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ANNUAL PERFORMANCE REPORT 1 JANUARY 2016 – 31 DECEMBER 2016

TROUTDALE SANDSTONE AQUIFER REMEDY

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TABLE OF CONTENTS

	Page
1.0 INTRODUCTION	1
1.1 Purpose of Report.....	1
2.0 SIGNIFICANT ISSUES, EVENTS, AND ACTIONS.....	2
2.1 Monitoring Program and Schedule Modifications	2
2.2 Portland Water Bureau Well Field	2
3.0 EXTRACTION AND TREATMENT SYSTEMS	4
3.1 CTS Operational Summary	4
3.2 Groundwater Extraction Rates	5
3.3 Treatment System Effluent Compliance	6
3.4 Well Decommissioning	6
3.5 SOIL VAPOR EXTRACTION.....	7
3.5.1 SVE Well Installation.....	7
3.5.2 SVE System Operation.....	8
3.5.3 SVE System Monitoring.....	8
3.5.4 SVE System Mass Removal.....	9
4.0 REMEDY PERFORMANCE SUMMARY	10
4.1 Groundwater Elevations.....	10
4.2 Groundwater Flow and Hydraulic Capture	10
4.3 Water Quality	11
4.3.1 Upper TSA.....	11
4.3.2 Lower TSA	11
5.0 PERFORMANCE SUMMARY	13
5.1 Mass Removal	13
5.2 Restoration Progress.....	14
5.3 Closure by Restoration Zone.....	14
6.0 RECOMMENDATIONS AND FUTURE PLANNED ACTIVITIES.....	16
6.1 Extraction Well Operation	16
6.2 SVE system	17
6.3 Monitoring Program and Schedule Modifications	17
7.0 REFERENCES	18

TABLE OF CONTENTS (Continued)

TABLES

Table 2-1:	Remedy Well Network Criteria
Table 2-2:	Performance Monitoring Schedule – 1 January 2016 through 31 December 2016
Table 2-3:	Significant Remedy Documents –1 January 2016 through 31 December 2016
Table 3-1:	Well Construction Data – 1 January 2016 through December 2016

FIGURES

Figure 1-1:	Project Location
Figure 1-2:	TSA Monitoring Well Locations and Remediation System Layout
Figure 3-1:	Vapor Monitoring Well Locations, Groundwater and Soil Vapor Trichloroethene (TCE) Results, November 2016
Figure 4-1a:	Upper TSA Aquifer Groundwater Levels February 2016
Figure 4-1b:	Lower TSA Aquifer Groundwater Levels January – February 2016
Figure 4-2a:	Upper TSA Aquifer Groundwater Levels August 2016
Figure 4-2b:	Lower TSA Aquifer Groundwater Levels August 2016
Figure 5-1a:	Upper TSA Aquifer Trichloroethene Concentrations January – February 2016
Figure 5-1b:	Lower TSA Aquifer Trichloroethene Concentrations January – February 2016
Figure 5-2a:	Upper TSA Aquifer Trichloroethene Concentrations - August 2016
Figure 5-2b:	Lower TSA Aquifer Trichloroethene Concentrations - August 2016

APPENDICES

Appendix A: Extraction Rate Profiles

Table A-1	TSA Extraction Rates January 2016 through December 2016 and 12-Month Averages through 31 December 2016
Table A-2	Discharge Monitoring Summary – Central Treatment System, 1 January 2016 through 31 December 2016
Figure A-1	EW-1 Monthly Average Extraction Rate
Figure A-2	EW-2 Monthly Average Extraction Rate
Figure A-3	EW-14 Monthly Average Extraction Rate
Figure A-4	EW-16 Monthly Average Extraction Rate
Figure A-5	EW-23 Monthly Average Extraction Rate
Figure A-6	Total Extraction Rate for Remedy Wells

Appendix B: Groundwater Elevation Data

Table B-1	Groundwater Elevations – 1 January 2016 through 31 December 2016
Figure B-1	Hydrograph for TSA Well BOP-20(ds,dg)
Figure B-2	Hydrograph for TSA Well BOP-21(ds)

TABLE OF CONTENTS (Continued)

Figure B-3	Hydrograph for TSA Wells January – December 2016
Figure B-4	Hydrograph for TSA Well BOP-22R(ds)
Figure B-5	Hydrograph for TSA Well BOP-60(dg)
Figure B-6	Precipitation January – December 2016

Appendix C: Groundwater Quality Data

Table C-1	Groundwater Analytical Results (µg/L) 1 Jan. 2016 through 31 Dec. 2016
Figure C-1	TCE Concentration Profile CMW-17(ds)
Figure C-2	BOP-13(ds) TCE Concentration Profile
Figure C-3	BOP-31(ds) TCE Concentration Profile
Figure C-4	BOP-31(dg) TCE Concentration Profile
Figure C-5	TCE Concentration Profile CMW-20(ds)
Figure C-6	TCE Concentration Profile CMW-10 (ds)
Figure C-7	TCE Concentration Profile CMW-18(ds)
Figure C-8	TCE Concentration Profile D-17(ds)
Figure C-9	Operating Extraction Wells TCE Concentration Profiles

Appendix D: Well Decommissioning

BOP-22dg Well Construction and Decommissioning Logs

Appendix E: SVE Data

Vapor Monitoring Well Boring and Well Construction Logs

VMW – A Well Construction Log

VMW – B Well Construction Log

VMW – C Well Construction Log

VMW – D Well Construction Log

Table E-1 Soil Vapor Extraction 1 January 2016 through 31 December 2016

Table E-2 Soil Vapor Extraction – Laboratory VOC results

Figure E-1 SVE Effluent cVOC Vapor Concentration

Figure E-2 SVE Extracted Vapor Flow (Weekly Average)

Figure E-3 SVE System Mass Removal

Appendix F: Data Validation Memoranda, Annual Reporting Period

Laboratory Reports (CD)

Historical Data Summary Tables – VOCs and Groundwater Elevations (CD)

Appendix G: TCE Mass Removal Estimates

Table G-1 TCE Mass Removal – January 1998 through December 2016

Table G-2 TCE Mass Removal Per Extraction Well

Figure G-1 TCE Mass Removal

Figure G-2 TCE Mass Removal per Extraction Well

Annual Performance Report
1 January 2016 – 31 December 2016
Troutdale Sandstone Aquifer Remedy

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1.0 INTRODUCTION

This 2016 Annual Performance Report is submitted on behalf of Cascade Corporation (Cascade) and The Boeing Company (Boeing) and summarizes performance and monitoring data for the East Multnomah County, Troutdale Sandstone Aquifer (TSA) remedy. Data presented in this Annual Performance Report were collected during the period of 1 January 2016 through 31 December 2016 as part of the joint remedy being implemented under the Department of Environmental Quality's (DEQ's) Consent Order No. WMCSR-NWR-96-08 (DEQ, 1997).

1.1 Purpose of Report

The reporting period for the TSA remedy Annual Performance Report presents data through the calendar year 2016. This Annual Performance Report provides an evaluation of TSA remedy performance, including:

- A summary of the remediation system operation, maintenance, and performance monitoring data;
- Implementation of an additional remedial action, a soil vapor extraction (SVE) system; and
- An assessment of aquifer restoration progress.

Data presented and evaluated in this report includes water level, groundwater extraction rate, discharge compliance, and water quality data for the operating remediation system, as well as data related to the SVE system. Laboratory reports for samples collected during this reporting period are contained on a compact disc provided with this report.

The project area and site are shown on Figure 1-1. The Lower TSA restoration zones (Zones A, B, C, and D), the TSA remedy network of extraction wells and monitoring wells, and the former and current TSA remedy extraction system layouts are shown on Figure 1-2.

Currently Sand and Gravel Aquifer (SGA) groundwater elevation data are collected monthly from one SGA well, BOP-44(usg), as part of the Portland Water Bureau (PWB) contingency plan (Landau Associates 2015). The location of this SGA well is included on Figure 1-2.

2.0 SIGNIFICANT ISSUES, EVENTS, AND ACTIONS

This section summarizes significant issues, events, and actions taken during the reporting period. The TSA remedy criteria for well and system decommissioning, monitoring well modifications, and changes in sampling frequency are summarized in Table 2-1. The current groundwater monitoring schedule is summarized in Table 2-2, and a summary of significant documents exchanged with DEQ during the period are presented in Table 2-3.

2.1 Monitoring Program and Schedule Modifications

Monitoring schedule modifications implemented during the reporting period were presented in the *Annual Performance Report: 1 October 2014 through 31 December 2015, Troutdale Sandstone Aquifer Remedy* (Geosyntec, Landau Associates, and SSPA, 2016), as well as other work plans for EW-16 Cycling/Pilot Shutdown (Geosyntec, 2014a), Soil Vapor Extraction (SVE) (Geosyntec, 2014c), and TSA SVE Expansion WP (Geosyntec, 2016a). These changes are described below:

- Well BOP-22(dg) was decommissioned in November 2016.
- Planned decommissioning for TSA wells BOP-70(ds), BOP-71(ds), and EMC-2(usg). Access agreements and final coordination activities are being conducted for the three wells, with decommissioning planned for early 2017.
- Installed four new soil vapor extraction wells and connected them to the current vapor extraction system in November and December 2016. Vapor and groundwater samples will be collected quarterly.
- Reduced water quality monitoring at TSA wells EW-11, EW-15, PWB-1(lts), MW-36dg, and BOP-60R(ds) from annual to biennial.
- Reduced water quality monitoring at TSA wells BOP-65(ds), EW-3, and EW-13 from semiannual to annual.
- Discontinued water quality monitoring and water level monitoring at Lower TSA well PMX-196, Upper TSA wells D-16(ds) and D-18(ds), and SGA well PWB-1(usg).
- Reduced water level monitoring at wells BOP-44(ds) and BOP-44(dg) from semiannual to annual, and water quality sampling at BOP-44(ds) from annual to biennial.

2.2 Portland Water Bureau Well Field

PWB did not operate the well field for over 30 days in 2016, so TSA remedy contingency monitoring was not implemented, pursuant to the PWB Contingency Monitoring Plan (Landau

Associates, 2015). PWB operated its Columbia South Shore wellfield from 25 July through 10 August 2016 (17 days) for operation and maintenance and pumped approximately 280 million gallons (PWB, 2016b).

3.0 EXTRACTION AND TREATMENT SYSTEMS

This section summarizes the operation and performance of the groundwater extraction remedy. The Central Treatment System (CTS) is the only extraction and treatment system remaining in operation for the TSA remedy. The CTS operates to remove VOC mass and maintain ongoing hydraulic plume control for the TSA. The location of the CTS compound and the currently operating four Lower TSA extraction wells are shown on Figure 1-2. Monitoring well construction details and location coordinates for monitoring and extraction wells are summarized in Table 3-1.

3.1 CTS Operational Summary

The CTS and Lower TSA extraction wells EW-1, EW-2, EW-14, and EW-23 operated nearly continuously during the twelve-month reporting period. EW-16 was not operational as part of the pump cycling/pilot shutdown. Ten unplanned temporary well shutdowns occurred during the reporting period, as well as routinely-scheduled shut downs for sonar cleaning, as follows:

- 3/13/16 to 3/15/16: EW-23 shut off for three days because of rainwater triggering vault high water level. The vault was drained and the pump turned back on.
- 6/5/16 to 6/6/16: All wells were shut down for one day due to a system power outage.
- 6/12/16 to 6/21/16: EW-1 shutdown for nine days due to equipment failure. The pump and motor were replaced, sonar cleaning was conducted on the well, and the well restarted.
- 6/27/16: EW-1 shutdown for one partial day and the flow meter was reset.
- 9/13/16 to 9/19/16: Programmable logic control (PLC) data collection for all wells was interrupted for six days, although the pumps remained operational during this time.
- 10/16/16: A storm caused power outages, and all wells were shutdown for one day,
- 10/16/16 to 10/17/16: EW-23 was shutdown for two days as a result of storm caused power outages. Rainwater accumulation in the vault prevented the well from being restarted immediately.
- 11/25/16 to 11/28/16: The EW-23 vault flooded and caused pump to shutdown for three days. The vault was pumped out and the pump restarted.
- 12/11/16 to 12/13/16: EW-1, EW-2, and EW-14 shutdown for two days as a result of storm caused power outages.
- 12/12/16 to 12/14/16: EW-23 shutdown for two days because the vault flooded. The water in the vault couldn't be pumped out immediately because of equipment parked on the vault.

Pilot shutdown of EW-16 was approved by DEQ (DEQ, 2014a) and commenced in November 2014. Water quality samples were collected on a quarterly basis at EW-16 beginning in November 2014. Trichloroethene (TCE) concentrations have remained below the 5 micrograms per liter (µg/L) maximum contaminant limit (MCL) threshold since the initial pump shutoff. However, TCE concentrations have increased during the last two quarterly monitoring events, so quarterly sampling of EW-16 will continue. If TCE concentrations remain below the MCL through the August 2017 sampling event, the EW-16 pump assembly will be removed and the well will remain in use for monitoring purposes only.

Upper TSA extraction well EW-3 and Lower TSA extraction well EW-13 remain in use as monitoring wells. Extraction well EW-12 remained in pilot shutdown mode (monitoring only) during the reporting period.

3.2 Groundwater Extraction Rates

Current operating extraction wells include: EW-1, EW-2, and EW-14, located in the mound area near the CTS; and EW-23 located on the Boeing property in the western treatment area. Extraction well construction data are presented in Table 3-1.

Daily flow data from each well is recorded by the automated PLC system. Data from the PLC is downloaded weekly, and manual inspections and system field checks are also conducted weekly. Routine system inspections include manual collection of total flow meter readings, filter pressure monitoring, system inspection and maintenance, and collection of temperature and pH data.

During the reporting period, average extraction rates decreased steadily in EW-1 from about 60 gallons per minute (gpm) in January 2016 to 28 gpm at the end of June 2016. Due to the declining flows, and because the pump and motor had to be removed from the well due to electrical issues, sonar cleaning was conducted in June 2016. Following the sonar cleaning, EW-1 flow increased to 67 gpm and then slowly decreased to approximately 40 gpm by the end of December 2016. Overall, water levels decreased from January 2016 to June 2016 and again from June to September 2016, possibly correlating with increased extraction rates from EW-1.

EW-2 flows decreased from approximately 34 gpm at the beginning of January 2016 to approximately 22 gpm by the end of December 2016. EW-14 had an annual average flow rate of 20 gpm, and EW-23 had an annual average flow rate of 28 gpm for 2016. EW-14 and EW-23 average monthly flow rates remained relatively steady, varying 3 gpm and 4 gpm respectively throughout 2016.

Flow rate and water level data for extraction wells are provided in Appendix A. Average monthly extraction well flow rates over the most recent 5-year period are shown on Figures A-1 through A-5. The combined average monthly flow for all wells is shown on Figure A-6. Significant repair and cleaning events for the operating TSA extraction wells are also noted on Figures A-1 through

A-5. Average flow data for the 12-month reporting period for individual wells and the total combined system are summarized in Table A-1.

3.3 Treatment System Effluent Compliance

CTS performance data consist of weekly flow, pH, and temperature measurements. In addition, influent and effluent samples are collected from the CTS on a quarterly basis. Permits to discharge treated groundwater effluent from the CTS are presented in Attachment C to TSA Remedy Consent Order No. WMCSR-NWR-96-08 (DEQ, 1997).

CTS data for the reporting period are as follows:

- The average flow during the 12-month period, January 2016 through December 2016, was 127 gpm (Table A-1);
- Effluent pH ranged from 7.5 to 7.8 standard units (SU) and remained within the effluent limits of 6 to 9 SU;
- Effluent temperature ranged from 51 to 63 degrees Fahrenheit (F); and
- VOCs were not detected in effluent samples.

Flow, pH, temperature, and influent and effluent VOC data for the reporting period, including compliance (or discharge) limits, are presented in Appendix A (Table A-2).

3.4 Well Decommissioning

Groundwater monitoring well, BOP-22(dg), was decommissioned in November 2016. TCE concentrations in BOP-22(dg) were consistently below the laboratory reporting limit since 1991. The well was decommissioned by overdrilling in accordance with the DEQ-approved work plan (Landau Associates, 2016; DEQ, 2016a). Well decommissioning activities were conducted by Oregon State licensed drillers and observed by representatives from Landau Associates. Original boring logs and decommissioning logs are provided in Appendix D.

Decontamination water and water removed from the well during decommissioning was routed to the groundwater treatment system at the Boeing property. Soil cuttings generated during the decommissioning were temporarily stored in a 20 yard roll off bin and allowed to dewater at the onsite Remediation Yard (generated water was routed to the GWTS). Per the work plan, no signs of environmental impact were observed in the soil cuttings; therefore, no disposal characterization sample was collected. Soil cuttings were disposed of at Columbia Ridge Landfill utilizing Boeing's internal disposal procedures.

3.5 SOIL VAPOR EXTRACTION

The SVE system has effectively removed VOCs from the unsaturated zone of the TSA since the startup of the SVE Pilot Study in 2014 and continuation of the long term SVE extraction system in 2015 and 2016 (Geosyntec, Landau Associates, and SSPA, 2016; DEQ, 2014b, 2016b). Due to the effectiveness of the SVE system for removing VOC mass from the TSA, the system was expanded in November and December of 2016 with the addition of four new wells.

3.5.1 SVE Well Installation

Four vapor monitoring wells were installed in November and December 2016: VMW-A, VMW-B, VMW-C, and VMW-D (Figure 3-1). The wells were installed using a sonic track rig and drilled to depths ranging from 110 to 114 feet below ground surface (bgs). The vapor monitoring wells were constructed of 4-inch, schedule 40 polyvinyl chloride (PVC) with 20-foot-long, 10-slot screens, and above-ground monuments. The wells were designed and installed to intersect TSA groundwater and be used for both groundwater and vapor monitoring.

Telescoping drilling methods were utilized during drilling, and a bentonite seal was placed at the base of the Troutdale Gravel Aquifer (TGA) before advancing into the underlying Confining Unit 1 (CU1). Outer casing used in the TGA was 10-inches in diameter and stepped down to 8- and/or 9-inch diameter casing for drilling/advancing through CU1 and the upper TSA. Observations made during the advancement of the borings included soil and rock type descriptions and results of field screening (photoionization detector [PID] measurements). Soil types were characterized using the United Soil Classification System (USCS) as a guideline. Boring and monitoring well construction logs are provided in Appendix E, and well construction details are summarized in Table 3-1.

Following installation, the wells were developed by pumping and surging. Two wells did not sustain continued pumping and were pumped dry during development, so the wells were pumped dry at least three times. Groundwater elevations in the wells ranged from 10.65 to 15.9 feet above mean sea level (MSL). Groundwater elevations are summarized in Table B-1. Groundwater samples were collected from the wells and analyzed for VOCs by EPA Method 8260, and results are summarized in Table C-1. Groundwater elevations and analytical results are discussed in more detail, below (Sections 5.2 and 5.3).

SVE piping was installed in below-ground trenches approximately 12 inches bgs to connect the new vapor monitoring wells to the SVE system. The extraction from the four new SVE wells commenced 14 December 2016 and initial flow measurements were consistent with design parameters. Existing vapor well VW-17d-95.5 operation continues, but the two shallower vapor wells, VW-17d-42.5 and VW-17d--75 were disconnected due to reduced extraction efficiency (i.e. low to no remaining mass removal).

3.5.2 SVE System Operation

The SVE system consists of a 15-horsepower, TurboTron regenerative blower and a knock-out tank situated on a concrete pad within the chain-link fence that surrounds the CTS. The system is connected to VW-17d-95.5 by aboveground PVC piping and to the four new wells by below ground PVC piping. A PVC exhaust stack directly discharges to the atmosphere at a height of approximately 8 feet. The system pulled from the three existing SVE wells until 14 December 2016, when the two shallow wells were turned off and the four new vapor monitoring wells were added. The SVE system now pulls vapor from five wells.

Throughout 2016, the SVE system maintained an average flow rate around 220 standard cubic feet per minute (scfm). In December 2016, the extraction flow rate was increased to approximately 480 scfm to extract from the five wells. SVE system operational data are provided in Appendix E. Flow rates, vapor concentrations (field and laboratory), and estimated mass extracted are summarized in Appendix E, Tables E-1 and E-2, and in Figures E-1, E-2, and E-3.

3.5.3 SVE System Monitoring

Routine SVE system monitoring consists of the following parameters and schedule for the four new SVE wells (VMW-A, VMW-B, VMW-C, VMW-D), the existing SVE well (VW-17d-95.5), and the system outlet, as follows:

- Weekly Sampling:
 - SVE system temperature, pressure, and flow;
 - SVE well temperature, pressure, and flow; and
 - System outlet field vapor sampling for VOCs (photoionization detector [PID]).
- Monthly Sampling:
 - System outlet laboratory vapor sampling for VOCs (summa canister).
 - SVE well post start-up sampling (December, January, and February).
- Quarterly Sampling:
 - SVE well laboratory sampling for VOCs (summa canisters).

Extracted vapor concentrations are measured at the effluent riser pipe using a PID for weekly measurements and an evacuated, 1.0-liter summa canisters for monthly laboratory analysis. Summa canisters are submitted for analytical testing of VOCs by EPA Method TO-15. VOC results from PID measurements and laboratory testing are summarized in Tables E-1 and E-2 and Figure E-1. Analytical laboratory reports and data validation memoranda are provided in Appendix F.

3.5.4 SVE System Mass Removal

Based on laboratory data, approximately 13 pounds of VOCs were removed in 2016 (Table E-2), with a total of 28 pounds of VOCs removed since system startup in April 2015¹. VOC mass removal from the SVE system for 2017 is estimated to be on the order of 40 to 60 pounds (Figure E-3).

VOC concentrations for each of the vapor wells are shown on Figure E-4. Possible sources of TCE that the SVE system is extracting from include:

- The vadose zone above the former groundwater table from the TGA;
- The smear zone where dewatering occurred (originally contaminated by groundwater); and/or
- The volatilization from existing contaminated groundwater.

Monthly groundwater sampling at monitoring well CMW-17ds, which is located adjacent to the vapor wells, was conducted from November 2015 through May 2016 to evaluate the potential effect of SVE mass removal on groundwater concentrations. CMW-17ds is screened from elevation 14 to 24 feet mean sea level (MSL), or depths of 97.89 to 107.89 feet bgs, at a depth just below the deepest vapor monitoring well (VW-17D-95.5 is screened from elevation 44.5 to 24.5 feet MSL). No direct correlation between the vapor mass removed and groundwater VOC concentrations was observed. Groundwater elevations and TCE concentrations at CMW-17ds are shown on Figure C-1.

Operation of the SVE system is planned to continue through at least March 2018. In addition to the quarterly vapor monitoring, quarterly groundwater samples will be obtained from the four new vapor monitoring wells (VMW-A through VMW-D). These data, along with quarterly groundwater monitoring well data from mound area wells (including CMW-17ds) will be used to evaluate possible effects of the SVE operation and VOC mass removal on groundwater quality.

¹ VOCs mass removal rates are estimated using both the PID and laboratory data (Figure E-3). Due to low concentrations detected using the field PID meter (1-2 ppm), the laboratory data is viewed as more reliable and a more accurate representation of mass removal with the SVE system.

4.0 REMEDY PERFORMANCE SUMMARY

This section summarizes remedy performance data obtained during this reporting period, including groundwater levels and groundwater quality data. Groundwater elevation data are summarized in Appendix B, and groundwater quality data are summarized in Appendix C. Laboratory reports, along with data validation reports, are presented in Appendix F.

4.1 Groundwater Elevations

Groundwater elevations are measured monthly, quarterly, semi-annually, and annually depending on the well, as summarized in Table 2-2. Water levels are measured monthly in the four operating Lower TSA extraction wells, and quarterly at eight Upper and Lower TSA former extraction wells that are currently utilized for as monitoring wells (including EW-16 that is in pilot shutdown mode). Semiannual events are conducted at 36 Upper and Lower TSA monitoring wells, and annual events are conducted at seven Upper and Lower TSA monitoring wells. Details of the monitoring schedule for measuring groundwater levels are included in Table 2-2.

Depth to groundwater is measured using a portable electric tape meter in the monitoring wells, and with pressure transducers located in five wells (1 Upper TSA wells, 3 Lower TSA wells, and 1 SGA well). Water level data are downloaded monthly from the pressure transducers. Groundwater depths and groundwater elevations are summarized in Table B-1. Water level hydrographs for the five wells with pressure transducers are also included in Appendix B on Figures B-1 through B-5 for the 12-month period from January through December 2016. Precipitation during the 12-month reporting period was approximately 43.35 inches (Appendix B, Figure B-6; NOAA, 2016). Normal annual precipitation at the Portland airport is about 36.0 inches.

4.2 Groundwater Flow and Hydraulic Capture

Groundwater levels near the TSA mound area indicate that inward horizontal gradients towards the extraction wells continue due to ongoing remedy pumping. Groundwater contours for the semiannual water level measurement event (February 2016) and the annual event (August 2016) are provided in Figures 4-1a, 4-1b, 4-2a, and 4-2b. Upper TSA groundwater flow direction is generally towards the north-northwest. Lower TSA inward hydraulic gradients toward the extraction wells are indicative of hydraulic capture and demonstrate the effectiveness of Lower TSA extraction wells EW-1, EW-2, and EW-14 in achieving and maintaining capture. Groundwater flow directions in the Lower TSA do not typically vary significantly from wet to dry season and are strongly influenced by the operating extraction wells. Hydraulic capture is also achieved in the western portion of the site by the operation of EW-23. These extraction wells capture groundwater within areas of the site where TCE concentrations remain above the cleanup level.

4.3 Water Quality

Analytical results for groundwater samples collected during the reporting period are summarized in Appendix C, Table C-1. Plots of time versus TCE concentrations for select monitoring wells in the mound area and the four operating extraction wells and EW-16 are presented in Figures C-1 through C-9. TCE concentration contours for the semiannual event (February 2016) and the annual event (August 2016) are shown on Figures 5-1a, 5-1b, 5-2a, and 5-2b for the Upper and Lower TSA wells. VOC results for wells sampled in 2016 are presented in Appendix C.

4.3.1 Upper TSA

TCE concentrations in the TSA mound area persist near an area where the Cascade TGA plume historically discharged into the TSA. TCE concentrations during the monitoring period (January 2016 through December 2016 sampling events) ranged from 36.1 to 52.1 µg/L in water table well CMW-17(ds) (Figure C-1), 48.1 to 78.7 µg/L at CMW-18(ds) (Figure C-7), and 19.1 to 25.4 µg/L at CMW-10(ds) (Figure C-6). Groundwater is captured by nearby Lower TSA extraction wells EW-2 and EW-14 in the vicinity of these three monitoring wells.

In the Upper TSA near the western extent of the TSA mound area, TCE concentrations remain below the MCL of 5.0 µg/L. TCE concentrations at BOP-13(ds) ranged from 1.0 to 3.4 µg/L during this reporting period, which is a decrease from 3.7 µg/L in 2015 (Figure C-2). TCE concentrations ranged from 5.8 to 7.6 µg/L at BOP-61(ds), which is located further west and northwest of the TSA mound area (Figure 5-2a). TCE concentrations ranged from less than the laboratory reporting limit to 3.2 µg/L at CMW-19(ds), located south of the mound area.

4.3.2 Lower TSA

In Lower TSA Zone B, the western portion of the remediation area, TCE concentrations were below the MCL during this reporting period except for monitoring well BOP-61(dg), where TCE concentrations ranged from 3.9 to 5.6 µg/L. TCE concentrations at BOP-61(dg) have remained near the 5.0 µg/L MCL for the last 3 years (Figure C-4). During the February and August 2016 sampling events, TCE concentrations at extraction well EW-23 remained constant at 2.06 µg/L (Table C-1 and Figure C-9).

In the Lower TSA Zone C, the central portion of the remedy, TCE concentrations were below the MCL of 5 µg/L in extraction well EW-1 (3.26 to 4.26 µg/L), and above the MCL at extraction wells EW-2 (9.58 and 13.3 µg/L) and EW-14 (6.25 and 9.30 µg/L) (Table C-1 and Figure C-9).

In Lower TSA monitoring wells EW-8, EW-12, and EW-13, which are non-pumping extraction wells converted to monitoring use, TCE concentrations remained below the MCL during this reporting period (Table C-1).

The highest TCE concentration in the Lower TSA Zone C continued to occur in the mound area well D-17(ds). Monitoring well D-17(ds) is screened at the top of the Lower TSA across the water table. TCE concentrations ranged from 22 to 54.1 µg/L at D-17(ds) during this reporting period (Table C-1 and Figure C-8).

In Lower TSA Zone D, the eastern portion of the remediation area, TCE concentrations remained below the MCL in monitoring well CMW-26(dg), where TCE concentrations ranged from 2.33 to 3.95 µg/L. However, TCE concentrations at EW-16 increased from below the laboratory reporting limit up to 4.94 µg/L for the February and August 2016 events, respectively (Table C-1).

5.0 PERFORMANCE SUMMARY

Significant remedy performance findings are summarized below.

- Groundwater flow directions in the Upper and Lower TSA indicate ongoing inward and downward flow towards the operating extraction wells. The 12-month average flow rate from the four operating extraction wells was 127 gpm, the same rate during the previous reporting period. Extraction rates at EW-1 did not decline below optimal levels during the reporting period; however, sonar cleaning of the well was conducted in June 2016 due to declining trends and because the pump was removed for repair. Flow rates at extraction well EW-2 were close to 30 gpm during winter months, and declined to approximately 24 gpm during summer months. Flow rates at EW-14 were fairly consistent near 20 gpm year-round. Flow rates at EW-2 and EW-14 are being watched to evaluate the potential need for sonar cleaning.
- In the Upper TSA, TCE concentrations remain above the MCL in the mound area wells CMW-10ds (25.4 and 21 µg/L), CMW-17ds (52.1 and 38.6 µg/L), and CMW-18ds (56.3 and 78.7 µg/L) during the February and August 2016 monitoring events, respectively. TCE concentrations in wells located outside of the mound area are below the MCL, with the exception of monitoring well BOP-61(ds) (7.6 and 5.8 µg/L during the February and August 2016 monitoring events, respectively).
- In the Lower TSA, the highest TCE concentrations remain in the vicinity of the mound area (Zone C) near wells D-17(ds) (54.1 and 22 µg/L) during the February and August 2016 events, respectively. In Zones B and D, TCE concentrations were below the MCL during the reporting period with the exception of BOP-61(dg), where a TCE concentration of 5.6 was measured in August 2016. TCE concentrations for Lower TSA extraction wells remained generally stable with the following maximum concentrations during this reporting period: EW-1 (4.26 µg/L), EW-2 (13.3 µg/L), EW-14 (9.30 µg/L), and EW-23 (2.06 µg/L).
- The dissolved VOC plume continues to be hydraulically captured by remedy operation.
- The SVE system has been operating since April 2015 and has removed an estimated 28 pounds of VOC mass from the unsaturated zone near the mound area through November 2016. The system is anticipated to operate through at least March 2018, at which time an evaluation will be conducted to determine if additional operation time is warranted. Data evaluation is ongoing to determine the source of the VOCs being removed by the system, including monthly/quarterly vapor sampling of the new vapor monitoring wells.

5.1 Mass Removal

The annual TCE mass removal estimates are based on groundwater influent TCE concentrations, the average quarterly groundwater flow for the operating extraction wells, and assumes that the

TCE is completely removed during groundwater treatment. During 2016, approximately 3.25 pounds (lbs) of TCE mass were removed through groundwater extraction, reflecting a slight increase from the 2.98 lbs removed during the prior year (2015). Since 1996, an estimated total of 490 lbs of TCE have been removed from the TSA and SGA. TCE annual mass removal estimates for the TSA remedy are summarized in Appendix G, Table G-1 and Figure G-1, and TCE mass removal estimates for each extraction well are summarized in Appendix G, Table G-2 and Figure G-2.

5.2 Restoration Progress

In 2016, a little over three pounds of VOC mass was removed from the groundwater extraction system. Performance data indicates that the existing pump and treat system is effective in containing the groundwater plume; however, progress toward restoration in the mound area (Zone C) is slow and restoration will likely not be achieved by 2018, the 20th year of remedy operation. A design criterion for the remedy was a 20-year restoration time frame. The Record of Decision states that if restoration is not achieved within this time frame, that groundwater pump and treat will continue until restoration is complete. It is anticipated that operation of the pump and treat system will continue beyond 2018 until restoration is complete.

5.3 Closure by Restoration Zone

The following summarizes the status of closure by restoration zone:

- Restoration has been achieved in Zone A for the Upper TSA, Lower TSA, and the SGA. Currently two Upper TSA wells [BOP-44(ds) and PWB-1(uts)], three Lower TSA wells [BOP-44(dg), MW-36(dg), and PWB-1(lts)], and 1 SGA well [BOP-44(usg)] are monitored as part of either the remedy monitoring program or the PWB contingency monitoring plan. Groundwater quality data continues to indicate that TCE concentrations in Zone A are below the MCL. Monitoring and groundwater elevation data are being collected for the SGA at well BOP-44(usg) as part of the PWB contingency monitoring plan. Wells used for monitoring water levels and VOCs as part of the PWB contingency monitoring plan were relocated in 2015 to wells positioned closer to the leading edge of the dissolved VOC plume.
- Restoration in Zone B is complete except for a small area near wells BOP-61(ds) and BOP-61(dg).
- Restoration in Zone C continues, as this area of the site contains the highest TCE concentrations. TCE concentrations in the mound area continue to decrease; however, this portion of the remediation area has been slower to respond to remedial actions. The SVE system was expanded in the central portion of Zone C in 2016 to expedite mass removal.

- Restoration in Zone D is almost complete as current TCE concentrations are below the MCL. Continued groundwater monitoring is ongoing as part of EW-16 pilot shutdown monitoring.

6.0 RECOMMENDATIONS AND FUTURE PLANNED ACTIVITIES

Water-quality restoration has been achieved in the SGA, in the Upper and Lower TSA north of Sandy Boulevard (Zone A), and in the western portion of the remedy area in the Upper and Lower TSA (Zone B), with a minor exception near the Zone C boundary. Restoration progress in the eastern portions (Zone D) of the remedy area continues with groundwater concentrations below the MCL. An SVE system operated during 2016 and an expanded SVE system will continue through at least March 2018. The following recommendations are proposed to improve the monitoring programs and optimize the remedy treatment and performance.

6.1 Extraction Well Operation

Continued pumping of operating extraction wells EW-1, EW-2, EW-14, and EW-23 is recommended to maintain hydraulic capture, with continued pumping at the current rates. Sonar cleaning twice per year appears to be necessary at extraction well EW-1 to optimize water flow. Sonar cleaning of EW-2 will likely be necessary once per year, but that may increase if extraction rates decrease below target levels. In addition, pilot shutdown at EW-16 will continue through 2017. Continued maintenance and scheduled cleaning of the wells will be conducted as needed to meet target extraction pump rates.

- Extraction well EW-1 has a target pumping rate of 25 gpm, with the last sonar well cleaning occurring in June 2016. Sonar cleaning of EW-1 is tentatively scheduled for early spring of 2017. The monthly average extraction rates ranged from 28 gpm in June 2016 to 67 gpm in July 2016 after sonar cleaning.
- Extraction well EW-2 has a target pumping rate of 25 gpm or greater. Over the last 12 months, the pumping rate has gradually decreased from 34 to 22 gpm. The last sonar cleaning at EW-2 was in December 2015 and the flow rate increased to 34 gpm. Based on this observed extraction rate trend, we anticipate a sonar cleaning event will likely be necessary in the spring of 2017.
- At EW-14, the extraction rate over the last 12 months has ranged from 19 to 22 gpm, with an average flow rate of 20.1 gpm; the target pumping rate for EW-14 is 20 gpm. The last sonar cleaning at EW-14 was conducted in June 2013, and while flow rates increased immediately following cleaning, the extraction rate has declined steadily. A sonar cleaning event may be necessary in 2017.
- Extraction well EW-16 remained in pilot shutdown for the entirety of the reporting cycle, and TCE concentrations remained below the MCL. Monitoring at EW-16 will continue, and removal of the pump and motor assembly will be evaluated later this year.

- Pumping rates at EW-23 ranged from 27 to 30 gpm during the last 12 months, with an average of 28.4 gpm. The target flow rate for EW-23 is 30 gpm.

6.2 SVE system

The current SVE system has extracted 28 pounds of VOCs between system startup in April 2015 and December 2016. The SVE system will continue to operate through approximately March 2018, with performance evaluated after one-year of operation.

6.3 Monitoring Program and Schedule Modifications

Monitoring program modifications are recommended for wells in Zone A, which align with revisions to the PWB contingency monitoring plan. These wells have met the criteria for well decommissioning (Table 2-1) and are no longer needed for PWB contingency monitoring. We recommend the following:

- Decommission remedy monitoring wells D-16ds, D-18ds, and RPW-1ds. TCE concentrations at these three remedy monitoring wells have either been less than the laboratory detection limit or less than 1 µg/L of TCE for the past 10 years.
- Decommission shallow vapor extraction wells VW-17d-42.5 and VW-17d-75.5. SVE at these two vapor wells has been completed and the wells are no longer efficient or necessary.
- Decrease the frequency of water level monitoring at several remedy monitoring wells located outside the dissolved VOC plume. Reduce water level monitoring from semiannual (February and August) to annual (August) at Upper TSA wells BOP-21(ds), BOP-42(ds), and BOP-62(ds) and at Lower TSA wells BOP-13(dg), BOP-42(dg), BOP-60(dg), and EW-3 (former Upper TSA extraction well converted to groundwater monitoring).
- Decrease water quality monitoring frequency from annual to biennial at Upper TSA monitoring well EW-3 due to distance of the well from the dissolved VOC plume. Also, TCE concentrations have been less than the detection limit since May 2010 and below the MCL since February 2007.
- Decrease water quality monitoring frequency at Lower TSA monitoring well CMW-14R(ds) from quarterly to semiannual due to stable TCE concentrations. VOCs concentrations detected at CMW-14R(ds) have been less than the MCL since January 2009, and at or near 1.0 µg/L since February 2011.

7.0 REFERENCES

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- Oregon Department of Environmental Quality (DEQ), 2016b. Email from B. Williams, Approval of TSA SVE Expansion Work Plan. 11 October 2016.

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TABLES

Table 2-1
Remedy Well Network Criteria
TSA Remedy - East Multnomah County

This table summarizes TSA remedy criteria for extraction well pilot shutdown, well and system decommissioning, monitoring well network modifications, and changes in sampling frequency. These criteria were presented in Section 5 of the eighth TSA annual performance report¹ and are summarized below for ongoing reference.

1. PILOT SHUTDOWN CRITERIA

The following criteria are for TSA extraction well(s) currently in pilot shutdown mode:

- *If TCE concentrations in these pilot shutdown wells increase to levels equal to or above the MCL for two consecutive quarters, extraction at individual wells shall resume.*
- *If TCE remains below the MCL cleanup level for 2 years, DEQ will evaluate potential decommissioning of these wells.*

2. MONITORING WELL NETWORK MODIFICATION

Wells may be removed from the monitoring program if a well meets one or more of the following criteria:

- *TCE concentrations have been consistently below detection limits for 2 or more years.*
- *The well is located outside the limits of the plume and is no longer needed to monitor hydraulic plume control or restoration progress.*
- *The location of a well duplicates another well better suited to evaluate hydraulic control and restoration progress.*

3. SAMPLING FREQUENCY MODIFICATIONS

The following criteria serve to standardize current and future monitoring adjustments as restoration progresses over the coming years:

Criteria for Increasing Sampling Frequency:

- *The sampling frequency will be increased at a well if TCE concentrations increase to detected levels for two consecutive sampling events where they have been below detection limits for 2 or more years.*
- *The sampling frequency will be increased at a well if TCE concentrations increase above the MCL for two consecutive sampling events where they have been below the MCL for 2 or more years.*

Criteria for Reducing Sampling Frequency:

- *If TCE has been consistently below detection limits for the prior 2 years, the sampling frequency may be reduced.*
- *If TCE has been stable to declining for the prior 2 years, the sampling frequency may be reduced.*

4. CRITERIA FOR WELL DECOMMISSIONINGS

Extraction and monitoring well decommissionings will be proposed to DEQ if the following criteria are met:

- *Extraction well decommissioning may be proposed to DEQ if TCE concentrations remain consistently below the MCL in that well for 2 years following pilot shutdown; two consecutive TCE detections at or above the MCL may prompt resumed operation.*
- *Monitoring well decommissioning will be proposed to DEQ if TCE concentrations remain below the MCL during the confirmation sampling round that will be performed 2 years after a well has been removed from the remedy monitoring schedule; if TCE is detected at or above the MCL during the confirmation sampling round, additional monitoring may be required.*

¹Landau Associates, Prowell Environmental, Pegasus Geoscience, 2006. Troutdale Sandstone Aquifer Remedial Action Annual Performance Evaluation, 04/01/05 through 03/31/06. 30 June 2006.

Table 2-2
Performance Monitoring Schedule - 1 January 2016 through 31 December 2016
TSA Remedy - East Multnomah County

Well	Aquifer	Water Level Measurements	Water Quality Sampling	Responsibility
Groundwater Systems				
CTS Influent	—	—	Quarterly	Cascade
CTS Effluent	—	—	Quarterly	Cascade
TSA Extraction Wells				
EW-1 (on)	Lower TSA	Monthly	Quarterly	Cascade
EW-2 (on)	Lower TSA	Monthly	Quarterly	Cascade
EW-14 (on)	Lower TSA	Monthly	Quarterly	Cascade
EW-16 (pilot shutdown)	Lower TSA	Monthly	Quarterly	Cascade
EW-23 (on)	Lower TSA	Monthly	Semiannually	Cascade
TSA Monitoring Wells				
BOP-13(ds)	Upper TSA	Quarterly	Quarterly	Boeing
BOP-13(dg)	Lower TSA	Semiannually to Annually	Annually	Boeing
BOP-20(ds)	Upper TSA	Semiannually PWB Monitoring	Annually PWB Monitoring	Boeing
BOP-20(dg)	Lower TSA	Semiannually PWB Monitoring	Annually PWB Monitoring	Boeing
BOP-21(ds)	Upper TSA	Semiannually to Annually PWB Monitoring	Annually PWB Monitoring	Boeing
BOP-22R(ds)	Upper TSA	Annually PWB Monitoring	Annually PWB Monitoring	Boeing
BOP-23(dg)	Lower TSA	Semiannually PWB Monitoring	Annually PWB Monitoring	Boeing
BOP-31(ds)	Upper TSA	Quarterly	Quarterly	Boeing
BOP-31(dg)	Lower TSA	Semiannually	Semiannually	Boeing
BOP-42(ds)	Upper TSA	Semiannually to Annually	Annually	Boeing
BOP-42(dg)	Lower TSA	Semiannually to Annually	Annually	Boeing
BOP-44(ds)	Upper TSA	Annually PWB Monitoring	Biennial	Cascade
BOP-44(dg)	Lower TSA	Annually PWB Monitoring	Biennial	Cascade
BOP-60R(ds)	Upper TSA	Annually	Biennial	Boeing
BOP-60(dg)	Lower TSA	Semiannually to Annually PWB Monitoring	Annually PWB Monitoring	Boeing
BOP-61(ds)	Upper TSA	Semiannually	Semiannually	Boeing
BOP-61(dg)	Lower TSA	Semiannually	Semiannually	Boeing
BOP-62(ds)	Upper TSA	Semiannually to Annually	Annually	Boeing
BOP-65(ds)	Upper TSA	Semiannually	Annually	Boeing
BOP-66(ds)	Upper TSA	Semiannually	Semiannually	Boeing
D-16(ds)	Upper TSA	Decommission	Decommission	Cascade
D-17(ds)	Lower TSA	Quarterly	Quarterly	Cascade
D-17(dg)	Lower TSA	Semiannually	Semiannually	Cascade
D-18(ds)	Upper TSA	Decommission	Decommission	Cascade
DEQ-1(dg)	Lower TSA	Semiannually	—	Cascade
DEQ-5(ds)	Upper TSA	Semiannually	—	Cascade
DEQ-5(dg)	Lower TSA	Semiannually	—	Cascade
EMC-2(dg)	Lower TSA	PWB Monitoring	—	Cascade
EW-3 (monitoring only)	Upper TSA	Semiannually to Annually	Annually to Biennially	Boeing
EW-8 (monitoring only)	Lower TSA	Semiannually	Semiannually	Cascade
EW-11 (monitoring only)	Lower TSA	Annually	Biennial	Cascade
EW-12 (monitoring only)	Lower TSA	Semiannually	Quarterly	Cascade

Table 2-2
Performance Monitoring Schedule - 1 January 2016 through 31 December 2016
TSA Remedy - East Multnomah County

Well	Aquifer	Water Level Measurements	Water Quality Sampling	Responsibility
EW-13 (monitoring only)	Lower TSA	Semiannually	Annually	Boeing
EW-15 (monitoring only)	Lower TSA	Annually	Biennial	Cascade
CMW-3	TSA	Semiannually	—	Cascade
CMW-8(dg)	Lower TSA	Semiannually	Biennial	Cascade
CMW-10(ds)	Upper TSA	Quarterly	Quarterly	Cascade
CMW-10(dg)	Lower TSA	Semiannually	Annually	Cascade
CMW-14R(ds)	Lower TSA	Semiannually	Quarterly to SemiAnnually	Cascade
CMW-17(ds)	Upper TSA	Quarterly	Quarterly	Cascade
CMW-18(ds)	Upper TSA	Quarterly	Quarterly	Cascade
CMW-19(ds)	Upper TSA	Quarterly	Quarterly	Cascade
CMW-20(ds)	Upper TSA	Semiannually	Annually	Cascade
CMW-22(dg)	Lower TSA	Semiannually	Biennial	Cascade
CMW-24(dg)/EW-5	Lower TSA	Semiannually	Semiannually	Cascade
CMW-25(dg)	Lower TSA	Semiannually	Semiannually	Cascade
CMW-26(dg)	Lower TSA	Semiannually	Quarterly	Cascade
CMW-36(dg)	Lower TSA	PWB Monitoring	PWB Monitoring	Cascade
PMX-167 [W. Interlachen]	Upper TSA	Semiannually	—	Cascade
PMX-208(dg) [Simpson]	Lower TSA	Semiannually	—	Cascade
PWB-1(uts)	Upper TSA	Semiannually	Biennial	Cascade
PWB-1(lts)	Lower TSA	Annually	Biennial	Cascade
PWB-2(lts)	Lower TSA	Semiannually	—	Cascade
RPW-1(ds)	Upper TSA	Decommission	Decommission	Cascade
SGA Monitoring Wells				
BOP-44(ug)	Upper SGA	PWB Monitoring	--	Cascade
Vapor Monitoring Wells				
VMW-17-45.5	Upper TSA	Decommission	Decommission	Cascade
VMW-17-75.5	Upper TSA	Decommission	Decommission	Cascade
VMW-17d-95.5	Upper TSA	--	--	Cascade
VMW-A	Upper TSA	Quarterly	Quarterly	Cascade
VMW-B	Upper TSA	Quarterly	Quarterly	Cascade
VMW-C	Upper TSA	Quarterly	Quarterly	Cascade
VMW-D	Upper TSA	Quarterly	Quarterly	Cascade

NOTES:

^a Annual monitoring performed in August; semiannual in February and August; quarterly in February, May, August, and November. Two-year monitoring was performed in August 2015 and is scheduled August 2017.

