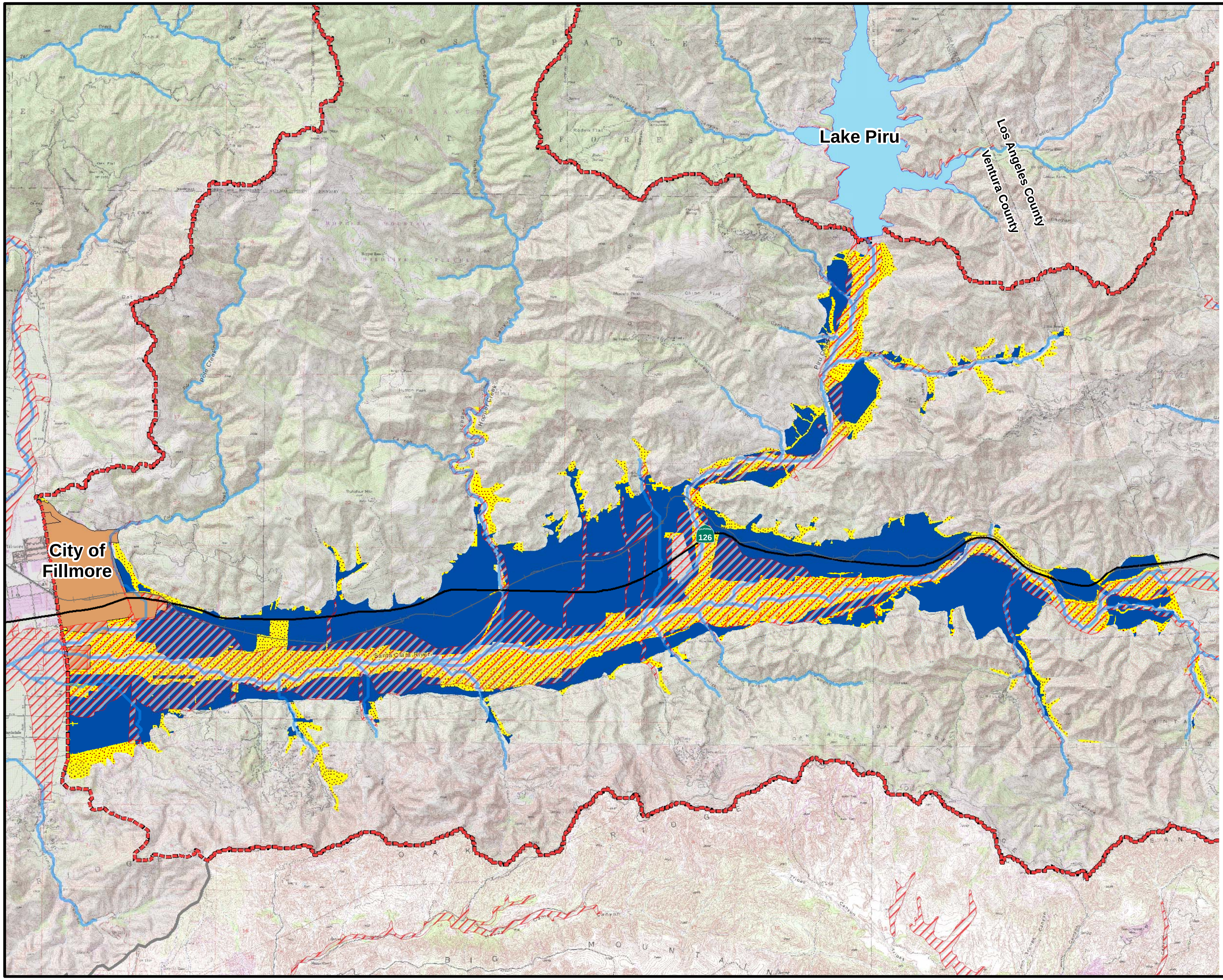

FIGURE 5-13
POTENTIALLY DEVELOPABLE AREA IN PIRU VALLEY

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL HGL

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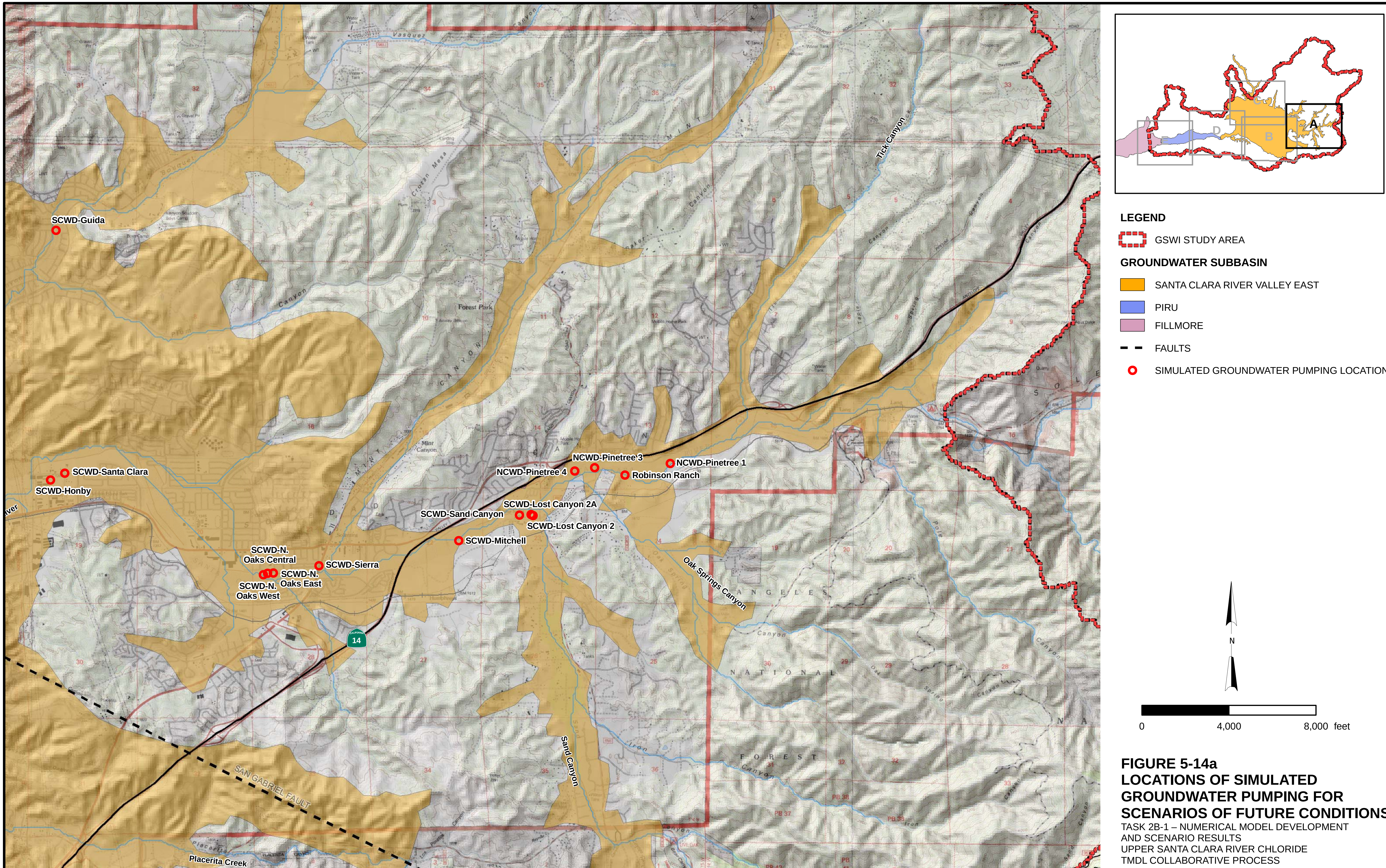

FIGURE 5-14a
LOCATIONS OF SIMULATED GROUNDWATER PUMPING FOR SCENARIOS OF FUTURE CONDITIONS
TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL -HGL

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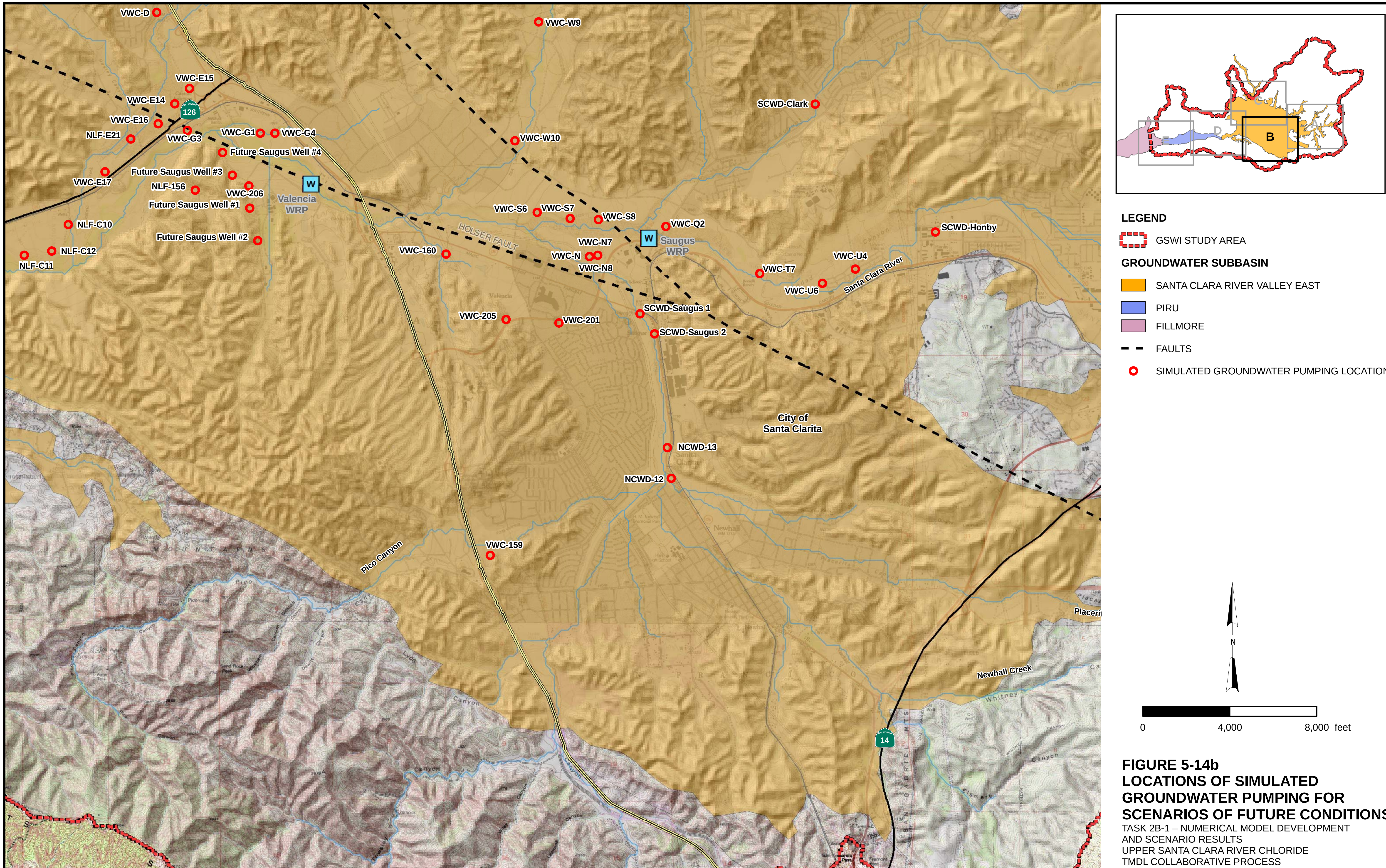
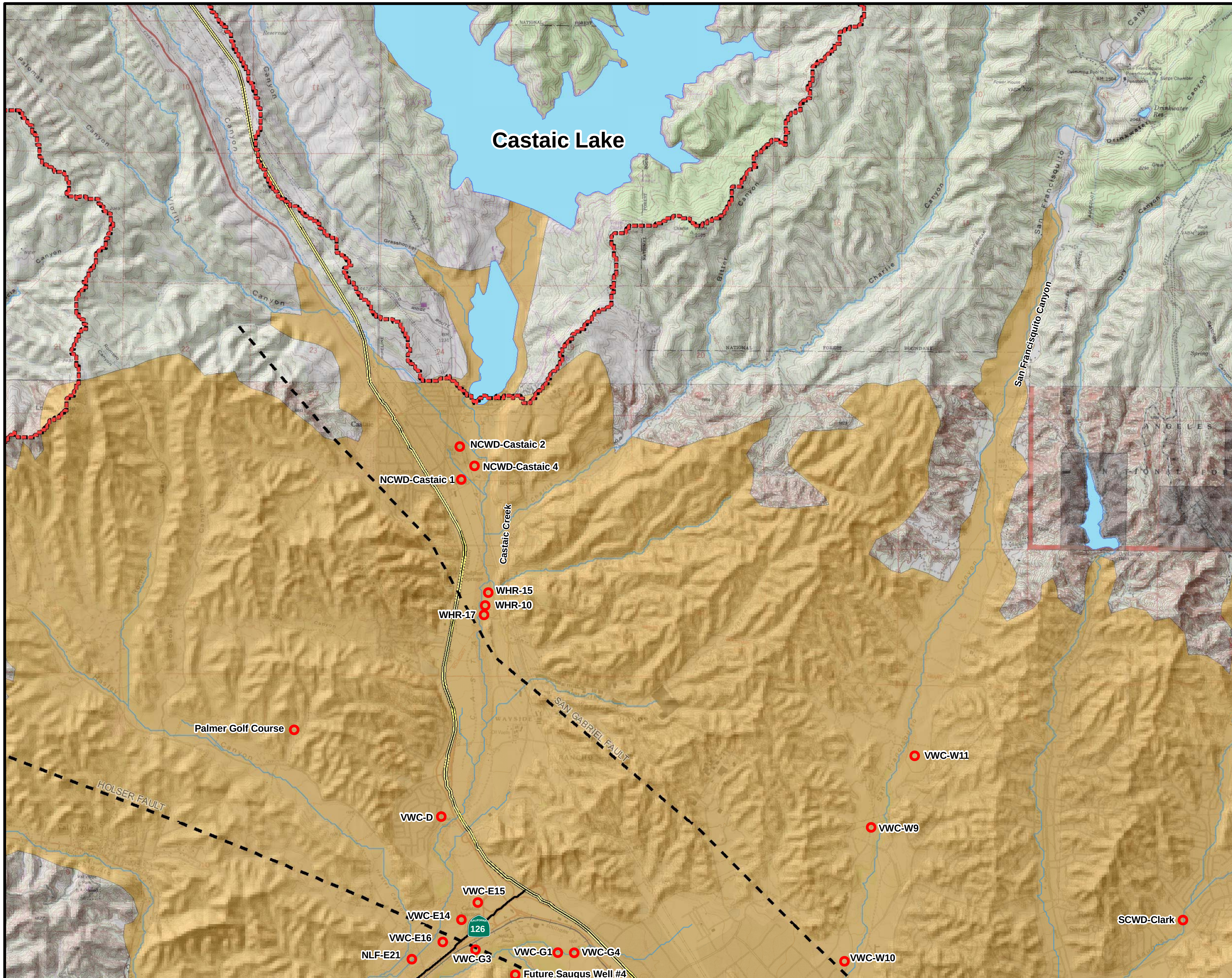


FIGURE 5-14b
LOCATIONS OF SIMULATED GROUNDWATER PUMPING FOR SCENARIOS OF FUTURE CONDITIONS
TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL -HGL



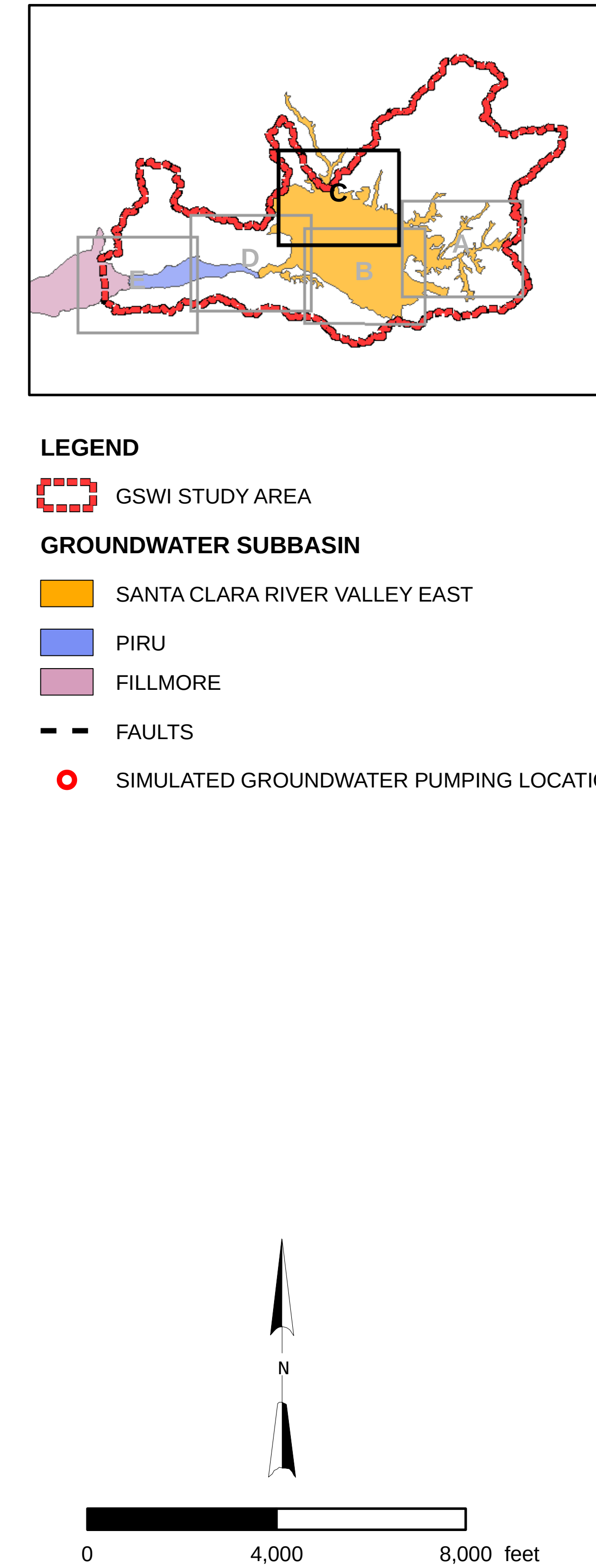


FIGURE 5-14c
LOCATIONS OF SIMULATED GROUNDWATER PUMPING FOR SCENARIOS OF FUTURE CONDITIONS

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL HGL

\\ODIN\PROJ\COUNTYSANDISTLA\332056GSWI\DOC\TASK2B-NUMERICALMODELDEV\DRAFT\FIGURES\MXD\FIG05-14C_PUMPINGLOCSFUTURE.MXD 2/3/2008 18:55:41

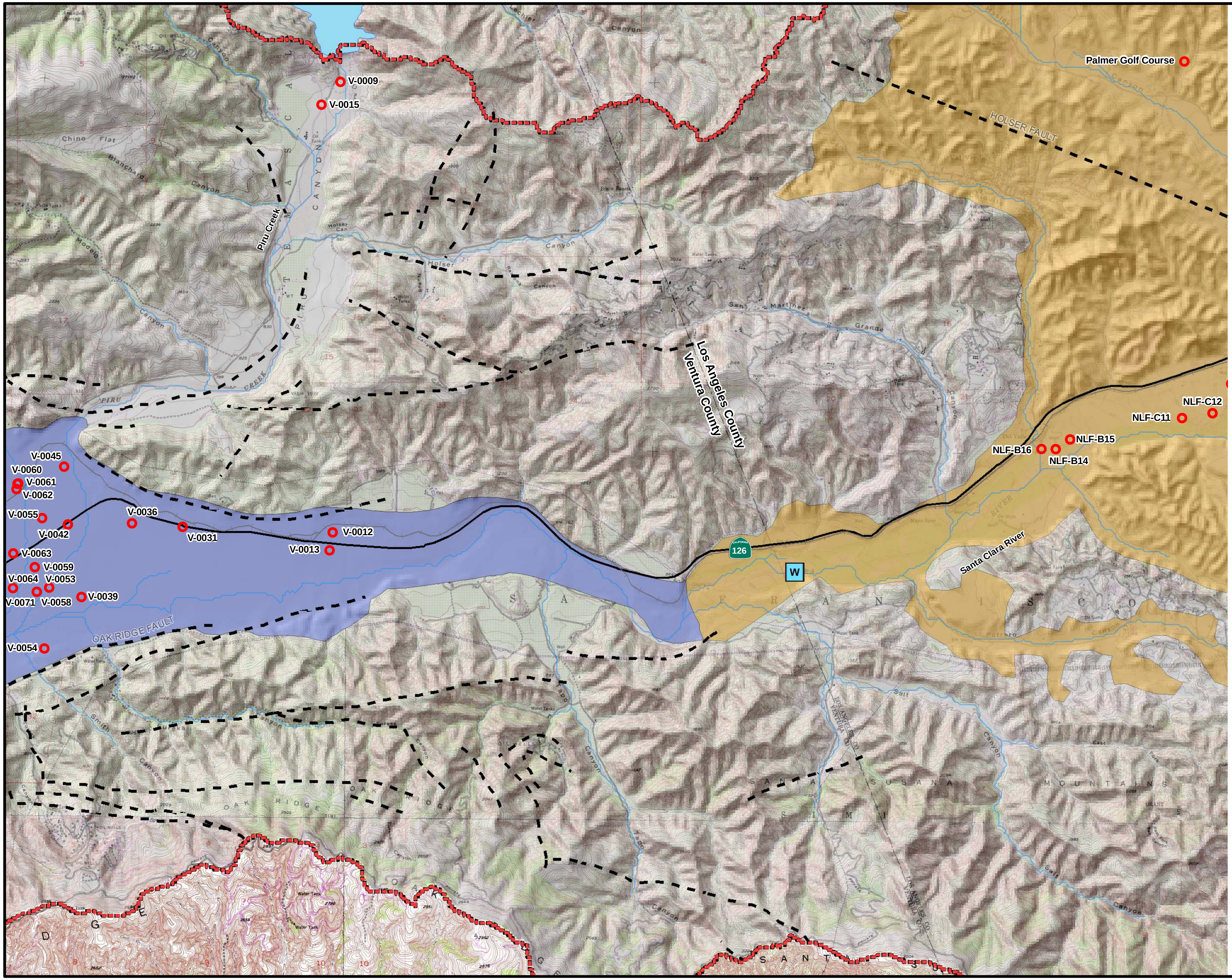


FIGURE 5-14d
LOCATIONS OF SIMULATED GROUNDWATER PUMPING FOR SCENARIOS OF FUTURE CONDITIONS

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL -HGL

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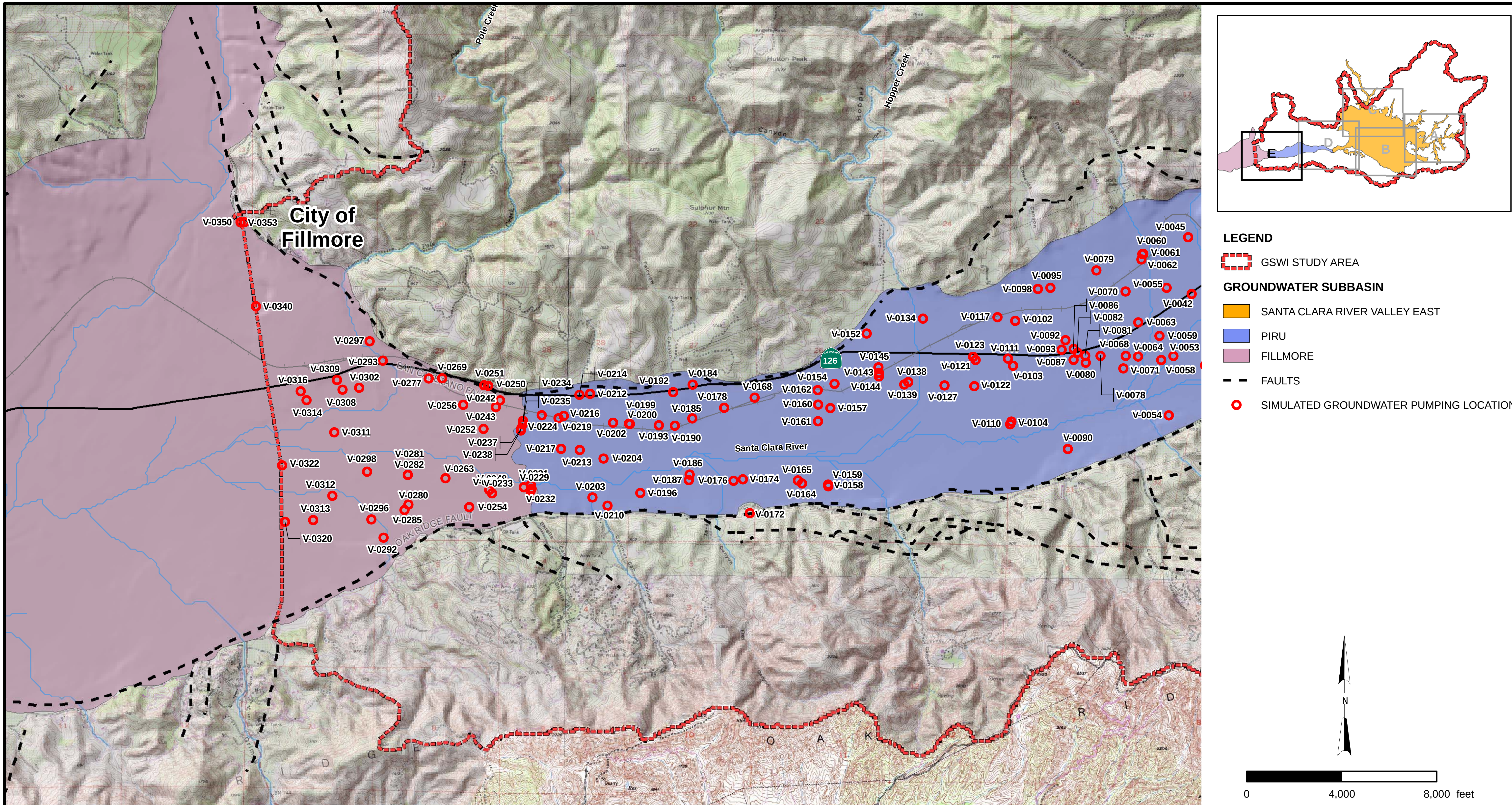


FIGURE 5-14e
LOCATIONS OF SIMULATED GROUNDWATER PUMPING FOR SCENARIOS OF FUTURE CONDITIONS

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL -HGL

\\ODIN\PROJ\COUNTYSANDISTLA\332056GSWI\DOC\TASK2B-NUMERICALMODELDEV\DRAFT\FIGURES\MXD\FIG05-14E_PUMPINGLOCSFUTURE.MXD 2/3/2008 18:38:14

