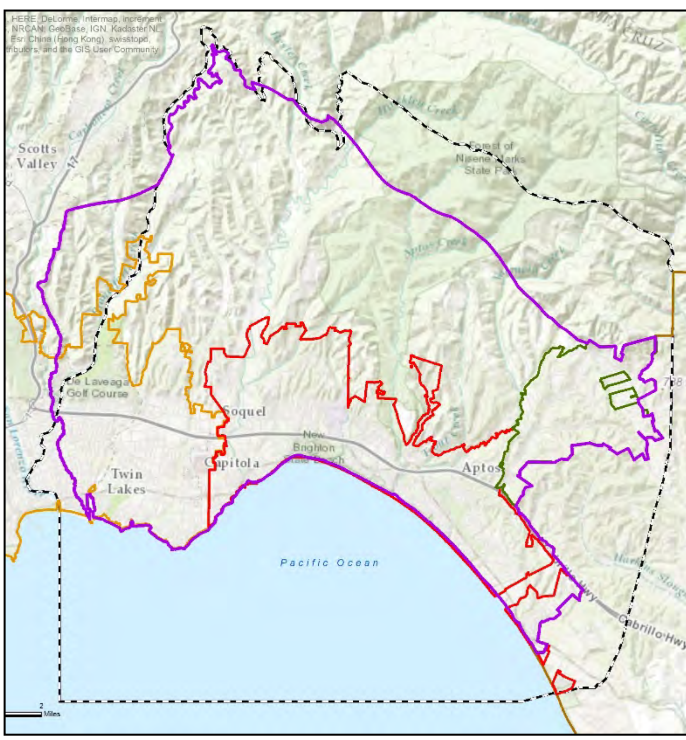
Santa Cruz Mid-County Basin Groundwater Management Biennial Review and Report Water Years 2015-2016

Prepared for:
Santa Cruz Mid-County Groundwater Agency

July 2017
MGA Board DRAFT



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
Basin...............................Santa Cruz Mid-County Groundwater Basin
BIG..................................Basin Implementation Group
BMO...............................basin management objective
BRR.................................Biennial Review and Report
CASGEM........................California Statewide Groundwater Elevation Monitoring
CDS ....Coastal Distribution System
CWD...............................Central Water District
DWR...............................California Department of Water Resources
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
GSA ....Groundwater Sustainability Agency
GSP.................................Groundwater Sustainability Plan
gpd ....gallons per day
IRWMP ....Integrated Regional Water Management Plan
JPA..................................Joint Exercise of Powers Agreement
LAFCO...........................Local Agency Formation Commission
MAMP ....Soquel Creek Monitoring and Adaptive Management Program
MCL ....maximum contaminant level
MGA...............................Santa Cruz Mid-County Groundwater Agency
mg/L...............................milligrams per Liter
msl ....mean sea level (this report considers equivalent to NGVD29)
NGVD29.........................National Geodetic Vertical Datum of 1929
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
RPE.................................reference point elevation
RWQCB ....Central Coast Regional Water Quality Control Board
SAGMA ....Soquel Aptos Groundwater Management Alliance
SAGMC...........................Soquel Aptos Groundwater Management Committee
SGMA ....Sustainable Groundwater Management Act
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

EXECUTIVE SUMMARY – WATER YEAR 2015-16

INTRODUCTION

This Biennial Review and Report (BRR) is part of the implementation of the Groundwater Management Plan (GMP) for the Soquel-Aptos groundwater management area approved by Soquel Creek Water District (SqCWD) and Central Water District (CWD) in 2007 (SqCWD and CWD, 2007). The BRR summarizes groundwater conditions in the Santa Cruz Mid-County Groundwater Basin for Water Years 2015 and 2016 and documents the status of groundwater management activities. The report updates a living document that has been updated annually starting with the Water Year 2009 report and will be updated biennially beginning with this report. This report is presented to the Santa Cruz Mid-County Groundwater Agency (MGA), the Groundwater Sustainability Agency for the Santa Cruz Mid-County Groundwater Basin, which has taken over implementation of the GMP until the MGA adopts a Groundwater Sustainability Plan (GSP). The MGA is a Joint Powers Authority of CWD, SqCWD, the City of Santa Cruz, and Santa Cruz County with three private well representatives as Board members. This BRR includes a number of changes from previous ARRs that reflect implementation of the Sustainable Groundwater Management Act (SGMA).

GROUNDWATER CONDITIONS

Long-term overdraft of the basin has led to ongoing risk of seawater intrusion. As a result of long-term recovery and an acceleration of recovery over the last two years, average groundwater levels in Water Year 2016 met the established protective elevations at the most monitoring wells since the wells were installed. Average groundwater levels in Water Year 2016 met established protective elevations at 8 of 13 of the wells. Since five wells have average groundwater levels below established protective elevations, full basin recovery has not been achieved and the basin is still considered in long-term overdraft. (Figure ES- *1*). Recovery of the basin and overdraft will be eliminated when coastal groundwater levels rise to protective elevations at all coastal wells. The MGA will also need to reevaluate the established protective elevations for the GSP.

In Water Year 2015, rainfall in the Santa Cruz Mid-County Basin was below average for the fourth straight year, but rainfall in Water Year 2016 was above average. In Water Year 2015, SqCWD and the City of Santa Cruz continued

Stage 3 water shortage emergency with a drought curtailment target of 25% and CWD continued a Stage 2 water shortage alert with a drought curtailment target of 20%. In Water Year 2016, the lower than average rainfall over the preceding five years led SqCWD and CWD to maintain these curtailment targets. In Water Years 2015 and 2016, municipal production of 4,121 and 3,928 acre-feet were the lowest totals since 1977.

Figure ES- 2 shows groundwater level trends for the productive aquifer units across the basin over the last five years. Groundwater level trends in the western Purisima area where both SqCWD and City pump from the Purisima A and AA Units and sub-Purisima Tu Unit have shown slight declines over the last five years. However, groundwater levels at coastal wells in this area (Moran Lake, Pleasure Point, Soquel Point, and SC-1A) have increased over Water Year 2015-2016. Groundwater level trends in the western Purisima area where SqCWD is the municipal pumper that pumps primarily from the Purisima A Unit have shown increases over the last five years with accelerated recovery over Water Years 2015 and 2016, including in coastal wells for the area (SC-3A and SC-5A). Groundwater level trends in the central Purisima areas (BC and DEF units) also have been increasing over the last five years with accelerated recovery over Water Years 2015 and 2016, including in coastal wells for the area (SC-9C and SC-8D). The groundwater level trend in coastal wells in the Aromas area (SC-A1, SC-A8, SC- A2, SC-A3, and SC-A4) has generally been stable or increasing over the last five years while wells further inland in the Aromas area have shown declines over the last five years (Figure ES- 2).

There is ongoing risk of seawater intrusion into the productive units of the Santa Cruz Mid-County Basin due to coastal groundwater levels being below protective elevations. Observed Total Dissolved Solids (TDS) and chloride concentrations are used to assess seawater intrusion. Figure ES- 3 and Figure ES-4 show TDS and chloride concentrations from Fall 2016 for the productive aquifer units across the Basin, which are representative of recent conditions in the Basin. The occurrence of seawater intrusion varies by area in the Santa Cruz Mid-County Basin:

- TDS and chloride concentrations do not suggest seawater intrusion at SqCWD's monitoring wells in the western Purisima area (A, AA, and Tu-units).
- TDS and chloride concentrations show seawater intrusion has not affected SqCWD production wells in the western Purisima area (A, AA, and Tu-units).

- TDS and chloride concentrations in one of the City of Santa Cruz's monitoring wells indicate seawater intrusion in the westernmost Purisima area (A-unit), but concentrations in this Soquel Point Medium monitoring well show a decreasing trend Concentrations in the Moran Lake Medium monitoring well indicated seawater intrusion in the past but no longer suggest seawater intrusion and continue to decline. However, TDS and chloride concentrations show seawater intrusion has not affected City of Santa Cruz production wells in the westernmost Purisima area (A, AA, and Tu units)
- TDS and chloride concentrations do not suggest seawater intrusion at SqCWD's monitoring wells in the central Purisima area (BC and DEF-units).
- TDS and chloride concentrations show seawater intrusion has not affected SqCWD production wells in the central Purisima area (BC and DEF-units).
- TDS and chloride concentrations continue to indicate seawater intrusion in deep monitoring wells installed below the freshwater-saltwater interface in the Aromas area (Purisima F-unit and Aromas Red Sands).
- At the Aromas area monitoring wells where the saltwater interface has risen into after being installed above the saltwater interface, concentrations continue to indicate intrusion but do not appear to be continuing to increase.
- However, TDS and chloride concentrations show seawater intrusion has not affected SqCWD and CWD production wells 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. A drinking water standard for chromium VI was in effect from 2014 through 2016 and concentrations at several SqCWD production wells exceeded the standard. 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 2016. The main basin management objectives of concern are BMO 1-1 to pump within the sustainable yield and BMO 2-2 to maintain groundwater levels to prevent seawater intrusion. New measurable objectives will be required for the Groundwater Sustainability Plan. In addition, the groundwater model under development will be used to evaluate sustainable yield and groundwater management alternatives to achieve sustainability.

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

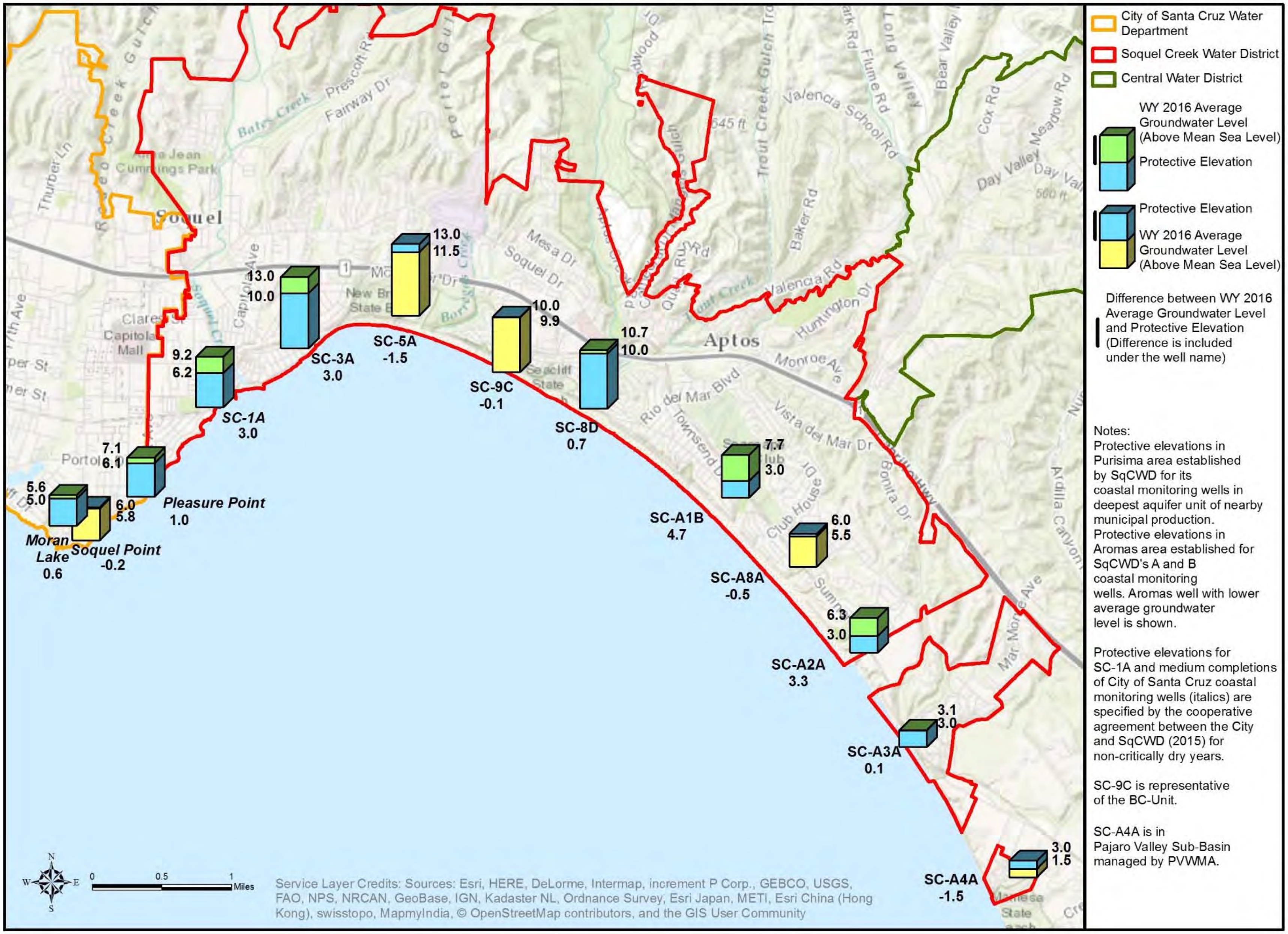

Figure ES- 1 (2016): Average Water Year 2016 Groundwater Levels at Coastal Monitoring Wells Relative to Protective Elevations

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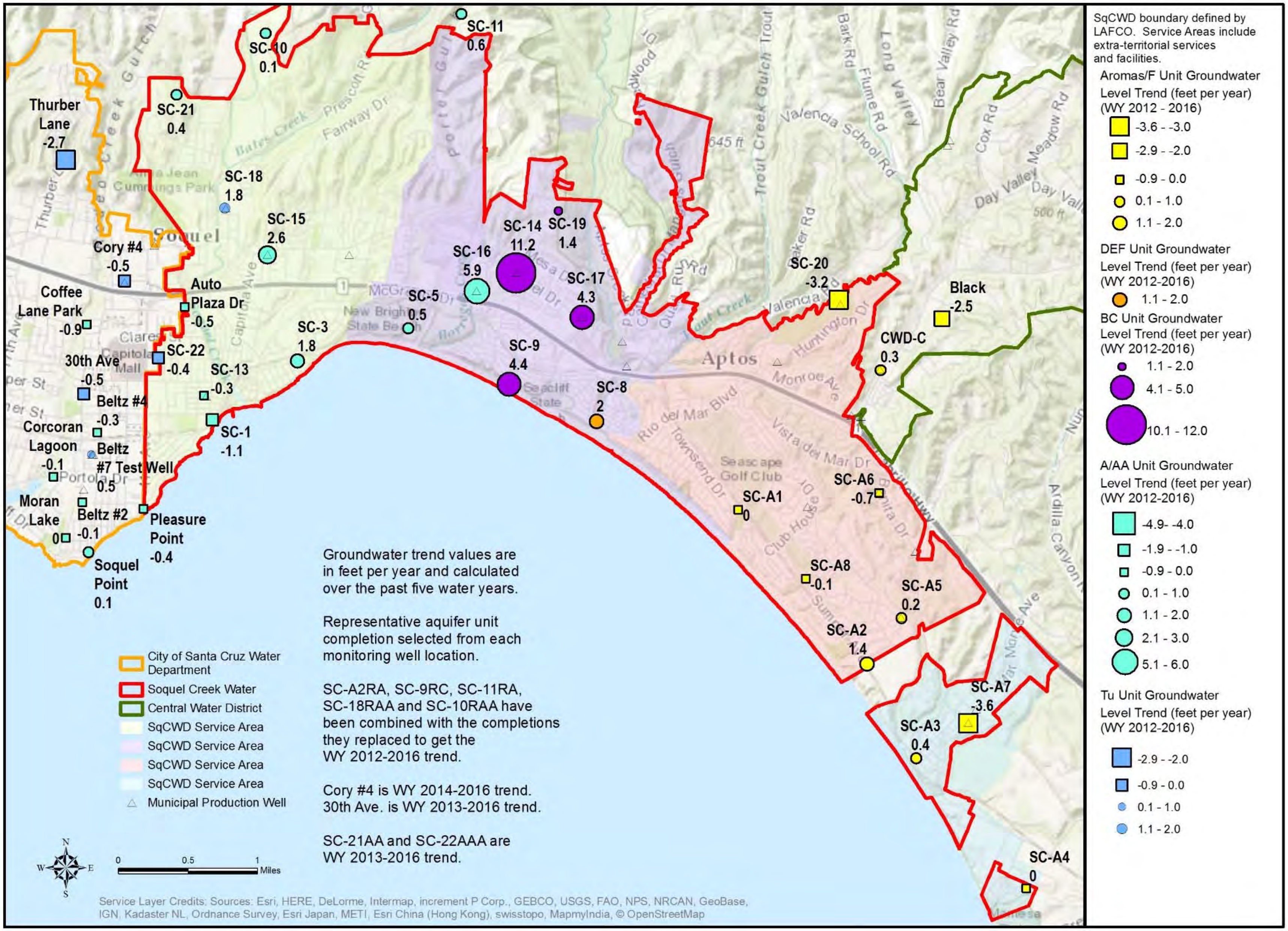

Figure ES- 2 (2016): Groundwater Level Trends Water Years 2012-2016 at Representative Monitoring Wells

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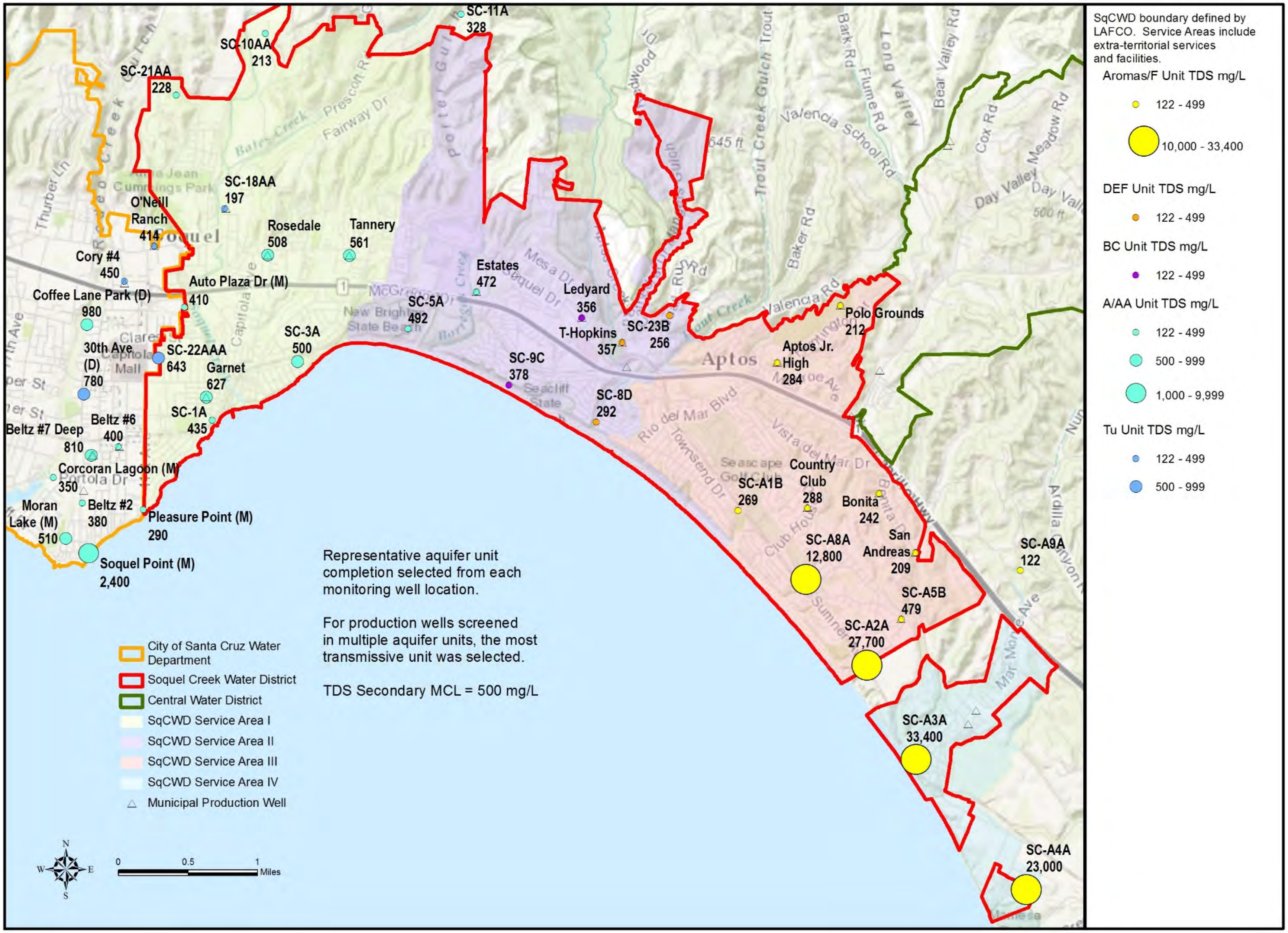

Figure ES- 3 (2016) Concentrations of Total Dissolved Solids in Groundwater, Fall 2016

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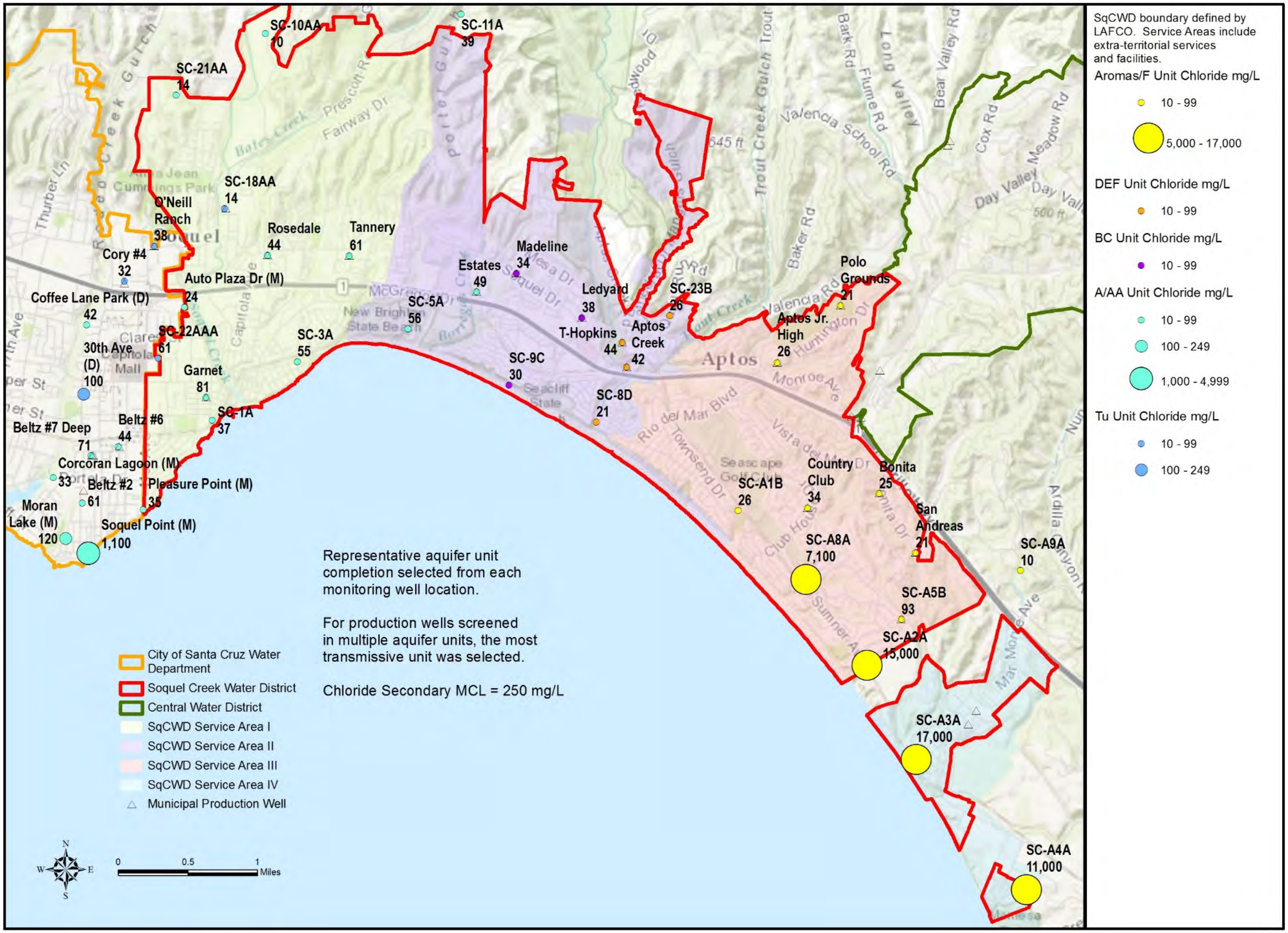

Figure ES- 4 (2016). Concentrations of Chlorides in Groundwater, Fall 2016

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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 includes 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. The format of this report has been used starting with the Water Year 2009 ARR. The report will serve as a living document to be updated. This Biennial Review and Report (BRR) is the seventh update using the new format, covering Water Years 2015-16 (October 2014-September 2016).

ARRs for Water Years 2007 through 2013 were prepared for the GMP Basin Implementation Group (BIG) consisting of Soquel Creek Water District, Central Water District, and a private well representative. The Water Year 2014 ARR was prepared for the Soquel Aptos Groundwater Management Committee (SAGMC), which added the City of Santa Cruz and County of Santa Cruz to the members of BIG. This BRR covering Water Years 2015-16 is the first update prepared for the Santa Cruz Mid-County Groundwater Agency (MGA), which is a joint powers authority between the four public agency members of SAGMC to implement the Sustainable Groundwater Management Act (SGMA) enacted by the state of California as of January 1, 2015. In addition to two members of the governing boards of each of the four member agencies, the MGA Board has three private well representatives.

The Basin Advisory Group has reviewed drafts of all ARRs and this BRR since adoption of the GMP. The Basin Advisory Group consists of staff from the four current members of the MGA and Pajaro Valley Water Management Agency (PVWMA).

1.1 CHANGES DUE TO SUSTAINABLE GROUNDWATER MANAGEMENT ACT (SGMA)

Under the Sustainable Groundwater Management Act (SGMA) enacted by the state of California as of January 1, 2015, the 2007 Groundwater Management Plan (GMP) remains in effect until a Groundwater Sustainability Plan (GSP) is adopted. However, SGMA prevents updates of the GMP (§10750.1)

Implementation of SGMA results in a number of changes beginning with this BRR covering Water Years 2015-2016:

- The Santa Cruz Mid-County Groundwater Agency (MGA), a joint powers authority of Central Water District, City of Santa Cruz, County of Santa Cruz, and Soquel Creek Water District with Board seats allotted to private well representatives, formed as a Groundwater Sustainability Agency (GSA) for SGMA implementation.
- The MGA took over responsibilities of the Soquel Aptos Groundwater Management Committee (SAGMC), including implementation of the GMP until a GSP is adopted.
- The MGA covers the Santa Cruz Mid-County Groundwater Basin, a basin approved by the California Department of Water Resources (DWR) in 2016 as a result of a basin boundary modification request by SAGMC and then the MGA. The BRR provides updates on groundwater conditions in the Santa Cruz Mid-County Groundwater Basin while previous updates covered the Soquel-Aptos Groundwater Management Area (Figure 1-1),
- The Santa Cruz Mid-County Groundwater Basin is listed by DWR as a basin in critical overdraft so the GSP covering the basin must be adopted by January 31, 2020
- The MGA decided to reduce updates to a biennial basis to manage resources while it undertakes concurrent activities to implement SGMA, including GSP development. There is time for one additional BRR under the GMP covering Water Years 2017 and 2018 prior to adoption of the GSP by January 31, 2020.
- The BRR notes applicability of GMP objectives and elements to meeting requirements for the GSP to aid development of the GSP.
- Although a GSP has not been developed and the BRR does not need to meet DWR regulations for GSP implementation, the BRR includes additional information required in annual reports for GSP implementation where the information is available.

1.2 Prior Groundwater Management Plan Review

Water Year 2012 ARR included a review of the GMP itself. Proposed revisions to the Existing Groundwater Conditions and Basin Management Objectives were approved by the Basin Implementation Group in 2013. An official update of the GMP requires approval of the governing bodies of members of the Soquel Groundwater Management Committee. The Sustainable Groundwater

Management Act (SGMA) prohibits renewal of existing GMPs so these updates of the GMP will not be brought forward to be approved by the governing bodies. However, ongoing groundwater management is based on the proposed revisions so the revisions are referenced in this report. This report is also considered an addendum to the GMP so state requirements for the GMP that have been developed since approval of the GMP are included in the report.

1.3 Living Document Concept

The living document is contained in a 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 PDF file, with summaries and maps for the most recent water year successively added. Some maps will not change each year. 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 PDF file each year. New map figures for the executive summary were added for Water Year 2011 and map figures for this and subsequent years will be added each year.

1.4 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 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. As of the Water Years 2015-2016 BRR, Section 2 includes available information on total water use and water available for replenishment that will be required in annual reports for GSP implementation. The updated Section 2 is inserted in front of the previous Section 2. Multi-year graphs of precipitation and pumping are replaced each year. Maps of rainfall stations, study areas, small water systems, and recharge areas will not change each year.

Sections 3-5 describe conditions for three different portions of the Santa Cruz Mid-County Groundwater Basin (Basin). Section 3 discusses the western portion of the Basin, 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 Basin, 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) (Figure 1-2). 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, 2012a). Protective groundwater elevations for the City of Santa Cruz's coastal monitoring wells and SqCWD's SC-1A monitoring well are established in the cooperative groundwater management agreement between SqCWD and the City (SqCWD and City, 2015). A table comparing coastal groundwater levels in the water year versus protective elevations for the aquifer group is inserted.
- Hydrographs of logger data at coastal monitoring wells that only required straightforward processing were added for the Water Year 2014 report and have been replaced. Logger data hydrographs have been added to the hydrographs of individual completions.
- 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 except for review of information in the GMP. However, the MGA may decide that not all items require an update every year. The MGA 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). Basin management elements discussed include projects, programs, or policies implemented by MGA, the four individual member agencies of the MGA, and also other basin stakeholders, such as the Pajaro Valley Water Management Agency (PVWMA). 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. This year, this section will include recommended revisions to the descriptions of Basin Management Objectives to include updated information.

Section 7 discusses current GMP action priorities, and data gaps. The current GMP action priorities should be considered the current guide for groundwater management programs, projects, and policies (GMP Elements) to implement. For the Water Year 2015-2016 BRR, priorities focus on activities to improve basin understanding. 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
Hydrostratigraphy Figures	Replace only if necessary
Section 2 - Basinwide Conditions	
Text	Insert
Precipitation, pumping, and surface water use charts	Replace
Recharge table	Insert
Location Maps	Replace only if necessary
GMP Information Review	2012 Only
Section 3 - 5 - Aquifer Conditions	
Text	Insert
Summary tables	Insert
Pumping charts	Replace
Groundwater elevation maps	Insert
Logger Data Hydrographs	2014 Only
Hydrographs (with Logger Data)	Replace
Chemographs	Replace
Section 6 - GMP Implementation Status	Replace
Recommendations for BMO Revisions	2012 Only
Section 7 - Recommendations	Insert

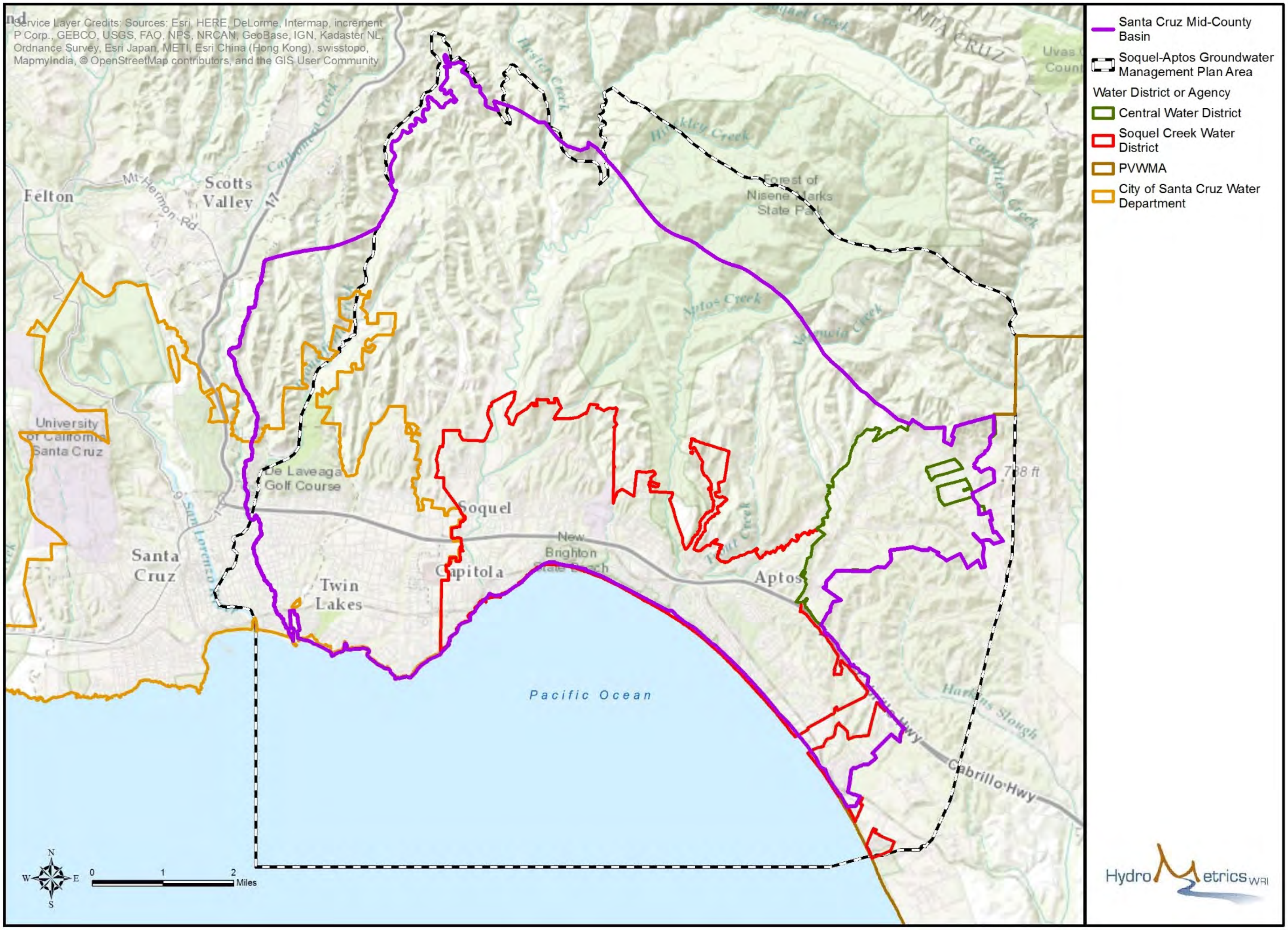

Figure 1-1: Santa Cruz Mid-County Groundwater Basin and Soquel-Aptos Groundwater Management Area

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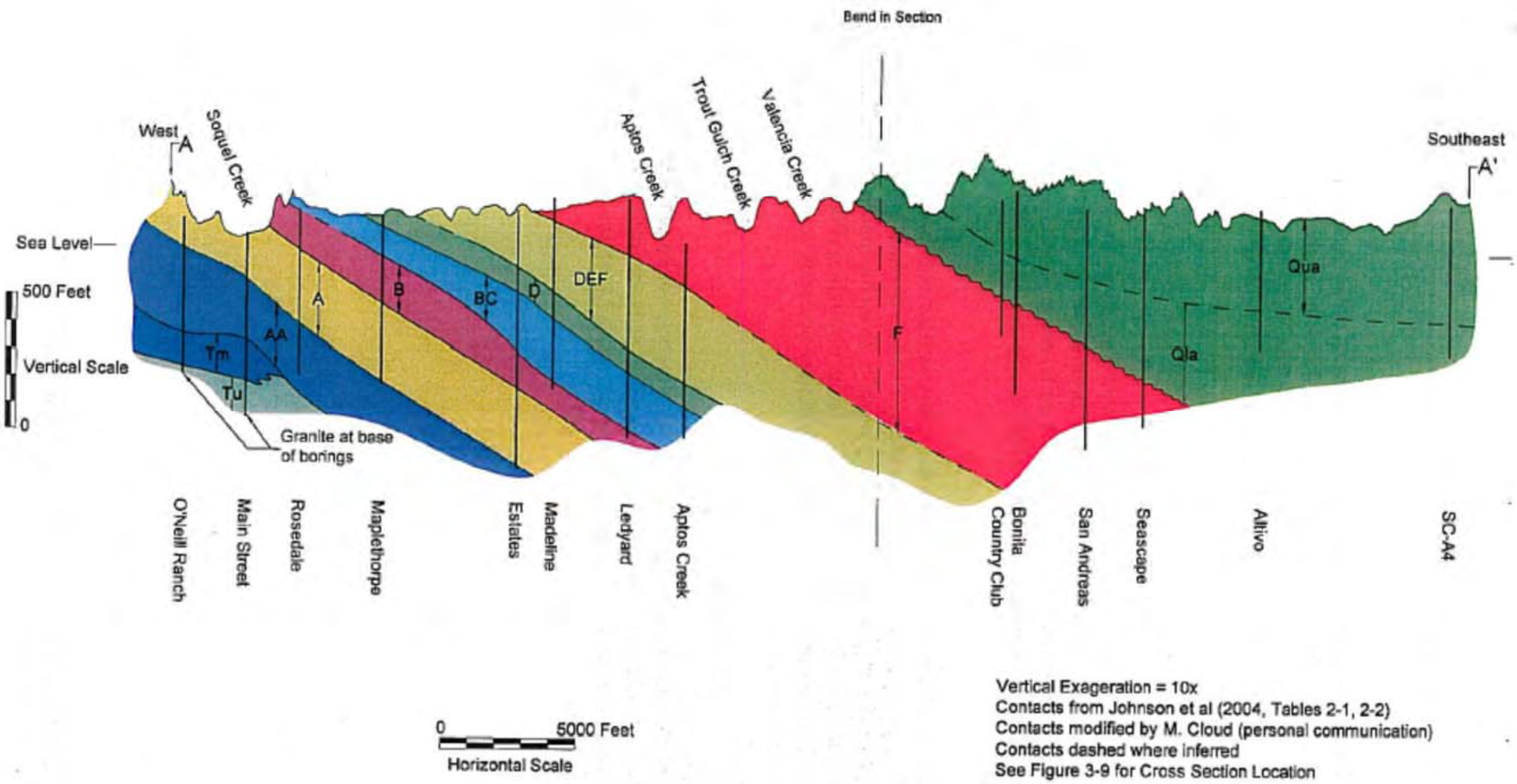

Figure 1-2: Cross-section of Basin Hydrostratigraphy (reproduced from GMP Figure 3-10

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SECTION 2 – WATER YEARS 2015-16 BASINWIDE CONDITIONS IN THE SANTA CRUZ MID-COUNTY BASIN

This section presents conditions in the Santa Cruz Mid-County Groundwater Basin for Water Years 2015 and 2016 that affect the entire groundwater basin. This section also includes a review of information in GMP Section 3 (Existing Groundwater Conditions).

2.1 ANNUAL RAINFALL AND RECHARGE

SqCWD collects rainfall data from three gauges in and near the Santa Cruz Mid-County Basin: the Mancarti gauge on Laurel Road, the Kraeger gauge on Longridge Road, and the weather station at the Main Street well site. Data loggers record rainfall at these gauges at 15-minute intervals. Precipitation at the Mancarti and Kraeger gauges during Water Year 2015 was 15.3 and 24.8 inches respectively. These rainfall totals were below the average (mean) values of 35.4 inches at the Mancarti gauge and 36.4 inches at the Kraeger gauge measured between Water Year 1984 and Water Year 2016. Water Year 2016 had above average rainfall with rainfall at Mancarti gauge totaling 40.9 inches and the Kraeger gauge totaling 39.4 inches. Water Years 2015 and 2016 were the third and fourth full water years with data from the Main Street weather station and rainfall totaled 18.5 and 28.7 inches, respectively. Annual rainfall totals by Water Year for all three gauges are presented on Figure 2-1. Figure 2-2 shows the locations of the stations and average distribution of rainfall used for the groundwater model under development based on data from PRISM (PRISM Climate Group, 2016).

Figure 2-1 also shows rainfall totals for the NOAA Cooperative station in Santa Cruz (station number 047916). Rainfall in Water Year 2015 at the Santa Cruz station was 21.7 inches, which was below the average value of 29.1 inches observed from Water Year 1984 through Water Year 2016 for the fourth consecutive year. Water Year 2014 ranks as the 17^{h} driest year in the 72 year record for this station. Rainfall in Water Year 2016 at the Santa Cruz station was above average rainfall at 32.6 inches. However, the five year rainfall for Water Years 2012-2016 estimated for the Santa Cruz station was 108.9 inches, which is below the trigger condition of 129 inches that led SqCWD to continue Stage 3 drought curtailment from 2014-2016.

Seven of the last ten water years have had below average rainfall. Water Year 1998 was the last full water year with rainfall above 50 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 (2005-2006) of above average precipitation was when the majority of the basin's recharge occurred, 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. This deep recharge total is estimated for the hydrogeologic system area defined by Johnson et al. (2004) that is more similar to Soquel-Aptos groundwater management area than the Santa Cruz Mid-County basin area (Figure 1-1). However, these recharge estimates can be used to evaluate changes over time. 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 (HydroMetrics WRI, 2013a). Table 2-1 shows the estimated deep recharge based on this relationship for Water Years 2010-2016. The average recharge for Water Years 1984-2016 is estimated as 10,170 acre-feet per year based on these estimates combined with calibrated PRMS results. This annual average is approximately 6% lower than the annual average of 10,800 acre-feet per year based on calibrated PRMS results for Water Years 1984-2009.

Table 2-1. Estimated Deep Recharge for Water Years 2010-2016

Water Year	Rainfall at Santa Cruz Co-op (inches)	Estimated Recharge (acre-feet)
2010	30.8	9,700
2011	42.2[1]	21,000
2012	22.2[1]	4,000
2013	18.0	2,100
2014	14.4	800
2015	21.7	3,700
2016	32.6	11,300

[1] Rainfall estimated based on De Laveaga totals due to missing data at Santa Cruz Co-op station

Added to Figure 2-1 and Figure 2-2 in this biennial report are rainfall totals for the NOAA Cooperative station in Watsonville (station number 049473) just southeast of the Santa Cruz Mid-County Basin in the Pajaro Valley Subbasin. Daily rainfall data from this station and the Santa Cruz station are used at inputs in the groundwater model under development (HydroMetrics WRI, 2016c). Figure 2-2 also shows average rainfall at the El Pueblo Yard station in the Santa Margarita Basin for reference.

2.2 ANNUAL PRODUCTION

Water Years 2015 and 2016 were marked by historically low groundwater production in the Santa Cruz Mid-County Basin. Total municipal production for the Soquel-Aptos area in Water Years 2015 and 2016 was 4,121 and 3,928 acre-feet (AF) respectively, the lowest annual total since 1977. Annual production by water year for SqCWD, CWD, and the City of Santa Cruz is shown on Figure 2-3.

CWD pumping in Water Years 2015 and 2016 was 391 and 384 acre-feet, representing a 29% reduction from Water Years 2012-2013 before CWD declared a Stage 2 water shortage consistent with the state's 2014 request for voluntary 20% reductions in water use. Prior to Water Year 2014, CWD pumping had been typically higher in years with below average rainfall. CWD pumping had not been below 400 acre-feet per year since Water Year 1985.

SqCWD pumping of 3,155 and 3,094 acre-feet in Water Years 2015 and 2016 were the lowest annual totals since 1972. In addition, SqCWD pumping in Water Years 2010-2016 have been the seven lowest annual totals since 1979. SqCWD reduced pumping in Water Year 2015 and 2016 approximately 24% from already historically low pumping of Water Years 2010-2013. This reduction appears related to SqCWD's declaration of a Stage 3 water shortage emergency in 2014 with a drought curtailment target of 25%. After declaring a Stage 1 water shortage alert in 2012 and Stage 2 water shortage warning in 2013 with requests for voluntary conservation to meet a drought curtailment target of 5-15%, the Stage 3 declaration in 2014 and continued through 2016 included mandatory conservation measures.

For the demand reductions that began seven years ago before any drought curtailment was declared, it appears that economic conditions and conservation were likely factors in reduced demand. The economic conditions resulted in both residential and commercial vacancies. Secondly, reduced demand within the SqCWD service area may have been accelerated due to completed water demand offsets for which the corresponding development had not been completed. Thirdly, 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 local water agencies, but also from the State of California with Governor Brown's 2014 proclamation of drought emergency, his 2015 executive order for restrictions to achieve 25 percent reduction in statewide potable use, and substantial statewide conservation marketing.

City of Santa Cruz production in Water Years 2015 and 2016 of 574 and 450 acre-feet had an average similar to the average water year pumping from Water Years 1984-2016 of 517 acre-feet. The City's pumping over its pumping season is better represented by the calendar year total production. In 2014, the City declared a Stage 3 water shortage emergency that it kept in place through 2015. In addition, San Lorenzo River flows in Water Years 2015 and 2016 were above the critically dry threshold. The City's pumping during calendar years 2015 and 2016 was 483 and 505 acre-feet, which is less than the City's planned maximum groundwater production during non-critically dry years of 520 acre-feet per year (SqCWD and City, 2015).

For its 2015 Community Water Plan to evaluate supplemental supply needs, 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 estimated with a water balance approach using modeled offshore flows required to protect against seawater intrusion, estimated recharge, SqCWD share of consumptive use, SqCWD consumptive use factors, and climate change estimates. These estimates assume that SqCWD would reduce pumping based on its proportion of basinwide consumptive use to maintain groundwater levels at protective elevations after recovery (HydroMetrics WRI, 2015b). SqCWD pumping for the Purisima area in the last two water years of 2,055 and 2,025 acre-feet per year was less than the estimated post-recovery pumping yield of approximately 2,450 acre-feet per year for the Purisima area. SqCWD pumping in the Aromas area in Water Years 2015-2016 of 1,110 and 1,069 acre-feet per year was above the estimated post-recovery pumping yield of 850 acre-feet per year for the Aromas area. Total SqCWD production in Water Years 2015 and 2016 was below the combined post-recovery pumping yield of 3,300 acre-feet per year for the first time since 1974.

However, to recover groundwater levels to protective elevations, pumping must be reduced below post-recovery pumping yields for multiple years. SqCWD's current planning goal for allowing groundwater elevations to recover is to limit pumping to 2,300 acre-feet per year with an estimated recovery time frame of 20 years (HydroMetrics WRI, 2012a). Based on the post-recovery pumping yield, the planning goal for recovery assumes that SqCWD would reduce pumping based on its proportion of consumptive use to help achieve recovery. The planning goal is lower than goals cited in previous ARRs because estimated effects of climate change are included. A peer review of earlier sustainable yield estimates that did not include climate change effects did suggest that a higher estimate for sustainable yield was appropriate (Todd, 2014), but SqCWD continues to use the estimates above as a conservative goal for planning. A groundwater model is being developed that will replace the water balance approach used for the estimates of post-recovery yield and pre-recovery pumping goals (HydroMetrics WRI, 2014).

Since Water Year 2004 when CWD's maximum annual pumping of 632 acre-feet occurred, CWD pumping has ranged from 384 to 594 acre-feet per year which is less than the 622 acre-feet per year that is assumed for sustainable yield calculations in the GMP. For non-critically dry calendar years 2008 to 2013 and 2015 to 2016, City of Santa Cruz pumping ranged from 472 to 548 acre-feet per year. Including pumping from critically dry year 2014, the City's average pumping over the last nine years has been 523 acre-feet per year, similar to the 520 acre-feet per year cited as its long-term pumping goal in the recently finalized cooperative monitoring/adaptive groundwater management agreement between the City and SqCWD (2015).

HydroMetrics WRI has estimated non-municipal pumping for implementation in the groundwater model under development (HydroMetrics WRI, 2017). For this BRR, HydroMetrics WRI separately estimated non-municipal domestic, institutional and recreational, and agricultural water use using the same methodology used for the groundwater model. Figure 2-3 shows these estimates for Water Years 1985-2016. An estimate for Water Year 1984 was not developed so the estimate for 1985 is displayed in 1984. The distribution of pumping between Purisima and Aromas areas defines the Aromas area as the eastern half of the Valencia Creek watershed, Central Water District, and areas within and between Soquel Creek Water District's Service Areas III and IV.

Estimates of non-municipal domestic pumping are based primarily on a count of building footprints not served by municipal water supplies (Figure 2-4) and annual water use factors. After adjusting for population changes over time, 2,400 residential buildings not served by municipal systems are estimated for 2015. The annual water use factor for 2015 and 2016 is based on an evaluation of water use in 2015 by small water system use in the Basin. The estimated non-municipal domestic water use factor for the Basin in 2015 and 2016 is 0.23 acre-feet per year per home and non-municipal domestic pumping in the Basin is estimated at approximately 550 acre-feet per year in 2015 and 2016. Non-municipal domestic pumping is estimated over time by adjusting the number of building footprints for population and increasing the water use factor back in time to 1985 up to 0.46 acre-feet per year per home.

Groundwater pumping for institutional/recreational water use includes institutions or facilities that pump their own groundwater primarily for large-scale irrigation of recreational turf, as well as Trout Gulch Mutual, the only small water system in the Basin with available and consistent historical usage records (Figure 2-5). The irrigation of recreational turf is estimated based on the area irrigated, crop coefficient for turfgrass, an irrigation inefficiency of 10%, and evapotranspiration demand estimated by the Precipitation Runoff Model System (PRMS) used to simulate watershed processes for the groundwater model under development. Evapotranspiration demand is based on potential evapotranspiration minus evapotranspiration of rainfall simulated by PRMS based on climatic conditions for Water Years 1985-2016. The resulting estimates for institutional/recreational groundwater pumping in the Basin for Water Years 2015-2016 is approximately 300-330 acre-feet per year.

Groundwater pumping for agricultural use is estimated based on crop evapotranspiration. The estimate is based on irrigated crop acreage (Figure 2-6), specific crop coefficients, an irrigation inefficiency of 10%, and evapotranspiration demand estimated by PRMS based on climatic conditions for Water Years 1985-2016. The resulting estimate for agricultural groundwater pumping in the Basin is approximately 700 acre-feet for drier Water Year 2015 and 455 acre-feet for wetter Water Year 2016.

2.3 NON-GROUNDWATER USE IN BASIN

The California Department of Water Resources regulations (DWR) for Groundwater Sustainability Plans (GSPs) include requirements that Annual Reports under GSPs include information about water use in the Basin not supplied by groundwater (§356.2(b)(4)). Although the GSP has not yet been developed and the BRR does not implement a GSP, available information about this water use is provided below. The main non-groundwater sources of supply for use in the Basin are City of Santa Cruz surface water supply and the Soquel Creek surface water adjudication.

The City of Santa Cruz primary water supply is surface water from the San Lorenzo River, west of the Basin. Municipal water use supplied by the City of Santa Cruz within the Basin has been estimated to simulate return flow for the City's service area in the groundwater model under development (HydroMetrics WRI, 2017). This estimate is based on annual consumption data for various use types (i.e., residential, industrial, irrigation, etc.) for the entire City service area. To estimate the amount of water delivered for municipal use within the groundwater model, consumption data was apportioned based on the percentage of connections in 2015 for each consumption use type inside and outside City of Santa Cruz limits and the areas inside and outside the City limits overlapping with the model area. Municipal water use estimates include system losses incurred before consumption data is recorded at individual meters which is added to the City's consumption data. System loss percentage of 7.5% is used based on City of Santa Cruz's Urban Water Management Plan (2016).

Figure 2-7 plots the City's water use estimate for calendar years 1985-2015 compared to the City's groundwater pumping from the Basin over that time. Based on the City's distribution system, it can be assumed that all of the groundwater pumped by the City from the Basin is delivered within the Basin.

Surface water flows in Soquel Creek are adjudicated. The County has not quantified the rights recently, but estimates that total allocations are approximately 2 cubic feet per second. However, most allocations are not utilized (Ricker, 2017).

2.4 Available Supplies for Replenishment

DWR's GSP regulations also include requirements that Annual Reports quantify surface water supply used or available for groundwater recharge, including as in-lieu use (§356.2(b)(3)). Although the GSP has not yet been developed and the BRR does not implement a GSP, information about the availability of surface water supply for groundwater recharge is provided here.

The most imminently available surface water supply for replenishment is from the cooperative water transfer pilot project between City of Santa Cruz (City) and Soquel Creek Water District (SqCWD) (City and SqCWD, 2016). This pilot project would transfer available surface water supplies from the City's pre-1914 North Coast water rights to SqCWD for in-lieu use to reduce groundwater demand. The water would be transferred via an intertie between the two agencies that has a capacity of approximately 1.5 million gallons per day. Under the existing contract, the maximum annual available supplies would be approximately 300 acre-feet per year (City, 2015), but vary based on a number of conditions outlined in the pilot project agreement and SqCWD demand.

The pilot project agreement was not in place for the winters of Water Years 2015 and 2016 and will not be implemented until Water Year 2019 to allow SqCWD to prepare its system and processes to reduce the risk of water quality issues arising from the introduction of surface water in its distribution system. To facilitate preparation of its system for this reason, SqCWD will restrict delivery of surface water to SqCWD's service area west of Soquel Creek, which will limit the maximum transfer to 215 acre-feet per year.

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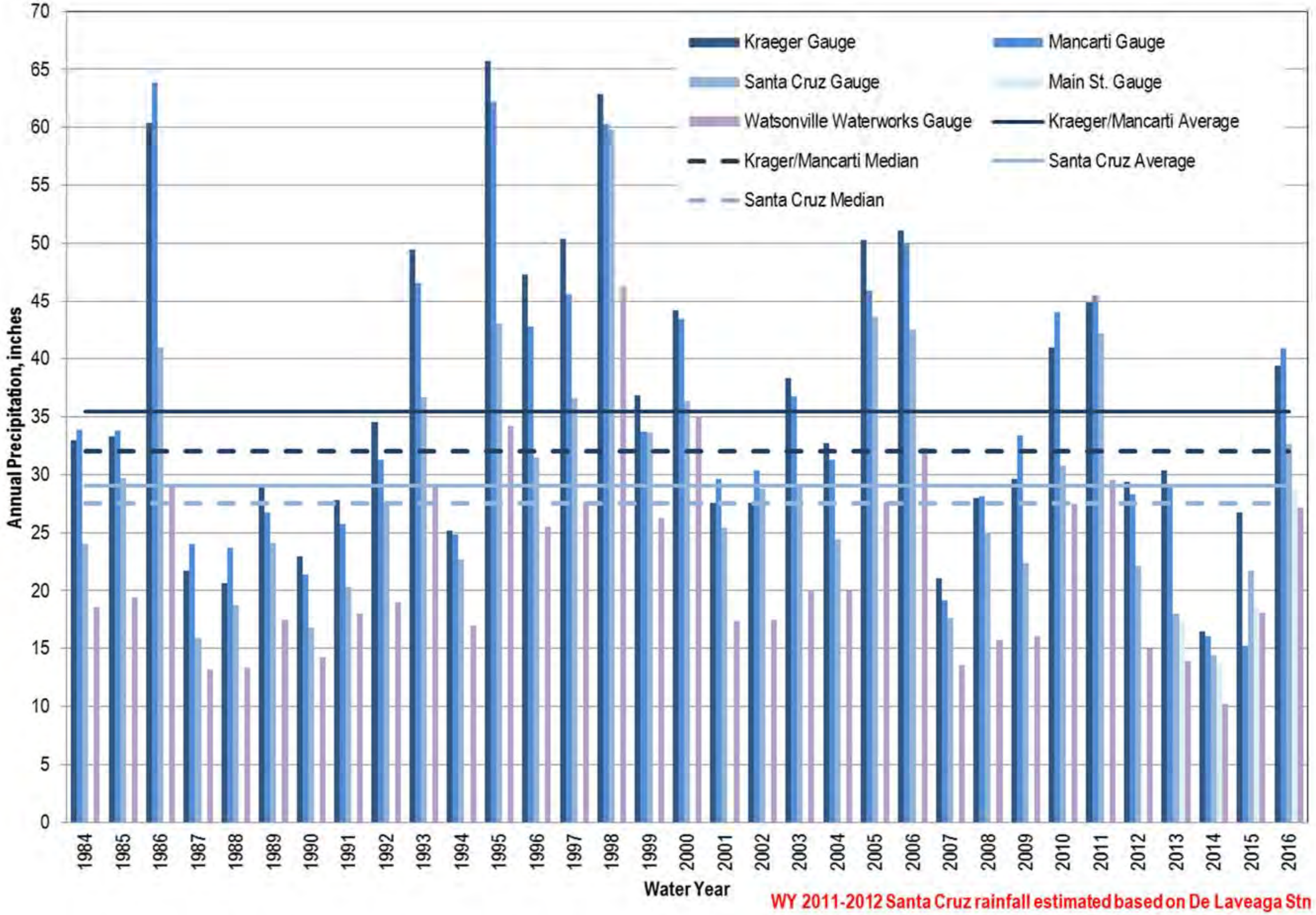

Figure 2-1: Precipitation at Kraeger, Mancarti, Santa Cruz Co-op, Watsonville Waterworks and Main Street Gauges

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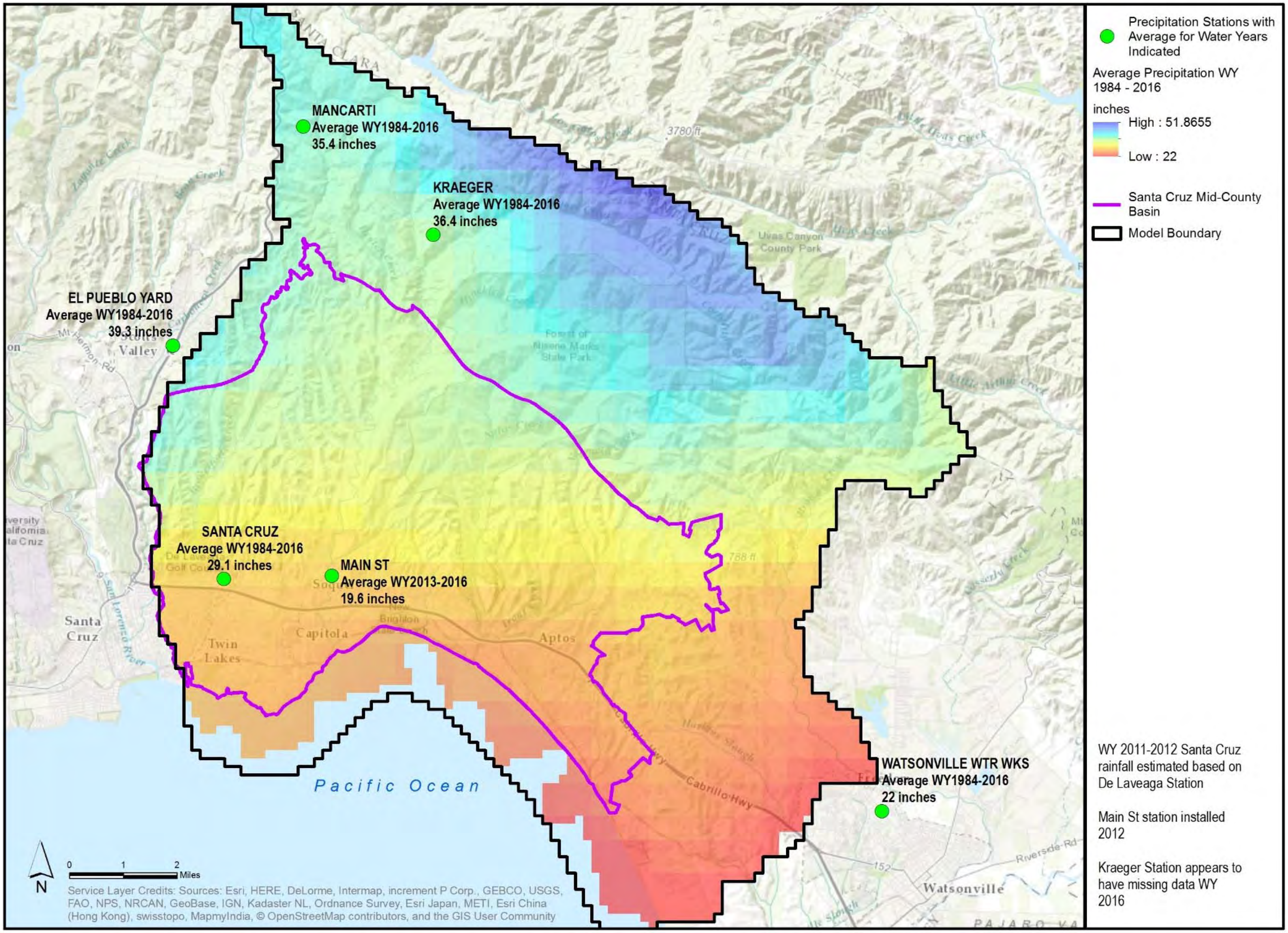

Figure 2-2: Rainfall Station Locations

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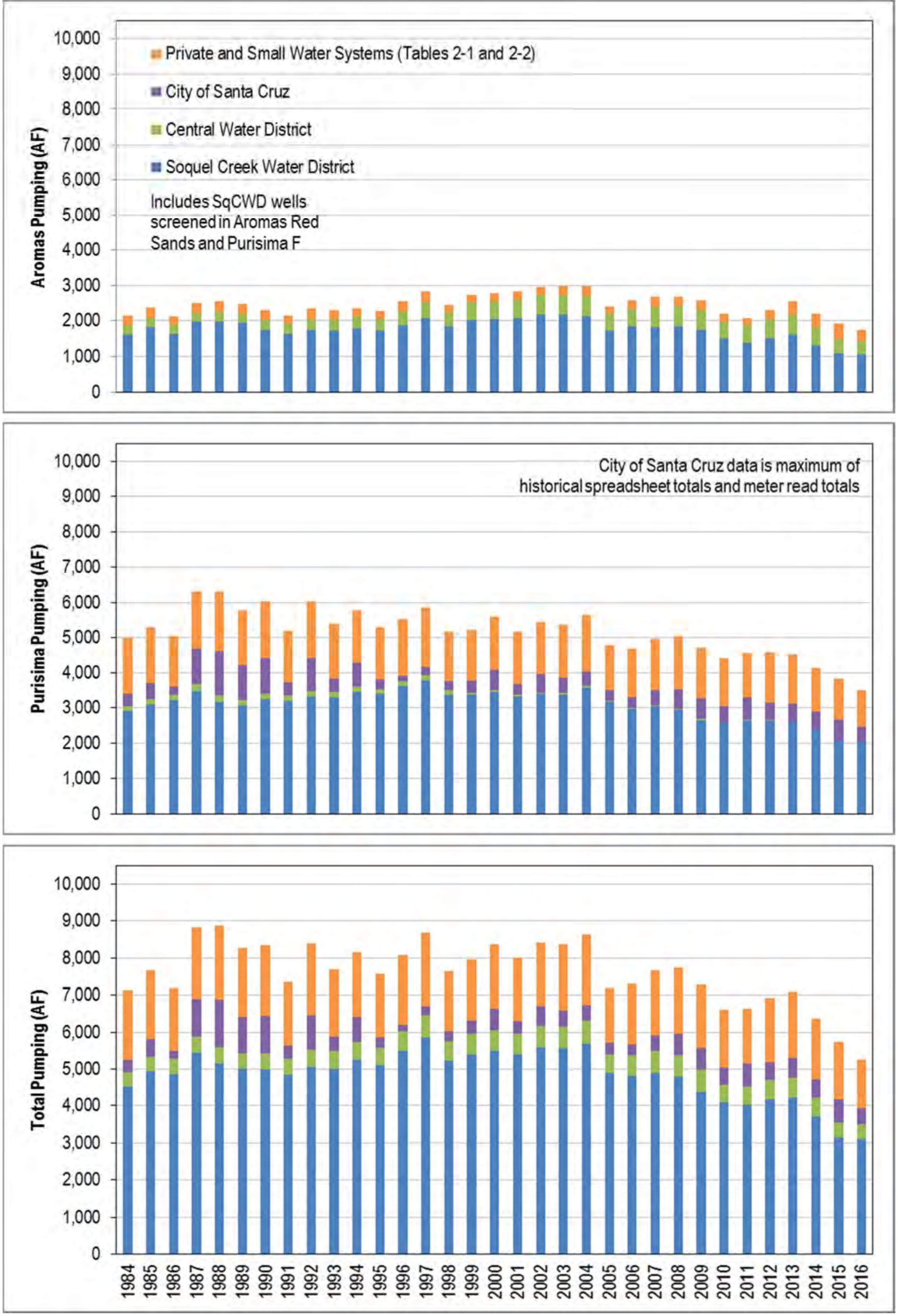

Figure 2-3: Santa Cruz Mid-County Basin Pumping by Water Year in Acre-Feet

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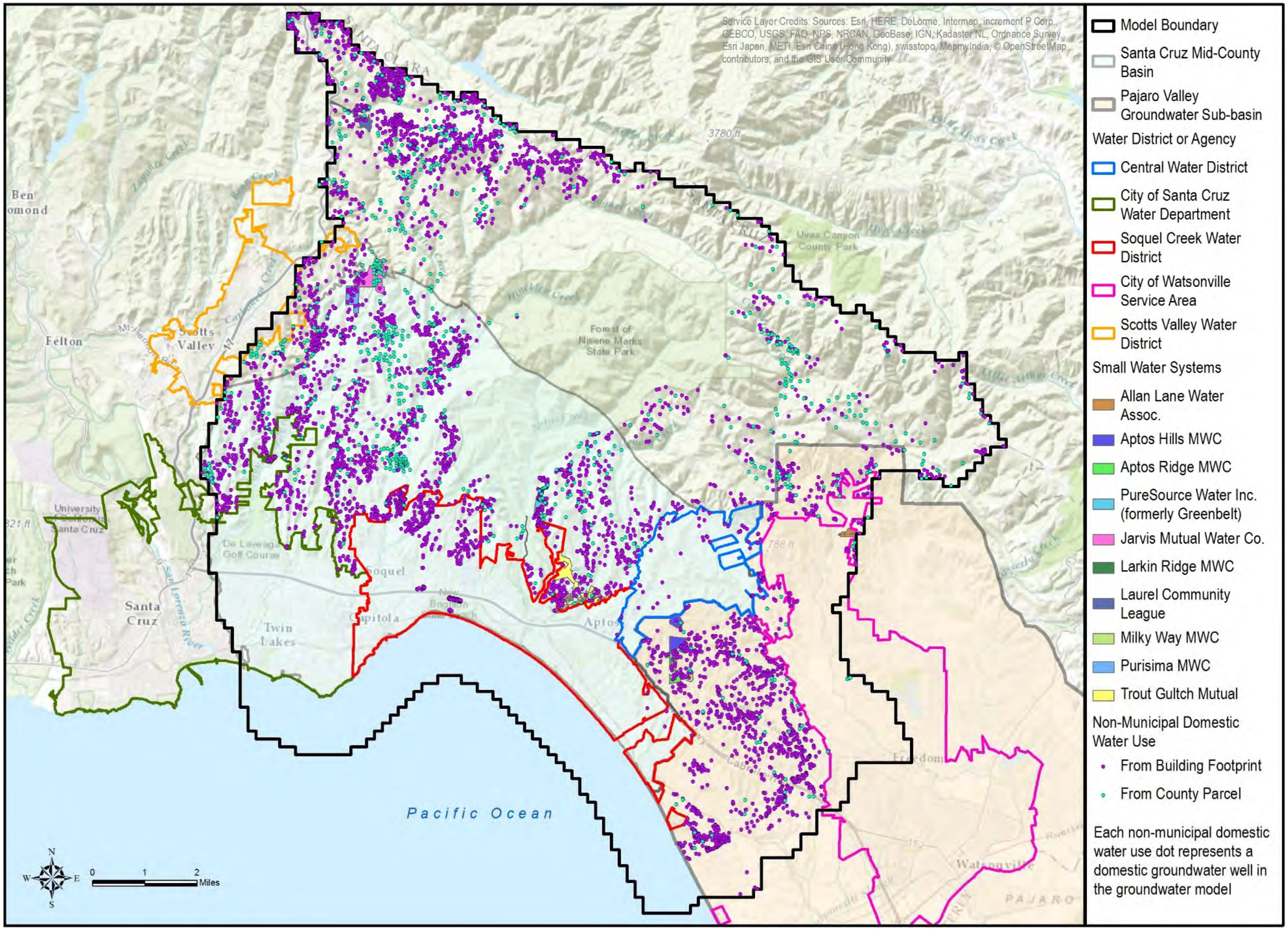

Figure 2-4: Non-Municipal Water Use Building Footprints, Residential Parcels and Small Water Systems

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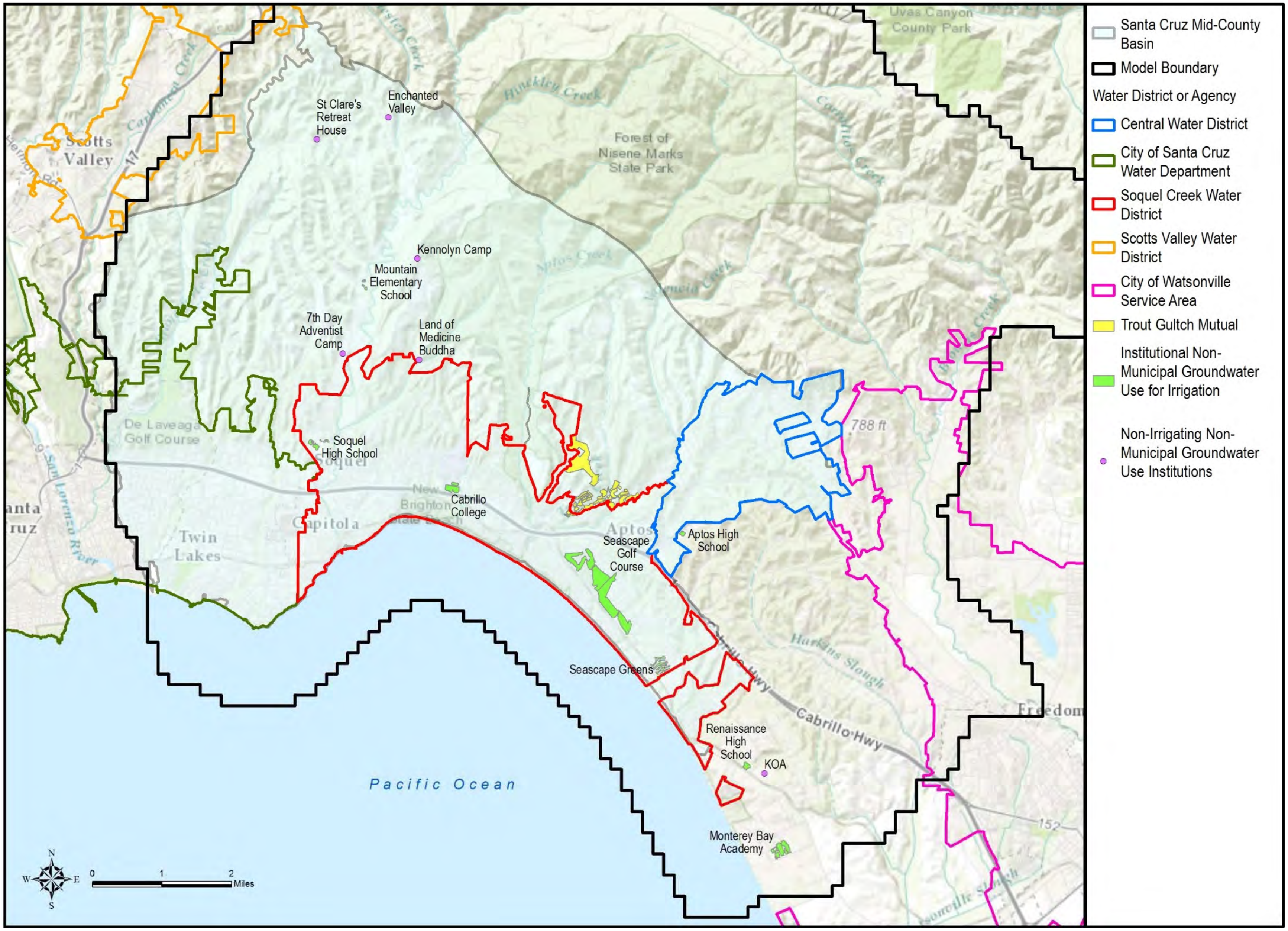

Figure 2-5. Non-Municipal Groundwater Use Institutions

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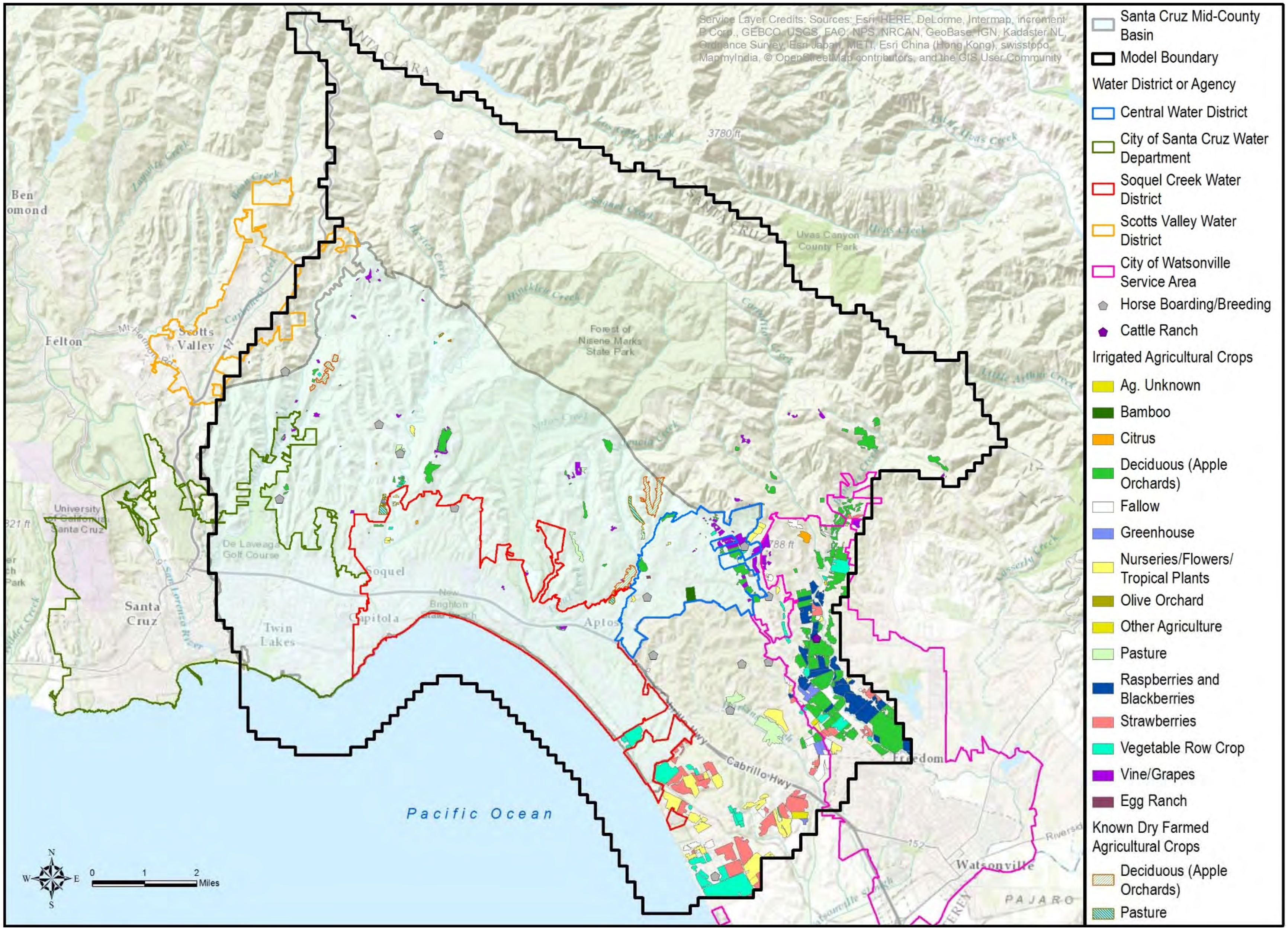

Figure 2-6. Agriculture in the Santa Cruz Mid-County Basin and Model

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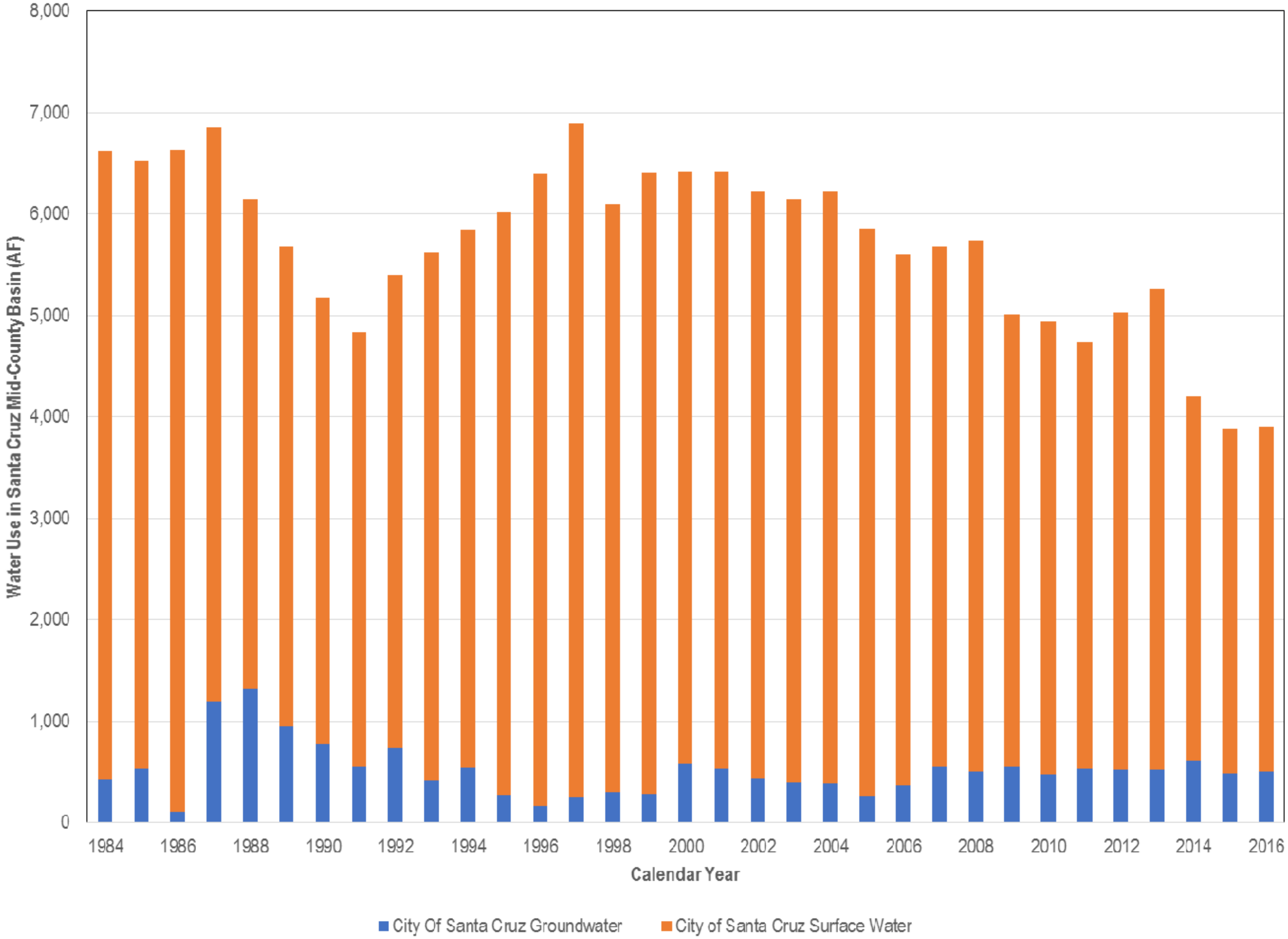

Figure 2-7: City of Santa Cruz Surface Water Use in Santa Cruz Mid-County Basin

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SECTION 3 - WATER YEARS 2015-16 AQUIFER CONDITIONS FOR WESTERN PURISIMA AREA (A/AA/TU-UNITS)

This section presents groundwater level and water quality conditions for Water Years 2015 and 2016 in the western portion of the Santa Cruz Mid-County Basin 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 Santa Cruz Mid-County Basin, 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 1,448 and 1,671 acre-feet in Water Years 2015 and 2016, the lowest and third lowest annual amounts since service area data have been recorded starting in 1984 with Water Year 2014 production being the second lowest annual amount. Production in Service Area I has been below the historical average since Water Year 2004. The O'Neill Ranch well came online in Service Area I in Water Year 2015 and pumps from the Tu and AA units like the Main Street well. Water Year 2015 and 2016 production at the Estates well in Service Area II was 214 and 164 acre-feet. These are the two lowest annual amounts since the well was brought online in 1986, production at the Estates well in each of the last eight years was lower than all prior years since 1991.

The City of Santa Cruz's production from the Live Oak well field was 613 and 450 acre-feet in Water Years 2015 and 2016. The Beltz 12 well came online in Water Year 2015 and pumps from the Tu and AA units farther inland than the other Beltz production wells. The City's pumping season spans two water years as the pumping season typically extends from April-May to November-December so the City manages pumping based on calendar year totals. The City's pumping in calendar years 2015 and 2016 was 483 acre-feet and 505 acre-feet, less than its planned amount of 520 acre-feet per year during non-critically dry years (SqCWD and City, 2015). Pumping over these two calendar years was also the lowest consecutive years of pumping since 2005-6.

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 2016, City production ranged from 473 to 615 acre-feet per year with an average of 523 acre-feet per year, similar to its planned average amount of 520 acre-feet per year for all years.

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 and the City have established protective groundwater elevations in coastal monitoring wells to protect the Purisima A-unit in the western portion of the Santa Cruz Mid-County Basin from seawater intrusion. Average groundwater levels below protective elevations are evidence of basin overdraft and recovery to the protective elevations is necessary to prevent seawater intrusion over the long term. The MGA will likely re-consider the protective elevations established by SqCWD and the City when it develops measurable objectives for seawater intrusion in the Groundwater Sustainability Plan (GSP). Therefore, the coastal groundwater level averages below are presented in context of how SqCWD and the City established the protective elevations.

SqCWD set protective elevations at its monitoring wells (names beginning with "SC") based on cross-sectional models of density dependent flow to simulate the long term seawater interface resulting from the groundwater level set at each monitoring well (HydroMetrics LLC, 2009, and HydroMetrics WRI, 2012a) . Due to lack of offshore data for calibration, an uncertainty analysis was performed using runs of each cross-sectional model with 100 different sets of hydrologic parameters within documented ranges. SqCWD based its protective elevations on groundwater levels that protect against seawater intrusion in at least 70 percent of the runs. However, the model results also allow the percentage of the runs that protect against seawater intrusion to be quantified for the observed average groundwater levels presented below.

The City set its protective elevations at its monitoring wells (Moran Lake, Soquel Point, and Pleasure Point) based on the commonly used Ghyben-Herzberg relationship. This relationship does not account for local aquifer characteristics and do not provide probabilities for protection against seawater intrusion, but based on the most likely pathway for seawater intrusion in the area, the Ghyben-Herzberg results are more conservative than results from the cross-sectional modeling (HydroMetrics WRI, 2016a). For example, the Ghyben-Herzberg results for SqCWD's well SC-1A of 6.2 feet mean sea level (msl) is higher than the 4 feet msl that is protective at 70 percent of the runs for the well. As part of the cooperative groundwater management agreement between SqCWD and the City, 6.2 feet msl is used as the agreed upon protective level for SC-1A (City and SqCWD, 2015).

Table 3-1 shows the average groundwater levels calculated for Water Years 2015 and 2016 based on logger data recorded at 15 minute intervals. The average groundwater levels are compared to protective elevations and, where available, the percentage of cross-sectional model runs that protect against seawater intrusion at the average level.

Table 3-1 (2015-16): Comparison of Water Years 2015-2016 Coastal Groundwater Levels with Protective Elevations in Western Purisima Area

Unit A Monitoring Well	Protective Elevation (ft msl) [1]	Avg. Groundwater Level Water Year 2015 (ft msl)	Percentage of Runs Protective	Avg. Groundwater Level Water Year 2016 (ft msl)	Percentage of Runs Protective
Moran Lake Medium	5	5.2	N/A	5.6	N/A
Soquel Point Medium	6	4.8	N/A	5.8	N/A
Pleasure Point Medium	6.1	5.5	N/A	7.1	N/A
SC-1A	6.2	9.1	>99%	9.2	>99%
SC-3A	10	10.2	>=70%	13.0	>99%
SC-5A	13	4.8	<50%	11.5	<50%

[1] msl = mean sea level

Over Water Years 2015 and 2016, recovery due to historically low pumping from the A unit resulted in average groundwater levels at a fourth well, SC-3A, meeting the protective elevation for the well. Moran Lake Medium, Pleasure Point Medium, and SC-1A remained above protective elevations.

The A unit was still in overdraft as Soquel Point Medium and SC-5A remained below protective elevations through Water Year 2016. Although average groundwater levels in 2016 at SC-5A were the highest annual average at the well since installation in 1984, the average level still would be protective against seawater intrusion for less than half of the cross-sectional model runs.

Table 3-2 summarizes by monitoring well groundwater level trends over the last five years along with any changes to the trends over Water Years 2015 and 2016. Changes to trends in Water Years 2015 and 2016 include:

- At the City's coastal monitoring wells and SqCWD's SC-1A, there has been a slight increasing trend in groundwater levels over the last two water years after declines from Water Years 2012 to 2015. The decreasing trend over the last five years at the Pleasure Point and SC-1A wells can be attributed to redistribution of pumping to the nearest City and SqCWD production wells, but groundwater levels have remained above protective elevations.
- Further east, SqCWD's monitoring wells SC-3A and SC-5A show an acceleration in recovery over the last two water years after declines from Water Years 2012-2014.
- Inland and Tu unit pumping declines with SqCWD's Main Street well back online and SqCWD's O'Neill Ranch and the City's Beltz 12 wells brought online in Water Year 2015. These trends will be evaluated on an annual basis as part of the cooperative groundwater management agreement between SqCWD and City of Santa Cruz.

Table 3-2 (2015-16): Summary of Groundwater Level Trends in Western Purisima Area

Category	Well	Groundwater Level Trend Description	Notes
City of Santa Cruz Coastal A and AA-unit Wells	Moran Lake	Stable five year trend after slight increases over WY 2015-16	Redistribution of pumping from Beltz #9 to #8 in WY 2012-16 compared to WY 2010-11. WY 2015-16 pumping at Beltz #7/10, 8,9 lowest since 2006
	Soquel Point		
	Pleasure Point	Decreasing five year trend despite slight increases over WY 2015-16	
SqCWD Coastal	SC-1A	Decreasing five year trend despite slight increases over	Decrease since 2012 when Garnet offline. WY 2015-16

Monitoring A-unit Wells		WY 2015-16	Garnet pumping slightly lower from WY 2014
	SC-3A	Increasing five year trend due to increase of ~6 feet since WY 2014 average	Lowest Rosedale pumping WY 2015-16 since WY 1984
	SC-5A	Increasing five year trend due to increase of ~8 feet since WY 2014 average	Lowest combined pumping from Rosedale, Tannery II and Estates in WY 2016 since WY 1984
SqCWD Coastal Monitoring B and BC-unit Wells	SC-1B	Overall downward trend since WY 1998, stabilizes WY 2015-16 after decline over WY 2012-2014	Higher precipitation in WY 2015-16 compared to WY 2012-14. Decreased rainfall since WY 1998
	SC-3C	Long term downward trend, rise over winter WY 2016	
Inland A and AA unit wells	Coffee Lane Park	Decline since WY 2011, slight rise WY 2016	None
	Auto Plaza Drive	Slight decline since WY 2012	None
	Cory Street	Decline 10-20 ft since WY 2012	None
	SC-18A	Increasing five year trend but declines over WY 2015-6	Main St pumping back online WY 2015-6 after rehab
	SC-10AA	Slightly increasing five year trend due to increases over WY 2015-16	None
Tu-(or SM) unit Wells	Beltz #7 Test	Increasing five year trend but declines of ~5 feet over WY 2015-16	O'Neill Ranch and Beltz 12 online
	30th Ave #1	Decline of 5-10 feet since WY 2014	
	Cory-4	Decline of ~20 feet since WY 2014 installation	
	SC-18AA	Increasing five year trend but declines over WY 2015-16	Main St pumping back online WY 2015-6 after rehab
	Thurber Lane Deep	Decreasing five year trend due to decline of ~20 feet since WY 2014	O'Neill Ranch and Beltz 12 online

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 plotted with chemographs. These hydrographs show trend lines and rates of change for Water Years 2012-2016 when municipal production for the Western Purisima has been below historical averages.

Contour maps of groundwater elevations in Spring and Fall 2016 for the Purisima A-unit and AA-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 generally higher than protective elevations in the western half of the western Purisima area, with limited depressions inland of the coast around SqCWD's pumping wells. Figure 3-4 shows that fall coastal groundwater levels in the A-unit were lower than protective or target elevations in much of the area, with defined pumping depressions inland of the coast around SqCWD production wells. The area of pumping depressions below sea level is limited to the Tannery II well when as recently as Fall 2013 the area of groundwater levels below sea level extended to the coast at SC-5A and SC-9A.

As inferred from the contour maps, groundwater flows towards SqCWD's production wells but flows offshore also occur that reduce risk of seawater intrusion. Groundwater flows from inland toward the coast to be intercepted by the City of Santa Cruz's production wells in the most western portion of the Purisima area. The contour maps indicate significant flow from the northwest consistent with outcrop areas for the A and AA- units being towards the north and west (Johnson et al., 2004).

Figure 3-4 and Figure 3-5 show Spring and Fall 2016 groundwater levels in the Tu unit below the Purisima Formation as snapshots of conditions after SqCWD's O'Neill Ranch and the City's Beltz 12 well came online in 2015. Flow tests at these wells indicate that significant flow in these wells comes from the Tu unit (also called the SM unit as it may be Santa Margarita Formation), but pumping tests at these wells showed slow recovery so monitoring groundwater levels in the Tu unit will be important for assessing the reliability of supply from these wells. Figure 3-4 and Figure 3-5 show that fall groundwater levels were lower than spring groundwater levels in the Tu unit for Water Year 2016 with Beltz 12 pumping primarily in summer and fall. Groundwater levels below sea level extend to the Beltz 7 Test Well in the fall.

3.3 Shallow Groundwater Levels along Soquel Creek

Figure 3-2 and Figure 3-3 show locations of shallow groundwater wells along Soquel Creek, a stream where surface water is considered interconnected with groundwater. The contour levels shown on Figure 3-2 and Figure 3-3 do not incorporate groundwater levels from these wells because the shallow groundwater levels are not considered representative of deeper groundwater levels in the Purisima A and AA units. The substantial downward vertical gradient between shallow groundwater levels and underlying Purisima AA unit at the Main Street site was discussed in the shallow groundwater evaluation for the MGA (HydroMetrics WRI, 2016b).

SqCWD first installed shallow wells along Soquel Creek in 2001. Shallow wells were added and replaced in 2012 and 2014 for SqCWD and City of Santa Cruz's Soquel Creek Monitoring and Adaptive Management Program (MAMP, HydroMetrics WRI, 2012b) as part of improvement measures in the Environmental Impact Reports (EIR) for the new O'Neill Ranch (ESA, 2011) and Beltz #12 (Chambers, 2011) wells. At the Simons, Balogh, Main Street, and Nob Hill sites, there are also stream gauges for measuring stream water levels and comparing shallow groundwater to stream water levels as shown in Figure 3-6. Figure 3-6 shows that shallow groundwater levels are below Soquel Creek stream levels (losing stream) at Main Street and upstream to approximately the Balogh site, while shallow groundwater level have been above Soquel Creek stream levels (gaining stream) upstream at the Simons site and downstream at Wharf Rd. and Nob Hill. While Main Street well pumping has been shown to influence shallow groundwater levels (HydroMetrics WRI, 2015a), the losing stream condition near this well predated the construction of the Main Street well and may result from a local increase in transmissivity of the shallow aquifers (Johnson et al., 2004).

Although Main Street well pumping influences shallow groundwater levels, the baseline report for the Soquel Creek MAMP concluded any effects of Main Street well pumping on streamflow in Soquel Creek has limited temporal and areal extent (HydroMetrics WRI, 2015), a result consistent with previous studies (Johnson et al., 2004). Pumping at O'Neill Ranch and Beltz #12 wells that came online in 2015 show no effect on shallow groundwater levels along Soquel Creek and therefore no observable effect on streamflow in Soquel Creek (HydroMetrics WRI, 2016d).

3.4 WATER QUALITY CONDITIONS AND TRENDS

The most significant groundwater quality threat in the Santa Cruz Mid-County Basin is seawater intrusion. As discussed above, average groundwater levels were below protective elevations in four of six coastal monitoring wells in the A-unit as of Fall 2016. As a result, there is ongoing risk of seawater intrusion into the productive units of the western Purisima area.

TDS and chloride concentrations at two City of Santa Cruz monitoring wells near the coast have suggested seawater intrusion. Chloride concentrations in the Medium completion (A-unit) of the Moran Lake well cluster have steadily decreased from a maximum of 700 mg/L in 2005 to below 250 mg/L in 2012 and have continued to decline through 2016. 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 140 mg/L since 2004. The City replaced the Soquel Point Deep well in 2012 due to concerns about whether water quality data from the well were representative, but samples from the replacement well in 2013 confirm the increasing trend in chloride concentrations

Observed Total Dissolved Solids (TDS) and chloride concentrations in production wells do not suggest any seawater intrusion impacting SqCWD's and City of Santa Cruz’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-3RC 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.

Higher chlorides and TDS concentrations were observed in Water Year 2013 at SC-1A than previous years, but the trend for these constituents have decreased since then from Water Years 2014-16. A previous evaluation of the general mineral composition concluded that there was no consistent indication of seawater intrusion (HydroMetrics WRI, 2014). These elevated salt concentrations continued to be coincident with relatively high groundwater elevations at this well. At wells where chloride concentrations are less than 100 mg/L, there is generally no correlation between changes in salt concentrations and groundwater levels.

Groundwater pumped from the Purisima Formation continues to be treated for iron and manganese to meet drinking water standards. In Water Years 2015 and 2016, color and turbidity were also reduced during treatment to meet drinking water standards. Ammonia concentrations rose at the O'Neill Ranch well after it was brought online, necessitating increases in required chlorine dosage beyond maximum limits so modification of this well is being evaluated.

3.5 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 the City and SqCWD's protective elevations in four of the six coastal monitoring well locations. The City and SqCWD's pumping in the Western Purisima were low compared to the historical average, leading to increasing groundwater levels at all coastal monitoring wells in the area. Groundwater levels recovered enough at SC-3A to rise above the protective elevation at the well. A longer period of low production with adaptive management of the pumping distribution will be required to fully recover the basin to protect against the risk of seawater intrusion.

SqCWD and the City have installed inland production wells (O'Neill Ranch and Beltz #12) that will extract primarily from the Tu unit. Groundwater levels measured during testing of these wells indicate recharge rate of the Tu unit may be limited so active management of pumping these wells based on groundwater levels in the Tu unit will be needed when these wells come online.

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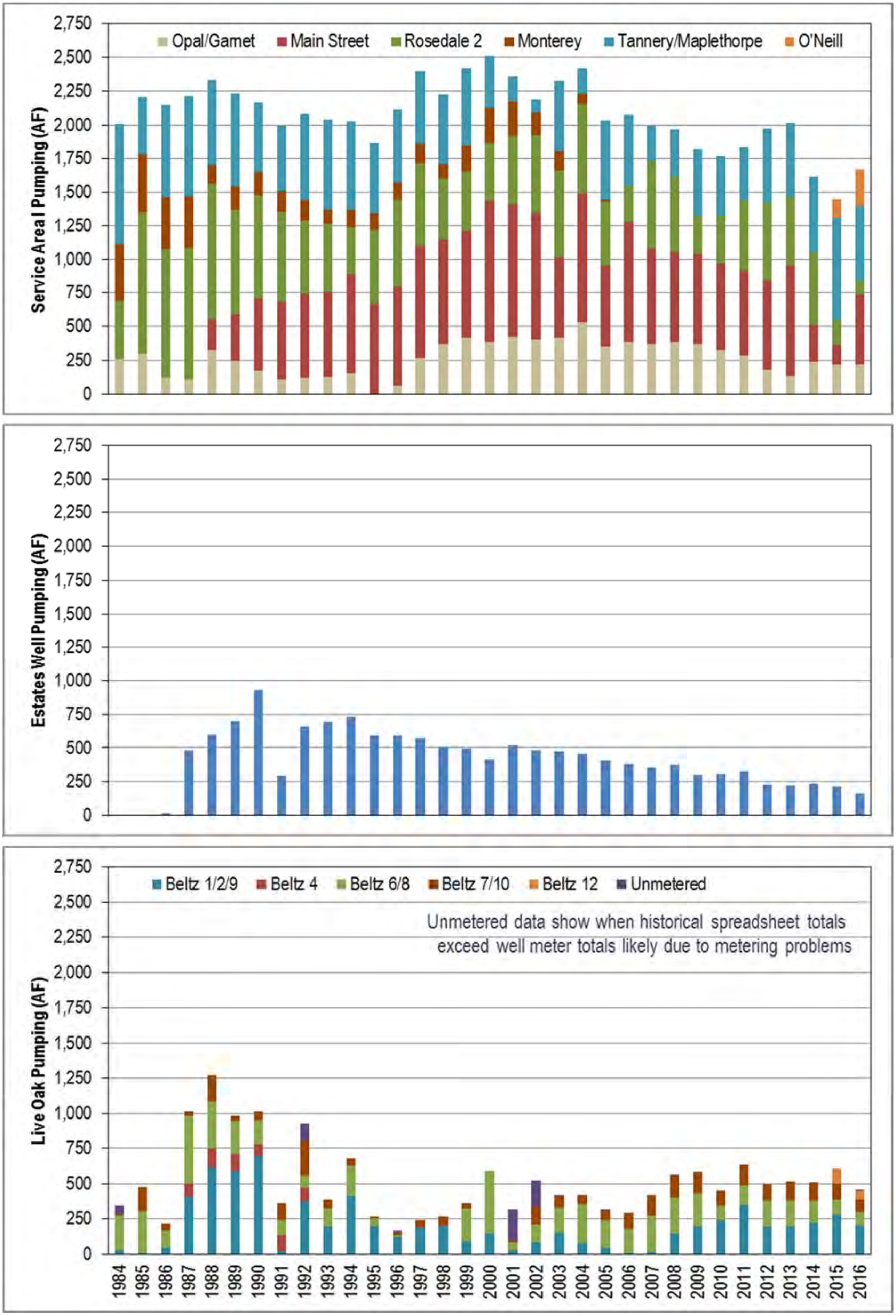

Figure 3-1: Pumping by Water Year in Western Purisima Area

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Figure 3-2 (2016): Groundwater Elevation Contours, Purisima A/AA-Units, Spring 2016

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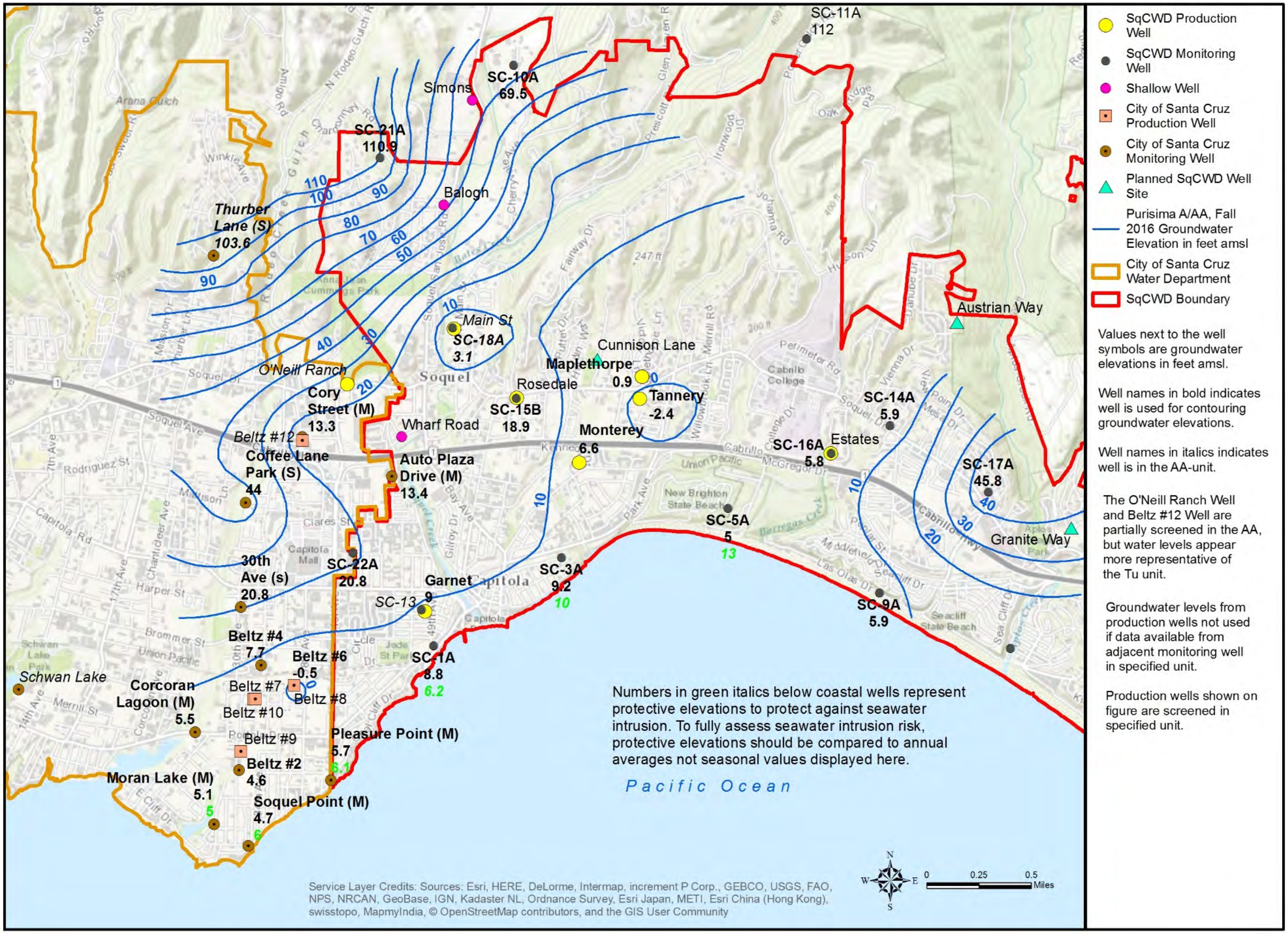

Figure 3-3 (2016): Groundwater Elevation Contours, Purisima A/AA-Units, Fall 2016

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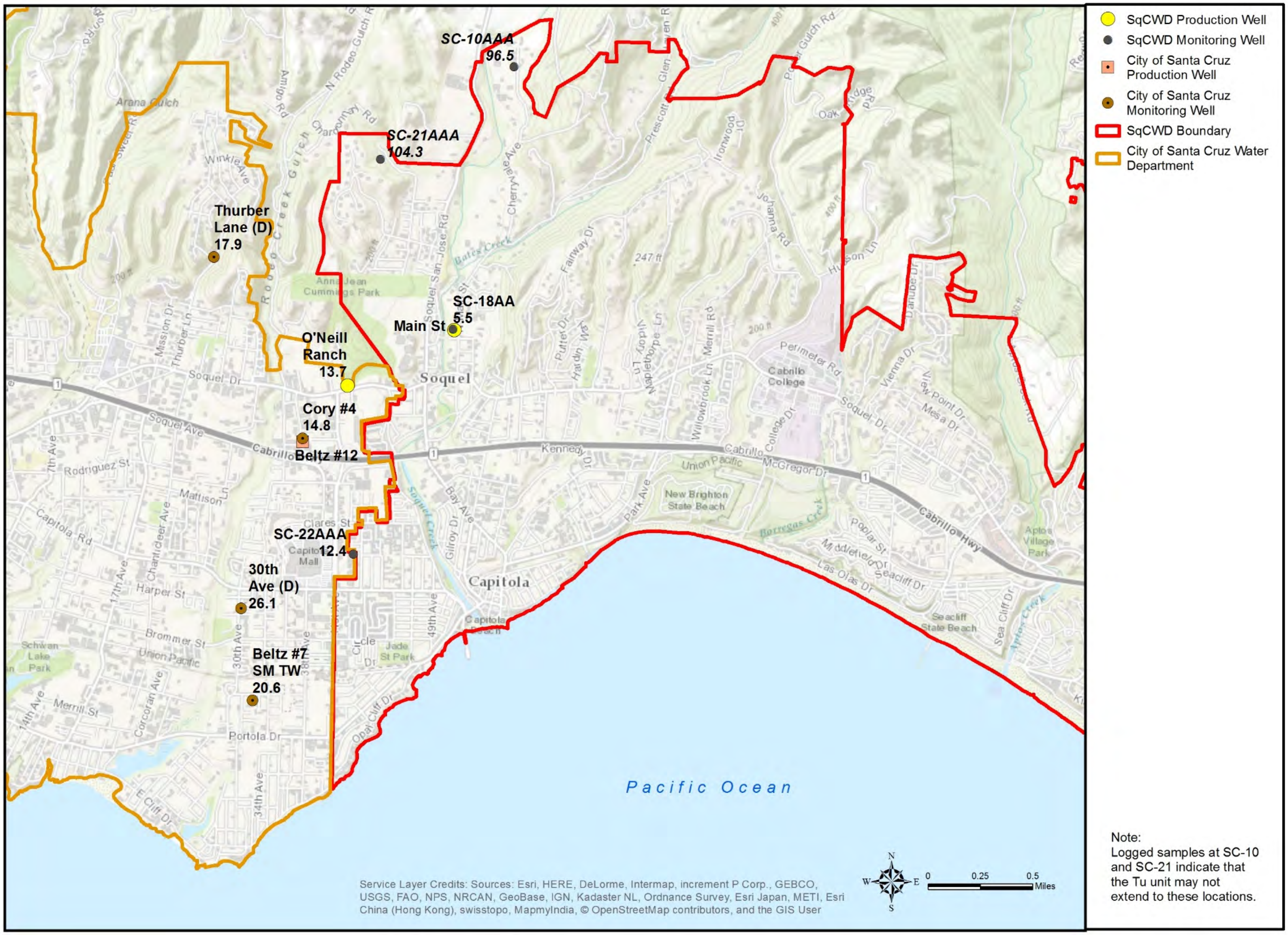

Figure 3-4 (2016): Groundwater Elevations Tu Unit, Spring 2016

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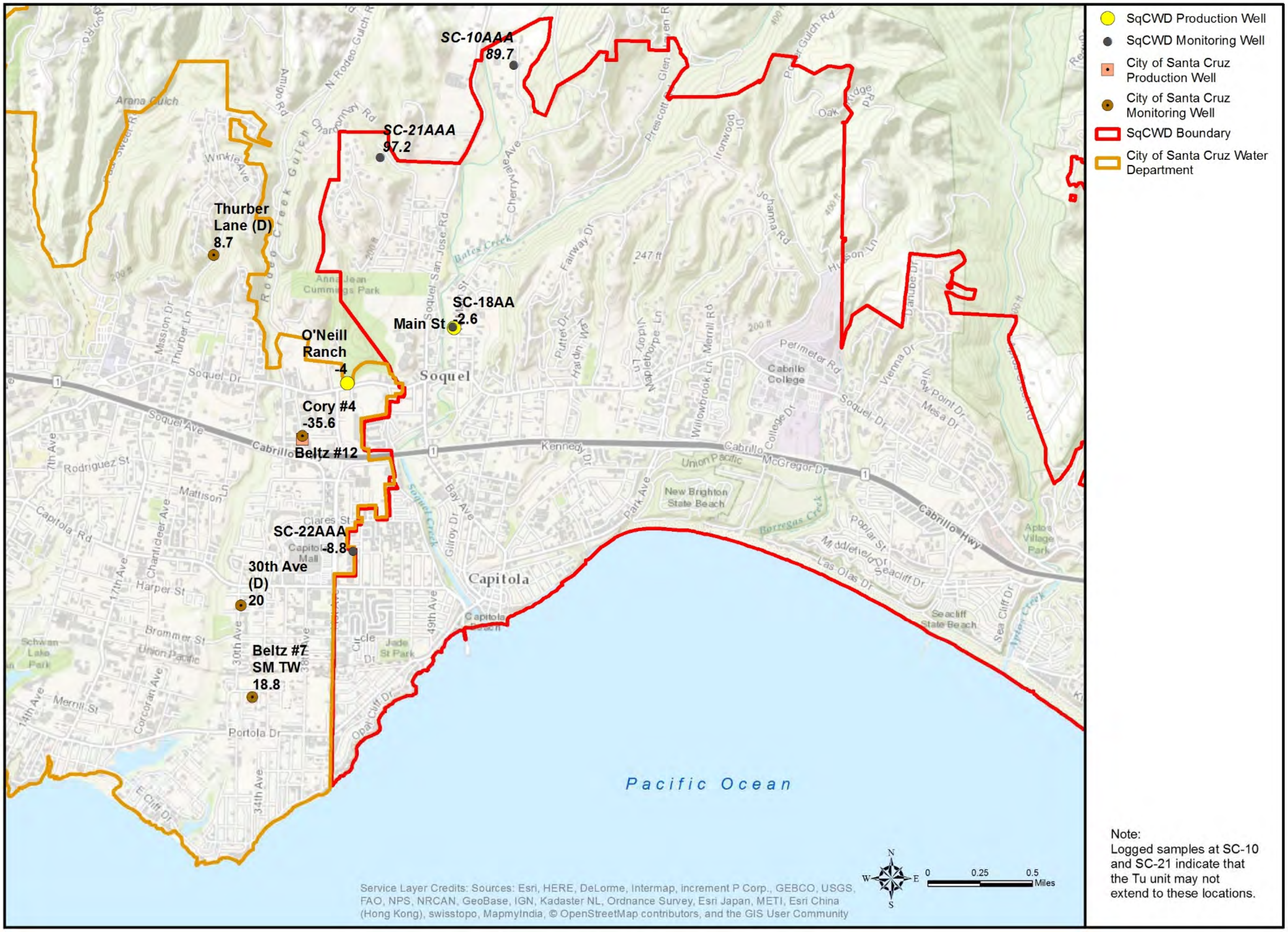

Figure 3-5 (2016): Groundwater Elevations Tu Unit, Fall 2016

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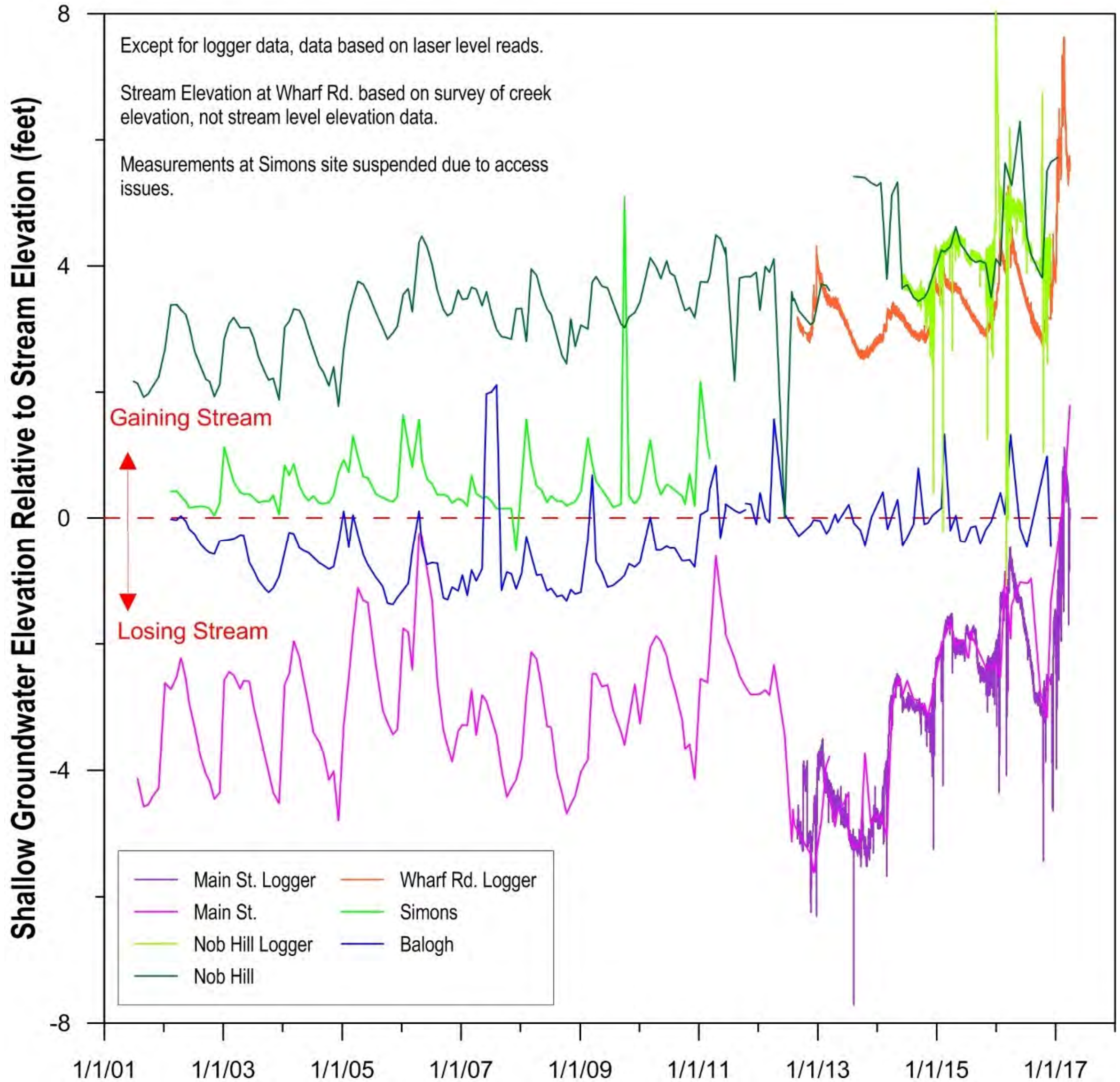

Figure 3-6 (2016): Shallow Groundwater Levels vs. Soquel Creek Elevations

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Monitoring Well Hydrographs for Western Purisima Area

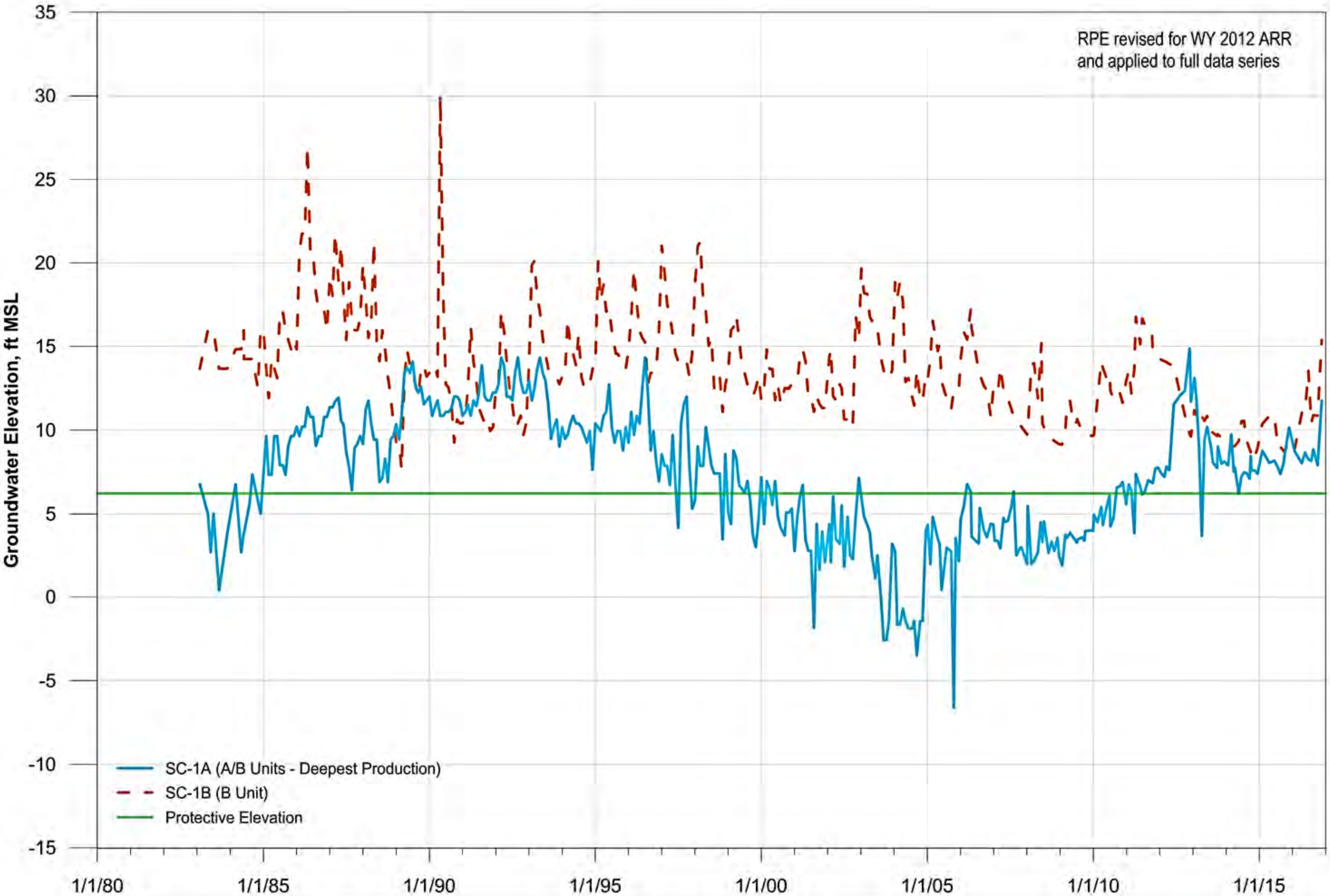
Hydrographs of SqCWD Coastal Monitoring Well Clusters

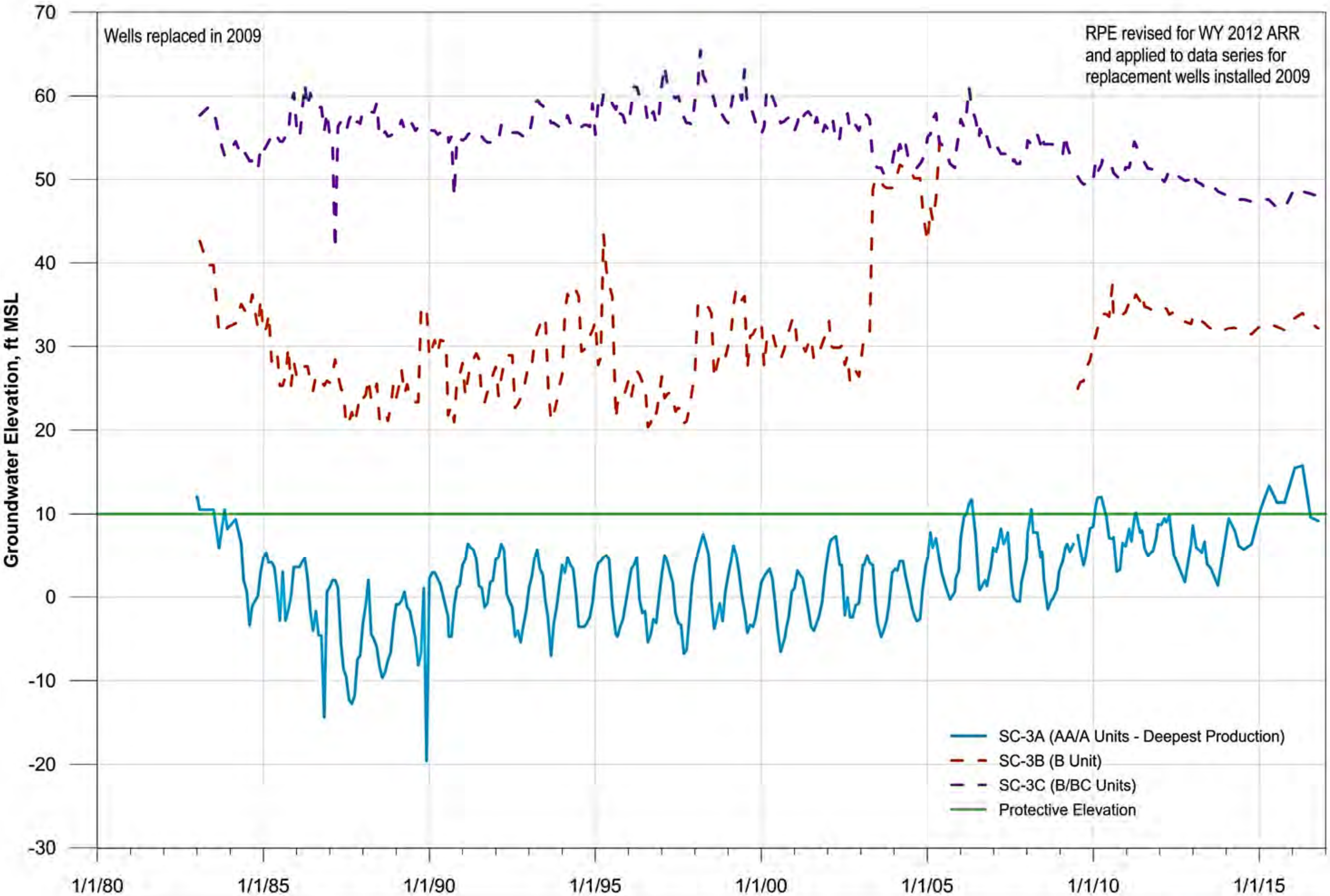
Hydrographs of City of Santa Cruz Coastal Monitoring Well Clusters

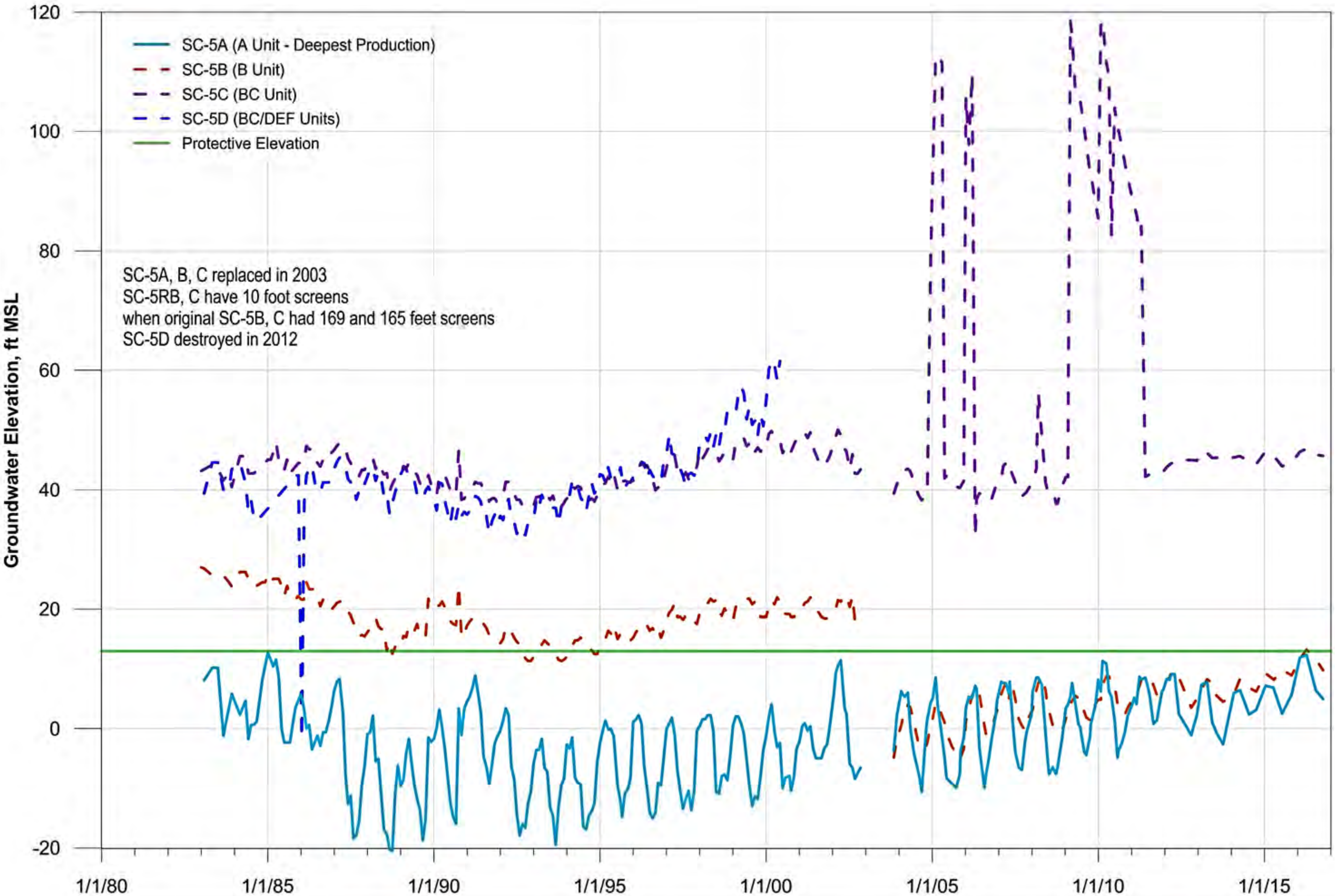
Hydrographs of SqCWD Inland Monitoring Well Clusters

