NAVAL FACILITIES ENGINEERING COMMAND MID-ATLANTIC
9324 VIRGINIA AVENUE NORFOLK, VA 23511-3095

TO: Jason Pelton, NYSDEC Remedial Project Manager

FROM: Brian Murray, NAVFAC MIDLANT Sr. Remedial Project Manager

DATE: 26 June 2020

SUBJECT: Technical Memorandum for Operable Unit 3 Site 4 Underground Storage Tanks Steam Injection Operation and Performance Summary Report, Naval Weapons Industrial Reserve Plant, Bethpage, New York

1. INTRODUCTION

This technical memorandum describes the operation and monitoring activities of the steam injection system with free product recovery and biosparging conducted from August 2017 to May 2020 at the Naval Weapons Station Industrial Reserve (NWIRP) Bethpage, Site 4 located in Bethpage, New York.

The Site 4 operation and monitoring is being performed by APTIM Federal Services, LLC. (formerly CB&I Federal Services, LLC) under the Remedial Action Contract VII No. N62470-16-D-9004, Contract Task Order WE03.

1.1 Facility Description and Background

The Navy's Bethpage facility is located in Nassau County on Long Island. The facility, that later would become the NWIRP Bethpage, was established in 1942 and operated by Northrop Grumman until the late 1990s. At that time, the facility was approximately 109.5 acres in size. The majority of the facility was transferred to Nassau County in 2008. Site 4 is on the remaining nine-acre parcel being retained by the Navy for environmental investigations (**Figure 1**). The site is open to the public and is currently being used for commercial, industrial, and remedial activities.

1.2 Site 4 Description

Site 4 is a relatively flat area located south of Plant No. 3 (**Figure 2**). Prior to 1980, three Underground Storage Tanks (USTs) were used to store No. 6 Fuel Oil. The USTs were reportedly removed between 1980 and 1984. In the immediate area of the former USTs, petroleum-contaminated soil starts at a depth of approximately 10- to 20- feet (ft) below ground surface (bgs) and extends to the water table (55- to 60-ft bgs). At a distance of 10- to 40-ft from the former Site 4 USTs, petroleum-contaminated soils are only found at the water table. The soils above the water table were relatively clean. This area corresponds to approximately ¼-acre. At a distance greater than 60-ft from the former USTs, petroleum-contaminated soils were not observed.

Contaminants of Concern (COCs) identified for groundwater include volatile organic compounds (VOCs) (benzene, ethylbenzene, and total xylenes), semi-VOCs (SVOCs) (naphthalene and pentachlorophenol), and metals (cobalt and manganese). COCs identified for subsurface soil include SVOCs, including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, and naphthalene.

1.3 Treatability Study

As documented in the *Basis of Design/Design Criteria Report Intermediate (60%) Remedial Design* (Resolution Consultants, 2016) [hereafter 60% RD] soil was collected from the most contaminated zone

and a treatability study was conducted to evaluate the effectiveness of hot water flushing/low temperature steam extraction and high temperature steam extraction. This technology is to be employed to obtain the Site 4 cleanup levels presented in the OU-3 Record of Decision (Navy, 2015).

The treatability study evaluated the effectiveness of recovering Non Aqueous Phase Liquid (NAPL), meeting the soil clean-up levels, and reducing the potential for contaminants to leach to groundwater. The treatability study indicated that only high-temperature steam extraction (approximately at 212°F [Fahrenheit]) was effective in removing NAPL from site.

It was also noted in the Treatability Testing Results detailed in Attachment A of the 60% RD that based on the conclusions of the treatability study, steam is likely to have limited effectiveness in the field. If steam technology were to be implemented at Site 4, a small scale field pilot test should be completed to confirm that NAPL can be recovered and that reductions in PAHs observed during the treatability study can be replicated in the field. Objectives of the pilot test should include the following:

- Determine the steam injection radius of influence
- Confirm that planned steam injection rates can be injected into the subsurface
- Determine how NAPL can be recovered, transported and separated in the field
- Observe pre- and post-treatment soil conditions
- Evaluate reduction in PAH concentrations
- Evaluate cost-effectiveness of NAPL recovery

1.4 Pilot Treatment System Design

A combination of steam injection, product recovery, biosparging, and soil vapor extraction (SVE) has been constructed to meet the Remedial Action Objectives outlined in the 60% RD. The individual treatment components are described below.

Steam Injection — Steam injection (SI) is used to enhance free product recovery. Steam is injected into the subsurface to increase the temperature of the treatment zone in order to lower the viscosity of the contaminant to promote free product recovery. In addition, the temperature increase volatilizes certain contaminants (with low boiling points) that are then recovered in the vapor stream. Steam injection will be initially completed as part of a pilot study. The estimated duration of steam injection required to achieve free product movement is eight (8) months.

Product Recovery — Free product that accumulates on the water table will be pumped from a recovery well to a storage tank using a positive displacement pump designed to recover and transport high viscosity product at high temperature.

Biosparging — Biosparging consists of injecting air into the subsurface to increase the dissolved oxygen concentration in groundwater to promote aerobic biological degradation of the organic contaminant. In the unsaturated zone it is used to promote airflow and agitation to enhance biological degradation. Biosparging is to be implemented after the conclusion of steam injections to treat remaining concentrations in groundwater and to promote biological degradation in soil.

Soil Vapor Extraction — A soil vapor extraction (SVE) system is used to collect soil vapors from the steam injection and biosparging operations. A vacuum blower is used to apply a vacuum to SVE wells to

create a zone of negative pressure above the treatment zone to collect any vapor. Granular activated carbon (GAC) is used to treat the vapor prior to discharge to the atmosphere.

1.5 Site 4 Remedial Work Plan

The construction and operation of the pilot treatment system is described in detail in the *Work Plan Site 4 – Former Underground Storage Tanks, NWIRP Bethpage (*CB&I Federal Services, LLC [CB&I], 2017. Appendices to the Work Plan, include Design Specifications, an Accident Prevention Plan, a project schedule, the Sampling and Analysis Plan/Quality Assurance Plan, (hereafter SAP), and a Community Air Monitoring Plan.

As described below, multiple types of samples are collected to evaluate pre-treatment and system performance; this sampling is detailed in the SAP. Sample results are compared to Project Action Limits as indicated in SAP Worksheet #11 and derived from the Site 4 ROD. Worksheet #11 provides the most recent US EPA risk-based clean up levels.

2. PILOT TREATMENT SYSTEM OPERATION

2.1 Steam Injection

System startup and initial testing of the steam injection and product recovery system began on January 24, 2019. The steam injection system consists of injection wells, conveyance piping, injection manifold, and steam generation equipment. A total of six SI wells are being used to treat the target area, composed of three well clusters that each contain a shallow and deep injection well (**Figure 2**). The shallow SI wells are screened between 33- and 35-ft bgs. The deep SI wells are screened between 73- and 75-ft bgs. Steam injections were initiated on April 9, 2019.

The SI process delivers generated steam through the conveyance piping to the steam injection manifold, which control the flow of steam to each of the three clusters of steam injection wells. The injected steam is intended to heat the pilot test treatment zone to temperatures between 120 – 210°F. During the steam injection process, subsurface temperatures are monitored to prevent damage to overlying utilities. Thermocouples were installed at 15- to 20-ft bgs, 13-ft above the steam injection zone, and approximately 10-ft below the utility corridor, to monitor temperature migration from the steam injection zone to the utility corridor.

During the period of steam injection operation, temperature is measured for a base temperature and daily, throughout the duration of steam injections. Thermocouple monitoring began on May 11, 2019.

Attachment A provides the underground temperature monitoring from May 31, 2019 through May 20, 2020 at Site 4. As indicated in the two graphs (13 and 20 ft above SI zone), subsurface temperatures have been maintained between the minimum and maximum temperature ranges, 120 – 210°F, respectively, in both intervals. **Attachment E** provides a steam injection activity log indicating temperature measurement dates.

2.2 Product Recovery

The free product recovery system consists of one recovery well, electrical service, control panel, pump, conveyance piping, and two free product storage tanks. The recovery system consists of a Blackhawk Pneumatic Piston Pump installed on July 15, 2019, and is rated for temperatures in excess of 220°F. The

fluid pulled from the well is piped to storage tanks that are vented to the SVE system to capture vapors. The product recovery well was installed in a central location in relation to the SI wells (**Figure 2**).

Following full system operation, recovery well pumping began daily. However, more water than product/NAPL was observed to be recovered by the system. As time went on, the system was observed to recover little to no product, which led to the reduction of the pumping frequency from daily to weekly. Following a status meeting with the Navy on December 4, 2019 to discuss product recovery and a path forward regarding the recovery system, it was decided to discontinue daily free product recovery pumping as of December 5, 2019. However, the well is pumped during site visits to observe if any change in extracted groundwater. The typical recovery is hot water with dispersed globs (flecks) of product.

2.3 Biosparging

The biosparge system (also termed air sparge) consists of an air compressor, filters, injection manifold, conveyance piping, and injection wells (a total of nine wells). The three, pre-existing deep SI wells are to be converted to biosparge wells (upon termination of steam injection phase) and an additional six biosparge wells were constructed to supplement the converted SI wells (**Figure 2**). The newly installed biosparge wells are screened below the water table, between 73- and 75-ft. The air compressor generates compressed air, which passes through an oil coalescing filter and a moisture filter before being injected under pressure through the biosparge injection wells. The air supply line is divided into two banks of wells, with one injection bank being operated at time, cycled at half-hour intervals.

Operation of the biosparging system will begin following the conclusion of the steam injection process and installation/sampling of new groundwater monitoring wells as explained in Section 4.

2.4 Soil Vapor Extraction

The SVE system consists of a regenerative blower, pipe manifold, air/water separator, liquid and air waste stream treatment, and a series of seven SVE wells to extract the vapors from the subsurface soils within the treatment area (**Figure 2**). The SVE wells (SVE1 through SVE7) are screened between 20- and 25-ft bgs based on the depths of the treatment zone and utility zone. Additional components include a transfer pump, two 55-gallon drum vapor-phase GAC vessels, two 55-gallon drum liquid-phase GAC vessels, a free product storage container with secondary containment, and liquid-phase GAC pre-filters.

The SVE system is used to collect soil vapors during the operation of the steam injection and biosparging systems. A vacuum blower rated at 300-standard cubic ft. per minute generates the vacuum to remove vapors from the subsurface. Recovered vapors run through a moisture separator and vapors are treated using vapor-phase GAC. The liquids are pumped from the moisture separator to the oil water separator to remove free product. Recovered water is treated using liquid-phase GAC prior to discharge to an onsite storage tank.

Startup and initial testing of the SVE system began on May 8, 2019 and was operational beginning June 5, 2019.

2.5 Post Steam Injection Soil Sampling

Following the steam injection period, confirmation soil sampling to quantify the extent of the soil remaining will be performed. Soils with Total Petroleum Hydrocarbon (TPH) concentrations above 1,000-milligrams (mg)/kilograms (kg) will be treated using biosparging. This sampling has not been completed to date.

3. STEAM INJECTION EFFECTINESS MONITORING

3.1 Soil Vapor Gas Sample Collection, Analyses, and Results

Concentrations of organic COCs in soil vapors extracted from Site 4 are monitored quarterly, during implementation of the remedy to assess migration of vapors to the ground surface and to ensure the SVE system is operating as intended. These samples are collected from five soil vapor sampling probes (SV-1, SV-3, SV-5, SV-6, and SV-9) and from the SVE system (pre-GAC treatment, mid-GAC treatment, and prior to discharge). Samples have been analyzed for VOCs by U.S. Environmental Protection Agency (EPA) Method TO-15. In addition, these same locations have been screened on a weekly basis with a photoionization detector (PID) during the operation of the steam injection system. Sample results for SV locations are provided in **Table 1** with sample results for the SVE system (pre-GAC treatment, mid-GAC treatment, and prior to discharge) provided in **Table 1**.

3.1.1 Baseline Soil Vapor Gas Sampling Results

On December 4, 2018, baseline soil vapor gas samples were collected in Summa canisters from four of the five soil vapor sampling probes (SV-1, SV-3, SV-6, and SV-9) in accordance with the SAP. Soil vapor probe SV-5 was not sampled during the baseline sampling event due to the presence of sand in the line. SVE locations are depicted in **Figure 2**. The baseline soil vapor gas samples were analyzed for VOCs.

The analytes detected in the soil vapor samples and PID readings collected from the Site 4 soil vapor sampling probes during this sampling event are provided in **Table 1**. Concentrations of the analytes detected in the soil vapor gas samples during the baseline sampling event were less than their respective Project Action Limits (PALs) for VOCs.

3.1.2 Quarterly Soil Vapor Gas Sampling Results

Quarterly soil vapor samples were collected on November 2019 and February 2020 as described in the SAP. Soil vapor samples were collected from the five soil vapor sampling probes (SV-1, SV-3, SV-5, SV-6, and SV-9) and from the SVE system (pre-GAC treatment, mid-GAC treatment, and prior to discharge). The SVE influent, mid-fluent, and effluent measurements are presented in **Table 1a**. PID readings were also collected and are presented in **Table 1 and 1a**. The quarterly soil vapor gas samples were analyzed for VOCs.

During the sampling event performed on November 22, 2019, soil vapor gas samples were collected during steam injections. Concentrations of benzene in SV-03, ethylbenzene in SV-06, and total xylenes in SV-03 and SV-06 increased in November 2019 compared to the respective baseline samples, however, the analytes detected in the soil vapor gas samples during the November 2019 sampling event were less than their respective PALs for VOCs. The analytes were detected within the stages of the SVE system (influent, mid-fluent, and effluent). Benzene exceeded the PAL in the influent; all other analytes were below their respective PALs for VOCs.

The next quarterly soil vapor gas sampling event occurred on February 26, 2020. Concentrations of benzene in all soil vapor sampling probes decreased since the sampling event from November 2019 and remained below the PAL. Concentrations for ethylbenzene and total xylenes were non-detect in all soil vapor sampling probes. The sample associated with the SVE mid-fluent was not analyzed due to being compromised during shipping. Benzene exceeded the respective PAL (12 micrograms per cubic meter

[µg/m³]) in the SVE influent and effluent with concentrations of 660 µg/m³ and 70 µg/m³, respectively (Table 1b). All other analytes were detected however were below their respective PALs for VOCs.

Attachment B presents graphs of COC concentrations from baseline sampling and quarterly sampling events. Graphs are provided for four compounds (benzene, ethylbenzene, m-xylene, p-xylene, and o-xylene) as measured in the SV wells prior to steam injection (December 2019), during steam injection (November 2019), and a quarterly sample (February 2020). Note vertical scale for each graph. No soil vapor concentration as measured in the SV-01, 03, -05, 06, and -09 exceeded the project action limit for each respective compound in these samples. **Attachment B** also provides SVE concentration for these four compounds at the influent, mid-fluent, and effluent measurement points.

3.2 Soil Sample Collection, Analyses, and Results

3.2.1 Baseline Soil Samples

To assess pre-pilot test insitu soil concentrations, soil was sampled during July/August 2017 from six locations within the treatment zone prior to the start of steam injection. Six soil borings to a depth of approximately 75-ft bgs were drilled. At each location, a nine-point composite sample was comprised of soil collected from each five-foot interval between 30- and 75-feet. Visual contamination was observed between 55- and 65-ft bgs in each location. Samples were shipped to an analytical laboratory and analyzed for VOCs by U.S. EPA Method 8260B and SVOCs by U.S. EPA Method 8270C in accordance with the SAP.

Sample ID BETHP-S4-SB-303A was collected as a discrete grab sample at location SB-303 of the product saturated 55- to 60-ft core sample. The comprehensive analytical results (detected and undetected analytes) from baseline soil sampling are presented in **Table 2**. As indicated in this table, the concentration of chrysene at 1,600 mg/kg is the single exceedance of its respective PAL concentration of 1,000 mg/kg.

3.3 Groundwater Sample Collection, Analyses, and Results

Concentrations of COCs in groundwater are collected from eight monitoring wells (MW-03, MW-04, and MW-06 through MW-11) to determine if the pilot treatment system is having effects on groundwater quality. Samples are analyzed for VOCs by U.S. EPA Method 8260B, SVOCs) by U.S. EPA Method 8270D, metals by U.S. EPA Method 6020 in accordance with the SAP.

Attachment C presents COC concentration trends from baseline and quarterly groundwater sampling events.

3.3.1 Baseline Groundwater Samples

From August 22 through 24, 2017, baseline groundwater samples were collected from the eight monitoring wells that comprise the treatment zone at Site 4. The analytes detected above their respective PALs in baseline groundwater samples collected in August 2017 from Site 4 are presented in **Table 3**.

3.3.2 Quarterly Groundwater Samples

On July 29, 2019, the first round of groundwater samples from the eight monitoring wells were collected, after the first month following steam injection. The quality control samples included one field duplicate, one field blank, and three trip blanks. The following quarterly groundwater sampling events were performed on November 4 and 5, 2019 and February 13, 2020.

The comprehensive analytical historical data (detected and undetected analytes) from baseline and quarterly (July 2019 – February 2020) are presented in **Table 3**.

Those analytes measured at concentrations above their detection limit include the single organic compound benzene in well MW-04 and the inorganic COCs cobalt and manganese in multiple wells. The benzene concentrations for all samples are less than 1 µg/L in five samples from well MW-04.

Concentrations for cobalt and manganese have fluctuated during the baseline and two quarterly sampling events, however, consistently remain above their respective MCLs. The following table shows a summary of cobalt and manganese concentrations that were measured above their respective PALs during the July 2019, November 2019, and February 2020 groundwater sampling events.

Site 4 COC Groundwater PAL Exceedances – July 2019 through February 2020 Monitoring Events

COC	Project Action Limit (µg/L)	Location	Concentration (µg/L)	Monitoring Event
Cobalt	6.0	MW-03	6.19	July 2019
			6.83	November 2019
			6.37	February 2020
		MW-04	13.2	July 2019
			74.0	November 2019
			76.6	February 2020
		MW-11	15.4	February 2020
Manganese	430	MW-03	527	November 2019
		MW-04	864	July 2019
			6,230	November 2019
			4,880	February 2020

3.4 Groundwater Temperature Monitoring

To determine the steam injection radius of influence and the effect on the groundwater temperature, a Solinst Model 201 Water Level and Temperature Meter was used to record the temperature of the groundwater at 5-foot intervals between 55 and 75 feet within the deep steam injection wells, SI-1D, SI-2D, and SI-3D, and the recovery well (**Figure 3**).

Temperature was recorded over four events between January 28, 2020 and March 6, 2020. The following table shows the average temperature at each steam injection well, as well as the average temperature at each depth within the steam injection zone. A chronological log documenting periods of steam injection and measurements recorded is provided in **Attachment E**.

Site 4 Average Groundwater Temperature – Shallow and Deep Steam Injection

Depth	SI-1D (°F)	SI-2D (°F)	SI-3D (°F)	Steam Injection Zone Average (°F)
55	158.9	174.4	171.4	168.2
60	132.4	143.0	141.7	139.0
65	107.8	116.2	114.3	112.8
70	92.1	99.2	99.6	97.0
75	83.2	89.1	92.3	88.2

A graph depicting the average temperature of each deep steam injection wells and the recovery well is included as **Attachment D**. **Figure 3** shows the isothermal contours at 60-feet bgs. These contours represent the steam injection well temperatures as recorded on March 6, 2020 and the groundwater monitoring well temperatures as recorded during the quarterly groundwater sampling event on February 13, 2020.

3.5 Stream Re-Direction to Deep Interval

An interim evaluation of the steam injection effectiveness was warranted due to a lack of product in the groundwater captured in the recovery well. Following a period of steam injection of 276 days (9.2 months), it was evident the system was not achieving release of NAPL for recovery.

Per the project team review of the data collected to date, a decision was made to re-direct all steam to only the deep steam injection wells SI-1D, -2D, and -3D. This re-direction was begun on March 30, 2020 by closing manifold valves to the shallow steam injection wells. Observations for product in the recovery well were increased and monitoring of well MW-04 was performed to check for accumulation of light non-aqueous phase liquid (LNPAL). No observation of LNAPL occurred in either location.

To assess the effect of the deep steam re-direction, temperature measurements were taken. Temperature measurement was attempted on April 1, 2020, but the temperature probe was overheated after one reading (SI-1D, 228°F at 75 ft below ground surface). The boiler was taken off line on May 7, 2020 after 42 days of deep steam injection to begin temperature measurements. On May 8, 2020, the temperature in the steam injection wells and surrounding air sparging wells was above the range of the temperature gauge to record any readings. A measurement in MW-04 indicated a water temperature of 168°F at 60-ft bgs. A check on May 11, 2020 indicated the steam injection wells were still above range of the temperature gauge however a measurement in AS4 indicated a temperature of 205°F at 60-ft bgs. Following a full week of no deep steam injection, the SI wells had cooled enough to record temperatures at all depths as provided in the table below.

Site 4 Groundwater Temperature Following Steam Re-Direction (May 14, 2020)

Depth	SI-1D	SI-2D	SI-3D	AS4	AS5	AS6	MW-04	Steam Injection

	(°F)	(°F)	(°F)	(°F)	(°F)	(°F)	(°F)	Zone Average (°F)
55	216	207	216	_	_	_	_	213
60	223	214	222	160	207	207	106	220
65	199	219	223	_	_	_	_	214
70	169	189	183	_	_	_	_	180
75	159	180	171	_	_	_	_	170

A graph depicting the temperature of each deep steam injection well as recorded on May 14, 2020 is included in **Attachment D. Figure 3A** depicts the isothermal contours at 60-feet bgs following the period of steam re-direction to the deep interval. Temperatures surrounding the recovery well are greater than 220 °F, well above the maximum target temperature of 212°F. No product accumulation occurred in the recovery well during the deep steam injection period.

4. CONCLUSIONS AND PATH FORWARD

4.1 Conclusion from Operation of Steam Injection System

Steam injection began on April 9, 2019 through all six steam injection wells: SI-1S, SI-2S, SI-3S, SI-1D, SI-2D, and SI-3D. The system was operated continuously, with minor interruptions throughout the year. System parameters, including water meter readings, steam injection flowmeter readings, and thermocouple temperature readings at 15 and 20 feet below ground surface were recorded daily beginning May 31, 2019.

As described in the 60% RD, in order to enhance recovery and transport of NAPL, the temperature of NAPL will need to be increased to around 90°C (~194°F) to achieve release of the NAPL from the subsurface matrix. The lack of free product in the recovery well following deep re-direction of the steam to enhance heat application indicates the inability to lower the viscosity of the product within the subsurface matrix at temperatures well above 194°F. Groundwater sample results indicate no increase in the VOC or SVOC concentrations indicating no release into the aqueous phase. Based on this evidence, the Navy will ceasesteam injection.

4.2 Path Forward

To assess site conditions prior to initiation of biosparging, the Navy will perform the post-steam injection collection of subsurface soils as described in the SAP. Analysis of the samples will allow assessment of a changes in site subsurface soil chemistry prior to changing treatment methods. In addition, the Navy will install and sample two groundwater monitoring wells in the vicinity of the previously existing MW-01 and MW-02. The sampling of these wells will occur following installation/development and then again following cessation of biosparging. As per the 60% RD, biosparging is planned for a 10-month period.

5. REFERENCES

CB&I Federal Services, LLC, 2017. Final Sampling and Analysis Plan/Quality Assurance Plan, Site 4 – Former Underground Storage Tanks, Former NWIRP Bethpage, Bethpage, New York. August.

NAVFAC, 2015. Record of Decision Operable Unit 3 (OU 3) Site 4 – Former Underground Storage Tanks. October.

Resolution Consultants, 2016. Draft Basis of Design/Design Criteria Report Intermediate (60%) Remedial Design. June.