Recommendations for modifications to the Monitoring Schedules are indicated in red text, and wells recommended for decommissioning are also in red text and shaded blue.

Table 2-3
Significant Remedy Documents – 1 January 2016 through 31 December 2016
TSA Remedy – East Multnomah County Oregon

Date	Document Type	Author	Title	Comments
2/29/16	Report	Geosyntec Consultants, Landau Associates, and SSPA	Cascade Boeing TSA 2015 Annual Report	2015 Annual Performance Report, 1 October 2014 – 31 December 2015. Recommendations included: • Decommission wells BOP-70(ds), BOP-71(ds), BOP-22(dg), and EMC-2(usg). • Cease monitoring at PWB-1(usg) and PMX-196. • Discontinue monitoring at wells D-16(ds) and D-18(ds). • Reduce/change monitoring at PWB-1(lts), BOP-44(dg), BOP-44(ds), BOP-65(ds), EW-3, EW-11, EW-13, EW-15, BOP-60R(ds), and MW-36dg.
05/26/16	Email	DEQ	RE: Cascade Boeing TSA 2015 Annual Report	DEQ approval of TSA 2015 Annual Report
8/4/16	Technical Memorandum	Landau Associates	To PWB: Well Ownership Transfer, East Multnomah County Remedy, Gresham, Oregon	Proposal to Portland Water Bureau to transfer well ownership of four wells: BOP-22(dg), BOP-70(ds), BOP-71(ds), and EMC-2(usg).
9/9/16	Report	Geosyntec Consultants	Cascade Corp TSA SVE System Expansion Work Plan	Work plan describing proposed expansion of the Soil Vapor Extraction system located at the Cascade Corporation TSA remediation site.

Table 2-3
Significant Remedy Documents – 1 January 2016 through 31 December 2016
TSA Remedy – East Multnomah County Oregon

Date	Document Type	Author	Title	Comments
9/14/16	Report	Landau Associates	East Multnomah Cleanup-TSA/SGA Well Decommissioning Work Plan (ECSI No. 1479)	Work Plan for decommissioning wells BOP-22(dg), BOP-70(ds), BOP-71(ds), and EMC-2(usg).
9/28/16	Email	DEQ	RE: East Multnomah Cleanup-TSA/SGA Well Decommissioning Work Plan (ECSI No. 1479)	DEQ approval of Work Plan for decommissioning wells BOP-22(dg), BOP-70(ds), BOP-71(ds), and EMC-2(usg).
10/11/16	Email	DEQ	RE: Cascade Corp TSA SVE Expansion Work Plan	DEQ approval of TSA SVE Expansion Work Plan

Table 3-1
Well Construction Data - 1 January 2016 through 31 December 2016
TSA Remedy - East Multnomah County

		NAD 1983 State Plane Oregon (ft)		Elevations (ft MSL)				
Well	Aquifer Screened	X Coordinate	Y Coordinate	Ground Surface	Measuring Point	Top of Screen	Bottom of Screen	Depth of Boring (ft bgs)
Extraction Wells								
EW-1	Lower TSA	7699560.1	689504.6	124.1	124.04	-27.8	-57.8	183
EW-2	Lower TSA	7700692.2	689205.9	126.2	126.01	-6.8	-46.8	179
EW-14	Lower TSA	7699952.7	689329.7	128.4	127.63	-21.9	-51.9	230
EW-16	Lower TSA	7702424.1	689665.5	84.2	83.71	-40.3	-80.3	198
EW-23	Lower TSA	7698806.9	690524.7	83.8	83.93	-26.2	-66.2	157
Monitoring Wells & Former Extraction Wells Approved for Monitoring Use								
BOP-13(ds)	Upper TSA	7699461.3	689388.4	126.7	128.94	9.0	-1.0	132
BOP-13(dg)	Lower TSA	7699465.9	689375.4	127.5	128.71	-41.0	-61.0	193
BOP-20(ds)	Upper TSA	7698395.4	691041.6	78.2	77.45	9.0	-11.0	97
BOP-20(dg)	Lower TSA	7698381.4	691042.6	78.1	77.32	-105.0	-125.0	209
BOP-21(ds)	Upper TSA	7697591.5	691105.0	77.1	78.02	-88.0	-108.0	192
BOP-22R(ds)	Upper TSA	7697050.5	691019.5	84.2	82.91	-158.8	-178.8	310
BOP-23(dg)	Lower TSA	7699526.6	690832.2	75.2	76.96	-26.0	-46.0	125
BOP-31(ds)	Upper TSA	7699322.2	690090.6	97.1	99.04	17.0	7.0	91
BOP-31(dg)	Lower TSA	7699323.6	690105.1	96.5	98.51	-34.0	-54.0	154
BOP-42(ds)	Upper TSA	7698251.0	689588.3	129.3	130.74	-8.0	-28.0	159
BOP-42(dg)	Lower TSA	7698236.8	689588.9	129.5	130.71	-92.0	-112.0	243
BOP-44(ds)	Upper TSA	7698995.4	691938.6	32.5	35.24	-23.0	-43.0	76
BOP-44(dg)	Lower TSA	7699014.1	691938.6	32.6	35.15	-104.0	-124.0	166
BOP-60R(ds)	Upper TSA	7697726.6	690503.5	83.2	82.80	-71.8	-81.8	165
BOP-60(dg)	Lower TSA	7697704.8	690369.9	93.8	93.59	-165.0	-185.0	280
BOP-61(ds)	Upper TSA	7698640.8	690240.7	96.3	94.64	6.0	-4.0	100
BOP-61(dg)	Lower TSA	7698632.5	690246.1	96.2	94.43	-60.0	-70.0	171
BOP-62(ds)	Upper TSA	7697855.5	689987.2	112.1	112.29	-42.0	-51.9	166
BOP-65(ds)	Upper TSA	7698234.0	690115.0	104.4	104.22	2.0	-8.0	113
BOP-66(ds)	Upper TSA	7698670.7	690111.4	103.3	102.97	13.0	3.0	102
D-16(ds)	Upper TSA	7699286.4	693072.9	15.4	16.91	-114.0	-134.0	152
D-17(dg)	Lower TSA	7699869.5	689532.2	121.8	124.61	-30.0	-50.0	178
D-17(ds)	Lower TSA	7699886.2	689530.7	121.9	123.28	12.0	2.0	121
D-18(ds)	Upper TSA	7697175.0	692775.9	18.1	18.01	-153.0	-163.0	179
DEQ-1(dg)	Lower TSA	7701973.4	688195.6	151.0	150.58	-53.0	-73.0	235
DEQ-5(ds)	Upper TSA	7698660.3	688786.4	155.9	155.68	19.9	0.0	160
DEQ-5(dg)	Lower TSA	7698650.5	688787.3	155.9	155.95	-58.0	-78.0	240
EMC-2(dg)	Lower TSA	7701014.5	692008.0	44.8	43.51	-75.0	-85.0	140
EW-3	Upper TSA	7697737.4	690313.3	97.1	94.26	-77.9	-102.9	205
EW-8	Lower TSA	7699521.9	690435.9	77.3	77.16	6.8	-33.2	163
EW-11	Lower TSA	7702091.6	689192.5	115.4	114.73	-22.8	-62.8	235
EW-12	Lower TSA	7699532.9	689992.8	94.4	94.14	-16.1	-46.1	197
EW-13	Lower TSA	7698486.3	690082.6	104.5	103.59	-33.5	-73.5	234
EW-15	Lower TSA	7701759.5	689205.3	116.7	116.21	-27.3	-57.3	186
MW-3	Upper & Lower TSA	7700342.3	688415.4	148.1	147.69	25.0	-53.0	209
CMW-8(dg)	Lower TSA	7700075.7	689028.3	137.0	136.21	-41.0	-56.0	199
CMW-10(ds)	Upper TSA	7700599.9	688922.1	135.2	134.54	21.0	6.0	135
CMW-10(dg)	Lower TSA	7700589.4	688923.9	135.3	135.05	-53.0	-68.0	210
CMW-14R(ds)	Lower TSA	7700852.9	689866.6	83.9	83.48	29.0	9.0	76
CMW-17(ds)	Upper TSA	7700547.4	689425.5	120.0	121.89	24.0	14.0	110
CMW-18(ds)	Upper TSA	7700889.2	689267.3	118.2	117.66	16.0	6.0	118
CMW-19(ds)	Upper TSA	7700297.2	688642.8	144.3	144.08	10.0	0.0	170
CMW-20(ds)	Upper TSA	7699683.6	688990.1	150.5	152.72	6.0	-4.0	158
CMW-22(dg)	Lower TSA	7701545.4	689850.7	82.1	81.65	-42.0	-52.0	142
CMW-24(dg)/EW-5	Lower TSA	7700192.8	689918.9	80.5	77.74	8.0	-42.1	127
CMW-25(dg)	Lower TSA	7699797.3	690022.8	75.7	75.28	-34.0	-44.0	131
CMW-26(dg)	Lower TSA	7703189.8	689303.5	106.3	108.98	-59.0	-69.0	238
CMW-36(dg)	Lower TSA	7701389.7	690792.4	79.1	78.84	-31.0	-41.0	162
PMX-167 [W. Interlachen]	Upper TSA	7701730.1	693573.0	45.0	44.84	---- Not Available ----		50
PMX-208(dg) [Simpson]	Lower TSA	7701239.6	690330.0	80.2	81.14	-15.0	-35.0	115
PWB-1(lts)	Lower TSA	7700352.3	692604.8	14.0	16.48	-98.0	-118.0	134
PWB-1(uts)	Upper TSA	7700344.1	692612.1	13.9	15.98	-51.0	-71.0	86

Table 3-1
Well Construction Data - 1 January 2016 through 31 December 2016
TSA Remedy - East Multnomah County

Well	Aquifer Screened	NAD 1983 State Plane Oregon (ft)		Elevations (ft MSL)				Depth of Boring (ft bgs)
		X Coordinate	Y Coordinate	Ground Surface	Measuring Point	Top of Screen	Bottom of Screen	
PWB-2(lts)	Lower TSA	7701771.0	693589.1	45.1	44.32	-20.0	-40.0	90
<i>RPW-1(ds)</i>	<i>Upper TSA</i>	<i>7700327.8</i>	<i>693175.0</i>	<i>10.9</i>	<i>15.90</i>	<i>-63.0</i>	<i>-103.0</i>	<i>119</i>
BOP-44(usg)	SGA	7698996.3	691888.8	24.6	34.25	-181.0	-191.0	219
Vapor Extraction/Vapor Monitoring Wells								
<i>VMW-17-45.5</i>	<i>Upper TSA - Vapor</i>	<i>7,700,554.1</i>	<i>689,407.1</i>	<i>120.0</i>	<i>123.00</i>	<i>37.5</i>	<i>42.5</i>	<i>45</i>
<i>VMW-17-75.5</i>	<i>Upper TSA - Vapor</i>	<i>7,700,546.4</i>	<i>689,408.6</i>	<i>120.0</i>	<i>123.00</i>	<i>55.0</i>	<i>75.0</i>	<i>95</i>
VW-75d-95.5	Upper TSA - Vapor	7700536.9	689410.4	120.0	-----	44.5	24.5	130
VMW-A	Upper TSA - Vapor	7700436.7	689423.9	121.0	-----	34.5	14.5	114
VMW-B	Upper TSA - Vapor	7700630.8	689380.7	120.7	-----	36.2	16.2	111
VMW-C	Upper TSA - Vapor	7700339.8	689398.9	122.0	-----	34.5	14.5	110
VMW-D	Upper TSA - Vapor	7700693.2	689302.0	120.6	-----	33.1	13.1	110

NOTES:

- EW-16 pilot shutdown (quarterly cycling) began in November 2014; approved by DEQ 11/2/14.
- Monitoring wells indicated in red text are recommended for sampling frequency modifications (Table 2-2). Wells indicated in red, italicized text and blue shading are recommended for decommissioning.

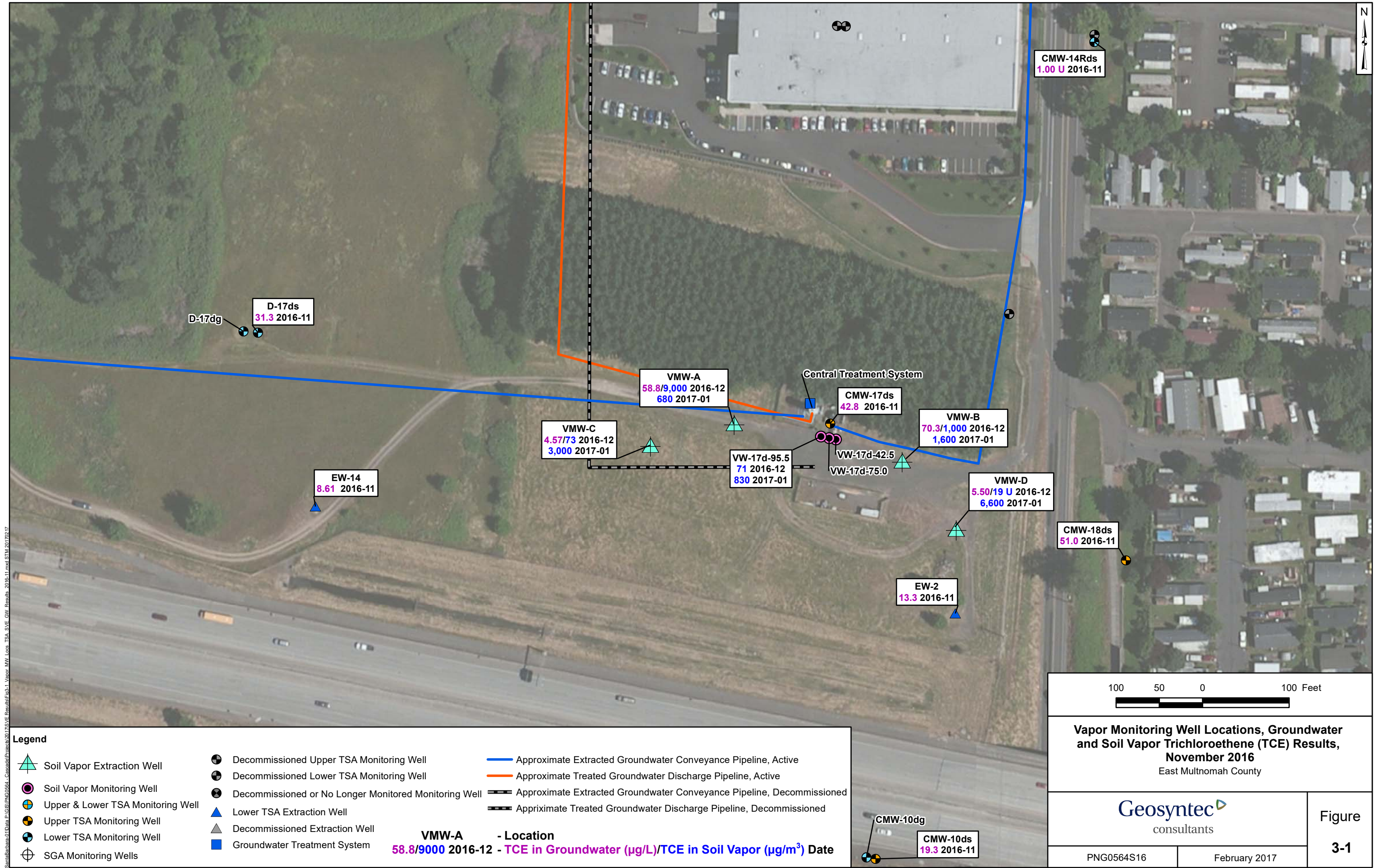
ft = feet

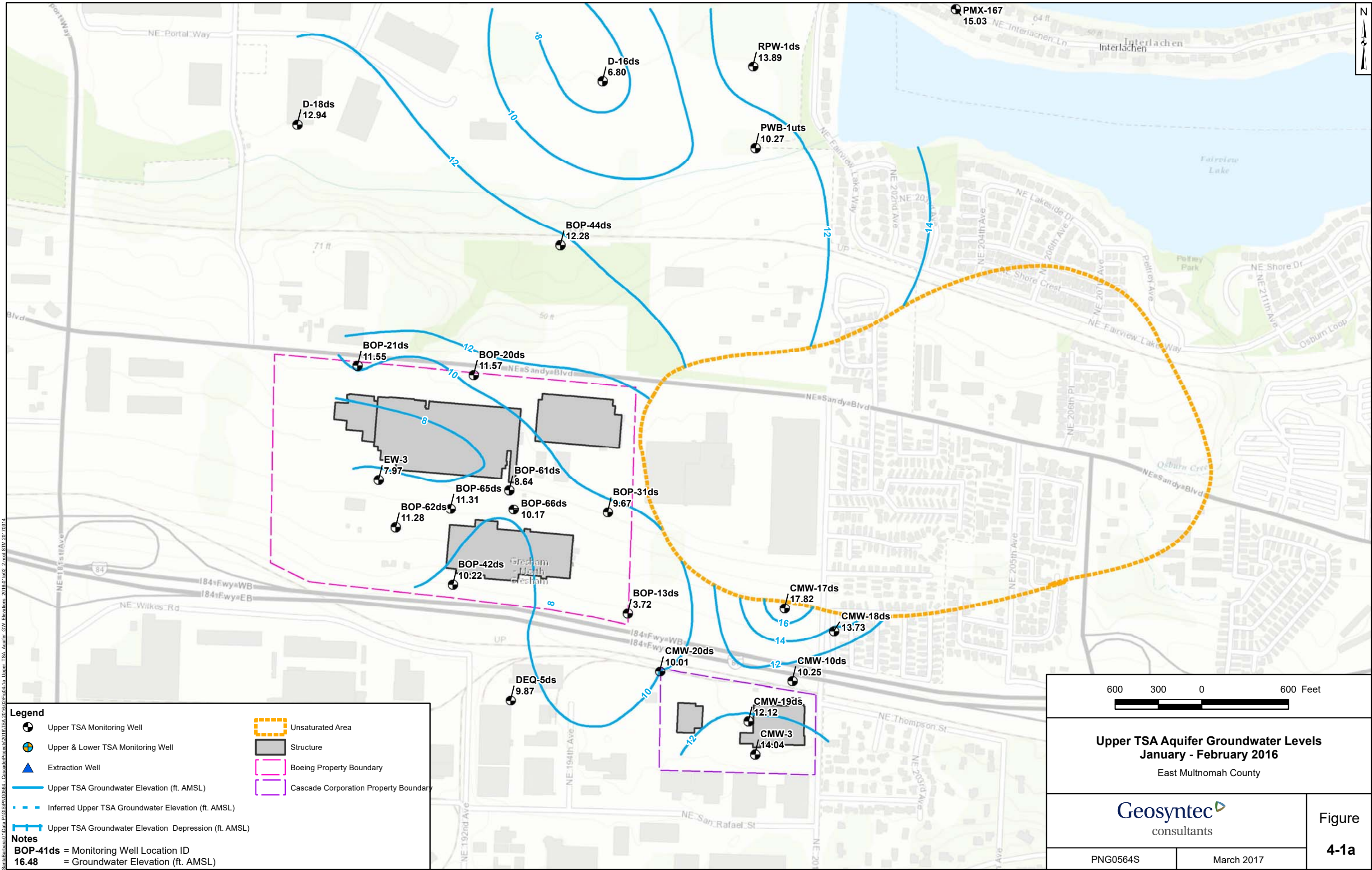
MSL = mean sea level

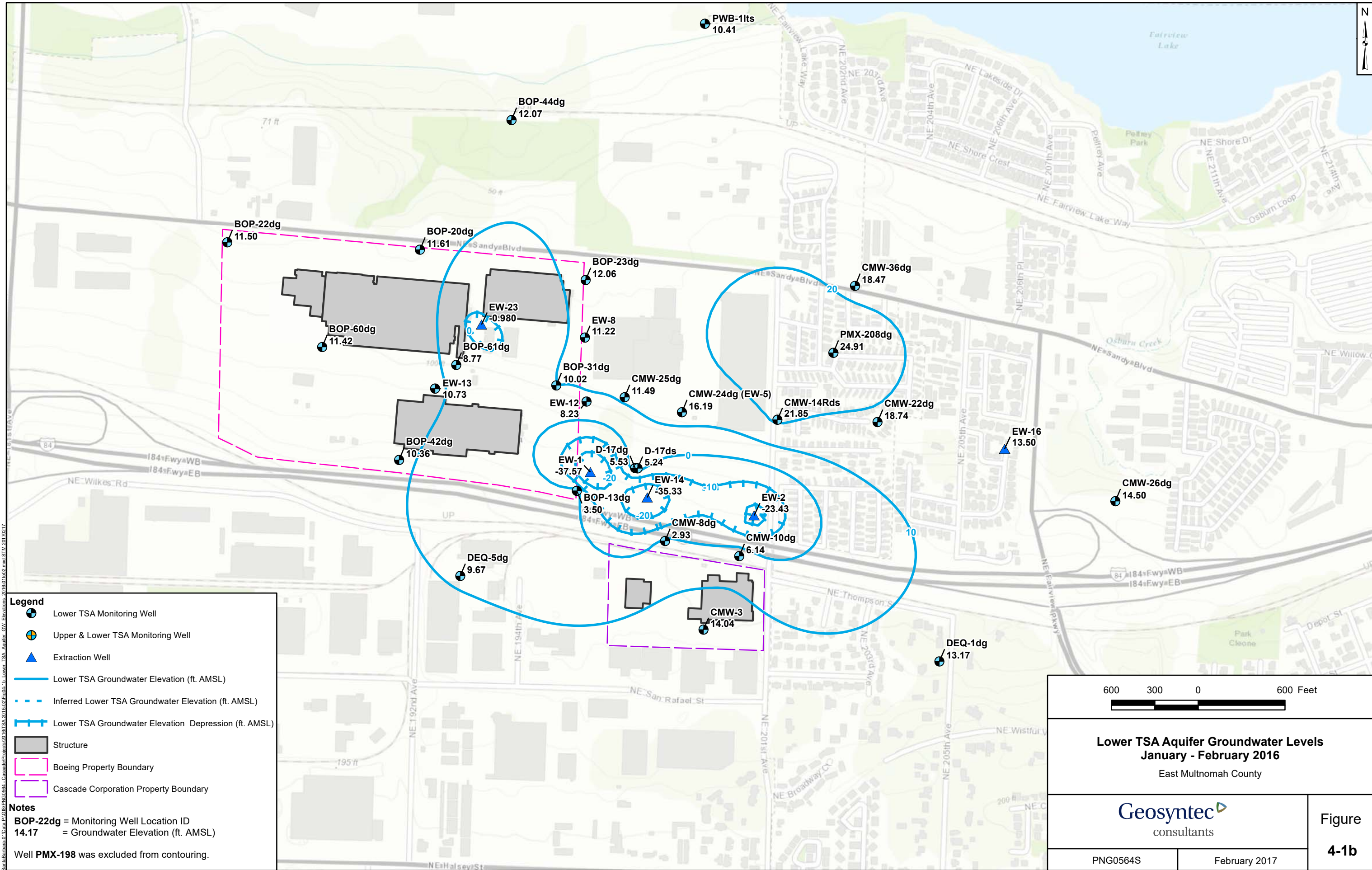
bgs = below ground surface

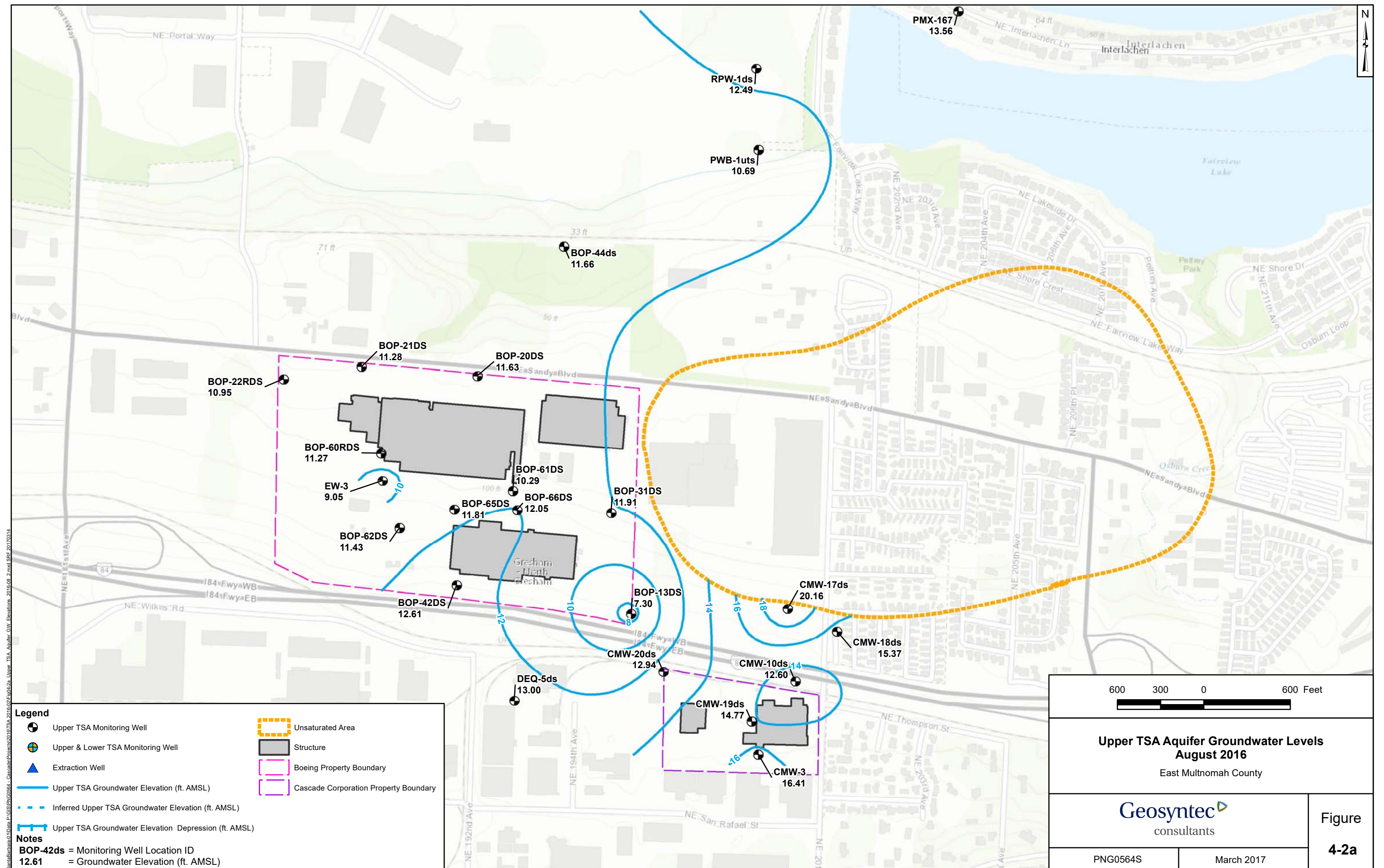
FIGURES

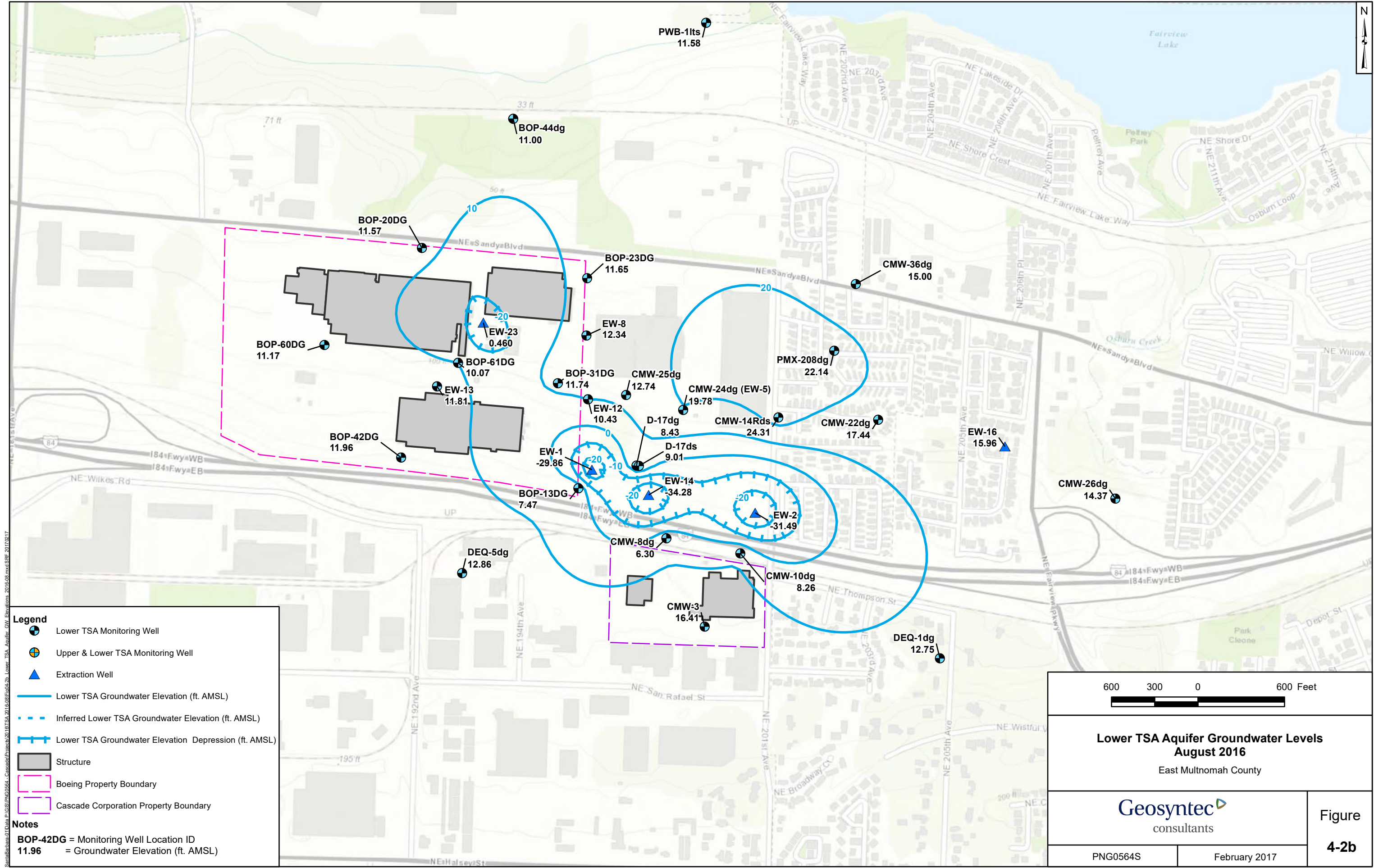




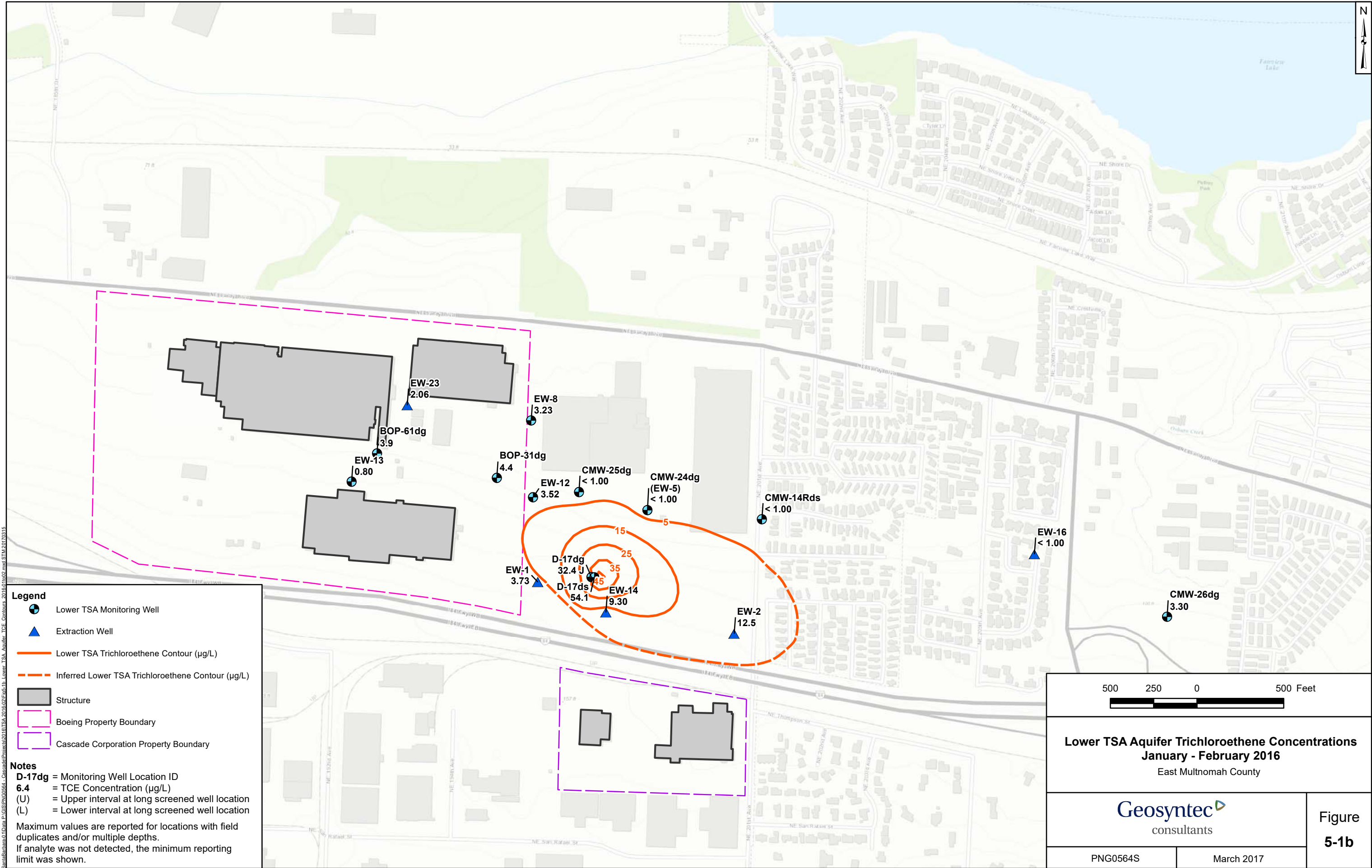


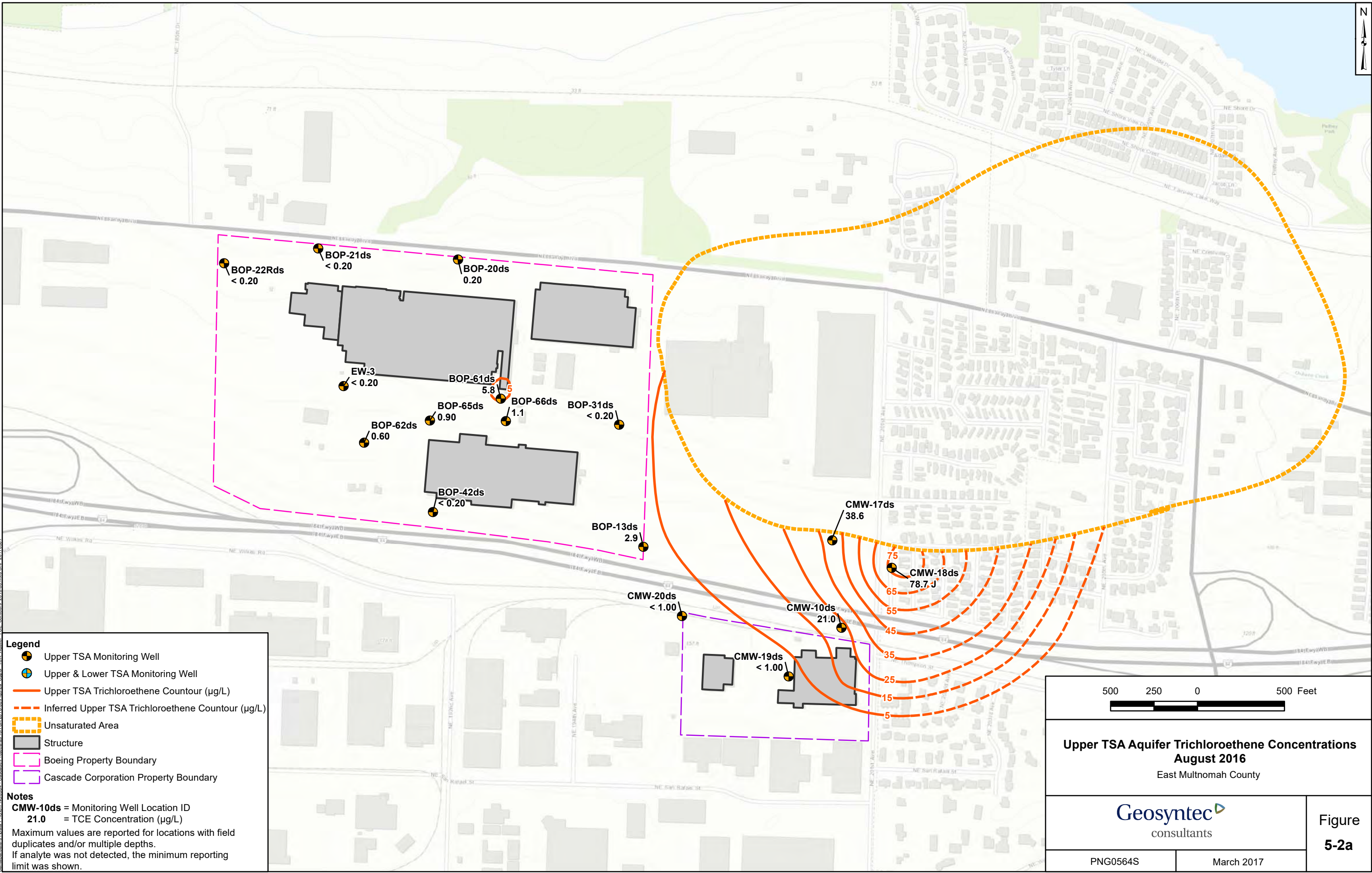


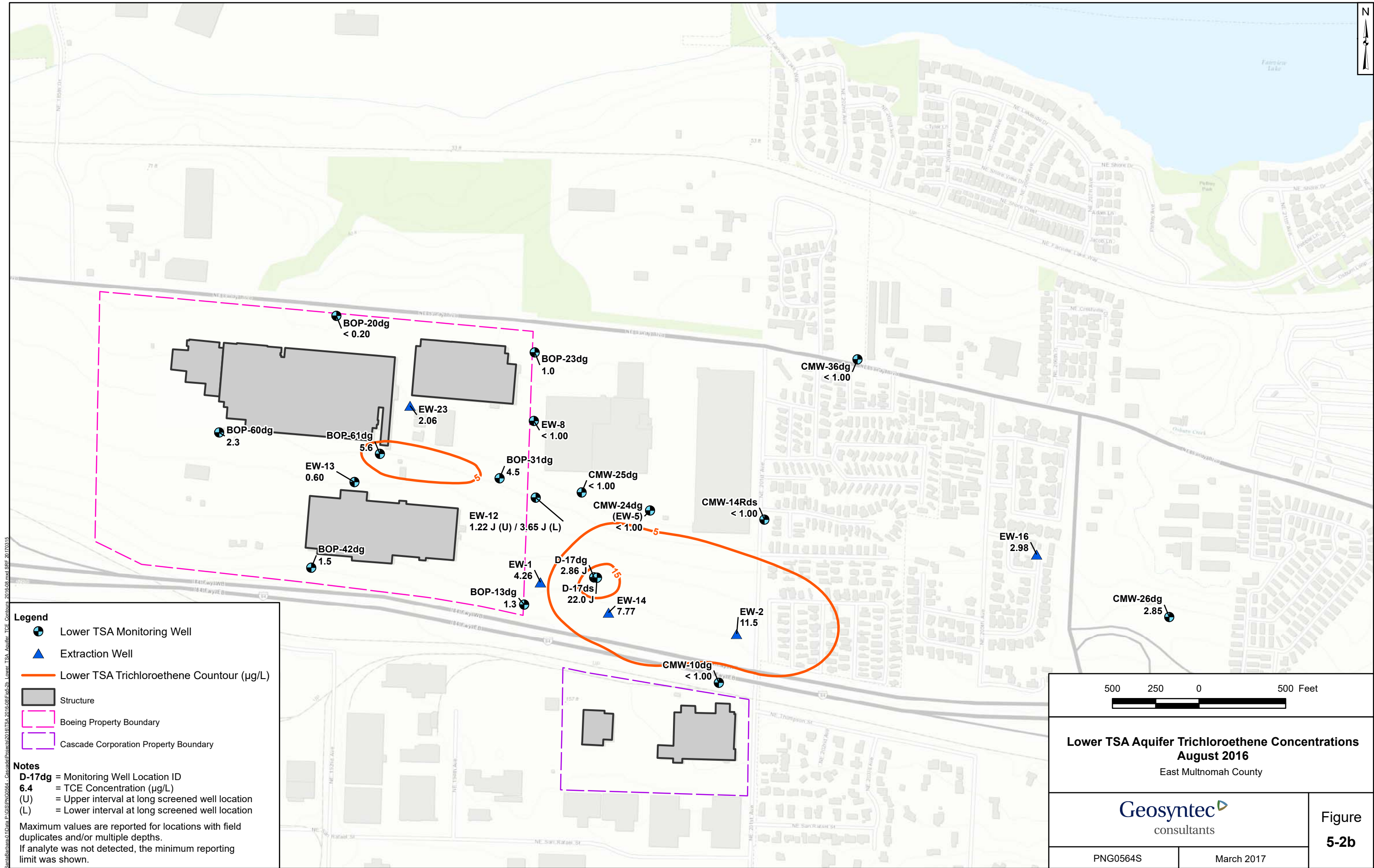












APPENDIX A

Extraction Rate Profiles

Table A-1
TSA Extraction Rates January 2016 through December 2016
and 12-Month Averages through 31 December 2016
TSA Remedy - East Multnomah County

Zone	12-Mo. Avg.	01/2016	02/2016	03/2016	04/2016	05/2016	06/2016	07/2016	08/2016	09/2016	10/2016	11/2016	12/2016
Zone B	28	28	29	27	29	29	29	29	29	29	26	27	30
<i>EW-23</i>	<i>28</i>	<i>28</i>	<i>29</i>	<i>27</i>	<i>29</i>	<i>29</i>	<i>29</i>	<i>29</i>	<i>29</i>	<i>29</i>	<i>26</i>	<i>27</i>	<i>30</i>
Zone C	98	113	107	102	98	91	78	114	107	98	94	96	84
<i>EW-1</i>	<i>49</i>	<i>60</i>	<i>54</i>	<i>49</i>	<i>45</i>	<i>40</i>	<i>28</i>	<i>67</i>	<i>63</i>	<i>54</i>	<i>52</i>	<i>51</i>	<i>43</i>
<i>EW-2</i>	<i>26</i>	<i>34</i>	<i>34</i>	<i>32</i>	<i>32</i>	<i>30</i>	<i>29</i>	<i>26</i>	<i>24</i>	<i>24</i>	<i>24</i>	<i>24</i>	<i>22</i>
<i>EW-14</i>	<i>20</i>	<i>19</i>	<i>19</i>	<i>20</i>	<i>21</i>	<i>22</i>	<i>21</i>	<i>21</i>	<i>19</i>	<i>20</i>	<i>19</i>	<i>20</i>	<i>19</i>
Zone D	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>EW-16</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>
Total Avg Flow TSA	127	141	136	129	127	120	108	143	135	127	120	123	114

NOTES:

Monthly average flow rates are shown in gallons per minute for each well.

Wells that have not operated during the last 12 months are not shown.

EW-16 pilot shutdown began in November 2014.

