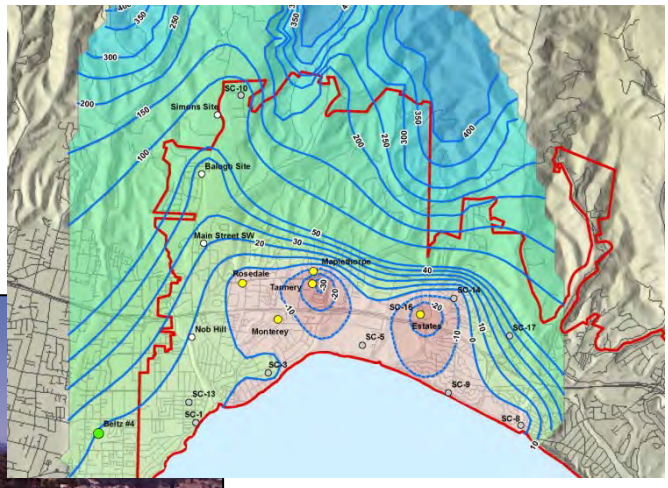
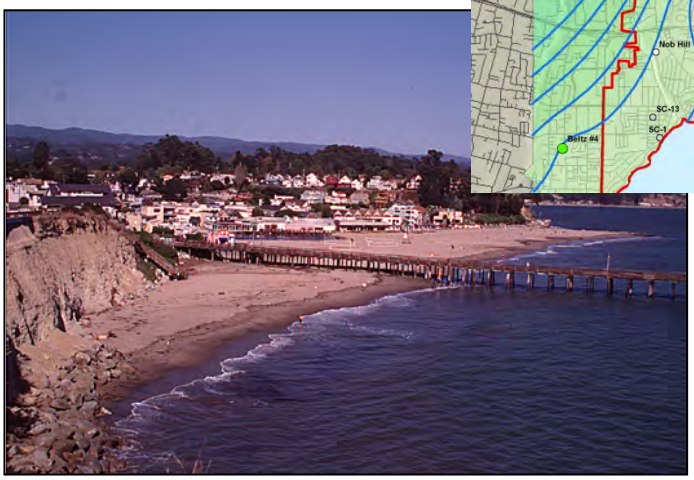
Soquel-Aptos Area Groundwater Management Annual Review and Report Water Year 2011

Prepared for:
Soquel Creek Water District
Central Water District

May 2012





Prepared by:

HydroMetrics WRI

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ABBREVIATIONS

AF ..... acre-feet
ARR .....Annual Review and Report
ASR.....aquifer storage and recovery
BAG .....Groundwater Management Plan Basin Advisory Group
BIG.....Basin Implementation Group
BMO .....basin management objective
CASGEM .....California Statewide Groundwater Elevation Monitoring
CDS .....Coastal Distribution System
CWD.....Central Water District
DWSAP.....Drinking Water Source Assessment and Protection
EIR .....environmental impact report
FTP .....file transfer protocol
GAMA .....Groundwater Ambient Monitoring and Assessment Program
GMP .....Groundwater Management Plan
gpd .....gallons per day
IRWMP .....Integrated Regional Water Management Plan
JPA.....Joint Exercise of Powers Agreement
MCL .....maximum contaminant level
mg/L .....milligrams per Liter
msl .....mean sea level
OEHHA .....California Office of Environmental Health Hazard Assessment
PDF .....portable document format
PHG.....public health goal
PRMS.....Precipitation-Runoff Modeling System
PVWMA .....Pajaro Valley Water Management Agency
RCD .....Resource Conservation District of Santa Cruz County
RWQCB .....Central Coast Regional Water Quality Control Board
SAGMA .....Soquel Aptos Groundwater Management Alliance
SCWD2 .....Santa Cruz Water Department/Soquel Creek Water District desalination project
SqCWD .....Soquel Creek Water District
SRP .....satellite reclamation plant
TMDL.....total maximum daily load
TDS.....total dissolved solids

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EXECUTIVE SUMMARY – WATER YEAR 2011

INTRODUCTION

This Annual Review and Report (ARR) is part of the implementation of the Groundwater Management Plan (GMP) for the Soquel-Aptos basin approved by Soquel Creek Water District (SqCWD) and Central Water District (CWD) in 2007 (SqCWD and CWD, 2007). The ARR summarizes groundwater conditions in the Soquel-Aptos basin, documents the status of groundwater management activities, and recommends any amendments to the GMP. The report will serve as a living document that has been updated annually starting with the Water Year 2009 report.

GROUNDWATER CONDITIONS

In Water Year 2011, precipitation in the Soquel-Aptos basin was above average for the second straight year. Although SqCWD did not declare a Precautionary Drought Curtailment as it did in Water Year 2009, municipal production in the Soquel-Aptos basin for Water Years 2010 and 2011 were the two lowest years of production since Water Year 1984 likely due to four factors:

1. Economic conditions that resulted in both residential and commercial vacancies or reduced use; and
2. Within SqCWD, completed water demand offsets for which the corresponding development had not yet been completed.
3. Higher precipitation and a cooler summer reduced demand for outdoor irrigation.
4. Heightened public awareness about the importance of sustained water conservation.

Recently estimated post-recovery pumping yields for SqCWD (HydroMetrics WRI, 2012) are a combined 800 acre-feet below pumping goals stated in the GMP. Municipal production in Water Years 2009-2011 has been below the combined post-recovery pumping yield of 3,375 acre-feet per year by SqCWD and the City of Santa Cruz in the Purisima area. Municipal production remains above the combined post-recovery pumping yield of 1,822 acre-feet per year by SqCWD and CWD in the Aromas area. However, pumping at post-recovery yields do not protect the basin from seawater intrusion until after groundwater levels recover to protective elevations.

Coastal groundwater levels in nine out of thirteen SqCWD and City of Santa Cruz monitoring wells screened in productive units remained below elevations that protect the aquifers from seawater intrusion (Figure ES- 1). The basin remains in overdraft and future pumping must be below the post-recovery pumping yield to recover coastal groundwater levels to protective elevations. The combined accumulated pumping deficit for the approximately thirty year period when SqCWD production was above post-recovery pumping yields was calculated as 21,600 acre-feet. Based on SqCWD's current planning goal to pump 2,900 acre-feet per year in order to recover the basin, the estimated time to eliminate the accumulated pumping deficit and recover the basin is 20 years.

In general, the groundwater level trend in these coastal wells in the western and central Purisima areas has been increasing over the last three to four years. The groundwater level trend in coastal wells in the Aromas area has generally been stable over the last three years after showing declines over the previous several years (Figure ES- 2).

Wells that may provide an indication of basin storage include wells located in upgradient areas of the basin or screened in overlying aquifers. Many of these wells showed a declining groundwater level trend over the last five years or greater, but the trend has been stable over the last two to three years.

There is ongoing risk of seawater intrusion into the productive units of the Soquel-Aptos basin due to coastal groundwater levels being below protective elevations. Observed Total Dissolved Solids (TDS) and chloride concentrations are used to assess seawater intrusion. The occurrence of seawater intrusion varies by area in the Soquel-Aptos basin:

- TDS and chloride concentrations do not suggest seawater intrusion at SqCWD's production wells or monitoring wells in the western Purisima area (A, AA, and Tu-units).
- TDS and chloride concentrations in two of the City of Santa Cruz's monitoring wells suggest seawater intrusion in the westernmost Purisima area (A-unit).
- TDS and chloride concentrations do not suggest seawater intrusion at SqCWD's production wells or monitoring wells in the central Purisima area (BC and DEF-units).
- TDS and chloride concentrations continue to be elevated in deep monitoring wells installed below the freshwater-saltwater interface in the Aromas area (Purisima F-unit and Aromas Red Sands).

- There is a long-term increasing trend in TDS and chloride concentrations at wells installed above the freshwater-saltwater interface in the Aromas area.

Naturally occurring constituents such as iron and manganese in the Purisima Formation and chromium VI in the Aromas Red Sands continue to have high concentrations in groundwater. High nitrate concentrations were detected at the Sells well which caused its removal from service in Water Year 2009. All delivered water met drinking water standards for constituents found in groundwater.

STATUS OF GROUNDWATER MANAGEMENT

The status of basin management objectives (BMO) is updated through Water Year 2011. The main basin management objective of concern is BMO 1-1, which addresses pumping within the sustainable yield. Overall municipal production exceeds the combined post-recovery pumping yield, even though annual municipal production for Water Years 2010 and 2011 were the lowest for records starting in Water Year 1984. Therefore, achieving BMO 1-1 may require fulfilling BMO 1-2 to develop alternative water supplies to achieve a long-term balance between recharge and withdrawals to meet current and future demand.

Achieving BMO 1-1 also affects the ability to achieve other basin management objectives, such as:

- BMO 1-3, Manage groundwater storage for future beneficial uses and drought reserve.
- BMO 2-2, Maintain groundwater levels to prevent seawater intrusion.

Basin management elements are specific projects, programs, and policies for meeting basin management objectives. The status of elements is also updated in this report.

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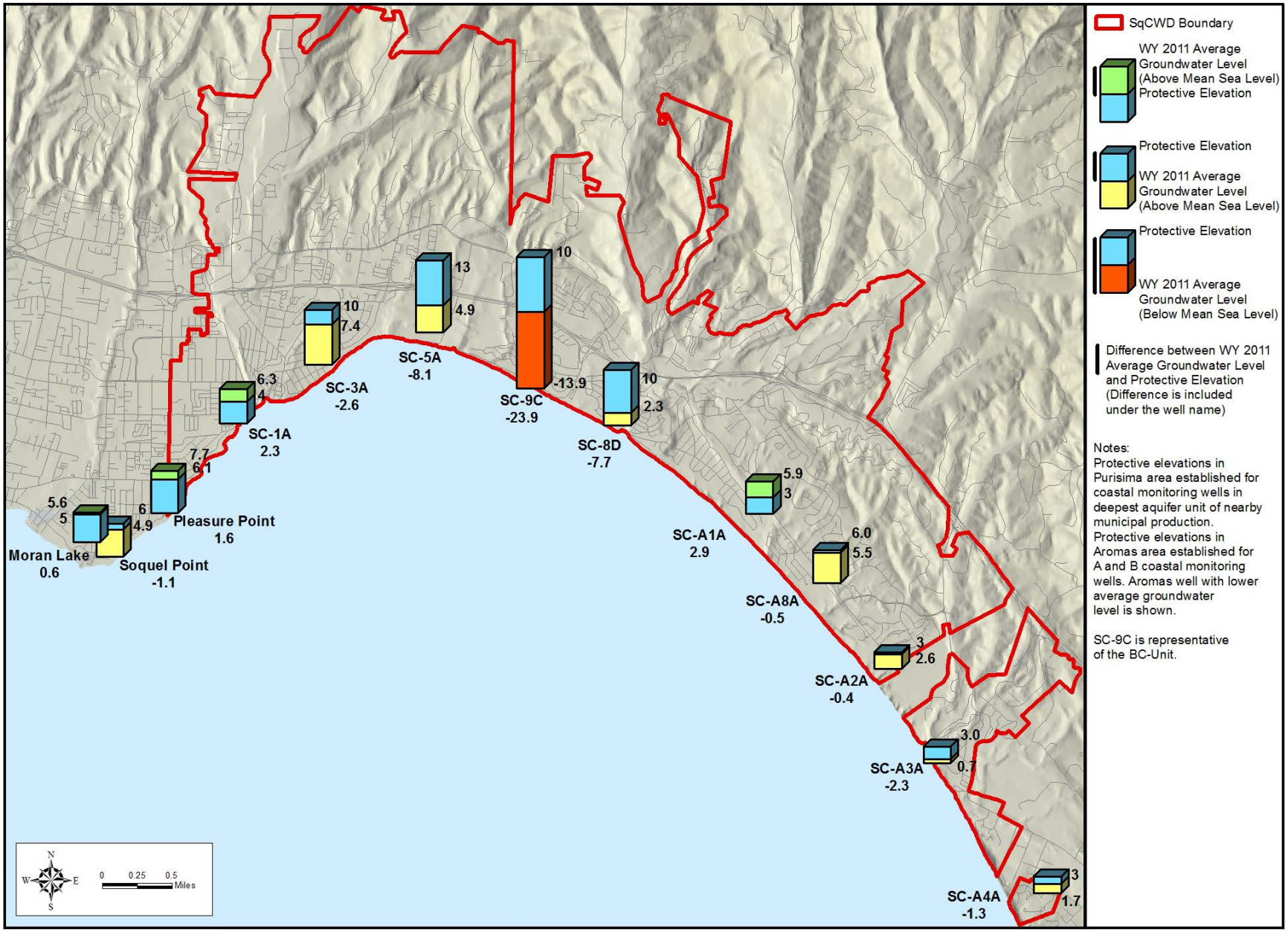

Figure ES- 1 (2011): Average Water Year 2011 Groundwater Levels at Coastal Monitoring Wells Relative to Protective Elevations

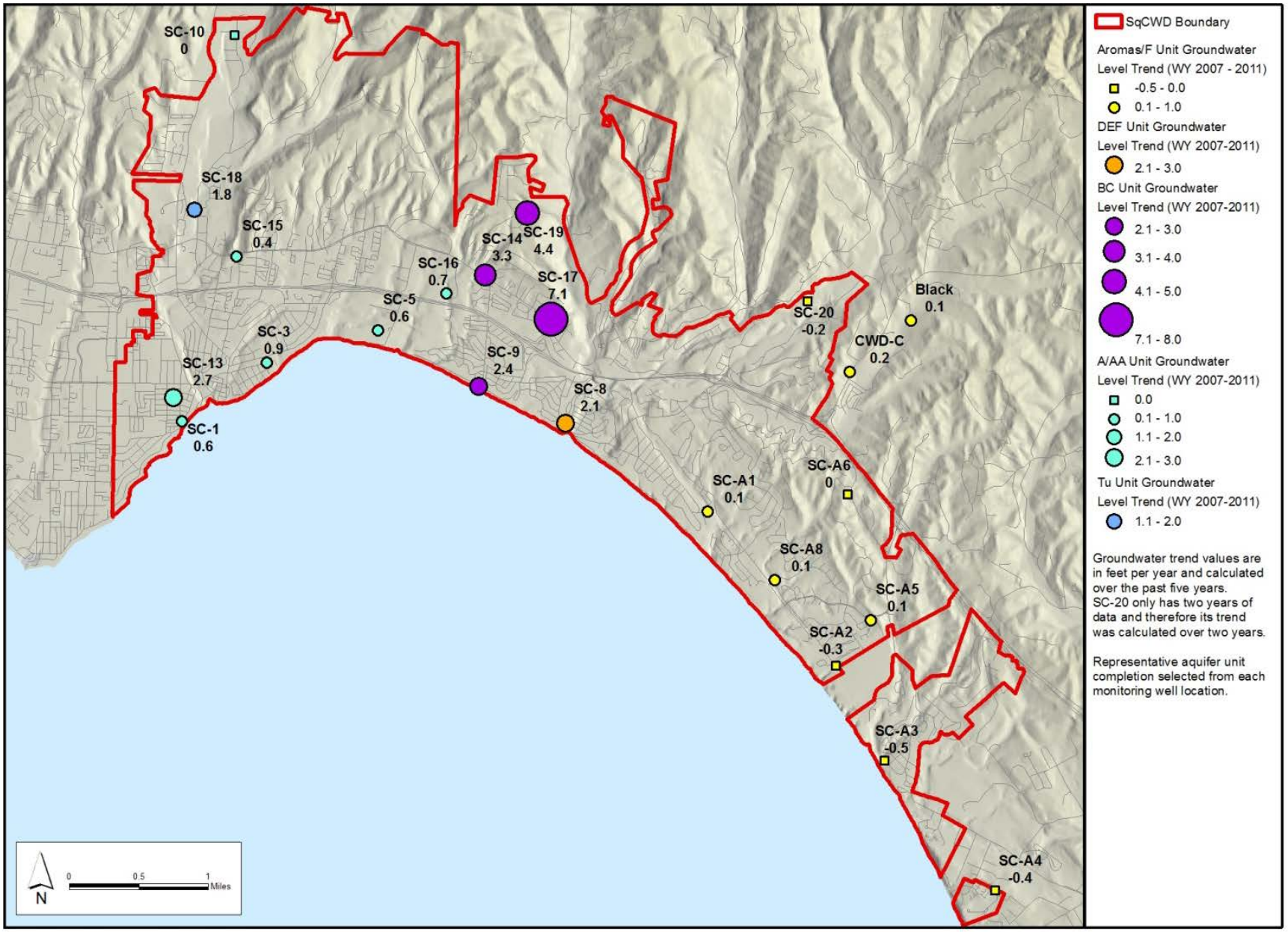

Figure ES- 2 (2011): Groundwater Level Trends Water Years 2007-2011 at Representative Monitoring Wells

SECTION 1
BACKGROUND AND SCOPE

Soquel Creek Water District (SqCWD) and Central Water District (CWD) approved a Groundwater Management Plan (GMP) in 2007 (SqCWD and CWD, 2007). Part of the GMP implementation requires preparation of an Annual Review and Report (ARR) following each water year. The ARR summarizes groundwater conditions in the Soquel-Aptos area, documents the status of groundwater management activities, and recommends amendments to the GMP. Under direction of the Soquel-Aptos area Basin Implementation Group (BIG), a new format for the report has been prepared starting with the Water Year 2009 ARR. The report will serve as a living document and be updated annually. This is the second annual update using the new format, covering Water Year 2011 (October 2010-September 2011).

1.1 LIVING DOCUMENT CONCEPT

The living document is contained in a three-ring binder and portable document format (PDF) electronic file that will be updated with new information on basin conditions each year. Summaries and maps of previous water years will remain in the binder and PDF file, with summaries and maps for the most recent water year successively added. The section reviewing the status of GMP implementation is similar to Section 3 of the Water Year 2008 report, but will be updated through the most recent water year. An executive summary of the entire water year will also be added to the front of the binder and PDF file each year. New map figures for the executive summary have been added for Water Year 2011 and map figures for subsequent years will be added each year.

1.2 DOCUMENT ORGANIZATION

Sections 2-5 update basin conditions for the water year. Since each year new Sections 2-5 discussing the latest water year are inserted to the binder and PDF, the sections are labeled with the subject water year. Some figures and tables illustrating basin conditions or current basin understanding, such as multi-year graphs, are replaced when they are updated. Other figures and tables, such as snapshot contour maps, are added when updated and their figure and table numbers labeled with the subject water year.

Section 2 describes conditions for the subject water year such as precipitation and overall pumping that affect the entire basin. The updated Section 2 is inserted in front of the previous Section 2. Multi-year graphs of precipitation and pumping are replaced each year.

Sections 3-5 describe conditions for three different portions of the Soquel-Aptos area. Section 3 discusses the western portion of the Soquel-Aptos area, where the productive aquifer units are the Purisima A and AA-units and the sub-Purisima Tu-unit. Section 4 discusses the central portion of the Soquel-Aptos area, where the productive aquifer units are the Purisima BC and DEF-units. Section 5 discusses the eastern portion of the Soquel-Aptos area, where the productive aquifer units are the Purisima F-unit and Aromas Red Sands aquifer. The above productive aquifer units are defined by the basin hydrostratigraphy outlined in Johnson et al. (2004). The deep to shallow sequence of productive aquifer units in the Purisima Formation is AA, A, BC, DEF, to F. The Aromas Red Sands overlies the Purisima F-unit.

Each of Sections 3-5 is organized as follows:

- A description of pumping for the relevant SqCWD service areas and CWD or City of Santa Cruz is summarized and inserted.
- A multi-year graph of the water agencies' pumping for the area is replaced. The estimates of non-agency pumping will also be replaced if there is new information.
- A summary of the overall groundwater condition and groundwater level trends for the water year is inserted.
- SqCWD has established and updated protective groundwater elevations in coastal monitoring wells to protect the basin from seawater intrusion over the long term (HydroMetrics LLC, 2009b and HydroMetrics WRI, 2012). The City of Santa Cruz has also proposed protective groundwater elevations for its coastal monitoring wells. A table comparing coastal groundwater levels in the water year versus protective elevations for the aquifer group is inserted.
- A map showing representative groundwater elevation contours for the spring and fall of the reported water year is inserted. The groundwater elevation contour maps from the water year 2007 report are also included as a baseline.
- A summary of the overall condition and trends of water quality for the water year is inserted.

- The section will include a discussion of any specific issues that arise for the reported water year.
- Hydrographs and chemographs will be replaced.

The current procedure is to update all items (summaries, tables, multi-year graphs, and contour maps) in Sections 2-5 each year. However, the BIG may decide that not all items require an update every year. The BIG may also decide that additional items should be added in subsequent years.

Section 6 discusses the updated status of GMP Basin Management Objectives and Basin Management Elements (projects, programs, or policies). This section will be replaced each year, but completion of any objectives or elements in previous years will remain in the description in order to keep an ongoing record of activities.

Section 7 discusses current GMP action priorities, data gaps, and recommendations.

Table 1-1 provides a summary of whether updated items in each report will be inserted or replaced in the binder and PDF.

Table 1-1: Summary of Items to Add or Replace for Each Annual Report

Report Item	**Insert or Replace in Report**
Executive Summary	
Text	Insert
Summary Maps	Insert
Section 1 - Background and Scope	Replace
Section 2 - Basinwide Conditions	
Text	Insert
Precipitation and pumping charts	Replace
Pumping tables	Replace
Section 3 - 5 - Aquifer Conditions	
Text	Insert
Summary tables	Insert
Pumping charts	Replace
Contour maps	Insert
Hydrographs	Replace
Chemographs	Replace
Section 6 - GMP Implementation Status	Replace
Section 7 - Recommendations	Insert

SECTION 2 – WATER YEAR 2011
BASINWIDE CONDITIONS IN THE SOQUEL-APTOS GROUNDWATER MANAGEMENT AREA

This section presents conditions in the Soquel-Aptos area for Water Year 2011 that affect the entire groundwater basin.

2.1 ANNUAL PRECIPITATION

SqCWD collects rainfall data from two gauges in the Soquel-Aptos area: the Mancarti gauge on Laurel Road and the Kraeger gauge on Longridge Road. Data loggers record rainfall at these gauges at 15-minute intervals. Precipitation at the Mancarti and Kraeger gauges during Water Year 2011 was 45.54 and 44.88 inches respectively. These rainfall totals were above the average (mean) values of 37.1 inches at the Mancarti gauge and 37.8 inches at the Kraeger gauge measured between Water Year 1984 and Water Year 2011.

Annual rainfall totals by Water Year for both gauges are presented on Figure 2-1. Water Year 2011 was the second consecutive year with above average and median rainfall at these gauges. Water Year 2011 ranks as the 8th and 9th wettest year in the 28 year record for the Mancarti and Kraeger gauges, respectively.

Figure 2-1 also shows rainfall totals for the NOAA Cooperative station in Santa Cruz (station number 047916). Rainfall in Water Year 2011 at this station was 40.06 inches, which was above the average value of 30.6 inches between Water Year 1984 and Water Year 2011. Water Year 2011 ranks as the 15th wettest year in the 70 year record for this station

Four of the last eleven water years have had above average rainfall. Water Year 1998 was the last year with rainfall above 60 inches per year. Results from the Soquel-Aptos Precipitation-Runoff Modeling System (PRMS) study (HydroMetrics WRI, 2011a) show that from 2001 through 2009 (which was the end of the modeled period), the average groundwater recharge was approximately 8,200 acre-feet per year, while the overall average for the calibrated period (1984 through 2009) was 10,800 acre-feet per year. The two years of above average precipitation was when the majority of the basin's recharge occurs, and those years were not wet enough to bring the average for the period up to the overall annual average recharge.

A relationship between rainfall and deep recharge has been derived from the calibrated PRMS simulation of Water Years 1984-2009 based on a best fit of rainfall and simulated deep recharge. The best fit quadratic equation for deep recharge based on rainfall at the Santa Cruz Cooperative station over the full water year is Deep Recharge = 15.855 x Rainfall^2 – 171.51 x Rainfall (Tana and King, 2012). Based on this relationship, the estimate for deep recharge in Water Year 2011 is 18,600 acre-feet, or 70% higher than the average simulated for the calibration period of Water Years 1984-2009 (HydroMetrics WRI, 2011a).

2.2 ANNUAL PRODUCTION

Total municipal production for the Soquel-Aptos area in Water Year 2011 was 5,150 acre-feet (AF), the second lowest annual total since Water Year 1984. Only Water Year 2010 had less municipal production. Annual production by water year for SqCWD, CWD, and the City of Santa Cruz is shown on Figure 2-2.

CWD and SqCWD pumped less in Water Year 2011 than the previous year. CWD production of 483 acre-feet was the lowest annual total since Water Year 1995. SqCWD pumping of 4,030 acre-feet was the lowest annual total since 1978 (Johnson et al., 2004). No drought curtailment or additional conservation effort took place in Water Year 2011 so it appears that economic conditions, weather, and conservation were likely factors in the reduced demand. The economic conditions resulted in both residential and commercial vacancies. Secondly, reduced demand within the SqCWD service area may have resulted from completed water demand offsets for which the corresponding development had not been completed. Thirdly, weather conditions reduced outdoor irrigation demand as precipitation was higher and the summer temperatures were cooler than Water Years 2007-2009. Lastly, public awareness about the importance of sustained water conservation has been heightened in recent years due in part to ongoing outreach and education programs by the local water agencies.

City of Santa Cruz Water Year 2011 production of 637 acre-feet was the largest annual water year production for the City since Water Year 1994. However, the City's pumping over its pumping season is better represented by the calendar year total production. The City's pumping during calendar year 2011 was 531 acre-feet, which is similar to the City's planned future maximum groundwater production during non-critically dry years of 525 acre-feet per year (Chambers Group, 2011).

Starting in Water Year 2005, SqCWD has not pumped more than 2% above its GMP pumping goal of 4,800 acre-feet per year. This goal has been met after averaging

5,375 acre-feet of pumping per year between Water Years 1987 and 2004. Available records starting in Water Year 1974 show that CWD has never pumped more than 1% above its sustainable yield share of 622 acre-feet per year that is implied in the GMP. From Water Year 1995 through 2010, City of Santa Cruz had not pumped more than 3% above its sustainable yield share of 575 acre-feet per year that is assumed in the GMP.

In early 2012, SqCWD updated its estimates for its post-recovery pumping yields, which are meant to protect the Aromas and Purisima areas from seawater intrusion after groundwater levels recover to protective elevations. The post-recovery pumping yields are based on modeled offshore flows required to protect against seawater intrusion; along with estimated recharge, non-District consumptive use, and District consumptive use factors (HydroMetrics WRI, 2012). SqCWD pumping for the Purisima area has ranged from 2,582 to 2,651 acre-feet per year the last three years, which is less than the estimated post-recovery pumping yield of 2,800 acre-feet per year for the Purisima area. Although SqCWD pumping in the Aromas area in Water Year 2011 of 1,396 acre-feet per year was the lowest annual total since 1982 (Johnson et al., 2004), this amount is still above the post-recovery pumping yield of 1,200 acre-feet per year for the Aromas area. Total SqCWD production in Water Year 2011 was nearly reduced to the combined post-recovery pumping yield of 4,000 acre-feet per year. However, to recover groundwater levels to protective elevations, pumping must be reduced below post-recovery pumping yields. SqCWD's current planning goal for allowing groundwater elevations to recover is to limit pumping to 2,900 acre-feet per year with an estimated recovery time frame of 20 years (HydroMetrics WRI, 2012).

Estimated production by private wells and small water systems, including residential, commercial, and agricultural supply, are also shown on Figure 2-2. Estimated private well production of approximately 2,236 acre-feet per year in the Purisima area and 954 acre-feet per year in the Aromas area have not been updated since Johnson et al. (2004) expanded on estimates developed by Faler (1992) and Wolcott (1999). The exceptions are more recent pumping information provided by the Santa Cruz County Parks Department and Cabrillo College. The Parks Department provided estimates of Polo Grounds park irrigation well pumping (Branham, 2007) and Cabrillo College provided pumping records for calendar year 2009 (Cabrillo College, 2010). Cabrillo College pumping for that year was one-third of the estimate provided by Wolcott (285 acre-feet per year). Figure 2-3 shows the study areas for the Purisima and Aromas used for these estimates presented in Johnson et al. (2004) and how they relate to the Soquel-Aptos groundwater management area. Table 2-1 summarizes water use estimates for the Purisima area. Table 2-2 summarizes water use estimates for the Aromas area.

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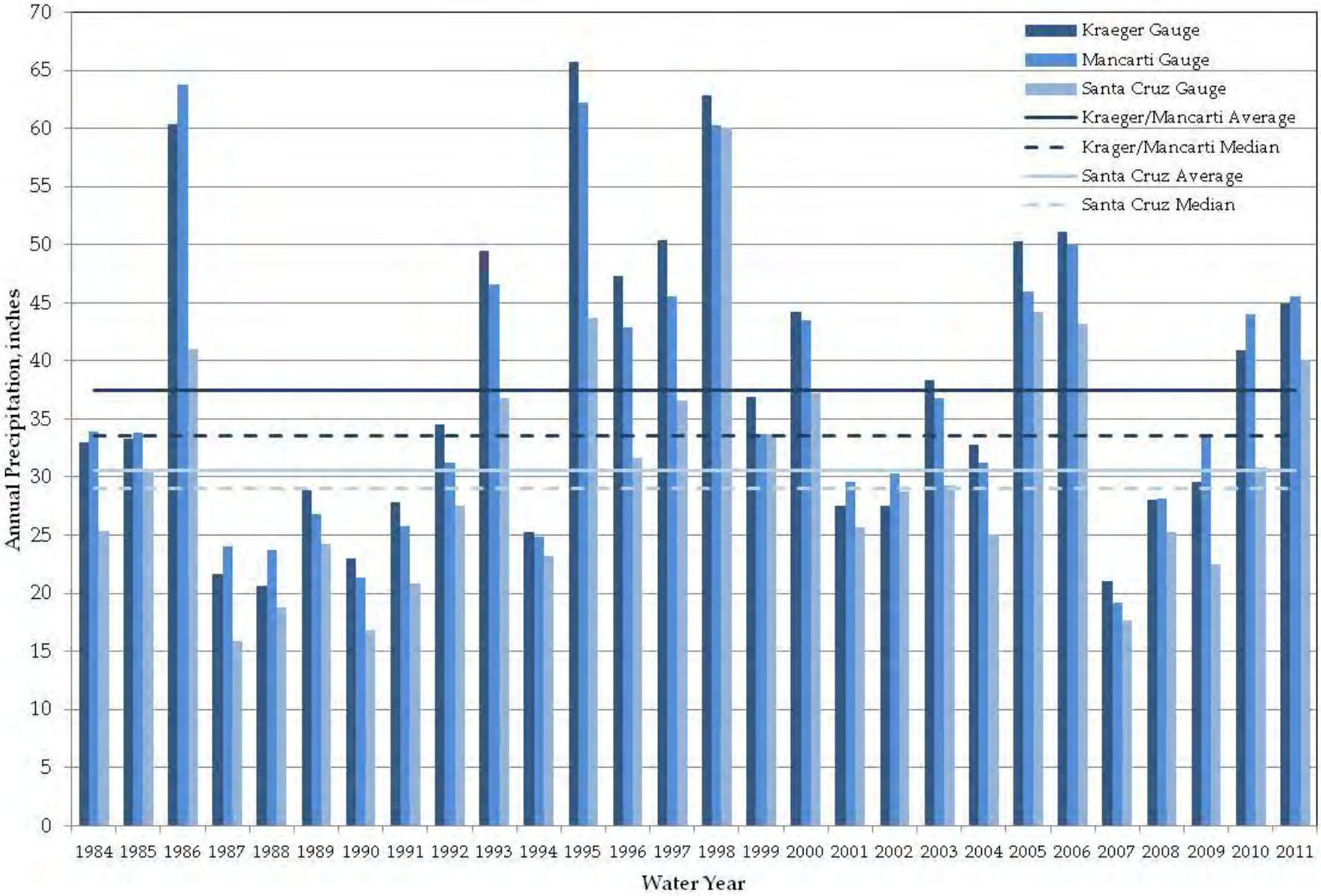

Figure 2-1: Precipitation at Kraeger and Mancarti Gauge

Figure 2-2: Pumping by Water Year in Acre-Feet

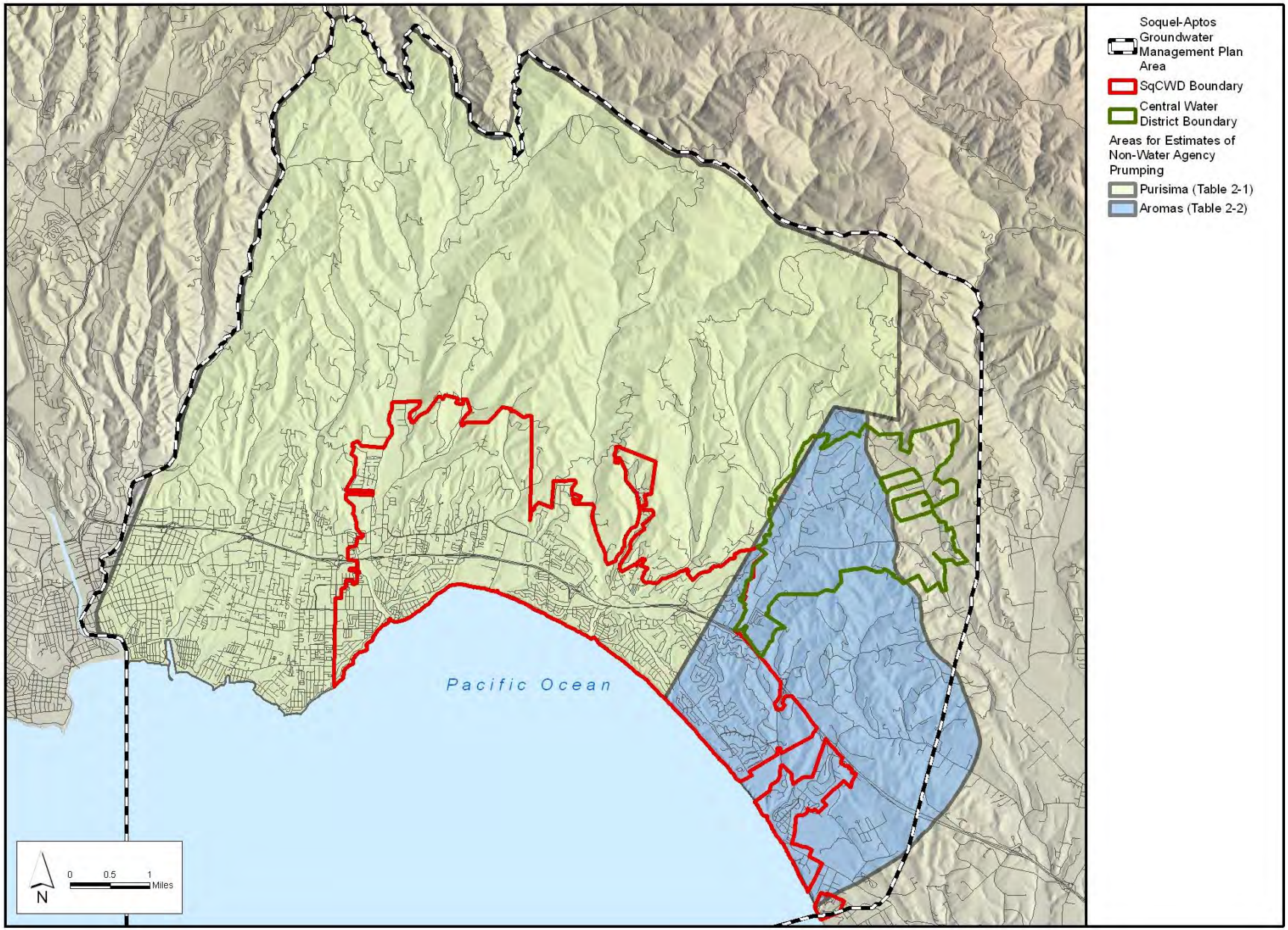

Figure 2-3: Study Area for Estimating Non-Agency Pumping

Table 2-1: Estimates of Non-Water Agency Pumping in the Purisima Area.

	User	Estimated Water Use (AF/year)	Source	Comments
Private Urban	Residential and Commercial	124	Wolcott, 1999	may include stream diversions
	Agriculture	93		
	Seascape Golf Course	232		
Private Rural	Residential and Commercial	1,099	Wolcott, 1999	
	Agriculture	163		
Small Water Systems	Cabrillo College	95	Cabrillo College, 2010	Calendar Year 2009
	Other Urban	29		
	Rural	211		
Total Purisima Area		**2,046**		

Table 2-2: Previous Estimates of Non-Water Agency Pumping in the Aromas Area.

	User	Estimated Water Use (AF/year)	Source	Comments
	Polo Grounds Park	30	Branham, 2007	
Private Rural	Residential and Commercial	557	Johnson et al., 2004	Parcel count and areas from Faler and water use factors from Wolcott
	Agriculture	309		
Small Water Systems	Rural	58	Johnson et al., 2004	Number of connections from Faler and water use factors from Wolcott
Total Aromas Area		**954**		

SECTION 3 - WATER YEAR 2011 AQUIFER CONDITIONS FOR WESTERN PURISIMA AREA (A/AA/TU-UNITS)

This section presents groundwater level and water quality conditions for Water Year 2011 in the western portion of the Soquel-Aptos area where the primary production aquifers are the Purisima A-unit, the Purisima AA-unit, and the sub-Purisima Tu-unit.

3.1 SqCWD Service Area I and City of Santa Cruz Annual Production

In the western portion of the Soquel-Aptos area, groundwater is produced for municipal purposes by SqCWD in its Service Area I and the City of Santa Cruz from its Live Oak well field. SqCWD's Estates well in Service Area II to the east is also partially completed in the A-unit.

SqCWD's Service Area I production was 1,833 acre-feet in Water Year 2011, the third lowest annual amount since service area data have been recorded starting in 1984. The only two years with lower production in Service Area 1 are Water Years 2009 and 2010. Production in Service Area I over the last seven years has been below the historical average. Water Year 2011 pumping in Service Area I was approximately 65% of the SqCWD's revised estimate of its post-recovery pumping yield for the Purisima area (HydroMetrics WRI, 2012). Water Year 2011 production at the Estates well in Service Area II was 326 acre-feet, slightly higher than the 300-307 acre-feet produced in Water Years 2009 and 2010. Production at the Estates well in each of the last three years was lower than all years since 1991.

The City of Santa Cruz's production from the Live Oak well field was 637 acre-feet in Water Year 2011, which is the largest annual water year production for the City since Water Year 1994. However, the City's pumping season spans two water years as the pumping season typically extends from April-May to November-December. The City pumped 136 acre-feet from October-December 2010. The City's pumping in calendar year 2011 was 531 acre-feet, which is similar to the City's planned future maximum groundwater production during non-critically dry years of 525 acre-feet per year (Chambers

Group, 2011). The planned pumping of 525 acre-feet per year is based on average annual production by the City since 1984.

The City of Santa Cruz's groundwater production depends on availability of its surface water supply resulting in larger annual variation in groundwater production than SqCWD. For calendar years 2008 to 2011, City production ranged from 473 to 548 acre-feet per year with an average of 514 acre-feet per year.

Figure 3-1 shows production at SqCWD wells in Service Area I, the Estates well, and the City's Live Oak well field by water year.

3.2 GROUNDWATER LEVEL CONDITIONS AND TRENDS

SqCWD has established protective groundwater elevations in coastal monitoring wells to protect the Purisima A-unit in the western portion of the Soquel-Aptos area from seawater intrusion. Cross-sectional models were used to estimate groundwater elevations that result in the long term freshwater-salt water interface in the Purisima A-unit being seaward of the coast (HydroMetrics LLC, 2009b).

In Water Year 2011, average coastal groundwater levels in two of the three SqCWD A-unit monitoring wells remained below protective elevations, as shown in Table 3-1. Average groundwater levels at SC-1A were above the protective elevation in the Water Year 2011 for the first year since Water Year 1999. Pumping at the nearby Garnet well has been decreased steadily since 2004 and the amount pumped in Water Year 2011 was the lowest amount since Water Year 1997 (Figure 3-1). Although maximum groundwater levels exceed protective elevations at SC-3A, average groundwater levels must meet protective elevations to protect against seawater intrusion. Hydrographs for these wells follow at the end of this section. The hydrographs show that average groundwater levels have been below protective elevations for the entire period of record at SC-3A and SC-5A.

Table 3-1 (2011): Comparison of Water Year 2011 Coastal Groundwater Levels with Protective Levels in Western Purisima Area

Unit A Well	Location	Minimum Groundwater Elevation (feet msl)[1]	Maximum Groundwater Elevation (feet msl)	Average Groundwater Elevation (feet msl)	Protective Elevation (feet msl)
SC-1A	Prospect	3.9	7.4	6.3	4
SC-3A	Escalona	3.7	10.5	7.4	10
SC-5A	New Brighton	-0.31	8.7	4.9	13
Moran Lake Medium		4.9	6.0	5.6	5.0[2]
Soquel Point Medium		3.7	5.8	4.9	6.0[2]
Pleasure Point Medium		5.7	8.9	7.7	6.1[2]

[1] msl = mean sea level

[2] Proposed by City of Santa Cruz (Almond, 2012)

The City of Santa Cruz has proposed annual averages of 5.0-6.1 feet msl as protective groundwater elevations for its coastal monitoring wells at Pleasure Point, Soquel Point, and Moran Lake during non-critically dry years. For critically dry years, the City has proposed minimum quarterly averages of 2 feet msl as protective groundwater elevations for its three coastal monitoring wells (Almond, 2012). The City defines critically dry years as years with less than 29,000 acre-feet runoff at the Felton gauge on the San Lorenzo River (City of Santa Cruz, 2009). The hydrographs for these wells identify when water years were classified as critically dry and the protective groundwater elevation would have been the minimum quarterly average of 2 feet msl.

Water Year 2011 was not critically dry; and the protective elevations for the City of Santa Cruz coastal monitoring wells were 5.0-6.1 feet msl. As shown on Table 3-1, the average groundwater level in the Soquel Point well was below the City's protective elevation, while the average groundwater levels in the Moran Lake and Pleasure Point wells were above the City's protective elevation in Water Year 2011. Average groundwater levels in the Pleasure Point well have been above the protective elevation the last two years, which has coincided with combined Beltz #7 and #8 pumping being between 211 and 287 acre-feet the last two years after being between 383 and 411 acre-feet the previous three years. Groundwater levels from the Medium completion of these well clusters are used because it is the deepest completion in the A unit, which is the primary aquifer supplying the

Live Oak well field, and it has lower groundwater levels than the Deep completion in the AA unit.

The groundwater levels in Table 3-1 are based on monthly measurements at the wells and do not reflect tidal variations. Loggers have been installed in the SqCWD wells to monitor the tidal variation as shown in the hydrographs at the end of this section. Logger measurements from well SC-1A from 2007 and 2008 show a tidal range of approximately 5 feet. With a tidal range of this magnitude, average groundwater elevation based on monthly measurements may not be adequate for comparison with the protective elevation because the monthly measurements are dependent on measurement time and do not represent a tidal average. Monthly measurements at SC-1A for 2007 and 2008 underestimated average groundwater levels when compared to the full tidal range. Although there is some tidal variation at SC-3A and SC-5A, the hydrographs show that the monthly measurements are representative of the time series.

Groundwater levels show increasing trends since Water Year 2008 in SqCWD's coastal monitoring wells completed in the productive A-unit. The increasing trends are likely due to reduced pumping at nearby SqCWD production wells (Figure 3-1). However, groundwater level rises at SC-3A and SC-5A leveled off in Water Year 2011 with increases in pumping at the Rosedale and Estates wells over the previous years.

Groundwater levels at the City of Santa Cruz's coastal monitoring wells completed in the A and AA-units show different recent trends depending on location. Groundwater levels at the Pleasure Point wells have increased over the last two years, coinciding with decreased pumping at Beltz #8 and #10. Groundwater levels at the Soquel Point and Moran Lake wells in Water Year 2011 were near minimums measured at the wells since the wells were installed in 2004.

Groundwater levels show declining trends since Water Year 1998 in coastal monitoring wells completed in the unconfined B and BC-units. Rainfall was higher in 1998 than in any of the subsequent eleven years. This trend therefore is consistent with a correlation between declining basin storage and reduced precipitation. Groundwater levels in the B and BC units during Water Years 2010 and 2011 show slight increases, which coincides with higher rainfall over these two years, compared to the longer-term declining trend.

Multi-year declines of at least six years have been observed in wells completed in the AA and Tu-units upgradient of the municipal production wells. However, groundwater levels over the last three water years (2009 to 2011) have been relatively stable at the Thurber Lane Deep well and have shown slight increases over the last two water years (2010 to 2011) at SC-10AA.

Monitoring wells at three locations inland of the Live Oak well field were installed in 2009. These wells at Coffee Lane Park, Cory Street, and Auto Plaza Drive screened in the A and AA units show rising groundwater levels over the last two years.

Table 3-2 summarizes the important groundwater level trends by monitoring well. Hydrographs for multiple completions of these wells follow at the end of this section. Hydrographs for multiple completions of monitoring wells adjacent to production wells are also included following this section.

Hydrographs for single wells including production wells are included with chemographs. These hydrographs show trend lines and rates of change for Water Years 2007-2011 when municipal production for the Western Purisima has been decreasing and been below historical averages.

Contour maps of groundwater elevations in Spring and Fall 2011 for the Purisima A-unit are shown in Figure 3-2 and Figure 3-3. Figure 3-2 shows that spring coastal groundwater levels in the A-unit were lower than protective elevations in much of the western Purisima area and Figure 3-3 shows even lower coastal groundwater levels in the fall. Figure 3-3 shows Fall 2011 pumping depressions below sea level included the Main Street well in the western portion of the A-unit and the Estates well in the eastern portion of the A-unit, and included a portion of the coast. The area of pumping depressions below sea level was smaller than Fall 2010.

Table 3-2 (2011): Summary of Groundwater Level Trends in Western Purisima Area

Category	Well	Groundwater Level Trend Description	Notes
SqCWD Coastal Monitoring A-unit Wells	SC-1A	Rise of 3 feet from WY 2009 to WY 2011	Reduced pumping at Garnet
	SC-3A	Decline of 1.5 feet from WY 2010 to WY 2011	Increased pumping at Rosedale in WY 2011
	SC-5A	Rise of 4.5 feet from WY 2008 to WY 2011	Reduced pumping at Estates in WY 2009-2011
City of Santa Cruz Coastal A and AA-unit Wells	Moran Lake Soquel Point	Decline in WY 2011	Increased pumping at Beltz #9 in WY 2011
	Pleasure Point	Rise in WY 2010 and 2011	Reduced pumping at Beltz #7 and #8
SqCWD Coastal Monitoring B and BC-unit Wells	SC-1B SC-3C	Decline of 5-10 feet in overlying unit since WY 1998	Decreased precipitation since WY 1998
		Slight rise WY 2010-2011	Higher precipitation compared to WY 2007-2009
Inland A and AA unit wells	Coffee Lane Park Cory Street Auto Plaza Drive	Rise over WY 2010-2011	None
Inland AA and Tu-unit Wells	SC-10AA	Decline of 5-10 feet in inland AA-unit since WY 2002; Slight rise WY 2010-2011	None
	Thurber Lane Deep	Decline of 50 feet in inland Tu-unit since WY 2005; Stable WY 2009-2011	None

3.3 WATER QUALITY CONDITIONS AND TRENDS

The most significant groundwater quality threat in the Soquel-Aptos basin is seawater intrusion. As discussed above, average groundwater levels generally remain below protective elevations in the A-unit. As a result, there is ongoing risk of seawater intrusion into the productive units of the western Purisima area.

Observed Total Dissolved Solids (TDS) and chloride concentrations in production wells do not suggest any seawater intrusion impacting SqCWD's production wells in the Purisima A and AA-units and sub-Purisima Tu-unit. Observed TDS and chloride concentrations in SqCWD's monitoring wells also do not indicate incipient seawater intrusion. The maximum contaminant limit (MCL) for chlorides is 250 mg/L and recent chloride concentrations in both production and monitoring wells have been below 100 mg/L or less except for a one-time measurement at SC-3RA in April 2010 (wells replacing SC-3 wells at Escalona in 2009 were labeled SC-3R). Chemographs for SqCWD wells in the area are included at the end of this section.

TDS and chloride concentrations at two City of Santa Cruz monitoring wells near the coast suggest seawater intrusion. Chloride concentrations in the Medium completion (A-unit) of the Moran Lake well cluster has been above 300 mg/L since measurements began in 2004, although concentrations have been decreasing since that time. Chloride concentrations in the Medium completion (A-unit) of the Soquel Point well cluster have remained relatively stable above 1,100 mg/L starting in 2005. Chloride concentrations in the Deep completion (AA-unit) of the Soquel Point well cluster have shown an increasing trend from 67 mg/L to above 120 mg/L since 2004.

Groundwater pumped from the Purisima formation continues to be treated for iron and manganese to meet drinking water standards. In Water Year 2011, color and turbidity were also reduced during treatment to meet drinking water standards.

3.4 STATE OF THE AQUIFER SUMMARY

Seawater intrusion has not been detected in most of the Western Purisima area. However, the productive Purisima A and AA-units remain at risk for seawater intrusion as coastal groundwater levels remain below protective elevations. Despite relatively low overall production, changes in pumping distribution resulted in groundwater levels in the Purisima A and AA-units showing less recovery in Water Year 2011 than the previous year. A longer period of low production will be required to recover the basin to be protected against the risk for seawater intrusion.

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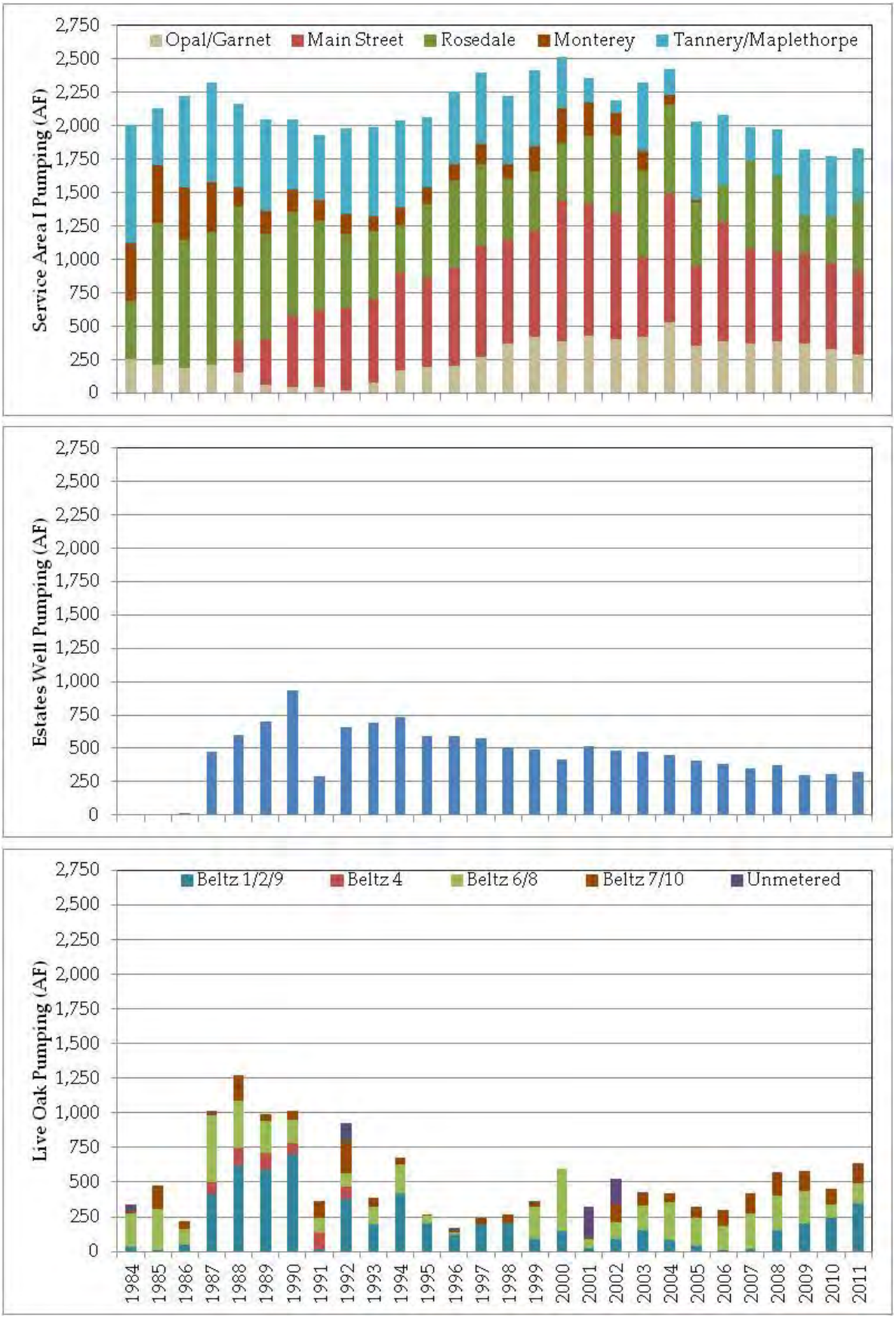


Figure 3-1: Pumping by Water Year in Western Purisima Area

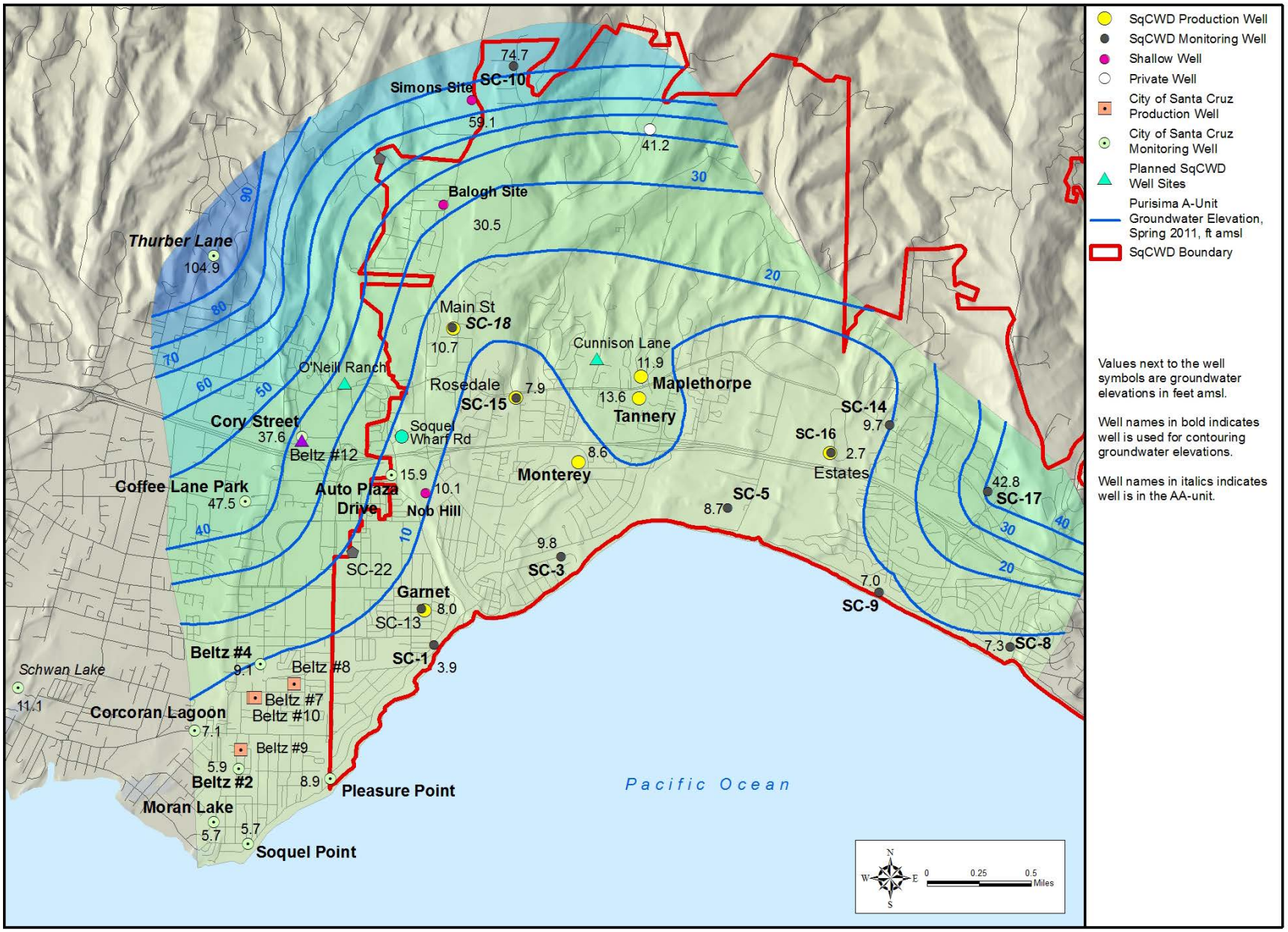


Figure 3-2 (2011): Groundwater Elevation Contours, Purisima A-Unit, Spring 2011

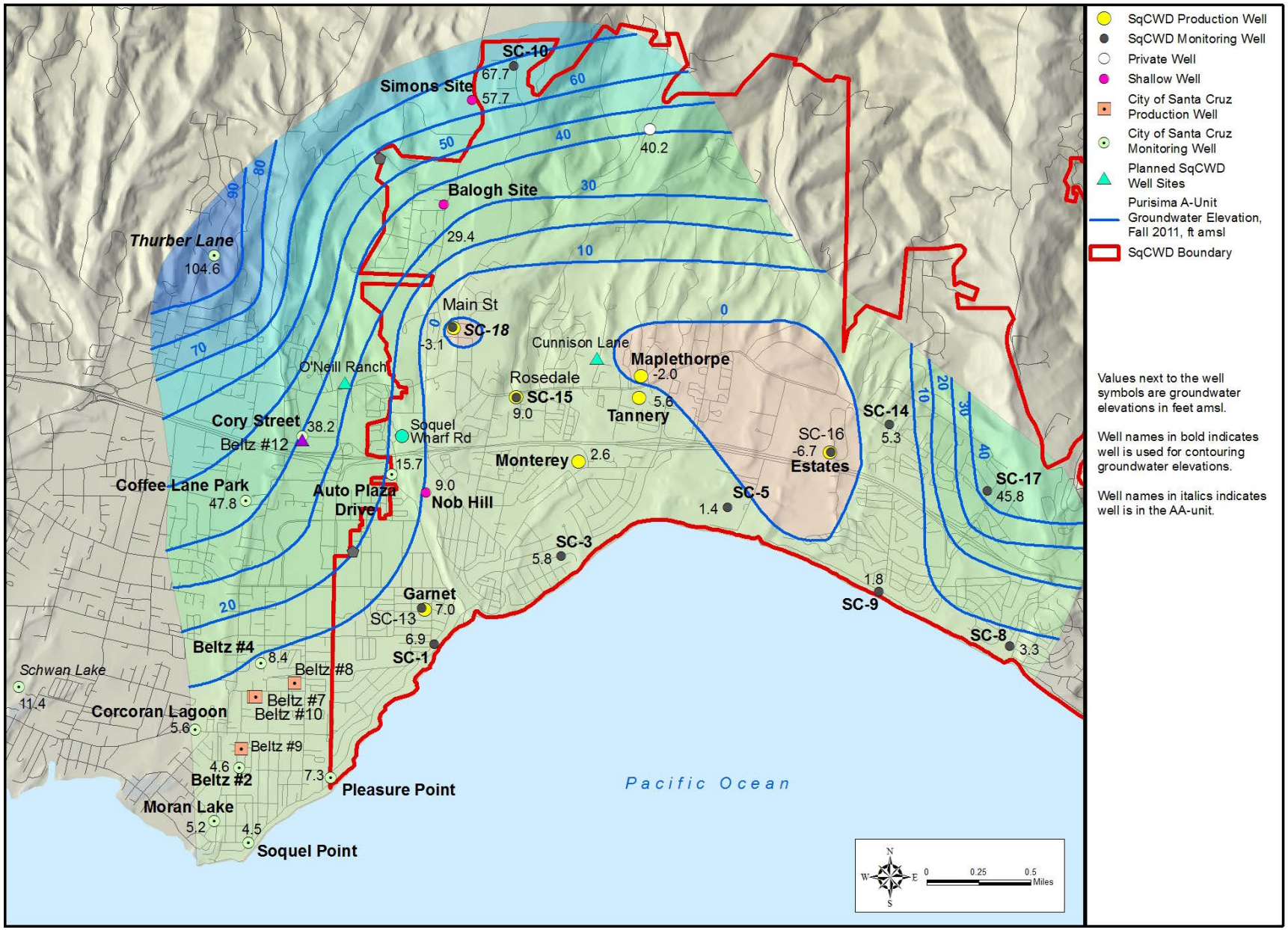


Figure 3-3 (2011): Groundwater Elevation Contours, Purisima A-Unit, Fall 2011

Monitoring Well Hydrographs for Western Purisima Area

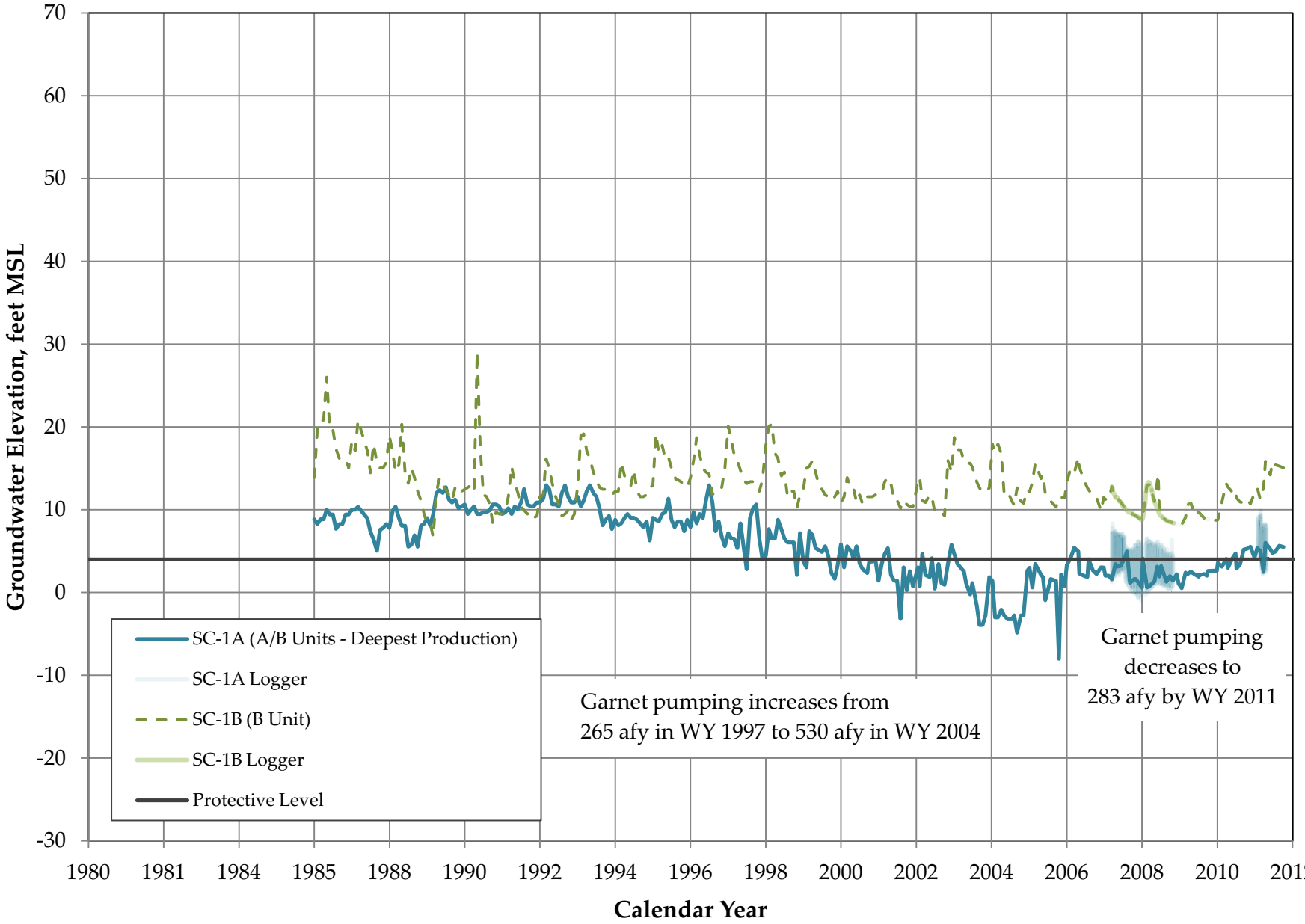
Hydrographs of SqCWD Coastal Monitoring Well Clusters

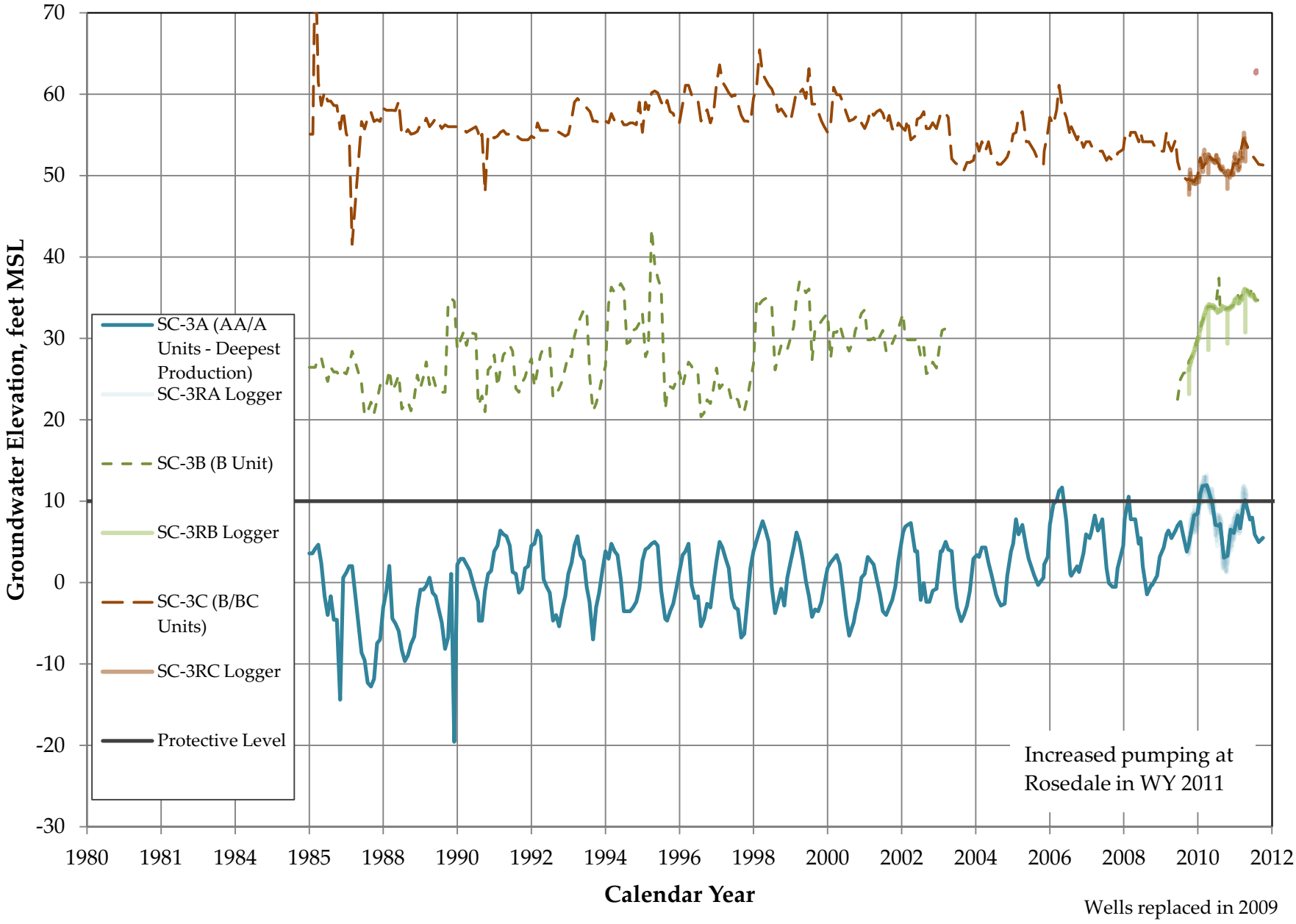
Hydrographs of City of Santa Cruz Coastal Monitoring Well Clusters

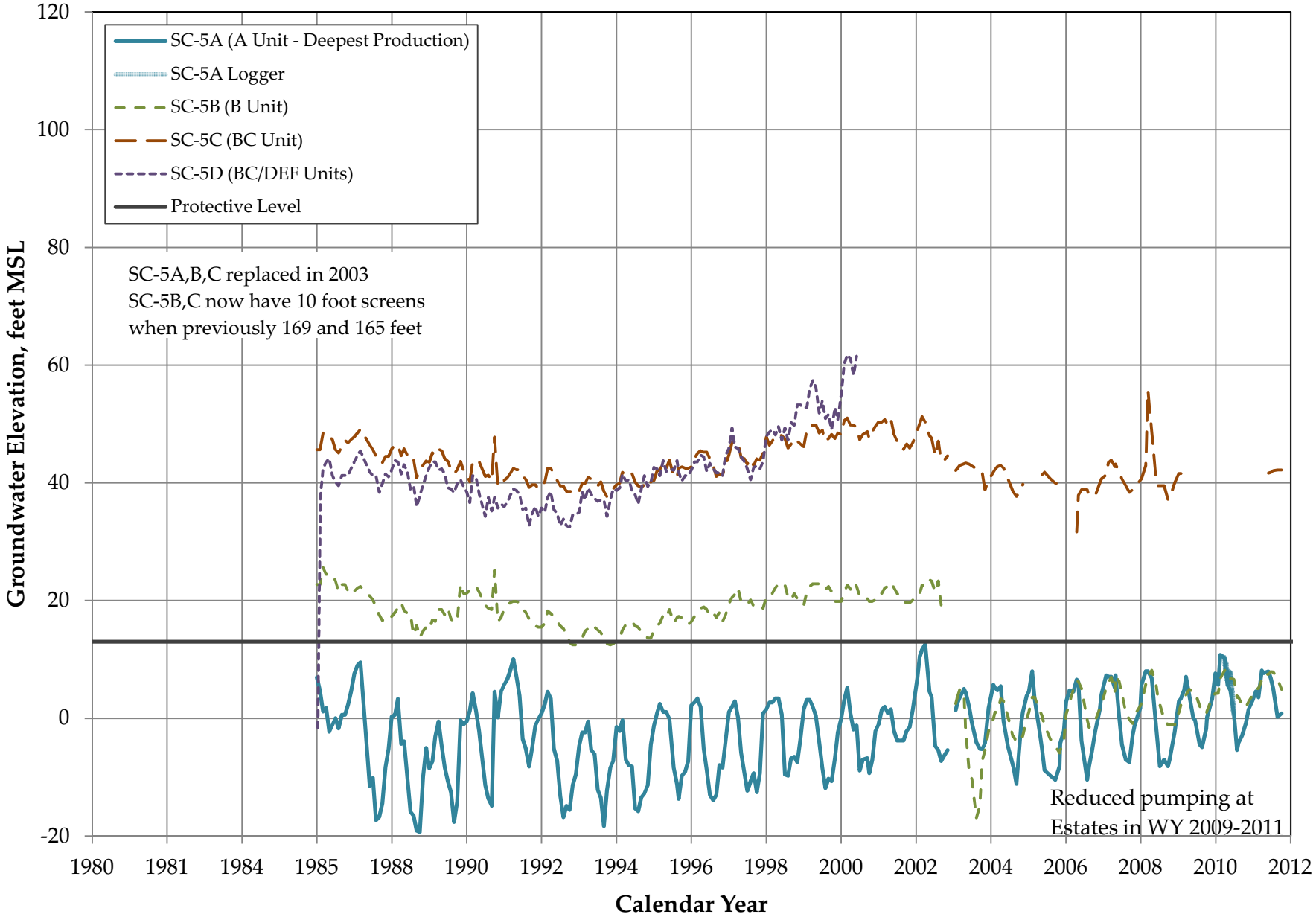
Hydrographs of SqCWD Inland Monitoring Well Clusters

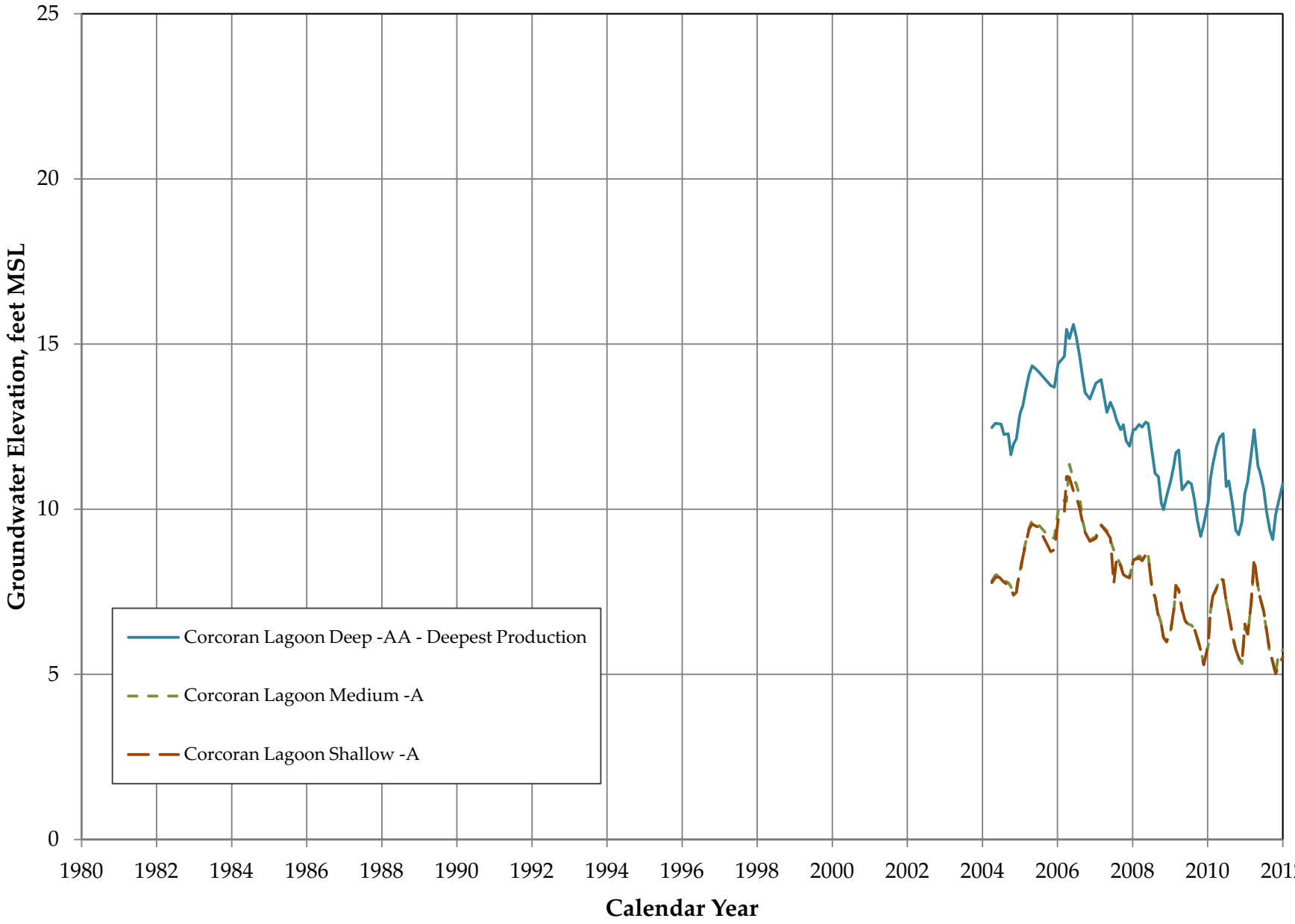
Hydrographs of City of Santa Cruz Inland Monitoring Well Clusters

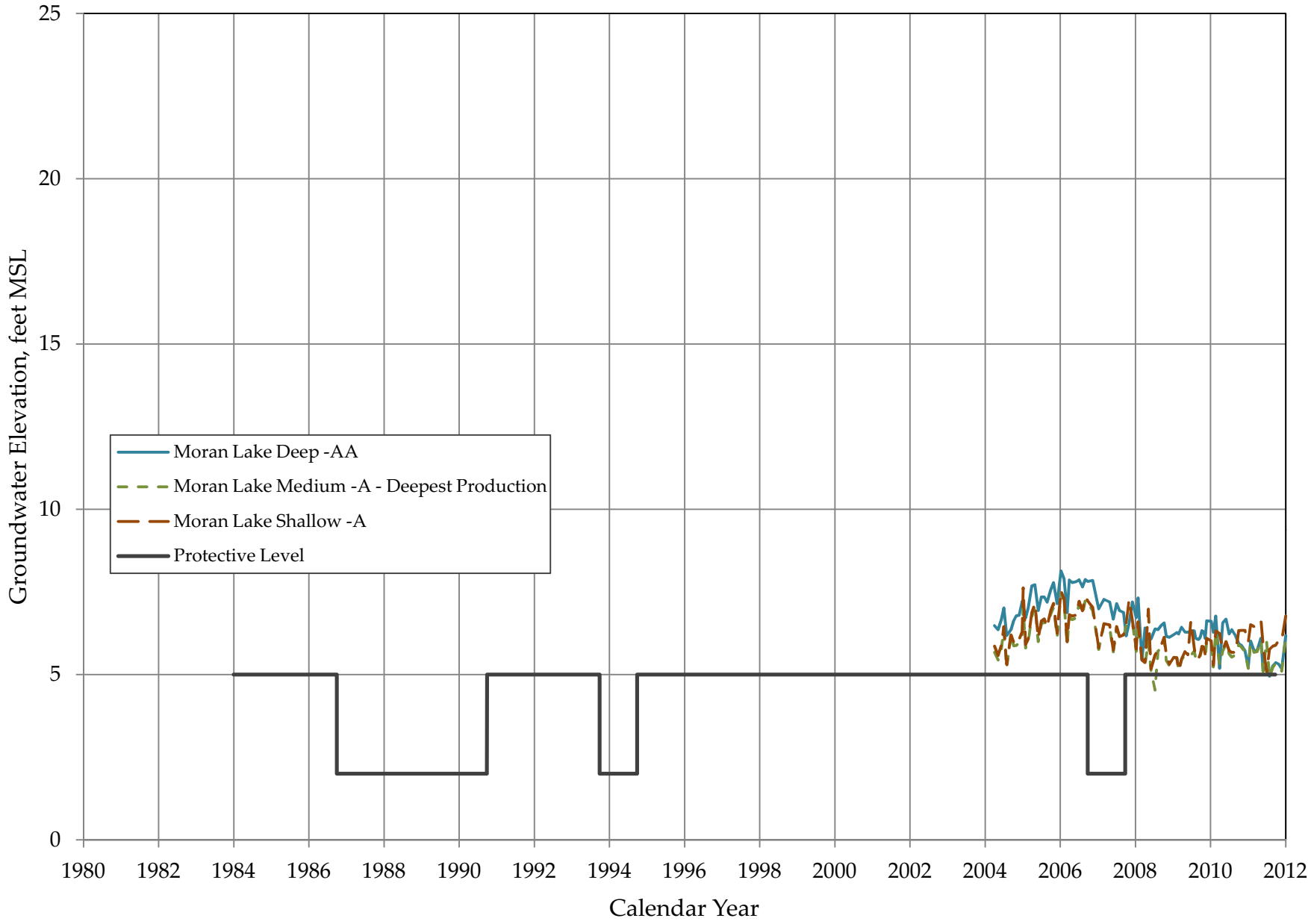
Hydrographs of SqCWD Monitoring Wells Adjacent to Production Wells

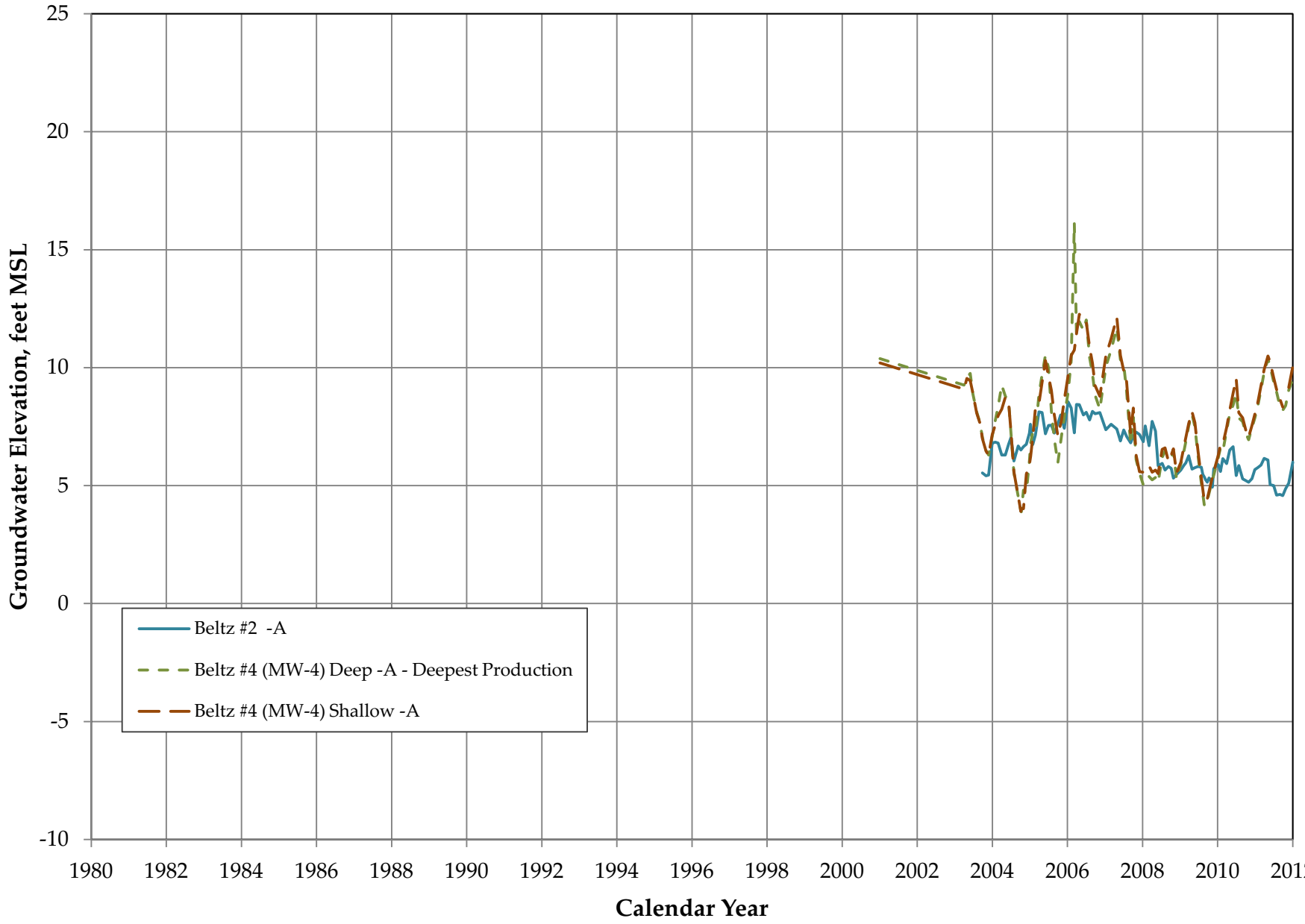

Groundwater Elevation, feet MSL
70
60
50
40
30
20
10
0
-10
-20
-30
1980
1981
1984
1985
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
SC-1A (A/B Units - Deepest Production)
SC-1A Logger
SC-1B (B Unit)
SC-1B Logger
Protective Level
Garnet pumping increases from
265 afy in WY 1997 to 530 afy in WY 2004
Garnet pumping
decreases to
283 afy by WY 2011

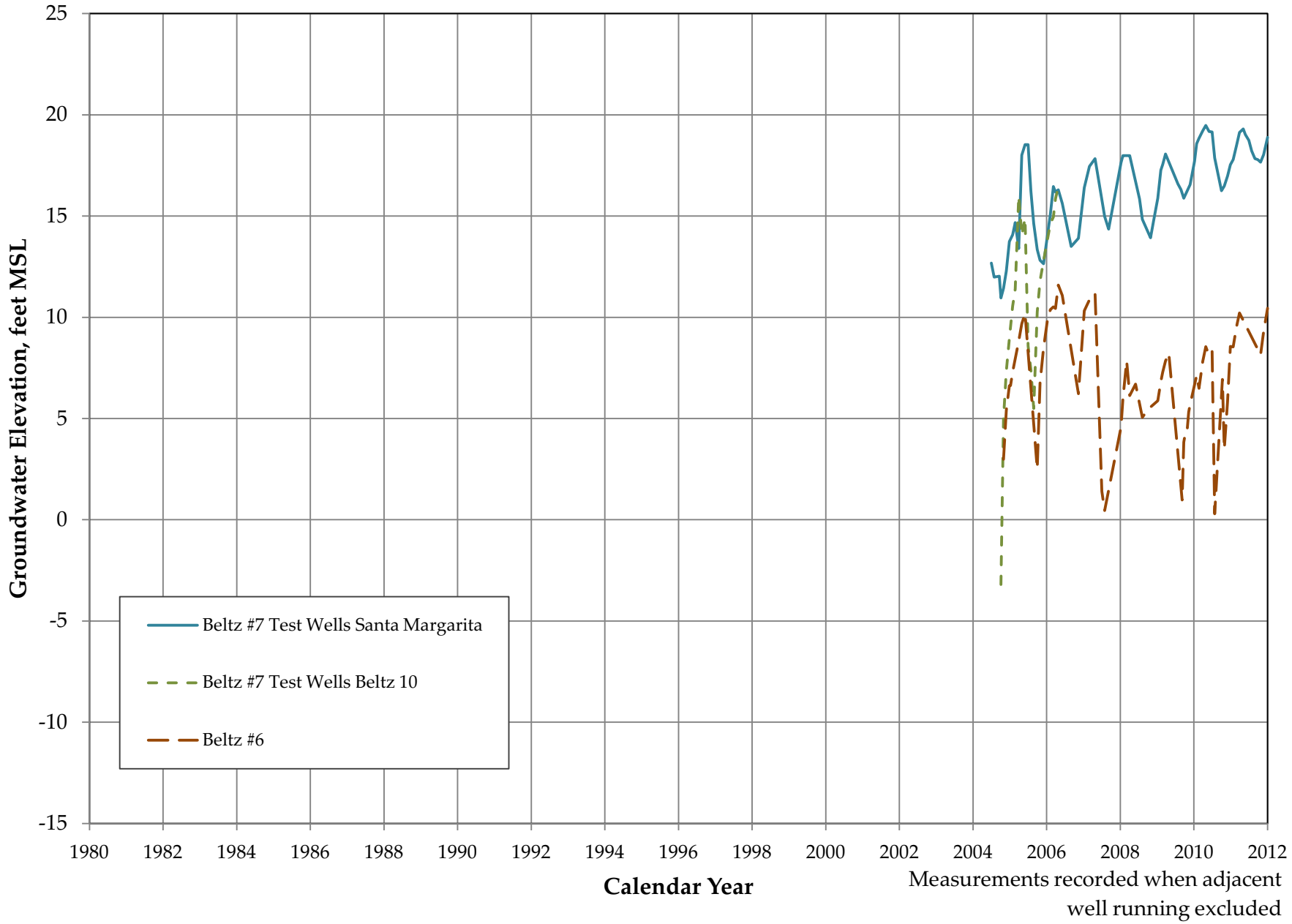

Groundwater Elevation, feet MSL
70
60
50
40
30
20
10
0
-10
-20
-30
1980
1981
1984
1985
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
SC-3A (AA/A Units - Deepest Production)
SC-3RA Logger
SC-3B (B Unit)
SC-3RB Logger
SC-3C (B/BC Units)
SC-3RC Logger
Protective Level
Increased pumping at Rosedale in WY 2011
Wells replaced in 2009

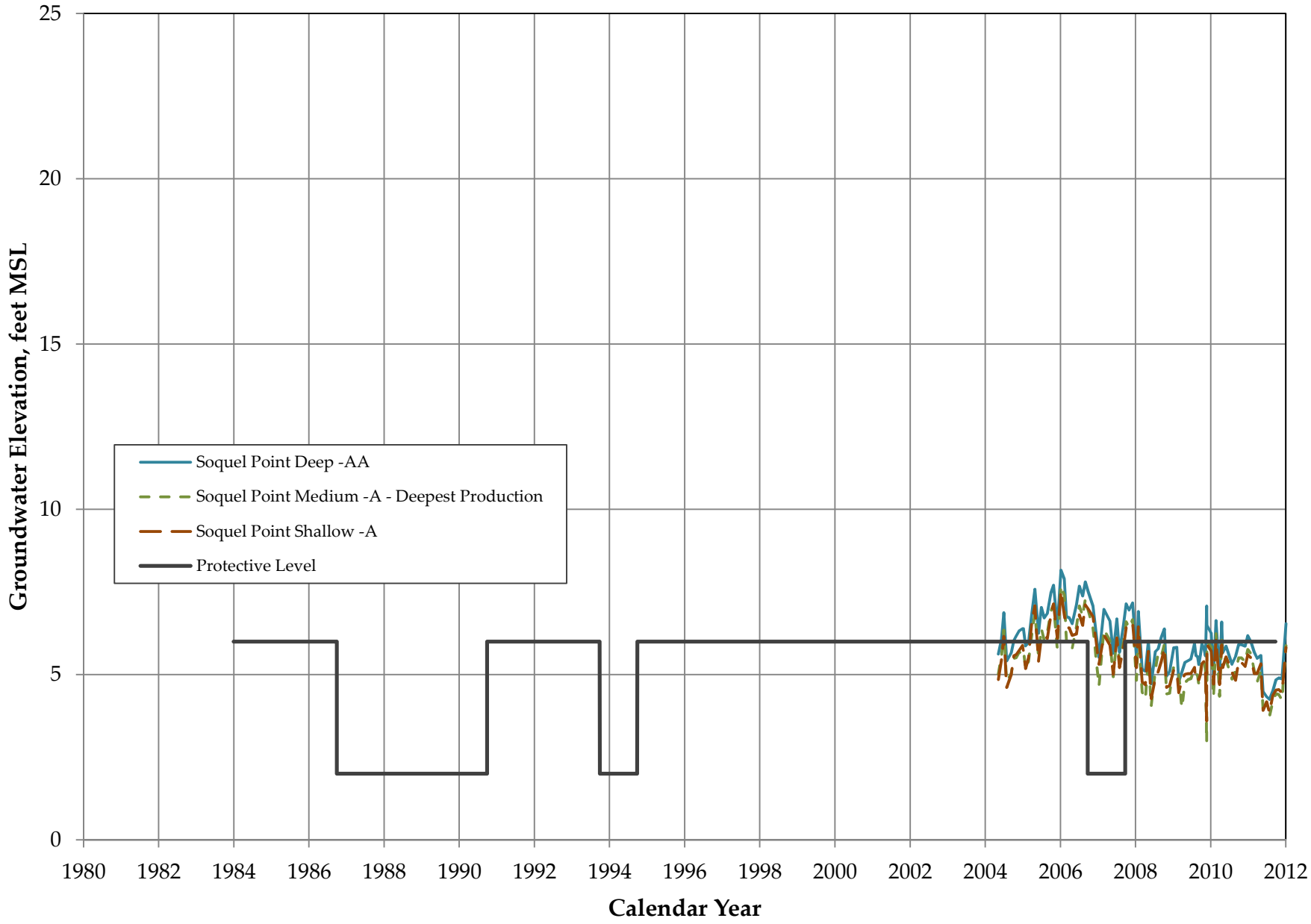

SC-5A (A Unit - Deepest Production)
SC-5A Logger
SC-5B (B Unit)
SC-5C (BC Unit)
SC-5D (BC/DEF Units)
Protective Level
SC-5A,B,C replaced in 2003
SC-5B,C now have 10 foot screens
when previously 169 and 165 feet
Reduced pumping at
Estates in WY 2009-2011
Groundwater Elevation, feet MSL
Calendar Year
120
100
80
60
40
20
0
-20
1980
1981
1984
1985
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012

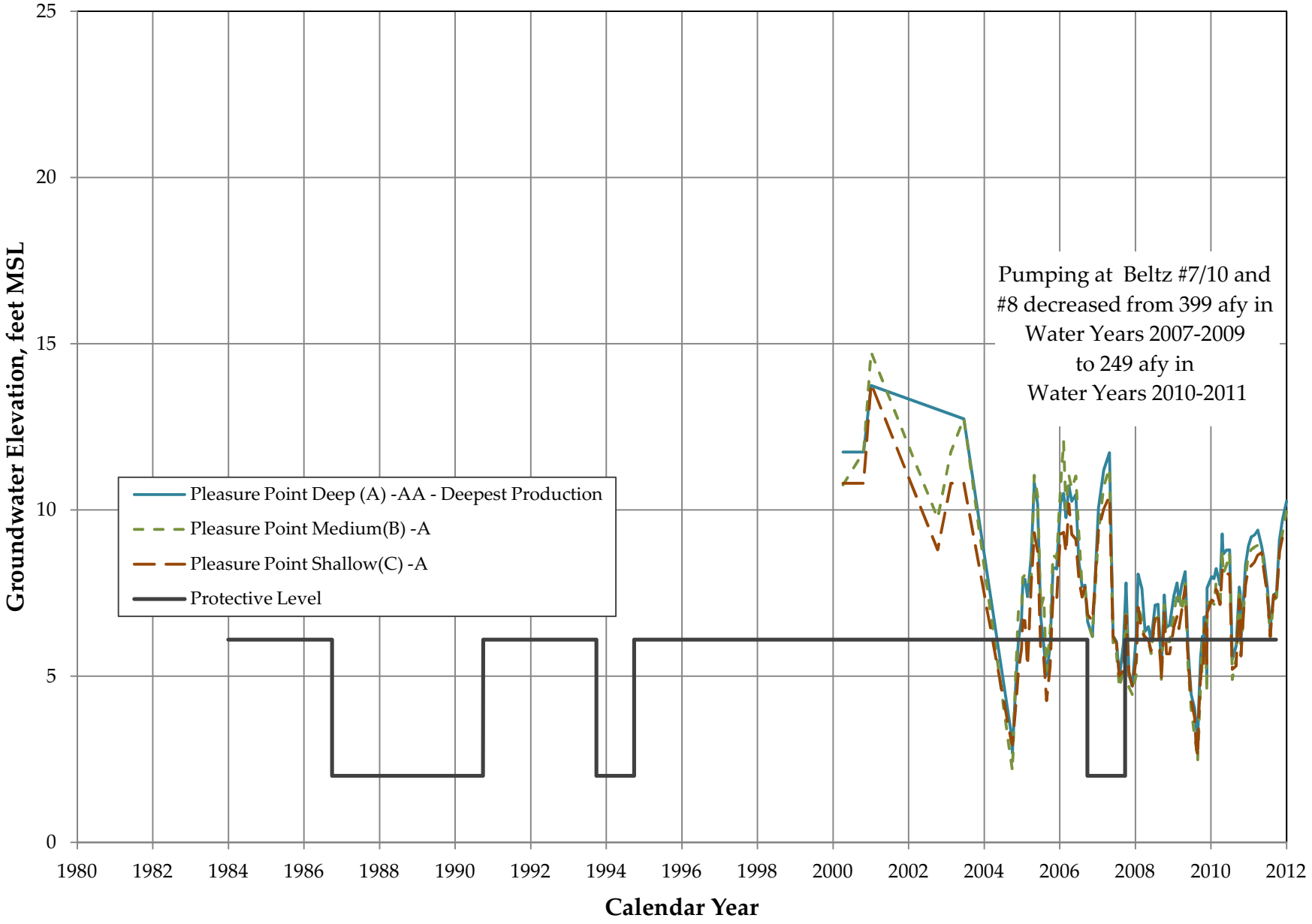

Groundwater Elevation, feet MSL
25
20
15
10
5
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
Corcoran Lagoon Deep -AA - Deepest Production
Corcoran Lagoon Medium -A
Corcoran Lagoon Shallow -A

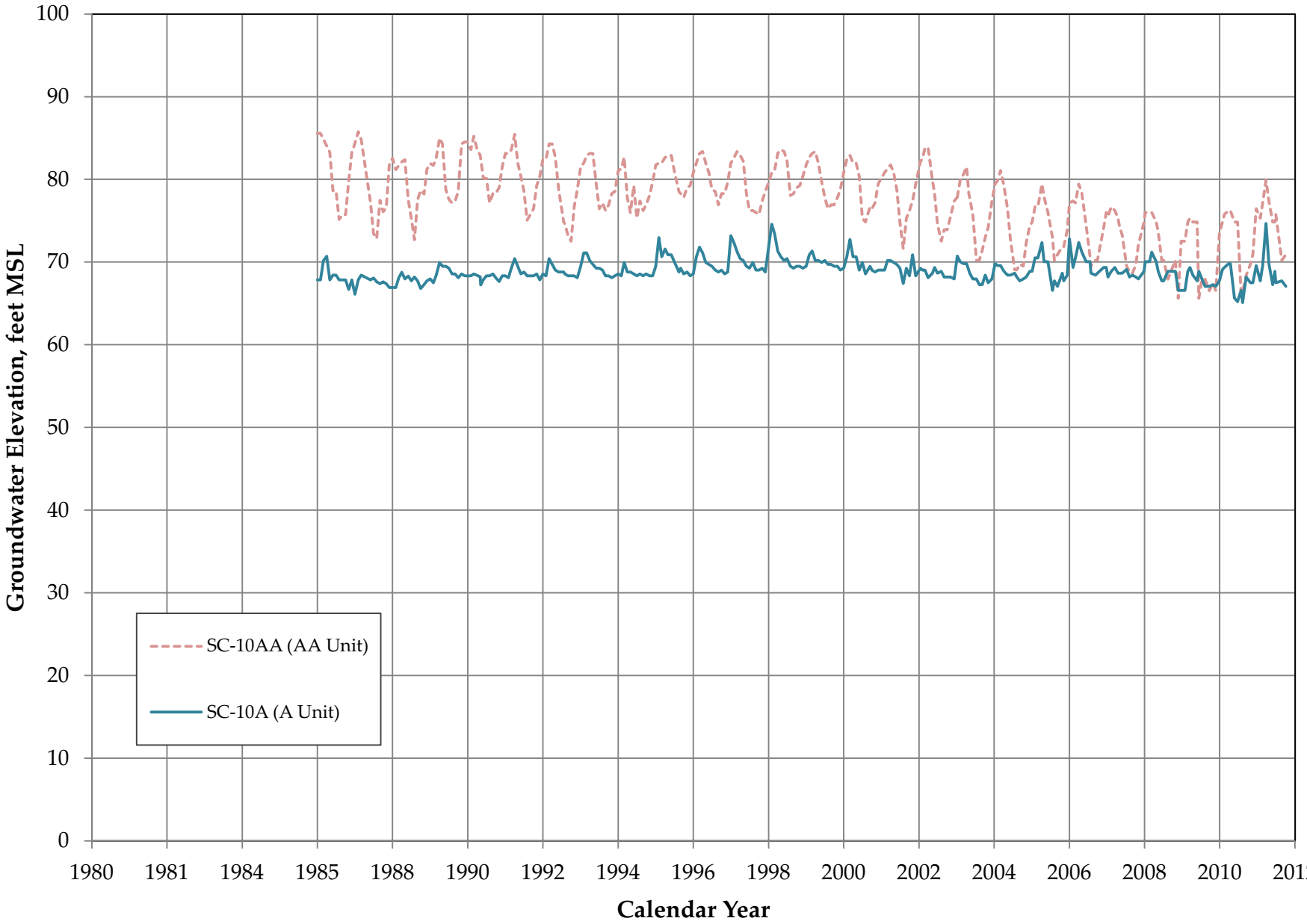

Groundwater Elevation, feet MSL
25
20
15
10
5
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
Moran Lake Deep -AA
Moran Lake Medium -A - Deepest Production
Moran Lake Shallow -A
Protective Level


Groundwater Elevation, feet MSL
25
20
15
10
5
0
-5
-10
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
Beltz #2 -A
Beltz #4 (MW-4) Deep -A - Deepest Production
Beltz #4 (MW-4) Shallow -A

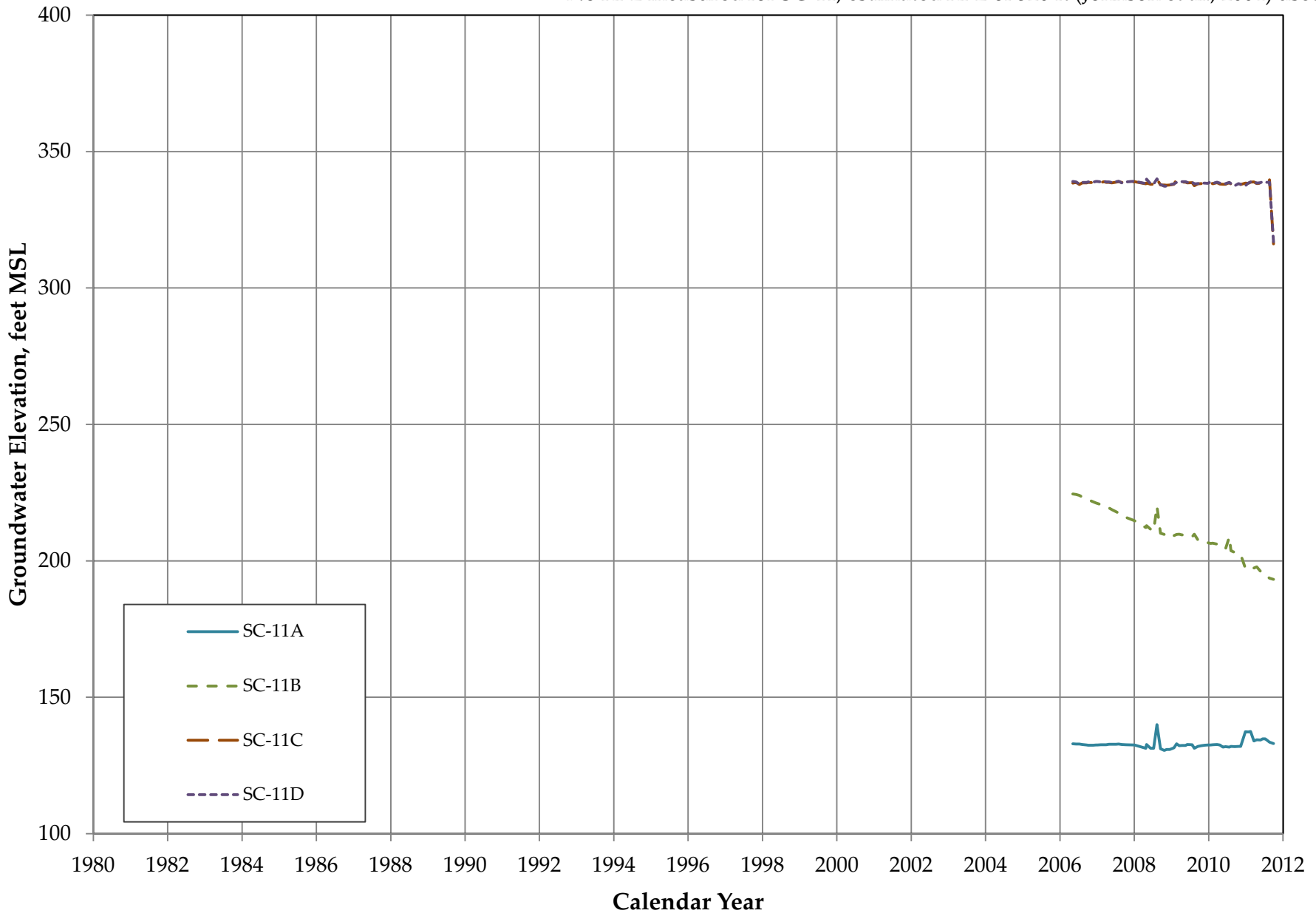

Groundwater Elevation, feet MSL
25
20
15
10
5
0
-5
-10
-15
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
Beltz #7 Test Wells Santa Margarita
Beltz #7 Test Wells Beltz 10
Beltz #6
Measurements recorded when adjacent well running excluded

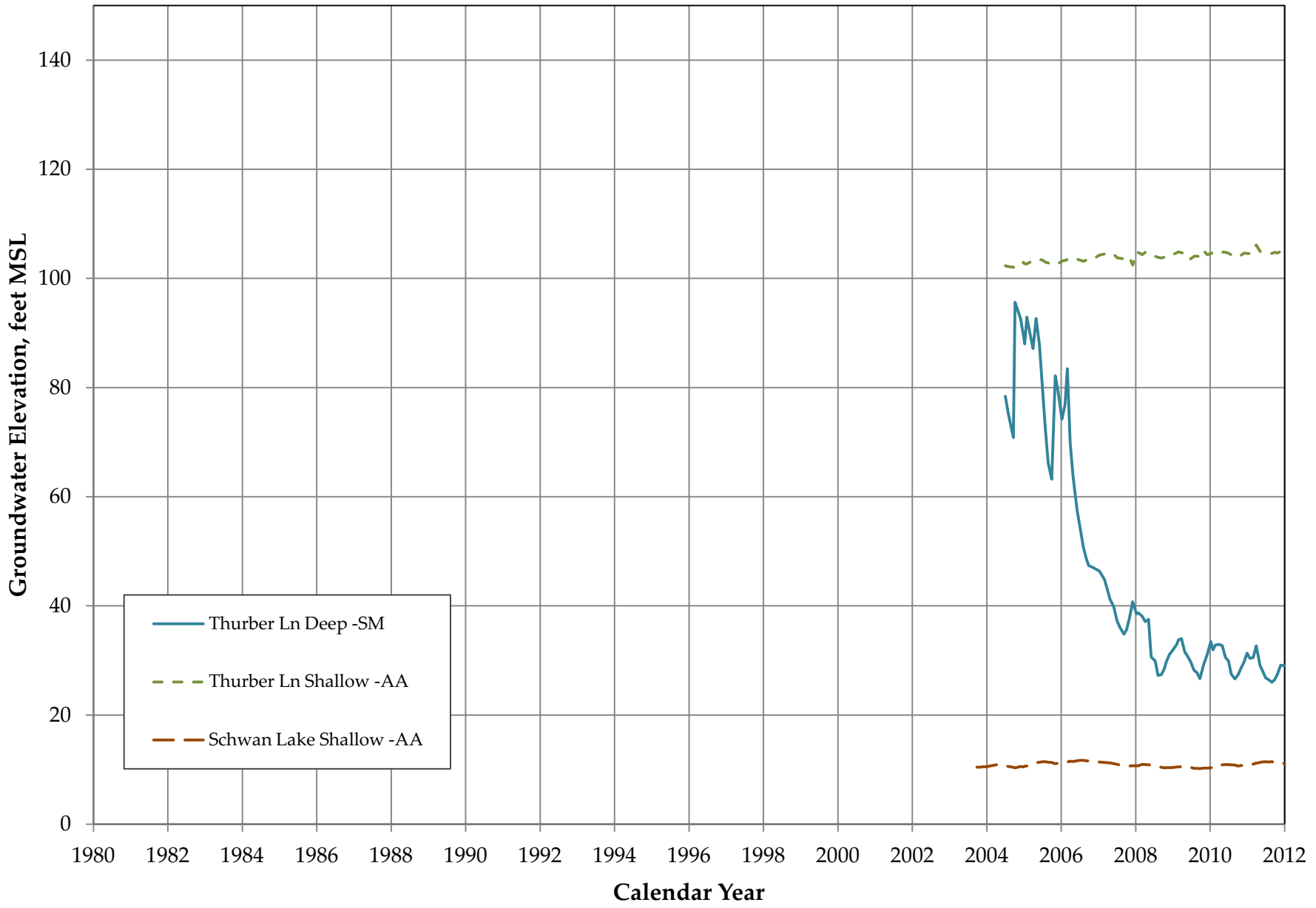

Groundwater Elevation, feet MSL
25
20
15
10
5
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
Soquel Point Deep -AA
Soquel Point Medium -A - Deepest Production
Soquel Point Shallow -A
Protective Level

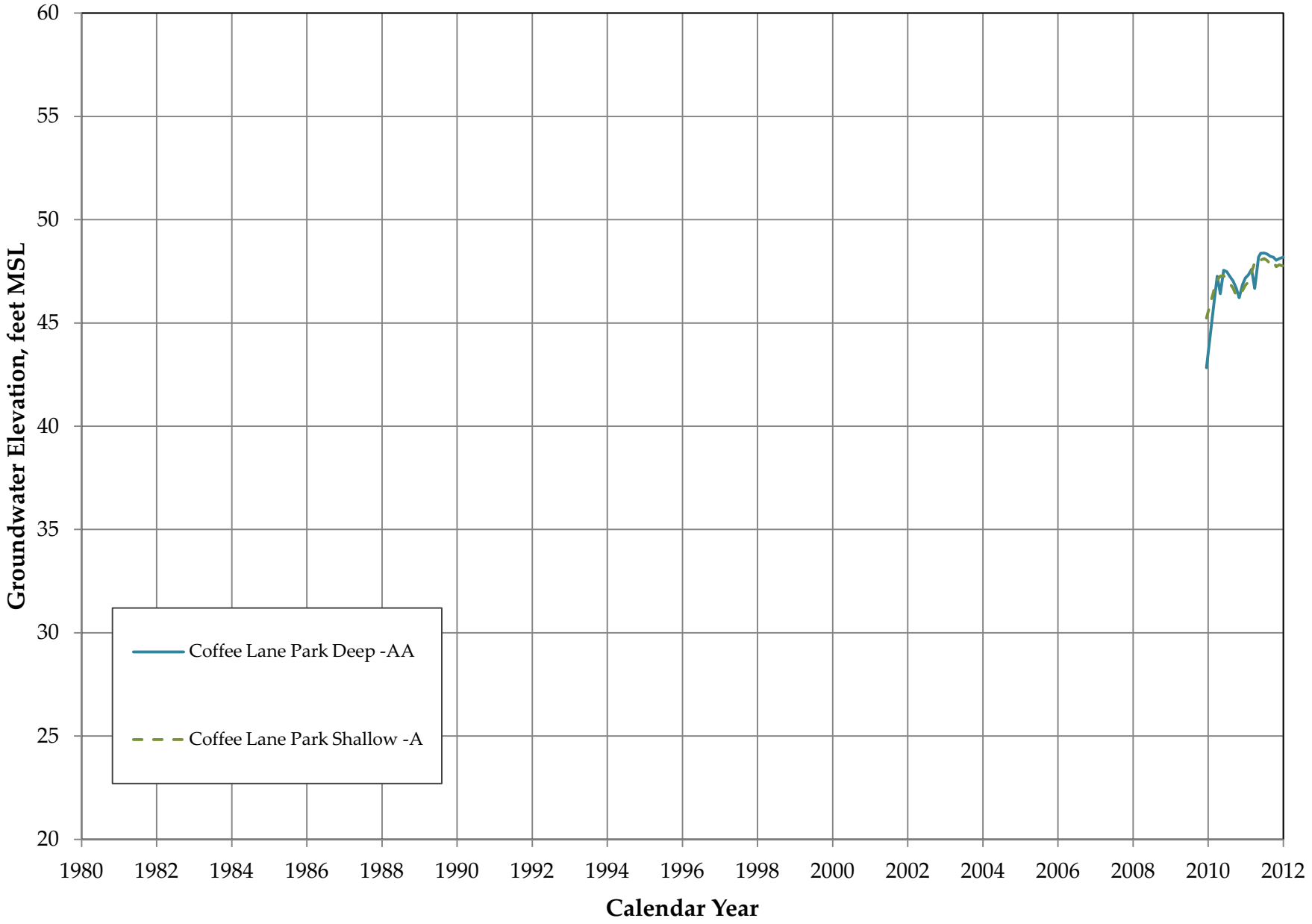

Groundwater Elevation, feet MSL
25
20
15
10
5
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
Pleasure Point Deep (A) -AA - Deepest Production
Pleasure Point Medium(B) -A
Pleasure Point Shallow(C) -A
Protective Level
Pumping at Beltz #7/10 and #8 decreased from 399 afy in Water Years 2007-2009 to 249 afy in Water Years 2010-2011

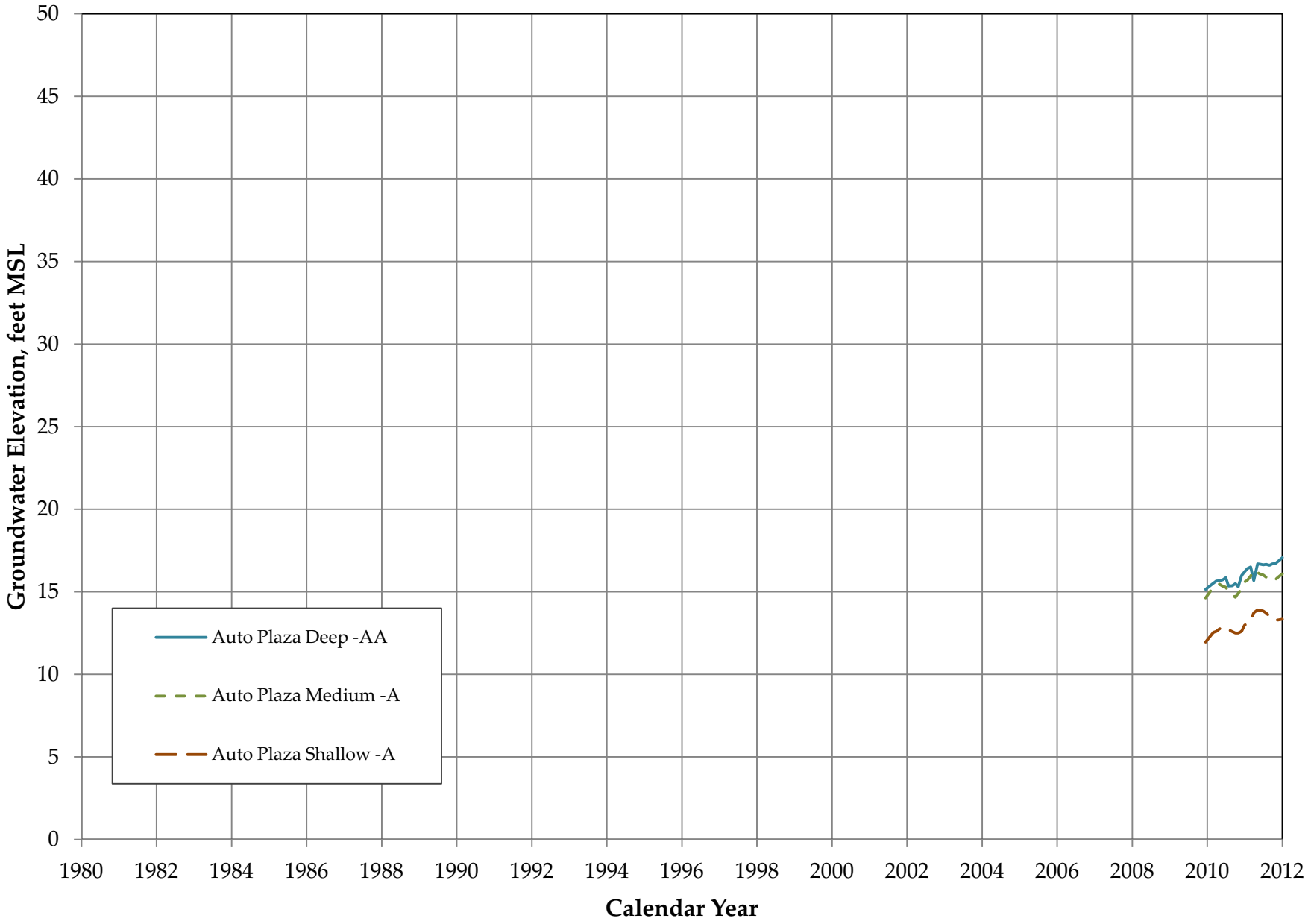

Groundwater Elevation, feet MSL
100
90
80
70
60
50
40
30
20
10
0
1980
1981
1984
1985
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
SC-10AA (AA Unit)
SC-10A (A Unit)