Figures

Tables

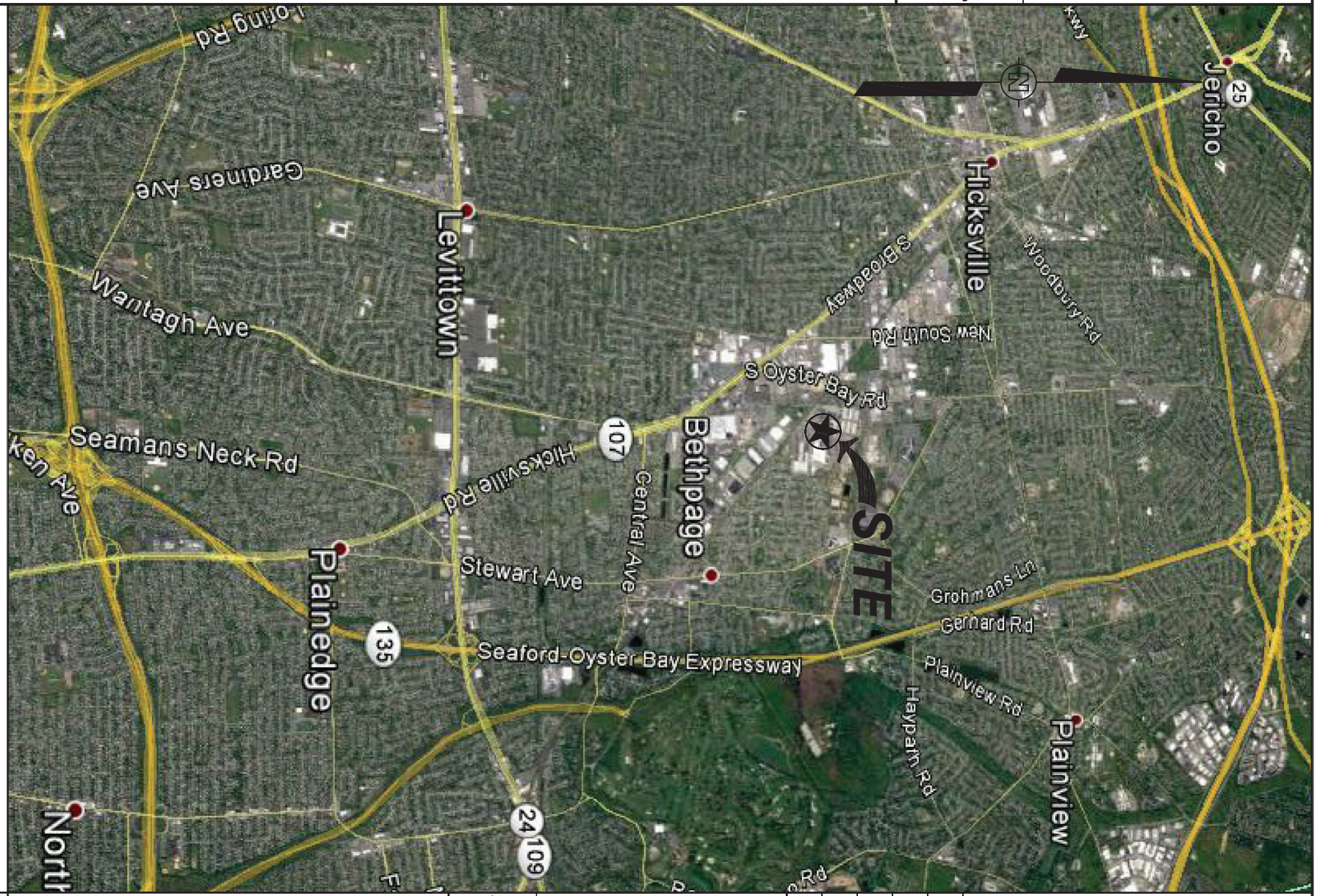
Attachments

FIGURES

File: O:\Project\LANTDIV\Bethpage NY\500689\500689-A1.dwg
Plot Date/Time: Apr 18, 2017 - 5:08pm
Plotted By: bernadette.oconnor

FIGURE 3.jpg
NAVFAC Logo.jpg
Site Location Map.jpg
Site Map.jpg
site Map bing2.jpg
utilities.jpg

OFFICE	DRAWING NUMBER
Pittsburgh, PA	500689-A1



REFERENCE:
DRAWING PREPARED USING GOOGLE EARTH
DATED: 5/11/16

SCALE
0
3000
6000 FEET

14

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE

REVISIONS

NAVFAC Naval Facilities Engineering Command MID-ATLANTIC

APTIM

APTIM Federal Services LLC
150 Boush Street, Suite 701
Norfolk, Virginia 23510

NAVAL WEAPONS INDUSTRIAL RESERVE PLANT — BETHPAGE, NEW YORK
SITE 4

SITE LOCATION MAP

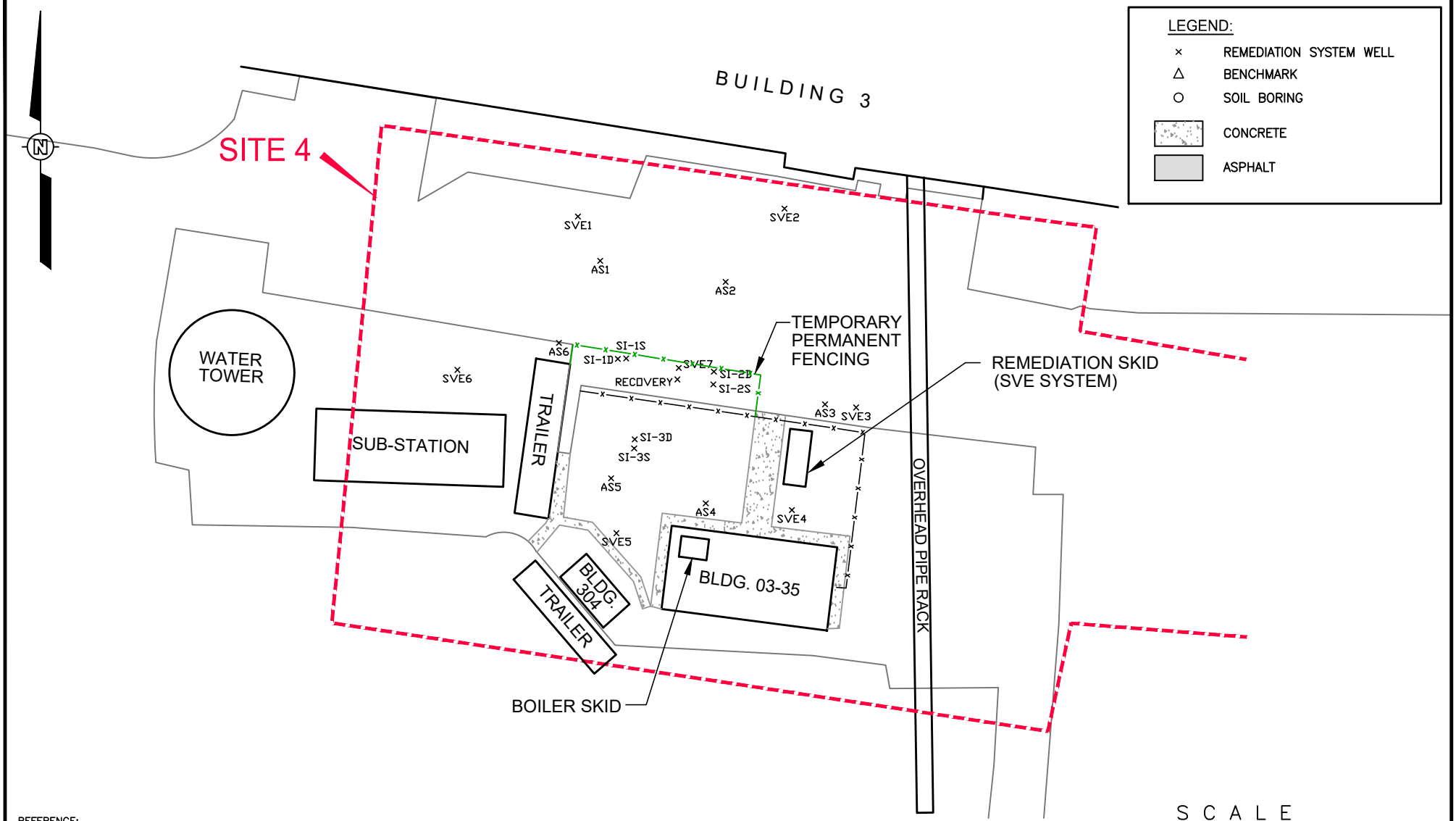
DESIGNED BY S. Kinna	DATE 8/11/16	CHECKED BY	DATE
DRAWN BY B. O'Connor	DATE 8/11/16	APPROVED BY	DATE

SCALE: AS SHOWN
SIZE: A
DELIVERY ORDER NO. WE03
CONSTR. CONTRACT NO. N6247O-16-D-9004
NAVFAC DRAWING NO. --

SHEET I.D.
FIGURE 1

File: O:\project\LANTDIV\Bethpage NY\500809\509809-A1.dwg
Plot Date/Time: Sep 09, 2019 - 5:44pm
Plotted By: bernadette.oconnor

OFFICE	DRAWING NUMBER
Pittsburgh, PA	500809-A1



REFERENCE:

THIS DRAWING PREPARED UTILIZING FILE PROVIDED BY ???
TITLE: SYSTEM LAYOUT, SCALES: 1"=30' AND 1"=40'.

SCALE
0 50 100 FEET

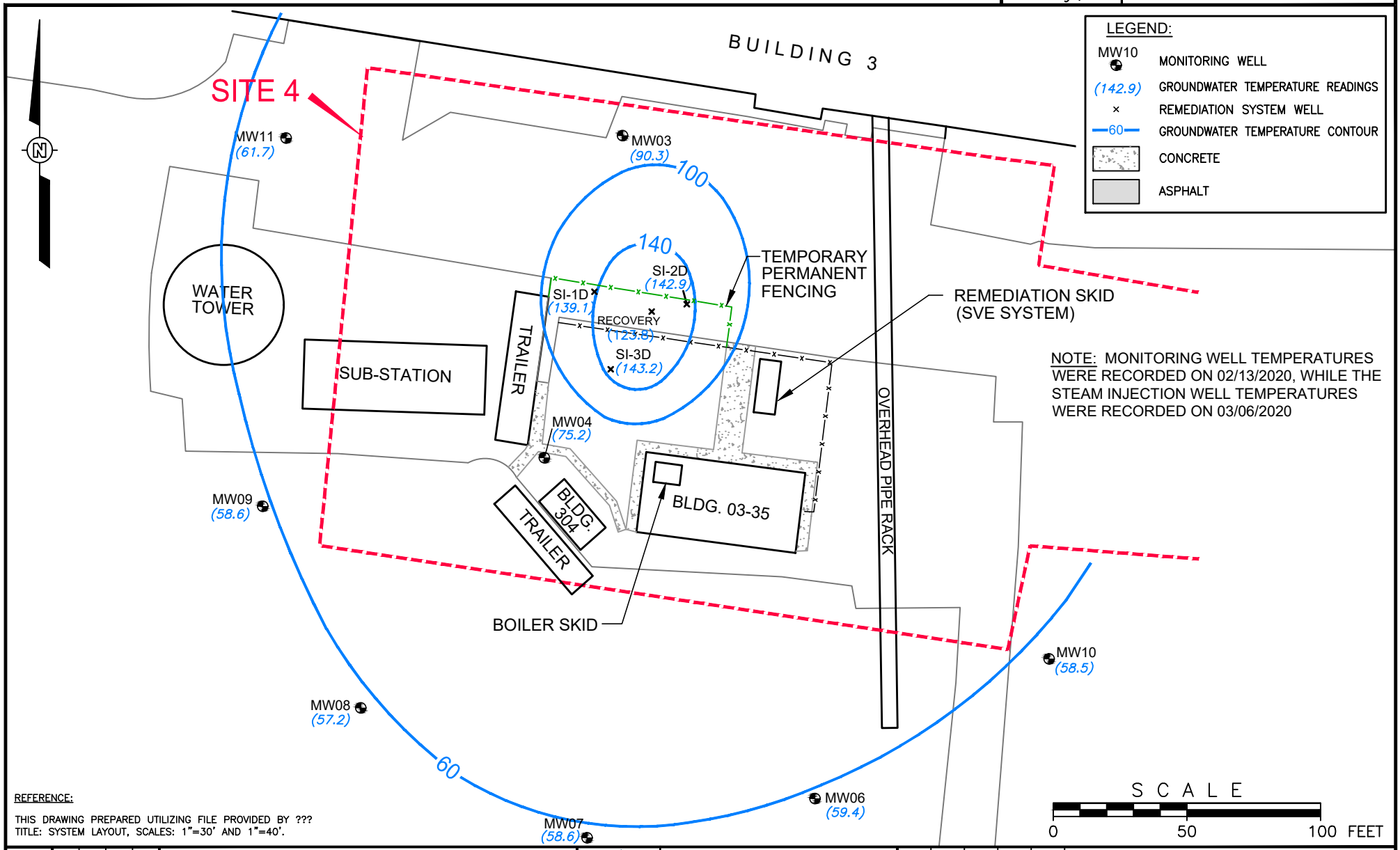
SHEET I.D. FIGURE 2	NAVFAC Naval Facilities Engineering Command MID-ATLANTIC	APTIM	APTIM Federal Services, LLC 150 Boush Street, Suite 701 Norfolk, Virginia 23510		
NAVFAC DRAWING NO. --	NAVAL WEAPONS INDUSTRIAL RESERVE PLANT SITE 4 BETHPAGE, NEW YORK	DESIGNED BY M. Smeal	DATE 8/14/19	CHECKED BY	DATE
CONSTR. CONTRACT NO. N62470-16-D-9004	SITE PLAN	DRAWN BY B. O'Connor	DATE 8/14/19	APPROVED BY	DATE
DELIVERY ORDER NO. WE03					
SCALE: AS SHOWN					
SIZE: A					

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE

REVISIONS

File: O:\project\LANTDIV\Bethpage NY\500809\509809-A1.dwg
Plot Date/Time: Mar 27, 2020 - 8:54am
Plotted By: bernadette.oconnor

OFFICE	DRAWING NUMBER
Pittsburgh, PA	500809-A1



REFERENCE:

THIS DRAWING PREPARED UTILIZING FILE PROVIDED BY ???
TITLE: SYSTEM LAYOUT, SCALES: 1"=30' AND 1"=40'.

FIGURE 3
SHEET I.D.

NAVFAC DRAWING NO. --
CONSTR. CONTRACT NO. N62470-16-D-9004
DELIVERY ORDER NO. WE03
SCALE: AS SHOWN
SIZE: A

NAVFAC Naval Facilities Engineering Command MID-ATLANTIC

NAVAL WEAPONS INDUSTRIAL RESERVE PLANT BETHPAGE, NEW YORK
SITE 4
GROUNDWATER TEMPERATURE 60' BGS

APTIM

APTIM Federal Services, LLC
150 Boush Street, Suite 701
Norfolk, Virginia 23510

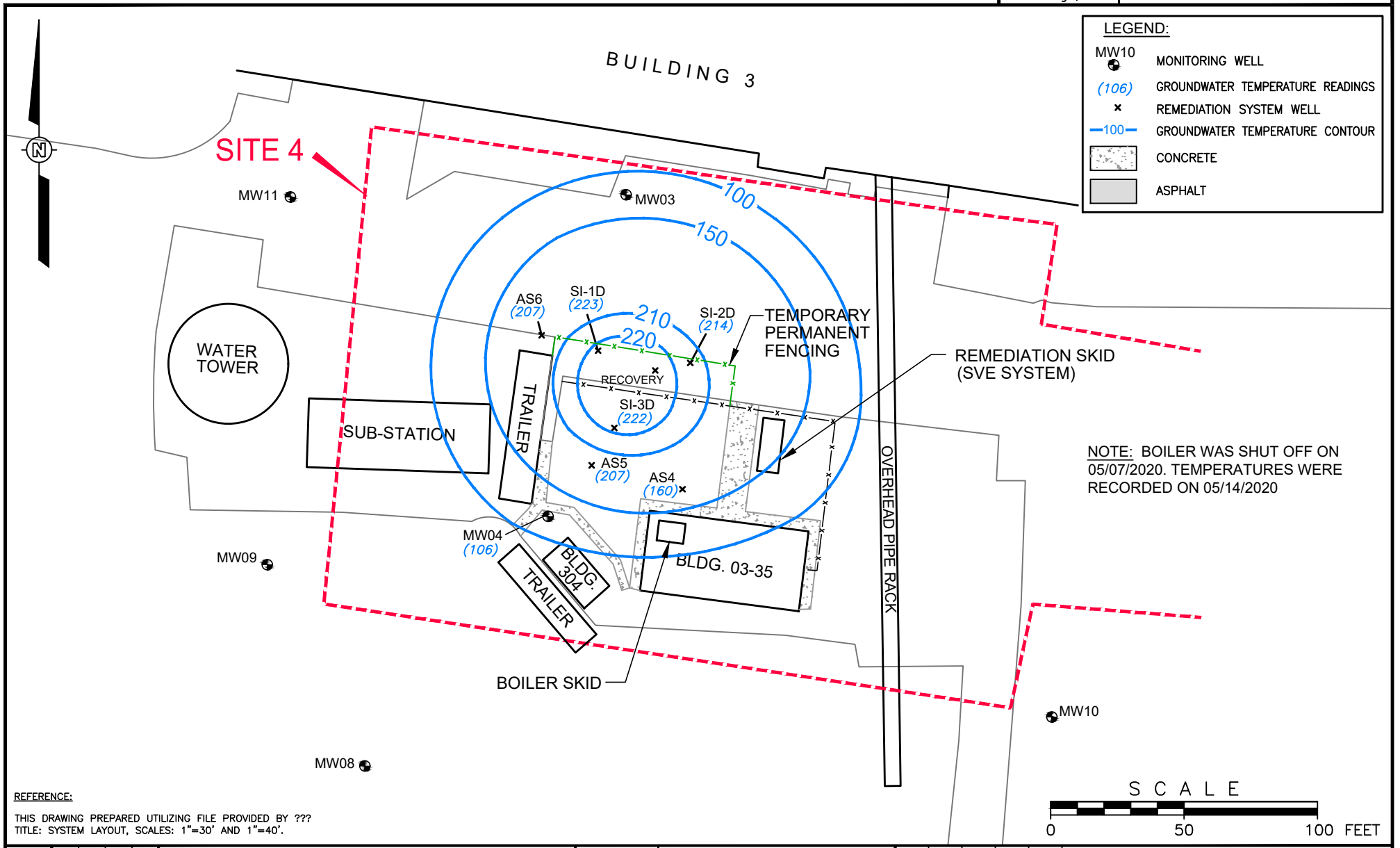
DESIGNED BY	DATE	CHECKED BY	DATE
M. Smeal	3/26/20		
DRAWN BY	DATE	APPROVED BY	DATE
B. O'Connor	3/26/20		

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE

REVISIONS

File: O:\project\LANTDIV\Bethpage NY\500809\509809-A2.dwg
Plot Date/Time: May 19, 2020 - 6:46pm
Plotted By: bernadette.oconnor

OFFICE	DRAWING NUMBER
Pittsburgh, PA	500809-A2



REFERENCE:

THIS DRAWING PREPARED UTILIZING FILE PROVIDED BY ???
TITLE: SYSTEM LAYOUT, SCALES: 1"=30' AND 1"=40'.

FIGURE 3A

SHEET I.D. --
NAVFAC DRAWING NO. --
CONSTR. CONTRACT NO. N62470-16-D-9004
DELIVERY ORDER NO. WE03
SCALE: AS SHOWN
SIZE: A

NAVFAC Naval Facilities Engineering Command MID-ATLANTIC

NAVAL WEAPONS INDUSTRIAL RESERVE PLANT BETHPAGE, NEW YORK
SITE 4
GROUNDWATER TEMPERATURE 60' BGS - 05/14/2020

APTIM

APTIM Federal Services, LLC
150 Boush Street, Suite 701
Norfolk, Virginia 23510

DESIGNED BY	DATE	CHECKED BY	DATE
M. Smeal	5/19/20		
DRAWN BY	DATE	APPROVED BY	DATE
B. O'Connor	5/19/20		

REV	DATE	BY	CHK'D	APR'VD	DESCRIPTION/ISSUE

REVISIONS

TABLES

Table 1
Historical Soil Vapor Analytical Results
Baseline through February 2020
Site 4
NWIRP Bethpage, New York

Station ID		SV-1		
Sample ID	**Project**	BETHP-S4-SV-01	BETHP-S4-SV-09	BETHP-S4-SV-22
Lab Sample ID	**Action**	320-45795-1	140-17437-4	140-18393-4
Sample Date	**Limit[1]**	12/04/18	11/22/19	02/26/20
Chemical Name				
Volatile Organic Compounds (ppb v/v)				
Benzene	---	**0.62**	**0.12 J**	**0.10 J**
Ethylbenzene	---	**0.18 J**	**0.091 J**	0.065 U
m-Xylene & p-Xylene	---	**0.39 J**	**0.29 J**	0.15 U
o-Xylene	---	**0.10 J**	**0.13 J**	0.075 U
Volatile Organic Compounds (µg/m^3)				
Benzene	12.0	**2.00**	**0.37 J**	**0.32 J**
Ethylbenzene	37.0	**0.78 J**	**0.40 J**	0.28 U
m-Xylene & p-Xylene	350	**1.70 J**	**1.20 J**	0.63 U
o-Xylene	350	**0.45 J**	**0.57**	0.33 U
PID (ppm)	---	NR	NR	0.00

Notes:
Bold concentrations indicates detections
Shaded cells indicate Project Action Level exceedances
U - analyte is not detected above the stated result
µg/m^3 - Micrograms per cubis meter
ppb v/v - part per billion by volume
ppm - part per million
J - Estimated
NR - Not recorded

[1]Table 2-3 – Groundwater Cleanup Levels from Final SAP/QAPP Site 4 – Former Underground Storage Tanks Former NWIRP Bethpage; Bethpage, New York (Aug 2017).

Table 1
Historical Soil Vapor Analytical Results
Baseline through February 2020
Site 4
NWIRP Bethpage, New York

Station ID		SV-3		
Sample ID	**Project**	BETHP-S4-SV-02	BETHP-S4-SV-07	BETHP-S4-SV-21
Lab Sample ID	**Action**	320-45795-2	140-17437-2	140-18393-3
Sample Date	**Limit[1]**	12/04/18	11/22/19	02/26/20
Chemical Name				
Volatile Organic Compounds (ppb v/v)				
Benzene	---	**0.41**	**1.30**	**0.45**
Ethylbenzene	---	**0.32 J**	**0.31 J**	0.065 U
m-Xylene & p-Xylene	---	**1.10**	**1.30**	0.15 U
o-Xylene	---	**0.34 J**	**0.59**	0.075 U
Volatile Organic Compounds (µg/m^3)				
Benzene	12.0	**1.30**	**4.20**	**1.40**
Ethylbenzene	37.0	**1.40 J**	**1.40 J**	0.28 U
m-Xylene & p-Xylene	350	**4.80**	**5.60**	0.63 U
o-Xylene	350	**1.50 J**	**2.60**	0.33 U
PID (ppm)	---	NR	0.00	0.00

Notes:
Bold concentrations indicates detections
Shaded cells indicate Project Action Level exceedances
U - analyte is not detected above the stated result
µg/m^3 - Micrograms per cubis meter
ppb v/v - part per billion by volume
ppm - part per million
J - Estimated
NR - Not recorded

[1]Table 2-3 – Groundwater Cleanup Levels from Final SAP/QAPP Site 4 – Former Underground Storage Tanks Former NWIRP Bethpage; Bethpage, New York (Aug 2017).

Table 1
Historical Soil Vapor Analytical Results
Baseline through February 2020
Site 4
NWIRP Bethpage, New York

Station ID		**SV-5**		
Sample ID	**Project**	NS[2]	BETHP-S4-SV-13	BETHP-S4-SV-20
Lab Sample ID	**Action**		140-17437-8	140-18393-2
Sample Date	**Limit[1]**		11/22/19	02/26/20
Chemical Name				
Volatile Organic Compounds (ppb v/v)				
Benzene	---	NS	**0.45 J**	**0.12 J**
Ethylbenzene	---	NS	**0.38 J**	0.065 U
m-Xylene & p-Xylene	---	NS	**1.40**	0.15 U
o-Xylene	---	NS	**0.65 J**	0.075 U
Volatile Organic Compounds (µg/m^3)				
Benzene	12.0	NS	**1.40 J**	**0.39 J**
Ethylbenzene	37.0	NS	**1.70 J**	0.28 U
m-Xylene & p-Xylene	350	NS	**5.90**	0.63 U
o-Xylene	350	NS	**2.80**	0.33 U
PID (ppm)	---	NR	**0.30**	0.00

Notes:
Bold concentrations indicates detections
Shaded cells indicate Project Action Level exceedances
U - analyte is not detected above the stated result
µg/m^3 - Micrograms per cubis meter
ppb v/v - part per billion by volume
ppm - part per million
J - Estimated
NR - Not recorded
NS - Not sampled

[1]Table 2-3 – Groundwater Cleanup Levels from Final SAP/QAPP Site 4 – Former Underground Storage Tanks Former NWIRP Bethpage; Bethpage, New York (Aug 2017).

[2] SV-05 was not sampled during the baseline sampling event due to sand in the line.