Hydrographs of City of Santa Cruz Inland Monitoring Well Clusters

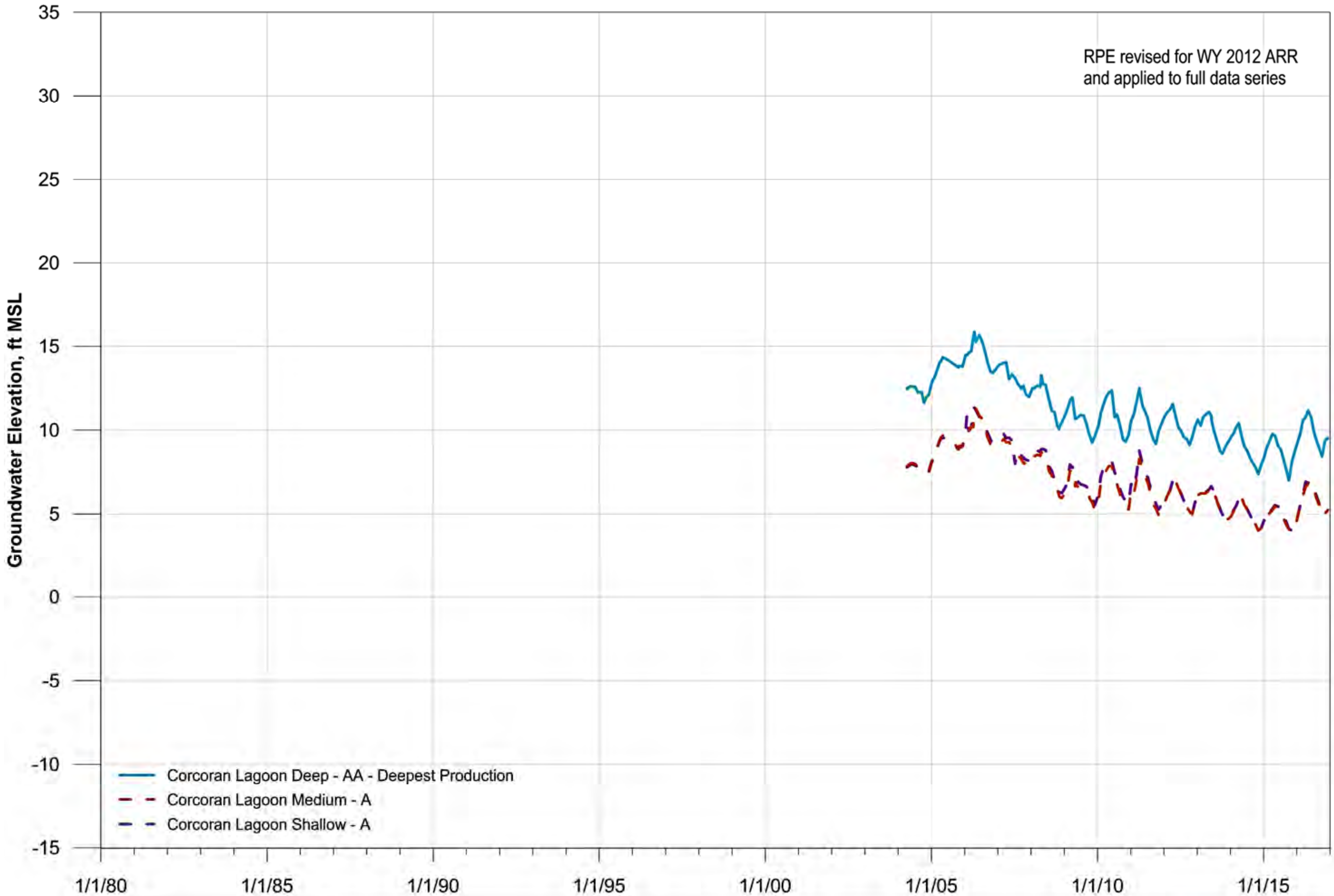
Hydrographs of SqCWD Monitoring Wells Adjacent to Production Wells

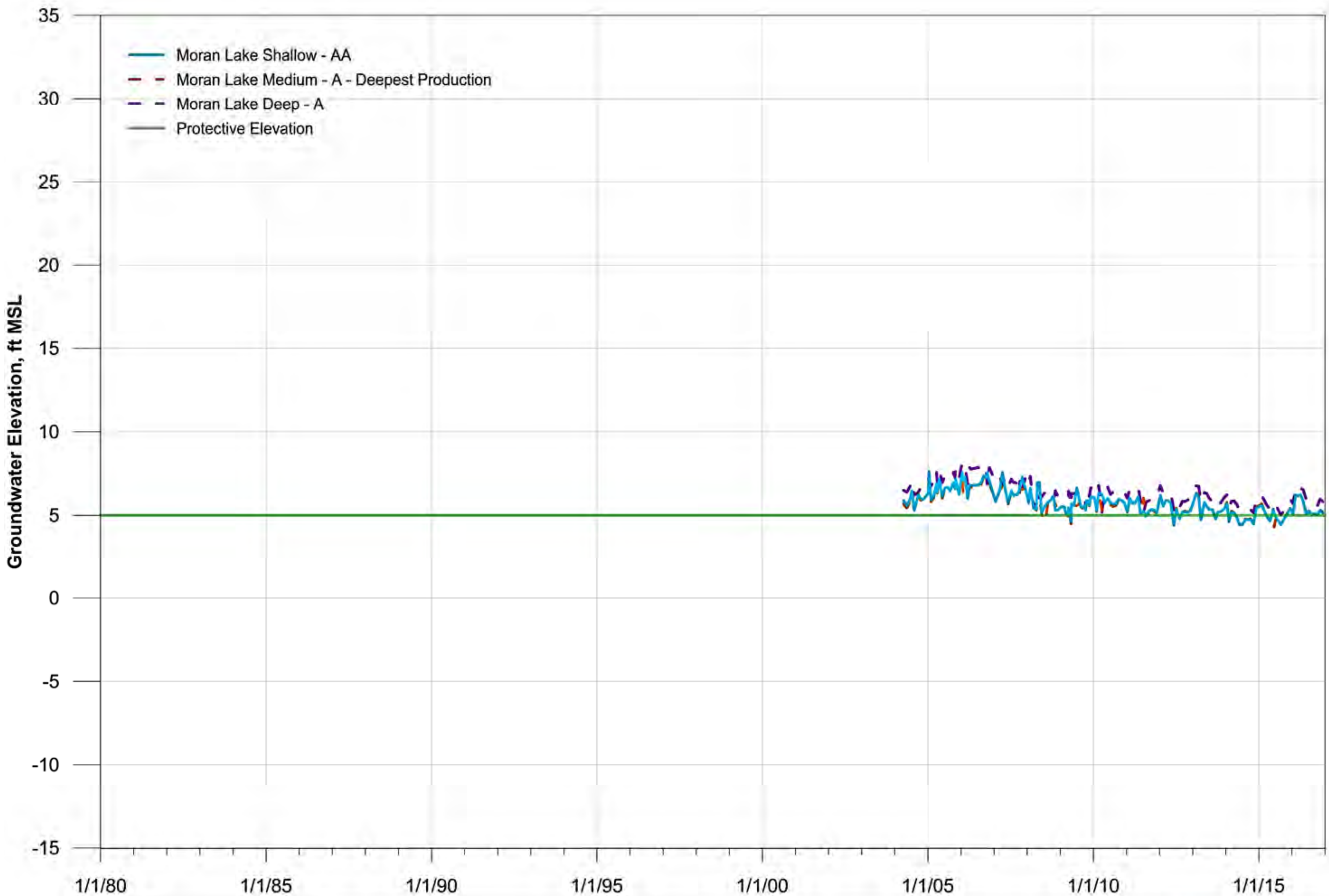

RPE revised for WY 2012 ARR
and applied to full data series
Groundwater Elevation, ft MSL
35
30
25
20
15
10
5
0
-5
-10
-15
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-1A (A/B Units - Deepest Production)
SC-1B (B Unit)
Protective Elevation


Wells replaced in 2009
RPE revised for WY 2012 ARR
and applied to data series for
replacement wells installed 2009
Groundwater Elevation, ft MSL
70
60
50
40
30
20
10
0
-10
-20
-30
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-3A (AA/A Units - Deepest Production)
SC-3B (B Unit)
SC-3C (B/BC Units)
Protective Elevation

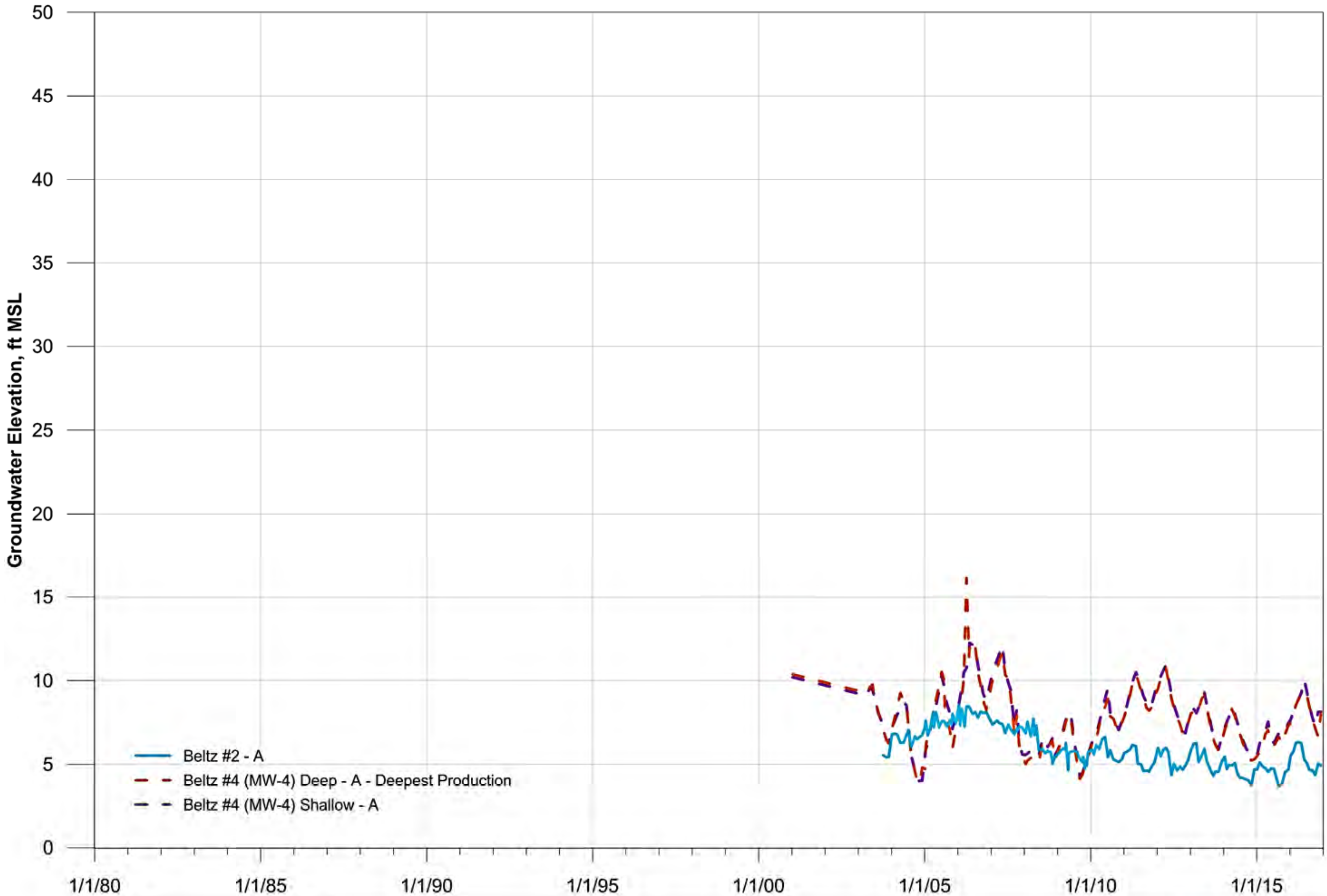


Hydro Metrics WRI

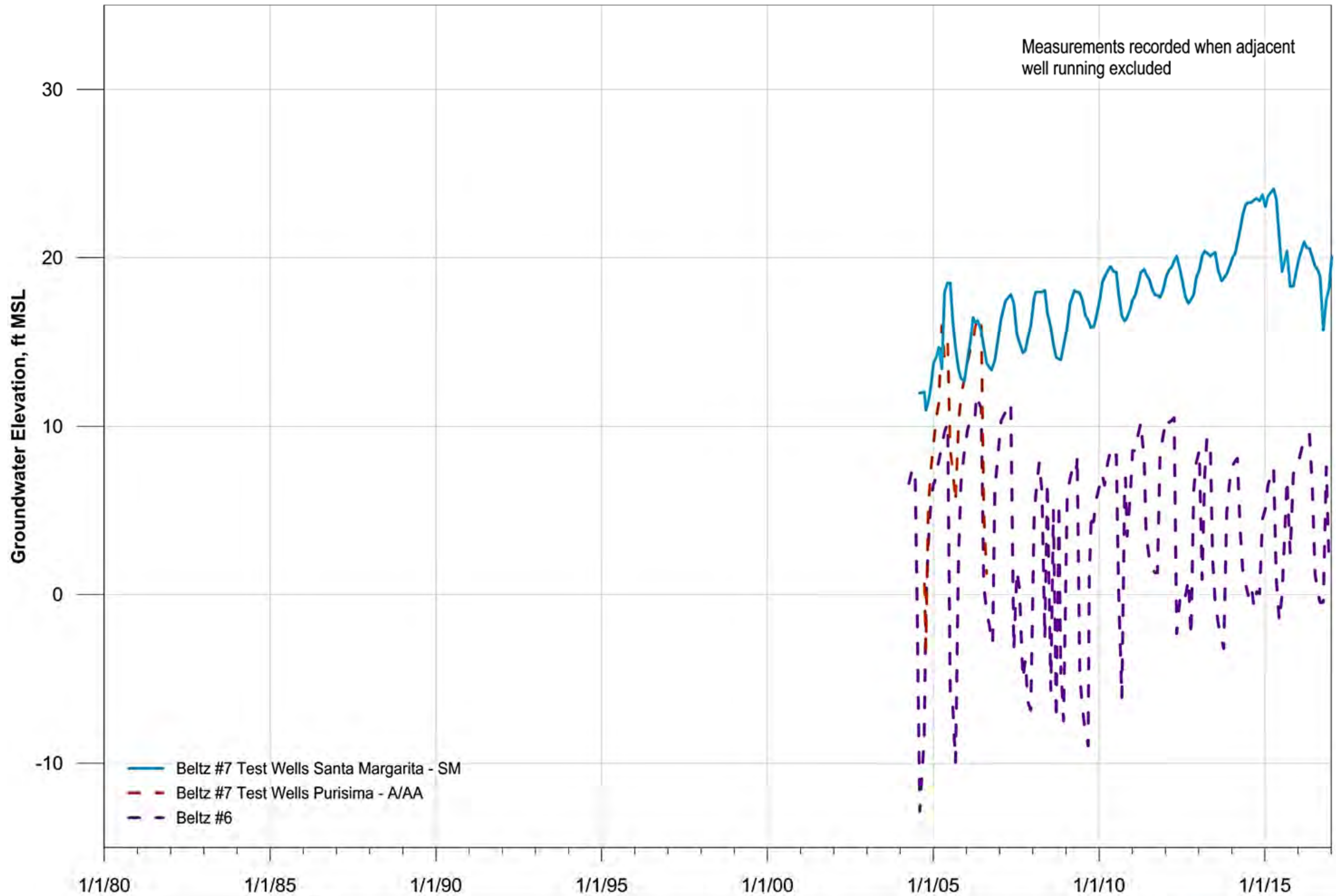

RPE revised for WY 2012 ARR
and applied to full data series
Groundwater Elevation, ft MSL
35
30
25
20
15
10
5
0
-5
-10
-15
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
Corcoran Lagoon Deep - AA - Deepest Production
Corcoran Lagoon Medium - A
Corcoran Lagoon Shallow - A

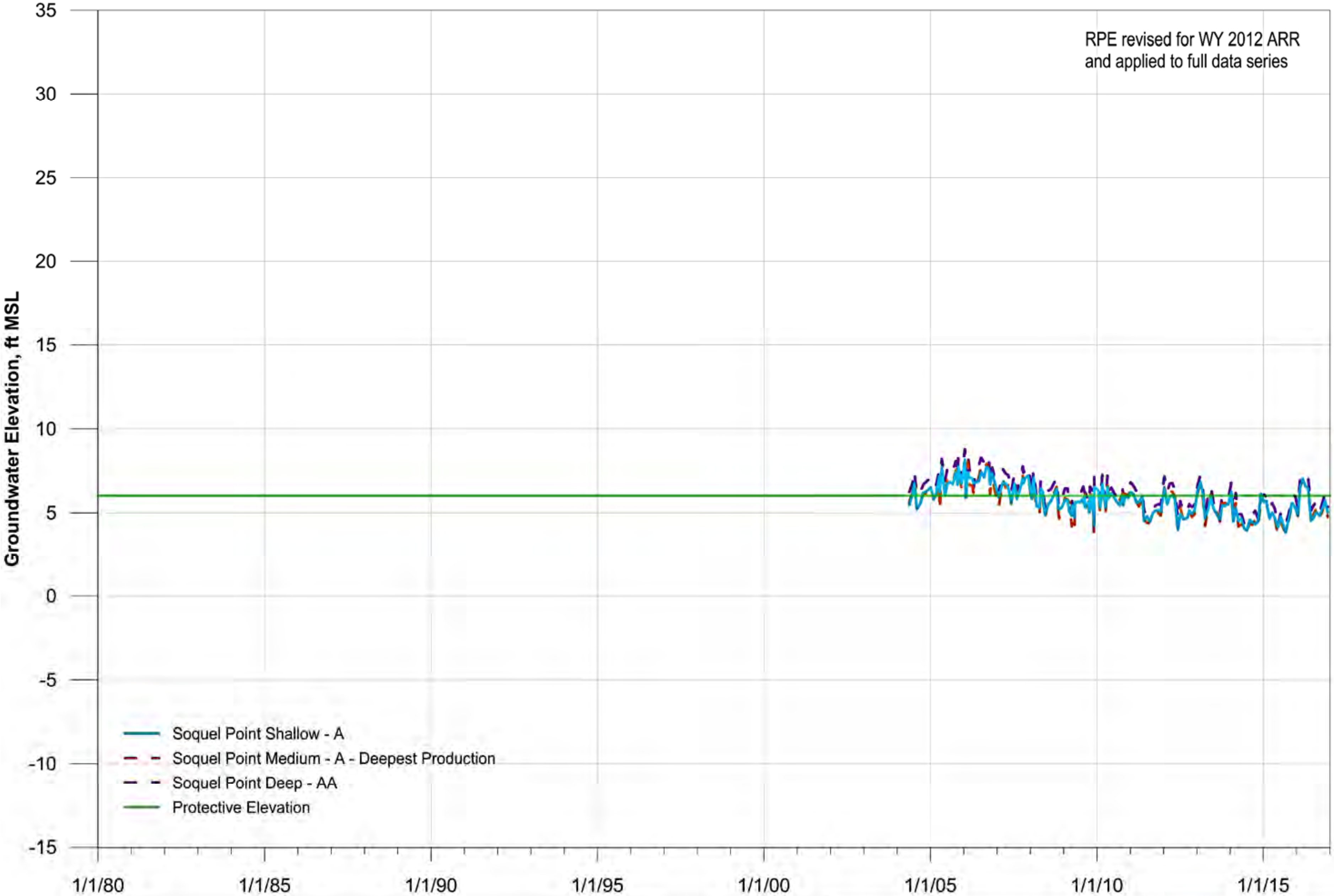


Moran Lake Shallow - AA
Moran Lake Medium - A - Deepest Production
Moran Lake Deep - A
Protective Elevation
Groundwater Elevation, ft MSL
35
30
25
20
15
10
5
0
-5
-10
-15
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

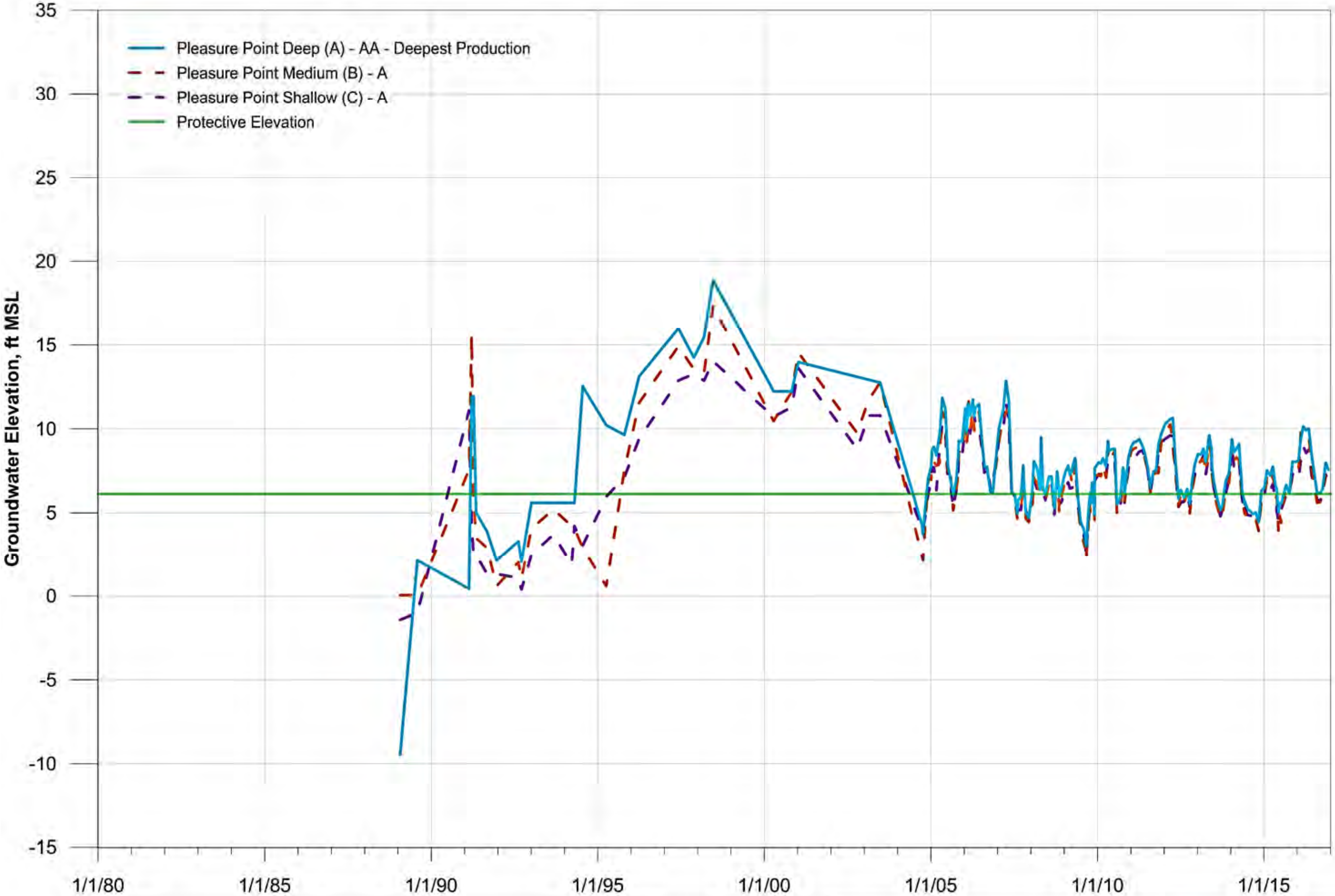


Groundwater Elevation, ft MSL
50
45
40
35
30
25
20
15
10
5
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
Beltz #2 - A
Beltz #4 (MW-4) Deep - A - Deepest Production
Beltz #4 (MW-4) Shallow - A

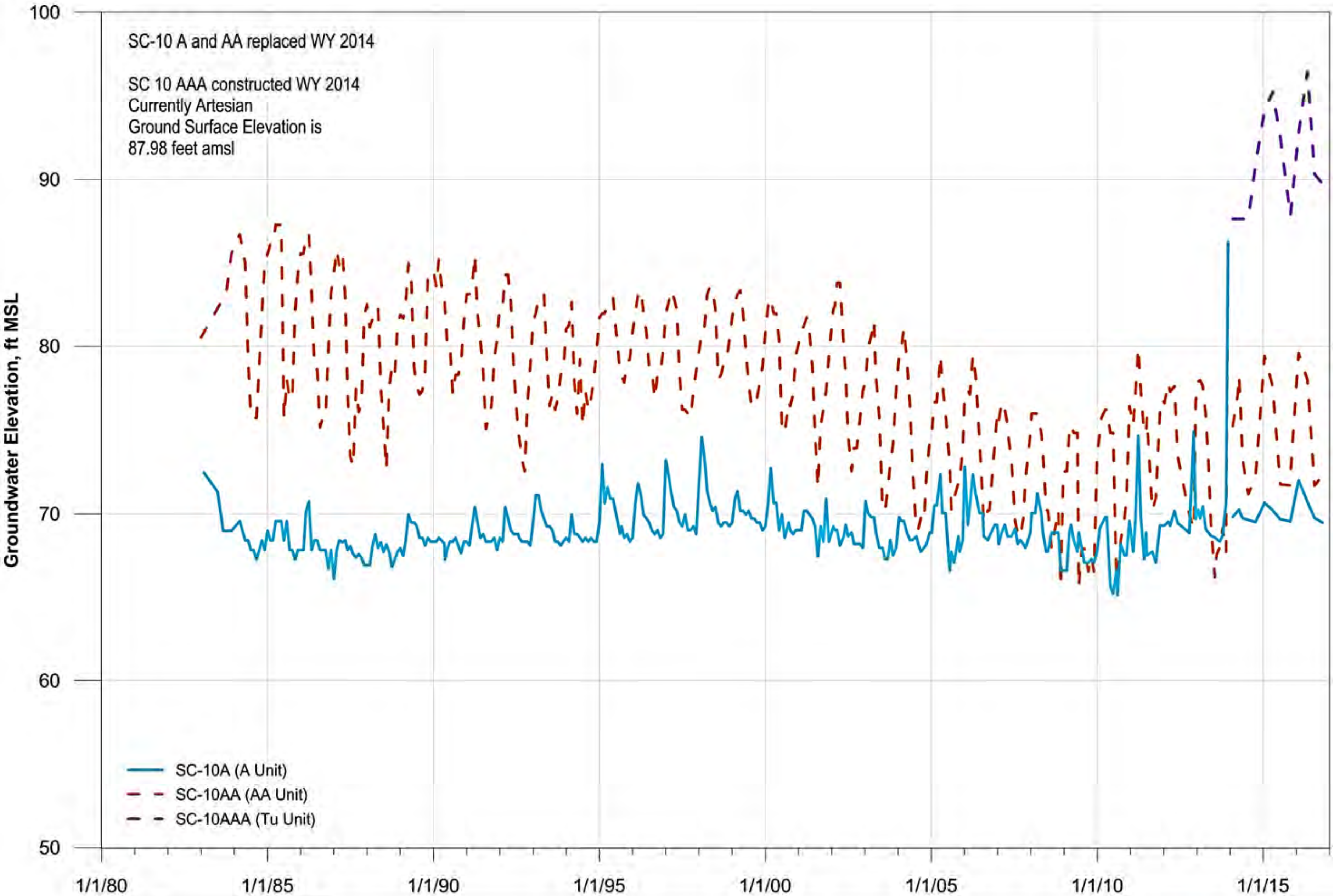

Measurements recorded when adjacent well running excluded
Groundwater Elevation, ft MSL
30
20
10
0
-10
Beltz #7 Test Wells Santa Margarita - SM
Beltz #7 Test Wells Purisima - A/AA
Beltz #6
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15



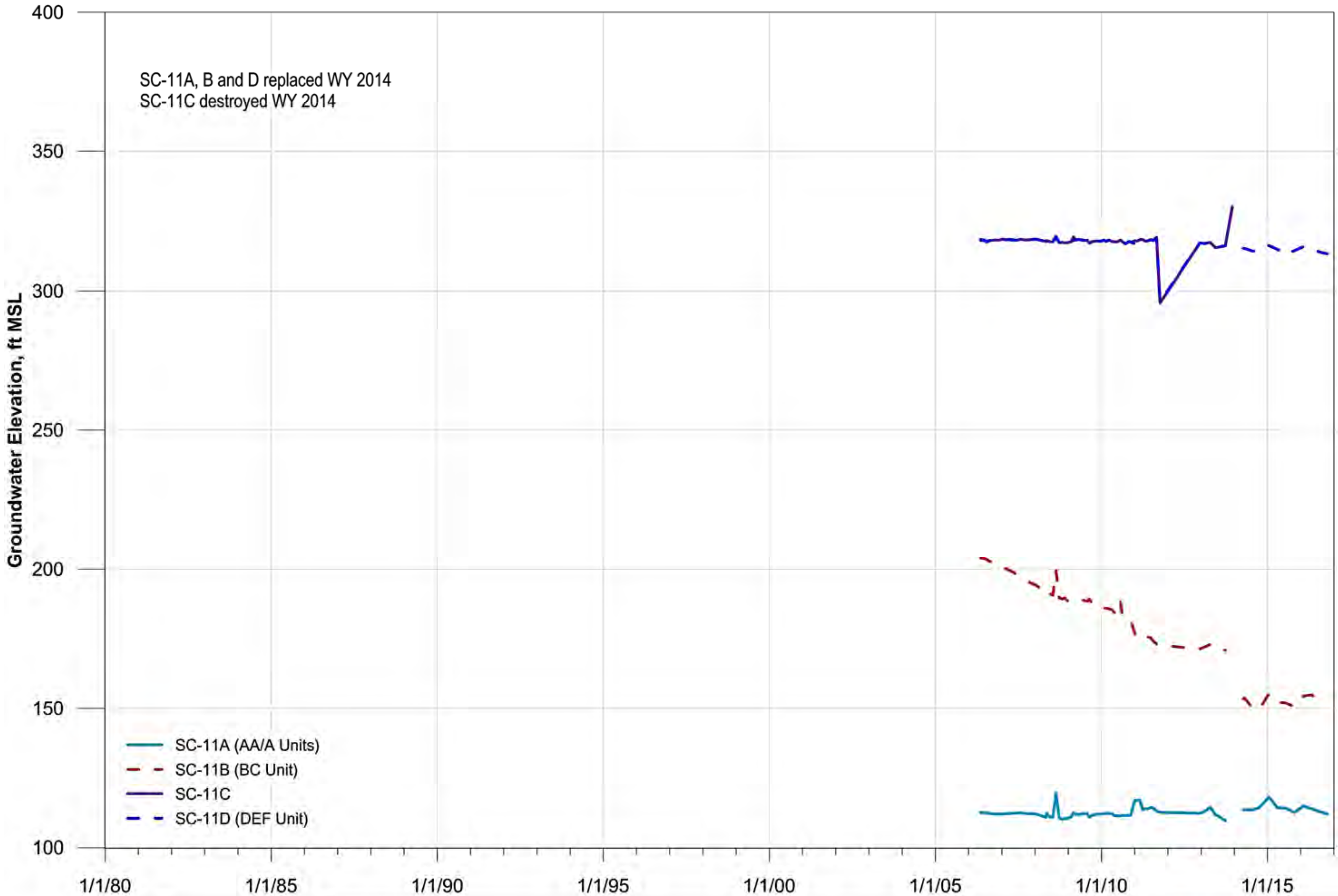
Hydro Metrics WRI

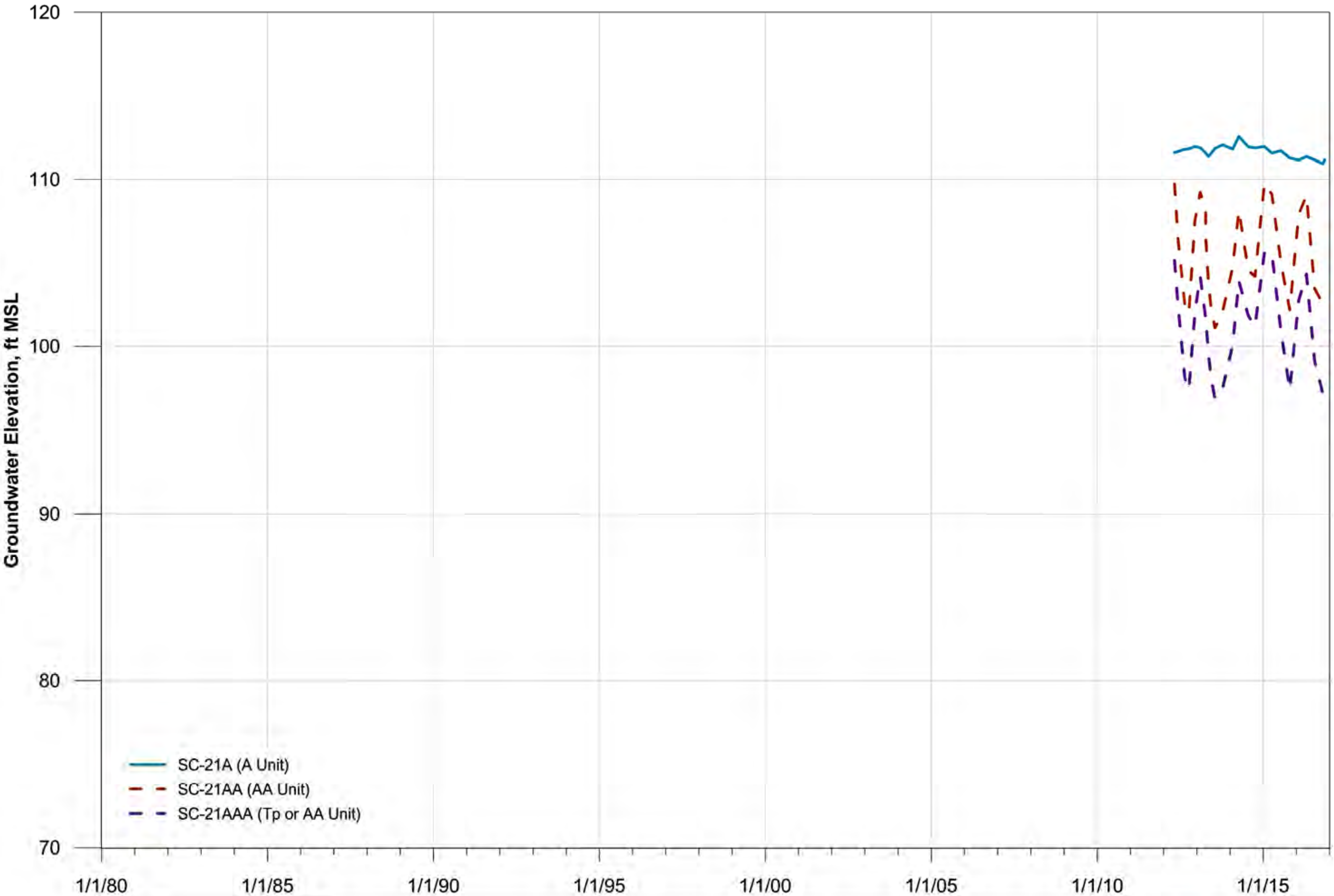


Pleasure Point Deep (A) - AA - Deepest Production
Pleasure Point Medium (B) - A
Pleasure Point Shallow (C) - A
Protective Elevation
Groundwater Elevation, ft MSL
35
30
25
20
15
10
5
0
-5
-10
-15
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

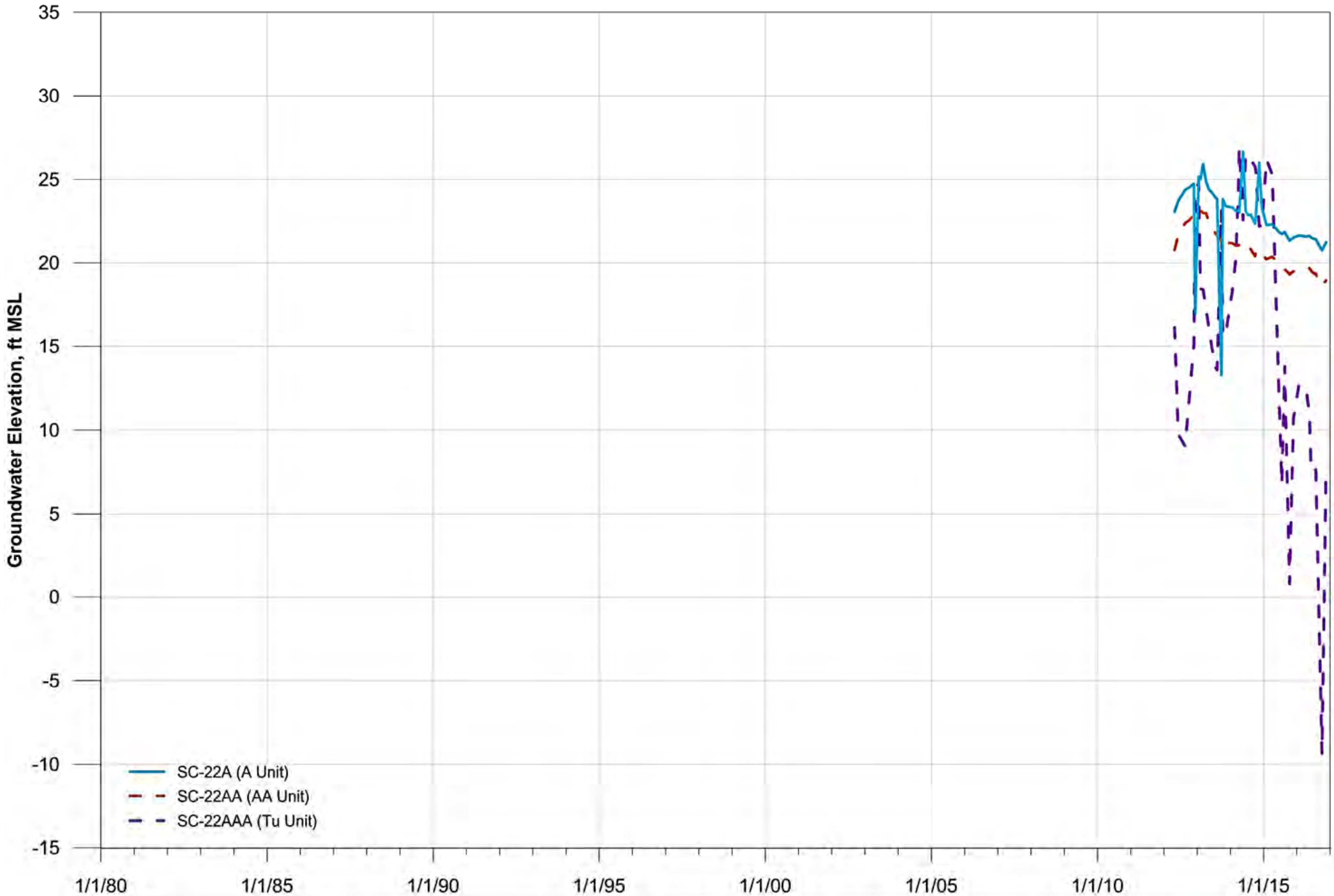


SC-10 A and AA replaced WY 2014
SC 10 AAA constructed WY 2014
Currently Artesian
Ground Surface Elevation is
87.98 feet amsl
Groundwater Elevation, ft MSL
100
90
80
70
60
50
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-10A (A Unit)
SC-10AA (AA Unit)
SC-10AAA (Tu Unit)

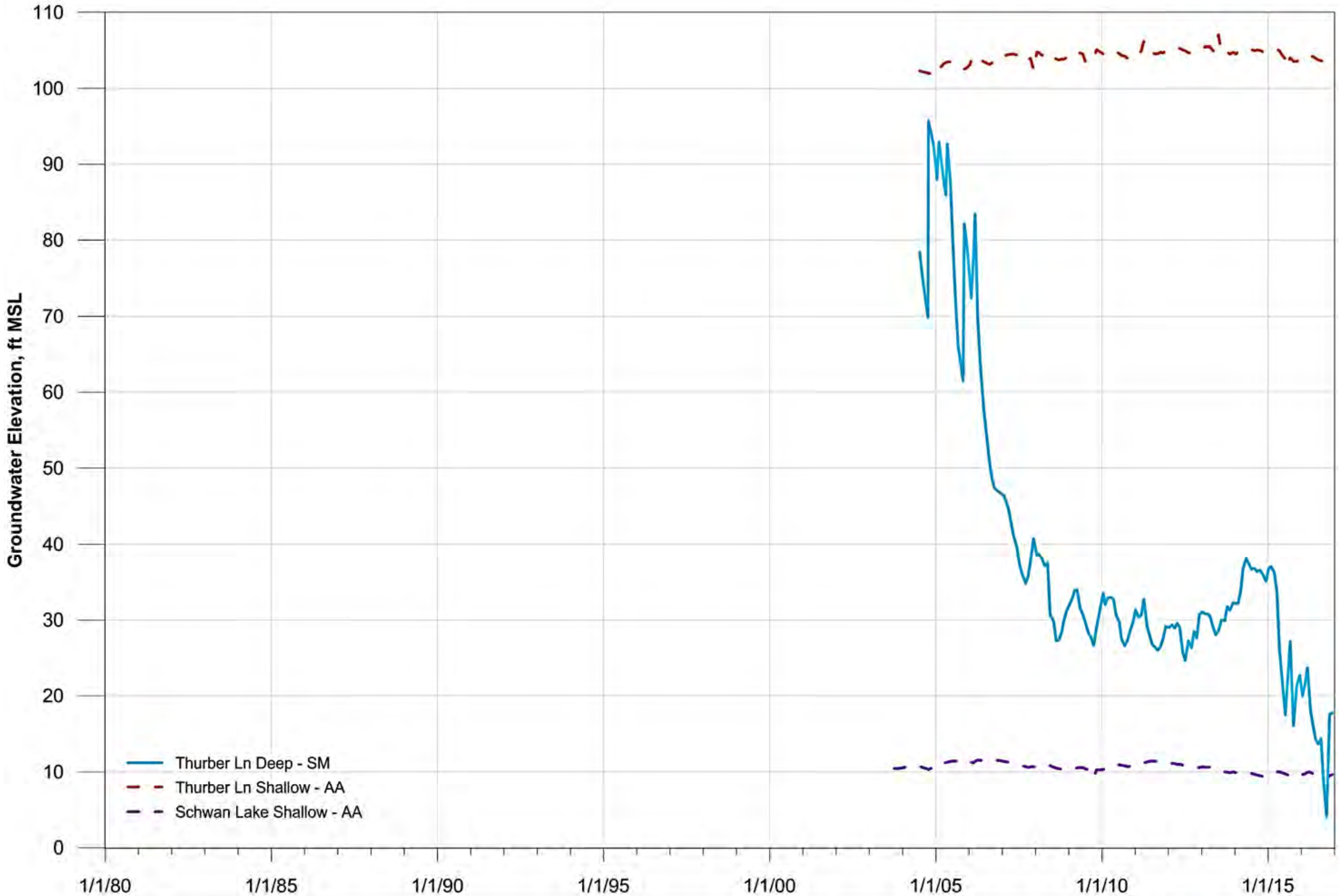

SC-11A, B and D replaced WY 2014
SC-11C destroyed WY 2014
Groundwater Elevation, ft MSL
400
350
300
250
200
150
100
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-11A (AA/A Units)
SC-11B (BC Unit)
SC-11C
SC-11D (DEF Unit)



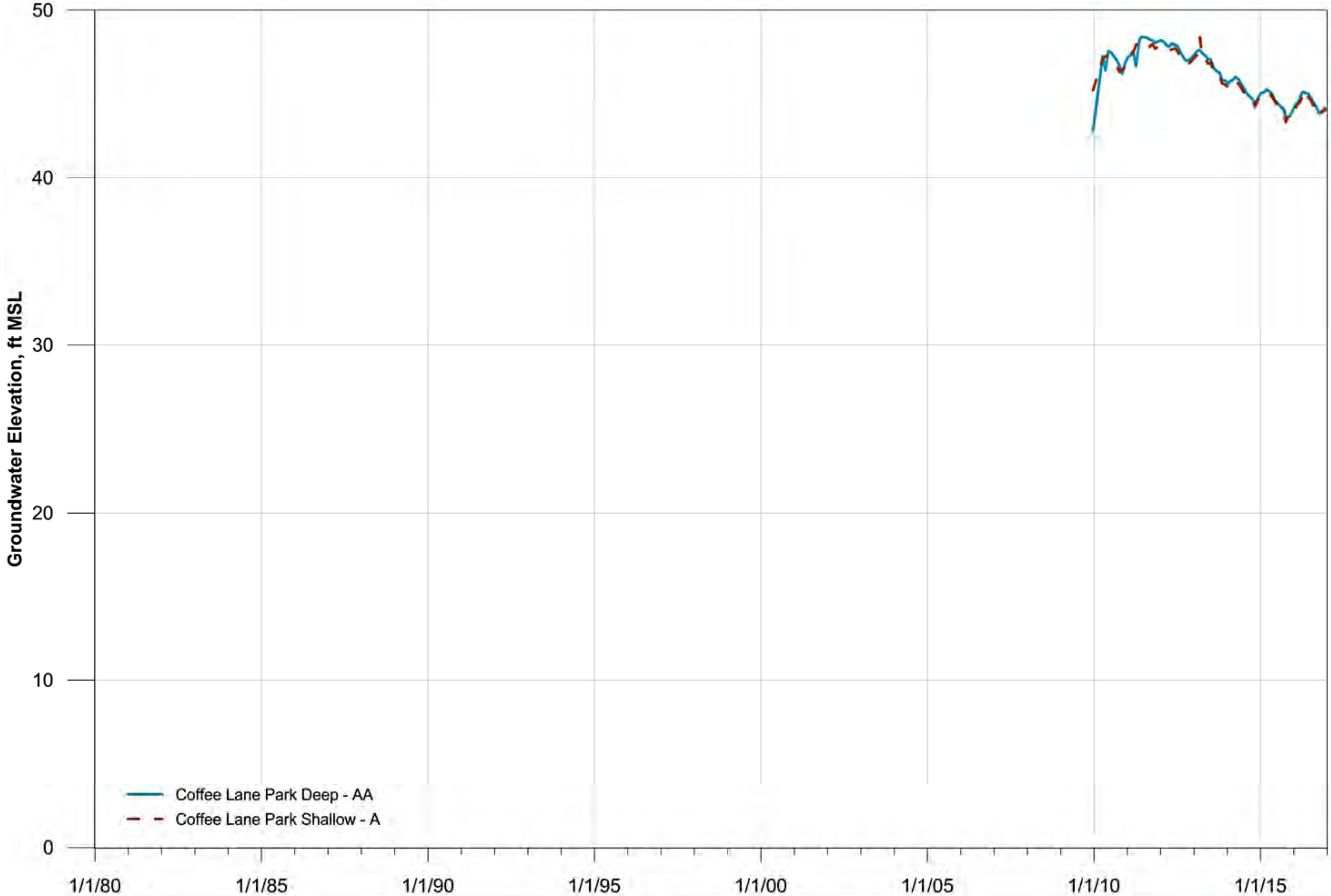
120
110
100
90
80
70
Groundwater Elevation, ft MSL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-21A (A Unit)
SC-21AA (AA Unit)
SC-21AAA (Tp or AA Unit)



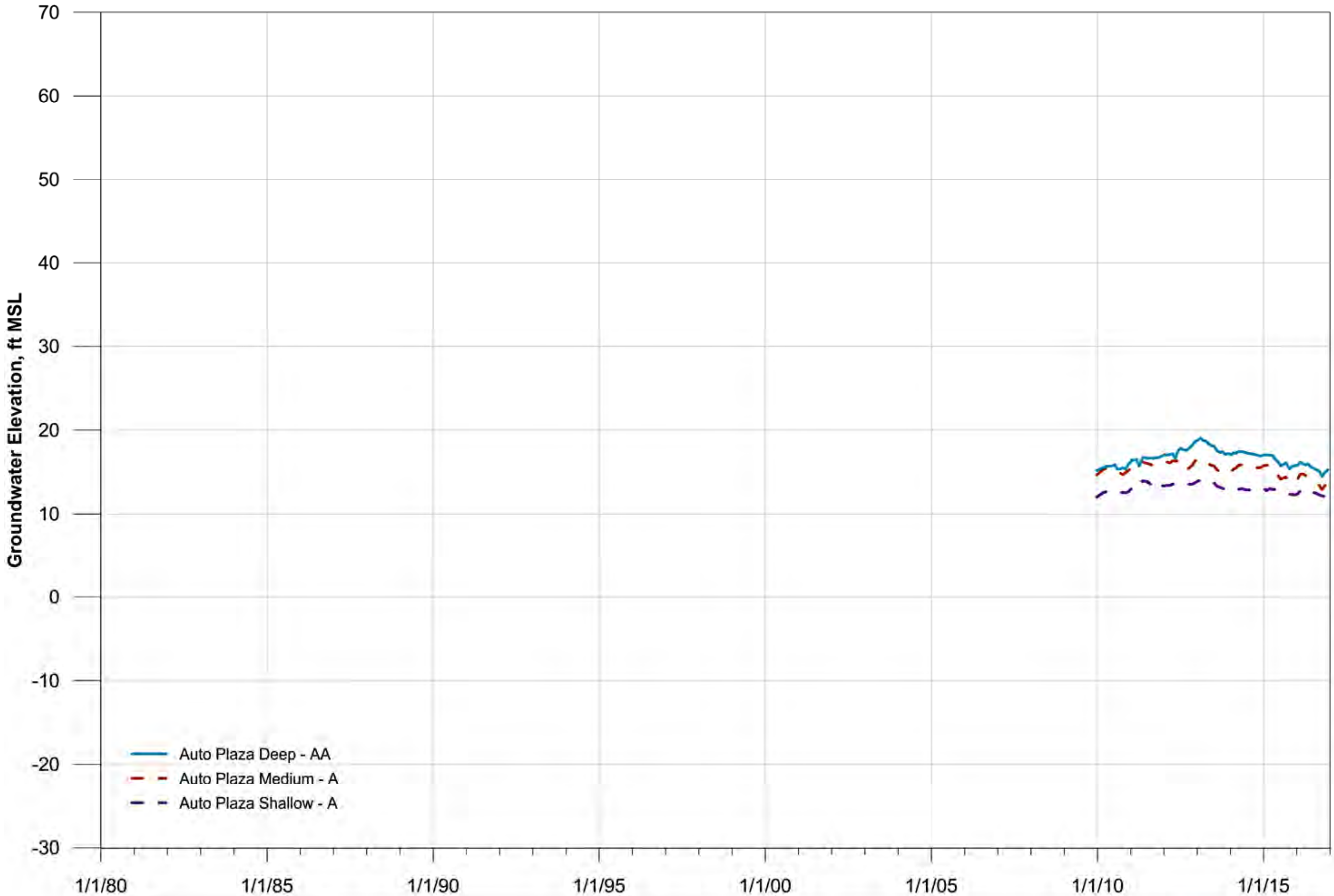
35
30
25
20
15
10
5
0
-5
-10
-15
Groundwater Elevation, ft MSL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-22A (A Unit)
SC-22AA (AA Unit)
SC-22AAA (Tu Unit)



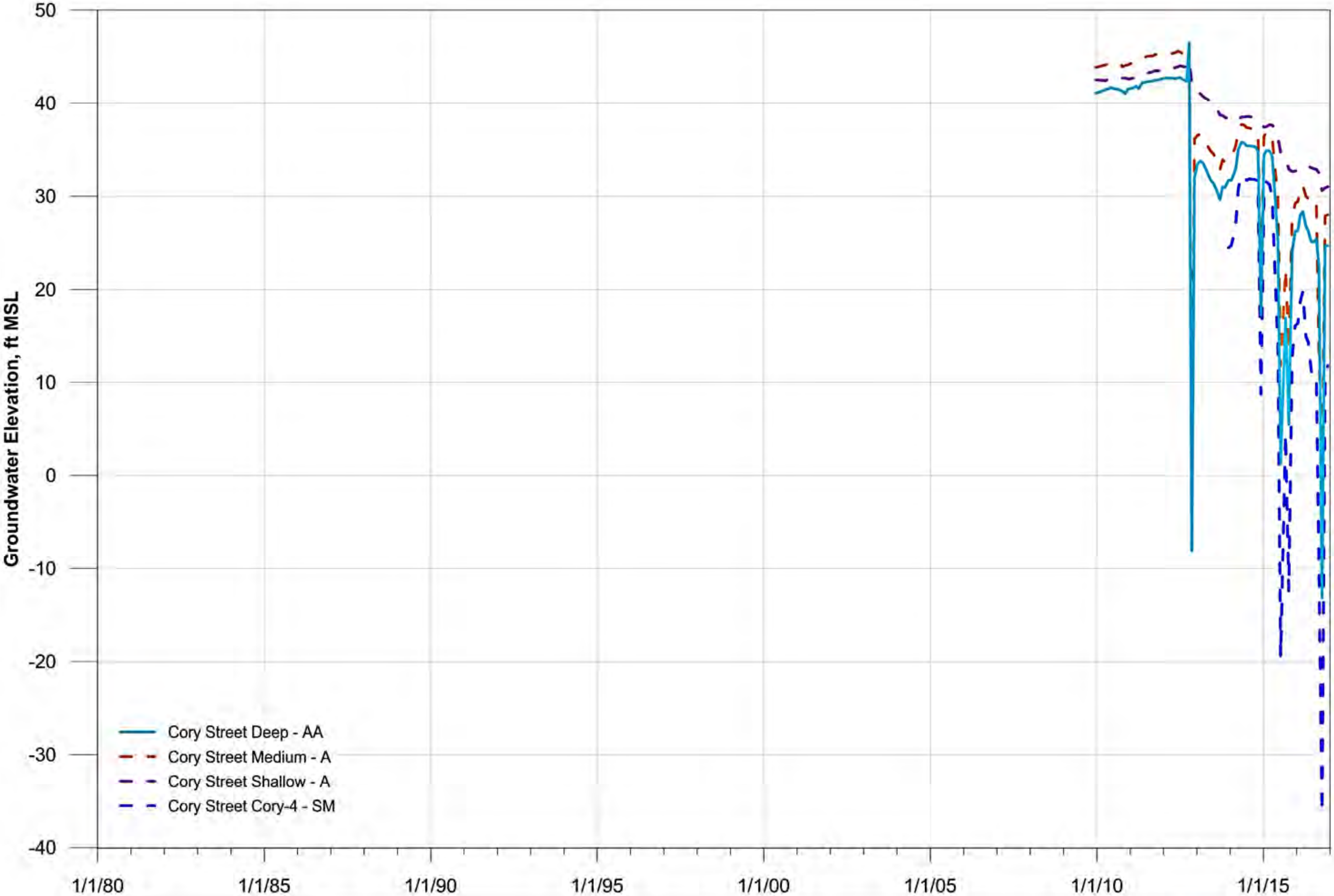
Groundwater Elevation, ft MSL
110
100
90
80
70
60
50
40
30
20
10
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
Thurber Ln Deep - SM
Thurber Ln Shallow - AA
Schwan Lake Shallow - AA



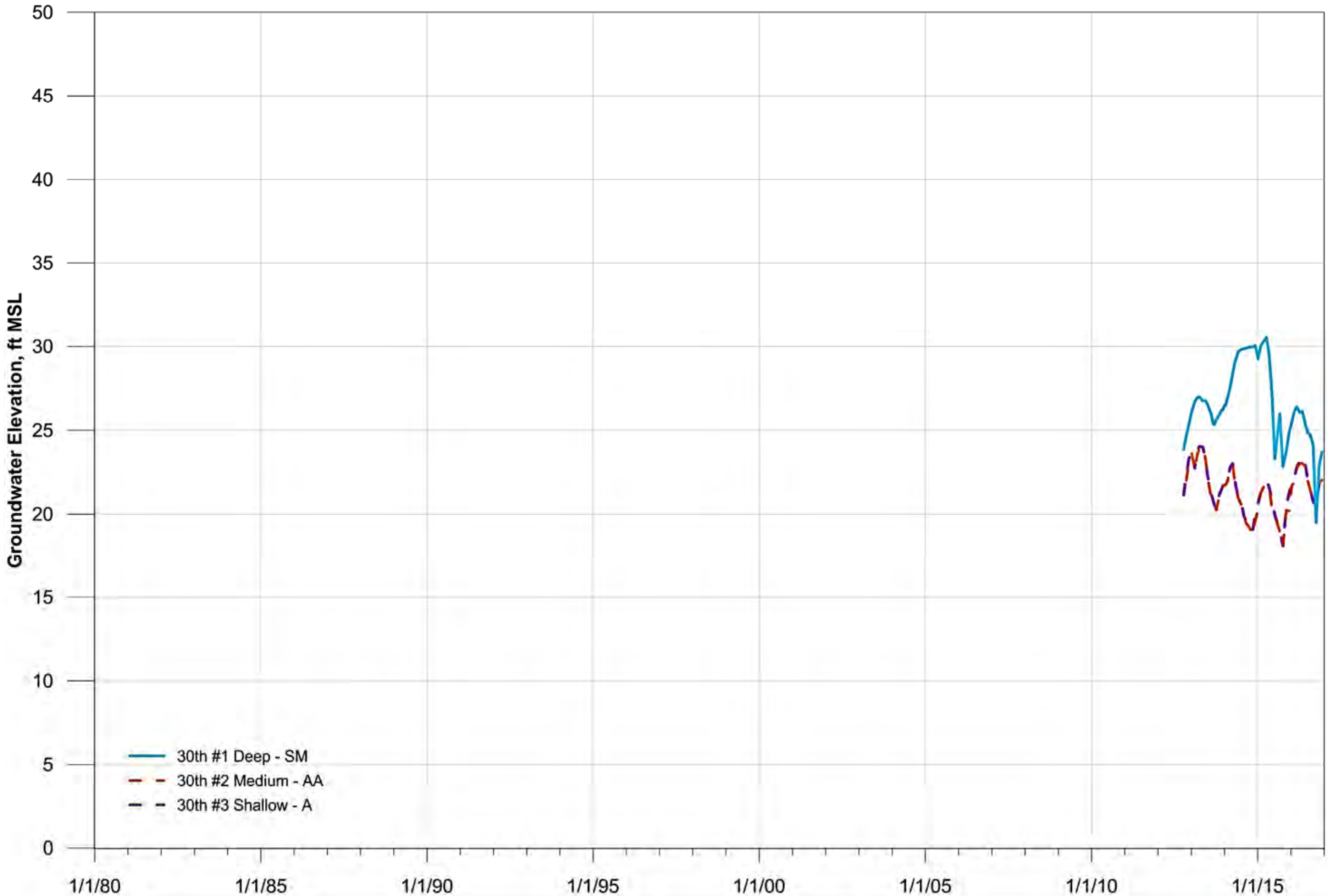
50
40
30
20
10
0
Groundwater Elevation, ft MSL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
Coffee Lane Park Deep - AA
Coffee Lane Park Shallow - A



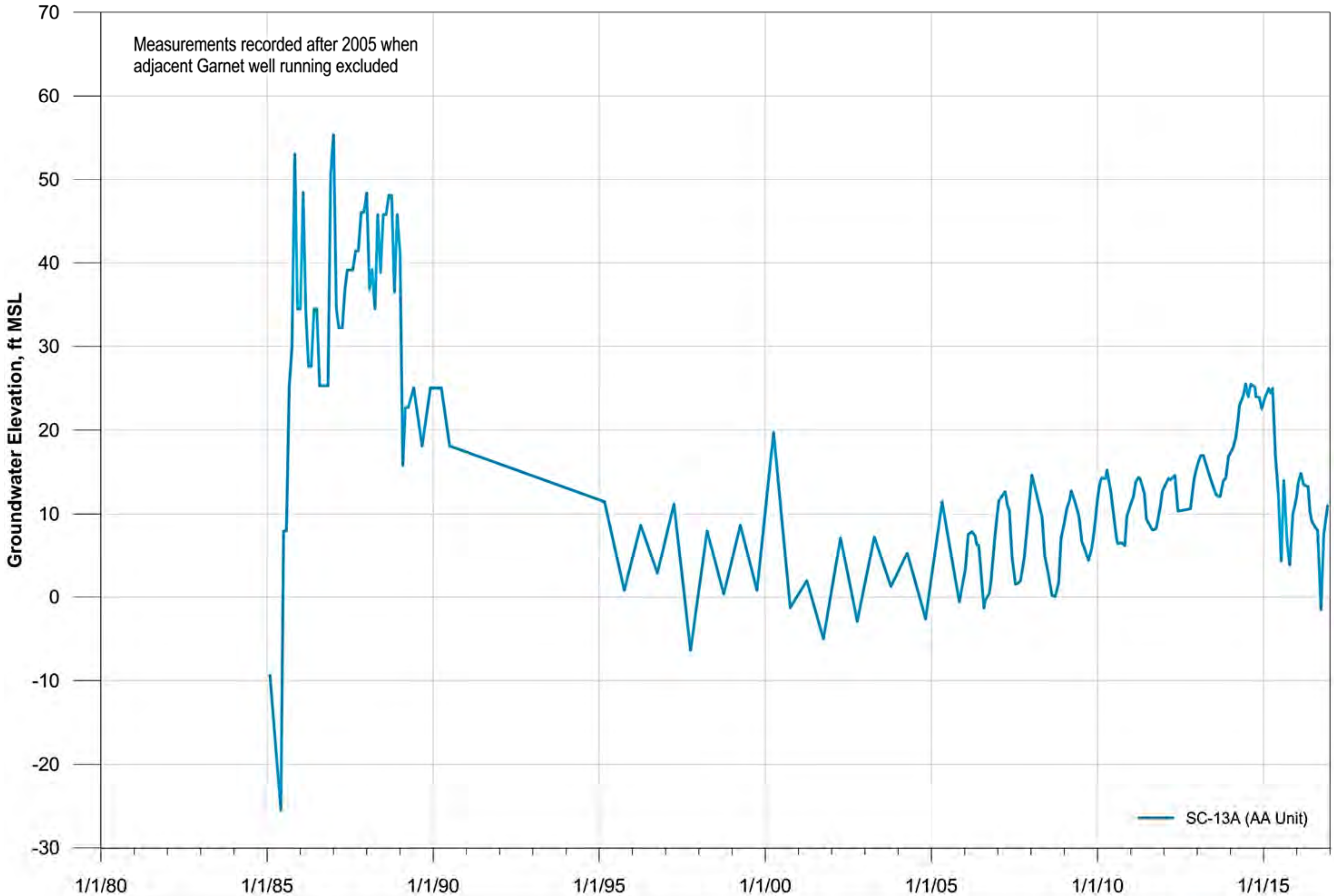
Groundwater Elevation, ft MSL
70
60
50
40
30
20
10
0
-10
-20
-30
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
Auto Plaza Deep - AA
Auto Plaza Medium - A
Auto Plaza Shallow - A



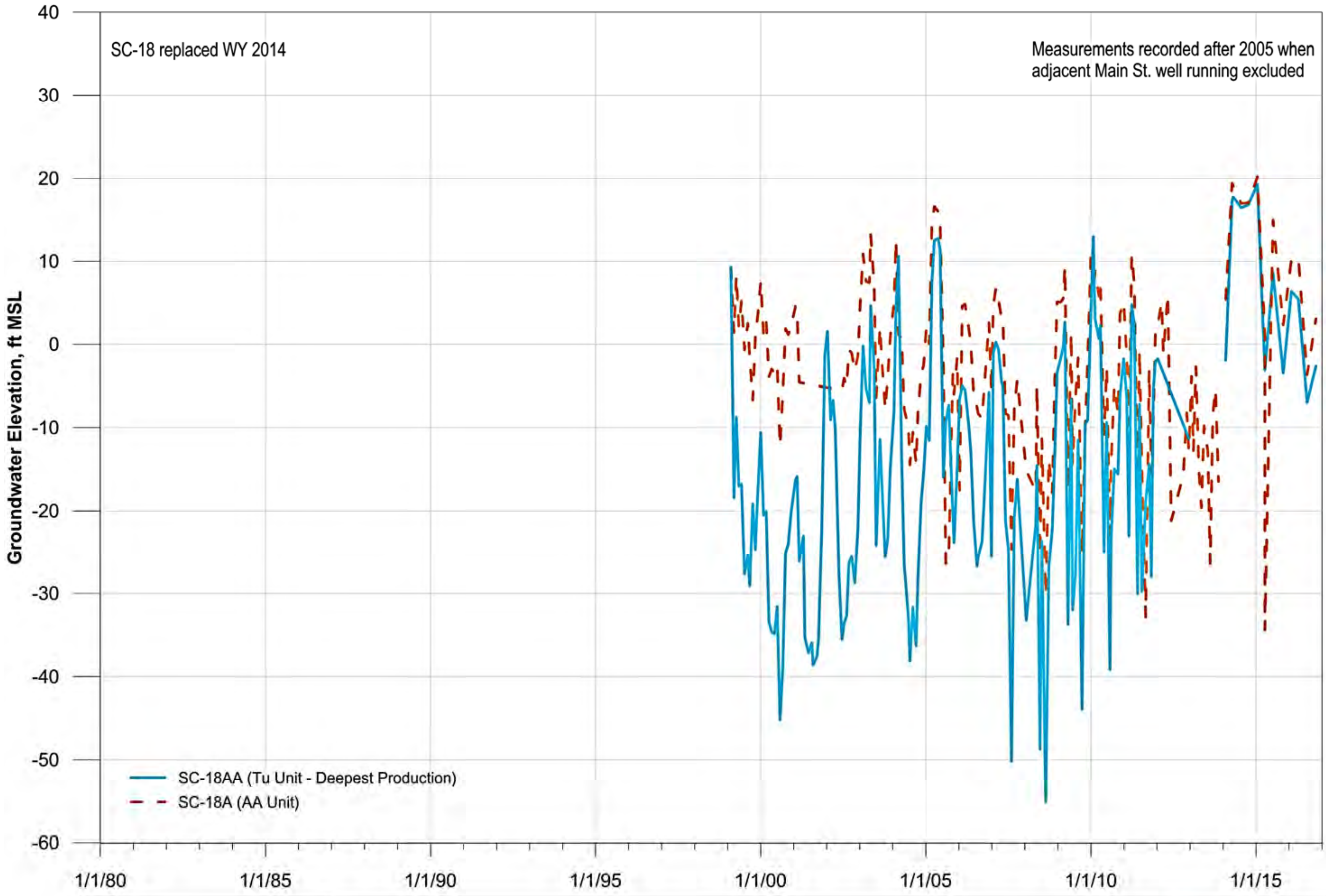
Groundwater Elevation, ft MSL
50
40
30
20
10
0
-10
-20
-30
-40
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
Cory Street Deep - AA
Cory Street Medium - A
Cory Street Shallow - A
Cory Street Cory-4 - SM



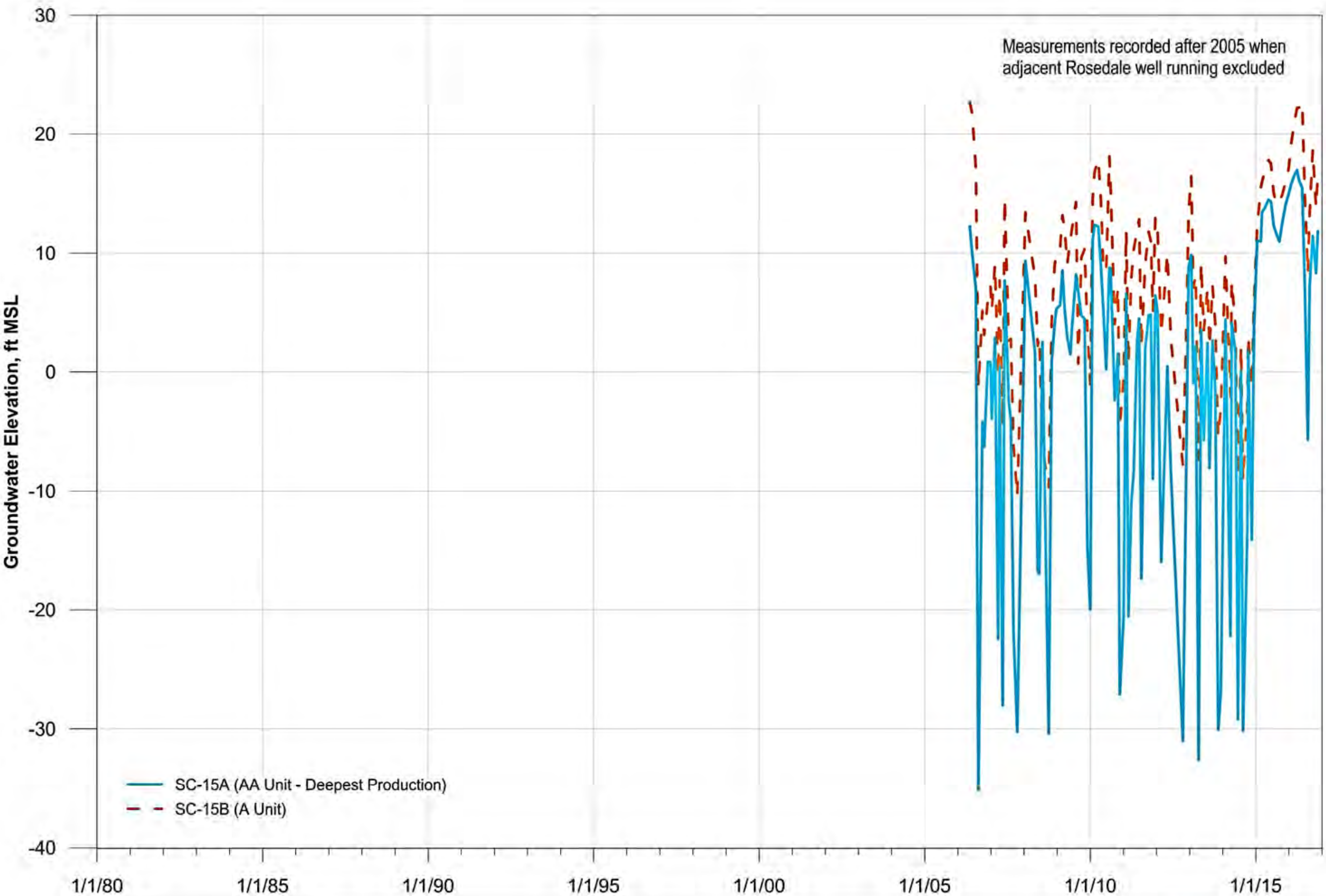
Groundwater Elevation, ft MSL
50
45
40
35
30
25
20
15
10
5
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
30th #1 Deep - SM
30th #2 Medium - AA
30th #3 Shallow - A



HydroMetrics WRI



SC-18 replaced WY 2014
Measurements recorded after 2005 when adjacent Main St. well running excluded
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
-20
-30
-40
-50
-60
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-18AA (Tu Unit - Deepest Production)
SC-18A (AA Unit)



Measurements recorded after 2005 when adjacent Rosedale well running excluded
Groundwater Elevation, ft MSL
30
20
10
0
-10
-20
-30
-40
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-15A (AA Unit - Deepest Production)
SC-15B (A Unit)

Chemographs and Single Well Hydrographs for Western Purisima Area

Graphs of SqCWD Coastal Monitoring Well Clusters

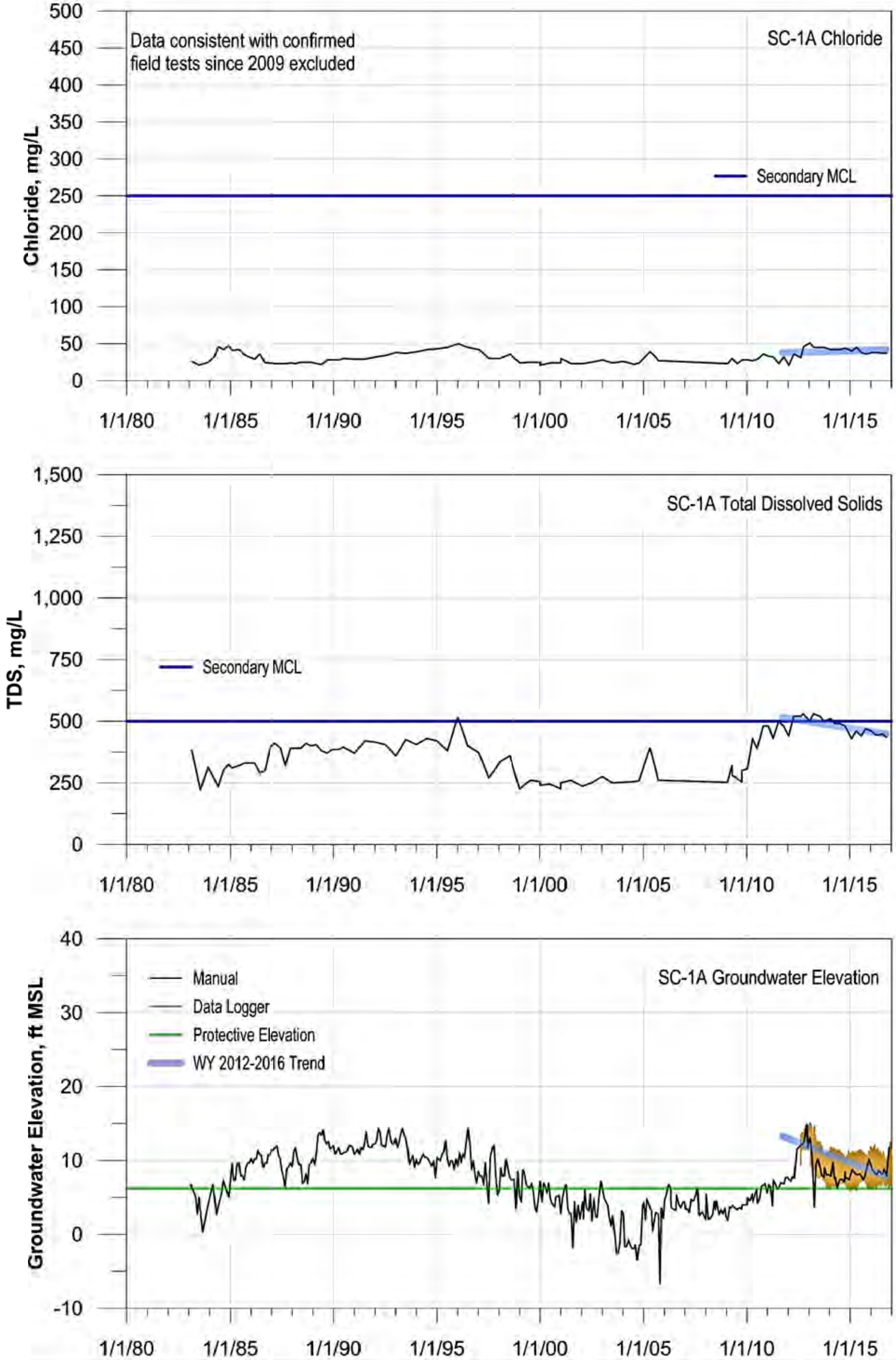
Graphs of City of Santa Cruz Coastal Monitoring Well Clusters

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

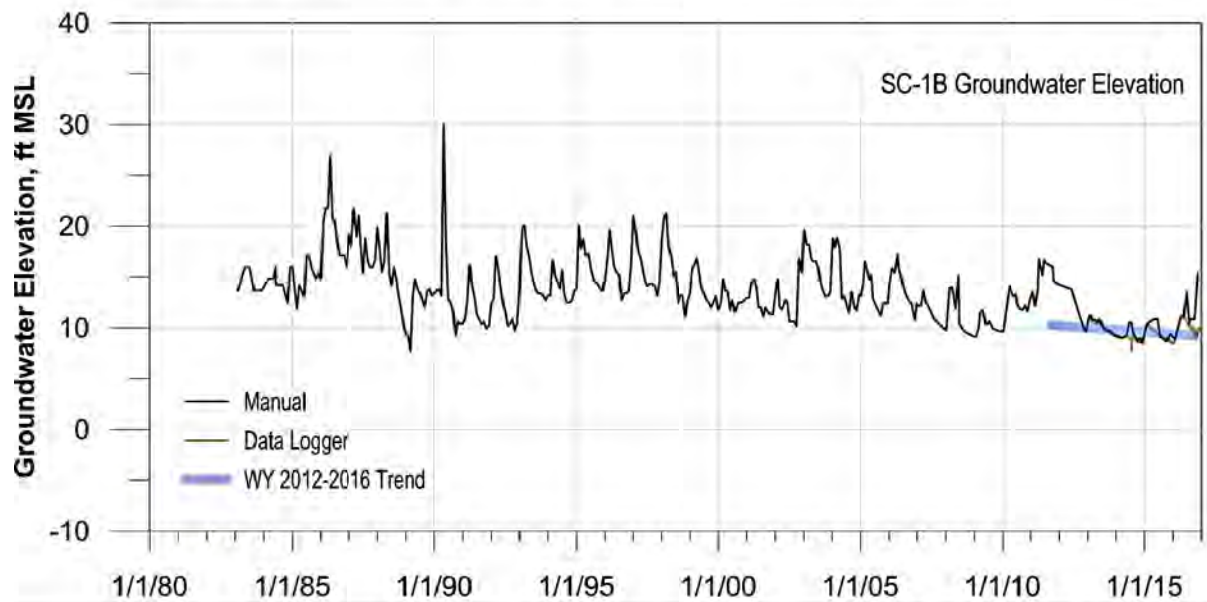
Trends shown on the hydrographs and chemographs are based on a linear fit to data in the specified time period.

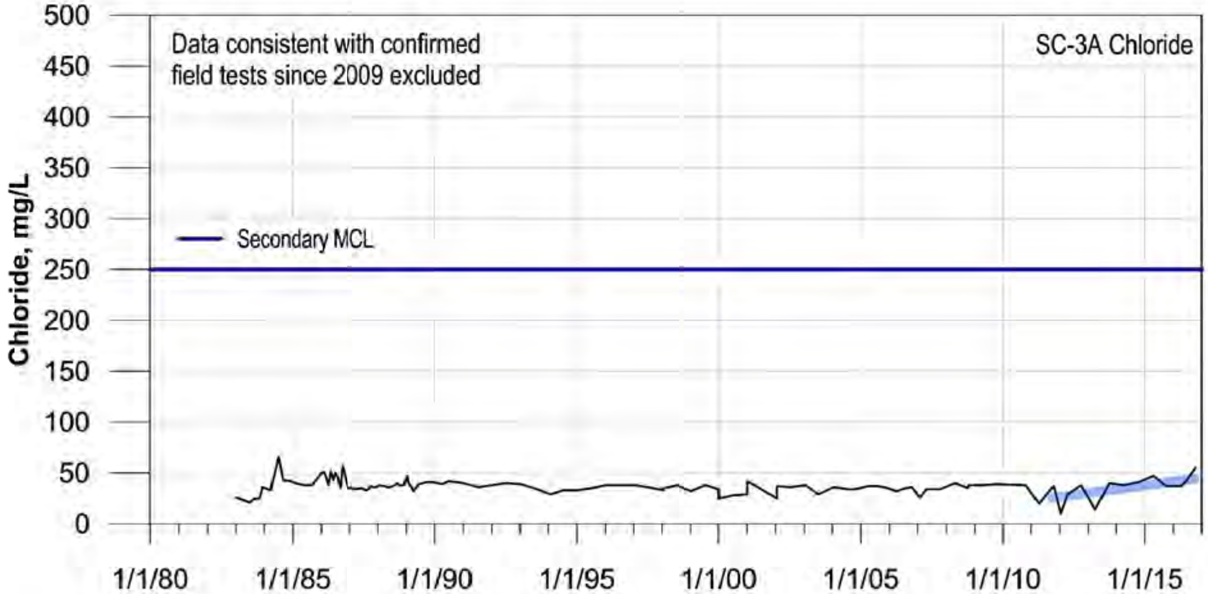


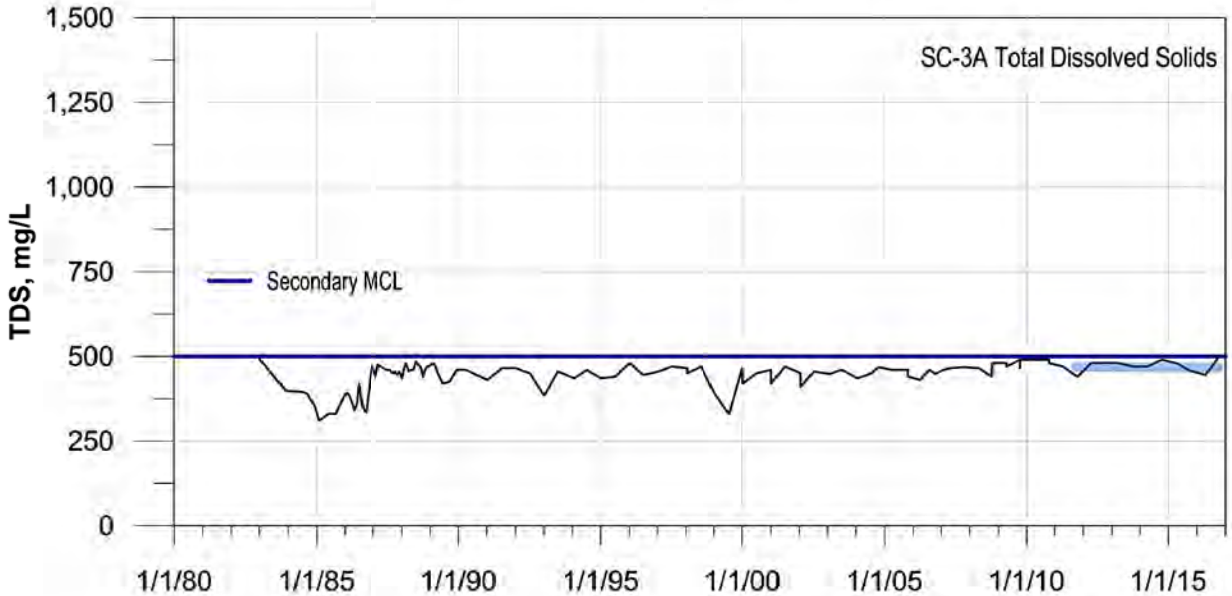
Data consistent with confirmed field tests since 2009 excluded
SC-1A Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-1A Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
Manual
Data Logger
Protective Elevation
WY 2012-2016 Trend
SC-1A Groundwater Elevation
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

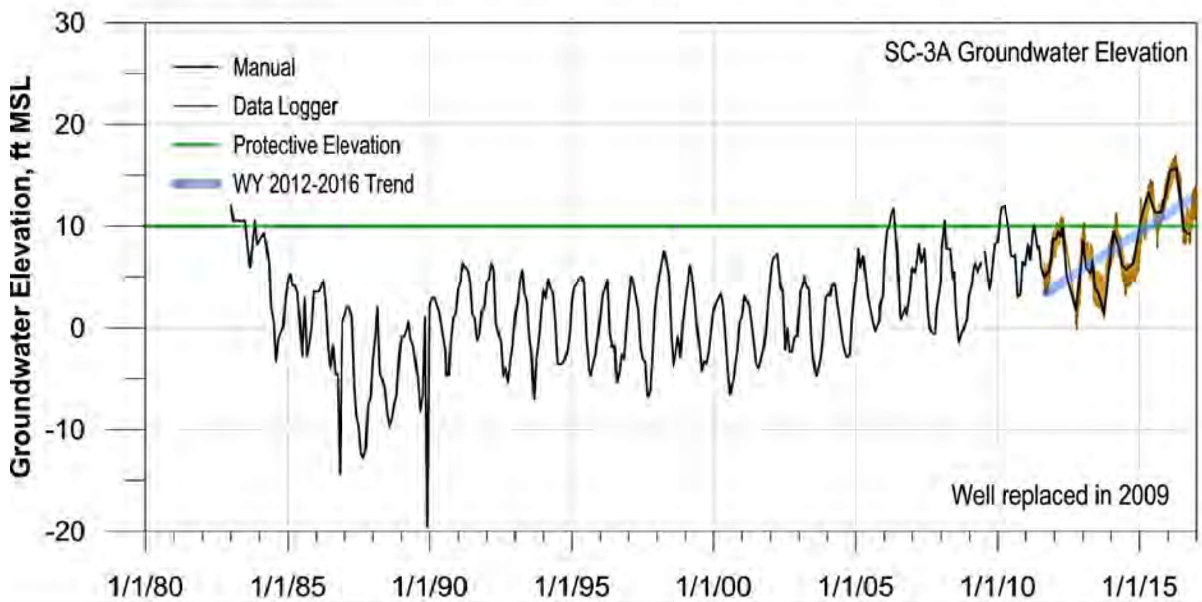

SC-1B Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-1B Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

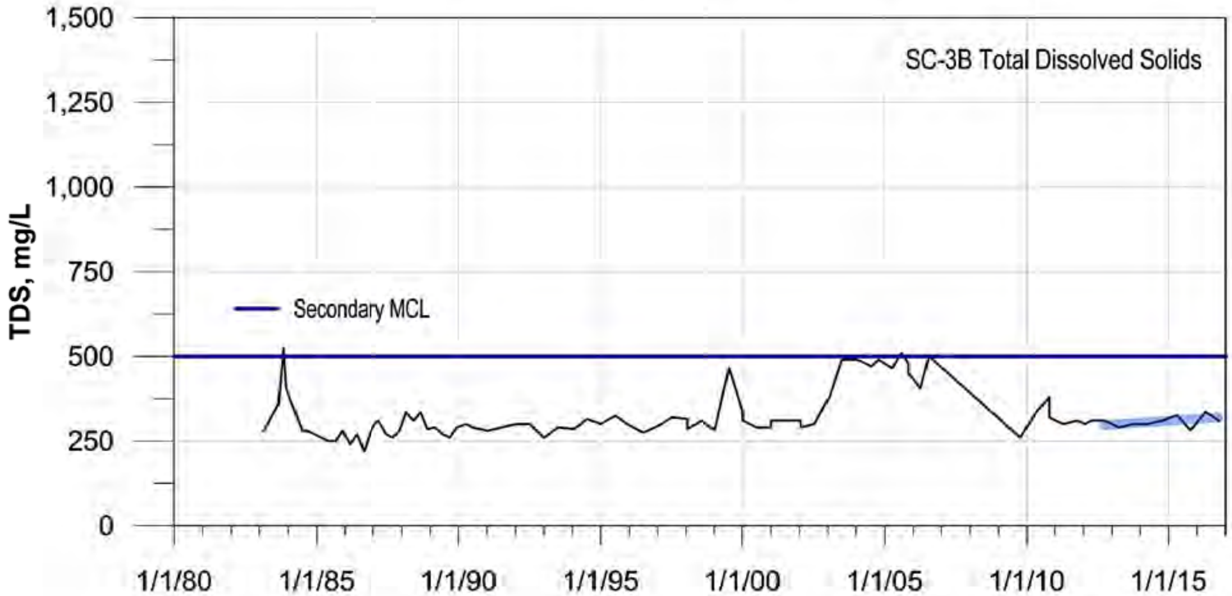

SC-1B Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
Data Logger
WY 2012-2016 Trend
40
30
20
10
0
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

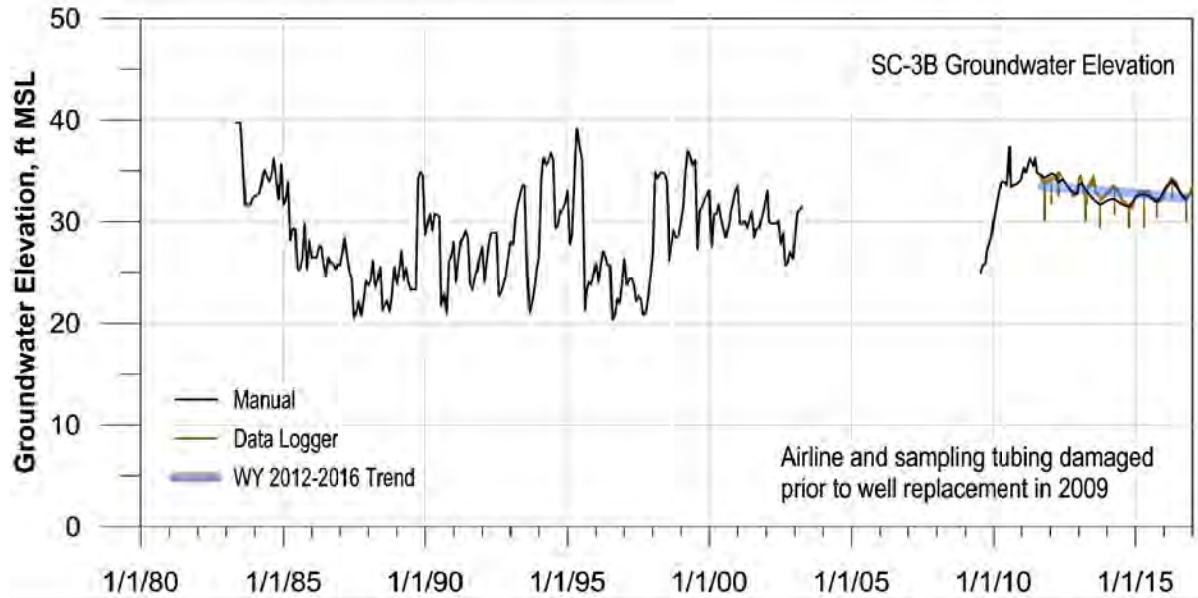

Data consistent with confirmed field tests since 2009 excluded
SC-3A Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-3A Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

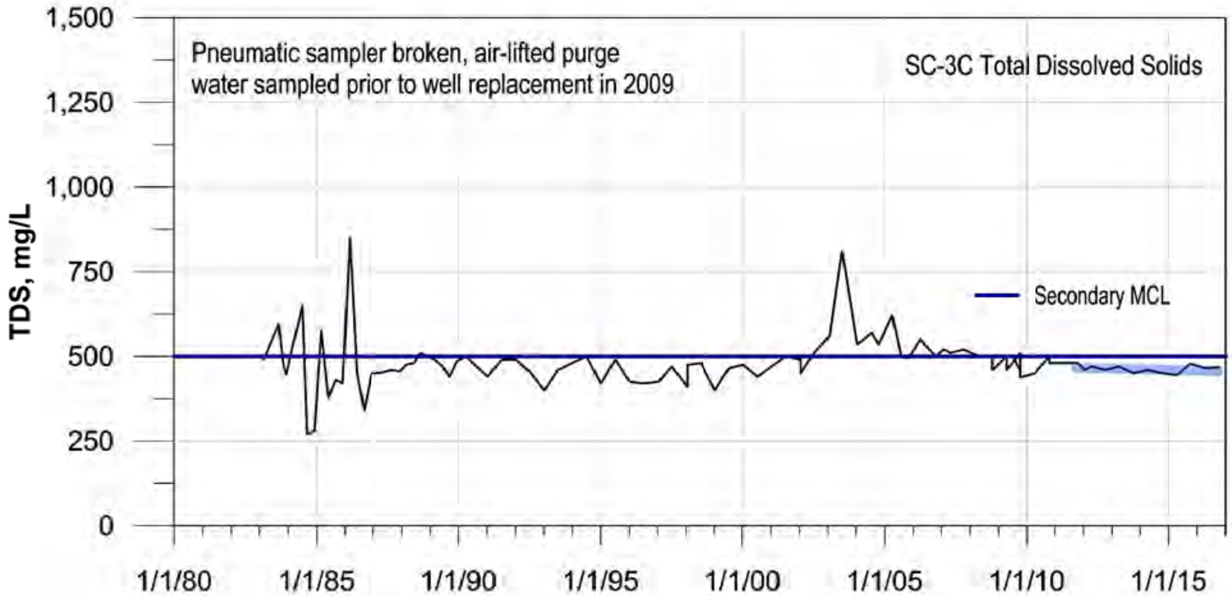

SC-3A Groundwater Elevation
Manual
Data Logger
Protective Elevation
WY 2012-2016 Trend
Well replaced in 2009
Groundwater Elevation, ft MSL
30
20
10
0
-10
-20
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

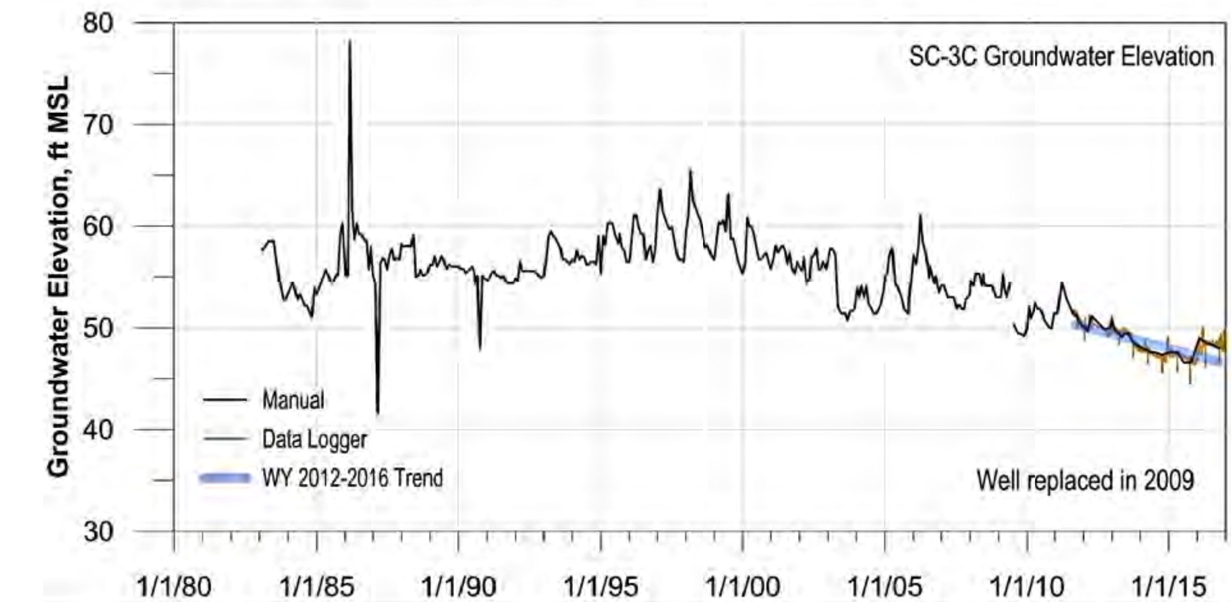

SC-3B Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

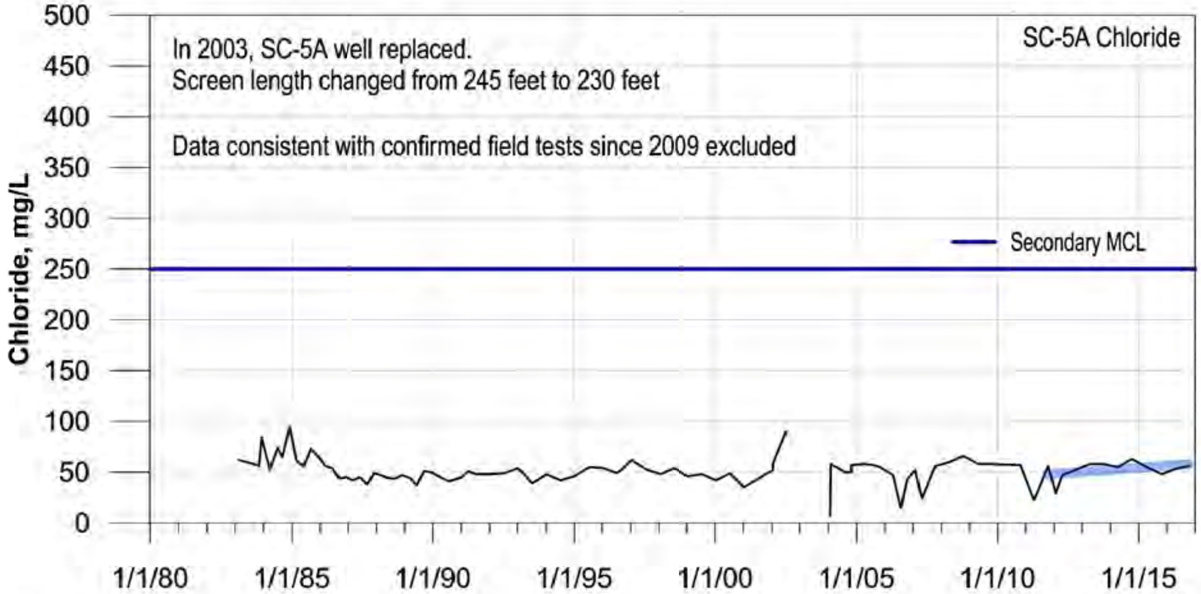

SC-3B Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

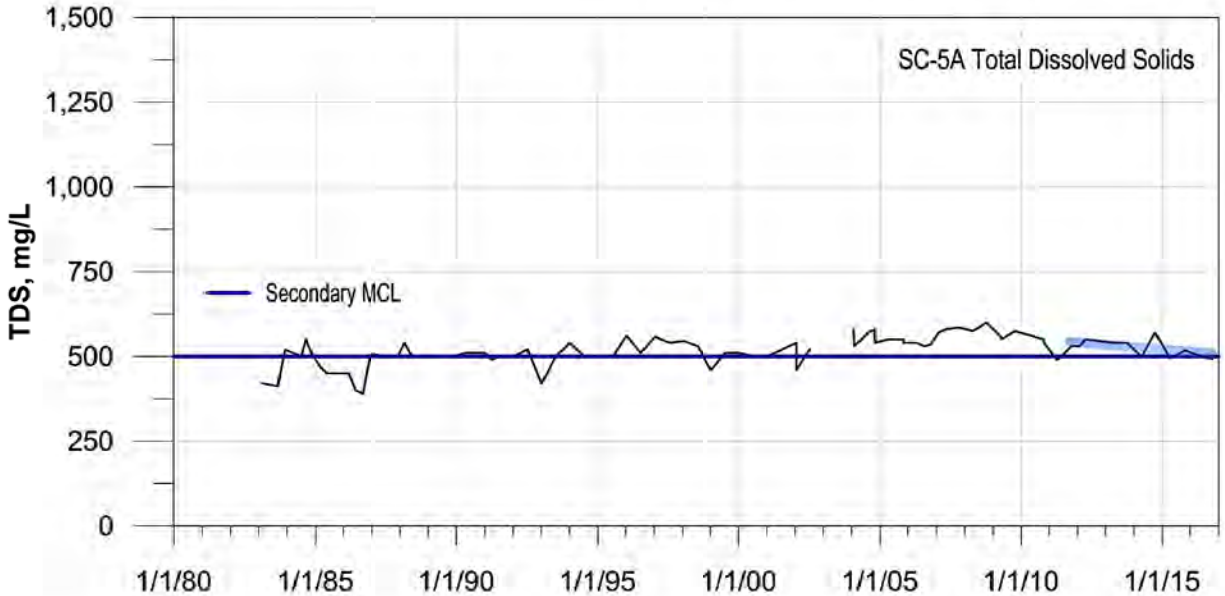

SC-3B Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
Data Logger
WY 2012-2016 Trend
Airline and sampling tubing damaged
prior to well replacement in 2009
50
40
30
20
10
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

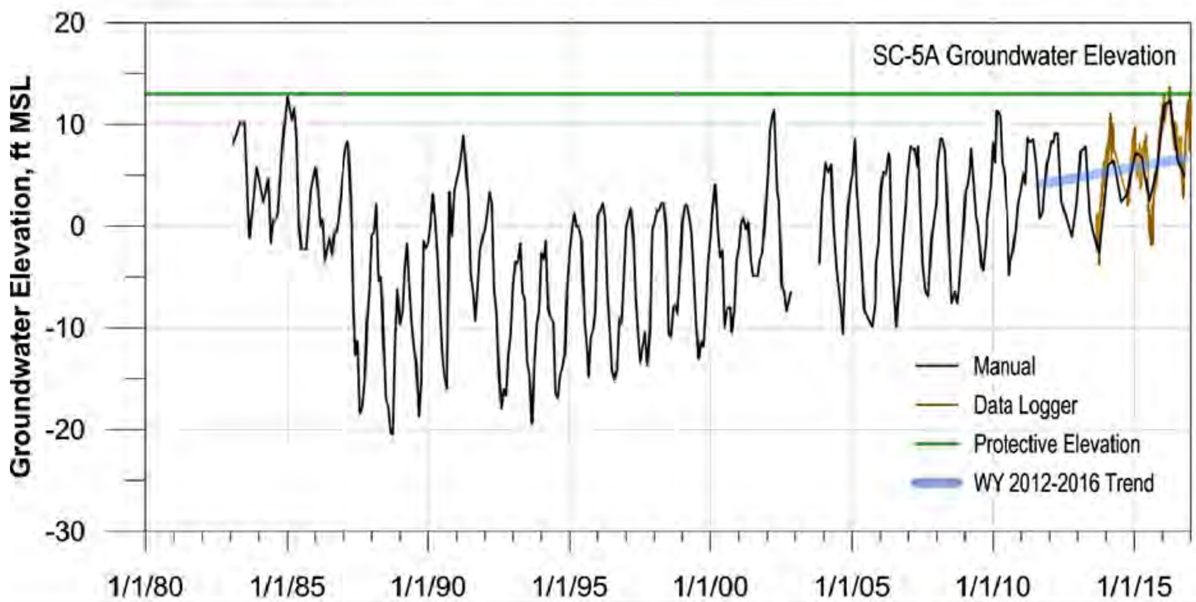

SC-3C Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

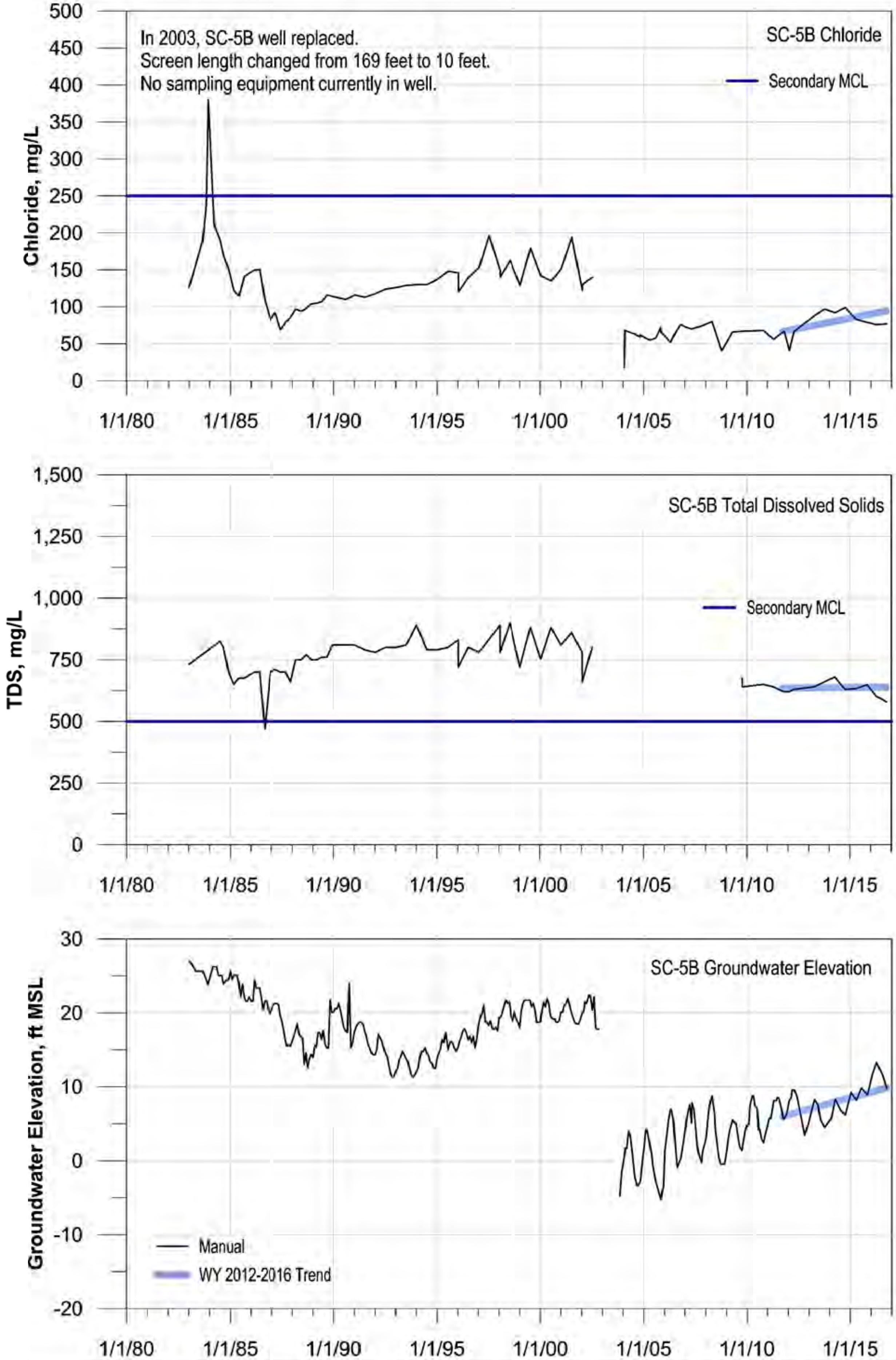

Pneumatic sampler broken, air-lifted purge water sampled prior to well replacement in 2009
SC-3C Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

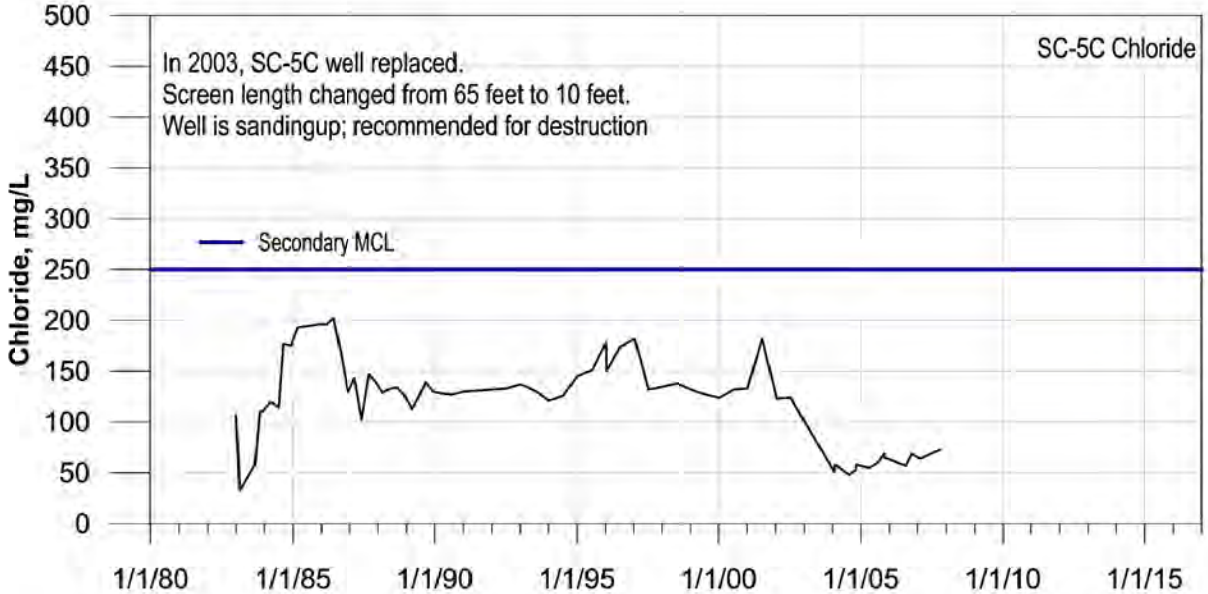

SC-3C Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
Data Logger
WY 2012-2016 Trend
Well replaced in 2009
80
70
60
50
40
30
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-5A Chloride
In 2003, SC-5A well replaced.
Screen length changed from 245 feet to 230 feet
Data consistent with confirmed field tests since 2009 excluded
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

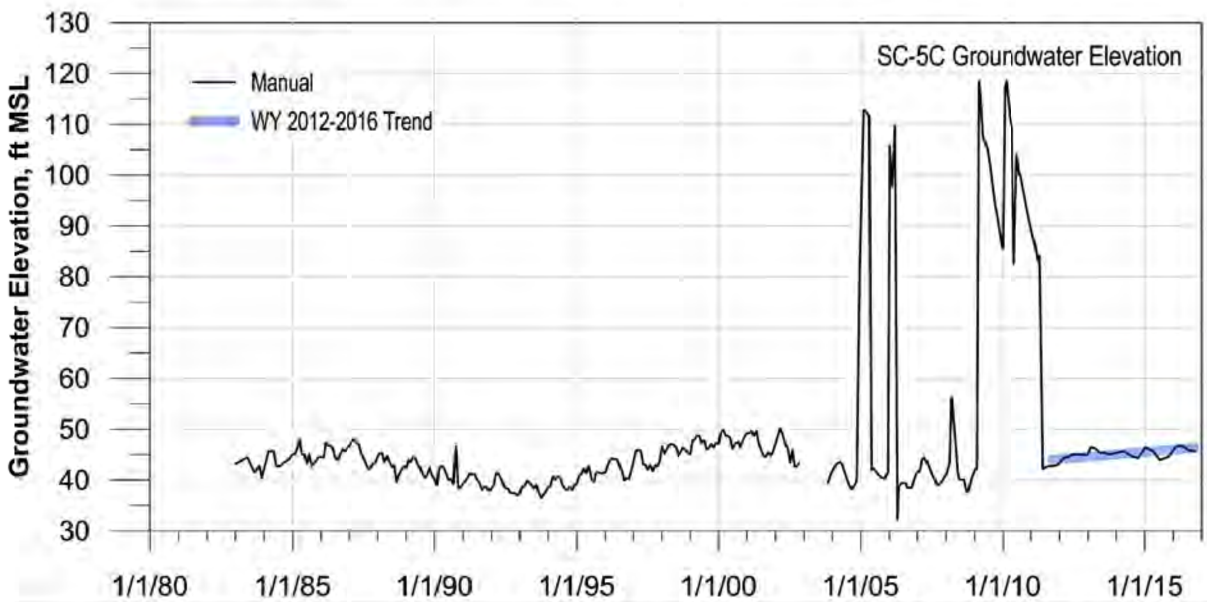

SC-5A Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

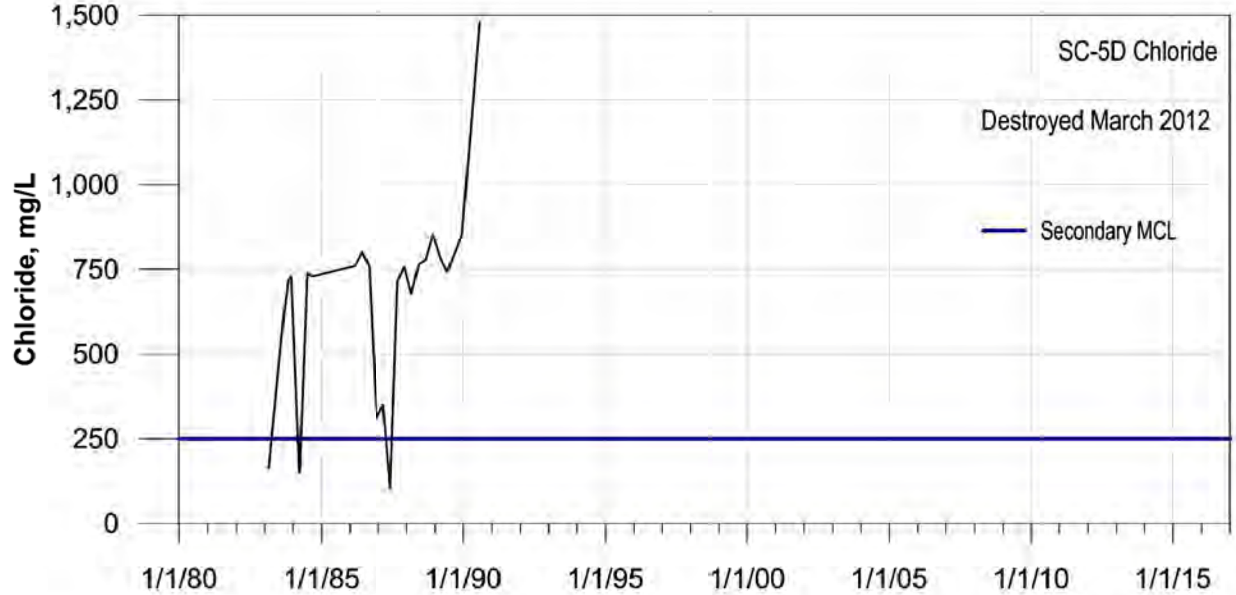

SC-5A Groundwater Elevation
Groundwater Elevation, ft MSL
20
10
0
-10
-20
-30
Manual
Data Logger
Protective Elevation
WY 2012-2016 Trend
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


In 2003, SC-5B well replaced.
Screen length changed from 169 feet to 10 feet.
No sampling equipment currently in well.
SC-5B Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-5B Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
SC-5B Groundwater Elevation
Groundwater Elevation, ft MSL
30
20
10
0
-10
-20
Manual
WY 2012-2016 Trend

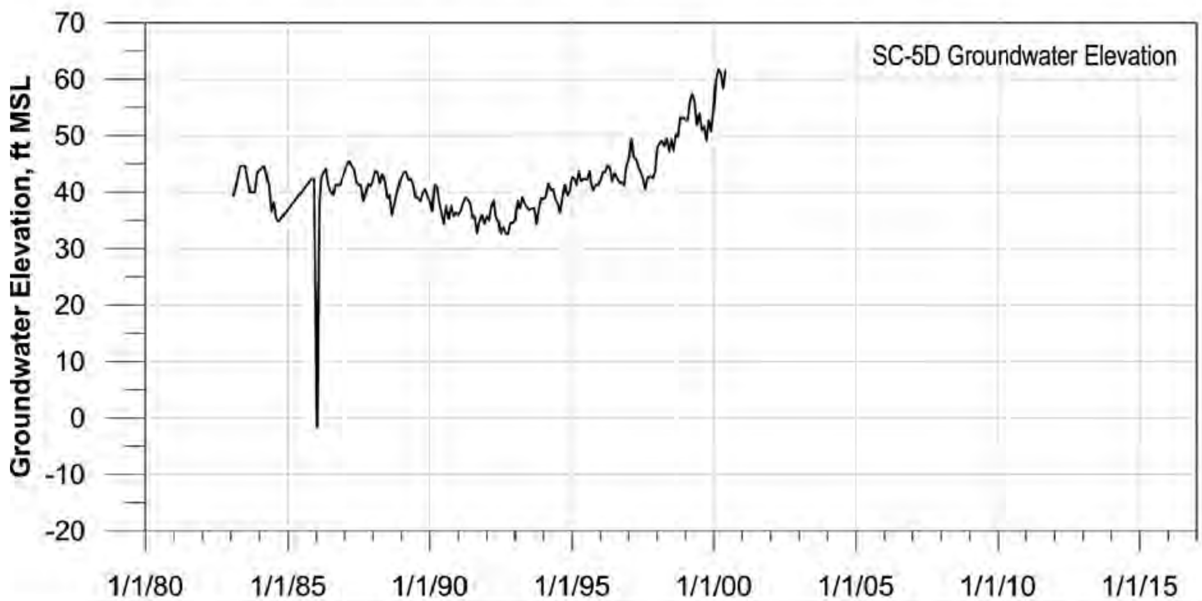

SC-5C Chloride
In 2003, SC-5C well replaced.
Screen length changed from 65 feet to 10 feet.
Well is sandingup; recommended for destruction
Secondary MCL
Chloride, mg/L
0
50
100
150
200
250
300
350
400
450
500
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

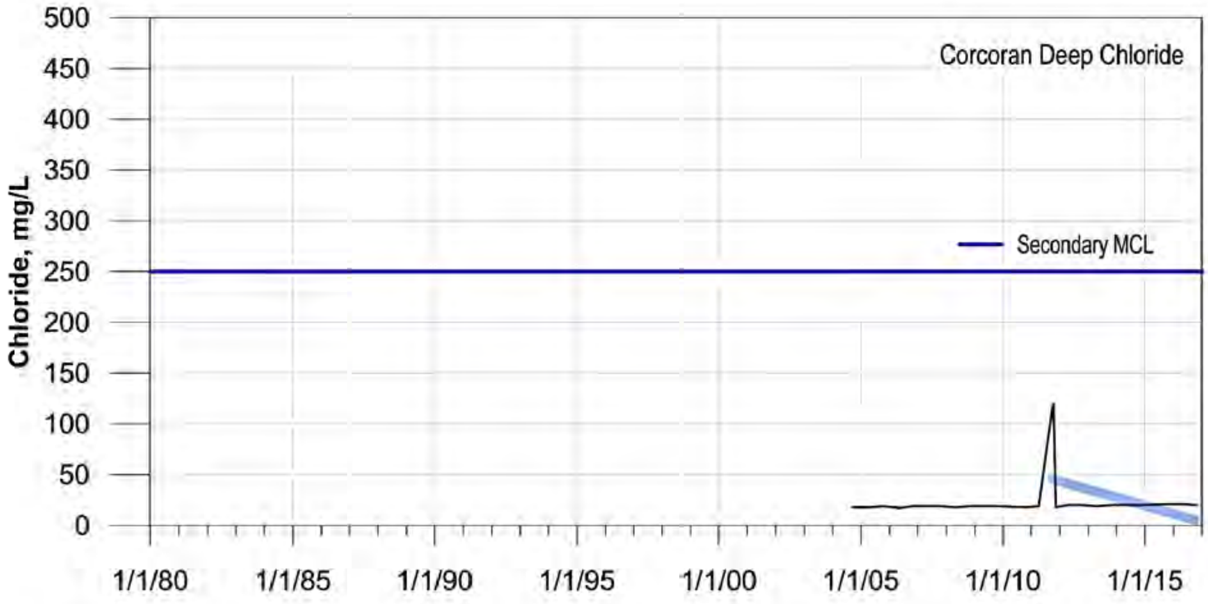

SC-5C Total Dissolved Solids
Secondary MCL
TDS, mg/L
0
250
500
750
1,000
1,250
1,500
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-5C Groundwater Elevation
Manual
WY 2012-2016 Trend
Groundwater Elevation, ft MSL
30
40
50
60
70
80
90
100
110
120
130
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

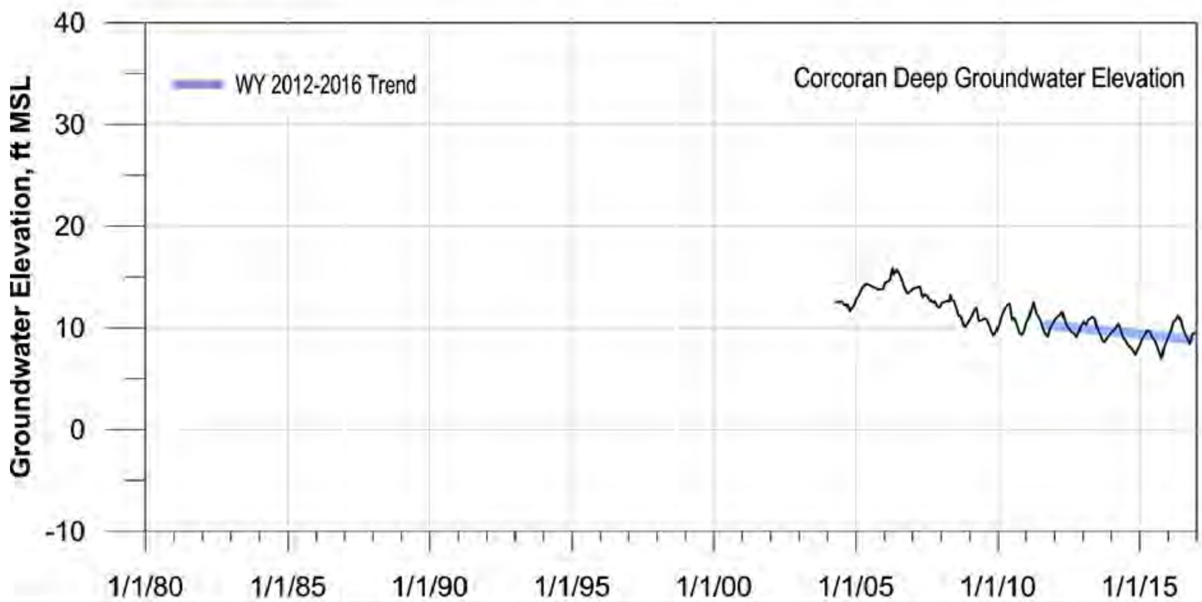

SC-5D Chloride
Destroyed March 2012
Secondary MCL
Chloride, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

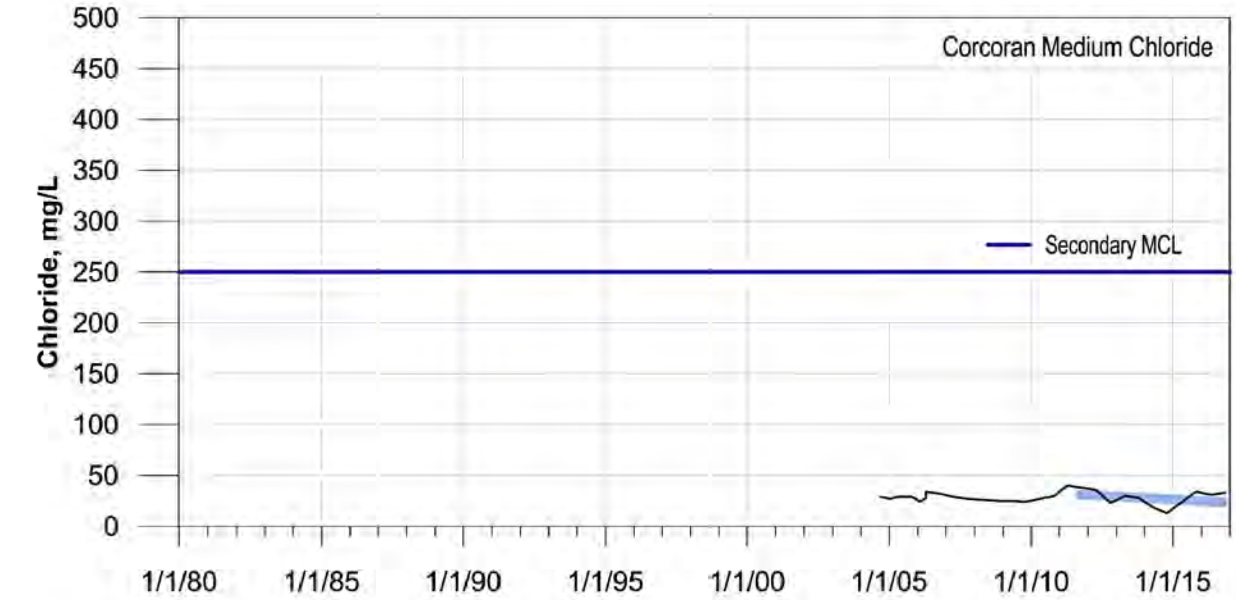

SC-5D Total Dissolved Solids
Secondary MCL
TDS, mg/L
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

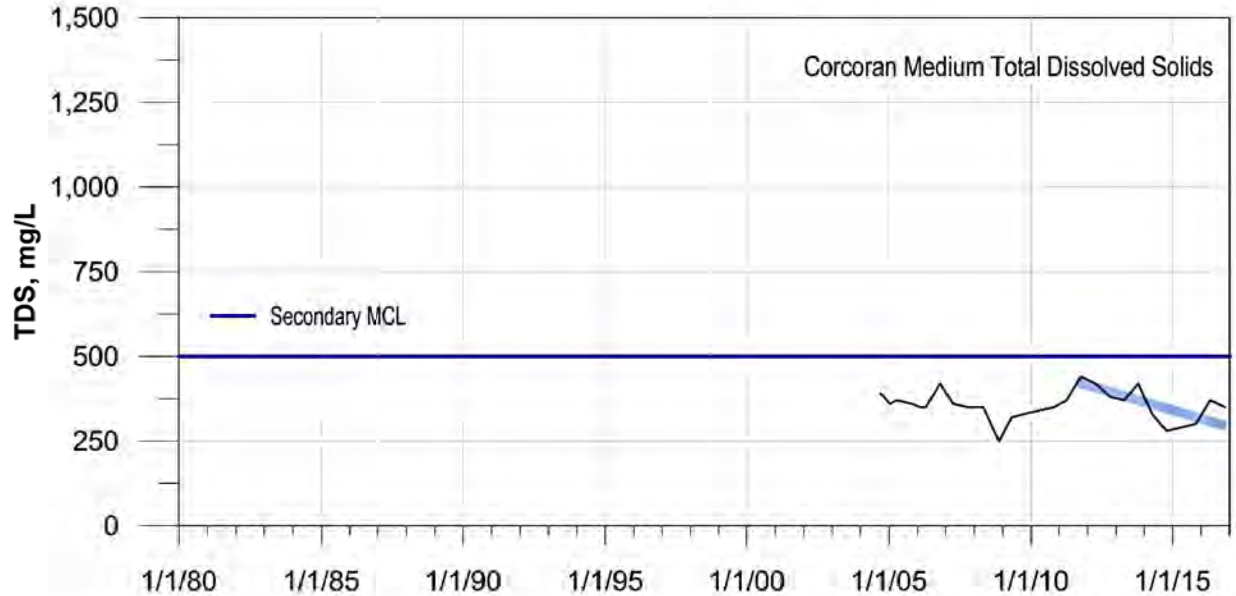

SC-5D Groundwater Elevation
Groundwater Elevation, ft MSL
70
60
50
40
30
20
10
0
-10
-20
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