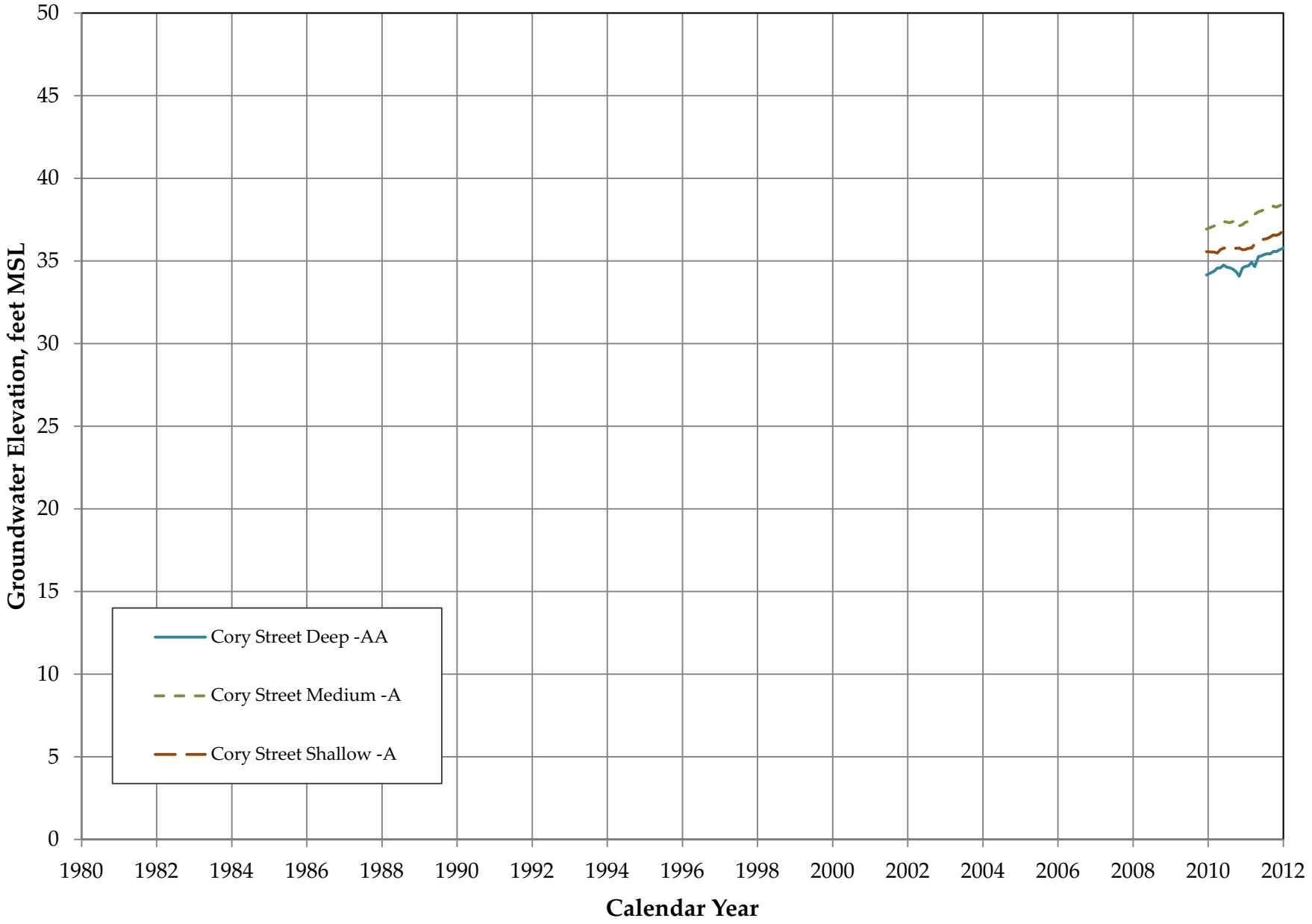
No RPE measured for SC-11, estimated RPE of 520 ft (Johnson et al., 2004) used

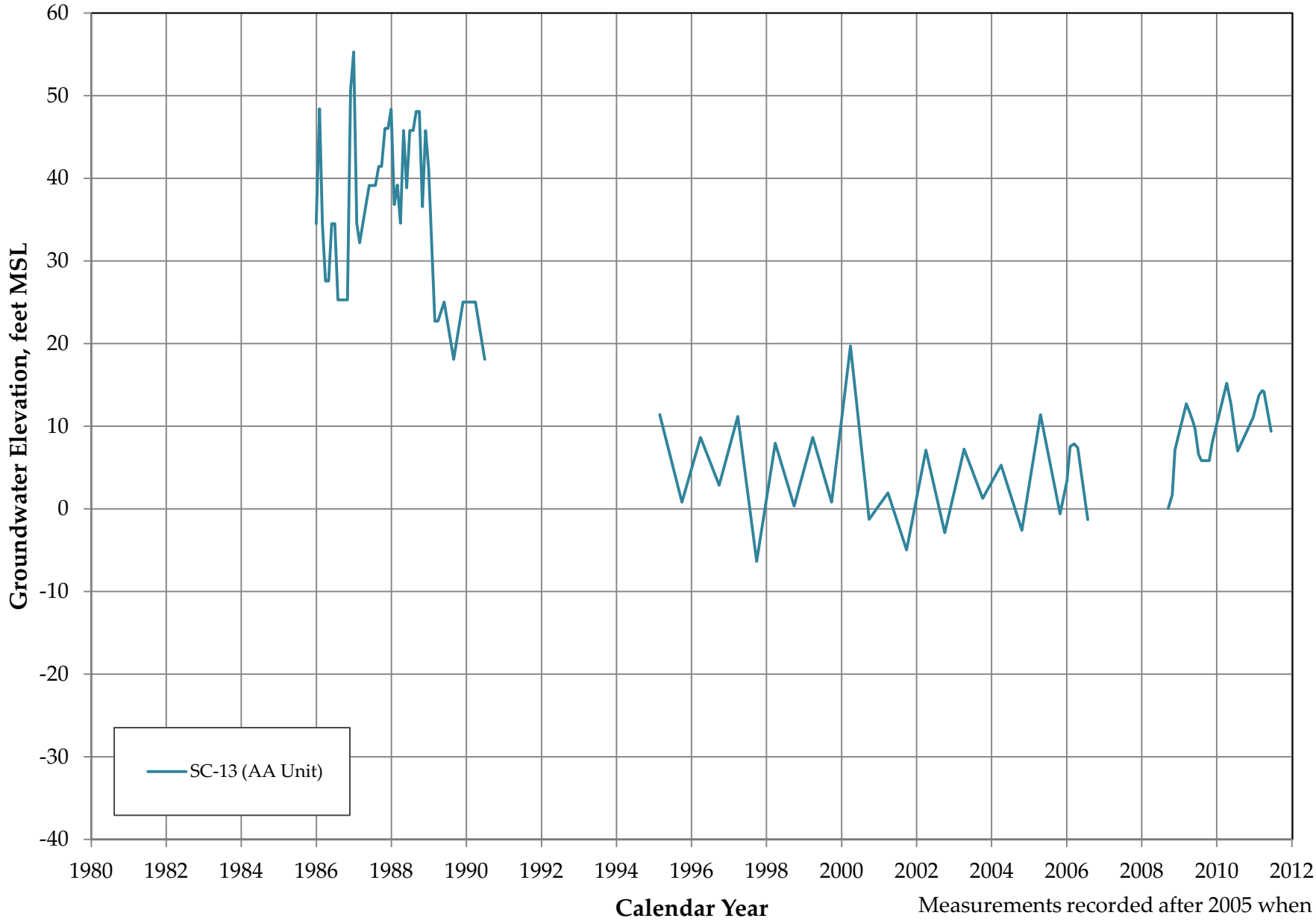



Groundwater Elevation, feet MSL
140
120
100
80
60
40
20
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
Thurber Ln Deep -SM
Thurber Ln Shallow -AA
Schwan Lake Shallow -AA

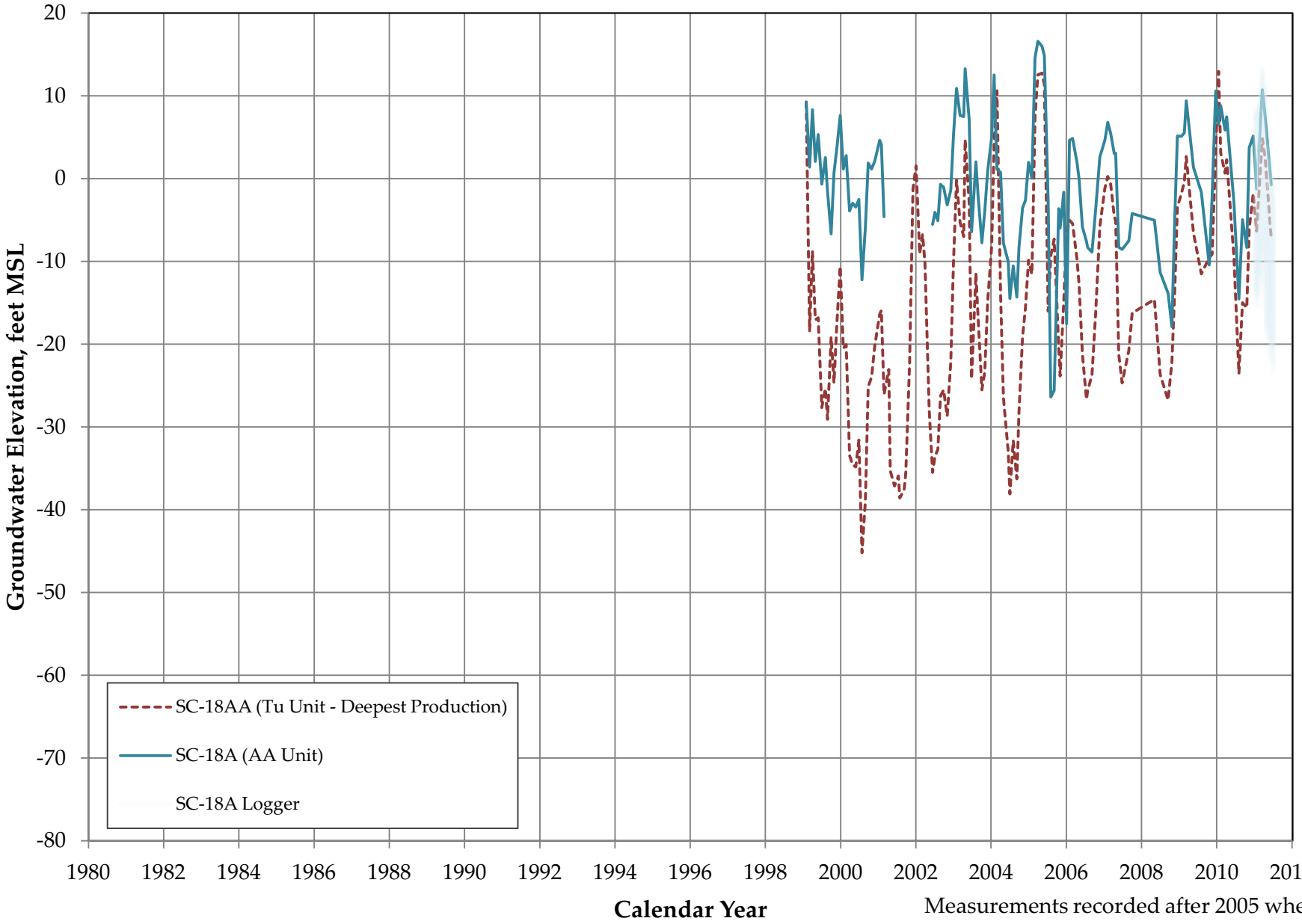

Groundwater Elevation, feet MSL
60
55
50
45
40
35
30
25
20
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
Coffee Lane Park Deep -AA
Coffee Lane Park Shallow -A

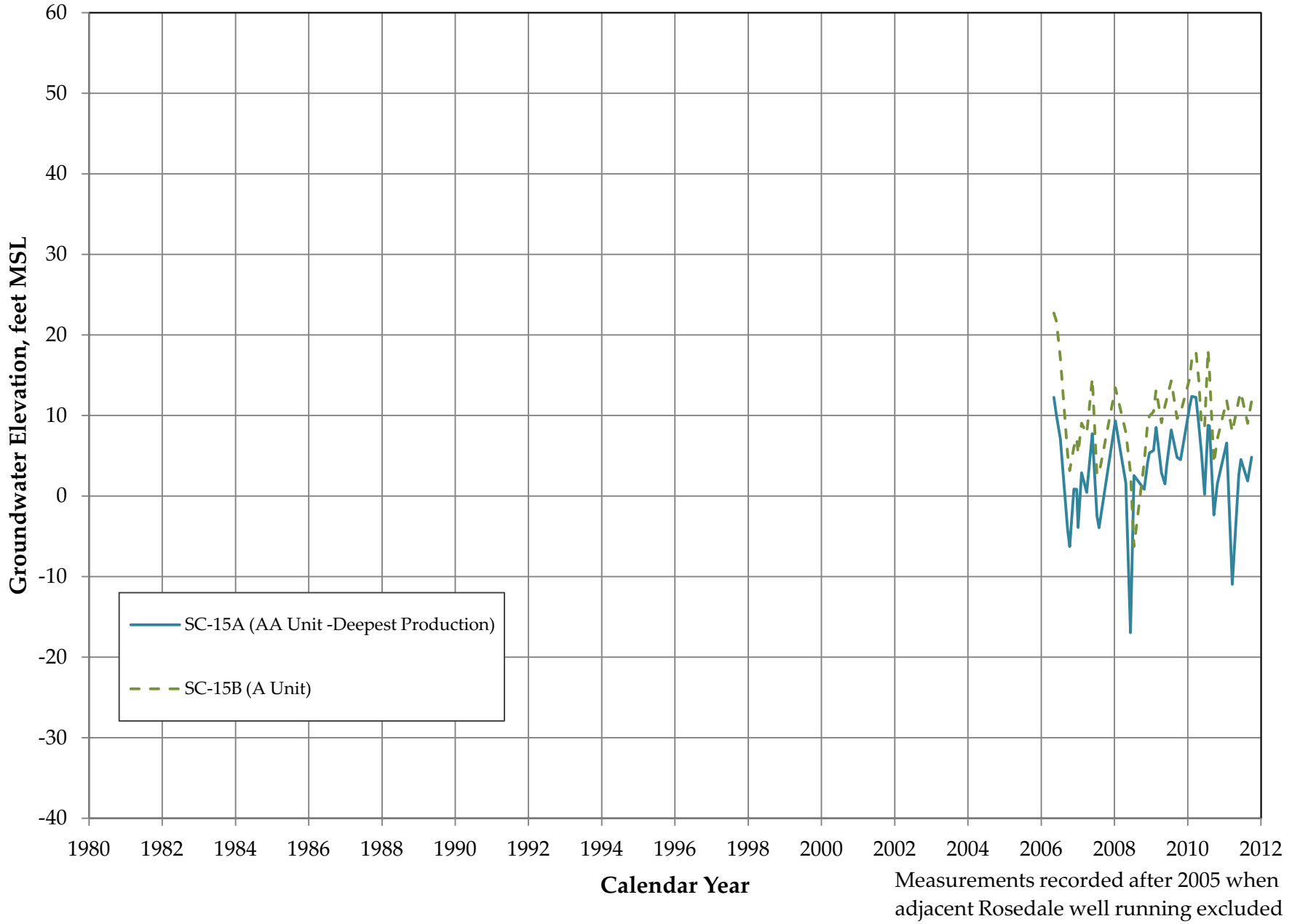

Groundwater Elevation, feet MSL
50
45
40
35
30
25
20
15
10
5
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
Auto Plaza Deep -AA
Auto Plaza Medium -A
Auto Plaza Shallow -A


Groundwater Elevation, feet MSL
50
45
40
35
30
25
20
15
10
5
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
Cory Street Deep -AA
Cory Street Medium -A
Cory Street Shallow -A



Measurements recorded after 2005 when adjacent Garnet well running excluded


Groundwater Elevation, feet MSL
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
SC-18AA (Tu Unit - Deepest Production)
SC-18A (AA Unit)
SC-18A Logger
Measurements recorded after 2005 when adjacent Main St. well running excluded


60
50
40
30
20
10
0
-10
-20
-30
-40
Groundwater Elevation, feet MSL
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
SC-15A (AA Unit -Deepest Production)
SC-15B (A Unit)
Measurements recorded after 2005 when adjacent Rosedale well running excluded

Chemographs and Single Well Hydrographs for Western Purisima Area

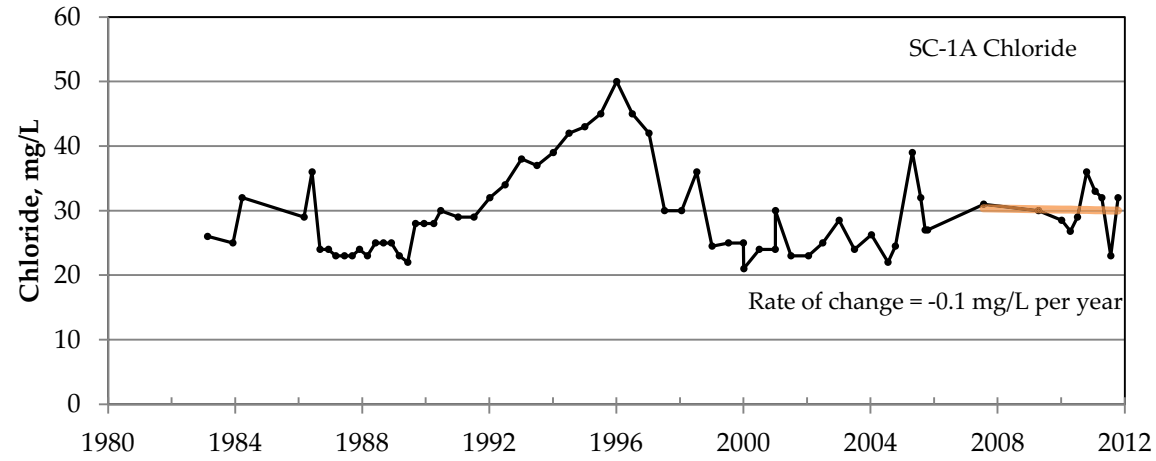
Graphs of SqCWD Coastal Monitoring Well Clusters

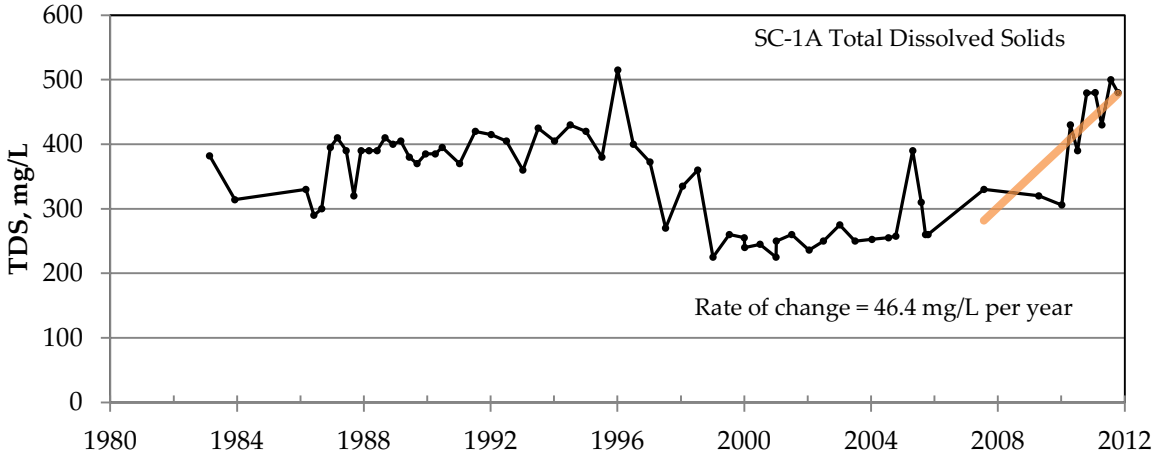
Graphs of City of Santa Cruz Coastal Monitoring Well Clusters

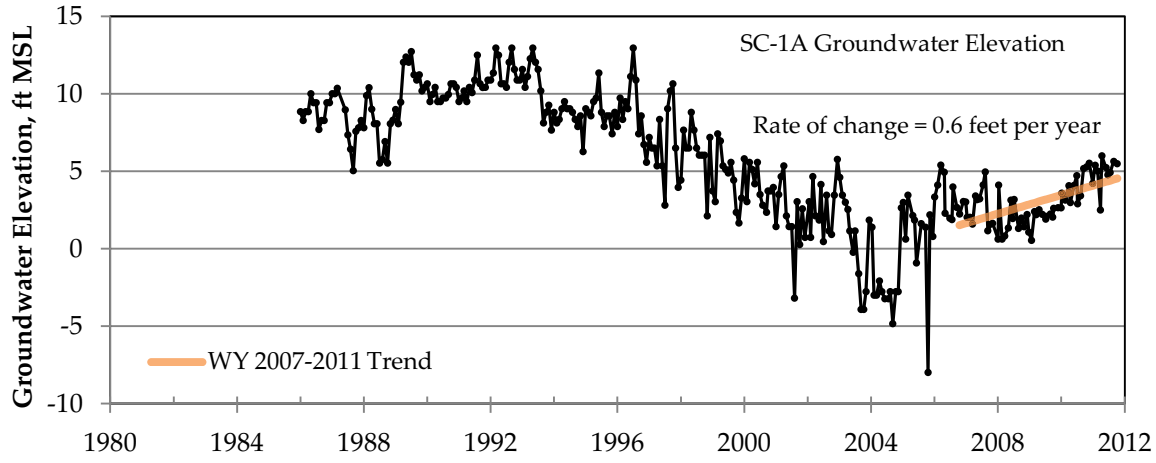
Graphs of SqCWD Inland Monitoring Well Clusters

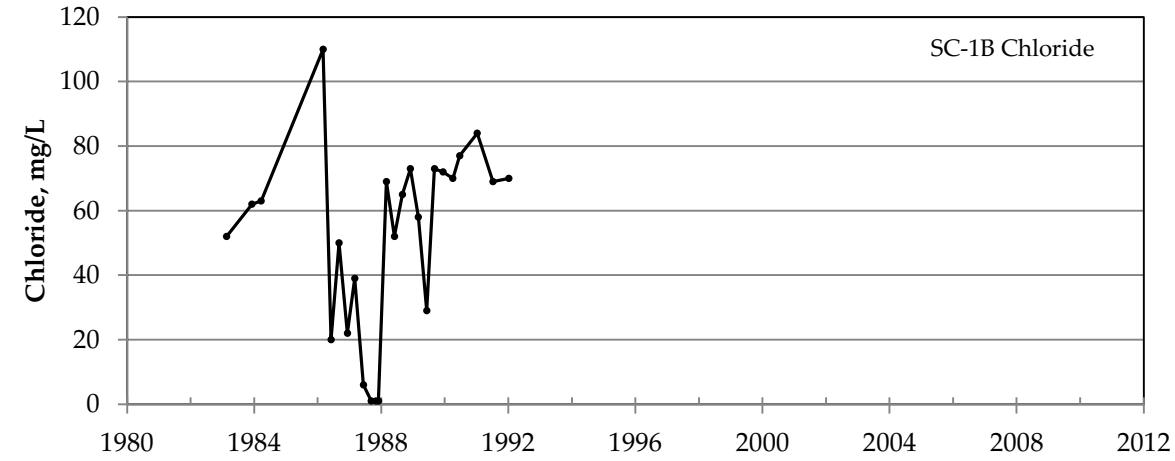
Graphs of City of Santa Cruz Inland Monitoring Well Clusters

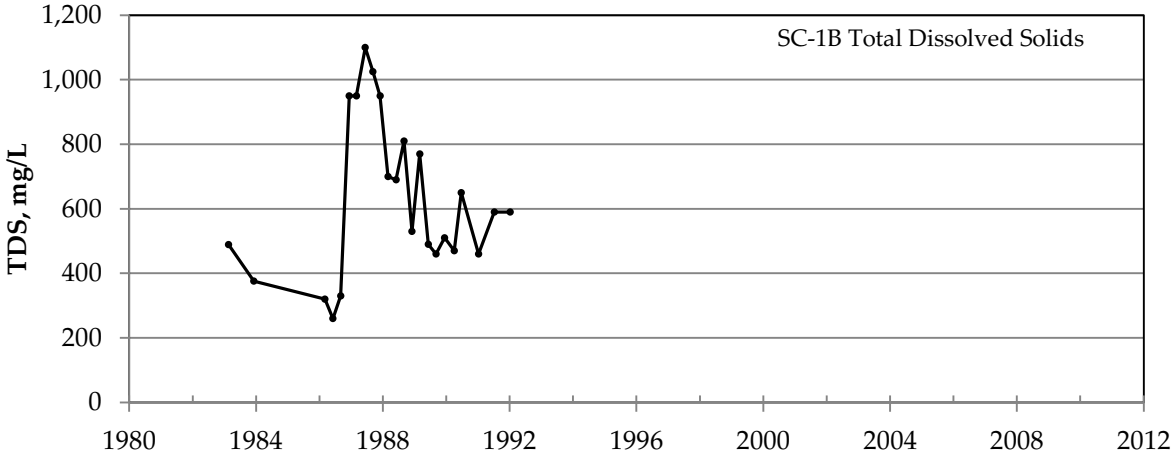
Graphs of SqCWD Production Wells and Monitoring Wells Adjacent to Production Wells

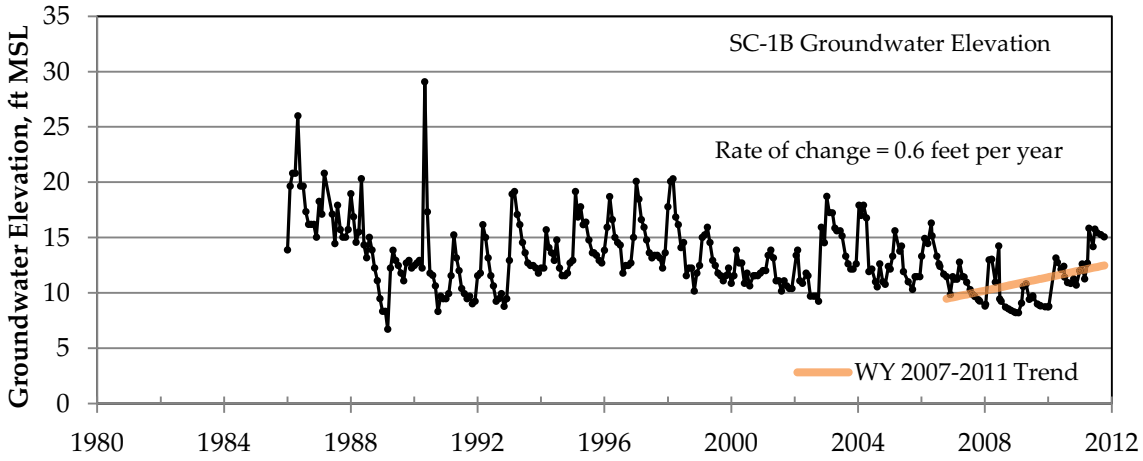

SC-1A Chloride
Chloride, mg/L
Rate of change = -0.1 mg/L per year
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

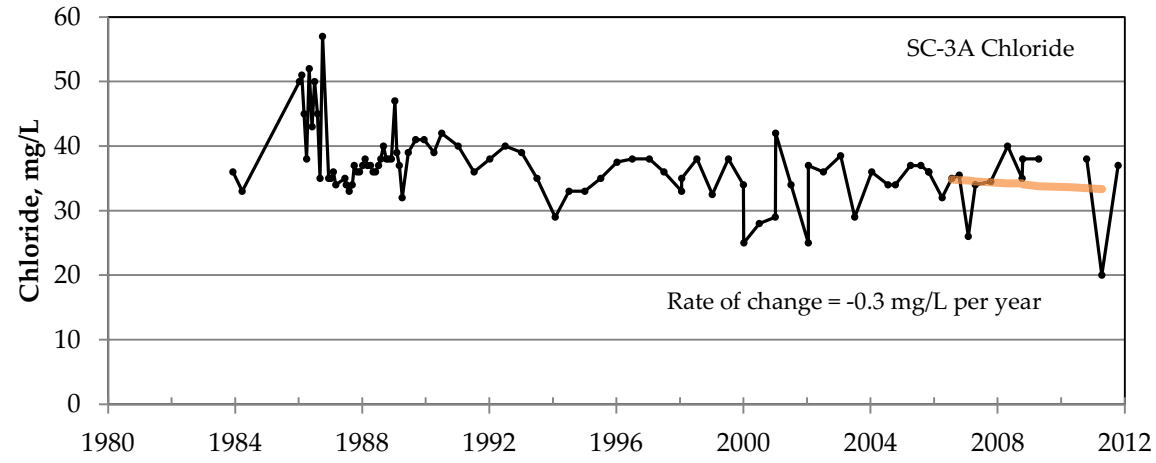

SC-1A Total Dissolved Solids
TDS, mg/L
Rate of change = 46.4 mg/L per year
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

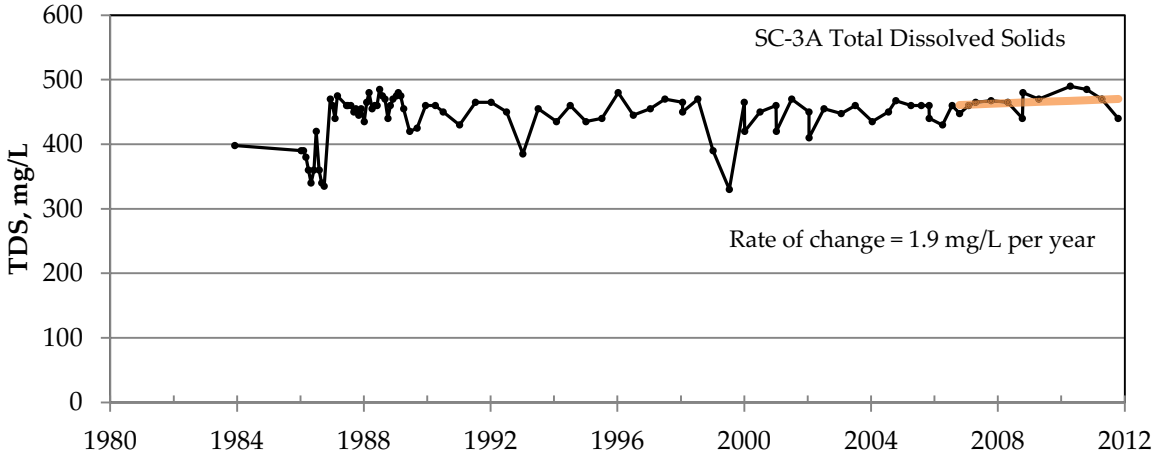

SC-1A Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = 0.6 feet per year
WY 2007-2011 Trend
15
10
5
0
-5
-10
1980
1984
1988
1992
1996
2000
2004
2008
2012

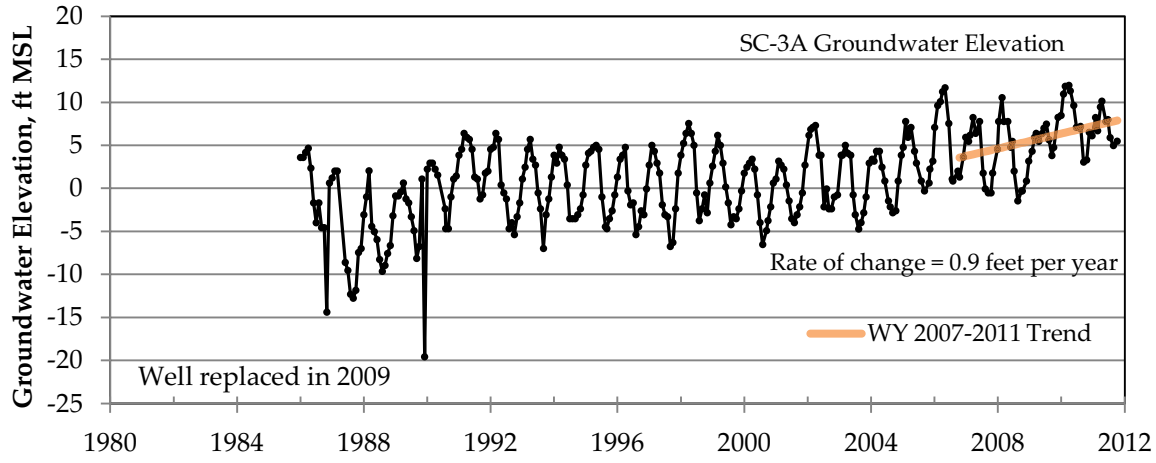

SC-1B Chloride
Chloride, mg/L
120
100
80
60
40
20
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

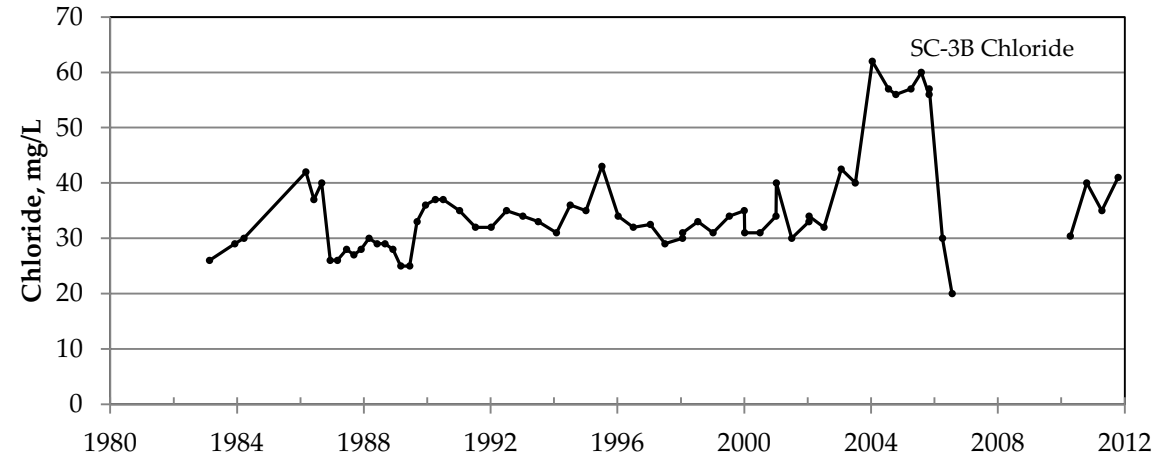

SC-1B Total Dissolved Solids
TDS, mg/L
1,200
1,000
800
600
400
200
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

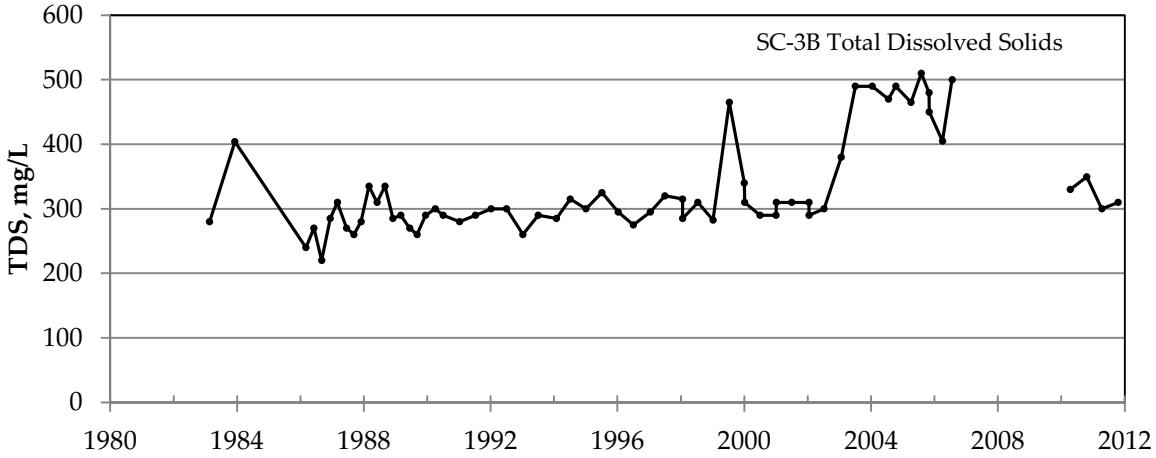

SC-1B Groundwater Elevation
Rate of change = 0.6 feet per year
WY 2007-2011 Trend
Groundwater Elevation, ft MSL
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

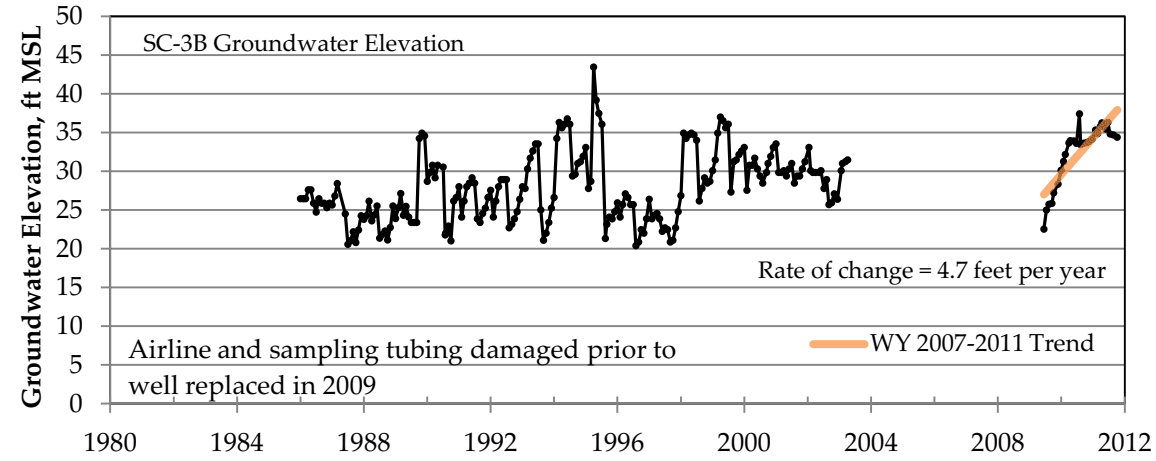

SC-3A Chloride
Chloride, mg/L
Rate of change = -0.3 mg/L per year
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

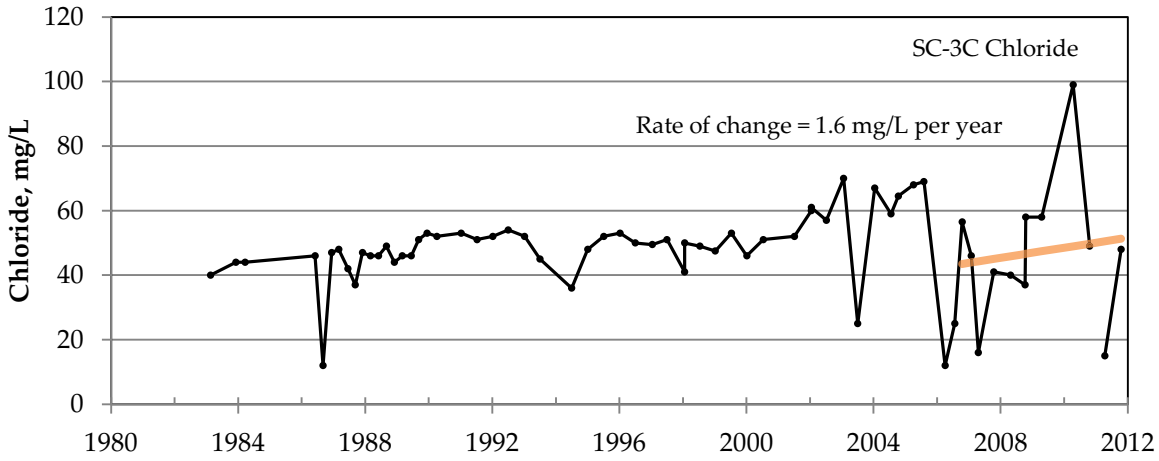

SC-3A Total Dissolved Solids
TDS, mg/L
Rate of change = 1.9 mg/L per year
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

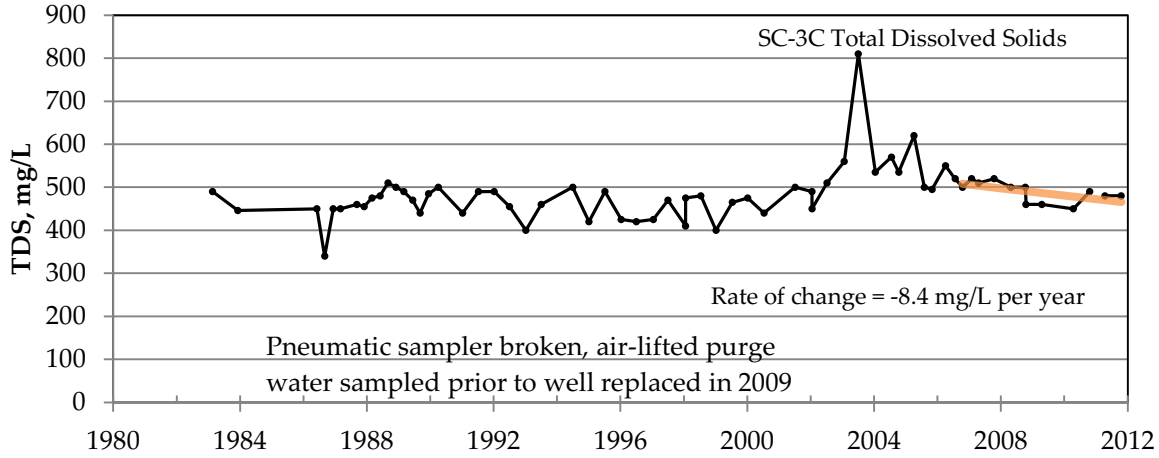

SC-3A Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = 0.9 feet per year
WY 2007-2011 Trend
Well replaced in 2009
20
15
10
5
0
-5
-10
-15
-20
-25
1980
1984
1988
1992
1996
2000
2004
2008
2012

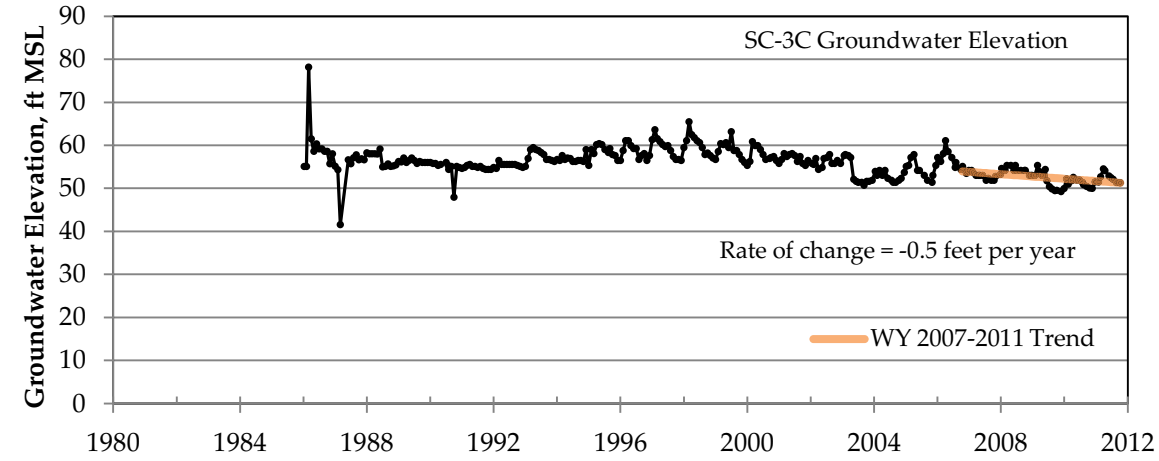

SC-3B Chloride
Chloride, mg/L
70
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

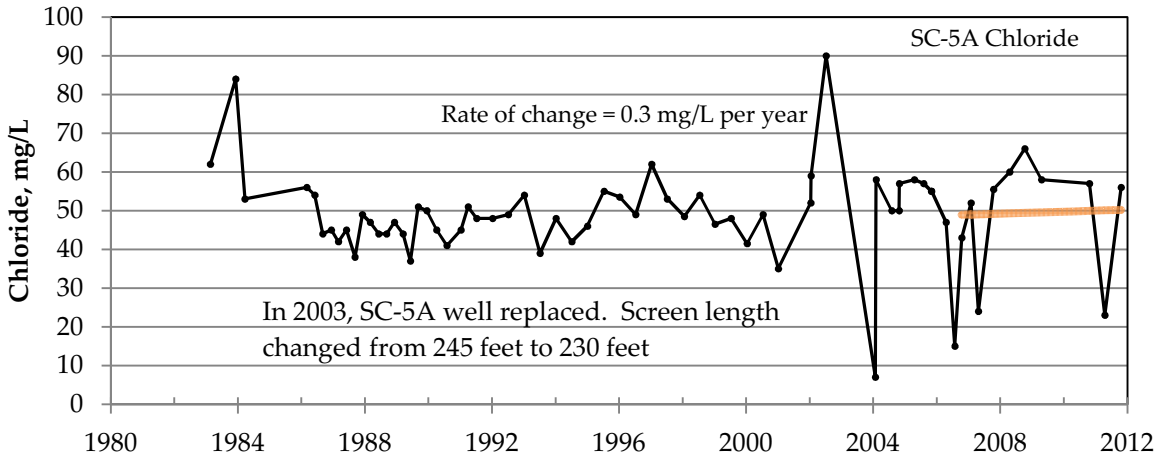

SC-3B Total Dissolved Solids
TDS, mg/L
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

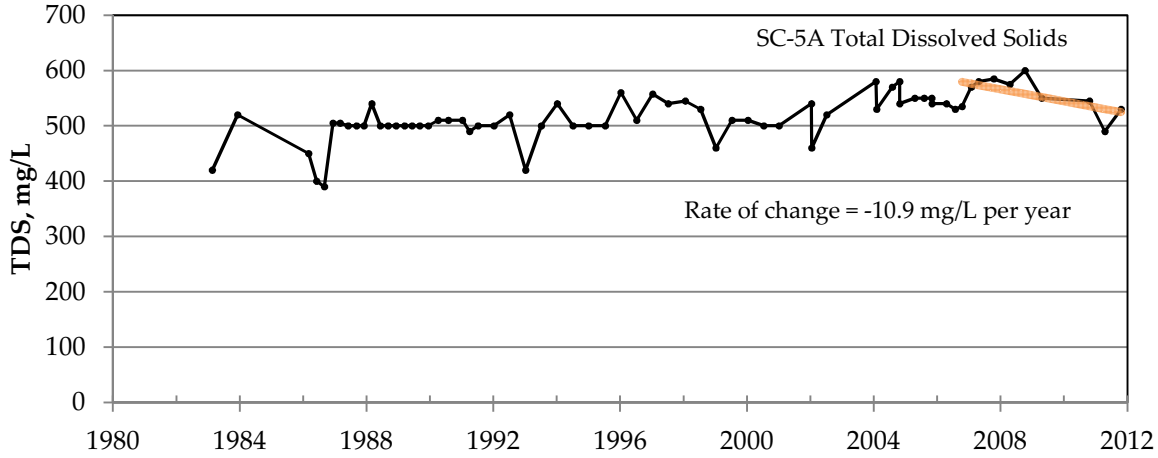

SC-3B Groundwater Elevation
Groundwater Elevation, ft MSL
50
45
40
35
30
25
20
15
10
5
0
Rate of change = 4.7 feet per year
WY 2007-2011 Trend
Airline and sampling tubing damaged prior to well replaced in 2009
1980
1984
1988
1992
1996
2000
2004
2008
2012

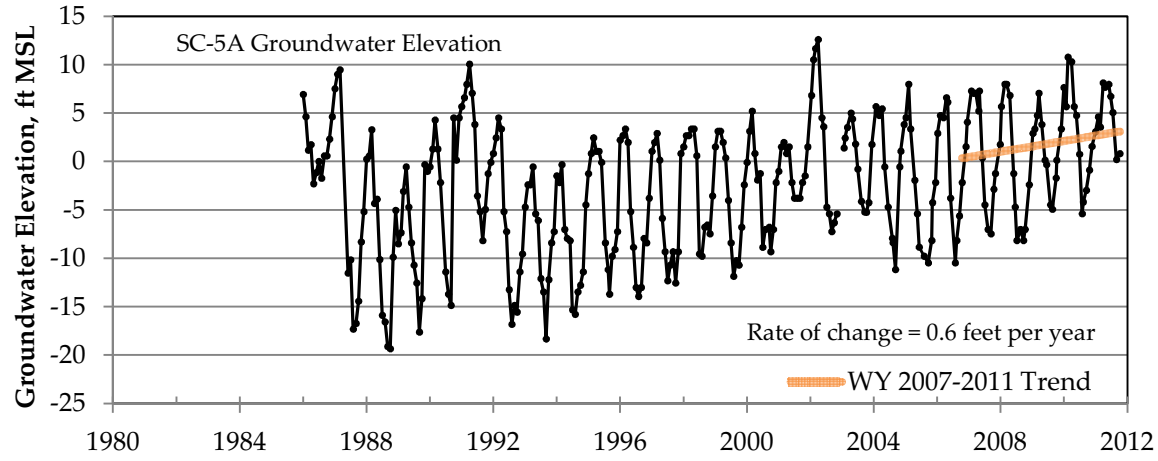

SC-3C Chloride
Rate of change = 1.6 mg/L per year
Chloride, mg/L
120
100
80
60
40
20
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

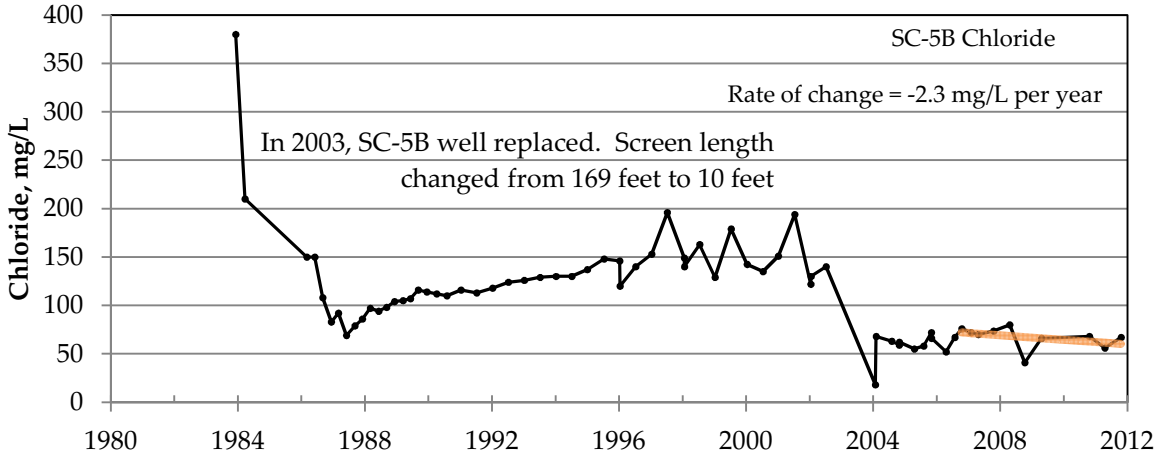

SC-3C Total Dissolved Solids
Rate of change = -8.4 mg/L per year
Pneumatic sampler broken, air-lifted purge
water sampled prior to well replaced in 2009
TDS, mg/L
900
800
700
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

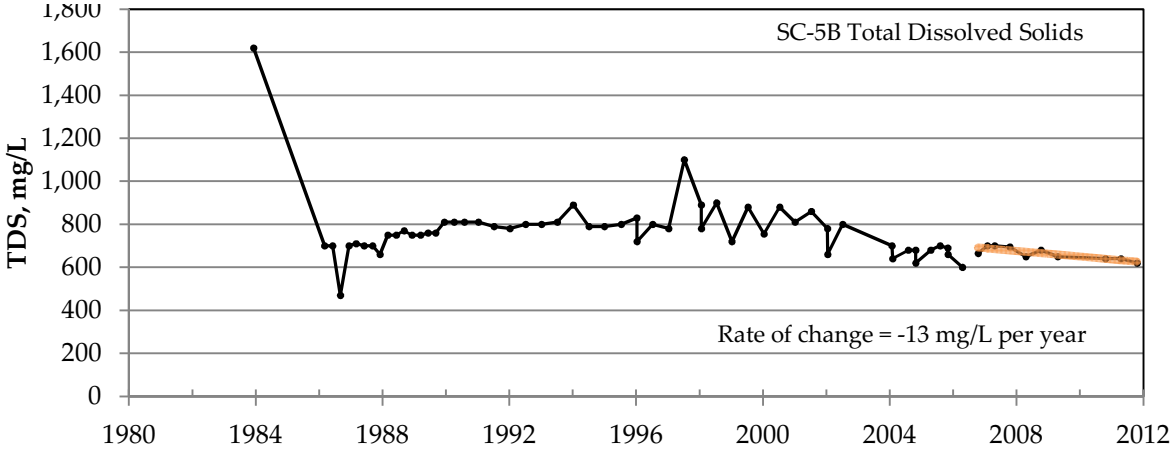

SC-3C Groundwater Elevation
Rate of change = -0.5 feet per year
WY 2007-2011 Trend
Groundwater Elevation, ft MSL
90
80
70
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

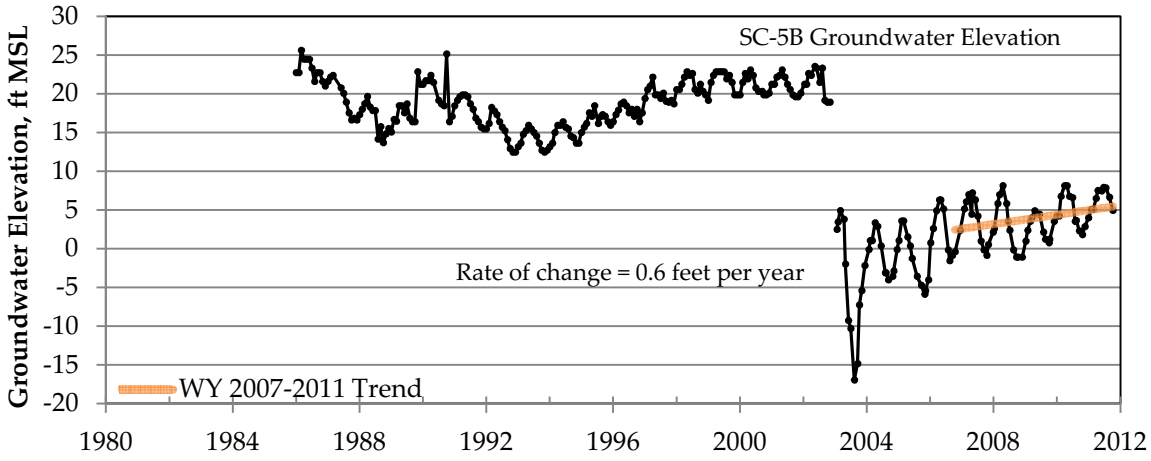

SC-5A Chloride
Rate of change = 0.3 mg/L per year
In 2003, SC-5A well replaced. Screen length changed from 245 feet to 230 feet
Chloride, mg/L
100
90
80
70
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

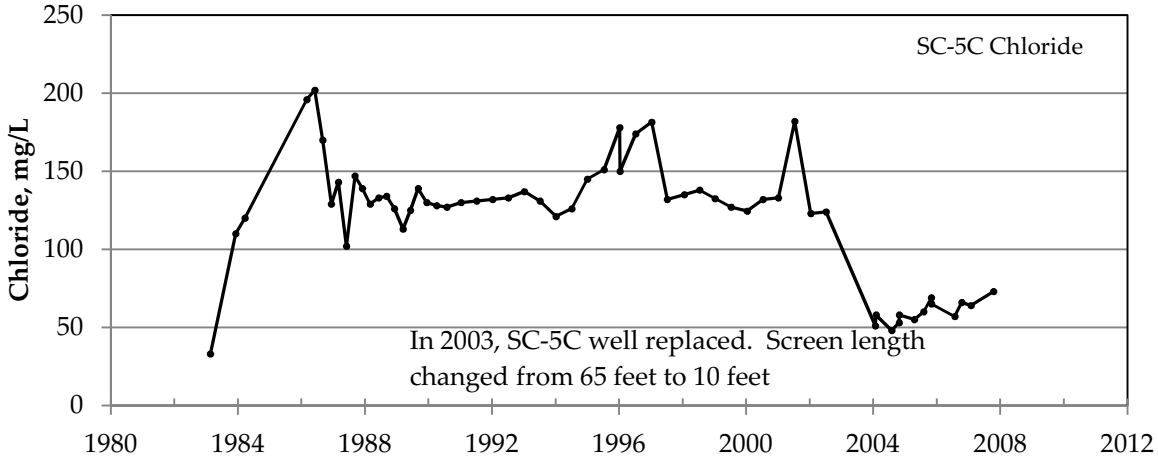

SC-5A Total Dissolved Solids
Rate of change = -10.9 mg/L per year
TDS, mg/L
700
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

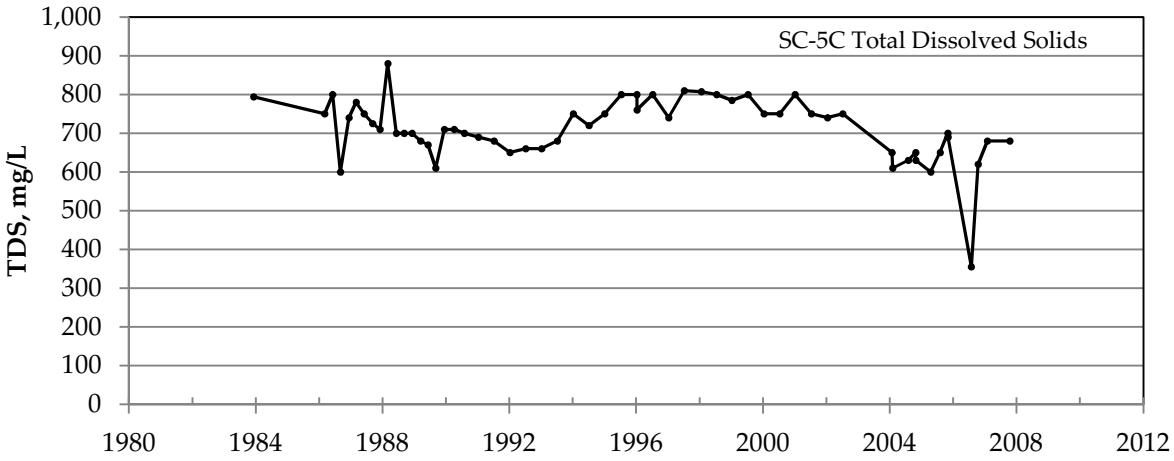

SC-5A Groundwater Elevation
Rate of change = 0.6 feet per year
WY 2007-2011 Trend
Groundwater Elevation, ft MSL
15
10
5
0
-5
-10
-15
-20
-25
1980
1984
1988
1992
1996
2000
2004
2008
2012

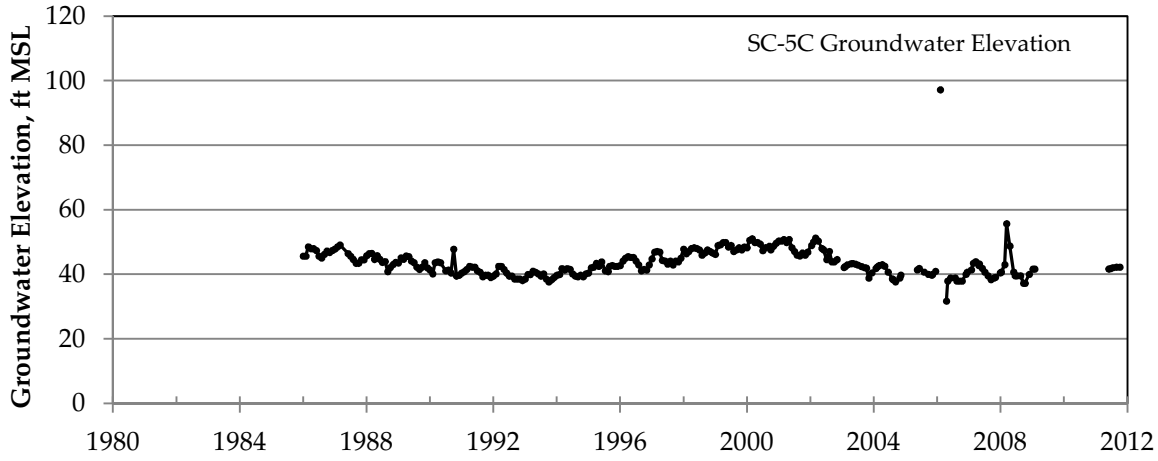

SC-5B Chloride
Rate of change = -2.3 mg/L per year
In 2003, SC-5B well replaced. Screen length changed from 169 feet to 10 feet
Chloride, mg/L
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

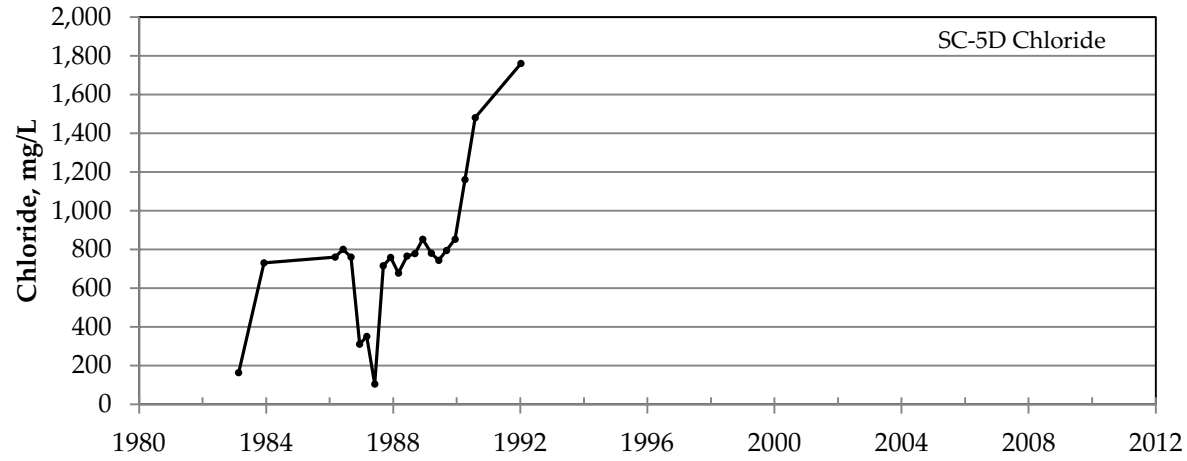

SC-5B Total Dissolved Solids
Rate of change = -13 mg/L per year
TDS, mg/L
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

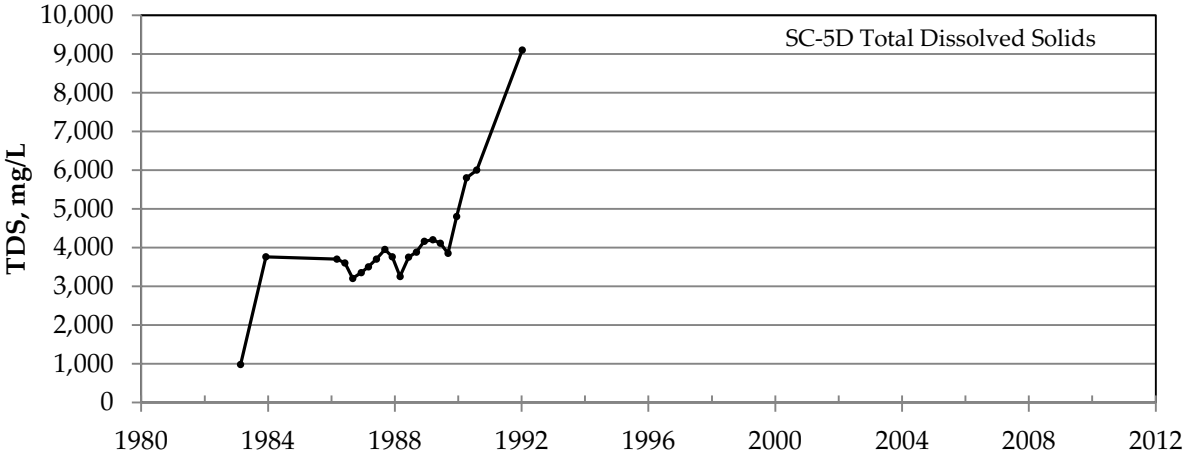

SC-5B Groundwater Elevation
Rate of change = 0.6 feet per year
WY 2007-2011 Trend
Groundwater Elevation, ft MSL
30
25
20
15
10
5
0
-5
-10
-15
-20
1980
1984
1988
1992
1996
2000
2004
2008
2012

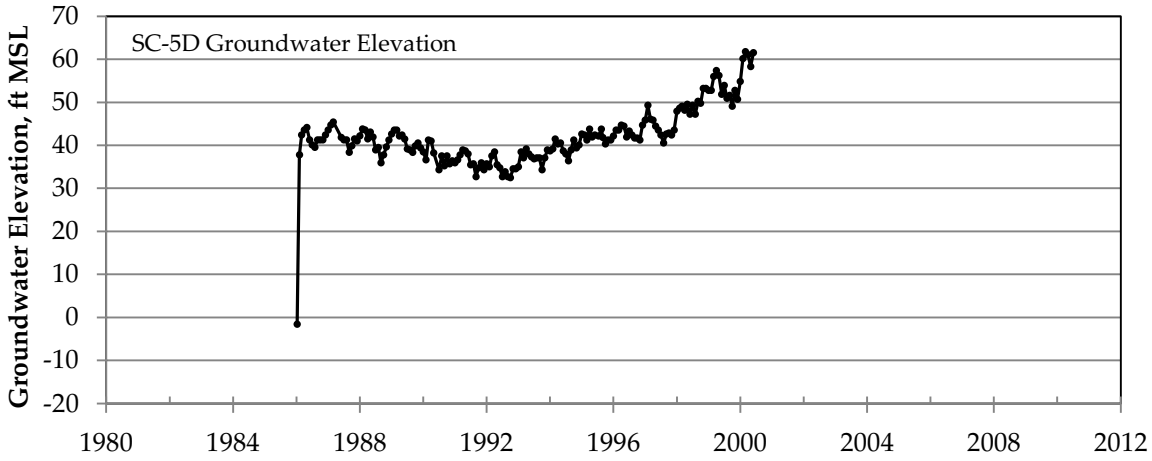

SC-5C Chloride
Chloride, mg/L
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012
In 2003, SC-5C well replaced. Screen length changed from 65 feet to 10 feet

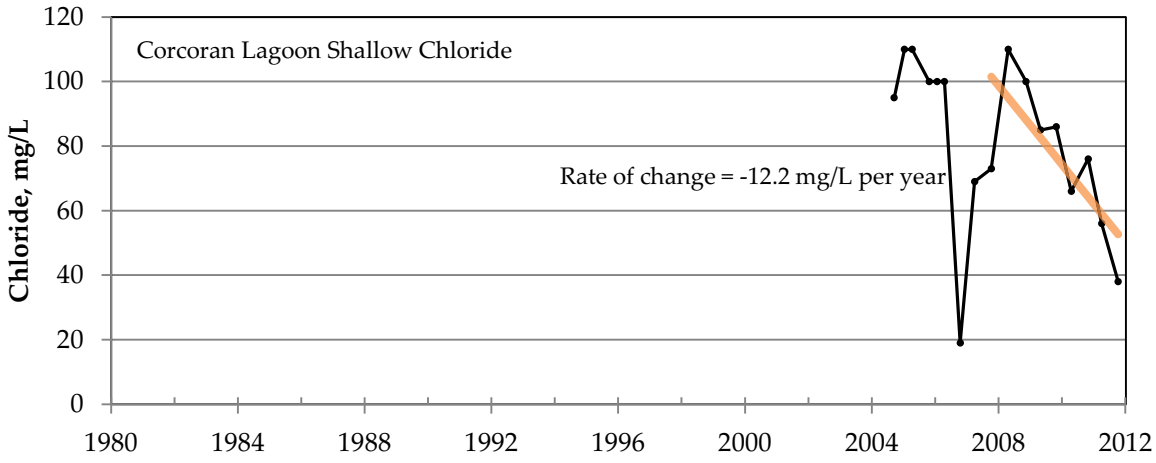

SC-5C Total Dissolved Solids
TDS, mg/L
1,000
900
800
700
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

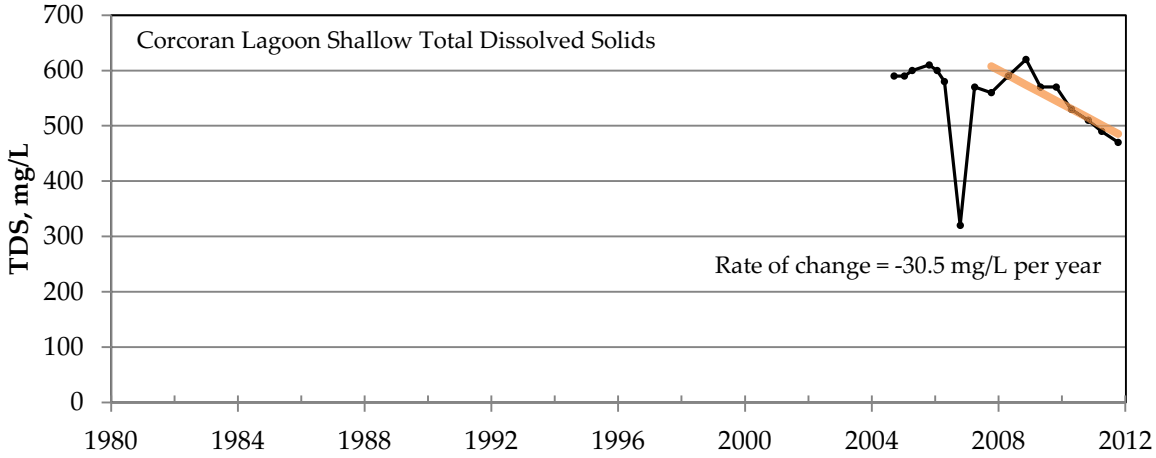

SC-5C Groundwater Elevation
Groundwater Elevation, ft MSL
120
100
80
60
40
20
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

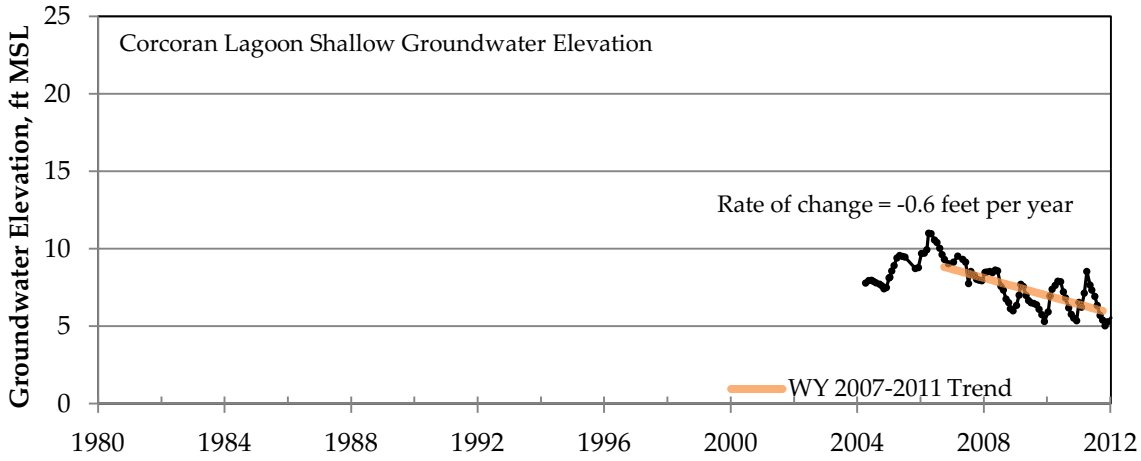

SC-5D Chloride
Chloride, mg/L
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

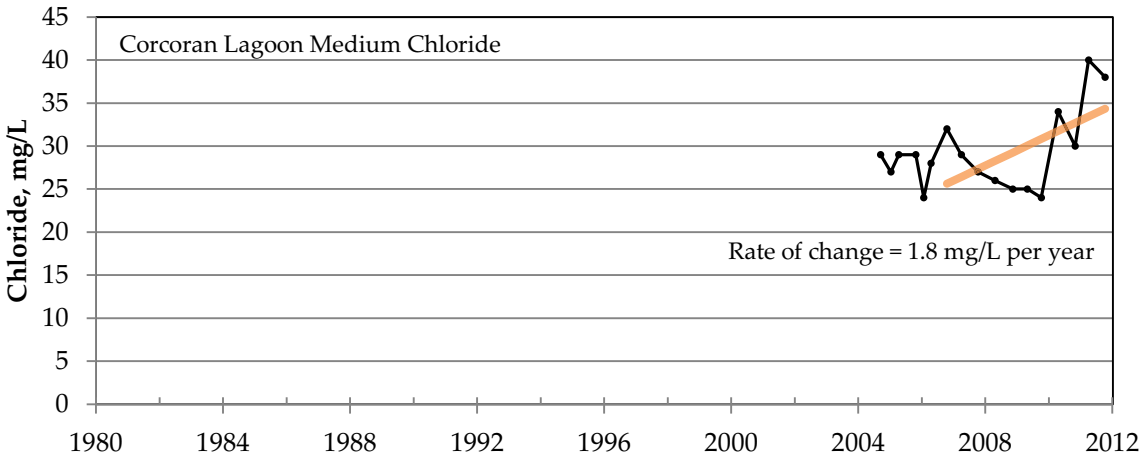

SC-5D Total Dissolved Solids
TDS, mg/L
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

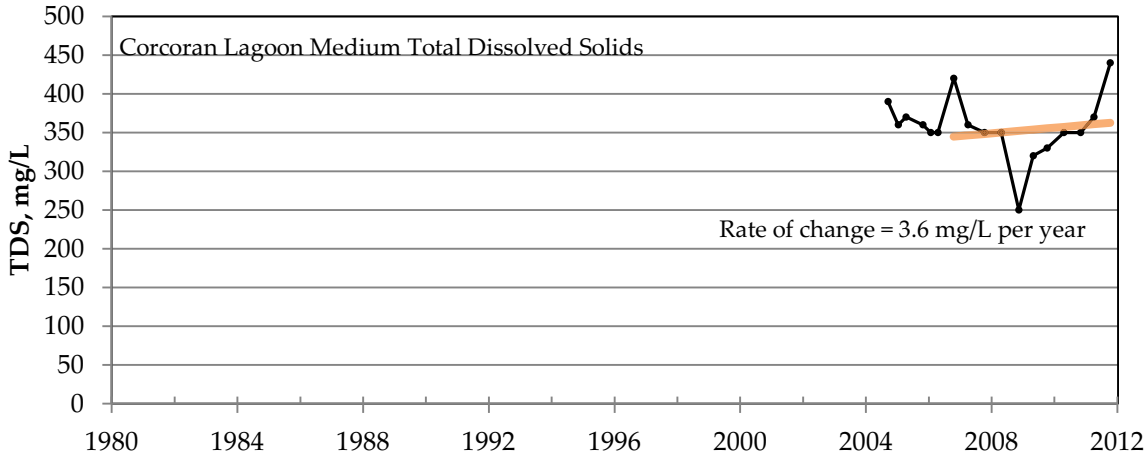

SC-5D Groundwater Elevation
Groundwater Elevation, ft MSL
70
60
50
40
30
20
10
0
-10
-20
1980
1984
1988
1992
1996
2000
2004
2008
2012

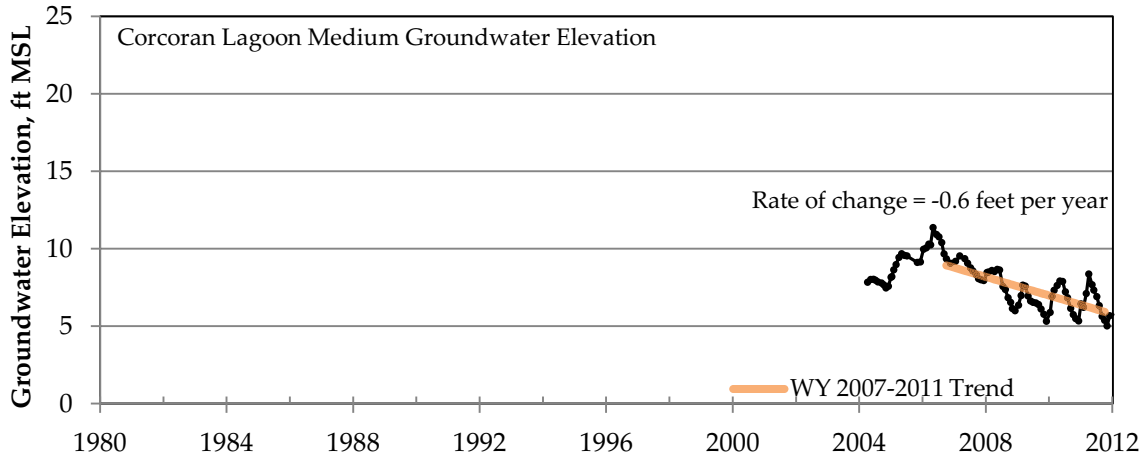

Corcoran Lagoon Shallow Chloride
Chloride, mg/L
Rate of change = -12.2 mg/L per year
120
100
80
60
40
20
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

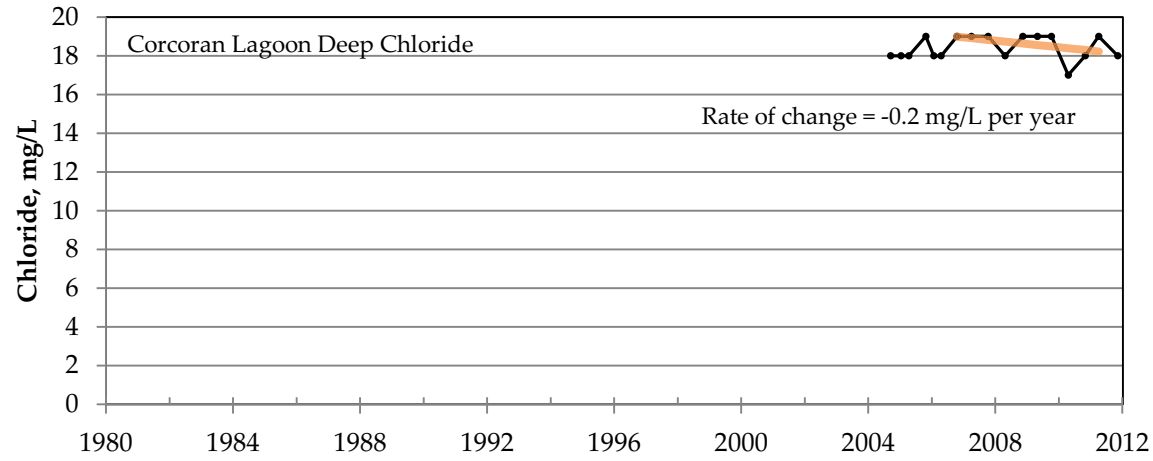

Corcoran Lagoon Shallow Total Dissolved Solids
TDS, mg/L
Rate of change = -30.5 mg/L per year
700
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

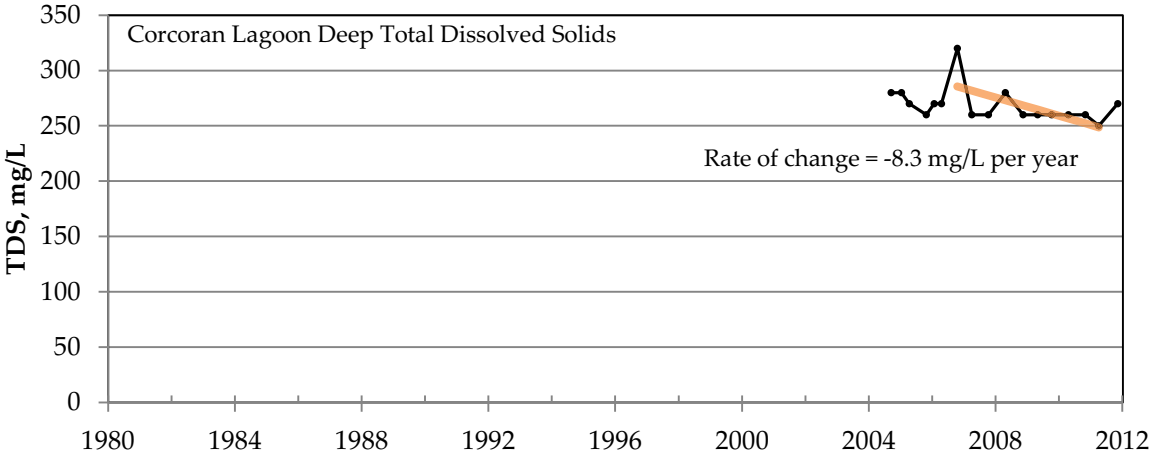

Corcoran Lagoon Shallow Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = -0.6 feet per year
WY 2007-2011 Trend
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

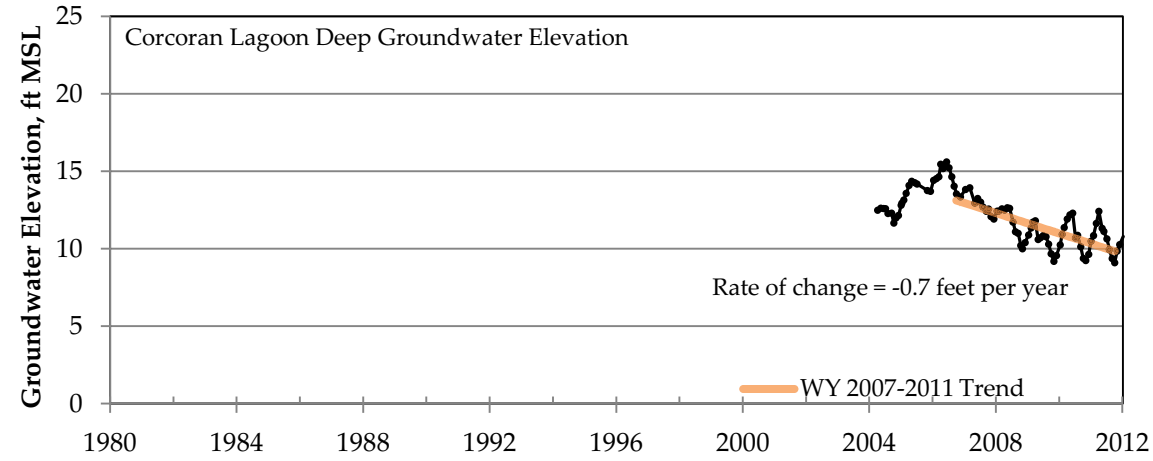

Corcoran Lagoon Medium Chloride
Chloride, mg/L
Rate of change = 1.8 mg/L per year
0
5
10
15
20
25
30
35
40
45
1980
1984
1988
1992
1996
2000
2004
2008
2012

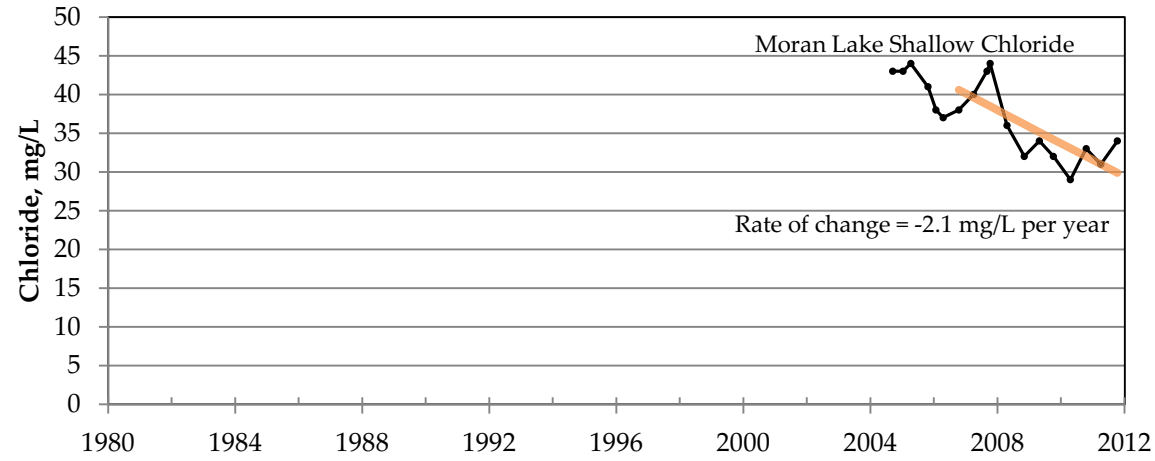

Corcoran Lagoon Medium Total Dissolved Solids
TDS, mg/L
Rate of change = 3.6 mg/L per year
0
50
100
150
200
250
300
350
400
450
500
1980
1984
1988
1992
1996
2000
2004
2008
2012

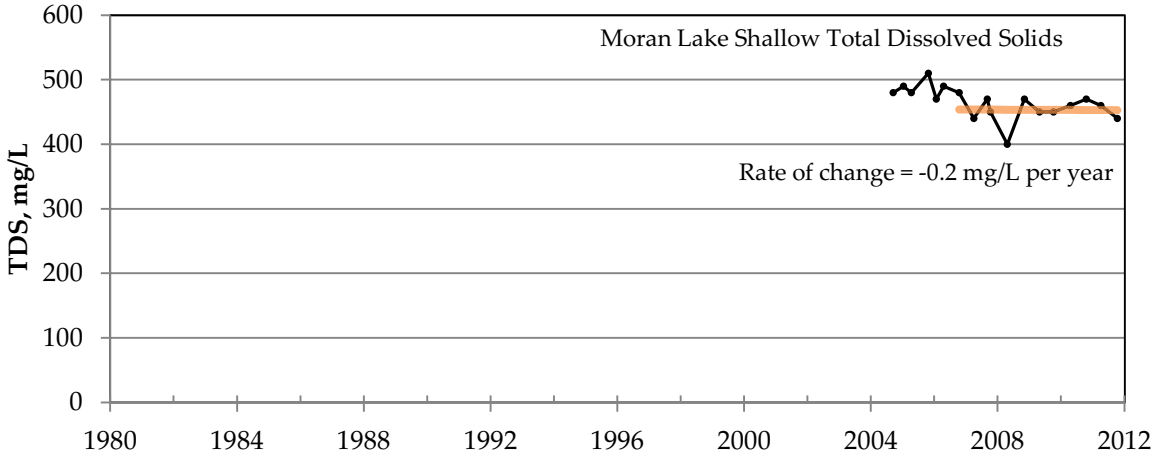

Corcoran Lagoon Medium Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = -0.6 feet per year
WY 2007-2011 Trend
0
5
10
15
20
25
1980
1984
1988
1992
1996
2000
2004
2008
2012

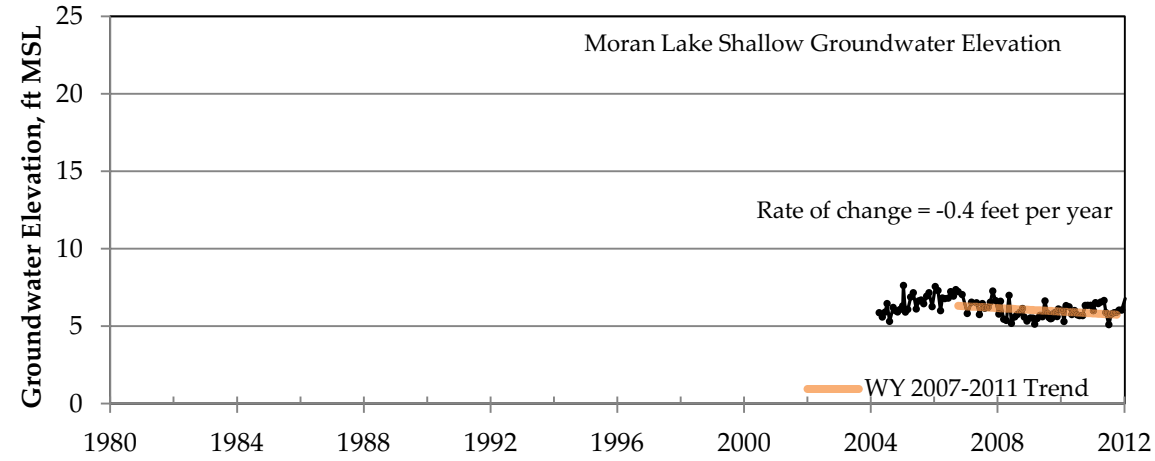

Corcoran Lagoon Deep Chloride
Rate of change = -0.2 mg/L per year
Chloride, mg/L
20
18
16
14
12
10
8
6
4
2
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

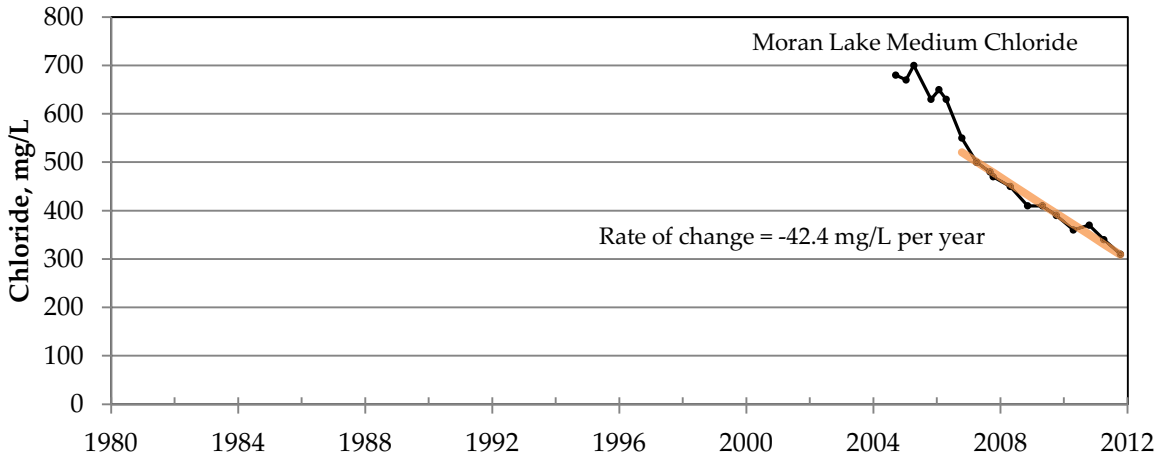

Corcoran Lagoon Deep Total Dissolved Solids
Rate of change = -8.3 mg/L per year
TDS, mg/L
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

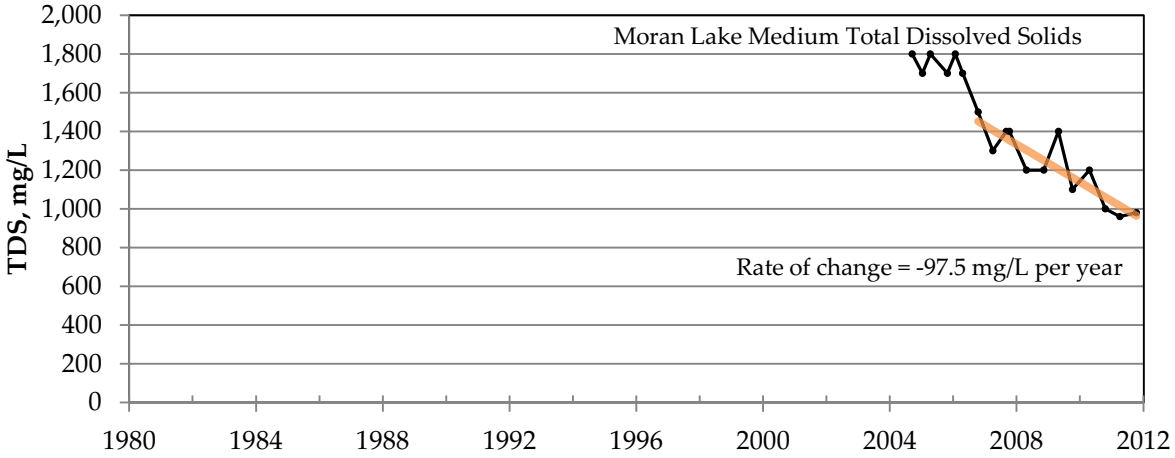

Corcoran Lagoon Deep Groundwater Elevation
Rate of change = -0.7 feet per year
WY 2007-2011 Trend
Groundwater Elevation, ft MSL
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

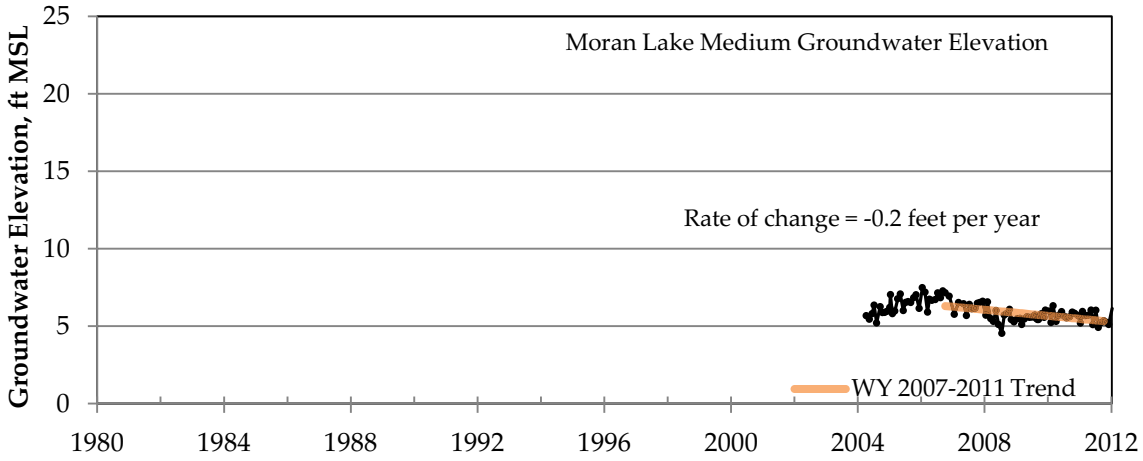

Moran Lake Shallow Chloride
Chloride, mg/L
Rate of change = -2.1 mg/L per year
50
45
40
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012


Moran Lake Shallow Total Dissolved Solids
TDS, mg/L
Rate of change = -0.2 mg/L per year
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

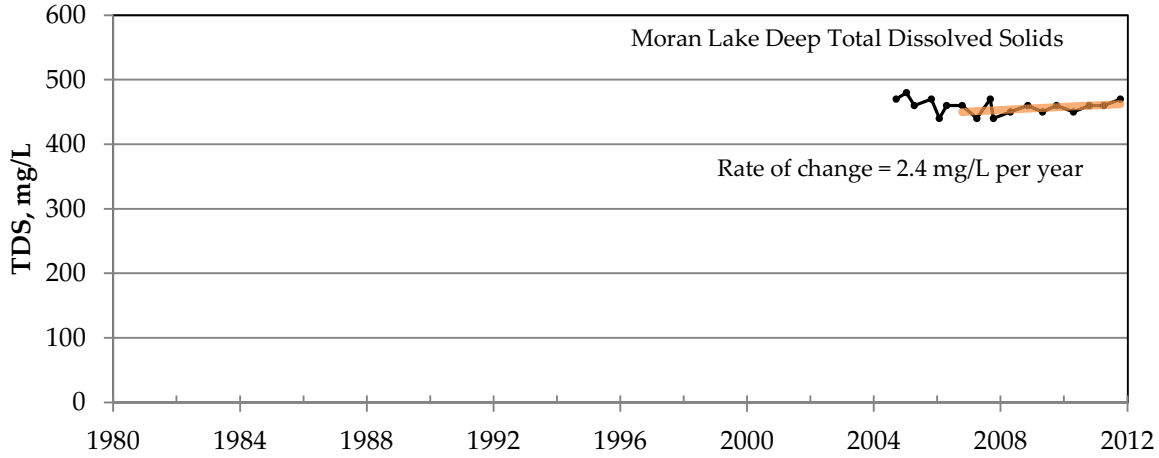

Moran Lake Shallow Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = -0.4 feet per year
WY 2007-2011 Trend
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

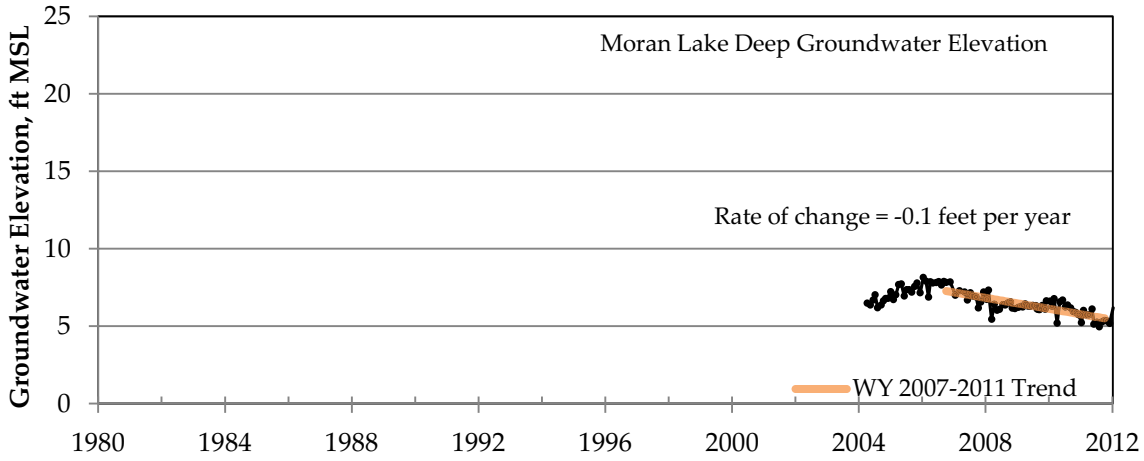

Moran Lake Medium Chloride
Chloride, mg/L
800
700
600
500
400
300
200
100
0
Rate of change = -42.4 mg/L per year
1980
1984
1988
1992
1996
2000
2004
2008
2012

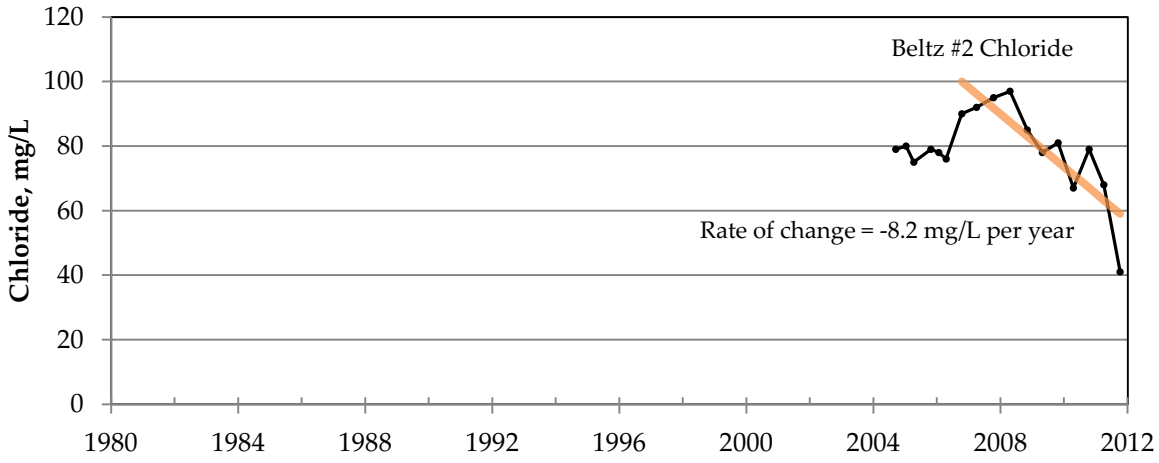

Moran Lake Medium Total Dissolved Solids
TDS, mg/L
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
Rate of change = -97.5 mg/L per year
1980
1984
1988
1992
1996
2000
2004
2008
2012

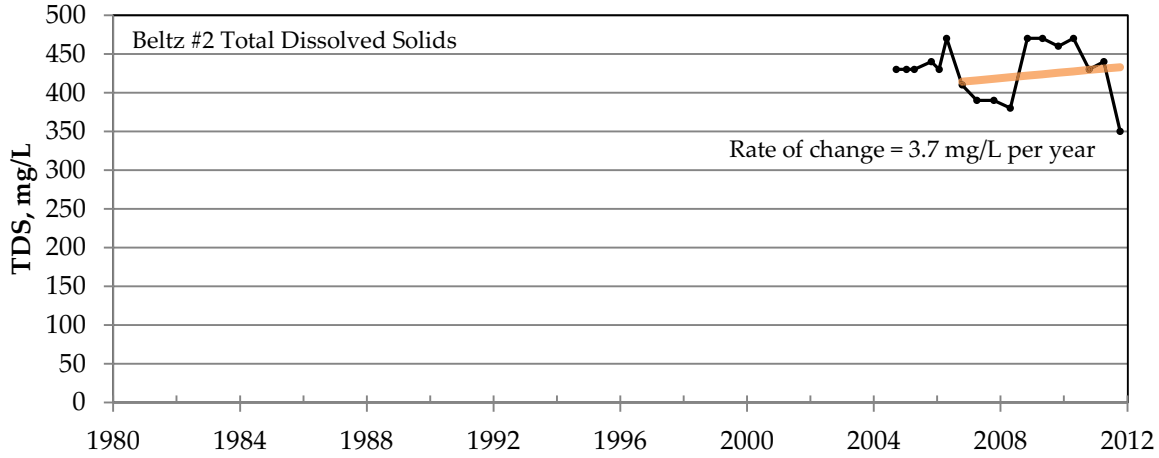

Moran Lake Medium Groundwater Elevation
Groundwater Elevation, ft MSL
25
20
15
10
5
0
Rate of change = -0.2 feet per year
WY 2007-2011 Trend
1980
1984
1988
1992
1996
2000
2004
2008
2012

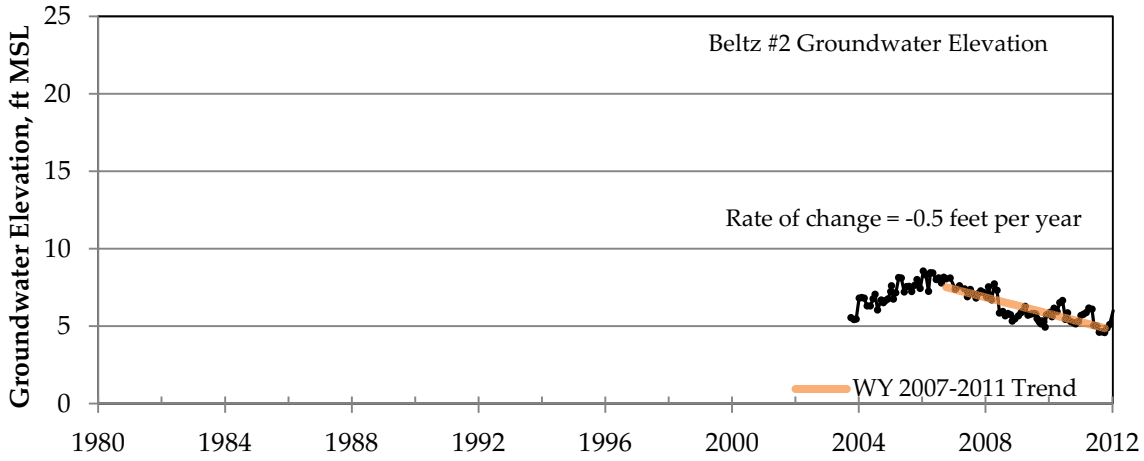

Moran Lake Deep Chloride
Chloride, mg/L
Rate of change = 0.3 mg/L per year
100
90
80
70
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

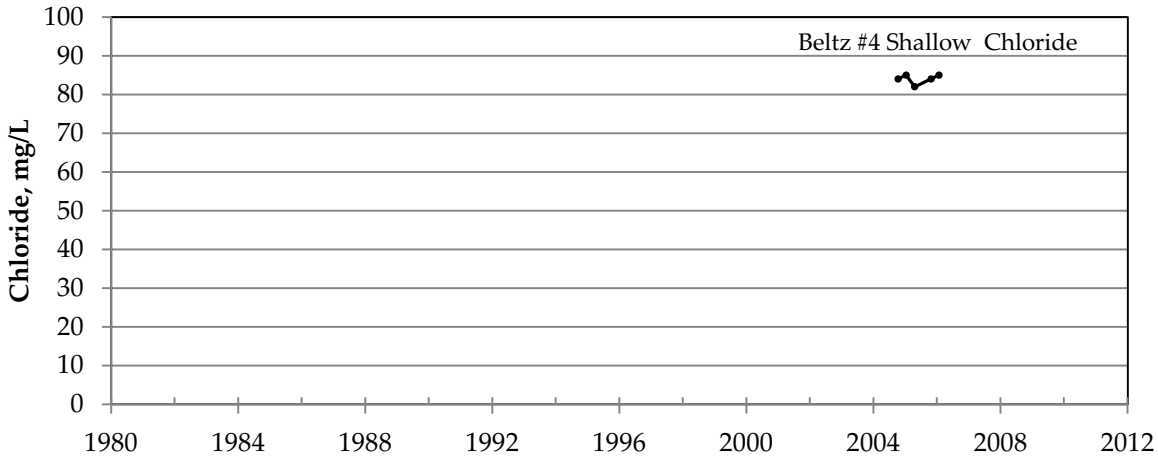

Moran Lake Deep Total Dissolved Solids
TDS, mg/L
Rate of change = 2.4 mg/L per year
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

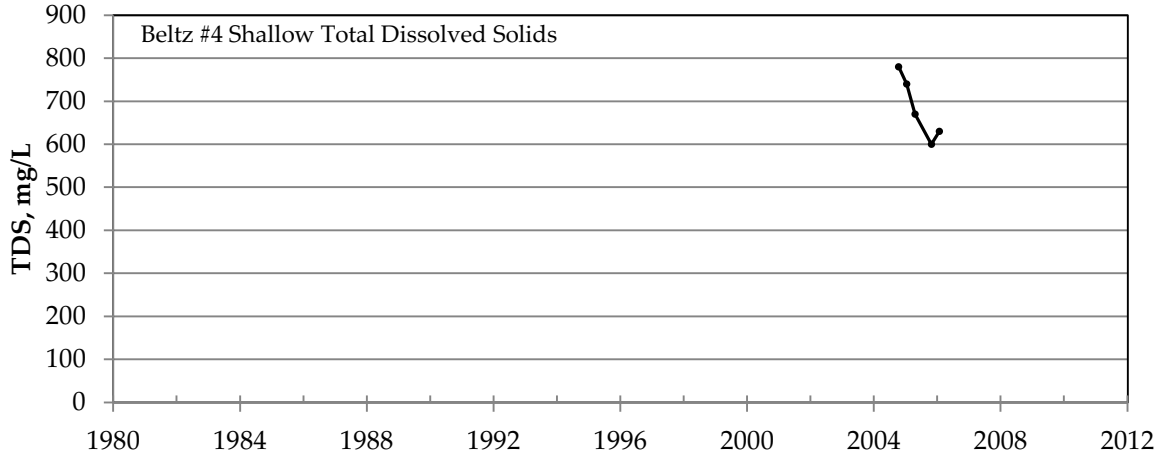

Moran Lake Deep Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = -0.1 feet per year
WY 2007-2011 Trend
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

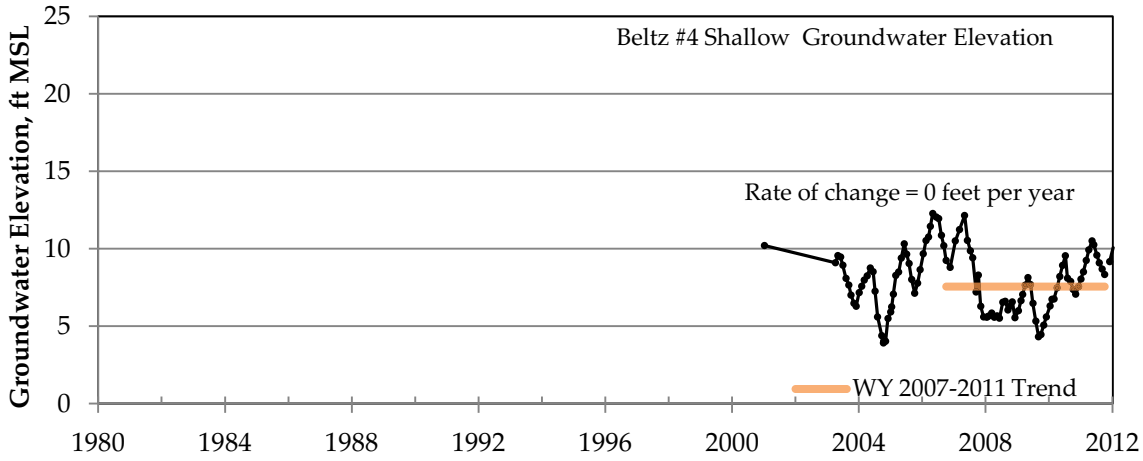

Beltz #2 Chloride
Chloride, mg/L
Rate of change = -8.2 mg/L per year
120
100
80
60
40
20
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

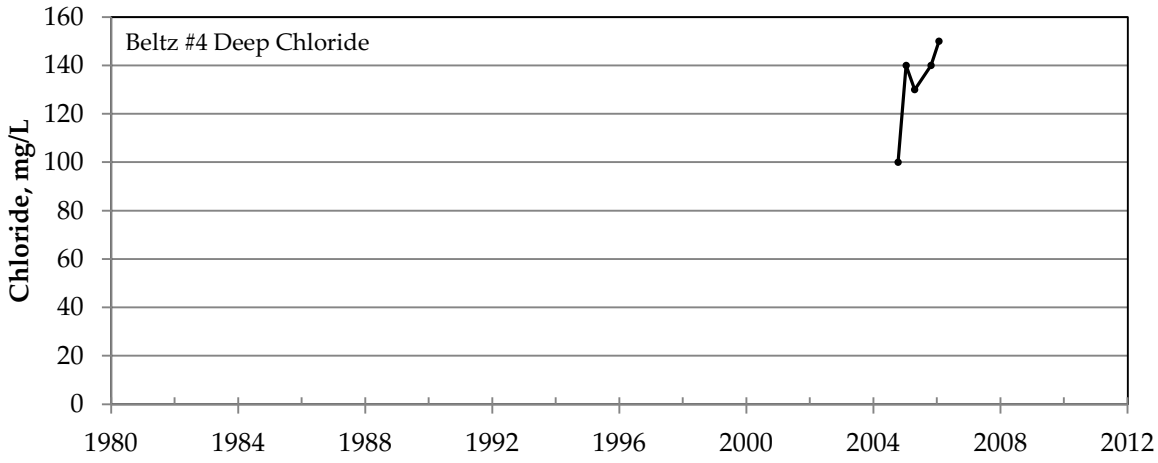

Beltz #2 Total Dissolved Solids
TDS, mg/L
Rate of change = 3.7 mg/L per year
500
450
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

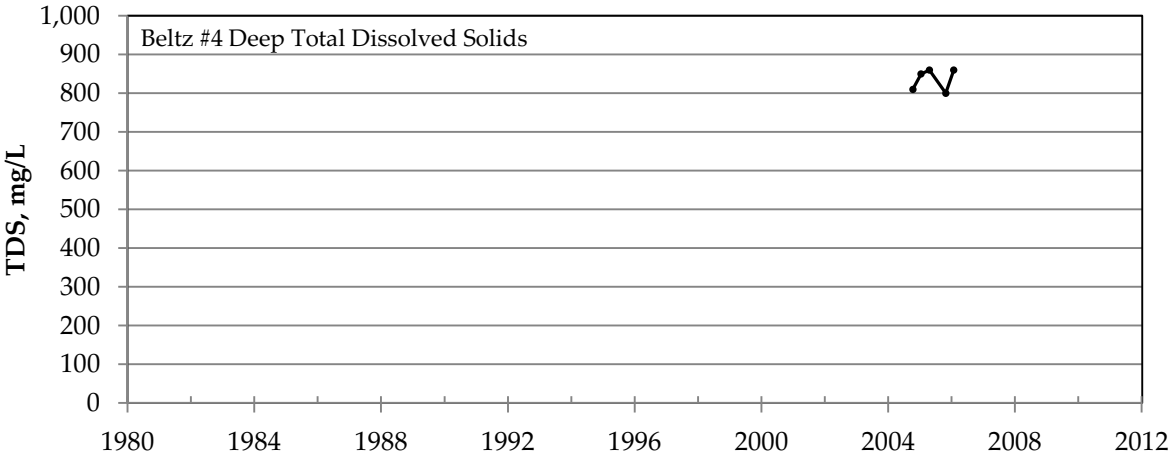

Beltz #2 Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = -0.5 feet per year
WY 2007-2011 Trend
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

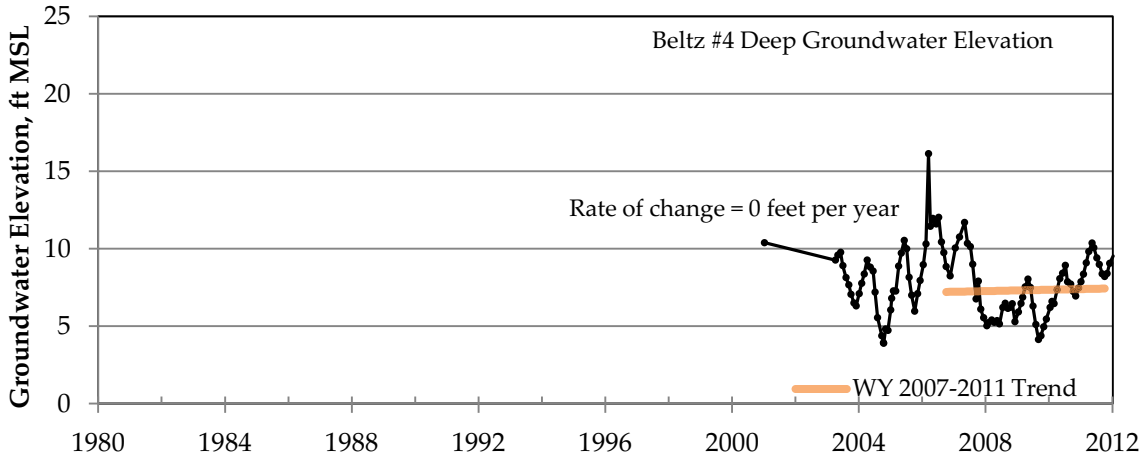

Beltz #4 Shallow Chloride
Chloride, mg/L
100
90
80
70
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

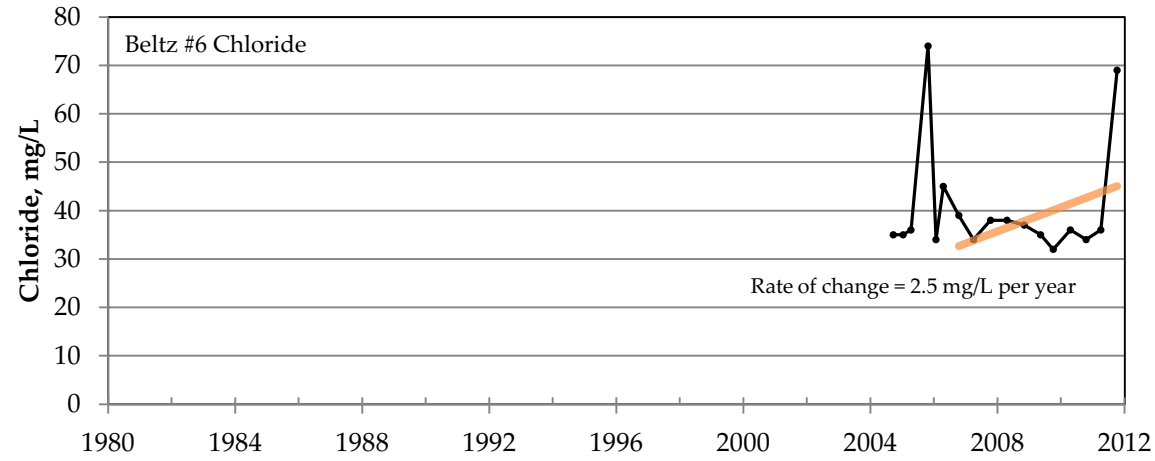

Beltz #4 Shallow Total Dissolved Solids
TDS, mg/L
900
800
700
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