Table 1
Historical Soil Vapor Analytical Results
Baseline through February 2020
Site 4
NWIRP Bethpage, New York

Station ID		SV-6		
Sample ID	**Project**	BETHP-S4-SV-04	BETHP-S4-SV-08	BETHP-S4-SV-19
Lab Sample ID	**Action**	320-45795-3	140-17437-3	140-18393-1
Sample Date	**Limit[1]**	12/04/18	11/22/19	2/26/2020
Chemical Name				
Volatile Organic Compounds (ppb v/v)				
Benzene	---	**0.62**	**0.39 J**	**0.093 J**
Ethylbenzene	---	**0.1 J**	**0.33 J**	0.065 U
m-Xylene & p-Xylene	---	**0.21 J**	**1.40**	0.15 U
o-Xylene	---	**0.071 J**	**0.70**	0.075 U
Volatile Organic Compounds (µg/m^3)				
Benzene	12.0	**2.00**	**1.30 J**	**0.30 J**
Ethylbenzene	37.0	**0.44 J**	**1.40 J**	0.28 U
m-Xylene & p-Xylene	350	**0.93 J**	**6.20**	0.63 U
o-Xylene	350	**0.31 J**	**3.00**	0.33 U
PID (ppm)	---	NR	0.00	0.00

Notes:
Bold concentrations indicates detections
Shaded cells indicate Project Action Level exceedances
U - analyte is not detected above the stated result
µg/m^3 - Micrograms per cubis meter
ppb v/v - part per billion by volume
ppm - part per million
J - Estimated
NR - Not recorded

[1]Table 2-3 – Groundwater Cleanup Levels from Final SAP/QAPP Site 4 – Former Underground Storage Tanks Former NWIRP Bethpage; Bethpage, New York (Aug 2017).

Table 1
Historical Soil Vapor Analytical Results
Baseline through February 2020
Site 4
NWIRP Bethpage, New York

Station ID		SV-9		
Sample ID	**Project**	BETHP-S4-SV-05	BETHP-S4-SV-06	BETHP-S4-SV-23
Lab Sample ID	**Action**	320-45795-4	140-17437-1	140-18393-5
Sample Date	**Limit[1]**	12/04/18	11/22/19	02/26/20
Chemical Name				
Volatile Organic Compounds (ppb v/v)				
Benzene	---	**0.25 J**	**0.10 J**	**0.072 J**
Ethylbenzene	---	**0.33 J**	**0.14 J**	0.065 U
m-Xylene & p-Xylene	---	**0.79 J**	**0.38 J**	0.15 U
o-Xylene	---	**0.26 J**	**0.15 J**	0.075 U
Volatile Organic Compounds (µg/m^3)				
Benzene	12.0	**0.79 J**	**0.32 J**	**0.23 J**
Ethylbenzene	37.0	**1.40 J**	**0.62 J**	0.28 U
m-Xylene & p-Xylene	350	**3.40 J**	**1.60 J**	0.63 U
o-Xylene	350	**1.10 J**	**0.65**	0.33 U
PID (ppm)	---	NR	**0.20**	0.00

Notes:
Bold concentrations indicates detections
Shaded cells indicate Project Action Level exceedances
U - analyte is not detected above the stated result
µg/m^3 - Micrograms per cubis meter
ppb v/v - part per billion by volume
ppm - part per million
J - Estimated
NR - Not recorded

[1]Table 2-3 – Groundwater Cleanup Levels from Final SAP/QAPP Site 4 – Former Underground Storage Tanks Former NWIRP Bethpage; Bethpage, New York (Aug 2017).

Table 1a
Historical Soil Vapor Analytical Results
Baseline through February 2020
Site 4
NWIRP Bethpage, New York

Station ID		SVE INFLUENT	SVE MID-FLUENT	SVE EFFLUENT	SVE INFLUENT	SVE MID-FLUENT	SVE EFFLUENT
Sample ID	**Project**	BETHP-S4-SV-10	BETHP-S4-SV-12	BETHP-S4-SV-11	BETHP-S4-SV-24	BETHP-S4-SV-25	BETHP-S4-SV-26
Lab Sample ID	**Action**	320-45795-5	320-45795-7	140-17437-6	140-18393-6	NS[2]	140-18393-8
Sample Date	**Limit[1]**	11/22/19	11/22/19	11/22/19	02/26/20	02/26/20	02/26/20
Chemical Name							
Volatile Organic Compounds (ppb v/v)							
Benzene	---	**20.0**	**0.18 J**	**0.29 J**	**210 J**	NS	**22.0**
Ethylbenzene	---	**1.70**	**0.079 J**	**0.074 J**	**0.43 M**	NS	**1.10**
m-Xylene & p-Xylene	---	**9.60**	**0.27 J**	**0.27 J**	**2.00 M**	NS	**6.50**
o-Xylene	---	**2.30**	**0.12 J**	**0.12 J**	**0.40**	NS	**1.40**
Volatile Organic Compounds (µg/m^3)							
Benzene	12.0	**64.0**	**0.57 J**	**0.94 J**	**660**	NS	**70.0**
Ethylbenzene	37.0	**7.40**	**0.34 J**	**0.32 J**	**1.90 M**	NS	**4.90**
m-Xylene & p-Xylene	350	**42.0**	**1.20 J**	**1.20 J**	**8.60**	NS	**28.0**
o-Xylene	350	**9.90**	**0.53**	**0.52 J**	**1.70**	NS	**5.90**
PID (ppm)	---	NR	**6.10**	**2.80**	**28.2**	**89.5**	**72.1**

Notes:
Bold concentrations indicates detections
Shaded cells indicate Project Action Level exceedances
U - analyte is not detected above the stated result
M - manually integrated compound
µg/m^3 - Micrograms per cubis meter
ppb v/v - part per billion by volume
ppm - part per million
J - Estimated
NR - Not recorded

[1]Table 2-3 – Groundwater Cleanup Levels from Final SAP/QAPP Site 4 – Former Underground Storage Tanks Former NWIRP Bethpage; Bethpage, New York (Aug 2017).
[2]NS - Not Sampled; Sample was compromised during shipping to the laboratory.

Table 2
Historical Soil Analytical Results
Baseline July 2017
Site 4
NWIRP Bethpage, New York

		Baseline			
Sample Location	**Project**	ETHP-S4-SB-300	BETHP-S4-SB-304	BETHP-S4-SB-305	BETHP-S4-SB-306
Lab Sample ID	**Action**	L17071177-01	L17071177-02	L17071177-03	L17071177-04
Sample Date	**Limit[1]**	07/22/17	07/22/2017	07/21/17	07/23/17
Chemical Name					
Semi Volatile Organic Compounds (µg/L)					
Benzo(a)anthracene	1,000	**472 J**	**921 J**	**456 J**	**351 J**
Benzo(a)pyrene	1,000	**714 J**	**698 J**	**330 J**	**239 J**
Benzo(b)fluoranthene	1,000	482 U	596 U	582 U	316 U
Chrysene	1,000	**839 J**	**1,600**	**781 J**	**614 J**
Naphthalene	12,000	**1,170**	**2,400**	582 U	316 U

Notes:

Bold concentrations indicates detections

Shaded cells indicate Project Action Level exceedances

U - analyte is not detected above the stated result

µg/L - Micrograms per liter

J - Estimated

[1]Table 2-2 – Soil Cleanup Levels from Final SAP/QAPP Site 4 – Former Underground Storage Tanks Former NWIRP Bethpage;

Bethpage, New York (Aug 2017).

[2] Sample ID BETHP-S4-MW-12 is a duplicate of BETHP-S4-MW-06

Table 3
Historical Groundwater Analytical Results
August 2017 through February 2020
Site 4
NWIRP Bethpage, New York

Station ID		MW-03			
Sample ID	Project	BETHP-S4-MW-03	BETHP-S4-MW-03	BETHP-S4-MW-03	BETHP-S4-MW-03
Lab Sample ID	Action	L17081354-01	L19070150-01	L19110033-03	M0B1011-01
Sample Date	Limit[1]	08/24/17	07/29/19	11/05/19	02/13/20
Chemical Name					
Volatile Organic Compounds (µg/L)					
Benzene	5.0	0.25 U	0.25 U	0.25 U	0.25 U
Ethylbenzene	5.0	0.50 U	0.50 U	0.50 U	0.50 U
Xylenes	5.0	1.00 U	1.00 U	1.00 U	1.00 U
Metals (µg/L)					
Cobalt, Total	6.0	**6.86**	**6.19**	**6.83**	**6.37**
Manganese, Total	430	**172**	**403**	**527**	**340**
Semivolatile Organic Compounds (µg/L)					
Naphthalene	6.1	0.44 U	0.50 U	1.00 U	0.435 U
Pentachlorophenol	1.0	2.20 U	2.00 U	4.00 U	2.17 U

Notes:
Bold concentrations indicates detections
Shaded cells indicate Project Action Level exceedances
U - analyte is not detected above the stated result
µg/L - Micrograms per liter
J - Estimated

[1]Table 2-3 – Groundwater Cleanup Levels from Final SAP/QAPP Site 4 – Former Underground Storage Tanks Former NWIRP Bethpage; Bethpage, New York (Aug 2017).

Table 3
Historical Groundwater Analytical Results
August 2017 through February 2020
Site 4
NWIRP Bethpage, New York

Station ID		MW-04						
Sample ID	**Project**	BETHP-S4-MW-04	BETHP-S4-MW-04	BETHP-S4-MW-12[2]	BETHP-S4-MW-04	BETHP-S4-MW-12[2]	BETHP-S4-MW-04	BETHP-S4-MW-12[2]
Lab Sample ID	**Action**	L17081285-01	L19070150-02	L19070150-09	L19110033-06	L19110033-07	M0B1011-02	M0B1011-03
Sample Date	**Limit[1]**	08/23/17	07/29/19	07/29/19	11/05/19	11/05/19	02/13/20	02/13/20
Chemical Name								
Volatile Organic Compounds (µg/L)								
Benzene	5.0	**0.913**	0.25 U	0.25 U	**0.98**	**0.985**	**0.915**	**0.85**
Ethylbenzene	5.0	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Xylenes	5.0	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Metals (µg/L)								
Cobalt, Total	6.0	**27.0**	**11.1**	**13.2**	**70.5**	**74.0**	**76.6**	**74.6**
Manganese, Total	430	**547**	**766**	**864**	**5,880**	**6,230**	**4,880**	**4,840**
Semivolatile Organic Compounds (µg/L)								
Naphthalene	6.1	0.43 U	0.50 U	0.50 U	1.00 U	1.00 U	0.40 U	0.40 U
Pentachlorophenol	1.0	2.18 U	2.00 U	2.00 U	4.00 U	4.00 U	2.00 U	2.00 U

Notes:

Bold concentrations indicates detections

Shaded cells indicate Project Action Level exceedances

U - analyte is not detected above the stated result

µg/L - Micrograms per liter

J - Estimated

[1]Table 2-3 – Groundwater Cleanup Levels from Final SAP/QAPP Site 4 – Former Underground Storage Tanks Former NWIRP Bethpage; Bethpage, New York (Aug 2017).

[2] Sample ID BETHP-S4-MW-12 is a duplicate of BETHP-S4-MW-04

Table 3
Historical Groundwater Analytical Results
August 2017 through February 2020
Site 4
NWIRP Bethpage, New York

Station ID		MW-06				
Sample ID	**Project**	BETHP-S4-MW-06	BETHP-S4-MW-12[2]	BETHP-S4-MW-06	BETHP-S4-MW-06	BETHP-S4-MW-06
Lab Sample ID	**Action**	L17081354-02	L17081354-04	L19070150-03	L19110021-01	M0B1011-04
Sample Date	**Limit[1]**	08/24/17	08/24/17	07/29/19	11/04/19	02/13/20
Chemical Name						
Volatile Organic Compounds (µg/L)						
Benzene	5.0	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
Ethylbenzene	5.0	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Xylenes	5.0	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Metals (µg/L)						
Cobalt, Total	6.0	**5.81**	**5.94**	**1.00 J**	**1.01 J**	1.00 U
Manganese, Total	430	**449**	**452**	**48.2**	**53.3**	**83.2**
Semivolatile Organic Compounds (µg/L)						
Naphthalene	6.1	0.44 U	0.43 U	0.50 U	0.544 U	0.400 U
Pentachlorophenol	1.0	2.20 U	2.16 U	**2.00 U**	2.18 U	2.00 U

Notes:
Bold concentrations indicates detections
Shaded cells indicate Project Action Level exceedances
U - analyte is not detected above the stated result
µg/L - Micrograms per liter
J - Estimated

[1]Table 2-3 – Groundwater Cleanup Levels from Final SAP/QAPP Site 4 – Former Underground Storage Tanks Former NWIRP Bethpage; Bethpage, New York (Aug 2017).

[2] Sample ID BETHP-S4-MW-12 is a duplicate of BETHP-S4-MW-06

Table 3
Historical Groundwater Analytical Results
August 2017 through February 2020
Site 4
NWIRP Bethpage, New York

Station ID		MW-07			
Sample ID	**Project**	BETHP-S4-MW-07	BETHP-S4-MW-07	BETHP-S4-MW-07	BETHP-S4-MW-07
Lab Sample ID	**Action**	L17081285-02	L19070150-04	L19110033-02	M0B1011-05
Sample Date	**Limit**[1]	08/22/17	07/29/19	11/05/19	02/13/20
Chemical Name					
Volatile Organic Compounds (µg/L)					
Benzene	5.0	0.25 U	0.25 U	0.25 U	0.25 U
Ethylbenzene	5.0	0.50 U	0.50 U	0.50 U	0.50 U
Xylenes	5.0	1.00 U	1.00 U	1.00 U	1.00 U
Metals (µg/L)					
Cobalt, Total	6.0	**2.12**	**1.08 J**	**0.93 J**	1.00 U
Manganese, Total	430	**147**	**47.5**	**91.0**	**103**
Semivolatile Organic Compounds (µg/L)					
Naphthalene	6.1	0.44 U	0.50 U	1.00 U	0.44 U
Pentachlorophenol	1.0	2.22 U	2.00 U	4.00 U	2.20 U

Notes:

Bold concentrations indicates detections

Shaded cells indicate Project Action Level exceedances

U - analyte is not detected above the stated result

µg/L - Micrograms per liter

J - Estimated

[1]Table 2-3 – Groundwater Cleanup Levels from Final SAP/QAPP Site 4 – Former Underground Storage Tanks Former NWIRP Bethpage; Bethpage, New York (Aug 2017).

Table 3
Historical Groundwater Analytical Results
August 2017 through February 2020
Site 4
NWIRP Bethpage, New York

Station ID		MW-08			
Sample ID	**Project**	BETHP-S4-MW-08	BETHP-S4-MW-08	BETHP-S4-MW-08	BETHP-S4-MW-08
Lab Sample ID	**Action**	L17081354-03	L19070150-05	L19110033-01	M0B1011-06
Sample Date	**Limit[1]**	08/24/17	07/29/19	11/05/19	02/13/20
Chemical Name					
Volatile Organic Compounds (µg/L)					
Benzene	5.0	0.25 U	0.25 U	0.25 U	0.25 U
Ethylbenzene	5.0	0.50 U	0.50 U	0.50 U	0.50 U
Xylenes	5.0	1.00 U	1.00 U	1.00 U	1.00 U
Metals (µg/L)					
Cobalt, Total	6.0	**0.59 J**	1.00 U	**0.881 J**	1.00 U
Manganese, Total	430	**66.0**	**15.1**	**6.62**	**20.1**
Semivolatile Organic Compounds (µg/L)					
Naphthalene	6.1	0.43 U	0.51 U	0.526 U	0.455 U
Pentachlorophenol	1.0	2.12 U	2.04 U	2.10 U	2.27 U

Notes:

Bold concentrations indicates detections

Shaded cells indicate Project Action Level exceedances

U - analyte is not detected above the stated result

µg/L - Micrograms per liter

J - Estimated

[1]Table 2-3 – Groundwater Cleanup Levels from Final SAP/QAPP Site 4 – Former Underground Storage Tanks Former NWIRP Bethpage; Bethpage, New York (Aug 2017).

Table 3
Historical Groundwater Analytical Results
August 2017 through February 2020
Site 4
NWIRP Bethpage, New York

Station ID		MW-09			
Sample ID	**Project**	BETHP-S4-MW-09	BETHP-S4-MW-09	BETHP-S4-MW-09	BETHP-S4-MW-09
Lab Sample ID	**Action**	L17081285-03	L19070150-06	L19110033-04	M0B1011-07
Sample Date	**Limit**[1]	08/22/17	07/29/19	11/05/19	02/13/20
Chemical Name					
Volatile Organic Compounds (µg/L)					
Benzene	5.0	0.25 U	0.25 U	0.25 U	0.25 U
Ethylbenzene	5.0	0.50 U	0.50 U	0.50 U	0.50 U
Xylenes	5.0	1.00 U	1.00 U	1.00 U	1.00 U
Metals (µg/L)					
Cobalt, Total	6.0	1.00 U	1.00 U	1.00 U	1.00 U
Manganese, Total	430	**1.78 J**	**12.6**	**12.4**	**35.7**
Semivolatile Organic Compounds (µg/L)					
Naphthalene	6.1	0.47 U	0.51 U	0.544 U	0.444 U
Pentachlorophenol	1.0	2.36 U	2.04 U	2.18 U	2.22 U

Notes:

Bold concentrations indicates detections

Shaded cells indicate Project Action Level exceedances

U - analyte is not detected above the stated result

µg/L - Micrograms per liter

J - Estimated

[1]Table 2-3 – Groundwater Cleanup Levels from Final SAP/QAPP Site 4 – Former Underground Storage Tanks Former NWIRP Bethpage; Bethpage, New York (Aug 2017).

Table 3
Historical Groundwater Analytical Results
August 2017 through February 2020
Site 4
NWIRP Bethpage, New York

Station ID		MW-10			
Sample ID	Project	BETHP-S4-MW-10	BETHP-S4-MW-10	BETHP-S4-MW-10	BETHP-S4-MW-10
Lab Sample ID	Action	L17081285-04	L19070150-07	L19110021-02	M0B1011-08
Sample Date	Limit[1]	08/22/17	07/29/19	11/04/19	02/13/20
Chemical Name					
Volatile Organic Compounds (µg/L)					
Benzene	5.0	0.25 U	0.25 U	0.25 U	0.25 U
Ethylbenzene	5.0	0.50 U	0.50 U	0.50 U	0.50 U
Xylenes	5.0	1.00 U	1.00 U	1.00 U	1.00 U
Metals (µg/L)					
Cobalt, Total	6.0	1.00 U	1.00 U	1.00 U	1.00 U
Manganese, Total	430	**2.75 J**	**130**	**56.4**	**71.2**
Semivolatile Organic Compounds (µg/L)					
Naphthalene	6.1	0.44 U	0.51 U	0.50 U	0.40 U
Pentachlorophenol	1.0	2.20 U	2.04 U	2.00 U	2.00 U

Notes:

Bold concentrations indicates detections

Shaded cells indicate Project Action Level exceedances

U - analyte is not detected above the stated result

µg/L - Micrograms per liter

J - Estimated

[1]Table 2-3 – Groundwater Cleanup Levels from Final SAP/QAPP Site 4 – Former Underground Storage Tanks Former NWIRP Bethpage; Bethpage, New York (Aug 2017).

Table 3
Historical Groundwater Analytical Results
August 2017 through February 2020
Site 4
NWIRP Bethpage, New York

Station ID		MW-11			
Sample ID	**Project**	BETHP-S4-MW-11	BETHP-S4-MW-11	BETHP-S4-MW-11	BETHP-S4-MW-11
Lab Sample ID	**Action**	L17081285-05	L19070150-08	L19110033-05	M0B1011-09
Sample Date	**Limit**[1]	08/22/17	07/29/19	11/05/19	02/13/20
Chemical Name					
Volatile Organic Compounds (µg/L)					
Benzene	5.0	0.25 U	0.25 U	0.25 U	0.25 U
Ethylbenzene	5.0	0.50 U	0.50 U	0.50 U	0.50 U
Xylenes	5.0	1.00 U	1.00 U	1.00 U	1.00 U
Metals (µg/L)					
Cobalt, Total	6.0	1.00 U	**0.618 J**	1.00 U	**15.4**
Manganese, Total	430	**3.63 J**	**10.5**	**4.75**	**298**
Semivolatile Organic Compounds (µg/L)					
Naphthalene	6.1	0.47 U	2.50 U	0.52 U	2.30 U
Pentachlorophenol	1.0	2.32 U	10.0 **U**	2.08 U	11.50 U

Notes:

Bold concentrations indicates detections

Shaded cells indicate Project Action Level exceedances

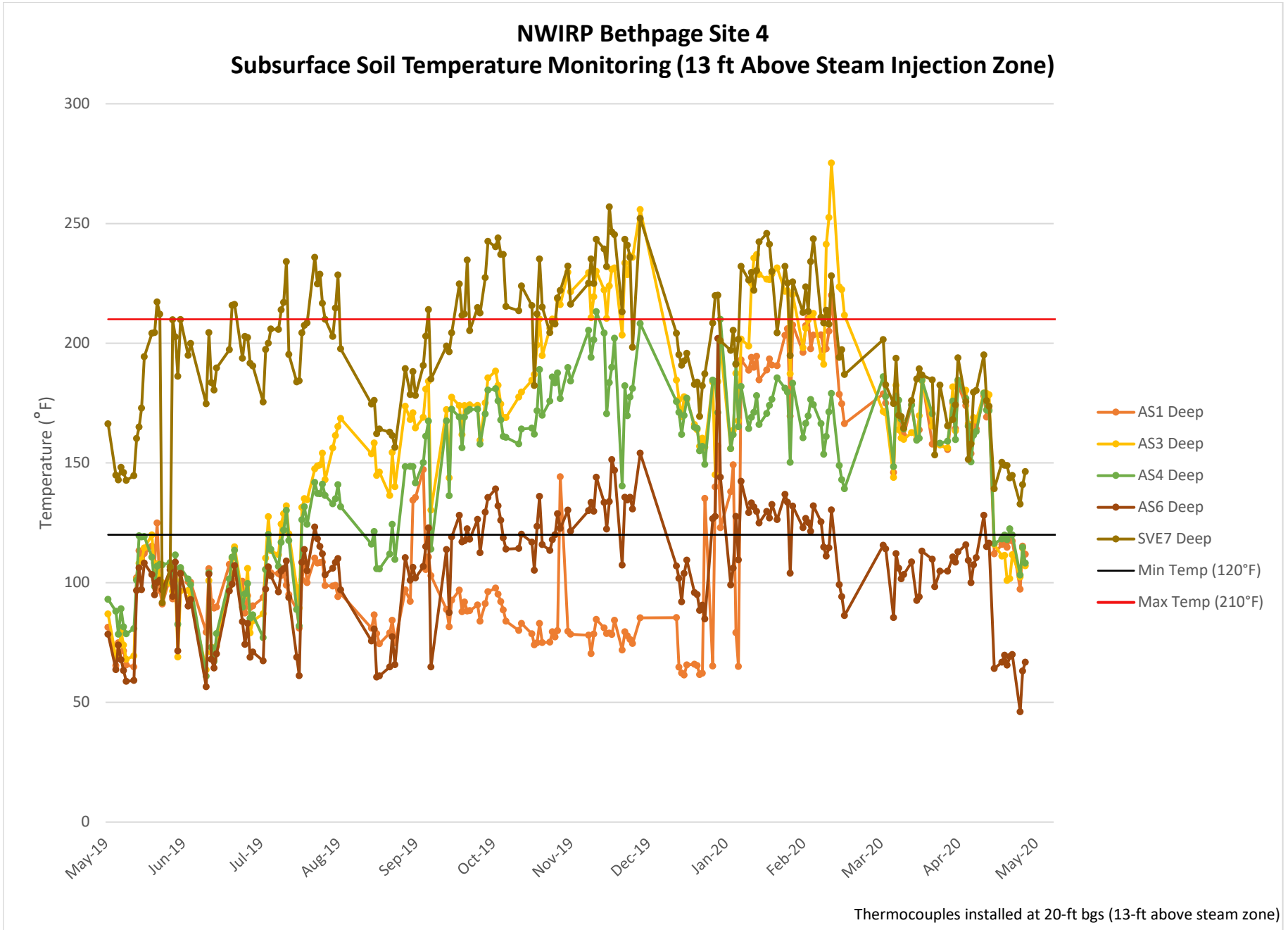
U - analyte is not detected above the stated result