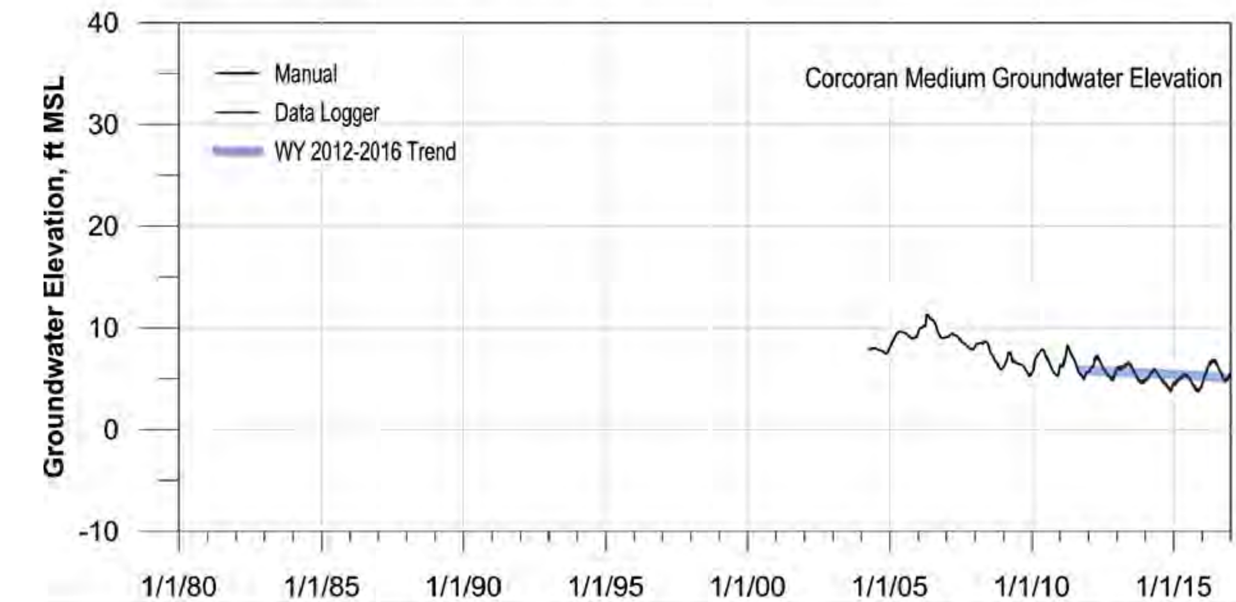

Corcoran Deep Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Corcoran Deep Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


WY 2012-2016 Trend
Corcoran Deep Groundwater Elevation
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

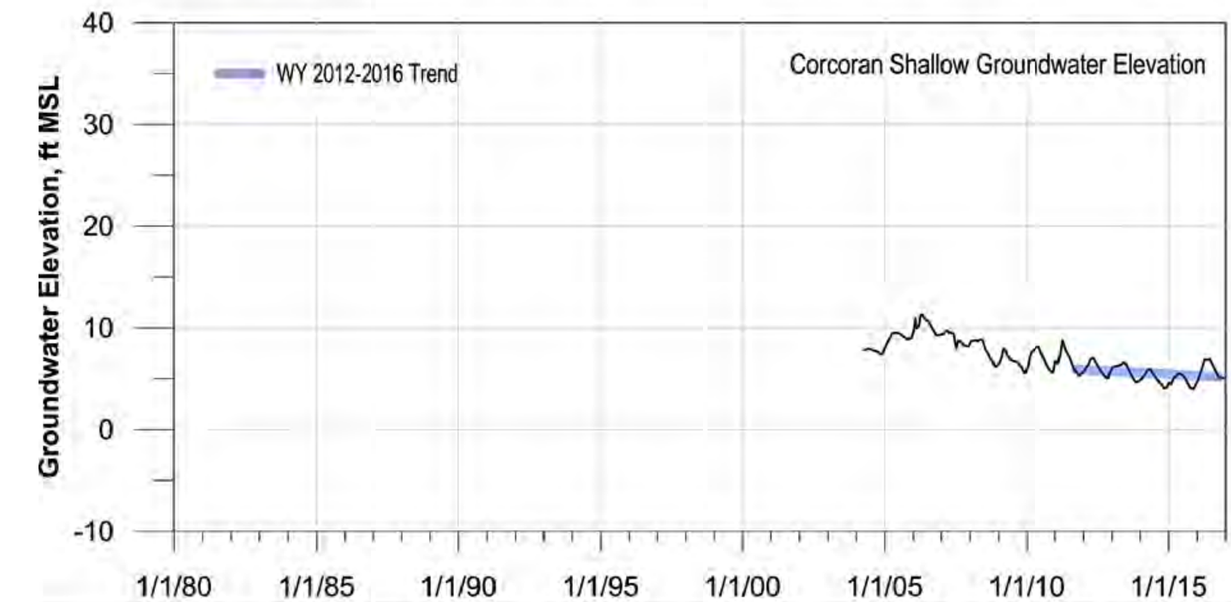

Corcoran Medium Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Corcoran Medium Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

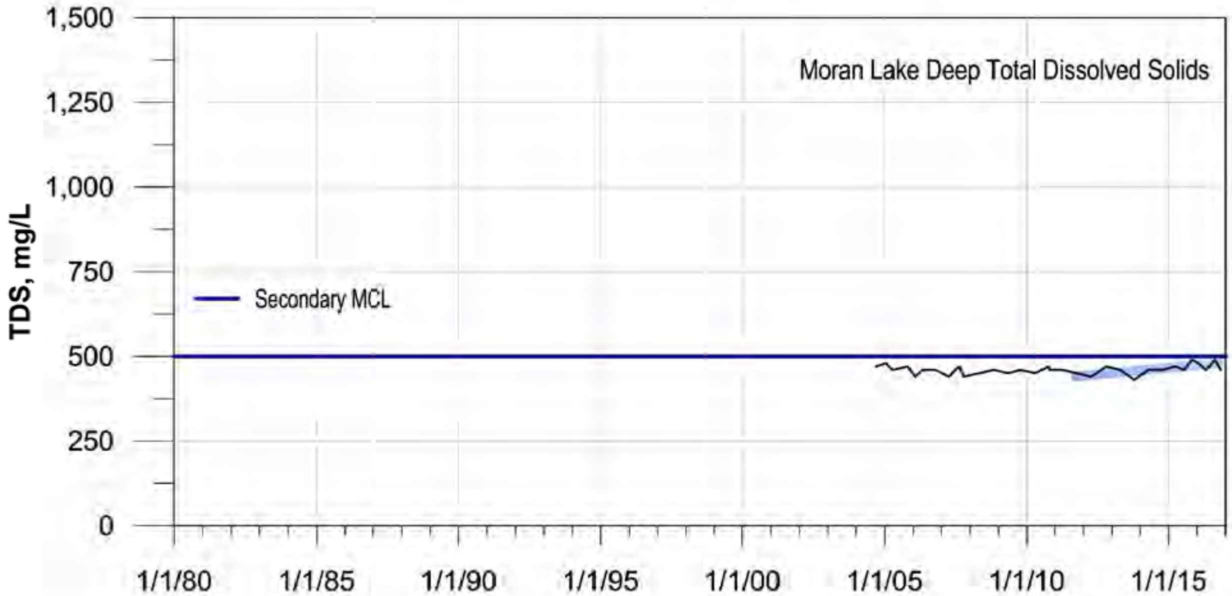

Manual
Data Logger
WY 2012-2016 Trend
Corcoran Medium Groundwater Elevation
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

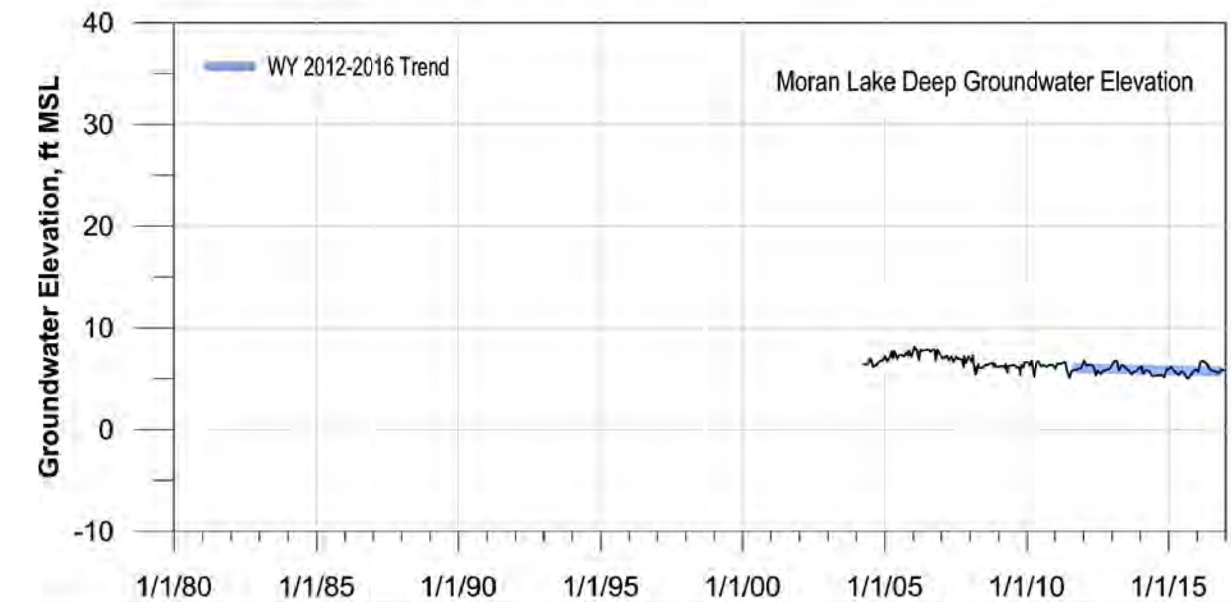

Corcoran Shallow Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

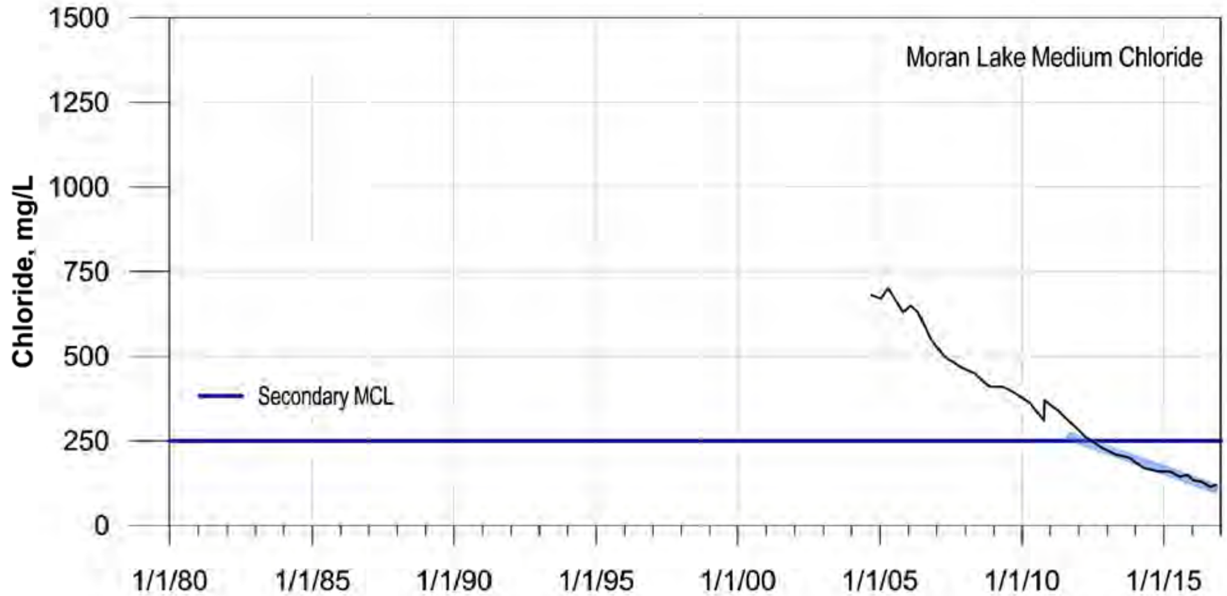

Corcoran Shallow Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

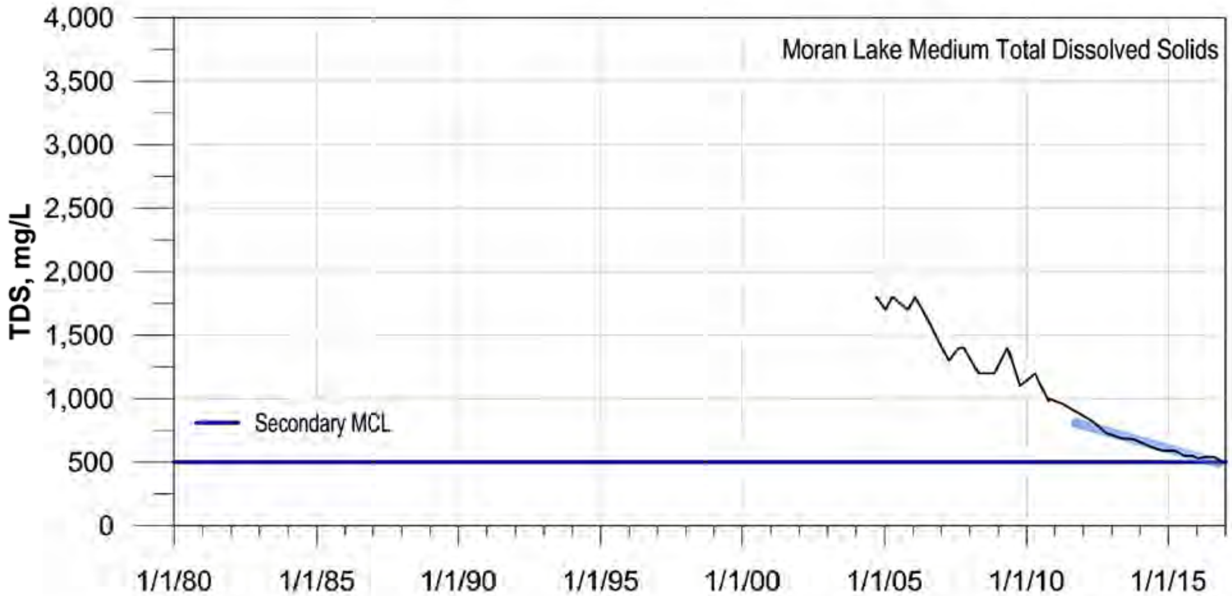

WY 2012-2016 Trend
Corcoran Shallow Groundwater Elevation
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

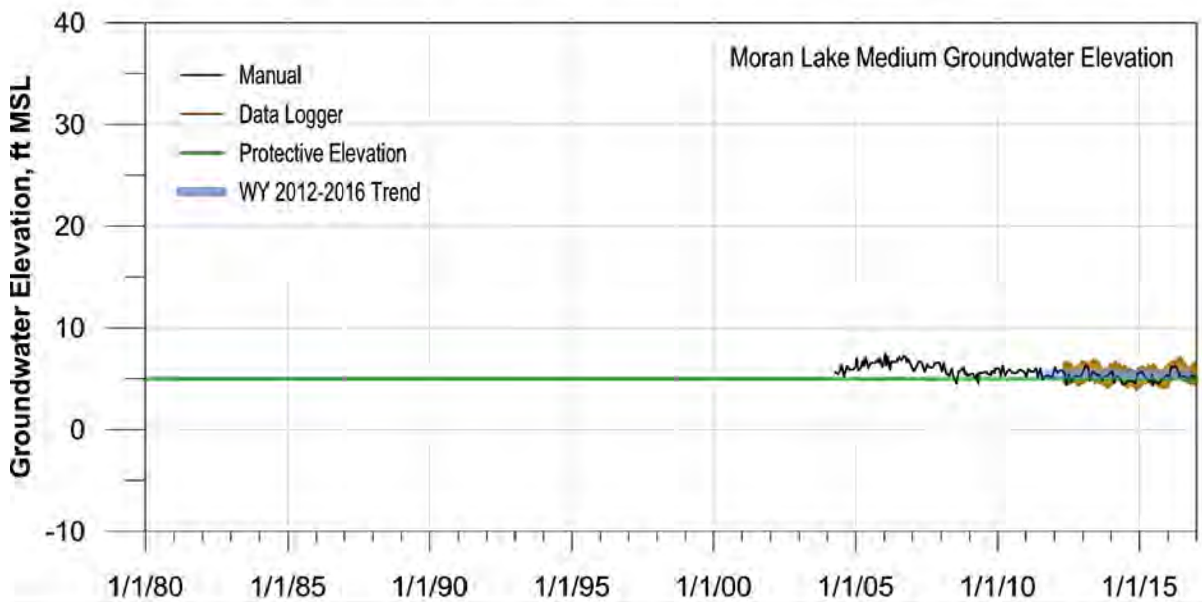

Moran Lake Deep Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

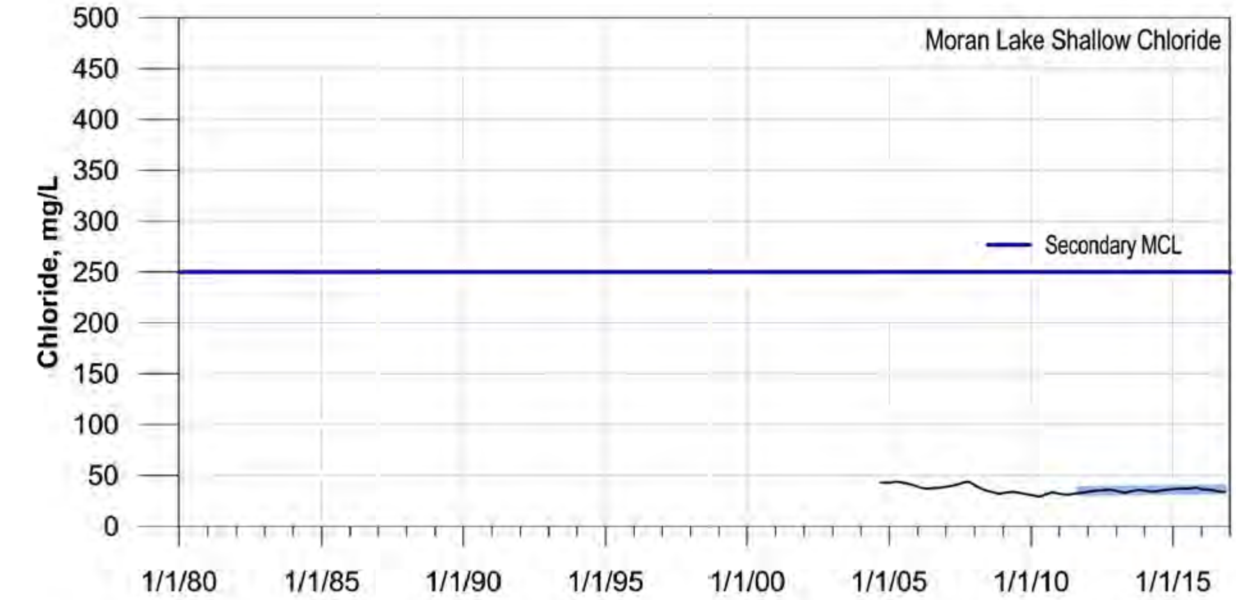

Moran Lake Deep Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


WY 2012-2016 Trend
Moran Lake Deep Groundwater Elevation
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

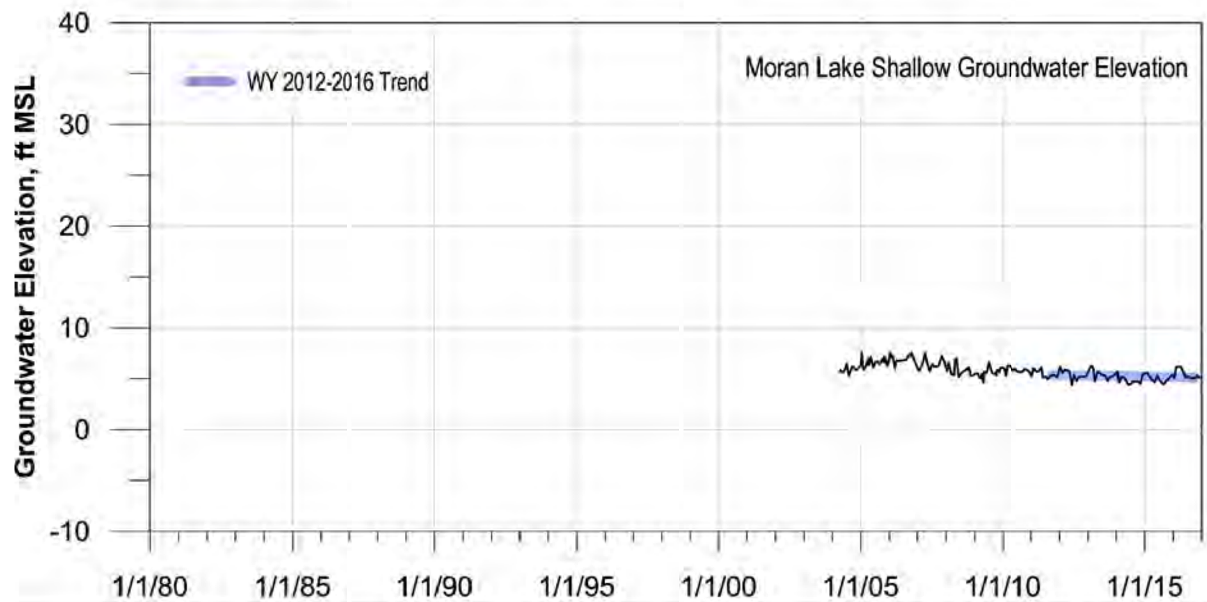

Moran Lake Medium Chloride
Chloride, mg/L
Secondary MCL
1500
1250
1000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Moran Lake Medium Total Dissolved Solids
TDS, mg/L
Secondary MCL
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

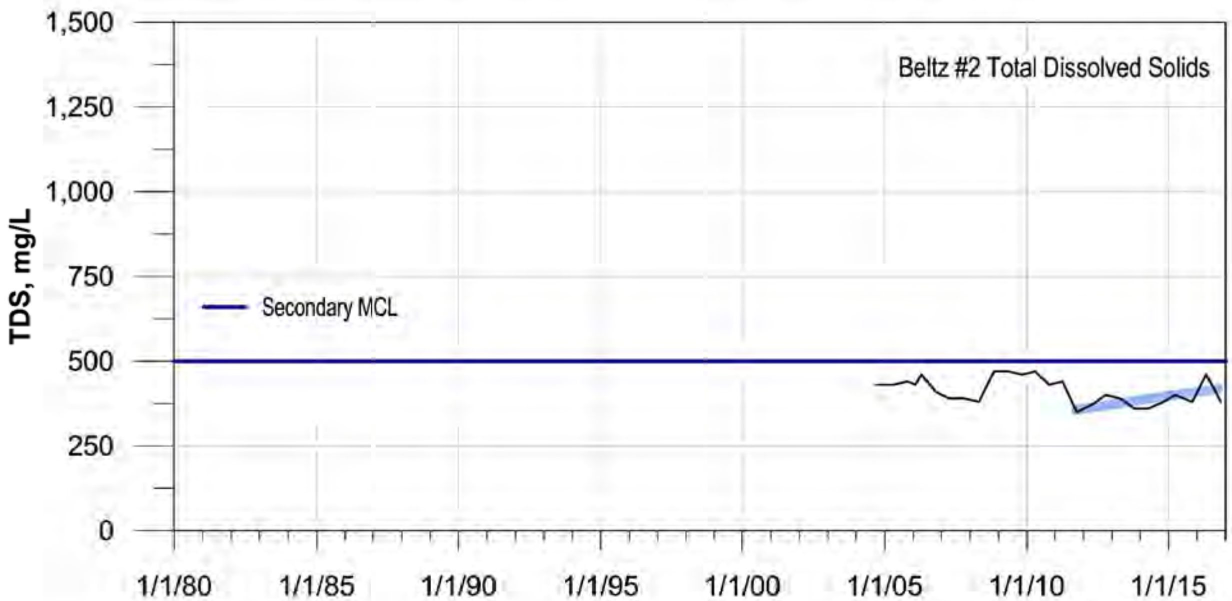

Moran Lake Medium Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
Data Logger
Protective Elevation
WY 2012-2016 Trend
40
30
20
10
0
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

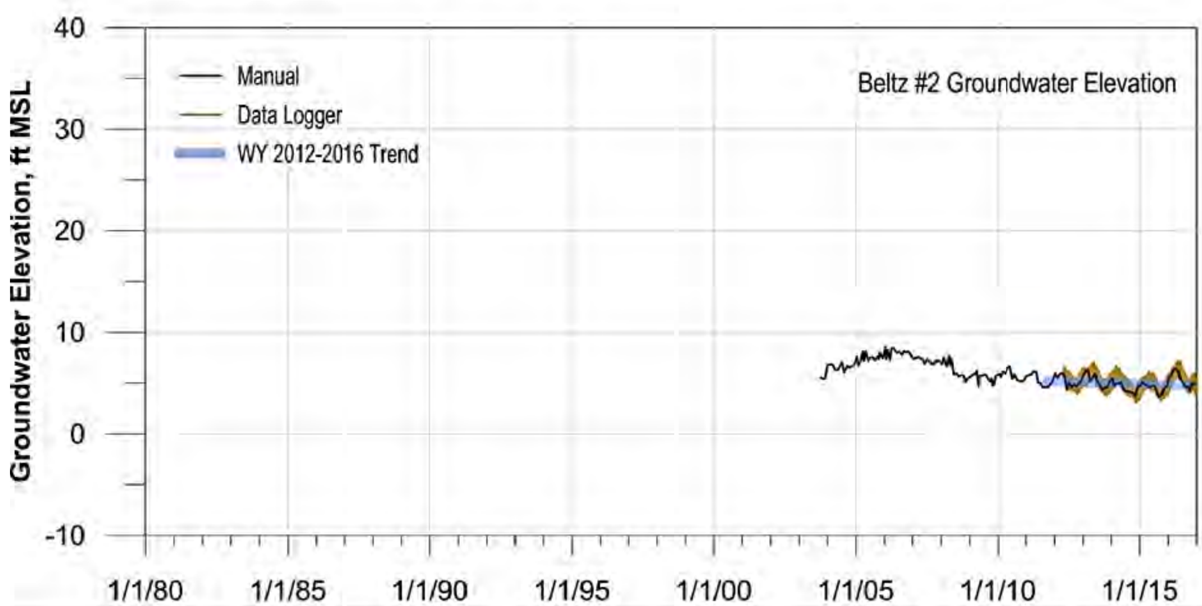

Moran Lake Shallow Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

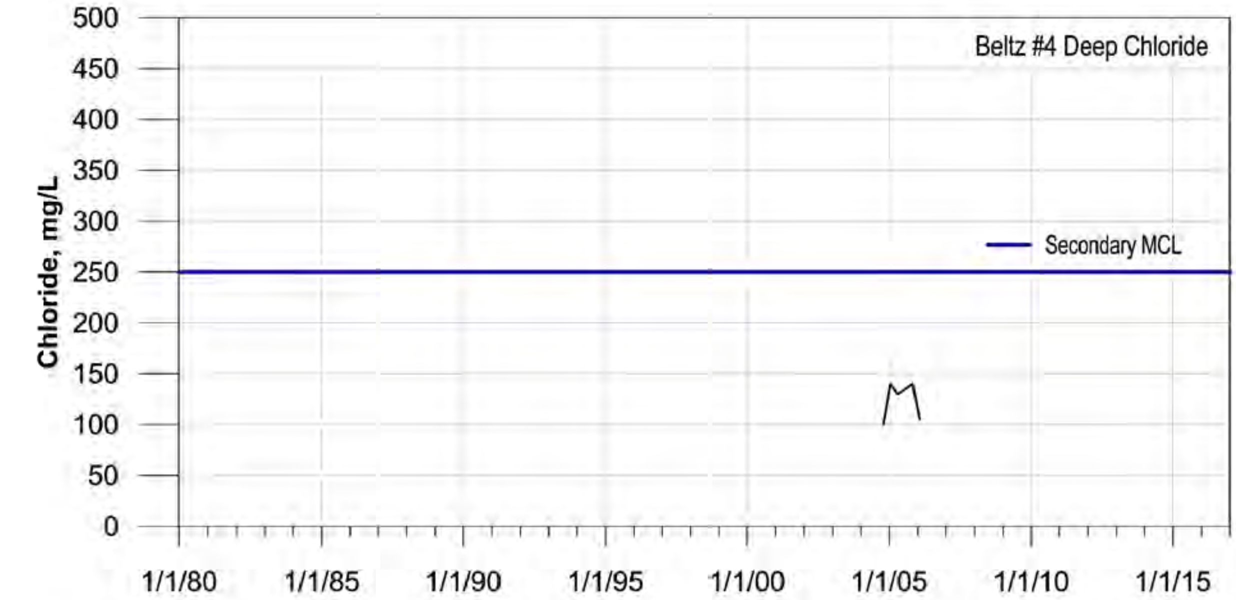

Moran Lake Shallow Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Moran Lake Shallow Groundwater Elevation
WY 2012-2016 Trend
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

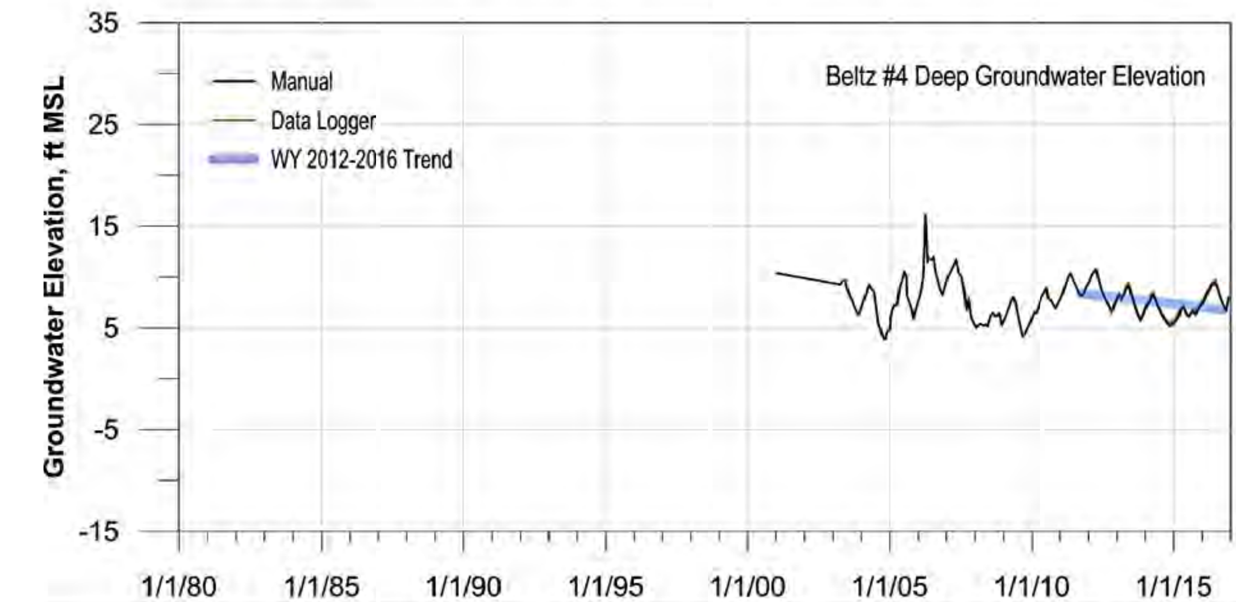

Beltz #2 Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

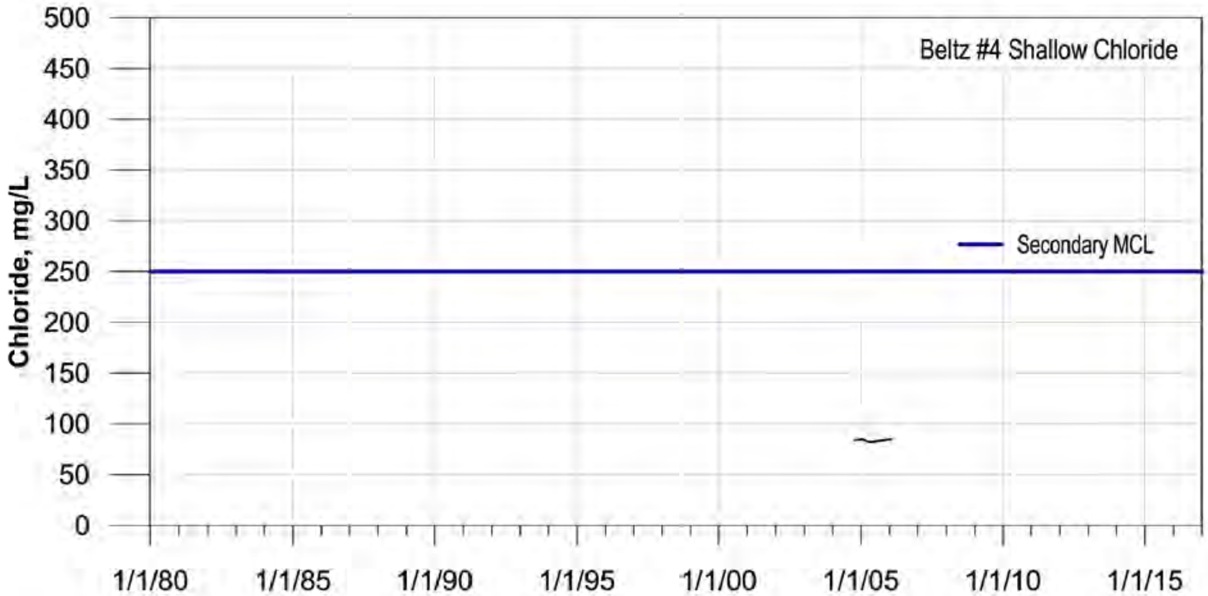

Beltz #2 Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Manual
Data Logger
WY 2012-2016 Trend
Beltz #2 Groundwater Elevation
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

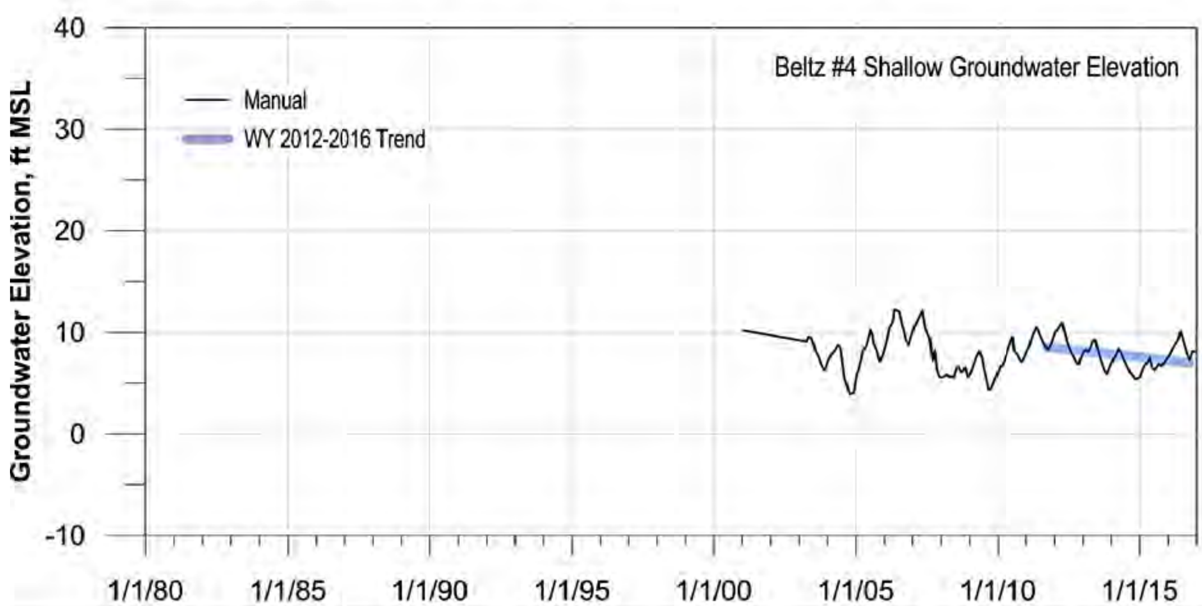

Beltz #4 Deep Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Beltz #4 Deep Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Beltz #4 Deep Groundwater Elevation
Manual
Data Logger
WY 2012-2016 Trend
Groundwater Elevation, ft MSL
35
25
15
5
-5
-15
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

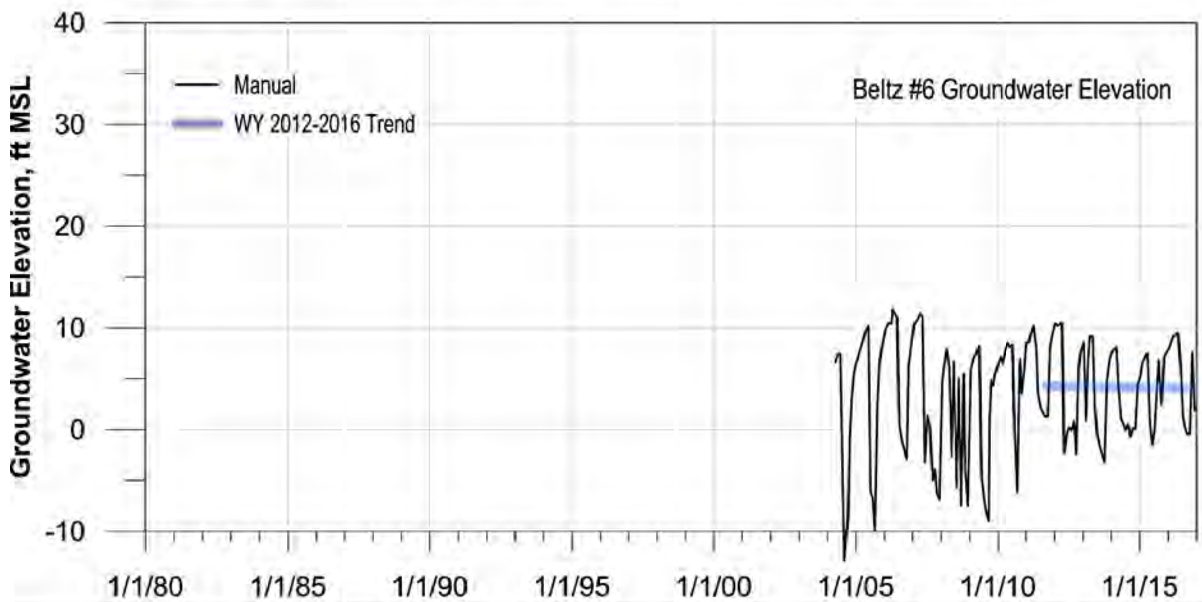

Beltz #4 Shallow Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

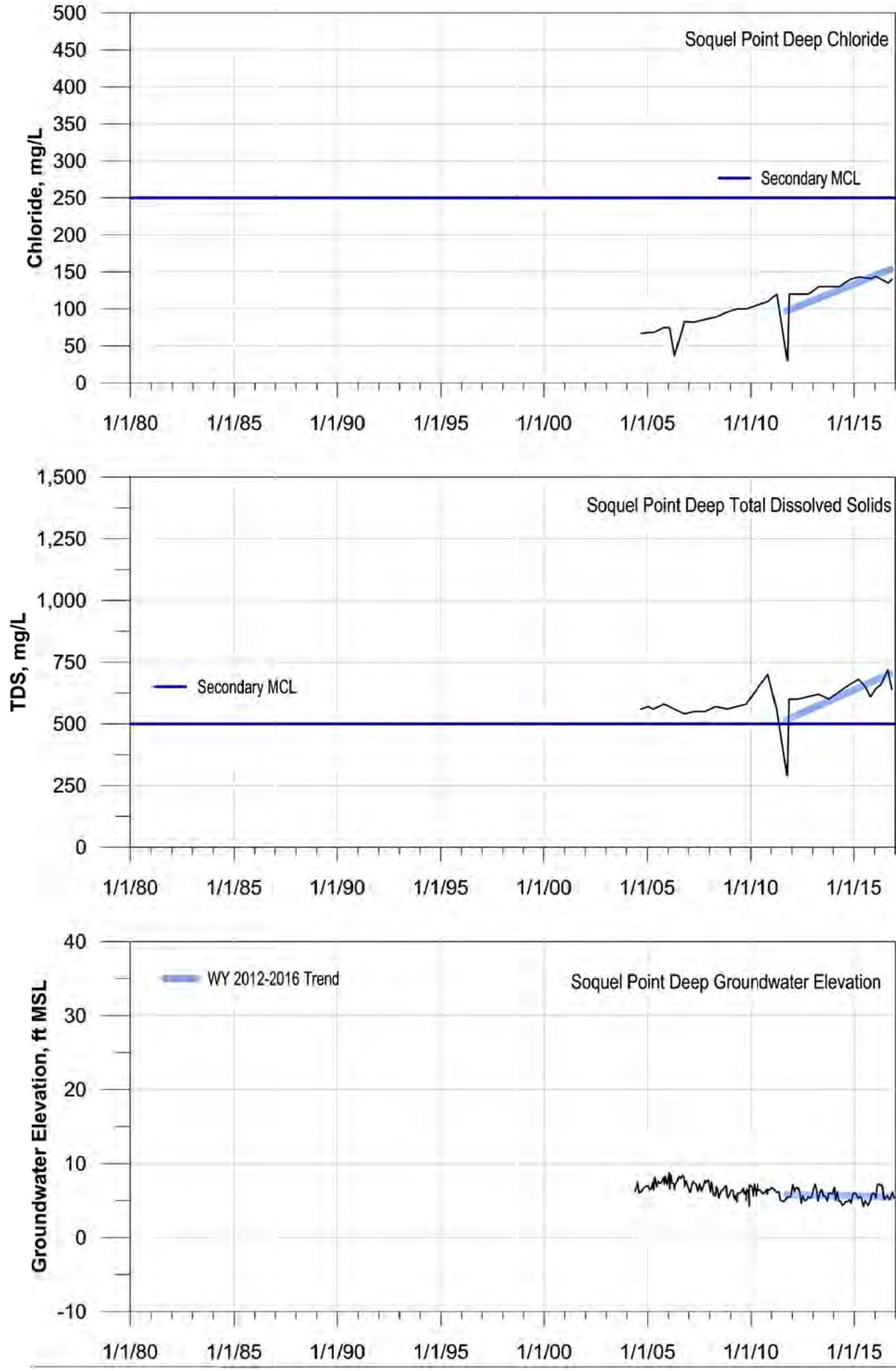

Beltz #4 Shallow Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Beltz #4 Shallow Groundwater Elevation
Manual
WY 2012-2016 Trend
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Beltz #6 Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

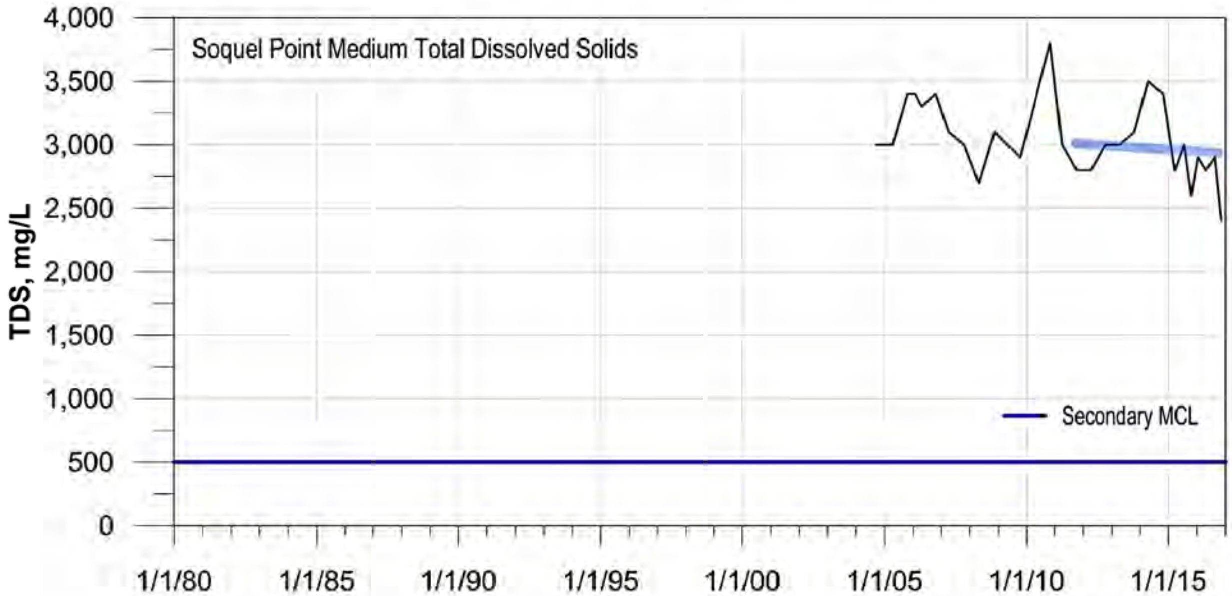

Beltz #6 Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

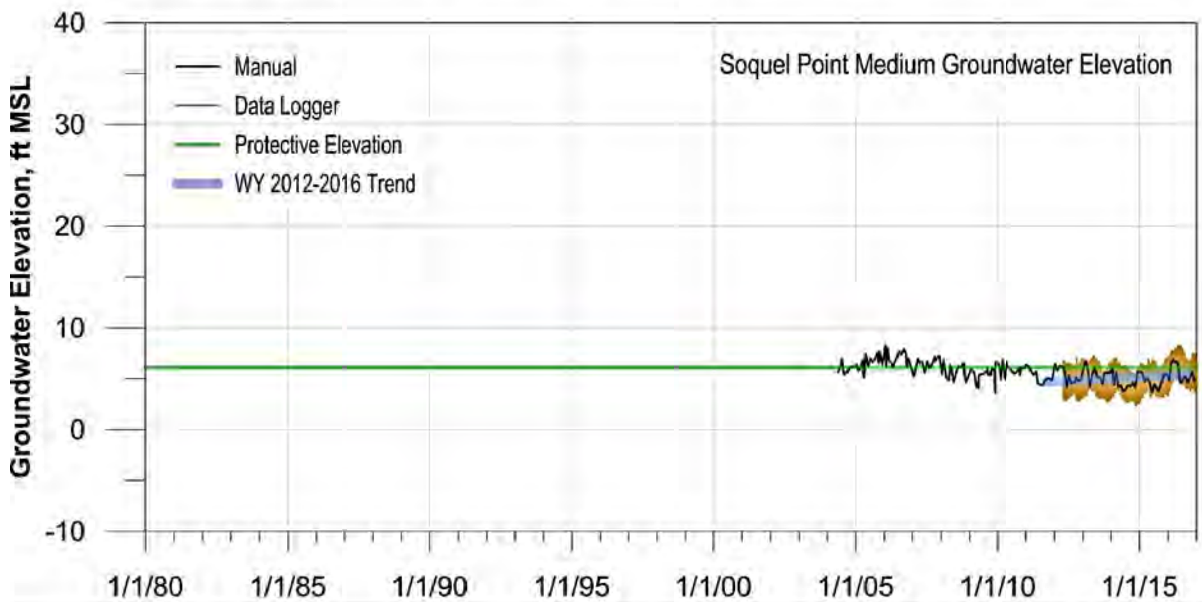

Manual
WY 2012-2016 Trend
Beltz #6 Groundwater Elevation
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15



Hydro Metrics WRI

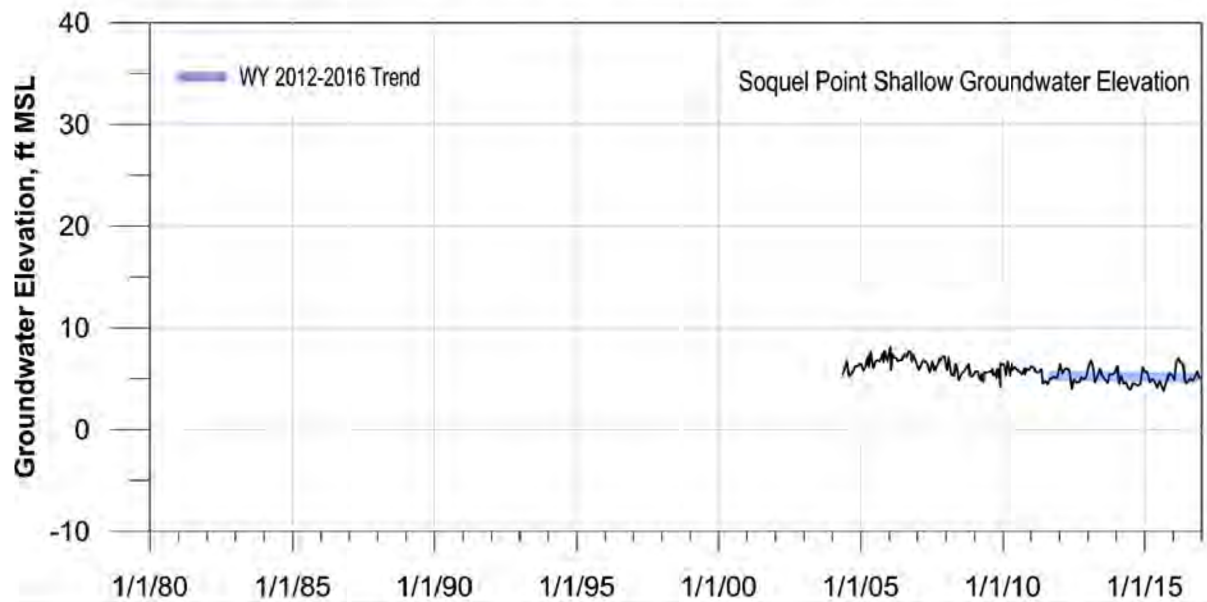

Soquel Point Medium Chloride
Secondary MCL
Chloride, mg/L
1500
1250
1000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

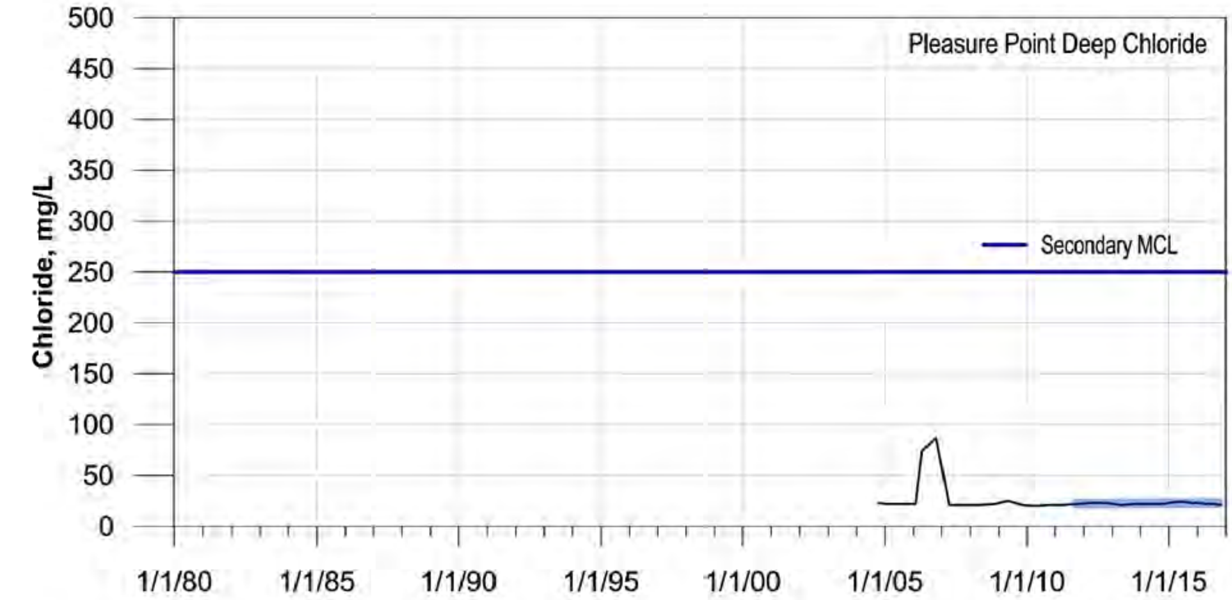

Soquel Point Medium Total Dissolved Solids
Secondary MCL
TDS, mg/L
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

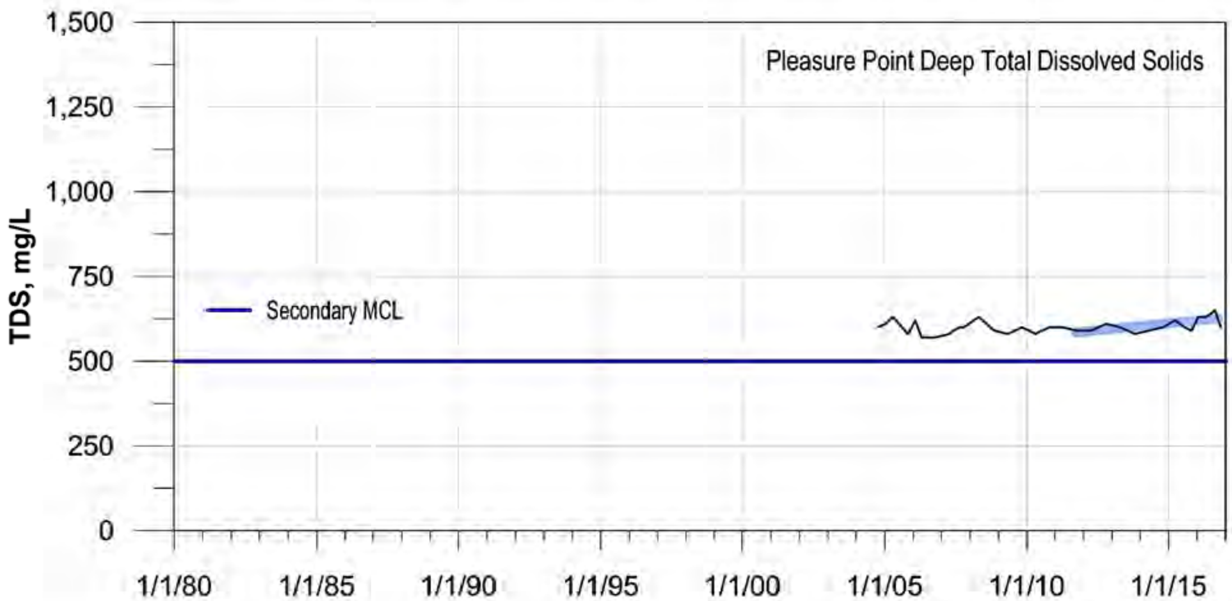

Manual
Data Logger
Protective Elevation
WY 2012-2016 Trend
Soquel Point Medium Groundwater Elevation
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

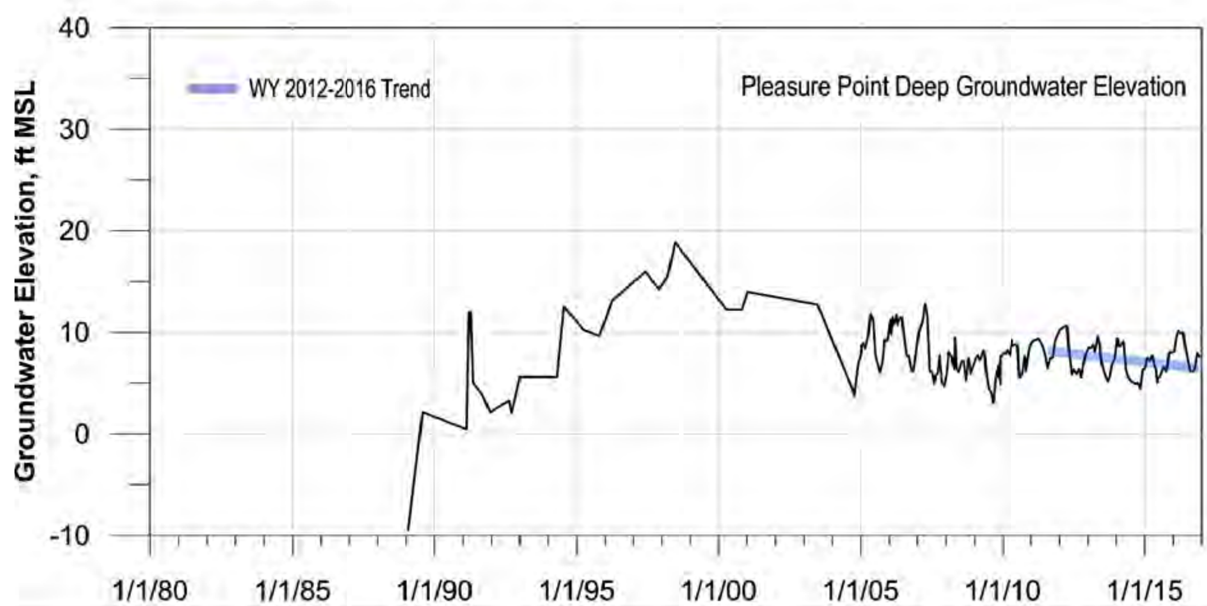

Soquel Point Shallow Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Soquel Point Shallow Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


WY 2012-2016 Trend
Soquel Point Shallow Groundwater Elevation
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

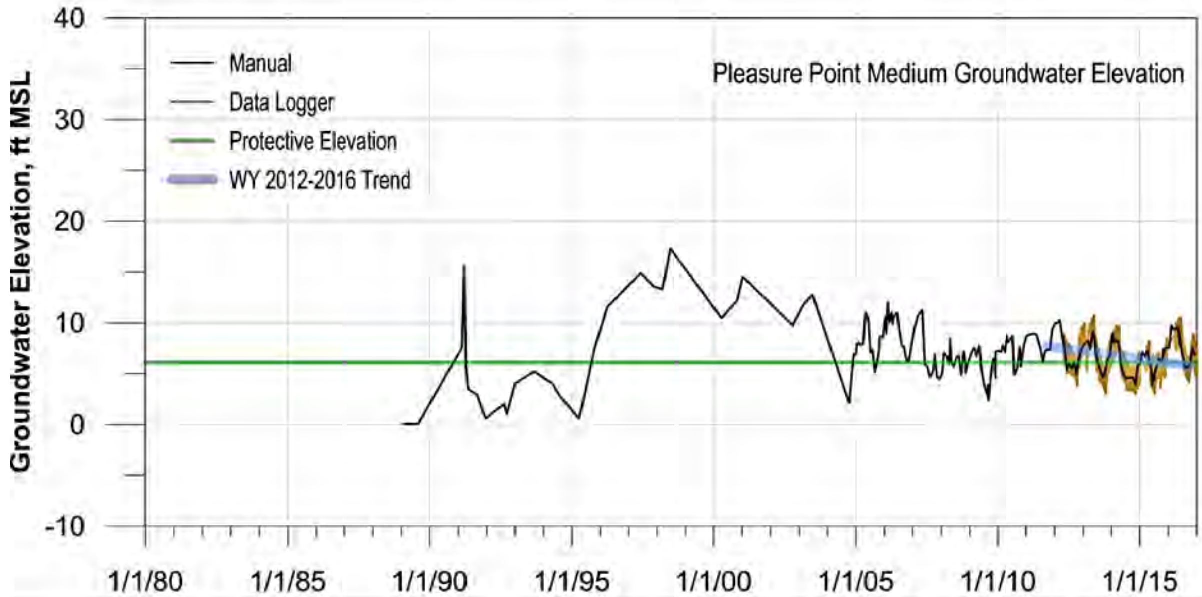

Pleasure Point Deep Chloride
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
Secondary MCL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

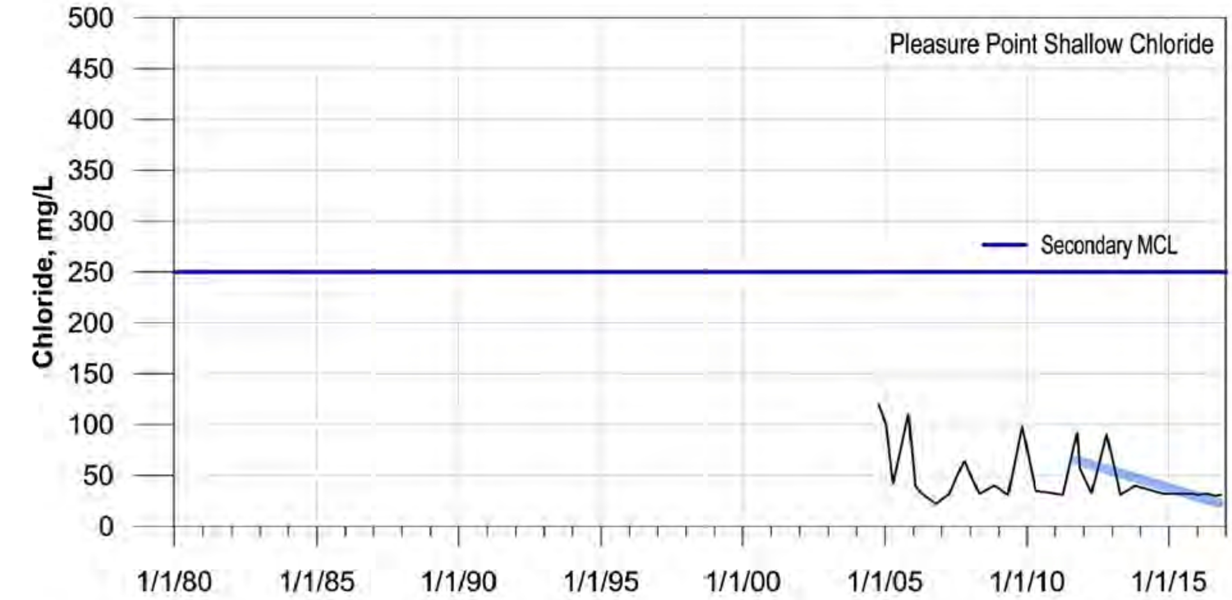

Pleasure Point Deep Total Dissolved Solids
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
Secondary MCL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

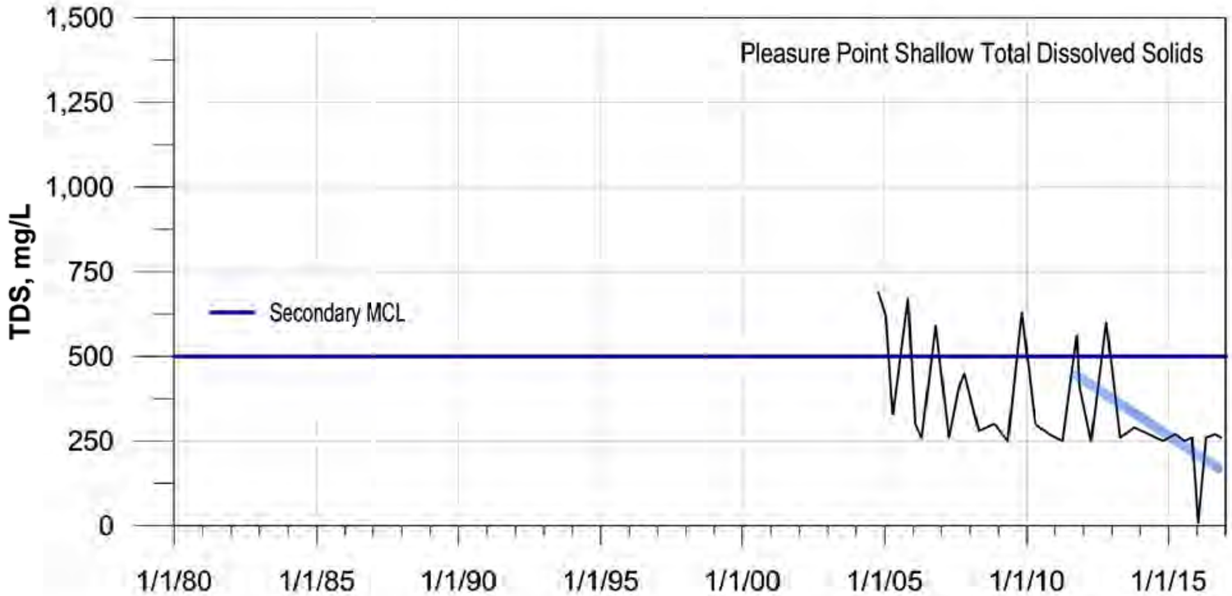

Pleasure Point Deep Groundwater Elevation
WY 2012-2016 Trend
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

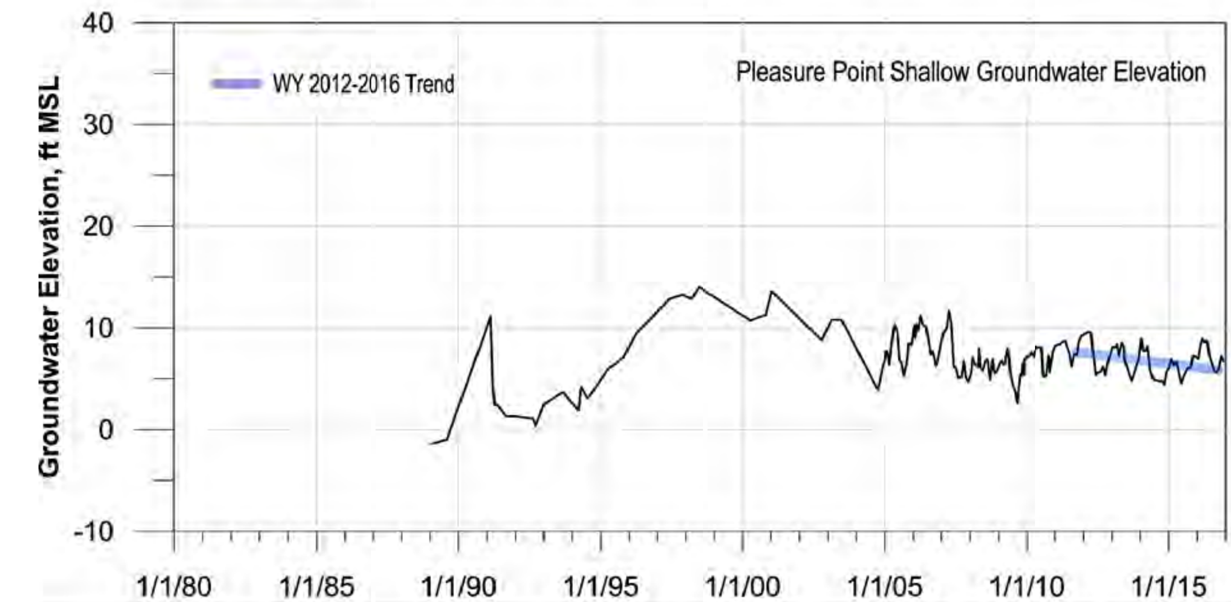

Pleasure Point Medium Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

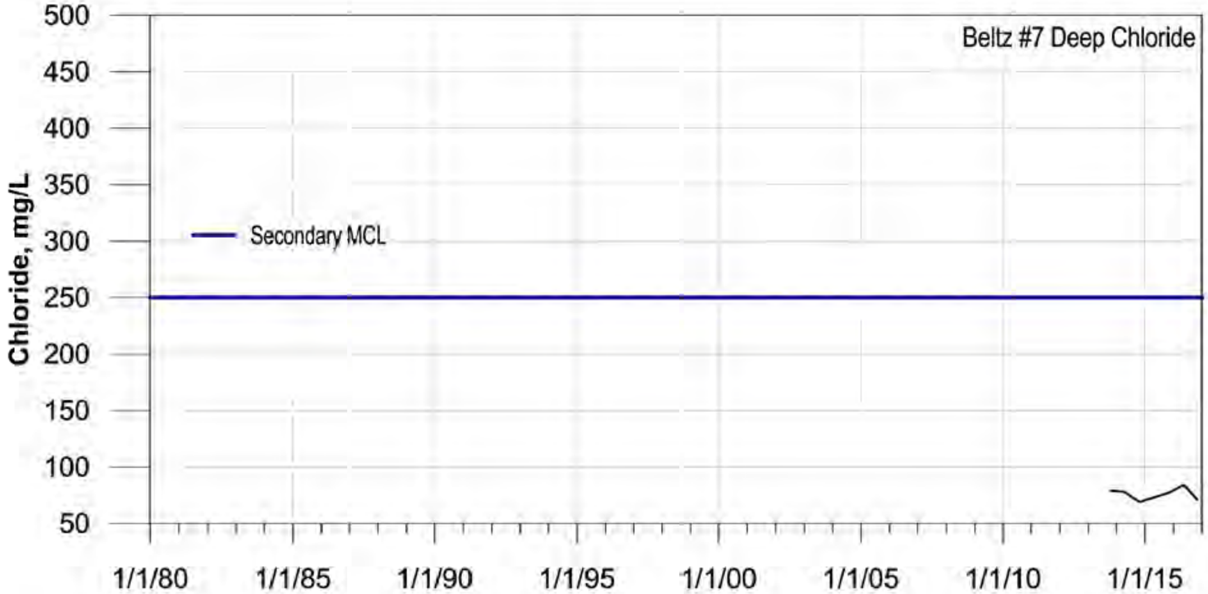

Pleasure Point Medium Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Manual
Data Logger
Protective Elevation
WY 2012-2016 Trend
Pleasure Point Medium Groundwater Elevation
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

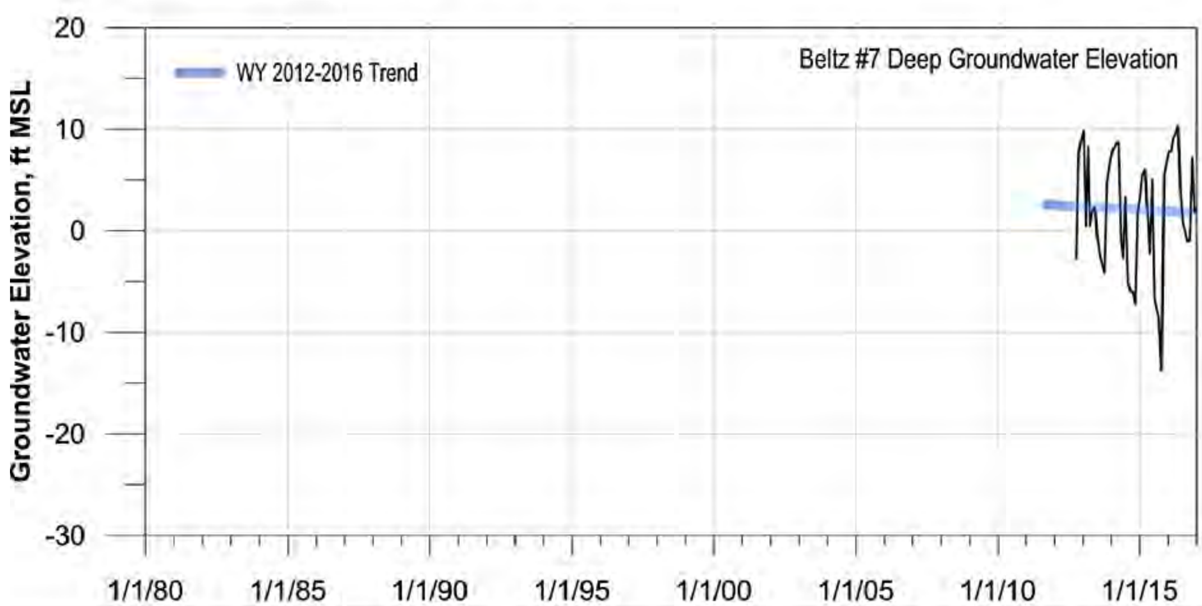

Pleasure Point Shallow Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

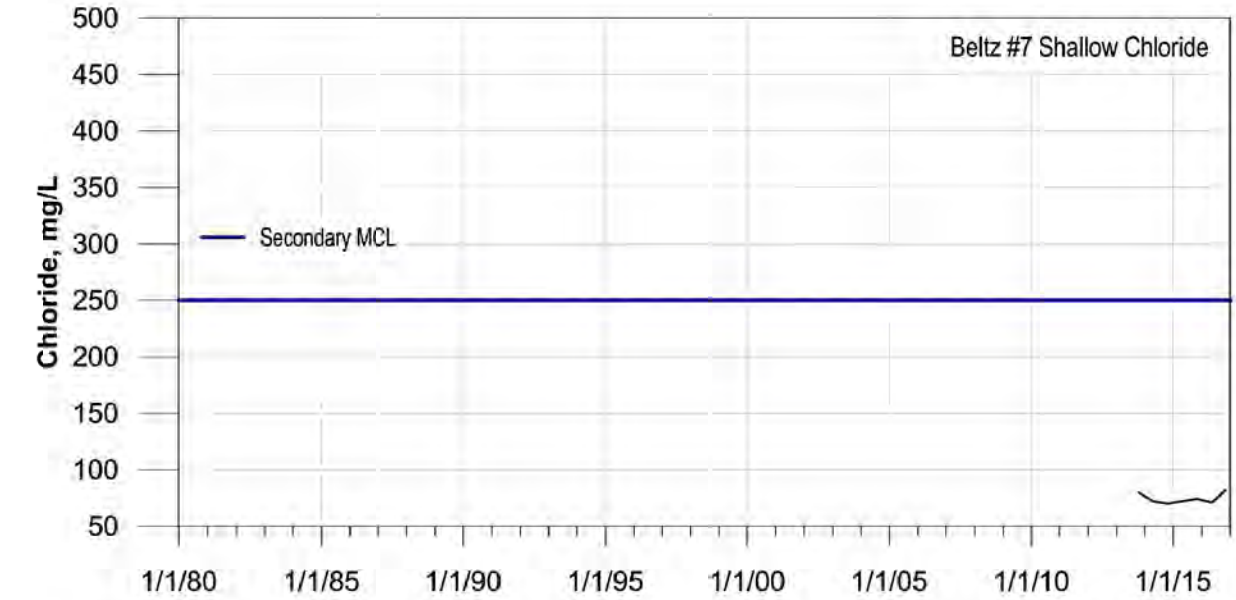

Pleasure Point Shallow Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


WY 2012-2016 Trend
Pleasure Point Shallow Groundwater Elevation
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

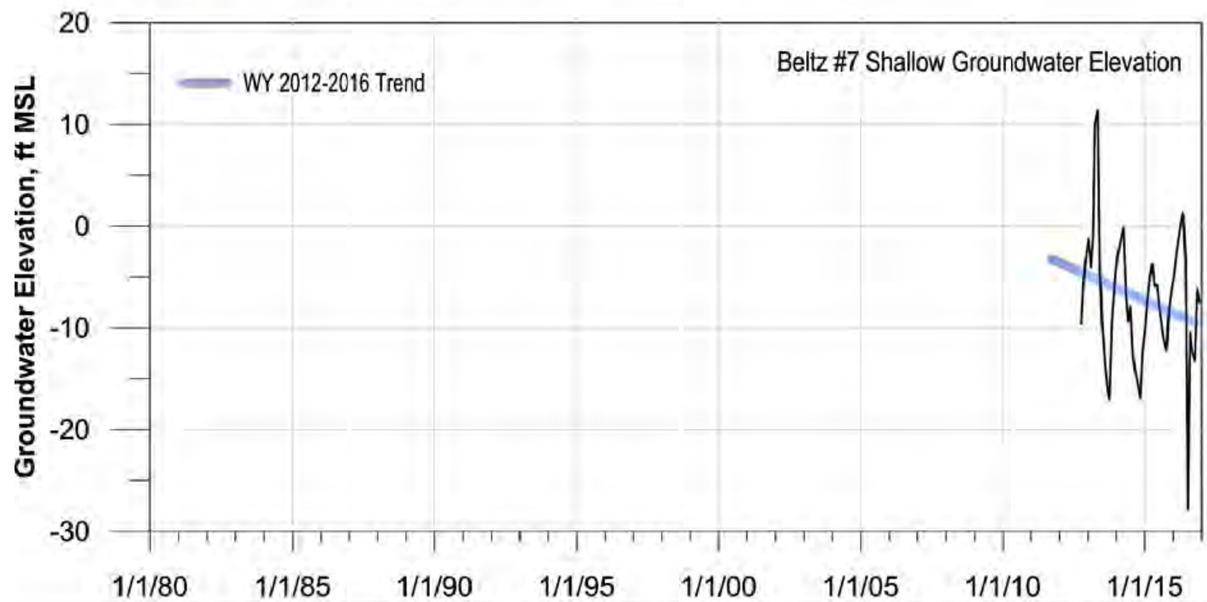

Beltz #7 Deep Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

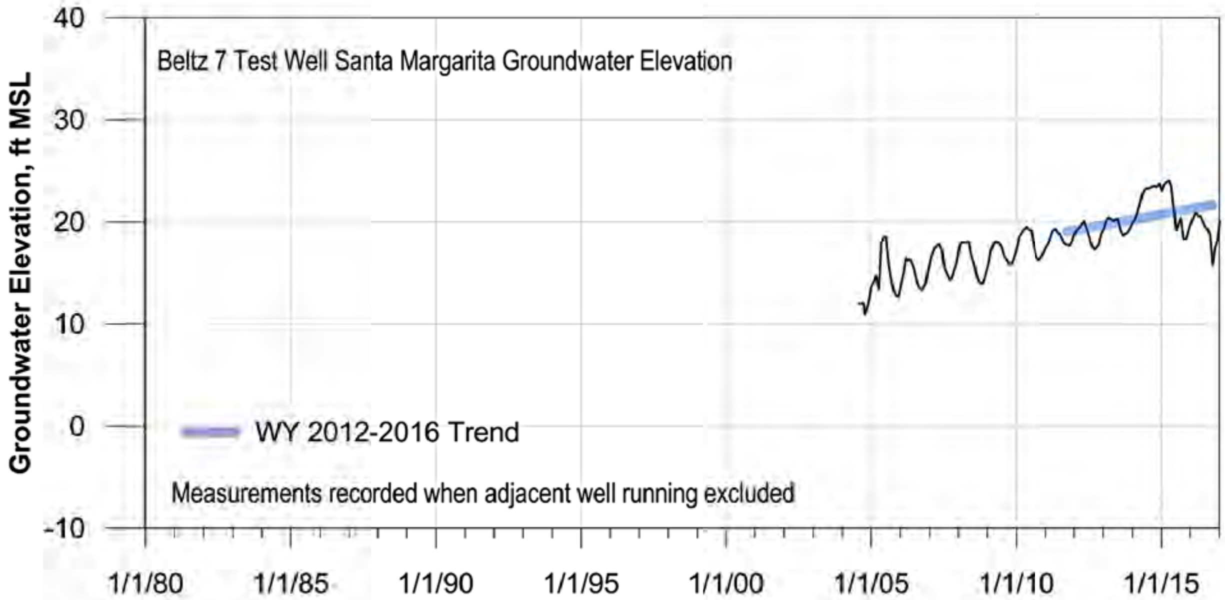

Beltz #7 Deep Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

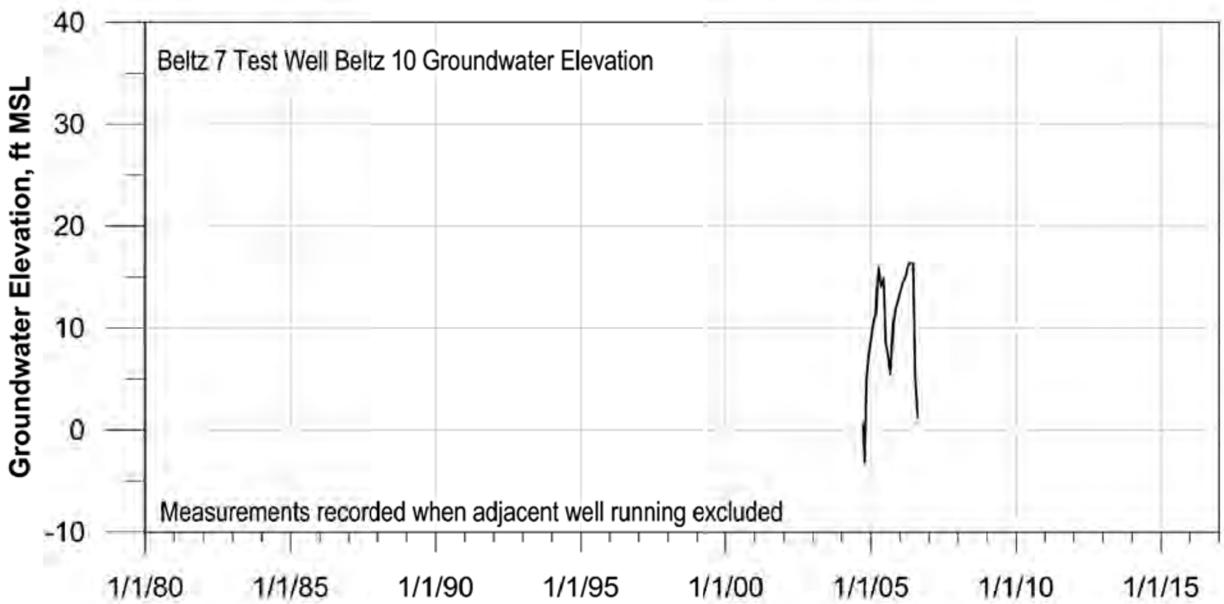

Beltz #7 Deep Groundwater Elevation
WY 2012-2016 Trend
Groundwater Elevation, ft MSL
20
10
0
-10
-20
-30
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

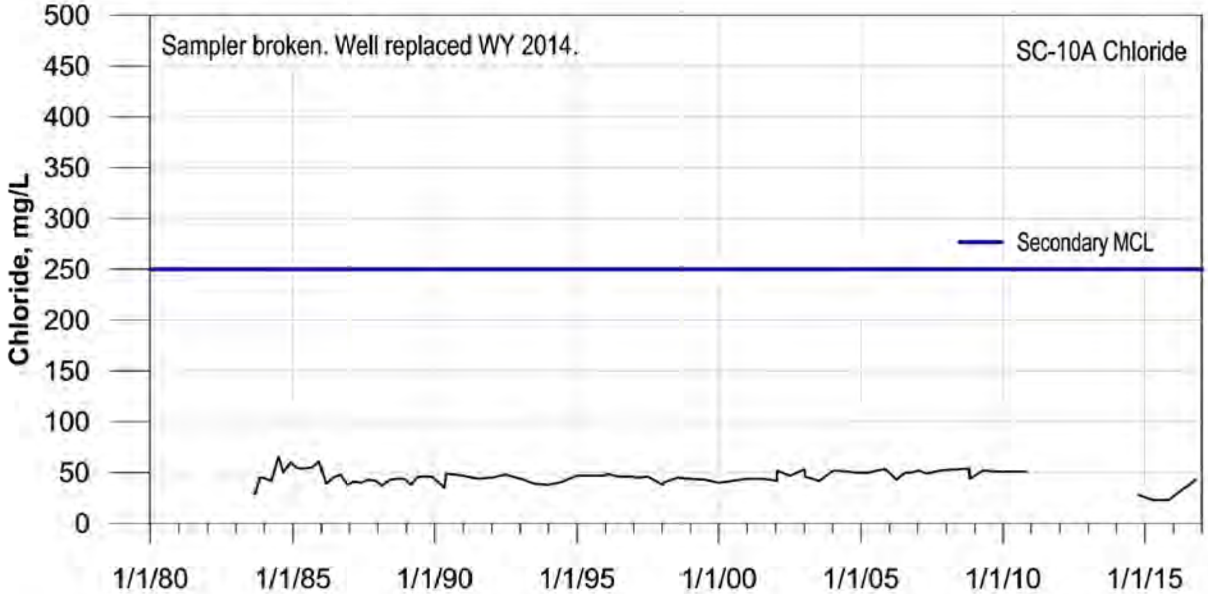

Beltz #7 Shallow Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Beltz #7 Shallow Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

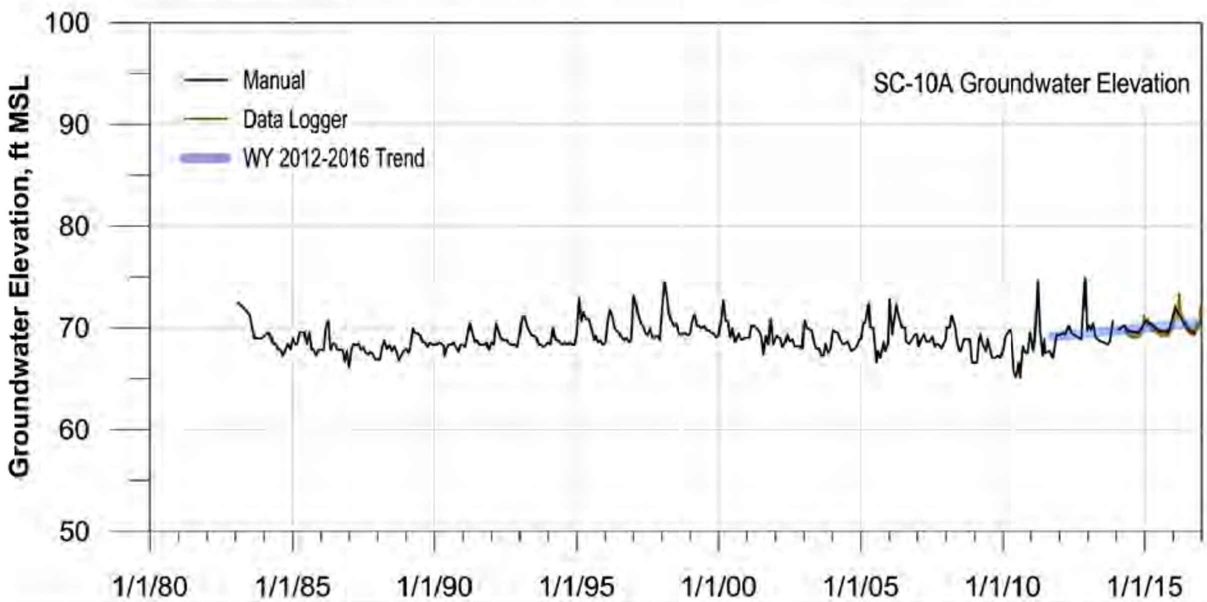

Beltz #7 Shallow Groundwater Elevation
Groundwater Elevation, ft MSL
WY 2012-2016 Trend
20
10
0
-10
-20
-30
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

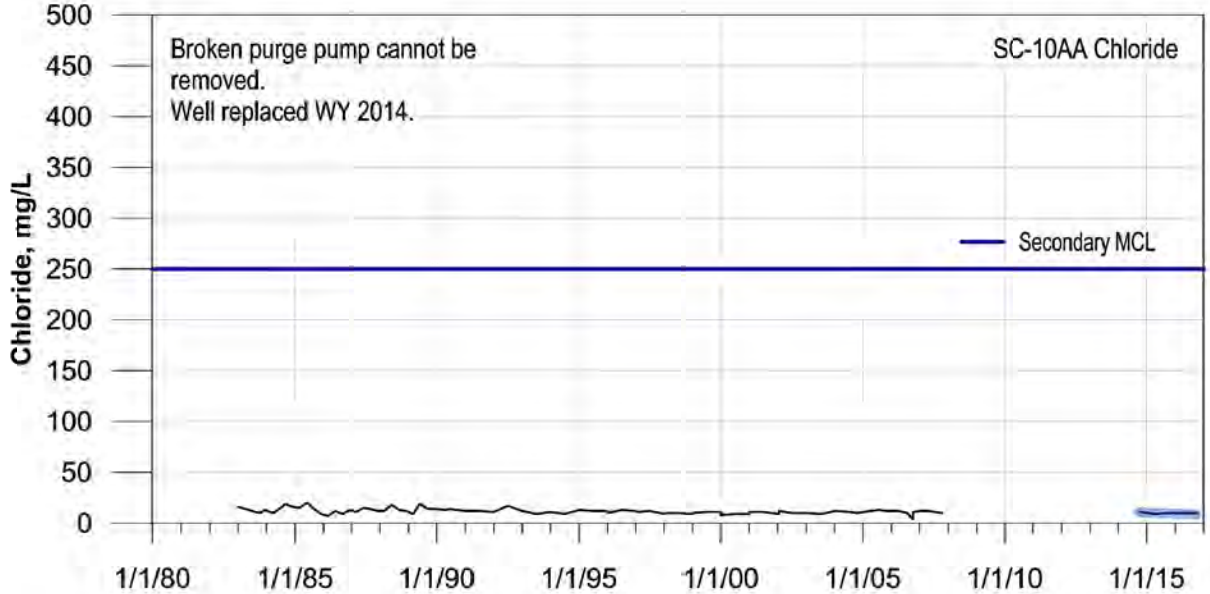

Beltz 7 Test Well Santa Margarita Groundwater Elevation
Groundwater Elevation, ft MSL
WY 2012-2016 Trend
Measurements recorded when adjacent well running excluded
40
30
20
10
0
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Beltz 7 Test Well Beltz 10 Groundwater Elevation
Groundwater Elevation, ft MSL
Measurements recorded when adjacent well running excluded
40
30
20
10
0
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Sampler broken. Well replaced WY 2014.
SC-10A Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

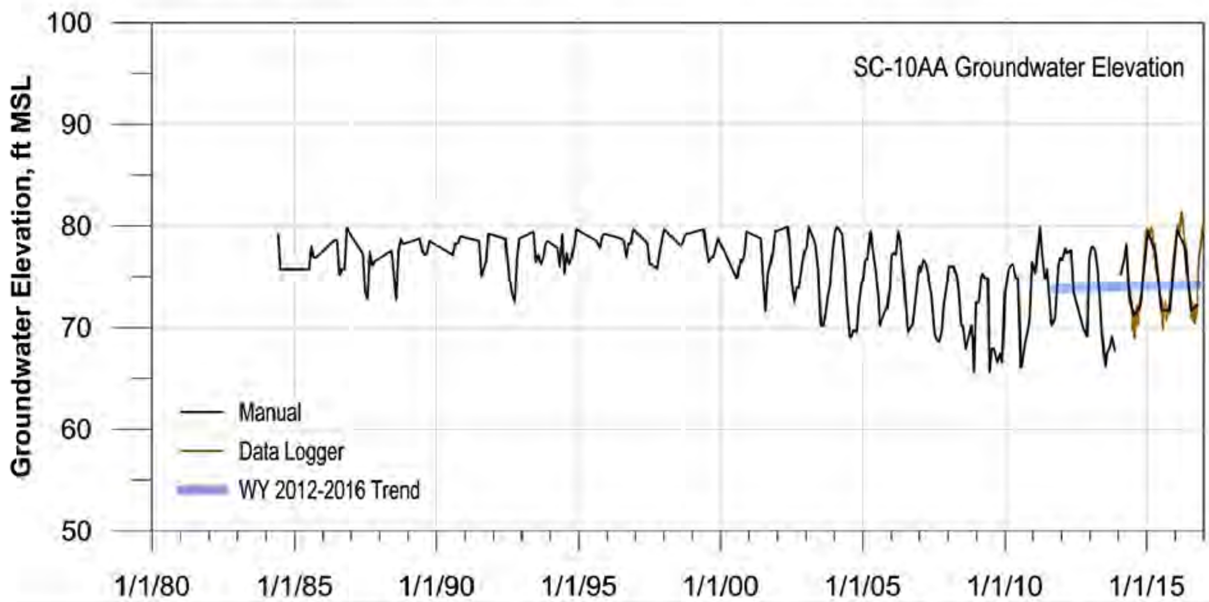

SC-10A Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Manual
Data Logger
WY 2012-2016 Trend
SC-10A Groundwater Elevation
Groundwater Elevation, ft MSL
100
90
80
70
60
50
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

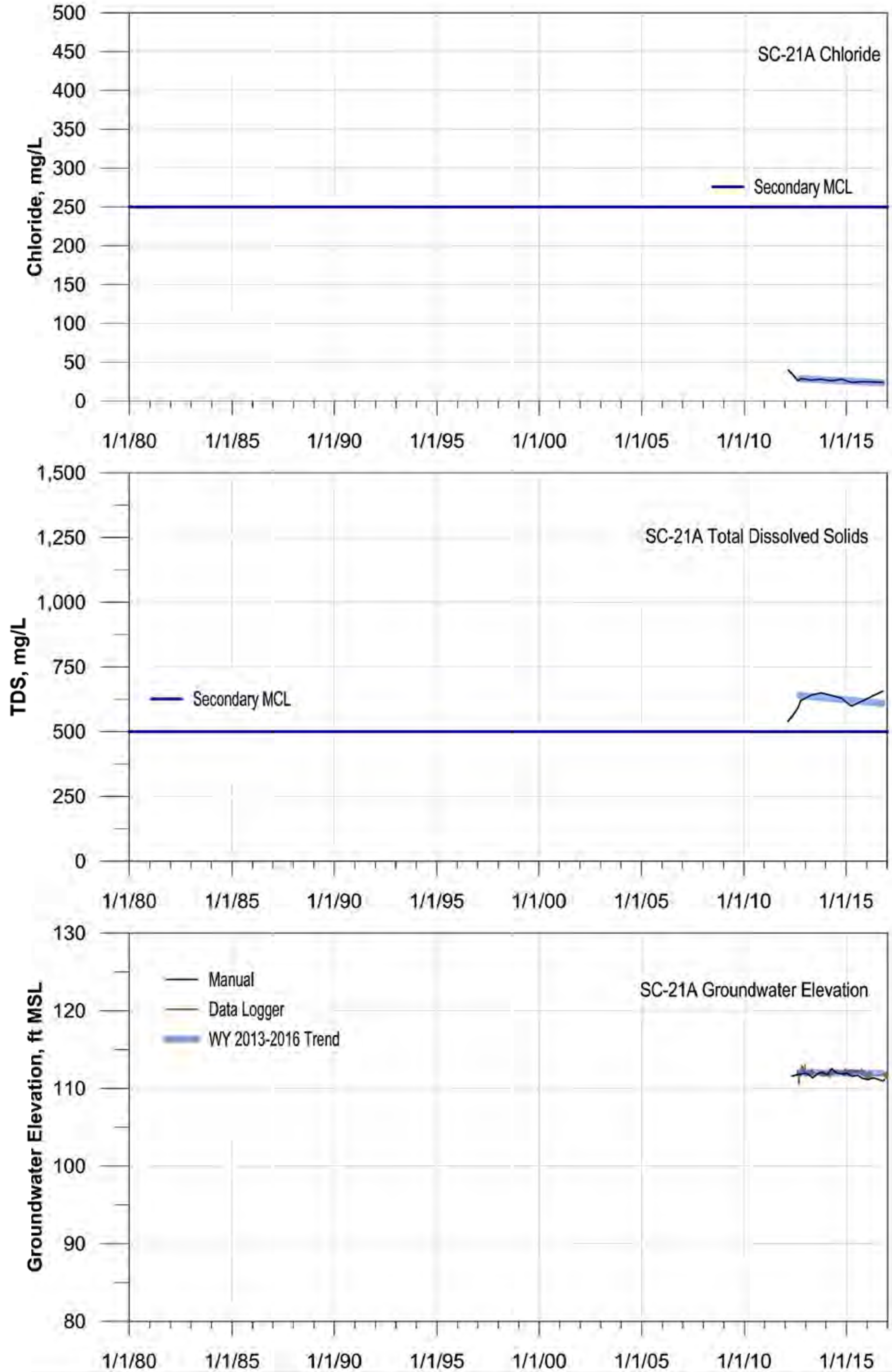


Broken purge pump cannot be removed.
Well replaced WY 2014.
SC-10AA Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

SC-10AA Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

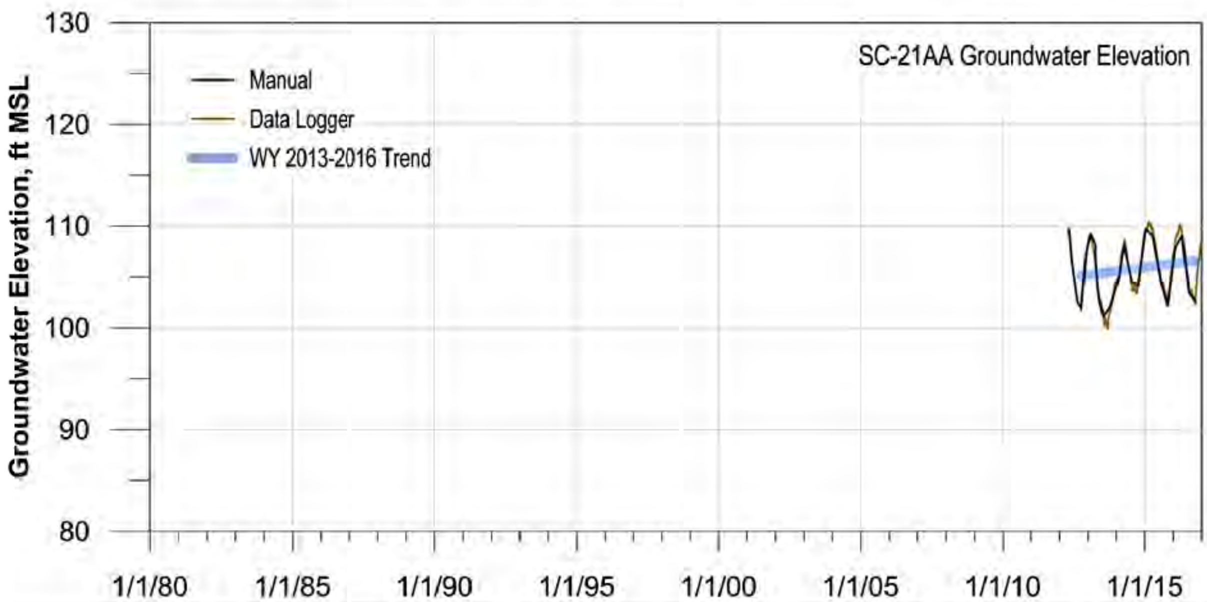


SC-10AA Groundwater Elevation
Groundwater Elevation, ft MSL
100
90
80
70
60
50
Manual
Data Logger
WY 2012-2016 Trend
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-21A Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-21A Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
SC-21A Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
Data Logger
WY 2013-2016 Trend
130
120
110
100
90
80

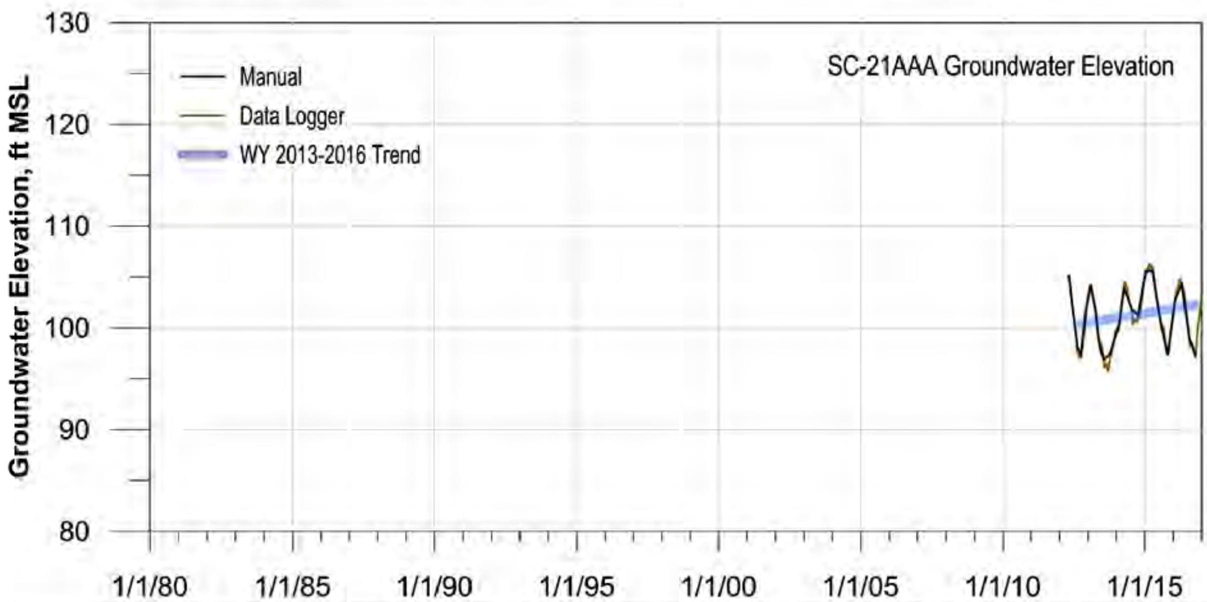

SC-21AA Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-21AA Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-21AA Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
Data Logger
WY 2013-2016 Trend
130
120
110
100
90
80
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

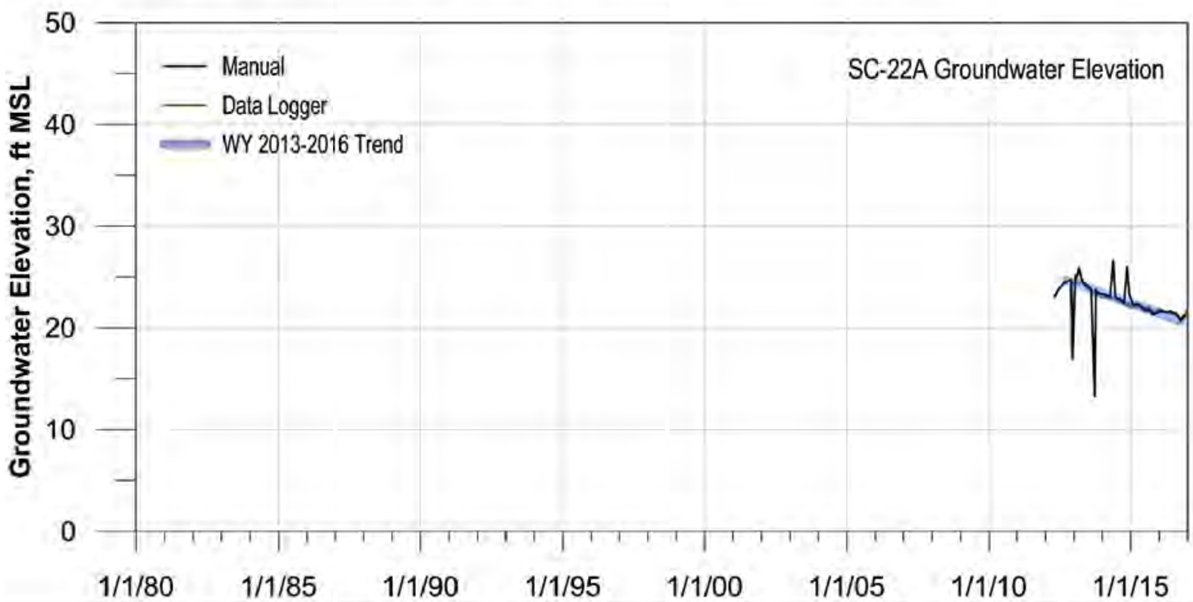

SC-21AAA Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-21AAA Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-21AAA Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
Data Logger
WY 2013-2016 Trend
130
120
110
100
90
80
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

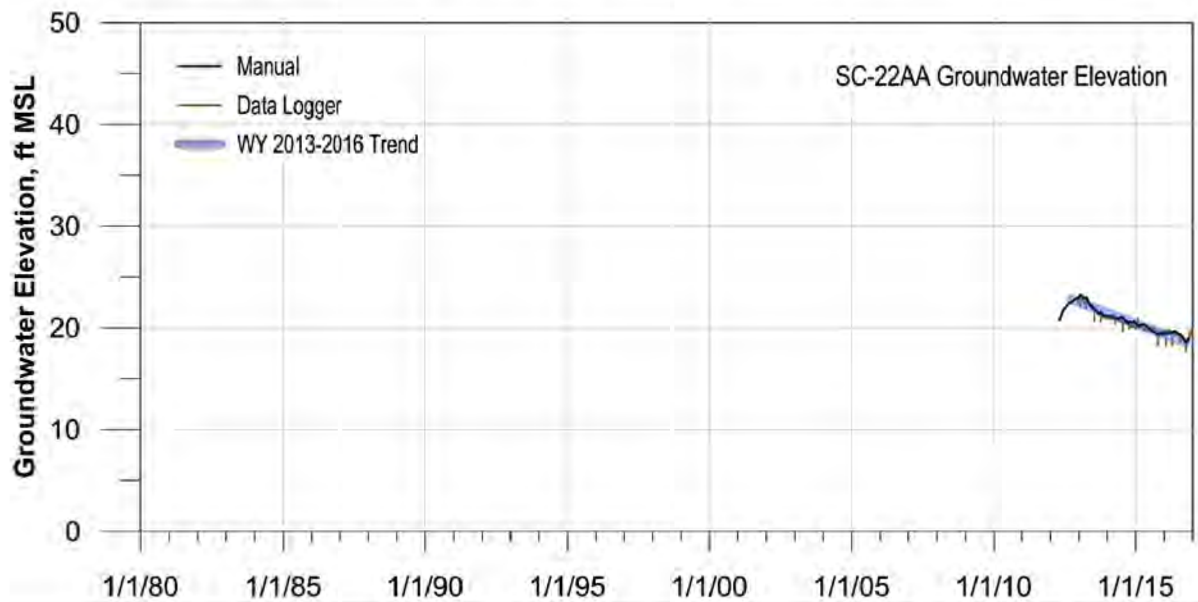

SC-22A Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-22A Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

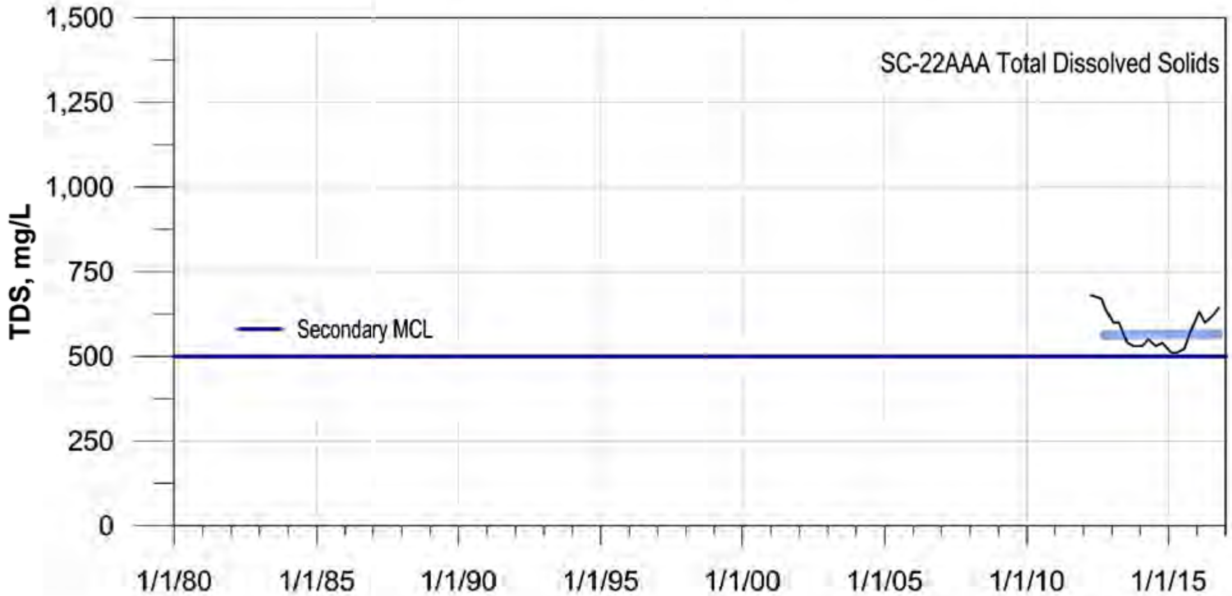

Manual
Data Logger
WY 2013-2016 Trend
SC-22A Groundwater Elevation
Groundwater Elevation, ft MSL
50
40
30
20
10
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

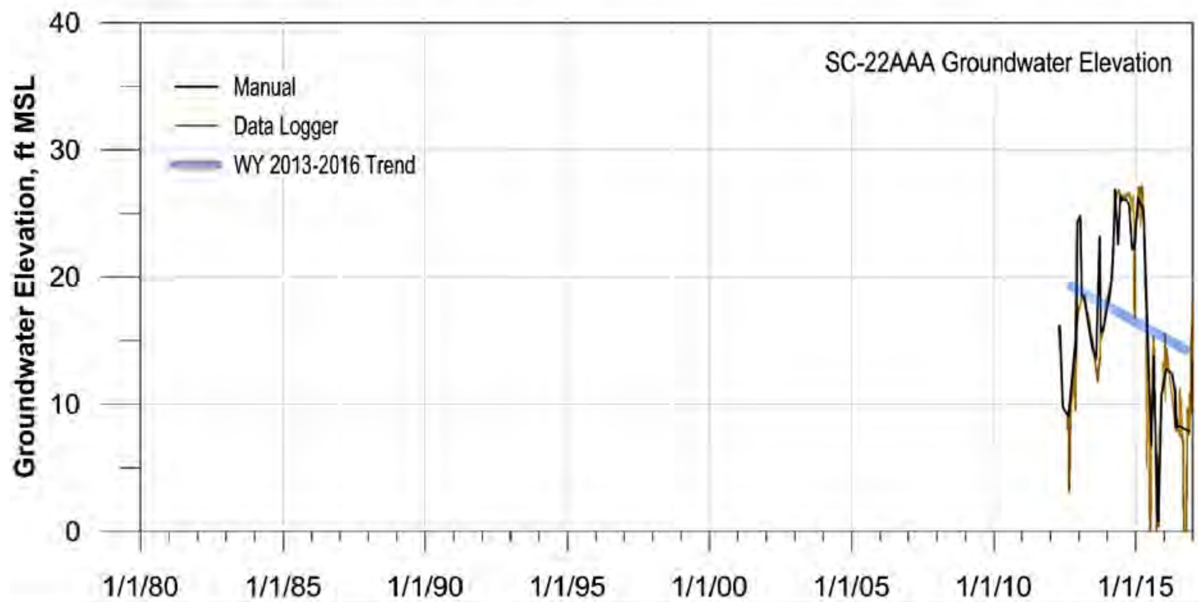

SC-22AA Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

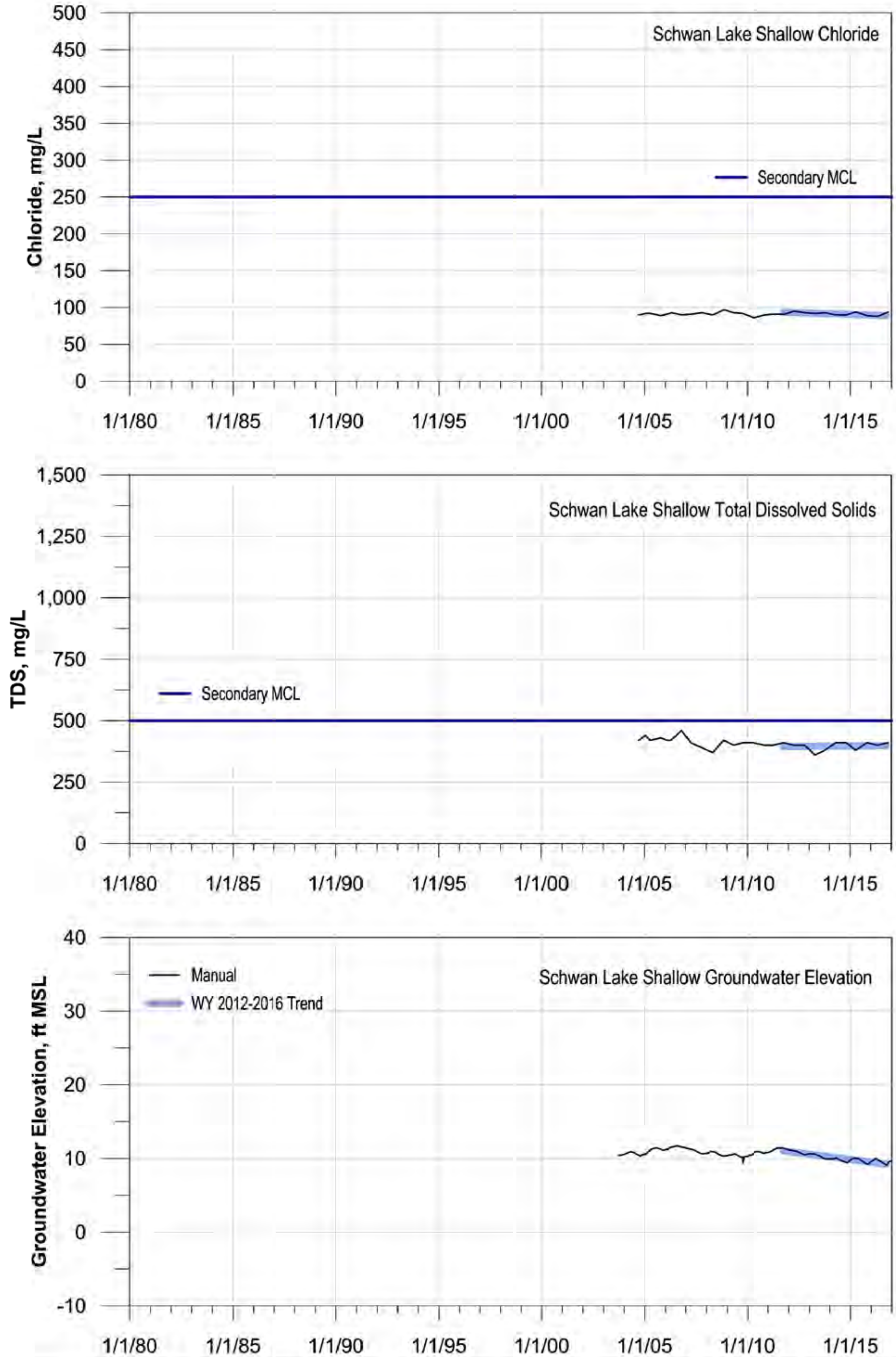

SC-22AA Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

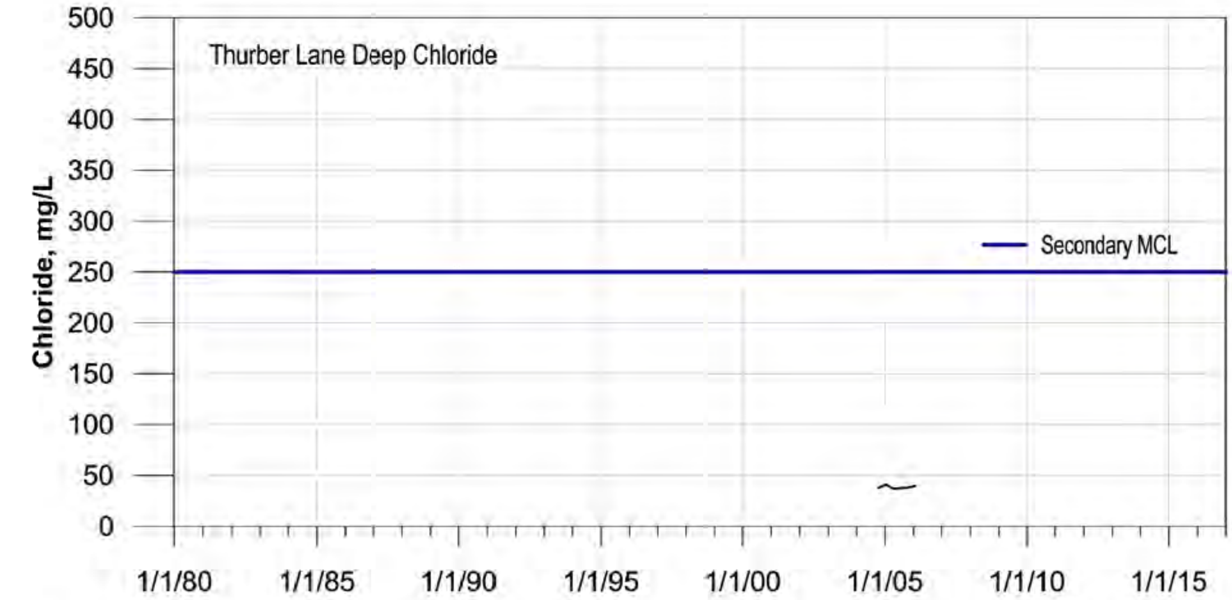

Manual
Data Logger
WY 2013-2016 Trend
SC-22AA Groundwater Elevation
Groundwater Elevation, ft MSL
50
40
30
20
10
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

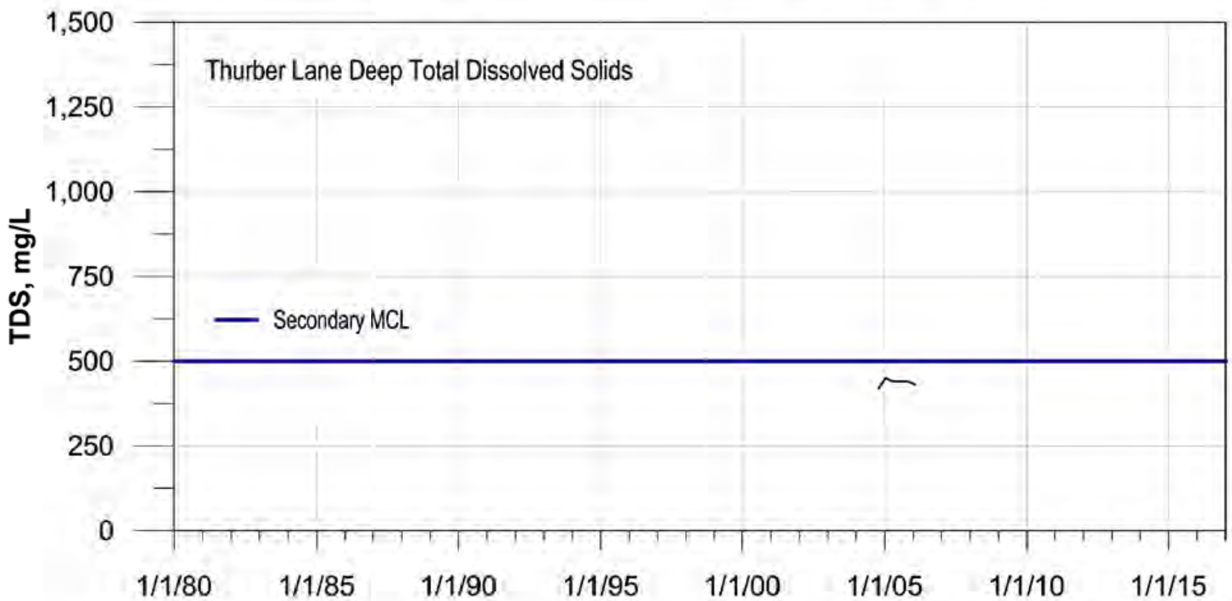

SC-22AAA Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

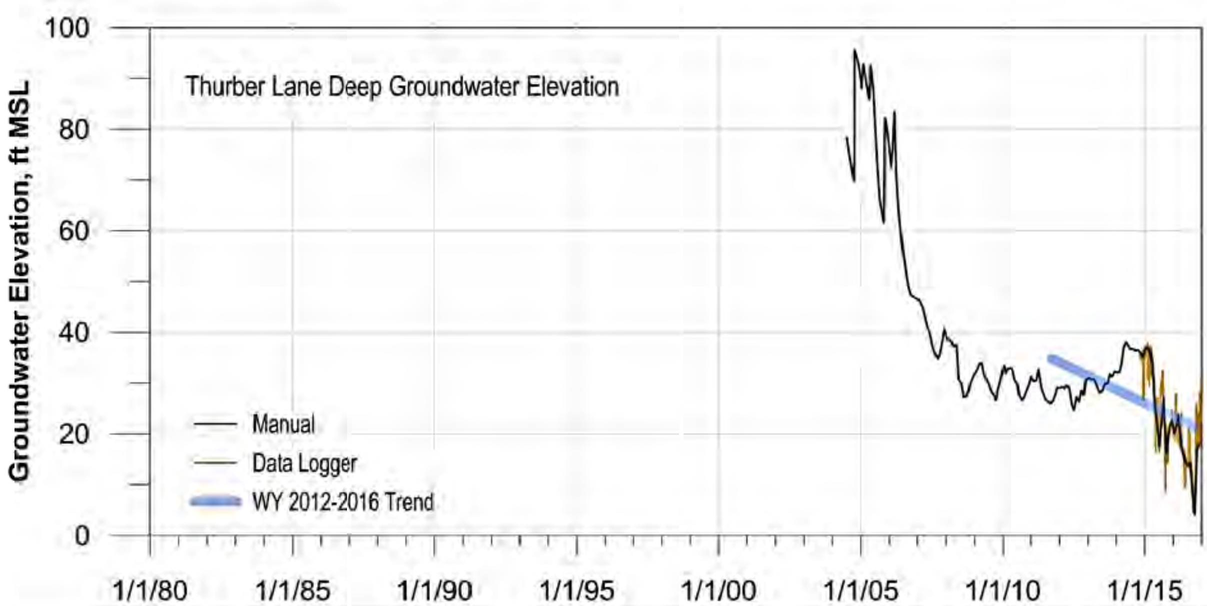

SC-22AAA Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-22AAA Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
Data Logger
WY 2013-2016 Trend
40
30
20
10
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Schwan Lake Shallow Chloride
Chloride, mg/L
Secondary MCL
Schwan Lake Shallow Total Dissolved Solids
TDS, mg/L
Secondary MCL
Schwan Lake Shallow Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
WY 2012-2016 Trend
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

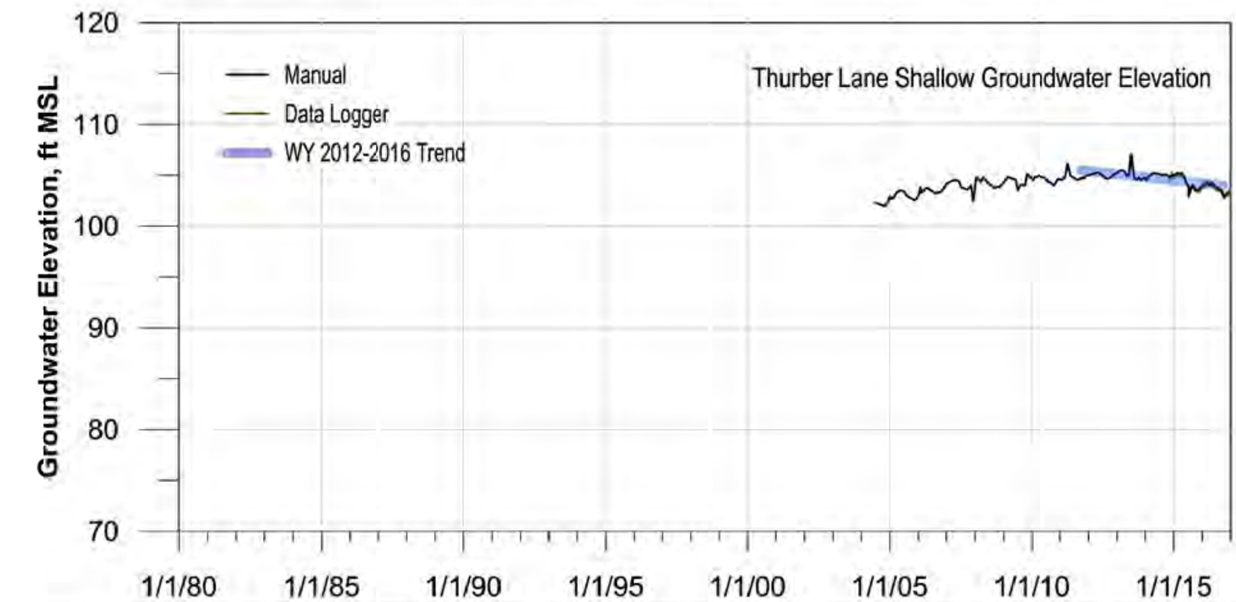

Thurber Lane Deep Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Thurber Lane Deep Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