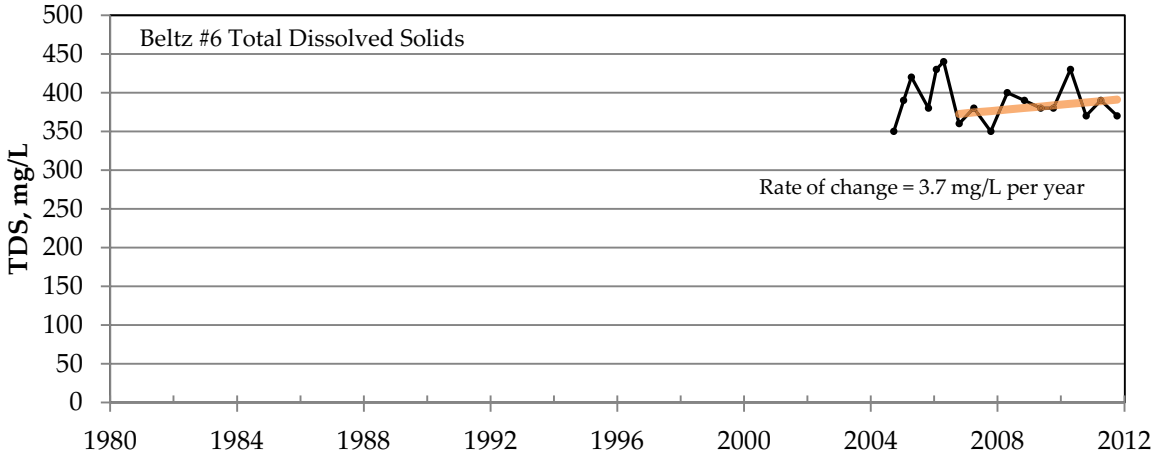

Beltz #4 Shallow Groundwater Elevation
Groundwater Elevation, ft MSL
25
20
15
10
5
0
Rate of change = 0 feet per year
WY 2007-2011 Trend
1980
1984
1988
1992
1996
2000
2004
2008
2012

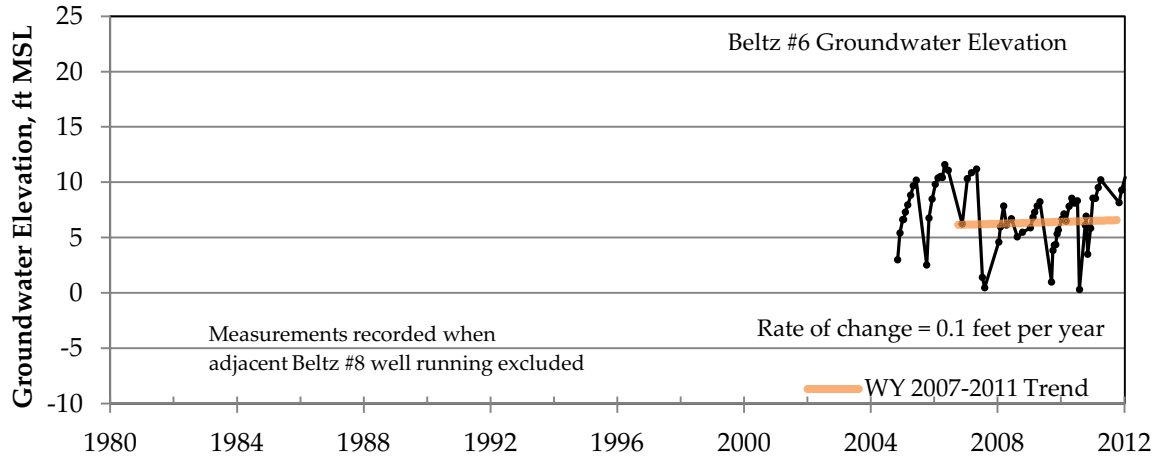

Beltz #4 Deep Chloride
Chloride, mg/L
160
140
120
100
80
60
40
20
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

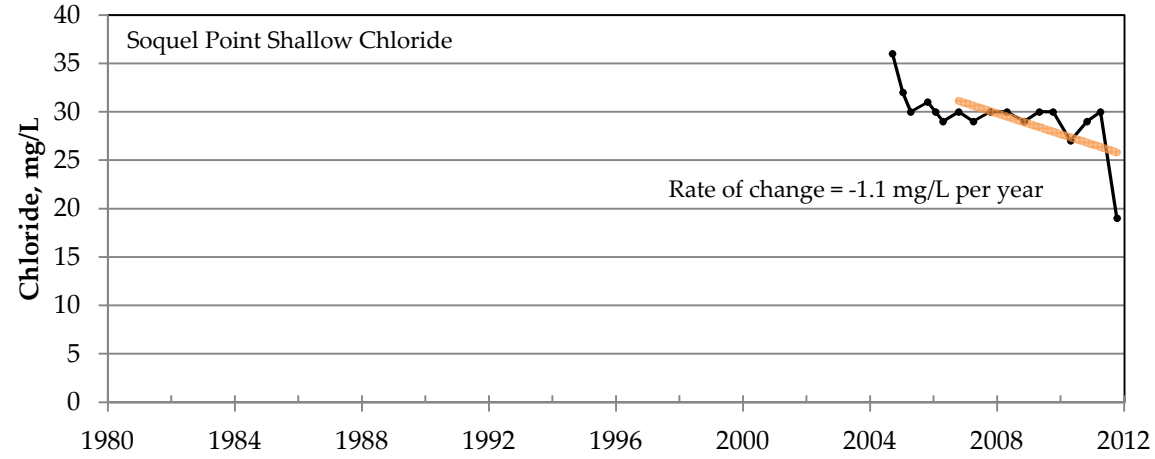

Beltz #4 Deep Total Dissolved Solids
TDS, mg/L
1,000
900
800
700
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

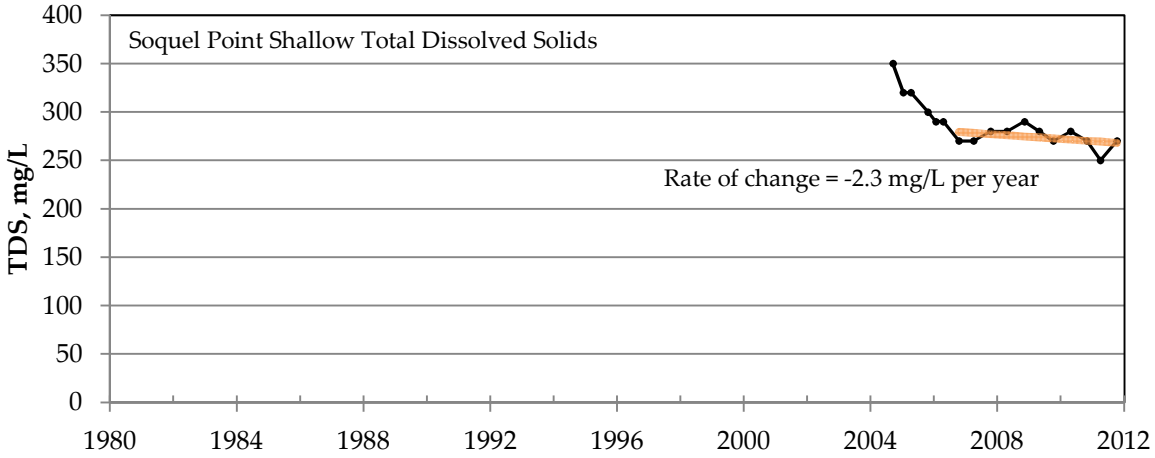

Beltz #4 Deep Groundwater Elevation
Groundwater Elevation, ft MSL
25
20
15
10
5
0
Rate of change = 0 feet per year
WY 2007-2011 Trend
1980
1984
1988
1992
1996
2000
2004
2008
2012

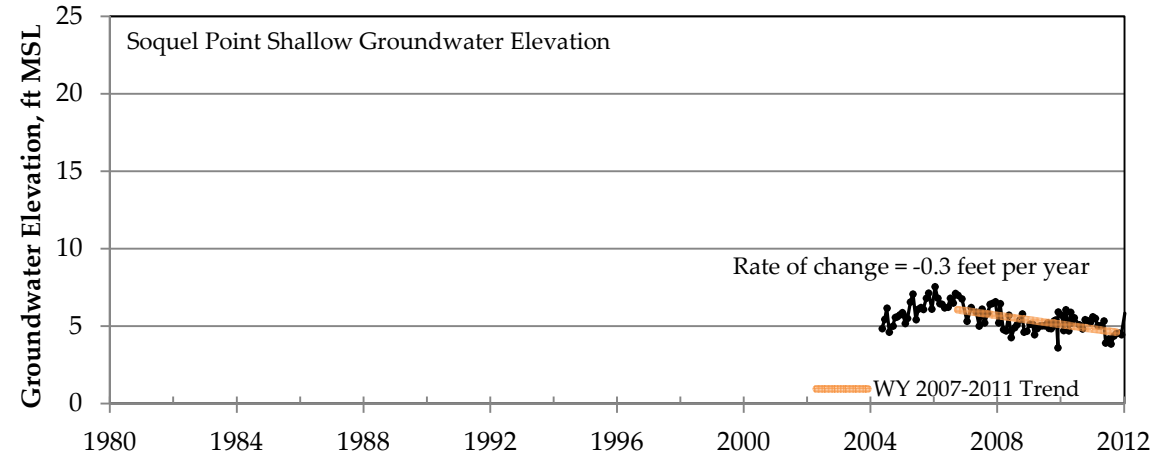

Beltz #6 Chloride
Chloride, mg/L
80
70
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012
Rate of change = 2.5 mg/L per year

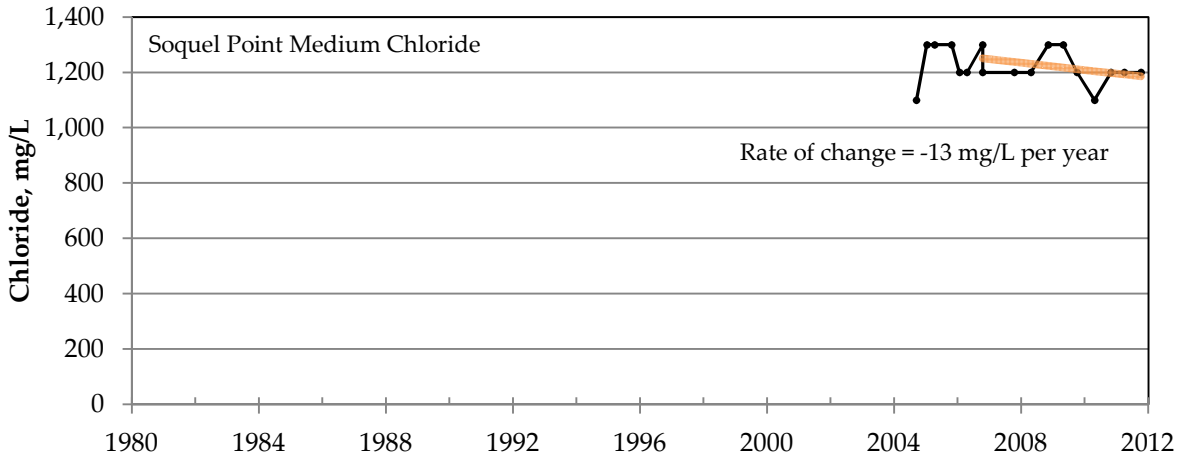

Beltz #6 Total Dissolved Solids
TDS, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012
Rate of change = 3.7 mg/L per year

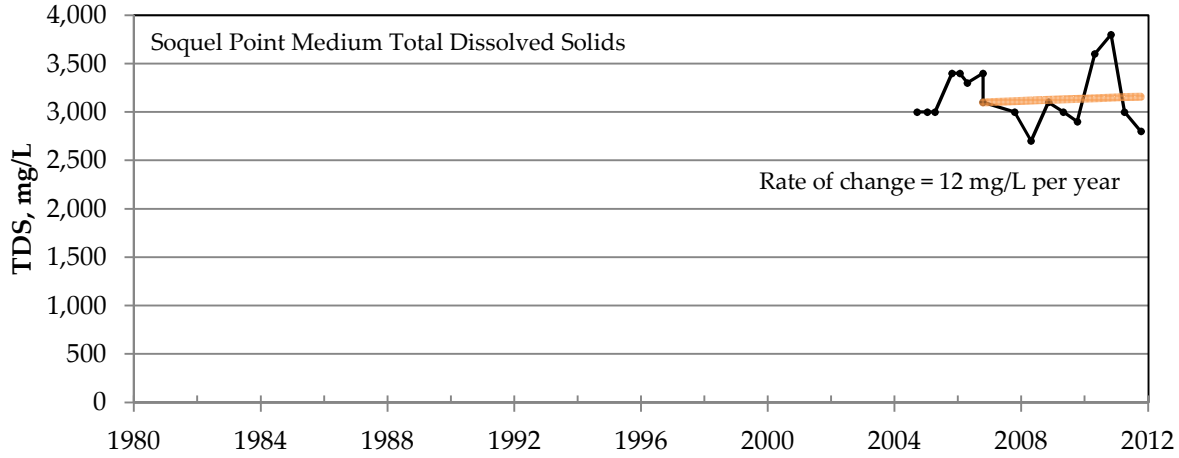

Beltz #6 Groundwater Elevation
Groundwater Elevation, ft MSL
25
20
15
10
5
0
-5
-10
1980
1984
1988
1992
1996
2000
2004
2008
2012
Measurements recorded when
adjacent Beltz #8 well running excluded
Rate of change = 0.1 feet per year
WY 2007-2011 Trend

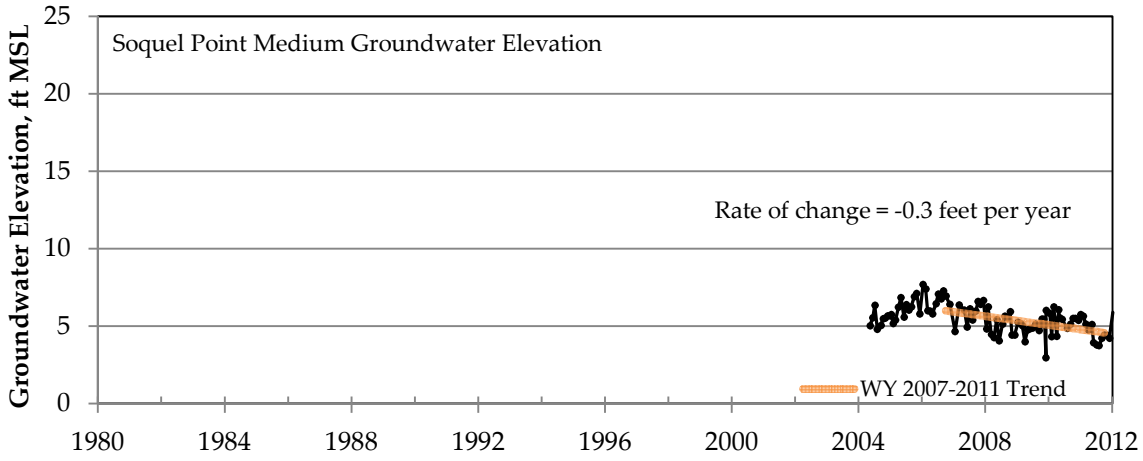

Soquel Point Shallow Chloride
Chloride, mg/L
Rate of change = -1.1 mg/L per year
40
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

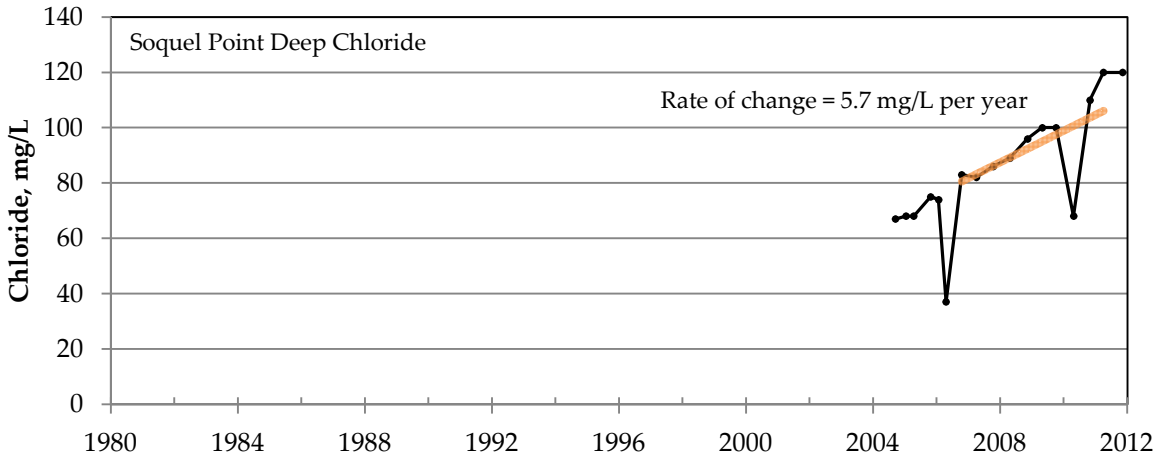

Soquel Point Shallow Total Dissolved Solids
TDS, mg/L
Rate of change = -2.3 mg/L per year
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

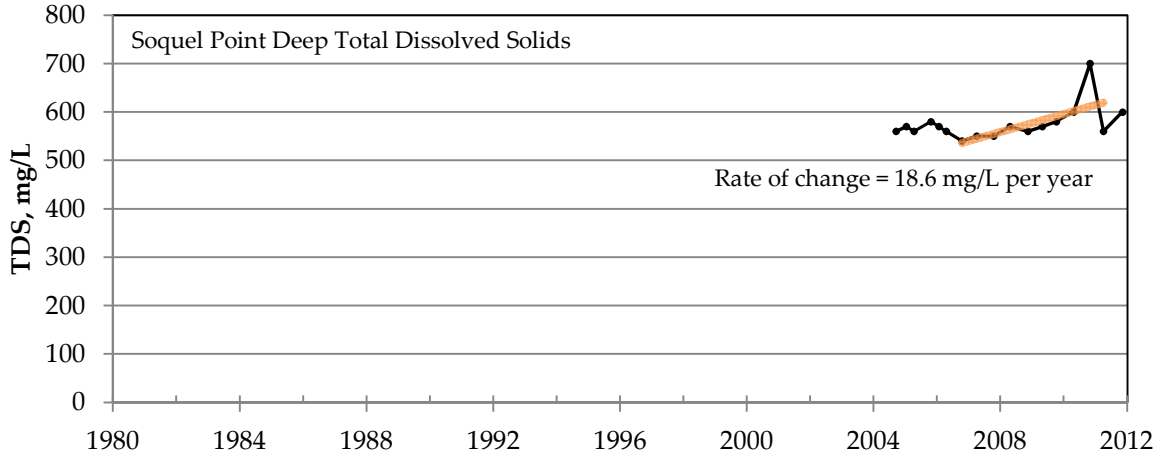

Soquel Point Shallow Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = -0.3 feet per year
WY 2007-2011 Trend
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

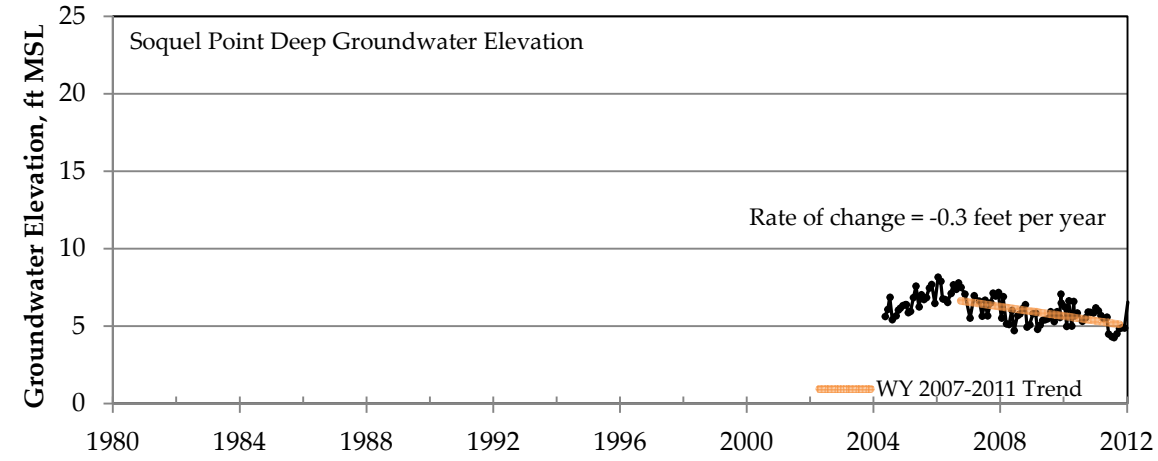

Soquel Point Medium Chloride
Chloride, mg/L
Rate of change = -13 mg/L per year
1,400
1,200
1,000
800
600
400
200
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

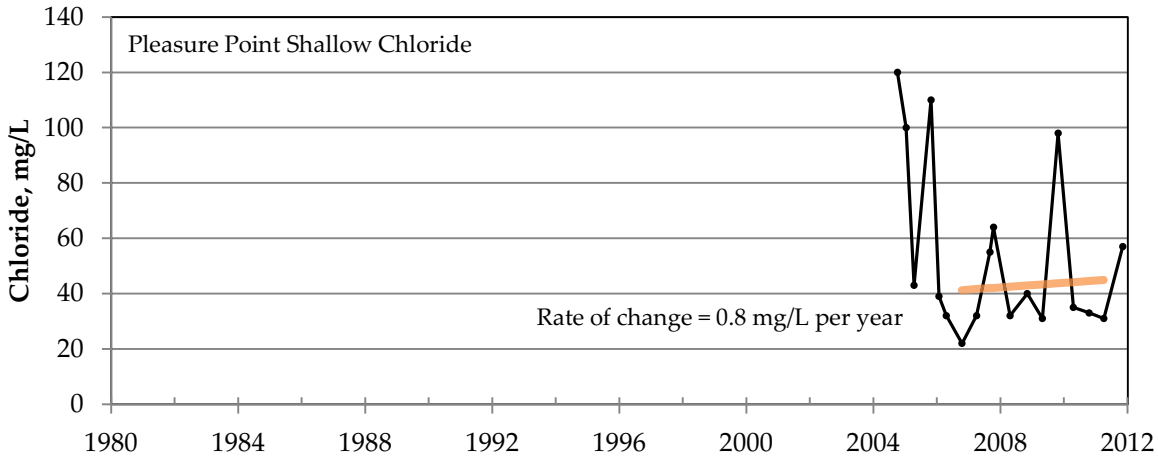

Soquel Point Medium Total Dissolved Solids
TDS, mg/L
Rate of change = 12 mg/L per year
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

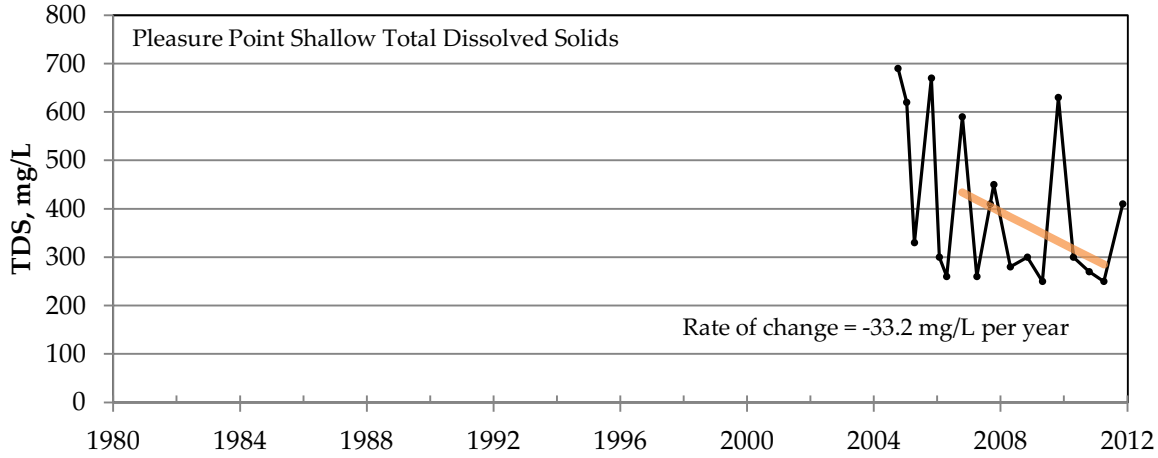

Soquel Point Medium Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = -0.3 feet per year
WY 2007-2011 Trend
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

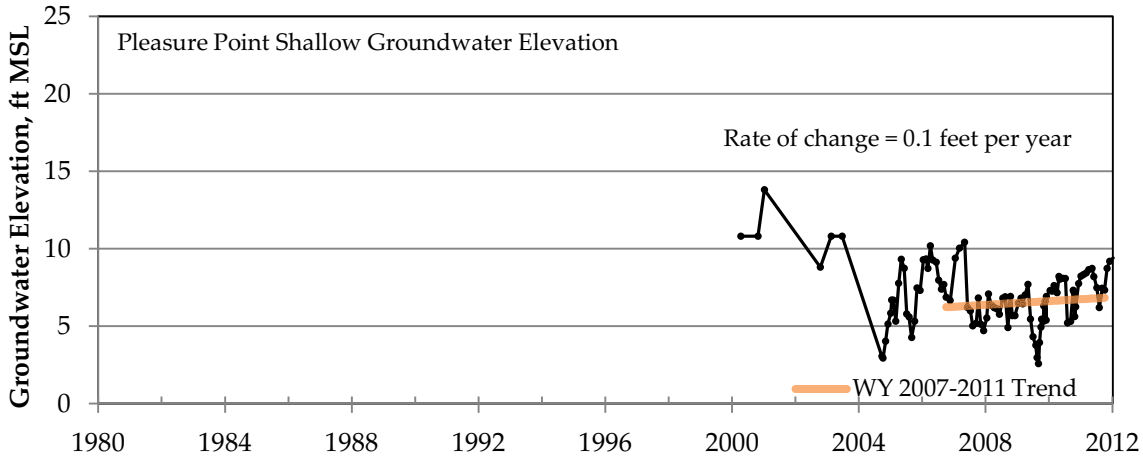

Soquel Point Deep Chloride
Rate of change = 5.7 mg/L per year
Chloride, mg/L
140
120
100
80
60
40
20
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

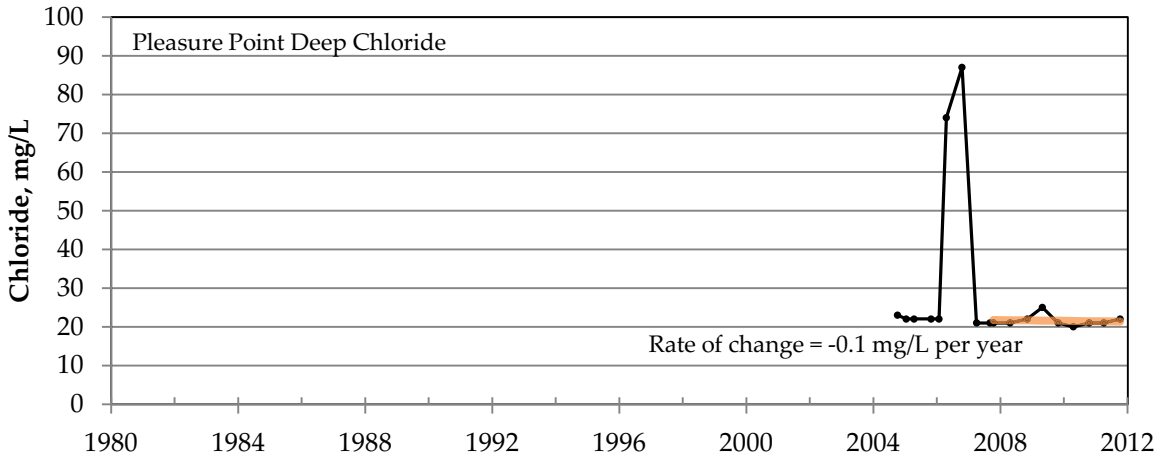

Soquel Point Deep Total Dissolved Solids
Rate of change = 18.6 mg/L per year
TDS, mg/L
800
700
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

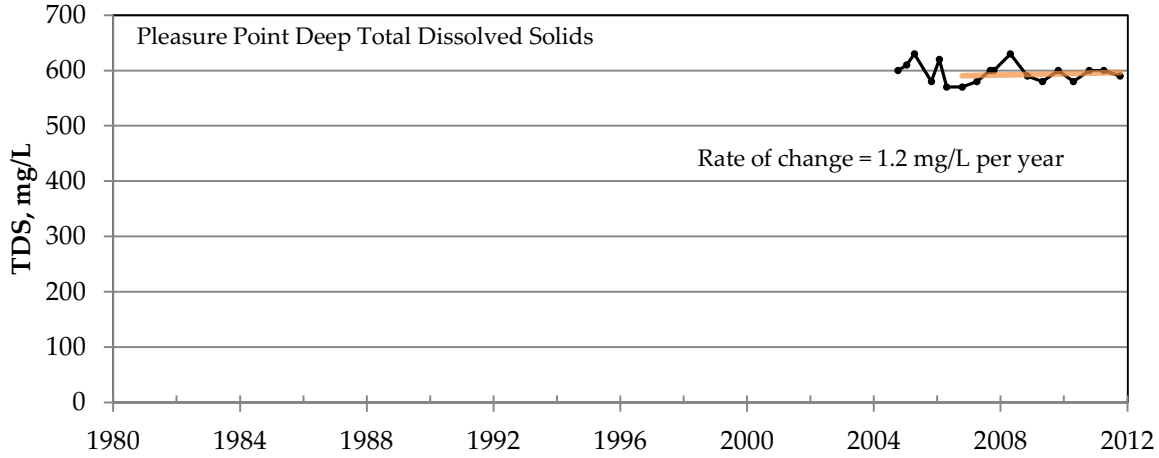

Soquel Point Deep Groundwater Elevation
Rate of change = -0.3 feet per year
WY 2007-2011 Trend
Groundwater Elevation, ft MSL
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

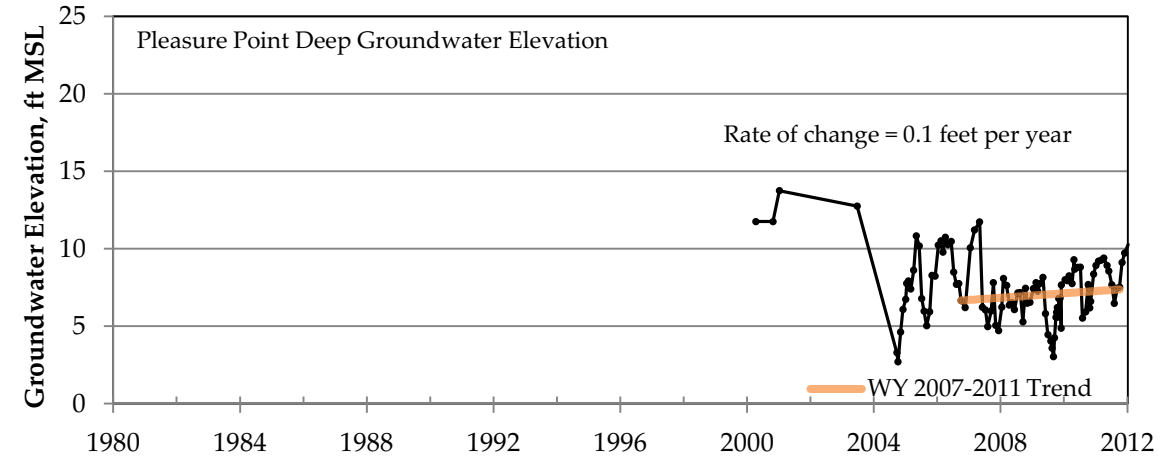

Pleasure Point Shallow Chloride
Chloride, mg/L
Rate of change = 0.8 mg/L per year
140
120
100
80
60
40
20
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

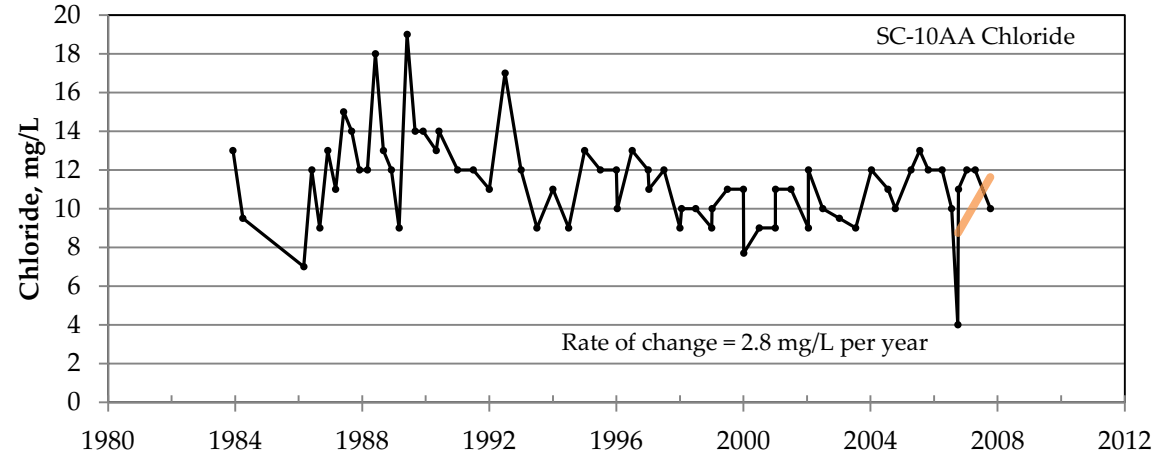

Pleasure Point Shallow Total Dissolved Solids
TDS, mg/L
Rate of change = -33.2 mg/L per year
800
700
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

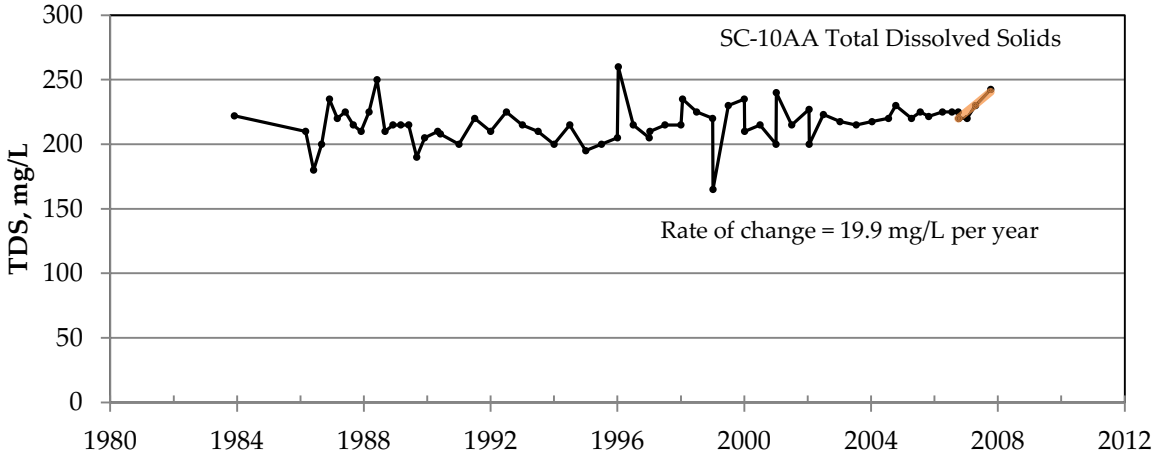

Pleasure Point Shallow Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = 0.1 feet per year
WY 2007-2011 Trend
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

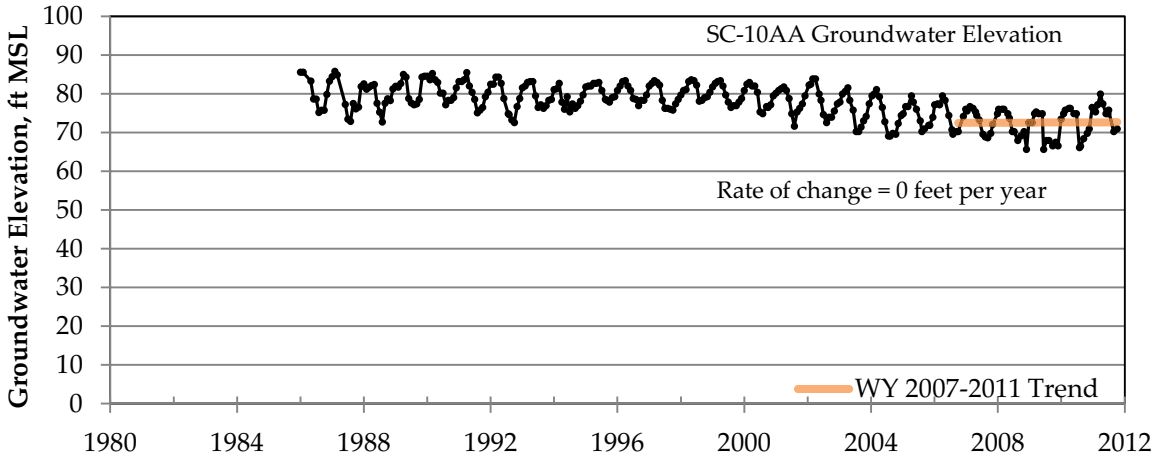

Pleasure Point Deep Chloride
Chloride, mg/L
Rate of change = -0.1 mg/L per year
100
90
80
70
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

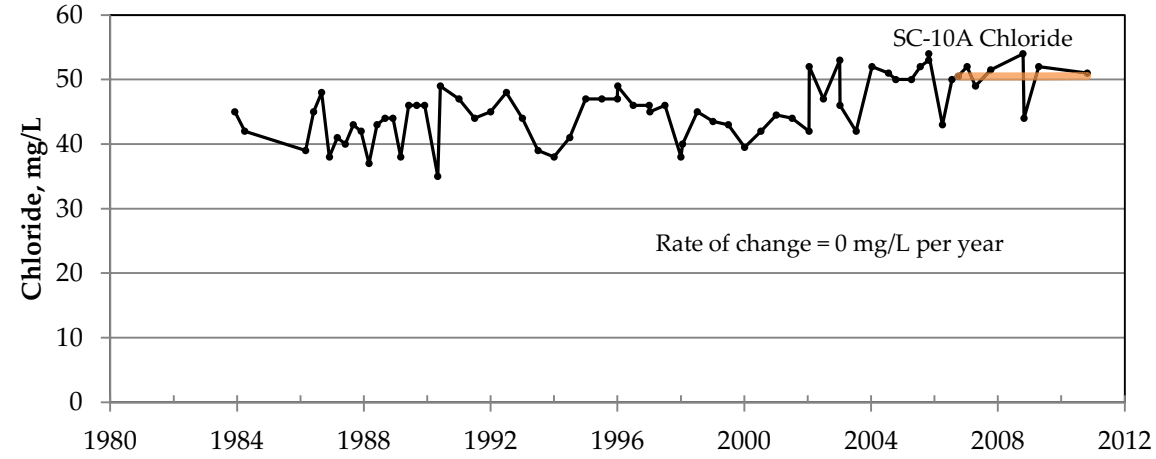

Pleasure Point Deep Total Dissolved Solids
TDS, mg/L
Rate of change = 1.2 mg/L per year
700
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

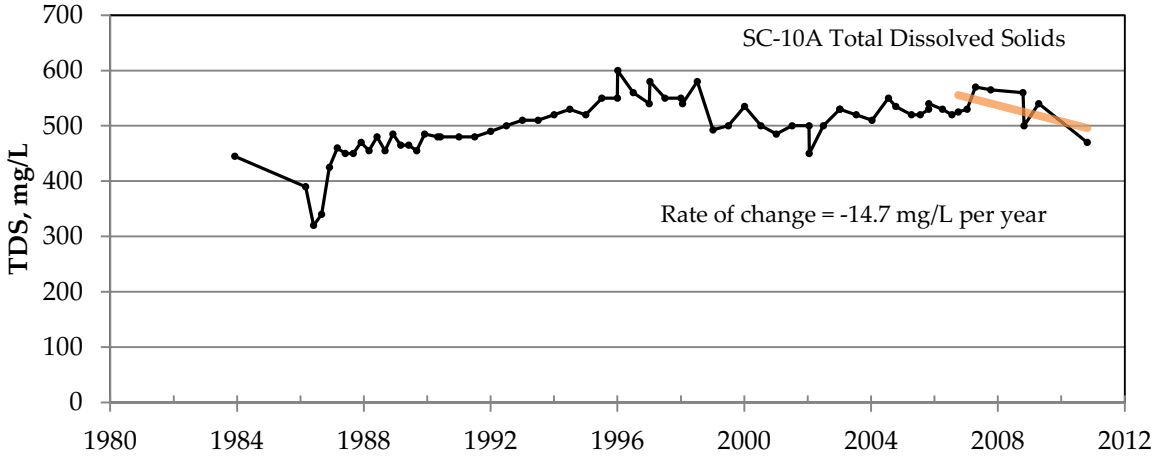

Pleasure Point Deep Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = 0.1 feet per year
WY 2007-2011 Trend
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

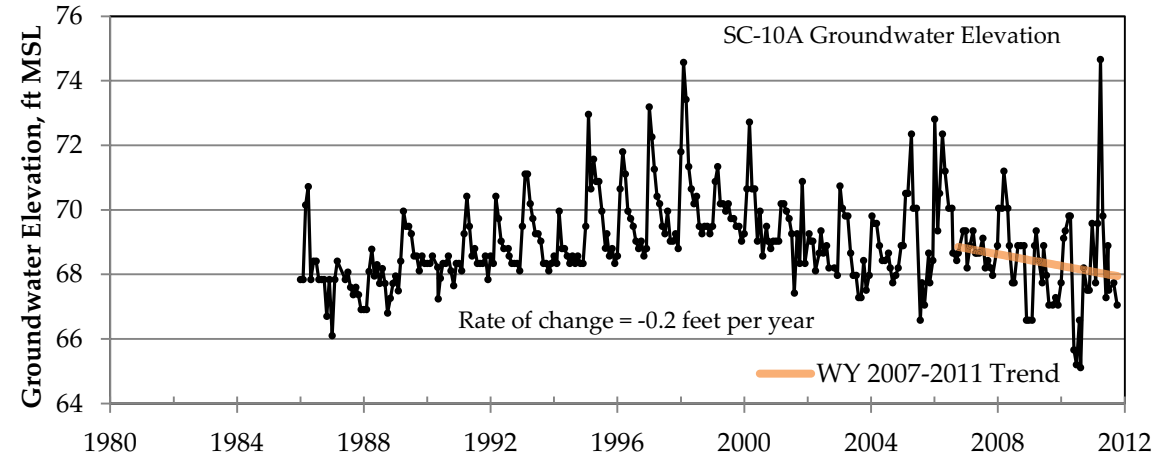

SC-10AA Chloride
Chloride, mg/L
Rate of change = 2.8 mg/L per year
0
2
4
6
8
10
12
14
16
18
20
1980
1984
1988
1992
1996
2000
2004
2008
2012

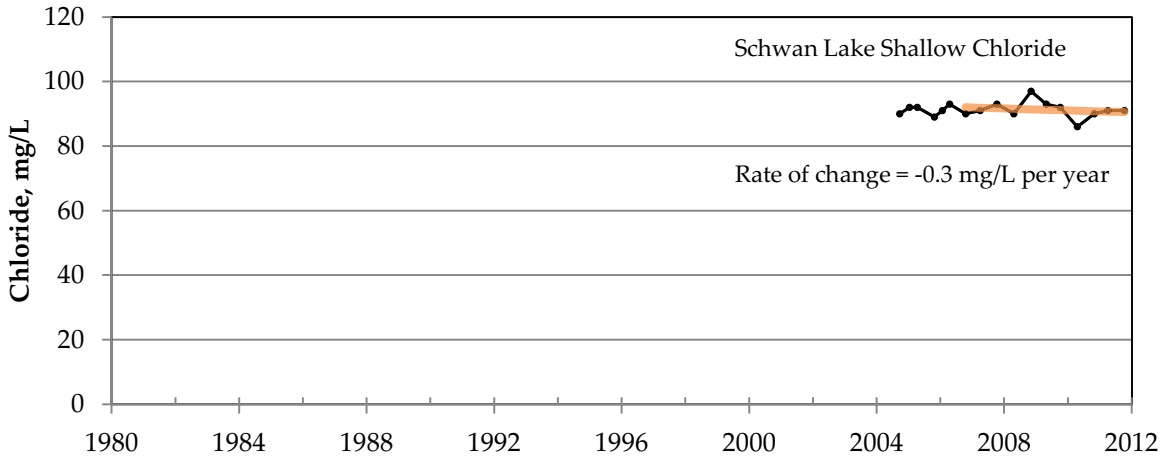

SC-10AA Total Dissolved Solids
TDS, mg/L
Rate of change = 19.9 mg/L per year
0
50
100
150
200
250
300
1980
1984
1988
1992
1996
2000
2004
2008
2012

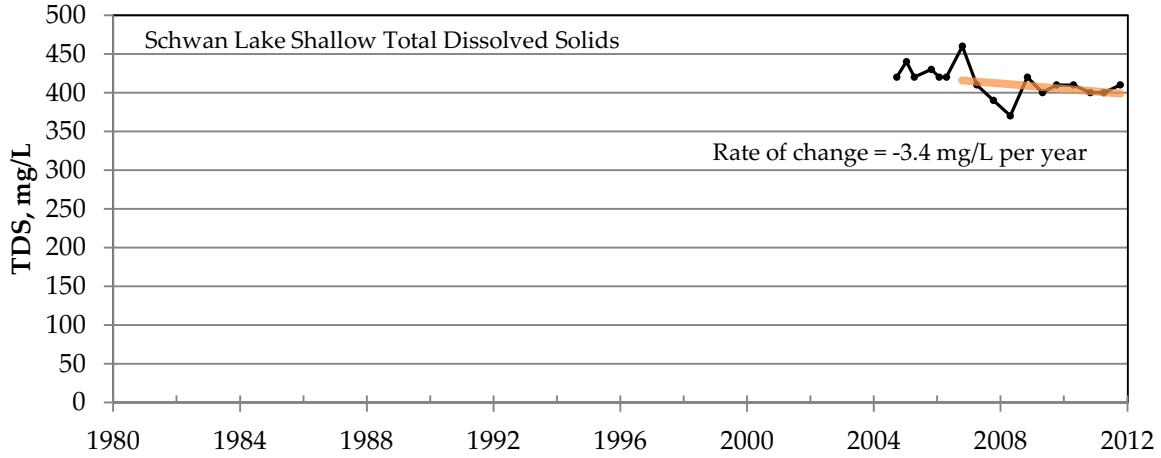

SC-10AA Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = 0 feet per year
WY 2007-2011 Trend
0
10
20
30
40
50
60
70
80
90
100
1980
1984
1988
1992
1996
2000
2004
2008
2012

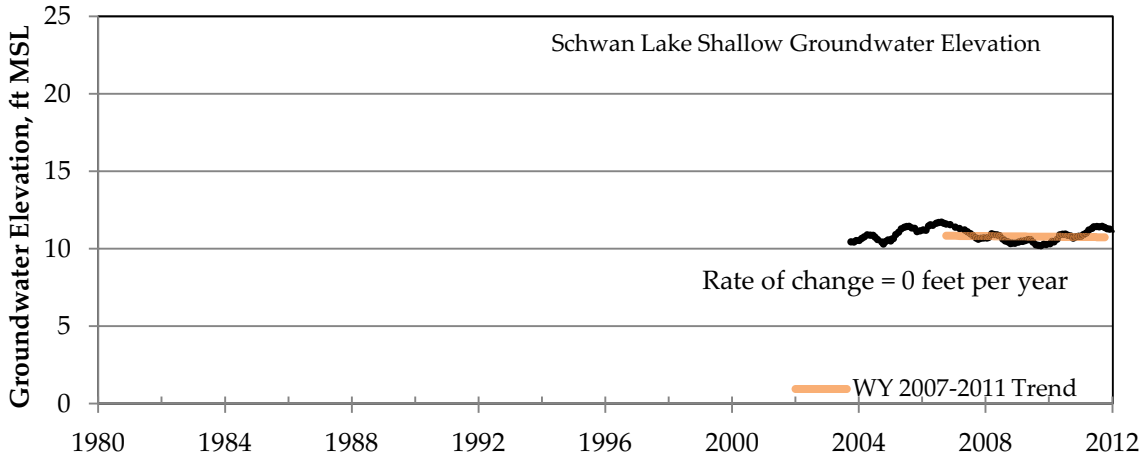

SC-10A Chloride
Chloride, mg/L
Rate of change = 0 mg/L per year
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

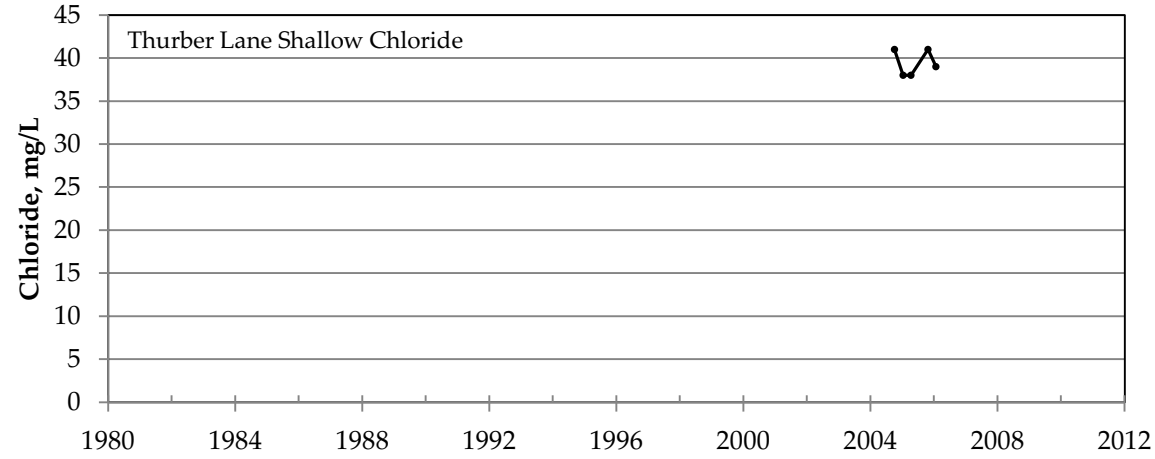

SC-10A Total Dissolved Solids
TDS, mg/L
Rate of change = -14.7 mg/L per year
700
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

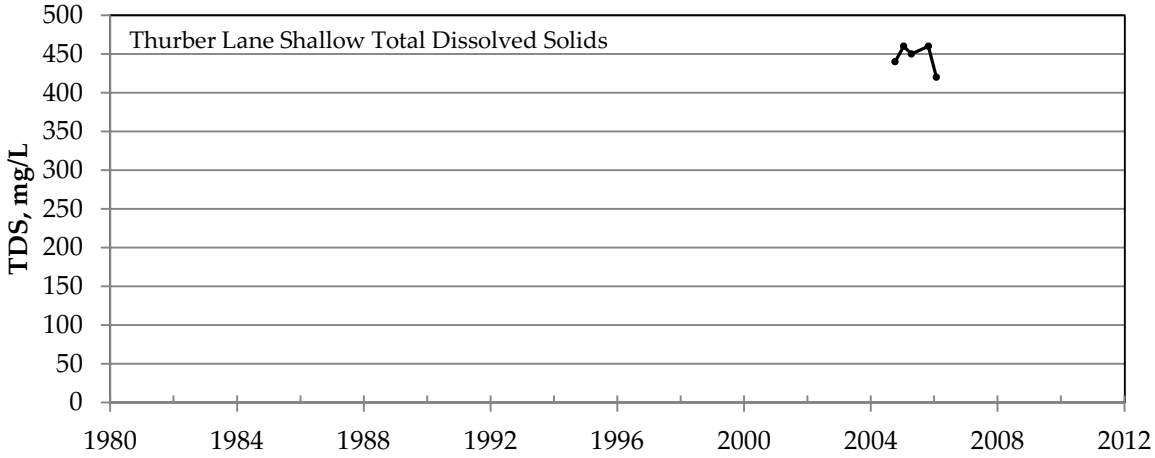

SC-10A Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = -0.2 feet per year
WY 2007-2011 Trend
76
74
72
70
68
66
64
1980
1984
1988
1992
1996
2000
2004
2008
2012

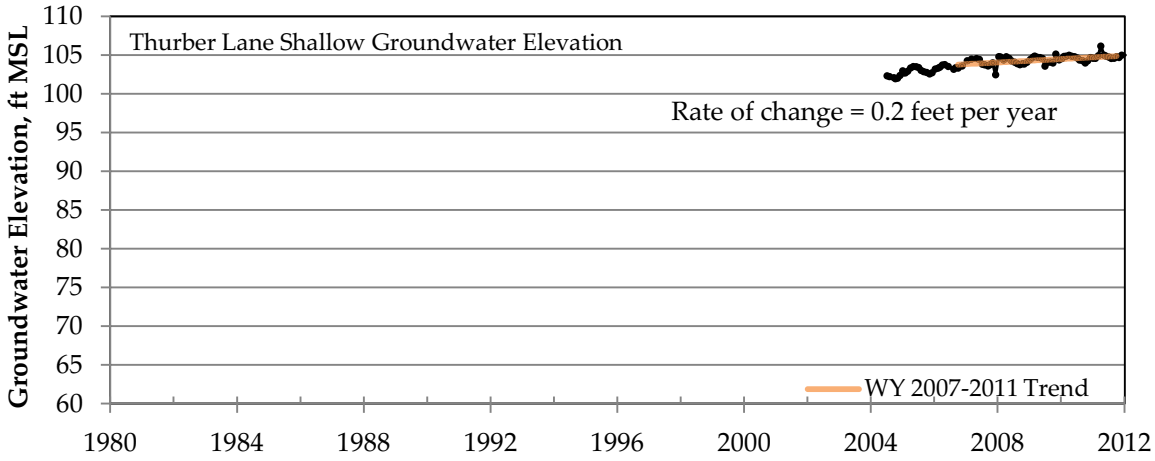

Schwan Lake Shallow Chloride
Chloride, mg/L
120
100
80
60
40
20
0
1980
1984
1988
1992
1996
2000
2004
2008
2012
Rate of change = -0.3 mg/L per year

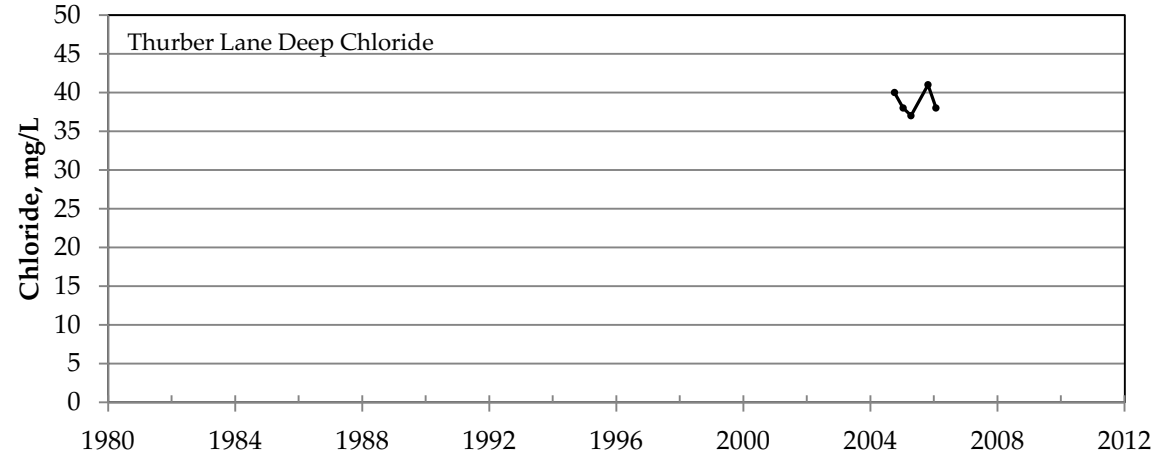

Schwan Lake Shallow Total Dissolved Solids
TDS, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012
Rate of change = -3.4 mg/L per year

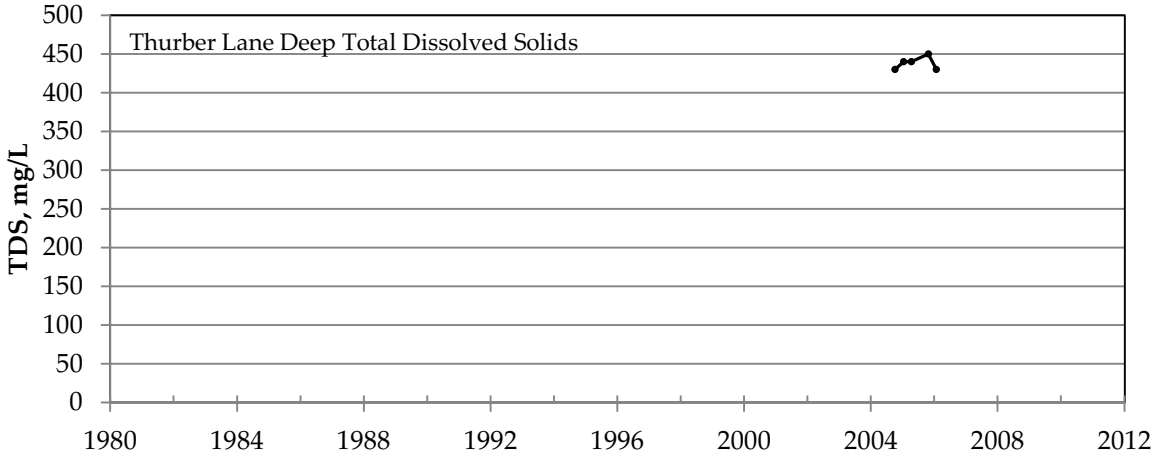

Schwan Lake Shallow Groundwater Elevation
Groundwater Elevation, ft MSL
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012
Rate of change = 0 feet per year
WY 2007-2011 Trend

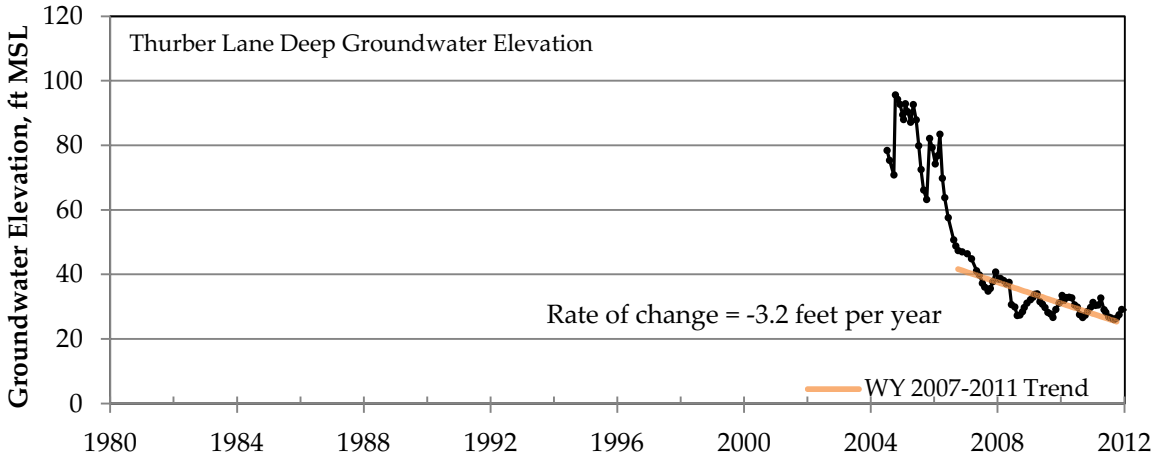

Thurber Lane Shallow Chloride
Chloride, mg/L
45
40
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

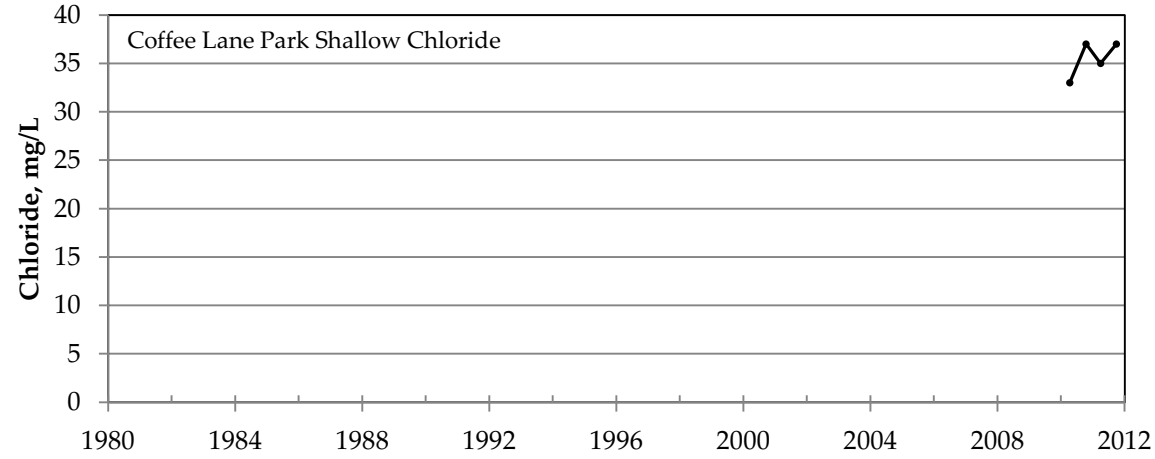

Thurber Lane Shallow Total Dissolved Solids
TDS, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

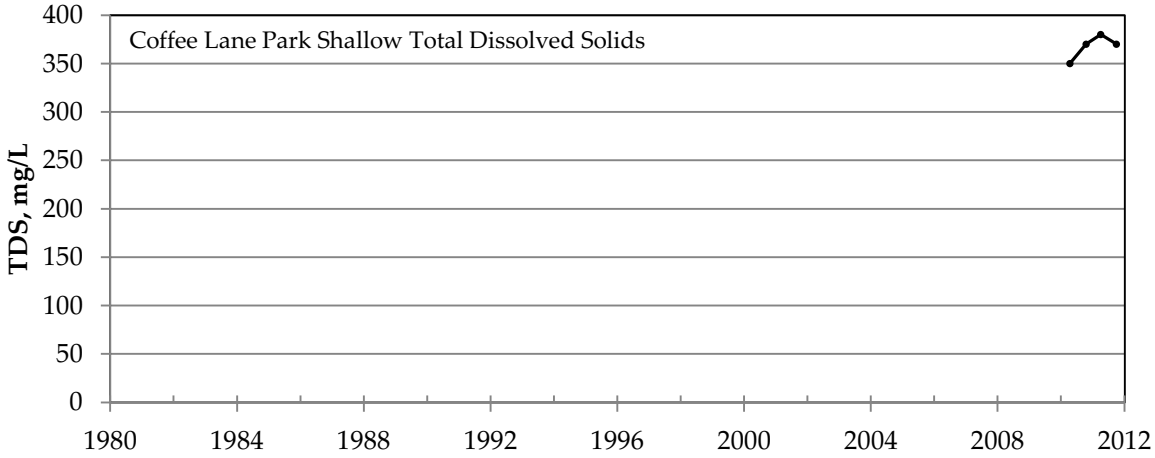

Thurber Lane Shallow Groundwater Elevation
Rate of change = 0.2 feet per year
WY 2007-2011 Trend
Groundwater Elevation, ft MSL
110
105
100
95
90
85
80
75
70
65
60
1980
1984
1988
1992
1996
2000
2004
2008
2012

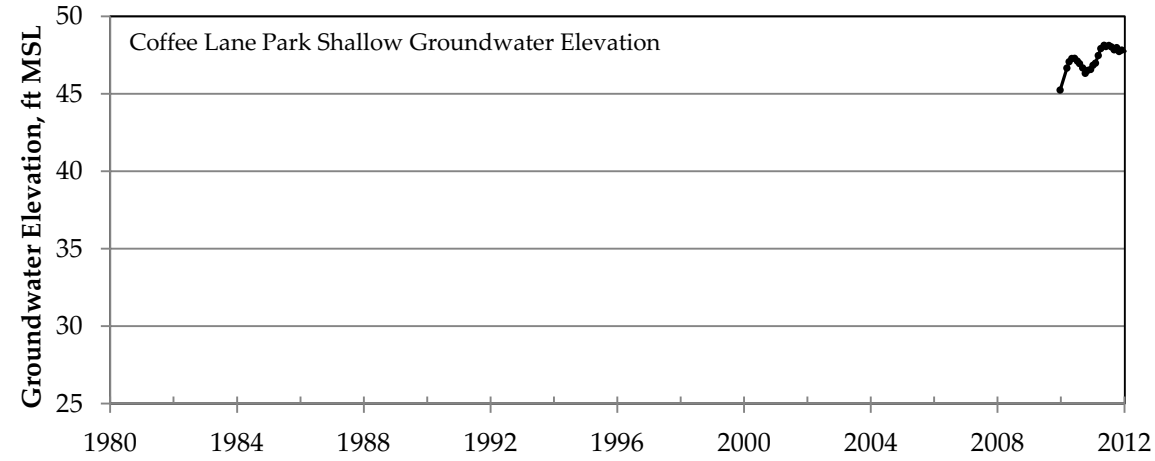

Thurber Lane Deep Chloride
Chloride, mg/L
50
45
40
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

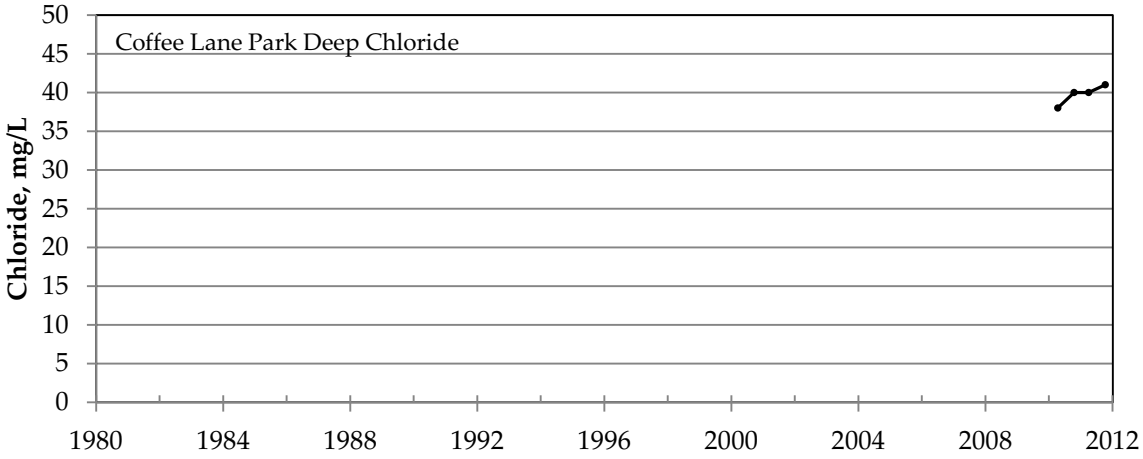

Thurber Lane Deep Total Dissolved Solids
TDS, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

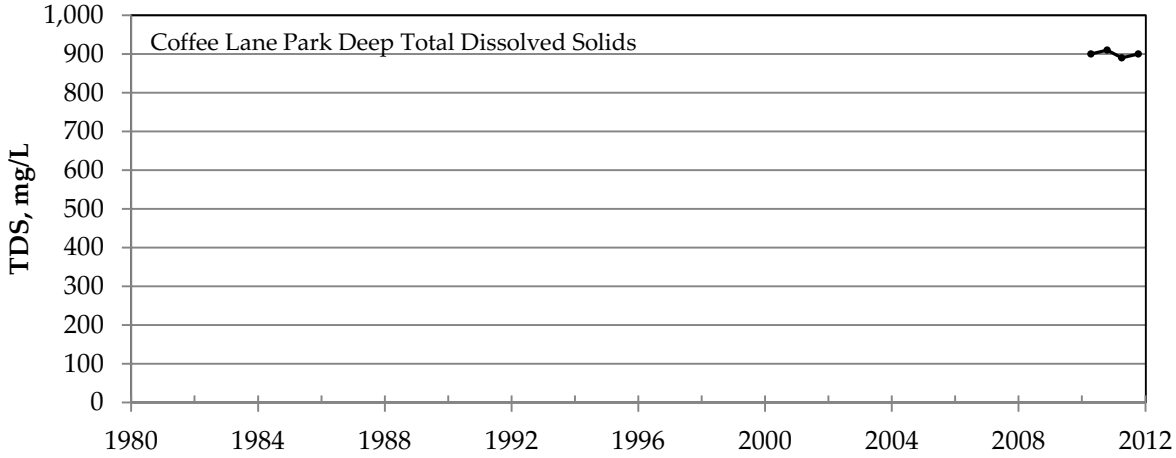

Thurber Lane Deep Groundwater Elevation
Groundwater Elevation, ft MSL
120
100
80
60
40
20
0
Rate of change = -3.2 feet per year
WY 2007-2011 Trend
1980
1984
1988
1992
1996
2000
2004
2008
2012

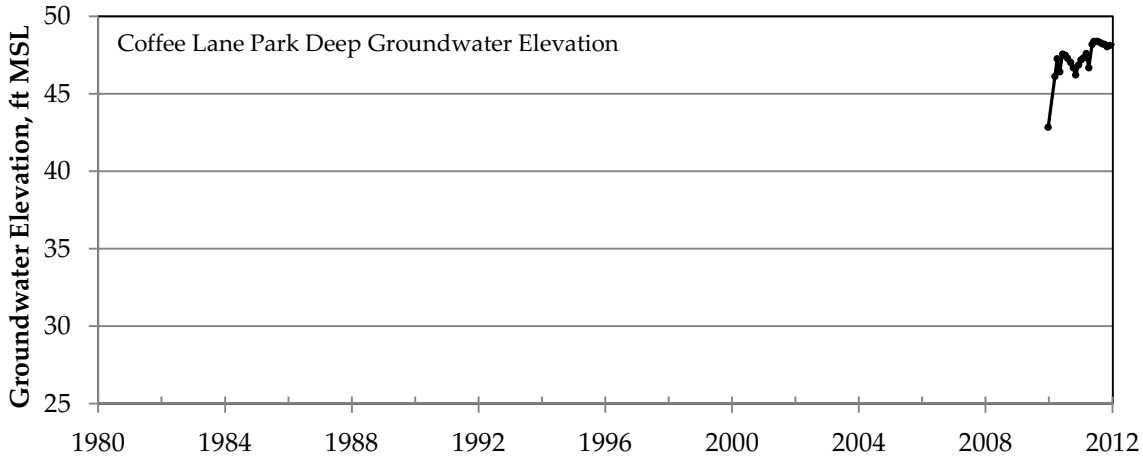

Coffee Lane Park Shallow Chloride
Chloride, mg/L
40
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

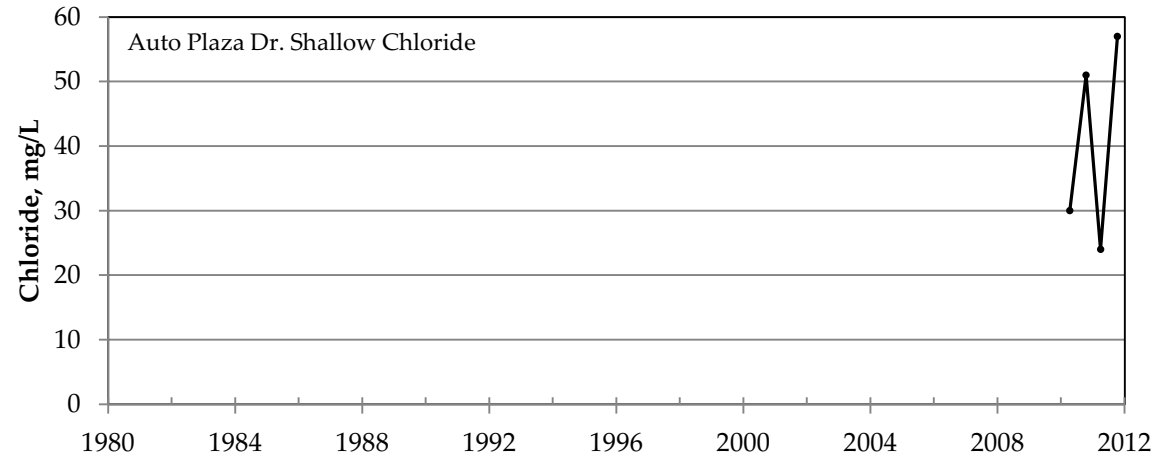

Coffee Lane Park Shallow Total Dissolved Solids
TDS, mg/L
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

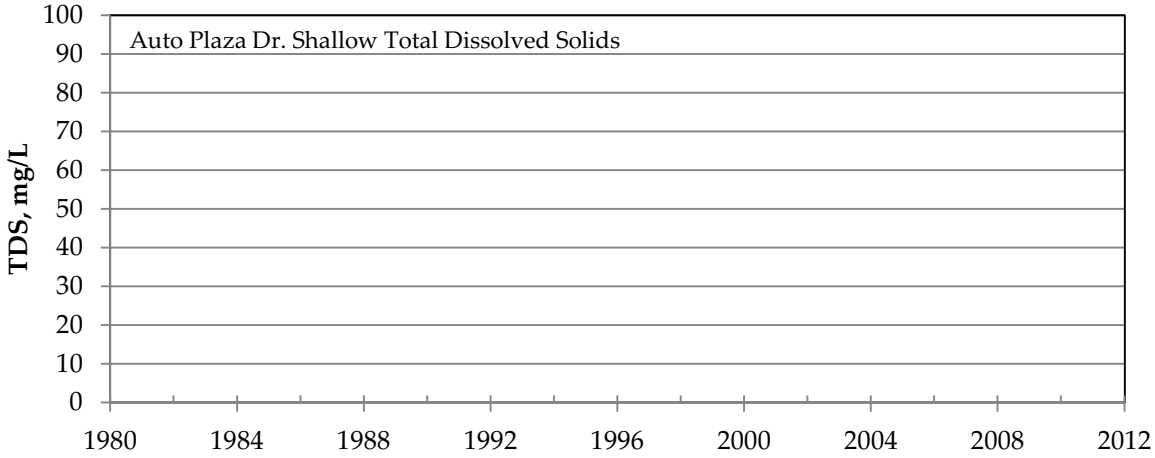

Coffee Lane Park Shallow Groundwater Elevation
Groundwater Elevation, ft MSL
50
45
40
35
30
25
1980
1984
1988
1992
1996
2000
2004
2008
2012

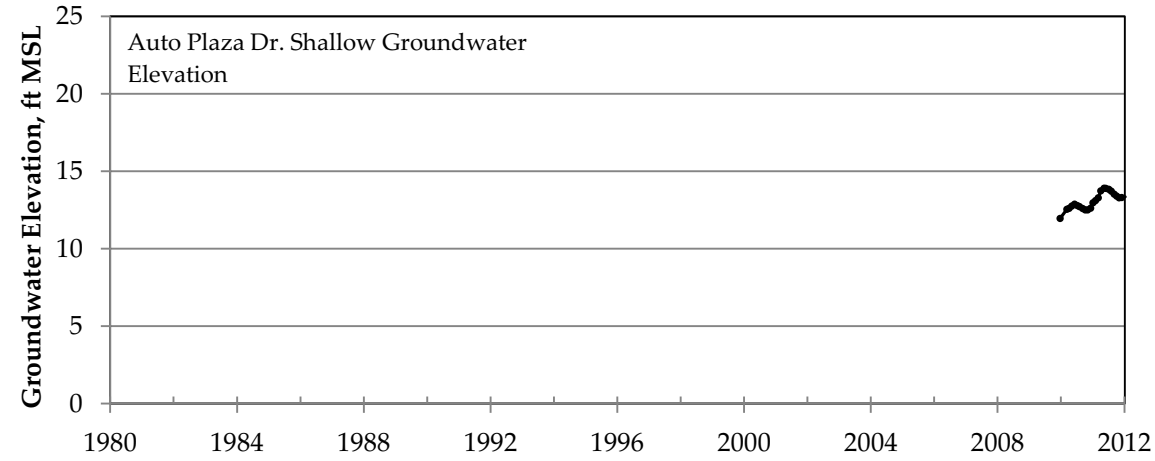

Coffee Lane Park Deep Chloride
Chloride, mg/L
50
45
40
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

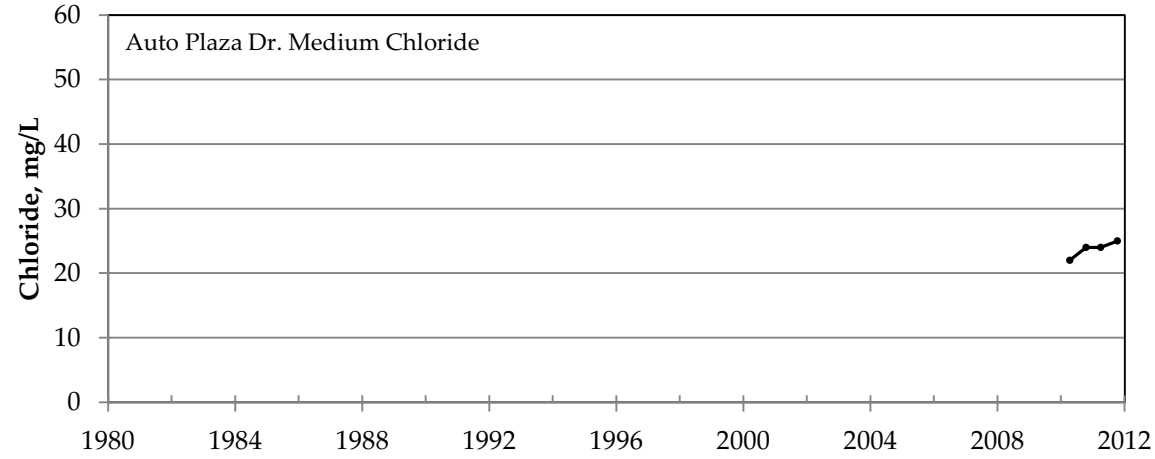

Coffee Lane Park Deep Total Dissolved Solids
TDS, mg/L
1,000
900
800
700
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

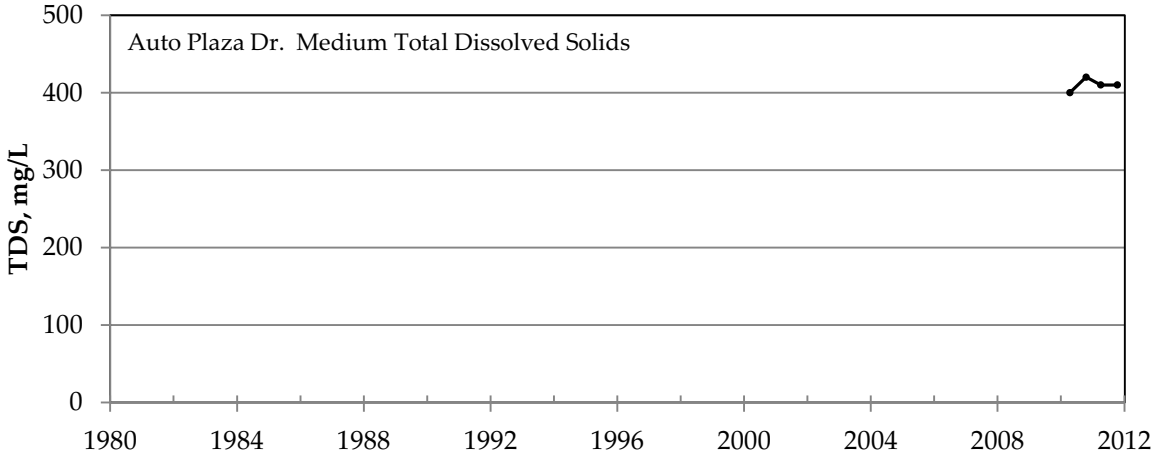

Coffee Lane Park Deep Groundwater Elevation
Groundwater Elevation, ft MSL
50
45
40
35
30
25
1980
1984
1988
1992
1996
2000
2004
2008
2012

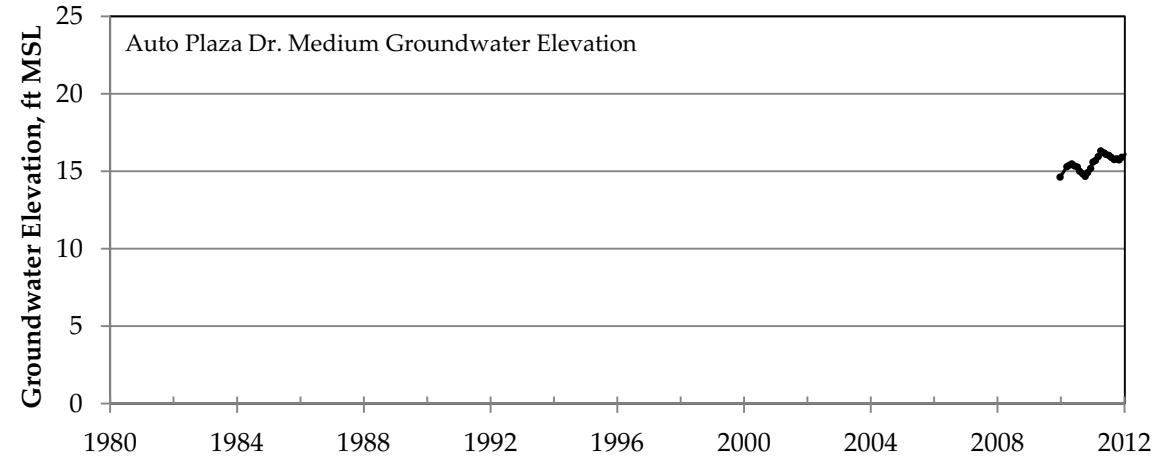

Auto Plaza Dr. Shallow Chloride
Chloride, mg/L
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

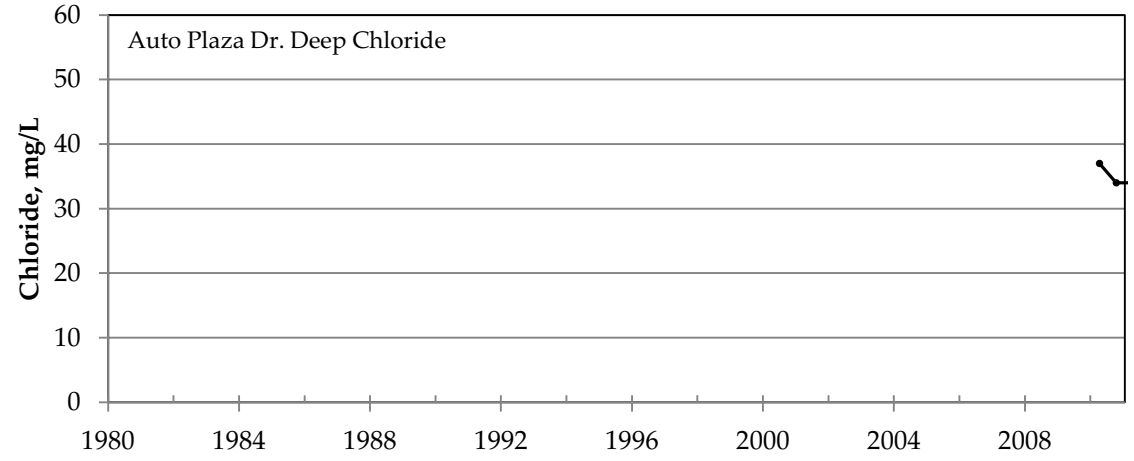

Auto Plaza Dr. Shallow Total Dissolved Solids
TDS, mg/L
100
90
80
70
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

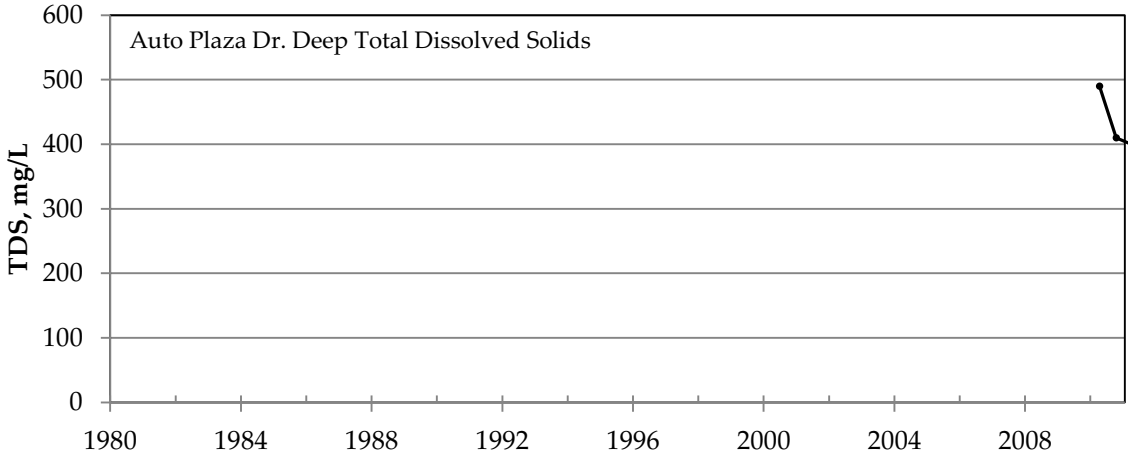

Auto Plaza Dr. Shallow Groundwater Elevation
Groundwater Elevation, ft MSL
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

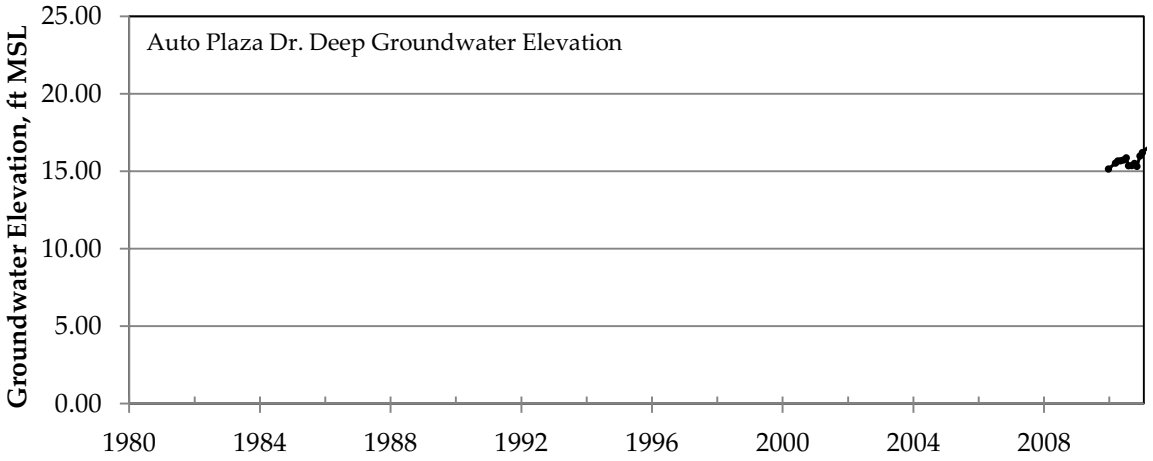

Auto Plaza Dr. Medium Chloride
Chloride, mg/L
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

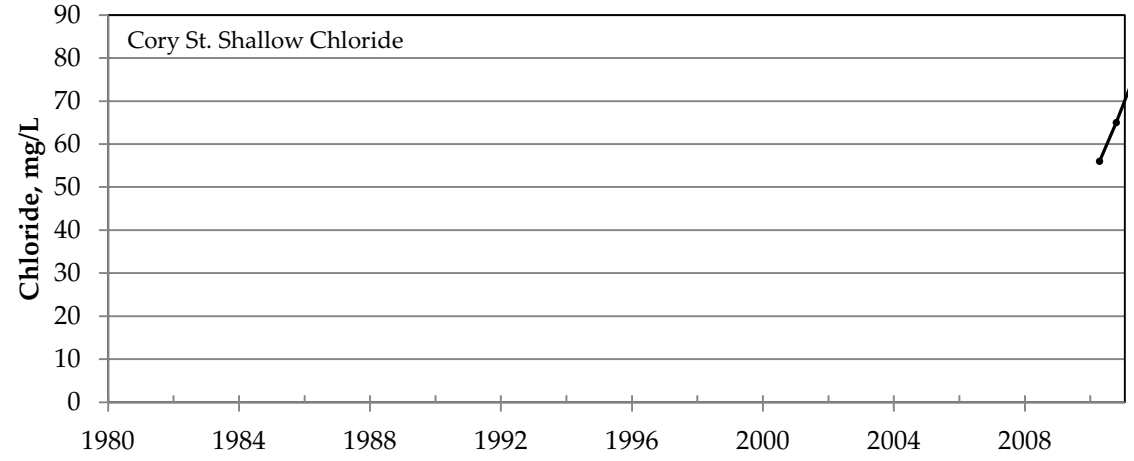

Auto Plaza Dr. Medium Total Dissolved Solids
TDS, mg/L
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

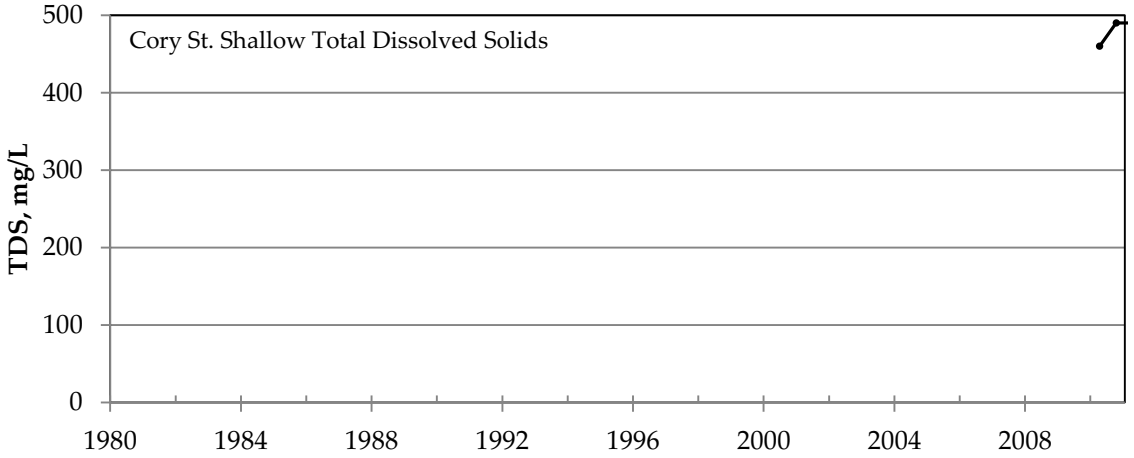

Auto Plaza Dr. Medium Groundwater Elevation
Groundwater Elevation, ft MSL
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

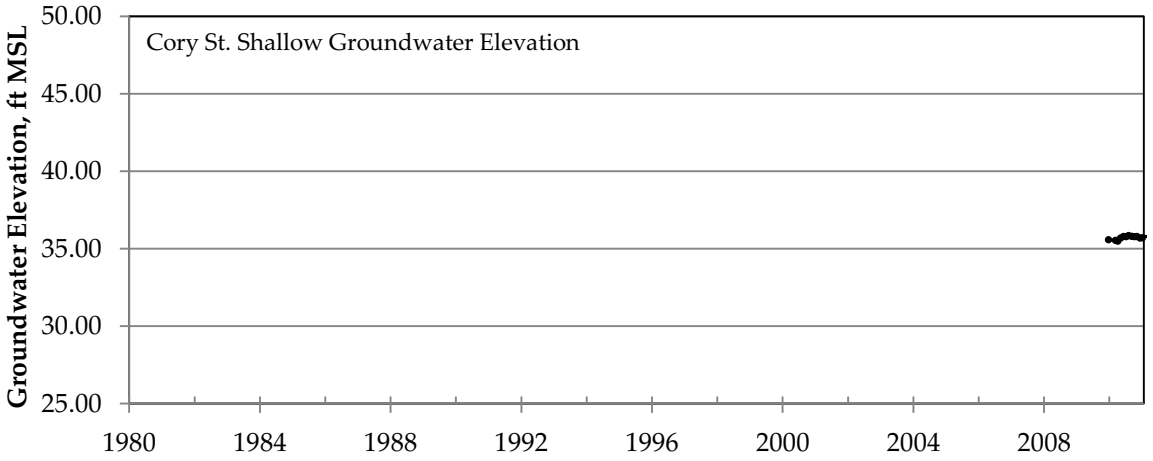

Auto Plaza Dr. Deep Chloride
Chloride, mg/L
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008

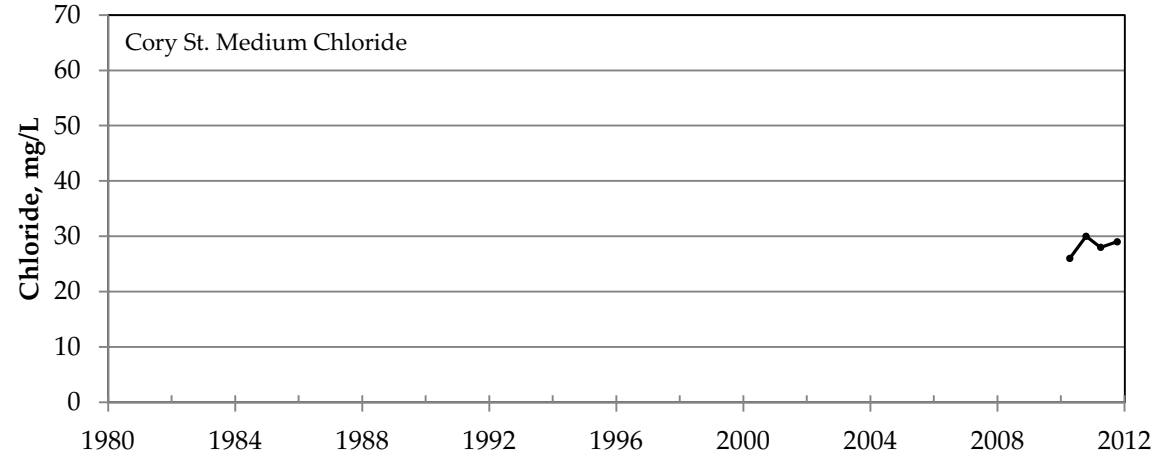

Auto Plaza Dr. Deep Total Dissolved Solids
TDS, mg/L
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008

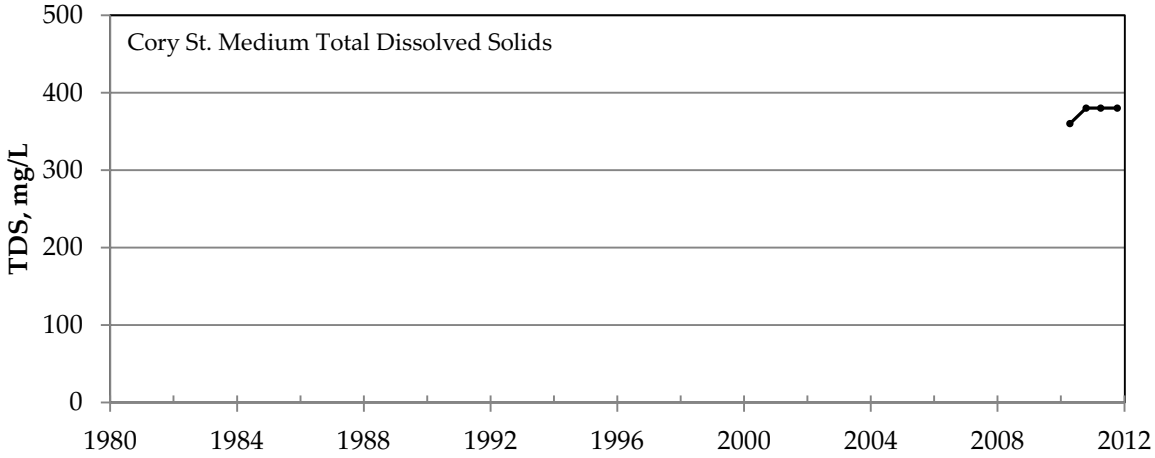

Auto Plaza Dr. Deep Groundwater Elevation
Groundwater Elevation, ft MSL
25.00
20.00
15.00
10.00
5.00
0.00
1980
1984
1988
1992
1996
2000
2004
2008

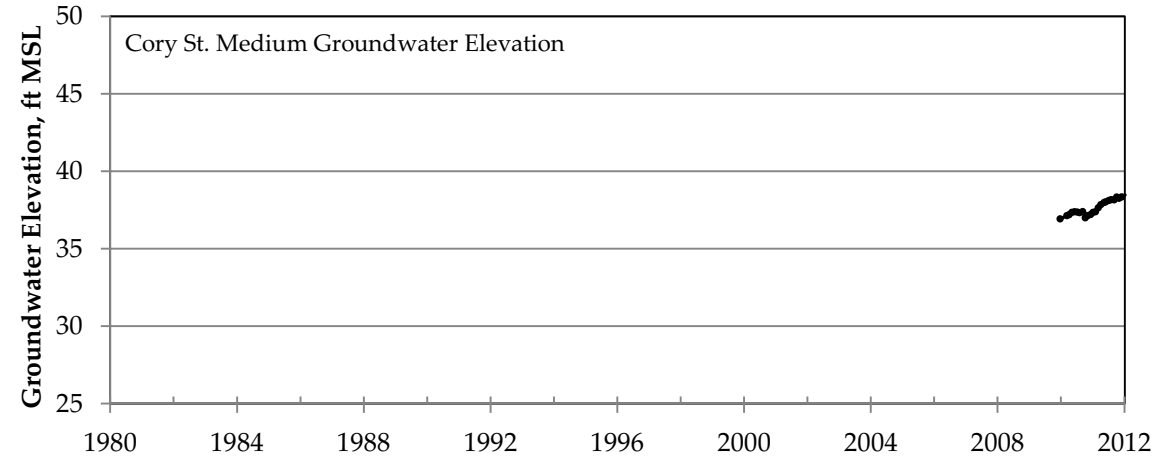

Cory St. Shallow Chloride
Chloride, mg/L
90
80
70
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008

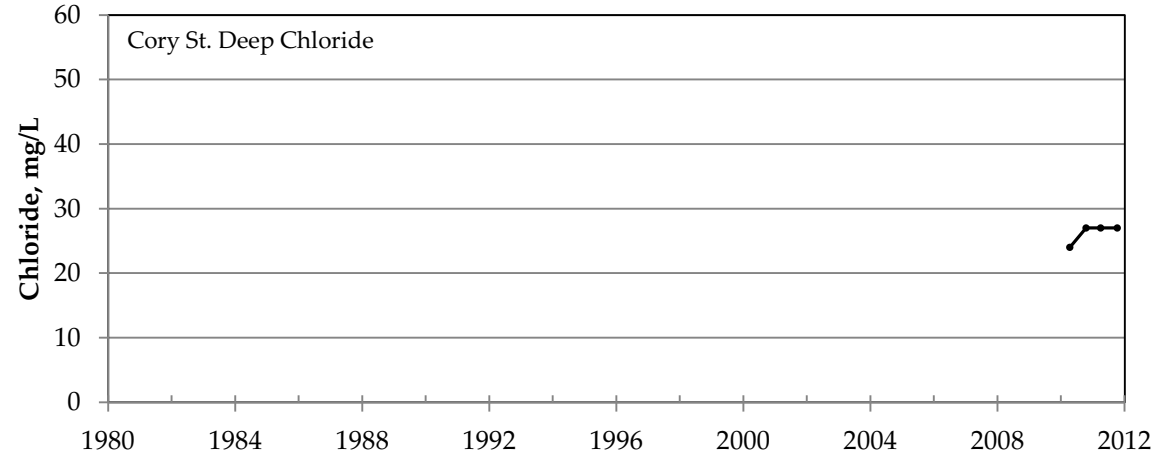

Cory St. Shallow Total Dissolved Solids
TDS, mg/L
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008

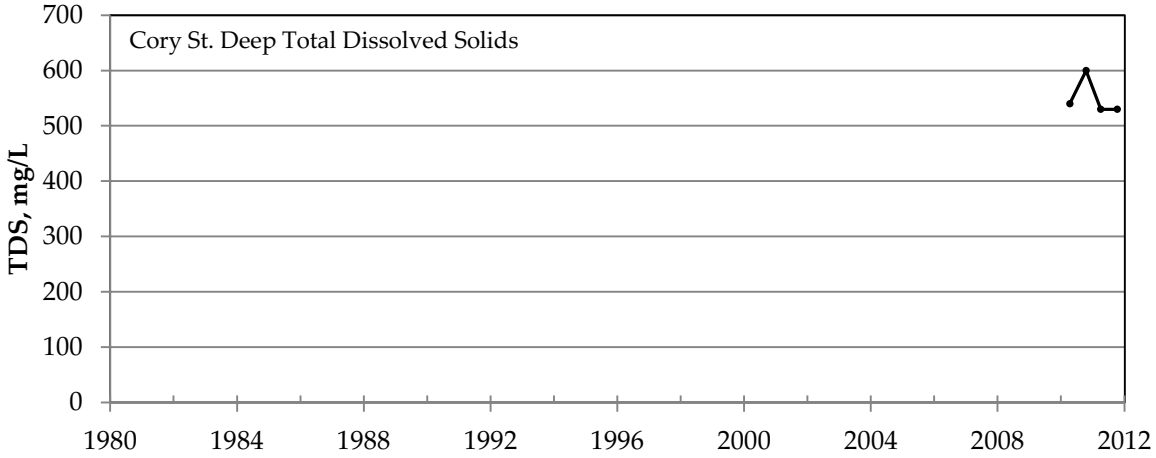

Cory St. Shallow Groundwater Elevation
Groundwater Elevation, ft MSL
50.00
45.00
40.00
35.00
30.00
25.00
1980
1984
1988
1992
1996
2000
2004
2008

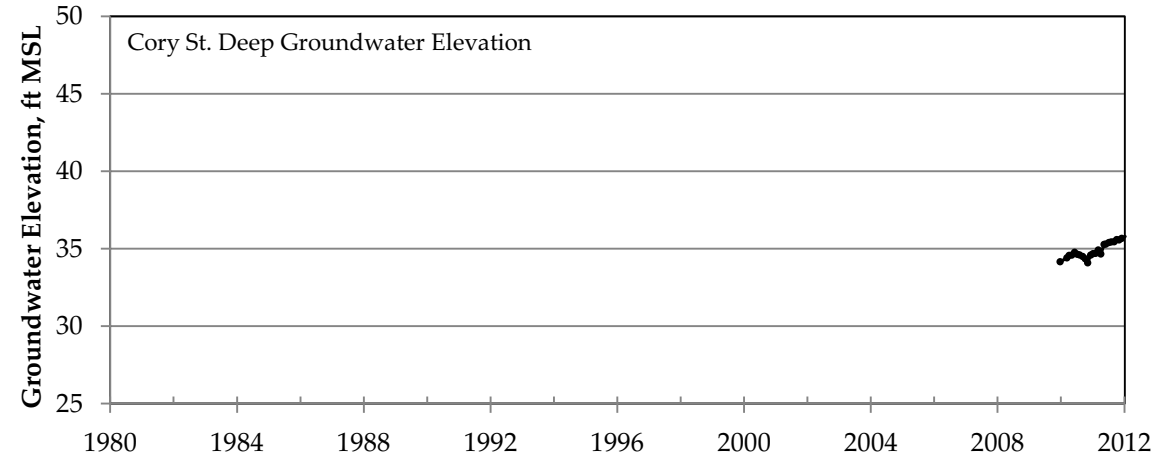

Cory St. Medium Chloride
Chloride, mg/L
70
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

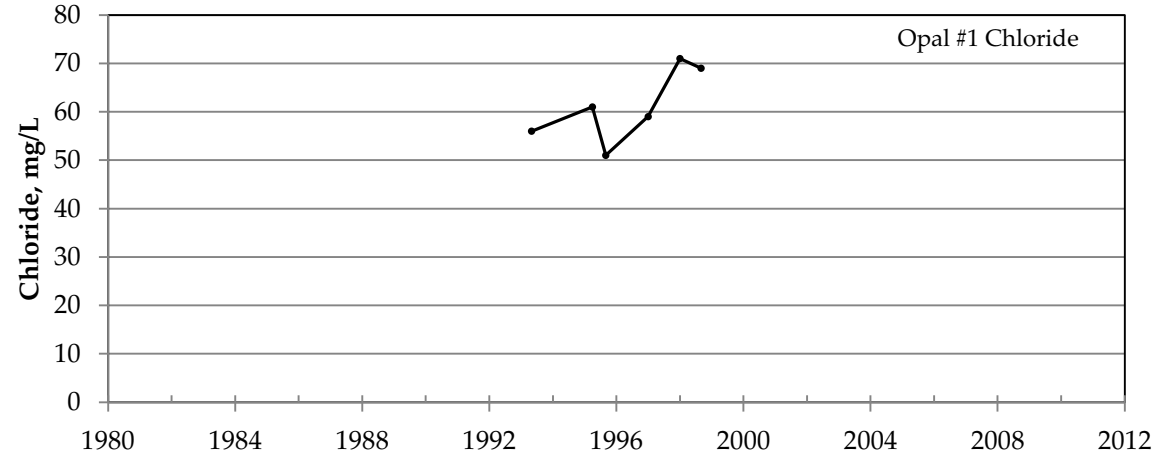

Cory St. Medium Total Dissolved Solids
TDS, mg/L
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

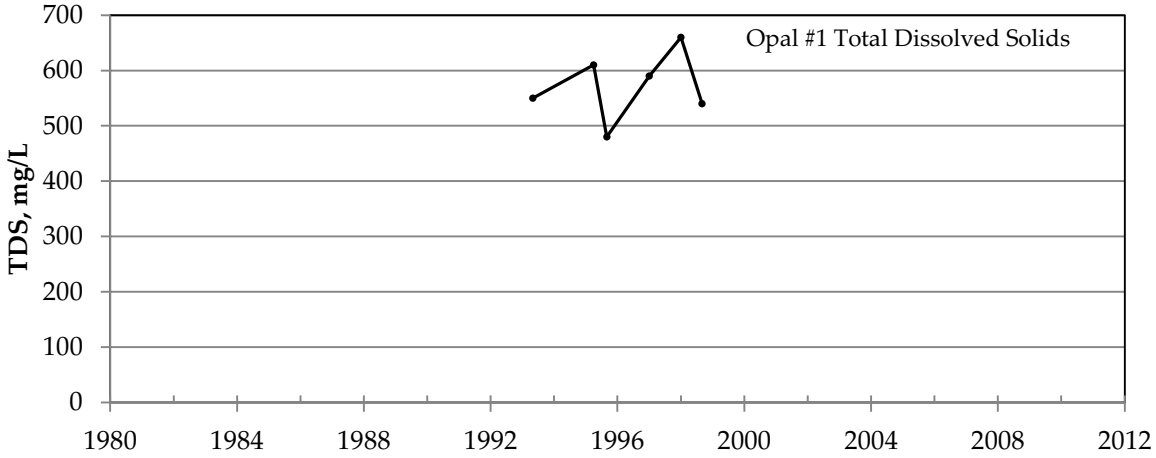

Cory St. Medium Groundwater Elevation
Groundwater Elevation, ft MSL
50
45
40
35
30
25
1980
1984
1988
1992
1996
2000
2004
2008
2012

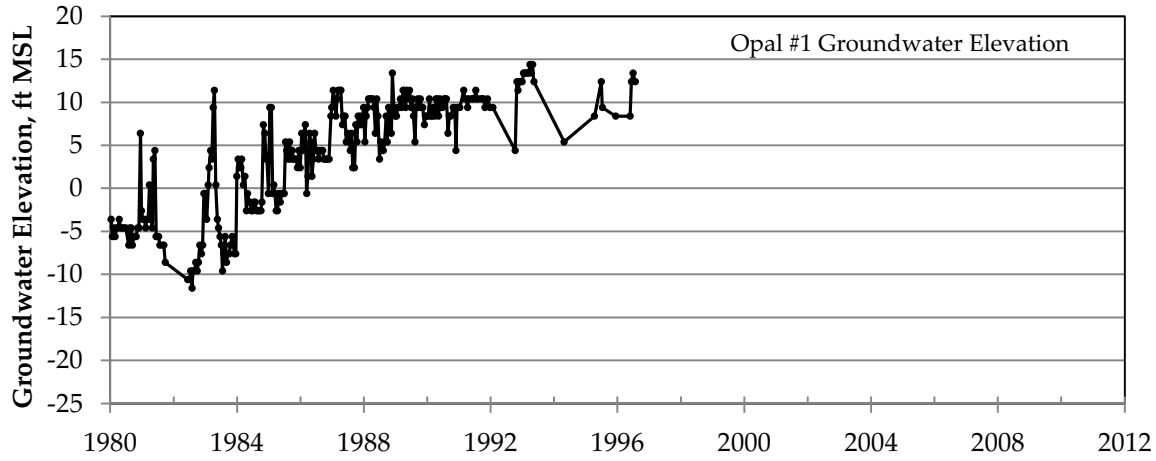

Cory St. Deep Chloride
Chloride, mg/L
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

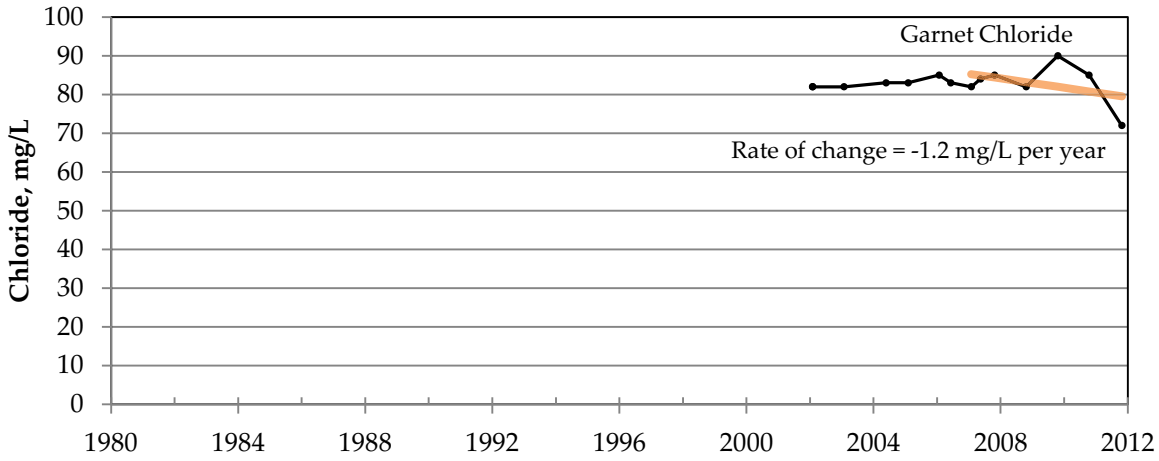

Cory St. Deep Total Dissolved Solids
TDS, mg/L
700
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

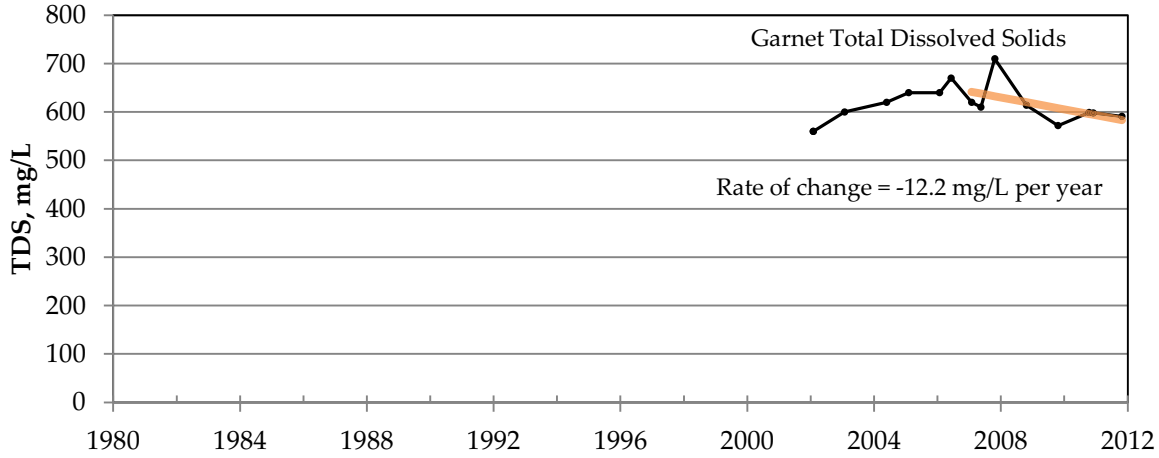

Cory St. Deep Groundwater Elevation
Groundwater Elevation, ft MSL
50
45
40
35
30
25
1980
1984
1988
1992
1996
2000
2004
2008
2012

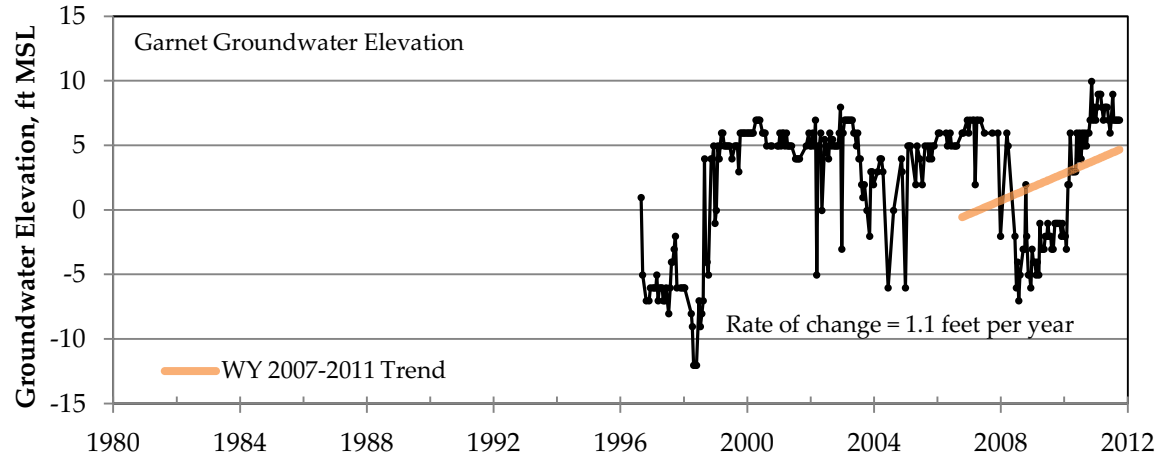

Opal #1 Chloride
Chloride, mg/L
80
70
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

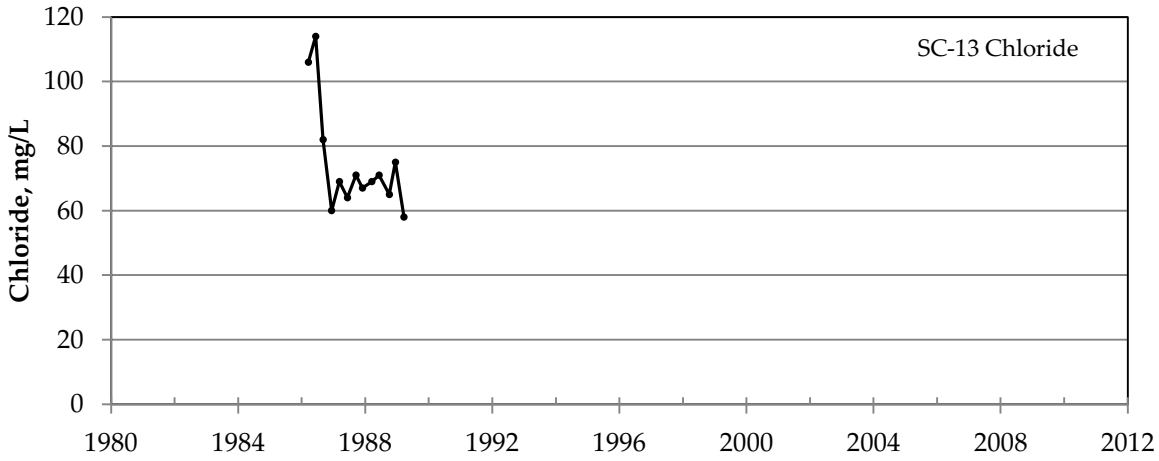

Opal #1 Total Dissolved Solids
TDS, mg/L
700
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

