PEACE RIVER MANASOTA REGIONAL WATER SUPPLY AUTHORITY

Hon. Alan Maio
Sarasota County

Hon. Elton A. Langford
DeSoto County

Hon. Bill Truex
Charlotte County

Hon. George Kruse
Manatee County

Mike Coates, P.G., Executive Director

August 10, 2022

Marian Fugitt, P.G.
Source and Drinking Water Program
Division of Water Resource Management
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

RE: Water Quality Criteria Exemption
Response to Request for Additional Information (RAI)
DeSoto County
Facility Name: Peace River Manasota Regional Water Supply Authority
Facility WACS ID: 40593

Dear Ms. Fugitt:

On behalf of the Peace River Manasota Regional Water Supply Authority ("Authority"), please find our response to the Department's July 18, 2022, Request for Additional information (RAI) regarding the Authority's Petition for a Water Quality Criteria Exemption (WQCE) for Wellfield 2 at our Aquifer Storage and Recovery (ASR) facility. The Department's comments are provided in bold, followed by the Authority's response.

1. **The petition requests an aquifer exemption for the Suwannee Limestone. Pursuant to Chapter 62-520, Florida Administrative Code (F.A.C.), what Class of ground water (based on TDS concentrations) does this represent?**

   The Suwannee Limestone is a G-II ground water aquifer based on the background total dissolved solids (TDS) of 800 mg/L (Rule 62-520.410(1), F.A.C.). It should be noted that the petition is not for an Aquifer Exemption but for a Water Quality Criteria Exemption (WQCE).

2. **Please provide documentation to support the requested alternative compliance levels. Are there any monitor wells further out from the Aquifer Storage Recovery (ASR) wells that don't show exceedances? The proposed alternate compliance level for aluminum listed in the petition is 40.0 mg/l, while the maximum observed concentration was reported to be only 0.8 mg/l. Please justify the need for an alternative compliance level that is 50 times the value of the observed maximum or propose a value more in-line with other requested alternative compliance levels.**

Monitor Wells Without Exceedances

WF2 ASR and monitor wells at the facility are listed with completion details on **Table 1-2** in the attached 2020 annual report. Of the four parameters subject to the Petition, only aluminum and color were required to be sampled from WF2 monitor wells during cycle testing with PTSW. Results for those wells are shown on **Figures 1-4 and 1-5** of the Petition, and those not exceeding the MCL for aluminum or color can be determined. Monitor wells completed above the Suwannee Limestone have not shown impacts from the ASR operation. Monitor well M-6 is a Suwannee Limestone well which has not shown exceedances or been affected by ASR operations. As stated in response to Question No. 3 below, the exemption Petition is for WF2 in its entirety and should not be limited to wells with exceedances.

Requested Alternative Compliance Level for Aluminum

Although the maximum aluminum concentration in the partially treated surface water (PTSW) was 0.8 mg/L, the cycle tests using PTSW in 2017 led to concentrations temporarily higher than 0.8 mg/L in monitor wells M-11, M-12, M-14, and M-15, with the highest concentrations being nearly 20 mg/L in monitor wells M-11 and M-12 (**Figure 1-4** of the Petition). Requested alternative compliance levels for other WQCEs are approximately twice the observed value in the injectate or in the affected aquifer. That is the case with the aluminum alternative compliance level in the Peace River exemption petition. Higher aluminum concentrations in M-11, M-12, M-14, and M-15 may be due to higher turbidity values in those monitor well samples as seen in **Figure 1-6** (attached). As shown on **Figure 1-4** of the Petition, aluminum concentration in all monitor wells used for the PTSW cycle testing decreased to less than 0.1 mg/L after the recharge period of the second cycle was complete. **Table 1-1** of the Petition shows that aluminum background levels were below the detection limit (BDL) for every ASR well in Wellfield 2. We have revised **Table 1-2** of the Petition to identify the requested maximum values in both the PTSW and the monitor wells (see attached **Table 1-2**). The requested alternative compliance level for aluminum remains unchanged at 40 mg/L.

Requested Alternative Compliance Level for Color

The requested alternative compliance level for color has been revised and is identified in the attached **Table 1-2**. The maximum observed color value was 800 color units (CU) in monitor well M-11. It is considered an anomaly and is likely not representative of the effects in the ASR zone during cycle testing. Monitor well M-12 had a maximum value of 400 CU during PTSW cycle testing which is not unusually high compared with other data points for M-12 in **Figure 1-5**. For this reason, the alternative color compliance level has been changed to 800 color units (twice the maximum value in M-12) on the attached **Table 1-2**.

Requested Alternative Compliance Level for Iron

The requested alternative compliance level for iron has been revised and is identified in the attached **Table 1-2**. Based on monitor well M-14 having a maximum iron value of 0.7 mg/L during PTSW cycle testing (**Appendix A, Figure 1**), the alternative iron compliance level has been changed to 1.5 mg/L.

Requested Alternative Compliance Level for Odor

The requested alternative compliance level for odor remains the same as was identified in the Petition. Aluminum, color, odor, and iron were not required to be monitored for this facility prior to a permit modification issued in 2016. The modification, issued to allow two cycle tests with PTSW in Wellfield 2, required aluminum and color to be monitored during the PTSW cycle tests. Iron was added to some Suwannee monitor wells as part of a geochemical study during PTSW cycle testing (Appendix A of the Petition). **Table 1-1** of the Petition has background odor values for the ASR wells of Wellfield 2, with results ranging from BDL to 50 threshold odor number (TON). Odor has not been monitored, but the limited available data and knowing the potential for PTSW to contain elevated odor led to the inclusion of odor in the Petition with the requested alternative compliance level of 75 TON (see attached **Table 1-2**).

3. **Section 38 of the petition states that the ASR zone and the overlying Hawthorn aquifer system are rigorously monitored to detect any adverse effects related to ASR activities. Please provide a recent analysis of these results and comment on any adverse effects.**

   The Authority is in the process of finalizing the 2021 annual report required by the current permit. The 2020 annual report is attached with graphs of water quality parameters and reviews of each monitor well provided. No new trends have developed in 2021 and the analyses provided in the 2020 report will not change much for the 2021 report. In 2021 there was no recharge into the two wellfields with moderate volumes of water recovered.

4. **Please list which monitor wells for Wellfield 2 need water quality exemptions in a summary table that identifies the names of the monitor wells, well construction details (cased and total depth).**

   Table 1-2 of the 2020 annual report lists all ASR and monitor wells in Wellfield 2 with cased and total depths included. The exemption Petition is for Wellfield 2 in its entirety.

5. **Figure 1-3 of the petition only shows the locations for 13 monitor wells, while the document states that there are 15 monitor wells for Wellfield 2. Please provide a map with the locations of each compliance well measuring for aluminum, color, odor and iron along with the effluent source.**

   Figure 1-2 of the Petition shows the locations for all UIC wells for the two wellfields. The two monitor wells not included in **Figure 1-3** of the Petition are I-9 (plugged and abandoned) and I-10. Aluminum, color, odor, and iron were not required to be monitored for this facility prior to a permit modification issued in 2016. The modification, issued to allow two cycle tests with PTSW in Wellfield 2, required aluminum and color to be monitored during the PTSW cycle tests. Iron was added to some Suwannee monitor wells as part of a geochemical study during PTSW cycle testing (**Appendix A** of the Petition).

6. **Please provide a current graph or tabular data showing aluminum, color, odor and iron concentrations through time for both the effluent and the monitor wells, and highlight any exceedances. Figures 1-4 and 1-5 of the petition uses colors that are difficult to differentiate because they do not have enough contrast. Please provide a legend that clearly distinguishes between the data for each monitor well depicted, and indicate when injection and withdrawal is occurring. What is the difference between PTSW Storage and WF2 Storage, and why are the aluminum and color values for PTSW Storage so much lower than WF2 Storage?**

The bulk of the data collected for aluminum, color, and iron were presented in the exemption Petition in **Figure 1-4**, **Figure 1-5**, and **Appendix A, Figure 1**. Exceedances above the maximum contaminant level (MCL) are values above 0.2 mg/L for aluminum, 15 color units for color, and 0.3 mg/L for iron. These parameters were sampled primarily for the 2017 cycle test periods; odor was not monitored. The 2020 annual report contains a table of water quality data for that year. Iron was sporadically sampled but all iron results were below the MCL.

For **Figures 1-4 and 1-5** of the Petition, the Authority believes the inclusion of all 18 monitoring stations on one graph provides a clearer view of the impact of PTSW testing on Wellfield 2. The symbols used in addition to the colors on the graphs (dots, triangles, diamonds, and the letter x) help to distinguish between monitoring stations. Revisions of these two figures are attached ("**Figure 1-4 Revised**" and "**Figure 1-5 Revised**"), with some monitoring wells labeled with arrows and names.

Periods of injection and withdrawal using PTSW can be determined from the green line labeled "PTSW Storage". Both this line and the WF2 Storage line measure the total volume of water in storage in the Suwannee Limestone in Wellfield 2. The PTSW line is for storage using only the PTSW water using two ASR wells (i.e., ASR-4 and ASR-20). WF2 Storage represents the total volume in storage in the entire Wellfield 2. WF2 storage is comprised of potable water injected for years plus the PTSW volume injected in 2017, which accounts for the larger volume of water in storage for WF2.

Aluminum and color values increased in some monitor wells during injection using PTSW due to these parameters being higher in the PTSW than in the Authority's potable water which is normally injected. Shown clearly in **Figures 1-4 and 1-5** is the rapid decrease in aluminum and color when the PTSW injection ceases and the wellfield enters storage and recovery modes. In the case of color, monitor well M-11 had one sample with 800 CU. It appears to be an anomaly. The next highest value in a monitor well was 400 CU, which should be used as the basis for an alternative MCL of 800 CU.

7. **Paragraph 6 (on page 3 of 16 of the petition states that *through two wellfields, the Authority injects fully treated surface water meeting federal and state drinking water standards into the ASR System when river flows are high*. This contradicts paragraph 42 which states that partially treated surface water may be stored and recovered at wellfield 2. Please provide an explanation.**

   The current permit requires all surface water to be treated to potable standards before it is injected (paragraph 6). The Petition's purpose is to complement the upcoming permit renewal which is anticipated to allow the Authority to have the option of injecting PTSW in the ASR wells of Wellfield 2 **in addition to** potable water (paragraph 42). ASR wells in Wellfield 1 will continue to receive only potable water.

8. **What is the general ground water flow direction in relation to the other wells within the vicinity of Wellfield 2 that are described in Section 29 of the petition? Is a map showing the locations of these wells available?**

   Figures 1-2 and 1-3 of the Petition show the locations of wells in the vicinity of Wellfield 2. Attached in **Appendix B** are five figures from the February 2018 operation permit renewal application that is on file with the Department. These figures contain the locations of all known wells in the 2-mile area of review. The inventory data was obtained from the Southwest Florida Management District, the Florida Geological Survey, the Florida Department of Health, and the Petitioner's files. The direction of groundwater flow is generally to the northwest, but the Authority's ASR wellfields locally influence the flow direction. During recharge periods the flow is radially outward from the points of injection and during recovery flow it is towards the wells.

9. **The second to last sentence in paragraph 16 (on page 6 of 16 of the petition) states that "…*This well* (which recently sampled for odor with a result of 67 TON) *has shown no effects from the Authority's ASR system"*. Please provide documentation to support this statement.**

   Monitor well M-6 is located 7,500 feet south of Wellfield 2 and is not in the direction of the groundwater gradient, which is to the northwest. **Figure D-3** of the 2020 annual report is a graph of key monitoring parameters for M-6 since 2002. Over the 18-year monitoring period the parameters remain at background conditions, with TDS at 900 mg/L. The injected water has not affected the water quality of monitor well M-6.

10. **The cover letter for the petition was incorrectly dated May 24, 2020. Please correct and resubmit the cover letter to the petition.**

    The original cover letter has been revised to correct the date to May 26, 2022 and is attached to this response.

The Authority appreciates the Department's assistance and we trust the information provided herein is sufficient to bring our Petition to completion. We look forward to receipt of the requested exemption.

If you have any questions or if we can be of any further assistance, please do not hesitate to contact me or Pete Larkin, P.G. of ASRus, LLC at 813-382-8516.

Sincerely,

Mike J. Coates, P.G.
Executive Director

Attachments
- Revised Figures 1-4 and 1-5
- Figure 1-6
- Revised Table 1-2
- Appendix B – Well Inventory
- PRMRWSA Annual Report 2020
- Revised (redacted) original cover letter

cc:

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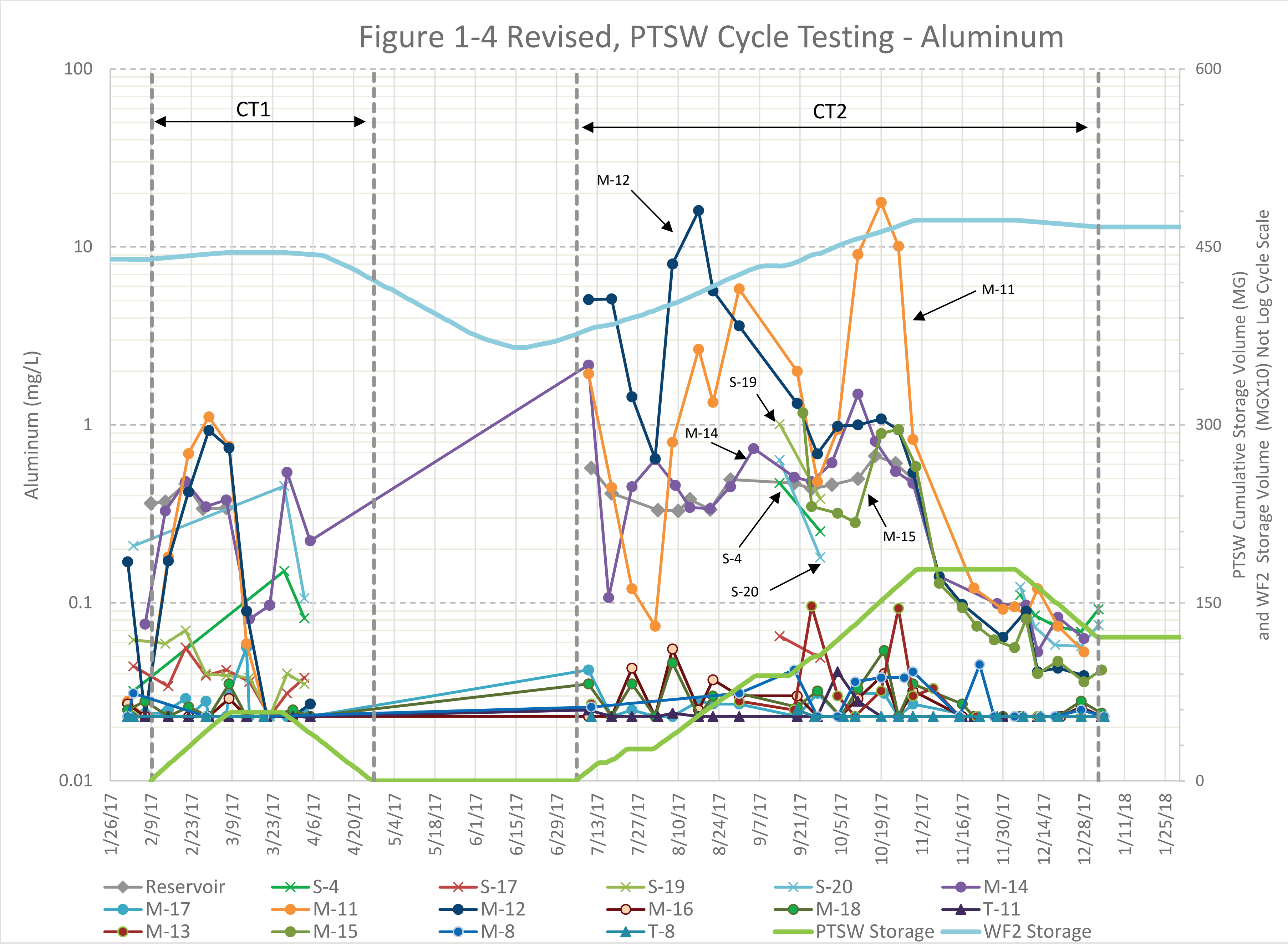


Figure 1-4 Revised, PTSW Cycle Testing - Aluminum
Aluminum (mg/L)
PTSW Cumulative Storage Volume (MG) and WF2 Storage Volume (MGX10) Not Log Cycle Scale
100
10
1
0.1
0.01
600
450
300
150
0
CT1
CT2
M-12
M-11
S-19
M-14
S-4
M-15
S-20
1/26/17
2/9/17
2/23/17
3/9/17
3/23/17
4/6/17
4/20/17
5/4/17
5/18/17
6/1/17
6/15/17
6/29/17
7/13/17
7/27/17
8/10/17
8/24/17
9/7/17
9/21/17
10/5/17
10/19/17
11/2/17
11/16/17
11/30/17
12/14/17
12/28/17
1/11/18
1/25/18
Reservoir
S-4
S-17
S-19
S-20
M-14
M-17
M-11
M-12
M-16
M-18
T-11
M-13
M-15
M-8
T-8
PTSW Storage
WF2 Storage

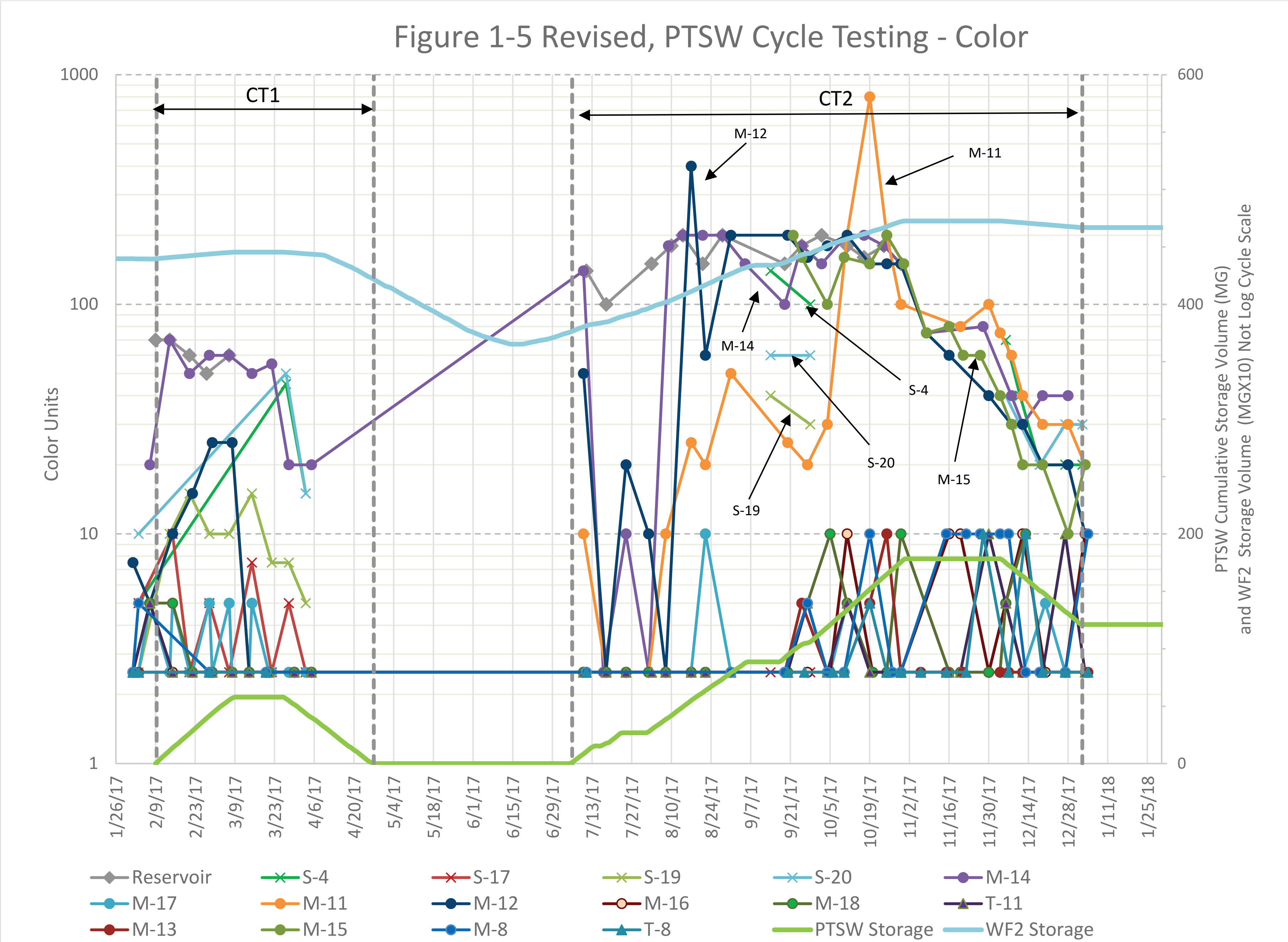


Figure 1-5 Revised, PTSW Cycle Testing - Color
CT1
CT2
M-12
M-11
M-14
S-4
S-20
S-19
M-15
Color Units
1000
100
10
1
PTSW Cumulative Storage Volume (MG)
and WF2 Storage Volume (MGX10) Not Log Cycle Scale
600
400
200
0
1/26/17
2/9/17
2/23/17
3/9/17
3/23/17
4/6/17
4/20/17
5/4/17
5/18/17
6/1/17
6/15/17
6/29/17
7/13/17
7/27/17
8/10/17
8/24/17
9/7/17
9/21/17
10/5/17
10/19/17
11/2/17
11/16/17
11/30/17
12/14/17
12/28/17
1/11/18
1/25/18
Reservoir
S-4
S-17
S-19
S-20
M-14
M-17
M-11
M-12
M-16
M-18
T-11
M-13
M-15
M-8
T-8
PTSW Storage
WF2 Storage

Figure 1-6 PTSW Cycle Testing - Turbidity Log

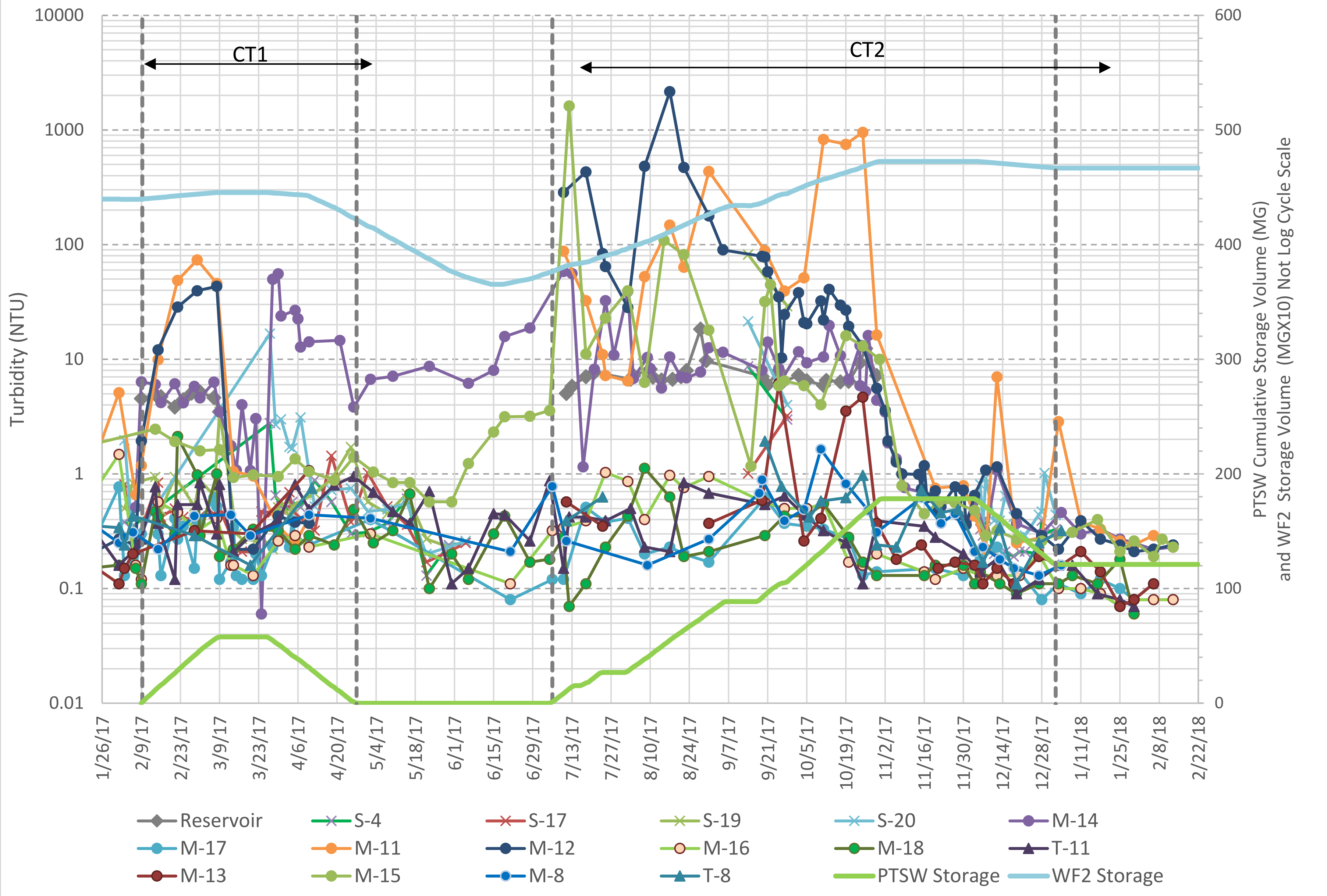
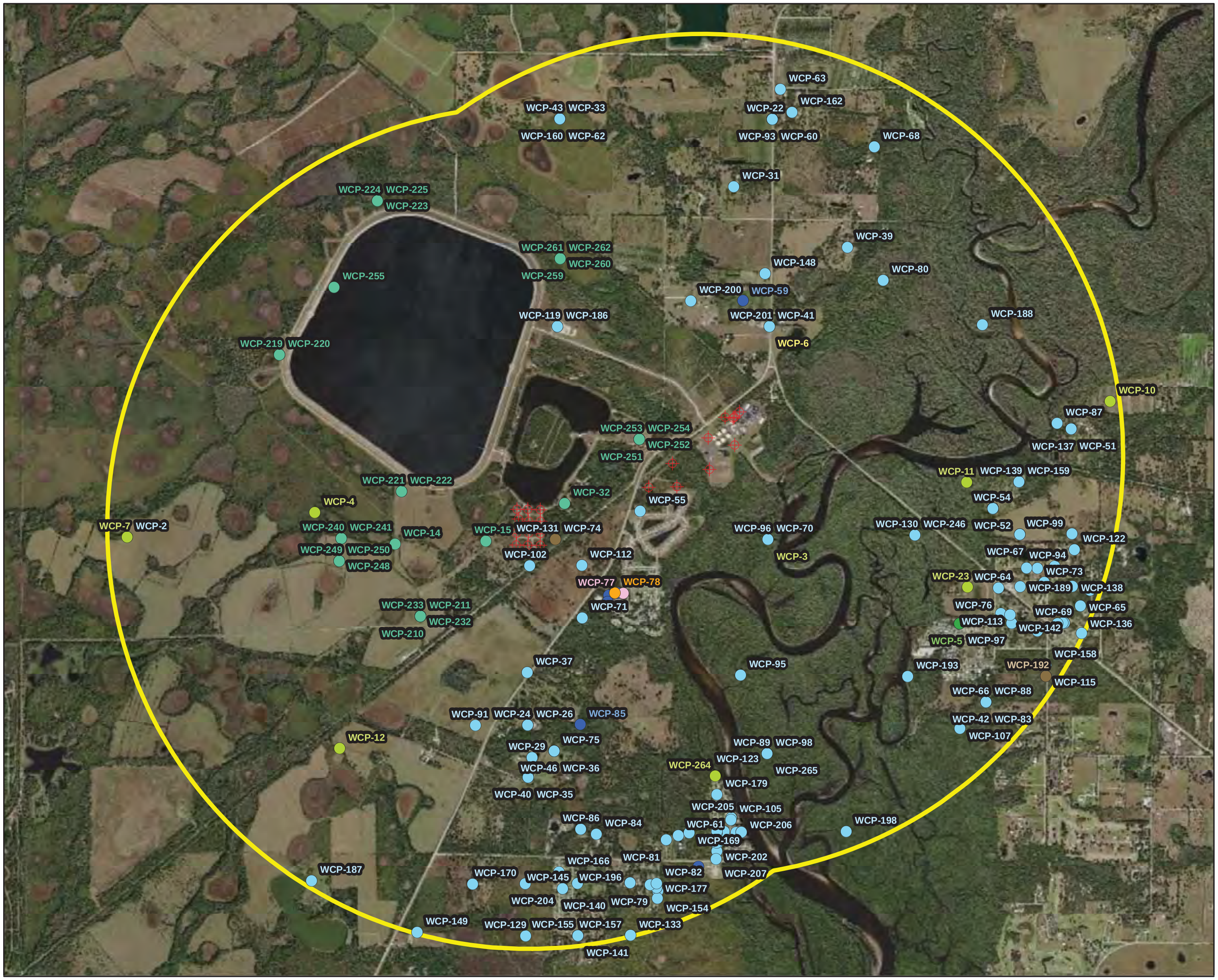


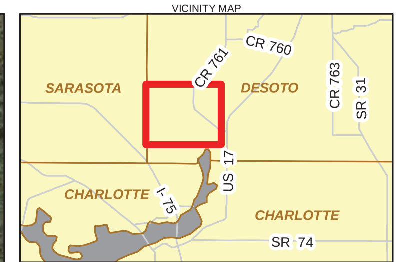
Table 1-2 Revised.
Requested Alternative Water Quality Criteria Exemption Concentrations

Parameter	Units	DWS Maximum Contaminant Level	Maximum Observed in PTSW or Monitor Wells	Background Concentration ASR Zone	Proposed WQCE Concentration PTSW
Aluminum	mg/L	0.2	0.8 PTSW 19 mon. wells	< 0.2	40
Color	CU	15	200 PTSW 400 mon. wells	<15	800
Odor	TON	3	uncertain	≤ 50	75
Iron	mg/L	0.3	0.353 PTSW 0.7 mon. wells	<0.3	1.5

Appendix B
Well Inventory of Area of Review

Source: Aquifer Storage and Recovery (ASR) Well
System Operation Permit Application dated February 2018





Legend

- PRMRWSA ASR Wells
- Area of Review

Well Construction Permits

- DOMESTIC
- HVAC RETURN (CLASS V)
- HVAC SUPPLY
- IRRIGATION
- LIVESTOCK
- MINING
- MONITOR
- PUBLIC SUPPLY
- PUBLIC SUPPLY - LIMITED USE/DOH
- SEALING WATER
- UNKNOWN

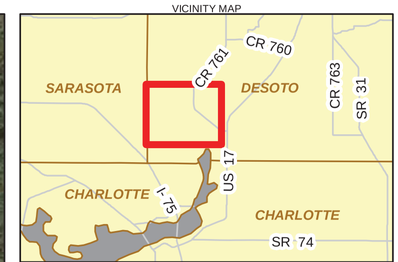
Notes:
1. Peace River-Manasota Regional Water Supply Authority explicitly owned wells, with the exception of ASR Wells, are not included in figure or associated tables.
2. WCPs, State Counties, Roads, SWFWMD 2018; Aerial Imagery, ESRI 2018.

0 0.25 0.5 0.75 1 Miles

N

FIGURE 2-11
2-Mile AOR Well Inventory - All SWFWMD WCPs
Permit Application
Peace River Manasota Regional Water Supply Authority

ch2m:



Legend

- PRMRWSA ASR Wells
- Area of Review

Water Use Permits

- IRRIGATION
- LIVESTOCK
- PUBLIC SUPPLY (CAPPED)
- UNKNOWN (CAPPED)

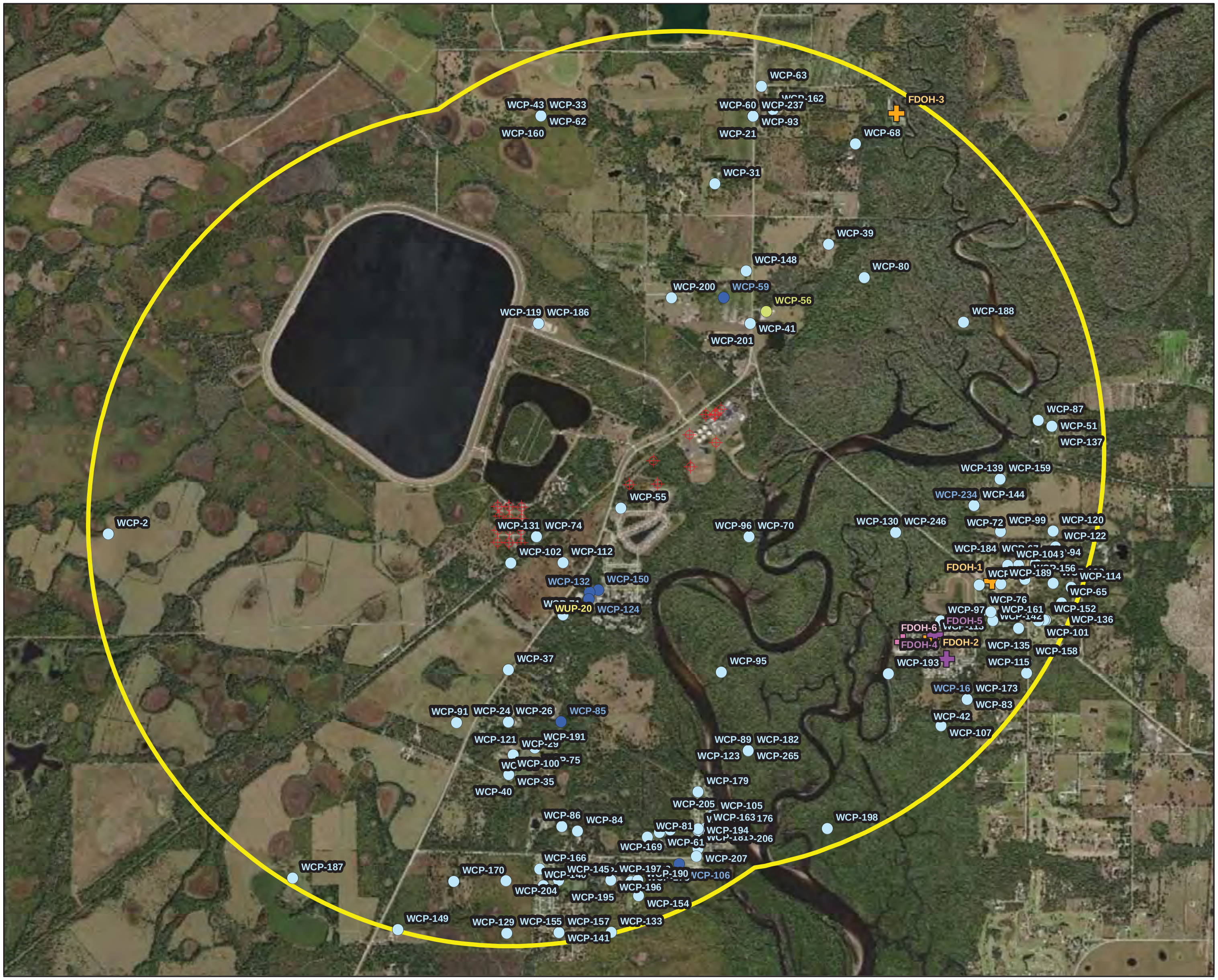
Notes:
1. Peace River-Manasota Regional Water Supply Authority explicitly owned wells, with the exception of ASR Wells, are not included in figure or associated tables.
2. WUPs, State Counties, Roads, SWFWMD 2018; Aerial Imagery, ESRI 2018.

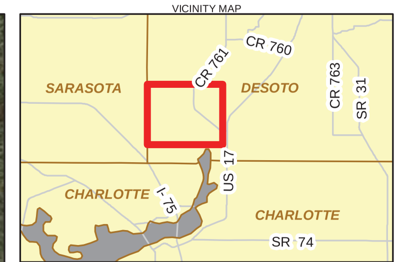
0 0.25 0.5 0.75 1 Miles

N

FIGURE 2-12
2-Mile AOR Well Inventory - All SWFWMD WUPs
Permit Application
Peace River Manasota Regional Water Supply Authority

ch2m:





Legend

- PRMRWSA ASR Wells
- Area of Review

Well Construction Permits

- DOMESTIC
- PUBLIC SUPPLY
- PUBLIC SUPPLY - LIMITED USE/DOH

Water Upse Permits

- PUBLIC SUPPLY (CAPPED)

FDOH Wells

- Limited Use PWS
- Non-Community PWS
- Non-Transient Non-Community PWS

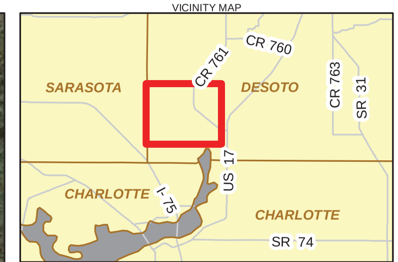
Notes:
1. Peace River-Manasota Regional Water Supply Authority explicitly owned wells, with the exception of ASR Wells, are not included in figure or associated tables.
2. WCPs, WUPs, State Counties, Roads, SWFWMD 2018; FDOH Wells, FDOH 2018; Aerial Imagery, ESRI 2018.

0 0.25 0.5 0.75 1 Miles

N

FIGURE 2-13
2-Mile AOR Well Inventory
Domestic and Public Supply (WCPs, WUPs, FDOH)
Permit Application
Peace River Manasota Regional Water Supply Authority Peace River Facility

ch2m:



Legend

- PRMRWSA ASR Wells
- Area of Review

Well Construction Permits ≥ 500 feet bls

- DOMESTIC
- IRRIGATION
- MINING
- SEALING WATER
- UNKNOWN

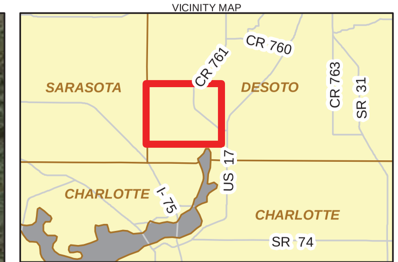
Notes:
1. Peace River-Manasota Regional Water Supply Authority explicitly owned wells, with the exception of ASR Wells, are not included in figure or associated tables.
2. WCPs, State Counties, Roads, SWFWMD 2018; Aerial Imagery, ESRI 2018.

0 0.25 0.5 0.75 1 Miles

N

FIGURE 2-14
2-Mile AOR Well Inventory - SWFWMD WCPs ≥ 500 feet bls
Permit Application
Peace River Manasota Regional Water Supply Authority

ch2m:



Legend

PRMRWSA ASR Wells

Area of Review

Water Use Permits

≥ 500 feet bls

IRRIGATION

LIVESTOCK

UNKNOWN (CAPPED)

Notes:
1. Peace River-Manasota Regional Water Supply Authority explicitly owned wells, with the exception of ASR Wells, are not included in figure or associated tables.
2. WUPs, State Counties, Roads, SWFWMD 2018; Aerial Imagery, ESRI 2018.

0 0.25 0.5 0.75 1 Miles

N

FIGURE 2-15
2-Mile AOR Well Inventory - SWFWMD WUPs ≥ 500 feet bls
Permit Application
Peace River Manasota Regional Water Supply Authority

ch2m:

Peace River Facility ASR System
2020 Annual Report

Prepared for

Peace River Manasota
Regional Water Supply Authority

August 2021

ASRUS, LLC

ASRus, LLC
13329 N. Armenia Avenue,
Tampa, Florida 33613

Contents

Appendices

Tables (provided at the end of each section)

Figures (provided at the end of each section)

Figures (continued)

Acronyms and Abbreviations

µg/L	micrograms per liter
APHPZ	Avon Park high permeability zone
ASR	aquifer storage and recovery
Authority	Peace River Manasota Regional Water Supply Authority
BG	billion gallons
bls	below land surface
BMDL	below method detection level
CFU/100 mL	colony forming units per 100 milliliters
CT1	Cycle Test 1
CT2	Cycle Test 2
FDEP	Florida Department of Environmental Protection
gpm/ft	gallon(s) per minute per foot (of drawdown or rise)
IAS	Intermediate Aquifer System
MCL	maximum contaminant level
MG	million gallons
mg/L	milligrams per liter
mg/L/MG	milligrams per liter per million gallons
mgd	million gallon(s) per day
NAVD	North American Vertical Datum
NGVD	National Geodetic Vertical Datum
POR	Period of Record
PRF	Peace River Regional Water Supply Facility
PTW	partially treated water
Q	pumping rate (in gallons per minute)
Q/s	specific capacity (gpm/foot of drawdown)
s	drawdown (feet)
SI	specific injectivity (gpm/foot of water level increase)
Tampa Zone	Tampa Member of the Arcadia Formation
TDS	total dissolved solids
UFA	Upper Floridan aquifer
UIC	underground injection control
WF1	ASR Wellfield No. 1
WF2	ASR Wellfield No. 2
WQCE	Water Quality Criteria Exemption
WUP	Water Use Permit
ZOD	zone of discharge

Professional Geologist

The evaluation and interpretations in *The Peace River Facility ASR System 2020 Annual Report* on behalf of the Peace River Manasota Regional Water Supply Authority were prepared by or reviewed by a Licensed Professional Geologist in the State of Florida.

Mark B. McNeal, P. G.

8/3/2021

Date

1231

License No.

James P. Larkin, P. G.

8/3/2021

Date

2793

License No.

Certification Signature

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Signature

Mike Coates
Printed Name

Executive Director
Title

08-05-2021
Date

Executive Summary

The Peace River Manasota Regional Water Supply Authority (Authority) operates an Aquifer Storage and Recovery (ASR) system that includes ASR Wellfield No. 1 (WF1) and ASR Wellfield No. 2 (WF2) at the Peace River Regional Water Supply Facility (PRF). The Underground Injection Control (UIC) Permit for those wellfields requires completion and submittal of an annual report on ASR operations. This annual report summarizes data collected from the ASR system through calendar year 2020 and provides analysis of the operations and performance of the ASR system. The Florida Department of Environmental Protection (FDEP) UIC operation permit was issued April 24, 2013, including both WF1 and WF2. The permit had a five-year duration, and therefore an application renewal was submitted February 19, 2018. The permit application requested the inclusion of Partially Treated Water (PTW), water from the Authority's above ground reservoirs, as a new source water for the ASR system. The permit has yet to be issued by the FDEP, however since the permit application was submitted within 60 days of the expiration of the current permit it was deemed to be a timely renewal and therefore the operation of the ASR system is permitted to continue under the conditions of the 2013 operation permit while the permit is being processed. Recent communications with FDEP indicate that they do not currently support use of partially treated water (PTW) without disinfection. However, FDEP may agree to include PTW as a source water for WF2 in the permit if the water is disinfected to meet the groundwater discharge standard for total coliform and the disinfection does not result in exceedance of primary drinking water standards associated with disinfection byproducts such as total trihalomethanes and total haloacetic acids. A request dated July 30, 2020 was made to the FDEP for inclusion of PTW with chloramine disinfection as a potential source water in the permit that is currently under review.

The two primary issues associated with the operation of the potable water ASR wellfields are increasing salinity throughout recovery and arsenic mobilization. During recovery events, increasing salinity is caused by a combination of recharged potable water mixing with the storage zone native water and, to a greater extent, upconing from higher salinity permeable units below the storage zone. Upconing is a term used to describe the upward movement of water to the well bore versus lateral movement of water to the well bore in response to pumping.

The second issue that has affected operation of ASR with regard to permitting is the mobilization of arsenic. FDEP UIC regulations state that injection activities of an ASR system cannot cause an exceedance of a primary drinking water standard maximum contaminant level (MCL) in the aquifer. The Authority was issued a water quality criteria exemption (WQCE) on February 12, 2013 to mitigate increases in arsenic concentration within the storage zone and allow exceedances of arsenic standards on land under the institutional control of the Authority. This exemption allowed the Authority to secure an operation permit for the system in April 2013 without the need for an accompanying Administrative Order. Now both WF1 and WF2 are addressed under a single operation permit with an associated WQCE. A renewal of the WQCE for arsenic or any other federal primary drinking water standard may not be available from FDEP. However, on September 27, 2013, the U.S. Environmental Protection Agency sent a letter to FDEP that allows potable water ASR projects to be permitted if arsenic is being mobilized as long as the permit is protective of groundwater and other groundwater users.

Arsenic is mobilized in the aquifer at both WF1 and WF2, as well as at most, if not all, other ASR sites in Florida. However, the following points demonstrate that public health has not been endangered through operation of this ASR system, and they are the primary basis for issuance of the WQCE and operation permit issued by the FDEP:

- Water recovered from the ASR system is pumped to the reservoirs where it mixes with surface water and is then re-treated at the PRF, which significantly reduces the arsenic concentration. Finished water from the PRF meets all state and federal drinking water standards.

- As demonstrated in this report, the Authority has an extensive monitoring well network with a very robust dataset. This network has shown the areal extent of arsenic exceedances to be limited to land owned or controlled by The Authority.
- There is strong evidence that arsenic is unstable in groundwater when influenced by ASR operations and reabsorbs to the host rock matrix relatively near the ASR boreholes.
- No competing users of the storage zone are located near either of the wellfields.
- The Authority owns or controls a large area of land surrounding the ASR wellfields and data have shown that arsenic mobilization is remaining onsite, providing an institutional control of the stored water.
- Arsenic concentrations have decreased with continued use of the ASR system, with most of the ASR wells now operating within drinking water MCL.

This report details the operational and water quality data of the ASR wells. Recommendations and considerations for future operation of the wellfields, based on the analysis presented herein, are presented at the end of the report. The following are a few of the more significant findings and recommendations made in this report:

- During the 2020 recovery event, arsenic concentrations from the ASR wells remained below the regulatory limit of 10 micrograms per liter (µg/L) at the ASR wells with the exceptions of S-3R and S-13, which showed maximum concentrations of 10.0 µg/L and 10.8 µg/L, respectively.
- Monitoring wells that serve as compliance wells bordering the wellfields continue to support the limited extent of arsenic mobilization from the ASR wells as most are below the regulatory limit of 10 micrograms per liter (µg/L). However, because of the increase in storage at WF2 and potentially the addition of PTW, an increase in arsenic at storage zone monitoring well M-15 was observed from 2015 through 2020, reaching a maximum of 32 µg/L in 2018. This well is a compliance well in the WQCE and as a result the frequency of the sampling of this well was increased to closely monitor this well until concentrations are below 10 µg/L. From 2018 through 2020 arsenic concentrations in M-15 decreased, and in 2020 most samples were below or just over 10 µg/L, and the highest concentration was 11.6 µg/L. This well is a significant distance from the institutional control boundary (RV Griffin Reserve boundary) to the south. If arsenic continues to be an issue at M-15, the installation of a new more distal compliance monitoring well should be considered that would be more representative of water quality of the ASR storage zone before stored water leaves the site.
- The Authority continued to increase storage volume in the ASR wellfields in 2020. A total of 284 million gallons (MG) of water was recharged at WF1 and 654 MG was recharged at WF2, for a total recharge volume of 938 MG in 2020. Recovery from WF1 and WF2 was conducted in spring 2020. A total of 179 MG of water was recovered from WF1 and 313 MG was recovered from WF2, for a total of 492 MG of water recovery from the system. Cumulative storage balance in the ASR system at the end of 2020 was approximately 8.2 billion gallons.
- Increasing storage volume at WF1 and WF2 over the past few years has resulted in improvements in water quality during recovery. To maintain water quality in the ASR wells, recovering from the wells in consecutive years without recharging water between the recovery events should be avoided if conditions allow. Data analysis has shown that the starting total dissolved solid (TDS) concentrations is a major factor influencing TDS concentrations at the end of recovery.
- The addition of PTW to the ASR permit should continue to be pursued. Treating the water stored and recovered in the ASR wells once instead of twice will provide a more cost-effective alternative to the Authority for delivering a high-quality water supply to its customers.

- The Authority should consider adding a deeper zone recharge well at WF2 to mitigate the effects of upconing. This is expected to add reliability to the ASR system by improving recovered water quality (ability to recover more water) and may qualify for cooperative funding by the Southwest Florida Water Management District.

SECTION 1

Introduction

The Peace River Manasota Regional Water Supply Authority (Authority) operates a potable water Aquifer Storage and Recovery (ASR) system referred to as ASR Wellfield No. 1 (WF1) and ASR Wellfield No. 2 (WF2). WF1 consists of nine ASR wells located on the Peace River Regional Water Supply Facility (PRF) property and has been in operation since the mid-1980s. Each well has the capacity to inject or recover approximately 1 million gallons per day (mgd). Also in the vicinity of WF1 is a high capacity ASR well, currently inactive, completed into the Avon Park high permeability zone (APHPZ). WF2 consists of 12 ASR wells, each with a capacity of approximately 1 mgd. WF2 is located directly west of the PRF and south of Surface Reservoir No. 1.

Permitting of the Authority's ASR system is under the oversight of the Florida Department of Environmental Protection's (FDEP's) Underground Injection Control (UIC) Program. A water quality criteria exemption (WQCE) was issued February 12, 2013, that waived the arsenic standard in the ASR zone within property under institutional control of the Authority. The WQCE was issued based on the extensive historical dataset collected at the PRF monitoring wells that showed that elevated arsenic concentrations did not extend far from the ASR wells, arsenic concentrations decreased over time, and groundwater exceedances of the arsenic standard did not extend beyond the property under control of the Authority. Supported by the WQCE, a Class V Operation Permit was issued to the Authority on April 24, 2013, for operation of the two wellfields under a single permit. The two wellfields are now operated as one ASR system.

An application for permit renewal was submitted February 19, 2018 requesting the inclusion of PTW as a new source water for the ASR system. The permit renewal is under review, however since the permit application was submitted more than 60 days prior to the expiration of the current permit it was deemed a timely renewal and therefore the operation of the ASR system is permitted to continue under the conditions of the 2013 operation permit while the new permit renewal is being processed. A copy of the most recent Class V Operation Permit is included in **Appendix A**.

Figure 1-1 shows the location of the PRF in southwest DeSoto County, Florida. **Figure 1-2** is a site plan showing the locations of the 21 ASR wells and monitoring well network.

The purpose of this report is to evaluate data collected through 2020 at WF1 and WF2, and to comply with specific condition III.A.2 of operation permit 0136595-014-UO/5Q. **Figure 1-3** presents a site plan showing the locations of WF1 ASR and monitoring wells. **Figure 1-4** presents a site plan of WF2 showing the locations of the ASR wells and associated monitoring wells. **Tables 1-1** and **1-2** provide the well construction details for WF1 and WF2 wells, respectively.

WF1 consists of eight ASR wells completed into the Suwannee Limestone (Suwannee Zone, "S" well names) of the Upper Floridan aquifer (UFA) and one ASR well completed into the Tampa Member of the Arcadia Formation (Tampa Zone, T-1) of the UFA. The final casing depths of the Suwannee Zone ASR wells range from 510 to 650 feet below land surface (bls) and the total well depths range from 623 to 955 feet bls. The Tampa Zone ASR well has an open hole interval from 380 to 482 feet bls. **Figure 1-5** is a cross-section of the WF1 ASR wells and shows well construction details and hydrogeologic intervals intercepted by each well. Previous data analysis reports for WF1 are referenced in the Bibliography, Section 9 of this report.

The 12 ASR wells in WF2 were completed in 2002 into the Suwannee Limestone permeable zone of the UFA. The final casing depths of the ASR wells range from 566 to 621 feet bls and the total original well depths range from 883 to 905 feet bls. **Figure 1-6** is a cross-section of the ASR wells and shows well construction details and hydrogeologic intervals intercepted by each well. The wells were installed in a grid pattern with approximately 300 feet between each ASR well. Cycle testing of WF2 began in June 2002 with an abbreviated cycle test to verify the functionality of the mechanical and instrumentation components. The first significant cycle test, Cycle Test 2, began in July 2002, and was completed in June 2003. Data reports outlining past cycle testing activities are referenced in Section 9 of this report.

An enhanced groundwater monitoring well network was completed in 2005, adding 12 more Suwannee Zone monitoring wells and 1 more Tampa Zone monitoring well at the PRF. Water quality sampling of these wells began prior to Cycle Test 5 and continues today. Data from these and the other ASR monitoring wells are included in Section 4 of this report.

The remainder of the report is organized into the following sections:

- Section 2 – ASR Well Recharge and Recovery Volumes
- Section 3 – ASR Well Capacity Data Evaluation
- Section 4 – Water Quality Data Evaluation
- Section 5 – Water Level Data
- Section 6 – Partially Treated Surface Water ASR
- Section 7 – Summary and Conclusions
- Section 8 – Recommendations
- Section 9 – Bibliography

Data evaluations for WF1 are typically provided first, followed by WF2. Monitoring wells are presented with each corresponding wellfield.

Table 1-1

WF1 ASR Wells and Monitoring Well Construction Details

Well	Casing Diameter (inches)	Casing Depth (feet bls)	Total Depth (feet bls)	Latitude	Longitude	Hydrogeologic Interval
T-1	12	380	482	27 5' 29.04"	82 0' 9.78"	LPZ
S-1	8	570	920	27 5' 27.96"	82 0' 17.28"	Suwannee Zone
S-2	12	570	900	27 5' 29.46"	82 0' 9.24"	Suwannee Zone
S-6	12	580	910	27 5' 17.52"	82 0' 26.34"	Suwannee Zone
S-7	12	575	915	27 5' 11.76"	82 0' 25.2"	Suwannee Zone
S-8	12	510	623	27 5' 22.2"	82 0' 33.3"	Suwannee Zone
S-3R	16	580	769	27 5' 22.2"	82 0' 9.3"	Suwannee Zone
S-5R	16	650	808	27 5' 24.06"	82 0' 16.56"	Suwannee Zone
S-9R	16	580	906	27 5' 16.14"	82 0' 16.26"	Suwannee Zone
E	6	140	200	27 05' 28"	82 00' 06"	UPZ
T-2	4	393	490	27 06' 24"	82 00' 30"	LPZ
M-2	6	596	900	27 06' 24"	82 00' 30"	Suwannee Zone
I-4 (MW-8)	*8*	*205*	*330*	*27 07' 37"*	*82 02' 25"*	*LPZ*
M-4 (MW-5)	*12*	*505*	*800*	*27 07' 37"*	*82 02' 51"*	*Suwannee Zone*
M-6	6	579	640	27 03' 39.6114"	82 01' 19.6979"	Suwannee Zone
I-7	6	220	261	27 05' 21.2475"	82 00' 25.7496"	LPZ
T-7	6	349	400	27 05' 21.1874"	82 00' 25.8985"	LPZ
M-7	6	584	688	27 5.472'	82 0.304'	Suwannee Zone
M-20	6	575	672	27 5.186'	82 0.457'	Suwannee Zone
M-21	6	565	572	27 5.490'	82 0.151'	Suwannee Zone
M-22	6	580	605	27 05' 21.1291"	82 00' 26.0461"	Suwannee Zone

LPZ = lower producing zone of the Intermediate Aquifer System

UPZ = upper producing zone of the Intermediate Aquifer System

Suwannee Zone = refers to the Upper Floridan aquifer permeable unit within the Suwannee Limestone Formation

MW-8 and MW-5 are previous SWFWMD nomenclature

** abandoned*

Table 1-2

WF2 ASR Wells and Monitoring Wells Construction Details

Well	Casing Diameter (inches)	Casing Depth (feet bls)	Total Depth (feet bls)	Latitude	Longitude	Hydrogeologic Interval
S-4	12	570	905	27 05’ 06.1042”	82 01’ 06.4977”	Suwannee Zone
S-10	16	620	906	27 04’ 57.1407”	82 01’ 03.3015”	Suwannee Zone
S-11	16	585	900	27 05’ 00.1137”	82 01’ 03.2584”	Suwannee Zone
S-12	16	600	900	27 04’ 57.1524”	82 01’ 06.6125”	Suwannee Zone
S-13	16	621	898	27 05’ 00.1531”	82 01’ 06.5644”	Suwannee Zone
S-14	16	568	900	27 04’ 57.2286”	82 01’ 09.9465”	Suwannee Zone
S-15	16	583	900	27 05’ 00.2032”	82 01’ 09.8760”	Suwannee Zone
S-16	16	583	902	27 05’ 03.0748”	82 01’ 03.2110”	Suwannee Zone
S-17	16	579	883	27 05’ 06.0299”	82 01’ 03.1812”	Suwannee Zone
S-18	16	592	900	27 05’ 03.1111”	82 01’ 06.5295”	Suwannee Zone
S-19	16	585	900	27 05’ 05.7252”	82 01’ 03.2877”	Suwannee Zone
S-20	16	566	898	27 05’ 03.2466”	82 01’ 02.7664”	Suwannee Zone
T11	6	350	400	27 5.117'	82 1.225'	LPZ
M11	6	570	677	27 5.125'	82 1.222'	Suwannee Zone
M12	6	585	705	27 5.037'	82 1.230'	Suwannee Zone
M13	6	550	670	27 5.108'	82 1.284'	Suwannee Zone
M14	6	575	676	27 5.077'	82 1.187'	Suwannee Zone
M15	6	570	678	27 4.976'	82 1.270'	Suwannee Zone
M16	6	560	673	27 4.988'	82 1.138'	Suwannee Zone
M17	6	565	670	27 5.051'	82 1.074'	Suwannee Zone
M18	6	575	700	27 4.914'	82 1.071'	Suwannee Zone
M19	6	580	680	27 5.100'	82 0.958'	Suwannee Zone
I-8	6	155	190	27 05' 09.3137"	82 01' 19.0732"	UPZ
T-8	12	354	401	27 05' 09.4042"	82 01' 18.5632"	LPZ
M-8	10	570	860	27 05' 09.1883"	82 01' 19.6788"	Suwannee Zone
*I-9**	*12*	*280*	*320*	*27 05' 45.3058"*	*82 01' 36.0568"*	*LPZ*
I-10	6	260	312	27 05' 04.0074"	82 02' 19.8766"	LPZ

LPZ = lower producing zone of the Intermediate Aquifer System Intermediate Aquifer System

UPZ = upper producing zone of the Intermediate Aquifer System

Suwannee Zone = refers to the Upper Floridan aquifer permeable unit within the Suwannee Limestone Formation

** abandoned*

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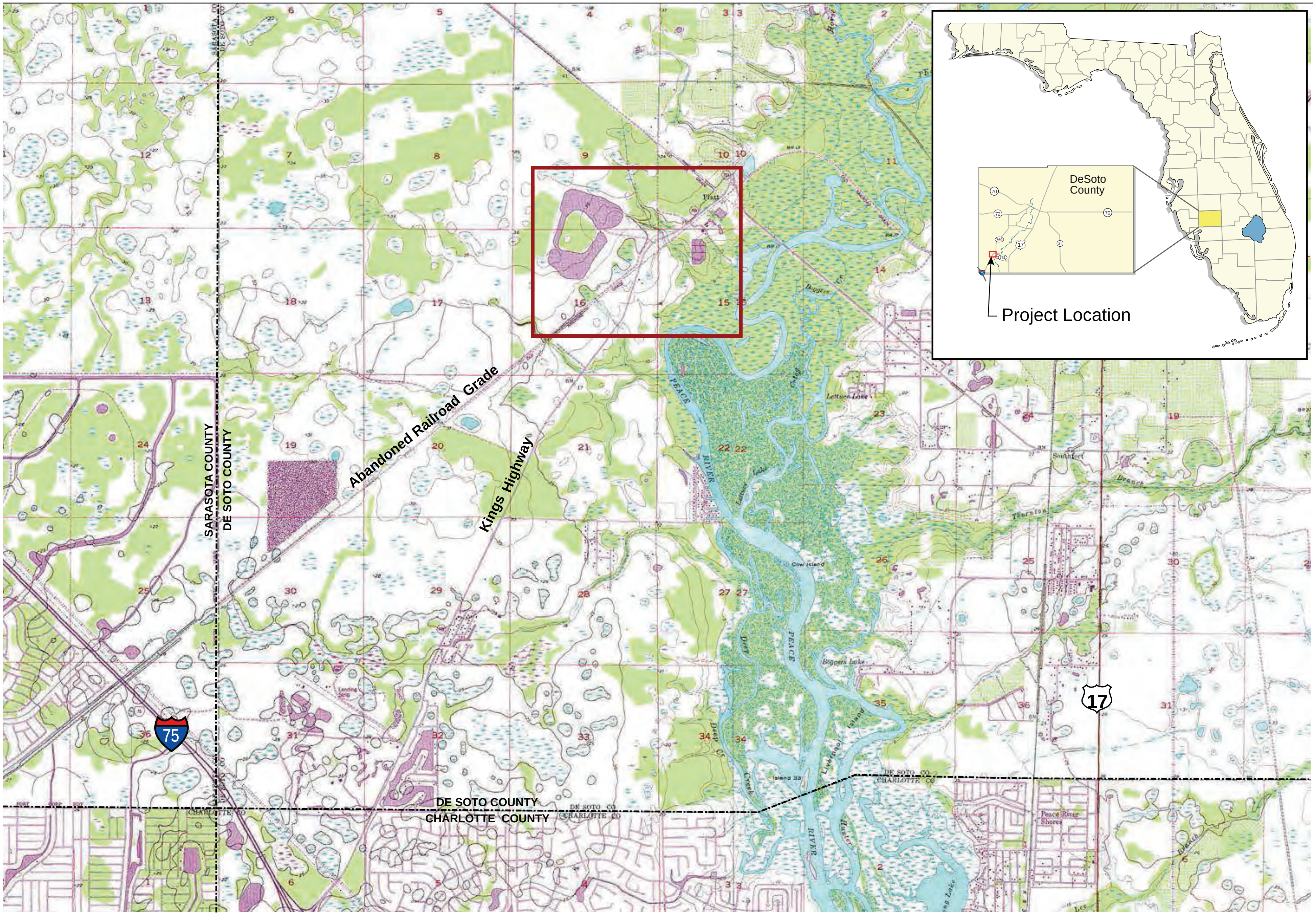


North

0 1/2 1
Scale in Miles

USGS Quad Maps:
Murdock SE, Florida, 1987
Fort Ogden, Florida, 1987

Peace River Manasota Regional Water Supply Authority

FIGURE 1-1
Project Location Map

ASRUS, LLC

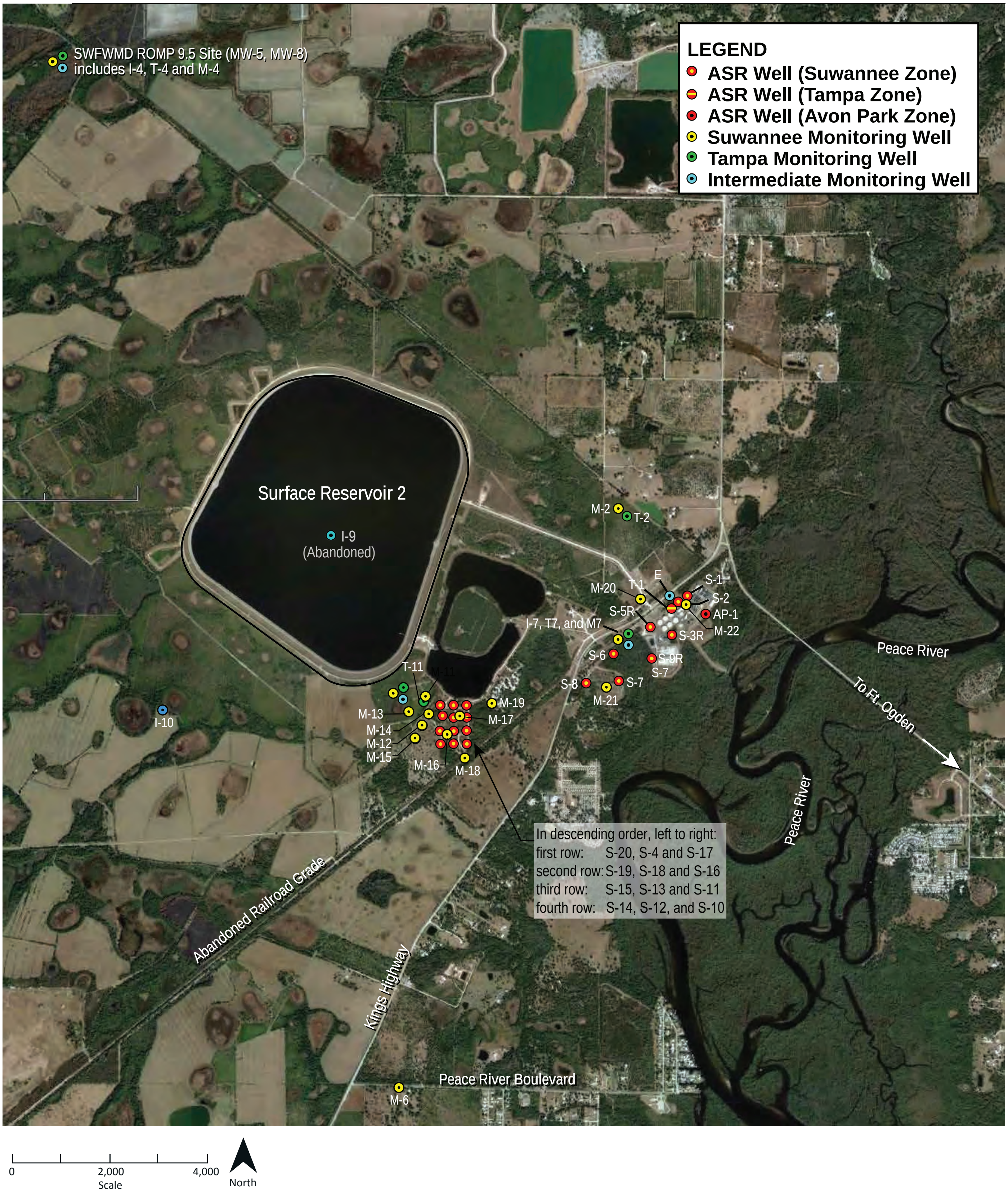
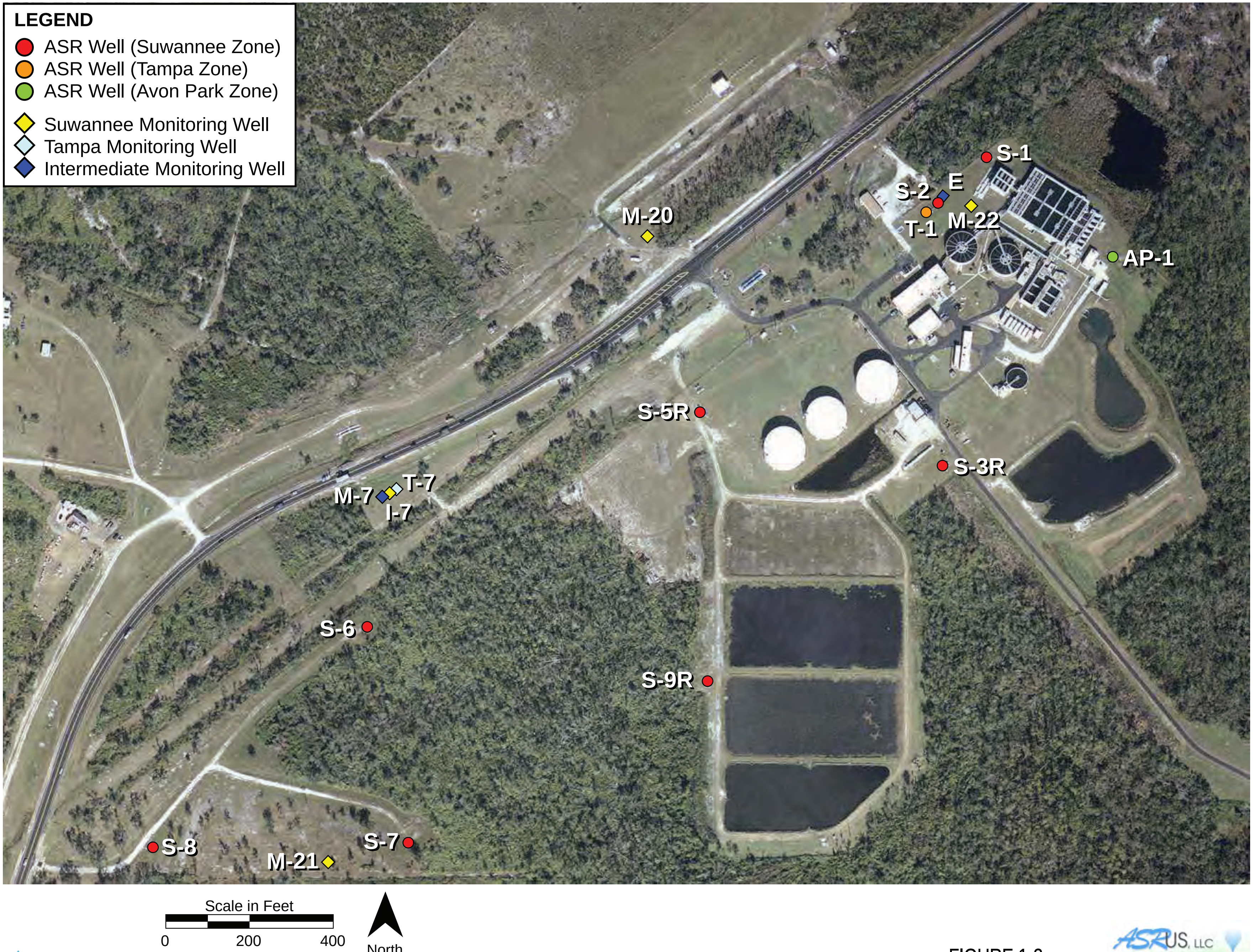


FIGURE 1-2
Peace River Facility ASR Site Plan

Peace River Manasota Regional Water Supply Authority

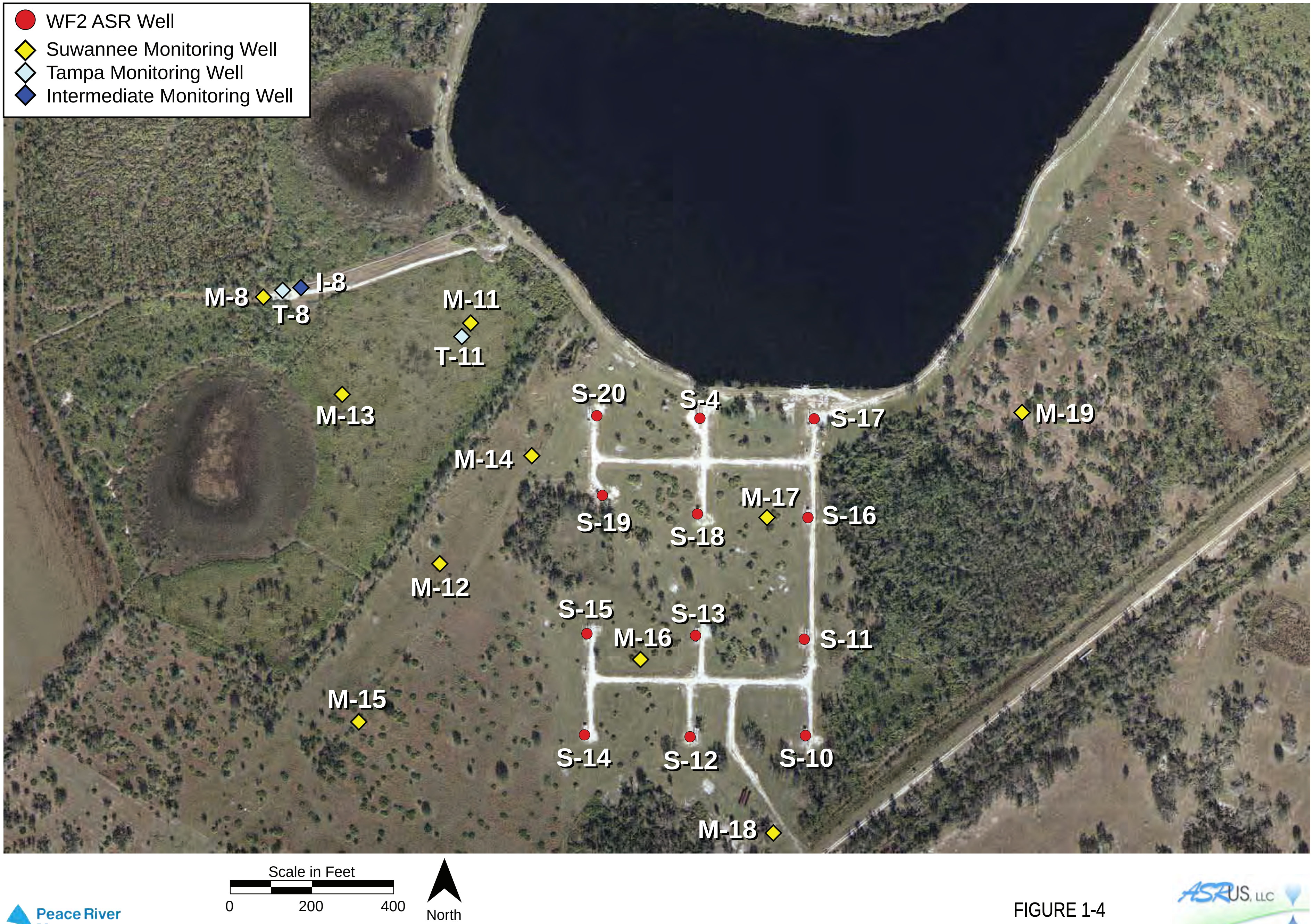
ASRUS, LLC



Peace River Manasota Regional Water Supply Authority

FIGURE 1-3
WF1 Site Plan

ASRUS, LLC



Peace River Manasota Regional Water Supply Authority

FIGURE 1-4
WF2 Site Plan

ASRUS, LLC

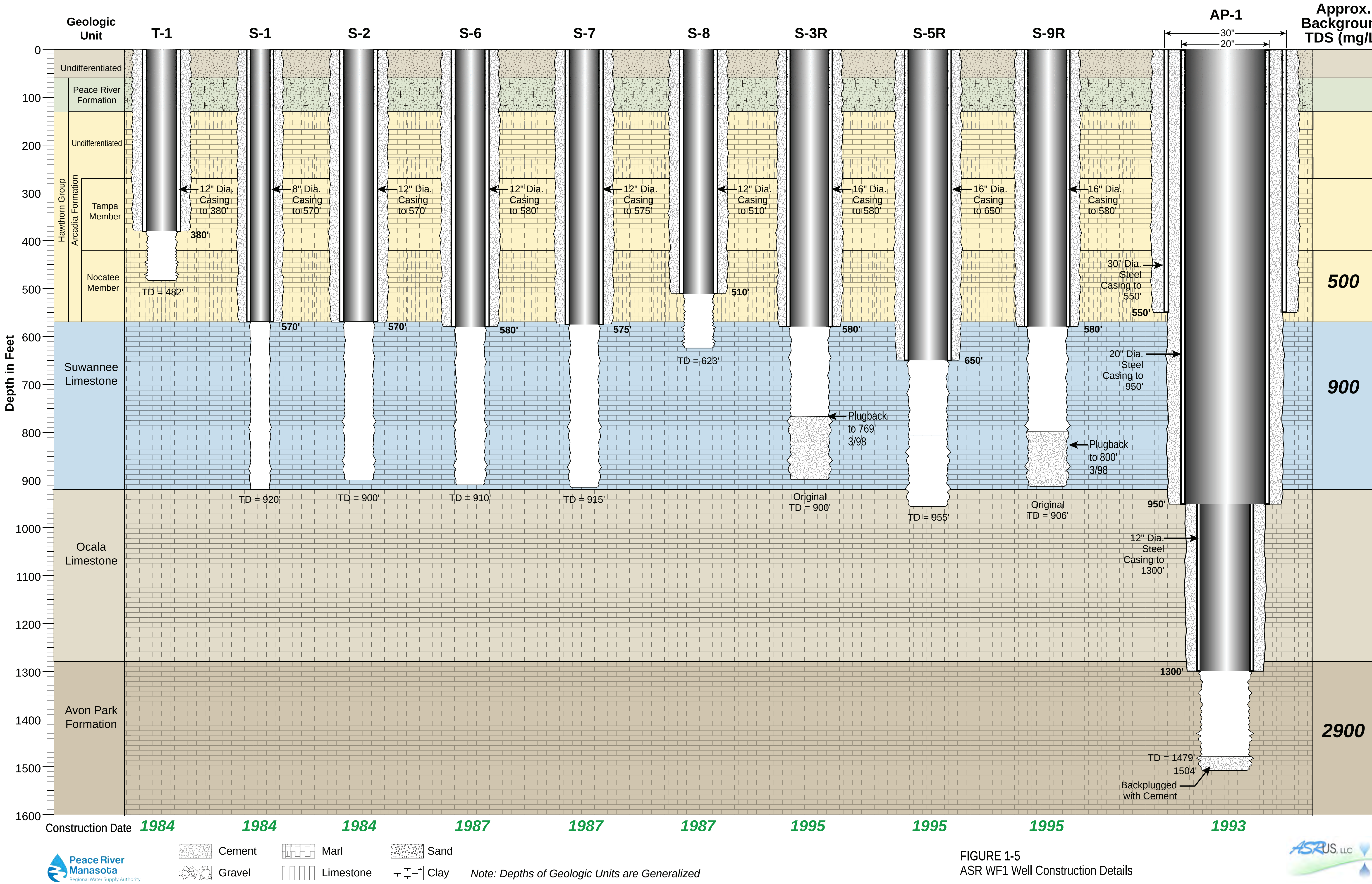
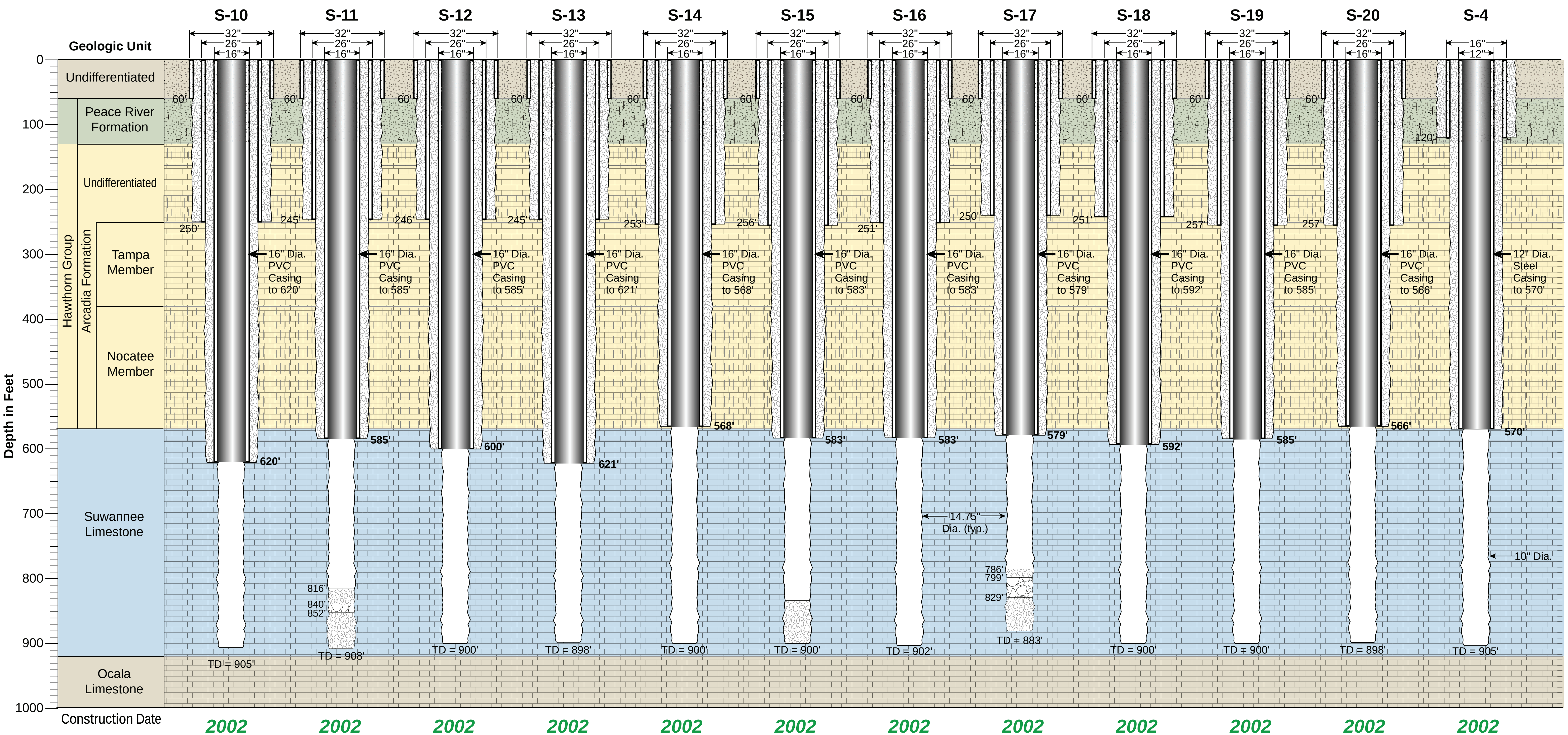


FIGURE 1-5
ASR WF1 Well Construction Details



Cement | Gravel | Marl | Limestone | Sand | Clay

Note: Depths of Geologic Units are Generalized

FIGURE 1-6
ASR WF2 Well Construction Details

SECTION 2

ASR Well Recharge and Recovery Volumes

2.1 Recharge and Recovery Volumes

The ASR wellfields and surface reservoirs at the PRF provide a storage mechanism to meet water demands during the dry season. The recharge and recovery volumes of the wells are subject to many factors that ultimately dictate how and to what capacity the wells are used. Expansions of the PRF in 2009 and 2014 increased treatment capacity from 24 to 48 mgd and from 48 to 51 mgd, respectively, providing a significant amount of treatment capacity available to recharge the ASR system. The addition of Surface Reservoir No. 2 in 2009 provided the Authority with adequate storage capacity to meet typical dry-season demands with limited dependence upon the ASR system except during extreme droughts. The ASR wells now serve to supplement the surface reservoirs and improve reliability in the Authority's water storage management strategy.

Prior to April 24, 2013, WF2 was regulated under an FDEP UIC construction permit, which required cycle testing. A typical cycle test consisted of a recharge period during the wet season, a storage period, and a recovery period during the subsequent dry season. During cycle testing, the Authority attempted to maintain the volumes listed in the FDEP construction permit, but that was possible only when the availability of water and system demands allowed. During severe water shortages, such as those the region faced in 2006, 2007, and 2009, the ASR system was used as needed to meet the water demands of the public; therefore, cycle test targeted recovery volumes were exceeded. This is no longer an issue because in 2013, WF1 and WF2 were both permitted under a single operation permit (0136595-014-UO/5Q) that does not require a formal cycle testing program.

WF1 has been regulated under an operation permit since August 2008. Prior to that it was operated under an "authorization to use" permitting mechanism. Both of these permits offered greater flexibility in the operation of the wellfield than the construction permit that WF2 operated under prior to April 2013. This allowed the Authority to use WF1 to supply water during short intermittent periods of high demand or to store water during short-term water supply surplus periods without being overly restricted by the operational limits of a cycle test plan.

Figures 2-1 and **2-2** show the historical recharge minus recovery balance and the effective storage volume from WF1 and WF2, respectively. The cumulative recharge/recovery balance is the total amount of recharge minus the total amount of recovery. The effective storage volume is the amount of water stored. The distinction between the two is that the effective storage volume does not calculate negative recovery volumes since once all of the stored water is removed the "negative" is assumed to be native groundwater and its inclusion in the calculation of storage does not accurately reflect the volume of subsequent water stored. Once the storage balance becomes negative (native groundwater) the amount in storage is considered to be zero for the calculation of effective storage volume.

WF1 has been in operation since the mid-1980s. During its existence, the volume of storage at WF1 has been greater than the volume of recovered water. However, drought years between 2000 and 2001 and 2006 and 2009 are evident as higher recovery volumes were recorded during these periods. During 2020, a total of 284 million gallons (MG) of water was recharged at WF1 and 179 MG was recovered. At the end of 2020, approximately 2,058 MG of potable water remained in storage at WF1. Since WF1 has always maintained a positive storage balance there is no graph of "effective storage" since it is the same as the recharge minus recovery balance for WF1.

WF2 has been in operation since 2002. The operation permit was issued in April 2013 during the middle of the Cycle 12 recovery. The Cycle 12 recovery period ended on June 5, 2013. For the purposes of this report, the cycle testing period of this wellfield will include Cycles 1 through 12 recovery events.

Subsequent recharge and recovery events will be referred to by the event (recharge or recovery) and the year that the event occurred. During cycles 1 through 12, approximately 7,672 MG of water was recharged, and approximately 7,489 MG was recovered. Due to the drought conditions from 2006 to 2009, water available for recharge was limited and demand was high, resulting in lower recharge volumes and higher recovery volumes than typical, ultimately resulting in full recovery of all water stored in WF2 during that period. From the end of cycle testing in June 2013 through 2018, approximately 6,457 MG of water was recharged at WF2 and only 1,669 MG was recovered. In 2019, a total of 588 MG of water was recharged at WF2 and only 72 MG was recovered. In 2020 a total of 654 MG of water was recharged and 313 MG recovered at WF2. The cumulative recharge/recovery balance at WF2 at the end of 2020 was approximately 6,120 MG, and the effective storage volume was 7,172MG.

Figure 2-3 is a graph showing the cumulative recharge/recovery balance and the effective storage volume of WF1 and WF2. This shows that the ASR system historically has maintained a positive storage balance through most of its operation. The combined wellfields exhibited a negative recharge/recovery balance in 2009 and 2010 as a result of surplus withdrawal from WF2. At the end of 2020, the Peace River ASR system had a recharge/recovery balance of approximately 8,178 MG and an effective storage volume of 9,230 MG.

2.2 Rainfall Data

Rainfall data for the PRF are shown on **Figure 2-4**. Monthly rainfall totals (upper graph) and annual rainfall totals (lower graph) are shown for the period from January 2002 through December 2020. The seasonal variation of rainfall is clearly evident on the monthly rainfall graph. Highest monthly rainfall totals typically are recorded from June through September each year, whereas the drier months are typically October through May. From 2002 to 2020, annual rainfall at the PRF ranged from 33 to 66 inches and averaged 55 inches. Rainfall in 2006, 2007, 2009, and 2010 represented below average rainfall conditions, with 2007 having the most significant rainfall deficit (22 inches below the average over the period of record [POR]). From 2011 to 2014, rainfall increased each year and averaged 55 inches over that four-year period. During 2015, the annual rainfall decreased marginally to approximately 54 inches, slightly below the average over the POR. The highest annual rainfall over this period occurred in 2016 with a record of 66 inches.

Rainfall in 2020 was slightly below the average over the POR, with approximately 52 inches of rainfall. March was the driest month and August was the wettest month, with 0.5 and 9 inches of total monthly rainfall, respectively. Annual rainfall totals over the past five years have been higher than the historical average. From 2002 to 2015, the average annual rainfall was 53 inches. From 2016 through 2020, the average annual rainfall total was 59 inches.

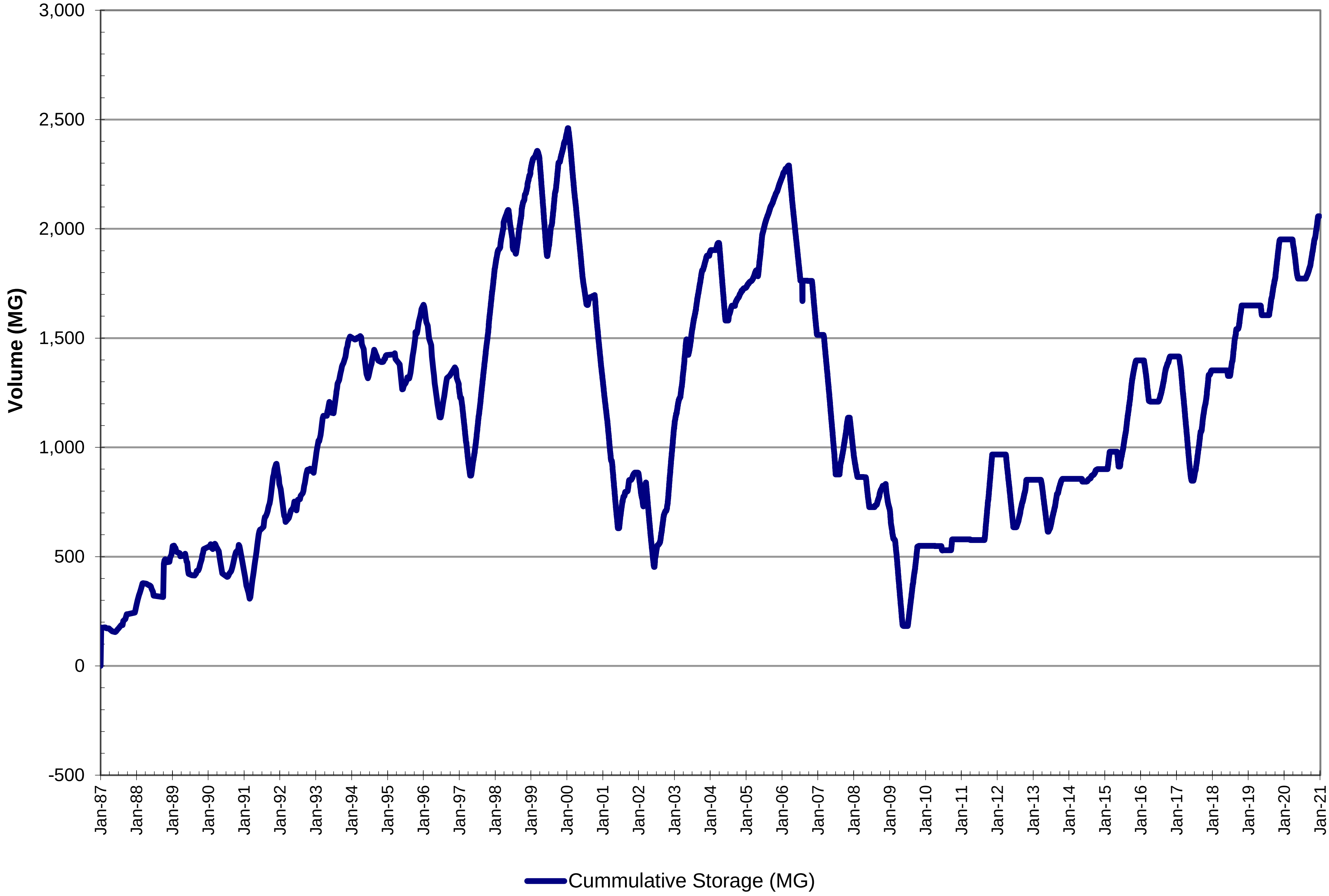


Figure 2-1

WF1 Historical Cumulative Storage Summary

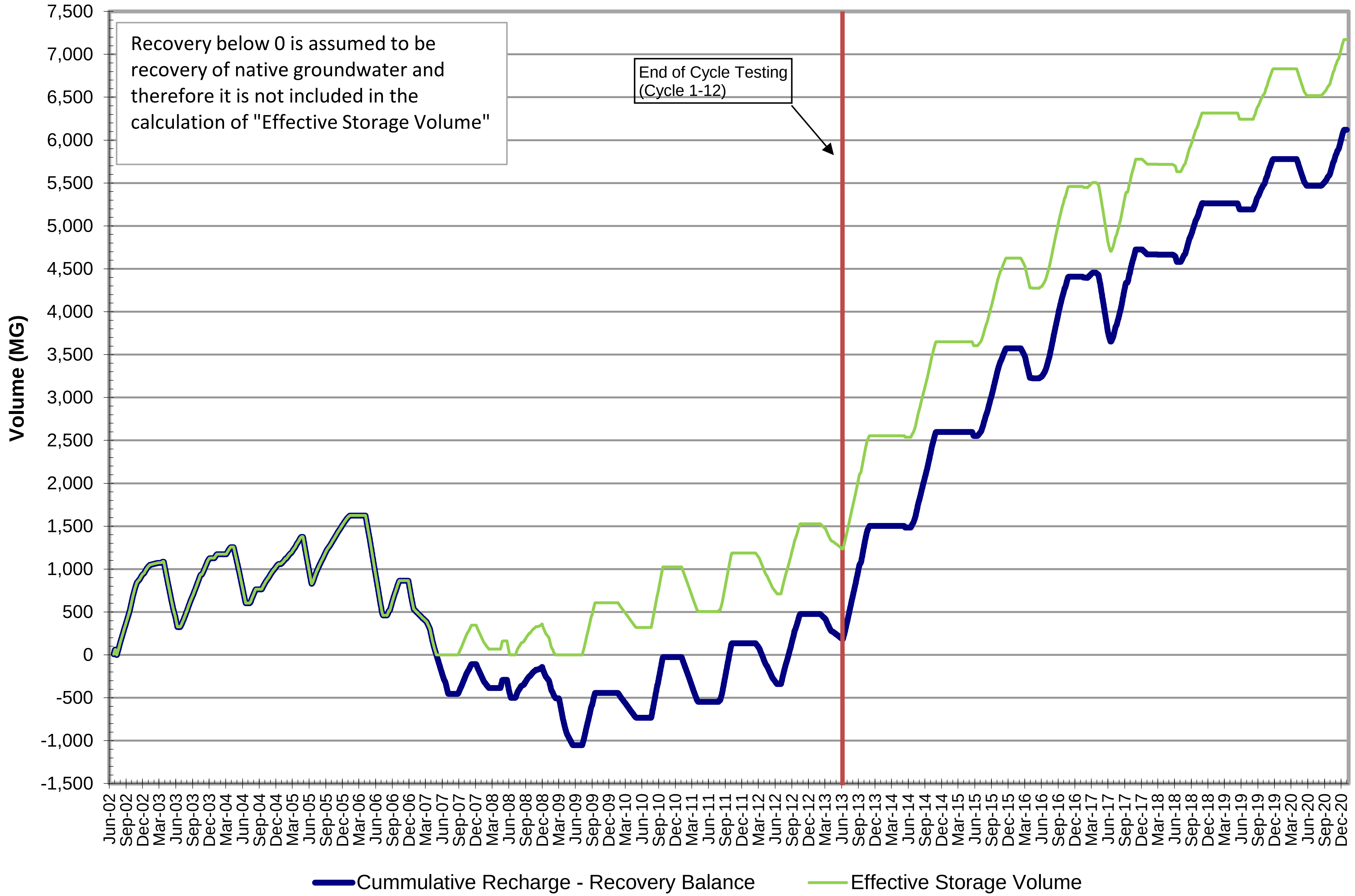


Figure 2-2
WF2 Historical Cumulative Storage Summary

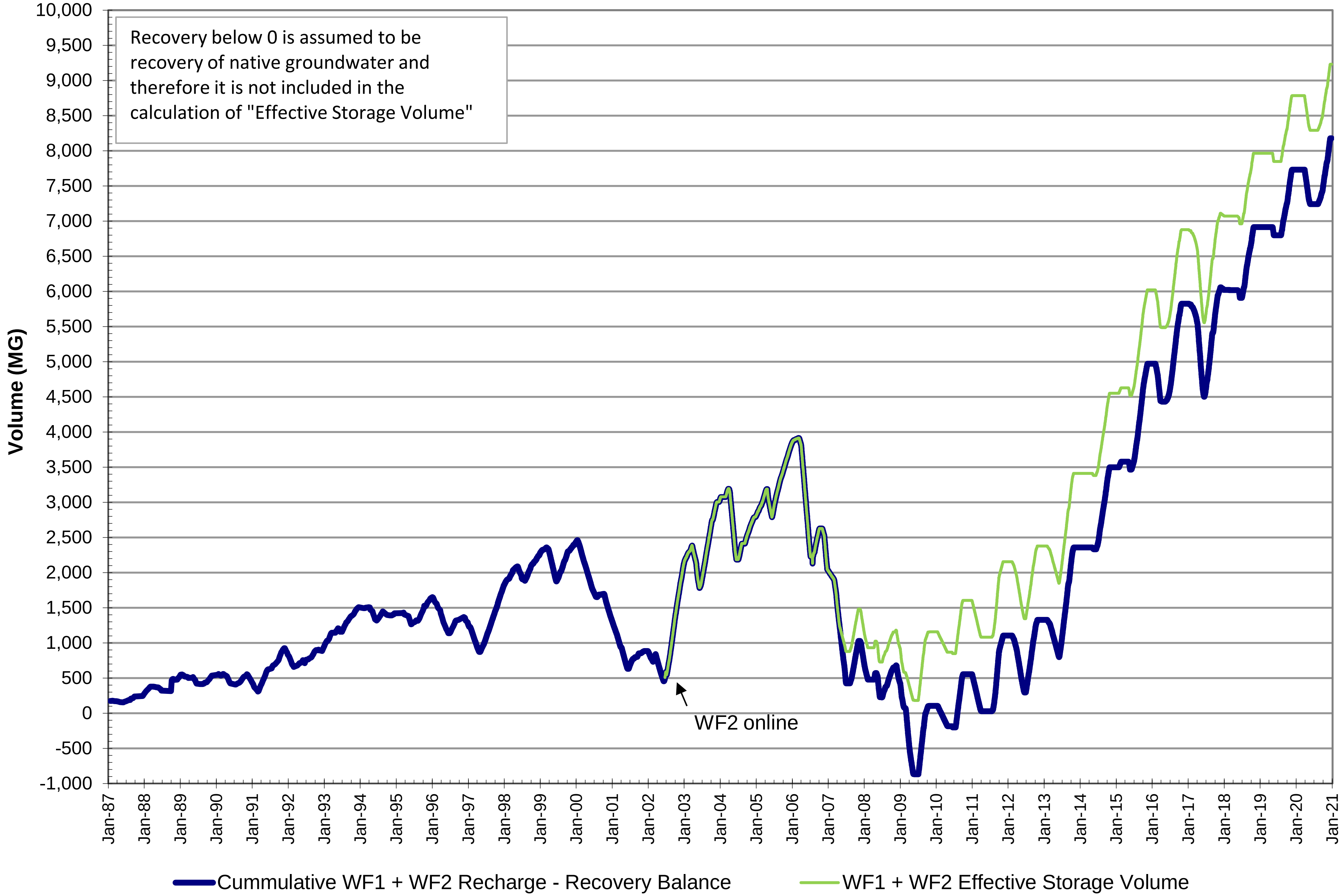
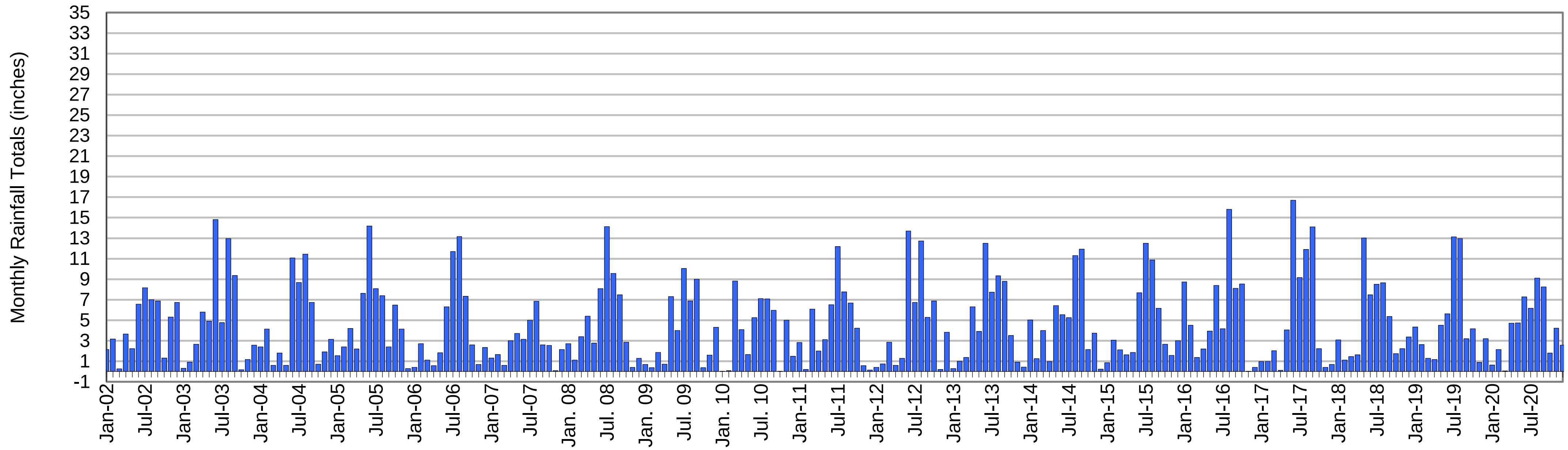


Figure 2-3

Peace River ASR (WF1 and WF2) Cumulative Historical Storage Summary



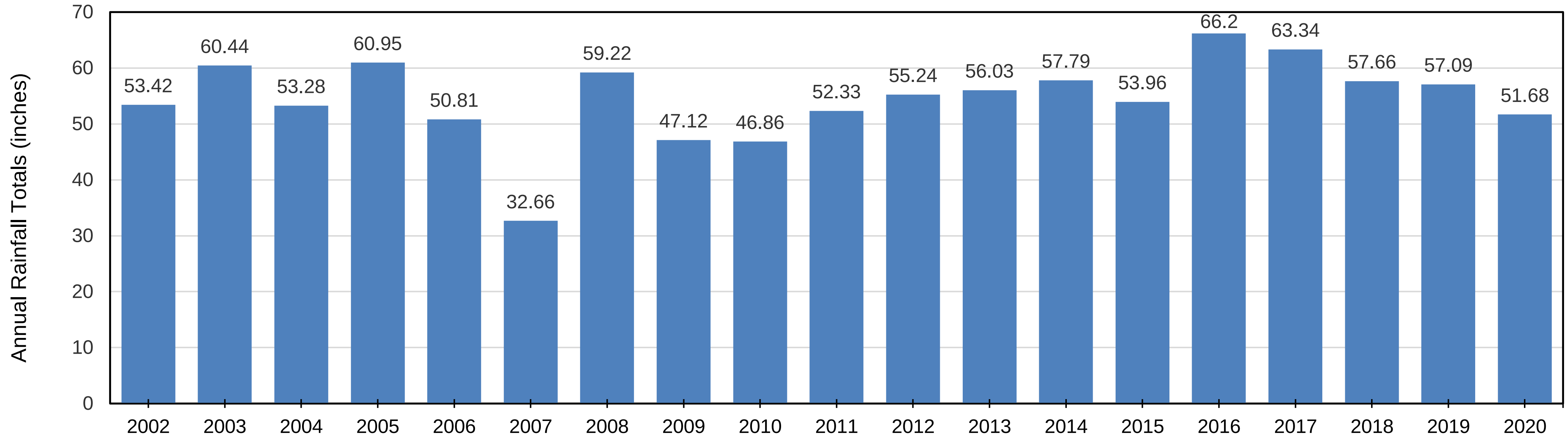


Figure 2-4
Monthly and Annual Rainfall Totals
SWFWMD Station ID: 24573

SECTION 3

ASR Well Capacity Data Evaluation

3.1 Overview

Performance of the ASR wells is evaluated in terms of specific injectivity (SI) during recharge and specific capacity (Q/s) during recovery. SI is calculated as the flow rate into the well divided by the resulting change in water level (head pressure). Q/s is the pumping rate (Q) divided by the change in water level (s, drawdown). Both values are recorded in units of gallons per minute per foot (gpm/ft) of drawdown or rise. The starting (static) water level used to calculate the change in water level is the last recorded water level measurement available from a period of no activity in the wellfield. Changes in water levels are measured during ASR operations generally when all wells or multiple wells are pumping/injecting simultaneously; therefore, the actual Q/s and SI values (if the well was operated independently) are greater than what is reported. Fluctuation in well and wellfield flow rates and water level changes attributed to well interference significantly affect the Q/s and SI and make it difficult to accurately assess the relative change in a well's performance from year to year. Nonetheless, these data are useful in evaluating general trends in well performance and providing a comparative analysis among the wells.