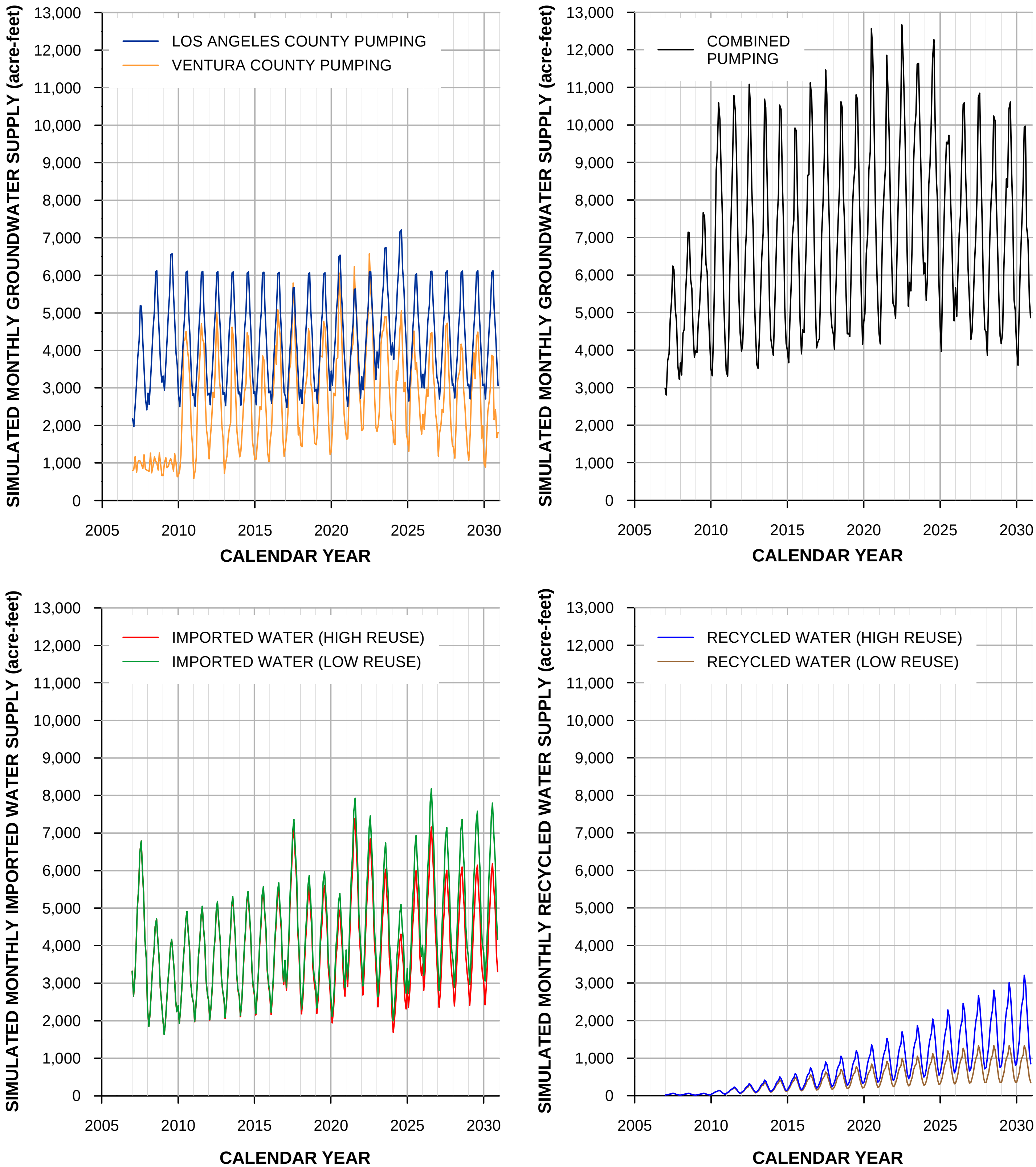
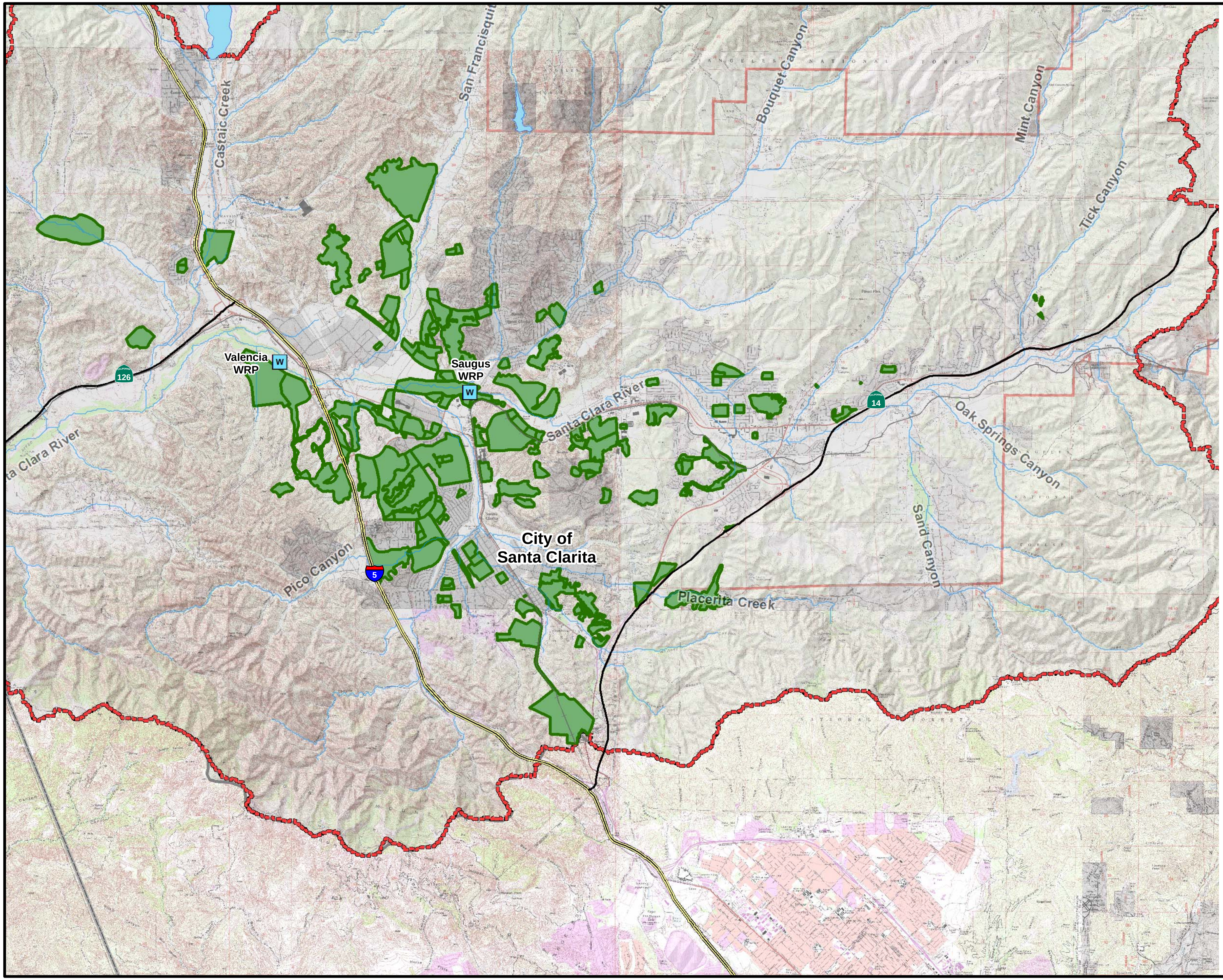


FIGURE 5-15
MONTHLY WATER SUPPLY QUANTITIES ASSUMED FOR THE SCENARIOS OF FUTURE CONDITIONS

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

MonthlySupplies.grf

CH2MHILL –HGL



LEGEND

- AREA OF RECYCLED WATER USE OUTSIDE OF NEWHALL RANCH UNDER HIGH-REUSE SCENARIO
- GSWI STUDY AREA
- STREAM
- RAILROAD

N

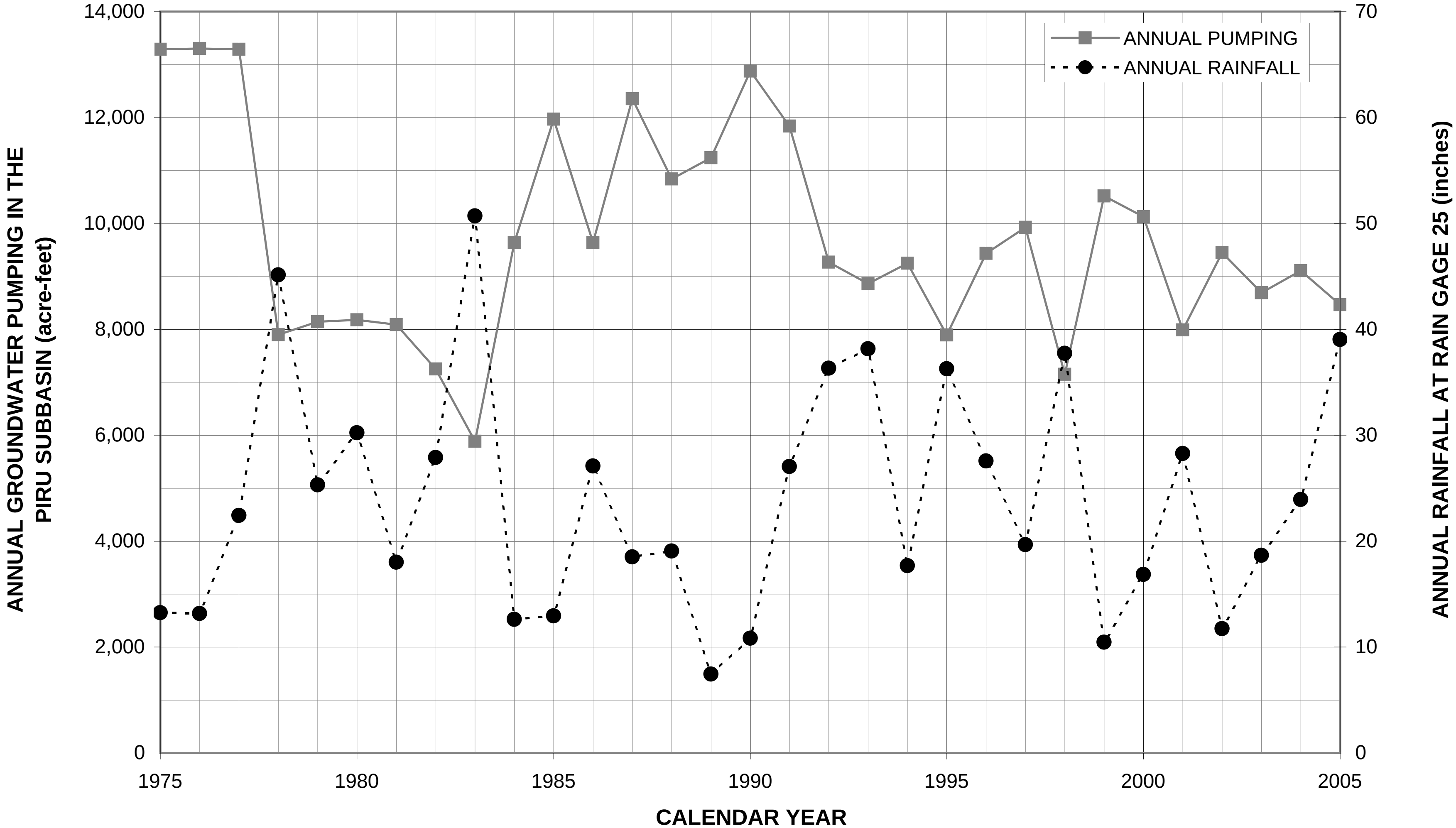
0 1.5 3 miles

FIGURE 5-16
AREAS LOCATED OUTSIDE OF NEWHALL RANCH ASSUMED TO RECEIVE RECYCLED WATER FOR OUTDOOR USE UNDER HIGH-REUSE SCENARIOS

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL -HGL

\\ODIN\PROJ\COUNTYSANDISTLA\332056GSWI\DOC\TASK2B-NUMERICALMODELDEV\DRAFT\FIGURES\MXD\FIG05-16_F_RECWATERAPP.MXD 2/3/2008 19:18:19

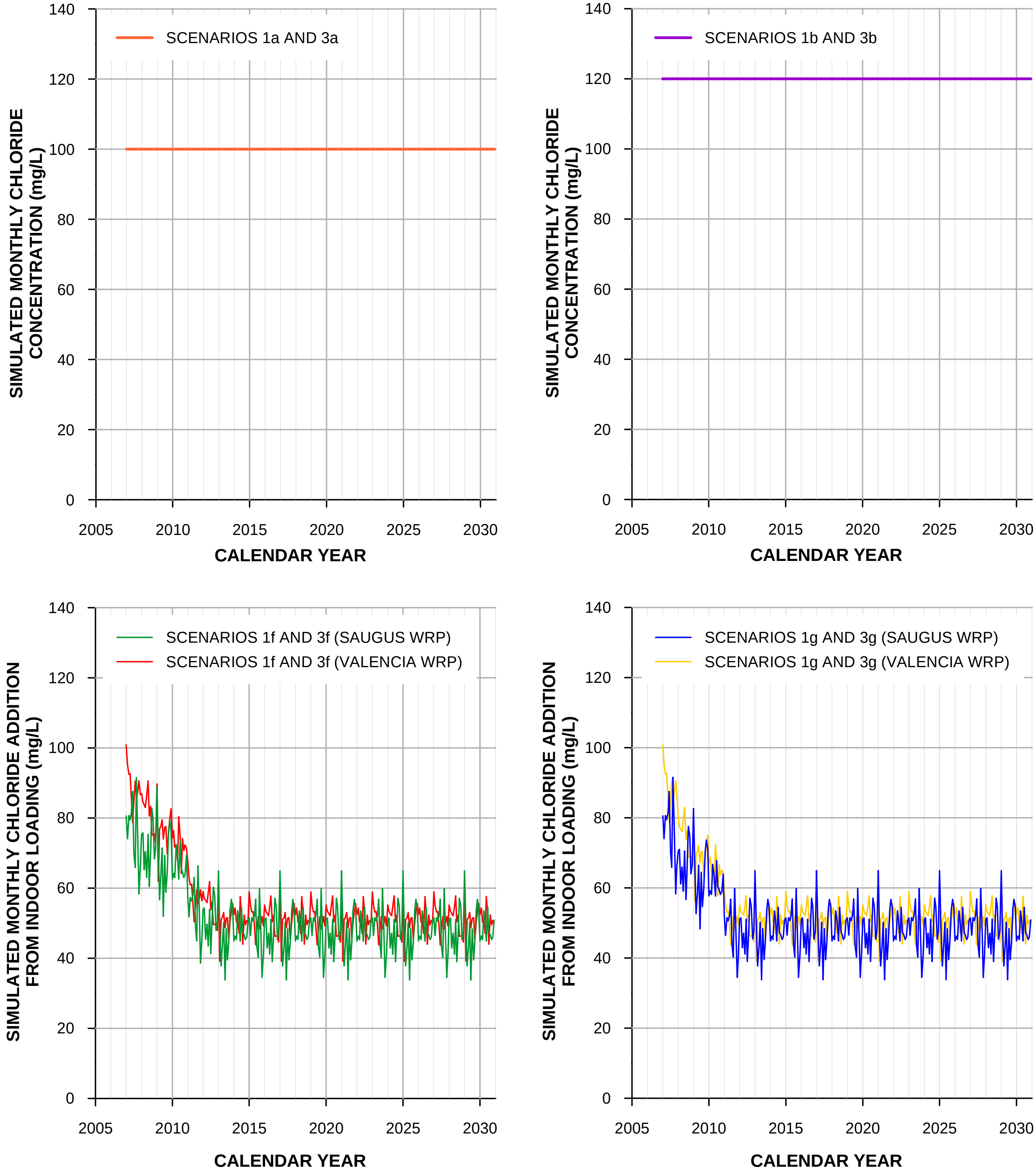


NOTES:

1. RAINFALL DATA FROM RAIN GAGE 25, NEAR THE COUNTY LINE.
2. GROUNDWATER PUMPING DATA PROVIDED BY UWCD.

FIGURE 5-17
COMPARISON OF ANNUAL GROUNDWATER PUMPING AND RAINFALL IN THE PIRU SUBBASIN

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

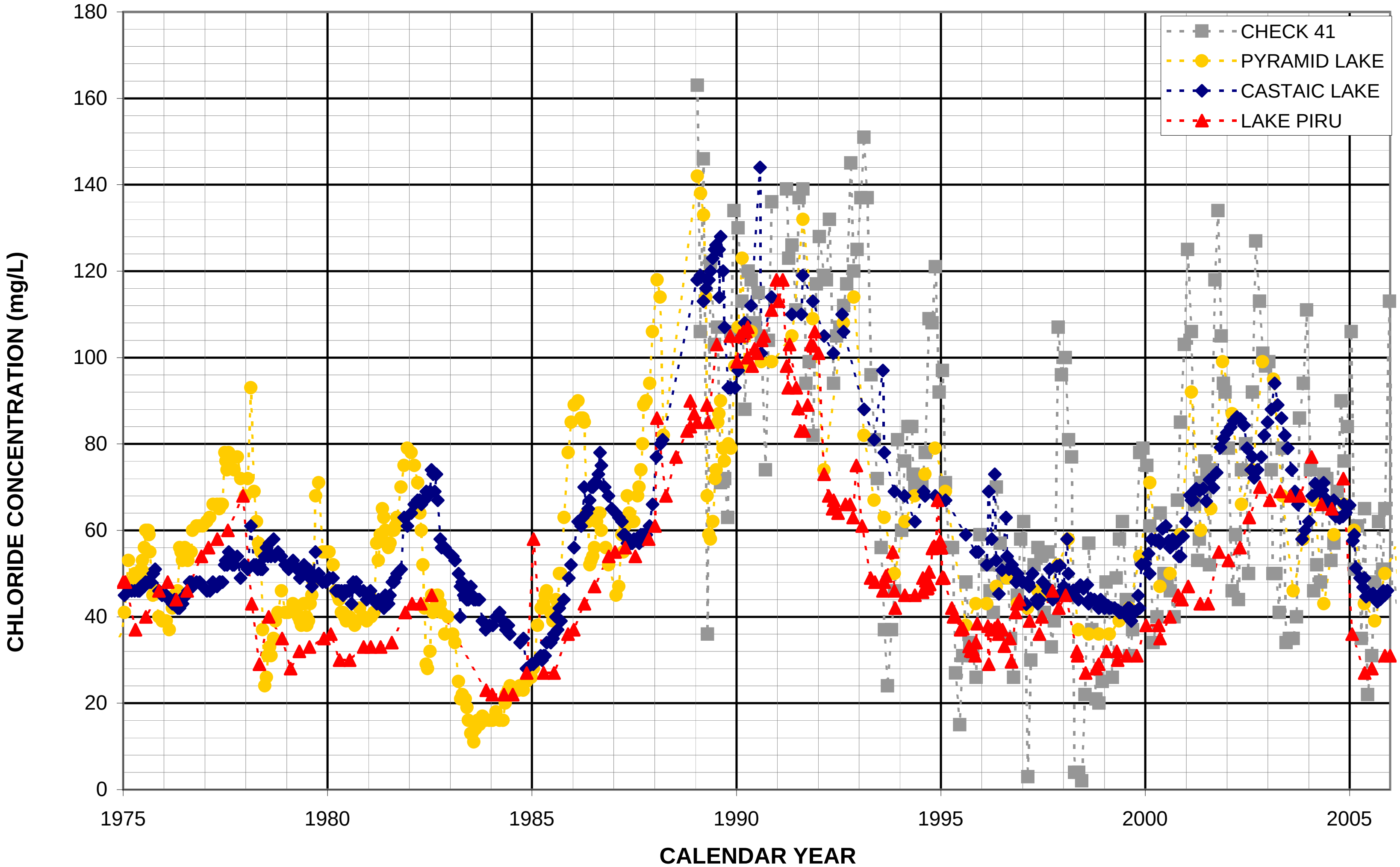


NOTES
1. CHLORIDE CONCENTRATIONS SHOWN IN THE TOP TWO PLOTS ARE SIMULATED IN THE SAUGUS AND VALENCIA WRP DISCHARGE.
2. CHLORIDE CONCENTRATIONS SHOWN IN THE BOTTOM TWO PLOTS ARE ADDED TO THE CHLORIDE CONCENTRATION OF THE BLENDED WATER SUPPLY TO SIMULATE THE CHLORIDE CONCENTRATION OF THE WRP DISCHARGE. THIS IS DONE INTERNALLY BY GSWIM.
3. CHLORIDE CONCENTRATIONS IN DISCHARGE AND RECYCLED WATER FROM THE NEWHALL RANCH WRP WAS SET AT 100 AND 150 mg/L, RESPECTIVELY.

FIGURE 5-18
MONTHLY CHLORIDE CONCENTRATIONS ASSUMED FOR THE SCENARIOS OF FUTURE CONDITIONS

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

ChlorideAssumptions.grf



NOTES:

1. CHECK 41 IS NORTH OF THE GSWI STUDY AREA AT THE TEHACHAPI AFTERBAY, WHICH IS NEAR THE COUNTY LINE BETWEEN LOS ANGELES AND KERN COUNTIES (SEE FIGURE 1-1).
2. WATER QUALITY DATA PROVIDED BY DWR AND CLWA.

FIGURE 5-19
HISTORICAL CHLORIDE CONCENTRATIONS AT CHECK 41 OF THE CALIFORNIA AQUEDUCT AND IN LOCAL RESERVOIRS

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

Fig05-19_ReservoirWaterQuality.xls\Fig5-19

CH2MHILL -HGL

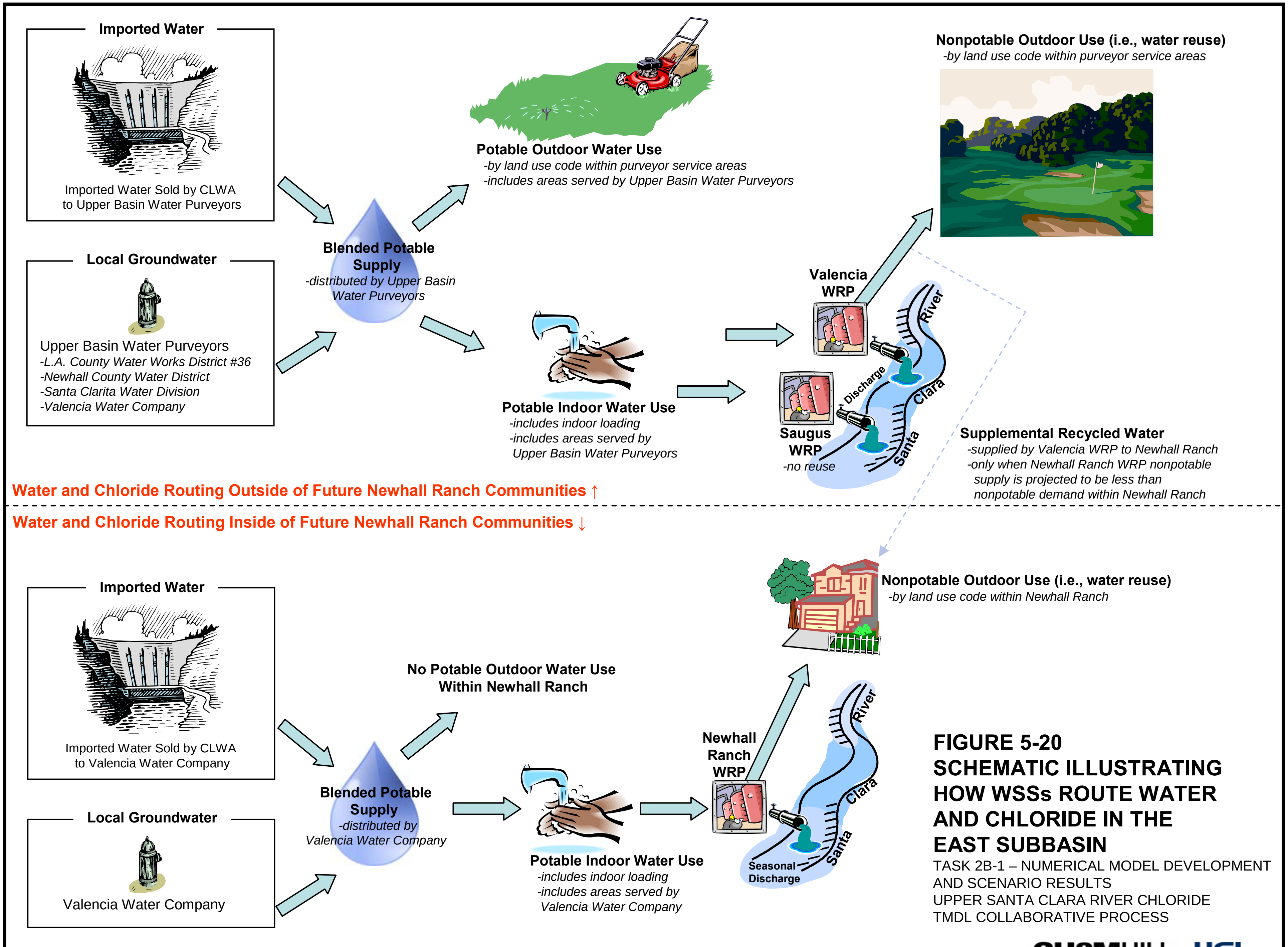
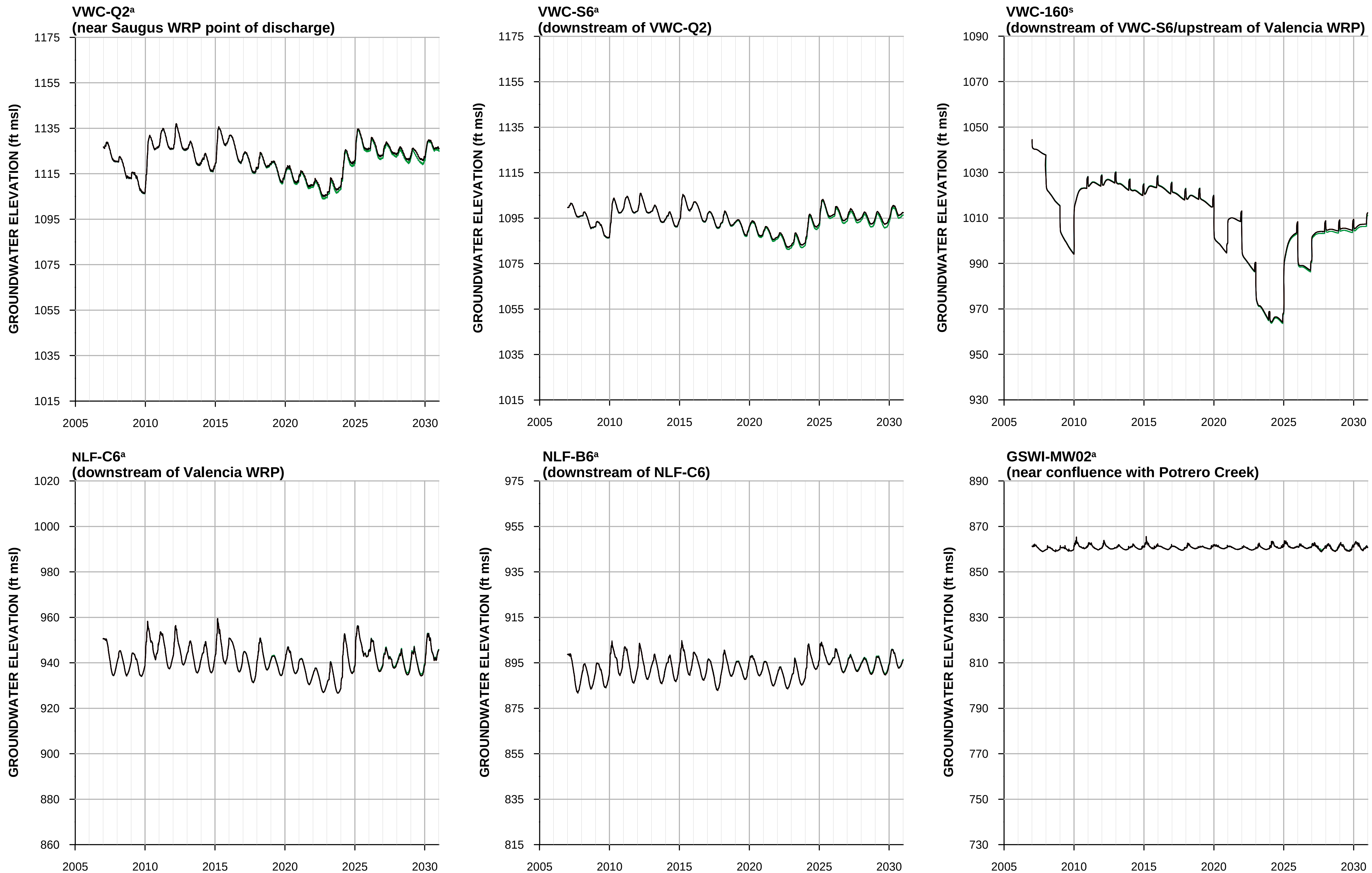


FIGURE 5-20
SCHEMATIC ILLUSTRATING HOW WSSs ROUTE WATER AND CHLORIDE IN THE EAST SUBBASIN
TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL – HGL

Fig05-20_WaterRoutingFutureScenarios.ppt



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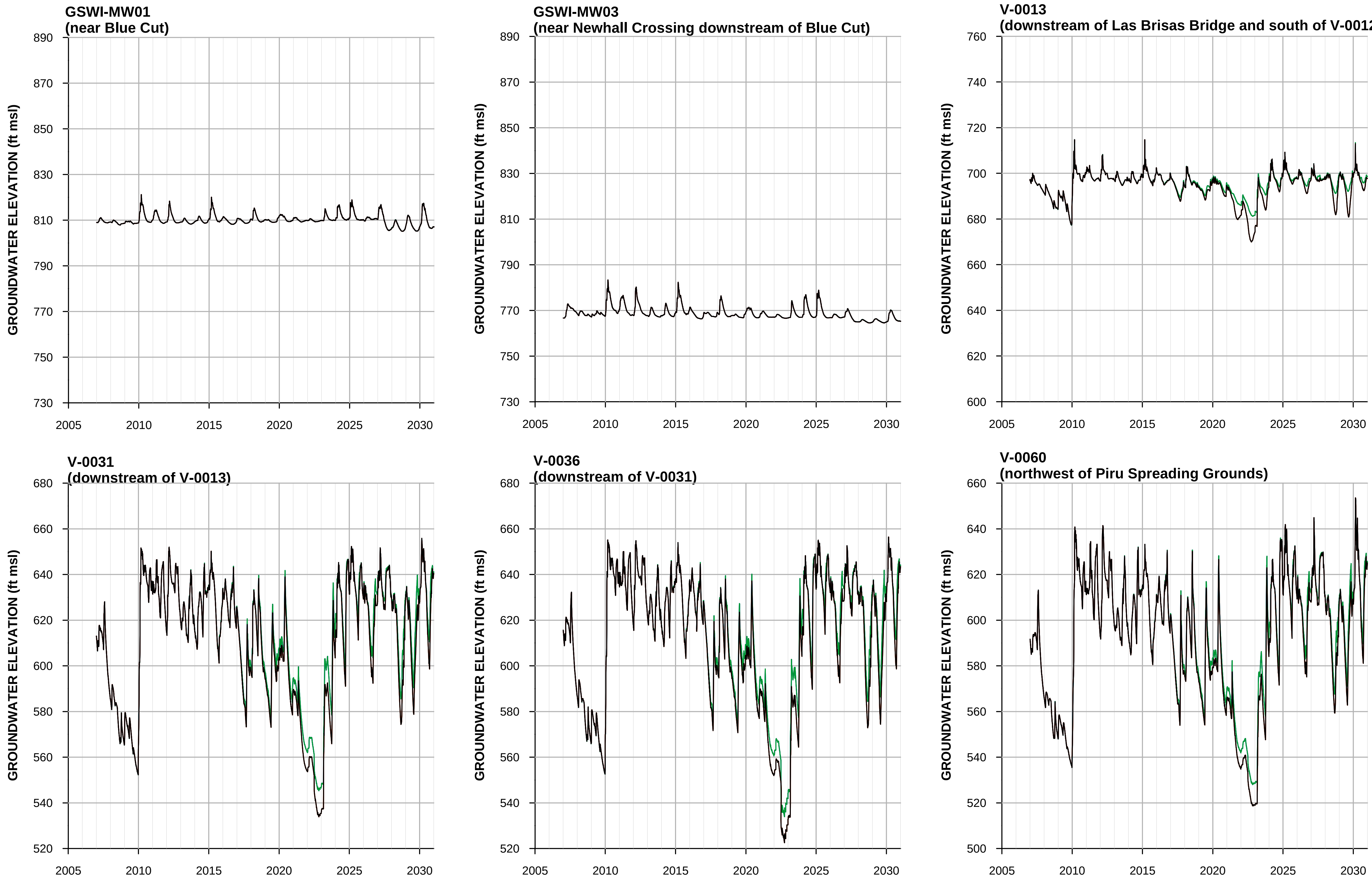
2008	1976
2009	1977
2010	1978
2011	1979
2012	1980
2013	1981
2014	1982
2015	1983
2016	1984
2017	1985
2018	1986
2019	1987
2020	1988
2021	1989
2022	1990
2023	1991
2024	1992
2025	1993
2026	1994
2027	1995
2028	1996
2029	1997
2030	1998

NOTES:
1. a = ALLUVIAL AQUIFER WELL.
2. s = SAUGUS FORMATION WELL.
3. MODEL RESULTS ARE TAKEN FROM THE FWL5 PACKAGE, UNLESS OTHERWISE NOTED IN THE TARGET LOCATION NAME. FOR EXAMPLE, LACFCD-7187C (3) INDICATES THE RESULTS WERE TAKEN FROM MODEL LAYER 3.
4. SEE FIGURES 4-1a THROUGH 4-1e FOR MODEL-OUTPUT LOCATIONS.
5. X-AXIS VALUES REPRESENT CALENDAR YEARS OF THE FUTURE SIMULATION PERIOD.