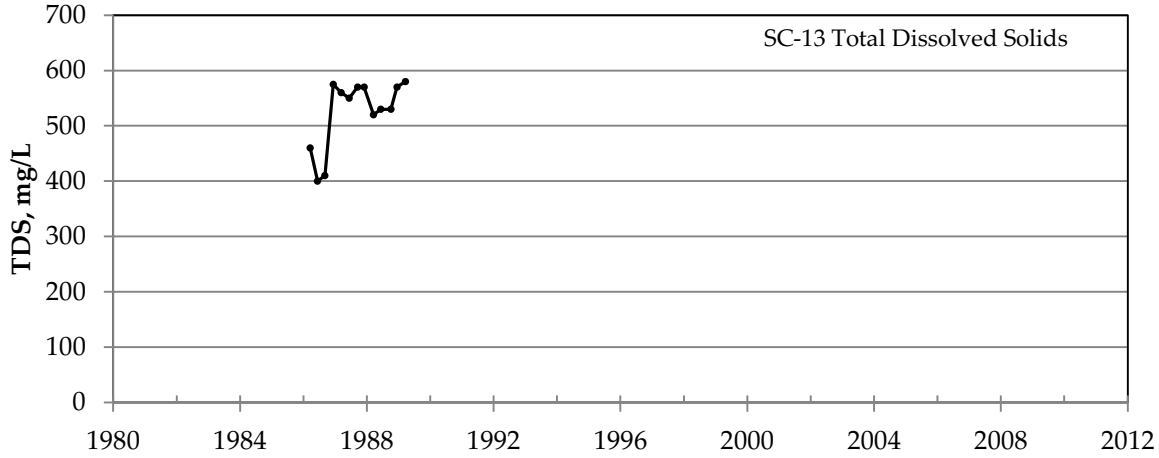

Opal #1 Groundwater Elevation
Groundwater Elevation, ft MSL
20
15
10
5
0
-5
-10
-15
-20
-25
1980
1984
1988
1992
1996
2000
2004
2008
2012

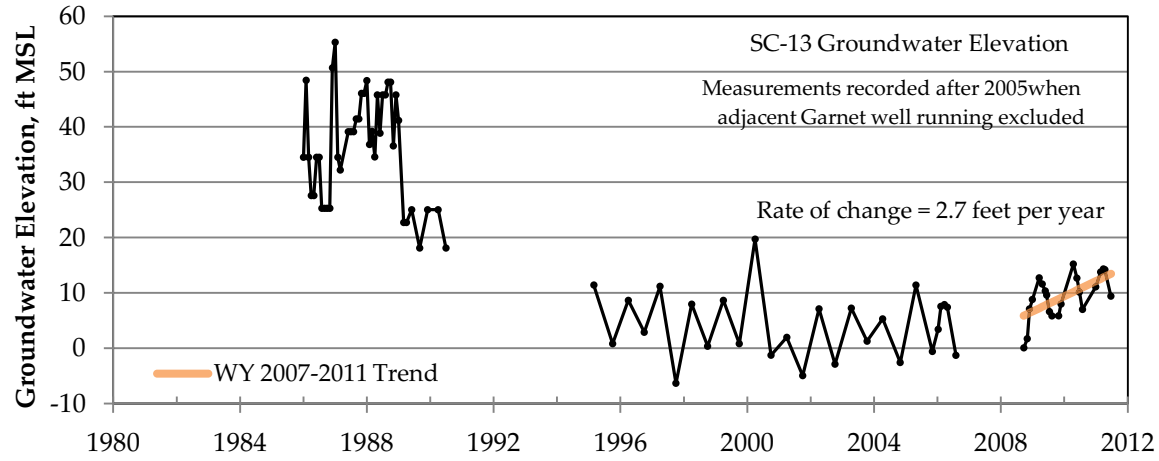

Garnet Chloride
Rate of change = -1.2 mg/L per year
Chloride, mg/L
100
90
80
70
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

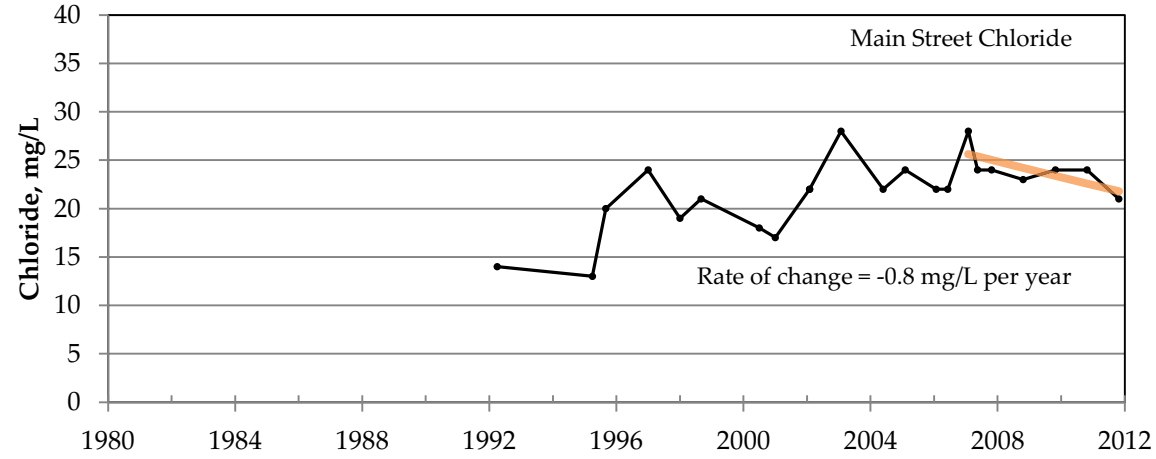

Garnet Total Dissolved Solids
Rate of change = -12.2 mg/L per year
TDS, mg/L
800
700
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012


Garnet Groundwater Elevation
Rate of change = 1.1 feet per year
WY 2007-2011 Trend
Groundwater Elevation, ft MSL
15
10
5
0
-5
-10
-15
1980
1984
1988
1992
1996
2000
2004
2008
2012

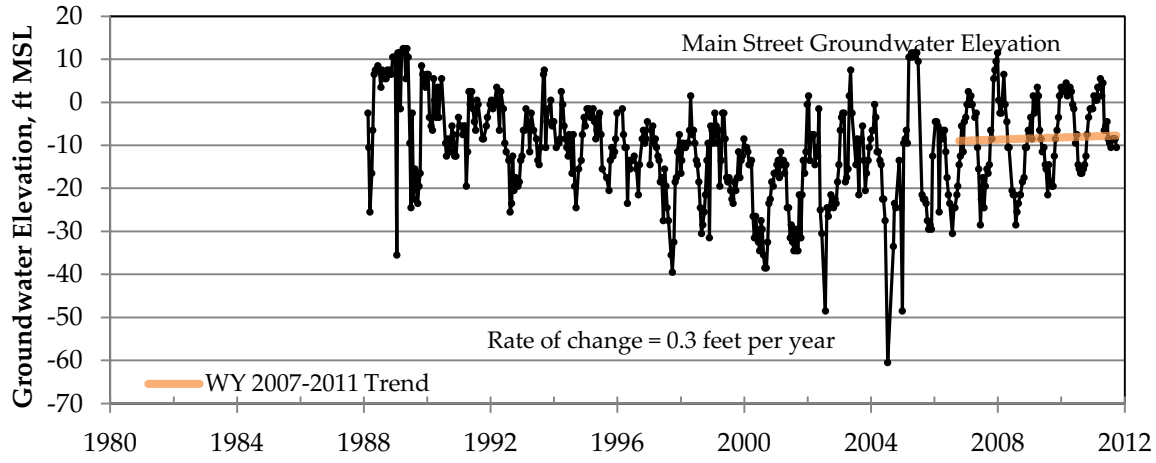

SC-13 Chloride
Chloride, mg/L
120
100
80
60
40
20
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

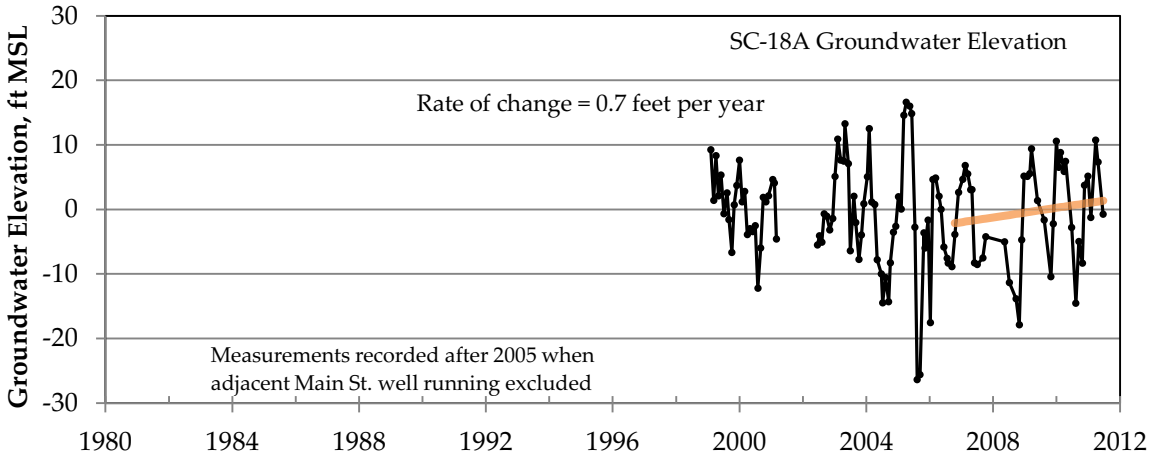

SC-13 Total Dissolved Solids
TDS, mg/L
700
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

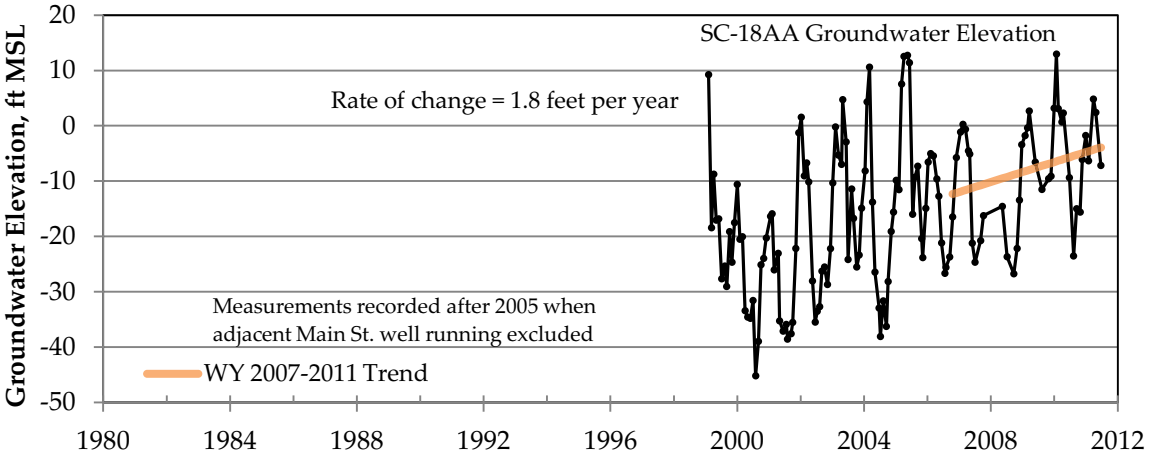

SC-13 Groundwater Elevation
Measurements recorded after 2005when adjacent Garnet well running excluded
Rate of change = 2.7 feet per year
WY 2007-2011 Trend
Groundwater Elevation, ft MSL
60
50
40
30
20
10
0
-10
1980
1984
1988
1992
1996
2000
2004
2008
2012

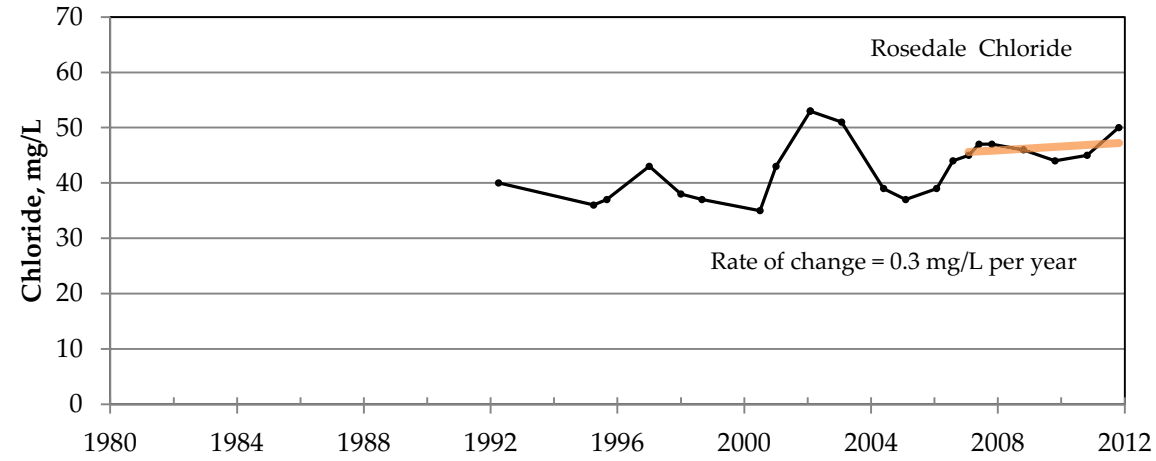

Main Street Chloride
Chloride, mg/L
Rate of change = -0.8 mg/L per year
40
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012


Main St. Total Dissolved Solids
TDS, mg/L
Rate of change = -11.4 mg/L per year
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

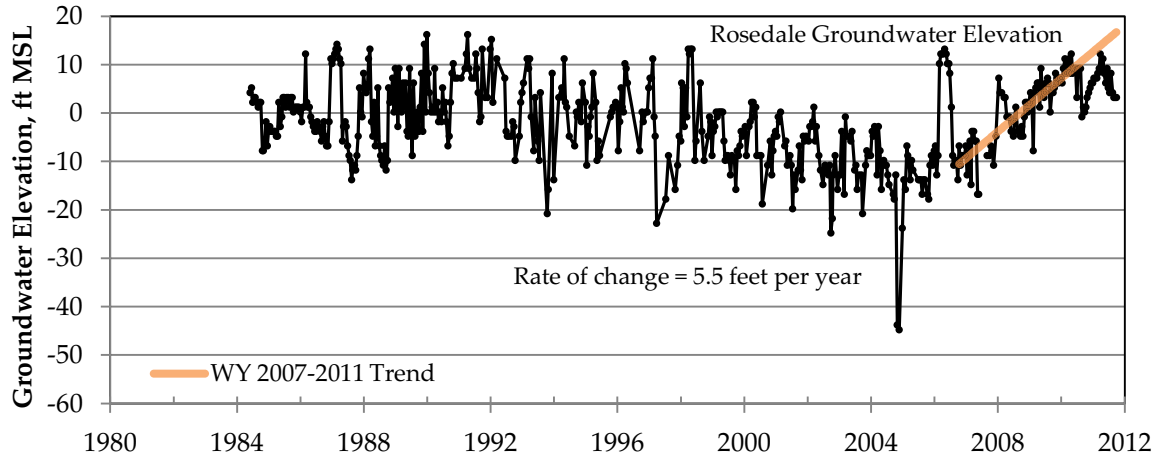

Main Street Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = 0.3 feet per year
WY 2007-2011 Trend
20
10
0
-10
-20
-30
-40
-50
-60
-70
1980
1984
1988
1992
1996
2000
2004
2008
2012

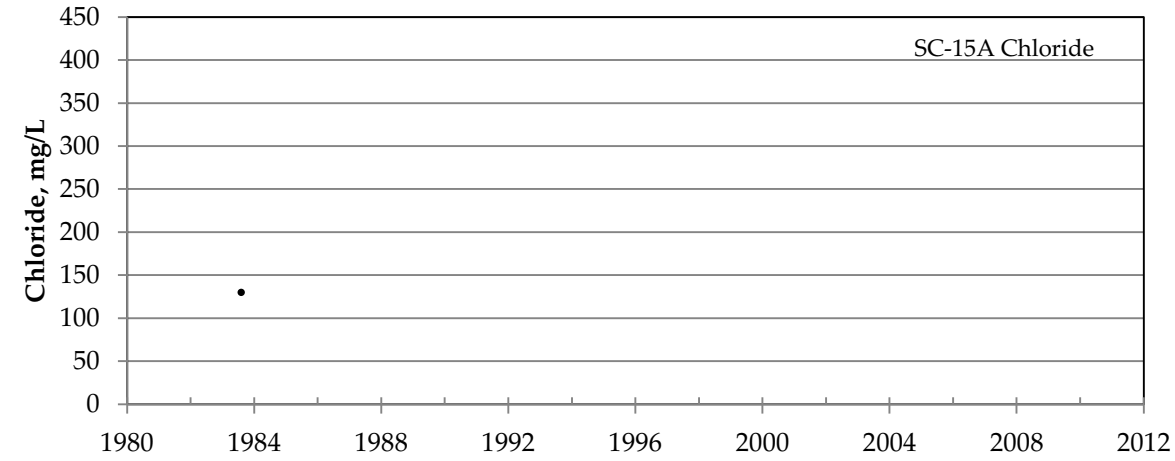

SC-18A Groundwater Elevation
Rate of change = 0.7 feet per year
Measurements recorded after 2005 when adjacent Main St. well running excluded
Groundwater Elevation, ft MSL
30
20
10
0
-10
-20
-30
1980
1984
1988
1992
1996
2000
2004
2008
2012

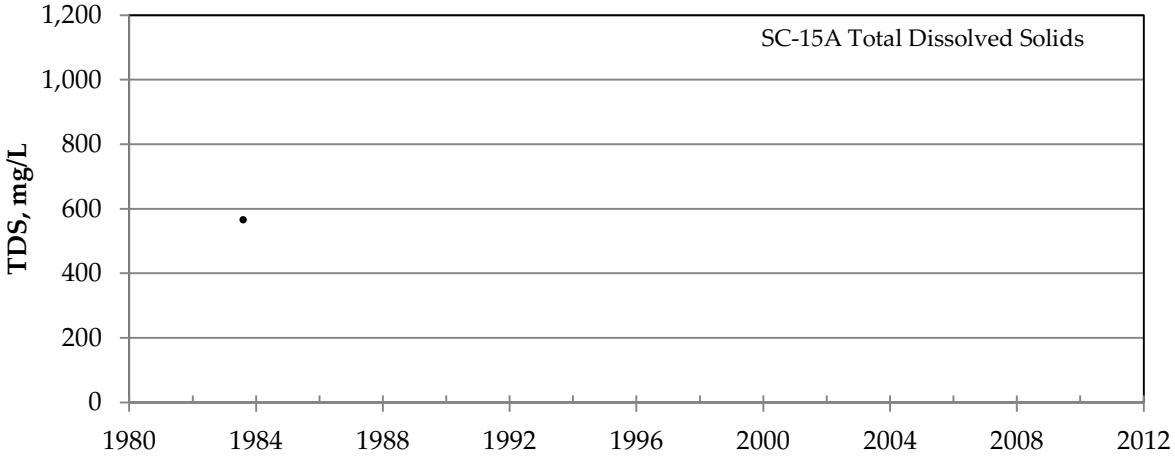

SC-18AA Groundwater Elevation
Rate of change = 1.8 feet per year
Measurements recorded after 2005 when adjacent Main St. well running excluded
WY 2007-2011 Trend
Groundwater Elevation, ft MSL
20
10
0
-10
-20
-30
-40
-50
1980
1984
1988
1992
1996
2000
2004
2008
2012

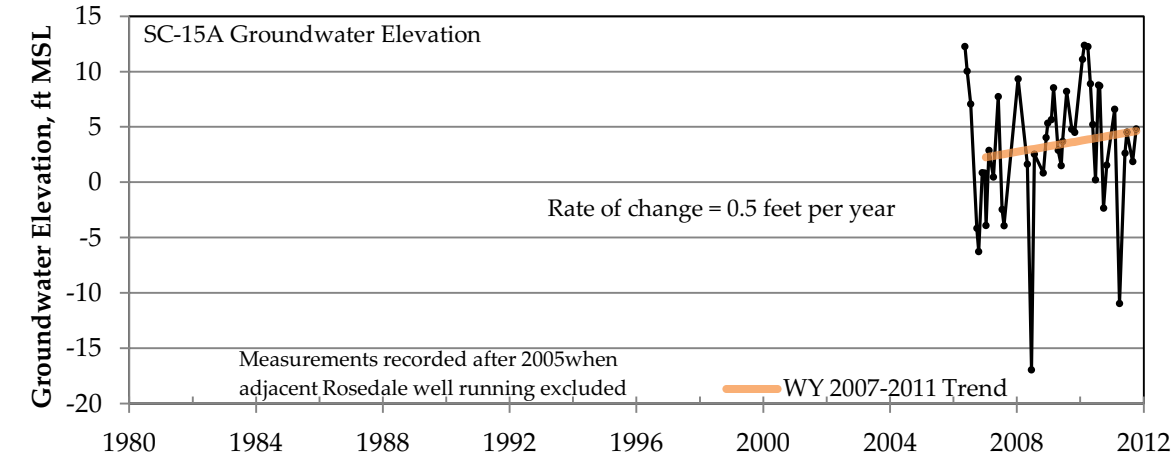

Rosedale Chloride
Chloride, mg/L
70
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012
Rate of change = 0.3 mg/L per year

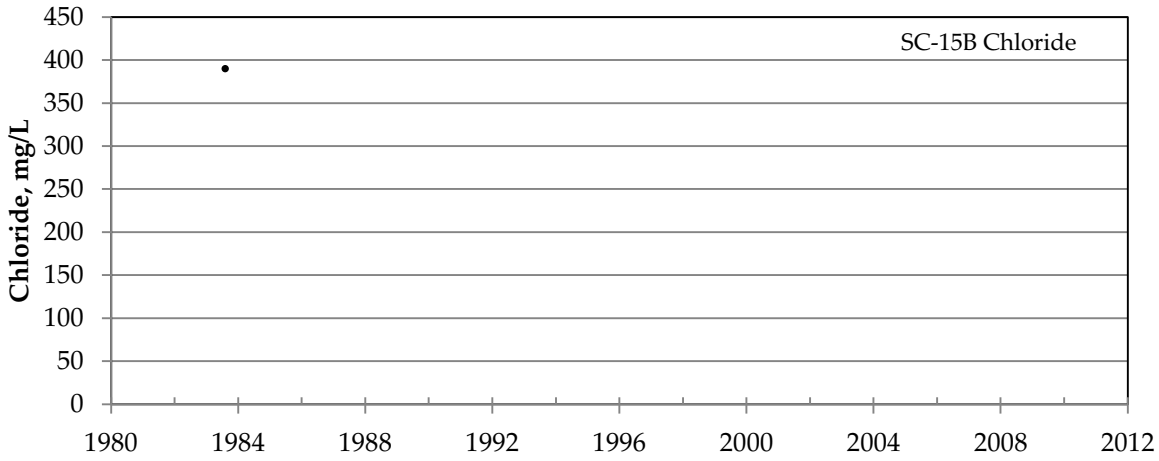

Rosedale Total Dissolved Solids
TDS, mg/L
700
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012
Rate of change = -4.4 mg/L per year

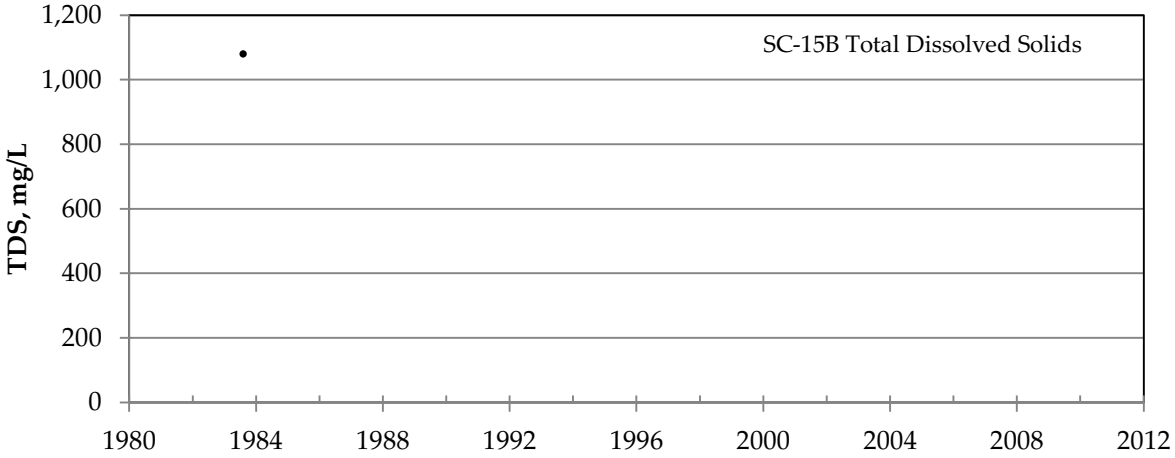

Rosedale Groundwater Elevation
Groundwater Elevation, ft MSL
20
10
0
-10
-20
-30
-40
-50
-60
1980
1984
1988
1992
1996
2000
2004
2008
2012
Rate of change = 5.5 feet per year
WY 2007-2011 Trend

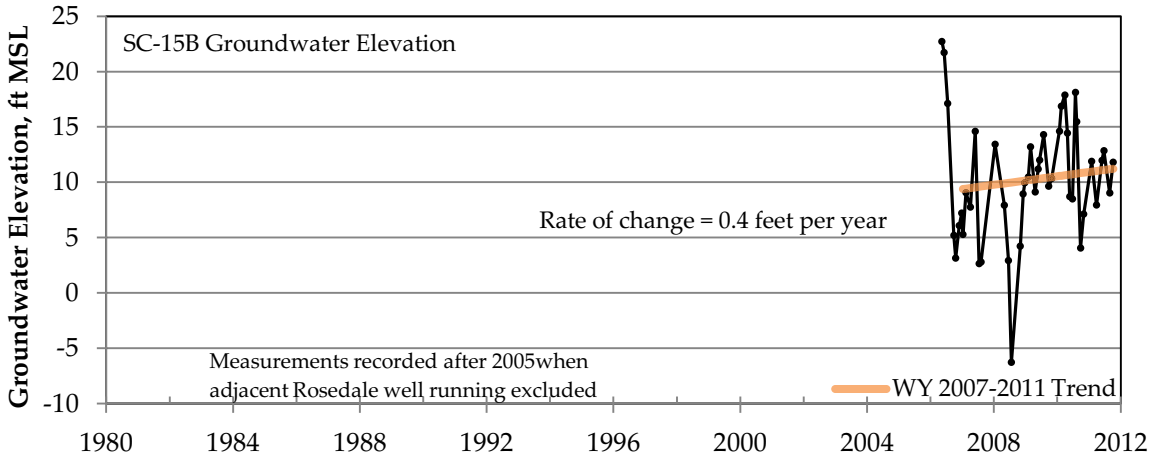

SC-15A Chloride
Chloride, mg/L
450
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

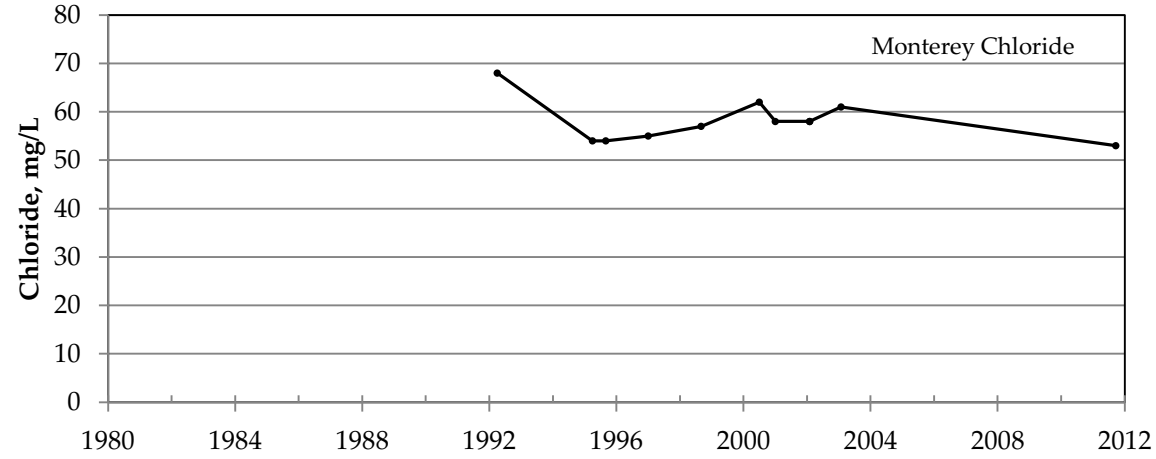

SC-15A Total Dissolved Solids
TDS, mg/L
1,200
1,000
800
600
400
200
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

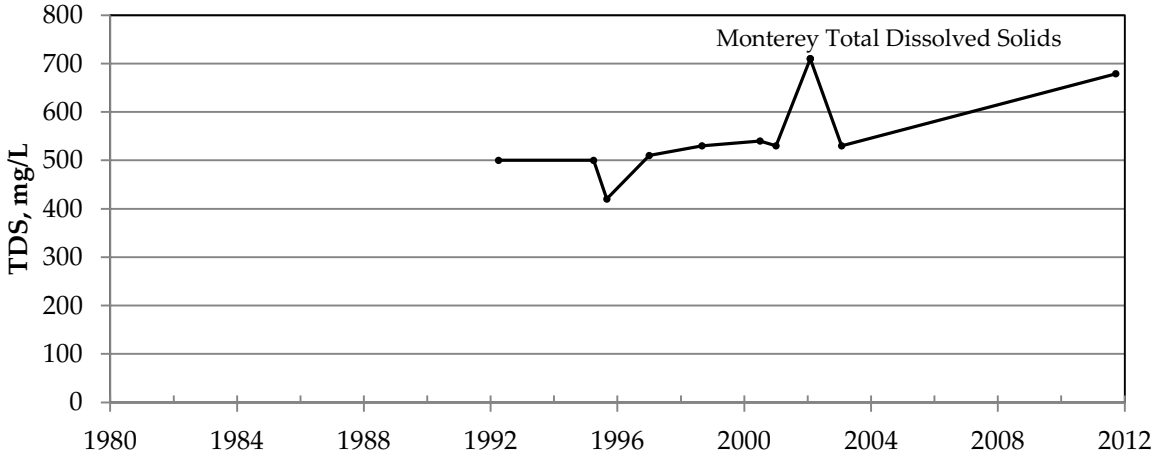

SC-15A Groundwater Elevation
Groundwater Elevation, ft MSL
15
10
5
0
-5
-10
-15
-20
Rate of change = 0.5 feet per year
Measurements recorded after 2005when
adjacent Rosedale well running excluded
WY 2007-2011 Trend
1980
1984
1988
1992
1996
2000
2004
2008
2012

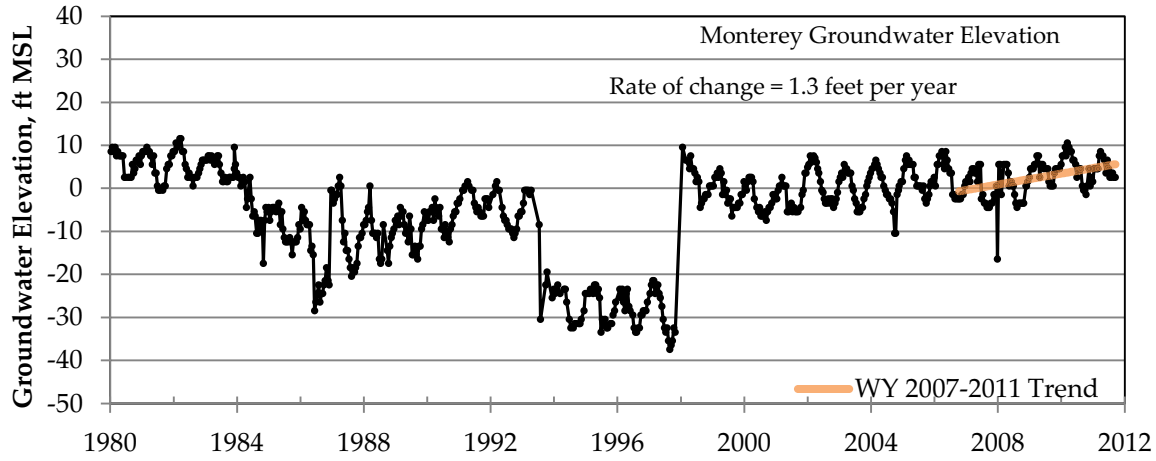

SC-15B Chloride
Chloride, mg/L
450
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

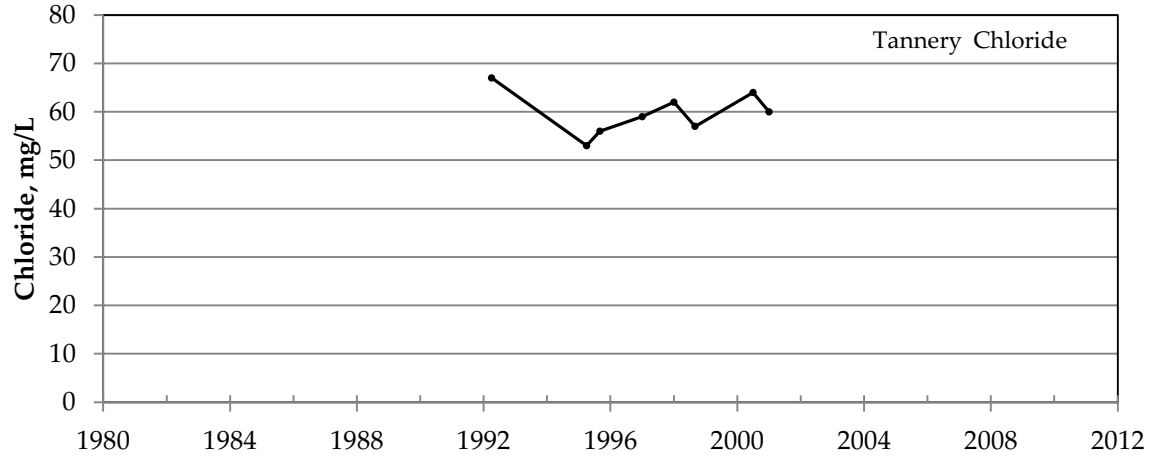

SC-15B Total Dissolved Solids
TDS, mg/L
1,200
1,000
800
600
400
200
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

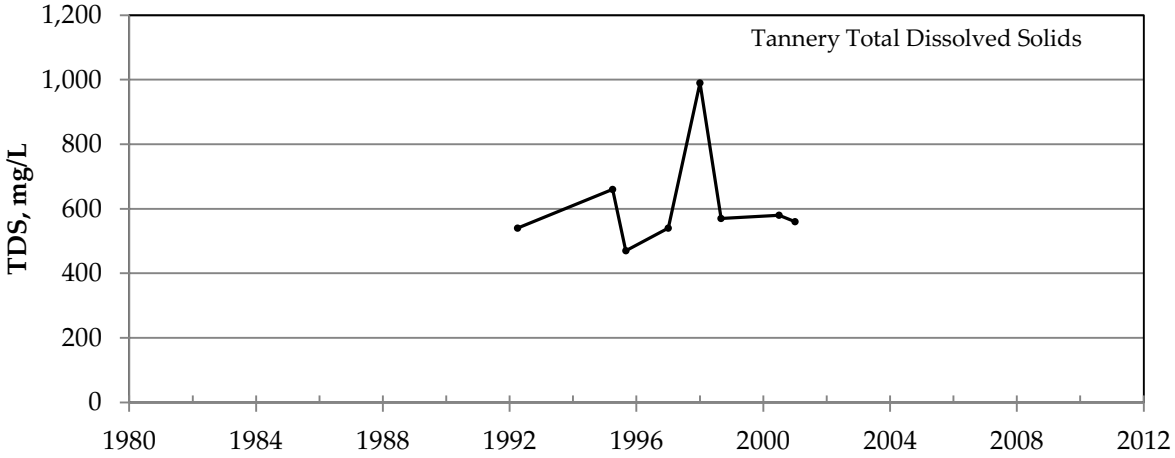

SC-15B Groundwater Elevation
Groundwater Elevation, ft MSL
25
20
15
10
5
0
-5
-10
Rate of change = 0.4 feet per year
Measurements recorded after 2005when
adjacent Rosedale well running excluded
WY 2007-2011 Trend
1980
1984
1988
1992
1996
2000
2004
2008
2012

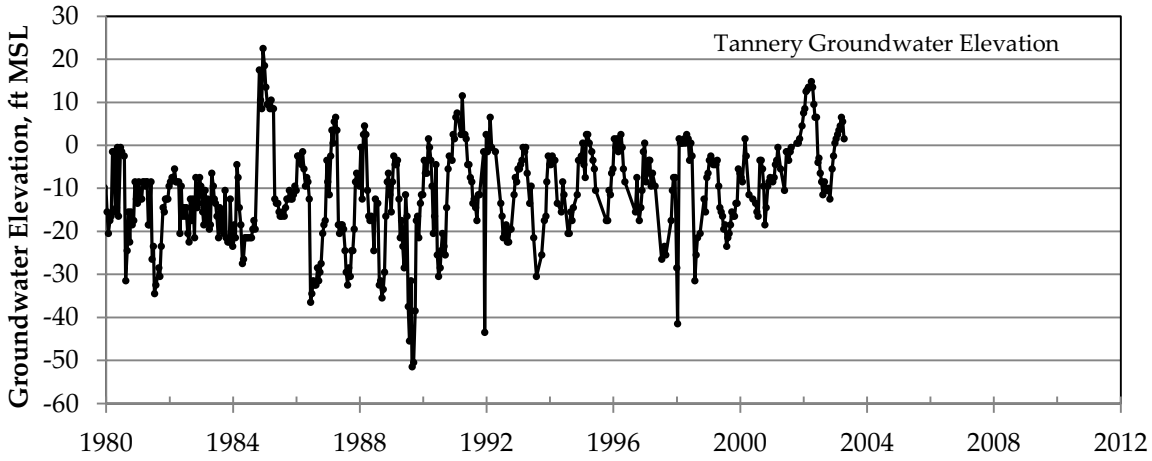

Monterey Chloride
Chloride, mg/L
80
70
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

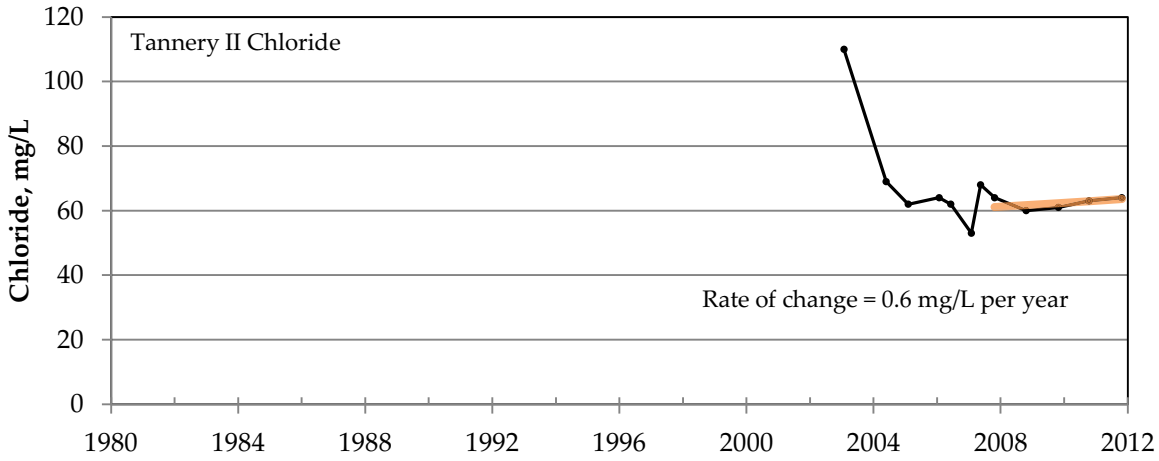

Monterey Total Dissolved Solids
TDS, mg/L
800
700
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

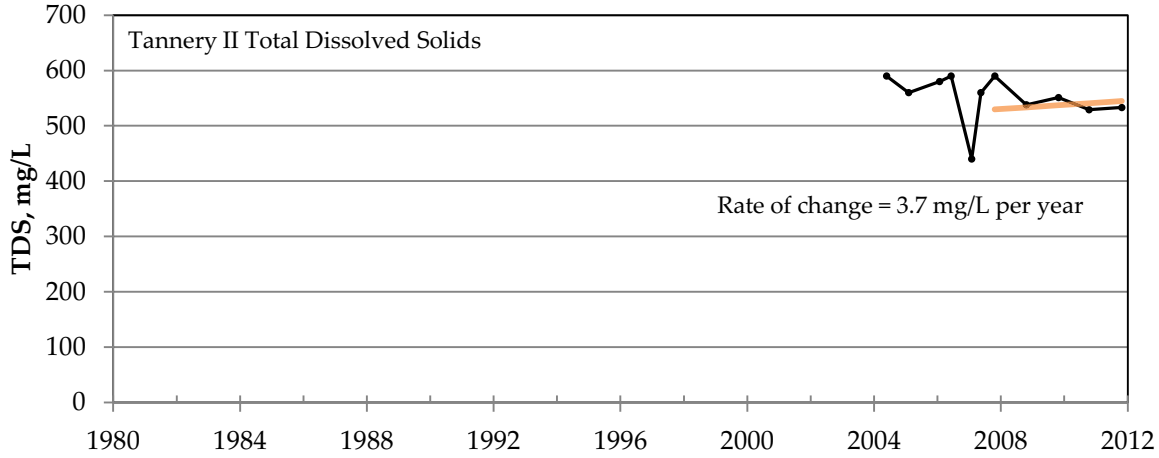

Monterey Groundwater Elevation
Rate of change = 1.3 feet per year
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
-20
-30
-40
-50
WY 2007-2011 Trend
1980
1984
1988
1992
1996
2000
2004
2008
2012

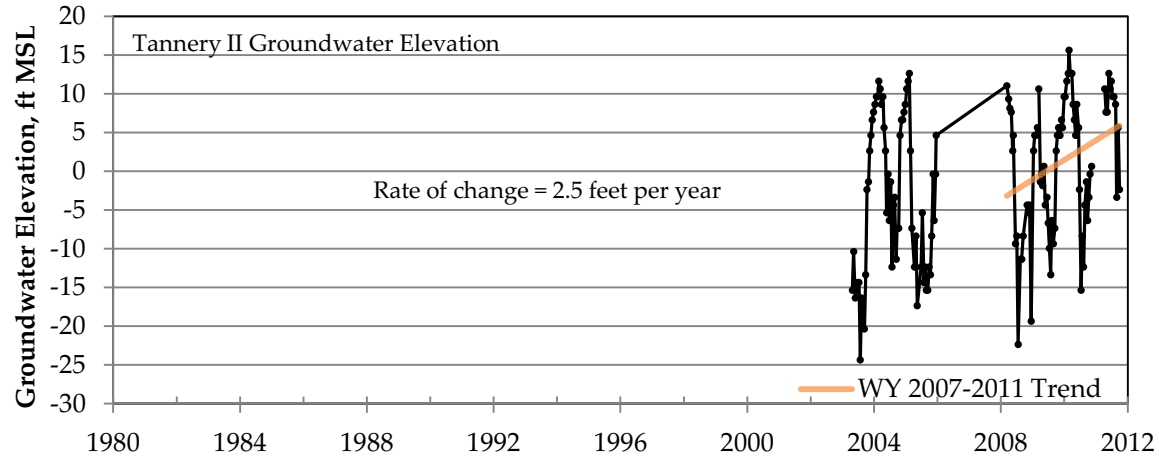

Tannery Chloride
Chloride, mg/L
80
70
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

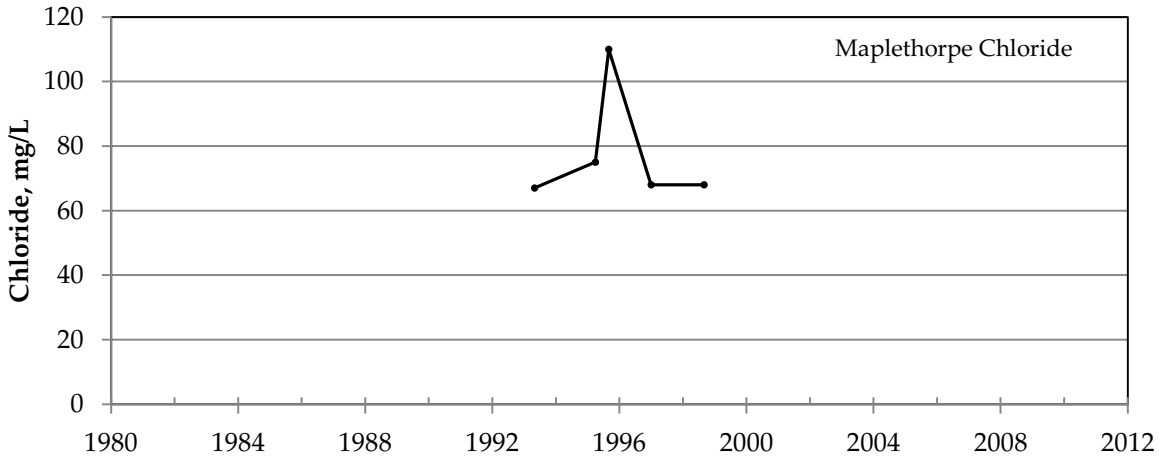

Tannery Total Dissolved Solids
TDS, mg/L
1,200
1,000
800
600
400
200
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

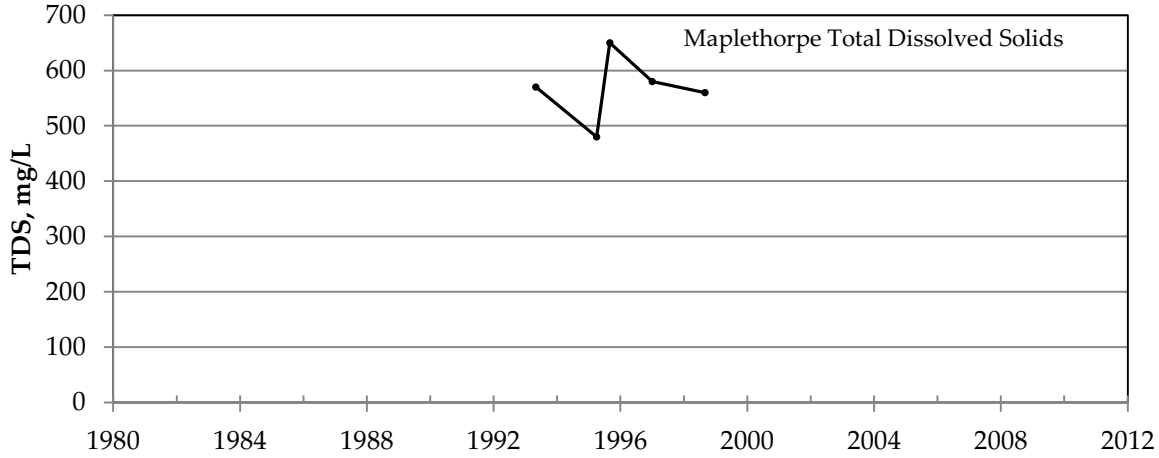

Tannery Groundwater Elevation
Groundwater Elevation, ft MSL
30
20
10
0
-10
-20
-30
-40
-50
-60
1980
1984
1988
1992
1996
2000
2004
2008
2012

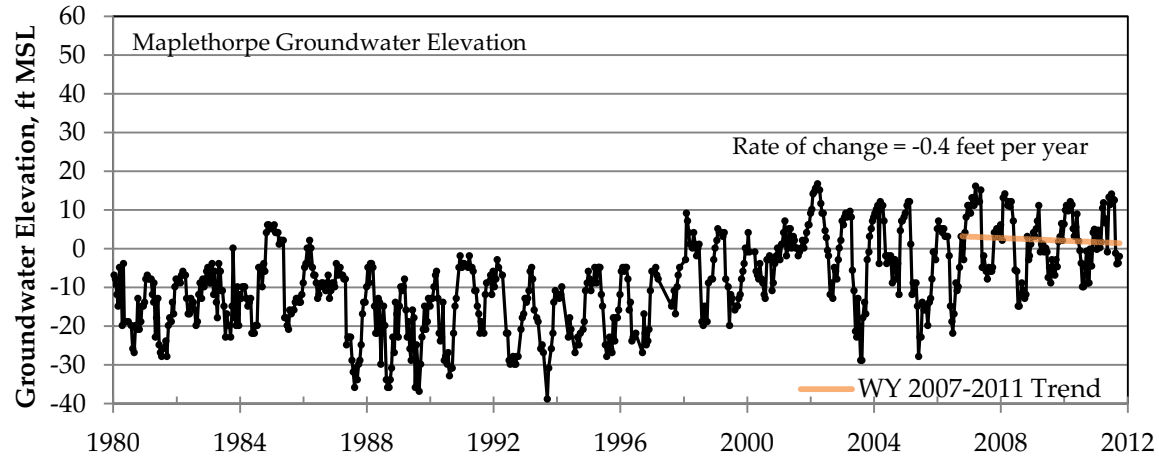

Tannery II Chloride
Chloride, mg/L
120
100
80
60
40
20
0
1980
1984
1988
1992
1996
2000
2004
2008
2012
Rate of change = 0.6 mg/L per year


Tannery II Total Dissolved Solids
TDS, mg/L
700
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012
Rate of change = 3.7 mg/L per year


Tannery II Groundwater Elevation
Groundwater Elevation, ft MSL
20
15
10
5
0
-5
-10
-15
-20
-25
-30
1980
1984
1988
1992
1996
2000
2004
2008
2012
Rate of change = 2.5 feet per year
WY 2007-2011 Trend


Maplethorpe Chloride
Chloride, mg/L
120
100
80
60
40
20
0
1980
1984
1988
1992
1996
2000
2004
2008
2012


Maplethorpe Total Dissolved Solids
TDS, mg/L
700
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012


Maplethorpe Groundwater Elevation
Rate of change = -0.4 feet per year
WY 2007-2011 Trend
Groundwater Elevation, ft MSL
60
50
40
30
20
10
0
-10
-20
-30
-40
1980
1984
1988
1992
1996
2000
2004
2008
2012

SECTION 4 – WATER YEAR 2011 AQUIFER CONDITIONS FOR CENTRAL PURISIMA AREA (BC/DEF-UNITS)

This section presents groundwater level and water quality conditions for Water Year 2011 in the central portion of the Soquel-Aptos area where the primary production aquifers are the Purisima BC-unit and the Purisima DEF-unit.

4.1 SqCWD Service Area II Production

In the central portion of the Soquel-Aptos area, groundwater is produced for municipal purposes by SqCWD in Service Area II. SqCWD's Service Area II production was 801 acre-feet in Water Year 2011, the lowest annual total since Water Year 1986 and the fourth consecutive year of production decreases. Production in Service Area II over the last six years has been below the historical average. Figure 4-1 shows the production in Service Area II by water year. Figure 4-1 also shows the production by well in Service Area II grouped by aquifer unit. Combined pumping at the wells grouped as BC-unit wells (Estates, Ledyard, and Madeline) was 495 acre-feet, the lowest annual amount since Water Year 1986. Combined pumping at the wells grouped as DEF-unit wells (Aptos Creek and T. Hopkins) was 306 acre-feet, the third lowest amount since Water Year 1990. Water Year 2010 pumping in Service Area II was approximately 29% of SqCWD's revised estimate of the post-recovery pumping yield in the Purisima area (HydroMetrics WRI, 2012).

4.2 Groundwater Level Conditions and Trends

SqCWD has established protective groundwater elevations in coastal monitoring wells to protect the Purisima BC-unit and DEF-unit in the central portion of the Soquel-Aptos area from seawater intrusion. Cross-sectional models were used to estimate groundwater elevations that result in the freshwater-salt water interface in the productive aquifer unit being seaward of the coast over the long term (HydroMetrics LLC, 2009b).

Coastal groundwater levels in the SqCWD's BC-unit and DEF-unit monitoring wells remained below protective elevations in Water Year 2011, as shown in Table 4-1. Hydrographs for wells in the SC-9 and SC-8 clusters follow at the end of this section. The hydrographs show that groundwater levels at wells SC-9B,

SC-9C, and SC-8D have been below protective elevations for most of the data record, and remained below protective elevations in Water Year 2011.

Table 4-1 (2011): Comparison of Water Year 2011 Coastal Groundwater Levels with Protective Elevations

Well	Location	Unit	Minimum Groundwater Elevation (feet msl)[1]	Maximum Groundwater Elevation (feet msl)	Protective Elevation (feet msl)
SC-9B	Seacliff	B/BC	-14.4	-5.2	10
SC-9C		BC	-21.9	-9.4	
SC-8D	Aptos Creek	DEF	-4.1	8	10

[1] msl = mean sea level

Groundwater levels show increasing trends over the last 4 years at SqCWD's coastal monitoring wells completed in the BC and DEF-units. Four years ago, groundwater levels at wells SC-9B/C and SC-8D were close to historical lows. The increasing trend since that time has likely been due to reduced pumping at nearby SqCWD production wells.

Groundwater levels in the BC-unit are lower than groundwater levels in the DEF-units. This separation has occurred in the Aptos Creek area since Water Year 2004 even though the pumping at the Aptos Creek and T. Hopkins wells is mostly derived from the DEF-unit. This would suggest that drawdown caused by production wells in the BC-unit spreads farther laterally than drawdown in the DEF-unit.

Groundwater levels in shallower coastal monitoring wells in the DEF-unit declined slightly after Water Year 2006 and have been relatively stable since declining. This decline in the shallow interval of the DEF-unit may reflect a reduction in basin storage correlated with less precipitation. There has been a slight rise in these groundwater levels in Water Years 2010 and 2011, coinciding with increased precipitation.

Table 4-2 summarizes the important groundwater level trends by monitoring well. Hydrographs for multiple completions of these wells follow at the end of this section. Hydrographs for multiple completions of monitoring wells adjacent to production wells, and static groundwater levels in groups of production wells are also included following this section.

Hydrographs for single wells including production wells are included with chemographs. These hydrographs show trend lines for Water Years 2007-2011, a period when production in the Central Purisima area was decreasing and below historical averages.

Contour maps of groundwater elevations in Spring and Fall 2011 for the Purisima BC-unit are shown in Figure 4-2 and Figure 4-3. Figure 4-2 shows that the Spring 2011 pumping depression in the BC-unit was below sea level, with below sea level groundwater levels extending to the coast. Figure 4-3 shows the below sea level pumping depression deepened in the fall at some locations, and extended to more of the coast than in the spring. The pumping depressions were less deep in 2011 than the previous year.

Table 4-2 (2011): Summary of Groundwater Level Trends in Central Purisima Area

Category	Well	Groundwater Level Trend Description	Notes
SqCWD Coastal Monitoring BC and DEF-unit Wells	SC-9B/C	Rise WY 2008-2011	Reduced pumping at Estates WY 2009-2011
	SC-8D	Rise WY 2008-2011	Reduced pumping at Aptos Creek and T. Hopkins WY 2008-2011
	SC-8B	Rise WY 2008-2011 in BC-unit and > 10 feet below SC-8D	Deeper drawdown from BC-unit pumping
SqCWD Shallow Monitoring Coastal Wells	SC-9E SC-8E	Rise of 1.5 feet since WY 2008-2009 in overlying interval of DEF-unit after 1-2 foot drop WY 2007	Increasing precipitation since WY 2007
	SC-8F	Unreliable data	Well filled up to a depth of 106 feet from original 200 feet depth
SqCWD Inland BC Unit Monitoring Well	SC-19	10+ feet rise since installation in WY 2007	Increasing precipitation since WY 2007

4.3 WATER QUALITY CONDITIONS AND TRENDS

The most significant groundwater quality threat in the Soquel-Aptos basin is seawater intrusion. As discussed above, groundwater levels remain below protective elevations in the BC and DEF-units. As a result, there is ongoing risk of seawater intrusion into the productive units of the central Purisima area.

Observed Total Dissolved Solids (TDS) and chloride concentrations do not suggest any seawater intrusion impacting SqCWD's production wells in the Purisima BC and DEF-units. Observed TDS and chloride concentrations in SqCWD's monitoring wells in the BC and DEF-units also do not indicate incipient seawater intrusion. Recent chloride concentrations in both production and monitoring wells are at 100 mg/L or less, while the maximum contaminant limit (MCL) for chlorides is 250 mg/L. Chemographs for SqCWD wells in the area are included following this section.

Chloride concentrations in well SC-8F, completed in the shallow F-unit, were approximately 3,000 mg/L starting in Water Year 2007. Data from this well, however, are not reliable. The well was sanded up to 100 feet and was replaced in 2012. The chloride concentration from the replacement well was 43 mg/L.

Water pumped from the Purisima formation continues to be treated for iron and manganese to meet drinking water standards. In Water Year 2011, color and turbidity were also reduced during treatment to meet drinking water standards.

In Water Years 2009 through 2011, the Aptos Creek and T. Hopkins wells had detections of arsenic that ranged from 1.9-4.7 μg/L, below the MCL of 10 μg/L for arsenic. Water from these wells is treated to reduce arsenic concentrations below 1.1-3.0 μg/L, with an average of 2.0 μg/L.

4.4 STATE OF THE AQUIFER SUMMARY

Seawater intrusion has not been detected in most of the Central Purisima area. However, the productive Purisima BC and DEF-units remain at risk for seawater intrusion as coastal groundwater levels remain well below protective elevations. Due to historically low production in Water Years 2009 through 2011, groundwater levels in the Purisima BC and DEF-units showed recovery over the last two years. A longer period of low production will be required to recover the basin to be protected against the risk for seawater intrusion.

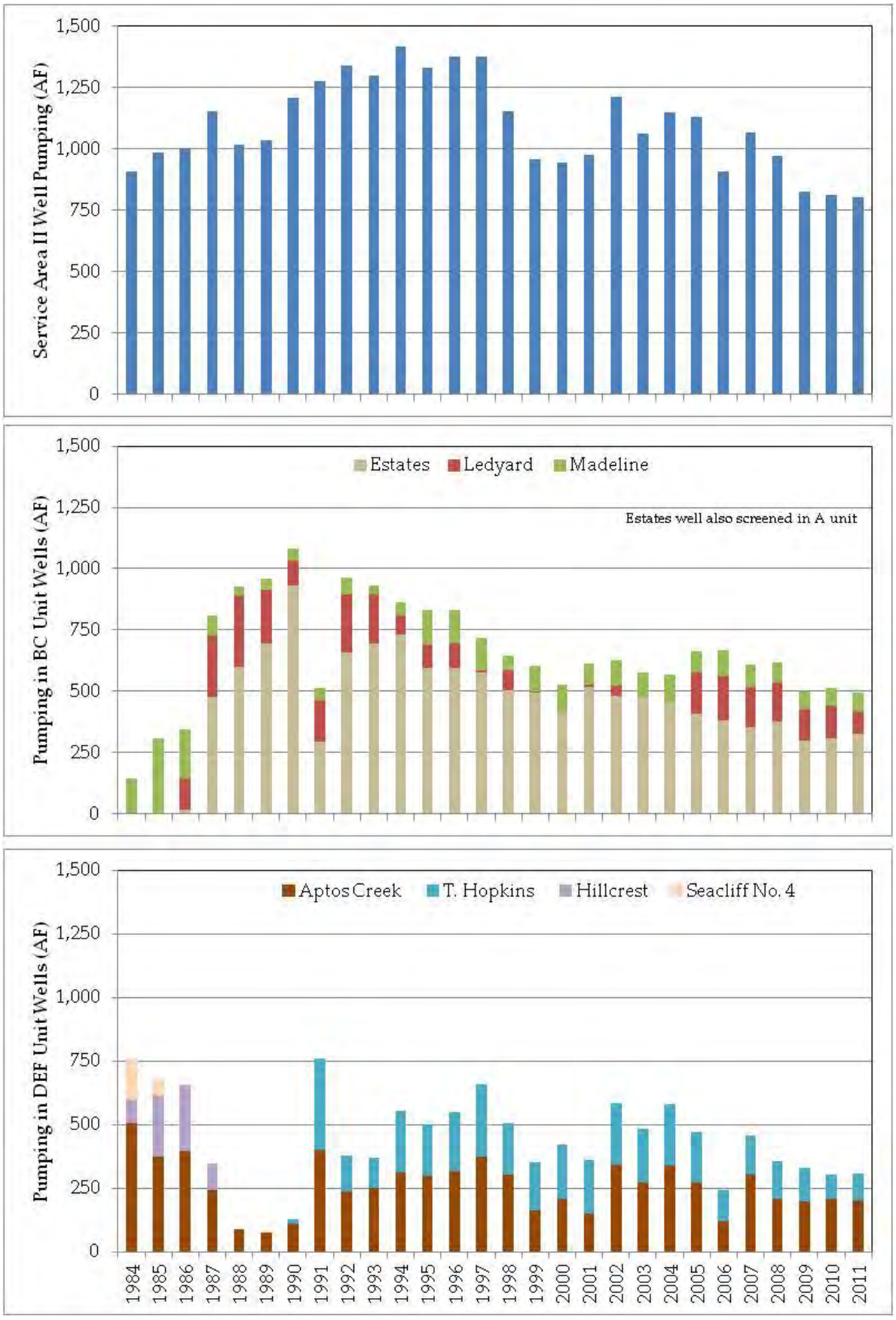


Figure 4-1: Pumping by Water Year in Central Purisima Area

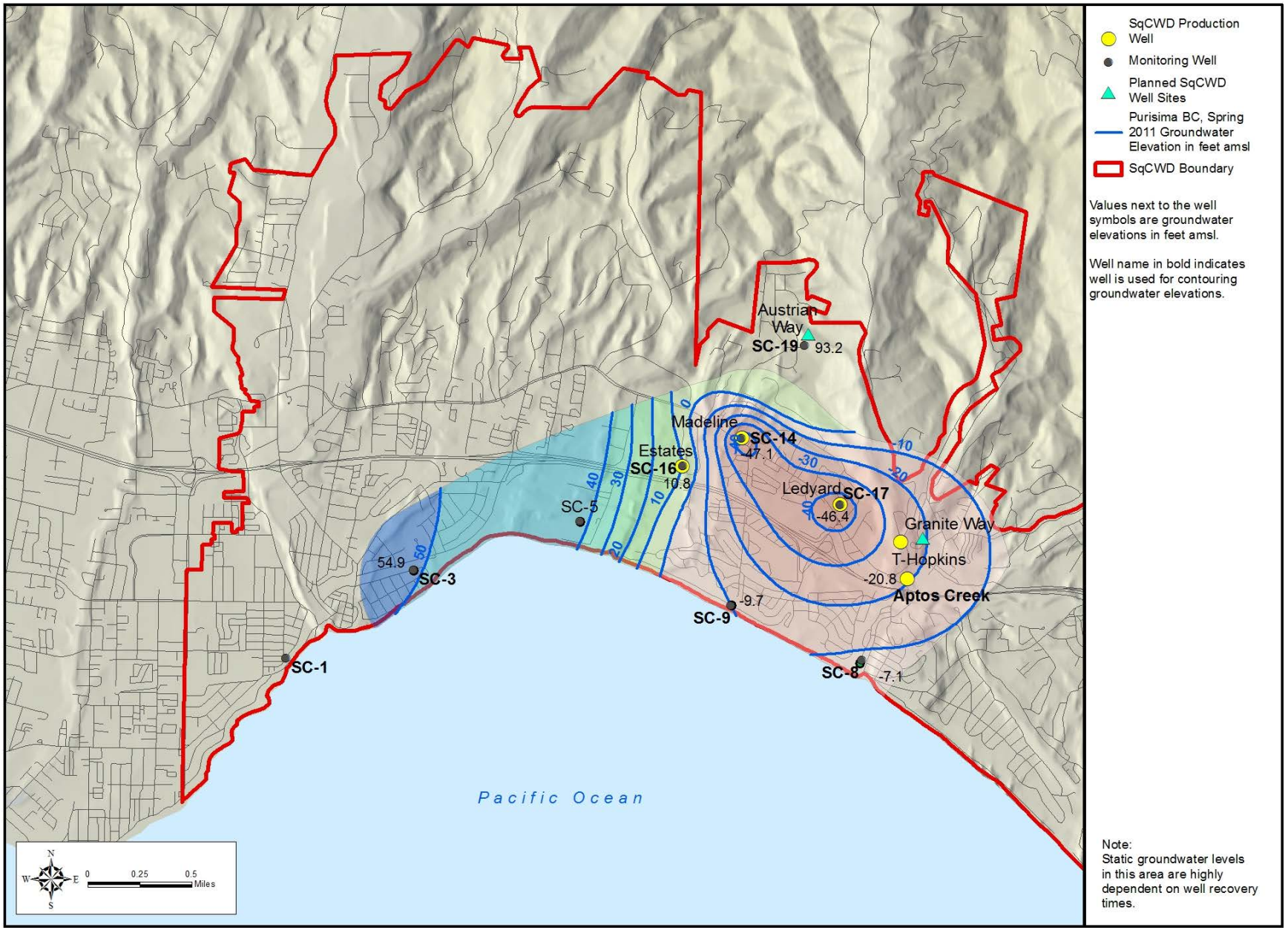


Figure 4-2 (2011): Groundwater Elevation Contours, Purisima BC-Unit, Spring 2011

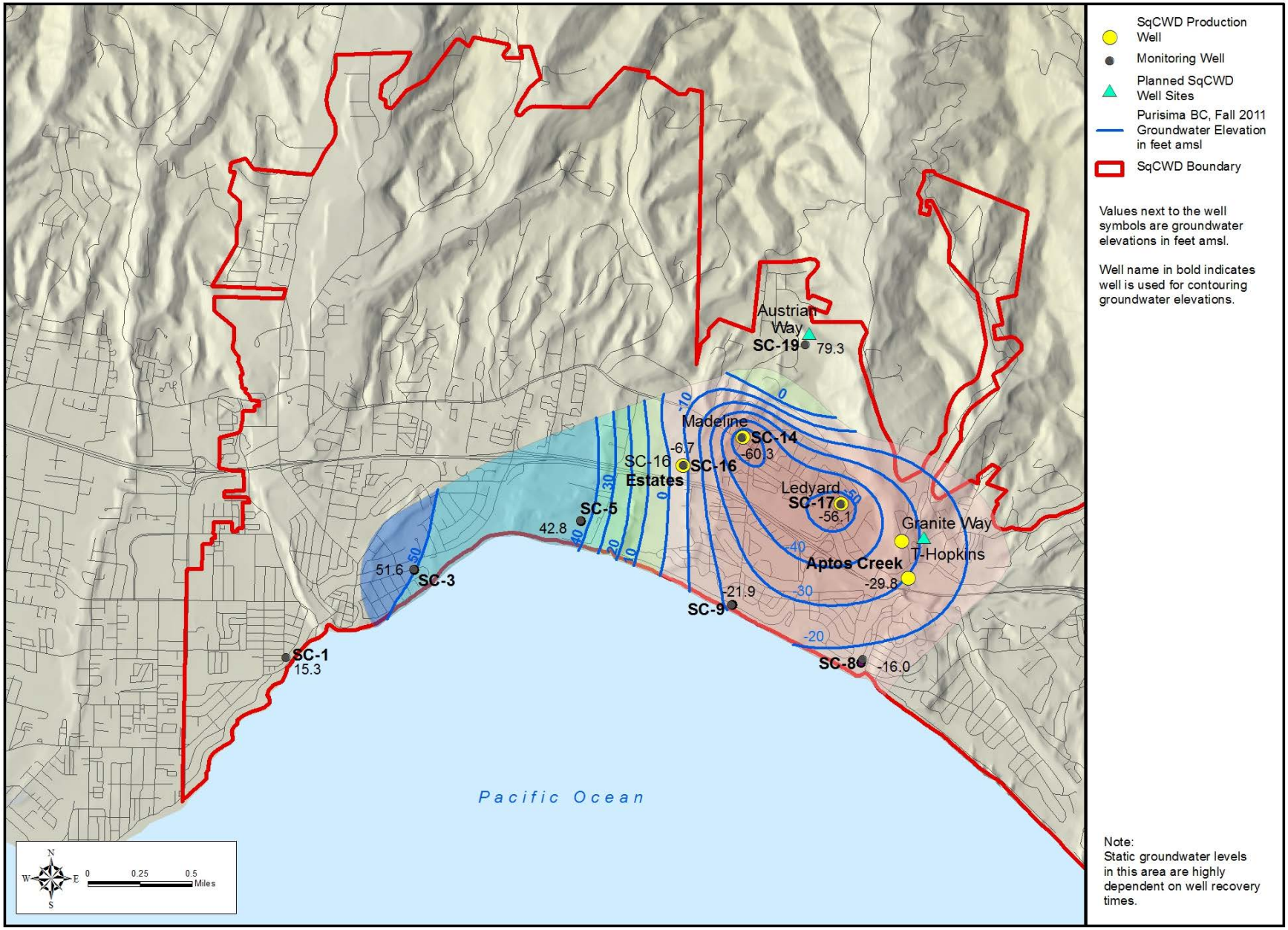


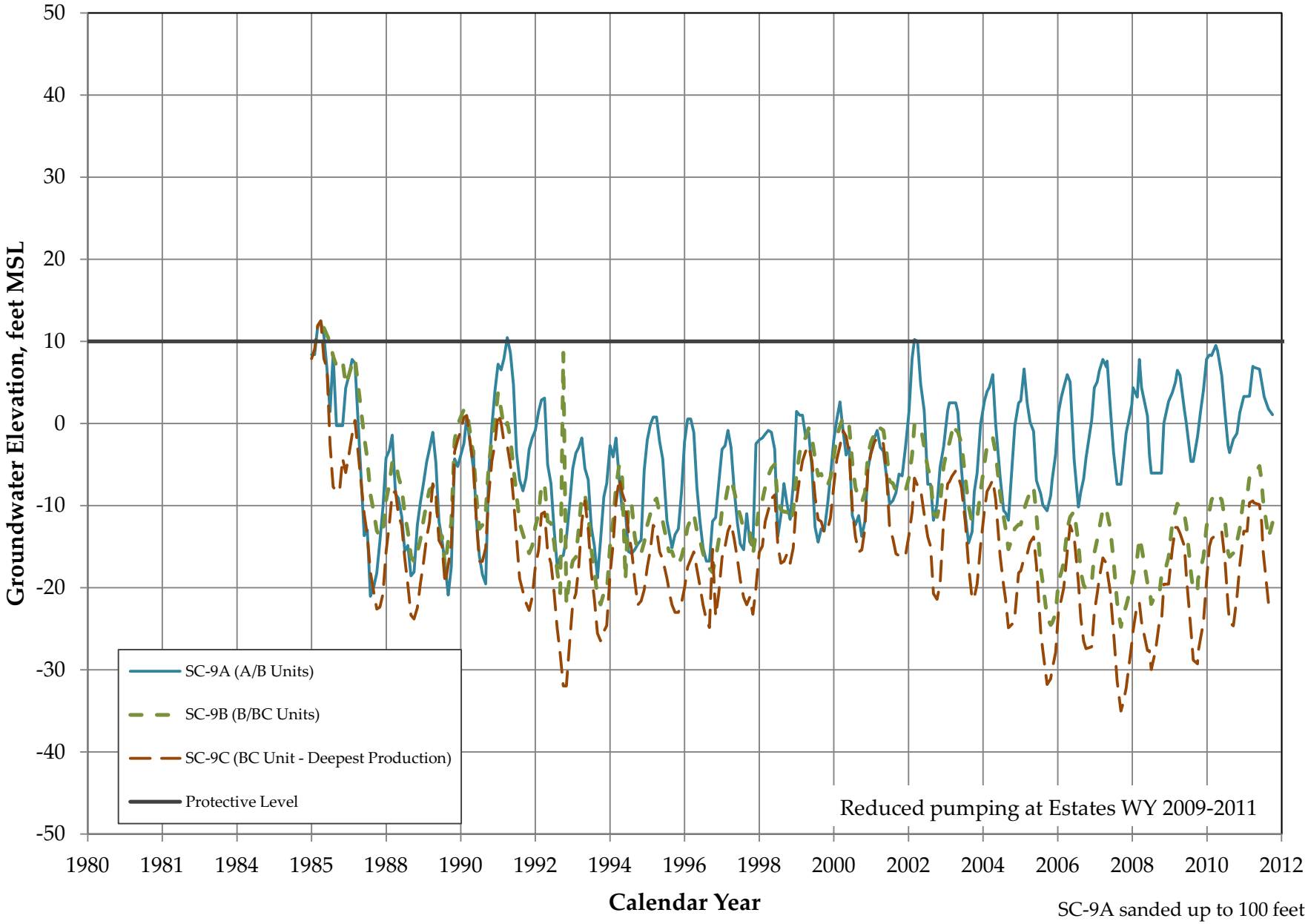
Figure 4-3 (2011): Groundwater Elevation Contours, Purisima BC-Unit, Fall 2011

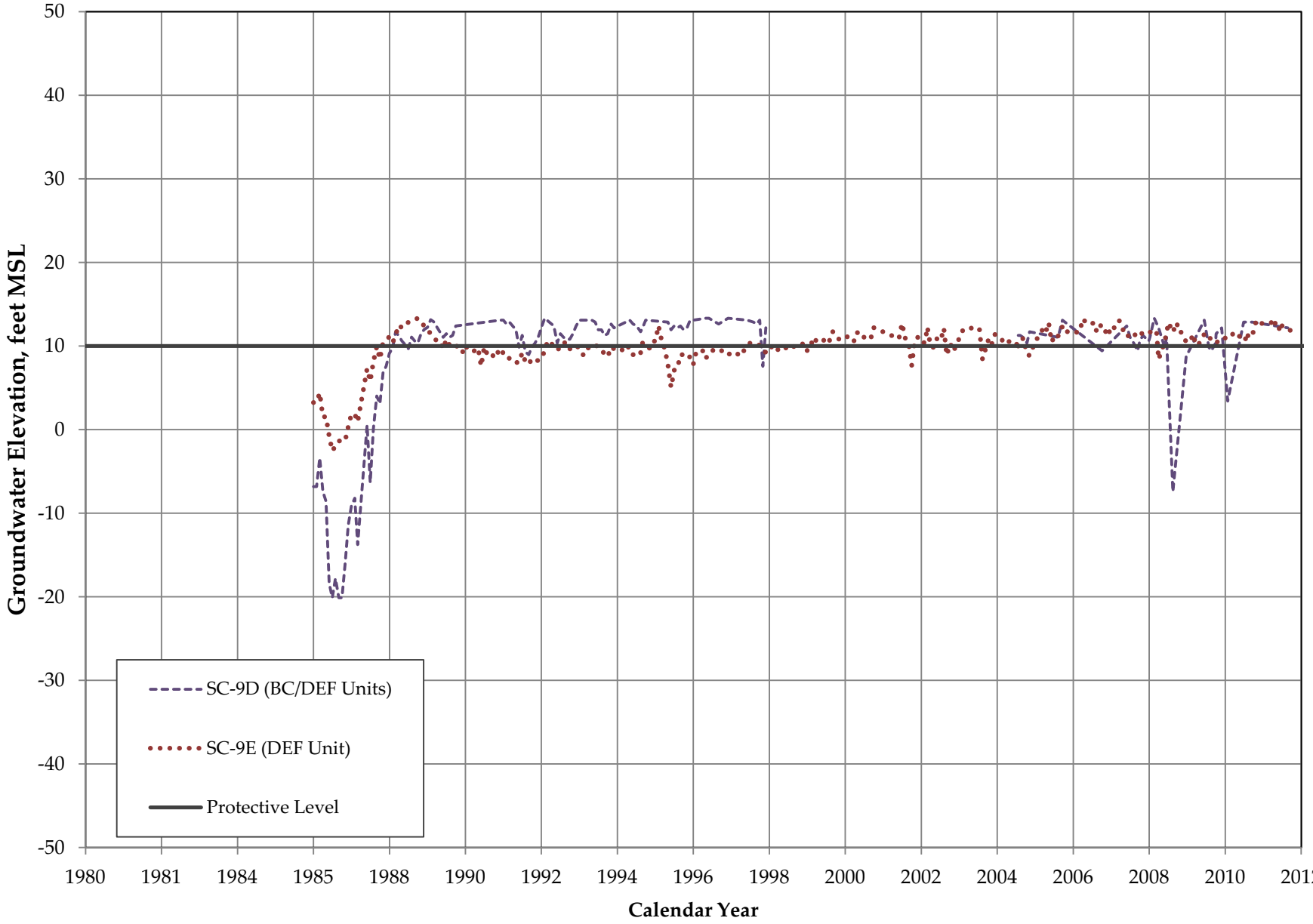
Monitoring Well Hydrographs for Central Purisima Area

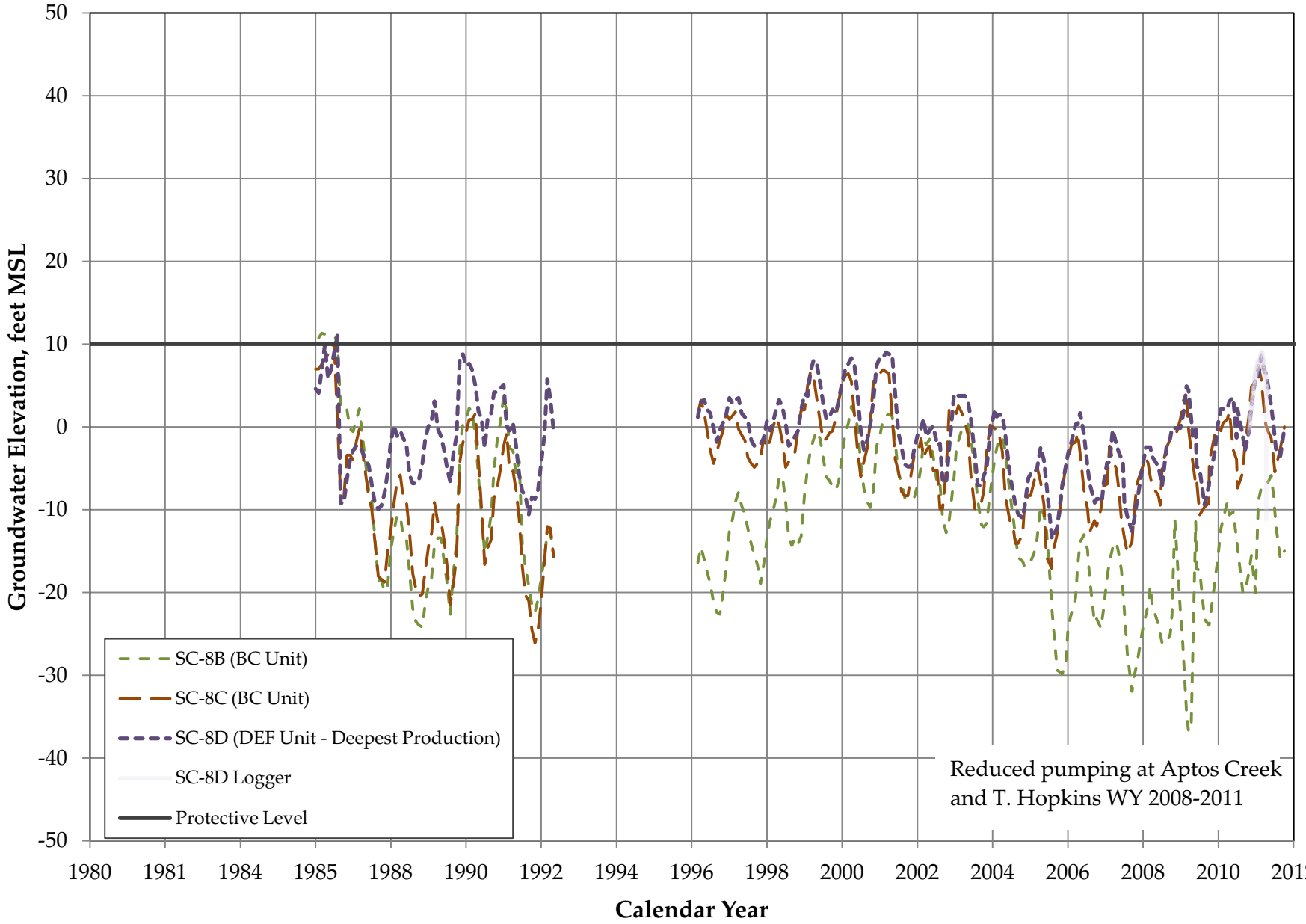
Hydrographs of SqCWD Coastal Monitoring Well Clusters

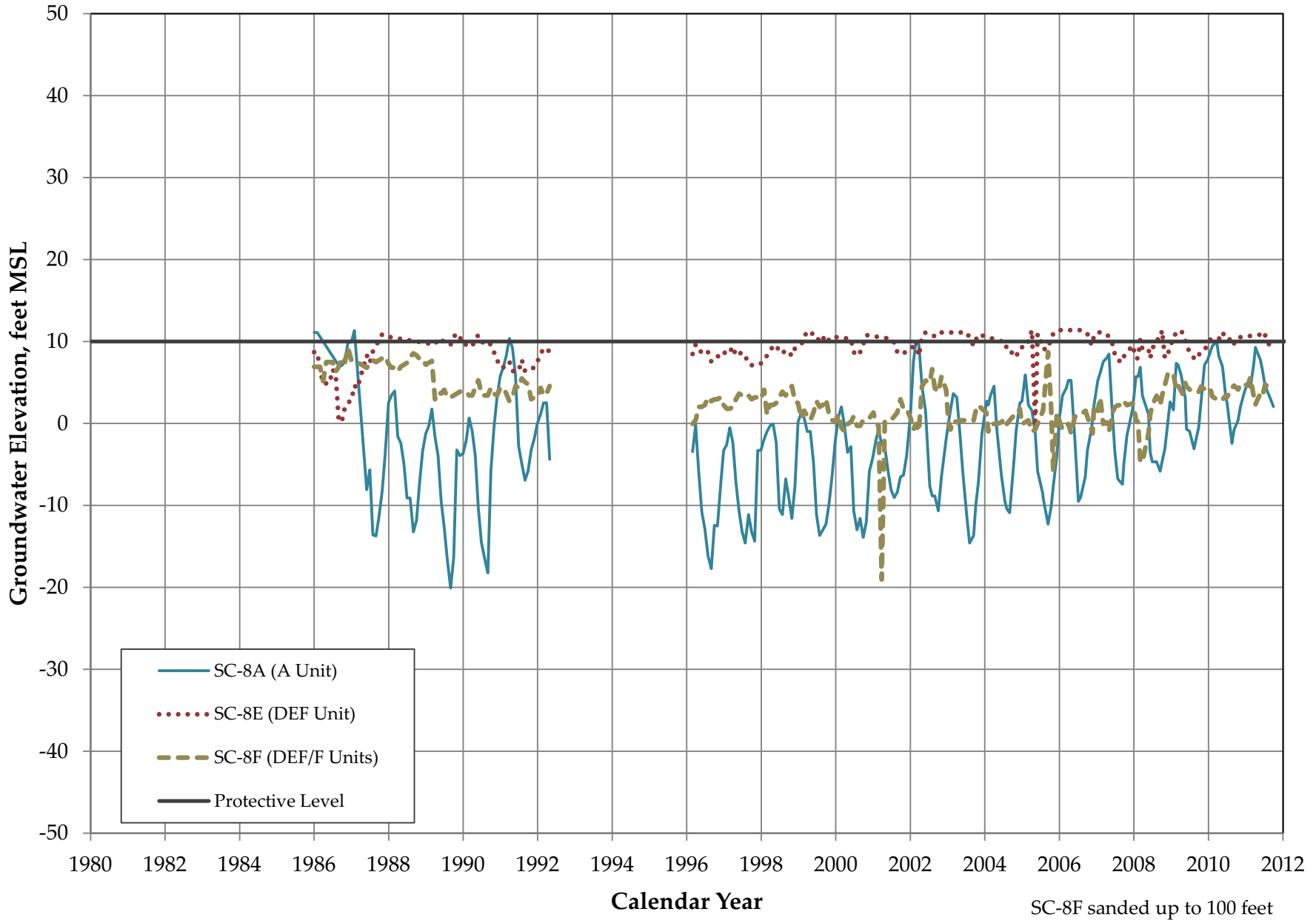
Hydrographs of SqCWD Inland Monitoring Well Clusters

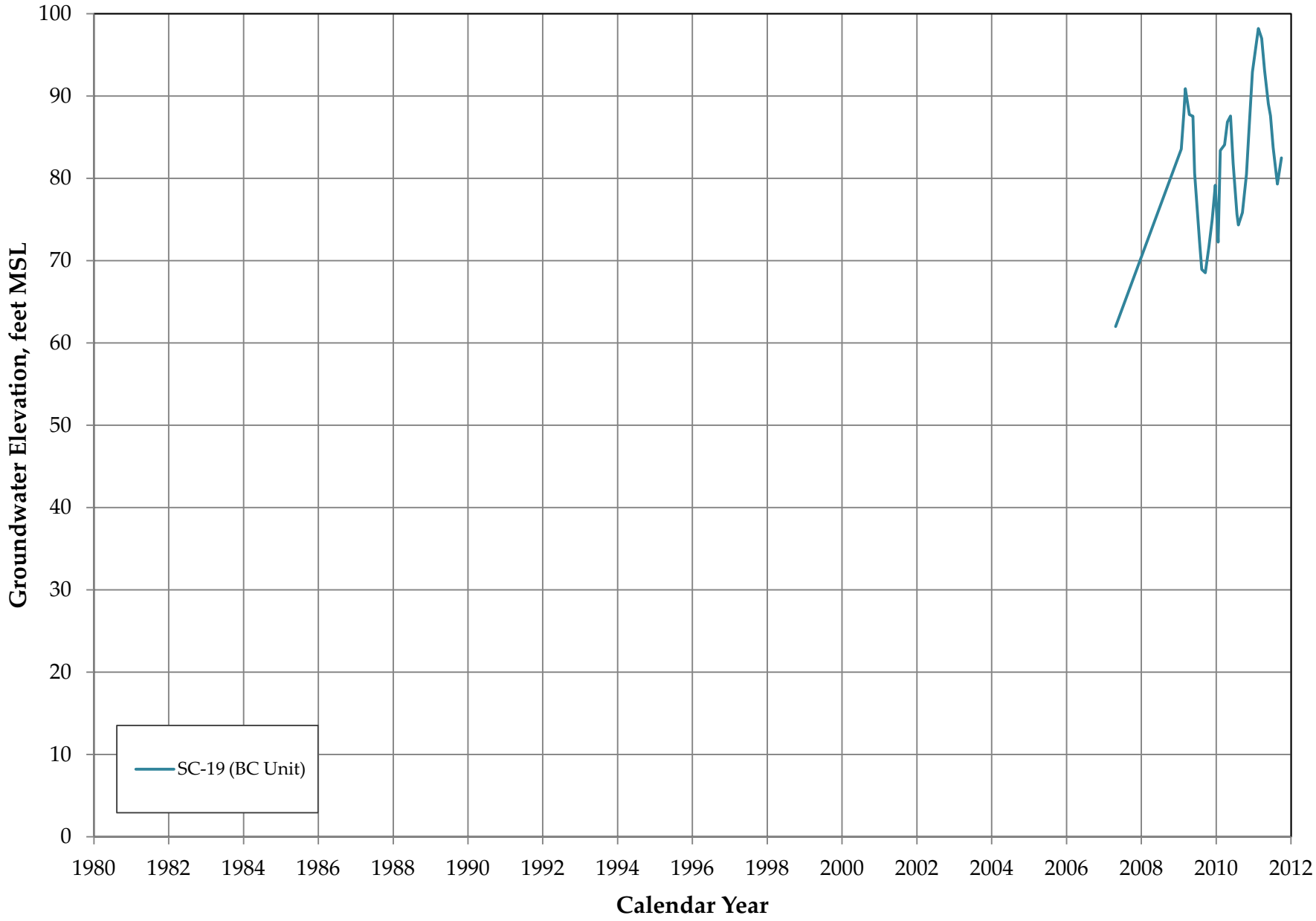
Hydrographs of SqCWD Monitoring Wells Adjacent to Production Wells

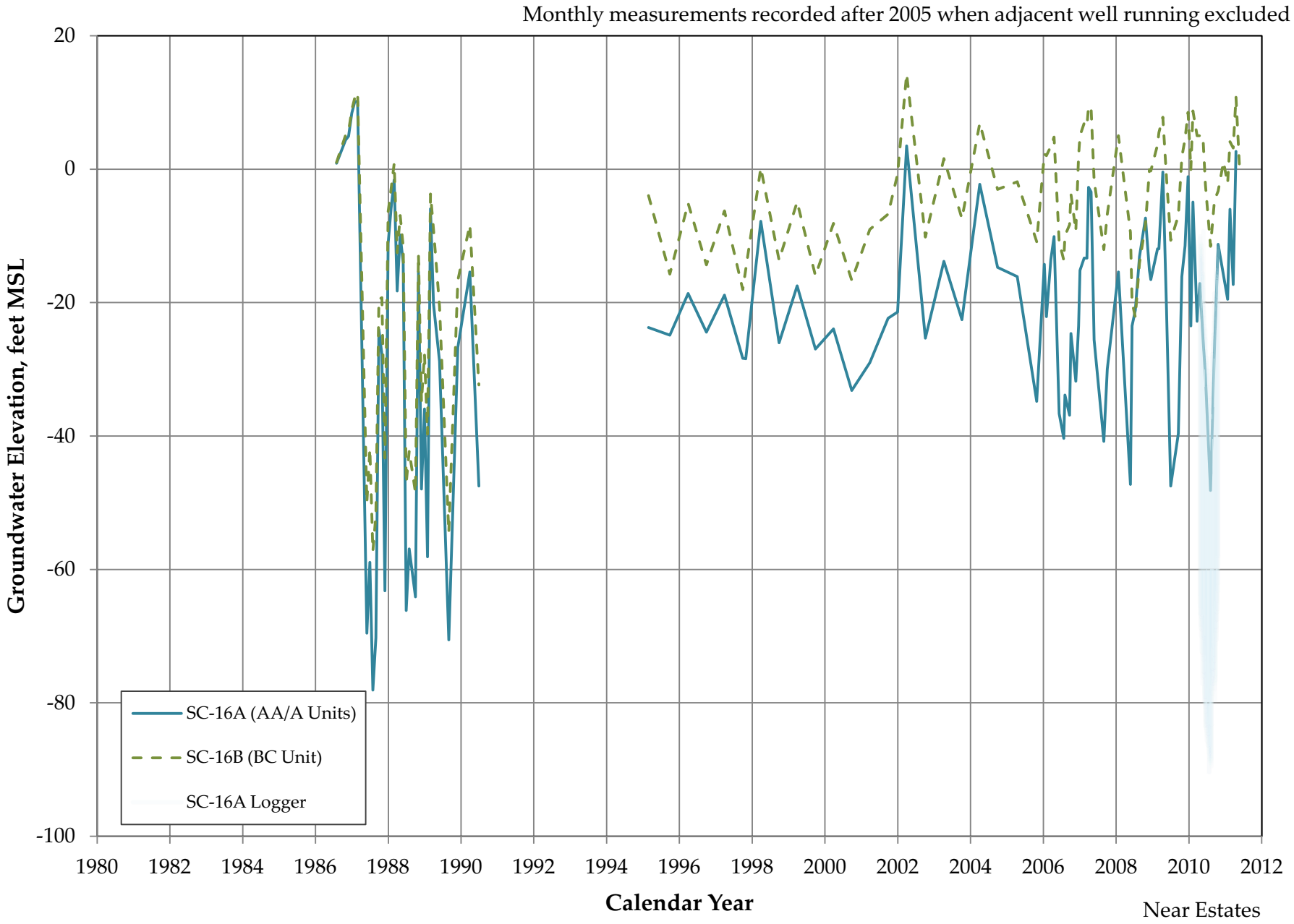

Groundwater Elevation, feet MSL
50
40
30
20
10
0
-10
-20
-30
-40
-50
1980
1981
1984
1985
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
SC-9A (A/B Units)
SC-9B (B/BC Units)
SC-9C (BC Unit - Deepest Production)
Protective Level
Reduced pumping at Estates WY 2009-2011
SC-9A sanded up to 100 feet

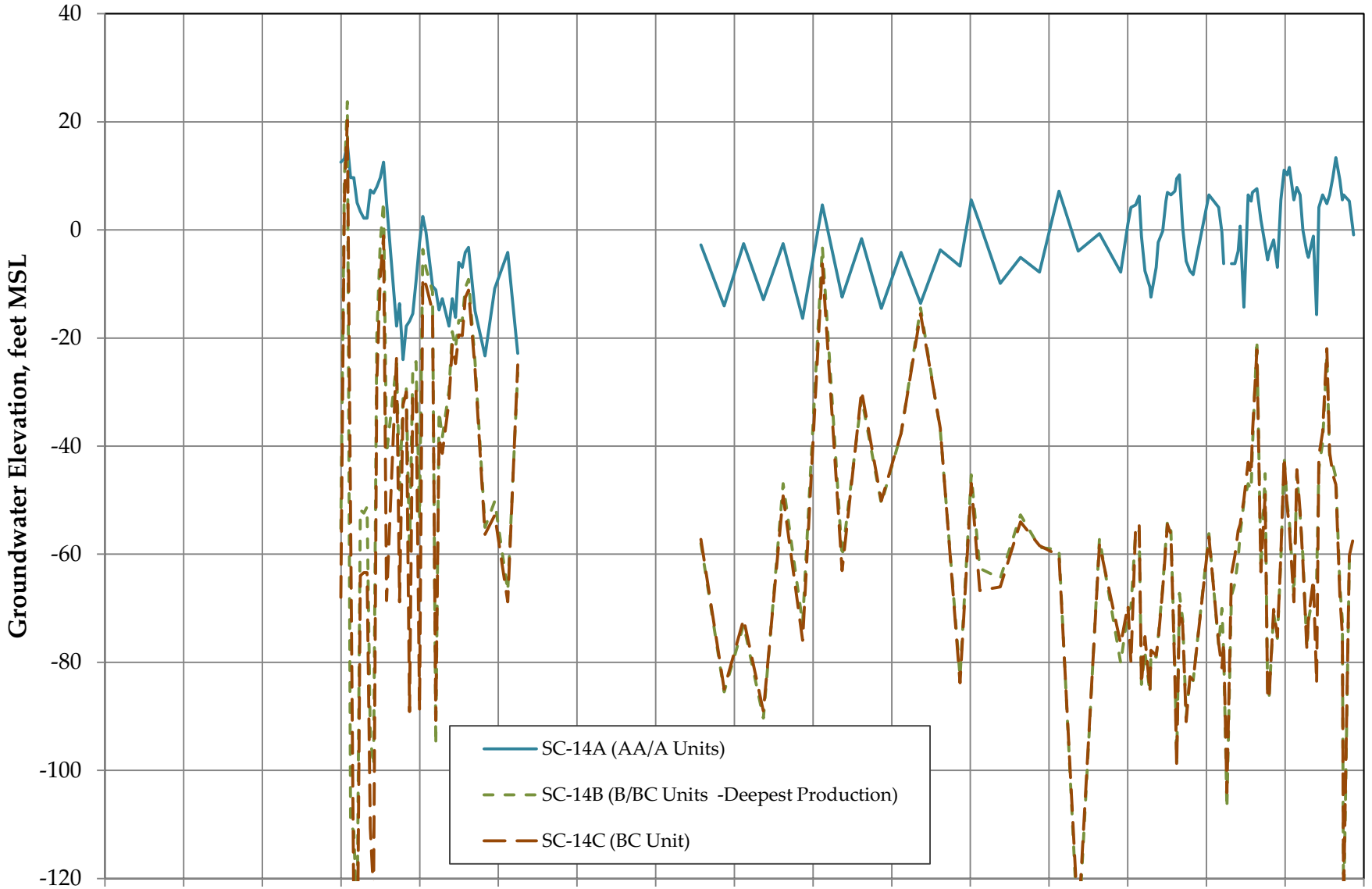

Groundwater Elevation, feet MSL
50
40
30
20
10
0
-10
-20
-30
-40
-50
1980
1981
1984
1985
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
SC-9D (BC/DEF Units)
SC-9E (DEF Unit)
Protective Level


Groundwater Elevation, feet MSL
50
40
30
20
10
0
-10
-20
-30
-40
-50
1980
1981
1984
1985
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
SC-8B (BC Unit)
SC-8C (BC Unit)
SC-8D (DEF Unit - Deepest Production)
SC-8D Logger
Protective Level
Reduced pumping at Aptos Creek
and T. Hopkins WY 2008-2011

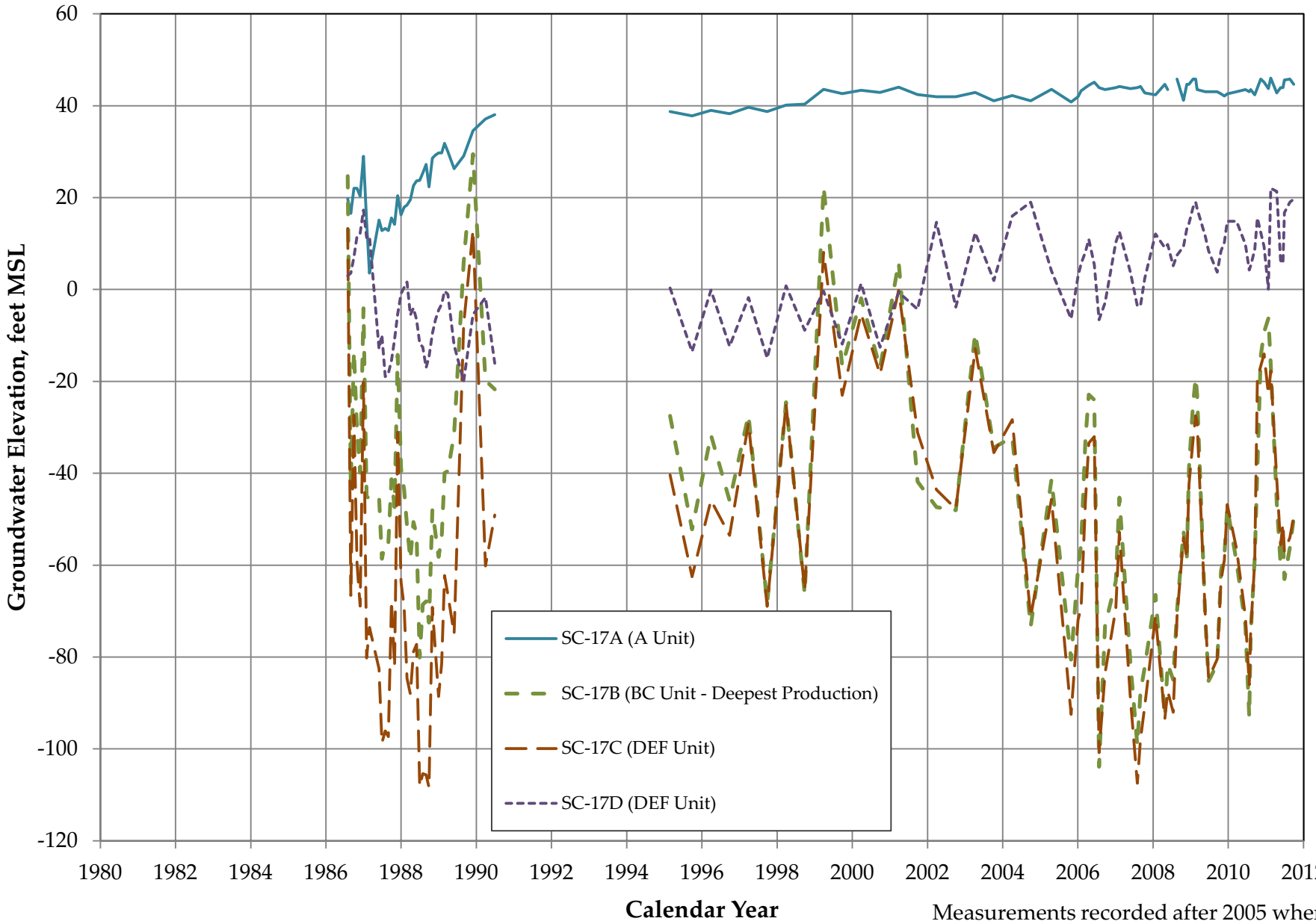

Groundwater Elevation, feet MSL
50
40
30
20
10
0
-10
-20
-30
-40
-50
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
SC-8A (A Unit)
SC-8E (DEF Unit)
SC-8F (DEF/F Units)
Protective Level
SC-8F sanded up to 100 feet


Groundwater Elevation, feet MSL
100
90
80
70
60
50
40
30
20
10
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
SC-19 (BC Unit)


Monthly measurements recorded after 2005 when adjacent well running excluded
Groundwater Elevation, feet MSL
20
0
-20
-40
-60
-80
-100
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
SC-16A (AA/A Units)
SC-16B (BC Unit)
SC-16A Logger
Near Estates



Measurements recorded after 2005 when adjacent Madeline well running excluded



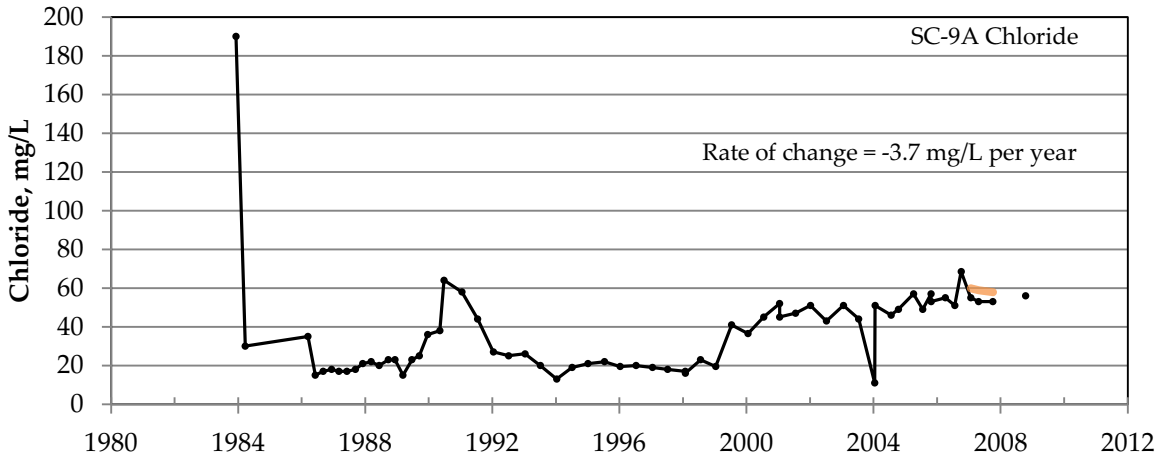
Measurements recorded after 2005 when adjacent Ledyard well running excluded

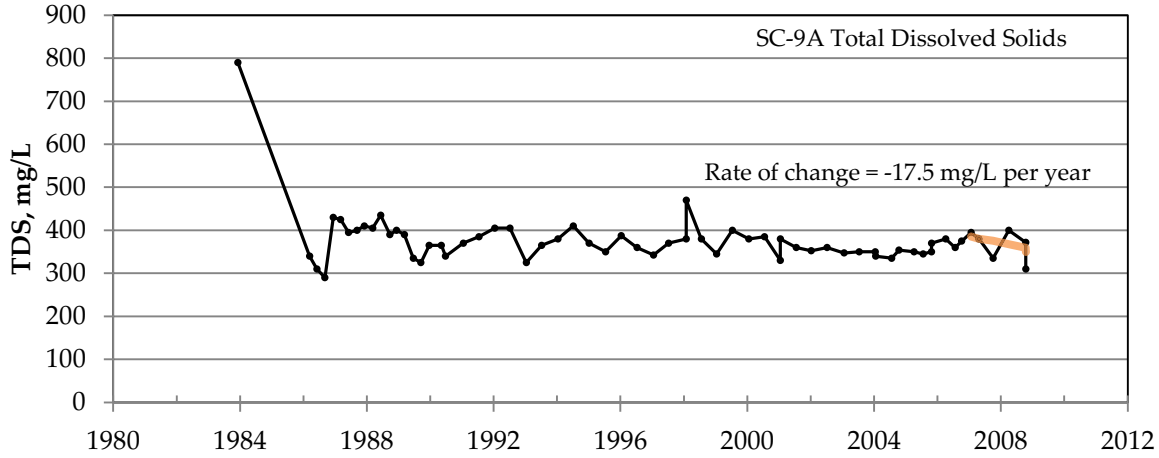
Chemographs and Single Well Hydrographs for Central Purisima Area

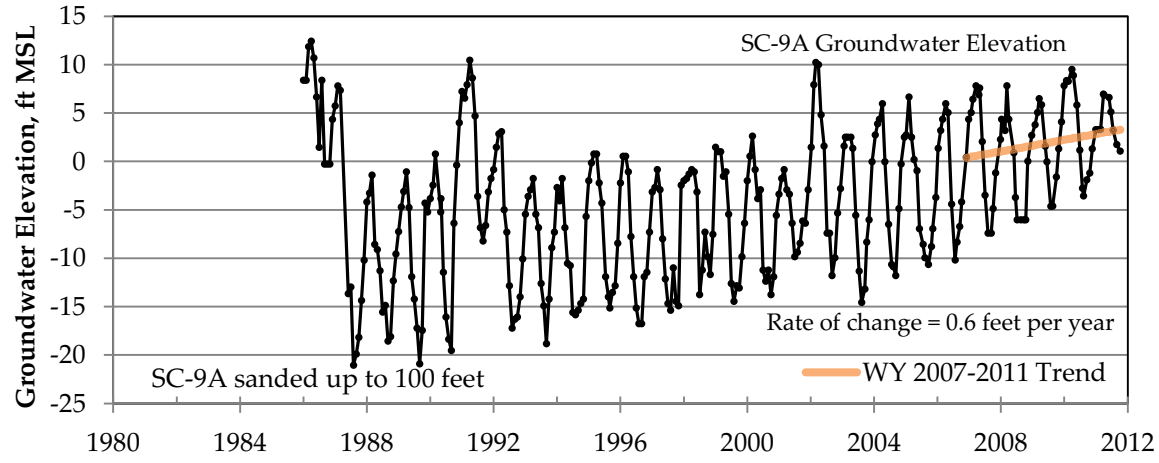
Graphs of SqCWD Coastal Monitoring Well Clusters

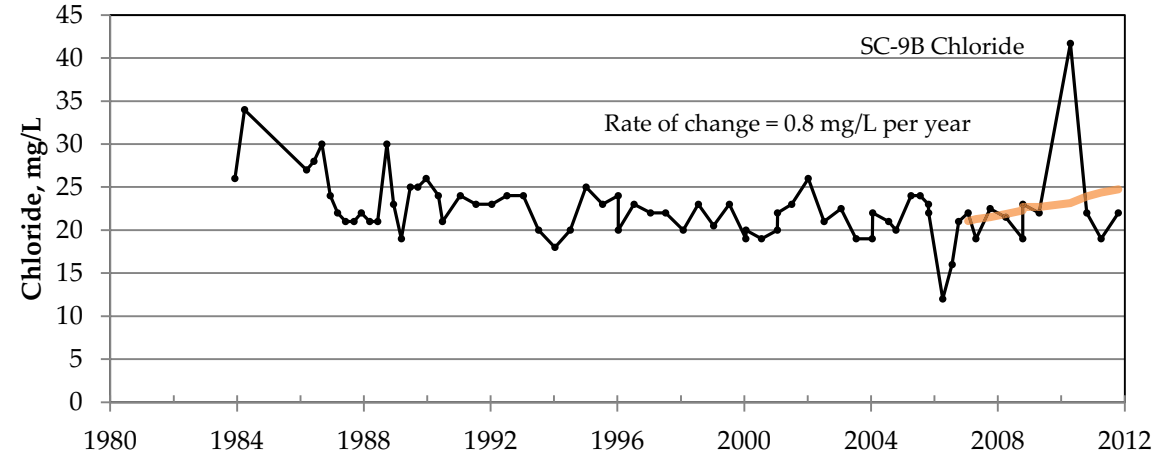
Graphs of SqCWD Inland Monitoring Well Clusters

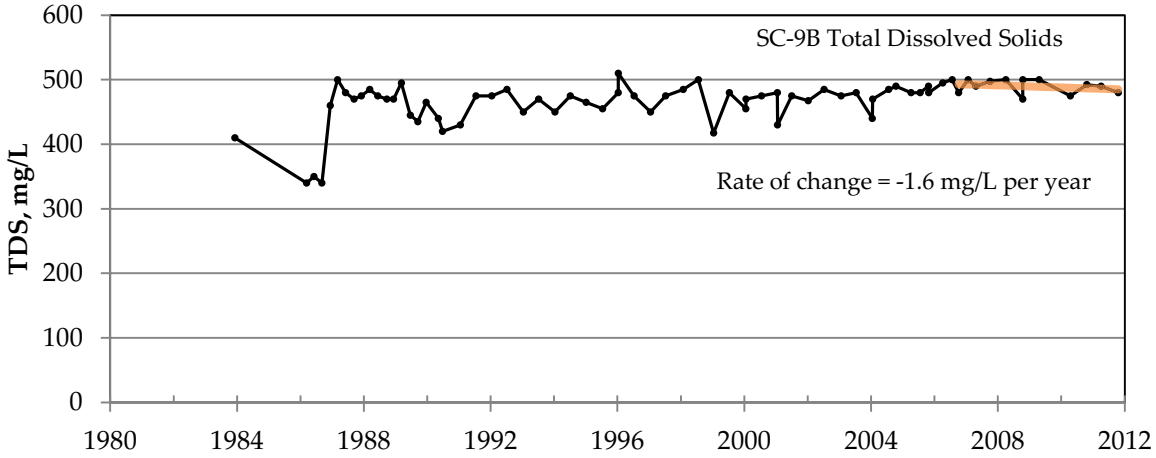
Graphs of SqCWD Production Wells and Monitoring Wells Adjacent to Production Wells

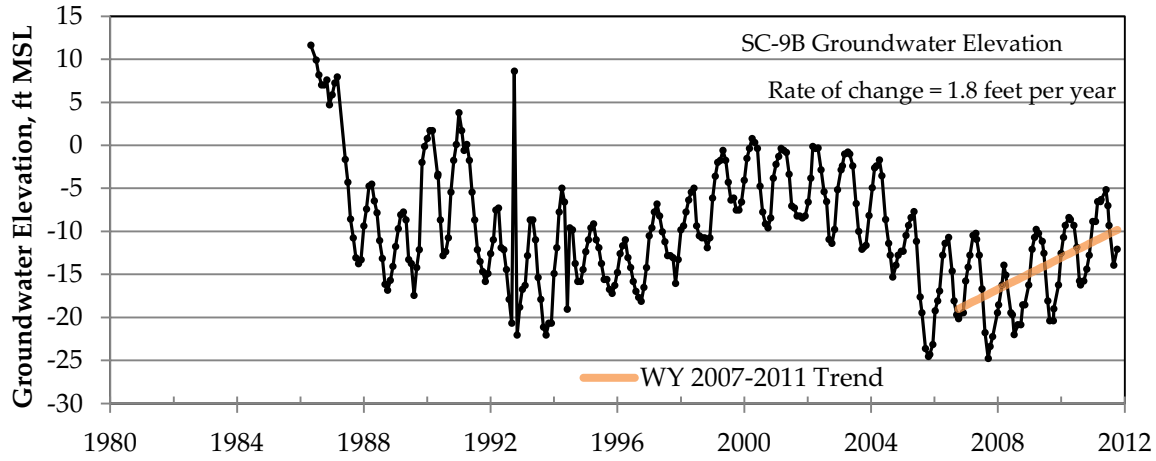

SC-9A Chloride
Rate of change = -3.7 mg/L per year
Chloride, mg/L
200
180
160
140
120
100
80
60
40
20
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

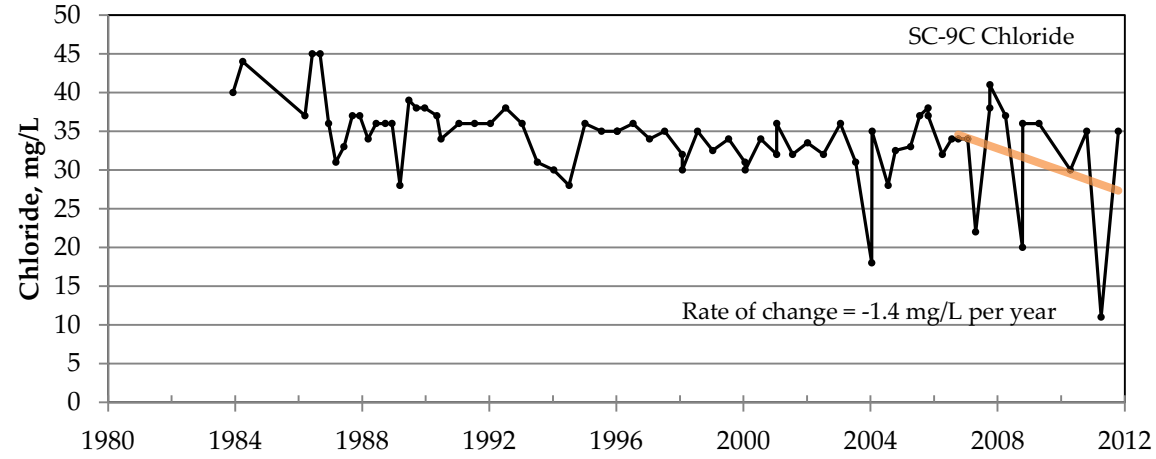

SC-9A Total Dissolved Solids
Rate of change = -17.5 mg/L per year
TDS, mg/L
900
800
700
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

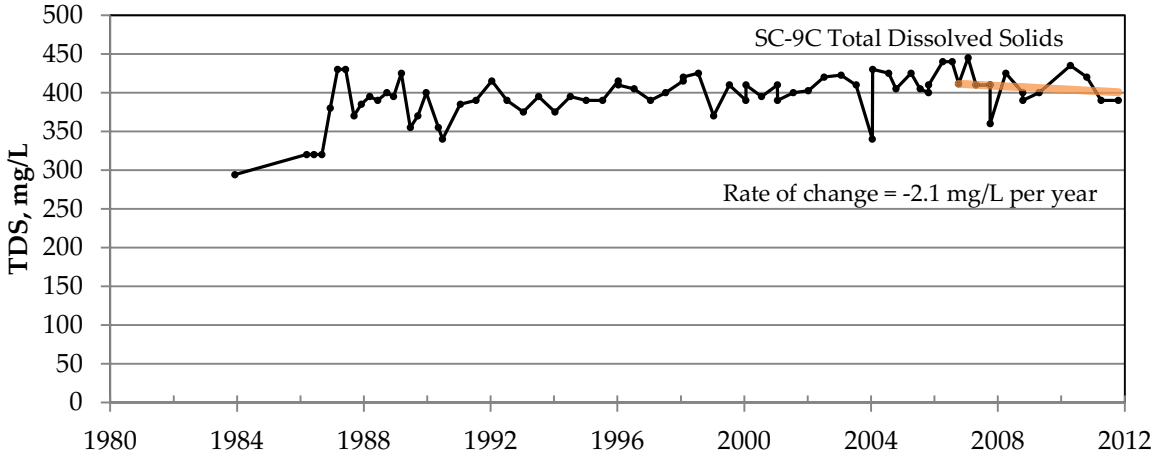

SC-9A Groundwater Elevation
Rate of change = 0.6 feet per year
WY 2007-2011 Trend
SC-9A sanded up to 100 feet
Groundwater Elevation, ft MSL
15
10
5
0
-5
-10
-15
-20
-25
1980
1984
1988
1992
1996
2000
2004
2008
2012