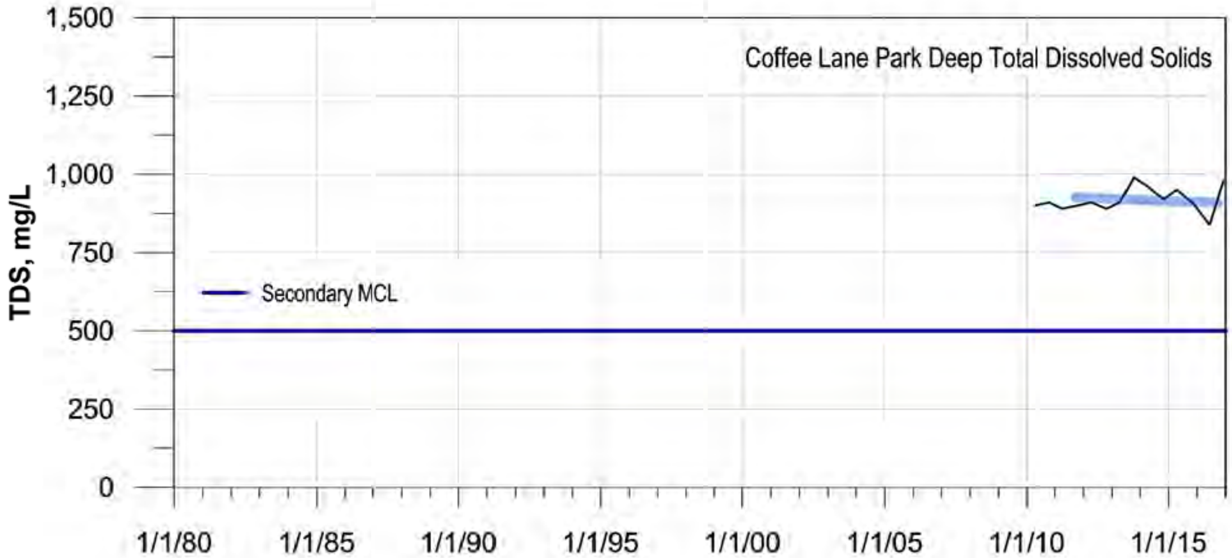

Thurber Lane Deep Groundwater Elevation
Manual
Data Logger
WY 2012-2016 Trend
Groundwater Elevation, ft MSL
100
80
60
40
20
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

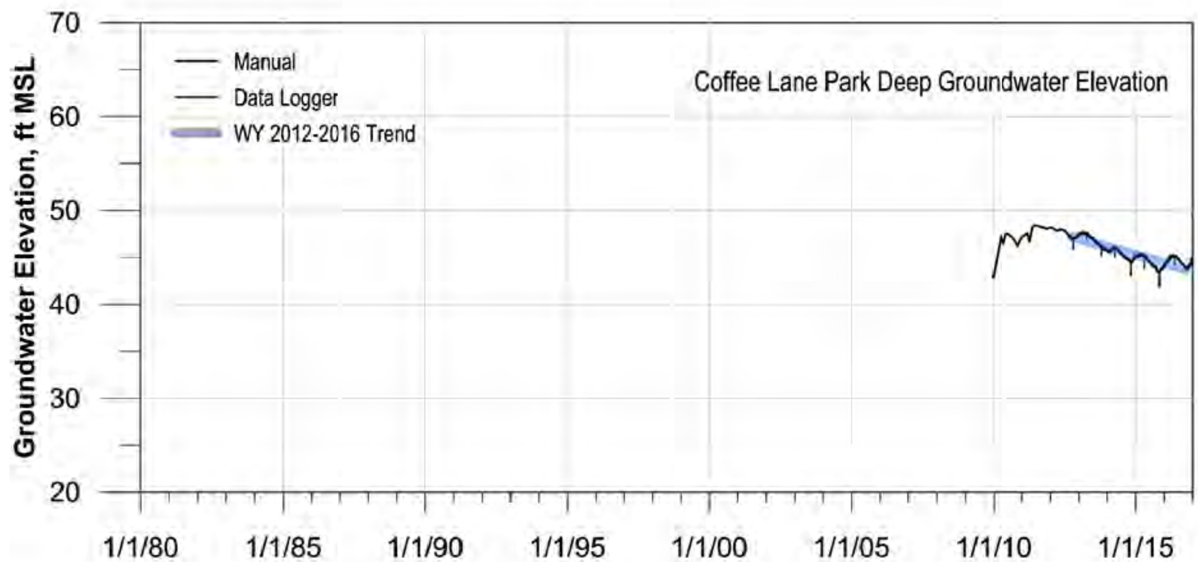

Thurber Lane Shallow Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

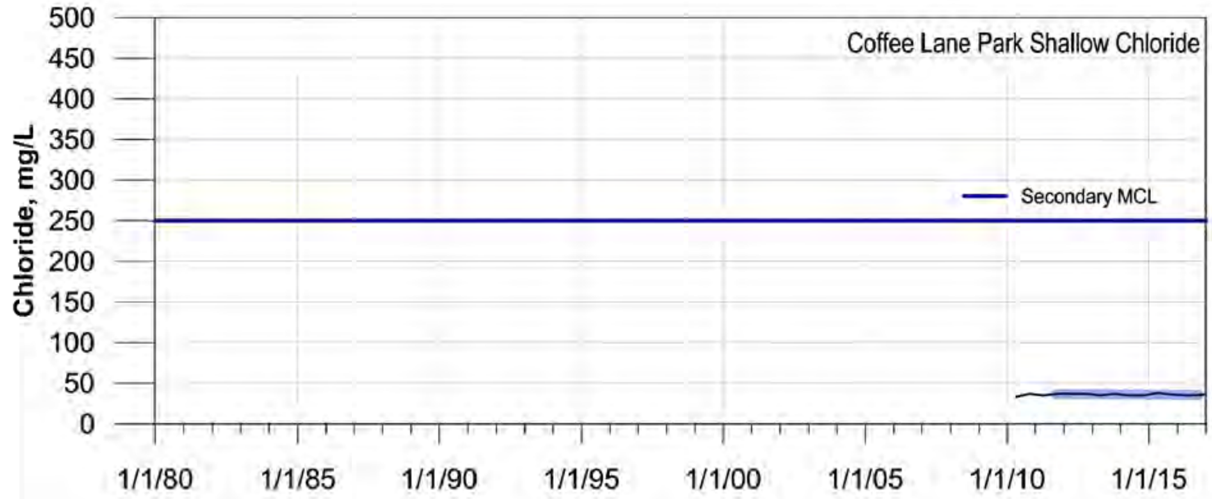

Thurber Lane Shallow Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

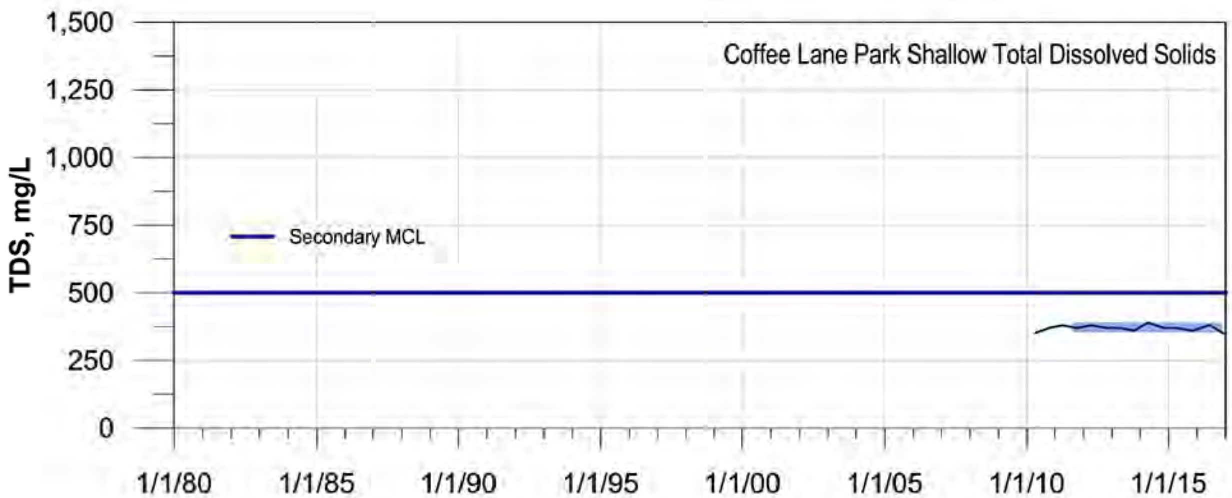

Thurber Lane Shallow Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
Data Logger
WY 2012-2016 Trend
120
110
100
90
80
70
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

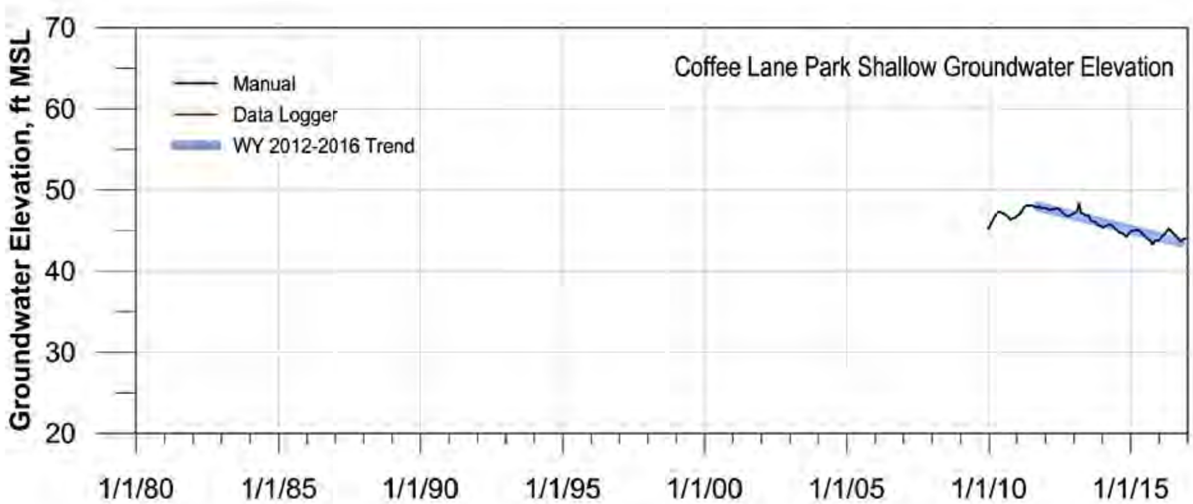

Coffee Lane Park Deep Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Coffee Lane Park Deep Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

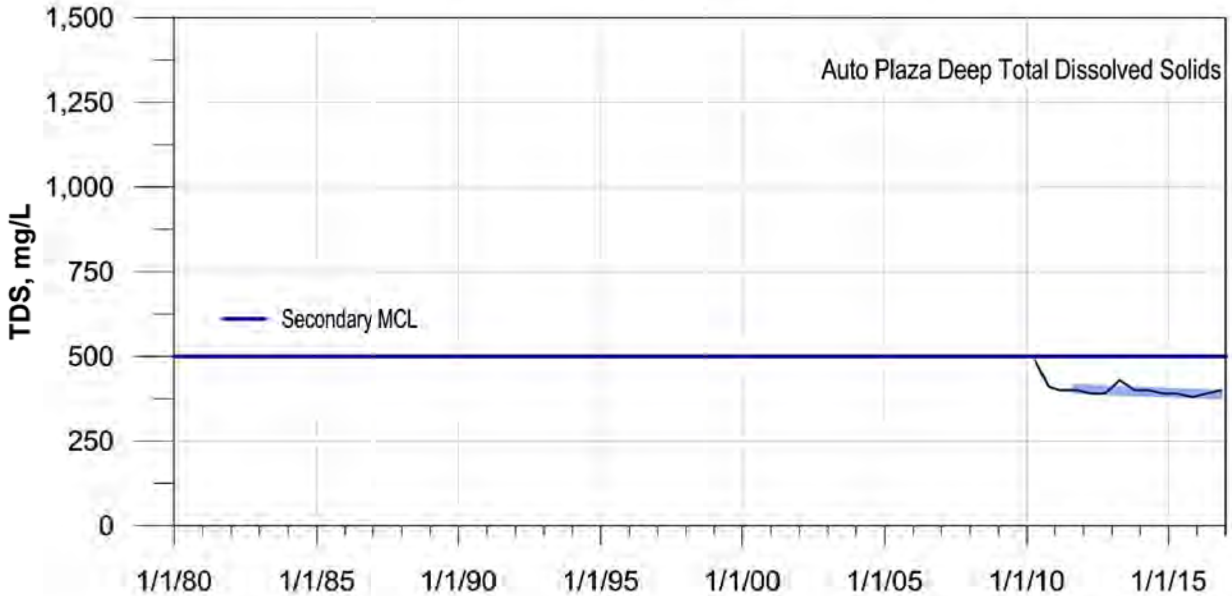

Manual
Data Logger
WY 2012-2016 Trend
Coffee Lane Park Deep Groundwater Elevation
Groundwater Elevation, ft MSL
70
60
50
40
30
20
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Coffee Lane Park Shallow Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

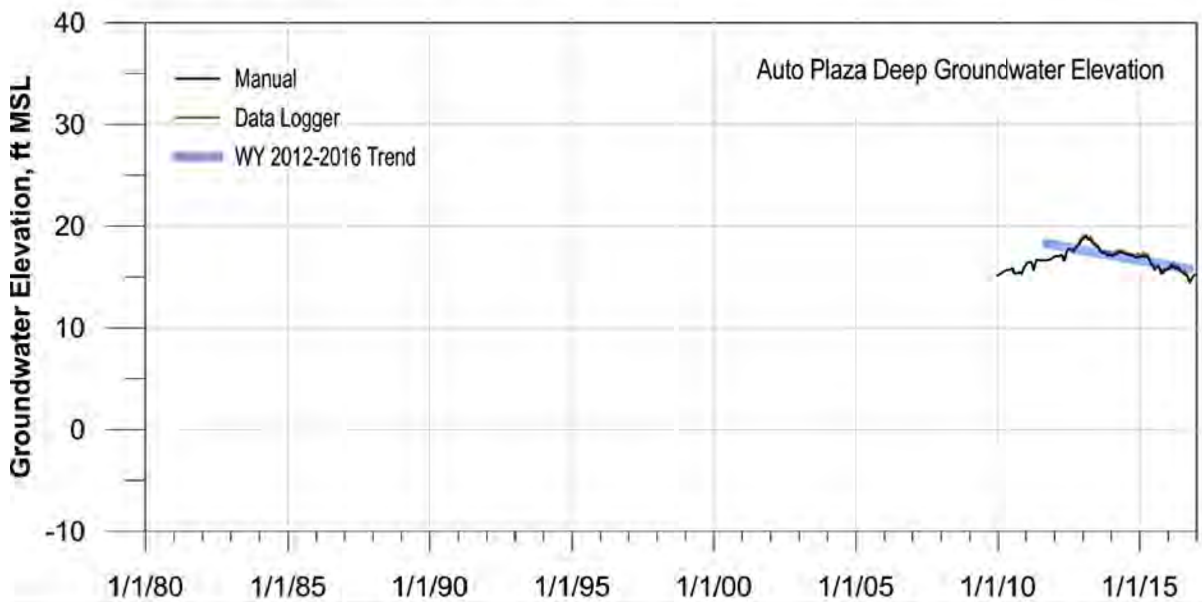

Coffee Lane Park Shallow Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Coffee Lane Park Shallow Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
Data Logger
WY 2012-2016 Trend
70
60
50
40
30
20
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

Auto Plaza Deep Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15



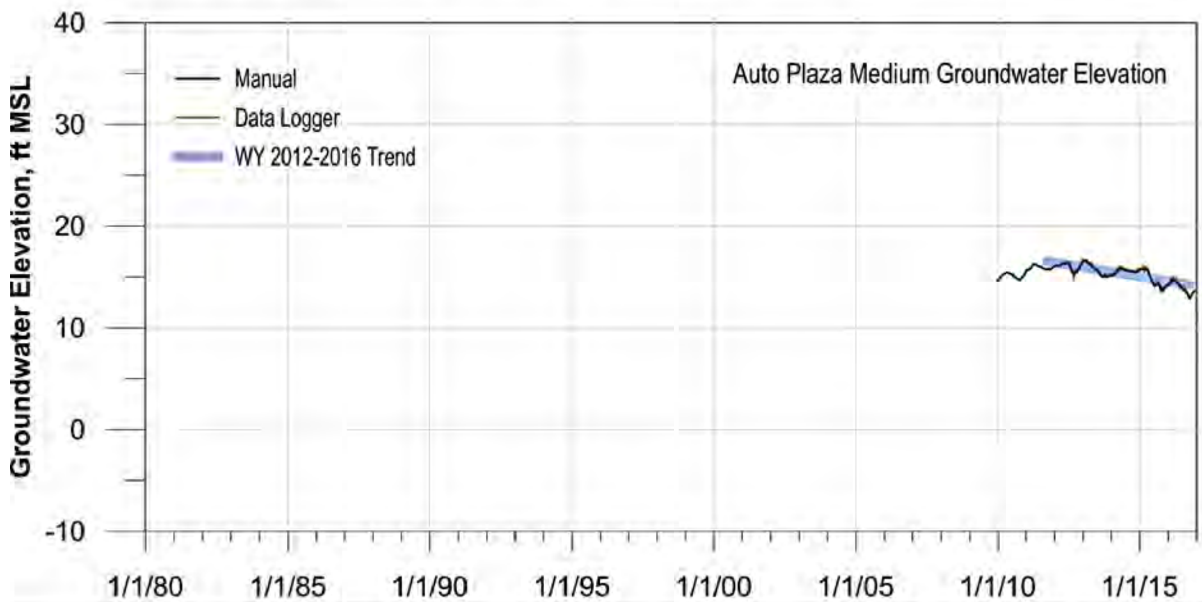
Auto Plaza Deep Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15



Manual
Data Logger
WY 2012-2016 Trend
Auto Plaza Deep Groundwater Elevation
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

Auto Plaza Medium Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

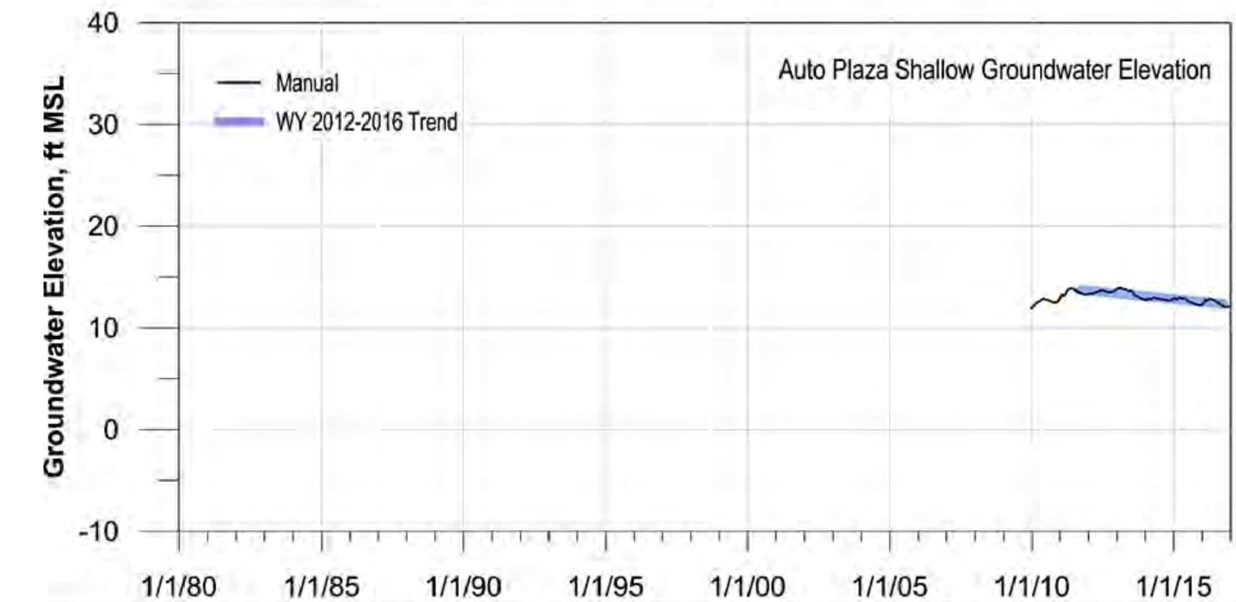
Auto Plaza Medium Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15



Auto Plaza Medium Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
Data Logger
WY 2012-2016 Trend
40
30
20
10
0
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

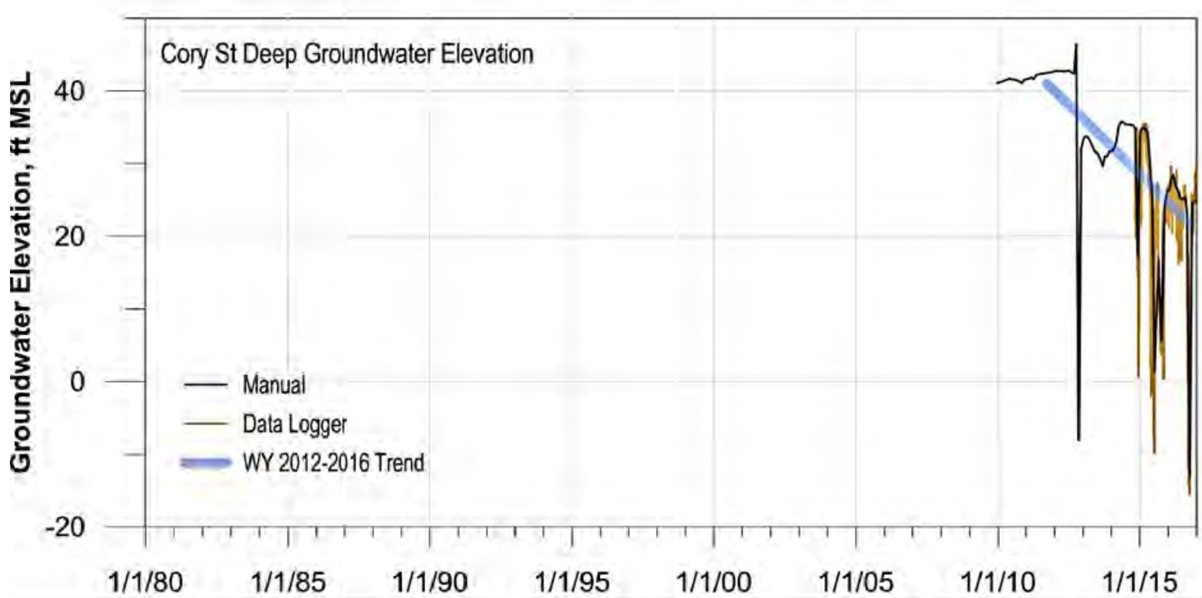

Auto Plaza Shallow Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

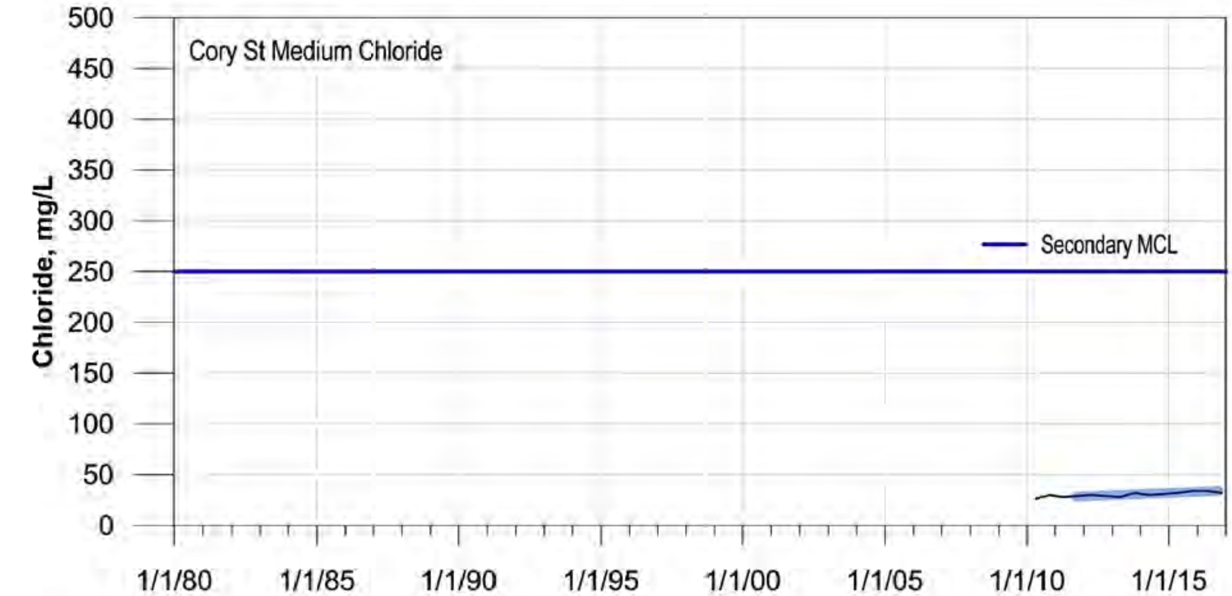

Auto Plaza Shallow Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Auto Plaza Shallow Groundwater Elevation
Manual
WY 2012-2016 Trend
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

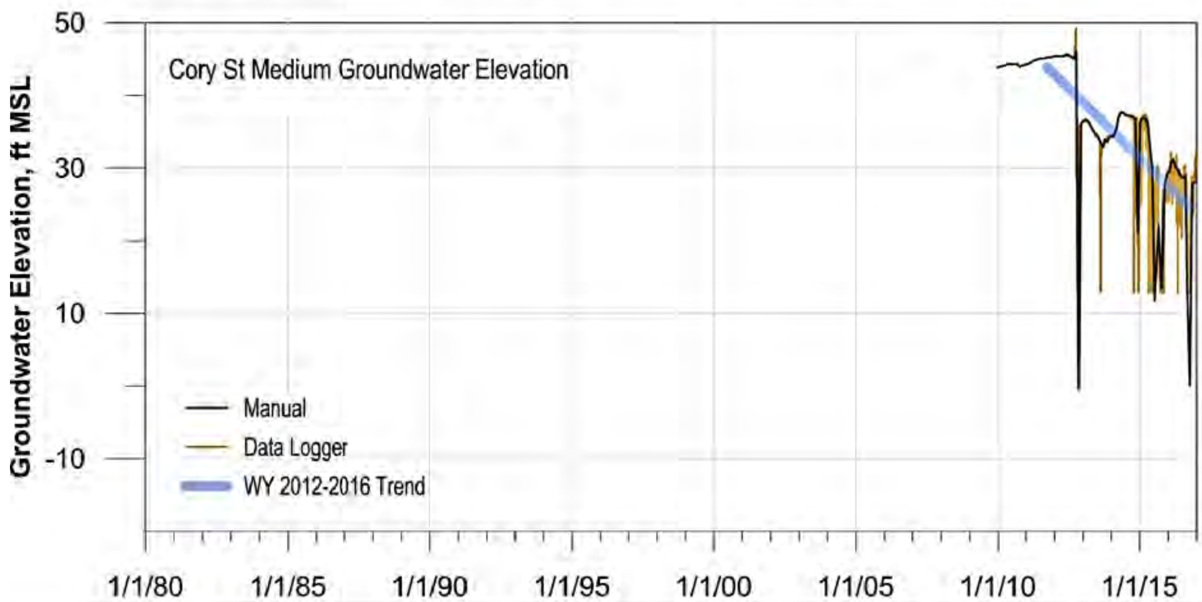

Cory St Deep Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Cory St Deep Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Cory St Deep Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
Data Logger
WY 2012-2016 Trend
40
20
0
-20
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

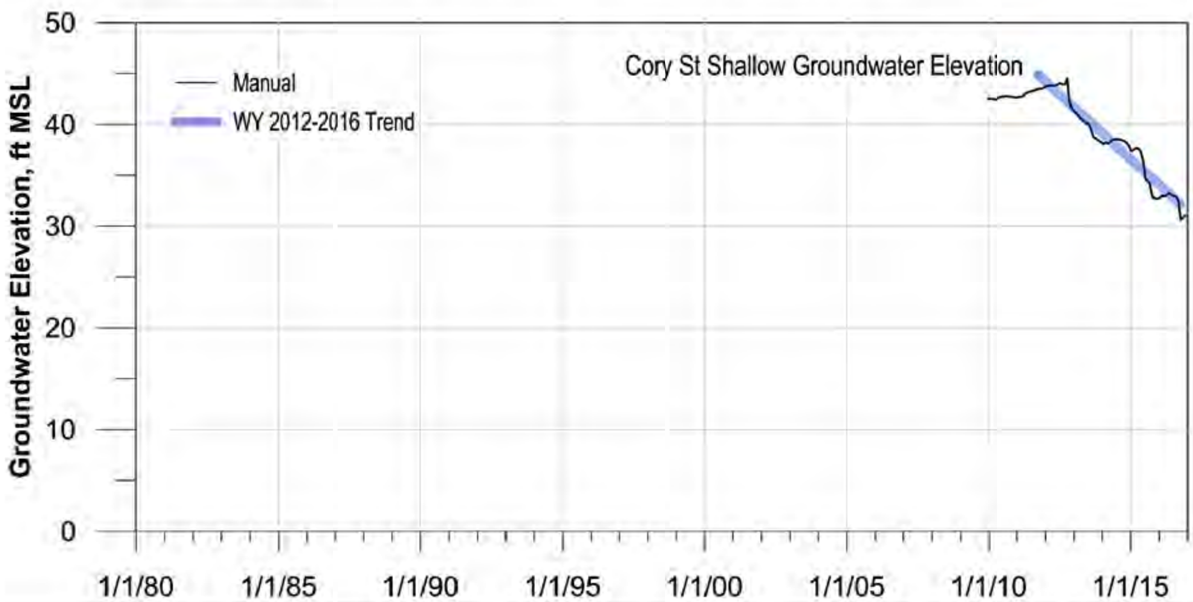

Cory St Medium Chloride
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
Secondary MCL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Cory St Medium Total Dissolved Solids
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
Secondary MCL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Cory St Medium Groundwater Elevation
Groundwater Elevation, ft MSL
50
30
10
-10
Manual
Data Logger
WY 2012-2016 Trend
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

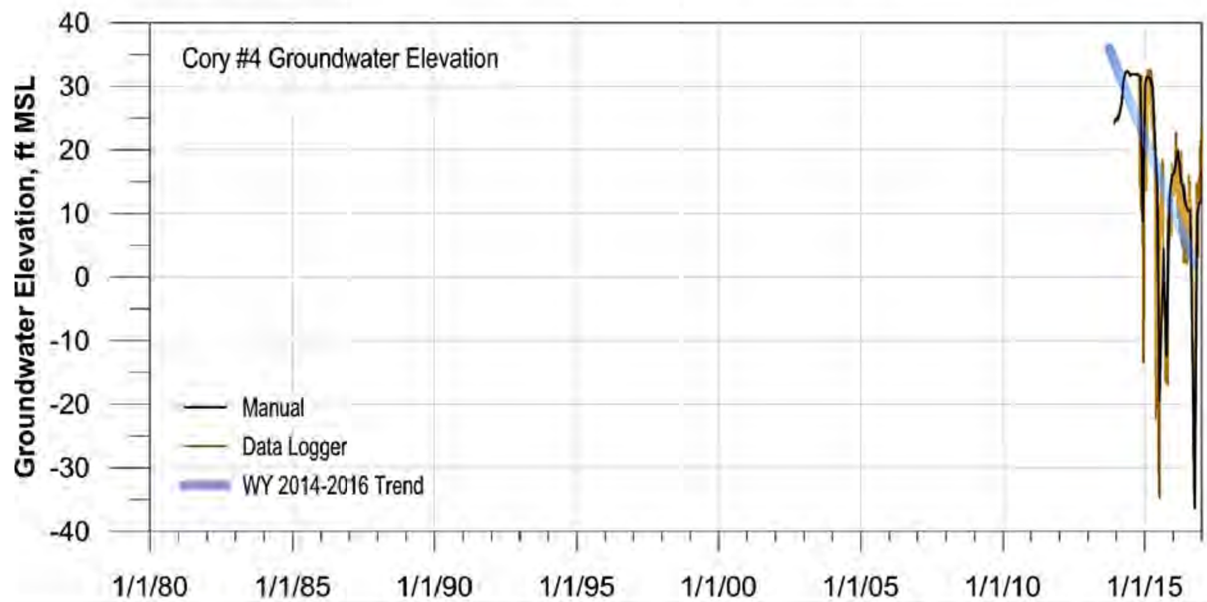

Cory St Shallow Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Cory St Shallow Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

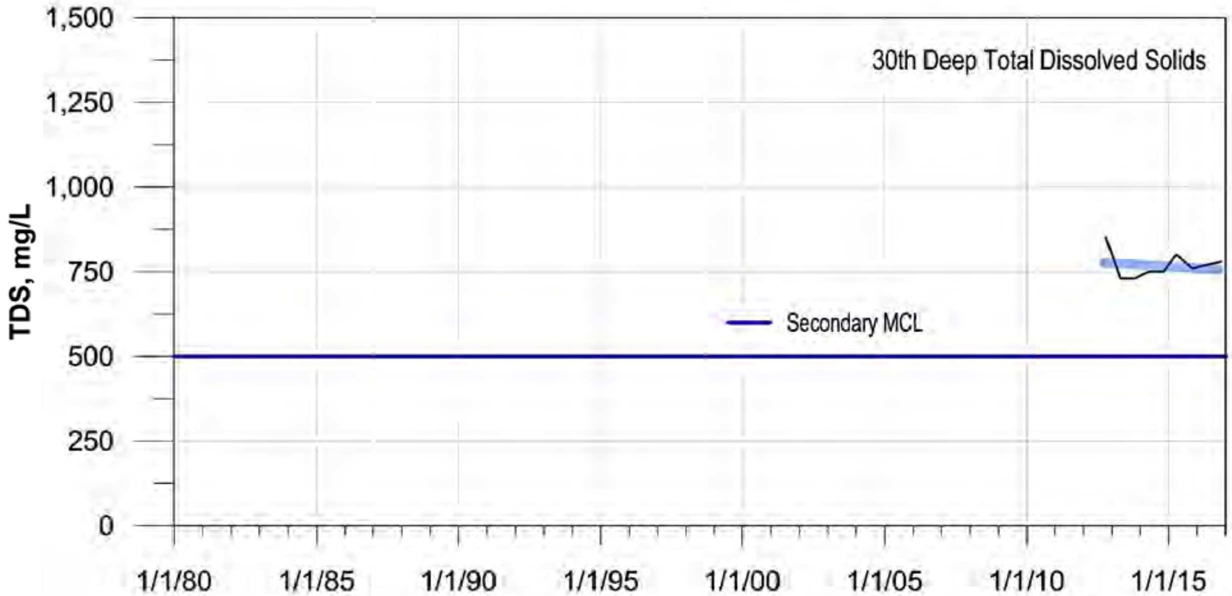

Manual
WY 2012-2016 Trend
Cory St Shallow Groundwater Elevation
Groundwater Elevation, ft MSL
50
40
30
20
10
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

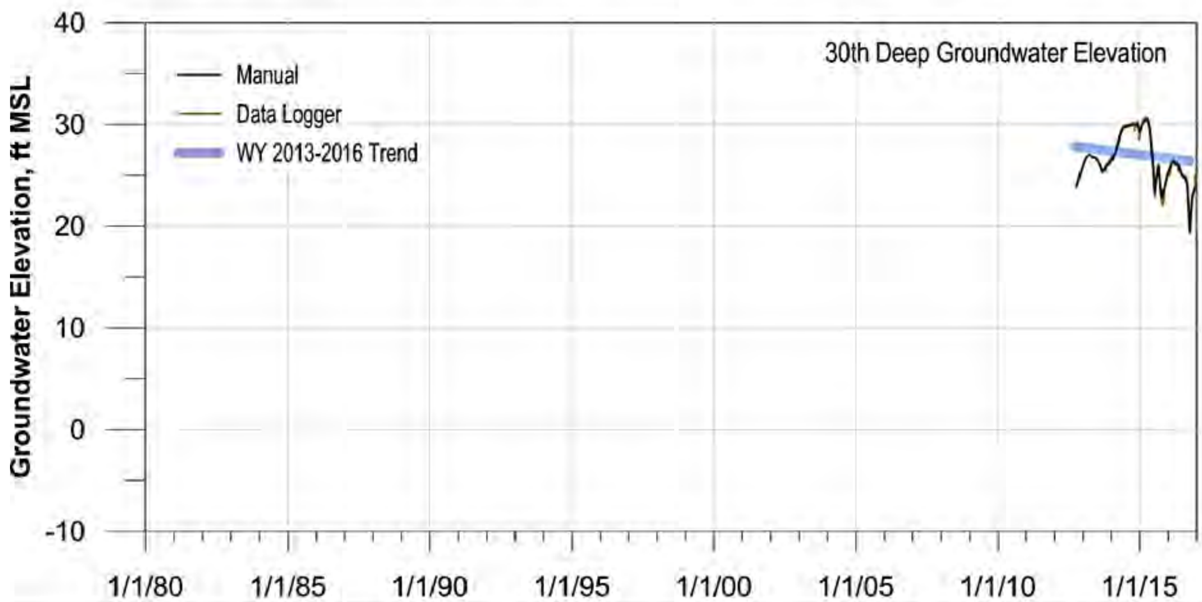

Cory #4 Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Cory #4 Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

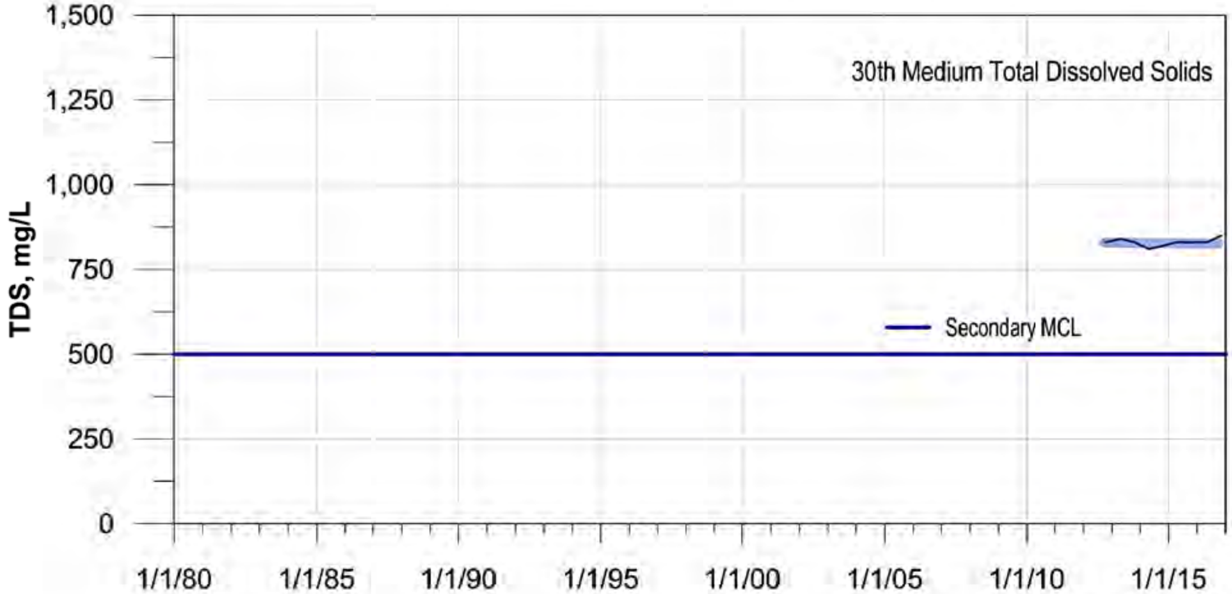

Cory #4 Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
Data Logger
WY 2014-2016 Trend
40
30
20
10
0
-10
-20
-30
-40
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

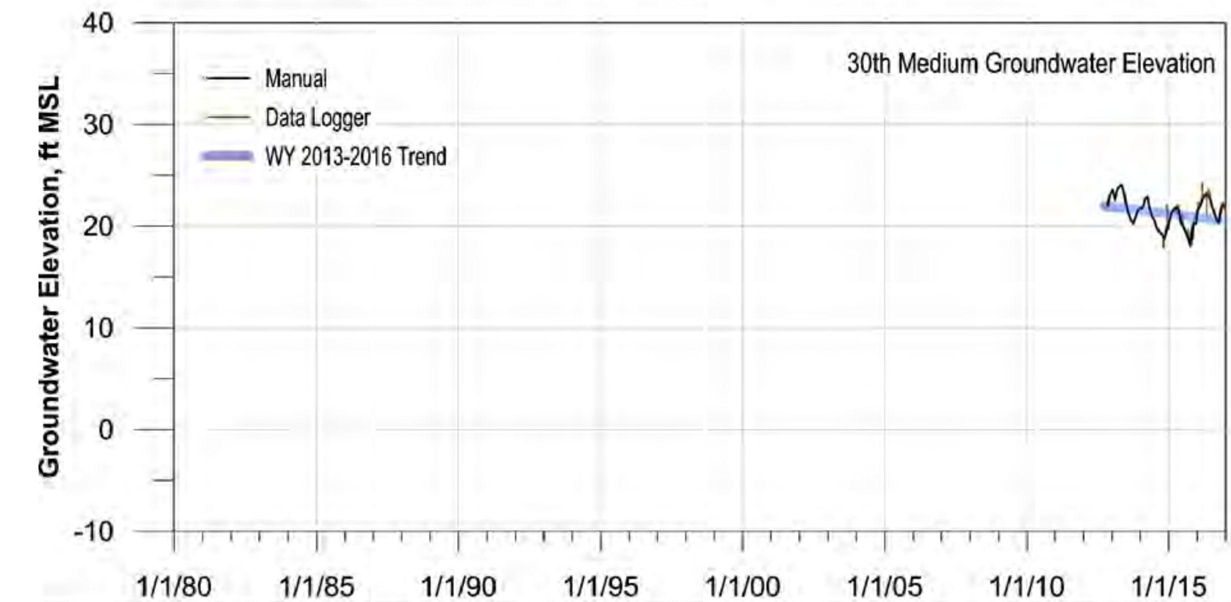

30th Deep Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


30th Deep Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

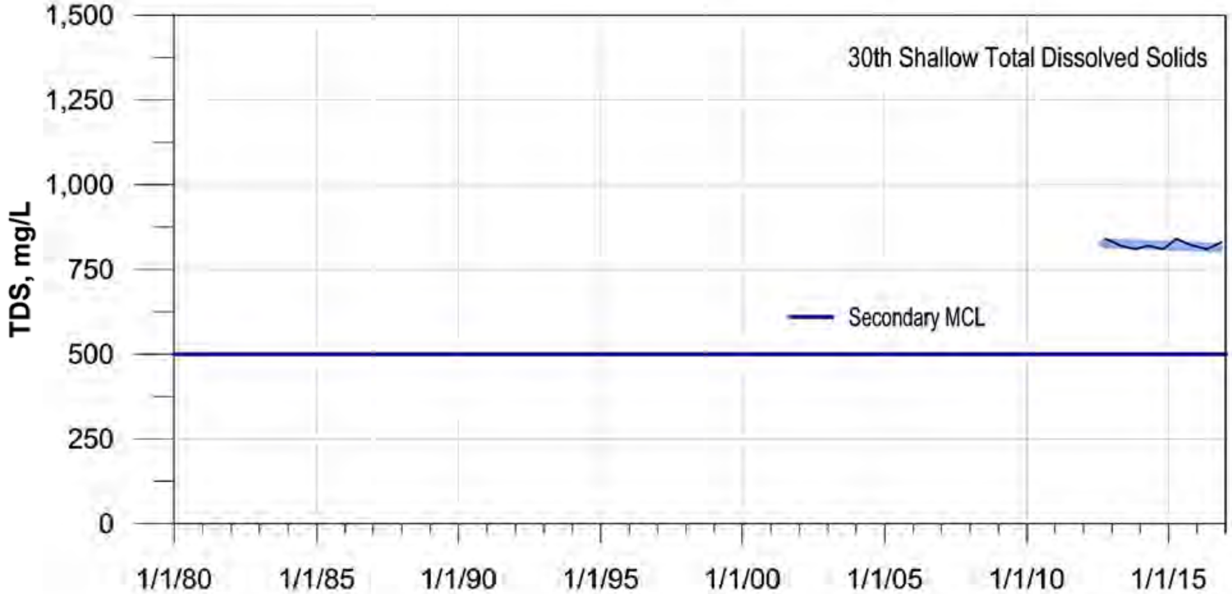

30th Deep Groundwater Elevation
Manual
Data Logger
WY 2013-2016 Trend
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

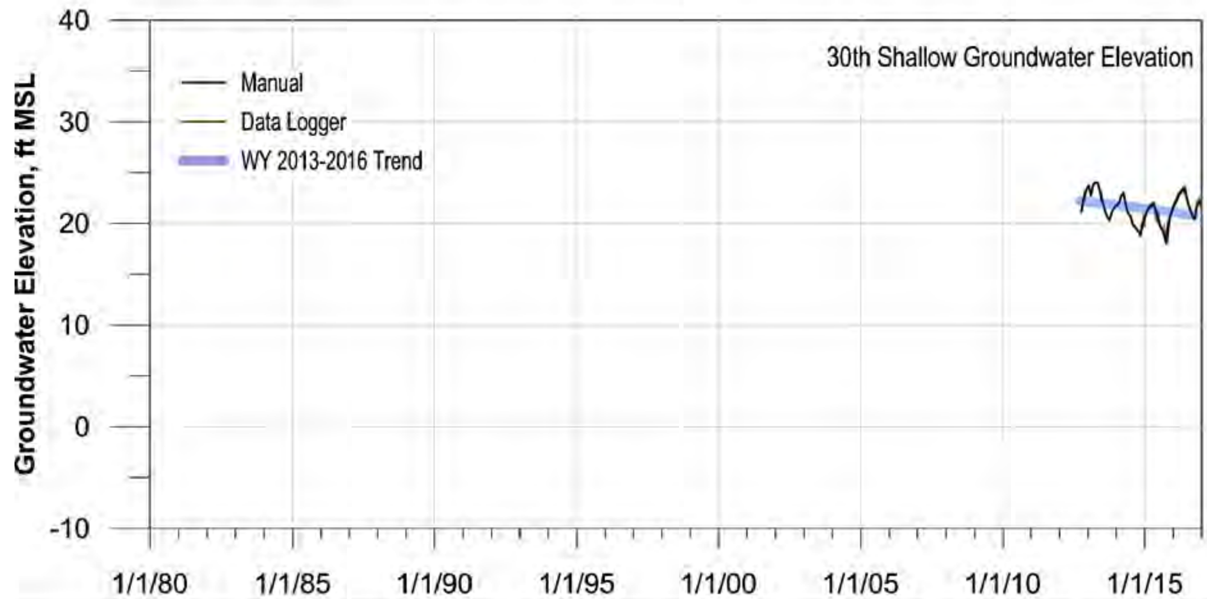

30th Medium Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


30th Medium Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


30th Medium Groundwater Elevation
Manual
Data Logger
WY 2013-2016 Trend
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

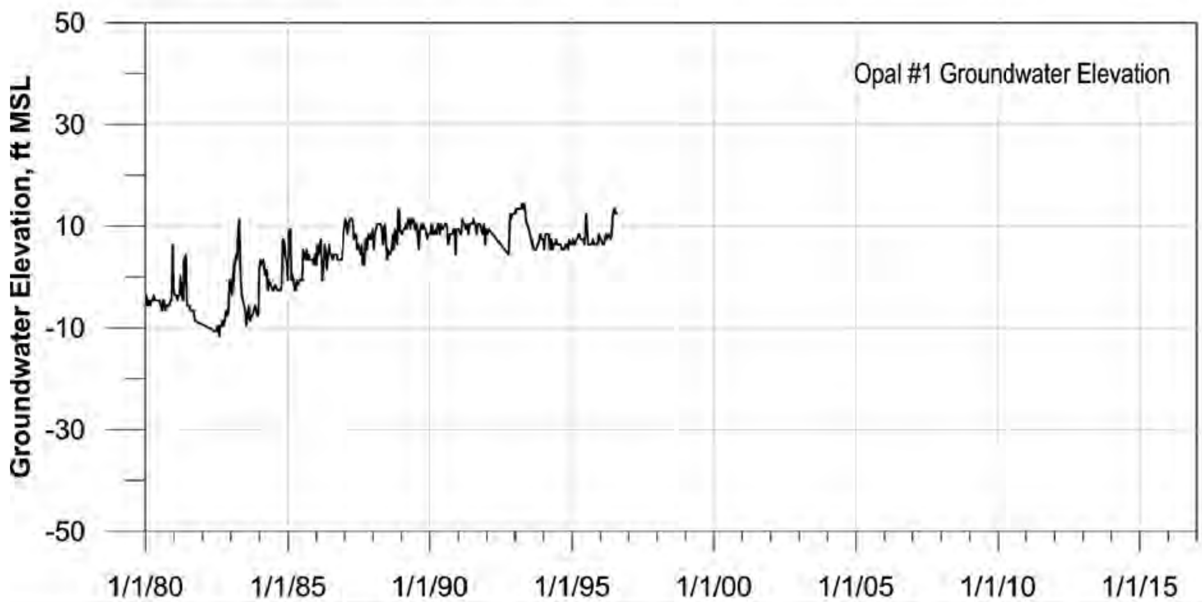

30th Shallow Chloride
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
Secondary MCL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


30th Shallow Total Dissolved Solids
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
Secondary MCL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


30th Shallow Groundwater Elevation
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
Manual
Data Logger
WY 2013-2016 Trend
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

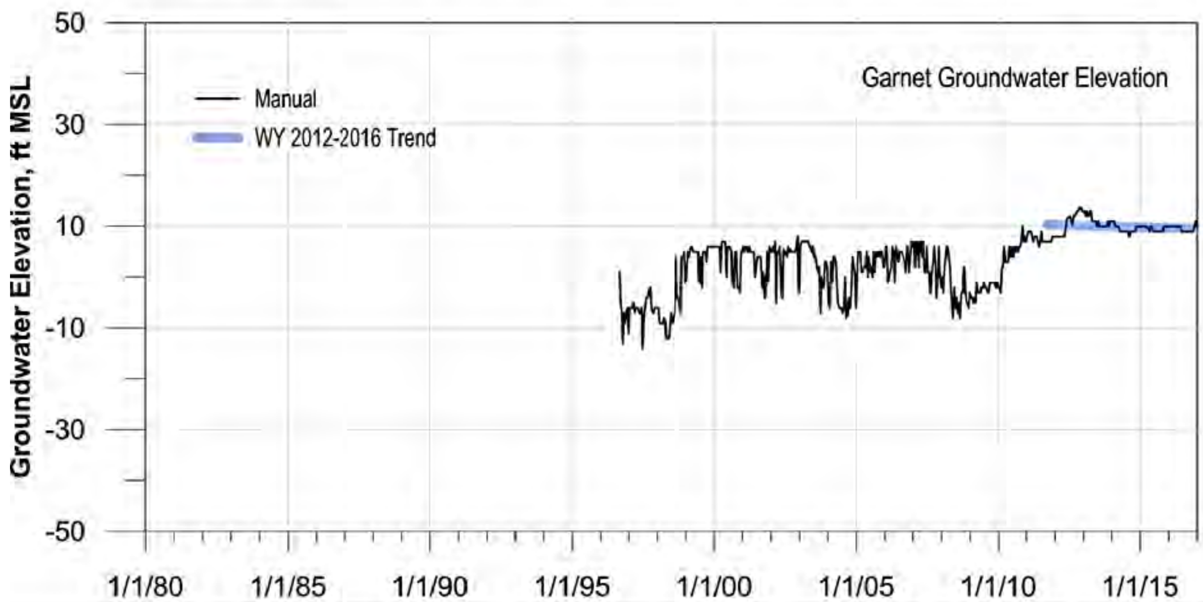

Opal #1 Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Opal #1 Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

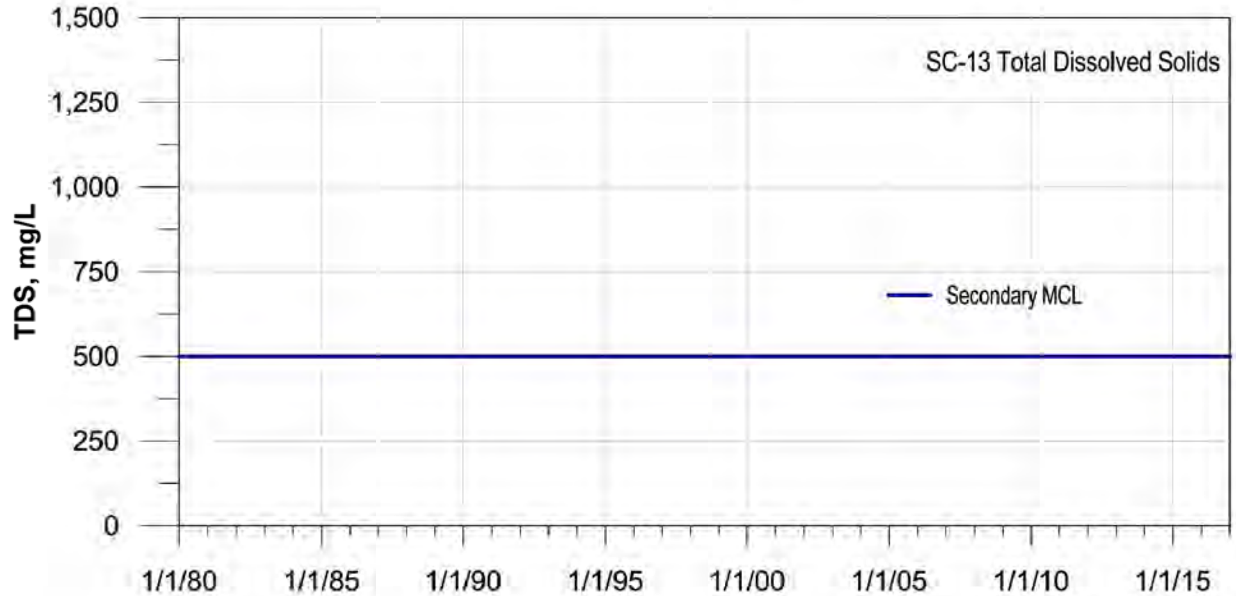

Opal #1 Groundwater Elevation
Groundwater Elevation, ft MSL
50
30
10
-10
-30
-50
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

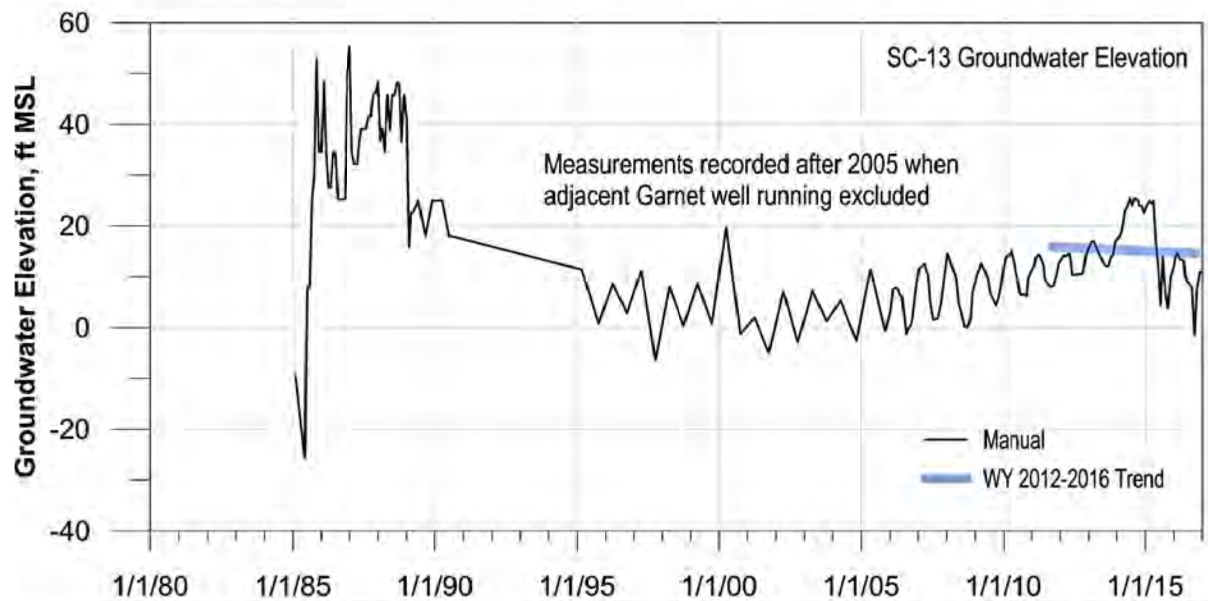

Garnet Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Garnet Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

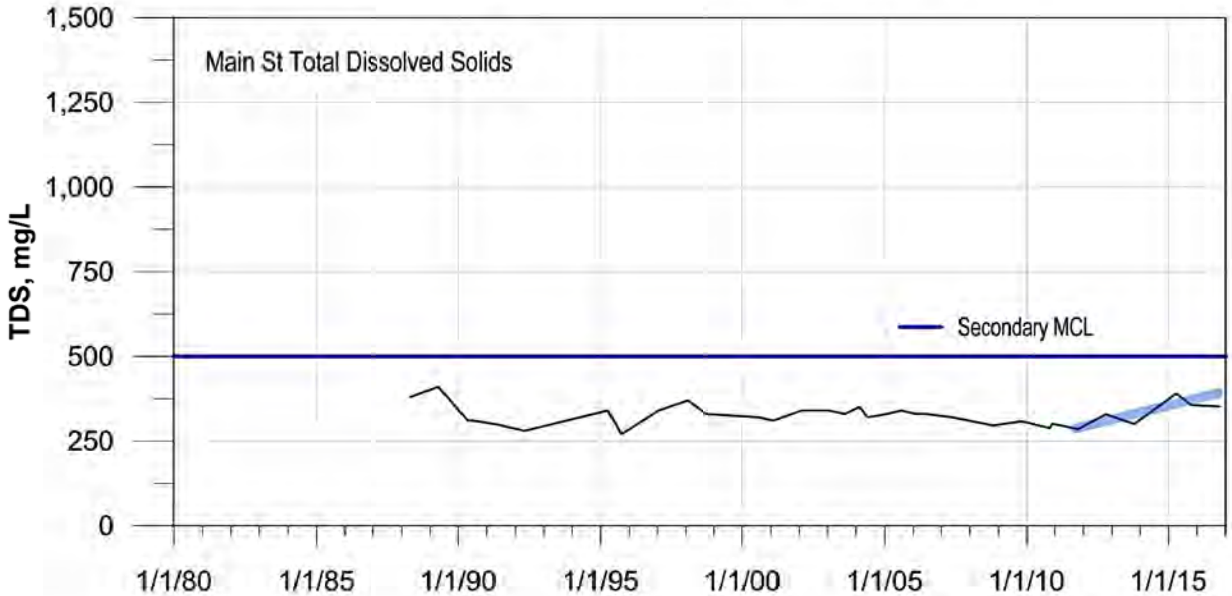

Garnet Groundwater Elevation
Manual
WY 2012-2016 Trend
Groundwater Elevation, ft MSL
50
30
10
-10
-30
-50
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

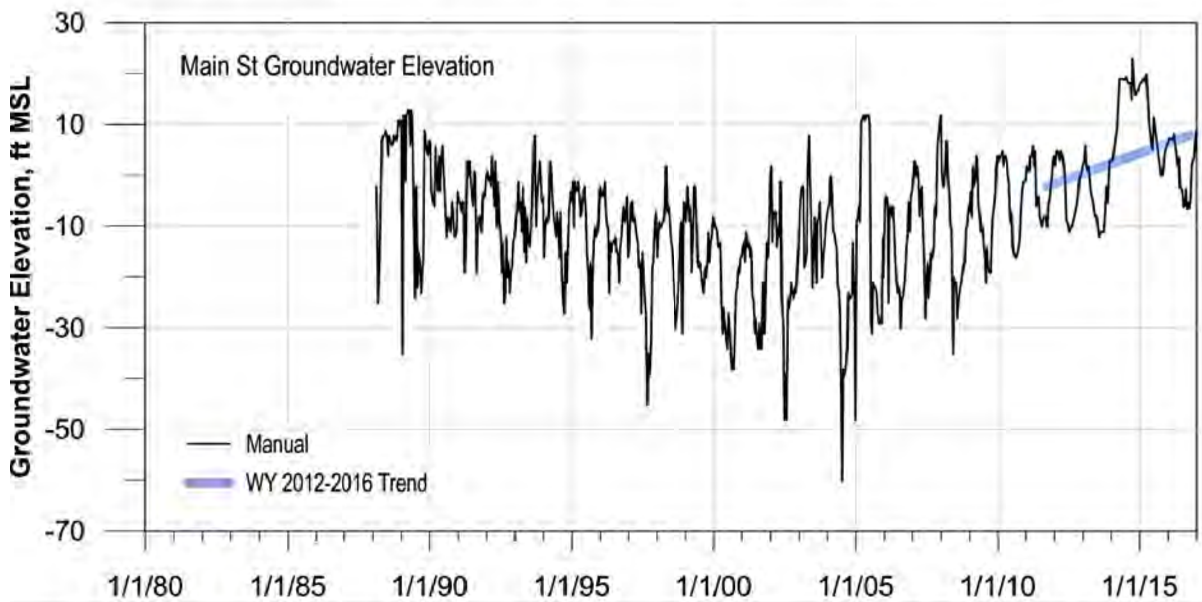

SC-13 Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

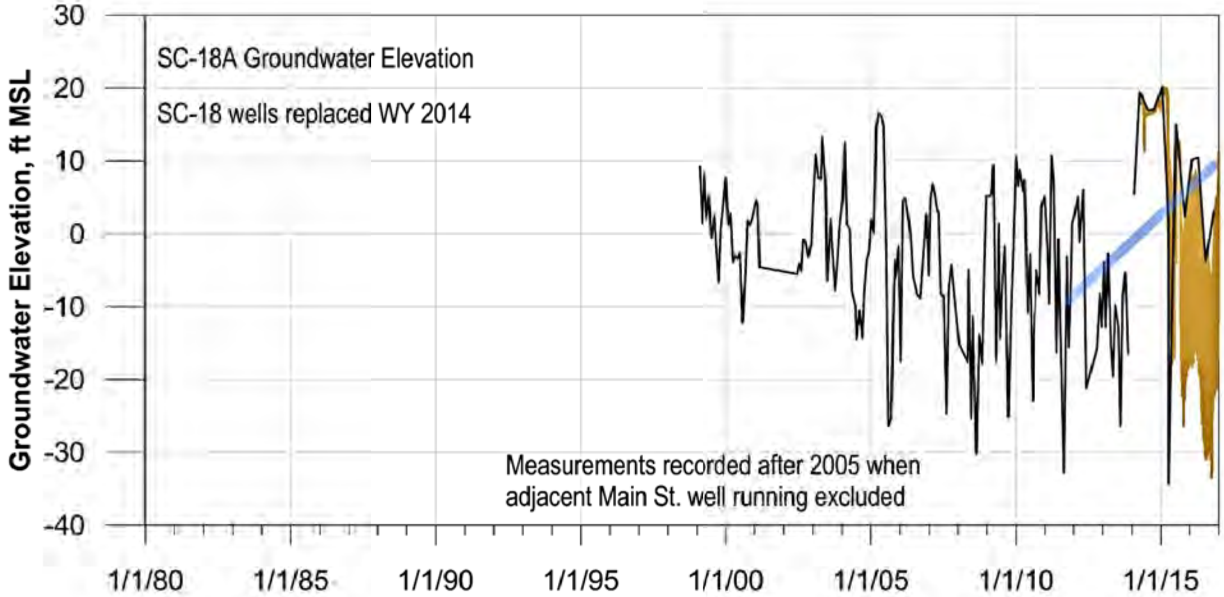

SC-13 Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

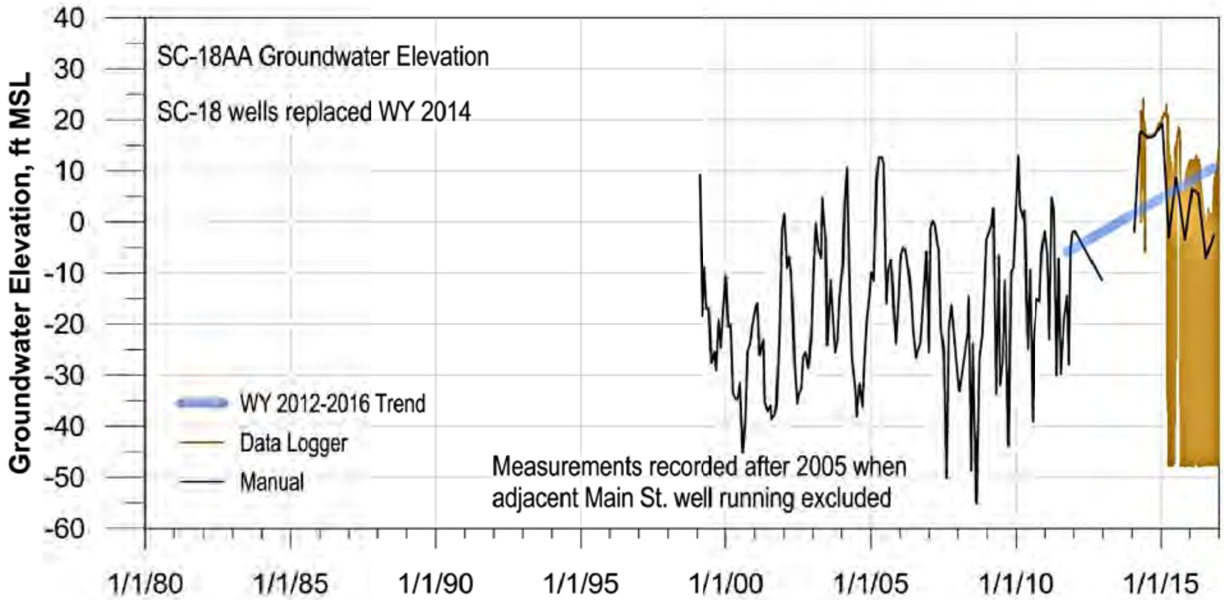

SC-13 Groundwater Elevation
Groundwater Elevation, ft MSL
Measurements recorded after 2005 when
adjacent Garnet well running excluded
Manual
WY 2012-2016 Trend
60
40
20
0
-20
-40
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

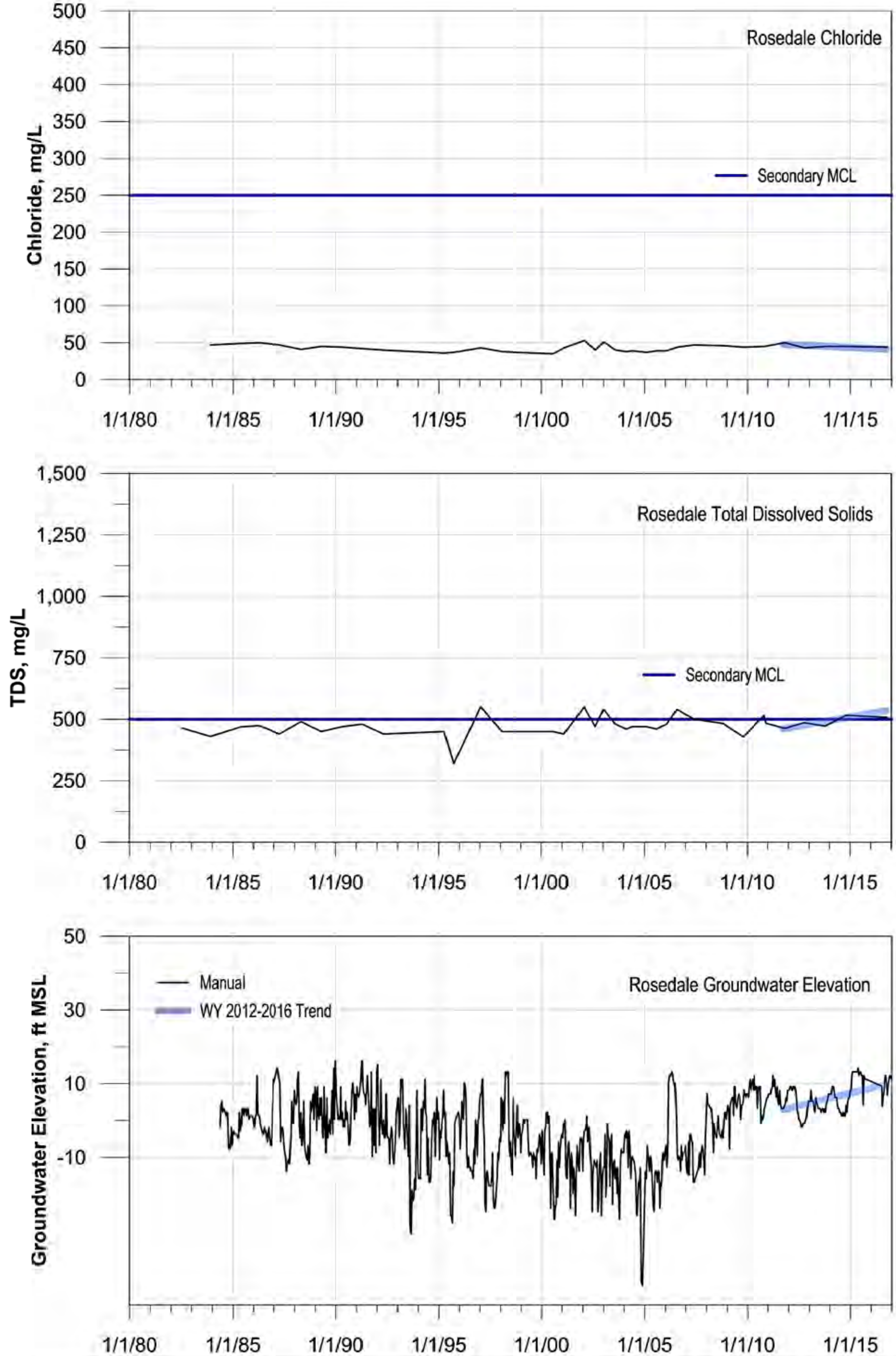

Main St Shallow Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Main St Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Main St Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
WY 2012-2016 Trend
30
10
-10
-30
-50
-70
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

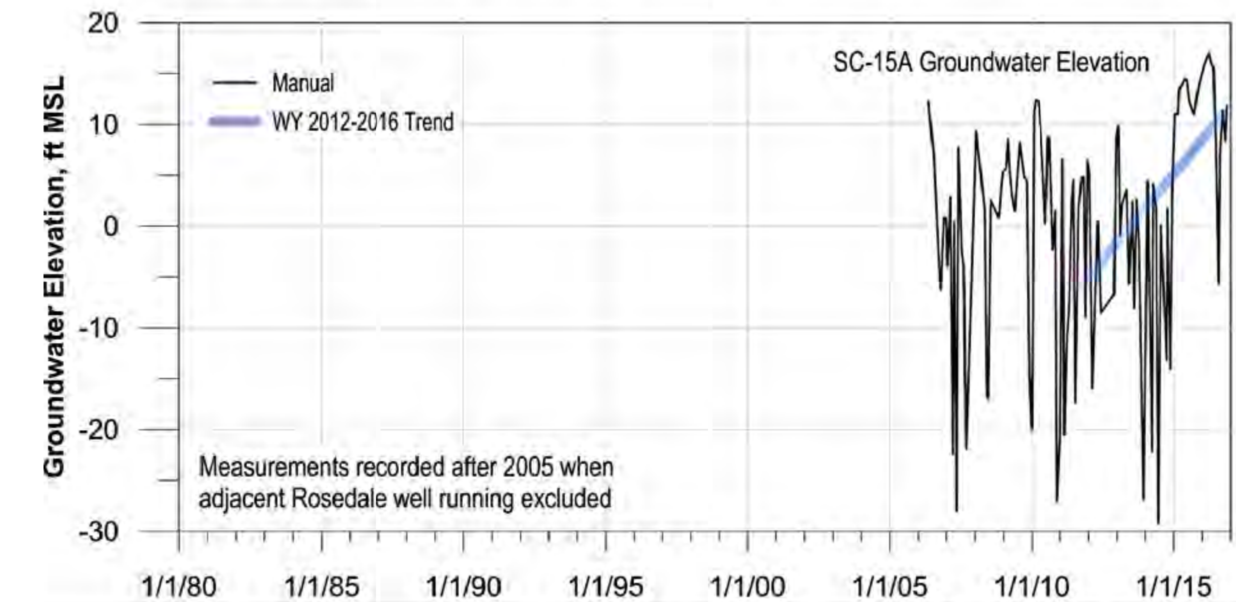

SC-18A Groundwater Elevation
SC-18 wells replaced WY 2014
Groundwater Elevation, ft MSL
30
20
10
0
-10
-20
-30
-40
Measurements recorded after 2005 when
adjacent Main St. well running excluded
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-18AA Groundwater Elevation
SC-18 wells replaced WY 2014
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
-20
-30
-40
-50
-60
WY 2012-2016 Trend
Data Logger
Manual
Measurements recorded after 2005 when
adjacent Main St. well running excluded
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Rosedale Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
Rosedale Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
Rosedale Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
WY 2012-2016 Trend
50
30
10
-10

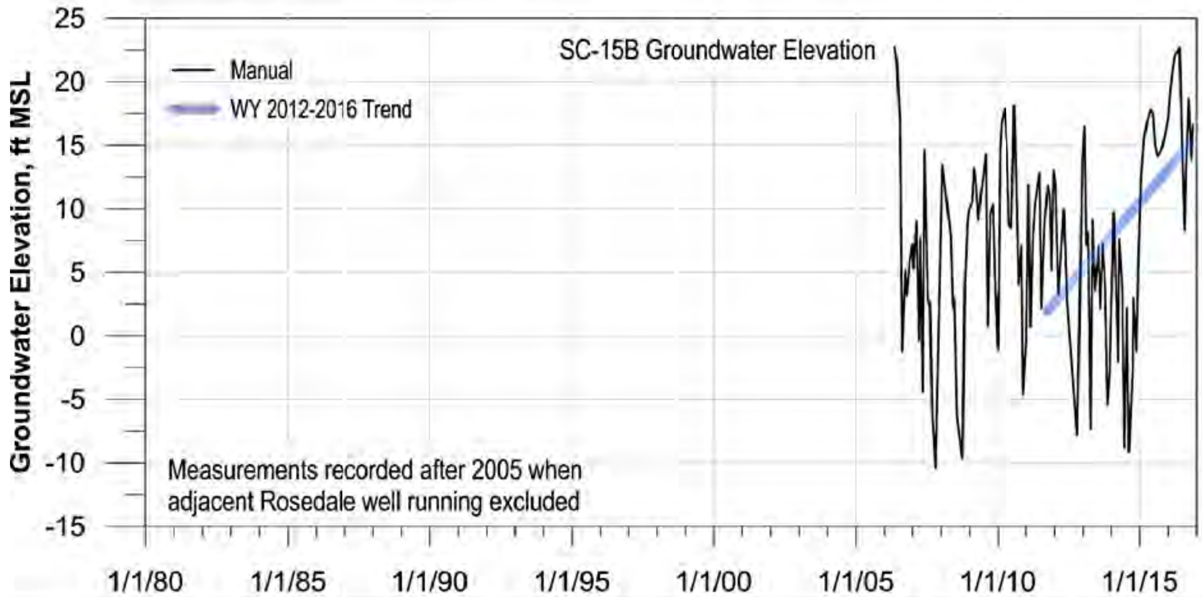

SC-15A Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-15A Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

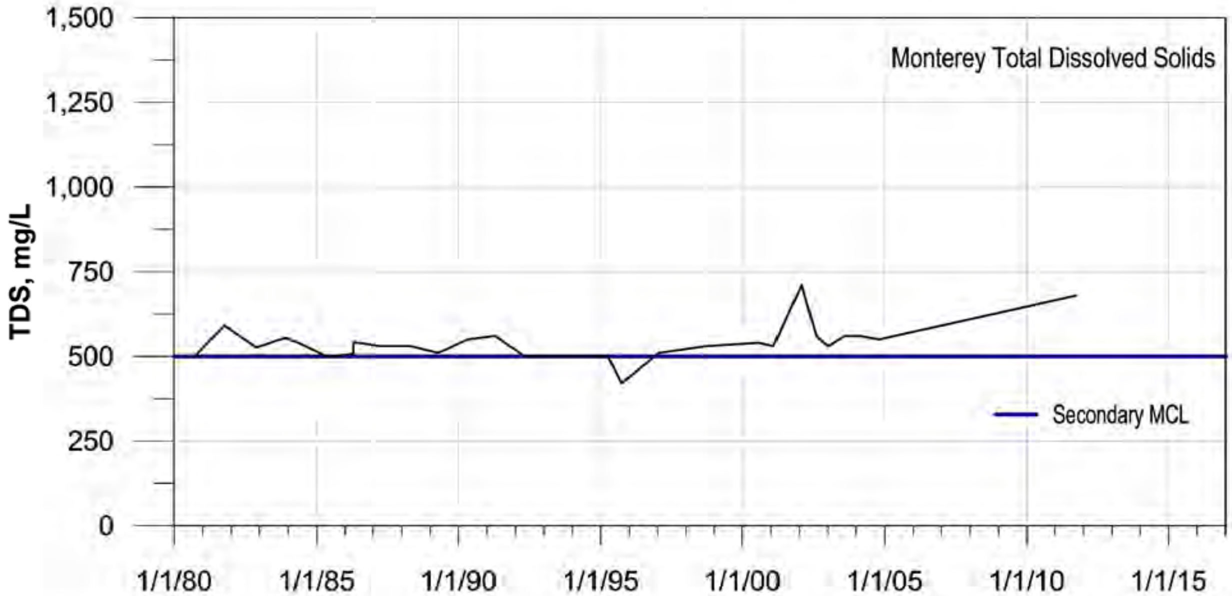

SC-15A Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
WY 2012-2016 Trend
Measurements recorded after 2005 when
adjacent Rosedale well running excluded
20
10
0
-10
-20
-30
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

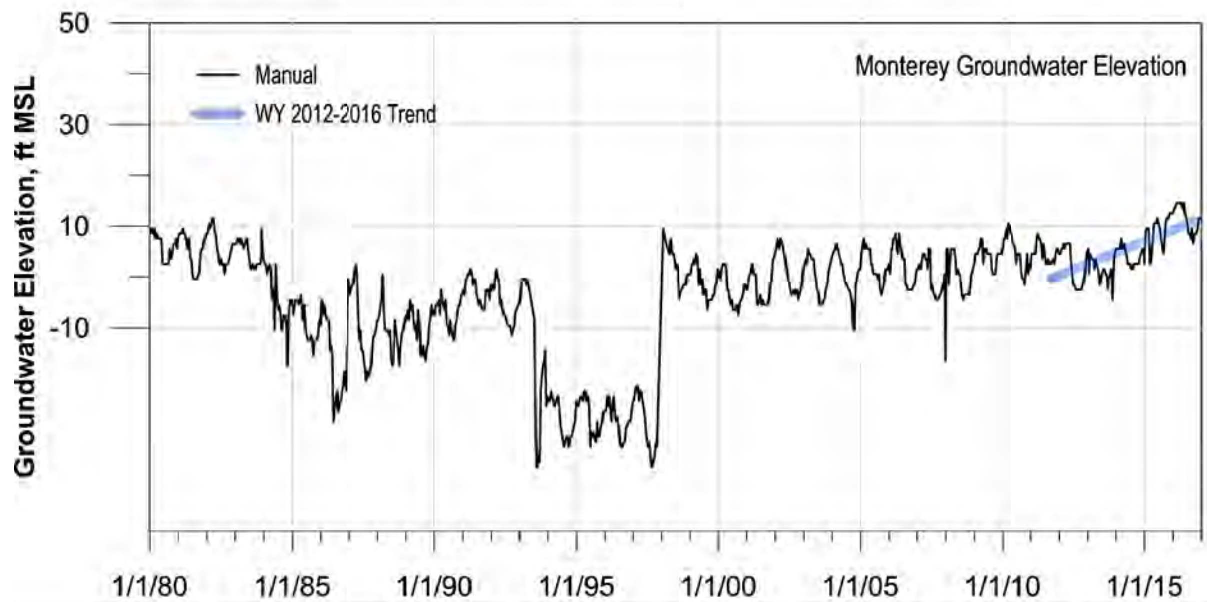

SC-15B Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-15B Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-15B Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
WY 2012-2016 Trend
Measurements recorded after 2005 when
adjacent Rosedale well running excluded
25
20
15
10
5
0
-5
-10
-15
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

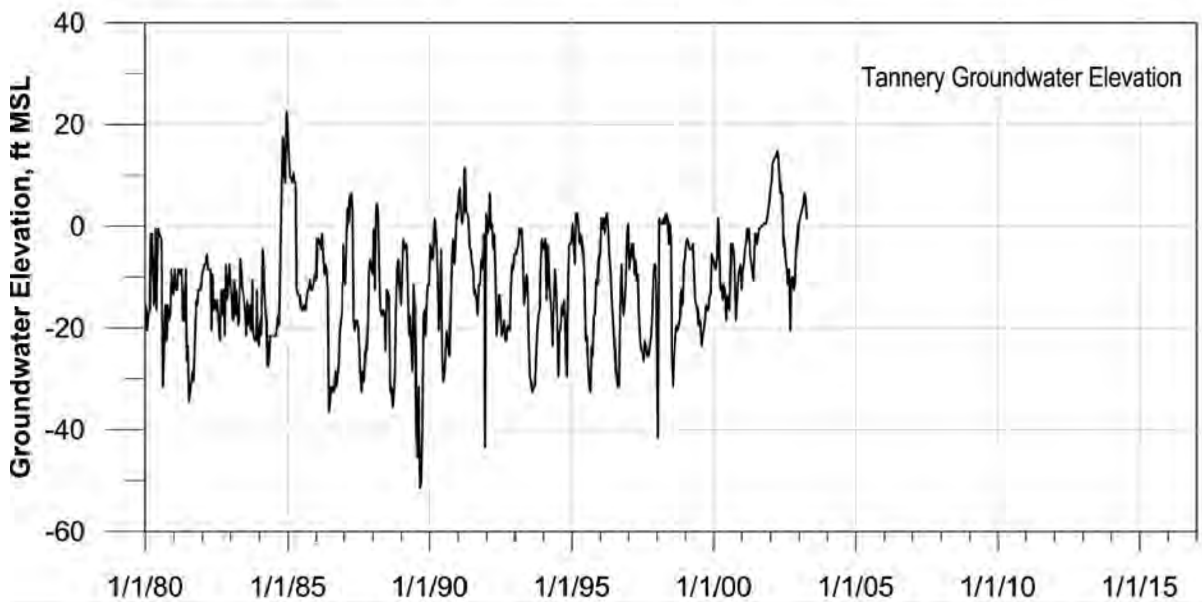

Monterey Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

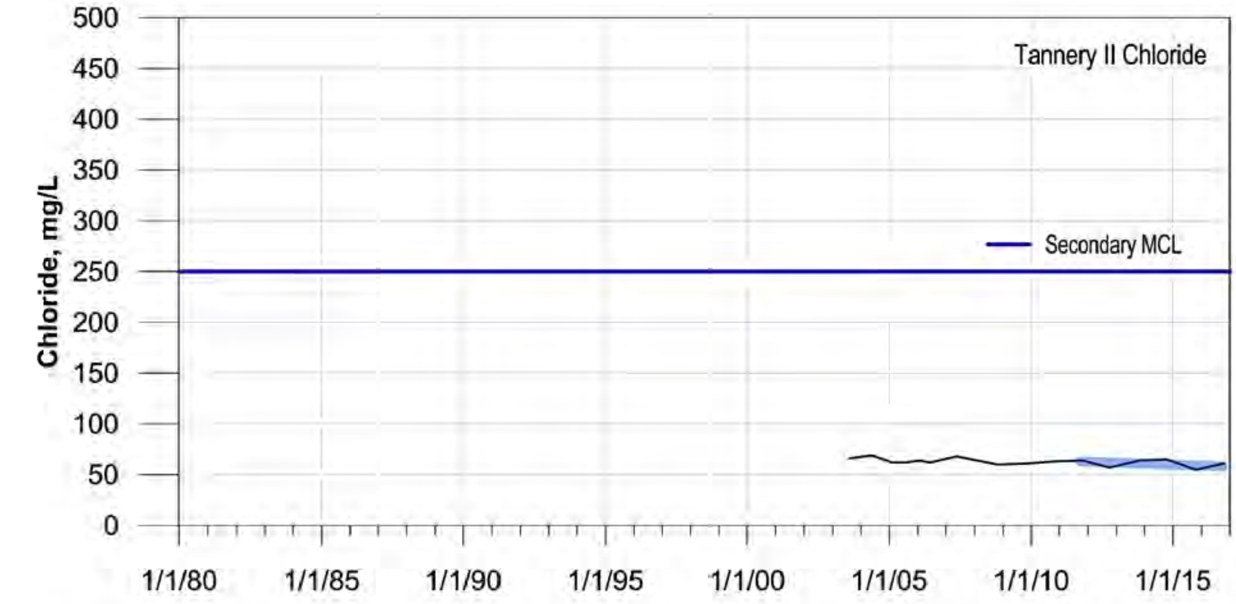

Monterey Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

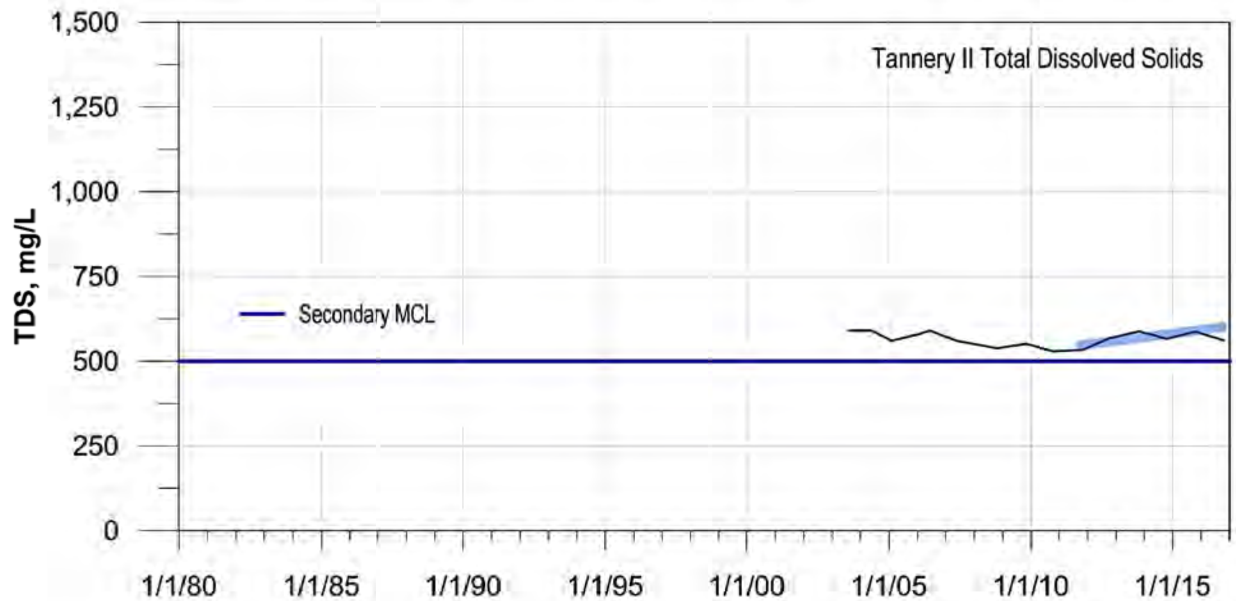

Manual
WY 2012-2016 Trend
Monterey Groundwater Elevation
Groundwater Elevation, ft MSL
50
30
10
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

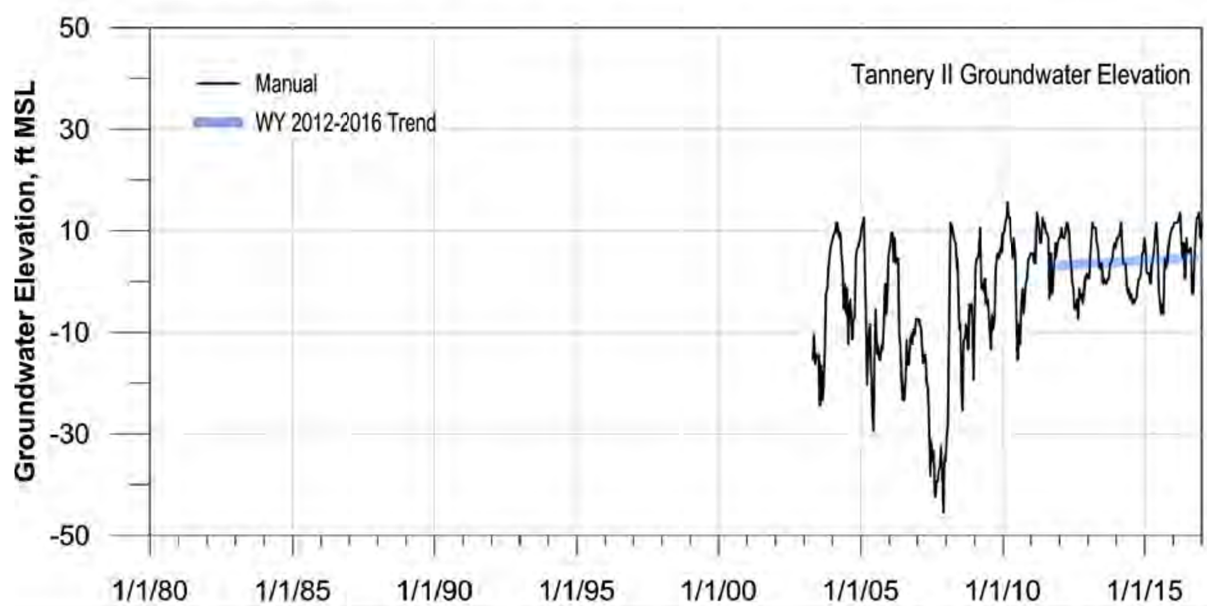

Tannery Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

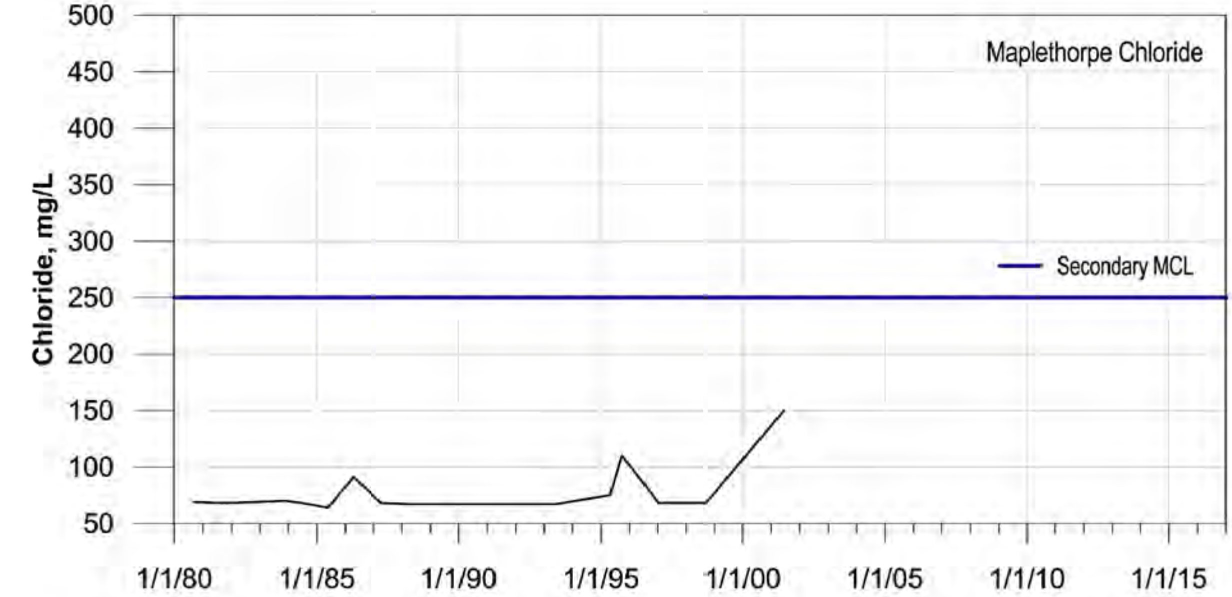

Tannery Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

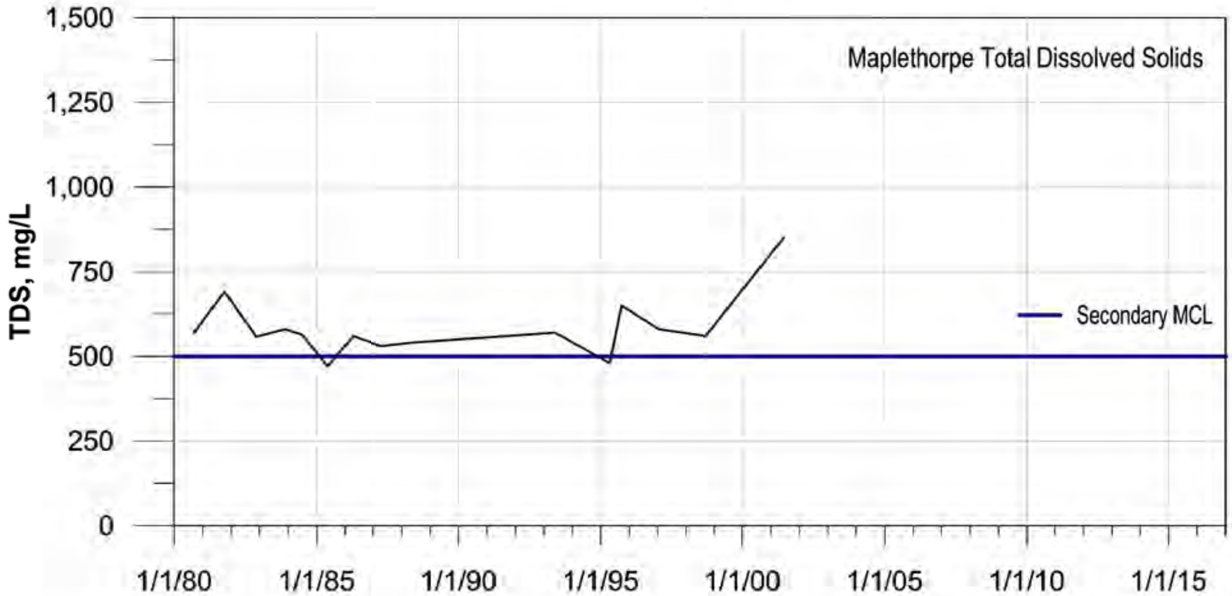

Tannery Groundwater Elevation
Groundwater Elevation, ft MSL
40
20
0
-20
-40
-60
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

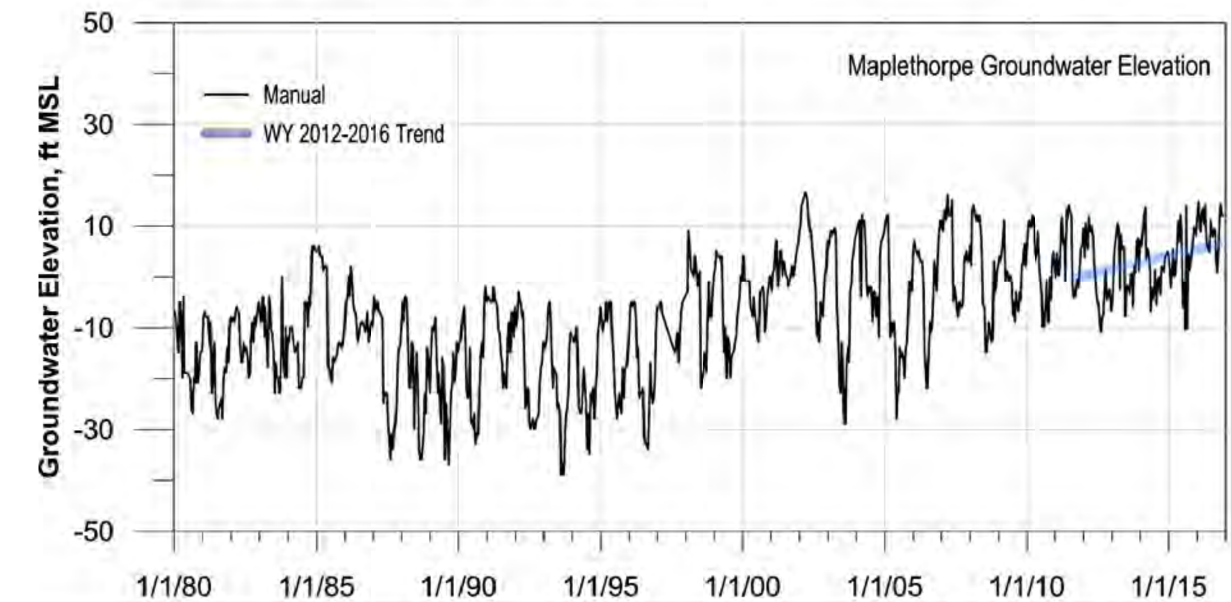

Tannery II Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Tannery II Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

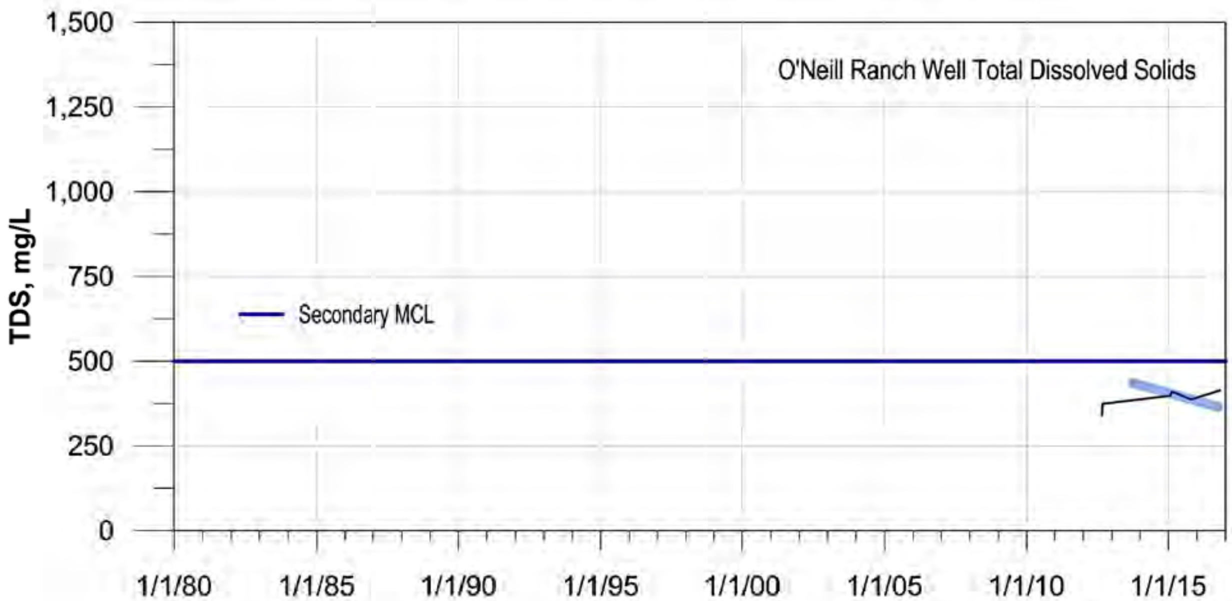

Tannery II Groundwater Elevation
Manual
WY 2012-2016 Trend
Groundwater Elevation, ft MSL
50
30
10
-10
-30
-50
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

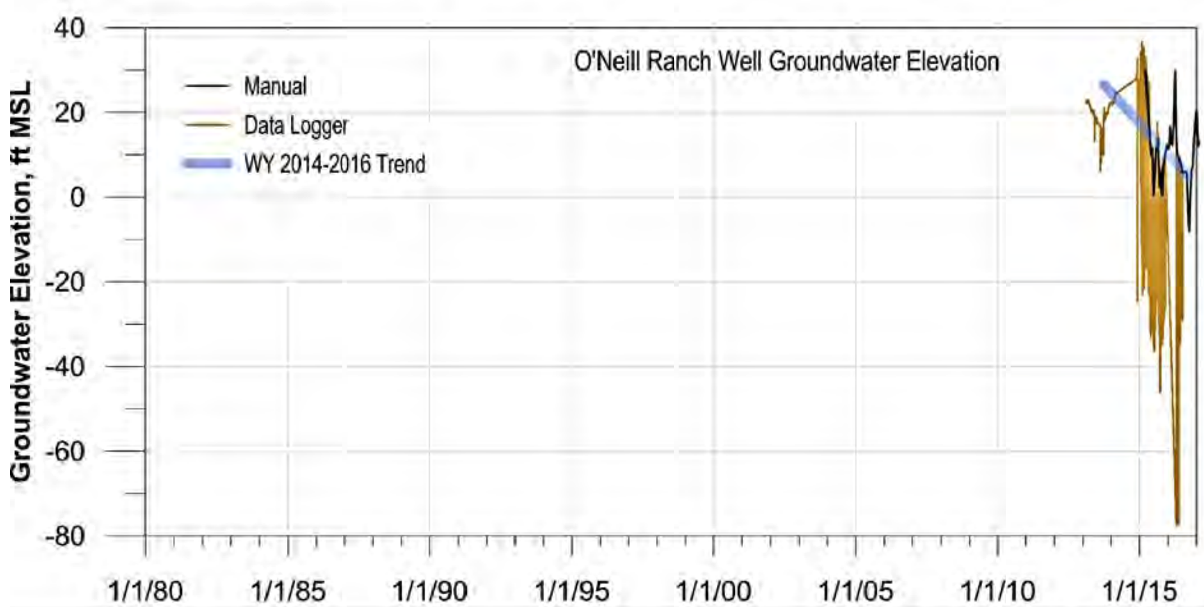

Maplethorpe Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Maplethorpe Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Maplethorpe Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
WY 2012-2016 Trend
50
30
10
-10
-30
-50
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


O'Neill Ranch Well Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


O'Neill Ranch Well Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


O'Neill Ranch Well Groundwater Elevation
Manual
Data Logger
WY 2014-2016 Trend
Groundwater Elevation, ft MSL
40
20
0
-20
-40
-60
-80
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

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SECTION 4 – WATER YEARS 2015-16 AQUIFER CONDITIONS FOR CENTRAL PURISIMA AREA (BC/DEF-UNITS)

This section presents groundwater level and water quality conditions for Water Years 2015 and 2016 in the central portion of the Santa Cruz Mid-County Basin 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 along the coast of the Santa Cruz Mid-County Basin, groundwater is produced for municipal purposes by SqCWD in Service Area II. SqCWD's Service Area II production was 607 and 354 acre-feet in Water Years 2015 and 2016, the third lowest and lowest annual totals since service area totals have been recorded from Water Year 1984. In addition to SqCWD's overall low demand, the Madeline well was offline for rehabilitation for both water years and SqCWD increased transfer of water from Service Area I. Production in Service Area II over the last nine 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 296 and 262 acre-feet in Water Years 2015 and 2016, the two lowest years since Water Years 1984. Combined pumping at the wells grouped as DEF-unit wells (Aptos Creek and T. Hopkins) was 310 and 92 acre-feet in Water Years 2015 and 2016. The pumping in Water Year 2016 for DEF wells was the lowest total since Water Year 1989.

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). As discussed in Section 3.2, the MGA will likely re-consider the protective elevations established by SqCWD when it develops measurable objectives for seawater intrusion in the Groundwater Sustainability

Plan (GSP). Therefore, Table 4-1 below presents the percentage of the cross-sectional model runs that protect against seawater intrusion at the average groundwater levels for the water years as well as for comparison against the protective elevations.

Average coastal groundwater levels in SqCWD's BC-unit monitoring well SC-9C remained below protective elevations in Water Years 2015 and 2016. Meanwhile, average coastal groundwater levels in SqCWD's DEF unit monitoring well SC-8D rose just above the protective elevations in Year 2015 as shown in Table 4-1.

Table 4-1 (2015-16): Comparison of Water Years 2015-6 Coastal Groundwater Levels with Protective Elevations

Monitoring Well	Protective Elevation (ft msl[1])	Avg. Groundwater Level Water Year 2015 (ft msl)	Percentage of Runs Protective	Avg. Groundwater Level Water Year 2016 (ft msl)	Percentage of Runs Protective
SC-9C	10	0.3	<50%	9.9	>=60%
SC-8D	10	9.2	<50%	10.7	>=70%

[1] msl = mean sea level

Table 4-2 summarizes by monitoring well groundwater level trends over the last five years along with any changes to the trends over Water Years 2015. Increasing groundwater elevations reflect the historically low pumping at the Service Area II wells in Water Year 2015 and 2016.

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 2012-2016, a period when production in the Central Purisima area was generally decreasing and below historical averages.

Contour maps of groundwater elevations in Spring and Fall 2016 for the Purisima BC-unit are shown in Figure 4-2 and Figure 4-3. Figure 4-2 shows that the Spring and Fall 2016 coastal groundwater levels in the BC-unit were at protective elevations due to an acceleration of recovery in early 2016 that was maintained for the remaining part of the year. Pumping depressions around SqCWD production wells are shown but are much smaller than previous years. The figures show groundwater flows from all directions including from the coastal area towards the pumping depression in the BC-unit.

For the biennial report of Water Years 2015-16, contour maps of groundwater elevations of the DEF and F units for spring and fall of Water Year 2016 are included. The DWR regulations for GSPs require that annual reports provide groundwater elevation contour maps for each principal aquifer in the Basin (§356.2). The DEF and F units are combined for the contour maps as they are as a single model layer in the groundwater model under development (HydroMetrics WRI, 2015c).

Contour maps of groundwater elevations in Spring and Fall 2016 including the Purisima DEF-unit are shown in Figure 4-4 and Figure 4-5. The western area with SC-9, SC-8, T. Hopkins, and SC-23 wells represent the deeper DEF unit groundwater levels. Figure 4-4 shows that the Spring and Fall 2016 coastal groundwater levels in the DEF-unit were above protective elevations due to an acceleration of recovery in early 2016 that was maintained for the remaining part of the year. The figures show groundwater flows towards a pumping depression at the T. Hopkins well but flows offshore are also shown that reduce risk of seawater intrusion.

Table 4-2 (2015-16): 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-9C	Increasing trend since WY 2008 accelerated by increase of ~18 feet since WY 2014 average	Lowest BC pumping WY 2015-16 since WY 1984, including Madeline well offline
	SC-8D	Increasing trend since WY 2008 accelerated by increase of ~6 feet since WY 2014 average	Lowest DEF pumping WY 2016 since WY 1989
	SC-8B	Increasing trend since WY 2008 accelerated by increase of ~10 feet since WY 2014	BC-unit shows deeper drawdown than DEF-unit (SC-8D) with Aptos Creek well pumping from both units. Aptos Creek well offline in 2016.
SqCWD Shallow Monitoring Coastal Wells	SC-9E	Generally steady since WY 2010	Increasing rainfall WY 2008-2011, but lower rainfall in WY 2012-2016
	SC-8F	Increasing five year trend despite slight declines over WY 2015-2016	Well replaced in 2012, data consistent with previous data
SqCWD Inland BC Unit Monitoring Well	SC-19	Increasing trend since 2009 including ~10 foot rise in WY 2015-16	BC unit recovery appears to extend upgradient

4.3 WATER QUALITY CONDITIONS AND TRENDS

The most significant groundwater quality threat in the Santa Cruz Mid-County Basin is seawater intrusion. As discussed above, groundwater levels remain below the protective elevation in the BC unit and is just above the protective elevation in the DEF-unit established to protect against seawater intrusion in 70% of model runs. 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.

Well SC-8F, completed in the shallow F-unit, was sanded up to 100 feet and was replaced in 2012. Water quality data prior to the replacement from 2007 are not reliable. The chloride concentration from the replacement well was 40 mg/L in Water Year 2014.

Water pumped from the Purisima Formation continues to be treated for iron and manganese to meet drinking water standards. In Water Years 2015 and 2016, color and turbidity were also reduced during treatment to meet drinking water standards.

Over Water Years 2015 and 2016, the Aptos Creek and T. Hopkins wells had detections of arsenic that ranged from 2.0 to 4.0 µg/L, below the MCL of 10 µg/L for arsenic. Treatment of water from these wells reduces arsenic concentrations.

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 below protective elevations. Due to historically low production in Water Years 2009 through 2016, groundwater levels in the Purisima BC and DEF-units showed recovery over recent annual periods. Recovery accelerated in Water Years 2015 and 2016 with further reductions of pumping in the Central Purisima area. An extended period of low production will be required for the basin to recover to a level where it is protected against the risk for seawater intrusion.

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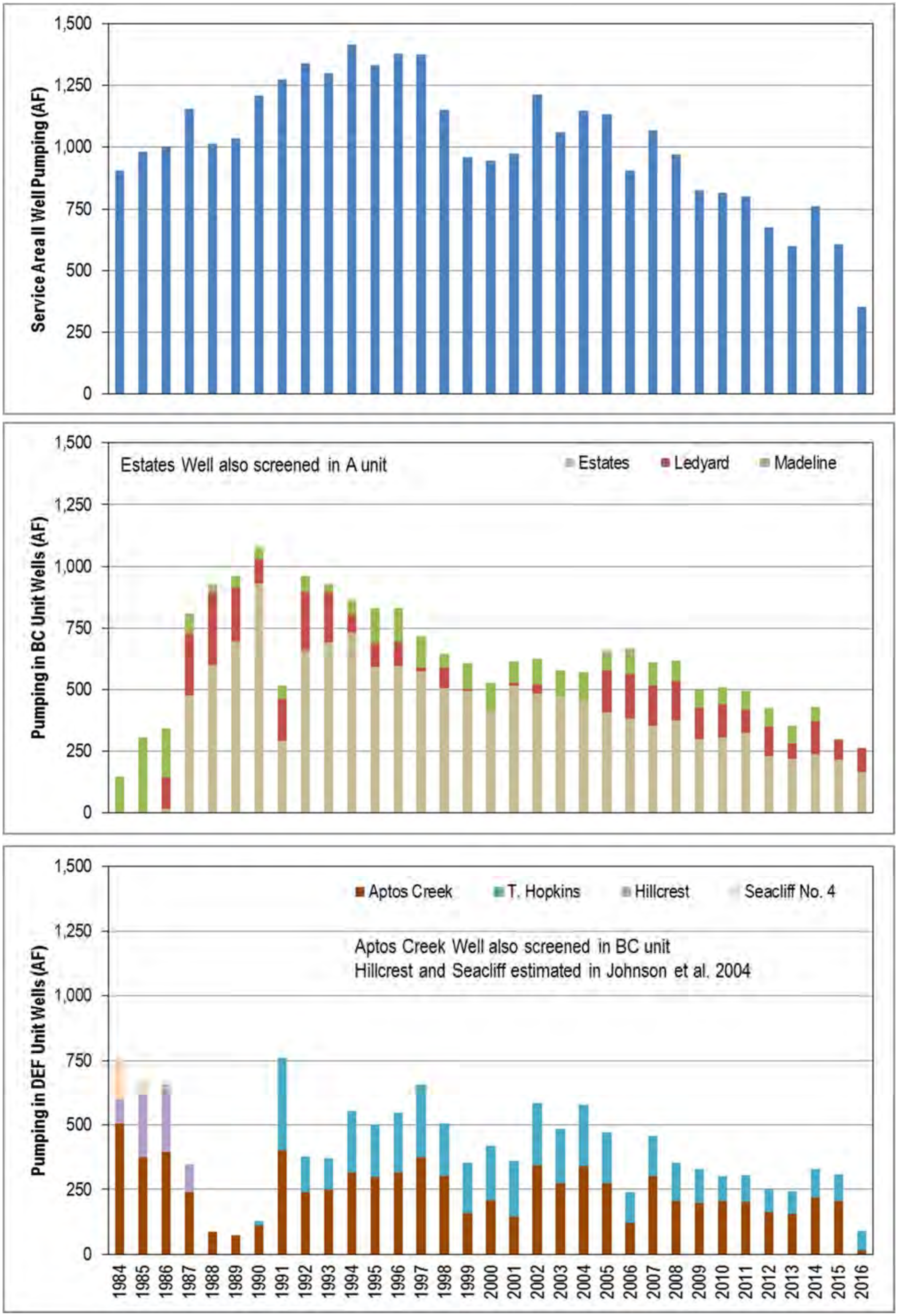

Figure 4-1: Pumping by Water Year in Central Purisima Area

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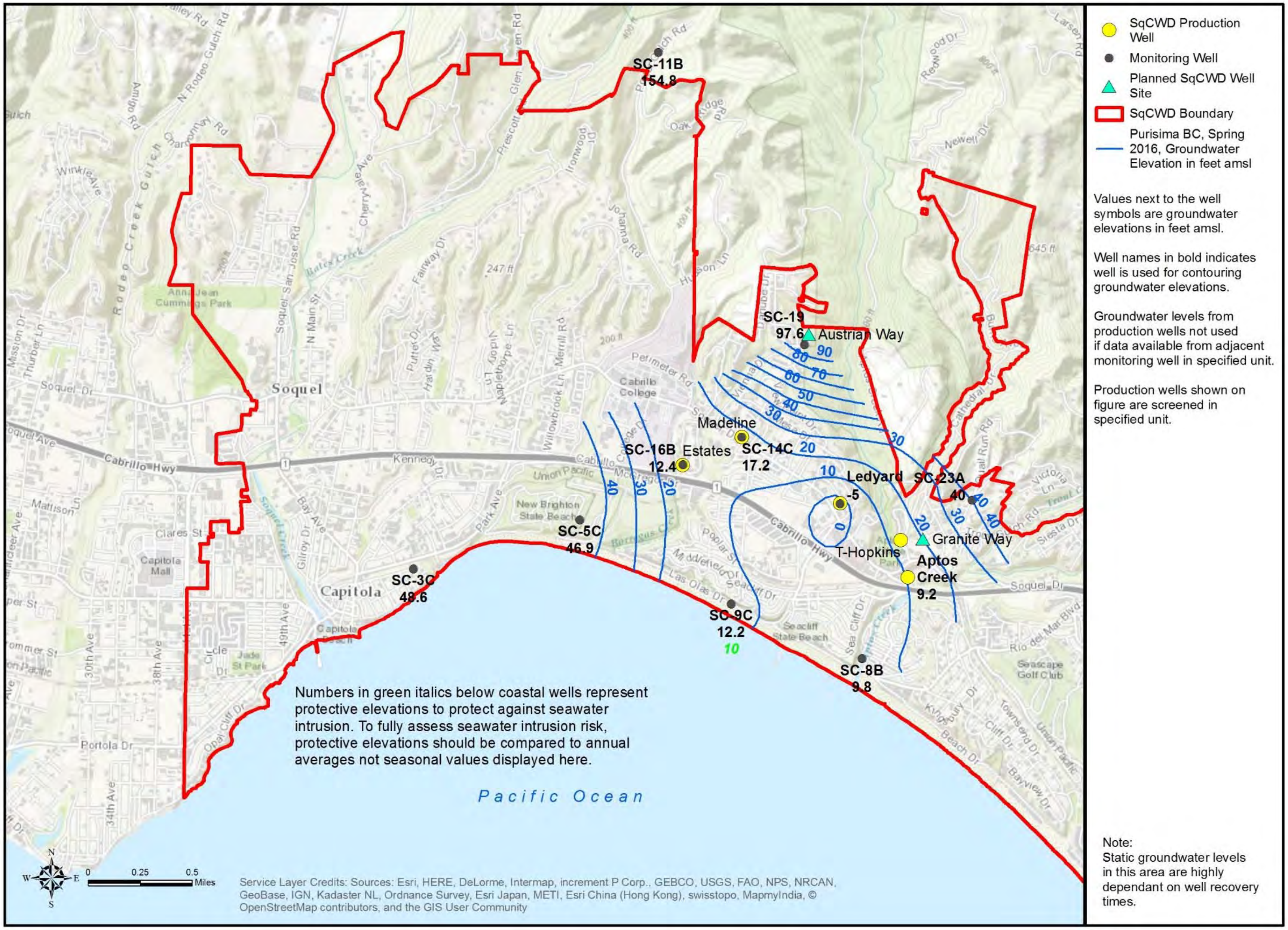

Figure 4-2 (2016): Groundwater Elevation Contours, Purisima BC-Unit, Spring 2016

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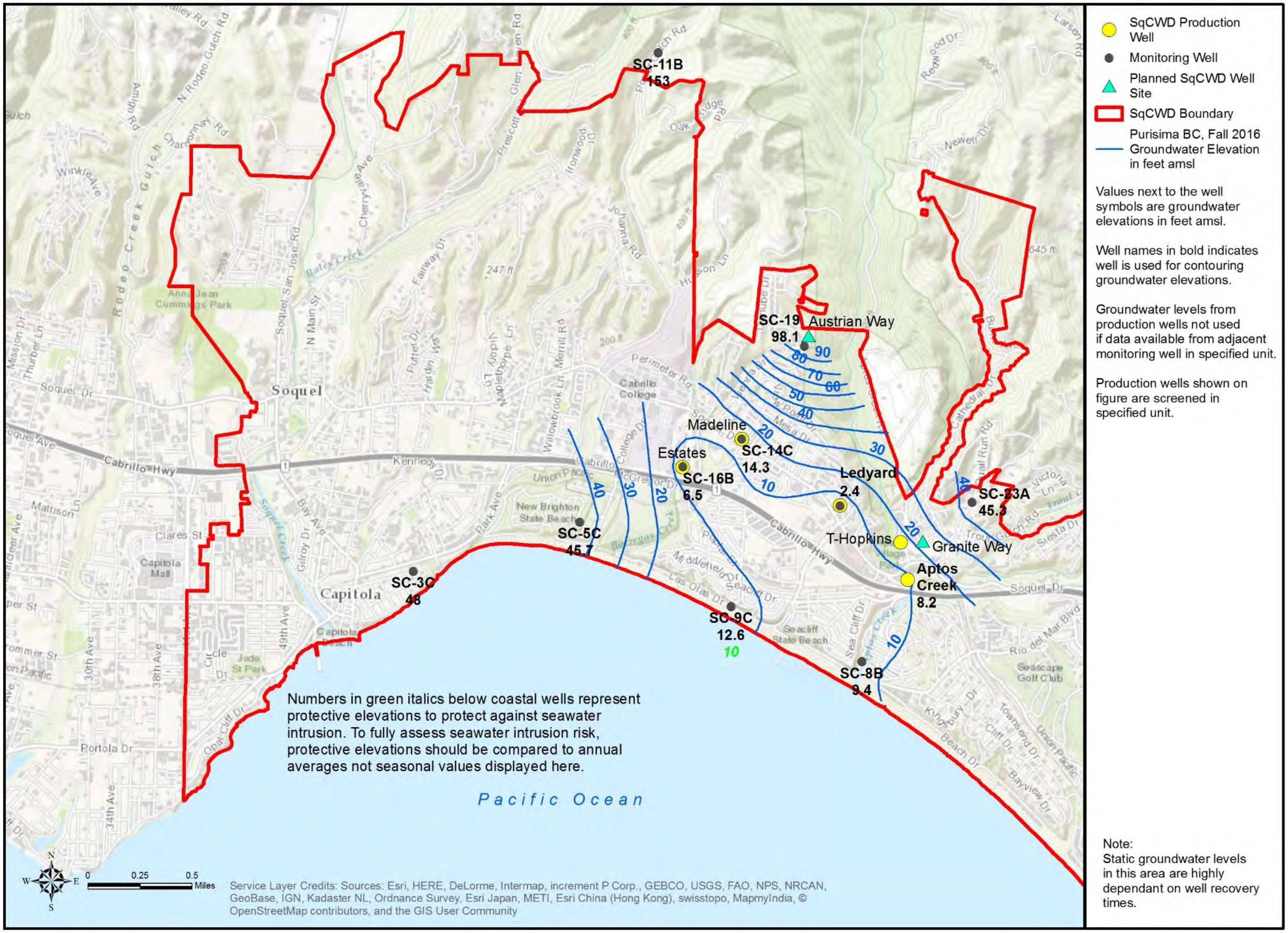

Figure 4-3 (2016): Groundwater Elevation Contours, Purisima BC-Unit, Fall 2016

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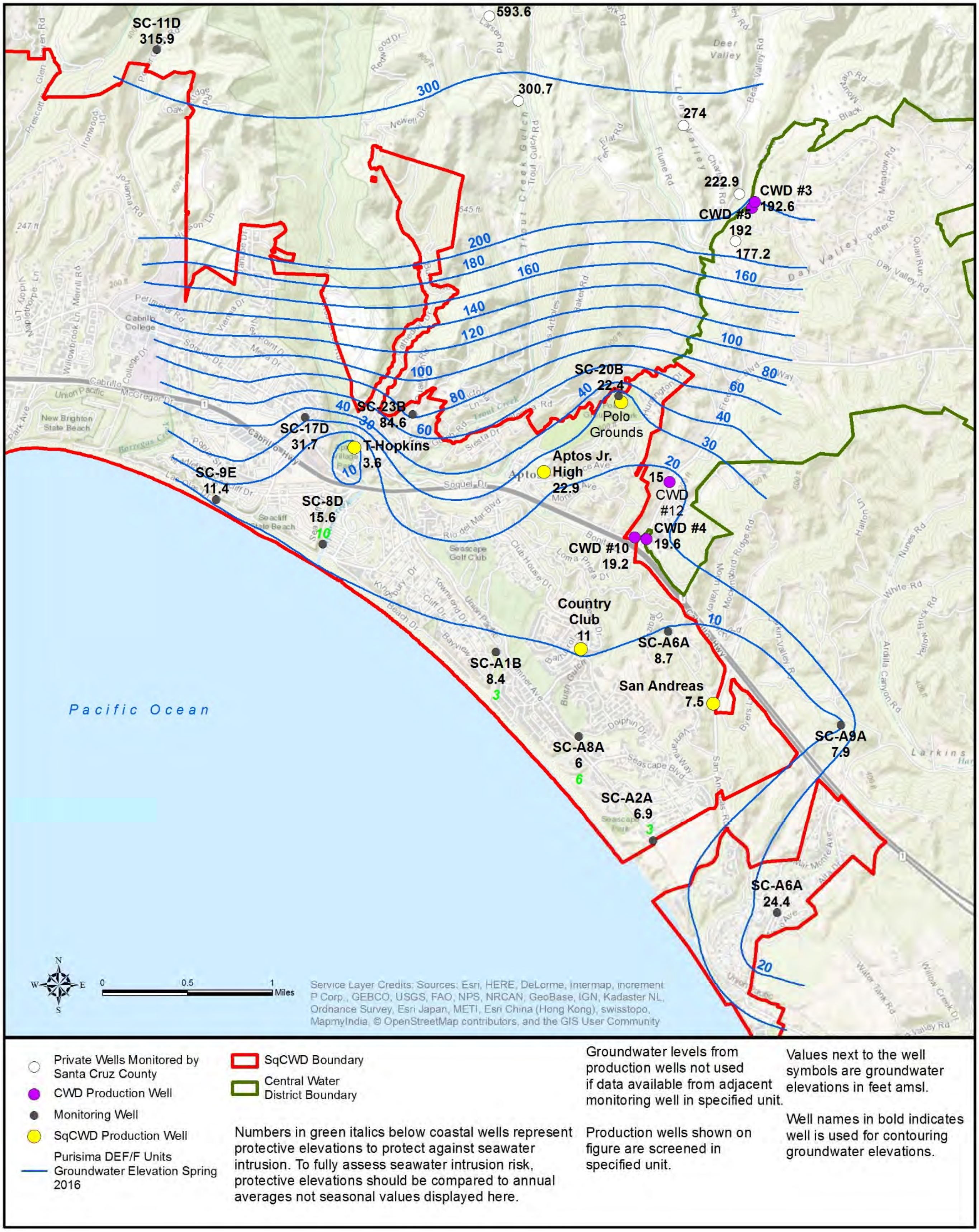

Figure 4-4 (2016): Groundwater Elevation Contours, Purisima DEF/F-Units Spr. 2016

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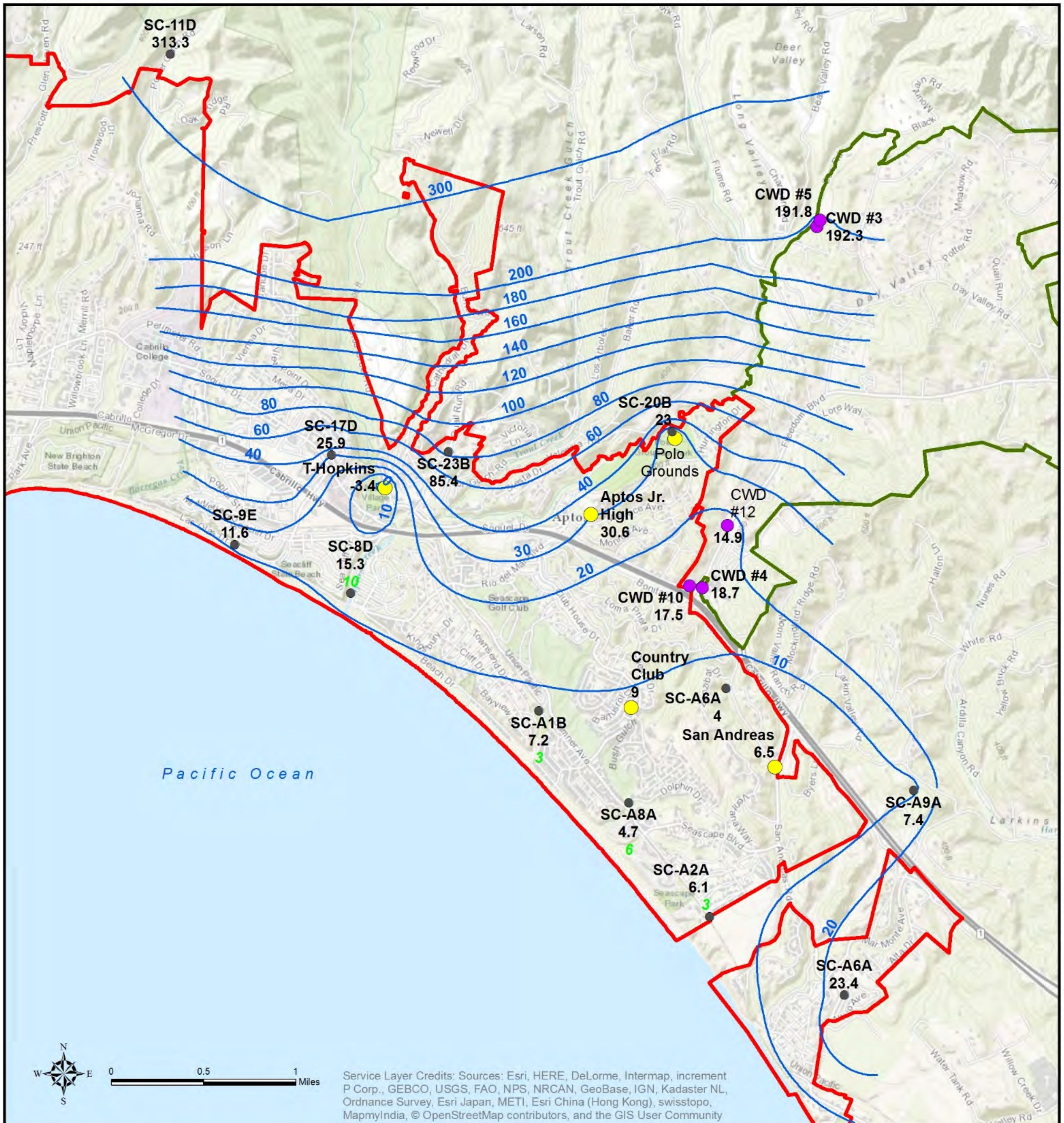

- CWD Production Well
- Monitoring Well
- SqCWD Production Well
- Purisima DEF/F Units Groundwater Elevation Fall 2016
- SqCWD Boundary
- Central Water District Boundary

Numbers in green italics below coastal wells represent protective elevations to protect against seawater intrusion. To fully assess seawater intrusion risk, protective elevations should be compared to annual averages not seasonal values displayed here.