FIGURE 5-21
SIMULATED GROUNDWATER ELEVATIONS IN WELLS LOCATED IN THE EAST SUBBASIN: SCENARIOS 1A/B, 3A/B, 1F/G, AND 3F/G
TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL –HGL

HeadsEastSubbasin.grf



LEGEND

- HIGH REUSE; 100 mg/L CHLORIDE IN SAUGUS AND VALENCIA WRP DISCHARGE (SCENARIO 1A)
- HIGH REUSE; 120 mg/L CHLORIDE IN SAUGUS AND VALENCIA WRP DISCHARGE (SCENARIO 1B)
- LOW REUSE; 100 mg/L CHLORIDE IN SAUGUS AND VALENCIA WRP DISCHARGE (SCENARIO 3A)
- LOW REUSE; 120 mg/L CHLORIDE IN SAUGUS AND VALENCIA WRP DISCHARGE (SCENARIO 3B)
- HIGH REUSE; 50 PERCENT REMOVAL OF SELF REGENERATING WATER SOFTENERS (SCENARIO 1F)
- HIGH REUSE; 100 PERCENT REMOVAL OF SELF REGENERATING WATER SOFTENERS (SCENARIO 1G)
- LOW REUSE; 50 PERCENT REMOVAL OF SELF REGENERATING WATER SOFTENERS (SCENARIO 3F)
- LOW REUSE; 100 PERCENT REMOVAL OF SELF REGENERATING WATER SOFTENERS (SCENARIO 3G)

SIMULATION YEAR	HYDROLOGY YEAR
2007	1975
2008	1976
2009	1977
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2012	1980
2013	1981
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2016	1984
2017	1985
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2019	1987
2020	1988
2021	1989
2022	1990
2023	1991
2024	1992
2025	1993
2026	1994
2027	1995
2028	1996
2029	1997
2030	1998

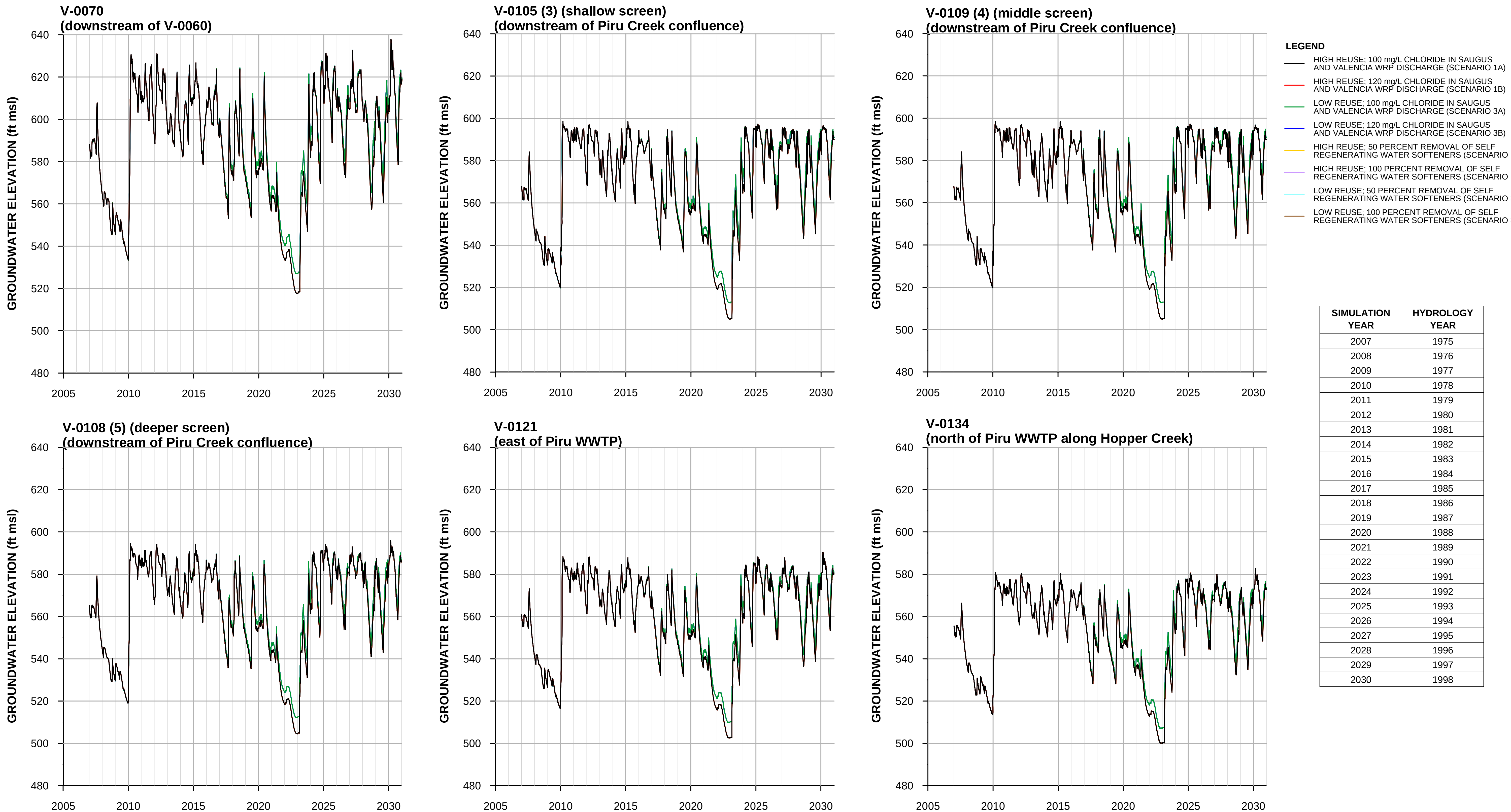
NOTES:
1. SEE FIGURES 4-1a THROUGH 4-1e FOR MODEL-OUTPUT LOCATIONS.
2. MODEL RESULTS ARE TAKEN FROM THE FWL5 PACKAGE, UNLESS OTHERWISE NOTED IN THE TARGET LOCATION NAME. FOR EXAMPLE, LACFCD-7187C (3) INDICATES THE RESULTS WERE TAKEN FROM MODEL LAYER 3.
3. X-AXIS VALUES REPRESENT CALENDAR YEARS OF THE FUTURE SIMULATION PERIOD.

FIGURE 5-22
SIMULATED GROUNDWATER ELEVATIONS IN WELLS LOCATED EAST OF TORREY ROAD IN THE PIRU SUBBASIN: SCENARIOS 1A/B, 3A/B, 1F/G, AND 3F/G

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL –HGL

Piru_Heads_EastTorrey.grf



SIMULATION YEAR	HYDROLOGY YEAR
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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

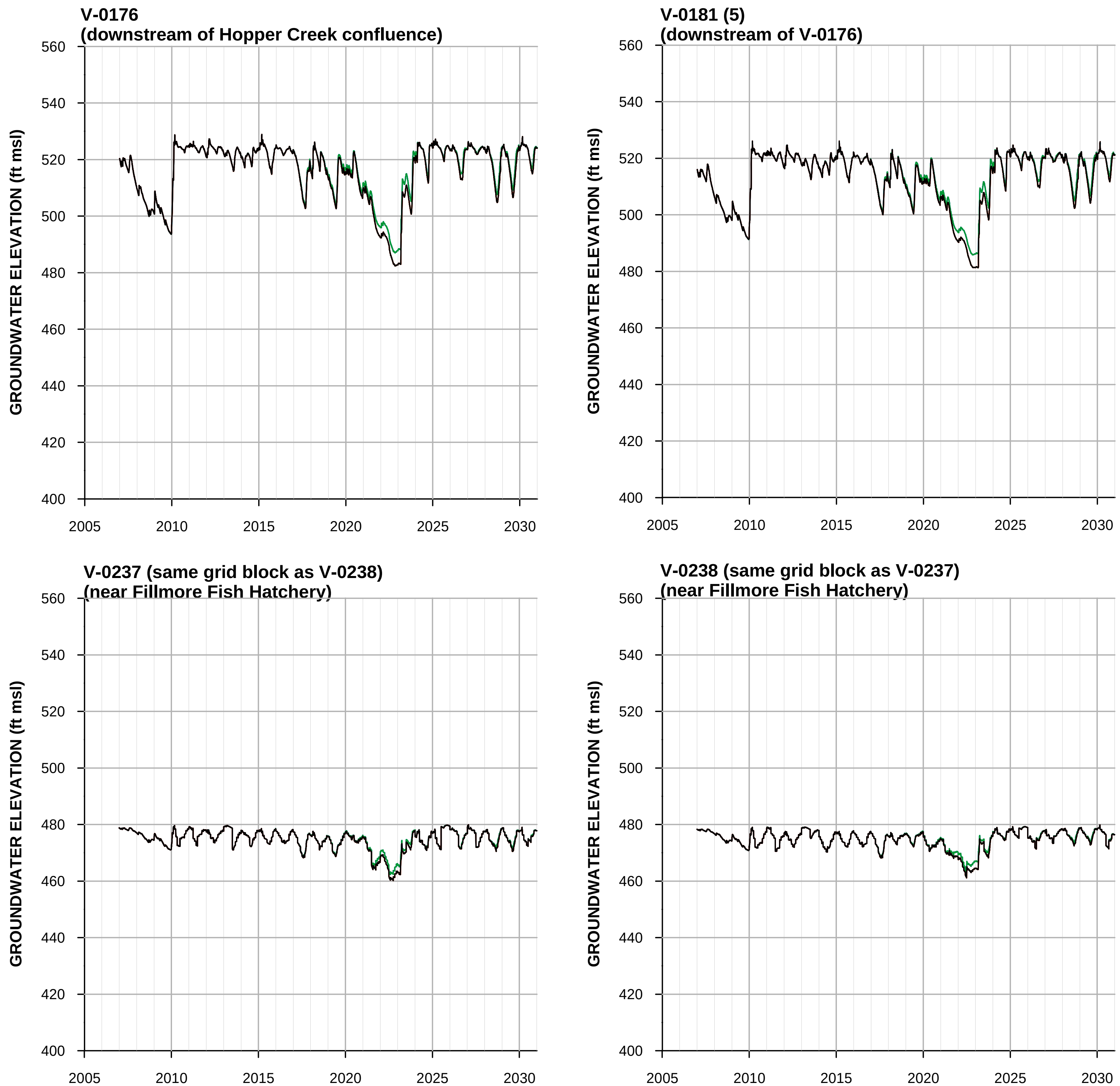
NOTES:
1. SEE FIGURES 4-1a THROUGH 4-1e FOR MODEL-OUTPUT LOCATIONS.
2. MODEL RESULTS ARE TAKEN FROM THE FWL5 PACKAGE, UNLESS OTHERWISE NOTED IN THE TARGET LOCATION NAME. FOR EXAMPLE, V-0105 (3) INDICATES THE RESULTS WERE TAKEN FROM MODEL LAYER 3.
3. X-AXIS VALUES REPRESENT CALENDAR YEARS OF THE FUTURE SIMULATION PERIOD.

FIGURE 5-23
SIMULATED GROUNDWATER ELEVATIONS IN WELLS LOCATED BETWEEN HOPPER CREEK AND TORREY ROAD IN THE PIRU SUBBASIN:
SCENARIOS 1A/B, 3A/B, 1F/G, AND 3F/G

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL –HGL

Piru_Heads_HopperTorrey.grf



LEGEND

- HIGH REUSE; 100 mg/L CHLORIDE IN SAUGUS AND VALENCIA WRP DISCHARGE (SCENARIO 1A)
- HIGH REUSE; 120 mg/L CHLORIDE IN SAUGUS AND VALENCIA WRP DISCHARGE (SCENARIO 1B)
- LOW REUSE; 100 mg/L CHLORIDE IN SAUGUS AND VALENCIA WRP DISCHARGE (SCENARIO 3A)
- LOW REUSE; 120 mg/L CHLORIDE IN SAUGUS AND VALENCIA WRP DISCHARGE (SCENARIO 3B)
- HIGH REUSE; 50 PERCENT REMOVAL OF SELF REGENERATING WATER SOFTENERS (SCENARIO 1F)
- HIGH REUSE; 100 PERCENT REMOVAL OF SELF REGENERATING WATER SOFTENERS (SCENARIO 1G)
- LOW REUSE; 50 PERCENT REMOVAL OF SELF REGENERATING WATER SOFTENERS (SCENARIO 3F)
- LOW REUSE; 100 PERCENT REMOVAL OF SELF REGENERATING WATER SOFTENERS (SCENARIO 3G)

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

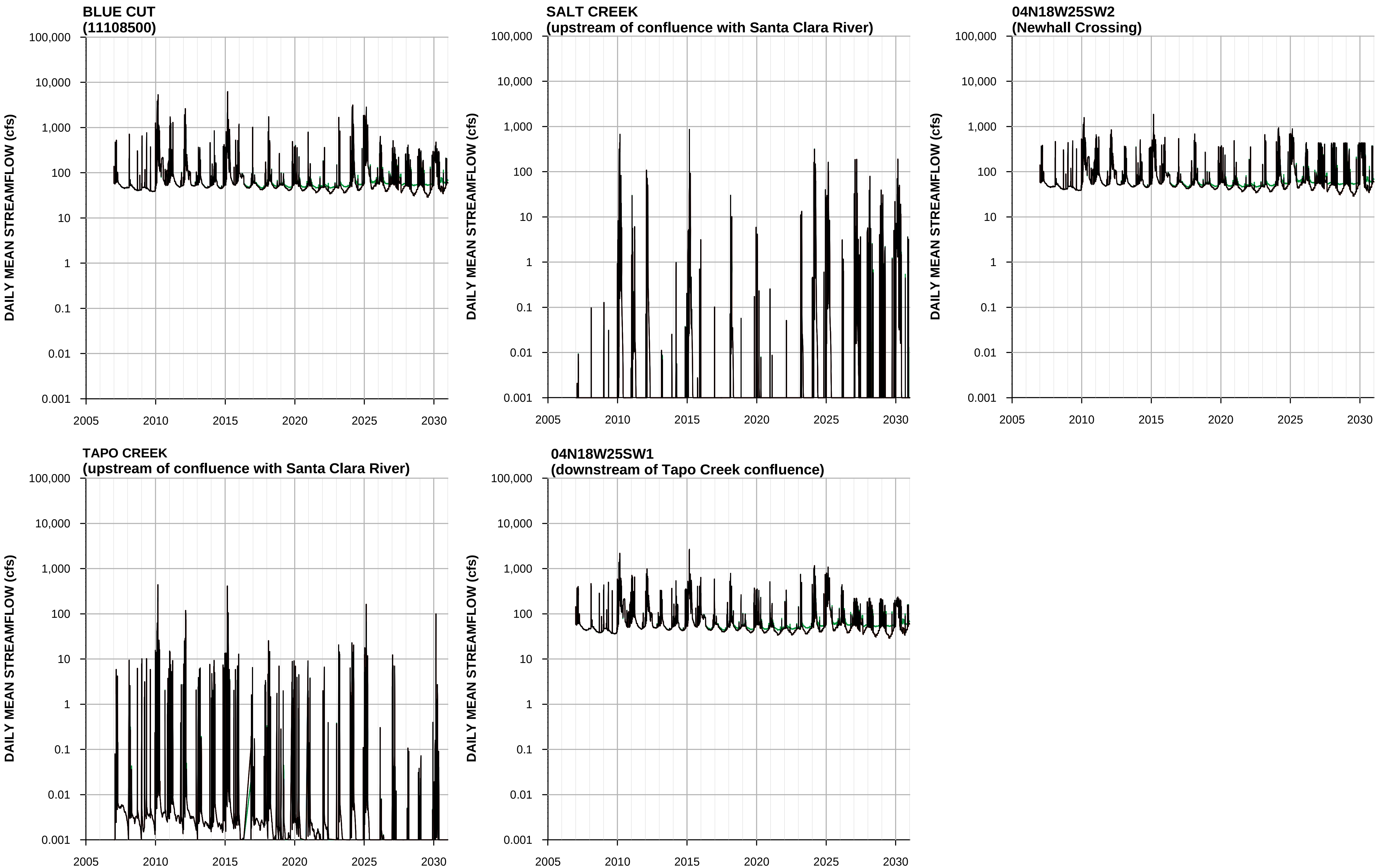
NOTES:
1. SEE FIGURES 4-1a THROUGH 4-1e FOR MODEL-OUTPUT LOCATIONS.
2. MODEL RESULTS ARE TAKEN FROM THE FWL5 PACKAGE, UNLESS OTHERWISE NOTED IN THE TARGET LOCATION NAME. FOR EXAMPLE, V-0181 (3 through 5) INDICATES THE RESULTS WERE TAKEN FROM MODEL LAYERS 3 THROUGH 5.
3. X-AXIS VALUES REPRESENT CALENDAR YEARS OF THE FUTURE SIMULATION PERIOD.

FIGURE 5-24
SIMULATED GROUNDWATER ELEVATIONS IN WELLS LOCATED WEST OF HOPPER CREEK IN THE PIRU SUBBASIN: SCENARIOS 1A/B, 3A/B, 1F/G, AND 3F/G

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL –HGL

Piru_Heads_WestHopper.grf



SIMULATION YEAR	HYDROLOGY YEAR
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2008	1976
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2010	1978
2011	1979
2012	1980
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2014	1982
2015	1983
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2017	1985
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2020	1988
2021	1989
2022	1990
2023	1991
2024	1992
2025	1993
2026	1994
2027	1995
2028	1996
2029	1997
2030	1998

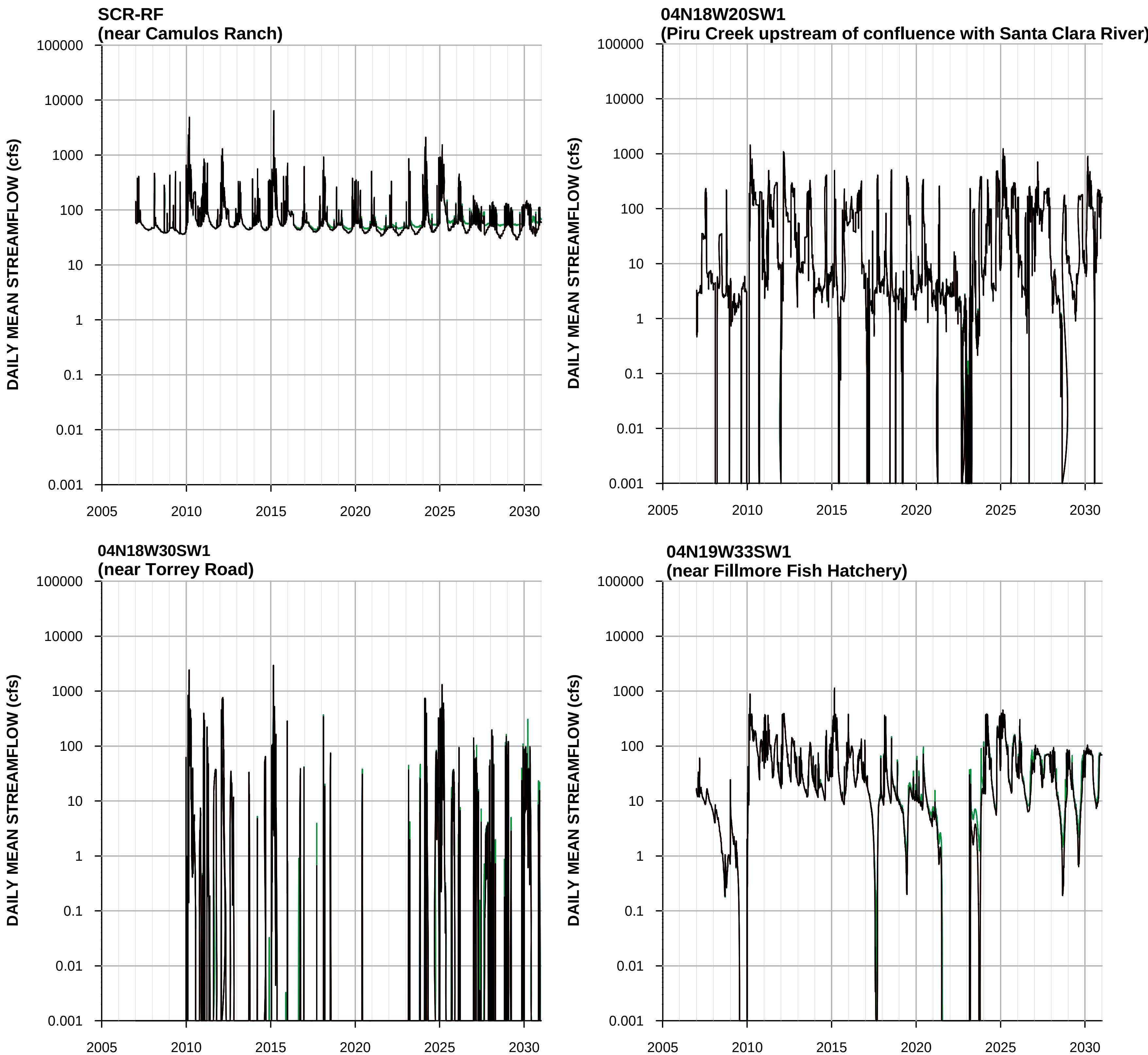
NOTES:
1. SEE FIGURES 4-1a THROUGH 4-1e FOR MODEL-OUTPUT LOCATIONS.
2. X-AXIS VALUES REPRESENT CALENDAR YEARS OF THE FUTURE SIMULATION PERIOD.

FIGURE 5-25 (PAGE 1 of 2)
SIMULATED STREAMFLOWS AT SELECTED LOCATIONS IN THE PIRU SUBBASIN: SCENARIOS 1A/B, 3A/B, 1F/G, AND 3F/G

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL –HGL–

SW_Piru1.grf



LEGEND

- HIGH REUSE; 100 mg/L CHLORIDE IN SAUGUS AND VALENCIA WRP DISCHARGE (SCENARIO 1A)
- HIGH REUSE; 120 mg/L CHLORIDE IN SAUGUS AND VALENCIA WRP DISCHARGE (SCENARIO 1B)
- LOW REUSE; 100 mg/L CHLORIDE IN SAUGUS AND VALENCIA WRP DISCHARGE (SCENARIO 3A)
- LOW REUSE; 120 mg/L CHLORIDE IN SAUGUS AND VALENCIA WRP DISCHARGE (SCENARIO 3B)
- HIGH REUSE; 50 PERCENT REMOVAL OF SELF REGENERATING WATER SOFTENERS (SCENARIO 1F)
- HIGH REUSE; 100 PERCENT REMOVAL OF SELF REGENERATING WATER SOFTENERS (SCENARIO 1G)
- LOW REUSE; 50 PERCENT REMOVAL OF SELF REGENERATING WATER SOFTENERS (SCENARIO 3F)
- LOW REUSE; 100 PERCENT REMOVAL OF SELF REGENERATING WATER SOFTENERS (SCENARIO 3G)

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
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2020	1988
2021	1989
2022	1990
2023	1991
2024	1992
2025	1993
2026	1994
2027	1995
2028	1996
2029	1997
2030	1998

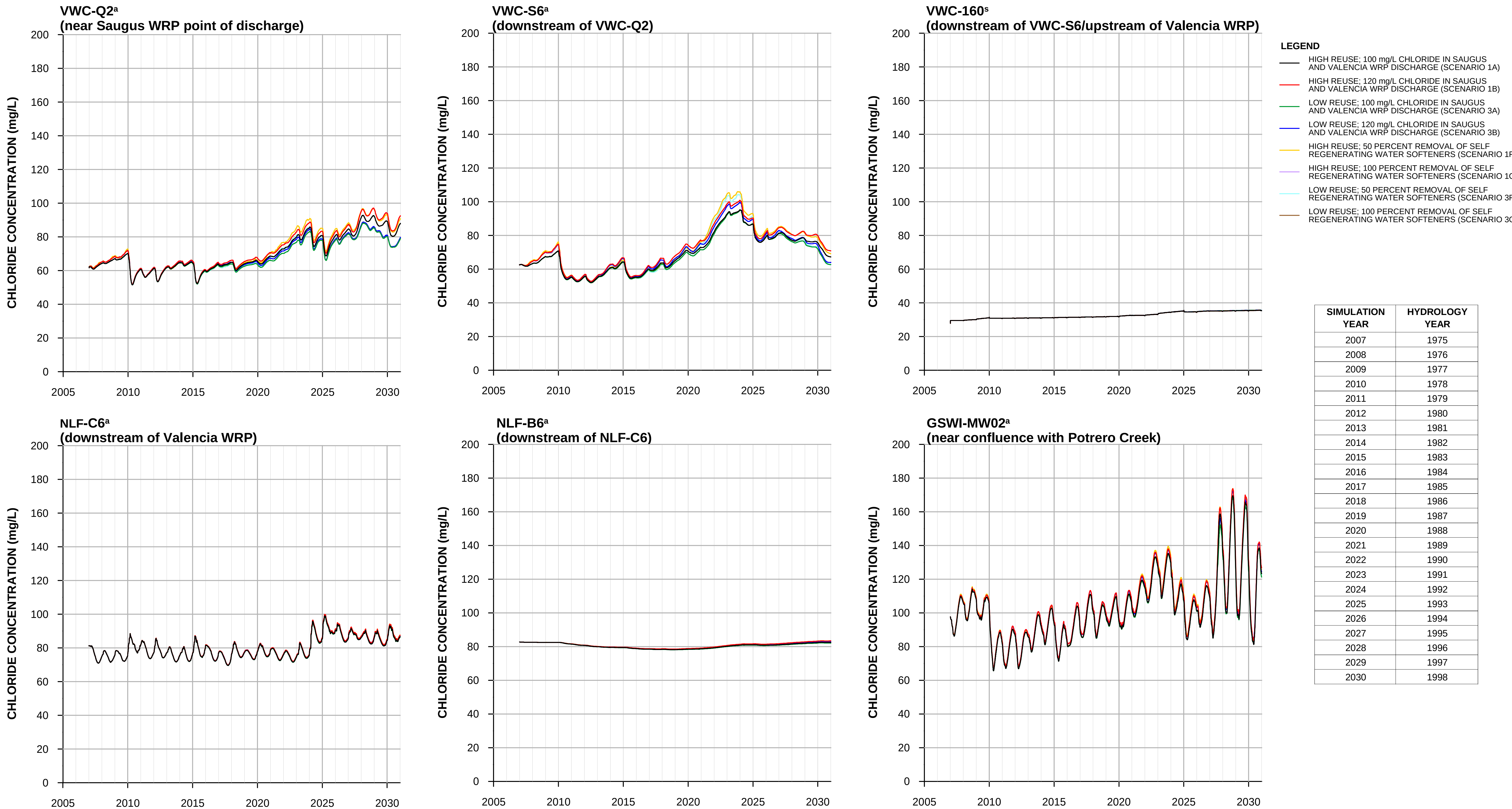
NOTES:
1. SEE FIGURES 4-1a THROUGH 4-1e FOR MODEL-OUTPUT LOCATIONS.
2. X-AXIS VALUES REPRESENT CALENDAR YEARS OF THE FUTURE SIMULATION PERIOD.