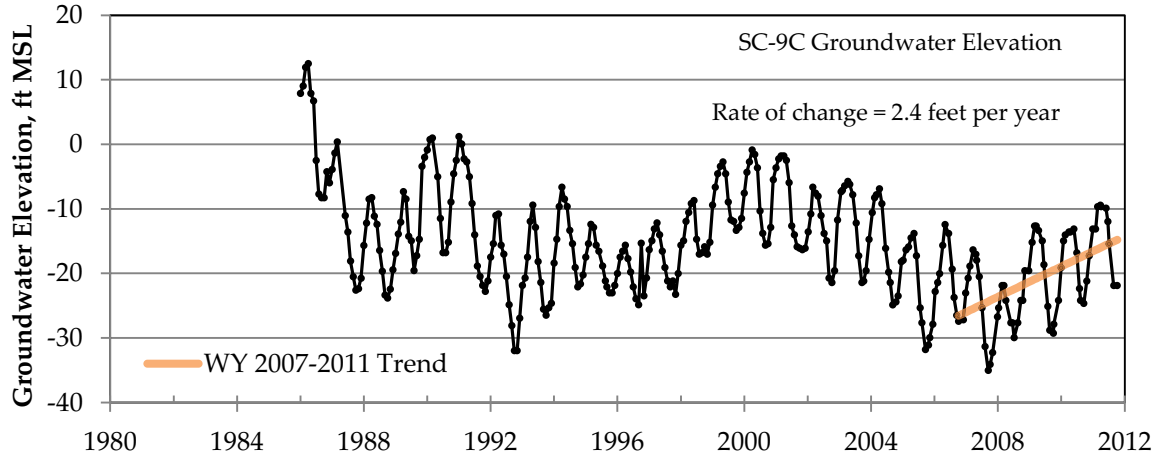

SC-9B Chloride
Rate of change = 0.8 mg/L per year
Chloride, mg/L
45
40
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

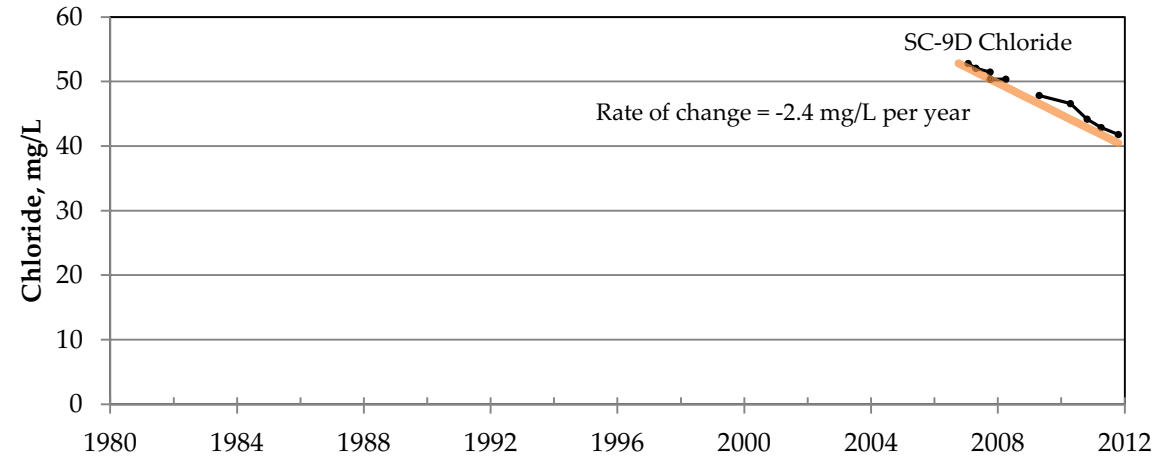

SC-9B Total Dissolved Solids
Rate of change = -1.6 mg/L per year
TDS, mg/L
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

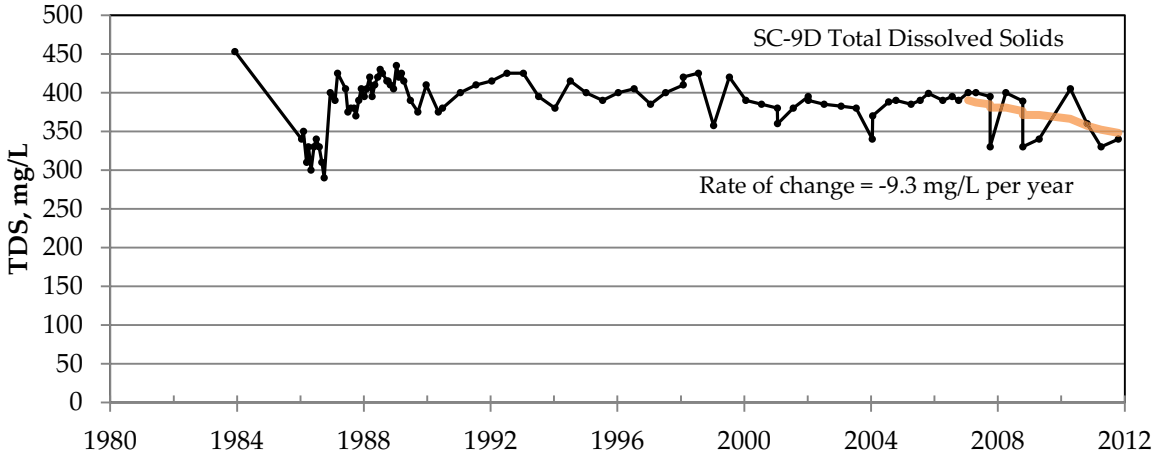

SC-9B Groundwater Elevation
Rate of change = 1.8 feet per year
WY 2007-2011 Trend
Groundwater Elevation, ft MSL
15
10
5
0
-5
-10
-15
-20
-25
-30
1980
1984
1988
1992
1996
2000
2004
2008
2012

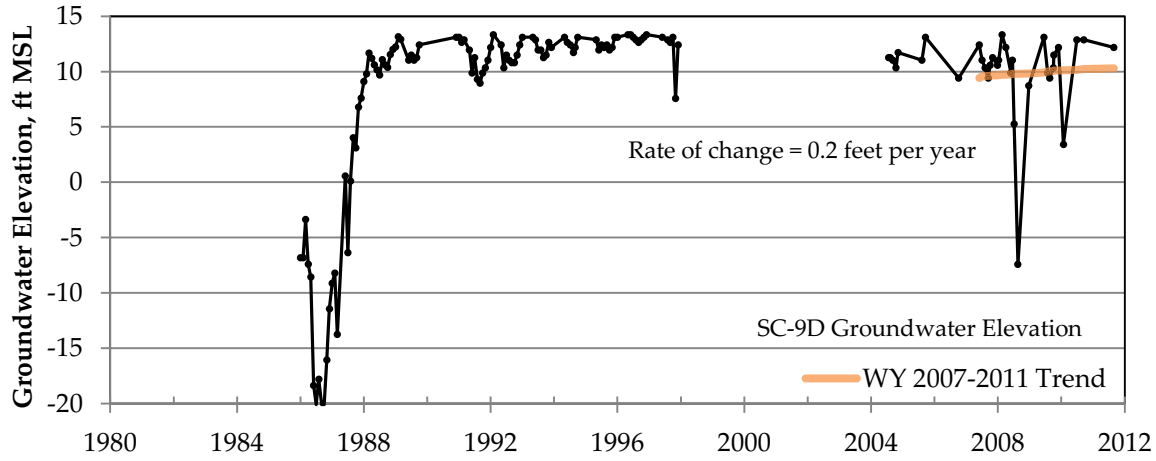

SC-9C Chloride
Chloride, mg/L
Rate of change = -1.4 mg/L per year
50
45
40
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

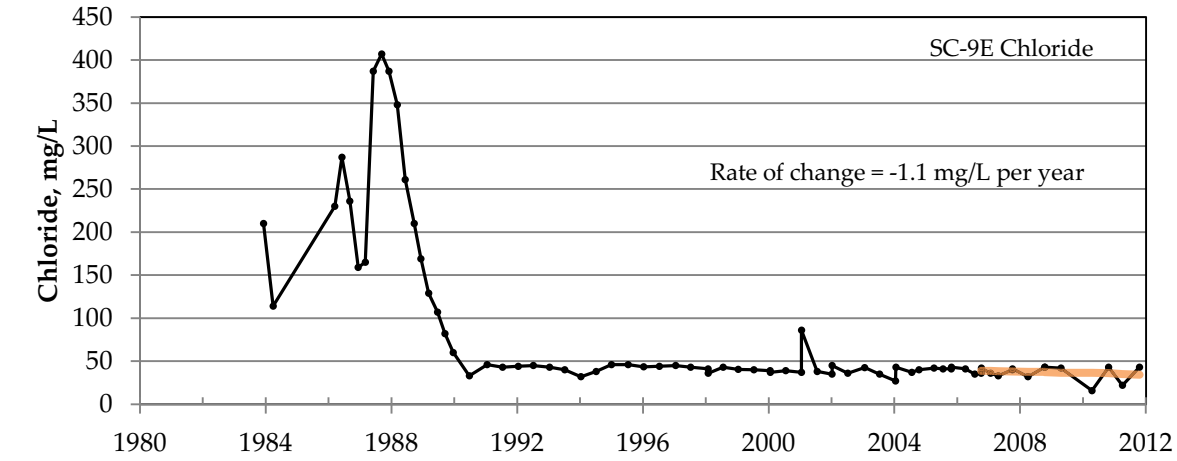

SC-9C Total Dissolved Solids
TDS, mg/L
Rate of change = -2.1 mg/L per year
500
450
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

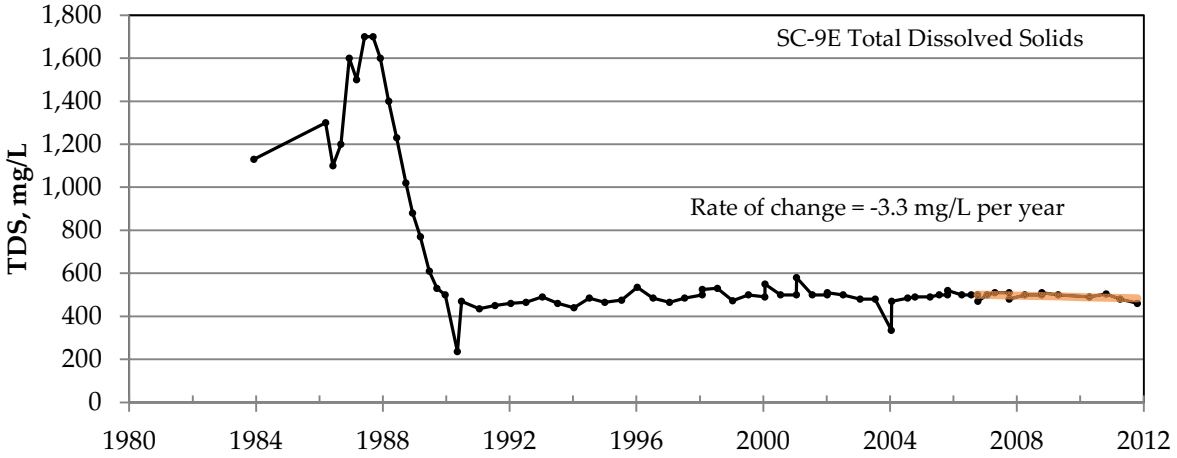

SC-9C Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = 2.4 feet per year
WY 2007-2011 Trend
20
10
0
-10
-20
-30
-40
1980
1984
1988
1992
1996
2000
2004
2008
2012

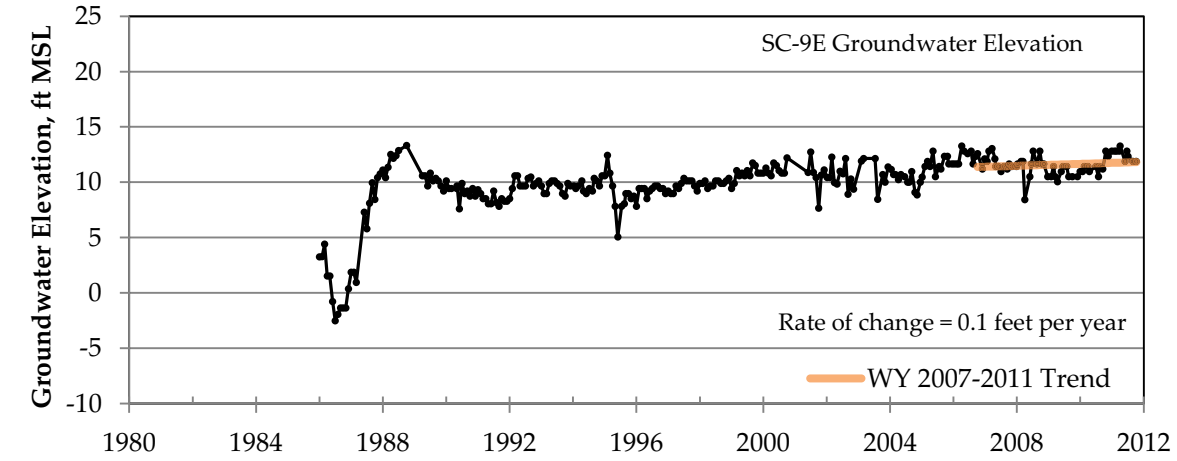

SC-9D Chloride
Rate of change = -2.4 mg/L per year
Chloride, mg/L
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

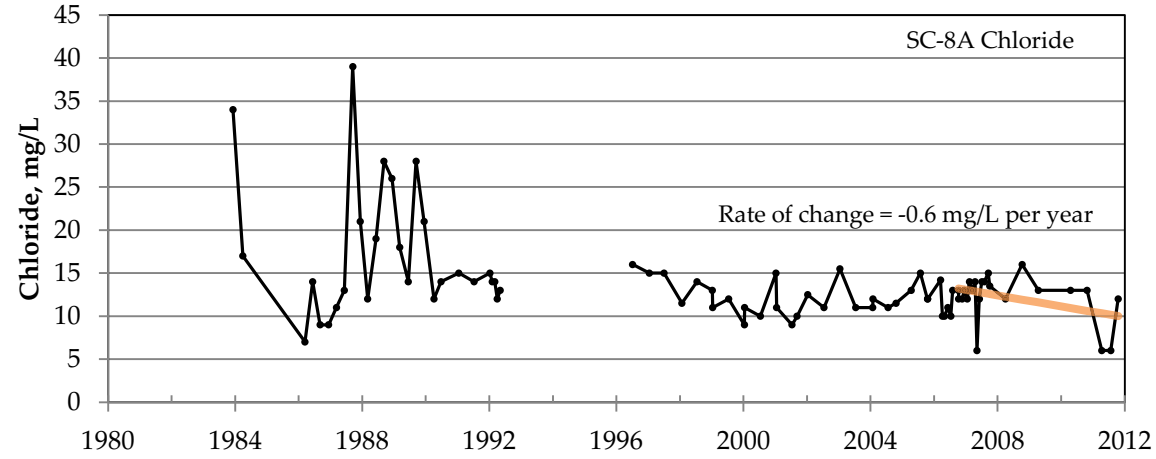

SC-9D Total Dissolved Solids
Rate of change = -9.3 mg/L per year
TDS, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

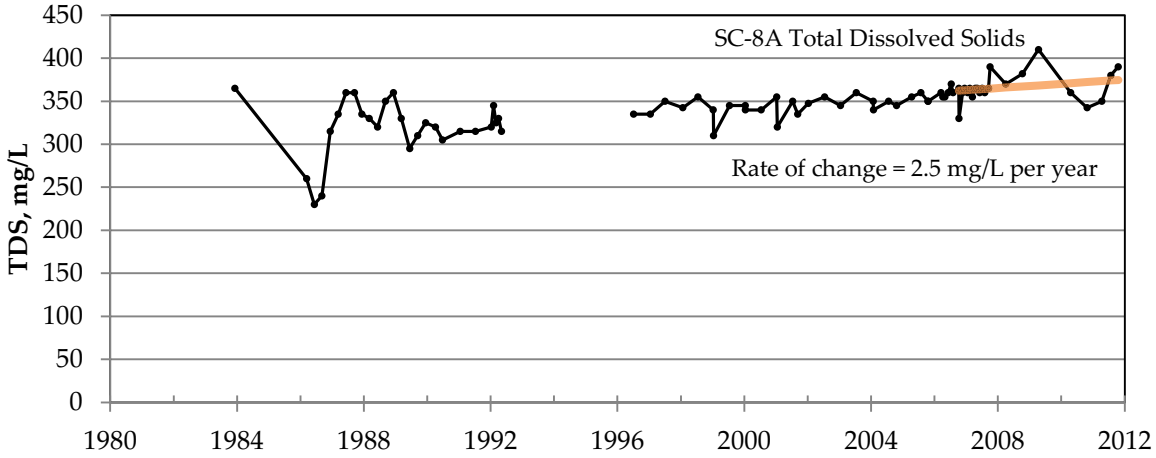

Rate of change = 0.2 feet per year
SC-9D Groundwater Elevation
WY 2007-2011 Trend
Groundwater Elevation, ft MSL
15
10
5
0
-5
-10
-15
-20
1980
1984
1988
1992
1996
2000
2004
2008
2012

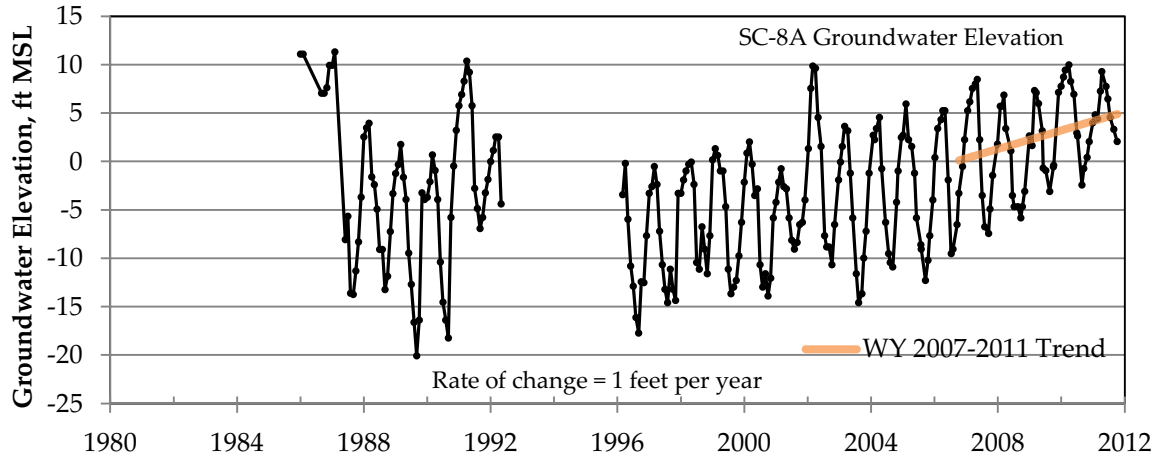

SC-9E Chloride
Rate of change = -1.1 mg/L per year
Chloride, mg/L
450
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

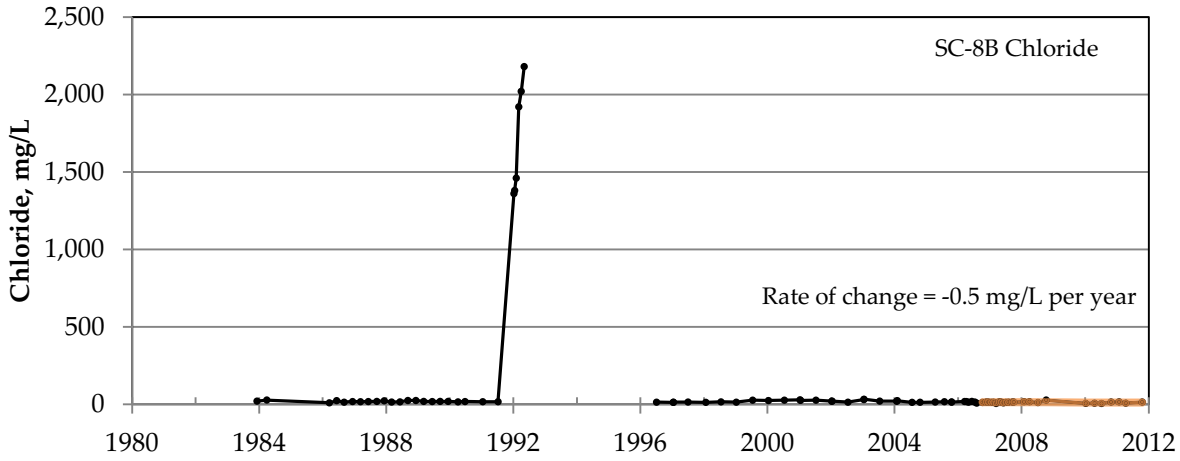

SC-9E Total Dissolved Solids
Rate of change = -3.3 mg/L per year
TDS, mg/L
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

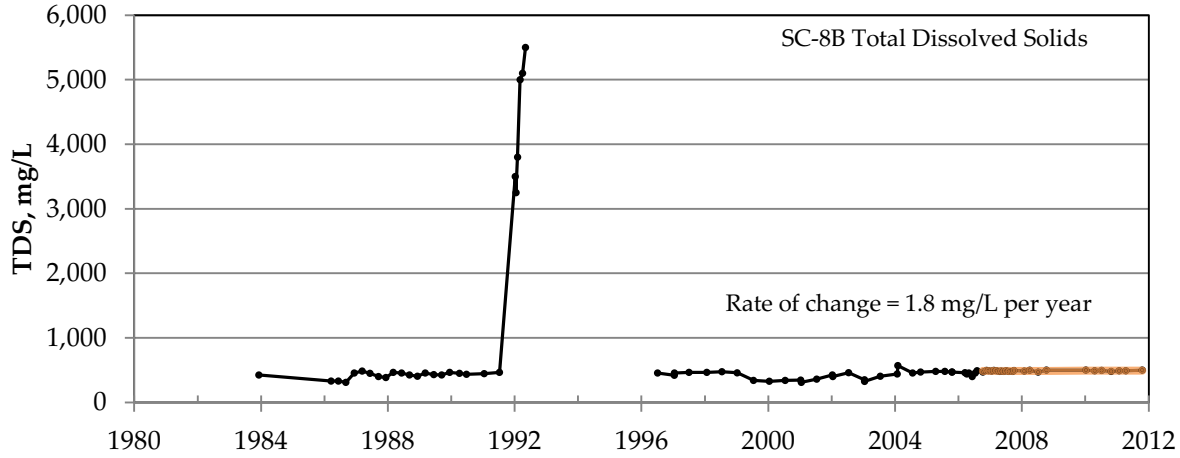

SC-9E Groundwater Elevation
Rate of change = 0.1 feet per year
WY 2007-2011 Trend
Groundwater Elevation, ft MSL
25
20
15
10
5
0
-5
-10
1980
1984
1988
1992
1996
2000
2004
2008
2012

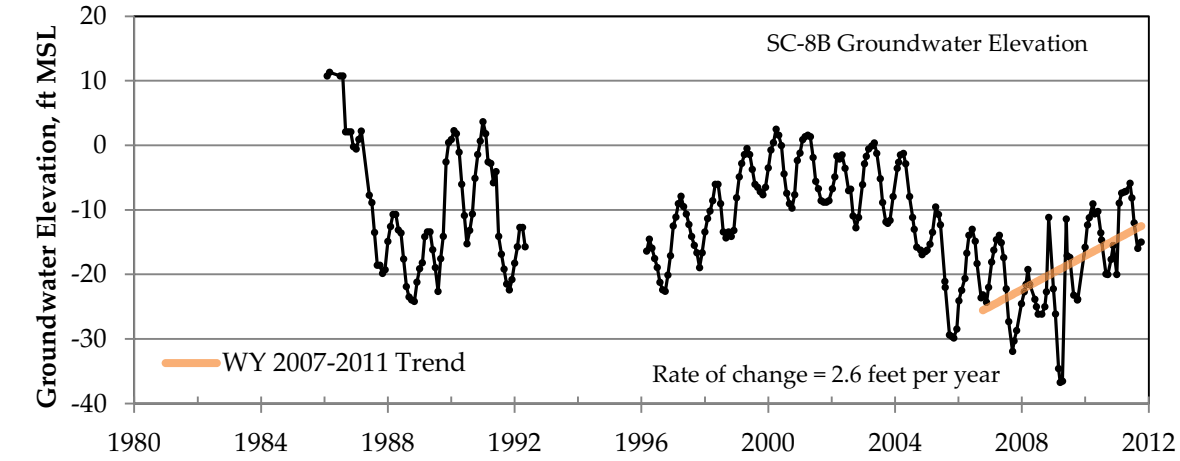

SC-8A Chloride
Chloride, mg/L
Rate of change = -0.6 mg/L per year
45
40
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

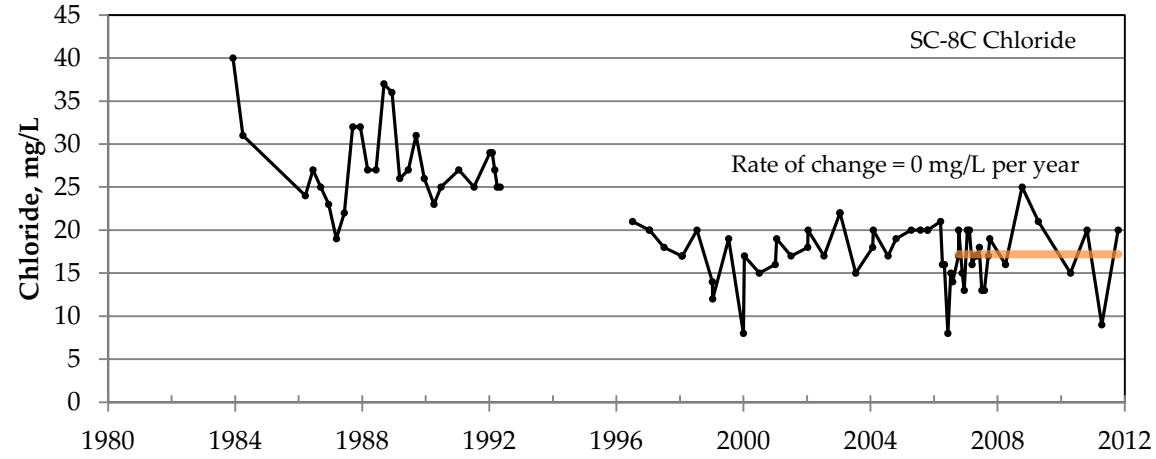

SC-8A Total Dissolved Solids
TDS, mg/L
Rate of change = 2.5 mg/L per year
450
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

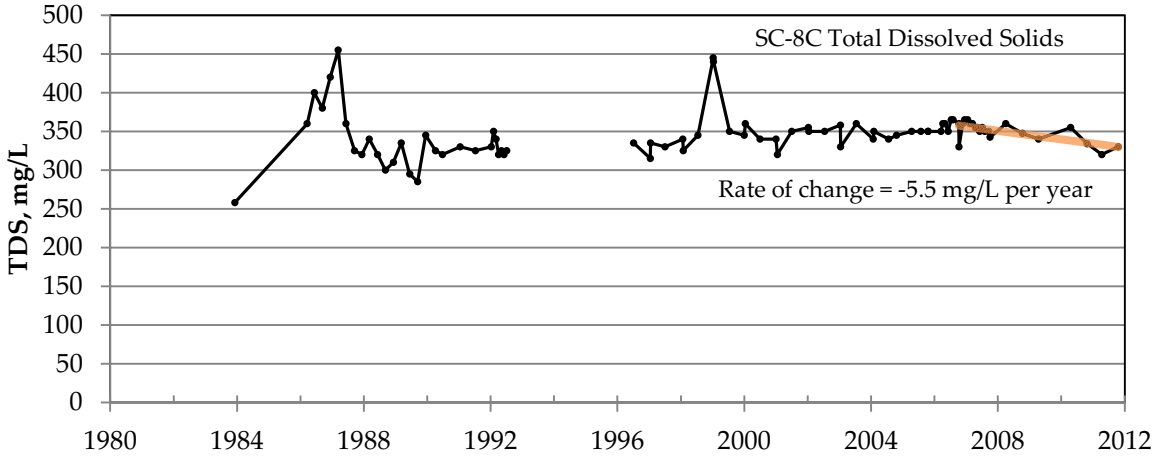

SC-8A Groundwater Elevation
Groundwater Elevation, ft MSL
WY 2007-2011 Trend
Rate of change = 1 feet per year
15
10
5
0
-5
-10
-15
-20
-25
1980
1984
1988
1992
1996
2000
2004
2008
2012

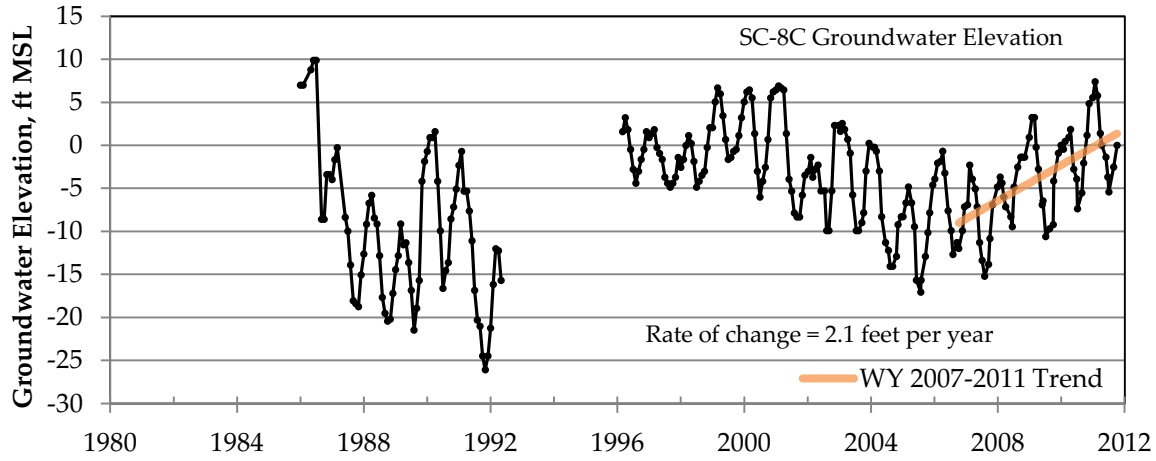

SC-8B Chloride
Chloride, mg/L
2,500
2,000
1,500
1,000
500
0
Rate of change = -0.5 mg/L per year
1980
1984
1988
1992
1996
2000
2004
2008
2012

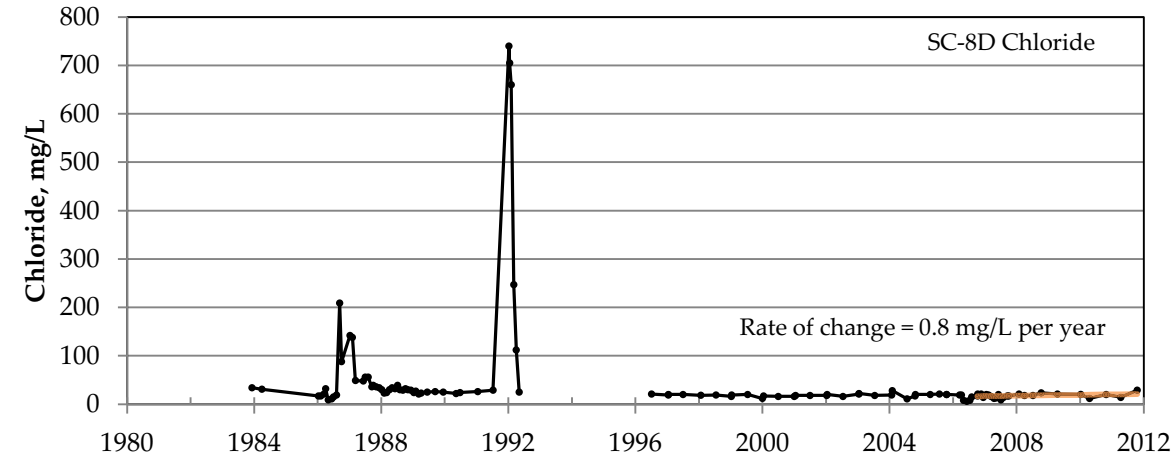

SC-8B Total Dissolved Solids
TDS, mg/L
6,000
5,000
4,000
3,000
2,000
1,000
0
Rate of change = 1.8 mg/L per year
1980
1984
1988
1992
1996
2000
2004
2008
2012

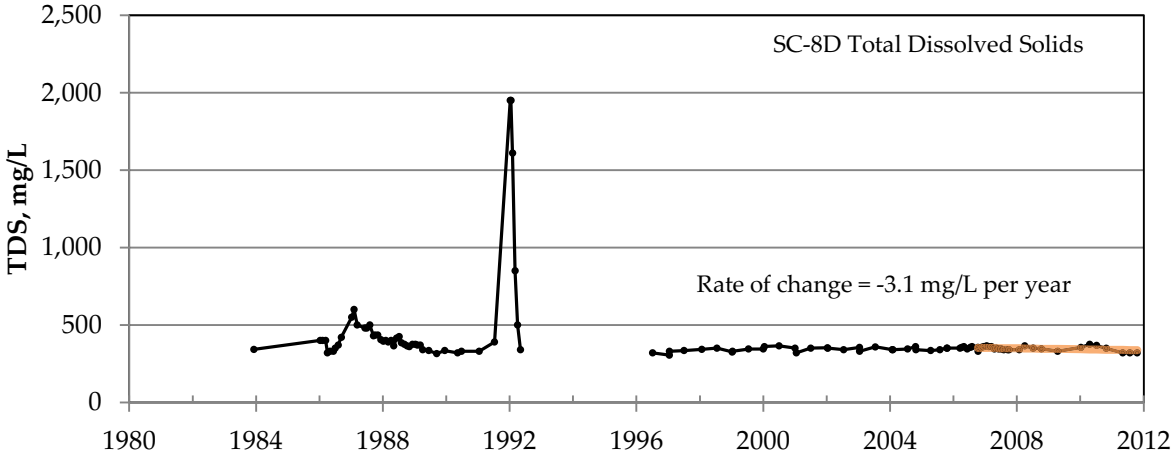

SC-8B Groundwater Elevation
Groundwater Elevation, ft MSL
20
10
0
-10
-20
-30
-40
WY 2007-2011 Trend
Rate of change = 2.6 feet per year
1980
1984
1988
1992
1996
2000
2004
2008
2012

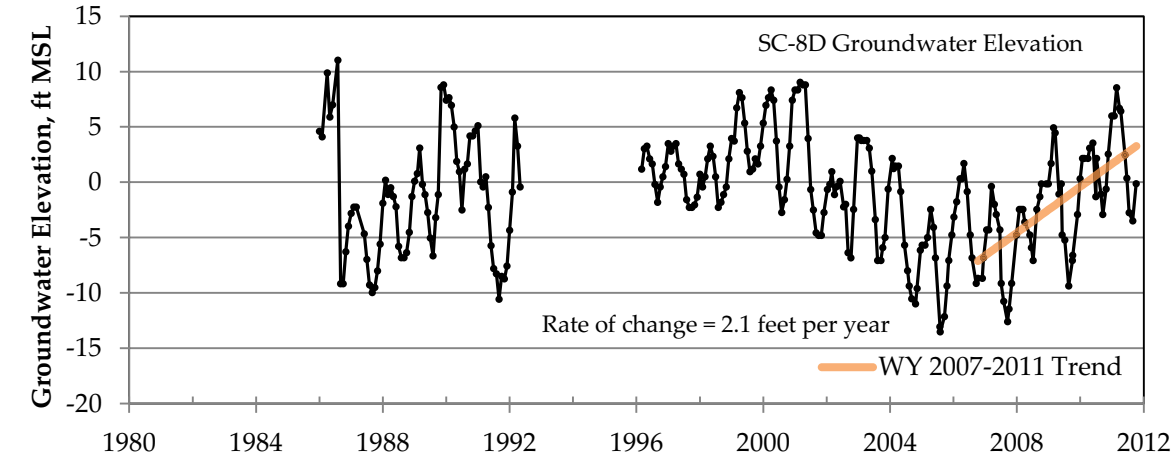

SC-8C Chloride
Rate of change = 0 mg/L per year
Chloride, mg/L
45
40
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

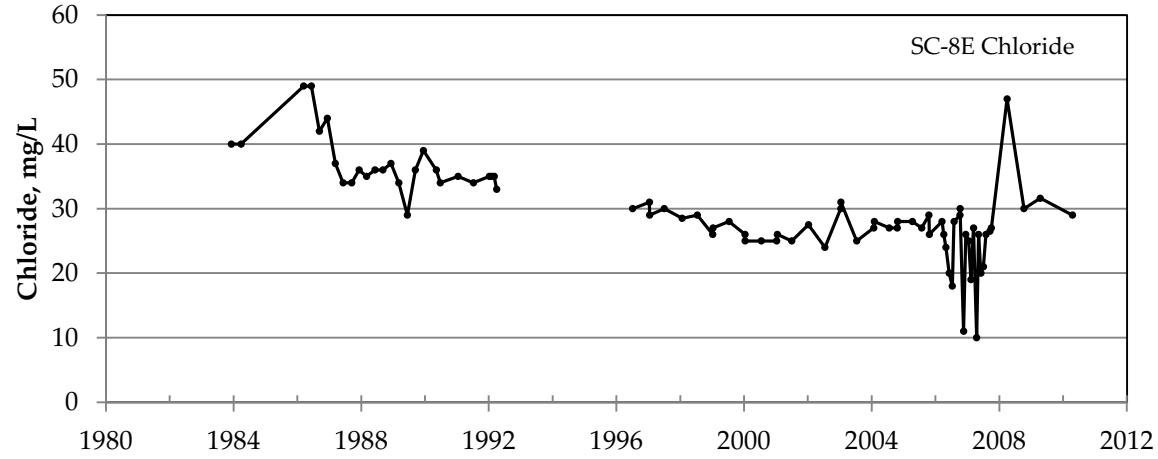

SC-8C Total Dissolved Solids
Rate of change = -5.5 mg/L per year
TDS, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

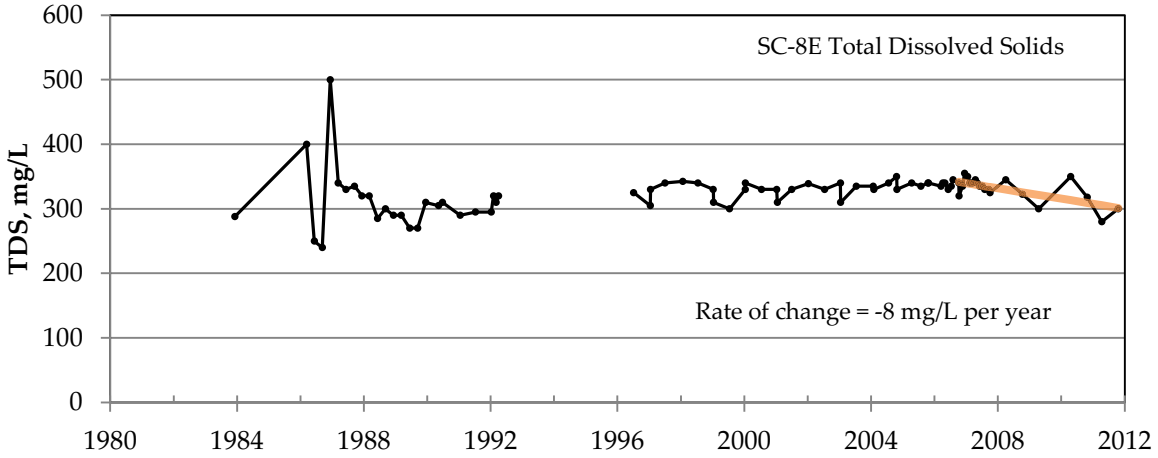

SC-8C Groundwater Elevation
Rate of change = 2.1 feet per year
WY 2007-2011 Trend
Groundwater Elevation, ft MSL
15
10
5
0
-5
-10
-15
-20
-25
-30
1980
1984
1988
1992
1996
2000
2004
2008
2012

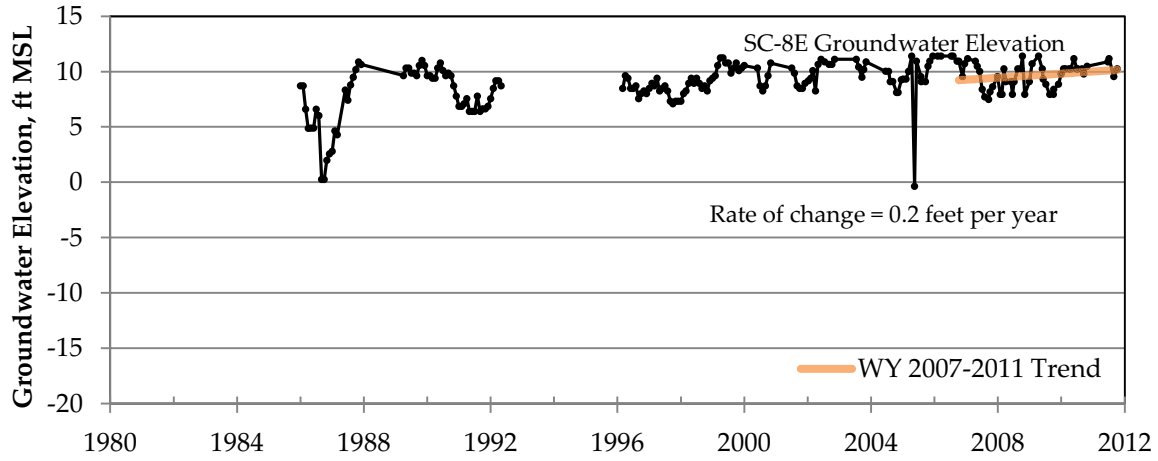

SC-8D Chloride
Chloride, mg/L
800
700
600
500
400
300
200
100
0
Rate of change = 0.8 mg/L per year
1980
1984
1988
1992
1996
2000
2004
2008
2012

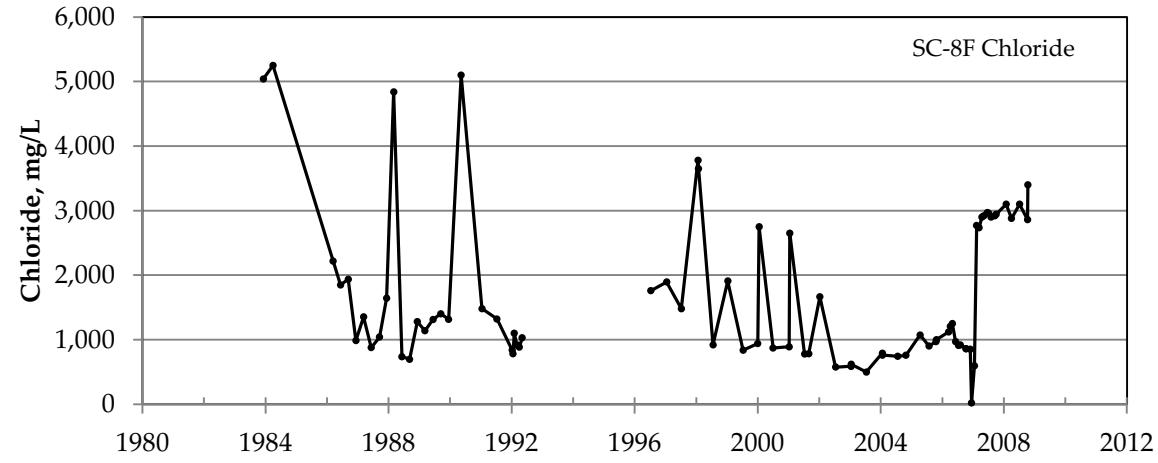

SC-8D Total Dissolved Solids
TDS, mg/L
2,500
2,000
1,500
1,000
500
0
Rate of change = -3.1 mg/L per year
1980
1984
1988
1992
1996
2000
2004
2008
2012

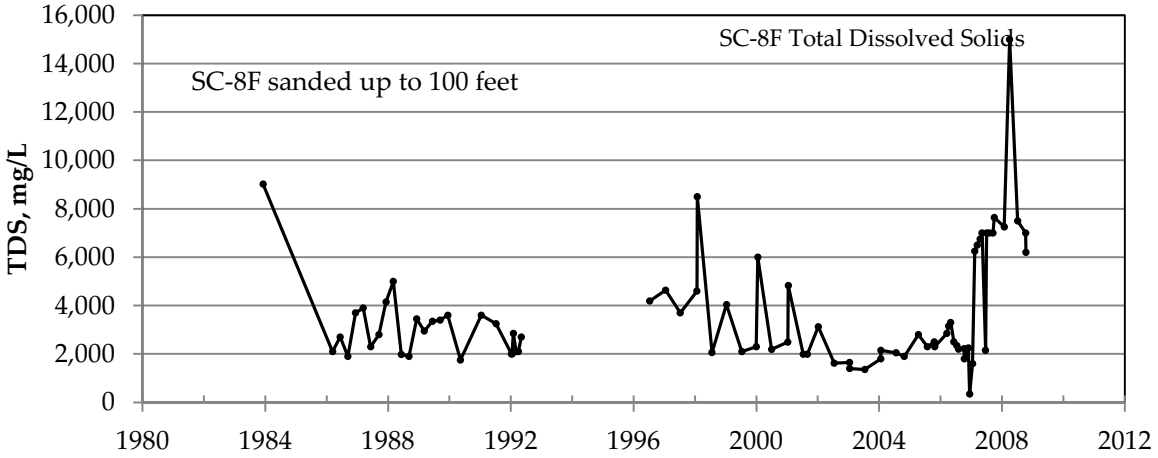

SC-8D Groundwater Elevation
Groundwater Elevation, ft MSL
15
10
5
0
-5
-10
-15
-20
Rate of change = 2.1 feet per year
WY 2007-2011 Trend
1980
1984
1988
1992
1996
2000
2004
2008
2012

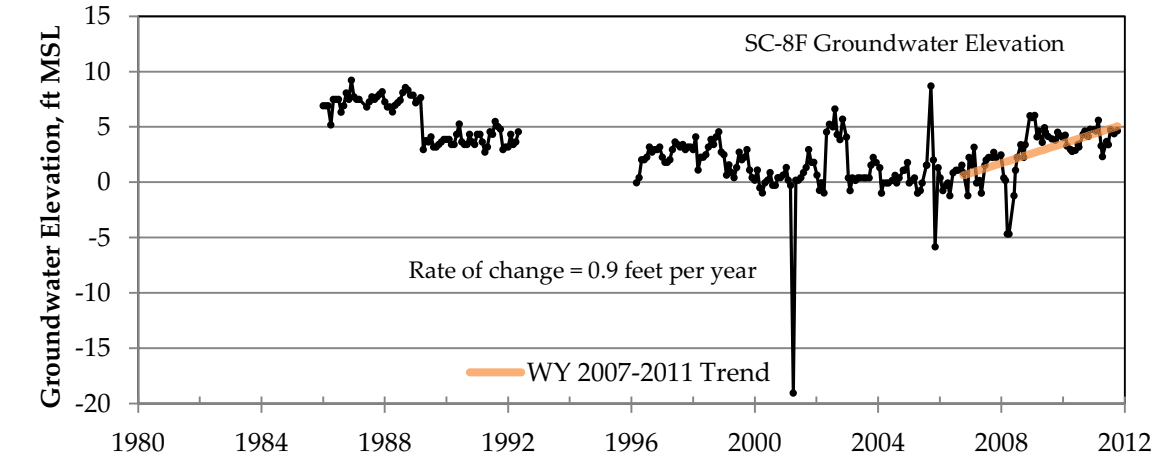

SC-8E Chloride
Chloride, mg/L
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

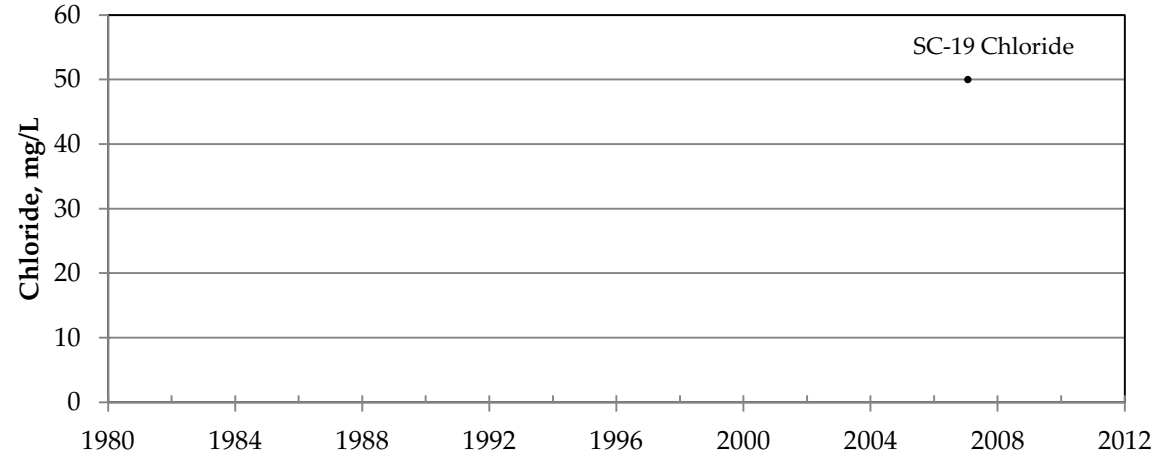

SC-8E Total Dissolved Solids
TDS, mg/L
600
500
400
300
200
100
0
Rate of change = -8 mg/L per year
1980
1984
1988
1992
1996
2000
2004
2008
2012

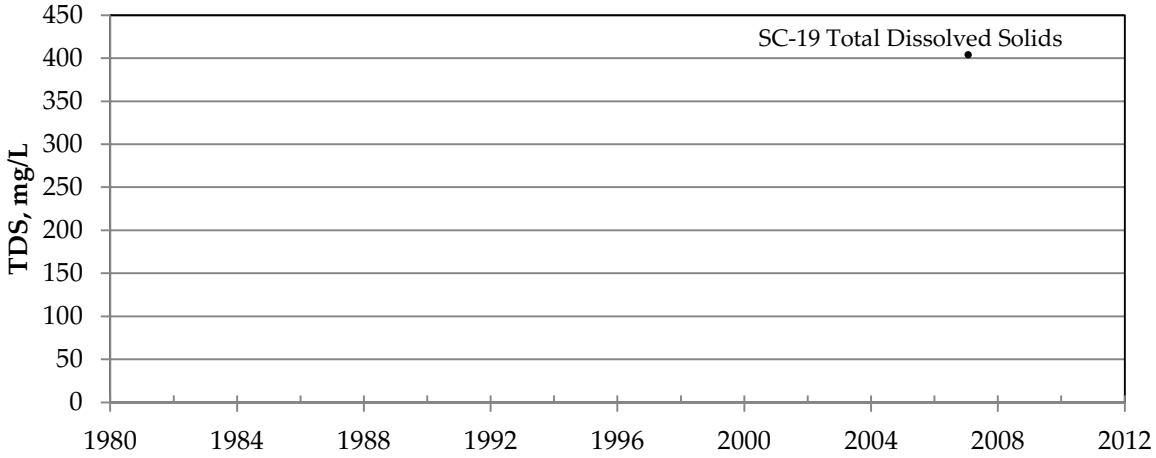

SC-8E Groundwater Elevation
Groundwater Elevation, ft MSL
15
10
5
0
-5
-10
-15
-20
Rate of change = 0.2 feet per year
WY 2007-2011 Trend
1980
1984
1988
1992
1996
2000
2004
2008
2012

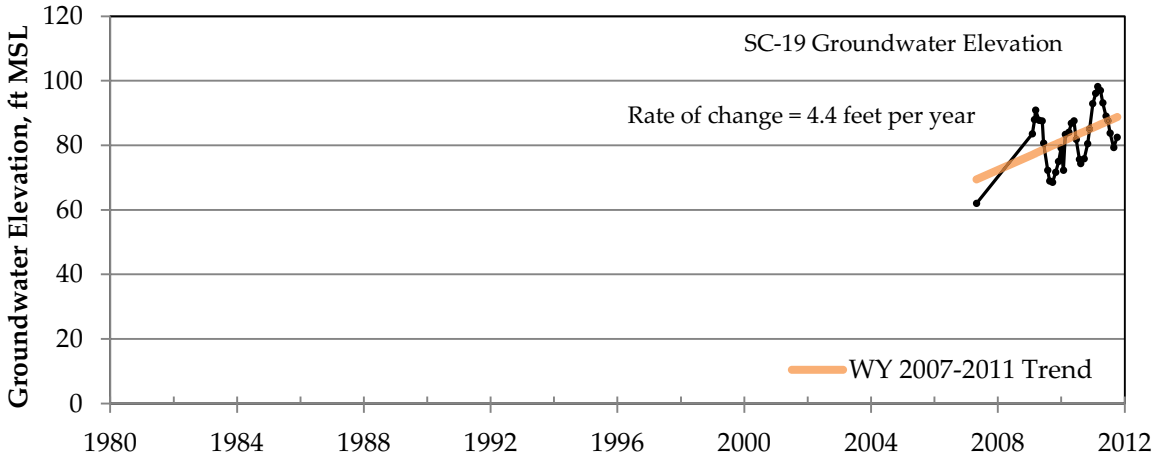

SC-8F Chloride
Chloride, mg/L
6,000
5,000
4,000
3,000
2,000
1,000
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

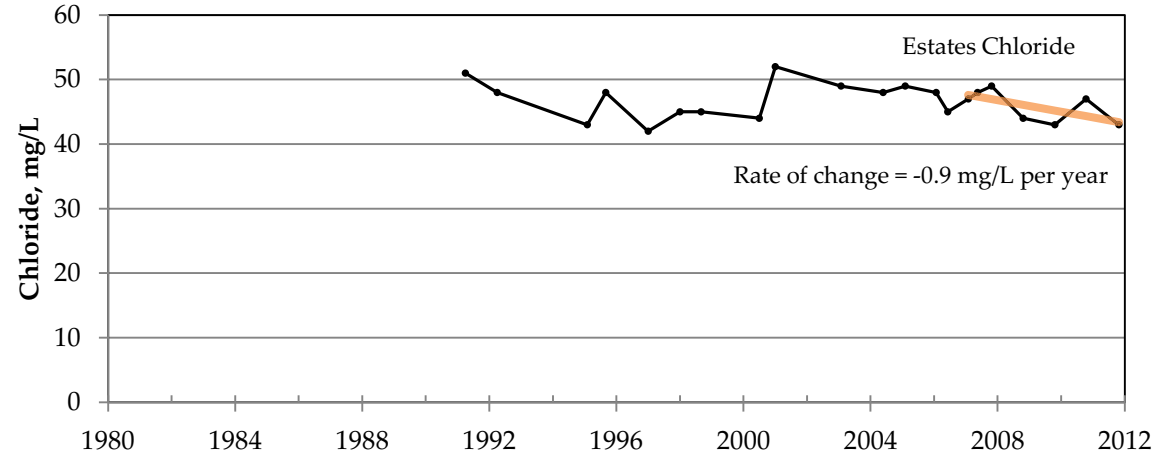

SC-8F Total Dissolved Solids
SC-8F sanded up to 100 feet
TDS, mg/L
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

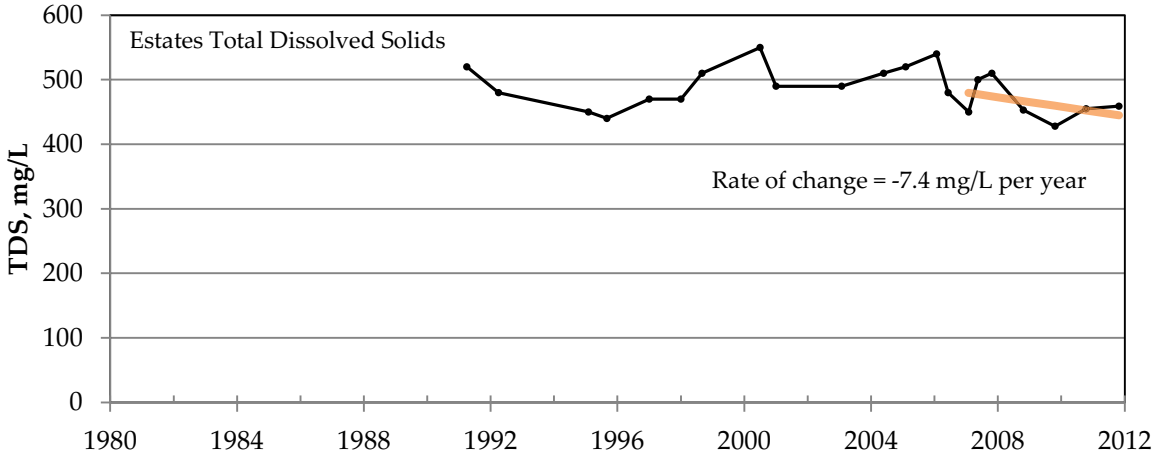

SC-8F Groundwater Elevation
Groundwater Elevation, ft MSL
15
10
5
0
-5
-10
-15
-20
Rate of change = 0.9 feet per year
WY 2007-2011 Trend
1980
1984
1988
1992
1996
2000
2004
2008
2012

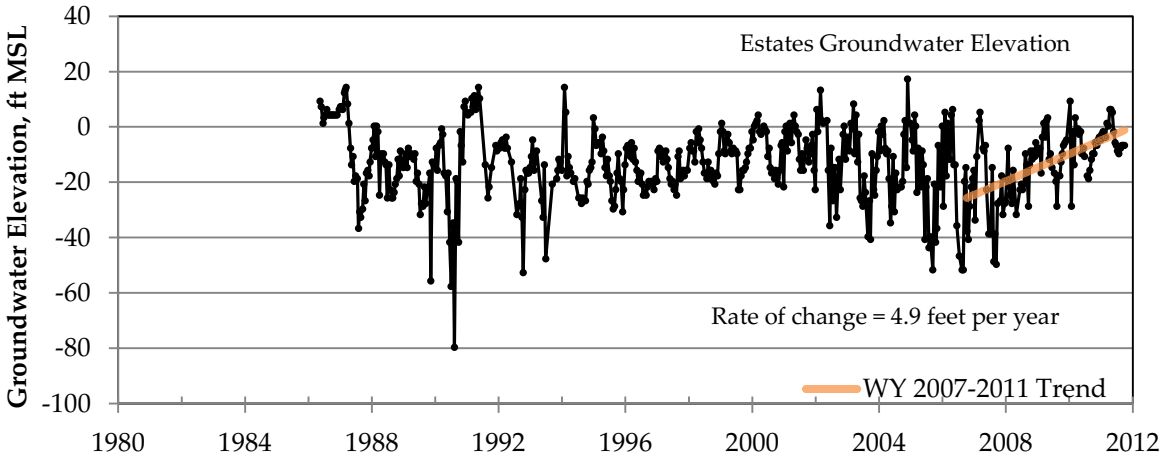

SC-19 Chloride
Chloride, mg/L
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

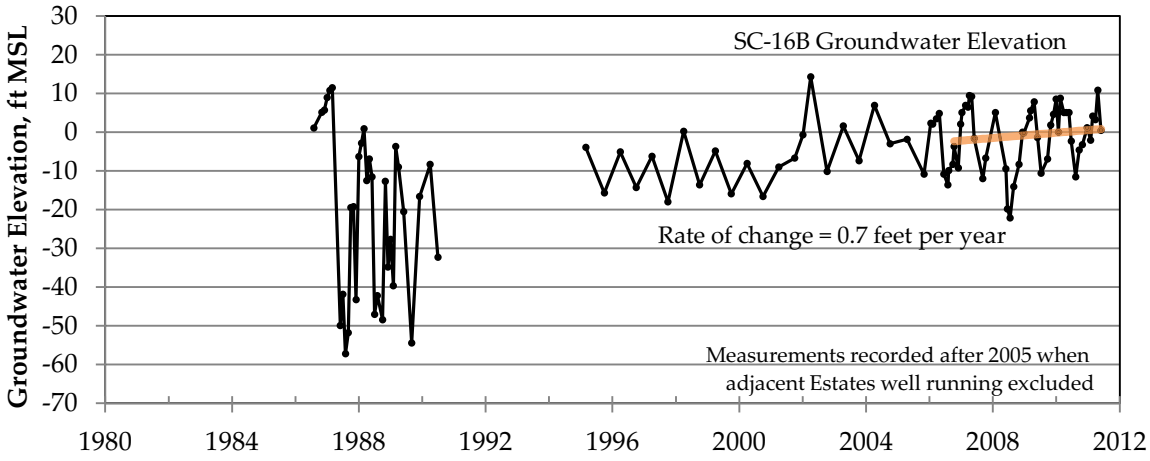

SC-19 Total Dissolved Solids
TDS, mg/L
450
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

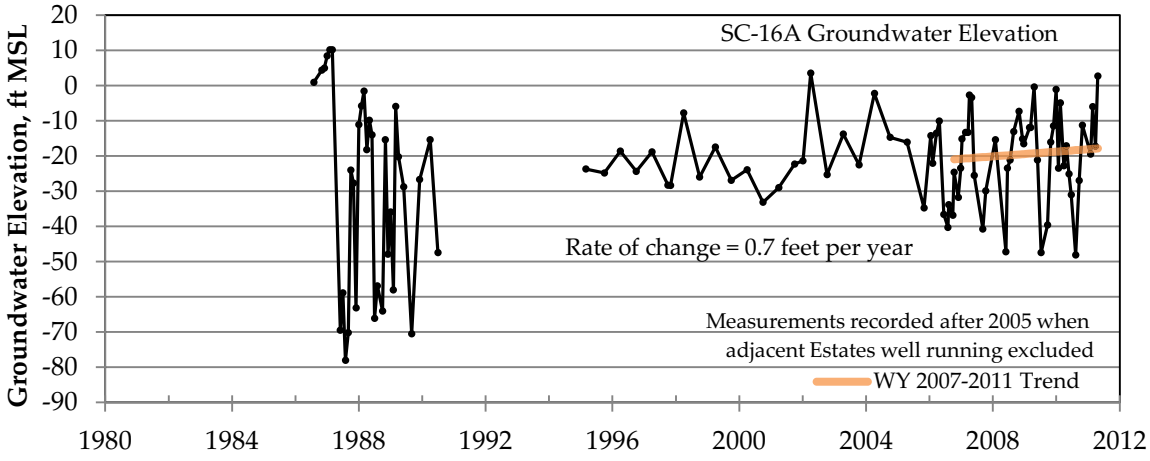

SC-19 Groundwater Elevation
Rate of change = 4.4 feet per year
WY 2007-2011 Trend
Groundwater Elevation, ft MSL
120
100
80
60
40
20
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

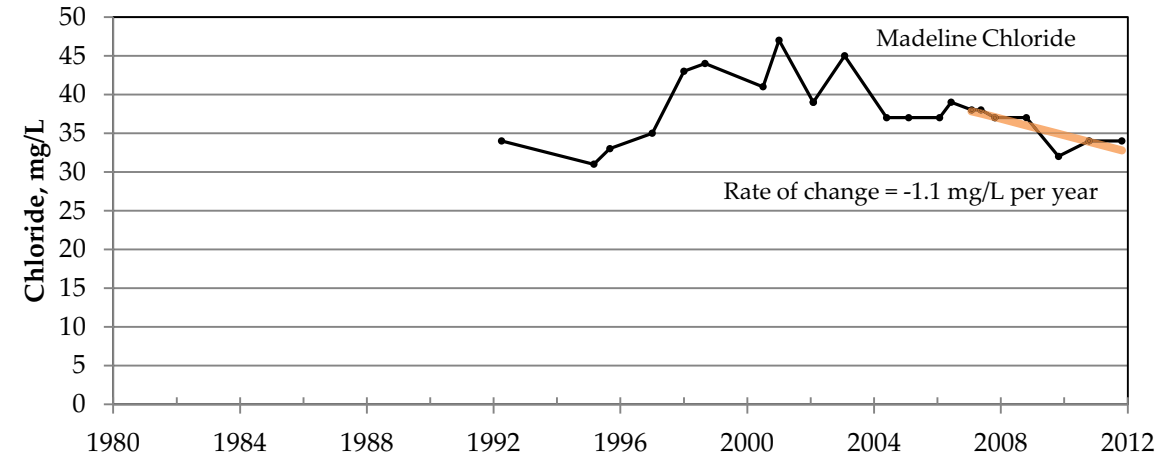

Estates Chloride
Chloride, mg/L
Rate of change = -0.9 mg/L per year
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

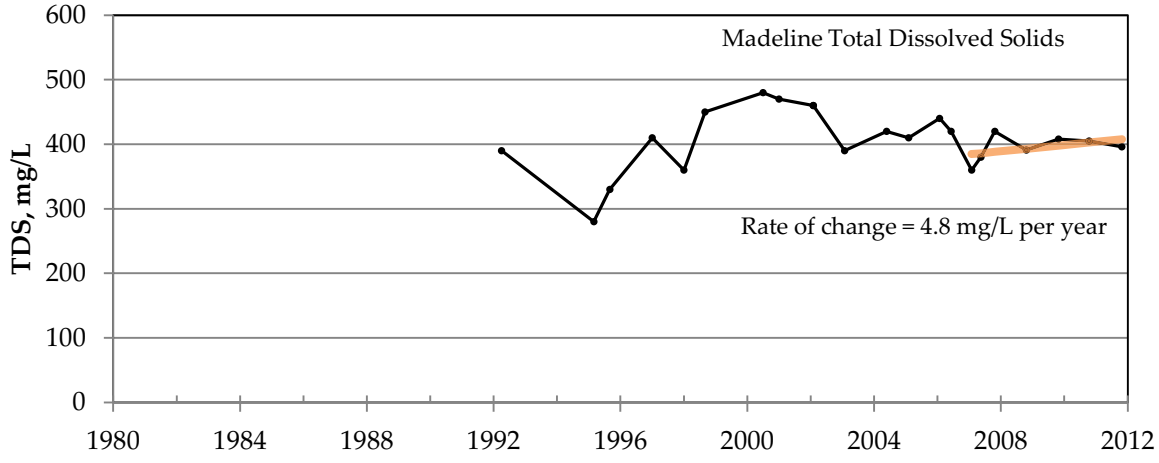

Estates Total Dissolved Solids
TDS, mg/L
Rate of change = -7.4 mg/L per year
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

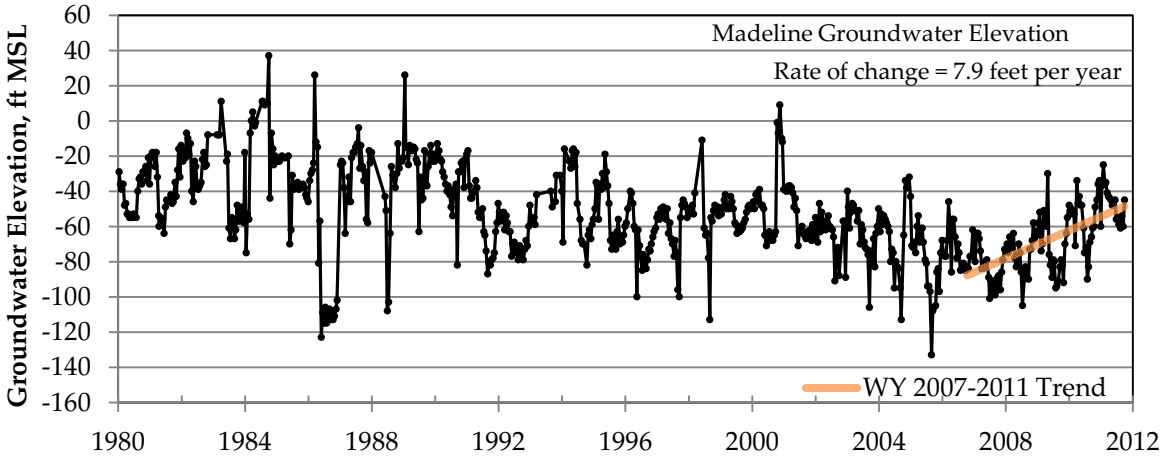

Estates Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = 4.9 feet per year
WY 2007-2011 Trend
40
20
0
-20
-40
-60
-80
-100
1980
1984
1988
1992
1996
2000
2004
2008
2012

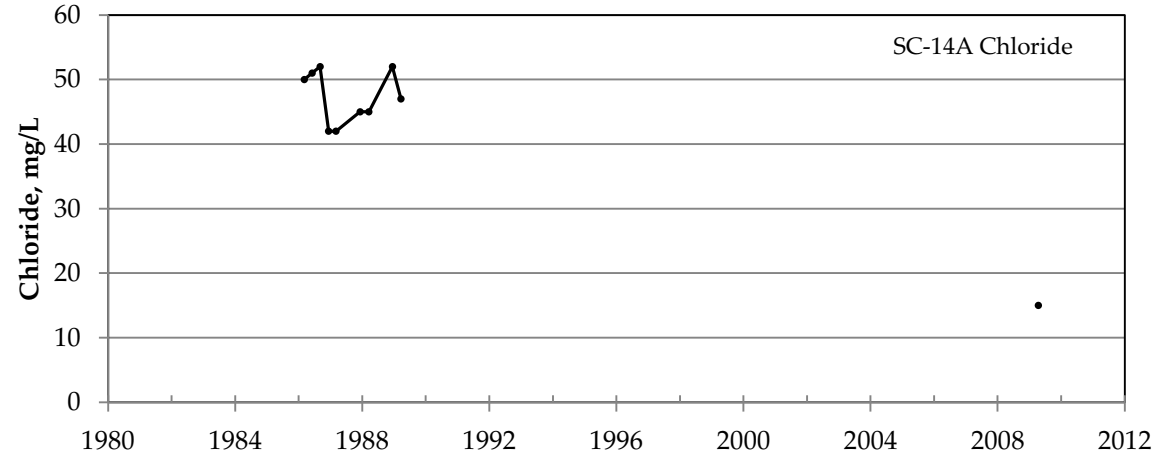

SC-16B Groundwater Elevation
Groundwater Elevation, ft MSL
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
1980
1984
1988
1992
1996
2000
2004
2008
2012
Rate of change = 0.7 feet per year
Measurements recorded after 2005 when
adjacent Estates well running excluded

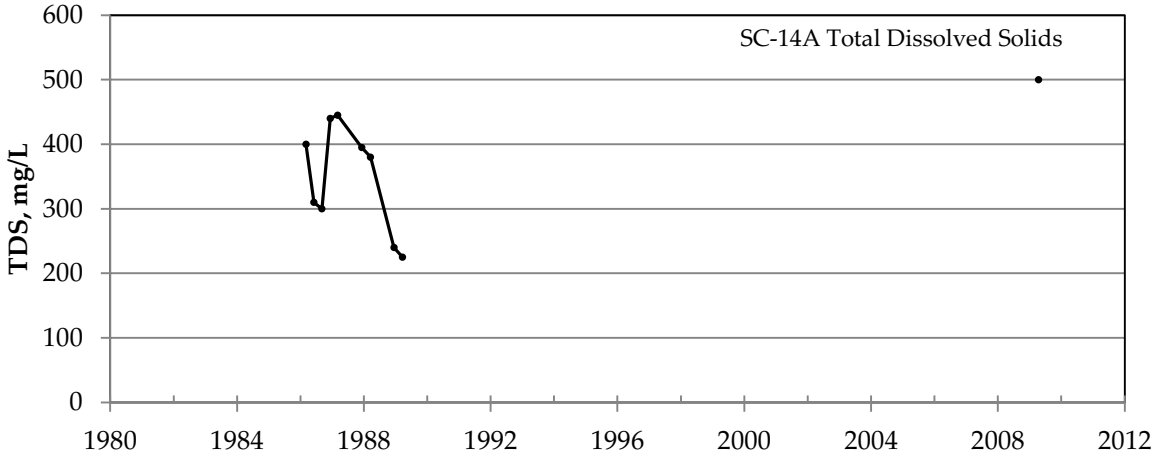

SC-16A Groundwater Elevation
Groundwater Elevation, ft MSL
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1980
1984
1988
1992
1996
2000
2004
2008
2012
Rate of change = 0.7 feet per year
Measurements recorded after 2005 when
adjacent Estates well running excluded
WY 2007-2011 Trend

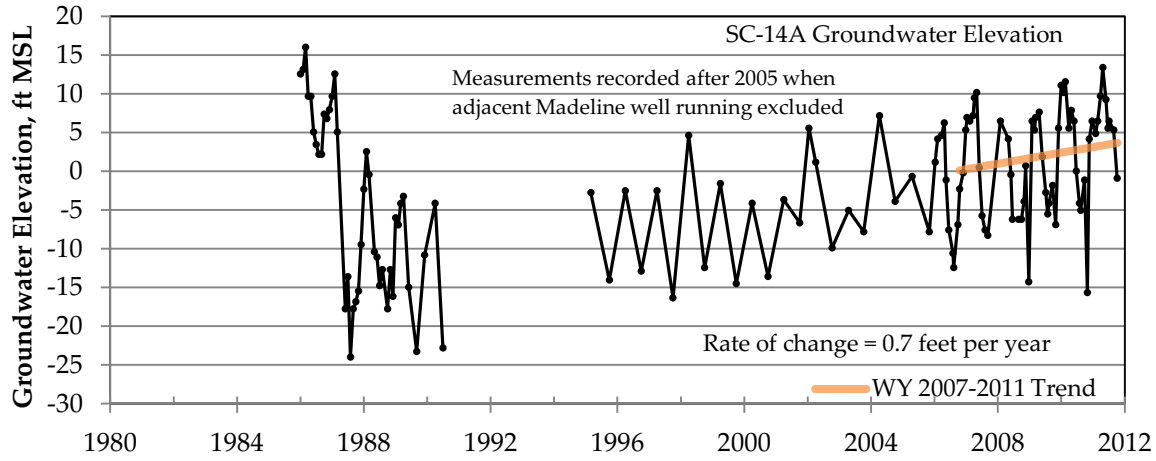

Madeline Chloride
Chloride, mg/L
Rate of change = -1.1 mg/L per year
50
45
40
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

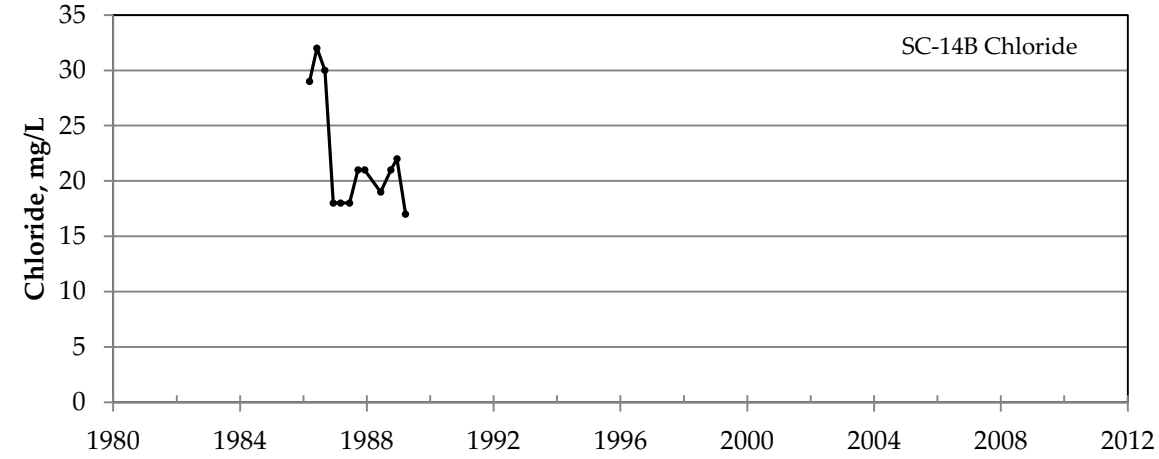

Madeline Total Dissolved Solids
TDS, mg/L
Rate of change = 4.8 mg/L per year
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

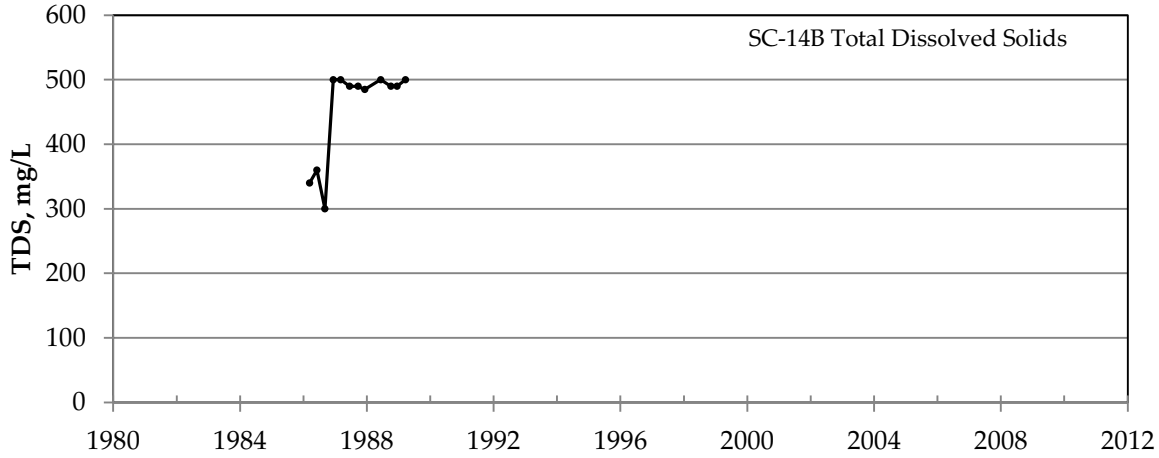

Madeline Groundwater Elevation
Rate of change = 7.9 feet per year
Groundwater Elevation, ft MSL
WY 2007-2011 Trend
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
1980
1984
1988
1992
1996
2000
2004
2008
2012

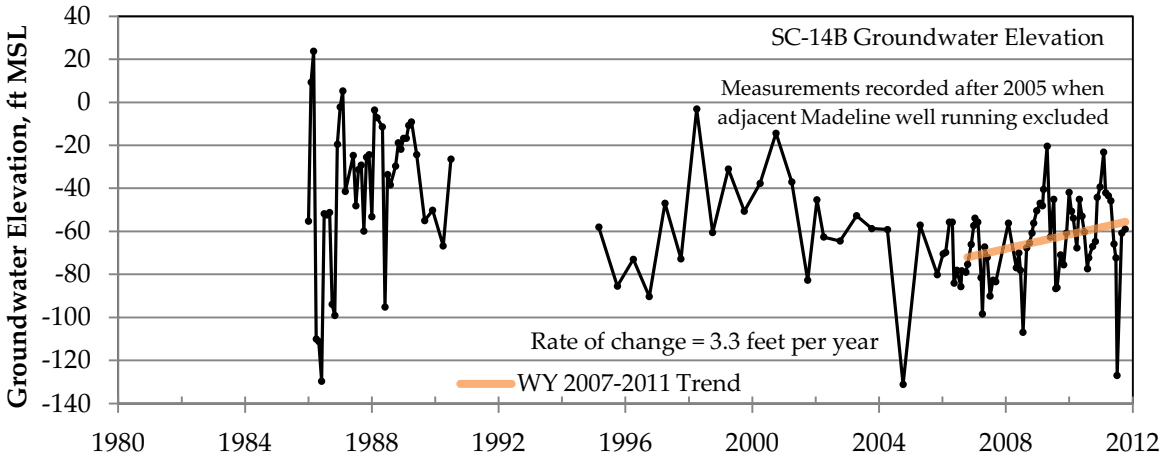

SC-14A Chloride
Chloride, mg/L
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

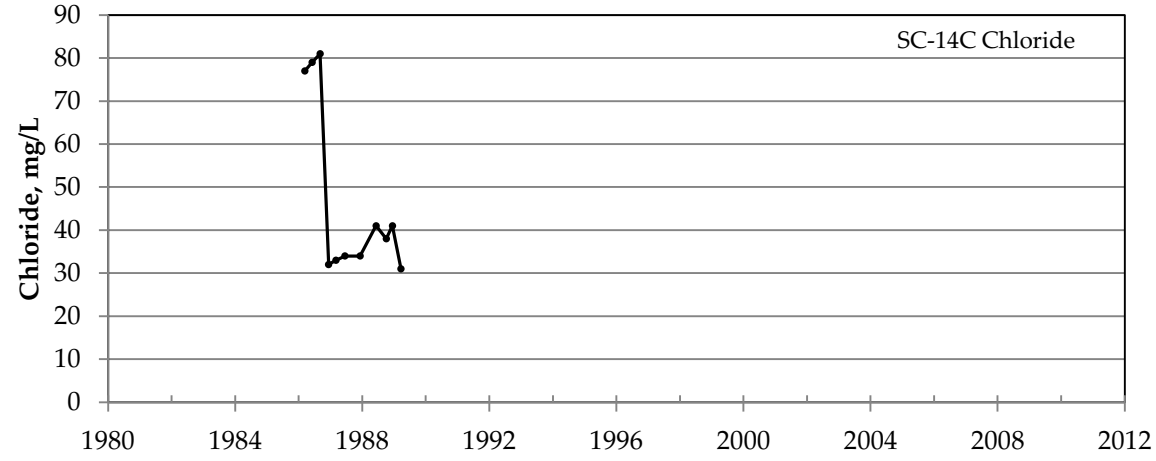

SC-14A Total Dissolved Solids
TDS, mg/L
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

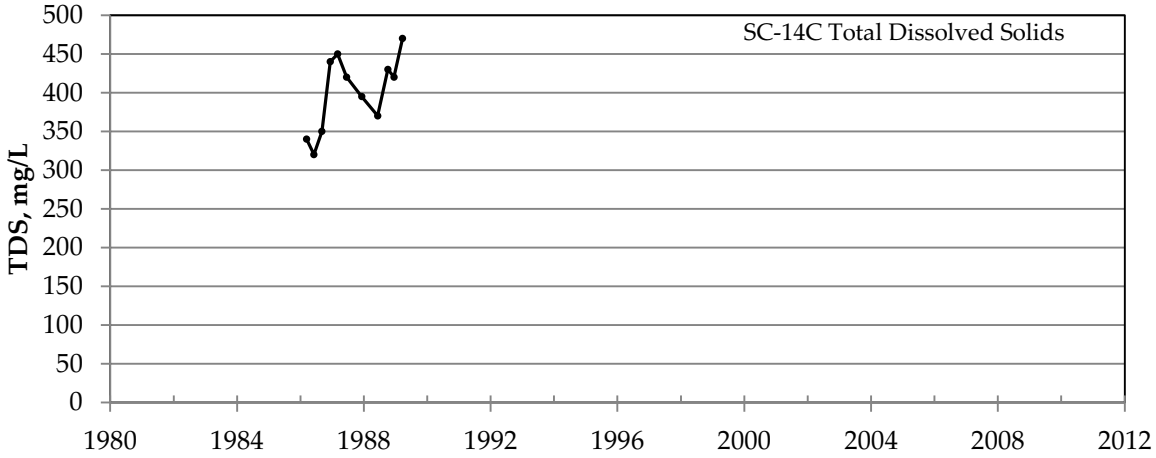

SC-14A Groundwater Elevation
Measurements recorded after 2005 when
adjacent Madeline well running excluded
Rate of change = 0.7 feet per year
WY 2007-2011 Trend
Groundwater Elevation, ft MSL
20
15
10
5
0
-5
-10
-15
-20
-25
-30
1980
1984
1988
1992
1996
2000
2004
2008
2012

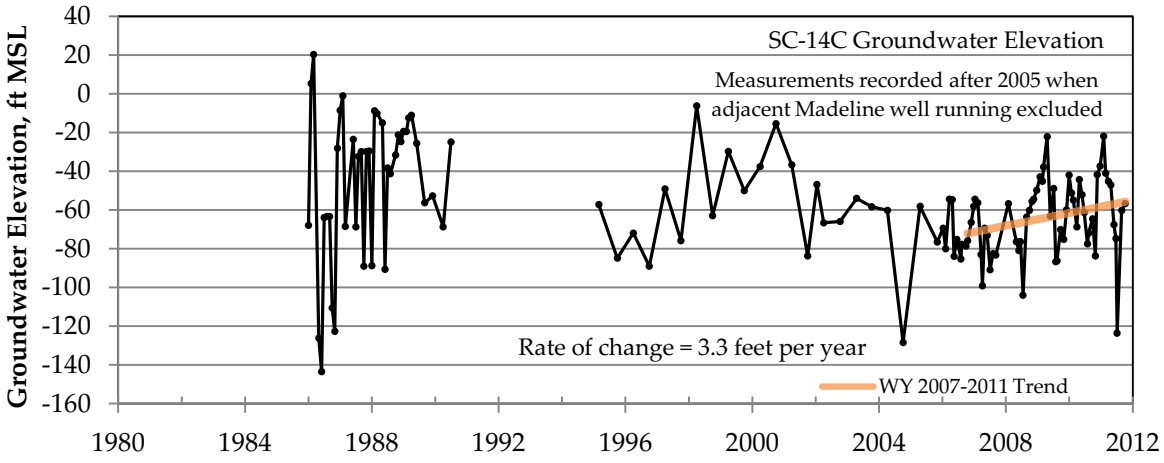

SC-14B Chloride
Chloride, mg/L
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

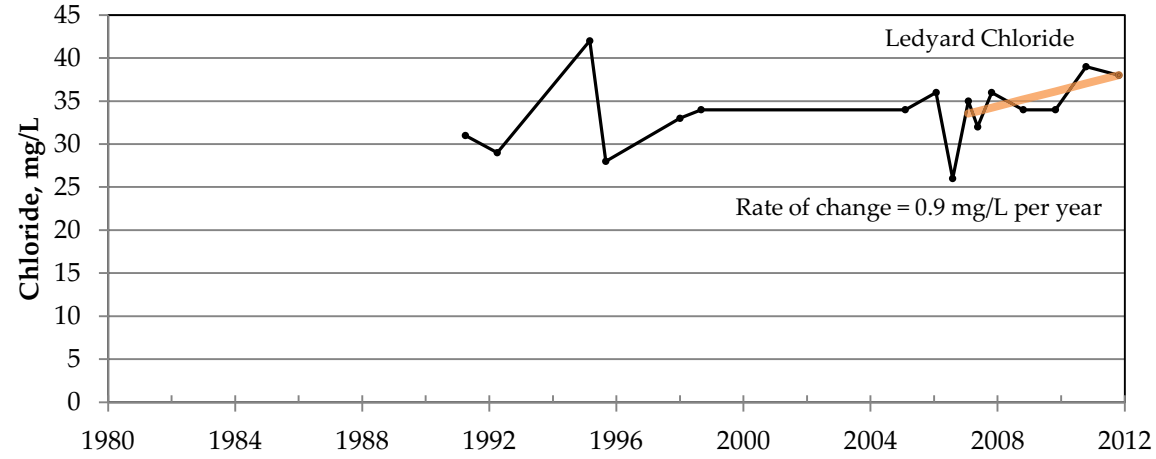

SC-14B Total Dissolved Solids
TDS, mg/L
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

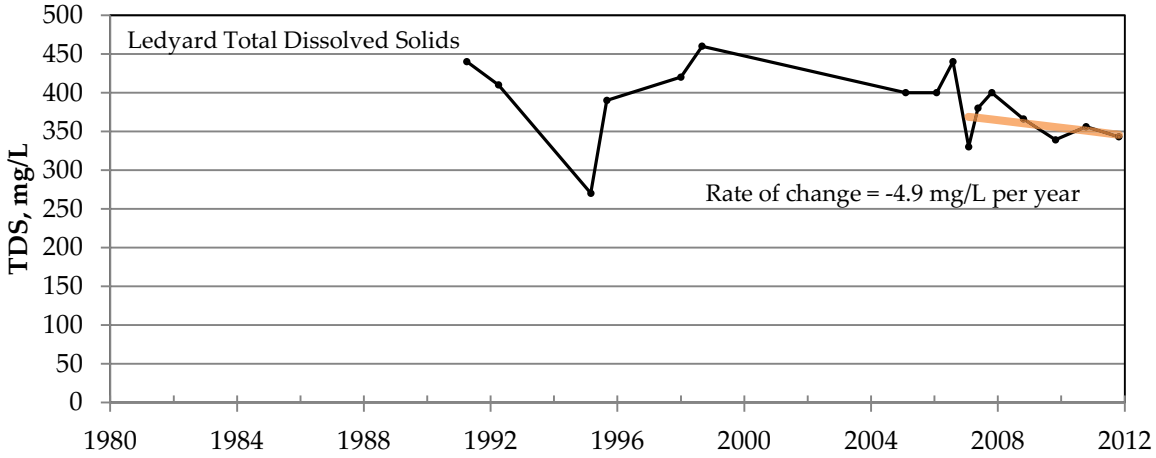

SC-14B Groundwater Elevation
Measurements recorded after 2005 when adjacent Madeline well running excluded
Groundwater Elevation, ft MSL
40
20
0
-20
-40
-60
-80
-100
-120
-140
Rate of change = 3.3 feet per year
WY 2007-2011 Trend
1980
1984
1988
1992
1996
2000
2004
2008
2012

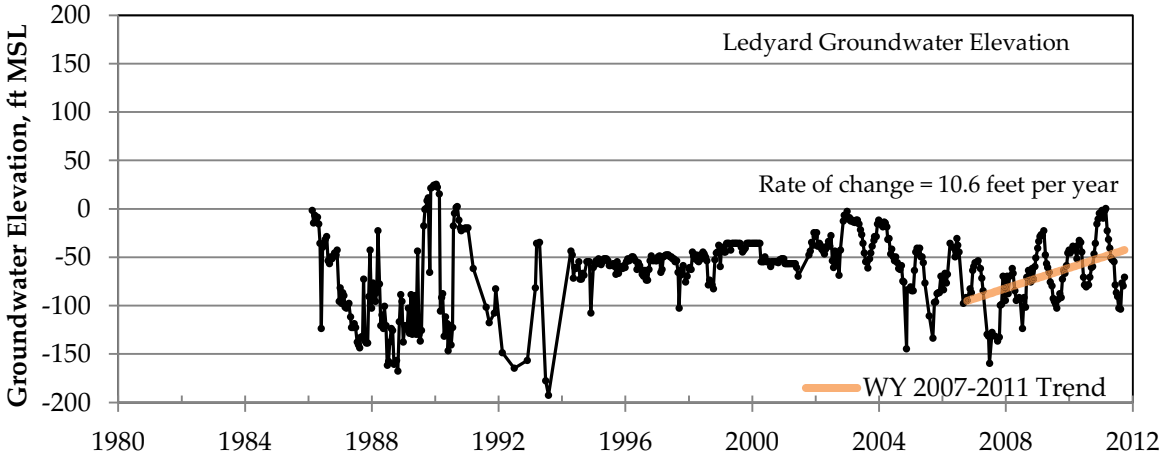

SC-14C Chloride
Chloride, mg/L
90
80
70
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

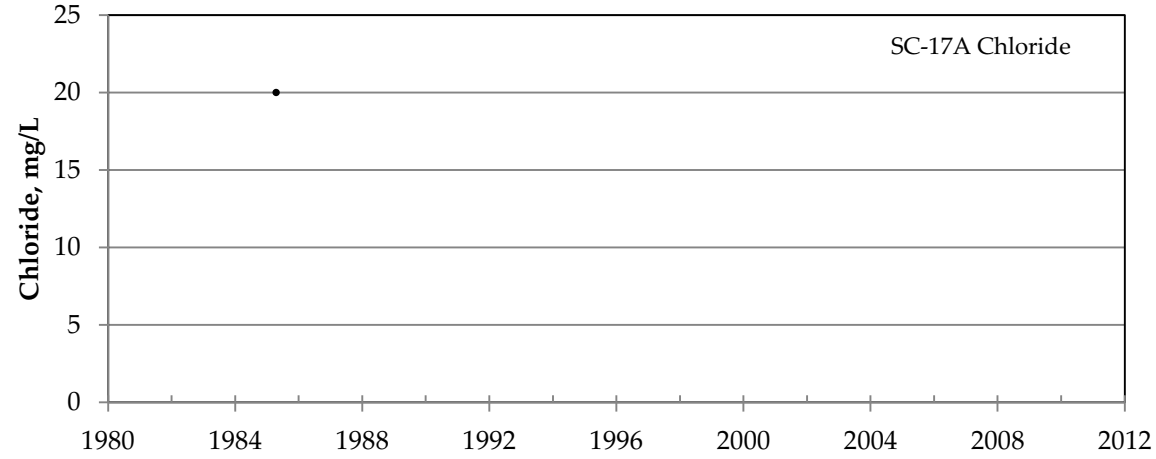

SC-14C Total Dissolved Solids
TDS, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

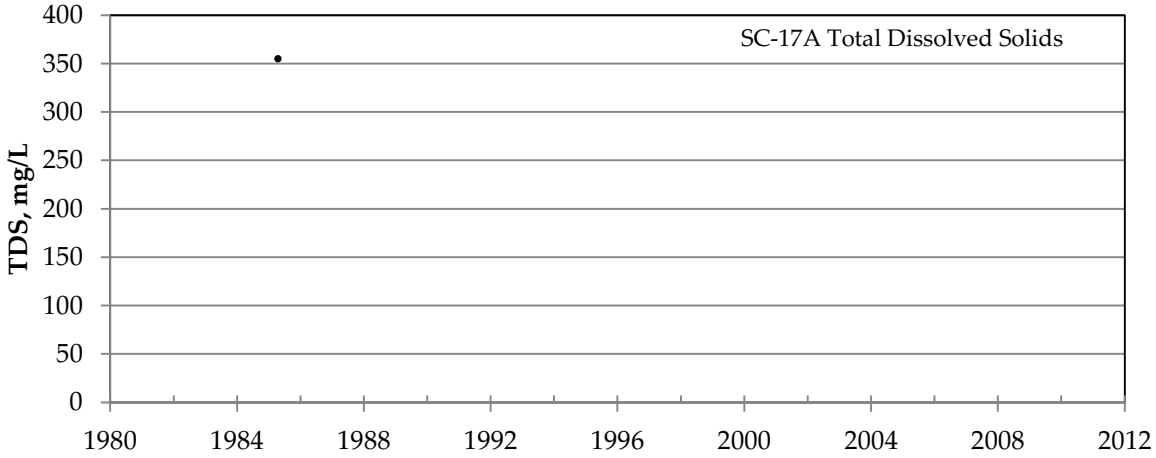

SC-14C Groundwater Elevation
Measurements recorded after 2005 when adjacent Madeline well running excluded
Groundwater Elevation, ft MSL
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
Rate of change = 3.3 feet per year
WY 2007-2011 Trend
1980
1984
1988
1992
1996
2000
2004
2008
2012

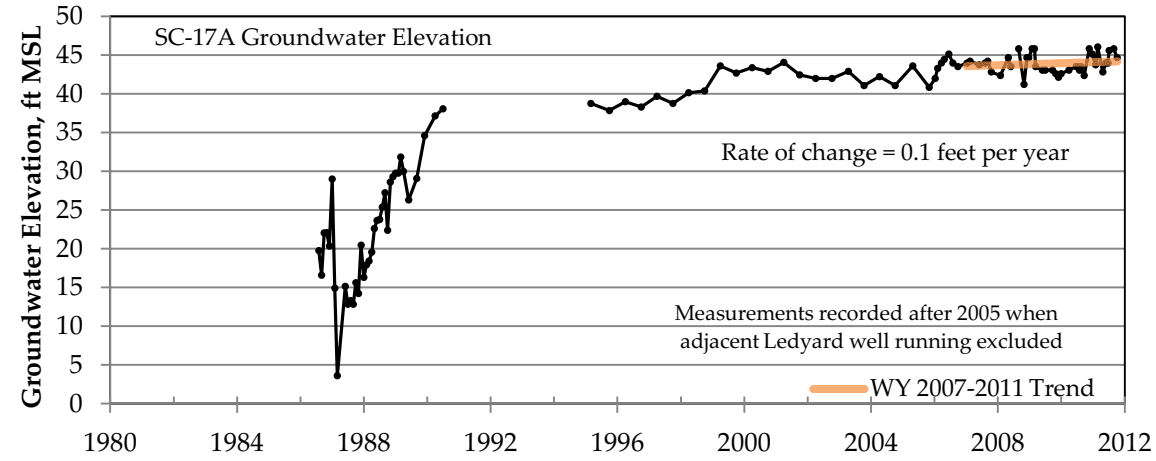

Ledyard Chloride
Chloride, mg/L
Rate of change = 0.9 mg/L per year
45
40
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

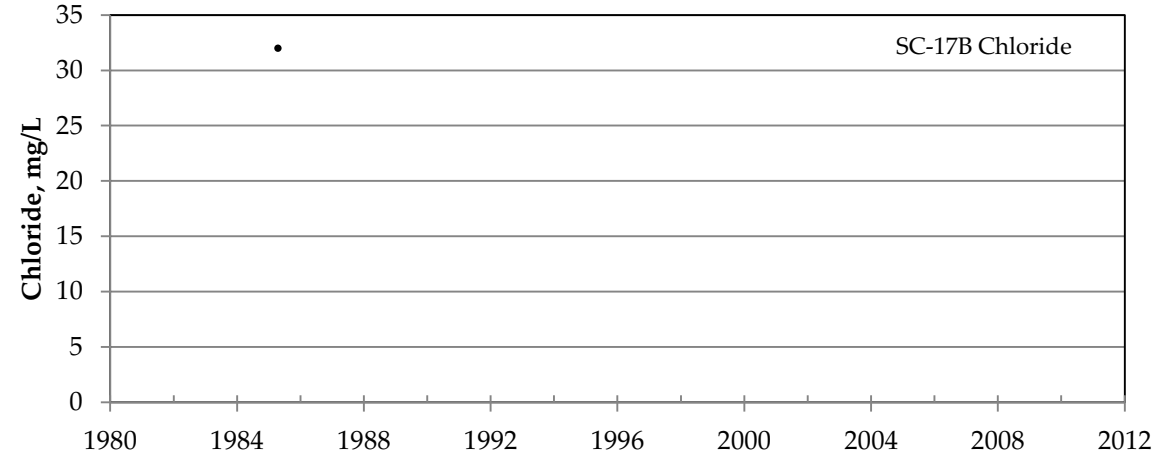

Ledyard Total Dissolved Solids
TDS, mg/L
Rate of change = -4.9 mg/L per year
500
450
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

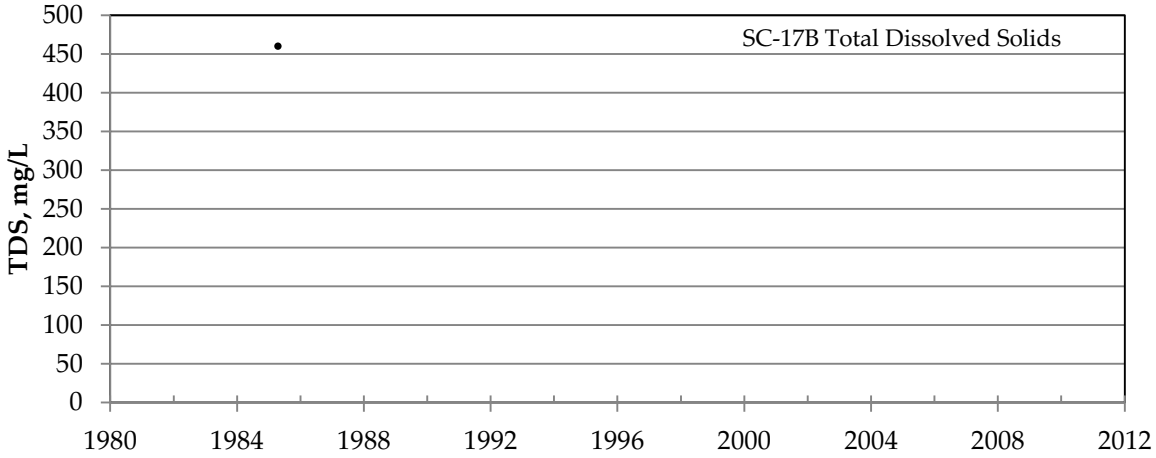

Ledyard Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = 10.6 feet per year
WY 2007-2011 Trend
200
150
100
50
0
-50
-100
-150
-200
1980
1984
1988
1992
1996
2000
2004
2008
2012

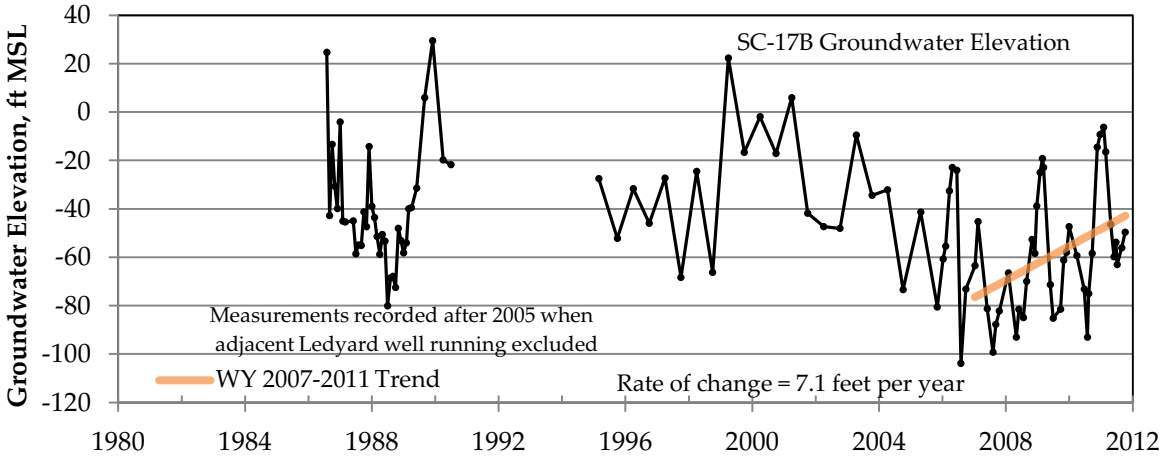

SC-17A Chloride
Chloride, mg/L
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

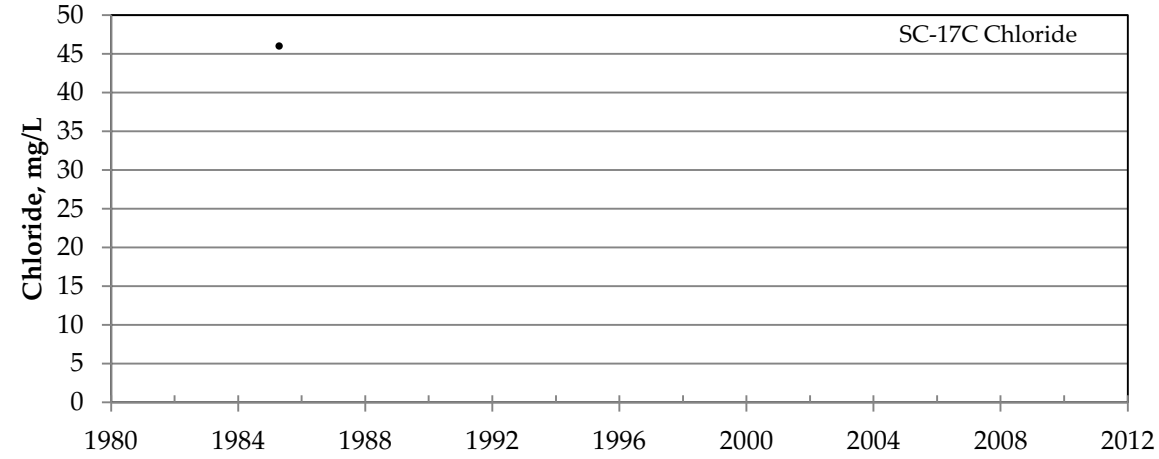

SC-17A Total Dissolved Solids
TDS, mg/L
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

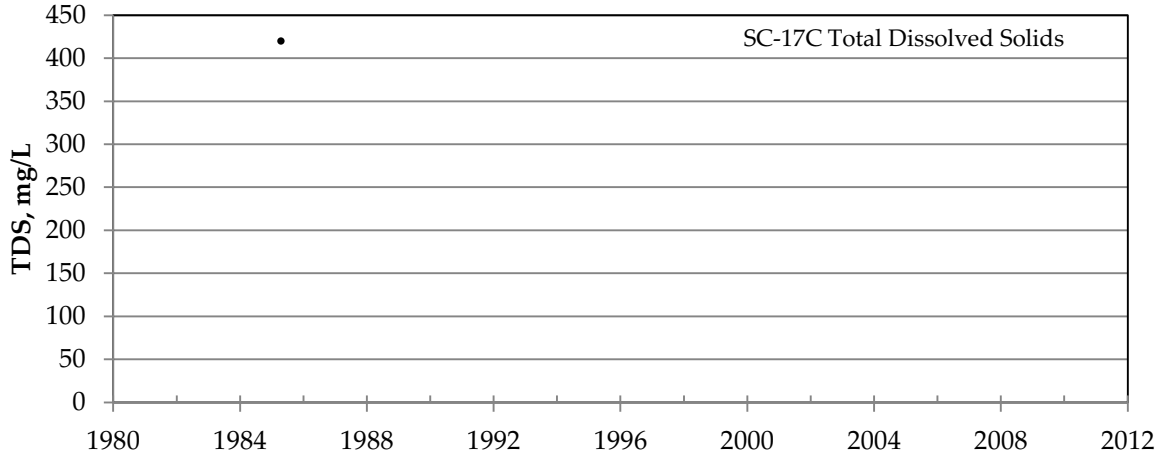

SC-17A Groundwater Elevation
Groundwater Elevation, ft MSL
50
45
40
35
30
25
20
15
10
5
0
Rate of change = 0.1 feet per year
Measurements recorded after 2005 when adjacent Ledyard well running excluded
WY 2007-2011 Trend
1980
1984
1988
1992
1996
2000
2004
2008
2012

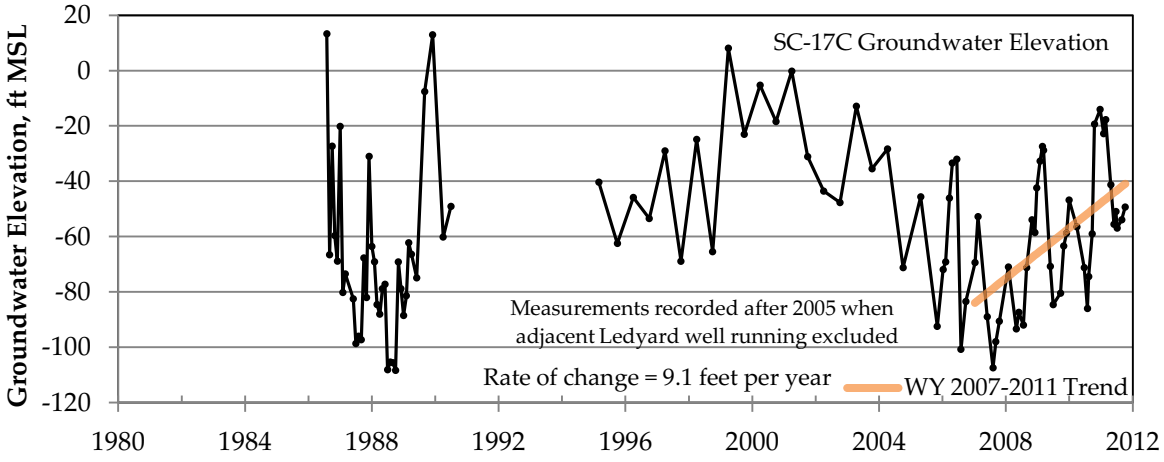

SC-17B Chloride
Chloride, mg/L
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

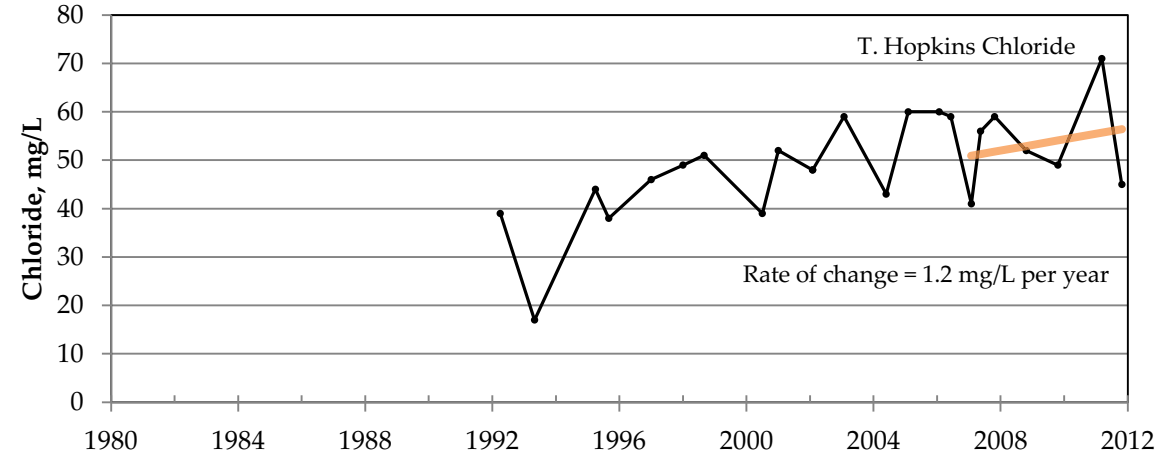

SC-17B Total Dissolved Solids
TDS, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

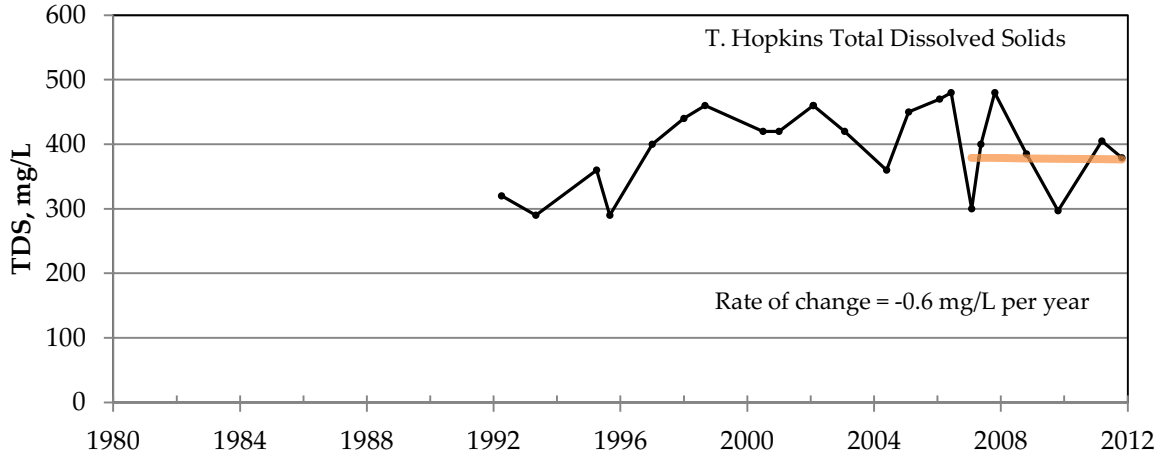

SC-17B Groundwater Elevation
Groundwater Elevation, ft MSL
40
20
0
-20
-40
-60
-80
-100
-120
Measurements recorded after 2005 when adjacent Ledyard well running excluded
WY 2007-2011 Trend
Rate of change = 7.1 feet per year
1980
1984
1988
1992
1996
2000
2004
2008
2012

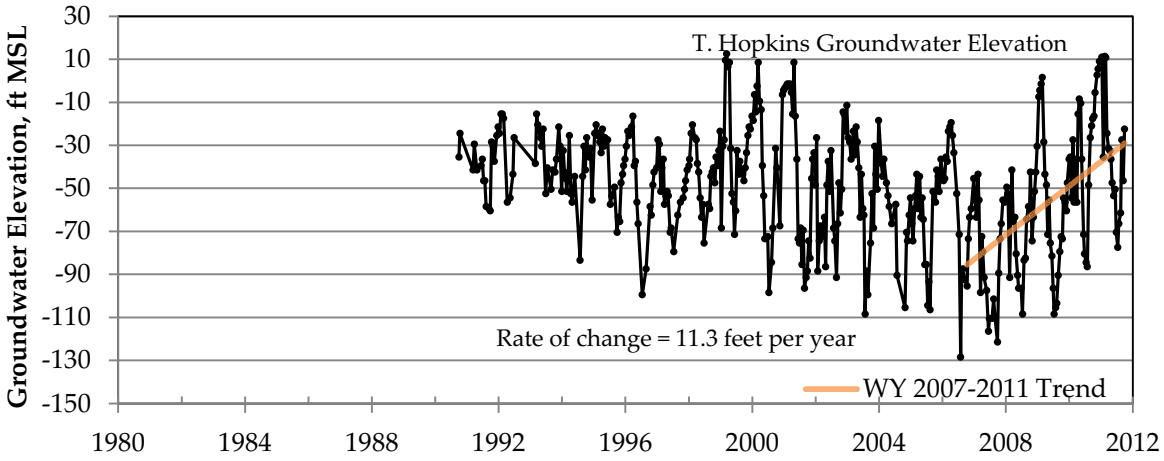

SC-17C Chloride
Chloride, mg/L
50
45
40
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

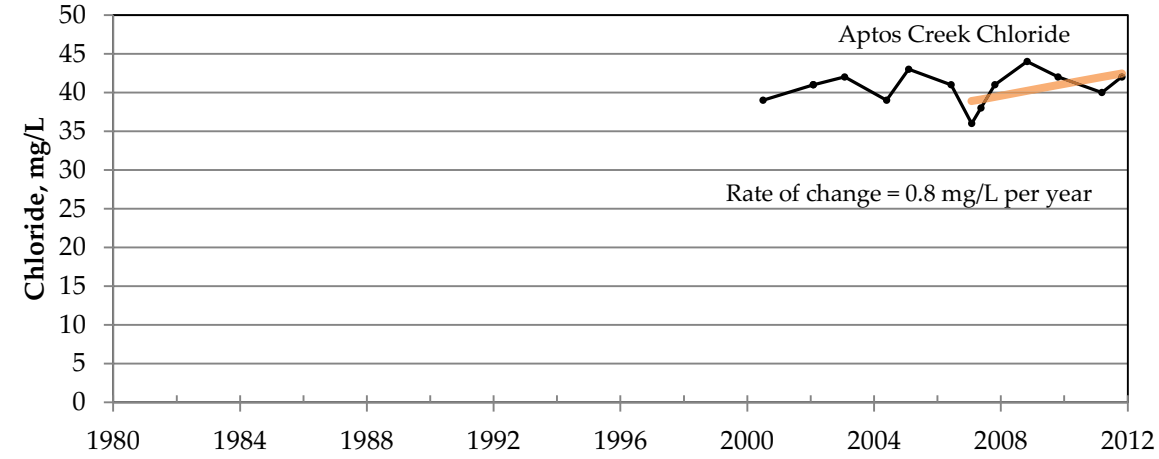

SC-17C Total Dissolved Solids
TDS, mg/L
450
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

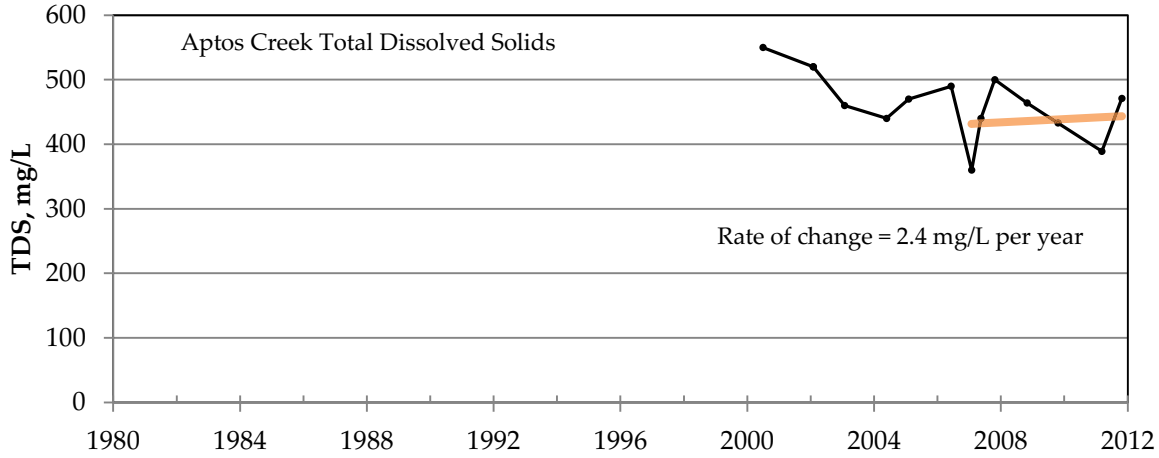

SC-17C Groundwater Elevation
Groundwater Elevation, ft MSL
20
0
-20
-40
-60
-80
-100
-120
Measurements recorded after 2005 when adjacent Ledyard well running excluded
Rate of change = 9.1 feet per year
WY 2007-2011 Trend
1980
1984
1988
1992
1996
2000
2004
2008
2012

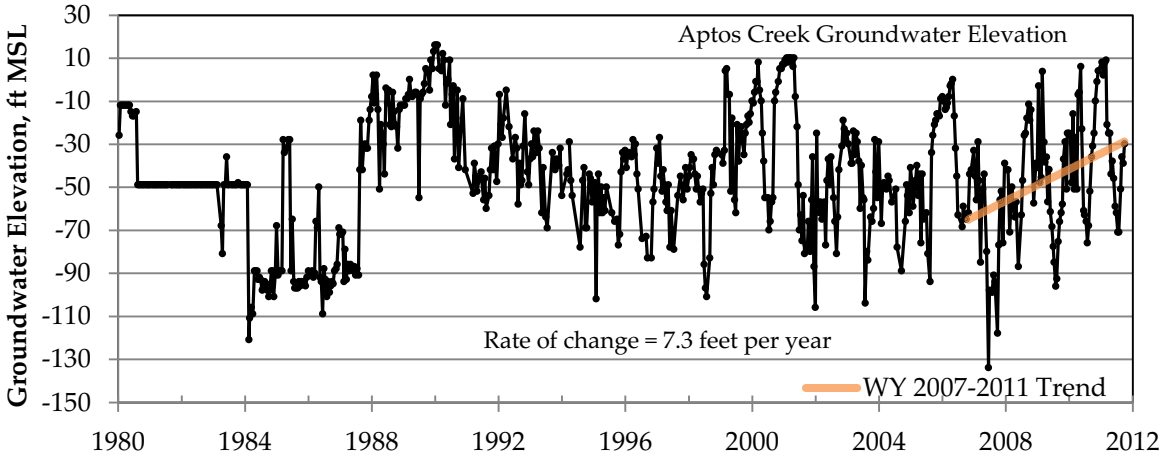

T. Hopkins Chloride
Chloride, mg/L
Rate of change = 1.2 mg/L per year
80
70
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012


T. Hopkins Total Dissolved Solids
TDS, mg/L
Rate of change = -0.6 mg/L per year
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012


T. Hopkins Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = 11.3 feet per year
WY 2007-2011 Trend
30
10
-10
-30
-50
-70
-90
-110
-130
-150
1980
1984
1988
1992
1996
2000
2004
2008
2012


Aptos Creek Chloride
Chloride, mg/L
Rate of change = 0.8 mg/L per year
50
45
40
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012


Aptos Creek Total Dissolved Solids
TDS, mg/L
Rate of change = 2.4 mg/L per year
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012


Aptos Creek Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = 7.3 feet per year
WY 2007-2011 Trend
30
10
-10
-30
-50
-70
-90
-110
-130
-150
1980
1984
1988
1992
1996
2000
2004
2008
2012

SECTION 5 – WATER YEAR 2011
AQUIFER CONDITIONS FOR AROMAS AREA
(PURISIMA F-UNIT/AROMAS RED SANDS)

This section presents groundwater level and water quality conditions for Water Year 2011 in the eastern portion of the Soquel-Aptos area where the primary production aquifers are the Purisima F-unit and the Aromas Red Sands.