Groundwater levels from production wells not used if data available from adjacent monitoring well in specified unit.

Production wells shown on figure are screened in specified unit.

Values next to the well symbols are groundwater elevations in feet amsl.

Well names in bold indicates well is used for contouring groundwater elevations.

Figure 4-5 (2016): Groundwater Elevation Contours, Purisima DEF/F-Units, Fall 2016

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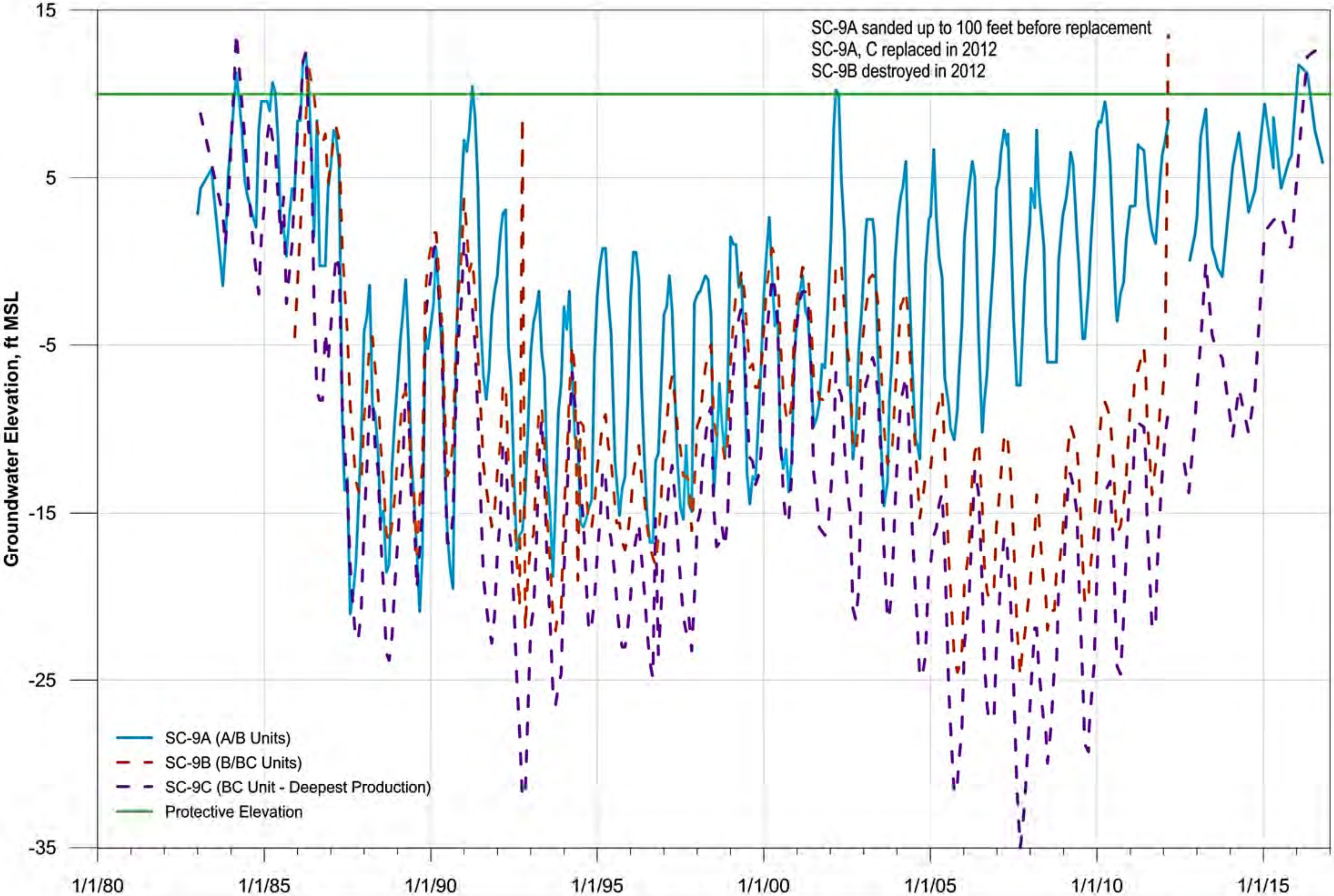
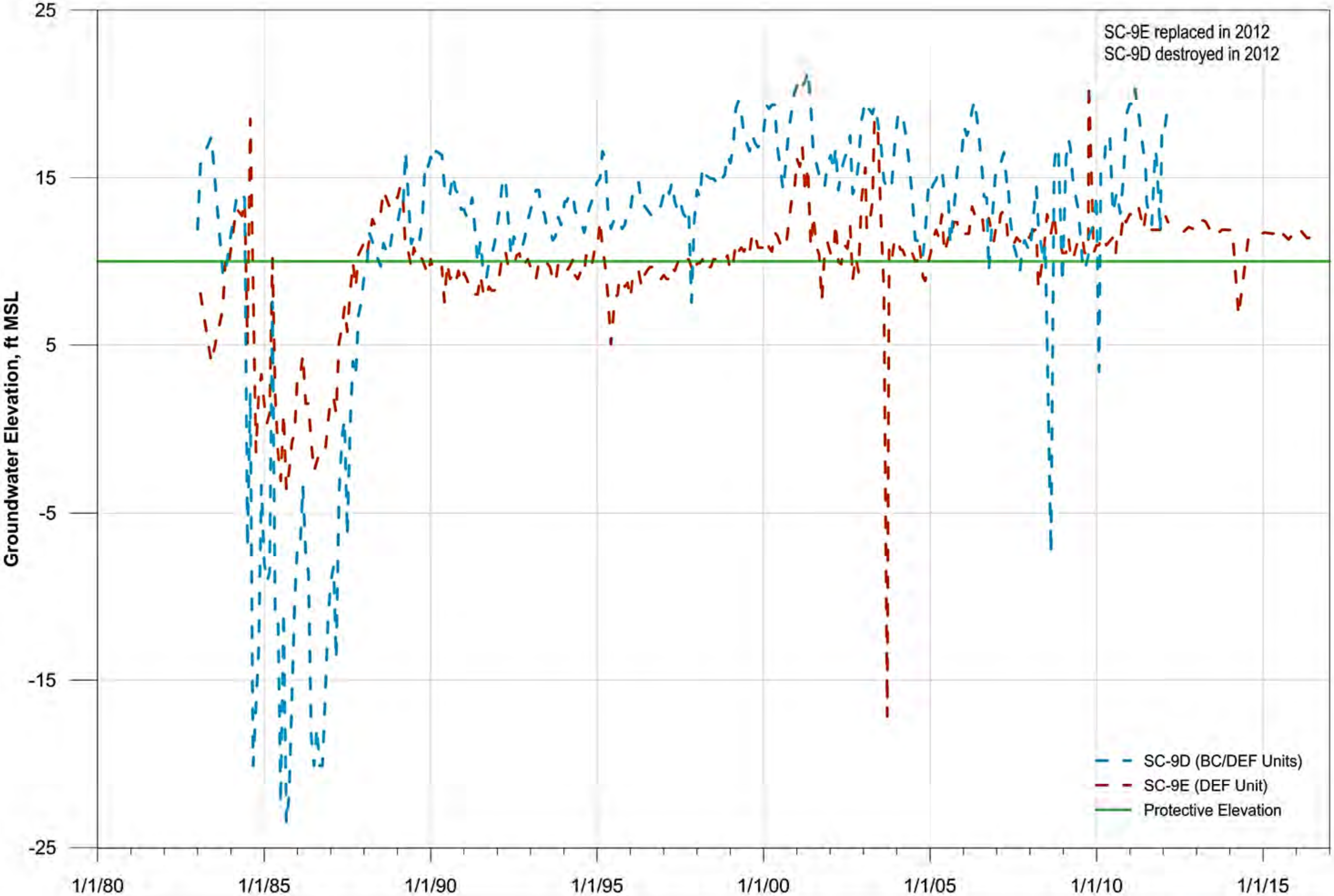
Monitoring Well Hydrographs for Central Purisima Area

Hydrographs of SqCWD Coastal Monitoring Well Clusters

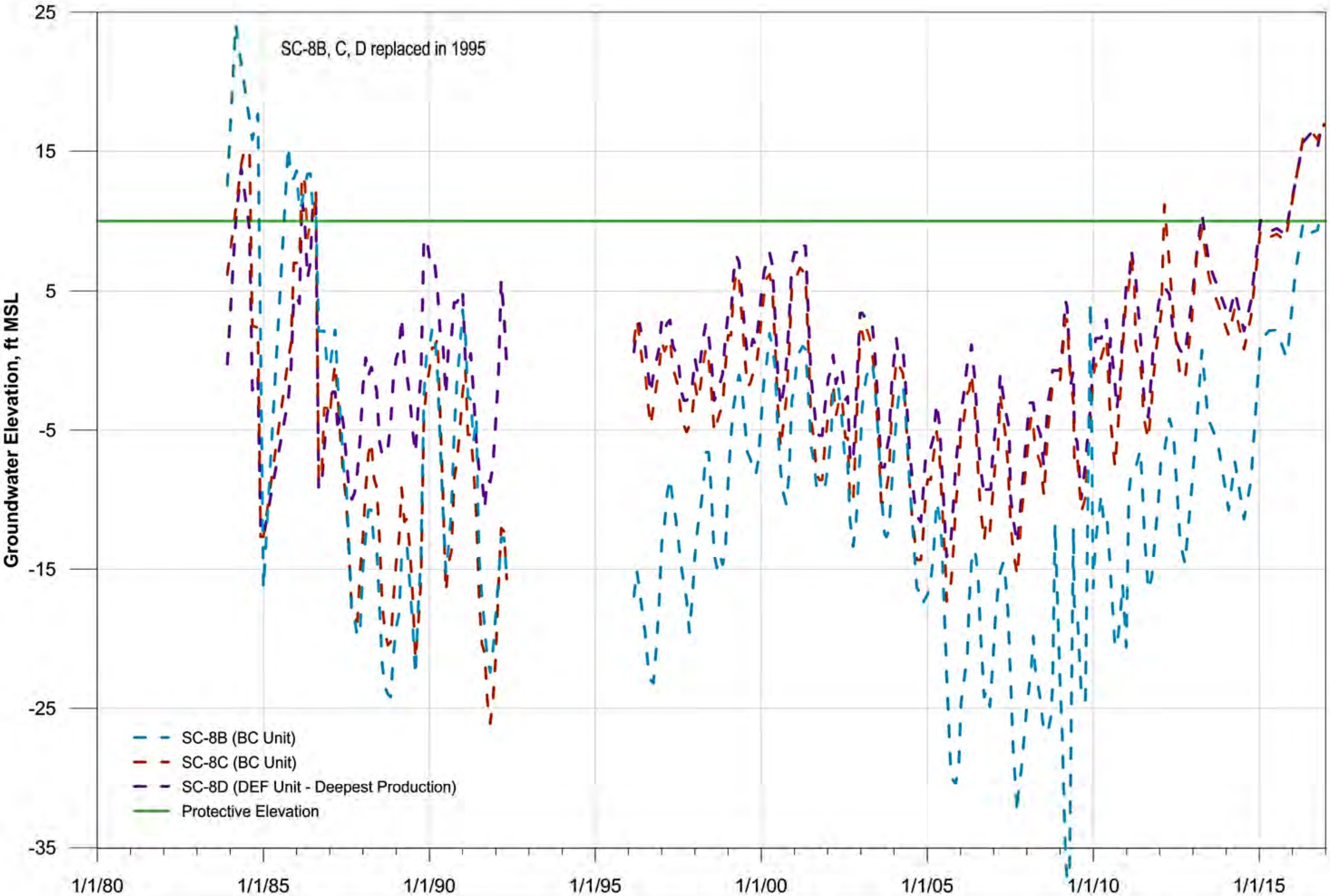
Hydrographs of SqCWD Inland Monitoring Well Clusters

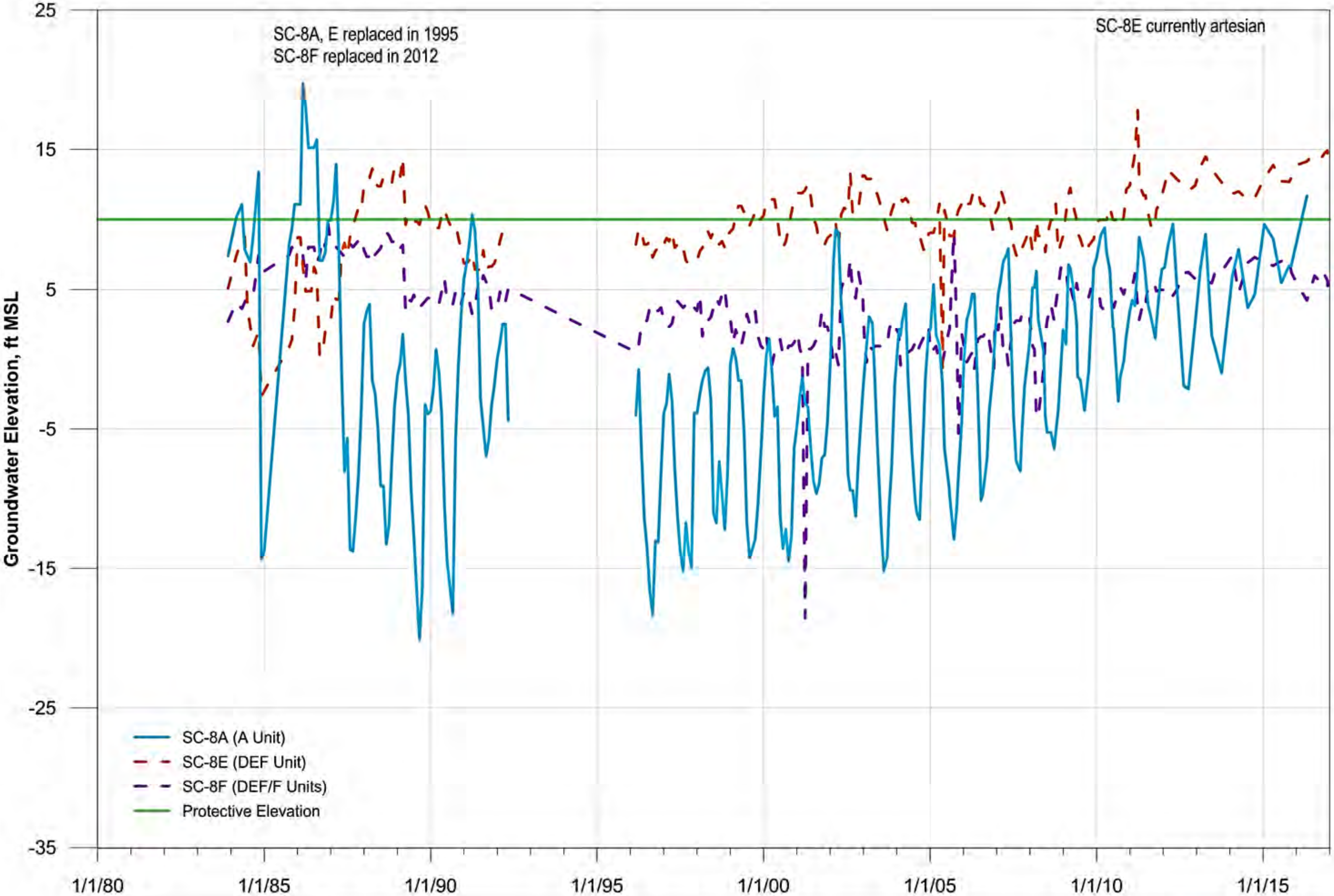
Hydrographs of SqCWD Monitoring Wells Adjacent to Production Wells

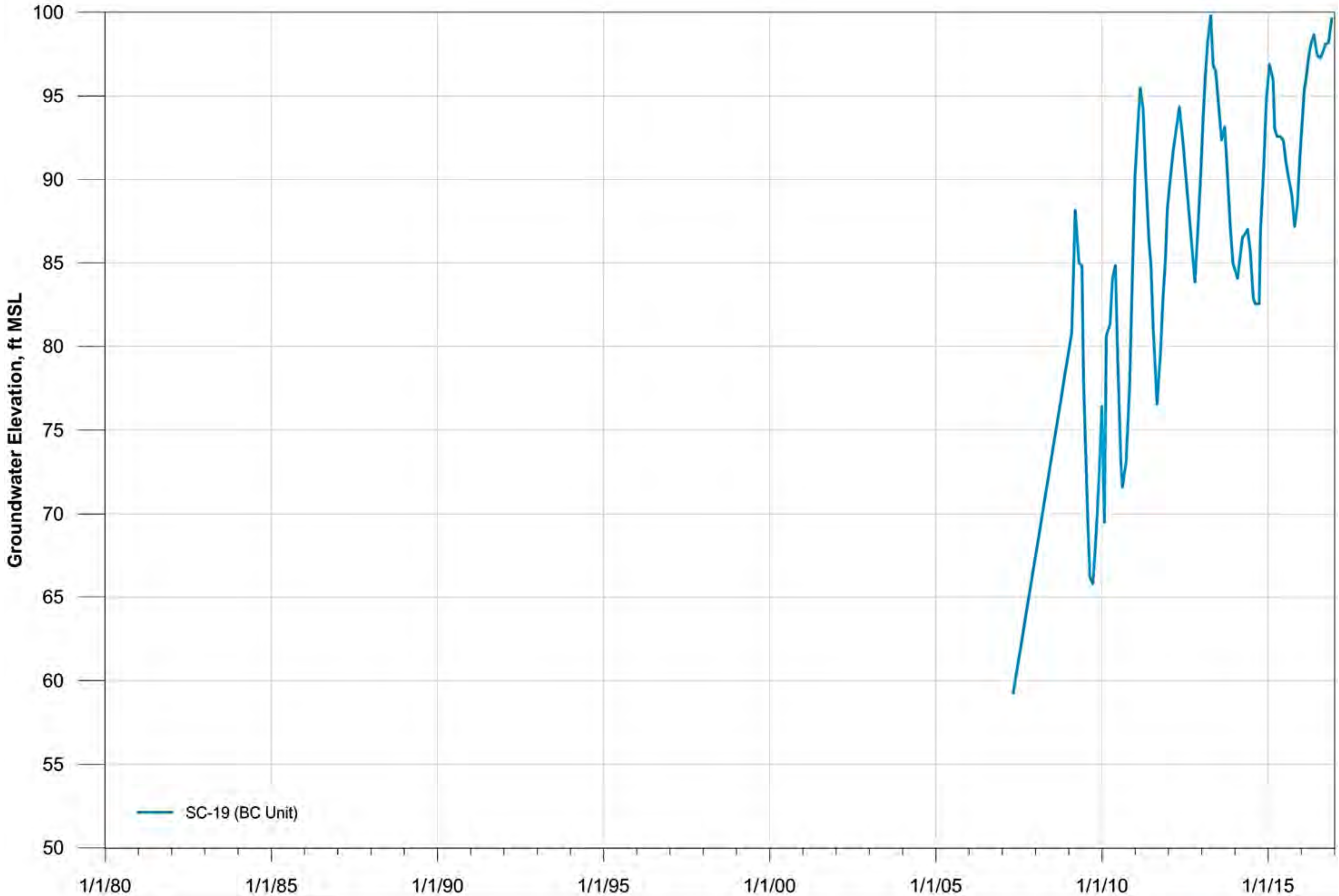

SC-9A sanded up to 100 feet before replacement
SC-9A, C replaced in 2012
SC-9B destroyed in 2012
15
5
-5
-15
-25
-35
Groundwater Elevation, ft MSL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-9A (A/B Units)
SC-9B (B/BC Units)
SC-9C (BC Unit - Deepest Production)
Protective Elevation



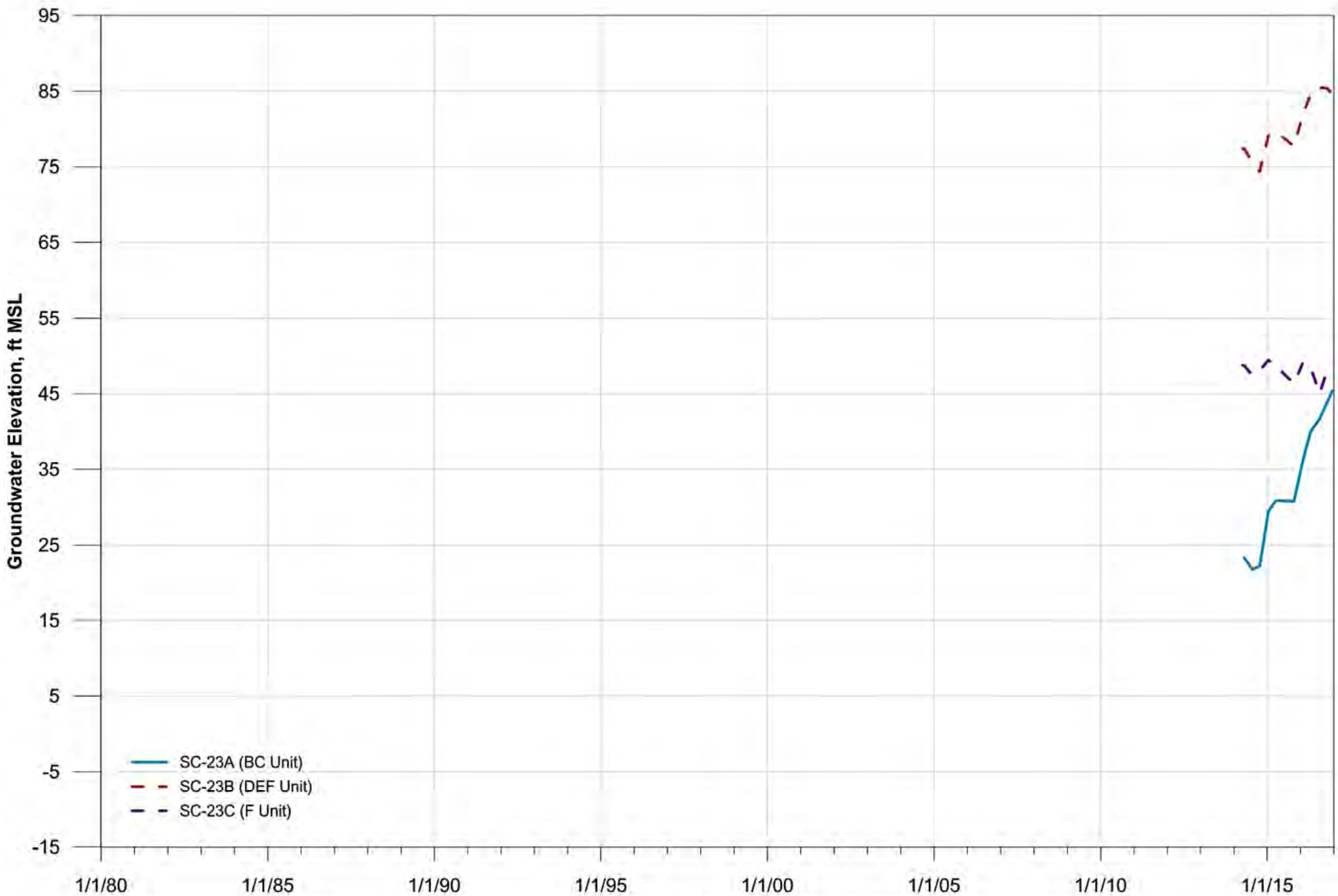
SC-9E replaced in 2012
SC-9D destroyed in 2012
Groundwater Elevation, ft MSL
25
15
5
-5
-15
-25
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-9D (BC/DEF Units)
SC-9E (DEF Unit)
Protective Elevation


SC-8B, C, D replaced in 1995
Groundwater Elevation, ft MSL
25
15
5
-5
-15
-25
-35
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-8B (BC Unit)
SC-8C (BC Unit)
SC-8D (DEF Unit - Deepest Production)
Protective Elevation

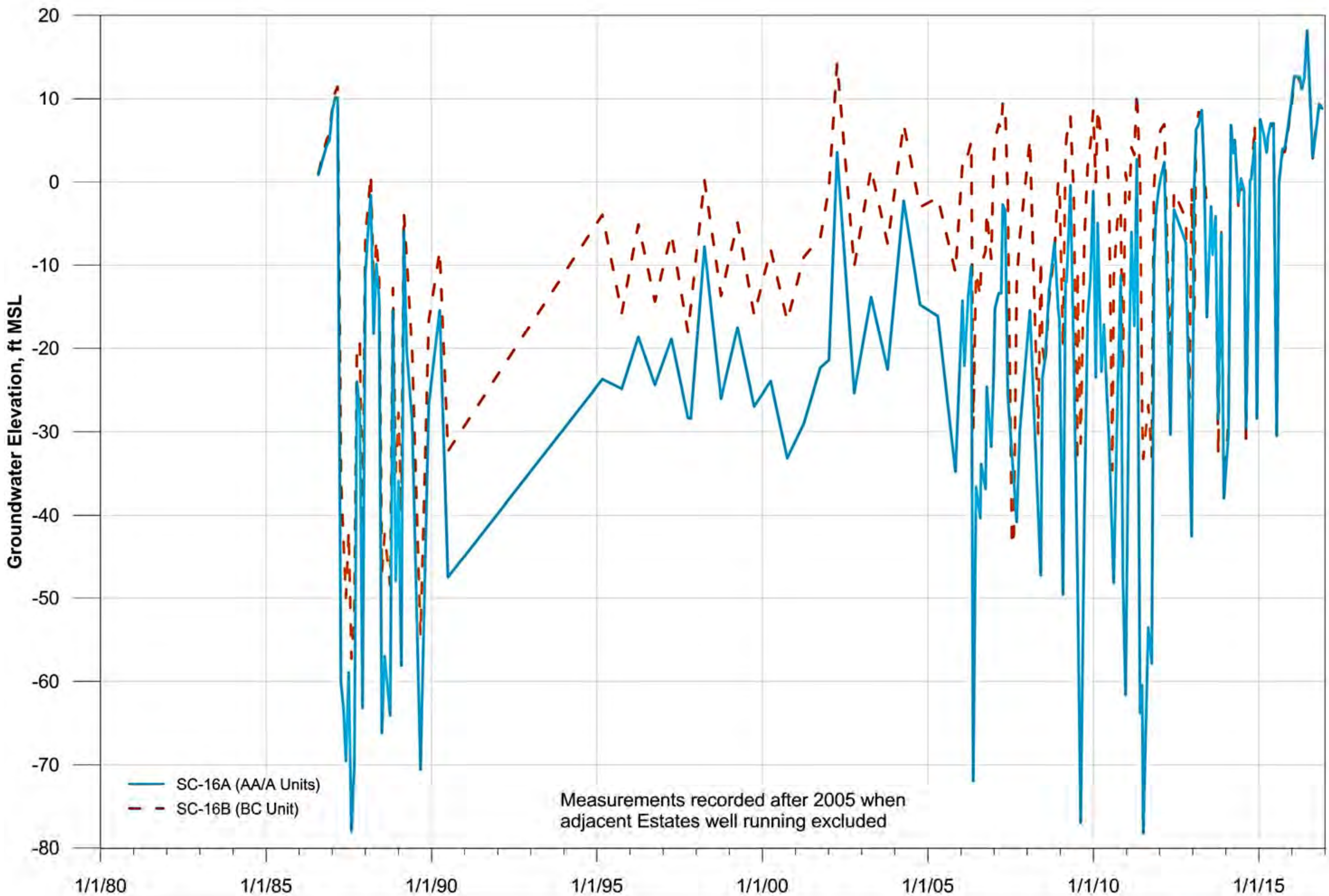

SC-8A, E replaced in 1995
SC-8F replaced in 2012
SC-8E currently artesian
Groundwater Elevation, ft MSL
25
15
5
-5
-15
-25
-35
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-8A (A Unit)
SC-8E (DEF Unit)
SC-8F (DEF/F Units)
Protective Elevation

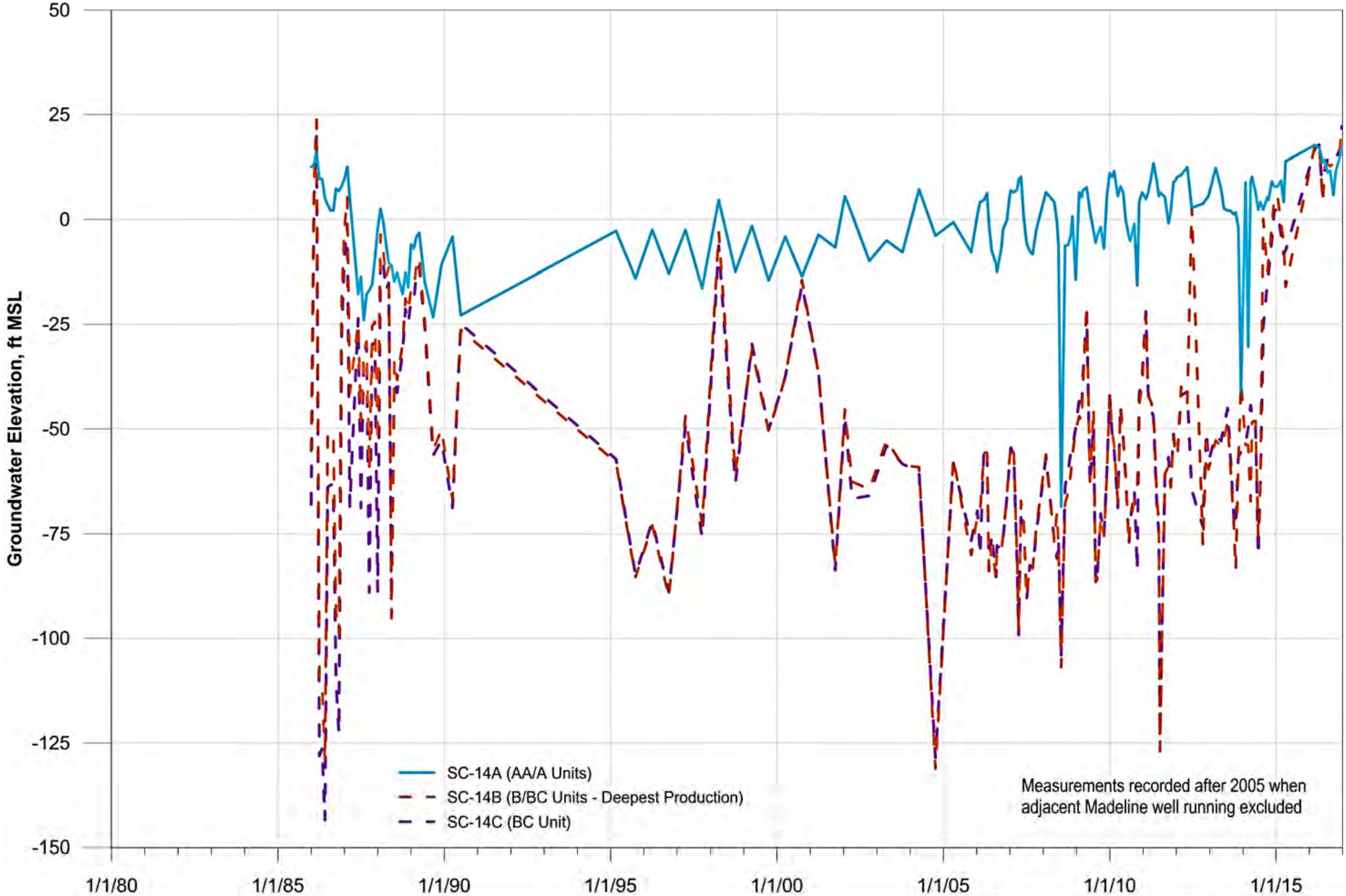


Groundwater Elevation, ft MSL
100
95
90
85
80
75
70
65
60
55
50
SC-19 (BC Unit)
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

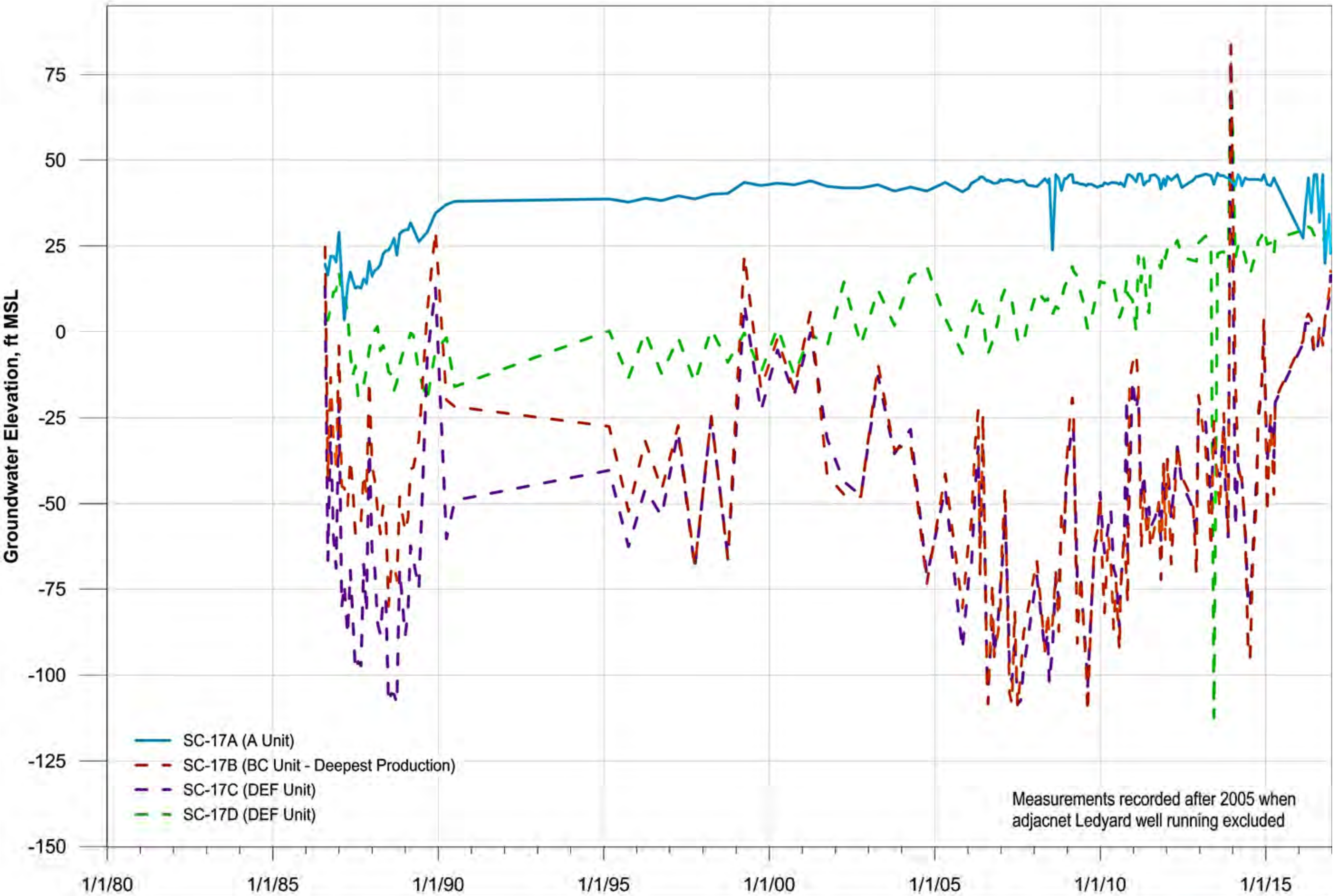


95
85
75
65
55
45
35
25
15
5
-5
-15
Groundwater Elevation, ft MSL
SC-23A (BC Unit)
SC-23B (DEF Unit)
SC-23C (F Unit)
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Groundwater Elevation, ft MSL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-16A (AA/A Units)
SC-16B (BC Unit)
Measurements recorded after 2005 when
adjacent Estates well running excluded



50
25
0
-25
-50
-75
-100
-125
-150
Groundwater Elevation, ft MSL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-14A (AA/A Units)
SC-14B (B/BC Units - Deepest Production)
SC-14C (BC Unit)
Measurements recorded after 2005 when adjacent Madeline well running excluded



75
50
25
0
-25
-50
-75
-100
-125
-150
Groundwater Elevation, ft MSL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-17A (A Unit)
SC-17B (BC Unit - Deepest Production)
SC-17C (DEF Unit)
SC-17D (DEF Unit)
Measurements recorded after 2005 when
adjacnet Ledyard well running excluded

Chemographs and Single Well Hydrographs for Central Purisima Area

Graphs of SqCWD Coastal Monitoring Well Clusters

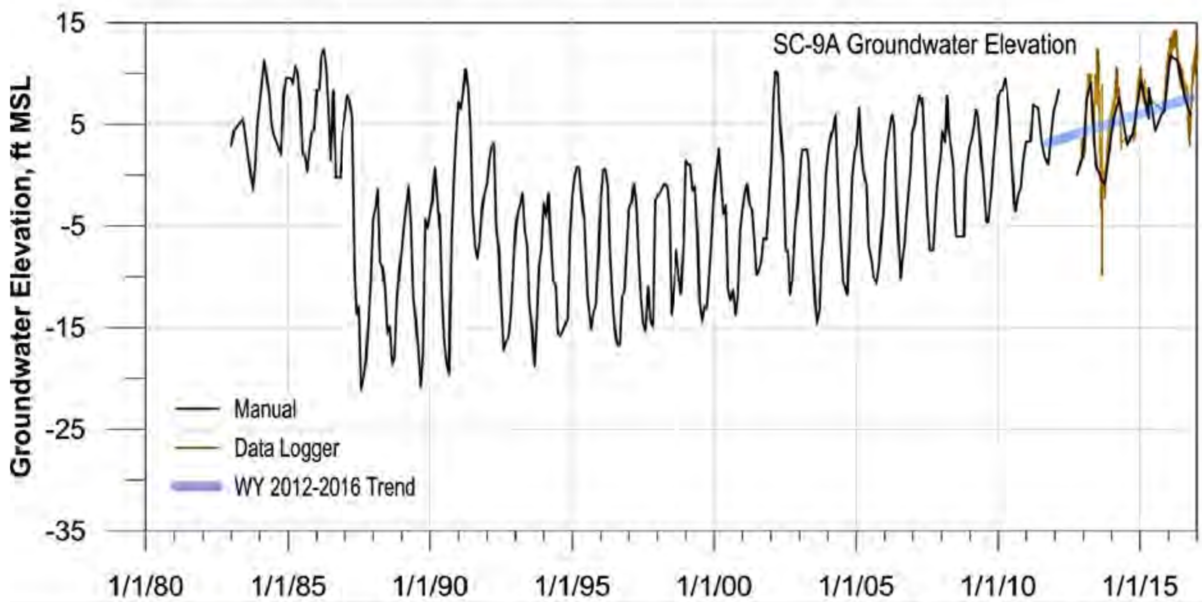
Graphs of SqCWD Inland Monitoring Well Clusters

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

Trends shown on the hydrographs and chemographs are based on a linear fit to data in the specified time period.

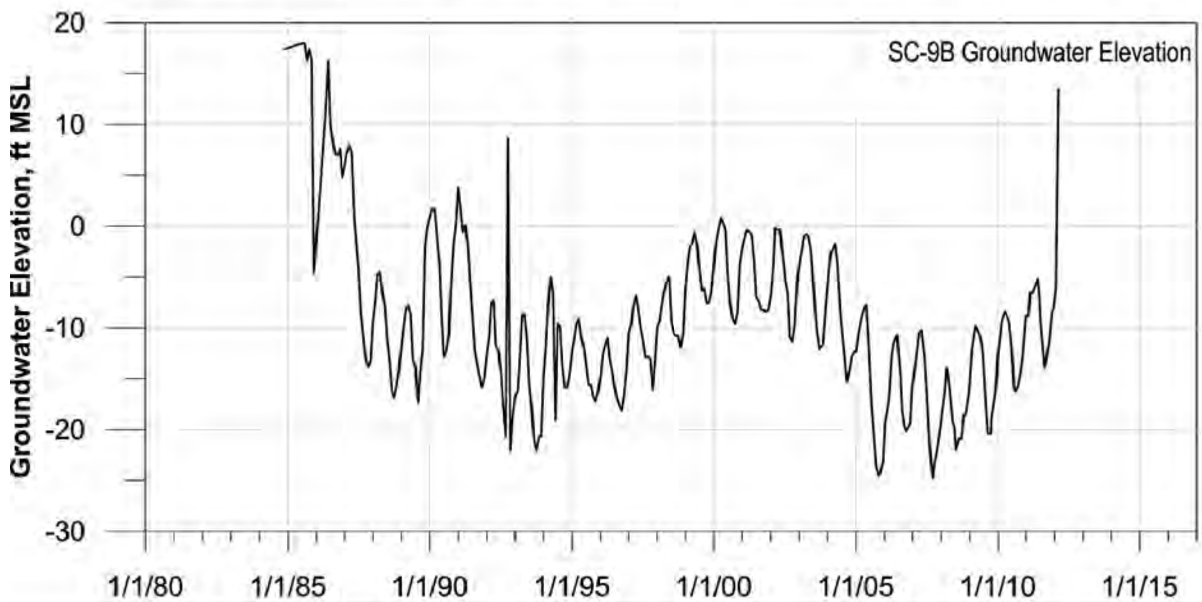

SC-9A sanded up to 100 feet
prior to replacement in 2012
SC-9A Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

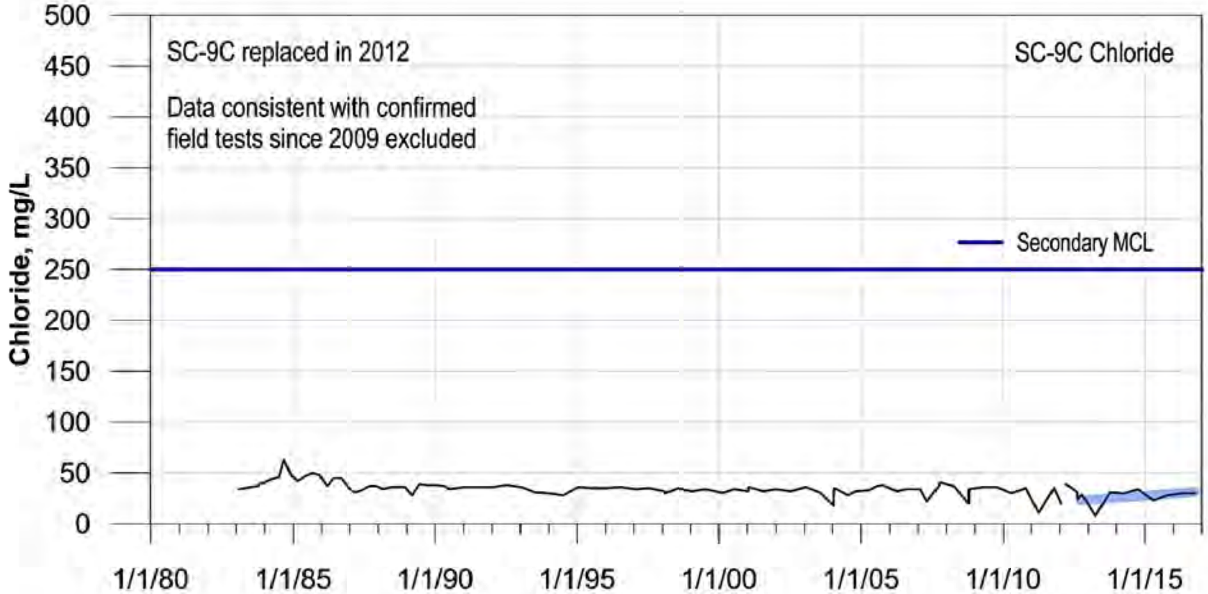

SC-9A Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-9A Groundwater Elevation
Groundwater Elevation, ft MSL
15
5
-5
-15
-25
-35
Manual
Data Logger
WY 2012-2016 Trend
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

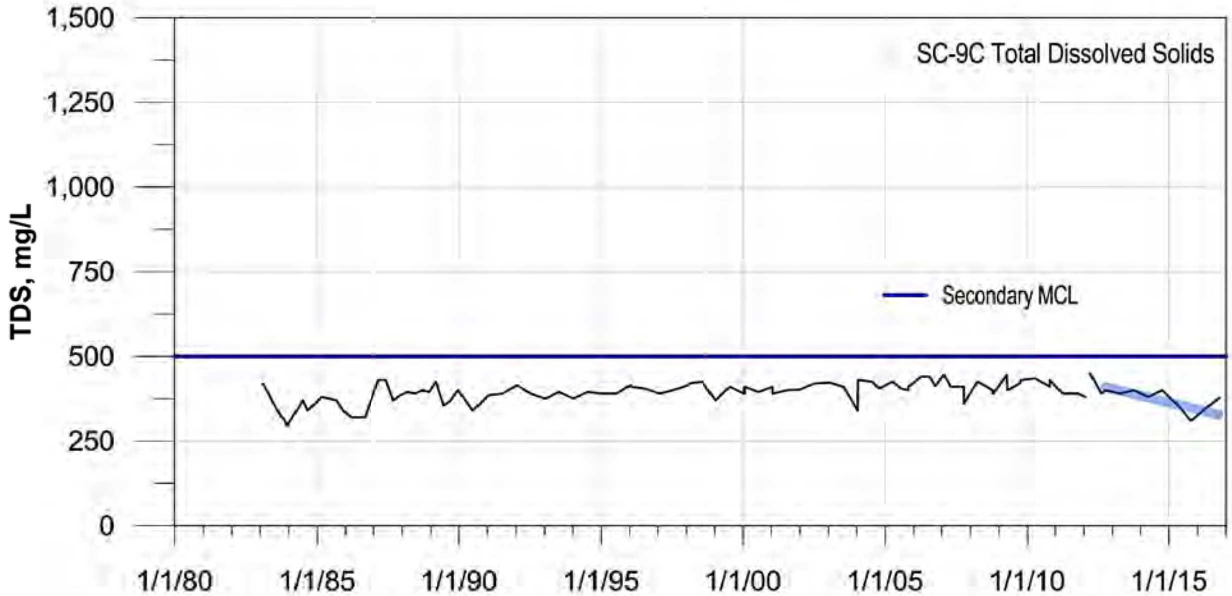

SC-9B destroyed in 2012
SC-9B Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Secondary MCL
SC-9B Total Dissolved Solids
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

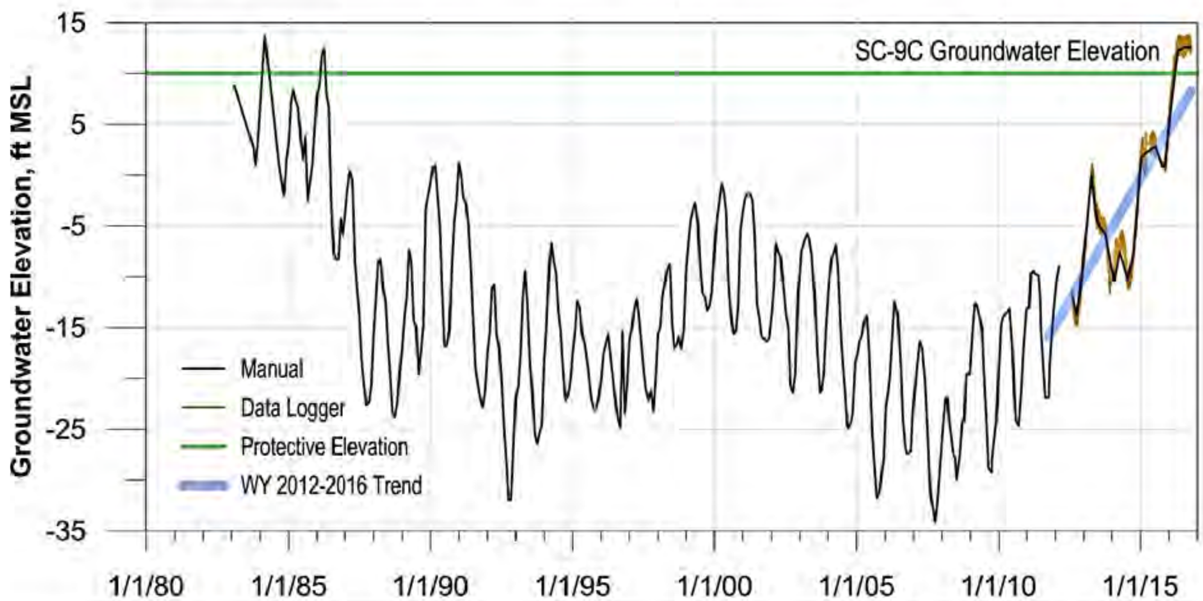

SC-9B Groundwater Elevation
Groundwater Elevation, ft MSL
20
10
0
-10
-20
-30
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15



SC-9C replaced in 2012
Data consistent with confirmed field tests since 2009 excluded
SC-9C Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15



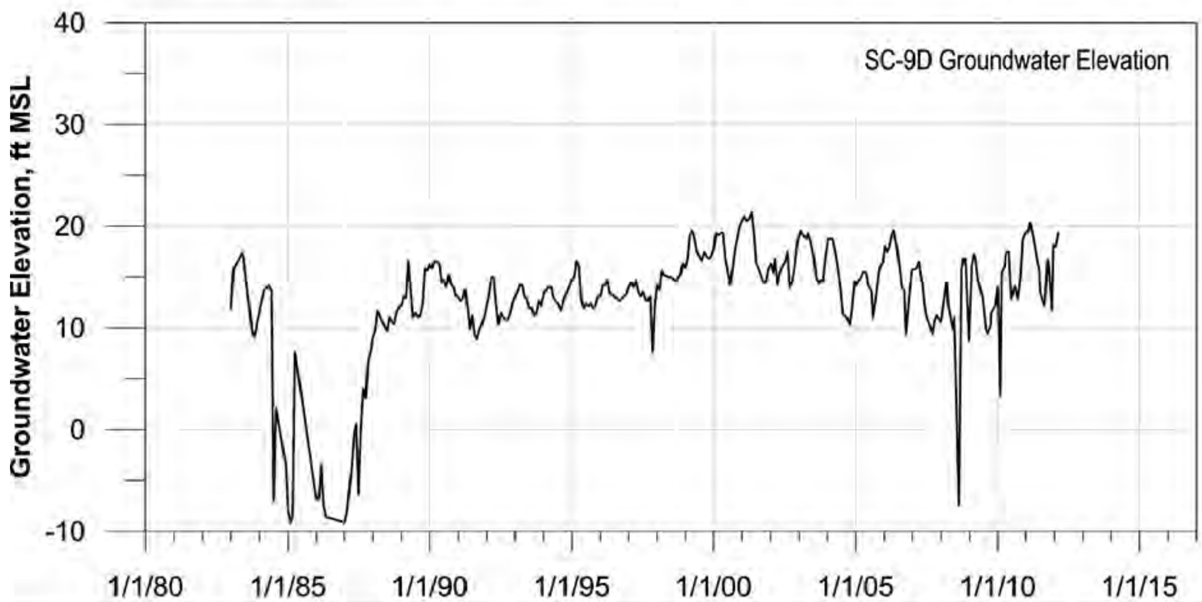
SC-9C Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

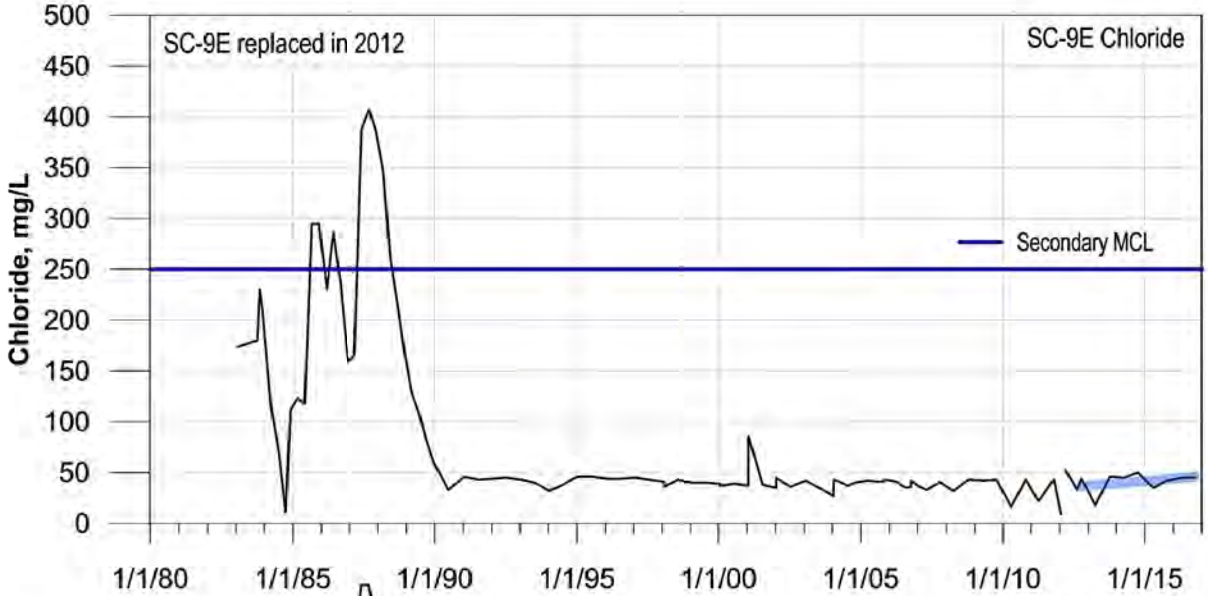


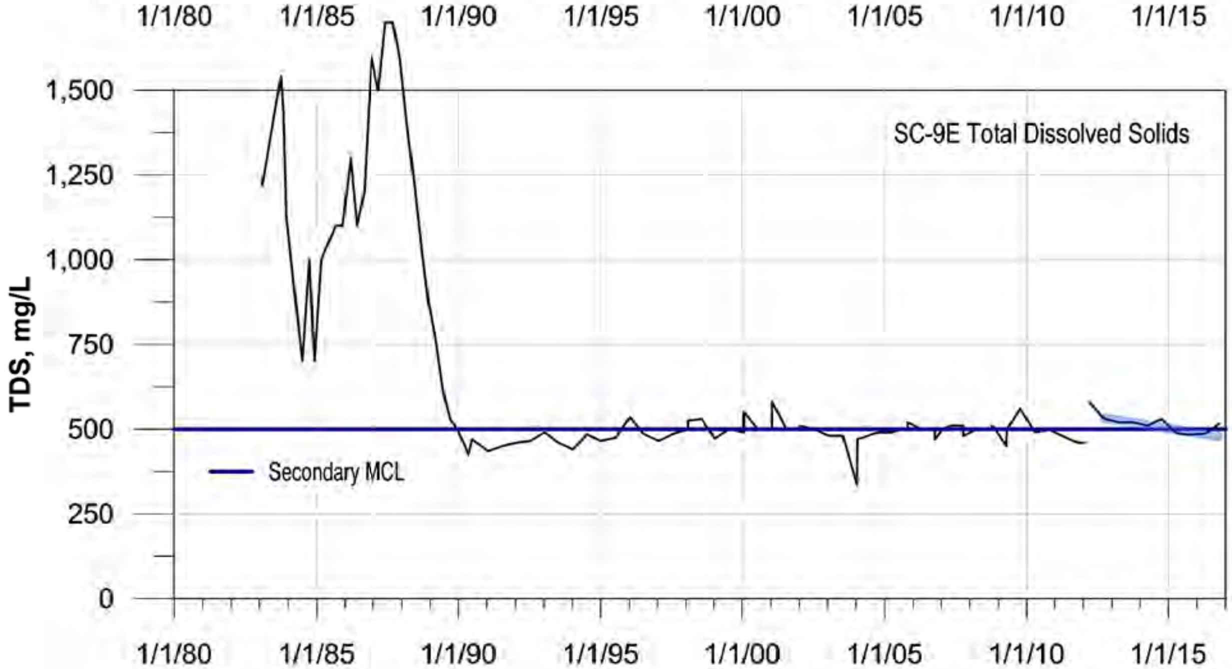
SC-9C Groundwater Elevation
Groundwater Elevation, ft MSL
15
5
-5
-15
-25
-35
Manual
Data Logger
Protective Elevation
WY 2012-2016 Trend
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-9D destroyed in 2012
SC-9D Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-9D Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-9D Groundwater Elevation
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

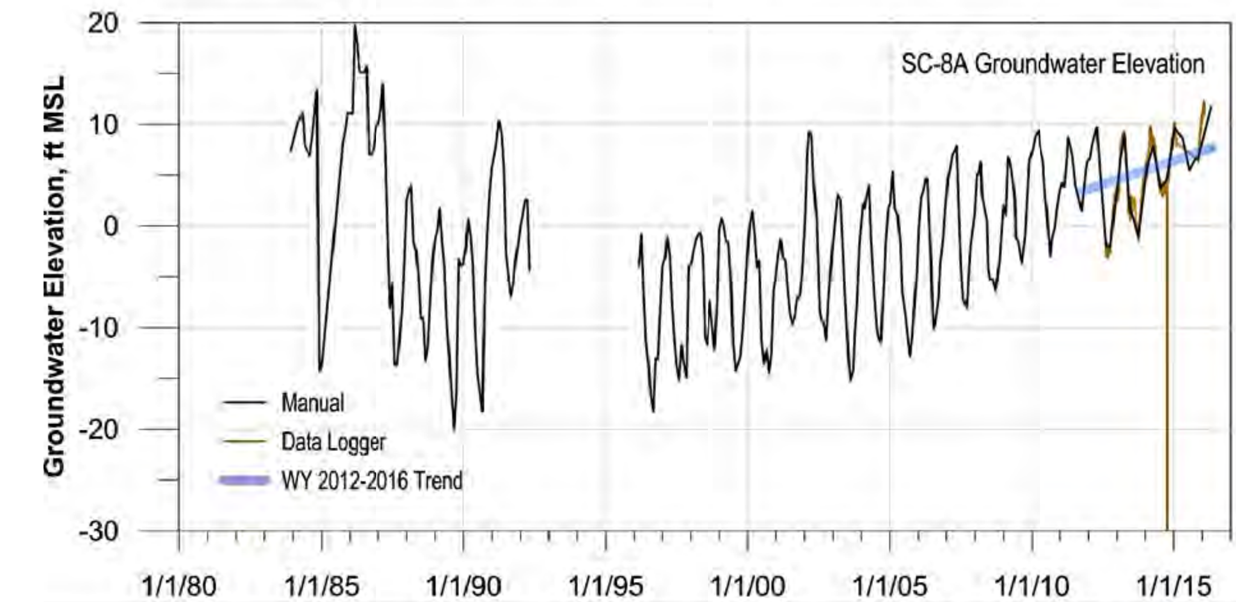

SC-9E replaced in 2012
SC-9E Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

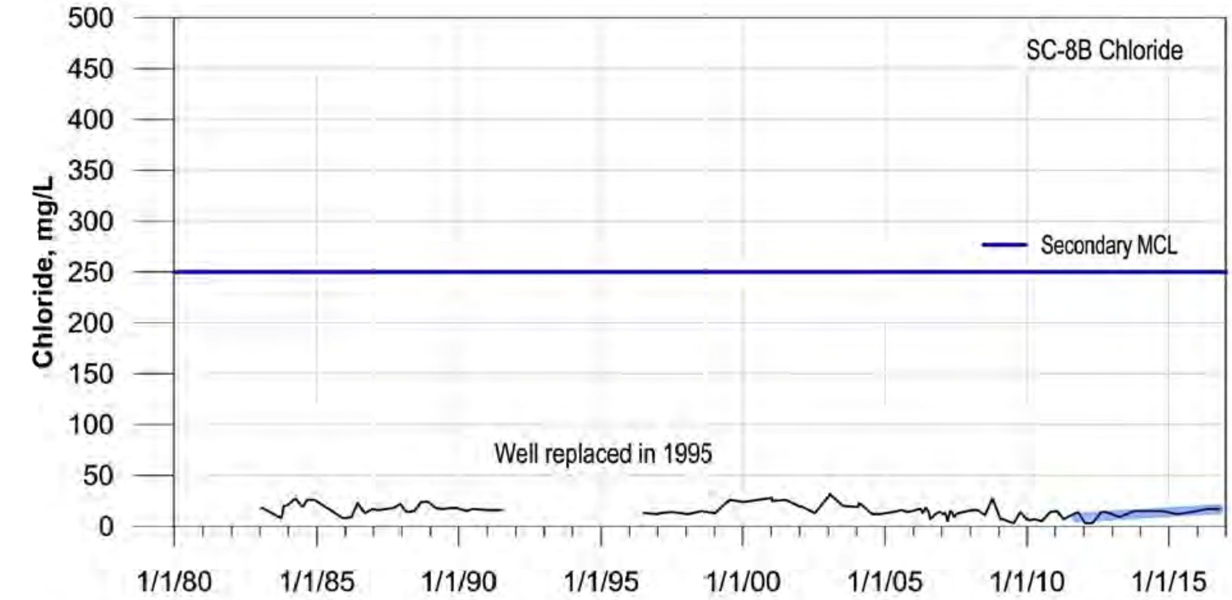

SC-9E Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Manual
Data Logger
WY 2012-2016 Trend
SC-9E Groundwater Elevation
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

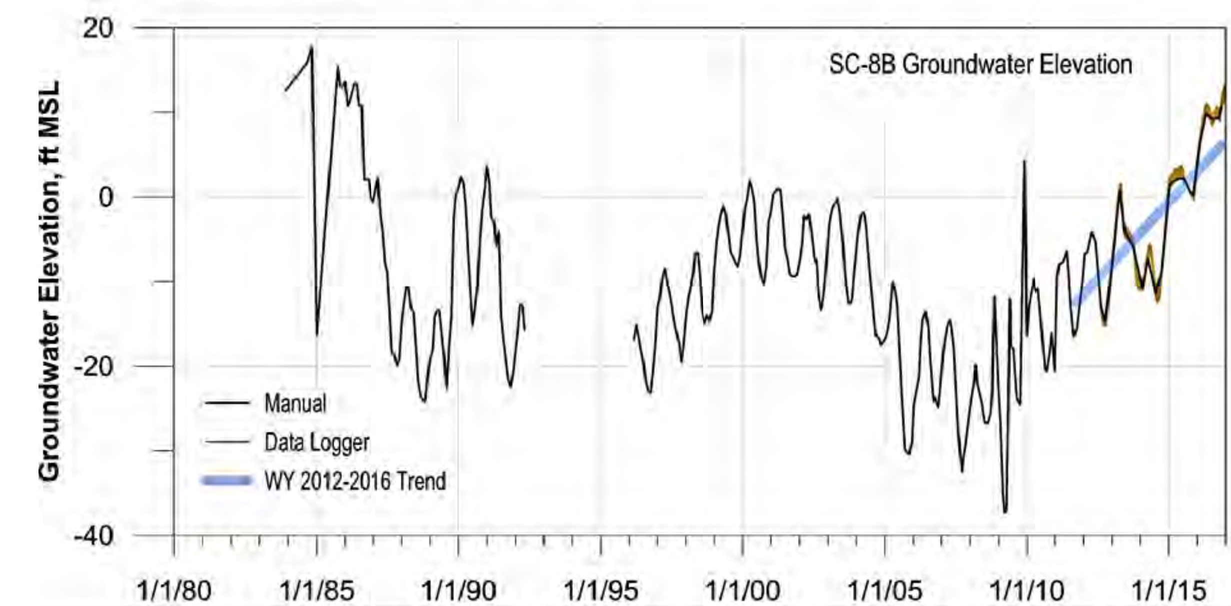

Well replaced in 1995
SC-8A Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-8A Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-8A Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
Data Logger
WY 2012-2016 Trend
20
10
0
-10
-20
-30
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

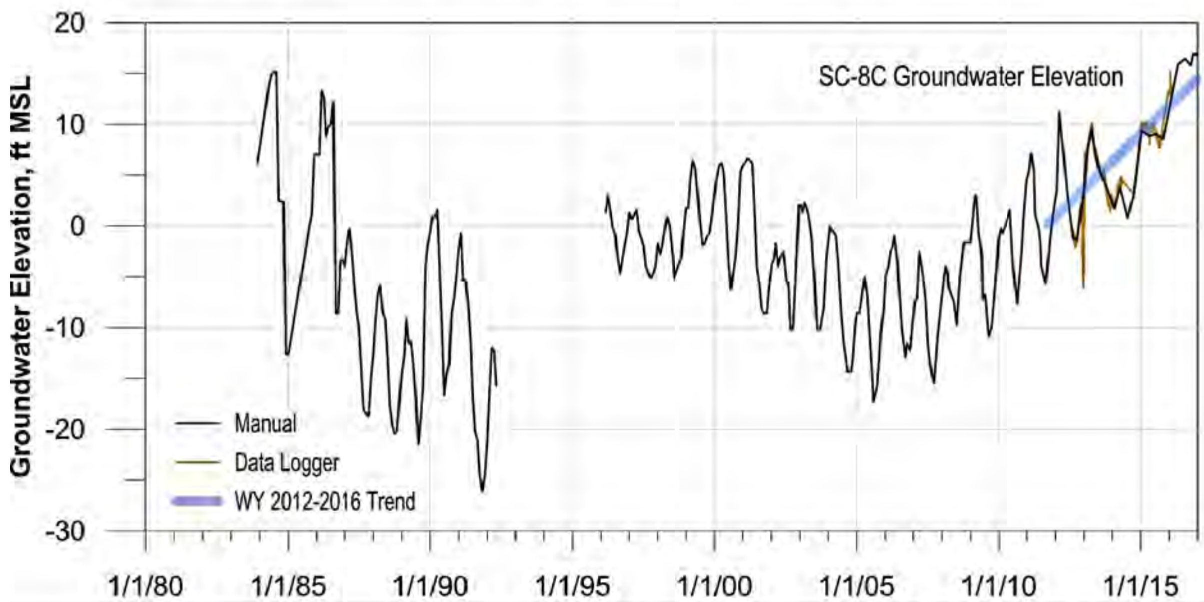

SC-8B Chloride
Chloride, mg/L
Secondary MCL
Well replaced in 1995
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

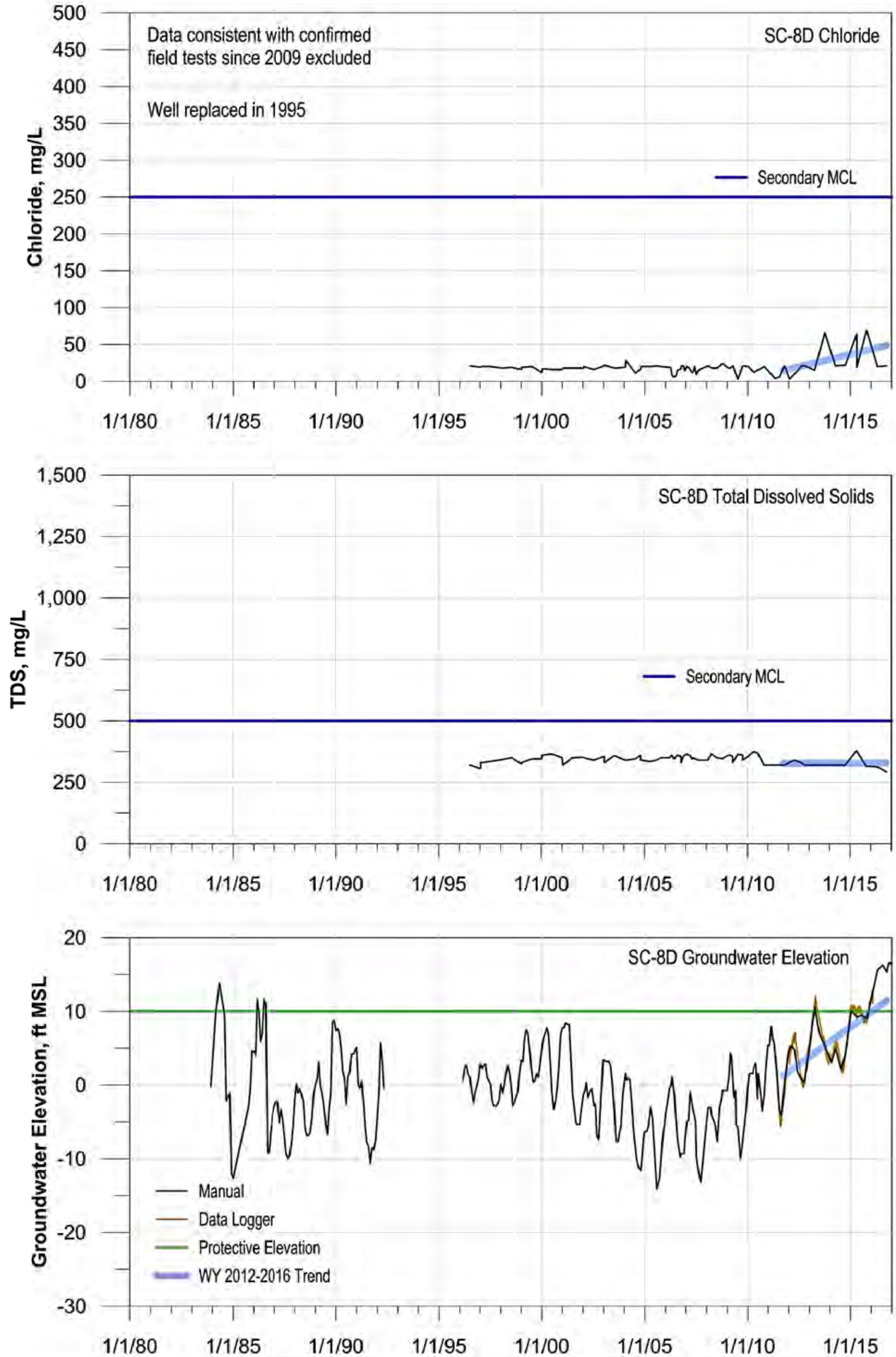

SC-8B Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-8B Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
Data Logger
WY 2012-2016 Trend
20
0
-20
-40
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-8C Chloride
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
Secondary MCL
Well replaced in 1995
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-8C Total Dissolved Solids
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
Secondary MCL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

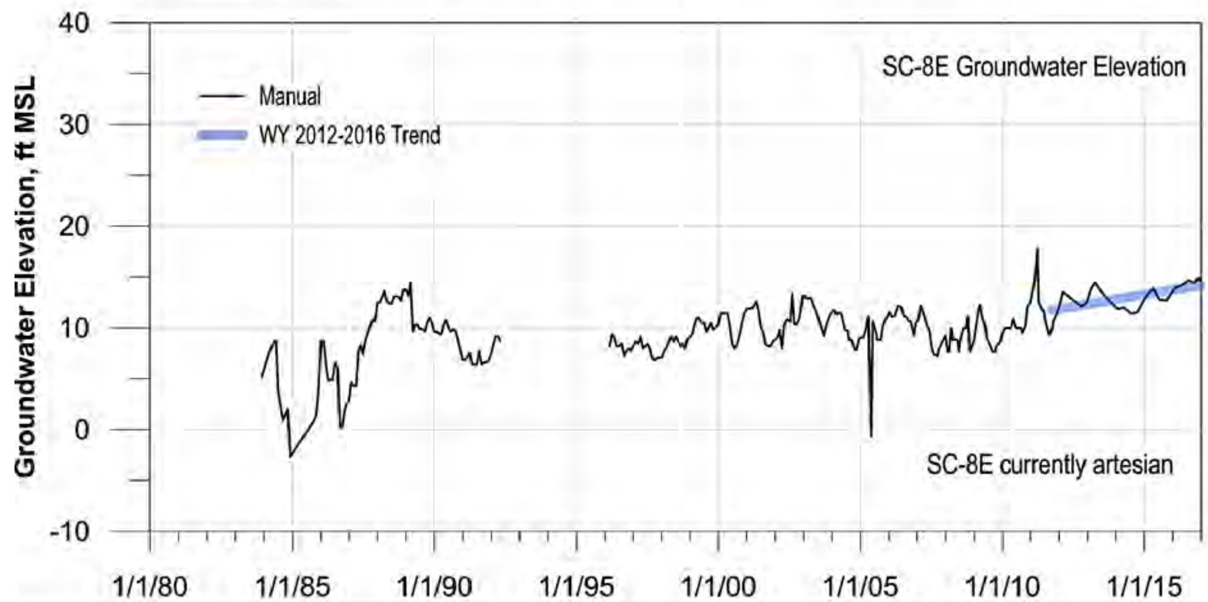

SC-8C Groundwater Elevation
Groundwater Elevation, ft MSL
20
10
0
-10
-20
-30
Manual
Data Logger
WY 2012-2016 Trend
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

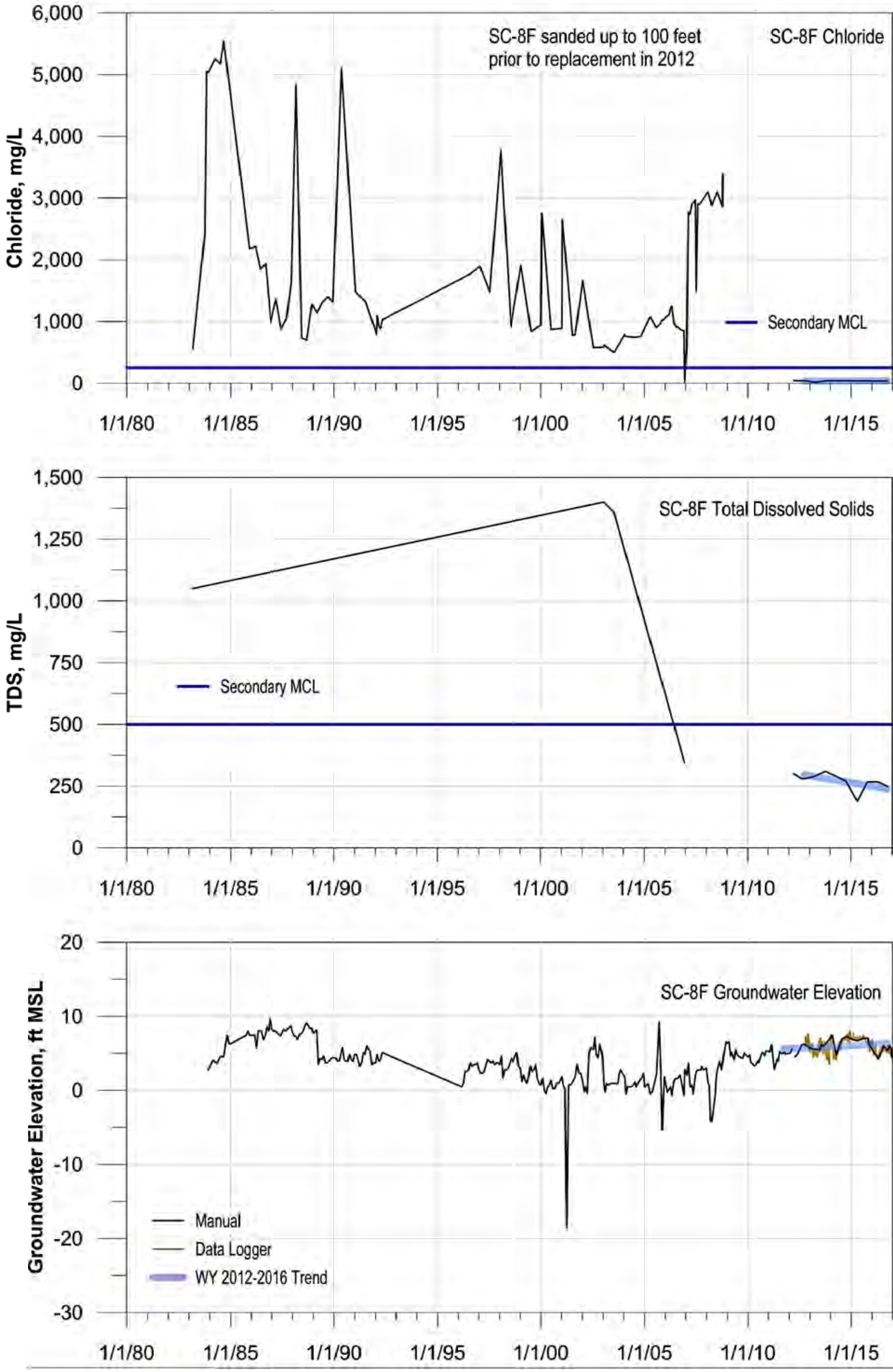


Data consistent with confirmed field tests since 2009 excluded
Well replaced in 1995
SC-8D Chloride
Secondary MCL
Chloride, mg/L
SC-8D Total Dissolved Solids
Secondary MCL
TDS, mg/L
SC-8D Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
Data Logger
Protective Elevation
WY 2012-2016 Trend
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

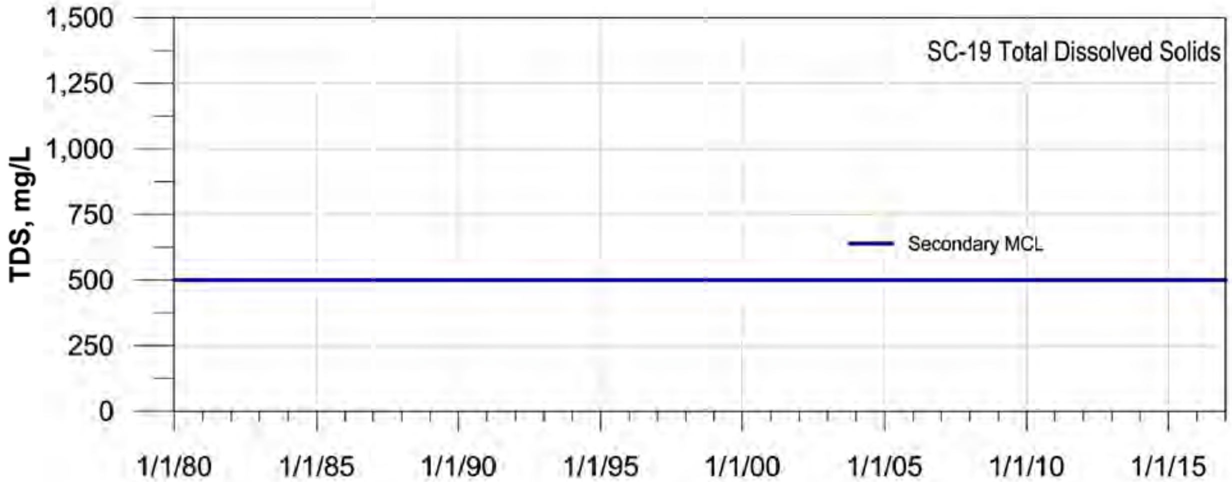

SC-8E Chloride
Secondary MCL
Chloride, mg/L
Well replaced in 1995
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

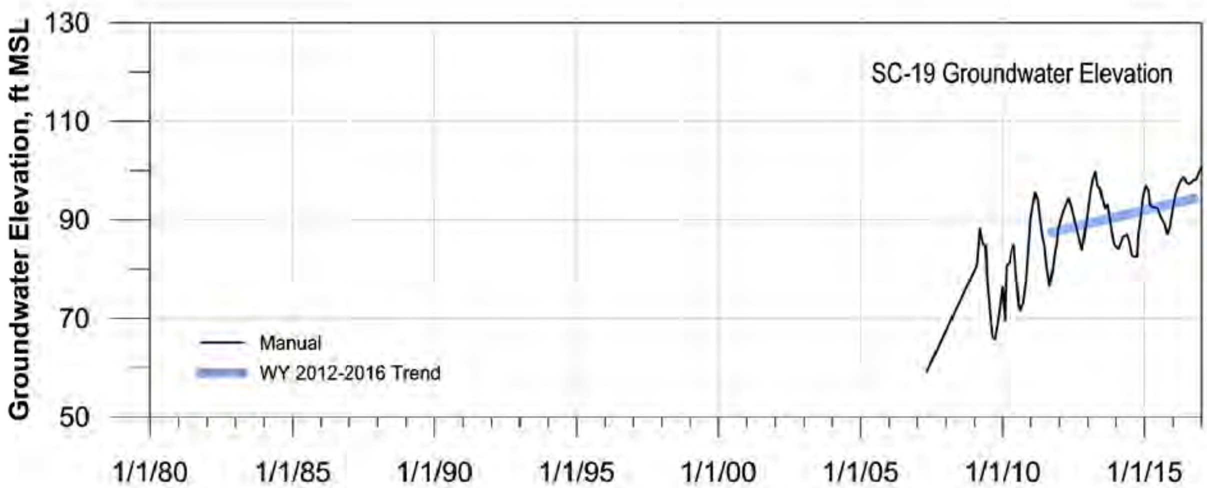

SC-8E Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-8E Groundwater Elevation
Manual
WY 2012-2016 Trend
Groundwater Elevation, ft MSL
SC-8E currently artesian
40
30
20
10
0
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

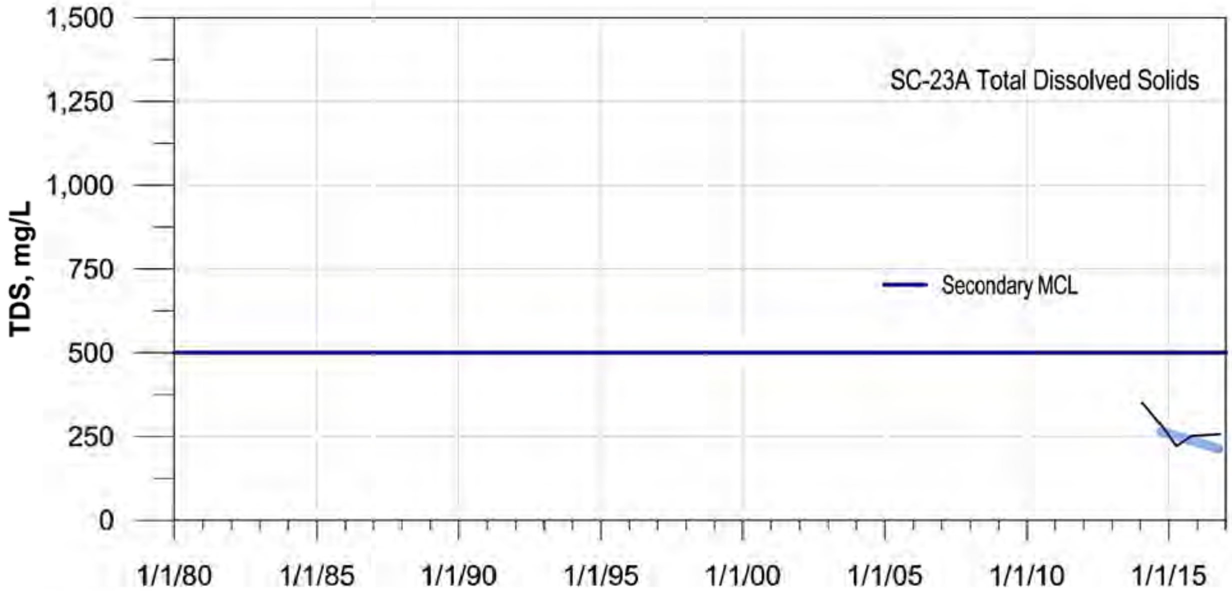

SC-8F sanded up to 100 feet prior to replacement in 2012
SC-8F Chloride
Chloride, mg/L
6,000
5,000
4,000
3,000
2,000
1,000
0
Secondary MCL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-8F Total Dissolved Solids
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
Secondary MCL
SC-8F Groundwater Elevation
Groundwater Elevation, ft MSL
20
10
0
-10
-20
-30
Manual
Data Logger
WY 2012-2016 Trend

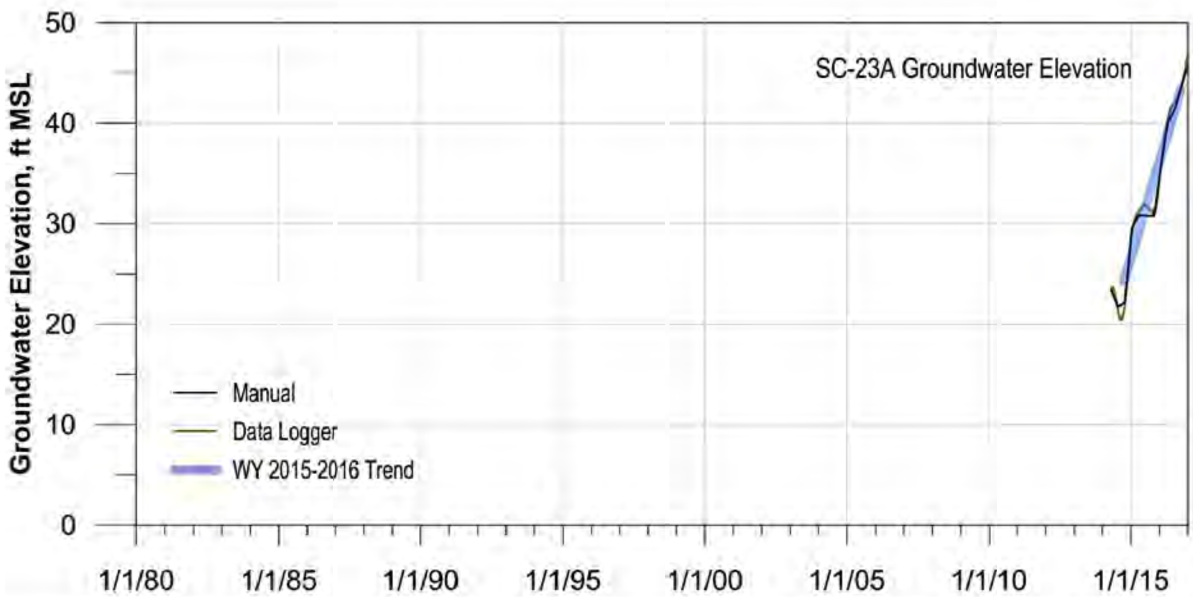

SC-19 Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-19 Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-19 Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
WY 2012-2016 Trend
130
110
90
70
50
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

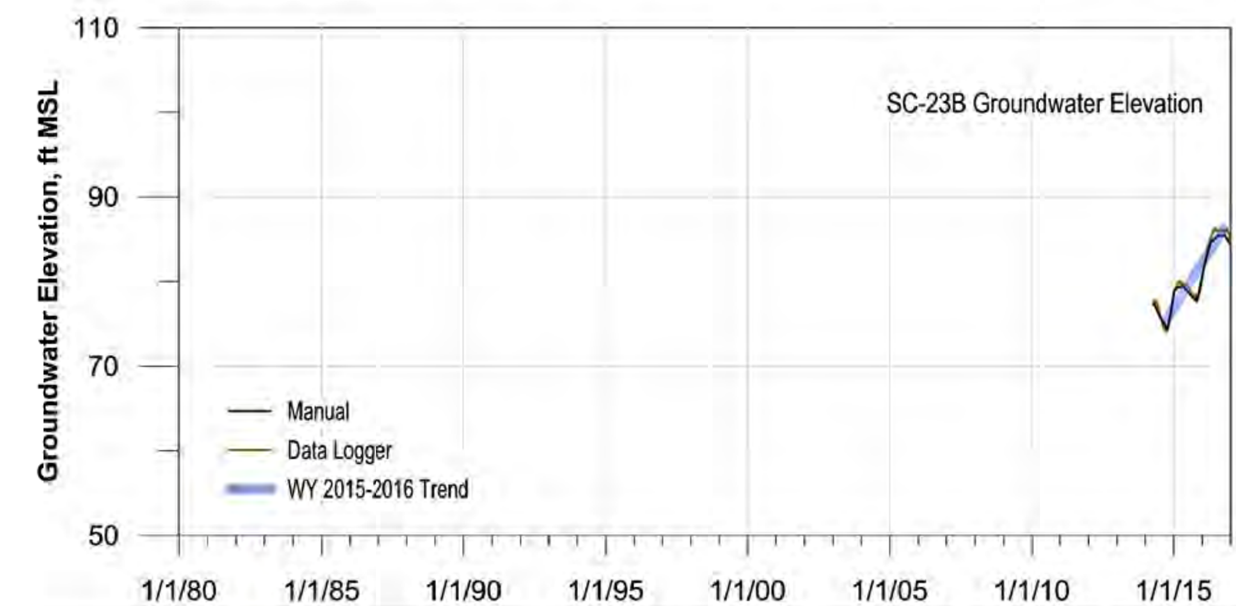

SC-23A Chloride
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
Secondary MCL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-23A Total Dissolved Solids
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
Secondary MCL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-23A Groundwater Elevation
Groundwater Elevation, ft MSL
50
40
30
20
10
0
Manual
Data Logger
WY 2015-2016 Trend
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

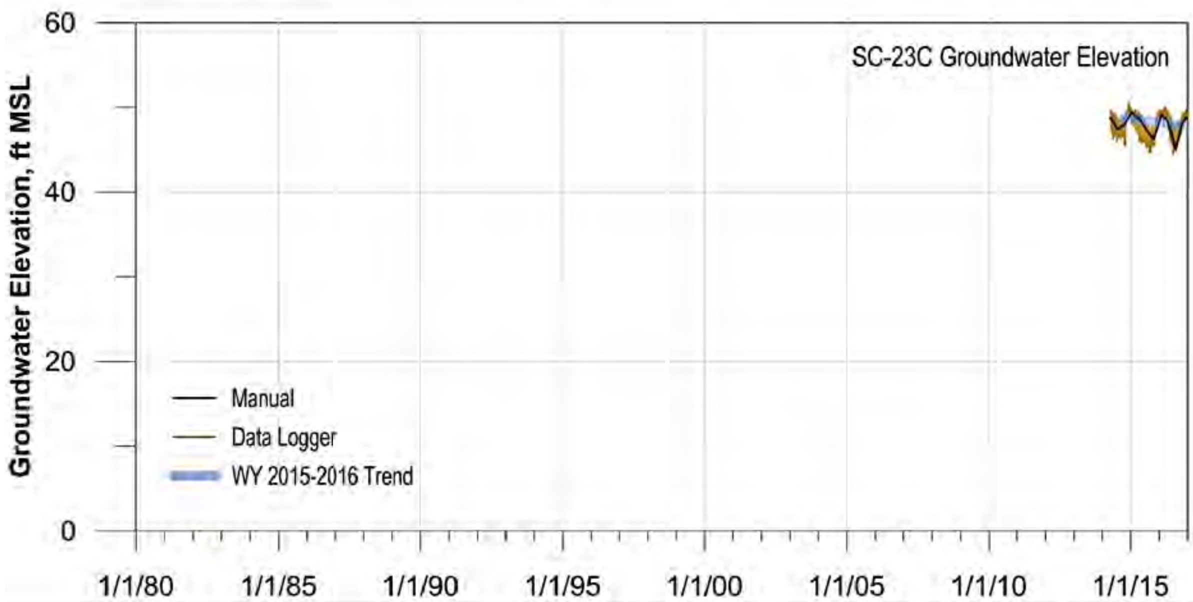

SC-23B Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-23B Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

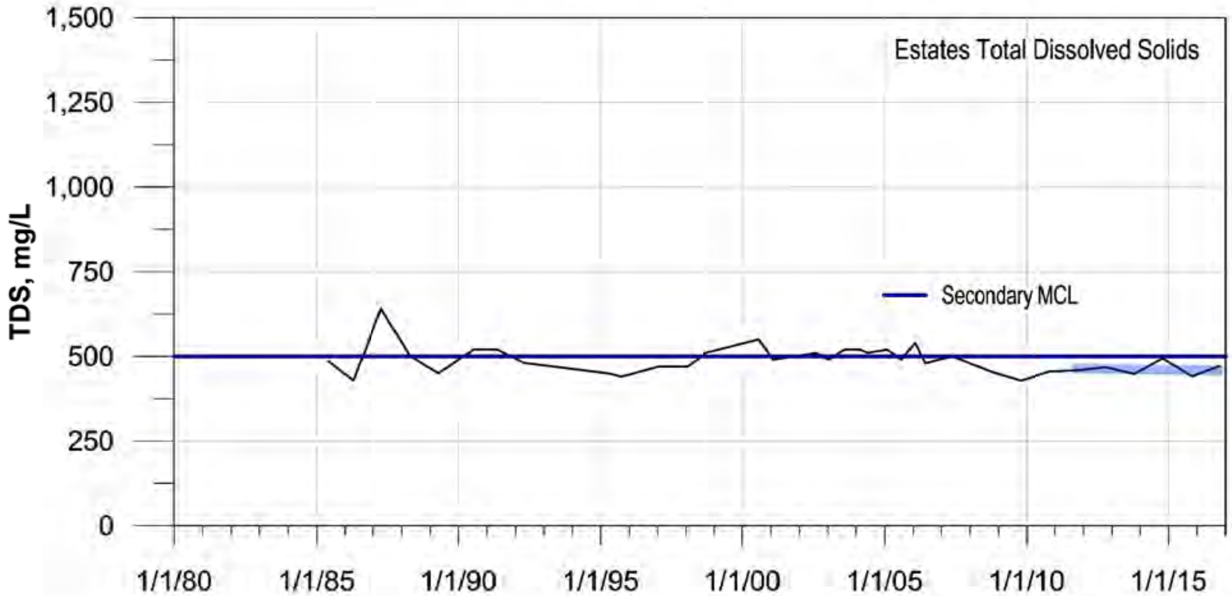

SC-23B Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
Data Logger
WY 2015-2016 Trend
110
90
70
50
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

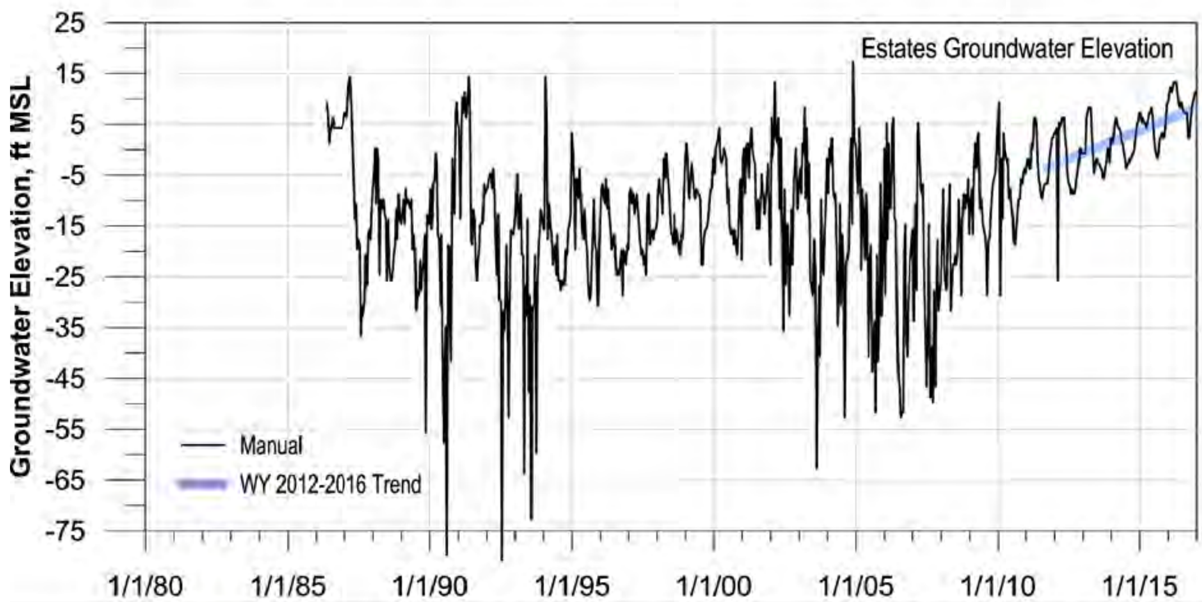

SC-23C Chloride
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
Secondary MCL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

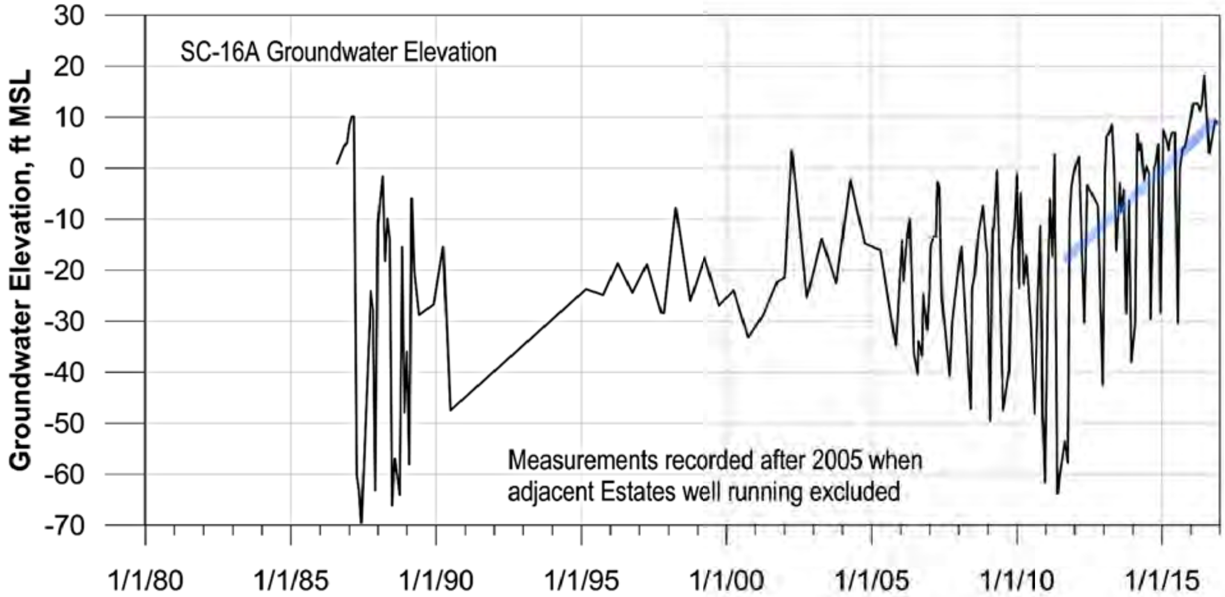

SC-23C Total Dissolved Solids
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
Secondary MCL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

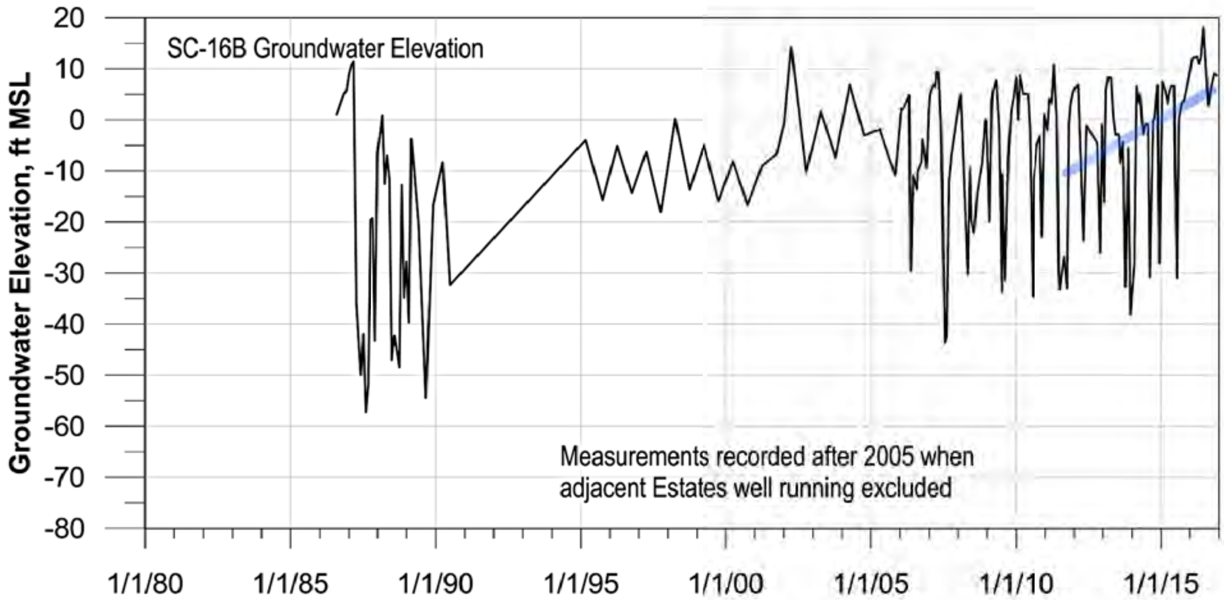

SC-23C Groundwater Elevation
Groundwater Elevation, ft MSL
60
40
20
0
Manual
Data Logger
WY 2015-2016 Trend
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Estates Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

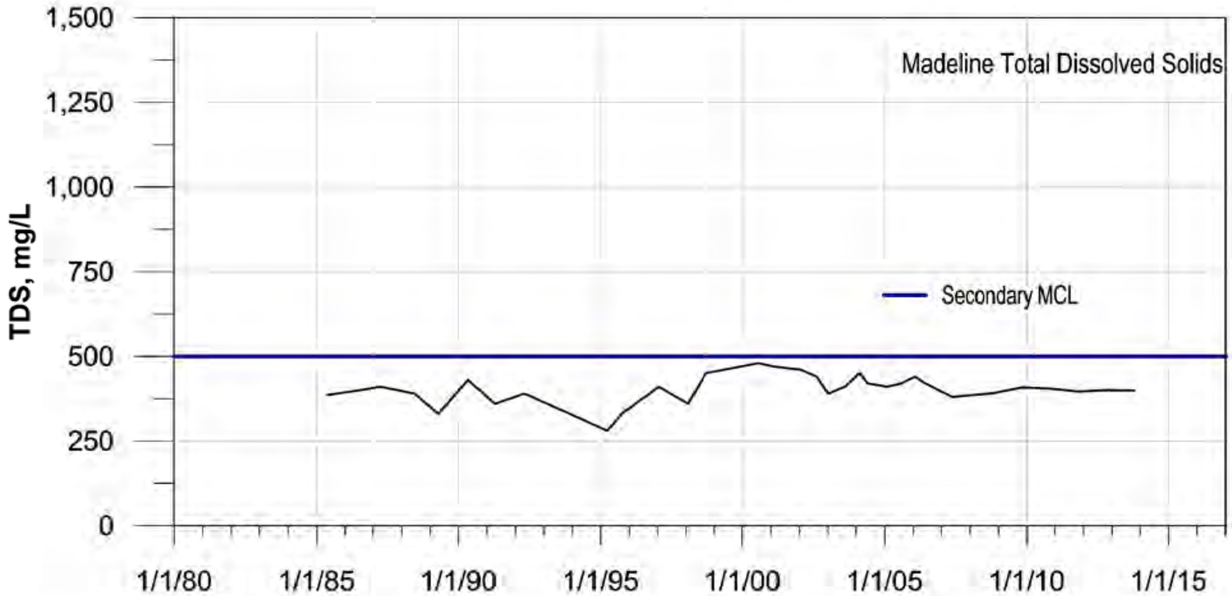

Estates Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

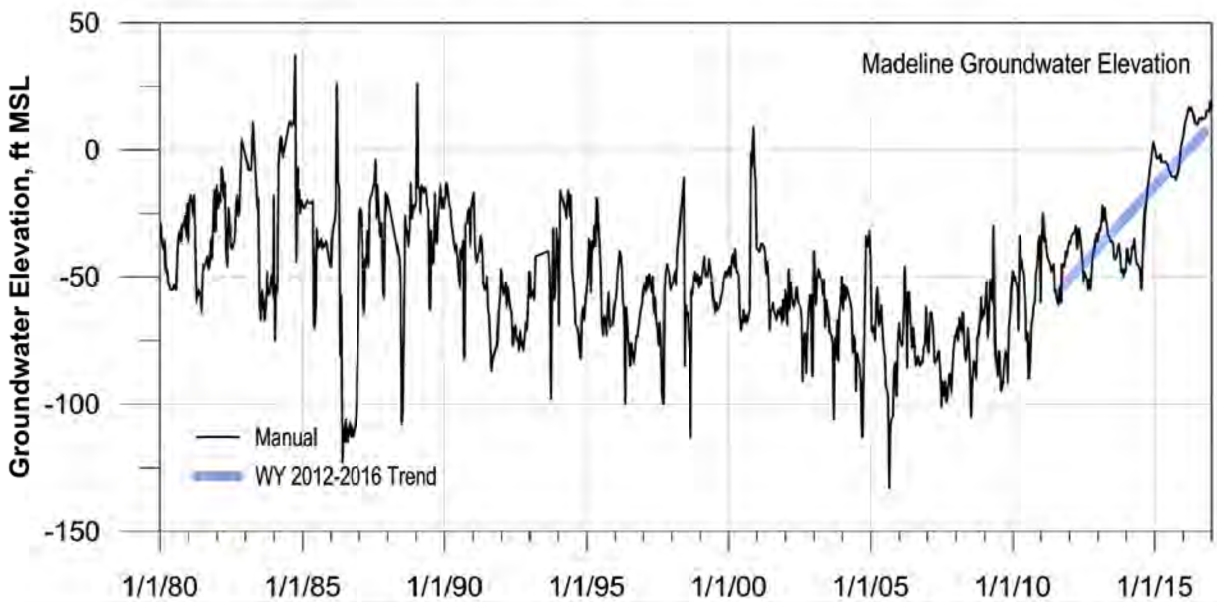

Estates Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
WY 2012-2016 Trend
25
15
5
-5
-15
-25
-35
-45
-55
-65
-75
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-16A Groundwater Elevation
Groundwater Elevation, ft MSL
Measurements recorded after 2005 when adjacent Estates well running excluded
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-16B Groundwater Elevation
Groundwater Elevation, ft MSL
Measurements recorded after 2005 when adjacent Estates well running excluded
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

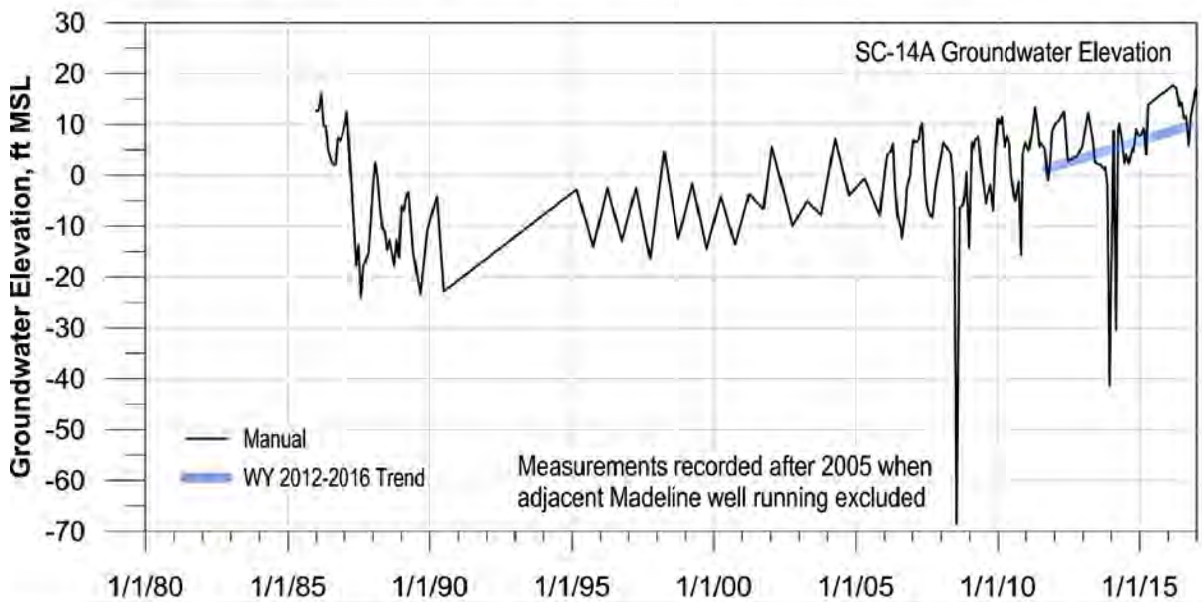

Madeline Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Madeline Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Madeline Groundwater Elevation
Manual
WY 2012-2016 Trend
Groundwater Elevation, ft MSL
50
0
-50
-100
-150
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

SC-14A Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

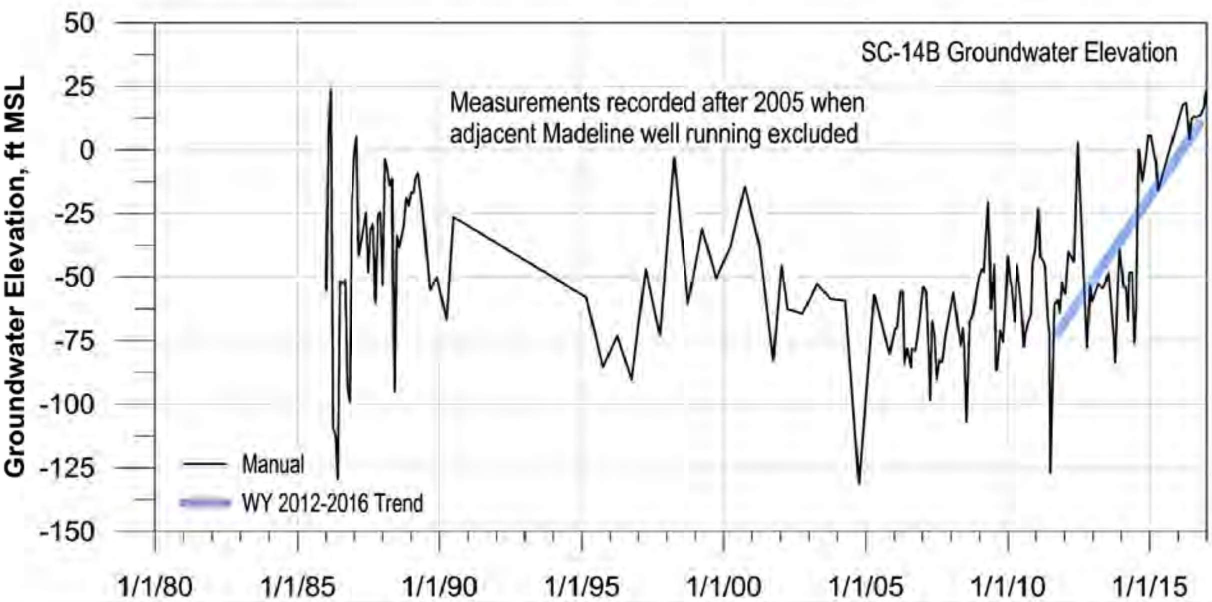
SC-14A Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15



SC-14A Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
WY 2012-2016 Trend
Measurements recorded after 2005 when
adjacent Madeline well running excluded
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

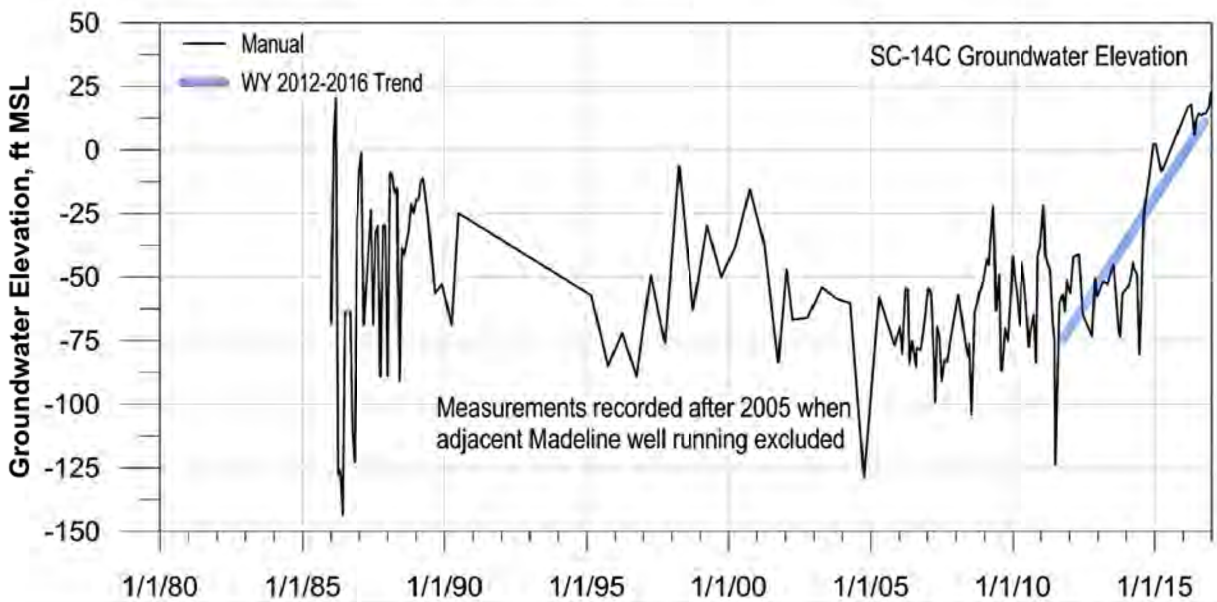

SC-14B Chloride
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
Secondary MCL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-14B Total Dissolved Solids
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
Secondary MCL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

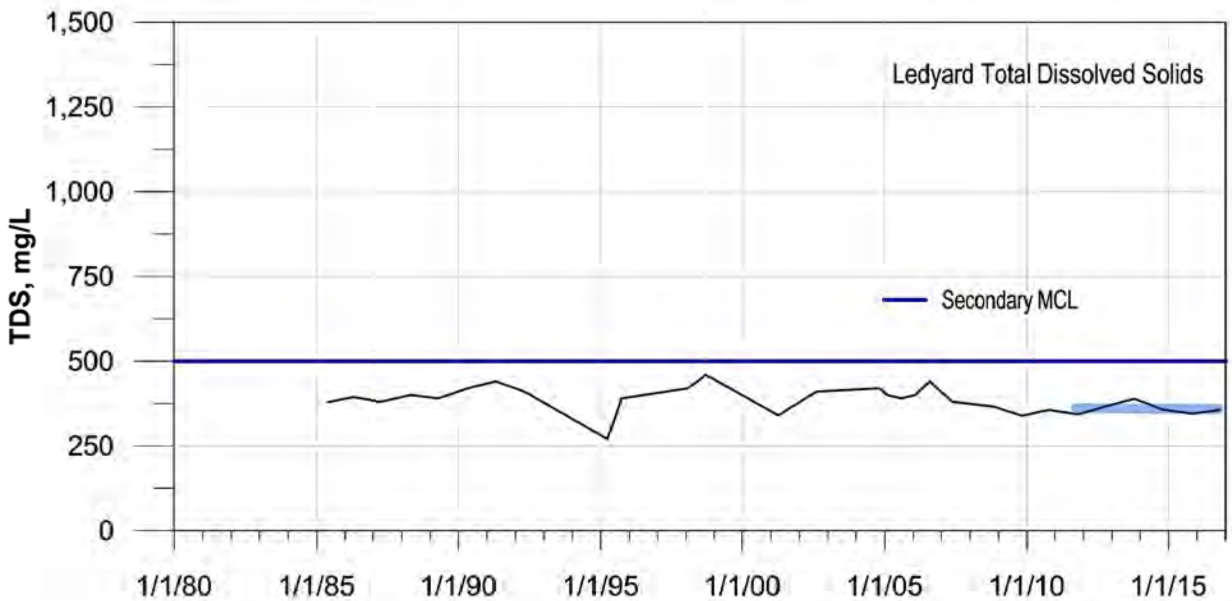

SC-14B Groundwater Elevation
Measurements recorded after 2005 when adjacent Madeline well running excluded
Groundwater Elevation, ft MSL
50
25
0
-25
-50
-75
-100
-125
-150
Manual
WY 2012-2016 Trend
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-14C Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

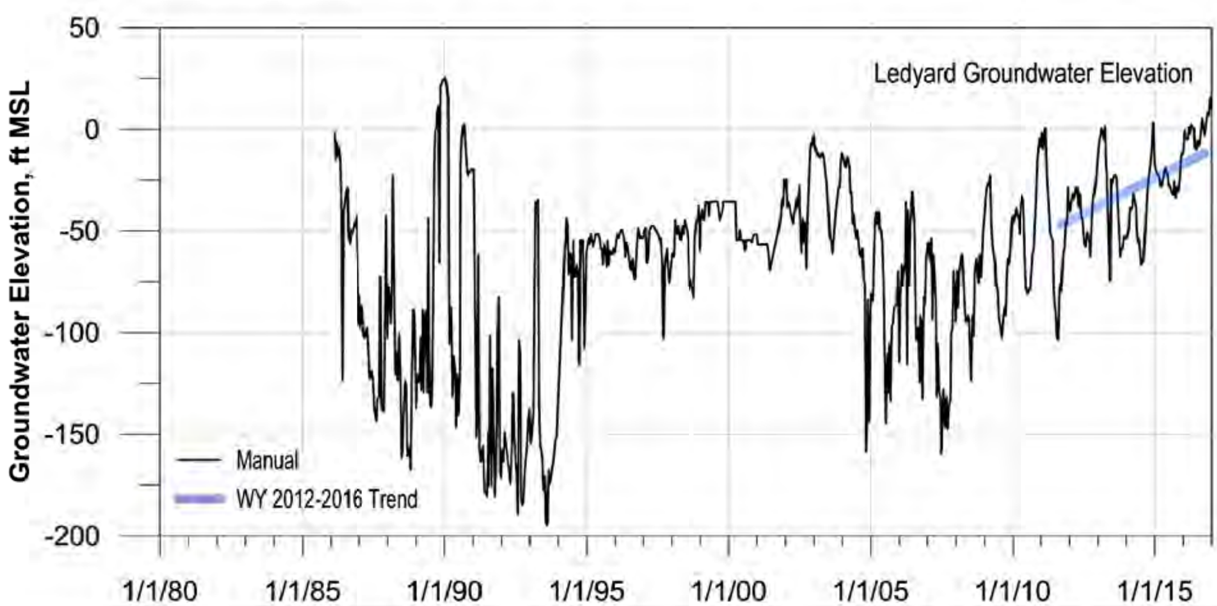

SC-14C Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Manual
WY 2012-2016 Trend
SC-14C Groundwater Elevation
Measurements recorded after 2005 when
adjacent Madeline well running excluded
Groundwater Elevation, ft MSL
50
25
0
-25
-50
-75
-100
-125
-150
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

Ledyard Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15



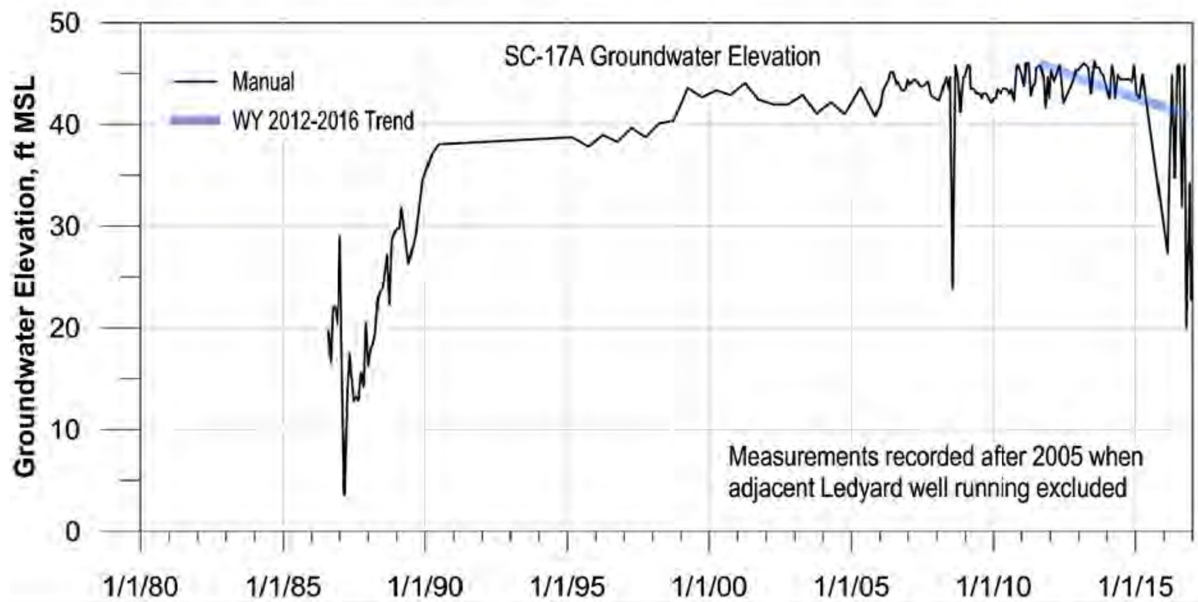
Ledyard Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15



Ledyard Groundwater Elevation
Groundwater Elevation, ft MSL
50
0
-50
-100
-150
-200
Manual
WY 2012-2016 Trend
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

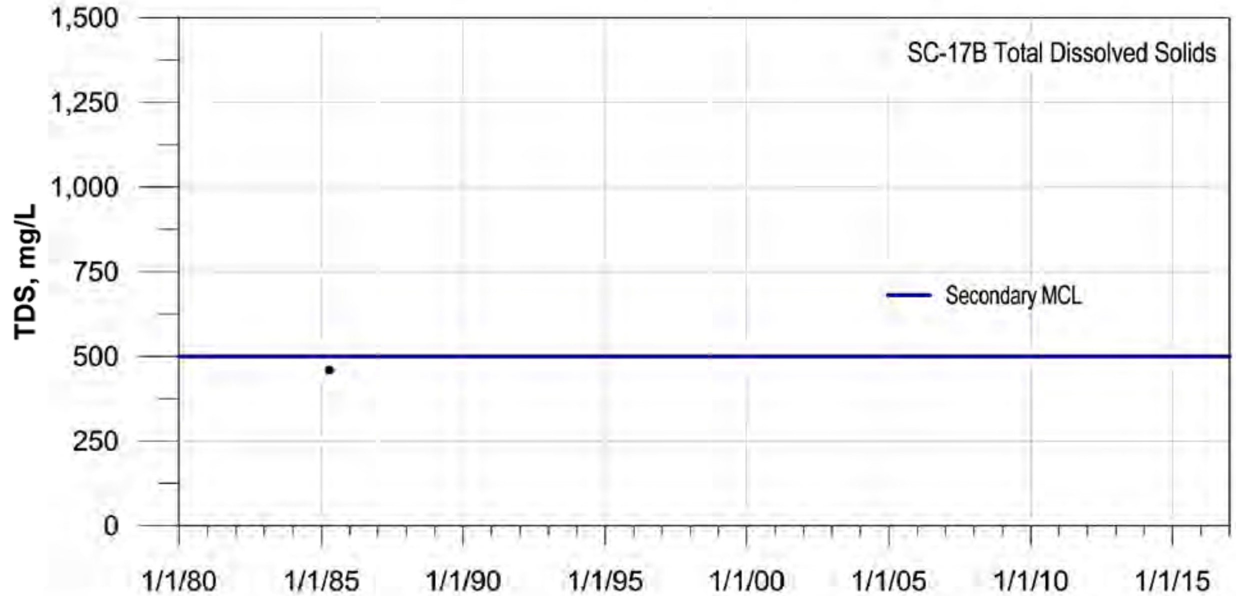
SC-17A Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

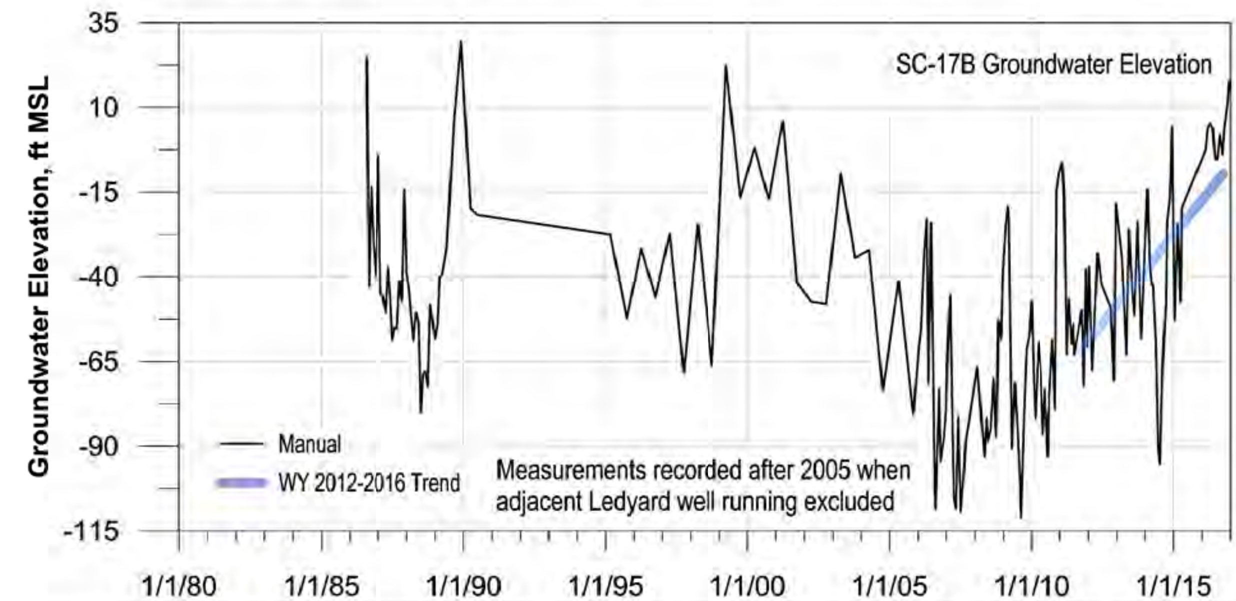
SC-17A Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15



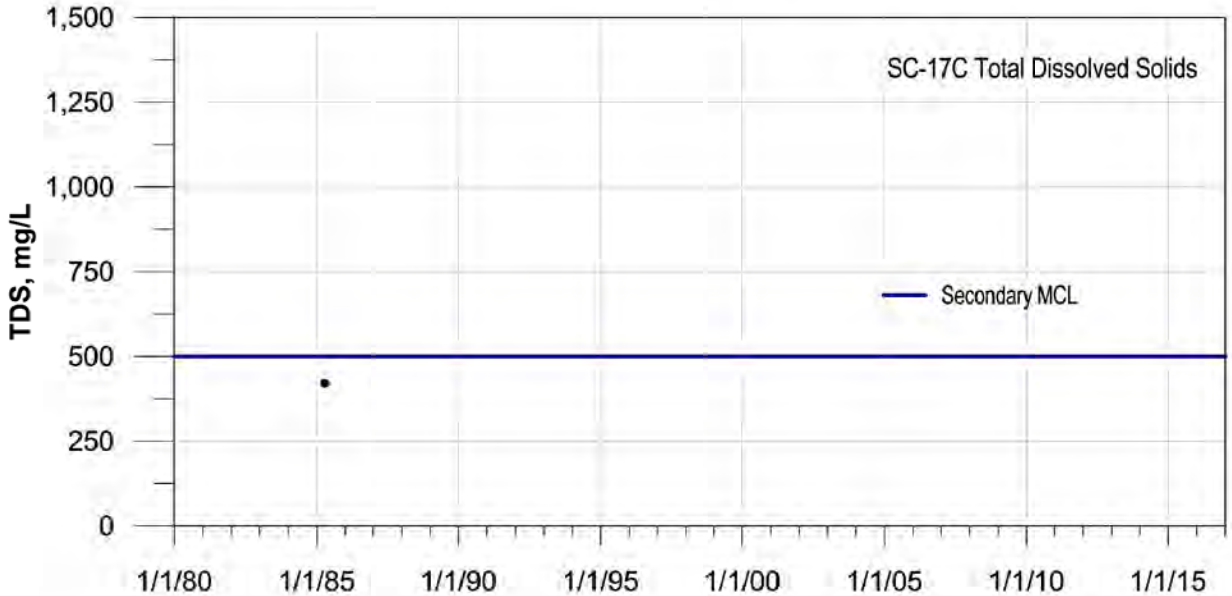
SC-17A Groundwater Elevation
Manual
WY 2012-2016 Trend
Groundwater Elevation, ft MSL
50
40
30
20
10
0
Measurements recorded after 2005 when adjacent Ledyard well running excluded
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

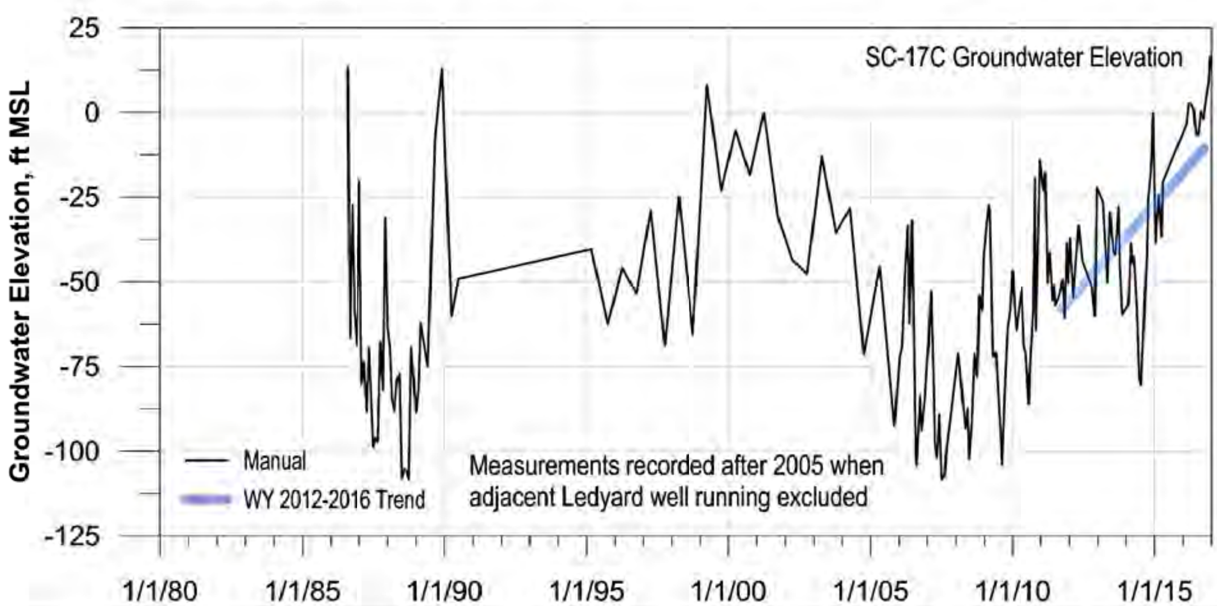

SC-17B Chloride
Chloride, mg/L
Secondary MCL
0
50
100
150
200
250
300
350
400
450
500
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

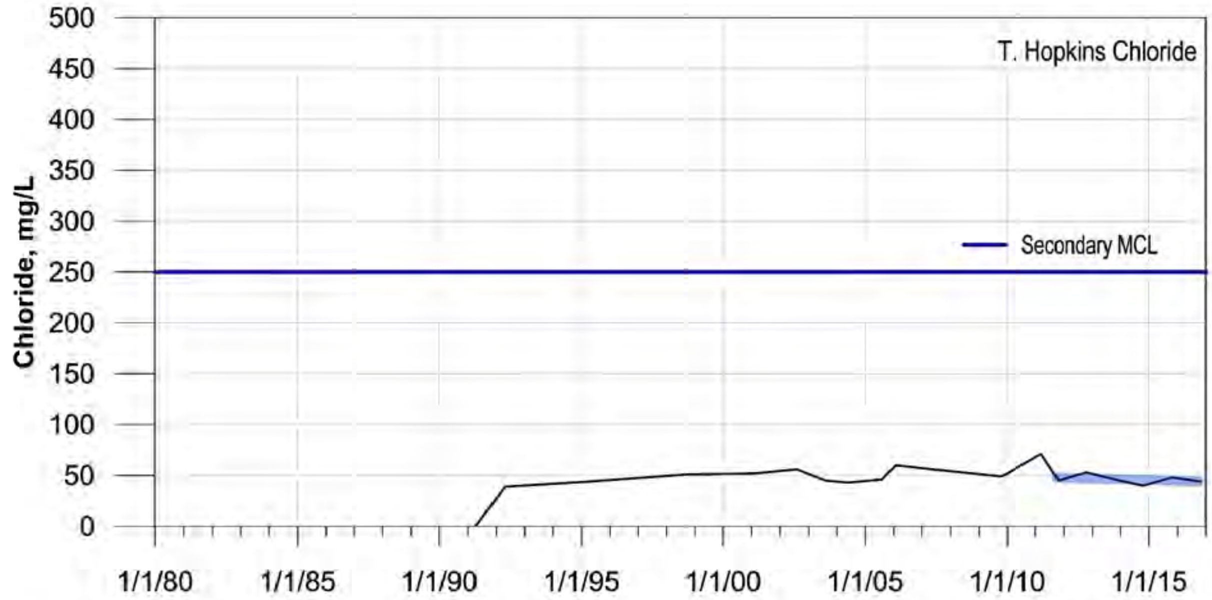

SC-17B Total Dissolved Solids
TDS, mg/L
Secondary MCL
0
250
500
750
1,000
1,250
1,500
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-17B Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
WY 2012-2016 Trend
Measurements recorded after 2005 when adjacent Ledyard well running excluded
35
10
-15
-40
-65
-90
-115
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

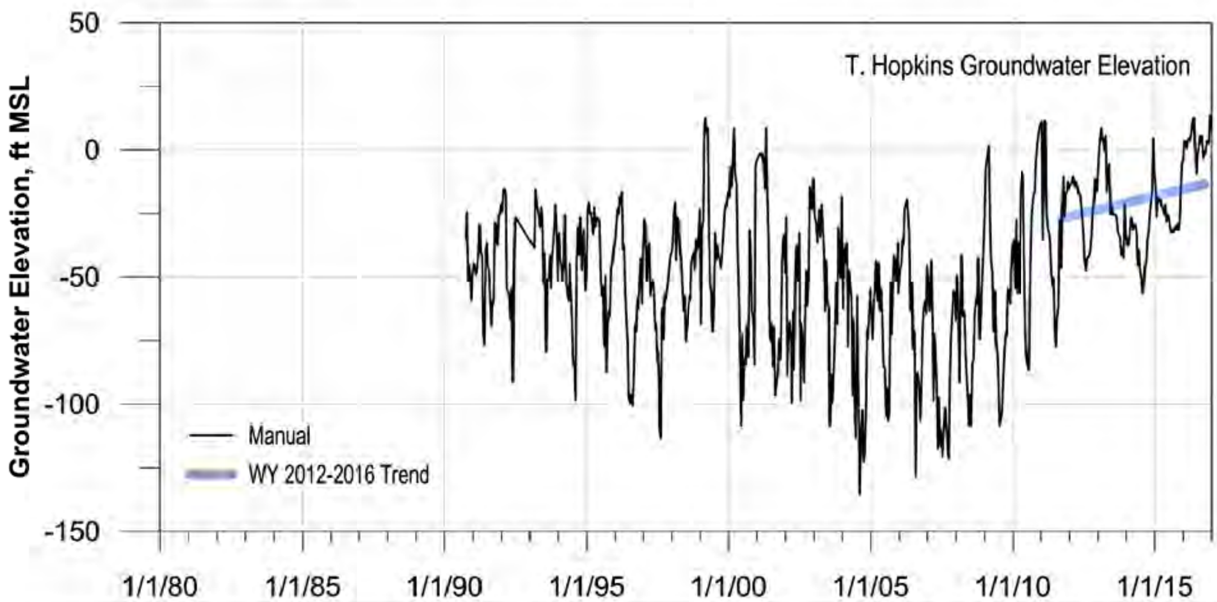

SC-17C Chloride
Chloride, mg/L
Secondary MCL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-17C Total Dissolved Solids
TDS, mg/L
Secondary MCL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

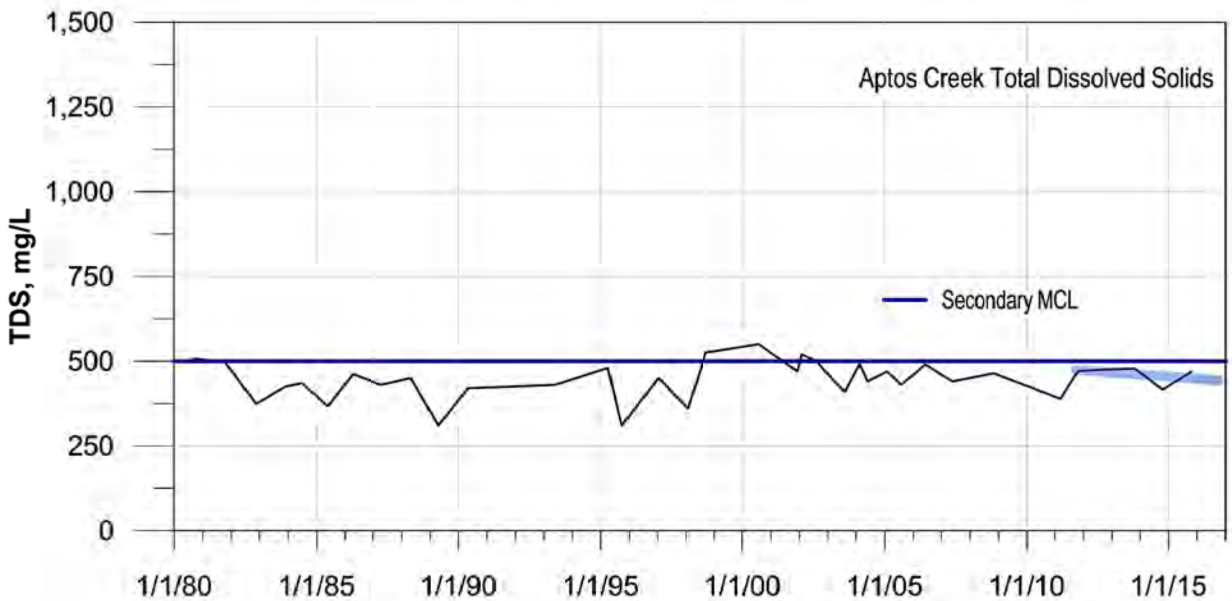

SC-17C Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
WY 2012-2016 Trend
Measurements recorded after 2005 when adjacent Ledyard well running excluded
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

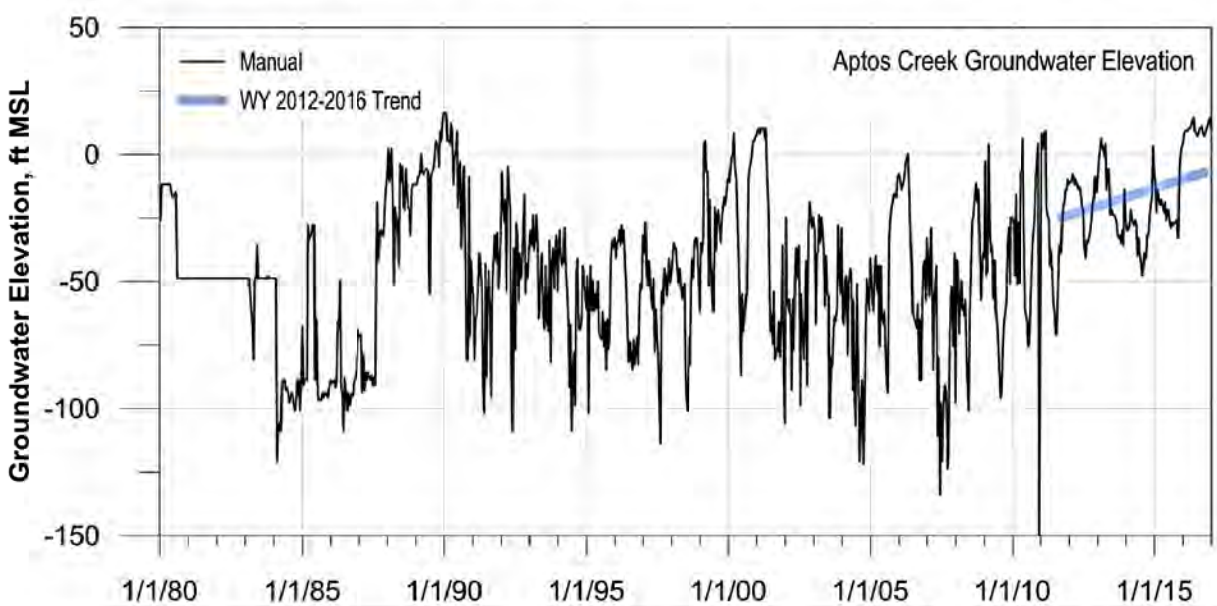

T. Hopkins Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


T. Hopkins Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


T. Hopkins Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
WY 2012-2016 Trend
50
0
-50
-100
-150
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Aptos Creek Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Aptos Creek Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Manual
WY 2012-2016 Trend
Aptos Creek Groundwater Elevation
Groundwater Elevation, ft MSL
50
0
-50
-100
-150
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

SECTION 5 – WATER YEAR 2015-16 AQUIFER CONDITIONS FOR AROMAS AREA (PURISIMA F-UNIT/AROMAS RED SANDS)

This section presents groundwater level and water quality conditions for Water Years 2015 and 2016 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 Santa Cruz Mid-County Basin, 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 1,100 and 1,069 acre-feet in Water Years 2015 and 2016, a decrease from the previous water year, and the lowest since service area production started being recorded in 1984. Service Area IV production in the La Selva Beach area was less than 1 acre-foot for Water Years 2015-16. The Sells well was taken out of service in April 2009 due to high nitrate concentrations. The Altivo well was taken out of service in January 2015 due to high Chromium VI concentrations.