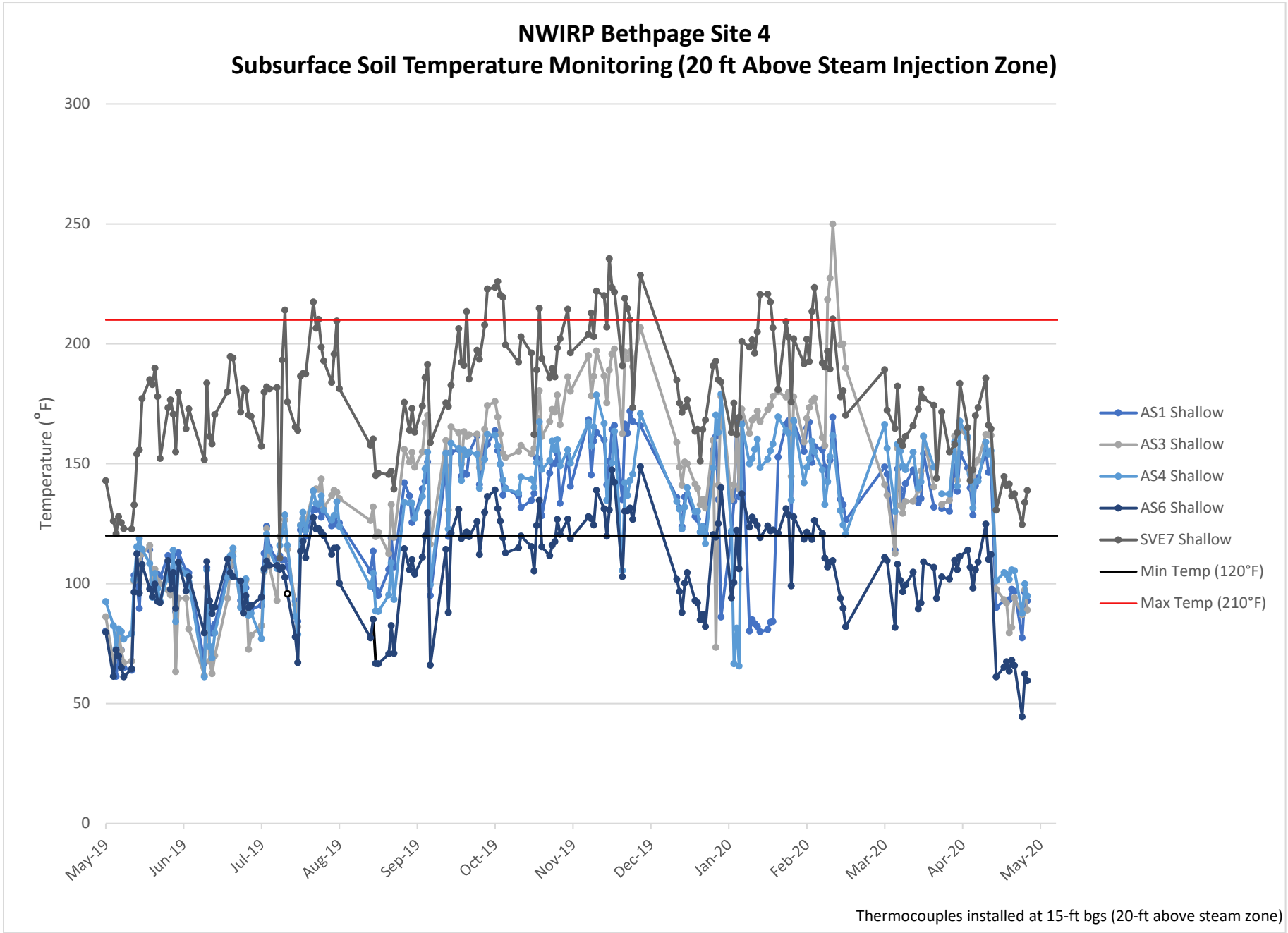
µg/L - Micrograms per liter

J - Estimated

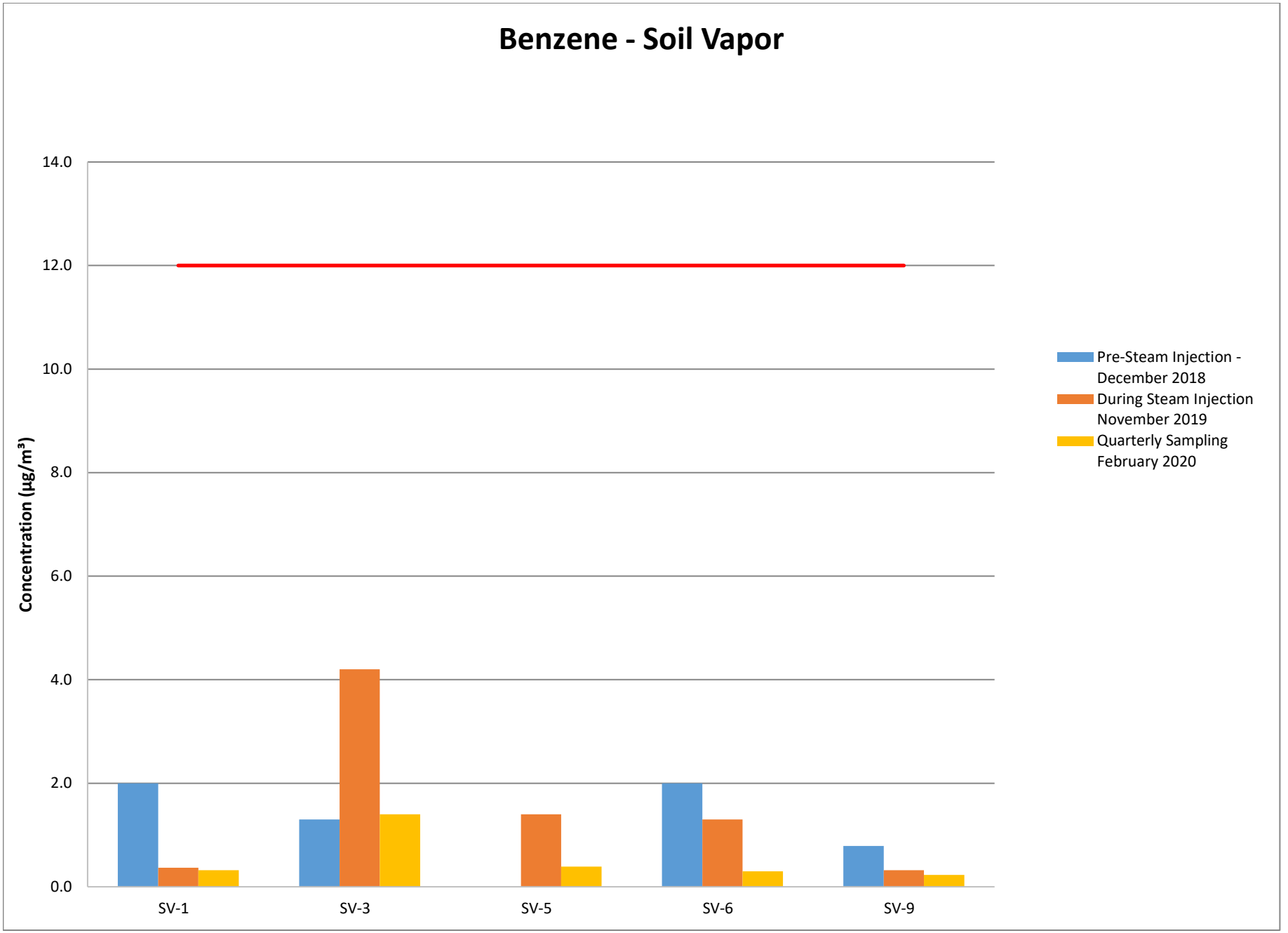
[1]Table 2-3 – Groundwater Cleanup Levels from Final SAP/QAPP Site 4 – Former Underground Storage Tanks Former NWIRP Bethpage; Bethpage, New York (Aug 2017).

ATTACHMENT A

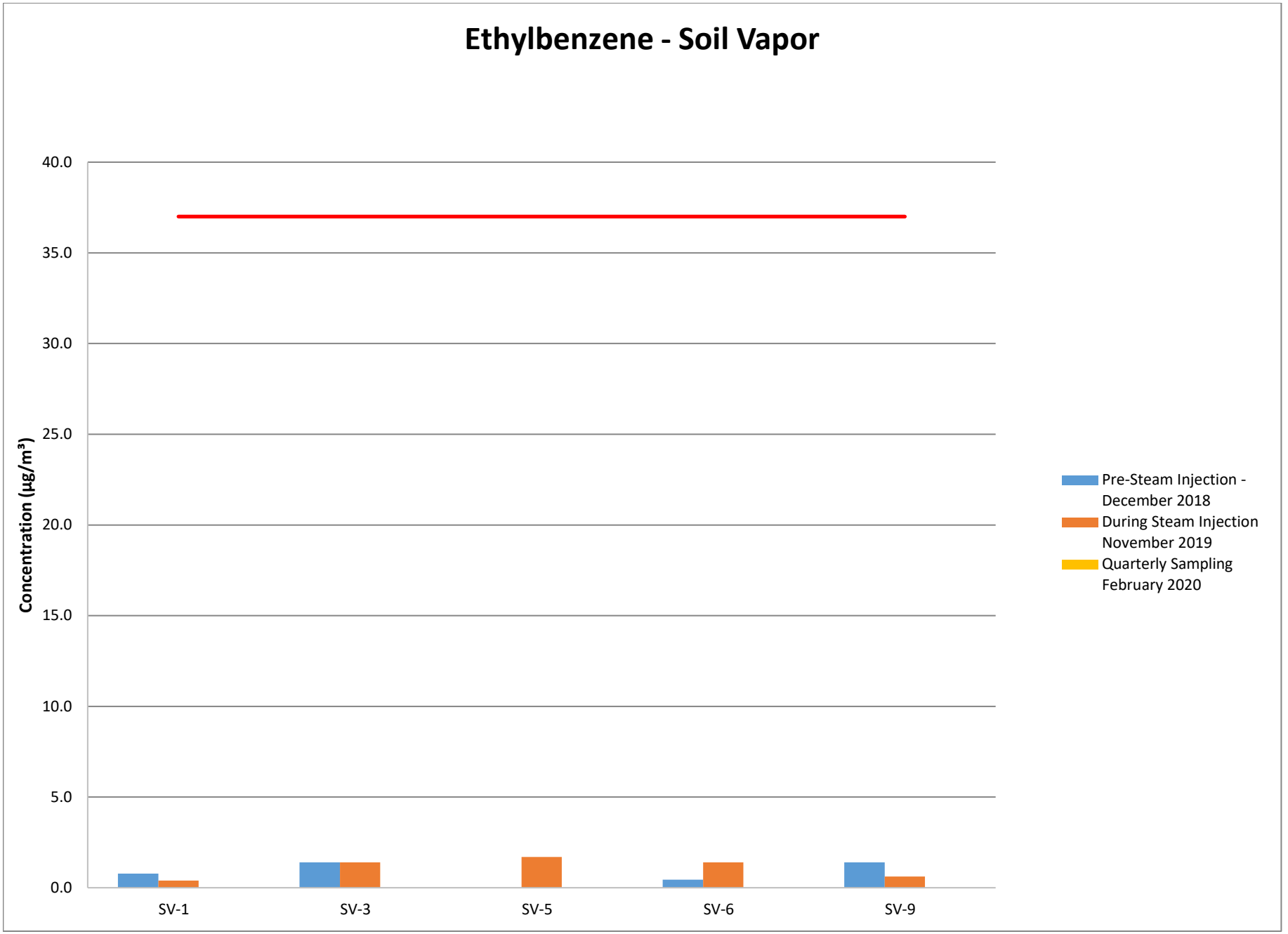

NWIRP Bethpage Site 4
Subsurface Soil Temperature Monitoring (13 ft Above Steam Injection Zone)
Temperature (°F)
300
250
200
150
100
50
0
May-19
Jun-19
Jul-19
Aug-19
Sep-19
Oct-19
Nov-19
Dec-19
Jan-20
Feb-20
Mar-20
Apr-20
May-20
AS1 Deep
AS3 Deep
AS4 Deep
AS6 Deep
SVE7 Deep
Min Temp (120°F)
Max Temp (210°F)
Thermocouples installed at 20-ft bgs (13-ft above steam zone)


NWIRP Bethpage Site 4
Subsurface Soil Temperature Monitoring (20 ft Above Steam Injection Zone)
Temperature (°F)
300
250
200
150
100
50
0
May-19
Jun-19
Jul-19
Aug-19
Sep-19
Oct-19
Nov-19
Dec-19
Jan-20
Feb-20
Mar-20
Apr-20
May-20
AS1 Shallow
AS3 Shallow
AS4 Shallow
AS6 Shallow
SVE7 Shallow
Min Temp (120°F)
Max Temp (210°F)
Thermocouples installed at 15-ft bgs (20-ft above steam zone)

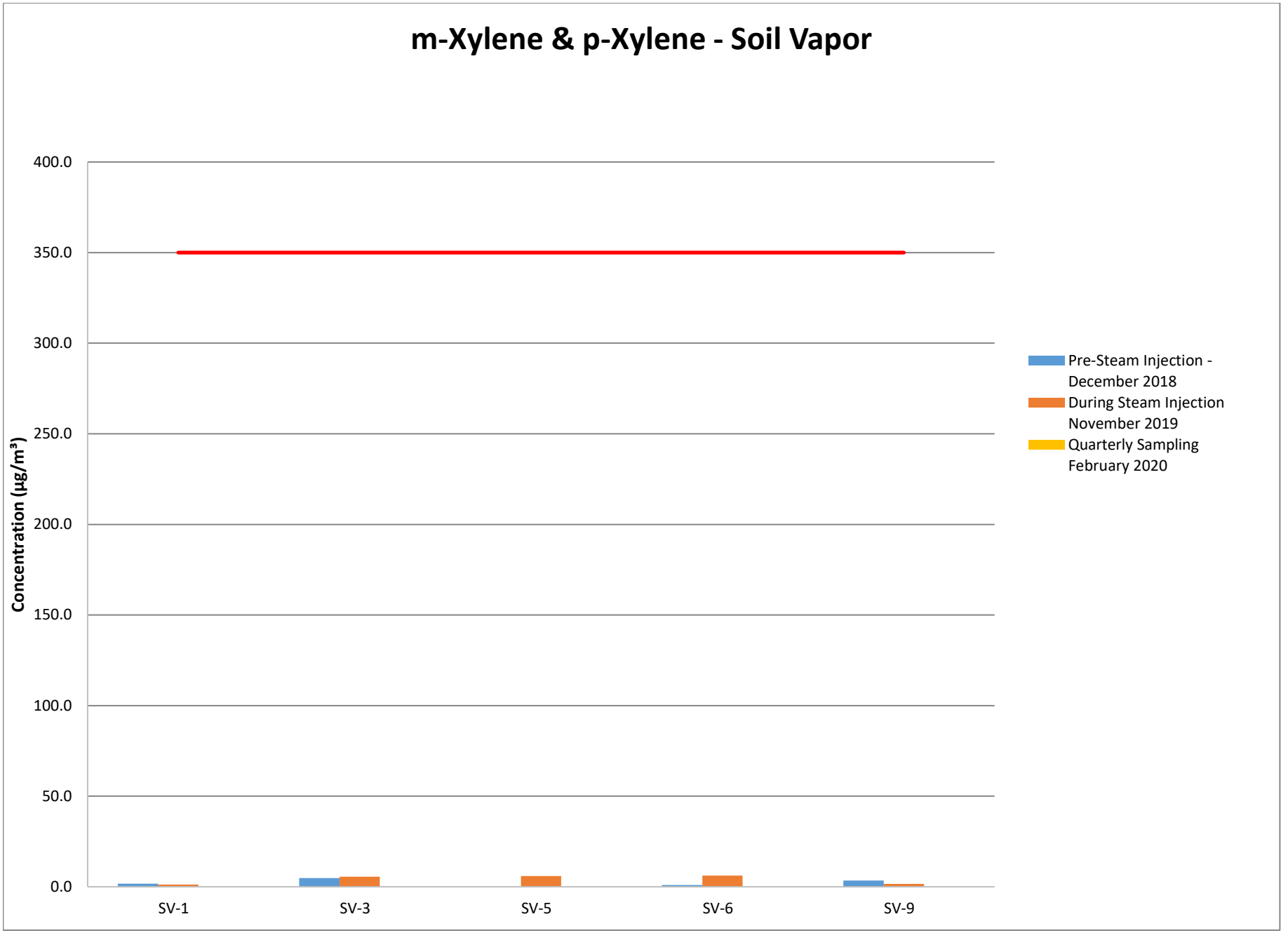
ATTACHMENT B



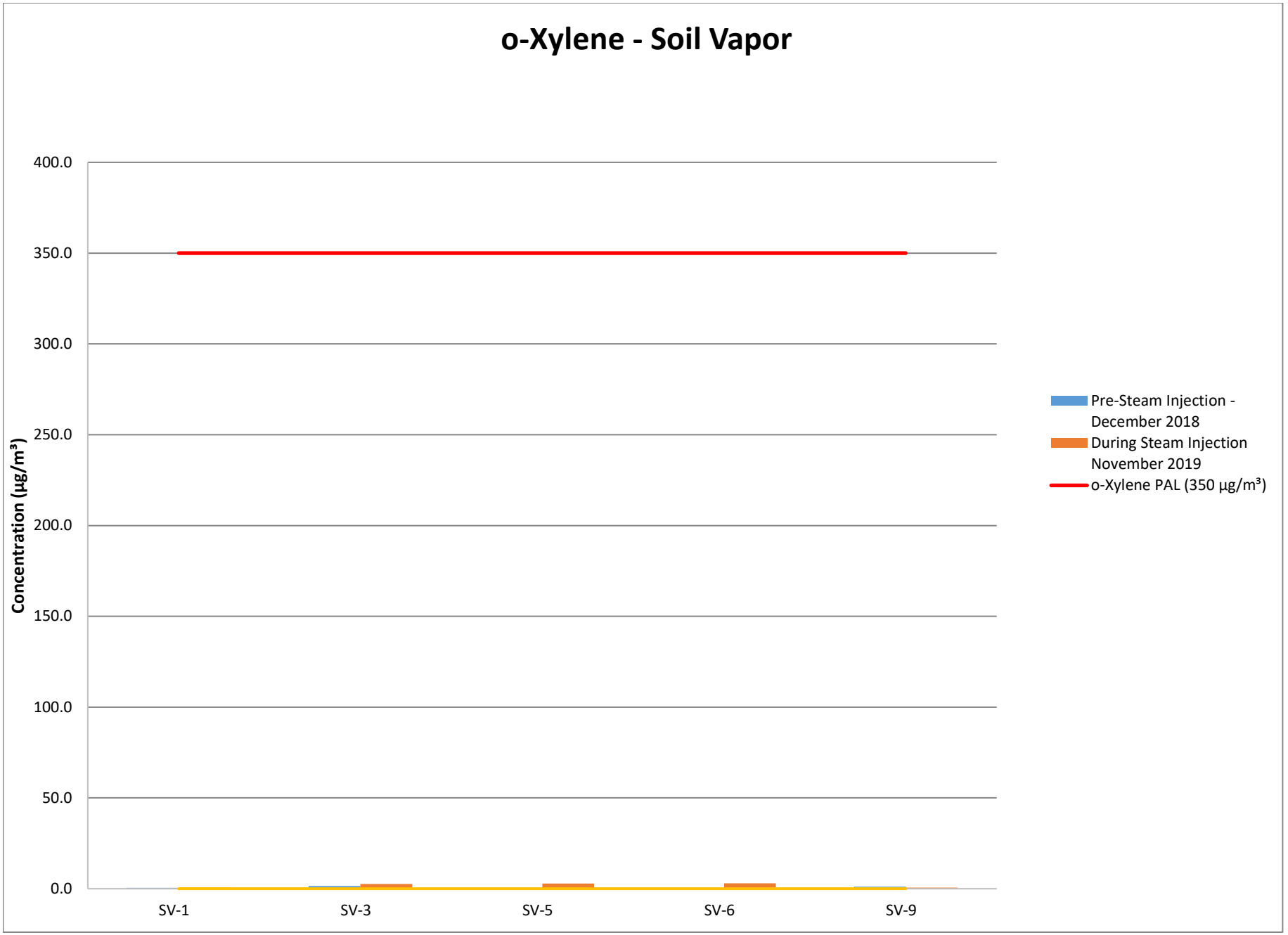
Note: SV-05 was not sampled Pre-Steam Injection



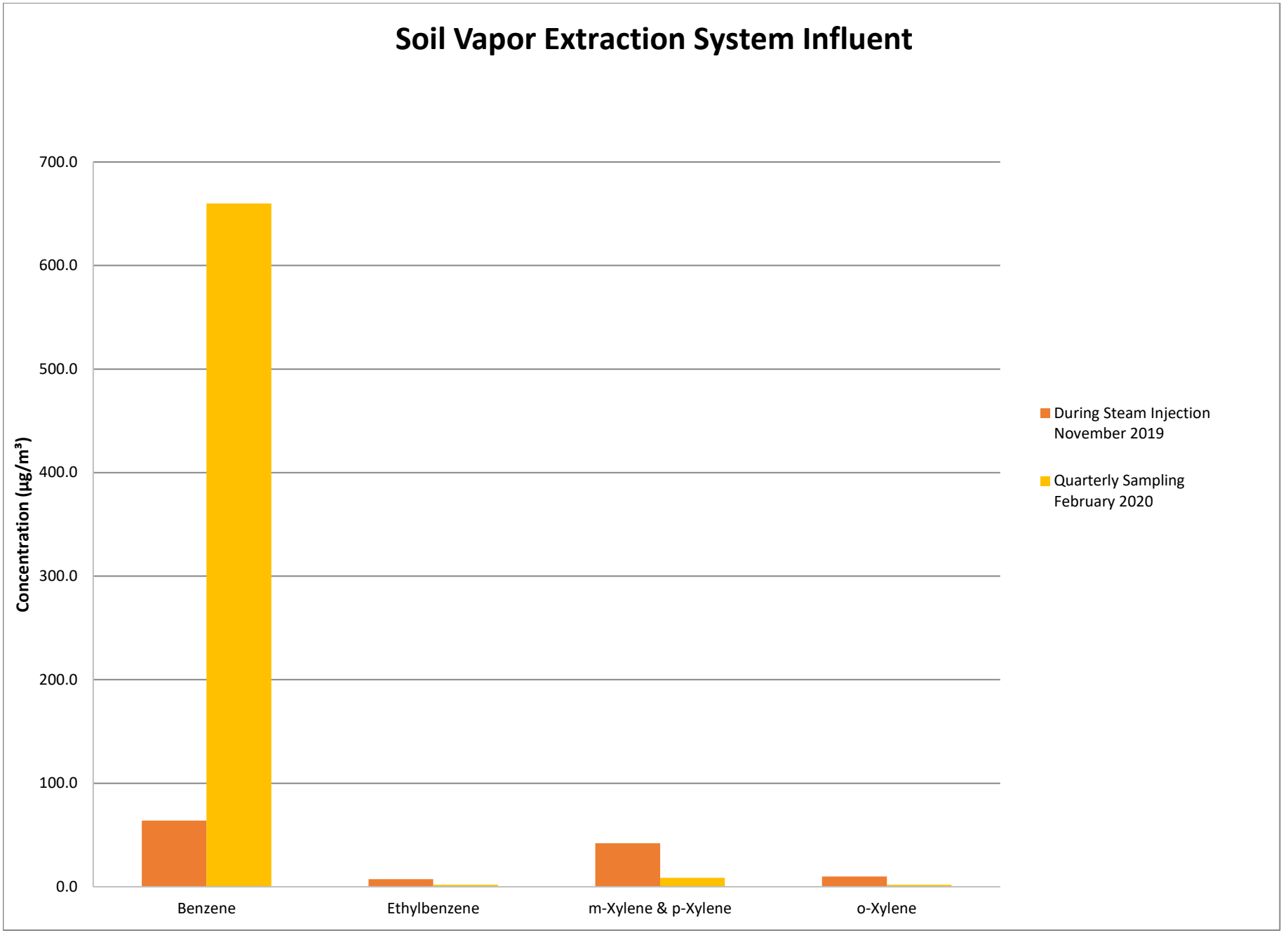
Note: SV-05 was not sampled Pre-Steam Injection