FIGURE 5-25 (PAGE 2 of 2)
SIMULATED STREAMFLOWS AT SELECTED LOCATIONS IN THE PIRU SUBBASIN: SCENARIOS 1A/B, 3A/B, 1F/G, AND 3F/G

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

SW_Piru2.grf

CH2MHILL –HGL–



SIMULATION YEAR	HYDROLOGY YEAR
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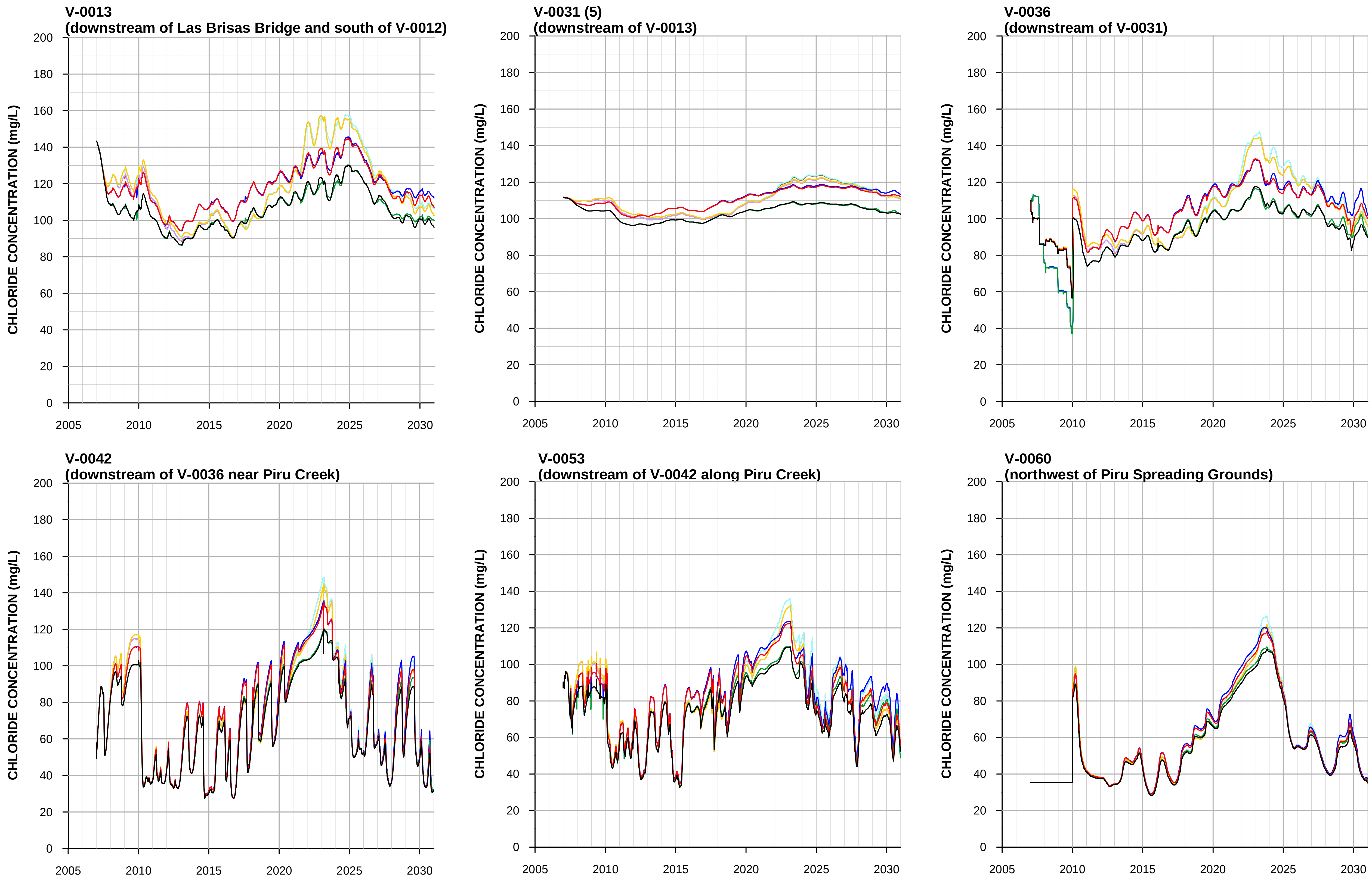
2021	1989
2022	1990
2023	1991
2024	1992
2025	1993
2026	1994
2027	1995
2028	1996
2029	1997
2030	1998

NOTES:
1. ᵃ = ALLUVIAL AQUIFER WELL.
2. ˢ = SAUGUS FORMATION WELL.
3. MODEL RESULTS ARE TAKEN FROM THE FWL5 PACKAGE, UNLESS OTHERWISE NOTED IN THE TARGET LOCATION NAME. FOR EXAMPLE, LACFCD-7187C (3) INDICATES THE RESULTS WERE TAKEN FROM MODEL LAYER 3.
4. SEE FIGURES 4-1a THROUGH 4-1e FOR MODEL-OUTPUT LOCATIONS.
5. X-AXIS VALUES REPRESENT CALENDAR YEARS OF THE FUTURE SIMULATION PERIOD.

FIGURE 5-26
SIMULATED CHLORIDE CONCENTRATIONS IN WELLS LOCATED IN THE EAST SUBBASIN: SCENARIOS 1A/B, 3A/B, 1F/G, AND 3F/G
TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL –HGL

ClEastSubbasin.grf



SIMULATION YEAR	HYDROLOGY YEAR
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2017	1985
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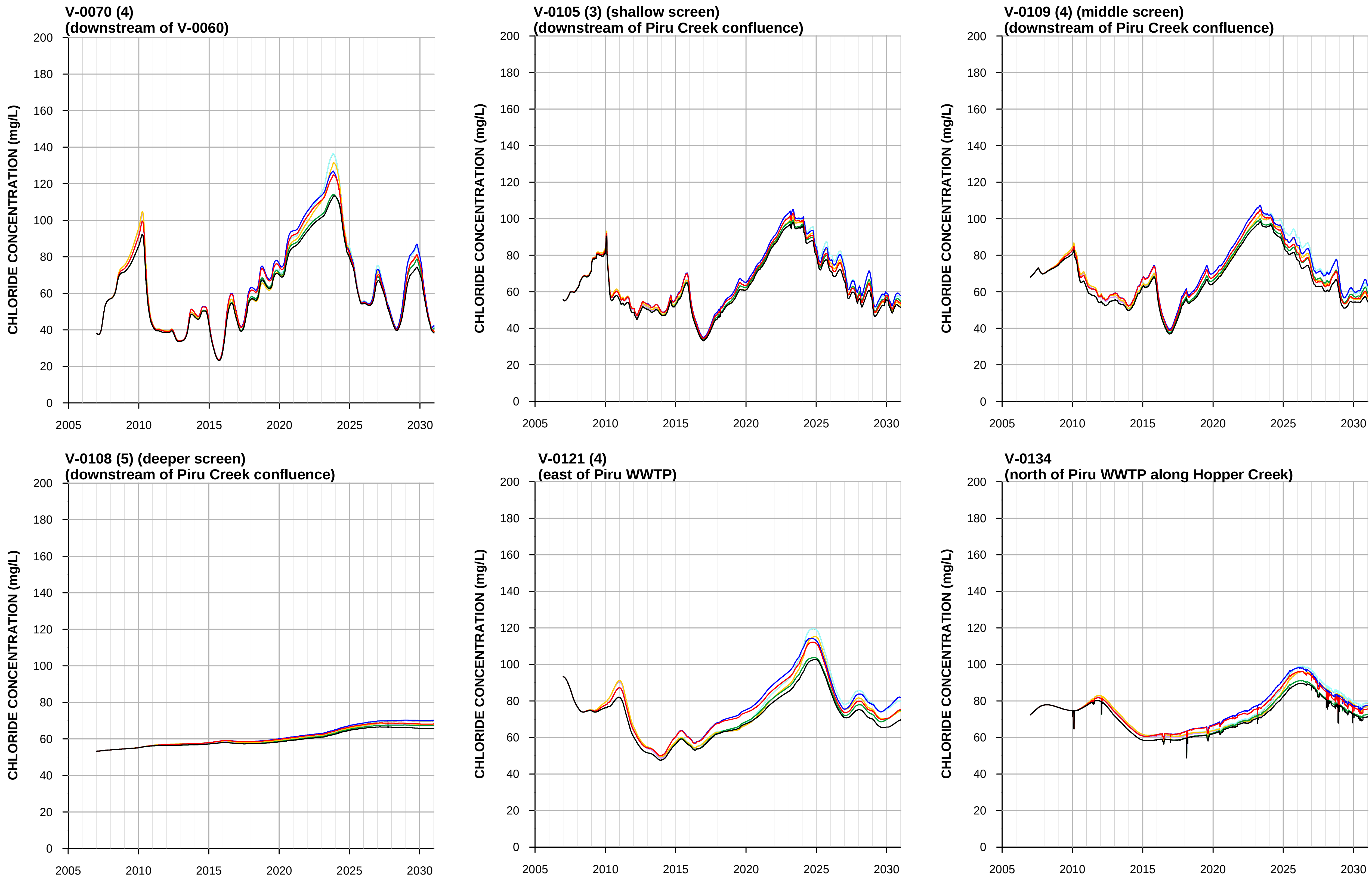
2020	1988
2021	1989
2022	1990
2023	1991
2024	1992
2025	1993
2026	1994
2027	1995
2028	1996
2029	1997
2030	1998

NOTES:
1. SEE FIGURES 4-1a THROUGH 4-1e FOR MODEL-OUTPUT LOCATIONS.
2. MODEL RESULTS ARE TAKEN FROM THE FWL5 PACKAGE, UNLESS OTHERWISE NOTED IN THE TARGET LOCATION NAME. FOR EXAMPLE, V-0031 (5) INDICATES THE RESULTS WERE TAKEN FROM MODEL LAYER 5.
3. X-AXIS VALUES REPRESENT CALENDAR YEARS OF THE FUTURE SIMULATION PERIOD.

FIGURE 5-27
SIMULATED CHLORIDE CONCENTRATIONS IN WELLS LOCATED EAST OF TORREY ROAD IN THE PIRU SUBBASIN: SCENARIOS 1A/B, 3A/B, 1F/G, AND 3F/G
TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL –HGL

Piru_ClEastTorrey.grf



LEGEND

- HIGH REUSE; 100 mg/L CHLORIDE IN SAUGUS AND VALENCIA WRP DISCHARGE (SCENARIO 1A)
- HIGH REUSE; 120 mg/L CHLORIDE IN SAUGUS AND VALENCIA WRP DISCHARGE (SCENARIO 1B)
- LOW REUSE; 100 mg/L CHLORIDE IN SAUGUS AND VALENCIA WRP DISCHARGE (SCENARIO 3A)
- LOW REUSE; 120 mg/L CHLORIDE IN SAUGUS AND VALENCIA WRP DISCHARGE (SCENARIO 3B)
- HIGH REUSE; 50 PERCENT REMOVAL OF SELF REGENERATING WATER SOFTENERS (SCENARIO 1F)
- HIGH REUSE; 100 PERCENT REMOVAL OF SELF REGENERATING WATER SOFTENERS (SCENARIO 1G)
- LOW REUSE; 50 PERCENT REMOVAL OF SELF REGENERATING WATER SOFTENERS (SCENARIO 3F)
- LOW REUSE; 100 PERCENT REMOVAL OF SELF REGENERATING WATER SOFTENERS (SCENARIO 3G)

SIMULATION YEAR	HYDROLOGY YEAR
2007	1975
2008	1976
2009	1977
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2012	1980
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2016	1984
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2023	1991
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2026	1994
2027	1995
2028	1996
2029	1997
2030	1998

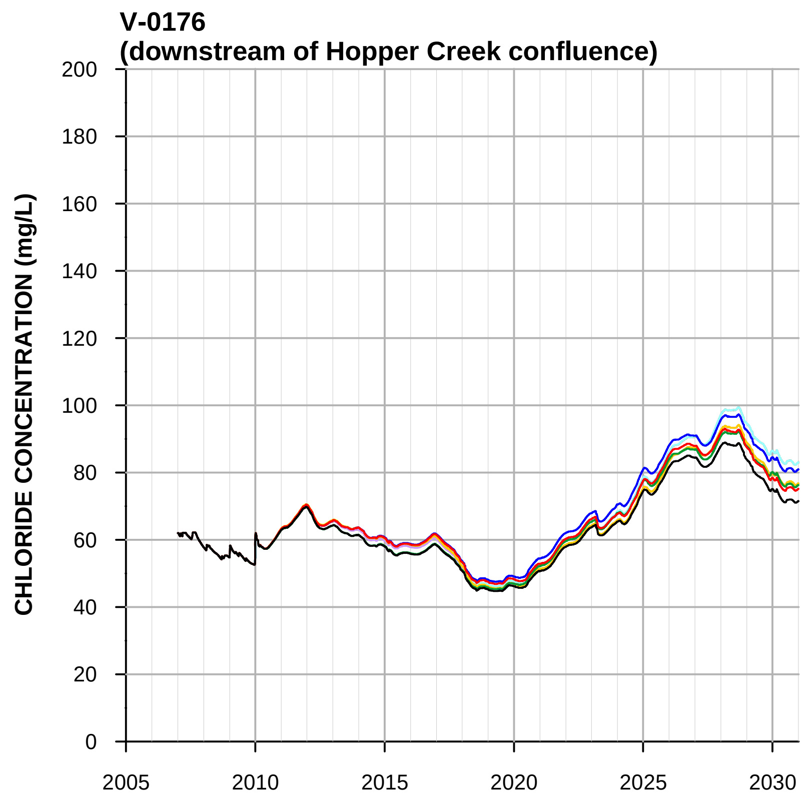
NOTES:
1. SEE FIGURES 4-1a THROUGH 4-1e FOR MODEL-OUTPUT LOCATIONS.
2. MODEL RESULTS ARE TAKEN FROM THE FWL5 PACKAGE, UNLESS OTHERWISE NOTED IN THE TARGET LOCATION NAME. FOR EXAMPLE, V-0121 (4) INDICATES THE RESULTS WERE TAKEN FROM MODEL LAYER 4.
3. X-AXIS VALUES REPRESENT CALENDAR YEARS OF THE FUTURE SIMULATION PERIOD.

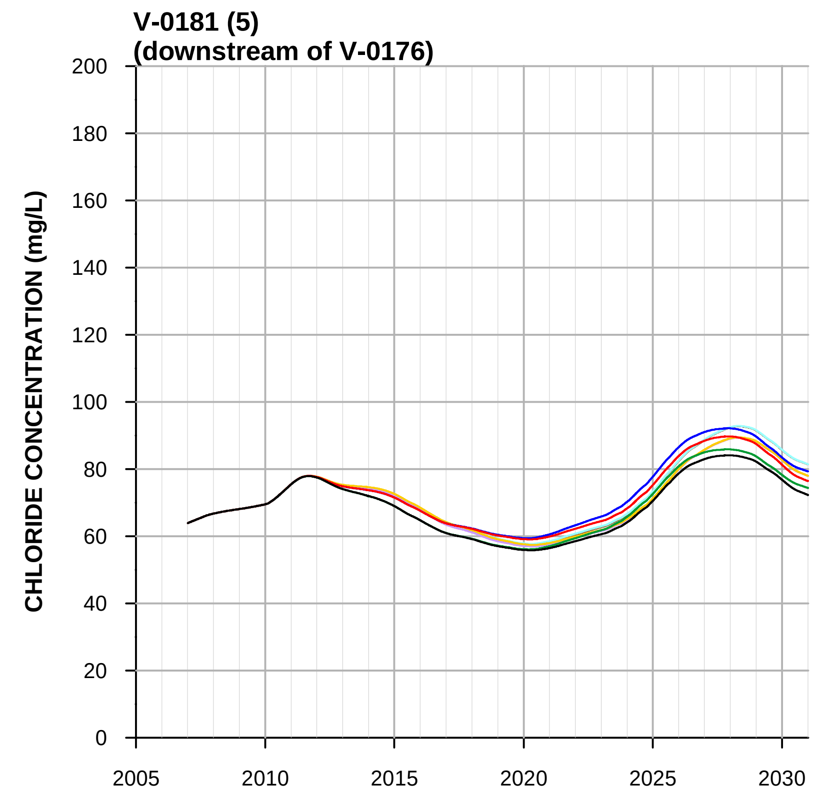
FIGURE 5-28
SIMULATED CHLORIDE CONCENTRATIONS IN WELLS LOCATED BETWEEN HOPPER CREEK AND TORREY ROAD IN THE PIRU SUBBASIN: SCENARIOS 1A/B, 3A/B, 1F/G, AND 3F/G

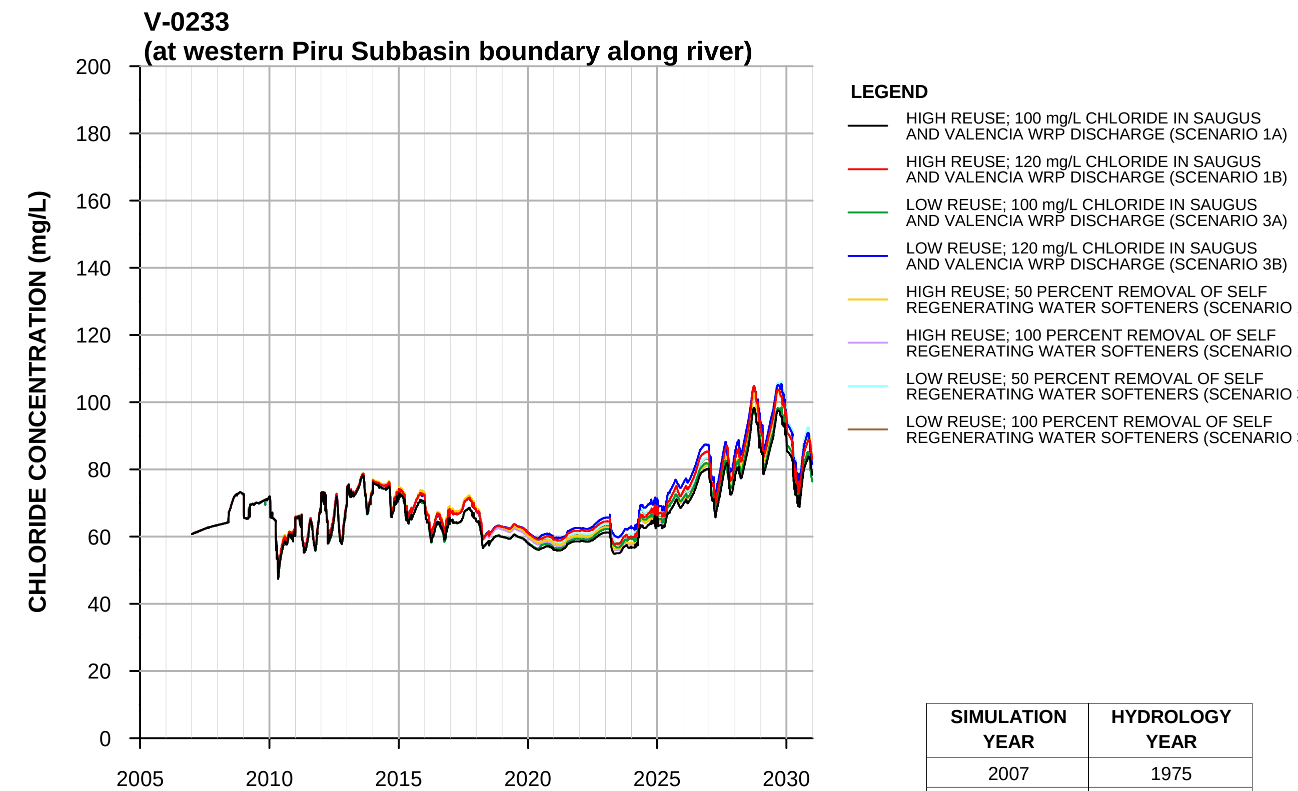
TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL – HGL

Piru_ClHopperTorrey.grf







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
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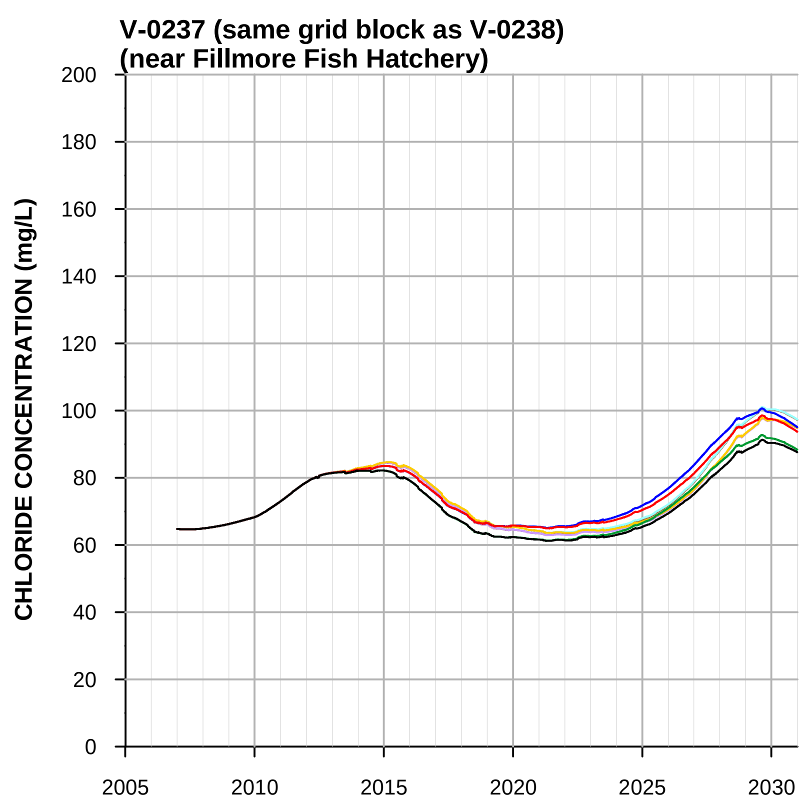
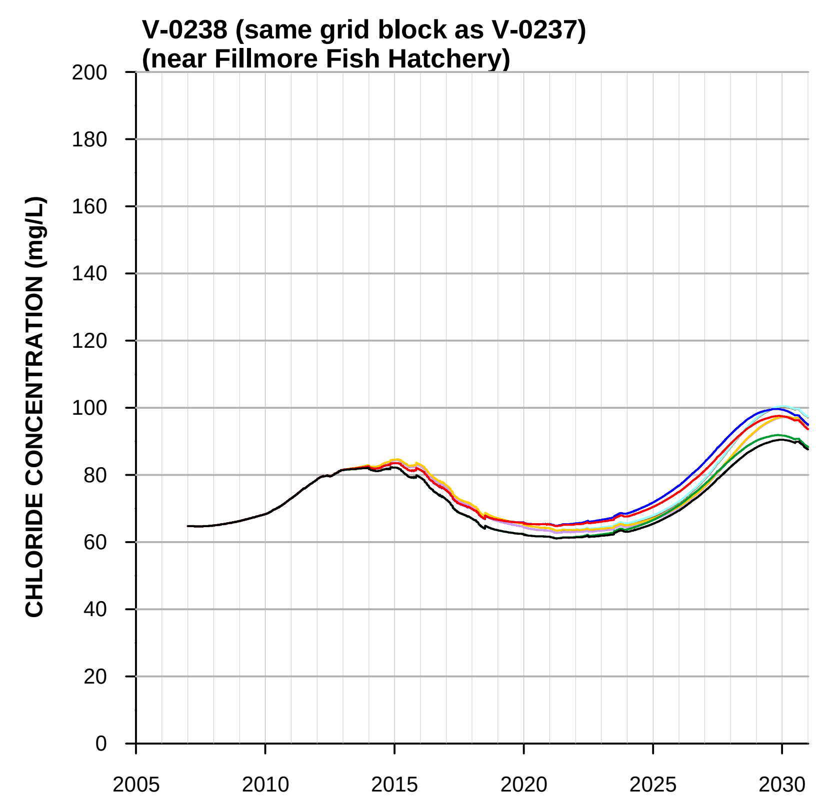
2023	1991
2024	1992
2025	1993
2026	1994
2027	1995
2028	1996
2029	1997
2030	1998



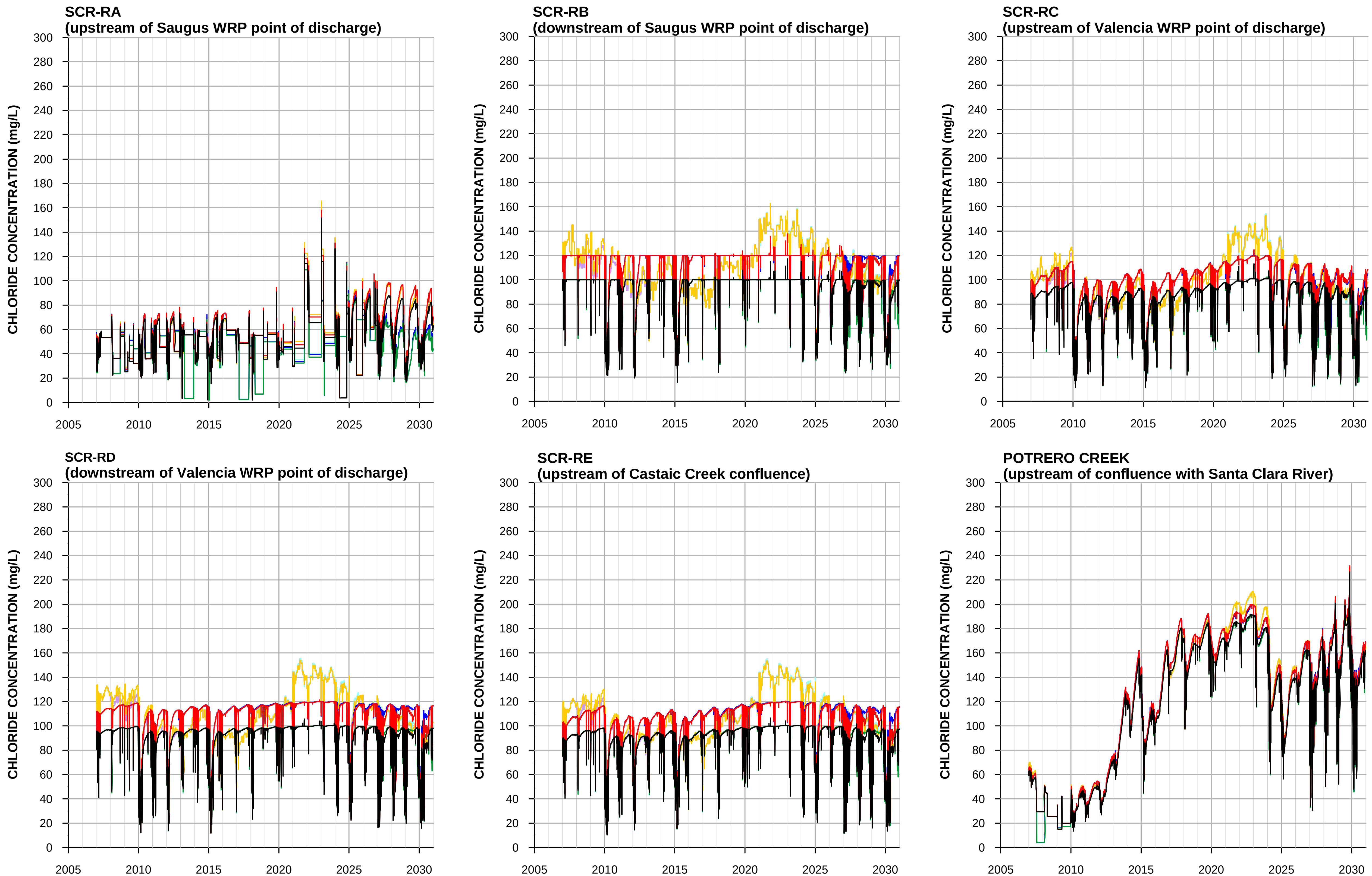


NOTES:
1. SEE FIGURES 4-1a THROUGH 4-1e FOR MODEL-OUTPUT LOCATIONS.
2. MODEL RESULTS ARE TAKEN FROM THE FWL5 PACKAGE, UNLESS OTHERWISE NOTED IN THE TARGET LOCATION NAME. FOR EXAMPLE, V-0181 (5) INDICATES THE RESULTS WERE TAKEN FROM MODEL LAYER 5.
3. X-AXIS VALUES REPRESENT CALENDAR YEARS OF THE FUTURE SIMULATION PERIOD.

FIGURE 5-29
SIMULATED CHLORIDE CONCENTRATIONS IN WELLS LOCATED WEST OF HOPPER CREEK IN THE PIRU SUBBASIN: SCENARIOS 1A/B, 3A/B, 1F/G, AND 3F/G
TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL –HGL

Piru_ClWestHopper.grf



SIMULATION YEAR	HYDROLOGY YEAR
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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

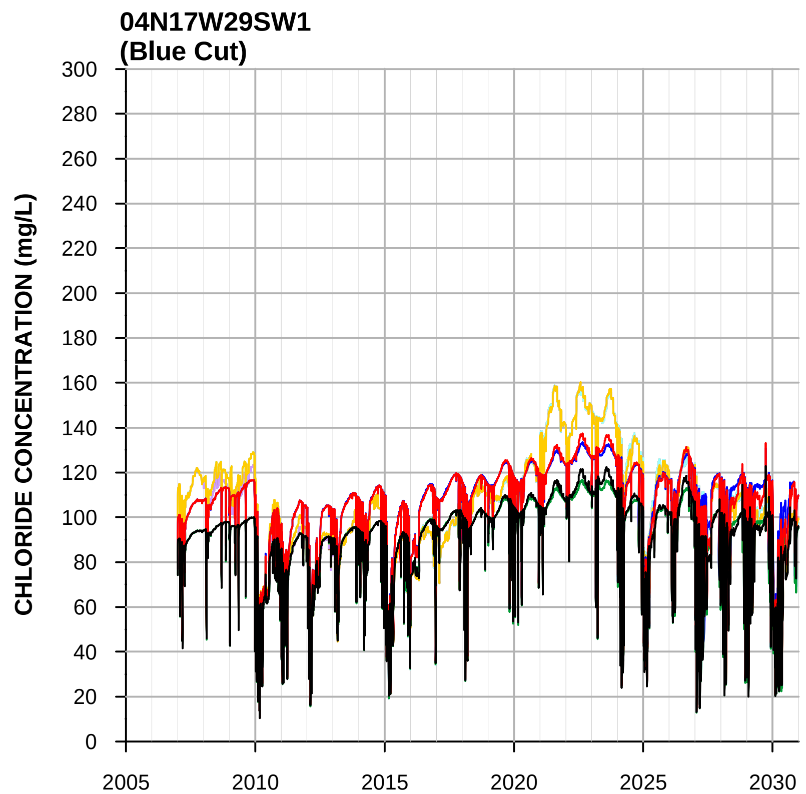
NOTES:
1. SEE FIGURES 4-1a THROUGH 4-1e FOR MODEL-OUTPUT LOCATIONS.
2. X-AXIS VALUES REPRESENT CALENDAR YEARS OF THE FUTURE SIMULATION PERIOD.