Table A-2
Discharge Monitoring Summary - Cental Treatment System
1 January 2016 through 31 December 2016
TSA Remedy - East Multnomah County

Parameter	Discharge Limitations ^a	Unit	Sample Date	System Discharge			Number of Exceedances	Sample Frequency
				Min	Avg	Max		
January 2016								
pH	6.0 – 9.0	su	—	7.50	7.58	7.60	0	Weekly
Temperature	—	°F	—	52	52	53	—	Weekly
Flow [#]	—	gpm	—	-	114	-	—	Daily
February 2016								
Trichloroethene	5.0	µg/L	2/2/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
1,1-Dichloroethene	7.0	µg/L	2/2/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
cis-1,2-Dichloroethene	70	µg/L	2/2/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
Tetrachloroethene	5.0	µg/L	2/2/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
Vinyl Chloride	2.0	µg/L	2/2/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
pH	6.0 – 9.0	su	—	7.50	7.56	7.60	0	Weekly
Temperature	—	°F	—	52	54	60	—	Weekly
Flow [#]	—	gpm	—	-	123	-	—	Daily
March 2016								
pH	6.0 – 9.0	su	—	7.60	7.60	7.60	0	Weekly
Temperature	—	°F	—	51	52	52	—	Weekly
Flow [#]	—	gpm	—	-	120	-	—	Daily
April 2016								
pH	6.0 – 9.0	su	—	7.60	7.68	7.70	0	Weekly
Temperature	—	°F	—	52	53	54	—	Weekly
Flow [#]	—	gpm	—	-	127	-	—	Daily
May 2016								
Trichloroethene	5.0	µg/L	5/3/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
1,1-Dichloroethene	7.0	µg/L	5/3/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
cis-1,2-Dichloroethene	70	µg/L	5/3/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
Tetrachloroethene	5.0	µg/L	5/3/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
Vinyl Chloride	2.0	µg/L	5/3/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
pH	6.0 – 9.0	su	—	7.60	7.68	7.70	0	Weekly
Temperature	—	°F	—	53	55	57	—	Weekly
Flow [#]	—	gpm	—	-	135	-	—	Daily

Table A-2
Discharge Monitoring Summary - Cental Treatment System
1 January 2016 through 31 December 2016
TSA Remedy - East Multnomah County

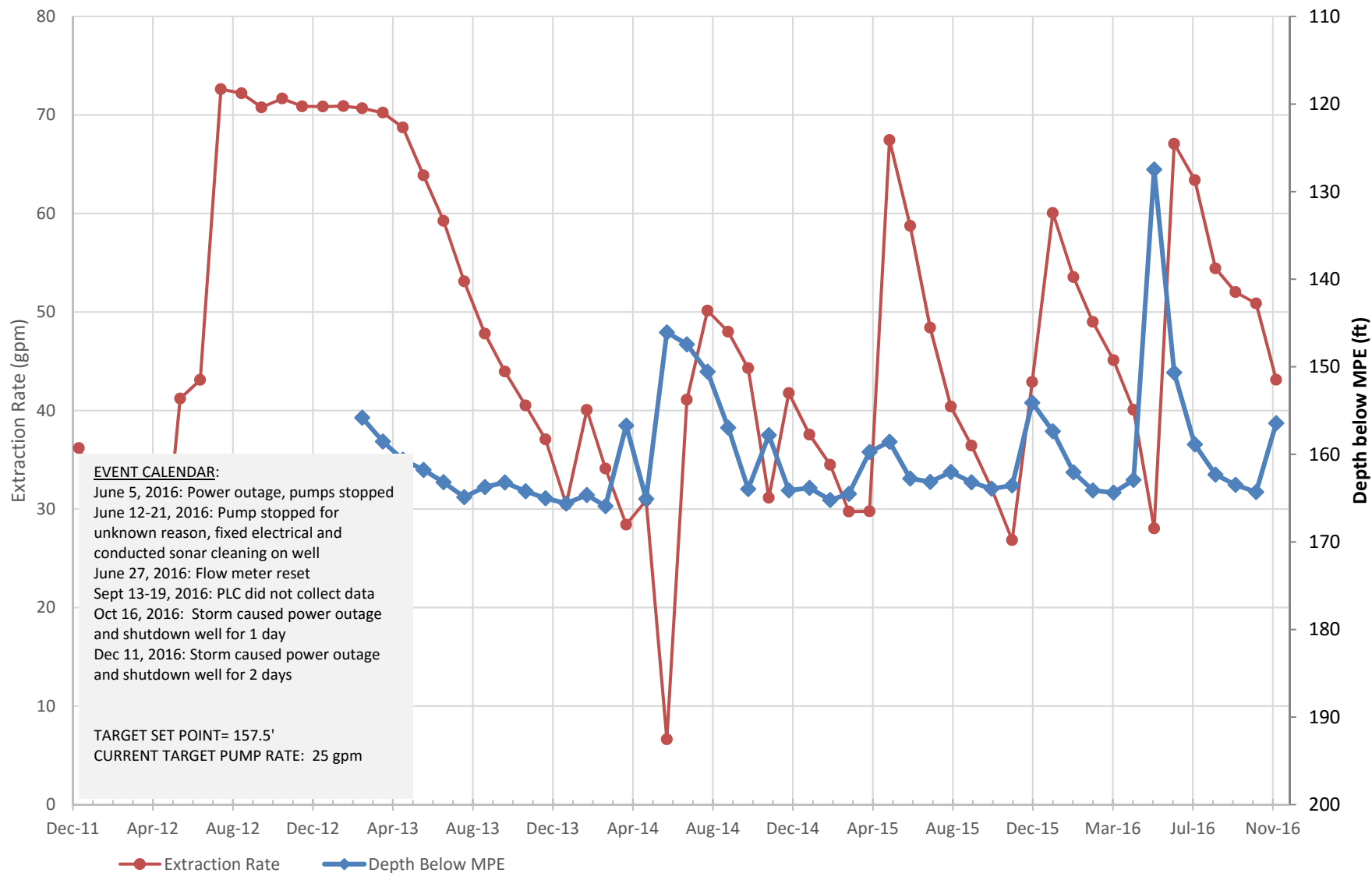
Parameter	Discharge Limitations ^a	Unit	Sample Date	System Discharge			Number of Exceedances	Sample Frequency
				Min	Avg	Max		
June 2016								
pH	6.0 – 9.0	su	—	7.60	7.65	7.70	0	Weekly
Temperature	—	°F	—	56	57	58	—	Weekly
Flow [#]	—	gpm	—	-	143	-	—	Daily
July 2016								
pH	6.0 – 9.0	su	—	7.60	7.75	7.80	0	Weekly
Temperature	—	°F	—	56	61	63	—	Weekly
Flow [#]	—	gpm	—	-	108	-	—	Daily
August 2016								
Trichloroethene	5.0	µg/L	8/4/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
1,1-Dichloroethene	7.0	µg/L	8/4/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
cis-1,2-Dichloroethene	70	µg/L	8/4/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
Tetrachloroethene	5.0	µg/L	8/4/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
Vinyl Chloride	2.0	µg/L	8/4/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
pH	6.0 – 9.0	su	—	7.70	7.70	7.70	0	Weekly
Temperature	—	°F	—	63	63	63	—	Weekly
Flow [#]	—	gpm	—	-	120	-	—	Daily
September 2016								
pH	6.0 – 9.0	su	—	7.70	7.70	7.70	0	Weekly
Temperature	—	°F	—	61	62	63	—	Weekly
Flow	—	gpm	—	-	127	-	—	Daily
October 2016								
pH	6.0 – 9.0	su	—	7.70	7.70	7.70	0	Weekly
Temperature	—	°F	—	62	62	63	—	Weekly
Flow [#]	—	gpm	—	-	129	-	—	Daily
November 2016								
Trichloroethene	5.0	µg/L	11/1/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
1,1-Dichloroethene	7.0	µg/L	11/1/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
cis-1,2-Dichloroethene	70	µg/L	11/1/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
Tetrachloroethene	5.0	µg/L	11/1/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
Vinyl Chloride	2.0	µg/L	11/1/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
pH	6.0 – 9.0	su	—	7.50	7.65	7.70	0	Weekly
Temperature	—	°F	—	59	61	63	—	Weekly
Flow [#]	—	gpm	—	19	136	27	—	Daily
December 2016								
pH	6.0 – 9.0	su	—	7.70	7.78	7.80	0	Weekly
Temperature	—	°F	—	46	56	60	—	Weekly
Flow [#]	—	gpm	—	-	141	-	—	Daily

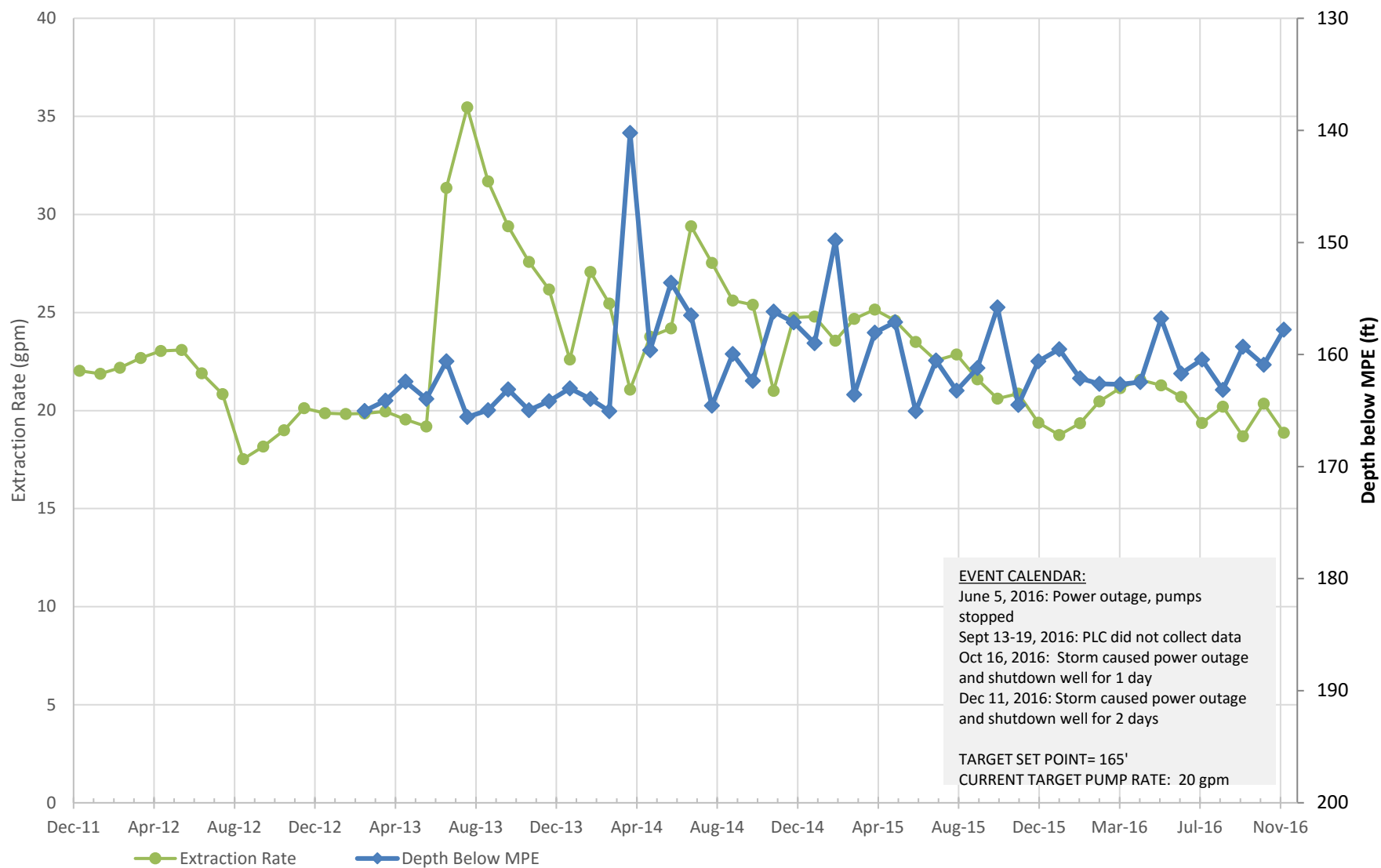
NOTES:

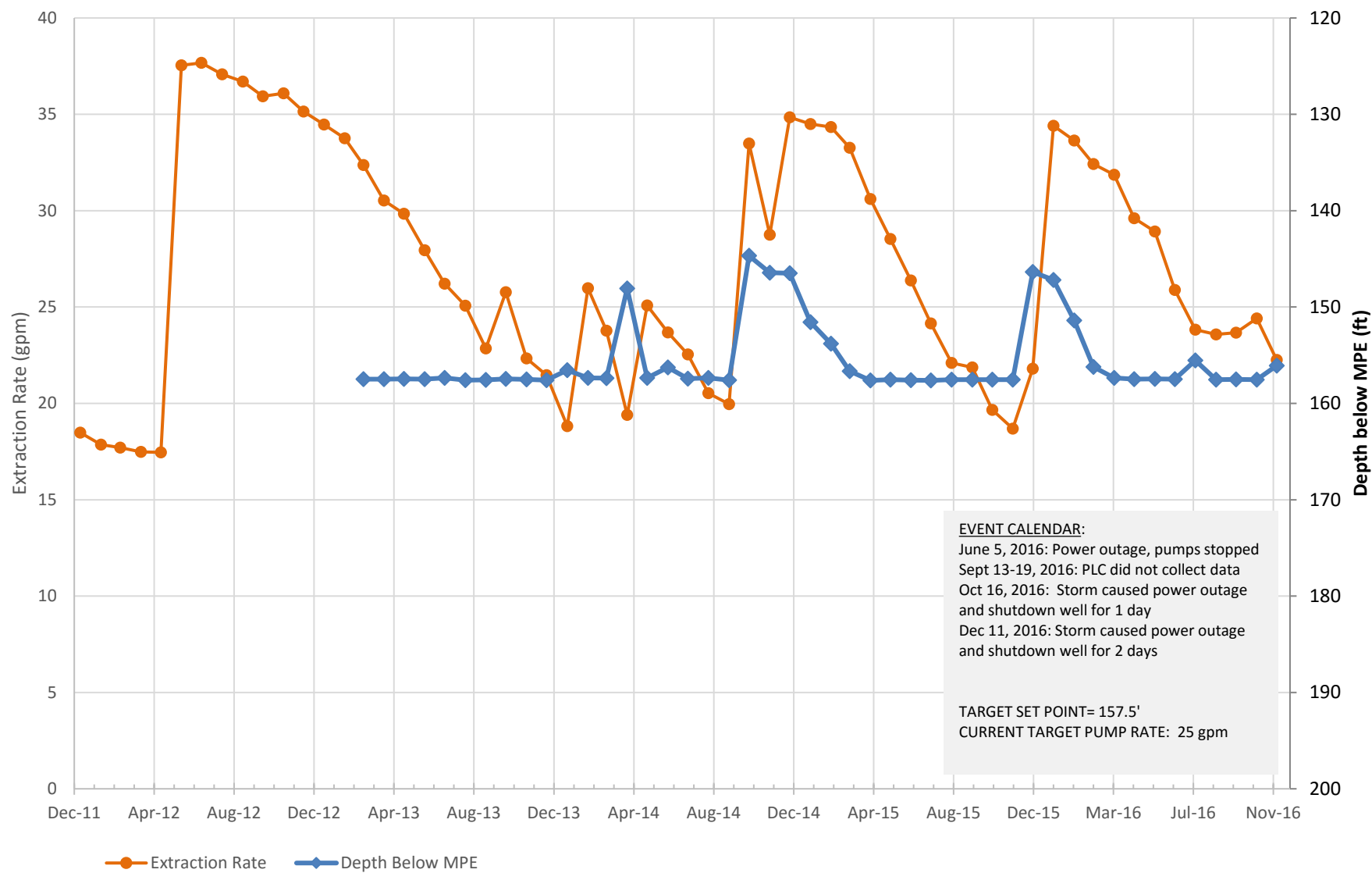
^aDischarge limitations for the CTS are per Attachment C to DEQ Consent Order No. WMCSR-NWR-96-08 dated 2/14/97. Analysis for VOCs includes TS-C-Eff.

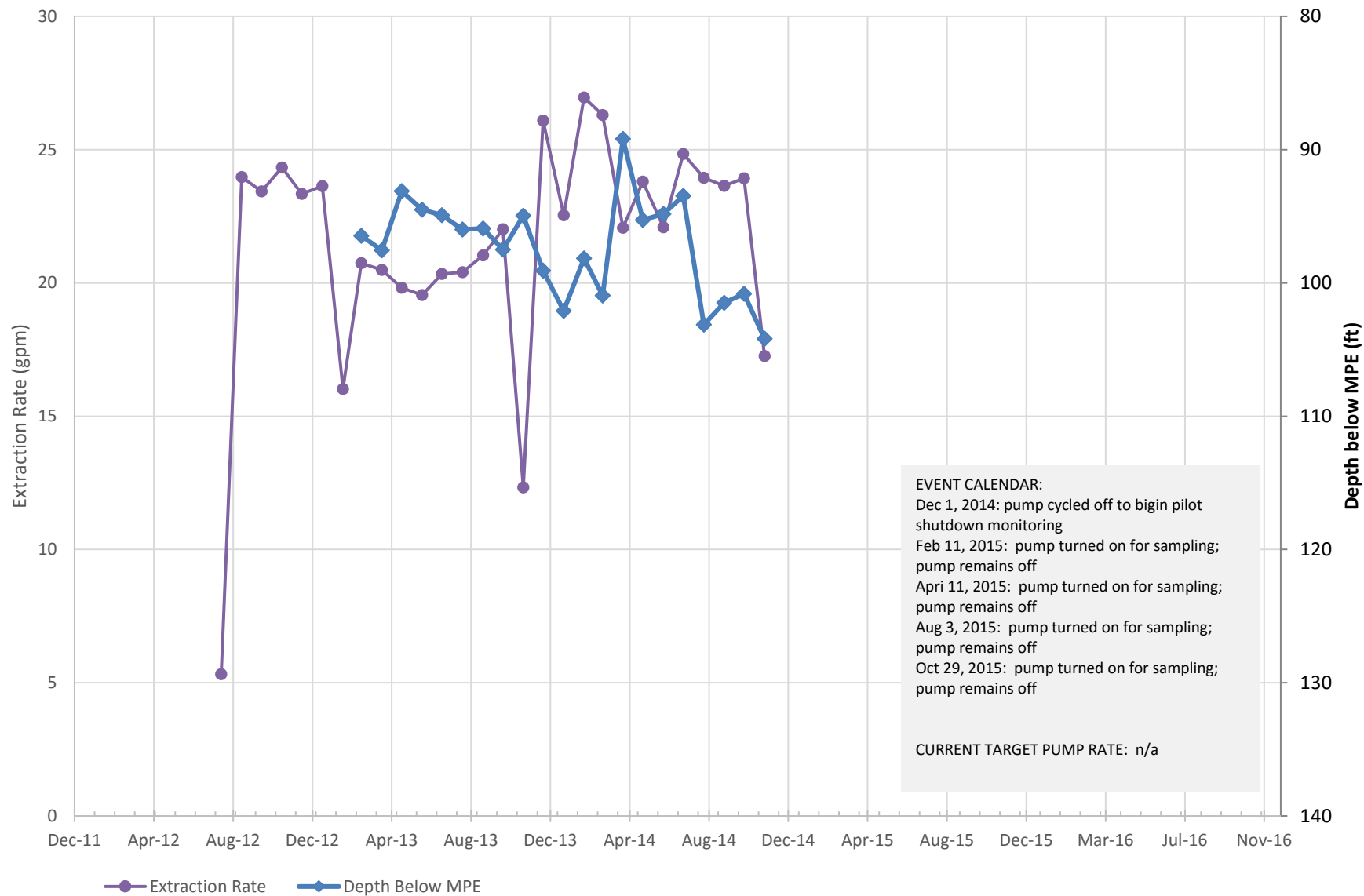
[#]Flow includes EW-1, EW-2, EW-14, and EW-23.

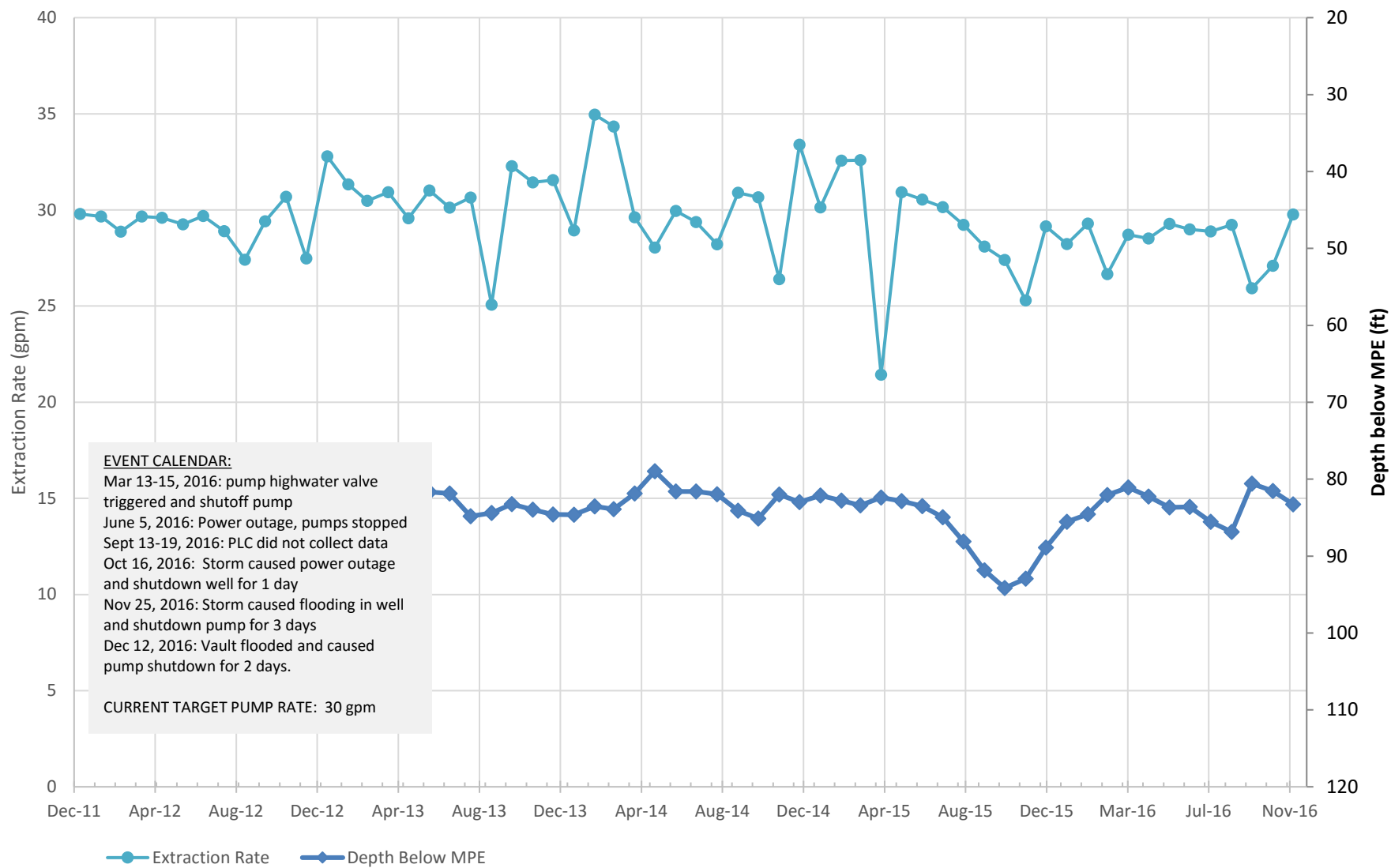
µg/L = micrograms/liter; °F = degrees Fahrenheit; gpm = gallons per minute; su = standard units.

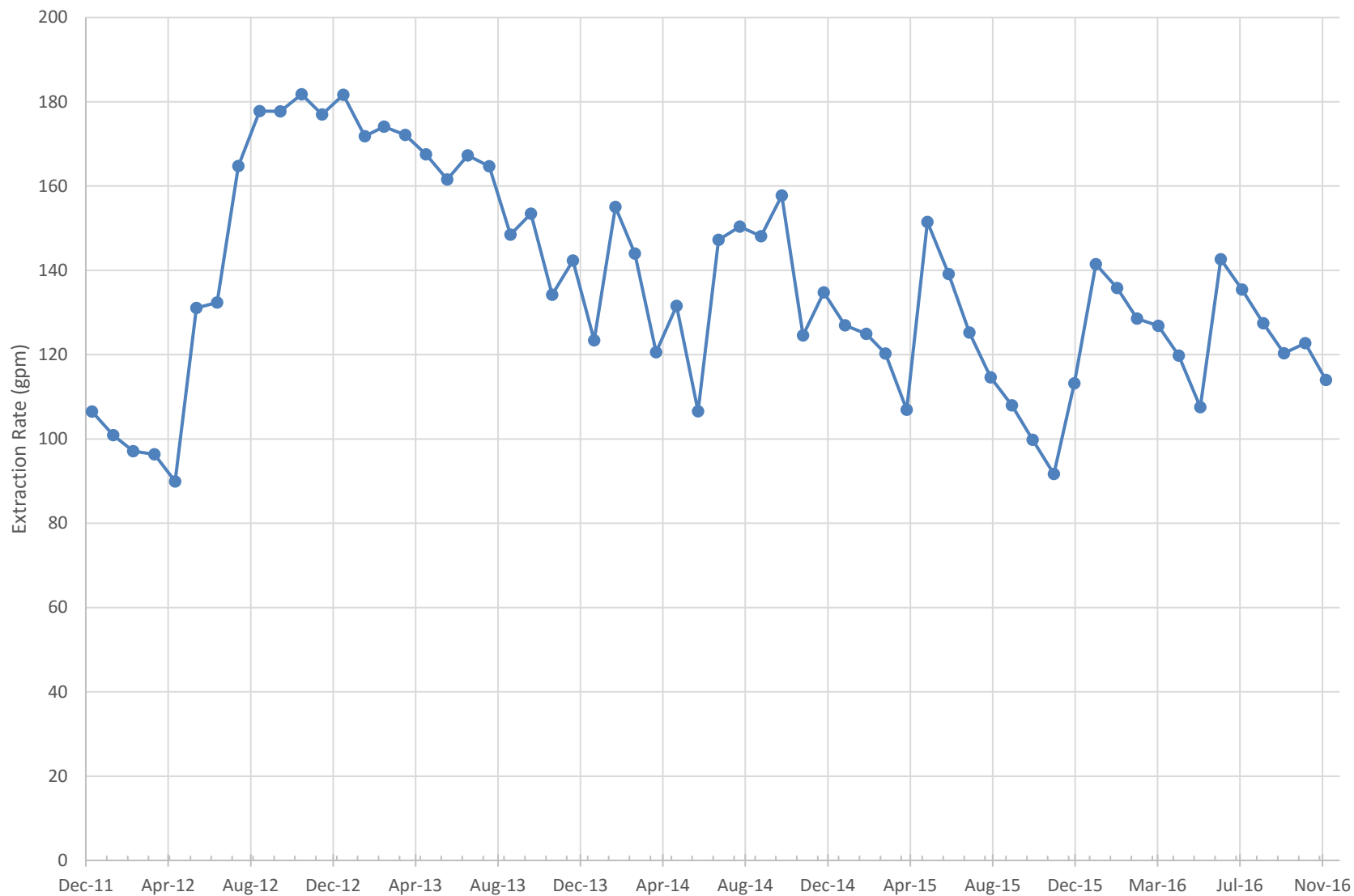












APPENDIX B

Groundwater Elevation Data

Table B-1
Groundwater Elevations - 1 January 2016 through 31 December 2016
TSA Remedy - East Multnomah County

TSA Zone	Well ID	Date	Time	Top of Casing Elevation (ft MSL)	Depth to Water (ft below TOC)	Groundwater Elevation (ft MSL)
Extraction Wells						
Lower	EW-1	2/2/2016	10:15	124.04	161.61	-37.57
Lower	EW-1	5/3/2016	16:17	124.04	162.43	-38.39
Lower	EW-1	8/4/2016	11:00	124.04	153.9	-29.86
Lower	EW-1	11/1/2016	10:50	124.04	163.14	-39.1
Lower	EW-1	12/5/2016	12:30	124.04	164.14	-40.1
Lower	EW-2	2/2/2016	10:00	126.01	149.44	-23.43
Lower	EW-2	5/3/2016	16:00	126.01	157.48	-31.47
Lower	EW-2	8/4/2016	11:18	126.01	157.5	-31.49
Lower	EW-2	11/1/2016	10:30	126.01	157.51	-31.5
Lower	EW-2	12/5/2016	12:26	126.01	157.53	-36.03
Lower	EW-12	2/2/2016	12:45	94.14	85.91	8.23
Lower	EW-12	5/3/2016	12:55	94.14	82.07	12.07
Lower	EW-12	8/4/2016	12:54	94.14	83.71	10.43
Lower	EW-12	11/1/2016	11:30	94.14	84.74	9.4
Lower	EW-13	2/1/2016	12:42	103.59	92.86	10.73
Lower	EW-13	8/2/2016	11:20	103.59	91.78	11.81
Lower	EW-14	2/2/2016	10:30	127.63	162.96	-35.33
Lower	EW-14	5/3/2016	16:10	127.63	162.61	-34.98
Lower	EW-14	8/4/2016	11:36	127.63	161.91	-34.28
Lower	EW-14	11/1/2016	10:40	127.63	161.18	-33.55
Lower	EW-14	12/5/2016	12:33	127.63	162.04	-34.41
Lower	EW-16	2/2/2016	8:41	83.71	70.21	13.5
Lower	EW-16	5/3/2016	16:30	83.71	64.28	19.43
Lower	EW-16	8/4/2016	20:21	83.71	67.75	15.96
Lower	EW-16	11/1/2016	12:00	83.71	91.24	-7.53
Lower	EW-23	2/2/2016	10:45	83.93	84.91	-0.98
Lower	EW-23	5/3/2016	--	83.93	82.32	1.61
Lower	EW-23	8/4/2016	10:47	83.93	83.47	0.46
Lower	EW-23	11/1/2016	9:10	83.93	84.81	-0.88
Lower	EW-23	12/5/2016	11:46	83.93	86.19	-2.26
Monitoring Wells						
Lower	BOP-13dg	2/1/2016	16:04	128.71	125.21	3.5
Lower	BOP-13dg	8/2/2016	14:05	128.71	121.24	7.47
Lower	BOP-20dg	2/1/2016	14:55	77.32	65.71	11.61
Lower	BOP-20dg	8/2/2016	12:34	77.32	65.75	11.57
Lower	BOP-22dg	2/1/2016	8:20	81.05	82.94	11.5
Lower	BOP-23dg	2/1/2016	14:28	76.96	64.9	12.06
Lower	BOP-23dg	8/2/2016	12:21	76.96	65.31	11.65
Lower	BOP-31dg	2/1/2016	14:23	98.51	88.49	10.02
Lower	BOP-31dg	8/2/2016	12:14	98.51	86.77	11.74
Lower	BOP-42dg	2/1/2016	15:56	130.71	120.35	10.36
Lower	BOP-42dg	8/2/2016	13:59	130.71	118.75	11.96
Lower	BOP-44dg	2/2/2016	16:51	35.15	23.08	12.07
Lower	BOP-44dg	8/4/2016	14:49	35.15	24.15	11
Lower	BOP-60dg	2/1/2016	10:45	93.59	82.17	11.42
Lower	BOP-60dg	8/2/2016	10:02	93.59	82.42	11.17
Lower	BOP-61dg	2/1/2016	14:09	94.43	85.66	8.77

Table B-1
Groundwater Elevations - 1 January 2016 through 31 December 2016
TSA Remedy - East Multnomah County

TSA Zone	Well ID	Date	Time	Top of Casing Elevation (ft MSL)	Depth to Water (ft below TOC)	Groundwater Elevation (ft MSL)
Lower	BOP-61dg	8/2/2016	12:09	94.43	84.36	10.07
Lower	CMW-10dg	2/2/2016	8:22	135.05	128.91	6.14
Lower	CMW-10dg	8/4/2016	10:45	135.05	126.28	8.26
Lower	CMW-14Rds	2/2/2016	13:00	83.48	61.63	21.85
Lower	CMW-14Rds	5/3/2016	14:30	83.48	58.34	25.14
Lower	CMW-14Rds	8/4/2016	13:38	83.48	59.17	24.31
Lower	CMW-14Rds	11/1/2016	13:20	83.48	60.51	22.97
Lower	CMW-22dg	2/2/2016	12:49	81.65	62.91	18.74
Lower	CMW-22dg	8/4/2016	13:43	81.65	64.21	17.44
Lower	CMW-24dg (EW-5)	2/2/2016	13:22	77.74	63.81	13.93
Lower	CMW-24dg (EW-5)	8/4/2016	14:04	77.74	62.48	19.78
Lower	CMW-25dg	2/2/2016	13:50	75.28	63.79	11.49
Lower	CMW-25dg	8/4/2016	16:25	75.28	62.54	12.74
Lower	CMW-26dg	2/2/2016	8:49	108.98	94.48	14.5
Lower	CMW-26dg	5/3/2016	14:50	108.98	92.94	16.04
Lower	CMW-26dg	8/4/2016	17:40	108.98	94.61	14.37
Lower	CMW-26dg	11/1/2016	9:30	108.98	94.64	14.34
Lower	CMW-36dg	2/2/2016	14:48	78.84	60.37	18.47
Lower	CMW-36dg	8/4/2016	14:38	78.84	63.84	15
Lower	CMW-8dg	2/2/2016	8:15	136.21	133.28	2.93
Lower	CMW-8dg	8/4/2016	20:02	136.21	129.91	6.3
Lower	D-17dg	2/2/2016	12:15	124.61	119.08	5.53
Lower	D-17dg	8/4/2016	11:30	124.61	116.18	8.43
Lower	D-17ds	2/2/2016	12:17	123.28	118.04	5.24
Lower	D-17ds	5/3/2016	12:38	123.28	114.28	9
Lower	D-17ds	8/4/2016	11:40	123.28	114.27	9.01
Lower	D-17ds	11/1/2016	13:00	123.28	115.21	8.07
Lower	DEQ-1dg	2/2/2016	15:28	150.58	137.41	13.17
Lower	DEQ-1dg	8/4/2016	18:04	150.58	137.83	12.75
Lower	DEQ-5dg	2/2/2016	15:17	155.95	146.28	9.67
Lower	DEQ-5dg	8/4/2016	15:43	155.95	143.09	12.86
Lower	EW-8	2/2/2016	14:25	77.16	65.94	11.22
Lower	EW-8	8/4/2016	15:18	77.16	64.82	12.34
Lower	PMX-208dg	2/2/2016	15:34	81.14	56.23	24.91
Lower	PMX-208dg	8/4/2016	14:30	81.14	59	22.14
Lower	PWB-1lts	2/2/2016	16:44	16.48	6.11	10.44
Lower	PWB-1lts	8/4/2016	3:21	16.48	4.97	11.58
Lower	PWB-2lts	2/2/2016	16:07	44.32	32.19	12.13
Lower	PWB-2lts	8/4/2016	18:25	44.32	33.48	10.84
Upper	BOP-13ds	2/1/2016	16:01	128.94	125.22	3.72
Upper	BOP-13ds	5/2/2016	8:23	128.94	120.42	8.52
Upper	BOP-13ds	8/2/2016	14:07	128.94	121.64	7.3
Upper	BOP-13ds	11/16/2016	10:25	128.94	122.01	6.93
Upper	BOP-20ds	2/1/2016	14:54	77.45	65.88	11.57
Upper	BOP-20ds	8/2/2016	12:32	77.45	65.82	11.63
Upper	BOP-21ds	2/1/2016	10:16	78.02	66.47	11.55
Upper	BOP-21ds	8/2/2016	12:52	78.02	66.74	11.28
Upper	BOP-22Rds	8/2/2016	13:20	82.91	71.96	10.95

Table B-1
Groundwater Elevations - 1 January 2016 through 31 December 2016
TSA Remedy - East Multnomah County

TSA Zone	Well ID	Date	Time	Top of Casing Elevation (ft MSL)	Depth to Water (ft below TOC)	Groundwater Elevation (ft MSL)
Upper	BOP-31ds	2/1/2016	14:19	99.04	89.37	9.67
Upper	BOP-31ds	5/2/2016	8:11	99.04	86.12	12.92
Upper	BOP-31ds	8/2/2016	12:17	99.04	87.13	11.91
Upper	BOP-31ds	11/16/2016	12:05	99.04	88.00	11.04
Upper	BOP-42ds	2/1/2016	15:55	130.74	120.52	10.22
Upper	BOP-42ds	8/2/2016	13:58	130.74	118.13	12.61
Upper	BOP-44ds	2/2/2016	16:53	35.24	22.96	12.28
Upper	BOP-44ds	8/4/2016	14:46	35.24	23.58	11.66
Upper	BOP-60Rds	8/2/2016	10:43	82.8	71.53	11.27
Upper	BOP-61ds	2/1/2016	14:03	94.64	86	8.64
Upper	BOP-61ds	8/2/2016	12:07	94.64	84.35	10.29
Upper	BOP-62ds	2/1/2016	16:39	112.29	101.01	11.28
Upper	BOP-62ds	8/2/2016	10:52	112.29	100.86	11.43
Upper	BOP-65ds	2/1/2016	16:34	104.22	92.91	11.31
Upper	BOP-65ds	8/2/2016	11:13	104.22	92.41	11.81
Upper	BOP-66ds	2/1/2016	16:28	102.97	92.8	10.17
Upper	BOP-66ds	8/2/2016	14:58	102.97	90.92	12.05
Upper	CMW-10ds	2/2/2016	8:25	134.54	124.29	10.25
Upper	CMW-10ds	5/3/2016	15:30	134.54	122.88	11.66
Upper	CMW-10ds	8/4/2016	10:35	134.54	121.94	12.6
Upper	CMW-10ds	11/1/2016	14:34	134.54	123.31	11.23
Upper	CMW-17ds	2/2/2016	8:56	121.89	104.07	17.82
Upper	CMW-17ds	4/27/2016	12:18	121.89	102.71	19.18
Upper	CMW-17ds	8/4/2016	14:00	121.89	101.73	20.16
Upper	CMW-17ds	11/1/2016	9:47	121.89	102.06	19.83
Upper	CMW-18ds	2/2/2016	12:52	117.66	103.93	13.73
Upper	CMW-18ds	5/3/2016	13:20	117.66	103.17	14.76
Upper	CMW-18ds	8/4/2016	13:20	117.66	102.56	15.37
Upper	CMW-18ds	11/1/2016	13:30	117.66	102.64	15.02
Upper	CMW-19ds	2/2/2016	15:00	144.08	131.96	12.12
Upper	CMW-19ds	5/3/2016	15:12	144.08	130.24	13.84
Upper	CMW-19ds	8/4/2016	19:29	144.08	129.31	14.77
Upper	CMW-19ds	11/1/2016	14:14	144.08	129.71	14.37
Upper	CMW-20ds	2/2/2016	15:10	152.72	142.71	10.01
Upper	CMW-20ds	8/4/2016	15:39	152.72	139.78	12.94
Upper	D-16ds	2/2/2016	15:50	16.91	10.08	6.76
Upper	D-18ds	2/2/2016	12:50	18.01	5.07	12.94
Upper	DEQ-5ds	2/2/2016	15:19	155.68	145.81	9.87
Upper	DEQ-5ds	8/4/2016	15:46	155.68	142.68	13
Upper	EW-3	2/1/2016	13:13	94.26	86.29	7.97
Upper	EW-3	8/2/2016	10:24	94.26	85.21	9.05
Upper	PMX-167	2/2/2016	16:05	44.84	29.81	15.03
Upper	PMX-167	8/4/2016	18:22	44.84	31.28	13.56
Upper	PWB-1uts	2/2/2016	16:42	15.98	5.71	10.27
Upper	PWB-1uts	8/4/2016	19:10	15.98	5.29	10.69
Upper	RPW-1ds	2/2/2016	16:30	15.9	2.01	13.89
Upper	RPW-1ds	8/4/2016	18:50	15.9	3.41	12.49

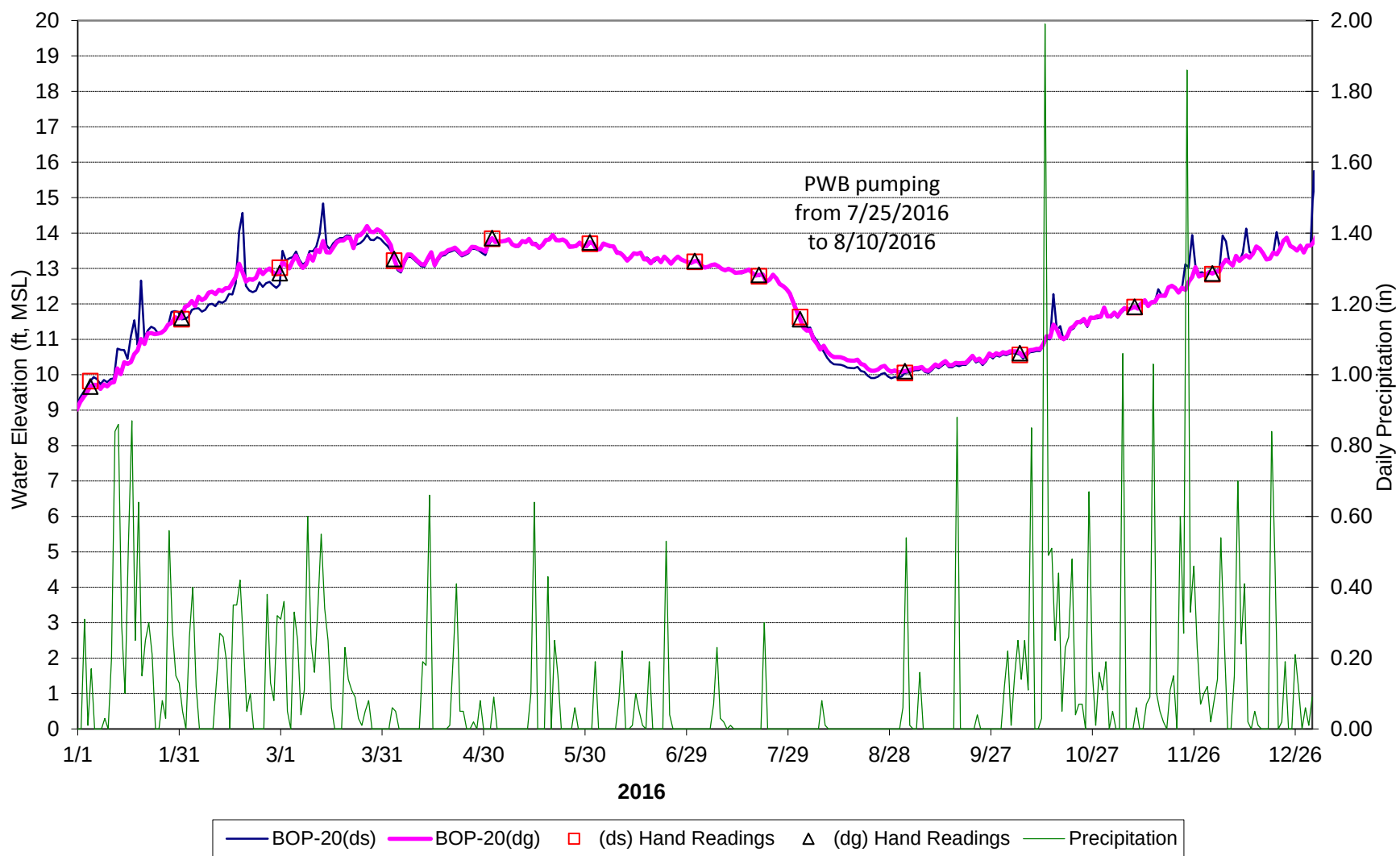
Table B-1
Groundwater Elevations - 1 January 2016 through 31 December 2016
TSA Remedy - East Multnomah County

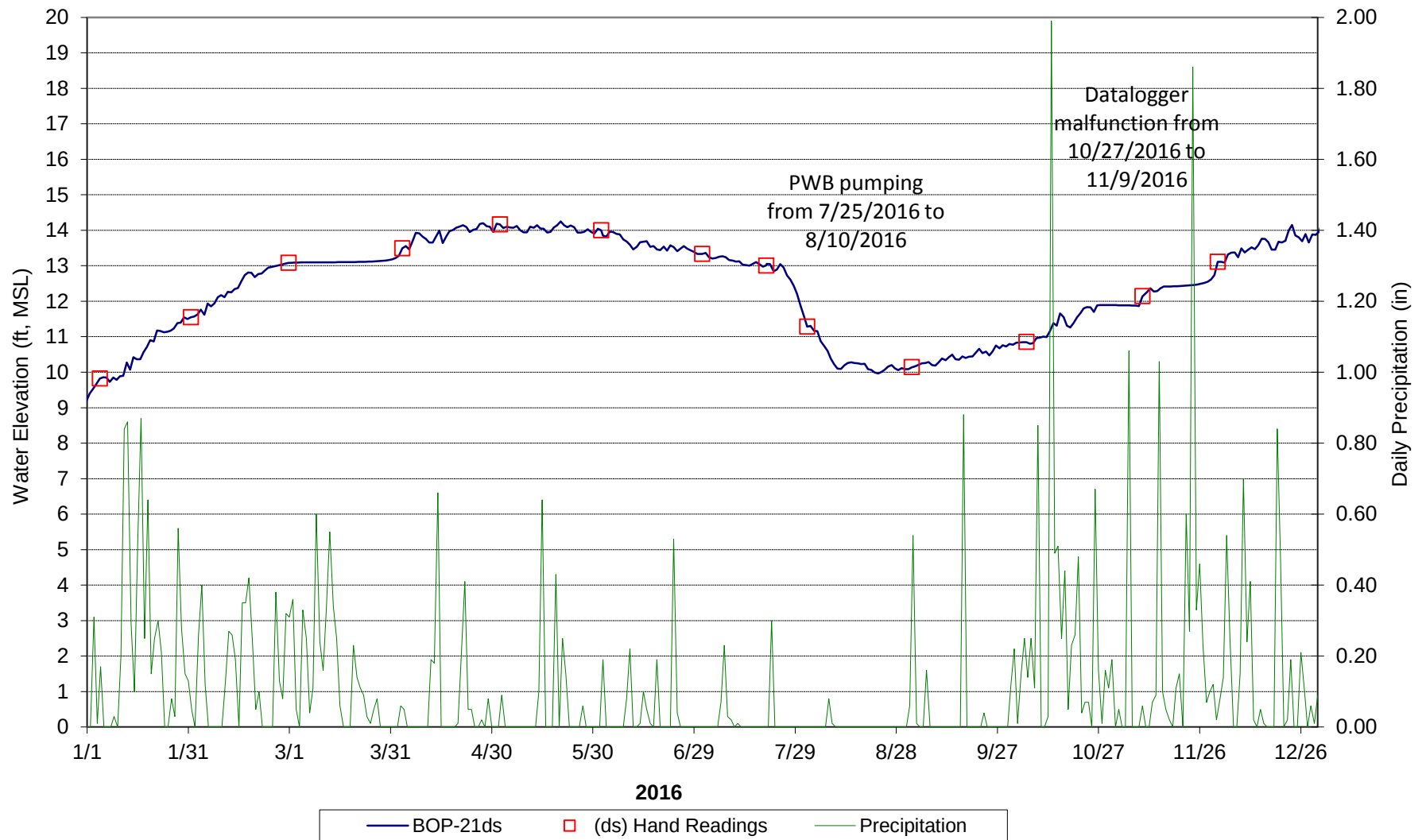
TSA Zone	Well ID	Date	Time	Top of Casing Elevation (ft MSL)	Depth to Water (ft below TOC)	Groundwater Elevation (ft MSL)
Upper and Lower	CMW-3	2/2/2016	15:07	147.69	133.65	14.04
Upper and Lower	CMW-3	8/4/2016	19:23	147.69	131.28	16.41
Vapor Monitoring Wells						
Upper	VMW-A	1/4/2017	--	113.93	103.28	10.65
Upper	VMW-B	1/4/2017	--	114.58	101.31	13.27
Upper	VMW-C	1/4/2017	--	114.7	101.22	13.48
Upper	VMW-D	1/4/2017	--	114.21	98.31	15.9