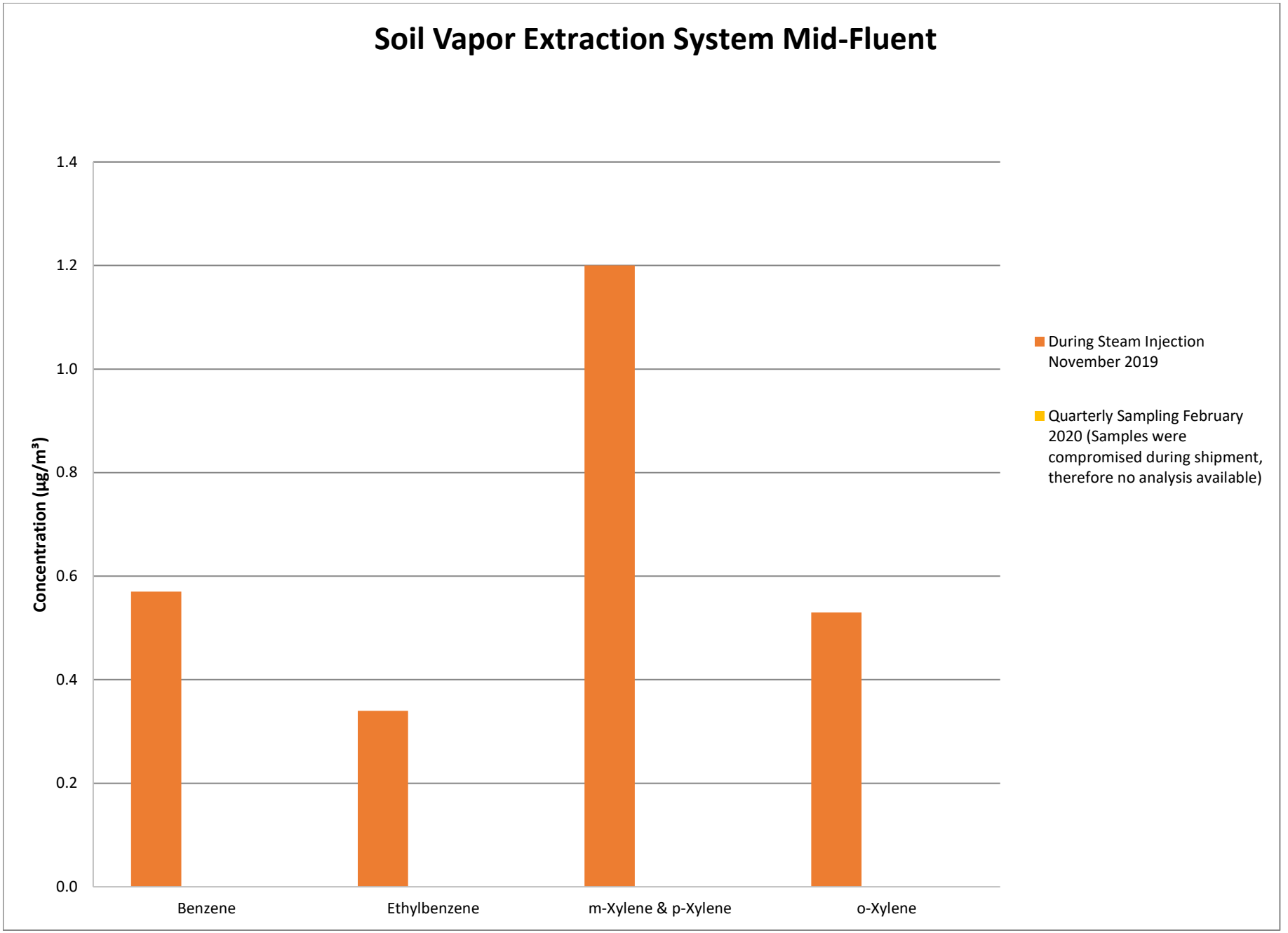


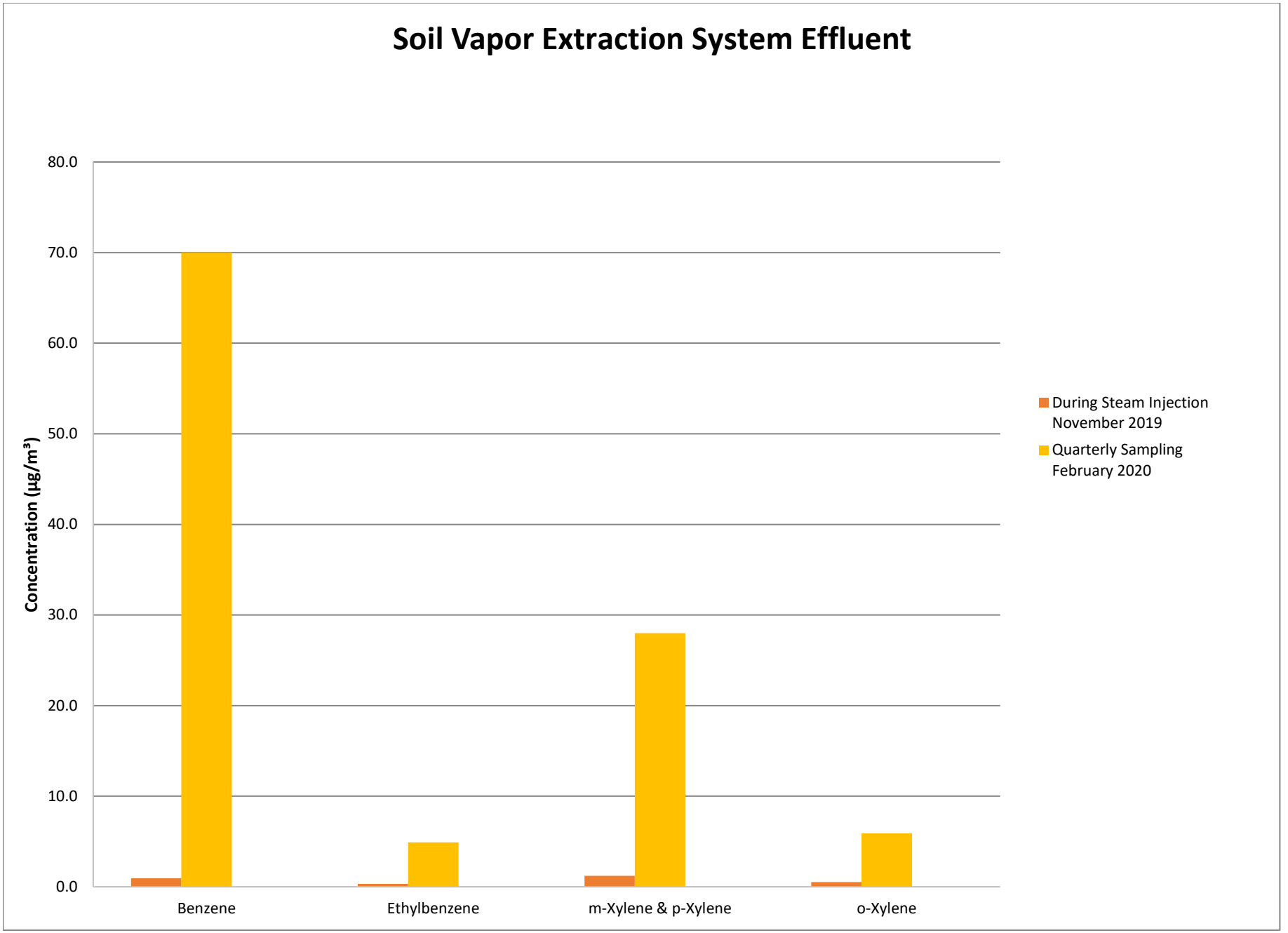
Note: SV-05 was not sampled Pre-Steam Injection



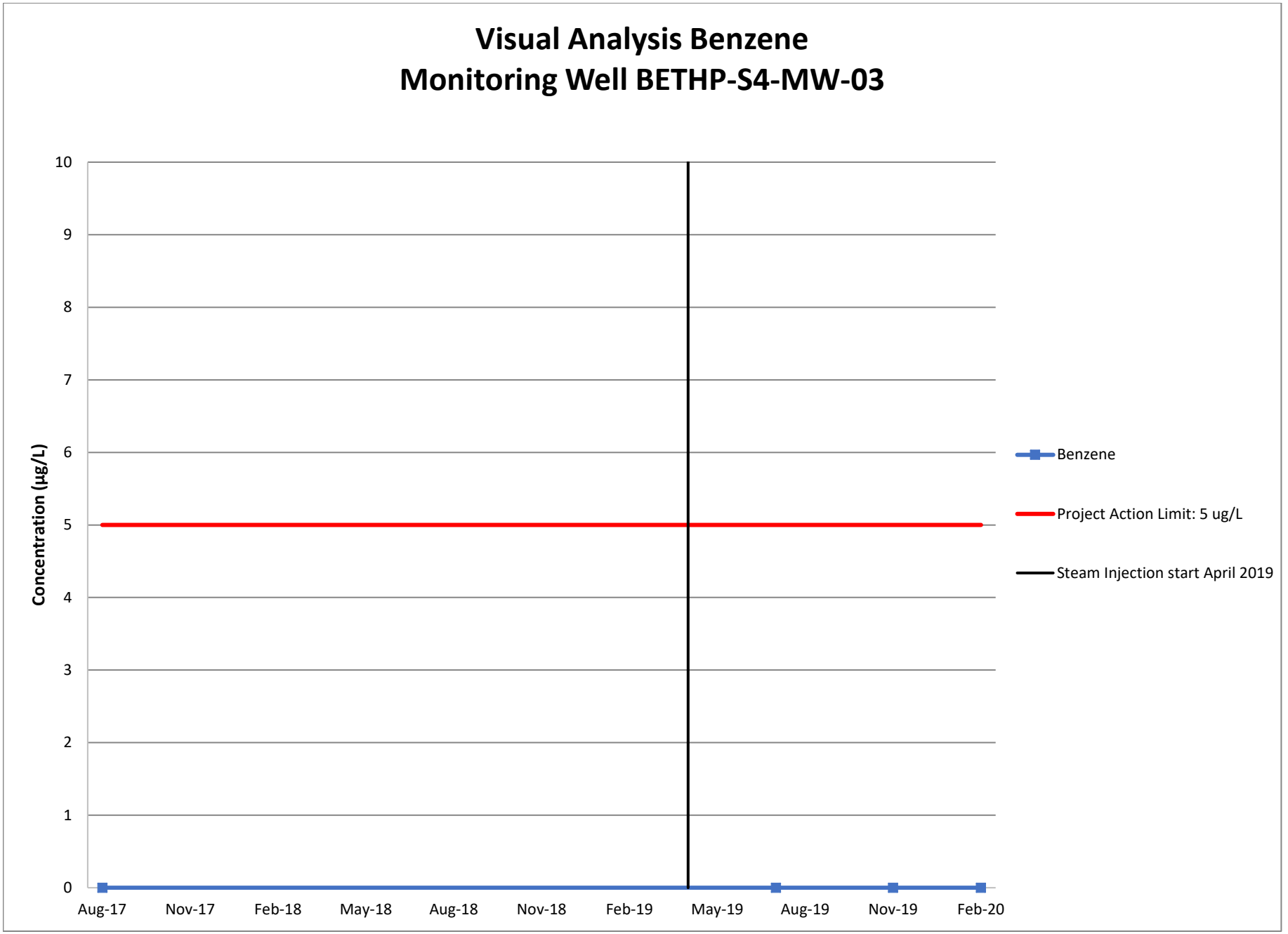
Note: SV-5 was not sampled Pre-Steam Injection


Soil Vapor Extraction System Influent
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
Concentration (µg/m³)
Benzene
Ethylbenzene
m-Xylene & p-Xylene
o-Xylene
During Steam Injection November 2019
Quarterly Sampling February 2020

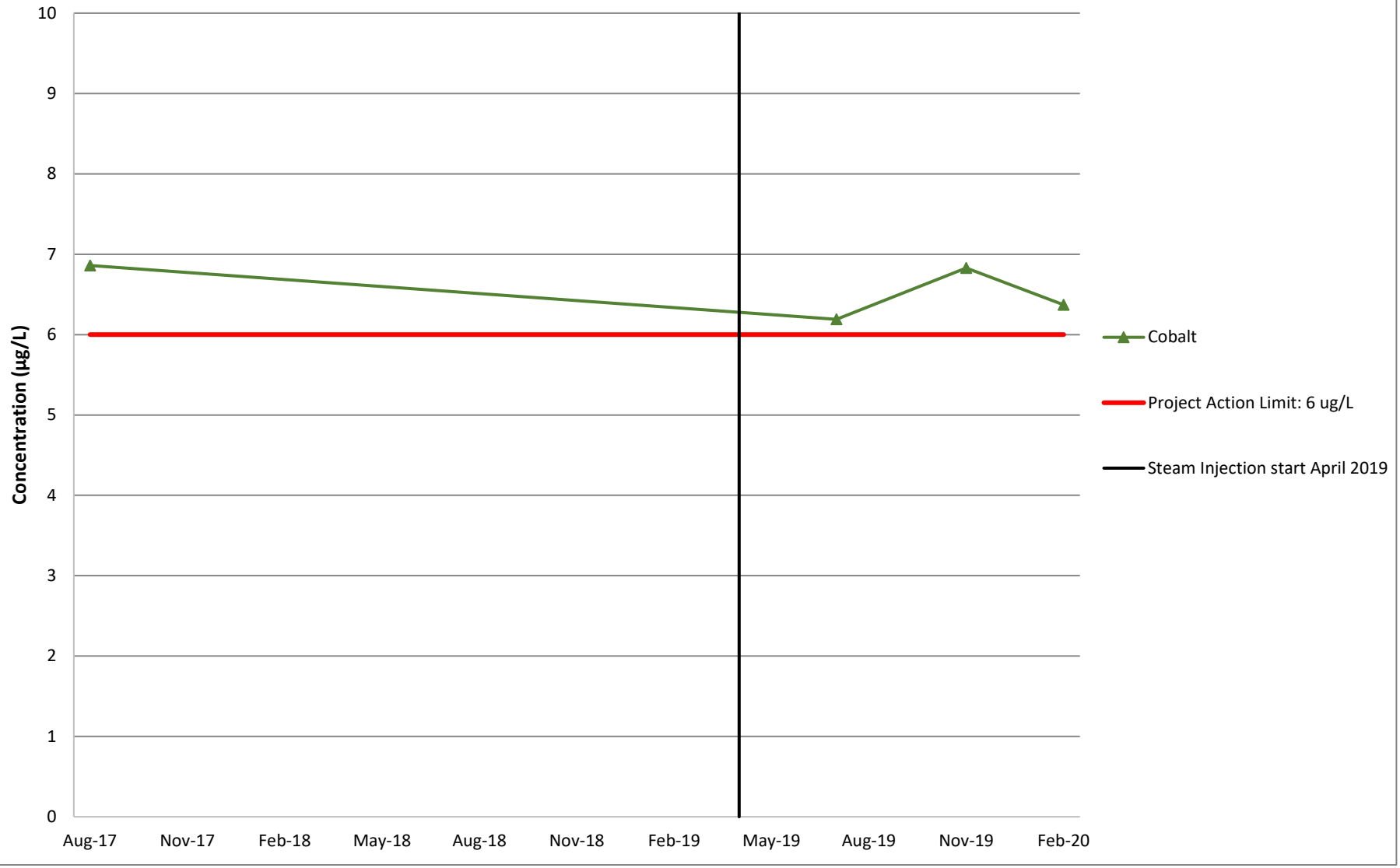

Soil Vapor Extraction System Mid-Fluent
Concentration (µg/m³)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Benzene
Ethylbenzene
m-Xylene & p-Xylene
o-Xylene
During Steam Injection November 2019
Quarterly Sampling February 2020 (Samples were compromised during shipment, therefore no analysis available)

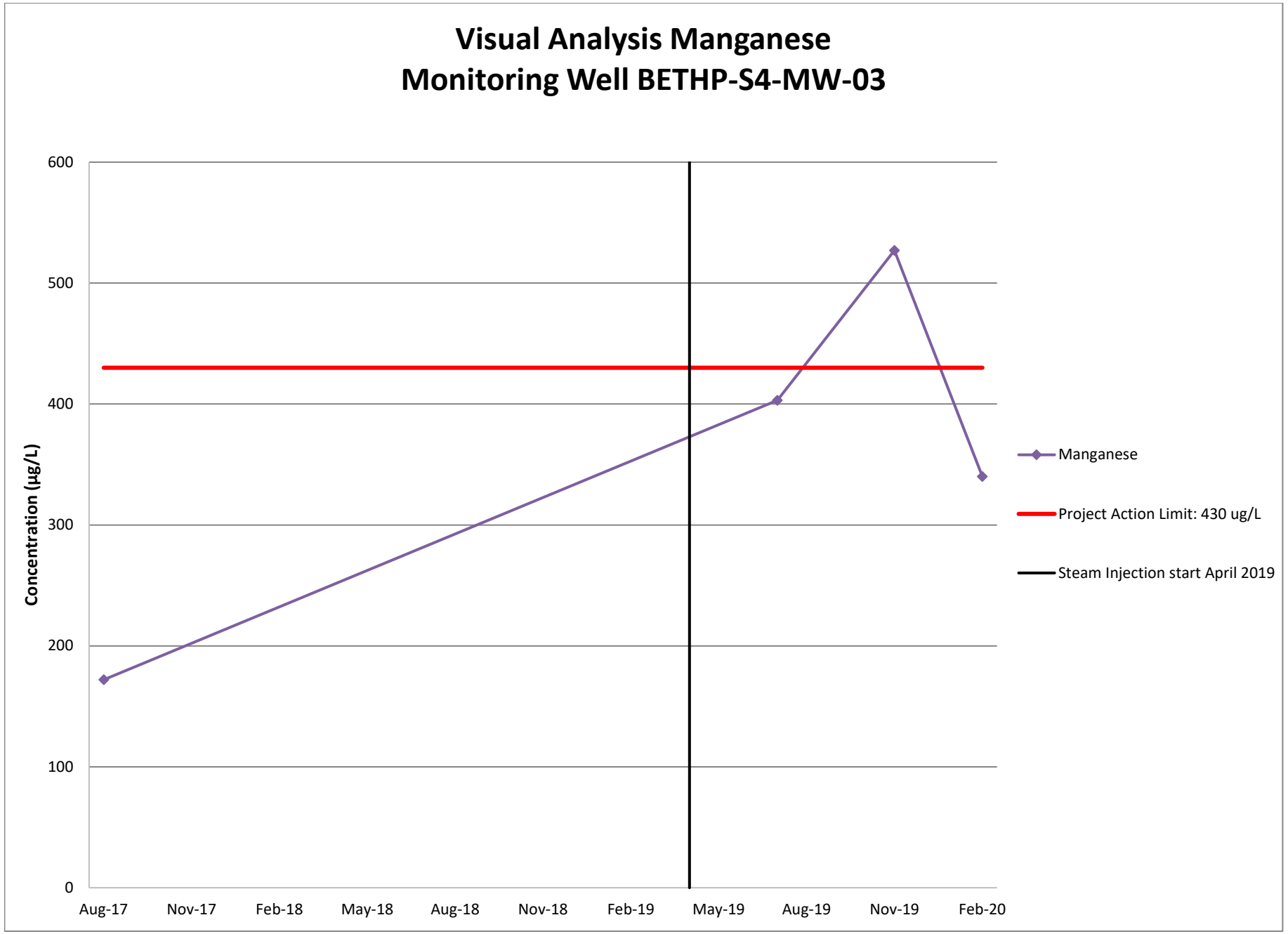

Soil Vapor Extraction System Effluent
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Concentration (µg/m³)
Benzene
Ethylbenzene
m-Xylene & p-Xylene
o-Xylene
During Steam Injection November 2019
Quarterly Sampling February 2020

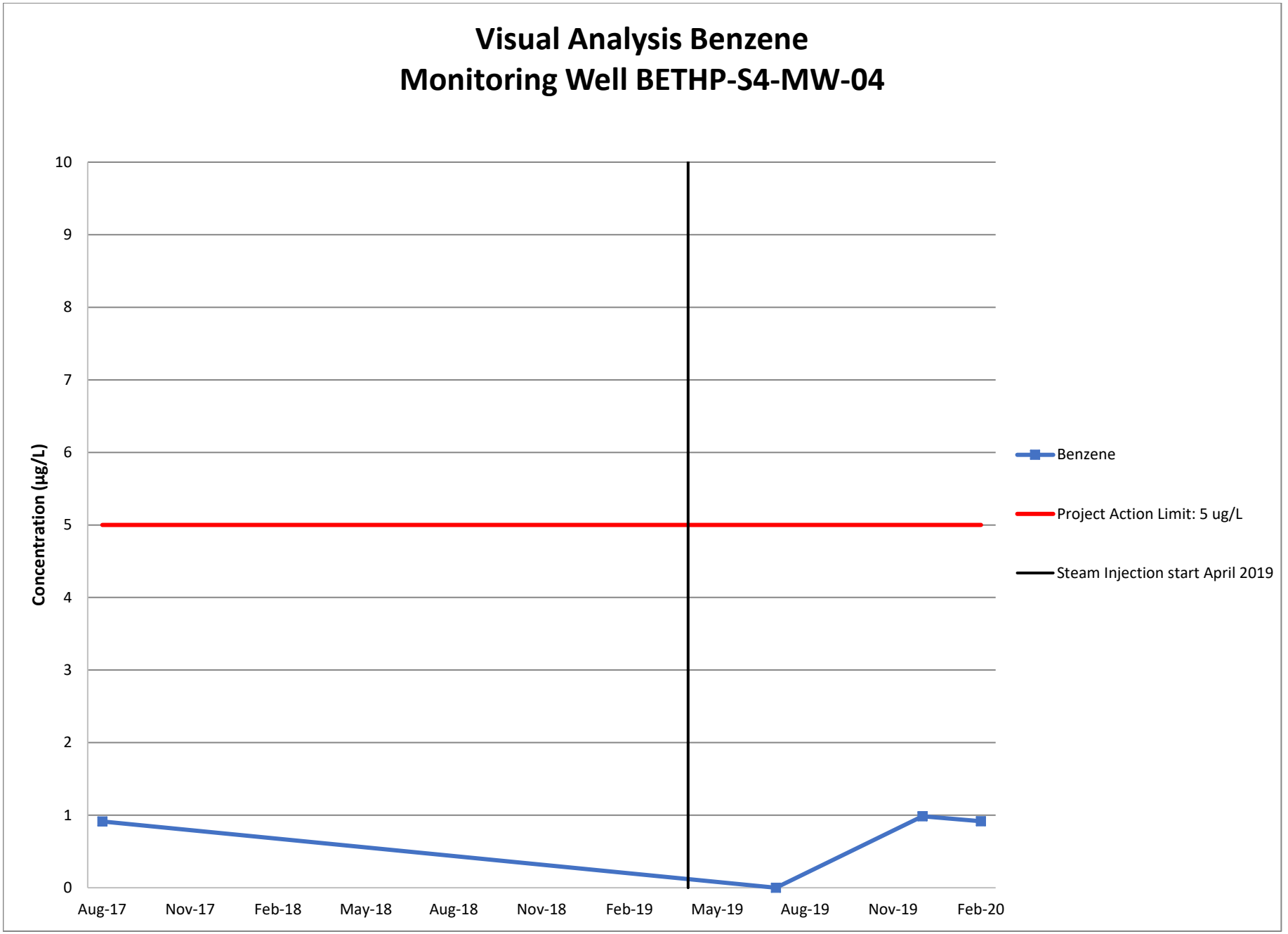
ATTACHMENT C

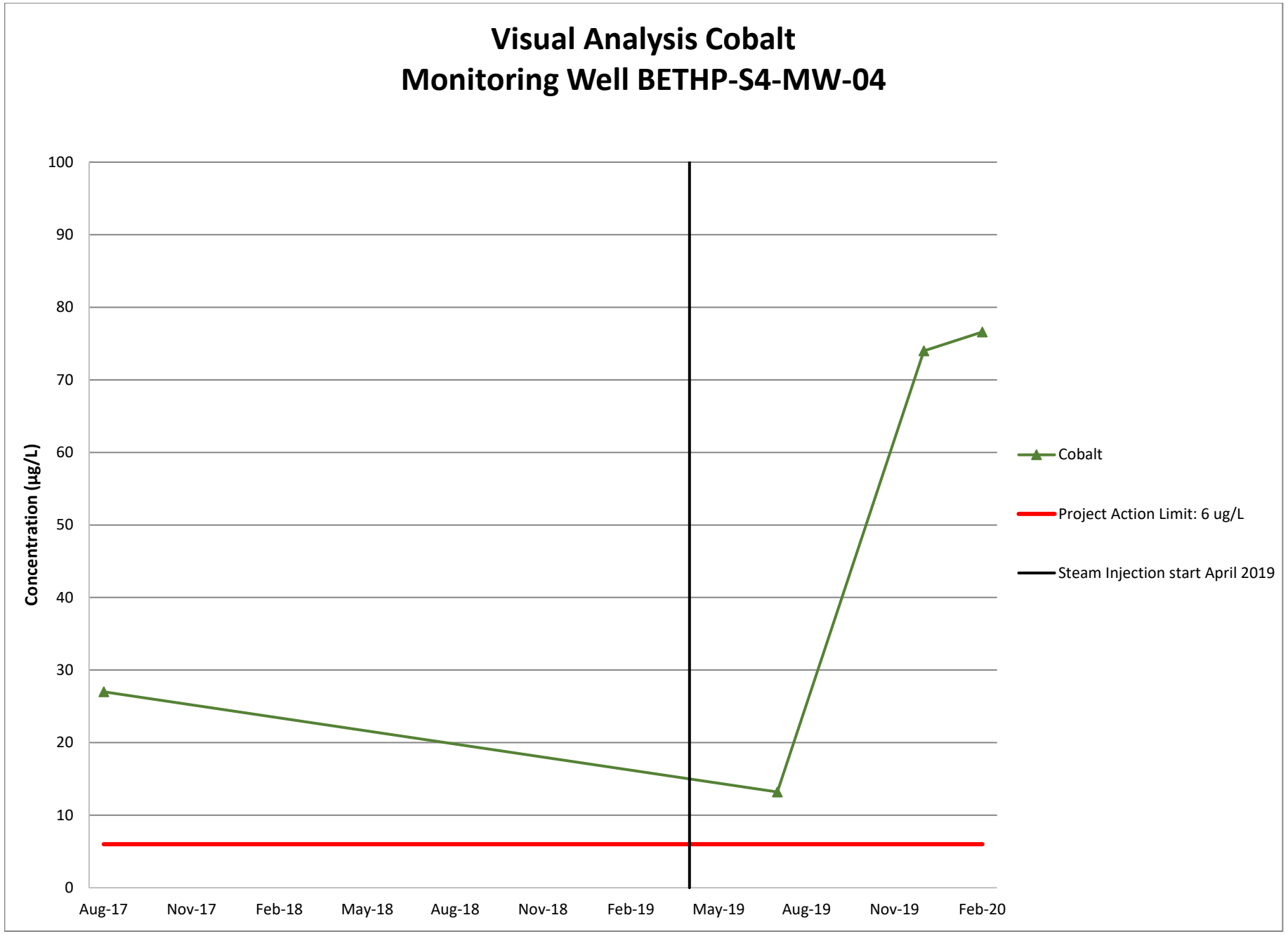

Visual Analysis Benzene
Monitoring Well BETHP-S4-MW-03
Concentration (µg/L)
10
9
8
7
6
5
4
3
2
1
0
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Feb-20
Benzene
Project Action Limit: 5 ug/L
Steam Injection start April 2019