The following paragraphs provide a summary of the Q/s and SI data for WF1 and WF2. A detailed analysis of the historical SI and Q/s data recorded at each ASR well was provided in the 2007 annual report titled *Data Analysis for the Peace River Facility ASR System Including Wellfield 2 Cycle Test 6* (CH2M HILL and ASRus, 2008). This report will focus on general trends in well capacity performance, highlighting any significant changes noted over the past year. Figures showing the historical Q/s and SI data for each well are provided at the end of this section.

3.2 ASR WF1 Well Capacity Summary

Table 3-1 provides a summary of the SI and Q/s data for the nine operational ASR wells in WF1. Early data are compared to more recent data to evaluate changes in well capacity. The wells with the highest capacity at WF1 are S-8, S-9R, S-2, and T-1. The remaining wells have similar well capacities with SI and Q/s in the 3 to 14 gpm/ft range. Slight differences in SI and Q/s are observed between the 1997 data and the 2020 data that likely are due to variability in flow rates, recharge/recovery duration, and/or number of wells in operation. These minor differences are not considered significant and do not suggest a substantial change in well performance.

Figure 3-1 shows the SI data for each well, comparing earlier data to 2020. The SI generally has been consistent at most of the ASR wells, suggesting that well plugging is not occurring at WF1. Variability in the SI at wells S-8 and S-9R is believed to be related to the sensitivity of these high capacity wells to fluctuating flow rates and overall wellfield flow rates, and not actual changes in the wells' capacity. ASR well S-3R was out of service during the 2020 recharge period and ASR wells S-5R and S-9R had a brief recharge period. SI data for S-9R was not included as the transducer appeared to be malfunctioning. The recorded water level data appeared to be abnormally low during the recharge period.

Figure 3-2 shows the Q/s data from each of the wells during 2002, 2018, 2019, and 2020 recovery. The Q/s data in 2020 generally were similar to earlier Q/s data, suggesting that no discernable decline in well performance has occurred.

Appendix B (B-1 through **B-9)** shows the historical SI and Q/s data for each of the WF1 ASR wells. The data values for SI and Q/s generally vary over a wide range, and occasional changes are observed. However, these changes likely are not indications of increasing or decreasing well capacity. Rather, they are likely the result of other factors including fluctuating flow rates in the well, overall wellfield flow rate changes (well interference), natural seasonal changes in the aquifer's potentiometric head, and drift or errors in the water level transducer readings. The general consistency of the SI and Q/s data set from year to year suggests that no significant decrease in well performance has occurred over the POR at the ASR wells in WF1.

3.3 ASR WF2 Well Capacity Summary

Table 3-2 provides a summary of SI and Q/s data for the ASR wells in WF2. Data from the beginning of cycle testing are compared to the most recent data to evaluate changes in well capacity. With the exception of wells S-11 and S-17, which were partially back-plugged in 2007, the SI data were similar to slightly higher than earlier data. The highest SI values are observed at wells S-19 and S-20. The SI of these wells are approximately two times higher than the other wells in WF2. The Q/s values of the wells were also similar to slightly higher than the earlier data.

Figure 3-3 shows the SI data for each well comparing earlier data to 2020. The graph represents the average SI selected during a period of consistent flow rates. The SI data in 2020 are similar to historical data, suggesting that significant well plugging is not occurring at WF2. Wells S-11 and S-17 both have values lower than they did in 2002, which is attributed to the partial back-plugging of those wells in 2007. **Figure 3-4** shows the Q/s data from each of the wells during 2003, 2016, 2018, 2019, and 2020 recovery. The Q/s data in 2020 are similar to earlier Q/s data in most of the wells and showed a slight increase in Q/s compared to the previous years. The Q/s is significantly lower in S-11 and S-17 from the early data as a result of the wells being partially back-plugged in 2007. Based on the Q/s data from 2020 no significant plugging of the wells is observed.

Appendix B (Figures B-10 through **B-21)** shows the historical SI and Q/s data for each of the WF2 ASR wells.

TABLE 3-1
Summary of Specific Capacity and Specific Injectivity Data – WF1

Well No.	1997 SI	2018 SI	2019 SI	2020 SI	1997 Q/s	2018 Q/s	2019 Q/s	2020 Q/s
T-1	10-28	11-20	15-26	11-19	12-20	18-19	21-18	17-22
S-1	3-6	4-9	4-7	2-4	10-15	NA	7-8	7-11
S-2	15-35	16-53	20-39	11-35	25-35	27-31	23-30	26-33
S-6	8-13	10-20	12-27	9-13	11-14	NA	NA	10-12
S-7	5-10	7-9	8-28	6-9	7-13	9-10	12-8	6-9
S-8	30-140	30-91	50-122	33-68	70-150	73-84	50-93	51-165
S-3R	NA	4-8	6-9	NA	NA	5	NA	5-6
S-5R	2-4	5-8	8-11	2-7	NA	11-12	10-12	11-20
S-9R	NA	25-136	NA	NA	NA	75-85	NA	NA

1997 Wellfield Injection Rate 2-4 MGD
1997 Wellfield Recovery Rate 2-4 MGD
2018 Wellfield Injection Rate 1-5 MGD
2018 Wellfield Recovery Rate 2-4 MGD
2019 Wellfield Injection Rate 1-5 MGD
2019 Wellfield Recovery Rate 2-4 MGD
2020 Wellfield Injection Rate 2-4 MGD
2020 Wellfield Recovery Rate 1-5 MGD
SI and Q/s = gpm / foot of water level change
NA – data not available or transducer malfunction

TABLE 3-2
Summary of Specific Capacity and Specific Injectivity Data – WF2

Well No.	2002 SI	2018 SI	2019 SI	2020 SI	2003 Q/s	2018 Q/s	2019 Q/s	2020 Q/s
S-4	1-6*	1-9	9-11	7-18	6-7	7-9	6-14	2-18
S-10	2-7	7-10	7-11	7-13	4-7	6-7	7-9	7-12
S-11	9-19	3-5	2-7	3-4	11-15	2	3-4	4-5
S-12	2-4	8-13	6-10	6-12	4-6	3-4	6-8	7-10
S-13	2-7	4-14	5-14	8-14	4-7	8	8-11	9-15
S-14	2-6	8-13	4-16	6-14	5-9	9-10	10-13	9-16
S-15	1-4	7-13	8-15	7-15	5-8	8	8-10	8-11
S-16	1-5	5-8	5-10	4-16	5-8	NA	5-9	2-11
S-17	34-80	10-13	9-16	10-18	51-73	8	9-11	9-16
S-18	1-5	5-10	5-24	8-12	6-8	5	8-12	2-14
S-19	14-35	15-25	16-30	15-38	24-35	17-23	19-27	23-56
S-20	5-10	15-25	17-31	17-30	13-19	18-27	19-26	20-36

*Data from 2003 used in lieu of 2002 because there is no data or limited data available during 2002 recharge.
2002 Wellfield Injection Rate 1-10 MGD
2003 Wellfield Recovery Rate 7-11 MGD
2018 Wellfield Injection Rate 1-7 MGD
2018 Wellfield Recovery Rate 1-7 MGD
2019 Wellfield Injection Rate 1-10 MGD
2019 Wellfield Recovery Rate 3-7 MGD
2020 Wellfield Injection Rate 1-9 MGD
2020 Wellfield Recovery Rate 2-9 MGD

SI and Q/s = gpm / foot of water level change
NA – data not available or transducer malfunction

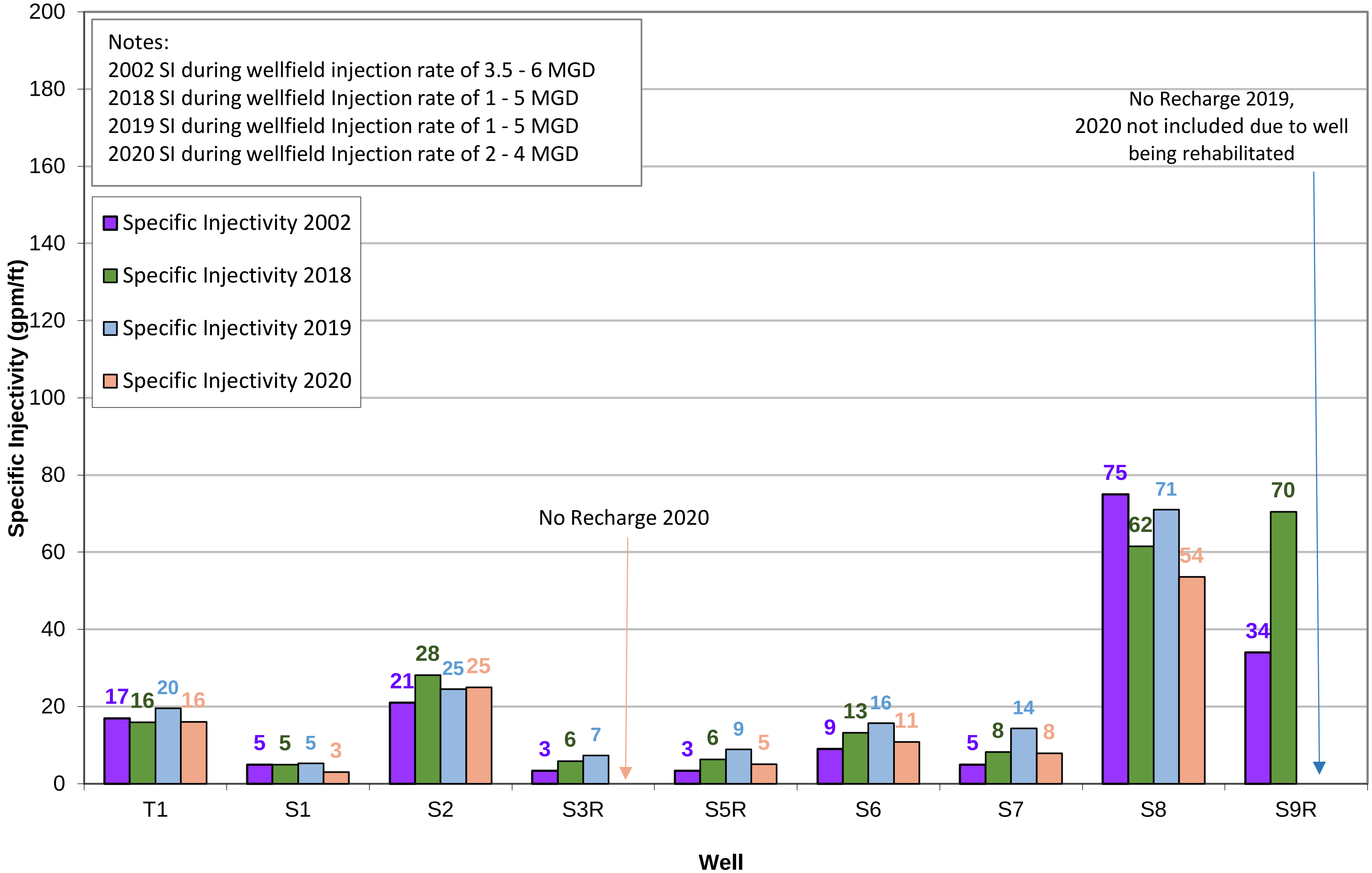


Figure 3-1
WF1 Specific Injectivity Summary

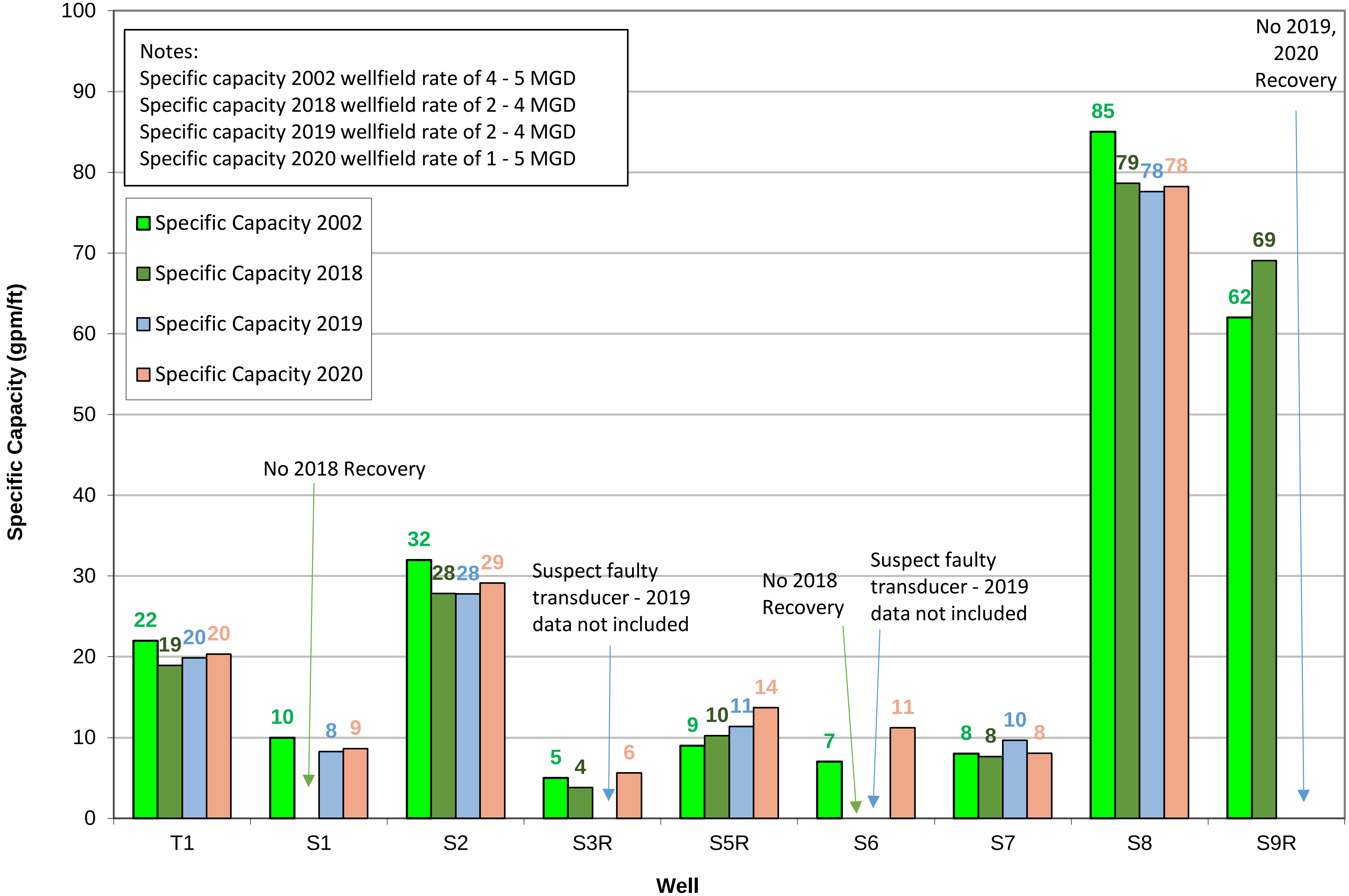


Figure 3-2
WF1 Specific Capacity Summary

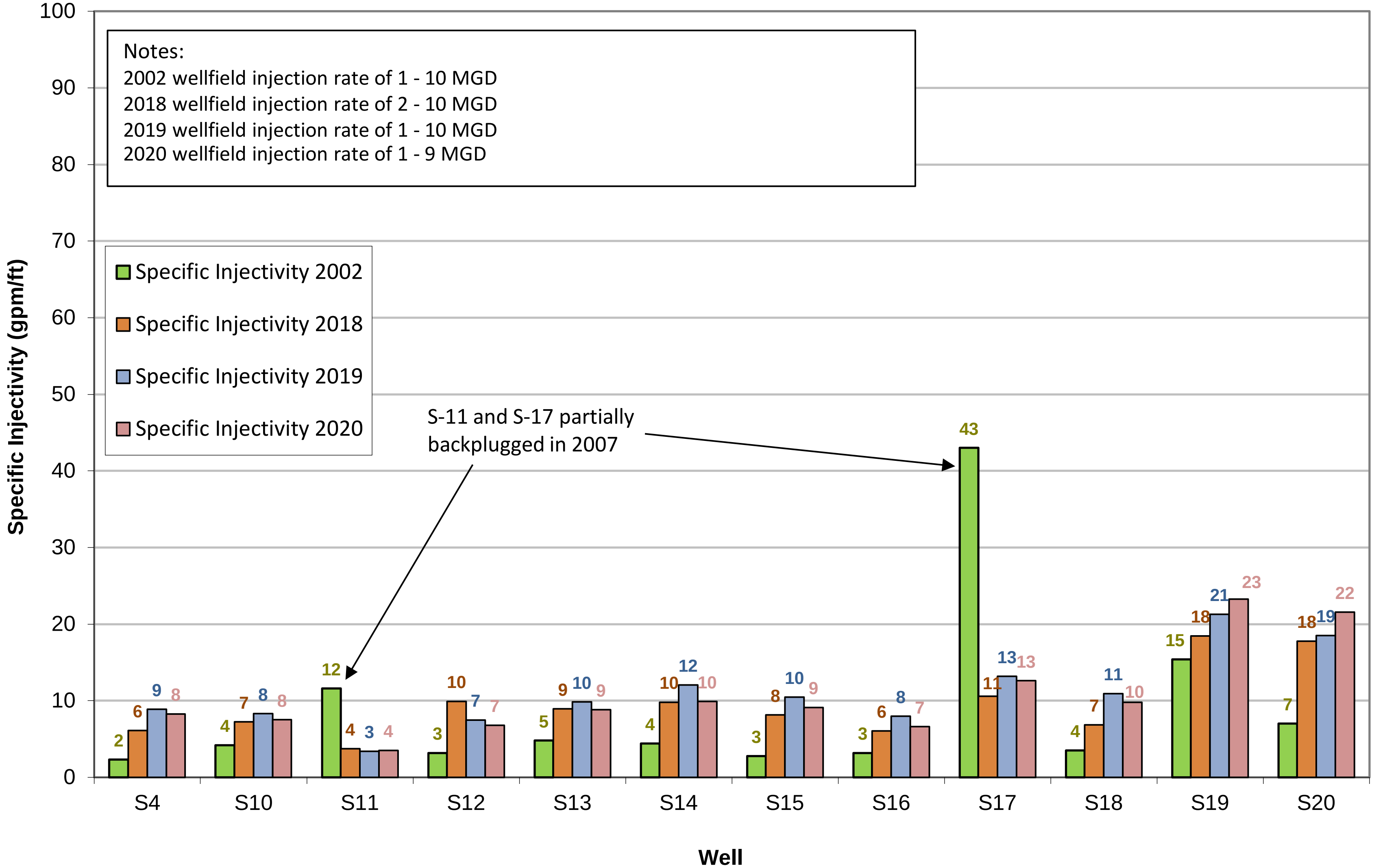


Figure 3-3

WF2 Specific Injectivity Summary

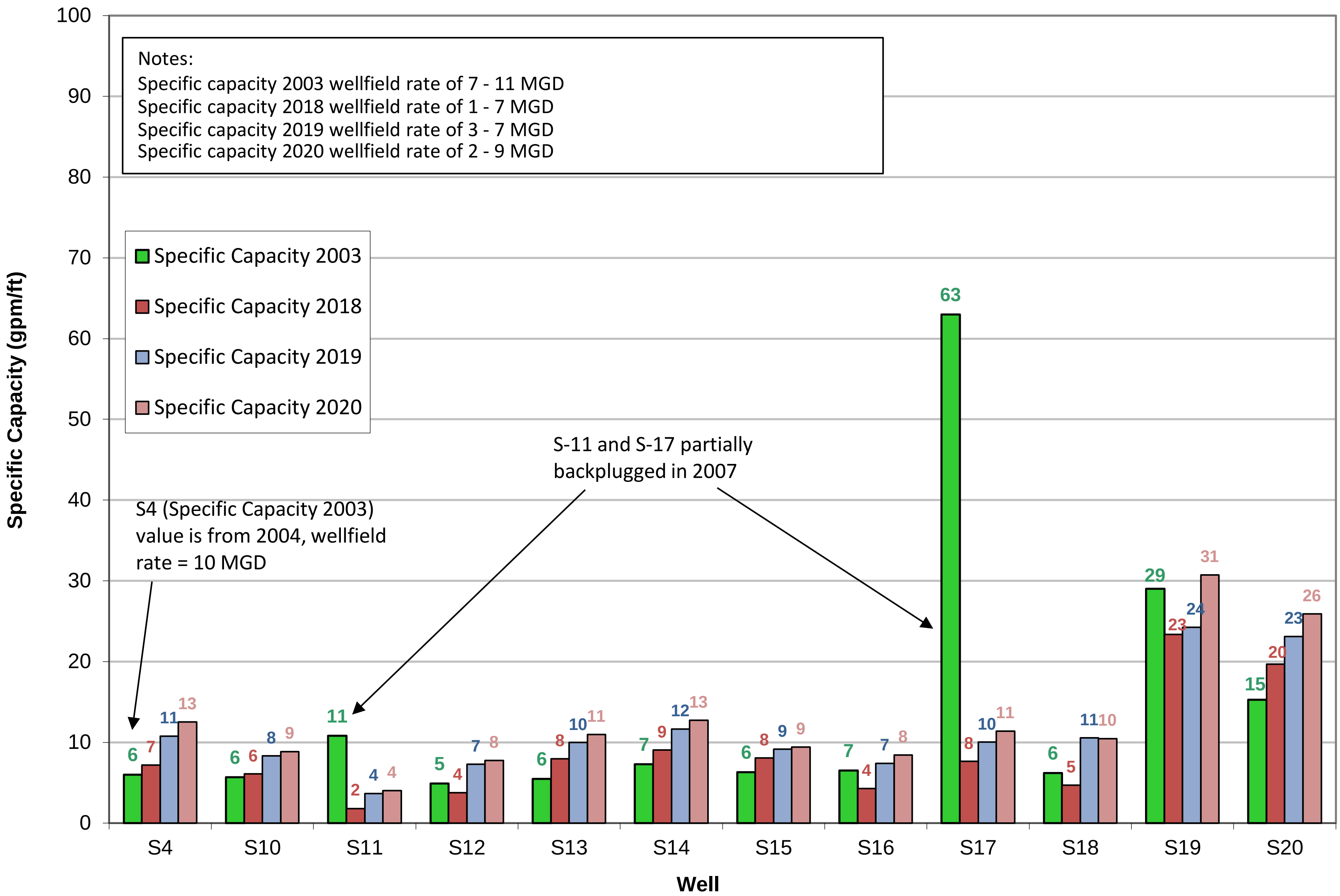


Figure 3-4
WF2 Specific Capacity Summary

Water Quality Data Evaluation

The Authority collects water samples for laboratory analysis from the ASR wells and monitoring wells in accordance with UIC permit requirements. This section presents water quality information for the finished water (potable water source), ASR wells, and monitoring wells, focusing on the water quality parameters that are of most interest. These are salinity parameters (such as total dissolved solids [TDS], chloride, and sulfate) and arsenic, which has been shown to mobilize from the host rock in response to ASR operations. All tables and figures referenced in Section 4 are located at the end of the section. Additional water quality tables containing the data from which the graphs were constructed are provided in **Appendix C**.

4.1 ASR Wells Water Quality Data

4.1.1 Finished Water Quality

Appendix C contains a table summarizing the water quality of the finished water (water stored in the ASR wells) from 2020. Water stored in the ASR wells is potable water treated at the PRF that meets primary and secondary drinking water standards. **Figure 4-1** is a graph of selected finished water quality parameters from 2006 through 2020 showing TDS, chloride, sulfate, total alkalinity (through 2012), and dissolved oxygen. The graph shows the seasonal fluctuations in finished water quality from the PRF. Only finished water during ASR recharge events is shown since 2010. Finished water quality has been consistent since 2010 because of the addition of the 6-billion-gallon Regional Reservoir. TDS concentration of the recharge water in 2020 ranged from 272 to 290 milligrams per liter (mg/L), and chloride concentrations ranged from 30 to 37 mg/L, both slightly higher than the previous year’s TDS and chloride ranges of 249 to 266 mg/L and 30 to 33 mg/L, respectively. Overall, the quality of the recharge water in terms of salinity was excellent in 2020.

4.1.2 WF1 ASR Water Quality Data

4.1.2.1 ASR Well T-1

Figures 4-2 and **4-3** present recovered water quality data including TDS, chloride, sulfate, and arsenic versus cumulative storage volume for ASR well T-1 from 1987 through 2020. The individual well volume is shown in each of the WF1 water quality graphs rather than the cumulative wellfield storage volume as shown in the WF2 ASR graphs. Since the wells in WF2 are all within close proximity of one another, they are assumed to operate like a system, with injected and recovered water coalescing among the ASR wells, whereas WF1 wells are more spread out and are therefore more influenced by their individual well storage volumes.

Recharge water TDS is also shown on **Figure 4-2** for this period to illustrate the historical fluctuation in recharge TDS concentrations over the POR. During the POR, well T-1 has had a positive storage balance, fluctuating between approximately 58 and 302 MG. The stored volume at the end of 2020 was approximately 237 MG, which is 20 MG more than the volume stored at the end of 2019.

TDS, chloride, and sulfate concentrations increase during recovery events. TDS concentrations of the recovered water during the POR have ranged from approximately 230 to 556 mg/L, and from 274 to 290 mg/L during the recovery period in 2020. Chloride concentrations typically have ranged from approximately 30 to 100 mg/L. Sulfate concentrations have ranged from approximately 100 to 206 mg/L. Arsenic concentrations have been less than 10 micrograms per liter (µg/L) since 2009. There are no discernible trends indicating long-term increases in salinity or arsenic concentrations. During the recovery period in 2020, the initial concentrations of TDS, sulfate, and chloride were relatively low compared to earlier cycles, likely a result of a relatively short recovery period in 2019 and lower salinity of the recharge water. In 2020, arsenic concentrations continued to be low, and ranged from below method detection level (BMDL) of 0.5 to 1.8 µg/L.

4.1.2.2 ASR Well S-1

Figure 4-4 shows recharge and recovered TDS concentrations versus cumulative storage volume for ASR Well S-1 from 1987 through 2020. Well S-1 had approximately 481 MG in storage at the end of 2020, which is an increase of approximately 3 MG from storage at the end of 2019. As with each of the ASR wells, salinity increases at well S-1 during recovery events, as shown on **Figures 4-4** and **4-5**. Historically, the TDS concentration during recovery appears to have an overall increasing trend through 2009. TDS concentrations have been more stable and actually decreased since then; however, recovery has been minimal, and recharge has increased during this period.

The overall chloride and sulfate concentrations increased during successive recovery events in 2006, 2007 and the extended recovery event in 2017, but the rate of increase was similar for each recovery event. Starting TDS, chloride, and sulfate concentrations in 2019 were unexpectedly higher than the initial starting concentrations during more recent recovery events in 2016 and 2017. Recovery salinity parameters for 2020 see a return to lower initial concentrations, proving the higher initial concentrations of 2019 an abnormality. TDS concentrations in 2020 ranged from 268 to 326 mg/L during the recovery period. Arsenic concentrations at well S-1 have been below 10 µg/L since June 2013. Arsenic concentrations from the 2020 recovery event ranged from BMDL of 0.5 µg/L to 0.9 µg/L.

4.1.2.3 ASR Well S-2

Figure 4-6 shows recharge and recovered TDS concentrations versus cumulative storage volume for ASR well S-2 from 1987 through 2020. Well S-2 had approximately 200 MG in storage at the end of 2020, which is approximately 31 MG more than the volume stored at the end of 2019. Historically, an increasing trend in the TDS concentration of the recovered water has been observed for the POR through 2009. TDS concentrations in the recovered water have ranged from approximately 200 to 950 mg/L over the POR, and from 360 to 478 mg/L during the recovery period in 2020.

Chloride, sulfate, and arsenic concentrations from 2006 to 2020 are shown on **Figure 4-7**. Chloride and sulfate concentrations increase during recovery events. The chloride concentrations ranged from 34 to approximately 250 mg/L and sulfate concentrations ranged from approximately 120 to 220 mg/L during the POR. The starting TDS, chloride, and sulfate concentrations from the 2020 recovery event were within range of previous cycles. Arsenic levels at S-2 have been below 10 µg/L since 2011. During the 2020 recovery event, arsenic concentrations ranged between 3 µg/L and 8.5 µg/L.

4.1.2.4 ASR Well S-3R

Figure 4-8 shows recovered TDS concentrations versus cumulative storage volume for ASR well S-3R from 1995 through 2020. Well S-3R had approximately 195 MG in storage at the end of 2020, which is 23 MG less than the volume stored at the end of 2019. Recharge did not occur at S-3R due to the well being out of service. POR TDS concentrations have ranged from approximately 280 to 980 mg/L, and from 316 to 478 mg/L during the recovery period in 2020. TDS concentrations in the recovered water showed an overall increasing trend through 2009, followed by lower concentrations during the 2010 through 2020 recovery events. As shown on **Figure 4-9,** chloride concentrations during the POR have ranged from 43 mg/L to 279 mg/L, with the maximum concentrations occurring during the 2009 recovery event. Chloride concentrations during the 2020 recovery event ranged from 51 to 97 mg/L. Sulfate has shown more moderate increases during recovery events and has ranged from approximately 110 to 250 mg/L during the POR. The starting TDS, chloride, and sulfate concentrations analyzed during the 2020 recovery event were substantially less than the concentrations from the recovery event in 2009 when storage volumes were less. Historical data have shown that during sustained recovery periods salinity increases rapidly at S-3R. However, consistent seasonal recharge with significant storage volumes can mitigate this by lowering the starting salinity concentration from the well. Arsenic levels have been as high as 43 µg/L at the end of the 2007 recovery event at well S-3R but have been at or below 21 µg/L since the 2009 recovery event. In 2020, the arsenic concentrations ranged from 1 µg/L to 10 µg/L.

4.1.2.5 ASR Well S-5R

Figure 4-10 shows recharge and recovered TDS concentrations versus cumulative storage volume for ASR well S-5R from 1995 through 2020. Over the POR, well S-5R has stored up to 172 MG of water and also realized a negative storage balance of approximately 297 MG. At the end of 2020, well S-5R had a negative storage balance of approximately 125 MG based on the cumulative storage volume. Historically, salinity water quality parameters have demonstrated increasing trends during recovery, as shown on **Figures 4-10** and **4-11**. TDS concentrations in the recovered water, reached the highest level (approximately 750 mg/L) in 2009 during an extended recovery period. TDS concentrations ranged from 284 to 314 mg/L in 2020. Chloride concentrations showed an overall increasing trend from 2006 to 2009; however, lower starting chloride concentrations were observed during subsequent recovery events. Sulfate concentrations follow similar trends as TDS and chloride, and typically range from approximately 120 to 215 mg/L. Starting TDS, chloride, and sulfate concentrations observed during the 2020 recovery event were slightly higher than the starting concentrations observed during the 2019 recovery event. Arsenic concentrations have remained below 10 µg/L since 2013. In 2020, arsenic concentrations ranged from BMDL to 1.7 µg/L.

4.1.2.6 ASR Well S-6

Figure 4-12 shows recharge and recovered TDS concentrations versus cumulative storage volume for ASR well S-6 from 1987 through 2020. During the POR, well S-6 has stored up to 426 MG of water, with approximately 349 MG in storage at the end of 2020, 30 MG more than at the end of 2019. TDS concentrations at well S-6 have shown an overall increasing trend during recovery, with the shorter-duration cycles demonstrating lower TDS concentrations compared to the longer-duration recovery events. Chloride and sulfate concentrations increase during recovery events, as shown on **Figure 4-13**. Over the POR, TDS concentrations in the recovered water have ranged from approximately 200 to 650 mg/L, chloride concentrations have typically ranged from approximately 25 to 120 mg/L, and sulfate concentrations have ranged from approximately 110 to 240 mg/L. Starting TDS, chloride and sulfate concentrations were lower in 2020 compared to the recovery event in 2019, likely due to the higher recharge volumes committed in 2019 compared to 2018. Arsenic levels have been less than 10 µg/L since 2010. In 2020, arsenic concentrations were less than 0.8 µg/L.

4.1.2.7 ASR Well S-7

Figure 4-14 shows recharge and recovered TDS concentrations versus cumulative storage volume for ASR well S-7 from 1987 through 2020. During the POR, well S-7 has stored up to 355 MG of water, with approximately 177 MG stored at the end of 2020. Water quality data have shown that initial recovery TDS concentrations generally correlate with the recharge water quality during the preceding recharge event and the volume of water stored during the recharge event. TDS concentrations of the recovered water over the POR have ranged from approximately 200 to 830 mg/L. TDS concentration ranged from 288 to 380 mg/L in 2020 during recovery.

Figure 4-15 shows chloride, sulfate, and arsenic concentrations from 2006 through 2020. Chloride and sulfate show a similar rate of increase during recovery events and have ranged from approximately 35 to 190 mg/L and 120 to 230 mg/L, respectively. In 2020, chloride and sulfate concentrations ranged from 41 to 67 mg/L and 131 to 146 mg/L, respectively, and were similar to higher than the recovery period in 2019, most likely due to the longer recovery event. Arsenic concentrations at well S-7 have been below 10 µg/L since June 2013 and were below 5 µg/L during the recovery event in 2020.

4.1.2.8 ASR Well S-8

Figure 4-16 shows recharge and recovered TDS concentrations versus cumulative storage volume for ASR well S-8 from 1987 through 2020. During the POR, well S-8 has stored up to 330 MG of water, with approximately 299 MG stored at the end of 2020. TDS concentrations in the recovered water during the POR ranged from approximately 200 mg/L to 1,000 mg/L, and from 292 to 370 mg/L during the recovery period in 2020.

Chloride, sulfate, and arsenic data from 2006 through 2020 are shown on **Figure 4-17**. Chloride and sulfate concentrations follow similar trends as TDS, increasing during recovery events. A positive response to larger recharge events and lower salinity recharge water quality, is observed in the lower initial TDS, chloride, and sulfate concentration with each successive recovery event after 2012. Over the POR, chloride concentration ranged from approximately 30 to 260 mg/L, and from 36 to 59 mg/L in 2020. Sulfate concentrations ranged from approximately 120 to 240 mg/L during the POR, and from 128 to 145 mg/L in 2020. Arsenic concentrations at well S-8 have been consistently less than 10 µg/L since 2006 and all samples collected during the 2020 recovery event were less than 3.3 µg/L.

4.1.2.9 ASR Well S-9R

Figure 4-18 shows recharge and recovered TDS concentrations versus cumulative storage volume for ASR well S-9R from 1995 through 2020. During the POR, well S-9R has stored up to 235 MG of water, with approximately 241 MG stored at the end of 2020. No significant recharge or recovery was conducted at S-9R in 2019. Well S-9R was placed back into service in December 2020, recharging 6 MG. From 1995 through the recovery event of 2009, the overall TDS concentration of the recovered water increased during operation of well S-9R. TDS concentrations in the recovered water have ranged from approximately 250 to 1,050 mg/L. Well S-9R was not used from 2009 through 2014 because of poor recovery efficiency at this well, possibly related to insufficient recharge volumes. A significant amount of water was recharged in summer and fall 2015 (approximately 75 MG). This resulted in a significant improvement in the starting recovered water quality in 2016. A significant amount of water was recharged between July and December of 2017 (approximately 90 MG), which resulted in a slight improvement of the starting water quality during the recovery event in 2018. No water quality samples were collected in 2019 or 2020 due to the rehabilitation of this well's surface equipment.

Figure 4-19 shows the chloride, sulfate, and arsenic data and cumulative storage volume from 2006 to 2020. Chloride concentrations increased from approximately 70 mg/L to the POR maximum of 300 mg/L during the recovery event in 2009. Sulfate concentrations ranged from approximately 170 to 260 mg/L during the POR. Arsenic levels were less than 5 µg/L from 2006 through 2015; however, the arsenic concentration reached 32 µg/L in 2016. This increased geochemical interaction likely was spurred by the relatively high volume of potable water recharged during the 2015 recharge event, the first significant recharge event since 2003. Arsenic at well S-9R during the 2018 recovery event ranged from an initial concentration of 14 µg/L to 22 µg/L at the end of the recovery period. This is attributed, in part, to the significant volume of potable water during the recharge event in 2017. No recharge or recovery occurred at S-9R in 2019. A brief recharge period occurred at the end of 2020.

4.1.3 WF2 ASR Water Quality Data

WF2 ASR well graphs are presented for each well to establish trends in salinity parameters and geochemical interactions. The graphs show chloride, sulfate, TDS, and arsenic over time as well as the wellfield storage volume. The wellfield volume is used in the graphs rather than the individual well's storage volume as seen in the WF1 graphs. Since the wells in WF2 are all within proximity of one another, they are assumed to operate like a system, with injected and recovered water coalescing among the ASR wells. Unlike the graphs for ASR wells in WF1 which contain TDS of recharged and recovered water, the WF2 ASR well graphs show TDS of recovered water only.

During recovery, TDS, chloride, and sulfate concentrations increase as the stored water is removed and the ratio of native water increases. Typically, at the later stages of a recovery event, the concentrations of TDS, sulfate, and chloride reach levels higher than the native water in the storage zone, suggesting that the water quality is influenced by upconing of more brackish water from beneath the wellfield. Upconing is a term used to describe the upward movement of water to the well bore versus lateral movement of water to the well bore in response to pumping. Data have demonstrated that the upconing effect is observed even beneath wells that are idle as a result of pumping from nearby wells. The rate at which TDS, chloride, and sulfate increase during recovery cycles generally has been consistent from cycle to cycle. The increase also begins at the start of recovery, further suggesting that a percentage of the water contribution is from beneath the wellfield.

The rate at which TDS concentrations increase, versus volume and percent recharge volume recovered, is generally the same from cycle to cycle and concentrations generally climb at a linear rate even after the previous recharge volume is removed. In general, TDS, chloride, and sulfate concentrations showed an increasing trend during periods of greater recovery and lower recharge as observed from 2006 through 2009. Since 2010, salinity concentrations have decreased as a result of higher storage volumes and more moderate recovery volumes. Data over the POR suggest that increased recharge volumes improve the starting salinity of the subsequent recovery cycle, thereby lowering the overall salinity concentrations over the recovery period. The rate of salinity increase during recovery is generally consistent and is not significantly dependent on the pumping rate.

In general, arsenic concentrations have shown improvement with successive cycles when larger recharge volumes are invested. Arsenic concentrations at most of the wells are close to the maximum contaminant level (MCL; 10 µg/L) and with continued operation of the wellfield, arsenic concentrations are expected to continue to decrease as observed in WF1. During the recovery period in 2020, arsenic concentrations were below 10 µg/L at each of the ASR wells in WF2 with the exception of well S-13 where the maximum concentration was 10.8 µg/L. Arsenic concentrations were overall lower than the concentrations observed during the 2019 recovery event.

4.1.3.1 ASR Well S-4

A graph of sulfate, chloride, TDS, and arsenic data plotted with cumulative wellfield storage volume for the POR at well S-4 is shown on **Figure 4-20**. TDS concentrations at well S-4 have ranged from approximately 250 to 1,300 mg/L over the POR, and from 308 to 392 mg/L in 2020. Over the POR, chloride and sulfate concentrations ranged from approximately 25 to 270 mg/L, and from 74 to 280 mg/L, respectively. TDS, chloride, and sulfate concentrations averaged 350 mg/L, 47 mg/L, and 146 mg/L, respectively in 2020. Arsenic concentrations over the POR decreased from approximately 84 µg/L in 2006 to less than 10 µg/L in 2013 and remained below 10 µg/L through 2017. The maximum arsenic concentration at well S-4 in 2018 was 18.9 µg/L, which is the highest arsenic value since 2013. Arsenic concentration decreased in 2019, recorded at 8.3 µg/L and 6.8 µg/L for the 2 samples collected during the short recovery period. Arsenic remained lower than the MCL with a maximum of 8 µg/L in 2020.

4.1.3.2 ASR Well S-10

A graph of sulfate, chloride, TDS, and arsenic data plotted with cumulative wellfield storage volume for the POR at well S-10 is shown on **Figure 4-21**. TDS concentrations at well S-10 have ranged from 280 to 1,384 mg/L over the POR and from 304 to 386 mg/L in 2020. Chloride and sulfate concentrations in this well typically ranged from approximately 30 to 475 mg/L, and from 110 to 280 mg/L, respectively. During the 2020 recovery event, TDS, chloride, and sulfate concentrations averaged 340 mg/L, 46 mg/L, and 144 mg/L, respectively. The starting concentrations for TDS, chloride and sulfate were generally in range with recent recovery events. Arsenic concentrations decreased significantly over the POR to less than 10 µg/L in 2013. Arsenic concentrations continued to be less than 10 µg/L during the 2020 recovery event.

4.1.3.3 ASR Well S-11

A graph of sulfate, chloride, TDS, and arsenic data plotted with cumulative wellfield storage volume for the POR at well S-11 is shown on **Figure 4-22**. Over the POR, TDS concentrations at well S-11 have ranged from approximately 270 to 1,350 mg/L, and chloride and sulfate concentrations at the well typically ranged from approximately 30 to 480 mg/L and 110 to 300 mg/L, respectively.

Well S-11 was backplugged in November 2007 to minimize upconing from this well during future recovery events. This most likely caused an increase in arsenic concentrations in the well in subsequent years. Since 2009, arsenic concentrations at well S-11 have gradually decreased with each recovery event, from a maximum concentration of 80 µg/L in 2009 to less than 10 µg/L during the recovery event in 2018. There was no recovery from well S-11 in 2019. In 2020 TDS, chloride, and sulfate concentrations averaged 292 mg/L, 34 mg/L, and 126 mg/L, respectively. Arsenic concentrations in 2020 continued decreasing and did not exceed 4.18 µg/L.

4.1.3.4 ASR Well S-12

A graph of sulfate, chloride, TDS, and arsenic data plotted with cumulative wellfield storage volume for the POR at well S-12 is shown on **Figure 4-23**. TDS concentrations have ranged from approximately 300 to 1,000 mg/L over the POR. Chloride and sulfate concentrations typically ranged from approximately 30 to 300 mg/L and 100 to 300 mg/L, respectively. TDS, chloride, and sulfate concentrations during the 2020 recovery event averaged 352 mg/L, 47 mg/L, and 146 mg/L, respectively. Arsenic concentrations at well S-12 decreased to less than 10 µg/L after the 2013 recovery event and remained below 10 µg/L through 2020.

4.1.3.5 ASR Well S-13

A graph of sulfate, chloride, TDS, and arsenic data plotted with cumulative wellfield storage volume for the POR at well S-13 is shown on **Figure 4-24**. TDS concentrations at well S-13 typically have ranged from approximately 300 mg/L to more than 1,000 mg/L. Over the POR, chloride and sulfate concentrations at the well typically ranged from approximately 30 to 320 mg/L and from 120 to 290 mg/L, respectively. Initial TDS, chloride, and sulfate concentration in 2020 decreased slightly from concentrations observed during the 2019 recovery event. Arsenic concentrations at well S-13 decreased over the POR from a maximum concentration of 79 µg/L in 2006 to less than 10 µg/L until the 2020 recovery event. The maximum arsenic level in 2020 was 10.8 µg/L. The 2020 maximum arsenic concentration is relatively low and likely due to the increased recovery volume compared to 2019.

4.1.3.6 ASR Well S-14

A graph of sulfate, chloride, TDS, and arsenic data plotted with cumulative wellfield storage volume for the POR at well S-14 is shown on **Figure 4-25**. Typical TDS concentrations have ranged from approximately 300 mg/L to over 1,000 mg/L over the POR. Chloride and sulfate concentrations ranged from approximately 30 to 230 mg/L and from 115 to 240 mg/L, respectively. Initial TDS, chloride, and sulfate concentrations in 2020 decreased slightly from the 2019 concentrations but stayed generally within the range of concentrations observed during recovery events since 2014. Arsenic concentrations at well S-14 generally decreased over the POR and continued to decrease slightly in 2020 to 6.7 µg/L at the end of the recovery event.

4.1.3.7 ASR Well S-15

A graph of sulfate, chloride, TDS, and arsenic data plotted with cumulative wellfield storage volume for the POR at well S-15 is shown on **Figure 4-26**. TDS concentrations typically have ranged from approximately 300 to 800 mg/L over the POR. Chloride concentrations ranged from approximately 30 to 210 mg/L and sulfate concentrations have ranged from approximately 120 to 240 mg/L. TDS, chloride, and sulfate concentrations in 2020 continued the neutral trend observed since 2014, which followed the trend of decreasing concentrations which began after the 2007 recovery event. Over the POR, arsenic concentrations have decreased significantly. The maximum arsenic concentration at well S-15 in 2020 was 3.3 µg/L.

4.1.3.8 ASR Well S-16

A graph of sulfate, chloride, TDS, and arsenic data plotted with cumulative wellfield storage volume for the POR at well S-16 is shown on **Figure 4-27**. TDS concentrations at well S-16 typically have ranged from approximately 300 to 1,000 mg/L. Over the POR, chloride and sulfate concentrations typically ranged from approximately 30 to 250 mg/L and from 100 to 280 mg/L, respectively. Starting TDS, chloride, and sulfate concentrations in 2020 were similar to concentration observed during the 2019 recovery event. Arsenic concentrations over the POR decreased from a maximum concentration of 260 µg/L in 2006 to a maximum of 3.1 µg/L during the 2020 recovery event.

4.1.3.9 ASR Well S-17

A graph of sulfate, chloride, and arsenic data plotted with cumulative wellfield storage volume for the POR at well S-17 is shown on **Figure 4-28**. TDS concentrations have ranged from 200 to 2,131 mg/L over the POR. Chloride and sulfate concentrations have typically ranged from approximately 30 to 575 mg/L and from 130 to 290 mg/L, respectively.

Well S-17 was partially backplugged in 2007 to minimize upconing in this well during future recovery events. This was the most likely cause for the increase in arsenic concentrations to the maximum of 52 µg/L observed in 2008. Since then, arsenic concentrations have gradually decreased, with values during the 2020 recovery event observed to be less than 7 µg/L.

The slope of the recovery TDS curves after 2007 are lower, suggesting that back-plugging of the lower portion of well S-17 appears to have successfully reduced the TDS rate of increase during subsequent recovery events, allowing more water to be recovered prior to reaching unacceptable TDS concentrations. As a result of the relatively large annual recharge volumes committed to the well since 2013, TDS, chloride and sulfate concentrations during the 2020 recovery event remained relatively low, averaging 350 mg/L, 47 mg/L, and 144 mg/L, respectively.

4.1.3.10 ASR Well S-18

A graph of sulfate, chloride, and arsenic data plotted with cumulative wellfield storage volume for the POR at well S-18 is shown on **Figure 4-29**. Typical TDS concentrations at well S-18 have ranged from approximately 280 to 1,230 mg/L. Over the POR, chloride and sulfate concentrations ranged from approximately 30 to 400 mg/L and from 100 to 270 mg/L, respectively. TDS, chloride, and sulfate concentrations in 2020 were comparable to slightly lower than concentrations observed during the 2019 recovery event. Arsenic concentrations over the POR decreased from a maximum concentration of 87 µg/L in 2003 to 5.9 µg/L at the end of the 2020 recovery event.

4.1.3.11 ASR Well S-19

A graph of sulfate, chloride, and arsenic data plotted with cumulative wellfield storage volume for the POR at well S-19 is shown on **Figure 4-30**. Typical TDS concentrations have ranged from approximately 350 to 1,260 mg/L over the POR. Chloride concentrations typically ranged from approximately 30 to 300 mg/L and sulfate concentrations have ranged from approximately 110 to 290 mg/L. During 2020 recovery, TDS, chloride, and sulfate concentrations were comparable to the 2019 concentrations, with initial concentrations lower than those observed in 2019. While arsenic concentrations have generally decreased over the POR, concentrations periodically increase above 10 µg/L. During the 2020 recovery event, arsenic concentrations remained below 10 µg/L.

4.1.3.12 ASR Well S-20

A graph of sulfate, chloride, and arsenic data plotted with cumulative wellfield storage volume for the POR at well S-20 is shown on **Figure 4-31**. TDS concentrations at well S-20 have ranged from approximately 100 to 1,000 mg/L with the lowest concentrations observed during PTW cycle testing. Over the POR, chloride and sulfate concentrations ranged from approximately 30 to 290 mg/L and from 80 to 280 mg/L, respectively. TDS, chloride, and sulfate concentrations in 2020 were comparable to 2019 recovery event. Arsenic concentrations have generally decreased over the POR but were occasionally above 10 µg/L in 2017 to 2019. Arsenic concentrations fell below 10 µg/L in 2020.

4.2 Monitoring Well Water Quality Data

Monitoring well water level data and water quality data were reviewed as part of this annual ASR operations report. Each monitoring well is potentially influenced more by either WF1 or WF2; therefore, this section is organized to reflect monitoring wells associated with each ASR wellfield. Several monitoring wells have long-term data while others were installed after ASR operation began. Several of the monitoring wells were constructed as part of the ASR expansion for the Peace River Option (WF2) and 13 additional monitoring wells were constructed in 2005 as part of an enhanced groundwater monitoring program. Most of the wells constructed in 2005 were in the vicinity of WF2 in order to better understand the geochemical interactions between the stored (treated) surface water and the host rock. Wells associated with WF1 are presented, followed by the monitoring wells associated with WF2.

4.2.1 WF1 Monitoring Well Water Quality Data

WF1 has four “compliance monitoring wells” listed in the FDEP Operation permit and WQCE which include wells M-2, T-2, T-7, and M-21. These four wells are analyzed more frequently to assure arsenic concentrations are met at the Authority’s institutional boundary. Water quality data from these four wells are described individually in the following paragraphs. Locations of the wells are shown on **Figure 1-2**, presented previously.

4.2.1.1 Monitoring Well M-2

Water quality data for Suwannee Limestone monitoring well M-2 over the POR are presented on **Figure 4-32**. Chloride, sulfate, and TDS concentrations have been relatively stable in this well but do show some fluctuations in response to ASR activities. In 2020, chloride, sulfate, and TDS concentrations remained within the ranges observed over the POR, with averages of 109, 323, and 834 mg/L, respectively. Arsenic concentrations at well M-2 have ranged from 8 µg/L to BMDL over the POR. None of the samples collected have ever exceeded the groundwater standard of 10 µg/L. Since 2007, arsenic concentrations at this well have remained at or below 3.5 µg/L. In 2020, all but two of the 37 samples collected were below the laboratory detection limit for arsenic.

4.2.1.2 Monitoring Well T-2

Figure 4-33 presents the water quality data for the POR for monitoring well T-2. This well monitors the slightly lower salinity groundwater present in the Tampa Zone at a depth of 393 to 490 feet bls. Over the POR, TDS concentrations for this well averaged 693 mg/L, sulfate concentrations averaged 226 mg/L, and chloride concentrations averaged 127 mg/L. Minor fluctuations in water quality are observed in response to ASR operations but the responses are muted when compared the Suwannee Limestone monitor wells. In 2020, TDS, sulfate, and chloride concentrations averaged 696, 224, and 125 mg/L, respectively. Arsenic concentrations are generally below detection levels in this well, with only 13 samples above the MDL for the POR. The highest detected arsenic concentration during the POR was 3 µg/L in September of 2006. Arsenic samples were BMDL in all samples collected in 2020.

4.2.1.3 Monitoring Well T-7

Figure 4-34 presents water quality data for the POR for monitoring well T-7. This well also monitors the slightly lower salinity groundwater present in the Tampa Zone near monitoring well M-7. Chloride concentration in this zone is modestly higher than the sulfate concentration, which is different than the

Suwanee Limestone monitoring horizon. During the POR, beginning in 2002, chloride, sulfate, and TDS concentrations have averaged 186, 140, and 672 mg/L, respectively. In 2020, chloride, sulfate, and TDS concentrations averaged 192, 145, and 694 mg/L. Arsenic concentrations have generally been below detection levels in this well. All but three of the 37 arsenic samples were BMDL in 2020, with a maximum concentration of 0.6 µg/L. These data suggest that the extent of arsenic mobilization is limited to localized areas near the ASR wells within the Suwannee Limestone, and that geochemical interactions do not extend into the overlying zone above the ASR storage interval.

4.2.1.4 Monitoring Well M-21

Figure 4-35 presents water quality data available for monitoring well M-21. This well was constructed in 2005 as part of the enhanced groundwater monitoring program and the POR data are presented. This well is located approximately 200 feet west of ASR well S-7 (**Figure 1-3**). Chloride, sulfate, and TDS concentrations at well M-21 fluctuate in response to ASR operations. TDS concentrations averaged 655 mg/L, sulfate concentrations averaged 242 mg/L, and chloride concentrations averaged 124 mg/L over the POR. In 2020, TDS, sulfate, and chloride concentrations averaged 613, 221, and 100 mg/L, respectively. Over the POR, arsenic concentrations have not exceeded the groundwater standard of 10 µg/L. In 2020, all arsenic samples were BMDL, but one recorded at 0.57 µg/L.

4.2.1.5 Shallow Monitoring Wells E and I-7

Water quality data for WF1 monitoring wells E and I-7 are included in **Appendix D** (**Figures D-1** and **D-2**). Monitoring well E is among the shallowest of the monitoring wells evaluated, monitoring a zone from 140 to 200 feet bls. As expected, this well has the lowest salinity among the monitoring wells evaluated for WF1. The salinity and arsenic concentrations are within the range of background values suspected to be representative of this zone. Data support the lack of geochemical influences above the Suwannee Limestone storage zone at this site.

Well I-7 monitors the Intermediate Aquifer System (IAS) from 220 feet to 261 feet bls in the vicinity of the other 7-series monitoring wells. Chloride, sulfate, and TDS concentrations in this well have been relatively stable to date. Each of these constituents are higher at monitoring well I-7 compared to monitoring well E. This is believed to be a function of water quality variability in this zone rather than a result of ASR operations in this area. Arsenic values have all been 4 µg/L or below at monitoring wells I-7 and E for the POR with most samples BMDL. No significant changes in water quality were observed in 2020. Arsenic concentrations were BMDL in all samples collected from monitoring wells E and I-7 in 2020.

4.2.1.6 Monitoring Wells M-6, M-7, M-20, and M-22

Water quality data for WF1 monitoring wells M-6, M-7, M-20, and M-22 are included in **Appendix D** (**Figures D-3**, **D-4**, **D-5,** and **D-6**). Monitoring well M-6 is located at a considerable distance to the south of ASR operations (**Figure 1-2**). Salinity parameters have been relatively stable in this well for the POR. The majority of the arsenic data have been BMDL. The range in salinity values and arsenic concentrations at this well is likely representative of ambient concentrations in the Suwannee Limestone in this area. Arsenic was not detected above BMDL in all 4 of the samples collected in 2020.

Monitoring well M-7 is located approximately 400 feet north of ASR well S-6 (**Figure 1-3**). Salinity concentrations are influenced by ASR operations in WF1. Salinity values are considerably lower than ambient TDS concentrations in the Suwannee Limestone, supporting the assumption that this zone has experienced an overall freshening since WF1 ASR operations began. No arsenic concentrations above the MCL have been observed in this monitoring well. Since 2006, all samples have had an arsenic concentration of less than 4 µg/L. Arsenic was detected at concentrations of 0.75 µg/L or less in all of the samples collected in 2020.

Monitoring well M-20 was constructed approximately 400 feet north of well S-5R in 2005 as part of the enhanced groundwater monitoring program. Salinity concentrations have shown minor influence from ASR operations in WF1. Salinity parameters are somewhat lower than ambient TDS concentrations in the Suwannee Limestone, suggesting that this zone has experienced some freshening from WF1 ASR operations. Over the POR, arsenic concentrations have not exceeded the groundwater standard of 10 µg/L. In 2020, all 12 samples were BMDL.

Monitoring well M-22 was constructed in 2005 as part of the enhanced groundwater monitoring program. This storage zone monitoring well is located closer to an ASR well than any other monitoring well, approximately 60 feet east of ASR well S-2. Salinity concentrations are influenced considerably by ASR WF1 operations, as demonstrated by the much fresher water in this well compared to ambient Suwannee zone conditions and the noticeable response during recharge and recovery events. This monitoring well is within the influence of the stored water from well S-2. Arsenic concentrations historically have risen during periods of WF1 recovery, increasing to approximately 38 µg/L in 2006, but improving during subsequent cycles. In 2020, arsenic concentrations were less than 8.2 µg/L for all 12 samples collected.

4.2.2 WF2 Monitoring Well Water Quality Data

WF2 has four “compliance monitoring wells” under the 2013 FDEP Operation Permit and WQCE, which includes monitoring wells T-11, M-15, M-18, and M-19. The water quality data from these four wells are described individually in the following paragraphs. Monitoring well T-11 is located approximately 500 feet northwest of WF2 and monitors the lower producing zone of the intermediate aquifer from 350 to 400 feet below land surface. Storage zone monitoring wells M-15, M-18, and M-19 surround WF2 in each direction from the property boundary, as shown on **Figure 1-4** presented previously.

4.2.2.1 Intermediate Aquifer Well T-11

Figure 4-36 shows the TDS, chloride, sulfate, and arsenic concentrations from monitoring well T-11, which monitors the first permeable unit above the ASR storage zone. TDS, chloride, and sulfate concentrations have shown a gradual increasing trend since 2011 which correlates with an increasing storage volume at WF2 over this period. The increase in salinity may suggest upward movement of more saline water from below the well potentially caused by the increased WF2 storage and resulting increased head difference between the two permeable intervals. However, water quality changes at T-11 have been relatively minor and appear to be localized, as this increase in salinity is not observed at T-8. During 2020, TDS, chloride, and sulfate concentrations averaged 522, 135, and 103 mg/L, respectively. Over the POR, arsenic concentrations have generally remained below the MDL. Arsenic concentrations in all of the samples collected in 2020 were below the MDL, except for two samples that were below the practical quantitation limit (PQL) of 0.5 µg/L.

4.2.2.2 Monitoring Well M-15

A graph of the TDS, chloride, sulfate, and arsenic concentrations from monitoring well M-15 is provided on **Figure 4-37**. Water quality changes at well M-15 correlate with WF2 injection and recovery activities, with freshening generally occurring during recharge activities and increases in salinity observed during recovery activities. TDS, chloride, and sulfate concentrations over the POR have decreased from approximately 650 to 340 mg/L, 100 to 40 mg/L, and 200 to 140 mg/L, respectively. During 2020, TDS, chloride, and sulfate concentrations averaged approximately 382, 52, and 151 mg/L, respectively, suggesting this monitoring well continues to freshen from the large recharge volumes committed to WF2 between 2013 through 2020. As a result of the increased recharge volumes, arsenic concentrations increased at monitoring well M-15 between 2014 and 2020. Arsenic concentrations were overall lower in 2020 compared to 2019, averaging 7.4 µg/L and reached a maximum of 11.6 µg/L. Arsenic was sampled twice weekly at this well in 2020 when concentrations increase over 10 µg/L, and weekly when concentrations remained below 10 µg/L.

4.2.2.3 Monitoring Well M-18

Figure 4-38 shows the TDS, chloride, sulfate, and arsenic concentrations at well M-18. Fluctuations in water quality in response to ASR activities are observed at well M-18. Between 2011 and 2017, TDS, sulfate, and chloride concentrations have decreased in response to an increase in storage in WF2 during that period. From 2018 through 2020 TDS, chloride, and sulfate concentrations have been relatively stable with small fluctuations in response to ASR activities. TDS, chloride, and sulfate concentrations have decreased from approximately 800 to 400 mg/L, 150 to 50 mg/L, and 250 to 170 mg/L, respectively, during the POR. During 2020, TDS, chloride, and sulfate concentrations averaged 394, 47, and 170 mg/L, respectively, representing a slight decrease in TDS, chloride, and sulfate from the previous year. During the POR, arsenic concentrations have generally remained below 2 µg/L. The maximum arsenic concentration in 2020 was 2.72 µg/L and concentrations averaged 1.36 µg/L.

4.2.2.4 Monitoring Well M-19

A graph of the TDS, chloride, sulfate, and arsenic concentrations from this well is provided on **Figure 4-39**. Monitoring well M-19 shows a correlation to the ASR injection and recovery activities even though it is one of the farthest monitoring wells from WF2. TDS has decreased from approximately 800 to 400 mg/L over the POR. Chloride and sulfate concentrations have decreased from approximately 200 to 50 mg/L and 300 to 170 mg/L, respectively, over the POR. During 2020, TDS, chloride, and sulfate concentrations averaged 387, 46, and 168 mg/L, respectively, each decreasing slightly from the previous year. Over the POR, all samples were below the arsenic MCL of 10 µg/L. Between 2014 and 2020 more samples had arsenic concentrations above the laboratory MDL. Arsenic concentrations reached their highest levels in 2019, reaching a maximum of 7.05 µg/L. In 2020 the highest recorded arsenic concentration was 6.4 µg/L. Data suggest that concentrations have increased in response to an increase in storage volumes at WF2, however concentrations are consistently below 10 µg/L.

4.2.2.5 Other WF2 Monitoring Wells

Other monitoring wells in WF2 include two IAS wells (I-8 and I-10), one Tampa Zone well (T-8), and seven Suwannee Zone wells (M-8, M-11, M-12, M-13, M-14, M-16, and M-17). POR water quality data for these 10 other monitoring wells are included in **Appendix D** (**D-7** through **D-16**). Water quality data are summarized by zone below.

4.2.2.6 Intermediate Aquifer System Monitoring Wells I-8 and I-10

IAS (now referred to as the Hawthorn aquifer) monitoring wells I-8 and I-10 (**Figures D-7** and **D-8**) show stable salinity parameters for the POR. The stable salinity data indicate that ASR operations have negligible, if any, impact on these wells in the Intermediate aquifer above the Suwannee Zone.

4.2.2.7 Tampa Zone Monitoring Well T-8

Monitoring well T-8 has an open hole from 354 to 401 feet bls and monitors a lower permeability zone approximately 600 feet northwest of WF2. POR data are stable for salinity parameters and arsenic even with the increase in storage in WF2 beginning in 2013, indicating that wellfield operations have no discernable impact on this zone (**Figure D-9**).

4.2.2.8 Suwannee Zone Monitoring Wells M-8, M-11, M-12, M-13, M-14, M-16, and M-17

Monitoring wells M-8, M-11, M-12, M-13, M-16, and M-17 (**Figures D-10** through **D-16**, respectively) salinity data indicate varying degrees of water quality changes that correlate to recharge or recovery activities that are generally dependent on the distance of the monitoring well to the ASR wellfield. Monitoring well M-14 shows the most direct influence of ASR operations as changes in TDS and chloride concentrations correlate to ASR recharge and recovery events. Less variability is noted in the remaining wells; however, a slight decreasing trend in TDS and chloride is observed due to the increased storage volume at WF2. A significant change in salinity is observed at M-12 in 2017 that coincides with the start of PTW cycle testing, however this may be the result of the arrival of recharged water following years of consecutive increased storage. Arsenic data at these monitoring wells in 2020 are generally above detection limits with the exception of M-13 and M-8, however concentrations remain relatively low. Arsenic concentrations remained below 10 µg/L at all seven monitoring wells in 2020.

4.3 Summary of WF1 Water Quality Data

WF1 has been in operation since the mid-1980s. Water quality analyses from the ASR wells and monitoring wells have focused on TDS to evaluate the recovery success of the ASR wells and the lateral extent of water movement during recharge. After arsenic mobilization became an issue during cycle testing of WF2, in 2006, the water quality sampling program of WF1 and its associated monitoring wells was expanded to include arsenic, chloride, and sulfate analyses. The current sampling frequency and list of parameters is dictated by the FDEP operating permit issued in April 2013.

All the ASR wells in WF1 are completed into the Suwannee Limestone of the UFA except for ASR well T-1, which is completed into the overlying Tampa Member and Nocatee Member of the Arcadia Formation, part of the IAS. The two critical water quality concerns in the operation of the Peace River ASR system are salinity and arsenic; therefore, the following discussion focuses on these two issues.

Due to drought conditions, consecutive recovery events with minimal storage were completed between 2006 and 2009 with a reduction in water storage volume from 2,289 MG in 2006 to 182 MG prior to the summer of 2009. During this period recovery TDS concentrations increased above historic levels typically observed at WF1. Since 2009, more recharge has been committed to WF1, increasing the storage balance from 182 MG at the end of the recovery event in 2009 to 2,058 MG at the end of 2020, an increase of 1,876 MG over this period. This increase in storage resulted in a decrease in TDS concentrations during recovery events that occurred between 2010 through 2020 compared to recovered water TDS concentrations during the 2006 to 2009 recovery events. TDS ranges in 2020 were as follows: 274 to 290 mg/L at well T-1, 268 to 326 mg/L at S-1, 360 to 478 mg/L at well S-2, 316 to 478 mg/L at well S-3R, 284 to 314 mg/L at well S-5R, 270 to 316 mg/L at S6, 288 to 380 mg/L at well S-7, and 292 to 370 mg/L at well S-8. No recovery occurred from well S-9R in 2020. The higher range of TDS concentrations observed in 2020 are a result of higher recovery volumes compared to 2018 and 2019.

Sampling of arsenic at the WF1 ASR wells began during recovery events starting in 2006. Over the POR arsenic concentrations have been relatively low, with all samples from WF1 ASR wells below 50 µg/L. The greatest arsenic concentrations were observed between 2006 and 2009 when recovery volumes were greatest and minimal recharge was invested in the wellfield. Since then, concentrations have been significantly lower and showing an overall declining trend, with the exception of S-9R where concentrations were highest in the 2016 recovery event that followed the first significant recharge event in the previous 9 years. From 2017 (the last significant recovery event for WF1) to 2020, arsenic concentrations have remained below 10 µg/L in each of the wells, with the exception of S-3R and S-9R which had maximum arsenic concentrations of 10 µg/L during that period. No water was recovered from well S-9R in 2020.

Water quality sampling at the WF1 monitoring wells began in 2005 with the exception of monitoring wells T-2, M-2, I-7, T-7, M-7 and M-6 which have longer monitoring periods. The available POR for the water quality data for the 2-series monitoring wells (M-2 and T-2) began in 1991 and the POR for the 7-series monitoring wells (I-7, T-7, M-7) and monitoring well M-6 began in 2002.

The TDS, chloride, and sulfate from the regional monitoring wells M-6, M-2, and T-2 have shown no significant trends in response to ASR operations.

The two monitoring wells located closest to ASR wells in WF1 are M-7 and M-22. Monitoring well M-7 shows moderate water quality changes, with respect to salinity, in response to ASR operations and monitoring well M-22 exhibits more pronounced changes due to the proximity to ASR wells T-1, S-2, and

S-1. The remaining wells (E, I-7, T-7, M-20, and M-21) show minimal to no changes in salinity in response to ASR operations.

Sampling for arsenic at the WF1 monitoring wells began in 2005. Well M-22 is the only monitoring well with a significant number of arsenic detections above the MCL of 10 µg/L, reaching over 30 µg/L during the 2008 recovery event. The maximum arsenic concentration in 2020 at monitoring well M-22 was 8.2 µg/L. The higher arsenic detections at well M-22 are due to the proximity of the monitoring well to the ASR wells (83 feet), which is within the primary zone of influence around each ASR well. Monitoring well M-7 has shown several arsenic samples above the method detection limit; however, no concentration was over 10 µg/L for the POR and detections have been significantly less frequent since 2009 when storage volumes began to increase. In 2020, the highest arsenic concentration from monitoring well M-7 was 0.75 µg/L. The remaining monitoring wells (M-20, M-21, M-2, T-2, T-7, I-7, and E) had relatively few arsenic detections over the POR, none of which were above 10 µg/L. In 2020, all but five of the samples from these wells were BMDL. Laboratory data from the monitoring wells surrounding WF1 suggest that arsenic mobilization does not extend laterally beyond the wellfield or migrate into the overlying permeable zones. In fact, the greatest arsenic mobilization is confined to the area immediately around the ASR wells.

4.4 Summary of WF2 Water Quality Data

WF2 has been in operation since 2002, initially under an FDEP construction permit, which required extensive water quality sampling from the ASR wells and associated monitoring wells. FDEP issued a combined operating permit for both wellfields in April 2013. As with WF1, the primary water quality concerns in the operation of WF2 are increased salinity and arsenic concentrations in the recovered water. All the ASR wells in WF2 are completed into the Suwannee Limestone.

TDS, chloride, and sulfate concentrations increase during recovery events in all the WF2 ASR wells, albeit at different rates. An overall improvement in water quality is observed in the ASR wells since 2010. This is partially a result of the larger volumes of water invested in storage during this period; however, some improvement likely is due to lower recovery volumes and recovery rates compared to earlier recovery phases. Minimal recovery occurred in 2014 through 2015 and significant storage was invested in WF2 from 2013 to 2019 (a net increase of 5.6 billion gallons [BG]). Minimal recovery in 2018 and 2019 resulted in a cumulative storage balance of approximately 5,779 MG. In 2020, the recovered volume increased to 313 MG and the recharge volume totaled 654 MG. The cumulative storage balance in 2020 was 6,120 MG.

Sampling for arsenic at WF2 began at the outset of cycle testing and continues through the present. Arsenic concentrations at the WF2 ASR wells declined from concentrations observed during earlier recovery cycles. During the recovery period in 2020, arsenic concentration remained below the MCL of 10 µg/L at all WF2 ASR wells with the exception of S-13, which showed a maximum concentration of 10.8 µg/L .

Water quality sampling from the upper IAS monitoring wells (I-8 and I-10) and the IAS Tampa Zone monitoring well T-8 began in January 2002. Monitoring well T-11 sampling began in June 2005. No discernible water quality trends are noted in the "I-series" monitoring wells at WF2 with respect to salinity, suggesting there are no impacts from ASR operations. TDS concentrations from the Tampa Zone well T-8 have been generally consistent with no observed trending in response to ASR operations. Monitoring well T-11 has shown a steady increase in TDS since 2010, correlating to increased storage in WF2. This may suggest movement of more saline water into the monitoring well from beneath the well as it is displaced by recharge water from the ASR zone. However, the TDS change has been moderate, increasing from approximately 350 to 530 mg/L.

The Suwannee Limestone storage zone monitoring wells (M-series) show varying influence from ASR operations that generally depend on the distance of the well from the ASR wellfield and its location relative to the regional groundwater gradient, which is generally to the southwest. TDS concentrations have decreased since 2013 is as a result of the increase in storage balance and limited recovery during this period.

The majority of the arsenic samples from the overlying Tampa Zone monitoring wells, T-8 and T-11, were BMDL. All samples with detected concentrations during the POR were less than 0.5 µg/L at these wells. Data from these wells suggest that arsenic mobilization is not occurring in the zone overlying the ASR wells.

Among the storage zone monitoring wells, the largest arsenic data set is from monitoring well M-8, where sampling began in 2002 at the start of cycle testing at WF2. Only one arsenic sample from M-8, which appears to be an outlier, was above the MCL recorded at 12 µg/L in June 2006. Since June 2007, all arsenic concentrations were below 2.6 µg/L. This monitoring well provides the most complete historical record of arsenic data in the storage zone downgradient from WF2. The data provide evidence that arsenic mobilization in the direction of, and within the distance of M-8 does not exceed drinking water standards.

Arsenic concentrations at the storage zone monitoring wells vary depending on the proximity and direction of the monitoring well to the ASR wells. In addition to these variables, pilot cycle testing at wells S-4 and S-20 with PTW in 2017 may have affected the geochemistry involved in the mobilization of arsenic. Monitoring wells M-14, M-16, and M-17, all located inside WF2 or proximal to WF2, had the highest historical arsenic concentrations. Concentrations at well M-17 have been less than 10 µg/L since 2006. Arsenic concentrations at well M-16 have been below 10 µg/L since August of 2011 through December 2017 but showed an increasing trend near the end of 2017 during the second PTW cycle test. This trend continued into 2018 with four exceedances above 10 µg/L before decreasing at the end of 2018 and remaining below 10 µg/L through 2020. Historically, the highest arsenic concentrations were seen at monitoring well M-14. Although a general improvement has been observed at monitoring well M-14 over the POR, arsenic concentrations increased during the PTW cycle testing and continue to be elevated in 2019, decreasing slightly from 2018. Arsenic concentrations at monitor well M-14 dropped below 10 µg/L in 2020.

The remaining storage zone monitoring wells that surround the exterior of the wellfield (M-8, M-11, M-12, M-13, M-15, M-18, M-19) historically have had few arsenic detections above the MDL. However, an increase in the number of detections has been observed at these monitoring wells as storage volumes have increased over the past few years, and possibly as a result of PTW pilot testing in 2017. Arsenic concentrations at monitoring wells M-8, M-13, M-18, and M-19 have remained below 10 µg/L, however an increasing trend is observed at M-19 correlating to the increased storage volumes at WF2. The arsenic concentration at monitoring well M-11 reached 13.1 µg/L in 2018 and 12.4 µg/L in 2019. In 2020, M-11 arsenic concentrations continued to decrease with a maximum concentration of 9.19 µg/L. Monitoring well M-15 has shown a significant increase in arsenic concentrations since 2015, but until 2017 had been below 10 µg/L. In 2018, arsenic concentration at well M-15 reached a maximum of 32.4 µg/L but decreased in 2020 with a maximum of 11.6 µg/L. Arsenic concentrations at monitoring well M-12 also increased beginning in 2017 reaching a maximum concentration of 19 µg/L. Arsenic concentrations continue to be elevated through 2020, however a declining trend is observed. The highest value in 2020 was 8.73 µg/L. Monitoring wells M-12 and M-15 showed nearly 100 percent PTW arrival during the PTW pilot cycle testing, indicating a dominant flow path in the direction of these two monitoring wells. The influence of PTW and the increased storage volumes at WF2 are believed to have played a role in the increased arsenic concentrations observed at wells M-12 and M-15. Increased sampling to twice weekly is implemented at M-15 when arsenic concentrations rise above 10 µg/L.