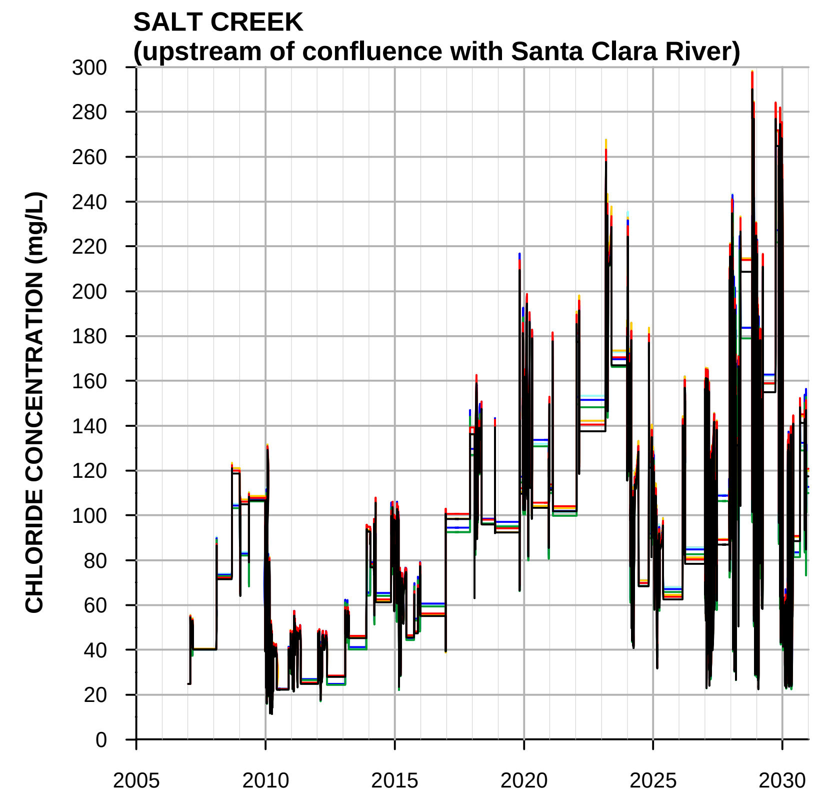
FIGURE 5-30
SIMULATED CHLORIDE CONCENTRATIONS IN THE SANTA CLARA RIVER AND SELECTED TRIBUTARIES IN THE EAST SUBBASIN: SCENARIOS 1A/B, 3A/B, 1F/G, AND 3F/G

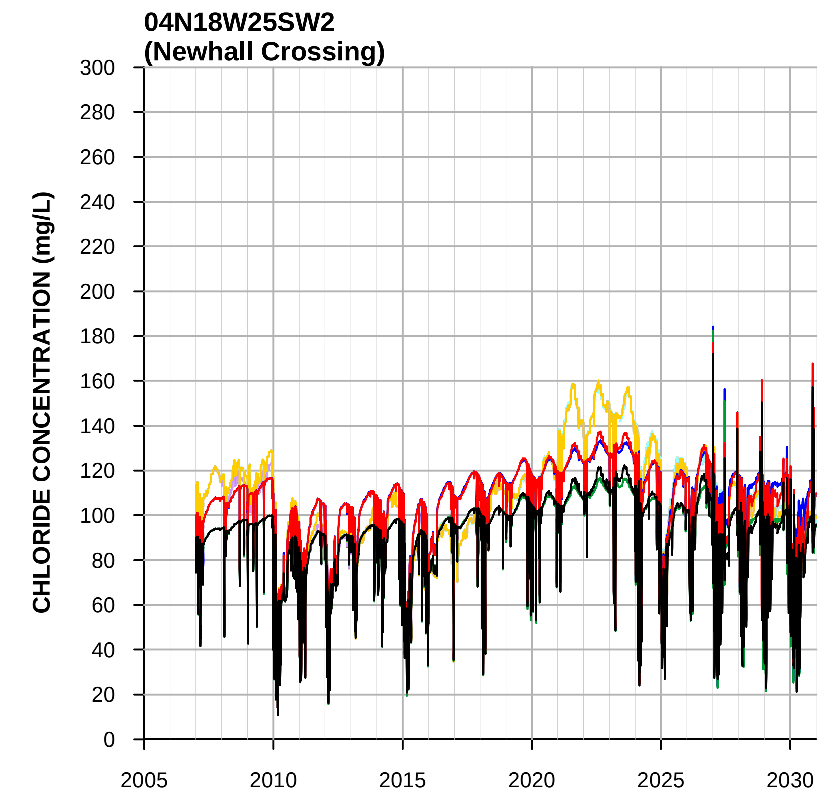
TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

Cl_SW_EastSubbasin.grf

CH2MHILL –HGL–







LEGEND

- HIGH REUSE; 100 mg/L CHLORIDE IN SAUGUS AND VALENCIA WRP DISCHARGE (SCENARIO 1A)
- HIGH REUSE; 120 mg/L CHLORIDE IN SAUGUS AND VALENCIA WRP DISCHARGE (SCENARIO 1B)
- LOW REUSE; 100 mg/L CHLORIDE IN SAUGUS AND VALENCIA WRP DISCHARGE (SCENARIO 3A)
- LOW REUSE; 120 mg/L CHLORIDE IN SAUGUS AND VALENCIA WRP DISCHARGE (SCENARIO 3B)
- HIGH REUSE; 50 PERCENT REMOVAL OF SELF REGENERATING WATER SOFTENERS (SCENARIO 1F)
- HIGH REUSE; 100 PERCENT REMOVAL OF SELF REGENERATING WATER SOFTENERS (SCENARIO 1G)
- LOW REUSE; 50 PERCENT REMOVAL OF SELF REGENERATING WATER SOFTENERS (SCENARIO 3F)
- LOW REUSE; 100 PERCENT REMOVAL OF SELF REGENERATING WATER SOFTENERS (SCENARIO 3G)

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
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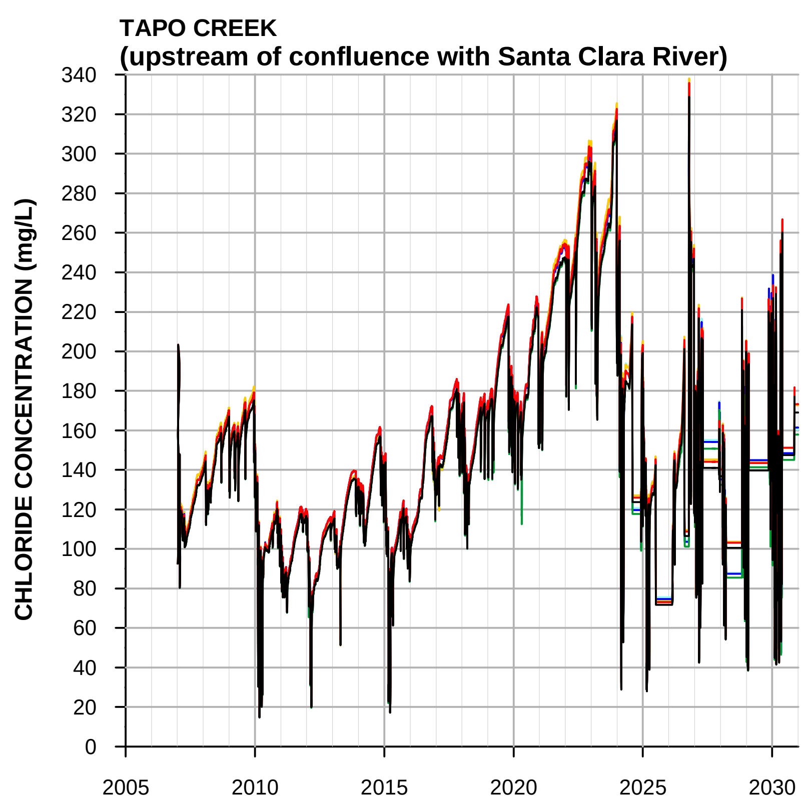
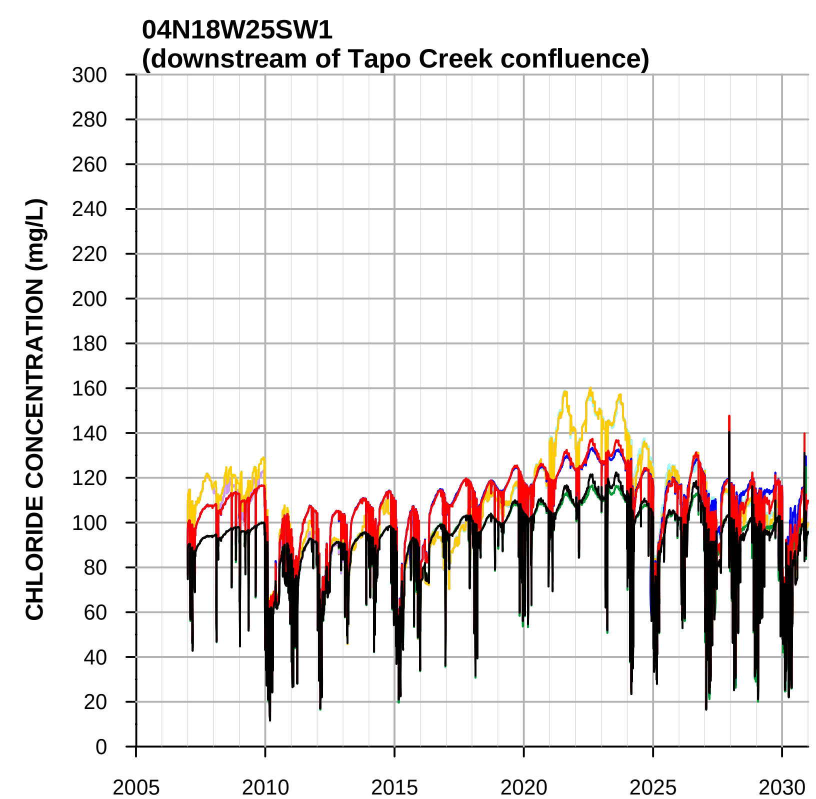


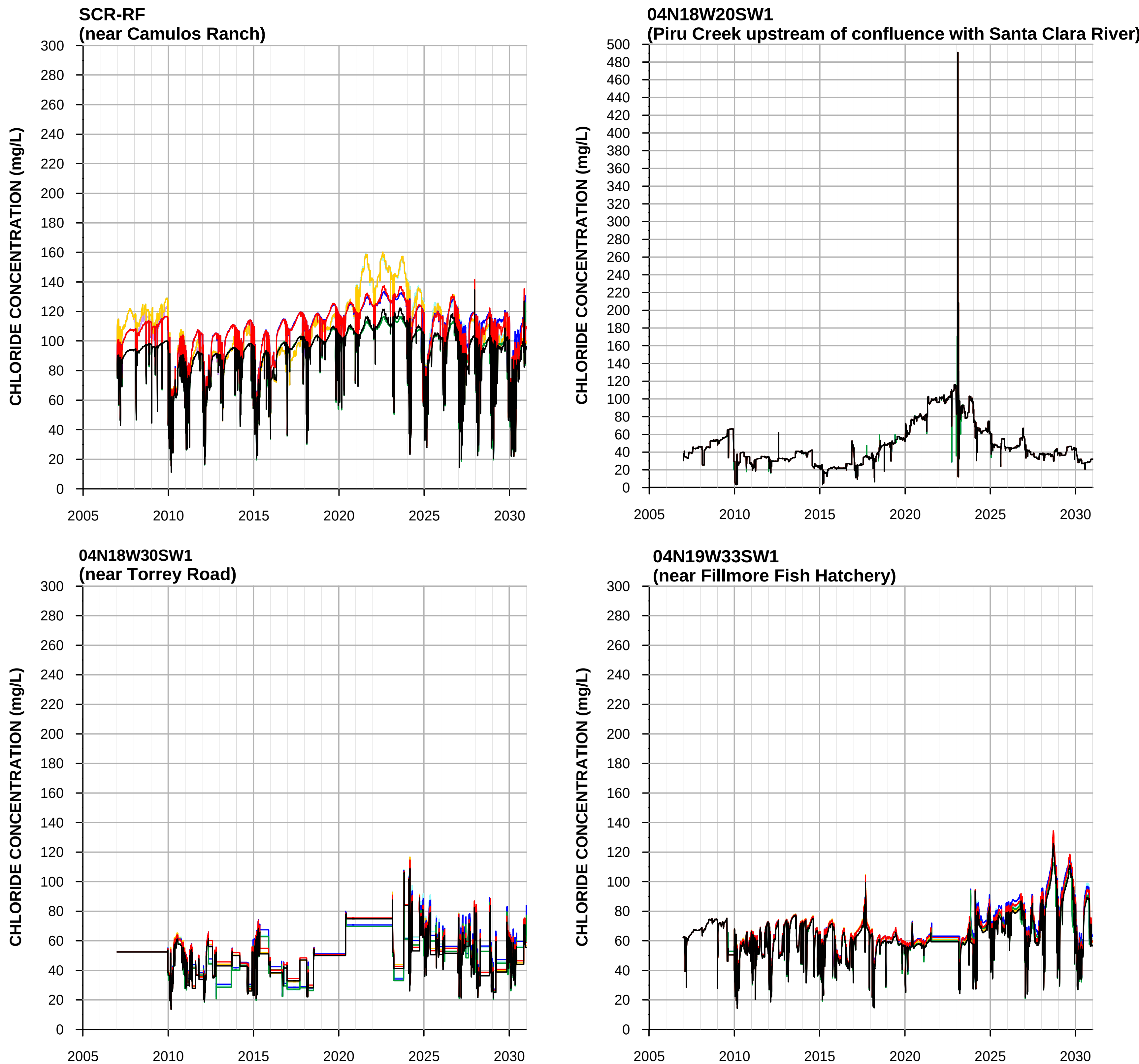


NOTES:
1. SEE FIGURES 4-1a THROUGH 4-1e FOR MODEL-OUTPUT LOCATIONS.
2. X-AXIS VALUES REPRESENT CALENDAR YEARS OF THE FUTURE SIMULATION PERIOD.

FIGURE 5-31 (PAGE 1 of 2)
SIMULATED CHLORIDE CONCENTRATIONS IN THE SANTA CLARA RIVER AND SELECTED TRIBUTARIES IN THE PIRU SUBBASIN: SCENARIOS 1A/B, 3A/B, 1F/G, AND 3F/G
TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

Cl_SW_PiruSubbasin1.grf

CH2MHILL –HGL–



LEGEND

- HIGH REUSE; 100 mg/L CHLORIDE IN SAUGUS AND VALENCIA WRP DISCHARGE (SCENARIO 1A)
- HIGH REUSE; 120 mg/L CHLORIDE IN SAUGUS AND VALENCIA WRP DISCHARGE (SCENARIO 1B)
- LOW REUSE; 100 mg/L CHLORIDE IN SAUGUS AND VALENCIA WRP DISCHARGE (SCENARIO 3A)
- LOW REUSE; 120 mg/L CHLORIDE IN SAUGUS AND VALENCIA WRP DISCHARGE (SCENARIO 3B)
- HIGH REUSE; 50 PERCENT REMOVAL OF SELF REGENERATING WATER SOFTENERS (SCENARIO 1F)
- HIGH REUSE; 100 PERCENT REMOVAL OF SELF REGENERATING WATER SOFTENERS (SCENARIO 1G)
- LOW REUSE; 50 PERCENT REMOVAL OF SELF REGENERATING WATER SOFTENERS (SCENARIO 3F)
- LOW REUSE; 100 PERCENT REMOVAL OF SELF REGENERATING WATER SOFTENERS (SCENARIO 3G)

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

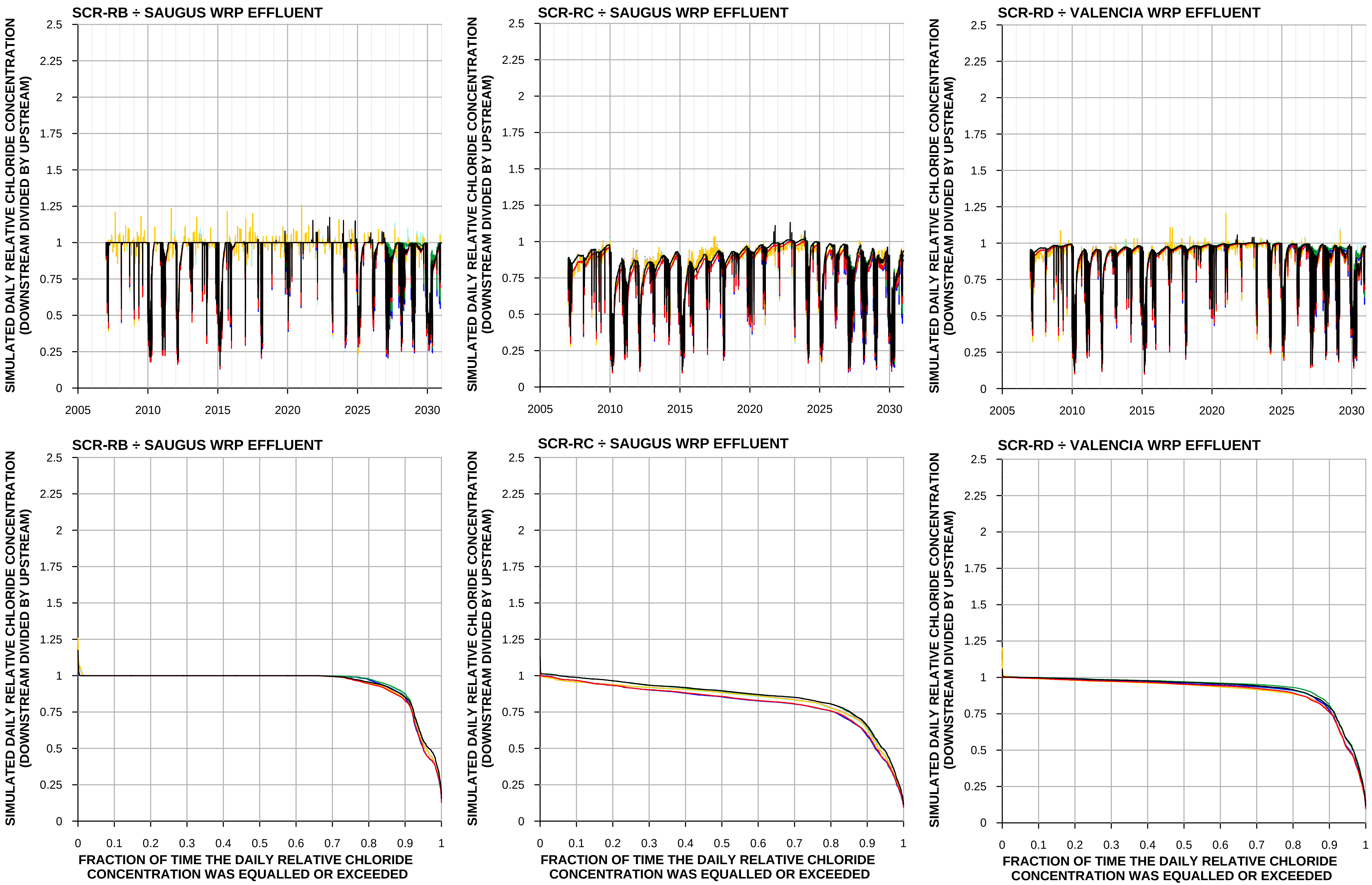
NOTES:
1. SEE FIGURES 4-1a THROUGH 4-1e FOR MODEL-OUTPUT LOCATIONS.
2. X-AXIS VALUES REPRESENT CALENDAR YEARS OF THE FUTURE SIMULATION PERIOD.

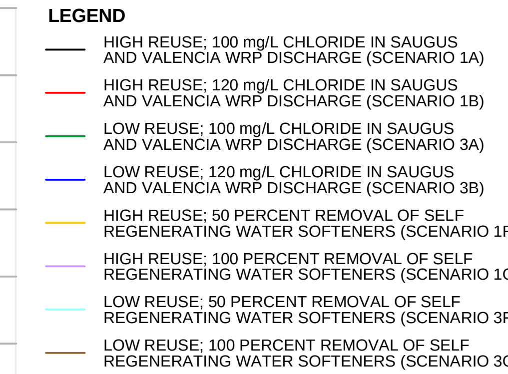
FIGURE 5-31 (PAGE 2 of 2)
SIMULATED CHLORIDE CONCENTRATIONS IN THE SANTA CLARA RIVER AND SELECTED TRIBUTARIES IN THE PIRU SUBBASIN: SCENARIOS 1A/B, 3A/B, 1F/G, AND 3F/G

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

Cl_SW_PiruSubbasin2.grf

CH2MHILL –HGL–





SIMULATION YEAR	HYDROLOGY YEAR
2007	1975
2008	1976
2009	1977
2010	1978
2011	1979
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2017	1985
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2020	1988
2021	1989
2022	1990
2023	1991
2024	1992
2025	1993
2026	1994
2027	1995
2028	1996
2029	1997
2030	1998

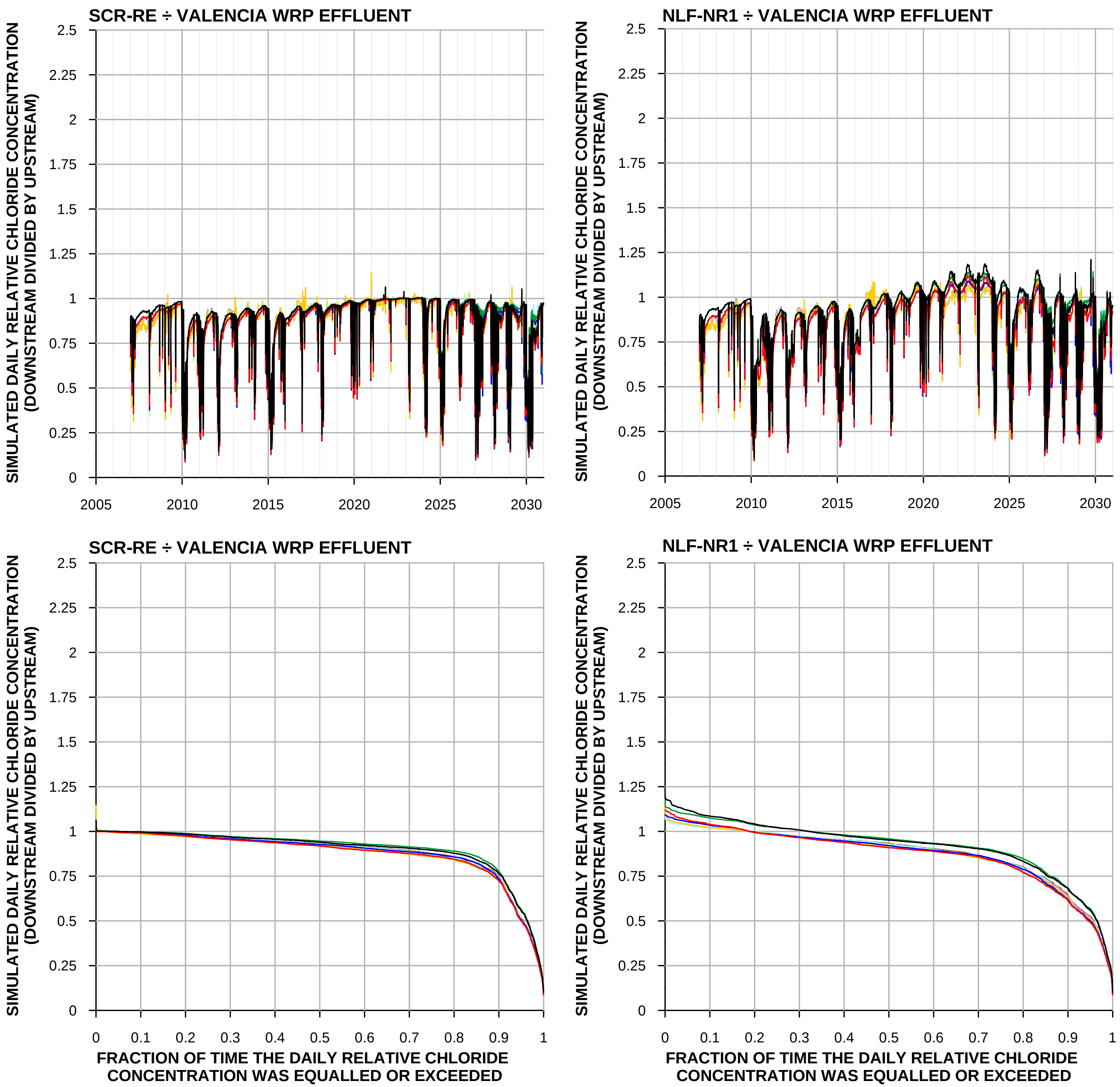
NOTES:
1. SEE FIGURES 4-1a THROUGH 4-1e FOR MODEL-OUTPUT LOCATIONS.
2. SCR-RB IS LOCATED 300 FEET DOWNSTREAM OF THE SAUGUS WRP POINT OF DISCHARGE.
3. SCR-RC IS LOCATED 300 FEET UPSTREAM OF THE VALENCIA WRP POINT OF DISCHARGE.
4. SCR-RD IS LOCATED 300 FEET DOWNSTREAM OF THE VALENCIA WRP POINT OF DISCHARGE.
5. X-AXIS VALUES ON TOP THREE PLOTS REPRESENT CALENDAR YEARS OF THE FUTURE SIMULATION PERIOD.

FIGURE 5-32 (PAGE 1 of 2)
SIMULATED RELATIVE CHLORIDE CONCENTRATIONS BETWEEN UPSTREAM AND DOWNSTREAM MONITORING LOCATIONS IN THE EAST SUBBASIN: SCENARIOS 1A/B, 3A/B, 1F/G, AND 3F/G

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CL_SW_DilutionPlots_East1.grf

CH2MHILL –HGL–



SIMULATION YEAR	HYDROLOGY YEAR
2007	1975
2008	1976
2009	1977
2010	1978
2011	1979
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2013	1981
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2017	1985
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2020	1988
2021	1989
2022	1990
2023	1991
2024	1992
2025	1993
2026	1994
2027	1995
2028	1996
2029	1997
2030	1998

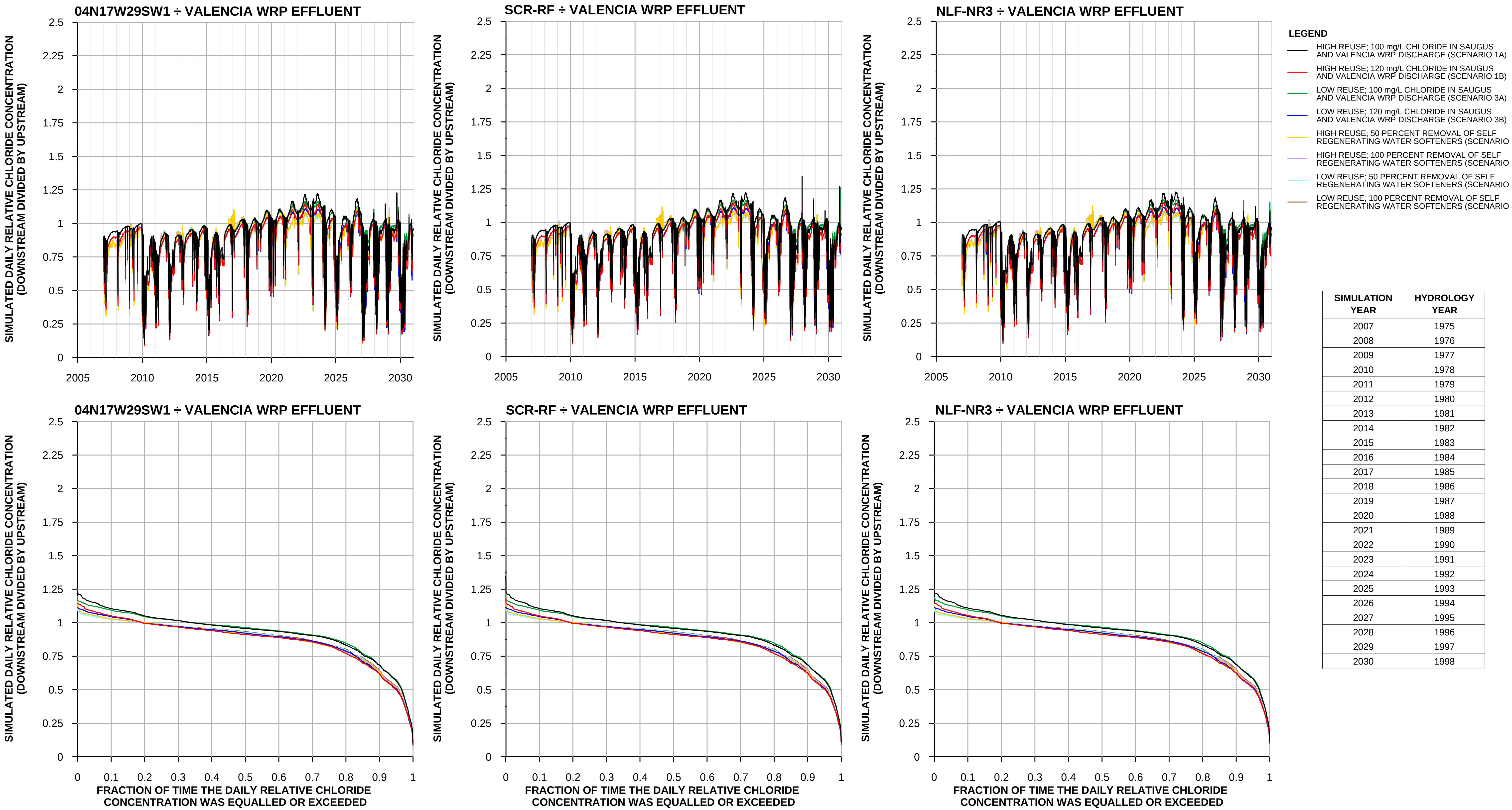
NOTES:
1. SEE FIGURES 4-1a THROUGH 4-1e FOR MODEL-OUTPUT LOCATIONS.
2. SCR-RE IS LOCATED JUST UPSTREAM OF THE CONFLUENCE OF CASTAIC CREEK, 1.6 MILES UPSTREAM OF CHIQUITA CANYON ROAD.
3. NLF-NR1 IS LOCATED JUST UPSTREAM OF THE COUNTY LINE.
4. X-AXIS VALUES ON TOP TWO PLOTS REPRESENT CALENDAR YEARS OF THE FUTURE SIMULATION PERIOD.