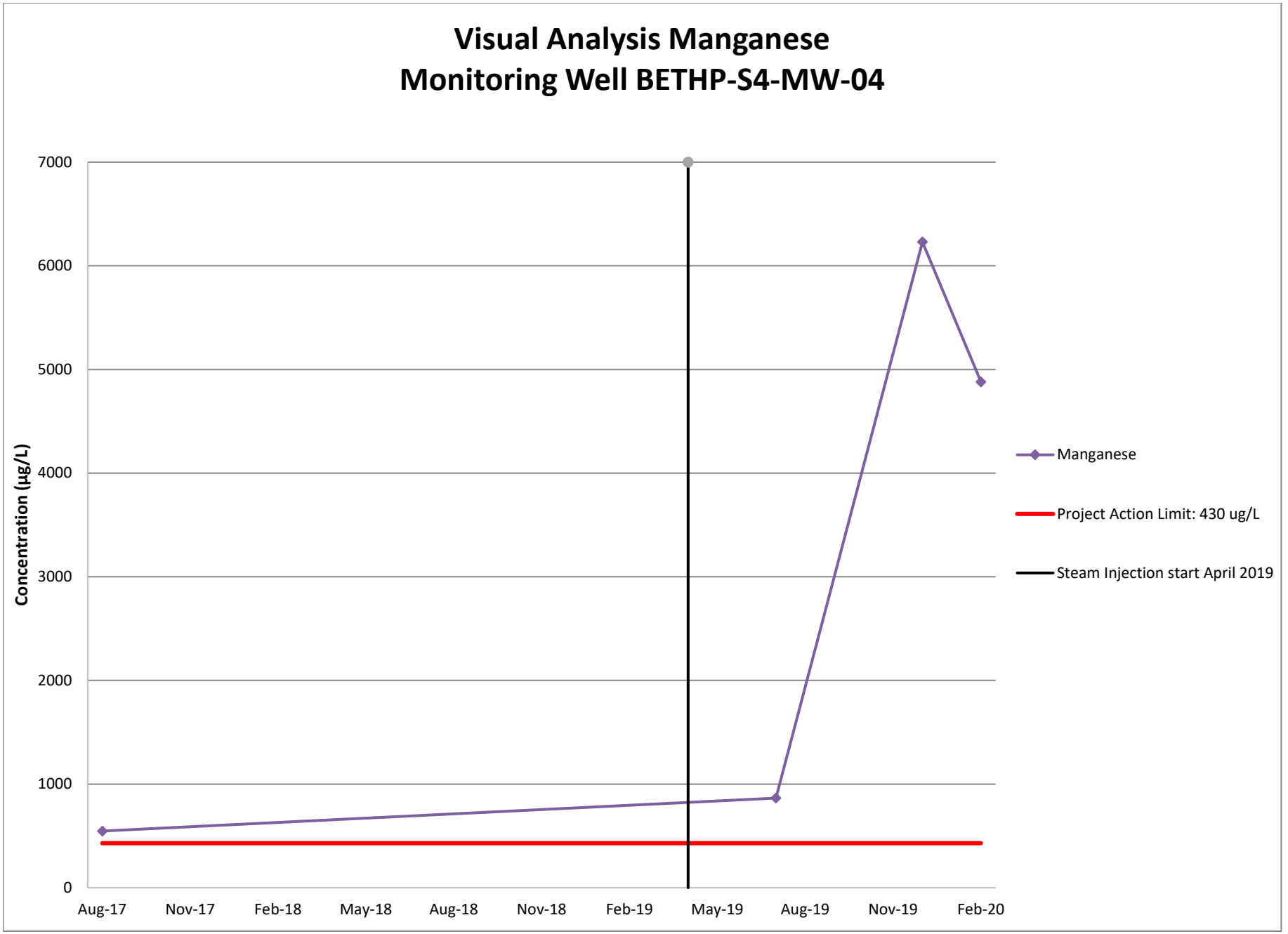
Visual Analysis Cobalt
Monitoring Well BETHP-S4-MW-03

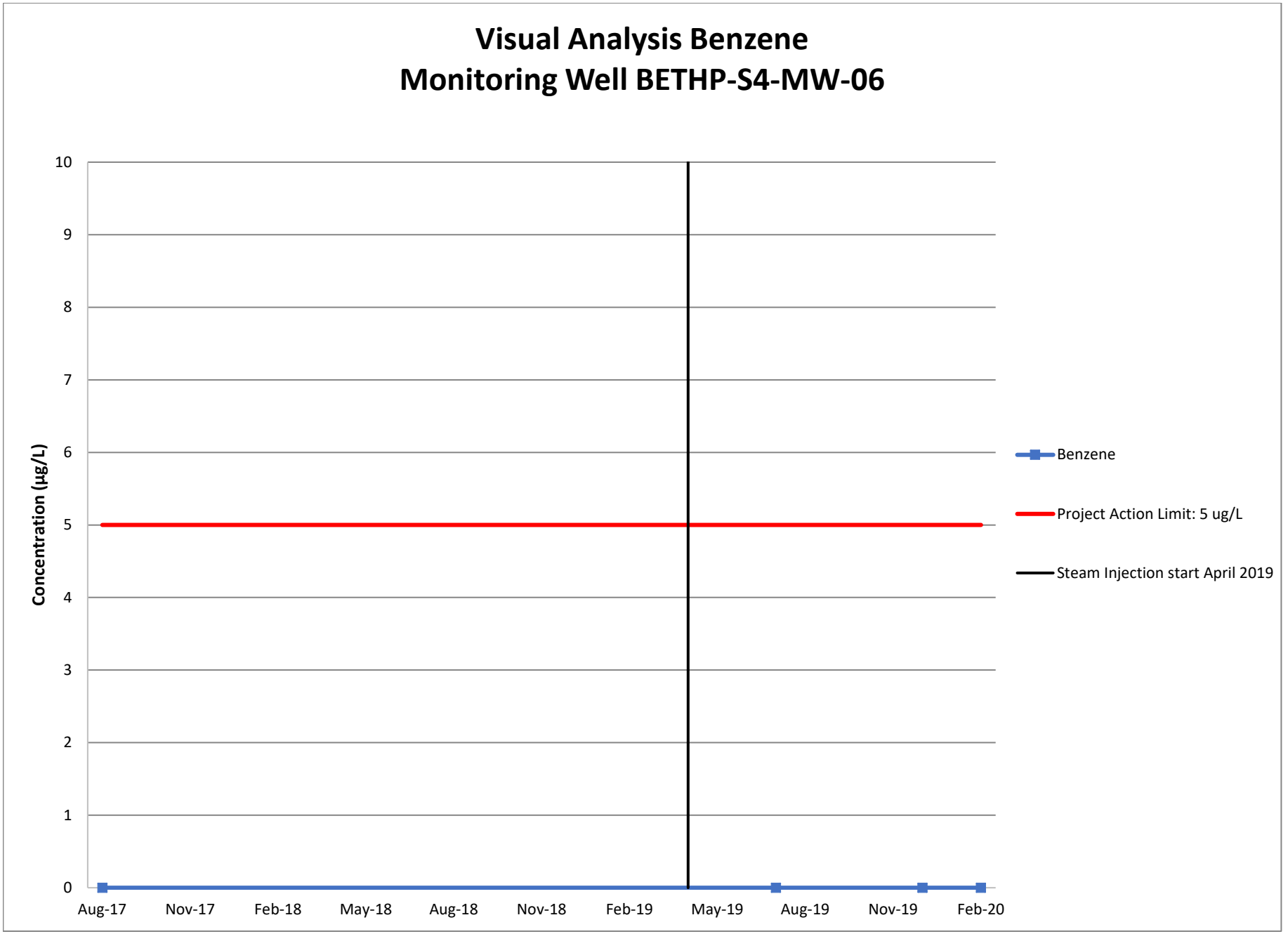



Visual Analysis Manganese
Monitoring Well BETHP-S4-MW-03
Concentration (µg/L)
600
500
400
300
200
100
0
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Feb-20
Manganese
Project Action Limit: 430 ug/L
Steam Injection start April 2019

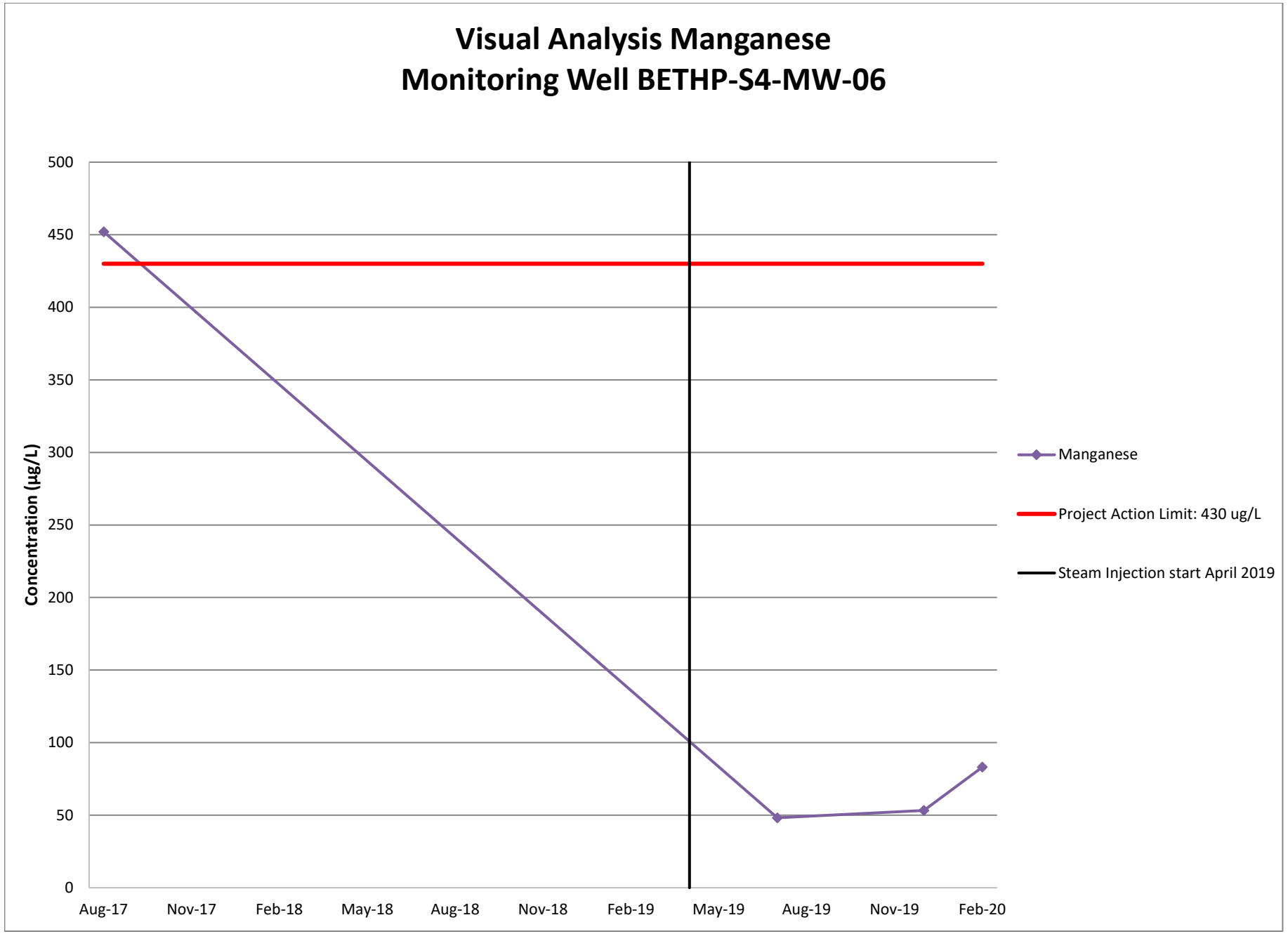

Visual Analysis Benzene
Monitoring Well BETHP-S4-MW-04
Concentration (µg/L)
10
9
8
7
6
5
4
3
2
1
0
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Feb-20
Benzene
Project Action Limit: 5 ug/L
Steam Injection start April 2019

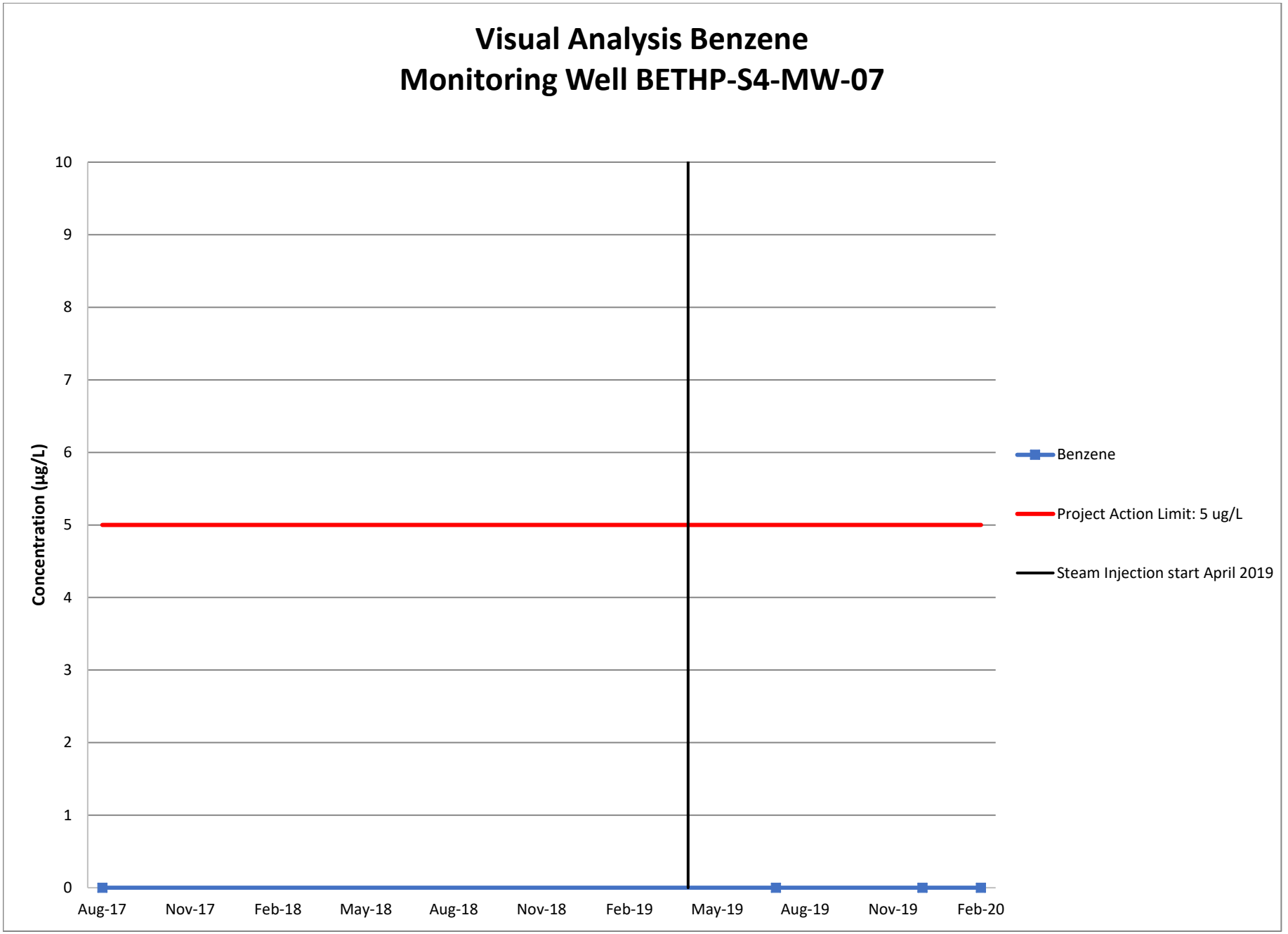

Visual Analysis Cobalt
Monitoring Well BETHP-S4-MW-04
Concentration (µg/L)
100
90
80
70
60
50
40
30
20
10
0
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Feb-20
Cobalt
Project Action Limit: 6 ug/L
Steam Injection start April 2019

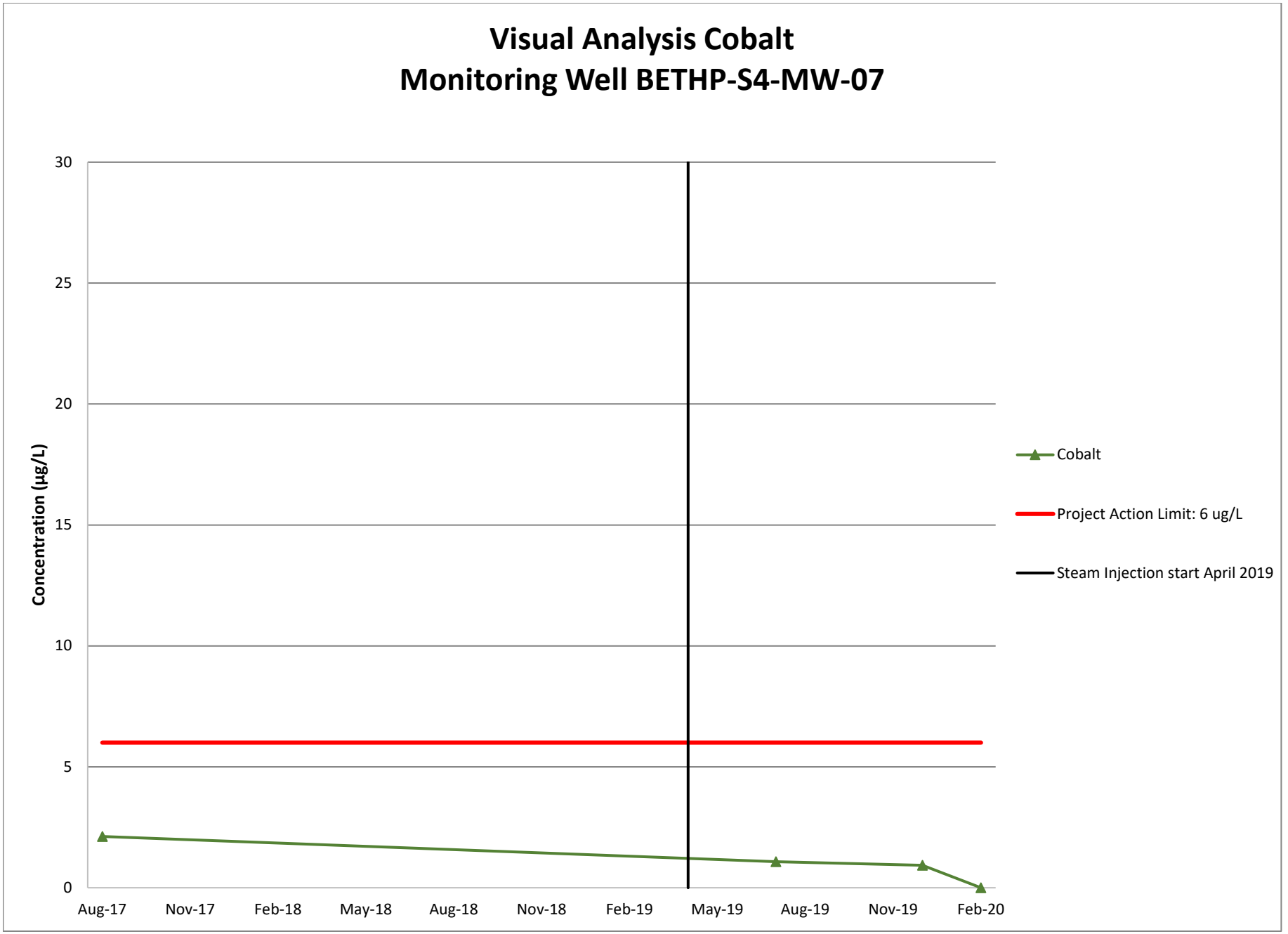

Visual Analysis Manganese
Monitoring Well BETHP-S4-MW-04
Concentration (µg/L)
7000
6000
5000
4000
3000
2000
1000
0
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Feb-20
Manganese
Project Action Limit: 430 ug/L
Steam Injection start April 2019

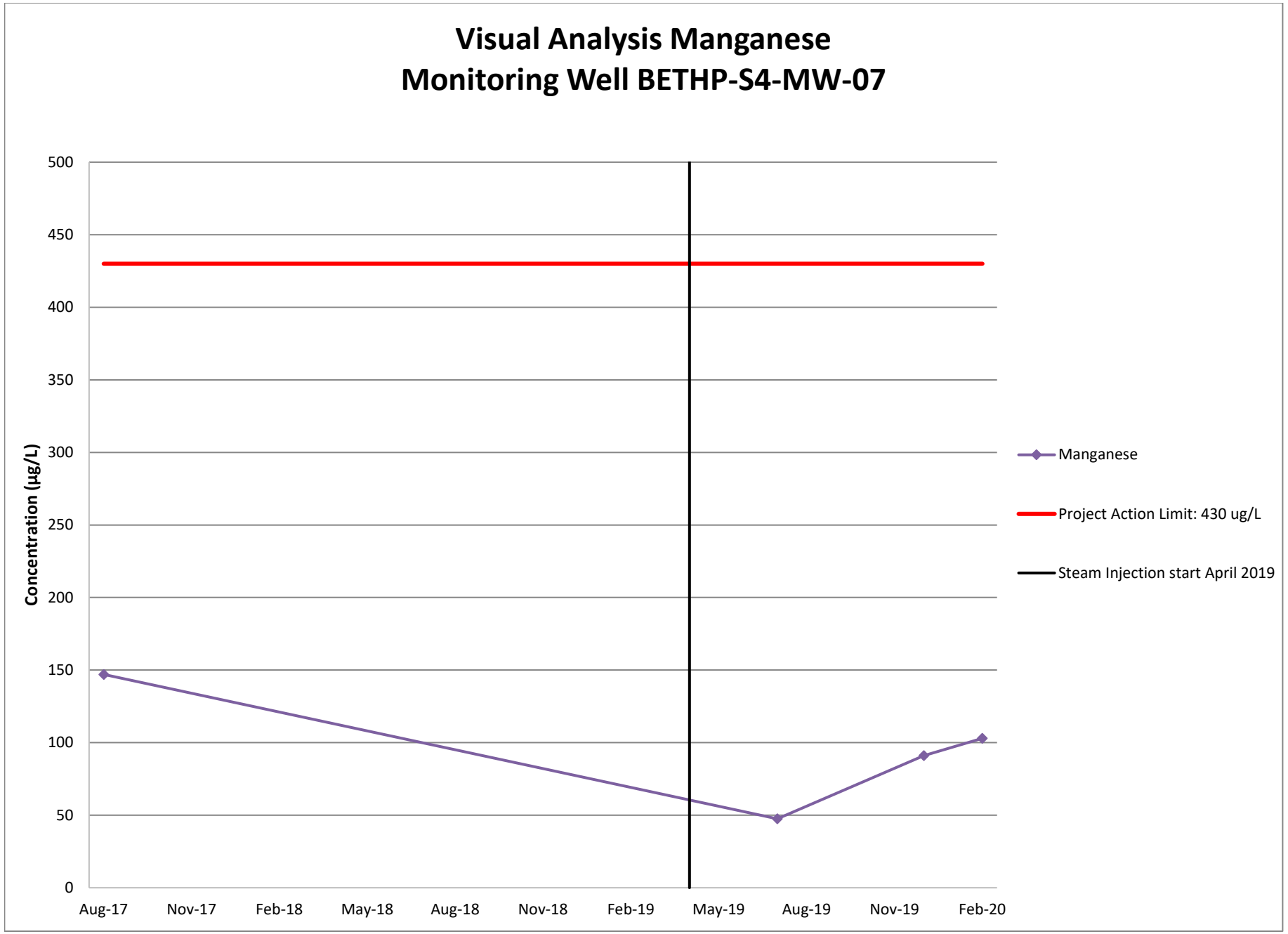

Visual Analysis Benzene
Monitoring Well BETHP-S4-MW-06
Concentration (µg/L)
10
9
8
7
6
5
4
3
2
1
0
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Feb-20
Benzene
Project Action Limit: 5 ug/L
Steam Injection start April 2019