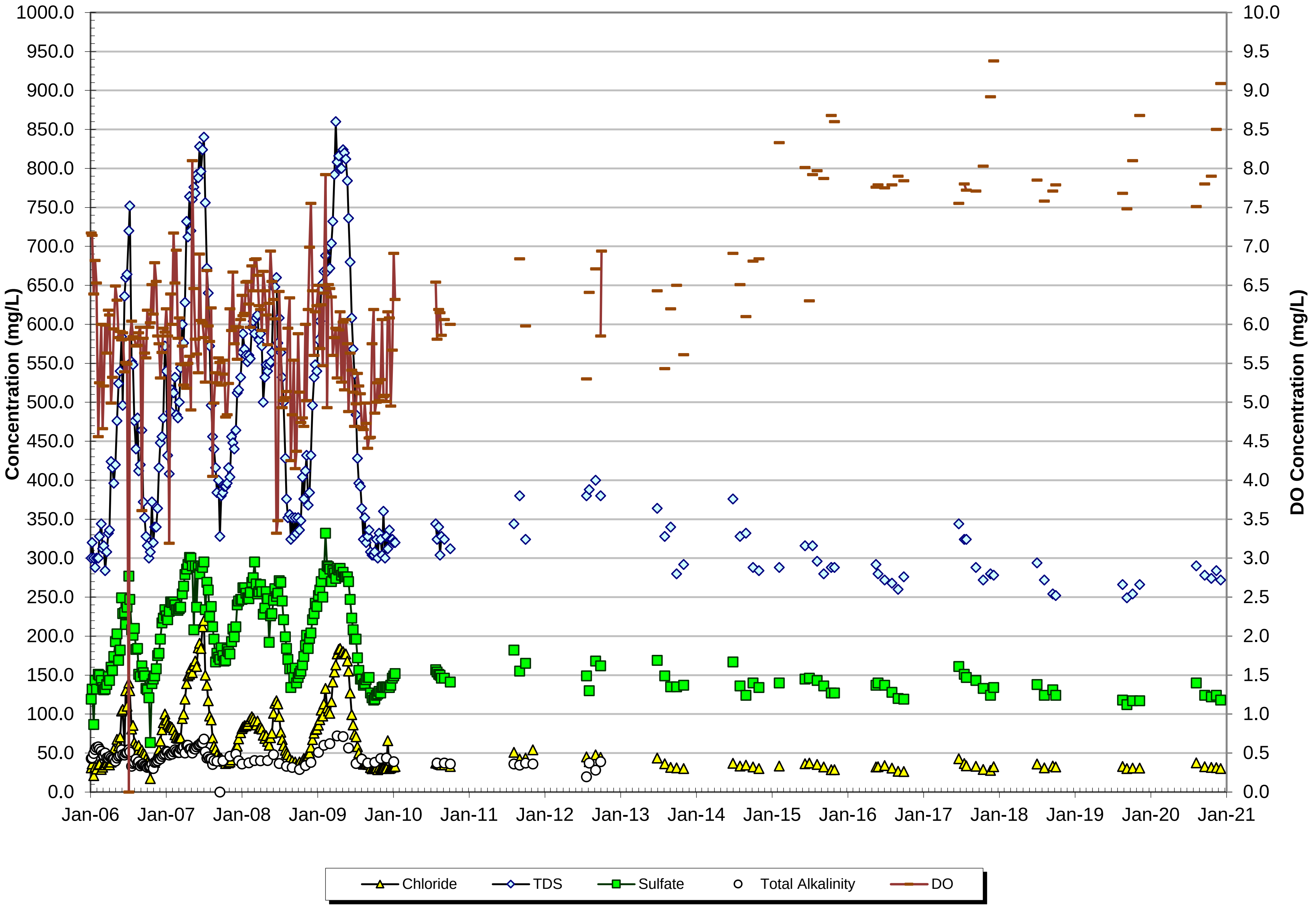


Figure 4-1
Finished Water Quality

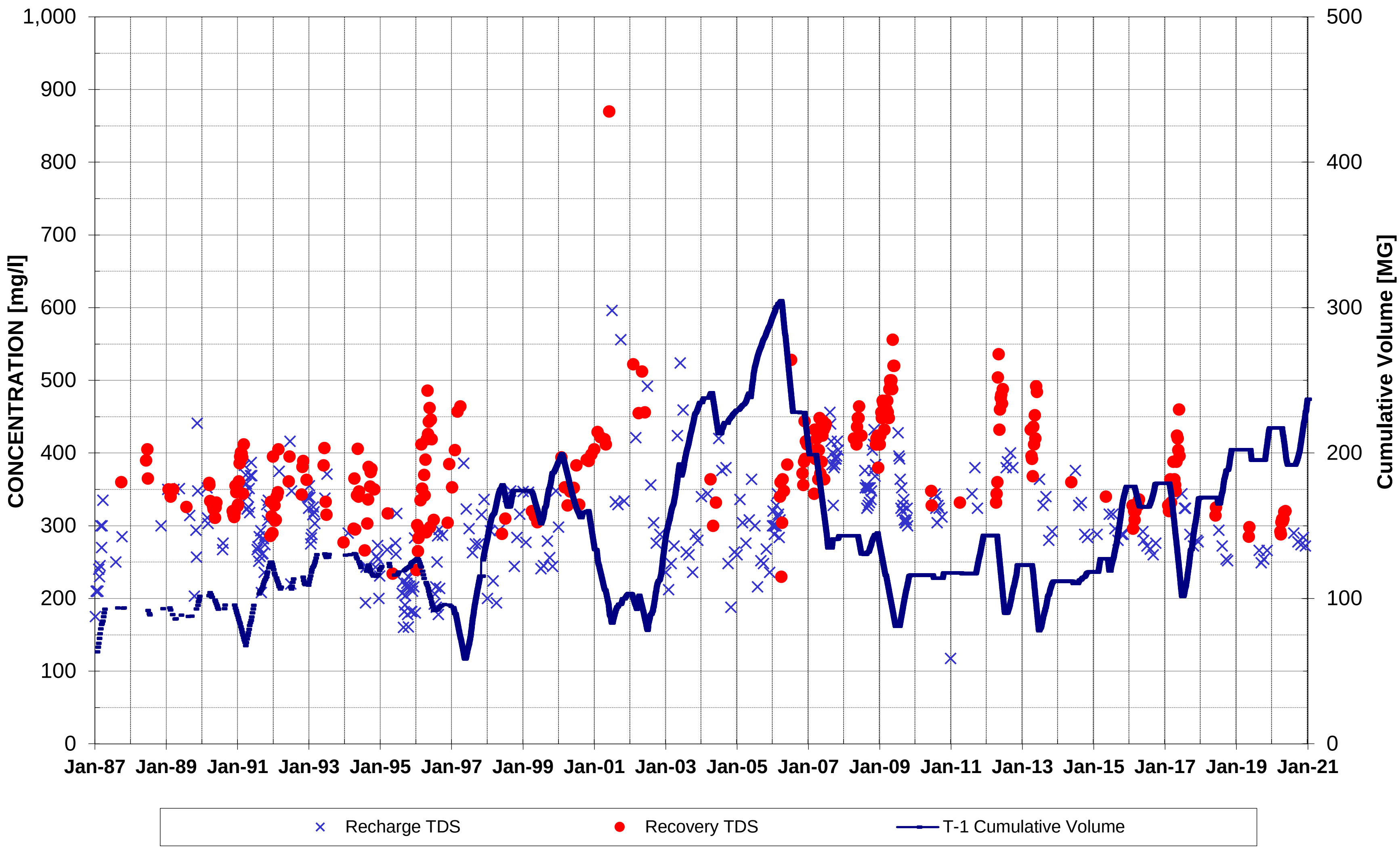


Figure 4-2
T-1 Water Quality Data

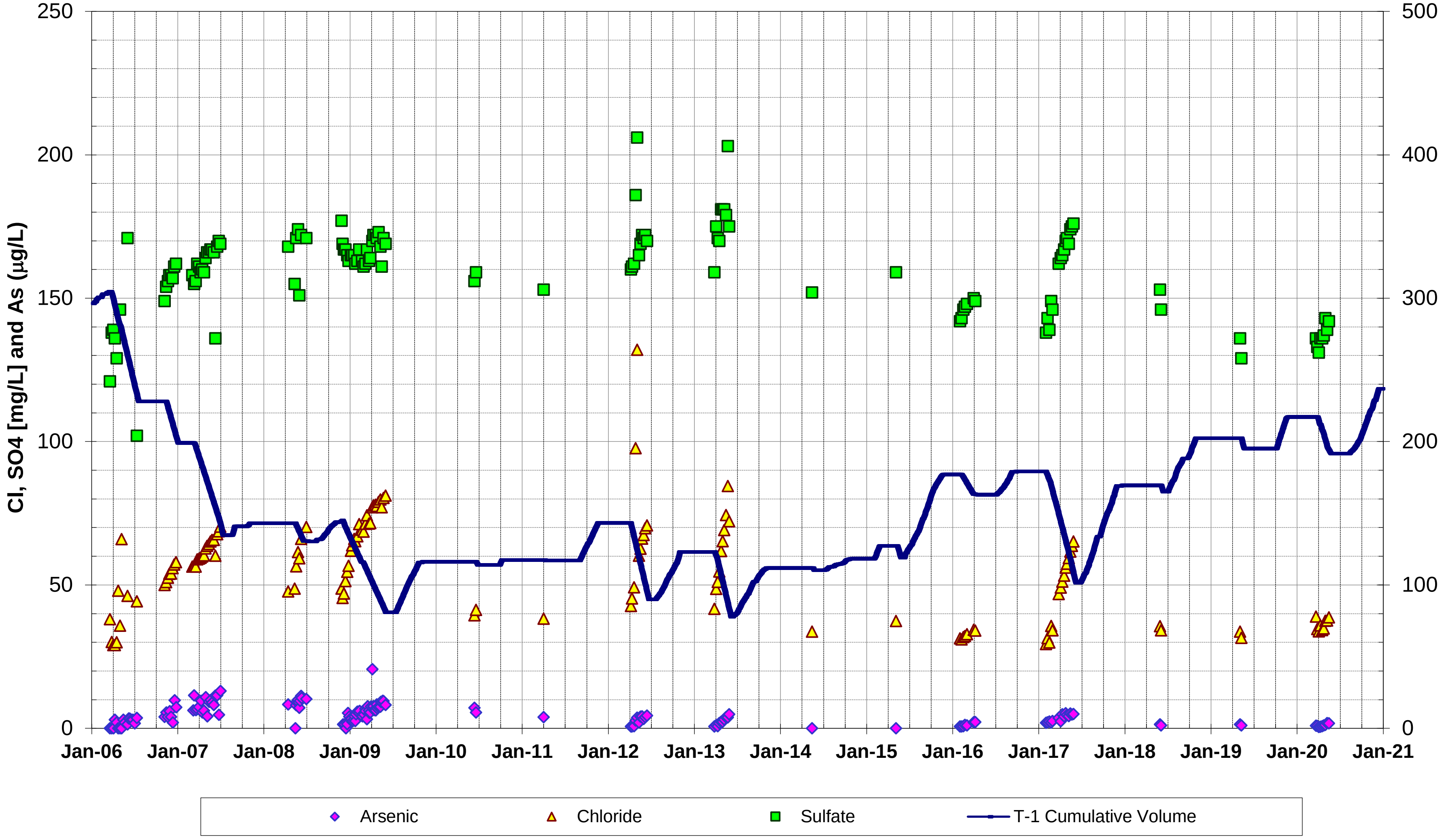


Figure 4-3

T-1 Water Quality Data

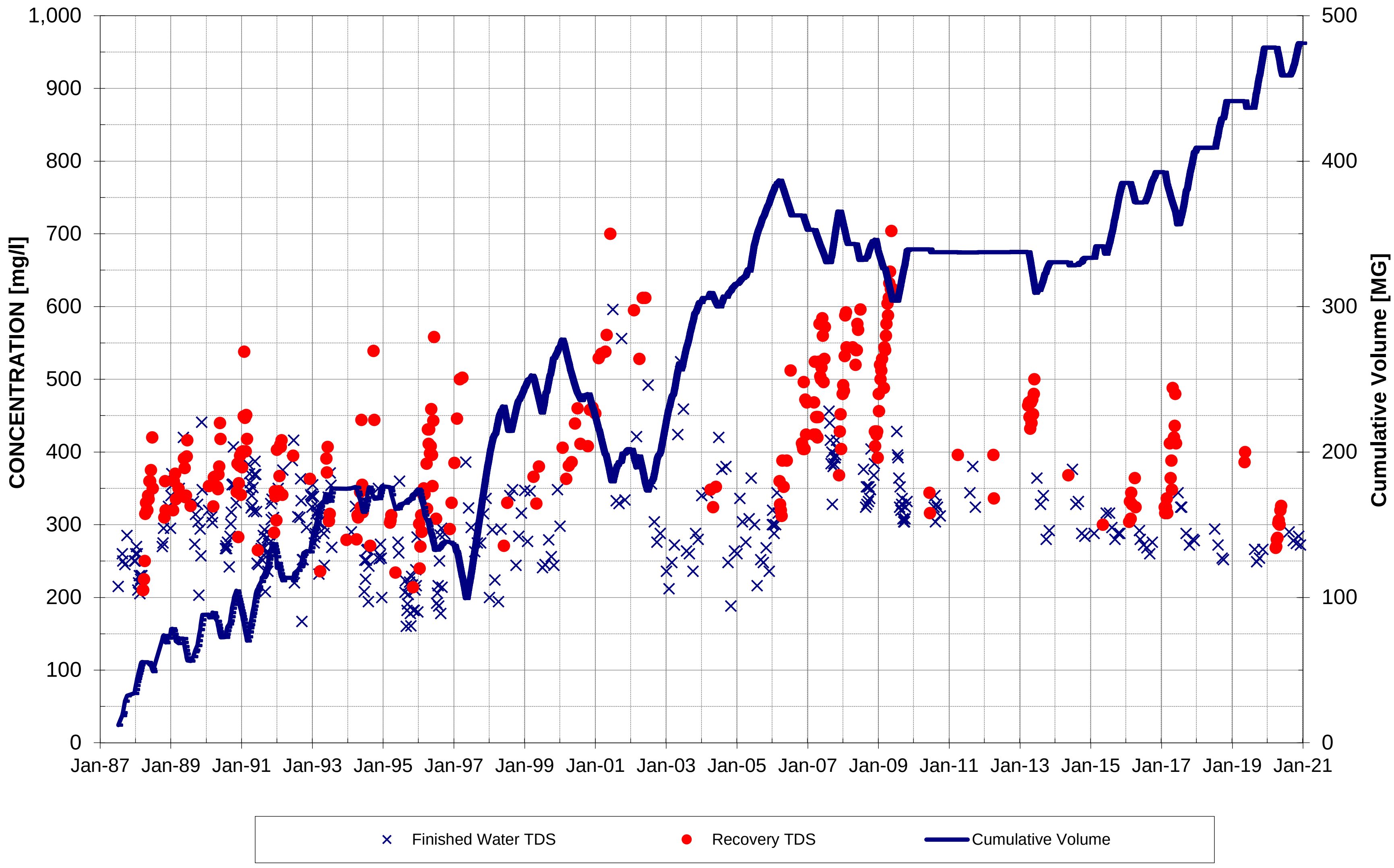


Figure 4-4
S-1 Water Quality Data

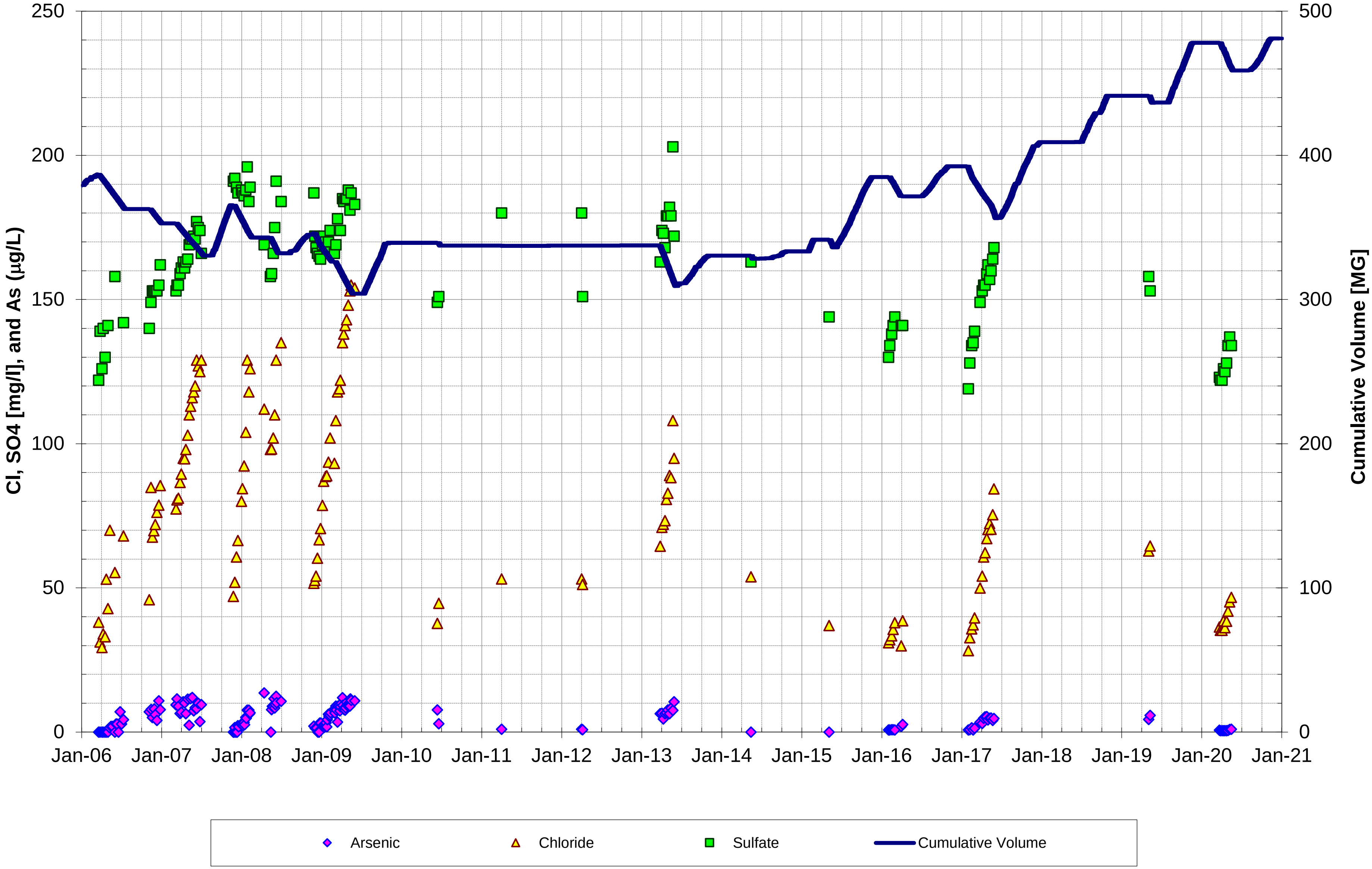


Figure 4-5
S-1 Water Quality Data

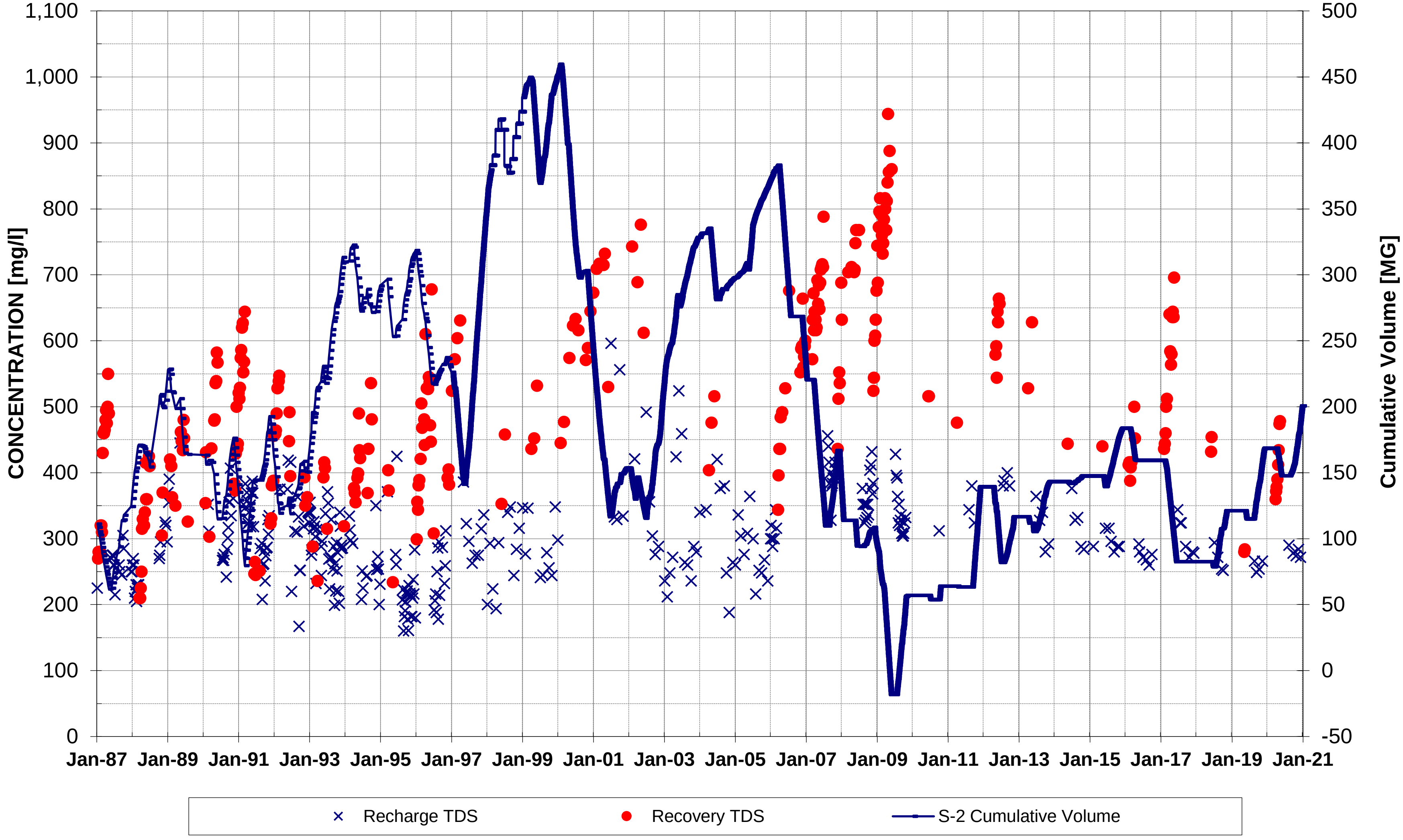


Figure 4-6
S-2 Water Quality Data

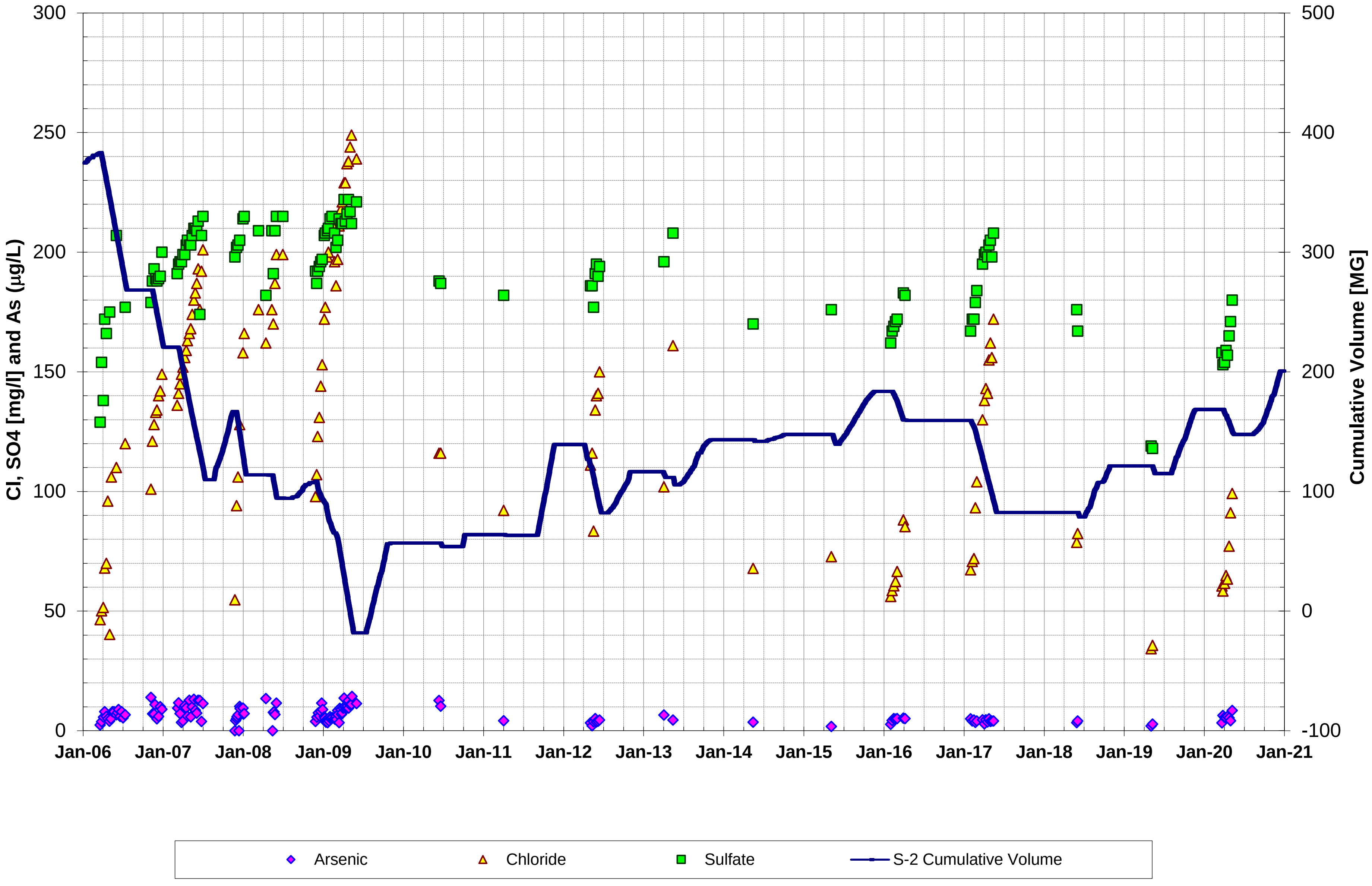


Figure 4-7
S-2 Water Quality Data

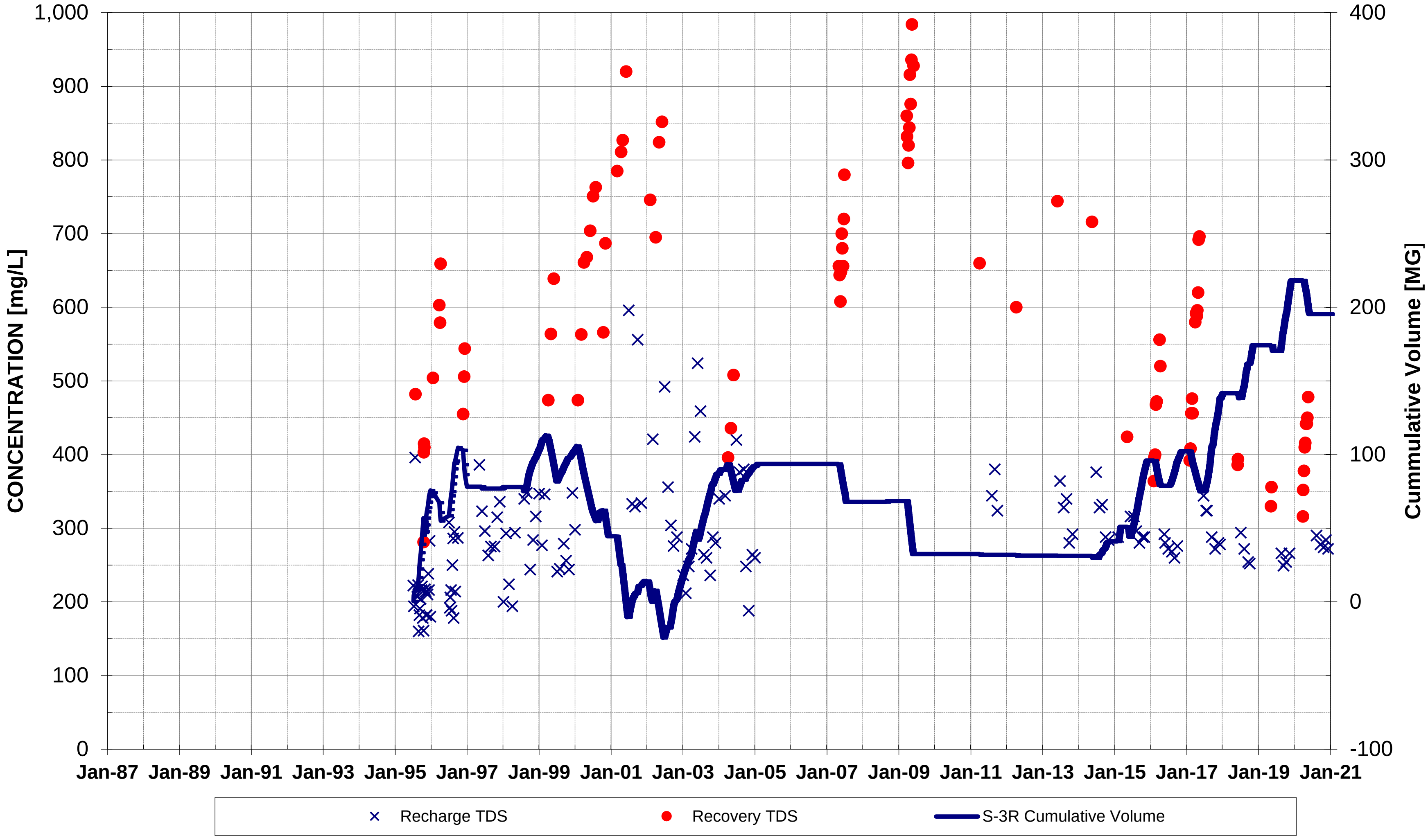


Figure 4-8

S-3R Water Quality Data

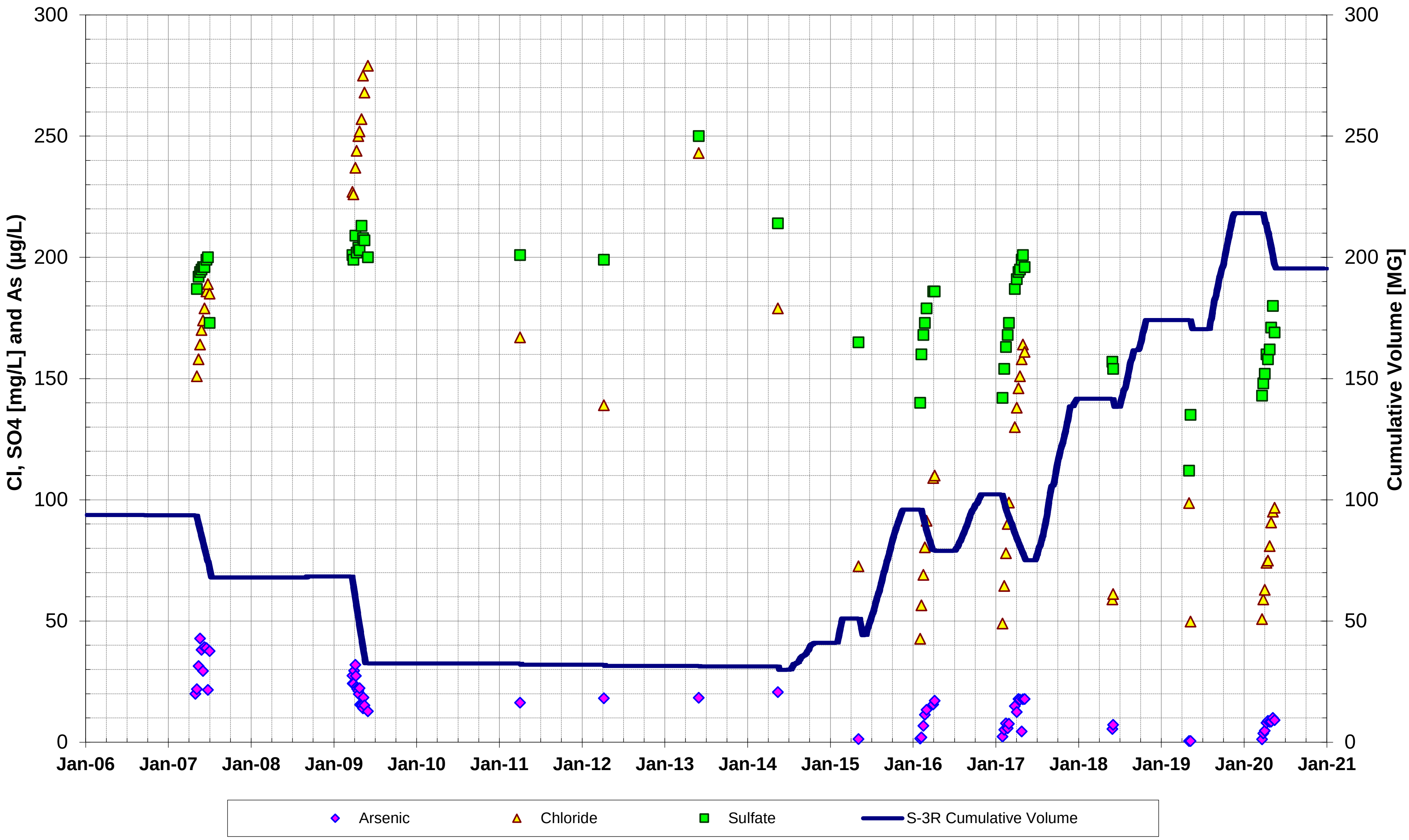


Figure 4-9
S-3R Water Quality Data

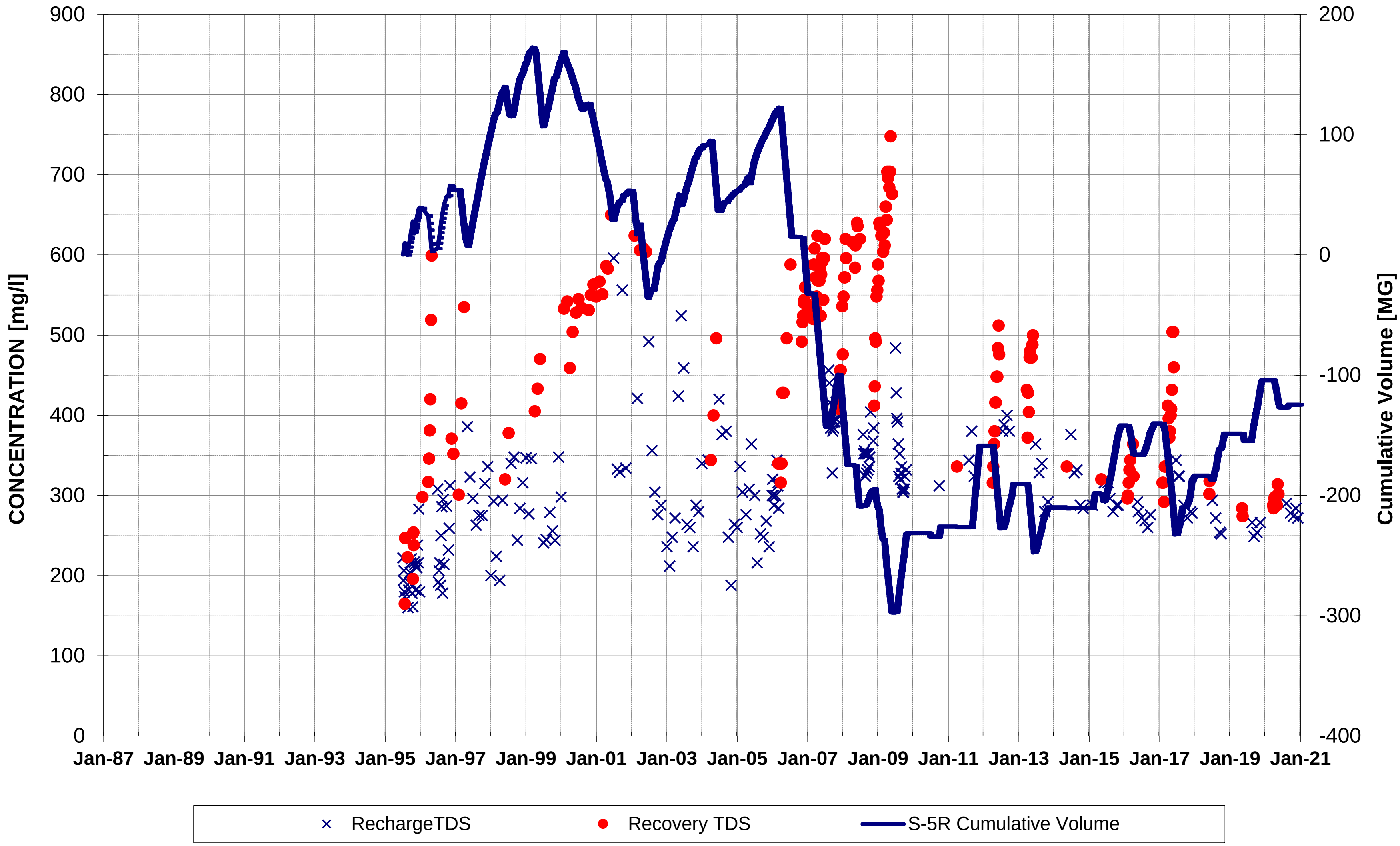


Figure 4-10
S-5R Water Quality Data

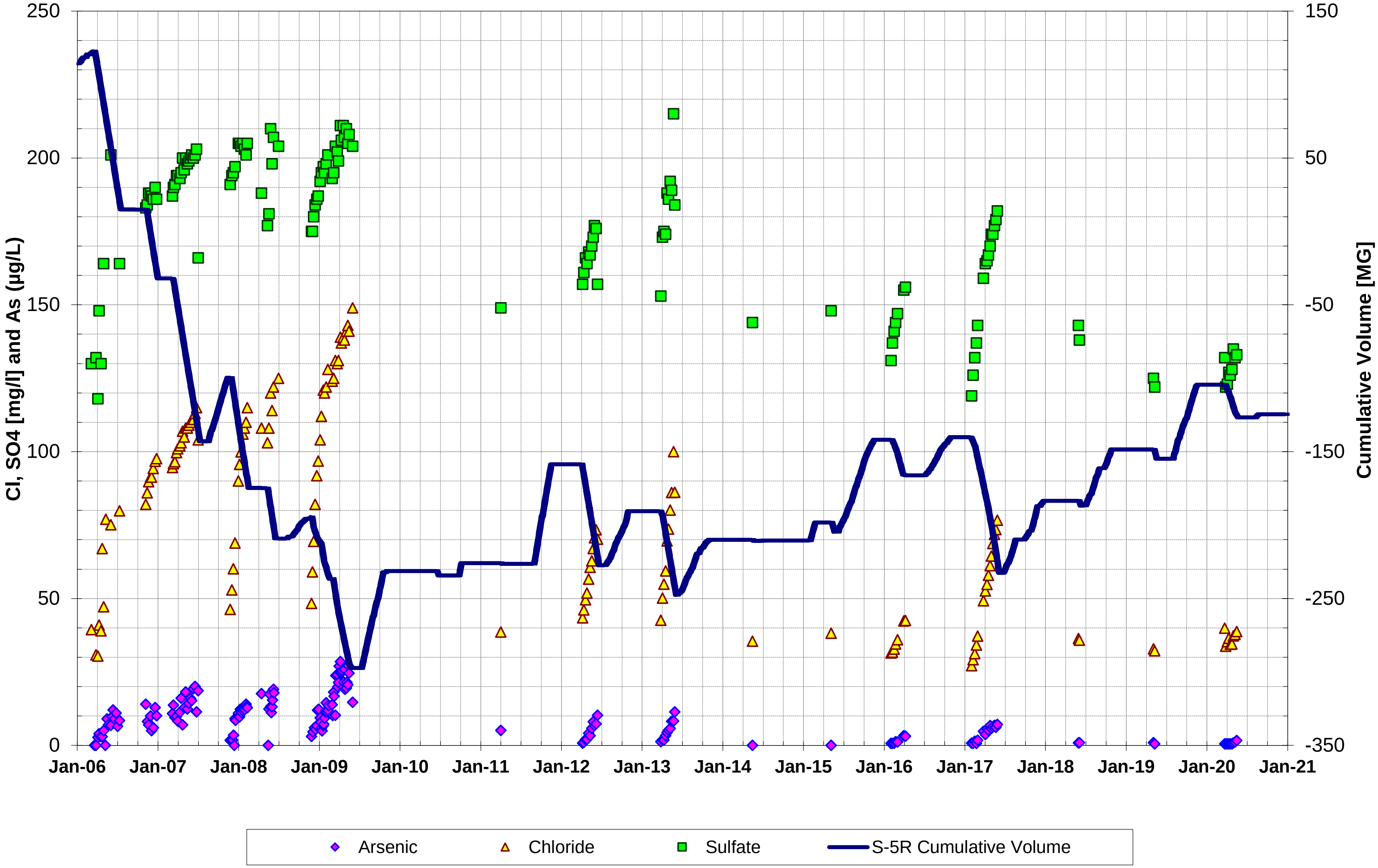


Figure 4-11
S-5R Water Quality Data

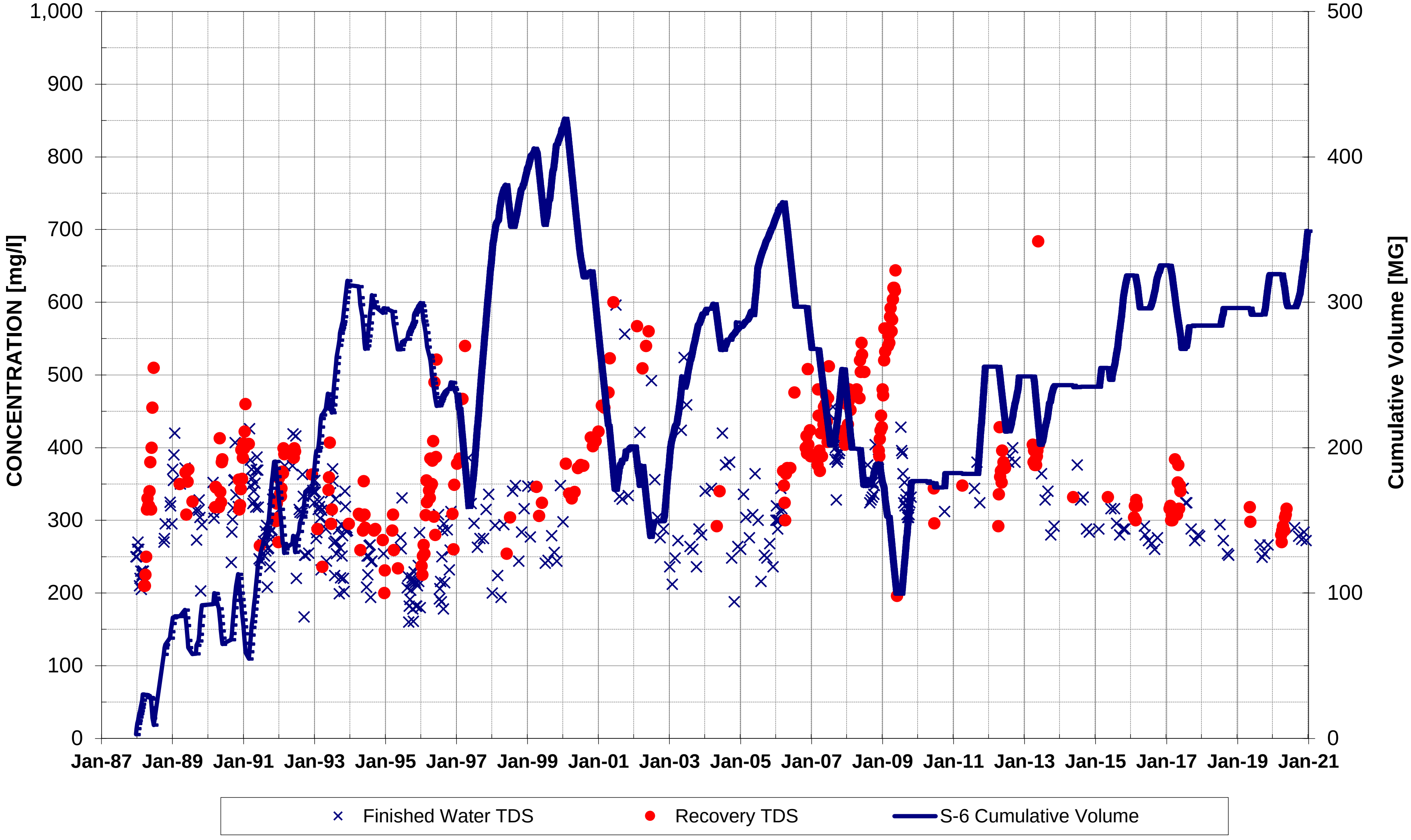


Figure 4-12
S-6 Water Quality Data

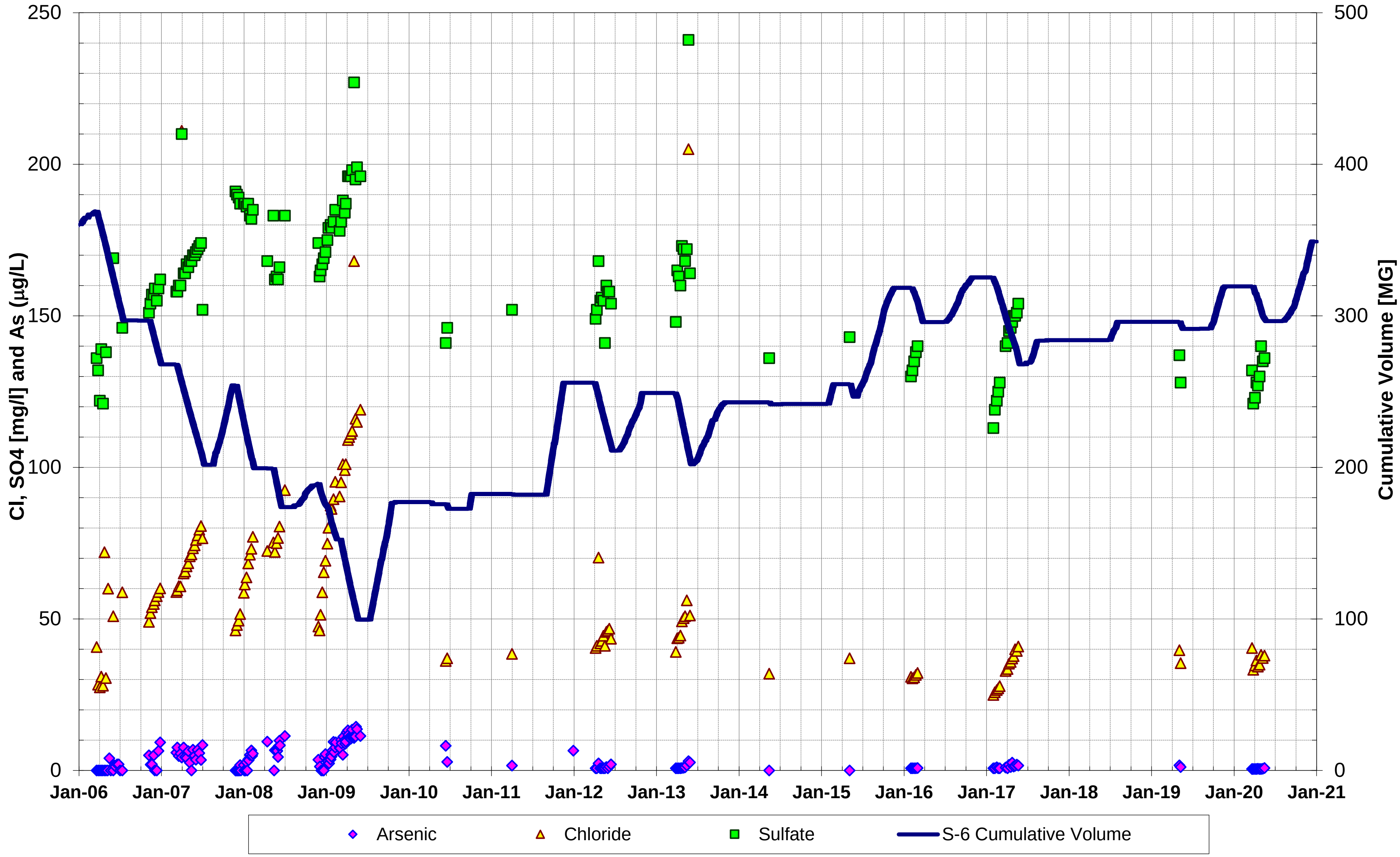


Figure 4-13

S-6 Water Quality Data

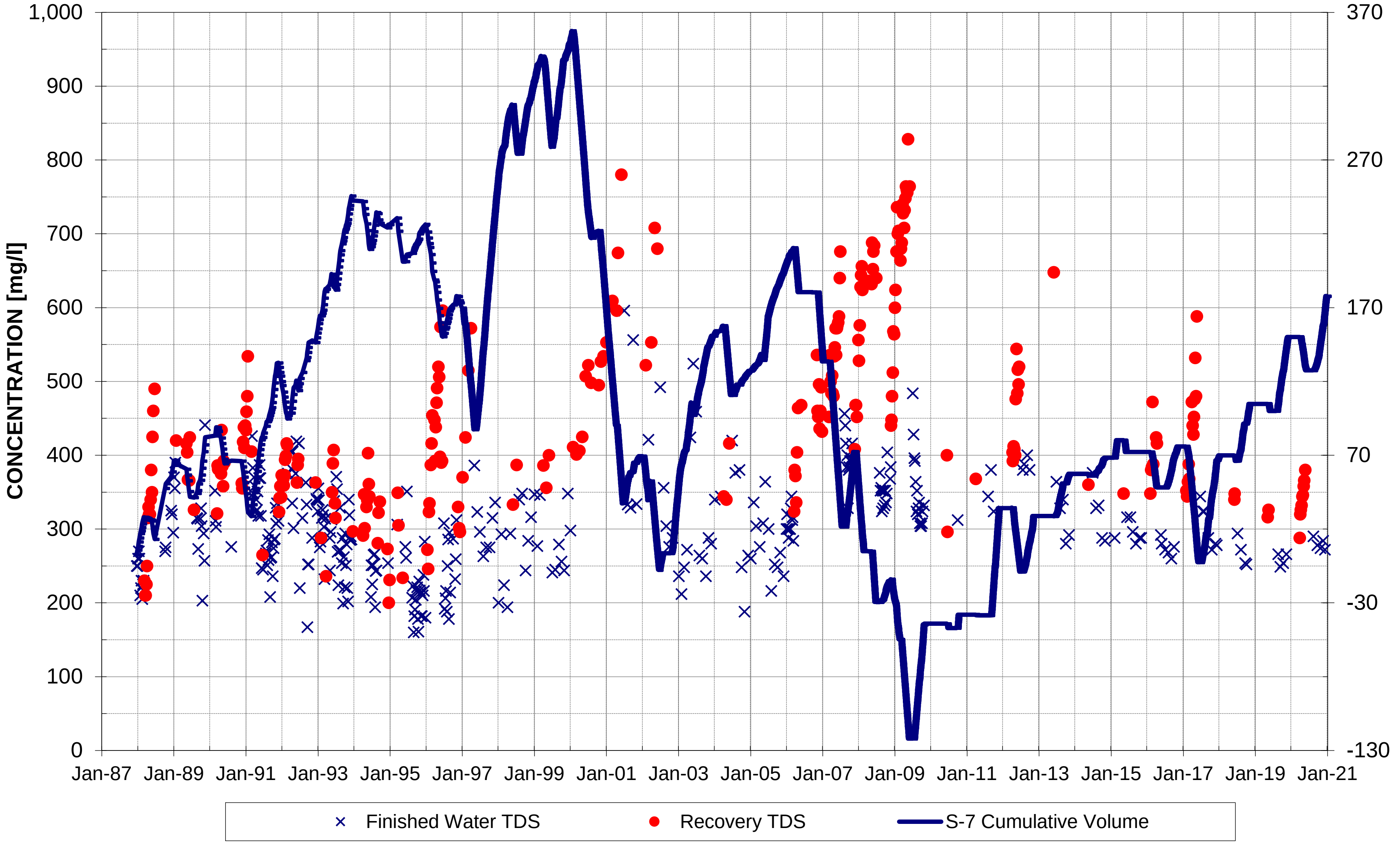


Figure 4-14
S-7 Water Quality Data

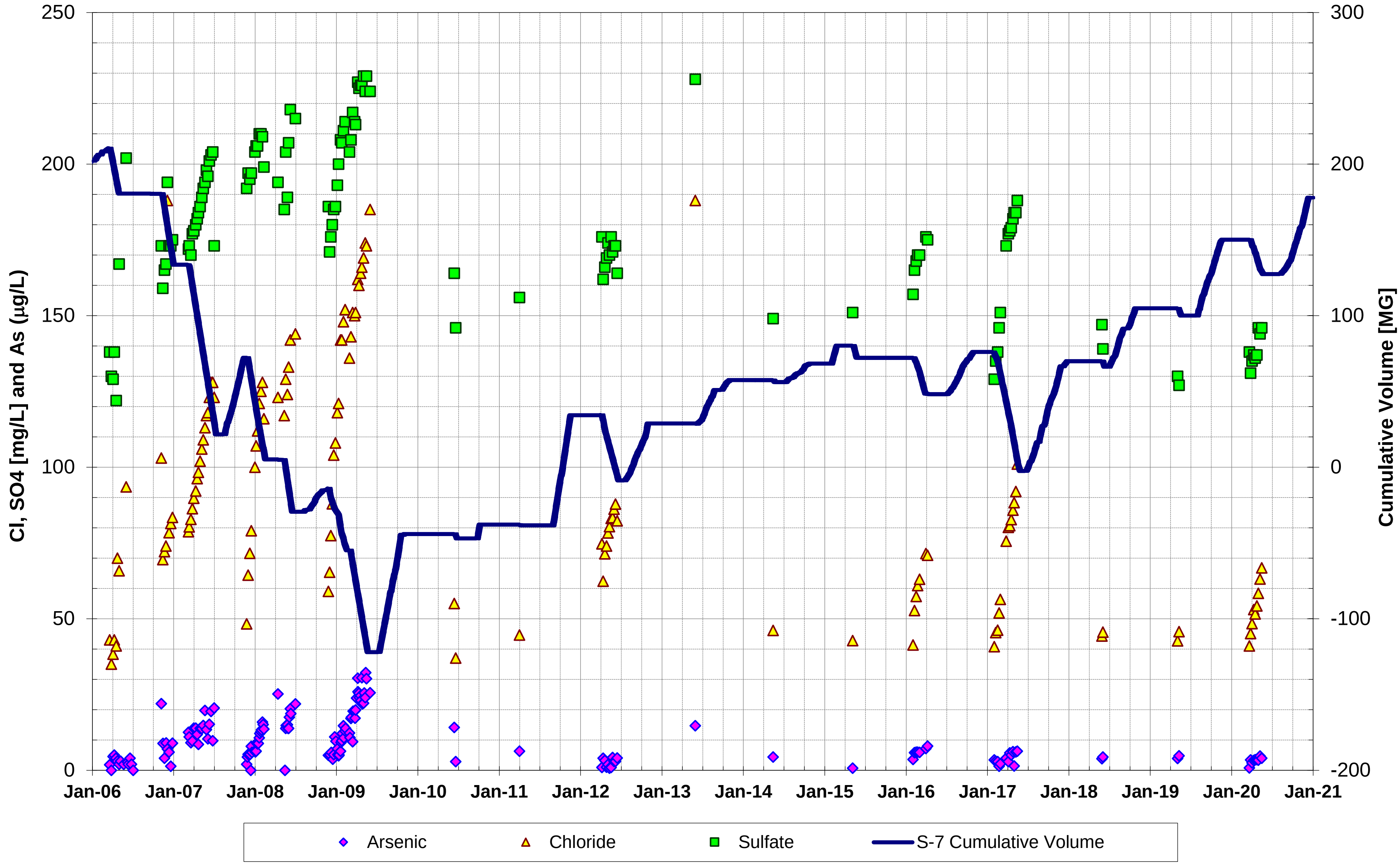


Figure 4-15
S-7 Water Quality Data

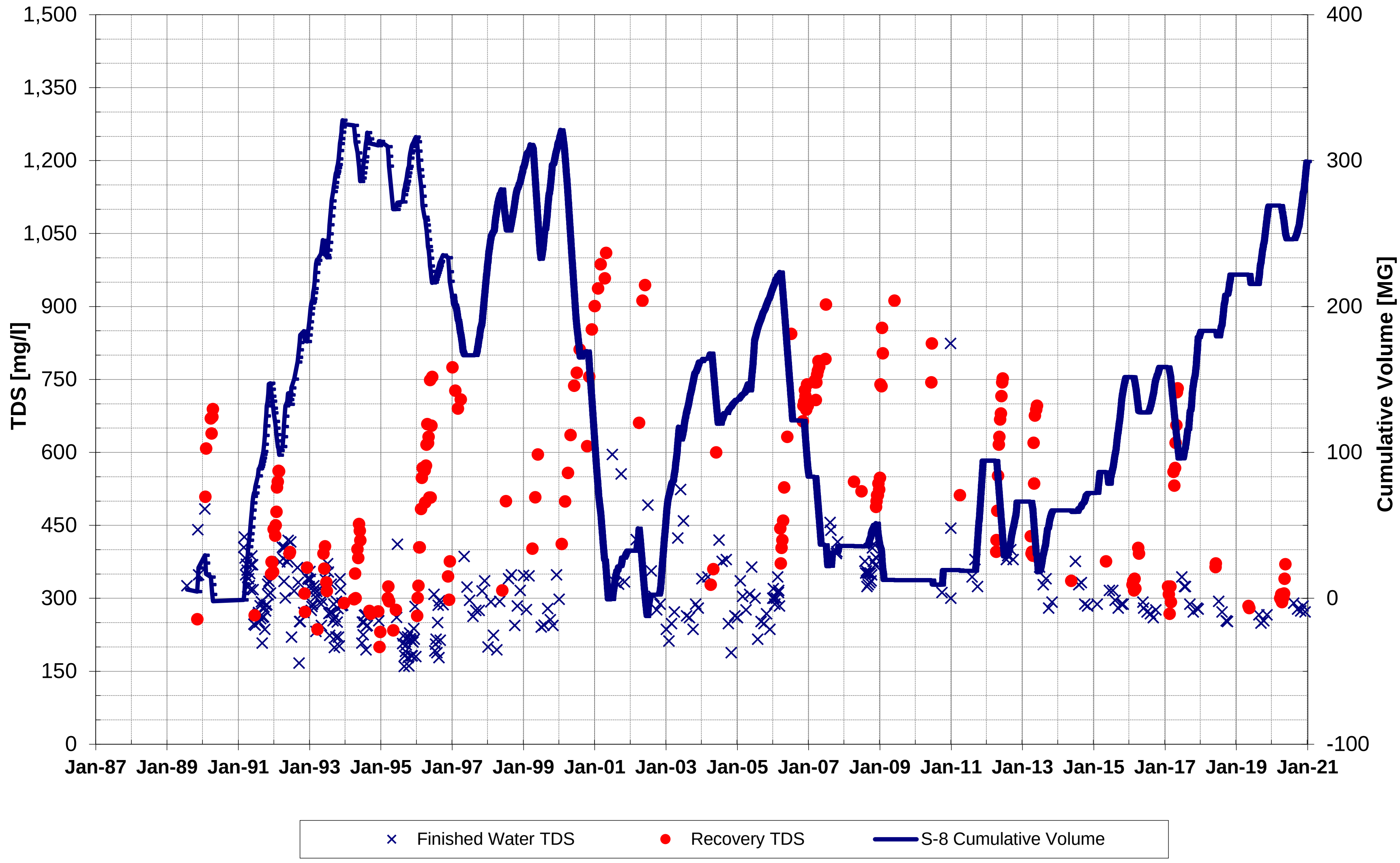


Figure 4-16

S-8 Water Quality Data

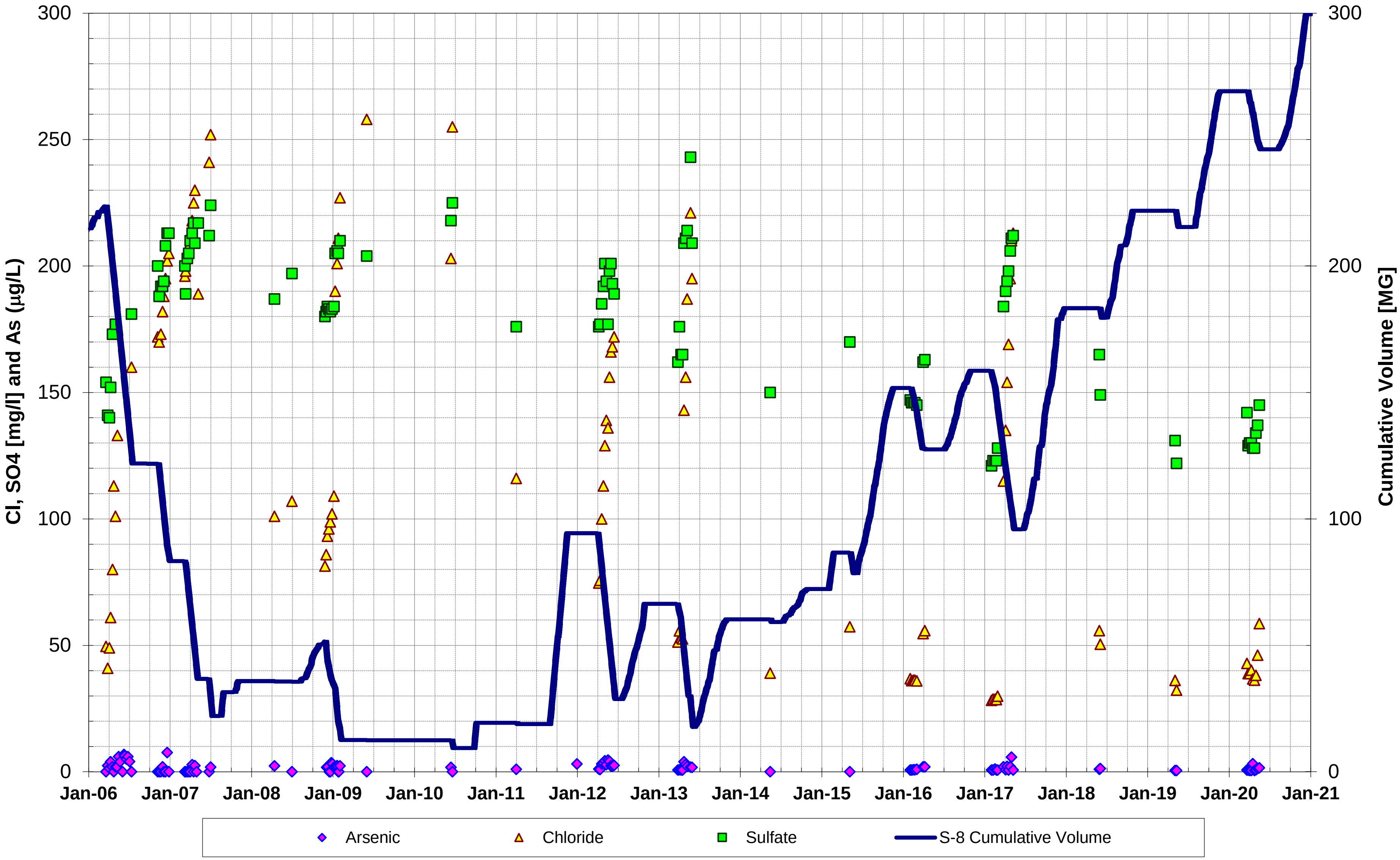


Figure 4-17
S-8 Water Quality Data

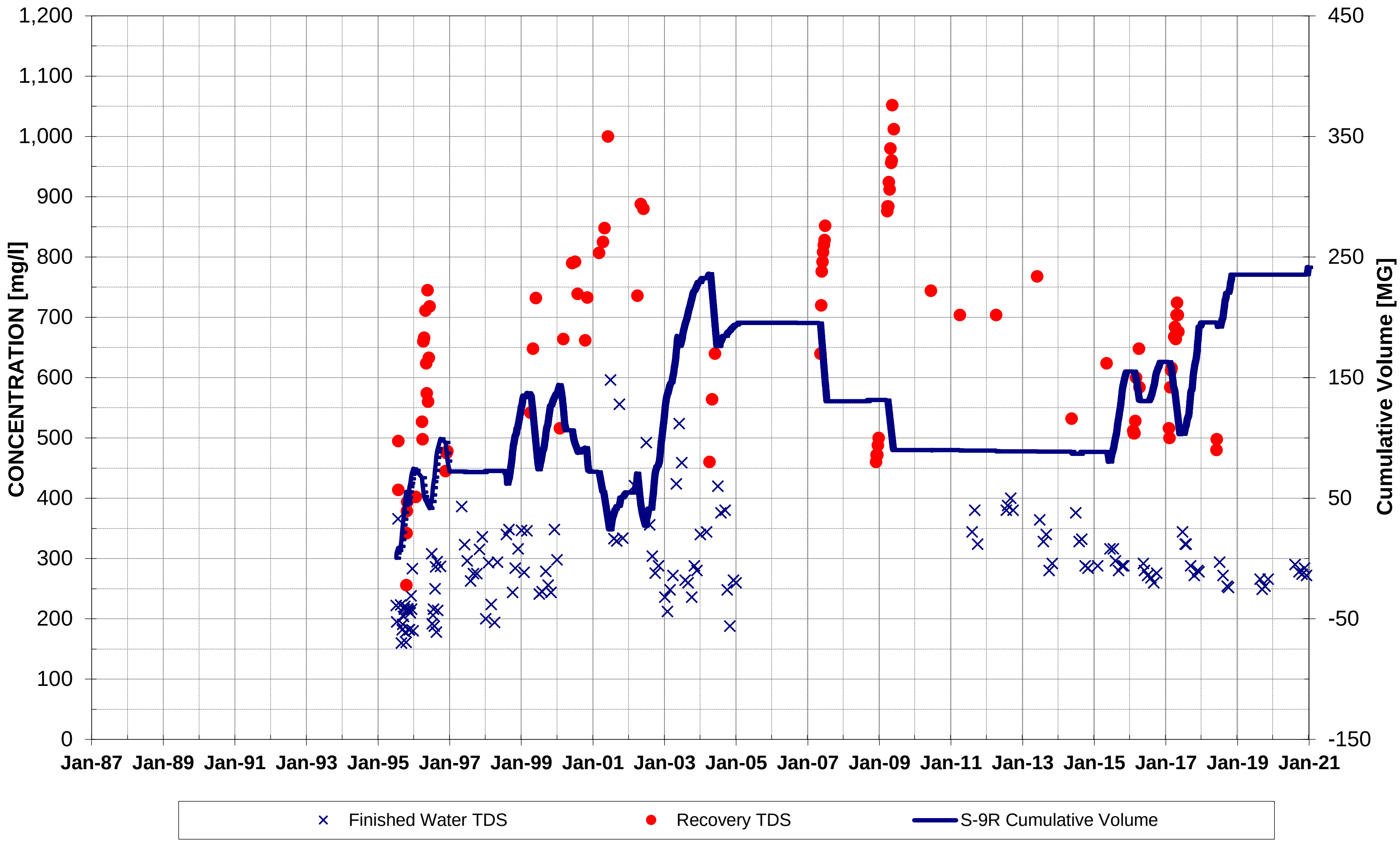


Figure 4-18
S-9R Water Quality Data

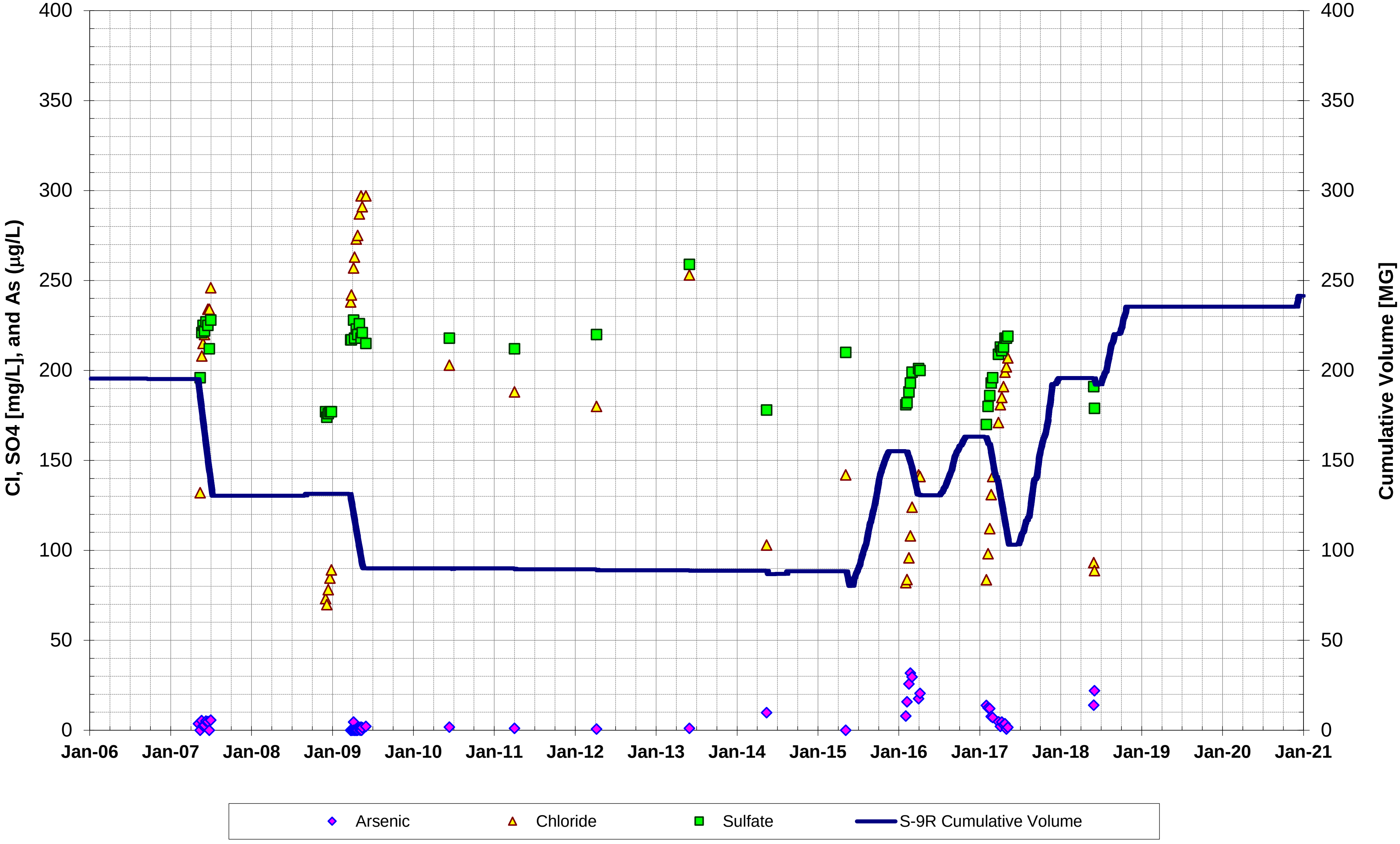


Figure 4-19
S-9R Water Quality Data

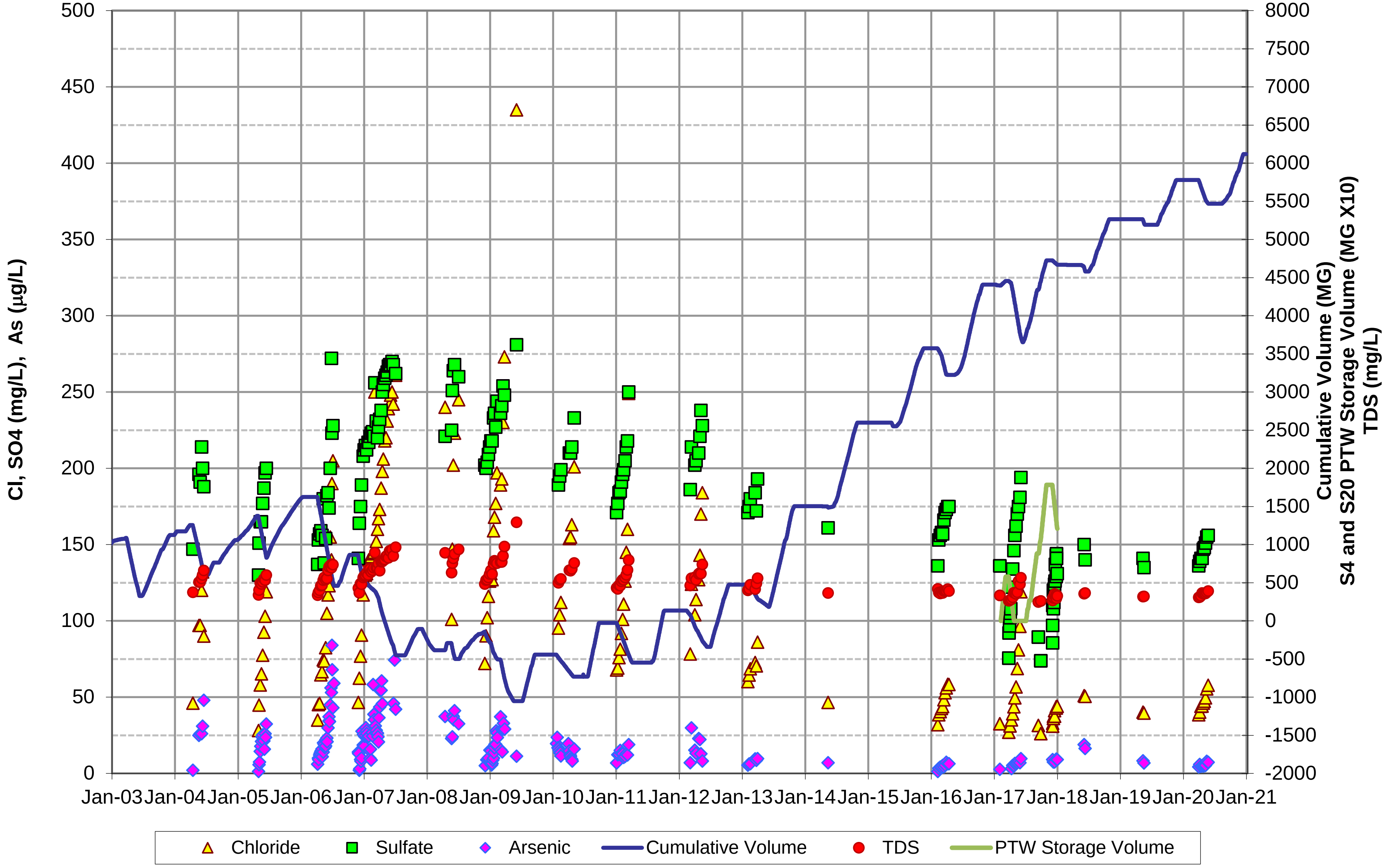


Figure 4-20
S-4 Water Quality Data

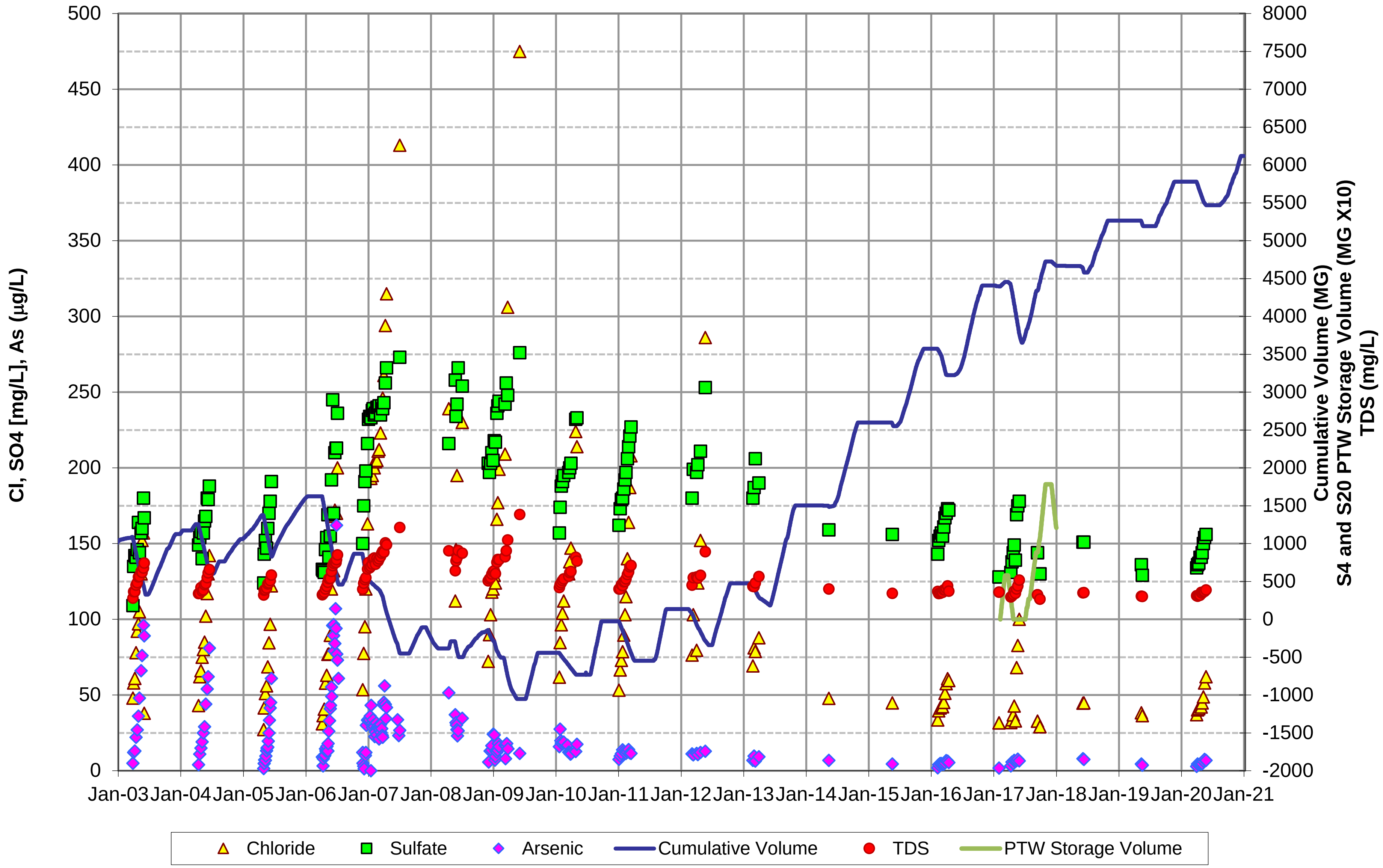


Figure 4-21
S-10 Water Quality Data

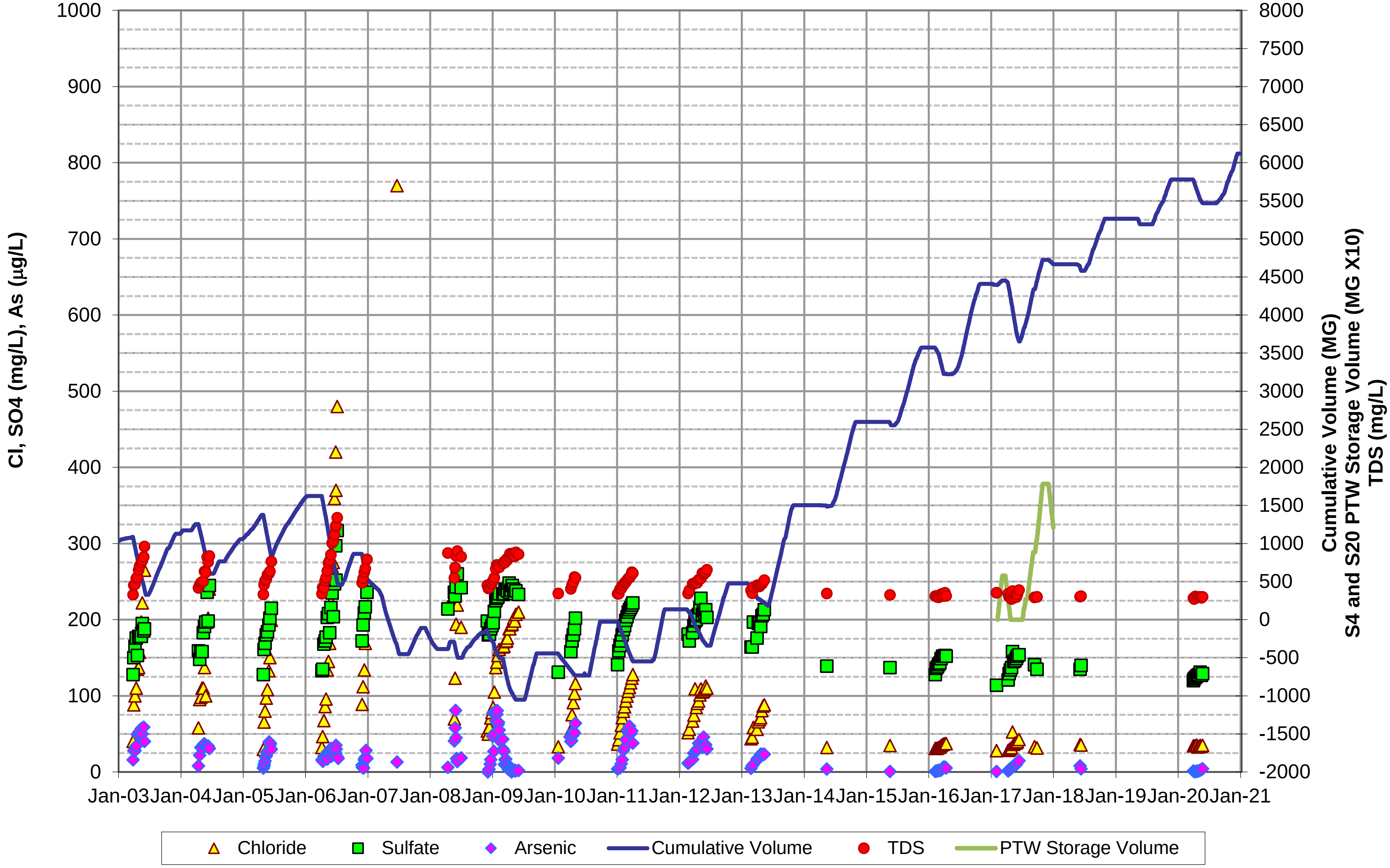


Figure 4-22

S-11 Water Quality Data

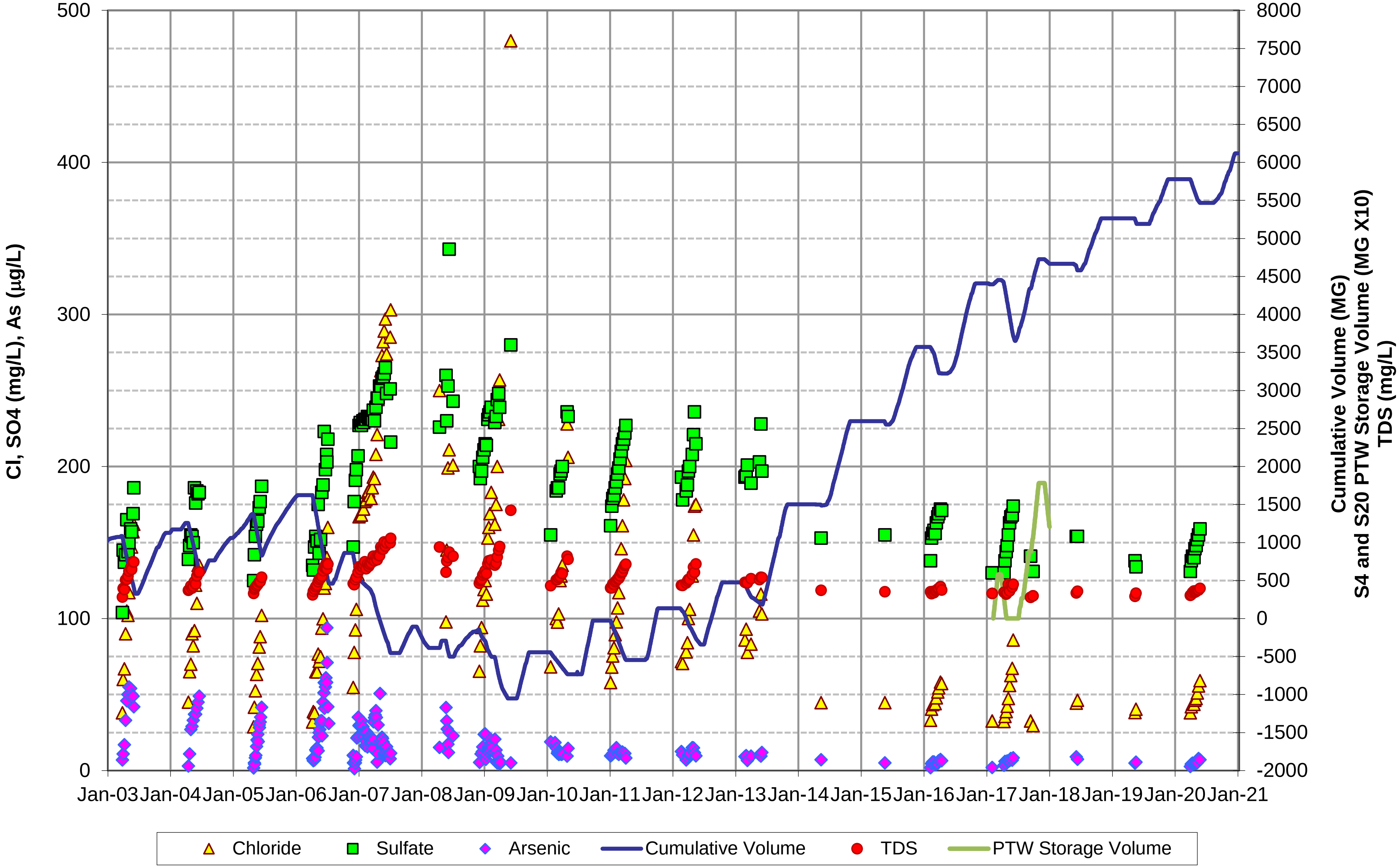


Figure 4-23
S-12 Water Quality Data

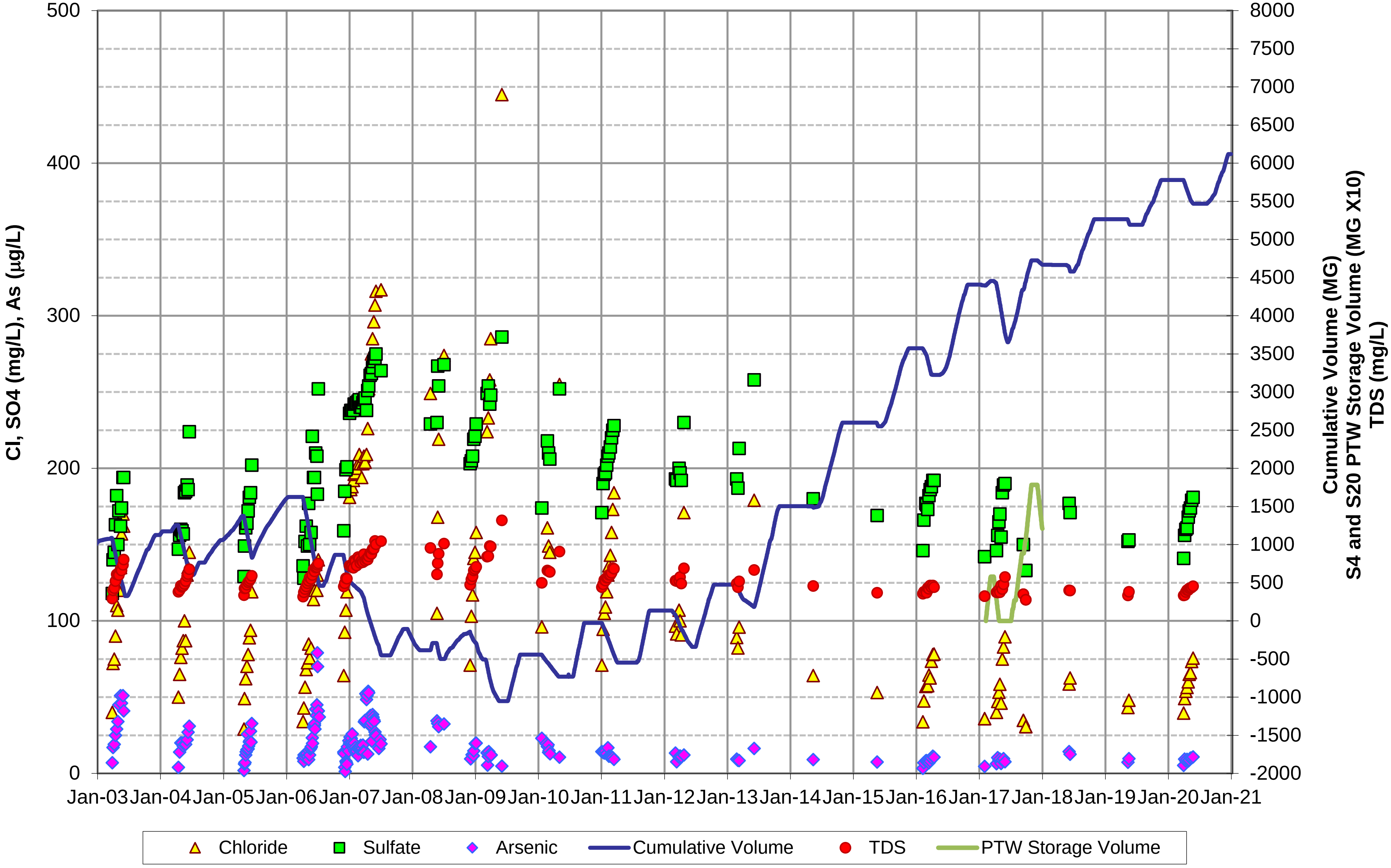


Figure 4-24
S-13 Water Quality Data

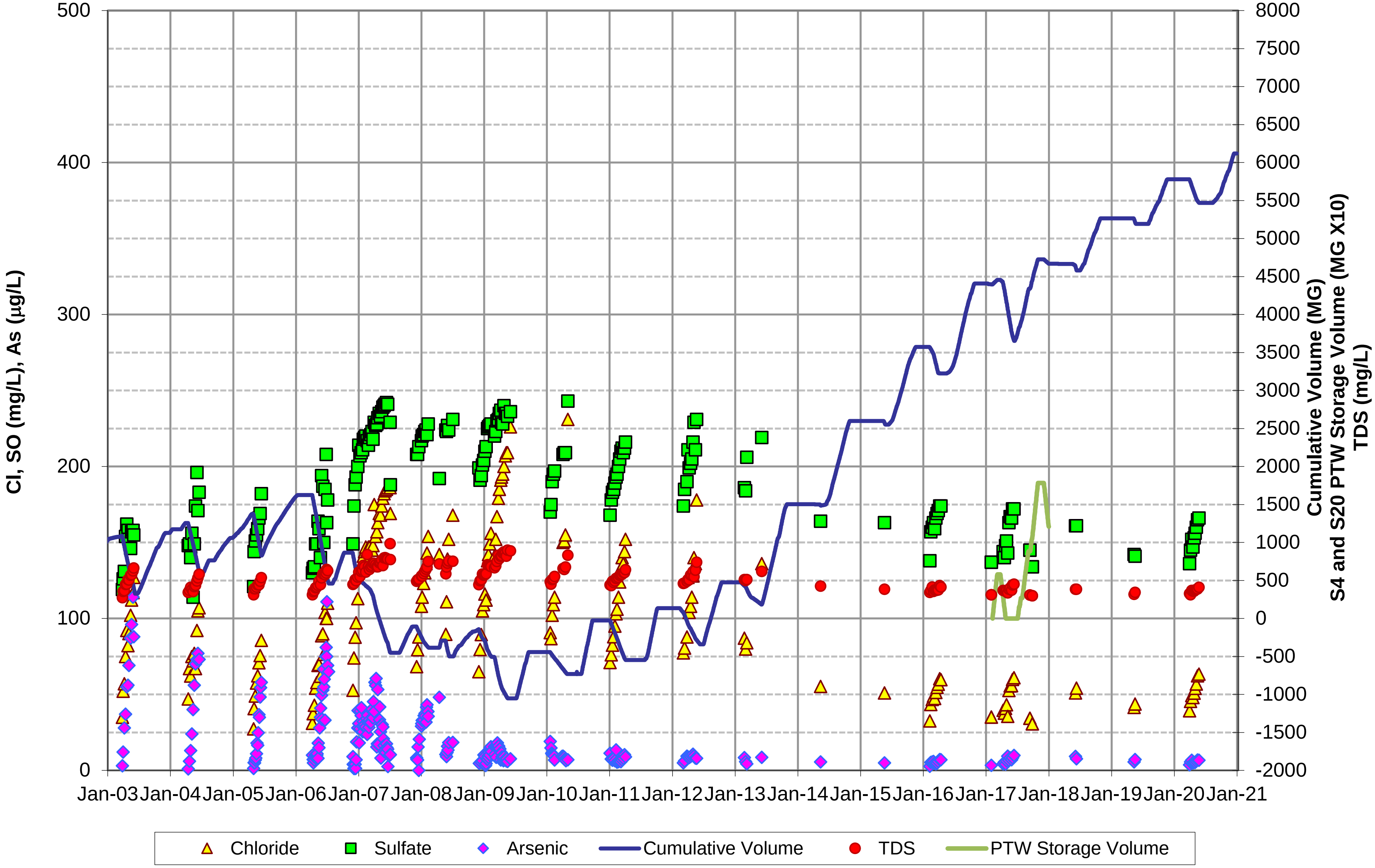


Figure 4-25
S-14 Water Quality Data

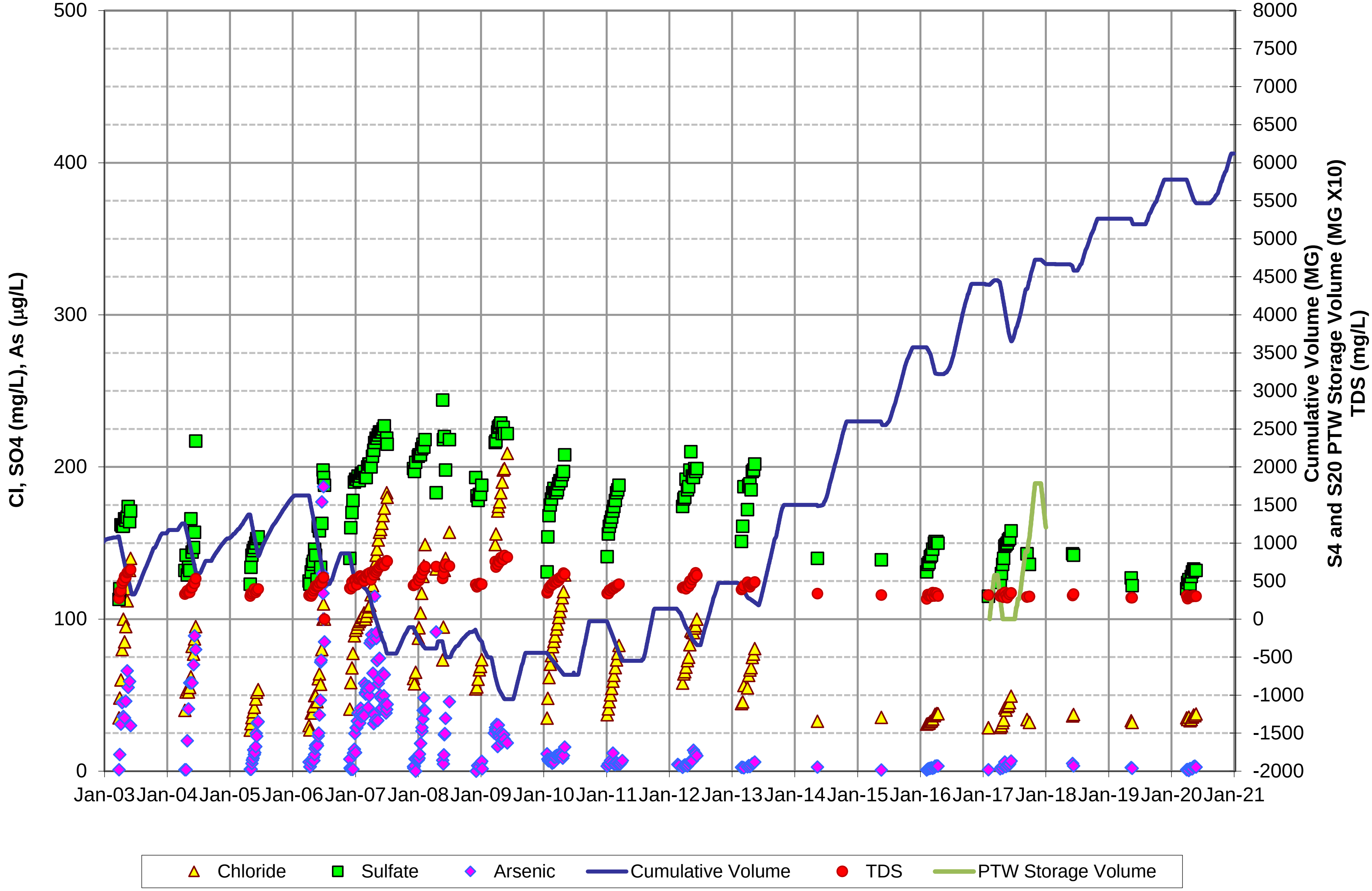


Figure 4-26
S-15 Water Quality Data

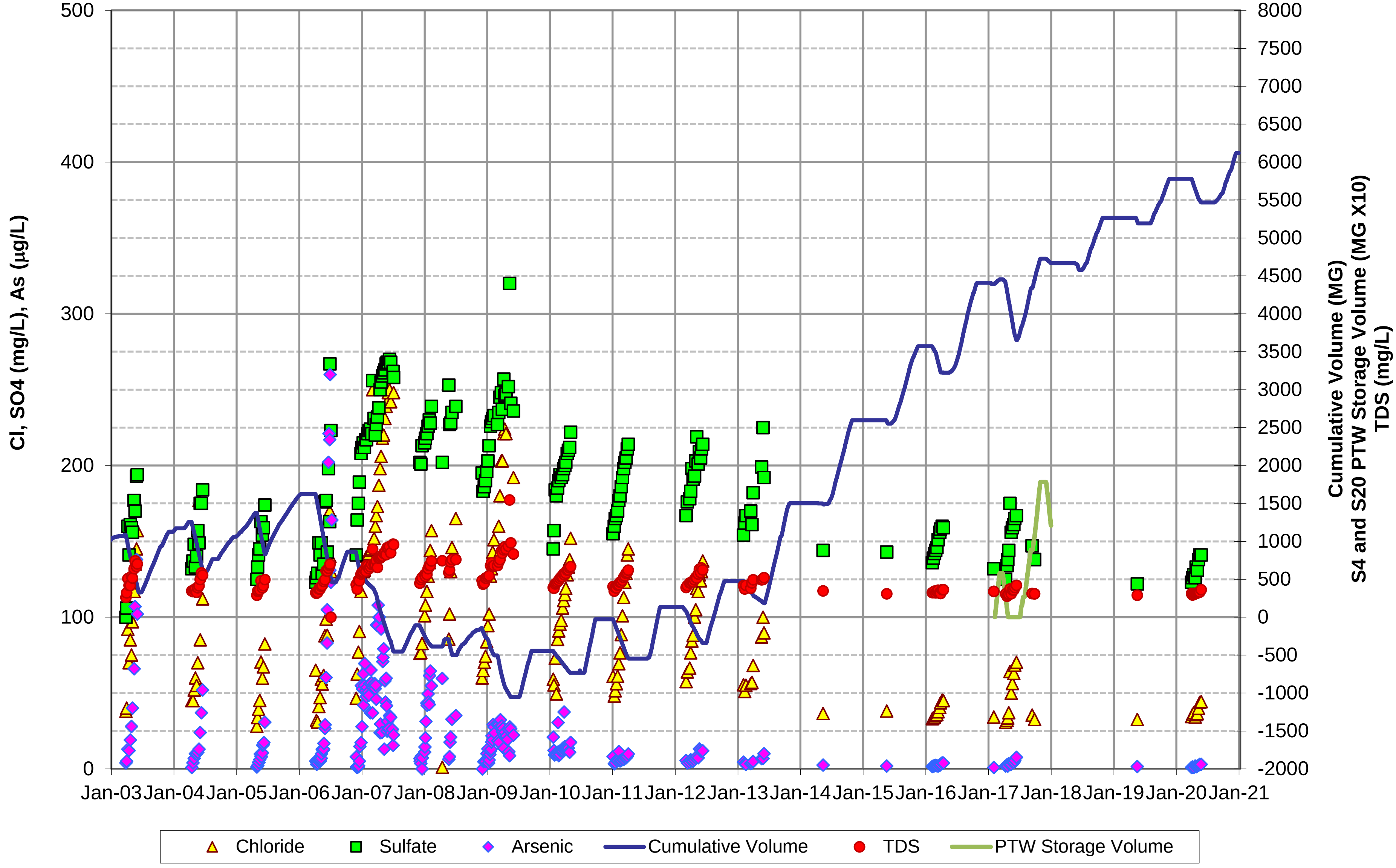


Figure 4-27

S-16 Water Quality Data

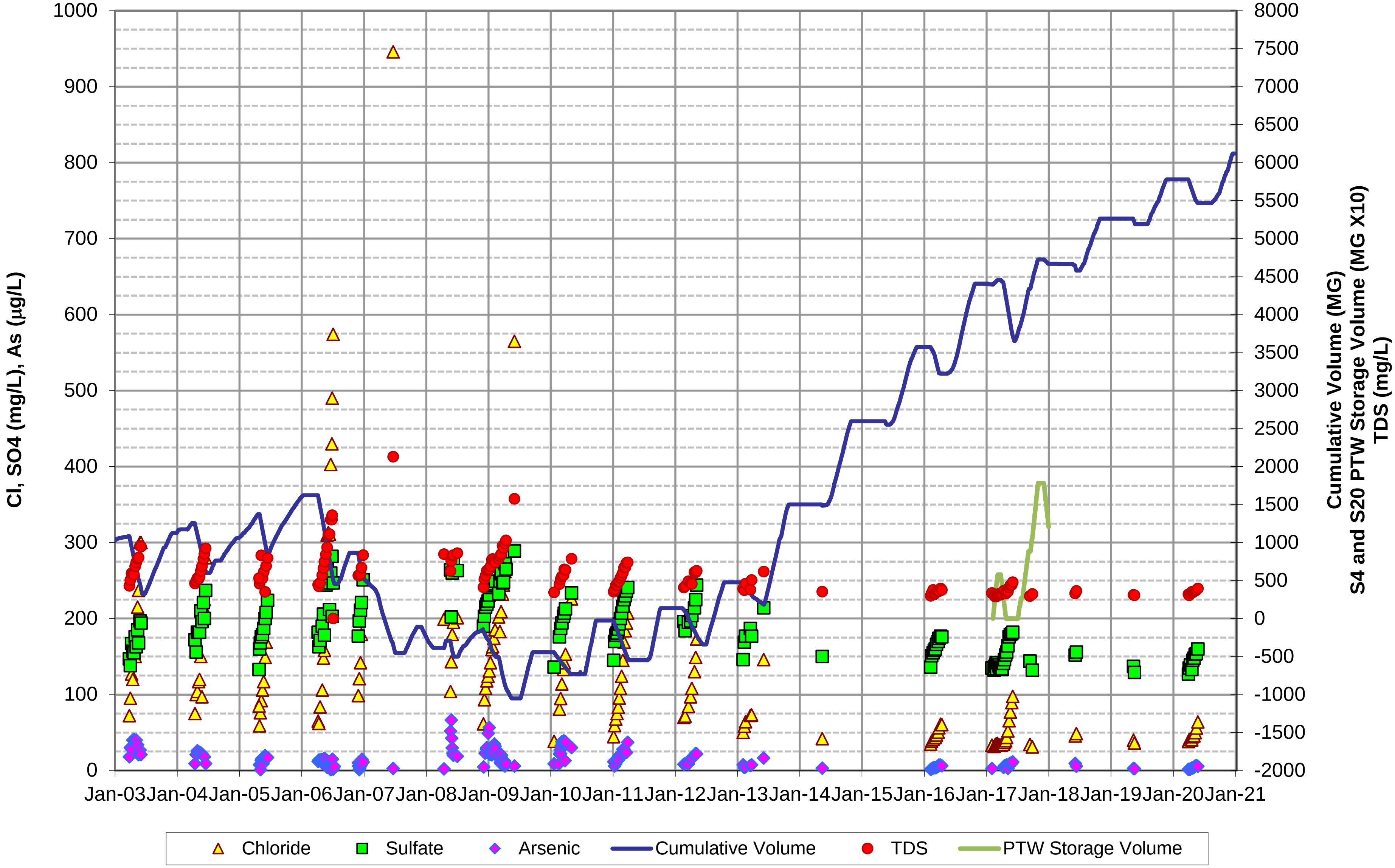


Figure 4-28
S-17 Water Quality Data

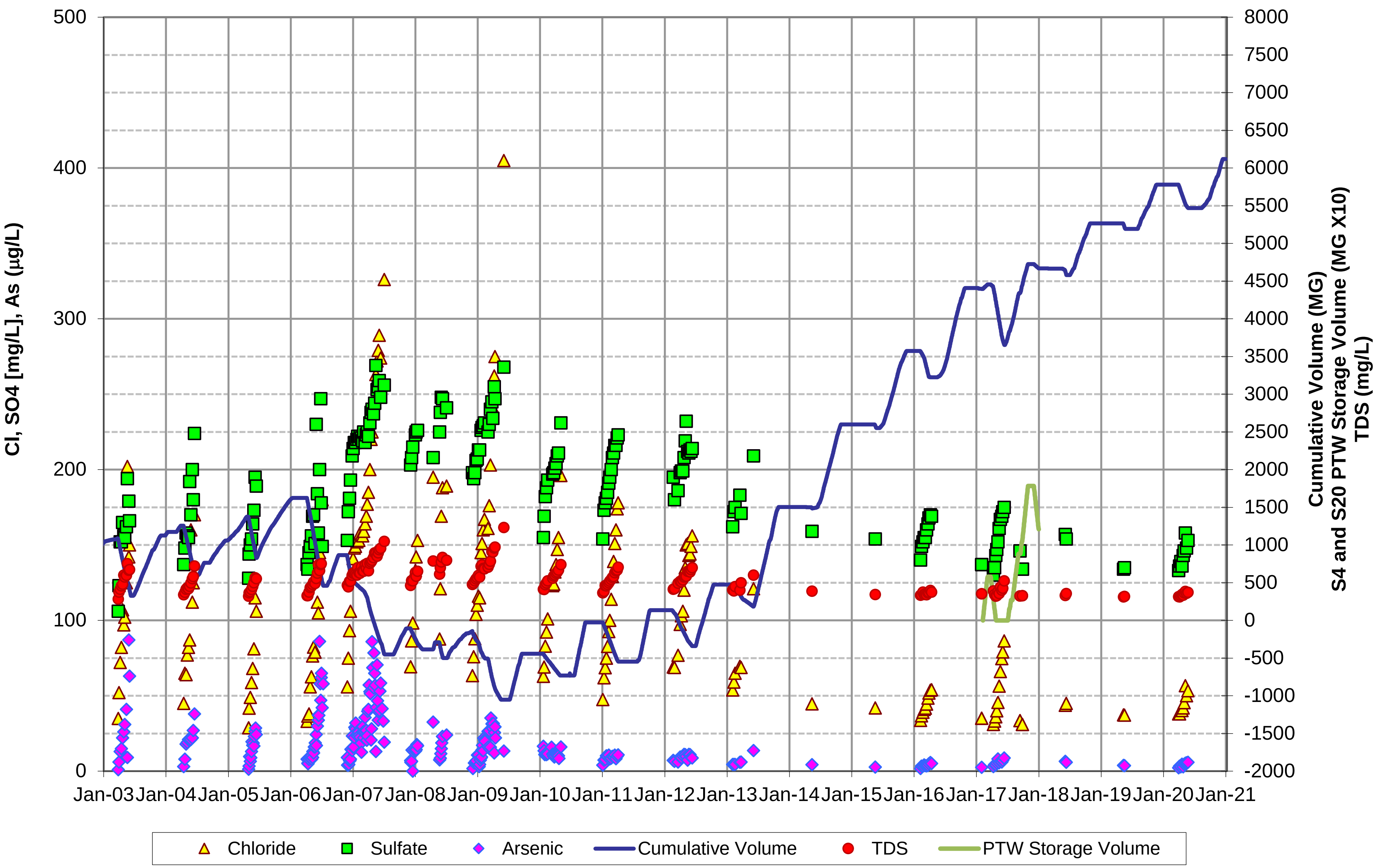


Figure 4-29
S-18 Water Quality Data

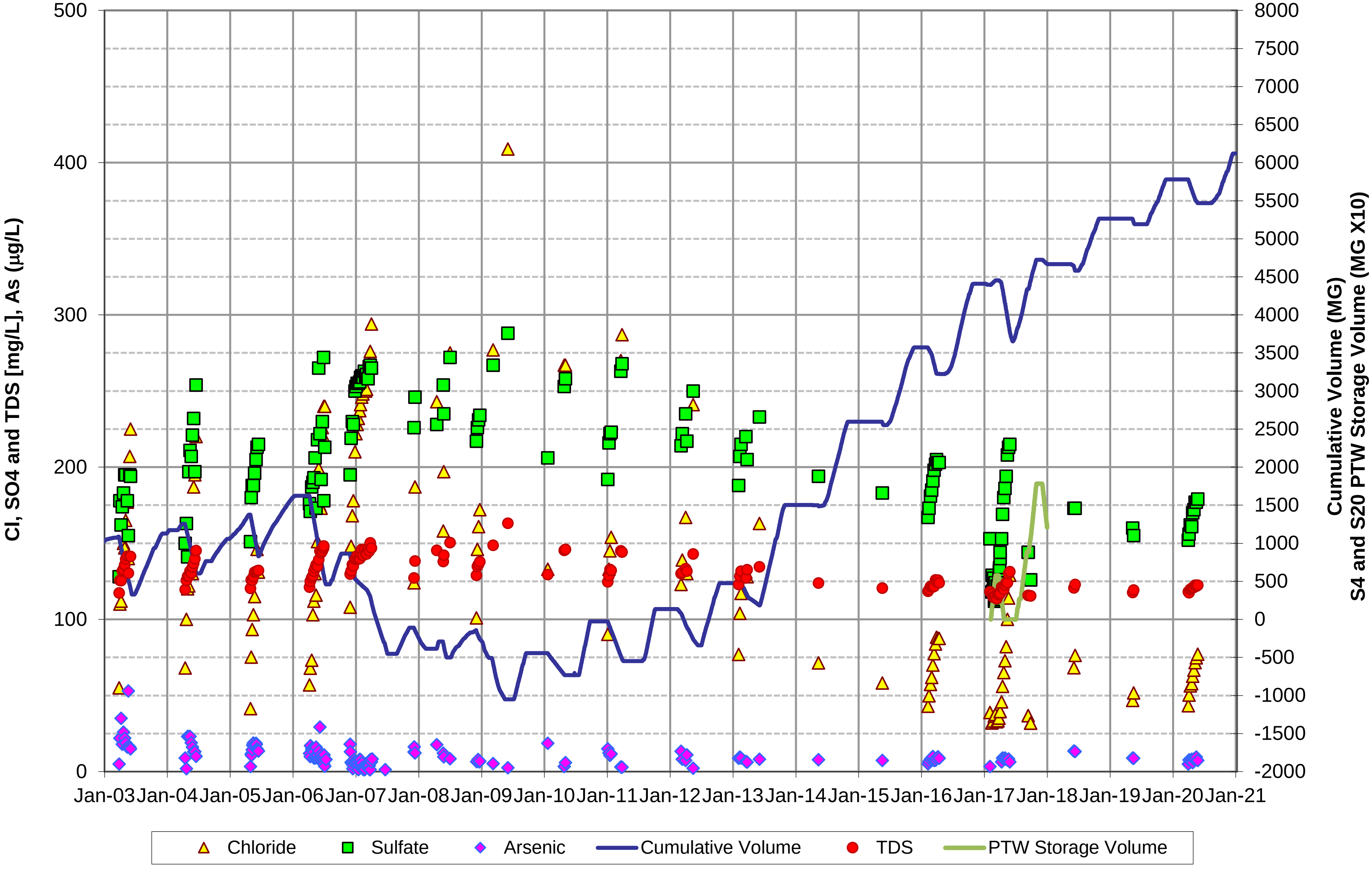


Figure 4-30
S-19 Water Quality Data

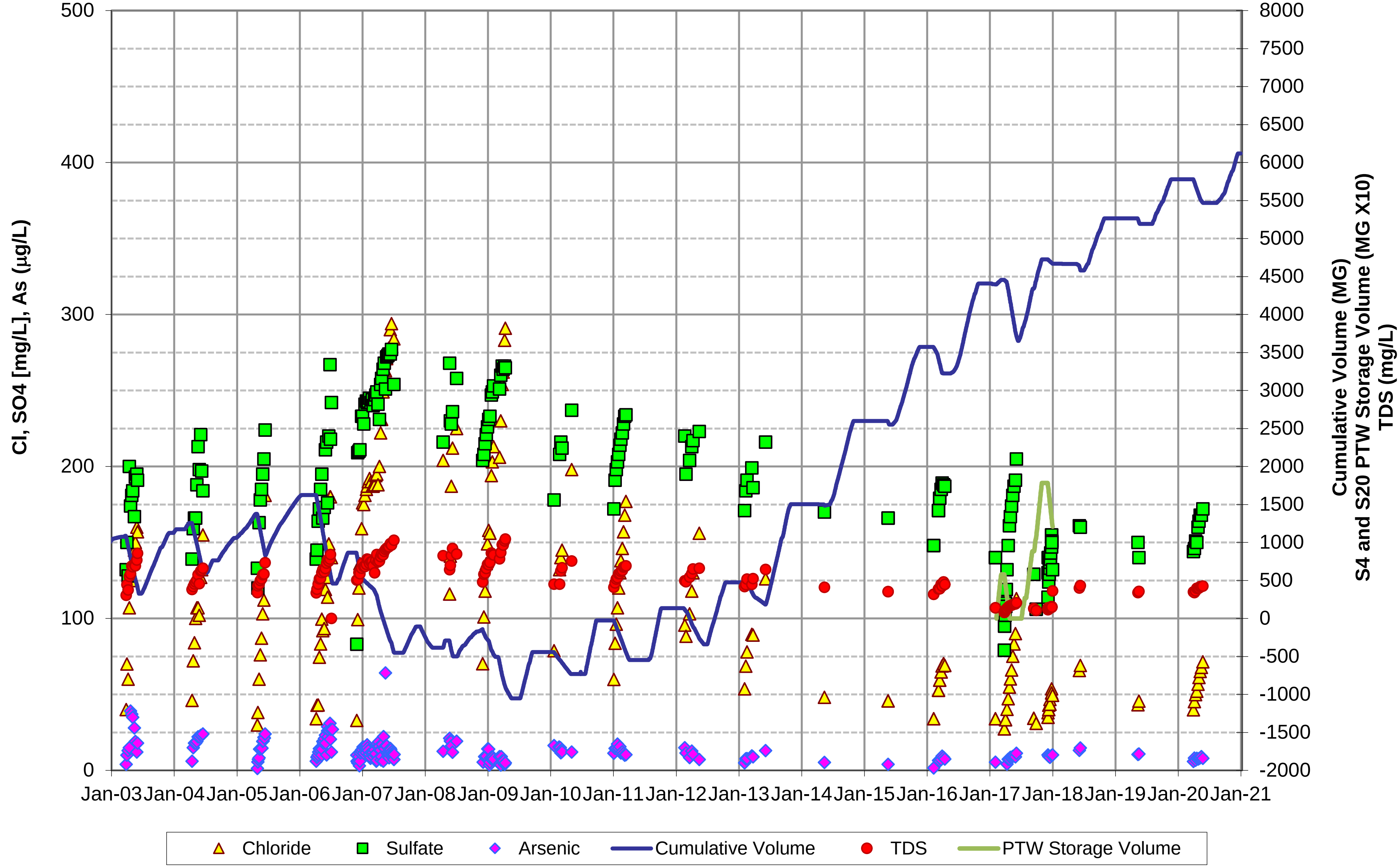


Figure 4-31
S-20 Water Quality Data

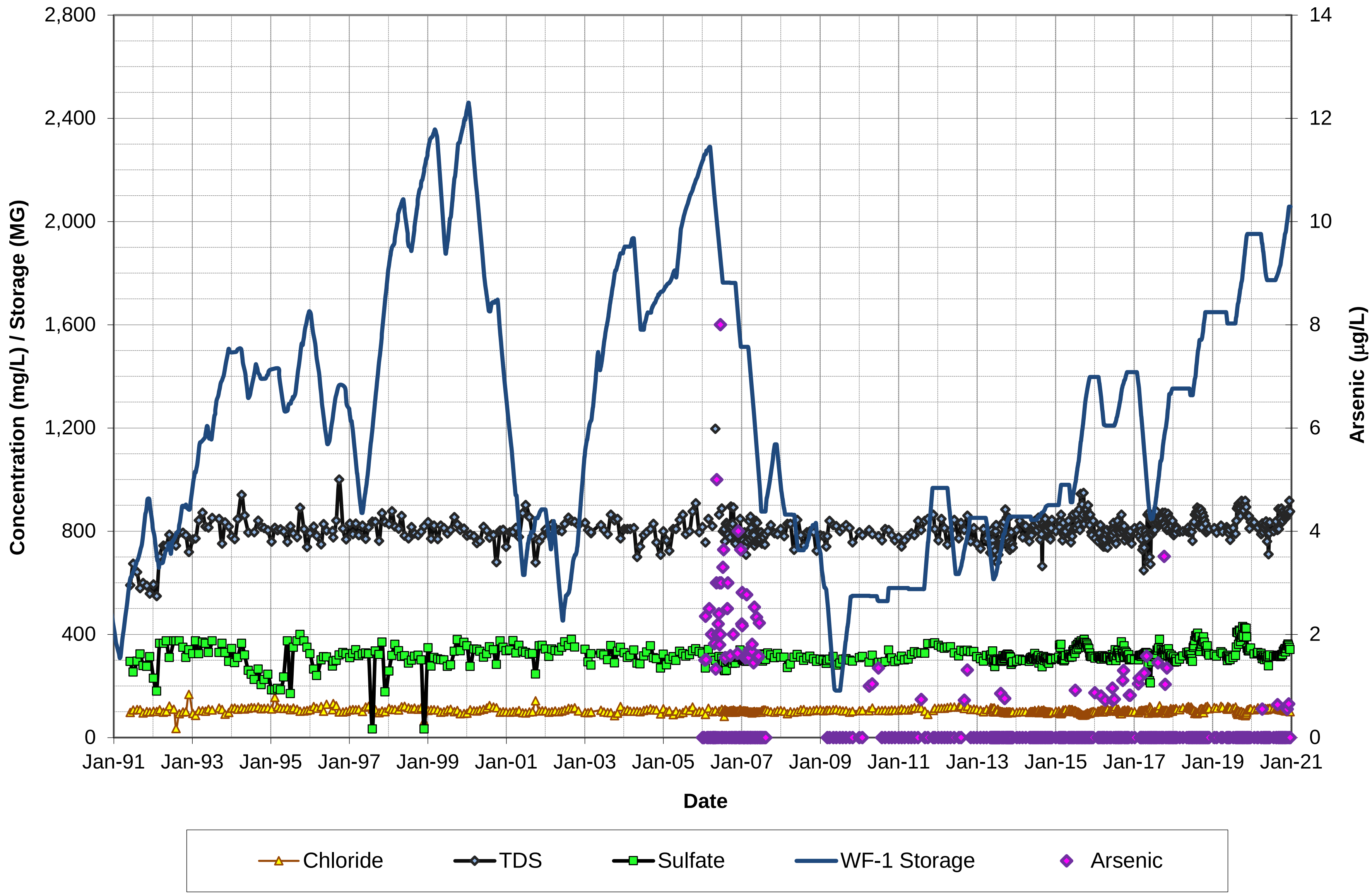


Figure 4-32

Monitoring Well M-2 Water Quality

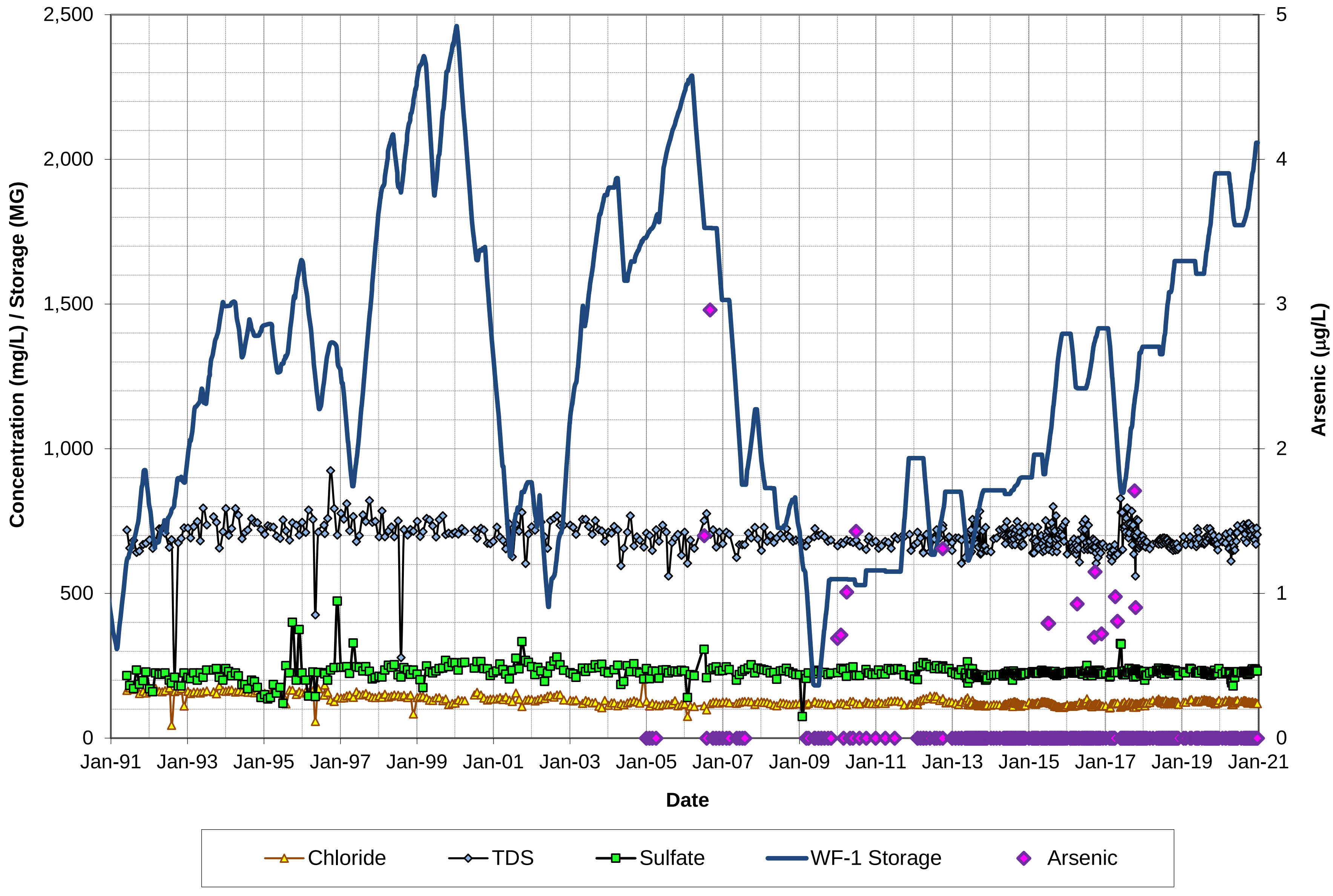


Figure 4-33
Monitoring Well T-2 Water Quality

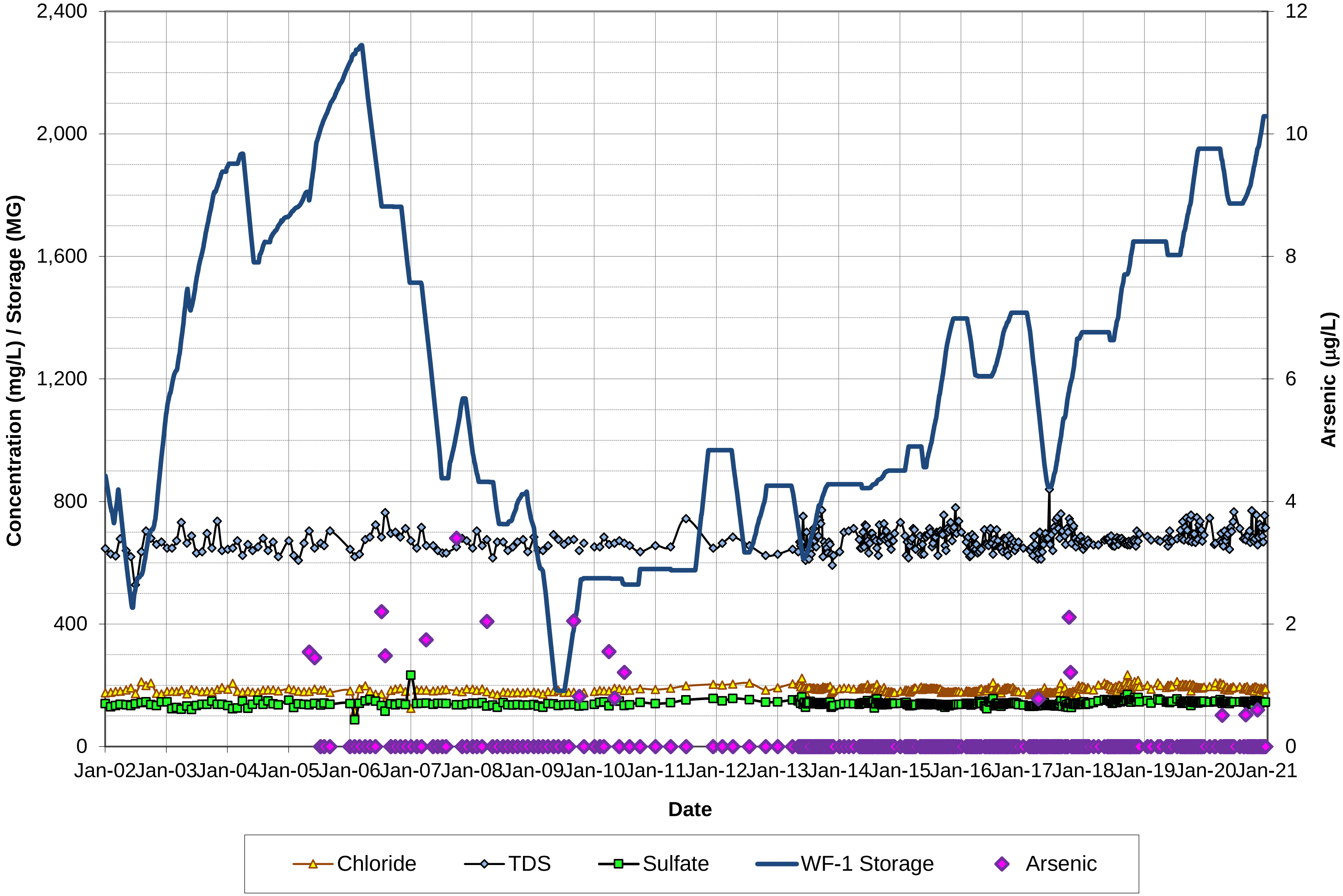


Figure 4-34
Monitoring Well T-7 Water Quality

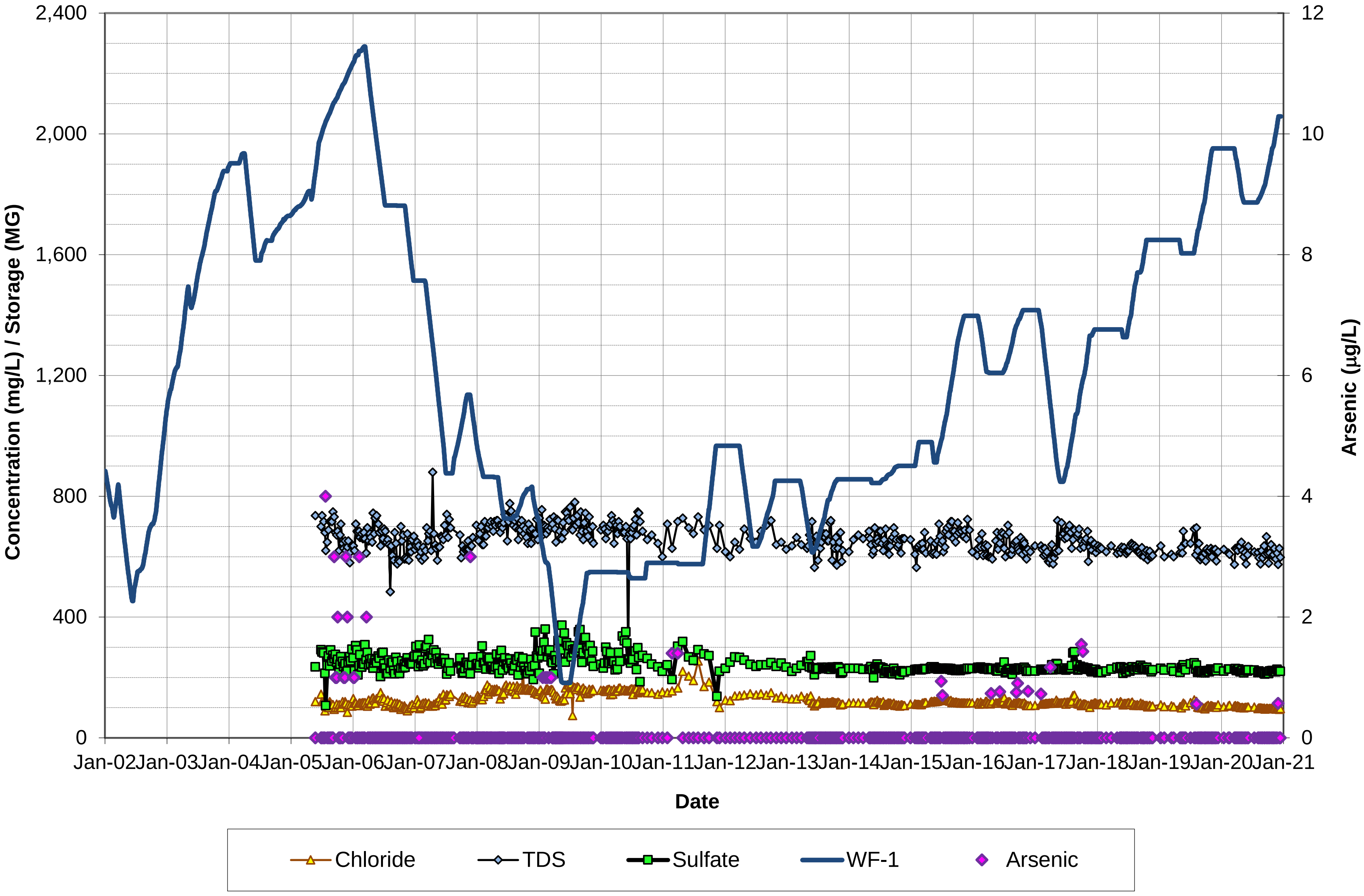
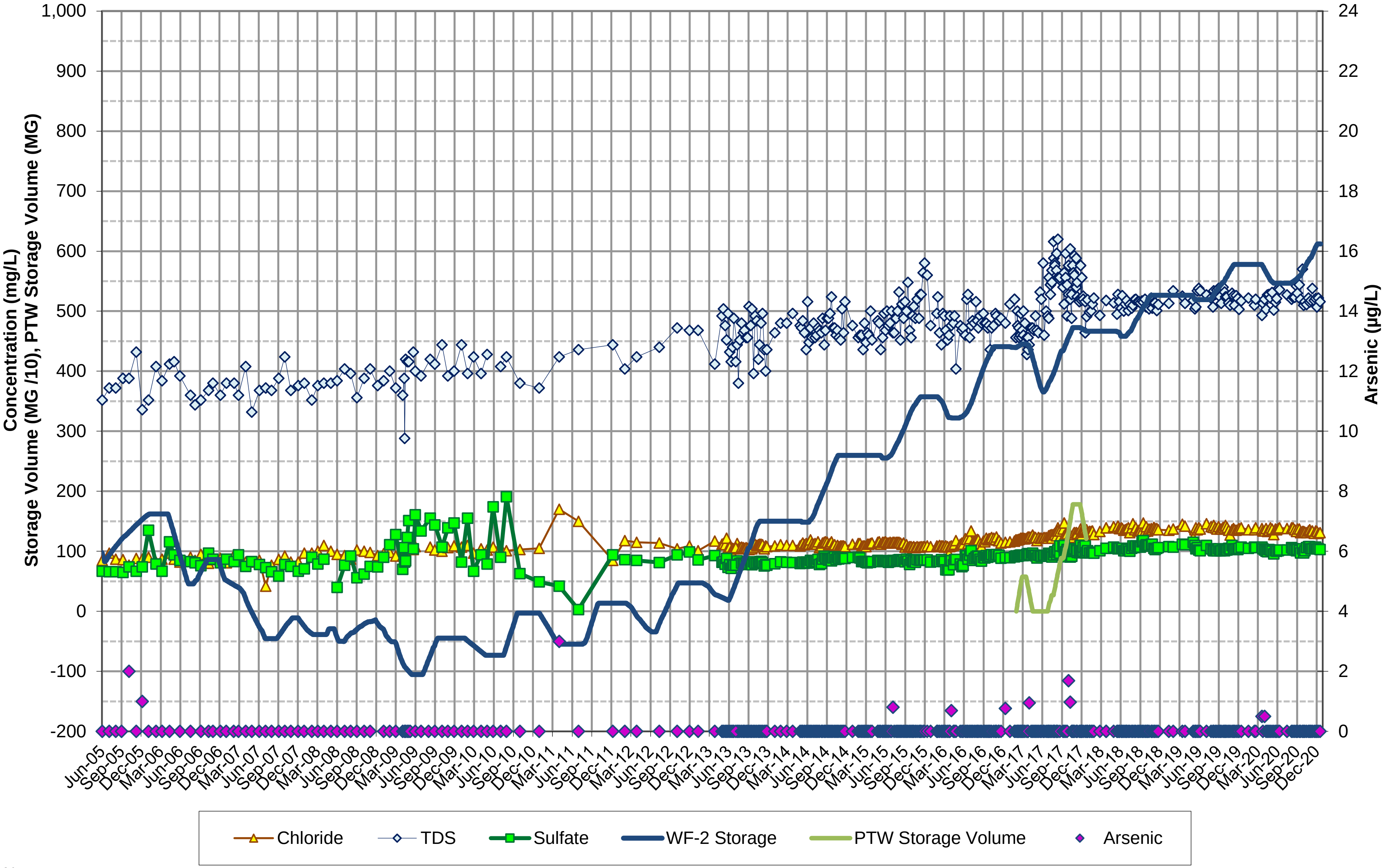


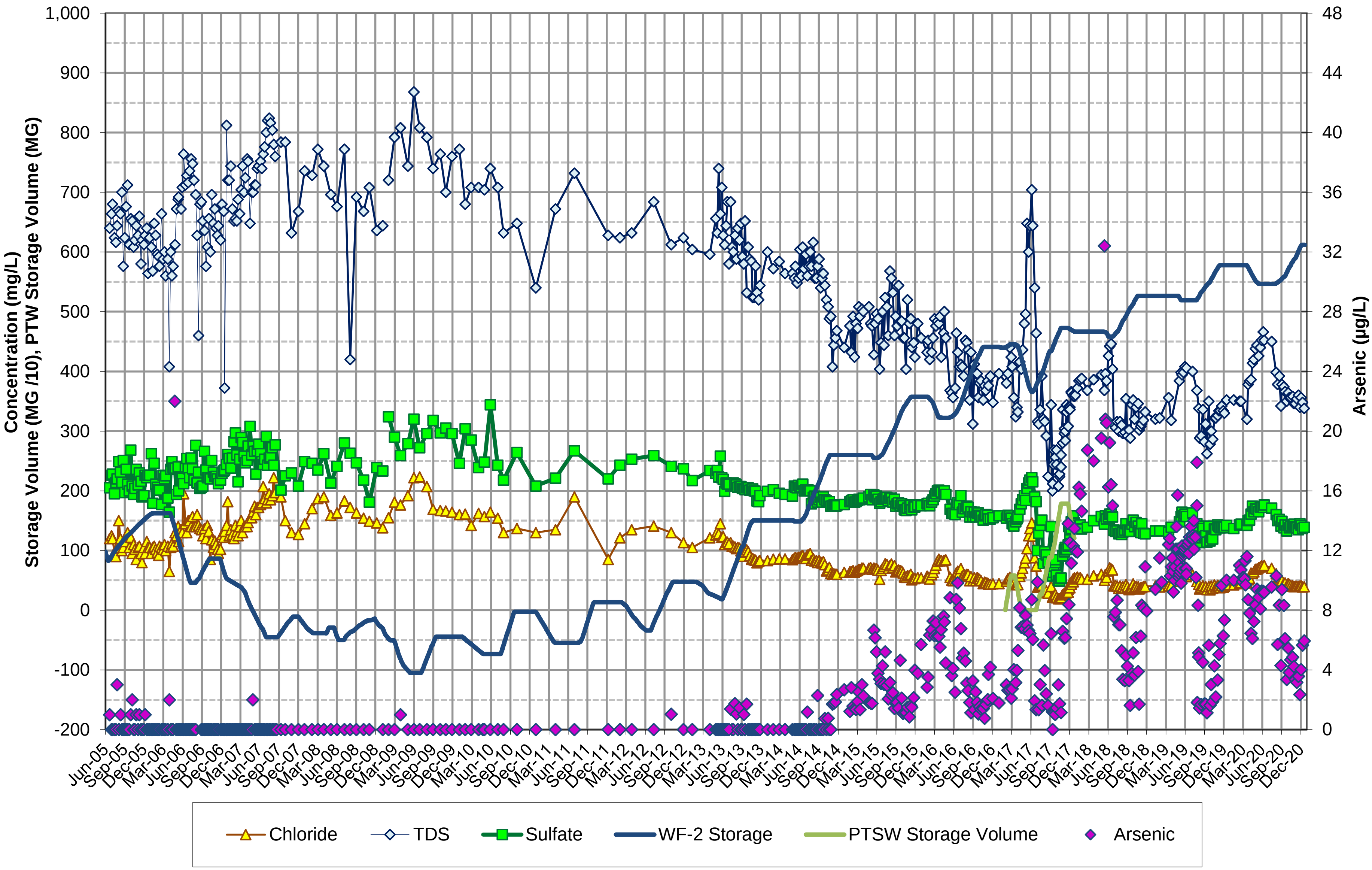
Figure 4-35

Monitoring Well M-21 Water Quality



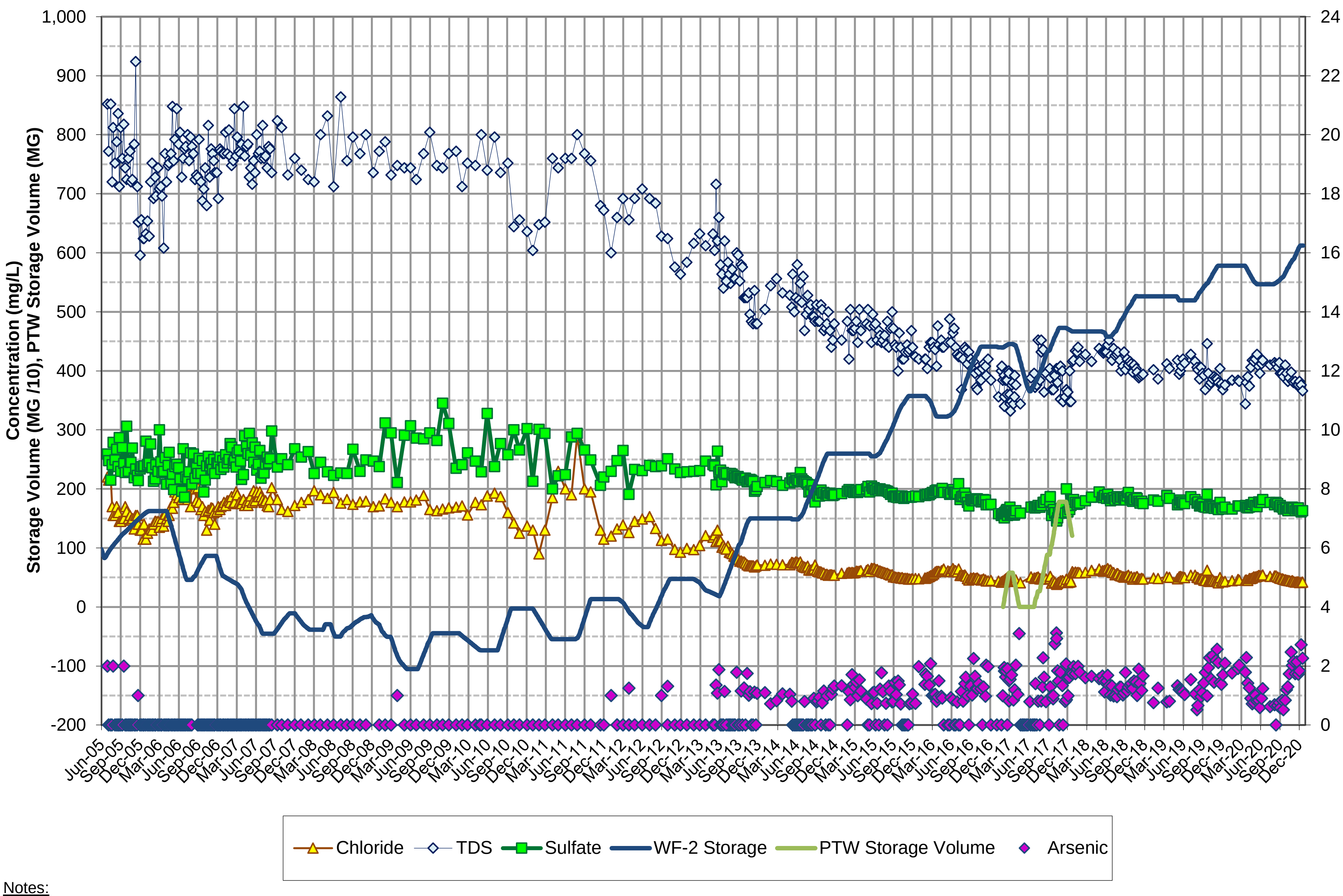
Notes:
For the purpose of this graphic any readings below the laboratory method detection limit were assigned zero
Sampling events for the PTSW testing occasionally resulted in duplicate samples on the same day, in that instance the result with the higher concentration of the two samples was used.

Figure 4-36
Monitoring Well T-11 Water Quality



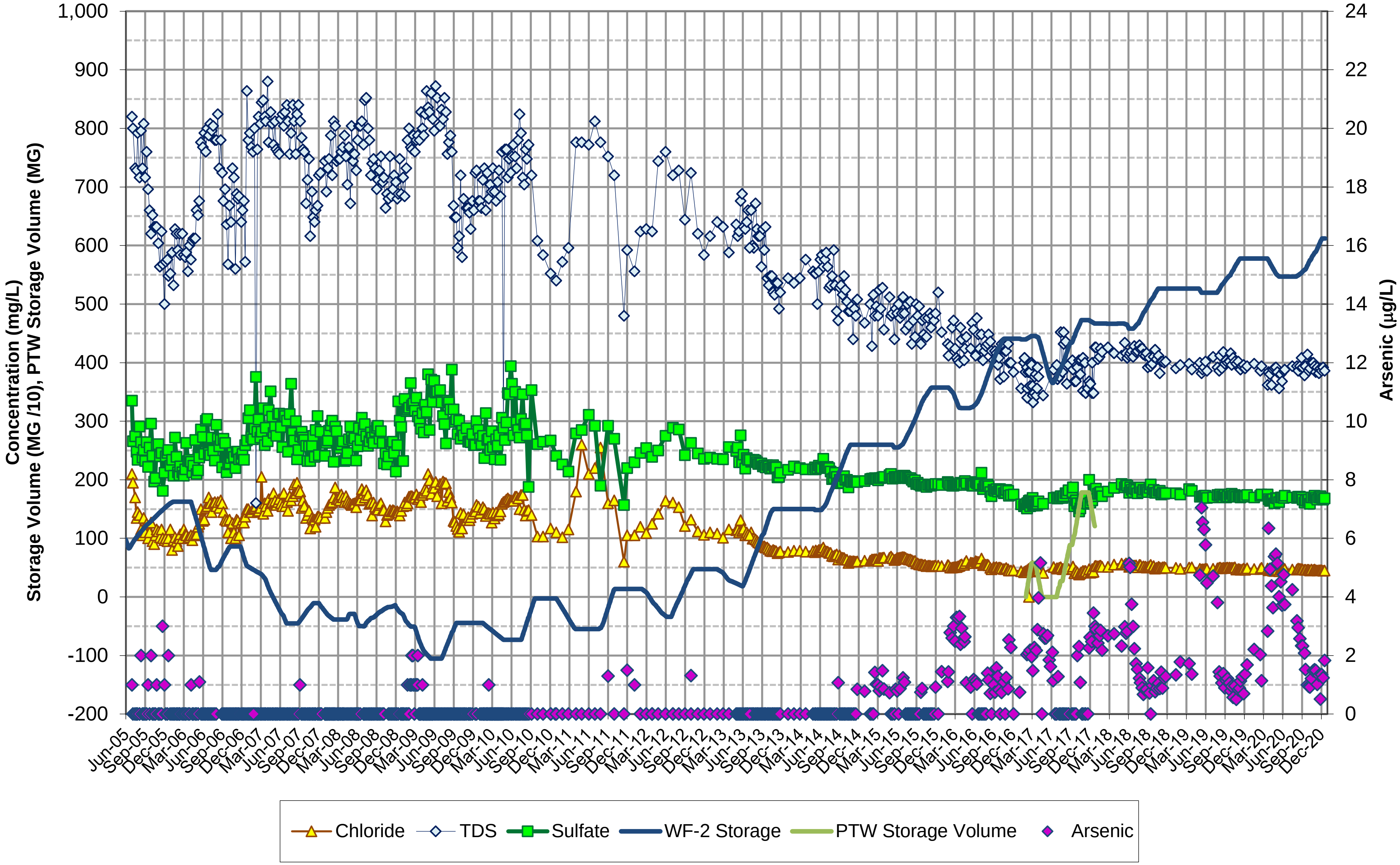
Notes:
For the purpose of this graphic any readings below the laboratory method detection limit were assigned zero
Sampling events for the PTSW testing occasionally resulted in duplicate samples on the same day, in that instance the result with the higher concentration of the two samples was used

Figure 4-37
Monitoring Well M-15 Water Quality



Notes:
For the purpose of this graphic any readings below the laboratory method detection limit were assigned zero
Sampling events for the PTSW testing occasionally resulted in duplicate samples on the same day, in that instance the result with the higher concentration of the two samples was used

Figure 4-38
Monitoring Well M-18 Water Quality



Note: For the purpose of this graphic any readings below the laboratory method detection limit were assigned zero

Figure 4-39

Monitoring Well M-19 Water Quality

SECTION 5

Water Level Data

This section presents summaries of water level data from the 21 ASR wells at the PRF and associated monitoring wells. Water level data are evaluated to investigate whether long-term trends may be developing. This section first presents water level data for WF1 and its monitoring wells, followed by data for WF2 ASR wells and its associated monitoring wells. Water level data has historically been reported in National Geodetic Vertical Datum (NGVD) for the POR however the datum was changed in August 2019 to North American Vertical Datum (NAVD).

5.1 WF1 ASR Wells

Figures 5-1 through **5-9** show the water level data for the ASR wells at WF1 for the POR. Water level elevations in WF1 have ranged from approximately 225 to -75 feet during ASR operations but vary greatly from well to well. Static water level elevations typically range from 40 to 50 feet. Outlying maximum and minimum water level values are generally the effect of malfunctioning water level meters. Typically, the inconsistent data are flagged as suspect and not included in calculations. The greatest water level changes are seen at wells S-1, S-3R, S-5R, S-6, and S-7, which have the lowest specific capacities in WF1. During recharge events, water levels in these wells have increased by 125 to 175 feet. During recovery events, water levels at these wells decrease by 50 to 150 feet.

ASR Wells T-1, S-2, S-8, and S-9R show significantly less water level response during ASR operations than other ASR wells. During recharge events, water levels in these wells typically increase by 50 to 100 feet. During recovery events, water levels in these wells generally decrease by 40 to 75 feet. Unfortunately, the low water-level fluctuations observed at wells S-2, S-8, and S-9R do not translate into lower TDS concentrations because these wells are also among the highest in TDS concentrations during recovery. It is possible that the high productivity from these wells is due to fracture systems that may have vertical connections to the more saline waters in the permeable units below the Suwannee Limestone, but this cannot be confirmed. The moderate water level response in well T-1 is in part attributed to this ASR well being completed into the overlying Tampa Zone storage interval.

In 2020, water levels at WF1 remained within the ranges observed in previous years. Changes in water levels correspond to recharge and recovery events in 2020 as expected. No discernible long-term trend in aquifer potentiometric head conditions is observed over the POR. Data logger malfunctions/failures were observed in S-2, S-3R, and S-5R in 2020 resulting in partial water level data at these wells.

5.2 WF1 Surrounding Monitoring Wells

Water-level data for monitoring wells surrounding WF1 were reviewed as part of this investigation. Two monitoring wells with long-term data (T-2 and M-2) were evaluated together. Other monitoring wells constructed as part of the ASR expansion for the Peace River Option and those constructed as part of the enhanced groundwater monitoring program have shorter monitoring periods and are also graphed together for comparison purposes. Finally, monitoring well water level data are presented for the three distinct horizons monitored at Site 7 (I-7, M-7, and T-7 cluster) to compare water level elevations among these three permeable units in this area. The well construction details for the monitoring wells at the PRF were listed in **Tables 1-1** and **1-2**, presented previously.

5.2.1 Monitoring Wells M-2 and T-2 Water Level Data

A water level hydrograph for the POR (1991 through 2020) for monitoring wells M-2 and T-2 is presented on **Figure 5-10**. Monitoring well M-2 is located north of WF1 and the water levels show a correlation with ASR well recharge during the wet season and recovery during the dry season. Typical seasonal water level fluctuations in this well range from 10 to 20 feet. The long-term data show the recharge and recovery events as well as drought events. Typical water level elevations in the wet season (recharge periods) range from 45 to 55 feet. Typical water levels in the dry season (recovery periods) range from 35 to 45 feet, but have been below 30 feet, as observed in 2007. In 2020, water levels at monitoring well M-2 were within normal ranges.

Monitoring well T-2 is located north of WF1, adjacent to monitoring well M-2. Water levels at well T-2 show a correlation with ASR well recharge during the wet season and recovery during the dry season. Typical seasonal water level fluctuations in this well range from 10 to 20 feet. The long-term data show the recharge and recovery events as well as drought events. Typical water level elevations in the wet season range from 45 to 55 feet. Typical recovery water level elevations in the dry season range from 30 to 40 feet but have been observed below 25 feet. From fall 2013 through 2014, water levels in well T-2 were below normal and did not correlate with a period of drought or a significant ASR recovery event. From mid October 2019 to early August 2020 water levels at well T-2 were below normal and did not correlate with a period of drought or a significant ASR recovery event. The low water levels at T-2 were not observed at the other Tampa Zone monitor wells and it is suspected that this data are in error. The data logger/transducer has since been replaced and is functioning properly.

5.2.2 Suwannee Zone Monitoring Wells

Water level data for the Suwannee Zone monitoring wells are included in **Appendix E**. **Figure E-1** presents data from several monitoring wells installed to monitor water level and water quality in the Suwannee Limestone ASR storage zone near WF1. Monitoring well hydrographs are presented for monitoring wells M-6, M-7, M-20, M-21, and M-22 for the 14-year period from January 2006 through December 2020. Water level elevation data during static periods generally were similar between 40 and 50 feet. However, when the ASR wells are in operation, water levels in Suwannee Zone monitoring wells are driven largely by the recharge and recovery rates of the nearby ASR wells and the distances of the monitoring wells from the nearby ASR wells. Water levels elevations appeared to show the most fluctuation due to ASR operation (largest influence from WF1) in wells M-7 and M-20, generally ranging from 10 to 30 feet during recovery to approximately 70 to 80 feet during recharge. Wells M-21 and M-22 showed a smaller water level response to recharge and recovery than wells M-7 and M-20. It is suspected that the lower water level response seen at well M-22 is due to the lower flow rates generally seen at well S-1 and the monitoring well’s location on the outer boundary of the central cone of depression when considering the cumulative effect of pumping at both WF1 and WF2. Given the proximity to wells S-1 and S-2, the water level impacts at monitoring well M-22 are lower than expected, but a direct hydraulic connection does exist as demonstrated by the water quality changes during ASR activities (Section 4). Recharge and recovery water levels in 2020 were similar to historical events. A data logger malfunction occurred at M-21 during early 2020 but is now functioning properly since the replacement of the data logger’s batteries.