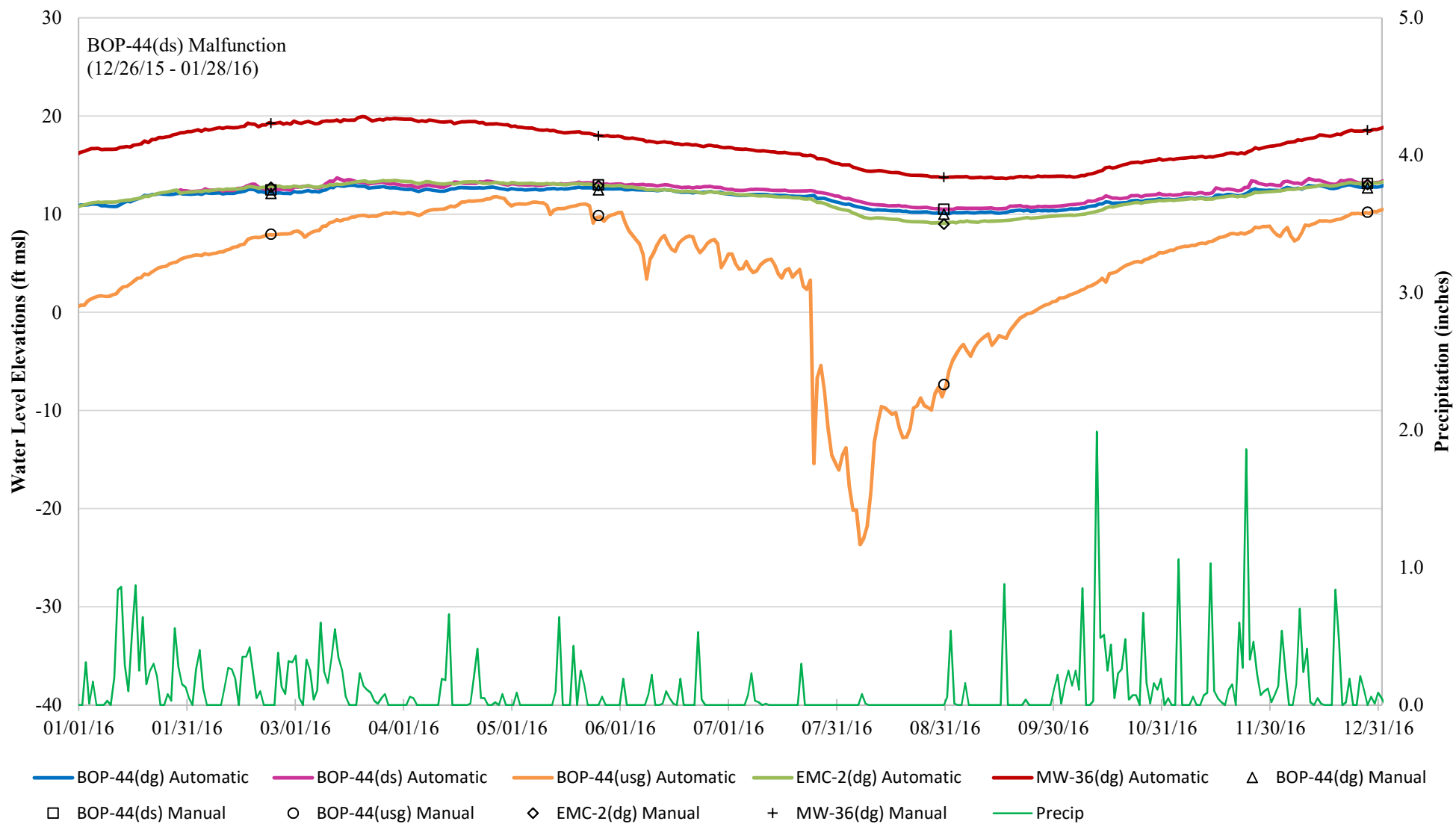
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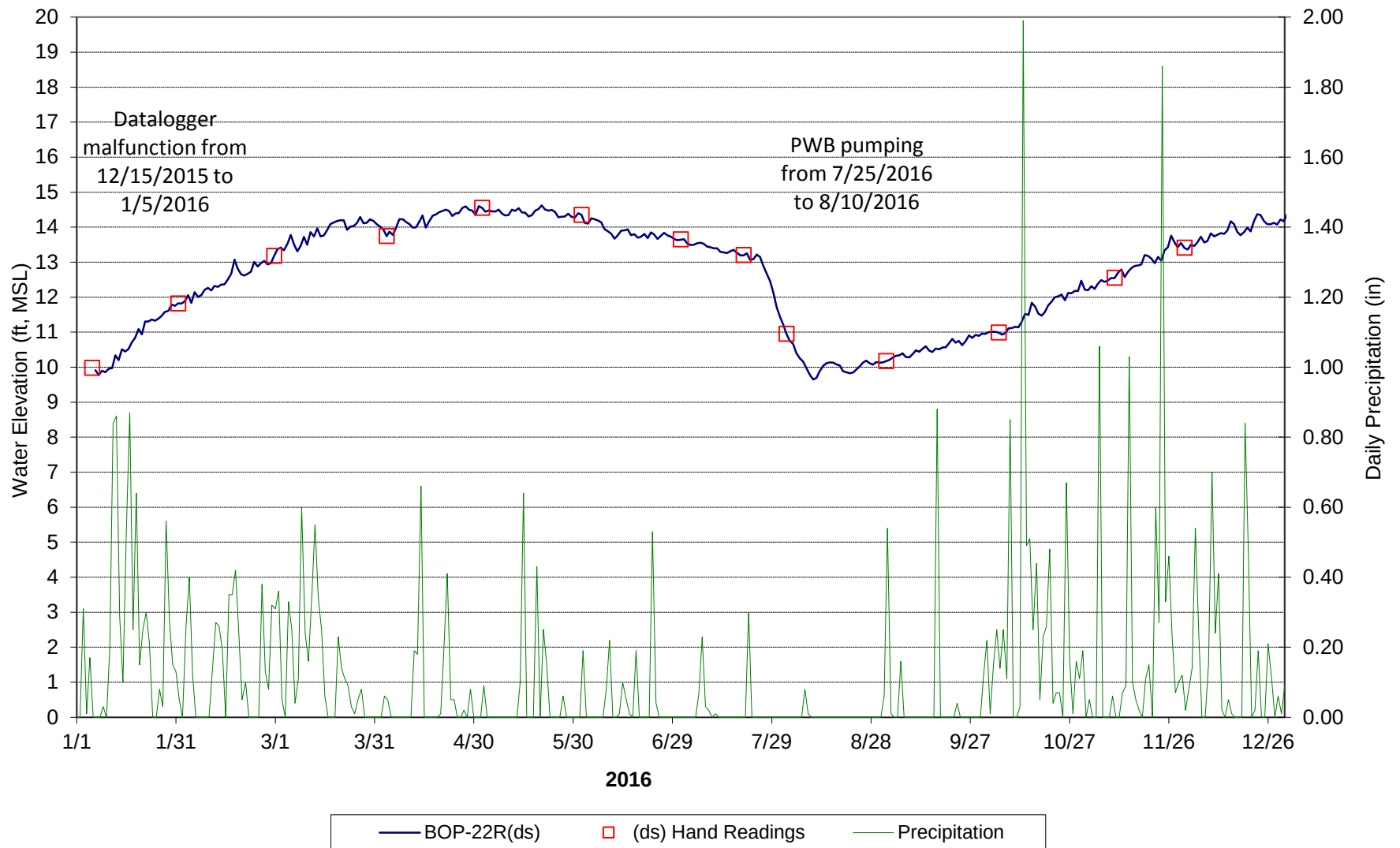
ft MSL = feet above mean sea level

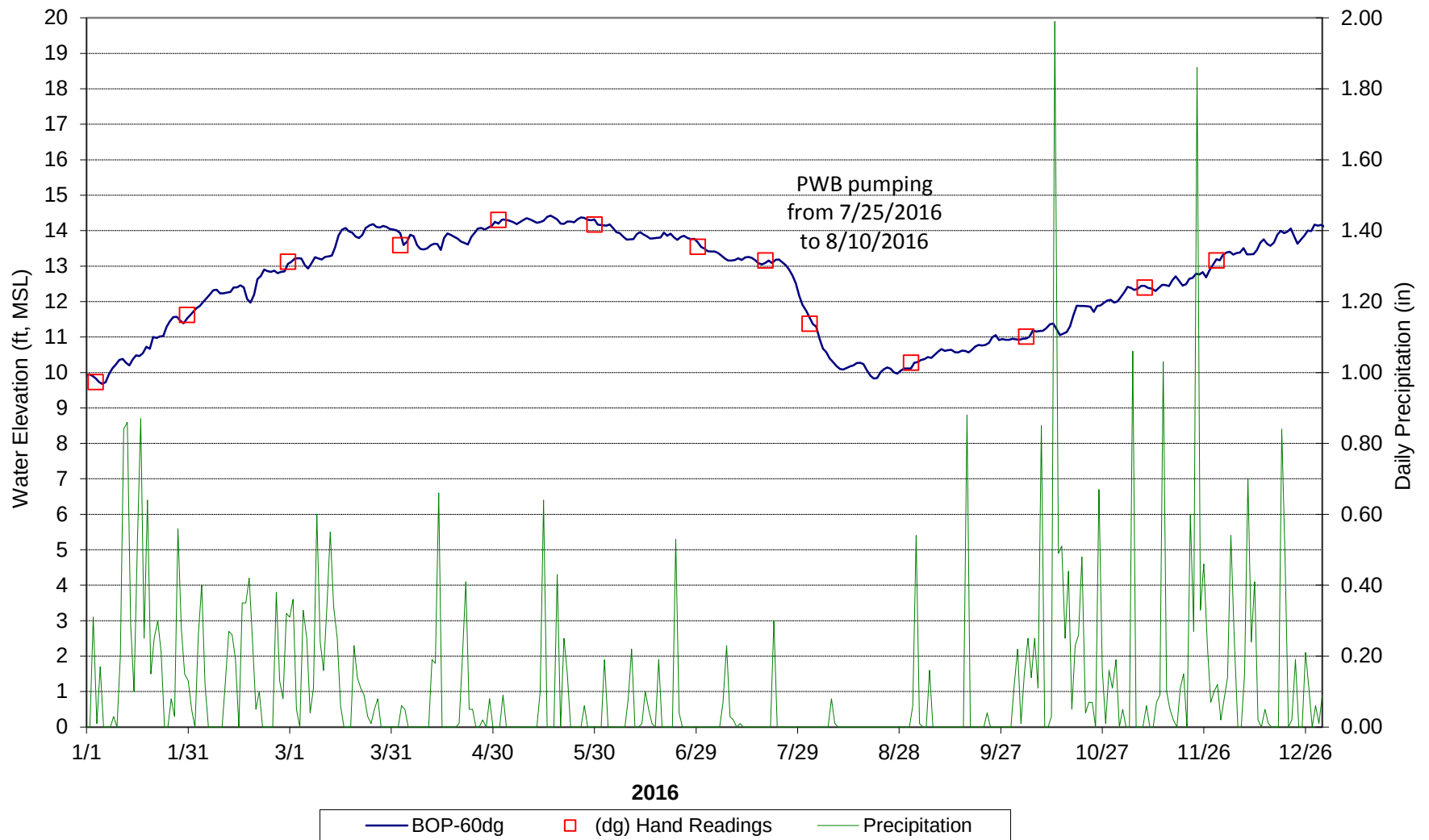
TOC = top of casing

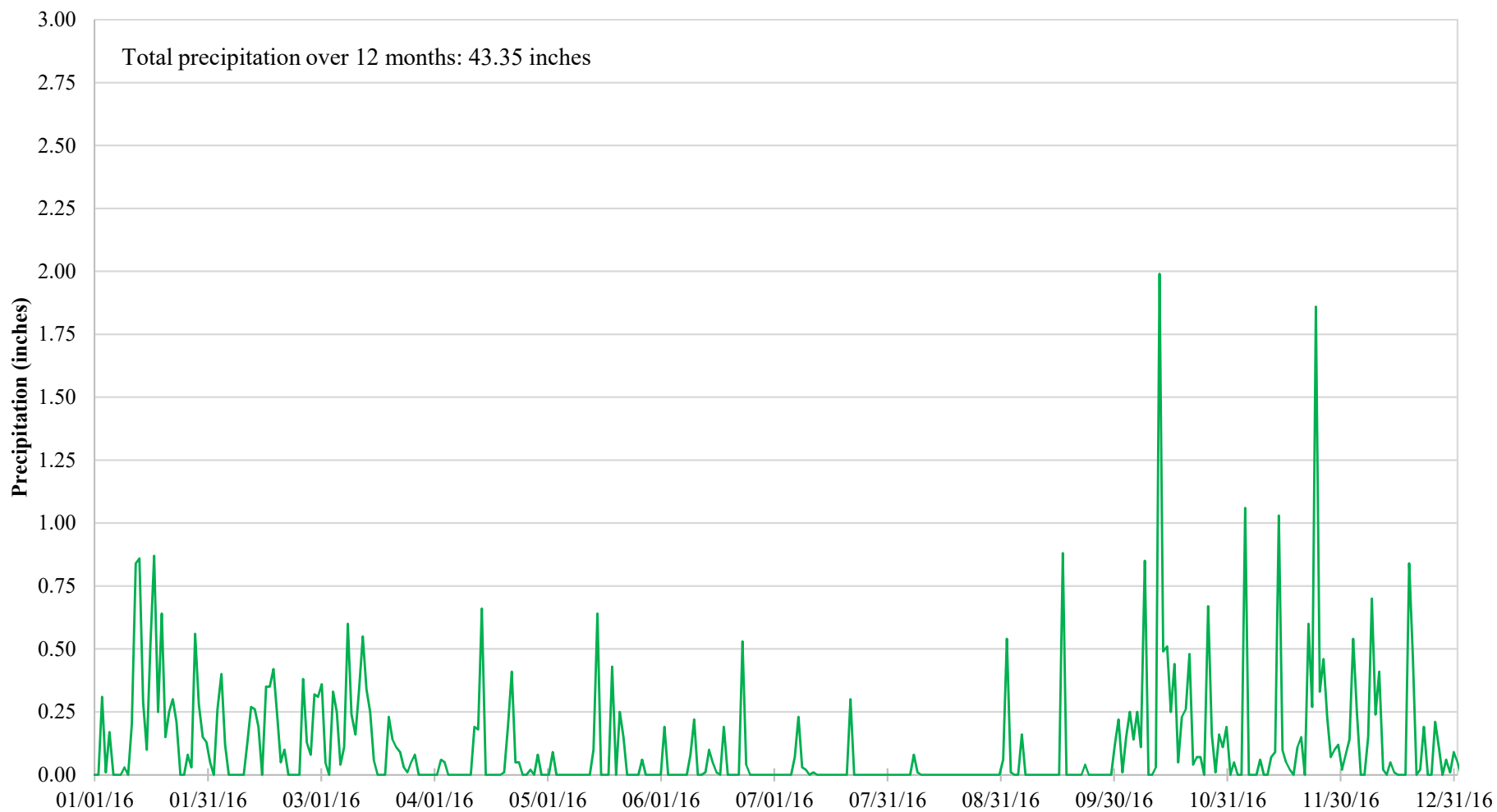












Note: Data from NOAA National Weather Service Preliminary Local Climatological Data (WS Form: F-6); Portland International Airport

APPENDIX C

Groundwater Quality Data

Table C-1
Groundwater Analytical Results - (µg/L)
1 January 2016 through 31 December 2016
TSA Remedy - East Multnomah County

TSA Zone	Monitoring Well ID	Sample ID	Sample Date	Trichloroethene (TCE)	Tetrachloroethene (PCE)	cis-1,2-Dichloroethene	1,1-Dichloroethene	Vinyl Chloride
System Influent/Effluent								
Lower	TS-C-Inf	TS-C-INF-020216	2/2/2016	5.07	< 1.0	< 1.0	< 1.0	< 1.0
Lower	TS-C-Inf	TS-C-INF-050316	5/3/2016	3.72	< 1.0	< 1.0	< 1.0	< 1.0
Lower	TS-C-Inf	TS-C-INF-080416	8/4/2016	5.5	< 1.0	< 1.0	< 1.0	< 1.0
Lower	TS-C-Inf	TS-C-INF-110116	11/1/2016	5.44	< 1.0	< 1.0	< 1.0	< 1.0
Lower	TS-C-Eff	TS-C-EFF-020216	2/2/2016	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Lower	TS-C-Eff	TS-C-EFF-020216-DUP	2/2/2016	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Lower	TS-C-Eff	TS-C-EFF-050316	5/3/2016	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Lower	TS-C-Eff	TS-C-EFF-050316-DUP	5/3/2016	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Lower	TS-C-Eff	TS-C-EFF-080416	8/4/2016	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Lower	TS-C-Eff	TS-C-EFF-080416-DUP	8/4/2016	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Lower	TS-C-Eff	TS-C-EFF-110116	11/1/2016	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Lower	TS-C-Eff	TS-C-EFF-110116-DUP	11/1/2016	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Extraction Wells								
Lower	EW-1	EW1-020216	2/2/2016	3.73	< 1.0	< 1.0	< 1.0	< 1.0
Lower	EW-1	EW1-050316	5/3/2016	3.26	< 1.0	< 1.0	< 1.0	< 1.0
Lower	EW-1	EW1-080416	8/4/2016	4.26	< 1.0	< 1.0	< 1.0	< 1.0
Lower	EW-1	EW1-110116	11/1/2016	3.76	< 1.0	< 1.0	< 1.0	< 1.0
Lower	EW-2	EW2-020216	2/2/2016	12.5	< 1.0	1.24	< 1.0	< 1.0
Lower	EW-2	EW2-050316	5/3/2016	9.58	< 1.0	1.05	< 1.0	< 1.0
Lower	EW-2	EW2-080416	8/4/2016	11.5	< 1.0	1.13	< 1.0	< 1.0
Lower	EW-2	EW2-110116	11/1/2016	13.3	< 1.0	1.08	< 1.0	< 1.0
Lower	EW-14	EW14-020216	2/2/2016	9.3	< 1.0	1.02	< 1.0	< 1.0
Lower	EW-14	EW14-050316	5/3/2016	6.25	< 1.0	< 1.0	< 1.0	< 1.0
Lower	EW-14	EW14-080416	8/4/2016	7.77	< 1.0	< 1.0	< 1.0	< 1.0
Lower	EW-14	EW14-110116	11/1/2016	8.61	< 1.0	< 1.0	< 1.0	< 1.0
Lower	EW-16	EW16-020216	2/2/2016	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Lower	EW-16	EW16-050316	5/3/2016	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Lower	EW-16	EW16-080416	8/4/2016	2.98	< 1.0	< 1.0	< 1.0	< 1.0
Lower	EW-16	EW16-110116	11/1/2016	4.94	< 1.0	< 1.0	< 1.0	< 1.0
Lower	EW-23	EW23-020216	2/2/2016	2.06	< 1.0	< 1.0	< 1.0	< 1.0
Lower	EW-23	EW23-080416	8/4/2016	2.06	< 1.0	< 1.0	< 1.0	< 1.0
Monitoring Wells								
Lower	BOP-13dg	BOP-13dg-0816	8/4/2016	1.3	< 0.20	< 0.20	< 0.20	< 0.20
Lower	BOP-20dg	BOP-20dg-0816	8/8/2016	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Lower	BOP-23dg	BOP-23dg-0816	8/4/2016	1	0.2	< 0.20	< 0.20	< 0.20
Lower	BOP-31dg	BOP-31dg-0216	2/2/2016	4.4	0.4	0.5	< 0.20	< 0.20

Table C-1
Groundwater Analytical Results - (µg/L)
1 January 2016 through 31 December 2016
TSA Remedy - East Multnomah County

TSA Zone	Monitoring Well ID	Sample ID	Sample Date	Trichloroethene (TCE)	Tetrachloroethene (PCE)	cis-1,2-Dichloroethene	1,1-Dichloroethene	Vinyl Chloride
Lower	BOP-31dg	BOP-31dg-0816	8/4/2016	4.5	0.5	0.6	< 0.20	< 0.20
Lower	BOP-42dg	BOP-42dg-0816	8/4/2016	1.5	0.2	0.5	< 0.20	< 0.20
Lower	BOP-60dg	BOP-60(dg)-0816	8/8/2016	2.3	< 0.20	0.3	< 0.20	< 0.20
Lower	BOP-60dg	BOP-60(dg)-0816	8/8/2016	2.3	< 0.20	0.3	< 0.20	< 0.20
Lower	BOP-61dg	BOP-61dg-0216	2/2/2016	3.9	< 0.20	1.4	< 0.20	< 0.20
Lower	BOP-61dg	BOP-61dg-0816	8/8/2016	5.6	0.20	0.7	< 0.20	< 0.20
Lower	CMW-10dg	MW-10DG-080416	8/4/2016	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Lower	CMW-14Rds	CMW14RDS-020216	2/2/2016	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Lower	CMW-14Rds	CMW14RDS-050316	5/3/2016	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Lower	CMW-14Rds	MW-14RDS-080216	8/2/2016	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Lower	CMW-14Rds	CMW14RDS-110116	11/1/2016	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Lower	CMW-24dg (EW-5)	CMW24DG-020216-L	2/2/2016	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Lower	CMW-24dg (EW-5)	CMW24DG-020216-U	2/2/2016	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Lower	CMW-24dg (EW-5)	MW-24DG-080216-L	8/2/2016	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Lower	CMW-24dg (EW-5)	MW-24DG-080216-U	8/2/2016	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Lower	CMW-25dg	CMW25DG-020216	2/2/2016	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Lower	CMW-25dg	MW-25DG-080216	8/2/2016	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Lower	CMW-26dg	CMW26DG-020216	2/2/2016	3.3	< 1.0	< 1.0	< 1.0	< 1.0
Lower	CMW-26dg	CMW26DG-050316	5/3/2016	2.33	< 1.0	< 1.0	< 1.0	< 1.0
Lower	CMW-26dg	CMW26DG-080216	8/2/2016	2.85	< 1.0	< 1.0	< 1.0	< 1.0
Lower	CMW-26dg	CMW26DG-110116	11/1/2016	3.95	< 1.0	< 1.0	< 1.0	< 1.0
Lower	CMW-36dg	CMW36DG-080216	8/2/2016	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Lower	D-17dg	D17DG-020216	2/2/2016	32.4 J	< 1.00	8.01	< 1.0	< 1.0
Lower	D-17dg	D-17DG-080216	8/4/2016	2.86 J	< 1.00	< 1.00	< 1.0	< 1.0
Lower	D-17ds	D17DS-020216	2/2/2016	54.1	1.24	12.8	< 1.0	< 1.0
Lower	D-17ds	D17DS-050316	5/3/2016	27.5	1.12	6.35	< 1.0	< 1.0
Lower	D-17ds	D-17DS-080216	8/2/2016	22 J	< 1.00	4.55	< 1.0	< 1.0
Lower	D-17ds	D17DS-110116	11/1/2016	31.3	< 1.00	6.82	< 1.0	< 1.0
Lower	EW-8	EW8-020216-L	2/2/2016	3.23	< 1.0	< 1.0	< 1.0	< 1.0
Lower	EW-8	EW8-020216-U	2/2/2016	3.08	< 1.0	< 1.0	< 1.0	< 1.0
Lower	EW-8	EW-8-080216-L	8/2/2016	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Lower	EW-8	EW-8-080216-U	8/2/2016	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Lower	EW-12	EW12-020216-L	2/2/2016	3.52	< 1.0	< 1.0	< 1.0	< 1.0
Lower	EW-12	EW12-020216-U	2/2/2016	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Lower	EW-12	EW12-050316-L	5/3/2016	2.75	< 1.0	< 1.0	< 1.0	< 1.0
Lower	EW-12	EW12-050316-U	5/3/2016	2.18	< 1.0	< 1.0	< 1.0	< 1.0
Lower	EW-12	EW-12-080216-L	8/2/2016	3.65 J	< 1.0	< 1.0	< 1.0	< 1.0

Table C-1
Groundwater Analytical Results - (µg/L)
1 January 2016 through 31 December 2016
TSA Remedy - East Multnomah County

TSA Zone	Monitoring Well ID	Sample ID	Sample Date	Trichloroethene (TCE)	Tetrachloroethene (PCE)	cis-1,2-Dichloroethene	1,1-Dichloroethene	Vinyl Chloride
Lower	EW-12	EW-12-080216-U	8/2/2016	1.22 J	< 1.0	< 1.0	< 1.0	< 1.0
Lower	EW-12	EW12-110116-L	11/1/2016	3.37	< 1.0	< 1.0	< 1.0	< 1.0
Lower	EW-12	EW12-110116-U	11/1/2016	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Lower	EW-13	EW-13-0216	2/2/2016	0.8	< 0.20	0.4	< 0.20	< 0.20
Lower	EW-13	EW-13-0816	8/2/2016	0.6	< 0.20	< 0.20	< 0.20	< 0.20
Upper	BOP-13ds	BOP-13ds-0216	2/2/2016	3.4	< 0.20	0.50	< 0.20	< 0.20
Upper	BOP-13ds	BOP-13ds-0216-DUP	2/2/2016	3.3	< 0.20	0.40	< 0.20	< 0.20
Upper	BOP-13ds	BOP-13ds-0516	5/3/2016	1.0	< 0.20	< 0.20	< 0.20	< 0.20
Upper	BOP-13ds	BOP-13ds-0816	8/2/2016	2.9	< 0.20	0.30	< 0.20	< 0.20
Upper	BOP-13ds	BOP-13ds-1116	11/16/2016	3.2	< 0.2	0.4	< 0.2	< 0.2
Upper	BOP-20ds	BOP-20ds-0816	8/8/2016	0.2	< 0.20	< 0.20	< 0.20	< 0.20
Upper	BOP-20ds	BOP-20ds-0816-DUP	8/8/2016	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Upper	BOP-21ds	BOP-21ds-0816	8/8/2016	< 0.20	< 0.20	1.0	< 0.20	< 0.20
Upper	BOP-22Rds	BOP-22R(ds)-0816	8/8/2016	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Upper	BOP-31ds	BOP-31ds-0216	2/2/2016	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Upper	BOP-31ds	BOP-31ds-0516	5/5/2016	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Upper	BOP-31ds	BOP-31ds-0816	8/10/2016	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Upper	BOP-31ds	BOP-31ds-1116	11/16/2016	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Upper	BOP-42ds	BOP-42ds-0816	8/4/2016	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Upper	BOP-61ds	BOP-61ds-0216	2/2/2016	7.6	0.3	1.3	< 0.20	< 0.20
Upper	BOP-61ds	BOP-61ds-0816	8/10/2016	5.8	0.2	0.6	< 0.20	< 0.20
Upper	BOP-62ds	BOP-62ds-0815	8/10/2016	0.6	< 0.20	< 0.20	< 0.20	< 0.20
Upper	BOP-65ds	BOP-65ds-0216	2/2/2016	1.1	< 0.20	< 0.20	< 0.20	< 0.20
Upper	BOP-65ds	BOP-65ds-0816	8/10/2016	0.90	< 0.20	< 0.20	< 0.20	< 0.20
Upper	BOP-66ds	BOP-66ds-0216	2/2/2016	1.9	< 0.20	< 0.20	< 0.20	< 0.20
Upper	BOP-66ds	BOP-66ds-0816	8/10/2016	1.1	< 0.20	< 0.20	< 0.20	< 0.20
Upper	CMW-10ds	CMW10DS-020216	2/2/2016	25.4 J	1.03 J	< 1.0	< 1.0	< 1.0
Upper	CMW-10ds	CMW10DS-050316	5/3/2016	19.1	< 1.0	< 1.0	< 1.0	< 1.0
Upper	CMW-10ds	MW-10DS-080416	8/4/2016	21	< 1.0	< 1.0	< 1.0	< 1.0
Upper	CMW-10ds	CMW10DS-110116	11/1/2016	19.3	< 1.0	< 1.0	< 1.0	< 1.0
Upper	CMW-17ds	CMW17DS-012616	1/26/2016	52.1	1.87	7.63	< 1.0	< 1.0
Upper	CMW-17ds	CMW17DS-022316	2/23/2016	47.6	1.52	8.85	< 1.0	< 1.0
Upper	CMW-17ds	CMW17DS-031516	3/15/2016	46.7	1.35	6.86	< 1.0	< 1.0
Upper	CMW-17ds	CMW17DS-042716	4/27/2016	43.2	1.87	6.51	< 1.0	< 1.0

Table C-1
Groundwater Analytical Results - (µg/L)
1 January 2016 through 31 December 2016
TSA Remedy - East Multnomah County

TSA Zone	Monitoring Well ID	Sample ID	Sample Date	Trichloroethene (TCE)	Tetrachloroethene (PCE)	cis-1,2-Dichloroethene	1,1-Dichloroethene	Vinyl Chloride
Upper	CMW-17ds	CMW17DS-052416	5/24/2016	36.1	1.43	5.98	< 1.0	< 1.0
Upper	CMW-17ds	CMW17DS-062116	6/21/2016	38.7	1.39	6.50	< 1.0	< 1.0
Upper	CMW-17ds	CMW17DS-072616	7/26/2016	38.6	1.42	6.33	< 1.0	< 1.0
Upper	CMW-17ds	CMW17DS-083016	8/30/2016	37.6	1.78	6.36	< 1.0	< 1.0
Upper	CMW-17ds	CMW17DS-110116	11/1/2016	42.8	2.11	5.43	< 1.0	< 1.0
Upper	CMW-18ds	CMW18DS-020216	2/2/2016	56.3	2.34	6.60	< 1.0	< 1.0
Upper	CMW-18ds	CMW18DS-050316	5/3/2016	60.7	1.61	8.55	< 1.0	< 1.0
Upper	CMW-18ds	MW-18DS-080216	8/2/2016	78.7 J	2.76	9.40	< 1.0	< 1.0
Upper	CMW-18ds	CMW18DS-110116	11/1/2016	48.1	1.85	5.53	< 1.0	< 1.0
Upper	CMW-18ds	CMW18DS-110116-DUP	11/1/2016	51.0	1.96	5.84	< 1.0	< 1.0
Upper	CMW-19ds	CMW19DS-020216	2/2/2016	3.20	< 1.0	< 1.0	< 1.0	< 1.0
Upper	CMW-19ds	CMW19DS-050316	5/3/2016	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Upper	CMW-19ds	MW-19DS-080216	8/2/2016	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Upper	CMW-19ds	CMW19DS-110116	11/1/2016	1.00	< 1.0	< 1.0	< 1.0	< 1.0
Upper	CMW-20ds	MW-20DS-080416	8/4/2016	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Upper	EW-3	EW3-0216	2/2/2016	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Upper	EW-3	EW3-0816	8/2/2016	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Vapor Monitoring Wells								
Upper	VMW-A	VMW-A-GW	11/21/2016	58.8	2.85	5.20	< 1.00	< 1.00
Upper	VMW-B	VMW-B	11/23/2016	70.3	3.95	8.17	< 1.00	< 1.00
Upper	VMW-C	VMW-C-121316	12/13/2016	4.57	< 1.00	< 1.00	< 1.00	< 1.00
Upper	VMW-D	VMW-D-121316	12/13/2016	5.50	< 1.00	2.33	< 1.00	< 1.00

Notes:

Results are presented in micrograms per liter (µg/L)

BOP = wells installed by and /or on Boeing Corporation Property

CMW = monitoring wells installed by and/or on Cascade Corporation property.

< = compound not detected above the reporting limit shown.

Bold value indicates detection above method detection limit.

Sample ID with "DUP" indicates duplicate sample.

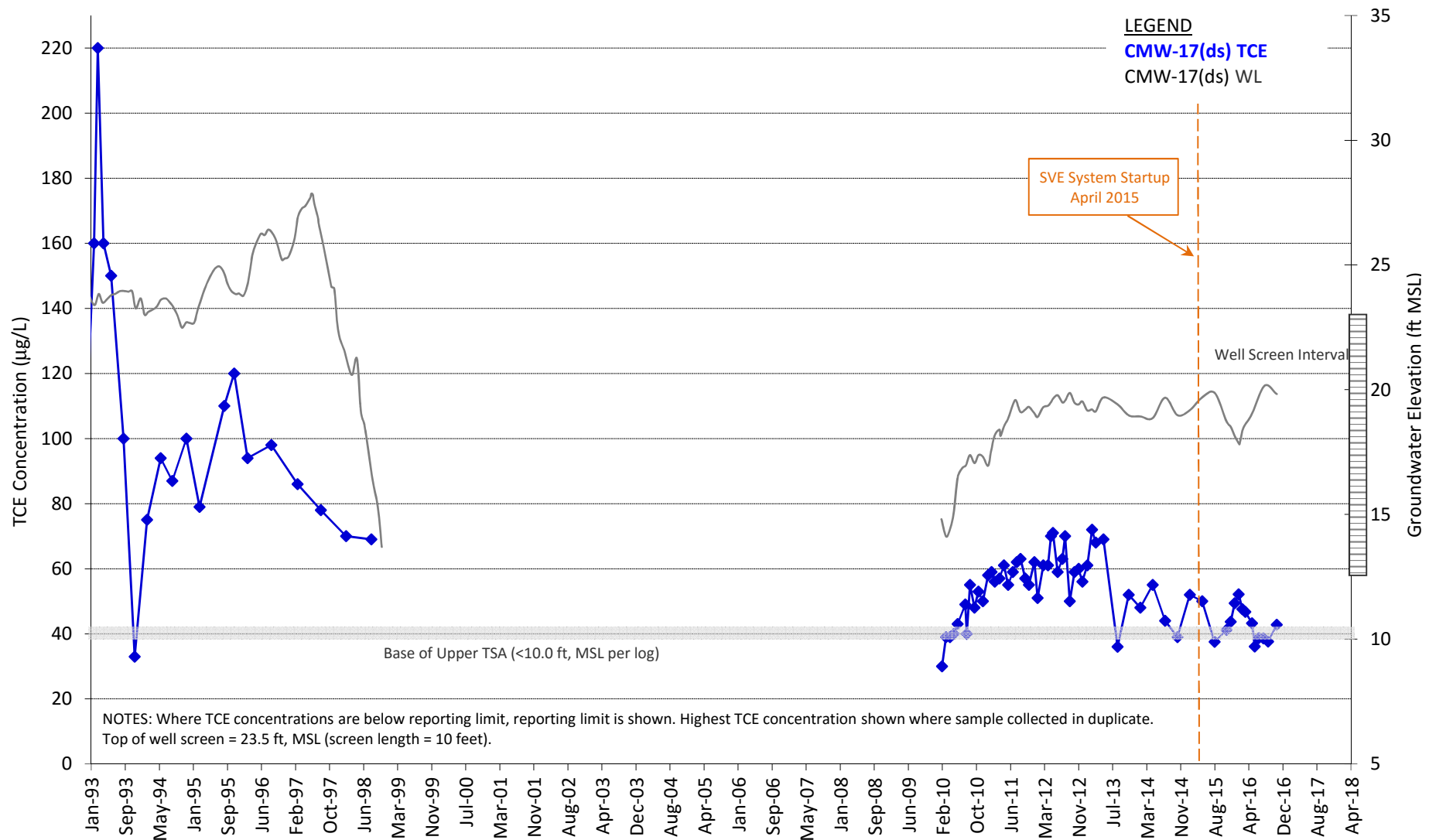
Sample ID with "U" indicates sample collected from the upper portion of the screened interval.

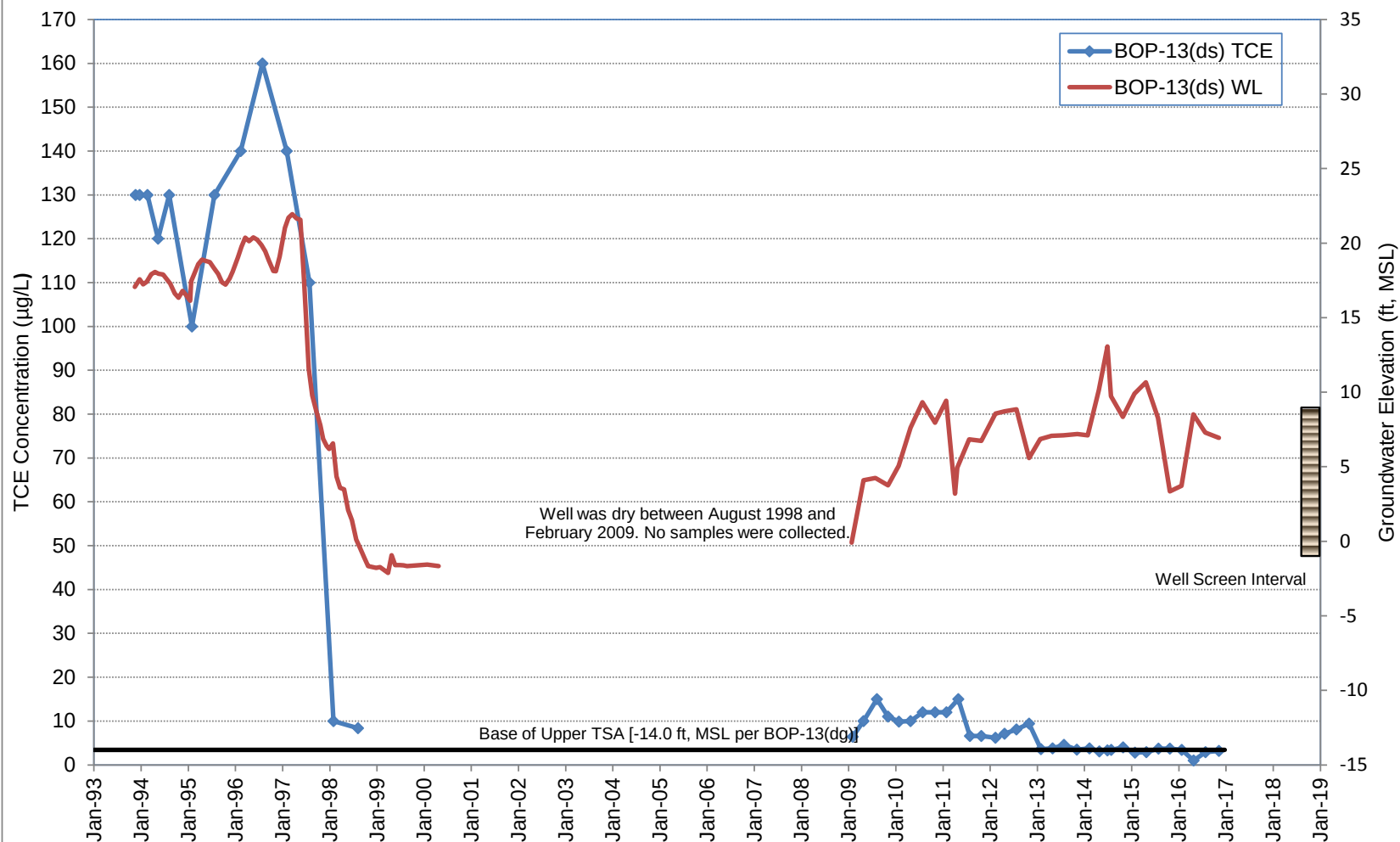
Sample ID with "L" indicates sample collected from the lower portion of the screened interval.

Samples analyzed using EPA Method 8260 and results shown above have been validated with applicable qualifiers shown.

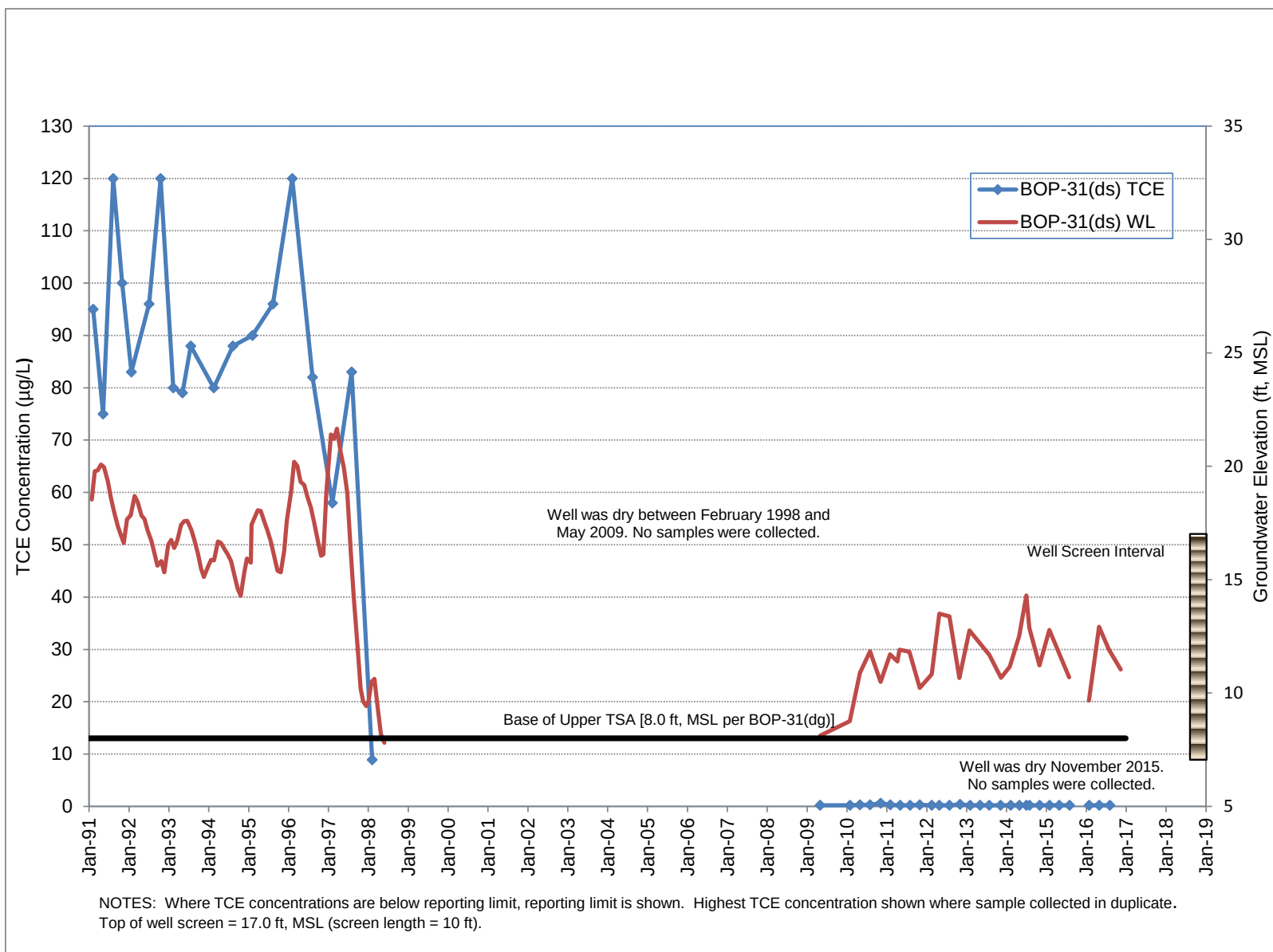
Laboratory and validation reports for above listed samples are presented on a disc in Appendix F.

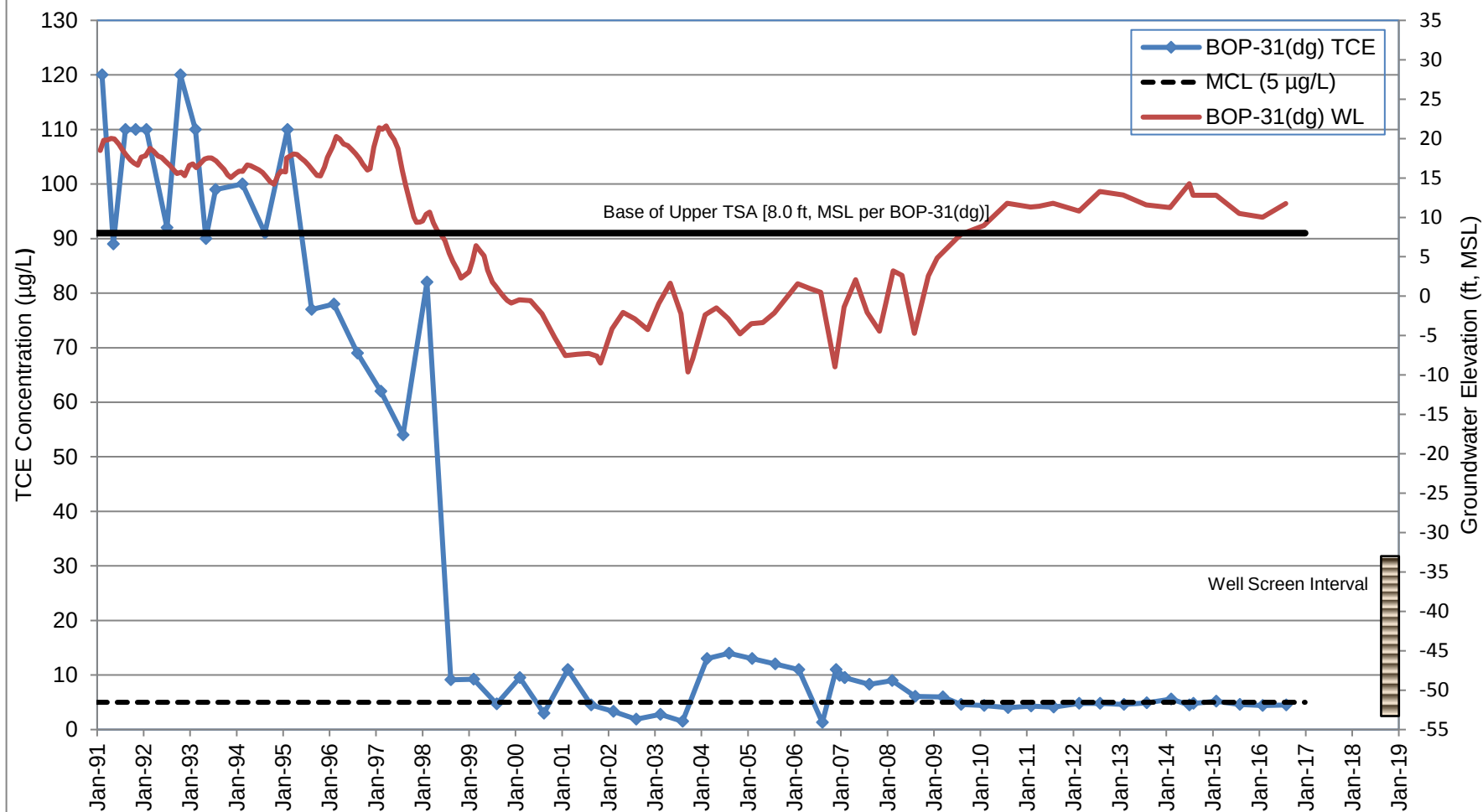
N/A = not applicable



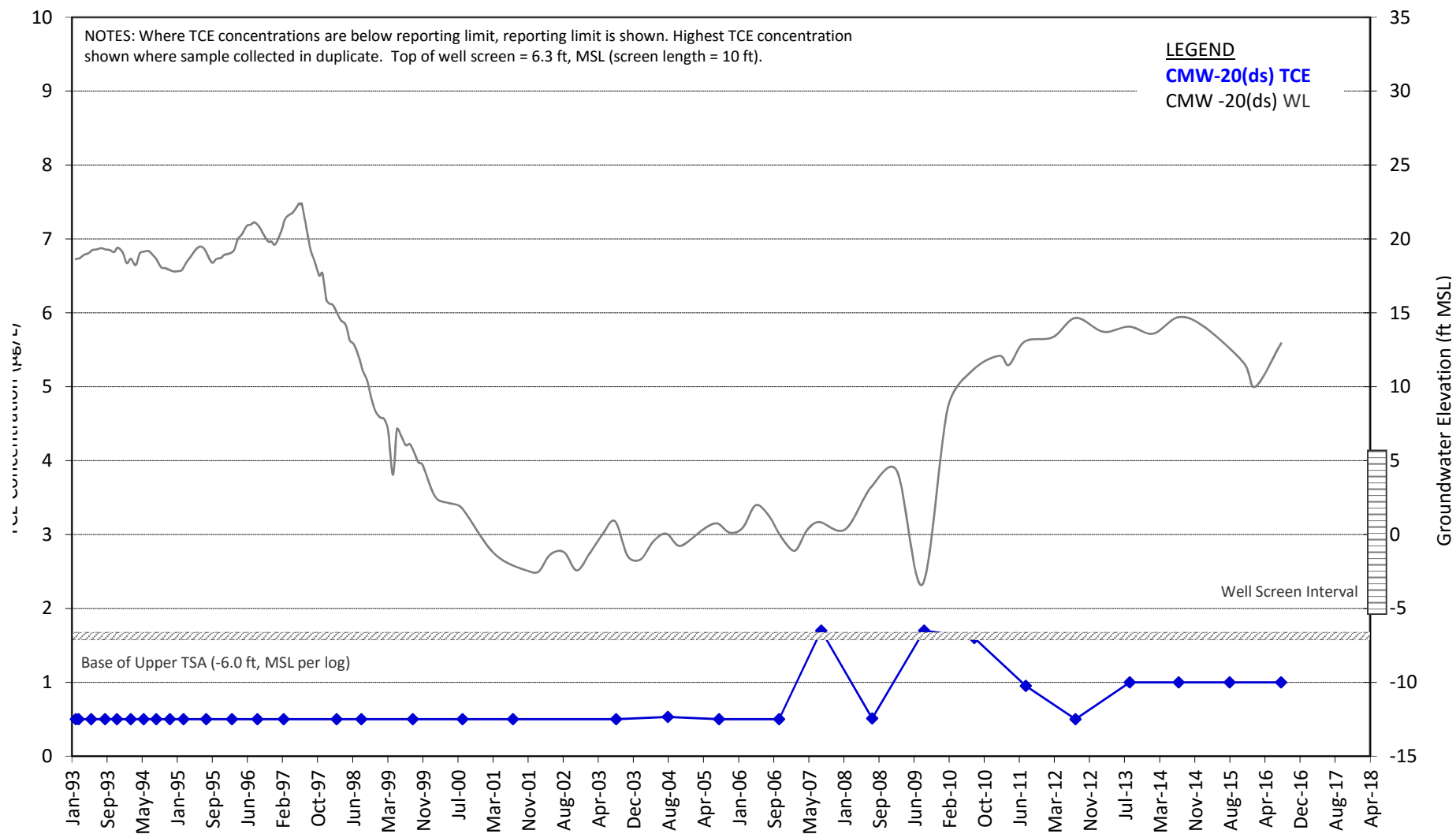


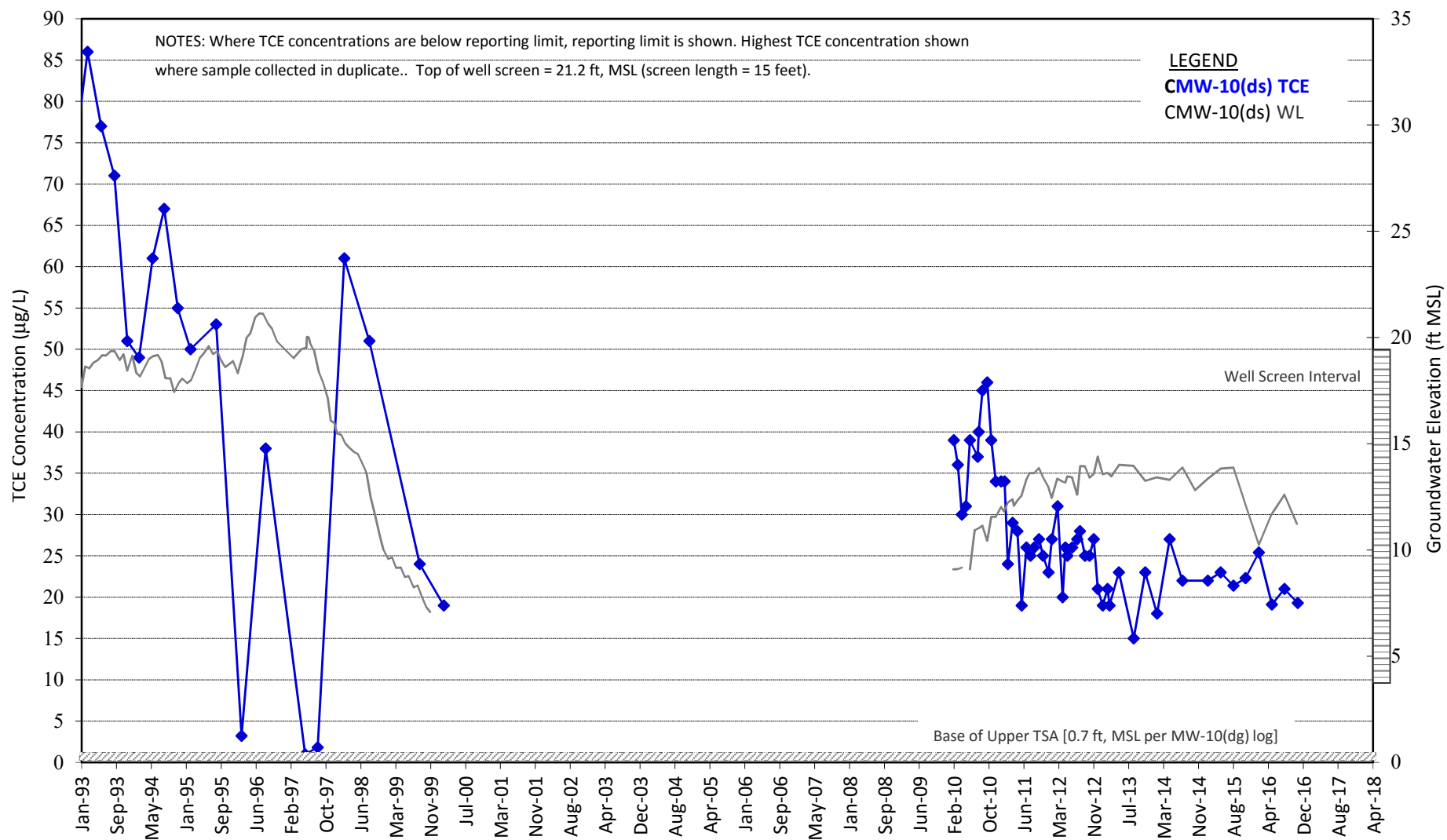
NOTES: Where TCE concentrations are below reporting limit, reporting limit is shown. Highest TCE concentration shown where sample collected in duplicate.
Top of well screen = 9.0 ft, MSL (screen length = 10 ft).