There was no production from the CWD Cox well field, completed in the Purisima F-unit, due to the poor condition of those wells (HydroMetrics WRI and Kennedy/Jenks, 2013), during Water Years 2014-16 and the Cox wells have been disconnected from CWD's system. Over the previous fifteen years prior to 2014, only a small proportion of CWD's pumping has been from the Cox well field. Production at its Rob Roy well field completed in the Aromas Red Sands was 391 and 384 acre-feet in Water Years 2015 and 2016. Production at the Rob Roy well field was below 400 acre-feet per year for the first time since Water Year 1985. Well #12 has been used as the lead well starting in 2003.

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 and Polo Grounds wells and CWD's Cox wells, which are screened in the Purisima F-unit. With pumping at the Aptos Jr. High and Polo Grounds wells totaling 295 and 247 acre-feet in Water Year 2015 and 2016, falling below 300 acre-feet after three straight years above that amount. The Aptos Jr.

High well was taken out of service in Water Year 2016 for replacement. 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 for which recharge has been estimated (HydroMetrics WRI, 2012a).

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. Overall, production has declined since Water Year 2004 and declined to the lowest amounts since well specific production became available in Water Year 1984. SqCWD production in the Seascape area was 805 and 822 acre-feet in Water Year 2015 and 2016. Seascape area and Rob Roy combined total pumping in Water Year 2014 was 1,196 and 1,206 acre-feet, also the lowest amounts since well specific production became available in Water Year 1984.

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. In addition, SqCWD has also stopped pumping at the Altivo well as it is the SqCWD production well with the highest Chromium VI concentrations.

5.2 GROUNDWATER LEVEL CONDITIONS AND TRENDS

SqCWD has revised protective groundwater elevations in coastal monitoring wells to protect the Aromas 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, 2012a). As discussed in Section 3.2, the MGA will likely re-consider the protective elevations established by SqCWD when it develops measurable objectives for seawater intrusion in the Groundwater Sustainability Plan (GSP). Therefore, Table 5-1 below presents the percentage of the cross-sectional model runs that protect against seawater intrusion at the average groundwater levels for the water years as well as for comparison against the protective elevations.

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. Table 4-1 shows the screen with lower groundwater levels at each coastal monitoring well location. Hydrographs for multiple completions of monitoring wells in the Aromas area follow at the end of this section

Average groundwater levels are above protective elevations in the northwest part of the Aromas area coastline at SC-A1, where the hydrographs show groundwater levels at these wells have been above protective elevations for most of the monitoring record. In the Seascape area, average groundwater levels remain below protective elevations at SC-A8A. Average groundwater levels at SC-A2 and SC-A3 were above protective elevations in Water Year 2016. Groundwater levels at SC-A3A rising above the protective elevation the last five years is associated with reduced Service Area IV pumping with the Sells well remaining offline. Maintaining groundwater levels above protective elevation at SC-A4 located in the Pajaro Valley Sub-basin will likely depend on pumping by nearby small water systems and private pumping that are closer to SC-A4 than any municipal well.

Table 5-1 (2015-16): Comparison of Water Year 2015-16 Coastal Groundwater Levels with Protective Elevations

Monitoring Well	Protective Elevation (ft msl[1])	Avg. Groundwater Level Water Year 2015 (ft msl)	Percentage of Runs Protective	Avg. Groundwater Level Water Year 2016 (ft msl)	Percentage of Runs Protective
SC-A1B	3	7.6	>99%	7.7	>99%
SC-A8A	6	5.5	>=50%	5.5	>=50%
SC-A2A	3	6.0	>99%	6.3	>99%
SC-A3A	3	2.9	>=50%	3.1	>=80%
SC-A4A[2]	3	1.4	<50%	1.5	<50%

[1] msl = mean sea level

[2] SC-A4 is located in the Pajaro Valley Subbasin southeast of the Santa Cruz Mid-County Basin

Groundwater levels at SqCWD's coastal monitoring wells SC-A1, SC-A8, and SC-A2 showed higher levels in Water Years 2015-16 than previous years. The stabilized groundwater levels correspond with historically low production by SqCWD in the area. However, groundwater levels at SqCWD’s coastal monitoring wells SC-A3 and SC-A4 were slightly lower in Water Years 2015-16 than Water Year 2014 despite no nearby municipal pumping. The lack of correlation between groundwater levels and local municipal pumping may indicate that non-municipal pumping had a more immediate effect on groundwater levels in the Aromas area than the Purisima area. Johnson et al. (2004) had previously concluded that groundwater levels in the area did not reflect year to year changes in climatic conditions. Table 5-2 summarizes by monitoring well groundwater level trends over the last five years along with any changes to the trends over Water Years 2015 and 2016.

Hydrographs for multiple completions of monitoring wells near the SqCWD and CWD production wells are included at the end of this section. Hydrographs for single wells including production wells are included with chemographs. These hydrographs show trend lines for Water Years 2010-2014 when there have been decreases of municipal production for the Aromas area.

Contour maps of groundwater elevations in Spring and Fall 2016 for the Aromas Red Sands are shown in Figure 5-2 and Figure 5-3, respectively. Both Spring and Fall 2016 contour maps show that groundwater levels were above sea level, although coastal groundwater levels are below protective elevations for some of the coast. Groundwater flows toward the coast where it is partially intercepted by production wells from SqCWD's Country Club well to San Andreas well. These flows may not be sufficient to prevent seawater intrusion as coastal groundwater levels are sometimes below protective elevations.

As discussed in Section 4.2, contour maps of groundwater elevations of the DEF and F units for spring and fall of the two water years are included as Figure 4-4 and Figure 4-5. The eastern area with SqCWD's Service Area 3 and 4 wells and CWD's wells represent the shallower F unit groundwater levels. SqCWD's Aptos Jr. High and Polo Grounds wells and CWD's now inactive Cox well field do not underlie the Aromas Red Sands and a pumping depression at the Polo Grounds well is evident on Figure 4-4 and Figure 4-5. East of this area, the F unit mostly underlies Aromas Red Sands. Pumping depressions are evident at CWD's Rob Roy #12 as well as between Country Club and San Andreas wells where production wells are screened in both the F unit and Aromas Red Sands. Groundwater flows towards production wells but also toward the coast that helps reduce risk of further seawater intrusion into the F unit.

The contour maps show that groundwater generally flows from the hills to Monterey Bay with some of the flow pattern altered by pumping. There also appears to be a groundwater flow divide south and east of SqCWD and CWD. South and east of this divide, groundwater flows to Pajaro Valley. There is also a surface watershed divide in this area.

Table 5-2 (2015-16): Summary of Groundwater Level Trends in Aromas Area

Category	Well	Groundwater Level Trend Description	Notes
	SC-A1B	Stable five year trend with WY 2015-16 ~0.5 feet higher than WY 2014	Country Club well offline WY 2012-16
	SC-A8A	Increasing trend since WY 2008 installation with WY 2015-16 ~0.5 feet higher than WY 2014	Low combined pumping at Bonita and San Andreas continues WY 2015-16
	SC-A2A	Increasing five year trend with WY 2015-16 ~2.5 feet higher than WY 2014	Increased pumping at San Andreas and Seascape in WY 2015-16 from WY 2014 still historically low
	SC-A3A	Decreasing five year trend continues in WY 2015-16	Near zero SA IV pumping in WY 2015-16 with Sells and Altivo offline
	SC-A4A	Decreasing five year trend continues in WY 2015-16	In Pajaro Valley Sub-basin, non-municipal pumping more likely to effect
CWD Monitoring Wells in Rob Roy Field	CWD-A	Small downward trend since WY 2010	None
	CWD-B	Small downward trend since WY 2010	None
	CWD-C	Increasing five year trend and WY 2015-16 higher than WY 2014	Lower CWD pumping at Rob Roy WY 2015-16
Inland Wells	SC-20A	Decreasing five year trend slows in WY 2015-16	WY 2013 first full year Polo Grounds online
	SC-20B	Decreasing five year trend slows in WY 2015-16	
	Black Monitoring Well	Decreasing five year trend continues in WY 2015-16	Lower rainfall in WY 2012-2016.
	Cox Wells	Decreasing five year trend continues in WY 2015-16	Lower rainfall in WY 2012-2016 while Cox pumping < 10 afy

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 are below protective elevations in the part of the Aromas area nearest most of SqCWD's pumping in the Aromas area. This indicates there is risk of seawater intrusion continuing to advance 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 (SC-A8A, SC-A2A, SC-A3A, and SC-A4A) installed below the freshwater-saltwater interface but are stable. Chloride concentrations are above 6,000 mg/L, approximately 30% full strength seawater, in these wells.

At Aromas area wells (SC-A1A, SC-A1B, SC-A8B, and SC-A4B) where the saltwater interface has not been indicated, concentrations are stable or decreasing.

At the Aromas area wells installed above the saltwater interface but the interface has since risen into (SC-A2B and SC-A3B), concentrations continue to indicate intrusion but do not appear to be continuing to increase. A series of changes in sampling equipment and settings at SC-A3B make it difficult to evaluate the trend at that well beyond the last two years. The presence of saltwater interface in these wells represent the closest interface of the location to SqCWD production wells with the Seascape, Sells, and Altivo wells closest to the interface. SqCWD limits pumping at those three wells. Groundwater levels at these coastal monitoring wells are now at or above protective elevations and stable concentrations in these wells indicate groundwater levels are high enough to prevent further intrusion.

In addition, concentrations at the SC-A5 wells screened below the Seascape well are high and indicate that seawater has advanced to below that production well. However, concentrations have stabilized over Water Years 2015 and 2016 after previously rising, consistent with intrusion stabilizing at SC-A2 and low pumping at the Seascape well. The high concentrations should be monitored closely as a potential risk to the Seascape 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.

Observed Total Dissolved Solids (TDS) and chloride concentrations in SqCWD's and CWD’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 SqCWD’s 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 in 2009 and 2010. The well was removed from service in April 2009. The well was not sampled for nitrate from 2011.

The California Division of Drinking Water implemented a new drinking water standard (MCL) for Chromium VI of 10 µg/L beginning July 1, 2014 and was in effect through 2016. Chromium VI concentrations in SqCWD’s Altivo well have been approximately 40 µg/L and SqCWD took this well offline December 2014. Chromium VI concentrations in SqCWD production wells Bonita, San Andreas, and Seascape screened in the Aromas Red Sands ranged from 8 to 17 µg/L in Water Years 2015 and 2016. Chromium VI has also been detected in the Country Club well at lower concentrations. SqCWD operates a temporary treatment plant to treat water pumped from Bonita and San Andreas wells with a treatment goal of 2 µg/L. Chromium VI concentrations in CWD production wells Rob Roy 4, 10, and 12 screened in the Aromas Red Sands are below 10 µg/L. 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). Similar tests were conducted at the Rob Roy 12 well in 2012 (HydroMetrics WRI, 2014a).

OEHHA established a PHG for 1,2,3-trichloropropane of 0.0007 µg/L in August 2009. An enforceable drinking water standard of 0.005 ug/L was proposed by the California Division of Drinking Water; the final standard is expected to be set in 2017. Detections of 1,2,3-trichloropropane averaged 0.0089 µg/L in the Country Club well in Water Years 2015-16. This constituent has not been detected at other wells.

In Fall 2016, arsenic was measured below 1 μg/L in groundwater from the Aptos Jr. High #2 well, which is below the MCL of 10 μg/L for arsenic.

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 parts 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, but has not advanced over Water Years 2015-16. Overall, historically low municipal production in the Aromas area has resulted in some recovery of groundwater levels, but not enough to protect the production aquifers over the entire Aromas area. Reducing the risk of seawater intrusion by raising groundwater levels may not be achieved by maintaining recent low municipal production in the Aromas area.

Table 5-3 (2015-16): 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 freshwater/seawater interface
	SC-A8A	Relatively stable since 2007 installation; chloride=7,000 mg/L	Installed (-391 to -411 ft msl[1]) below interface
	SC-A2A	Long-term increasing trend; chloride = 14,500 mg/L stable WY 2013-16	Installed below interface; near Seascape
	SC-A2B	Long-term increasing trend, chloride decline to <250 mg/L in WY 2015-16 after rise in WY 2014	Installed (-293 to -313 ft msl[1]) above interface when chloride ~ 30 mg/L in WY 1987
	SC-A3A	Stable long-term trend, slight decline in WY 2015-16 after rise in WY 2013-14; chloride > 17,000 mg/L (near full strength seawater)	Installed below interface; near Sells and Bonita, rise in groundwater levels WY 2012
	SC-A3B	Long-term increasing trend; stable over WY 2015-16	Installed (-127 to -167 ft msl[1]) above interface when chloride < 10 mg/L in WY 1987. Changes to sampling depths 2012-15
	SC-A4A	Long-term increasing trend; chloride > 10,000 mg/L. Decreasing over WY 2014-16	Installed (-334 to -354 ft msl[1]) below interface
	SC-A4B	Chloride <50 mg/L in WY 2014-16	Installed above interface
SqCWD Monitoring Wells near Production Wells	SC-A5A	Long-term increasing trend; chloride > 8,000 mg/L stable WY 2015-16	Installed (-475 to -495 ft msl[1]) below interface; screened 100 feet below Seascape well
	SC-A5B	Long-term increasing trend; Chloride ~100 mg/L stable WY 2015-16.	Installed above 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

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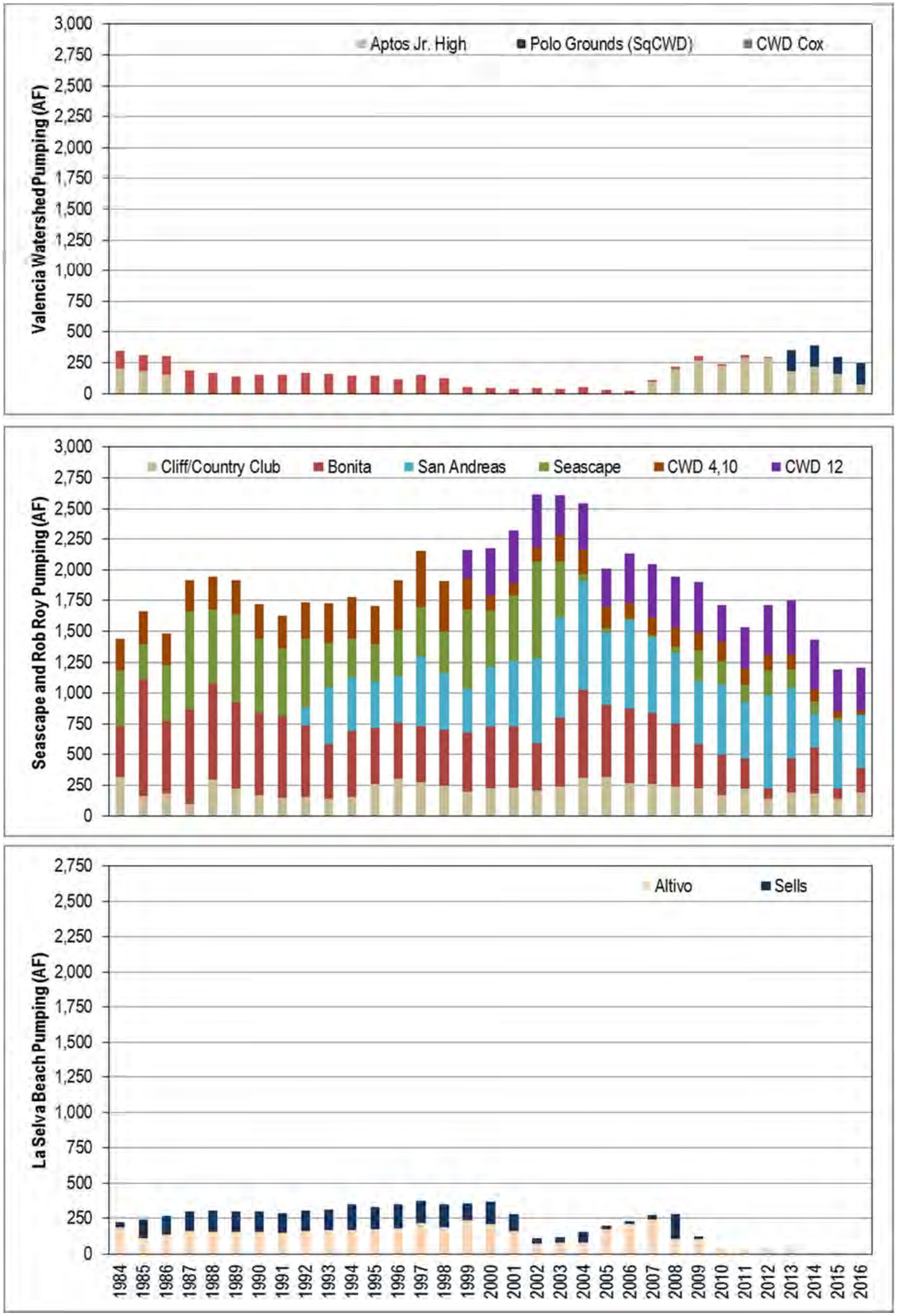

Figure 5-1: Pumping By Water Year in the Aromas Area

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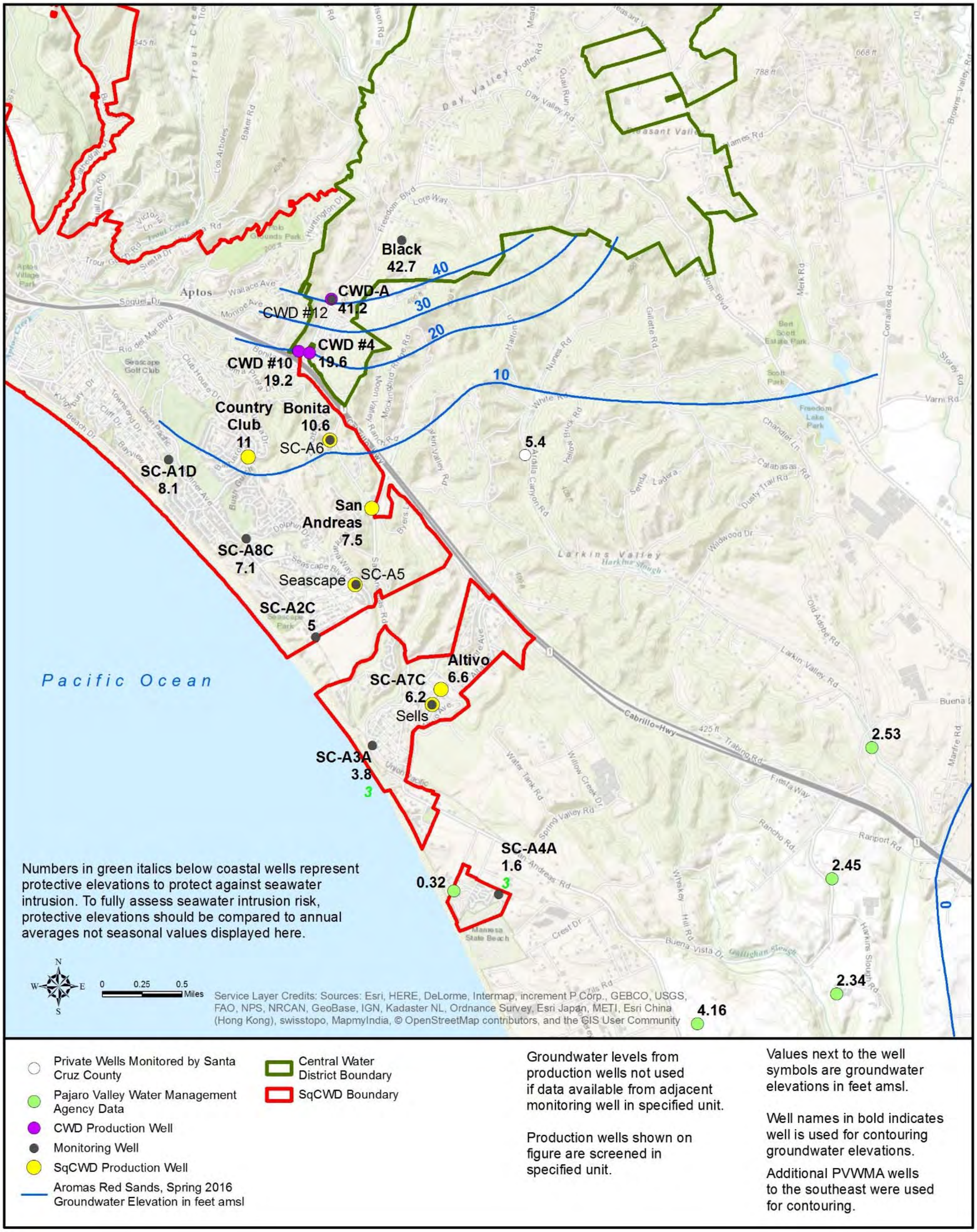

Figure 5-2 (2016): Groundwater Elevation Contours, Aromas Area, Spring 2016

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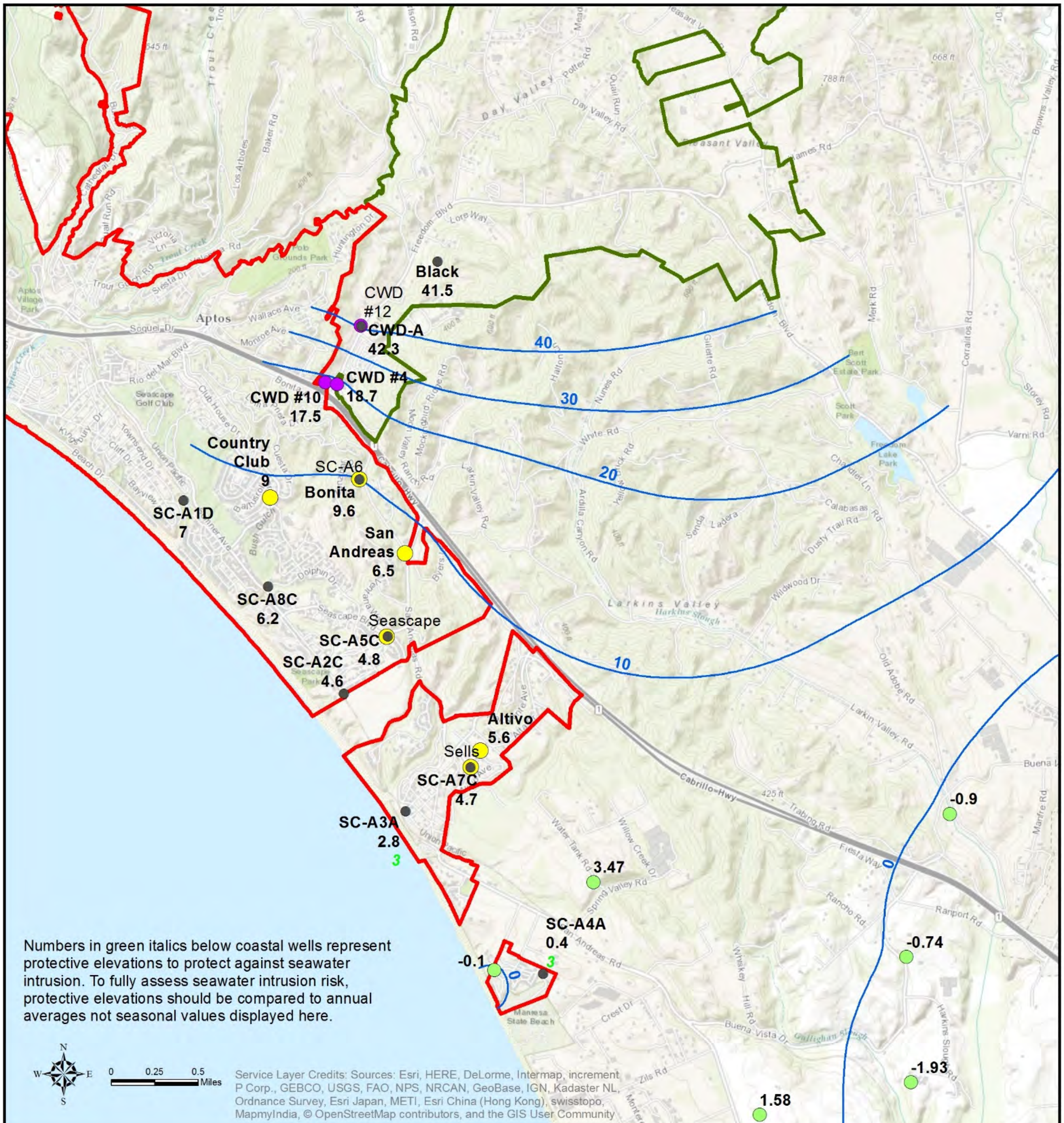

- Pajaro Valley Water Management Agency Data
- Monitoring Well
- CWD Production Well
- SqCWD Production Well
- Aromas Red Sands Fall 2016 Groundwater Elevation in feet amsl
- SqCWD Boundary
- Central Water District Boundary

Groundwater levels from production wells not used if data available from adjacent monitoring well in specified unit.

Production wells shown on figure are screened in specified unit.

Values next to the well symbols are groundwater elevations in feet amsl.

Well names in bold indicates well is used for contouring groundwater elevations.

Additional PVWMA wells to the southeast were used for contouring.

Figure 5-3 (2016): Groundwater Elevation Contours, Aromas Area, Fall 2016

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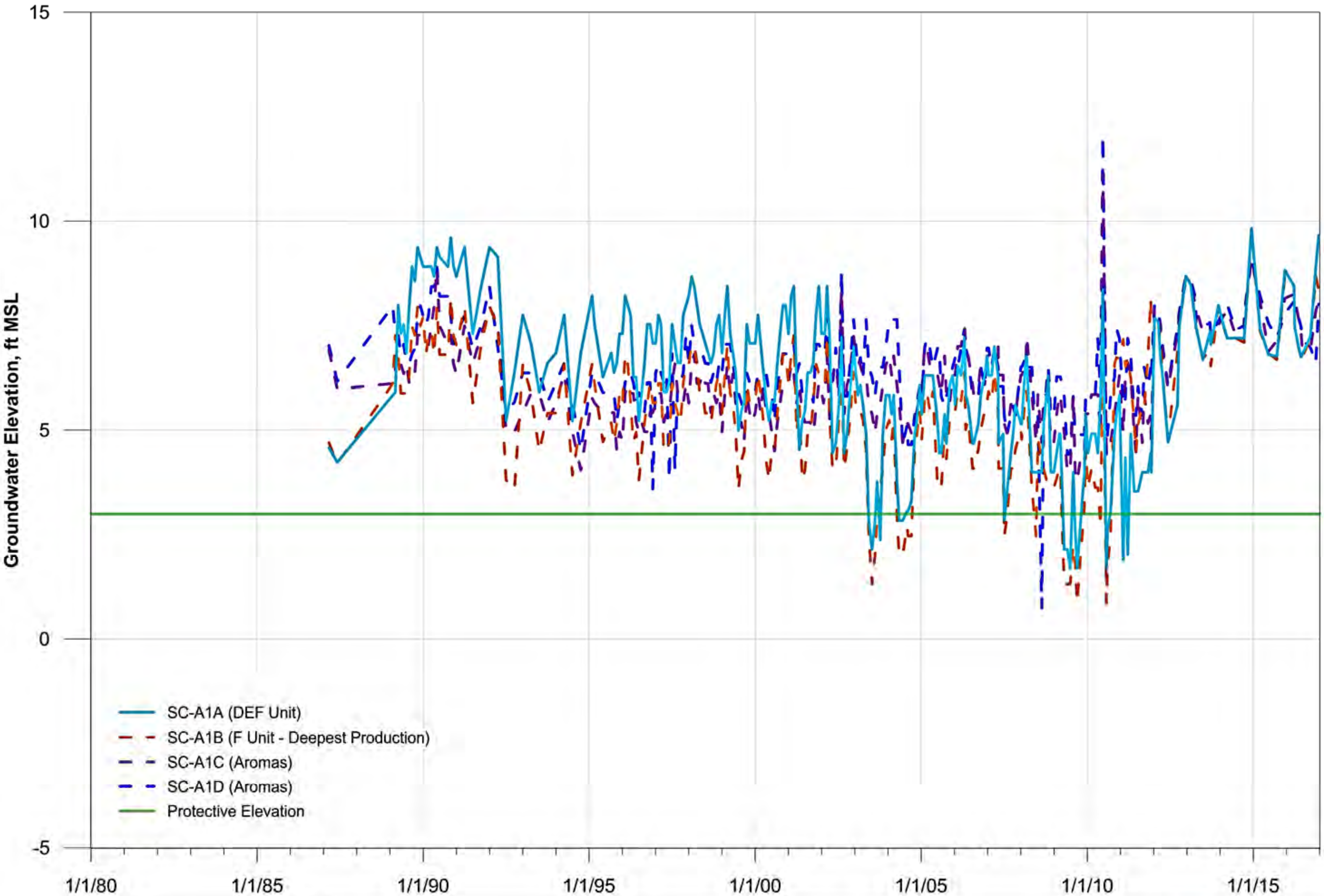
Hydrographs for Aromas Area

Hydrographs of SqCWD Coastal Monitoring Well Clusters

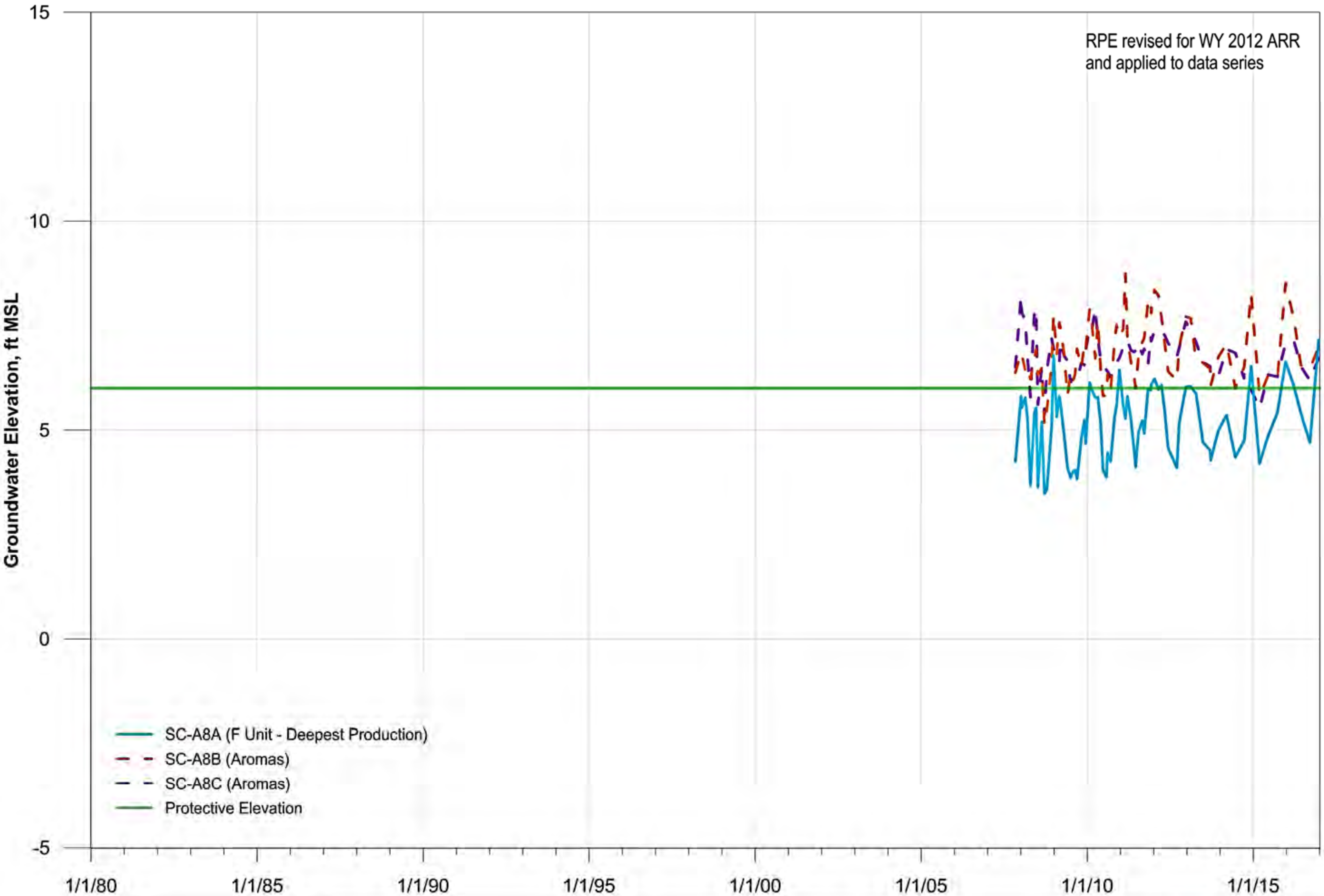
Hydrographs of SqCWD Monitoring Wells Adjacent to Production Wells

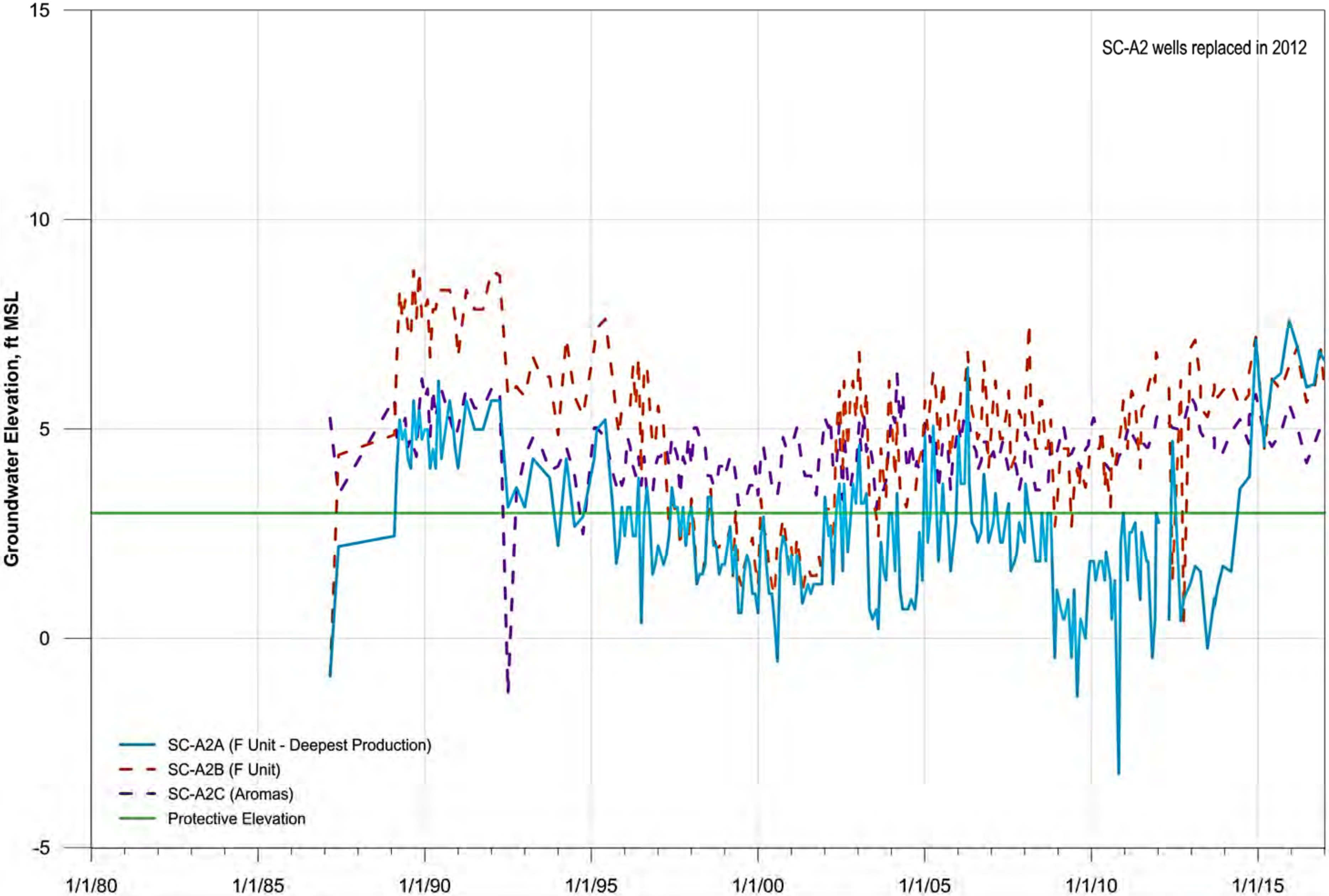
Hydrographs of CWD Monitoring Wells Adjacent to Production Wells

Hydrograph of Inland Monitoring Wells

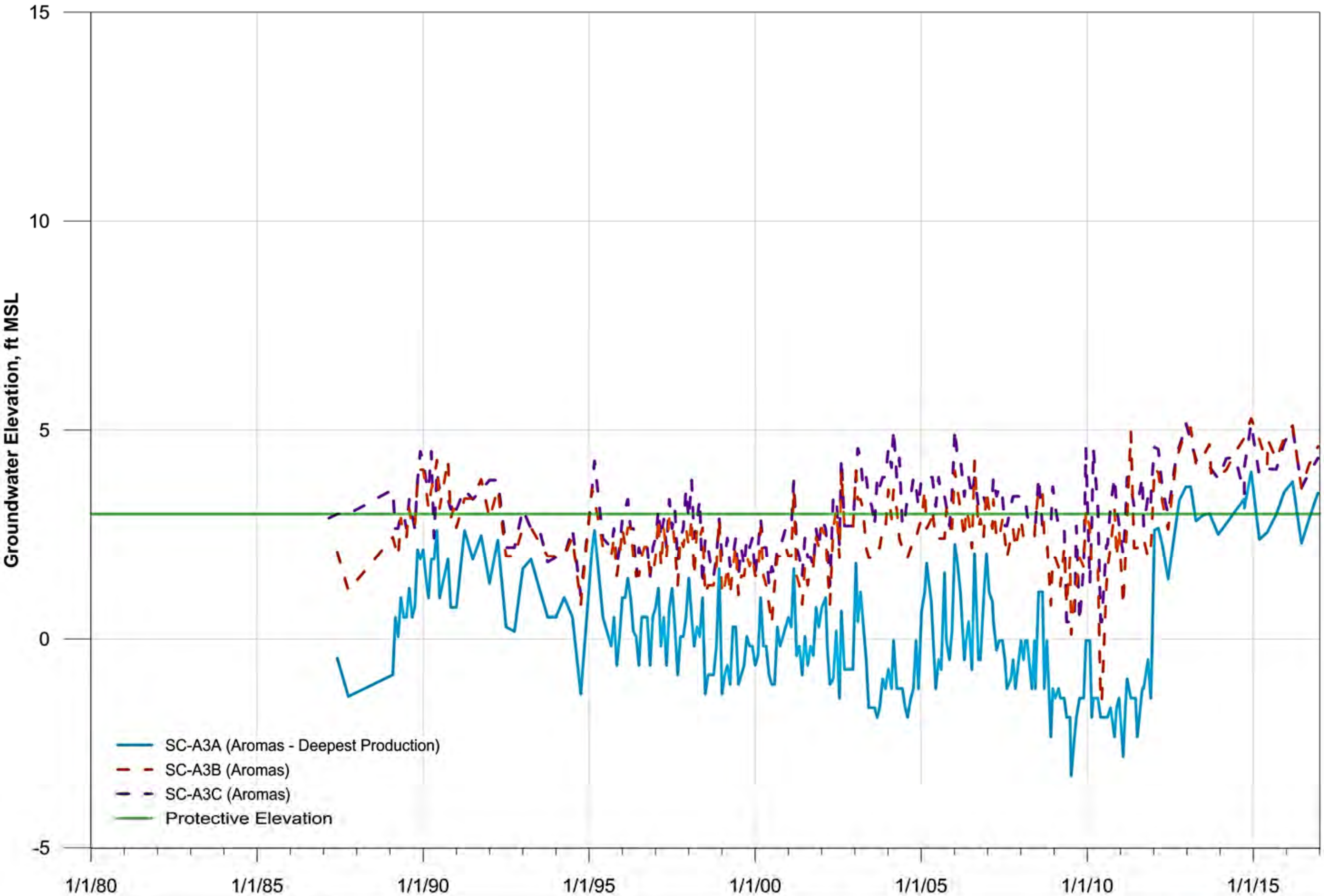


15
10
5
0
-5
Groundwater Elevation, ft MSL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-A1A (DEF Unit)
SC-A1B (F Unit - Deepest Production)
SC-A1C (Aromas)
SC-A1D (Aromas)
Protective Elevation

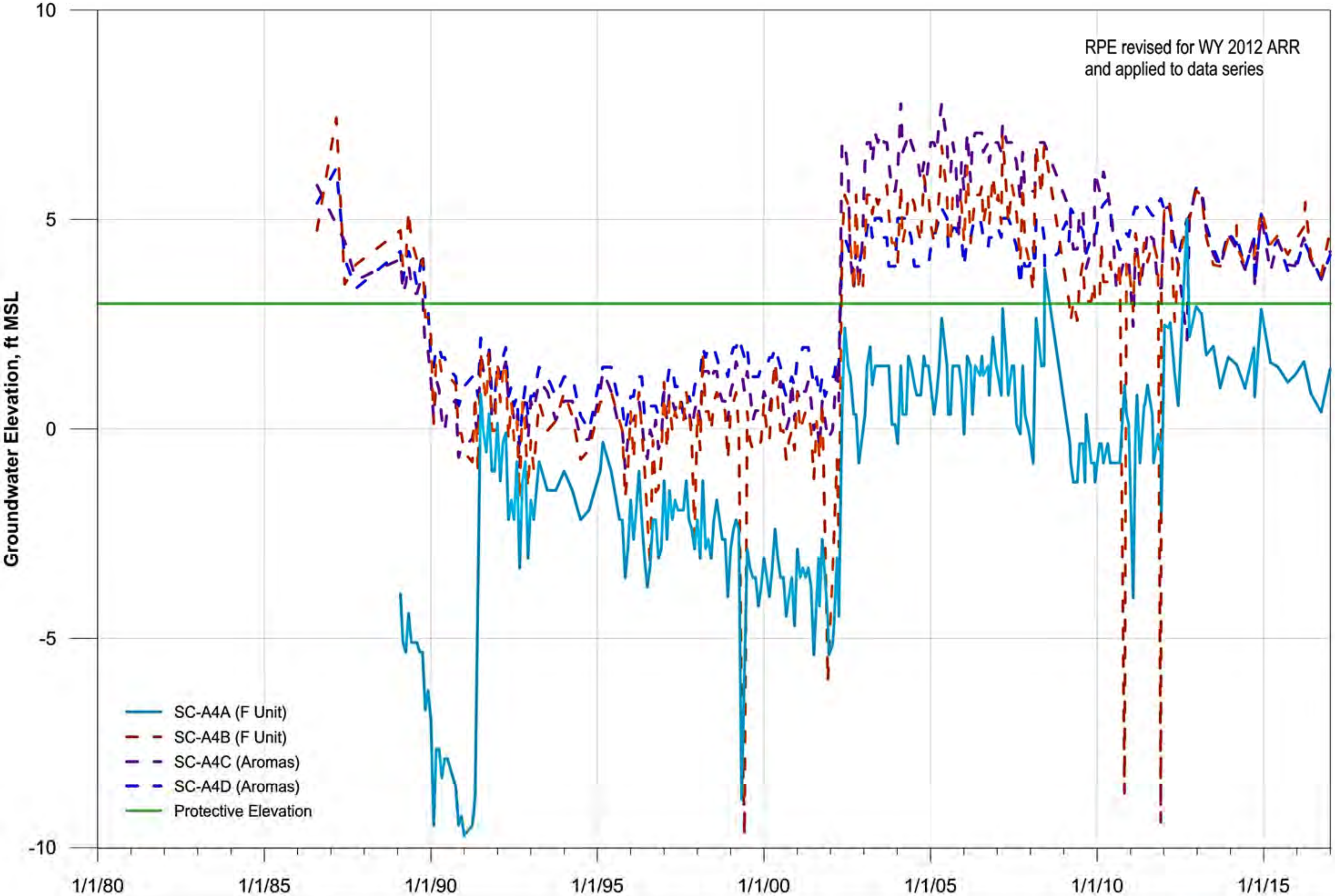

RPE revised for WY 2012 ARR
and applied to data series
Groundwater Elevation, ft MSL
15
10
5
0
-5
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-A8A (F Unit - Deepest Production)
SC-A8B (Aromas)
SC-A8C (Aromas)
Protective Elevation



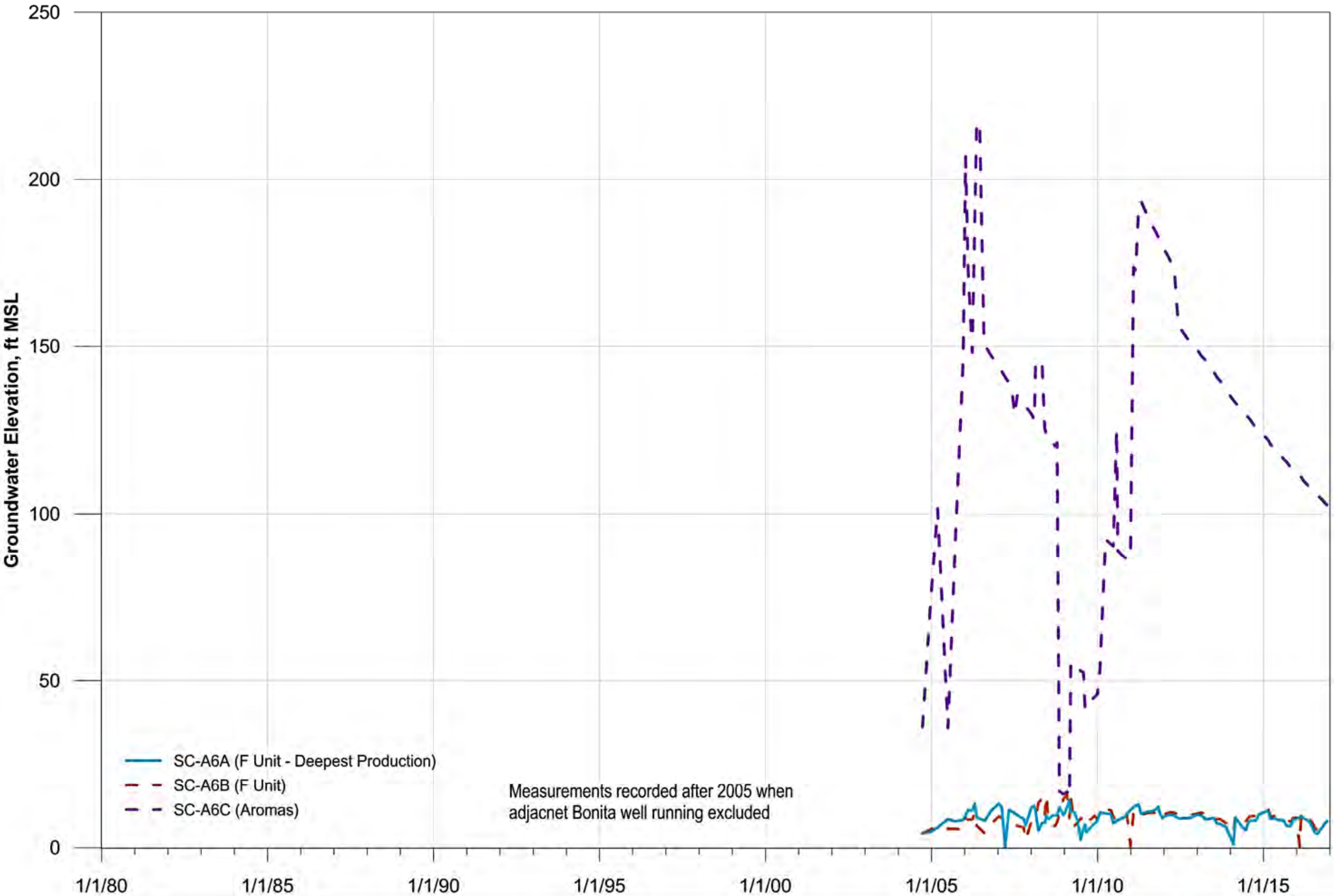
SC-A2 wells replaced in 2012
Groundwater Elevation, ft MSL
15
10
5
0
-5
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-A2A (F Unit - Deepest Production)
SC-A2B (F Unit)
SC-A2C (Aromas)
Protective Elevation



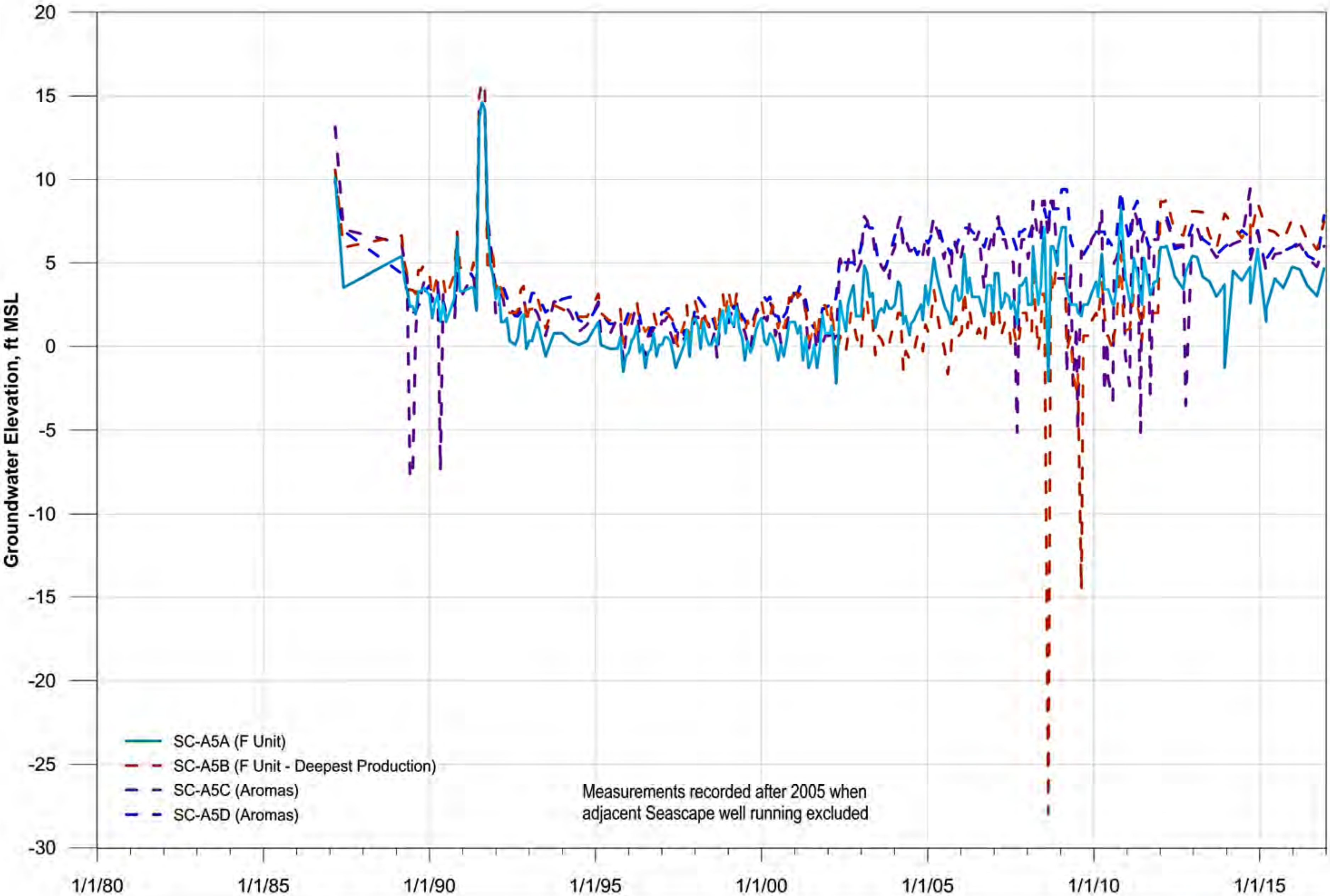
15
10
5
0
-5
Groundwater Elevation, ft MSL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-A3A (Aromas - Deepest Production)
SC-A3B (Aromas)
SC-A3C (Aromas)
Protective Elevation

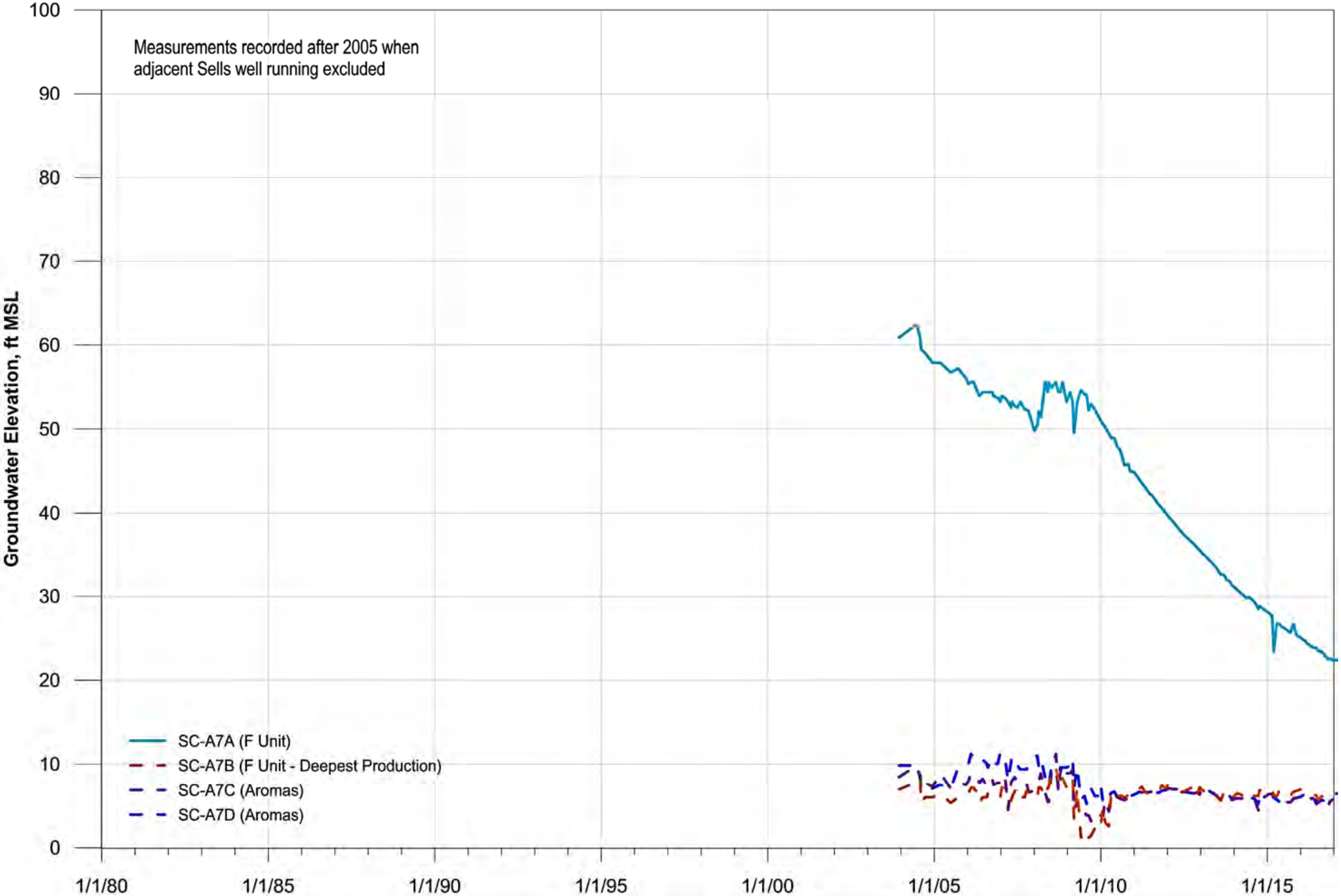


RPE revised for WY 2012 ARR
and applied to data series
Groundwater Elevation, ft MSL
10
5
0
-5
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-A4A (F Unit)
SC-A4B (F Unit)
SC-A4C (Aromas)
SC-A4D (Aromas)
Protective Elevation

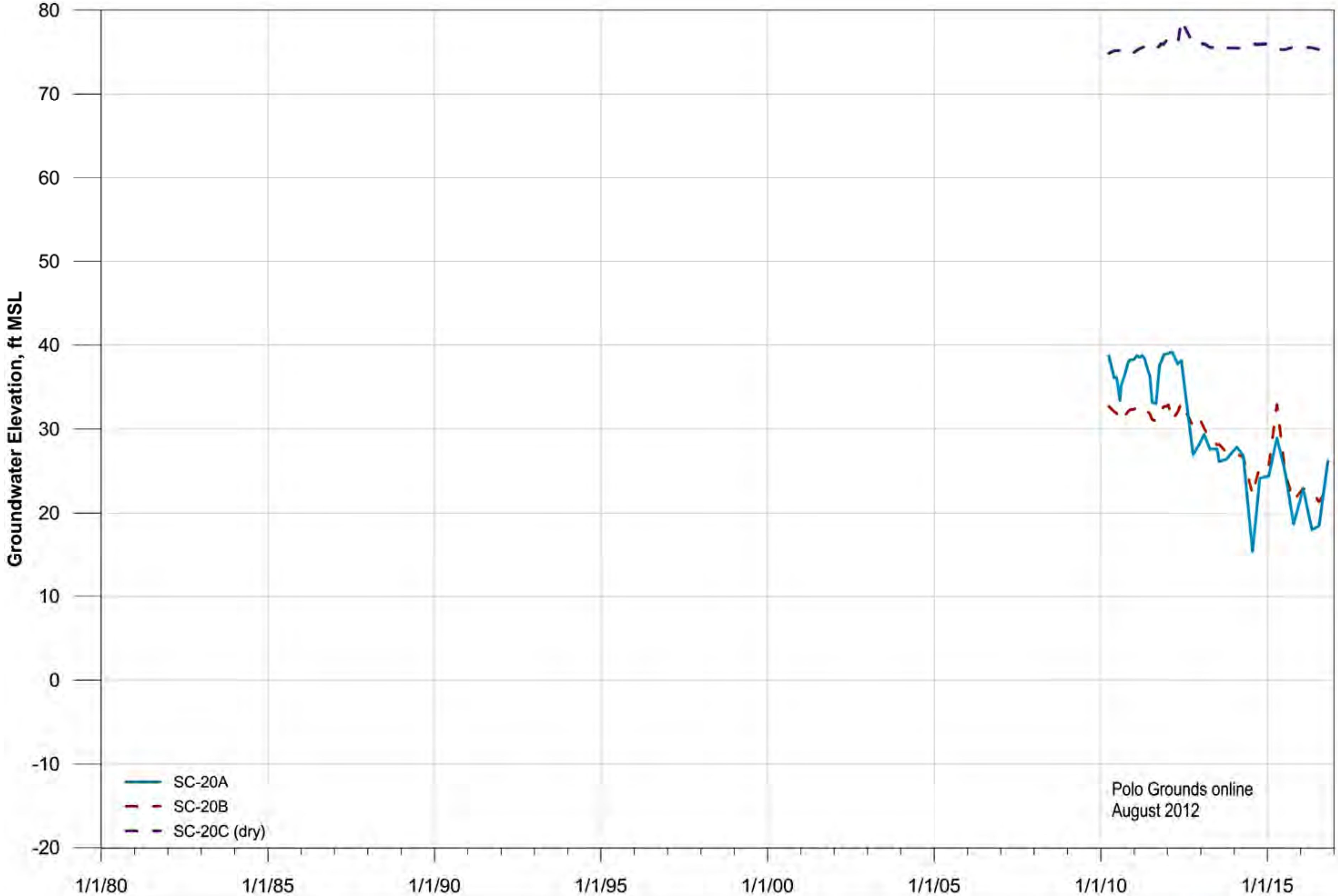


Hydro Metrics WRI

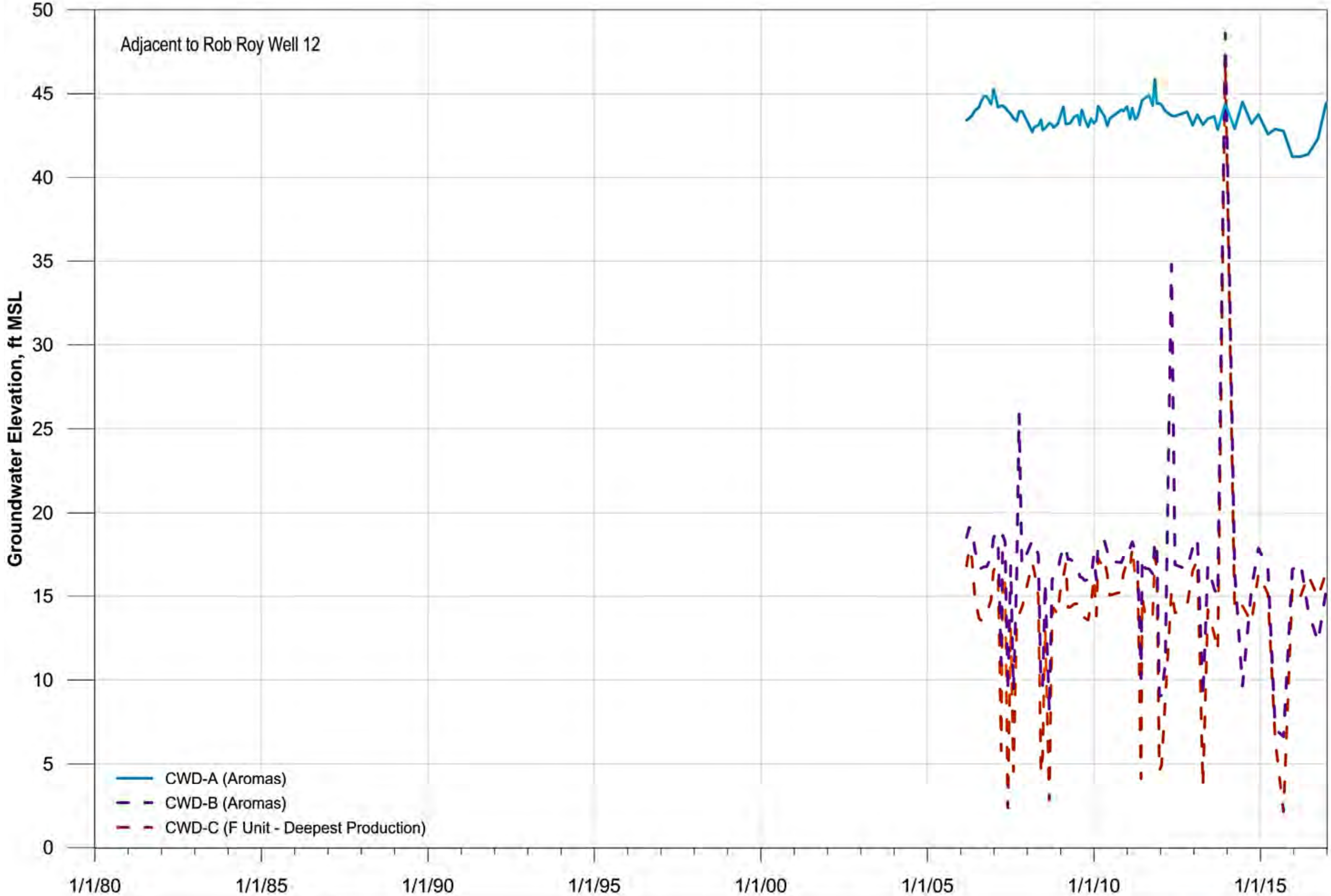

Groundwater Elevation, ft MSL
20
15
10
5
0
-5
-10
-15
-20
-25
-30
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-A5A (F Unit)
SC-A5B (F Unit - Deepest Production)
SC-A5C (Aromas)
SC-A5D (Aromas)
Measurements recorded after 2005 when adjacent Seascape well running excluded



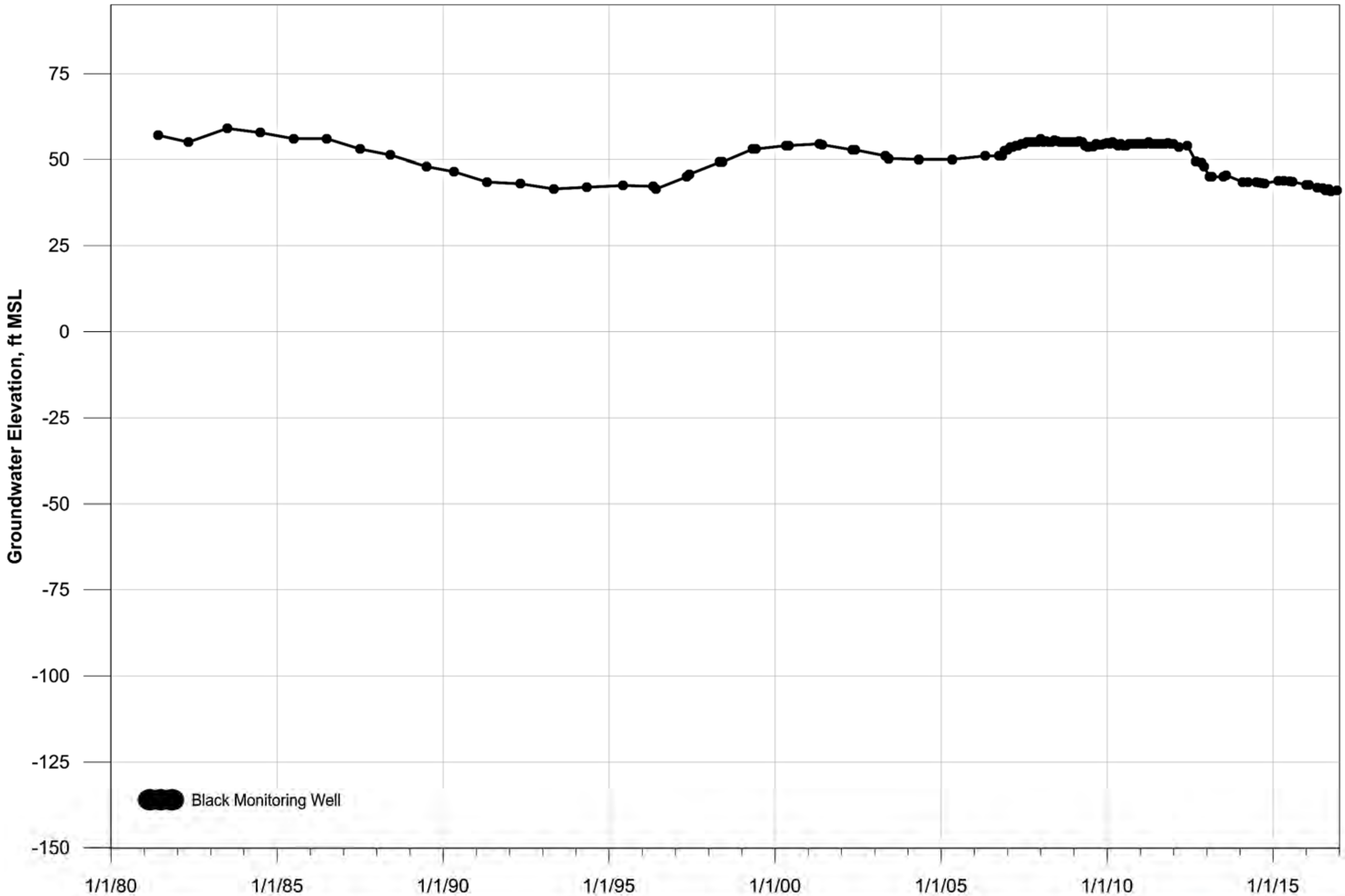
Measurements recorded after 2005 when adjacent Sells well running excluded
Groundwater Elevation, ft MSL
100
90
80
70
60
50
40
30
20
10
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-A7A (F Unit)
SC-A7B (F Unit - Deepest Production)
SC-A7C (Aromas)
SC-A7D (Aromas)

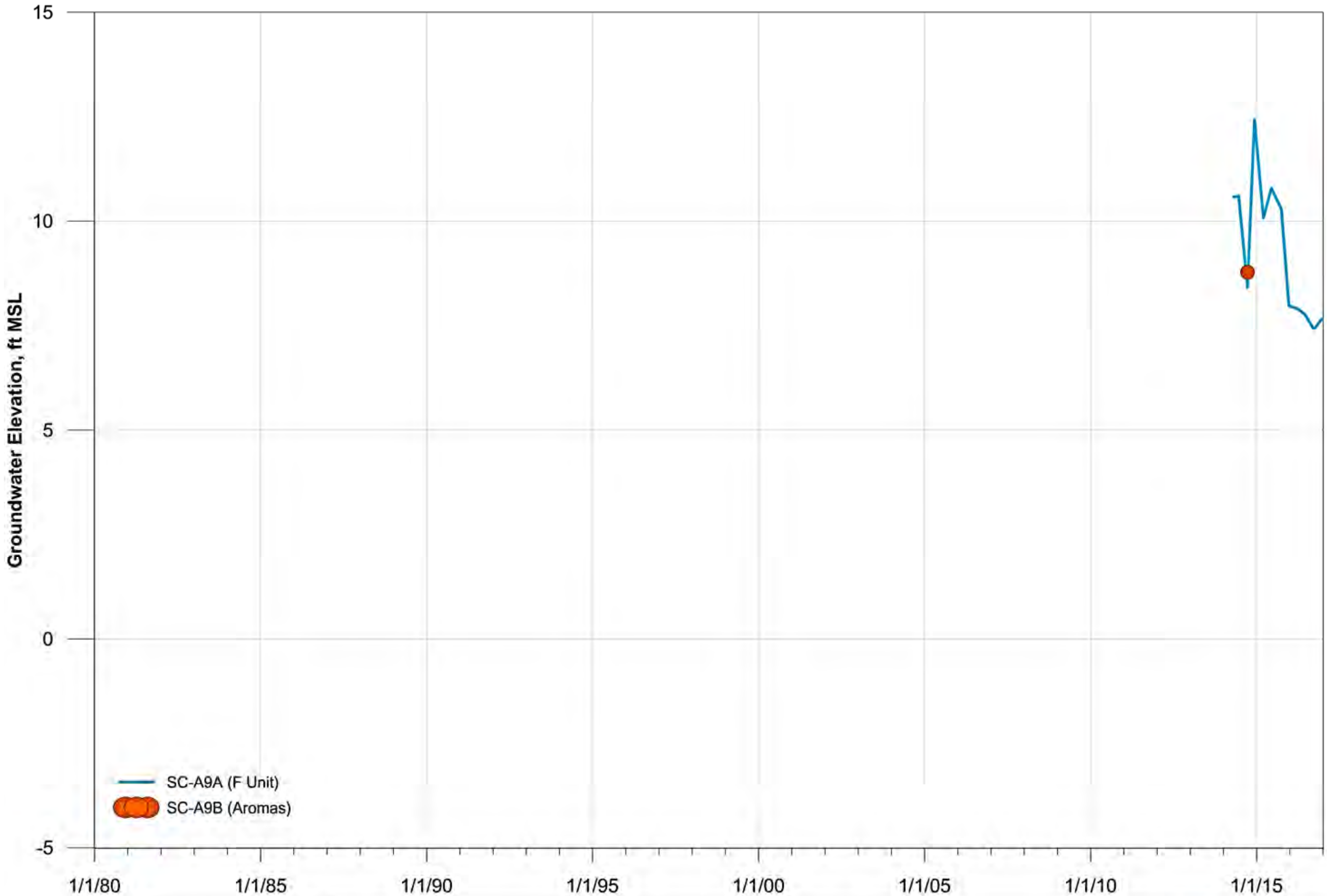


Groundwater Elevation, ft MSL
80
70
60
50
40
30
20
10
0
-10
-20
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-20A
SC-20B
SC-20C (dry)
Polo Grounds online
August 2012



Adjacent to Rob Roy Well 12
Groundwater Elevation, ft MSL
50
45
40
35
30
25
20
15
10
5
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
CWD-A (Aromas)
CWD-B (Aromas)
CWD-C (F Unit - Deepest Production)


75
50
25
0
-25
-50
-75
-100
-125
-150
Groundwater Elevation, ft MSL
Black Monitoring Well
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15



Hydro Metrics WRI

Chemographs and Single Well Hydrographs for Aromas Area

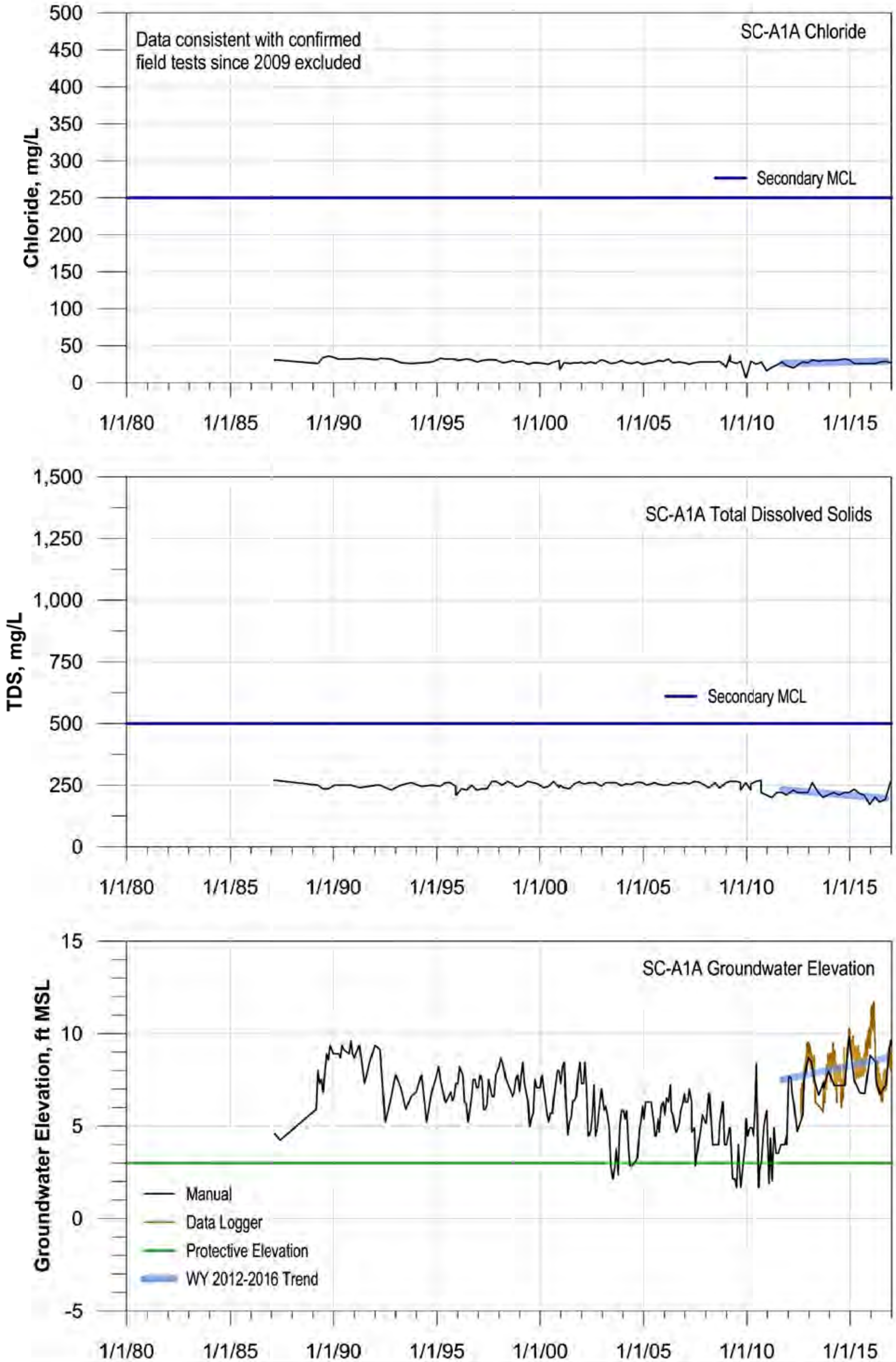
Graphs of SqCWD Coastal Monitoring Well Clusters

Graphs of SqCWD Production Wells and Adjacent Monitoring Wells

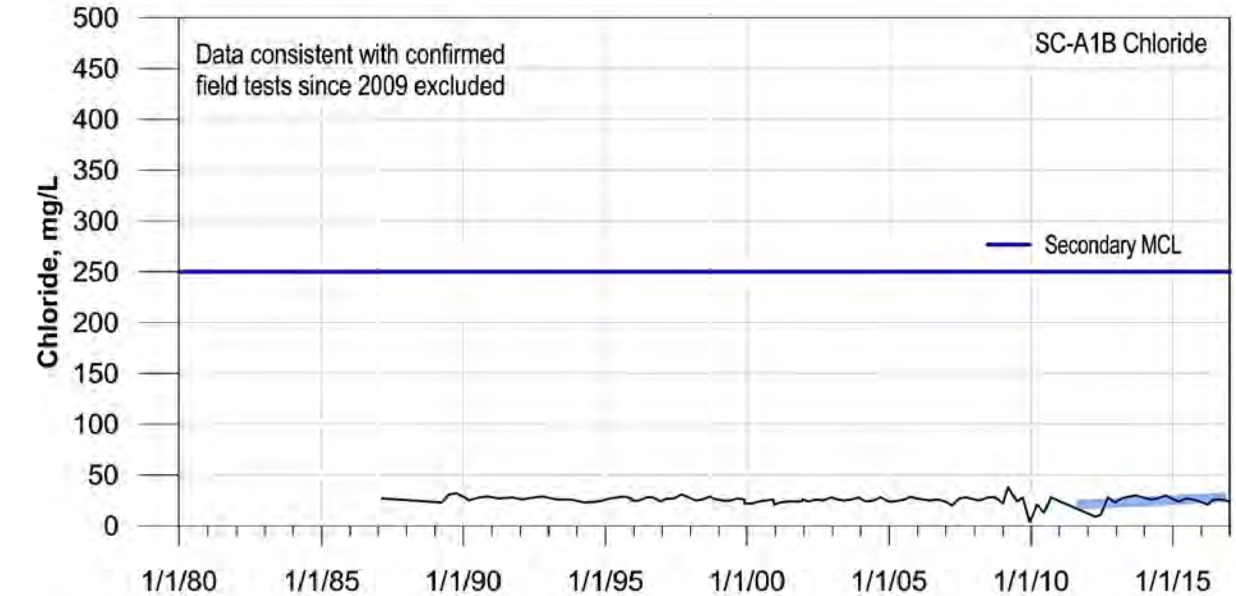
Graphs of CWD Production Wells and Monitoring Wells

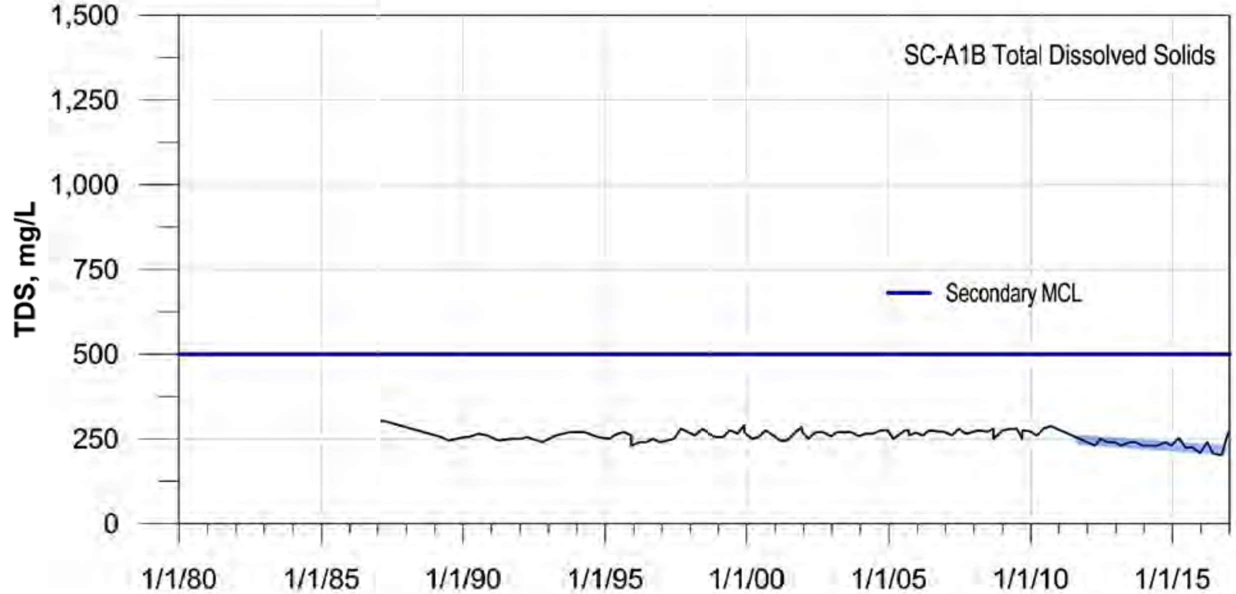
Graphs of Inland SqCWD Monitoring Wells

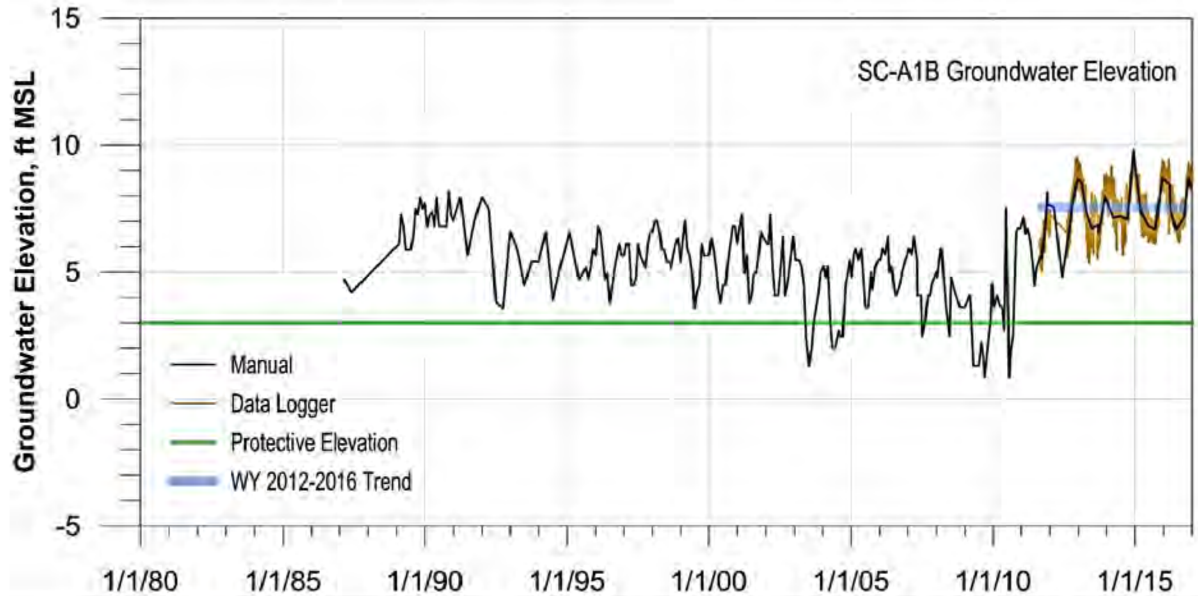
Trends shown on the hydrographs and chemographs are based on a linear fit to data in the specified time period.



SC-A1A Chloride
Data consistent with confirmed field tests since 2009 excluded
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
Secondary MCL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-A1A Total Dissolved Solids
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
Secondary MCL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-A1A Groundwater Elevation
Groundwater Elevation, ft MSL
15
10
5
0
-5
Manual
Data Logger
Protective Elevation
WY 2012-2016 Trend
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

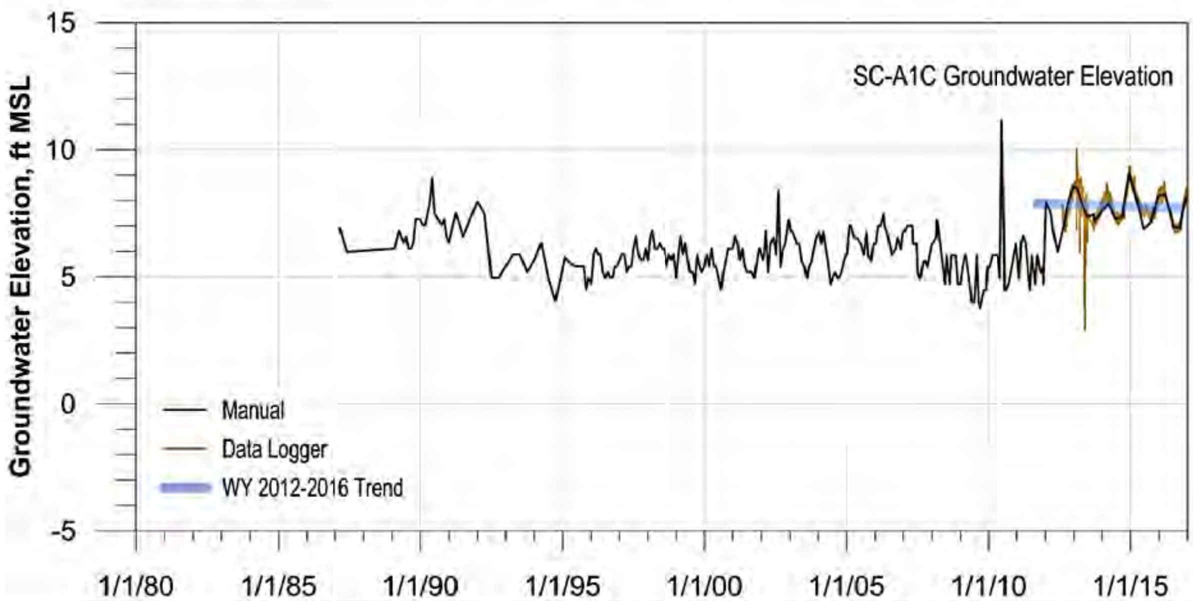

SC-A1B Chloride
Data consistent with confirmed field tests since 2009 excluded
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-A1B Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

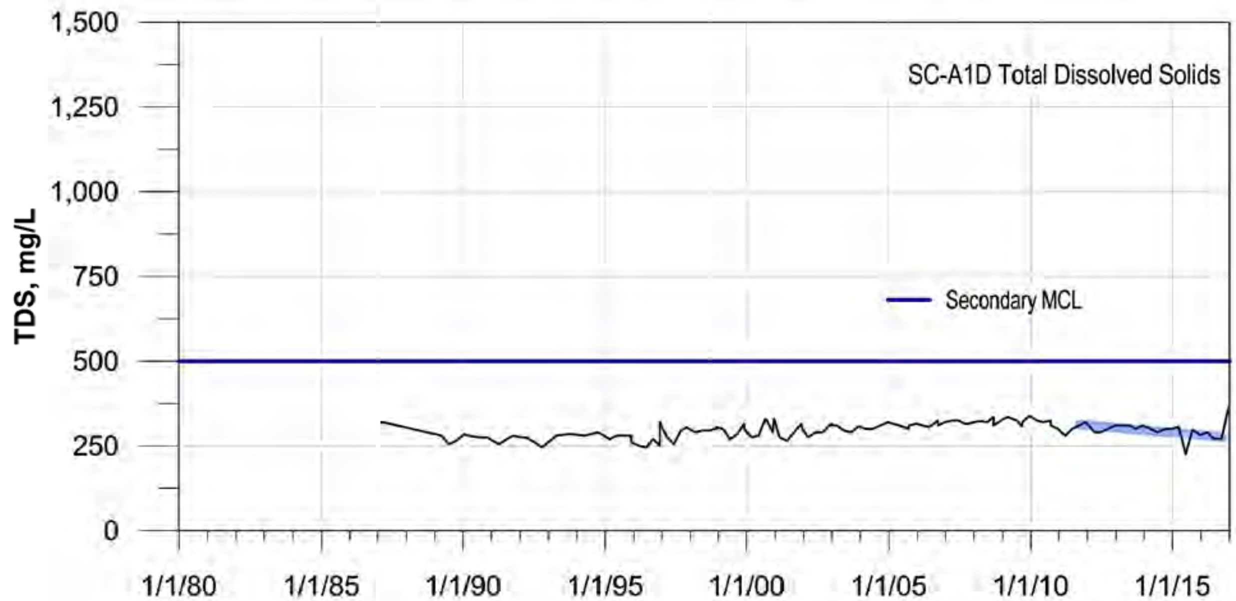

SC-A1B Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
Data Logger
Protective Elevation
WY 2012-2016 Trend
15
10
5
0
-5
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

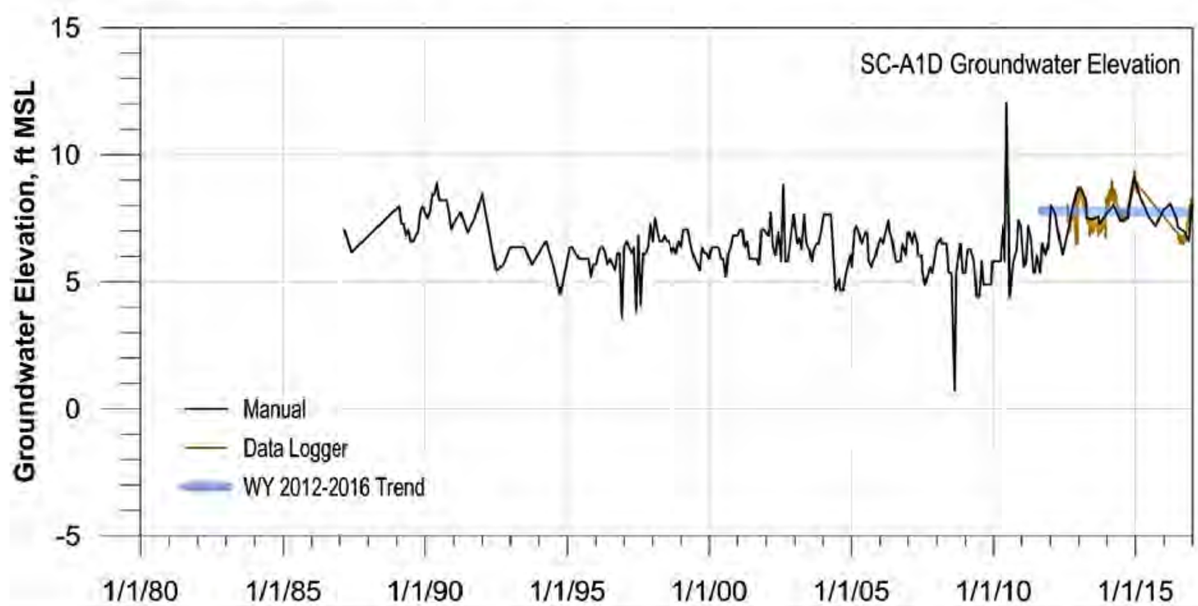

SC-A1C Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

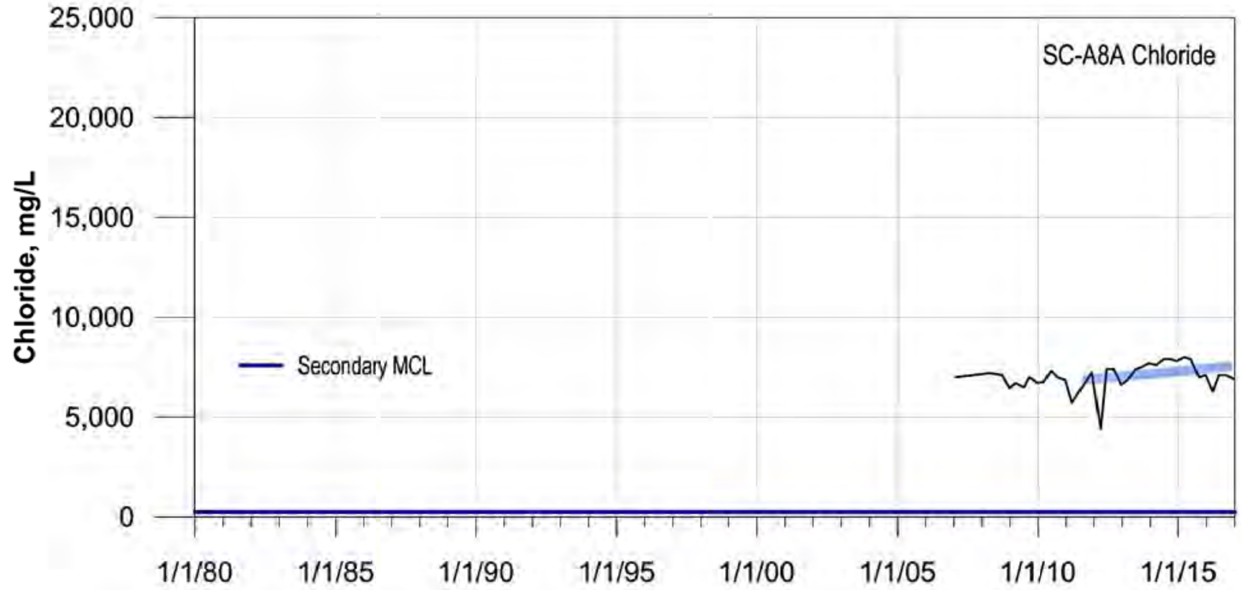

SC-A1C Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

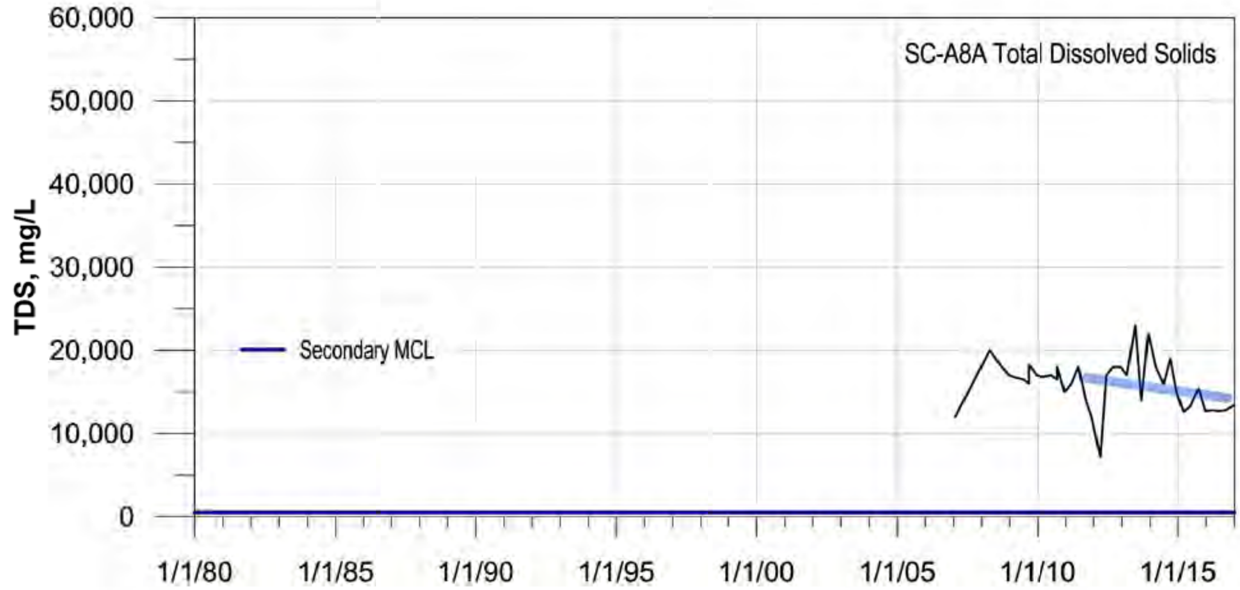

SC-A1C Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
Data Logger
WY 2012-2016 Trend
15
10
5
0
-5
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-A1D Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

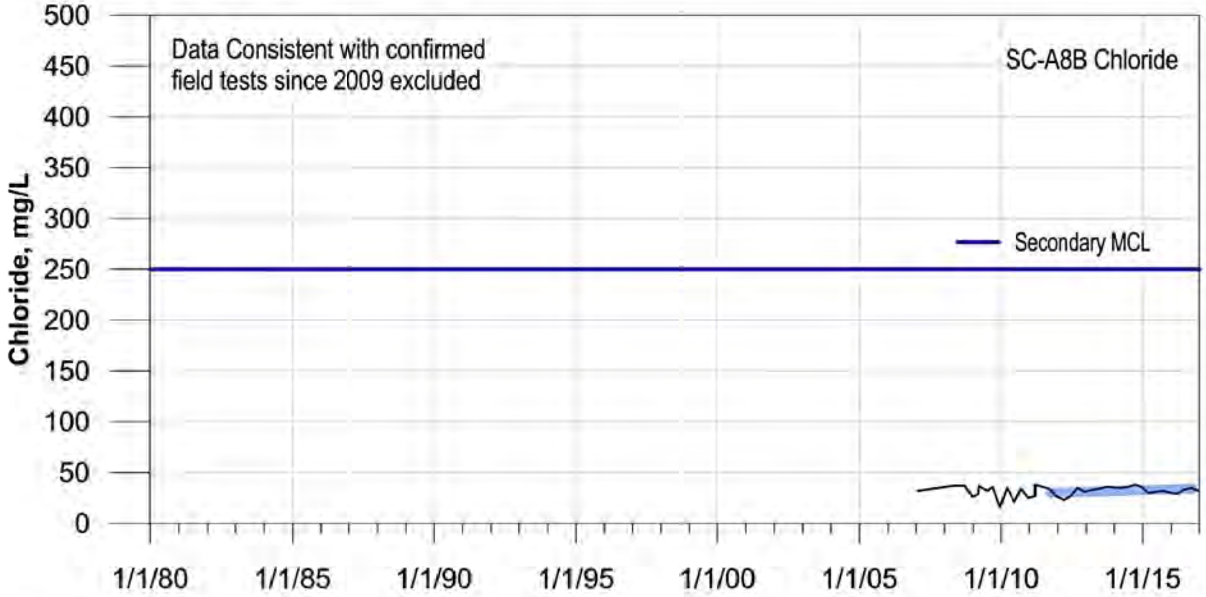

SC-A1D Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-A1D Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
Data Logger
WY 2012-2016 Trend
15
10
5
0
-5
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-A8A Chloride
Chloride, mg/L
25,000
20,000
15,000
10,000
5,000
0
Secondary MCL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-A8A Total Dissolved Solids
TDS, mg/L
60,000
50,000
40,000
30,000
20,000
10,000
0
Secondary MCL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-A8A Groundwater Elevation
Groundwater Elevation, ft MSL
15
10
5
0
-5
Manual
Data Logger
Protective Elevation
WY 2012-2016 Trend
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

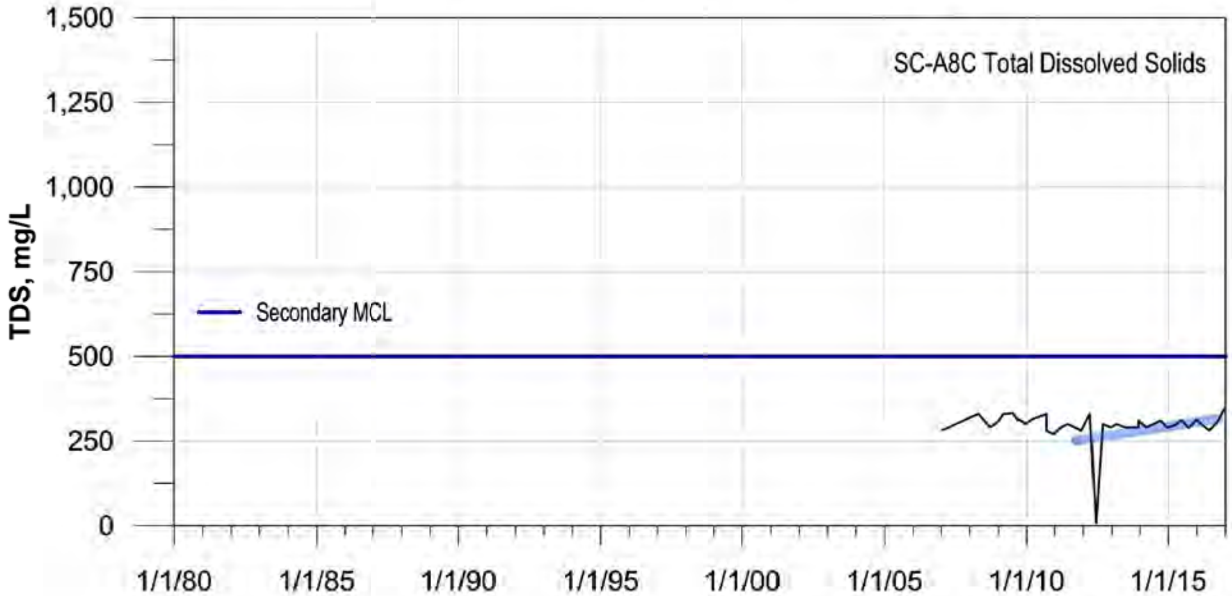


Data Consistent with confirmed field tests since 2009 excluded
SC-A8B Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

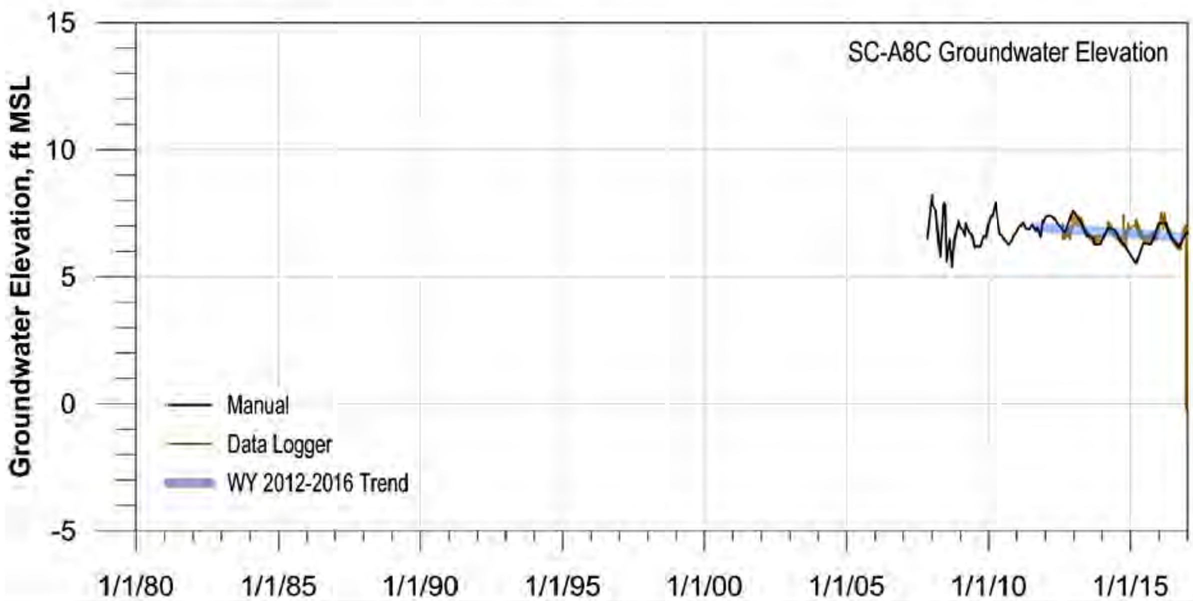
SC-A8B Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

SC-A8B Groundwater Elevation
Groundwater Elevation, ft MSL
15
10
5
0
-5
Manual
Data Logger
Protective Elevation
WY 2012-2016 Trend
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

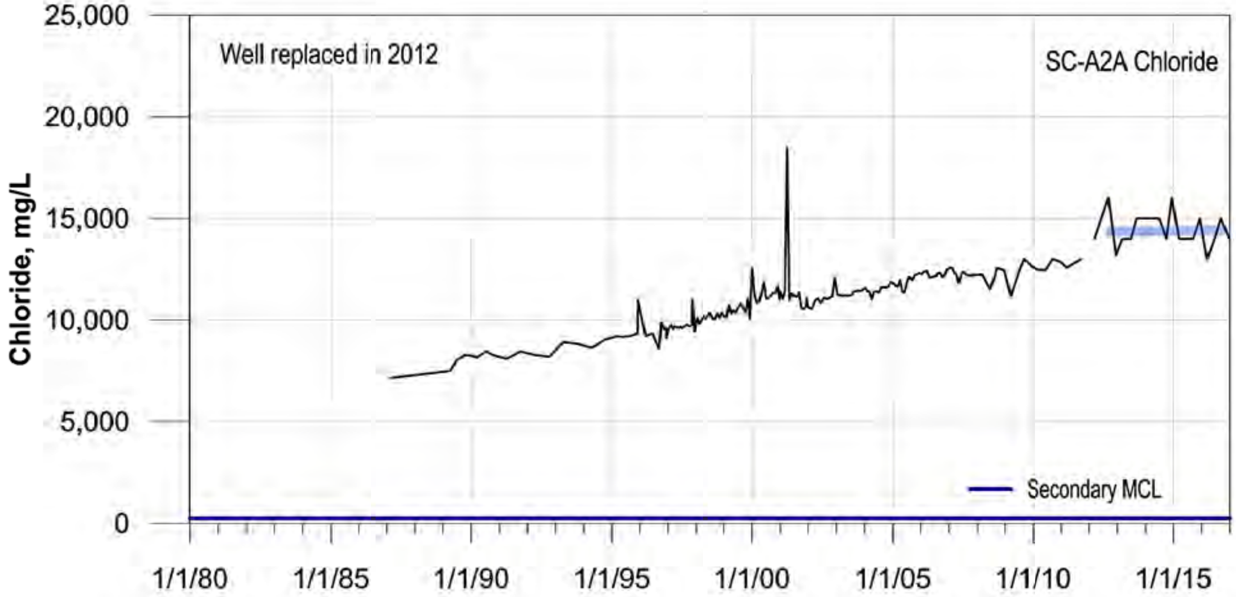
SC-A8C Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