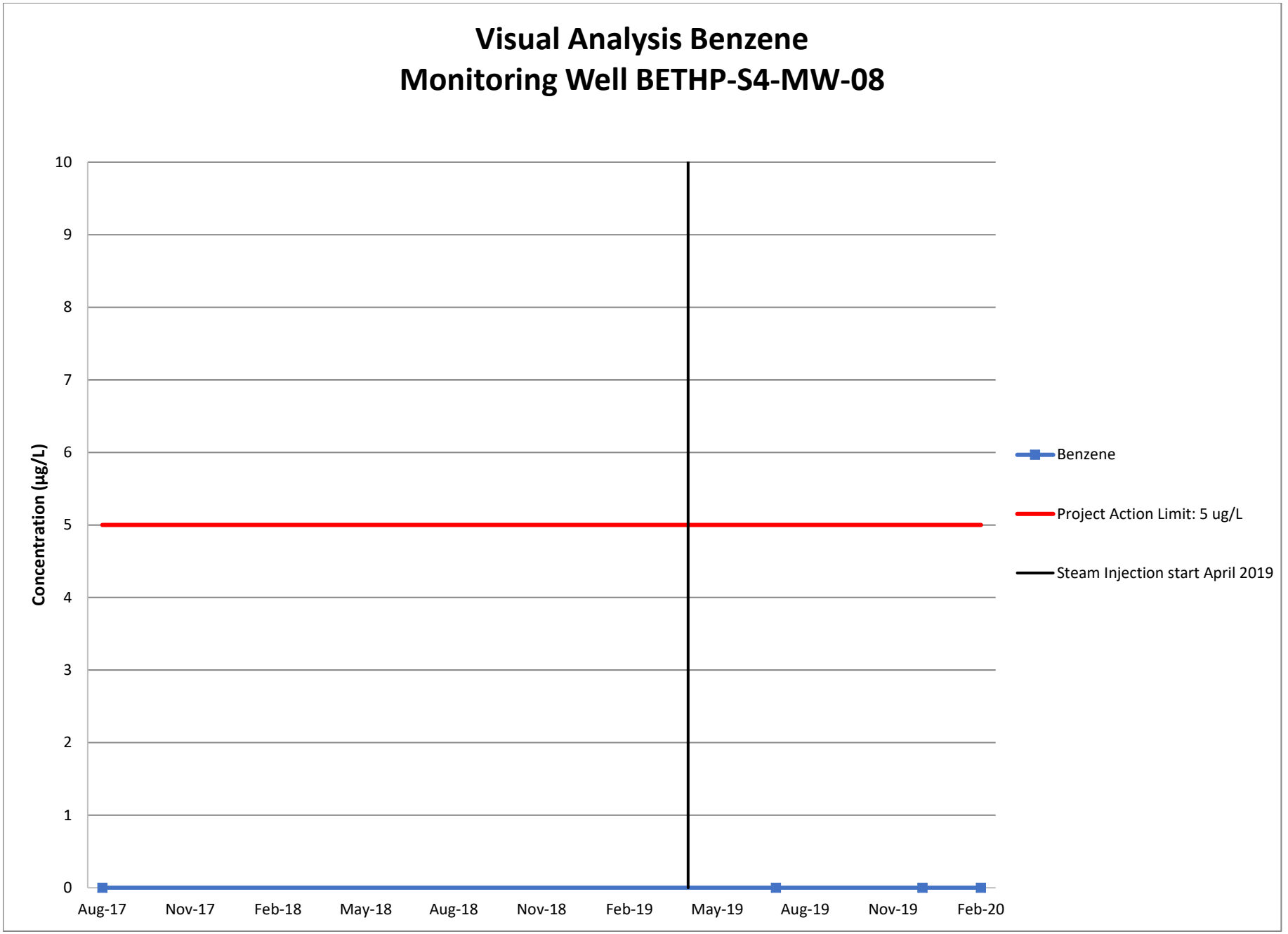
Visual Analysis Cobalt
Monitoring Well BETHP-S4-MW-06

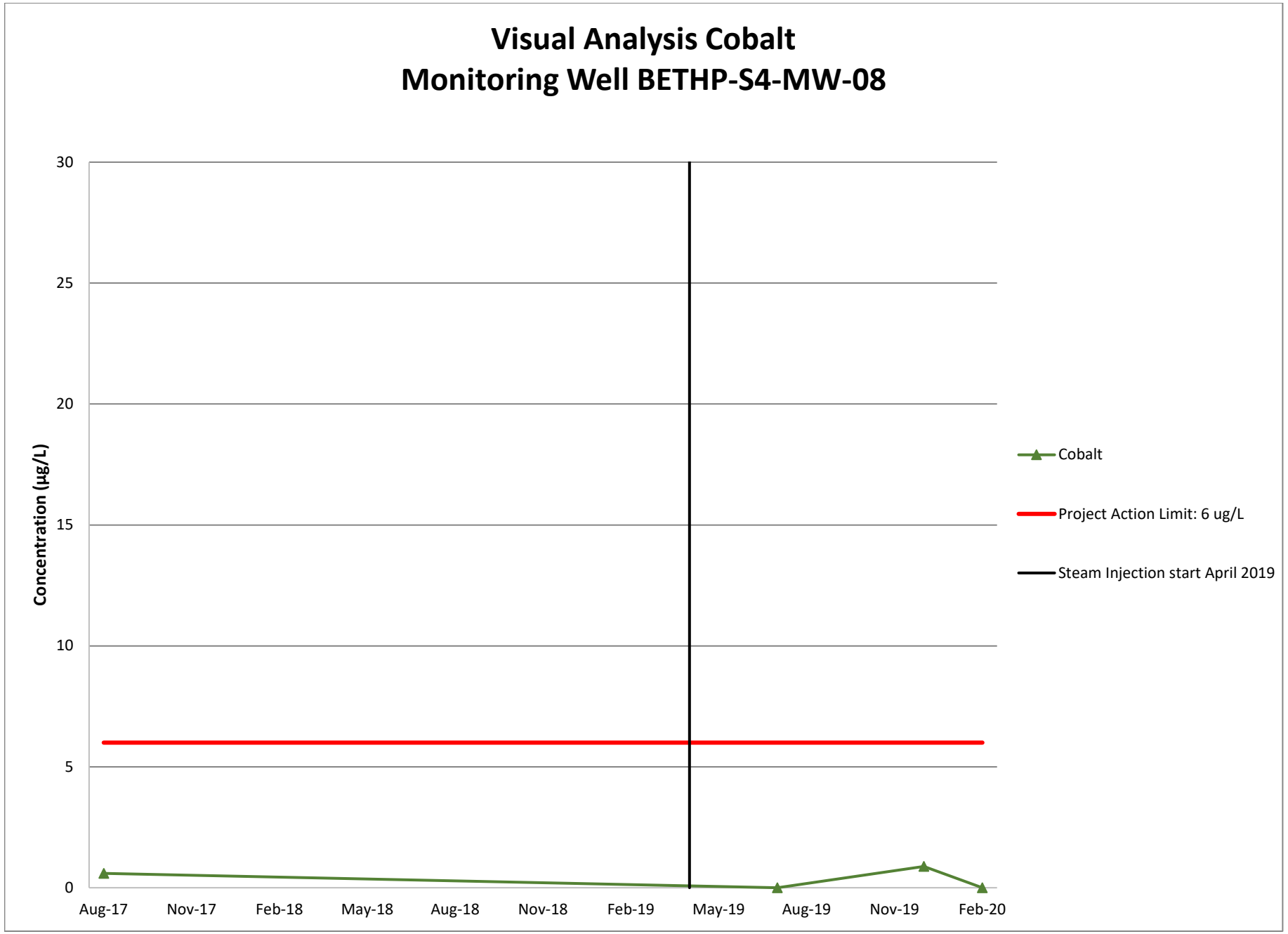

Visual Analysis Manganese
Monitoring Well BETHP-S4-MW-06
Concentration (µg/L)
500
450
400
350
300
250
200
150
100
50
0
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Feb-20
Manganese
Project Action Limit: 430 ug/L
Steam Injection start April 2019

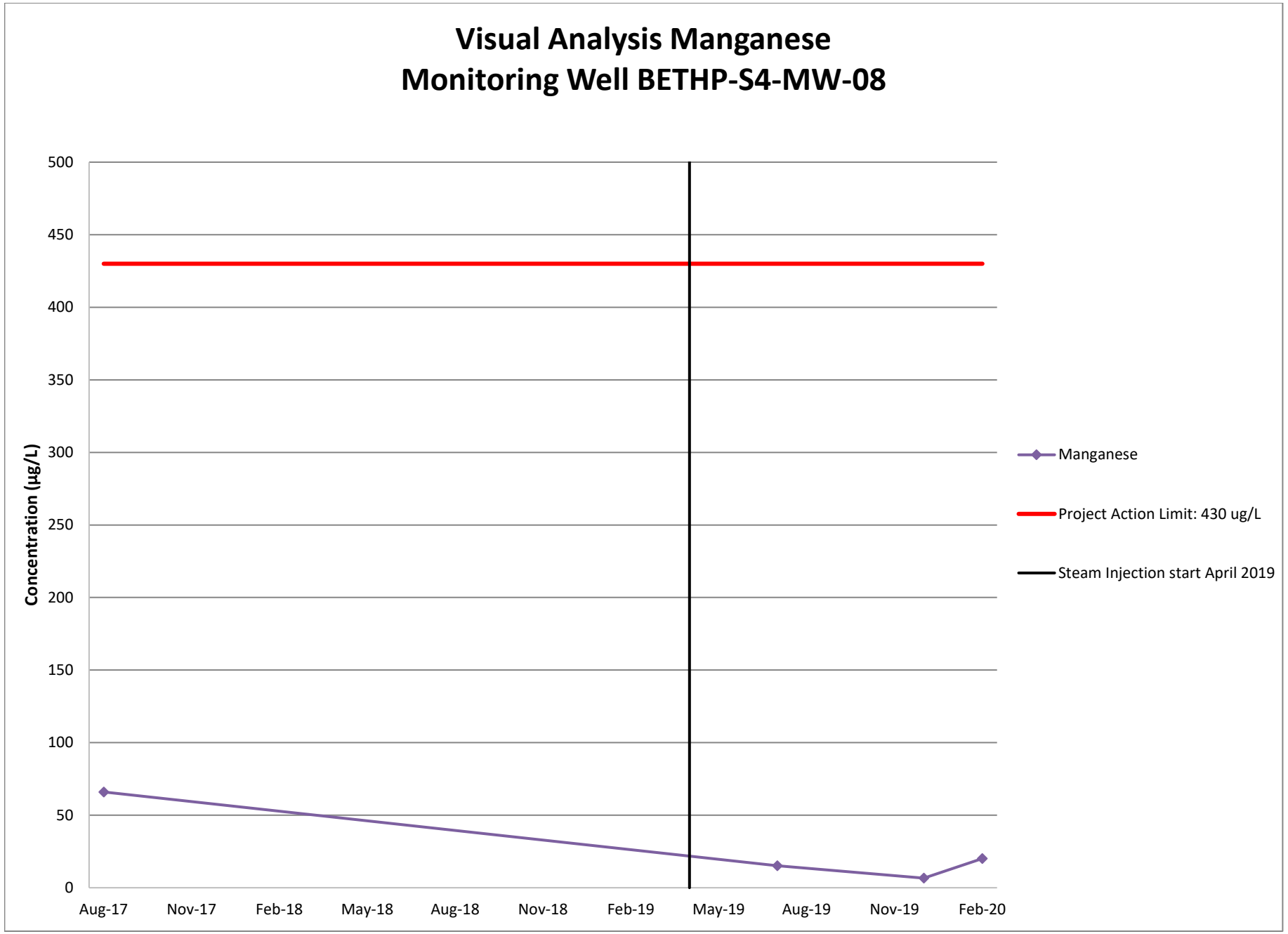

Visual Analysis Benzene
Monitoring Well BETHP-S4-MW-07
Concentration (µg/L)
10
9
8
7
6
5
4
3
2
1
0
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Feb-20
Benzene
Project Action Limit: 5 ug/L
Steam Injection start April 2019

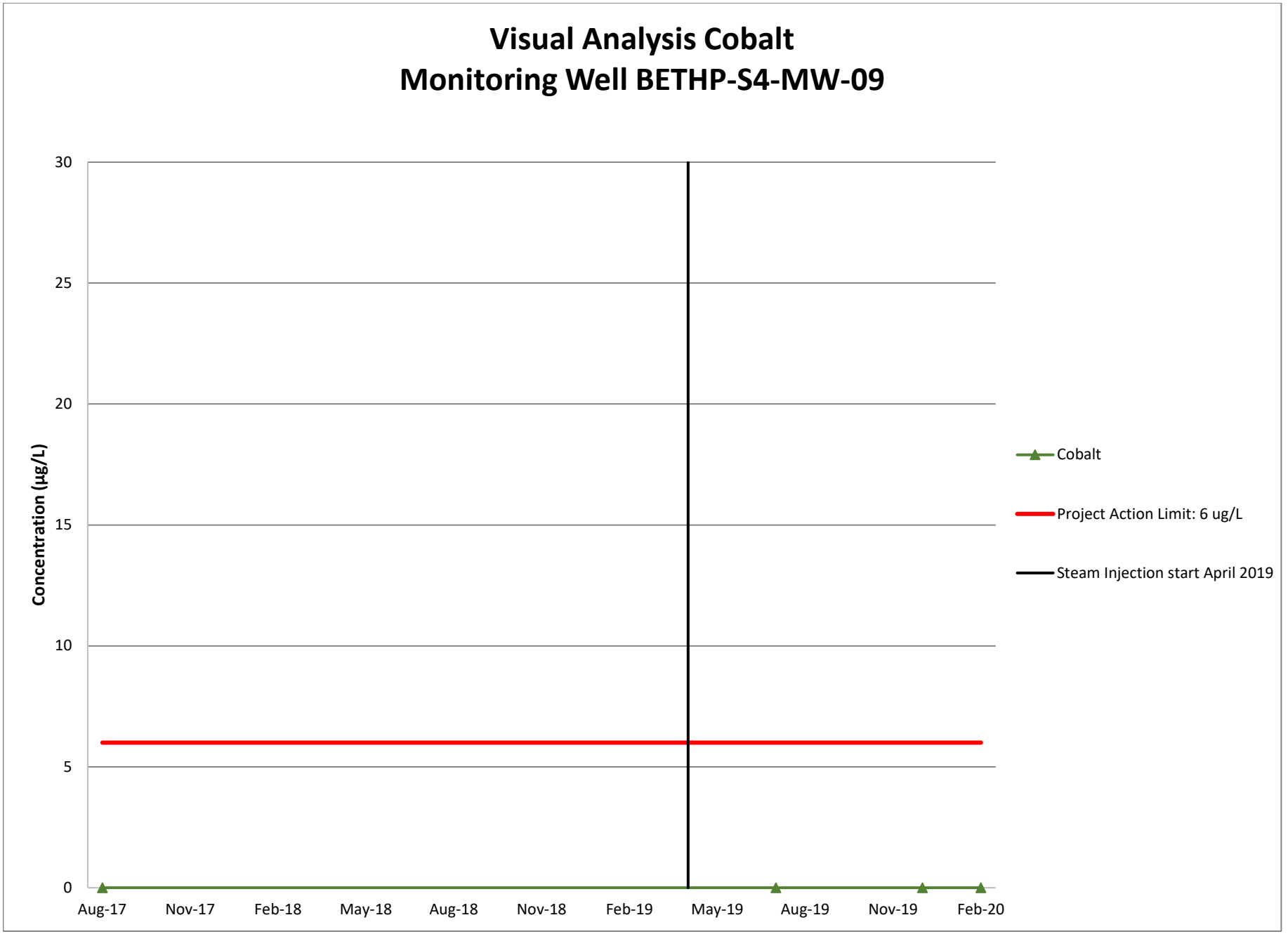

Visual Analysis Cobalt
Monitoring Well BETHP-S4-MW-07
Concentration (µg/L)
30
25
20
15
10
5
0
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Feb-20
Cobalt
Project Action Limit: 6 ug/L
Steam Injection start April 2019

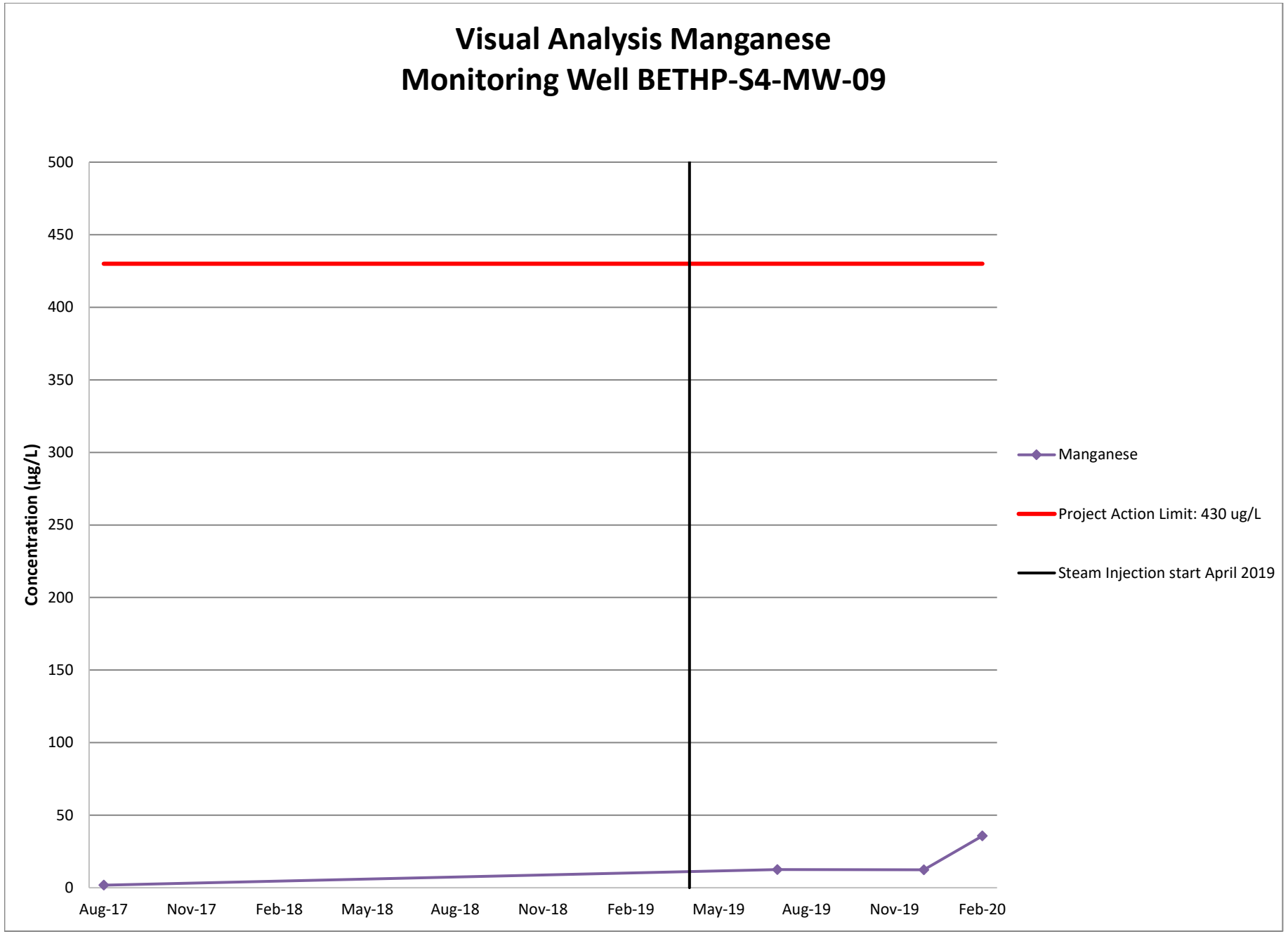

Visual Analysis Manganese
Monitoring Well BETHP-S4-MW-07
Concentration (µg/L)
500
450
400
350
300
250
200
150
100
50
0
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Feb-20
Manganese
Project Action Limit: 430 ug/L
Steam Injection start April 2019

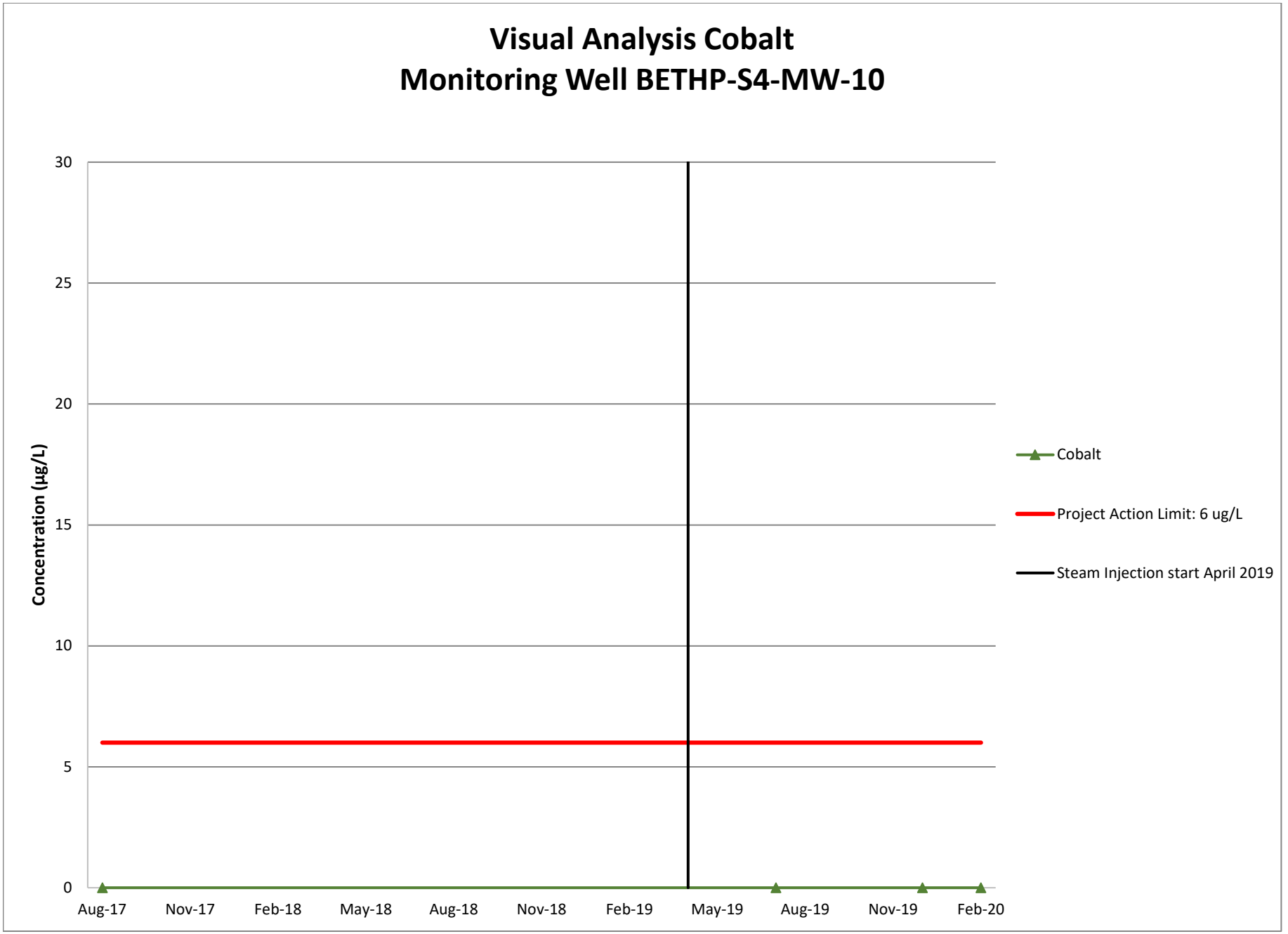

Visual Analysis Benzene
Monitoring Well BETHP-S4-MW-08
Concentration (µg/L)
10
9
8
7
6
5
4
3
2
1
0
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Feb-20
Benzene
Project Action Limit: 5 ug/L
Steam Injection start April 2019