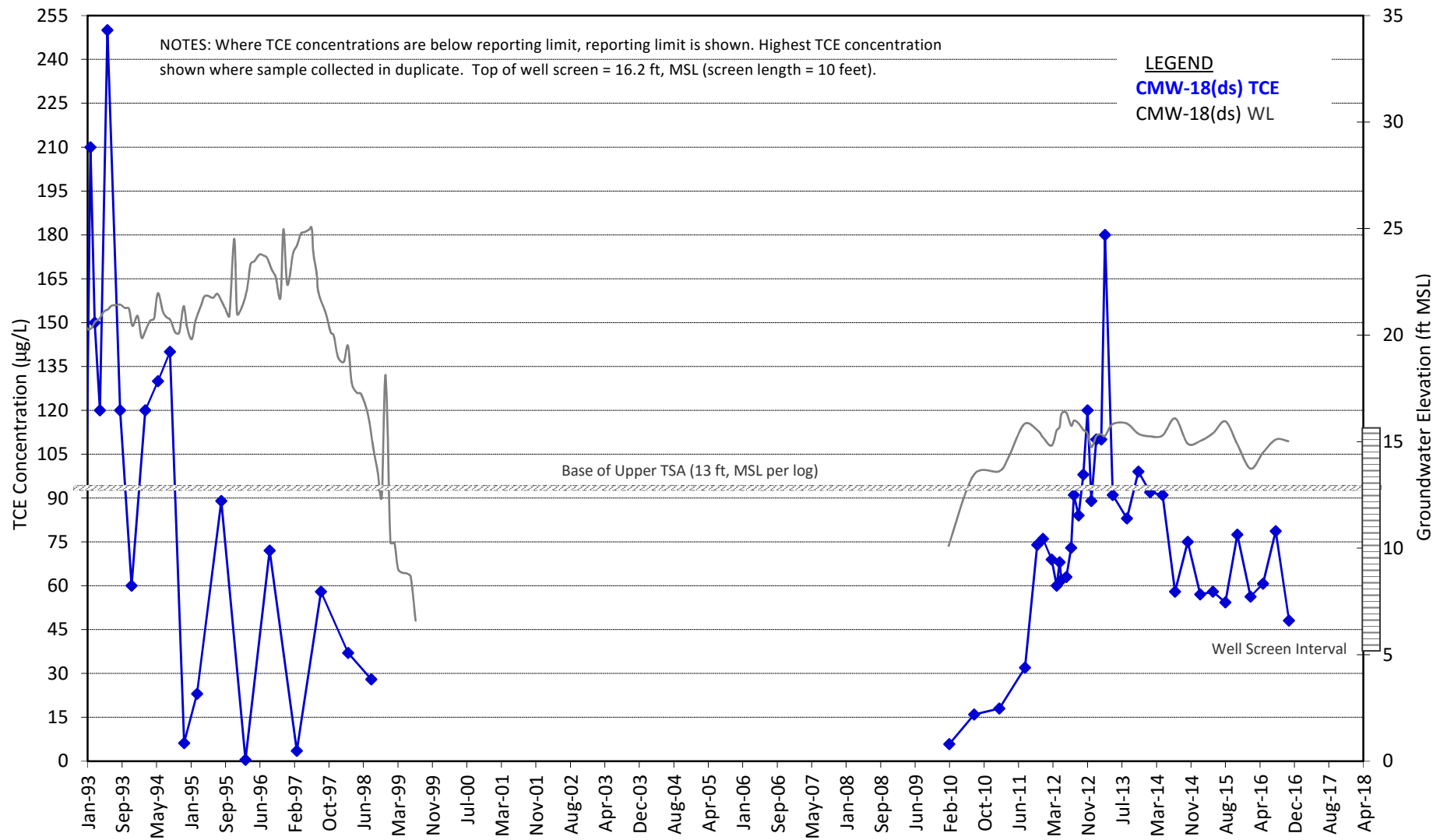


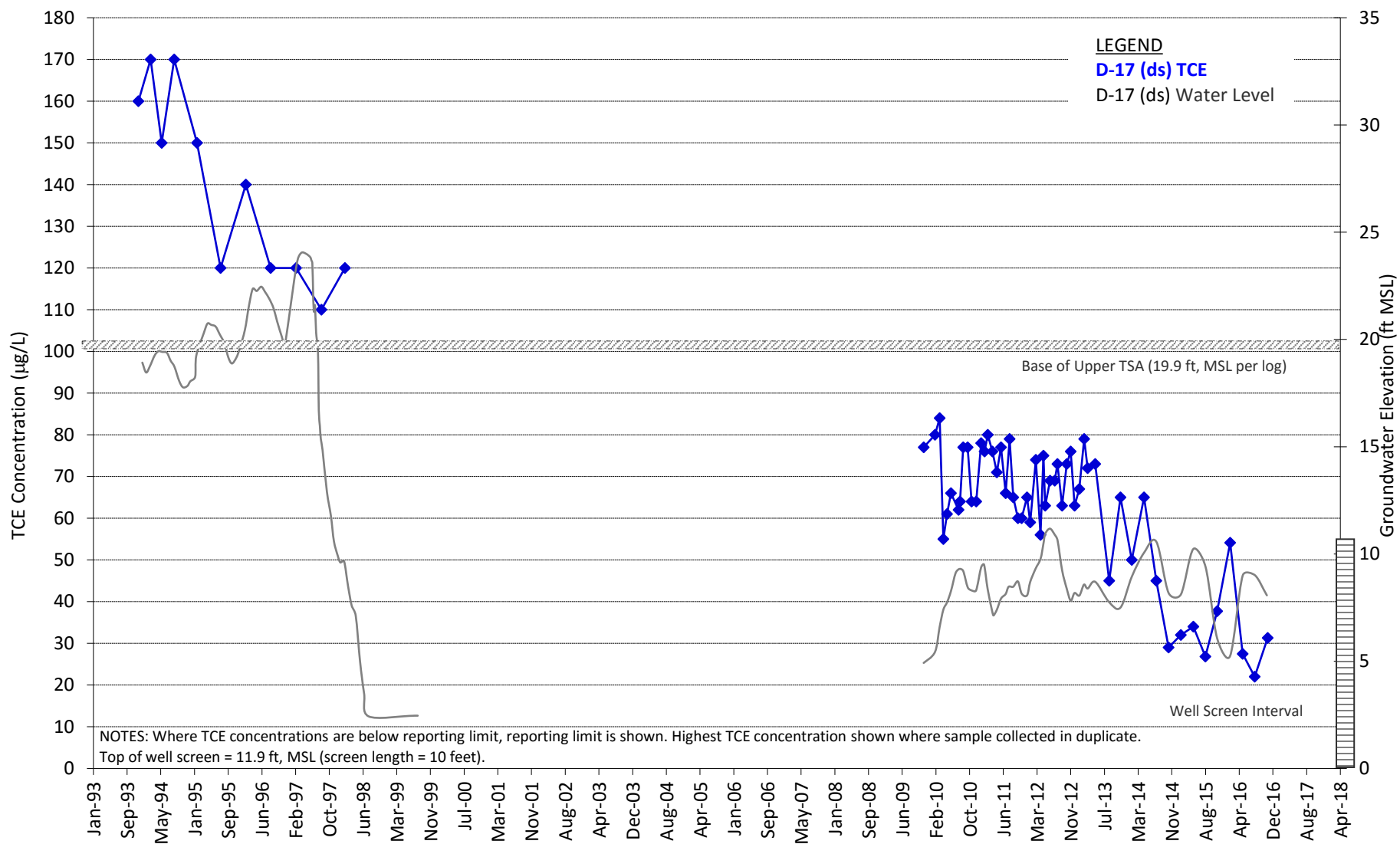


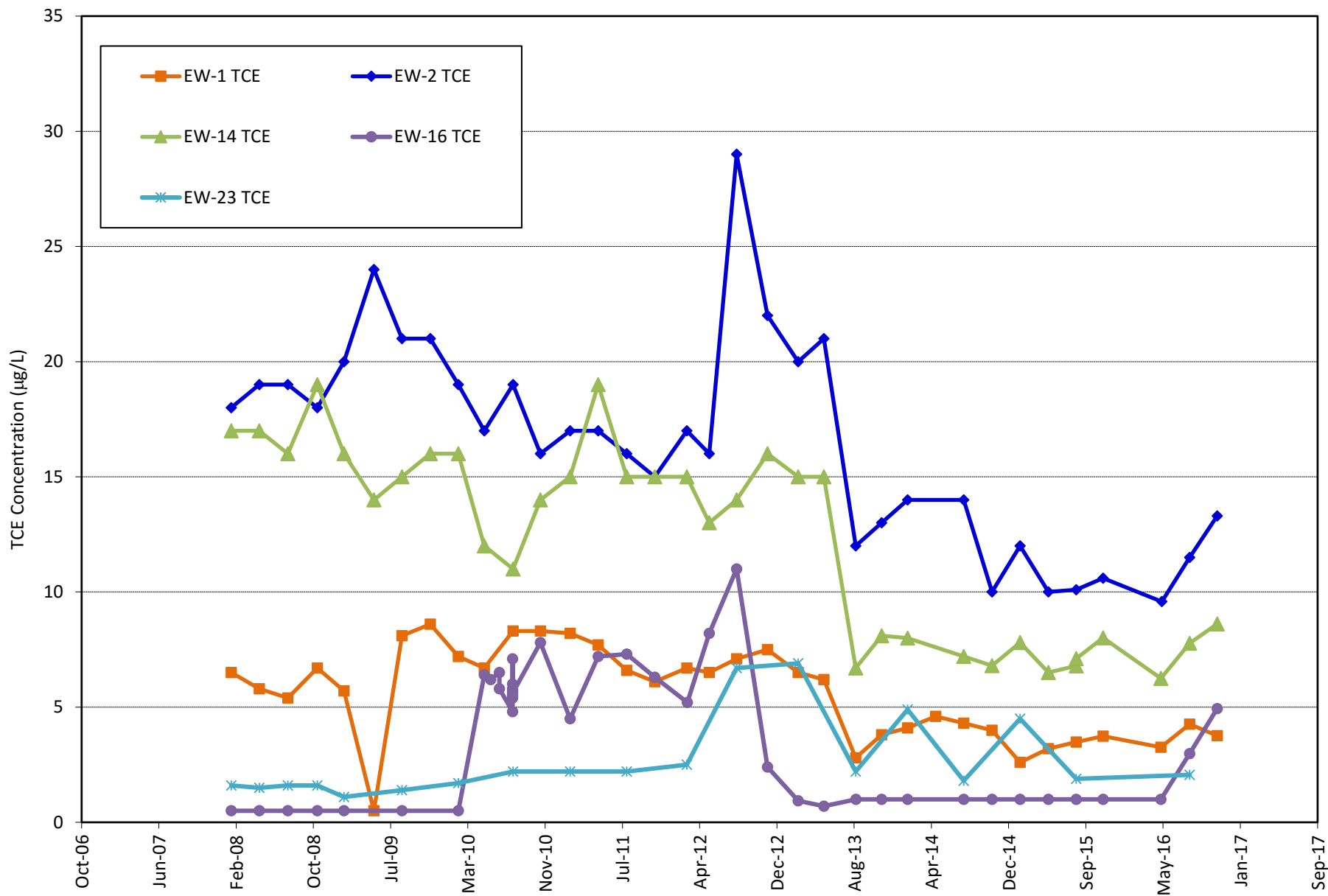
NOTES: Where TCE concentrations are below reporting limit, reporting limit is shown. Highest TCE concentration shown where sample collected in duplicate.











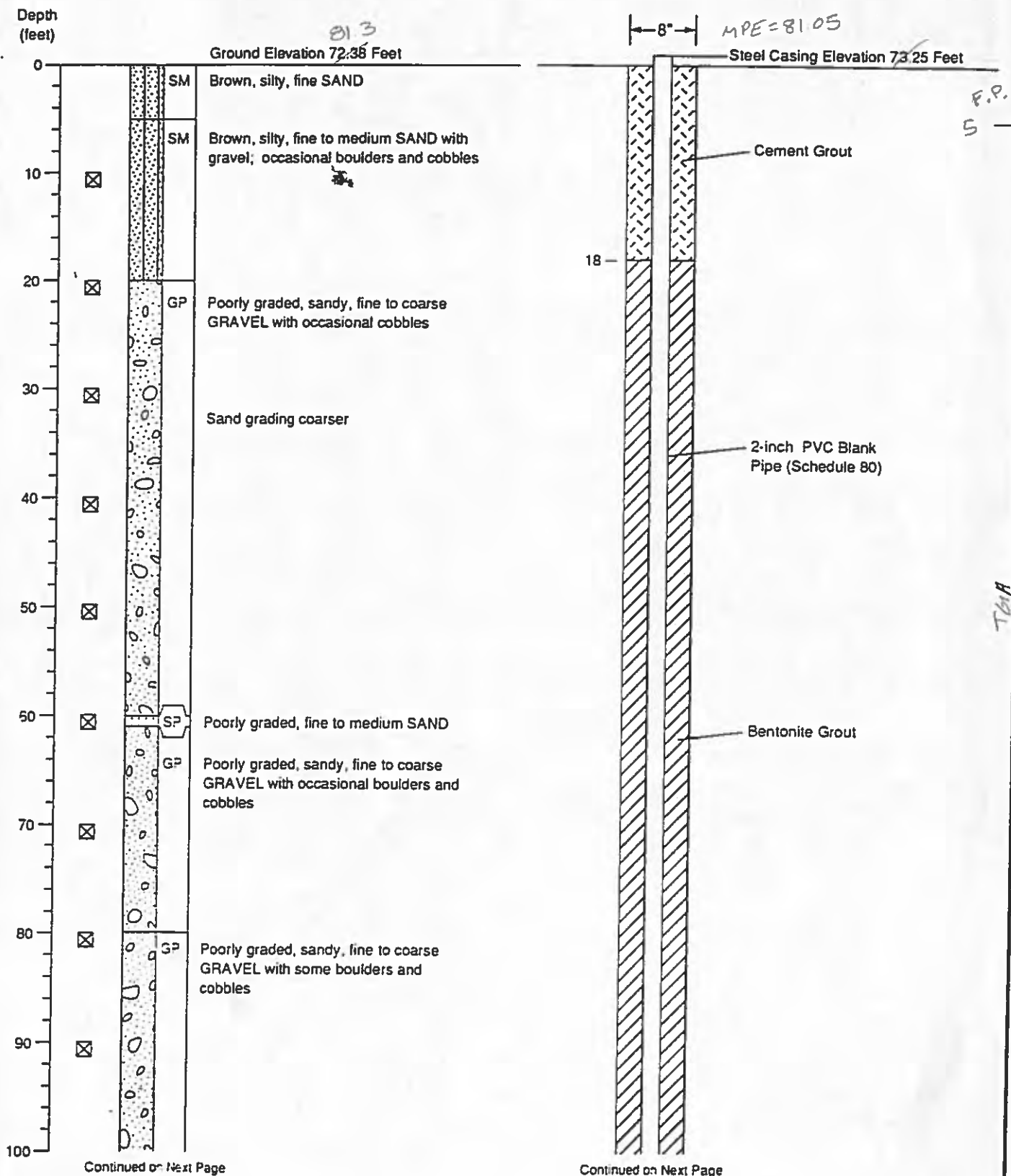
APPENDIX D

Well Decommissioning

Well BOP-22(dg)

Soil Profile

As-Built



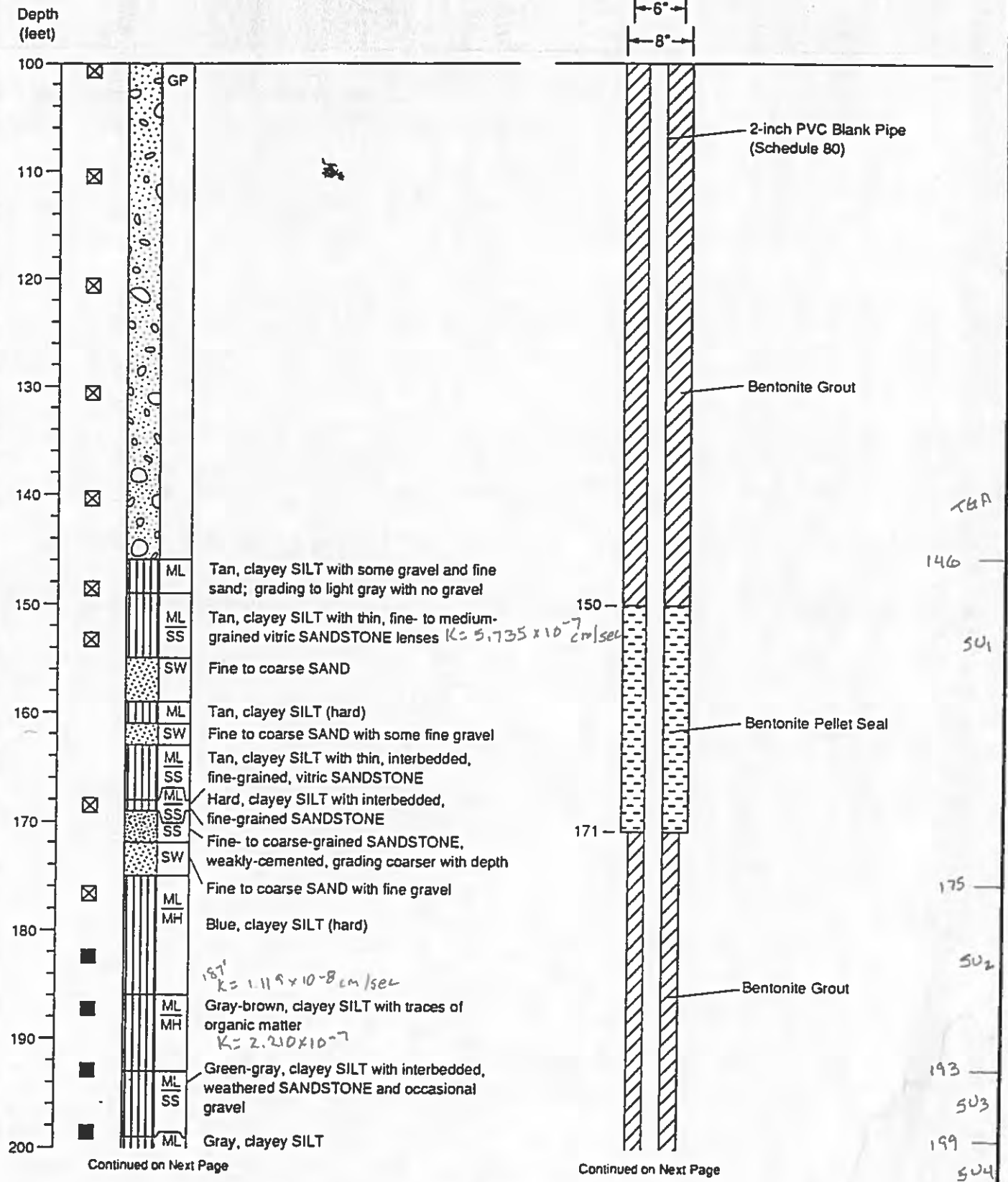
LANDAU ASSOCIATES, INC.

Soil Profile and Well Log
for Well BOP-22(dg)

Well BOP-22(dg) (Continued)

Soil Profile

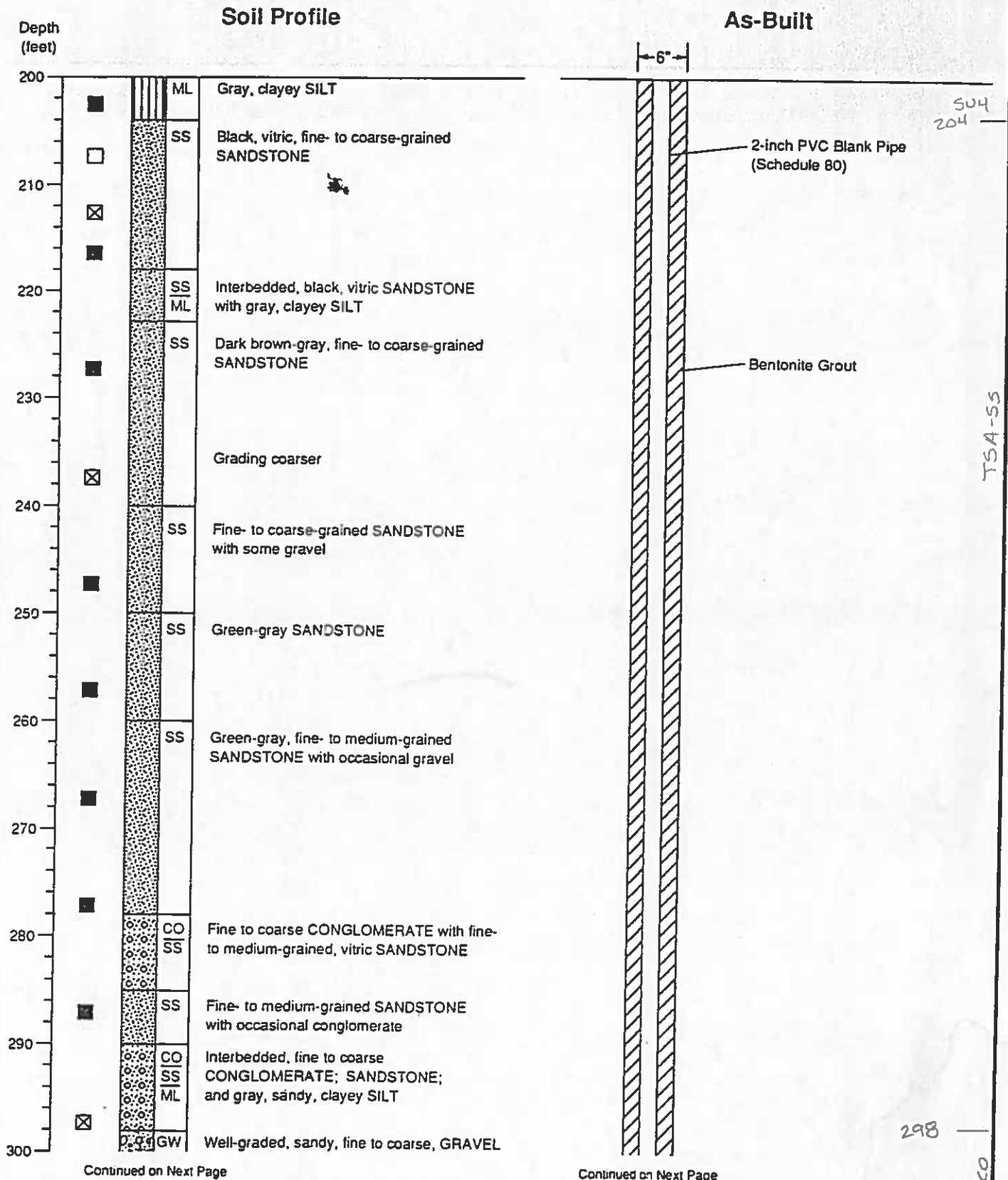
As-Built



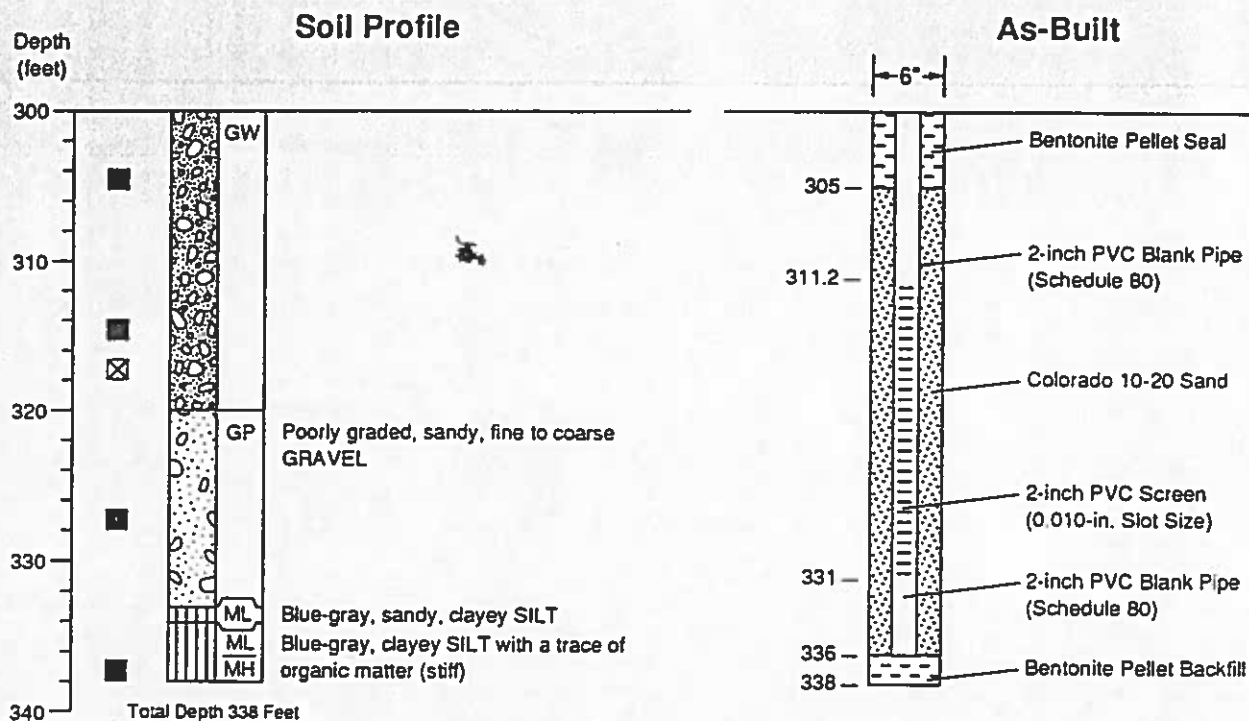
LANDAU ASSOCIATES, INC.

Soil Profile and Well Log
for Well BOP-22(dg)

Well BOP-22(dg) (Continued)



Well BOP-22(dg) (Continued)





Well Decommissioning Record

Project Name: BOP-22dg Decommissioning Project Number: 025116.616.690
 Location: Gresham, Oregon Date: 10/5/16 and 10/15/16 through 10/21/16
 Client: Boeing Company Landau Representative: EMW
 Sub Contractor : Holt Services Decommissioning Method: Rotosonic Overdrill

Type of Well: Monitoring Well Type of Casing: 2 inch Schedule 80
 Well Depth: 336 ft Casing Diameter: 8 inch to 6 inch at 171 ft
 Depth to Water: 69.40 ft Screen Interval: 311 ft to 331 ft
 Well Annulus Diameter: 8 inch to 6 inch Filter Pack Interval: 305 ft to 336 ft
 Notes: 2 inch schedule 80 PVC well

If well was backfilled or grouted

Type of backfill or grout used: Quick Grout/Portland Cement

Volume of well casing and screen: _____

Volume of well casing, screen, and filter pack: _____

Volume of backfill or grout material used: Approx. 50 lbs of Portland Cement and 140 lbs of Quick Grout

Weight of grout used: Greater than or equal to 9.8 lb/gal

Notes: Grout mix was too thick to pump watered down a bit

If well was over-drilled N/A

Type of drilling equipment used: Rotosonic

Diameter of drill bit: 8 inch to 6 inch at 171 ft Total depth of overdrilling: 338 ft

Type of backfill or grout used: Quick Grout to 5 ft, Bentonite Chips to 1 ft, gravel surface

Volume of over-drilled boring: _____

Volume of backfill or grout used: Bags of Quick Grout: 19 (47 lb sacks)

Weight of grout used: Grout ranged from 9.5 to 9.8 lb/gal

Notes: Thick grout mix, nearly too thick to pump

Notes and Comments (materials removed during overdrilling, geology or groundwater encountered, surface conditions, unsatisfactory or unusual conditions, etc.):

Lost well for sections, had to move over 4 inches to the east at 20 ft bgs

Decommissioning Completed: 10/21/16

APPENDIX E

SVE Data

GS FORM:
CORE3 10/00

BOREHOLE LOG

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOLIC LOG	WELL LOG	WELL CONSTRUCTION MATERIAL	ELEVATION (ft)	SAMPLES				USCS Classification	COMMENTS
						SAMPLE NAME	TYPE	% RECOVERY	PID READING (ppm)		
5	Brown, firm, SILT with some gravel (clasts of quartzite and basalt) and sand; FILL.								6.2	FILL	10" casing with a 7" sampler.
									6.5		
									47.8		
									23.6		
								100	23.6		
									7.5		Ambient PID reading 6.5 - 7.5 ppm.
									7.6		
									6.3	FILL	
10	Gray, medium dense, moist, well-graded, fine, subangular GRAVEL with some sand and silt; FILL.								6.1		
	Woody debris (<1" in size).							90	5.9	FILL	Depth to groundwater 9'.
	Brown, loose, wet, well-graded, fine GRAVEL with some silt; FILL.								5.9		
									6.5		
									6.5		
								50		FILL	
15	Brown matrix black clasts, loose, wet, well-graded GRAVEL with some silt; occasional 3.5-inch cobbles (basalt and quartzite); FILL.								6.1		Driller having difficult time getting a core; core barrel in casing sinking through material.
20				4" Sch 40 PVC well casing				50	5.5		
									5.4		
									5.4		
									5.3		
									4.8		
								100	5.6		
25									3.8		Core sample contains 4" slotted PVC. Set Bentonite seal from 23-30'.
									4.4	ML	
	Blue green (5BG 3/2), slightly firm, moist, SILT.								4.5		Core sample contains geotech material; bottom of fill.
									4.0		
	28.5' - Transitions to gray blue SILT with brown lenses of clay.							100	3.6	ML	
30											

CONTRACTOR Cascade **NORTHING** 689425.300
EQUIPMENT See Remarks **EASTING** 7700452.080
DRILL MTHD Sonic **ANGLE** Vertical
DIAMETER 10"(0-30') 9"(30-80') 8"(80-114') **BEARING** ----
LOGGER D. M-L **REVIEWER** C. Bartlett **PRINTED** 03/15/17

REMARKS: Equipment: Boar Longyear Mini Sonic w/ 5' tooling to 82.5' (11/14-11/15); Mini Sonic w/ 10' tooling could not advance (11/16); Pro Sonic to final depth (11/18& 11/21); Well Tag # L118625

COORDINATE SYSTEM:
SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

GS FORM:
CORE3 10/00

BOREHOLE LOG

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOLIC LOG	WELL LOG	WELL CONSTRUCTION MATERIAL	ELEVATION (ft)	SAMPLES				USCS Classification	COMMENTS
						SAMPLE NAME	TYPE	% RECOVERY	PID READING (ppm)		
	Moderate brown (3YR 3/4), stiff, moist, SILT; mottled with oxidized nodules.								4.6		
									6.0		
	Red-brown, weak, slightly moist, sandy SILTSTONE.								5.9	SILTSTONE	
									7.9		
	Becomes dark brown and dry.								7.0		
35								100	6.1		
									6.1		Drilling difficult.
	36' - Moderate strength; fractures in cylinders.								6.3		
	Red-brown, soft, dry; sandy SILT.								6.0	ML	
									5.9		
				Haliburton Quik-Grout (9 x 50-lb bags; 270-315 gal water)				100	5.8	SANDSTONE	
40	Dark brown, low strength, silty SANDSTONE.							100	7.4	SANDSTONE	Ambient PID spiked to >150 ppm.
	Dark brown; moderate to high strength, fractured, dry, silty SANDSTONE.								9.5		
									7.0		
										SANDSTONE	
	Light to dark yellowish brown (10YR 4/2), medium high strength, moist, silty SANDSTONE.							100	7.0		
45									10.0		Stopped drilling for 11/14/2016.
	Light olive gray (5Y 5/2); firm, slightly moist, SILT with some clay.								7.7	ML	
	Moderate yellow, soft, dry, SILT with some sand; oxidation around some sand grains.								7.2	ML	Ambient PID reading 0.0-0.7 ppm.
								100	6.5		
50									6.9		
									4.6		
	Moderate yellow, high strength, fractured, dry, SILTSTONE.								6.8	SILTSTONE	
									4.6		
	Moderate yellow, loose, dry, silty, subangular SAND.							100	7.6	SM	
55									8.2		
									11	SANDSTONE	
	Dark yellowish brown (10YR 4/4) grades to yellow (10YR 7/6), very low strength, fractured, silty SANDSTONE with some bedding.								4.8		
60								100			

CONTRACTOR Cascade **NORTHING** 689425.300
EQUIPMENT See Remarks **EASTING** 7700452.080
DRILL MTHD Sonic **ANGLE** Vertical
DIAMETER 10"(0-30') 9"(30-80') 8"(80-114') **BEARING** ----
LOGGER D. M-L **REVIEWER** C. Bartlett **PRINTED** 03/15/17

REMARKS: Equipment: Boar Longyear Mini Sonic w/ 5' tooling to 82.5'
(11/14-11/15); Mini Sonic w/ 10' tooling could not advance (11/16); Pro
Sonic to final depth (11/18& 11/21); Well Tag # L118625

COORDINATE SYSTEM:
SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

GS FORM:
CORE3 10/00

BOREHOLE LOG

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOLIC LOG	WELL LOG	WELL CONSTRUCTION MATERIAL	ELEVATION (ft)	SAMPLES				USCS Classification	COMMENTS
						SAMPLE NAME	TYPE	% RECOVERY	PID READING (ppm)		
	60' - 3 to 4" cylinder of high strength, silty SANDSTONE.								5.7		
									4.6		
								100	5.7		Drill sticking; added water.
								100			
65	Yellow (10YR 7/6), loose, moist, silty SAND.								1.5	SM	
									1.5		
	Yellow (10YR 7/6), loose, dry, silty SAND.								1.0	SM	
70	Yellowish gray (5Y 7/2), soft, moist, SILT with some sand; no clay.							100	1.8	ML	
									0.9		
	71-72' - Silt increases and sand grains fine.										
	Moderate olive brown (5Y 5/6) to moderate yellowish brown (10YR 5/4), very loose, dry, silty SAND.								1.0	SM	
									1.5		
								100	1.5		
75	Dark brown to lighter brown, loose, moist, medium-grained, angular SAND with some silt and clay.								1.4	SM	
									1.6		
									2.0		
									2.1		
									2.0		
80	80-85' - Alternates between loose SAND to vitric SANDSTONE.							100	4.1		
									3.0		
									10.1		Begin logging 11/21/2016; 9" casing ends and 8" begins.
									21.0		
									5.9		Drill is stuck at 82.5'.
									30.9		
85	Yellow brown, friable to dense, dry, silty SAND and SANDSTONE; medium-grained, angular sand with visible bedding in sandstone.								4.5	SM	
									10.1		
									5.6		
									9.2		
									12.8		
									5.3		
									8.2		
90								130			

Colorado 20/40
Sand (2 x 50lb
bags)

Filter Pack =
Colorado 10/40
Silica Sand (13 x
50lb bags)

CONTRACTOR Cascade
EQUIPMENT See Remarks
DRILL MTHD Sonic
DIAMETER 10"(0-30') 9"(30-80') 8"(80-114')
LOGGER D. M-L
NORTHING 689425.300
EASTING 7700452.080
ANGLE Vertical
BEARING -----
REVIEWER C. Bartlett
PRINTED 03/15/17

REMARKS: Equipment: Boar Longyear Mini Sonic w/ 5' tooling to 82.5' (11/14-11/15); Mini Sonic w/ 10' tooling could not advance (11/16); Pro Sonic to final depth (11/18& 11/21); Well Tag # L118625

COORDINATE SYSTEM:
SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

621 SW Morrison Street, Suite 600
Portland, Oregon 97205
Phone: 503.222.9518

BORING **VMW-A**

SHEET 4 OF 4

START DATE 11/14/2016

Elevation FT. MSL

FINISH DATE 11/21/2016

PROJECT Cascade Corporation

LOCATION 2525 NE 201st; Fairview, OR

PROJECT NUMBER PNG0564S16

GS FORM:
CORE3 10/00

BOREHOLE LOG

[illegible]

CONTRACTOR	Cascade	NORTHING	689425.300
EQUIPMENT	See Remarks	EASTING	7700452.080
DRILL MTHD	Sonic	ANGLE	Vertical
DIAMETER	10"(0-30") 9"(30-80") 8"(80-114")	BEARING	-----
LOGGER D. M-L	REVIEWER C. Bartlett	PRINTED	03/15/17

REMARKS: Equipment: Boar Longyear Mini Sonic w/ 5' tooling to 82.5 (11/14-11/15); Mini Sonic w/ 10' tooling could not advance (11/16); Pro Sonic to final depth (11/18& 11/21); Well Tag # L118625

COORDINATE SYSTEM:
SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

3BORING LOG W/WELL SONIC (PORTLAND) PNG0564S16.GPJ EED DEFAULT GINT LIBRARY.GLB 3/15/17

GS FORM:
CORE3 10/00

BOREHOLE LOG

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOLIC LOG	WELL LOG	WELL CONSTRUCTION MATERIAL	ELEVATION (ft)	SAMPLES				USCS Classification	COMMENTS
						SAMPLE NAME	TYPE	% RECOVERY	PID READING (ppm)		
	Dark brown black, loose, moist, Silty GRAVEL; organics.									GM	
	Dark clasts in dark yellow-brown matrix, soft, moist, SILT with some sand and cobbles (basalt).									ML	
	3' - 4" thick layer of sand.										
5	5' - 6" diameter cobble										
	Grayish brown (10YR 5/2), loose, well-graded, medium-grained SAND with some sub-angular to rounded gravel and cobbles. Transitions to silty SAND.							100		SW-SM	Drill hit something hard; stopped to verify well location.
	Olive gray (5Y 5/2), medium dense, SILT with some sand and gravel.									ML	
10	Grayish brown (2.5Y 5/2), loose, silty SAND (% silt and sand vary) with trace coarse, rounded gravel.									SM	
	12' - Oxidation.										
15											
	Tan gray, medium stiff to very stiff, dry, medium-grained, sandy SILT; saprolitic siltstone.							100		ML	
20											
	Blue gray, hard, dry, SILT.			4" Sch 40 PVC well casing				100		ML	
25											
	28-29' - Mottled tan and blue gray SILT.										
	Blue gray, firm, moist, SILT with some sand; some thin zones of oxidation.							100		ML	Set bentonite seal from 25'-30'.
30											

CONTRACTOR Cascade **NORTHING** 689382.110
EQUIPMENT Pro Sonic Rig **EASTING** 7700646.220
DRILL MTHD Sonic **ANGLE** Vertical
DIAMETER 10"(0-30') 8"(30-110') **BEARING** ----
LOGGER D. M-L **REVIEWER** C. Bartlett **PRINTED** 03/15/17

REMARKS: Well Tag # L118636

COORDINATE SYSTEM:
SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

GS FORM:
CORE3 10/00

BOREHOLE LOG

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOLIC LOG	WELL LOG	WELL CONSTRUCTION MATERIAL	ELEVATION (ft)	SAMPLES				USCS Classification	COMMENTS
						SAMPLE NAME	TYPE	% RECOVERY	PID READING (ppm)		
	Red brown, dense to very dense, fractured, silty SANDSTONE; concretions.										
35	34-37' - Very dense SANDSTONE.							100		SANDSTONE	
	37-41.5' - Grades into dark red brown, alternating between friable and medium high strength, silty SANDSTONE.			Haliburton Quik-Grout (7 x 50-lb bags; 210-245 gal water)				100		SANDSTONE	Telescoped casing from 10" to 8"; 7" sampler.
40	Blue gray, medium high strength, silty SANDSTONE.							100			
45	Red brown, very loose or friable, silty SAND to SANDSTONE (zones of fractured rock).							100		SM	
	Red brown, very hard, SILT.									ML	
50	Red brown, loose, angular SAND with some silt.									SM	
	Red brown, loose, sandy SILT.									ML	
	Grayish yellow, very soft to soft, moist, SILT with some sand (increases with depth) and clay (color reddens with depth); oxidized concentrations.									ML	
55								100			
60											

CONTRACTOR Cascade
EQUIPMENT Pro Sonic Rig
DRILL MTHD Sonic
DIAMETER 10"(0-30') 8"(30-110')
LOGGER D. M-L
NORTHING 689382.110
EASTING 7700646.220
ANGLE Vertical
BEARING ----
PRINTED 03/15/17

REMARKS: Well Tag # L118636

COORDINATE SYSTEM:
SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

GS FORM:
CORE3 10/00

BOREHOLE LOG

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOLIC LOG	WELL LOG	WELL CONSTRUCTION MATERIAL	ELEVATION (ft)	SAMPLES				USCS Classification	COMMENTS	
						SAMPLE NAME	TYPE	% RECOVERY	PID READING (ppm)			
	62' - Two, 4" long cores.											
65	65' - Increased moisture and silt.							100	0.2	SANDSTONE	New PID (MiniRAE 3000); background reading: 0.1 ppm.	
	Grayish yellow, high strength, SANDSTONE.								0.3			
									0.3			
70	Blue gray, alternating moderate strength to loose, poorly-graded, small to medium-grained SANDSTONE.							100	0.4	SANDSTONE	Top of the TSA.	
									0.5			
	Yellow-tan to gray, loose, dry, coarse-grained, angular, silty SAND.								0.2			
									0.3			
									0.4			
75									0.1	SANDSTONE		
								100	0.2			
									0.2			
	Red brown, moderate strength, dry, coarse-grained, angular SANDSTONE.								0.2	SM		
									0.6			
									0.6			
80	Red brown, loose, moist, silty SAND with trace clay; some lithification.								0.2	SM		
	Red brown, dense, dry; silty SAND.								0.2			
									0.1			
				Colorado 20/40 Sand (2 x 50lb bags)				100	0.2	SM		
									0.2			
									0.3			
85	Tan to brown, loose to friable, dry, SAND and SANDSTONE.			Filter Pack = Premier Colorado 10/40 Silica Sand (11 x 50lb bags)					0.1			
									0.3			
									0.2			
								100	0.2			
									0.2			
									0.3			
90									0.4			

Colorado 20/40
Sand (2 x 50lb
bags)

Filter Pack =
Premier Colorado
10/40 Silica Sand
(11 x 50lb bags)

CONTRACTOR Cascade
EQUIPMENT Pro Sonic Rig
DRILL MTHD Sonic
DIAMETER 10"(0-30') 8"(30-110')
LOGGER D. M-L
NORTHING 689382.110
EASTING 7700646.220
ANGLE Vertical
BEARING ----
PRINTED 03/15/17
REVIEWER C. Bartlett

REMARKS: Well Tag # L118636

COORDINATE SYSTEM:
SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

GS FORM:
CORE3 10/00

BOREHOLE LOG

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOLIC LOG	WELL LOG	WELL CONSTRUCTION MATERIAL	ELEVATION (ft)	SAMPLES				USCS Classification	COMMENTS
						SAMPLE NAME	TYPE	% RECOVERY	PID READING (ppm)		
95	Gray, medium dense, silty SAND with trace sub-rounded gravel (<5%).			4" Sch 40 PVC 0.01" slotted well screen				100	0.7 0.3 0.6 0.2 0.4 0.7 0.7 0.6	SM	Screen: 84.5-104.5'.
	Gray, firm, sandy SILT.							100	0.6 0.3 0.5 0.5 0.6 0.5 0.1	ML SM	
100	Light brown, dense, dry, silty, coarse SAND (% silt and sand vary); cemented.										
105	Gray, moist to wet, well-graded, subrounded, silty SAND to silty GRAVEL.					VMW-16GW; 11/23/16 @ 1655		95	0.1 0.1 0.1 1.2 0.3 0.2	SM-GM	From 105-110' PID readings are not from discrete samples, but from moving PID across the core. DTW: 105.1' at time of drilling.
	108' - 6" thick SILTSTONE							100			
110	End of boring on 11/23/2016			Backfill = Haliburton Quik-Grout (5-6 gal of grout)							

CONTRACTOR Cascade
EQUIPMENT Pro Sonic Rig
DRILL MTHD Sonic
DIAMETER 10"(0-30') 8"(30-110')
LOGGER D. M-L

NORTHING 689382.110
EASTING 7700646.220
ANGLE Vertical
BEARING ----
PRINTED 03/15/17

REMARKS: Well Tag # L118636

COORDINATE SYSTEM:
SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

GS FORM:
CORE3 10/00

BOREHOLE LOG

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOLIC LOG	WELL LOG	WELL CONSTRUCTION MATERIAL	ELEVATION (ft)	SAMPLES				USCS Classification	COMMENTS
						SAMPLE NAME	TYPE	% RECOVERY	PID READING (ppm)		
	Brown, firm, moist, sandy SILT.								0.0	ML	10" casing with a 7" sampler.
									0.0		
									0.1		
									0.1		
									0.1		
5	Brown, moist, well-graded, subrounded, sandy GRAVEL with trace silt and cobbles.							100	0.1	GW	
									0.1		
									0.1		
									0.1		
									0.1		
9	9' - Increasing cobbles.							100	0.1		
									0.1		
									0.1		
									0.1		
									0.1		
12	12' - Large cobbles.							100	0.4		
									0.2	ML	
	Gray, very stiff, moist, sandy SILT.								0.2	GM	
	Brown, wet, subrounded, sandy GRAVEL with trace cobbles.								0.1		
15								100	0.0	SW	
	Brown, wet, fine to medium-grained, subrounded, SAND and SANDSTONE with trace gravel.								1.0		
									0.3		
	16-17' - SANDSTONE.								1.0	ML	
	Brown, firm, dry, SILT with trace fine sand.								0.2		
20	20' - Moist.			4" Sch 40 PVC well casing					0.1		
									0.1		Top of Confining Unit 1 (CU1).
									0.1		
	Brown, very firm, dry, SILTSTONE.								0.0	SILTSTONE	
25									0.0		
									0.0		
	Brown, firm, dry, SILT with trace fine sand.									ML	Heavy rain; PID not working.
										ML	
	Blue gray (5B 5/1), wet (27-28') to moist (28-32'), hard, SILT with trace gravel.							100			
30											Bentonite seal from 25.0-30.5'.