5.2.3 Site 7 Water Level Data

Figure E-2 shows the water level data for the three monitoring wells at Site 7. Monitoring wells are completed at this site into the Suwannee Limestone, the Tampa Member, and the IAS permeable units. Static water level elevation data in all zones are approximately 40 to 45 feet. Water level elevation in the Suwannee Limestone fluctuate from 50 to 85 feet during recharge events to approximately 10 to 30 feet during recovery (pumping) periods. A response of approximately 25 to 35 feet was observed in the Suwannee Limestone at this site during recharge and recovery events in WF1. The Tampa Member well (T-7) and the IAS monitoring well (I-7) showed a similar water level response during recharge and recovery periods. A response of approximately 4 to 5 feet was observed in monitoring well I-7 during normal ASR operations, much of which is attributed to the regional water level trends. In 2020, water levels changed in response to the recharge and recovery activities. Water levels in monitor wells T-7 and I-7 demonstrated slight changes in response to recharge and recovery periods in 2020.

5.3 WF2 ASR Wells

Water level data for the ASR wells in WF2 are summarized in the following paragraphs. **Figures 5-11** through **5-22** show the water level data from each ASR well for the POR through 2020. The water level data from the ASR wells are primarily a function of the injection/pumping rate and the Q/s. Water level data are useful in evaluating well interference and establishing maximum water level responses during recharge and recovery periods.

Static water level elevation at the ASR wells during storage periods ranged from 24 to 55 feet, but static water level elevations typically fluctuated between 35 and 50 feet. Water level elevations have ranged from approximately 250 feet during recharge to -140 feet during recovery. Typical water level elevations during recharge were between 50 and 200 feet. During recovery, levels were between 0 and -100 feet. The wells have similar water level responses, with the exception of wells S-19 and S-20 (which both have high specific capacities and therefore less water level impact during ASR operations). For the earlier period, wells S-11 and S-17 showed lower water level responses; however, these wells were backplugged in November 2007. Subsequent data have shown a greater water level response during ASR activities at these two wells, as expected. Water level responses in 2020 were generally within the historical range during both during both recharge and recovery events.

5.4 WF2 Surrounding Monitoring Wells

Water level data from the WF2 monitoring wells were reviewed as part of this investigation. Monitoring well I-10 monitors water levels within the IAS and has a POR dating back to 2002. Cluster 8 wells (M-8, T-8, and I-8) were constructed as part of the ASR expansion for the Peace River Option. This site monitors three distinct horizons to compare water level elevations among these three permeable units at one location. The remaining wells were constructed as part of the enhanced groundwater monitoring program and have a shorter POR. Water level data are recorded every half hour with an installed pressure transducer data logger and the data are downloaded monthly. Wellhead pressure gauge readings are used in the event of a failed pressure transducer. Obvious instances of failed monitoring equipment resulting in inaccurate data were removed from the data sets. All figures referenced in this section are provided in **Appendix E**.

5.4.1 Intermediate Aquifer Well I-10

Well I-10 is a monitoring well constructed into the upper zones of IAS. The zone monitored by well I-10 historically has been referred to as PZ-2 of the IAS. This well serves to monitor the potential regional impacts to the IAS from ASR operations. Well I-10 is located approximately 5,500 feet west of WF2. Well I-10 has casing to 260 feet bls and an open hole interval to 312 feet bls. A graph of the water level elevation from this well is provided in **Figure E-3**.

Well I-10 appears to exhibit minor water level responses due to ASR operations. The water level elevation of well I-10 has fluctuated from 35 to 48 feet. However, approximately 5 to 10 feet of water level change typically is observed at well I-10 between ASR recharge and recovery periods. It is difficult to determine the degree of influence attributed to ASR operations because other factors, such as withdrawals by irrigation users and seasonal fluctuations in the aquifer, likely influence the IAS. Seasonal declines in water levels were observed in the dry season of 2013 to 2014 and 2014 to 2015, even though no significant recovery occurred at the ASR wells during these periods. An overall increase in the mean water level was observed from approximately 2013 to 2016, indicating a regional rebound of aquifer water levels, likely in response to the relatively high rainfall over this period. In 2017, water levels during the dry season were greater than normal likely resulting from regional influences and potentially from the significant recovery event from WF2 in 2017. In 2019 and 2018 I-10 demonstrated muted seasonal water level responses which may be partially due to the low recharge and recovery at the ASR wellfield during this period but is more likely a reflection of the regional conditions in the IAS. In 2020 I-10 demonstrated water levels lower than the previous two years, possibly from the increase in recovery.

5.4.2 Monitoring Well Cluster I-8, T-8, and M-8

The 8-series monitoring well cluster is located approximately 900 feet west-northwest of ASR well S-20. Three wells were constructed at this location: PZ-1 intermediate aquifer monitoring well (I-8), Tampa Zone (PZ-3) monitoring well (T-8), and Suwannee Limestone (storage zone) monitoring well (M-8). Continuous water levels are recorded at these three wells. Monitoring well I-8 has casing to 155 feet bls and an open hole interval to 190 feet bls, monitoring the upper portion of the intermediate aquifer often referred to as PZ-1. Monitoring well T-8 is cased to 354 feet bls, with a total depth to 404 feet bls. This well monitors the first permeable unit above the ASR storage zone and historically has been referred to as PZ-3 of the IAS, which includes the Tampa Zone. Monitoring well M-8 is constructed into the same zone as the ASR storage zone, the Suwannee Limestone. The well has casing to 570 feet bls and has an open hole interval to 860 feet bls. **Figure E-4** is a graph of water level elevations from wells I-8, T-8, and M-8 from January 2003 through December 2020. In general, water levels decline during recovery and then rebound during recharge in all three wells. Water level variations between recharge and recovery periods were greatest (as much as 65 feet) in well M-8, which would be expected because this is the same zone as the WF2 ASR storage zone. Water level variations were less in well T-8, which has shown up to approximately 30 feet of water level change. In2019 the maximum water level variation at T-8 was 42 feet deviating substantially from the previous maximum of 15 feet. The large increase in water level fluctuation at T-8 is unexplained but is suspected to be a result of data logger/transducer malfunction. In 2020 water level variations at T-8 were within historical ranges. Well I-8 had up to approximately 10 feet of water level variations during recharge and recovery events; however, a significant portion of the water level responses in wells T-8 and I-8 are seasonal changes in the aquifer that occur regardless of whether the ASR system is in operation.

5.4.3 Monitoring Well Cluster T-11 and M-11

Monitoring wells T-11 and M-11 were constructed as part of the enhanced groundwater monitoring program. They are located approximately 340 feet west of ASR well S-20. Well T-11 is cased to 350 feet bls with an open hole interval to 400 feet bls. This well monitors the first permeable unit above the ASR storage zone, historically referred to as PZ-3 of the Intermediate aquifer. Well M-11 monitors the same zone as the ASR storage zone interval and is cased to 570 feet bls with an open hole interval to 677 feet bls. The well is located approximately 340 feet west of ASR well S-20. **Figure E-5** shows the water level elevation data of both wells T-11 and M-11 from January 2006 through December 2020. Water level variations were minor at well T-11 but did correspond to ASR activities. Water levels at well T-11 increased by approximately 5 feet in response to the WF2 recharge periods. Water level elevations at well M-11 have ranged from -5 to 107 feet during the POR. The highest elevation of 107 feet was recorded during recharge of WF2 and WF1 in August 2011, the lowest elevation of -5 was recorded in May 2017. Static water elevations at wells T-11 and M-11 were between 40 and 48 feet. Water level responses at wells T-11 and M-11 in 2020 were within the range of water levels observed in previous years.

5.4.4 Suwannee Zone Monitoring Wells (M-series)

Water level data for Suwannee Zone monitoring wells M-12 through M-19 are provided in **Appendix E** as **Figures E-6** through **E-13,** respectively, showing data from January 2006 through December 2020. The monitoring wells surround the wellfield and are located at distances varying from 640 to 100 feet from the ASR wells.

Water level elevations during ASR storage periods at the M-series wells are similar to the ASR wells during static periods, ranging from 30 to 49 feet. Water level elevation changes during ASR operations at the interior monitoring wells (M-14, M-16, M-17, and M-18) ranged from 141 feet during recharge events to -34 feet during recovery. The other Suwannee Zone monitoring wells typically range from approximately 80 to 135 feet during recharge events and 30 to -18 feet during recovery events with wellfield flow rates influencing the degree of water level change; wells closer to the ASR wellfield showed greater responses, as expected. Water level responses from the monitoring wells in 2020 were generally within the normal ranges observed over the POR with the exception of M-12. The data logging transducer at M-12 failed in late August and has not yet been replaced.