5.1 SqCWD Service Areas III and IV and CWD Production

In the eastern portion of the Soquel-Aptos area, groundwater is produced for municipal purposes by SqCWD in Service Areas III and IV, and by CWD at its Cox and Rob Roy well fields. SqCWD's Service Area III production was 1,360 acre-feet in Water Year 2011, the lowest annual total since Water Year 1991. Service Area IV production in the La Selva Beach area was 36 acre-feet in Water Year 2011, the lowest annual total going back to Water Year 1984. The Sells well was taken out of service in April 2009 due to high nitrate concentrations. CWD production at its Cox well field, completed in the Purisima F-unit, was 19 acre-feet in Water Year 2011, while production at its Rob Roy well field completed in the Aromas Red Sands was 464 acre-feet. Rob Roy production was the lowest annual total since Water Year 1998. Also, the distribution of CWD production between the two well fields is consistent with the previous thirteen years.

Figure 5-1 shows production in the Aromas area by water year, grouped into three geographical areas. The Valencia watershed area includes the SqCWD's Aptos Jr. High well and CWD's Cox wells, which are screened in the Purisima F-unit. With the increase in pumping at the Aptos Jr. High well, annual municipal pumping in this area exceeded 300 acre-feet for the first time since Water Year 1986. Pumping increased in Water Year 2007 when the Aptos Jr. High well was put back into service. The Valencia watershed area south and east of Valencia Creek is now included in pumping totals for the Aromas area for comparisons to the post-recovery yield because geologic maps include this sub-area in the Aromas outcrop (HydroMetrics WRI, 2012). Water Year 2011 pumping at the Aptos Jr. High well was approximately 24% of SqCWD's revised estimate of its post-recovery pumping yield in the Aromas area.

The wells in the other two areas are screened in both the Purisima F-unit and the Aromas Red Sands. The Seascape and Rob Roy area includes most of SqCWD's Service Area III wells and CWD's Rob Roy wells. This area has the largest portion of municipal production in the Aromas area, although production has declined since Water Year 2005. SqCWD production in the Seascape area was 1,070 acre-feet in Water Year 2011, the lowest total going back to Water Year 1984, when records for service area totals begin. SqCWD production of 1,070 acre-feet is approximately 89% of SqCWD's post-recovery yield for the Aromas yield (HydroMetrics WRI, 2012). Seascape and Rob Roy combined total pumping in Water Year 2011 was 1,534 acre-feet, the lowest total since Water Year 1986. CWD production at Rob Roy has been relatively steady over the last fifteen years and Well #12 has been used as the lead well starting in 2003.

The La Selva Beach area consists of SqCWD's Service Area IV wells, where pumping has declined since Water Year 2008 after the Sells well was taken out of service. Water Year 2011 pumping of 36 acre-feet in Service Area IV was the lowest total going back to Water Year 1984, when records for service area totals begin.

SqCWD's post-recovery pumping yield for the Aromas area has been updated to 1,200 acre-feet per year, including pumping from the Aptos Jr. High well and the planned Polo Grounds well (HydroMetrics WRI, 2012). Therefore, SqCWD's pumping of 1,396 acre-feet in Water Year 2011 from SqCWD wells in the Aromas area still exceeds the post-recovery pumping yield. In addition, pumping will have to be reduced below the pumping yield to recover the basin to protective levels.

5.2 GROUNDWATER LEVEL CONDITIONS AND TRENDS

SqCWD has revised protective groundwater elevations in coastal monitoring wells to protect the Purisima F-unit and Aromas Red Sands in the eastern portion of the Soquel-Aptos area from seawater intrusion. Cross-sectional models were used to estimate groundwater elevations that result in the freshwater-salt water interface being maintained at the current location at the coastal monitoring wells in the long term (HydroMetrics WRI, 2012).

Coastal groundwater levels in the SqCWD's F-unit and Aromas Red Sands monitoring wells compared to protective elevations are shown in Table 5-1. In the Aromas area, the revised protective elevations are selected to maintain the

interface in both the A and B screens. Therefore, observed groundwater levels in both screens should be compared to protective elevations. Hydrographs for multiple completions of monitoring wells in the Aromas area follow at the end of this section Observed groundwater levels must also be adjusted to account for salinity before they are compared to protective elevations. The protective groundwater elevation estimated by SEAWAT-2000 is the equivalent freshwater head (Langevin and others, 2003). The equivalent freshwater head for groundwater with a substantial amount of salinity is higher than the observed groundwater levels due to the higher density of saline water. Equivalent freshwater heads are calculated where chloride concentrations in coastal monitoring wells are greater than 250 mg/L as described in Attachment A of HydroMetrics WRI (2012). The hydrographs for single monitoring wells grouped with chemographs for chlorides and total dissolved solids show the equivalent freshwater heads.

Average equivalent freshwater heads are above protective elevations in the northwest part of the Aromas area coastline at SC-A1 and SC-A8. The hydrographs show groundwater levels at these wells have been above protective elevations for most of the monitoring record. In the southeast part of the Aromas area coastline, average equivalent freshwater heads are below protective elevations at SC-A2, SC-A3, and SC-A4. The hydrographs show equivalent freshwater heads in the A screens have been below protective elevations for much of the monitoring record.

Table 5-1 (2011): Comparison of Water Year 2011 Coastal Groundwater Levels with Protective Elevations

Well	Location	A Screen Unit/ B Screen Unit	Average Equivalent Freshwater Head A screen (feet msl) [1]	Average Equivalent Freshwater Head B screen (feet msl) [1]	Protective Elevation (feet msl) [1]
SC-A1B	Cliff	DEF/F	5.9	7.9	3
SC-A8B	Dolphin & Sumner	F/ Aromas	5.5	6.7	6
SC-A2B	Sumner	F/F	2.2	5.3	3
SC-A3B	Playa & Vista	Aromas/Aromas	0.8	2.7	3
SC-A4B	Canon del Sol	F/F	1.7	4.4	3

[1] msl = mean sea level

In general, groundwater levels at SqCWD's coastal monitoring wells in the area have stabilized or show a slight increasing trend over the last three years, after showing a declining trend over previous years. The stabilized or rising groundwater levels correspond with historically low production by SqCWD in the area. However, the previous declines occurred despite reductions in pumping at some nearby municipal production wells. The lack of correlation between groundwater levels and local pumping may indicate that non-municipal pumping and/or lower precipitation had a more immediate effect on groundwater levels in the Aromas area than the Purisima area.

Hydrographs for multiple completions of monitoring wells near the SqCWD and CWD production wells are included at the end of this section. Some inland, upgradient wells, including the Black monitoring well, have a stable groundwater level trend. Table 5-2 summarizes the important groundwater level trends by well.

Hydrographs for single wells including production wells are included with chemographs. These hydrographs show trend lines for Water Years 2007-2011 when there have been decreases of municipal production for the Aromas area.

Table 5-2 (2011): Summary of Groundwater Level Trends in Aromas Area

Category	Well	Groundwater Level Trend Description	Notes
SqCWD Coastal Monitoring Wells	SC-A1	Long-term decline in A screen, but relatively stable WY 2009-2011. Rise of 3+ feet in B screen since WY 2009.	Lower pumping at Country Club WY 2008-2011 vs. previous four years; Bonita pumping in WY 2011 lowest on record, Seascape Golf Course also pumping nearby
	SC-A2	Decline of 1.5-3+ feet WY 2006-2009; Rise of 1.5-2 feet WY 2009-2011	Combined pumping at San Andreas and Seascape WY 2011 lowest since WY 1991
	SC-A3	Decline of 1.5-2 feet since WY 2006-2009; relatively stable WY 2009-2011	Historical low SA IV pumping in WY 2010-2011 after Sells went offline

Category	Well	Groundwater Level Trend Description	Notes
	SC-A4	Slight rise WY 2009-2011	Nearest SqCWD wells are in SA IV
SqCWD Monitoring Wells near Production Wells	SC-A6A	Recovery in WY 2010-2011 from WY 2009 decline	Historical low Bonita pumping WY 2009-2011
	SC-A5	Relatively stable WY 2009-2011	Seascape pumping decreased from WY 2009 to WY 2011 but not to WY 2004-2008 totals
	SC-A7A	Decline since WY 2009	Historical low SA IV pumping in WY 2010-2011
	SC-A7B,C	Increase of 4-7 feet in WY 2010 then stable	
CWD Monitoring Wells in Rob Roy Field	CWD-A	Stable trend since WY 2006, but increase in WY 2010-2011	Increased precipitation WY 2010-2011
	CWD-B	Stable trend since WY 2011, but decrease in WY 2011	None
	CWD-C	Rise in WY 2010-2011	Reduced pumping at Rob Roy WY 2010-2011
Inland Wells	Aptos Jr. High well	Decline of at least 10 feet since WY 2007; Decline in WY 2011 after rise in WY 2010	Well returned to service in WY 2007; historical high pumping in WY 2011
	Black Monitoring Well	Stable WY 2007-2011; higher than prior	None

Contour maps of groundwater elevations in spring and fall 2011 for the Purisima F-unit and Aromas Red Sands are shown in Figure 5-2 and Figure 5-3, respectively. Both spring and fall 2011 contour maps show that groundwater levels were above sea level, although coastal groundwater levels are below protective elevations in the southeast part of the coast.

5.3 WATER QUALITY CONDITIONS AND TRENDS

Seawater intrusion has been consistently detected at deep monitoring wells along the coast of the Aromas area. At all coastal monitoring clusters in the Aromas area except SC-A1, the deepest completion was installed to be below the freshwater-saltwater interface. As discussed above, groundwater levels continue to be below protective elevations in the southeast part of the Aromas area. As a result, there is risk of seawater intrusion advancing toward production wells in the Aromas area.

Observed Total Dissolved Solids (TDS) and chloride concentrations continue to be elevated at the deep coastal monitoring wells installed below the freshwater-saltwater interface. Chloride concentrations are above 6,000 mg/L in these wells.

In the northwest part of the Aromas area coast, the freshwater-salt water interface has not been observed at SC-A1 and salt concentrations at SC-A8A below the interface have remained stable since well installation in 2007. The hydrographs show groundwater levels at these wells have been above protective elevations for most of the monitoring record.

In the southeast part of the Aromas area coast, the freshwater-saltwater interface has apparently moved shallower and landward over the long term. The hydrographs show equivalent freshwater heads in the SC-A2A, SC-A3A, and SC-A4A have been below protective elevations for much of the monitoring record There is a long-term increasing trend in TDS and chloride concentrations at wells SC-A2B and SC-A3B, where the interface is most shallow. This apparent landward movement of seawater has put the nearby Seascape, Altivo, and Sells wells at the highest risk to be impacted by seawater intrusion. In addition, concentrations at the SC-A5 wells near the Seascape well continue to indicate that seawater has advanced to just below that production well.

Chemographs of TDS and chloride for SqCWD monitoring wells in the Aromas area are included at the end of this section. Table 5-3 summarizes the important water quality trends by well.

Table 5-3 (2011): Summary of TDS and Chloride Concentration Trends in Aromas Area

Category	Well	Concentration Trend Description	Notes
SqCWD Coastal Monitoring Wells	SC-A1	Chloride consistently <40 mg/L	No completions (deepest to -455 ft msl[1]) installed below interface
	SC-A2A	Long-term increasing trend; chloride = 13,000 mg/L in WY 2011	Installed below fresh water/seawater interface; near Seascape
	SC-A2B	Long-term increasing trend, chloride ~ 500 mg/L in WY 2011	Installed (-293 to -313 ft msl[1]) above interface when chloride ~ 30 mg/L in WY 1987
	SC-A3A	Stable trend; chloride > 17,000 mg/L (near full strength seawater)	Installed below fresh water/seawater interface; near Sells and Bonita
	SC-A3B	Long-term increasing trend, but relatively stable WY 2008-2011; chloride ~2,700 mg/L in WY 2011	Installed (-127 to -167 ft msl[1]) above fresh water/seawater interface when chloride < 10 mg/L in WY 1987
	SC-A4A	Increasing trend; chloride > 8,000 mg/L in WY 2010	Installed (-334 to -354 ft msl[1]) below fresh water/seawater interface
	SC-A4B	Increasing trend; chloride 20-38 mg/L in WY 2011	Installed above fresh water/seawater interface
SqCWD Monitoring Wells near Production Wells	SC-A5A	Increasing trend; chloride > 6,000 mg/L in WY 2010	Installed (-475 to -495 ft msl[1]) below fresh water/seawater interface; screened 100 feet below Seascape well
	SC-A5B	Increasing trend; Chloride ~ 50 mg/L in WY 2010	Installed above fresh water/seawater interface; screened 30 feet below Seascape well

[1] msl = mean sea level

Screen elevations listed for most shallow well in the cluster with current chloride concentrations above 250 mg/L.

SC-A8A has approximately 7,000 mg/L chloride and is installed at -388 to -408 ft msl.

Observed Total Dissolved Solids (TDS) and chloride concentrations in SqCWD's production wells do not suggest any seawater intrusion impact on municipal production in the Purisima F-unit and Aromas Red Sands. Recent chloride concentrations in the production wells are at 60 mg/L or less, while the maximum contaminant level(MCL) for chlorides is 250 mg/L. Chemographs for SqCWD production wells in the area are included at the end of this section.

Nitrate at SqCWD's Sells well showed concentrations at or just under the maximum contaminant limit of 45 mg/L. The well was removed from service in April 2009. Concentrations from the offline well continued to be above the maximum contaminant limit in 2011.

California Office of Environmental Health Hazard Assessment (OEHHA) released a revised draft public health goal (PHG) for Chromium VI in December 2010, however, the PHG has not been finalized and is only one step in developing an enforceable drinking water standard set by the California Department of Public Health. Chromium VI concentrations in SqCWD production wells screened in the Aromas Red Sands ranged from 0.42 to 40 µg/L in 2011. Chromium VI concentrations in CWD production wells screened in the Aromas Red Sands ranged from 4 to 11 µg/L in 2009. Concentrations for total chromium met current drinking water standards for all wells. A report on depth discrete testing of flows and Chromium VI concentrations at the Bonita, San Andreas, and Altivo wells was issued in 2009 (HydroMetrics LLC, 2009d).

OEHHA established a PHG for 1,2,3-trichloropropane of 0.0007 µg/L in August 2009, but an enforceable drinking water standard has not yet been set by the California Department of Public Health. The compound 1,2,3-trichloropropane ranged from <0.005 µg/L to 0.015 µg/L in the Country Club well in 2011. However, this constituent has not been detected at other wells.

In 2011, arsenic averaged 1.3 µg/L at the Aptos Jr. High well and was detected at Country Club well (0.71 µg/L) and San Andreas Well, (0.59 µg/L), but at levels below the MCL of 10 µg/L for arsenic. Water from the Aptos Jr. High well is treated to reduce arsenic concentrations.

5.4 STATE OF THE AQUIFER SUMMARY

Seawater intrusion has been detected along the coast of the Aromas area. Coastal groundwater levels have been below protective elevations in the southeast part of the Aromas area indicating risk for continued seawater intrusion into the productive Purisima F unit and the Aromas aquifer. The long-term water quality trend indicates that seawater intrusion has advanced over the last 25 years. Historically low municipal production in the Aromas area has resulted in some recovery of groundwater levels, but not enough to protect the basin. Reducing the risk of seawater intrusion by raising groundwater levels may not be achieved by maintaining recent low municipal production in the Aromas area.

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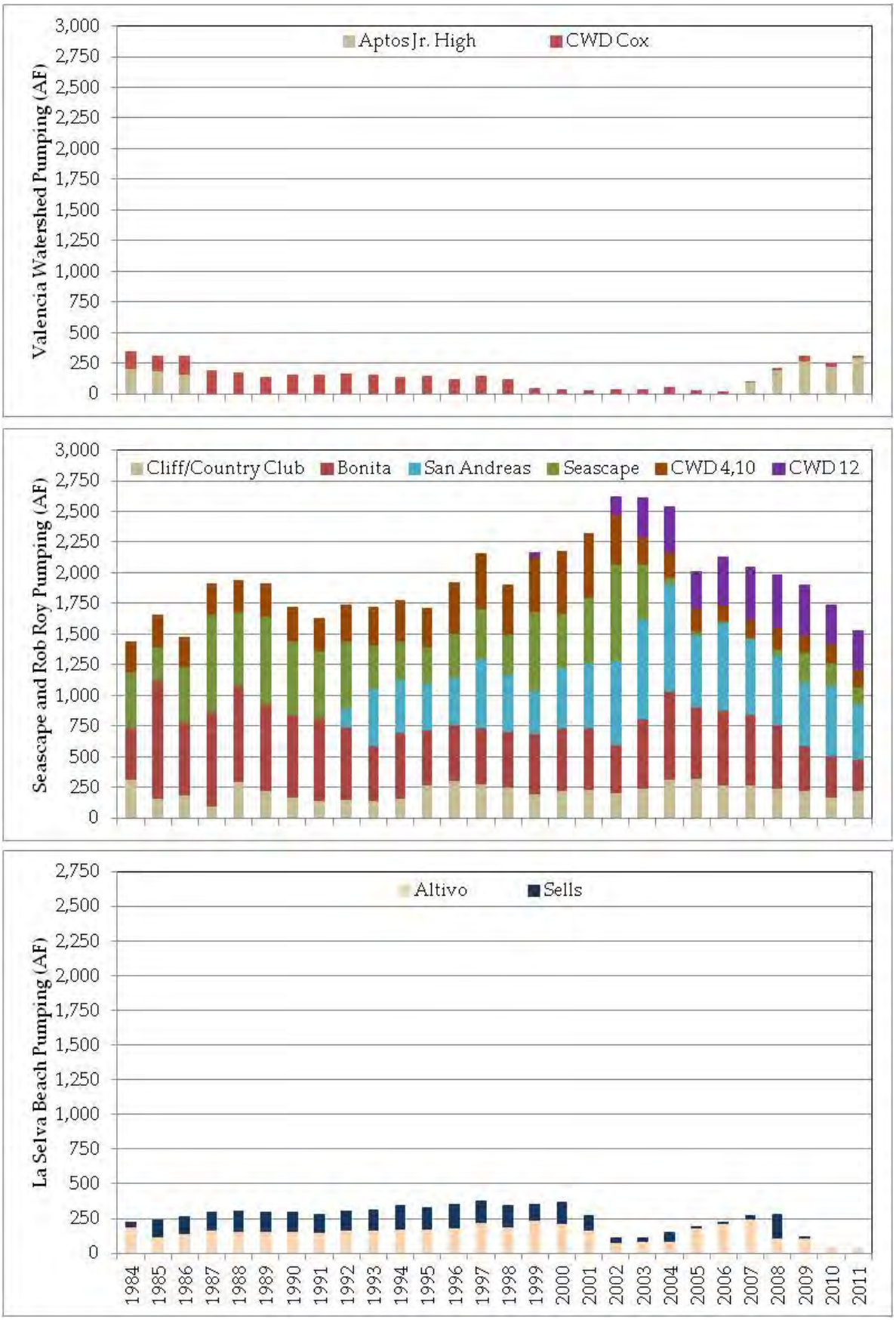


Figure 5-1: Pumping By Water Year in the Aromas Area

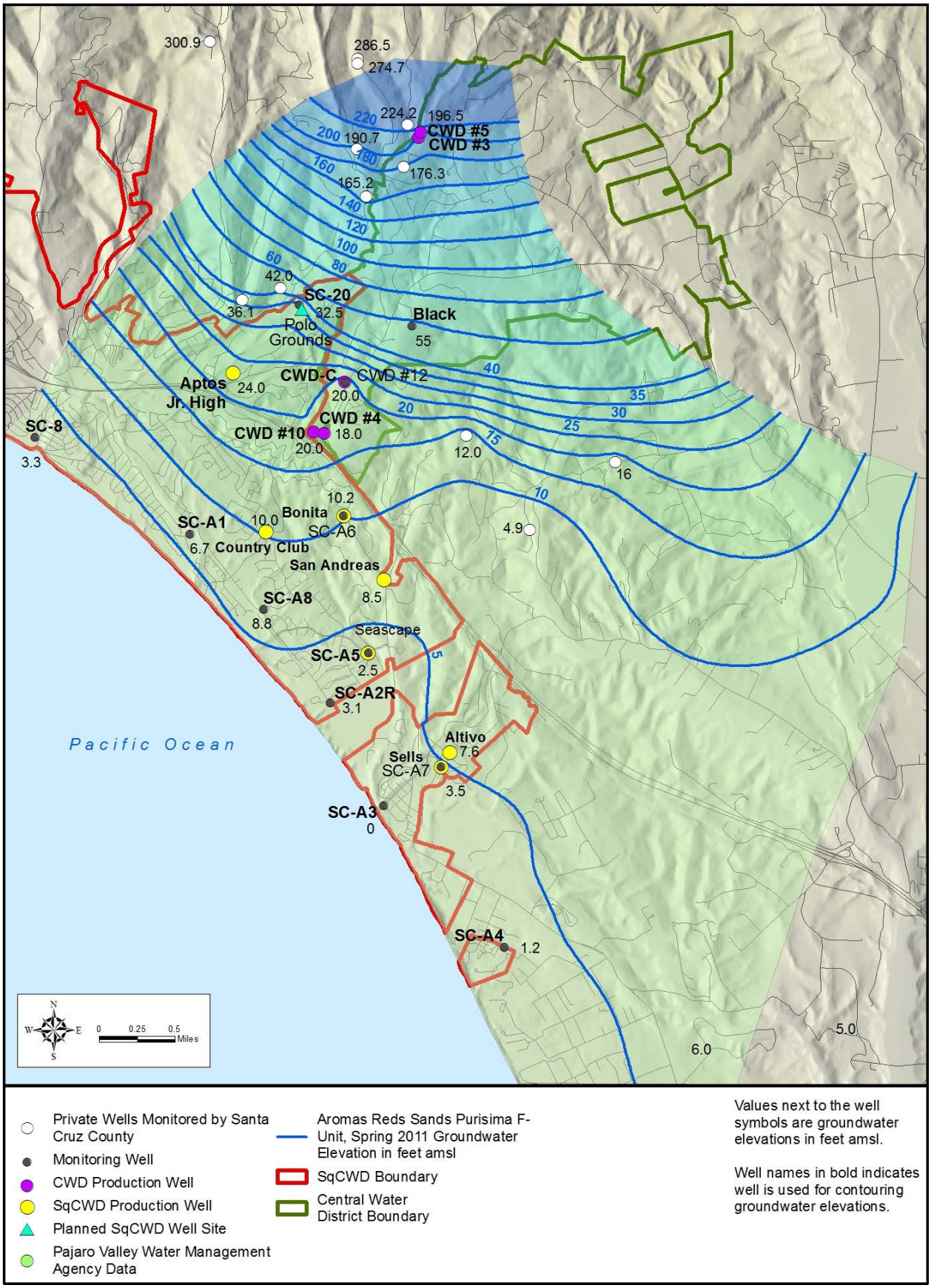


Figure 5-2 (2011): Groundwater Elevation Contours, Aromas Area, Spring 2011

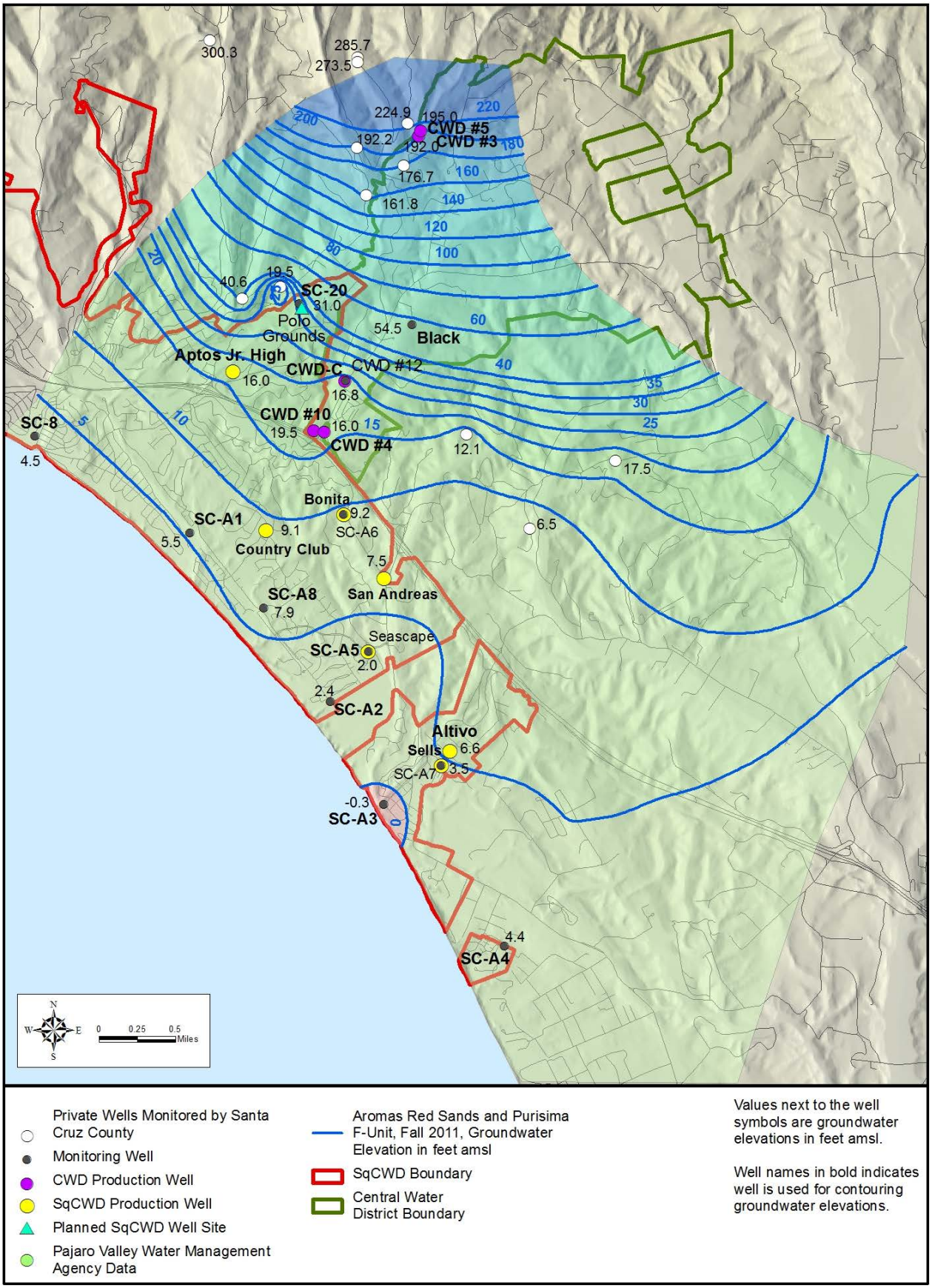


Figure 5-3 (2011): Groundwater Elevation Contours, Aromas Area, Fall 2011

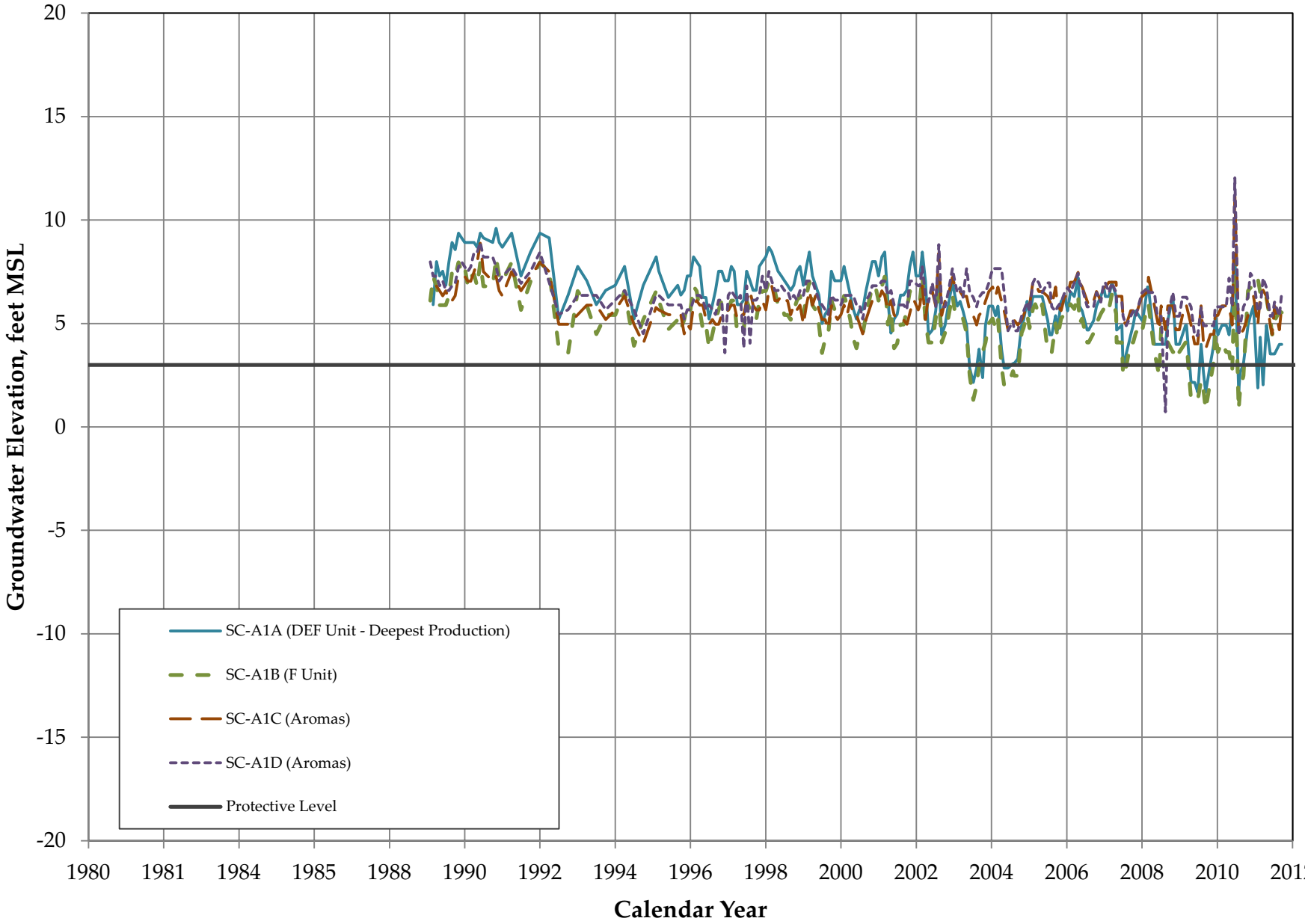
Hydrographs for Aromas Area

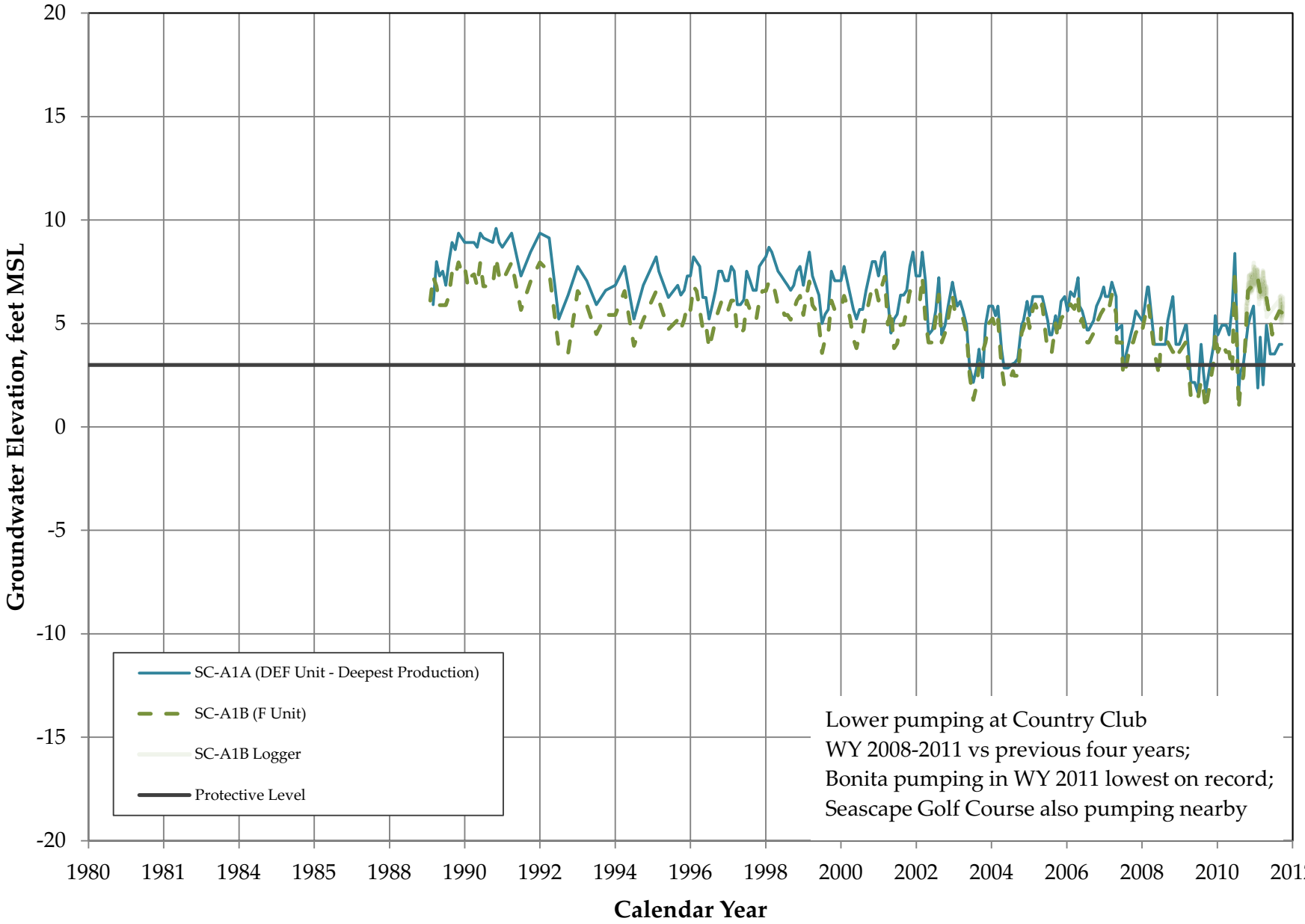
Hydrographs of SqCWD Coastal Monitoring Well Clusters

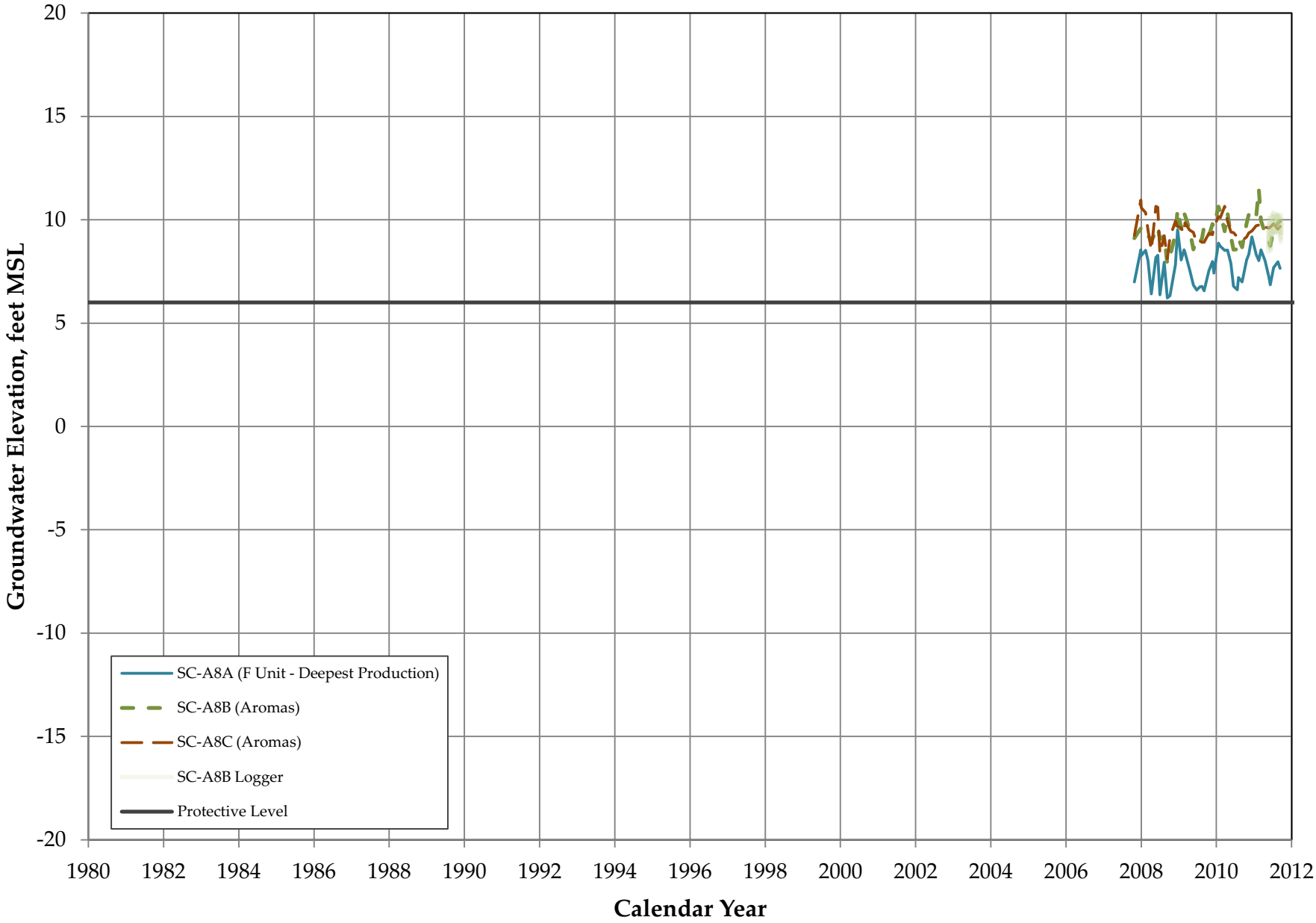
Hydrographs of SqCWD Monitoring Wells Adjacent to Production Wells

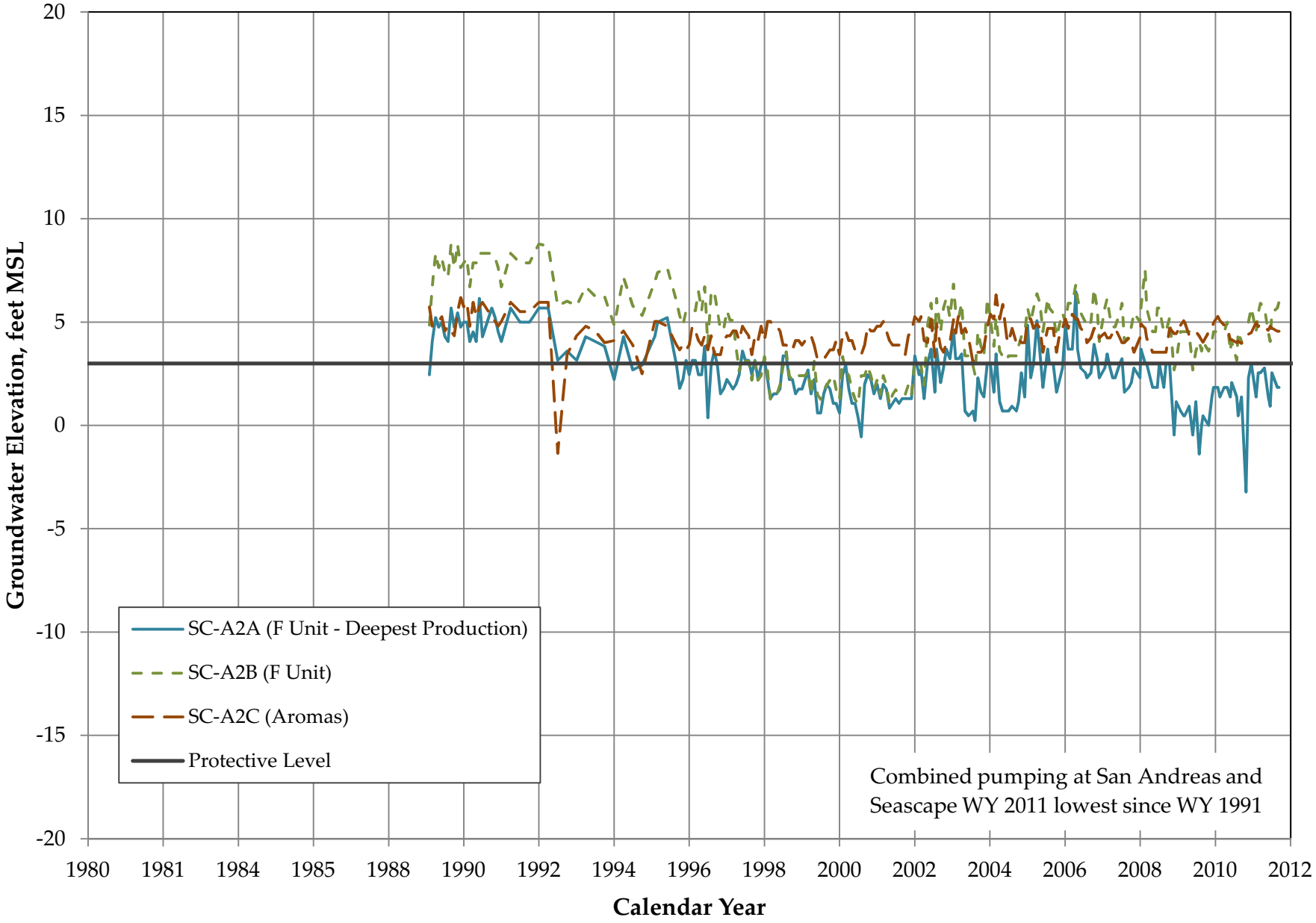
Hydrographs of CWD Monitoring Wells Adjacent to Production Wells

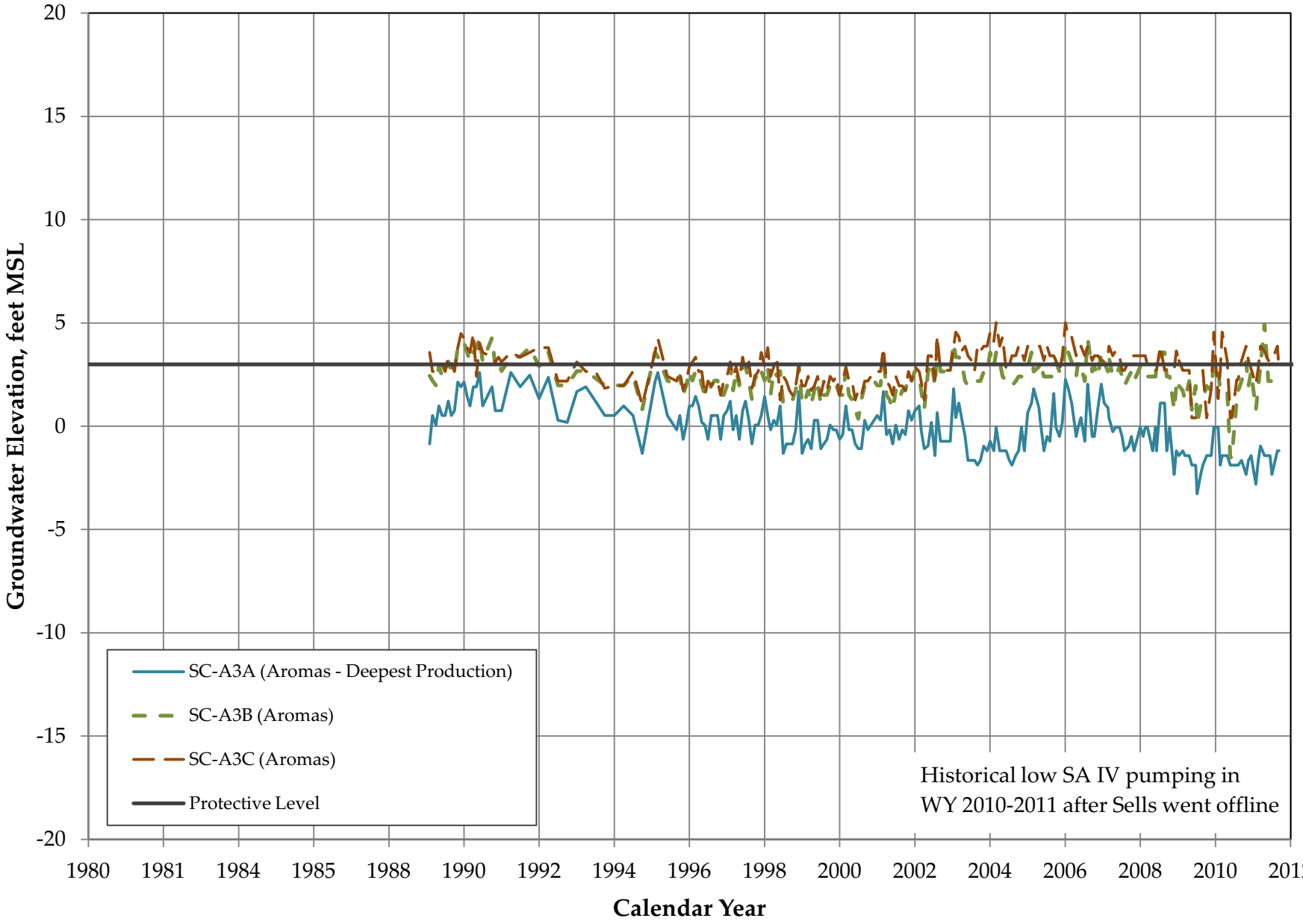
Hydrograph of Inland Monitoring Wells

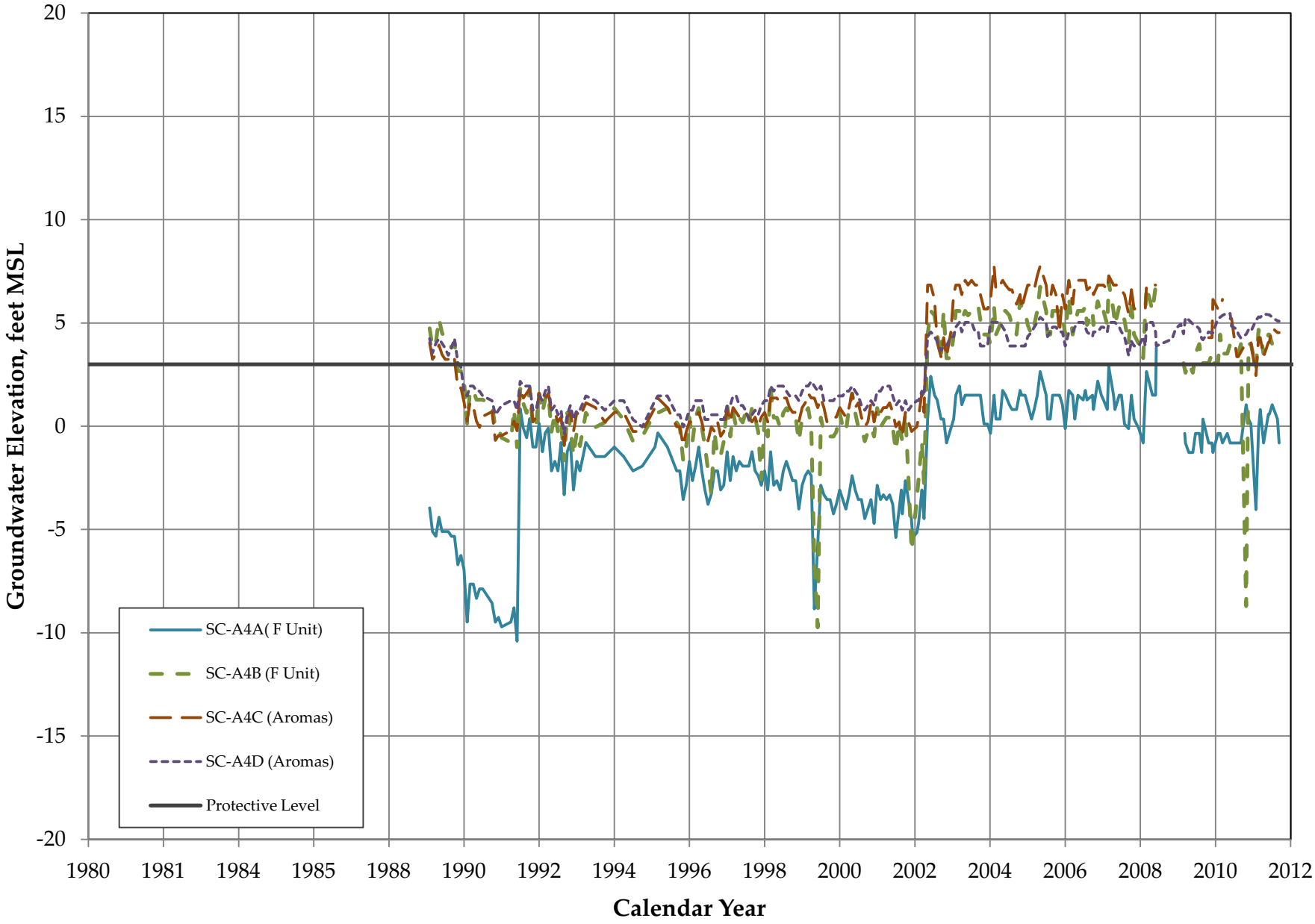

Groundwater Elevation, feet MSL
20
15
10
5
0
-5
-10
-15
-20
1980
1981
1984
1985
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
SC-A1A (DEF Unit - Deepest Production)
SC-A1B (F Unit)
SC-A1C (Aromas)
SC-A1D (Aromas)
Protective Level

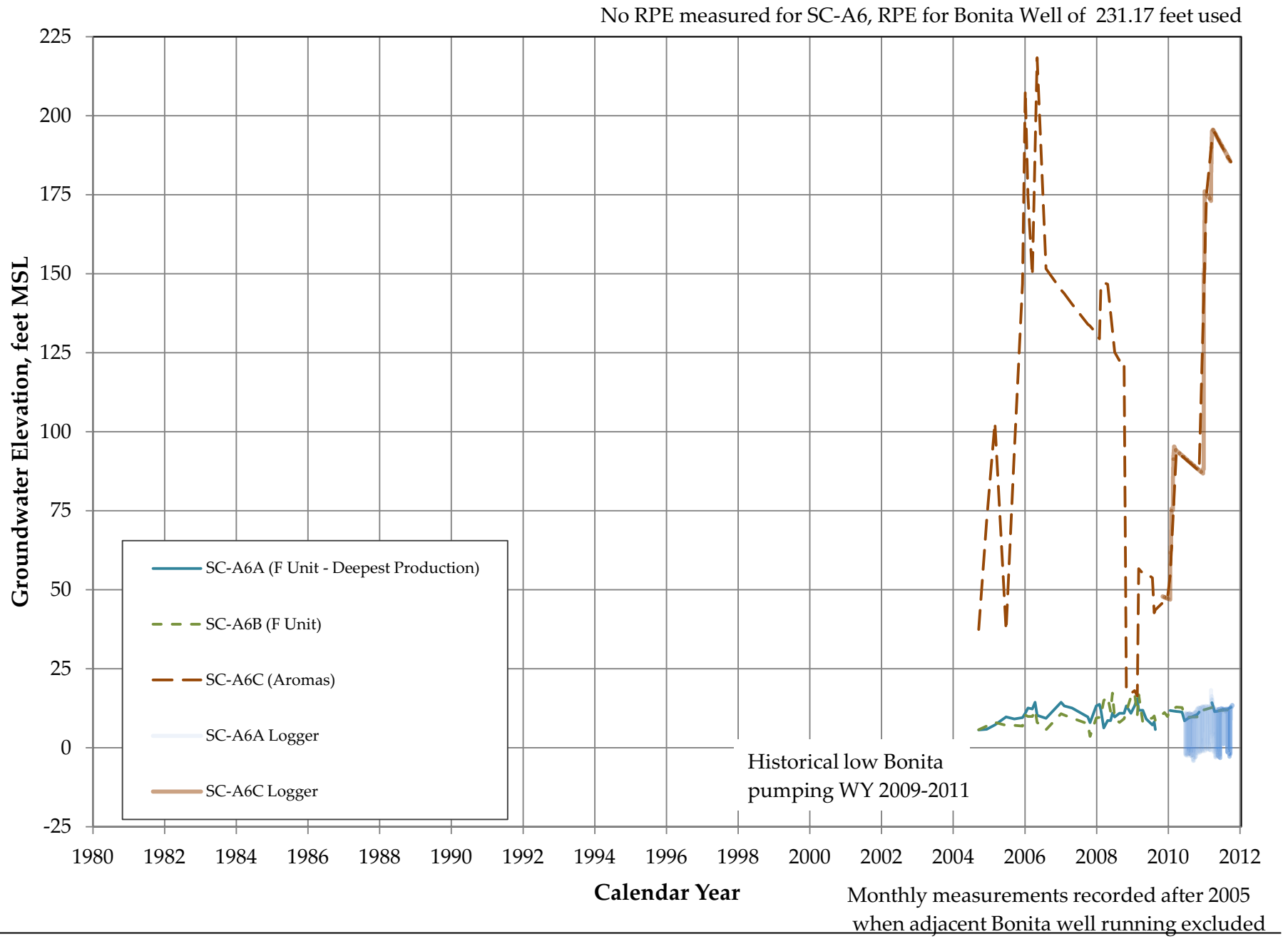

Groundwater Elevation, feet MSL
20
15
10
5
0
-5
-10
-15
-20
1980
1981
1984
1985
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
SC-A1A (DEF Unit - Deepest Production)
SC-A1B (F Unit)
SC-A1B Logger
Protective Level
Lower pumping at Country Club
WY 2008-2011 vs previous four years;
Bonita pumping in WY 2011 lowest on record;
Seascape Golf Course also pumping nearby

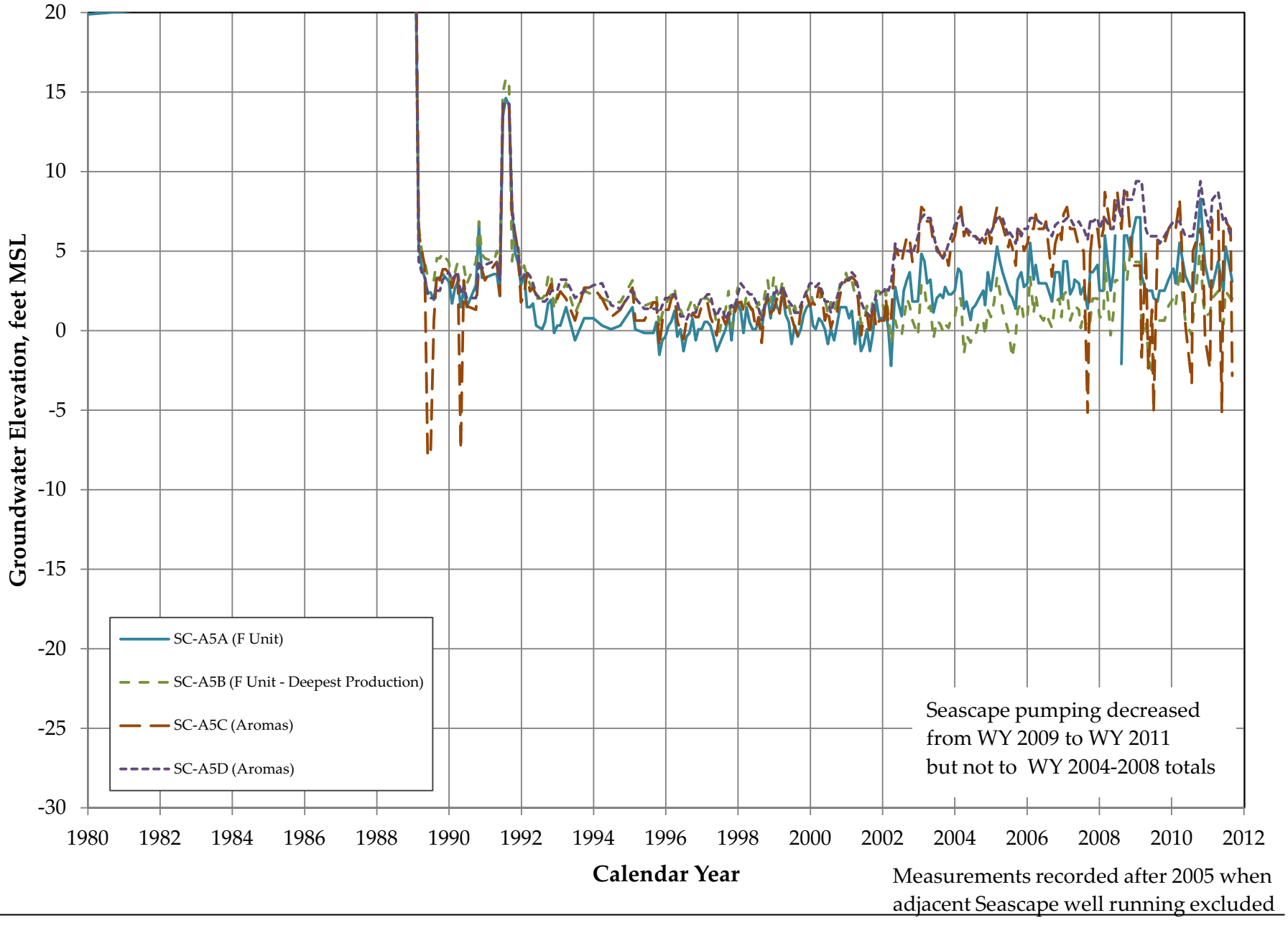

Groundwater Elevation, feet MSL
20
15
10
5
0
-5
-10
-15
-20
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
SC-A8A (F Unit - Deepest Production)
SC-A8B (Aromas)
SC-A8C (Aromas)
SC-A8B Logger
Protective Level


Groundwater Elevation, feet MSL
20
15
10
5
0
-5
-10
-15
-20
1980
1981
1984
1985
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
SC-A2A (F Unit - Deepest Production)
SC-A2B (F Unit)
SC-A2C (Aromas)
Protective Level
Combined pumping at San Andreas and Seascape WY 2011 lowest since WY 1991

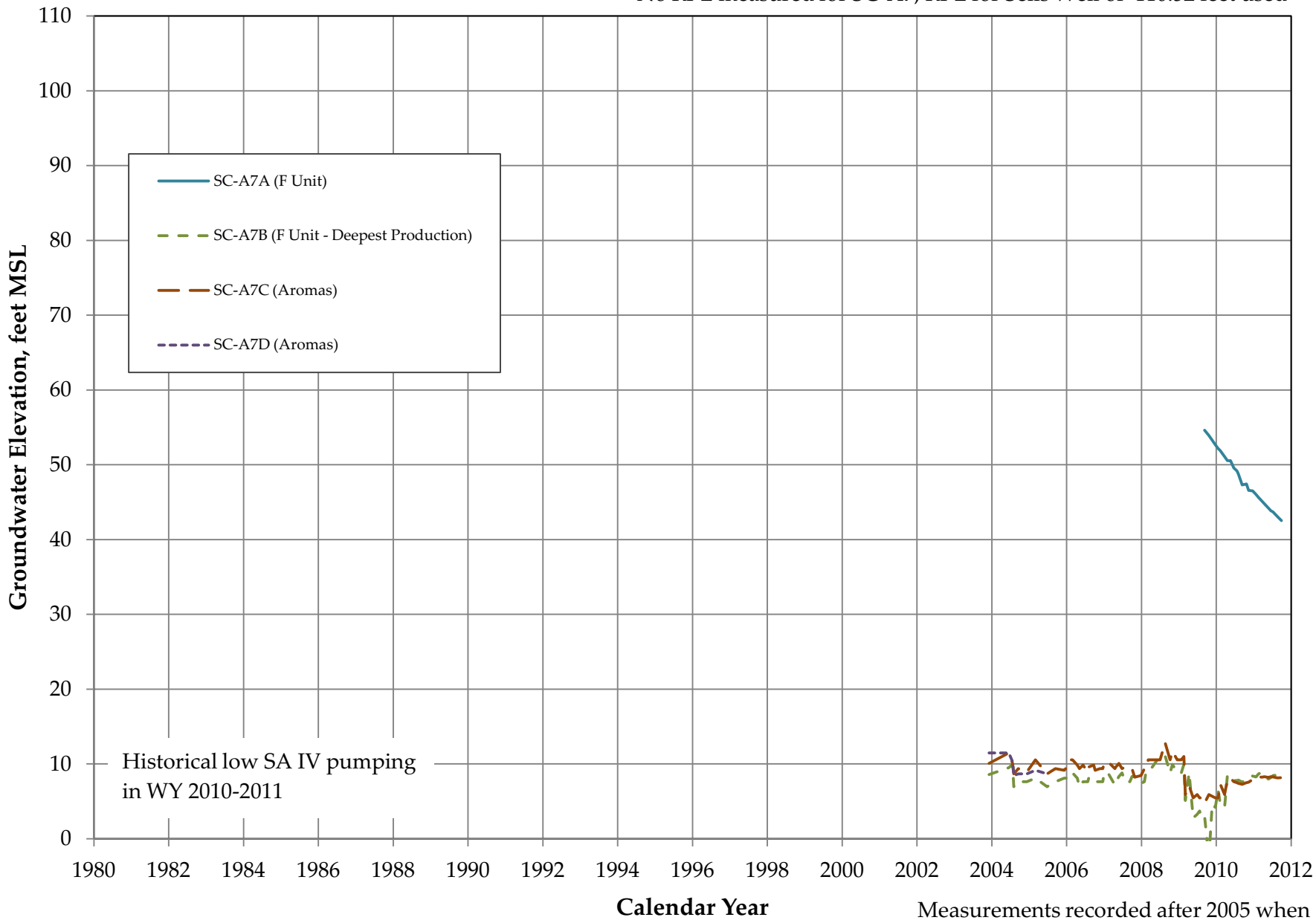

Groundwater Elevation, feet MSL
20
15
10
5
0
-5
-10
-15
-20
1980
1981
1984
1985
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
SC-A3A (Aromas - Deepest Production)
SC-A3B (Aromas)
SC-A3C (Aromas)
Protective Level
Historical low SA IV pumping in
WY 2010-2011 after Sells went offline


Groundwater Elevation, feet MSL
20
15
10
5
0
-5
-10
-15
-20
1980
1981
1984
1985
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
SC-A4A(F Unit)
SC-A4B (F Unit)
SC-A4C (Aromas)
SC-A4D (Aromas)
Protective Level

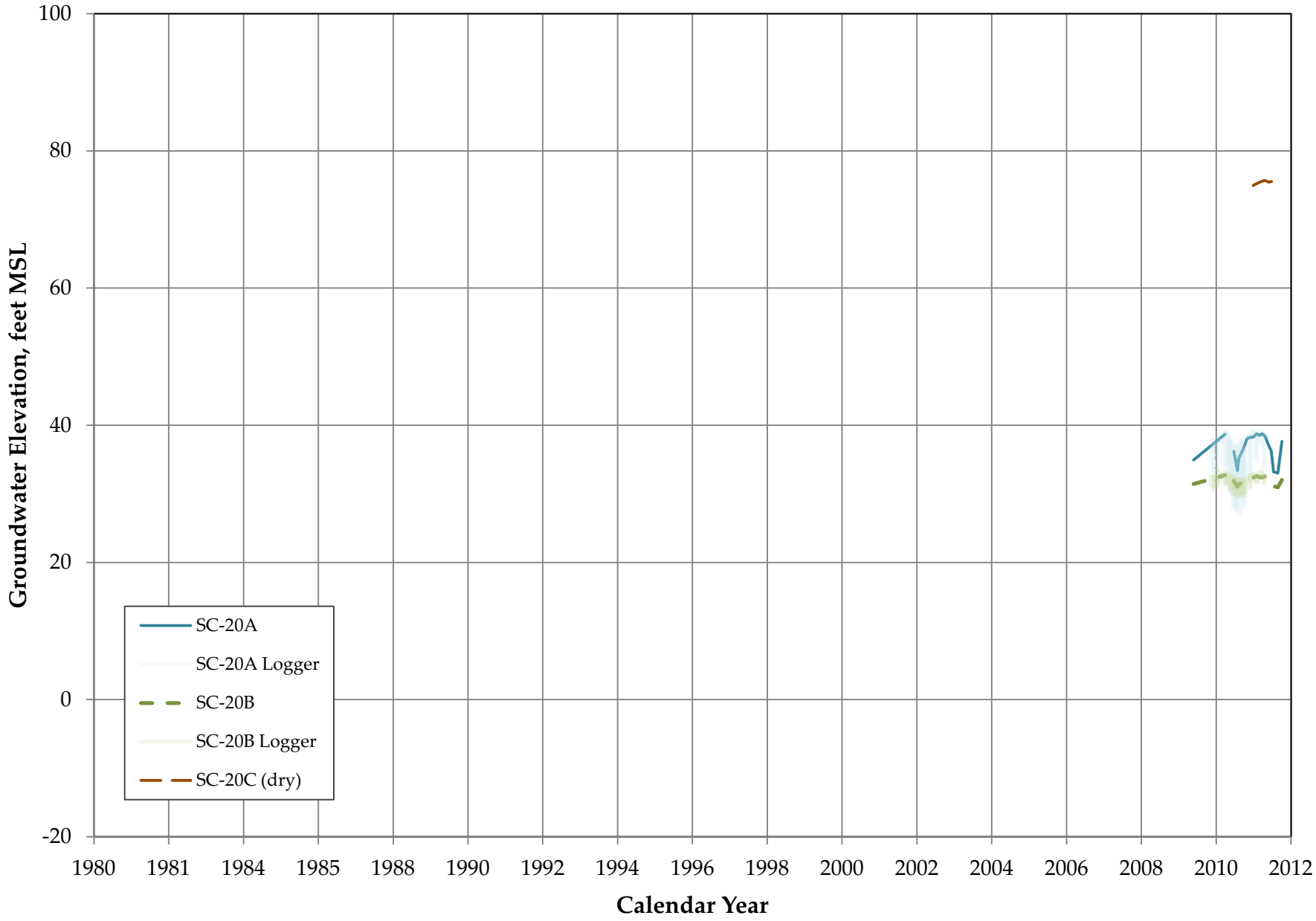

No RPE measured for SC-A6, RPE for Bonita Well of 231.17 feet used
Groundwater Elevation, feet MSL
225
200
175
150
125
100
75
50
25
0
-25
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
SC-A6A (F Unit - Deepest Production)
SC-A6B (F Unit)
SC-A6C (Aromas)
SC-A6A Logger
SC-A6C Logger
Historical low Bonita pumping WY 2009-2011
Monthly measurements recorded after 2005 when adjacent Bonita well running excluded

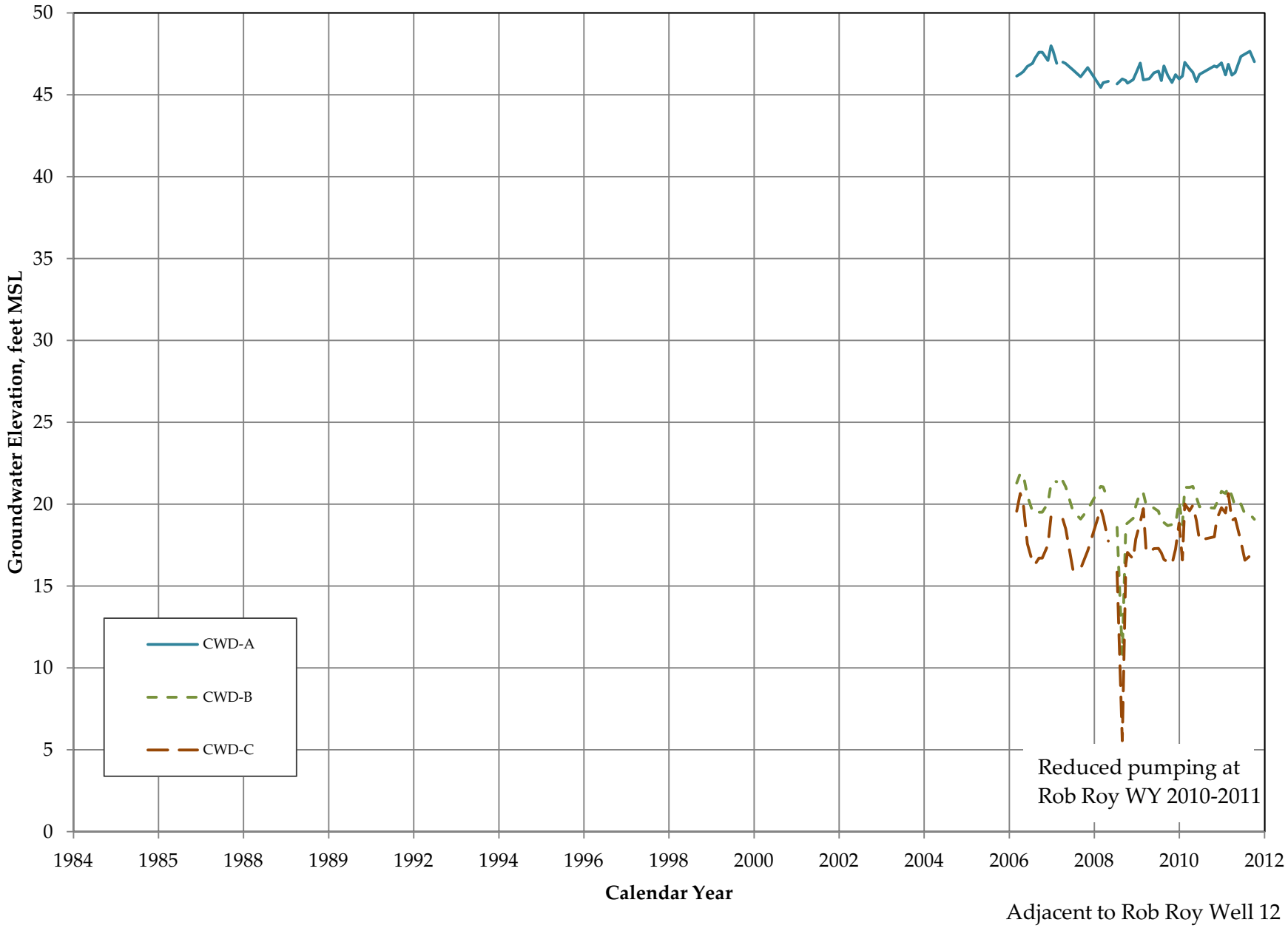

Groundwater Elevation, feet MSL
20
15
10
5
0
-5
-10
-15
-20
-25
-30
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
SC-A5A (F Unit)
SC-A5B (F Unit - Deepest Production)
SC-A5C (Aromas)
SC-A5D (Aromas)
Seascape pumping decreased
from WY 2009 to WY 2011
but not to WY 2004-2008 totals
Measurements recorded after 2005 when
adjacent Seascape well running excluded

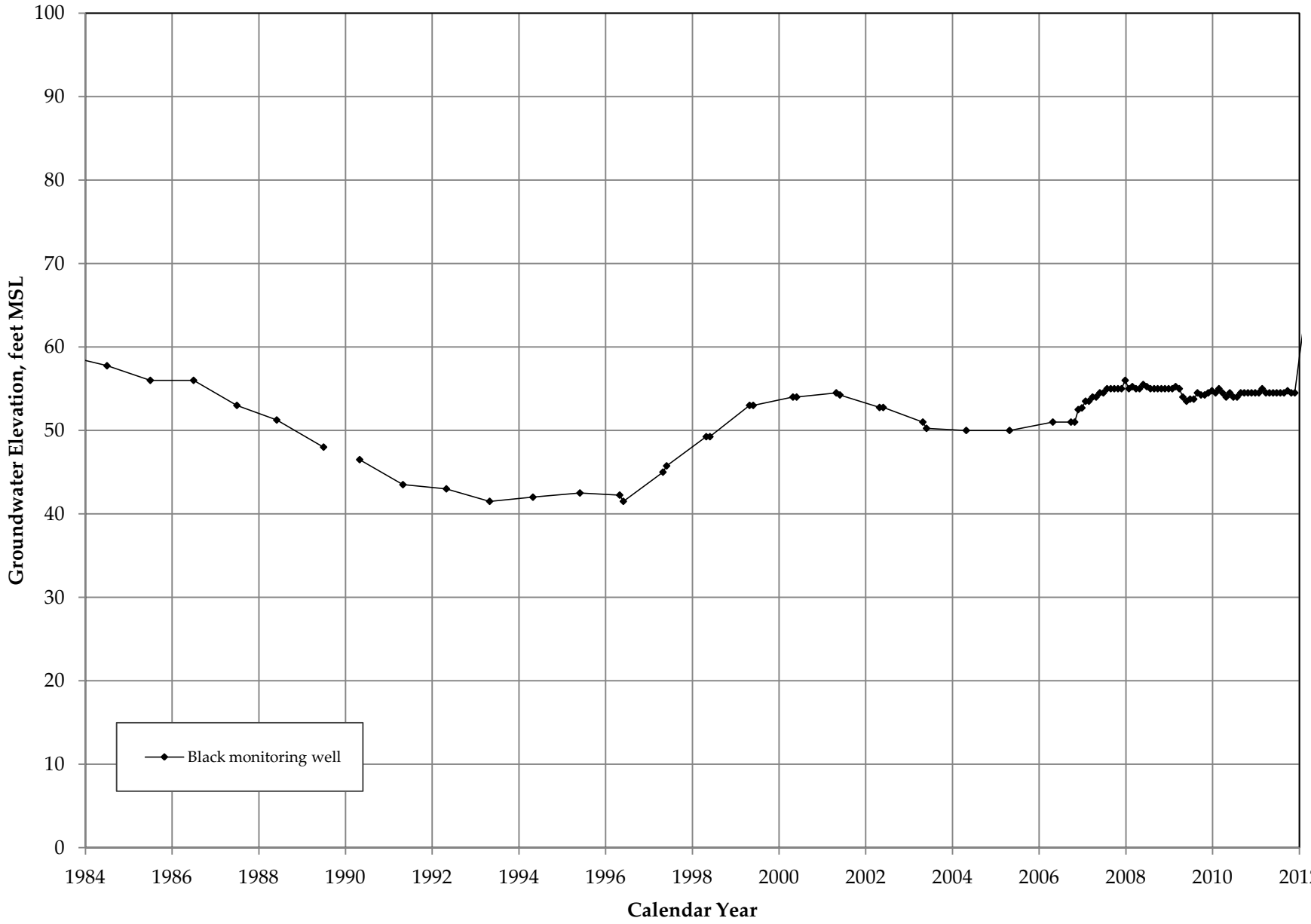
No RPE measured for SC-A7, RPE for Sells Well of 110.52 feet used



Measurements recorded after 2005 when adjacent Sells well running excluded


100
80
60
40
20
0
-20
Groundwater Elevation, feet MSL
1980
1981
1984
1985
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
SC-20A
SC-20A Logger
SC-20B
SC-20B Logger
SC-20C (dry)


Groundwater Elevation, feet MSL
50
45
40
35
30
25
20
15
10
5
0
1984
1985
1988
1989
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
CWD-A
CWD-B
CWD-C
Reduced pumping at
Rob Roy WY 2010-2011
Adjacent to Rob Roy Well 12

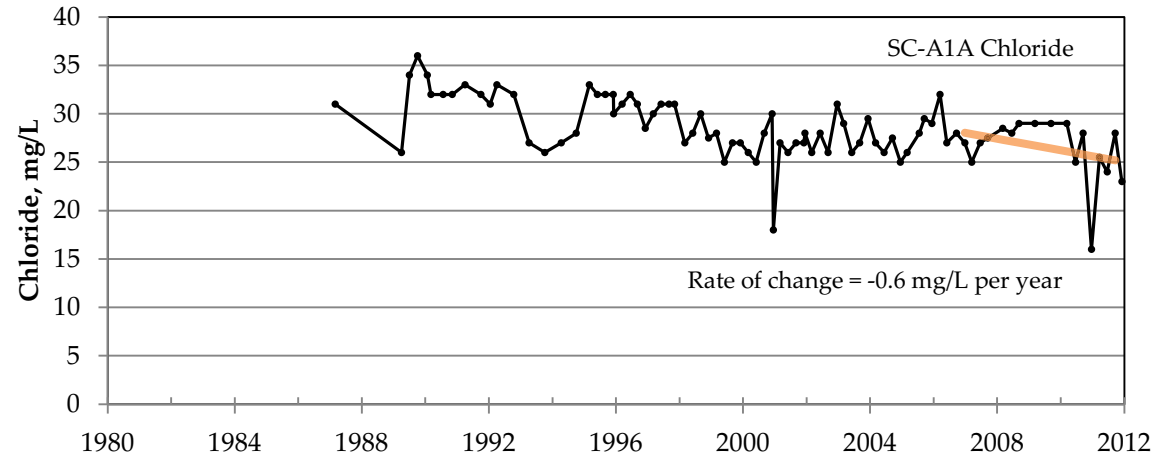

Groundwater Elevation, feet MSL
100
90
80
70
60
50
40
30
20
10
0
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
Calendar Year
Black monitoring well

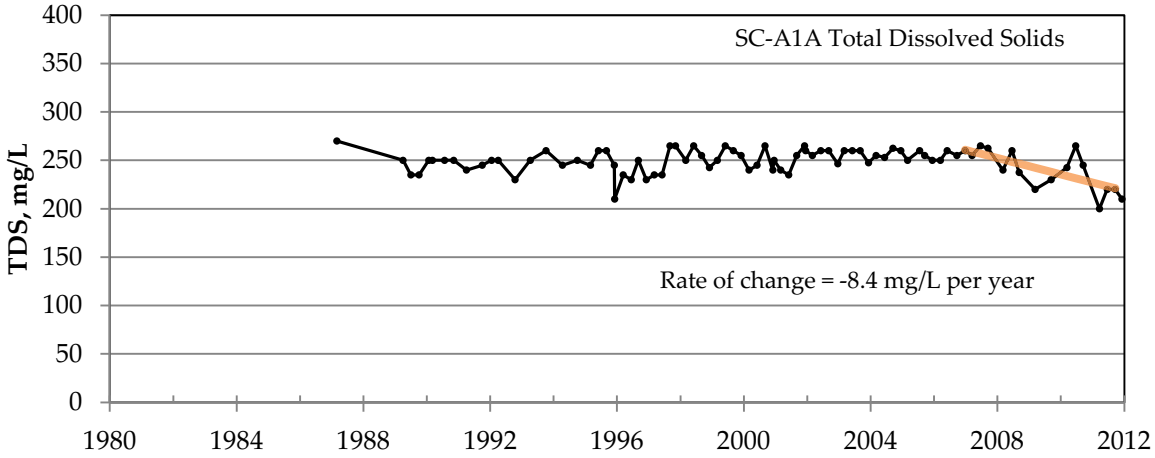
Chemographs and Single Well Hydrographs for Aromas Area

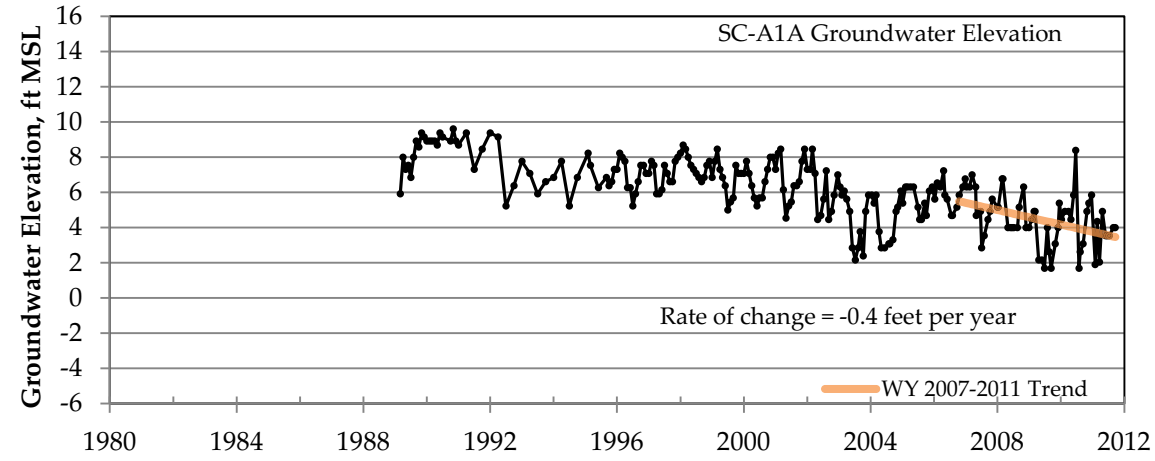
Graphs of SqCWD Coastal Monitoring Well Clusters

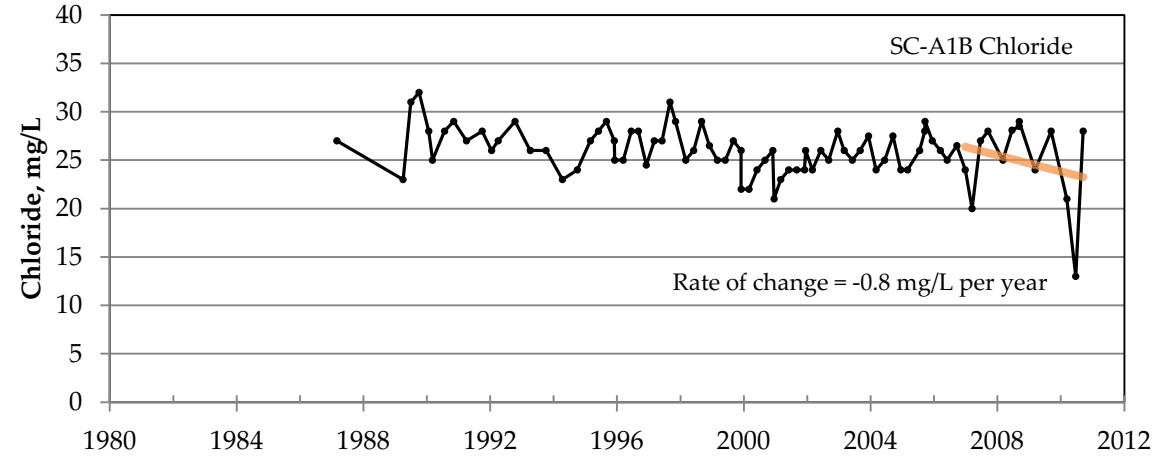
Graphs of SqCWD Production Wells and Adjacent Monitoring Wells

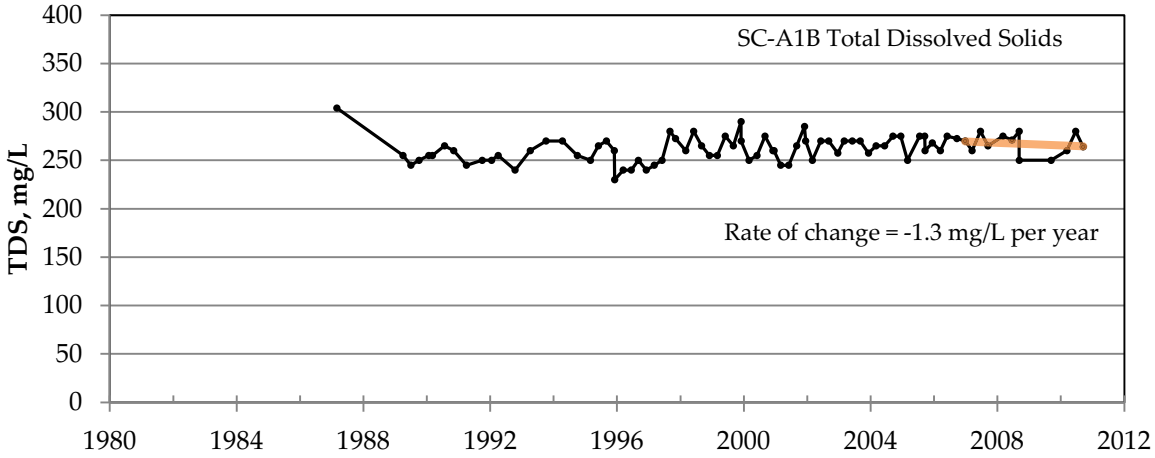
Graphs of CWD Production Wells and Monitoring Wells

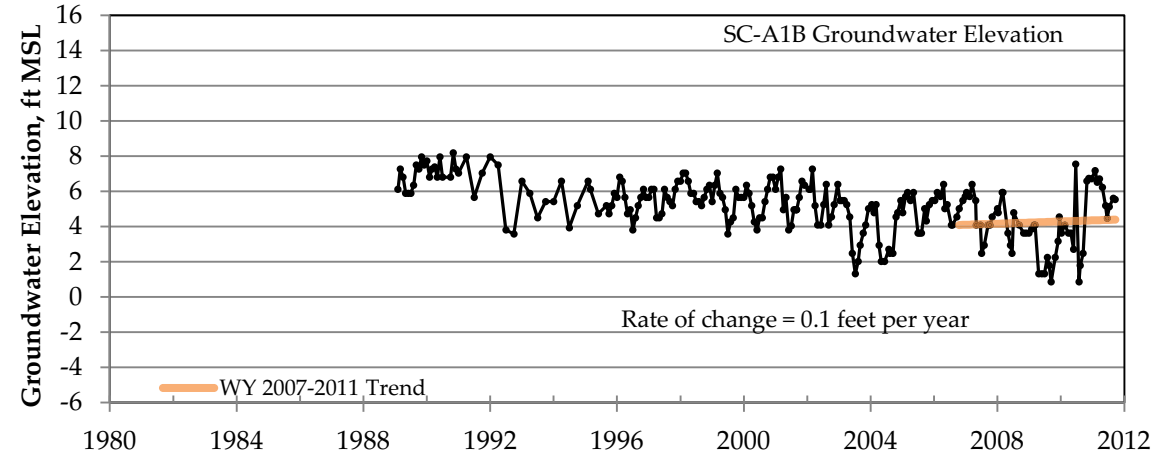

SC-A1A Chloride
Chloride, mg/L
Rate of change = -0.6 mg/L per year
40
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

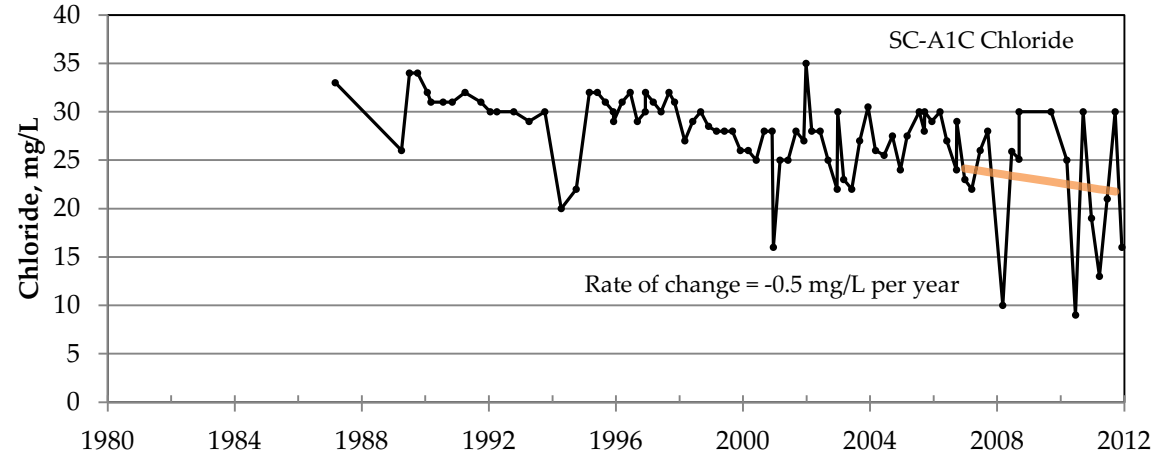

SC-A1A Total Dissolved Solids
TDS, mg/L
Rate of change = -8.4 mg/L per year
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

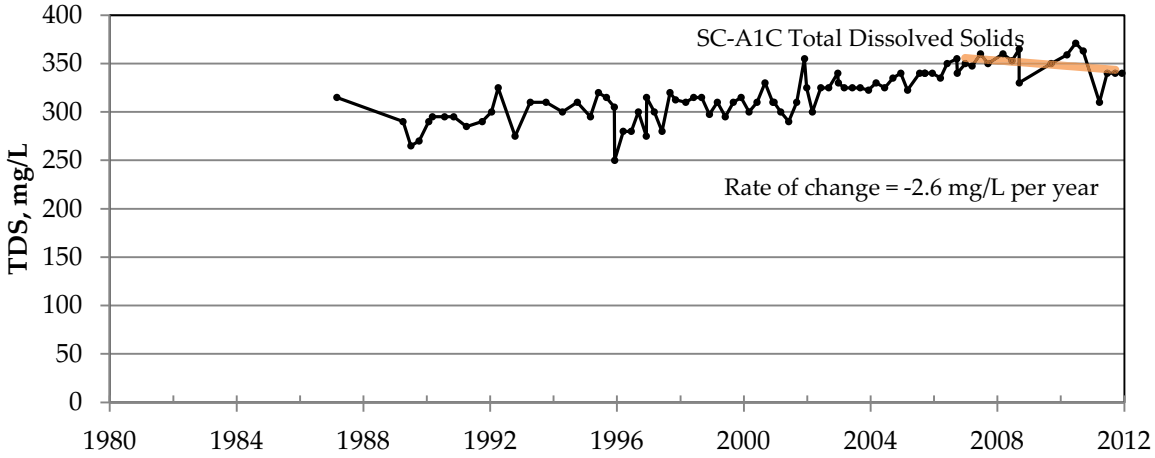

SC-A1A Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = -0.4 feet per year
WY 2007-2011 Trend
16
14
12
10
8
6
4
2
0
-2
-4
-6
1980
1984
1988
1992
1996
2000
2004
2008
2012

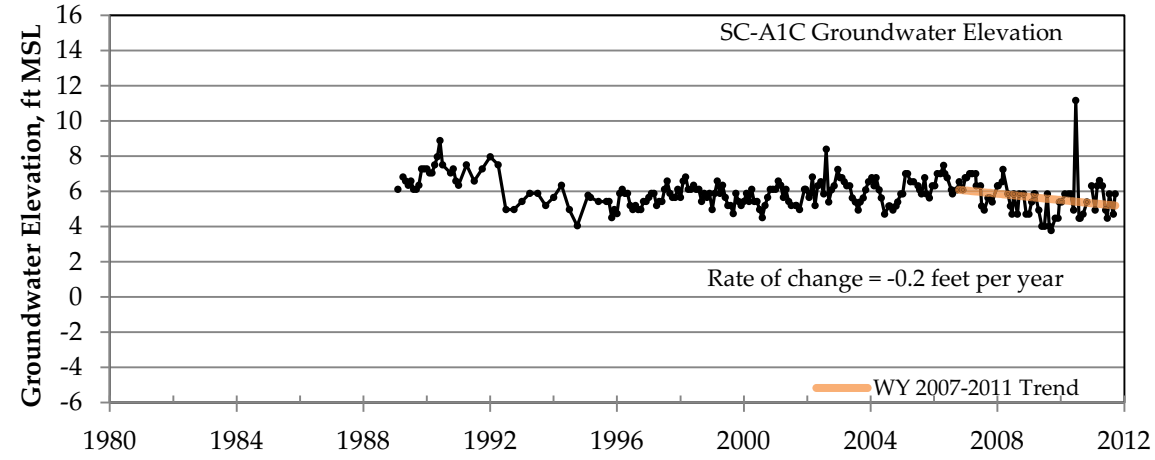

SC-A1B Chloride
Chloride, mg/L
Rate of change = -0.8 mg/L per year
40
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

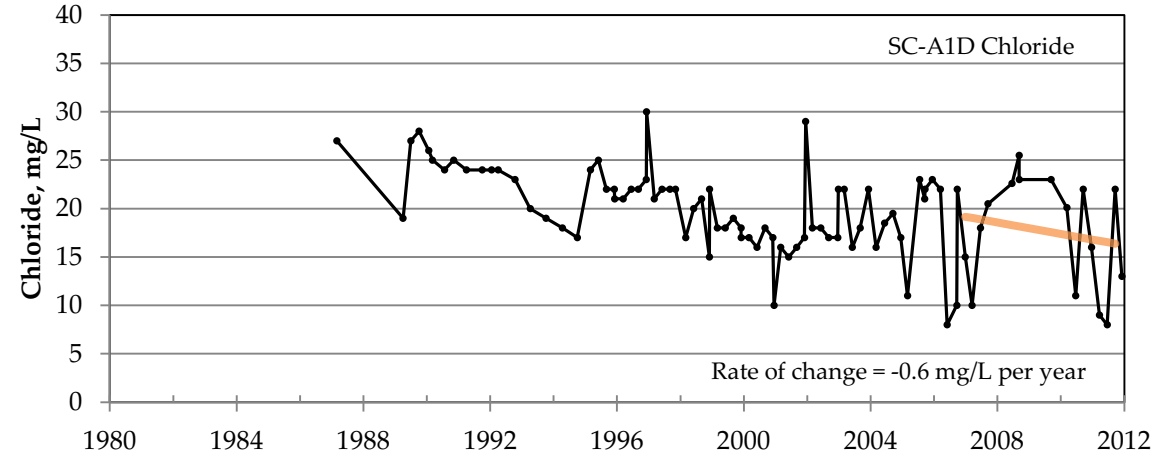

SC-A1B Total Dissolved Solids
TDS, mg/L
Rate of change = -1.3 mg/L per year
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

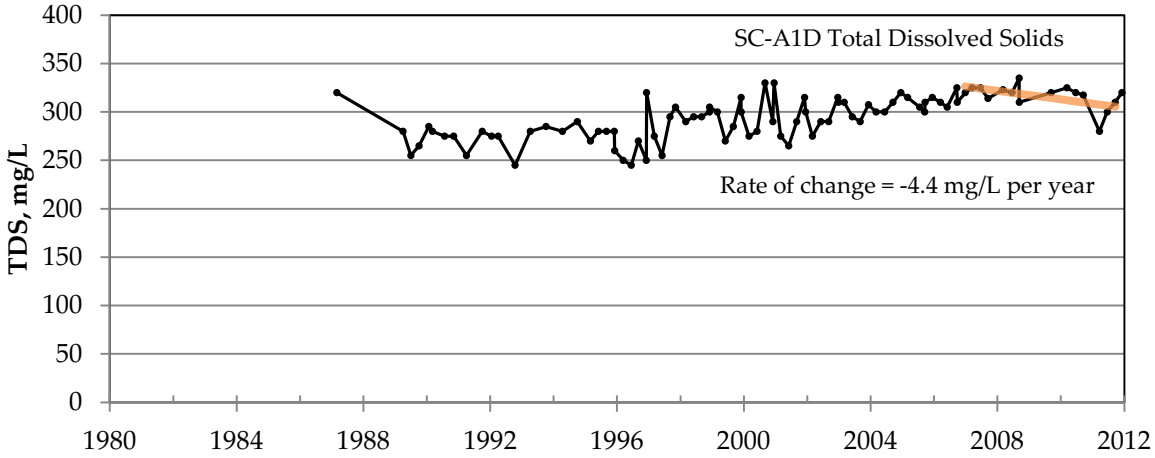

SC-A1B Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = 0.1 feet per year
WY 2007-2011 Trend
16
14
12
10
8
6
4
2
0
-2
-4
-6
1980
1984
1988
1992
1996
2000
2004
2008
2012

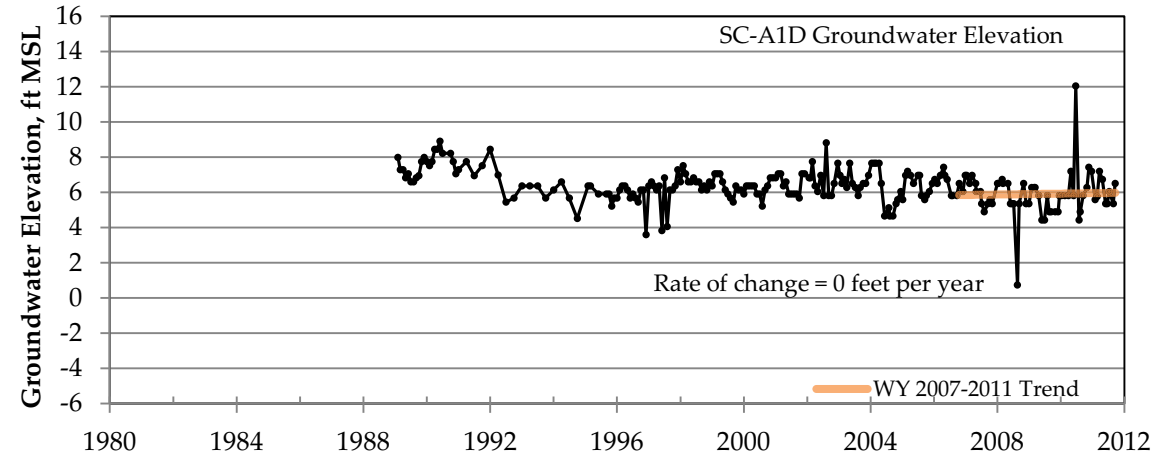

SC-A1C Chloride
Chloride, mg/L
Rate of change = -0.5 mg/L per year
40
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

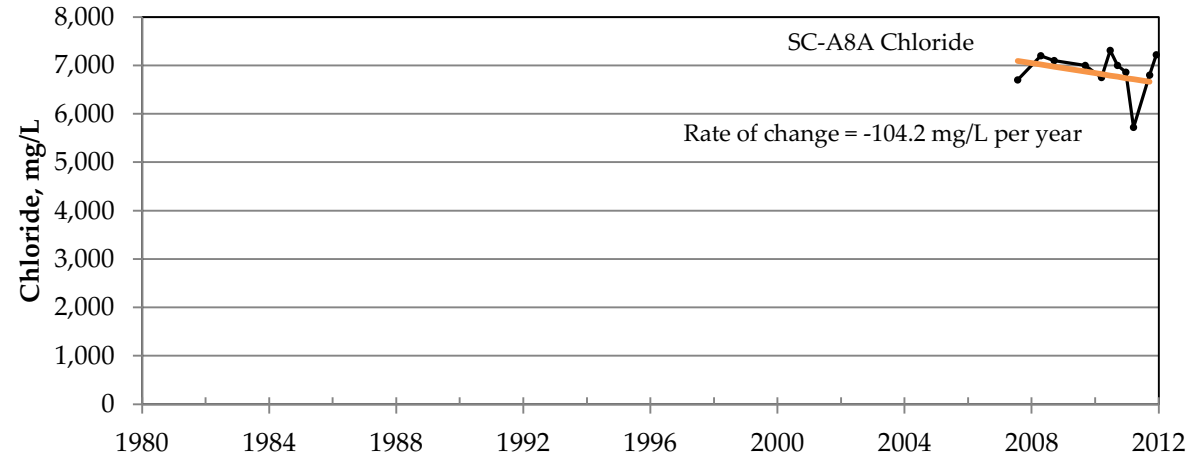

SC-A1C Total Dissolved Solids
TDS, mg/L
Rate of change = -2.6 mg/L per year
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

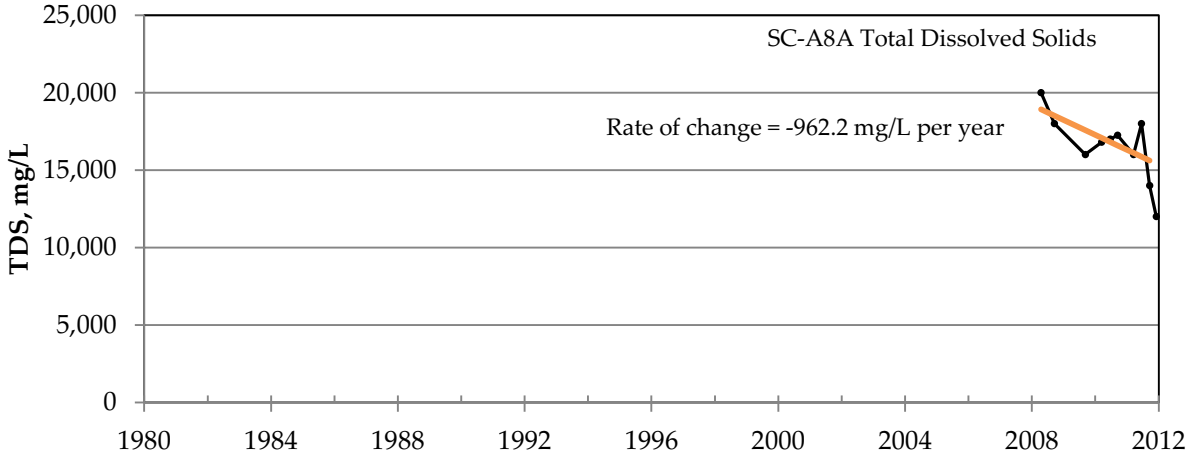

SC-A1C Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = -0.2 feet per year
WY 2007-2011 Trend
16
14
12
10
8
6
4
2
0
-2
-4
-6
1980
1984
1988
1992
1996
2000
2004
2008
2012

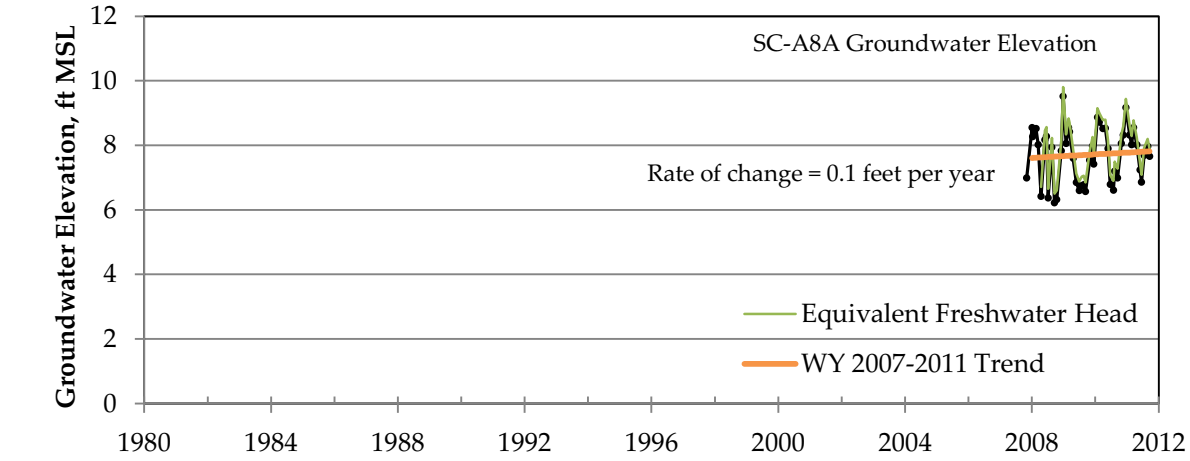

SC-A1D Chloride
Chloride, mg/L
Rate of change = -0.6 mg/L per year
40
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

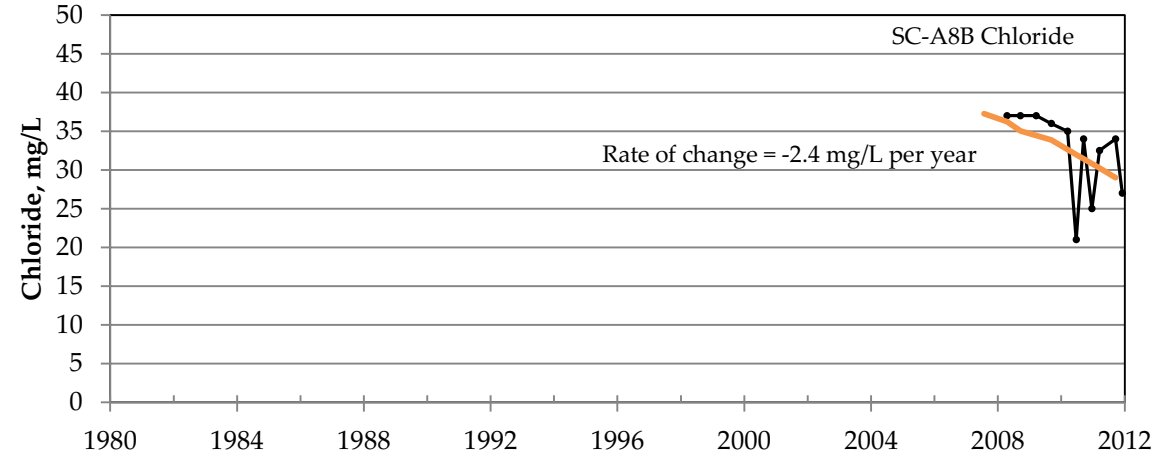

SC-A1D Total Dissolved Solids
TDS, mg/L
Rate of change = -4.4 mg/L per year
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

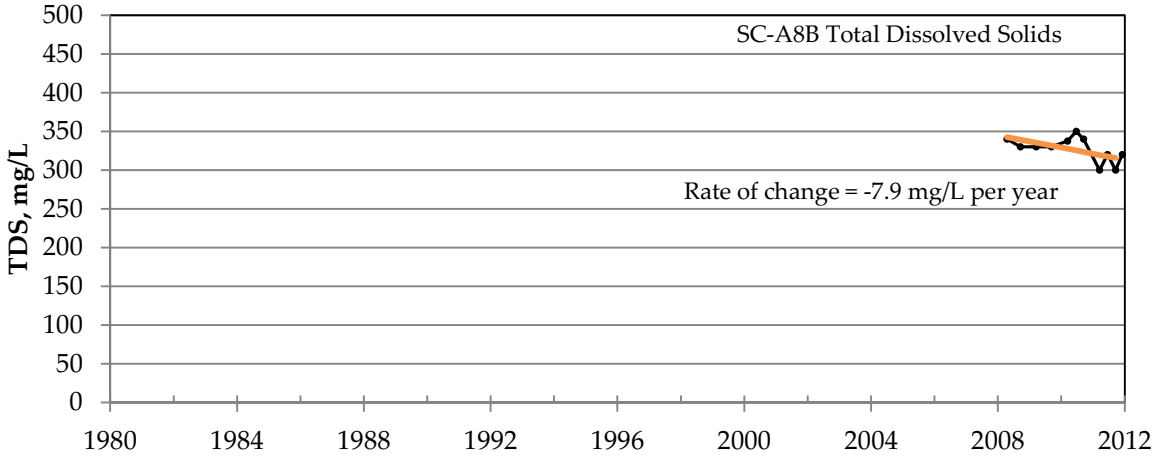

SC-A1D Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = 0 feet per year
WY 2007-2011 Trend
16
14
12
10
8
6
4
2
0
-2
-4
-6
1980
1984
1988
1992
1996
2000
2004
2008
2012

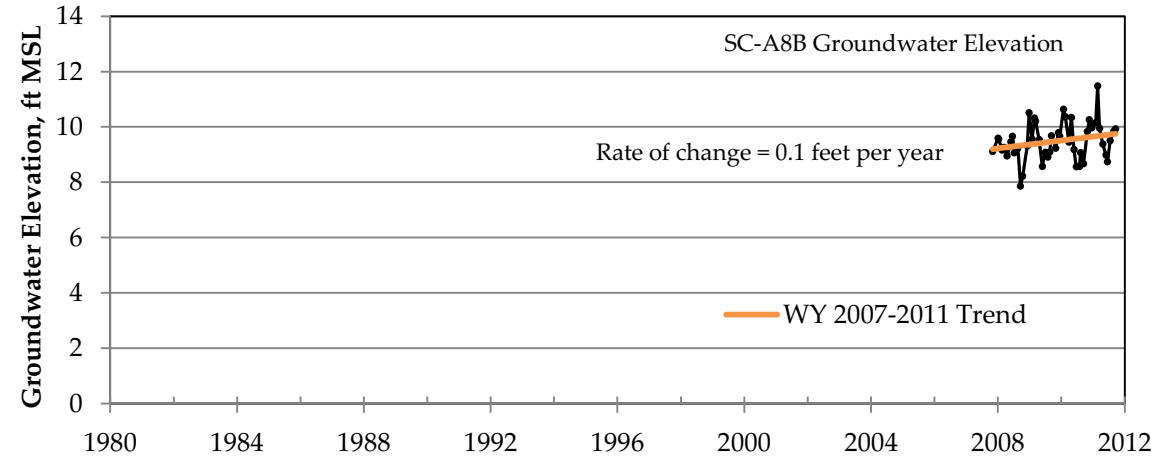

SC-A8A Chloride
Rate of change = -104.2 mg/L per year
Chloride, mg/L
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

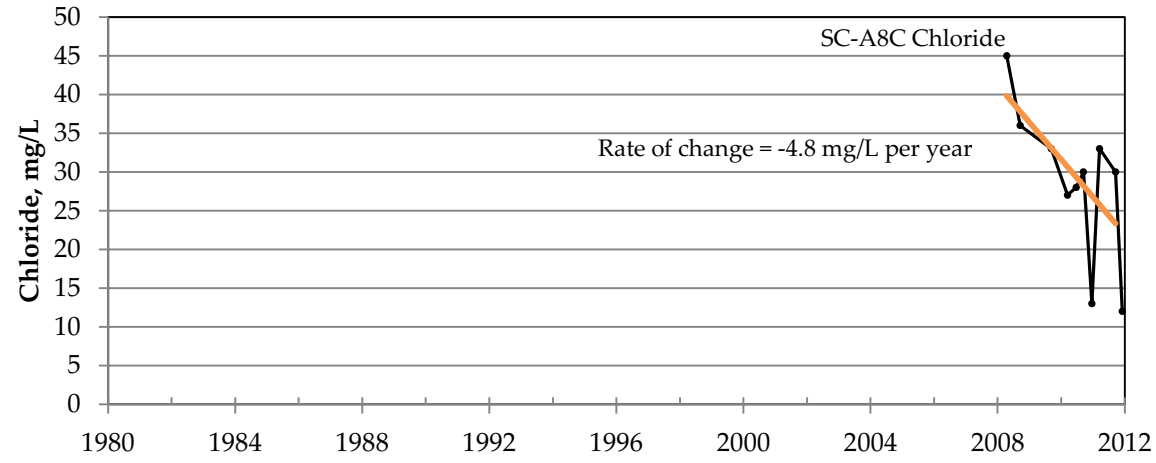

SC-A8A Total Dissolved Solids
Rate of change = -962.2 mg/L per year
TDS, mg/L
25,000
20,000
15,000
10,000
5,000
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

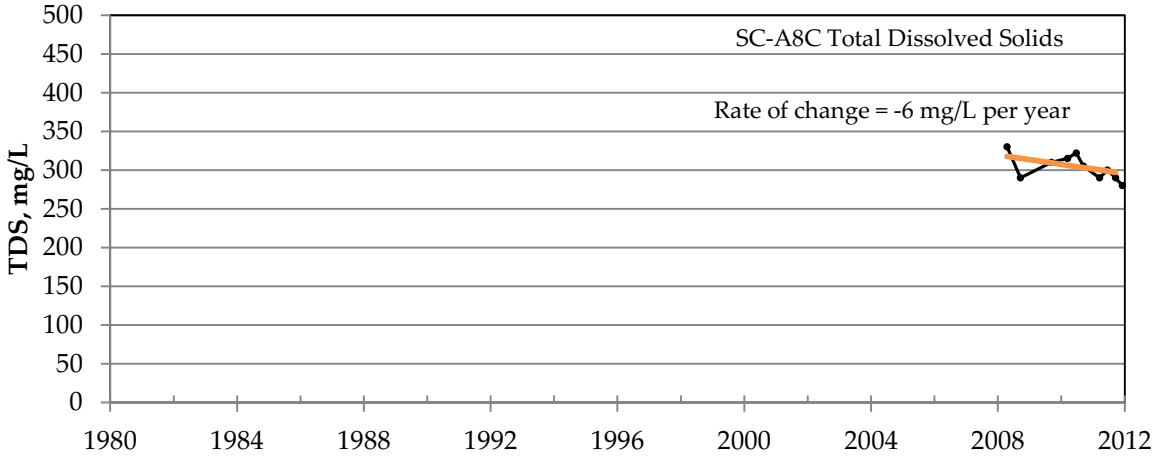

SC-A8A Groundwater Elevation
Rate of change = 0.1 feet per year
Groundwater Elevation, ft MSL
12
10
8
6
4
2
0
Equivalent Freshwater Head
WY 2007-2011 Trend
1980
1984
1988
1992
1996
2000
2004
2008
2012

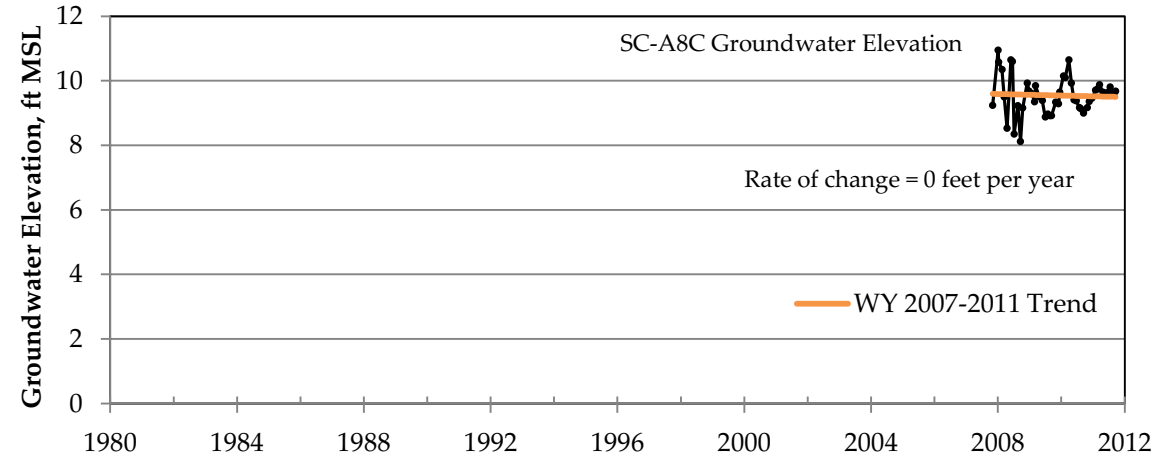

SC-A8B Chloride
Rate of change = -2.4 mg/L per year
Chloride, mg/L
50
45
40
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