CONTRACTOR Cascade **NORTHING** 689400.310
EQUIPMENT Pro Sonic Rig **EASTING** 7700355.210
DRILL MTHD Sonic **ANGLE** Vertical
DIAMETER 10"(0-30') 8"(30-110') **BEARING** ----
LOGGER J. Dahl **REVIEWER** C. Bartlett **PRINTED** 03/15/17

REMARKS: Well Tag # L122478

COORDINATE SYSTEM:
SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

GS FORM:
CORE3 10/00

BOREHOLE LOG

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOLIC LOG	WELL LOG	WELL CONSTRUCTION MATERIAL	ELEVATION (ft)	SAMPLES				USCS Classification	COMMENTS
						SAMPLE NAME	TYPE	% RECOVERY	PID READING (ppm)		
	Dark brown with blue motteling, hard, moist, SILT.								1.3 1.5 1.7	ML	End of drilling 11/28/16; resumed 11/29; 8" casing with 7" sampler.
	Reddish brown (5YR 3/4), hard to very hard, dry, silty SAND with thin layers SANDSTONE .								1.0 2.1	SM	
35	Reddish brown (5YR 3/4), loose to fractured, dry; SILTSTONE and SANDSTONE with trace of angular to subangular gravel (basalt).							100	2.2 1.0 2.8	SILTSTONE	
	Dark brown, moist, very fine-grained, silty SAND.			Haliburton Quik-Grout (9 x 50-lb bags; 270-315 gal water)					1.9 3.2 4.1	SM	
40	Brown, moist, SANDSTONE with trace silt.								3.8 2.9 2.0	SANDSTONE	
									2.0 1.6		
45									0.9 1.3 1.1		
									1.4 1.6		
	Brown, medium high strength, dry, silty SANDSTONE.								1.7 2.0 2.2	SANDSTONE	
									2.0	ML	
55	Light gray (5BG 5/2), soft, moist, SILT.								0.4	ML	Top of Troutdale Sandstone Aquifer (TSA).
	Light bluish brown, very hard, moist, SILT.								1.1	SANDSTONE	
	Reddish brown, high strength, moist, SANDSTONE.							100	1.5		
									3.1		
60											

CONTRACTOR Cascade
EQUIPMENT Pro Sonic Rig
DRILL MTHD Sonic
DIAMETER 10"(0-30') 8"(30-110')
LOGGER J. Dahl
NORTHING 689400.310
EASTING 7700355.210
ANGLE Vertical
BEARING ----
PRINTED 03/15/17

REMARKS: Well Tag # L122478

COORDINATE SYSTEM:
SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

GS FORM:
CORE3 10/00

BOREHOLE LOG

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOLIC LOG	WELL LOG	WELL CONSTRUCTION MATERIAL	ELEVATION (ft)	SAMPLES				USCS Classification	COMMENTS
						SAMPLE NAME	TYPE	% RECOVERY	PID READING (ppm)		
65	Brown, high strength, dry, sandy SILTSTONE.							100	1.7	SILTSTONE	
									1.3		
									3.1		
									3.1		
									2.2		
									1.8		
									1.8		
									1.9		
									2.1		
									2.0		
70								100	2.4	SILTSTONE	
									2.4		
									2.0		
									1.8		
									1.7		
									2.0		
									2.5		
									1.9		
									2.8		
									2.2		
75	Light brown, loose, dry, silty SAND; weakly cemented.							100	2.1	SM	
									1.8		
									1.7		
									2.0		
									2.5		
									1.9		
									2.8		
									2.2		
									2.1		
									1.8		
80	Brown, dense, dry, silty SAND; cemented.							100	1.9	SM	
									3.4		
									2.4		
									2.5		
									2.1		
									1.1		
									1.6		
									1.2		
									2.1		
									1.1		
85	Brown, medium high strength, dry, SANDSTONE.			Colorado 20/40 Sand (2 x 50lb bags)				100	1.7	SANDSTONE	
									2.0		
									2.5		
									1.9		
									2.8		
									2.2		
									2.1		
									1.8		
									1.9		
									3.4		
90	Black, medium high strength, dry, SANDSTONE with trace silt.			Filter Pack = Colorado 10/40 Silica Sand (10 x 50lb bags)				100	2.4	SANDSTONE	
									2.4		
									2.5		
									2.1		
									1.1		
									1.6		
									1.2		
									2.1		
									1.1		
									1.6		
90	Light brown, medium high strength, dry, SANDSTONE with some silt (20-30%).							100	1.7	SANDSTONE	
									1.3		
									3.1		
									3.1		
									2.2		
									1.8		
									1.8		
									1.9		
									2.1		
									2.0		
90	Gray, medium to high strength, moist, SANDSTONE with trace silt (10-20%).							100	2.4	SANDSTONE	
									2.4		
									2.0		
									1.8		
									1.7		
									2.0		
									2.5		
									1.9		
									2.8		
									2.2		
90	Light brownish gray to dark brownish gray (10YR 6/2 - 10YR 4/2), medium high strength, dry, well-graded, fine to medium-grained SANDSTONE; cemented.							100	2.1	SANDSTONE	
									1.8		
									1.9		
									3.4		
									2.4		
									2.5		
									2.1		
									1.1		
									1.6		
									1.2		

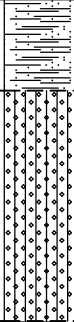
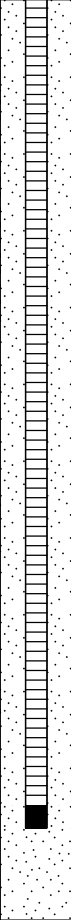
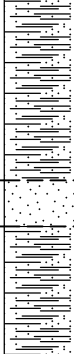
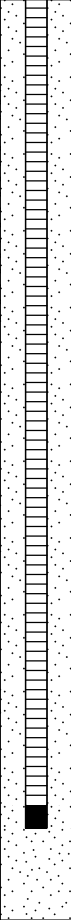
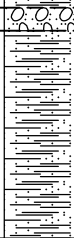
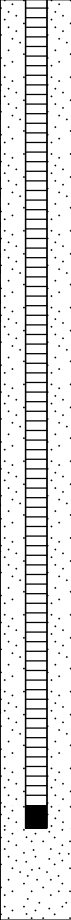
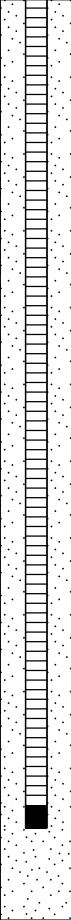
CONTRACTOR Cascade
EQUIPMENT Pro Sonic Rig
DRILL MTHD Sonic
DIAMETER 10"(0-30') 8"(30-110')
LOGGER J. Dahl
NORTHING 689400.310
EASTING 7700355.210
ANGLE Vertical
BEARING ----
PRINTED 03/15/17

REMARKS: Well Tag # L122478

COORDINATE SYSTEM:
SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

GS FORM:
CORE3 10/00

BOREHOLE LOG

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOLIC LOG	WELL LOG	WELL CONSTRUCTION MATERIAL	ELEVATION (ft)	SAMPLES				USCS Classification	COMMENTS
						SAMPLE NAME	TYPE	% RECOVERY	PID READING (ppm)		
95	Light brownish gray to dark brownish gray (10YR 6/2 - 10YR 4/2), very dense, moist, fine to medium-grained, silty SAND. 93' - Thin, brittle layers of siltstone. 94' - Dry. 95' - Very dense; vitric.			4" Sch 40 PVC 0.01" slotted well screen				100	1.5	SM	Screen: 87.5 - 107.5'.
									1.2		
									1.6		
									2.1		
									2.3		
									1.2		
									2.0		
									2.4		
									2.8		
									3.5		
100	Light brownish gray (10YR 6/2), medium high strength, SANDSTONE; streaks of oxidation. Grayish brown (10YR 5/2), moderate strength, moist, fine to medium-grained SAND. Brown to black, moderate strength, moist, SANDSTONE with trace silt.			4" Sch 40 PVC 0.01" slotted well screen				100	2.4	SANDSTONE	Screen: 87.5 - 107.5'.
									2.4		
									4.8		
									2.2		
									2.0		
									2.1		
									1.9		
									1.0		
									1.2		
									1.5		
105	Black, wet, medium to coarse-grained SAND. Brown, moist, medium high strength, fine to medium-grained SANDSTONE.			4" Sch 40 PVC 0.01" slotted well screen				100	1.4	SW SANDSTONE	DTW: 107.3' at time of drilling.
110	End of boring on 11/29/2016			4" Sch 40 PVC 0.01" slotted well screen				100		Entire boring completed without water.	

CONTRACTOR Cascade
EQUIPMENT Pro Sonic Rig
DRILL MTHD Sonic
DIAMETER 10"(0-30') 8"(30-110')
LOGGER J. Dahl
NORTHING 689400.310
EASTING 7700355.210
ANGLE Vertical
BEARING ----
PRINTED 03/15/17

REMARKS: Well Tag # L122478

COORDINATE SYSTEM:
SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

GS FORM:
CORE3 10/00

BOREHOLE LOG

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOLIC LOG	WELL LOG	WELL CONSTRUCTION MATERIAL	ELEVATION (ft)	SAMPLES				USCS Classification	COMMENTS
						SAMPLE NAME	TYPE	% RECOVERY	PID READING (ppm)		
	FILL								1.2	FILL	10" casing with a 7" sampler.
	Dark brown, soft, moist, sandy SILT; trace organics.								1.0	ML	
	Reddish brown, firm, moist, SILT with trace sand.								1.2	ML	
									1.1		
5	Reddish brown, wet, silty GRAVEL with a trace sand. 5' - Boulder.							100	0.7	GM	
									1.7		
	Reddish brown, loose, moist, well-graded, sandy GRAVEL; subrounded gravels.							100	1.5	GW	
									2.1	ML	
	Brownish red, wet, gravely SILT.								2.0	GW	
10	Reddish brown, loose, moist, well-graded, sandy GRAVEL; subrounded gravels.								1.2		
									3.3		
								100	2.3		
									2.1	ML	
	Brown, hard, moist, sandy SILT.							100	2.0		
15									2.3	SANDSTONE	
	Brown, high strength, SANDSTONE.								2.5	SM	
	Brown, loose, moist, SAND with trace subrounded gravel.							100	1.7		
									2.2	ML	
	Brown, very hard, dry, sandy SILT; cementation.								2.3		
20									2.0		
									1.9		
									1.6		
									1.8	ML	
25	Gray, hard, dry, SILT.								1.6		Bentonite seal from 22-27'.
									1.4		
									1.7		
	26-28' - Grades to blue gray.							100	0.6		
									0.8		
30	29-34' - Grades to some brown mixed with blue gray.										

4" Sch 40 PVC
well casing

CONTRACTOR Cascade
EQUIPMENT Pro Sonic Rig
DRILL MTHD Sonic
DIAMETER 10"(0-30') 9"(30-80') 8"(80-110')
LOGGER J. Dahl
NORTHING 689303.350
EASTING 7700708.640
ANGLE Vertical
BEARING ----
REVIEWER C. Bartlett
PRINTED 03/15/17

REMARKS: Well Tag # L122498

COORDINATE SYSTEM:
SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

GS FORM:
CORE3 10/00

BOREHOLE LOG

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOLIC LOG	WELL LOG	WELL CONSTRUCTION MATERIAL	ELEVATION (ft)	SAMPLES				USCS Classification	COMMENTS
						SAMPLE NAME	TYPE	% RECOVERY	PID READING (ppm)		
									0.8		9" casing with a 7" sampler.
									2.0		
									0.7		
									0.8		
									1.8	SM	
35	Brown, dense, dry, silty SAND.								1.3	ML	
	Blue gray, hard, dry, SILT.								1.5	SANDSTONE	
	Brown to reddish brown, moderate strength, dry, poorly-graded, fine-grained, SANDSTONE.							100	1.6		
									1.6		
40				Haliburton Quik-Grout (9 x 50-lb bags; 270-315 gal water)					0.7		
									1.4		
								100	1.4		
									1.9		
	Reddish brown, firm, moist, SILT; medium plasticity.								2.0	ML	
45	Reddish brown, medium high strength, poorly-graded, fine-grained SANDSTONE.								1.3	SANDSTONE	
									1.4		
								100	1.8		
									1.2		
									1.4		
50	Brown, loose, wet, silty SAND; weak cementation.								1.2	SM	
									0.5		
									1.9		
									1.6		
									1.8	ML	
55	Brown, dense, dry, sandy SILT with trace fine-grained sand.								1.6		
									1.7		
								100	1.1	SP	
	Gray, dense, dry, poorly-graded, fine-grained SAND.								1.5		
60											

CONTRACTOR Cascade
EQUIPMENT Pro Sonic Rig
DRILL MTHD Sonic
DIAMETER 10"(0-30') 9"(30-80') 8"(80-110')
LOGGER J. Dahl
NORTHING 689303.350
EASTING 7700708.640
ANGLE Vertical
BEARING ----
REVIEWER C. Bartlett
PRINTED 03/15/17

REMARKS: Well Tag # L122498

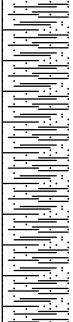
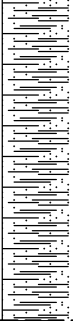
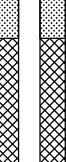
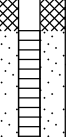
COORDINATE SYSTEM:
SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

621 SW Morrison Street, Suite 600
Portland, Oregon 97205
Phone: 503.222.9518

BORING **VMW-D** **SHEET 3 OF 4**
START DATE 12/1/2016 **Elevation** **FT. MSL**
FINISH DATE 12/5/2016
PROJECT Cascade Corporation
LOCATION 2525 NE 201st; Fairview, OR
PROJECT NUMBER PNG0564S16

GS FORM:
CORE3 10/00

BOREHOLE LOG

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOLIC LOG	WELL LOG	WELL CONSTRUCTION MATERIAL	ELEVATION (ft)	SAMPLES				USCS Classification	COMMENTS
						SAMPLE NAME	TYPE	% RECOVERY	PID READING (ppm)		
65	Reddish brown, high strength, dry, silty SANDSTONE.							100	1.6	SANDSTONE	Top of Troutdale Sandstone Aquifer (TSA).
	1.8										
	1.6										
	1.5										
	1.6										
70	Brown, high strength, dry, SANDSTONE.							100	0.6	SANDSTONE	Drill stuck; water used.
	0.0										
	0.2										
	0.1										
	0.0										
75	Gray, subrounded, sandy GRAVEL with trace cobbles (basalt - some vesicular).							100	0.1	GW	Core stuck in barrel; hammered until it released.
	2.3										
	1.7										
	2.1										
	1.9										
80	Dark brown, high strength, dry, SANDSTONE.							100	0.8	SANDSTONE	Polymer used to break rod free; finished drilling to depth with water; samples are too wet for PID. 8" casing with a 7" sampler.
	1.3										
85	Dark brown, moderate strength, dry, SANDSTONE; weathered.			Colorado 20/40 Sand (2 x 50lb bags) Filter Pack = Colorado 10/40 Silica Sand (13 x 50lb bags)				100		SANDSTONE	
90	Dark brown, medium high strength, dry, SANDSTONE; weathered.							100	0.8	SANDSTONE	End of drilling 12/2/2016; resumed 12/5/2016.
	0.8										

CONTRACTOR	Cascade	NORTHING	689303.350
EQUIPMENT	Pro Sonic Rig	EASTING	7700708.640
DRILL MTHD	Sonic	ANGLE	Vertical
DIAMETER	10"(0-30") 9"(30-80") 8"(80-110")	BEARING	-----
LOGGER J. Dahl	REVIEWER C. Bartlett	PRINTED	03/15/17

REMARKS: Well Tag # L122498

COORDINATE SYSTEM:
SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

DRILLING LOG W/WELL SONIC (PORTLAND) PNG0564S16.GPJ EED DEFAULT GINT LIBRARY.GLB 3/15/17

GS FORM:
CORE3 10/00

BOREHOLE LOG

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOLIC LOG	WELL LOG	WELL CONSTRUCTION MATERIAL	ELEVATION (ft)	SAMPLES				USCS Classification	COMMENTS
						SAMPLE NAME	TYPE	% RECOVERY	PID READING (ppm)		
95	Dark brown, high strength, wet, well-graded, fine to coarse-grained SANDSTONE.			4" Sch 40 PVC 0.01" slotted well screen				100	2.2 1.8 1.8	SANDSTONE	Samples are too wet for PID.
97'	Becomes light brown.							100		SANDSTONE	Screen: 87.5 - 107.5'; DTW: unable to determine at time of drilling.
100	Dark brown, high strength, wet, SANDSTONE.							100			
105	Gray to brown, medium high strength, wet, fine to coarse-grained SANDSTONE.							100		SW	
107'	Becomes brown.							100	0.2 1.4 0.8		
110	End of boring on 12/5/2016										

CONTRACTOR Cascade **NORTHING** 689303.350
EQUIPMENT Pro Sonic Rig **EASTING** 7700708.640
DRILL MTHD Sonic **ANGLE** Vertical
DIAMETER 10"(0-30') 9"(30-80') 8"(80-110') **BEARING** -----
LOGGER J. Dahl **REVIEWER** C. Bartlett **PRINTED** 03/15/17

REMARKS: Well Tag # L122498

COORDINATE SYSTEM:
SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

Table E-1
Soil Vapor Extraction 1 January 2016 through 31 December 2016
TSA Remedy - East Multnomah County Oregon

Well ID	Date	Time (hrs)	Temperature (degrees F)	Flow Rate (scfm)	PID Measurement (ppm)	Calculated VOC Concentrations (µg/L)
Soil Vapor Extraction Outlet Well						
SVE System Outlet	1/5/2016	9:30	135	224.7	0.9	5.26
SVE System Outlet	1/11/2016	14:10	138	220.7	0.7	4.09
SVE System Outlet	1/18/2016	17:15	148	223.0	0.7	4.09
SVE System Outlet	1/26/2016	12:00	140	222.3	0.6	3.51
SVE System Outlet	2/1/2016	13:55	145	222.7	0.6	3.51
SVE System Outlet	2/9/2016	9:40	154	230.0	0.6	3.51
SVE System Outlet	2/16/2016	10:00	145	215.3	0.6	3.51
SVE System Outlet	2/23/2016	10:30	130	218.7	0.5	2.92
SVE System Outlet	3/1/2016	8:10	128	212.7	0.6	3.51
SVE System Outlet	3/8/2016	10:00	125	223.7	0.6	3.51
SVE System Outlet	3/15/2016	11:40	125	230.7	0.6	3.51
SVE System Outlet	3/22/2016	9:40	128	233.0	0.5	2.92
SVE System Outlet	3/29/2016	9:50	134	229.3	0.7	4.09
SVE System Outlet	4/5/2016	9:30	130	219.3	0.5	2.92
SVE System Outlet	4/11/2016	15:00	138	216.6	0.7	4.09
SVE System Outlet	4/19/2016	8:15	150	219.7	0.4	2.34
SVE System Outlet	4/26/2016	8:30	138	225.0	0.7	4.09
SVE System Outlet	5/3/2016	9:50	150	229.0	0.6	3.51
SVE System Outlet	5/10/2016	12:00	152	224.0	0.7	4.09
SVE System Outlet	5/17/2016	9:00	138	221.3	0.8	4.68
SVE System Outlet	5/24/2016	10:50	138	221.0	0.8	4.68
SVE System Outlet	5/31/2016	9:40	147	211.0	0.4	2.34
SVE System Outlet	6/7/2016	8:00	135	217.3	0.4	2.34
SVE System Outlet	6/13/2016	8:00	128	214.7	0.4	2.34
SVE System Outlet	6/21/2016	7:30	130.1	224.0	0.6	3.51
SVE System Outlet	6/28/2016	6:50	130	217.3	0.8	4.68
SVE System Outlet	7/4/2016	13:00	140	220.0	0.6	3.51
SVE System Outlet	7/12/2016	14:00	144	224.3	0.6	3.51
SVE System Outlet	7/19/2016	8:10	130	217.7	0.7	4.09
SVE System Outlet	7/26/2016	11:40	145	224.0	0.5	2.92
SVE System Outlet	8/2/2016	9:50	135	224.3	0.5	2.92
SVE System Outlet	8/9/2016	10:10	138	224.0	0.4	2.34
SVE System Outlet	8/16/2016	9:40	140	221.3	0.5	2.92
SVE System Outlet	8/24/2016	13:30	160	222.7	0.5	2.92
SVE System Outlet	8/30/2016	10:40	130	220.3	0.5	2.92
SVE System Outlet	9/6/2016	9:50	130	221.3	0.5	2.92
SVE System Outlet	9/13/2016	14:00	150	220.3	0.5	2.92
SVE System Outlet	9/20/2016	10:00	138	220.0	0.5	2.92
SVE System Outlet	9/27/2016	9:10	135	222.7	0.5	2.92

Table E-1
Soil Vapor Extraction 1 January 2016 through 31 December 2016
TSA Remedy - East Multnomah County Oregon

Well ID	Date	Time (hrs)	Temperature (degrees F)	Flow Rate (scfm)	PID Measurement (ppm)	Calculated VOC Concentrations (µg/L)
Soil Vapor Extraction Outlet Well						
SVE System Outlet	10/4/2016	10:40	130	216.7	0.5	2.92
SVE System Outlet	10/11/2016	9:40	135	218.7	0.5	2.92
SVE System Outlet	10/18/2016	17:00	125	221.3	0.5	2.92
SVE System Outlet	10/27/2016	13:30	125	226.5	0.5	2.92
SVE System Outlet	11/2/2016	8:30	125	220.4	0.5	2.92
SVE System Outlet	11/8/2016	9:00	125	220.7	0.5	2.92
SVE System Outlet	11/15/2016	11:50	124	211.0	0.5	2.92
SVE System Outlet	11/23/2016	11:30	118	212.5	0.5	2.92
SVE System Outlet	11/29/2016	10:50	115	215.6	0.5	2.92
SVE System Outlet	12/5/2016	13:00	115	216.2	0.5	2.92
SVE System Outlet	12/14/2016	11:10	110	332.5	4.9	28.64
SVE System Outlet	12/20/2016	13:00	125	487.5	2.8	16.37
SVE System Outlet	12/28/2016	11:30	120	480.0	2.5	14.61

Notes:

ID = identification

hrs = hours

F = Fahrenheit

scfm = standard cubic feet per minute

ppm = parts per million

µg/L = micrograms per Liter

VOC = volatile organic compounds

Bold text indicates sampling dates for data shown on Table E-2

Calculated VOC concentrations are based on PID readings

Flow rates increased on 12/14/16 due to new wells online

Table E-2
Soil Vapor Extraction - Laboratory VOC Results
TSA Remedy - East Multnomah County Oregon

Well ID	Date	cis-1,2-dichloroethene ($\mu\text{g}/\text{m}^3$)	Trichloroethene ($\mu\text{g}/\text{m}^3$)	Tetrachloroethene ($\mu\text{g}/\text{m}^3$)	Total VOCs ($\mu\text{g}/\text{m}^3$)	Flow Rate (scfm)
System Outlet	1/26/16	160	2,100	170	2,430	222.3
	2/23/16	160	1,700	120	1,980	218.7
	3/15/16	140	1,800	140	2,080	230.7
	4/27/16	140	1,800	130	2,070	225.0
	5/24/16	140	1,900	170	2,210	221.0
	6/21/16	150	1,700	110	1,960	224.0
	7/26/16	75	940	69	1,084	224.0
	8/24/16	96	1,100	84	1,280	222.7
	9/27/16	170	1,400	99	1,669	222.7
	10/27/16	130	1,600	120	1,850	226.5
	12/14/16	210	3,000	200	3,410	332.5
Well VW17D-42.5	1/26/16	1.1	1.1	1.1	3	24.6
	3/15/16	3	17	13	33	25.1
	6/21/16	72	440	25	537	24.3
Well VW17D-75	1/26/16	58.0	1,600.0	120.0	1,778	97.8
	3/15/16	52	550	93	695	99.4
	6/21/16	1	1	1	3	100.1
Well VW17D-95.5	1/26/16	160	2,100	170	2,430	100.3
	3/15/16	160	2,100	140	2,400	100.1
	6/21/16	170	1,800	140	2,110	102.1
	9/27/16	150	1,200	99	1,449	100.4
	12/14/16	7	71	5	83	103.7
Well VMW-A	12/14/16	590	9000	350	9940	139
Well VMW-B	12/14/16	49	1000	71	1120	132.8
Well VMW-C	12/14/16	5.7	73	3.6	82.3	142.55
Well VMW-D	12/14/16	360	9.5	440	809.5	141.35

Notes:

ID = identification

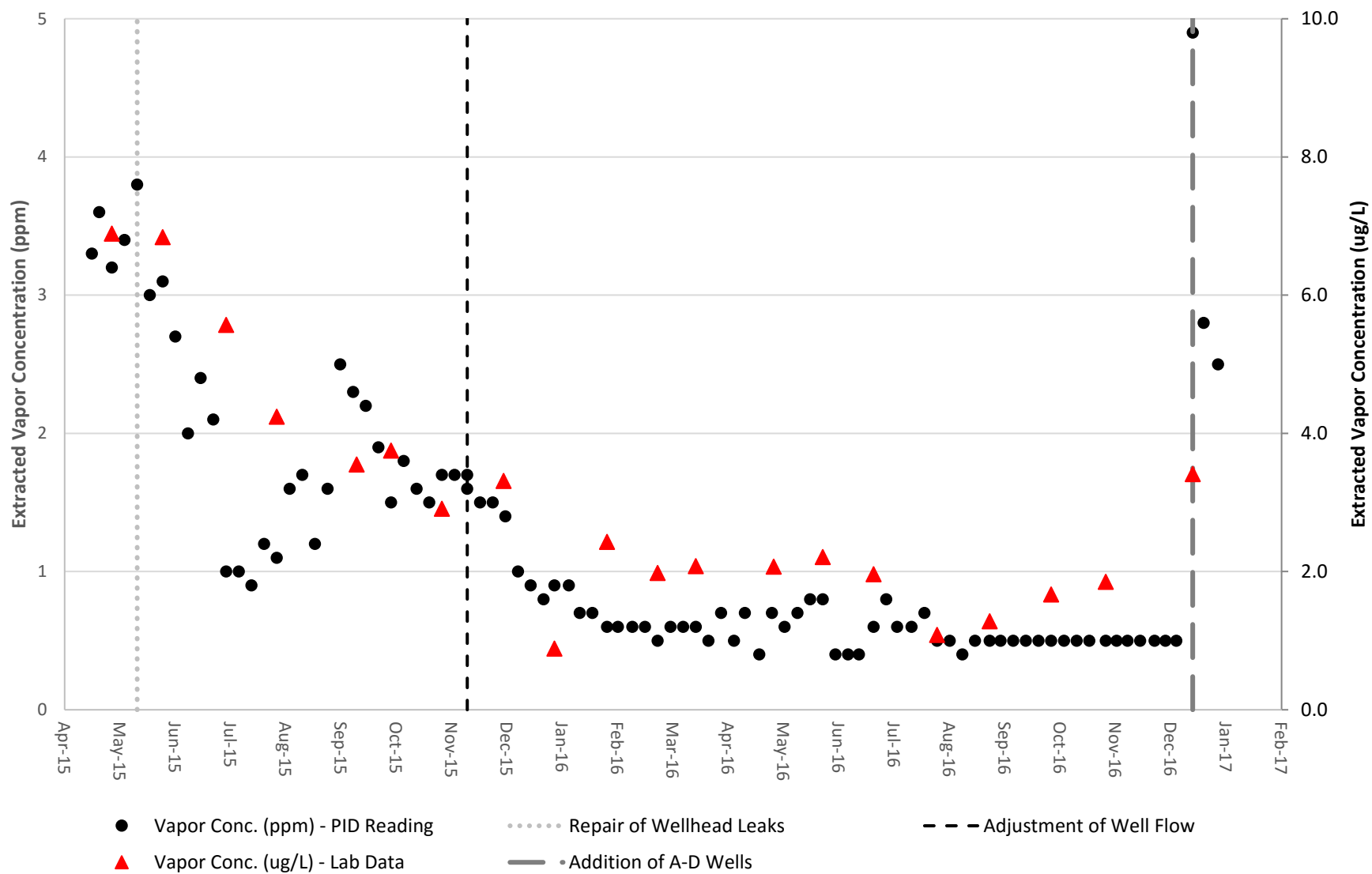
scfm = standard cubic feet per minute

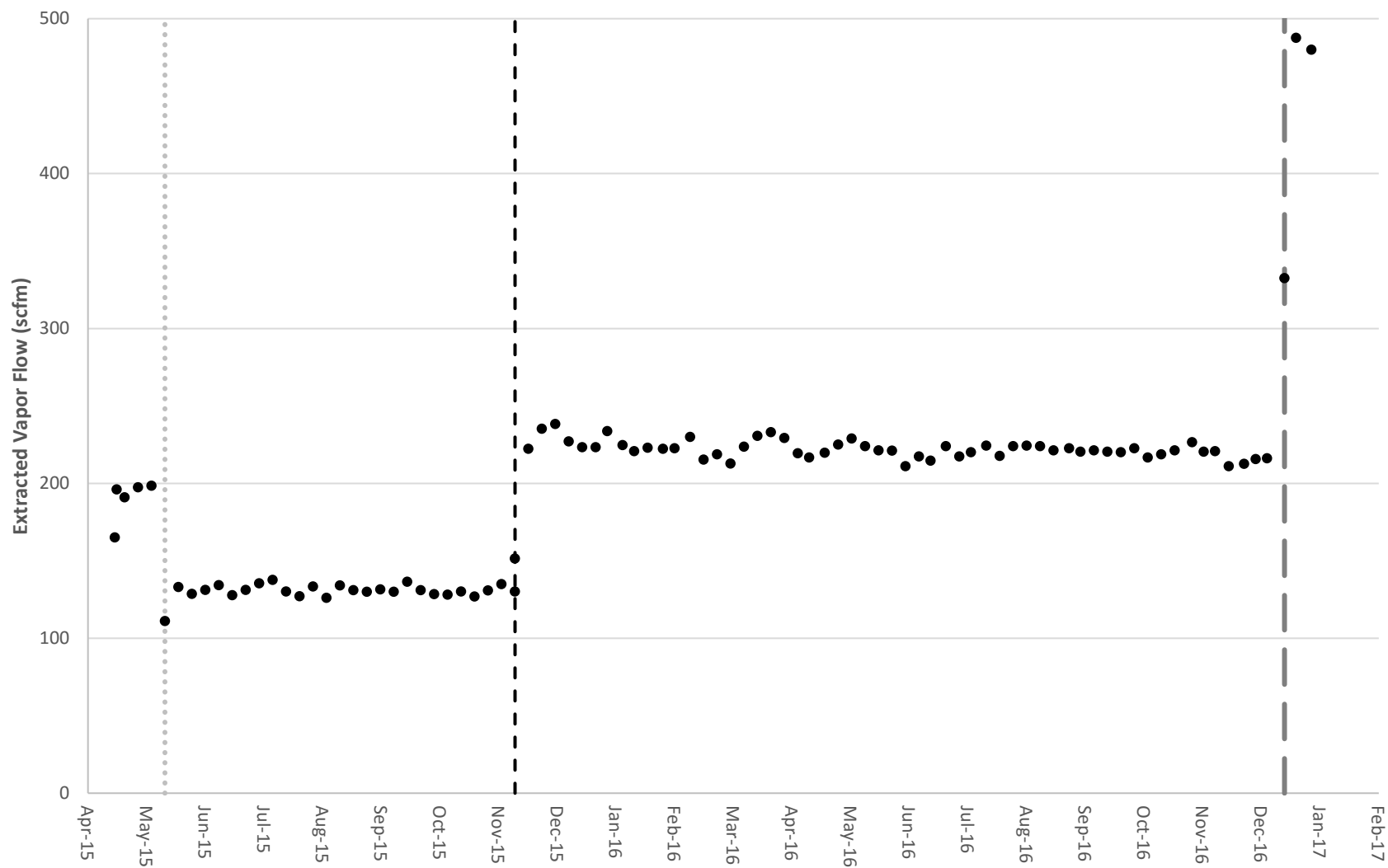
$\mu\text{g}/\text{m}^3$ = micrograms per cubic meter

VOC = volatile organic compounds

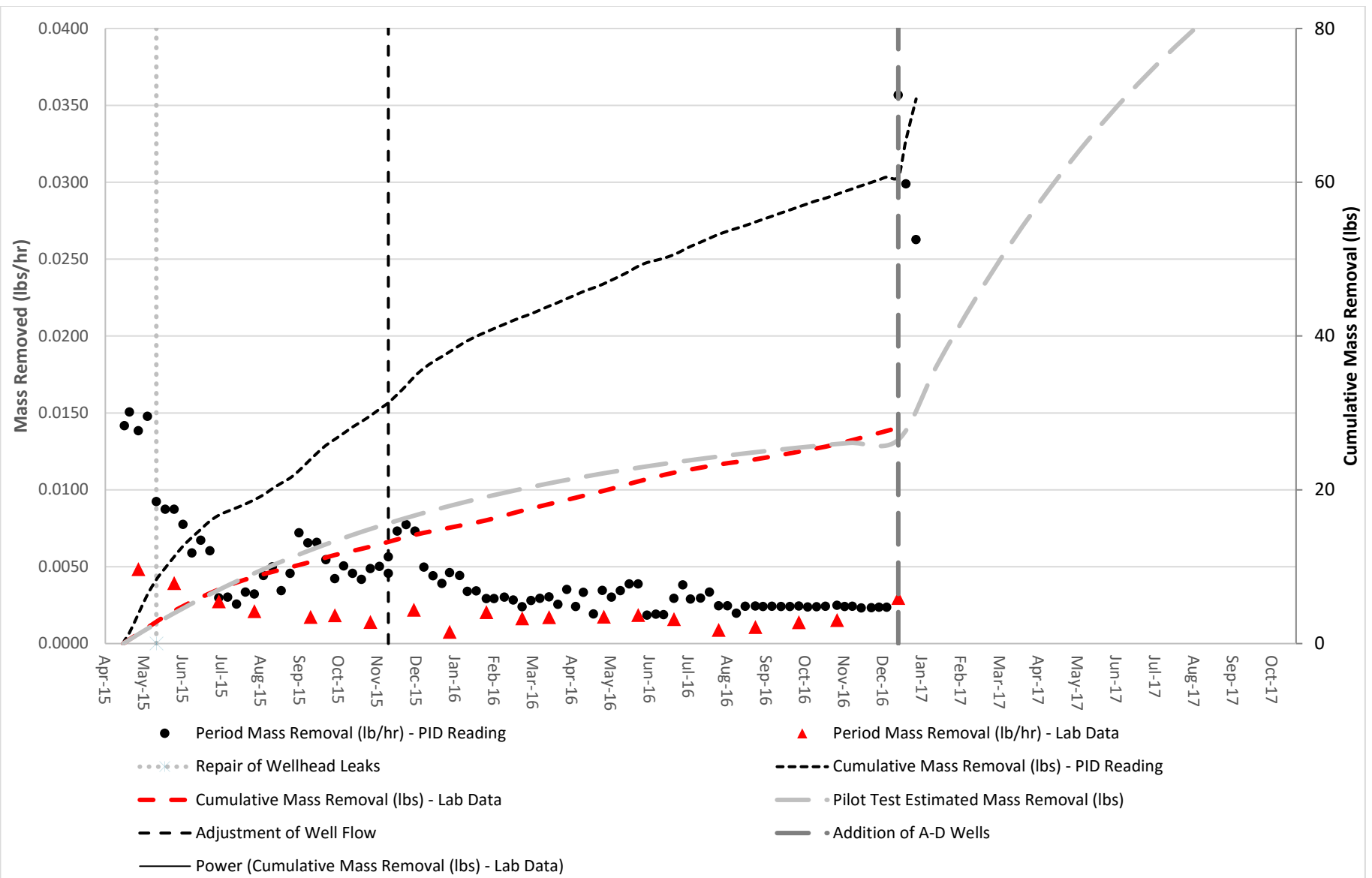
Total VOCs are the calculated sum of the three VOCs shown

Flow rates increased on 12/14/16 due to the four new wells online





● Extracted Vapor Flow (scfm)
 Repair of Wellhead Leaks
 --- Adjustment of Well Flow
 — Addition of A-D Wells



APPENDIX F

Data Validation Memoranda

Annual Reporting Period

Laboratory Reports (CD)

Historical Data Summary Tables – VOCs and
Groundwater Elevations (CD)

Technical Memorandum

TO: Chris Kimmel, Project Manager
FROM: Kristi Schultz and Anne Halvorsen
DATE: March 9, 2016
RE: **Boeing Portland (TSA)
First Quarter 2016 Groundwater Quality Sampling
Laboratory Data Quality Evaluation**

This technical memorandum provides the results of a focused data validation associated with 10 groundwater samples and 1 trip blank collected during the first quarter 2016 TSA water quality sampling event at Boeing Portland. Samples were analyzed by Eurofins Lancaster Laboratories Environmental LLC (LLI), located in Lancaster, Pennsylvania. This data quality evaluation covers LLI data package 1628887. Samples submitted to LLI were analyzed for volatile organic compounds ([VOCs] U.S. Environmental Protection Agency [EPA] Method SW8260C).

The verification and validation check was conducted with guidance from applicable portions of EPA's *National Functional Guidelines for Organic Data Review* (EPA 1999, 2008). The verification and validation check for each laboratory data package included the following:

- Verification that the laboratory data package contained all necessary documentation (including chain-of-custody records; identification of samples received by the laboratory; date and time of receipt of the samples at the laboratory; sample conditions upon receipt at the laboratory; date and time of sample analysis; explanation of any significant corrective actions taken by the laboratory during the analytical process; and, if applicable, date of extraction, definition of laboratory data qualifiers, all sample-related quality control data, and quality control acceptance criteria).
- Verification that all requested analyses, special cleanups, and special handling methods were performed.
- Evaluation of sample holding times.
- Evaluation of quality control data compared to acceptance criteria, including method blanks, surrogate recoveries, matrix spike results, laboratory duplicate and/or replicate results, and laboratory control sample results.
- Evaluation of overall data quality and completeness of analytical data.

Data validation qualifiers are added to the sample results, as appropriate, based on the verification and validation check. The absence of a data qualifier indicates that the reported result is acceptable without qualification. The data quality evaluation is summarized below. All data was found to be acceptable with no qualifications.

Chain-of-Custody Records

A signed chain-of-custody (COC) record was attached to the data packages. The laboratory received all samples in good condition. All analyses were performed as requested. No special cleanups or handling methods were requested.

Upon receipt by LLI, the sample container information was compared to the associated chain-of-custody and the cooler temperature was recorded. The cooler was received with a temperature within the EPA-recommended limit of $\leq 6^{\circ}\text{C}$. No qualification of the data was necessary.

Holding Times

For all analyses and all samples, the time between sample collection, extraction (if applicable), and analysis was determined to be within EPA- and project-specified holding times. No qualification of the data was necessary.

Blank Results

Laboratory Method Blanks

At least one method blank was analyzed with each batch of samples for VOCs analysis. No contamination was detected in the method blanks. No qualification of the data was necessary.

Field Trip Blanks and Field Equipment Blanks

One trip blank was submitted to the laboratory for VOC analysis with the sample batch. No contamination was detected in the trip blank. No qualification of the data was necessary. No field equipment blanks were submitted for analysis with this sample batch.

Surrogate Recoveries

Appropriate compounds were used as surrogate spikes for the VOCs analysis. Recovery values for the surrogate spikes were within the current laboratory-specified control limits. No qualification of the data was necessary.

Matrix Spike/Matrix Spike Duplicate (MS/MSD) and Laboratory Replicate Results

No matrix spike or laboratory duplicate samples were analyzed with this data package.

Laboratory Control Sample and Laboratory Control Sample Duplicate (LCS/LCSD) Results

At least one laboratory control sample and/or laboratory control sample duplicate (LCS/LCSD) was analyzed with each batch of samples for VOCs analysis. Recoveries and relative percent differences (RPDs) for the laboratory control samples and associated duplicates were within the current laboratory-specified control limits. No qualification of the data was necessary.

Blind Field Duplicate Results

One pair of blind field duplicate samples was submitted for VOC analysis: BOP-Z-0216/99BOP-13ds-0216.

A project-specified control limit of 20 percent was used to evaluate the RPDs between the duplicate water samples, except when the sample results were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus the reporting limit was used. RPDs for the duplicate sample pair submitted for analysis were within the project-specified control limits. No qualification of the data was necessary.

Quantitation Limits

Project-specified quantitation limits were met for all samples except for instances where high concentrations required dilution of the sample extracts.

Audit/Corrective Action Records

No audits were performed or required. No corrective action records were generated for this sample batch. Continuing calibration verification (CCV) recovery results were within laboratory-specified control limits.

Completeness and Overall Data Quality

The completeness for this data set is 100 percent, which meets the project-specified goal of 90 percent minimum.

Data precision was evaluated through laboratory control sample duplicates and blind field duplicates. Data accuracy was evaluated through laboratory control samples and surrogate spikes. No data were rejected.

LANDAU ASSOCIATES, INC.



Kristi Schultz
Assistant Scientist



Anne Halvorsen
Senior Project Scientist

ASH/kes

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EPA. 2008. *USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review*. USEPA-540-R-08-01. U.S. Environmental Protection Agency. Office of Superfund Remediation and Technology Innovation. Washington, D.C. June.

EPA. 1999. *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*. EPA-540/R-99-008. U.S. Environmental Protection Agency. Office of Emergency and Remedial Response. Washington, D.C. October.

Technical Memorandum

TO: Chris Kimmel, Project Manager
FROM: Kristi Schultz and Danille Jorgensen
DATE: July 6, 2016
RE: **Boeing Portland (TSA)
Second Quarter 2016 Groundwater Quality Sampling
Laboratory Data Quality Evaluation**

This technical memorandum provides the results of a focused data validation associated with 2 groundwater samples and 1 trip blank collected during the second quarter 2016 TSA water quality sampling event at Boeing Portland. Samples were analyzed by Eurofins Lancaster Laboratories Environmental LLC (LLI), located in Lancaster, Pennsylvania. This data quality evaluation covers LLI data package 1658053. Samples submitted to LLI were analyzed for volatile organic compounds ([VOCs] U.S. Environmental Protection Agency [EPA] Method SW8260C).

The verification and validation check was conducted with guidance from applicable portions of EPA's *National Functional Guidelines for Organic Data Review* (EPA 1999, 2008). Landau Associates performed an EPA-equivalent Level II verification and validation check on each laboratory data package, which included the following:

- Verification that the laboratory data package contained all necessary documentation (including chain-of-custody records; identification of samples received by the laboratory; date and time of receipt of the samples at the laboratory; sample conditions upon receipt at the laboratory; date and time of sample analysis; explanation of any significant corrective actions taken by the laboratory during the analytical process; and, if applicable, date of extraction, definition of laboratory data qualifiers, all sample-related quality control data, and quality control acceptance criteria).
- Verification that all requested analyses, special cleanups, and special handling methods were performed.
- Evaluation of sample holding times.
- Evaluation of quality control data compared to acceptance criteria, including method blanks, surrogate recoveries, matrix spike results, laboratory duplicate and/or replicate results, and laboratory control sample results.
- Evaluation of overall data quality and completeness of analytical data.

Data validation qualifiers are added to the sample results, as appropriate, based on the verification and validation check. The absence of a data qualifier indicates that the reported result is acceptable without qualification. The data quality evaluation is summarized below. All data was found to be acceptable with no qualifications.

Chain-of-Custody Records

A signed chain-of-custody (COC) record was attached to the data packages. The laboratory received all samples in good condition. All analyses were performed as requested. No special cleanups or handling methods were requested.

Upon receipt by LLI, the sample container information was compared to the associated chain-of-custody and the cooler temperature was recorded. The cooler was received with a temperature within the EPA-recommended limit of $\leq 6^{\circ}\text{C}$. No qualification of the data was necessary.

Holding Times

For all analyses and all samples, the time between sample collection, extraction (if applicable), and analysis was determined to be within EPA- and project-specified holding times. No qualification of the data was necessary.

Blank Results

Laboratory Method Blanks

At least one method blank was analyzed with each batch of samples for VOCs analysis. Target analytes were not detected at concentrations greater than the reporting limits in the associated method blanks. No qualification of the data was necessary.