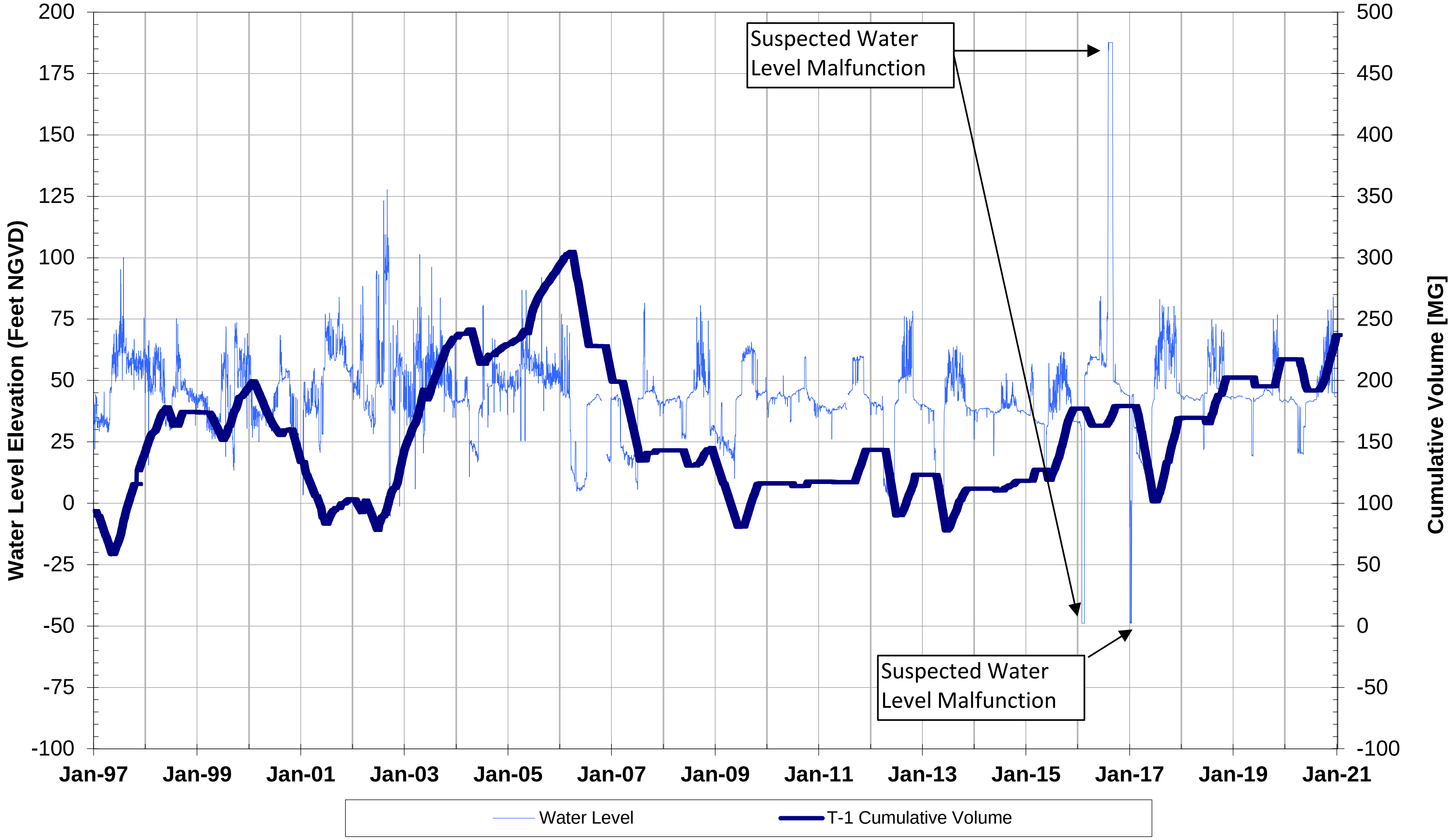


Figure 5-1
T-1 Water Level Data

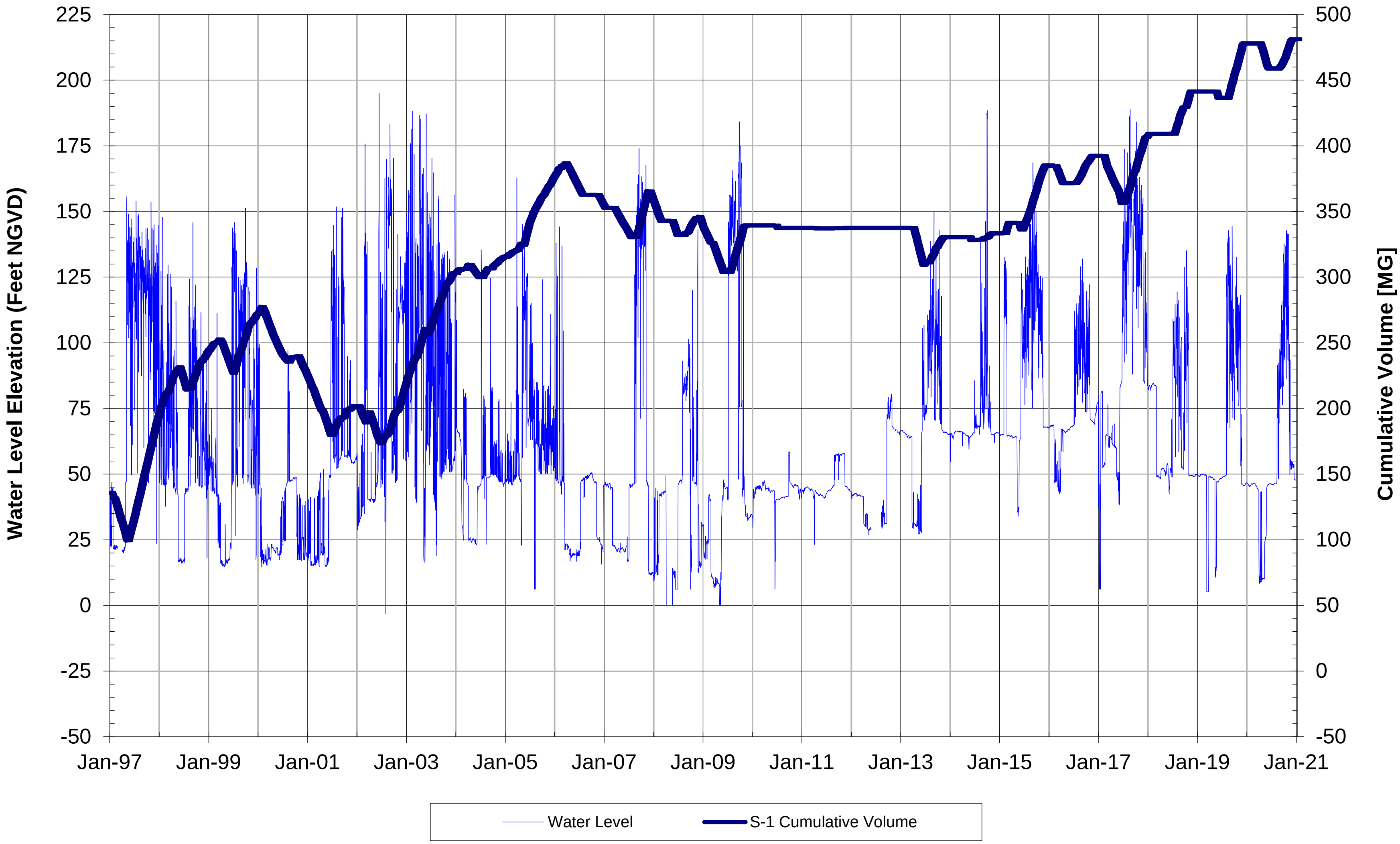


Figure 5-2
S-1 Water Level Data

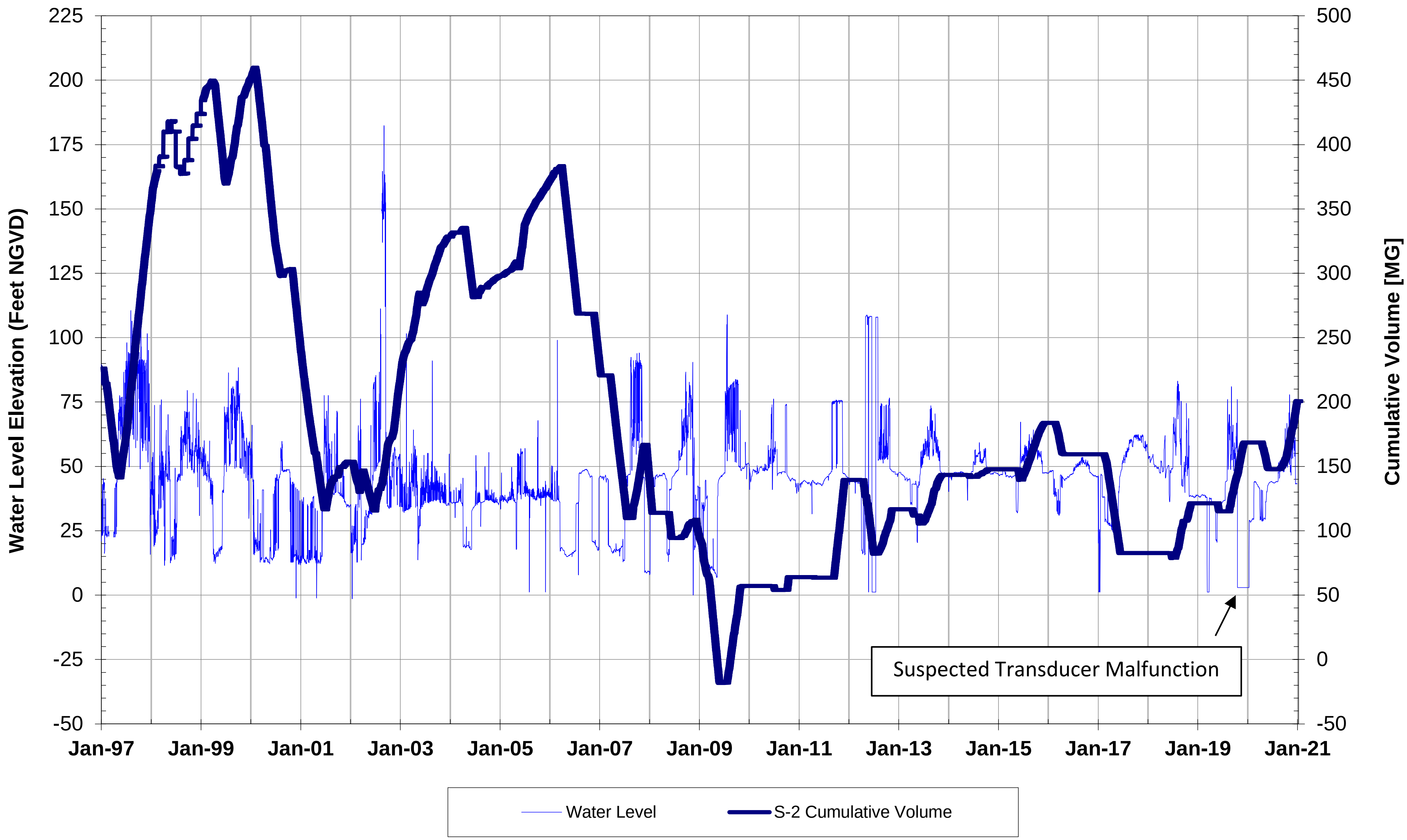


Figure 5-3

S-2 Water Level Elevation

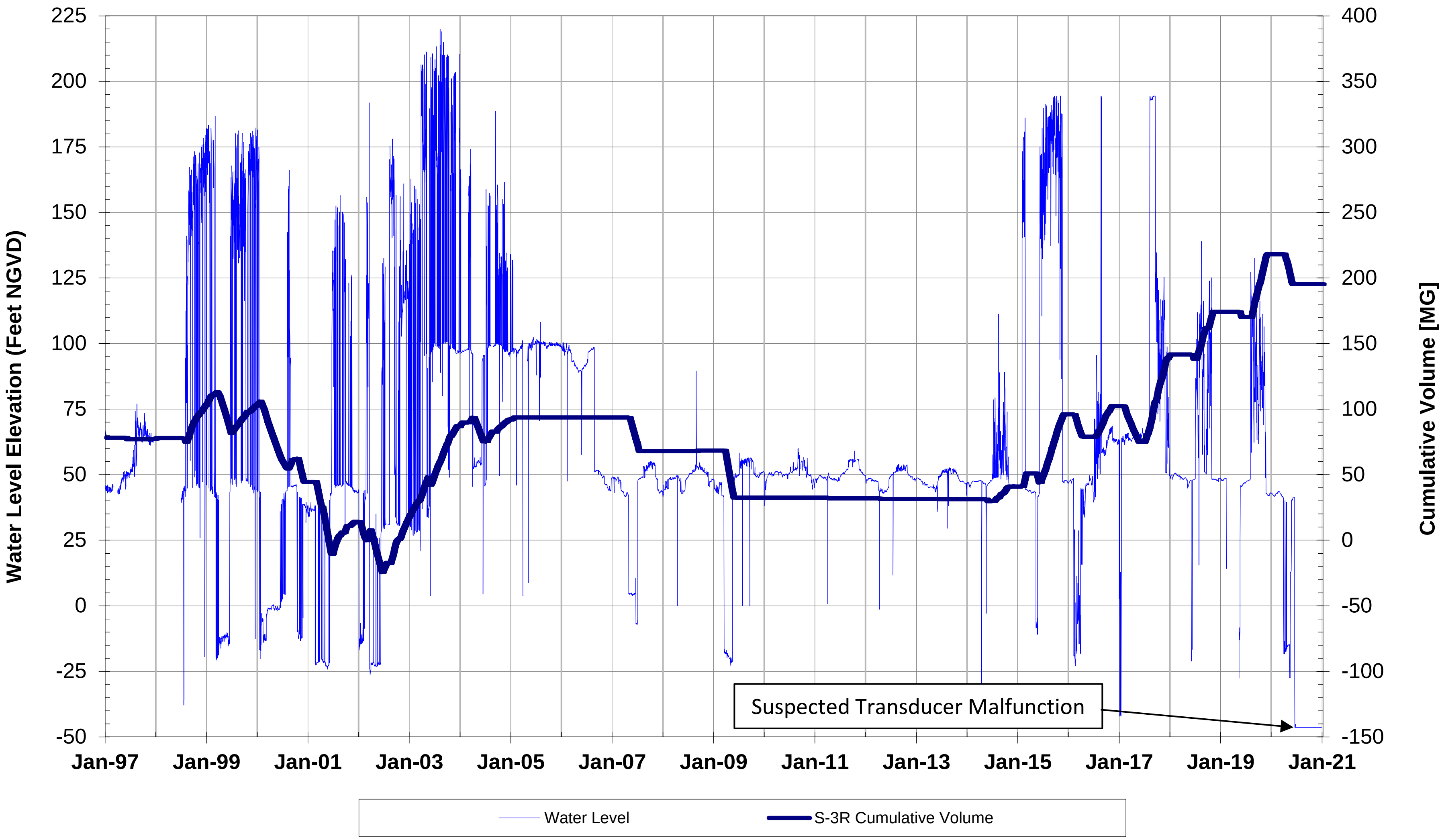


Figure 5-4
S-3R Water Level Elevation

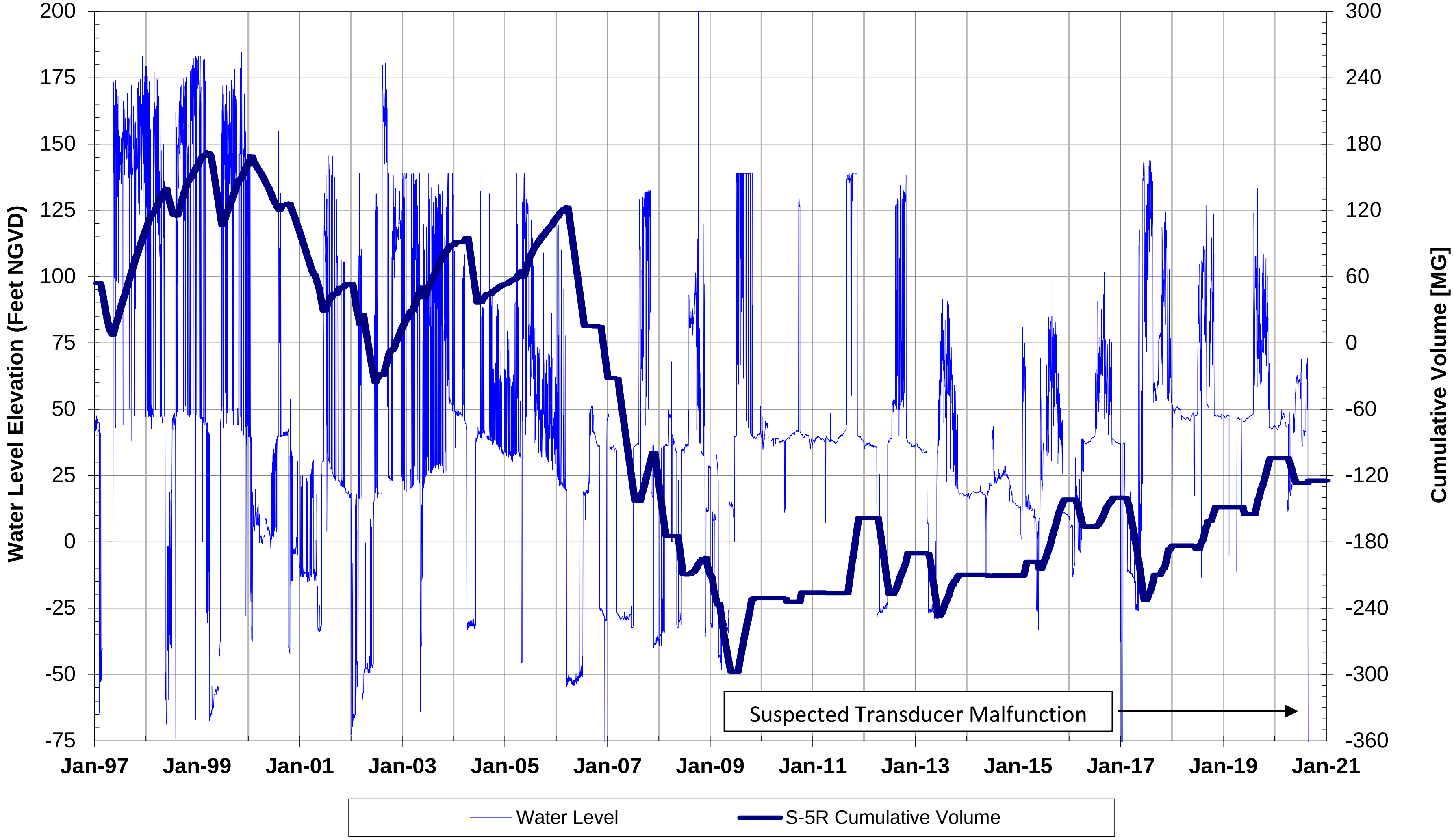


Figure 5-5
S-5R Water Level Elevation

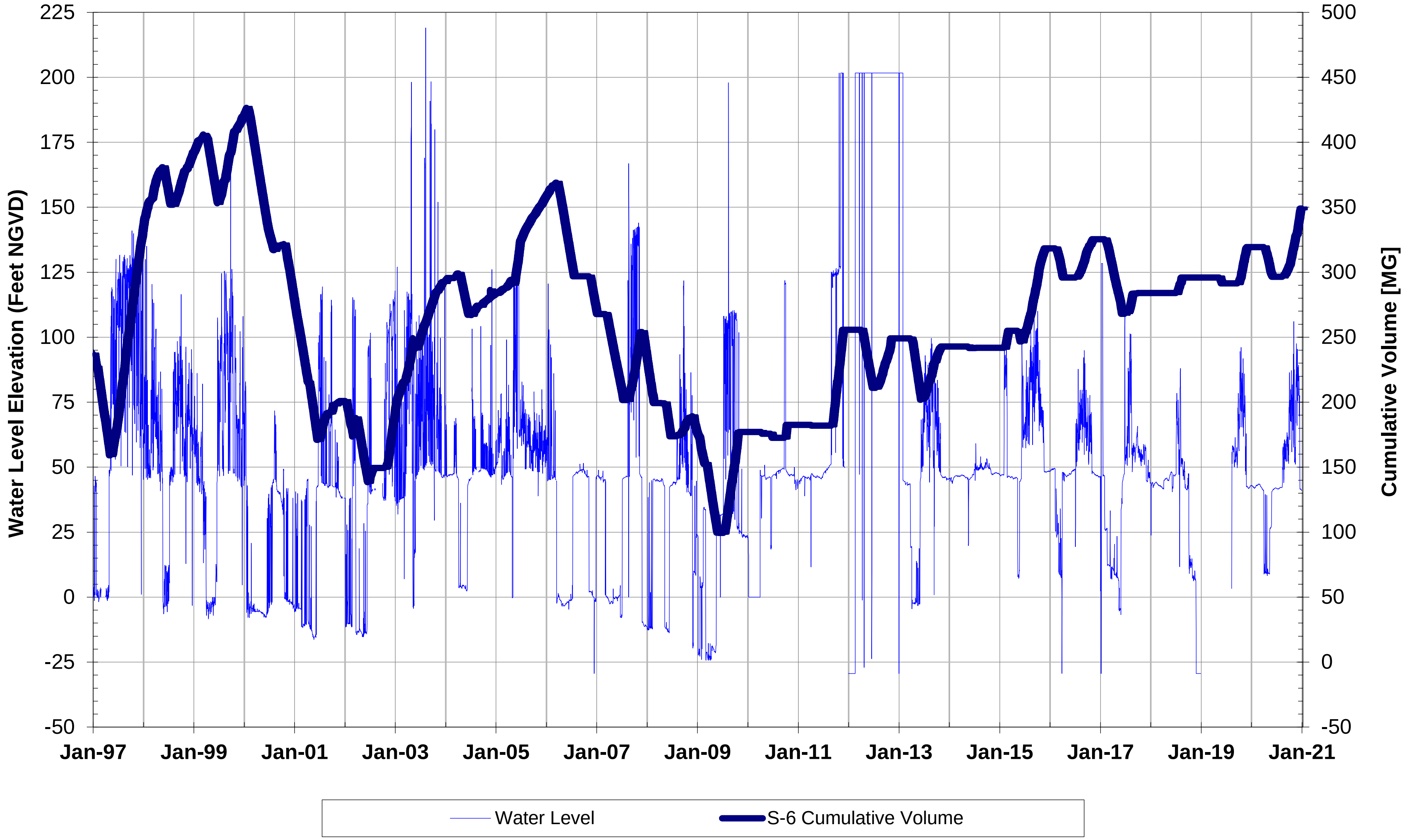


Figure 5-6
S-6 Water Level Elevation

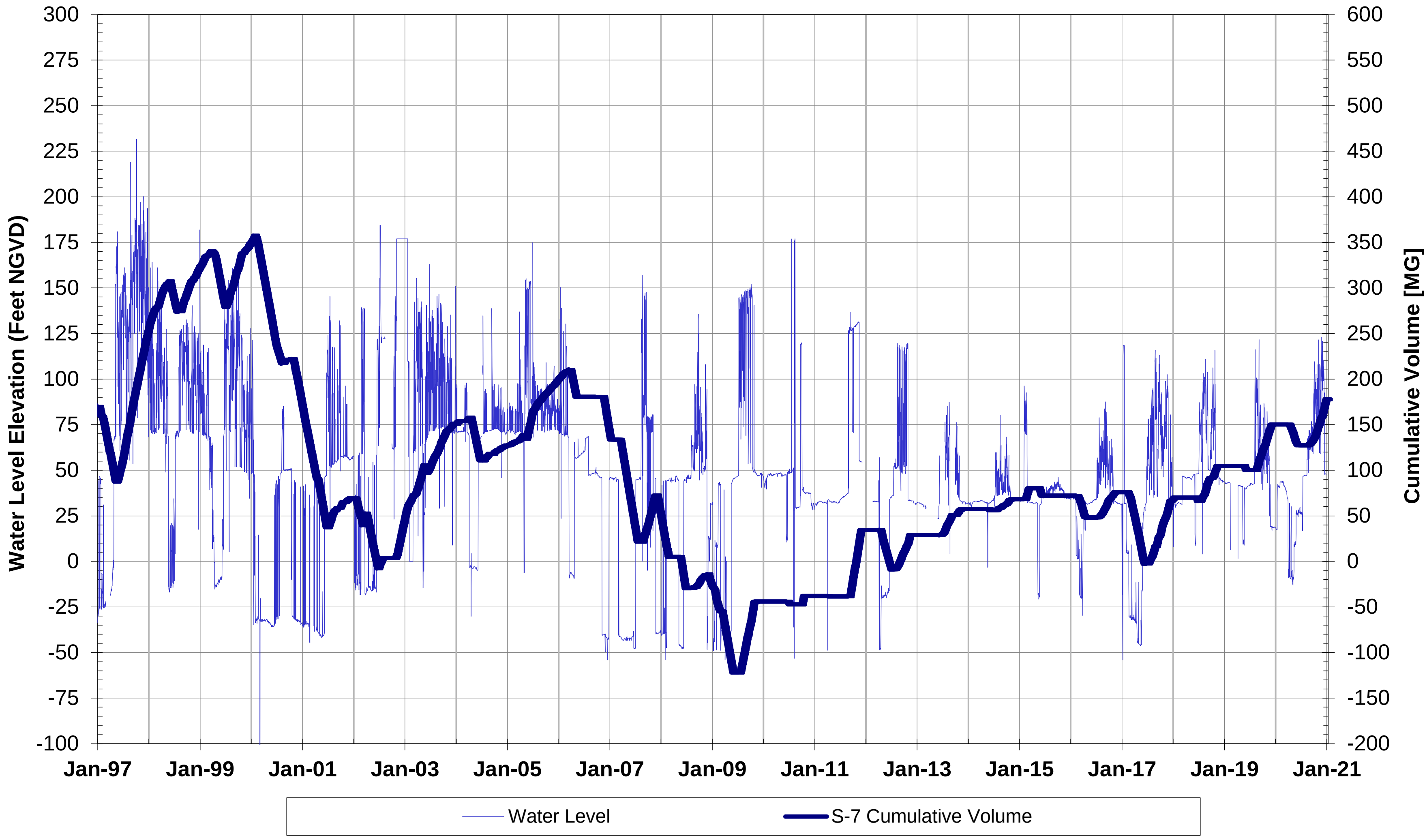


Figure 5-7

S-7 Water Level Elevation

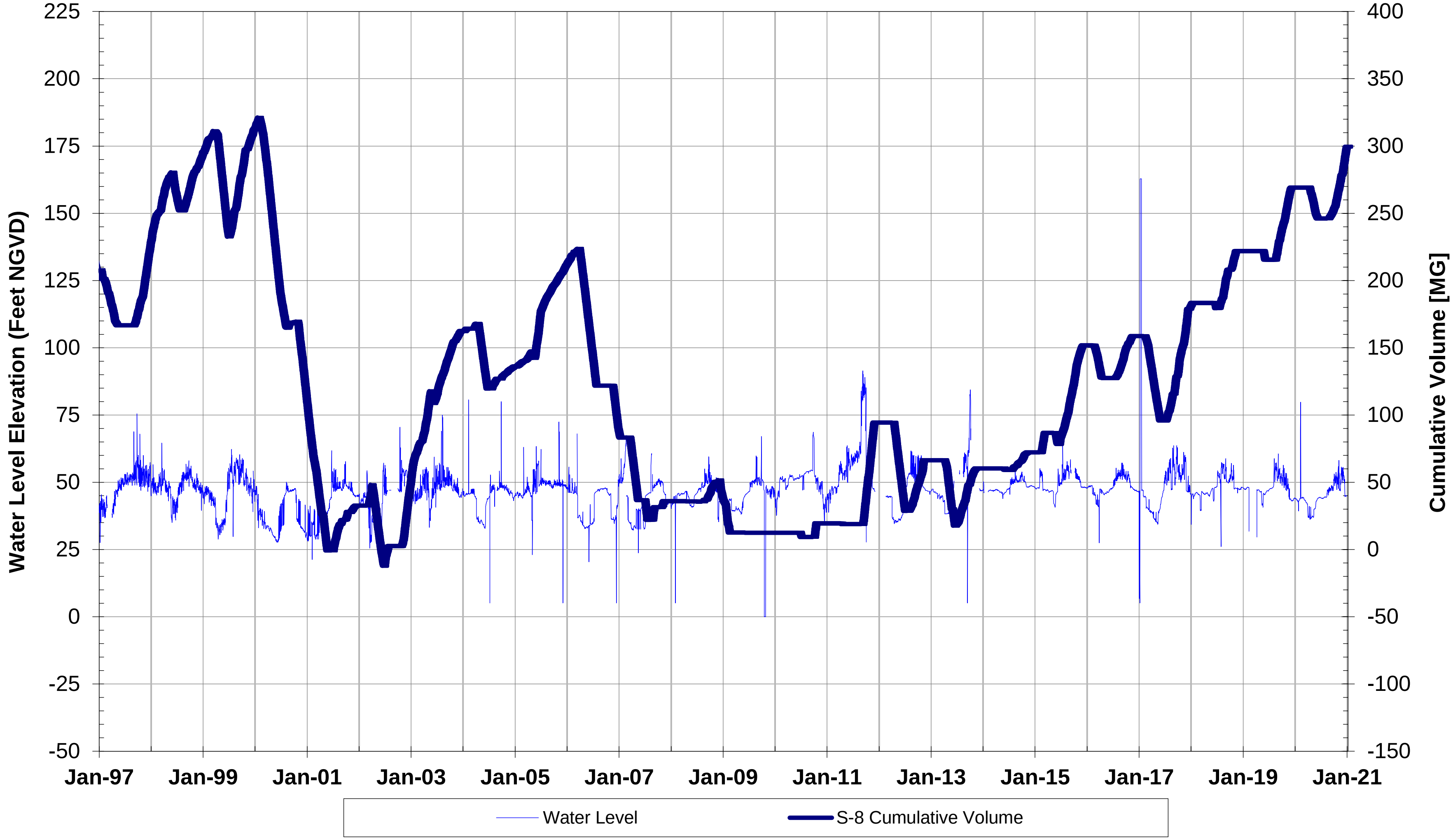


Figure 5-8
S-8 Water Level Elevation

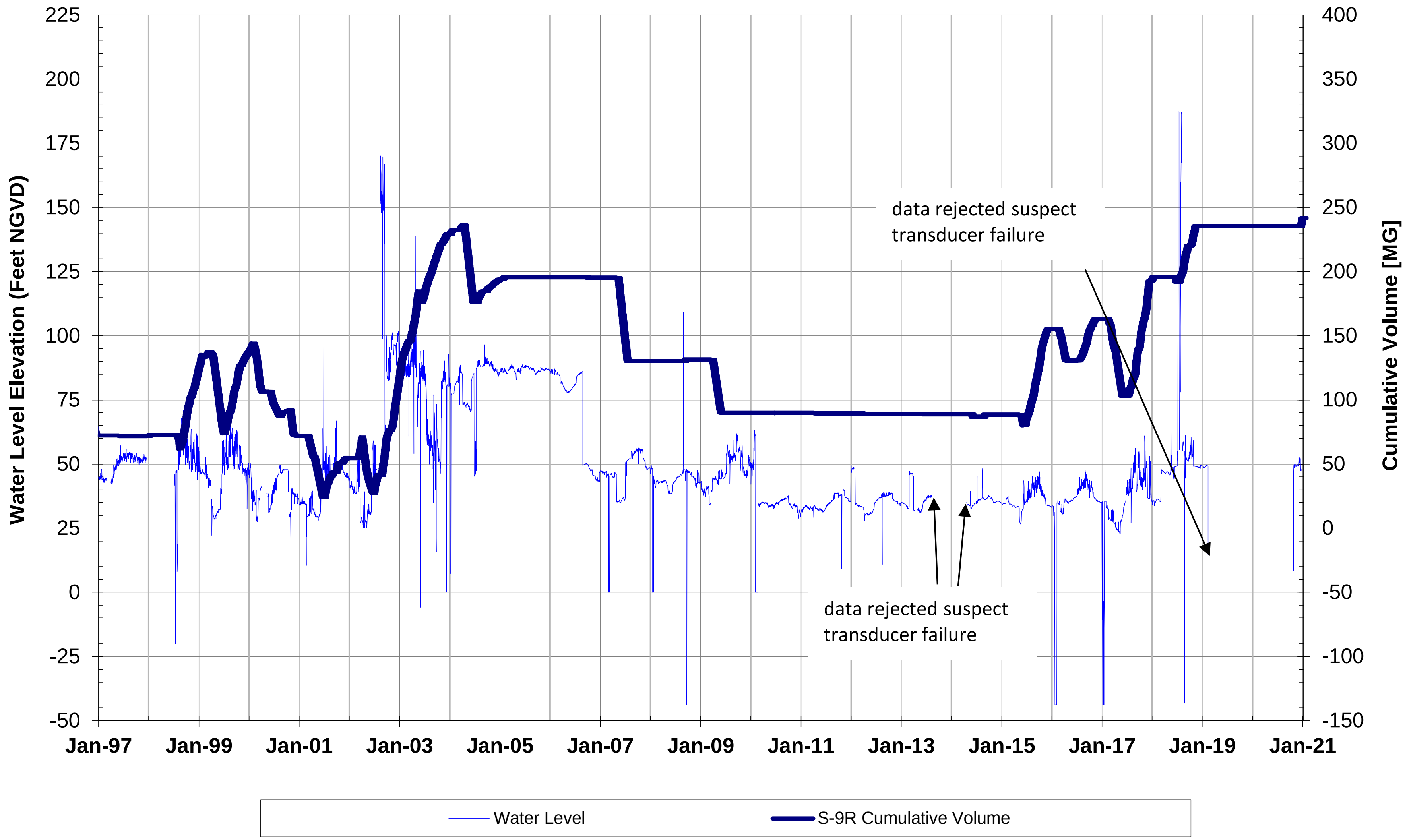


Figure 5-9
S-9R Water Level Elevation

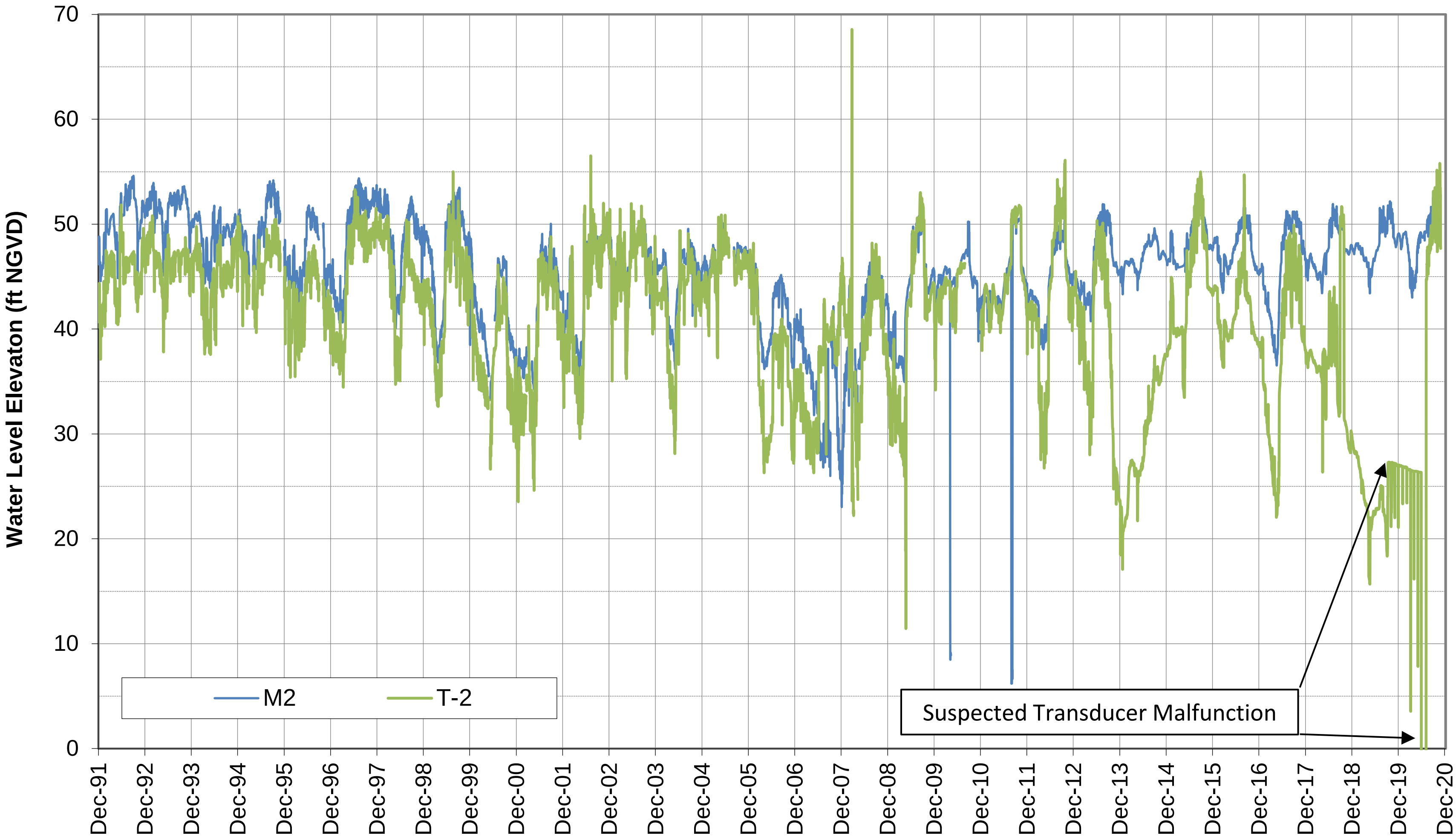


Figure 5-10

Monitoring Wells M-2 and T-2 Hydrographs

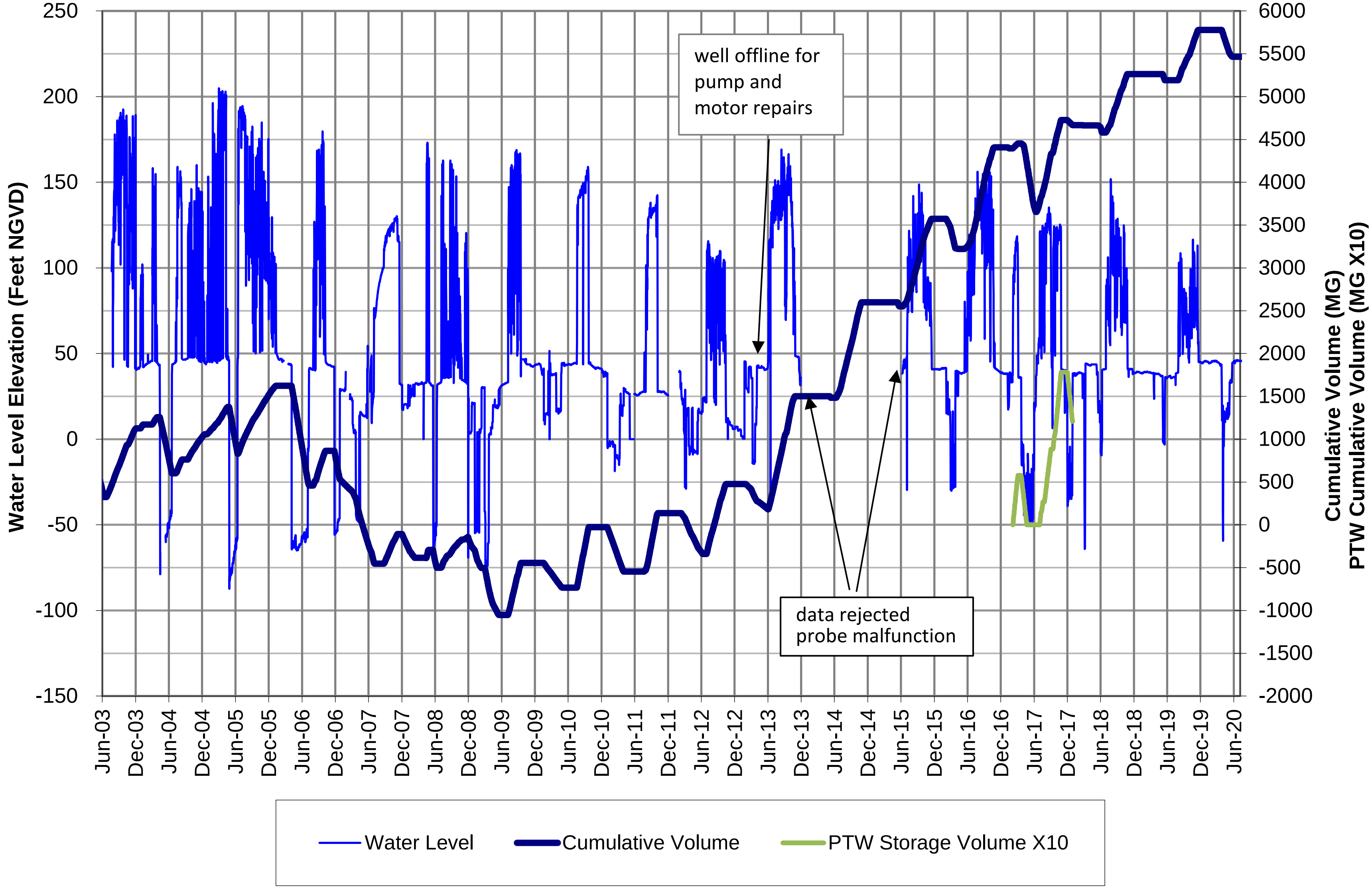


Figure 5-11
S-4 Water Level Elevation

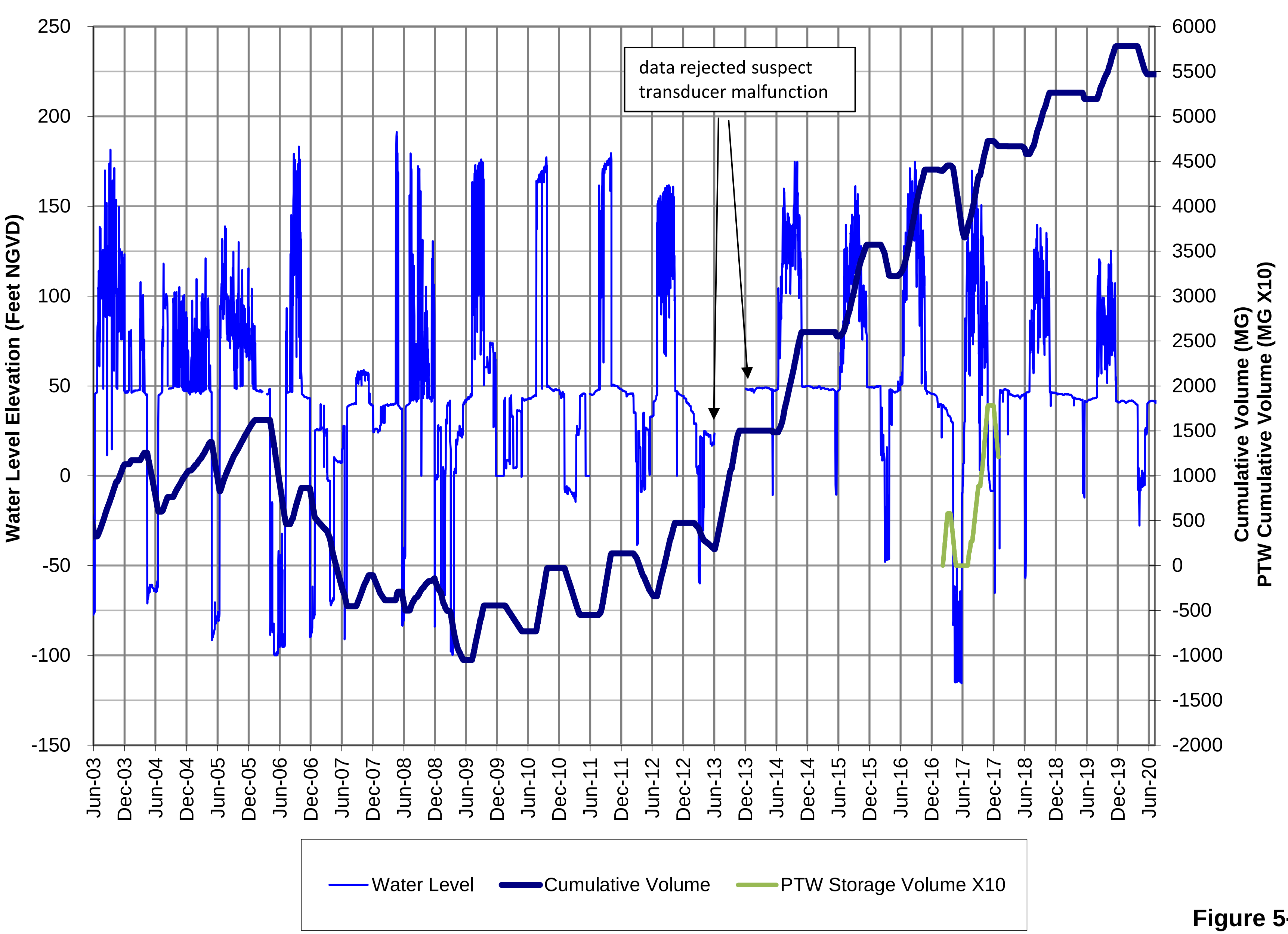


Figure 5-12

S-10 Water Level Elevation

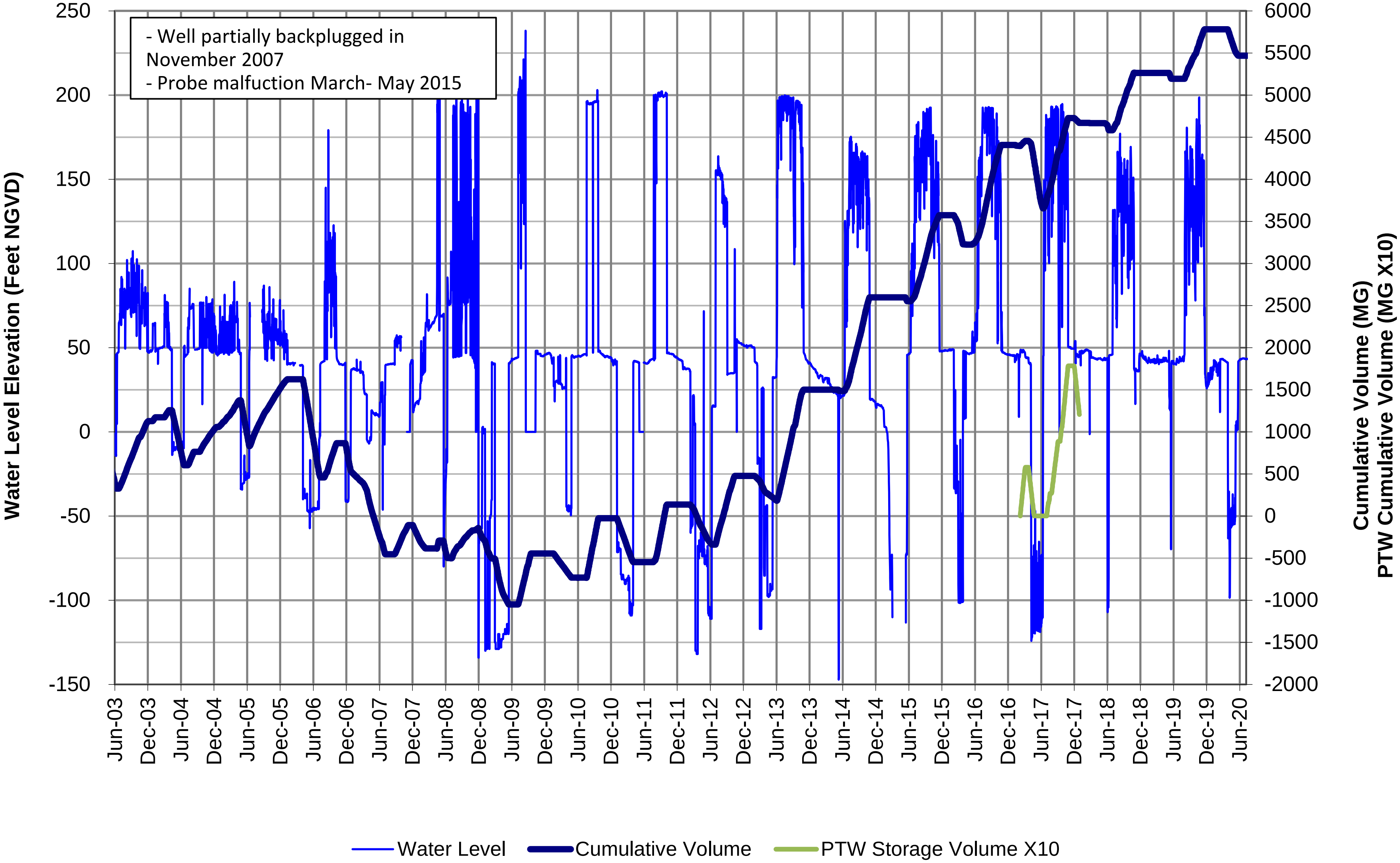


Figure 5-13
S-11 Water Level Elevation

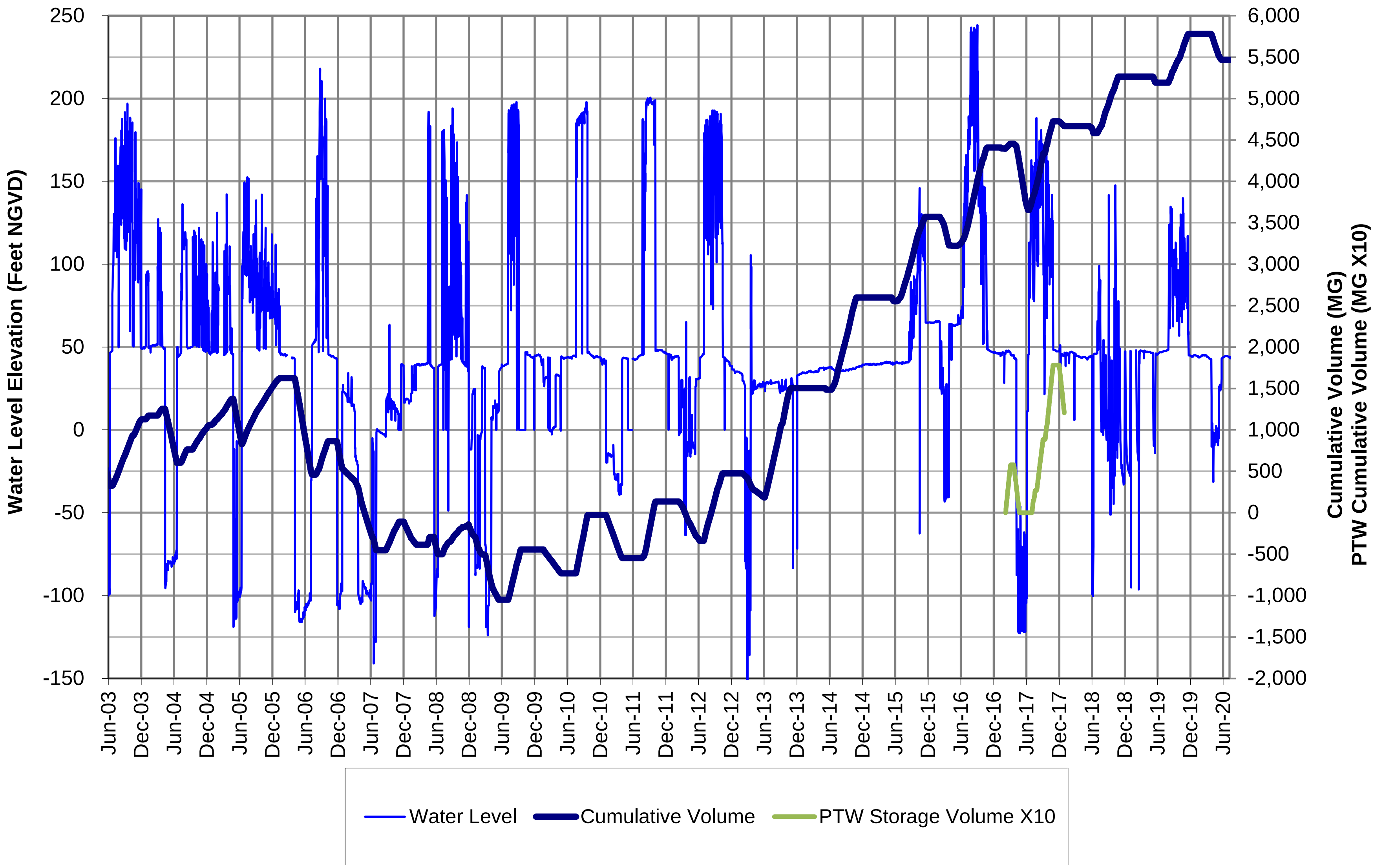


Figure 5-14

S-12 Water Level Elevation

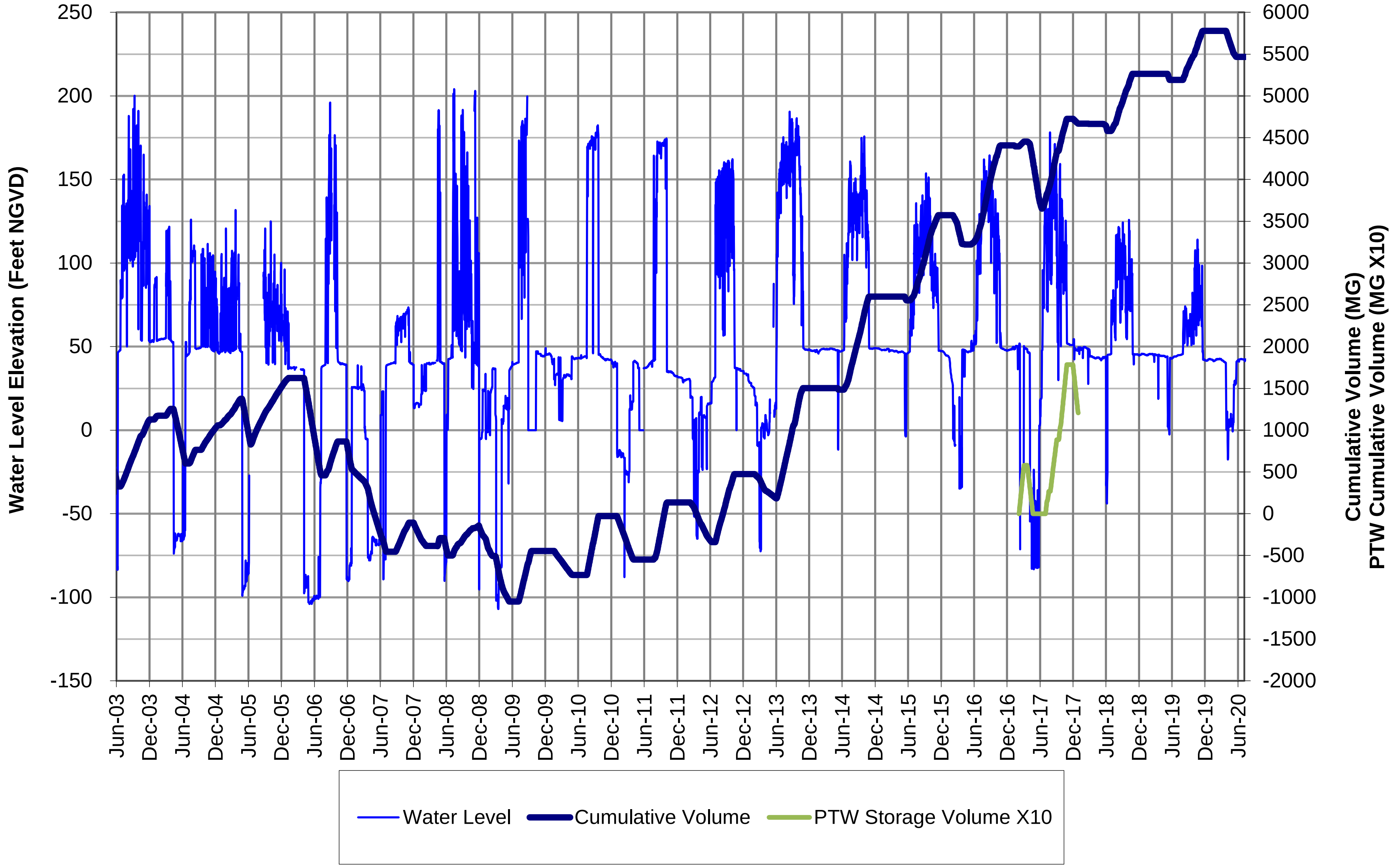


Figure 5-15
S-13 Water Level Elevation

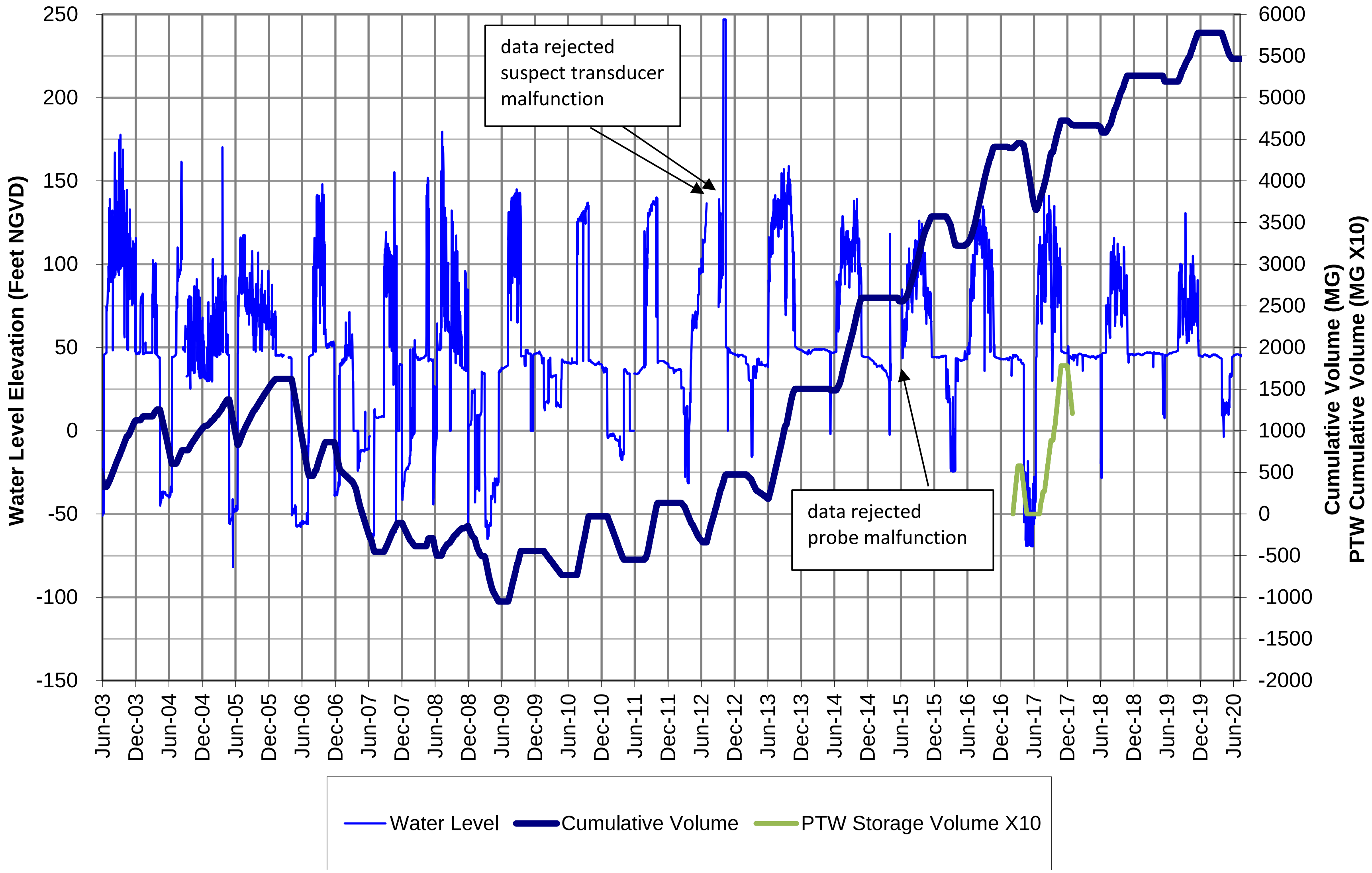


Figure 5-16
S-14 Water Level Elevation

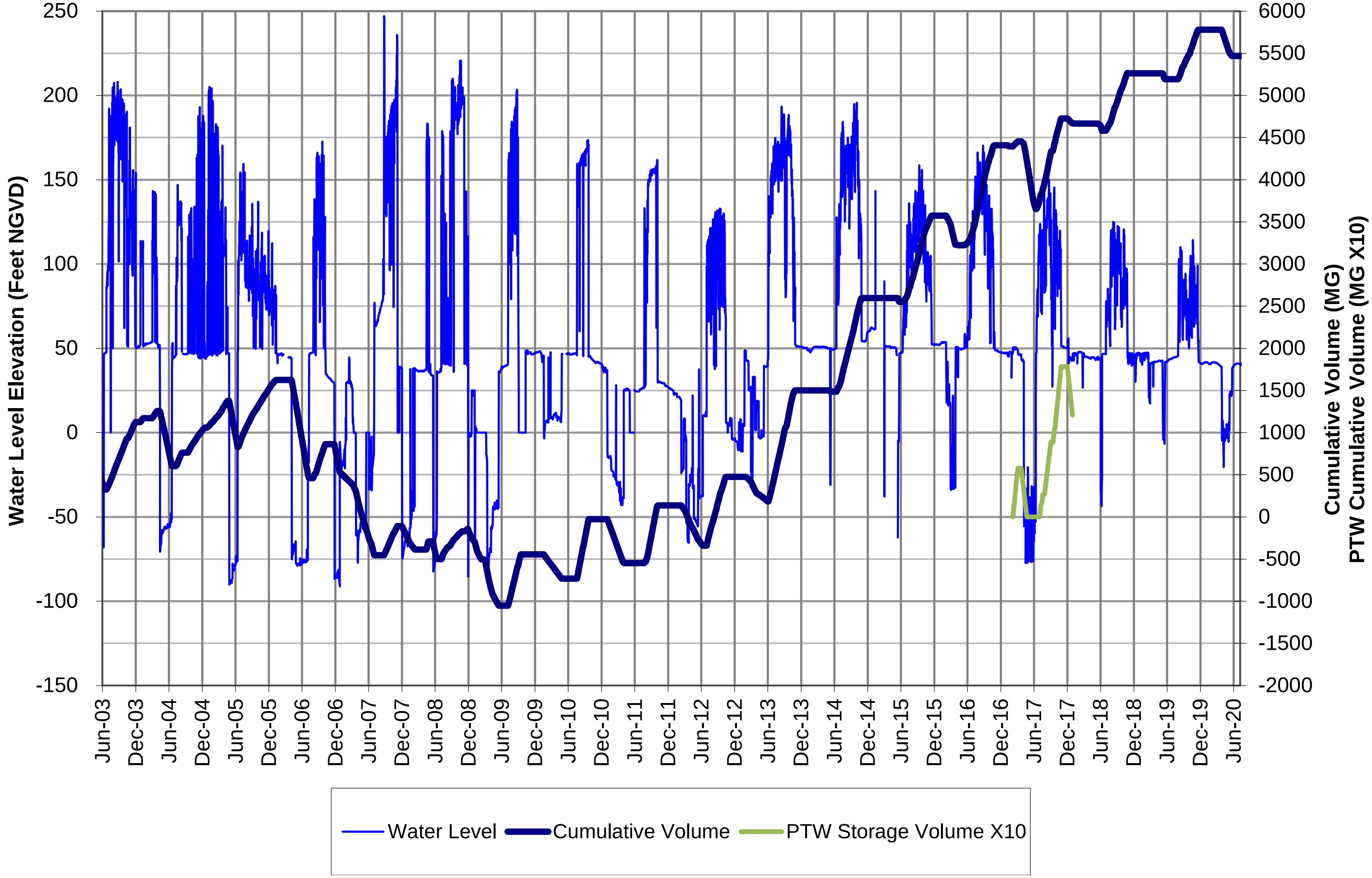


Figure 5-17

S-15 Water Level Elevation

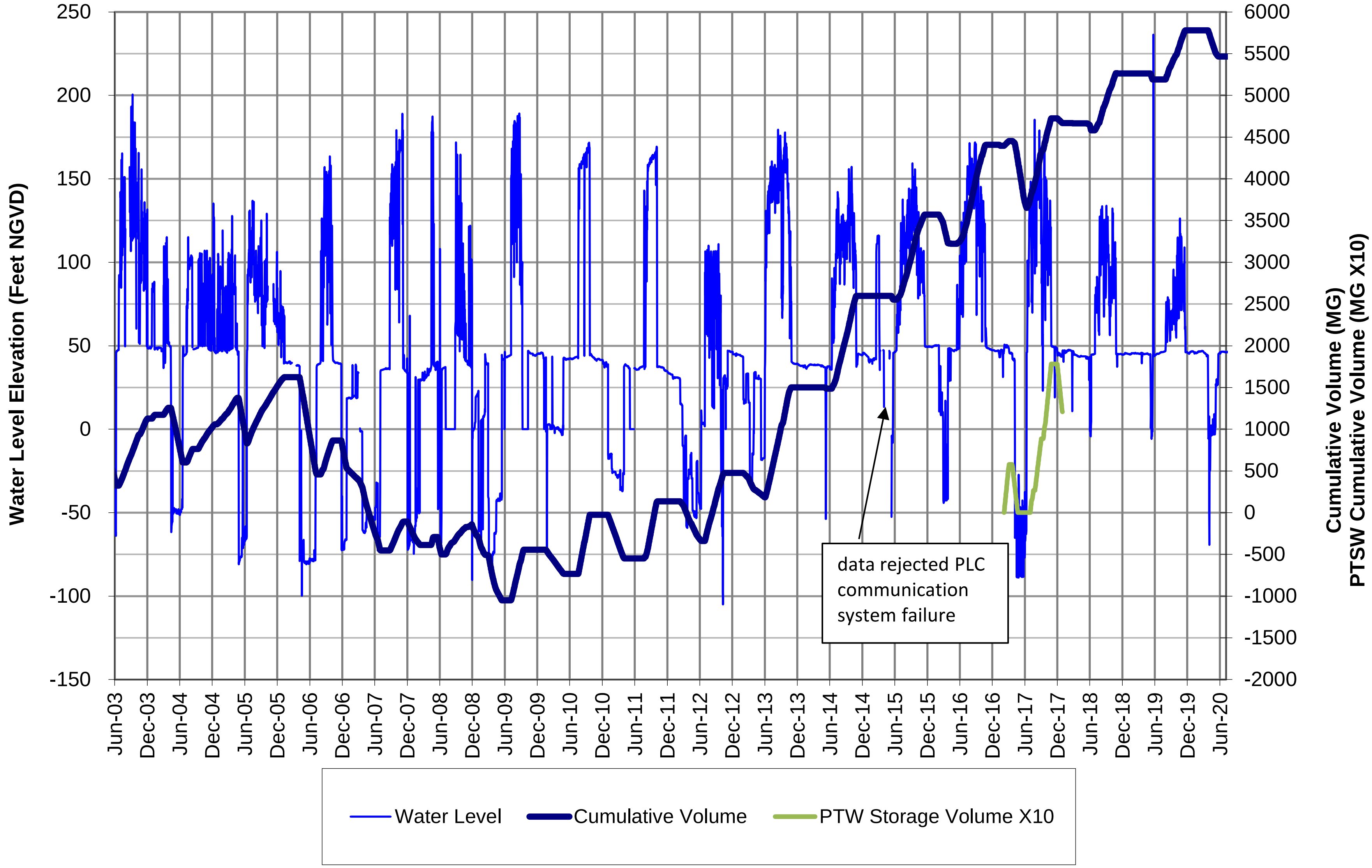


Figure 5-18
S-16 Water Level Elevation

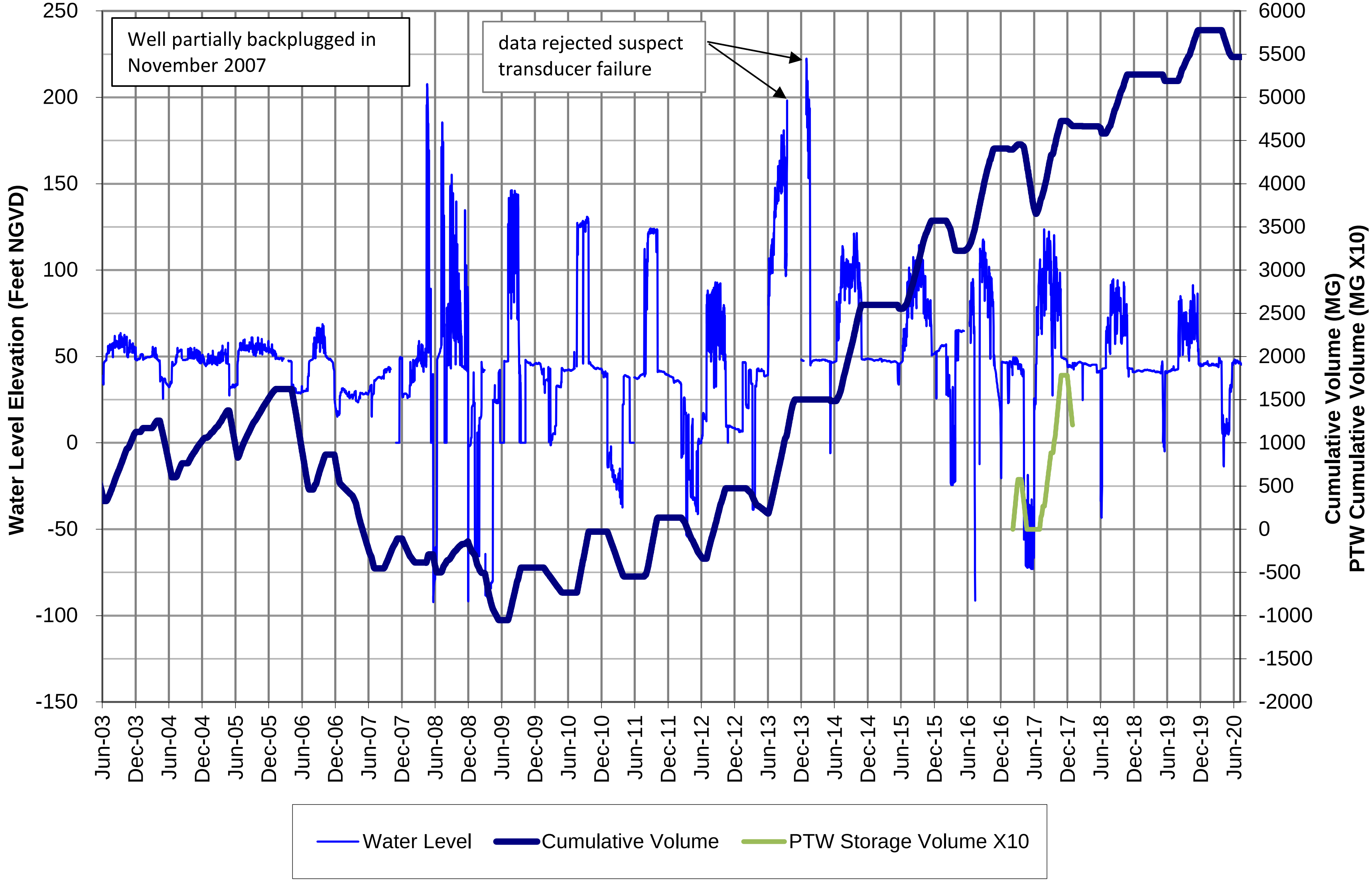


Figure 5-19
S-17 Water Level Elevation

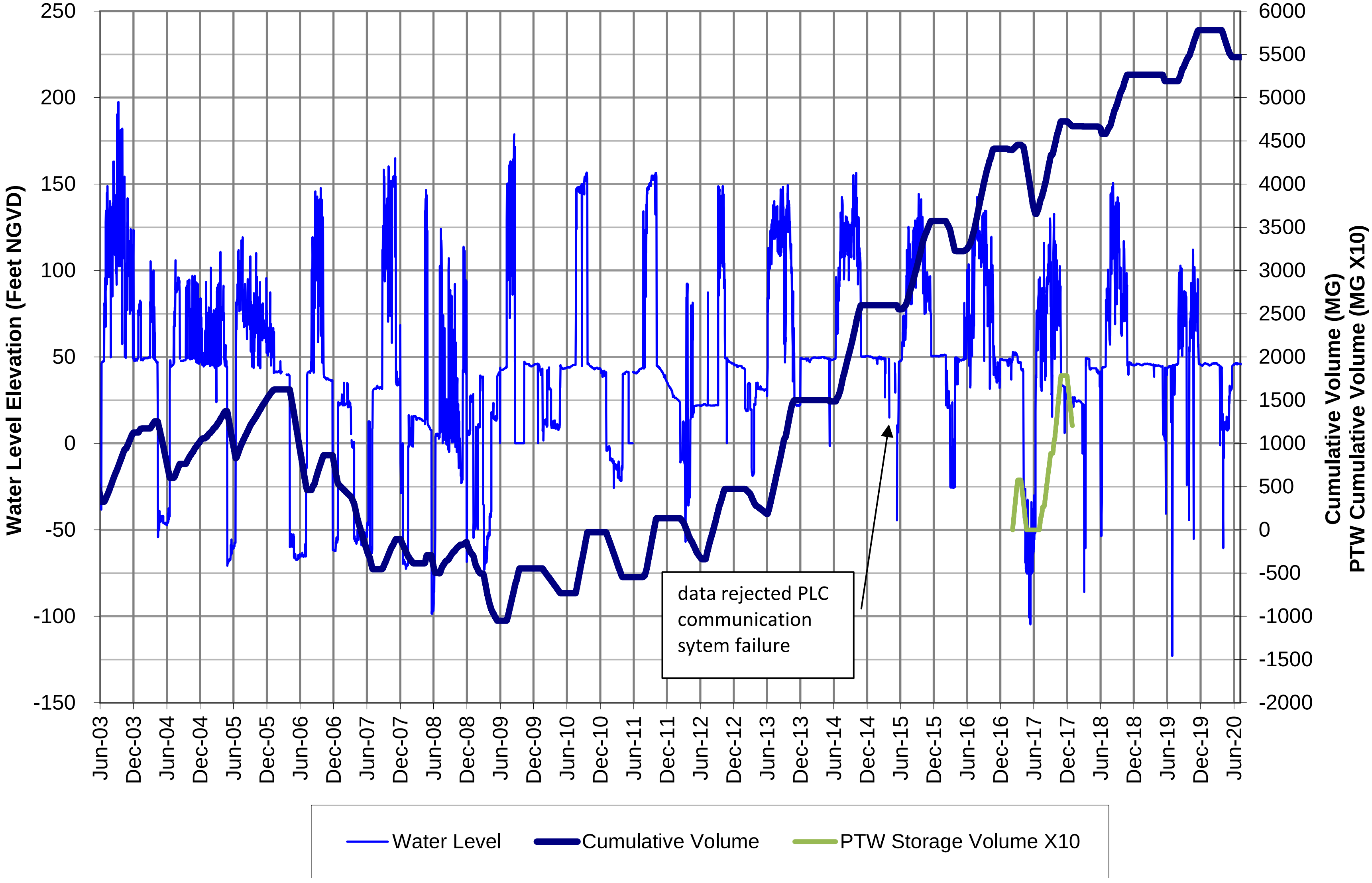


Figure 5-20
S-18 Water Level Elevation

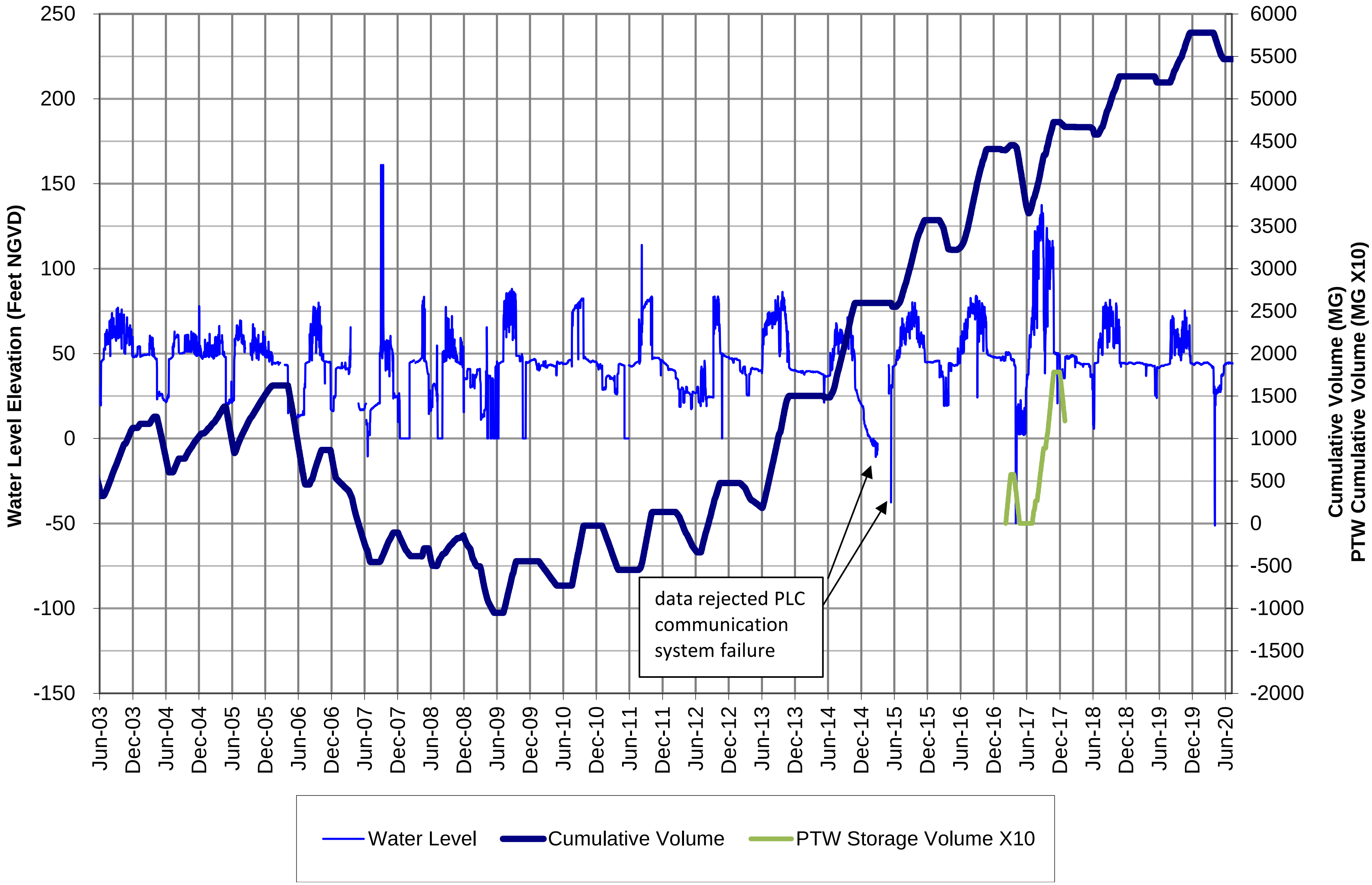


Figure 5-21
S-19 Water Level Elevation

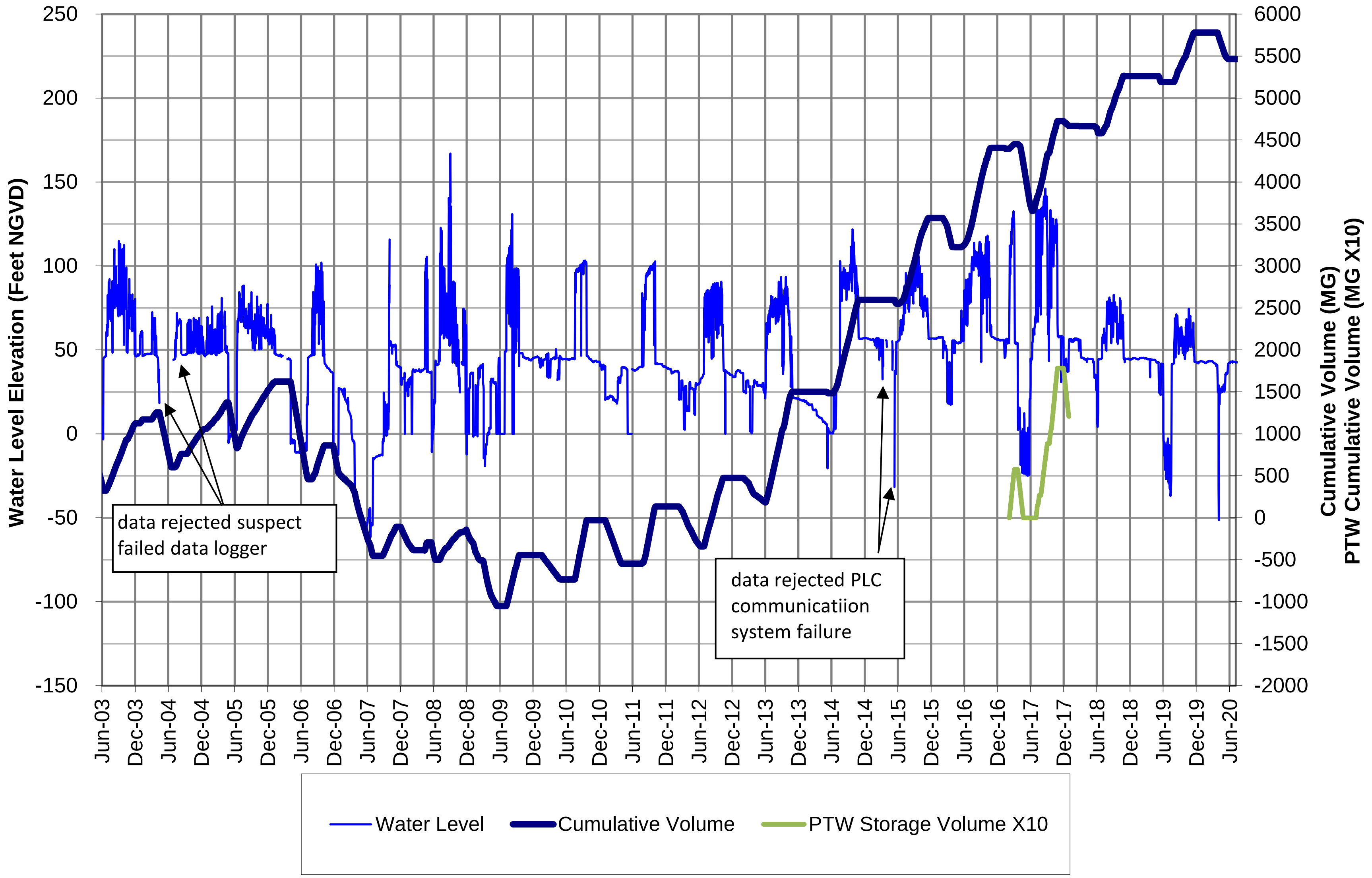


Figure 5-22
S-20 Water Level Elevation

SECTION 6

Partially Treated Water ASR

The Authority is committed to exploring options to bolster regional water supply system resiliency by increasing water supply capacity, improving water quality, adding supply diversity, increasing system storage for drought tolerance, or reducing operational costs. Sometimes projects are identified that can meet several of these objectives at the same time. Implementing partially treated water (PTW) instead of fully treated potable water as a recharge water source for the ASR system provides for additional storage capability, has expected water quality benefits, and offers a significant decrease in overall delivery costs. Rather than the current ASR operating practice of treating stored river water to potable standards twice before distributing treated water to the public (once for injection/recharge to ASR and again after recovery from ASR), the Authority would only need to treat raw water once through the PRF. Also, ASR injection is currently limited by treatment capacity, and compulsory maintenance often can take treatment trains out of operation for several months, which can constrain ASR recharge potential. Therefore, the Authority could more opportunistically inject water when it is available from the river since the water would not need to be routed through the PRF first.

The concept of using PTW at this location was first evaluated in a desk top study, *Partially Treated Surface Water ASR Desktop Study* (CH2M and ASRus, March 2016). Based on the findings of that study, a modification to the permit was requested and approved by the Florida Department of Environmental Protection (FDEP) to allow pilot testing at 2 of the 12 ASR wells in WF2 using PTW. PTW is surface water from the Peace River that is stored in the Authority's reservoir system and filtered prior to recharge into the ASR wells. The objectives of the pilot test included evaluating how water quality aspects associated with PTW differ from those associated with potable water ASR and observation of overall well performance with respect to production and recharge capacities.

Two cycles, each consisting of a period of recharge, storage, and recovery, were completed at ASR wells S-4 and S-20 as part of the pilot testing. Cycle Test 1 (CT1) began in February 2017 and included recharging ASR wells S-4 and S-20, with a total of 59 MG of PTW, and storing the water for approximately two weeks. A total of 25.1 MG was then subsequently recovered from these two wells before seasonally dry conditions warranted recovery operation from the other wells in the same wellfield. Although the two pilot wells continued recovery for nearly 2 months along with the remainder of wells in the wellfield, and theoretically withdrew far more water than the volume of PTW that originally had been injected, during this later period water from the two pilot wells represented only a small fraction of the total withdrawal from the wellfield.

Cycle Test 2 (CT2) began in July 2017, recharging a total of 178 MG of PTW, storing the water for approximately 1 month in November 2017, and then recovering approximately 57 MG from the same ASR wells during December 2017 and early January 2018. Unlike CT1, no other wells in the same wellfield were in recovery mode during the entirety of CT2 recovery. During the pilot test, water quality data were collected from the extensive monitoring well network surrounding WF2.

Data from the monitoring wells showed clear indications of arrival of the PTW from water quality indicators such as color, total organic carbon, and total coliform, each present at relatively high concentrations in PTW compared to native ground water or treated water. One of the primary water quality concerns of PTW ASR is the fate of total coliform (which is ubiquitous in surface water) once recharged into the aquifer. Data showed that while total coliform counts were observed at high levels as far away as monitoring well M-15 (located approximately 1,100 feet downgradient of well S-20), the levels decline rapidly after the PTW recharge period is ceased. The "die-off" or "inactivation" period to reach the regulatory groundwater standard of 4 colony forming units per 100 milliliters (CFU/100 mL) from a too-numerous-to-count CFU/100 mL was between 3 and 4 weeks based on the data collected from the monitoring wells.

Arsenic concentrations were monitored to evaluate potential impacts (positive or negative) from the use of PTW. Arsenic concentrations increased in some of the monitoring wells near the end of CT2 recharge, including monitoring well M-15, a compliance well listed in the Authority's Water Quality Criteria Exemption (WQCE) for arsenic associated with the ASR permit. However, the increase in arsenic concentration coincided with an overall increase in the total storage volume at WF2 (the highest since operations began at this site 16 years ago) as well as the largest recovery event since potable water was completely recovered from the ground in 2006 due to drought conditions. Therefore, the increases in arsenic could be attributed to PTW, or the higher potable water storage volumes (with the assumption that the large volume of stored water is resulting in geochemical changes further from the center of the wellfield than previously seen), or a combination of these events.

Since M-15 is 1,100 feet from the nearest property boundary to the southeast and over 2 miles from the property boundary to the southwest (the direction of groundwater flow), and other ASR compliance wells have remained below 10 μg/L, the mobilization of arsenic continues to be effectively managed at this system. Continued increases in ASR storage volumes and the conversion to PTW will need to be closely monitored to assure arsenic mobilization from ASR operations continues to remain within the Authority's property.

PTW was filtered with either 50-or 100-micron mesh bags, or a stainless-steel basket with 1/8-inch openings at various times during the test. The performance of wells S-4 and S-20 showed some decline during recharge events, with well S-4 showing more decline than well S-20. However, recovery of PTW after CT1 and CT2 showed that the wells could restore lost capacity. While only the stainless-steel basket was used for filtration late in the test, a back-flush protocol was implemented during PTW recharge that involved periodically stopping recharge activities and pumping the wells (recovery) briefly to remove any solids that potentially were accumulating in the well. The effort was successful in maintaining capacity in the wells, and no significant plugging of the wells was observed that would prevent implementation of PTW. The calculated SI for well S-4 during PTW was similar to SI values observed historically. The SI for well S-20 during PTW recharge was within range of historical SI values observed at this well.

The Authority has a significant investment in the current ASR system, not just in the capital cost of the infrastructure and the cost of the water currently in storage, but also the considerable resources spent collecting years of data that have led to a regulatory solution enabling the ASR system to receive an operation permit. Conversion of the potable system to a PTW system would maximize the use of this valuable resource, allowing the Authority to see a greater return on this investment.

Conclusions of the PTW pilot testing suggest that water quality issues likely can be managed, although a regulatory relief mechanism such as a zone of discharge (ZOD) would be needed to allow for temporary exceedances of total coliform and some secondary drinking water standards on property owned or controlled by the Authority. Recent discussions with FDEP regarding the permitting of this facility to include PTW have been less favorable than initial discussions with FDEP that resulted in a major permit modification authorizing pilot testing with PTW. Despite the positive results of the PTW pilot testing and preponderance of evidence showing the efficacy of pathogen removal in the aquifer, FDEP has indicated that they will not support PTW without disinfection at this time.

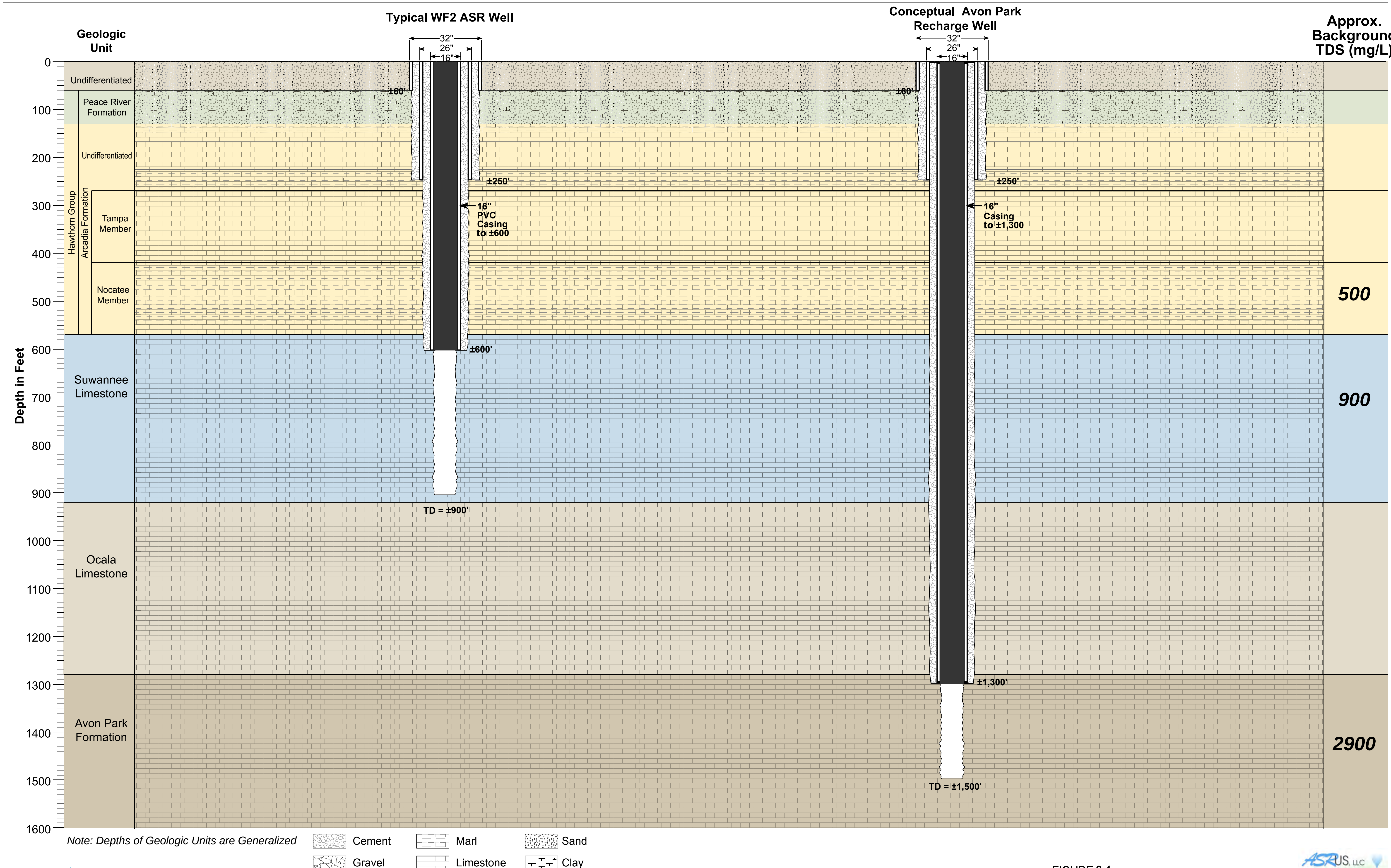
It should be anticipated that a permit renewal from FDEP would be similar to the existing WQCE in that primary and secondary drinking water standards would need to be maintained at the Authority's property boundary.

The Authority is evaluating possible disinfection treatment options for the recharge water. This along with appropriate monitoring and management strategies can be used to demonstrate compliance with drinking water standards. These strategies likely will include one or more of the following:

- ZOD in the permit for some secondary drinking water standards
- Construction of additional monitoring wells closer to the institutional control boundaries
- Replacement of ASR wells located nearest current property boundaries by new ASR production wells located further from the property boundaries
- Addition of ASR wells (ASR expansion)
- Authority purchase or control of additional property if needed
- Limits on total water in storage and/or development of alternative wellfield management (recharge and recovery) strategies

Another consideration to improve reliability, particularly at WF2, is an aquifer recharge concept. Because of the close spacing of wells in WF2, they exhibit significant upconing (movement of more saline water from below the ASR storage zone) during pumping events. Installing a PTW aquifer recharge well in the permeable zone below the ASR zone (Avon Park high permeability zone) would displace the brackish native water and provide a protective fresh water barrier beneath the wellfield. This is expected to reduce the increases in salinity observed during recovery and allow a greater recovery efficiency from the wells. Aquifer recharge may be considered an alternative water supply benefit by helping to maintain water levels in the UFA, which is utilized heavily by agriculture in the region and within the Southern Water Use Caution Area. This concept could potentially provide the Authority with groundwater withdrawal credits (also known as “net benefits”), negotiated with the water management district, based on a percentage of the water invested as a regional benefit.

Figure 6-1 shows a diagram of a conceptual recharge well along with a typical WF2 ASR well. The well would be similar to the existing Avon Park well at the PRF; however, to provide maximum effectiveness, a new well would be located in the middle of WF2 where upconing is believed to be at a maximum. Minimal aboveground facilities would be needed since the well potentially could be recharged with the same infrastructure that would serve WF2. Recharge wells completed into the Avon Park high permeability zone are expected to have a capacity of 5 mgd or more in a single well, which provides a cost-effective option for storing significant quantities of PTW during those periods when excess surface water is available.



Peace River Manasota Regional Water Supply Authority

ASRUS, LLC

FIGURE 6-1
Conceptual Recharge Well Construction Details

SECTION 7

Summary and Conclusions

The Authority continued to increase storage volumes in the ASR wellfields in 2020. A total of 284 MG of water was recharged at WF1 and 654 MG was recharged at WF2, for a total recharge volume of 938 MG in 2020. A total of 179 MG was recovered from WF1 and 313 MG was recovered from WF2, for a total of 492 MG of recovery from the system in 2020. Cumulative storage in the ASR system at the end of 2020 was approximately 8.2 BG, an increase of approximately 0.47 BG from the previous year.

The Q/s and SI of the ASR wells has remained relatively stable with no significant decreasing trends observed other than at wells S-11 and S-17 in 2007, when the wells were partially backplugged to address upconing of poor quality water from the Avon Park Formation.

During the recovery event in 2020, arsenic concentrations remained below 10 µg/L at the ASR production wells with the exception of S-3R and S-13, which showed a maximum concentration of 10 µg/L and 10.8 µg/L, respectively.

During the 2020 recovery event at WF2, the rate of increase in chloride and TDS concentrations were slightly improved or comparable to recent recovery events. Chloride and TDS concentrations were the highest at S-13, S-19, and S-20.

During the recovery event at WF1, chloride and TDS concentrations were comparable to the previous recent recovery events. In general, the ending salinity concentrations are higher due to the longer recovery period compared to 2018 and 2019. As a whole the chloride, TDS, and sulfate concentrations are trending down in response to an increase, or maintenance of recharge water invested in WF1.

In 2020, all arsenic samples from the WF1 monitoring wells were less than 10 µg/L. Arsenic concentrations at the WF2 storage zone monitoring wells remained below 10 µg/L in all wells except M-15, where the maximum concentration observed was 11.6 µg/L. Arsenic detections observed in 2020 were slightly lower compared to 2019. Arsenic concentrations in all shallow monitoring wells overlying the storage zone (T, I, and E series) remained below the arsenic standard during the 2020 reporting period.

The TDS concentrations observed in the storage zone monitoring wells vary depending on proximity to ASR wells and the mode of operation. Many of the monitoring wells near WF2 have shown a freshening trend correlating to the increased storage volumes in the ASR wells. In 2020, TDS concentrations were comparable with to slightly higher compared to the typical ranges observed in 2019. The slightly higher ranges are most likely due to the longer recovery period in 2020. Water quality in the shallower monitoring wells has been consistent, showing neutral water quality trends through 2020 with the exception of T-11, which has shown a long-term increasing trend.

Water levels in the monitoring wells change in response to ASR operations and seasonal variations in aquifer conditions. In 2020, the water level fluctuations observed in the monitoring wells were within the normal ranges observed in previous years.

PTW ASR pilot testing using water from Reservoir No. 1 was completed successfully in 2017. Two cycles, each consisting of a period of recharge, storage, and recovery were completed at ASR wells S-4 and S-20 as part of the pilot testing. CT1 began in February 2017 and included recharging a total of 59 MG of PTW and storing the water for approximately 2 weeks. A total of 25.1 MG subsequently was recovered from wells S-4 and S-20.

PTW CT2 began in July 2017, recharging a total of 178 MG of PTW, storing the water for approximately one month in November 2017 and then recovering approximately 57 MG from the same ASR wells during December 2017 and early January 2018. During the pilot test, water quality data were collected from the extensive monitoring well network surrounding WF2.

Data from the monitoring wells showed clear indications of arrival of the PTW from water quality indicators such as color, total organic carbon, and total coliform, each present at relatively high concentrations in PTW compared to native ground water or potable water. Total coliform concentration declined to less than 4 CFU/100 mL during storage. Arsenic concentrations in some of the nearby storage zone monitoring wells increased, likely in part due to differing geochemical conditions of PTW. However, it is anticipated that the continued use of PTW ultimately will result in a geochemical environment conducive to the natural attenuation of arsenic in the formation.

Despite the favorable results regarding the inactivation of total coliform during PTW cycle testing, FDEP has indicated that they will not support PTW unless disinfection is added. Even with the addition of disinfection treatment, a significant reduction in the cost of operating the ASR system is anticipated, since it would only require full treatment to drinking water standards one time, when recovered from ASR storage. It will allow the Authority to fully treat only that volume of water recovered and targeted for potable water use and not water recharged into the wells.

A request to include PTW with chloramine disinfection at WF2 has been submitted to the Department for inclusion in the current permit application that is under review. The FDEP has indicated that use of PTW that undergoes disinfection to meet the groundwater discharge standard for total coliform can be permitted as long as disinfection byproducts do not exceed their respective primary drinking water standard MCL.

SECTION 8

Recommendations

The following recommendations are offered based on review of the ASR system operational data:

1. **Continue to manage variables that impact wellfield recovery efficiency.** Limiting the recovery flow rates and stopping recovery once a TDS threshold is reached can limit excessively high TDS concentrations as seen in past recovery events. One of the main factors influencing TDS during recovery is the starting TDS concentration (y-intercept), as found in the yield modeling effort (updated in the 2016 Annual report). By conditioning the aquifer each season and avoiding successive recovery events without recharge, an improved (or stable) recovery curve can be expected during the subsequent recovery period. Data should continue to be collected and evaluated to validate and refine the new model developed in the 2020 Aquifer Storage and recovery System TDS Yield Update completed February 2021.
2. **Closely monitor arsenic mobilization.** A WQCE was issued in 2013 to allow arsenic mobilization within property under the control of the Authority. It has been conveyed by the FDEP that a WQCE will not be renewed during the next permit issuance. The 2013 letter from EPA that offers an opinion on the regulation of potable ASR systems that observe arsenic mobilization is presumed to be adequate to support the permitting of the Authority's ASR system since the Authority meets the objective of protecting public health by the use of institutional control of their ASR water. The language of the new draft permit should be carefully reviewed regarding the regulation of arsenic going forward without the use of a WQCE. Until the new permit is issued the conditions of the WQCE should continue to be followed.
3. **PTW ASR.** The FDEP has indicated that they do not intend to issue the permit to include PTW, but will consider PTW if it is disinfected to meet the groundwater discharge standard for total coliform. The Authority is pursuing this option as the cost of the infrastructure is anticipated to be relatively low, and the treatment cost required to disinfect the water will be significantly less than the cost of full treatment. PTW does not commit treatment plant capacity for aquifer recharge, potentially deferring future treatment plant expansion. Any exceedances of aesthetic based secondary drinking water standards such as color and aluminum can be addressed through a ZOD in the permit.
4. **Evaluate addition of an aquifer recharge well.** If PTW is implemented at WF2 in the future, investing excess water into the aquifer is no longer cost prohibitive. An Avon Park high permeability zone PTW recharge well completed below WF2 has the potential to significantly improve water quality of WF2 and provide a regional benefit to the UFA. Operation of a recharge well below WF2 would extend the recovery periods available from WF2 and allow the Authority to recover a much greater percentage of the water currently stored in WF2. This concept should be further evaluated, including the cost, benefits, and the potential for Southwest Florida Water Management District funding.
5. **Evaluate Water Level transducer/data loggers and replace or calibrate as needed.** Data should be evaluated on a monthly basis to assure transducer/data loggers are functioning properly. Development of a regular calibration schedule should be considered to maintain quality data.

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15. **CH2M HILL, September 1993.** *Interim Report on the Well Construction and Testing of the Peace River Regional Water Supply Facility Avon Park Test Well.* Prepared for the Peace River/Manasota Regional Water Supply Authority, Sarasota, Florida.

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18. **CH2M HILL, 1995.** *Water Use Permit Renewal – Response to the Request for Additional Information*. Prepared for the Peace River/Manasota Regional Water Supply Authority, Sarasota, Florida.

19. **CH2M HILL, November 1995.** *Results of Operational Testing of ASR Wells S-3R, S-5R, and S-9R*. Prepared for the Peace River/Manasota Regional Water Supply Authority, Sarasota, Florida.

20. **CH2M HILL, January 1998.** *Peace River Regional Water Supply Facility. Analysis of Aquifer Storage Recovery System Operational Data – 1987 to 1997*. Prepared for the Peace River/Manasota Regional Water Supply Authority, Sarasota, Florida.

21. **CH2M HILL, May 2003.** *Peace River Regional Water Supply Facility. Data Analysis for the East ASR WF1987 to 2002*. Prepared for the Peace River/Manasota Regional Water Supply Authority, Sarasota, Florida.

22. **CH2M HILL, July 2005.** *Well Completion Report for the ASR Wellfield Enhanced Groundwater Monitoring Program*. Prepared for the Peace River/Manasota Regional Water Supply Authority, Sarasota, Florida.

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26. **CH2M HILL and ASRus, May 2009.** *Peace River Facility ASR System 2008 Annual Report.* Prepared for the Peace River/Manasota Regional Water Supply Authority, Bradenton, Florida.

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30. **CH2M HILL and ASRus, April 2011.** *Class V Exploratory Well Construction Permit Application – Exploratory Well for Brine Concentrate Disposal at the Peace River Facility.* Prepared for the Peace River/Manasota Regional Water Supply Authority, Bradenton, Florida.

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32. **CH2M HILL and ASRus, May 2012.** *Peace River Facility ASR System 2011 Annual Report.* Prepared for the Peace River/Manasota Regional Water Supply Authority, Bradenton, Florida.

33. **CH2M HILL and ASRus, July 2012.** *Florida Department of Environmental Protection Class V, Group 7, Injection Well Operation Permit Application - Peace River Regional Water Supply Facility Aquifer Storage Recovery System.* Prepared for the Peace River/Manasota Regional Water Supply Authority, Bradenton, Florida.

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35. **CH2M HILL and ASRus, May 2013.** *Peace River Facility ASR System 2012 Annual Report.* Prepared for the Peace River/Manasota Regional Water Supply Authority, Bradenton, Florida.

36. **CH2M HILL and ASRus, December 2, 2013.** *Aquifer Storage and Recovery System Yield Study Update 2013.* Technical Memorandum prepared for the Peace River/Manasota Regional Water Supply Authority, Bradenton, Florida.

37. **CH2M HILL and ASRus, March 24, 2014.** *Aquifer Storage and Recovery Well Condition Assessment.* Technical Memorandum prepared for the Peace River/Manasota Regional Water Supply Authority, Bradenton, Florida.

38. **CH2M HILL and ASRus, August 2014.** *Peace River Facility ASR System 2013 Annual Report.* Prepared for the Peace River/Manasota Regional Water Supply Authority, Bradenton, Florida.

39. **CH2M HILL and ASRus, August 2015.** *Peace River Facility ASR System 2014 Annual Report.* Prepared for the Peace River/Manasota Regional Water Supply Authority, Bradenton, Florida.

40. **CH2M HILL and ASRus, March 2016.** *Partially Treated Surface Water Desktop Study.* Prepared for the Peace River/Manasota Regional Water Supply Authority, Bradenton, Florida.

41. **CH2M HILL and ASRus, August 2016.** *Peace River Facility ASR System 2015 Annual Report.* Prepared for the Peace River/Manasota Regional Water Supply Authority, Bradenton, Florida.

42. **CH2M HILL and ASRus, August 2016.** *Florida Department of Environmental Protection Class V, Group 7, Operation Permit Aquifer Storage Recovery – Request for Major Modification to Permit Peace River Regional Water Supply Facility Aquifer Peace River Facility.* Prepared for the Florida Department of Environmental Protection on behalf of the Peace River Manasota Regional Water Supply Authority.

43. **CH2M HILL and ASRus, August 2016.** *Peace River Facility ASR System 2015 Annual Report.* Prepared for the Peace River/Manasota Regional Water Supply Authority, Bradenton, Florida.

44. **CH2M HILL and ASRus, August 2017.** *Peace River Facility ASR System 2016 Annual Report.* Prepared for the Peace River/Manasota Regional Water Supply Authority, Bradenton, Florida.

45. **CH2M HILL and ASRus, February 2018.** *Florida Department of Environmental Protection Class V, Group 7, Aquifer Storage and Recovery (ASR) Well System Operation Permit Peace River Facility Aquifer Storage and Recovery System.* Prepared for the Florida Department of Environmental Protection on behalf of the Peace River Manasota Regional Water Supply Authority.

46. **CH2M HILL and ASRus, August 2018.** *Peace River Facility ASR System 2017 Annual Report.* Prepared for the Peace River/Manasota Regional Water Supply Authority, Bradenton, Florida.

47. **CH2M HILL and ASRus, August 2018.** *Peace River Facility Partially Treated Surface Water ASR Pilot Study.* Prepared for the Peace River/Manasota Regional Water Supply Authority, Bradenton, Florida.

48. **CH2M HILL and ASRus, August 2019.** *Peace River Facility ASR System 2018 Annual Report.* Prepared for the Peace River/Manasota Regional Water Supply Authority, Bradenton, Florida.

49. **CH2M HILL and ASRus, August 2020.** *Peace River Facility ASR System 2019 Annual Report.* Prepared for the Peace River/Manasota Regional Water Supply Authority, Bradenton, Florida.

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51. **Gerhardt M. Witt & Associates, January 31, 1997.** *The City of Venice, Florida Groundwater Modeling Report Intracoastal Wellfield and Eastern Wellfield*. Prepared for the City of Venice, Florida.

52. **Nodarse & Associates, 1999.** *Subsurface Soil Exploration – Peace River Water Treatment Facility, ASR Wellfield Expansion*. Prepared for the Peace River/Manasota Regional Water Supply Authority, Sarasota, Florida.

53. **PR/MRWSA, April 1988.** *GDU's Peace River Regional Water Treatment Facility CUP Renewal*. Prepared by the Peace River/Manasota Regional Water Supply Authority, Sarasota, Florida.

54. **PR/MRWSA, October 1991.** *Peace River Regional Water Supply Facility Monitor Well "E" Report*. Prepared by the Peace River/Manasota Regional Water Supply Authority, Sarasota, Florida.

55. **PR/MRWSA, July 10, 1997.** *ASR Wells S-4 and S-5 Capacity and Water Quality Test Program Final Report – WUP No. 2010420.02.* Prepared for the Southwest Florida Water Management District, Venice, Florida.

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57. **ViroGroup and Boyle Engineering, September 1998.** *Peace River Option – Peace River Facility/ASR Wellfield Expansion. Florida Department of Environmental Protection Class V, ASR Well Construction Permit Application*. Prepared for the Peace River/Manasota Regional Water Supply Authority, Sarasota, Florida.

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Appendix A
FDEP Underground Injection Control Permits

Florida Department of
Environmental Protection
Southwest District Office
13051 North Telecom Parkway
Temple Terrace, Florida 33637-0926

Rick Scott
Governor

Herschel T. Vinyard Jr.
Secretary

Underground Injection Control
Class V, Group 7
Aquifer Storage and Recovery (ASR) Well System
Operation Permit

Permittee:
Patrick Lehman, P.E.
Executive Director
Peace River/Manasota Regional
Water Supply Authority
9415 Town Center Parkway
Lakewood Ranch, FL 34202
plehman@regionalwater.org

Permit/Certification

PA File Number:	0136595-014-UO/5Q
Facility ID Number:	614-2734
WACS ID:	40593
Date of Issuance:	April 24, 2013
Date of Expiration:	April 23, 2018
Permit Processor:	Rommy Lahera-Aument, P.G.

Facility
Peace River Regional Water Supply Facility
8998 SW County Road 769
Arcadia, FL 34269

Location

County:	DeSoto
Latitude:	27˚05'27.85" N
Longitude:	83˚00' 3.87" W

Project: Class V, Group 7 ASR Wells in Well Field 1: T-1, S-1, S-2, S-6, S-7, S-8, S-3R, S-5R, S-9R
Class V, Group 7 ASR Wells in Well Field 2: S-4, S-10 through S-20

This permit is issued under the provisions of Chapter 403, Florida Statutes, and Florida Administrative Code (F.A.C.), Chapters 62-4, 62-520, 62-528, and 62-550. The above named permittee is hereby authorized to perform the work or operate the facility shown on the application and approved drawing(s), plans, and other documents attached hereto or on file with the Department and made a part hereof and specifically described as follows.

The permittee is reminded of the necessity to comply with the pertinent regulations of any other regulatory agency, as well as any county, municipal, and federal regulations applicable to the project. These regulations may include, but are not limited to, those of the Federal Emergency Management Agency in implementing flood control measures. This permit should not be construed to imply compliance with the rules and regulations of other regulatory agencies.

TO OPERATE: 21 ASR and 24 monitor wells in Well Fields 1 & 2, at a typical flow rate of 0.5 to 1 million gallons per day (MGD) for each ASR well for the storage and recovery of potable water.

IN ACCORDANCE WITH: The Application to Operate DEP Form No. 62-528.900(1) received August 20, 2012 and technical specifications, drawings, plan of study and addenda submitted to this agency.

LOCATION: The Peace River Regional Water Supply Facility is located at 8998 SW County Road 769, Arcadia, DeSoto County, Florida. Well Field 1 is located on the facility or east side of County Road 769, and Well Field 2 is on the reservoir or west side.

The ASR and monitoring wells at this facility are designated as follows:

ASR Wells:

Well Name	*WACS Effluent Test-site ID*	*Total Well Depth*	*Diameter (inches)*	*Interval Type*	*Interval (feet bls)*
T-1		482	12	LPZ	380-482
S-1		920	8	Suwannee Zone	570-920
S-2		900	12	Suwannee Zone	570-900
S-6		910	12	Suwannee Zone	580-910
S-7		915	12	Suwannee Zone	575-915
S-8		623	12	Suwannee Zone	510-623
S-3R		769	16	Suwannee Zone	580-769
S-5R		955	16	Suwannee Zone	650-955
S-9R		800	16	Suwannee Zone	580-800
S-4		905	12	Suwannee zone	570-905
S-10		906	16	Suwannee Zone	620-906
S-11		816	16	Suwannee Zone	585-816
S-12		900	16	Suwannee Zone	600-900
S-13		898	16	Suwannee Zone	621-898
S-14		900	16	Suwannee Zone	586-900
S-15		833	16	Suwannee Zone	583-833
S-16		902	16	Suwannee Zone	583-902
S-17		786	16	Suwannee Zone	579-786
S-18		900	16	Suwannee Zone	592-900
S-19		900	16	Suwannee Zone	585-900
S-20		898	16	Suwannee Zone	566-898

LPZ = lower producing zone of the Intermediate Aquifer system (a.k.a. Tampa Zone)
Suwannee Zone = refers to the Upper Floridan aquifer permeable unit within the Suwannee Limestone Formation

Monitoring Wells:

Well Name	*WACS Monitoring Well Testsite ID*	*Diameter (inches)*	*Interval Type*	*Depth Cased (ft bls)-Total (ft bls)*
E		6	UPZ	140-200
T-2		4	LPZ	393-490
M-2		6	Suwannee Zone	596-900
I-7		6	LPZ	220-261
T-7		6	LPZ	349-400

M-7		6	Suwannee Zone	580-605
M-20		6	Suwannee Zone	584-688
M-21		6	Suwannee Zone	575-672
M-22		6	Suwannee Zone	565-572
T-11		6	LPZ	350-400
M-11		6	Suwannee Zone	570-677
M-12		6	Suwannee zone	585-705
M-13		6	Suwannee Zone	550-670
M-14		6	Suwannee Zone	575-676
M-15		6	Suwannee Zone	570-678
M-16		6	Suwannee Zone	560-673
M-17		6	Suwannee Zone	565-670
M-18		6	Suwannee Zone	575-700
M-19		6	Suwannee Zone	580-680
I-10		6	LPZ	260-320
M-6		6	Suwannee Zone	579-640
I-8		6	UPZ	155-190
T-8		12	LPZ	354-401
M-8		10	Suwannee Zone	570-860

UPZ = upper producing zone of the Intermediate Aquifer System
LPZ = lower producing zone of the Intermediate Aquifer system (a.k.a. Tampa Zone)
Suwannee Zone = refers to the Upper Floridan aquifer permeable unit within the Suwannee Limestone Formation

SUBJECT TO: Specific Conditions I - IV and General Conditions 1- 24.

Specific Conditions

I. OPERATING REQUIREMENTS

A. General

1. Injection of fluids other than those permitted into the ASR well will constitute a violation of this permit and shall constitute cause for permit revocation and possible enforcement action for water quality violation. Only water from the Peace River Regional Water Supply Facility, a surface water drinking water facility, may be injected.

2. No underground injection is allowed that causes or allows movement of fluid into a USDW if such fluid movement may cause a violation of any Primary Drinking Water Standard or may otherwise affect the health of persons unless such activities are specifically authorized by permit or through the Water Quality Criteria Exemption issued for this facility. [62-528.440(2)(c)]

3. All equipment of this facility shall be operated and maintained so as to function consistently as designed in removing pollutants. [62-528.307(3)(b) and 62-528.400(1)

4. In the event a well must be plugged or abandoned, the permittee shall obtain a permit from the Department as required by Chapter 62-528, Florida Administrative Code. When no longer used for their intended purpose, these wells shall be properly plugged and abandoned. Within 180 days of well abandonment, the permittee shall submit to the Department the proposed plugging method, pursuant to Rule 62-528.460, F.A.C. [62-528.460(1) and 62-528.435(6)]

5. In accordance with rules 62-4.090 and 62-528.640(3), F.A.C., the permittee shall submit an application for permit renewal at least 60 days prior to expiration of this permit. [62-528.307(3)(a)]

6. Hurricane Preparedness: Preparations to be made by permittee upon issuance of a "Hurricane Watch" by the National Weather Service include, but are not limited to:
    a. Secure all onsite salt and other stockpiled additive materials to prevent surface and/or ground water contamination.
    b. Properly secure equipment to prevent damage to well(s) and onsite treatment process equipment.

    [62-528.307(3)(b)]

7. This ASR facility shall be operated in conformance with the criteria contained in Water Quality Criteria Exemption OGC File 12-1502.

B. Surface Equipment

1. The integrity of the monitoring zone sampling systems shall be maintained at all times. Sampling lines shall be clearly and unambiguously identified by monitoring zone at the point at which samples are drawn. All reasonable and prudent precautions shall be taken to ensure that samples are properly identified by monitoring zone and that samples obtained are representative of those zones. Sampling lines and equipment shall be kept free of contamination with independent discharges and no interconnections with any other lines. [62-528.307(1)(f) and 62-528.307(3)(b)]

2. The surface equipment for each ASR well shall maintain compliance with Chapter 62-528.450(2)(j), F.A.C. for water hammer control, screening, access for logging and testing, and reliability and flexibility in the event of damage to the well and surface piping. A regular program of exercising the valves integral to the well head shall be instituted. A record shall be maintained at the facility that documents the exercising of the valves. [62-528.307(1)(f) and 62-528.307(3)(b)]

3. The surface equipment and piping for the ASR and monitoring wells shall be kept free of corrosion, to the extent practical, at all times. [62-528.307(1)(f) and 62-528.307(3)(b)]

4. The ASR well pads shall be maintained and retained in service for the life of the ASR wells. The ASR and monitoring well pads are not, unless specific approval is obtained from the Department, to be used for storage of any material or equipment at any time. [62-528.307(1)(f) and 62-528.307(3)(b)]

II. QUALITY ASSURANCE/QUALITY CONTROL

1. The permittee shall ensure that the operation of this ASR well system shall be as described in the application and supporting documents. Any proposed modifications to the permit shall be submitted in writing to the Underground Injection Control Program for review and clearance prior to implementation. Changes of negligible impact to the environment and staff time will be reviewed by the program manager, cleared when appropriate and incorporated into this permit. Changes or modifications other than those described above will require submission of a completed application and appropriate processing fee as per Rule 62-4.050, F.A.C. [62-528.100, 62-4.050]

2. Proper operation and maintenance include effective performance and appropriate quality assurance procedures; adequate operator staffing and training; and adequate laboratory and process controls. [62-528.307(3)(b)]

3. All water quality samples required by this permit shall be collected in accordance with the appropriate Department Standard Operation Procedures (SOP), pursuant to Chapter 62-160, Quality Assurance, Part II, Field Procedures, F.A.C. A certified laboratory shall conduct the analytical work, as provided by Chapter 62-160, Quality Assurance, Part III, Laboratory Certification and Procedures, F.A.C. Department approved test methods shall be utilized, unless otherwise stated in this permit. All calibration procedures for field testing and laboratory equipment shall follow manufacturer's instrumentation manuals and satisfy the requirements of the Department SOPs. A listing of the SOPs pertaining to field and laboratory activities is available at the FDEP website at: **http://www.dep.state.fl.us/water/sas/sop/sops.htm**. [62-4.246, 62-160]

4. All indicating, recording and totalizing devices associated with the ASR well system shall be maintained in good operating condition and calibrated annually at a minimum. United States Environmental Protection Agency (USEPA) laboratory guidelines as expressed in Standard Methods for the Examination of Water and Wastewater. The pressure gauges, flow meter, and chart records shall be calibrated using standard engineering methods. [62-528.307(1)(f) and 62-528.307(3)(b)]

5. All reports submitted to satisfy the requirements of this permit shall be signed by a person authorized under Rule 62-528.340(1), F.A.C., or a duly authorized representative of that person under Rule 62-528.340(2), F.A.C. All reports required by this permit which are submitted to the Department shall contain the following certification as required by Rule 62-528.340(4), F.A.C.:

   > I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

   [62-528.340(1), (2), and (4)]

6. Analyses shall be conducted on unfiltered samples, unless filtered samples have been previously approved as being more representative of ground water conditions. [62-520.310(5)]

III. TESTING AND REPORTING REQUIREMENTS

A. General

1. The permittee shall submit monthly to the Department the results of all ASR well and monitoring well data required by this permit no later than the last day of the month immediately following the month of record. The report shall include:

    a. A cover page summarizing the current status of all monthly activities, including the certification and signature required in condition II.5.;
    b. Operational and water quality data in a tabular format. Standardized forms for the project may be provided by the Department if deemed necessary;
    c. Laboratory pages and supporting documentation;
    d. The following identifying information (to be provided by the Department) must be included on each data sheet:

        - Facility Name
        - Well Name
        - UIC Permit Number
        - WACS Facility ID
        - WACS Test site ID
        - WACS Test site Name

    The Monthly Operating Report (MOR) shall be submitted *via* direct internet electronic mail (e-mail) to UIC Staff at the South District (david.rhodes@dep.state.fl.us) and Tallahassee Offices (joe.haberfeld@dep.state.fl.us) in Adobe™ (.pdf) format. A compact disc may be sent instead of the e-mail format to the South District (2285 Victoria Avenue, Suite 364, Fort Myers, FL 33902-2549) and the Department of Environmental Protection, UIC Program (Mail Station 3530, 2600 Blair Stone Road, Tallahassee, FL 32399-2400). [62-528.307(3)(d)]

2. An Annual Summary Report shall be submitted to the Department South District and Tallahassee Underground Injection Control Program by September 1 of each year. A single report combining all ASR systems is acceptable. The report shall address and summarize the preceding year of operations (January 1 through December 31) and shall include at a minimum:

    a. All ASR well system monitoring data from the preceding year in both graphic and tabular formats;
    b. A summary of system specific injectivity efficiency;
    c. Proposed changes (if any) to the monitoring program.

    [62-528.307(1)(m)1.]

B. Monitoring

1. The ASR system shall be monitored in accordance with Rules 62-528.425(l)(g) and 62-528.430(2), F.A.C. The following ASR well performance data and monitor zone data shall be recorded and reported in the MOR as indicated below during each recharge, storage and recovery phase. Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity. [62-528.307(3)(d) and 528.430(2)]

PARAMETER	UNIT	RECORDING FREQUENCY	FREQUENCY OF ANALYSES			
			ASR wells	**M-2,M-15, M -18,M-19, M-21,T-2,T-7,T-11**	M-7, M-8, M-14, M-16, M-22 M-17, M-20	E,I-7,I-8, I-10, T-8,M-6, M-11, M-12,M-13
Flow Rate, max.	gpm	continuous	[a]			
Flow Rate, min.	gpm	continuous	[a]			
Flow Rate, avg.	gpm	continuous	[a]			
Total Volume Recharged	mg	Daily/Monthly				
Total Volume Recovered		Daily/Monthly				
Net Storage	MG	Monthly				
ASR Well Pressure, max.	psi	continuous	[a]			
ASR Well Pressure, min.	psi	continuous	[a]			
ASR Well Pressure, avg.	psi	continuous	[a]			
Water Level, max.[g]	feet (NGVD) / PSI	continuous		[a]	[a]	[a]
Water Level, min.[g]	feet (NGVD) / PSI	continuous		[a]	[a]	[a]
Water Level, avg.[g]	feet (NGVD) / PSI	continuous		[a]	[a]	[a]
pH [b]	std. units	Grab	W[c]	W	M	Q
Specific Conductivity [b]	µmhos/cm	Grab	W[c]	W	M	Q
Temperature [b]	°C	Grab	W[c]	W	M	Q
Dissolved Oxygen [b]	mg/L	Grab	W[c]	W	M	Q
Turbidity [b]	NTU	Grab	W[c]	W	M	Q
Oxidation – Reduction Potential [b]	mV	Grab	W[c]	W	M	Q
Total Dissolved Solids	mg/L	Grab	W[c]	W	M	Q
Chloride	mg/L	Grab	W[c]	W	M	Q
Sulfate	mg/L	Grab	W[c]	W	M	Q
Arsenic	µg/L	Grab	W[c]	W	M	Q
Gross Alpha	pCi/L	Grab	Q	Q	Q	
Total Uranium	µg/L	Grab	Q[e]	Q[e]	Q[e]	
Total Trihalomethanes	mg/L	Grab	A[d]	A	A	
Primary and Secondary stds.		Grab	A[f]			

W – Weekly; M - Monthly; Q - Quarterly; A – Annually.
No Sampling of ASR wells during storage.
[a] - Operational data reporting for flows, pressures and water levels: daily max, min and average from continuous reporting; monthly max, min and average (calculated from daily averages).
[b] – Field samples
[c] – Weekly during recovery from currently operating wells, monthly from common distribution during recharge
[d] – During recovery only
[e] – Analyzed only if Gross Alpha exceeds 15 pci/L
[f] – July (finished water)
[g] – Water Level readings from monitor wells M-11 through M-22 will be manual readings recorded monthly
Bolded wells are compliance wells.

2. During extended storage periods (greater than 30 days) the monitoring well water quality parameters listed above may be sampled and analyzed monthly. [62-528.615(2)]

3. A record shall be included in each MOR that documents the monthly exercising of valves. For each valve, this record shall include the valve identification number (tag), type of valve, date and time when exercised, and the initials of operator(s) performing the work. The record shall be maintained at the facility and shall be available for review by FDEP personnel at all times. [62-528.430(2)(b)2.b.]

4. Pertaining to the evacuation (purging) of monitoring wells, which is required prior to the collection of samples for the MOR, the facility may elect to follow either one of the following two purging protocols:

   a. The protocol stated below:

   A minimum of three well volumes of fluid shall be evacuated from the monitoring systems prior to sampling for the chemical parameters listed above. Sufficient purging shall have occurred when either of the following has occurred:

   1) pH, specific conductance and temperature when sampled, upon purging the third or subsequent well volume, each vary less than 5% from that sampled upon purging the previous well volume; or
   2) Upon purging the fifth well volume.

   b. The following protocol taken from DEP-SOP-001/01(Field Procedures):

   1) Purge until the water level has stabilized (well recovery rate equals the purge rate), then purge a minimum of one well volume, and then collect the first set of stabilization parameters, namely pH, specific conductance and temperature;
   2) Thereafter, collect stabilization parameters ≥ every ¼ well volume;
   3) Purging shall be complete when either of the following have occurred:

a) 3 consecutive readings of the parameters listed below are within the following ranges[1]:
 - pH ± 0.2 Standard Units
 - Specific Conductance ± 5.0% of reading
 - Temperature ± 0.2°C

b) Upon purging the fifth well volume.

[62-160.210(1) and 62-528.430(2)]

IV. ABNORMAL EVENTS

1. In the event the permittee is temporarily unable to comply with any of the conditions of a permit due to breakdown of equipment, power outages or destruction by hazard of fire, wind, or by other cause, the permittee of the facility shall notify the Southwest District Office. [62-528.415(4)(a)]

2. Notification shall be made in person, by telephone, or by electronic mail (e-mail) within 24 hours of breakdown or malfunction to the Southwest District Office. [62-528.307(1)(x)]

3. A written report of any noncompliance referenced in Specific Condition (1) above shall be submitted to the Southwest District and the Tallahassee offices within five days after its occurrence. The report shall describe the nature and cause of the breakdown or malfunction, the steps being taken or planned to be taken to correct the problem and prevent its reoccurrence, emergency procedures in use pending correction of the problem, and the time when the facility will again be operating in accordance with permit conditions. [62-528.415(4)(b)]

General Conditions

1. The terms, conditions, requirements, limitations and restrictions set forth in this permit are "permit conditions" and are binding and enforceable pursuant to section 403.141, F.S. [62-528.307(1)(a)]

2. This permit is valid only for the specific processes and operations applied for and indicated in the approved drawings or exhibits. Any unauthorized deviation from the approved drawings, exhibits, specifications, or conditions of this permit may constitute grounds for revocation and enforcement action. [62-528.307(1)(b)]

3. As provided in subsection 403.087(7), F.S., the issuance of this permit does not convey any vested rights or exclusive privileges. Neither does it authorize any injury to public or private property or any invasion of personal rights, nor infringement of federal, state, or local laws or regulations. This permit is not a waiver of or approval of any other Department permit that may be required for other aspects of the total project which are not addressed in this permit. [62-528.307(1)(c)]

---

[1] Provided dissolved oxygen in the groundwater of the zone being monitored is ≤ 20% of saturation for the measured temperature and turbidity is ≤ 20 NTUs. This assumption holds true for groundwater in most zones of the Floridan aquifer.

4. This permit conveys no title to land, water, does not constitute State recognition or acknowledgment of title, and does not constitute authority for the use of submerged lands unless herein provided and the necessary title or leasehold interests have been obtained from the State. Only the Trustees of the Internal Improvement Trust Fund may express State opinion as to title. [62-528.307(1)(d)]

5. This permit does not relieve the permittee from liability for harm to human health or welfare, animal, or plant life, or property caused by the construction or operation of this permitted source, or from penalties there from; nor does it allow the permittee to cause pollution in contravention of Florida Statutes and Department rules, unless specifically authorized by an order from the Department. [62-528.307(1)(e)]

6. The permittee shall properly operate and maintain the facility and systems of treatment and control (and related appurtenances) that are installed and used by the permittee to achieve compliance with the conditions of this permit, or are required by Department rules. This provision includes the operation of backup or auxiliary facilities or similar systems when necessary to achieve compliance with the conditions of the permit and when required by Department rules. [62-528.307(1)(f)]

7. The permittee, by accepting this permit, specifically agrees to allow authorized Department personnel, upon presentation of credentials or other documents as may be required by law and at reasonable times, access to the premises where the permitted activity is located or conducted to:

   a. Have access to and copy any records that must be kept under conditions of this permit;
   b. Inspect the facility, equipment, practices, or operations regulated or required under this permit; and
   c. Sample or monitor any substances or parameters at any location reasonably necessary to assure compliance with this permit or Department rules.
   d. Reasonable time will depend on the nature of the concern being investigated.

   [62-528.307(1)(g)]

8. If, for any reason, the permittee does not comply with or will be unable to comply with any condition or limitation specified in this permit, the permittee shall immediately provide the Department with the following information:

   a. A description of and cause of noncompliance; and
   b. The period of noncompliance, including dates and times; or, if not corrected the anticipated time the noncompliance is expected to continue, and steps being taken to reduce, eliminate, and prevent the recurrence of the noncompliance. The permittee shall be responsible for any and all damages which may result and may be subject to enforcement action by the Department for penalties or for revocation of this permit.

   [62-528.307(1)(h)]

9. In accepting this permit, the permittee understands and agrees that all records, notes, monitoring data and other information relating to the construction or operation of this permitted source which are submitted to the Department may be used by the Department as evidence in any enforcement case involving the permitted source arising under the Florida Statutes or Department rules, except

where such use is proscribed by sections 403.111 and 403.73, F.S. Such evidence shall only be used to the extent it is consistent with the Florida Rules of Civil Procedure and appropriate evidentiary rules. [62-528.307(1)(i)]

10. The permittee agrees to comply with changes in Department rules and Florida Statutes after a reasonable time for compliance; provided, however, the permittee does not waive any other rights granted by Florida Statutes or Department rules. [62-528.307(1)(j)]

11. This permit is transferable only upon Department approval in accordance with rules 62-4.120 and 62-528.350, F.A.C. The permittee shall be liable for any non-compliance of the permitted activity until the transfer is approved by the Department. [62-528.307(1)(k)]

12. This permit or a copy thereof shall be kept at the work site of the permitted activity. [62-528.307(1)(l)]

13. The permittee shall comply with the following:

    a. Upon request, the permittee shall furnish all records and plans required under Department rules. During enforcement actions, the retention period for all records shall be extended automatically unless the Department determines that the records are no longer required.
    b. The permittee shall hold at the facility or other location designated by this permit records of all monitoring information (including calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation) required by the permit, copies of all reports required by this permit, and records of all data used to complete the application for this permit. These materials shall be retained at least three years from the date of the sample, measurement, report, or application unless otherwise specified by Department rule.
    c. Records of monitoring information shall include:
        i. the date, exact place, and time of sampling or measurements;
        ii. the person responsible for performing the sampling or measurements;
        iii. the dates analyses were performed;
        iv. the person responsible for performing the analyses;
        v. the analytical techniques or methods used; and
        vi. the results of such analyses.
    d. The permittee shall furnish to the Department, within the time requested in writing, any information which the Department requests to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with this permit.
    e. If the permittee becomes aware that relevant facts were not submitted or were incorrect in the permit application or in any report to the Department, such facts or information shall be corrected promptly.

    [62-528.307(1)(m)]

14. All applications, reports, or information required by the Department shall be certified as being true, accurate, and complete. [62-528.307(1)(n)]

15. Reports of compliance or noncompliance with, or any progress reports on, requirements contained in any compliance schedule of this permit shall be submitted no later than 14 days following each scheduled date. [62-528.307(1)(o)]

16. Any permit noncompliance constitutes a violation of the Safe Drinking Water Act and is grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or for denial of a permit renewal application. [62-528.307(1)(p)]

17. It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit. [62-528.307(1)(q)]

18. The permittee shall take all reasonable steps to minimize or correct any adverse impact on the environment resulting from noncompliance with this permit. [62-528.307(1)(r)]

19. This permit may be modified, revoked and reissued, or terminated for cause, as provided in 40 C.F.R. sections 144.39(a), 144.40(a), and 144.41 (1998). The filing of a request by the permittee for a permit modification, revocation or reissuance, or termination, or a notification of planned changes or anticipated noncompliance, does not stay any permit condition. [62-528.307(1)(s)]

20. The permittee shall retain all records of all monitoring information concerning the nature and composition of injected fluid until five years after completion of any plugging and abandonment procedures specified under rule 62-528.435, F.A.C. The permittee shall deliver the records to the Department office that issued the permit at the conclusion of the retention period unless the permittee elects to continue retention of the records. [62-528.307(1)(t)]

21. All reports and other submittals required to comply with this permit shall be signed by a person authorized under rules 62-528.340(1) or (2), F.A.C. All reports shall contain the certification required in rule 62-528.340(4), F.A.C. [62-528.307(1)(u)]

22. The permittee shall notify the Department as soon as possible of any planned physical alterations or additions to the permitted facility. In addition, prior approval is required for activities described in rule 62-528.410(1)(h). [62-528.307(1)(v)]

23. The permittee shall give advance notice to the Department of any planned changes in the permitted facility or injection activity which may result in noncompliance with permit requirements. [62-528.307(1)(w)]

24. The permittee shall report any noncompliance which may endanger health or the environment including:

    a. Any monitoring or other information which indicates that any contaminant may cause an endangerment to an underground source of drinking water; or
    b. Any noncompliance with a permit condition or malfunction of the injection system which may cause unauthorized fluid migration into or between underground sources of drinking water.

c. Any information shall be provided orally within 24 hours from the time the permittee becomes aware of the circumstances. A written submission shall also be provided within 5 days of the time the permittee becomes aware of the circumstances. The written submission shall contain a description of the noncompliance and its cause, the period of noncompliance, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and the steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance.
[62-528.307(1)(x)]

Issued this 24th day of April, 2013

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Mary E. Yeargan

Mary E. Yeargan, P.G.
District Director
Southwest District Office

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Bob Martinez Center
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Rick Scott
Governor

Carlos Lopez-Cantera
Lt. Governor

Jonathan P. Steverson
Secretary

SENT VIA ELECTRONIC MAIL

In the Matter of an Application for Permit by:

14 December 2016

Mr. Patrick J. Lehman, P.E., Executive Director
Peace River Regional Water Supply Authority
9415 Town Center Parkway
Lakewood Ranch, FL 34202
PLehman@RegionalWater.org

Desoto County UIC
FDEP File No: 136595-016-017-UO/M5
WACS ID Number: 40593
Class V ASR Injection Well System
Operation Permit

NOTICE OF PERMIT

Enclosed is Permit Number 136595-016-017-UO/M5 to modify a non-hazardous Class V injection well operation permit to allow cycle tests of aquifer storage and recovery (ASR) wells S-4 and S-20 at wellfield No. 2. ASR wells S-4 and S-20 will receive partially treated surface water. Recharge of the remaining nineteen ASR wells with potable water from the Peace River Water Treatment Plant (WTP), 8998 SW County Road 769, Arcadia, DeSoto County will continue at Wellfields No. 1 & 2. ASR wells S-4 and S-20 will be recharged with 2 to 4 million gallons per day each.

Any party to this Order (permit) has the right to seek judicial review of the permit pursuant to Section 120.68, Florida Statutes, by the filing of a Notice of Appeal pursuant to Rules 9.110 and 9.190, Florida Rules of Appellate Procedure, with the Clerk of the Department in the Office of General Counsel, 3900 Commonwealth Boulevard, Mail Station 35, Tallahassee, Florida 32399-3000, agency_clerk@dep.state.fl.us; and by filing a copy of the Notice of appeal accompanied by the applicable filing fees with the appropriate District Court of Appeal. The Notice of Appeal must be filed within 30 days from the date this Notice is filed with the Clerk of the Department.

Executed in Leon County, Florida.

STATE OF FLORIDA DEPARTMENT
OF ENVIRONMENTAL PROTECTION

Joseph Haberfeld

Joseph Haberfeld, P.G.
Environmental Administrator
Aquifer Protection Program
Division of Water Resource Management

PERMITTEE: Mr. Patrick Lehman, Executive Director
Peace River Water Treatment Plant
Class V, ASR Injection Well System

WACS ID No.: 40593
Permit ID No.: 136595-016-017-UO/M5
Date: December 14, 2016

CERTIFICATE OF SERVICE

The undersigned designated clerk hereby certifies that this **NOTICE OF PERMIT** and all copies were mailed before the close of business on Wednesday, December 14, 2016, to the listed persons.

FILING AND ACKNOWLEDGMENT

FILED, on this date, pursuant to Section.120.52, Florida Statutes, with the designated Department Clerk, receipt of which is hereby acknowledged

Mary Genung

Clerk

December 14,2016

Date

Copies Furnished To:

Joseph Haberfeld, FDEP/TLH	*joe.haberfeld@dep.state.fl.us*
Neil Campbell, FDEP/TLH	*neil.i.campbell@dep.state.fl.us*
James Dodson, FDEP/TLH	*james.dodson@dep.state.fl.us*
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Mary Genung, FDEP/TLH	*mary.genung@dep.state.fl.us*
Nancy Marsh, USEPA/ATL	*marsh.nancy@epa.gov*

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Bob Martinez Center
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Rick Scott
Governor

Carlos Lopez-Cantera
Lt. Governor

Jonathan P. Steverson
Secretary

Underground Injection Control
Class V, Group 7, Aquifer Storage and Recovery (ASR) Well System
Operation Permit Major Modification

December 14, 2016

Permittee:
Peace River Regional Water Supply Authority

Responsible Official:
Mr. Patrick J. Lehman, P.E., Executive Director
9415 Town Center Parkway
Lakewood Ranch, FL 34202
PLehman@RegionalWater.org

Facility:
Peace River Water Treatment Plant
8998 Southwest County Road 769
Arcadia, Florida 34269

Permit/Certification:

Permit Number:	136595-016-017-UO/M5
WACS ID:	40593
Date of Issuance:	December 14, 2016
Date of Expiration:	April 23, 2018
Permit Processor:	Neil I. Campbell

Section/Township/Range S16 / T39S / R23E

Location:

County:	Desoto
Latitude:	27° 05' 06" N
Longitude:	82° 01' 08" W

RE: Major Modification to FDEP Permit 136595-016-017-UO/M5 under 136595-016-017-UO/M5 to allow cycle tests of aquifer storage and recovery (ASR) wells S-4 and S-20 at wellfield No. 2.

This permit is issued under the provisions of Chapter 403, Florida Statutes (F.S.), and the rules adopted thereunder. The above named permittee is hereby authorized to perform the work or operate the facility shown on the application and approved drawing(s), plans, and other documents attached hereto or on file with the Department and made a part hereof and specifically described as follows.

To modify a non-hazardous Class V injection well operation permit to allow cycle tests of aquifer storage and recovery (ASR) wells S-4 and S-20 at wellfield No. 2. ASR wells S-4 and S-20 will receive partially treated surface water. Recharge of the remaining nineteen ASR wells with potable water from the Peace River Water Treatment Plant (WTP), 8998 SW County Road 769, Arcadia, DeSoto County will continue at Wellfields No. 1 & 2. ASR wells S-4 and S-20 will be recharged with 2 to 4 million gallons per day each.

IN ACCORDANCE WITH: The Application to Modify the current Operating Permit DEP Form No. 62-528.900(1) received, August 16, 2016, response to the Department's request for additional information, received September 8, 2016, and supporting information submitted to this agency.

LOCATION: Peace River Water Treatment Plant, 8998 Southwest County Road 769, Arcadia, Florida 34269, in the county of Desoto.