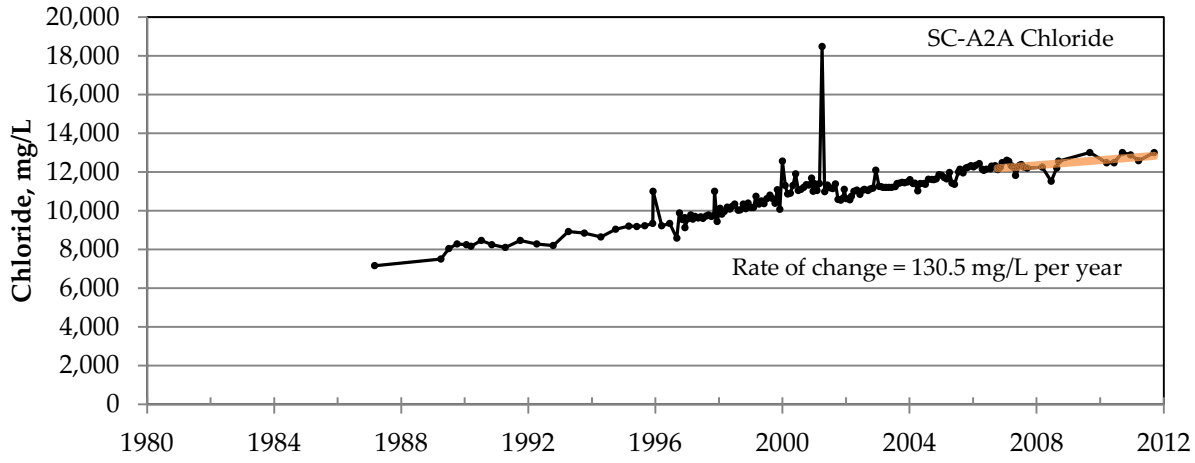

SC-A8B Total Dissolved Solids
Rate of change = -7.9 mg/L per year
TDS, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

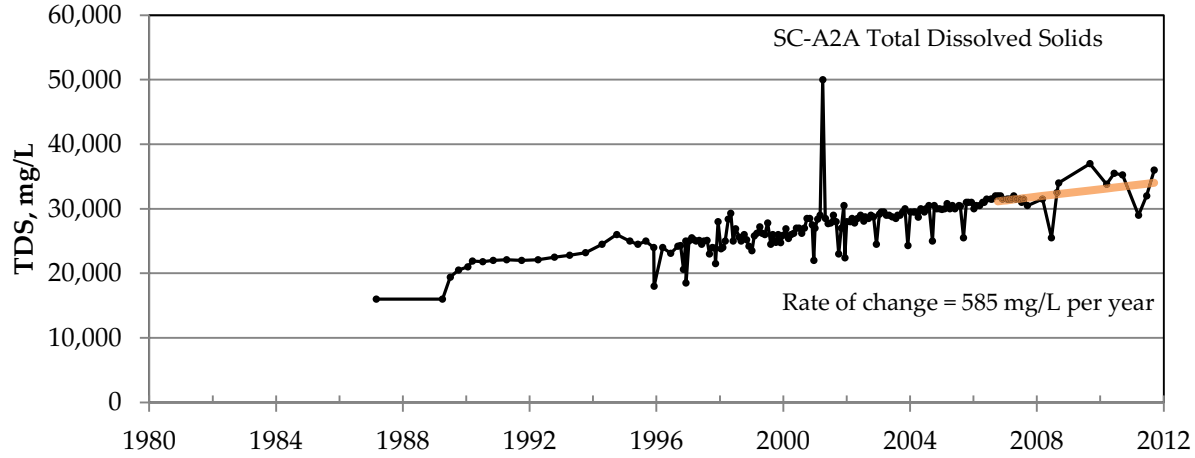

SC-A8B Groundwater Elevation
Rate of change = 0.1 feet per year
WY 2007-2011 Trend
Groundwater Elevation, ft MSL
14
12
10
8
6
4
2
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

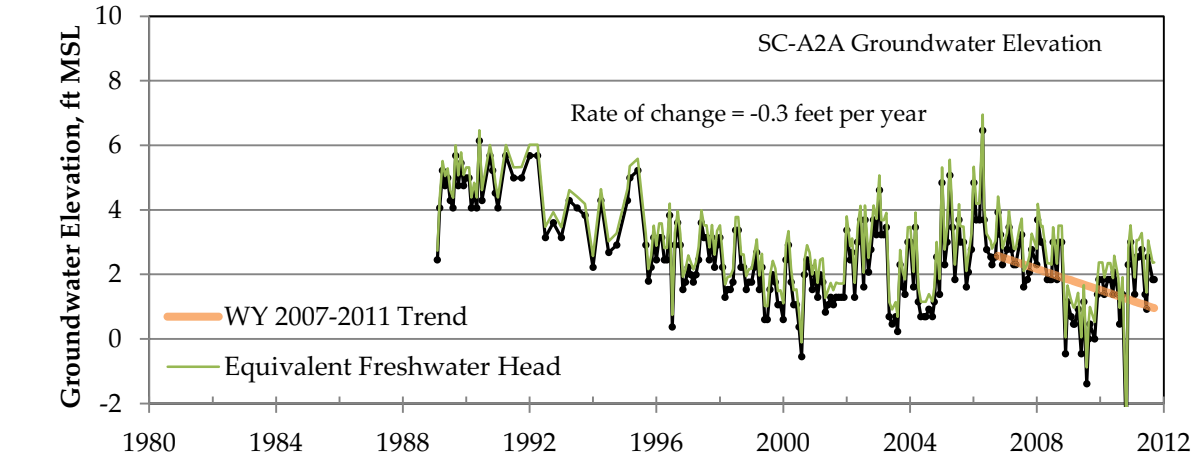

SC-A8C Chloride
Rate of change = -4.8 mg/L per year
Chloride, mg/L
50
45
40
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

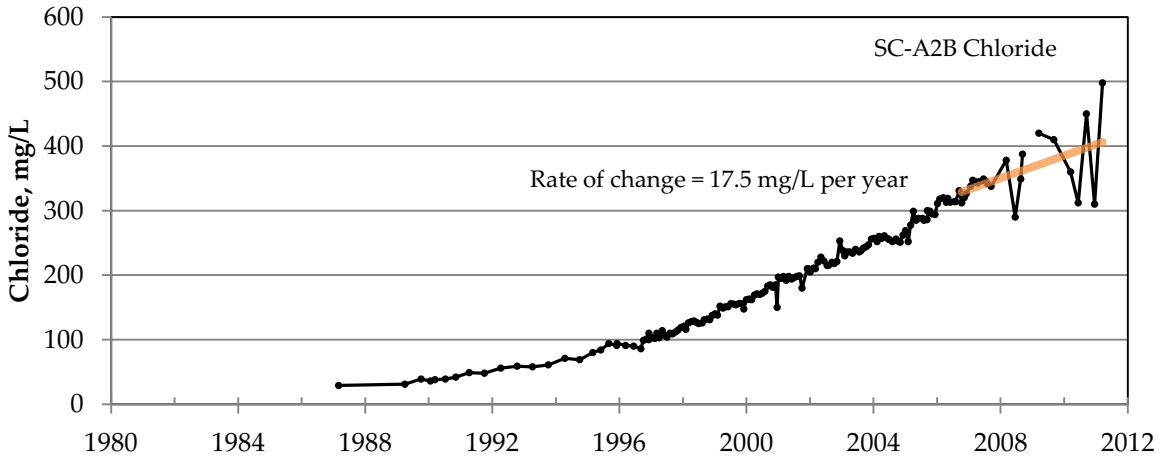

SC-A8C Total Dissolved Solids
Rate of change = -6 mg/L per year
TDS, mg/L
500
450
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

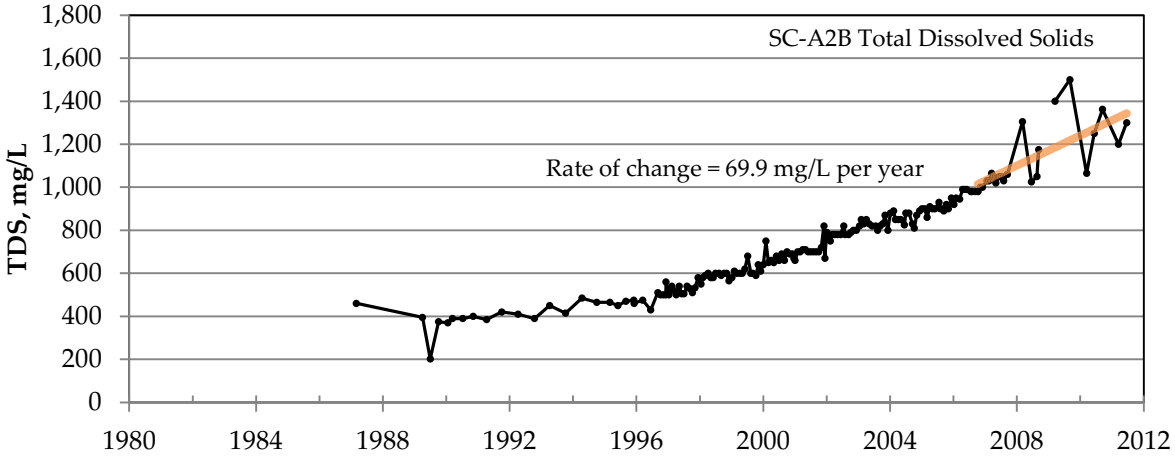

SC-A8C Groundwater Elevation
Rate of change = 0 feet per year
WY 2007-2011 Trend
Groundwater Elevation, ft MSL
12
10
8
6
4
2
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

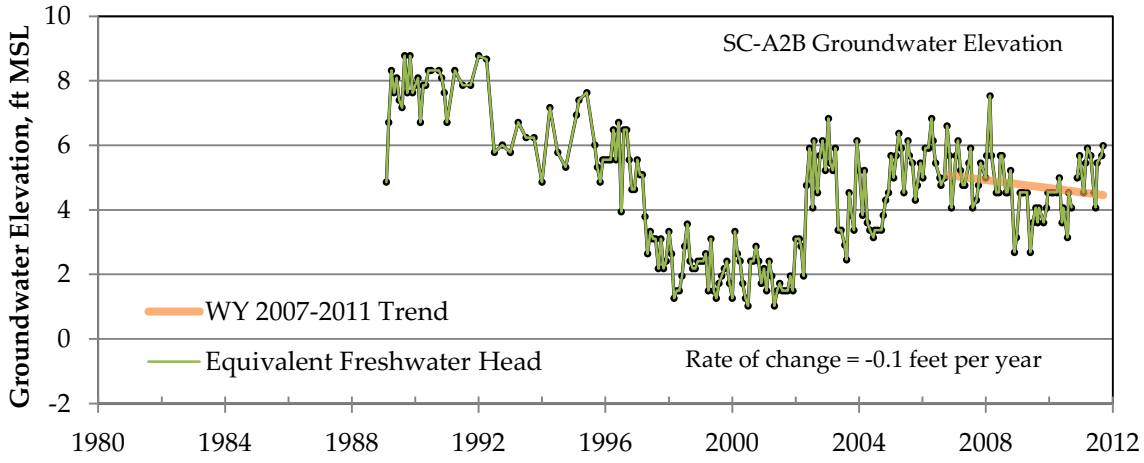

SC-A2A Chloride
Chloride, mg/L
Rate of change = 130.5 mg/L per year
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

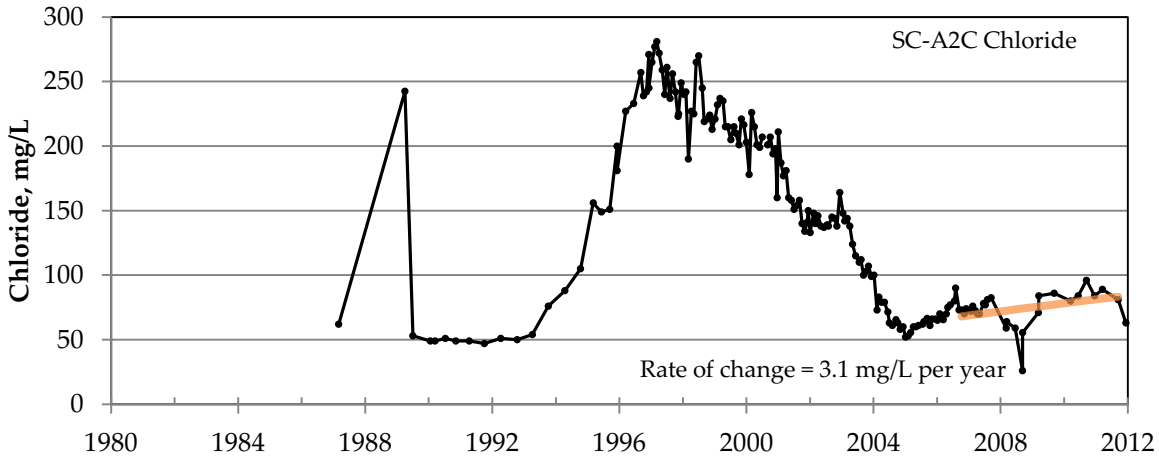

SC-A2A Total Dissolved Solids
TDS, mg/L
Rate of change = 585 mg/L per year
60,000
50,000
40,000
30,000
20,000
10,000
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

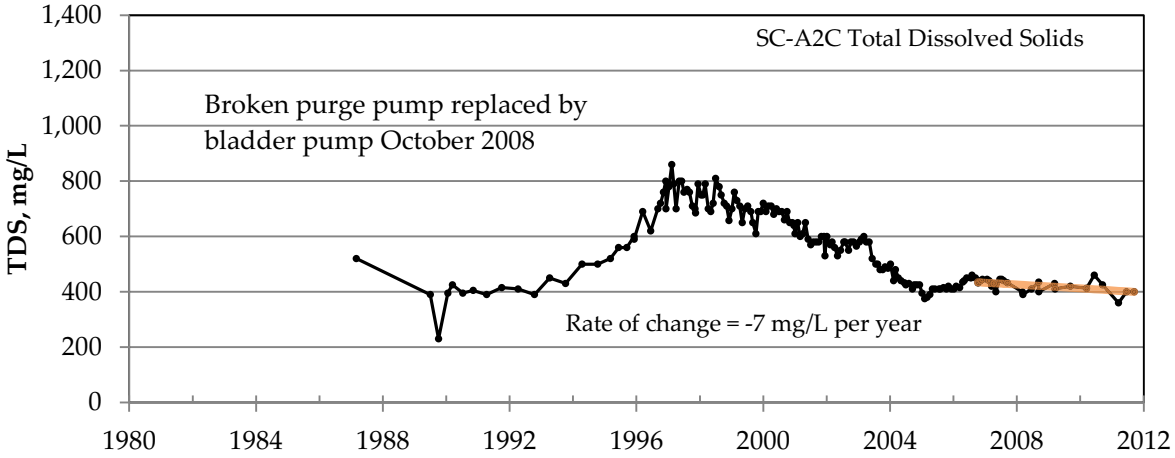

SC-A2A Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = -0.3 feet per year
WY 2007-2011 Trend
Equivalent Freshwater Head
10
8
6
4
2
0
-2
1980
1984
1988
1992
1996
2000
2004
2008
2012

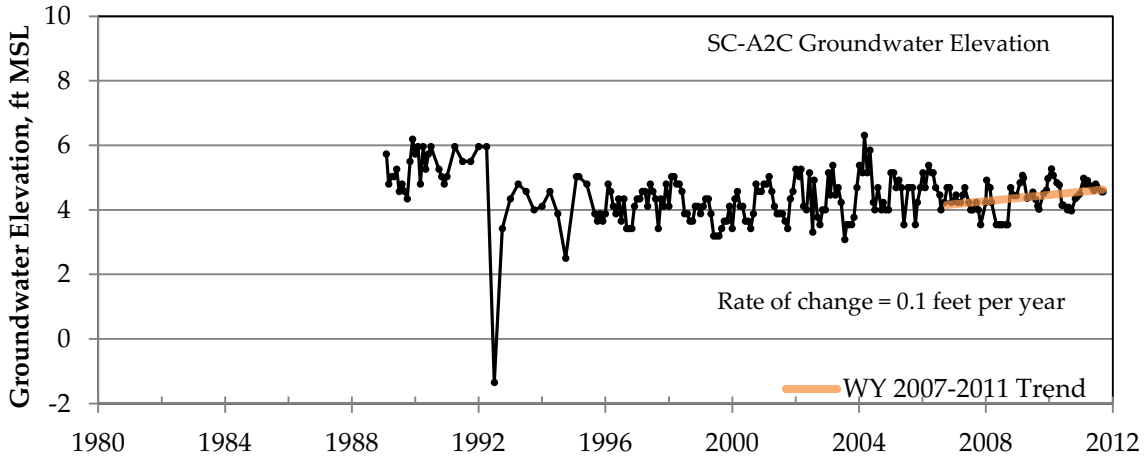

SC-A2B Chloride
Rate of change = 17.5 mg/L per year
Chloride, mg/L
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

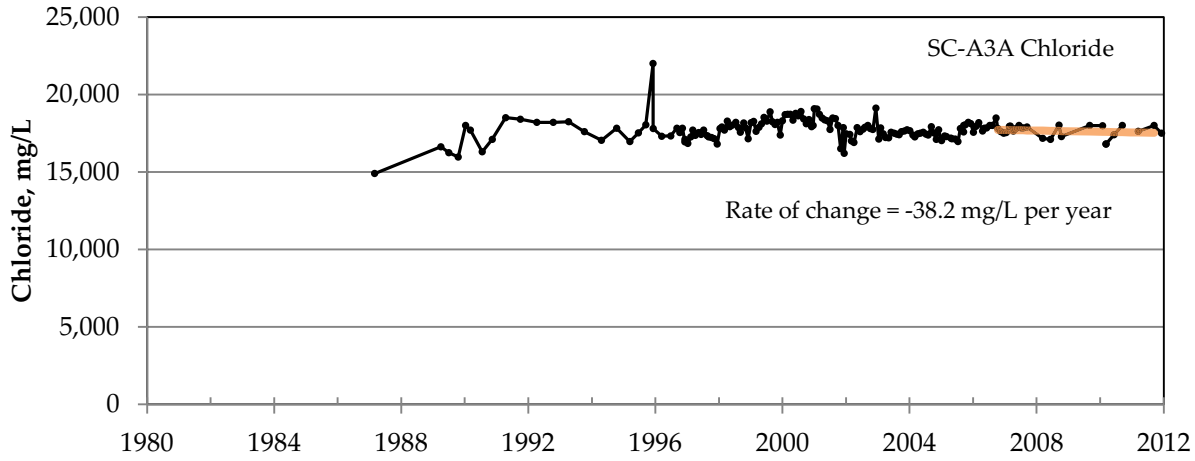

SC-A2B Total Dissolved Solids
Rate of change = 69.9 mg/L per year
TDS, mg/L
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

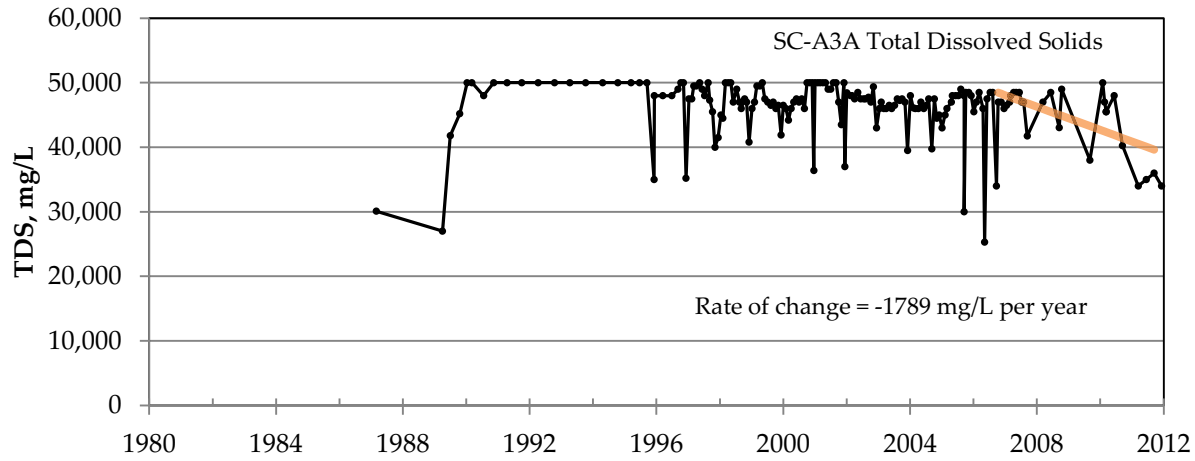

SC-A2B Groundwater Elevation
WY 2007-2011 Trend
Equivalent Freshwater Head
Rate of change = -0.1 feet per year
Groundwater Elevation, ft MSL
10
8
6
4
2
0
-2
1980
1984
1988
1992
1996
2000
2004
2008
2012

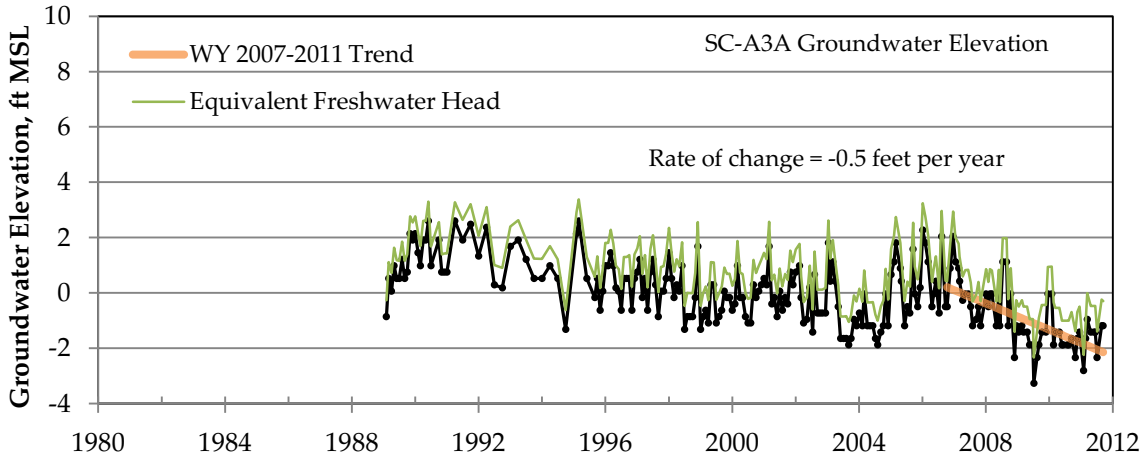

SC-A2C Chloride
Chloride, mg/L
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012
Rate of change = 3.1 mg/L per year

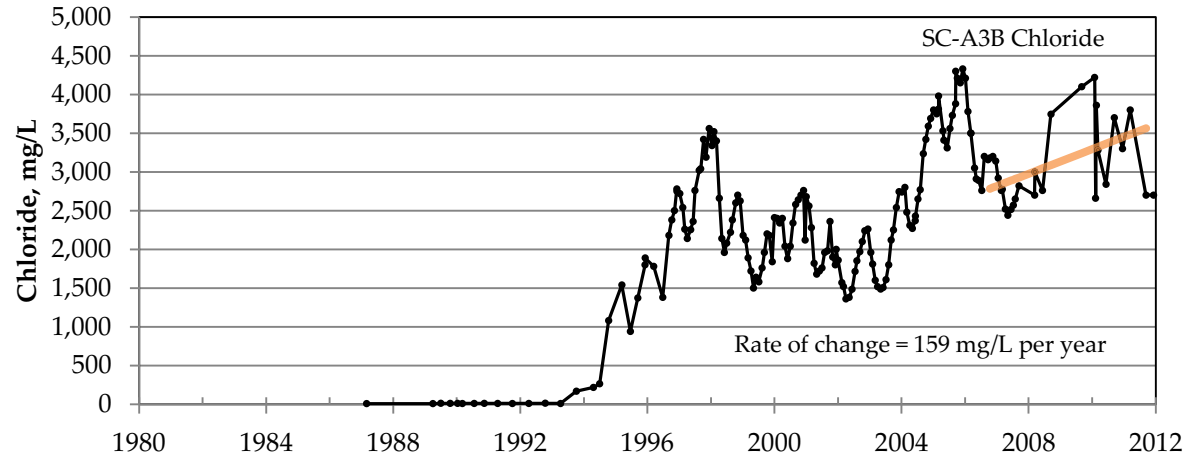

SC-A2C Total Dissolved Solids
TDS, mg/L
1,400
1,200
1,000
800
600
400
200
0
1980
1984
1988
1992
1996
2000
2004
2008
2012
Broken purge pump replaced by
bladder pump October 2008
Rate of change = -7 mg/L per year

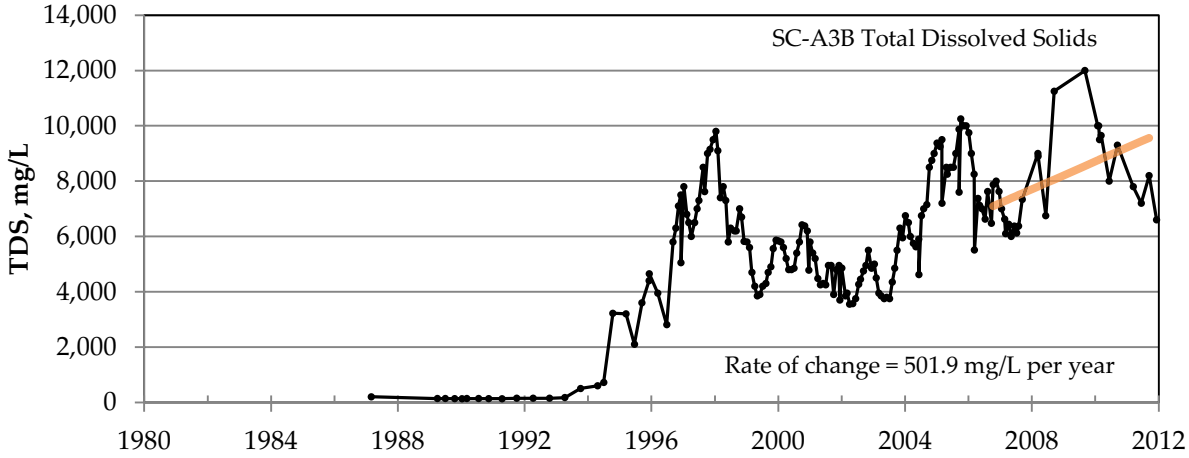

SC-A2C Groundwater Elevation
Groundwater Elevation, ft MSL
10
8
6
4
2
0
-2
1980
1984
1988
1992
1996
2000
2004
2008
2012
Rate of change = 0.1 feet per year
WY 2007-2011 Trend

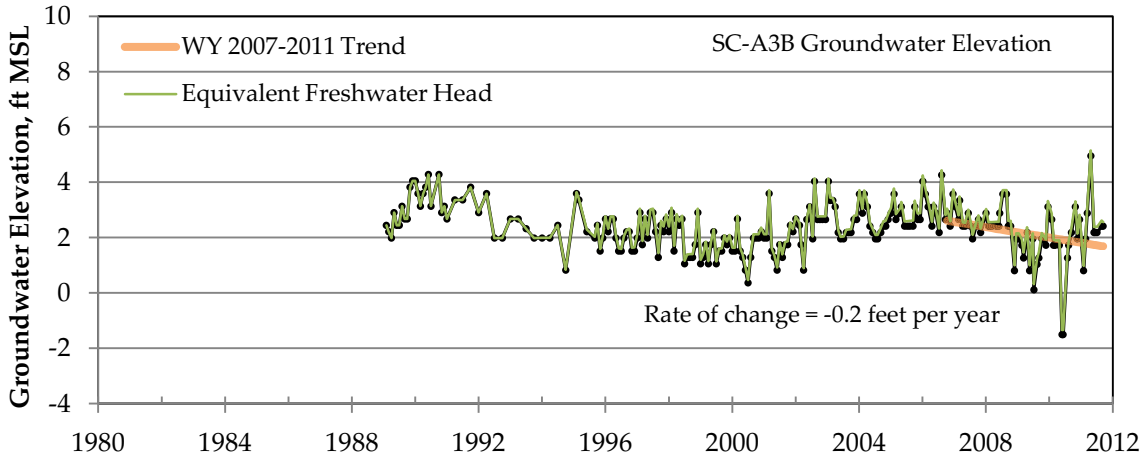

SC-A3A Chloride
Chloride, mg/L
25,000
20,000
15,000
10,000
5,000
0
Rate of change = -38.2 mg/L per year
1980
1984
1988
1992
1996
2000
2004
2008
2012

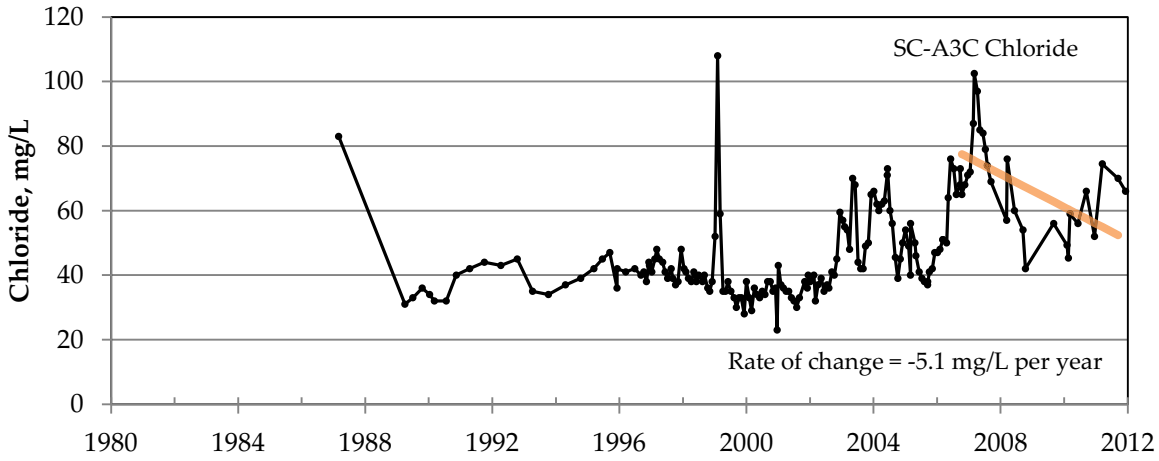

SC-A3A Total Dissolved Solids
TDS, mg/L
60,000
50,000
40,000
30,000
20,000
10,000
0
Rate of change = -1789 mg/L per year
1980
1984
1988
1992
1996
2000
2004
2008
2012

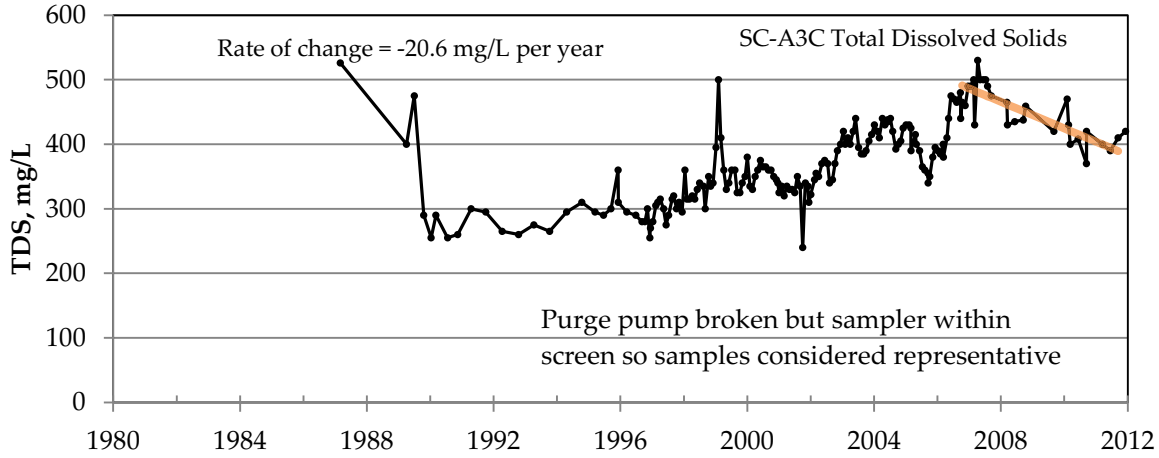

SC-A3A Groundwater Elevation
WY 2007-2011 Trend
Equivalent Freshwater Head
Groundwater Elevation, ft MSL
10
8
6
4
2
0
-2
-4
Rate of change = -0.5 feet per year
1980
1984
1988
1992
1996
2000
2004
2008
2012

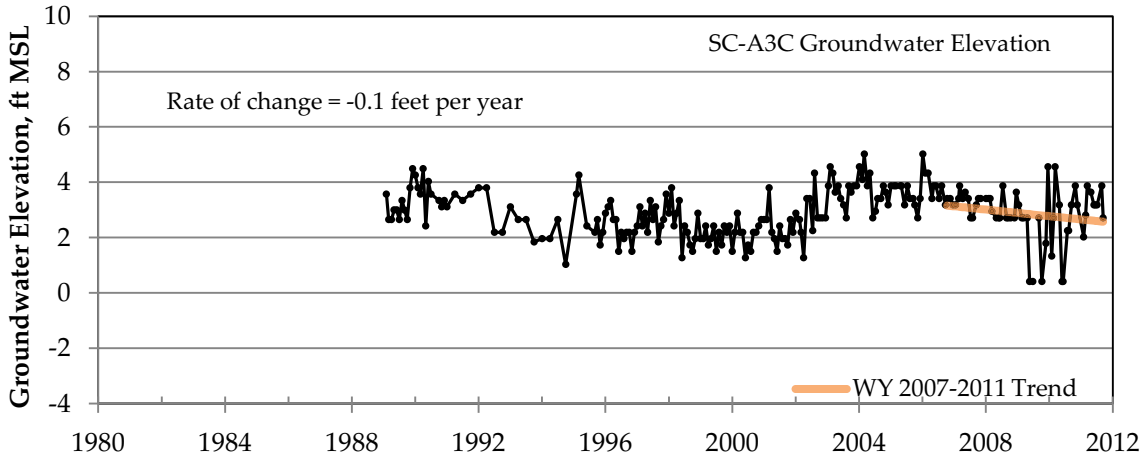

SC-A3B Chloride
Chloride, mg/L
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Rate of change = 159 mg/L per year
1980
1984
1988
1992
1996
2000
2004
2008
2012

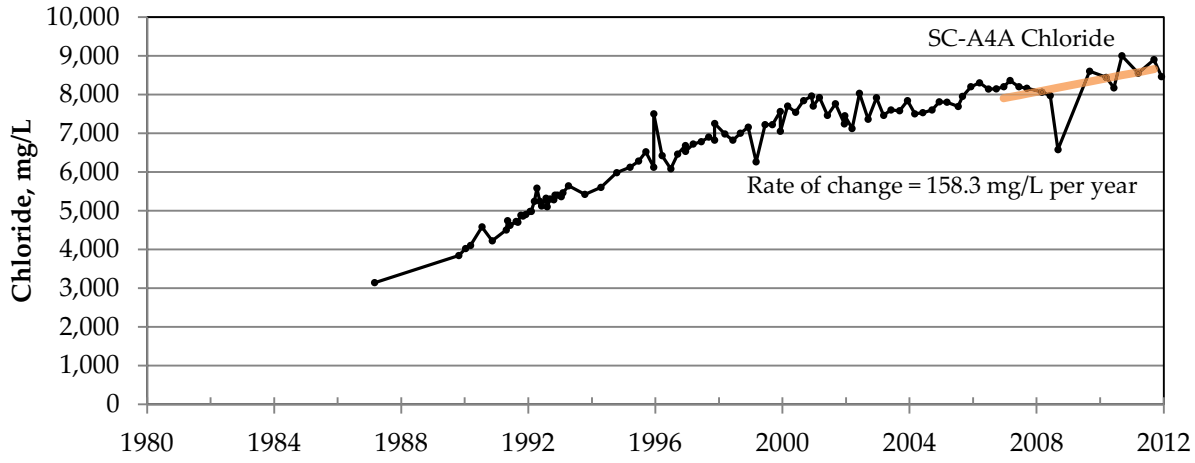

SC-A3B Total Dissolved Solids
TDS, mg/L
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Rate of change = 501.9 mg/L per year
1980
1984
1988
1992
1996
2000
2004
2008
2012

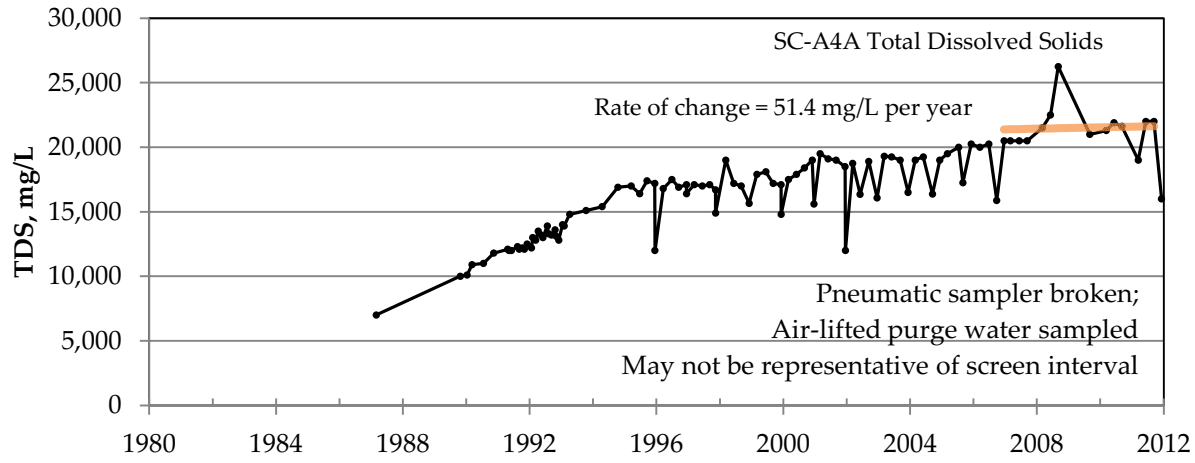

WY 2007-2011 Trend
Equivalent Freshwater Head
SC-A3B Groundwater Elevation
Groundwater Elevation, ft MSL
10
8
6
4
2
0
-2
-4
Rate of change = -0.2 feet per year
1980
1984
1988
1992
1996
2000
2004
2008
2012

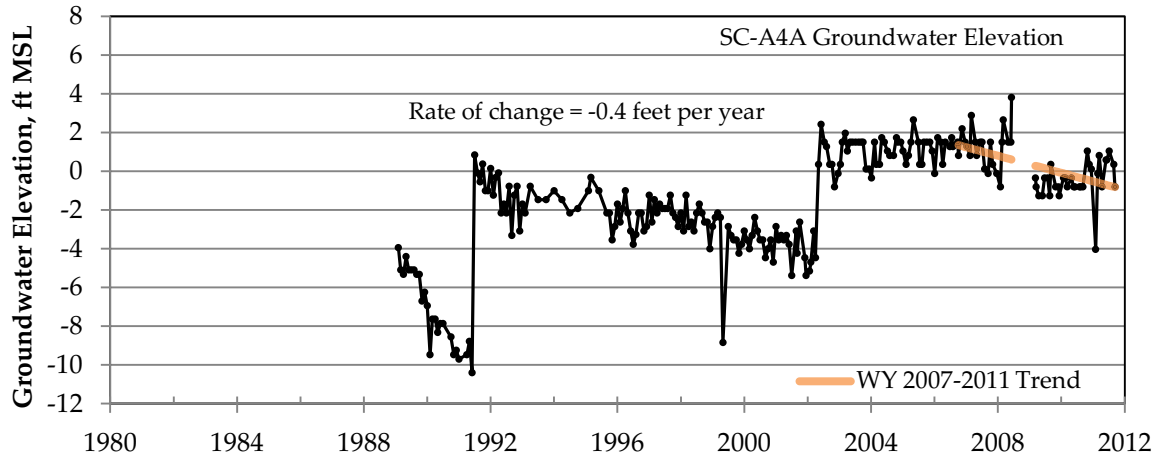

SC-A3C Chloride
Chloride, mg/L
Rate of change = -5.1 mg/L per year
120
100
80
60
40
20
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

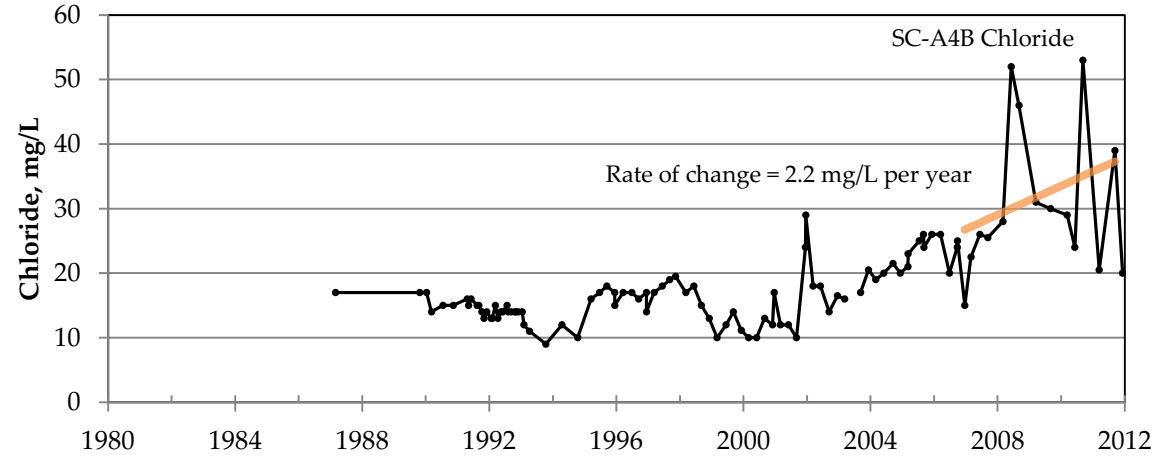

SC-A3C Total Dissolved Solids
Rate of change = -20.6 mg/L per year
TDS, mg/L
Purge pump broken but sampler within
screen so samples considered representative
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

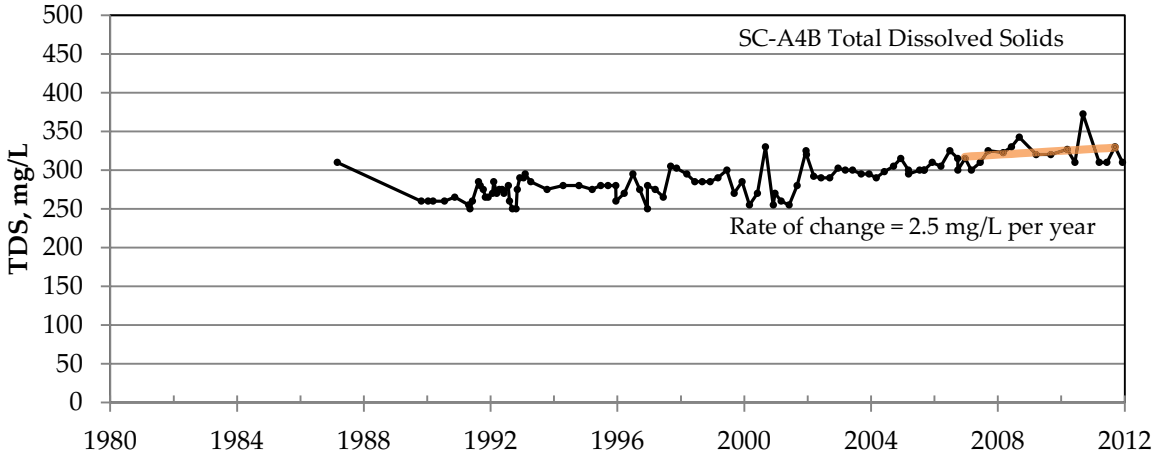

SC-A3C Groundwater Elevation
Rate of change = -0.1 feet per year
Groundwater Elevation, ft MSL
WY 2007-2011 Trend
10
8
6
4
2
0
-2
-4
1980
1984
1988
1992
1996
2000
2004
2008
2012

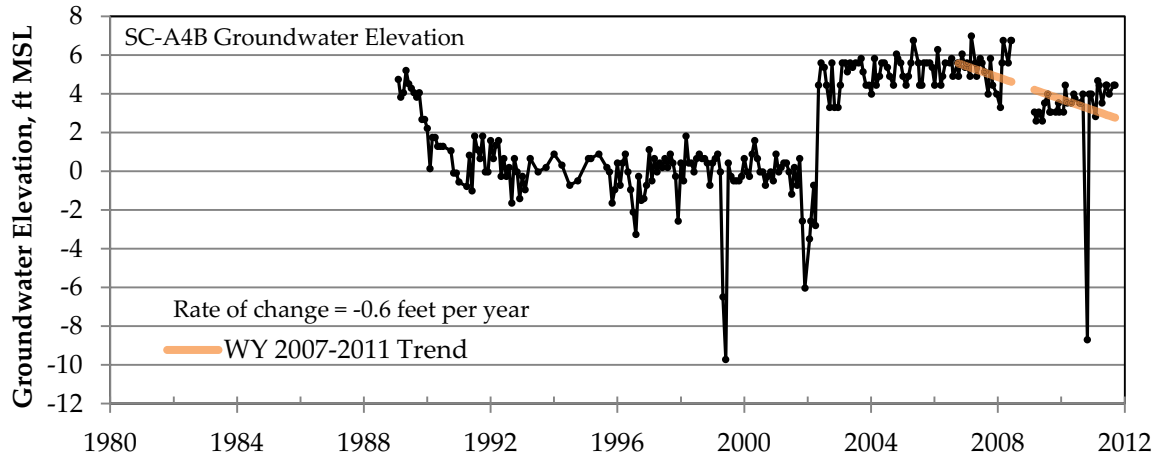

SC-A4A Chloride
Rate of change = 158.3 mg/L per year
Chloride, mg/L
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

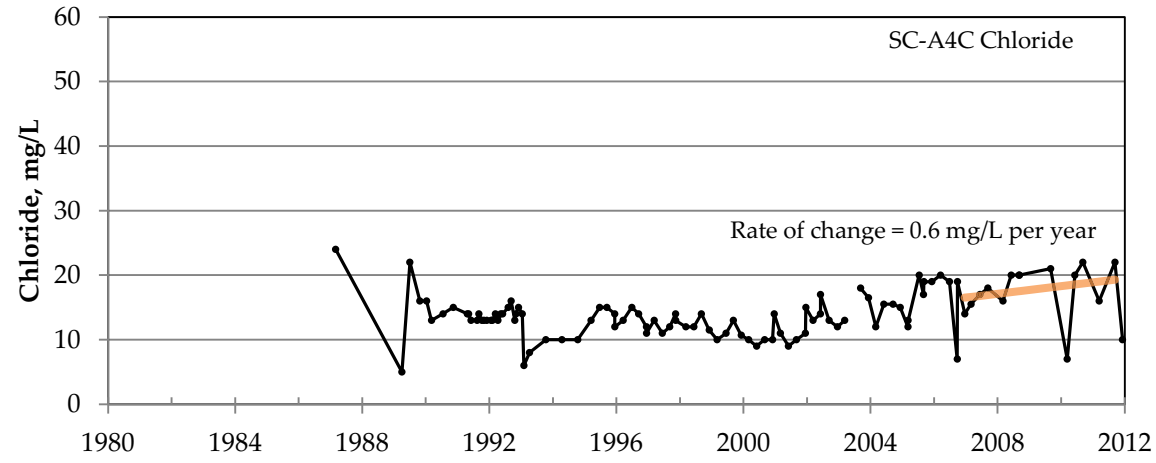

SC-A4A Total Dissolved Solids
Rate of change = 51.4 mg/L per year
Pneumatic sampler broken;
Air-lifted purge water sampled
May not be representative of screen interval
TDS, mg/L
30,000
25,000
20,000
15,000
10,000
5,000
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

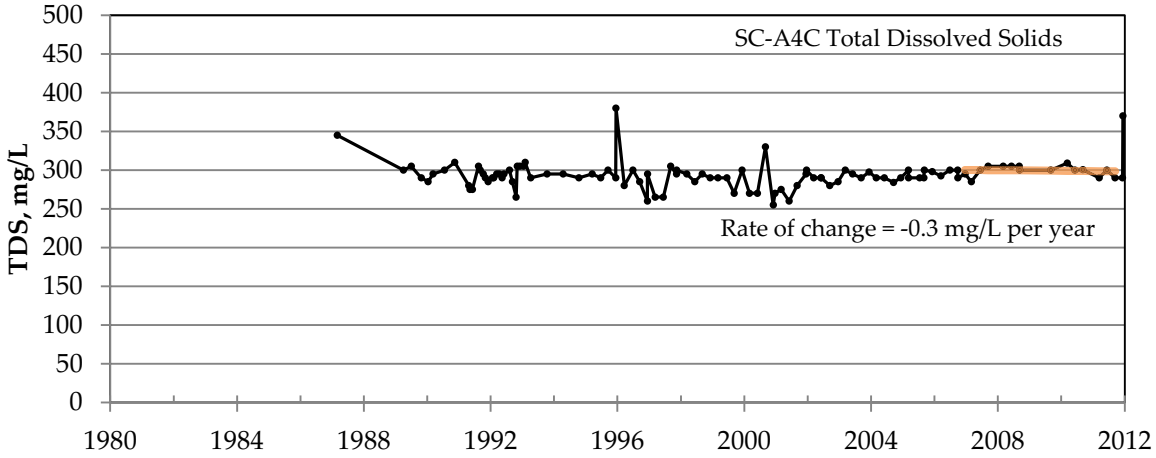

SC-A4A Groundwater Elevation
Rate of change = -0.4 feet per year
WY 2007-2011 Trend
Groundwater Elevation, ft MSL
8
6
4
2
0
-2
-4
-6
-8
-10
-12
1980
1984
1988
1992
1996
2000
2004
2008
2012

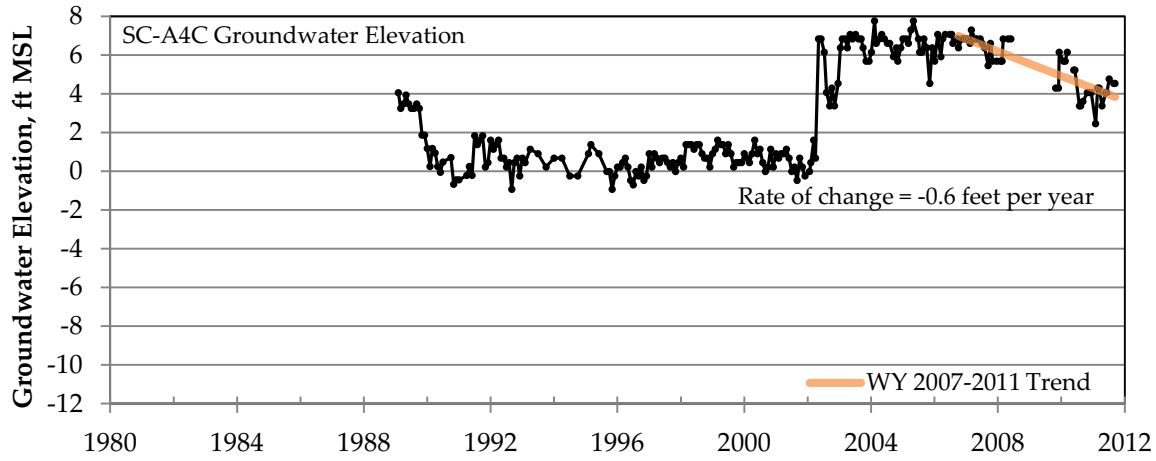

SC-A4B Chloride
Chloride, mg/L
Rate of change = 2.2 mg/L per year
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

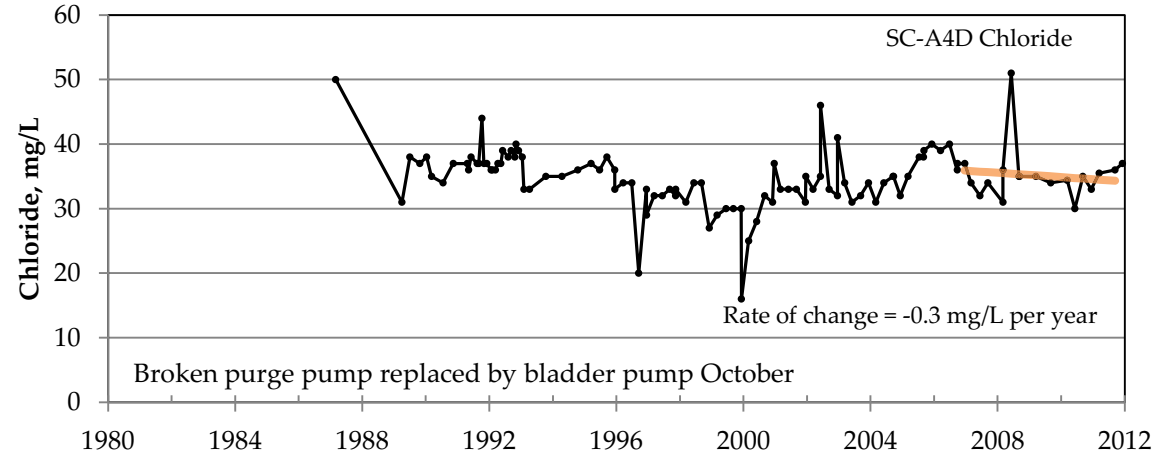

SC-A4B Total Dissolved Solids
TDS, mg/L
Rate of change = 2.5 mg/L per year
500
450
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

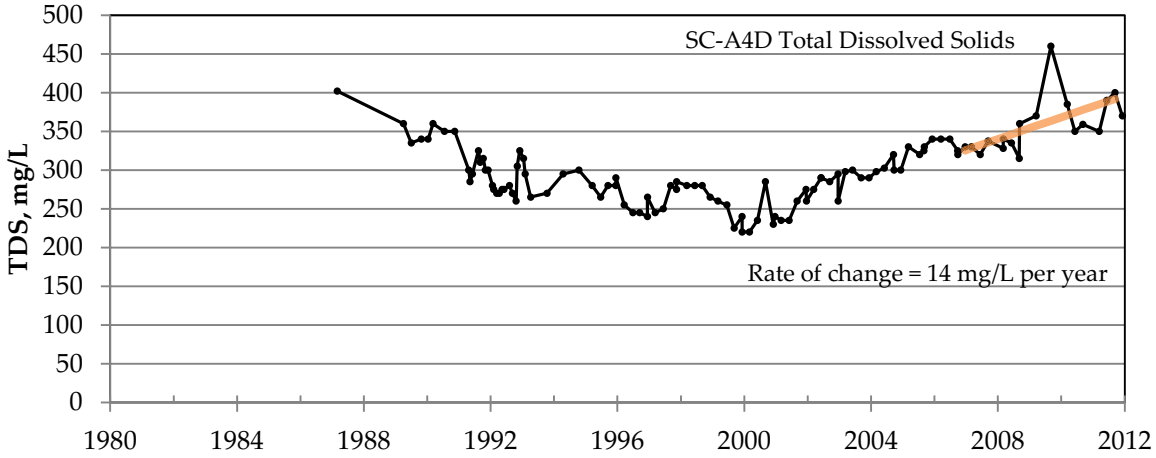

SC-A4B Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = -0.6 feet per year
WY 2007-2011 Trend
8
6
4
2
0
-2
-4
-6
-8
-10
-12
1980
1984
1988
1992
1996
2000
2004
2008
2012

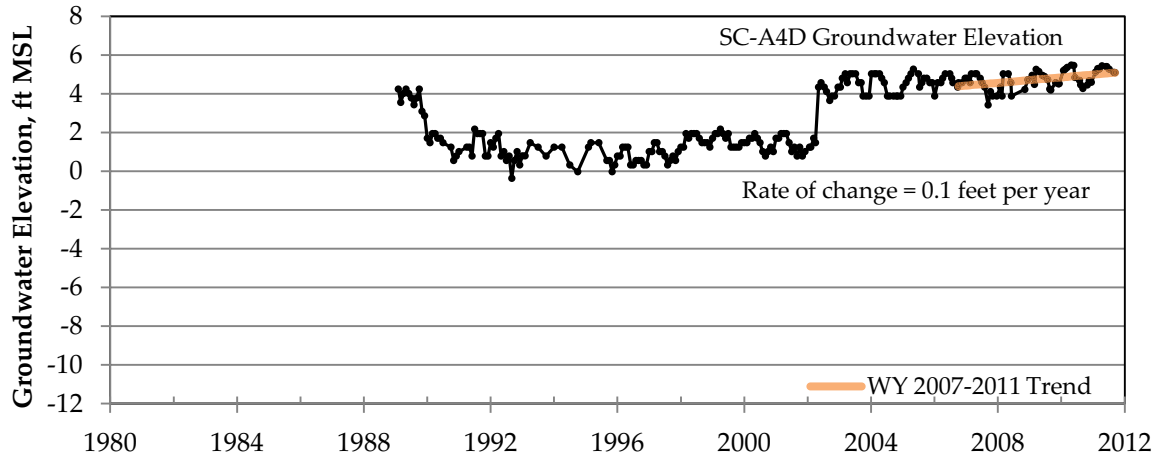

SC-A4C Chloride
Chloride, mg/L
Rate of change = 0.6 mg/L per year
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

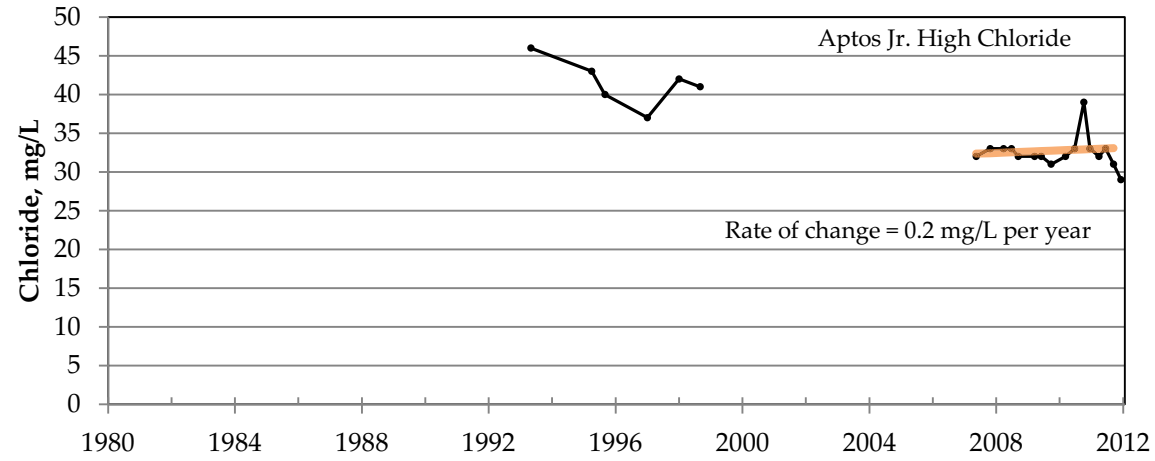

SC-A4C Total Dissolved Solids
TDS, mg/L
Rate of change = -0.3 mg/L per year
500
450
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

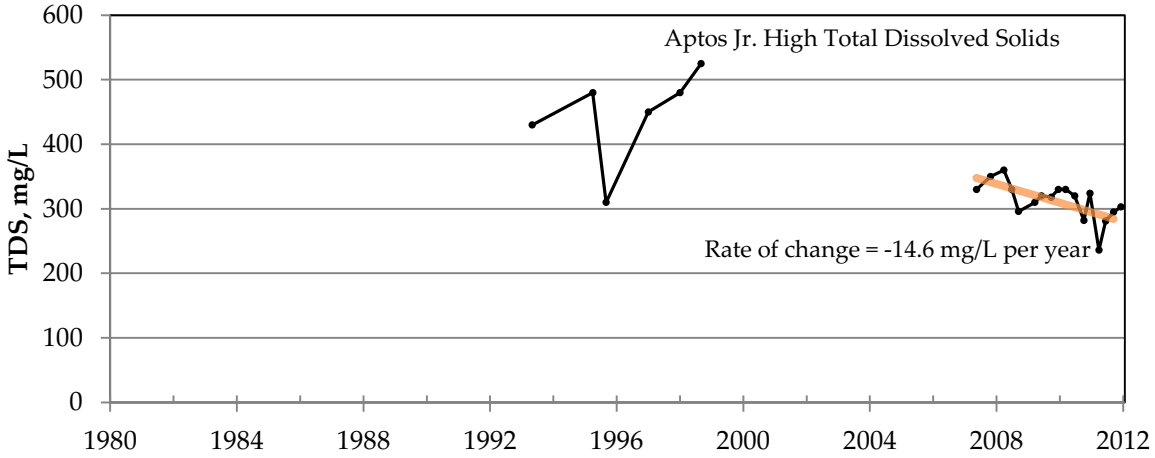

SC-A4C Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = -0.6 feet per year
WY 2007-2011 Trend
8
6
4
2
0
-2
-4
-6
-8
-10
-12
1980
1984
1988
1992
1996
2000
2004
2008
2012

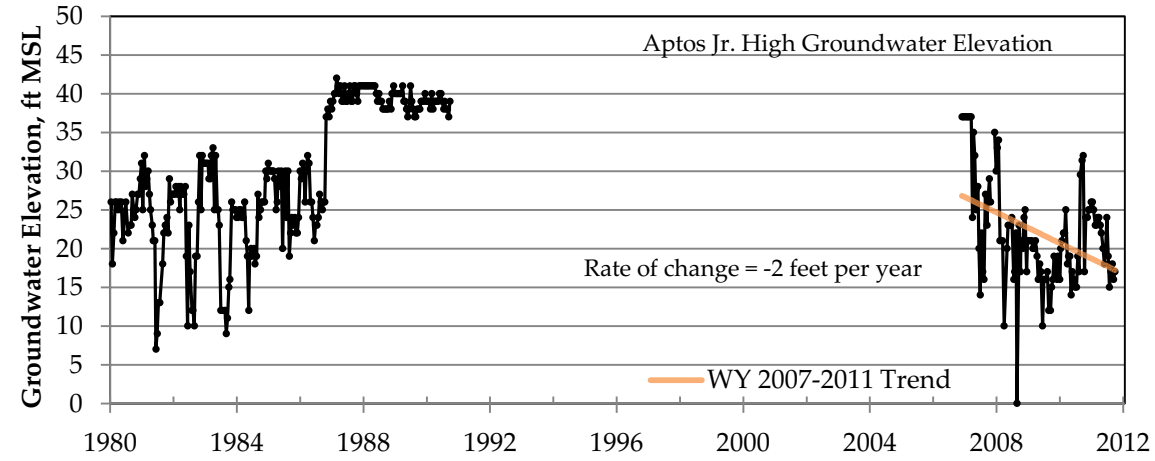

SC-A4D Chloride
Chloride, mg/L
Rate of change = -0.3 mg/L per year
Broken purge pump replaced by bladder pump October
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

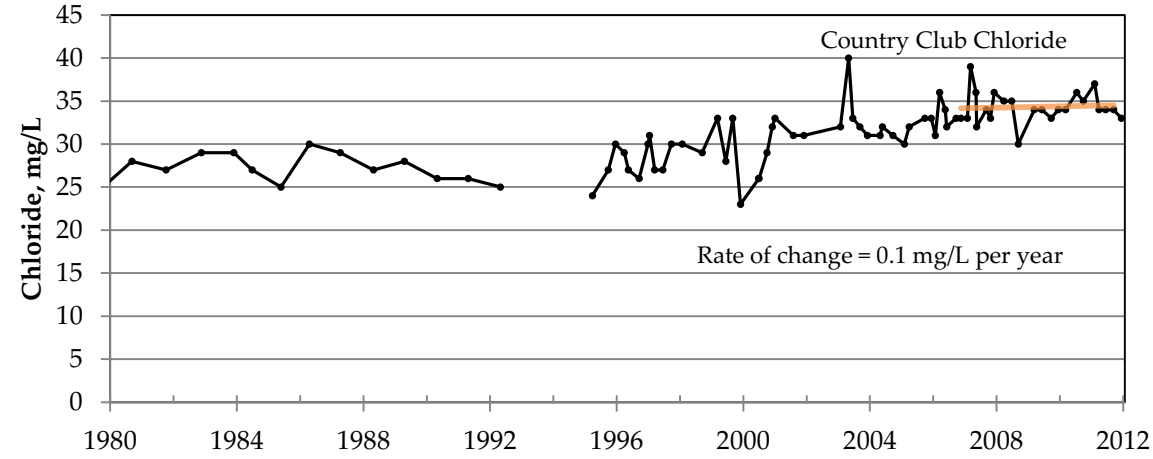

SC-A4D Total Dissolved Solids
TDS, mg/L
Rate of change = 14 mg/L per year
500
450
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

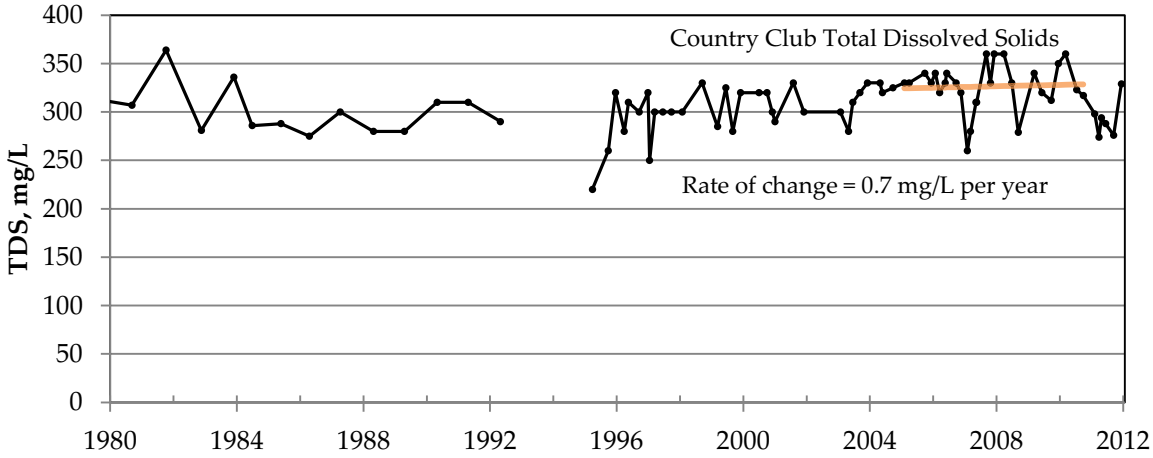

SC-A4D Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = 0.1 feet per year
WY 2007-2011 Trend
8
6
4
2
0
-2
-4
-6
-8
-10
-12
1980
1984
1988
1992
1996
2000
2004
2008
2012

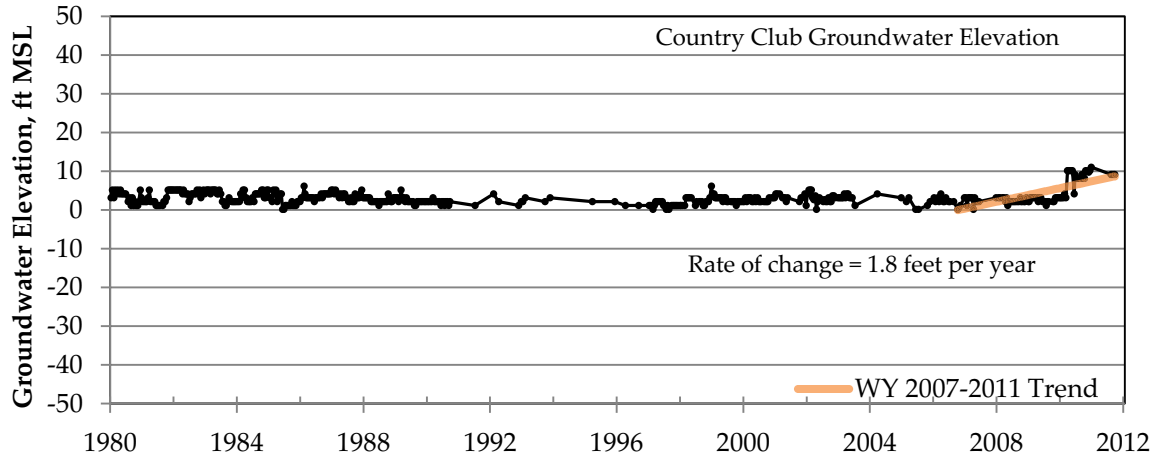

Aptos Jr. High Chloride
Chloride, mg/L
Rate of change = 0.2 mg/L per year
50
45
40
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

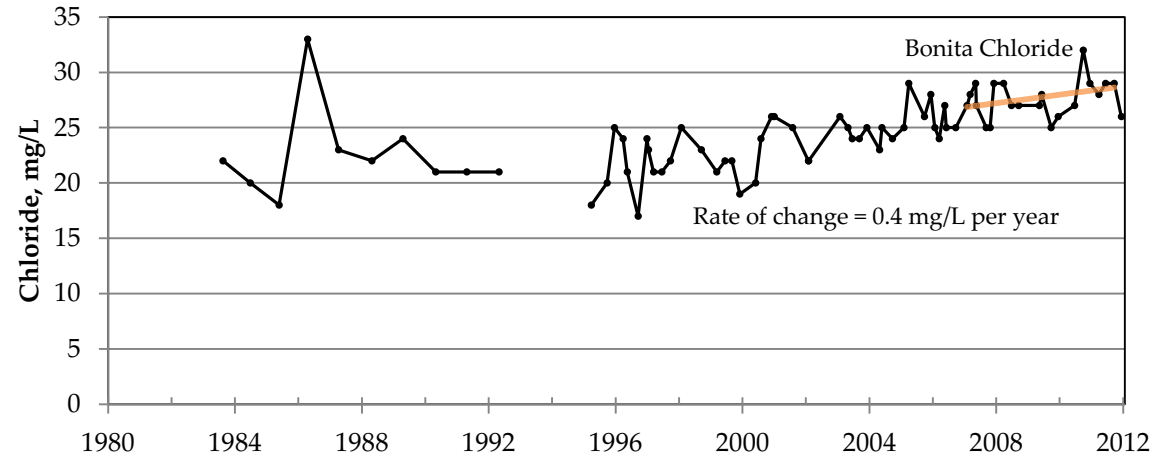

Aptos Jr. High Total Dissolved Solids
TDS, mg/L
Rate of change = -14.6 mg/L per year
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

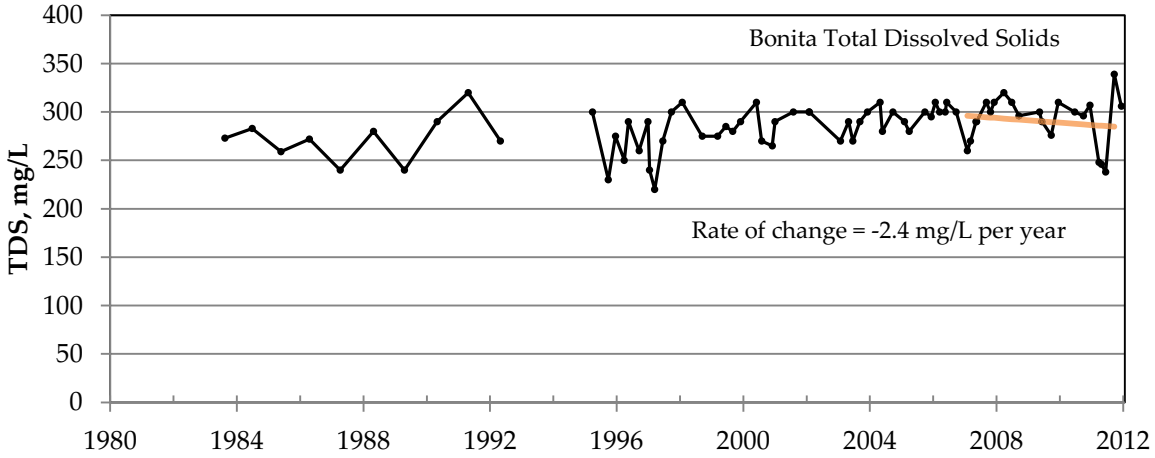

Aptos Jr. High Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = -2 feet per year
WY 2007-2011 Trend
50
45
40
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

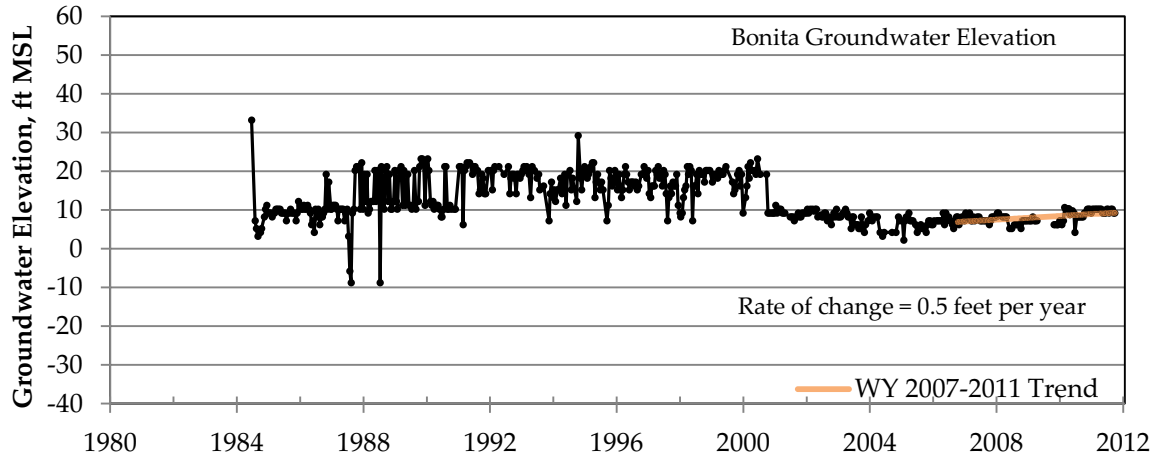

Country Club Chloride
Chloride, mg/L
Rate of change = 0.1 mg/L per year
45
40
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

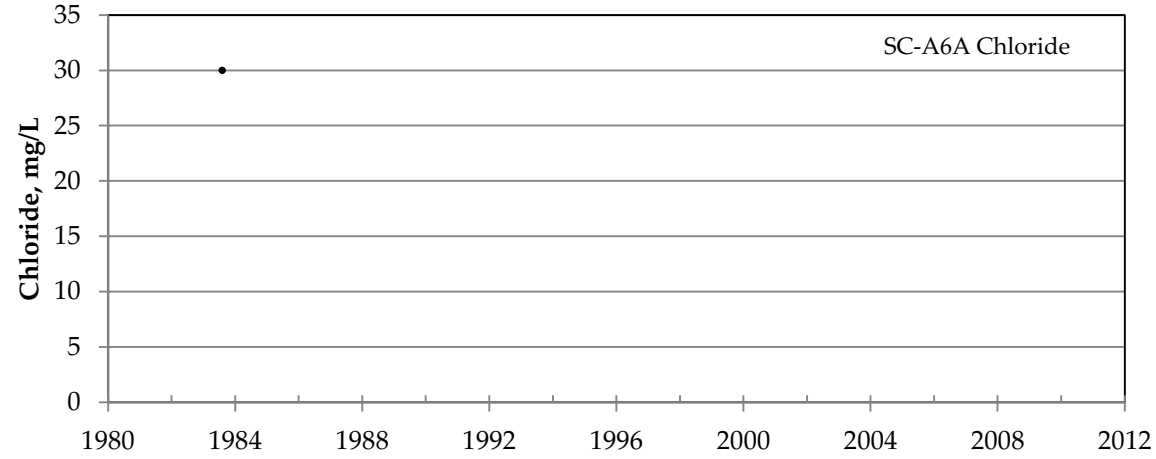

Country Club Total Dissolved Solids
TDS, mg/L
Rate of change = 0.7 mg/L per year
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

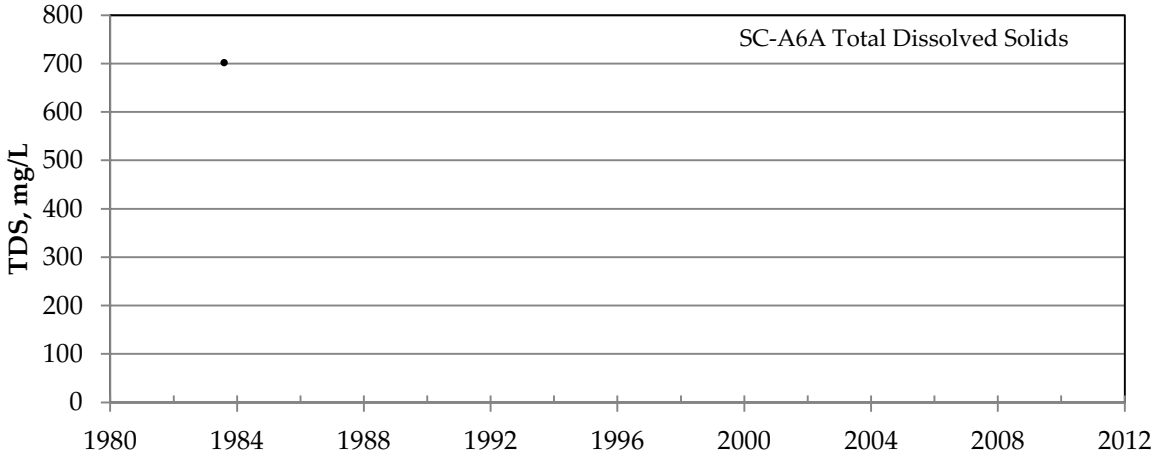

Country Club Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = 1.8 feet per year
WY 2007-2011 Trend
50
40
30
20
10
0
-10
-20
-30
-40
-50
1980
1984
1988
1992
1996
2000
2004
2008
2012

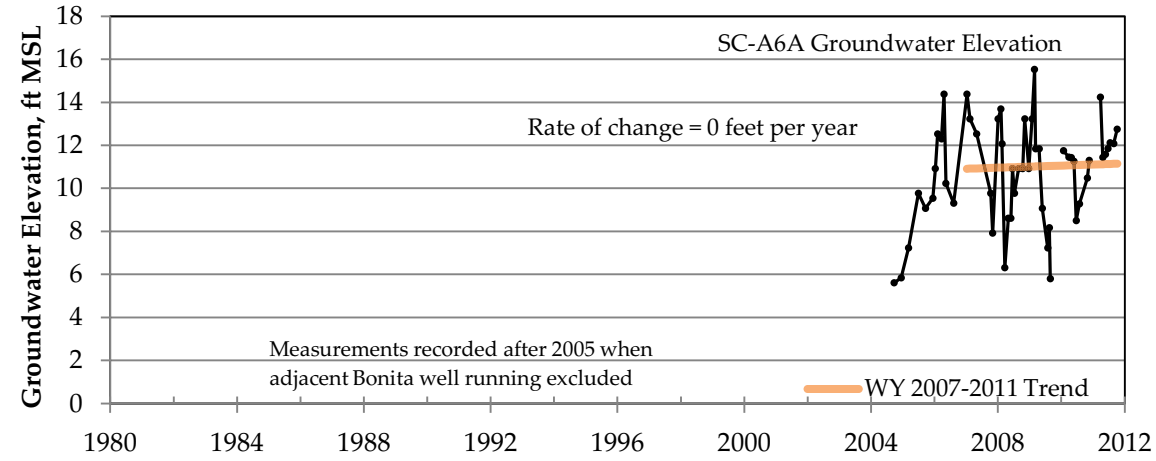

Bonita Chloride
Chloride, mg/L
Rate of change = 0.4 mg/L per year
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

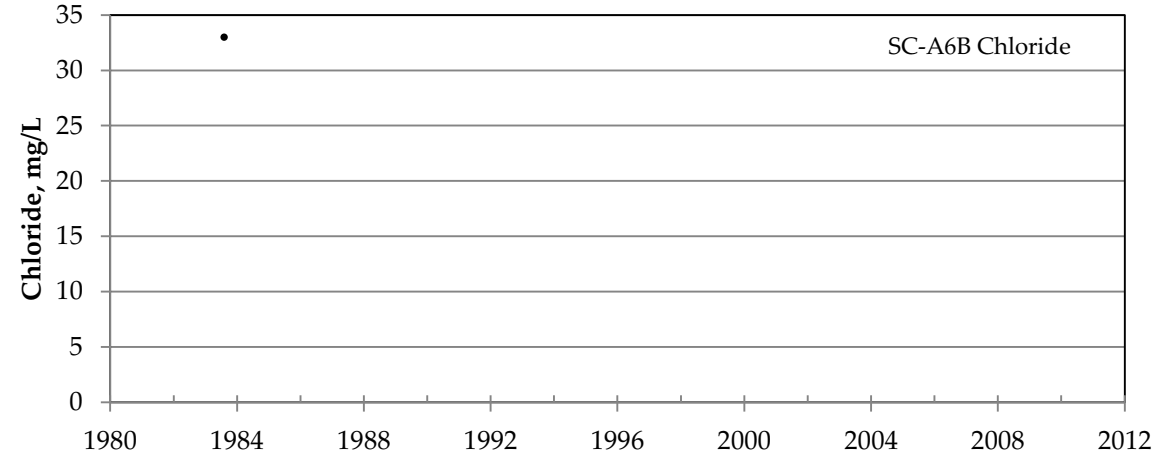

Bonita Total Dissolved Solids
TDS, mg/L
Rate of change = -2.4 mg/L per year
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

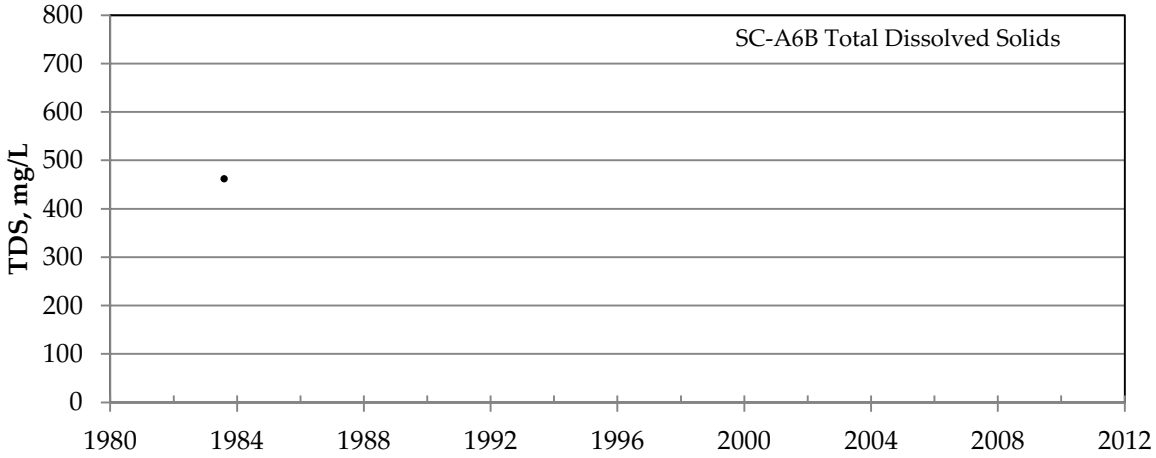

Bonita Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = 0.5 feet per year
WY 2007-2011 Trend
60
50
40
30
20
10
0
-10
-20
-30
-40
1980
1984
1988
1992
1996
2000
2004
2008
2012

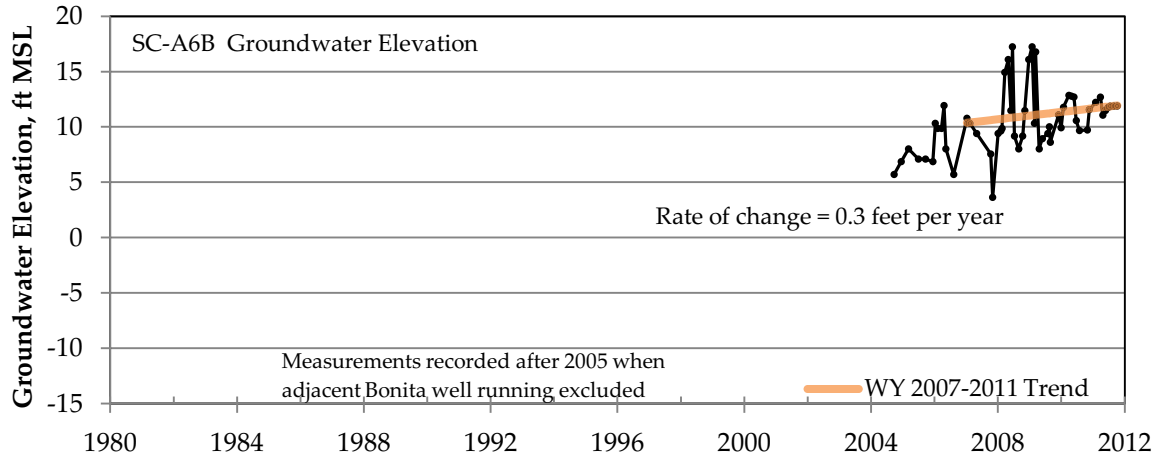

SC-A6A Chloride
Chloride, mg/L
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

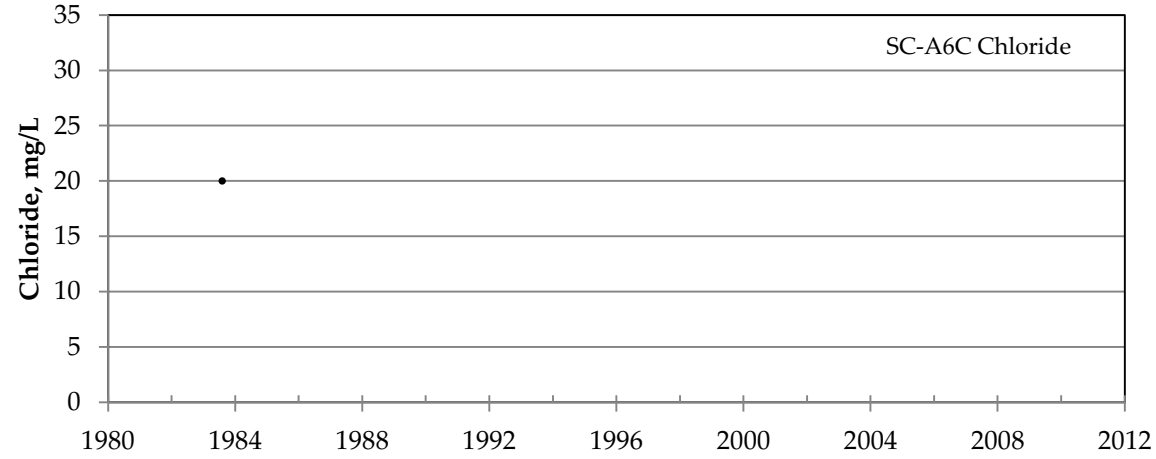

SC-A6A Total Dissolved Solids
TDS, mg/L
800
700
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

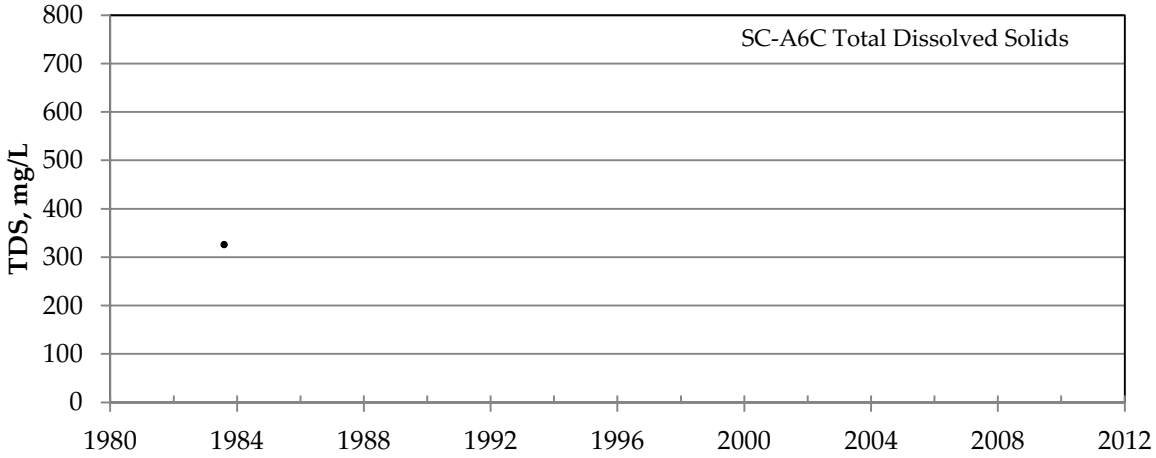

SC-A6A Groundwater Elevation
Rate of change = 0 feet per year
Measurements recorded after 2005 when adjacent Bonita well running excluded
WY 2007-2011 Trend
Groundwater Elevation, ft MSL
18
16
14
12
10
8
6
4
2
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

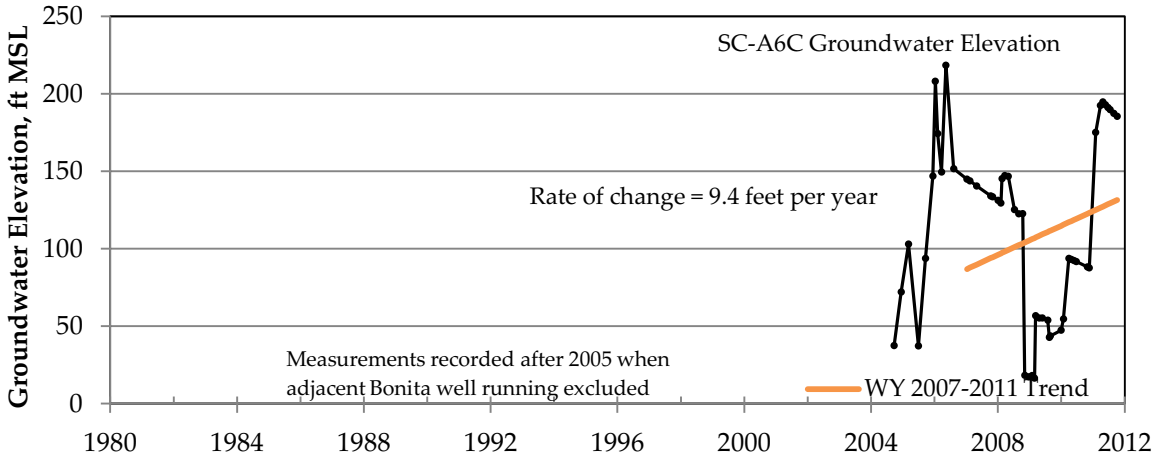

SC-A6B Chloride
Chloride, mg/L
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

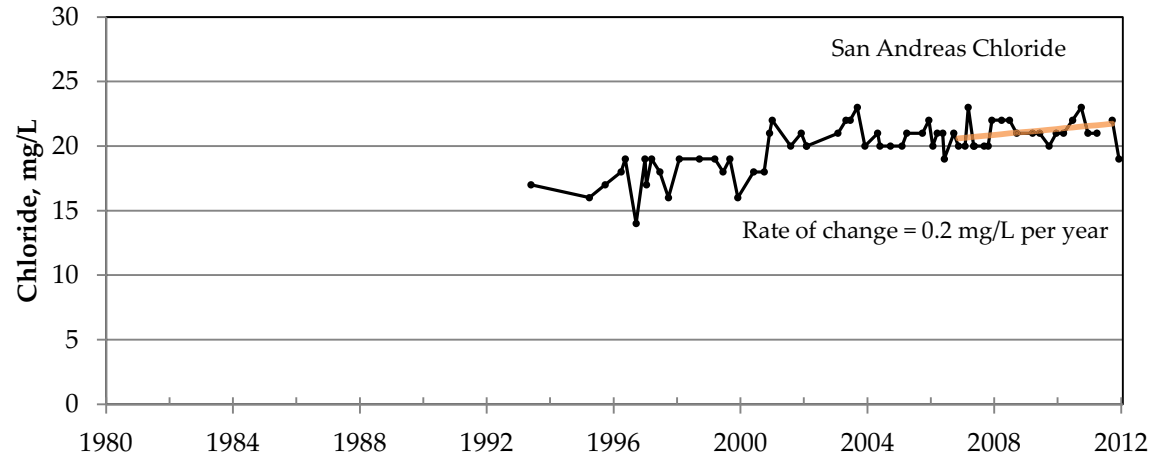

SC-A6B Total Dissolved Solids
TDS, mg/L
800
700
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

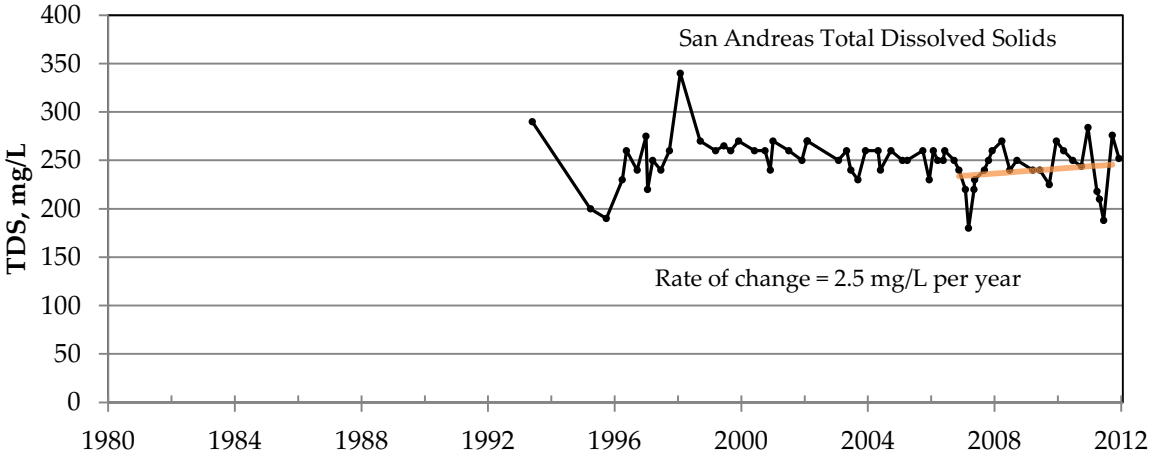

SC-A6B Groundwater Elevation
Groundwater Elevation, ft MSL
20
15
10
5
0
-5
-10
-15
Rate of change = 0.3 feet per year
Measurements recorded after 2005 when adjacent Bonita well running excluded
WY 2007-2011 Trend
1980
1984
1988
1992
1996
2000
2004
2008
2012

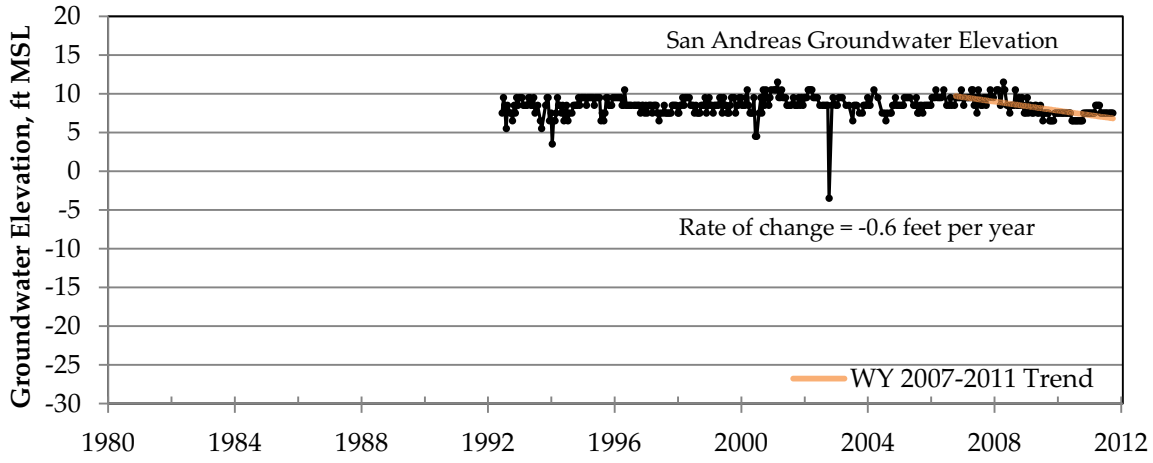

SC-A6C Chloride
Chloride, mg/L
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

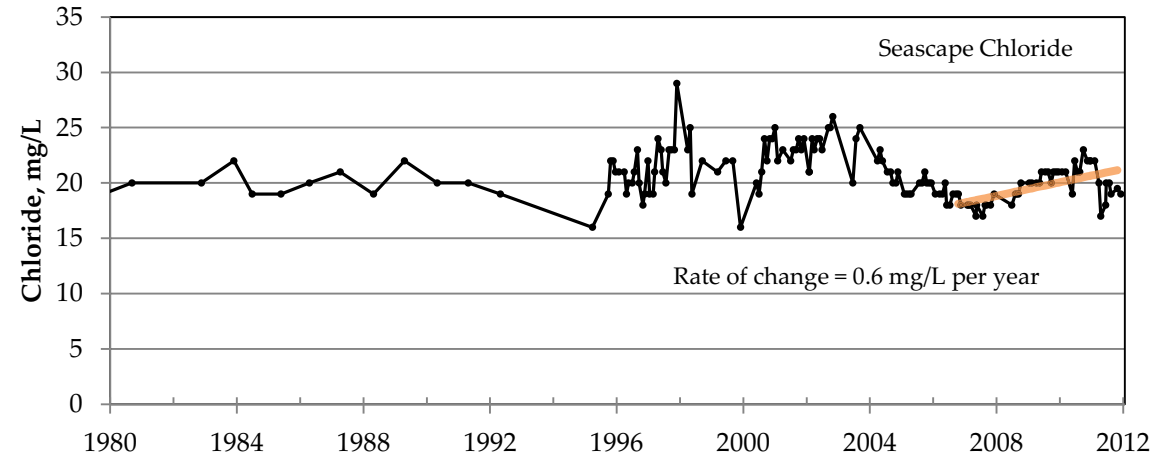

SC-A6C Total Dissolved Solids
TDS, mg/L
800
700
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

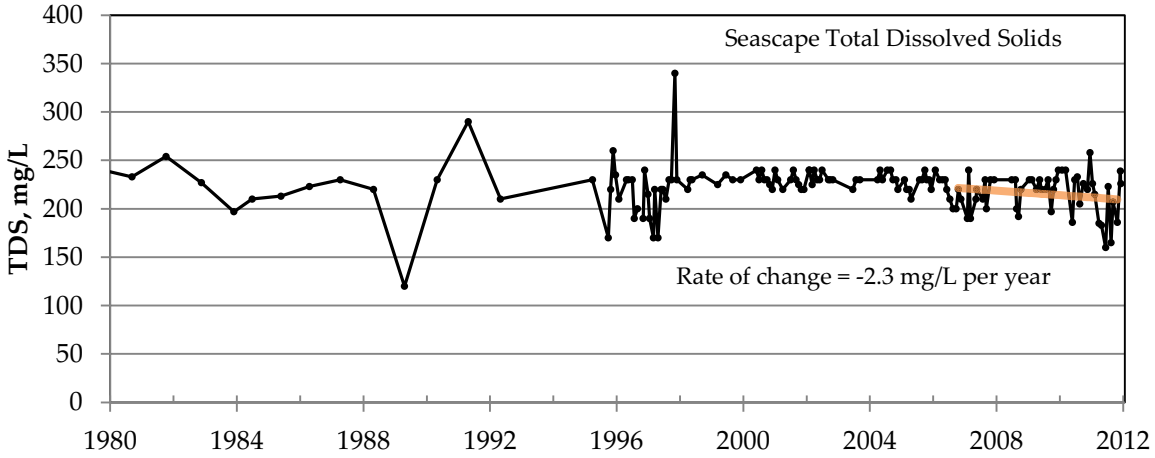

SC-A6C Groundwater Elevation
Groundwater Elevation, ft MSL
250
200
150
100
50
0
Rate of change = 9.4 feet per year
Measurements recorded after 2005 when adjacent Bonita well running excluded
WY 2007-2011 Trend
1980
1984
1988
1992
1996
2000
2004
2008
2012

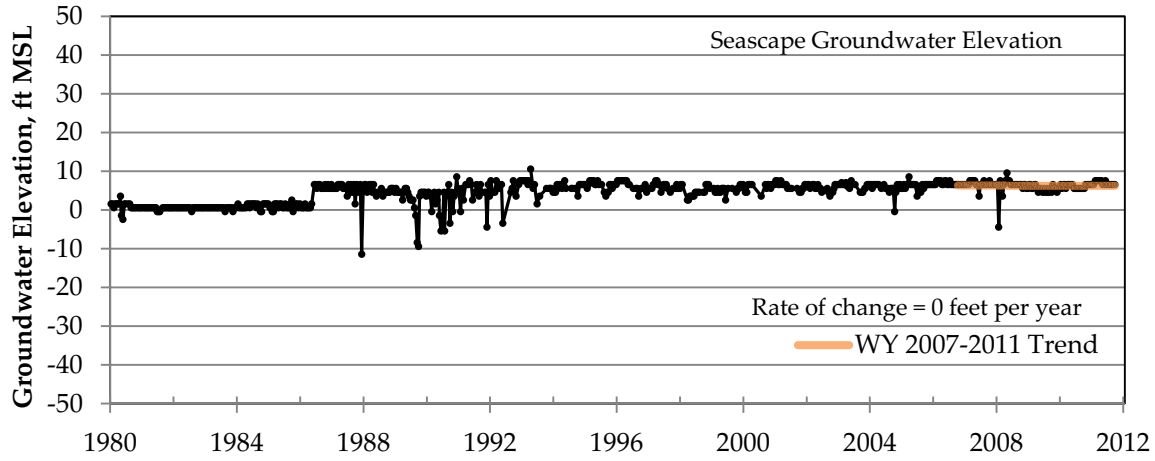

San Andreas Chloride
Chloride, mg/L
Rate of change = 0.2 mg/L per year
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

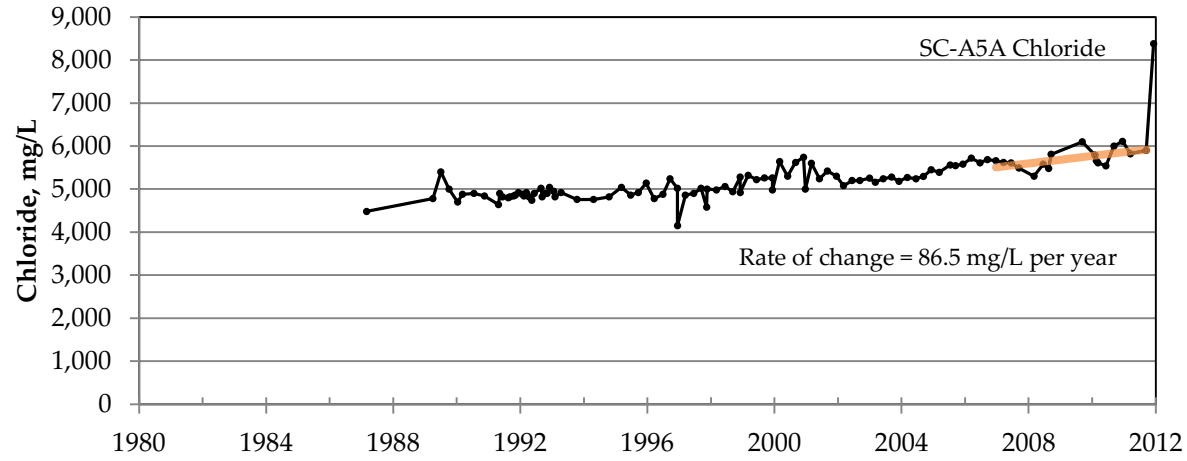

San Andreas Total Dissolved Solids
TDS, mg/L
Rate of change = 2.5 mg/L per year
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

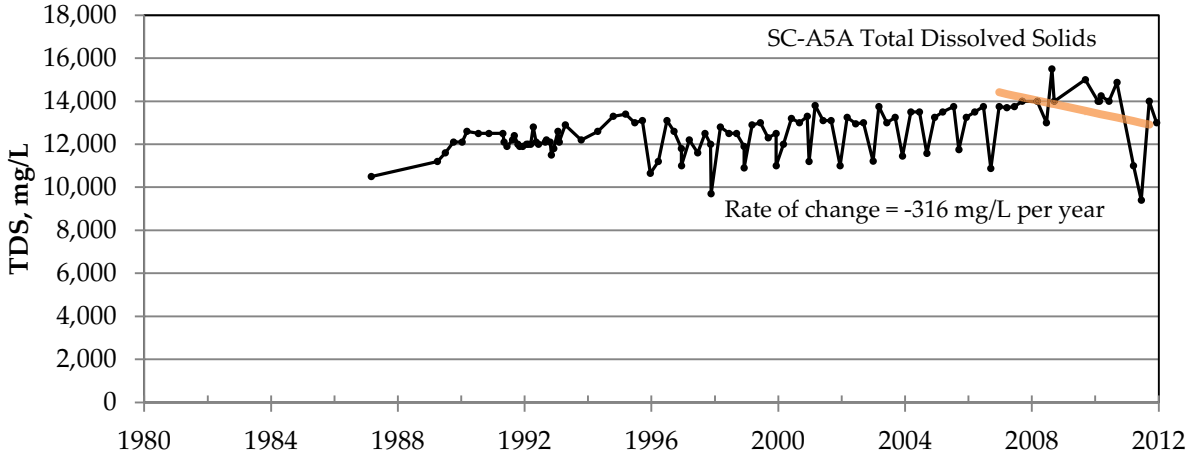

San Andreas Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = -0.6 feet per year
WY 2007-2011 Trend
20
15
10
5
0
-5
-10
-15
-20
-25
-30
1980
1984
1988
1992
1996
2000
2004
2008
2012

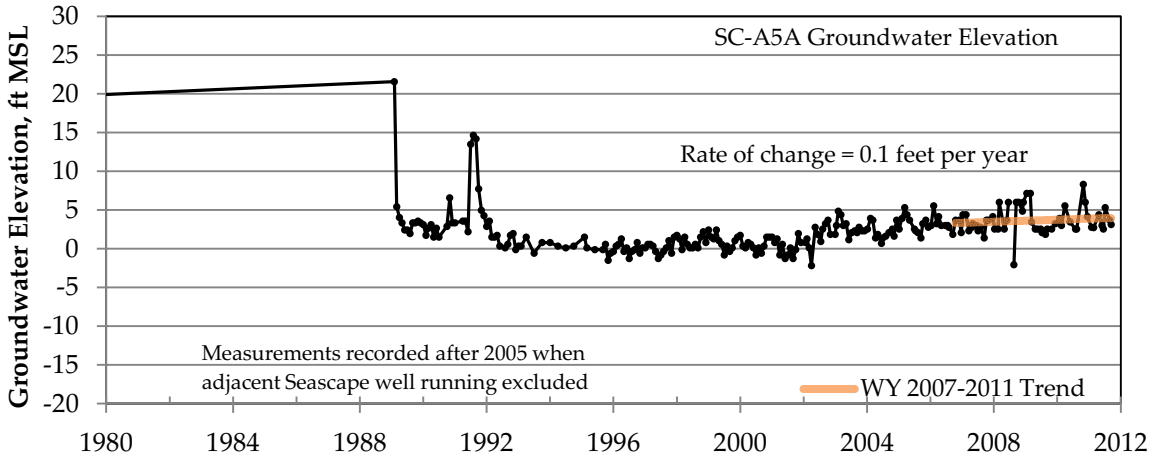

Seascape Chloride
Chloride, mg/L
Rate of change = 0.6 mg/L per year
35
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

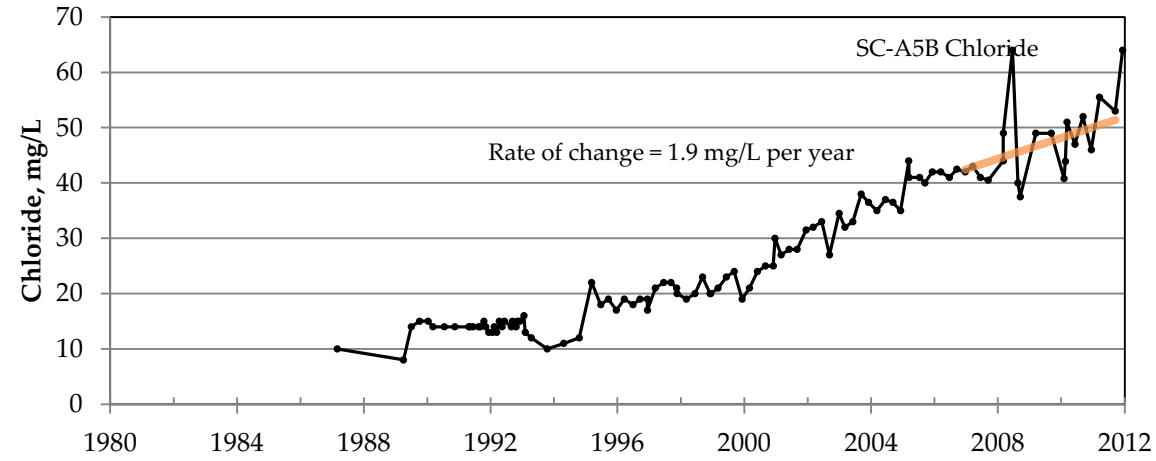

Seascape Total Dissolved Solids
TDS, mg/L
Rate of change = -2.3 mg/L per year
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

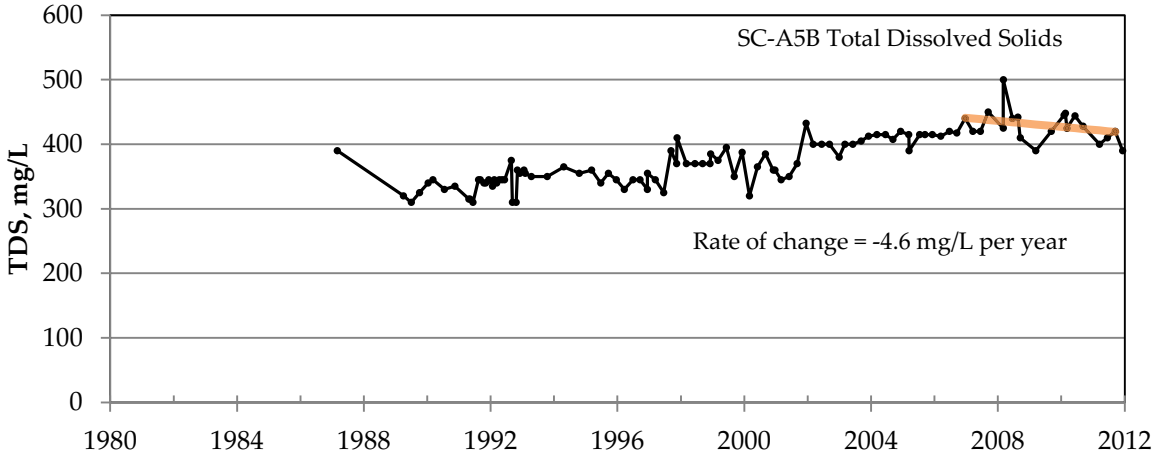

Seascape Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = 0 feet per year
WY 2007-2011 Trend
50
40
30
20
10
0
-10
-20
-30
-40
-50
1980
1984
1988
1992
1996
2000
2004
2008
2012

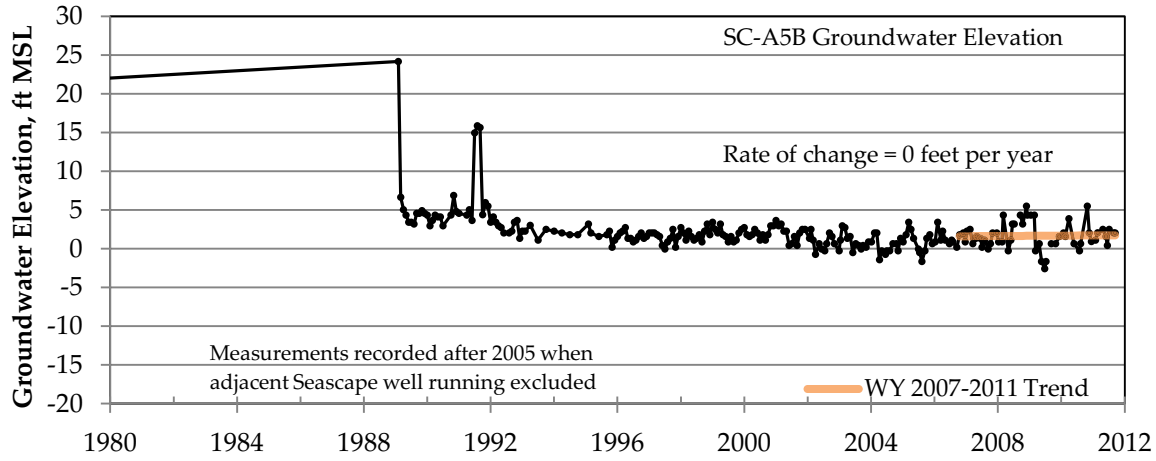

SC-A5A Chloride
Chloride, mg/L
Rate of change = 86.5 mg/L per year
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

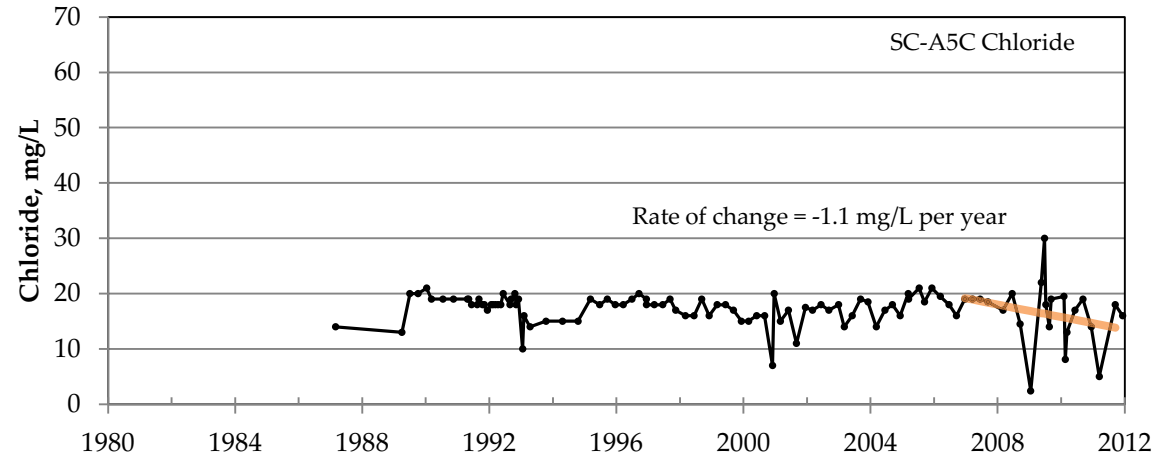

SC-A5A Total Dissolved Solids
TDS, mg/L
Rate of change = -316 mg/L per year
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

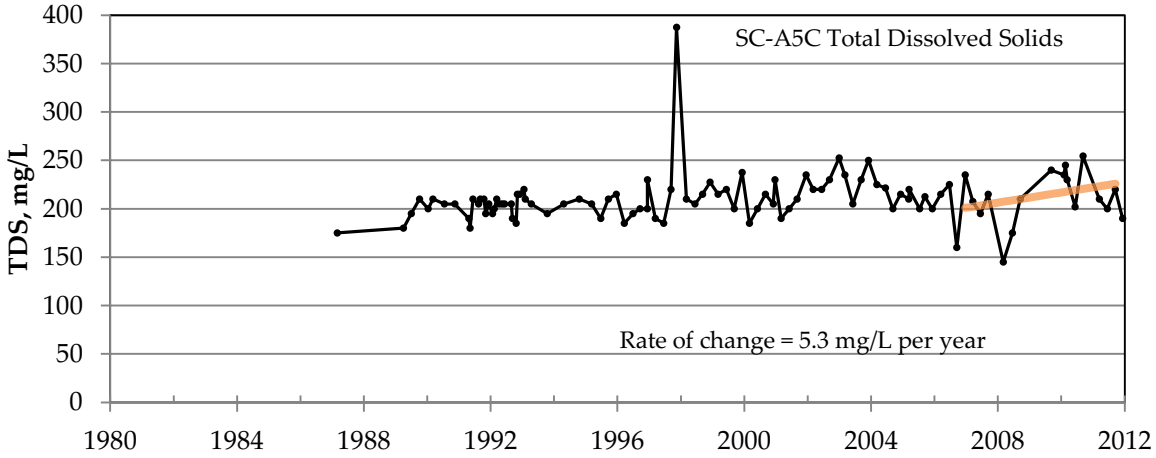

SC-A5A Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = 0.1 feet per year
Measurements recorded after 2005 when
adjacent Seascape well running excluded
WY 2007-2011 Trend
30
25
20
15
10
5
0
-5
-10
-15
-20
1980
1984
1988
1992
1996
2000
2004
2008
2012