Field Trip Blanks and Field Equipment Blanks

One trip blank was submitted to the laboratory for VOC analysis with the sample batch. Target analytes were not detected at concentrations greater than the reporting limits in the associated trip blank. No qualification of the data was necessary. No field equipment blanks were submitted for analysis with this sample batch.

Surrogate Recoveries

Appropriate compounds were used as surrogate spikes for the VOCs analysis. Recovery values for the surrogate spikes were within the current laboratory-specified control limits. No qualification of the data was necessary.

Matrix Spike/Matrix Spike Duplicate (MS/MSD) and Laboratory Replicate Results

No matrix spike or laboratory duplicate samples were analyzed with this data package.

Laboratory Control Sample and Laboratory Control Sample Duplicate (LCS/LCSD) Results

At least one laboratory control sample and/or laboratory control sample duplicate (LCS/LCSD) was analyzed with each batch of samples for VOCs analysis. Recoveries and relative percent differences

(RPDs) for the laboratory control samples and associated duplicates were within the current laboratory-specified control limits. No qualification of the data was necessary.

Blind Field Duplicate Results

No blind field duplicates were submitted for analysis with this sample batch.

Quantitation Limits

Project-specified quantitation limits were met for all samples except for instances where high concentrations required dilution of the sample extracts.

Audit/Corrective Action Records

No audits were performed or required. No corrective action records were generated for this sample batch. Based on the laboratory's case narrative, continuing calibration verification (CCV) recovery results were within laboratory-specified control limits.

Completeness and Overall Data Quality

The completeness for this data set is 100 percent, which meets the project-specified goal of 90 percent minimum.

Data precision was evaluated through laboratory control sample duplicates and blind field duplicates. Data accuracy was evaluated through laboratory control samples and surrogate spikes. No data were rejected.

LANDAU ASSOCIATES, INC.



Kristi Schultz
Data Specialist



Danille Jorgensen
Environmental Data Manager

DRJ/kes

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- EPA. 1999. USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review. edited by Office of Emergency and Remedial Response. Washington, DC: US Environmental Protection Agency.
- EPA. 2008. USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review. edited by Office of Superfund Remediation and Technology Innovation. Washington, DC: US Environmental Protection Agency.

Technical Memorandum

TO: Chris Kimmel, Project Manager
FROM: Kristi Schultz and Danille Jorgensen
DATE: September 13, 2016
RE: **Boeing Portland (TSA)**
Third Quarter 2016 Groundwater Quality Sampling
Laboratory Data Quality Evaluation

This technical memorandum provides the results of a focused data validation associated with 21 groundwater samples and 2 trip blanks collected during the third quarter 2016 TSA water quality sampling event at Boeing Portland. Samples were analyzed by Eurofins Lancaster Laboratories Environmental LLC (LLI), located in Lancaster, Pennsylvania. This data quality evaluation covers LLI data packages 1693903 and 1691408. Samples submitted to LLI were analyzed for volatile organic compounds ([VOCs]; US Environmental Protection Agency [EPA] Method SW8260C).

The verification and validation check was conducted with guidance from applicable portions of EPA's *National Functional Guidelines for Organic Data Review* (EPA 1999, 2008). Landau Associates performed an EPA-equivalent Level II verification and validation check on each laboratory data package, which included the following:

- Verification that the laboratory data package contained all necessary documentation (including chain-of-custody records; identification of samples received by the laboratory; date and time of receipt of the samples at the laboratory; sample conditions upon receipt at the laboratory; date and time of sample analysis; explanation of any significant corrective actions taken by the laboratory during the analytical process; and, if applicable, date of extraction, definition of laboratory data qualifiers, all sample-related quality control data, and quality control acceptance criteria).
- Verification that all requested analyses, special cleanups, and special handling methods were performed.
- Evaluation of sample holding times.
- Evaluation of quality control data compared to acceptance criteria, including method blanks, surrogate recoveries, matrix spike results, laboratory duplicate and/or replicate results, and laboratory control sample results.
- Evaluation of overall data quality and completeness of analytical data.

Data validation qualifiers are added to the sample results, as appropriate, based on the verification and validation check. The absence of a data qualifier indicates that the reported result is acceptable without qualification. The data quality evaluation is summarized below. Data validation qualifiers are summarized in Table 1.

Chain-of-Custody Records

A signed chain-of-custody (COC) record was attached to the data packages. The laboratory received all samples in good condition. All analyses were performed as requested. No special cleanups or handling methods were requested.

Upon receipt by LLI, the sample container information was compared to the associated chain-of-custody and the cooler temperatures were recorded. The coolers were received with temperatures within the EPA-recommended limit of $\leq 6^{\circ}\text{C}$. No qualification of the data was necessary.

Holding Times

For all analyses and all samples, the time between sample collection, extraction (if applicable), and analysis was determined to be within EPA- and project-specified holding times. No qualification of the data was necessary.

Blank Results

Laboratory Method Blanks

At least one method blank was analyzed with each batch of samples for VOCs analysis. Target analytes were not detected at concentrations greater than the reporting limits in the associated method blanks. No qualification of the data was necessary.

Field Trip Blanks and Field Equipment Blanks

One trip blank was submitted to the laboratory for VOC analysis with each sample batch. Target analytes were not detected at concentrations greater than the reporting limits in the associated trip blanks. No qualification of the data was necessary. No field equipment blanks were submitted for analysis with this sample batch.

Surrogate Recoveries

Appropriate compounds were used as surrogate spikes for the VOCs analysis. Recovery values for the surrogate spikes were within the current laboratory-specified control limits. No qualification of the data was necessary.

Matrix Spike/Matrix Spike Duplicate (MS/MSD) and Laboratory Replicate Results

One MS/MSD sample was analyzed with the VOC samples in data package 1693903. The recovery values for each required spiking compound and/or the relative percent differences (RPDs) between the MS/MSD results were within the current project-specified and/or laboratory-specified control limits for all project samples with the following exceptions:

- The MS/MSD recoveries for 1,1-dichloroethene and 1,1,2-trichloro-1,2,2-trifluoroethane associated with sample BOP-20ds-0816 in data package 1693903 exceeded the laboratory-

specified control limits. The affected compounds were not detected in the associated sample; therefore, no qualification of the data was necessary.

- The MS/MSD RPD for 2-butanone associated with sample BOP-20ds-0816 in data package 1693903 exceeded the laboratory-specified control limit. The affected compound was not detected in the associated sample; therefore, no qualification of the data was necessary.

Laboratory Control Sample and Laboratory Control Sample Duplicate (LCS/LCSD) Results

At least one laboratory control sample and/or laboratory control sample duplicate (LCS/LCSD) was analyzed with each batch of samples for VOCs analysis. Recoveries and RPDs for the laboratory control samples and associated duplicates were within the current laboratory-specified control limits, with the following exceptions:

- The LCS recoveries for 1,1-dichloroethene and 1,1,2-trichloro-1,2,2-trifluoroethane in data package 1693903 exceeded the laboratory-specified control limits. The affected compounds were not detected in the associated samples; therefore, no qualification of the data was necessary.
- The LCS/LCSD recoveries for 2-hexanone and 4-methyl-2-pentanone in data package 1693903 were below the laboratory-specified control limits. The associated sample results were qualified as estimated (J, UJ), as indicated in Table 1.

Blind Field Duplicate Results

As specified in the QAPP, blind field duplicate samples were collected at a rate of one blind field duplicate sample per 20 samples, but not less than one blind field duplicate per sampling round. Two pairs of blind field duplicate water samples (BOP-Y-0816/BOP-60dg-0815 and BOP-Z-0816/BOP-20ds-0816) were submitted for analysis with data package 1693903.

A project-specified control limit of 20 percent was used to evaluate the RPDs between the duplicate samples except when the sample results were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus the reporting limit was used. RPDs for the duplicate sample pairs submitted for analysis were within the project-specified control limits. No qualification of the data was necessary.

Quantitation Limits

Project-specified quantitation limits were met for all samples except for instances where high concentrations required dilution of the sample extracts.

Audit/Corrective Action Records

No audits were performed or required. No corrective action records were generated for this sample batch. Based on the laboratory's case narratives, continuing calibration verification (CCV) recovery results were within laboratory-specified control limits, with the following exceptions:

- The CCV recoveries were high for several VOC compounds in data package 1693903. The affected compounds were not detected in the associated samples; therefore, no qualification of the data was necessary.
- The CCV recoveries were low for several VOC compounds in data package 1693903. Associated sample results were qualified as estimated (J, UJ), as indicated in Table 1.
- The CCV recovery was high for Freon 113 in data package 1691408. The affected compound was not detected in the associated samples; therefore, no qualification of the data was necessary.

Completeness and Overall Data Quality

The completeness for this data set is 100 percent, which meets the project-specified goal of 90 percent minimum.

Data precision was evaluated through laboratory control sample duplicates, matrix spike duplicates, and blind field duplicates. Data accuracy was evaluated through laboratory control samples, matrix spike samples, and surrogate spikes. No data were rejected.

LANDAU ASSOCIATES, INC.



Kristi Schultz
Data Specialist



Danille Jorgensen
Environmental Data Manager

DRJ/kes

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EPA. 1999. USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review. edited by Office of Emergency and Remedial Response. Washington, DC: US Environmental Protection Agency.

EPA. 2008. USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review. edited by Office of Superfund Remediation and Technology Innovation. Washington, DC: US Environmental Protection Agency.

Table 1
Summary of Data Qualifiers
Boeing Portland TSA Phase I

Data Package	Analyte	Result	Qualifier	Sample Number	Reason
1693903	2-Butanone	5.0 U	UJ	BOP-20dg-0816	Low continuing calibration recovery
1693903	4-Methyl-2-pentanone	5.0 U	UJ	BOP-20dg-0816	Low continuing calibration recovery
1693903	2-Hexanone	5.0 U	UJ	BOP-20dg-0816	Low continuing calibration recovery
1693903	2-Butanone	5.0 U	UJ	BOP-20ds-0816	Low continuing calibration recovery
1693903	4-Methyl-2-pentanone	5.0 U	UJ	BOP-20ds-0816	Low continuing calibration recovery
1693903	2-Hexanone	5.0 U	UJ	BOP-20ds-0816	Low continuing calibration recovery
1693903	2-Butanone	5.0 U	UJ	BOP-21ds-0816	Low continuing calibration recovery
1693903	4-Methyl-2-pentanone	5.0 U	UJ	BOP-21ds-0816	Low continuing calibration recovery
1693903	2-Hexanone	5.0 U	UJ	BOP-21ds-0816	Low continuing calibration recovery
1693903	2-Butanone	5.0 U	UJ	BOP-60dg-0816	Low continuing calibration recovery
1693903	4-Methyl-2-pentanone	5.0 U	UJ	BOP-60dg-0816	Low continuing calibration recovery
1693903	2-Hexanone	5.0 U	UJ	BOP-60dg-0816	Low continuing calibration recovery
1693903	Acetone	57	J	BOP-Y-0816	Low continuing calibration recovery
1693903	Chloromethane	0.5 U	UJ	BOP-Y-0816	Low continuing calibration recovery
1693903	Chloroethane	0.5 U	UJ	BOP-Y-0816	Low continuing calibration recovery
1693903	2-Butanone	5.0 U	UJ	BOP-Y-0816	Low continuing calibration recovery
1693903	4-Methyl-2-pentanone	5.0 U	UJ	BOP-Y-0816	Low continuing calibration recovery
1693903	2-Hexanone	5.0 U	UJ	BOP-Y-0816	Low continuing calibration recovery
1693903	2-Butanone	5.0 U	UJ	BOP-Z-0816	Low continuing calibration recovery
1693903	4-Methyl-2-pentanone	5.0 U	UJ	BOP-Z-0816	Low continuing calibration recovery
1693903	2-Hexanone	5.0 U	UJ	BOP-Z-0816	Low continuing calibration recovery
1693903	2-Butanone	5.0 U	UJ	BOP-22Rds-0816	Low continuing calibration recovery
1693903	4-Methyl-2-pentanone	5.0 U	UJ	BOP-22Rds-0816	Low continuing calibration recovery
1693903	2-Hexanone	5.0 U	UJ	BOP-22Rds-0816	Low continuing calibration recovery
1693903	2-Butanone	5.0 U	UJ	BOP-62ds-0816	Low continuing calibration recovery
1693903	4-Methyl-2-pentanone	5.0 U	UJ	BOP-62ds-0816	Low continuing calibration recovery
1693903	2-Hexanone	5.0 U	UJ	BOP-62ds-0816	Low continuing calibration recovery
1693903	2-Butanone	5.0 U	UJ	BOP-65ds-0816	Low continuing calibration recovery
1693903	4-Methyl-2-pentanone	5.0 U	UJ	BOP-65ds-0816	Low continuing calibration recovery
1693903	2-Hexanone	5.0 U	UJ	BOP-65ds-0816	Low continuing calibration recovery
1693903	2-Butanone	5.0 U	UJ	BOP-66ds-0816	Low continuing calibration recovery
1693903	4-Methyl-2-pentanone	5.0 U	UJ	BOP-66ds-0816	Low continuing calibration recovery
1693903	2-Hexanone	5.0 U	UJ	BOP-66ds-0816	Low continuing calibration recovery
1693903	2-Butanone	5.0 U	UJ	EW-3-0816	Low continuing calibration recovery
1693903	4-Methyl-2-pentanone	5.0 U	UJ	EW-3-0816	Low continuing calibration recovery
1693903	2-Hexanone	5.0 U	UJ	EW-3-0816	Low continuing calibration recovery
1693903	2-Butanone	5.0 U	UJ	EW-13-0816	Low continuing calibration recovery
1693903	4-Methyl-2-pentanone	5.0 U	UJ	EW-13-0816	Low continuing calibration recovery
1693903	2-Hexanone	5.0 U	UJ	EW-13-0816	Low continuing calibration recovery
1693903	2-Hexanone	5.0 U	UJ	BOP-Y-0816	Low LCS/LCSD recovery
1693903	4-Methyl-2-pentanone	5.0 U	UJ	BOP-Y-0816	Low LCS/LCSD recovery

J = Indicates the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

UJ = The analyte was not detected in the sample; the reported sample reporting limit is an estimate.

Technical Memorandum

TO: Chris Kimmel, Project Manager
FROM: Kristi Schultz and Danille Jorgensen
DATE: December 9, 2016
RE: **Boeing Portland (TSA)
Fourth Quarter 2016 Groundwater Quality Sampling
Laboratory Data Quality Evaluation**

This technical memorandum provides the results of a focused data validation associated with 2 groundwater samples and 1 trip blank collected during the fourth quarter 2016 TSA water quality sampling event at Boeing Portland. Samples were analyzed by Eurofins Lancaster Laboratories Environmental LLC (LLI), located in Lancaster, Pennsylvania. This data quality evaluation covers LLI data package 1734527. Samples submitted to LLI were analyzed for volatile organic compounds ([VOCs]; US Environmental Protection Agency [EPA] Method SW8260C).

The verification and validation check was conducted with guidance from applicable portions of EPA's *National Functional Guidelines for Organic Data Review* (EPA 1999, 2008). Landau Associates performed an EPA-equivalent Level II verification and validation check on each laboratory data package, which included the following:

- Verification that the laboratory data package contained all necessary documentation (including chain-of-custody records; identification of samples received by the laboratory; date and time of receipt of the samples at the laboratory; sample conditions upon receipt at the laboratory; date and time of sample analysis; explanation of any significant corrective actions taken by the laboratory during the analytical process; and, if applicable, date of extraction, definition of laboratory data qualifiers, all sample-related quality control data, and quality control acceptance criteria).
- Verification that all requested analyses, special cleanups, and special handling methods were performed.
- Evaluation of sample holding times.
- Evaluation of quality control data compared to acceptance criteria, including method blanks, surrogate recoveries, matrix spike results, laboratory duplicate and/or replicate results, and laboratory control sample results.
- Evaluation of overall data quality and completeness of analytical data.

Data validation qualifiers are added to the sample results, as appropriate, based on the verification and validation check. The absence of a data qualifier indicates that the reported result is acceptable without qualification. The data quality evaluation is summarized below. Data validation qualifiers are summarized in Table 1.

Chain-of-Custody Records

A signed chain-of-custody (COC) record was attached to the data packages. The laboratory received all samples in good condition. All analyses were performed as requested. No special cleanups or handling methods were requested.

Upon receipt by LLI, the sample container information was compared to the associated chain-of-custody and the cooler temperatures were recorded. The coolers were received with temperatures within the EPA-recommended limit of $\leq 6^{\circ}\text{C}$. No qualification of the data was necessary.

Holding Times

For all analyses and all samples, the time between sample collection, extraction (if applicable), and analysis was determined to be within EPA- and project-specified holding times. No qualification of the data was necessary.

Blank Results

Laboratory Method Blanks

At least one method blank was analyzed with each batch of samples for VOCs analysis. Target analytes were not detected at concentrations greater than the reporting limits in the associated method blanks. No qualification of the data was necessary.

Field Trip Blanks and Field Equipment Blanks

One trip blank was submitted to the laboratory for VOC analysis with each sample batch. Target analytes were not detected at concentrations greater than the reporting limits in the associated trip blanks. No qualification of the data was necessary. No field equipment blanks were submitted for analysis with this sample batch.

Surrogate Recoveries

Appropriate compounds were used as surrogate spikes for the VOCs analysis. Recovery values for the surrogate spikes were within the current laboratory-specified control limits. No qualification of the data was necessary.

Matrix Spike/Matrix Spike Duplicate (MS/MSD) and Laboratory Replicate Results

No matrix spikes were analyzed with this sample batch. No qualification of the data was determined necessary.

Laboratory Control Sample and Laboratory Control Sample Duplicate (LCS/LCSD) Results

At least one laboratory control sample and/or laboratory control sample duplicate (LCS/LCSD) was analyzed with each batch of samples for VOCs analysis. Recoveries and RPDs for the laboratory control

samples and associated duplicates were within the current laboratory-specified control limits, with the following exceptions:

- The LCS/LCSD recoveries for 2-hexanone were below the laboratory-specified control limits. The associated sample results were qualified as estimated (J, UJ), as indicated in Table 1.

Blind Field Duplicate Results

No blind field duplicates were submitted with this sample batch. No qualification of the data was determined necessary.

Quantitation Limits

Project-specified quantitation limits were met for all samples except for instances where high concentrations required dilution of the sample extracts.

Audit/Corrective Action Records

No audits were performed or required. No corrective action records were generated for this sample batch. Based on the laboratory's case narratives, continuing calibration verification (CCV) recovery results were within laboratory-specified control limits, with the following exceptions:

- The CCV recoveries were low for several VOC compounds. Associated sample results were qualified as estimated (J, UJ), as indicated in Table 1.

Completeness and Overall Data Quality

The completeness for this data set is 100 percent, which meets the project-specified goal of 90 percent minimum.

Data precision was evaluated through laboratory control sample duplicates. Data accuracy was evaluated through laboratory control samples and surrogate spikes. No data were rejected.

LANDAU ASSOCIATES, INC.



Kristi Schultz
Data Specialist



Danille Jorgensen
Environmental Data Manager

DRJ/kes

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References

- EPA. 1999. USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review. edited by Office of Emergency and Remedial Response. Washington, DC: US Environmental Protection Agency.
- EPA. 2008. USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review. edited by Office of Superfund Remediation and Technology Innovation. Washington, DC: US Environmental Protection Agency.

Table 1
Summary of Data Qualifiers
Boeing Portland TSA Phase I

Data Package	Analyte	Result	Qualifier	Sample Number	Reason
1734527	2-Butanone	5.0 U	UJ	BOP-13ds-1116	Low continuing calibration recovery
1734527	4-Methyl-2-pentanone	5.0 U	UJ	BOP-13ds-1116	Low continuing calibration recovery
1734527	2-Hexanone	5.0 U	UJ	BOP-13ds-1116	Low continuing calibration recovery; low LCS/LCSD recovery
1734527	2-Butanone	5.0 U	UJ	BOP-31ds-1116	Low continuing calibration recovery
1734527	4-Methyl-2-pentanone	5.0 U	UJ	BOP-31ds-1116	Low continuing calibration recovery
1734527	2-Hexanone	5.0 U	UJ	BOP-31ds-1116	Low continuing calibration recovery; low LCS/LCSD recovery

J = Indicates the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

UJ = The analyte was not detected in the sample; the reported sample reporting limit is an estimate.

Memorandum

Date: 26 February 2016
To: Cindy Bartlett, RG, LG, Geosyntec Consultants, Portland, Oregon
From: Geosyntec Quality Assurance Group, Knoxville, Tennessee
Subject: **Stage 2A Data Validation - Level II Data Deliverables – ESC Lab Sciences Work Orders L813997, L815614, L815707 and ALS Environmental Service Request Numbers P1505641 and P1600415**

SITE: Cascade Corp, Utah; Job No: PNG0564S14

INTRODUCTION

This report summarizes the findings of the Stage 2A data validation of twenty-two groundwater samples, five air samples, two field duplicates, and three trip blanks, collected from 28 December 2015 – 2 February 2016, as part of the site investigation activities for the Cascade Corp, Utah project. ESC Lab Sciences (ESC), Mt. Juliet, Tennessee and ALS Environmental, Simi Valley, California provided the analytical services.

The samples were analyzed for the following tests:

- EPA Method 8260B - Volatile Organic Compounds (VOCs)
- EPA Method TO-15 – Selected Volatile Organic Compounds (1,1-Dichloroethene, cis-1,2-Dichloroethene, Trichloroethene, Tetrachloroethene, and Vinyl Chloride)

EXECUTIVE SUMMARY

The samples were handled, prepared, and measured in the same manner under similar prescribed conditions.

Overall, based on this Stage 2A data validation covering the quality control (QC) parameters listed below, the data as qualified are usable for meeting project objectives, with the following exceptions. The non-detect values of 2-chloroethyl vinyl ether in the water samples were R qualified as rejected due to matrix spike/matrix spike duplicate (MS/MSD) recoveries less than 20%, historical MS/MSD results, sample preservation (2-chloroethyl vinyl ether degrades in acidic conditions), and professional and technical judgment.

The remaining qualified data should be used within the limitations of the qualification.

The data were reviewed based on professional and technical judgment and the following documents:

- USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review, August 2014 (USEPA-540-R-013-001)
- The pertinent methods referenced by the data package and professional and technical judgment.

The following samples were analyzed in the data set:

Laboratory ID	Client ID
L813997-01	CMW17DS-012616
L813997-02	TRIP BLANK LOT# 342
L815614-01	CMW10DS-020216
L815614-02	CMW10DS-020216-DUP
L815614-03	CMW26DG-020216
L815614-04	EW2-020216
L815614-05	EW1-020216
L815614-06	EW14-020216
L815614-07	EW23-020216
L815614-08	EW16-020216
L815614-09	EW12-020216-U
L815614-10	EW12-020216-L
L815614-11	EW8-020216-U
L815614-12	EW8-020216-L
L815614-13	D17DG-020216
L815614-14	D17DS-020216

Laboratory ID	Client ID
L815614-15	CMW14RDS-020216
L815614-16	CMW18DS-020216
L815614-17	CMW19DS-020216
L815614-18	CMW24DG-020216-U
L815614-19	CMW24DG-020216-L
L815614-20	CMW25DG-020216
L815614-21	TRIPBLANK
L815707-01	TS-C-EFF-020216
L815707-02	TS-C-EFF-020216 DUP
L815707-03	TS-C-INF-020216
L815707-04	TRIP BLANK LOT 342
P1505641-001	SVE EFF-122815
P1600415-001	VW17d-95.5-012616
P1600415-002	VW17d-75-012616
P1600415-003	VW17d-42.5-012616
P1600415-004	SVE EFF-012616

The water samples were received at the laboratory at 2.4°C, within the criteria 0-6°C.

The trip blank in report L815614 was listed in the remarks of the chain of custody (COC) form without an analysis requested. The client was notified and the laboratory was instructed by the client to analyze the sample for VOCs.

The transfer on the COC form in report P1505641 did not list the relinquishing time.

1.0 VOLATILE ORGANIC COMPOUNDS BY EPA METHOD 8260B

Twenty-two water samples, two field duplicates, and three trip blanks were analyzed for VOCs per EPA Method 8260B.

The areas of data review are listed below. A leading check mark (✓) indicates an area of review in which the data were acceptable. A preceding crossed circle (⊗) signifies areas where issues were raised during the course of the validation review and should be considered to determine any impact on data quality and usability.

- ⊗ Overall Assessment (Completeness)
- ✓ Holding Time
- ✓ Method Blank
- ⊗ Matrix Spike/Matrix Spike Duplicate
- ⊗ Laboratory Control Sample
- ✓ Surrogates
- ⊗ Field Duplicate
- ✓ Trip Blank
- ✓ Sensitivity
- ✓ Electronic Data Deliverables Review

1.1 Overall Assessment (Completeness)

The VOC data reported in this package are considered to be usable for meeting project objectives, with the following exceptions. The non-detect values of 2-chloroethyl vinyl ether in the samples were R qualified as rejected due to MS/MSD recoveries less than 20%, historical MS/MSD results, sample preservation (2-chloroethyl vinyl ether degrades in acidic conditions), and professional and technical judgment (see Section 1.4 below). Therefore, the analytical completeness, defined as the ratio of the number of valid analytical results (valid analytical results include values qualified as estimated) to the total number of analytical results requested on samples submitted for analysis, for the project is 98.5%.

1.2 Holding Time

The holding time for the VOC analysis of a preserved water sample is 14 days from collection to analysis. The holding times were met for the sample analyses.

1.3 Method Blank

Method blanks were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Five method blanks were reported (batches WG845133,

WG847073, WG847201, WG847363, and WG847388). VOCs were not detected in the method blanks above the reported detection limits (RDLs).

1.4 **Matrix Spike/Matrix Spike Duplicate**

MS/MSD pairs were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Two sample set specific MS/MSD pairs were reported, using samples D17DG-020216 and D17DS-020216. The recovery and relative percent difference (RPD) results were within the laboratory specified acceptance criteria, with the following exceptions.

The recoveries of trichloroethene in the MS/MSD pair using sample D17DG-020216 were low and outside the laboratory specified acceptance criteria. Therefore, the concentration of trichloroethene in sample D17DG-020216 was J qualified as estimated. It was noted that vinyl 2-chloroethyl ether was reported from a different batch and was not reported in the MS/MSD pair using sample D17DG-020216.

The recoveries of vinyl 2-chloroethyl ether (8.13%/4.40%) in the MS/MSD pair using sample D17DS-020216 were less than 20% and the RPD (59.5%, limit 40%) was high and outside the laboratory specified acceptance criteria. Therefore, the nondetect values of vinyl 2-chloroethyl ether in the samples were R qualified as rejected based on low recovery in the MS/MSD pair (<10%), historical MS/MSD results, sample preservation (2-chloroethyl vinyl ether degrades in acidic conditions), and professional and technical judgment.

Three batch MS/MSD pairs were also reported. Since these are batch QC, the results do not affect the samples in this data set and qualifications were not applied to the data based on these results.

Sample ID	Compound	Laboratory Result (mg/L)	Laboratory Flag	Validation Result (mg/L)	Validation Qualifier*	Reason Code**
CMW17DS-012616	Vinyl 2-Chloroethyl ether	0.0500	U	0.0500	R	4
TRIP BLANK LOT# 342	Vinyl 2-Chloroethyl ether	0.0500	U	0.0500	R	4
CMW10DS-020216	Vinyl 2-Chloroethyl ether	0.0500	U	0.0500	R	4
CMW10DS-020216-DUP	Vinyl 2-Chloroethyl ether	0.0500	U	0.0500	R	4
CMW26DG-020216	Vinyl 2-Chloroethyl ether	0.0500	U	0.0500	R	4
EW2-020216	Vinyl 2-Chloroethyl	0.0500	U	0.0500	R	4

Sample ID	Compound	Laboratory Result (mg/L)	Laboratory Flag	Validation Result (mg/L)	Validation Qualifier*	Reason Code**
	ether					
EW1-020216	Vinyl 2-Chloroethyl ether	0.0500	U	0.0500	R	4
EW14-020216	Vinyl 2-Chloroethyl ether	0.0500	U	0.0500	R	4
EW23-020216	Vinyl 2-Chloroethyl ether	0.0500	U	0.0500	R	4
EW16-020216	Vinyl 2-Chloroethyl ether	0.0500	U	0.0500	R	4
EW12-020216-U	Vinyl 2-Chloroethyl ether	0.0500	U,J4	0.0500	R	4
EW12-020216-L	Vinyl 2-Chloroethyl ether	0.0500	U	0.0500	R	4
EW8-020216-U	Vinyl 2-Chloroethyl ether	0.0500	U	0.0500	R	4
EW8-020216-L	Vinyl 2-Chloroethyl ether	0.0500	U	0.0500	R	4
D17DG-020216	Trichloroethene	0.0324	J6	0.0324	J	4
D17DG-020216	Vinyl 2-Chloroethyl ether	0.0500	U	0.0500	R	4
D17DS-020216	Vinyl 2-Chloroethyl ether	0.0500	U,J4, J6, J3	0.0500	R	4
CMW14RDS-020216	Vinyl 2-Chloroethyl ether	0.0500	U,J4	0.0500	R	4
CMW18DS-020216	Vinyl 2-Chloroethyl ether	0.0500	U,J4	0.0500	R	4
CMW19DS-020216	Vinyl 2-Chloroethyl ether	0.0500	U,J4	0.0500	R	4
CMW24DG-020216-U	Vinyl 2-Chloroethyl ether	0.0500	U,J4	0.0500	R	4
CMW24DG-020216-L	Vinyl 2-Chloroethyl ether	0.0500	U,J4	0.0500	R	4
CMW25DG-020216	Vinyl 2-Chloroethyl ether	0.0500	U,J4	0.0500	R	4
TRIPBLANK	Vinyl 2-Chloroethyl ether	0.0500	U,J4	0.0500	R	4
TS-C-EFF-020216	Vinyl 2-Chloroethyl ether	0.0500	U,J4	0.0500	R	4
TS-C-EFF-020216 DUP	Vinyl 2-Chloroethyl ether	0.0500	U,J4	0.0500	R	4
TS-C-INF-020216	Vinyl 2-Chloroethyl ether	0.0500	U,J4	0.0500	R	4
TRIP BLANK LOT 342	Vinyl 2-Chloroethyl ether	0.0500	U,J4	0.0500	R	4

mg/L-milligram per liter

U-not detected at the reported RDL

J3-laboratory flag defined as the associated batch QC was outside the established quality control range for precision

J4-laboratory flag defined as the associated batch QC was outside the established quality controls range for accuracy

J6-laboratory flag defined as the sample matrix interfered with the ability to make any accurate determination; spike value is low

*Validation qualifiers are defined in Attachment 1 at the end of this report

** Reason codes are defined in Attachment 2 at the end of this report

1.5 Laboratory Control Sample (LCS)

LCSs were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Five LCS/LCS duplicate (LCSD) pairs were reported. The recovery and RPD results were within the laboratory specified acceptance criteria, with the following exceptions.

The recovery of chloroethane (154%, limit 41.2-153%) in the LCS in batch WG847073 was high and outside the laboratory specified acceptance criteria. Since chloroethane was not detected in the associated samples, no qualifications were applied to the data.

The recovery of 2-chloroethyl vinyl ether (188%, limit 23.4-162%) in the LCS in batch WG847201 was high and outside the laboratory specified acceptance criteria. No qualifications were applied to the 2-chloroethyl vinyl ether based on this result.

The recoveries of 2-chloroethyl vinyl ether (11.1%/10.1%, limit 23.4-162%) in the LCS/LCSD pair in batch WG847363 were low and outside the laboratory specified acceptance criteria. Therefore, the nondetect values of 2-chloroethyl vinyl ether in the associated samples were R qualified as rejected (also previously R qualified due to low MS/MSD recoveries).

Sample ID	Compound	Laboratory Result (mg/L)	Laboratory Flag	Validation Result (mg/L)	Validation Qualifier	Reason Code
TRIPBLANK	Vinyl 2-Chloroethyl ether	0.0500	U,J4	0.0500	R	5
TS-C-EFF-020216	Vinyl 2-Chloroethyl ether	0.0500	U,J4	0.0500	R	5
TS-C-EFF-020216 DUP	Vinyl 2-Chloroethyl ether	0.0500	U,J4	0.0500	R	5
TS-C-INF-020216	Vinyl 2-Chloroethyl ether	0.0500	U,J4	0.0500	R	5
TRIP BLANK LOT 342	Vinyl 2-Chloroethyl ether	0.0500	U,J4	0.0500	R	5

mg/L-milligram per liter

U-not detected at the reported RDL

J4-laboratory flag defined as the associated batch QC was outside the established quality controls range for accuracy

1.6 Surrogates

Acceptable surrogate recoveries were reported for the sample analyses.

1.7 Field Duplicate

Two field duplicate samples, CMW10DS-020216-DUP and TS-C-EFF-020216 DUP, were collected. Acceptable precision ($RPD \leq 30\%$) was demonstrated between the field duplicates and the original samples, CMW10DS-020216 and TS-C-EFF-020216, respectively, with the following exceptions.

Tetrachloroethene and trichloroethene were not detected above the RDLs in CMW10DS-020216-DUP and were detected above the RDLs in CMW10DS-020216. The RPDs were not calculable; therefore, the nondetect values of these compounds were UJ qualified as estimated less than the RDLs and the concentrations of these compounds were J qualified as estimated in the field duplicate pair.

Sample ID	Compound	Laboratory Result (mg/L)	Laboratory Flag	RPD	Validation Result	Validation Qualifier	Reason Code
CMW10DS-020216	Tetrachloroethene	0.00103	NA	NC	0.00103	J	7
CMW10DS-020216-DUP	Tetrachloroethene	0.00100	U	NC	0.00100	UJ	7
CMW10DS-020216	Trichloroethene	0.0254	NA	NC	0.0254	J	7
CMW10DS-020216-DUP	Trichloroethene	0.00100	U	NC	0.00100	UJ	7

mg/L-milligrams per liter

U-not detect at or above the RDL

NA-not applicable

NC-not calculable

1.8 Trip Blank

Three trip blanks, TRIP BLANK LOT# 342, TRIPBLANK, and TRIP BLANK LOT 342, accompanied the sample shipments. VOCs were not detected in the trip blanks above the RDLs.

1.9 Sensitivity

The sample results were reported to the RDLs. No elevated non-detect values were reported.

1.10 Electronic Data Deliverables (EDDs) Review

Results and sample IDs in the EDDs were reviewed against the information provided by the associated level II reports at a minimum of 20% as part of the data validation process. It was noted that the samples were reported to the RDLs in the hardcopy laboratory reports; both the RDLs and the method detection limits (MDLs) were listed in the EDDs. It was also noted that the data were reported in the units parts per million (mg/L) in the EDDs, while the sample data were reported in the units parts per billion (µg/L) and the QC samples were reported in the units mg/L in the level II laboratory reports. This did not affect the quality of the data. No other discrepancies were identified between the level II reports and the EDDs.

2.0 SELECTED VOLATILE ORGANIC COMPOUNDS BY EPA METHOD TO-15

Five air samples were analyzed for VOCs per EPA Method TO-15.

The areas of data review are listed below. A leading check mark (✓) indicates an area of review in which the data were acceptable. A preceding crossed circle (⊗) signifies areas where issues were raised during the course of the validation review and should be considered to determine any impact on data quality and usability.

- ✓ Overall Assessment (Completeness)
- ✓ Holding Time
- ✓ Method Blank
- ✓ Matrix Spike/Matrix Spike Duplicate
- ✓ Laboratory Control Sample
- ✓ Laboratory Duplicate
- ✓ Surrogates
- ✓ Field Duplicate
- ✓ Trip Blank
- ✓ Sensitivity
- ✓ Electronic Data Deliverables Review

2.1 Overall Assessment (Completeness)

The selected VOC data reported in this package are considered to be usable for meeting project objectives. The analytical completeness, defined as the ratio of the number of valid analytical results (valid analytical results include values qualified as estimated) to the total number of analytical results requested on samples submitted for analysis, for the project is 100%.

2.2 Holding Time

The holding time for the VOC analysis of a SUMMA Canister sample is 30 days from collection to analysis. The holding times were met for the sample analyses.

2.3 Method Blank

Method blanks were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Two method blanks were reported (batches P160202 and P160104). VOCs were not detected in the method blanks above the method reporting limits (MRLs).

2.4 Matrix Spike/Matrix Spike Duplicate

MS/MSD pairs were not reported.

2.5 Laboratory Control Sample

LCSs were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Two LCSs were reported. The recovery results were within the laboratory specified acceptance criteria.

2.6 Laboratory Duplicate

Laboratory duplicates were not reported.

2.7 Surrogates

Acceptable surrogate recoveries were reported for the sample analyses.

2.8 Field Duplicate

Field duplicates were not collected with the sample set.

2.9 Trip Blank

Trip blanks were not shipped with the sample set.

2.10 Sensitivity

The sample results were reported to the DLs. Elevated non-detect values were reported due to dilutions analyzed.

2.11 Electronic Data Deliverables Review

Results and sample IDs in the EDDs were reviewed against the information provided by the associated level II reports at a minimum of 20% as part of the data validation process. It was noted that the samples were reported to the MRLs in the hardcopy laboratory reports; both the MRLs and the MDLs were listed in the EDDs. It was also noted that the data were reported in micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) in the EDDs, while the sample data were reported in both micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) and parts per billion by volume (ppbv). This did not affect the quality of the data. No other discrepancies were identified between the level II reports and the EDDs.

* * * * *

ATTACHMENT 1
DATA VALIDATION QUALIFIER DEFINITIONS
AND INTERPRETATION KEY
Assigned by Geosyntec's Data Validation Team

DATA QUALIFIER DEFINITIONS

- U The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
- J The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
- J+ The analyte was positively identified; however, the associated numerical value is likely to be higher than the concentration of the analyte in the sample due to positive bias of associated QC or calibration data or attributable to matrix interference.
- J- The analyte was positively identified; however, the associated numerical value is likely to be lower than the concentration of the analyte in the sample due to negative bias of associated QC or calibration data or attributable to matrix interference.
- UJ The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
- R The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

DATA VALIDATION REASON CODES
Assigned by Geosyntec's Data Validation Team

Valid Value	Description
1	Preservation requirement not met
2	Analysis holding time exceeded
3	Blank contamination (i.e., method, trip, equipment, etc.)
4	Matrix spike/matrix spike duplicate recovery or RPD outside limits
5	LCS recovery outside limits and RPD outside limits (LCS/LCSD)
6	Surrogate recovery outside limits
7	Field Duplicate RPD exceeded
8	Serial dilution percent difference exceeded
9	Calibration criteria not met
10	Linear range exceeded
11	Internal standard criteria not met
12	Lab duplicates RPD exceeded
13	Other

RPD-relative percent difference

Memorandum

Date: 27 June 2016
To: Cindy Bartlett, RG, LG, Geosyntec Consultants, Portland, Oregon
From: Geosyntec Quality Assurance Group, Knoxville, Tennessee
Subject: **Stage 2A Data Validation - Level II Data Deliverables – ESC Lab Sciences Work Orders L819674, L823779, L832085, L833346, and L833349 and ALS Environmental Service Request Numbers P1600982, P1601453, and P1602274**

SITE: Cascade Corp, Fairview Oregon; Job No: PNG0564S16

INTRODUCTION

This report summarizes the findings of the Stage 2A data validation of seventeen groundwater samples, six air samples, one field duplicate, and four trip blanks, collected from February 23 - May 3, 2016, as part of the site investigation activities for the Cascade Corp, Fairview Oregon project. ESC Lab Sciences (ESC), Mt. Juliet, Tennessee and ALS Environmental, Simi Valley, California provided the analytical services.

The samples were analyzed for the following tests:

- EPA Method 8260B - Volatile Organic Compounds (VOCs)
- EPA Method TO-15 – Selected Volatile Organic Compounds (1,1-Dichloroethene, cis-1,2-Dichloroethene, Trichloroethene, Tetrachloroethene, and Vinyl Chloride)

EXECUTIVE SUMMARY

The samples were handled, prepared, and measured in the same manner under similar prescribed conditions.

Overall, based on this Stage 2A data validation covering the quality control (QC) parameters listed below, the data as qualified are usable for meeting project objectives, with the following exceptions. The non-detect values of 2-chloroethyl vinyl ether in the water samples were R qualified as rejected due to historical matrix spike/matrix spike duplicate (MS/MSD) results, sample preservation (2-chloroethyl vinyl ether degrades in acidic conditions), and professional and technical judgment.

The remaining qualified data should be used within the limitations of the qualification.

The organic data were reviewed based on USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review, August 2014 (USEPA-540-R-013-001), as well as by the pertinent methods referenced by the data package and professional and technical judgment.

The following samples were analyzed in the data set:

Laboratory ID	Client ID
L819674-01	CMW17DS-022316
L819674-02	TRIP BLANK
L823779-01	CMW17DS-031516
L823779-02	TRIP BLANK
L832085-01	CMW17DS-042716
L832085-02	TRIP BLANK
L833346-01	TS-C-EFF-050316
L833346-02	TS-C-EFF-050316-D
L833346-03	TS-C-INF-050316
L833346-04	EW12-050316-U
L833346-05	EW12-0503016-L
L833346-06	CMW18DS-0503016
L833346-07	D17DS-050316
L833346-08	CMW19DS-050316

Laboratory ID	Client ID
L833346-09	CMW26DG-050316
L833346-10	CMW14RDS-050316
L833349-01	CMW10DS-050316
L833349-02	EW2
L833349-03	TRIP BLANK
L833349-04	EW14-050316
L833349-05	EW1-050316
L833349-06	EW16-050316
P1600982-001	EFFSVE-022316
P1601453-001	VW17d 95.5-031516
P1601453-002	VW17d 75.0-0.031516
P1601453-003	VW17d 42.5-0.031516
P1601453-004	SVE EFF-031516
P1602274-001	SVE EFF-042716

The water samples were received at the laboratory at 3.1°C, 3.3°C, 3.2°C, and 2.1°C, within the criteria 0-6°C.

The relinquished time was missing on the chain of custody (COC) forms in report P1602274.

1.0 VOLATILE ORGANIC COMPOUNDS BY EPA METHOD 8260B

The groundwater samples were analyzed for VOCs per EPA Method 8260B.

The areas of data review are listed below. A leading check mark (✓) indicates an area of review in which the data were acceptable. A preceding crossed circle (⊗) signifies areas where issues were raised during the course of the validation review and should be considered to determine any impact on data quality and usability.

- ⊗ Overall Assessment (Completeness)
- ✓ Holding Time
- ✓ Method Blank
- ⊗ Matrix Spike/Matrix Spike Duplicate
- ⊗ Laboratory Control Sample
- ✓ Surrogates
- ✓ Field Duplicate
- ✓ Trip Blank
- ✓ Sensitivity
- ✓ Electronic Data Deliverables Review

1.1 Overall Assessment (Completeness)

The VOC data reported in this package are considered to be usable for meeting project objectives, with the following exceptions. The non-detect values of 2-chloroethyl vinyl ether in the samples were R qualified as rejected due to historical MS/MSD results, sample preservation (2-chloroethyl vinyl ether degrades in acidic conditions), and professional and technical judgment (see Section 1.4 below). Therefore, the analytical completeness, defined as the ratio of the number of valid analytical results (valid analytical results include values qualified as estimated) to the total number of analytical results requested on samples submitted for analysis, for the project is 98.5%.

1.2 Holding Time

The holding time for the VOC analysis of a preserved water sample is 14 days from collection to analysis. The holding times were met for the sample analyses.

1.3 Method Blank

Method blanks were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Four method blanks were reported (batches WG852647, WG857670, WG868456, and WG870092). VOCs were not detected in the method blanks above the reported detection limits (RDLs).

1.4 Matrix Spike/Matrix Spike Duplicate

MS/MSD pairs were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Four batch MS/MSD pairs were reported. Since these are batch QC, the results do not affect the samples in this data set and qualifications were not applied to the data based on these results.

Based on historical data, sample preservation (2-chloroethyl vinyl ether degrades in acidic conditions), and professional and technical judgment the nondetect values of 2-chloroethyl vinyl ether were R qualified as rejected.

Sample ID	Compound	Laboratory Result (mg/L)	Laboratory Flag	Validation Result (mg/L)	Validation Qualifier*	Reason Code**
CMW17DS-022316	Vinyl 2-Chloroethyl ether	0.050	U	0.050	R	4
TRIP BLANK	Vinyl 2-Chloroethyl ether	0.050	U	0.050	R	4
CMW17DS-031516	Vinyl 2-Chloroethyl ether	0.050	U J3 J4	0.050	R	4
TRIP BLANK	Vinyl 2-Chloroethyl ether	0.050	U J3 J4	0.050	R	4
CMW17DS-042716	Vinyl 2-Chloroethyl ether	0.050	U	0.050	R	4
TRIP BLANK	Vinyl 2-Chloroethyl ether	0.050	U	0.050	R	4
TS-C-EFF-050316	Vinyl 2-Chloroethyl ether	0.050	U	0.050	R	4
TS-C-EFF-050316-D	Vinyl 2-Chloroethyl ether	0.050	U	0.050	R	4
TS-C-INF-050316	Vinyl 2-Chloroethyl ether	0.050	U	0.050	R	4
EW12-050316-U	Vinyl 2-Chloroethyl ether	0.050	U	0.050	R	4
EW12-050316-L	Vinyl 2-Chloroethyl ether	0.050	U	0.050	R	4
CMW18DS-0503016	Vinyl 2-Chloroethyl ether	0.050	U	0.050	R	4
D17DS-050316	Vinyl 2-Chloroethyl ether	0.050	U	0.050	R	4
CMW19DS-050316	Vinyl 2-Chloroethyl ether	0.050	U	0.050	R	4
CMW26DG-050316	Vinyl 2-Chloroethyl ether	0.050	U	0.050	R	4
CMW14RDS-050316	Vinyl 2-Chloroethyl ether	0.050	U	0.050	R	4
CMW10DS-050316	Vinyl 2-Chloroethyl ether	0.050	U	0.050	R	4
EW2	Vinyl 2-Chloroethyl ether	0.050	U	0.050	R	4
TRIP BLANK	Vinyl 2-Chloroethyl ether	0.050	U	0.050	R	4
EW14-050316	Vinyl 2-Chloroethyl ether	0.050	U	0.050	R	4
EW1-050316	Vinyl 2-Chloroethyl ether	0.050	U	0.050	R	4
EW16-050316	Vinyl 2-Chloroethyl ether	0.050	U	0.050	R	4

mg/L-milligram per liter

U-not detected at the reported RDL

J3- laboratory flag defined as the associated batch QC was outside the established quality control range for precision

J4- laboratory flag defined as the associated batch QC was outside the established quality control range for accuracy

*Validation qualifiers are defined in Attachment 1 at the end of this report

** Reason codes are defined in Attachment 2 at the end of this report

1.5 Laboratory Control Sample (LCS)

LCSs were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Four LCS/LCS duplicate (LCSD) pairs were reported. The recovery and relative percent difference (RPD) results were within the laboratory specified acceptance criteria.

One or both the recoveries of acrolein, Freon 12, and chloromethane in the LCS/LCSD pair in batch WG852647 were high and outside the laboratory specified acceptance criteria. Since acrolein, Freon 12, and chloromethane were not detected in the associated samples, no qualifications were applied to the data.

Vinyl 2-chloroethyl ether was not recovered in the LCS and the LCSD recovery was less than 20% in the LCS/LCSD pair in batch WG857670. Since the nondetect vinyl 2-chloroethyl ether results in the associated samples were R qualified based on historical MS/MSD results, no additional qualifications were applied to the data.