FIGURE 5-32 (PAGE 2 of 2)
SIMULATED RELATIVE CHLORIDE CONCENTRATIONS BETWEEN UPSTREAM AND DOWNSTREAM MONITORING LOCATIONS IN THE EAST SUBBASIN: SCENARIOS 1A/B, 3A/B, 1F/G, AND 3F/G

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CL_SW_DilutionPlots_East2.grf

CH2MHILL –HGL–



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

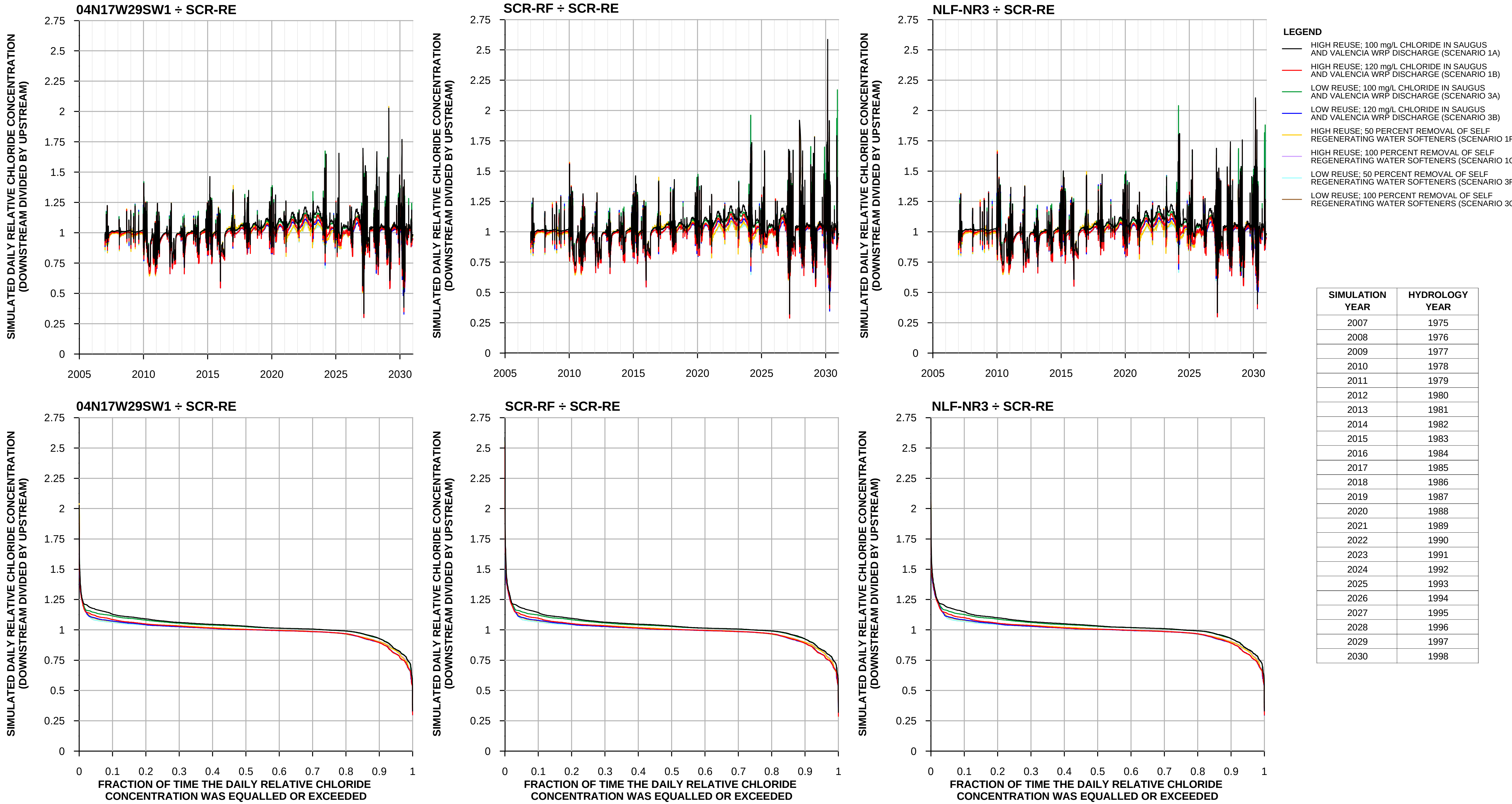
NOTES:
1. SEE FIGURES 4-1a THROUGH 4-1e FOR MODEL-OUTPUT LOCATIONS.
2. 04N17W29SW1 IS LOCATED AT BLUE CUT.
3. SCR-RF IS LOCATED NEAR THE CAMULOS DIVERSION.
4. NLF-NR3 IS LOCATED AT THE LAS BRISAS BRIDGE.
5. X-AXIS VALUES ON TOP THREE PLOTS REPRESENT CALENDAR YEARS OF THE FUTURE SIMULATION PERIOD.

FIGURE 5-33
SIMULATED RELATIVE CHLORIDE CONCENTRATIONS BETWEEN THE VALENCIA WRP AND DOWNSTREAM MONITORING LOCATIONS IN THE PIRU SUBBASIN: SCENARIOS 1A/B, 3A/B, 1F/G, AND 3F/G

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

DilutionPlots_Piru-Val.grf

CH2MHILL –HGL



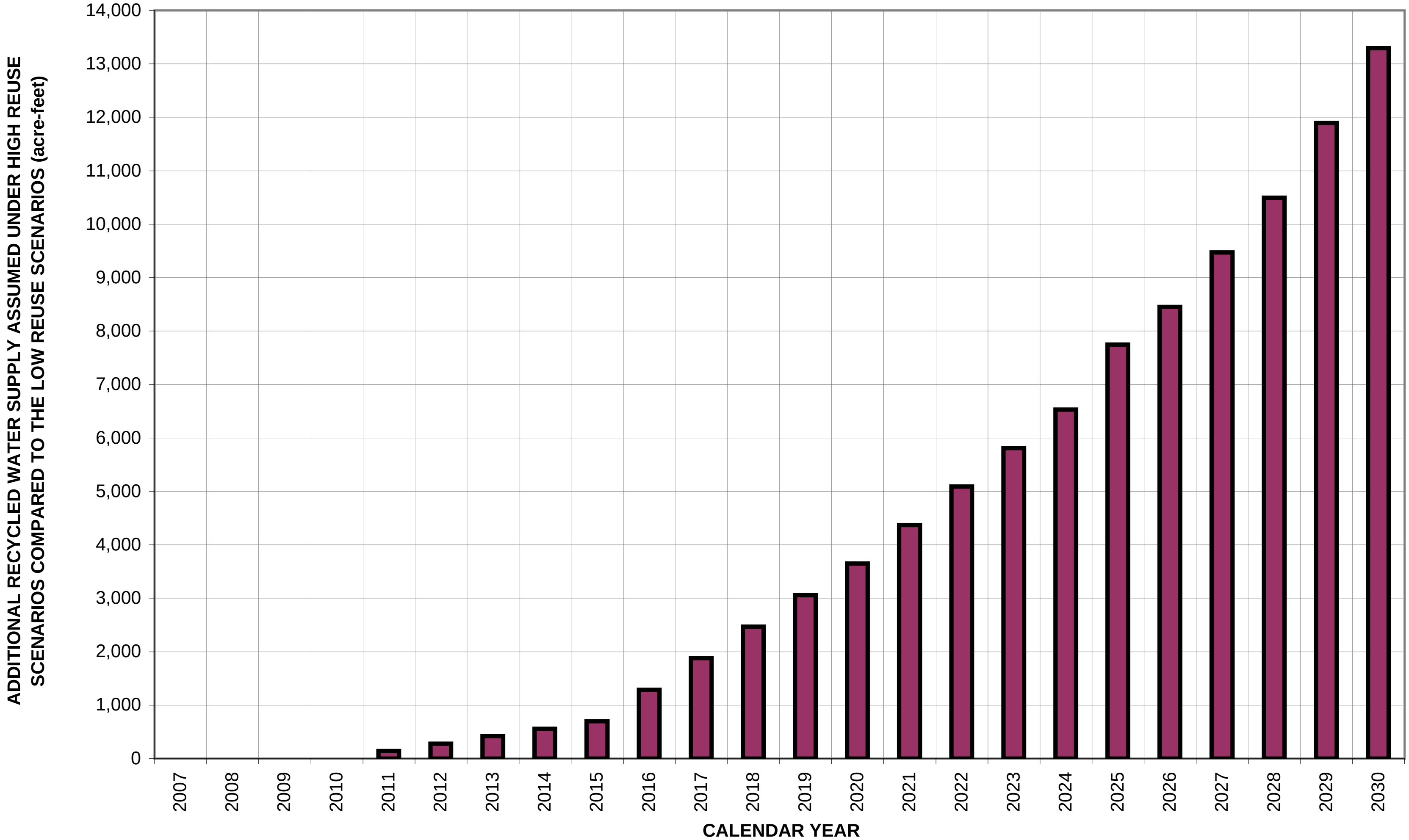
SIMULATION YEAR	HYDROLOGY YEAR
2007	1975
2008	1976
2009	1977
2010	1978
2011	1979
2012	1980
2013	1981
2014	1982
2015	1983
2016	1984
2017	1985
2018	1986
2019	1987
2020	1988
2021	1989
2022	1990
2023	1991
2024	1992
2025	1993
2026	1994
2027	1995
2028	1996
2029	1997
2030	1998

NOTES:
1. SEE FIGURES 4-1a THROUGH 4-1e FOR MODEL-OUTPUT LOCATIONS.
2. 04N17W29SW1 IS LOCATED AT BLUE CUT.
3. SCR-RE IS LOCATED JUST UPSTREAM OF THE CASTAIC CREEK CONFLUENCE.
4. SCR-RF IS LOCATED NEAR THE CAMULOS DIVERSION.
5. NLF-NR3 IS LOCATED AT THE LAS BRISAS BRIDGE.
6. X-AXIS VALUES ON TOP THREE PLOTS REPRESENT CALENDAR YEARS OF THE FUTURE SIMULATION PERIOD.

FIGURE 5-34
SIMULATED RELATIVE CHLORIDE CONCENTRATIONS BETWEEN CASTAIC CREEK AND DOWNSTREAM MONITORING LOCATIONS IN THE PIRU SUBBASIN: SCENARIOS 1A/B, 3A/B, 1F/G, AND 3F/G
TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

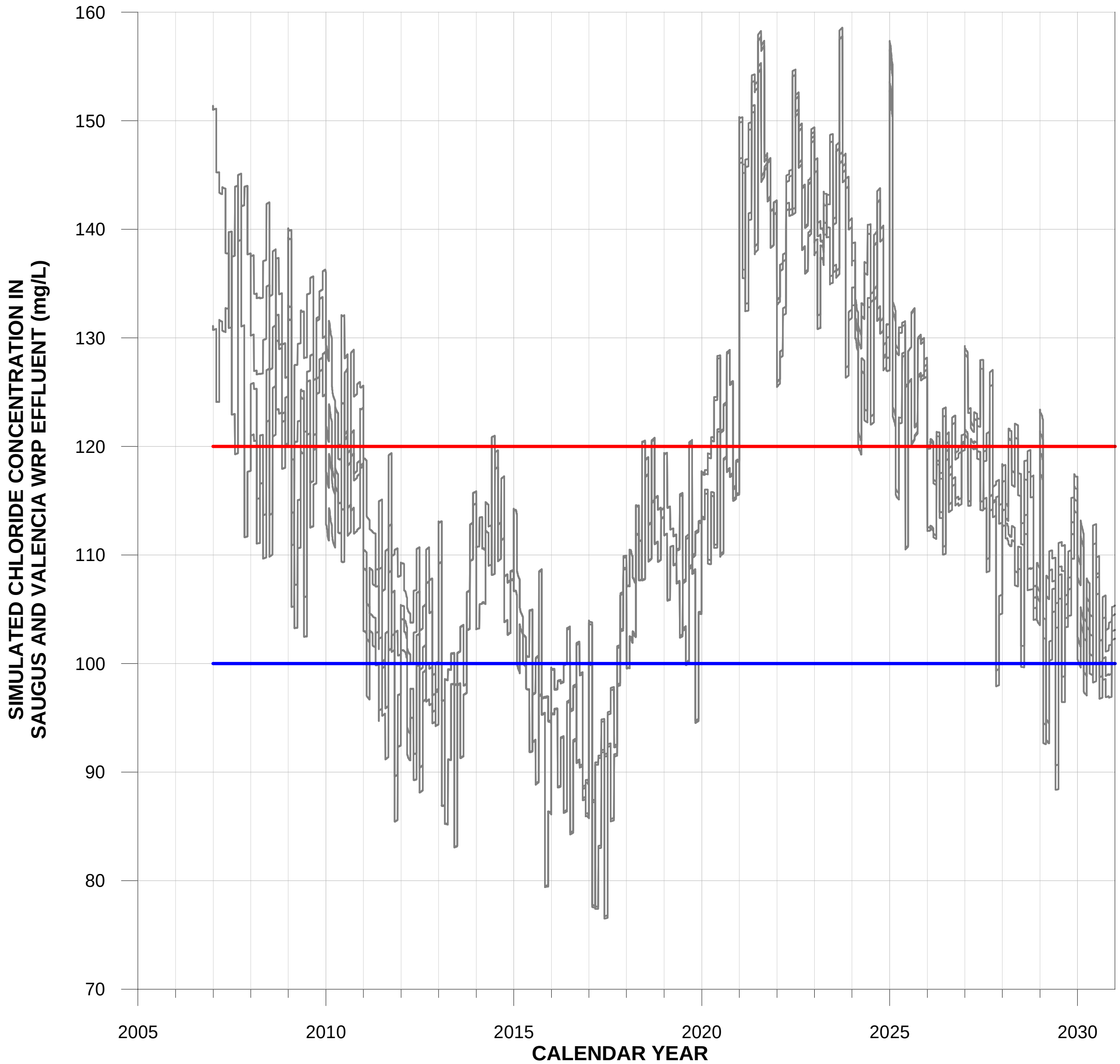
CH2MHILL –HGL

DilutionPlots_Piru-RE.grf



NOTE:
SEE TABLES 5-3 AND 5-4 FOR ANNUAL WATER USE ASSUMPTIONS BY SIMULATION YEAR.

FIGURE 5-35
ADDITIONAL RECYCLED WATER SUPPLY UNDER HIGH REUSE COMPARED TO LOW REUSE
TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS



LEGEND

- CHLORIDE CONCENTRATION IN WRP DISCHARGE UNDER THE A-SERIES RO SCENARIO
- CHLORIDE CONCENTRATION IN WRP DISCHARGE UNDER THE B-SERIES RO SCENARIO
- CHLORIDE CONCENTRATIONS IN WRP DISCHARGES UNDER THE SRWS-REMOVAL SCENARIOS

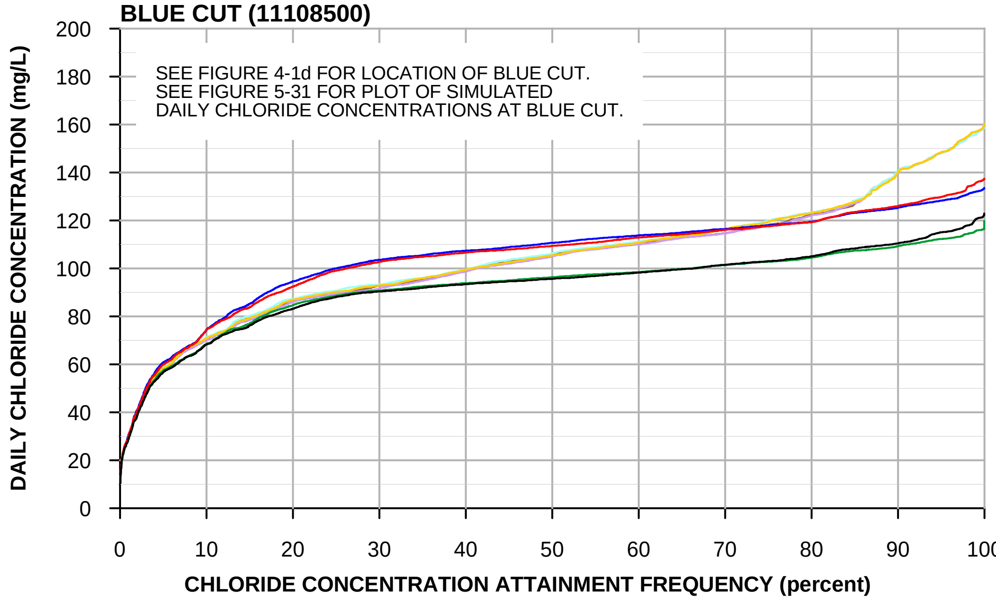
FIGURE 5-36
COMPARISON OF END-OF-PIPE CHLORIDE CONCENTRATIONS SIMULATED BY GSWIM

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

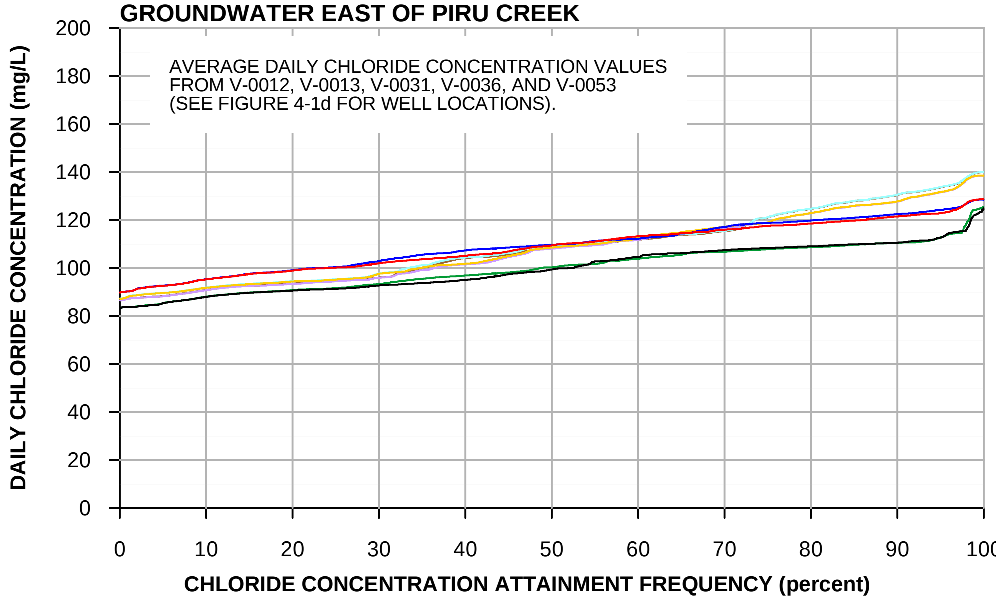
CH2MHILL – HGL

EndOfPipe.grf

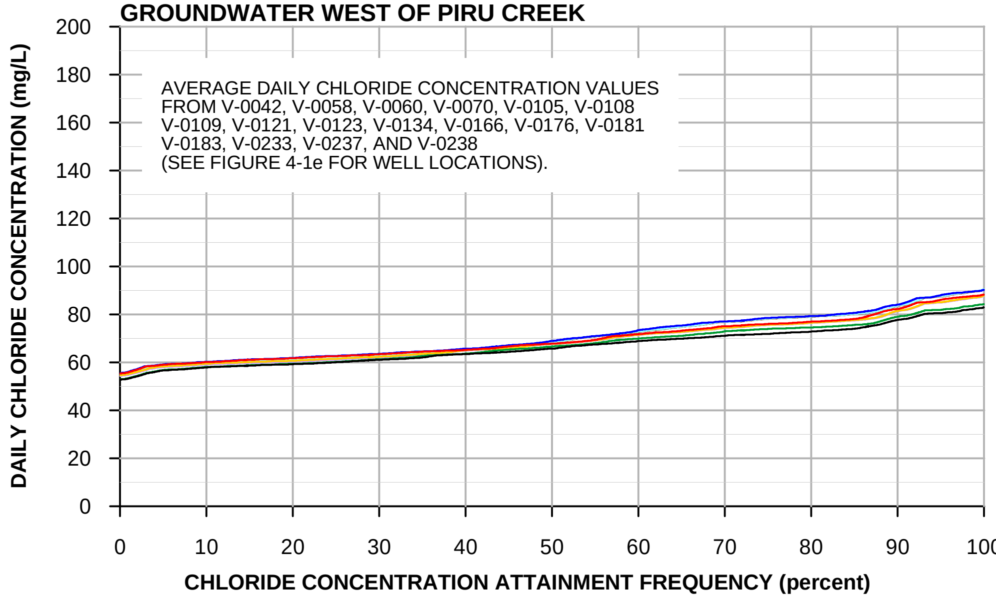
BLUE CUT (11108500)



GROUNDWATER EAST OF PIRU CREEK



GROUNDWATER WEST OF PIRU CREEK



DAILY CHLORIDE THRESHOLD ATTAINMENT FREQUENCY (units in percent)

BLUE CUT (11108500)

	SURFACE WATER WQO	AVOCADO THRESHOLD	
SCENARIO	100 mg/L	100 mg/L	120 mg/L
1a	66.4	66.4	98.9
3a	65.8	65.8	100.0
1b	26.1	26.1	80.9
3b	24.9	24.9	80.8
1f	40.7	40.7	75.5
3f	40.5	40.5	75.1
1g	41.2	41.2	77.8
3g	41.0	41.0	77.4

GROUNDWATER EAST OF PIRU CREEK

	GROUNDWATER WQO	AVOCADO THRESHOLD	
SCENARIO	200 mg/L	100 mg/L	120 mg/L
1a	100.0	52.2	98.5
3a	100.0	48.8	98.3
1b	100.0	24.2	85.9
3b	100.0	22.6	80.5
1f	100.0	34.8	75.6
3f	100.0	33.4	73.5
1g	100.0	36.4	75.7
3g	100.0	35.0	73.5

GROUNDWATER WEST OF PIRU CREEK

	GROUNDWATER WQO	AVOCADO THRESHOLD	
SCENARIO	100 mg/L	100 mg/L	120 mg/L
1a	100.0	100.0	100.0
3a	100.0	100.0	100.0
1b	100.0	100.0	100.0
3b	100.0	100.0	100.0
1f	100.0	100.0	100.0
3f	100.0	100.0	100.0
1g	100.0	100.0	100.0
3g	100.0	100.0	100.0

LEGEND

- HIGH REUSE; 100 mg/L CHLORIDE IN SAUGUS AND VALENCIA WRP DISCHARGE (SCENARIO 1A)
- HIGH REUSE; 120 mg/L CHLORIDE IN SAUGUS AND VALENCIA WRP DISCHARGE (SCENARIO 1B)
- LOW REUSE; 100 mg/L CHLORIDE IN SAUGUS AND VALENCIA WRP DISCHARGE (SCENARIO 3A)
- LOW REUSE; 120 mg/L CHLORIDE IN SAUGUS AND VALENCIA WRP DISCHARGE (SCENARIO 3B)
- HIGH REUSE; 50 PERCENT REMOVAL OF SELF REGENERATING WATER SOFTENERS (SCENARIO 1F)
- HIGH REUSE; 100 PERCENT REMOVAL OF SELF REGENERATING WATER SOFTENERS (SCENARIO 1G)
- LOW REUSE; 50 PERCENT REMOVAL OF SELF REGENERATING WATER SOFTENERS (SCENARIO 3F)
- LOW REUSE; 100 PERCENT REMOVAL OF SELF REGENERATING WATER SOFTENERS (SCENARIO 3G)

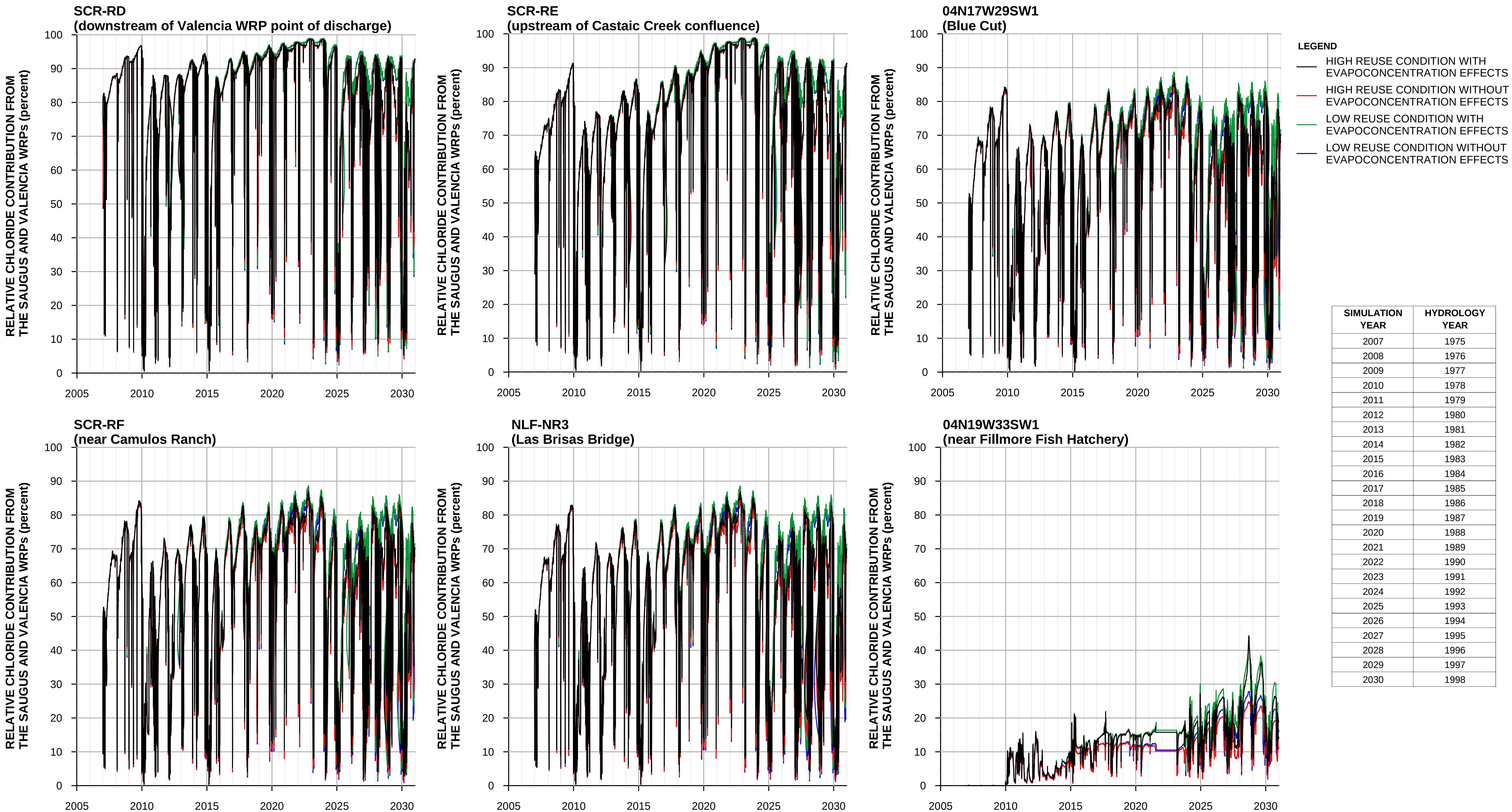
NOTES:
1. SEE FIGURES 5-27 THROUGH 5-29 FOR SIMULATED DAILY GROUNDWATER CHLORIDE CONCENTRATIONS.
2. ATTAINMENT FREQUENCY REPRESENTS THE PERCENT OF TIME DURING THE FUTURE SIMULATION PERIOD THAT CHLORIDE CONCENTRATIONS WERE AT OR BELOW THE INDICATED DAILY CHLORIDE CONCENTRATION.
3. SURFACE WATER WQO OF 100 mg/L TAKEN FROM TABLE 3-8 OF THE BASIN PLAN (REGIONAL BOARD, 1994).
4. GROUNDWATER WQO OF 200 mg/L EAST OF PIRU CREEK TAKEN FROM TABLE 3-10 OF THE BASIN PLAN (REGIONAL BOARD, 1994).
5. GROUNDWATER WQO OF 100 mg/L WEST OF PIRU CREEK TAKEN FROM TABLE 3-10 OF THE BASIN PLAN (REGIONAL BOARD, 1994).
6. LOWER AND UPPER BOUNDS FOR THE AVOCADO THRESHOLD TAKEN FROM CH2M HILL (2005a).

FIGURE 5-37
SIMULATED DAILY CHLORIDE CONCENTRATION ATTAINMENT FREQUENCIES IN THE PIRU SUBBASIN: SCENARIOS 1A/B, 3A/B, 1F/G, AND 3F/G

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL –HGL

SW-GW_ChlorideAttainment.grf



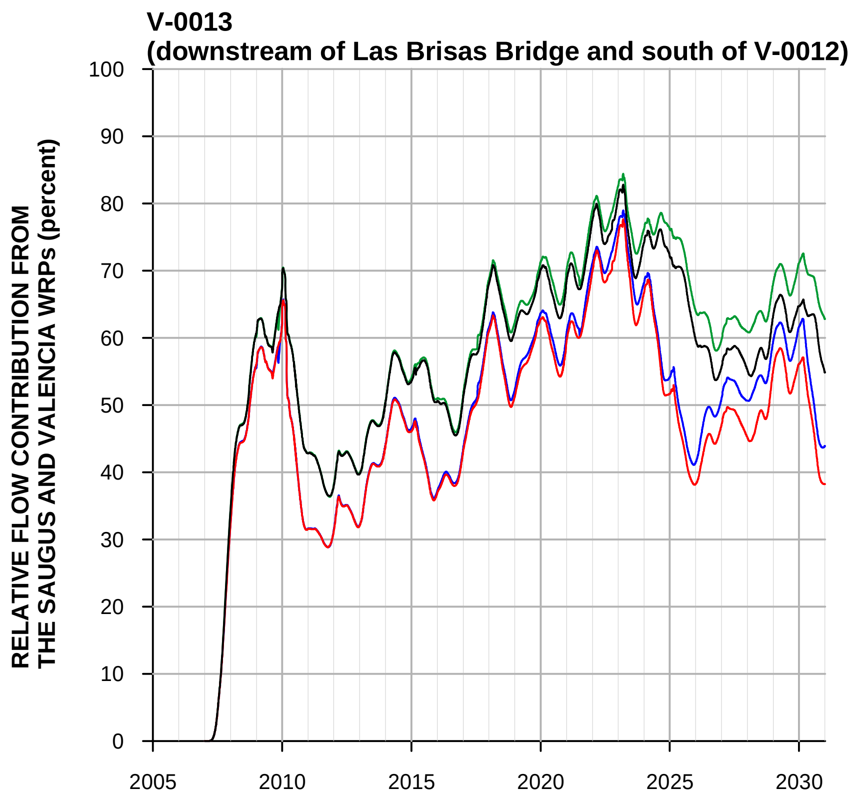
SIMULATION YEAR	HYDROLOGY YEAR
2007	1975
2008	1976
2009	1977
2010	1978
2011	1979
2012	1980
2013	1981
2014	1982
2015	1983
2016	1984
2017	1985
2018	1986
2019	1987
2020	1988
2021	1989
2022	1990
2023	1991
2024	1992
2025	1993
2026	1994
2027	1995
2028	1996
2029	1997
2030	1998

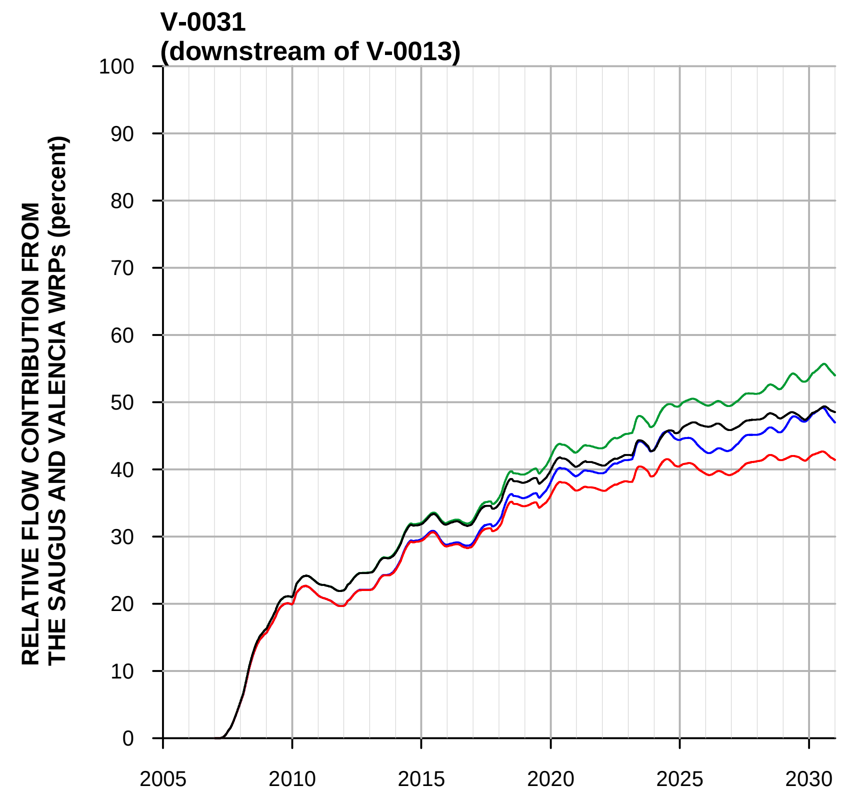
NOTES:
1. SEE FIGURES 4-1a THROUGH 4-1e FOR MODEL-OUTPUT LOCATIONS.
2. X-AXIS VALUES REPRESENT CALENDAR YEARS OF THE FUTURE SIMULATION PERIOD.