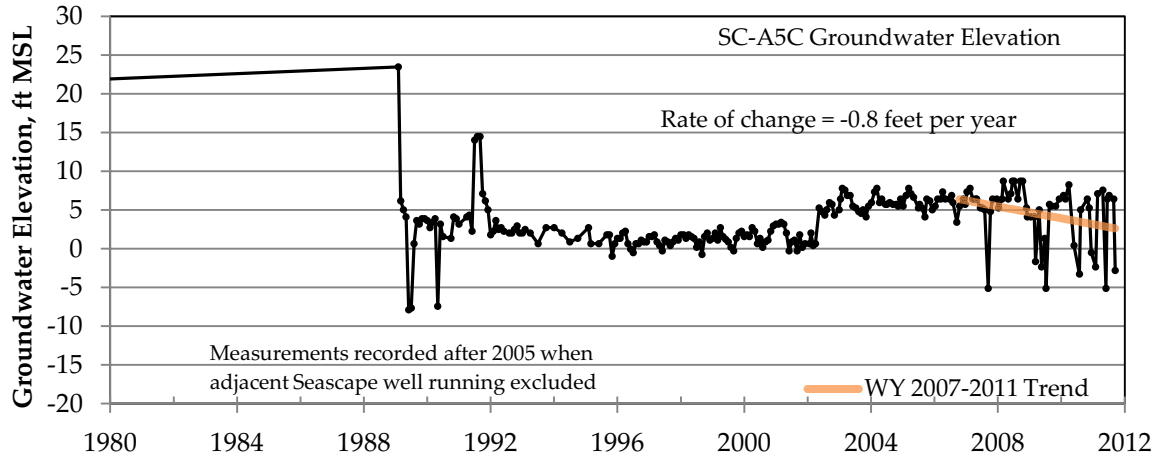

SC-A5B Chloride
Rate of change = 1.9 mg/L per year
Chloride, mg/L
70
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

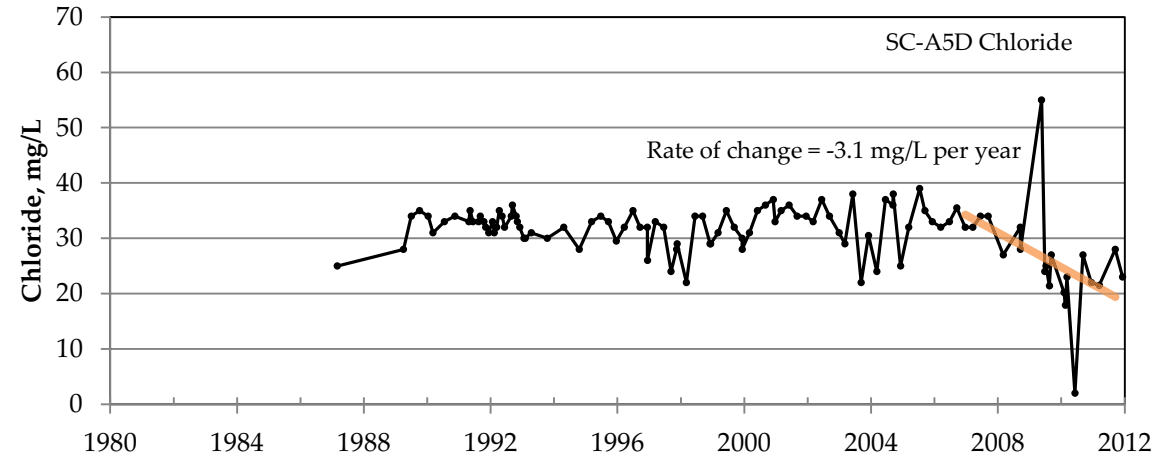

SC-A5B Total Dissolved Solids
Rate of change = -4.6 mg/L per year
TDS, mg/L
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

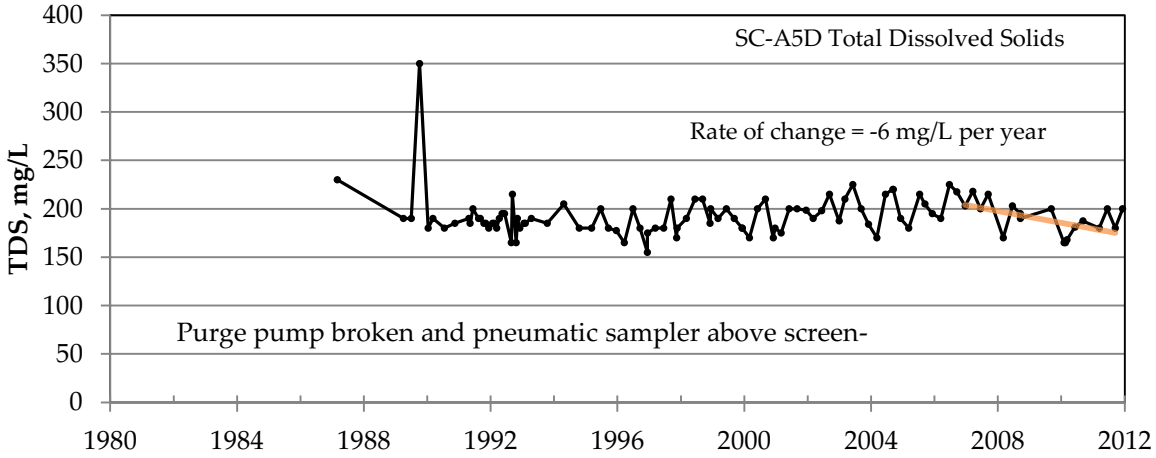

SC-A5B Groundwater Elevation
Rate of change = 0 feet per year
Measurements recorded after 2005 when
adjacent Seascape well running excluded
WY 2007-2011 Trend
Groundwater Elevation, ft MSL
30
25
20
15
10
5
0
-5
-10
-15
-20
1980
1984
1988
1992
1996
2000
2004
2008
2012

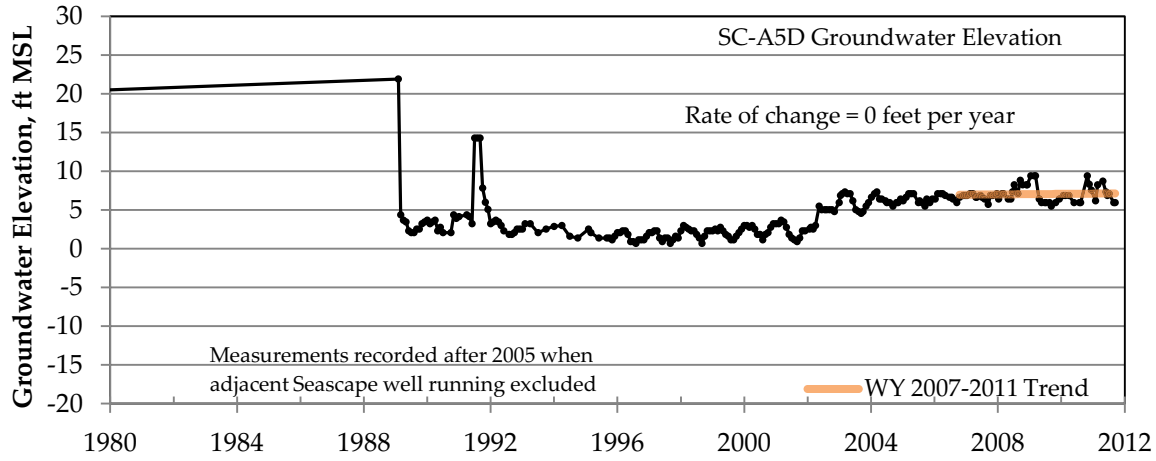

SC-A5C Chloride
Chloride, mg/L
Rate of change = -1.1 mg/L per year
70
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

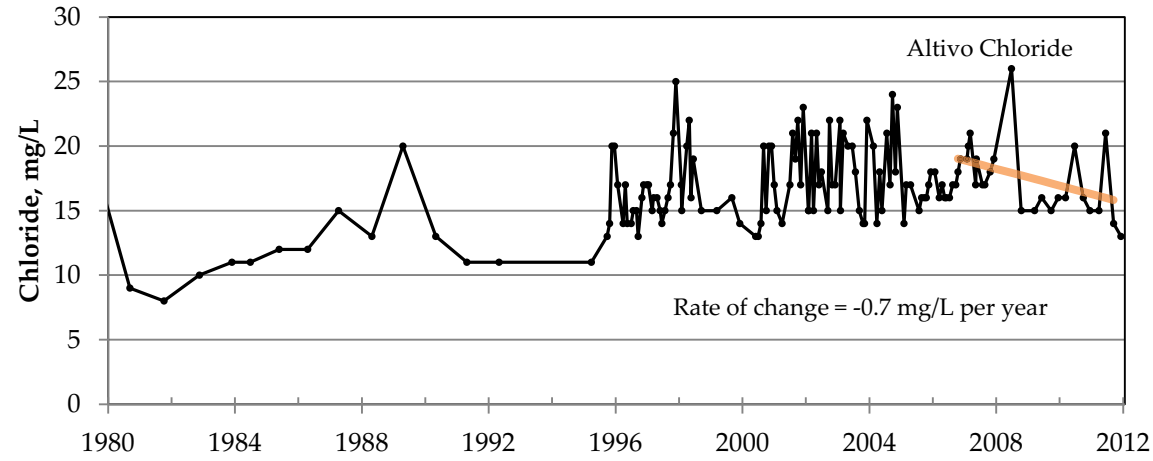

SC-A5C Total Dissolved Solids
TDS, mg/L
Rate of change = 5.3 mg/L per year
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

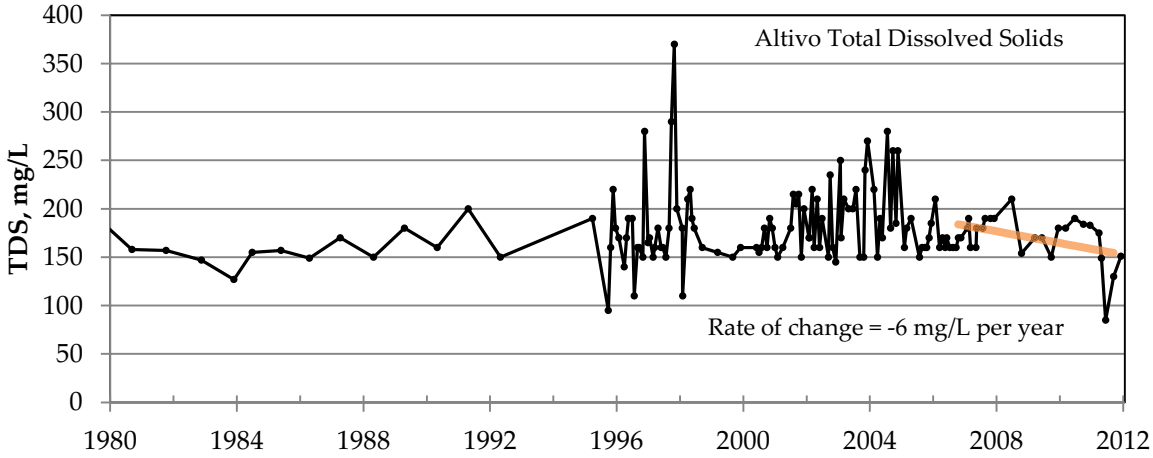

SC-A5C Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = -0.8 feet per year
Measurements recorded after 2005 when
adjacent Seascape well running excluded
WY 2007-2011 Trend
30
25
20
15
10
5
0
-5
-10
-15
-20
1980
1984
1988
1992
1996
2000
2004
2008
2012

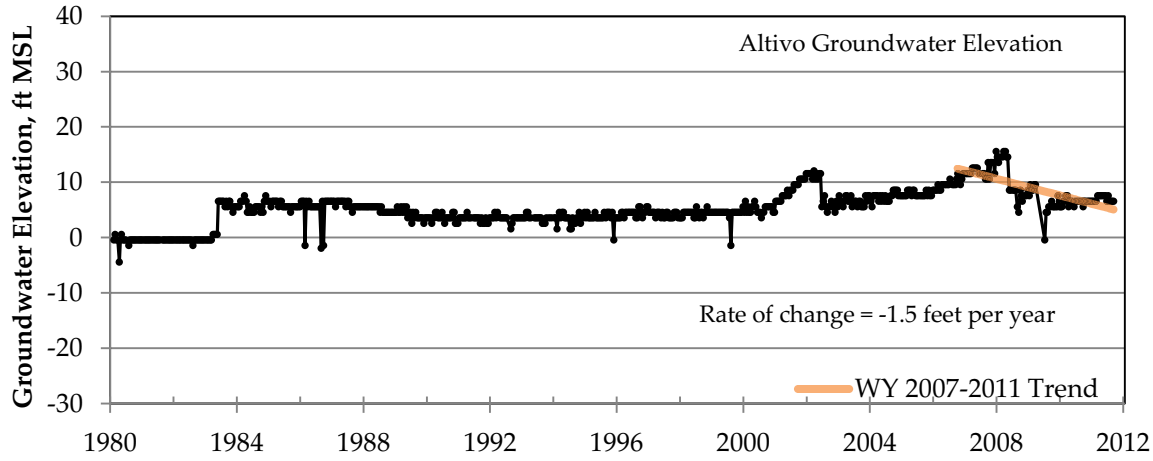

SC-A5D Chloride
Rate of change = -3.1 mg/L per year
Chloride, mg/L
70
60
50
40
30
20
10
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

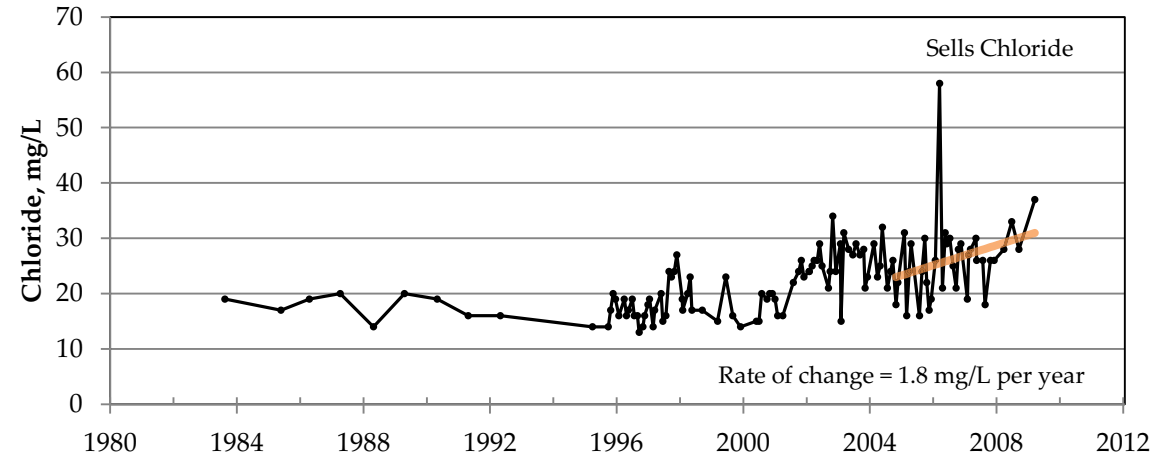

SC-A5D Total Dissolved Solids
Rate of change = -6 mg/L per year
Purge pump broken and pneumatic sampler above screen-
TDS, mg/L
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

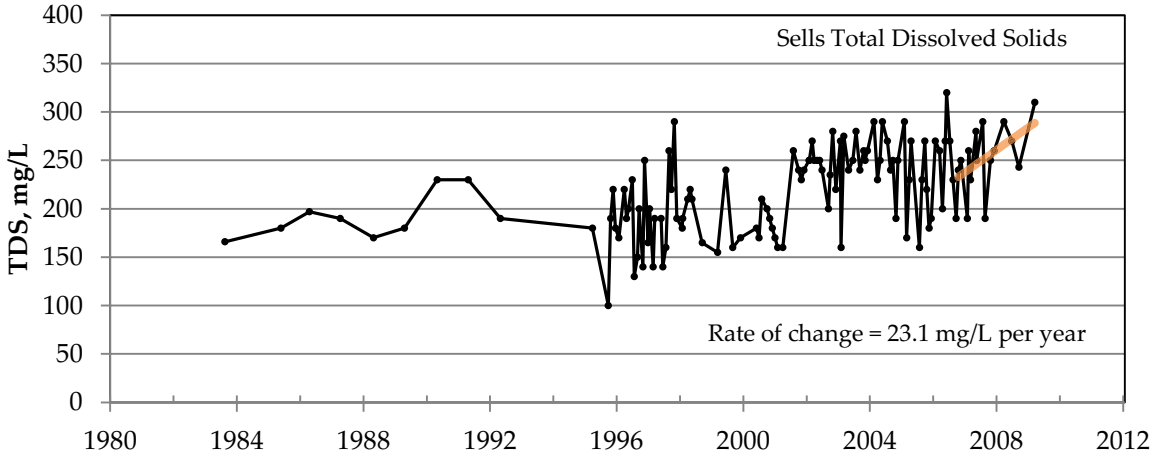

SC-A5D Groundwater Elevation
Rate of change = 0 feet per year
Measurements recorded after 2005 when
adjacent Seascape well running excluded
WY 2007-2011 Trend
Groundwater Elevation, ft MSL
30
25
20
15
10
5
0
-5
-10
-15
-20
1980
1984
1988
1992
1996
2000
2004
2008
2012

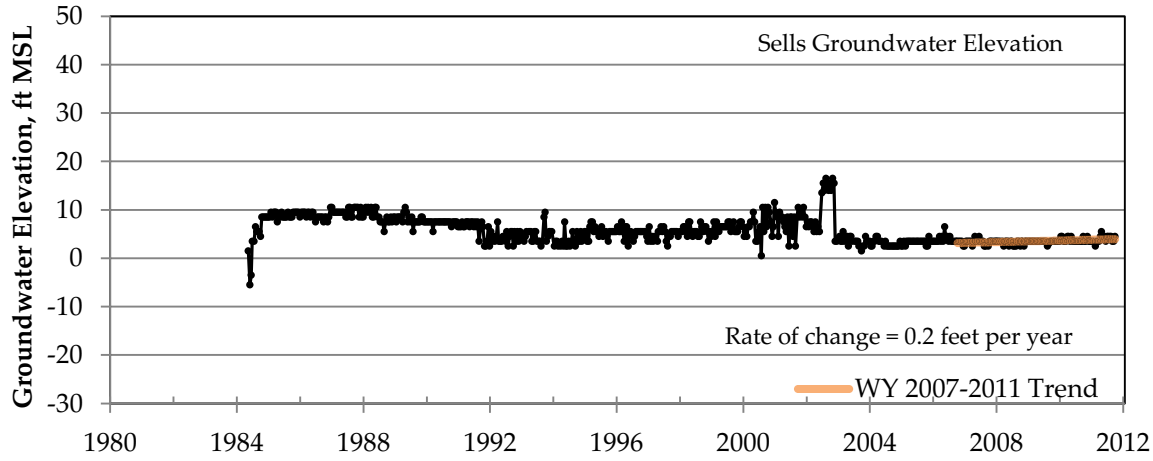

Altivo Chloride
Chloride, mg/L
Rate of change = -0.7 mg/L per year
30
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

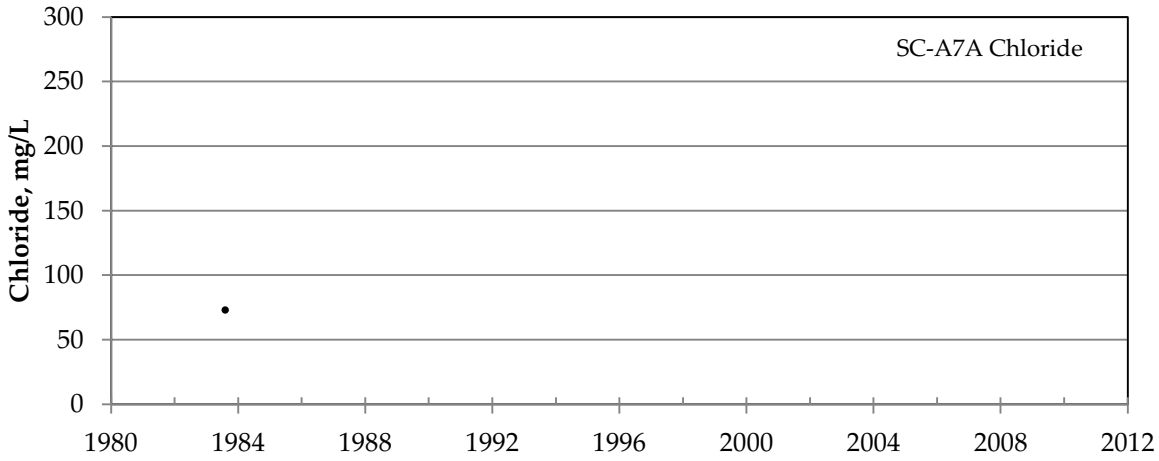

Altivo Total Dissolved Solids
TDS, mg/L
Rate of change = -6 mg/L per year
400
350
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

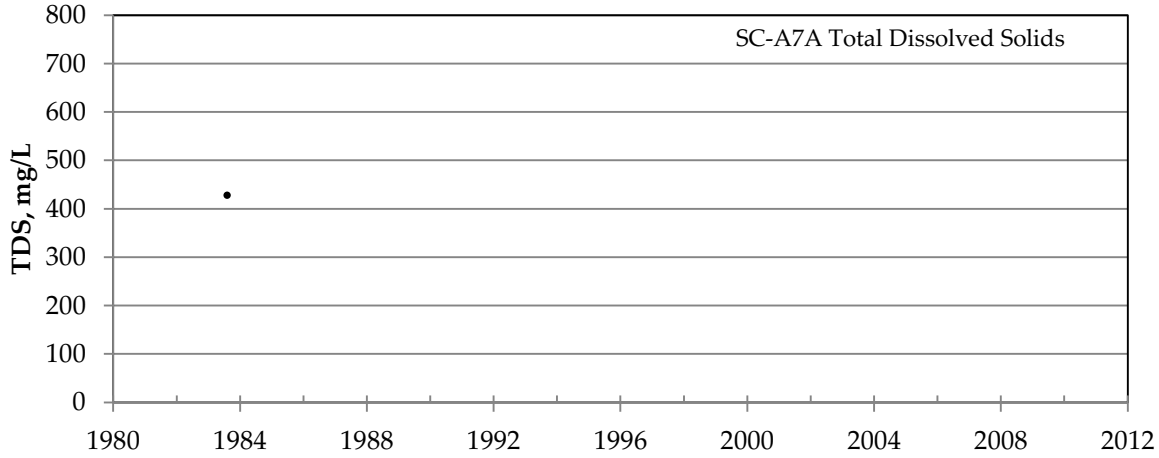

Altivo Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = -1.5 feet per year
WY 2007-2011 Trend
40
30
20
10
0
-10
-20
-30
1980
1984
1988
1992
1996
2000
2004
2008
2012

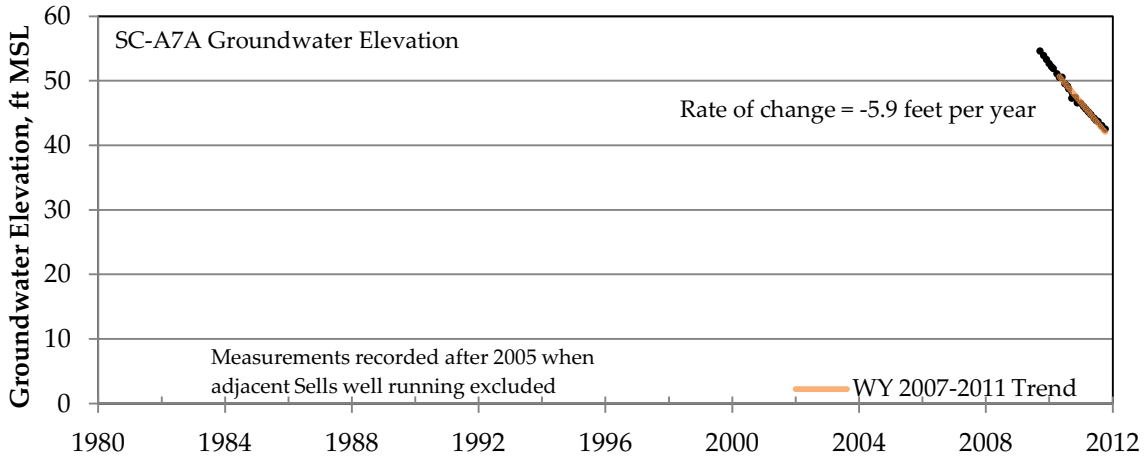

Sells Chloride
Chloride, mg/L
70
60
50
40
30
20
10
0
Rate of change = 1.8 mg/L per year
1980
1984
1988
1992
1996
2000
2004
2008
2012

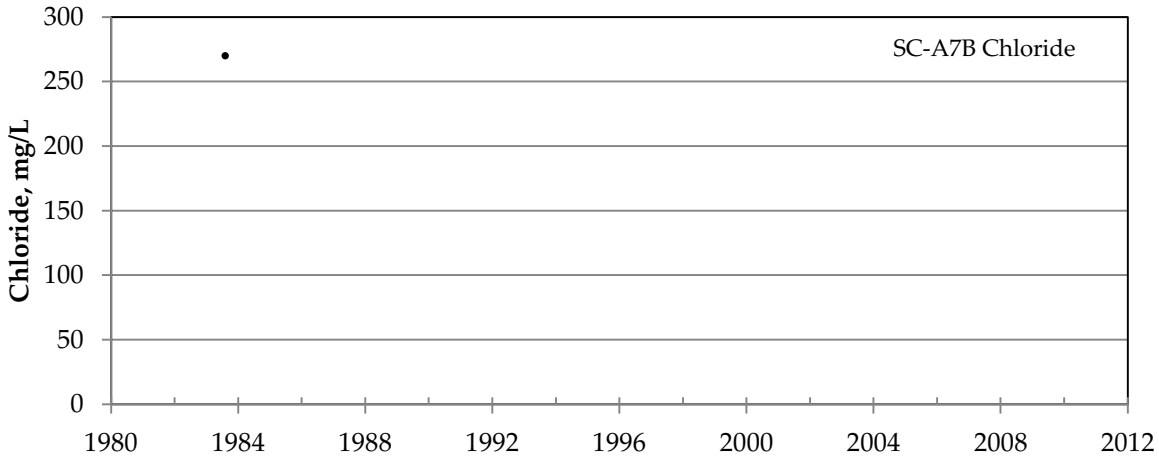

Sells Total Dissolved Solids
TDS, mg/L
400
350
300
250
200
150
100
50
0
Rate of change = 23.1 mg/L per year
1980
1984
1988
1992
1996
2000
2004
2008
2012

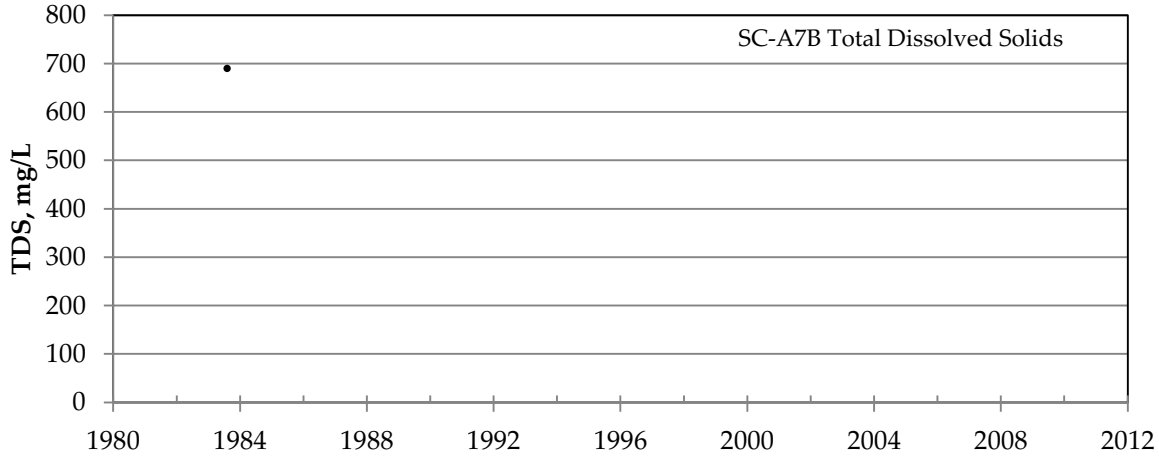

Sells Groundwater Elevation
Groundwater Elevation, ft MSL
50
40
30
20
10
0
-10
-20
-30
Rate of change = 0.2 feet per year
WY 2007-2011 Trend
1980
1984
1988
1992
1996
2000
2004
2008
2012

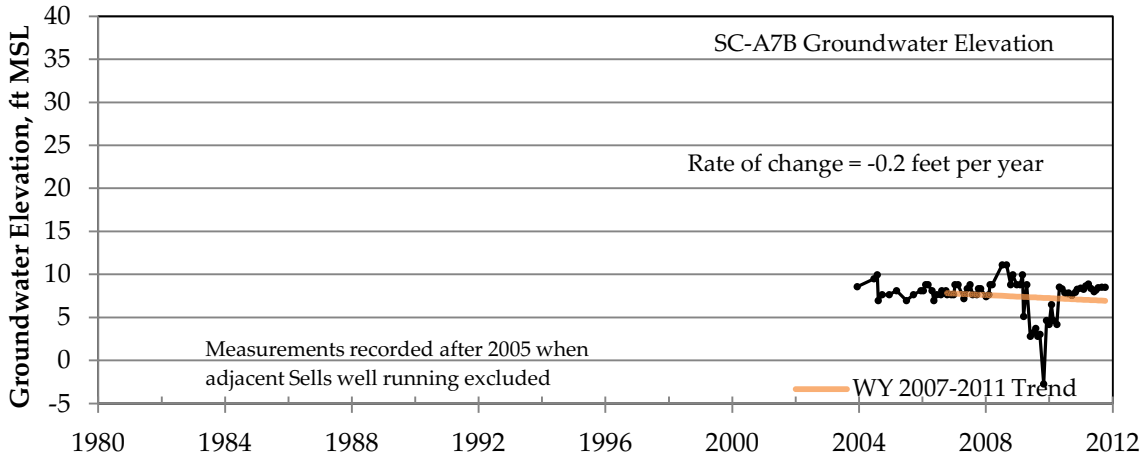

SC-A7A Chloride
Chloride, mg/L
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

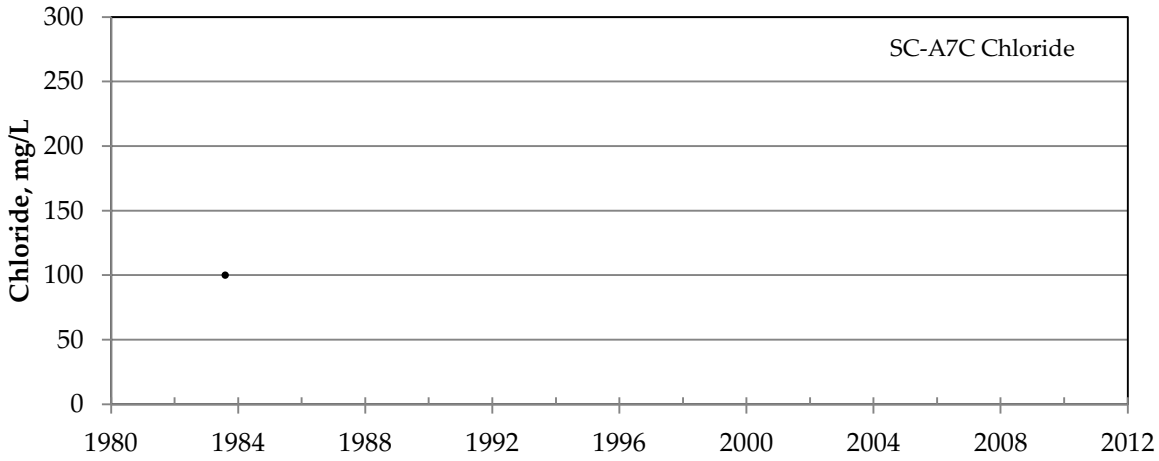

SC-A7A Total Dissolved Solids
TDS, mg/L
800
700
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

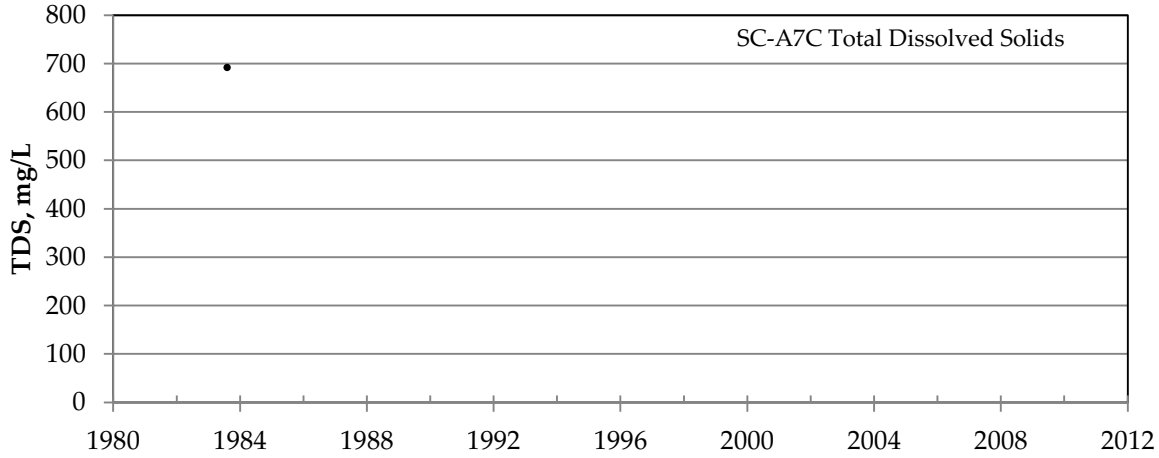

SC-A7A Groundwater Elevation
Rate of change = -5.9 feet per year
Groundwater Elevation, ft MSL
60
50
40
30
20
10
0
Measurements recorded after 2005 when adjacent Sells well running excluded
WY 2007-2011 Trend
1980
1984
1988
1992
1996
2000
2004
2008
2012

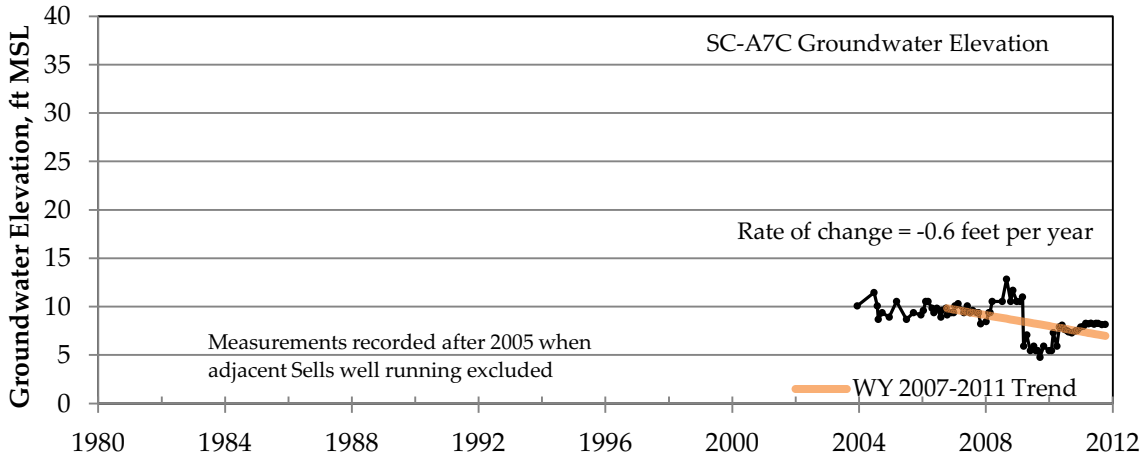

SC-A7B Chloride
Chloride, mg/L
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

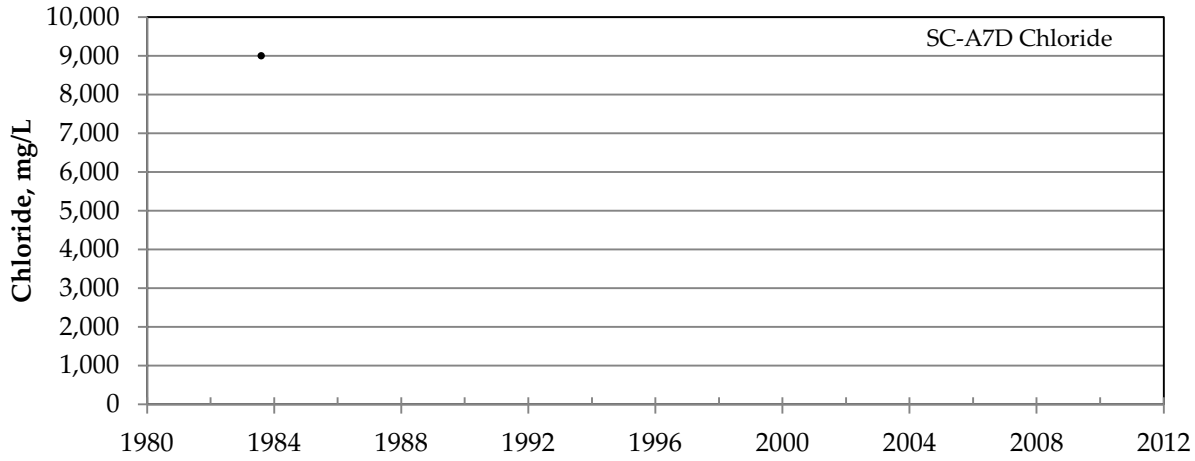

SC-A7B Total Dissolved Solids
TDS, mg/L
800
700
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

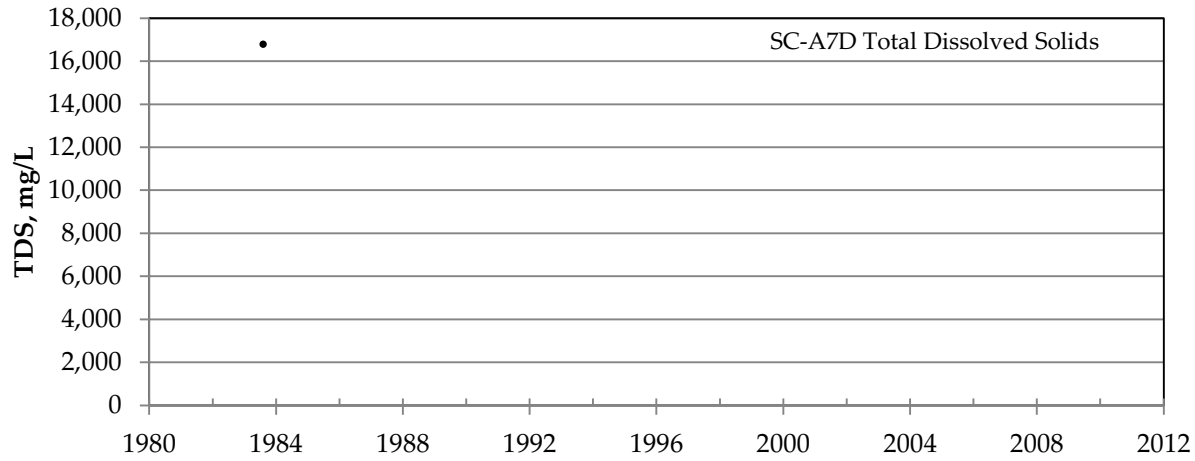

SC-A7B Groundwater Elevation
Rate of change = -0.2 feet per year
Groundwater Elevation, ft MSL
40
35
30
25
20
15
10
5
0
-5
Measurements recorded after 2005 when adjacent Sells well running excluded
WY 2007-2011 Trend
1980
1984
1988
1992
1996
2000
2004
2008
2012

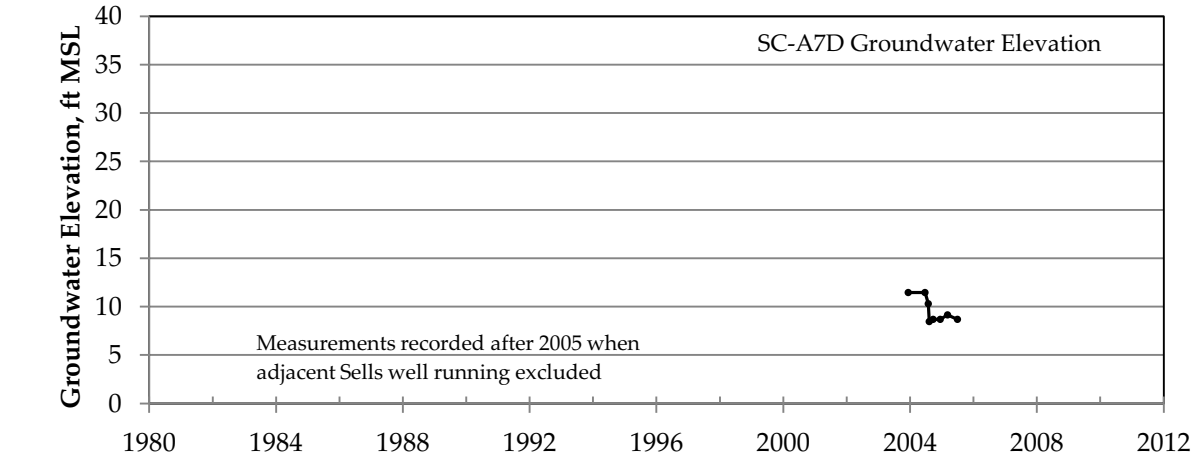

SC-A7C Chloride
Chloride, mg/L
300
250
200
150
100
50
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

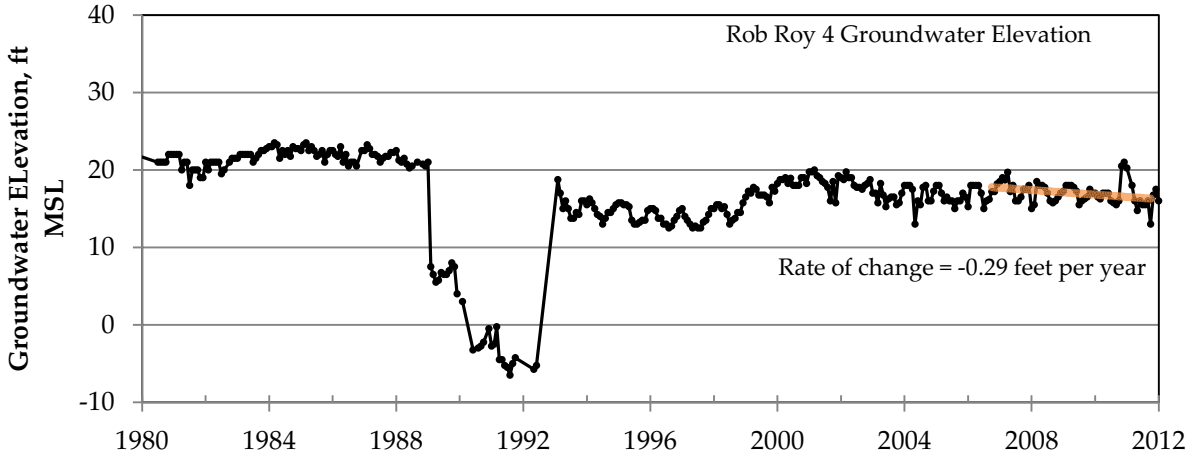

SC-A7C Total Dissolved Solids
TDS, mg/L
800
700
600
500
400
300
200
100
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

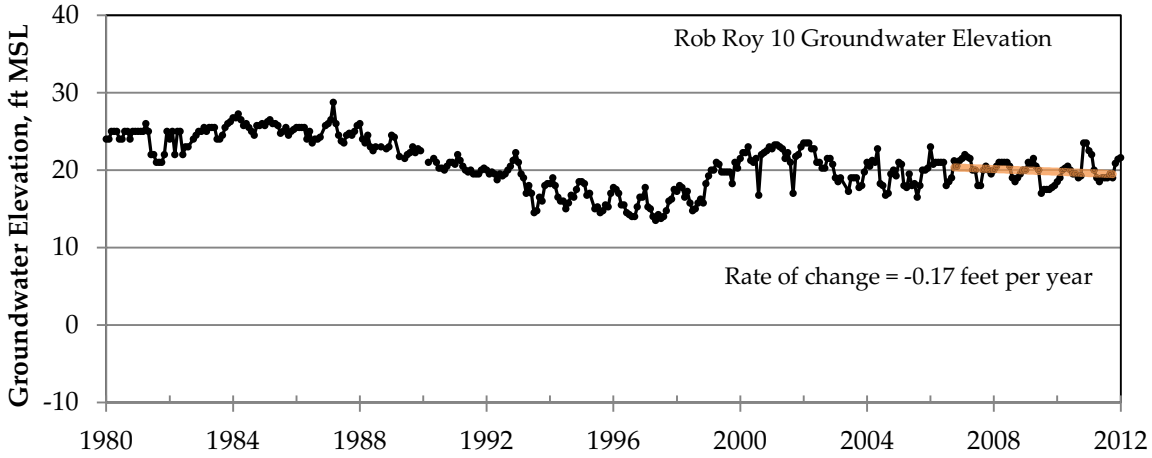

SC-A7C Groundwater Elevation
Groundwater Elevation, ft MSL
40
35
30
25
20
15
10
5
0
Rate of change = -0.6 feet per year
Measurements recorded after 2005 when
adjacent Sells well running excluded
WY 2007-2011 Trend
1980
1984
1988
1992
1996
2000
2004
2008
2012

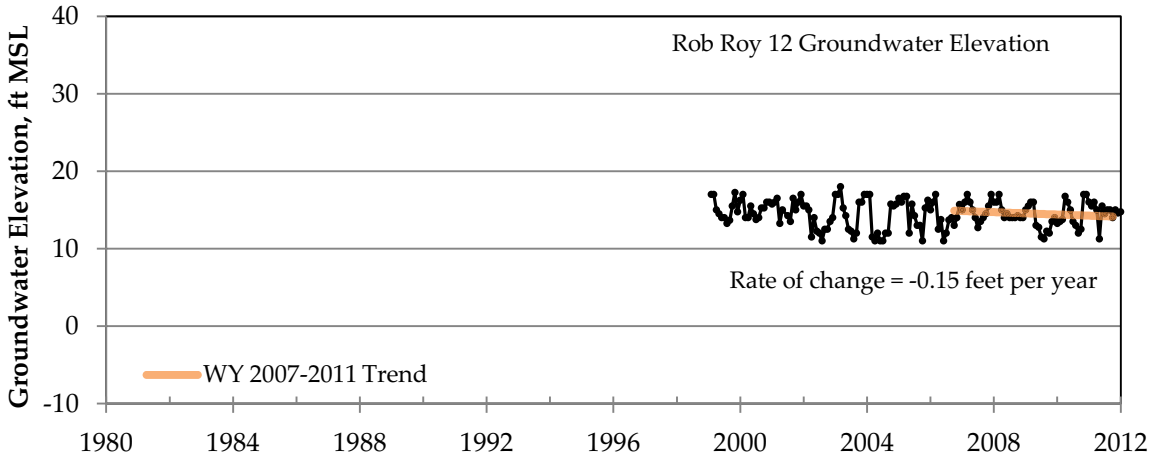

SC-A7D Chloride
Chloride, mg/L
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

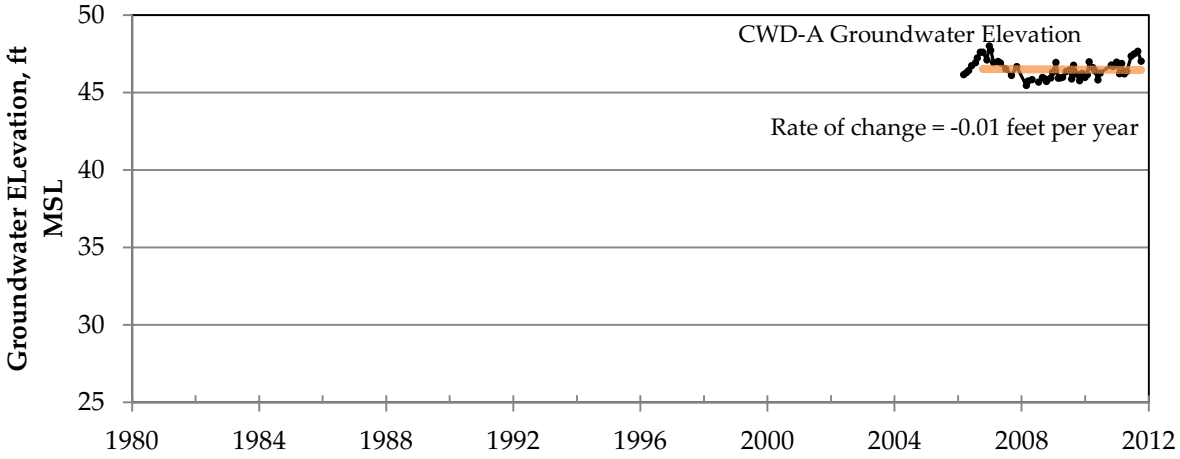

SC-A7D Total Dissolved Solids
TDS, mg/L
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

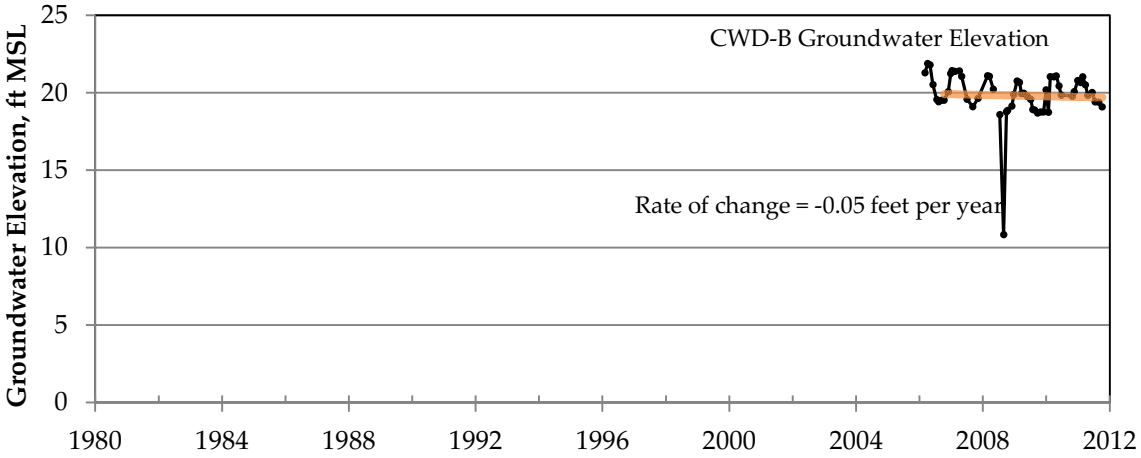

SC-A7D Groundwater Elevation
Groundwater Elevation, ft MSL
40
35
30
25
20
15
10
5
0
Measurements recorded after 2005 when
adjacent Sells well running excluded
1980
1984
1988
1992
1996
2000
2004
2008
2012

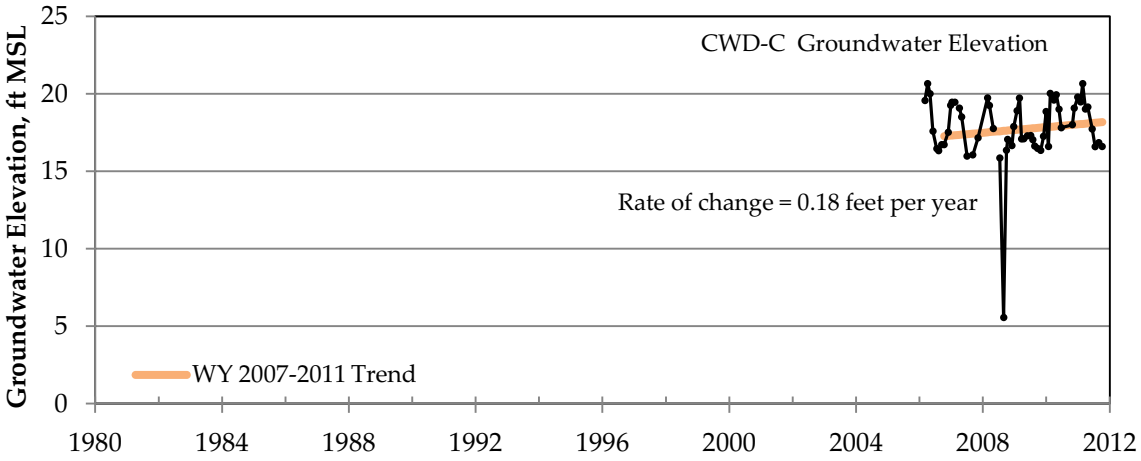

Rob Roy 4 Groundwater Elevation
Groundwater ELevation, ft MSL
Rate of change = -0.29 feet per year
40
30
20
10
0
-10
1980
1984
1988
1992
1996
2000
2004
2008
2012

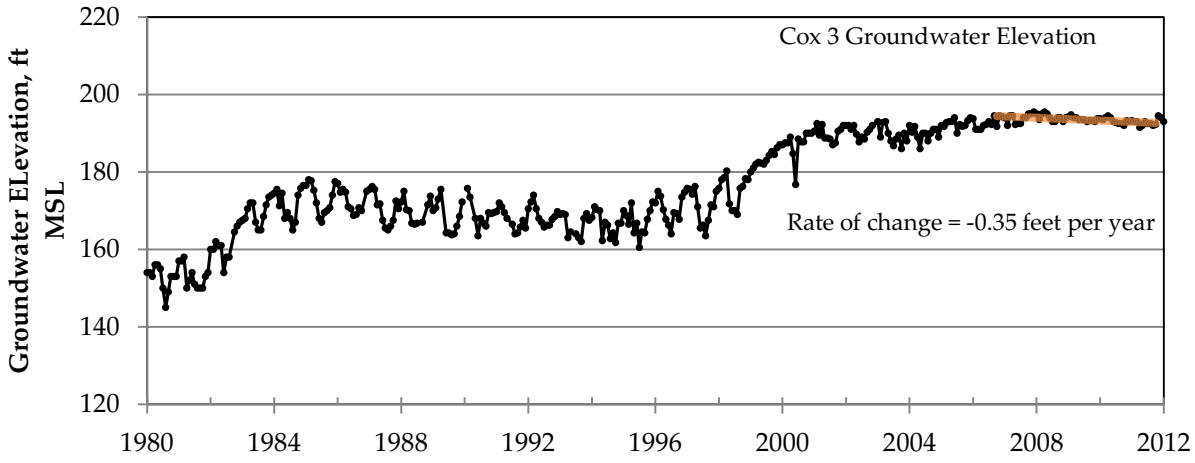

Rob Roy 10 Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = -0.17 feet per year
40
30
20
10
0
-10
1980
1984
1988
1992
1996
2000
2004
2008
2012

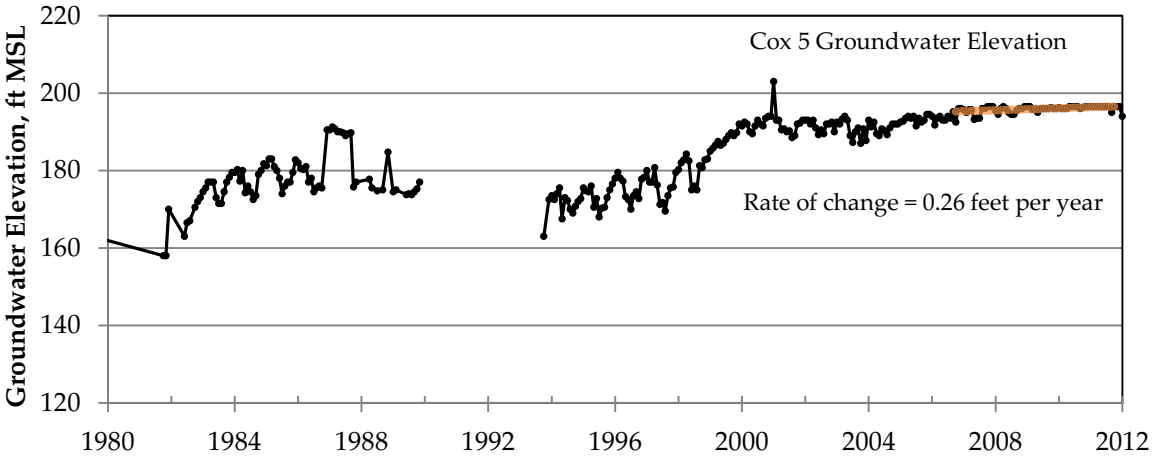

Rob Roy 12 Groundwater Elevation
Groundwater Elevation, ft MSL
Rate of change = -0.15 feet per year
WY 2007-2011 Trend
40
30
20
10
0
-10
1980
1984
1988
1992
1996
2000
2004
2008
2012

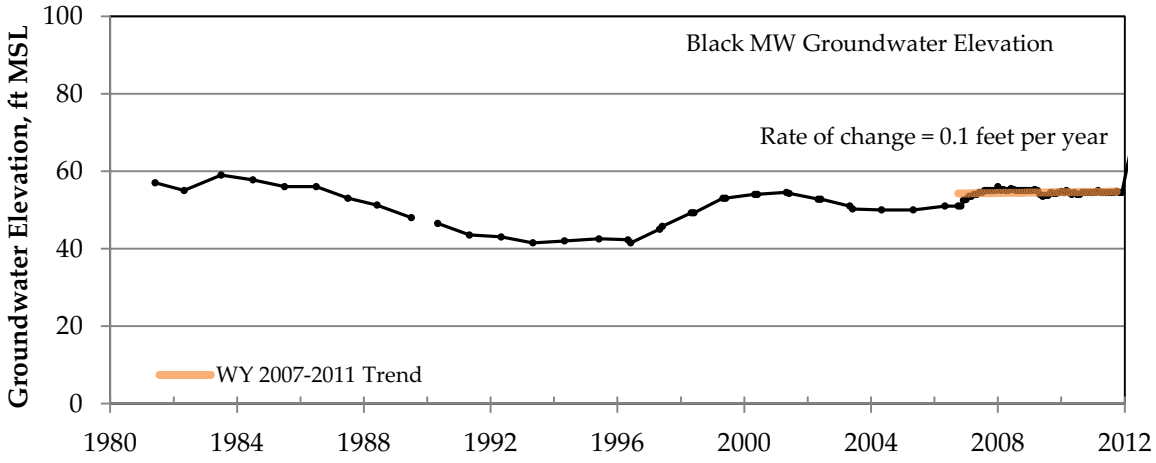

CWD-A Groundwater Elevation
Rate of change = -0.01 feet per year
Groundwater ELevation, ft MSL
50
45
40
35
30
25
1980
1984
1988
1992
1996
2000
2004
2008
2012


CWD-B Groundwater Elevation
Rate of change = -0.05 feet per year
Groundwater Elevation, ft MSL
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012


CWD-C Groundwater Elevation
Rate of change = 0.18 feet per year
WY 2007-2011 Trend
Groundwater Elevation, ft MSL
25
20
15
10
5
0
1980
1984
1988
1992
1996
2000
2004
2008
2012


Cox 3 Groundwater Elevation
Rate of change = -0.35 feet per year
Groundwater ELevation, ft MSL
220
200
180
160
140
120
1980
1984
1988
1992
1996
2000
2004
2008
2012


Cox 5 Groundwater Elevation
Rate of change = 0.26 feet per year
Groundwater Elevation, ft MSL
220
200
180
160
140
120
1980
1984
1988
1992
1996
2000
2004
2008
2012


Black MW Groundwater Elevation
Rate of change = 0.1 feet per year
WY 2007-2011 Trend
Groundwater Elevation, ft MSL
100
80
60
40
20
0
1980
1984
1988
1992
1996
2000
2004
2008
2012

SECTION 6
GROUNDWATER MANAGEMENT PLAN IMPLEMENTATION STATUS

6.1 STATUS OF BASIN MANAGEMENT OBJECTIVES

The 2007 Groundwater Management Plan (SqCWD and CWD, 2007) listed nine Basin Management Objectives (BMOs). The status of each of the BMOs during Water Year 2011 is summarized below. Each BMO in the Groundwater Management Plan (GMP) is listed, along with an assessment of how well the objective was met in Water Year 2011. Specific basin management activities, or elements, are discussed in Section 6.2.

BMO 1-1: PUMP WITHIN THE SUSTAINABLE YIELD

- In early 2012 SqCWD updated its estimates for its post-recovery pumping yields, which are meant to protect the Aromas and Purisima areas against seawater intrusion after groundwater levels recover to protective elevations. The post-recovery pumping yields are based on modeled offshore flows required to protect against seawater intrusion; along with estimated recharge, non-District consumptive use, and District consumptive use factors (HydroMetrics WRI, 2012). The 2012 updated estimates for post-recovery pumping yields show that pumping goals in the GMP may not be adequate to protect the basin against seawater intrusion after the basin recovers to protective elevations. The post-recovery pumping yield estimated for the Purisima area is 2,800 acre-feet per year as opposed to the pumping goal of 3,000 acre-feet per year in the GMP. The post-recovery pumping yield estimated for the Aromas area is 1,200 acre-feet per year; compared to the pumping goal of 1,800 acre-feet per year in the GMP.

- SqCWD's total groundwater pumping for Water Year 2011 was 4,030 acre-feet. SqCWD pumped 2,634 acre-feet from the Purisima area (Service Areas I and II). Pumping was less than the post-recovery pumping yield estimate of 2,800 acre-feet per year for the Purisima area for the third straight year. SqCWD pumped 1,396 acre-feet from the Aromas area (Service Areas III and IV including Aptos Jr. High). Although this is the lowest annual production by SqCWD from the Aromas area since Water

Year 1982, it remains above the post-recovery pumping yield estimate of 1,200 acre-feet per year.

- Based on post-recovery pumping yields adjusted for historical return flow percentages, accumulated pumping deficits were calculated for the approximately thirty year period when SqCWD production was above the post-recovery pumping yields. The accumulated pumping deficit in the Purisima area since 1979 totals 10,100 acre-feet. The accumulated pumping deficit in the Aromas area since 1982 totals 11,500 acre-feet (HydroMetrics WRI, 2012).

- To recover groundwater levels to protective elevations, pumping must be reduced below the estimated post-recovery pumping yields. SqCWD's current planning goal for allowing groundwater elevations to recover is to limit pumping to 2,900 acre-feet per year; with an estimated recovery time frame of 20 years (HydroMetrics WRI, 2012).

- Rainfall was above average in Water Year 2011, and SqCWD did not declare a drought curtailment. The decline in SqCWD production is mostly attributed to economic conditions, lack of corresponding development for completed water demand offsets, and weather conditions reducing outdoor irrigation demand; and does not reflect a permanent change in overall water use.

- CWD's groundwater pumping for Water Year 2011 was 19 acre-feet in the Purisima Formation and 464 acre-feet in the Aromas Red Sands, which meets CWD's target objectives for pumping within the sustainable yield.

- CWD has been within its pumping targets consistently over the last 38 years.

- SqCWD and CWD's target pumping are within the context of a total estimated pumping in the basin. Other pumpers in the Soquel-Aptos Area include the City of Santa Cruz, small water systems, and private domestic and agricultural wells.

- The City of Santa Cruz pumped 531 acre-feet from the Purisima area in calendar year 2011. This amount is below the 575 acre-feet per year estimate (Johnson et al., 2004) that was assumed for estimating SqCWD's post-recovery pumping yield and similar to the 525 acre-feet per year future production planned by the City in non-critically dry years (Chambers Group, 2011).

- Water Year 2011 was the first year the City of Santa Cruz has pumped more than 3% above the 575 acre-feet per year estimate by Johnson et al. (2004) since 1994.

- Except for updated pumping estimates for Polo Grounds Park in 2007 and Cabrillo College in 2009, there have been no updates on pumping estimates for other pumpers, such as private wells and small water systems, since the GMP was enacted.

- Measured pumping amounts meet numerical targets set under this BMO in the GMP; however, groundwater levels remain below protective elevations (BMO 2-2). The basin remains in overdraft and pumping will need to be reduced below updated post-recovery pumping yields to recover groundwater levels in the basin.

BMO 1-2: DEVELOP ALTERNATIVE WATER SUPPLIES TO ACHIEVE A LONG-TERM BALANCE BETWEEN RECHARGE AND WITHDRAWALS TO MEET CURRENT AND FUTURE DEMAND

- The pilot plant for the Santa Cruz Water Department/Soquel Creek Water District (SCWD^2) Regional Seawater Desalination Project completed testing in April 2009. The pilot study report was issued in 2010. A report on technology innovations and system optimization was issued in 2011.

- Environmental review and design were initiated for the Regional Seawater Desalination Project. The Notice of Preparation and Initial Study for the Regional Seawater Desalination Project was issued in November 2010. A scoping report was issued in February 2011 that summarizes public comment on the proposed scope and content of the Environmental Impact Report.

- Final reports of studies for the desalination plant including a watershed sanitary survey, open ocean intake study, offshore geophysical survey, dilution study of brine disposal were issued in 2010. A study on screened open intake and subsurface intake options was issued in 2011. The report on the energy minimization and greenhouse gas reduction study is due to be finalized in 2012.

- A tentative priority system for distributing water produced by the desalination plant has been developed. The plan provides for at least 1,148 acre-feet per year in all years to SqCWD for in-lieu recharge of the groundwater basin.

- Other alternative water supplies listed in SqCWD's Integrated Resources Plan (ESA, 2006) continue to be evaluated. SqCWD's water recycling planning study concluded that construction of satellite reclamation plants (SRP) to provide recycled water is not cost-effective (Black and Veatch, 2009). SqCWD could pursue grants to fund the SRP construction, although the yield from this source would be much less than required to recover and balance the basin based on projected demand.

- The County has evaluated the feasibility and benefits of interties and water transfers among water agencies in northern Santa Cruz County. Information about using excess winter flows in the San Lorenzo River to potentially meet 30% of SqCWD's winter demand was presented in 2011 (Khalsa, 2011). The study is ongoing.

- SqCWD, CWD, and the City of Santa Cruz continue to maintain and update their conservation programs to reduce current and future demand.

BMO 1-3: MANAGE GROUNDWATER STORAGE FOR FUTURE BENEFICIAL USES AND DROUGHT RESERVE

- Groundwater pumping in Water Year 2010 was not below the most recent estimates of the sustainable yield; therefore water was not stored for future beneficial uses and drought reserve.

- The GMP states that "achieving this objective is likely to depend on first achieving BMO 1-1 and BMO 1-2 since storing surplus water will not be possible without first eliminating overdraft conditions and developing alternative supplies." BMO 1-1 has not been met because the GMP pumping goal exceeds the sustainable yield as recently evaluated. The potential desalination plant identified under BMO 1-2 is not scheduled for completion until 2016 at the earliest.

BMO 2-1: MEET EXISTING WATER QUALITY STANDARDS FOR BENEFICIAL USES, SUCH AS DRINKING WATER STANDARDS

- Drinking water from SqCWD and CWD municipal wells was tested according to Title 22 requirements. In Water Year 2011, raw groundwater pumped by SqCWD from the Purisima Formation met all water quality standards except for iron, manganese, color and turbidity. Raw groundwater from the Purisima Formation was treated to meet water quality standards for these constituents; all delivered water met drinking water standards. In Water Year 2011, groundwater pumped by SqCWD from the Aromas Red Sands met all drinking water standards, thereby meeting the basin management objective for the Aromas Red Sands aquifer. Water delivered by CWD from its Purisima Formation and Aromas Red Sands sources met all drinking water standards.

- Groundwater from SqCWD monitoring wells was tested regularly for indications of seawater intrusion. TDS and chloride concentrations in Aromas monitoring wells show long term seawater intrusion. No new intrusion was detected in monitoring wells that were previously un-impacted.

- Groundwater at two City of Santa Cruz monitoring wells have TDS and chloride concentrations that suggest seawater intrusion.

- Testing at SqCWD's Sells well showed concentrations at or just under the maximum contaminant limit for nitrates. The Sells well was taken out of service in April 2009. Concentrations from the offline well continued to be above the maximum contaminant limit in 2010.

BMO 2-2: MAINTAIN GROUNDWATER LEVELS TO PREVENT SEAWATER INTRUSION

- Water Year 2011 groundwater levels at one of five SqCWD coastal monitoring well clusters in the Purisima area met protective elevations as outlined in *Groundwater Levels to Protect against Seawater Intrusion and Store Freshwater Offshore* (HydroMetrics LLC, 2009b). Average groundwater levels at well SC-1A rose above protective elevations for the first time since Water Year 1999.

- Water Year 2011 groundwater levels at two of five SqCWD coastal monitoring well clusters in the Aromas area met protective elevations as revised in *Revised Protective Elevations and Outflows for the Aromas Area and Updated Water Balance for the Soquel-Aptos Groundwater Basin* (HydroMetrics WRI, 2012). Average groundwater levels at the northwestern SC-A1 and SC-A8 wells have been above revised protective elevations for most of the monitoring record.

- Water Year 2011 groundwater levels at City of Santa Cruz coastal monitoring wells met protective elevations as proposed by the City (Almond, 2010) at one of three well clusters. Average groundwater levels at the Pleasure Point well have been above protective elevations Water Year 2010-2011.

- Groundwater levels will not meet all protective elevations until BMO 1-2 is achieved together with pumping in the basin being maintained below post-recovery pumping yields.

BMO 2-3: PREVENT AND MONITOR CONTAMINANT PATHWAYS

- SqCWD and CWD continue to implement the well abandonment requirements in Santa Cruz County's well ordinance.

- SqCWD has not updated its Drinking Water Source Assessment and Protection (DWSAP) reports (Todd Engineers, 2002 and LSCE, 2002) since the GMP has been enacted.

- SqCWD submitted a DWSAP report for the Aptos Jr. High well to State Department of Public Health in 2011 (HydroMetrics WRI, 2011b).

- CWD submitted updated DWSAP reports (Johnson, 2009) to State Department of Public Health in Water Year 2009.

- Santa Cruz County is scheduled to use Proposition 50 bond funding to implement a well destruction program in 2012.

BMO 3-1: MAINTAIN OR ENHANCE THE QUANTITY AND QUALITY OF GROUNDWATER RECHARGE BY PARTICIPATING IN LAND USE PLANNING PROCESSES

- SqCWD and CWD continue to support Santa Cruz County efforts to review land use proposals in Primary Recharge Areas and identify projects to enhance groundwater recharge. SqCWD has a representative on the Technical Advisory Committee for these efforts.

- CWD continued to maintain much of its area as a primary recharge area.

BMO 3-2: AVOID ALTERATION OF STREAMFLOWS THAT WOULD ADVERSELY IMPACT THE SURVIVAL OF POPULATIONS OF AQUATIC AND RIPARIAN ORGANISMS

- SqCWD continued to monitor streamflow and shallow groundwater levels near Soquel Creek.

- Analyses of these data are not included in this report, but it is recommended that the data are analyzed regularly in a separate report, particularly as new production wells are installed.

- SqCWD's finalized its Well Master Plan EIR in 2011 (ESA, 2011). The EIR includes measures for monitoring streamflow at Soquel Creek and Aptos Creek, and pumping modifications if baseflow depletion related to future pumping from the proposed O'Neill Ranch Well and Austrian Way Well are detected.

- SqCWD continued discussions in 2011 with Santa Cruz County and National Marine Fisheries Service regarding a stream monitoring and adaptive management plan for Soquel Creek. The plan includes a new shallow monitoring well and stream water level gauge and will be submitted to the resource agencies in 2012.

BMO 3-3: PROTECT THE STRUCTURE AND HYDRAULIC CHARACTERISTICS OF THE GROUNDWATER BASIN BY AVOIDING WITHDRAWALS THAT CAUSE SUBSIDENCE

- No subsidence was reported in Water Year 2011.

6.2 STATUS OF BASIN MANAGEMENT ELEMENTS

The Soquel-Aptos Basin Groundwater Management Plan Update includes 14 elements. Elements are the specific projects, programs, and policies that are planned for management of the Basin. Action items were identified for each element. This section provides a summary and status of the action items included in each element. Status descriptions were provided by SqCWD, CWD, City of Santa Cruz, Santa Cruz County, and Pajaro Valley Water Management Agency.

ELEMENT 1: GROUNDWATER MONITORING

1. ***Continue and expand existing regional groundwater monitoring programs***

   SqCWD and CWD continued measuring groundwater levels and sampling groundwater quality from their network of monitoring and production wells as described in the GMP.

   SqCWD has expanded its network by adding monitoring wells:

   - In Water Year 2008, quarterly groundwater level measurements were initiated at the SC-19 well at Austrian Way and monthly groundwater level measurements and quarterly water quality measurements were initiated at the three SC-A8 wells located at Dolphin Drive and Sumner Avenue.
   - In Water Year 2009, SqCWD installed three SC-20 monitoring wells at Polo Grounds Park using Proposition 50 bond funding. Data loggers were installed in these new wells to continuously record groundwater levels.
   - In Water Year 2012, SqCWD has installed new monitoring wells at the Cornwell Road Tank Site and on 41st Ave in the Western Purisima.

The City of Santa Cruz continued measuring groundwater levels and sampling groundwater quality at its network of monitoring wells. In early 2010, the City of Santa Cruz expanded its network when it installed monitoring wells at three new locations: Coffee Lane Park, Cory Street, and Auto Plaza Drive. Groundwater levels are measured monthly and groundwater quality is sampled semi-annually at all City of Santa Cruz's monitoring wells.

Santa Cruz County Environmental Health Services monitors groundwater levels in approximately 35 private and small water system wells constructed in the Purisima and Aromas aquifers. Most wells are measured semi-annually (spring and fall), but a smaller group of wells in the Valencia Creek area are measured monthly.

2. ***Continue shallow Groundwater Monitoring Program***

SqCWD continued to monitor groundwater levels in shallow wells along Soquel Creek.

3. ***Share and consolidate monitoring data among all agencies overlying the Soquel-Aptos Area Basin***

In 2009, the state enacted legislation (SBX7-6) implementing the California Statewide Groundwater Elevation Monitoring (CASGEM) program, requiring submittal of groundwater level data for all groundwater basins in the state. Groundwater elevation data from the Soquel-Aptos basin are being submitted to the State as part of the County-wide data submittals. With the support of the Basin Advisory Group, Santa Cruz County is the reporting entity for all groundwater basins in the County. PVWMA staff has developed a framework for the database that will be used to submit the data to the state. County staff prepared and submitted the coordinated monitoring plan to the state in 2011 (Khalsa, 2011). Submittals will begin in 2012.

Additional data are shared by SqCWD, CWD, Pajaro Valley Water Management Agency, the City of Santa Cruz, and Santa Cruz County in an ad-hoc manner. SqCWD's file transfer protocol (FTP) site is used for the agencies to upload and download data.

The County currently plans to integrate groundwater level data with other water resources data in the coordinated database being developed through the Integrated Regional Water Management Program.

4. Analyze data and assess the adequacy of the monitoring well network annually

Analyses of groundwater data are discussed in Sections 3-5.

In Water Year 2008, SqCWD began implementing recommendations in the *Evaluation of Water Quality Monitoring Network and Recommendations for Improvement* (HydroMetrics LLC, 2007) by installing new sampling equipment and identifying monitoring wells that need to be replaced.

Starting in 2007, SqCWD has installed bladder pumps in wells SC-1A, SC-8A, SC-8B, SC-A2C, SC-A4D, SC-A8A, SC-A8B, and SC-A8C.

In Water Year 2009, SqCWD replaced the three SC-3 monitoring wells at Escalona Drive because they were providing unreliable data. The new wells were outfitted with groundwater level data loggers and bladder pumps. Water quality measurements will continue to be measured quarterly at this location.

Monitoring wells SC-8F, SC-9A, and SC-A2 have also been identified as needing replacement. These wells were replaced in 2012, along with wells SC-9C and SC-9E. Wells SC-9B and SC-9D were destroyed and not replaced, as SC-9C and SC-9E provide more representative data of the aquifer units.

Based on an Assessment and Informational Update of the Groundwater Management Program, SqCWD's board approved a plan in 2009 for retrofitting existing monitoring wells with groundwater level data loggers and bladder pumps. In addition to the SC-3 monitoring wells, groundwater level loggers are currently installed in SC-1A, SC-8D, SC-18A, SC-20A, SC-20B, SC-20C, SC-A1B, SC-A6A , SC-A6C, and SC-A8B.

5. ***Coordinate with other groundwater resource agencies to develop uniform data collection procedures and data sharing protocols***

   Minimum standards for monitoring protocols have not yet been set for all agencies in the Soquel-Aptos Area Basin.

   SqCWD continued to support Santa Cruz County efforts to create a GIS well layer for information about private wells in Santa Cruz County. The database has information about 6,000 private wells throughout the County. The County provided a GIS layer of monitored private wells for use in this annual report.

   The County has begun development of a coordinated database for water resources data through the Integrated Regional Water Management Plan using Proposition 50 funds.

6. ***Develop an outreach program to obtain groundwater level data from private pumpers within the Soquel-Aptos area***

   In 2008, Santa Cruz County established a voluntary groundwater monitoring program with private well owners in the Soquel-Aptos basin and provided the data for use in this annual report.

   As part of the Well Master Plan EIR, SqCWD is including a voluntary monitoring and mitigation program for private wells within 1,000 meters of new SqCWD production wells (ESA, 2010). The program includes collection of production and groundwater level data at private wells to monitor for restrictive effects related to pumping of a new SqCWD well. Thirteen private wells near the Polo Grounds well enrolled in the program and monitoring at these wells commenced in 2011.

ELEMENT 2: SURFACE WATER MONITORING

1. ***Monitor stream gauges on Soquel Creek to identify and track changes in baseflow conditions***

   SqCWD continued to monitor streamflow and temperature at the Upper Soquel Creek and West Branch stream gauges. Data loggers record stream elevations every 15 minutes, and the data are downloaded and converted to daily values once a month. SqCWD continued to contribute toward the cost

to operate and maintain the Soquel Creek Stream Gauging Station at Bridge Street along with Santa Cruz County and the U.S. Geological Survey.

The County also continued a sediment monitoring program on Soquel Creek and the West Branch. This effort will continue for at least one more year.

SqCWD's Well Master Plan EIR contains plans for monitoring streamflow on Soquel Creek (ESA, 2011). A stream monitoring and adaptive management plan including a new shallow monitoring well and stream water level gauge downstream of the planned O'Neill Ranch and City of Santa Cruz Beltz #12 wells will be submitted to the resource agencies in 2012. In its response to comments on Beltz #12 EIR, the City committed to partner with SqCWD in developing and implementing the plan (Almond, 2011).

2. ***Monitor rainfall in the Soquel-Aptos Area Basin to establish rainfall-runoff relationship***

SqCWD continued to collect rainfall data at the Mancarti and Kraeger/Longridge Rain Gauges within the Soquel Creek Watershed. Data loggers record values every 15 minutes, and the data are downloaded and converted to daily values once a month.

SqCWD, CWD, and the City of Santa Cruz cooperatively funded a study to estimate the spatial and temporal variation in deep groundwater recharge. The study used daily rainfall data at four coop climate stations in and around the Soquel-Aptos Basin in addition to the Mancarti and Kraeger/Longridge gauges to estimate deep recharge.

3. ***Monitor selected shallow wells adjacent to creeks to identify and quantify stream aquifer interactions. Coordinate a meeting with SqCWD and the County of Santa Cruz to discuss future analysis of the shallow well monitoring data from 2003 – 2006***

SqCWD continued to measure shallow groundwater levels at the four monitoring sites along the eastern side of Soquel Creek: Simons, Balogh, Main Street, and Nob Hill.

Analysis of these shallow groundwater levels was provided in the *Water Year 2007 Annual Review and Report* (HydroMetrics LLC, 2009a). Santa Cruz County is on the Basin Advisory Group that reviewed the analysis.

SqCWD will install a new shallow well on the west side of Soquel Creek in 2012.

4. ***Analyze stream gauge data, rainfall data, and shallow monitoring data annually***

   Data from the above three monitoring programs were analyzed in the *Water Year 2007 Annual Review and Report* (HydroMetrics LLC, 2009a). Additional analysis is not included in this report, but further analysis will be included in a separate report before the proposed O'Neill Ranch becomes operational as part of the improvement measure approved for the Well Master Plan EIR. Additional reporting may be necessary in the future as the surface water monitoring program is expanded to other creeks such as Aptos Creek.

5. ***Support stream monitoring and management activities along Aptos Creek and Valencia Creek***

   The County has maintained a program of streamflow and sediment monitoring on Valencia Creek since September 2008.

   SqCWD's Well Master Plan EIR contains measures for monitoring streamflow on Aptos Creek, including installation of a new streamflow gauge downstream of the proposed Austrian Way well (ESA, 2011).

   The Aptos Creek pathogen TMDL has been adopted by the Regional Water Quality Control Board. The sediment TMDL for the Aptos watershed is on hold because management measures are being implemented through the Santa Cruz County Stormwater Management Program (Briggs, 2007). Stormwater management plans for the County were approved by the State Regional Water Quality Control Board in 2009 and implementation activities are ongoing.

   SqCWD continued its ongoing funding and review of stream habitat and juvenile salmonid (steelhead and coho salmon) monitoring in the Soquel and Aptos Creek watersheds as part of the Santa Cruz County Stream Habitat and Juvenile Salmonid Sampling Program.

ELEMENT 3: SUBSIDENCE MONITORING

1. ***Develop and implement a GPS based subsidence monitoring program***

   SqCWD and CWD have not initiated work to develop and implement a subsidence monitoring program.

2. ***Analyze data and assess the frequency of the subsidence monitoring***

   This action item cannot be performed until a subsidence monitoring program is implemented.

3. ***Review other means of subsidence measuring and monitoring***

   SqCWD and CWD have not reviewed alternate means of measuring and monitoring subsidence.

ELEMENT 4: INTERAGENCY COORDINATION

1. ***Develop and secure a supplemental source of supply with the City of Santa Cruz***

   The pilot plant for the Santa Cruz Water Department/Soquel Creek Water District (SCWD^2) Regional Seawater Desalination Project completed testing in 2009. Environmental review and design were initiated for the Regional Seawater Desalination Project in 2010. A Notice of Preparation and Initial Study for Environmental Impact Report of the Regional Seawater Desalination Project was issued in November 2010. A scoping report was issued in February 2011 that summarizes public comment on the proposed scope and content of the Environmental Impact Report.

2. ***Continue to cooperatively manage groundwater under the provisions of the Soquel Aptos Groundwater Management Alliance (SAGMA)***

   SAGMA continues to meet annually to discuss management of the groundwater basin. SAGMA makes up most of the Basin Advisory Group that reviews this annual report.

3. ***Expand the Soquel-Aptos Groundwater Management Authority to include other water resource agencies that have jurisdiction within the Soquel-Aptos area***

   The Soquel-Aptos Groundwater Management Authority has not been expanded and the area subject to the GMP remains the areas of SqCWD and CWD. However, the City of Santa Cruz indicated in 2009 an interest in joining the GMP.

4. ***Continue to support the USGS GAMA project and work cooperatively with USGS, State, and regional agencies to improve statewide monitoring***

   The Groundwater Ambient Monitoring and Assessment Program (GAMA) last tested private and public wells in the Soquel-Aptos area in 2005 (Kulongoski and Belitz, 2007). The GAMA program intends to sample a subset of these wells every three years to establish groundwater quality trends. SqCWD and CWD will support the USGS as it conducts new sampling at wells in the Soquel-Aptos area.

5. ***Continue to support the USGS Soquel Creek Stream Gauging Station***

   SqCWD continues to contribute toward the cost to operate and maintain the Soquel Creek Stream Gauging Station at Bridge Street in Soquel.

6. ***Continue to participate and support the Northern Santa Cruz County Integrated Regional Water Management Plan (IRWMP)***

   Proposition 50 funding for projects identified in the IRWMP has reimbursed the 2009 construction of monitoring wells at the Polo Grounds Park. SqCWD is currently using Proposition 50 funding to convert the Polo Grounds irrigation well to a municipal well. SqCWD and CWD support Santa Cruz County in its plans to use funding for abandoned well destruction and projects to enhance groundwater recharge. Funding has also been awarded for intake study costs of the regional desalination plant.

   A Proposition 84 planning grant for IRWMP studies was approved by the State in 2011. Included in the approved studies was the Aromas and Purisima Groundwater Basin Management Study. This study will be conducted by CWD and will evaluate maximizing the developable yield in CWD's Cox Well Field; address concerns about Chromium VI in the CWD

service area; and address SqCWD's Aromas water quality and overdraft concerns. This study will take place in 2012.

The general manager of SqCWD serves on the Board of the Regional Water Management Foundation which oversees the implementation of the Santa Cruz Integrated Regional Water Management Plan (IRWMP). The SqCWD general manager is a member of the IRWMP steering committee. An update of the IRWMP will also be completed using Proposition 50 funding.

7. ***Support implementation of Pajaro Valley Water Management Agency's (PVWMA) Basin Management Plan and PVWMA/City of Watsonville efforts to develop the Watsonville Area Water Recycling Project***

   SqCWD and CWD continue to support implementation of PVWMA's Basin Management Plan (BMP) and the Watsonville Area Water Recycling Project, which began operation in April 2009. From 2009-2011, approximately 4,900 acre-feet of recycled water was produced and 7,750 acre-feet of blended water was delivered by the Coastal Distribution System. The update of the BMP commenced in 2011 and the Conservation and Customer Service Field Manager of SqCWD serves on the ad-hoc BMP Advisory Committee. The update is expected to be completed in 2012.

8. ***Support PVWMA efforts to develop a numerical model of the Pajaro Valley groundwater basin***

   PVWMA has developed the Pajaro Valley Hydrologic Model, a numerical model of the Pajaro Valley basin. SqCWD had a representative on the model's Technical Advisory Committee, which approved the final model in 2010. SqCWD and CWD also provided data for the model. The model is being used in the update to PVWMA's Basin Management Plan.

9. ***Support the Central Coast Regional Water Quality Control Board's (RWQCB) Implementation Strategy for the Aptos Watershed Sediment Total Maximum Daily Load (TMDL) Report***

   RWQCB decided in 2007 to implement management measurements for sediment impairment of the Aptos watershed through the Santa Cruz County Stormwater Management Program (Briggs, 2007). The State Water Resources Control Board approved the County's Storm Water Management Plan in Water Year 2009. The County completed a draft runoff and pollution control

ordinance, draft stormwater construction best management practices manual, and updates to design criteria for stormwater management in 2011. SqCWD and CWD continue to support the County's implementation of stormwater management.

10. Action Items not Included in Groundwater Management Plan

In 2011, SqCWD and CWD agreed on cooperative groundwater management to monitor and mitigate any impacts on CWD's wells from operating the Polo Grounds well, which is being converted from park irrigation to municipal use.

SqCWD and CWD staff participated with County staff in a 2009 joint meeting of the County Water Advisory Commission and the Commission on the Environment to discuss local issues related to water supply and climate change. The County is sponsoring a U.S. Geological Survey study of climate change effects on County hydrology and water agency staff; and consultants from SqCWD and the City of Santa Cruz have reviewed preliminary results.

SqCWD, CWD, and the City of Santa Cruz cooperatively funded a study to estimate the spatial and temporal variation in deep groundwater recharge that was completed in 2011 (HydroMetrics WRI, 2011a).

SqCWD, CWD, the City of Santa Cruz, and PVWMA are working with the County to provide groundwater level data for submission to the state under the new California Statewide Groundwater Elevation Program (CASGEM).

The County, City of Santa Cruz, SqCWD, and CWD are coordinating water conservation efforts.

ELEMENT 5: DEVELOP A SUPPLEMENTAL SOURCE OF SUPPLY

1. Develop and secure a supplemental water supply suitable for implementing a conjunctive use program

The pilot plant for the Santa Cruz Water Department/Soquel Creek Water District (SCWD²) Regional Seawater Desalination Project completed testing in April 2009. A Notice of Preparation and Initial Study for Environmental Impact Report of the Regional Seawater Desalination Project was issued in November 2010. A scoping report was issued in February 2011. A tentative

priority schedule for water produced at the plant will provide at least 1,148 acre-feet per year to SqCWD for implementing a conjunctive use program.

2. ***Explore and pursue funding opportunities for supplemental supply projects***

SqCWD and CWD supported the IRWMP that was awarded Proposition 50 funding for intake study costs related to the desalination plant. SqCWD also received grant funding in 2008 to study the feasibility and cost-effectiveness of constructing satellite reclamation plants to provide recycled water. The recommendation from this study concluded that construction of satellite reclamation plants to provide recycled water is not cost-effective and SqCWD would need to obtain additional funding to pursue the project (Black and Veatch, 2009).

SqCWD participated with the County and City of Santa Cruz in the evaluation of the potential to utilize the City of Santa Cruz facilities to divert and treat excess winter streamflow from the San Lorenzo River to SqCWD during the months of November through April to allow reduction in groundwater pumping and in lieu recharge. SqCWD and Santa Cruz are participating in the next phase of evaluating the feasibility of this project, using a Prop 84 IRWM Planning grant.

ELEMENT 6: PROTECT EXISTING RECHARGE ZONES

1. ***Support existing Santa Cruz County efforts to update Groundwater Recharge Maps that identify primary groundwater recharge zones***

SqCWD and CWD continue to support Santa Cruz County efforts to update these maps. The County has updated primary groundwater recharge maps using electronic GIS data on soils and geology. The County also has soil information to assist with identifying secondary recharge areas as needed.

SqCWD, CWD, and the City of Santa Cruz cooperatively funded a study to estimate the spatial and temporal variation in deep groundwater recharge. The study used daily rainfall data at four coop climate stations in and around the Soquel-Aptos Basin in addition to the Mancarti and Kraeger/Longridge gauges to estimate deep recharge. This study identifies where most of the basin recharge takes place.

2. ***Support PVWMA's efforts to optimize recharge and recovery, and develop an ASR (Aquifer Storage and Retrieval) Project in the Aromas Red Sands***

PVWMA has developed, and is operating, its Harkins Slough Aquifer Storage and Retrieval (ASR) Project. This ASR project involves seasonal percolation of diverted Harkins Slough water into the Harkins Slough recharge basin for storage until the irrigation season, when it is extracted and delivered to the Coastal Distribution System (CDS) for distribution. The construction of the Harkins Slough diversion structure and recharge basin was completed in Fall 2001. The project has operated every year since 2002. Between 2002 and 2011, 6,780 acre feet of water have been diverted from Harkins Slough and pumped to the percolation pond. Recovery wells have extracted nearly 1,530 acre feet of diverted water for distribution in the CDS. The remaining water is left to recharge the Alluvial and Aromas Red Sands aquifers. Ongoing studies being performed by the University of California, Santa Cruz (hydrogeology), and Stanford University (geophysics) are meant to provide data to help understand the hydrologic structure that controls recharge and recovery. SqCWD and CWD wrote letters of support for PVWMA's successful Local Grant Assistance (AB303) grant application to study the recharge processes beneath the pond with the goal of gaining better understanding of the fate of percolated water. The study, called the Harkins Slough Project Re-Operation Feasibility Study began in 2010 with the installation of three new monitoring wells and is expected to be completed in 2012.

3. ***Support future efforts to characterize recharge areas within the Soquel-Aptos area***

The data from the GAMA project (Kulongoski and Belitz, 2007) are expected to include chemical analyses that will help characterize recharge areas. A full review of these data to perform this characterization has not taken place.

SqCWD, CWD, and the City of Santa Cruz cooperatively funded a study to estimate the spatial and temporal variation in deep groundwater recharge. The study used daily rainfall data at four coop climate stations in and around the Soquel-Aptos Basin in addition to the Mancarti and Kraeger/Longridge gauges to estimate deep recharge. This study identifies where most of the basin recharge takes place.

4. ***Coordinate and expand efforts between groundwater management agencies and the County of Santa Cruz to establish regulations for land use within Primary Recharge Areas***

   SqCWD and CWD continue to support County efforts to review land use proposals within Primary Recharge Areas.

ELEMENT 7: ENHANCE GROUNDWATER RECHARGE

1. ***Enhance groundwater recharge with stormwater runoff***

   SqCWD and CWD continue to support Santa Cruz County efforts to identify projects to enhance groundwater recharge. The County is leading a Proposition 50 funded effort to implement demonstration projects to restore groundwater infiltration from developed areas at Polo Grounds Park and Brommer Street Park within the Groundwater Management Area. Installation of two separate facilities at Polo Grounds Park was completed in October/November 2011. The Resource Conservation District of Santa Cruz County is also implementing a separate grant funded project to promote recharge through home drainage improvements, including outreach and technical assistance.

   CWD supported Aptos High School with its recharge pond project in 2008.

2. ***Develop and implement standards that require discretionary projects in primary recharge zones to maintain or increase a site's pre-development absorption of runoff***

   SqCWD and CWD continue to support County efforts to develop a program that will include standards regulating impervious surfaces and provide measures to increase groundwater recharge. The County is working with RWQCB to develop requirements for Low Impact Development to address hydromodification impacts as required in the County's stormwater plan. The County completed a draft runoff and pollution control ordinance, stormwater construction best practices manual, and updates to design criteria for stormwater runoff in 2011.

3. ***Support County of Santa Cruz efforts to prioritize potential sites for drainage facilities, and implement construction***

   SqCWD and CWD continue to support County efforts to identify drainage facilities with potential for groundwater recharge.

4. ***Participate in public outreach and awareness for groundwater recharge***

   SqCWD and CWD supported the County and Resource Conservation District (RCD)'s implementation of the grant funded projects to promote recharge.

5. ***Investigate the water storage potential of the Aromas Red Sands***

   Potential projects for enhanced recharge in the Pleasant Valley/Freedom Blvd. area may be considered by SqCWD and CWD.

ELEMENT 8: MANAGE PUMPING

1. ***Locate, design, and install additional and replacement production wells to improve pumping distribution, disperse the basin's overall drawdown and improve operational flexibility***

   SqCWD published its draft EIR for the Well Master Plan in 2010. After responding to comments, SqCWD certified the EIR in 2011 and approved the Polo Grounds well, Cunnison Lane well, Granite Way well, O'Neill Ranch well, and Austrian Way well projects. The first of the new municipal wells to be brought online is the Polo Grounds well. SqCWD is constructing a treatment plant for this well in 2012. Construction of the O'Neill Ranch well is scheduled for 2012.

2. ***Continue to encourage private well users located within critical groundwater areas of the Soquel-Aptos basin to discontinue pumping and connect to the local municipal water supply systems***

   SqCWD continued to use its Private Well Incentive Policy to encourage private well users located in critical groundwater areas to properly abandon their wells and connect to the District's distribution system.

   SqCWD has coordinated with the Potbelly Beach Club to remove 19 residences from coastal wells and connect to the District's distribution

system. This project was completed in 2011, although there are five additional homes that remain on existing wells and may be connected in the future.

3. ***Cooperatively work with City of Santa Cruz to develop a coordinated pumping plan for the City's Live Oak wells and SqCWD's Purisima wells***

   SqCWD and the City of Santa Cruz met in 2010 to develop a cooperative groundwater management agreement. SqCWD revised its monitoring and mitigation plan in the Well Master Plan EIR (ESA, 2011) in response to comments from the City. The City sought and received feedback from SqCWD on its CEQA documentation for its proposed new inland well, Beltz #12. The Beltz #12 EIR was certified by the City in 2011 (Chambers Group, 2011). SqCWD's and the City's EIRs are consistent in the amount of planned future maximum pumping by the City from its existing coastal production wells and Beltz #12 will be 525 acre-feet per calendar year during non-critically dry years and 645 acre-feet per calendar year during critically dry years.

4. ***Analyze groundwater level/quality data and groundwater pumping data at least annually, and recommend changes to the groundwater pumping distribution as necessary***

   This analysis is completed in Sections 2-5. SqCWD's consulting hydrologist has made informal recommendations to SqCWD for changes to groundwater pumping distribution, but significant changes to the pumping distribution cannot be made until the Well Master Plan is implemented.

   SqCWD completed installing groundwater level transducers in all of its production wells in Water Year 2010. The transducers are connected to SqCWD's SCADA system, allowing SqCWD to adjust pumping based on current pumping groundwater levels.

ELEMENT 9: IDENTIFY AND MANAGE CUMULATIVE IMPACTS

1. ***Encourage sustainable pumping from non-agency groundwater users***

   SqCWD worked with Cabrillo College, Trout Gulch Mutual, PureSource Mutual, Seascape Greens and Seascape Golf Course to improve water use efficiency and implement conservation opportunities.

2. ***Identify and manage well interference and manage groundwater storage for beneficial uses and drought reserve***

   Groundwater levels in production wells are monitored to assess whether cones of depression from other wells have caused lowered groundwater levels that result in an appreciable diminution in the quantity or quality of water pumped by that well. Based on monitoring data, well interference between the three agencies that operate municipal production wells in the Soquel-Aptos Area Basin has not been identified as an issue at this time. Well interference has been identified as an issue within the SqCWD system. Well production has been affected at the Estates and T. Hopkins wells due to cumulative drawdown.

   The Well Master Plan EIR includes monitoring and mitigation plans to address restrictive effects on nearby production wells after the Well Master Plan is implemented. The plans address private wells, the City of Santa Cruz's Live Oak well field, and CWD's Cox and Rob Roy well fields. Monitoring of private wells near the Polo Grounds well commenced in 2011. SqCWD installed monitoring wells on 41st Ave to monitor well interference between the City of Santa Cruz and SqCWD's production wells in 2012.

3. ***Install new wells in locations that reduce cumulative impacts***

   Cumulative effects of pumping the new wells in the Well Master Plan have been analyzed. Based on planned redistribution of pumping, the net cumulative effects of the Well Master Plan should be beneficial.

   Two of the new wells in the Well Master Plan, the Austrian Way and Granite Way wells, are intended to alleviate the identified cumulative impacts that affect the production of the Estates and T. Hopkins wells.

   The City of Santa Cruz certified its Environmental Impact Report (Chambers Group, 2011) for the Beltz #12 well at Research Park Drive and Cory Street to redistribute a portion of the City's projected drought year pumping to an inland location.

4. ***Continue to improve and quantify projected future demands from all groundwater users***

   SqCWD updated projections of future demands in Water Year 2009 to support analyses for the Well Master Plan EIR. Future projected demand was reduced 410 acre-feet per year from projections in SqCWD's *Integrated Resources Plan* (ESA, 2006) based on recent demand reductions. Updated demand projections were documented in the updated Urban Water Management Plan (SqCWD, 2011).

ELEMENT 10: WATER CONSERVATION

1. ***Continue and update the existing water conservation programs for SqCWD.***

   SqCWD continued a broad and multi-faceted water conservation program and added rebates for greywater, turf replacement and hot water recirculation devices. SqCWD adopted water use efficiency ordinances for indoor and outdoor use by new development and remodels, updated the water waste ordinance and began enforcement to prevent haulers from taking water from SqCWD bulk water stations outside the District. SqCWD also installed the first phase of a grant funded landscape demonstration project at its headquarters in 2010.

2. ***Continue and update the existing water conservation programs for CWD.***

   CWD continued its existing water conservation programs and opened a drought tolerant demonstration garden in Water Year 2009.

3. ***Annually report estimated savings from the ongoing water conservation program.***

   Water production by SqCWD in Water Year 2011 was the seventh straight year when production was at least 500 acre-feet less than the previous ten-year period average (1995-2004). Much of this continuing reduction is attributed to SqCWD's on-going conservation programs.

4. Action Items Not Included in Groundwater Management Plan.

The County is developing a water efficient landscape ordinance while implementing the state's water efficient landscape ordinance. The County is developing a package of measures to update and expand the County's water conservation measures that may include the creation of a water use impact fee. In 2009, amendments to the County well ordinance went into effect that resulted in increased water conservation by agricultural users and small water systems. New water use efficiency ordinances have been adopted for the SqCWD and City of Santa Cruz service areas. The County, SqCWD, the City of Santa Cruz, and the City of Capitola also worked with the local Greywater Alliance to establish procedures for use of greywater irrigation systems. SqCWD and CWD support these County efforts.

SqCWD's Urban Water Management Plan 2010 (SqCWD, 2011) includes criteria for declaring drought curtailments. The criteria are multi-year rainfall totals through March of the current year and are based on results from the Soquel-Aptos Area Recharge Model (HydroMetrics WRI, 2011a), a PRMS model that estimates the spatial and temporal variation in deep groundwater recharge

ELEMENT 11: SUPPORT THE DEVELOPMENT AND UPDATE OF POLICIES AND ORDINANCES FOR WELL CONSTRUCTION, ABANDONMENT, AND DESTRUCTION

1. Support existing well construction and well destruction standards, including the recent revisions to the County of Santa Cruz Well Ordinance

SqCWD and CWD worked closely with Santa Cruz County to implement revisions to the water well ordinance that went into effect March 23, 2009. SqCWD followed the revised ordinance when replacing monitoring wells SC-3 at Escalona Drive and constructing the new monitoring well cluster at Polo Grounds.

2. Support County of Santa Cruz's well destruction program

SqCWD and CWD support Santa Cruz County's abandoned well destruction program. With the support of the agencies through the IRWMP, the County

was awarded Proposition 50 water bond funding to destroy abandoned wells, an effort that is scheduled to take place by 2012.

SqCWD has identified one well at the County's Polo Grounds park for abandonment and destruction. Monitoring wells SC-5D and SC-5E have also been identified as needing proper destruction. Monitoring wells such as the SC-9 cluster and SC-8F will need to be properly destroyed when they are replaced in 2012. SqCWD will destroy SC-9, SC-8F, SC-5D, and SC-5E in 2012. The former production well at Madeline has also been identified for destruction.

3. ***Continue to implement SqCWD well destruction policy***

SqCWD continues to require property owners to properly destroy abandoned private wells before connecting to the SqCWD system.

4. ***Request Santa Cruz County Environmental Health Services establish a voluntary monitoring program of private wells, particularly in inland areas of the Soquel-Aptos groundwater management area***

The County has implemented this voluntary monitoring program of groundwater levels. Groundwater levels are being monitored semi-annually at wells in the inland areas of the groundwater management area and monthly at wells along Valencia Creek.

ELEMENT 12: WELLHEAD PROTECTION MEASURES

1. ***Periodically update and review the SqCWD and CWD Drinking Water Source Assessment and Protection (DWSAP) analysis and submittals.***

SqCWD has not updated DWSAP analysis and submittals (LSCE, 2002; Todd Engineers, 2002) since the GMP has been enacted. SqCWD submitted a DWSAP for the Aptos Jr. High well (HydroMetrics WRI, 2011b) and has prepared a DWSAP for the planned conversion of the Polo Grounds well to municipal supply. CWD submitted updated DWSAP reports (Johnson, 2009) to State Department of Public Health in Water Year 2009.

2. ***Continue to assist with and endorse Santa Cruz County's expanded wellhead protection programs.***

   SqCWD and CWD continue to support Santa Cruz County's programs for wellhead protection. Related programs not listed in the Groundwater Management Plan are the County's septic system management program and the RCD and Ecology Action's Livestock and Land program.

3. ***Support groundwater remediation activities.***

   SqCWD and CWD continue to support the State and Santa Cruz County's programs such as regulation of the cleanup and monitoring of sites with known or potential contamination by the Central Coast Regional Water Quality Control Board (RWQCB) and Santa Cruz County Department of Environmental Health, submittal of the MTBE Report to Public Water System Operators, and use of the State's Underground Storage Tank Cleanup Fund.

ELEMENT 13: PUBLIC EDUCATION

1. ***Maintain SqCWD's Public Information Program***

   In addition to its ongoing public information program, in 2010, SqCWD sponsored a demonstration garden on Wharf Rd. in Soquel, collaborated with other agencies and private non-profit organizations on the Green Gardner Program.

2. ***Maintain SqCWD School Education Program***

   SqCWD continued to conduct its robust school education program including assemblies, classroom teaching and teacher training.

3. ***Maintain CWD Public Education Programs***

   CWD continued to conduct its public education programs and completed development of a drought tolerant demonstration garden in Water Year 2009.

4. ***Support and participate in regional programs***

   SqCWD continued to support and participate in regional programs, such as outreach for the Integrated Regional Water Management Plan.

ELEMENT 14: IMPROVE GROUNDWATER BASIN MANAGEMENT TOOLS

1. Continue to improve and quantify sustainable yield estimates

SqCWD and CWD have continued to improve and update their sustainable yield estimates. Post-recovery pumping yields based on modeled offshore flows required to achieve groundwater elevations protective against seawater intrusion have been developed (HydroMetrics WRI, 2012). The post-recovery pumping yields are based on recently developed estimates for recharge (HydroMetrics WRI, 2011a), modifications of prior estimates for consumptive use (Johnson et al., 2004), and outflows to Pajaro Valley. The estimated post-recovery pumping yield for the Purisima area is 2,800 acre-feet per year. The estimated post-recovery pumping yield for the Aromas area is 1,200 acre-feet per year.

2. Establish water levels that protect the groundwater basin against seawater intrusion

SqCWD has established protective groundwater elevations at its coastal monitoring wells that protect against seawater intrusion. The protective groundwater elevations are documented in *Groundwater Levels to Protect against Seawater Intrusion and Store Freshwater Offshore* (HydroMetrics LLC, 2009b). Protective groundwater elevations for the Aromas area were revised to maintain the freshwater-salt water interface at its current location in the monitoring wells (HydroMetrics WRI, 2012).

3. Assist state, federal, or local wildlife and fisheries agencies as they develop water flow or water quality requirements for riparian and aquatic organisms

SqCWD continued its ongoing funding and review of stream habitat and juvenile salmonid (steelhead and coho salmon) monitoring in the Soquel and Aptos Creek watersheds as part of the Santa Cruz County Stream Habitat and Juvenile Salmonid Sampling Program. SqCWD and CWD also support the County's new policy for management of large woody material in county streams.

4. Maintain and enhance data collection and management.

Data collection has been enhanced by installing new sampling equipment in several of SqCWD's wells. SqCWD and CWD have also installed

groundwater level transducers in production wells to facilitate real-time management of pumping.

SqCWD and CWD continue to update the agencies' databases and Geographical Information Systems. Calendar year 2009 and future data for all water quality constituents analyzed by SqCWD are now stored in a new WaterTrax database.

5. ***Ensure data sharing among regional water agencies***

A formal process for data sharing among regional water agencies has been developed for the California Statewide Groundwater Elevation Monitoring (CASGEM) program. Data were also provided for this report by SqCWD, CWD, the City of Santa Cruz, and Santa Cruz County. SqCWD's file transfer protocol (FTP) site is used for the agencies to upload and download data.

6. ***Explore methods to collect data from non-agency groundwater users***

The County has implemented a voluntary monitoring program of groundwater levels at private wells. SqCWD's Well Master Plan EIR includes a voluntary monitoring and mitigation program for private wells within 1,000 meters of new SqCWD production wells (ESA, 2010) that will collect production and groundwater level data at private wells. Monitoring of private wells near the Polo Grounds well commenced in 2011.

7. ***Prepare a subregional groundwater model for CWD's Rob Roy Well Field***

A subregional model for the Aromas area was prepared for CWD as a tool to delineate well capture zones in the updated DWSAP reports (Johnson, 2009). This model will be adapted for CWD's Proposition 84 funded basin management study.

8. ***Provide data and technical assistance to Pajaro Valley Water Management Agency (PVWMA) Groundwater Basin Model***

PVWMA is finalizing the Pajaro Valley Hydrologic Model, a numerical model of the Pajaro Valley basin. SqCWD had a representative on the Technical Advisory Committee, which met in 2010 to approve the final model. The model is being used for the Basin Management Plan.

9. ***Explore opportunities to expand existing groundwater models to cover the Soquel-Aptos area***

   Two models were finalized in 2011 that may provide opportunities to develop a groundwater model that covers the Soquel-Aptos area: the Soquel-Aptos Area Recharge Model, a PRMS model that estimates the spatial and temporal variation in deep groundwater recharge, and the Pajaro Valley Hydrologic Model, a MODFLOW model of the Pajaro Valley basin. Results from the PRMS model will be used in the adaptation of CWD's DWSAPs model for its Proposition 84 funded basin management study.

10. ***Explore methods to measure and locate the seawater/freshwater interface***

    Methods to locate the seawater/freshwater interface have not been explored. Estimated travel times for the interface were presented to SqCWD in 2012. Other methods to explore include geophysics and infrared methods being used elsewhere on the Central Coast.

SECTION 7
BASIN MANAGEMENT ACTION PRIORITIES AND RECOMMENDATIONS

7.1 BASIN MANAGEMENT ACTION PRIORITIES

This section lists the top priorities for projects and programs to achieve BMOs. BMO 2-2, maintain groundwater levels to prevent seawater intrusion, is the best indicator of the status of basin management. This objective has not been met, so the highest priorities are given to projects that will help raise coastal groundwater levels to prevent seawater intrusion.

1. Secure Supplemental Supply (Element 5, BMO 1-2). BMO 2-2 and other BMOs rely on successfully securing a supplemental supply and achieving BMO 1-2. The regional desalination plant is currently the most likely supplemental supply option. The Integrated Resources Plan (ESA, 2006) adopted by SqCWD emphasizes continued implementation of existing and new conservation and drought management programs regardless of developing a supplemental supply. It also identifies local supplemental supply alternatives for consideration instead of, or in addition to, the regional desalination project: a Soquel Creek diversion project, local-only desalination, and/or site specific recycled water projects for non-potable irrigation use. A transfer of San Lorenzo River winter surplus flows from City of Santa Cruz to SqCWD is being evaluated but is unlikely to meet SqCWD's full supplemental supply for recovering the basin and achieving BMO 2-2.

2. Well Master Plan (Element 8). SqCWD should continue to implement the Well Master Plan so that additional wells can be used to effectively manage pumping in the basin.

3. Apply for Local Groundwater Assistance Grant (Element 1, Element 14). The State has released its Proposal Solicitation Package for Local Groundwater Assistance grants of up to $250,000 for fiscal year 2011-2012. The application submittal deadline is July 13, 2012. SqCWD should evaluate applying for the grant to assist with groundwater management. Possible uses for the funds include development of a groundwater model or installation of new or replacement monitoring wells.

4. Conduct Cox Well Field Aromas and Purisima Groundwater Basin Management Study. Using funds from a Proposition 84 planning grant, CWD should evaluate maximizing the developable yield in CWD's Cox Well Field to address concerns about Chromium VI in the CWD service area, and to address SqCWD's Aromas water quality and overdraft concerns.

5. Polo Grounds Well Monitoring and Mitigation Plan (Element 9). SqCWD should continue to implement the monitoring and mitigation plan in the Well Master Plan EIR regarding potential effects on private wells and CWD's Cox and Rob Roy well fields from converting the Polo Grounds well to municipal use. Implementation of this plan began in 2011.

6. Implement Soquel Creek Stream Monitoring and Adaptive Management Plan (Element 2, BMO 3-2). Project approval of the O'Neill Ranch well is conditioned on implementing a plan to monitor Soquel Creek for reductions in baseflow from pumping. The plan needs to be submitted to Santa Cruz County and National Marine Fisheries Service for comment, approved by SqCWD's Board, and implemented in time to provide baseline data for the Creek before the O'Neill Ranch and the City of Santa Cruz's Beltz#12 wells are operational.

7. Implement O'Neill Well Monitoring and Mitigation Measure for Impacts to Nearby Wells (Element 9). SqCWD should continue to implement the monitoring and mitigation plan in the Well Master Plan EIR regarding potential effects on private wells and the City of Santa Cruz's well fields. Implementation of this plan began with the construction of monitoring wells on 41st Avenue.

8. Cooperative Groundwater Management Agreement with City of Santa Cruz (Element 8). Plans by both agencies to install new wells in the shared portion of the basin increase the importance of an agreement for groundwater management of the area.

9. Continue to upgrade groundwater monitoring equipment (Element 1). SqCWD should continue to follow recommendations in *Evaluation of Water Quality Monitoring Network and Recommendations for Improvement* (HydroMetrics LLC, 2007) for replacing groundwater sampling equipment to improve sampling efficiencies. Upgrades should also include installing groundwater level loggers in more monitoring wells.

10. Comply with statewide groundwater monitoring requirement (Element 1). SqCWD and CWD activities meet the requirements of 2009 state water package for groundwater monitoring (CASGEM). Santa Cruz County is responsible for reporting data to the state and SqCWD and CWD should work with the County to meet reporting requirements.

11. Construct pump station on Soquel Drive to move water from Service Area II to III. To improve transfer of water in its system, SqCWD will be constructing a pump station on Soquel Drive to move water from its Service Area II to III. The pump station will have a pressure reducing valve and be bi-directional. The ability to transfer water between service areas will facilitate pumping redistribution to meet groundwater management objectives, especially after a supplemental supply is secured.

12. Survey elevations of monitoring wells that have not been surveyed (Element 1). Accurate groundwater level elevations depend on accurate survey information for well reference points. The SC-11, SC-A6, and SC-A7 monitoring wells do not have reference point elevations. The SC-11 wells at Porter Gulch are the highest priority for surveying because there is no nearby production well with survey information.

13. Replace identified monitoring wells (Element 1). To obtain useful groundwater data from the entire monitoring network, SqCWD should replace the monitoring wells SC-10 at Cherryvale and SC-11 at Porter Gulch. Sampling equipment at SC-10 has failed and cannot be replaced. SC-11 has sanded up. Replacements will be with 2 inch wells to facilitate water quality sampling to monitor background aquifer conditions.

14. Manage well operation based on pumping water levels (Element 8). SqCWD should continue to manage pumping based on current groundwater level data measured by transducers installed in production wells to better manage pumping.

15. Formalize relationships with small water systems (Element 10). Cooperative relationships with Trout Gulch Mutual Water, Pure Source Water, and San Andreas Mutual Water Company to meter their wells and share data as well as implement conservation measures would help encourage those systems to pump sustainably. Additional relationships to monitor for impacts of SqCWD pumping on small water systems are being formalized through the Well Master Plan private well monitoring and mitigation program.

16. Update Groundwater Management Plan with Mapped Recharge Areas (Element 7). AB 359 requires local Groundwater Management Plans to include maps of recharge areas by 2013. SqCWD and CWD should plan to update their GMP with recharge area maps developed by the County and/or information from the Soquel-Aptos recharge study (HydroMetrics WRI, 2011a).

7.2 CURRENT DATA INADEQUACIES

The following is a list of current data inadequacies that could be addressed to enhance basin understanding and management. Some of these inadequacies are being addressed by recently implemented programs or will be addressed by basin management action priorities listed in Section 7.1. It is recommended that SqCWD and CWD develop additional programs and projects to address remaining data inadequacies as they gain more priority.

- Non-agency pumping. As shown in Table 2-1 and Table 2-2, estimates of non-agency pumpers are based on data from 1999 or earlier, more recent data is needed for a more complete analysis of basin pumping.
- Shallow groundwater levels. Basin-wide shallow groundwater level monitoring would help assess changes in basin storage. The County's recently implemented private well monitoring program is starting to provide data to assess this inadequacy. Multi-year data from wells completed in the shallowest unit could help quantify changes in basin storage.
- Continuous groundwater level measurements in monitoring wells. These measurements are being recorded in several SqCWD and CWD monitoring wells. The effects of tides, season, and pumping cycles could be evaluated by installing groundwater level transducers in more monitoring wells.
- Pumping requirements for basin recovery. It is unknown what the reduction in pumping and expected time-frame is for the basin to recover to elevations protective against seawater intrusion. Reducing pumping to gather data for this question may require a supplemental supply.
- New monitoring wells between pumping wells. The monitoring network includes coastal wells, wells adjacent to pumping wells, and wells upland of pumping areas. There are no monitoring wells placed to monitor potential well interference between pumping areas except for wells

recently installed by the City of Santa Cruz and SqCWD in the 41st Ave area. There are also no monitoring wells to assess inland advancement of seawater intrusion in the Aromas area.

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SECTION 8
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