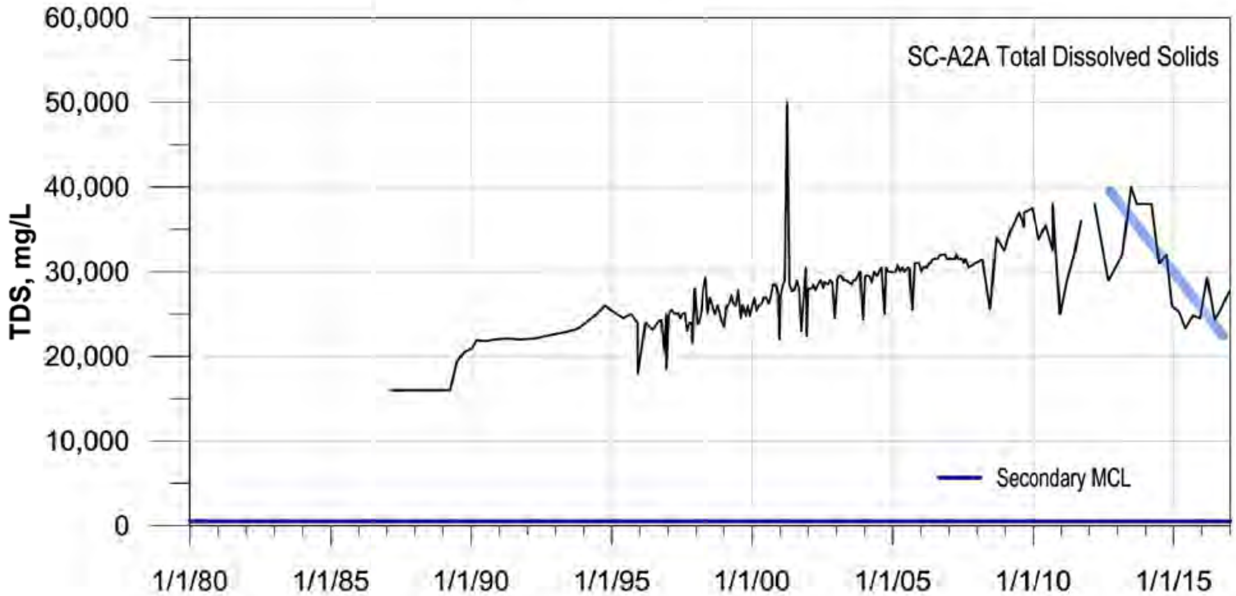


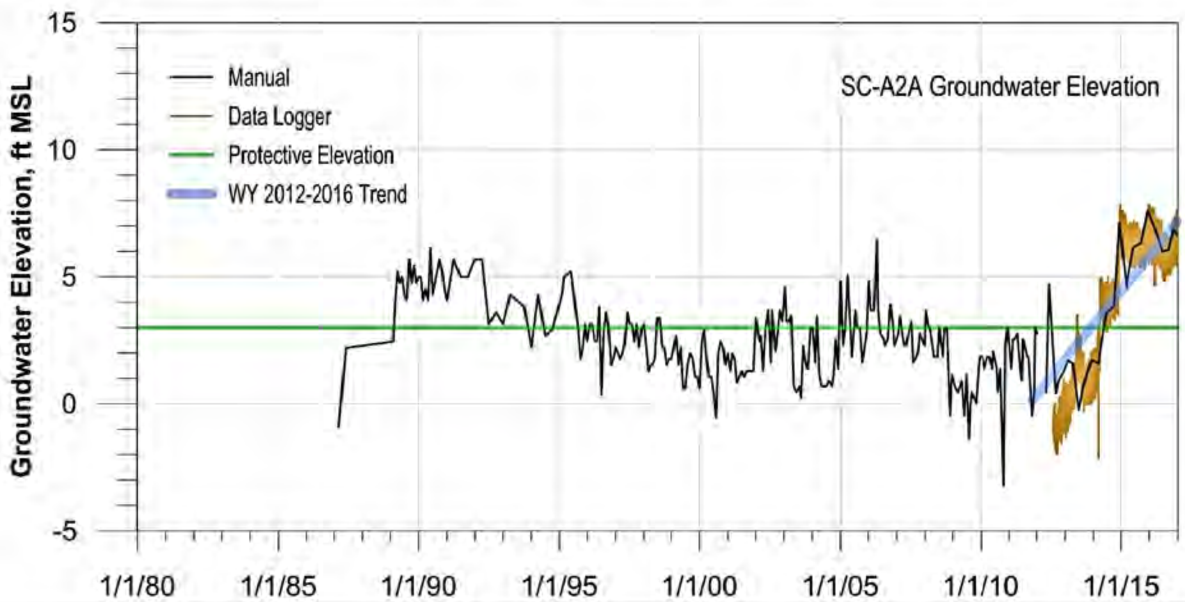
SC-A8C Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15



SC-A8C Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
Data Logger
WY 2012-2016 Trend
15
10
5
0
-5
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

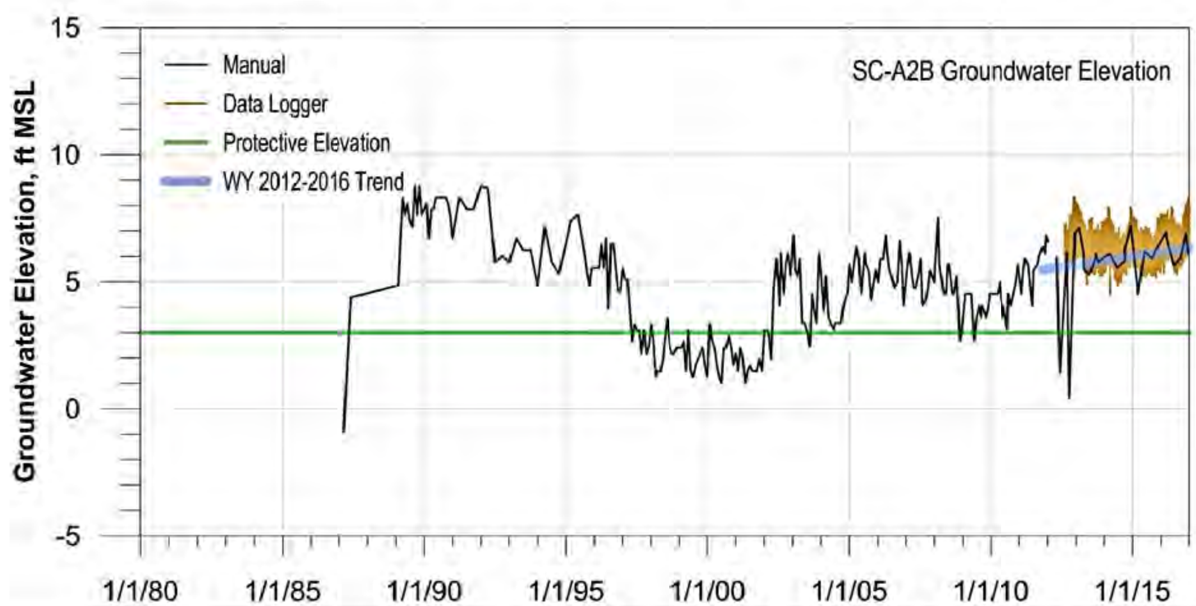

Well replaced in 2012
SC-A2A Chloride
Chloride, mg/L
25,000
20,000
15,000
10,000
5,000
0
Secondary MCL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-A2A Total Dissolved Solids
TDS, mg/L
60,000
50,000
40,000
30,000
20,000
10,000
0
Secondary MCL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

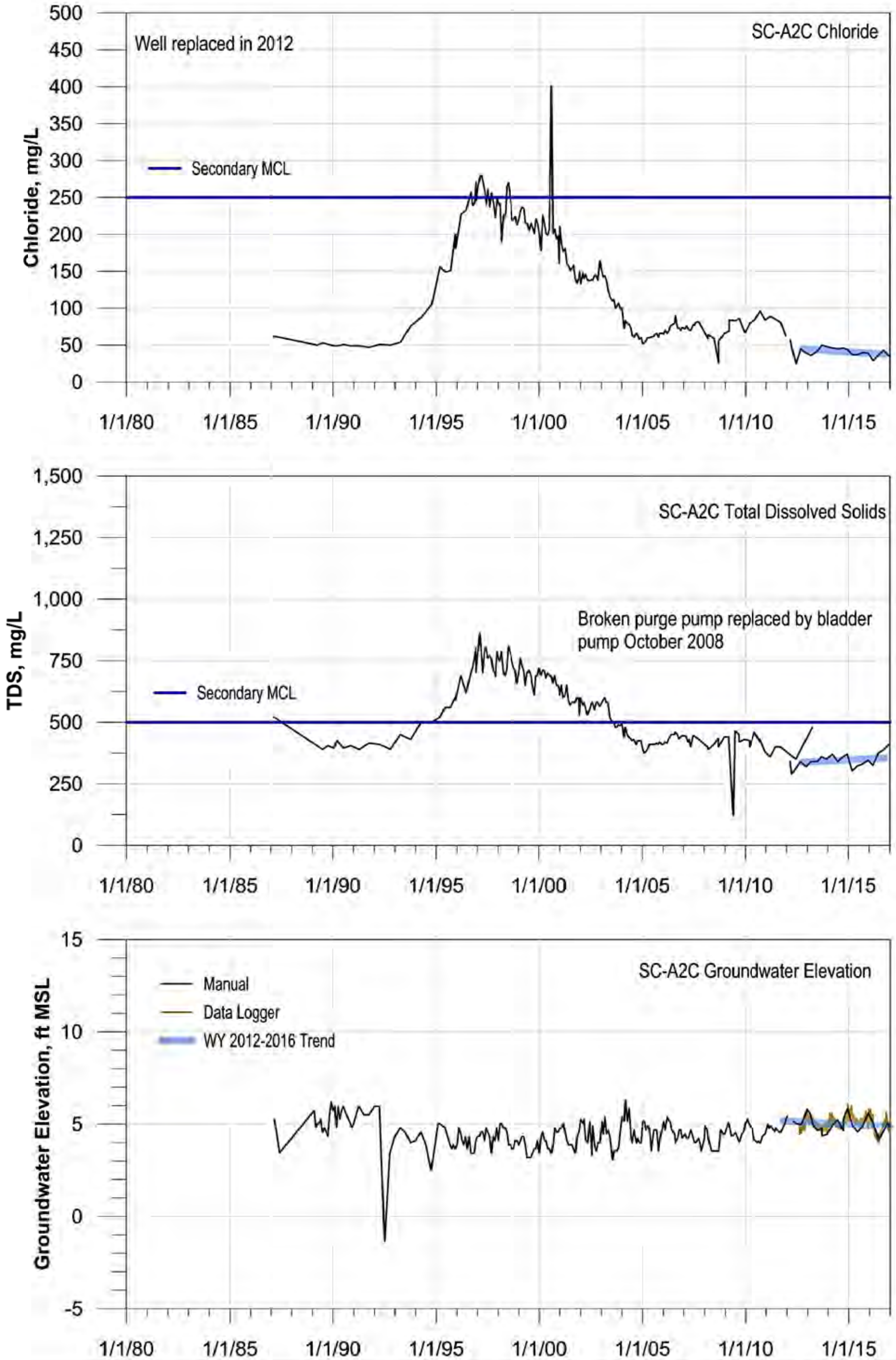

Manual
Data Logger
Protective Elevation
WY 2012-2016 Trend
SC-A2A Groundwater Elevation
Groundwater Elevation, ft MSL
15
10
5
0
-5
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

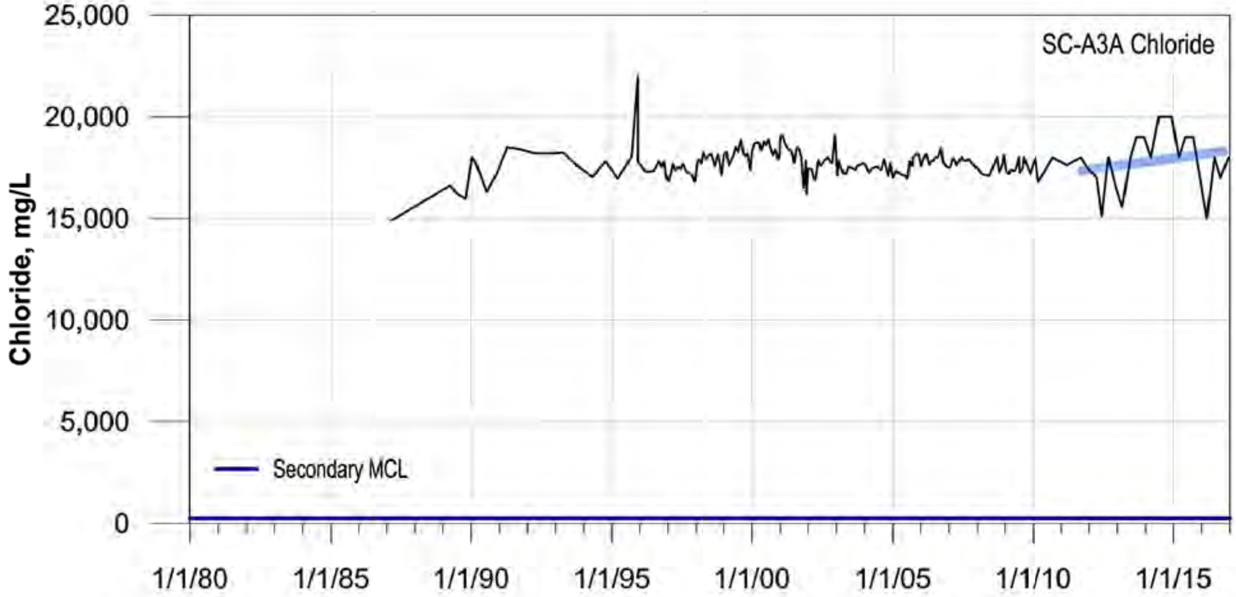
Well replaced in 2012
SC-A2B Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

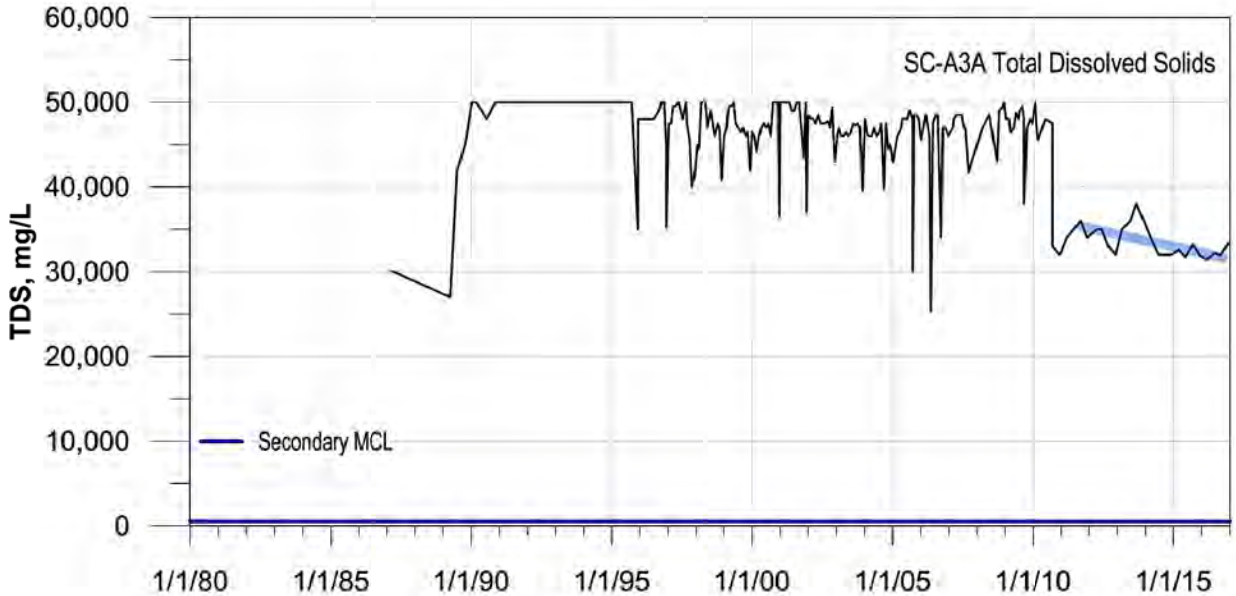
SC-A2B Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

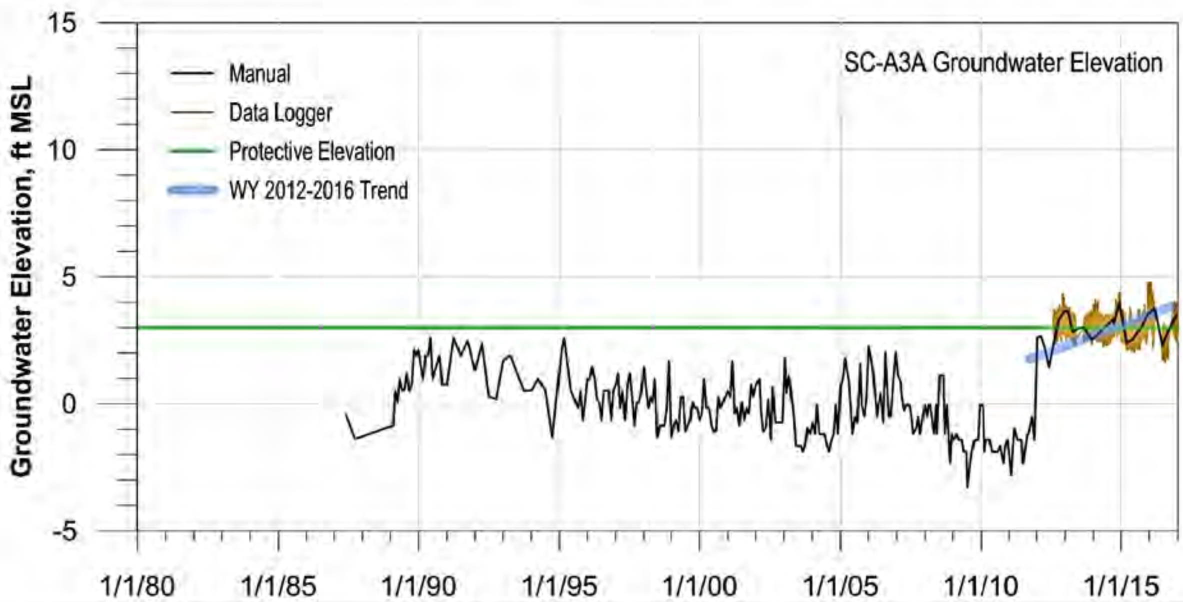


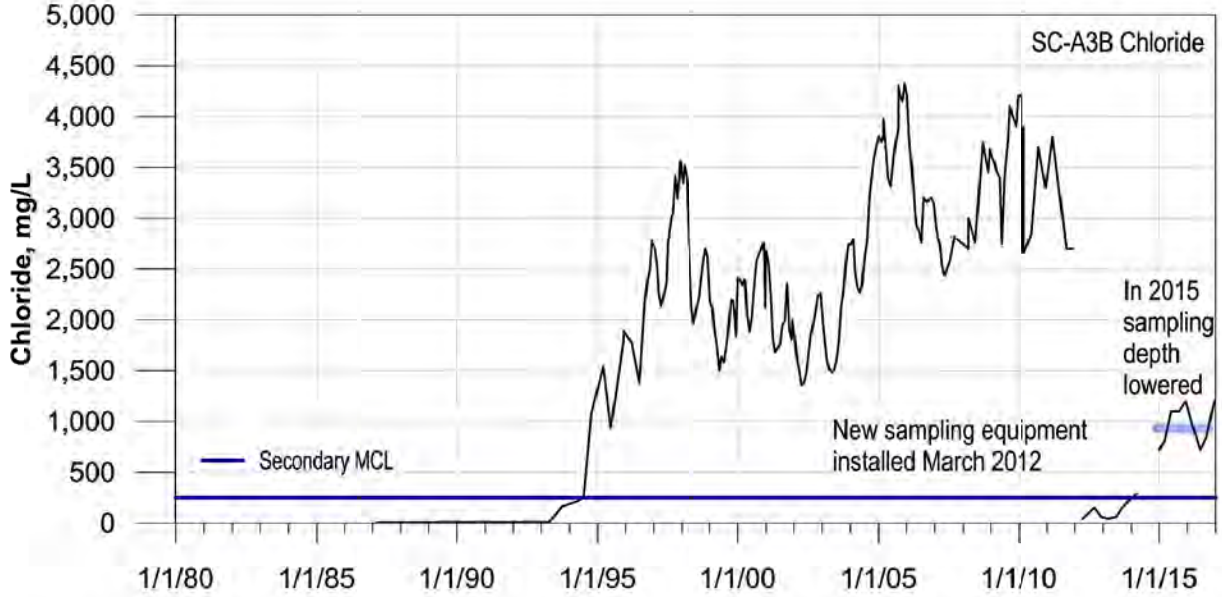
Manual
Data Logger
Protective Elevation
WY 2012-2016 Trend
SC-A2B Groundwater Elevation
Groundwater Elevation, ft MSL
15
10
5
0
-5
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

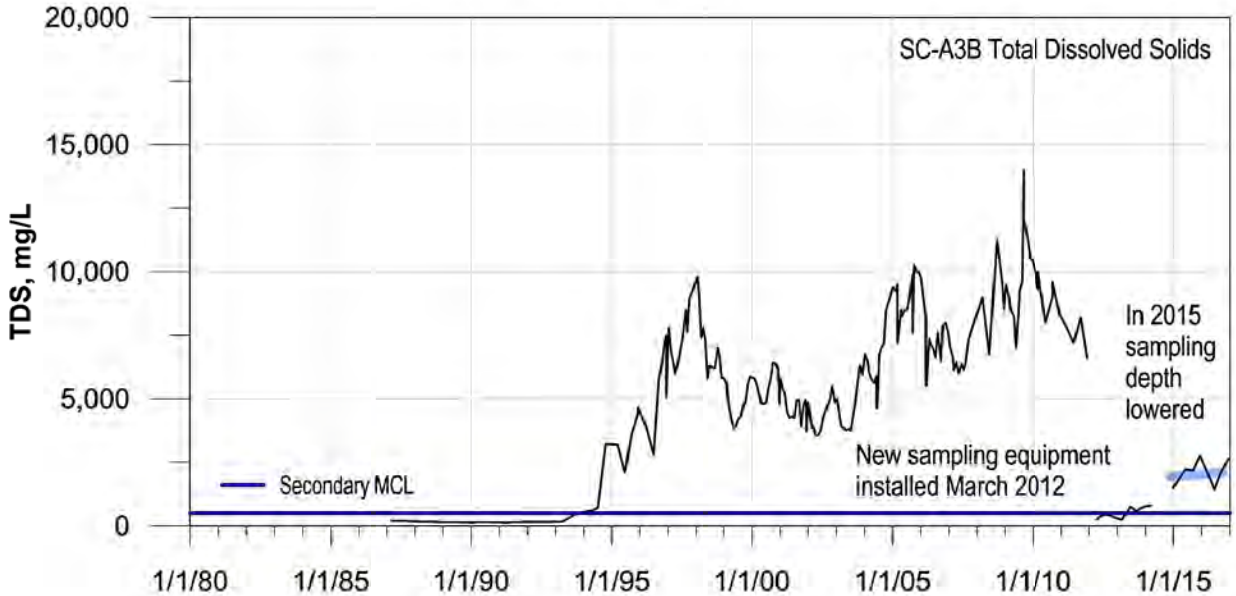

Well replaced in 2012
SC-A2C Chloride
Chloride, mg/L
Secondary MCL
SC-A2C Total Dissolved Solids
TDS, mg/L
Broken purge pump replaced by bladder pump October 2008
Secondary MCL
SC-A2C Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
Data Logger
WY 2012-2016 Trend
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

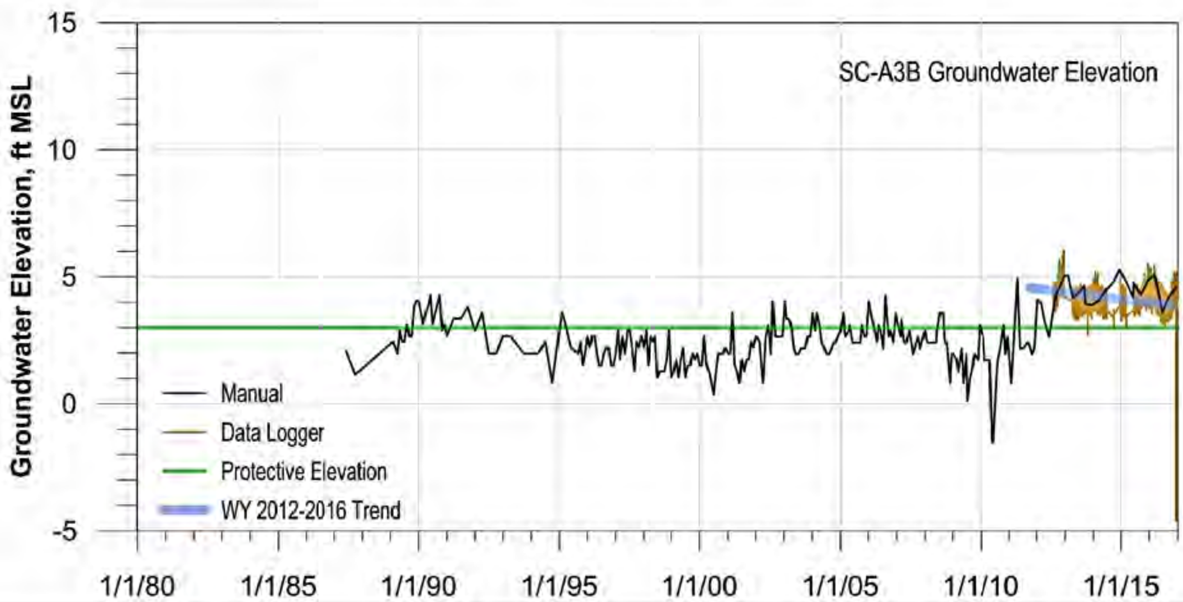

SC-A3A Chloride
Chloride, mg/L
25,000
20,000
15,000
10,000
5,000
0
Secondary MCL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-A3A Total Dissolved Solids
TDS, mg/L
60,000
50,000
40,000
30,000
20,000
10,000
0
Secondary MCL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

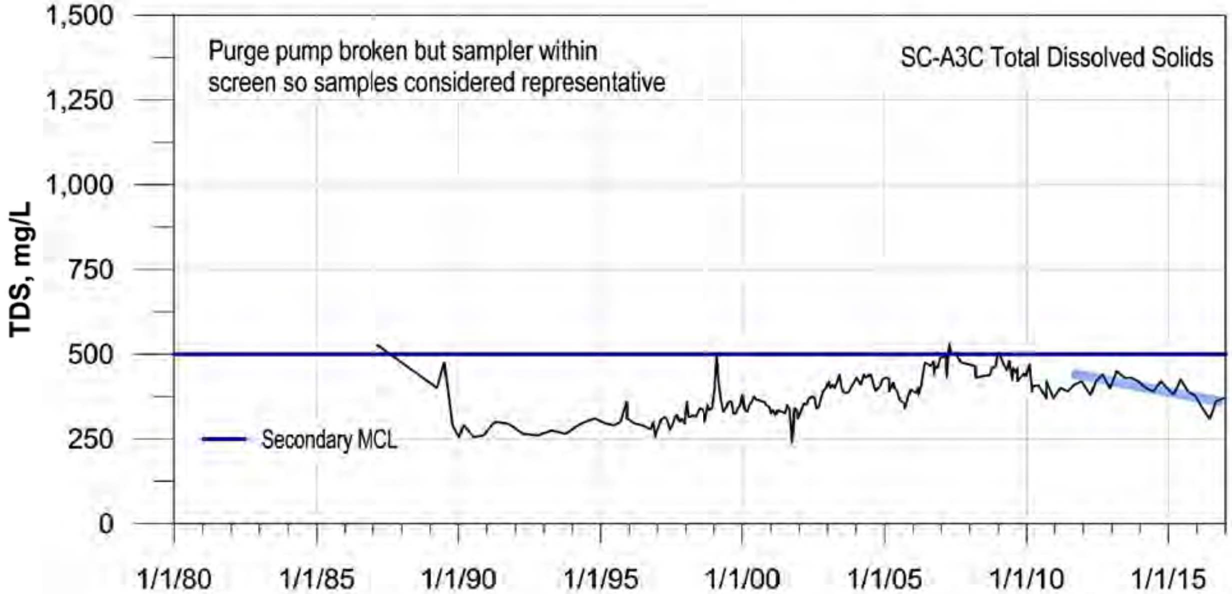

SC-A3A Groundwater Elevation
Groundwater Elevation, ft MSL
15
10
5
0
-5
Manual
Data Logger
Protective Elevation
WY 2012-2016 Trend
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

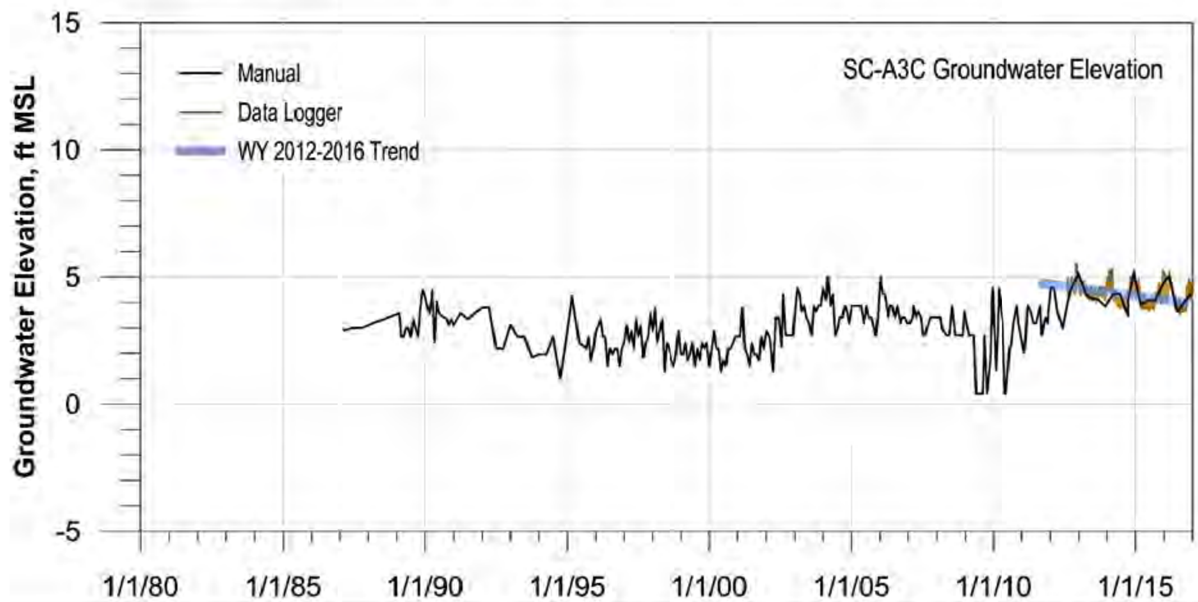

SC-A3B Chloride
Chloride, mg/L
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Secondary MCL
New sampling equipment installed March 2012
In 2015 sampling depth lowered
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

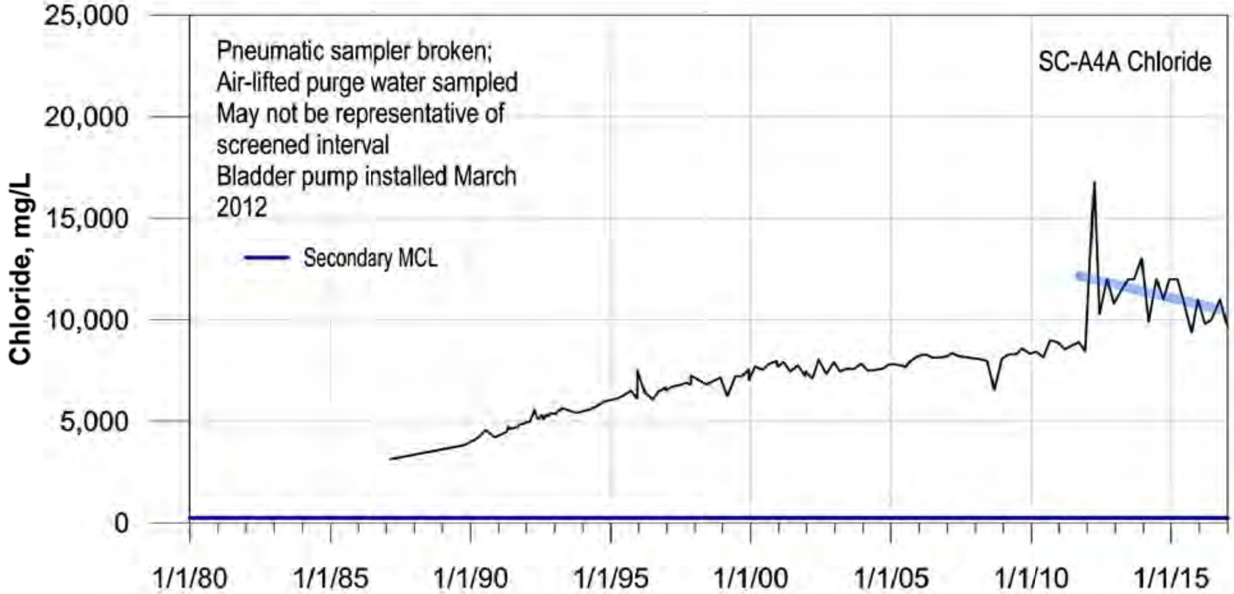

SC-A3B Total Dissolved Solids
TDS, mg/L
20,000
15,000
10,000
5,000
0
Secondary MCL
New sampling equipment installed March 2012
In 2015 sampling depth lowered
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-A3B Groundwater Elevation
Groundwater Elevation, ft MSL
15
10
5
0
-5
Manual
Data Logger
Protective Elevation
WY 2012-2016 Trend
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

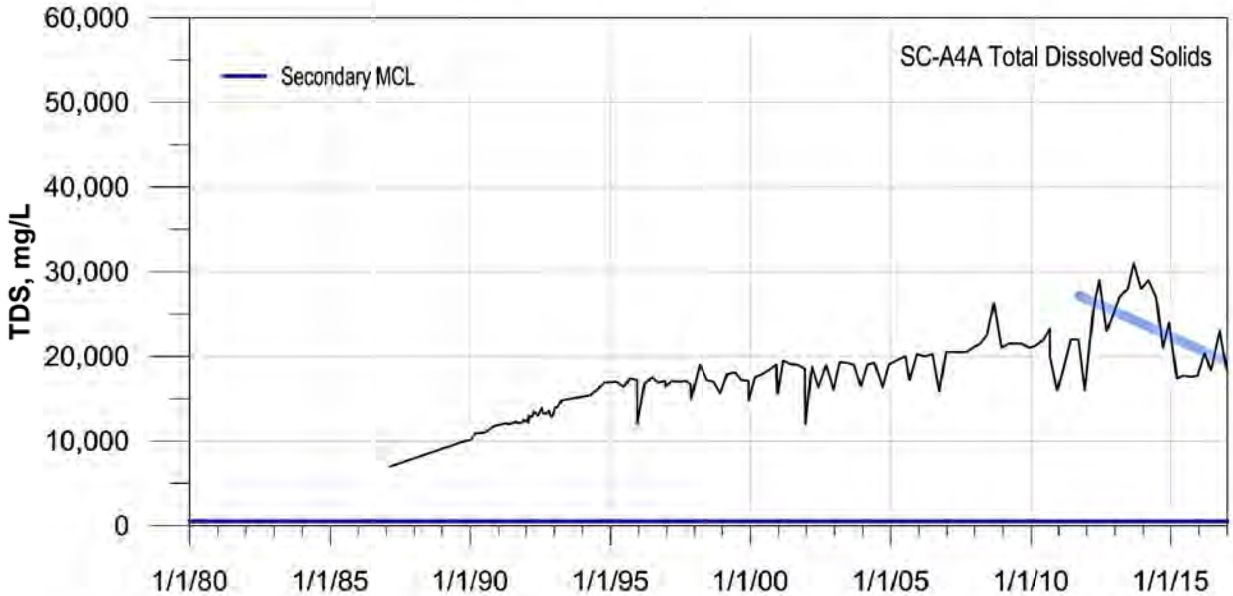

SC-A3C Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Purge pump broken but sampler within screen so samples considered representative
SC-A3C Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

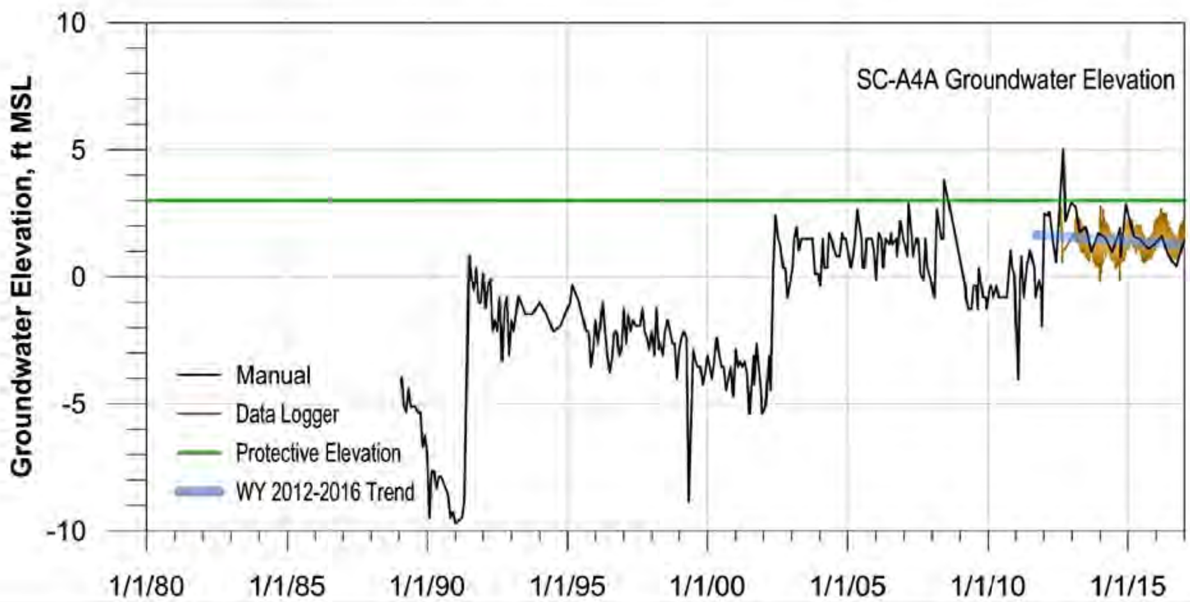

SC-A3C Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
Data Logger
WY 2012-2016 Trend
15
10
5
0
-5
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15



25,000
20,000
15,000
10,000
5,000
0
Chloride, mg/L
Pneumatic sampler broken;
Air-lifted purge water sampled
May not be representative of
screened interval
Bladder pump installed March
2012
Secondary MCL
SC-A4A Chloride
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

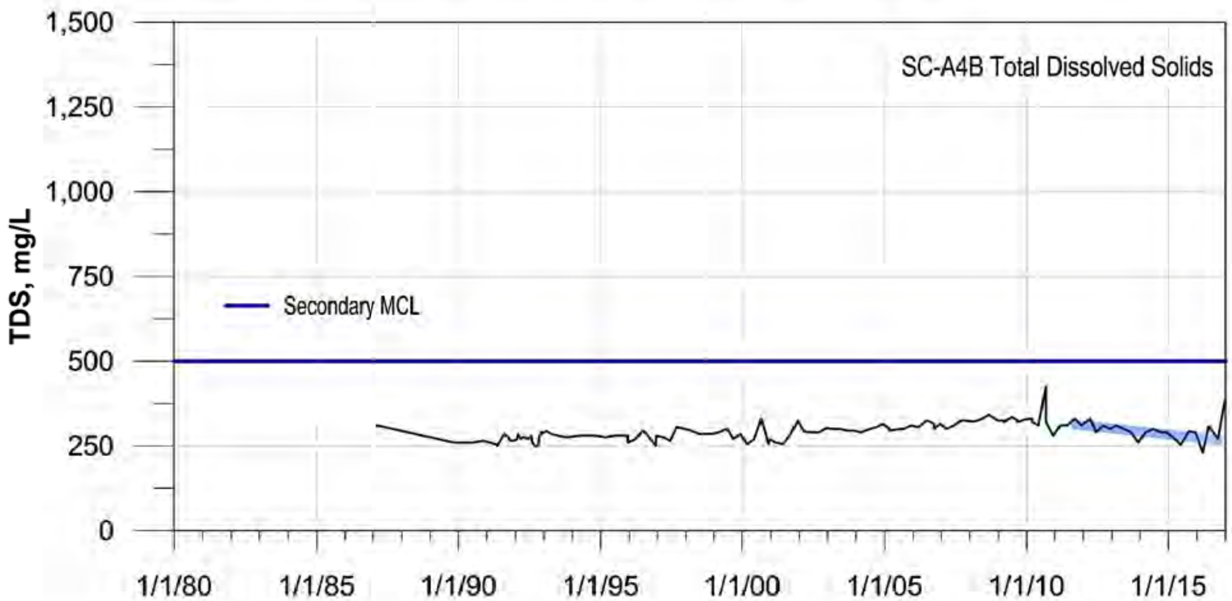


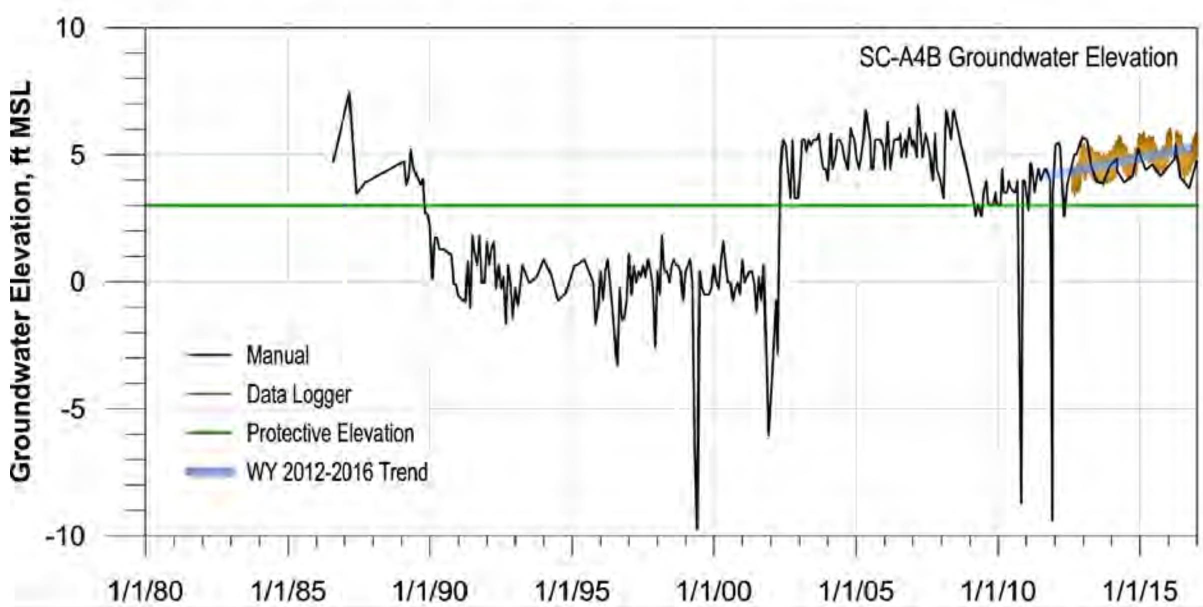
60,000
50,000
40,000
30,000
20,000
10,000
0
TDS, mg/L
Secondary MCL
SC-A4A Total Dissolved Solids
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15



10
5
0
-5
-10
Groundwater Elevation, ft MSL
SC-A4A Groundwater Elevation
Manual
Data Logger
Protective Elevation
WY 2012-2016 Trend
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

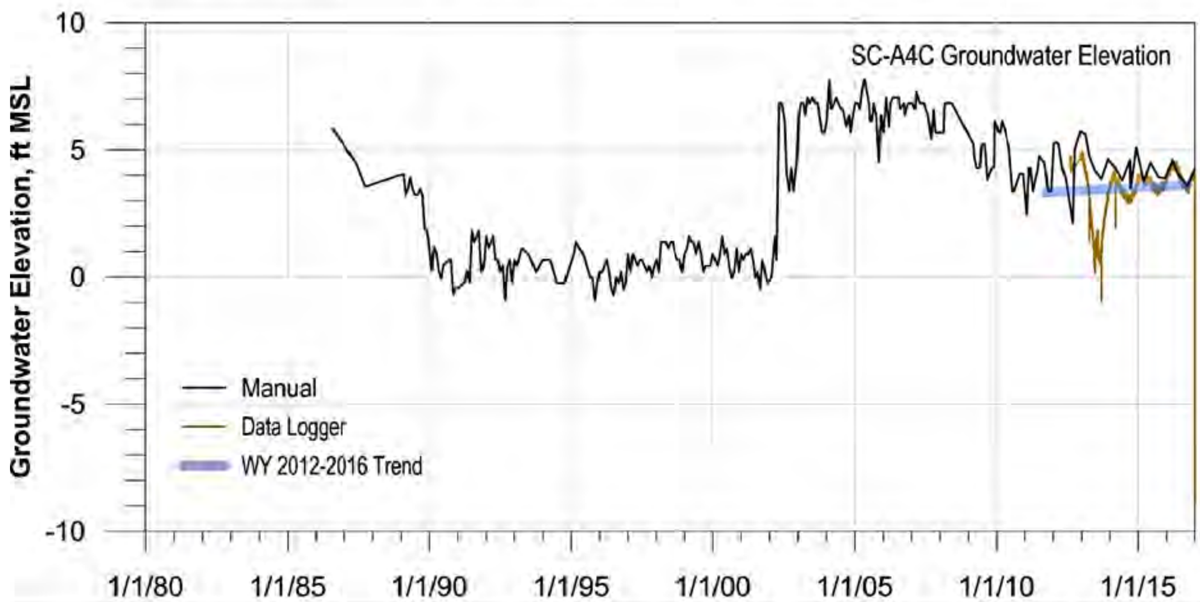

SC-A4B Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-A4B Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

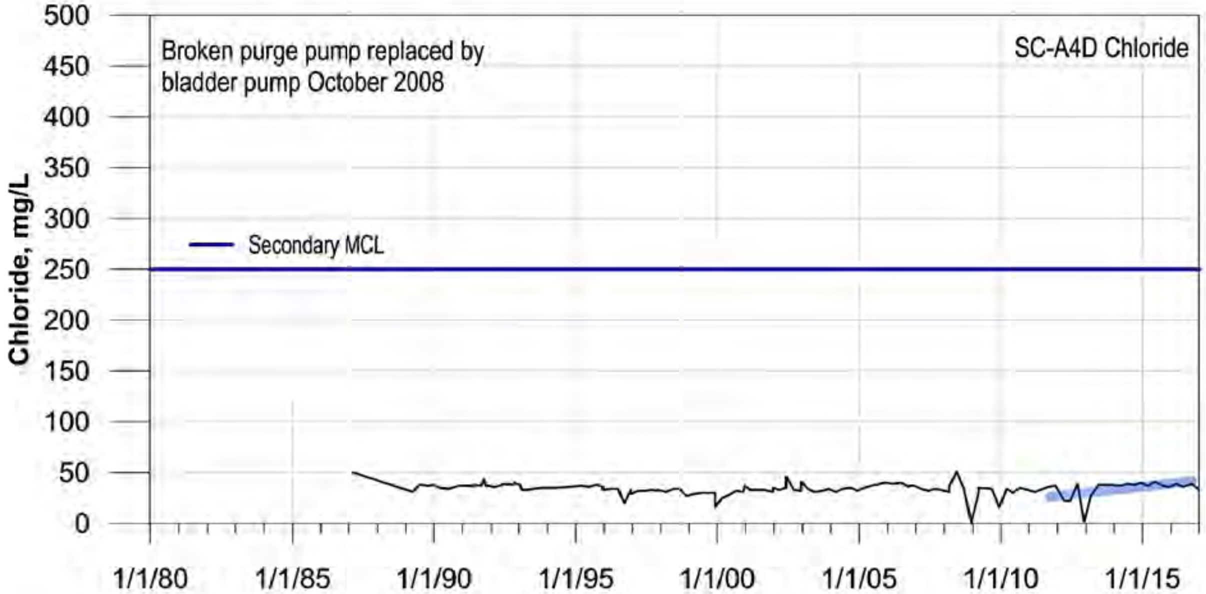

SC-A4B Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
Data Logger
Protective Elevation
WY 2012-2016 Trend
10
5
0
-5
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

SC-A4C Chloride
Secondary MCL
Chloride, mg/L
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

SC-A4C Total Dissolved Solids
Secondary MCL
TDS, mg/L
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

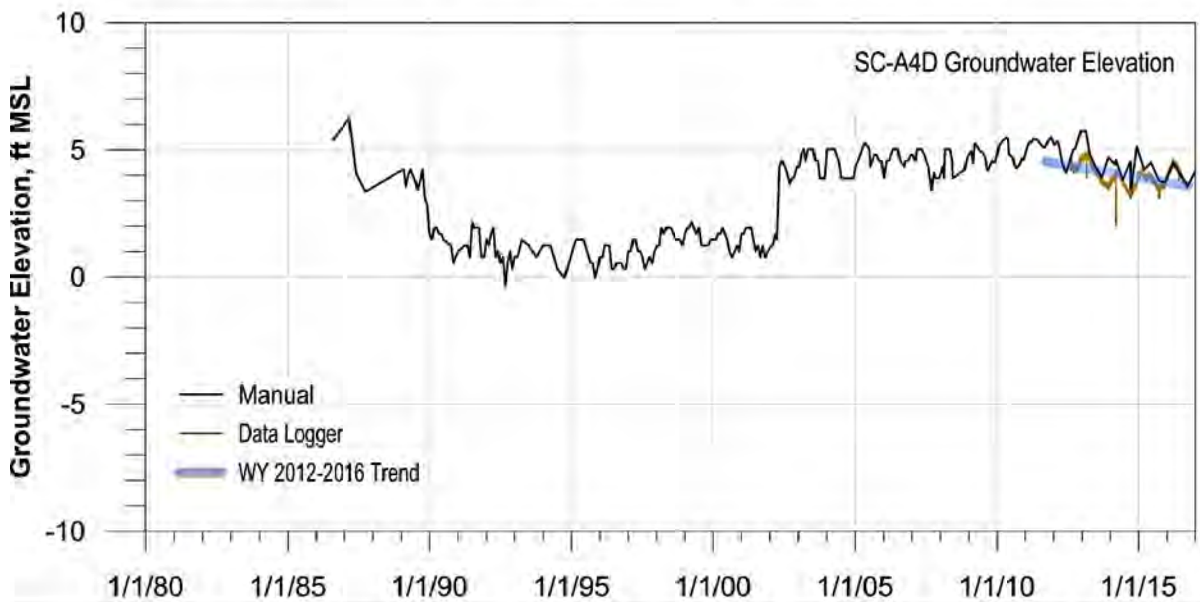


SC-A4C Groundwater Elevation
Manual
Data Logger
WY 2012-2016 Trend
Groundwater Elevation, ft MSL
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

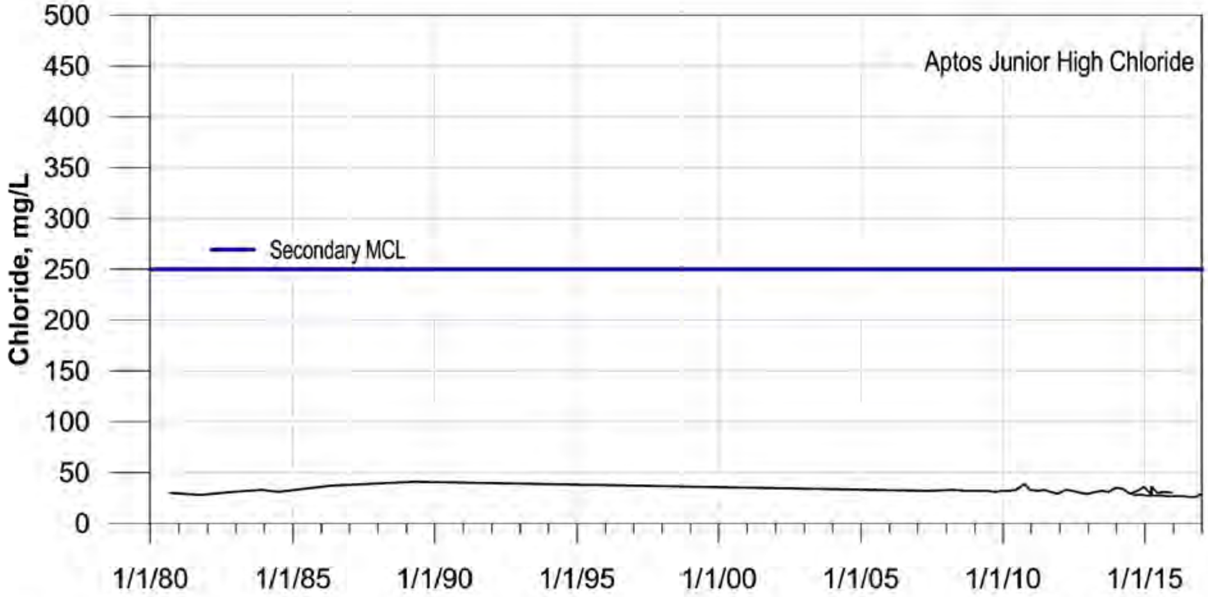


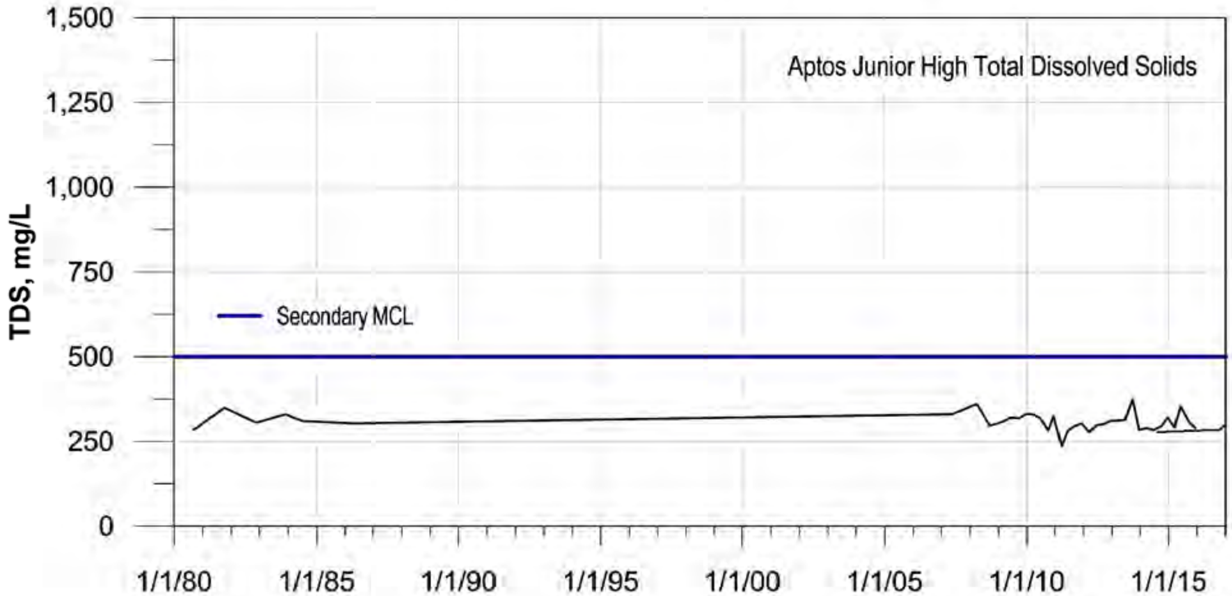
Broken purge pump replaced by bladder pump October 2008
SC-A4D Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

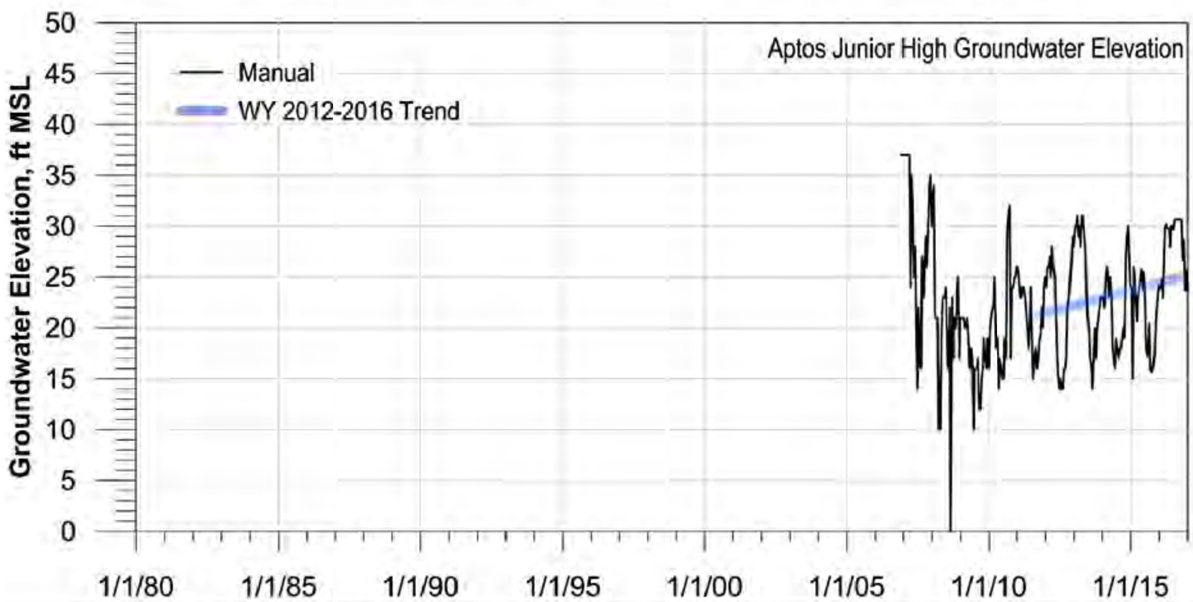
SC-A4D Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15



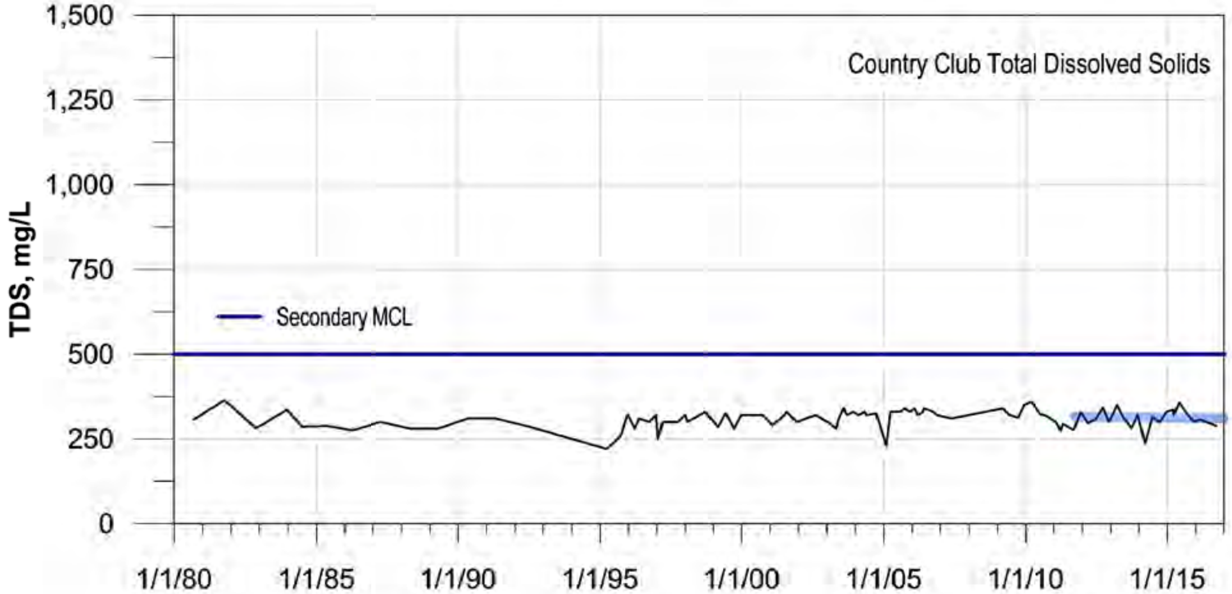
SC-A4D Groundwater Elevation
Groundwater Elevation, ft MSL
10
5
0
-5
-10
Manual
Data Logger
WY 2012-2016 Trend
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

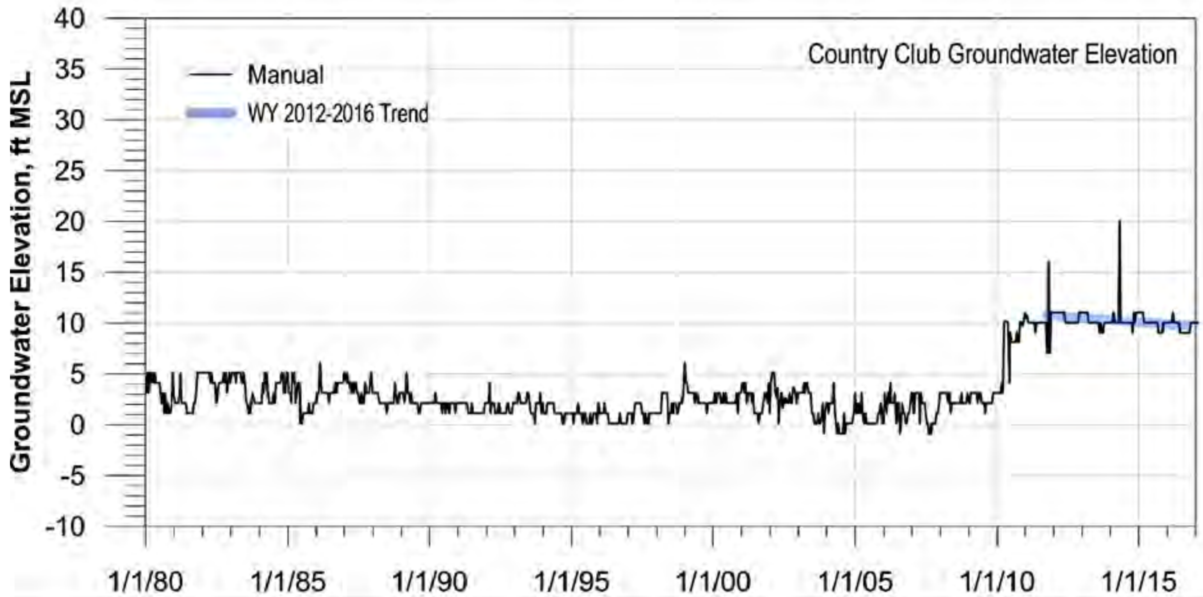

Aptos Junior High Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Aptos Junior High Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

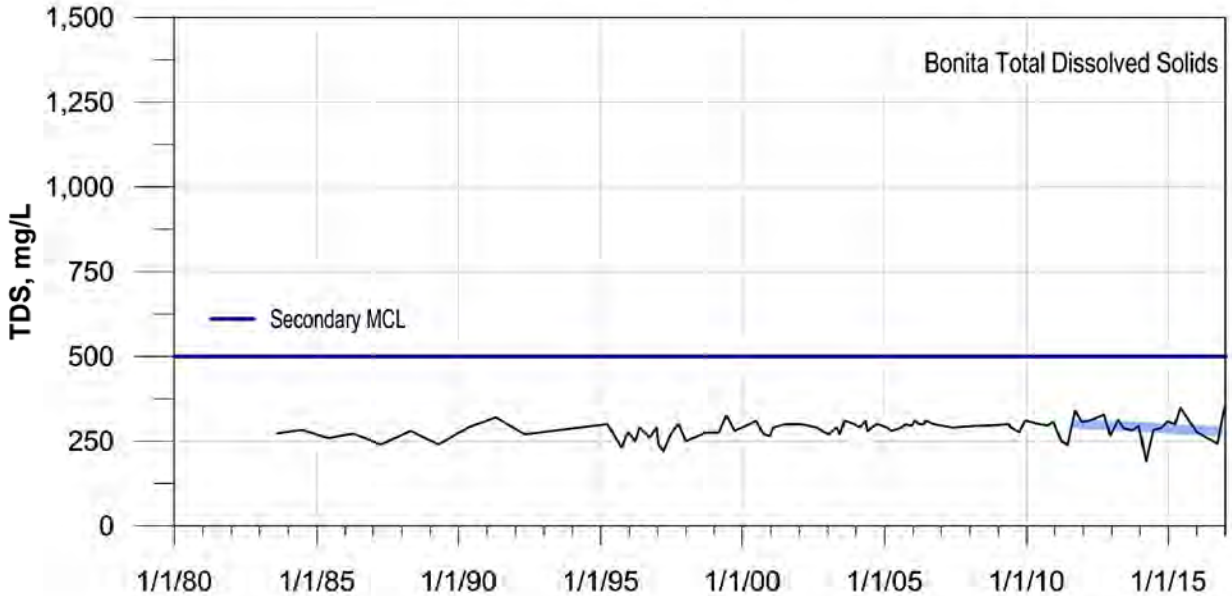

Aptos Junior High Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
WY 2012-2016 Trend
50
45
40
35
30
25
20
15
10
5
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

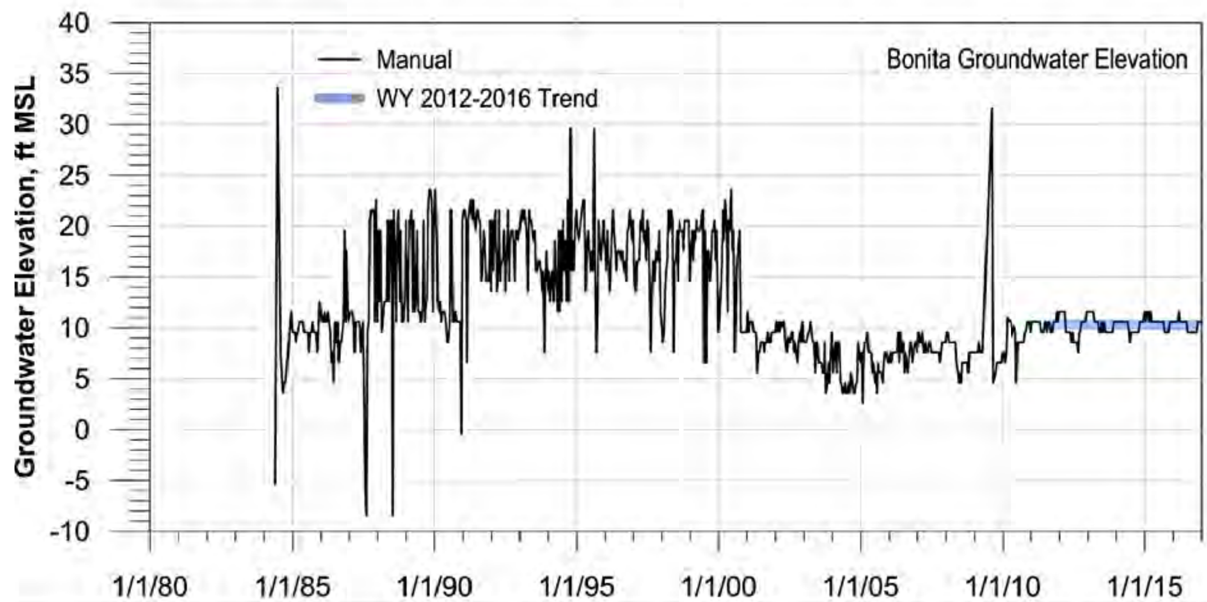

Country Club Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

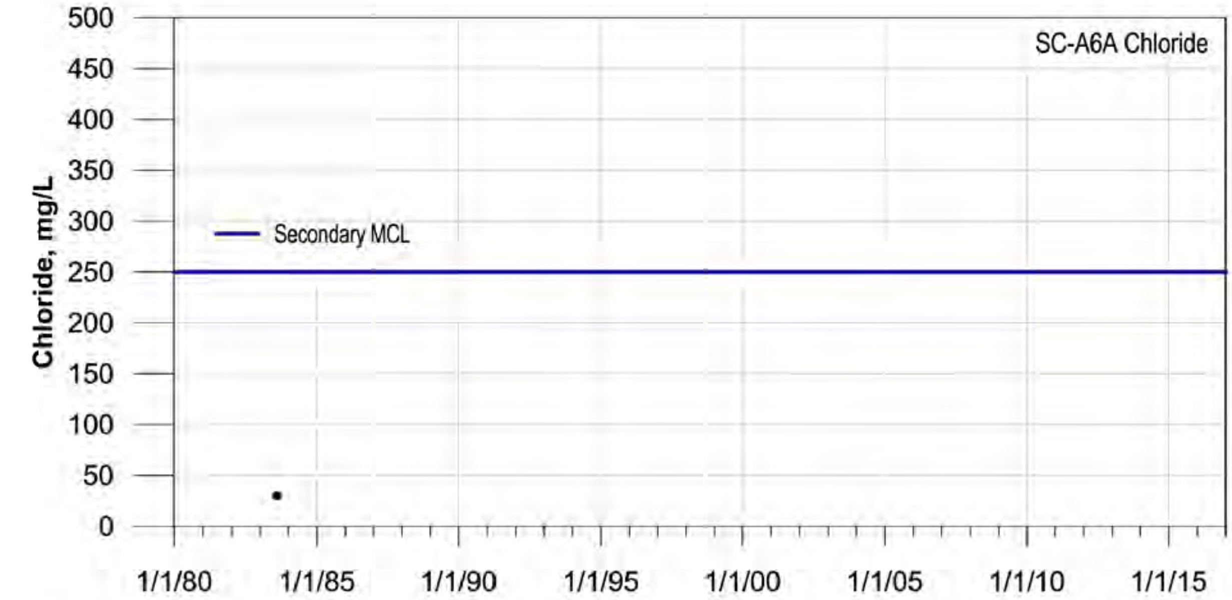

Country Club Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Country Club Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
WY 2012-2016 Trend
40
35
30
25
20
15
10
5
0
-5
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

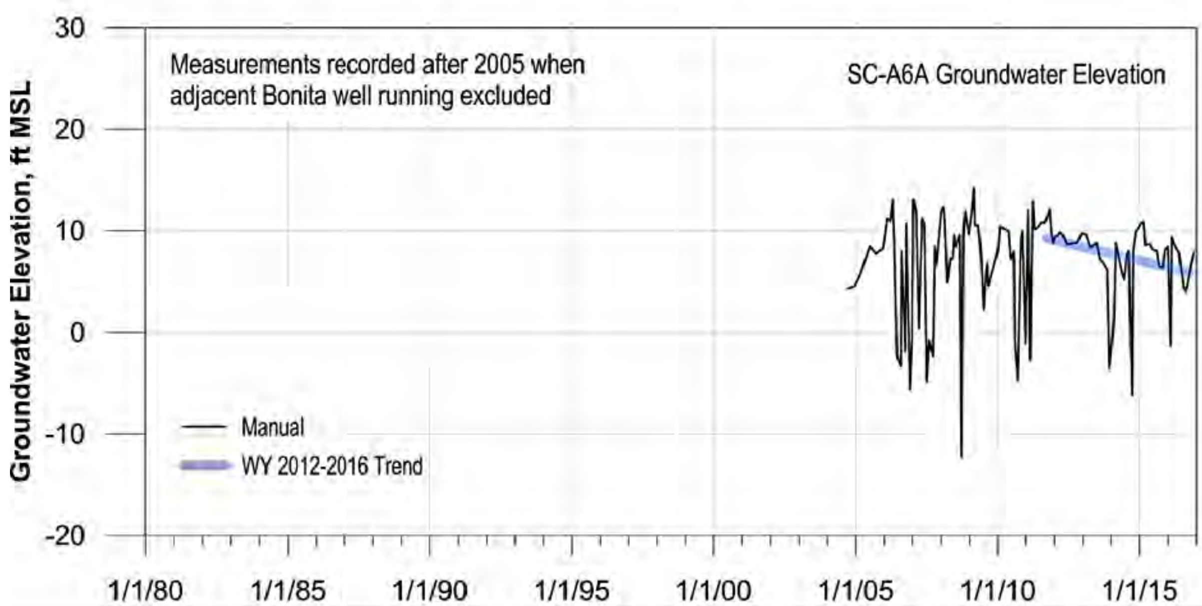

Bonita Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

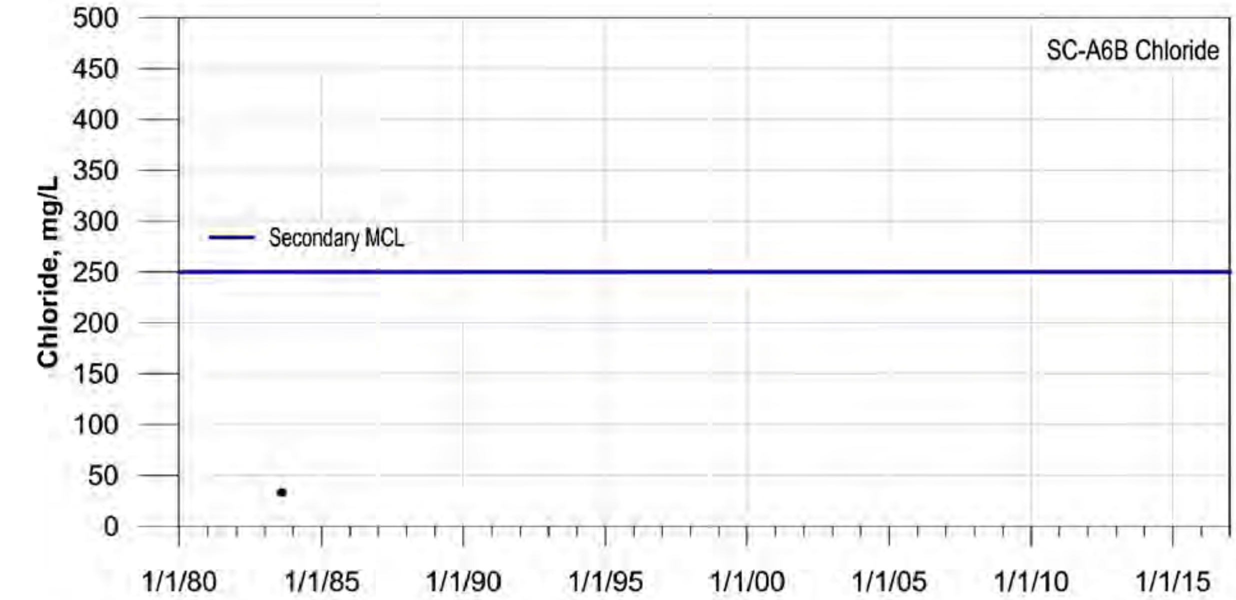

Bonita Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Manual
WY 2012-2016 Trend
Bonita Groundwater Elevation
Groundwater Elevation, ft MSL
40
35
30
25
20
15
10
5
0
-5
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

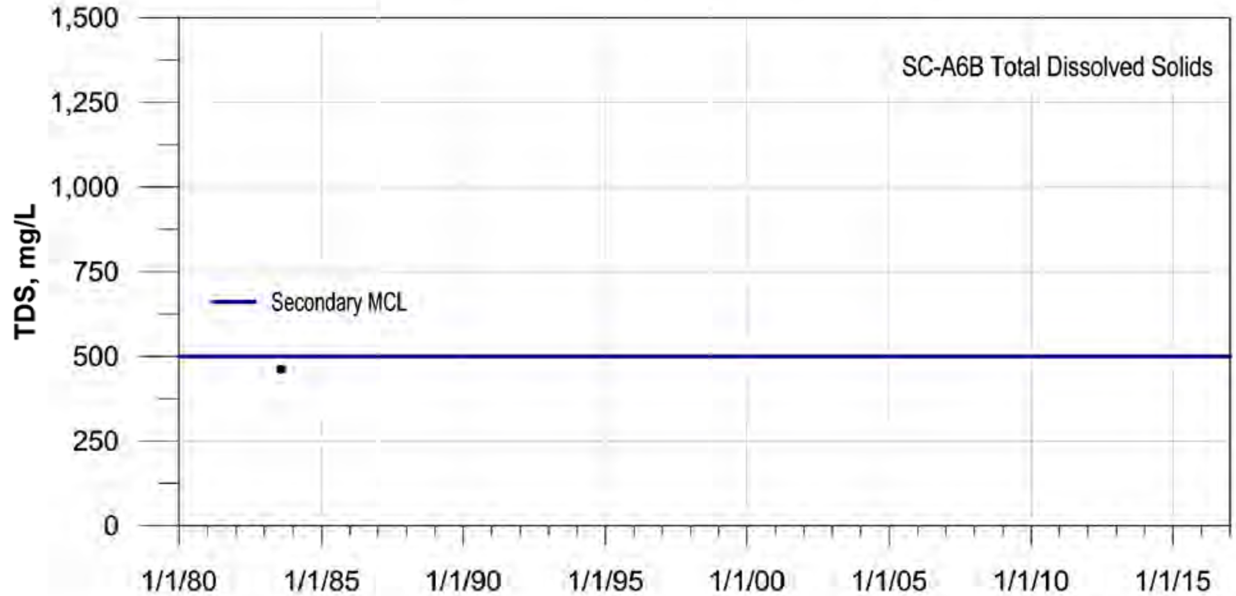

SC-A6A Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-A6A Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

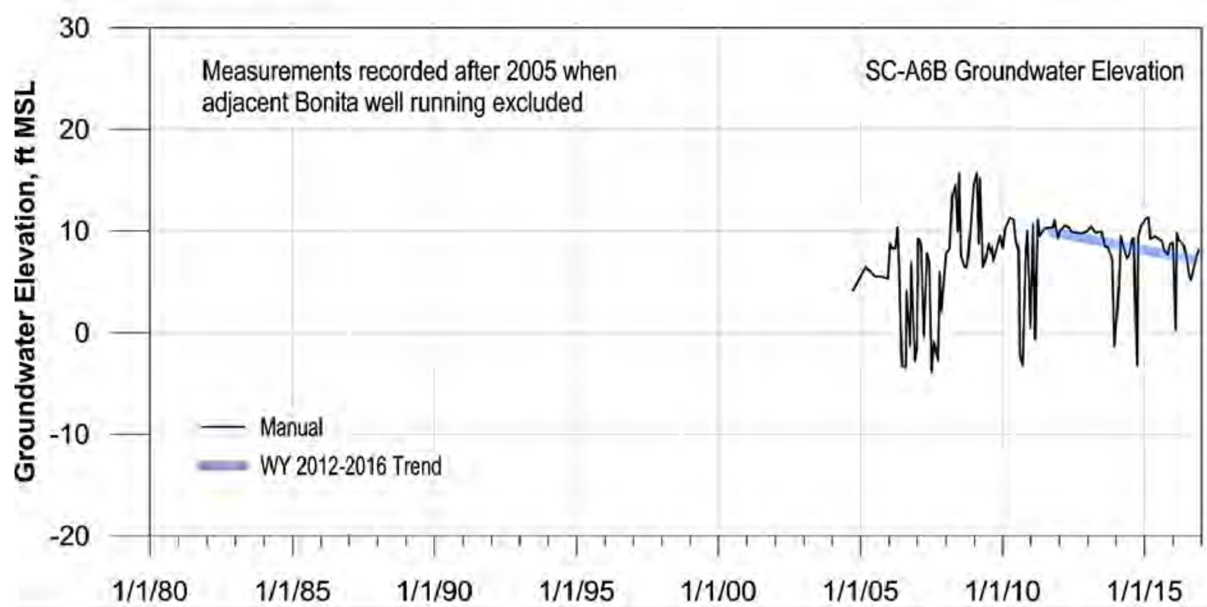

Measurements recorded after 2005 when adjacent Bonita well running excluded
SC-A6A Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
WY 2012-2016 Trend
30
20
10
0
-10
-20
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15



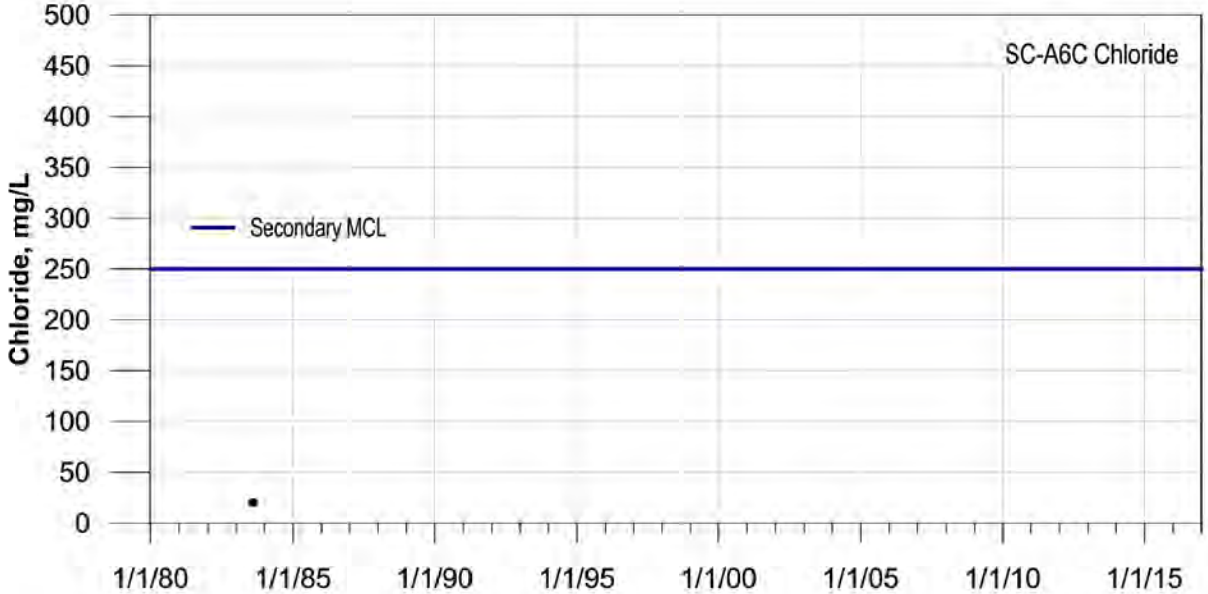
SC-A6B Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

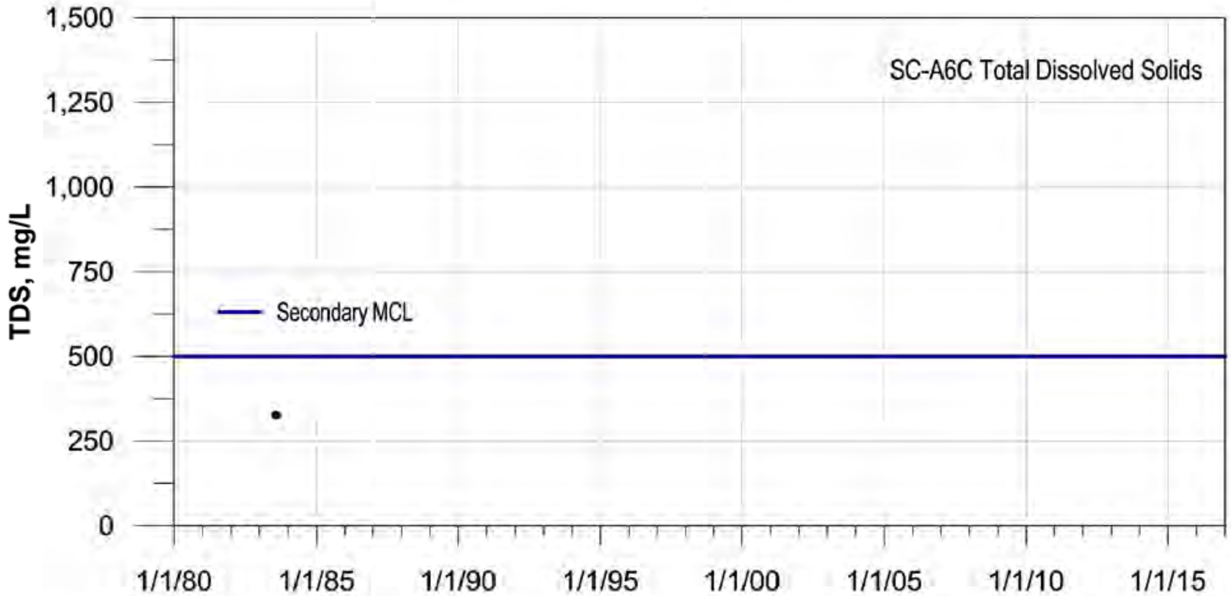


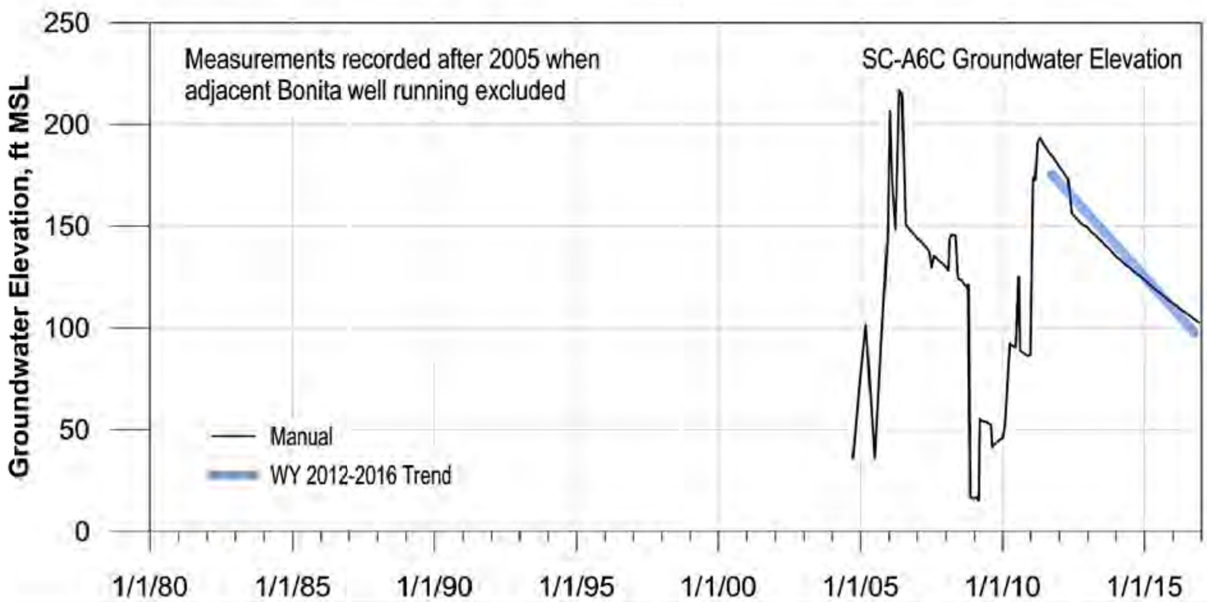
SC-A6B Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

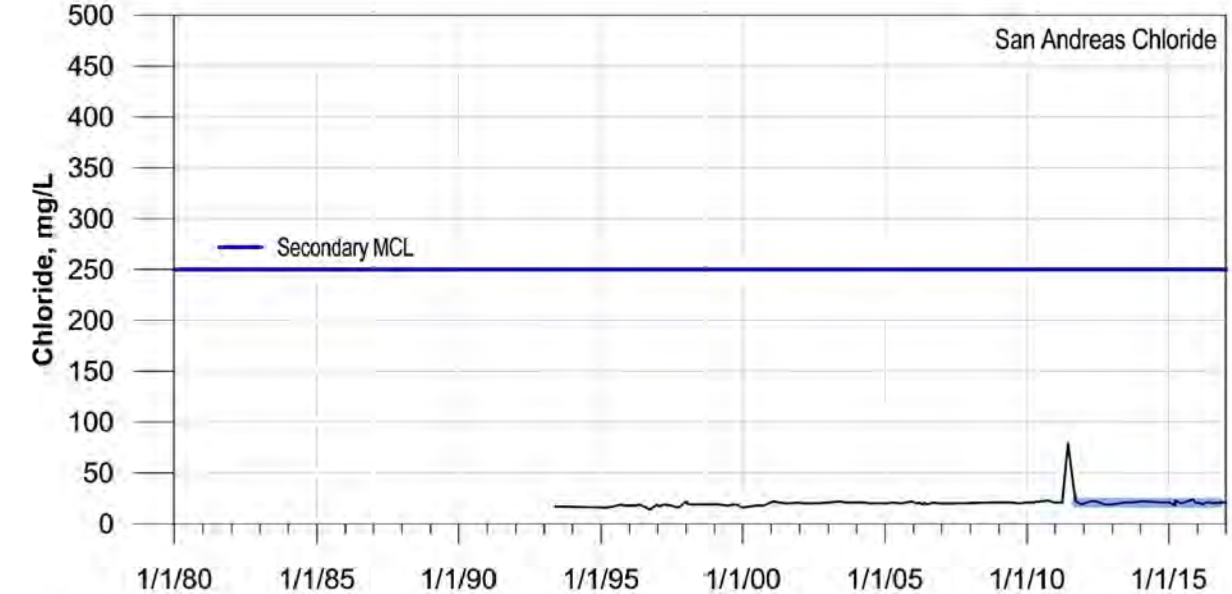


Measurements recorded after 2005 when adjacent Bonita well running excluded
SC-A6B Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
WY 2012-2016 Trend
30
20
10
0
-10
-20
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

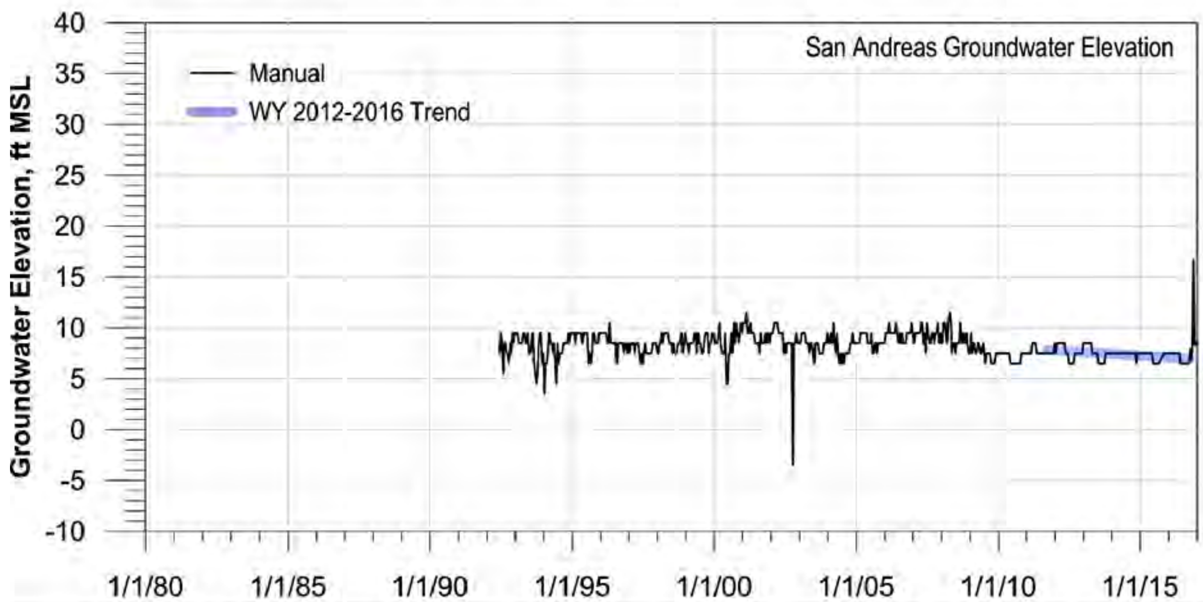

SC-A6C Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-A6C Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

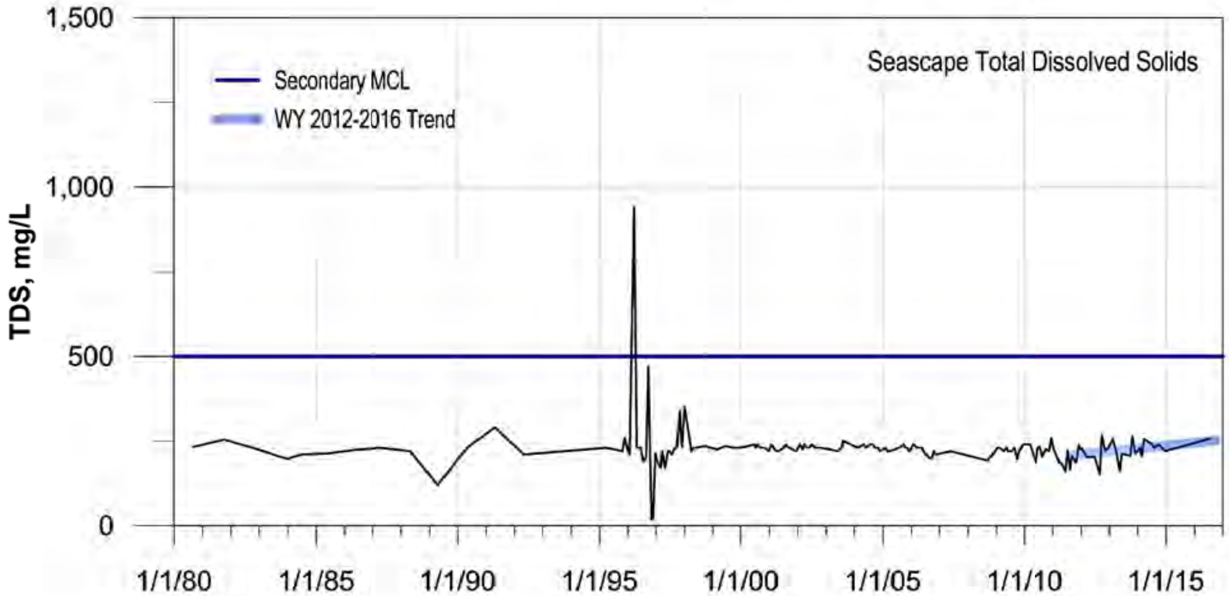

Measurements recorded after 2005 when adjacent Bonita well running excluded
SC-A6C Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
WY 2012-2016 Trend
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

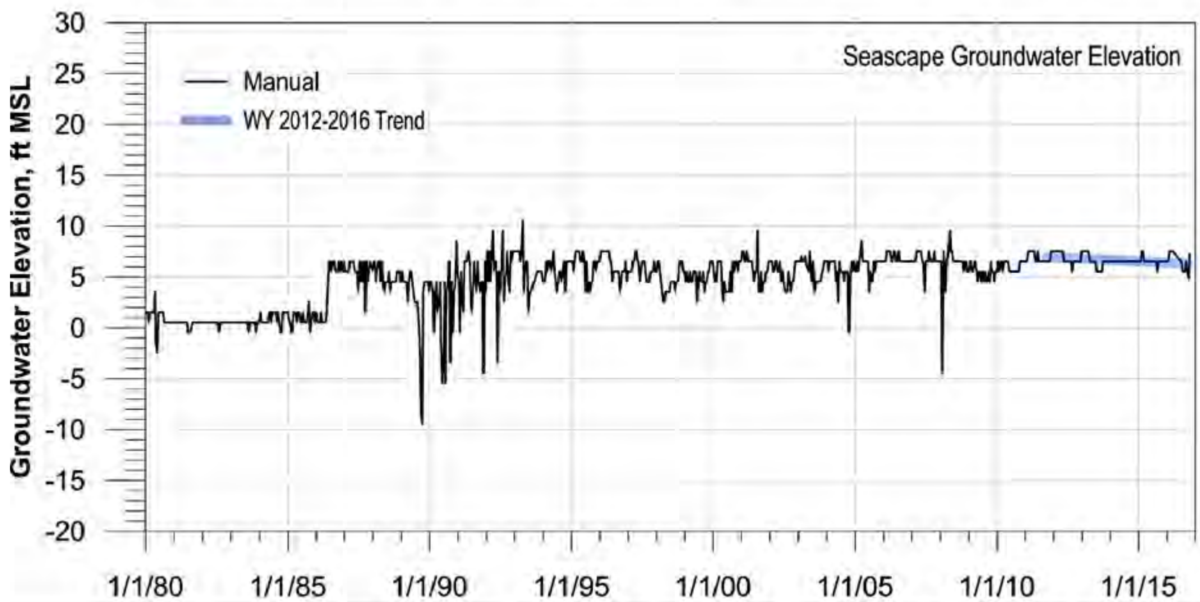

San Andreas Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

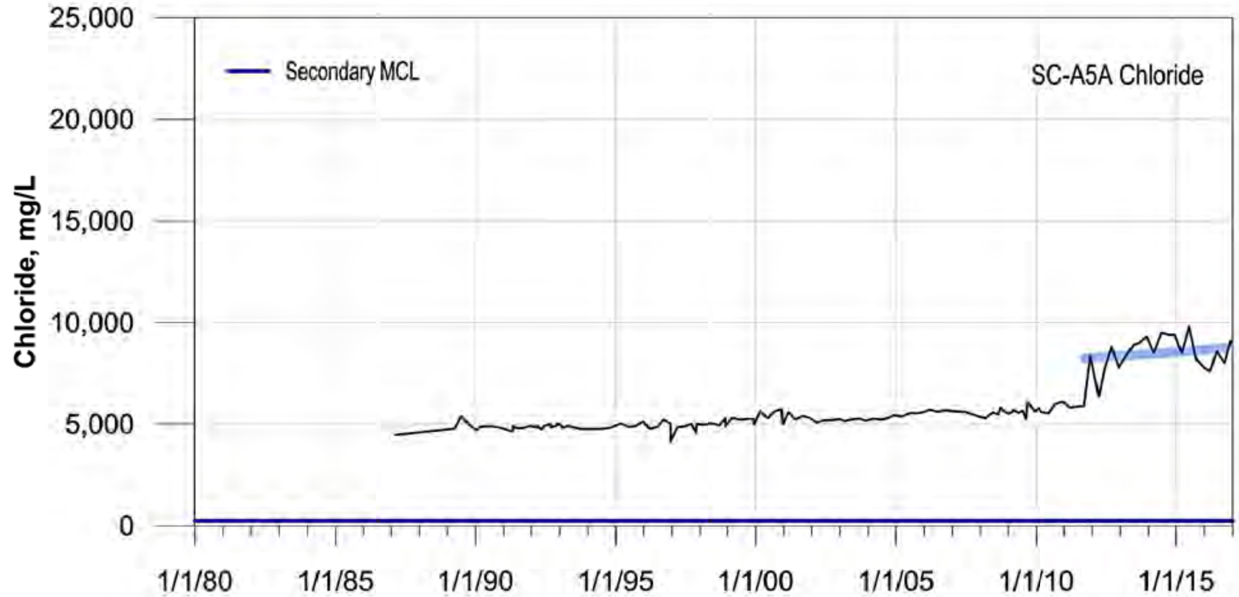

San Andreas Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


San Andreas Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
WY 2012-2016 Trend
40
35
30
25
20
15
10
5
0
-5
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

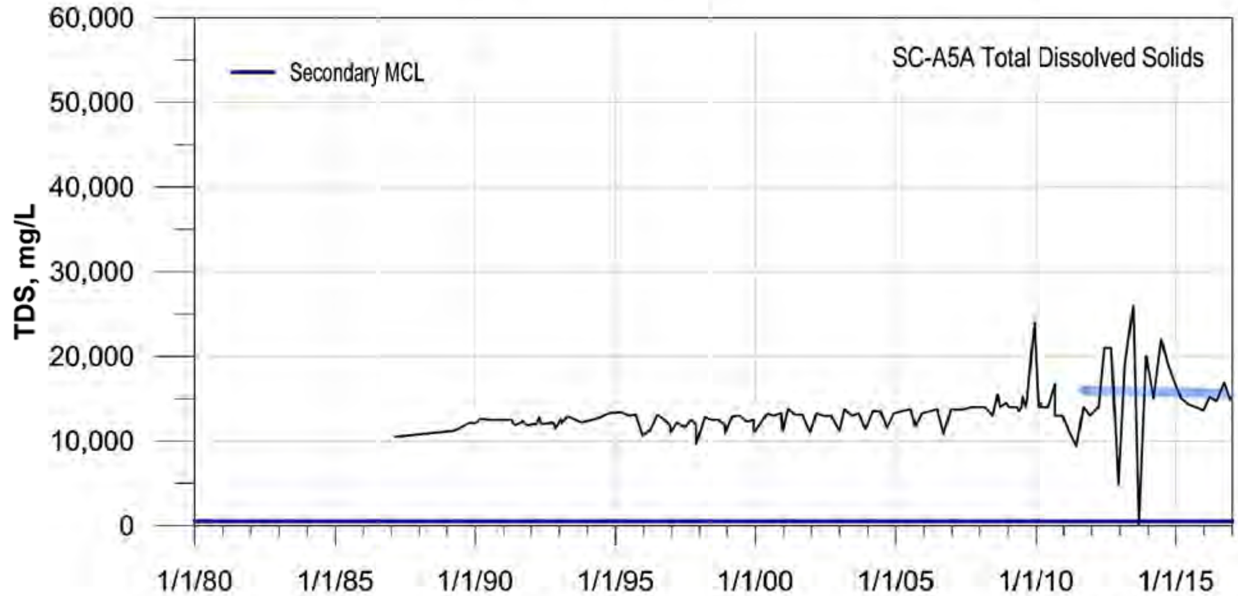

Seascape Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Seascape Total Dissolved Solids
Secondary MCL
WY 2012-2016 Trend
TDS, mg/L
1,500
1,000
500
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

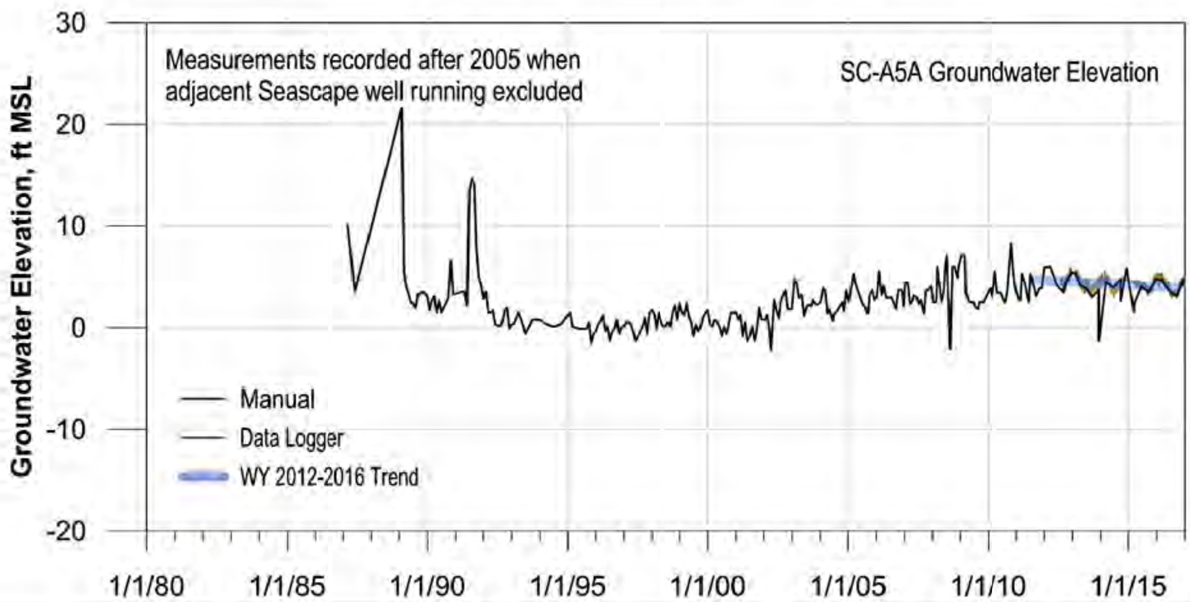

Seascape Groundwater Elevation
Manual
WY 2012-2016 Trend
Groundwater Elevation, ft MSL
30
25
20
15
10
5
0
-5
-10
-15
-20
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15



Secondary MCL
SC-A5A Chloride
Chloride, mg/L
25,000
20,000
15,000
10,000
5,000
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15



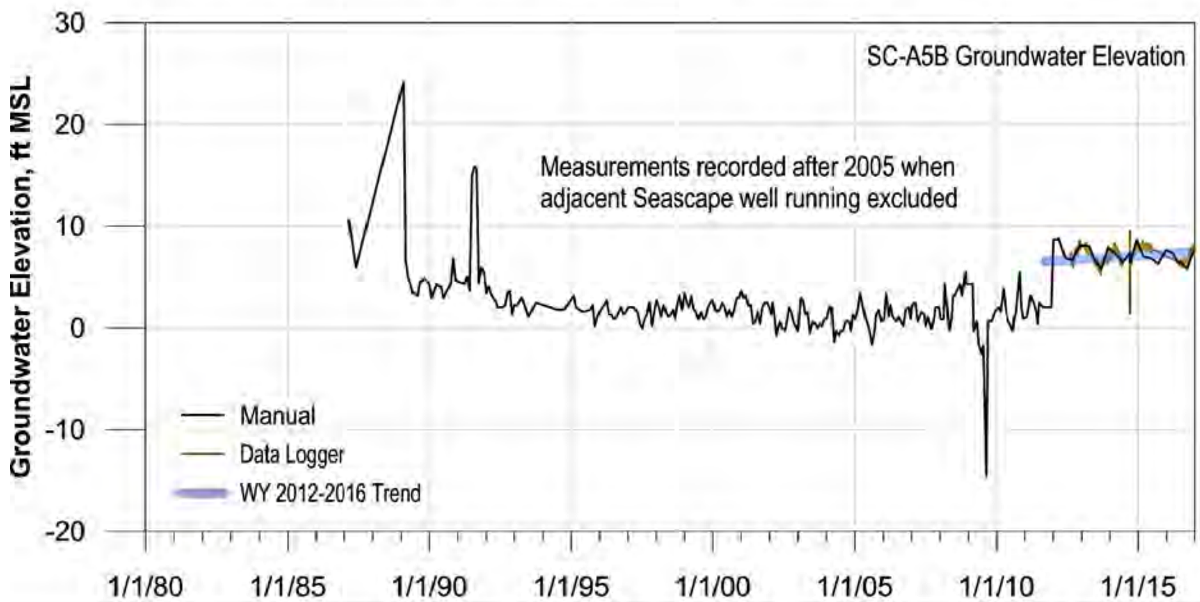
Secondary MCL
SC-A5A Total Dissolved Solids
TDS, mg/L
60,000
50,000
40,000
30,000
20,000
10,000
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

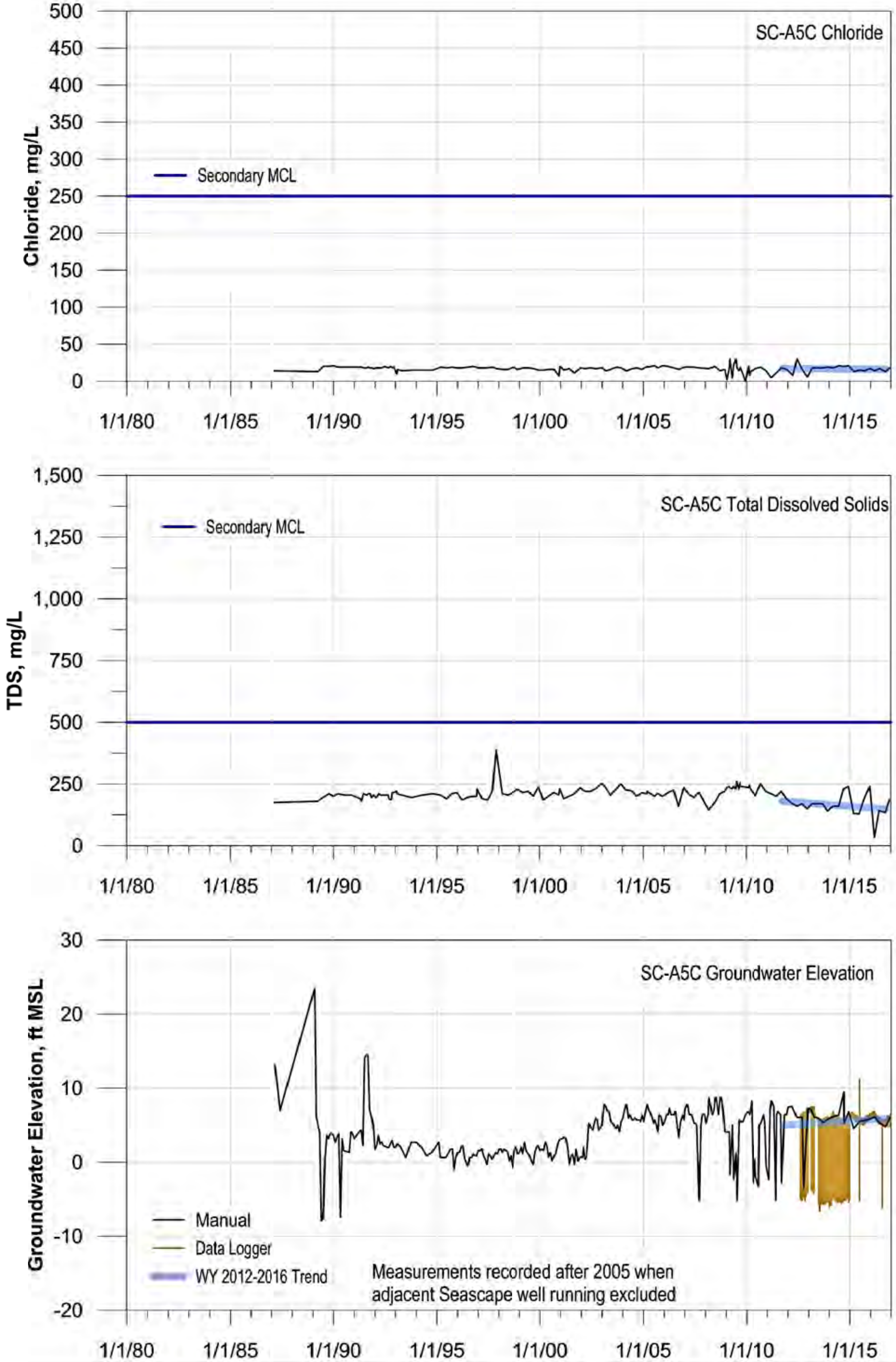


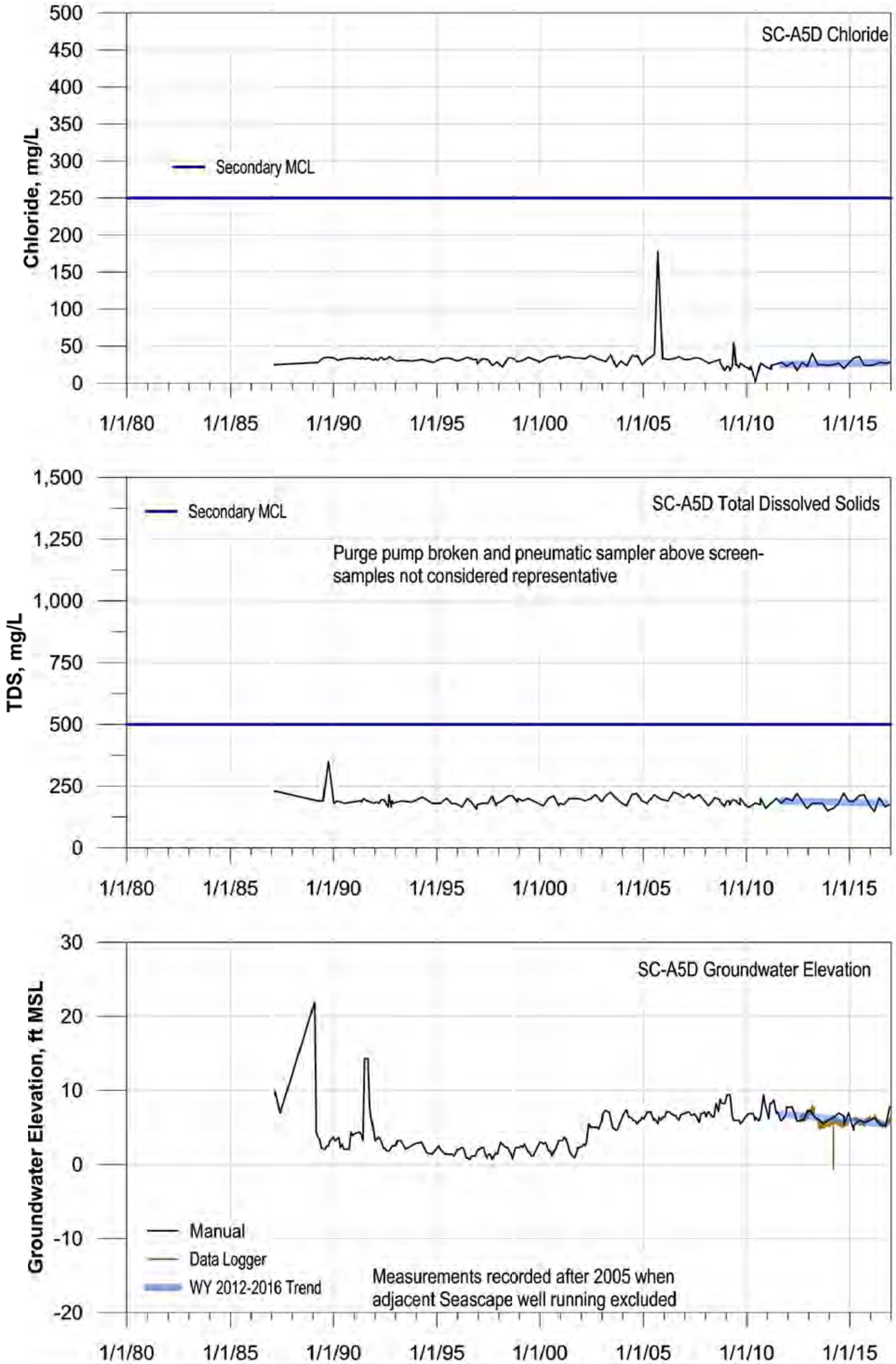
Measurements recorded after 2005 when adjacent Seascape well running excluded
SC-A5A Groundwater Elevation
Groundwater Elevation, ft MSL
30
20
10
0
-10
-20
Manual
Data Logger
WY 2012-2016 Trend
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-A5B Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

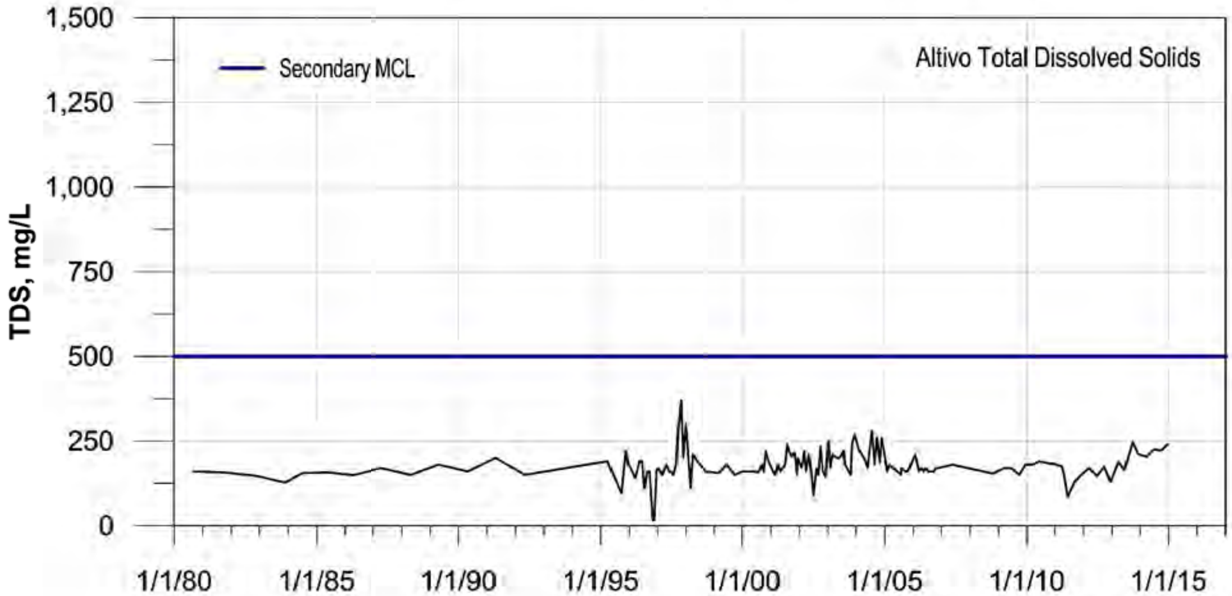

SC-A5B Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

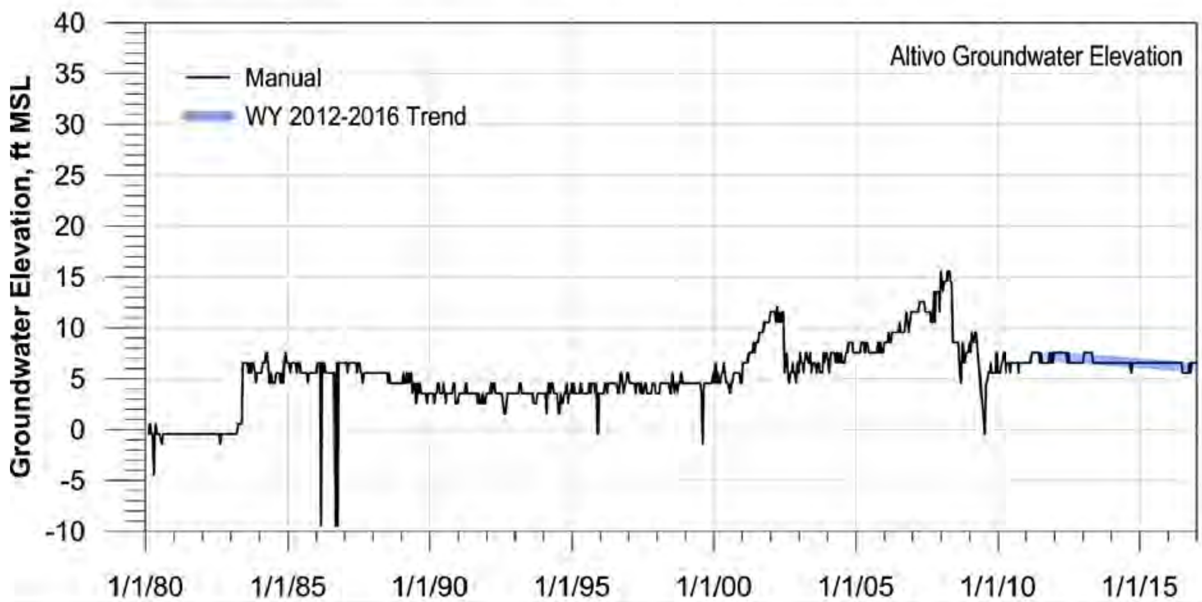

SC-A5B Groundwater Elevation
Groundwater Elevation, ft MSL
Measurements recorded after 2005 when adjacent Seascape well running excluded
Manual
Data Logger
WY 2012-2016 Trend
30
20
10
0
-10
-20
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-A5C Chloride
Chloride, mg/L
Secondary MCL
SC-A5C Total Dissolved Solids
TDS, mg/L
Secondary MCL
SC-A5C Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
Data Logger
WY 2012-2016 Trend
Measurements recorded after 2005 when adjacent Seascape well running excluded
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

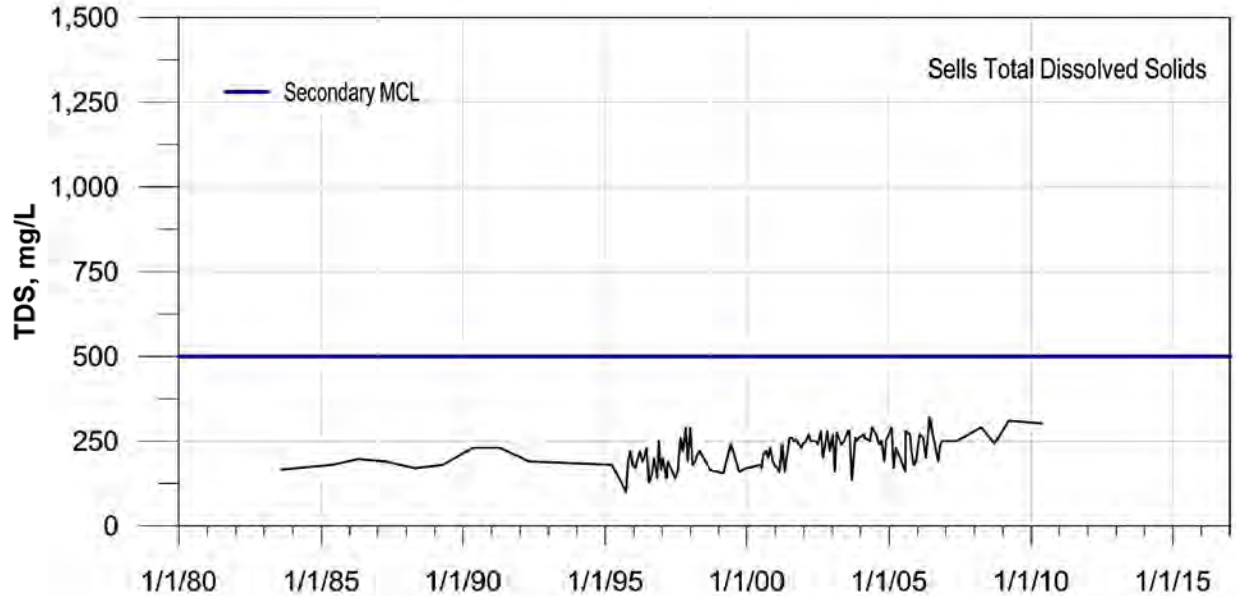

SC-A5D Chloride
Chloride, mg/L
Secondary MCL
SC-A5D Total Dissolved Solids
TDS, mg/L
Secondary MCL
Purge pump broken and pneumatic sampler above screen-
samples not considered representative
SC-A5D Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
Data Logger
WY 2012-2016 Trend
Measurements recorded after 2005 when
adjacent Seascape well running excluded
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

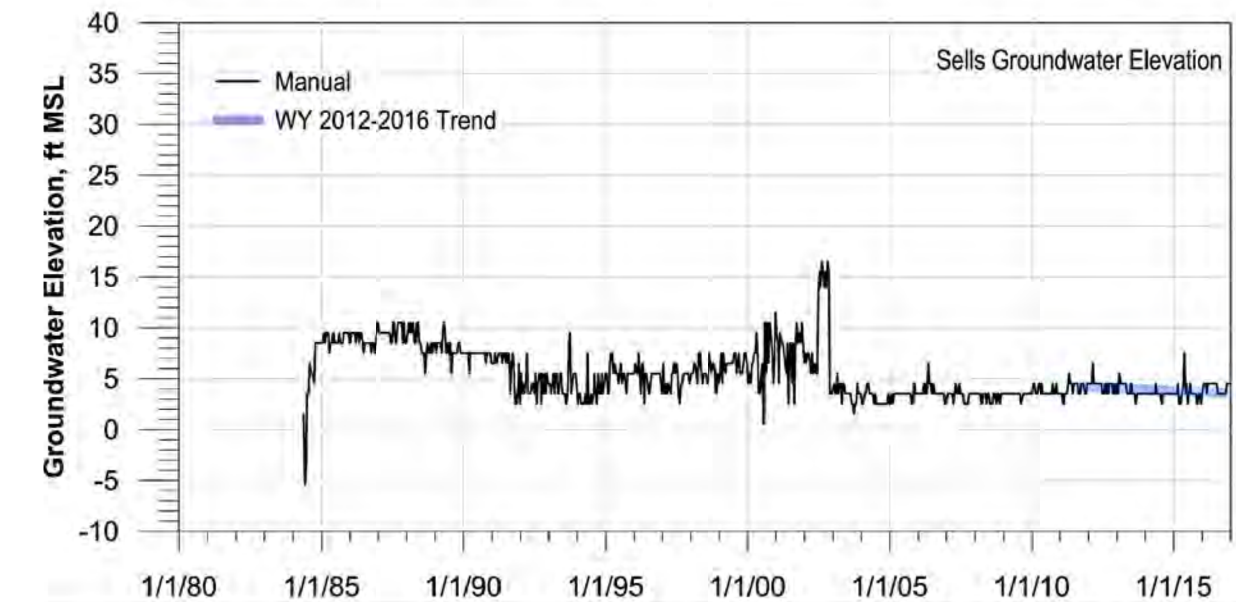

Secondary MCL
Altivo Chloride
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

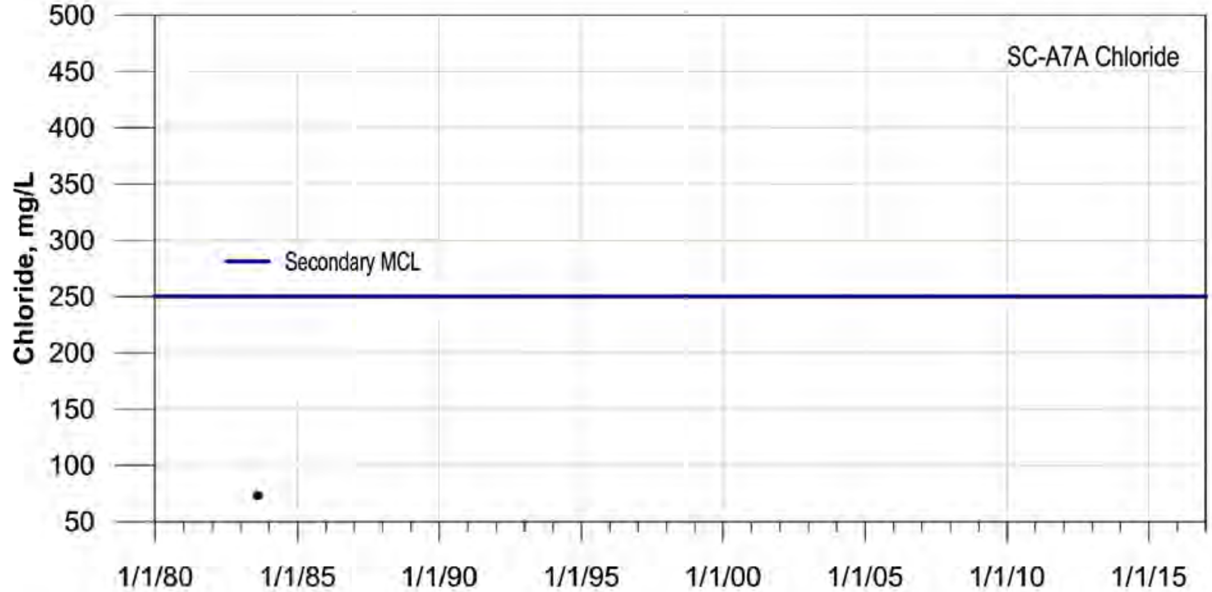

Secondary MCL
Altivo Total Dissolved Solids
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Manual
WY 2012-2016 Trend
Altivo Groundwater Elevation
Groundwater Elevation, ft MSL
40
35
30
25
20
15
10
5
0
-5
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