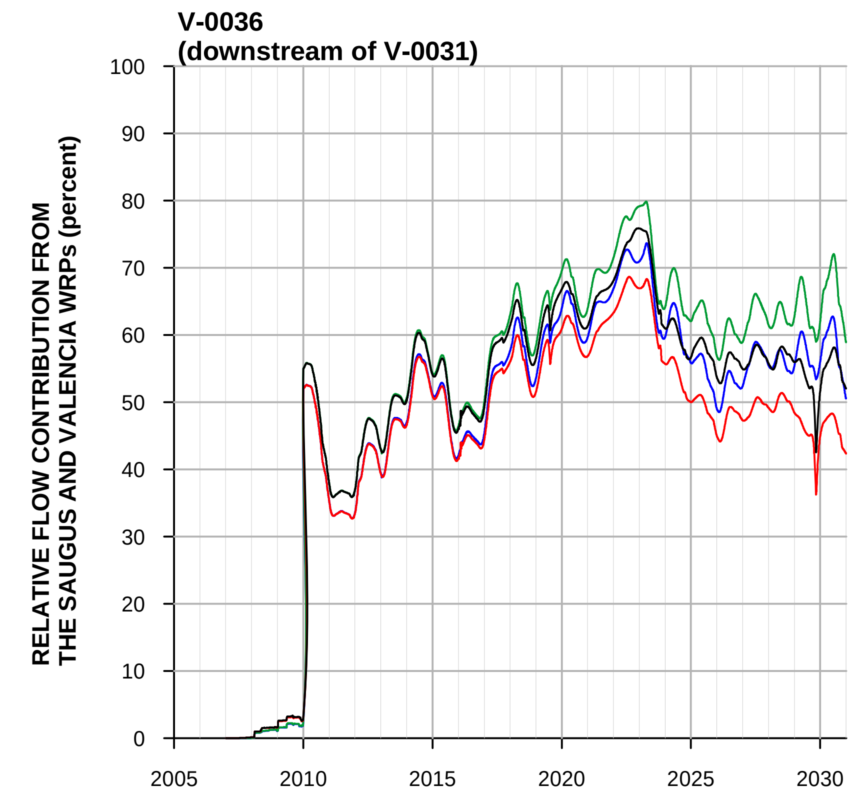
FIGURE 5-38
SIMULATED SAUGUS AND VALENCIA WRP FLOW CONTRIBUTION AT SELECTED LOCATIONS IN THE SANTA CLARA RIVER
TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

Supp_Cl_SW_EastSubbasin.grf

CH2MHILL –HGL–

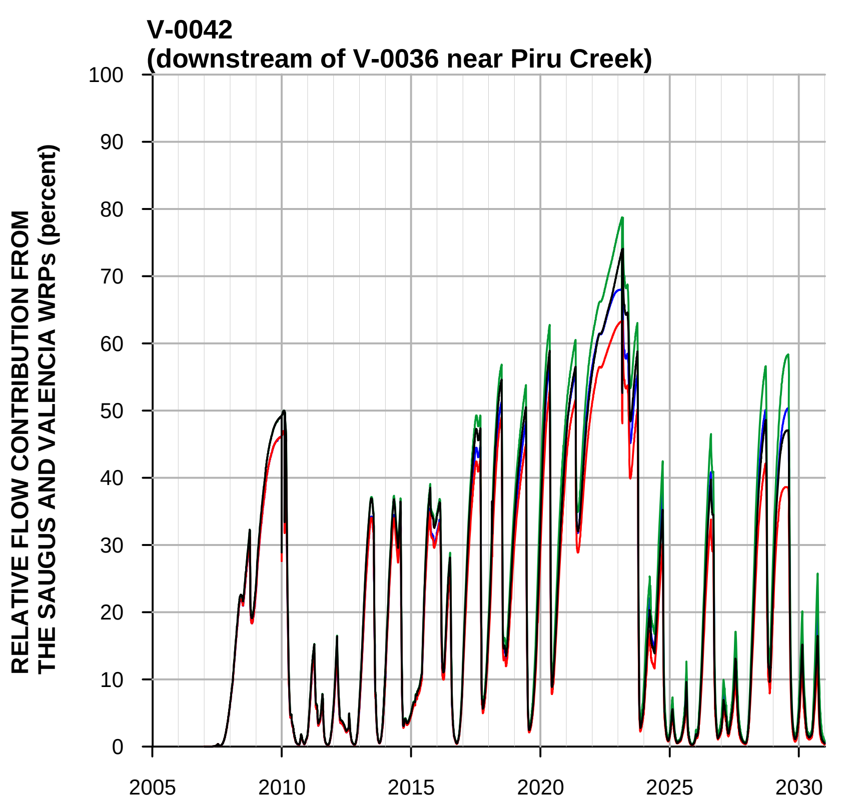


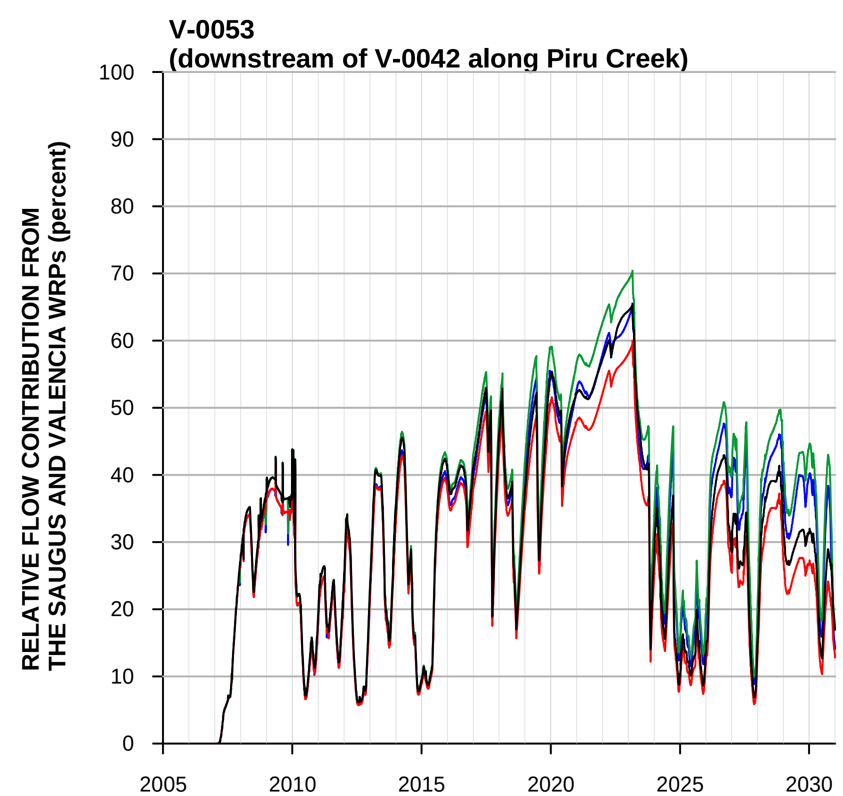


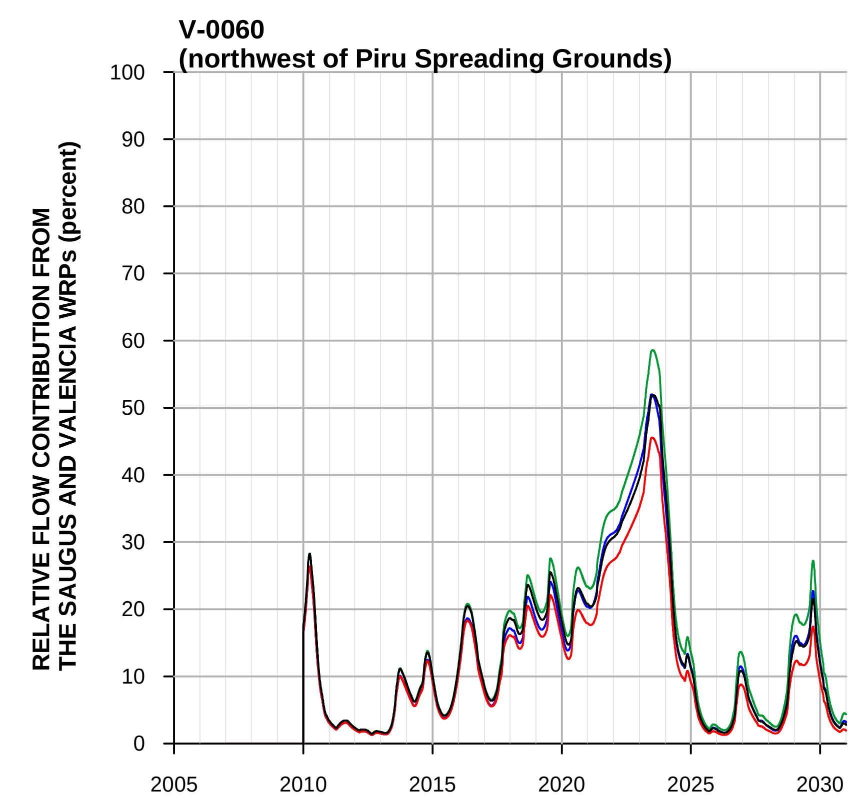


LEGEND

- HIGH REUSE CONDITION WITH EVAPOCONCENTRATION EFFECTS
- HIGH REUSE CONDITION WITHOUT EVAPOCONCENTRATION EFFECTS
- LOW REUSE CONDITION WITH EVAPOCONCENTRATION EFFECTS
- LOW REUSE CONDITION WITHOUT EVAPOCONCENTRATION EFFECTS







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

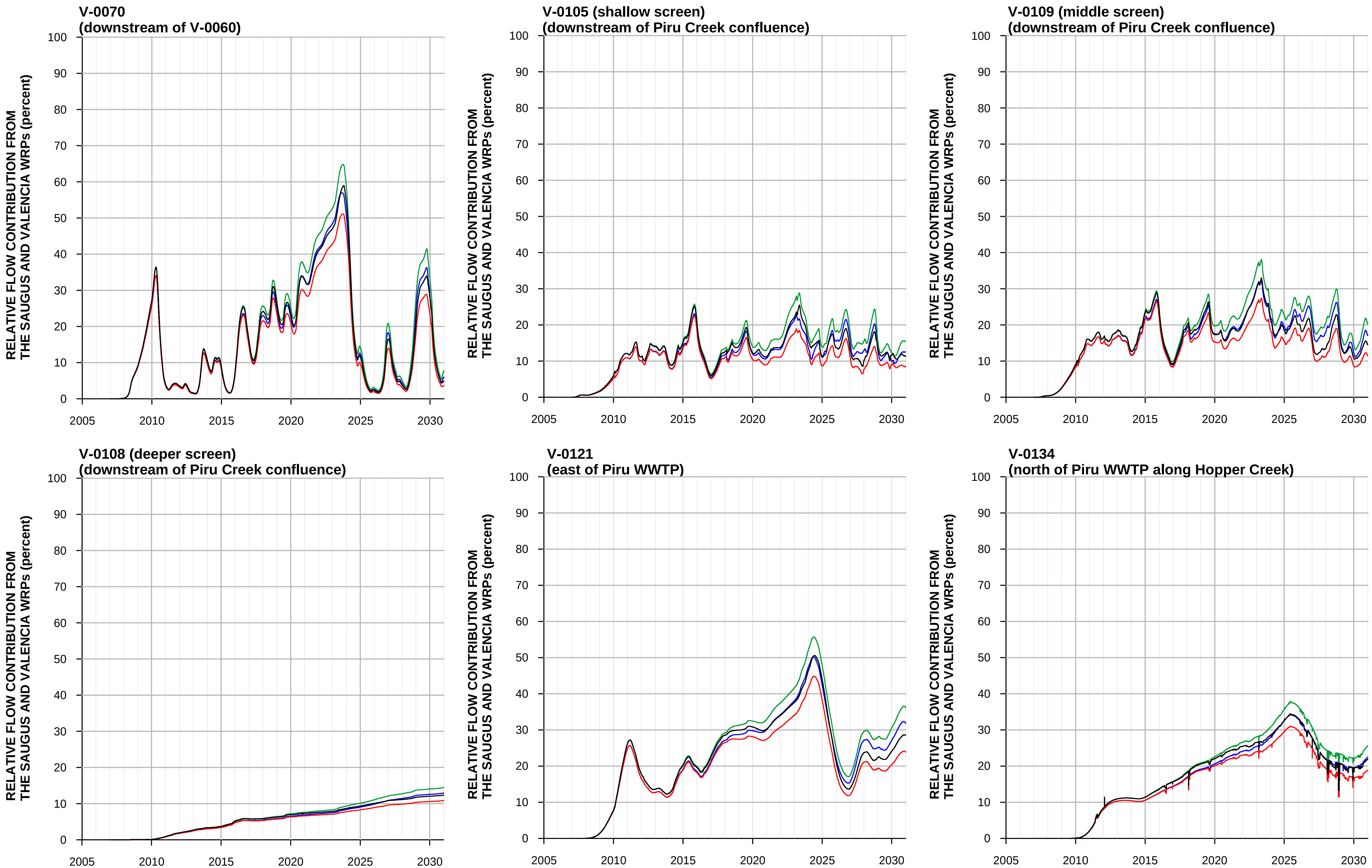
NOTES:
1. SEE FIGURES 4-1a THROUGH 4-1e FOR MODEL-OUTPUT LOCATIONS.
2. X-AXIS VALUES REPRESENT CALENDAR YEARS OF THE FUTURE SIMULATION PERIOD.

FIGURE 5-39
SIMULATED SAUGUS AND VALENCIA WRP FLOW CONTRIBUTION AT WELLS LOCATED EAST OF TORREY ROAD IN THE PIRU SUBBASIN

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL – HGL

Supp_Piru_ClEastTorrey.grf



LEGEND

HIGH REUSE CONDITION WITH EVAPOCONCENTRATION EFFECTS

HIGH REUSE CONDITION WITHOUT EVAPOCONCENTRATION EFFECTS

LOW REUSE CONDITION WITH EVAPOCONCENTRATION EFFECTS

LOW REUSE CONDITION WITHOUT EVAPOCONCENTRATION EFFECTS

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

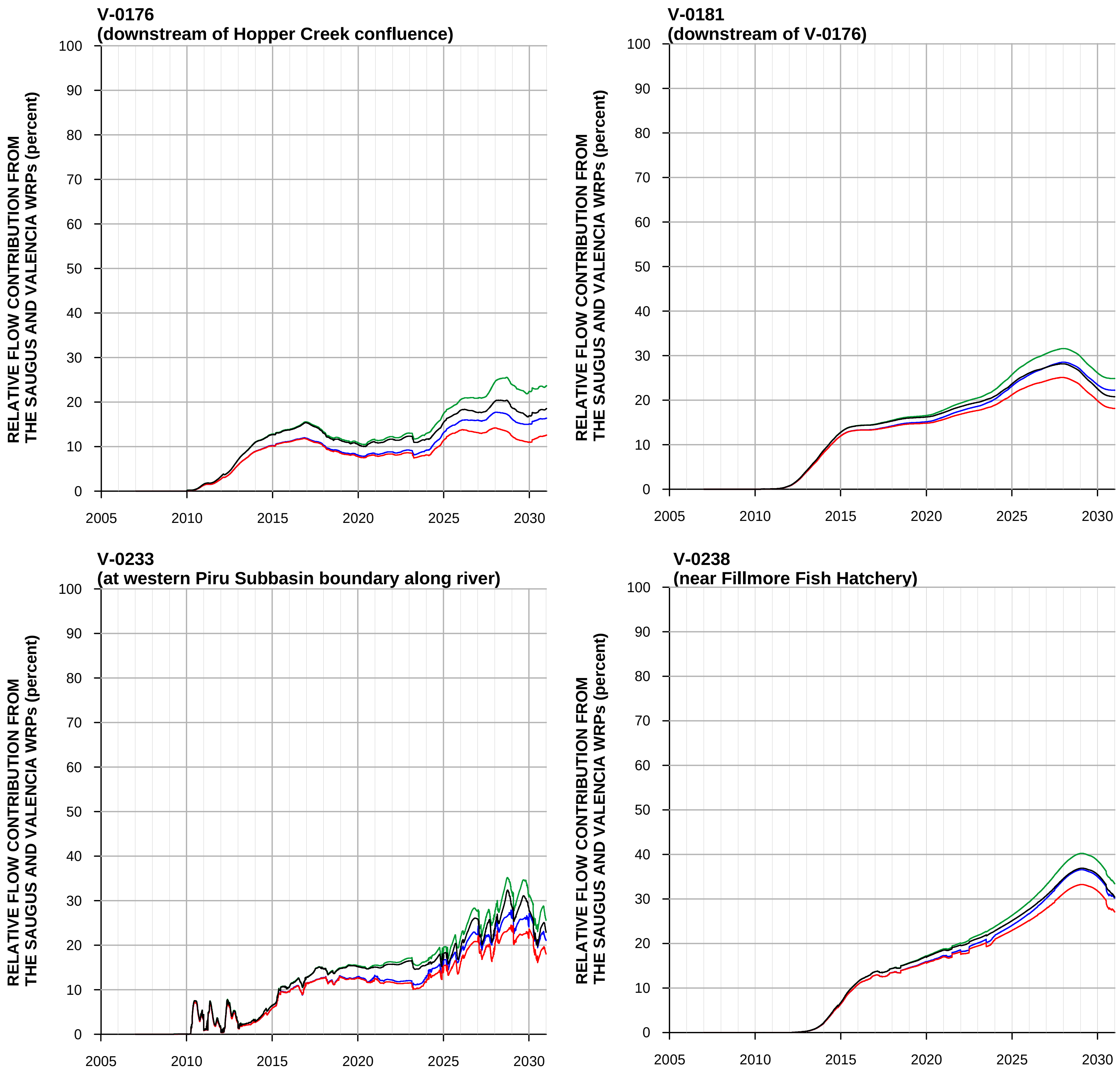
NOTES:
1. SEE FIGURES 4-1a THROUGH 4-1e FOR MODEL-OUTPUT LOCATIONS.
2. X-AXIS VALUES REPRESENT CALENDAR YEARS OF THE FUTURE SIMULATION PERIOD.

FIGURE 5-40
SIMULATED SAUGUS AND VALENCIA WRP FLOW CONTRIBUTION AT WELLS LOCATED BETWEEN HOPPER CREEK AND TORREY ROAD IN THE PIRU SUBBASIN

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

Supp_Piru_ClHopperTorrey.grf

CH2MHILL –HGL



LEGEND
- HIGH REUSE CONDITION WITH EVAPOCONCENTRATION EFFECTS
- HIGH REUSE CONDITION WITHOUT EVAPOCONCENTRATION EFFECTS
- LOW REUSE CONDITION WITH EVAPOCONCENTRATION EFFECTS
- LOW REUSE CONDITION WITHOUT EVAPOCONCENTRATION EFFECTS

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

NOTES:
1. SEE FIGURES 4-1a THROUGH 4-1e FOR MODEL-OUTPUT LOCATIONS.
2. X-AXIS VALUES REPRESENT CALENDAR YEARS OF THE FUTURE SIMULATION PERIOD.

FIGURE 5-41
SIMULATED SAUGUS AND VALENCIA WRP FLOW CONTRIBUTION AT WELLS LOCATED WEST OF HOPPER CREEK IN THE PIRU SUBBASIN

TASK 2B-1 – NUMERICAL MODEL DEVELOPMENT AND SCENARIO RESULTS
UPPER SANTA CLARA RIVER CHLORIDE TMDL COLLABORATIVE PROCESS

CH2MHILL –HGL–

Supp_Piru_ClWestHopper.grf

SECTION 6.0

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Appendix A
Response to Comments – Draft Task 2B-1 – Numerical Model Development and Scenario Results, East and Piru Subbasins Report

Response to GSWI TWG, TAP, and Stakeholder Comments
Draft Task 2B-1 – Numerical Model Development and Scenario Results

Section: **Section Title**

Reviewer **A. Keller, GSWI TAP – UCSB**

Subsection | **Page(s)** | **Comment Date** 2/25/2008

Comment The Draft Report for Task 2B-1 provides a very useful documentation of the modeling effort related to the Upper Santa Clara River Chloride TMDL Collaborative Process, providing in quite a bit of detail the information needed to understand the basis for implementing the model, the assumptions and decisions made during the implementation, the calibration process, the selection and construction of scenarios addressing future conditions, and the results of scenario simulations. The document is an accurate representation of the process as it developed and was discussed with the Technical Advisory Panel throughout the past 18 months.

The implementation of the model was of high quality, with a lot of thought given to each decision along the entire process. The model selected is one of the best available for addressing surface/groundwater interactions, and modeling the fate and transport of chloride within this complex system. The overall scope of the project was well defined, and this was translated into reasonable boundary and initial conditions, as well as in the construction of the future scenarios. The modelers made use of a large amount of existing local data, including information on parameter values (e.g. geology, hydrogeologic parameters, vegetation cover, land use and land use practices, meteorology, point source releases, etc.) as well as observed hydrology and water quality. It was a major undertaking to collect all this information and process into useable model files. They also used this information to its full extent in the calibration process, adequately fine tuning the model to best match the observed data. In general, sound practices were used for the calibration process. The construction of the future scenarios was done in collaboration with the stakeholders and thus represents the best estimates that can be done considering the uncertainties about the future. The results of the scenarios seem quite reasonable and should provide useful information for the stakeholders in addressing the concerns about Chloride concentrations in the Santa Clara River.
In addition to a well-written text, the authors should be commended for the high quality of the graphics throughout the report.

The following comments are meant to provide a valuable external perspective on the various aspects of the modeling effort and the documentation of this activity. It should be noted that in my opinion, the current documentation is of very high quality and would be considered more than adequate. However, as with any process, there are different perspectives and room for improvement.

Response Comment noted. No detailed response required.

Subsection 1.0 | **Page(s)** | **Comment Date** 2/25/2008

Comment This section provides a very good overview of the background, objectives and conceptual model considered before selecting a numerical model. The tables and graphics are of very high quality and serve to clearly explain the study area.

Response Comment noted. No detailed response required.

Subsection 2.0 | **Page(s)** | **Comment Date** 2/25/2008

Comment This section provides an overview of the numerical model, including a description of its origins and some of the peer-reviewed studies that have been used to test the model against analytical solutions. Although this is a fairly technical section, it is written clearly and provides a general description of the conceptual model. The section is not intended to be a “User’s Guide” for the model, which in my opinion is the correct approach. An interested reader is provided information on where to look for additional details on the MODHMS code.

Response Comment noted. No detailed response required.

Subsection 2.2 | **Page(s)** 2-3 | **Comment Date** 2/25/2008

Comment One comment is that in Section 2.2 there is actually no explanation of the solution techniques. It provides a defense of the techniques used in MODHMS, but the reader is referred to the MODHMS manual for more details. It would be useful to briefly describe them here.

Response The title of this subsection was changed from "Solution Techniques" to "Scientific Bases". For the purposes of the GSWI Study and the intended audience, no additional text describing the solution techniques of MODHMS was provided. The MODHMS User's Manual (HGL, 2006) should be relied upon for such a description.

Subsection 2.4 | **Page(s)** 2-3 | **Comment Date** 2/25/2008

Comment In addition, Section 2.4 discusses very generally the limitations. It would be useful to refer the reader to the latter Section 4.2.5 which discusses in more detail the potential sources of error.

Response Additional text was added as suggested.

Section: **Section Title**

Reviewer **A. Keller, GSWI TAP – UCSB**

Subsection 3.0 **Page(s)** **Comment Date** 2/25/2008

Comment This section provides detailed information on overall boundaries, grid generation, land surface parameters, interception storage and evapotranspiration parameters, subsurface hydraulic parameters, transport parameters, time discretization, and initial and boundary conditions. It provides detailed information on the decisions, assumptions and revisions to the assumptions (e.g. adjustment of subsurface layer thickness) made in constructing the model. It also provides useful documentation of the datasets that were used and of those subsets of data (e.g. precipitation from certain rain gages) which were questioned based on preliminary results.

In some cases the authors provide a short and useful description of a parameter (e.g. rill height, streambank elevation), but this is not consistently done (e.g. obstruction height, canopy interception storage). It would be useful to do it throughout, particularly since some of these parameters are not commonly used in other models.

Response Additional text was added, where appropriate, to better define parameters.

Subsection 3.0 **Page(s)** **Comment Date** 2/25/2008

Comment When the authors comment about work that will be explained in later sections (e.g. initial flow conditions using a "charge-up" simulation, described in Section 4), it is best to provide a reference to the section where such work will be discussed in detail.

Response Additional reference information was added as suggested, where appropriate.

Subsection 3.0 **Page(s)** **Comment Date** 2/25/2008

Comment The authors provide a very complete documentation of the model parameters in more than 35 tables. However, it would be useful for the reader to know whether the parameter values provided are the original ones (i.e. from the various sources) or the final calibration values. Also, in a few cases, the source of the data is not indicated in the table footnotes (e.g. evapotranspiration parameter values, dry and wet deposition of chloride).

Response Additional text was added to the report which states that the parameterization, as described in Section 3.0 of the Task 2B-1 report, is in reference to the calibrated parameters in GSWIM. The Task 2A report describes the parameterization that was initially used for model development.

Subsection 3.0 **Page(s)** 3-5 **Comment Date** 2/25/2008

Comment Typo: Page 3-5, 2nd paragraph: "…beneath Piru Creek its location outside…"

Response The referenced sentence was revised as suggested.

Subsection 4.0 **Page(s)** **Comment Date** 2/25/2008

Comment Section 4 presents the process undertaken to calibrate the model in detail, and then presents an evaluation of the results of the calibration. First a steady-state calibration was conducted, which is reasonable, to evaluate the initial conditions and determine whether the resulting gradients are in the right direction and magnitude. Then a transient calibration was performed, first for flow and then for chloride concentrations, which is the correct order. Calibration targets were very well defined for surface and groundwater flow, including a number of criteria for determining the "goodness of fit". There were no specific "goodness of fit" criteria for chloride concentrations. The modelers provide an adequate description of the preliminary calibration approach, which used monthly time steps to evaluate whether the general trends were in line with the observed values. This is a reasonable approach, given the complexity of the model and the relatively long simulation runs. Then a sensitivity analysis was performed, by varying parameter values over the entire domain to determine which parameters were more likely to influence the outcome of a simulation. The sensitivity was focused on evapotranspiration, since this was perceived as the major uncertainty in the modeling effort. The modelers then proceeded to perform a flow calibration of the model by subareas, which is reasonable, given that the model is quite complex. Finally the modelers calibrated chloride concentrations throughout the model.

It would be useful for the authors to indicate that the preliminary calibration was done only for the hydrologic system and not for chloride concentrations.

Response Additional text was added to Section 4.1.2.2 (Preliminary Calibration Approach) to explain that the initial calibration focused on flow only.

Section: **Section Title**

Reviewer **A. Keller, GSWI TAP – UCSB**

Subsection 4.0 **Page(s)** **Comment Date** 2/25/2008

Comment The sensitivity analysis was useful. However, rather than systematically changing parameter values by a known factor (e.g. increase/decrease by 2x or 10x), the modelers selected arbitrary increases or decreases in parameter values. Although this does provide an overall sense of the response of the outcome to a given parameter value, it makes it difficult to compare the sensitivity of one parameter relative to another. Also, a global sensitivity analysis would entail sampling the entire possible distribution of parameter values using a Monte Carlo approach; since that would require more than 10,000 simulations for a model of this level of complexity, it seems that the current approach is adequate in terms of providing a general sense of the parameter sensitivity. A Monte Carlo approach would give a better sense of the co-variances. Table 4-1 provides a good idea of the process used to conduct the sensitivity analysis.

Response Comment noted. No detailed response required.

Subsection 4.0 **Page(s)** **Comment Date** 2/25/2008

Comment In a number of instances, the authors indicate that a parameter value was changed to improve the goodness of fit. However, the original and final calibration values are seldom provided. Thus, the interested reader has no idea how much change was needed (a few percent, 100%, a factor of 1000?) to achieve the outcome and it is also not possible to determine whether the final value is reasonable. One assumes it is, but the information is not available. A table with the original and final calibration values for each parameter varied within a subarea would be very useful, along with some brief notes for each major change.