Based on the information provided to the Department, per the request of the Peace River Regional Water Supply Authority, the Department hereby approves the above major modification to FDEP Permit Number 136595-014-UO/5Q under FDEP Permit Modification Number 136595-016-017-UO/M5. Testing of partially treated surface water (PTSW) as a source water for storage in two of ASR Wellfield No. 2 (WF2) wells, S-20 and S-4, may begin upon receipt of this modification. The permit's operational specific conditions I. through III. are changed as specified below:

Page 3 – Adds the Avon Park Monitor well, AP-1, 12-inch casing set to 1300 feet below land surface (bls), open hole to 1479 feet bls.

Conditions I. Operating Requirements:

A.1 Injection of fluids other than those permitted into the ASR well will constitute a violation of this permit and shall constitute cause for permit revocation and possible enforcement action for water quality violation. Only water from the Peace River Regional Water Supply Facility, a surface water drinking water facility, may be injected, **except that partially treated surface water from Reservoir No. 1 may be injected into ASR wells S-4 and S-20.**

A.7 This ASR facility shall be operated in conformance with the criteria contained in Water Quality Criteria Exemption OGC File 12-1502. **This permit modification removes ASR wells S-4 and S-20 from the Exemption in order to cycle test those wells with partially treated surface water. All other provisions of the Exemption remain unchanged.**

A.8 **NEW: Zone of Discharge**

a. A zone of discharge under Rule 62-520.465(2)(b), F.A.C, is established for this injection project for the parameters of total coliform bacteria, aluminum, and color. The zone of discharge extends to the permittee's property boundary. *[62-520.465(2)(b)]*

b. Compliance with the zone of discharge shall be demonstrated at monitor well M-18; total coliform bacteria, aluminum, and color must be met at this compliance well. If the concentration for any standard in the natural background quality is greater than that which is listed in Rule 62-520.420(1), F.A.C., or in the case of pH is also less than the minimum, the representative natural background quality shall be the prevailing standard. *[62-520.420, 62-520.600]*

c. Should ground water monitoring during operation indicate drinking water parameters are not met at compliance well M-18, the permittee shall, upon the Department's request, submit a report addressing the results of the collected ground water monitoring data. The report shall be submitted to the Department no later than 90 days after the request and shall include a discussion of the changes in water quality for parameters exceeding maximum contaminant levels. The report shall also address the adequacy of the zone of discharge and the steps to be taken to come into compliance. *[62-520.700, 62-528.610(1)]*

Conditions III. Testing and Reporting Requirements

A.3 **NEW:** Cycle testing of ASR-4 and ASR-20 shall be in accordance with the schedule specified below:

Cycle	Recharge Rate (MGD)	Storage Duration (Days)	Recovery Rate (MGD)	Volume in Storage (MG)
1	2-4	15	1.5-2.5	50
2	2-4	15	1.5-2.5	100
3	2-4	15	1.5-2.5	150

Additional or fewer cycles, or changes in the cycle testing details above, may be authorized in writing by the Department.
[62-528.450(3)(a)]

B.5 **NEW**: Table 3 of the permittee's September 8, 2016 response to a Request for Additional Information is incorporated into this permit modification. It contains monitoring and sampling requirements specific to the cycle testing, and is reproduced as an attachment at the end of this modification. *[62-528.307(3)(d) and 528.430(2)]*

B.6 **NEW**: Monitoring well AP-1 shall be sampled semiannually for static pressure or water level, chloride, total dissolved solids, and field pH, specific conductance, and temperature (°C). *[62-528.307(2)(d) and 528.430(2)]*

This document must be attached to your permit and becomes a part of that permit. All conditions of Permit no. 0136595-014-UO/5Q not specifically modified or deleted in this document remain in effect.

Table 3. Proposed Monitoring Plan

Peace River WF2 PTSW ASR Pilot Testing

Parameter	**Units**	**Recording Frequency**	**Frequency of Analysis**			
			Recharge (reservoir)	***Recovery (S-4, S-20)***	***M-11, M-14, M-16, M-17, M-18, T-11***	***M-8, M-13, T-8***
Flow Rate, max.	gpm	daily	D/M	D/M		
Flow Rate, min.	gpm	daily	D/M	D/M		
Flow Rate, avg.	gpm	daily	D/M	D/M		
Total Volume Recharged	Mg	daily	D/M			
Total Volume Recovered	Mg	daily		D/M		
Injection Pressure, max.	Psi	continuous	D/M			
Injection Pressure, min.	Psi	continuous	D/M			
Injection Pressure, avg.	Psi	continuous	D/M			
Water Level, max.	feet (NGVD)	continuous		D/M	D/M	D/M
Water Level, avg.	feet (NGVD)	continuous		D/M	D/M	D/M
Water Level, min.	feet (NGVD)	continuous		D/M	D/M	D/M
pH +	std. Units		W[a]	W[b]	W	M
Specific Conductivity +	µmhos/cm		W[a]	W[b]	W	M
Temperature +	°C		W[a]	W[b]	W	M
Dissolved Oxygen +	mg/L		W[a]	W[b]	W	M
Turbidity +	NTU		W[a]	W[b]	W	M
Oxidation-Reduction Potential +	mV		W[a]	W[b]	W	M
Total Dissolved Solids	mg/L		W[a]	W[b]	W	M
Chloride	mg/L		W[a]	W[b]	W	M
Sulfate	mg/L		W[a]	W[b]	W	M
Arsenic	µg/L		W[a]	W[b]	W	M
Total Suspended Solids	mg/L		W[a]	W[b]	W	M
Nitrate (as N)	mg/L		W[a]	W[b]	W	M
TKN	mg/L		W[a]	W[b]	W	M
Ammonia	mg/L		W[a]	W[b]	W	M
TOC	mg/L		W[a]	W[b]	W	M
Color	Units		W[a]	W[b]	W	M
Aluminum	µg/L		W[a]	W[b]	W	M
Total Coliform	CFU/100 mL		W[a]	W[b]	W	M
Escherichia coli	CFU/100 mL		W[a]	W[b]	W	M
Primary and Secondary stds.	mg/L		B		-	-

Notes:

No sampling of ASR wells during storage

W - weekly; D/M - daily and monthly;

a - during recharge only

b - during recovery only

+ - field samples

B - Background sample prior to cycle 1 recharge

Appendix B
ASR Well Specific Injectivity, Specific Capacity, and Flow Rates

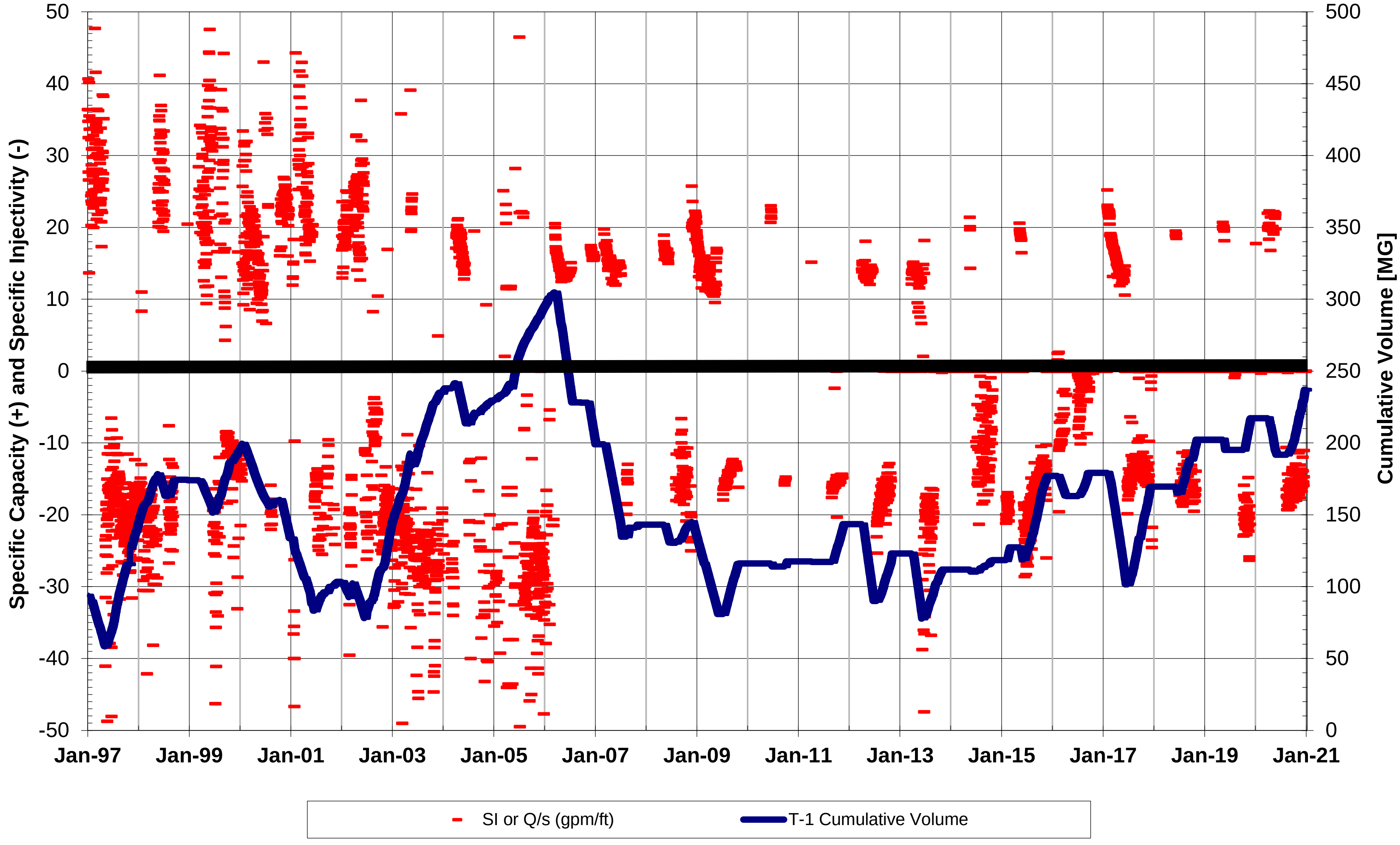


Figure B-1

T-1 Specific Capacity and Specific Injectivity

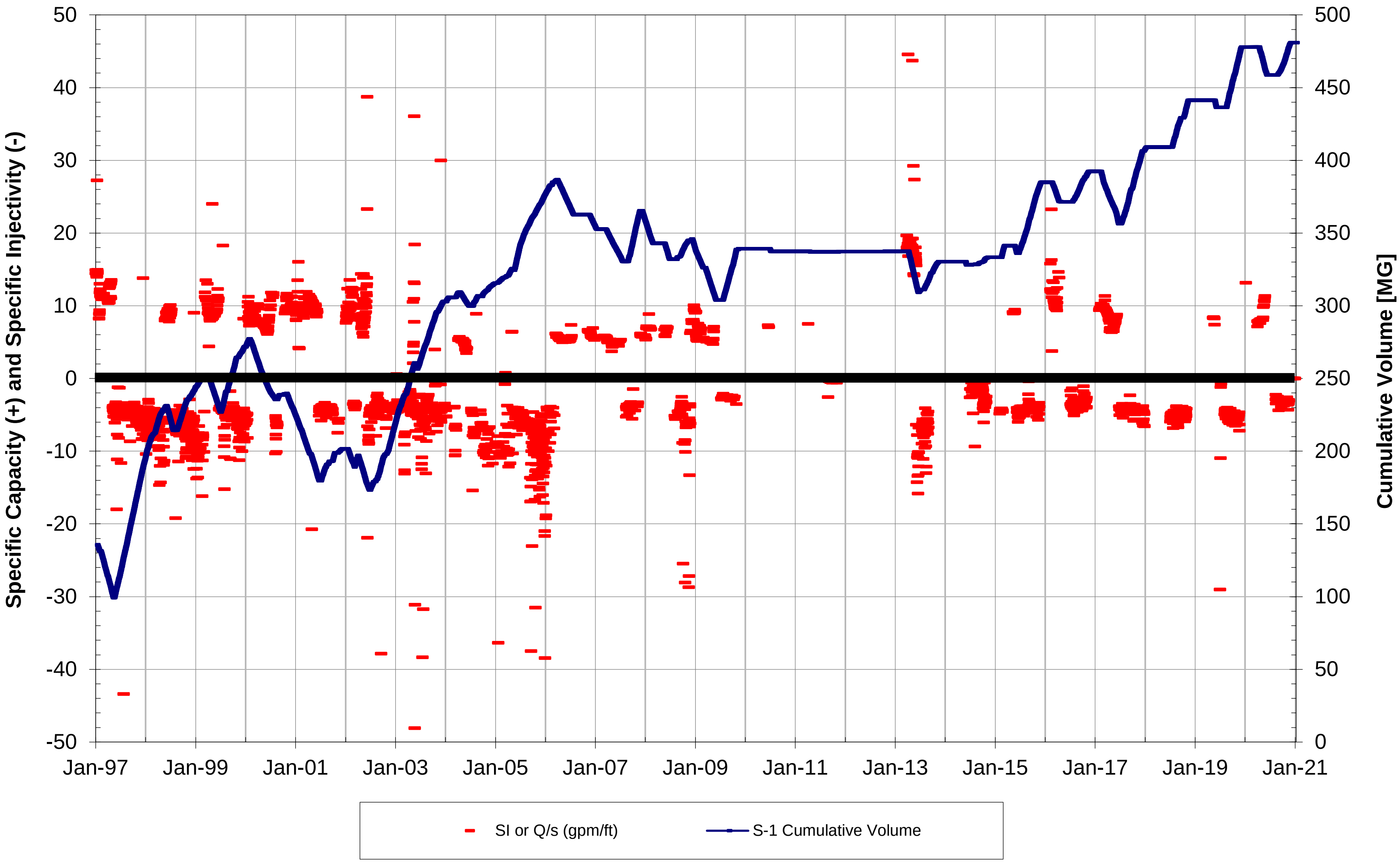


Figure B-2
S-1 Specific Capacity and Specific Injectivity

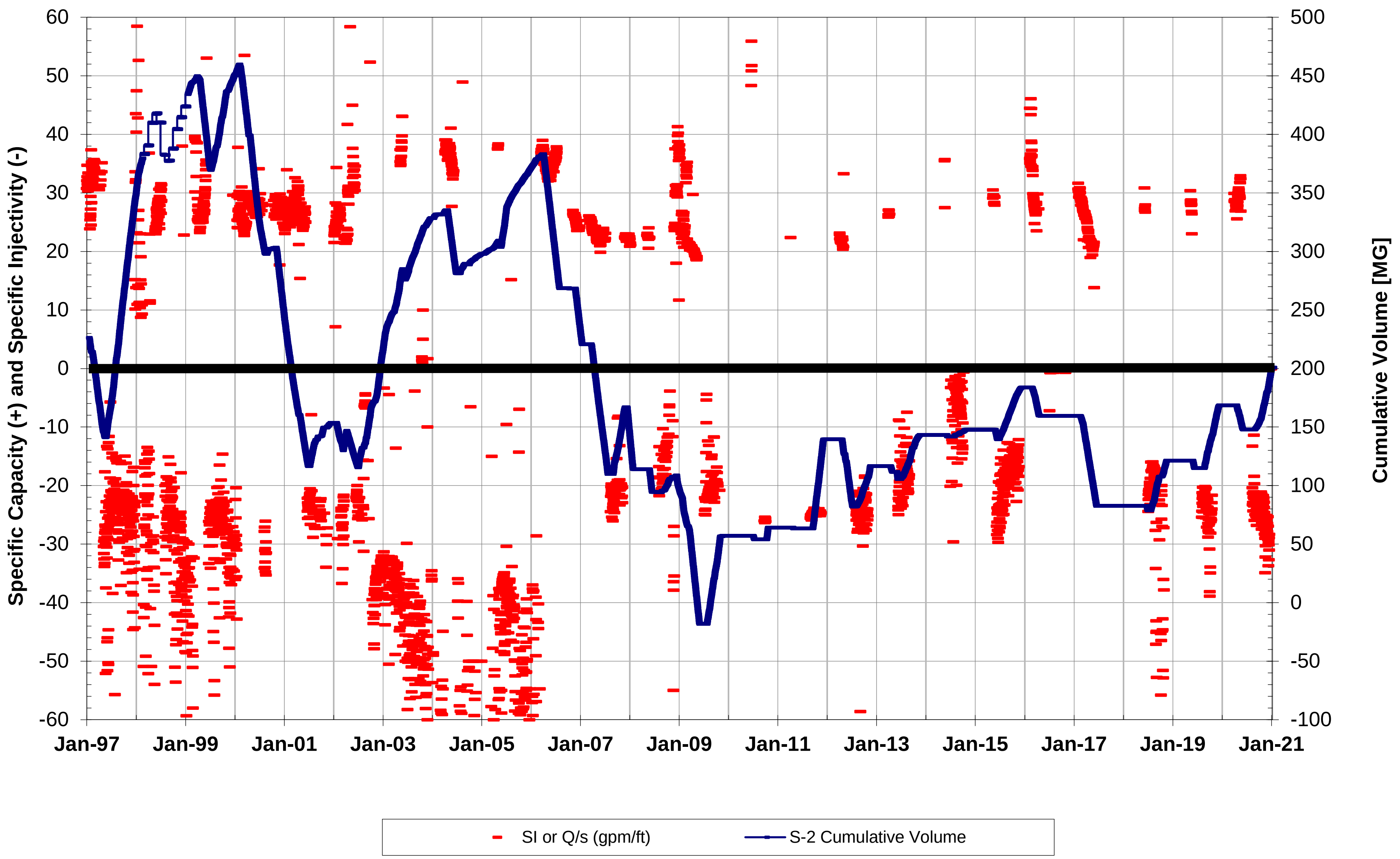


Figure B-3

S-2 Specific Capacity and Specific Injectivity

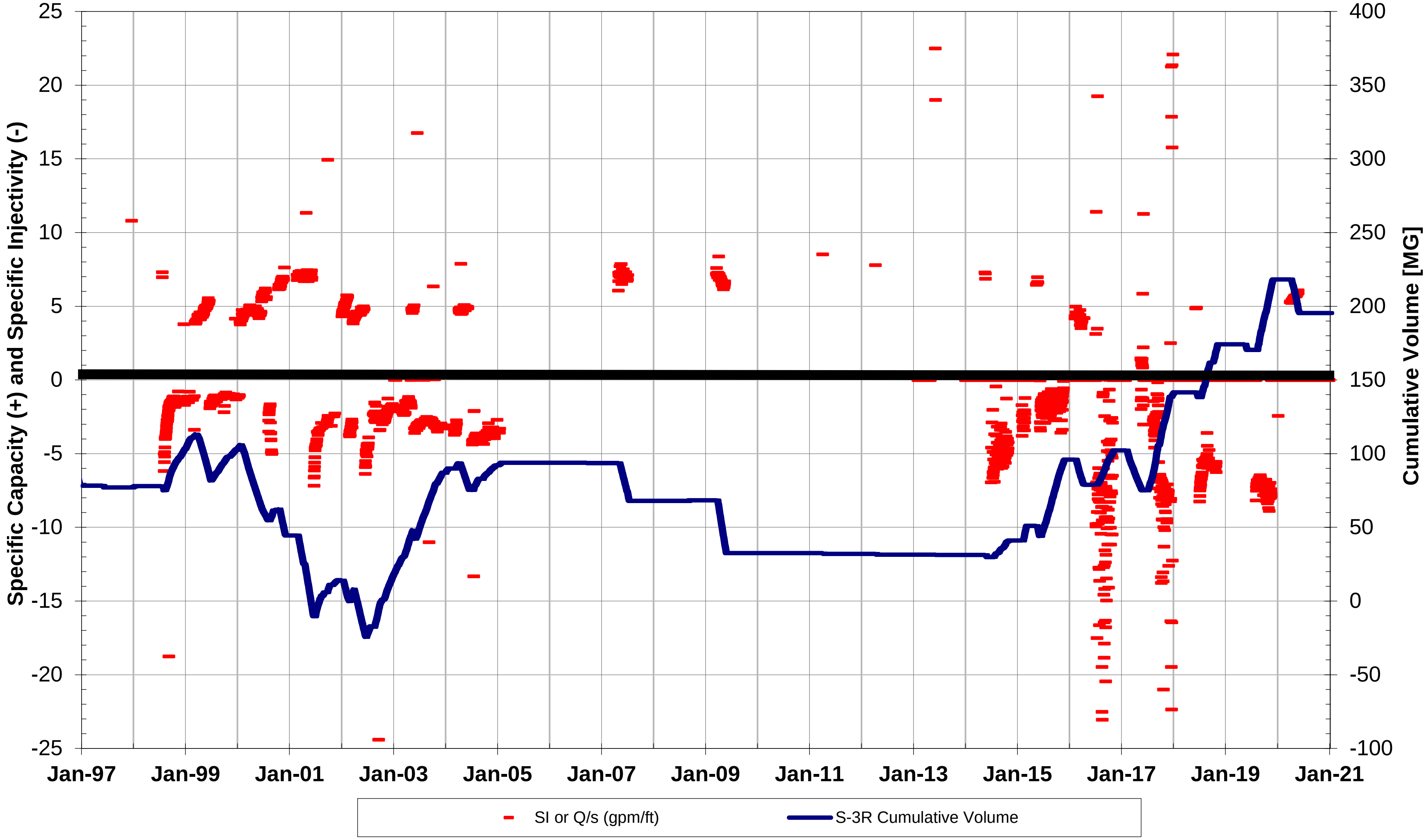


Figure B-4
S-3R Specific Capacity and Specific Injectiity

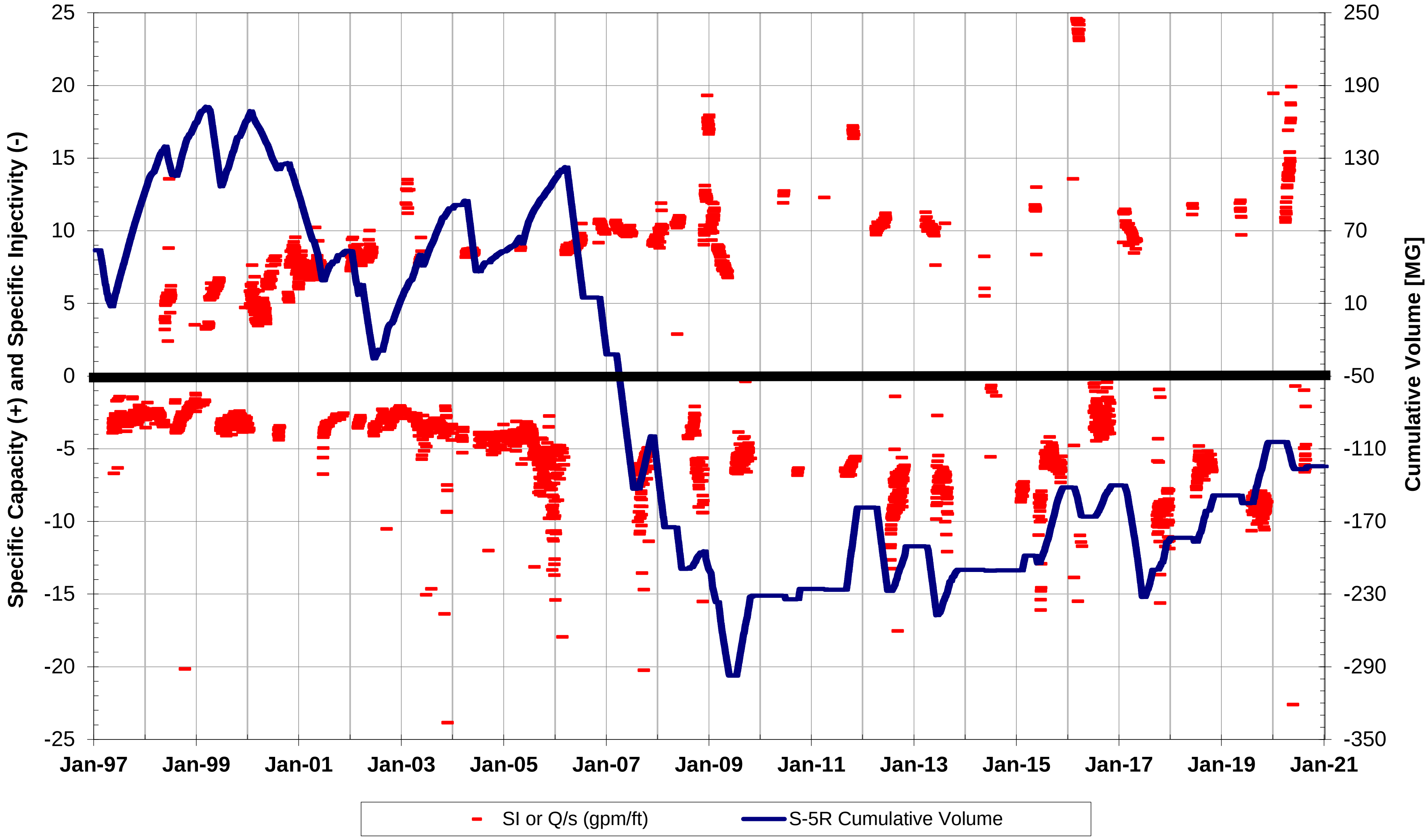


Figure B-5

S-5R Specific Capacity and Specific Injectivity

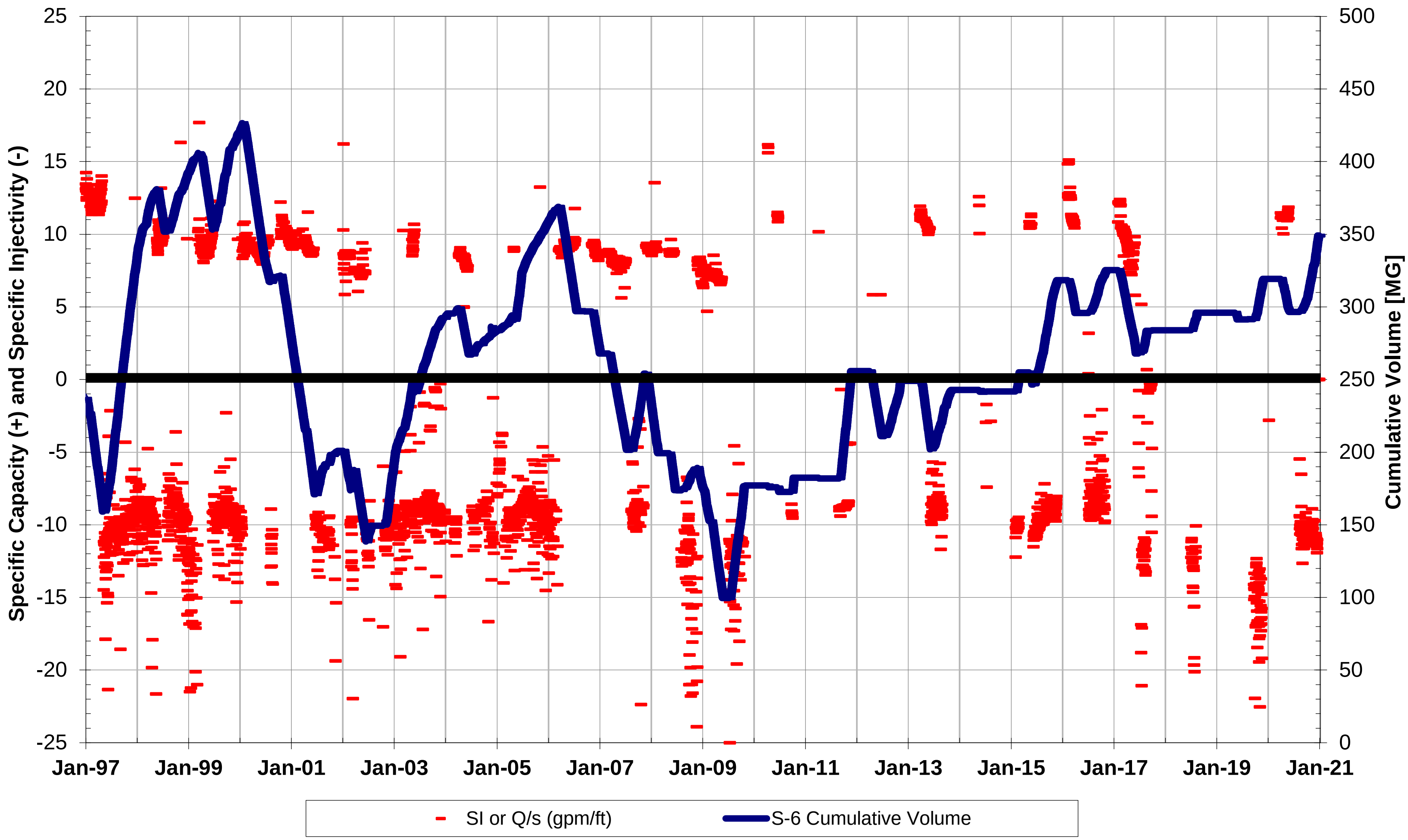


Figure B-6

S-6 Specific Capacity and Specific Injectivity

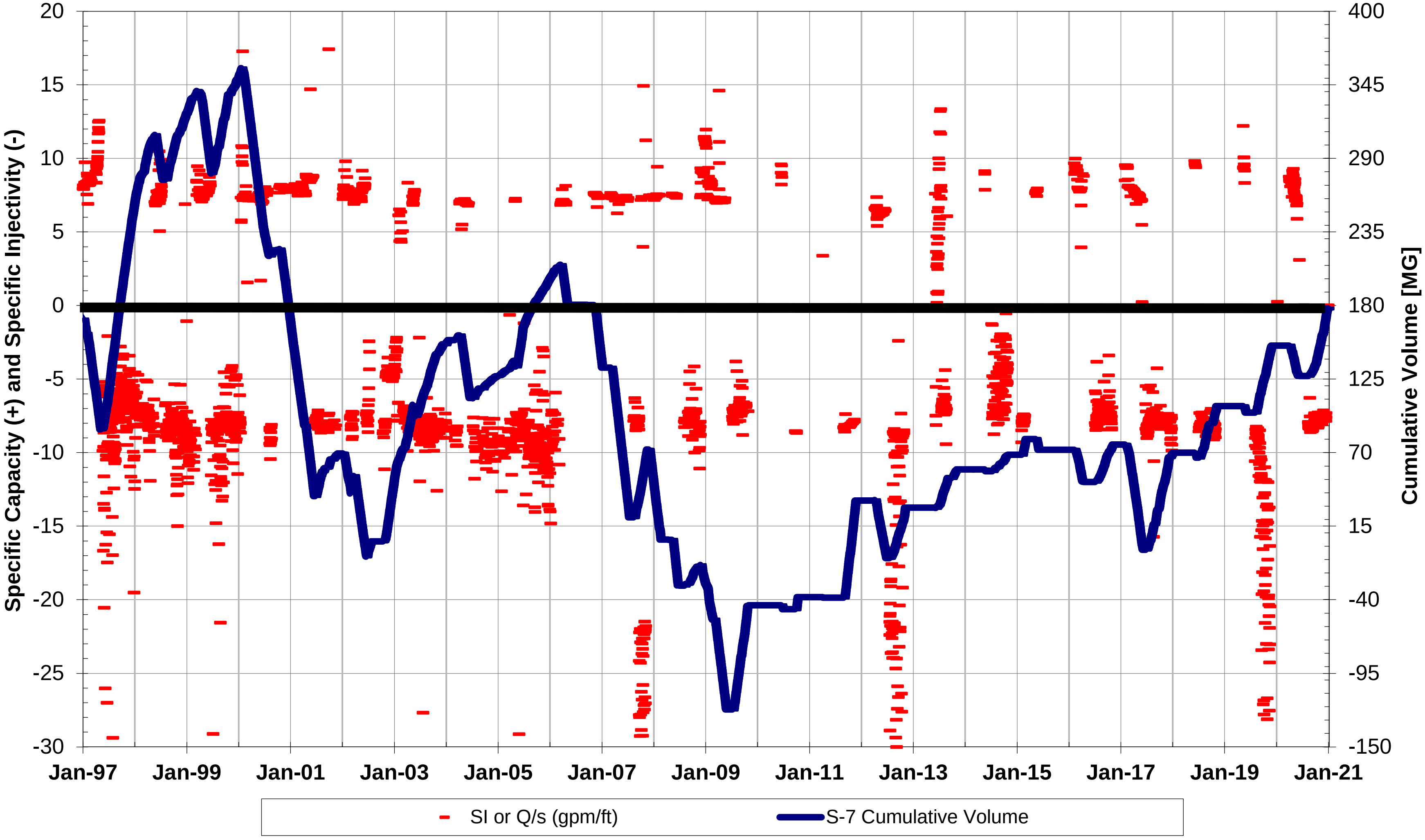


Figure B-7
S-7 Specific Capacity and Specific Injectivity

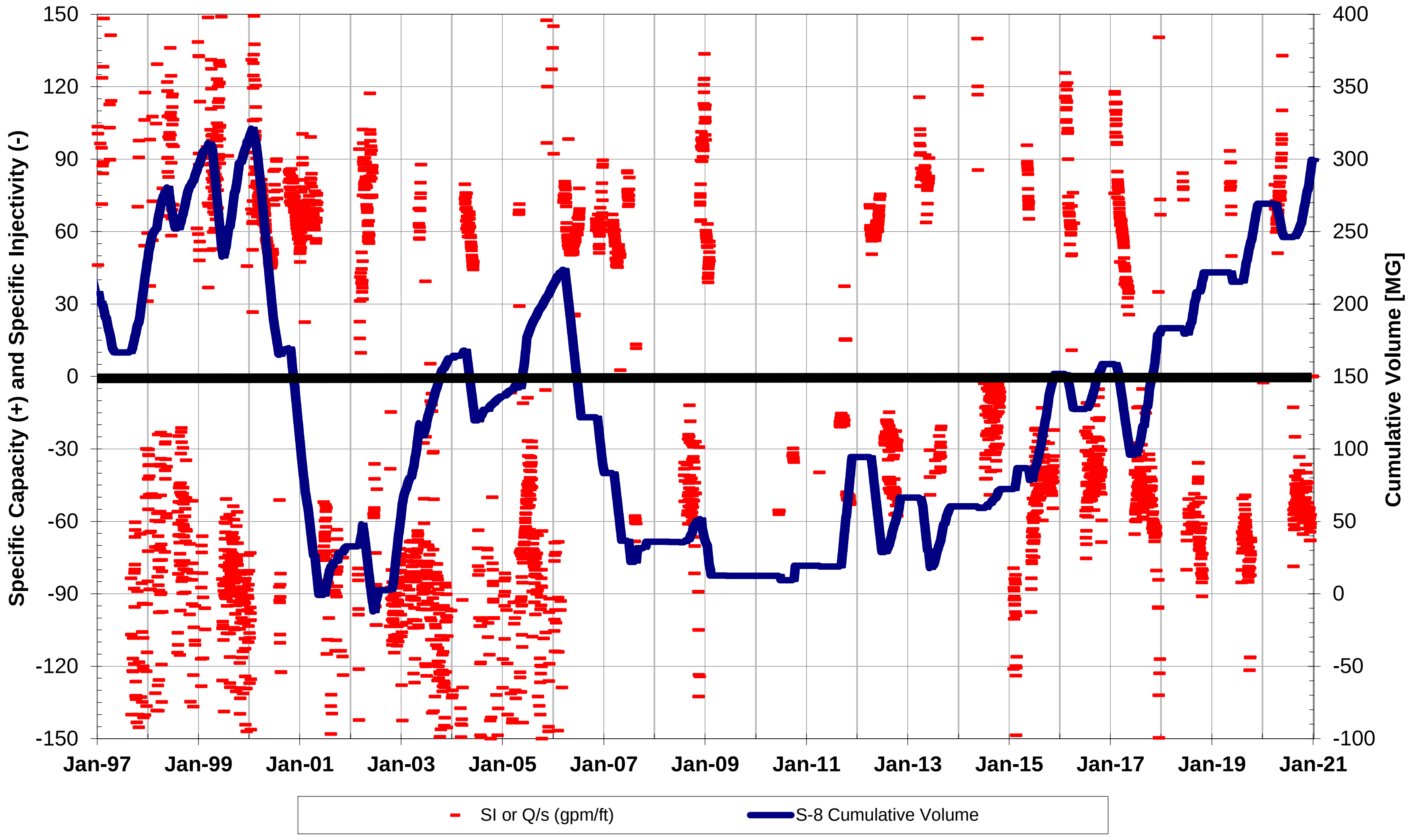


Figure B-8

S-8 Specific Capacity and Specific Injectivity

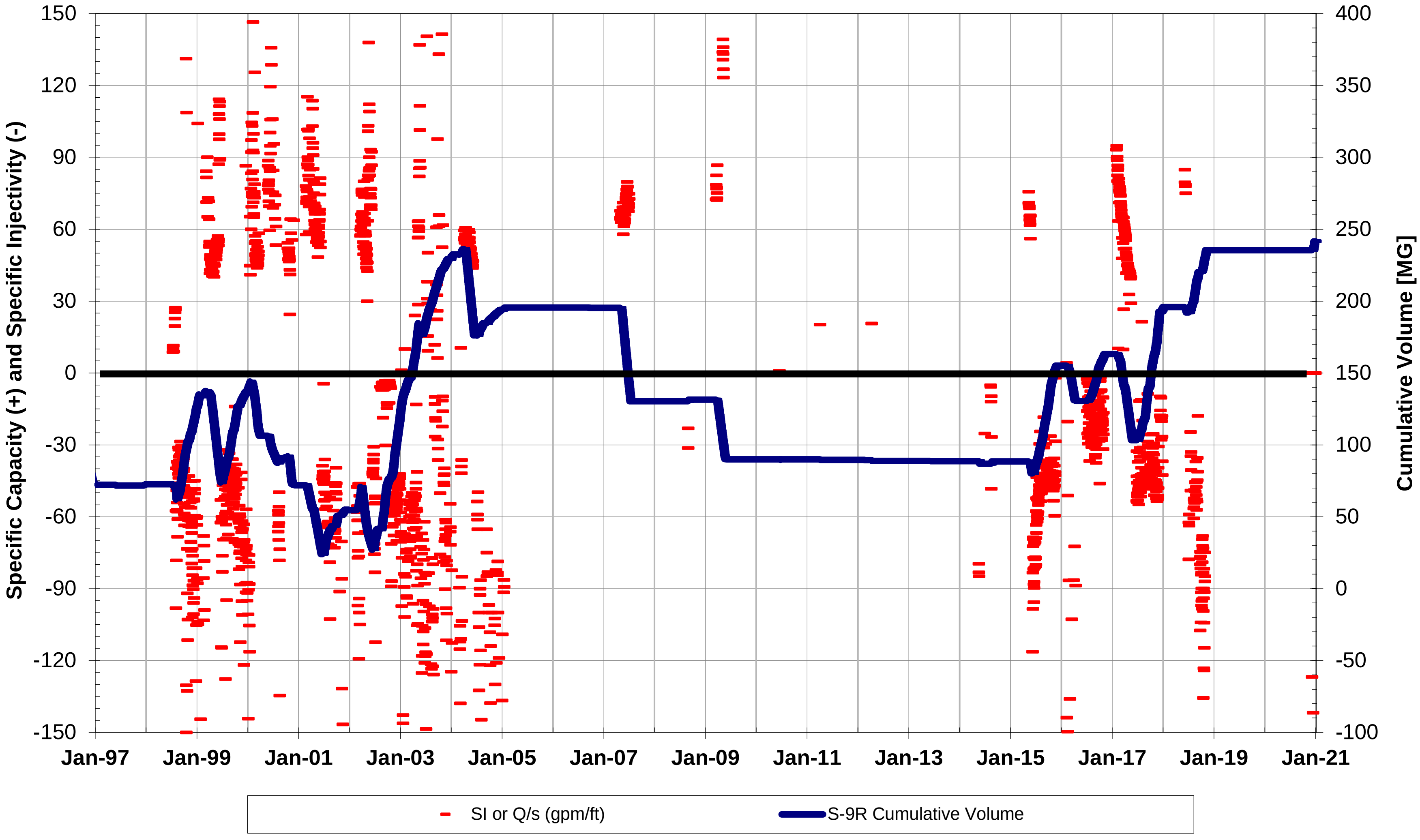


Figure B-9
S-9R Specific Capacity and Specific Injectivity

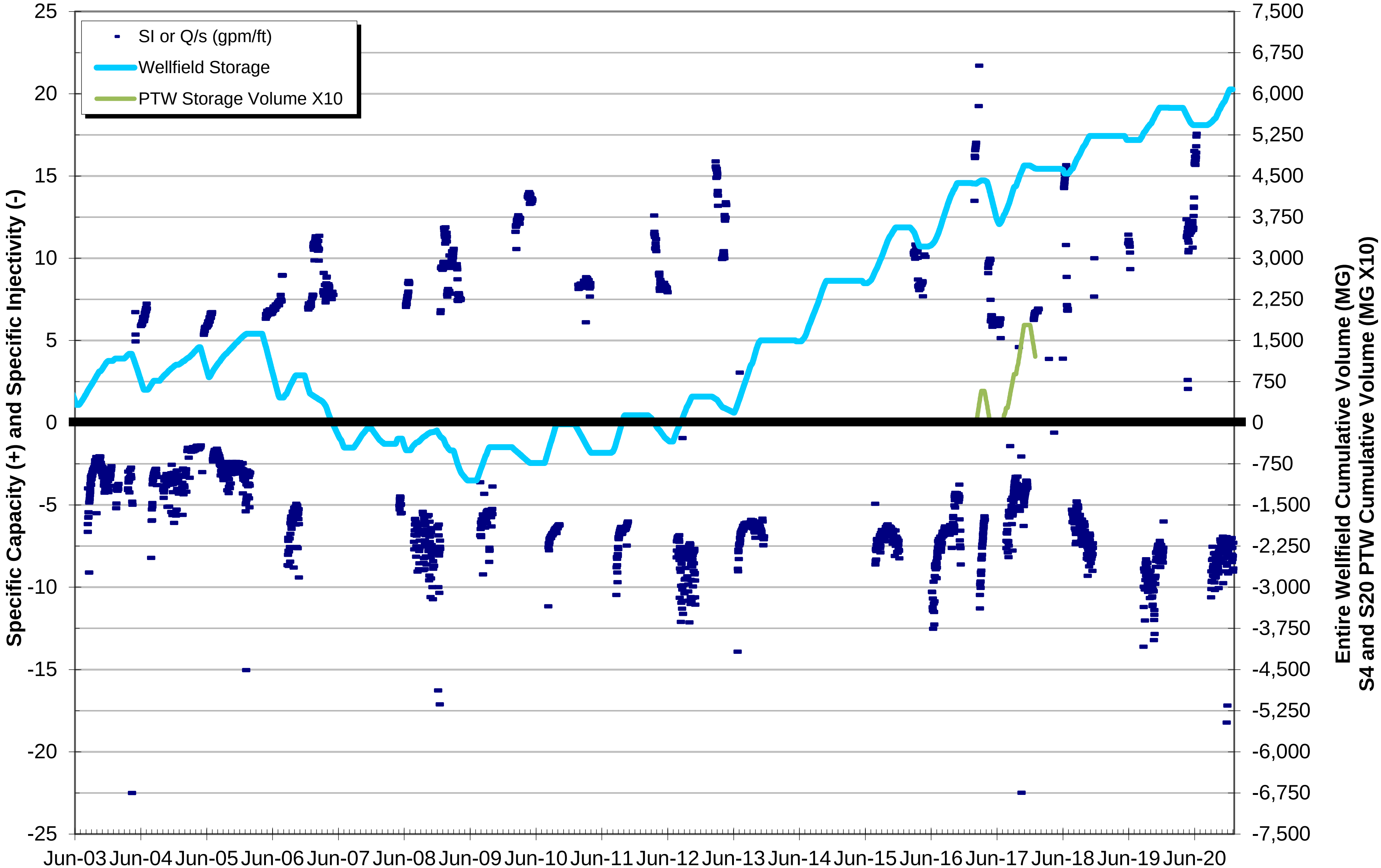


Figure B-10

S-4 Specific Capacity and Specific Injectivity

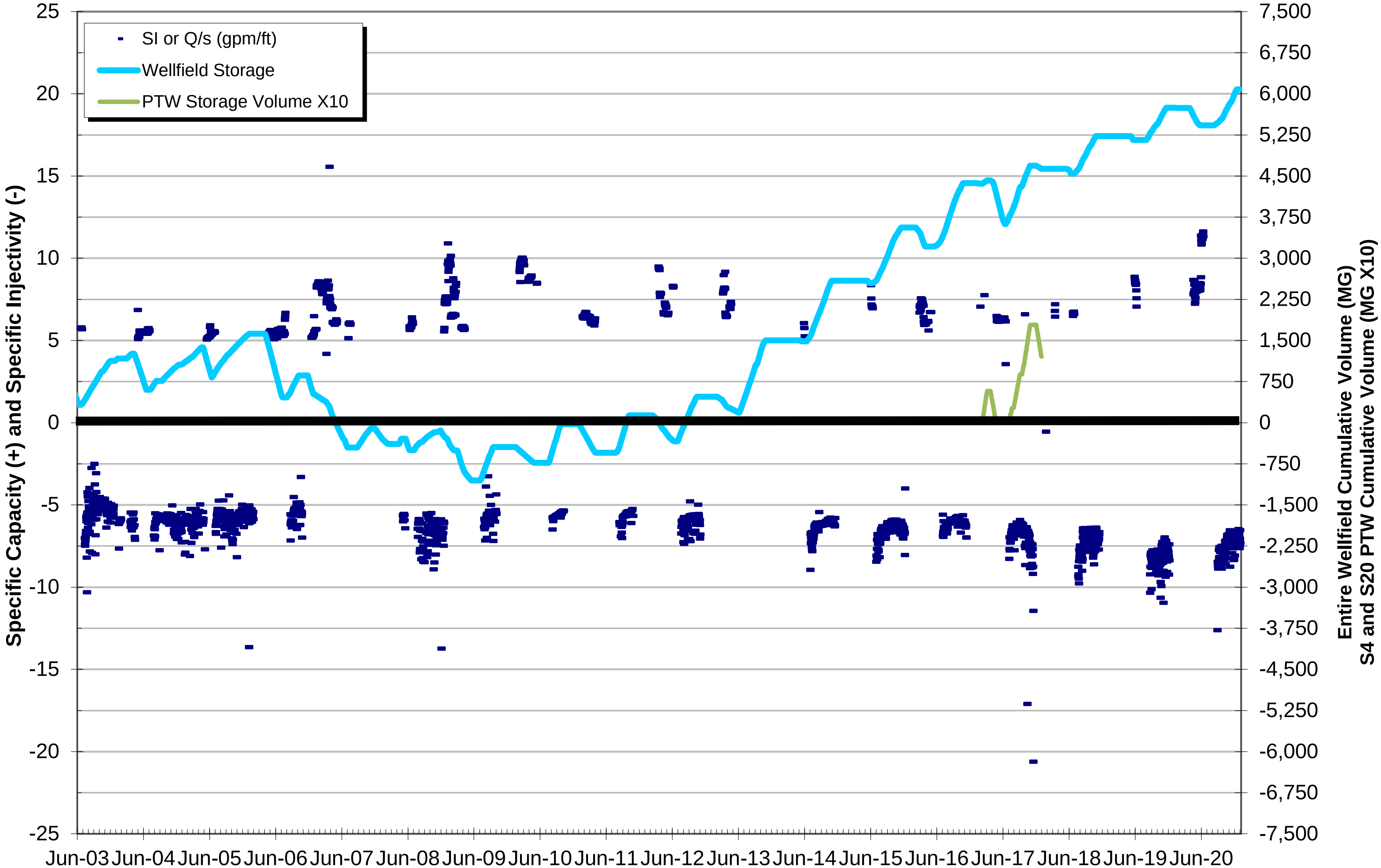


Figure B-11

S-10 Specific Capacity and Specific Injectivity

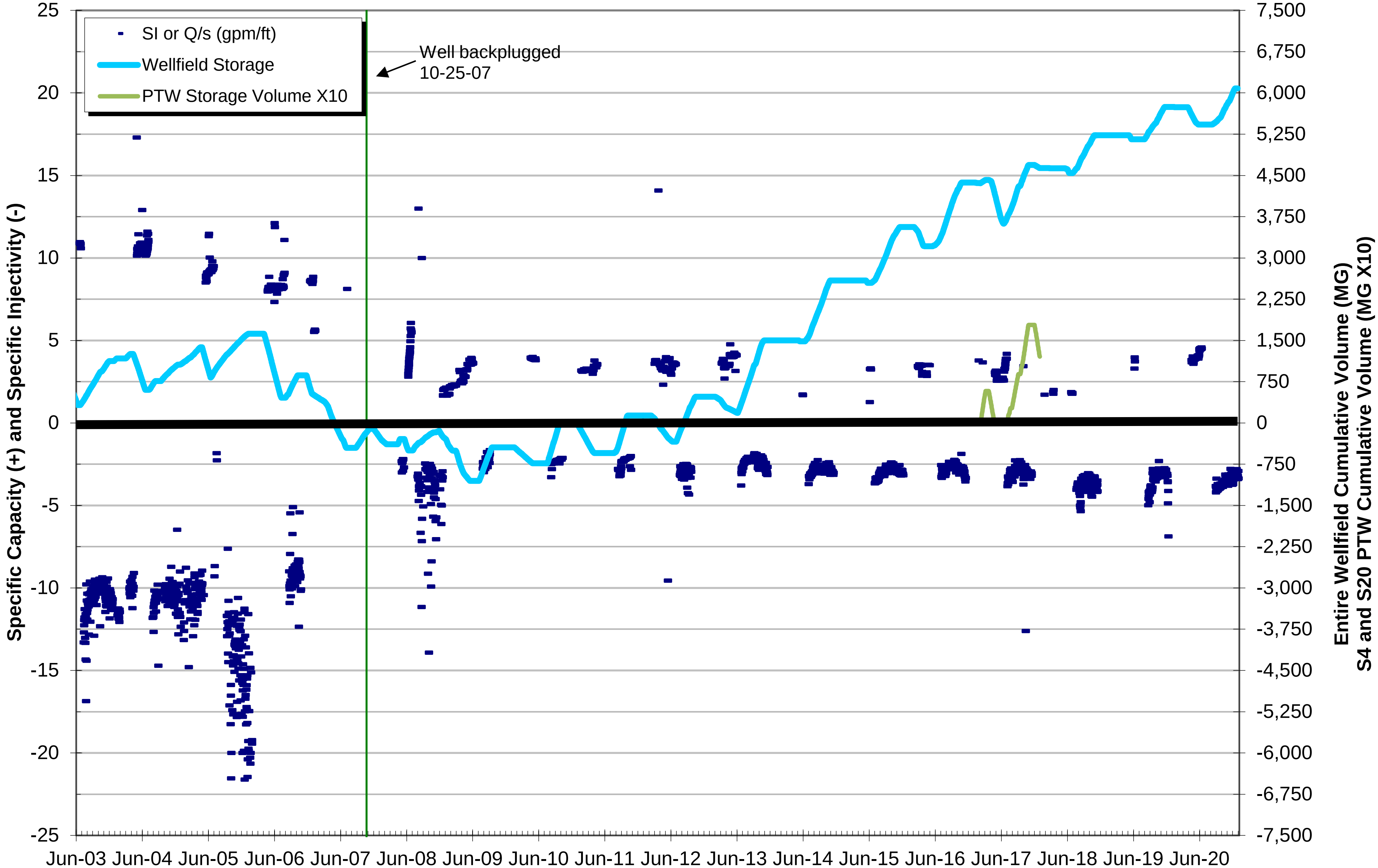


Figure B-12

S-11 Specific Capacity and Specific Injectivity

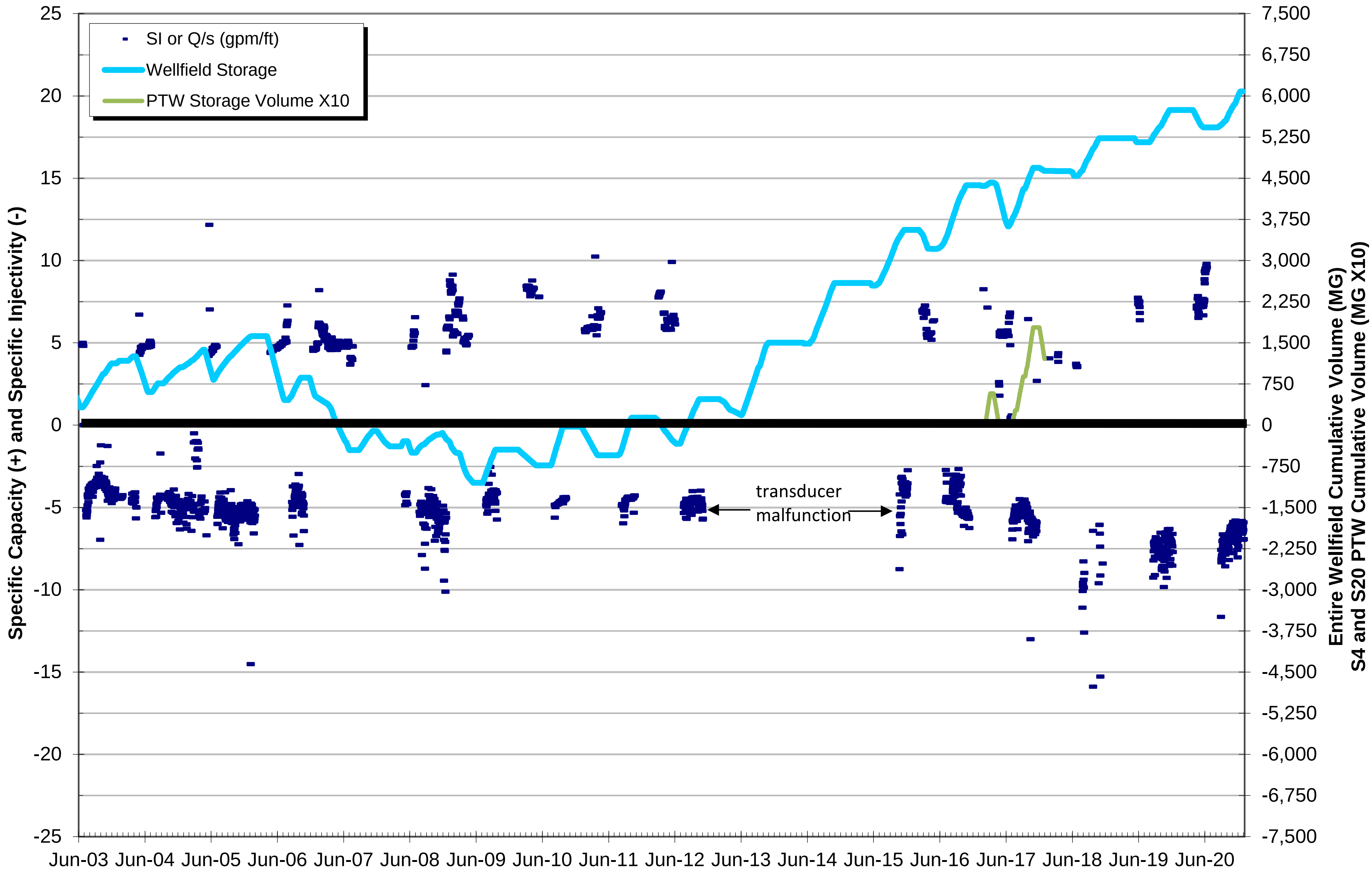


Figure B-13

S-12 Specific Capacity and Specific Injectivity

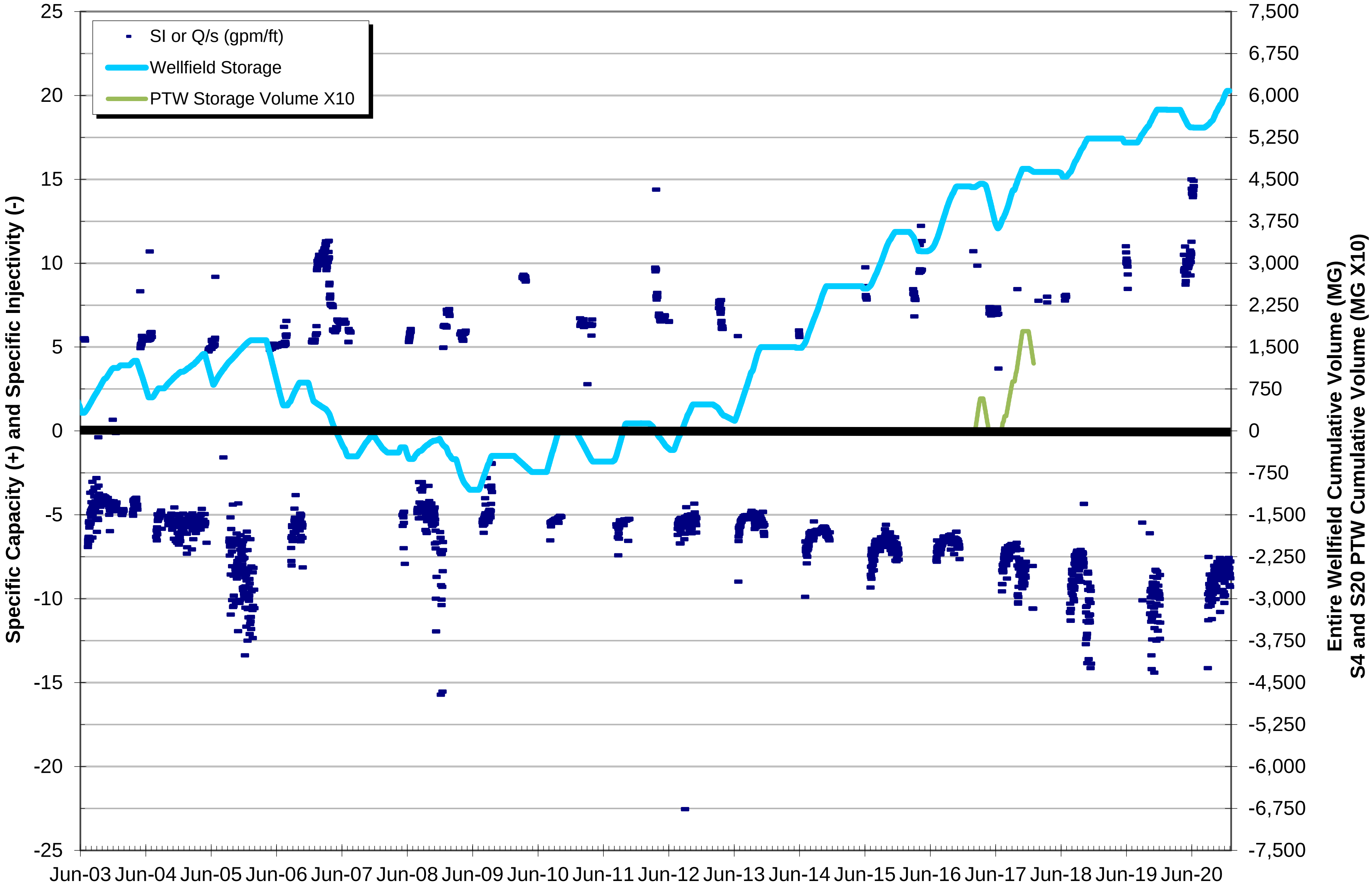


Figure B-14

S-13 Specific Capacity and Specific Injectivity

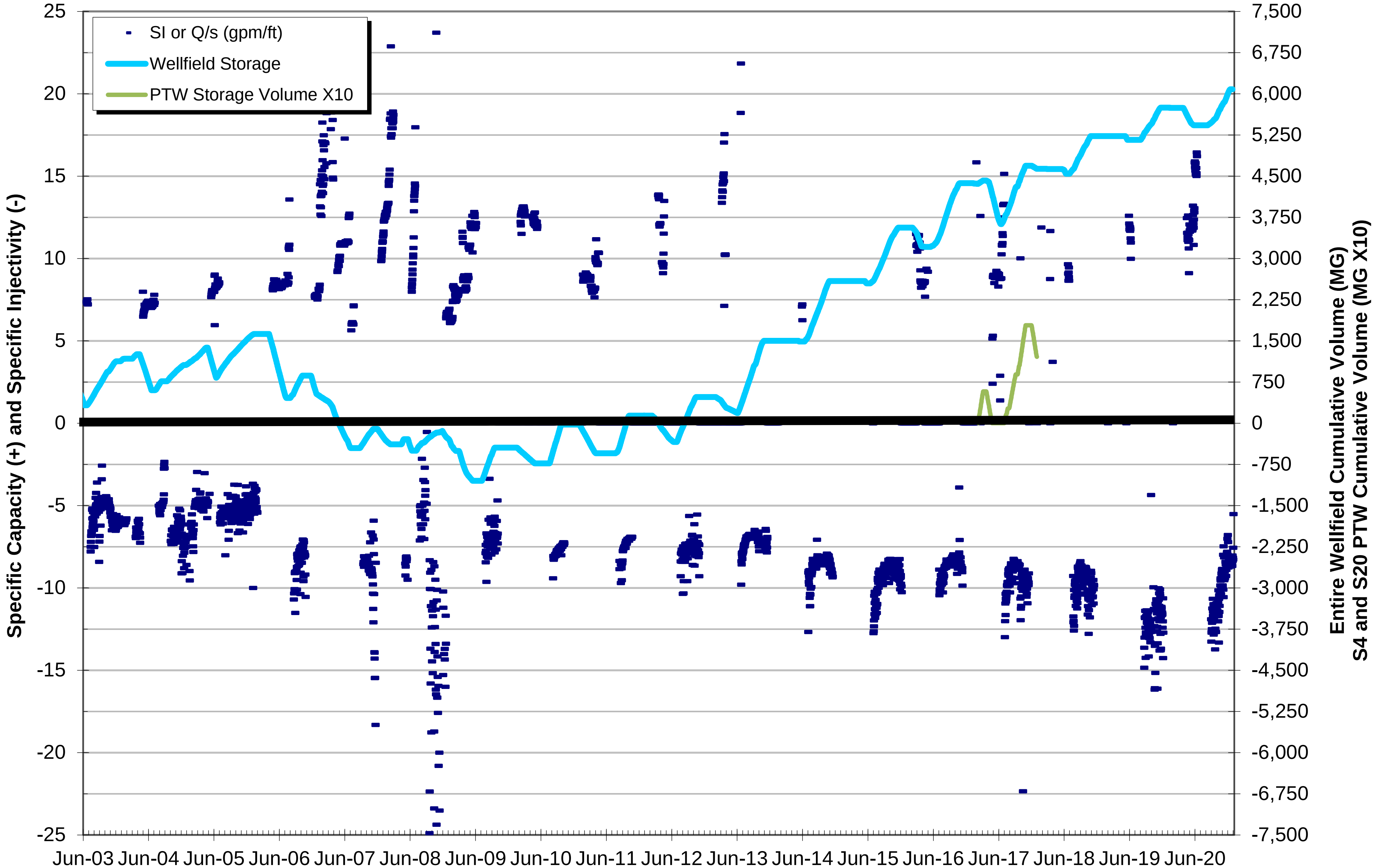


Figure B-15

S-14 Specific Capacity and Specific Injectivity

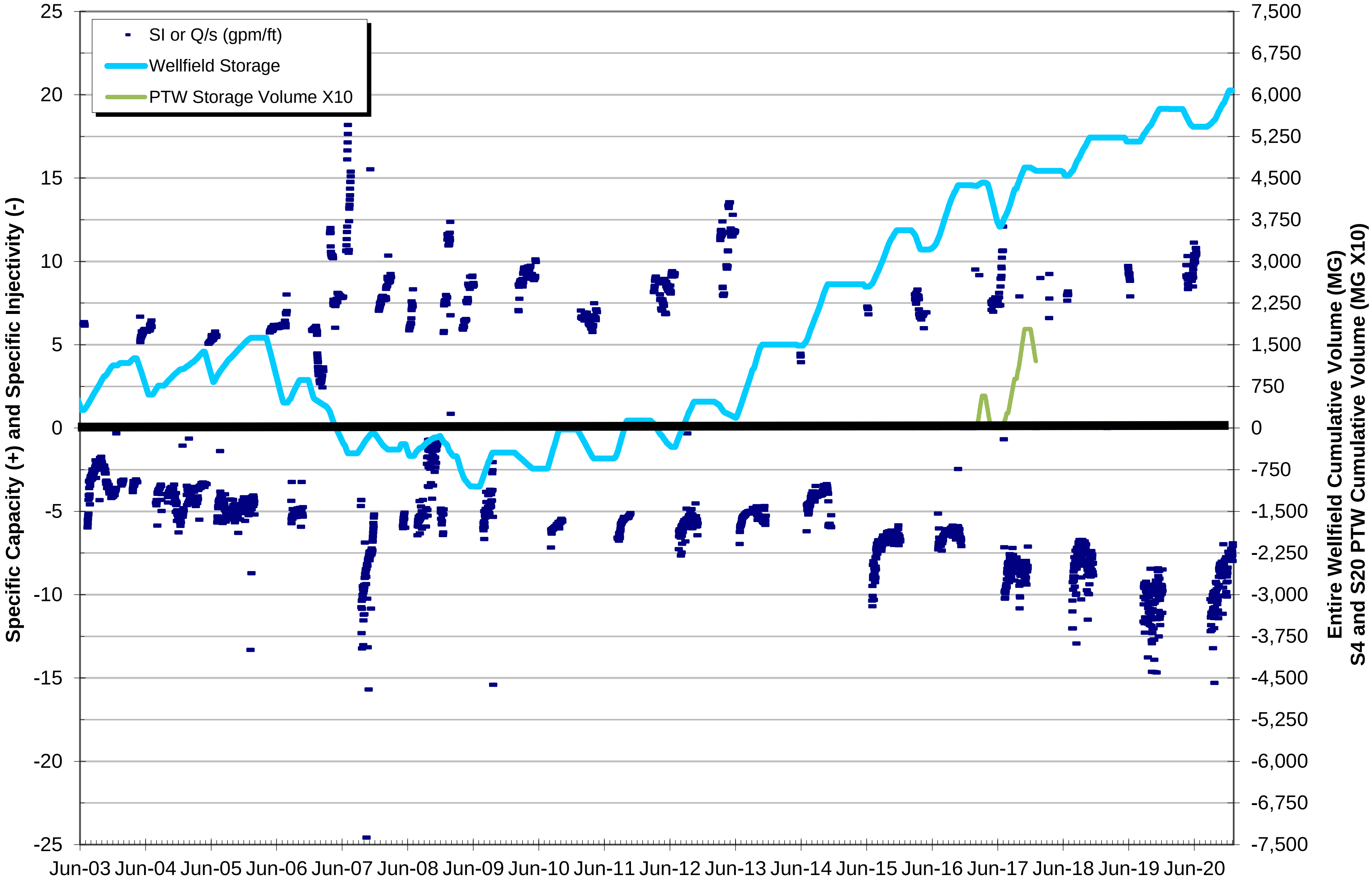


Figure B-16

S-15 Specific Capacity and Specific Injectivity

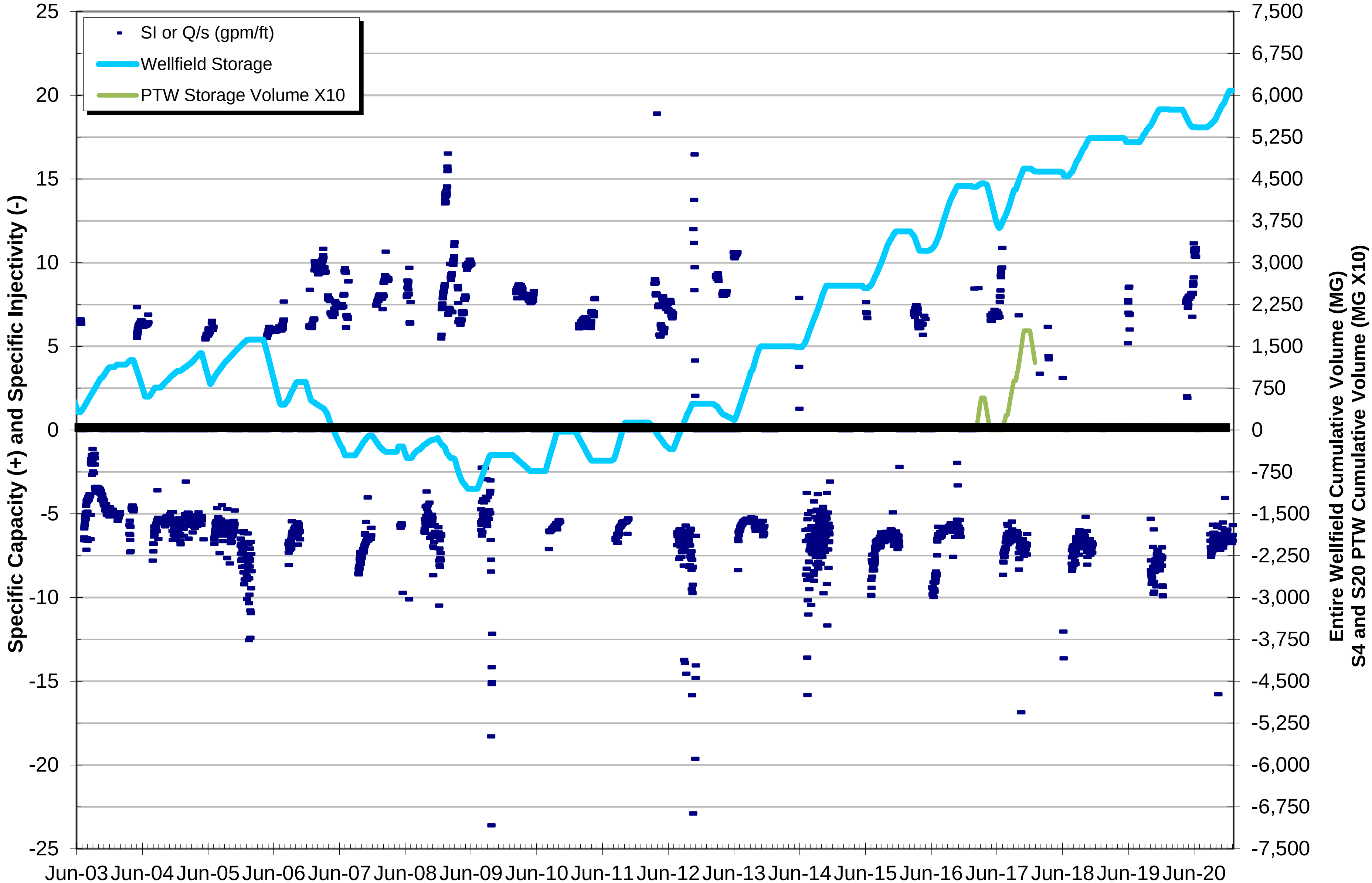


Figure B-17

S-16 Specific Capacity and Specific Injectivity

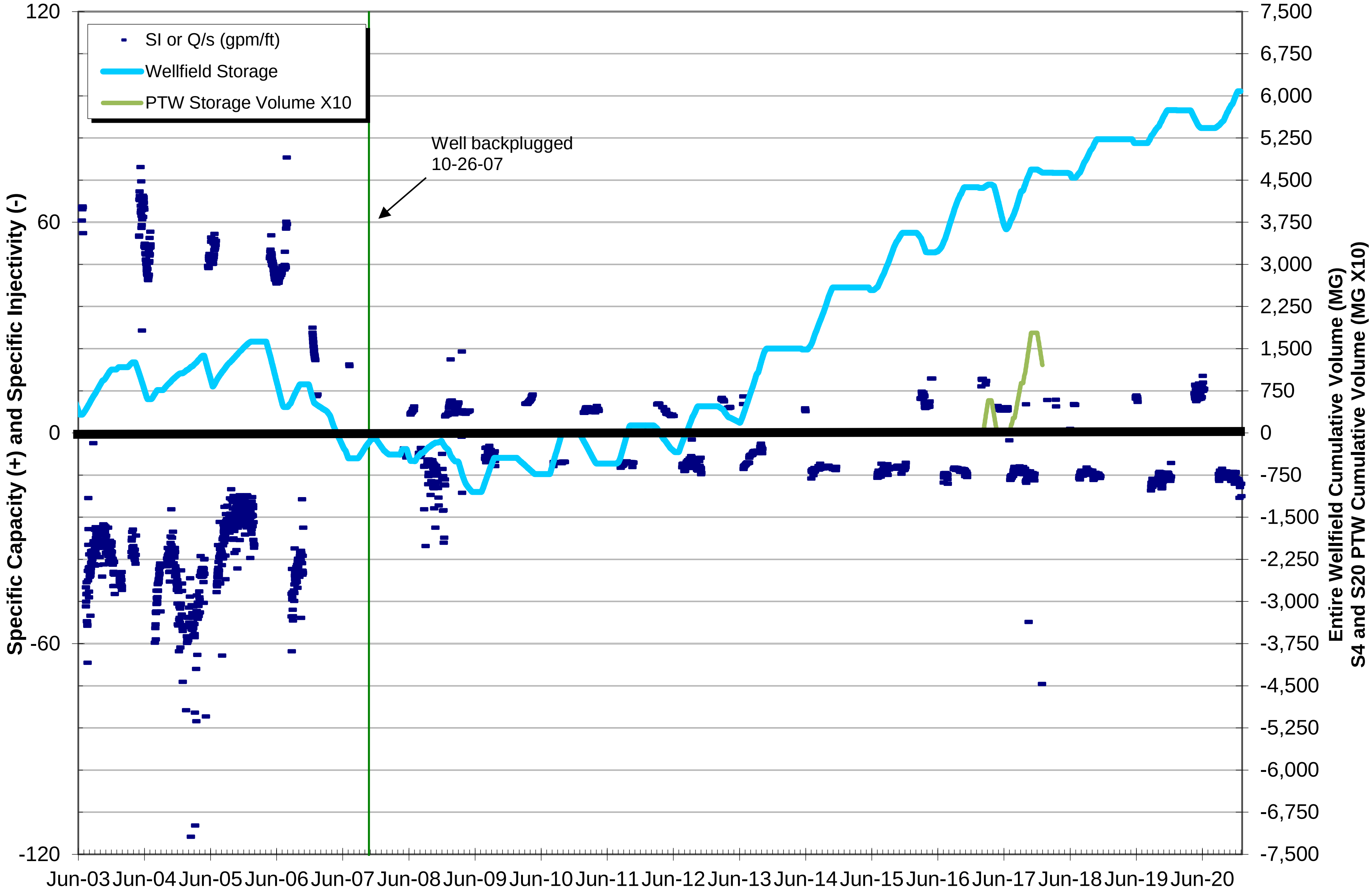


Figure B-18

S-17 Specific Capacity and Specific Injectivity

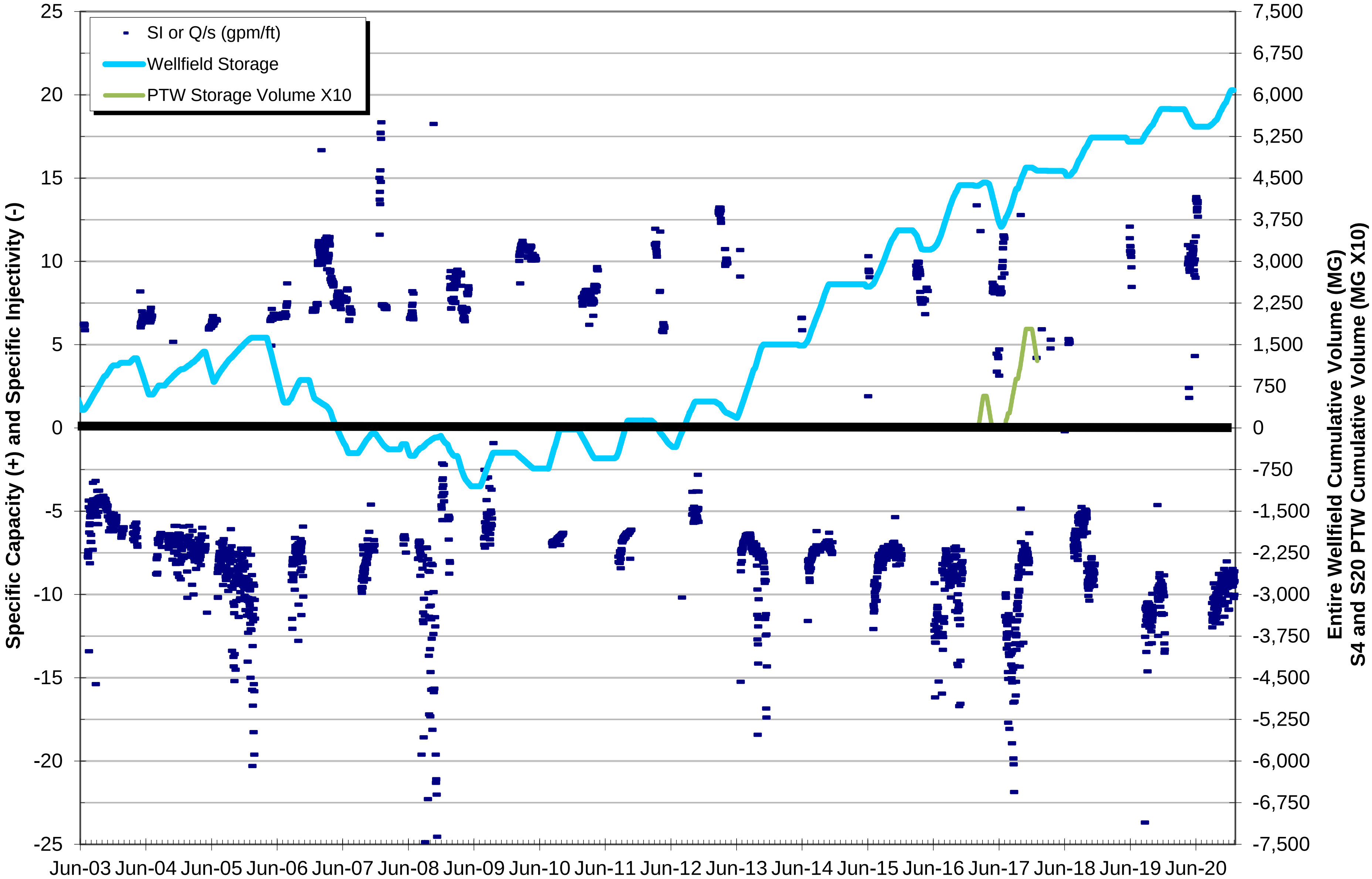


Figure B-19

S-18 Specific Capacity and Specific Injectivity

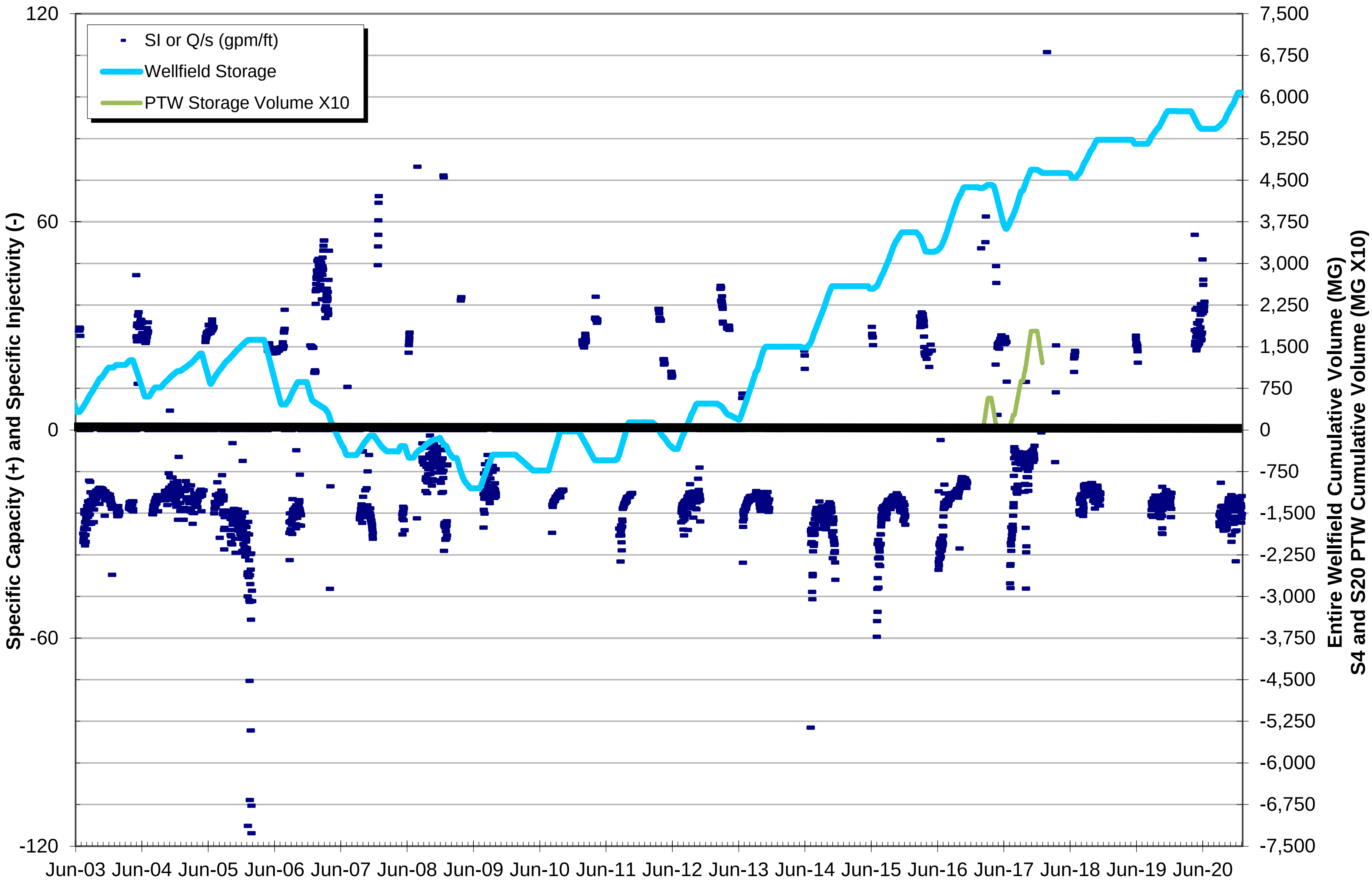


Figure B-20

S-19 Specific Capacity and Specific Injectivity

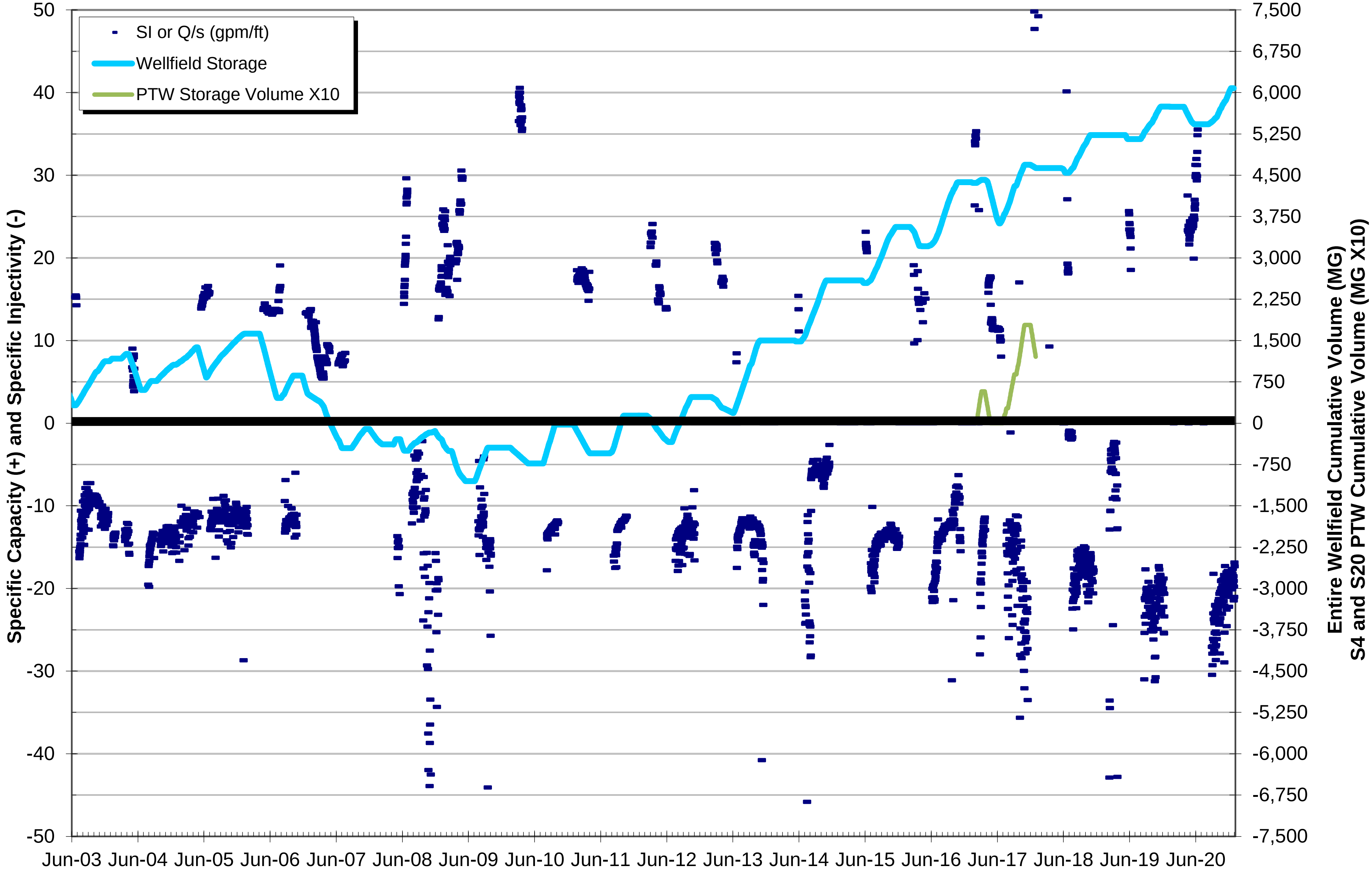


Figure B-21

S-20 Specific Capacity and Specific Injectivity

Appendix C
Table of Water Quality Data 2020

Station_ID	Sample Date	pH Std Units	Temp °C	Specific Conductance umhos/cm	Oxidation Reduction Potential mV	Dissolved Oxygen mg/l	Turbidity NTU	Chloride mg/l	Sulfate mg/l	Total Dissolved Solids mg/l	Total Alkalinity mg/l Ca CO3	Total Iron ug/l	Dissolved Iron ug/l	Manganese mg/l	Nitrate mg/l	Sulfide mg/l	Total Organic Carbon mg/l	Arsenic ug/L	TTHMs ug/L	Gross Alpha pCi/L	Total Uranium ug/l	Calcium mg/L	Fluoride mg/L	Magnesium mg/L	Sodium mg/L	Total Suspended Solids mg/L	Bicarbonate Alkalinity mg/L	Carbonate Alkalinity mg/L	HAAs mg/L	RA 226 + 228 pCi/L
Finish Water	8/18/2020	8.12	31.3	502	247.3	7.51	0.10	37.4	140.0	290								0.50 U												
Finish Water	9/28/2020	7.99	29.4	474	282.3	7.80	0.09	32.5	124.0	278								0.50 U												
Finish Water	10/30/2020	7.98	27.8	454	432.1	7.90	0.09	31.5	122.0	274								0.50 U												
Finish Water	11/23/2020	7.91	24.2	451	290.0	8.50	0.08	31.2	124.0	284								0.70 I												
Finish Water	12/14/2020	8.38	21.4	448	296.0	9.09	0.08	30.2	118.0	272								0.50 U												
I-10	1/7/2020	7.65	25.0	843	-74.3	0.66	0.33	170.0	22.7	458								0.50 U												
I-10	4/28/2020	7.76	24.8	826	-204.6	1.34	0.59	166.0	21.7	470								0.50 U												
I-10	7/21/2020	7.55	25.1	842	-200.4	0.92	0.44	168.0	22.2	456								0.50 U												
I-10	10/27/2020	7.71	25.4	838	-258.8	0.71	0.48	169.0	21.8	456								0.50 U												
I-1E	1/7/2020	8.04	25.6	412	-152.9	0.39	0.82	62.8																						
I-1E	1/7/2020	8.04	25.6	412	-152.9	0.39	0.82	59.6	2.7 I	218								0.50 U												
I-1E	2/26/2020	8.09	25.8	422	-159.0	1.26	0.40	65.7																						
I-1E	3/25/2020	7.97	25.8	396	-216.3	0.11	3.55	59.7																						
I-1E	4/28/2020	8.11	26.4	399	-202.8	0.28	0.45	57.3																						
I-1E	4/28/2020	8.11	26.4	399	-202.8	0.28	0.45	57.3	3.6	234								0.50 U												
I-1E	5/26/2020	7.90	27.0	473	-220.3	1.19	0.97	56.8																						
I-1E	6/23/2020	7.95	25.9	397	-193.0	0.67	0.23	70.6																						
I-1E	7/21/2020	7.96	25.8	408	-223.5	0.32	0.20	58.1																						
I-1E	7/21/2020	7.96	25.8	408	-223.5	0.32	0.20	58.1	3.8	204								0.50 U												
I-1E	8/25/2020	7.89	25.9	402	-204.2	0.88	2.14	60.3																						
I-1E	9/23/2020	7.92	25.9	395	-231.4	0.35	0.34	57.3																						
I-1E	10/14/2020	8.03	26.1	399	-231.9	0.47	0.26	56.3																						
I-1E	10/27/2020	8.01	26.0	400	-198.5	0.88	0.64	58.3	2.9 I	216								0.50 U												
I-1E	11/17/2020	7.88	25.9	407	-204.1	0.61	0.27	57.8																						
I-1E	12/9/2020	7.97	25.8	394	-180.3	0.55	0.41	57.3																						
I-7	1/7/2020	7.59	24.8	1111	-223.7	0.24	0.60	189.0	132.0	636								0.50 U												
I-7	4/28/2020	7.62	25.1	1087	-235.0	0.45	0.47	200.0	136.0	676								0.50 U												
I-7	7/21/2020	7.56	25.6	1142	-223.3	0.83	0.38	196.0	133.0	642								0.50 U												
I-7	10/27/2020	7.61	26.0	1097	-251.4	0.64	0.87	192.0	131.0	640								0.50 U												
I-8	1/7/2020	7.95	24.7	421	-175.8	0.55	0.65	53.1	2.4 I	220								0.50 U												
I-8	4/28/2020	8.04	25.1	412	-232.5	0.21	1.04	51.9	2.4 I	246								0.50 U												
I-8	7/21/2020	7.91	25.3	424	-223.4	0.62	1.23	54.0	2.6 I	228								0.50 U												
I-8	10/27/2020	7.94	25.2	417	-229.3	0.42	2.45	52.7	2.5 I	224								0.50 U												
M-11	1/7/2020	7.87	28.1	559	-142.0	0.33	4.01	39.0	136.0	330								5.35												
M-11	4/28/2020	7.98	28.6	656	-119.0	0.28	1.13	59.8	165.0	408								8.87												
M-11	7/21/2020	7.72	29.2	735	-131.8	0.36	2.62	75.8	182.0	454								9.19												
M-11	10/27/2020	8.27	28.1	468	342.8	6.78	87.50	33.7	126.0	274								3.63												
M-12	1/7/2020	7.77	28.7	665	-76.6	0.24	0.69	57.6	155.0	388								5.23												
M-12	4/28/2020	7.96	28.9	677	-128.3	0.26	0.61	62.4	169.0	426								7.19												
M-12	7/21/2020	7.71	29.3	740	-143.9	0.28	1.58	76.8	184.0	444								8.73												
M-12	10/27/2020	8.26	28.3	478	347.3	6.82	19.50	34.8	129.0	276								1.13 I												
M-13	1/7/2020	7.82	27.3	746	-159.6	0.27	0.48	64.5	191.0	464								0.50 U												
M-13	4/28/2020	7.84	27.6	753	-201.4	0.27	0.45	65.0	195.0	484								0.50 U												
M-13	7/21/2020	7.73	28.7	784	-184.5	0.76	0.36	72.3	204.0	488								0.50 U												
M-13	10/27/2020	7.86	27.8	767	-203.7	0.73	1.25	69.9	199.0	484								0.50 U												
M-14	1/21/2020	7.85	27.5	585	-102.3	0.59	0.47	40.0	138.0	330								7.97												
M-14	1/21/2020	7.85	27.5	585	-102.3	0.59	0.47													2.3										
M-14	2/17/2020	7.75	28.5	583	-112.5	0.51	0.84	42.1	140.0	342								5.84												
M-14	3/23/2020	7.81	28.6	588	-85.3	0.36	0.17	45.1	152.0	336								8.02												
M-14	4/7/2020	7.88	28.1	610	-88.4	0.53	0.33	49.9	157.0	378								7.81												
M-14	4/7/2020	7.88	28.1	610	-88.4	0.53	0.33												0.50 U											
M-14	4/7/2020	7.88	28.1	610	-88.4	0.53	0.33													2.2										
M-14	5/19/2020	7.76	29.7	739	-151.6	0.45	0.25	71.0	169.0	442								9.21												
M-14	6/19/2020	7.70	29.0	738	-125.1	0.43	0.36	74.1	176.0	450		0.123						8.81												
M-14	7/22/2020	7.75	29.4	741	-143.5	0.65	0.80	78.7	187.0	444		0.146						8.62		4.7										
M-14	8/25/2020	8.00	30.1	520	379.2	6.32	0.39	40.1	140.0	302								0.95 I												
M-14	9/15/2020	7.88	29.0	491	409.2	6.77	0.28	36.3	132.0	304								1.36 I												
M-14	10/14/2020	8.10	28.4	480	421.0	6.99	3.63	35.1	127.0	294								0.94 I		1.0 U										
M-14	11/17/2020	8.07	26.5	487	370.3	6.51	0.25	36.0	132.0	292								1.64 I												
M-14	12/9/2020	8.09	21.4	468	388.2	7.23	0.48	33.9	124.0	360								1.06 I												
M-15	1/29/2020	7.77	28.7	607	-140.8	0.22	0.62	42.6	137.0	352								10.00												
M-15	1/29/2020	7.77	28.7	607	-140.8	0.22	0.62													10.1										
M-15	2/26/2020	7.83	28.9	594	-135.0	0.18	0.33	44.6	143.0	350								11.00												
M-15	3/3/2020	7.73	28.8	593	-126.1	0.52	0.42	46.1	144.0	350								10.70												
M-15	3/10/2020	7.74	28.7	592	-73.4	0.35	0.29											9.91												
M-15	3/12/2020	7.83	28.3	583	-76.0	0.42	0.25											10.20												
M-15	3/16/2020	7.84	28.9	589	-84.1	0.32	0.28											10.20												
M-15	3/20/2020	7.82	28.9	577	-120.5	0.29	0.80											10.10												
M-15	3/23/2020	7.85	28.9	576	-81.3	0.19	0.21											11.30												
M-15	3/25/2020	7.89	28.9	578	-106.2	0.36	0.38											9.70												
M-15	4/1/2020	7.74	26.2	578	-74.7	0.36	0.32	45.7	142.0	320								11.60												
M-15	4/1/2020	7.84	28.2	607	-81.5	0.34	0.36													2.6										
M-15	4/1/2020	7.84	28.2	607	-81.5	0.34	0.36												0.50 U											
M-15	4/6/2020	7.84	28.2	607	-81.5	0.34	0.36	50.8	150.0	378								8.71												
M-15	4/13/2020	7.81	28.8	636	-146.6	0.29	0.36	53.3	151.0	384								7.79												
M-15	4/20/2020	7.70	28.7	658	-110.9	0.36	0.39	62.2	161.0	386								6.45												
M-15	4/27/2020	7.88	28.8	679	-150.5	0.60	0.34	61.2	174.0	414								6.10												
M-15	5/4/2020	7.80	29.3	693	-102.7	0.59	0.30	64.1	165.0	420								7.24												
M-15	5/11/2020	7.80	29.2	723	-154.4	0.27	0.29	68.5	170.0	438								8.33												
M-15	5/18/2020	7.78	29.0	729	-186.5	0.54	0.25	69.0	169.0	444								9.41												
M-15	5/26/2020	7.81	29.4	743	-183.4	0.44	0.43	71.1	165.0	426								8.86												
M-15	6/3/2020	7.77	29.1	744	-147.9	0.32	0.20	72.8	173.0	440		0.094 I						8.09												
M-15	6/9/2020	7.69	29.1	745	-132.2	0.29	0.41	74.4	173.0	452		0.097 I						9.29												
M-15	6/17/2020	7.79	29.3	741	-163.3	0.28	0.32	73.5	172.0	466		0.090 I						9.26												
M-15	6/22/2020	7.64	29.2	736	-82.3	0.56	0.40	74.9	176.0	452								9.19												
M-15	7/27/2020	7.75	29.3	747	-155.7	0.40	2.56	70.4	171.0	450								9.56		3.3										
M-15	8/18/2020	7.86	29.0	674	-149.3	0.43	0.74	61.0	160.0	398								10.30												
M-15	8/24/2020	7.75	29.0	634	11.2	1.16	0.86	52.1	150.0	378								5.70												