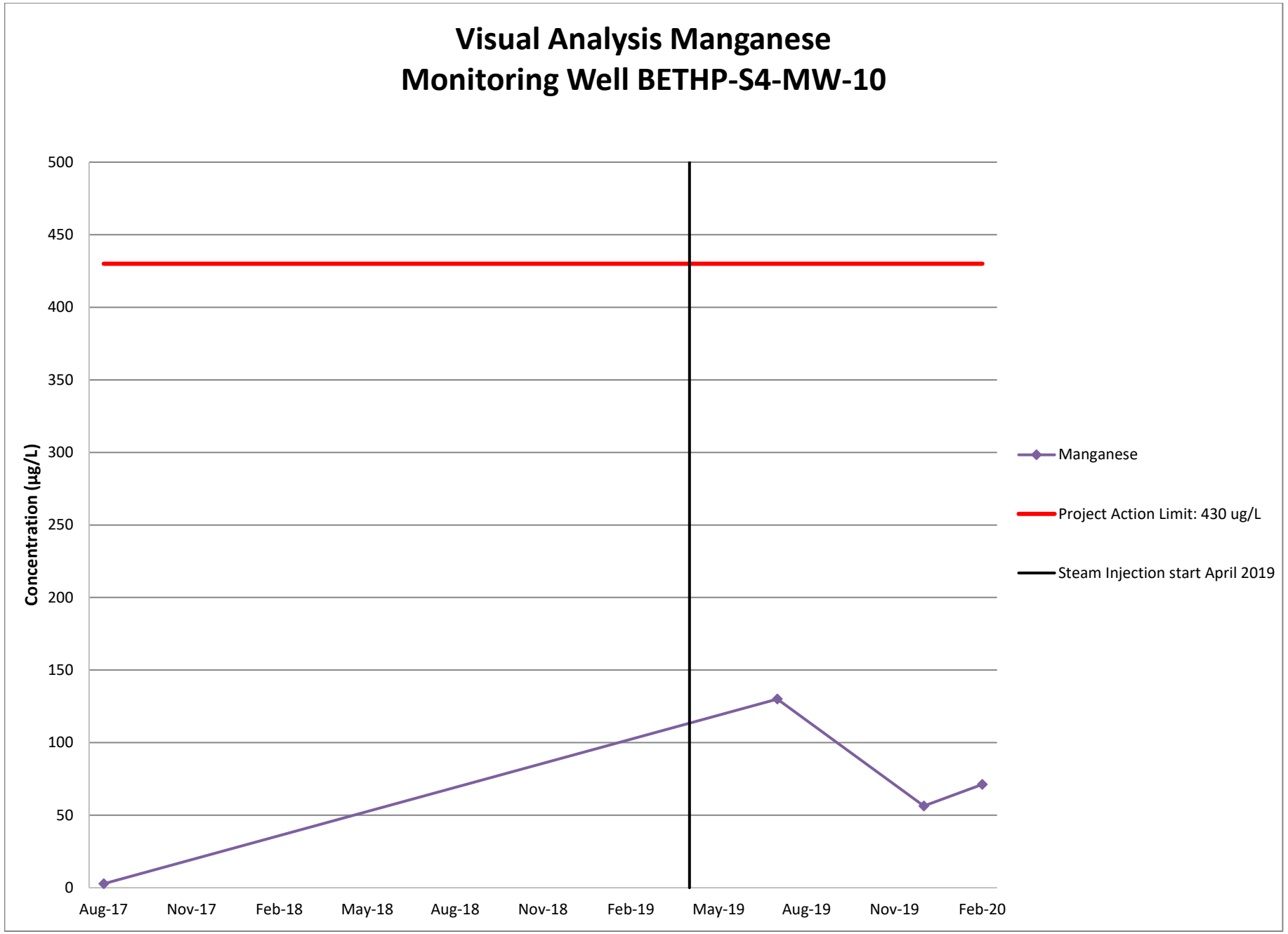

Visual Analysis Cobalt
Monitoring Well BETHP-S4-MW-08
Concentration (µg/L)
30
25
20
15
10
5
0
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Feb-20
Cobalt
Project Action Limit: 6 ug/L
Steam Injection start April 2019

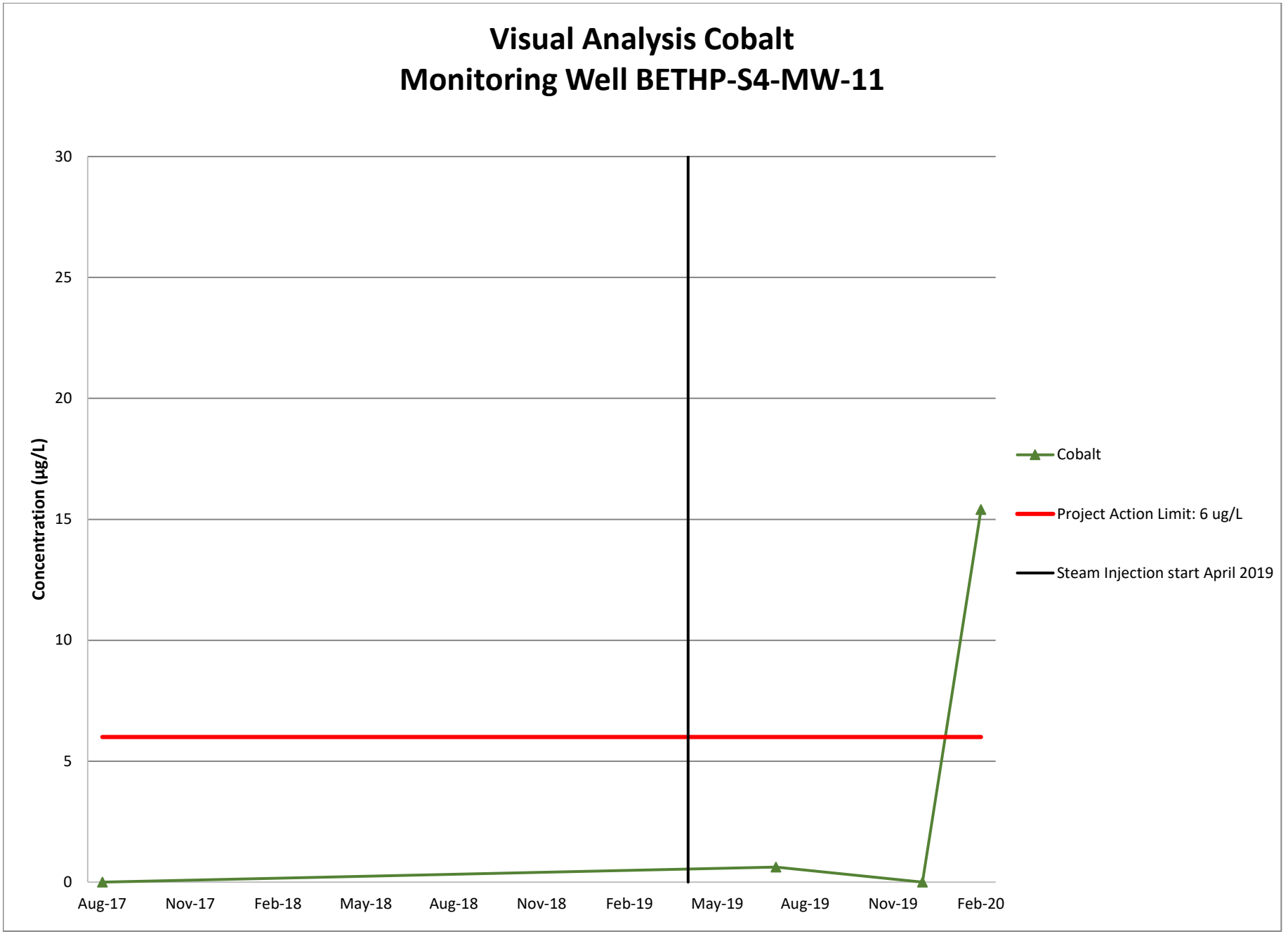

Visual Analysis Manganese
Monitoring Well BETHP-S4-MW-08
Concentration (µg/L)
500
450
400
350
300
250
200
150
100
50
0
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Feb-20
Manganese
Project Action Limit: 430 ug/L
Steam Injection start April 2019

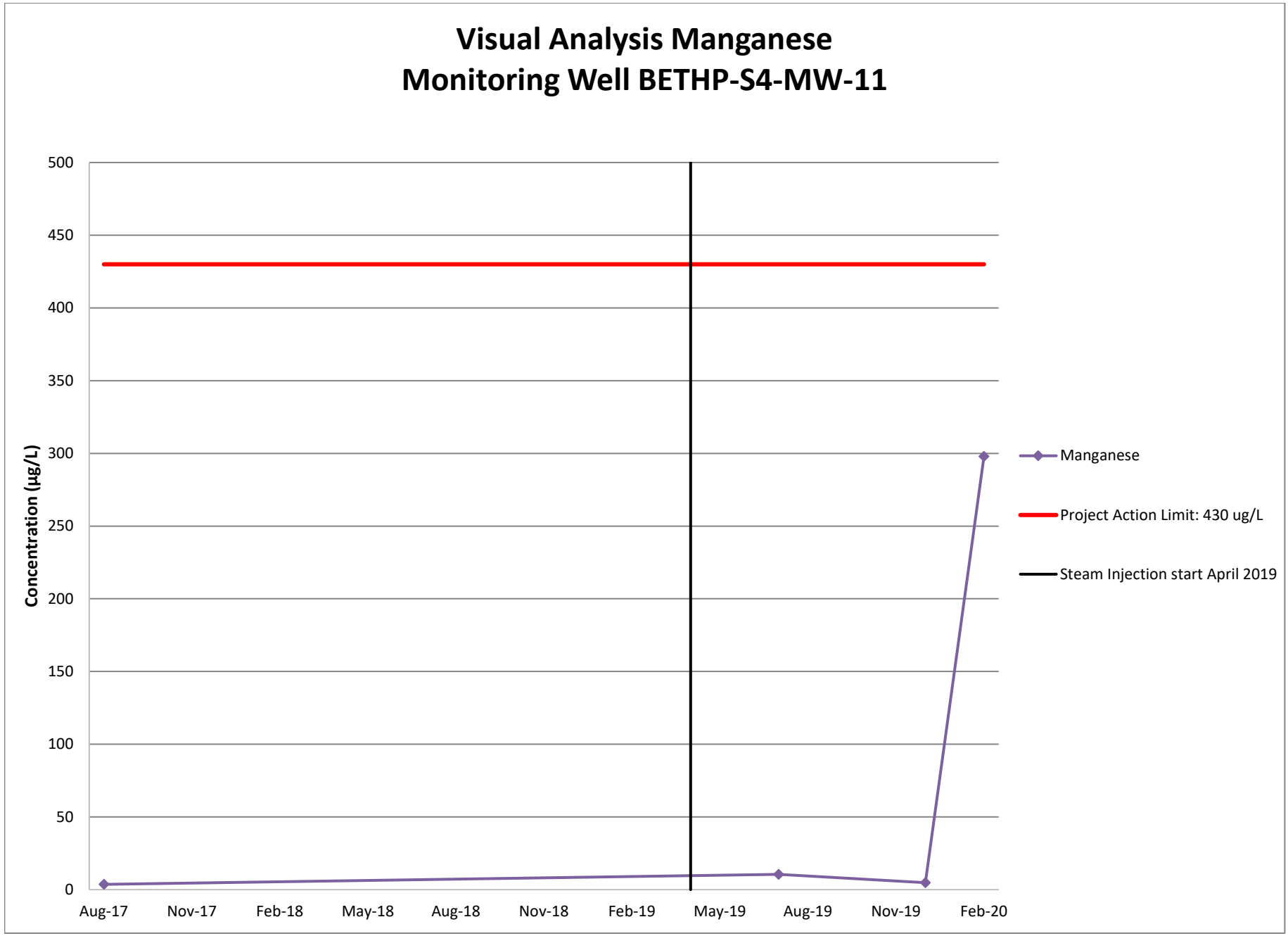

Visual Analysis Cobalt
Monitoring Well BETHP-S4-MW-09
Concentration (µg/L)
30
25
20
15
10
5
0
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Feb-20
Cobalt
Project Action Limit: 6 ug/L
Steam Injection start April 2019


Visual Analysis Manganese
Monitoring Well BETHP-S4-MW-09
Concentration (µg/L)
500
450
400
350
300
250
200
150
100
50
0
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Feb-20
Manganese
Project Action Limit: 430 ug/L
Steam Injection start April 2019

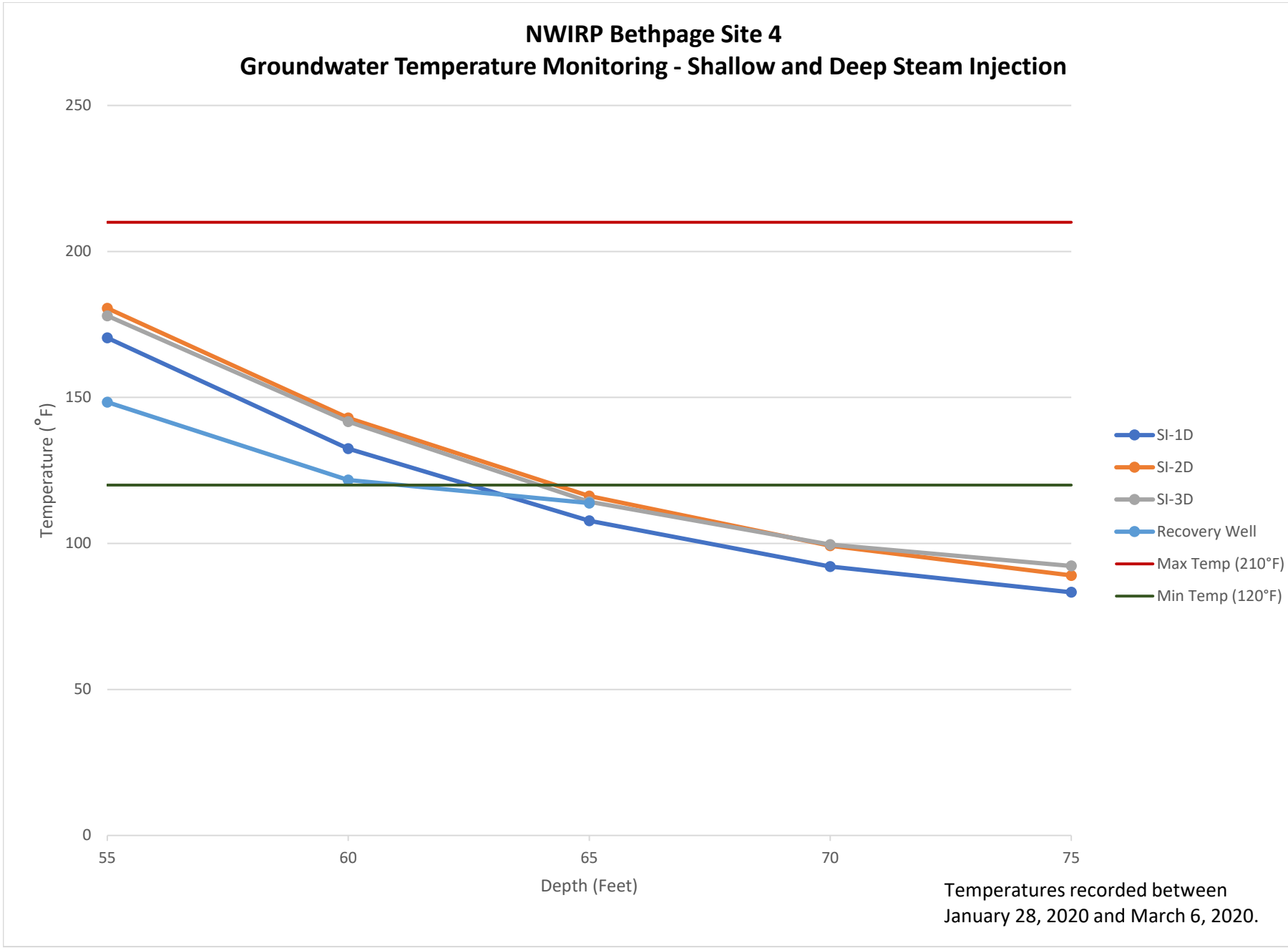

Visual Analysis Cobalt
Monitoring Well BETHP-S4-MW-10
Concentration (µg/L)
30
25
20
15
10
5
0
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Feb-20
Cobalt
Project Action Limit: 6 ug/L
Steam Injection start April 2019

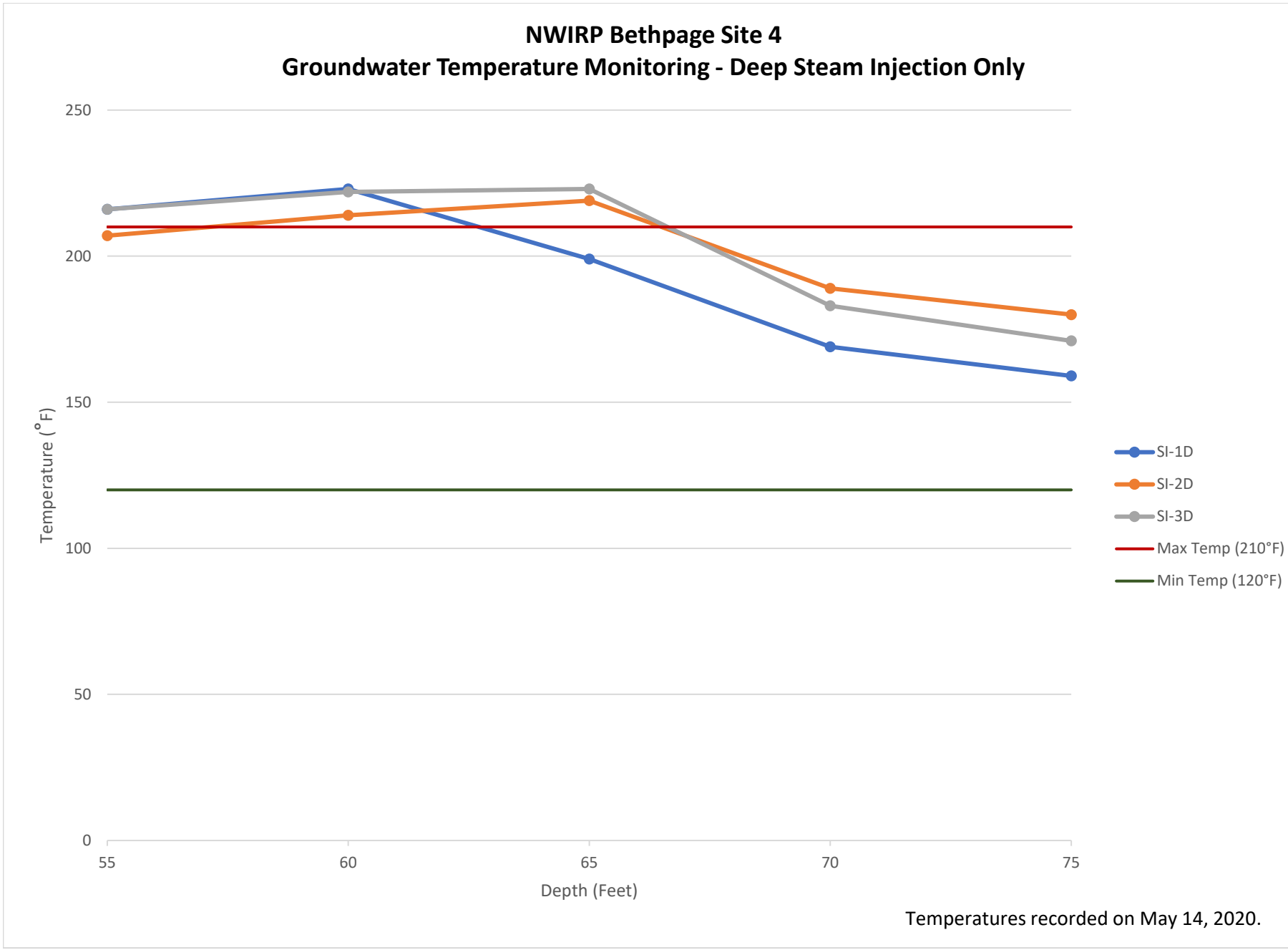

Visual Analysis Manganese
Monitoring Well BETHP-S4-MW-10
Concentration (µg/L)
500
450
400
350
300
250
200
150
100
50
0
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Feb-20
Manganese
Project Action Limit: 430 ug/L
Steam Injection start April 2019


Visual Analysis Cobalt
Monitoring Well BETHP-S4-MW-11
Concentration (µg/L)
30
25
20
15
10
5
0
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Feb-20
Cobalt
Project Action Limit: 6 ug/L
Steam Injection start April 2019


Visual Analysis Manganese
Monitoring Well BETHP-S4-MW-11
Concentration (µg/L)
500
450
400
350
300
250
200
150
100
50
0
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Feb-20
Manganese
Project Action Limit: 430 ug/L
Steam Injection start April 2019

ATTACHMENT D


NWIRP Bethpage Site 4
Groundwater Temperature Monitoring - Shallow and Deep Steam Injection
250
200
150
100
50
0
Temperature (°F)
55
60
65
70
75
Depth (Feet)
SI-1D
SI-2D
SI-3D
Recovery Well
Max Temp (210°F)
Min Temp (120°F)
Temperatures recorded between
January 28, 2020 and March 6, 2020.


NWIRP Bethpage Site 4
Groundwater Temperature Monitoring - Deep Steam Injection Only
250
200
150
100
50
0
Temperature (°F)
55
60
65
70
75
Depth (Feet)
SI-1D
SI-2D
SI-3D
Max Temp (210°F)
Min Temp (120°F)
Temperatures recorded on May 14, 2020.

ATTACHMENT E

Site 4 Steam Injection Activity Log

Date	Duration Offline	Activity	Details
4/9/2019		Began steam injection in all six steam injection wells	---
05/31/2019 – 06/10/2019	10 days	Boiler off-line	SVE System Maintenance (Hose Rupture)
07/10/2019 – 07/11/2019	1 day	Boiler off-line	Recovery Pump Installation
07/22/2019 – 07/30/2019	7 days	Boiler off-line	Boiler Cleaning
08/12/2019 – 08/13/2019	1 day	Boiler off-line	Recovery Pump Adjustment
09/10/2019 – 09/17/2019	7 days	Boiler off-line	Recovery Pump Troubleshooting
9/19/2019 - 09/22/2019	3 days	Boiler off-line	Recovery Pump Troubleshooting
12/24/2019 – 01/20/2020	27 days	Boiler off-line	Boiler shut down for Christmas holiday.
01/27/2020 (1400) – 01/28/2020 (1515)	1 day	Boiler off-line	Boiler shut down for approximately 11 hours in order to conduct temperature measurements within the steam injection wells
1/28/2020	---	Steam Injection Well Temperature Readings	See Table in Section IX
01/30/2020 (0730-1300)	1 day	Boiler off-line	Boiler shut down for approximately 5.5 hours in order to conduct temperature measurements within the steam injection wells
1/30/2020	---	Steam Injection Well Temperature Readings	See Table in Section IX
3/4/2020	---	Steam Injection Well Temperature Readings	See Table in Section IX
3/6/2020	---	Steam Injection Well Temperature Readings	See Table in Section IX
03/09 – 03/25/2020	16 days	Boiler off-line	Boiler shut down in order to service the SVE system vacuum blower.
3/30/2020	---	Steam redirected to deep injection wells only	---
05/07/2020 – Present		Boiler off-line	Boiler shut down in order to conduct temperature measurements within the steam injection wells
5/14/2020	---	Steam Injection Well Temperature Readings	See Table in Section IX