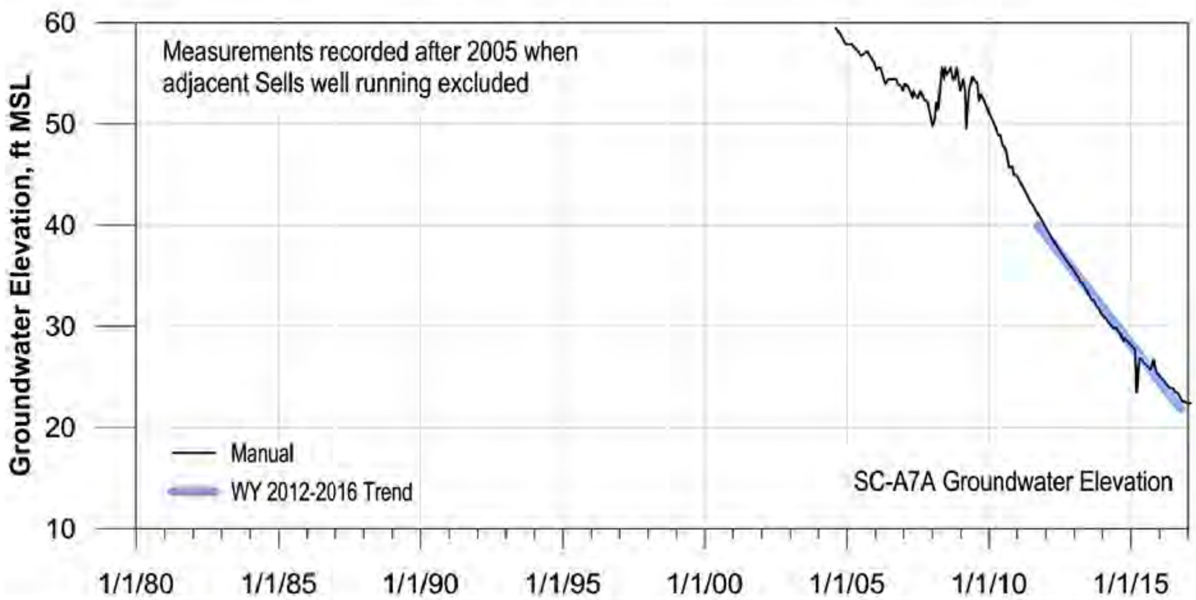

Sells Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

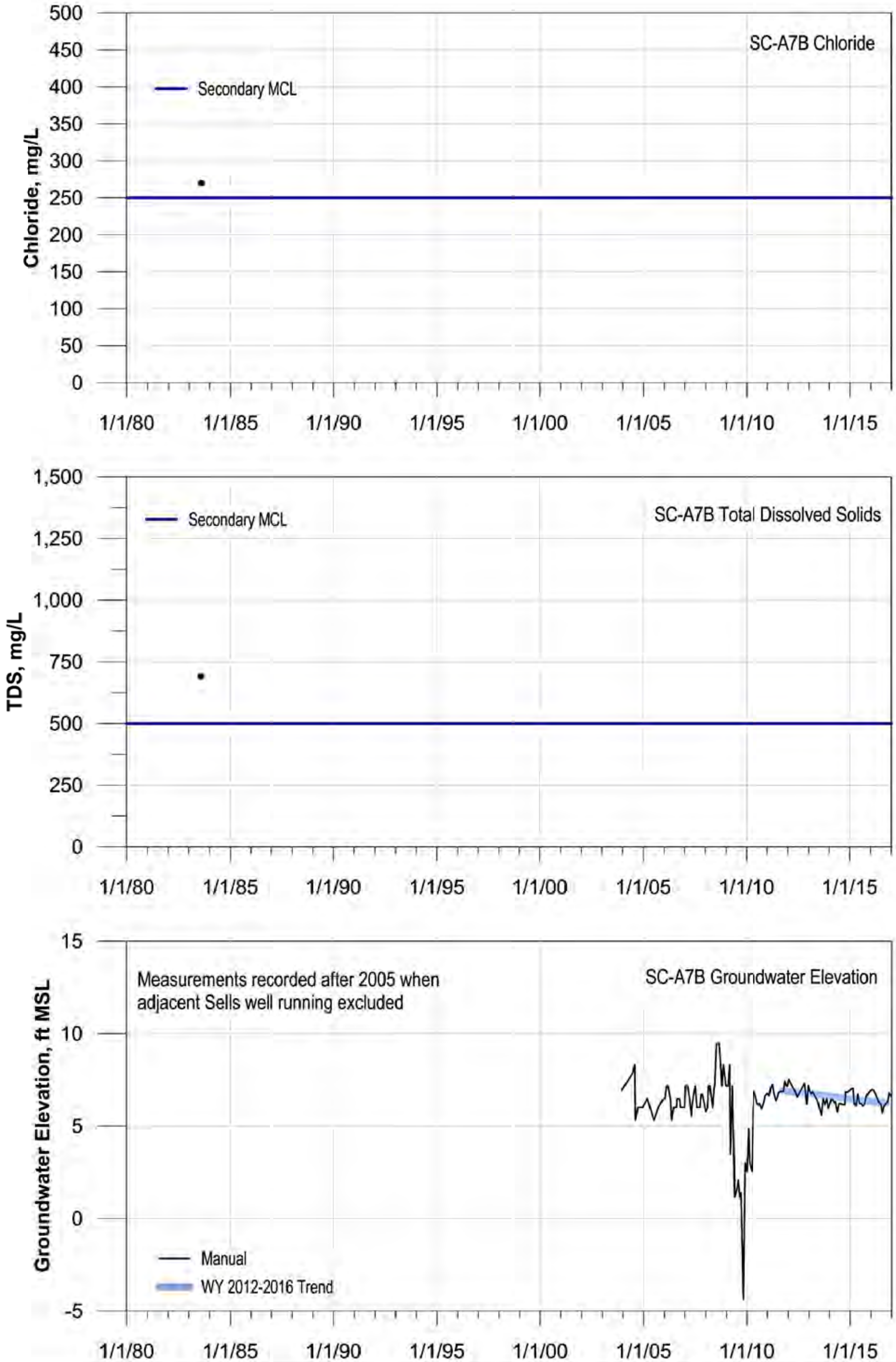

Sells Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Sells Groundwater Elevation
Manual
WY 2012-2016 Trend
Groundwater Elevation, ft MSL
40
35
30
25
20
15
10
5
0
-5
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

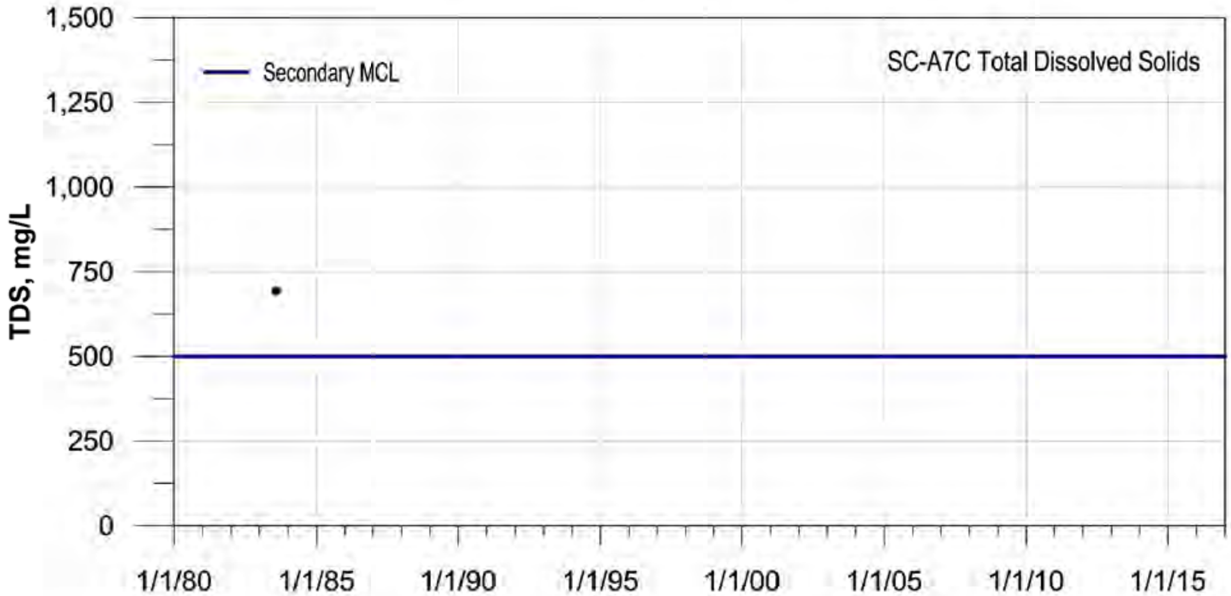

SC-A7A Chloride
Chloride, mg/L
Secondary MCL
500
450
400
350
300
250
200
150
100
50
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

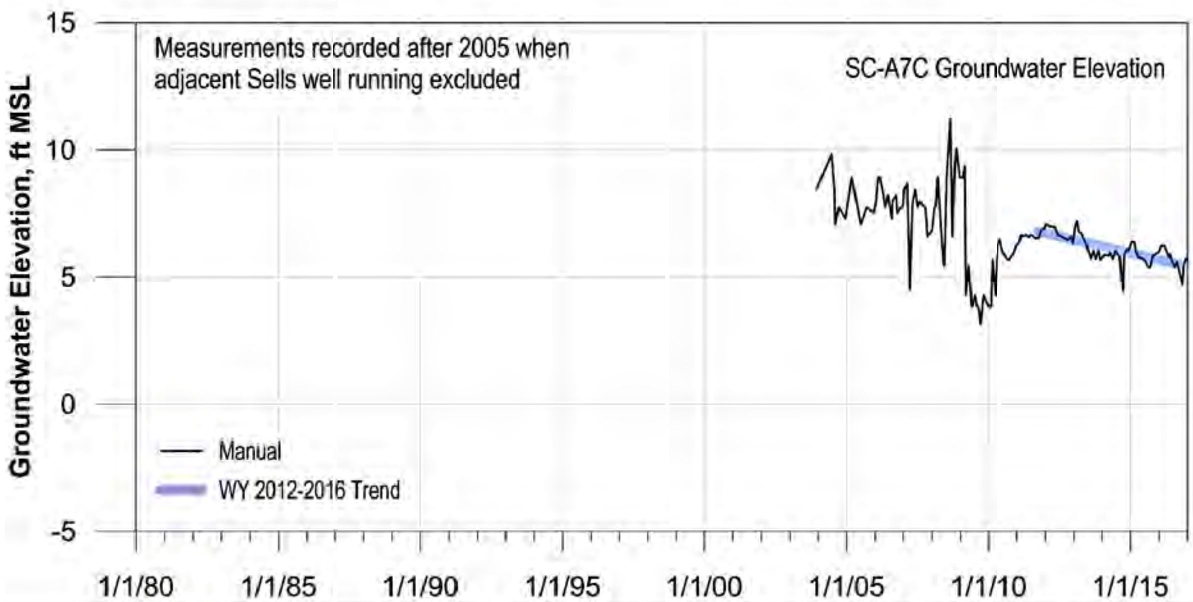

SC-A7A Total Dissolved Solids
TDS, mg/L
Secondary MCL
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

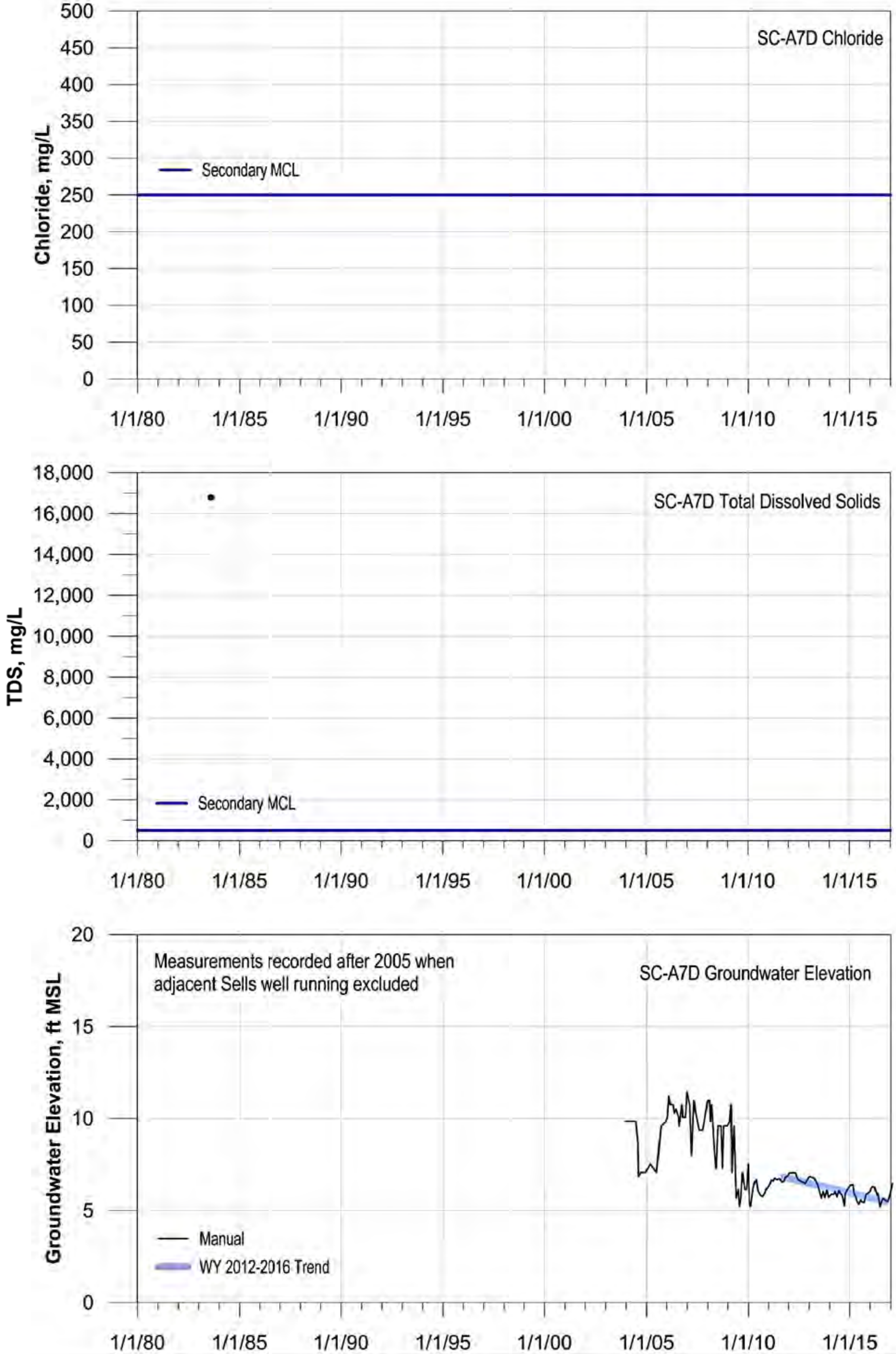

Measurements recorded after 2005 when adjacent Sells well running excluded
Groundwater Elevation, ft MSL
Manual
WY 2012-2016 Trend
SC-A7A Groundwater Elevation
60
50
40
30
20
10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-A7B Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15
SC-A7B Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
SC-A7B Groundwater Elevation
Measurements recorded after 2005 when adjacent Sells well running excluded
Groundwater Elevation, ft MSL
15
10
5
0
-5
Manual
WY 2012-2016 Trend

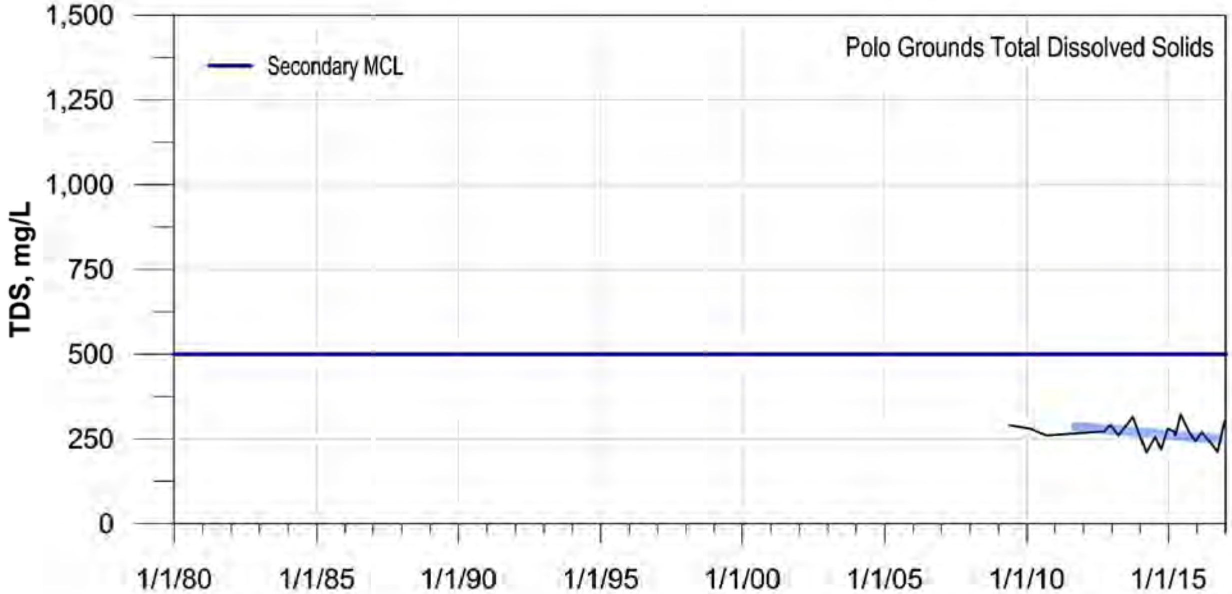

SC-A7C Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

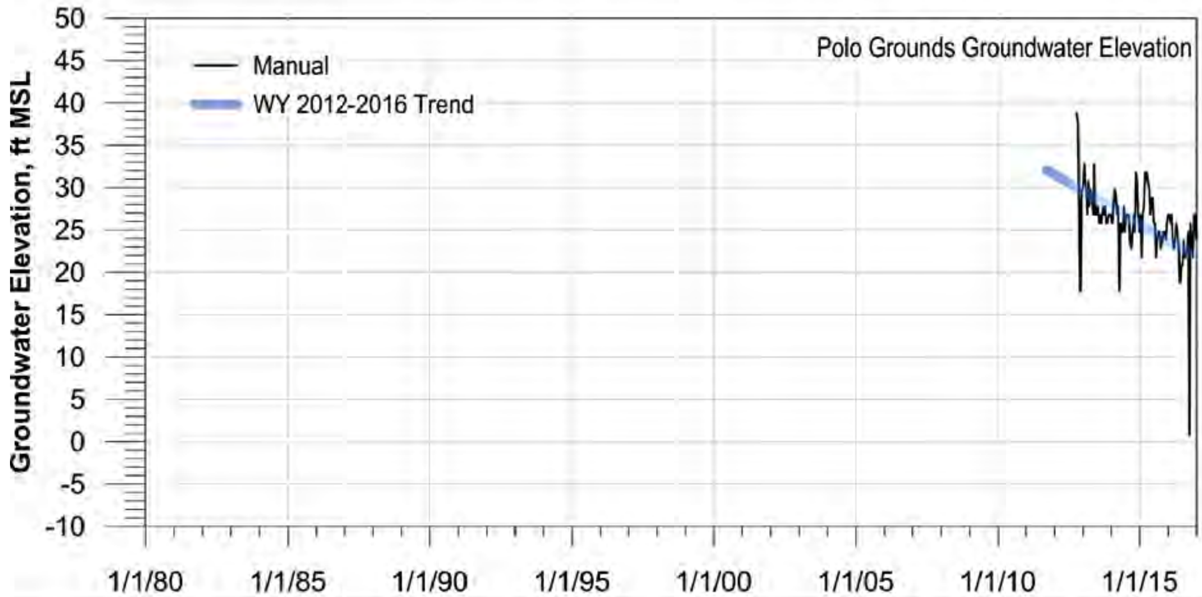

SC-A7C Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

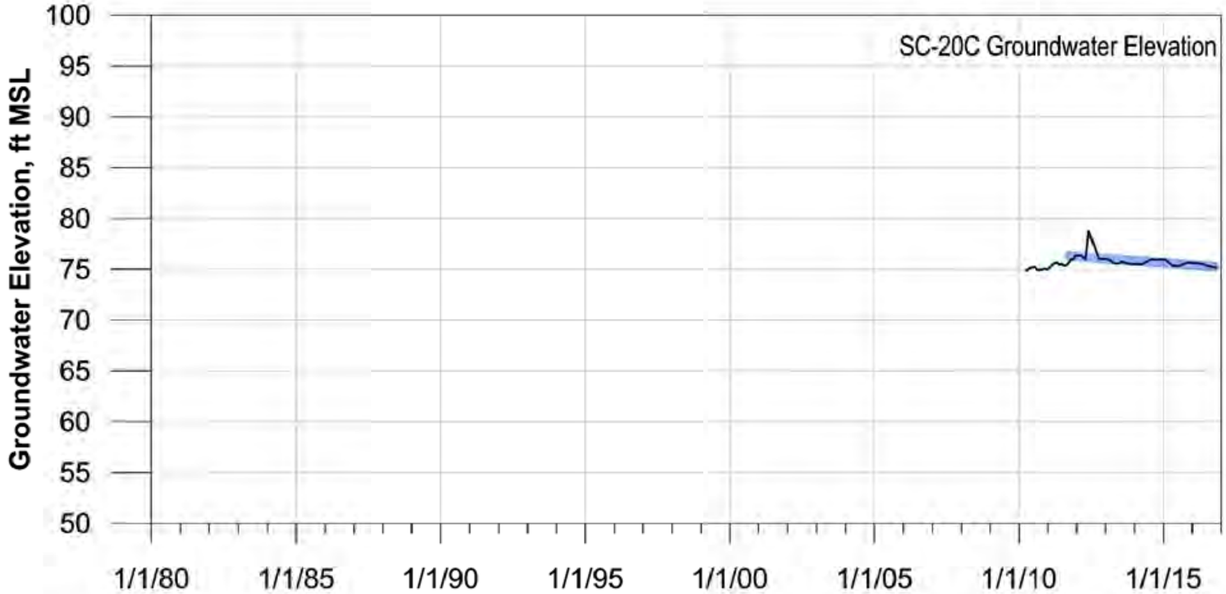

Measurements recorded after 2005 when adjacent Sells well running excluded
SC-A7C Groundwater Elevation
Groundwater Elevation, ft MSL
15
10
5
0
-5
Manual
WY 2012-2016 Trend
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

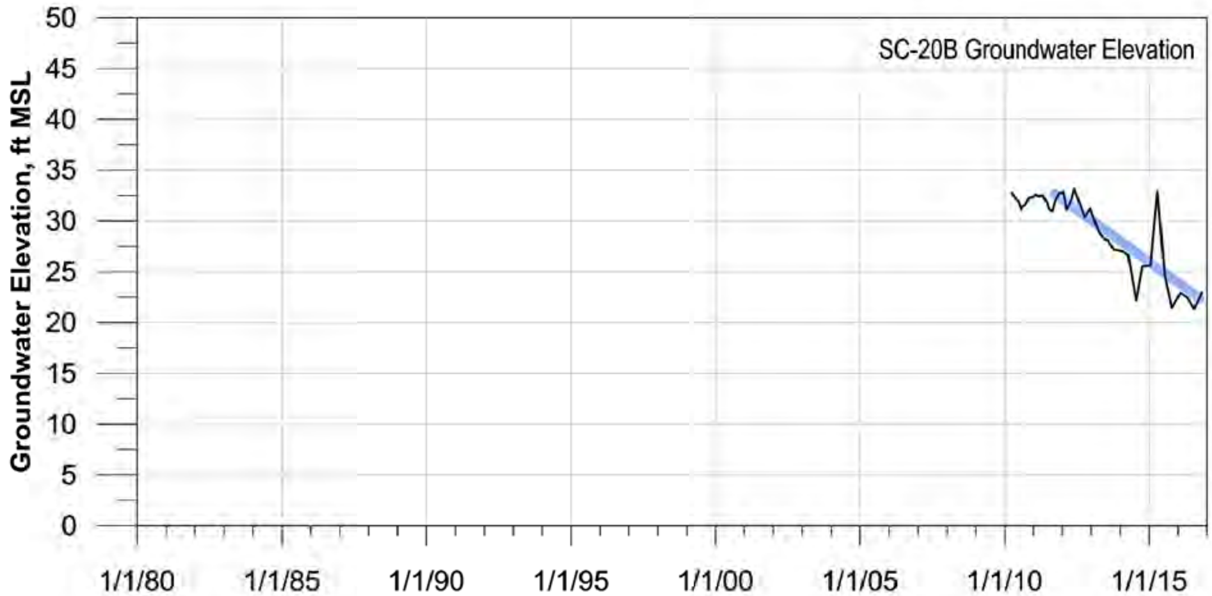

SC-A7D Chloride
Chloride, mg/L
Secondary MCL
SC-A7D Total Dissolved Solids
TDS, mg/L
Secondary MCL
Measurements recorded after 2005 when
adjacent Sells well running excluded
SC-A7D Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
WY 2012-2016 Trend
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

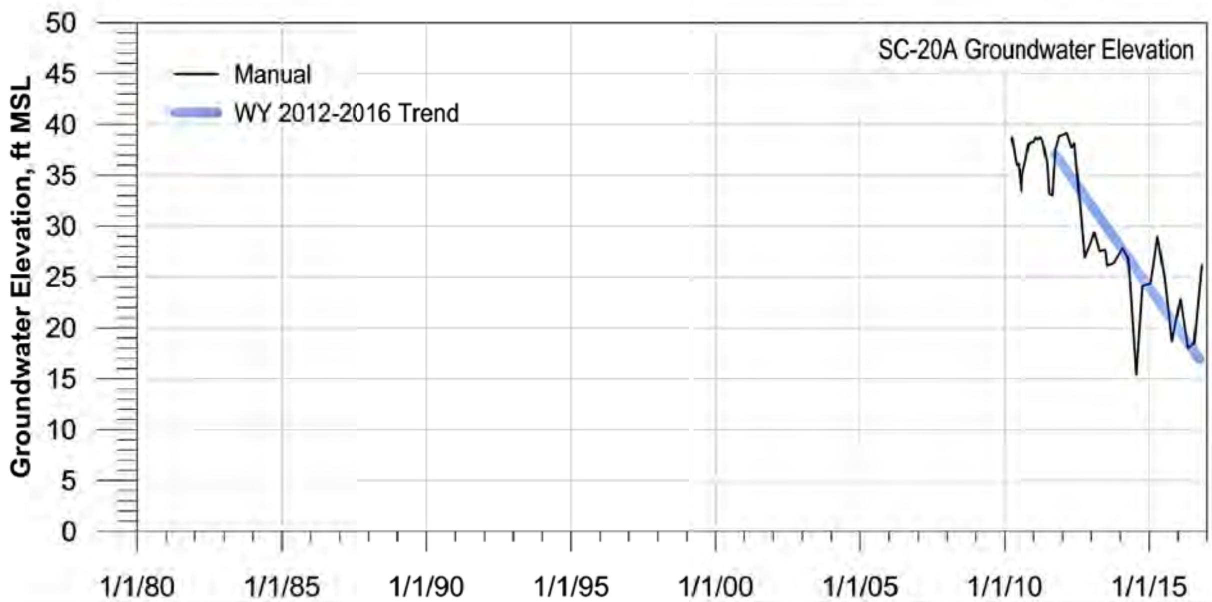

Polo Grounds Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

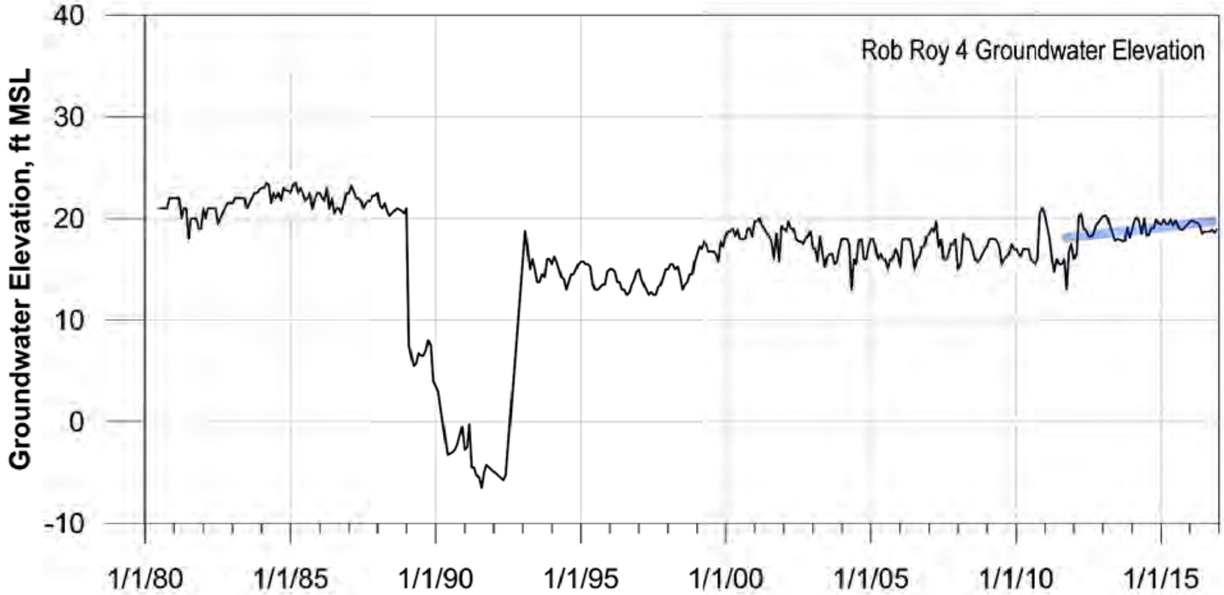

Polo Grounds Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

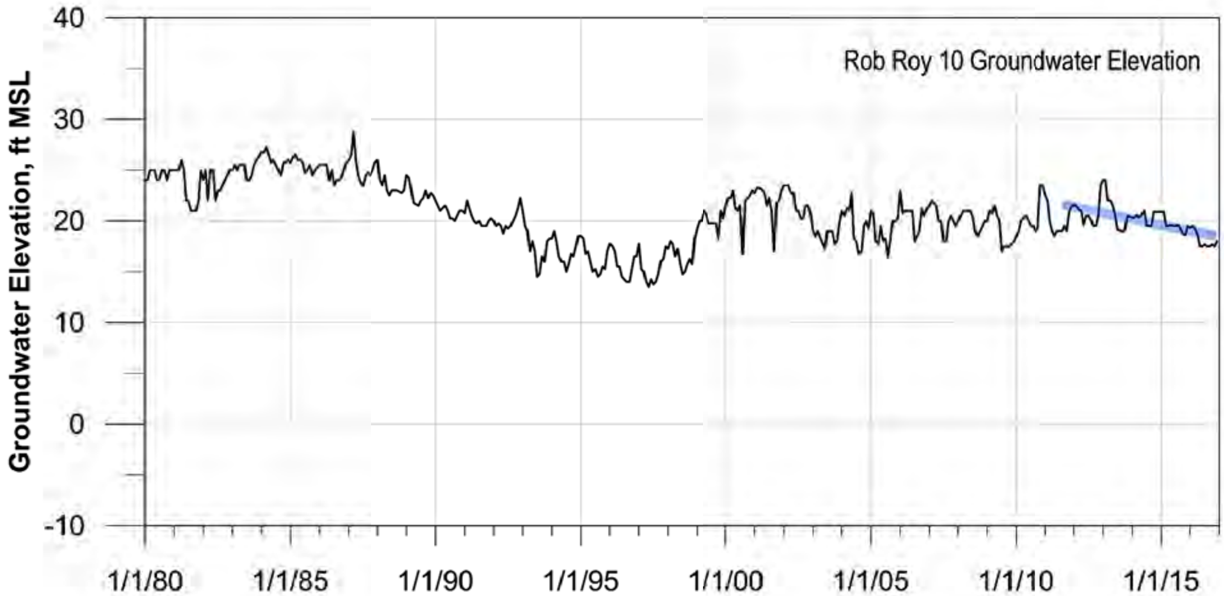

Polo Grounds Groundwater Elevation
Manual
WY 2012-2016 Trend
Groundwater Elevation, ft MSL
50
45
40
35
30
25
20
15
10
5
0
-5
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

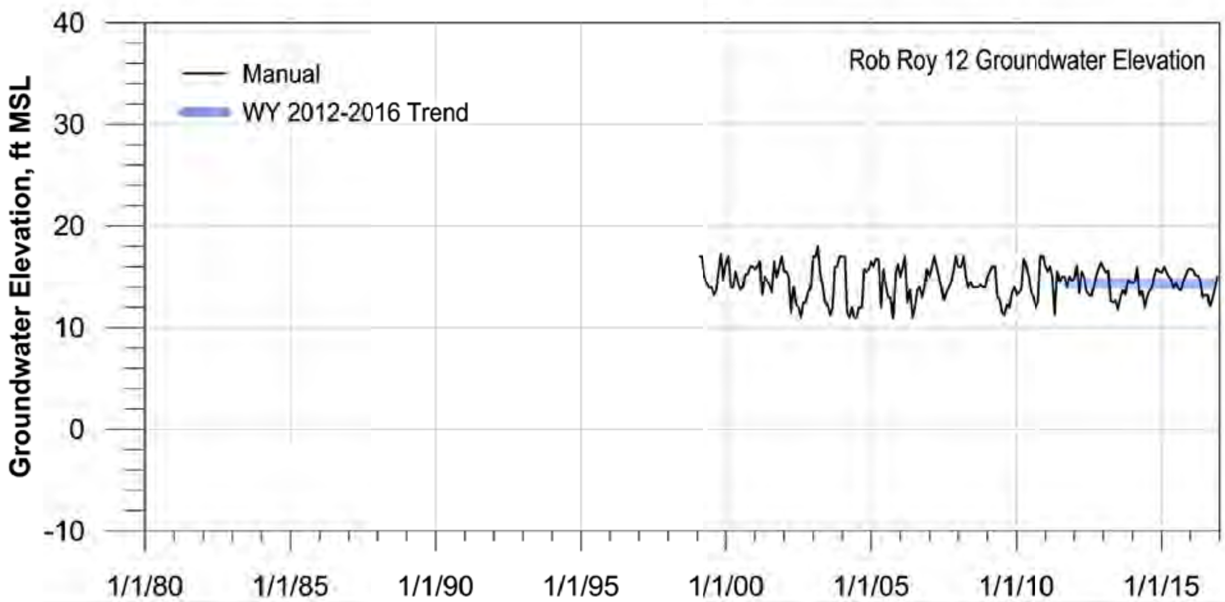

SC-20C Groundwater Elevation
Groundwater Elevation, ft MSL
100
95
90
85
80
75
70
65
60
55
50
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

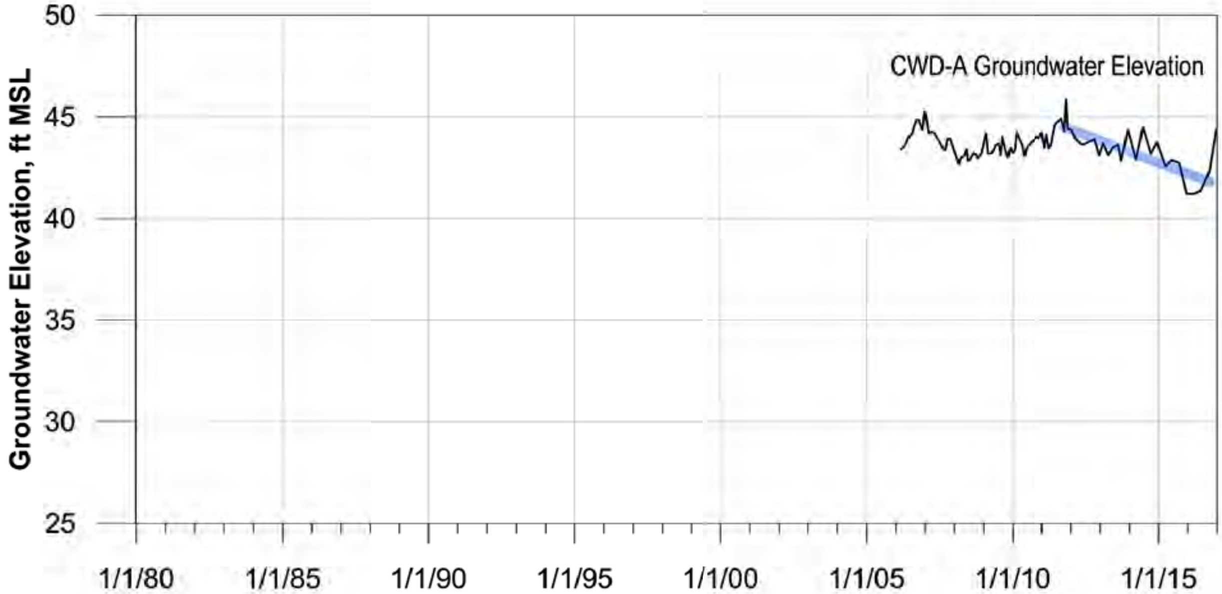

SC-20B Groundwater Elevation
Groundwater Elevation, ft MSL
50
45
40
35
30
25
20
15
10
5
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

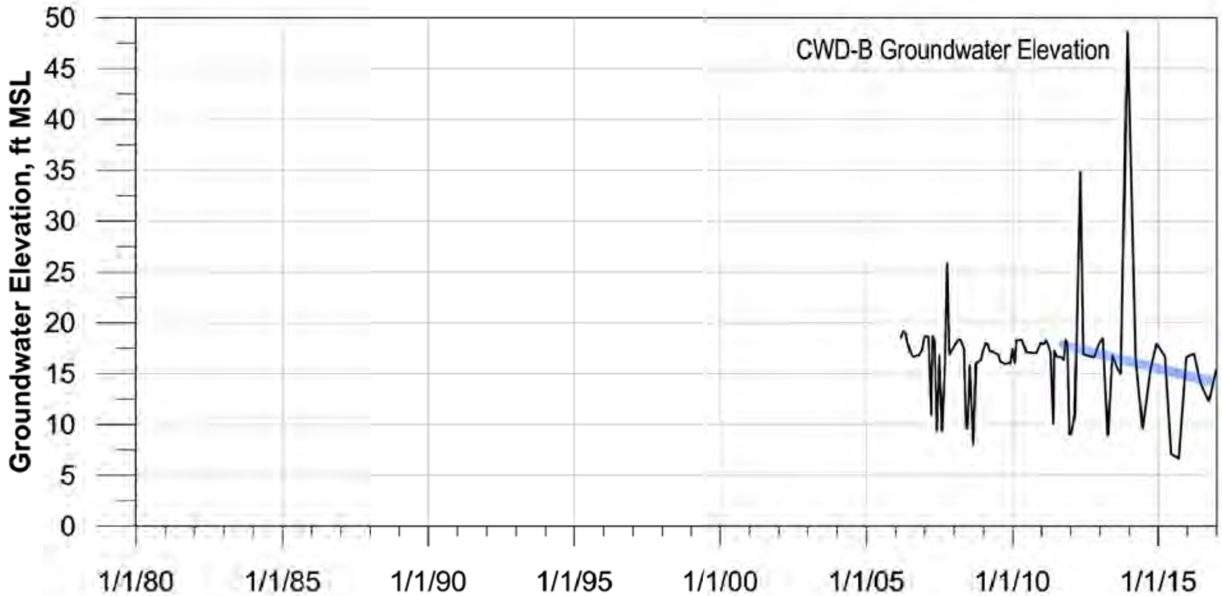

SC-20A Groundwater Elevation
Manual
WY 2012-2016 Trend
Groundwater Elevation, ft MSL
50
45
40
35
30
25
20
15
10
5
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

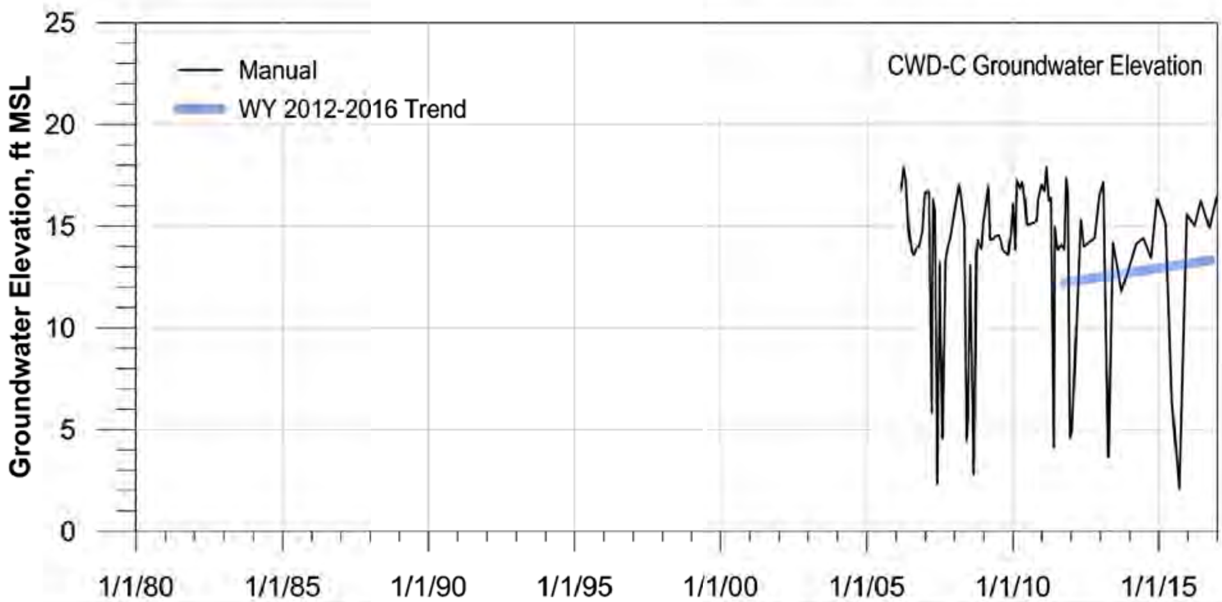

Rob Roy 4 Groundwater Elevation
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

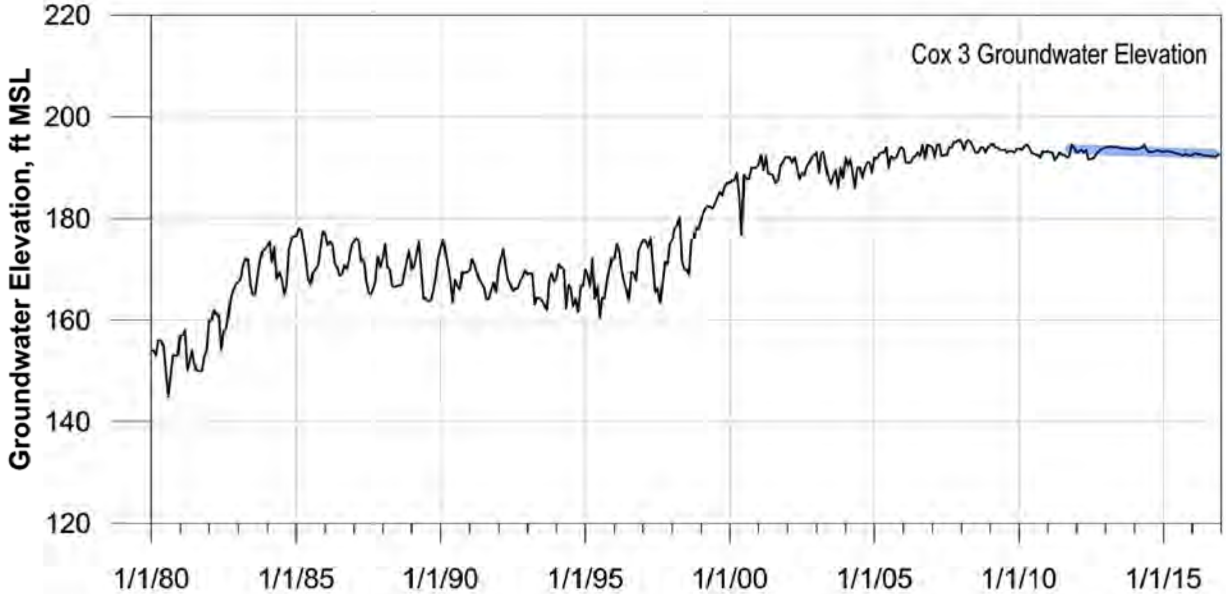

Rob Roy 10 Groundwater Elevation
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

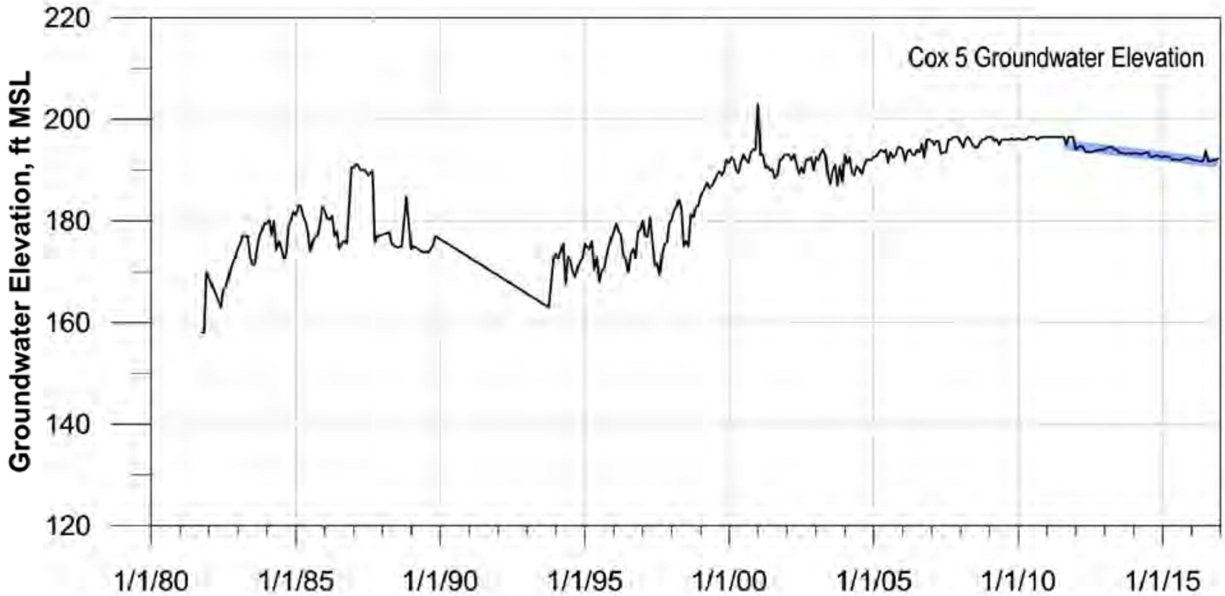

Manual
WY 2012-2016 Trend
Rob Roy 12 Groundwater Elevation
Groundwater Elevation, ft MSL
40
30
20
10
0
-10
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

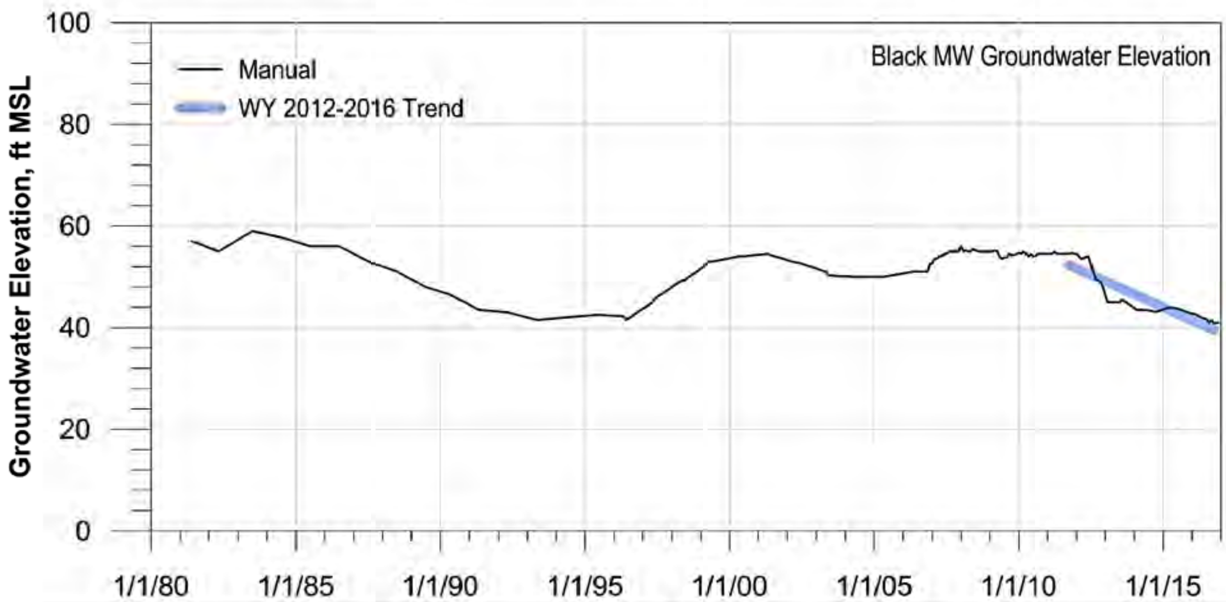

CWD-A Groundwater Elevation
Groundwater Elevation, ft MSL
50
45
40
35
30
25
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

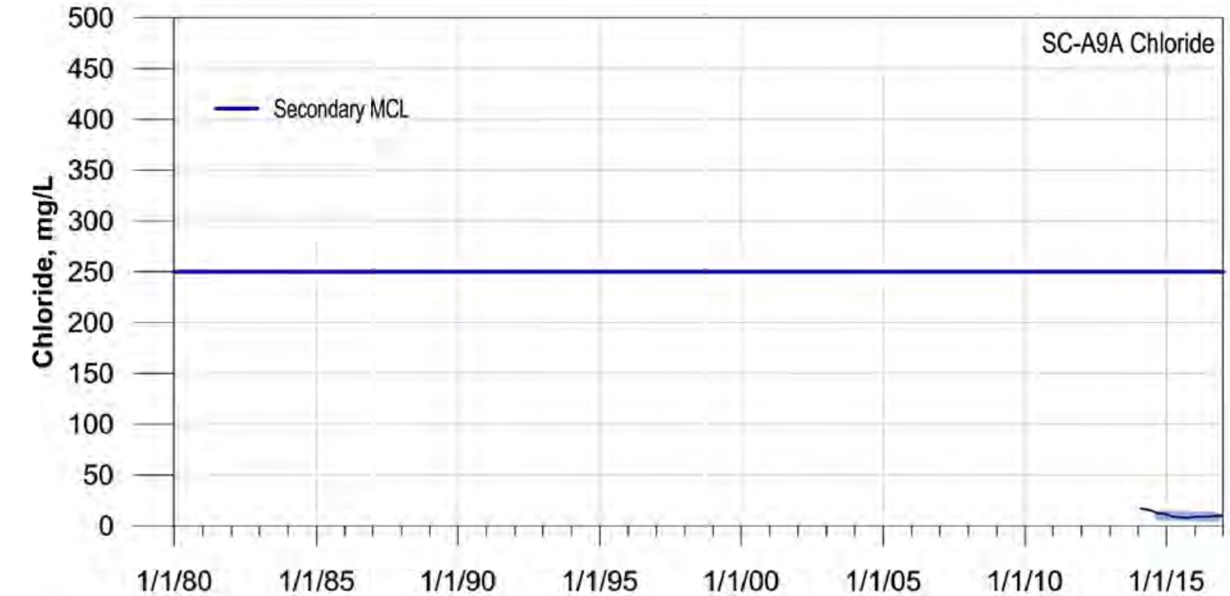

CWD-B Groundwater Elevation
Groundwater Elevation, ft MSL
50
45
40
35
30
25
20
15
10
5
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

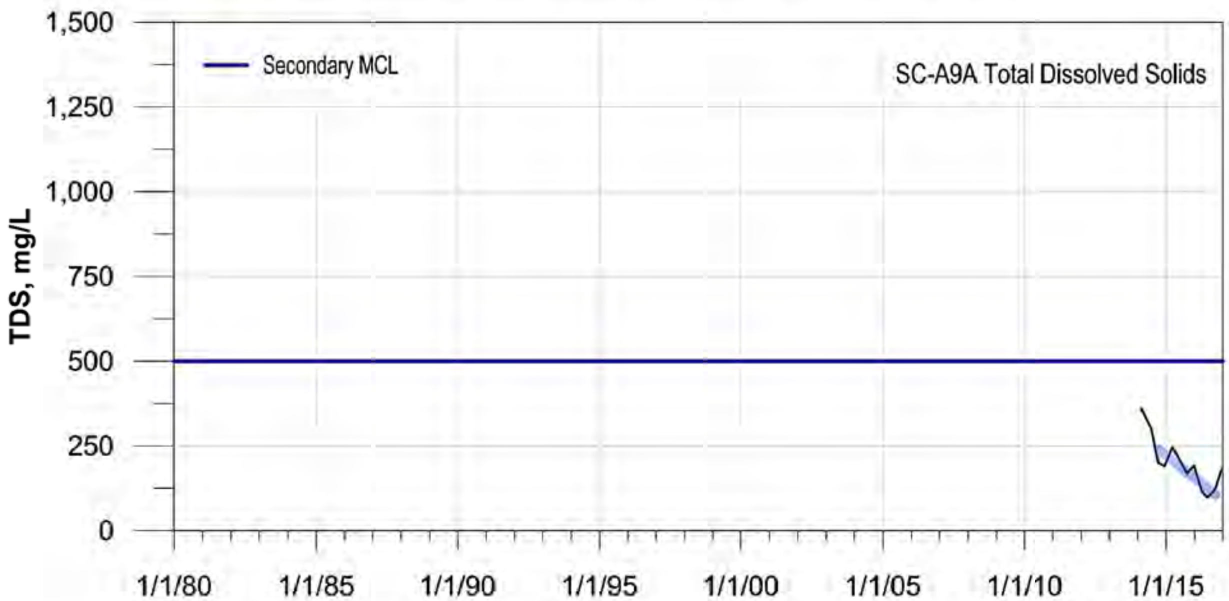

Manual
WY 2012-2016 Trend
CWD-C Groundwater Elevation
Groundwater Elevation, ft MSL
25
20
15
10
5
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

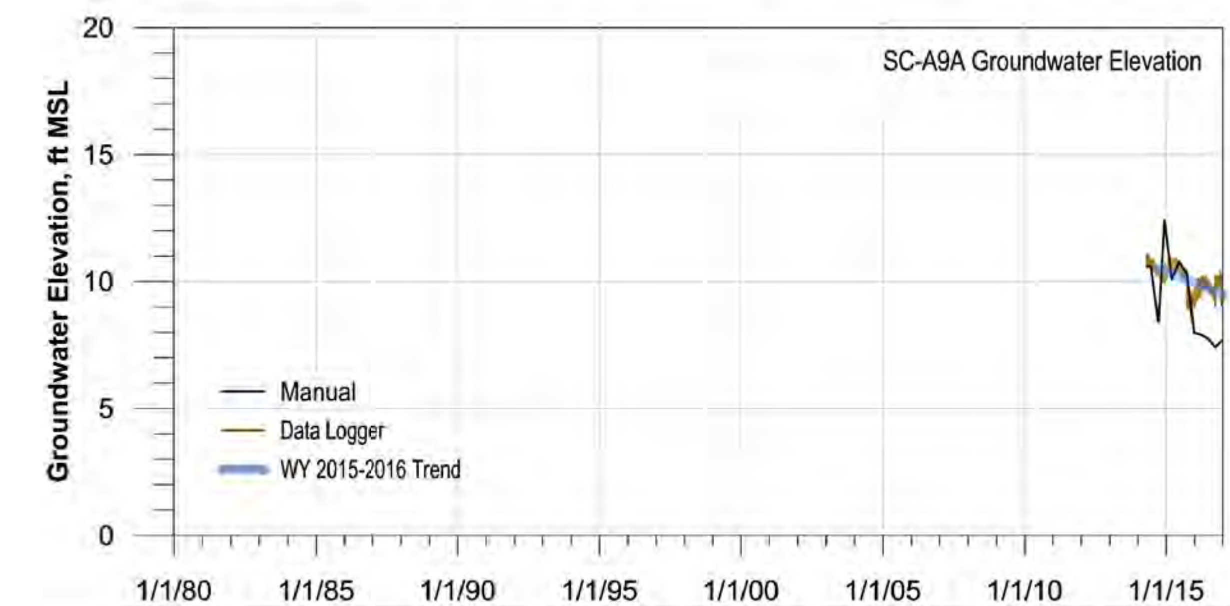

Cox 3 Groundwater Elevation
Groundwater Elevation, ft MSL
220
200
180
160
140
120
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

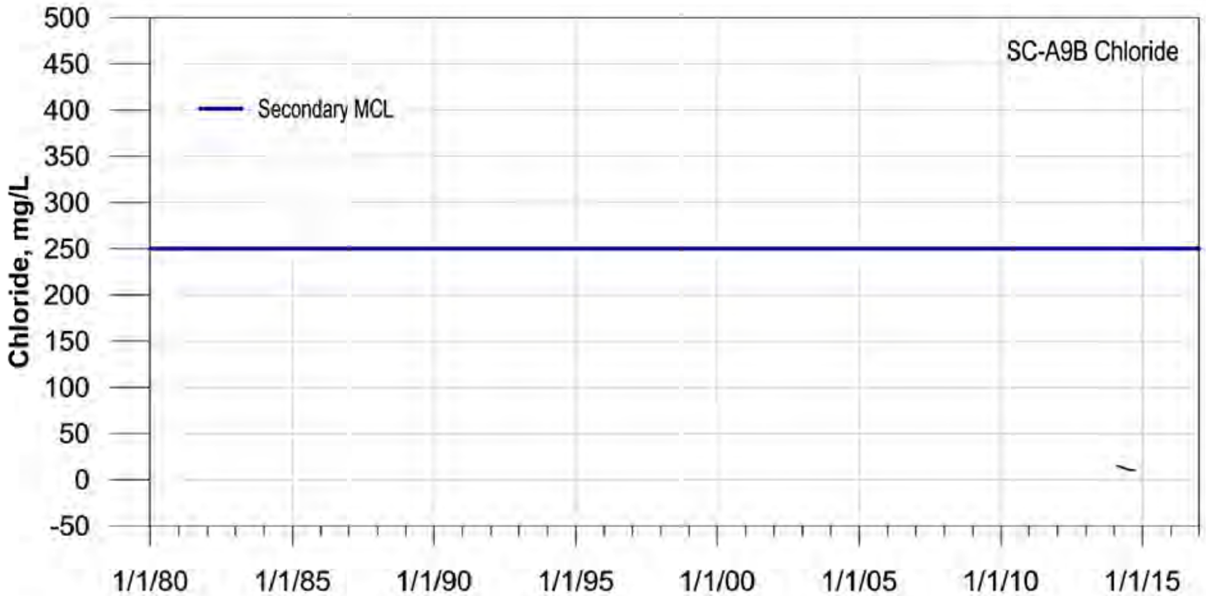

Cox 5 Groundwater Elevation
Groundwater Elevation, ft MSL
220
200
180
160
140
120
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Black MW Groundwater Elevation
Manual
WY 2012-2016 Trend
Groundwater Elevation, ft MSL
100
80
60
40
20
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

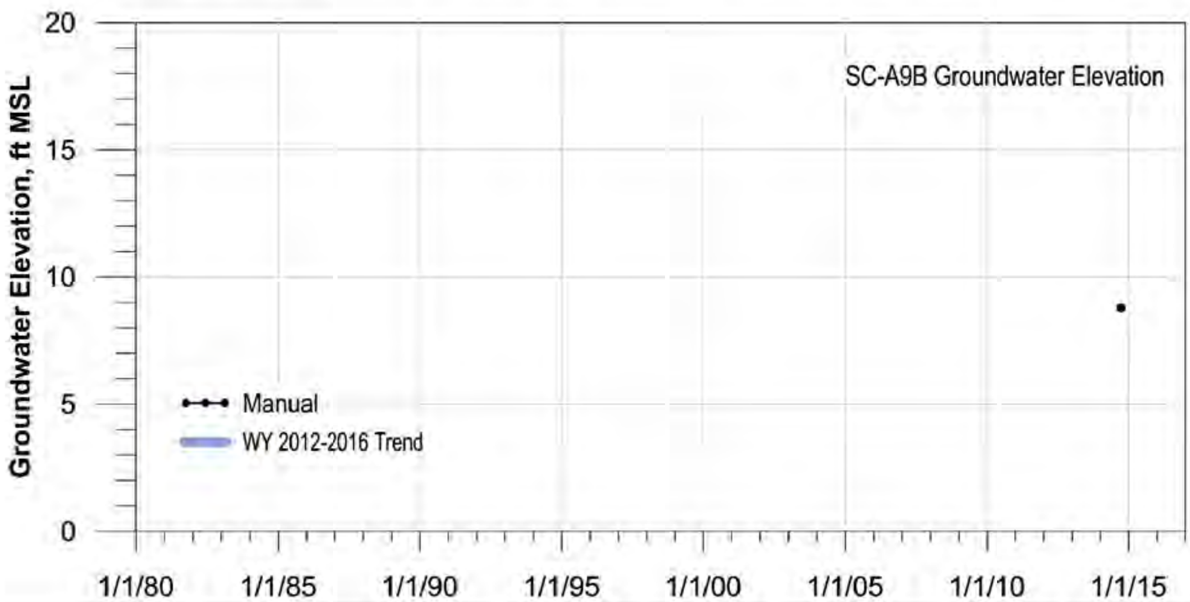

SC-A9A Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


Secondary MCL
SC-A9A Total Dissolved Solids
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-A9A Groundwater Elevation
Groundwater Elevation, ft MSL
20
15
10
5
0
Manual
Data Logger
WY 2015-2016 Trend
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-A9B Chloride
Secondary MCL
Chloride, mg/L
500
450
400
350
300
250
200
150
100
50
0
-50
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-A9B Total Dissolved Solids
Secondary MCL
TDS, mg/L
1,500
1,250
1,000
750
500
250
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15


SC-A9B Groundwater Elevation
Groundwater Elevation, ft MSL
Manual
WY 2012-2016 Trend
20
15
10
5
0
1/1/80
1/1/85
1/1/90
1/1/95
1/1/00
1/1/05
1/1/10
1/1/15

SECTION 6
GROUNDWATER MANAGEMENT PLAN IMPLEMENTATION STATUS

6.1 Groundwater Management Plan under SGMA

Under the Sustainable Groundwater Management Act (SGMA), the 2007 Groundwater Management Plan (GMP; SqCWD and CWD, 2007) will remain in effect until the Groundwater Sustainability Plan (GSP) for the Santa Cruz Mid-County Basin is adopted (§10750.1(a)). Therefore, the status of the GMP's basin management objectives (Section 6.2) and specific basin management activities, or elements (Section 6.3) are updated below. Also included are brief assessments of the applicability of the objectives and elements for meeting DWR's GSP regulations.

6.2 Status of Basin Management Objectives

The 2007 Groundwater Management Plan (SqCWD and CWD, 2007) listed nine Basin Management Objectives (BMOs) for meeting three basin management goals. The BMOs are specific criteria defining the desired state of the basin. The status of each of the BMOs through Water Year 2016 is summarized in Table 6-1and expanded upon below. Each BMO in the Groundwater Management Plan (GMP) is listed, along with an assessment of how well the objective was met in Water Years 2015-2016. Revisions to the BMOs were proposed and approved by the Basin Implementation Group (BIG) in 2013, but not officially approved by the SqCWD and CWD Board of Directors and SGMA now prohibits any renewal of the GMP (§10750.1(a)). However, the below assessment is based on the revised BMOs and more recent evaluations to best reflect current groundwater management.

These BMOs will generally not directly translate for use in the Groundwater Sustainability Plan (GSP). California Department of Water Resources (DWR) regulations for GSPs require that measurable objectives and minimum thresholds quantify values that will prevent undesirable results from occurring for sustainability indicators applicable to the basin. SGMA lists the following sustainability indicators: chronic lowering of groundwater levels, reduction of groundwater storage, seawater intrusion, degraded water quality, land subsidence, and depletions of interconnected surface water.

Table 6-1: Status of Basin Management Objectives

Number	Basin Management Objective	Status
Goal 1:Ensure water supply reliability for current and future beneficial uses		
1-1	Pump Within the Sustainable Yield	Pumping exceeds recovery goals
1-2	Develop alternative water supplies to achieve a long-term balance between recharge and withdrawals to meet current and future demand	Alternatives such as water transfers replenishment with purified water, and aquifer storage recovery being evaluated.
1-3	Manage groundwater storage for future beneficial uses and drought reserve	Depends on achieving BMOs 1-1, 1-2, and 2-2.
Goal 2: Maintain water quality to meet current and future beneficial uses		
2-1	Meet existing water quality standards for beneficial uses, such as drinking water standards	Drinking water standards met.
2-2	Maintain groundwater levels to prevent seawater intrusion	Achieved at 8 of 13 coastal well locations.
2-3	Prevent and monitor contaminant pathways	Activities ongoing.
Goal 3: Prevent adverse environmental impacts		
3-1	Maintain or Enhance the Quantity and Quality of Groundwater Recharge by participating in land use planning process	Activities ongoing.
3-2	Avoid alteration of stream flows that would adversely impact the survival of populations of aquatic and riparian organisms	Soquel Creek monitoring ongoing.
3-3	Protect the structure and hydraulic characteristics of the groundwater basin by avoiding withdrawals that cause subsidence	No subsidence reported.

BMO 1-1: PUMP WITHIN THE SUSTAINABLE YIELD

- For its 2015 Community Water Plan to evaluate supplemental supply needs, 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 estimated with a water balance approach using modeled offshore flows required to protect against seawater intrusion, estimated recharge, SqCWD share of consumptive use, SqCWD consumptive use factors, and climate change estimates. Unlike the GMP, these estimates assume that SqCWD would reduce pumping based on its proportion of basinwide consumptive use to maintain groundwater levels at protective elevations after recovery (HydroMetrics WRI, 2015b). The post-recovery pumping yield estimated for the Purisima area is 2,450 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 850 acre-feet per year; compared to the pumping goal of 1,800 acre-feet per year in the GMP.

- To recover groundwater levels to protective elevations, pumping must be reduced below the estimated post-recovery pumping yields. The SqCWD pumping goal based on the post-recovery pumping yield updated for the Community Water Plan is to limit net pumping to 2,300 acre-feet per year. (HydroMetrics WRI, 2015b).

- SqCWD's total groundwater pumping for Water Years 2015 and 2016 was 3,155 and 3,094 acre-feet. SqCWD pumped 2,025 acre-feet from the Purisima area (Service Areas I and II). Pumping was less than the post-recovery pumping yield estimate of 2,450 acre-feet per year for the Purisima area for the third straight year. SqCWD pumped 1,100 and 1,069 acre-feet from the Aromas area (Service Areas III and IV including Aptos Jr. High and the Polo Grounds well). Annual production remains above the post-recovery pumping yield estimate of 850 acre-feet per year. SqCWD pumping of 3,155 and 3,094 acre-feet for Water Years 2015 and 2016 remain above the recovery pumping goal of 2,300 acre-feet per year.

- CWD's groundwater pumping for Water Years 2015 and 2016 was 0 acre-feet in the Purisima Formation and under 400 acre-feet per year 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 40 years.

- The City of Santa Cruz pumped 483 and 505 acre-feet from the Purisima area in calendar years 2015 and 2016. This amount is less than the 520 acre-feet per year pumping goal for the City during non-critically dry years (SqCWD and City, 2015).

- Updates on private estimates for small water system and private wells have been performed for the groundwater development and are included in Section 2.2 (HydroMetrics WRI, 2016c).

- Measured pumping amounts do not meet current pumping goals to recover groundwater levels in the basin to protective elevations (BMO 2-2).

- DWR's GSP regulations do not consider pumping goals such as those included in BMO 1-1 as measurable objectives. The GSP regulations define sustainability based on the absence of undesirable results in the basin (§354.24), not the amount pumped.

- The water budget section of the GSP will need to include estimates of sustainable yield (§354.18(b)(7)). The GSP regulations set numerical groundwater and surface water models, such as the MGA's GSFLOW model currently under development, as the standard tool for evaluating projected water budget conditions (§354.18(e)). Therefore, the plan is to use the MGA's GSFLOW model for water budget evaluation and to estimate sustainable yield superseding estimates in BMO 1-1 and subsequent documents.

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

- In 2014, SqCWD performed a preliminary evaluation of alternative supply and identified groundwater replenishment using recycled water and water transfer projects to evaluate further. This evaluation was included in the 2015 Community Water Plan. In 2016, SqCWD issued a Notice of

Preparation and Initial Study for Pure Water Soquel, which would replenish the Santa Cruz Mid-County Basin with advanced purified recycled water.

- The City of Santa Cruz formed the Water Supply Advisory Committee to involve the community in water supply issues before making critical decisions involving future water supplies. Their efforts resulted in a Report on Agreements and Final Recommendations (October 2015) that was accepted by the City Council and is being pursued by the City. Water supply elements of the plan include in-lieu water transfers with neighboring water agencies to relieve pumping pressures on groundwater basins, aquifer storage and recovery, use of advanced treated wastewater, and seawater desalination. The timeline for decision making includes project selection in 2020 with ultimate water security by 2025.

- In 2016, SqCWD and the City agreed on a cooperative water transfer pilot project to transfer available surface water during the winter from the City to SqCWD for in-lieu recharge. Transfers are scheduled to begin in Water Year 2019 after SqCWD has adequately prepared its system for introduction of surface water to address water quality concerns.

- SqCWD and City of Santa Cruz plans for in-lieu water transfers build on previous work by the County to evaluate the feasibility and benefits of interties and water transfers among water agencies in northern Santa Cruz County. The County presented 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 evaluation includes a legal assessment of various water rights options for the water transfers (Nguyen, 2013). The County issued a final report in May 2015. With upgrades of diversion facilities and treatment facilities, as well as new water rights, potential annual average yield from transfers to SqCWD could be up to 1,200 af/yr (County, 2015)).

- SqCWD approved its 2012 Integrated Resources Plan Update (SqCWD, 2012), which evaluated other alternative water supplies such as off-stream diversion of Soquel Creek, satellite reclamation plants for providing recycled water, desalination by SqCWD only, the Glenwood Reservoir and transfer of surplus water from the San Lorenzo River by the City of Santa Cruz, as well as mandatory water restrictions to reduce consumption for typical residential customers by 35% in order to meet pumping goals. The Plan Update has been superseded by the 2015 Community Water Plan

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

- The City and SqCWD previously pursued the Santa Cruz Water Department/Soquel Creek Water District (SCWD[2]) Regional Seawater Desalination Project from 2007 to 2013. A draft Environmental Impact Report (EIR) was published in 2013; however, prior to completion of the final EIR, and due to public opposition, the City put the project on hold in order to re-engage the community in water supply planning efforts.

- DWR's GSP regulations do not consider development of management actions such as those included in BMO 1-2 as a measurable objective. Instead, the GSP will include a description of specific projects and management actions and the sustainability indicators that will benefit from those projects and actions (§354.44)

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

- Groundwater levels remain below protective elevations (BMO 2-2) in much of the basin 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 pumping is above goals to achieve recovery and eliminate overdraft. Options to develop alternative water supplies under BMO 1-2 are being re-evaluated with the regional desalination project on hold.

- However, groundwater levels at coastal wells such as SC-1A and SC-A1B have been above protective elevations by multiple feet over multiple years indicating pumping can be redistributed to these areas.

- DWR's GSP regulations do include groundwater storage as a sustainability indicator for which a measurable objective could be developed. However, BMO 1-3 is not sufficient as a measurable objective because it is not a defined numeric value (§354.30(b)). The numeric values could be groundwater elevations that serve as a proxy for groundwater storage (§354.28(d))).

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

- Drinking water from SqCWD, CWD, and City of Santa Cruz municipal wells was tested according to Title 22 requirements. In Water Years 2015 and 2016, raw groundwater pumped by SqCWD and the City of Santa Cruz 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 Years 2015-16, groundwater pumped by SqCWD from the Aromas Red Sands met all drinking water standards except for the standard for Chromium VI which became effective July 1, 2014. SqCWD conducted a successful pilot treatment project in 2013 that showed it will be able to meet this standard and meet the basin management objective for the Aromas Red Sands aquifer. SqCWD began operating a temporary treatment plant to treat for Chromium VI in October 2014. 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 in two City of Santa Cruz monitoring wells had TDS and chloride concentrations that suggest seawater intrusion when the wells were installed in 2004. However, only the Soquel Point Medium monitoring well currently has chloride concentrations above the secondary MCL. Chloride concentrations in this monitoring well have remained relatively stable since 2005.

- Groundwater from SqCWD's Sells well showed concentrations at or just under the maximum contaminant limit for nitrates starting in 2009. The Sells well was taken out of service in April 2009.

- DWR's GSP regulations do include degraded water quality as a sustainability indicator for which a measurable objective could be developed. However, the GSP regulations require more detail than BMO 2-1 where the objective is based on the number of supply wells, water volume, or isocontour location that exceeds water quality standards(§354.28(c)(4)).

BMO 2-2: Maintain groundwater levels to prevent seawater intrusion

- Water Year 2016 groundwater levels at three of the 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) and proposed as revisions to this BMO.

- Water Year 2016 groundwater levels at three of the 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, 2012a) and proposed as revisions to this BMO.

- SqCWD based its protective elevations on groundwater levels that protect against seawater intrusion in at least 70 percent of the runs. However, the model results also allow us to quantify the percentage of the runs that protect against seawater intrusion for the observed average groundwater levels for each water year. For Water Year 2016, the percentage of protective runs at the SqCWD monitoring wells ranged from less than 50% to greater than 99%.

- Water Year 2016 groundwater levels at City of Santa Cruz coastal monitoring wells met protective elevations established in the cooperative groundwater management agreement between SqCWD and the City (2015) at two of the City's three coastal well clusters.

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

- DWR's GSP regulations do include seawater intrusion as a sustainability indicator for which a measurable objective could be developed. The protective elevations that have been estimated could serve as groundwater elevation proxies as allowed by the DWR's GSP regulations (§354.28(d)). However, the protective elevations are primarily based on estimates and policy decisions by Soquel Creek Water District and City of Santa Cruz. The MGA should re-evaluate these estimates and policy decisions before setting groundwater elevations as measurable objectives for this sustainability indicator.

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.

- Santa Cruz County used Proposition 50 bond funding to implement a well destruction program in 2012 (Nguyen, 2013).

- In 2015, SqCWD updated its Drinking Water Source Assessment and Protection (DWSAP) reports originally submitted in 2002(Todd Engineers, 2002 and LSCE, 2002).

- SqCWD submitted a DWSAP report for the O'Neill Ranch well in 2014.

- SqCWD submitted DWSAP reports for the Aptos Jr. High and Polo Grounds wells to State Department of Public Health in 2011 (HydroMetrics WRI, 2011b and 2011c).

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

- City of Santa Cruz updated DWSAP report for Beltz 10 in 2009 and submitted the DWSAP report for Beltz 12 in 2015.

- DWR's GSP regulations do not consider plans and policies to prevent and monitor contaminant pathways that make up BMO 2-3 as a measurable objective. These plans and policies are management actions to help the basin meet the measurable objective for degraded water quality.

- SGMA does require well construction, destruction, and abandonment policies to be included as additional plan elements in the GSP (§10727.4)

BMO 3-1: Maintain or enhance the quantity and quality of groundwater recharge by participating in land use planning processes

- MGA member agencies 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. Santa Cruz County requires all new development and redevelopment projects to maintain or exceed pre-development stormwater infiltration rates.

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

- DWR's GSP regulations do not consider plans and policies to participate in land use processes that make up BMO 3-1 as a measurable objective. These plans and policies are management actions to help the basin meet the measurable objectives for various sustainability criteria.

- The County implemented stormwater capture, bio-filtration, and infiltration projects at Polo Grounds Park in 2012 (Nguyen, 2013), and Heart of Soquel Park and Brommer Street Park in 2015 (Nguyen, 2016). These projects were funded by Proposition 50 and 84 state grants.

- SGMA does require processes to review land use plans and coordinate with land use agencies to be included in the GSP (§10727.4)

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

- 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 O'Neill Ranch Well and proposed Austrian Way Well are detected.

- SqCWD submitted a stream monitoring and adaptive management plan for Soquel Creek to Santa Cruz County and National Marine Fisheries Service and began implementation of the plan in partnership with the City of Santa Cruz. Reports evaluating baseline conditions before the O'Neill Ranch and Beltz #12 wells came online and the first year after the two wells came online in 2015 have been submitted to the County and National Marine Fisheries Service. Effects of pumping the new wells on Soquel Creek streamflows was not observed based on stream gauge and shallow groundwater level data (HydroMetrics WRI, 2017).

- DWR's GSP regulations do include depletion of interconnected surface water as a sustainability indicator for which a measurable objective could be developed. However, BMO 3-2 is not sufficient as a measurable objective because it is not a defined numeric value (§354.30(b)). The GSFLOW model under development by the MGA meets the requirements of the GSP regulations as a groundwater and surface water model to support establishment of this measurable objective (§354.28(c)(6)(b)). In addition, the measurable objective could be groundwater elevations that serve as a proxy for depletion of interconnected surface water (§354.28(d)))

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

- No subsidence has been reported since the GMP was enacted

- DWR's GSP regulations do include land subsidence as a sustainability indicator for which a measurable objective could be developed. However, BMO 3-3 is not sufficient as a measurable objective because it is not supported by identification of land uses and property interests that are likely to be affected by land subsidence (§354.28(c)(5)) and is not a defined numeric value (§354.30(b)). The measurable objective could be groundwater elevations that serve as a proxy for prevention of land subsidence (§354.28(d)))

6.3 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 the MGA, SqCWD, CWD, City of Santa Cruz, Santa Cruz County, and Pajaro Valley Water Management Agency.

Action items that have been identified since the Groundwater Management Plan Update are added. The Water Year report where the action item is first identified is included in parentheses.

Elements required by SGMA or DWR's GSP regulations to be included in GSPs are identified.

ELEMENT 1: GROUNDWATER MONITORING

SGMA requires this element, monitoring of groundwater levels and quality, to be included in the GSP (§10727.2(d)).

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 installed new monitoring wells at the Cornwell Road Tank Site (SC-21) and on 41st Ave in the Western Purisima (SC-22). SqCWD also began monitoring the newly installed O'Neill Ranch production well in 2012.
   - In Water Year 2014, SqCWD installed new monitoring wells at the Larkin Valley Tank Site (SC-A9) and on Quail Run Road in the Eastern Purisima (SC-23).

   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. In 2012, the City installed monitoring wells at 30th Avenue and Elda Lane, converted the former Beltz 7 production well to two monitoring wells, and replaced the deep monitoring well at Soquel Point. Groundwater levels are measured monthly and groundwater quality is sampled semi-annually at all City of Santa Cruz's monitoring wells. In 2013, the City installed a deeper monitoring well at Cory Street to monitor the Tu unit that supplies the City's Beltz #12 well and SqCWD's O'Neill Ranch well.

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. Wells are measured semi-annually (spring and fall). County monitoring of 21 of these wells continues, while SqCWD now monitors the other wells for potential impacts of pumping at the Polo Grounds well.

2. *Continue shallow Groundwater Monitoring Program*

SqCWD continued to monitor groundwater levels in shallow wells along Soquel Creek. In 2012, SqCWD installed a new shallow well on Soquel Wharf Road, the first shallow well on the west side of the Creek. Monitoring of the Simons shallow well monitoring was suspended in 2011 due to access issues. Equipment for monitoring groundwater levels in shallow wells was installed and tested in 2012 at the Main Street, Soquel Wharf Road, and Nob Hill shallow wells. In Water Year 2014, a replacement shallow groundwater monitoring well was installed at the Nob Hill site.

3. *Share and consolidate monitoring data among all agencies overlying the Santa Cruz Mid-County Basin (formerly 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 Santa Cruz Mid-County 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 is used to submit the data to the state. County staff prepared and submitted the coordinated monitoring plan to the state in 2011 (Khalsa, 2011). County staff continues to coordinate submission of CASGEM data (Nguyen, 2017).

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 system is used for the agencies to upload and download data.

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 bladder pump equipment for sampling and identifying monitoring wells that need to be replaced.

In Water Year 2009, SqCWD replaced the three SC-3 monitoring wells at Escalona Drive because they were providing unreliable data. Monitoring wells SC-8F, SC-9A, and SC-A2 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. Monitoring wells at Cherryvale (SC-10), Porter Gulch (SC-11), and Main Street (SC-18) were replaced in the past year with a new deeper well installed at Cherryvale (SC-10AAA).

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. Groundwater level loggers and bladder pumps are currently installed in the SC-1, SC-3R, SC-5RA, SC-8R (except SC-8RE which is artesian), SC-9R, SC-10R, SC-11R, SC-18R, SC-21, SC-22, SC-23, SC-A1, SC-A2R, SC-A3, SC-A4, SC-A5, SC-A8, and SC-A9 wells. SC-5RB only has a bladder pump installed. SC-20 only has groundwater level loggers installed.

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 Santa Cruz Mid-County Basin, but will be required for the GSP.

MGA member agencies 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 on 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 2012. Eight private wells near the O'Neill Ranch well enrolled in the program and monitoring at these wells commenced in 2013. Three private wells near the Granite Way well enrolled in the program and monitoring at these wells commenced in 2016.

In 2016, Santa Cruz County received a grant from Department of Water Resources to assist with outreach and services targeted to private well owners, and update the database on wells and non-municipal water users. The County has also updated the Geographical Information System (GIS) map of parcels served by almost all water systems with five or more connections (Nguyen, 2017).

ELEMENT 2: SURFACE WATER MONITORING

SGMA requires this element, monitoring of changes in surface flow and surface water quality, to be included in the GSP, but specifically to monitor changes surface water that directly affect groundwater or are affected by groundwater extraction (§10727.2(d)(2)).

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 conducted a sediment monitoring program on Soquel Creek and the West Branch from 2008-2011.

   SqCWD's Well Master Plan EIR contains plans for monitoring streamflow on Soquel Creek (ESA, 2011). A stream monitoring and adaptive management plan was submitted to the resource agencies in 2012. The Soquel Wharf Road shallow well and Nob Hill stream water level gauge were installed downstream of the O'Neill Ranch and City of Santa Cruz Beltz #12 wells. As stated in its response to comments on Beltz #12 EIR, the City partners with SqCWD in developing and implementing the plan (Almond, 2011).

   Reports evaluating baseline conditions before the O'Neill Ranch and Beltz #12 wells came online and the first year after the two wells came online in 2015 have been submitted to the County and National Marine Fisheries Service. Effects of pumping the new wells on Soquel Creek streamflows was not observed based on stream gauge and shallow groundwater level data (HydroMetrics WRI, 2017).

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 Santa Cruz Mid-County Basin in addition to the Mancarti and Kraeger/Longridge gauges (Figure 2-1) to estimate deep recharge. Similar evaluation is used for watershed model used in the integrated groundwater model being developed.

SqCWD has installed a weather station at its Main Street well site as part of the Soquel Creek monitoring and adaptive management plan. The station monitors rainfall data.

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. A new shallow well on the western side of Soquel Creek was installed at Soquel Wharf Road in 2012.

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. Shallow well water levels are presented Figure 3-6 and evaluated for pumping effects in the Soquel Creek monitoring and adaptive management reports.

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). Figure 3-6 shows shallow groundwater level data relative to stream elevations and further analysis are included in reports for the Soquel Creek monitoring and adaptive management plan. 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 from September 2008 to September 2011.

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), but SqCWD has not decided to construct the Austrian Way well at this point.

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 Regional Water Quality Control Board in 2009 and implementation activities are ongoing.

The County of Santa Cruz implemented stormwater recharge facilities at Polo Grounds Park in 2012 (County, 2013) and implemented stormwater recharge facilities at Heart of Soquel Park and Brommer Street Park in 2015 (Nguyen, 2016) using funds from state grants.

With support of fellow MGA member agencies, Santa Cruz County continued its stream habitat and juvenile salmonid (steelhead and coho salmon) monitoring in the Soquel and Aptos Creek watersheds.

ELEMENT 3: SUBSIDENCE MONITORING

SGMA requires this element, monitoring of inelastic land surface subsidence to be included in the GSP (§10727.2(d)(2)).

1. Develop and implement a GPS based subsidence monitoring program

The MGA and its member agencies 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

The MGA and its member agencies have not reviewed alternate means of measuring and monitoring subsidence.

Element 4: Interagency Coordination

SGMA requires this element, collaboration with appropriate local agencies on plan elements, in the GSP (§10727.4).

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

The Santa Cruz Water Department/Soquel Creek Water District ($SCWD^2$) Regional Seawater Desalination Project was pursued by the two agencies from 2007 until 2013 at which time the City put it on hold due to public opposition to the project and to re-engage the public in water supply planning. The City is currently pursuing the recommendations of the Water Supply Advisory Committee that include the following water supply alternatives: passive recharge of groundwater basins via in lieu water transfers with neighboring water agencies (e.g., SqCWD); active recharge of groundwater basins using excess flows from the City's flowing sources and/or advanced treated recycled water; and seawater desalination.

In 2016, SqCWD and the City agreed to a cooperative water transfer pilot project for transfer of available surface water supply from the City to SqCWD for in-lieu recharge. Transfers are scheduled to begin in Water Year 2019 after SqCWD has adequately prepared its system for introduction of surface water to address water quality concerns.

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

SAGMA has been replaced by the Santa Cruz Mid-County Groundwater Agency.

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

The Joint Powers Authority was amended in 2015 to include the City of Santa Cruz and Santa Cruz County in the Soquel-Aptos Groundwater Management Committee. CWD, the City, the County, and SqCWD created the Santa Cruz Mid-County Groundwater Agency as a Joint Powers Authority in 2016, replacing the Soquel-Aptos Groundwater Management Committee.

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. The MGA will support the USGS as it conducts new sampling at wells in the Santa Cruz Mid-County Groundwater Basin

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 Santa Cruz Integrated Regional Water Management Program (IRWMP)***

Proposition 50 funding for projects identified in the IRWMP has reimbursed the 2009 construction of monitoring wells at the Polo Grounds Park. SqCWD used Proposition 50 funding to convert the Polo Grounds irrigation well to a municipal well. Santa Cruz County used funding for abandoned well destruction and projects to enhance groundwater recharge.

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 was conducted by CWD and evaluated maximizing the developable yield in CWD's Cox Well Field; addressed concerns about Chromium VI in the CWD service area; and addressed regional Aromas water quality and overdraft concerns. This study was completed in early 2014. This grant also supported the County's Phase II evaluation of transfer of surplus water from the San Lorenzo River by the City of Santa Cruz to allow reduction in groundwater pumping as documented in its 2015 report (County, 2015).

In Water Year 2014 the Resource Conservation District of Santa Cruz County worked with landowners and agency partners to complete over 70 habitat improvement projects through the Integrated Watershed Restoration Programs (IWRP). These projects included wetland restoration, fish barrier removal, rural road upgrades, stream habitat improvement and community education (Nguyen, 2015).

An update of the IRWM Plan was completed in August 2014 using Proposition 84 funding.

In 2016, the IRWMP received partial drought funding under Proposition 84 to contribute to treatment of Chromium VI by SqCWD (Nguyen, 2017).

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***

The MGA member agencies continue to support implementation of PVWMA's Basin Management Plan (BMP) and the Watsonville Area Water Recycling Project, which began operation in April 2009. Between 2015 and 2016, the recycled water facility produced and the PVWMA delivered approximately 5,930 acre-feet of recycled water, and in total 8,610 acre-feet of blended irrigation supply was delivered to growers connected to the Coastal Distribution System. Since the startup of the Recycled Water Facility in 2009, PVWMA has produced and delivered approximately 18,930 acre-feet of recycled water and a total of 28,675 acre-feet of supplemental water supply for use in-lieu of groundwater pumping.

Staff is working to implement Phase I of the Basin Management Plan Update, which was adopted by the Board of Directors in April 2014. Phase I implementation includes a combination of projects and programs aimed at optimizing existing water supply facilities, developing new water supply facilities utilizing local surface water supplies, and funding a robust a conservation irrigation efficiency program. Together these projects and programs are projected to balance a 12,100 AFY shortfall in the water budget of the Pajaro Valley Groundwater Basin and reduce seawater intrusion by 90%. The BMP projects to eliminate seawater intrusion in Phase II (2025-2035).

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

PVWMA developed the Pajaro Valley Hydrologic Model (PHVM), a numerical hydrologic flow model that simulates the use and movement of water within the Pajaro Valley Groundwater Basin. SqCWD had a representative on the model's Technical Advisory Committee, which approved the final model in 2010. SqCWD, CWD, and Monterey County Water Resources Agency (MCRWA) provided data for the initial model build, and continue to provide data for PVHM updates. PVWMA Staff, the USGS, and consultants used the PVHM determine Pajaro Valley Groundwater Basin's water budget and to simulate water management scenarios during the planning of the Basin Management Plan Update. In 2014, PVWMA staff began working with the USGS to upgrade the model (from MODFLOW-FMP to One Water Hydrologic Model), update the model, simulate climate change scenarios, and finally re-run the selected BMP scenario. This work is on schedule to be completed in 2017.

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 2012. MGA member agencies continue to support the County's implementation of stormwater management.

10 (2012). Develop and implement cooperative management agreements to monitor and mitigate impacts from operating new municipal wells.

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. Implementation of the agreement has commenced and the baseline report for conditions prior to operation of the Polo Grounds well was issued in 2013 with annual reports in each following year.

SqCWD and the City of Santa Cruz have developed plans to monitor and mitigate impacts from operating the O'Neill Ranch and Beltz #12 wells as part of the EIRs for those wells. In 2015, SqCWD and the City of Santa Cruz agreed on cooperative groundwater management for the western part of the Purisima area. SqCWD and City of Santa Cruz met in 2016 to discuss data for this area's groundwater conditions for 2015 when the two wells came online.

11 (2010). Coordinate on water resource data and technical studies.

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 sponsored a U.S. Geological Survey study of climate change effects on County hydrology, which was completed in 2012.

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).

Representatives from the County, SqCWD, and PVWMA served on the Technical Advisory Committee for CWD's Aromas and Purisima Groundwater Basin Management Study.

The agencies of the Basin Advisory Group are coordinating on water resource data that will be used for the groundwater model. There is also coordination with a subcommittee of the stakeholder advisory group on private well water use data.

SAGMC and the MGA has undertaken the following technical studies: modified cross-sectional modeling for protective elevations (HydroMetrics WRI, 2016a), shallow groundwater level evaluation (HydroMetrics WRI, 2016b), and an integrated watershed-groundwater model (HydroMetrics

WRI, 2016c). The MGA has also funded a project to use airborne geophysics to detect location of freshwater-salt water interface.

11 (2013). Support County efforts to engage non-municipal groundwater users

The County formed stakeholder advisory group to improve small water systems and private well owners' participation in groundwater management of the basin. MGA member agencies provided technical support to the County in this effort. In 2016, one of the quarterly Small Water Systems Forum was held on small water system involvement in SGMA (Nguyen, 2017)

The County Water Resources Laboratory has a program to offer free nitrate testing to residents with individual private wells (Nguyen, 2015).

The Joint Powers Authority creating the MGA includes three Board seats for non-municipal groundwater users. The MGA has engaged these users with stakeholder meetings, community drop-in hours, and an online survey.

ELEMENT 5: DEVELOP A SUPPLEMENTAL SOURCE OF SUPPLY

SGMA requires aspects of this element in the GSP described as follows:

- Surface water supply available for use as groundwater recharge or in-lieu use (§10727.2(d)(5)).
- Replenishment of groundwater extractions (§10727.4(e))
- Conjunctive use or underground storage activities (§10727.4(f))
- Water recycling (§10727.4(h))
- Efficient water management practices and conservation (§10727.4(i))

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

The Santa Cruz Water Department/Soquel Creek Water District (SCWD²) Regional Seawater Desalination Project was pursued by both agencies from 2007-2013. The project is currently on hold due to concerns about the level of community support for the project.

In 2014, SqCWD performed a preliminary evaluation of alternative supply options and identified groundwater replenishment using recycled water and water transfer projects to evaluate further.

From 2014-2015the City of Santa Cruz Water Supply Advisory Committee met to evaluate alternative supply options and issued its final report in October 2015. This Final Report on Agreements and Recommendations was accepted by the City Council and includes strategies to strengthen conservation, pursue groundwater storage of available San Lorenzo River flows and groundwater storage of advanced-treated recycled water. Seawater desalination remains as an alternative solution.

The County completed recommendations for conjunctive use and water transfers using a Proposition 84 IRWM Planning Grant in 2015.

In 2016, SqCWD and the City agreed on a pilot water transfer project to transfer available surface water during the winter from the City to SqCWD for in-lieu recharge. Transfers are scheduled to begin in Water Year 2019 after SqCWD has adequately prepared its system for introduction of surface water to address water quality concerns.

In 2016, SqCWD issued a Notice of Preparation and Initial Study for Pure Water Soquel, which would replenish groundwater with advanced purified recycled water.

2. Explore and pursue funding opportunities for supplemental supply projects

MGA member agencies 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 and feasibility 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. The County's work on the project was funded by a Prop 84 IRWM Planning grant and completed in 2015.

In 2014, the Santa Cruz IRWM region applied for drought funding under Proposition 84 to explore groundwater recharge with recycled water and make more efficient use of the City of Santa Cruz supply. Although the application scored well, there was not enough funding available for the Central Coast funding area (Nguyen, 2015). In 2016, the Santa Cruz IRWM region received partial drought funding under Proposition 84 to contribute funding for SqCWD's treatment of Chromium VI (Nguyen, 2017)

SqCWD has been awarded a U.S. Bureau of Reclamation grant to conduct a Title XVI recycling and reuse feasibility study for its Pure Water Soquel project. SqCWD has submitted an application for Prop 1 groundwater quality grant funds to fund planning and evaluation of its Pure Water Soquel project.

ELEMENT 6: PROTECT EXISTING RECHARGE ZONES

SGMA requires recharge areas to be identified in the GSP (§10727.4).

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

   MGA member agencies continue to support Santa Cruz County efforts to update these maps shown as Figure 6-1 to meet new state requirements to include a map of recharge areas in the GMP. 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. The current groundwater modeling effort updates modeling of watershed for integration with simulation of groundwater flows.

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 the Harkins Slough Managed Aquifer Recharge and Recovery Facility. This facility 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 facility has operated every year since 2002. Between 2002 and 2014, 7,064 acre feet of water have been diverted from Harkins Slough and pumped to the percolation pond. Recovery wells have extracted approximately 2,295 acre feet of diverted water for distribution in the CDS. The remaining water is in storage and left to recharge the underlying aquifers. A dry weather, brackish water flood event in January 2012 sent salty water over five miles upstream into Harkins Slough. The lack of rainfall due to the historic drought California is facing has largely prevented that brackish water from being flushed out of the system. As a result, diversions to the recharge basin have been limited. Recent studies performed by the University of California, Santa Cruz (hydrogeology), and Stanford University (geophysics) have improved staff's understanding of 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 was completed in 2012. A result of that grant funded study, and the work completed by UCSC and Stanford, led PVWMA to drilling two new recovery wells in the summer of 2012. PVWMA continues to work on optimizing this facility.

   PVWMA and its partners received approximately $5 million in drought relief funding under Proposition 84. This will help fund expanded storage and distribution for recycled water irrigation and improved irrigation efficiency (Nguyen, 2015).

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 (HydroMetrics WRI, 2011a). The study used daily rainfall data at four coop climate stations in and around the Santa Cruz Mid-County 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. The current groundwater modeling effort updates modeling of watershed for integration with simulation of groundwater flows.

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.

   In 2012, the County developed a regulation that the approximately 54,000 acres mapped as Primary Groundwater Recharge zones cannot be subdivided into parcels smaller than 10 acres. This is intended to ensure that these areas remain free from development and the associated impervious surfaces that could impede recharge.

ELEMENT 7: ENHANCE GROUNDWATER RECHARGE

This is an element that may be included in the GSP's list of project or management actions required by DWR's GSP regulations (§354.44)

1. *Enhance groundwater recharge with stormwater runoff*

   MGA member agencies continue to support Santa Cruz County efforts to identify projects to enhance groundwater recharge. The County led 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 2011 and 2012. The County received a Prop 84 stormwater grant to construct the Brommer Street project and provide additional infiltration measures as a part of a new park development at the Heart of Soquel Park to be that was implemented in 2015.

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. The Resources Conservation District and UC Santa Cruz are evaluating a Managed Aquifer Recharge suitability study to evaluate locations for projects to facilitate stormwater infiltration into the aquifer.

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***

MGA member agencies 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 adopted a runoff and pollution control ordinance, stormwater construction best practices manual, and updates to design criteria for stormwater runoff in 2012. The RWQCB has approved the County's program as meeting the state requirements, with some enhancements. The County completed its Storm Water Resources Plan in 2016 (County, 2016).

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

MGA member agencies continue to support County efforts to identify drainage facilities with potential for groundwater recharge.

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

MGA member agencies 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 the MGA, SqCWD and/or CWD.

ELEMENT 8: MANAGE PUMPING

This is an element that may be included in the GSP's list project or management actions required by DWR's GSP regulations (§354.44)

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. SqCWD constructed a treatment plant for the Polo Grounds well and brought the well online in 2012. Construction of the O'Neill Ranch well was completed in 2012 and construction of a treatment plant for the well was completed in 2014. A replacement production well was installed at the Aptos Junior High School location for SqCWD in 2014. SqCWD installed the Granite Way well in 2016.
   The City of Santa Cruz constructed the Beltz #12 well to redistribute pumping inland. The well came online in 2015.

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 Pot Belly 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 520 acre-feet per calendar year during non-critically dry years and 645 acre-feet per calendar year during critically dry years. The cooperative groundwater management agreement was finalized in 2015. SqCWD and City of Santa Cruz staff met in 2016 to review data from 2015 when the two new wells were brought online.

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. This report will now be conducted biannually. Recent pumping redistribution by the City of Santa Cruz and SqCWD is consistent with distributing pumping to areas near coastal wells with groundwater levels above protective elevations over multiple years.

   SqCWD's consulting hydrologist has provided recommendations for pumping distribution to meet different pumping goals (HydroMetrics WRI, 2013). 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

DWR's GSP regulations include requirements to identify cumulative impacts in the GSP's water budget evaluation (§354.18).

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.

   The County has begun receiving small water system meter reading reports based on requirements established in 2015 with the goal of minimizing excess water use (Nguyen, 2017)

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 Santa Cruz Mid-County 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.

   The potential for well interference between the newly installed SqCWD O'Neill Ranch well and City of Santa Cruz Beltz #12 well has been identified and the cooperative groundwater management agreement outlines a monitoring plan.

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.

A replacement well at the Aptos Junior High site was installed in 2014 which will be used to shift pumping away from the coast and to reduce cumulative impacts from pumping in the area.

SqCWD installed a new production well at Granite Way in 2016 to distribute pumping in the DEF unit farther inland. Initial distribution will replace Aptos Creek pumping with Granite Way pumping, which will also reduce pumping in the BC unit, where groundwater level drawdowns have historically been the largest in the Basin.

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, 2016).

Element 10: Water Conservation

SGMA requires this element, measures addressing conservation (§10727.4(h)) and water conservation methods (§10727.4(i)), to be included in the GSP.

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.

SqCWD has revised its Water Demand Offset program to require new water use be offset by 200%.

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 Years 2015-16 was the tenth and eleventh 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 (2010). Support County wide ordinances promoting conservation.

The County has developed a water efficient landscape ordinance while implementing the state's water efficient landscape ordinance. The ordinance was presented to the County Planning Commission and Board of Supervisors in 2013. The County updated and expanded the County's water conservation ordinance in 2013. 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.

5 (2011). Develop Drought Curtailment Criteria.

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. Drought curtailments were declared in 2012 (Stage 1), 2013 (Stage 2), and 2014-2016 (Stage 3). SqCWD groundwater production over Water Years 2015-2016 represented a 26% reduction from Water Year 2013, used by the state of California as the pre-drought baseline statewide.

CWD declared a Stage 2 water shortage alert with a drought curtailment target of 20% throughout Water Years 2014-2016. CWD groundwater production over Water Years 2015-2016 represented a 30% reduction from Water Year 2013.

City of Santa Cruz declared a Stage 3 Water Shortage Emergency in both 2014 and 2015. Rationing and restrictions reduced total 2015 water production 26% compared to 2013. During 2016 the water supply situation for the City of Santa Cruz was normal and no restrictions were imposed on customers. However, customers continued their conservation efforts voluntarily and kept up the pace in terms of savings, similar to 2015. City of Santa Cruz groundwater production from the Basin over calendar years 2015-2016 represented a 6% reduction from 2013.

6 (2016). Continue and update the City of Santa Cruz Conservation Programs

Though Santa Cruz is already one of the top water savings cities in the state, the Water Supply Advisory Committee recommendations increased the level of conservation even further. In 2016, the City:

- Completed an exhaustive Water Loss Control Study to see where water is being lost through leaks in the distribution system.
- Doubled the turf removal rebate.
- Doubled the high efficiency clothes washer rebate for machines that are certified as Energy Star Most Efficient.
- Expanded the large landscape water budget program and updated the City's water efficient landscape ordinance.

- Implemented budget-based water rates for irrigation accounts.
- Completed the 2015 Urban Water Management Plan, which was adopted by City Council in August 2016

Element 11: Support the Development and Update of Policies and Ordinances for Well Construction, Abandonment, and Destruction

SGMA requires this element, well construction policies (§10727.4(g) and a well abandonment and well destruction program (§10727.4(d)), to be included in the GSP.

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

   MGA member agencies 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 with its recent monitoring well replacement projects.

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

   MGA member agencies support Santa Cruz County's abandoned well destruction program. With the support of the agencies through the IRWMP, the County used Proposition 50 water bond funding to destroy abandoned wells, an effort that was completed in 2012, and included destruction of 4 wells. One of the destroyed wells was at the County's Polo Grounds park near the well recently added to SqCWD's municipal supply.

   Monitoring wells such as the SC-9 cluster and SC-8F were properly destroyed when they were replaced in 2012. SqCWD also destroyed SC-9, SC-8F, SC-5D, and SC-5E in 2012. In 2012, the monitoring well SC-5C was identified as needing to be sealed; the well cannot be fully destroyed since it shares a borehole with wells SC-5A and 5B. The former production well at Madeline has also been identified for destruction. In 2013-2014 monitoring wells such as the SC-10, SC-11 and SC-18 well clusters were properly destroyed after they were replaced.

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.

Monitoring Well completions SC-10, SC-11 and SC-18 were properly destroyed in 2014.

SqCWD is destroying several inactive production wells in 2017.

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 Basin.

ELEMENT 12: WELLHEAD PROTECTION MEASURES

SGMA requires identification of wellhead protection areas in the GSP (§10727.4(b)).

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

In 2015, SqCWD updated DWSAP analysis and submittals previously submitted in 2012 (LSCE, 2002; Todd Engineers, 2002). SqCWD has also submitted DWSAPs for the Aptos Jr. High and Polo Grounds wells (HydroMetrics WRI, 2011b and 2011c). CWD submitted updated DWSAP reports (Johnson, 2009) to State Department of Public Health in Water Year 2009. SqCWD submitted a DWSAP for the O'Neill Ranch well in 2014 and completed an update of the 2002 DWSAPs in 2015.

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.

The MGA has initiated a public education program to inform stakeholders about SGMA and MGA as a Groundwater Sustainability Agency.

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.

SqCWD and the County provided staff and consultant support for County efforts to develop a stakeholder advisory group to engage small water systems and private well owners. Group meetings included educational programs.

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, 2012a). 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 2,890 acre-feet per year. The estimated post-recovery pumping yield for the Aromas area is 1,440 acre-feet per year. A peer review in 2014 evaluated these estimates and concluded that these estimates are on the low end of a plausible range (Todd, 2014). An integrated surface water-groundwater model that will provide sustainable yield estimates for the Groundwater Sustainability Plan is under development.

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, 2012a). Protective elevations for the City's coastal monitoring wells and SqCWD's SC-1A have been established in the cooperative agreement between the two agencies (City and SqCWD, 2015). SAGMC funded development of modified cross-sectional model to evaluate protective elevations for seawater intrusion that travels from the nearest outcrop as opposed to directly offshore and through overlying layers. These modifications did not result in revision of protective elevations (HydroMetrics WRI, 2016a).

The protective elevations are primarily based on estimates and policy decisions by Soquel Creek Water District and City of Santa Cruz. The MGA should re-evaluate these estimates and policy decisions before setting groundwater elevations as measurable objectives for this sustainability indicator.

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

   With support of MGA member agencies, the County continued its 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. MGA member agencies also support the County's new policy for management of large woody material in county streams.

   County staff completed riparian assessment and stream condition surveys for Bean, Zayante, and Branciforte Creeks and portions of Soquel, Lompico and Mountain Charlie Gulch Creeks (Nguyen, 2015).

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.

In 2015, the County required installation of meters and annual production reporting of water production for all small water systems with 5-199 connections.

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 was adapted for CWD's Proposition 84 funded basin management study in 2013

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

On behalf of PVWMA, the US Geologic Survey finalized 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 and is being updated using MODFLOW-OHM.

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 was used in the adaptation of CWD's DWSAPs model for its Proposition 84 funded basin management study, which was completed in 2013.

A GSFLOW model of the Santa Cruz Mid-County Basin is under development. GSFLOW is a groundwater-surface water model that integrates PRMS and MODFLOW. DWR's GSP regulations set groundwater-surface water model as the standard for evaluation tools.

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

Stanford University has published results for locating the seawater/freshwater interface in the Aromas area based on an onshore geophysics study (Goebel et al., 2017). The MGA has commissioned an airborne geophysics study to locate seawater/freshwater interface in a larger area of the Basin.

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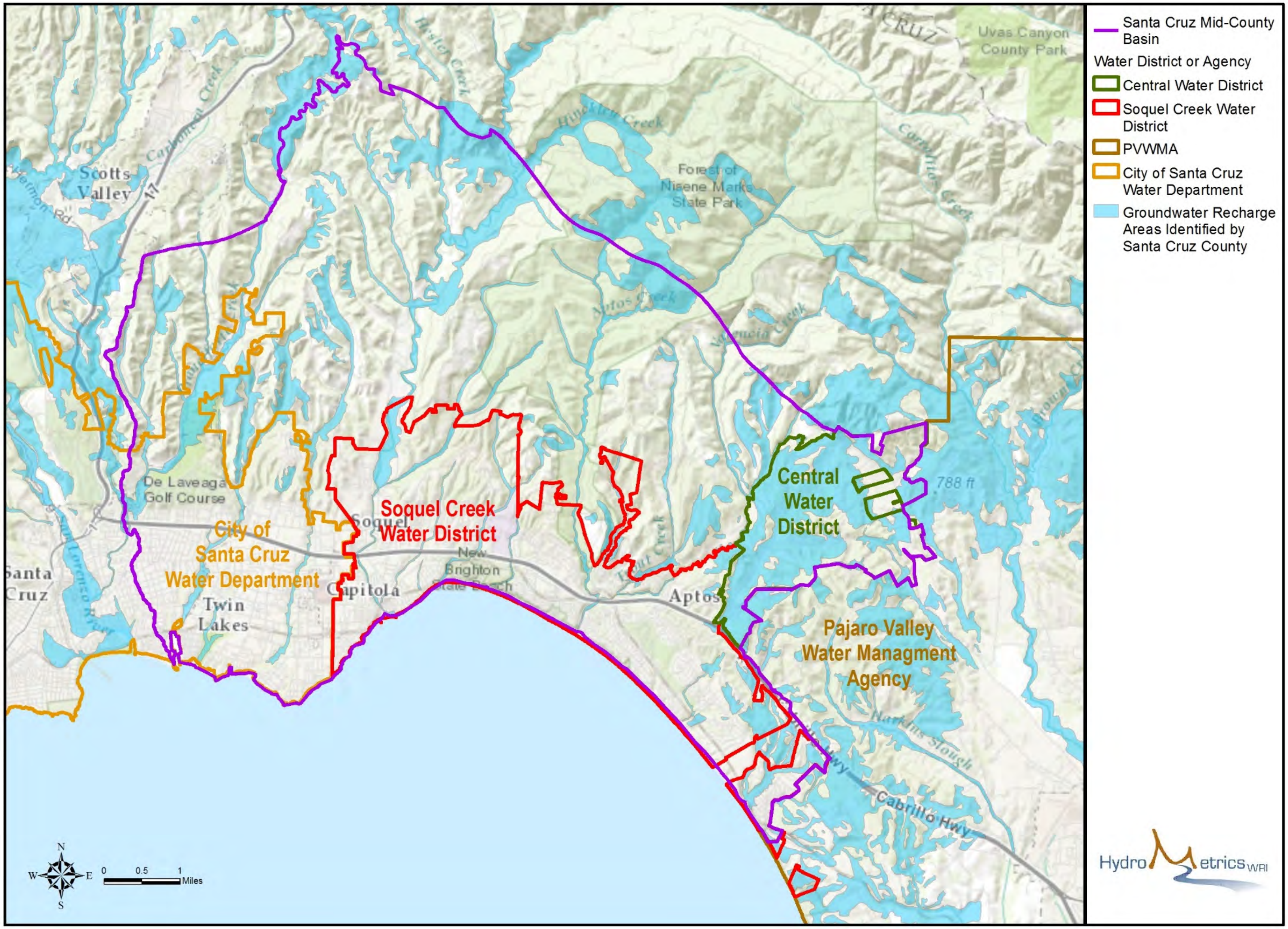

Figure 6-1: Groundwater Recharge Areas Identified by Santa Cruz County

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SECTION 7
BASIN MANAGEMENT ACTION PRIORITIES AND RECOMMENDATIONS

7.1 BASIN MANAGEMENT ACTION PRIORITIES

In previous years, this section listed the top priorities for projects and programs to achieve BMOs. The MGA will need to develop new measurable objectives for groundwater sustainability in its Groundwater Sustainability Plan (GSP). In addition, identification of projects and programs to achieve sustainability will be part of the GSP development process. Therefore, this report focuses on identifying activities that will improve basin understanding to inform development of the GSP.

7.2 ACTIVITIES TO IMPROVE BASIN UNDERSTANDING

The following highlights activities to enhance basin understanding for management and GSP development.

1. **Use Calibrated Groundwater Model to Evaluate Groundwater Management Alternatives.** The MGA has scoped using the calibrated GSFLOW model to evaluate groundwater management alternatives such as in-lieu recharge, well recharge and pumping redistribution, and aquifer storage and recovery. SqCWD and the City have also scoped runs related to the Pure Water Soquel and Aquifer Storage and Recovery that will be informative.
2. **Evaluate Basin Response to Changes in Pumping and Rainfall.** Increased groundwater level recovery occurred in Water Years 2015-16 coinciding with below average rainfall due to a large drop in pumping that can be related to drought curtailment. Water Year 2017 has had higher than average rainfall and may result in additional pumping changes so groundwater level response to those changes should be evaluated to inform evaluation of sustainable yield by the GSFLOW model. The one year increase in rainfall is not expected to be observed in deep groundwater levels as clearly as pumping changes but should be considered as a factor.
3. **Monitor Tu Unit (Unit Below Purisima Formation).** Groundwater levels indicate that recharge of the Tu unit supplying these wells may be limited. Groundwater levels in the Tu unit should continue to be closely

monitored with the O'Neill Ranch and Beltz #12 wells online and pumping managed to prevent well interference and effects on seawater intrusion risk.

4. **Monitor Effects of Pumping Distribution.** There will likely be changes in pumping distributions related to implementation of the pilot transfer of available surface water from the City to SqCWD and treatment of Chromium VI in the Aromas area. An evaluation of groundwater level response to these changes will help guide planning of future pumping distributions to help achieve sustainability.
5. **Evaluate Effects of Inland Pumpers on Basin.** The County has been awarded a grant to use the GSFLOW model to evaluate effects of inland pumping on basin conditions such as seawater intrusion risk and stream baseflows. This evaluation will guide GSP issues such as whether different management areas should be defined.
6. **Undertake Geophysics Study to Locate Seawater Interface.** Identifying the location of the seawater interface will assist with planning to prevent seawater intrusion in the Purisima and further advancement of seawater intrusion in the Aromas. Collection and analysis of geophysics data to provide this information has commenced in 2017.

SECTION 8
REFERENCES

Almond, L, 2010, *City of Santa Cruz Water Department Comments on Soquel Creek Water District's Well Master Plan Draft Environmental Impact Report (State Clearinghouse No. 2006072018)*, letter to Laura Brown, Soquel Creek Water District, October 15.

———, 2011, *Re: Beltz Well No. 12 and Soquel Creek baseflow effects*, letter to Dick Butler, NOAA National Marine Fisheries Service, December 8.

———, 2012, *Communication at Soquel-Aptos Basin Advisory Group Meeting*, May 4.

Black and Veatch, 2009, *Water Recycling Facilities Planning Study, Final Report*, prepared for Soquel Creek Water District, June.

Branham, G. 2007, Personal Communication,. February 8.

Briggs, R.W., 2007, *Re: Postponing staff efforts to prepare the Aptos Creek and Valencia Creek sediment Total Maximum Daily Load (TMDL) for Regional Board approval*, California Regional Water Quality Control Board Central Coast Section, June 28.

Cabrillo College, 2010, *Well Usage 2009, Upper Well and New Well*, provided by Joe Nugent, Maintenance & Operations Director, May 11.

———, 2015, *Well Usage 2014, Log sheets for 2014*, provided by Joe Nugent, Maintenance & Operations Director to Jon Kennedy, January 27.

California Department of Health Services Division of Drinking Water and Environmental Management, 1999, *Drinking Water Source Assessment and Protection (DWSAP) Program*, January.

Carollo Engineers, 2010, *Proposition 218 Service Charge Report, Appendix A – Unmetered User Consumption Estimate*, prepared for Pajaro Valley Water Management Agency, March.

Chambers Group, 2011, *Beltz Well No. 12 Draft Environmental Impact Report*, prepared for City of Santa Cruz Water Department, August.

City of Santa Cruz, 2009, *Water Shortage Contingency Plan*, March.

———,2015, *Notice of Intent to Adopt a Negative Declaration for Cooperative Water Transfer, Groundwater Recharge, and Resource Management Pilot Project*, December.

———, 2016, *2015 Urban Water Management Plan*. August.

City of Santa Cruz Water Supply Advisory Committee, 2015, *Final Report on Agreements and Recommendations*, October.

City of Santa Cruz and Soquel Creek Water District, 2016, *Cooperative Water Transfer Pilot Project for Groundwater Recharge and Water Resource Management*, August 1.

County of Santa Cruz, 2013, *Groundwater Recharge Policies and Projects (Component 6),* Northern Santa Cruz County Integrated Regional Water Management, February.

———, 2015, *Conjunctive Use and Water Transfers – Phase II (Task 6)*, Final Report, Northern Santa Cruz County Integrated Regional Water Management, May.

———, 2016, *Santa Cruz County Storm Water Resources Plan*, prepared by Department of Environmental Health, December.

Gary Fiske and Associates, 2003, *City of Santa Cruz integrated water plan draft final report*, prepared for City of Santa Cruz, June.

ESA, 2006, *Soquel Creek Water District Integrated Resources Plan*, prepared for Soquel Creek Water District, March 10.

ESA, 2010, *Soquel Creek Water District Well Master Plan Draft Environmental Impact Report*, State Clearinghouse No. 2006072018, prepared for Soquel Creek Water District, September 1.

ESA, 2011, *Soquel Creek Water District Well Master Plan Responses to Comments Document*, State Clearinghouse No. 2006072018, prepared for Soquel Creek Water District, February 9.

Faler, J. 1992, *Draft Private Well Location Program*, Soquel Creek Water District internal document, April.

Goebel, M., A. Pidlisecy, R. Knight. 2017, "Resistivity imaging reveals complex pattern of saltwater intrusion along Monterey coast", *Journal of Hydrology*, in press.

Hopkins, C.J. 2010, *Memorandum of Understanding for the Soquel Creek Water District and City of Santa Cruz Water Department, Proposed Cooperative Strategic Groundwater Production Program for the Live Oak/Capitola and Service Area I Wellfields,* letter to Bill Kocher, City of Santa Cruz Water Department, March 10.

Hopkins Groundwater Consultants. 2009, *Hydrogeological Conditions Study of Live Oak-Capitola Area Soquel-Aptos Groundwater Basin*, prepared for City of Santa Cruz Water Department, October.

HydroMetrics LLC, 2009a, *Draft - Water year 2007 annual review and report,* prepared for Soquel Creek Water District, January.

———, 2009b, *Groundwater levels to protect against seawater intrusion and store freshwater offshore,* prepared for Soquel Creek Water District, January.

———,2009c, *Modeled outflow to achieve protective water levels,* letter to Laura Brown, Soquel Creek Water District, September 15.

———, 2009d, *Depth discrete flow and Chromium VI testing at Aromas wells,* prepared for Soquel Creek Water District, September.

———, 2007, *Evaluation of water quality monitoring network and recommendations for improvement,* prepared for Soquel Creek Water District, September.

HydroMetrics WRI, 2011a, *Estimation of Deep Groundwater Recharge Using a Precipitation-Runoff Watershed Model*, prepared for Soquel Creek Water District, Central Water District, and the City of Santa Cruz, August.

———, 2011b, *Drinking Water Source Assessment, Aptos Jr. High Well*, prepared for Soquel Creek Water District, submitted to California Department of Public Health Monterey District, March.

———, 2011c, *Drinking Water Source Assessment, Polo Grounds Well*, prepared for Soquel Creek Water District, submitted to California Department of Public Health Monterey District, November.

———, 2012a, *Revised Protective Groundwater Elevations and Outflows for Aromas Area and Updated Water Balance for Soquel-Aptos Groundwater Basin,* letter to Laura Brown, Soquel Creek Water District, March 30.

———, 2012b, *Soquel Creek Monitoring and Adaptive Management Plan*, Technical Memorandum to Taj Dufour, Soquel Creek Water District, May 17.

———, 2013a, *Rainfall-Recharge Relationship Based on PRMS Model Results*, Technical Memorandum to Taj Dufour, Soquel Creek Water District, from C. Tana and G. King, April 12.

———, 2013b, *Pumping Distribution Plans for Total Pumping and Demand Outlined in 2012 Integrated Resources Plan,* Technical Memorandum to Taj Dufour, Soquel Creek Water District, from C. Tana, April 16.

———, 2014, *Quarterly Report for Coastal Monitoring Data through January 2014,* letter to Kim Adamson, Soquel Creek Water District, from C. Tana, March 13.

———, 2014b, *Peer Review of Sustainable Yield Estimates – Refining Estimates with the Groundwater Model and Additional Studies,* Technical Memorandum to Kim Adamson and Taj Dufour, Soquel Creek Water District, from C. Tana and D. Williams, October 8.

———, 2015a, *Soquel Creek Monitoring and Adaptive Management Plan Baseline Report*, Letter to Taj Dufour, Soquel Creek Water District, from C. Tana, August 31.

———, 2015b, *Estimated Effects on Sustainable Yield and Pumping Goals of Climate Change and Updated Basin Consumptive Use Using Water Balance Approach*, Technical Memorandum to Ron Duncan, Soquel Creek Water District, from C. Tana, October 27.

———, 2015c, *Soquel-Aptos Groundwater Flow Model Subsurface Model Construction (Task 3)*, Technical Memorandum to Ron Duncan, Soquel Creek Water District, from S. Culkin, M. Cloud, and C. Tana, November 24.

———, 2016a, *Cross-Sectional Model Modifications for Evaluation of Protective Groundwater Elevations to Prevent Seawater Intrusion*, Technical Memorandum to Soquel Aptos Groundwater Management Committee, January 27.

———, 2016b, *Shallow Groundwater Evaluation*, Technical Memorandum to Ron Duncan, June 20.

———, 2016c, *Technical Advisory Committee Meeting #3 Presentation,* Santa Cruz Mid-County Basin Groundwater Model, November 10, 2016.

———, 2016d, *Soquel Creek Monitoring and Adaptive Management Plan (MAMP -2nd Report*, Letter to Taj Dufour, Soquel Creek Water District, from C. Tana, December 19.

———, 2017, *Santa Cruz Mid-County Basin Groundwater Flow Model. Non-Municipal Groundwater Use and Return Flow Estimates*. Technical memorandum to J. Ricker and R. Duncan, Santa Cruz Mid-County Groundwater Agency, from G. King and C. Tana. March.

HydroMetrics WRI and Kennedy/Jenks Consultants, 2014, *Aromas and Purisima Basin Management Technical Study*, prepared for Central Water District, March.

Johnson, N.M., 2009, *Drinking Water Source Assessments (DWSAPs)*, prepared for Central Water District, March.

Johnson, N.M., D. Williams, E.B. Yates, and G. Thrupp, 2004, *Groundwater assessment of alternative conjunctive use scenarios – technical memorandum #2: hydrogeological conceptual model*, prepared for Soquel Creek Water District, September.

Khalsa, R., 2009, *County Water Resources Program Status Report*, letter to Board of Supervisors, County of Santa Cruz Health Services Agency, December 9.

Khalsa, R., 2010, *County Water Resources Program Status Report*, letter to Board of Supervisors, County of Santa Cruz Health Services Agency, December 1.

Khalsa, R., 2011, *County Water Resources Program Status Report*, letter to Board of Supervisors, County of Santa Cruz Health Services Agency, November 30.

King, G., 2011, *Responses to BAG Comments Received - Deep Groundwater Recharge Using a Precipitation-Runoff Watershed Model, Soquel-Aptos, California*, letter to Laura Brown, Soquel Creek Water District for HydroMetrics WRI, September 9.

Kulongoski, J.T., and K. Belitz, 2007, *Ground-water quality data in the Monterey Bay and Salinas Valley Basins, California, 2005 - results from the California GAMA program*, U.S. Geological Survey Data Series 258.

Langevin, C.D., W.B. Shoemaker, and W. Guo. 2003. *MODFLOW-2000, the U.S. Geological Survey Modular Ground-Water Model–Documentation of the SEAWAT-2000 Version with the Variable-Density Flow Process (VDF) and the Integrated*

MT3DMS Transport Process (IMT). U.S. Geological Survey Open-File Report 03-426.

Luhdorff and Scalmanini Consulting Engineers (LSCE), 2002, *Purisima Wells Drinking Water Source Assessment and Protection Report*, prepared for Soquel Creek Water District, December.

Nguyen, G.T., 2013, *County Water Resources Program Status Report*, letter to Board of Supervisors, County of Santa Cruz Health Services Agency, January 10.

Nguyen, G.T., 2014, *County Water Resources Program Status Report*, letter to Board of Supervisors, County of Santa Cruz Health Services Agency, January 6.

Nguyen, G.T., 2015, *County Water Resources Management Status Report for 2014*, letter to Board of Supervisors, County of Santa Cruz Health Services Agency, January 15.

Nguyen, G.T., 2016, *Water Resources Management Status Report for 2015*, letter to Board of Supervisors, County of Santa Cruz Health Services Agency, January 19.

Nguyen, G.T., 2017, 2016 *Water Resources Annual Report*, memorandum to Board of Supervisors, County of Santa Cruz Health Services Agency, January 24.

PRISM, 2016. Climate Group, Oregon State University. Accessed at http://prism.oregonstate.edu, November .

Ricker, J., 2012, *RE: Small Water Systems*, Email to Taj Dufour, July 20.

Ricker, J., 2013, *Status Update Report on the Potential Santa Cruz Regional Water Exchange for Northern Santa Cruz County Area*, presentation to Soquel Creek Water District Board of Directors, November 5.

Ricker, J., 2017, *RE: Soquel Creek Surface Water Rights*, Email to Cameron Tana, April 17.

Soquel Creek Water District and Central Water District, 2007, *Groundwater management plan -2007 Soquel-Aptos area,* Santa Cruz County, California, April.

Soquel Creek Water District and City of Santa Cruz, 2015, *Cooperative Monitoring/Adaptive Groundwater Management Agreement*, March.

Soquel Creek Water District, 2011, *Urban Water Management Plan 2010*, prepared for the California Department of Water Resources, September.

Todd Engineers, 2002, *Source Water of Soquel Creek Water District Aromas Red Sands Aquifer*, prepared for Soquel Creek Water District, April.

Todd Groundwater, 2014, *Peer Review of Technical Water Resources Studies Prepared for Soquel Creek Water District—Summary of Yield Estimates*, technical memorandum to Kim Adamson and Taj Dufour, Soquel Creek Water District, from G. Yates, September 8.

Wolcott, J. 1999, *Methodology of Calculating Water Use in Purisima Aquifer*, Santa Cruz County Environmental Health Services staff status report, October.

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