Station_ID	Sample Date	pH Std Units	Temp °C	Specific Conductance umhos/cm	Oxidation Reduction Potential mV	Dissolved Oxygen mg/l	Turbidity NTU	Chloride mg/l	Sulfate mg/l	Total Dissolved Solids mg/l	Total Alkalinity mg/l Ca CO3	Total Iron ug/l	Dissolved Iron ug/l	Manganese mg/l	Nitrate mg/l	Sulfide mg/l	Total Organic Carbon mg/l	Arsenic ug/L	TTHMs ug/L	Gross Alpha pCi/L	Total Uranium ug/l	Calcium mg/L	Fluoride mg/L	Magnesium mg/L	Sodium mg/L	Total Suspended Solids mg/L	Bicarbonate Alkalinity mg/L	Carbonate Alkalinity mg/L	HAAs mg/L	RA 226 + 228 pCi/L
M-15	9/1/2020	7.75	29.2	644	-115.7	0.31	0.91	54.5	152.0	392								8.33												
M-15	9/9/2020	7.84	29.1	572	268.2	2.96	3.48	44.5	141.0	342								4.29												
M-15	9/14/2020	7.60	28.8	621	-88.0	0.33	1.20	49.8	149.0	378								9.38												
M-15	9/23/2020	7.85	28.9	609	-135.7	0.42	0.77	45.1	138.0	374								8.32												
M-15	9/28/2020	7.82	29.1	602	-79.0	0.25	0.38	45.7	143.0	366								6.09												
M-15	10/7/2020	7.85	29.0	549	-153.3	1.70	0.83	40.6	133.0	350								3.36												
M-15	10/13/2020	7.90	29.1	593	-109.7	0.50	5.36	44.5	142.0	364								5.46		3.7										
M-15	10/19/2020	7.93	28.7	578	-96.9	0.23	0.20	43.2	138.0	356								3.83												
M-15	10/26/2020	7.88	29.0	586	-109.1	0.31	1.43	41.5	141.0	356								4.68												
M-15	11/4/2020	8.03	28.6	566	-61.5	0.77	0.83	41.1	142.0	358								4.85												
M-15	11/10/2020	7.98	28.5	569	-103.3	0.40	2.97	39.4	144.0	346								4.22												
M-15	11/16/2020	7.88	28.9	575	-81.7	0.35	1.48	39.9	140.0	346								3.36												
M-15	11/23/2020	7.83	28.3	561	-91.9	0.18	1.72	39.9	138.0	354								3.16												
M-15	12/1/2020	7.85	27.8	523	-64.9	0.67	9.23	39.7	135.0	360								3.57												
M-15	12/8/2020	7.92	28.3	559	-106.7	0.27	4.17	40.6	145.0	340								2.35												
M-15	12/14/2020	8.05	28.5	567	-149.5	0.30	1.54	40.7	142.0	356								4.01												
M-15	12/21/2020	8.00	28.0	558	-86.9	0.60	74.60	38.9	137.0	348								5.66												
M-15	12/28/2020	7.90	28.2	566	-31.6	0.42	11.50	39.2	139.0	338								5.94												
M-16	1/21/2020	7.76	24.7	766	-127.7	0.27	0.31	70.1	182.0	454								3.33												
M-16	1/21/2020	7.76	24.7	766	-127.7	0.27	0.31													2.6										
M-16	2/17/2020	7.74	24.8	759	-145.3	0.35	0.23	72.8	190.0	476								3.19												
M-16	3/23/2020	7.79	28.7	702	-130.5	0.21	0.18	65.7	185.0	420								3.98												
M-16	4/7/2020	7.79	28.4	706	-134.2	0.39	0.28	62.4	176.0	442								3.46												
M-16	4/7/2020	7.79	28.4	706	-134.2	0.39	0.28												0.50 U											
M-16	4/7/2020	7.79	28.4	706	-134.2	0.39	0.28													3.2										
M-16	5/19/2020	7.79	28.6	672	-145.3	0.28	0.22	53.4	172.0	400								4.87												
M-16	6/19/2020	7.83	28.9	663	-126.0	0.72	0.44	55.2	176.0	406		0.029 U						3.26												
M-16	7/22/2020	7.88	28.7	671	-167.2	0.36	0.80	57.5	182.0	418		0.029 U						3.46		3.4										
M-16	8/25/2020	7.73	28.8	672	-127.4	0.28	0.34	56.4	179.0	410								4.39												
M-16	9/15/2020	7.80	29.0	673	-164.7	0.37	0.33	56.8	175.0	420								3.73												
M-16	10/14/2020	7.81	29.2	693	-98.4	0.50	0.80	60.2	176.0	426								3.79		1.7 U										
M-16	11/17/2020	7.72	29.3	696	-139.7	0.38	0.26	61.7	182.0	422								5.25												
M-16	12/9/2020	7.81	28.5	676	-116.7	0.65	0.54	55.0	167.0	436								3.86												
M-17	1/21/2020	8.02	27.4	564	-62.1	0.25	0.35	40.2	145.0	328								4.06												
M-17	1/21/2020	8.02	27.4	564	-62.1	0.25	0.35													4.1										
M-17	2/17/2020	7.96	25.5	572	-133.3	0.31	0.31	43.2	154.0	340								5.14												
M-17	3/23/2020	7.87	28.7	603	-55.5	0.30	0.27	49.4	163.0	360								5.63												
M-17	4/7/2020	7.86	28.6	573	-125.5	0.60	0.25	42.6	151.0	354								4.10												
M-17	4/7/2020	7.86	28.6	573	-125.5	0.60	0.25												0.50 U											
M-17	4/7/2020	7.86	28.6	573	-125.5	0.60	0.25													3.1										
M-17	5/19/2020	7.87	29.5	594	-137.0	0.48	0.23	44.1	154.0	348								4.01												
M-17	6/19/2020	7.91	28.8	590	-79.2	0.61	1.10	45.4	157.0	362		0.029 U						3.02												
M-17	7/22/2020	7.90	28.9	603	-113.0	0.59	1.02	48.1	162.0	372		0.029 U						3.52		5.0										
M-17	8/25/2020	7.79	28.8	598	-62.5	0.29	0.23	46.4	160.0	346								3.00												
M-17	9/15/2020	7.85	28.9	590	-146.0	0.26	0.34	44.4	154.0	370								1.23 I												
M-17	10/14/2020	7.93	29.0	600	-85.6	0.40	0.21	45.2	155.0	358								1.17 I		5.2										
M-17	11/17/2020	7.84	28.8	602	-74.7	0.34	0.35	44.1	157.0	362								2.03												
M-17	12/9/2020	7.95	28.1	576	-72.6	0.36	0.37	41.0	153.0	362								1.39 I												
M-18	1/29/2020	8.02	25.7	636	-103.2	0.31	0.44	44.6	166.0	384								1.76 I												
M-18	1/29/2020	8.02	25.7	636	-103.2	0.31	0.44													3.3										
M-18	2/26/2020	8.08	26.6	625	-54.2	0.27	0.37	46.7	171.0	384								1.92 I												
M-18	3/3/2020	7.90	28.5	626	-71.5	0.32	0.12	45.5	171.0	382								2.03												
M-18	4/1/2020	7.97	27.9	608	-108.2	0.18	0.27	45.5	172.0	344								1.79 I												
M-18	4/1/2020	7.95	28.4	622	-143.1	0.37	0.18													2.7										
M-18	4/1/2020	7.95	28.4	622	-143.1	0.37	0.18												0.50 U											
M-18	4/6/2020	7.95	28.4	622	-143.1	0.37	0.18	45.6	169.0	380								2.29												
M-18	4/13/2020	7.81	28.6	630	-162.2	0.38	0.31	45.1	168.0	390								1.42 I												
M-18	4/20/2020	7.87	28.4	635	-178.6	0.32	0.24	48.1	169.0	374								1.26 I												
M-18	4/27/2020	8.00	28.4	644	-218.6	0.12	0.23	48.3	173.0	406								0.90 I												
M-18	5/4/2020	7.92	28.4	645	-189.5	0.10	0.19	49.0	173.0	418								0.72 I												
M-18	5/11/2020	7.89	28.4	666	-146.1	0.18	0.21	51.1	177.0	416								0.77 I												
M-18	5/18/2020	7.85	28.3	663	-180.7	0.15	0.29	50.9	172.0	420								1.01 I												
M-18	5/26/2020	7.90	28.7	670	-146.1	0.41	0.40	51.8	170.0	428								0.81 I												
M-18	6/3/2020	7.92	28.4	666	-184.4	0.17	0.20	53.5	178.0	408		0.029 U						0.84 I												
M-18	6/9/2020	7.84	28.5	668	-187.9	0.19	0.61	52.8	177.0	396		0.029 U						0.59 I												
M-18	6/17/2020	7.93	28.8	666	-154.5	0.53	0.27	52.6	177.0	412		0.029 U						0.90 I												
M-18	6/22/2020	7.86	28.8	667	-148.1	0.50	0.28	54.0	182.0	418								1.23 I												
M-18	7/27/2020	7.90	28.4	677	-200.9	0.14	1.47	51.7	177.0	410								0.62 I		2.4										
M-18	8/18/2020	7.90	28.4	671	-196.3	0.34	0.21	52.4	173.0	414								0.69 I												
M-18	8/24/2020	7.78	28.6	674	-116.0	0.37	0.20	52.6	177.0	412								0.50 U												
M-18	9/1/2020	7.80	28.6	664	-160.0	0.29	0.27	50.7	175.0	406								0.66 I												
M-18	9/9/2020	7.80	28.6	657	-146.1	0.47	0.15	49.5	170.0	414								0.76 I												
M-18	9/14/2020	7.76	28.5	647	-186.8	0.27	0.17	48.4	172.0	396								0.58 I												
M-18	9/23/2020	7.89	28.4	642	-141.2	0.54	0.13	47.9	169.0	396								0.84 I												
M-18	9/28/2020	7.82	28.7	645	-81.0	0.39	0.35	46.9	166.0	390								0.52 I												
M-18	10/7/2020	7.90	28.6	608	-170.3	1.05	0.40	46.1	167.0	410								0.84 I												
M-18	10/13/2020	8.01	28.6	636	-125.6	0.47	0.15	45.5	167.0	396								1.19 I		2.4										
M-18	10/19/2020	7.95	28.4	623	-170.8	0.28	0.18	45.1	163.0	382								1.30 I												
M-18	10/26/2020	7.90	28.6	629	-164.4	0.40	0.22	44.4	167.0	388								1.73 I												
M-18	11/4/2020	8.03	28.4	621	-97.6	0.57	0.20	43.9	168.0	398								2.47												
M-18	11/10/2020	7.97	28.3	625	-196.6	0.25	0.13	44.6	169.0	382								2.02												
M-18	11/16/2020	7.88	28.4	626	-183.3	0.21	0.19	42.9	167.0	380								2.16												
M-18	11/23/2020	7.86	28.5	615	-122.2	0.21	0.18	42.2	163.0	382								1.74 I												
M-18	12/1/2020	7.90	27.6	563	-80.3	0.69	0.17	42.6	166.0	376								2.14												
M-18	12/8/2020	7.94	28.0	601	-145.8	0.37	0.22	42.7	168.0	376								1.72 I												
M-18	12/14/2020	8.37	28.5	602	-146.7	0.38	0.20	41.2	163.0	382								1.84 I												
M-18	12/21/2020	8.04	28.2	606	-181.2	1.20	0.31	41.4	161.0	376								2.72												
M-18	12/28/2020	7.93	28.3	611	-105.4	0.27	0.20	42.0	163.0	366								2.26												

Station_ID	Sample Date	pH Std Units	Temp °C	Specific Conductance umhos/cm	Oxidation Reduction Potential mV	Dissolved Oxygen mg/l	Turbidity NTU	Chloride mg/l	Sulfate mg/l	Total Dissolved Solids mg/l	Total Alkalinity mg/l Ca CO3	Total Iron ug/l	Dissolved Iron ug/l	Manganese mg/l	Nitrate mg/l	Sulfide mg/l	Total Organic Carbon mg/l	Arsenic ug/L	TTHMs ug/L	Gross Alpha pCi/L	Total Uranium ug/l	Calcium mg/L	Fluoride mg/L	Magnesium mg/L	Sodium mg/L	Total Suspended Solids mg/L	Bicarbonate Alkalinity mg/L	Carbonate Alkalinity mg/L	HAAs mg/L	RA 226 + 228 pCi/L
M-19	1/29/2020	7.89	29.2	655	-63.1	0.36	0.36	47.5	170.0	398								2.21												
M-19	1/29/2020	7.89	29.2	655	-63.1	0.36	0.36													2.3										
M-19	2/26/2020	7.94	29.0	643	-17.5	0.29	0.23	47.4	173.0	386								2.03												
M-19	3/3/2020	7.81	29.3	652	-89.9	0.74	0.11	49.8	175.0	394								1.14 I												
M-19	4/1/2020	7.90	29.3	622	-108.9	0.28	0.32	48.5	175.0	362								2.83												
M-19	4/1/2020	7.90	29.2	620	-110.5	0.48	0.21													2.3										
M-19	4/1/2020	7.90	29.2	620	-110.5	0.48	0.21												0.50 U											
M-19	4/6/2020	7.90	29.2	620	-110.5	0.48	0.21	45.6	167.0	384								6.35												
M-19	4/13/2020	7.85	29.5	622	-92.1	0.36	0.30	46.1	164.0	380								4.94												
M-19	4/20/2020	7.80	29.2	617	-38.1	0.68	0.20	47.0	166.0	362								4.38												
M-19	4/27/2020	7.98	29.4	624	-150.3	0.74	0.23	44.8	167.0	388								3.63												
M-19	5/4/2020	7.76	29.2	618	-109.5	0.77	0.18	44.1	160.0	390								5.38												
M-19	5/11/2020	7.88	29.3	632	-131.4	0.68	0.16	46.1	169.0	392								5.46												
M-19	5/18/2020	7.87	28.9	626	-156.9	0.44	0.22	46.3	168.0	384								5.15												
M-19	5/26/2020	7.92	29.4	626	-158.2	0.56	0.24	43.9	162.0	356								4.01												
M-19	6/3/2020	7.94	29.2	626	-154.0	0.25	0.49	46.9	170.0	380		0.029 U						4.52												
M-19	6/9/2020	7.82	29.3	631	-102.8	0.80	0.25	46.8	170.0	368		0.029 U						3.72												
M-19	6/17/2020	7.93	29.4	631	-147.2	0.34	0.20	47.5	169.0	386		0.029 U						4.76												
M-19	6/22/2020	7.91	29.3	631	-169.7	0.44	0.29	47.5	173.0	388								3.74												
M-19	7/27/2020	7.86	29.3	643	-157.5	0.47	0.60	46.7	170.0	394								4.24		4.5										
M-19	8/18/2020	7.91	29.1	635	-150.0	0.62	0.17	46.6	169.0	394								3.18												
M-19	8/24/2020	7.71	29.1	644	-115.4	0.30	0.17	48.3	171.0	386								2.95												
M-19	9/1/2020	7.76	29.2	638	-154.1	0.24	0.27	48.1	171.0	394								2.57												
M-19	9/9/2020	7.80	29.2	636	-166.2	0.21	0.17	47.7	170.0	408								2.33												
M-19	9/14/2020	7.79	29.1	633	-185.3	0.43	0.22	46.8	166.0	392								2.32												
M-19	9/23/2020	7.86	29.0	635	-155.0	0.37	0.13	46.3	161.0	378								2.08												
M-19	9/28/2020	7.55	29.1	638	-78.0	0.36	0.45	46.5	165.0	394								1.52 I												
M-19	10/7/2020	7.95	29.4	605	-179.6	0.69	0.25	46.3	164.0	414								1.00 I												
M-19	10/13/2020	7.91	29.3	643	-180.2	0.29	0.29	46.4	166.0	386								0.95 I		1.9										
M-19	10/19/2020	7.91	29.1	628	-200.4	0.16	0.23	45.1	159.0	390								0.92 I												
M-19	10/26/2020	7.87	29.3	637	-139.4	0.22	0.27	46.8	170.0	400								1.21 I												
M-19	11/4/2020	7.97	29.1	632	-176.2	0.80	0.78	46.1	170.0	400								1.48 I												
M-19	11/10/2020	7.91	29.1	637	-187.8	0.35	0.55	46.7	173.0	394								1.51 I												
M-19	11/16/2020	7.82	29.0	642	-190.9	0.28	0.23	45.6	169.0	384								1.49 I												
M-19	11/23/2020	7.77	28.9	630	-163.1	0.33	0.48	45.1	166.0	392								1.01 I												
M-19	12/1/2020	7.84	28.7	579	-59.5	0.44	0.32	45.5	170.0	382								1.32 I												
M-19	12/8/2020	7.90	28.5	618	-163.7	0.55	0.32	45.7	172.0	390								0.51 I												
M-19	12/14/2020	7.85	29.1	625	-63.5	0.62	0.36	45.4	169.0	386								1.35 I												
M-19	12/21/2020	7.97	28.9	627	-131.4	0.48	0.38	44.8	166.0	392								1.24 I												
M-19	12/28/2020	7.90	28.9	635	-162.8	0.44	0.25	45.2	168.0	386								1.83 I												
M-2	1/29/2020	7.46	25.5	1241	-87.0	0.27	0.42	108.0	324.0	834								0.50 U												
M-2	1/29/2020	7.46	25.5	1241	-87.0	0.27	0.42													4.7										
M-2	2/26/2020	7.44	25.9	1206	-147.5	0.32	0.33	111.0	326.0	814								0.50 U												
M-2	3/3/2020	7.32	25.9	1211	-132.7	0.42	0.57	116.0	330.0	814								0.50 U												
M-2	4/1/2020	7.30	25.6	1183	-133.0	0.30	0.31	112.0	327.0	788								0.50 U												
M-2	4/1/2020	7.48	25.8	1185	-59.5	0.49	0.32													4.3										
M-2	4/1/2020	7.48	25.8	1185	-59.5	0.49	0.32												0.50 U											
M-2	4/6/2020	7.48	25.8	1185	-59.5	0.49	0.32	115.0	317.0	824								0.50 U												
M-2	4/13/2020	7.38	26.4	1170	-217.1	0.21	0.56	112.0	306.0	830								0.55 I												
M-2	4/20/2020	7.17	26.7	1179	-220.4	0.18	1.02	117.0	319.0	796								0.50 U												
M-2	4/27/2020	7.34	27.0	1185	-217.8	0.40	0.37	109.0	312.0	812								0.50 U												
M-2	5/4/2020	7.79	29.7	1082	-207.8	0.49	0.20	107.0	302.0	824								0.50 U												
M-2	5/11/2020	7.84	29.7	1049	-229.8	0.26	0.66	113.0	319.0	826								0.50 U												
M-2	5/18/2020	7.24	26.9	1183	-210.0	0.20	0.34	111.0	311.0	838								0.50 U												
M-2	5/26/2020	7.27	27.1	1188	-240.8	0.28	0.44	108.0	302.0	760								0.50 U												
M-2	6/3/2020	7.30	26.9	1180	-246.6	0.13	0.59	113.0	314.0	796		0.094 I						0.50 U												
M-2	6/9/2020	7.67	30.8	1085	-221.8	0.25	0.32	111.0	278.0	710		1.500						0.50 U												
M-2	6/17/2020	7.93	29.2	1009	-251.1	0.25	0.54	113.0	313.0	792		0.085 I						0.50 U												
M-2	6/22/2020	7.32	27.2	1185	-261.0	0.16	1.02	114.0	320.0	834								0.50 U												
M-2	7/27/2020	7.34	27.5	1211	-257.6	0.20	1.47	114.0	314.0	800								0.50 U		4.8										
M-2	8/18/2020	7.33	27.0	1187	-235.6	0.60	0.42	112.0	314.0	838								0.50 U												
M-2	8/24/2020	7.17	27.2	1203	-246.2	0.26	0.39	113.0	315.0	810								0.50 U												
M-2	9/1/2020	7.81	30.2	1064	-255.1	0.33	0.22	113.0	319.0	804								0.64 I												
M-2	9/9/2020	7.21	27.1	1194	-237.7	0.12	0.33	112.0	318.0	886								0.50 U												
M-2	9/14/2020	7.19	27.1	1186	-230.8	0.15	0.17	109.0	316.0	808								0.50 U												
M-2	9/23/2020	7.25	27.0	1188	-247.2	0.19	0.24	110.0	316.0	882								0.50 U												
M-2	9/28/2020	7.18	27.1	1199	-237.1	0.29	0.30	108.0	313.0	848								0.50 U												
M-2	10/7/2020	7.53	27.2	1139	-283.6	0.12	0.68	107.0	317.0	888								0.50 U												
M-2	10/13/2020	7.23	27.1	1207	-237.1	0.22	0.24	109.0	322.0	834								0.50 U		3.0										
M-2	10/19/2020	7.30	27.0	1189	-252.1	0.22	0.34	107.0	321.0	840								0.50 U												
M-2	10/26/2020	7.25	27.0	1210	-258.6	0.17	0.24	106.0	334.0	878								0.50 U												
M-2	11/4/2020	7.35	27.0	1205	-290.8	0.32	0.70	105.0	340.0	866								0.50 U												
M-2	11/10/2020	7.37	26.0	1217	-239.0	0.44	0.20	106.0	345.0	850								0.50 U												
M-2	11/16/2020	7.21	27.1	1224	-239.4	0.32	0.42	103.0	331.0	850								0.50 U												
M-2	11/23/2020	7.13	26.9	1217	-270.1	0.16	0.21	105.0	345.0	860								0.50 U												
M-2	12/1/2020	7.26	26.8	1122	-224.3	0.35	0.27	104.0	355.0	882								0.55 I												
M-2	12/8/2020	7.35	25.6	1200	-220.0	0.48	0.37	104.0	362.0	866								0.50 U												
M-2	12/14/2020	7.38	26.5	1216	-284.4	0.25	0.19	103.0	357.0	870								0.65 I												
M-2	12/21/2020	7.37	26.7	1222	-241.4	0.34	1.13	102.0	350.0	918								0.50 U												
M-2	12/28/2020	7.27	26.6	1232	-250.5	0.41	0.20	100.0	341.0	876								0.50 U												
M-20	1/21/2020	7.54	26.6	964	-107.0	0.49	0.33	90.0	228.0	608								0.50 U												
M-20	1/21/2020	7.54	26.6	964	-107.0	0.49	0.33													2.8										
M-20	2/17/2020	7.49	26.9	956	-139.4	0.67	1.81	92.6	234.0	592								0.50 U												
M-20	3/23/2020	7.51	27.4	947	-148.1	0.31	0.20	97.2	239.0	590								0.50 U												
M-20	4/7/2020	7.45	26.9	931	-148.3	0.28	0.32	89.9	229.0	606								0.50 U												
M-20	4/7/2020	7.45	26.9	931	-148.3	0.28	0.32												0.50 U											
M-20	4/7/2020	7.45	26.9	931	-148.3	0.28	0.32													3.6										
M-20	5/19/2020	7.42	27.6	976	-196.7	0.83	0.31	92.1	230.0	620								0.50 U												

Station_ID	Sample Date	pH Std Units	Temp °C	Specific Conductance umhos/cm	Oxidation Reduction Potential mV	Dissolved Oxygen mg/l	Turbidity NTU	Chloride mg/l	Sulfate mg/l	Total Dissolved Solids mg/l	Total Alkalinity mg/l Ca CO3	Total Iron ug/l	Dissolved Iron ug/l	Manganese mg/l	Nitrate mg/l	Sulfide mg/l	Total Organic Carbon mg/l	Arsenic ug/L	TTHMs ug/L	Gross Alpha pCi/L	Total Uranium ug/l	Calcium mg/L	Fluoride mg/L	Magnesium mg/L	Sodium mg/L	Total Suspended Solids mg/L	Bicarbonate Alkalinity mg/L	Carbonate Alkalinity mg/L	HAAs mg/L	RA 226 + 228 pCi/L
M-20	6/19/2020	7.47	27.6	972	-218.0	0.51	0.47	96.1	237.0	648		0.029 U						0.50 U												
M-20	7/22/2020	7.48	27.4	985	-217.2	0.26	0.45	99.0	247.0	652		0.029 U						0.50 U		3.3										
M-20	8/25/2020	7.44	27.5	986	-215.0	0.51	0.32	98.7	244.0	632								0.50 U												
M-20	9/15/2020	7.45	27.4	971	-206.5	0.98	0.18	93.1	228.0	652								0.50 U												
M-20	10/14/2020	7.56	27.4	991	-241.3	0.41	0.42	99.4	233.0	664								0.50 U		3.3										
M-20	11/17/2020	7.40	27.0	997	-229.4	1.73	0.29	101.0	239.0	626								0.50 U												
M-20	12/9/2020	7.44	26.8	990	-227.8	0.57	0.28	101.0	235.0	698								0.50 U												
M-21	1/29/2020	7.52	24.9	975	-130.0	0.27	0.57	103.0	221.0	624								0.50 U												
M-21	1/29/2020	7.52	24.9	975	-130.0	0.27	0.57													4.7										
M-21	2/26/2020	7.48	25.0	964	-153.7	0.30	0.36	105.0	228.0	612								0.50 U												
M-21	3/3/2020	7.49	26.8	958	-57.5	0.23	1.51	108.0	228.0	608								0.50 U												
M-21	4/1/2020	7.53	26.7	939	-62.3	0.21	0.75	105.0	228.0	574								0.50 U												
M-21	4/1/2020	7.51	27.2	976	-142.9	0.48	0.49													3.8										
M-21	4/1/2020	7.51	27.2	976	-142.9	0.48	0.49												0.50 U											
M-21	4/6/2020	7.51	27.2	976	-142.9	0.48	0.49	107.0	229.0	628								0.50 U												
M-21	4/13/2020	7.42	27.5	973	-195.0	0.24	0.53	103.0	223.0	624								0.50 U												
M-21	4/20/2020	7.57	27.2	978	-189.7	0.32	0.26	106.0	228.0	620								0.50 U												
M-21	4/27/2020	7.58	27.3	974	-256.8	0.36	0.54	104.0	228.0	636								0.50 U												
M-21	5/4/2020	7.50	27.6	961	-216.6	0.31	0.28	100.0	219.0	634								0.50 U												
M-21	5/11/2020	7.44	27.5	982	-179.6	0.64	0.61	100.0	221.0	648								0.50 U												
M-21	5/18/2020	7.43	27.1	962	-162.1	0.28	0.41	101.0	223.0	620								0.50 U												
M-21	5/26/2020	7.52	28.2	969	-188.3	0.56	0.43	99.7	215.0	600								0.50 U												
M-21	6/3/2020	7.56	27.1	943	-233.7	0.25	0.49	101.0	222.0	614		0.029 U						0.50 U												
M-21	6/9/2020	7.55	27.6	938	-223.6	0.25	0.64	101.0	223.0	576		0.029 U						0.50 U												
M-21	6/17/2020	7.61	27.8	935	-191.6	0.41	0.36	102.0	221.0	606		0.029 U						0.50 U												
M-21	6/22/2020	7.50	28.0	938	-216.0	0.41	0.82	102.0	225.0	634								0.50 U												
M-21	7/27/2020	7.58	27.9	971	-195.1	0.28	2.20	102.0	224.0	616								0.50 U		4.8										
M-21	8/18/2020	7.61	27.8	937	-209.9	0.40	0.53	96.9	216.0	614								0.50 U												
M-21	8/24/2020	7.43	27.6	943	-216.8	0.31	0.50	99.5	221.0	596								0.50 U												
M-21	9/1/2020	7.50	27.9	938	-196.3	0.40	0.42	99.5	218.0	576								0.50 U												
M-21	9/9/2020	7.44	27.6	931	-224.9	0.20	0.34	99.1	218.0	620								0.50 U												
M-21	9/14/2020	7.48	27.6	928	-230.7	0.34	0.72	97.9	217.0	596								0.50 U												
M-21	9/23/2020	7.51	27.5	925	-221.4	0.24	0.35	98.5	213.0	636								0.50 U												
M-21	9/28/2020	7.45	27.7	933	-206.2	0.32	0.37	95.7	211.0	608								0.50 U												
M-21	10/7/2020	7.51	27.7	887	-234.8	0.37	0.92	97.5	214.0	666								0.50 U												
M-21	10/13/2020	7.53	27.6	940	-236.6	0.20	0.45	98.1	217.0	610								0.50 U		2.0										
M-21	10/19/2020	7.46	27.3	918	-183.1	0.47	0.62	96.6	213.0	578								0.50 U												
M-21	10/26/2020	7.51	27.6	936	-217.1	0.29	0.68	97.6	221.0	612								0.50 U												
M-21	11/4/2020	7.60	27.6	930	-237.1	0.23	0.44	97.7	222.0	640								0.50 U												
M-21	11/10/2020	7.54	27.4	941	-234.8	0.39	0.56	98.2	223.0	602								0.50 U												
M-21	11/16/2020	7.48	27.8	942	-185.0	0.49	0.39	96.8	219.0	606								0.50 U												
M-21	11/23/2020	7.35	27.5	940	-208.1	0.49	4.18	97.2	219.0	628								0.50 U												
M-21	12/1/2020	7.49	27.1	862	-232.9	0.26	2.19	95.3	219.0	592								0.50 U												
M-21	12/8/2020	7.49	26.9	922	-210.5	0.40	1.69	99.0	227.0	612								0.50 U												
M-21	12/14/2020	7.95	27.5	927	-190.4	0.41	0.57	97.1	222.0	574								0.57 I												
M-21	12/21/2020	7.55	27.1	933	-204.2	0.44	0.44	95.0	220.0	628								0.50 U												
M-21	12/28/2020	7.52	27.3	939	-220.0	0.35	0.32	96.9	220.0	598								0.50 U												
M-22	1/21/2020	8.03	28.6	506	-43.3	0.27	0.45	33.9	124.0	296								4.31												
M-22	1/21/2020	8.03	28.6	506	-43.3	0.27	0.45													4.1										
M-22	2/17/2020	8.03	28.7	506	-27.9	0.30	0.38	35.7	129.0	295								4.20												
M-22	3/23/2020	8.02	28.8	502	-5.7	0.30	0.35	36.4	132.0	296								4.39												
M-22	4/7/2020	8.05	28.6	499	-49.6	0.24	0.28	36.2	127.0	302								5.50												
M-22	4/7/2020	8.05	28.6	499	-49.6	0.24	0.28												17.00											
M-22	4/7/2020	8.05	28.6	499	-49.6	0.24	0.28													6.4										
M-22	5/19/2020	7.87	28.7	586	-127.0	0.11	0.26	53.5	136.0	328								5.01												
M-22	6/19/2020	7.80	28.7	640	-31.3	0.45	0.74	66.9	153.0	383		0.029 U						6.43												
M-22	7/22/2020	7.74	28.6	656	6.1	0.37	0.58	70.5	158.0	390		0.029 U						8.18		3.4										
M-22	8/25/2020	7.82	28.7	638	-55.1	0.22	0.37	66.3	152.0	368								6.08												
M-22	9/15/2020	7.91	28.9	556	-84.0	0.73	0.44	44.1	140.0	336								5.26												
M-22	10/14/2020	7.98	29.3	538	-50.9	0.77	0.40	40.2	135.0	322								3.92		4.1										
M-22	11/17/2020	7.94	28.4	527	1.4	0.47	0.35	37.1	131.0	314								4.35												
M-22	12/9/2020	8.01	25.9	514	57.9	2.52	0.50	36.2	127.0	348								3.79												
M-6	1/7/2020	7.26	28.2	1493	-229.6	0.25	0.43	252.0	243.0	918								0.50 U												
M-6	4/28/2020	7.32	28.2	1476	-267.9	0.12	0.23	250.0	241.0	940								0.50 U												
M-6	7/21/2020	7.24	29.1	1504	-218.8	0.93	0.42	257.0	250.0	960								0.50 U												
M-6	10/27/2020	7.31	28.6	1488	-271.1	0.32	0.44	267.0	263.0	942								0.50 U												
M-7	1/21/2020	7.85	26.2	722	-90.6	0.48	0.34	61.4	174.0	438								0.50 U												
M-7	1/21/2020	7.85	26.2	722	-90.6	0.48	0.34													2.1										
M-7	2/17/2020	7.78	24.6	715	-123.4	0.18	1.39	65.1	182.0	444								0.53 I												
M-7	3/23/2020	7.79	27.2	704	-83.3	0.18	0.20	66.3	184.0	430								0.75 I												
M-7	4/7/2020	7.76	27.0	704	-66.6	0.31	1.43	64.9	179.0	438								0.50 U												
M-7	4/7/2020	7.76	27.0	704	-66.6	0.31	1.43												0.50 U											
M-7	4/7/2020	7.76	27.0	704	-66.6	0.31	1.43													2.2										
M-7	5/19/2020	7.63	27.1	710	-150.0	0.28	0.36	61.8	177.0	430								0.50 U												
M-7	6/19/2020	7.74	27.1	709	-107.1	0.60	0.49	65.3	182.0	448		0.029 U						0.50 U												
M-7	7/22/2020	7.63	26.9	723	-103.1	0.40	0.96	68.7	190.0	450		0.071 I						0.50 U		1.9										
M-7	8/25/2020	7.61	27.2	721	-164.4	0.33	0.36	68.3	188.0	446								0.50 U												
M-7	9/15/2020	7.67	27.2	707	-175.2	0.28	0.24	63.3	178.0	438								0.50 U												
M-7	10/14/2020	7.79	27.2	703	-159.6	0.26	0.29	61.3	177.0	434								0.50 U		1.2 U										
M-7	11/17/2020	7.67	27.1	694	-160.1	0.39	0.18	56.7	173.0	424								0.50 U												
M-7	12/9/2020	7.84	26.7	652	-97.5	0.50	0.22	51.7	170.0	416								0.50 U												
M-8	1/21/2020	7.47	27.3	899	-146.1	0.42	0.44	92.3	173.0	552								0.50 U												
M-8	1/21/2020	7.47	27.3	899	-146.1	0.42	0.44													2.3										
M-8	2/17/2020	7.45	27.2	890	-151.4	0.38	0.28	94.5	183.0	560								0.52 I												
M-8	3/23/2020	7.43	27.8	906	-55.5	0.37	0.23	102.0	194.0	566								0.50 U												
M-8	4/7/2020	7.36	27.9	854	-168.6	0.29	0.38	88.6	175.0	554								0.50 U												
M-8	4/7/2020	7.36	27.9	854	-168.6	0.29	0.38												0.50 U											
M-8	4/7/2020	7.36	27.9	854	-168.6	0.29	0.38													2.5										

Station_ID	Sample Date	pH Std Units	Temp °C	Specific Conductance umhos/cm	Oxidation Reduction Potential mV	Dissolved Oxygen mg/l	Turbidity NTU	Chloride mg/l	Sulfate mg/l	Total Dissolved Solids mg/l	Total Alkalinity mg/l Ca CO3	Total Iron ug/l	Dissolved Iron ug/l	Manganese mg/l	Nitrate mg/l	Sulfide mg/l	Total Organic Carbon mg/l	Arsenic ug/L	TTHMs ug/L	Gross Alpha pCi/L	Total Uranium ug/l	Calcium mg/L	Fluoride mg/L	Magnesium mg/L	Sodium mg/L	Total Suspended Solids mg/L	Bicarbonate Alkalinity mg/L	Carbonate Alkalinity mg/L	HAAs mg/L	RA 226 + 228 pCi/L
M-8	5/19/2020	7.44	28.2	860	-201.4	0.51	0.47	86.8	171.0	532								0.50 U												
M-8	6/19/2020	7.49	28.0	844	-250.6	0.20	0.36	85.0	168.0	542		0.029 U						0.50 U												
M-8	7/22/2020	7.50	27.9	865	-227.5	0.52	0.71	91.9	181.0	588		0.029 U						0.50 U		2.2										
M-8	8/25/2020	7.41	28.1	865	-220.7	0.46	0.23	90.5	180.0	580								0.50 U												
M-8	9/15/2020	7.50	28.4	872	-216.4	1.22	0.25	90.2	181.0	608								0.50 U												
M-8	10/14/2020	7.52	27.8	888	-242.8	0.34	0.16	90.2	181.0	590								0.50 U		2.1										
M-8	11/17/2020	7.47	27.6	895	-247.8	0.27	0.24	88.1	182.0	566								0.50 U												
M-8	12/9/2020	7.48	27.6	882	-225.8	0.56	1.07	89.2	183.0	572								0.50 U												
S-1	4/1/2020	7.93	25.9	479	-155.3	0.46	0.87	36.4	123.0	268								0.61 I												
S-1	4/6/2020	7.97	27.3	493	-174.9	0.21	0.42	35.3	122.0	270								0.51 I												
S-1	4/6/2020	7.97	27.3	493	-174.9	0.21	0.42												26.90											
S-1	4/6/2020	7.97	27.3	493	-174.9	0.21	0.42													1.9 U										
S-1	4/13/2020	7.96	27.6	497	-154.3	0.26	1.84	35.3	122.0	280								0.50 U												
S-1	4/20/2020	7.89	28.0	500	-109.3	0.41	0.94	38.6	126.0	282								0.50 U												
S-1	4/27/2020	8.11	28.5	512	62.8	0.52	0.97	36.2	125.0	302								0.50 U												
S-1	5/4/2020	8.02	28.6	520	-132.8	0.14	0.93	38.4	128.0	306								0.50 U												
S-1	5/11/2020	7.97	28.9	542	-141.9	0.17	0.59	41.9	134.0	300								0.52 I												
S-1	5/18/2020	7.96	28.0	546	-153.0	0.64	0.63	45.1	137.0	320								0.90 I												
S-1	5/26/2020	7.97	29.5	566	-118.3	0.71	0.36	46.7	134.0	326								0.94 I												
S-10	4/1/2020	7.95	27.1	514	-25.7	0.55	0.42	37.0	134.0	310								2.85												
S-10	4/6/2020	7.90	28.2	533	129.2	0.31	0.23	40.2	136.0	304								4.50												
S-10	4/6/2020	7.90	28.2	533	129.2	0.31	0.23												12.00											
S-10	4/6/2020	7.90	28.2	533	129.2	0.31	0.23													2.0										
S-10	4/13/2020	7.86	28.9	541	-12.4	0.25	0.34	40.9	137.0	316								3.90												
S-10	4/21/2020	7.94	29.0	549	33.1	0.18	0.34	42.7	141.0	316								4.41												
S-10	4/27/2020	8.02	29.2	558	38.6	0.04	0.23	42.0	141.0	354								4.47												
S-10	5/4/2020	7.98	29.5	562	-188.2	0.08	0.16	44.7	144.0	346								4.68												
S-10	5/11/2020	7.91	29.5	594	-26.6	0.14	0.14	48.8	150.0	362								6.28												
S-10	5/18/2020	7.73	30.0	634	-82.2	0.22	0.19	58.0	154.0	368								7.41												
S-10	5/26/2020	7.87	30.0	651	-107.8	0.16	0.19	62.0	156.0	386								6.83												
S-11	4/1/2020	7.98	25.6	477	-94.4	0.49	0.83	34.3	120.0	284								1.28 I												
S-11	4/6/2020	7.97	27.3	486	124.8	0.36	0.19	34.3	122.0	272								0.68 I												
S-11	4/6/2020	7.97	27.3	486	124.8	0.36	0.19												26.70											
S-11	4/6/2020	7.97	27.3	486	124.8	0.36	0.19													3.0										
S-11	4/13/2020	7.89	28.4	489	-23.4	0.21	0.27	34.5	124.0	306								0.50 U												
S-11	4/21/2020	8.02	28.7	486	65.0	0.22	0.35	35.3	126.0	290								0.99 I												
S-11	4/27/2020	8.12	28.8	495	166.0	0.54	0.22	32.9	127.0	296								1.10 I												
S-11	5/4/2020	8.04	29.3	493	-109.4	0.20	0.22	33.3	128.0	300								1.55 I												
S-11	5/11/2020	8.00	29.3	509	-11.2	0.17	0.22	35.0	131.0	300								2.42												
S-11	5/18/2020	7.89	29.4	506	-103.0	0.15	0.23	33.4	127.0	286								3.34												
S-11	5/26/2020	7.99	29.6	511	-74.9	0.22	0.18	35.0	129.0	298								4.18												
S-12	4/1/2020	7.95	27.0	508	-21.4	0.54	0.33	38.0	131.0	304								2.67												
S-12	4/6/2020	7.89	28.2	547	112.2	0.23	0.23	42.0	138.0	316								4.20												
S-12	4/6/2020	7.89	28.2	547	112.2	0.23	0.23												13.50											
S-12	4/6/2020	7.89	28.2	547	112.2	0.23	0.23													1.5										
S-12	4/13/2020	7.86	28.9	559	-58.1	0.25	0.27	43.9	141.0	342								4.86												
S-12	4/21/2020	7.73	29.0	572	-2.2	0.18	0.25	43.5	140.0	362								4.46												
S-12	4/27/2020	8.01	28.9	583	94.2	0.53	0.26	46.3	146.0	346								4.57												
S-12	5/4/2020	7.91	29.5	584	-110.0	0.05	0.32	47.4	148.0	356								4.69												
S-12	5/11/2020	7.87	29.5	610	-75.9	0.10	0.14	51.0	152.0	372								5.23												
S-12	5/18/2020	7.80	29.6	633	-84.2	0.44	0.28	55.6	155.0	376								7.87												
S-12	5/26/2020	7.86	29.9	648	-106.9	0.41	0.28	59.2	159.0	396								7.20												
S-13	4/1/2020	7.88	27.5	542	-59.7	0.78	0.61	39.6	141.0	334								5.30												
S-13	4/6/2020	7.79	28.3	602	57.8	0.28	0.21	49.1	156.0	336								9.38												
S-13	4/6/2020	7.79	28.3	602	57.8	0.28	0.21												3.11											
S-13	4/6/2020	7.79	28.3	602	57.8	0.28	0.21													2.3										
S-13	4/13/2020	7.80	29.0	627	-38.2	0.25	0.34	53.8	160.0	378								8.23												
S-13	4/21/2020	7.66	29.1	654	-41.8	0.21	0.22	56.4	161.0	404								9.27												
S-13	4/27/2020	7.93	28.9	672	38.0	0.50	0.28	60.0	168.0	404								8.12												
S-13	5/4/2020	7.82	29.6	684	-109.9	0.20	0.18	64.9	172.0	424								8.67												
S-13	5/11/2020	7.79	29.6	702	-98.2	0.13	0.20	66.0	174.0	430								10.00												
S-13	5/18/2020	7.75	29.7	731	-135.4	0.26	0.19	73.3	179.0	438								10.20												
S-13	5/26/2020	7.80	30.0	746	-146.3	0.26	0.21	75.5	181.0	454								10.80												
S-14	4/1/2020	7.91	27.4	524	-18.7	0.41	0.26	39.2	136.0	326								3.60												
S-14	4/6/2020	7.79	28.4	568	-42.3	0.18	0.24	45.4	145.0	310								5.50												
S-14	4/6/2020	7.79	28.4	568	-42.3	0.18	0.24												12.60											
S-14	4/6/2020	7.79	28.4	568	-42.3	0.18	0.24													1.7										
S-14	4/13/2020	7.89	29.1	603	-71.1	0.26	0.22	49.2	152.0	368								6.59												
S-14	4/21/2020	7.74	29.2	601	-97.4	0.23	0.23	47.9	147.0	360								4.98												
S-14	4/27/2020	7.97	29.2	613	106.6	0.70	0.25	50.8	153.0	360								5.31												
S-14	5/4/2020	7.88	29.6	618	-134.3	0.14	0.19	54.0	156.0	374								5.22												
S-14	5/11/2020	7.85	29.6	640	-108.8	0.12	0.18	56.9	160.0	380								6.07												
S-14	5/18/2020	7.81	29.7	667	-143.8	0.12	0.23	62.2	165.0	388								6.75												
S-14	5/26/2020	7.85	30.0	678	-140.7	0.26	0.19	63.4	166.0	408								6.73												
S-15	4/1/2020	7.97	26.4	484	-25.4	0.60	0.53	35.1	120.0	306								0.99 I												
S-15	4/6/2020	7.81	27.7	492	-22.4	0.21	0.21	34.0	124.0	268								1.18 I												
S-15	4/6/2020	7.81	27.7	492	-22.4	0.21	0.21												21.90											
S-15	4/6/2020	7.81	27.7	492	-22.4	0.21	0.21													1.0 U										
S-15	4/13/2020	7.94	28.6	495	-28.5	0.23	0.33	35.5	126.0	292								0.50 U												
S-15	4/21/2020	7.92	28.8	496	-44.4	0.23	0.26	33.2	123.0	292								1.79 I												
S-15	4/27/2020	8.10	28.9	504	143.8	0.63	0.25	33.9	128.0	300								1.64 I												
S-15	5/4/2020	8.03	29.3	504	-55.8	0.20	0.22	35.5	131.0	298								1.60 I												
S-15	5/11/2020	7.98	29.4	520	-93.6	0.15	0.14	37.0	133.0	306								3.05												
S-15	5/18/2020	7.95	29.4	518	-94.1	0.19	0.21	36.5	132.0	302								3.30												
S-15	5/26/2020	8.01	29.6	524	-106.7	0.33	0.26	37.6	132.0	302								2.71												
S-16	4/1/2020	8.00	26.4	487	-47.4	0.59	6.01	34.5	123.0	312								0.96 I												
S-16	4/6/2020	7.98	27.6	502	99.6	0.24	0.19	35.9	126.0	294								1.22 I												
S-16	4/6/2020	7.98	27.6	502	99.6	0.24	0.19												25.00											

Station_ID	Sample Date	pH Std Units	Temp °C	Specific Conductance umhos/cm	Oxidation Reduction Potential mV	Dissolved Oxygen mg/l	Turbidity NTU	Chloride mg/l	Sulfate mg/l	Total Dissolved Solids mg/l	Total Alkalinity mg/l Ca CO3	Total Iron ug/l	Dissolved Iron ug/l	Manganese mg/l	Nitrate mg/l	Sulfide mg/l	Total Organic Carbon mg/l	Arsenic ug/L	TTHMs ug/L	Gross Alpha pCi/L	Total Uranium ug/l	Calcium mg/L	Fluoride mg/L	Magnesium mg/L	Sodium mg/L	Total Suspended Solids mg/L	Bicarbonate Alkalinity mg/L	Carbonate Alkalinity mg/L	HAAs mg/L	RA 226 + 228 pCi/L
S-16	4/6/2020	7.98	27.6	502	99.6	0.24	0.19													1.4 U										
S-16	4/13/2020	8.02	28.4	506	-29.7	0.20	0.30	37.1	128.0	300								0.99 I												
S-16	4/21/2020	7.96	28.7	507	75.6	0.20	0.34	34.2	126.0	308								1.84 I												
S-16	4/27/2020	8.09	28.7	516	152.3	0.52	0.26	35.8	133.0	310								1.42 I												
S-16	5/4/2020	8.00	29.3	518	-95.9	0.08	0.22	36.4	131.0	320								1.88 I												
S-16	5/11/2020	7.95	29.3	540	-24.3	0.11	0.15	39.9	138.0	324								2.33												
S-16	5/18/2020	7.85	29.5	555	-115.7	0.16	0.15	43.8	141.0	330								3.07												
S-16	5/26/2020	7.94	29.6	564	-73.9	0.18	0.30	44.3	141.0	362								3.08												
S-17	4/1/2020	7.94	27.3	507	-133.8	0.41	4.43	38.0	127.0	318								1.54 I												
S-17	4/6/2020	7.99	28.6	529	92.4	0.21	0.29	40.6	135.0	308								1.87 I												
S-17	4/6/2020	7.99	28.6	529	92.4	0.21	0.29												13.60											
S-17	4/6/2020	7.99	28.6	529	92.4	0.21	0.29													1.2 U										
S-17	4/13/2020	7.80	29.3	542	-59.8	0.20	0.26	41.4	139.0	332								1.93 I												
S-17	4/21/2020	7.90	29.5	554	64.2	0.27	0.28	40.3	133.0	350								3.26												
S-17	4/27/2020	8.04	29.2	568	172.0	0.53	0.23	44.6	145.0	346								3.56												
S-17	5/4/2020	7.94	29.9	575	-104.9	0.11	0.22	45.7	148.0	358								4.18												
S-17	5/11/2020	7.90	29.8	600	-75.3	0.16	0.16	49.8	153.0	364								5.82												
S-17	5/18/2020	7.78	29.9	636	-126.1	0.39	0.17	56.0	154.0	376								6.72												
S-17	5/26/2020	7.87	30.0	664	-108.7	0.20	0.23	63.9	160.0	396								5.60												
S-18	4/1/2020	7.92	27.3	518	-55.6	0.48	0.60	37.9	133.0	314								2.15												
S-18	4/6/2020	7.90	28.4	529	80.0	0.20	0.26	38.0	136.0	312								3.41												
S-18	4/6/2020	7.90	28.4	529	80.0	0.20	0.26												9.24											
S-18	4/6/2020	7.90	28.4	529	80.0	0.20	0.26													2.7										
S-18	4/13/2020	7.80	28.8	538	-77.1	0.22	0.24	40.5	139.0	326								2.85												
S-18	4/21/2020	7.71	29.1	550	-52.6	0.16	0.22	40.2	136.0	344								4.60												
S-18	4/27/2020	8.04	29.0	560	85.6	0.43	0.38	41.9	143.0	334								2.91												
S-18	5/4/2020	7.93	29.6	586	-107.6	0.20	0.21	45.4	146.0	364								4.59												
S-18	5/11/2020	7.92	28.4	636	-105.5	0.05	0.31	56.6	158.0	384								5.27												
S-18	5/18/2020	7.87	29.4	608	-137.0	0.18	0.21	50.0	148.0	358								5.50												
S-18	5/26/2020	7.91	29.7	618	-116.9	0.41	0.19	53.4	153.0	372								5.90												
S-19	4/1/2020	7.83	27.6	568	-118.8	0.52	0.98	43.2	152.0	362								4.97												
S-19	4/6/2020	7.75	28.4	607	-133.8	0.19	0.32	50.3	156.0	350								7.71												
S-19	4/6/2020	7.75	28.4	607	-133.8	0.19	0.32												0.50 U											
S-19	4/6/2020	7.75	28.4	607	-133.8	0.19	0.32													2.9										
S-19	4/13/2020	7.58	28.9	635	-144.1	0.23	0.41	56.3	162.0	394								7.49												
S-19	4/21/2020	7.68	29.2	662	-126.1	0.21	0.28	57.8	161.0	408								8.12												
S-19	4/27/2020	7.92	29.4	682	-36.3	0.55	0.54	62.7	170.0	416								5.87												
S-19	5/4/2020	7.83	29.6	694	-153.2	0.27	0.29	66.6	172.0	420								8.24												
S-19	5/11/2020	7.79	29.7	724	-136.8	0.18	0.31	71.5	177.0	448								8.31												
S-19	5/18/2020	7.75	29.6	731	-159.1	0.16	0.19	74.8	177.0	436								9.55												
S-19	5/26/2020	7.81	30.0	743	-156.4	0.27	0.19	77.1	179.0	450								7.38												
S-2	4/1/2020	7.86	27.4	619	-129.3	0.40	11.00	60.5	158.0	360								3.33												
S-2	4/6/2020	7.83	28.3	637	-121.0	0.34	0.38	58.4	153.0	372								6.38												
S-2	4/6/2020	7.83	28.3	637	-121.0	0.34	0.38												8.24											
S-2	4/6/2020	7.83	28.3	637	-121.0	0.34	0.38													2.7										
S-2	4/13/2020	7.82	28.5	646	-136.6	0.32	0.47	61.6	154.0	378								5.60												
S-2	4/20/2020	7.80	28.7	652	-153.5	0.33	0.39	64.9	159.0	390								5.43												
S-2	4/27/2020	7.93	29.0	665	22.6	0.81	0.18	63.4	157.0	412								5.98												
S-2	5/4/2020	7.80	29.4	719	-120.7	0.24	0.30	77.1	165.0	434								5.41												
S-2	5/11/2020	7.73	29.1	785	-151.5	0.27	1.01	91.1	171.0	474								4.14												
S-2	5/18/2020	7.70	28.6	802	-167.0	0.53	1.20	99.2	180.0	478								8.47												
S-20	4/1/2020	7.75	28.1	554	-151.1	0.29	1.01	39.8	144.0	350								5.92												
S-20	4/6/2020	7.73	28.4	576	-147.7	0.20	0.26	45.3	146.0	340								8.06												
S-20	4/6/2020	7.73	28.4	576	-147.7	0.20	0.26												1.22 I											
S-20	4/6/2020	7.73	28.4	576	-147.7	0.20	0.26													2.6										
S-20	4/13/2020	7.82	28.9	602	-164.0	0.24	0.35	49.8	151.0	361								6.71												
S-20	4/21/2020	7.73	29.1	631	-147.3	0.19	0.28	52.1	150.0	397								7.96												
S-20	4/27/2020	7.93	29.3	648	-23.9	0.55	0.23	56.7	160.0	395								7.43												
S-20	5/4/2020	7.85	29.5	665	-154.0	0.08	0.21	61.1	164.0	399								7.72												
S-20	5/11/2020	7.80	29.5	692	-152.9	0.18	0.21	65.1	168.0	418								8.30												
S-20	5/18/2020	7.79	29.5	701	-165.5	0.22	0.17	67.8	168.0	420								8.99												
S-20	5/26/2020	7.80	29.5	699	-158.1	0.20	0.21	71.5	172.0	426								7.93												
S-3	4/1/2020	7.80	26.3	554	-148.8	0.21	2.03	50.8	143.0	316								1.21 I												
S-3	4/6/2020	7.78	27.8	621	-110.2	0.20	0.52	58.9	148.0	352								3.67												
S-3	4/6/2020	7.78	27.8	621	-110.2	0.20	0.52												15.70											
S-3	4/6/2020	7.78	27.8	621	-110.2	0.20	0.52													2.2										
S-3	4/13/2020	7.75	28.3	645	-173.8	0.21	0.93	62.9	152.0	378								4.76												
S-3	4/20/2020	7.76	28.6	677	-177.7	0.28	0.45	74.0	160.0	410								8.00												
S-3	4/27/2020	7.88	28.7	704	-77.5	0.42	0.61	74.9	158.0	416								8.84												
S-3	5/4/2020	7.76	28.9	724	-130.7	0.08	0.70	80.9	162.0	442								8.37												
S-3	5/11/2020	7.70	29.1	763	-174.6	0.27	0.48	90.6	171.0	442								8.50												
S-3	5/18/2020	7.67	28.9	772	-189.1	0.23	0.65	95.1	180.0	450								10.00												
S-3	5/26/2020	7.73	29.8	800	-193.8	0.67	0.55	96.7	169.0	478								9.15												
S-4	4/1/2020	7.84	27.3	529	-185.6	0.42	1.31	38.4	136.0	308								4.27												
S-4	4/6/2020	7.80	28.2	543	-143.7	0.25	0.44	40.1	139.0	310								5.95												
S-4	4/6/2020	7.80	28.2	543	-143.7	0.25	0.44												7.65											
S-4	4/6/2020	7.80	28.2	543	-143.7	0.25	0.44													3.3										
S-4	4/13/2020	7.70	28.6	557	-164.6	0.25	0.26	43.9	141.0	326								4.67												
S-4	4/21/2020	7.79	29.0	571	-146.6	0.19	0.27	44.2	141.0	366								5.11												
S-4	4/27/2020	8.01	29.0	586	-11.1	0.47	0.50	46.0	147.0	356								4.83												
S-4	5/4/2020	7.92	29.4	589	-164.3	0.15	0.21	47.3	148.0	358								5.09												
S-4	5/11/2020	7.88	29.4	610	-145.0	0.11	0.21	49.6	151.0	360								5.16												
S-4	5/18/2020	7.84	29.5	635	-162.9	0.21	0.23	55.4	155.0	374								8.00												
S-4	5/26/2020	7.89	29.7	647	-168.3	0.22	0.18	57.7	156.0	392								7.25												
S-5	4/1/2020	7.86	26.0	495	-150.9	0.28	1.58	39.9	132.0	288								0.50 U												
S-5	4/6/2020	7.88	27.2	490	-144.4	0.18	0.25	33.8	122.0	284								0.50 U												
S-5	4/6/2020	7.88	27.2	490	-144.4	0.18	0.25												26.00											
S-5	4/6/2020	7.88	27.2	490	-144.4	0.18	0.25													4.8										

Station_ID	Sample Date	pH Std Units	Temp °C	Specific Conductance umhos/cm	Oxidation Reduction Potential mV	Dissolved Oxygen mg/l	Turbidity NTU	Chloride mg/l	Sulfate mg/l	Total Dissolved Solids mg/l	Total Alkalinity mg/l Ca CO3	Total Iron ug/l	Dissolved Iron ug/l	Manganese mg/l	Nitrate mg/l	Sulfide mg/l	Total Organic Carbon mg/l	Arsenic ug/L	TTHMs ug/L	Gross Alpha pCi/L	Total Uranium ug/l	Calcium mg/L	Fluoride mg/L	Magnesium mg/L	Sodium mg/L	Total Suspended Solids mg/L	Bicarbonate Alkalinity mg/L	Carbonate Alkalinity mg/L	HAAs mg/L	RA 226 + 228 pCi/L
S-5	4/13/2020	8.05	27.8	493	-185.9	0.31	0.32	35.3	123.0	296								0.50 U												
S-5	4/20/2020	7.96	28.2	496	-236.4	0.21	0.33	36.5	127.0	298								0.50 U												
S-5	4/27/2020	8.15	28.5	503	11.2	0.61	0.21	34.4	126.0	290								0.56 I												
S-5	5/4/2020	8.08	28.7	505	-133.9	0.13	0.18	34.5	128.0	298								0.50 U												
S-5	5/11/2020	8.05	28.8	522	-240.4	0.06	0.28	37.3	135.0	288								0.82 I												
S-5	5/18/2020	8.00	28.6	526	-242.8	0.27	0.40	37.8	132.0	314								1.19 I												
S-5	5/26/2020	8.06	29.5	538	-211.0	0.71	0.28	38.8	133.0	302								1.71 I												
S-6	4/1/2020	7.90	26.2	493	-62.0	0.47	0.41	40.4	132.0	280								0.50 U												
S-6	4/6/2020	7.97	27.3	488	-75.3	0.33	0.22	33.2	121.0	270								0.50 U												
S-6	4/6/2020	7.97	27.3	488	-75.3	0.33	0.22												32.10											
S-6	4/6/2020	7.97	27.3	488	-75.3	0.33	0.22													1.1										
S-6	4/13/2020	7.94	27.5	491	-154.8	0.27	0.33	34.7	123.0	286								0.50 U												
S-6	4/20/2020	7.78	28.1	494	-82.6	0.30	0.29	36.3	128.0	292								0.50 U												
S-6	4/27/2020	8.11	28.3	506	82.5	0.44	0.17	34.3	127.0	286								0.53 I												
S-6	5/4/2020	8.03	28.6	511	-66.1	0.10	0.17	34.9	130.0	286								0.50 U												
S-6	5/11/2020	7.99	28.6	533	-89.4	0.12	0.17	38.1	140.0	304								0.50 U												
S-6	5/18/2020	7.95	28.5	534	-148.7	0.34	0.23	37.1	135.0	308								0.54 I												
S-6	5/26/2020	7.98	29.1	542	-138.5	0.76	0.27	37.9	136.0	316								0.77 I												
S-7	4/1/2020	7.97	26.8	512	-85.9	0.45	0.54	41.0	138.0	288								0.79 I												
S-7	4/6/2020	7.83	27.7	547	-78.6	0.38	0.23	45.1	131.0	320								3.44												
S-7	4/6/2020	7.83	27.7	547	-78.6	0.38	0.23												26.30											
S-7	4/6/2020	7.83	27.7	547	-78.6	0.38	0.23													2.4										
S-7	4/13/2020	7.85	27.8	563	-218.6	0.21	0.44	48.4	135.0	326								2.49												
S-7	4/20/2020	7.85	28.3	574	-165.8	0.30	0.31	53.0	137.0	332								3.28												
S-7	4/27/2020	8.01	28.6	585	-30.8	0.47	0.24	51.6	136.0	344								3.49												
S-7	5/4/2020	7.95	28.7	592	-210.2	0.17	0.26	54.2	137.0	346								3.47												
S-7	5/11/2020	7.88	28.8	614	-130.2	0.12	0.17	58.4	146.0	358								3.36												
S-7	5/18/2020	7.85	28.8	642	-204.5	0.29	0.22	63.1	144.0	366								4.72												
S-7	5/26/2020	7.89	29.2	653	-178.1	0.34	0.30	66.8	146.0	380								3.97												
S-8	4/1/2020	7.84	29.0	514	-49.4	0.41	0.20	42.9	142.0	300								0.70 I												
S-8	4/6/2020	7.82	28.9	520	-67.5	0.27	0.25	38.8	129.0	298								0.73 I												
S-8	4/6/2020	7.82	28.9	520	-67.5	0.27	0.25												20.30											
S-8	4/6/2020	7.82	28.9	520	-67.5	0.27	0.25													6.2										
S-8	4/13/2020	7.83	28.8	520	-112.0	0.32	0.24	38.8	130.0	308								0.50 U												
S-8	4/20/2020	7.70	28.8	514	-72.4	0.25	0.29	40.2	130.0	292								0.51 I												
S-8	4/27/2020	7.92	28.8	519	96.1	0.45	0.18	36.7	128.0	304								3.25												
S-8	5/4/2020	7.85	28.9	512	-30.1	0.09	0.16	36.2	128.0	302								0.50 U												
S-8	5/11/2020	7.90	28.7	528	-58.7	0.11	0.22	38.2	134.0	310								0.78 I												
S-8	5/18/2020	7.88	28.7	569	-154.4	0.32	0.22	46.1	137.0	340								1.26 I												
S-8	5/26/2020	7.88	29.8	628	-134.5	0.92	0.28	58.6	145.0	370								1.54 I												
T-1	4/1/2020	8.00	25.4	502	-122.0	0.31	0.88	39.0	136.0	292								0.94 I												
T-1	4/6/2020	7.92	26.7	505	-121.3	0.59	0.19	34.6	133.0	288								0.84 I												
T-1	4/6/2020	7.92	26.7	505	-121.3	0.59	0.19												17.30											
T-1	4/6/2020	7.92	26.7	505	-121.3	0.59	0.19													2.2										
T-1	4/13/2020	7.98	27.2	508	-131.1	0.32	0.40	33.8	131.0	305								0.50 U												
T-1	4/20/2020	7.90	27.8	515	-149.6	0.41	0.26	35.9	136.0	309								0.61 I												
T-1	4/27/2020	8.09	28.1	525	97.3	0.63	0.22	34.3	136.0	306								0.76 I												
T-1	5/4/2020	8.00	28.4	527	-94.3	0.27	0.15	34.8	137.0	309								1.02 I												
T-1	5/11/2020	7.96	28.5	547	-126.8	0.28	0.19	37.5	143.0	319								1.23 I												
T-1	5/18/2020	7.93	28.2	548	-137.5	0.89	0.52	37.6	139.0	319								1.80 I												
T-1	5/26/2020	7.98	30.2	556	-88.0	1.23	0.35	38.7	142.0	320								1.76 I												
T-11	1/29/2020	7.65	26.6	924	-235.3	0.30	0.78	136.0	105.0	522								0.50 U												
T-11	1/29/2020	7.65	26.6	924	-235.3	0.30	0.78													2.7										
T-11	2/26/2020	7.68	26.9	905	-201.1	0.39	0.23	136.0	107.0	510								0.50 U												
T-11	3/3/2020	7.49	27.1	915	-148.0	0.47	0.20	139.0	106.0	520								0.50 U												
T-11	4/1/2020	7.60	27.0	884	-223.0	0.38	0.28	138.0	107.0	493								0.50 I												
T-11	4/1/2020	7.59	27.3	901	-227.8	0.38	0.25													3.2										
T-11	4/1/2020	7.59	27.3	901	-227.8	0.38	0.25												0.50 U											
T-11	4/6/2020	7.59	27.3	901	-227.8	0.38	0.25	134.0	104.0	513								0.50 U												
T-11	4/13/2020	7.58	27.6	903	-237.8	0.36	0.36	134.0	102.0	520								0.50 I												
T-11	4/20/2020	7.50	27.0	900	-230.4	0.38	0.34	138.0	100.0	503								0.50 U												
T-11	4/27/2020	7.73	27.2	902	-258.8	0.30	0.34	133.0	99.2	527								0.50 U												
T-11	5/4/2020	7.63	27.4	893	-231.0	0.27	0.17	135.0	103.0	528								0.50 U												
T-11	5/11/2020	7.61	27.6	913	-232.5	0.46	0.18	139.0	102.0	522								0.50 U												
T-11	5/18/2020	7.61	26.9	902	-241.5	0.28	0.28	137.0	100.0	531								0.50 U												
T-11	5/26/2020	7.66	27.1	907	-247.7	0.42	0.29	128.0	95.8	502								0.50 U												
T-11	6/3/2020	7.70	26.6	901	-250.0	0.33	0.31	137.0	101.0	515		0.070 I						0.50 U												
T-11	6/9/2020	7.65	27.3	904	-259.8	0.33	0.34	136.0	100.0	521		0.065 I						0.50 U												
T-11	6/17/2020	7.65	27.1	898	-203.6	0.46	0.33	138.0	101.0	538		0.040 I						0.50 U												
T-11	6/22/2020	7.65	27.4	906	-234.5	0.50	0.44	139.0	102.0	536								0.50 U												
T-11	7/27/2020	7.68	27.8	929	-238.2	0.65	2.21	138.0	102.0	527								0.50 U		2.7										
T-11	8/18/2020	7.69	27.5	908	-237.8	0.44	0.38	139.0	106.0	520								0.50 U												
T-11	8/24/2020	7.58	26.8	915	-239.7	0.42	0.40	139.0	104.0	523								0.50 U												
T-11	9/1/2020	7.58	27.6	912	-227.6	0.51	0.27	136.0	102.0	523								0.50 U												
T-11	9/9/2020	7.59	27.3	907	-235.3	0.46	0.19	133.0	101.0	542								0.50 U												
T-11	9/14/2020	7.53	26.9	899	-233.3	0.44	0.38	137.0	103.0	530								0.50 U												
T-11	9/23/2020	7.63	26.9	901	-220.3	0.70	0.22	137.0	101.0	544								0.50 U												
T-11	9/28/2020	7.53	27.6	904	-63.2	0.52	0.34	131.0	97.2	520								0.50 U												
T-11	10/7/2020	7.81	27.2	859	-207.1	0.83	0.66	133.0	104.0	570								0.50 U												
T-11	10/13/2020	7.71	26.9	906	-233.0	0.72	0.26	133.0	97.4	510								0.50 U		1.7 U										
T-11	10/19/2020	7.68	26.4	889	-238.1	0.67	0.29	132.0	101.0	516								0.50 U												
T-11	10/26/2020	7.66	27.1	900	-243.4	0.48	0.18	131.0	106.0	511								0.50 U												
T-11	11/4/2020	7.75	26.8	892	-271.1	0.53	0.18	134.0	108.0	522								0.50 U												
T-11	11/10/2020	7.67	26.1	901	-246.0	0.62	0.58	136.0	108.0	515								0.50 U												
T-11	11/16/2020	7.44	26.9	909	-233.5	0.52	0.22	133.0	104.0	518								0.50 U												
T-11	11/23/2020	7.52	26.3	899	-247.0	0.46	0.34	134.0	104.0	538								0.50 U												
T-11	12/1/2020	7.64	25.8	819	-227.4	0.53	0.23	130.0	105.0	518								0.50 U												
T-11	12/8/2020	7.66	25.9	879	-241.5	0.50	0.30	134.0	107.0	521								0.50 U												

Station_ID	Sample Date	pH Std Units	Temp °C	Specific Conductance umhos/cm	Oxidation Reduction Potential mV	Dissolved Oxygen mg/l	Turbidity NTU	Chloride mg/l	Sulfate mg/l	Total Dissolved Solids mg/l	Total Alkalinity mg/l Ca CO3	Total Iron ug/l	Dissolved Iron ug/l	Manganese mg/l	Nitrate mg/l	Sulfide mg/l	Total Organic Carbon mg/l	Arsenic ug/L	TTHMs ug/L	Gross Alpha pCi/L	Total Uranium ug/l	Calcium mg/L	Fluoride mg/L	Magnesium mg/L	Sodium mg/L	Total Suspended Solids mg/L	Bicarbonate Alkalinity mg/L	Carbonate Alkalinity mg/L	HAAs mg/L	RA 226 + 228 pCi/L
T-11	12/14/2020	7.74	26.6	891	-250.7	0.46	0.26	133.0	104.0	507								0.50 U												
T-11	12/21/2020	7.73	26.3	895	-246.3	0.49	0.41	130.0	104.0	522								0.50 U												
T-11	12/28/2020	7.63	26.4	905	-229.9	0.59	0.28	131.0	103.0	516								0.50 U												
T-2	1/29/2020	7.53	25.6	1094	-104.0	0.38	0.29	125.0	222.0	678								0.50 U												
T-2	1/29/2020	7.53	25.6	1094	-104.0	0.38	0.29													13.5										
T-2	2/26/2020	7.46	25.9	1071	-154.7	0.29	0.18	130.0	227.0	674								0.50 U												
T-2	3/3/2020	7.37	26.0	1076	-146.4	0.33	0.14	128.0	229.0	706								0.50 U												
T-2	4/1/2020	7.46	25.9	1050	-144.7	0.23	0.19	131.0	229.0	654								0.50 U												
T-2	4/1/2020	7.57	25.8	1063	-62.8	0.55	0.21													10.9										
T-2	4/1/2020	7.57	25.8	1063	-62.8	0.55	0.21												0.50 U											
T-2	4/6/2020	7.57	25.8	1063	-62.8	0.55	0.21	129.0	224.0	688								0.50 U												
T-2	4/13/2020	7.34	26.6	1077	-199.2	0.22	0.33	127.0	222.0	712								0.50 U												
T-2	4/20/2020	7.35	26.0	1054	-200.3	0.26	0.38	127.0	202.0	612								0.50 U												
T-2	4/27/2020	7.68	28.3	1018	-215.3	0.77	0.20	116.0	191.0	646								0.50 U												
T-2	5/4/2020	7.49	26.7	1019	-194.4	0.36	0.62	126.0	205.0	676								0.50 U												
T-2	5/11/2020	7.52	26.2	1030	-222.1	0.19	0.14	116.0	180.0	648								0.50 U												
T-2	5/18/2020	7.45	26.6	1054	-201.9	0.48	0.28	125.0	216.0	662								0.50 U												
T-2	5/26/2020	7.49	26.8	1063	-241.4	0.22	0.22	122.0	210.0	650								0.50 U												
T-2	6/3/2020	7.46	26.4	1064	-239.5	0.15	0.38	128.0	226.0	708		0.029 U						0.50 U												
T-2	6/9/2020	7.47	26.5	1072	-269.8	0.23	0.42	128.0	226.0	680		0.029 U						0.50 U												
T-2	6/17/2020	7.51	26.7	1066	-247.5	0.21	0.22	127.0	225.0	710		0.029 U						0.50 U												
T-2	6/22/2020	7.51	26.8	1070	-255.4	0.24	0.41	130.0	229.0	734								0.50 U												
T-2	7/27/2020	7.48	26.6	1092	-246.0	0.21	0.43	127.0	226.0	724								0.50 U		10.8										
T-2	8/18/2020	7.50	26.4	1076	-251.5	0.25	0.31	129.0	231.0	738								0.50 U												
T-2	8/24/2020	7.36	26.6	1089	-242.7	0.19	0.34	130.0	229.0	688								0.50 U												
T-2	9/1/2020	7.45	26.7	1083	-234.2	0.22	0.42	129.0	229.0	706								0.50 U												
T-2	9/9/2020	7.40	26.5	1075	-248.0	0.19	0.21	128.0	228.0	732								0.50 U												
T-2	9/14/2020	7.38	26.6	1066	-249.6	0.18	0.64	125.0	225.0	676								0.50 U												
T-2	9/23/2020	7.44	26.6	1064	-245.7	0.20	0.15	123.0	221.0	740								0.50 U												
T-2	9/28/2020	7.41	26.7	1073	-232.1	0.42	0.22	121.0	219.0	718								0.50 U												
T-2	10/7/2020	7.69	27.0	1017	-263.9	0.27	0.54	126.0	228.0	742								0.50 U												
T-2	10/13/2020	7.44	26.6	1071	-249.2	0.27	0.61	124.0	224.0	694								0.50 U		7.2										
T-2	10/19/2020	7.47	26.4	1059	-262.5	0.12	0.47	122.0	224.0	718								0.50 U												
T-2	10/26/2020	7.40	26.5	1071	-235.9	0.24	0.27	123.0	230.0	700								0.50 U												
T-2	11/4/2020	7.54	26.5	1066	-281.9	0.27	0.29	123.0	234.0	732								0.50 U												
T-2	11/10/2020	7.48	26.4	1082	-266.4	0.26	0.21	126.0	239.0	722								0.50 U												
T-2	11/16/2020	7.40	26.6	1083	-233.2	0.23	0.20	121.0	232.0	690								0.50 U												
T-2	11/23/2020	7.32	26.4	1074	-275.3	0.16	1.10	119.0	231.0	694								0.50 U												
T-2	12/1/2020	7.44	26.2	983	-39.8	0.24	0.29	122.0	235.0	684								0.50 U												
T-2	12/8/2020	7.46	26.2	1055	-258.3	0.21	1.78	123.0	239.0	706								0.50 U												
T-2	12/14/2020	7.58	26.3	1067	-242.6	0.26	0.28	120.0	235.0	670								0.50 U												
T-2	12/21/2020	7.48	26.3	1075	-241.5	0.30	0.26	120.0	232.0	726								0.50 U												
T-2	12/28/2020	7.44	26.4	1080	-244.0	0.21	0.24	119.0	232.0	703								0.50 U												
T-7	1/29/2020	7.49	25.2	1189	-213.8	0.43	0.43	196.0	145.0	746								0.50 U												
T-7	1/29/2020	7.49	25.2	1189	-213.8	0.43	0.43													6.8										
T-7	2/26/2020	7.46	25.1	1167	-182.6	0.53	0.16	196.0	146.0	660								0.50 U												
T-7	3/3/2020	7.50	25.0	1168	-184.3	0.37	0.16	208.0	148.0	664								0.50 U												
T-7	4/1/2020	7.46	25.0	1144	-57.8	0.32	0.17	208.0	153.0	672								0.50 U												
T-7	4/1/2020	7.41	25.1	1159	-222.6	0.27	0.54													8.8										
T-7	4/1/2020	7.41	25.1	1159	-222.6	0.27	0.54												0.50 U											
T-7	4/6/2020	7.41	25.1	1159	-222.6	0.27	0.54	204.0	146.0	696								0.50 U												
T-7	4/13/2020	7.37	25.6	1156	-209.8	0.30	0.52	195.0	141.0	668								0.51 I												
T-7	4/20/2020	7.44	25.3	1153	-217.8	0.30	0.32	203.0	147.0	654								0.50 U												
T-7	4/27/2020	7.59	25.2	1151	-272.4	0.14	0.23	187.0	144.0	704								0.50 U												
T-7	5/4/2020	7.50	26.7	1140	-220.5	0.73	0.23	188.0	144.0	672								0.50 U												
T-7	5/11/2020	7.46	26.4	1168	-233.6	0.57	0.66	194.0	147.0	686								0.50 U												
T-7	5/18/2020	7.44	24.9	1150	-231.4	0.16	0.74	185.0	147.0	694								0.50 U												
T-7	5/26/2020	7.50	25.4	1157	-240.9	0.18	0.22	185.0	140.0	644								0.50 U												
T-7	6/3/2020	7.54	25.3	1150	-239.5	0.63	0.27	192.0	146.0	716		0.029 U						0.50 U												
T-7	6/9/2020	7.49	25.5	1154	-272.2	0.24	0.35	190.0	146.0	702		0.029 U						0.50 U												
T-7	6/17/2020	7.53	25.5	1149	-247.2	0.27	0.77	195.0	146.0	734		0.029 U						0.50 U												
T-7	6/22/2020	7.52	25.8	1154	-242.5	0.37	0.32	193.0	146.0	766								0.50 U												
T-7	7/27/2020	7.58	26.4	1166	-244.3	1.12	1.38	195.0	146.0	712								0.50 U		9.6										
T-7	8/18/2020	7.45	26.3	1158	-219.8	0.61	1.34	188.0	145.0	678								0.50 U												
T-7	8/24/2020	7.21	26.8	1178	-204.0	0.61	2.90	193.0	147.0	680								0.50 U												
T-7	9/1/2020	7.54	25.8	1161	-209.2	0.39	0.70	192.0	147.0	674								0.52 I												
T-7	9/9/2020	7.44	25.9	1156	-222.0	0.31	0.40	196.0	145.0	690								0.50 U												
T-7	9/14/2020	7.44	25.6	1149	-254.3	0.29	0.39	187.0	142.0	688								0.50 U												
T-7	9/23/2020	7.47	25.4	1146	-240.1	0.49	0.17	183.0	137.0	704								0.50 U												
T-7	9/28/2020	7.47	26.8	1155	-235.7	0.57	0.19	184.0	140.0	666								0.50 U												
T-7	10/7/2020	7.73	25.8	1095	-295.7	0.27	0.78	186.0	140.0	770								0.50 U												
T-7	10/13/2020	7.48	25.5	1162	-257.7	0.36	1.84	192.0	144.0	682								0.50 U		6.7										
T-7	10/19/2020	7.51	25.2	1135	-257.4	0.34	0.96	182.0	137.0	670								0.50 U												
T-7	10/26/2020	7.48	25.5	1150	-249.6	0.42	0.27	195.0	150.0	678								0.50 U												
T-7	11/4/2020	7.59	25.3	1146	-285.1	0.32	0.63	194.0	149.0	756								0.50 U												
T-7	11/10/2020	7.54	25.3	1154	-245.0	0.46	0.19	189.0	148.0	658								0.60 I												
T-7	11/16/2020	7.42	25.4	1161	-253.9	0.45	0.23	190.0	144.0	683								0.50 U												
T-7	11/23/2020	7.36	25.7	1151	-275.6	0.20	0.72	177.0	139.0	726								0.50 U												
T-7	12/1/2020	7.48	24.4	1048	-234.1	0.79	0.57	191.0	146.0	716								0.50 U												
T-7	12/8/2020	7.47	24.3	1130	-233.7	0.51	0.27	188.0	145.0	686								0.50 U												
T-7	12/14/2020	7.59	25.1	1139	-251.6	0.35	0.23	184.0	144.0	668								0.50 U												
T-7	12/21/2020	7.52	24.9	1149	-253.6	0.41	0.48	192.0	144.0	754								0.50 U												
T-7	12/28/2020	7.46	24.7	1158	-246.5	0.43	0.62	189.0	145.0	714								0.50 U												
T-8	1/7/2020	7.81	26.2	623	-211.8	0.36	0.88	94.1	25.2	337								0.50 U												
T-8	4/28/2020	7.88	26.6	621	-255.6	0.25	0.45	92.2	24.1	342								0.50 U												
T-8	7/21/2020	7.78	26.8	630	-235.0	0.41	2.37	97.9	26.7	328								0.50 U												
T-8	10/27/2020	7.89	26.2	608	-249.0	0.54	1.47	92.1	24.6	318								0.50 U												