The recoveries of bromobenzene and p-chlorotoluene in the LCS in batch WG870092 were low and outside laboratory acceptance criteria. Therefore, the nondetect bromobenzene and p-chlorotoluene results in the associated samples were UJ qualified as estimated less than the RDLs.

Sample ID	Compound	Laboratory Result (mg/L)	Laboratory Flag	Validation Result (mg/L)	Validation Qualifier	Reason Code
TS-C-EFF-050316	Bromobenzene	0.0010	U J4	0.0010	UJ	5
TS-C-EFF-050316	p-Chlorotoluene	0.0010	U J4	0.0010	UJ	5
TS-C-EFF-050316-D	Bromobenzene	0.0010	U J4	0.0010	UJ	5
TS-C-EFF-050316-D	p-Chlorotoluene	0.0010	U J4	0.0010	UJ	5
TS-C-INF-050316	Bromobenzene	0.0010	U J4	0.0010	UJ	5
TS-C-INF-050316	p-Chlorotoluene	0.0010	U J4	0.0010	UJ	5
EW12-050316-U	Bromobenzene	0.0010	U J4	0.0010	UJ	5
EW12-050316-U	p-Chlorotoluene	0.0010	U J4	0.0010	UJ	5
EW12-0503016-L	Bromobenzene	0.0010	U J4	0.0010	UJ	5
EW12-0503016-L	p-Chlorotoluene	0.0010	U J4	0.0010	UJ	5
CMW18DS-0503016	Bromobenzene	0.0010	U J4	0.0010	UJ	5
CMW18DS-0503016	p-Chlorotoluene	0.0010	U J4	0.0010	UJ	5
D17DS-050316	Bromobenzene	0.0010	U J4	0.0010	UJ	5
D17DS-050316	p-Chlorotoluene	0.0010	U J4	0.0010	UJ	5
CMW19DS-050316	Bromobenzene	0.0010	U J4	0.0010	UJ	5
CMW19DS-050316	p-Chlorotoluene	0.0010	U J4	0.0010	UJ	5
CMW26DG-050316	Bromobenzene	0.0010	U J4	0.0010	UJ	5
CMW26DG-050316	p-Chlorotoluene	0.0010	U J4	0.0010	UJ	5
CMW14RDS-050316	Bromobenzene	0.0010	U J4	0.0010	UJ	5
CMW14RDS-050316	p-Chlorotoluene	0.0010	U J4	0.0010	UJ	5
CMW10DS-050316	Bromobenzene	0.0010	U J4	0.0010	UJ	5
CMW10DS-050316	p-Chlorotoluene	0.0010	U J4	0.0010	UJ	5
EW2	Bromobenzene	0.0010	U J4	0.0010	UJ	5
EW2	p-Chlorotoluene	0.0010	U J4	0.0010	UJ	5

Sample ID	Compound	Laboratory Result (mg/L)	Laboratory Flag	Validation Result (mg/L)	Validation Qualifier	Reason Code
TRIP BLANK	Bromobenzene	0.0010	U J4	0.0010	UJ	5
TRIP BLANK	p-Chlorotoluene	0.0010	U J4	0.0010	UJ	5
EW14-050316	Bromobenzene	0.0010	U J4	0.0010	UJ	5
EW14-050316	p-Chlorotoluene	0.0010	U J4	0.0010	UJ	5
EW1-050316	Bromobenzene	0.0010	U J4	0.0010	UJ	5
EW1-050316	p-Chlorotoluene	0.0010	U J4	0.0010	UJ	5
EW16-050316	Bromobenzene	0.0010	U J4	0.0010	UJ	5
EW16-050316	p-Chlorotoluene	0.0010	U J4	0.0010	UJ	5

mg/L-milligram per liter

U-not detected at the reported RDL

J4-laboratory flag defined as the associated batch QC was outside the established quality control range for accuracy

1.6 Surrogates

Acceptable surrogate recoveries were reported for the sample analyses.

1.7 Field Duplicate

One field duplicate was collected with the sample sets, TS-C-EFF-050316-D. Acceptable precision ($RPD \leq 30\%$) was demonstrated between the field duplicate and the original sample, TS-C-EFF-050316. The RPDs were 0%.

1.8 Trip Blank

Four trip blanks, all identified as TRIP BLANK, accompanied the sample shipments. VOCs were not detected in the trip blanks above the RDLs.

1.9 Sensitivity

The sample results were reported to the RDLs. No elevated non-detect values were reported.

1.10 Electronic Data Deliverables (EDDs) Review

Results and sample IDs in the EDDs were reviewed against the information provided by the associated level II reports at a minimum of 20% as part of the data validation process. It was noted that the samples were reported to the RDLs in the hardcopy laboratory reports; both the DLs and the method detection limits (MDLs) were listed in the EDDs. It was also noted that the data were reported in the units parts per million (mg/L) in the EDDs, while the sample data were reported in the units parts per billion ($\mu\text{g/L}$) and the QC samples were reported in the units mg/L

in the level II laboratory reports. This did not affect the quality of the data. No other discrepancies were identified between the level II reports and the EDDs.

2.0 SELECTED VOLATILE ORGANIC COMPOUNDS BY EPA METHOD TO-15

The air samples were analyzed for VOCs per EPA Method TO-15.

The areas of data review are listed below. A leading check mark (✓) indicates an area of review in which the data were acceptable. A preceding crossed circle (⊗) signifies areas where issues were raised during the course of the validation review and should be considered to determine any impact on data quality and usability.

- ✓ Overall Assessment (Completeness)
- ✓ Holding Time
- ✓ Method Blank
- ✓ Matrix Spike/Matrix Spike Duplicate
- ✓ Laboratory Control Sample
- ✓ Laboratory Duplicate
- ✓ Surrogates
- ✓ Field Duplicate
- ✓ Trip Blank
- ✓ Sensitivity
- ✓ Electronic Data Deliverables Review

2.1 Overall Assessment (Completeness)

The selected VOC data reported in this package are considered to be usable for meeting project objectives. The analytical completeness, defined as the ratio of the number of valid analytical results (valid analytical results include values qualified as estimated) to the total number of analytical results requested on samples submitted for analysis, for the project is 100%.

2.2 Holding Time

The holding time for the VOC analysis of a SUMMA Canister sample is 30 days from collection to analysis. The holding times were met for the sample analyses.

2.3 Method Blank

Method blanks were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Four method blanks were reported (batches P160305,

P160328, P160331, and P160512). VOCs were not detected in the method blanks above the method reporting limits (MRLs).

2.4 Matrix Spike/Matrix Spike Duplicate

MS/MSD pairs were not reported.

2.5 Laboratory Control Sample

LCSs were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Four LCSs were reported. The recovery results were within the laboratory specified acceptance criteria.

2.6 Laboratory Duplicate

Laboratory duplicates were not reported.

2.7 Surrogates

Acceptable surrogate recoveries were reported for the sample analyses.

2.8 Field Duplicate

Field duplicates were not collected with the air sample sets.

2.9 Trip Blank

Trip blanks were not shipped with the air sample sets.

2.10 Sensitivity

The sample results were reported to the MRLs. No elevated non-detect values were reported.

2.11 Electronic Data Deliverables Review

Results and sample IDs in the EDDs were reviewed against the information provided by the associated level II reports at a minimum of 20% as part of the data validation process. It was noted that the samples were reported to the MRLs in the hardcopy laboratory reports; both the MRLs and the MDLs were listed in the EDDs. It was also noted that the data were reported in micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) in the EDDs, while the sample data were reported in both micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) and parts per billion by volume (ppbv). This did not affect

the quality of the data. No other discrepancies were identified between the level II reports and the EDDs.

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ATTACHMENT 1
DATA VALIDATION QUALIFIER DEFINITIONS
AND INTERPRETATION KEY
Assigned by Geosyntec's Data Validation Team

DATA QUALIFIER DEFINITIONS

- U The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
- J The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
- J+ The analyte was positively identified; however, the associated numerical value is likely to be higher than the concentration of the analyte in the sample due to positive bias of associated QC or calibration data or attributable to matrix interference.
- J- The analyte was positively identified; however, the associated numerical value is likely to be lower than the concentration of the analyte in the sample due to negative bias of associated QC or calibration data or attributable to matrix interference.
- UJ The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
- R The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

DATA VALIDATION REASON CODES
Assigned by Geosyntec's Data Validation Team

Valid Value	Description
1	Preservation requirement not met
2	Analysis holding time exceeded
3	Blank contamination (i.e., method, trip, equipment, etc.)
4	Matrix spike/matrix spike duplicate recovery or RPD outside limits
5	LCS recovery outside limits and RPD outside limits (LCS/LCSD)
6	Surrogate recovery outside limits
7	Field Duplicate RPD exceeded
8	Serial dilution percent difference exceeded
9	Calibration criteria not met
10	Linear range exceeded
11	Internal standard criteria not met
12	Lab duplicates RPD exceeded
13	Other

RPD-relative percent difference

Memorandum

Date: 20 September 2016
To: Cindy Bartlett, RG, LG, Geosyntec Consultants, Portland, Oregon
From: Geosyntec Quality Assurance Group, Knoxville, Tennessee
Subject: **Stage 2A Data Validation - Level II Data Deliverables – ESC Lab Sciences Work Orders L837852, L843467, L849569, L851218, L851478 and L851485 and ALS Environmental Service Request Numbers P1602713, P1603213, and P1603735**

SITE: Cascade Corp, Fairview Oregon; Job No: PNG0564S16

INTRODUCTION

This report summarizes the findings of the Stage 2A data validation of twenty-seven groundwater samples, six air samples, one field duplicate, and five trip blanks, collected from May 24 – August 4, 2016, as part of the site investigation activities for the Cascade Corp, Fairview Oregon project. ESC Lab Sciences (ESC), Mt. Juliet, Tennessee and ALS Environmental, Simi Valley, California provided the analytical services.

The samples were analyzed for the following tests:

- EPA Method 8260B - Volatile Organic Compounds (VOCs)
- EPA Method TO-15 – Selected Volatile Organic Compounds (1,1-Dichloroethene, cis-1,2-Dichloroethene, Trichloroethene, Tetrachloroethene, and Vinyl Chloride)

EXECUTIVE SUMMARY

The samples were handled, prepared, and measured in the same manner under similar prescribed conditions.

Overall, based on this Stage 2A data validation covering the quality control (QC) parameters listed below, the data as qualified are usable for meeting project objectives, with the following exceptions. The non-detect values of 2-chloroethyl vinyl ether in the water samples were R qualified as rejected due to historical matrix spike/matrix spike duplicate (MS/MSD) results, sample preservation (2-chloroethyl vinyl ether degrades in acidic conditions), and professional and technical judgment.

The remaining qualified data should be used within the limitations of the qualification.

The organic data were reviewed based on USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review, August 2014 (USEPA-540-R-013-001), as well as by the pertinent methods referenced by the data package and professional and technical judgment.

The following samples were analyzed in the data set:

Laboratory ID	Client ID
L837852-01	CMW17DS-052416
L837852-02	TRIP BLANK
L843467-01	CMW17DS-062116
L843467-02	TRIP BLANK
L849569-01	CMW17DS-072616
L849569-02	TRIP BLANK
L851218-01	EW8-080216-U
L851218-02	EW8-080216-L
L851218-03	EW12-080216-U
L851218-04	EW12-080216-L
L851218-05	D17DG-080216
L851218-06	D17DS-080216
L851218-07	CMW14RDS-080216
L851218-08	CMW18DS-080216
L851218-09	CMW19DS-080216
L851218-10	CMW24DG-080216-U
L851218-11	CMW24DG-080216-L
L851218-12	CMW25DG-080216
L851218-13	CMW26DG-080216
L851218-14	CMW36DG-080216

Laboratory ID	Client ID
L851218-15	TRIP BLANK LOT 367
L851478-01	TRIP BLANK
L851478-02	TS-C-EFF-080416
L851478-03	TS-C-EFF-080416DUP
L851478-04	TS-C-INF-080416
L851485-01	CMW10DS-080416
L851485-02	CMW10DG-080416
L851485-03	EW2-080416
L851485-04	EW14-080416
L851485-05	EW1-080416
L851485-06	EW23-080416
L851485-07	EW16-080416
L851485-08	TRIP BLANK
L851485-09	CMW20DS-080416
P1602713-001	SVE EFF-052416
P1603213-001	SVE EFF-062116
P1603213-002	VW17d-95.5-062116
P1603213-003	VW17d-75-062116
P1603213-004	VW17d-42.5-062116
P1603735-001	SVE EFF-052416

The water samples were received at the laboratory at 3.2°C, 2.8°C, 3.6°C, 2.1°C, 3.1°C, and 2.7°C, within the criteria of 0-6°C.

The relinquished time was missing on the chain of custody (COC) forms in reports L837852, L851218, L851478 and P1603213.

1.0 VOLATILE ORGANIC COMPOUNDS BY EPA METHOD 8260B

The groundwater samples were analyzed for VOCs per EPA Method 8260B.

The areas of data review are listed below. A leading check mark (✓) indicates an area of review in which the data were acceptable. A preceding crossed circle (⊗) signifies areas where issues were raised during the course of the validation review and should be considered to determine any impact on data quality and usability.

- ⊗ Overall Assessment (Completeness)
- ✓ Holding Time
- ✓ Method Blank
- ⊗ Matrix Spike/Matrix Spike Duplicate
- ⊗ Laboratory Control Sample
- ✓ Surrogates
- ✓ Field Duplicate
- ✓ Trip Blank
- ✓ Sensitivity
- ✓ Electronic Data Deliverables Review

1.1 Overall Assessment (Completeness)

The VOC data reported in this package are considered to be usable for meeting project objectives, with the following exceptions. The non-detect values of 2-chloroethyl vinyl ether in the samples were R qualified as rejected due to historical MS/MSD results, sample preservation (2-chloroethyl vinyl ether degrades in acidic conditions), and professional and technical judgment (see Section 1.4 below). Therefore, the analytical completeness, defined as the ratio of the number of valid analytical results (valid analytical results include values qualified as estimated) to the total number of analytical results requested on samples submitted for analysis, for the project is 99.8%.

1.2 Holding Time

The holding time for the VOC analysis of a preserved water sample is 14 days from collection to analysis. The holding times were met for the sample analyses.

1.3 Method Blank

Method blanks were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Eight method blanks were reported (batches WG876488, WG883471, WG893857, WG896654, WG896669, WG896674, WG896691 and WG897451.). VOCs were not detected in the method blanks above the reported detection limits (RDLs).

1.4 **Matrix Spike/Matrix Spike Duplicate**

MS/MSD pairs were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Two sample specific MS/MSD pairs using samples CMW17DS-062116 and CMW26DG-080216 were reported. The recovery and RPD results were within the laboratory specified acceptance criteria, with the following acceptance.

2-Chloroethyl vinyl ether was not detected in the MS/MSD pair using sample CMW17DS-062116. Based on historical data, sample preservation (2-chloroethyl vinyl ether degrades in acidic conditions), and professional and technical judgment the non-detect values of 2-chloroethyl vinyl ether were R qualified as rejected.

Four batch MS/MSD pairs were reported. Since these are batch QC, the results do not affect the samples in this data set and qualifications were not applied to the data based on these results.

Based on historical data, sample preservation (2-chloroethyl vinyl ether degrades in acidic conditions), and professional and technical judgment the non-detect values of 2-chloroethyl vinyl ether were R qualified as rejected.

Sample ID	Compound	Laboratory Result (mg/L)	Laboratory Flag	Validation Result (mg/L)	Validation Qualifier*	Reason Code**
CMW17DS-052416	Vinyl 2-Chloroethyl ether	0.050	U, J3	0.050	R	4
TRIP BLANK	Vinyl 2-Chloroethyl ether	0.050	U, J3	0.050	R	4
CMW 17DS-062116	Vinyl 2-Chloroethyl ether	0.050	U, J6	0.050	R	4
TRIP BLANK	Vinyl 2-Chloroethyl ether	0.050	U	0.050	R	4

mg/L-milligram per liter

U-not detected at the reported RDL

J3- laboratory flag defined as the associated batch QC was outside the established quality control range for precision

J6- laboratory flag defined as the sample matrix interfered with the ability to make any accurate determination; spike value is low

*Validation qualifiers are defined in Attachment 1 at the end of this report

** Reason codes are defined in Attachment 2 at the end of this report

1.5 **Laboratory Control Sample (LCS)**

LCSs were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Eight LCS/LCS duplicate (LCSD) pairs were reported. The recovery and relative percent difference (RPD) results were within the laboratory specified acceptance criteria.

The LCS recovery of 1,1,2,2-tetrachloroethane in batch WG876488 was low and outside the laboratory specified acceptance criteria. Therefore the non-detect results of 1,1,2,2-tetrachloroethane in the associated samples were UJ qualified as estimated less than the RDL.

The LCS recovery of trichloroethene in batch WG896654 was high and outside laboratory acceptance criteria. Therefore, the concentrations of trichloroethene in the associated samples were J qualified as estimated.

The LCSD recovery of 1,3-dichloropropane and both recoveries of acrolein in batches WG897451 and WG896631, respectively, were high and outside laboratory acceptance criteria. Since 1,3-dichloropropane and acrolein were not detected above the RDLs in the associated samples, no qualifications were applied to the data.

The LCS/LCSD RPD for acrolein was high and outside of laboratory acceptance criteria in batch WG896654. Since acrolein was not detected above the RDL in the associated samples, no qualifications were applied to the data.

The LCS/LCSD RPD for vinyl 2-chloroethyl ether was high and outside of laboratory acceptance criteria in batch WG876488. Since the nondetect vinyl 2-chloroethyl ether results in the associated samples were R qualified based on historical MS/MSD results, no additional qualifications were applied to the data.

Sample ID	Compound	Laboratory Result (mg/L)	Laboratory Flag	Validation Result (mg/L)	Validation Qualifier	Reason Code
CMW17DS-052416	1,1,2,2-Tetrachloroethane	0.0010	U, J4	0.0010	UJ	5
TRIP BLANK	1,1,2,2-Tetrachloroethane	0.0010	U, J4	0.0010	UJ	5
EW12-080216-L	Trichloroethene	0.00365	J4	0.00365	J	5
EW12-080216-U	Trichloroethene	0.00122	J4	0.00122	J	5
CMW18DS-080216	Trichloroethene	0.0787	J4	0.0787	J	5
D17DG-080216	Trichloroethene	0.00286	J4	0.00286	J	5
D17DS-080216	Trichloroethene	0.0220	J4	0.0220	J	5

mg/L-milligram per liter

U-not detected at the reported RDL

J4-laboratory flag defined as the associated batch QC was outside the established quality control range for accuracy

1.6 Surrogates

Acceptable surrogate recoveries were reported for the sample analyses.

1.7 Field Duplicate

One field duplicate was collected with the sample sets, TS-C-EFF-0080416DUP. Acceptable precision ($RPD \leq 30\%$) was demonstrated between the field duplicate and the original sample, TS-C-EFF-080416. The RPDs were 0%.

1.8 Trip Blank

Six trip blanks, five identified as TRIP BLANK and one identified as TRIP BLANK LOT 367 accompanied the sample shipments. VOCs were not detected in the trip blanks above the RDLs.

1.9 Sensitivity

The sample results were reported to the RDLs. No elevated non-detect values were reported.

1.10 Electronic Data Deliverables (EDDs) Review

Results and sample IDs in the EDDs were reviewed against the information provided by the associated level II reports at a minimum of 20% as part of the data validation process. It was noted that the samples were reported to the RDLs in the hardcopy laboratory reports; both the DLs and the method detection limits (MDLs) were listed in the EDDs. It was also noted that the data were reported in the units parts per million (mg/L) in the EDDs, while the sample data were reported in the units parts per billion ($\mu\text{g/L}$) and the QC samples were reported in the units mg/L in the level II laboratory reports. This did not affect the quality of the data. No other discrepancies were identified between the level II reports and the EDDs.

2.0 SELECTED VOLATILE ORGANIC COMPOUNDS BY EPA METHOD TO-15

The air samples were analyzed for VOCs per EPA Method TO-15.

The areas of data review are listed below. A leading check mark (✓) indicates an area of review in which the data were acceptable. A preceding crossed circle (⊗) signifies areas where issues were raised during the course of the validation review and should be considered to determine any impact on data quality and usability.

- ✓ Overall Assessment (Completeness)
- ✓ Holding Time
- ✓ Method Blank
- ✓ Matrix Spike/Matrix Spike Duplicate
- ✓ Laboratory Control Sample
- ✓ Laboratory Duplicate

- ✓ Surrogates
- ✓ Field Duplicate
- ✓ Trip Blank
- ✓ Sensitivity
- ✓ Electronic Data Deliverables Review

2.1 Overall Assessment (Completeness)

The selected VOC data reported in this package are considered to be usable for meeting project objectives. The analytical completeness, defined as the ratio of the number of valid analytical results (valid analytical results include values qualified as estimated) to the total number of analytical results requested on samples submitted for analysis, for the project is 100%.

2.2 Holding Time

The holding time for the VOC analysis of a SUMMA Canister sample is 30 days from collection to analysis. The holding times were met for the sample analyses.

2.3 Method Blank

Method blanks were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Three method blanks were reported (batches P160602, P160629 and P160801). VOCs were not detected in the method blanks above the method reporting limits (MRLs).

2.4 Matrix Spike/Matrix Spike Duplicate

MS/MSD pairs were not reported.

2.5 Laboratory Control Sample

LCSs were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Three LCSs were reported. The recovery results were within the laboratory specified acceptance criteria.

2.6 Laboratory Duplicate

Two laboratory duplicates, using samples SVE EFF-052416 and VW17d-95.5-062116, were reported. The RPD results were within the laboratory specified acceptance criteria.

2.7 Surrogates

Acceptable surrogate recoveries were reported for the sample analyses.

2.8 Field Duplicate

Field duplicates were not collected with the air sample sets.

2.9 Trip Blank

Trip blanks were not shipped with the air sample sets.

2.10 Sensitivity

The sample results were reported to the MRLs. No elevated non-detect values were reported.

2.11 Electronic Data Deliverables Review

Results and sample IDs in the EDDs were reviewed against the information provided by the associated level II reports at a minimum of 20% as part of the data validation process. It was noted that the samples were reported to the MRLs in the hardcopy laboratory reports; both the MRLs and the MDLs were listed in the EDDs. It was also noted that the data were reported in micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) in the EDDs, while the sample data were reported in both micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) and parts per billion by volume (ppbv). This did not affect the quality of the data. No other discrepancies were identified between the level II reports and the EDDs.

* * * * *

ATTACHMENT 1
DATA VALIDATION QUALIFIER DEFINITIONS
AND INTERPRETATION KEY
Assigned by Geosyntec's Data Validation Team

DATA QUALIFIER DEFINITIONS

- U The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
- J The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
- J+ The analyte was positively identified; however, the associated numerical value is likely to be higher than the concentration of the analyte in the sample due to positive bias of associated QC or calibration data or attributable to matrix interference.
- J- The analyte was positively identified; however, the associated numerical value is likely to be lower than the concentration of the analyte in the sample due to negative bias of associated QC or calibration data or attributable to matrix interference.
- UJ The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
- R The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

DATA VALIDATION REASON CODES
Assigned by Geosyntec's Data Validation Team

Valid Value	Description
1	Preservation requirement not met
2	Analysis holding time exceeded
3	Blank contamination (i.e., method, trip, equipment, etc.)
4	Matrix spike/matrix spike duplicate recovery or RPD outside limits
5	LCS recovery outside limits and RPD outside limits (LCS/LCSD)
6	Surrogate recovery outside limits
7	Field Duplicate RPD exceeded
8	Serial dilution percent difference exceeded
9	Calibration criteria not met
10	Linear range exceeded
11	Internal standard criteria not met
12	Lab duplicates RPD exceeded
13	Other

RPD-relative percent difference

Memorandum

Date: 17 January 2017
To: Cindy Bartlett, RG, LG, Geosyntec Consultants, Portland, Oregon
From: Geosyntec Quality Assurance Group, Knoxville, Tennessee
Subject: **Stage 2A Data Validation - Level II Data Deliverables – ESC Lab Sciences Work Orders L856780, L869969, L869976, L874078 and L874773 and ALS Environmental Service Request Numbers P1604174 and P1604638**

SITE: Cascade Corp, Fairview Oregon; Job No: PNG0564S16

INTRODUCTION

This report summarizes the findings of the Stage 2A data validation of eighteen groundwater samples, three air samples, two field duplicates, and four trip blanks, collected from August 24 – November 23, 2016, as part of the site investigation activities for the Cascade Corp, Fairview Oregon project. ESC Lab Sciences (ESC), Mt. Juliet, Tennessee and ALS Environmental, Simi Valley, California provided the analytical services.

The samples were analyzed for the following tests:

- EPA Method 8260B - Volatile Organic Compounds (VOCs)
- EPA Method TO-15 – Selected Volatile Organic Compounds (1,1-Dichloroethene, cis-1,2-Dichloroethene, Trichloroethene, Tetrachloroethene, and Vinyl Chloride)

EXECUTIVE SUMMARY

The samples were handled, prepared, and measured in the same manner under similar prescribed conditions.

Overall, based on this Stage 2A data validation covering the quality control (QC) parameters listed below, the data are usable for meeting project objectives.

The data were reviewed based on the pertinent methods referenced in the data package, professional and technical judgment and the following documents

- USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review, August 2014 (USEPA-540-R-013-001)

The following samples were analyzed in the data set:

Laboratory ID	Client ID
L856780-01	CMW17DS-083016
L856780-02	TRIP BLANK
L869969-01	CMW26DG-110116
L869969-02	CMW17DS-110116
L869969-03	EW2-110116
L869969-04	EW14-110116
L869969-05	EW1-110116
L869969-06	EW12-110116-L
L869969-07	EW12-110116-U
L869969-08	EW16-110116
L869969-09	D17DS-110116
L869969-10	CMW14RDS-110116
L869969-11	CMW18DS-110116
L869969-12	CMW18DS-110116-DUP

Laboratory ID	Client ID
L869969-13	CMW19DS-110116
L869969-14	CMW10DS-110116
L869969-15	TRIP LOT #357
L869976-01	TS-C-EFF-110116
L869976-02	TS-C-EFF-110116-DUP
L869976-03	TS-C-INF-110116
L874078-01	TRIPBLANK-161121
L874078-02	VMW-A-GW
L874773-01	VMW-B
L874773-02	TRIP BLANK VMW-B
P1604174-001	SVE EFF-082416
P1604638-001	VW 17d-95.5-092716
P1604638-002	SVE EFF-092716

The water samples were received at the laboratory at 3.2°C, 3.3°C, 3.1°C and 2.1°C, within the criteria 0-6°C.

The relinquished time was missing on the chain of custody (COC) forms in reports L856780 and P1604638.

L856780, L869969 and L869976: Sample collection times were not listed for the trip blanks. The trip blanks were logged in with a collection time of 00:00.

1.0 VOLATILE ORGANIC COMPOUNDS BY EPA METHOD 8260B

The groundwater samples were analyzed for VOCs per EPA Method 8260B.

The areas of data review are listed below. A leading check mark (✓) indicates an area of review in which the data were acceptable. A preceding crossed circle (⊗) signifies areas where issues were raised during the course of the validation review and should be considered to determine any impact on data quality and usability.

- ✓ Overall Assessment (Completeness)
- ✓ Holding Time
- ✓ Method Blank
- ✓ Matrix Spike/Matrix Spike Duplicate
- ✓ Laboratory Control Sample
- ✓ Surrogates
- ✓ Field Duplicate
- ✓ Trip Blank
- ✓ Sensitivity
- ✓ Electronic Data Deliverables Review

1.1 Overall Assessment (Completeness)

The VOC data reported in this package are considered usable for meeting project objectives. The analytical completeness, defined as the ratio of the number of valid analytical results (valid analytical results include values qualified as estimated) to the total number of analytical results requested on samples submitted for analysis, for the project is 100%.

1.2 Holding Time

The holding time for the VOC analysis of a preserved water sample is 14 days from collection to analysis. The holding times were met for the sample analyses.

1.3 Method Blank

Method blanks were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Six method blanks were reported (batches WG904114, WG923610, WG923614, WG924492, WG929068 and WG929908). VOCs were not detected in the method blanks above the reported detection limits (RDLs), with the following exception.

L874773: N-butylbenzene was detected at an estimated concentration greater than the method detection limit (MDL) and less than the RDL in the method blank in batch WG929908. Since n-butylbenzene was not detected in the associated samples, no qualifications were applied to the n-butylbenzene data.

1.4 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

Two batch MS/MSD pairs were reported. Since these are batch QC, the results do not affect the samples in this data set and qualifications were not applied to the data based on these results.

1.5 Laboratory Control Sample (LCS)

LCSs were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Six LCS/LCS duplicate (LCSD) pairs were reported. The recovery and relative percent difference (RPD) results were within the laboratory specified acceptance criteria, with the following exceptions.

L869969: The recoveries of 1,4-dichlorobenzene in the LCS/LCSD pair in batch WG923610 were high, outside the laboratory specified acceptance criteria. Since 1,4-dichlorobenzene was not detected in the associated samples, no qualifications were applied to the 1,4-dichlorobenzene data.

L869969 and L869976: The recoveries of acetone and the RPDs of acrolein and carbon disulfide in the LCS/LCSD pair in batch WG923614 were high, outside the laboratory specified acceptance criteria. Since acetone, acrolein and carbon disulfide were not detected in the associated samples, no qualifications were applied to the acetone, acrolein and carbon disulfide data.

L869976: The LCS recovery of acetone in batch WG924492 was high, outside the laboratory specified acceptance criteria. Since acetone was not detected in the associated samples, no qualifications were applied to the acetone data.

L874078 and L874773: One or both the recoveries of acrolein and carbon tetrachloride and the RPD of acetone in the LCS/LCSD pair in batch WG929068 were high, outside the laboratory specified acceptance criteria. Since acetone, acrolein and carbon tetrachloride were not detected in the associated samples, no qualifications were applied to the acetone, acrolein and carbon tetrachloride data.

L869976: The LCS recoveries of chlorobenzene and 1,3-dichloropropane in batch WG929908 were high, outside the laboratory specified acceptance criteria. Since chlorobenzene and 1,3-dichloropropane were not detected in the associated samples, no qualifications were applied to the chlorobenzene and 1,3-dichloropropane data.

1.6 Surrogates

Acceptable surrogate recoveries were reported for the sample analyses.

1.7 Field Duplicate

Two field duplicates were collected with the sample sets, CMW18DS-110116-DUP and TS-C-EFF-110116-DUP. Acceptable precision ($RPD \leq 30\%$) was demonstrated between the field duplicates and the original samples, CMW18DS-110116 and TS-C-EFF-110116, respectively.

1.8 Trip Blank

Four trip blanks, TRIP BLANK, TRIP LOT #357, TRIPBLANK-161121 and TRIP BLANK VMW-B accompanied the sample shipments. VOCs were not detected in the trip blanks above the RDLs.

1.9 Sensitivity

The sample results were reported to the RDLs. No elevated non-detect values were reported.

1.10 Electronic Data Deliverables (EDDs) Review

Results and sample IDs in the EDDs were reviewed against the information provided by the associated level II reports at a minimum of 20% as part of the data validation process. It was noted that the samples were reported to the RDLs in the hardcopy laboratory reports; both the RDLs and the MDLs were listed in the EDDs. It was also noted that the data were reported in the units parts per million (ppm) in the EDDs, while the sample data were reported in the units parts per billion (µg/L). This did not affect the quality of the data. No other discrepancies were identified between the level II reports and the EDDs.

2.0 SELECTED VOLATILE ORGANIC COMPOUNDS BY EPA METHOD TO-15

The air samples were analyzed for VOCs per EPA Method TO-15.

The areas of data review are listed below. A leading check mark (✓) indicates an area of review in which the data were acceptable. A preceding crossed circle (⊗) signifies areas where issues were raised during the course of the validation review and should be considered to determine any impact on data quality and usability.

- ✓ Overall Assessment (Completeness)
- ✓ Holding Time
- ✓ Method Blank
- ✓ Matrix Spike/Matrix Spike Duplicate
- ✓ Laboratory Control Sample
- ✓ Laboratory Duplicate
- ✓ Surrogates
- ✓ Field Duplicate
- ✓ Trip Blank
- ✓ Sensitivity
- ✓ Electronic Data Deliverables Review

2.1 Overall Assessment (Completeness)

The selected VOC data reported in this package are considered usable for meeting project objectives. The analytical completeness, defined as the ratio of the number of valid analytical results (valid analytical results include values qualified as estimated) to the total number of analytical results requested on samples submitted for analysis, for the project is 100%.

2.2 Holding Time

The holding time for the VOC analysis of a SUMMA Canister sample is 30 days from collection to analysis. The holding times were met for the sample analyses.

2.3 Method Blank

Method blanks were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Three method blanks were reported (batches P160902, P161004 and P161005). VOCs were not detected in the method blanks above the method reporting limits (MRLs).

2.4 Matrix Spike/Matrix Spike Duplicate

MS/MSD pairs were not reported.

2.5 Laboratory Control Sample

LCSs were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Three LCSs were reported. The recovery results were within the laboratory specified acceptance criteria.

2.6 Laboratory Duplicate

Laboratory duplicates were not reported with the data set.

2.7 Surrogates

Acceptable surrogate recoveries were reported for the sample analyses.

2.8 Field Duplicate

Field duplicates were not collected with the air sample sets.

2.9 Trip Blank

Trip blanks were not shipped with the air sample sets.

2.10 Sensitivity

The sample results were reported to the MRLs. Elevated non-detect values were reported for samples SVE EFF-082416, VW 17d-95.5-092716 and SVE EFF-092716 due to the sample dilutions analyzed.

2.11 Electronic Data Deliverables Review

Results and sample IDs in the EDDs were reviewed against the information provided by the associated level II reports at a minimum of 20% as part of the data validation process. It was noted that the samples were reported to the MRLs in the hardcopy laboratory reports; both the MRLs and the MDLs were listed in the EDDs. It was also noted that the data were reported in micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) in the EDDs, while the sample data were reported in both micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) and parts per billion by volume (ppbv). This did not affect the quality of the data. No other discrepancies were identified between the level II reports and the EDDs.

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ATTACHMENT 1
DATA VALIDATION QUALIFIER DEFINITIONS
AND INTERPRETATION KEY
Assigned by Geosyntec's Data Validation Team

DATA QUALIFIER DEFINITIONS

- U The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
- J The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
- J+ The analyte was positively identified; however, the associated numerical value is likely to be higher than the concentration of the analyte in the sample due to positive bias of associated QC or calibration data or attributable to matrix interference.
- J- The analyte was positively identified; however, the associated numerical value is likely to be lower than the concentration of the analyte in the sample due to negative bias of associated QC or calibration data or attributable to matrix interference.
- UJ The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
- R The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

DATA VALIDATION REASON CODES
Assigned by Geosyntec's Data Validation Team

Valid Value	Description
1	Preservation requirement not met
2	Analysis holding time exceeded
3	Blank contamination (i.e., method, trip, equipment, etc.)
4	Matrix spike/matrix spike duplicate recovery or RPD outside limits
5	LCS recovery outside limits and RPD outside limits (LCS/LCSD)
6	Surrogate recovery outside limits
7	Field Duplicate RPD exceeded
8	Serial dilution percent difference exceeded
9	Calibration criteria not met
10	Linear range exceeded
11	Internal standard criteria not met
12	Lab duplicates RPD exceeded
13	Other

RPD-relative percent difference

Memorandum

Date: 23 January 2017
To: Cindy Bartlett, RG, LG, Geosyntec Consultants, Portland, Oregon
From: Geosyntec Quality Assurance Group, Knoxville, Tennessee
Subject: **Stage 2A Data Validation - Level II Data Deliverables – ESC Lab Sciences Work Order L879450 and ALS Environmental Service Request Number P1605882**

SITE: Cascade Corp, Fairview Oregon; Job No: PNG0564S16

INTRODUCTION

This report summarizes the findings of the Stage 2A data validation of two groundwater samples, six air samples and one trip blank, collected from December 13-14, 2016, as part of the site investigation activities for the Cascade Corp, Fairview Oregon project. ESC Lab Sciences (ESC), Mt. Juliet, Tennessee and ALS Environmental, Simi Valley, California provided the analytical services.

The samples were analyzed for the following tests:

- EPA Method 8260B - Volatile Organic Compounds (VOCs)
- EPA Method TO-15 – Selected Volatile Organic Compounds (1,1-Dichloroethene, cis-1,2-Dichloroethene, Trichloroethene, Tetrachloroethene, and Vinyl Chloride)

EXECUTIVE SUMMARY

The samples were handled, prepared, and measured in the same manner under similar prescribed conditions.

Overall, based on this Stage 2A data validation covering the quality control (QC) parameters listed below, the data as qualified are usable for meeting project objectives.

The data were reviewed based on the pertinent methods referenced in the data package, professional and technical judgment and the following documents

- USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review, August 2014 (USEPA-540-R-013-001)

The following samples were analyzed in the data set:

Laboratory ID	Client ID
L879450-01	VMW-C-121316
L879450-02	VMW-D-121316
L879450-03	TRIP BLANK LOT #370
P1605882-001	VW17d-95.5-121416
P1605882-002	VMW-A-121416

Laboratory ID	Client ID
P1605882-003	VMW-C-121416
P1605882-004	VMW-B-121416
P1605882-005	VMW-D-121416
P1605882-006	EFF-121416

The water samples were received at the laboratory at 2.8°C, within the criteria 0-6°C.

1.0 VOLATILE ORGANIC COMPOUNDS BY EPA METHOD 8260B

The groundwater samples were analyzed for VOCs per EPA Method 8260B.

The areas of data review are listed below. A leading check mark (✓) indicates an area of review in which the data were acceptable. A preceding crossed circle (⊗) signifies areas where issues were raised during the course of the validation review and should be considered to determine any impact on data quality and usability.

- ✓ Overall Assessment (Completeness)
- ✓ Holding Time
- ✓ Method Blank
- ✓ Matrix Spike/Matrix Spike Duplicate
- ⊗ Laboratory Control Sample
- ✓ Surrogates
- ✓ Field Duplicate
- ✓ Trip Blank
- ✓ Sensitivity
- ✓ Electronic Data Deliverables Review

1.1 Overall Assessment (Completeness)

The VOC data reported in this package are considered usable for meeting project objectives. The analytical completeness, defined as the ratio of the number of valid analytical results (valid analytical results include values qualified as estimated) to the total number of analytical results requested on samples submitted for analysis, for the project is 100%.

1.2 Holding Time

The holding time for the VOC analysis of a preserved water sample is 14 days from collection to analysis. The holding times were met for the sample analyses.

1.3 Method Blank

Method blanks were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). One method blank was reported (batch WG936465). VOCs were not detected in the method blank above the reported detection limits (RDLs), with the following exception.

L879450: Hexachloro-1,3-butadiene and 1,2,3-trichlorobenzene were detected at estimated concentrations greater than the method detection limits (MDLs) and less than the RDLs in the method blank in batch WG936465. Since hexachloro-1,3-butadiene and 1,2,3-trichlorobenzene were not detected in the associated samples, no qualifications were applied to the data.

1.4 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

MS/MSD pairs were not reported with the data set.

1.5 Laboratory Control Sample (LCS)

LCSs were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). One LCS/LCS duplicate (LCSD) pair was reported. The recovery and relative percent difference (RPD) results were within the laboratory specified acceptance criteria, with the following exceptions.

L879450: The recoveries of acrolein in the LCS/LCSD pair in batch WG936465 were high, outside the laboratory specified acceptance criteria. Since acrolein was not detected in the associated samples, no qualifications were applied to the acrolein data. In addition, the recovery of 2,2-dichloropropane in the LCS was low, outside the laboratory specified acceptance criteria. Therefore, the nondetect 2,2-dichloropropane results in the associated samples were UJ qualified as estimated less than the MDL.

Sample	Compound	Laboratory Result (µg/L)	Laboratory Flag	Validation Result (µg/L)	Validation Qualifier*	Reason Code**
VMW-C-121316	2,2-Dichloropropane	1.00	U,J4	1.00	UJ	5
VMW-D-121316	2,2-Dichloropropane	1.00	U,J4	1.00	UJ	5
TRIP BLANK LOT #370	2,2-Dichloropropane	1.00	U,J4	1.00	UJ	5

µg/L-micrograms per liter

U-not detected at or above the RDL

J4-laborator flag indicating the associated batch QC was outside the laboratory limits for accuracy

*Validation qualifiers are defined in Attachment 1 at the end of this report

** Reason codes are defined in Attachment 2 at the end of this report

1.6 Surrogates

Acceptable surrogate recoveries were reported for the sample analyses.

1.7 Field Duplicate

Field duplicates were not collected with the sample set.

1.8 Trip Blank

One trip blank, TRIP BLANK LOT #370, accompanied the sample shipments. VOCs were not detected in the trip blank above the RDLs.

1.9 Sensitivity

The sample results were reported to the RDLs. No elevated non-detect values were reported.

1.10 Electronic Data Deliverable (EDD) Review

Results and sample IDs in the EDD were reviewed against the information provided by the associated level II report at a minimum of 20% as part of the data validation process. It was noted that the samples were reported to the RDLs in the hardcopy laboratory report; both the RDLs and the MDLs were listed in the EDD. It was also noted that the data were reported in the units parts per million (ppm) in the EDD, while the sample data were reported in the units parts per billion (µg/L). This did not affect the quality of the data. No other discrepancies were identified between the level II report and the EDD.

2.0 SELECTED VOLATILE ORGANIC COMPOUNDS BY EPA METHOD TO-15

The air samples were analyzed for VOCs per EPA Method TO-15.

The areas of data review are listed below. A leading check mark (✓) indicates an area of review in which the data were acceptable. A preceding crossed circle (⊗) signifies areas where issues were raised during the course of the validation review and should be considered to determine any impact on data quality and usability.

- ✓ Overall Assessment (Completeness)
- ✓ Holding Time
- ✓ Method Blank
- ✓ Matrix Spike/Matrix Spike Duplicate
- ✓ Laboratory Control Sample
- ✓ Laboratory Duplicate
- ✓ Surrogates
- ✓ Field Duplicate
- ✓ Trip Blank
- ✓ Sensitivity
- ✓ Electronic Data Deliverables Review

2.1 Overall Assessment (Completeness)

The selected VOC data reported in this package are considered usable for meeting project objectives. The analytical completeness, defined as the ratio of the number of valid analytical results (valid analytical results include values qualified as estimated) to the total number of analytical results requested on samples submitted for analysis, for the project is 100%.

2.2 Holding Time

The holding time for the VOC analysis of a SUMMA Canister sample is 30 days from collection to analysis. The holding times were met for the sample analyses.

2.3 Method Blank

Method blanks were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Two method blanks were reported (batches P161227 and P161228). VOCs were not detected in the method blanks above the method reporting limits (MRLs).

2.4 Matrix Spike/Matrix Spike Duplicate

MS/MSD pairs were not reported.

2.5 Laboratory Control Sample

LCSs were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Two LCSs were reported. The recovery results were within the laboratory specified acceptance criteria.

2.6 Laboratory Duplicate

Laboratory duplicates were not reported with the data set.

2.7 Surrogates

Acceptable surrogate recoveries were reported for the sample analyses.

2.8 Field Duplicate

Field duplicates were not collected with the air sample sets.

2.9 Trip Blank

Trip blanks were not shipped with the air sample sets.

2.10 Sensitivity

The sample results were reported to the MRLs. Elevated non-detect values were reported for samples VW17d-95.5-121416, VMW-A-121416, VMW-C-121416, VMW-B-121416 and VMW-D-121416 due to the sample dilutions analyzed.

2.11 Electronic Data Deliverables Review

Results and sample IDs in the EDD were reviewed against the information provided by the associated level II report at a minimum of 20% as part of the data validation process. It was noted that the samples were reported to the MRLs in the hardcopy laboratory report; both the MRLs and the MDLs were listed in the EDD. It was also noted that the data were reported in micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) in the EDD, while the sample data were reported in both micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) and parts per billion by volume (ppbv). This did not affect the quality of the data. No other discrepancies were identified between the level II report and the EDD.

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ATTACHMENT 1
DATA VALIDATION QUALIFIER DEFINITIONS
AND INTERPRETATION KEY
Assigned by Geosyntec's Data Validation Team

DATA QUALIFIER DEFINITIONS

- U The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
- J The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
- J+ The analyte was positively identified; however, the associated numerical value is likely to be higher than the concentration of the analyte in the sample due to positive bias of associated QC or calibration data or attributable to matrix interference.
- J- The analyte was positively identified; however, the associated numerical value is likely to be lower than the concentration of the analyte in the sample due to negative bias of associated QC or calibration data or attributable to matrix interference.
- UJ The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
- R The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

DATA VALIDATION REASON CODES
Assigned by Geosyntec's Data Validation Team

Valid Value	Description
1	Preservation requirement not met
2	Analysis holding time exceeded
3	Blank contamination (i.e., method, trip, equipment, etc.)
4	Matrix spike/matrix spike duplicate recovery or RPD outside limits
5	LCS recovery outside limits and RPD outside limits (LCS/LCSD)
6	Surrogate recovery outside limits
7	Field Duplicate RPD exceeded
8	Serial dilution percent difference exceeded
9	Calibration criteria not met
10	Linear range exceeded
11	Internal standard criteria not met
12	Lab duplicates RPD exceeded
13	Other

RPD-relative percent difference

APPENDIX G
TCE Mass Removal Estimates

Table G-1
TCE Mass Removal - January 1998 through December 2016
TSA Remedy - East Multnomah County

Date	Pounds of TCE Removed Per Year	Cumulative Pounds of TCE Removed
Jan-98	0.00	0.00
Aug-98	116.00	116.00
Feb-00	110.00	226.00
Feb-01	55.00	281.00
Feb-02	51.20	332.20
Feb-03	32.30	364.50
Feb-08	81.00	445.50
Feb-09	8.10	453.60
Feb-10	6.11	459.71
Feb-11	4.59	464.30
Feb-12	5.48	469.79
Feb-13	7.17	476.96
Dec-13	3.35	480.31
Dec-14	3.36	483.67
Dec-15	2.98	486.65
Dec-16	3.25	489.90

Table G-2
TCE Mass Removal Per Extraction Well
TSA Remedy - East Multnomah County

Date	Pounds of TCE Removed Per Well									
	EW-1	EW-2	EW-3	EW-13	EW-14	EW-15	EW-16	EW-18	EW-22	EW-23
March 2008- February 2009	1.02	2.03	1.54	0.47	1.69	0.60	0.08	0.13	0.12	0.43
March 2009- February 2010	0.68	1.93	1.07	0.20	1.52	0.21	0.04	0.08	0.00	0.38
March 2010- February 2011	0.79	1.70			1.41	0.03	0.05			0.61
March 2011- February 2012	1.86	1.60			1.58		0.00			0.46
March 2012- February 2013	1.72	3.10			1.36		0.22			0.77
March 2013-December 2013	0.80	1.34			0.83		0.00			0.37
2014	0.68	1.41			0.82		0.00			0.44
2015	0.60	1.22			0.74		0.00			0.43
2016	0.87	1.42			0.70		0.00			0.26

Notes

The amount of TCE removed by the extraction wells in the remedial systems was calculated by multiplying average monthly flow rates at each extraction well by estimated TCE concentration at the extraction wells at the mid-point of each month. The mid-monthly TCE concentrations were calculated by linear interpolation from the two near sampling dates.