Response We started with parameter values presented in the Task 2A report and ended with parameter values presented in the Task 2B-1 report. Additional text was also added to the Task 2B-1 report which states that the calibrated parameter values are within reasonable ranges of values.

Subsection 4.1.2.2 **Page(s)** 4-6 through 4-8 **Comment Date** 2/25/2008

Comment At the end of the description of the calibration of Hopper and Pole Creek, it is mentioned that a subsurface layer was included to help generate base flow. It is unclear whether this was additional to the layers described in Section 3. In addition, it is mentioned that “parameter assumptions … were then implemented in the GSWIM”. It is unclear whether this means that this additional layer was implemented elsewhere, or just some of the other parameter value changes discussed in the section.

Response Additional text was added to the report which states that the parameterization, as described in Section 3.0 of the Task 2B-1 report, is in reference to the calibrated parameters in GSWIM. The Task 2A report describes the parameterization that was initially used for model development. Thus, the subsurface layer that was included to help generate baseflow in Hopper Creek is already accounted for in Section 3.0 (see Figure 3-16).

Subsection 4.2 **Page(s)** **Comment Date** 2/25/2008

Comment It is unclear why no “goodness of fit” measures were used for the chloride concentrations. Calibration should not be just visual. It is tricky to match very few observations visually. At the very least, some of the criteria considered for flow (residual error, ME, RMSE, RMSE/range, r2) should be calculated and reported for those regions where observed data is available. The description of flow calibration is very detailed, whereas the description of the chloride concentration calibration is short (targets, criteria, approach?).

Response Mean Error (ME), Root Mean Squared Error (RMSE), Coefficient of Determination (R^2), and Number of Observations (n) were added to the time-series chloride calibration plots (i.e., Figures 4-16 through 4-24).

Subsection 4.2 **Page(s)** **Comment Date** 2/25/2008

Comment In terms of the calibration results (Section 4.2), the authors provide very detailed graphical information, allowing the reader to compare the simulation results against groundwater elevations, stream flows or chloride concentrations. The text provided in this section serves to guide the reader through all this information. It would be useful to reference the figures related to each section, so that the reader can follow them easily. However, in several instances the comparisons described in the text are very qualitative (e.g. “simulated heads matched the range of measured heads fairly well”), even though there are clear quantitative targets. Whenever possible, it would be best to use a specific goodness of fit measure to evaluate whether the simulation matches the observed data adequately. Although Figure 4-13 provides the general goodness of fit evaluation, it is best to use this information throughout this section. In addition, there are instances where the match is not as good (e.g. SCWD N-Oaks East and West) yet this is not mentioned in the text. It would be useful to provide a possible explanation for such instances. For example, is the consistent underestimate of the groundwater elevations in VWC-1 a datum issue?

Response Additional text was added in an attempt to better quantify the calibration results and more clearly associate appropriate figure numbers with the calibration results.

Section: **Section Title**

Reviewer **A. Keller, GSWI TAP – UCSB**

Subsection 4.2 **Page(s)** **Comment Date** 2/25/2008

Comment There seemed to be a consistent under-prediction of chloride concentrations in NCWD-Pinetree 1 and SCWD-N Oaks West. There should be an evaluation of the cause of this consistent bias. Similarly, wells VWC-K2, VWC-N and VWC-S6 consistently show increasing chloride concentrations (observed), which are not simulated adequately. Some analysis should be provided. Could there be missing sources?

Response Section 4.2.3.1 states that GSWIM had difficulty replicating groundwater chloride concentrations at NCWD-Pinetree 1 and SCWD-N.Oaks West. We stated that errors resulting from the lack of available streamflow and chloride data at Lang during the calibration period could be the reason GSWIM had difficulty matching some of the chloride trends in Soledad Canyon. Additional text was added to Section 4.2.3.1 which indicates the possibility that additional sources of chloride existed that were not simulated in GSWIM upstream of the referenced locations.

Subsection Figure 4-13 **Page(s)** **Comment Date** 2/25/2008

Comment The overall goodness of fit shown in Figure 4-13 is quite interesting. It serves to understand the trend in calibration from upstream to downstream. It appears there is an anomaly at around 1,280 ft, which should be commented on.

Response The anomalously low simulated heads within the measured head range of approximately 1,270 and 1,290 ft msl on Figure 4-13, occur at NCWD-9 between June 1975 and June 1977. Figure 4-6 shows that measured groundwater levels increased during this drought period. However, the monthly pumping rate at NCWD-9, according to data provided by the responsible agency for NCWD-9, increased during this drought period by approximately 40 percent per year. GSWIM simulated decreasing groundwater levels because of increased pumping during a drought period. So, either the measured groundwater levels or pumping rates are questionable at NCWD-9 between June 1975 and June 1977. Regardless, as shown on Figure 4-1b, NCWD-9 is located distant from the Santa Clara River near the headwaters of Newhall Creek and not in the main areas of interest with respect to the chloride TMDL study. Additional text, similar to that provided in this response, was incorporated into the report.

Subsection Figures 4-23 and 4-24 **Page(s)** **Comment Date** 2/25/2008

Comment Figures 4-23 and 4-24 present a comparison between observed and simulated chloride concentrations in the Santa Clara River. These are quite useful, and it shows that the model does a very nice job of simulating chloride concentrations in the river. However, the black line used for simulation results is quite thick, and this obscures the observed data, which is in light colors. It would be best to make it easier to see both observed and simulated data by selecting a thinner line for the simulation results and a darker color for the observed data. Observed data should be in the foreground.

Response The time-series calibration plots were revised in an attempt to improve clarity.

Subsection 4.2.5 **Page(s)** 4-24 through 4-25 **Comment Date** 2/25/2008

Comment The analysis of the potential sources of error is useful and provides a valuable analysis. There are a few additional potential sources of error:

- Input data (e.g. info from point sources) may have errors
- Input data is generally at a different time scale (e.g. monthly loading rate averages) than the simulation time step
- The conceptual model, although overall very accurate, may not adequately describe all the processes in particular regions
- The assumptions for the initial and boundary conditions may not hold everywhere where they are applied

Response Additional text was added to Section 4.2.5 (Sources of Error) to make this section more complete, as suggested.

Subsection 4.3 **Page(s)** 4-26 **Comment Date** 2/25/2008

Comment In the second to last bullet point in the Calibration Outcome, the authors indicate that the numerical solution is “highly” constrained. It would be better to simply state “adequately” constrained. With so many grid points, parameters and parameter values, there are so many degrees of freedom that it would be difficult to state it is highly constrained.

Response The term "highly" was replaced with "adequately" as suggested.

Subsection 4.1.2.1 **Page(s)** 4-2 **Comment Date** 2/25/2008

Comment Typos in page 4-2, last paragraph: “describe aspects of groundwater and …”, “variety of hydrologic and water use conditions”.

Response The referenced sentence was revised as suggested.

Section: **Section Title**

Reviewer **A. Keller, GSWI TAP – UCSB**

Subsection	4.1.2.2	**Page(s)**	4-9	**Comment Date**	2/25/2008
Comment	For clarity, in page 4-9, second paragraph, change to “Unlike the previous subarea models, the Bouquet Canyon…”				
Response	The referenced sentence was revised as suggested.				
Subsection	4.2.2.1	**Page(s)**	4-18	**Comment Date**	2/25/2008
Comment	Typo in page 4-18, second paragraph: “GSWIM replicated streamflow well…”				
Response	The referenced sentence was revised as suggested.				
Subsection	4.2.3.3	**Page(s)**	4-22	**Comment Date**	2/25/2008
Comment	Typo in page 4-22, fourth paragraph: “GSWIM replicated the range…”				
Response	The referenced sentence was revised as suggested.				

Section: **Section Title**

Reviewer **D. Williams, GSWI TAP – GEOSCIENCE.**

Subsection **Page(s)** **Comment Date** 2/22/2008

Comment In my professional opinion, the Task 2B-1 Draft Report meets the standards and criteria generally accepted in the ground water industry for development and analysis of geohydrological/geochemical problems through use of ground water modeling. In other words, there are no fatal flaws and the work is consistent with generally accepted principles used in ground water hydrology. The report is well organized, professionally written and includes a good understanding and approach which is consistent with the general goals of the study. Throughout the process, the project management was excellent in keeping the TAP members informed regarding technical issues related to the work. Interactive web-based presentations on a timely basis were very helpful in this process. What was particularly useful was the fact that all of the team expertise, as well as stakeholders, were readily available during these Web-based calls so that any questions by TAP members could be answered immediately (or at least discussed).

Response Comment noted. No detailed response required.

Subsection **Page(s)** **Comment Date** 2/22/2008

Comment Most of my detailed comments regarding specific figures, graphics, clarification in the text and other editorial and presentation issues have been addressed (or discussed) and conveyed to the project team. For completeness, the issues considered important to the overall project goals are listed below and include:

It is my understanding that the project goal for chloride concentrations in the Santa Clara River is now 100 mg/L. As such, and based on modeling scenarios to date, some mitigation may be needed to ensure this threshold -- even with low reuse and chloride output limited to 100 mg/L in the Valencia and Saugus WRPs discharge.

It is also my understanding that the most likely operational scenarios which would achieve the project objectives are currently being addressed. Specifically, it is my understanding that potential compliance options may include:

a. Advanced treatment and brine disposal
b. Advanced treatment and secondary effluent pipeline and outfall
c. Alternative WRP discharge locations
d. Alternative water resources management using dilution water
e. Hybrid mix of several alternatives

Response Comment noted. No detailed response required.

Section: **Section Title**

Reviewer **B. Steets/D. Parkinson on behalf of NLF, GSWI TWG and Stakeholders – GeoSyntec Consultants**

Subsection Figure 5-20 **Page(s)** **Comment Date** 2/22/2008

Comment For the Newhall Ranch water & chloride routing schematic, the "imported water" box should be removed and the word "blended" should be removed from the water droplet supply symbol. These changes should be made to reflect the fact that Newhall Ranch relies on groundwater for its potable water supply. Other locations in the text, if they exist, should similarly be revised to reflect this fact.

Response For modeling purposes, it was assumed that seven existing and future VWC wells (i.e., VWC-E14/E15/E16/E17 and VWC-G1/G3/G4) will supply up to 7,038 acre-feet of groundwater per year to Newhall Ranch. Using a total potable demand of 8,645 acre-feet per year at build-out (according to the Draft Additional Analysis [Impact Sciences, 2002]), the imported water needed to supply the remaining demand at build-out equals 1,607 acre-feet per year (8,645 minus 7,038). These assumptions indicate that imported water would make up less than 20 percent of the potable supply at build-out. Thus, Figure 5-20 correctly illustrates the water and chloride routing assumptions that were built into GSWIM for the scenarios of future conditions. If other water supply assumptions for Newhall Ranch are of interest, then additional scenarios can be simulated at the request of the GSWI TWG.

Subsection 4.0 **Page(s)** **Comment Date** 2/22/2008

Comment Chloride calibration summary statistics need to be summarized – including average relative & absolute error (or residuals) for specific output locations for surface water and groundwater chloride concentrations. Chloride concentration prediction uncertainty needs to be addressed in order to have a meaningful discussion of the differences within and between future scenarios, as well as for considering a margin of safety in the final recommendation for WRP effluent limits.

Response Mean Error (ME), Root Mean Squared Error (RMSE), Coefficient of Determination (R^2), and Number of Observations (n) were added to the time-series chloride calibration plots (i.e., Figures 4-16 through 4-24). A more thorough evaluation of scenario results in relation to the appropriate WQO and the upper and lower range of the avocado chloride threshold from CH2M HILL (2005) was also provided in a new section (5.3.4).

Subsection 5.2.5 **Page(s)** **Comment Date** 2/22/2008

Comment Basis for Water Demand/Supply Assumptions – Water supply and demand data and sources are provided for all but Newhall Ranch development. This impacts assumptions for influent and effluent chloride concentrations for Newhall Ranch WRP reuse water supply. Please provide a table of water supply flow assumptions for the Newhall Ranch development, as well as the data or source for chloride concentration assumptions.

Response Table 5-6 summarizes the projected annual effluent flows from the future Newhall Ranch WRP, which indicate that the annual effluent at build-out will be 7.72 million gallons per day (i.e., 8,645 acre-feet per year, as described in the Draft Additional Analysis [Impact Sciences, 2002]). Consistent with the scenario assumptions, the simulated chloride concentrations in the Newhall Ranch WRP discharge to the Santa Clara River were set at 100 mg/L (assumed to be run through reverse osmosis). The portion of the Newhall Ranch WRP effluent that will be reused within Newhall Ranch was assumed to have a constant chloride concentration of 150 mg/L, at your request. This information is described in Sections 5.2.9.2 and 5.2.10 in the Task 2B-1 report.

Subsection 5.2.11 **Page(s)** 5-11 **Comment Date** 2/22/2008

Comment Boundary conditions for chloride – Has two bullet items, but first sentence after bullets says “First two items straightforward…..Last item required modification to MODHMS…” What are first two? And what is last item?

Response There is a typo in that particular sentence that was corrected to indicate that "Implementation of the first item was straightforward".

Subsection 5.3.1 through 5.3.3 **Page(s)** **Comment Date** 2/22/2008

Comment Please be specific at the very beginning, if not in the title of the section, which scenarios are being discussed (i.e. Section 5.3.1 = Scenarios 1 vs. 3; Section 5.3.2 = Scenarios a vs b, etc.).

Response Additional text was included to more clearly state which scenarios are being discussed in each section.

Subsection 5.0 **Page(s)** **Comment Date** 2/22/2008

Comment Section 5 maps don’t show GSWI-MW-01, GSWI-MW-02, GSWI-MW-03. Yet these wells are discussed in the text of future scenarios, and plots of groundwater elevations and chloride concentrations are provided. Please locate these wells on the maps for Section 5.

Response Locations for GSWI-MW01, GSWI-MW02, and GSWI-MW03 were added to Figure 4-1 to be consistent with the notes on Figures 5-21 and 5-22.

Section: **Section Title**

Reviewer **B. Steets/D. Parkinson on behalf of NLF, GSWI TWG and Stakeholders – GeoSyntec Consultants**

Subsection 5.3.1.2 **Page(s)** 5-13 and 5-14 **Comment Date** 2/22/2008

Comment Bullet number 3 states, "GSWI-MW-02 exceeded the groundwater chloride WQO of 150 mg/L…" This is a misleading statement. The water quality for this well is extremely poor (existing chloride measurements range from 140-160 mg/L) and so the fact that it remains poor under future modeling scenarios is of little practical use. Suggest deleting, or rewording to include a statement that existing water quality for well is extremely poor. This applies to Figure 5-26 as well – please show existing water quality data for this well from 2002-2006 time frame, or remove the plot. In fact, any discussion of chloride concentrations at Bluecut should note the fact that existing groundwater data in the immediate area (MW-02, MW-03) indicates consistently elevated chloride concentrations.

Response The text describing results at GSWI-MW02 was removed.

Subsection Figure 5-25 **Page(s)** **Comment Date** 2/22/2008

Comment Add predicted future flows for Potrero and Salt Creeks. This information is required in order to assess the impacts of the chloride concentrations for these two tributaries shown in Figure 5-31.

Response Figure 5-25 was revised to show streamflow results for all locations shown on Figure 5-31 for consistency.

Subsection **Page(s)** **Comment Date** 2/22/2008

Comment Please provide an additional figure, as previously requested by C.P. Lai, of a profile along the Santa Clara River of surface water and alluvial groundwater chloride concentrations under both "average" and drought conditions. These should include a couple time slices at a minimum, so change over time can be represented.

Response As indicated in a previous response to Regional Board comments on the Draft Task 2B-1 report, the output control of GSWIM was not programmed to save results for every surface and subsurface computational grid point in longitudinal profile along the Santa Clara River, because of file management limitations. Inclusion of additional output locations would be required and the simulations would need to be rerun to create such profiles. Furthermore, available analytical data and modeling output indicate that chloride concentrations between Blue Cut and the Eastern Piru Subbasin fluctuate significantly in response to hydrology and upstream land use and water use/reuse. Thus, profiles of chloride concentrations could look substantially different depending on the selected periods. The chloride concentration animations that were provided to stakeholders during the development and application of GSWIM are useful in illustrating the variability in chloride concentrations in the groundwater and surface-water system. The GSWI Modeling Team will contact the Regional Board and GeoSyntec Consultants directly to discuss options for addressing their data request outside of the Task 2B-1 reporting task.

Subsection 5.3.1.3 **Page(s)** 5-14 **Comment Date** 2/22/2008

Comment The second bullet reads, "The differences in simulated surface-water chloride concentrations … between both water reuse scenarios were as much as approximately 50 mg/L (see differences between Scenarios 1a and 3f during dry periods)." This is a misleading statement. This 50 mg/L difference cannot be considered a cause of high reuse vs low reuse. It is very clearly caused by variations in influent water supply chloride concentrations (see Geomatrix supplemental report Figure 2 vs Figure 5). Suggest rewording this statement comparing 1a to 3a or 1f with 3f, but not 1a to 3f.

Response Additional text was included to clarify the statement, as suggested.

Subsection 5.4 **Page(s)** 5-23 **Comment Date** 2/22/2008

Comment The second to last bullet reads, "The RO scenarios [a and b] occasionally simulated unrealistically high chloride concentrations in Saugus and Valencia WRP effluent…". This not only created high concentrations, but also created an actual increase in total load to the system. The affect of this "occasionally simulated unrealistically high chloride concentrations" on the long term chloride concentrations downstream is impossible to gage. Scenarios a and b would have been much better, and more easily comparable to other scenarios, if the effluent concentrations were allowed to be no higher than 100 or 120 mg/L, but also allow this effluent to be lower, based on the same calculation of effluent concentration used for Scenarios f and g. Suggest not comparing a and b scenario results directly with f and g scenario results unless qualifying the difference as such. Scenarios a through g cannot be directly compared due to differing simplifying assumptions.

Response We agree that care must be taken when evaluating the scenario results. However, because the future cannot be predicted with any certainty, the ranges of assumptions that were agreed upon by the GSWI TWG and included in the simulations were compared to describe the ranges in results. Results from the RO scenarios, as simulated with a constant chloride concentration in the WRP discharges, do provide valuable insights regarding chloride loading downstream of the WRPs.

Where appropriate, additional text was added to remind the reader that the RO scenarios are not as physically meaningful as some of the other scenarios because of the additional chloride loading that is simulated to the system.

Section: **Section Title**

Reviewer **S. Unger/C. Lai, GSWI TWG and Stakeholders – LARWQCB**

Subsection **Page(s)** **Comment Date** 2/21/2007

Comment Chloride concentration gradient along the river – The purpose of this study is to provide the chloride concentration gradient (i.e. dilution factor) between two Wastewater Reclamation Plants (WRPs), and downstream receiving water stations. However, the Task 2B-1 report provided only the time series of relative chloride concentration at several stations between the Valencia WRP and downstream stations, which can not clearly indicate the profile of the chloride concentration gradient along the upper Santa Clara River. It will be very helpful for the Regional Board staff if the relative chloride concentrations in surface water and groundwater are presented at every computational grid point in longitudinal profile along the river at least for 1977, 1991 and 2003 (three drought periods) for calibration simulation periods and for 2009 and 2023 for future scenario simulation periods.

Response The output control of GSWIM was not programmed to save results for every surface and subsurface computational grid point in longitudinal profile along the Santa Clara River, because of file management limitations. Rather, results for a subset of locations, including at key receiving water stations, were output and included in the Task 2B-1 report (see relative chloride concentration [C/Co] values, which are also dilution factors, presented on Figures 4-25, 4-26, and 4-27 [historical dilution factors] and Figures 5-32, 5-33, and 5-34 [model-derived future dilution factors]). The GSWIM output files for a single simulation already consume approximately 20 GBs of hard drive space with the current subset of output locations. Inclusion of additional output locations as suggested would be prohibitive, given that the simulations would need to be rerun and the amount of hard drive space would be enormous.

The GSWI Modeling Team can provide the Regional Board the data files used to create the C/Co figures in the Task 2B-1 report, so that interested parties could zoom in on periods of interest. The GSWI Modeling Team will contact the Regional Board directly to discuss options for addressing their data request outside of the Task 2B-1 reporting task.

Subsection Figure 4-23 **Page(s)** **Comment Date** 2/21/2008

Comment Dilution factor between the Valencia WRP and SCR-RD station – In Figure 4-23, the results of chloride concentration indicate the dilution factor is about 0.85 (180/210 and 170/200) at SCR-RD during the drought periods at 1991 and 2003. As shown in Figure 4-1b, the distance between SCR-RD station and the discharge point of the Valencia WRP is very close and no other loading is entering the river. It needs to be explained why the dilution of the discharge from the Valencia WRP changes so quickly (from 1.0 to 0.85) in a short distance under no other external dilution effects. In addition, it can be seen that no similar dilution factor occurs at SCR-RD for the future scenario simulations when compared with Figure 5-30. It is recommended that you explain why these two inconsistent situations occur.

Response Historical chloride concentration data for the Valencia WRP effluent and Santa Clara River at SCR-RD were provided by SCVSD. These measured data are independent of GSWIM results and indicate that the Valencia WRP effluent was diluted by 10 to 20 mg/L in 2003 by the time it reached SCR-RD (no measured chloride concentration data were available prior to 1995 at SCR-RD).

The SCR-RD receiving water station is located in a groundwater discharge reach of the Santa Clara River. Chloride concentrations at SCR-RD are less than those in the Valencia WRP effluent because of mixing with the more dilute baseflow prior to SCR-RD.

The inconsistency between resulting dilution factors between the Valencia WRP and SCR-RD, when comparing the historical and future simulation periods, is because of the differing land use and water use/reuse assumptions between the historical and future simulation periods.

Section: **Section Title**

Reviewer **S. Unger/C. Lai, GSWI TWG and Stakeholders – LARWQCB**

Subsection **Page(s)** **Comment Date** 2/21/2008

Comment Simulated chloride concentrations at Blue Cut – When compared with the Figures 5-30 and Figure 5-31, the simulated chloride concentrations at Blue Cut increased significantly for future scenario simulations during the drought periods of 2020 through 2025. However, the simulated chloride concentrations at Blue Cut and SCR-RE do not show a similar trend as the results shown in Figures 4-23 and Figure 4-24 for calibration simulation during drought periods of 1988 though 1993. It implies that there is additional loading entering the river between SCR-RE and Blue Cut during future scenario simulations. The contributions of the additional loading to simulated chloride concentrations at Blue Cut are 15%-20% for 1A & 1B series and 7% for 1F and 1G series, respectively, and there is no additional contribution downstream of Blue Cut. What are the sources of additional loading entering the river between SCR-RE and Blue Cut? And why does the additional loading only affect the Blue Cut station and does not affect upstream and downstream of Blue Cut during the drought periods of 2020 through 2025?

Response The sources of additional chloride loading to the Santa Clara River between SCR-RE and Blue Cut include tributary inflow (e.g., Castaic Creek and smaller downstream tributaries) and groundwater discharge (includes underflow from upstream areas and return flow of locally applied water). The evapoconcentration of chloride in the shallow groundwater system between SCR-RE and Blue Cut also increases chloride concentrations in the Santa Clara River with increasing downstream river distance.

Chloride concentrations during drought periods of the future simulation period are higher than those during the historical simulation period because of the assumed increase in water reuse and imported water over this future period, coupled with assumed changes in land use (i.e., urbanization in the East Subbasin).

A short distance downstream of Blue Cut, the Santa Clara River begins to leak water to the subsurface. Thus, the groundwater discharge component of flow and chloride loading is not present in the losing reaches of the Santa Clara River.

Subsection **Page(s)** **Comment Date** 2/21/2008

Comment Chloride concentrations between Blue Cut/SCR-RF and East Piru Basin/V0013 – The profiles of chloride concentrations between Blue Cut/SCR-RF and East Piru Basin/V0013 are not clearly indicated and presented in the report. The real profile of chloride concentration change in surface water and groundwater between Blue Cut and East Piru Basin would be helpful to identify the fate and transport of chloride due to changes in water quality with respect to the variability associated with groundwater and surface water interaction. It is recommended that the profile of chloride concentrations between Blue Cut/SCR-RF and East Piru Basin/V0013 be provided in the report. The extent of dry gap between surface water and groundwater should be identified through the model simulation results and be presented in the report as well.

Response As indicated in a previous response to Regional Board comments on the Draft Task 2B-1 report, the output control of GSWIM was not programmed to save results for every surface and subsurface computational grid point in longitudinal profile along the Santa Clara River, because of file management limitations. Inclusion of additional output locations would be required and the simulations would need to be rerun to create such profiles. Furthermore, available analytical data and modeling output indicate that chloride concentrations between Blue Cut and the Eastern Piru Subbasin fluctuate significantly in response to hydrology and upstream land use and water use/reuse. Thus, profiles of chloride concentrations could look substantially different depending on the selected periods. The chloride concentration animations that were provided to stakeholders during the development and application of GSWIM are useful in illustrating the variability in chloride concentrations in the groundwater and surface-water system as well as the transient extent of the Dry Gap in the Piru Subbasin. The GSWI Modeling Team will contact the Regional Board directly to discuss options for addressing their data request outside of the Task 2B-1 reporting task.

Subsection **Page(s)** **Comment Date** 2/21/2008

Comment Lower flow rate in the river – The simulated chloride concentrations are significantly affected by the lower flow in the river during drought periods. The calibration results indicated that the model under-predicted lower stream flows in intermittent streams, which over-predicted chloride concentrations in intermittent streams during drought periods. The lower flow rate in the river during drought periods should be indicated in the report. Thus, it is recommended that the daily mean stream flow shown in Figure 4-14 and Figure 4-15 should be enlarged so that the lower flow rate can be clearly seen in the figures as the lower flows are shown in Figure 5-25.

Response The y-axes on the middle row of daily streamflow plots on Figures 4-14 and 4-15 were changed from linear to log scale as suggested, so the difference between measured and simulated streamflow results can be more easily discerned over the full range of flow conditions.

Section: **Section Title**

Reviewer **S. Unger/C. Lai, GSWI TWG and Stakeholders – LARWQCB**

Subsection Figure 3-6 **Page(s)** **Comment Date** 2/21/2008

Comment In Figure 3-6, please mark the dimensional scale of schematic cross sections along AA' and BB'.

Response Figure 3-6 is not to scale and is intended to provide a schematic representation of GSWIM in profile view along two transects. Figure 3-1 highlights the locations of the cross section lines along Row 69 and Column 187 of GSWIM's grid. A note was added to Figure 3-6 indicating that the images are not to scale and that the vertical to horizontal scale is exaggerated.

Subsection Figure 4-20 and Figure 5-27 **Page(s)** **Comment Date** 2/21/2008

Comment The results of chloride concentrations at V-0031 shown in Figure 4-20 and Figure 5-27 need to be tuned to match the measured data. Alternatively, explain why the model parameters can not be adjusted to match the measured data.

Response Figure 5-27 shows results from simulations of future conditions; thus, no measured chloride concentration data are available.

We agree that improvements could be made to calibration at some locations; however, such improvements cannot be made under the current project schedule limitations. The calibration results at V-0031 shown on Figure 4-20 were discussed at the GSWI Modeling Subcommittee and TWG meetings held on February 19, 2008. The results shown are from the FWL5 (fracture well) package, which resembled results from Model Layer 5 at V-0031. However, the chloride concentrations that were simulated in Model Layer 4 at V-0031 more closely resemble the measured chloride concentrations. Thus, some of the difference (i.e., residual) between the simulated and measured chloride concentrations shown on Figure 4-20 for V-0031 could be a result of discretization inaccuracies. If the linkage between the FWL5 well element of V-0031 and Model Layer 4 was improved, then the residual might be lowered at this location.

Subsection Figure 4-25 and Figure 5-32 **Page(s)** **Comment Date** 2/21/2008

Comment In Figure 4-25 and Figure 5-32, please show the time series of relative chloride concentrations for SCR-RB, SCR-RD and NLF-NR1stations as well.

Response Relative chloride concentrations for SCR-RB, SCR-RD, and NLF-NR1 were included on Figures 4-25 and 5-32, as requested.

Subsection **Page(s)** **Comment Date** 2/21/2008

Comment The results of chloride concentrations for groundwater shown in Figure 4-16 through Figure 4-22 and Figure 5-26 through Figure 5-29 should indicate whether it is for the average of total layers or for a specific layer.

Response Additional text was added to Section 4.0 and 5.0 figures which indicates whether results were from the FWL5 (fracture well) package or individual model layers.

Subsection Figure 4-24 **Page(s)** **Comment Date** 2/21/2008

Comment The chloride concentrations near Fillmore Fish Hatchery increase significantly during 2025-2030 as compared the results shown in Figure 4-24; please explain why.

Response When comparing calibration (i.e., historical) results to results from the scenarios of future conditions, it is important to remember that only the diversion flows, groundwater pumping in the Piru Subbasin, hydrology (i.e., precipitation and ET), and chloride concentrations in Bouquet Reservoir, Castaic Lake, and Lake Piru are repeated from 1975 through 1998 for 2007 through 2030. It was assumed that urbanization in the East Subbasin will increase the demand for recycled water and imported water during the future simulation period. Modeling results suggest that these future water use/reuse changes coupled with changing land use patterns in the East Subbasin could lead to occasional increases in chloride concentrations at some downstream locations, as compared to chloride concentrations observed during the historical simulation period.

Subsection Figure 5-36 **Page(s)** **Comment Date** 2/21/2008

Comment The estimate of chloride concentrations in the Saugus and Valencia effluents for RO scenarios as shown in Figure 5-36 need explanation as to how it was estimated.

Response The end-of-pipe chloride concentrations in GSWIM under the RO scenarios were fixed at the desired concentrations of 100 and 120 mg/L for the a- and b-series scenarios, respectively.

Subsection Figure 5-37 **Page(s)** **Comment Date** 2/21/2008

Comment The figure title as shown in Figure 5-37 for SCR-RD and SCR-RE should read as "downstream of …"instead of "upstream of …."

Response The text was modified for SCR-RD to read "downstream of" instead of "upstream of". However, according to our mapping (see Figure 4-1b), SCR-RE is located upstream of the Castaic Creek confluence as stated.