Appendix D
Water Quality Charts for Non-compliance Monitoring Wells

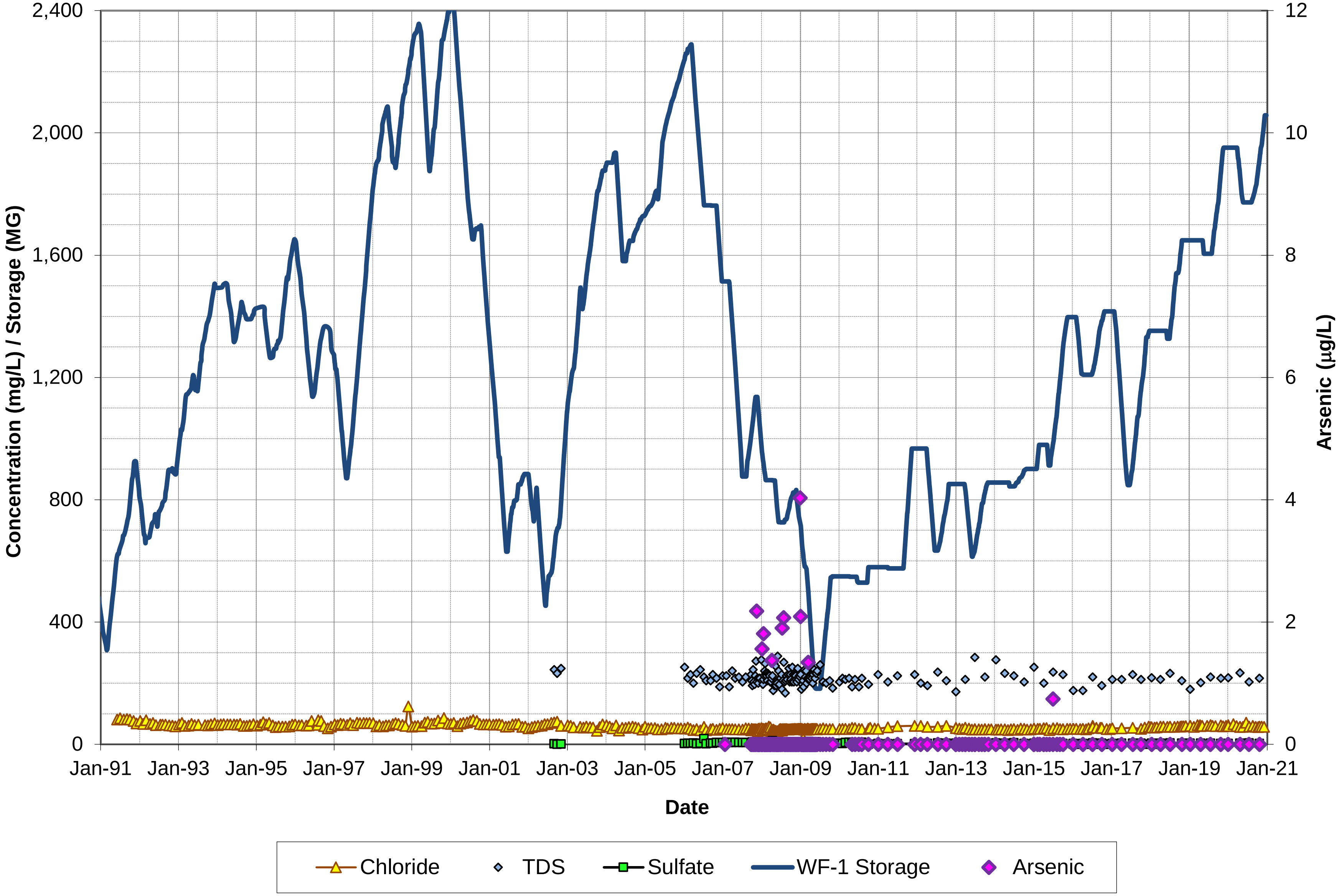


Figure D-1

Monitoring Well "E" Water Quality

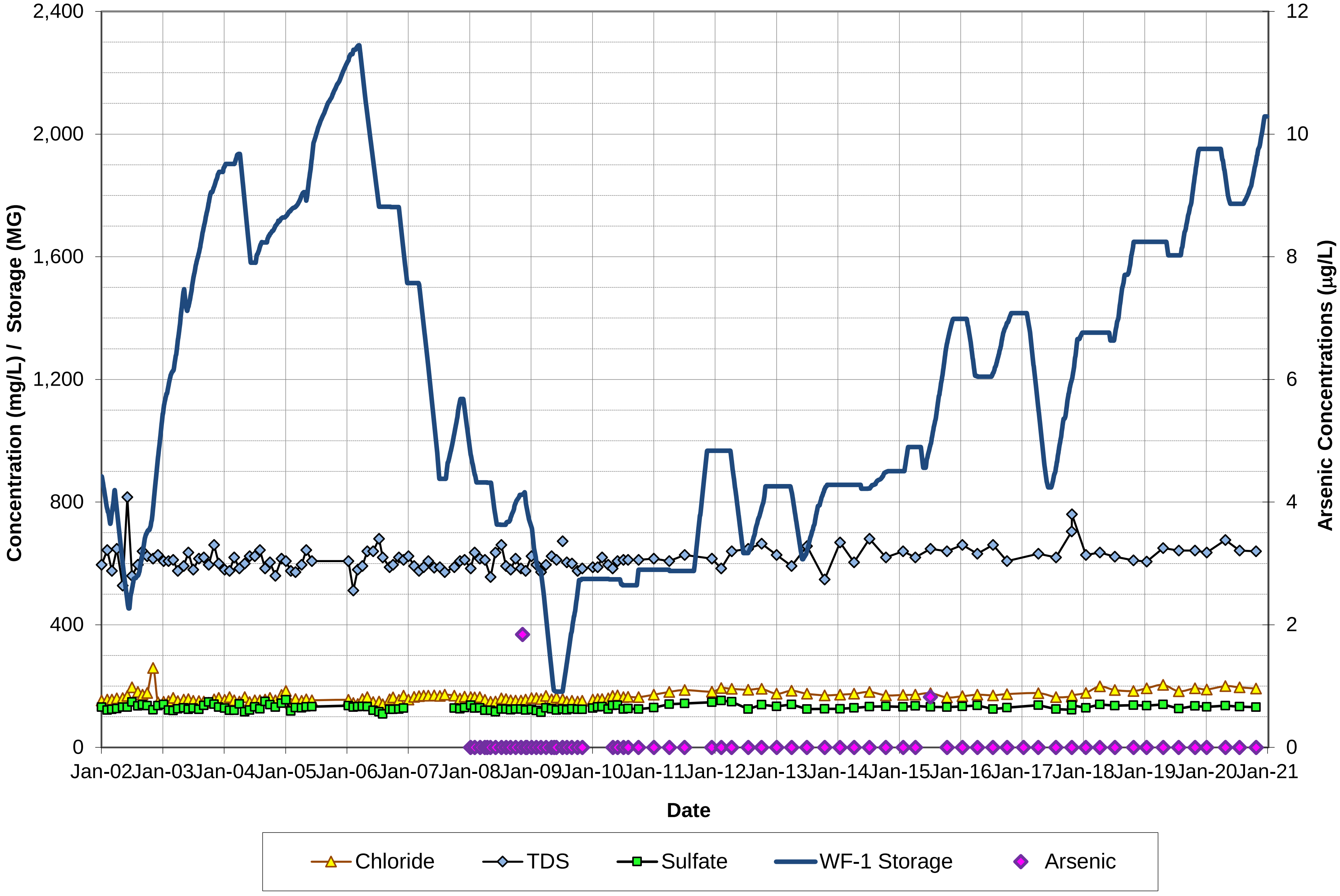


Figure D-2
Monitoring Well I-7 Water Quality

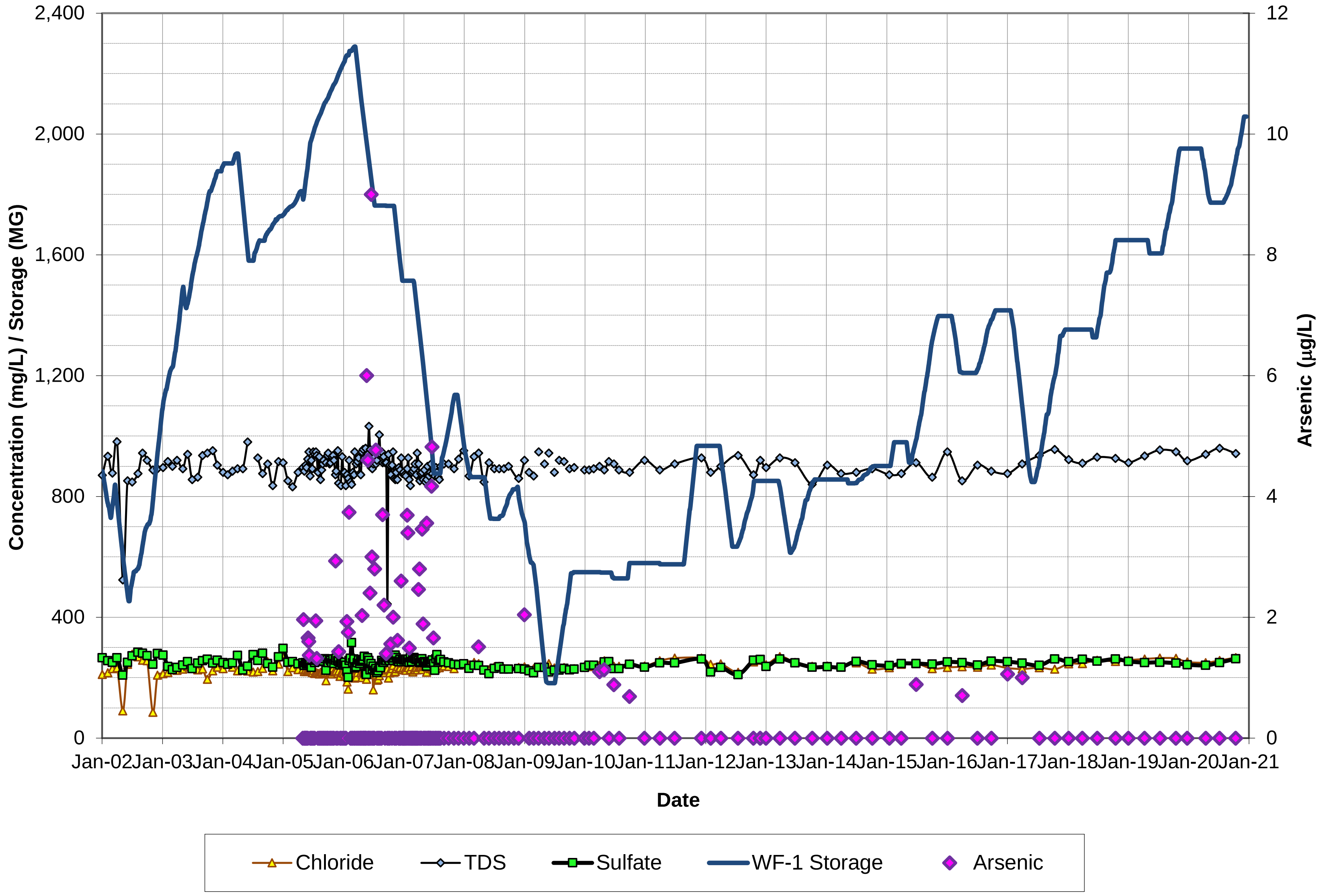


Figure D-3

Monitoring Well M-6 Water Quality

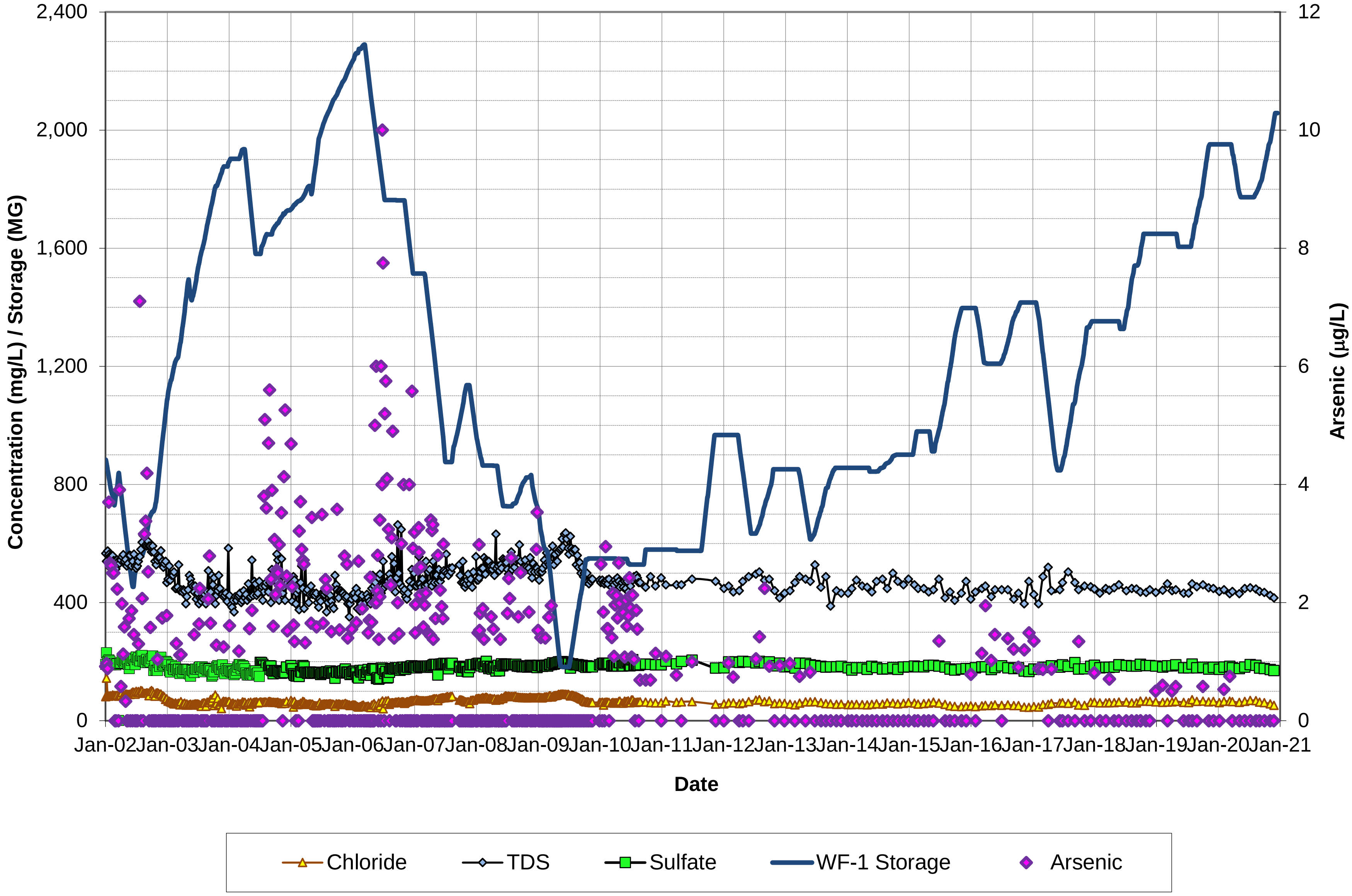


Figure D-4
Monitoring Well M-7 Water Quality

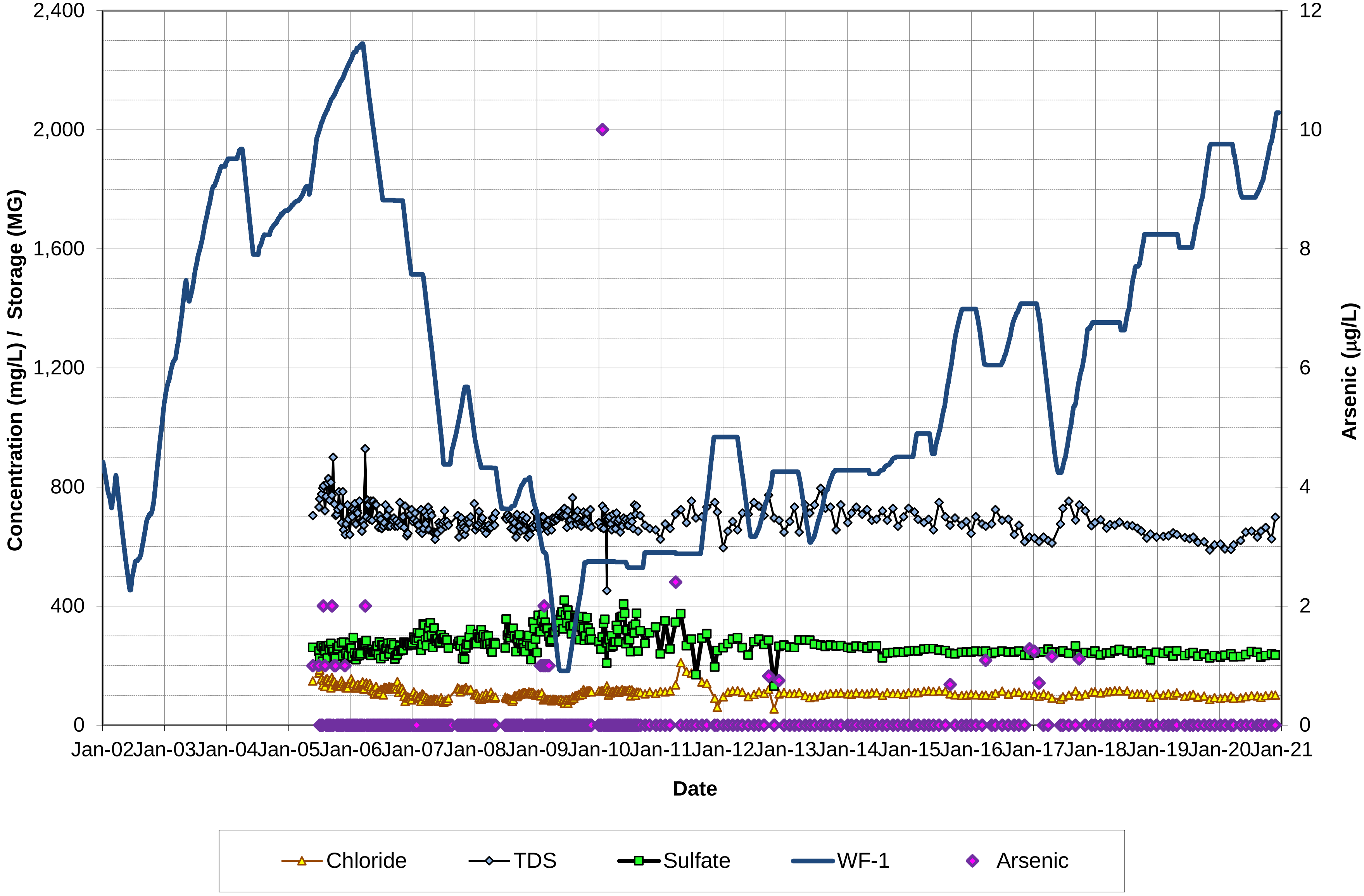


Figure D-5
Monitoring Well M-20 Water Quality

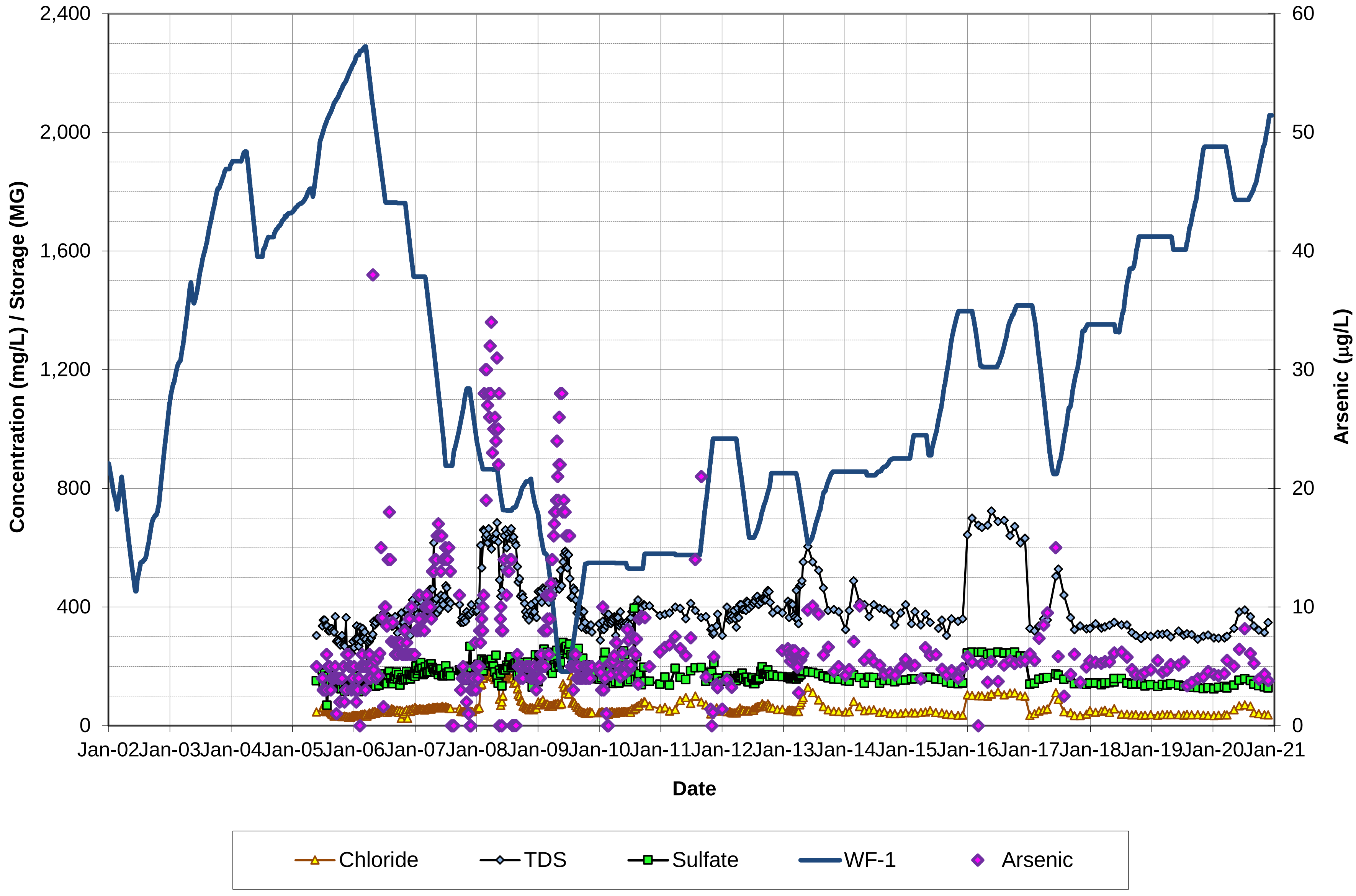


Figure D-6

Monitoring Well M-22 Water Quality

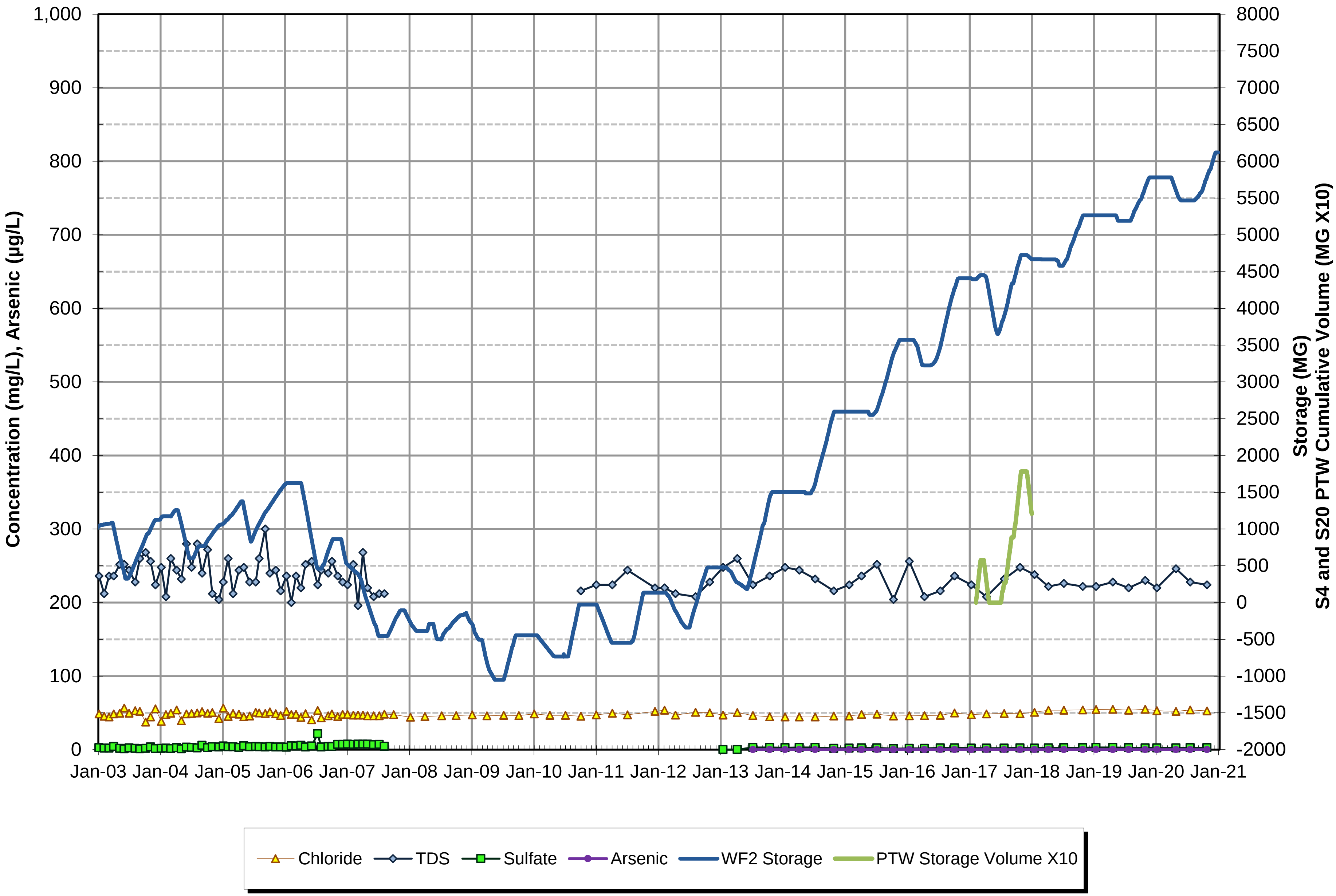


Figure D-7

Monitoring Well I-8 Water Quality

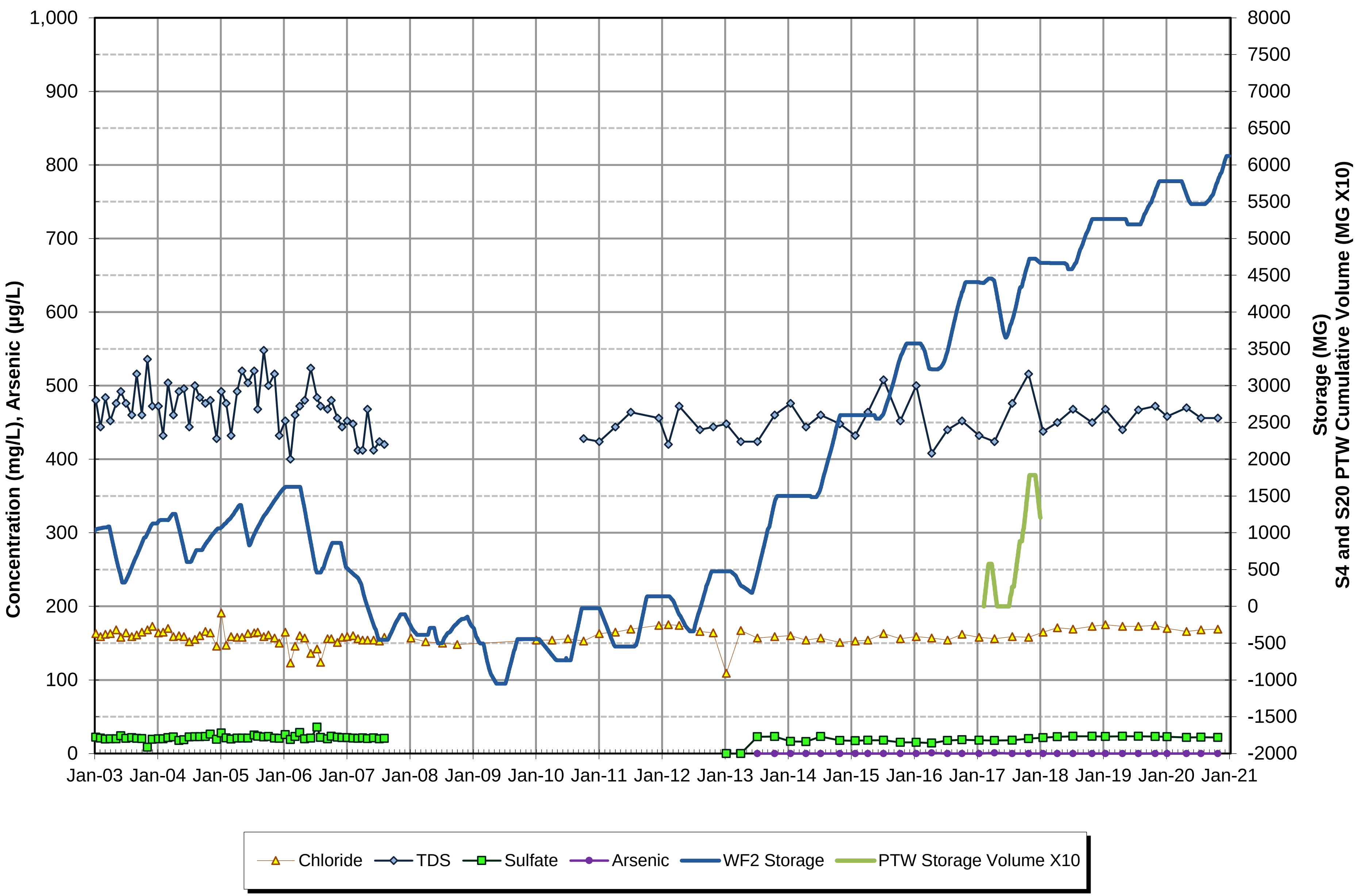


Figure D-8

Monitoring Well I-10 Water Quality

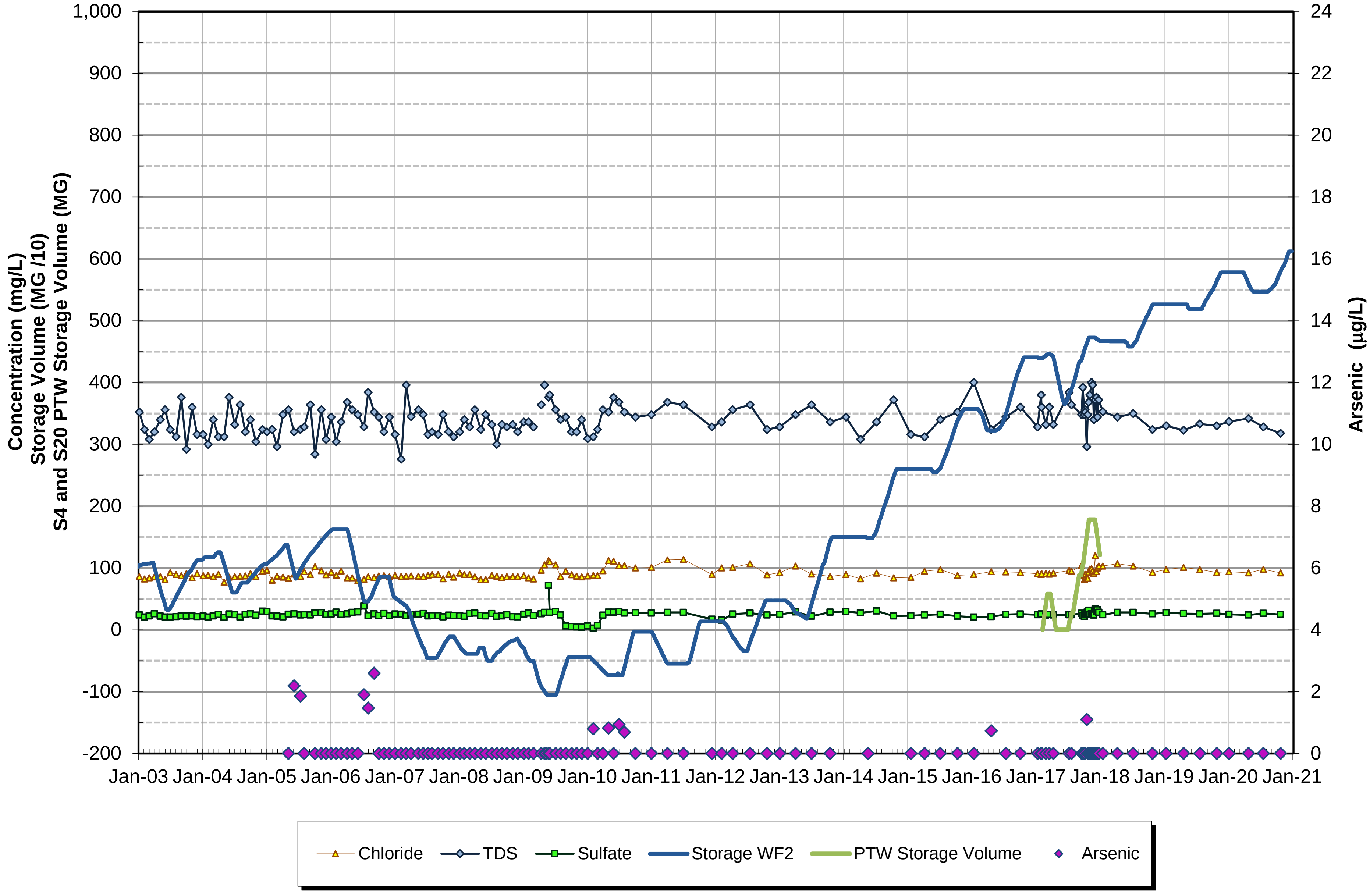


Figure D-9

Monitoring Well T-8 Water Quality

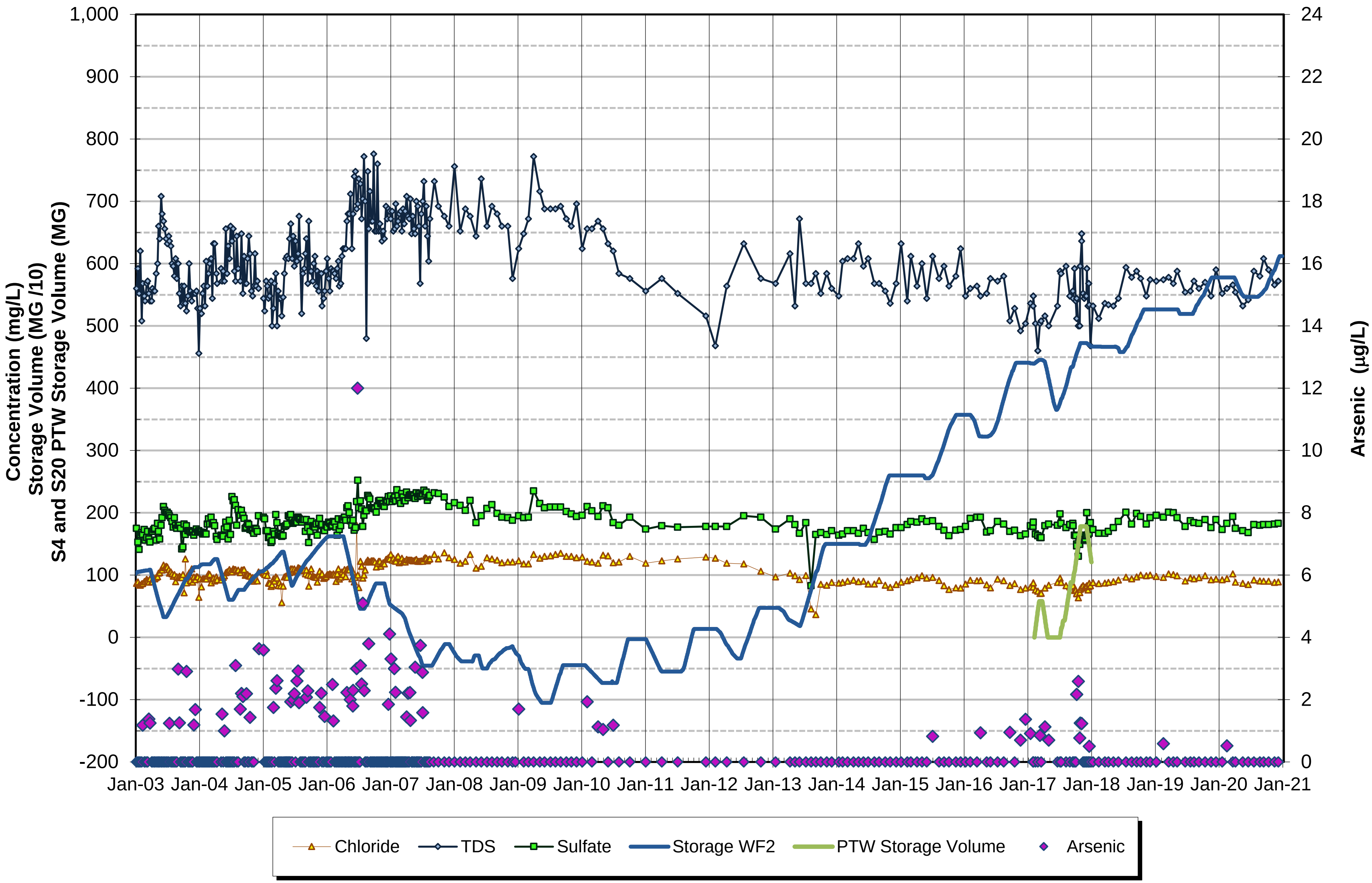
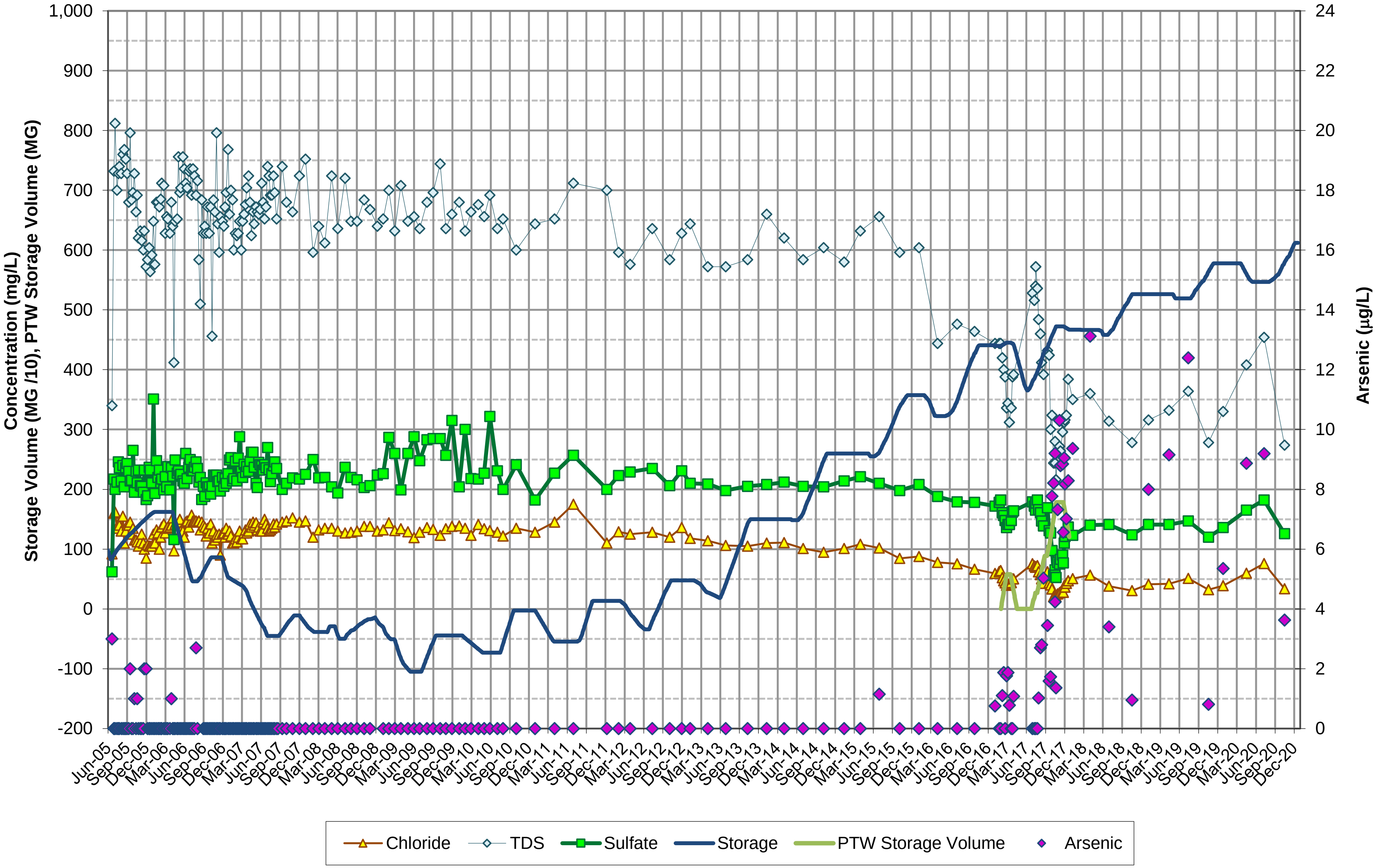


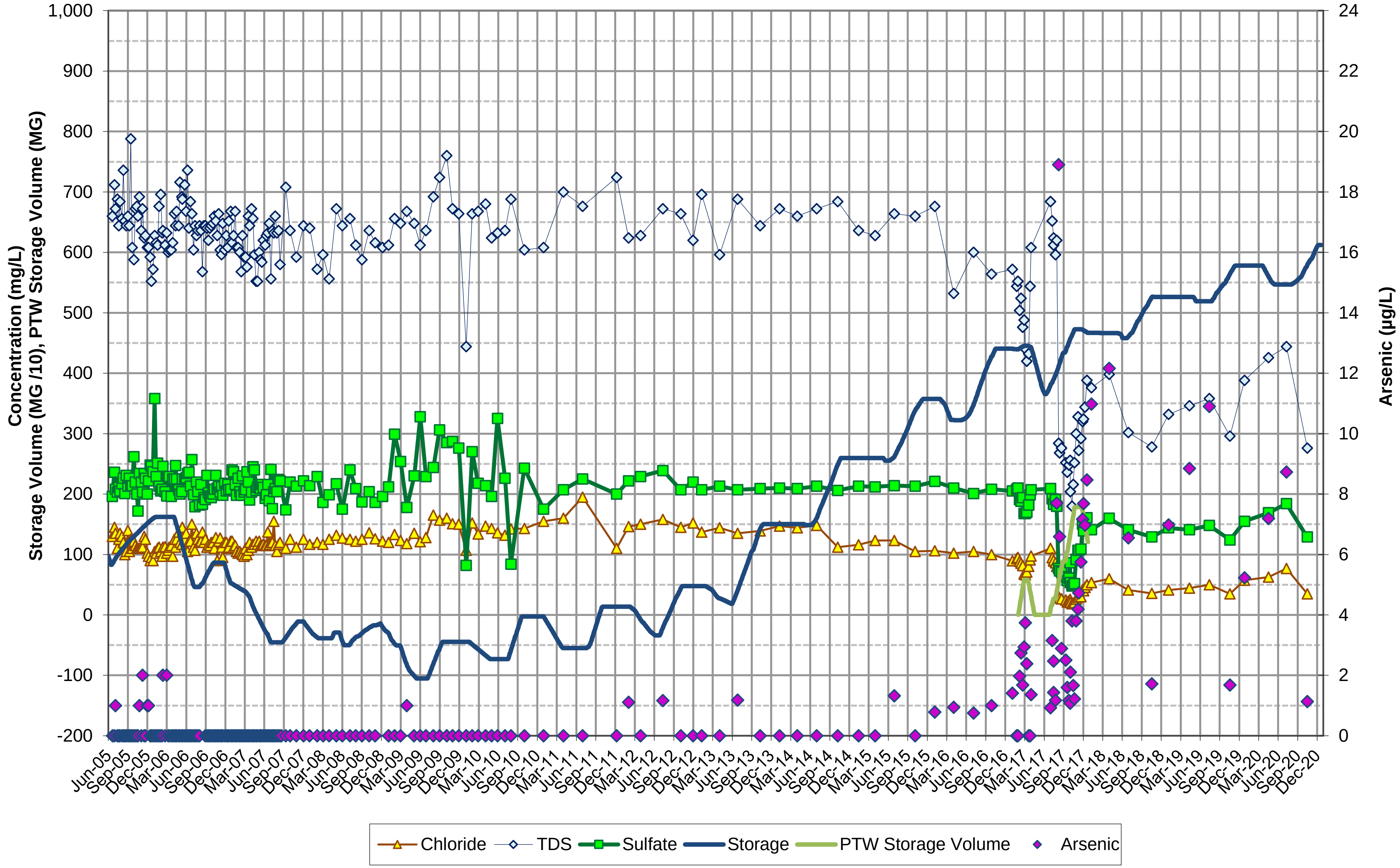
Figure D-10

Monitoring Well M-8 Water Quality



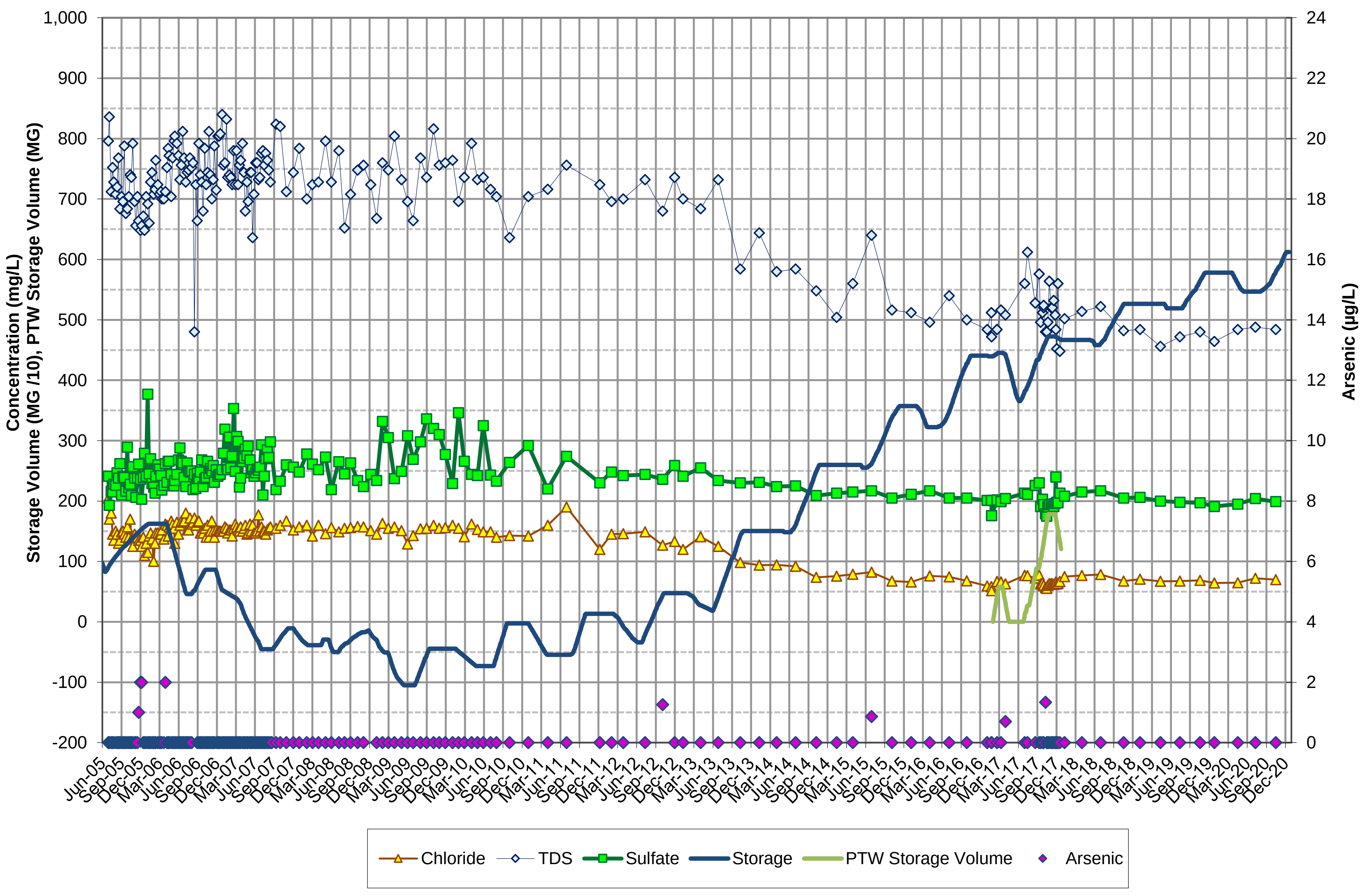
Notes:
For the purpose of this graphic any readings below the laboratory method detection limit were assigned zero
Sampling events for the PTSW testing occasionally resulted in duplicate samples on the same day, in that instance the result with the higher concentration of the two samples was used

Figure D-11
Monitoring Well M-11 Water Quality



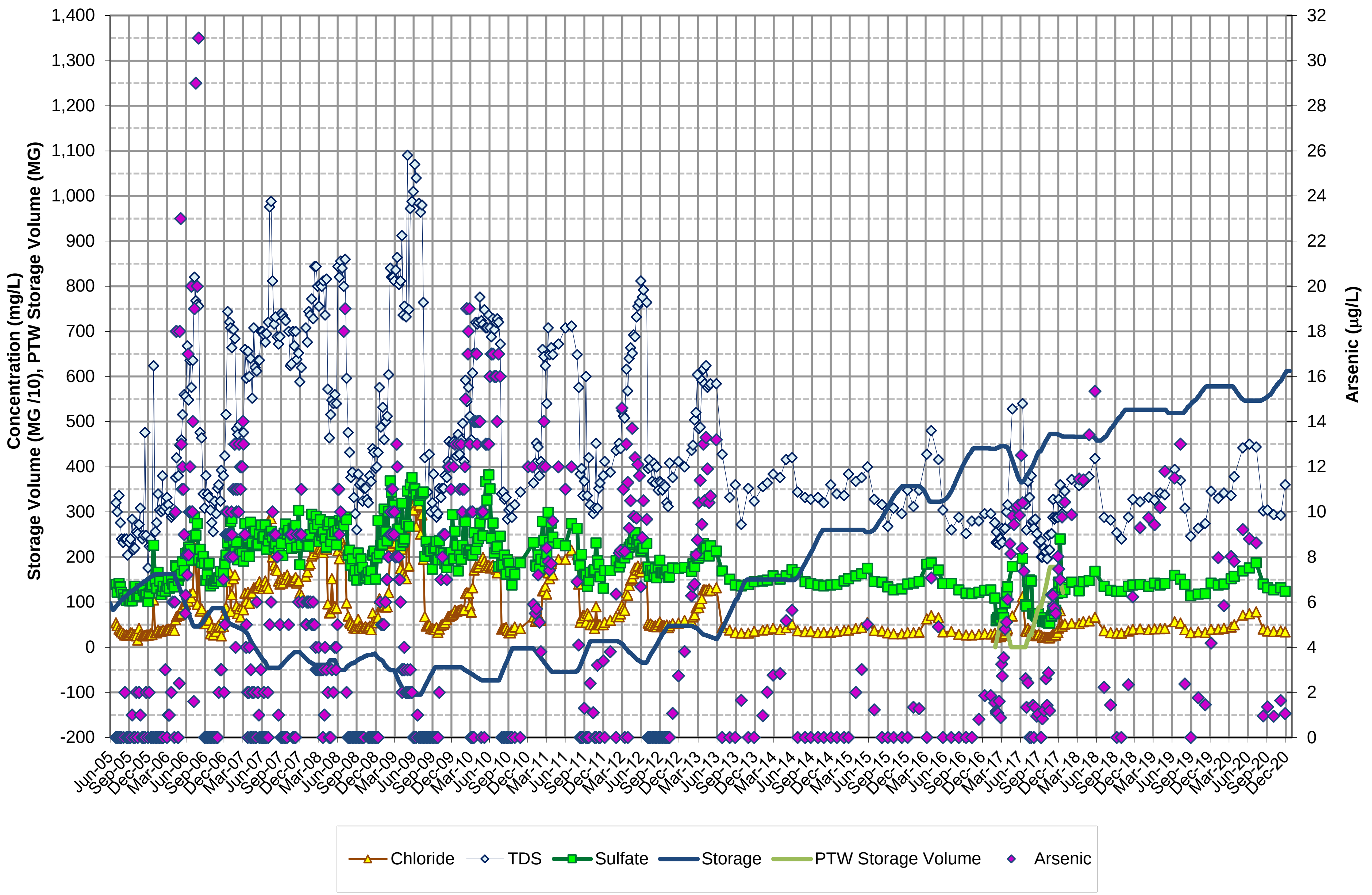
Notes:
For the purpose of this graphic any readings below the laboratory method detection limit were assigned zero
Sampling events for the PTSW testing occasionally resulted in duplicate samples on the same day, in that instance the result with the higher concentration of the two samples was used

Figure D-12
Monitoring Well M-12 Water Quality



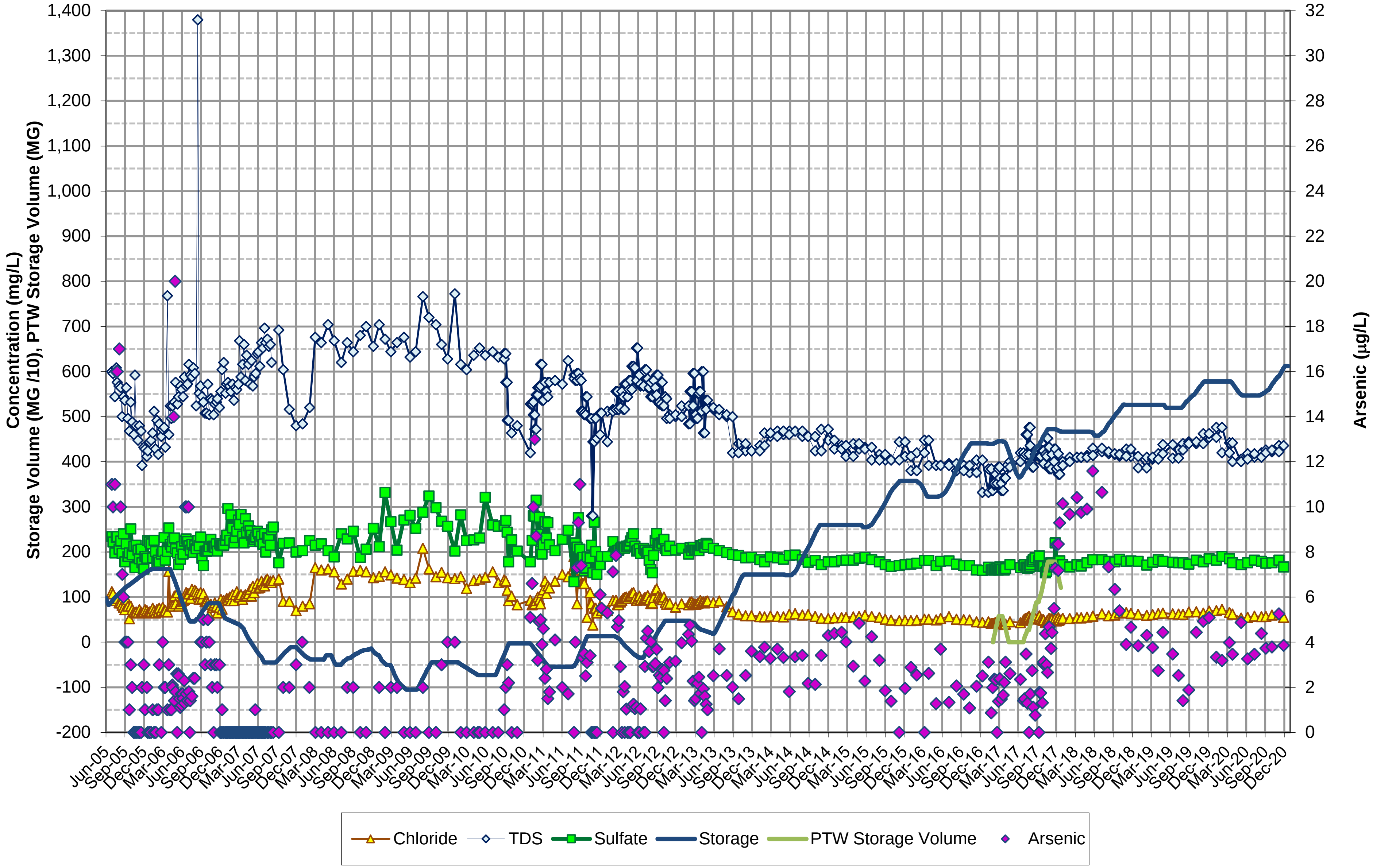
Notes:
For the purpose of this graphic any readings below the laboratory method detection limit were assigned zero
Sampling events for the PTSW testing occasionally resulted in duplicate samples on the same day, in that instance the result with the higher concentration of the two samples was used

Figure D-13
Monitoring Well M-13 Water Quality



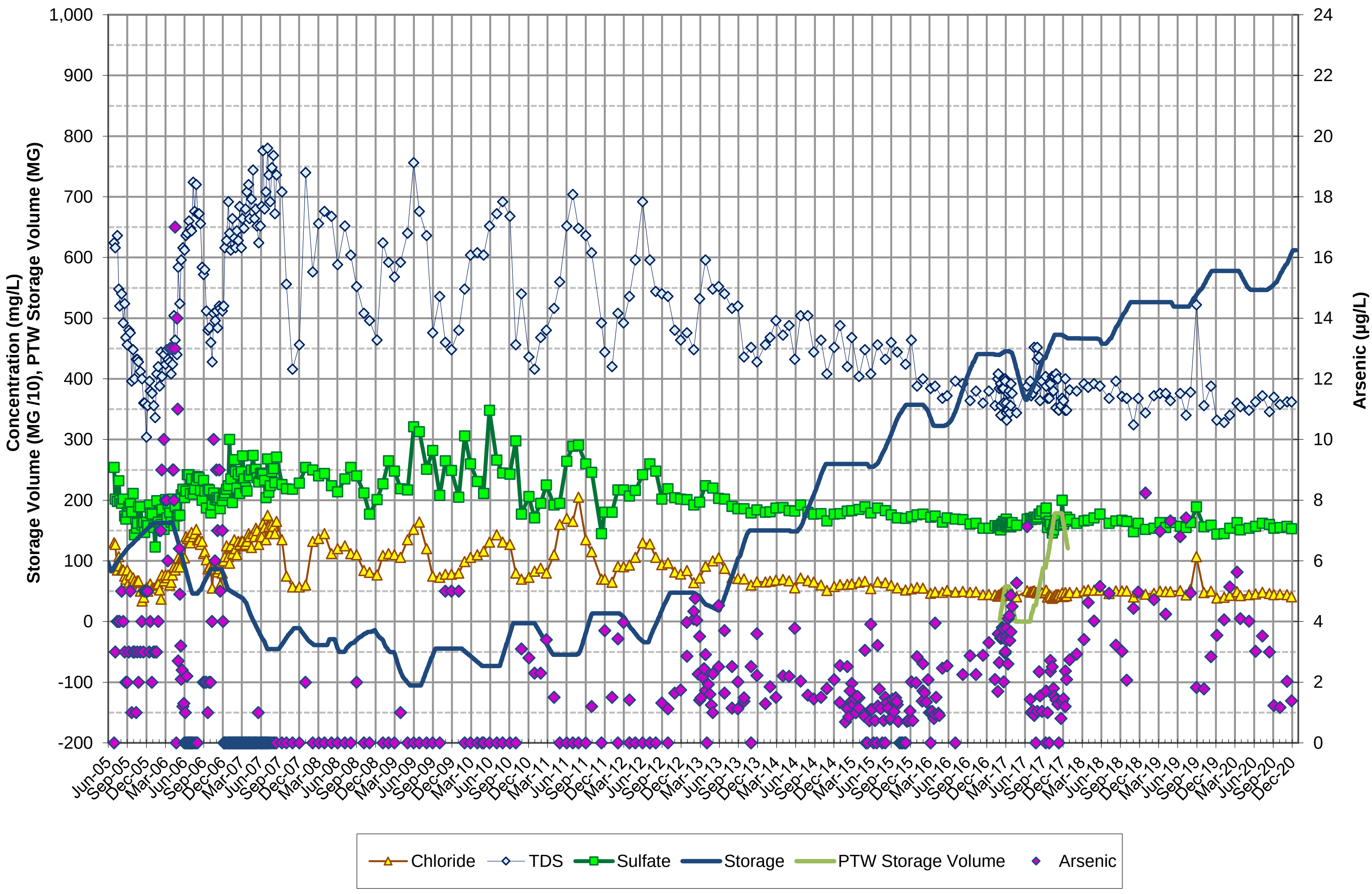
Notes:
For the purpose of this graphic any readings below the laboratory method detection limit were assigned zero
Sampling events for the PTSW testing occasionally resulted in duplicate samples on the same day, in that instance the result with the higher concentration of the two samples was used

Figure D-14
Monitoring Well M-14 Water Quality



Notes:
For the purpose of this graphic any readings below the laboratory method detection limit were assigned zero
Sampling events for the PTSW testing occasionally resulted in duplicate samples on the same day, in that instance the result with the higher concentration of the two samples was used

Figure D-15
Monitoring Well M-16 Water Quality



Notes:
For the purpose of this graphic any readings below the laboratory method detection limit were assigned zero
Sampling events for the PTSW testing occasionally resulted in duplicate samples on the same day, in that instance the result with the higher concentration of the two samples was used

Figure D-16
Monitoring Well M-17 Water Quality

Appendix E
Water Level Charts for Non-compliance Monitoring Wells

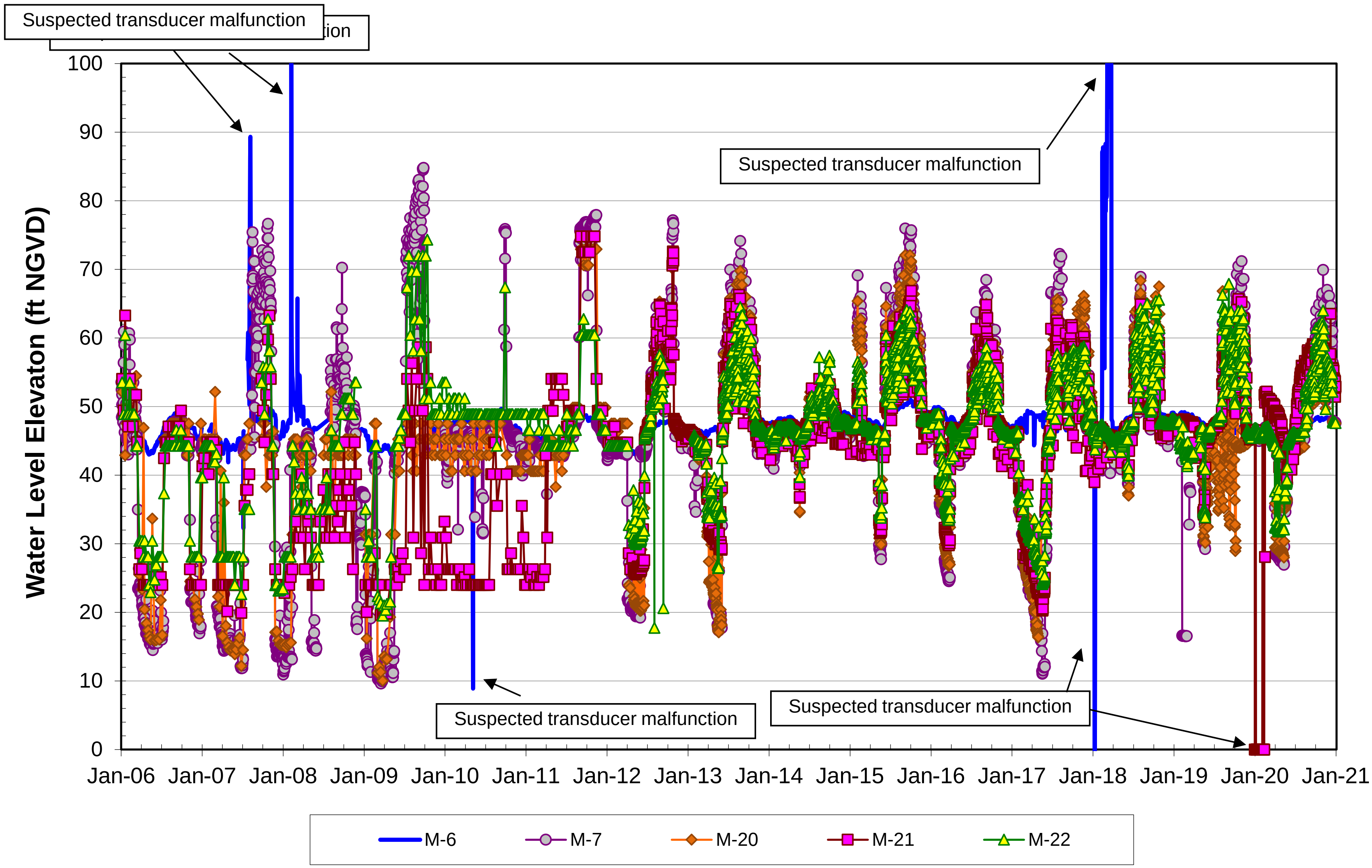


Figure E-1

WF-1 Suwannee Zone Monitoring Well Hydrographs

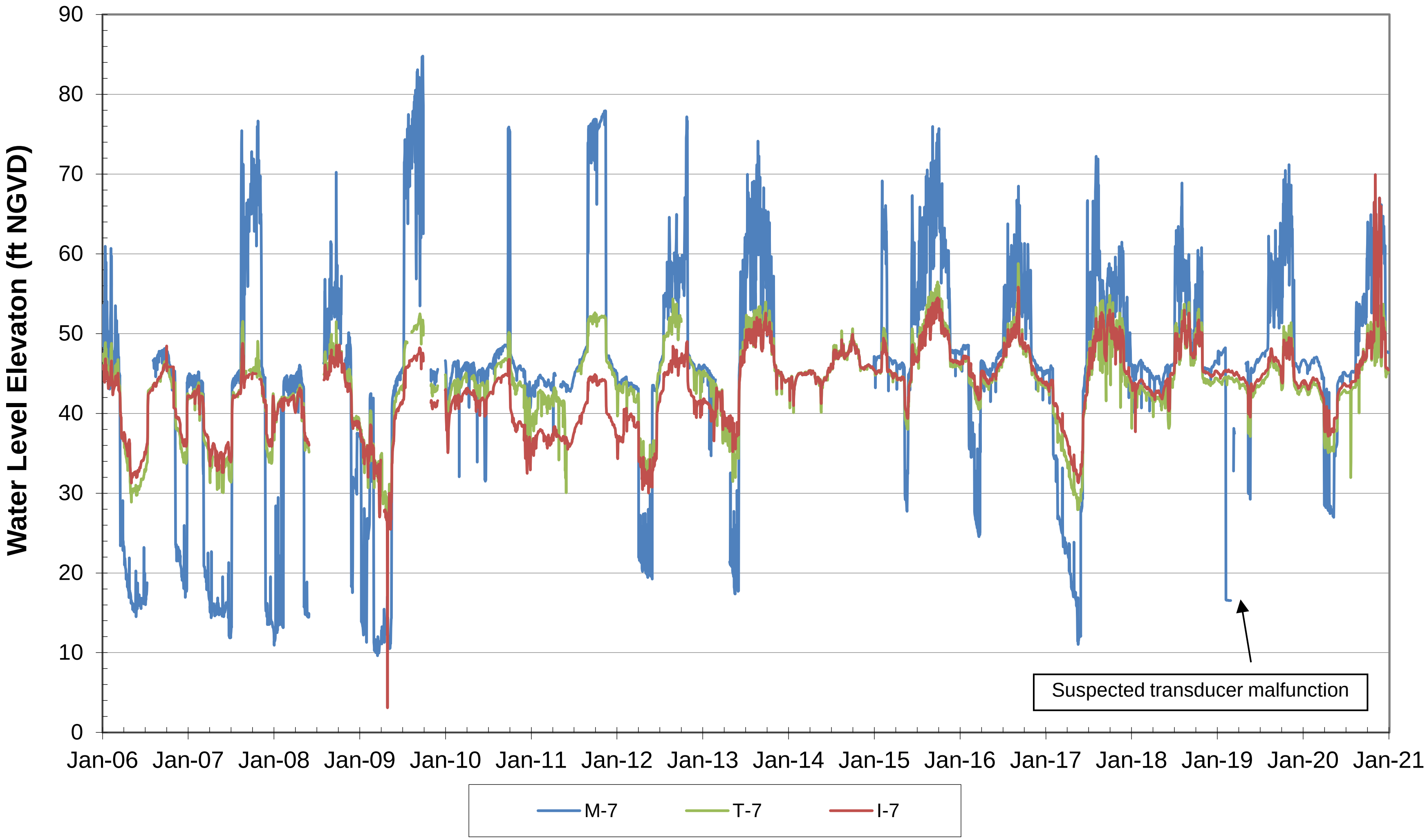


Figure E-2
Site 7 Monitoring Well Hydrographs

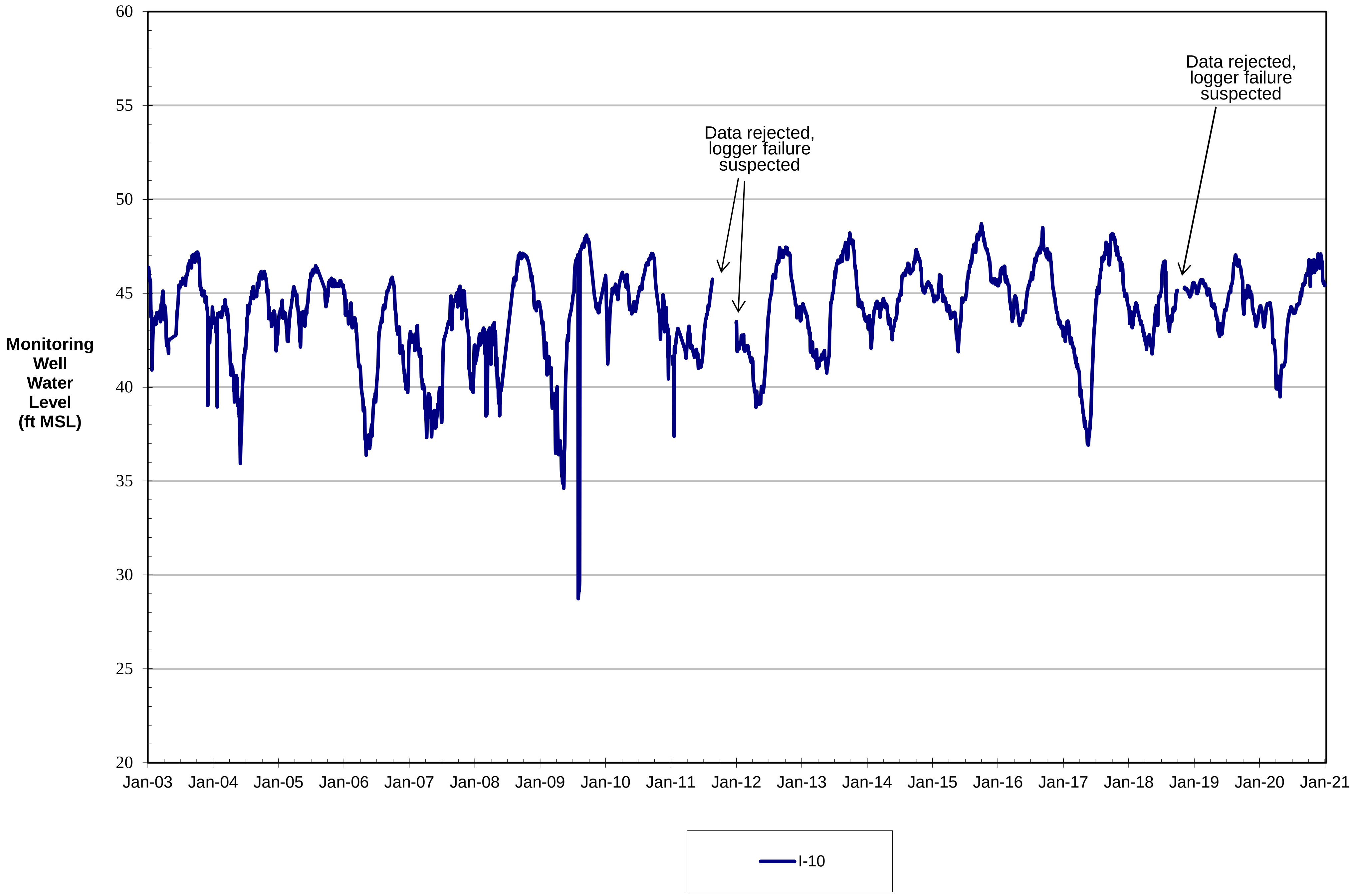


Figure E-3
I-10 Average Daily Water Levels

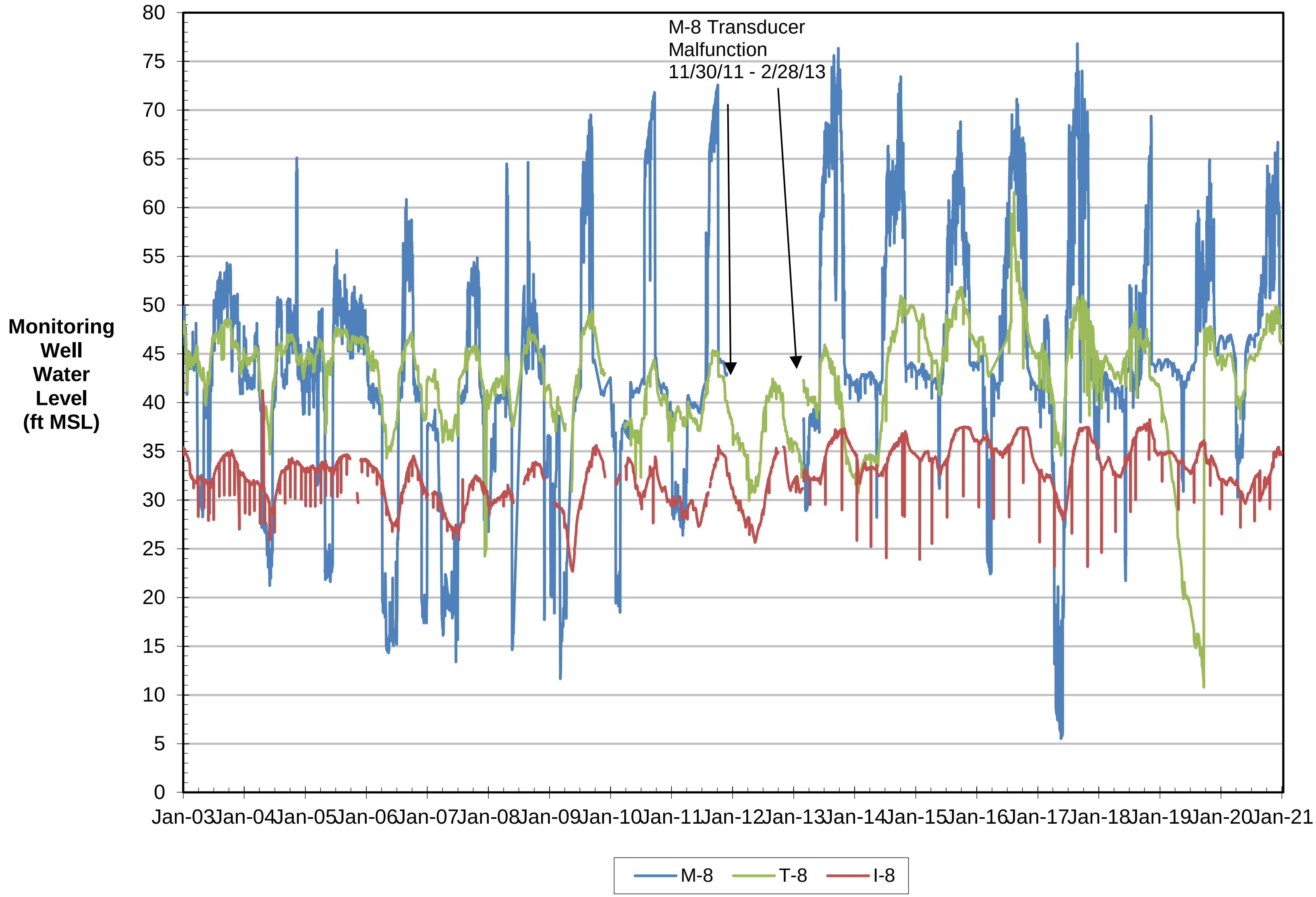


Figure E-4

I-8, T-8, M-8 Average Daily Water Levels

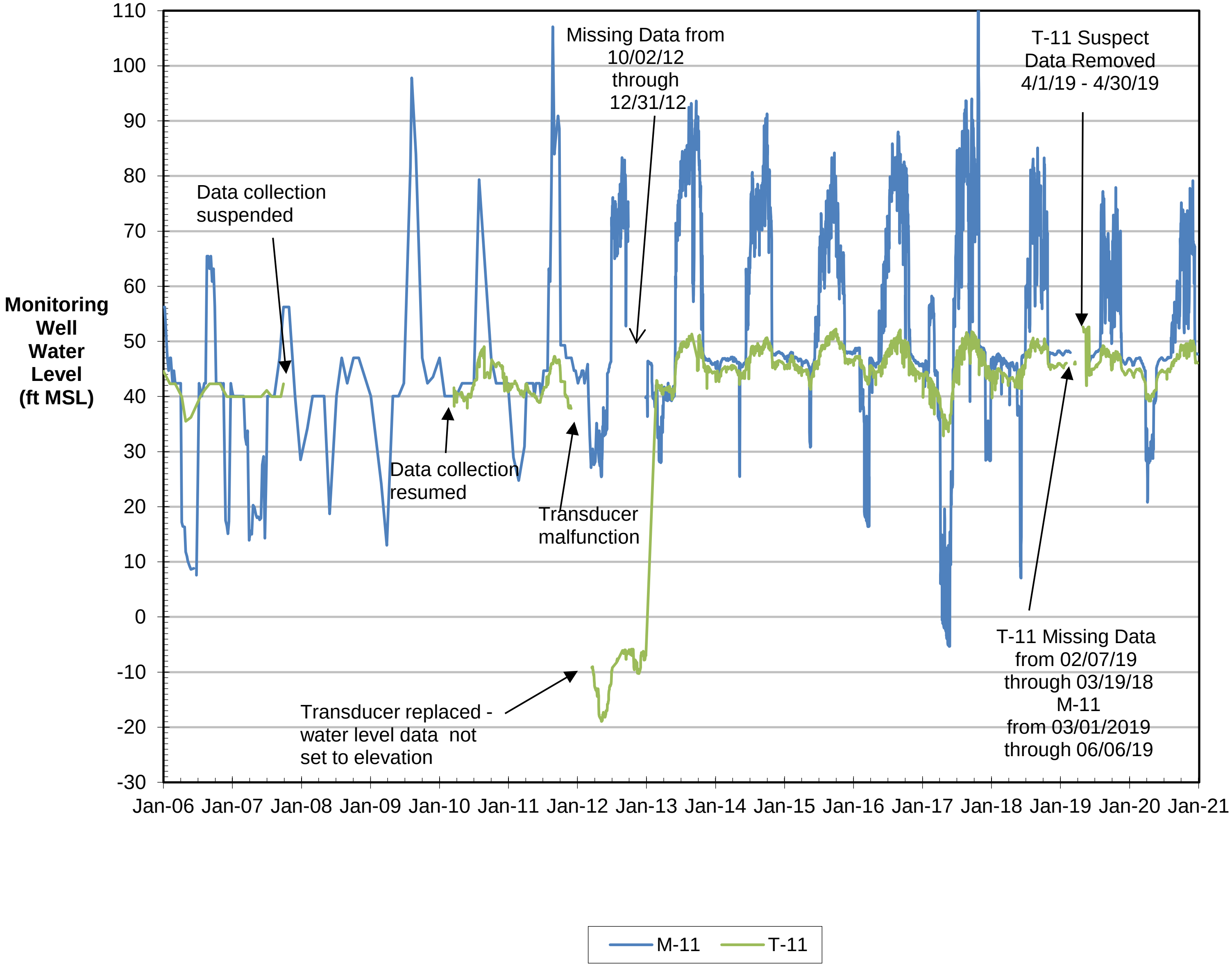


Figure E-5
T-11 and M-11 Average Daily Water Levels

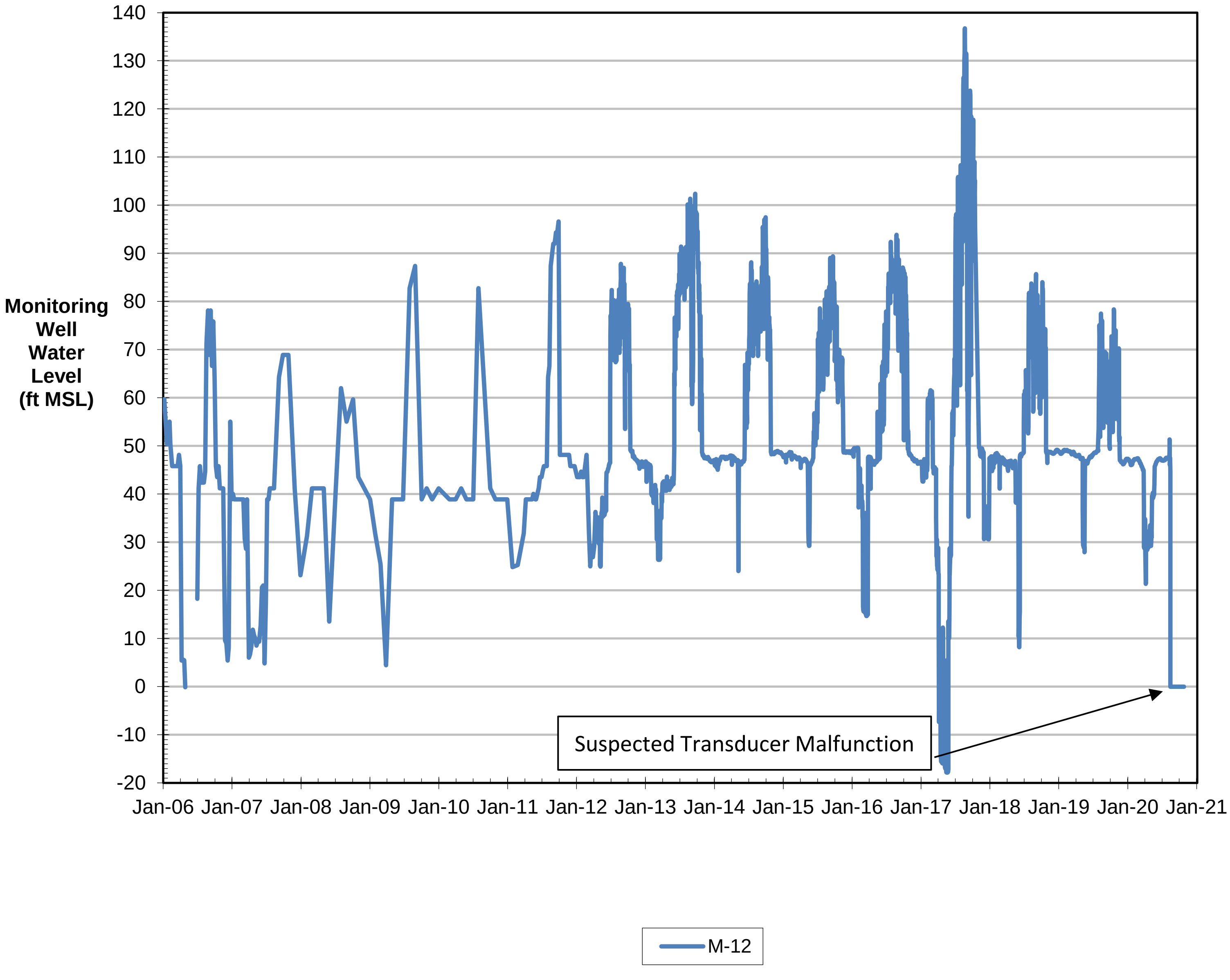


Figure E-6
M-12 Average Daily Water Levels

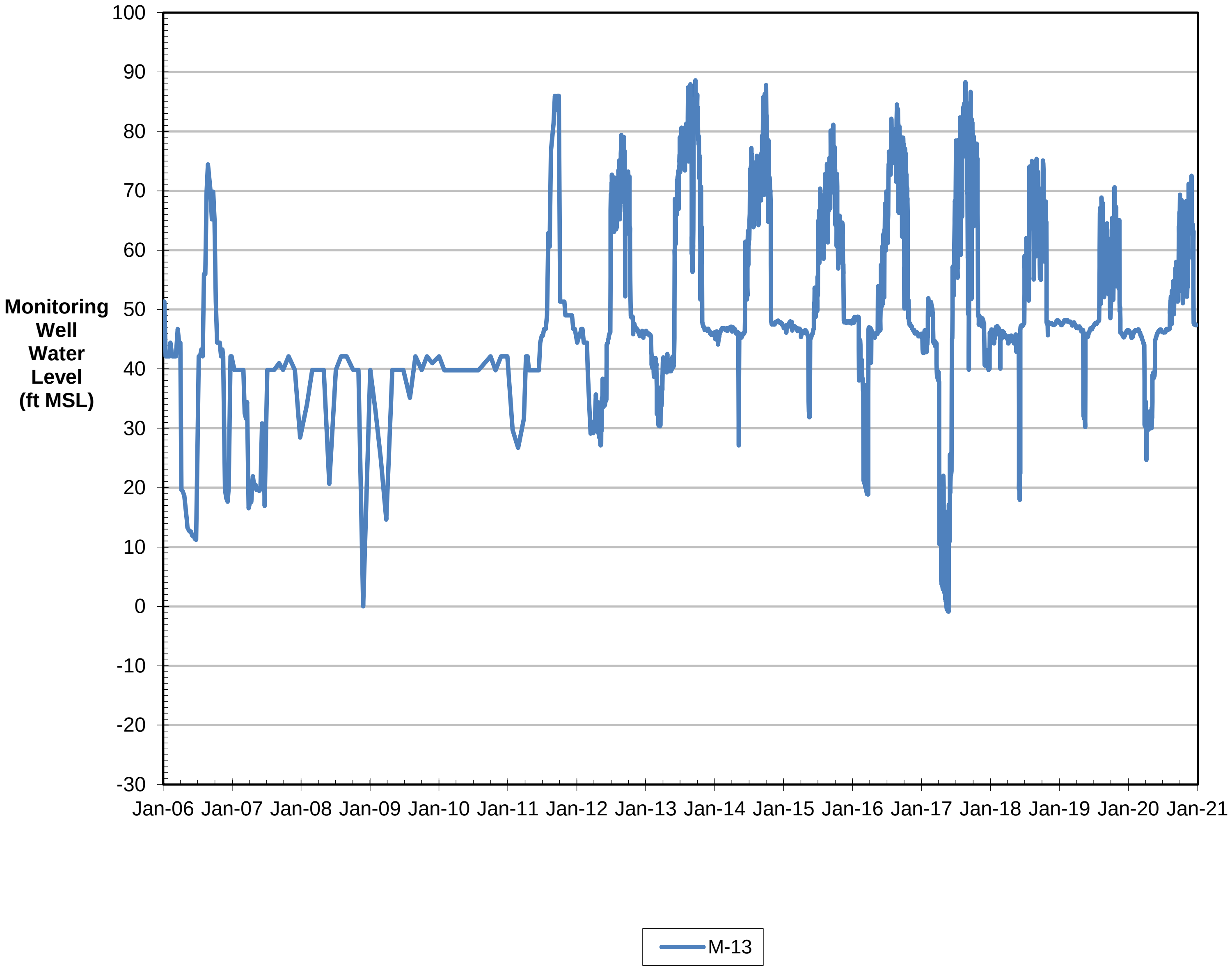


Figure E-7
M-13 Average Daily Water Levels

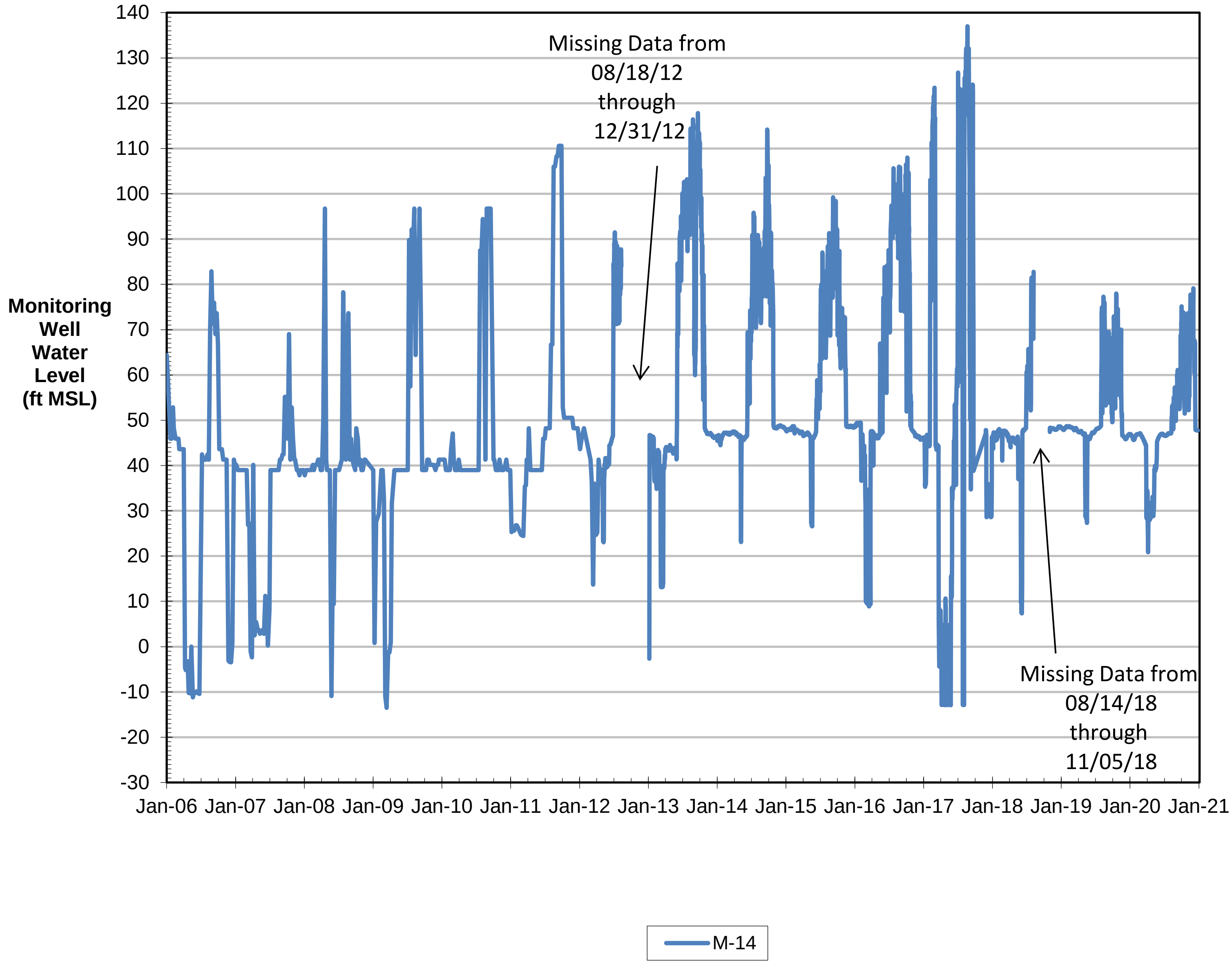


Figure E-8

M-14 Average Daily Water Levels

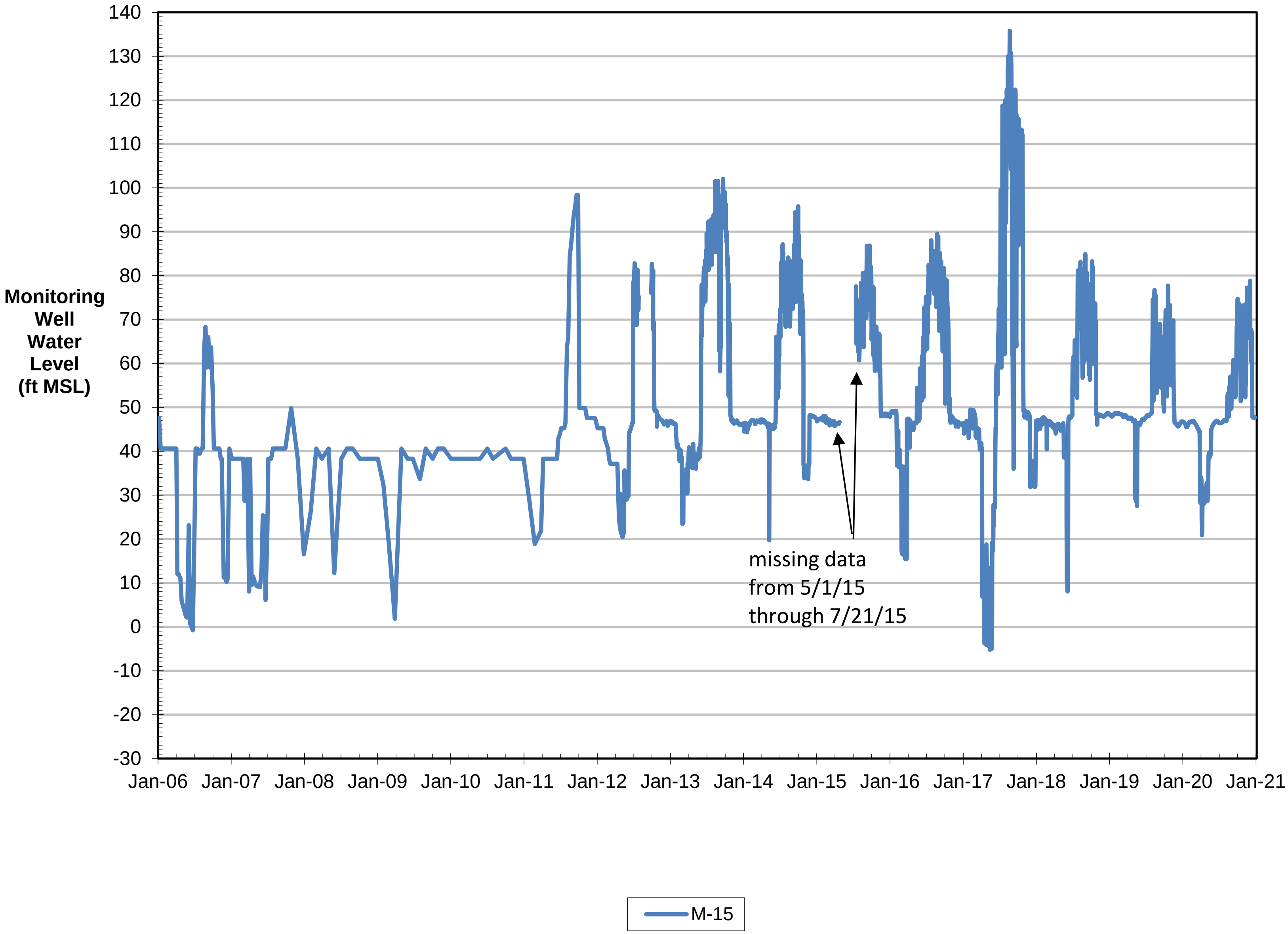


Figure E-9
M-15 Average Daily Water Levels

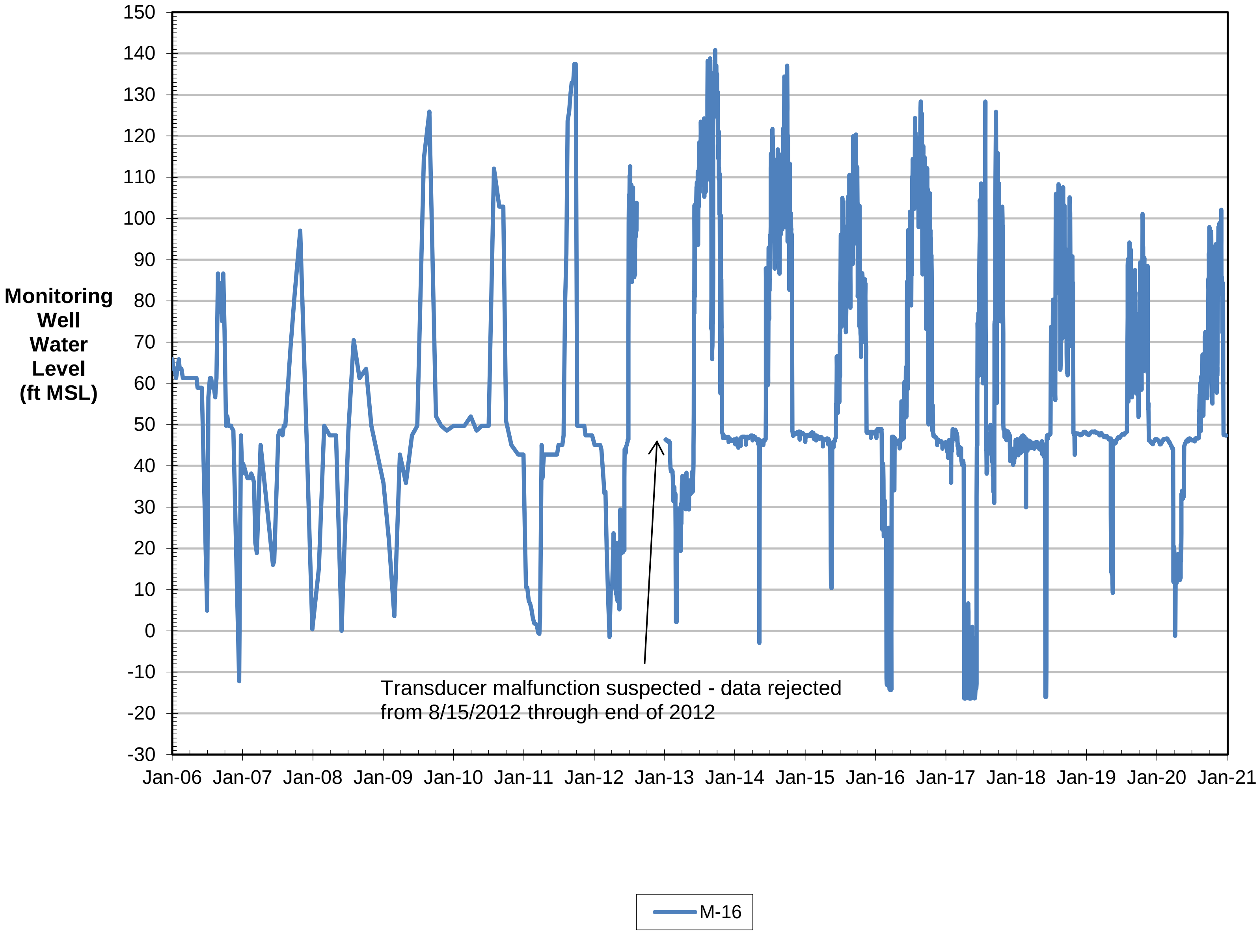


Figure E-10
M-16 Average Daily Water Levels

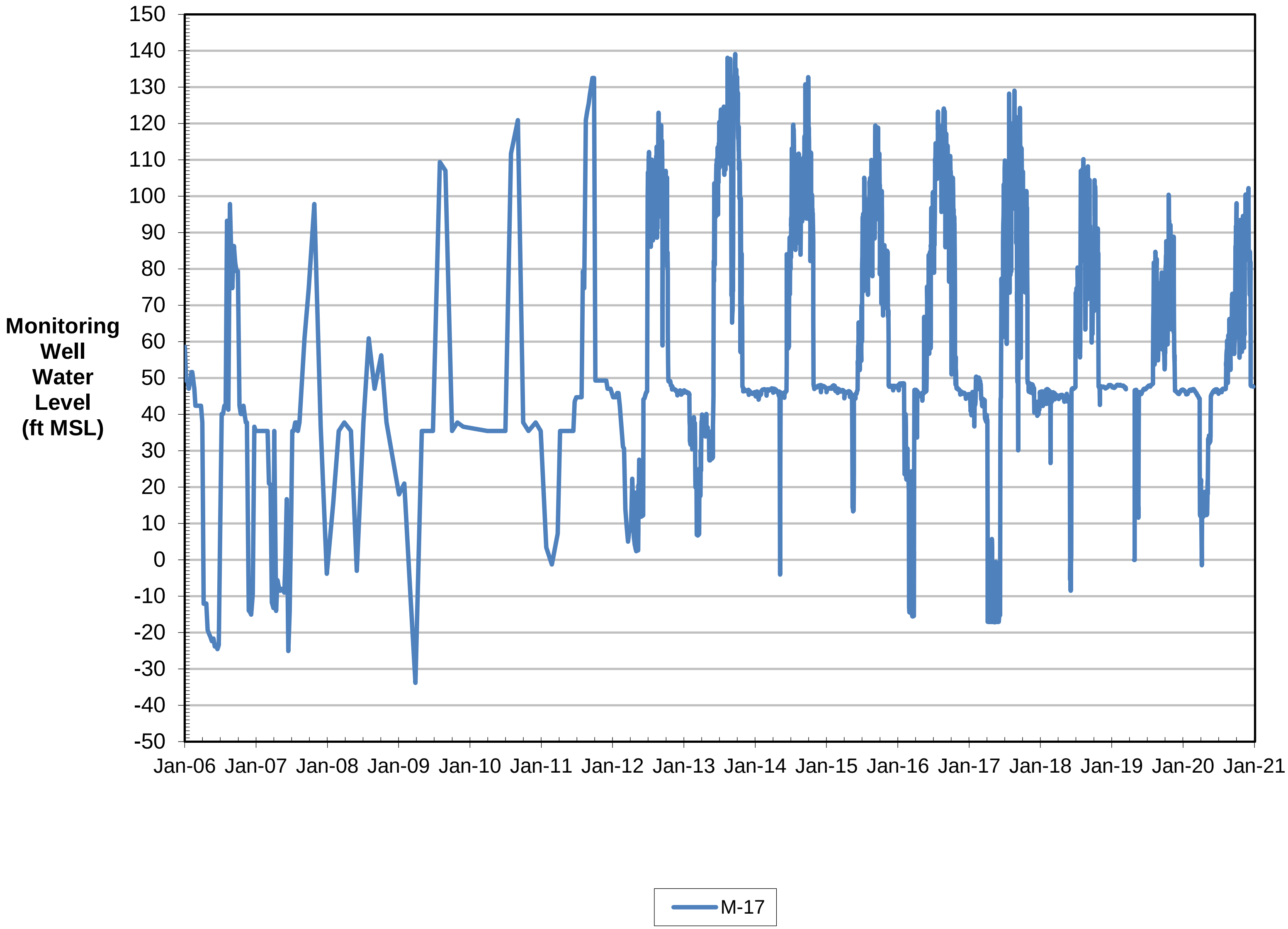


Figure E-11
M-17 Average Daily Water Levels

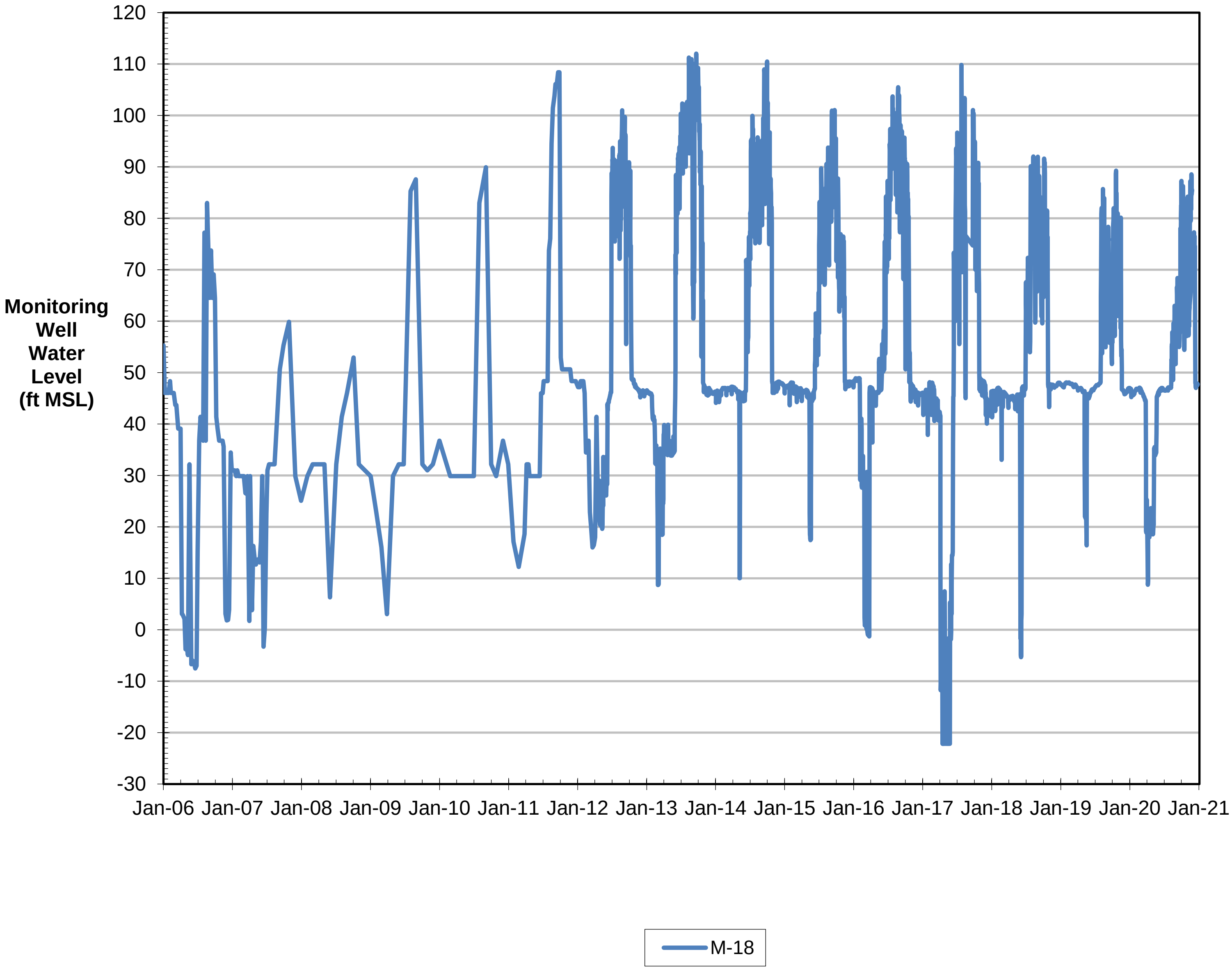


Figure E-12
M-18 Average Daily Water Levels

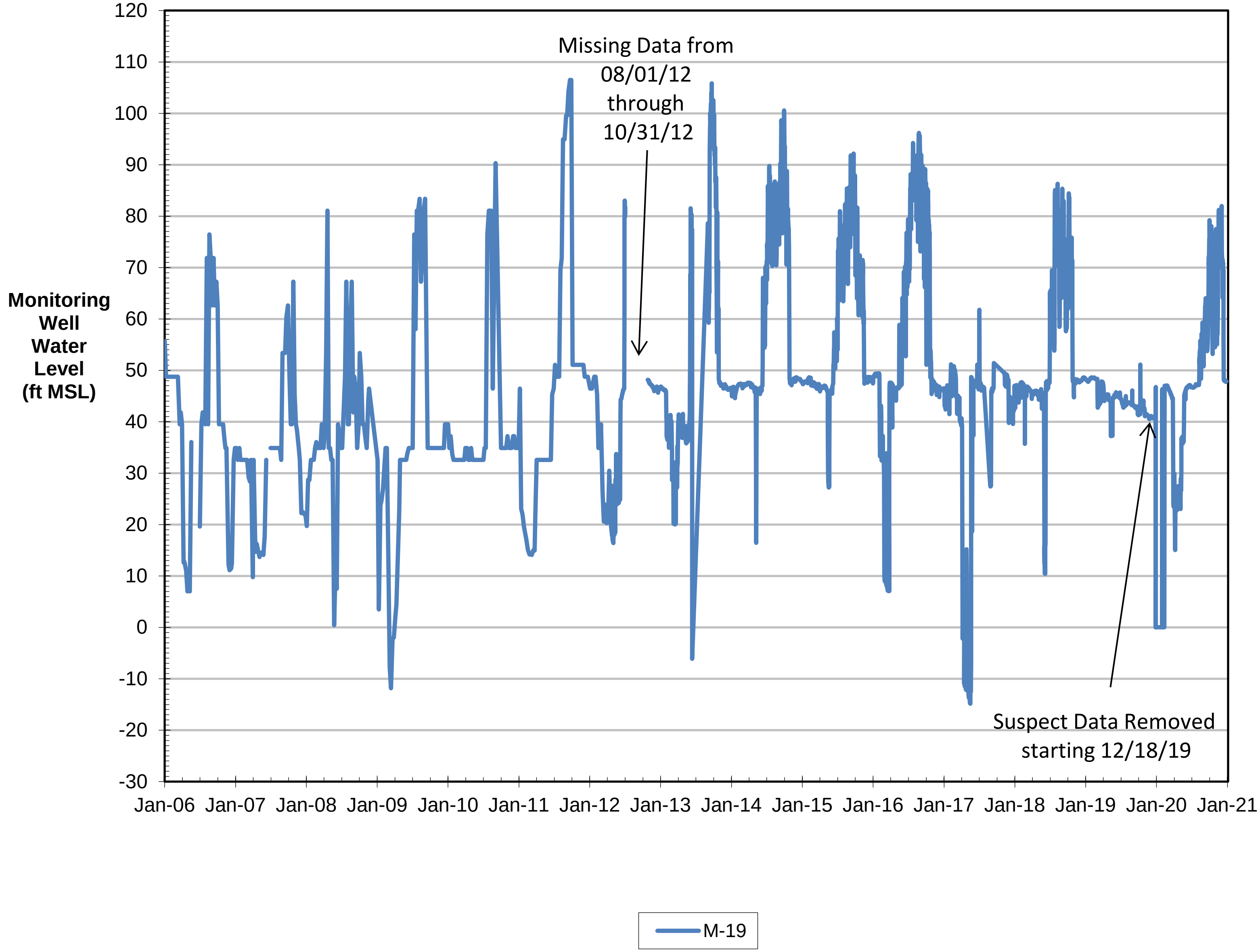


Figure E-13
M-19 Average Daily Water Levels

PEACE RIVER MANASOTA REGIONAL WATER SUPPLY AUTHORITY

May 26, 2022 (Revised)

Cindy Fischler, P.G.
Environmental Administrator
Aquifer Protection Program
Florida Department of Environmental Protection
2600 Blair Stone Road, MS 3530
Tallahassee, FL 32399-2400

Subject: Petition for Water Quality Criteria Exemption and Associated Processing Fee

Dear Ms. Fischler:

In follow-up to our previous discussions, the Peace River Manasota Regional Water Supply Authority (Authority) is submitting the attached Petition for Water Quality Criteria Exemption (Petition). The Petition regards four secondary drinking water standards. Therefore, we have also included a $24,000 check for the associated processing fee.

The Authority appreciates the Department's assistance to date and looks forward to receipt of the requested exemption. If you have any questions or if we can be of assistance, please do not hesitate to contact me or Pete Larkin, P.G. of ASRus, LLC at 813-382-8516.

Sincerely,

Mike J. Coates, P.G.
Executive Director

cc: James Dodson, P.G, FDEP
James Guida, P.G., PRMRWSA
Doug Manson, Esq., Manson Bolves
Craig Varn, Esq., Manson Bolves
Mark McNeal, P.G., ASRus
Peter Larkin, P.G., ASRus
Joseph Haberfeld, P.G., ASRus

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