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ANNUAL PERFORMANCE REPORT
1 JANUARY 2016 – 31 DECEMBER 2016

TROUTDALE SANDSTONE AQUIFER REMEDY

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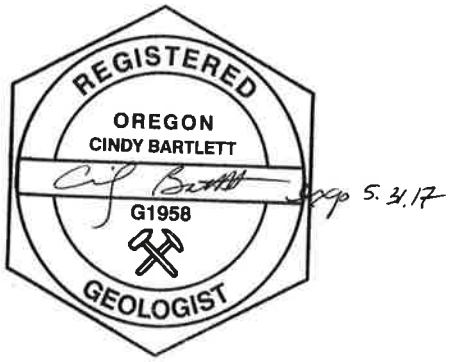
Troutdale Sandstone Aquifer Remedy

Prepared by:



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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 2015[1]. 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 25gpm, 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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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 report[1] 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.*

[1]Landau 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(usg)	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

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	
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

		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)**
PWB-2(lts)	Lower TSA	7701771.0	693589.1	45.1	44.32	-20.0	-40.0	90
RPW-1(ds)	*Upper TSA*	*7700327.8*	*693175.0*	*10.9*	*15.90*	*-63.0*	*-103.0*	*119*
BOP-44(usg)	SGA	7698996.3	691888.8	24.6	34.25	-181.0	-191.0	219
Vapor Extraction/Vapor Monitoring Wells								
VMW-17-45.5	*Upper TSA - Vapor*	*7,700,554.1*	*689,407.1*	*120.0*	*123.00*	*37.5*	*42.5*	*45*
VMW-17-75.5	*Upper TSA - Vapor*	*7,700,546.4*	*689,408.6*	*120.0*	*123.00*	*55.0*	*75.0*	*95*
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

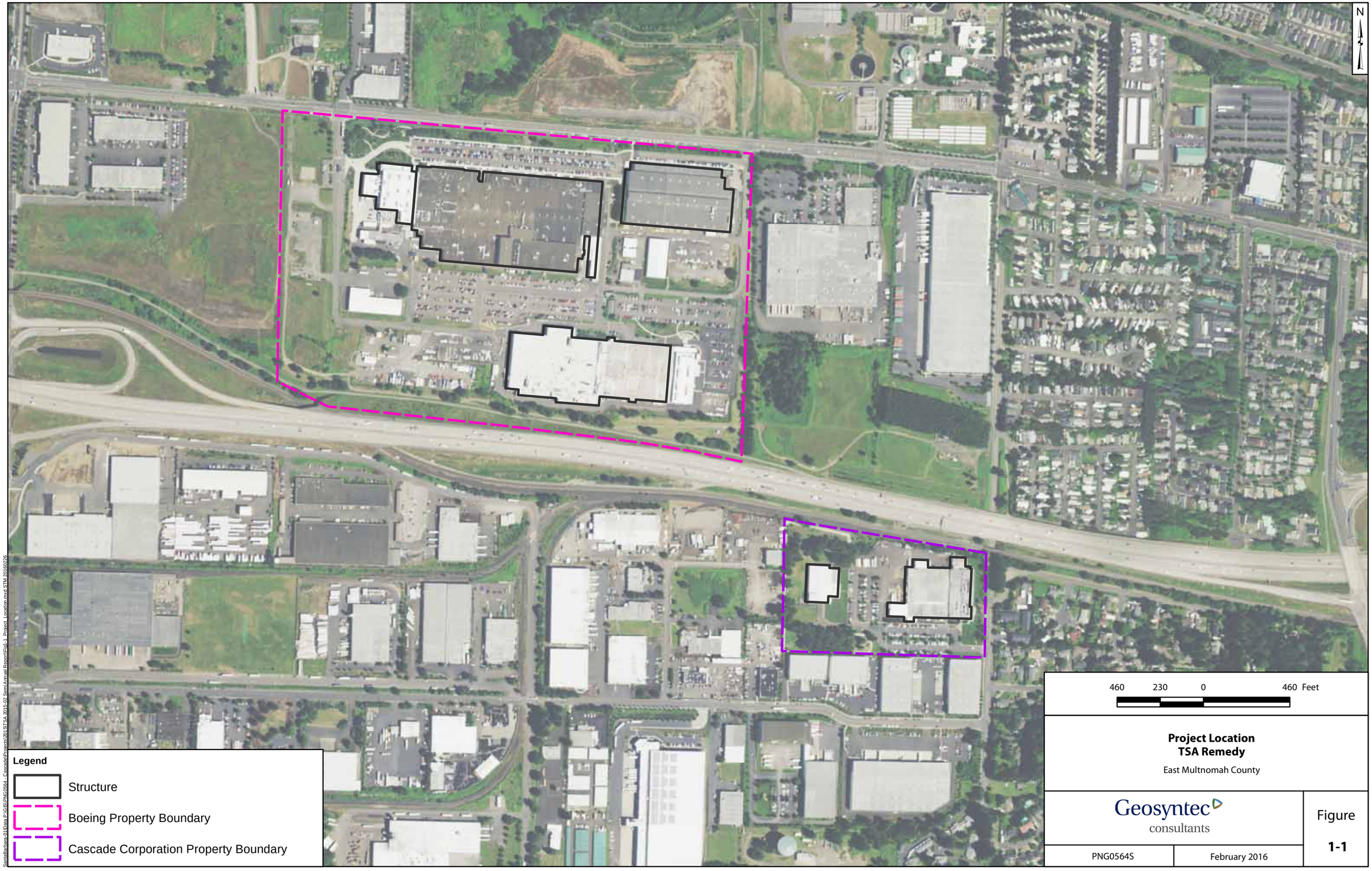
NOTES:

1. EW-16 pilot shutdown (quarterly cycling) began in November 2014; approved by DEQ 11/2/14.

2. 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



Project Location
TSA Remedy

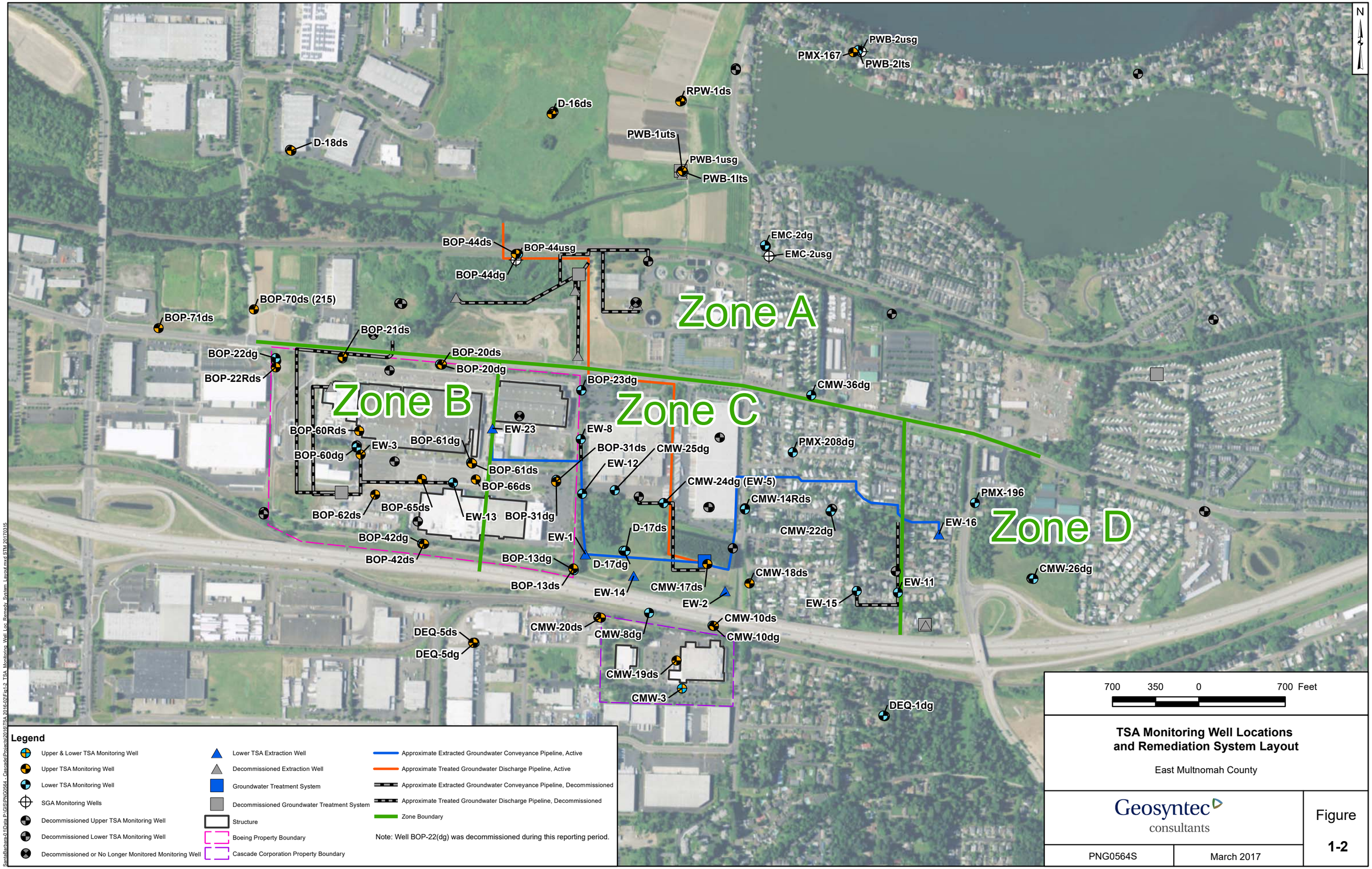
East Multnomah County

Geosyntec consultants

PNG0564S | February 2016

Figure **1-1**

S:\antaBarbara-01\Data P:\GIS\PNG\0564 - Cascade\Projects\2015\TSA 2015-02 Semi Annual Report\Fig1-1 Project Location.mxd STM 20160226



TSA Monitoring Well Locations and Remediation System Layout

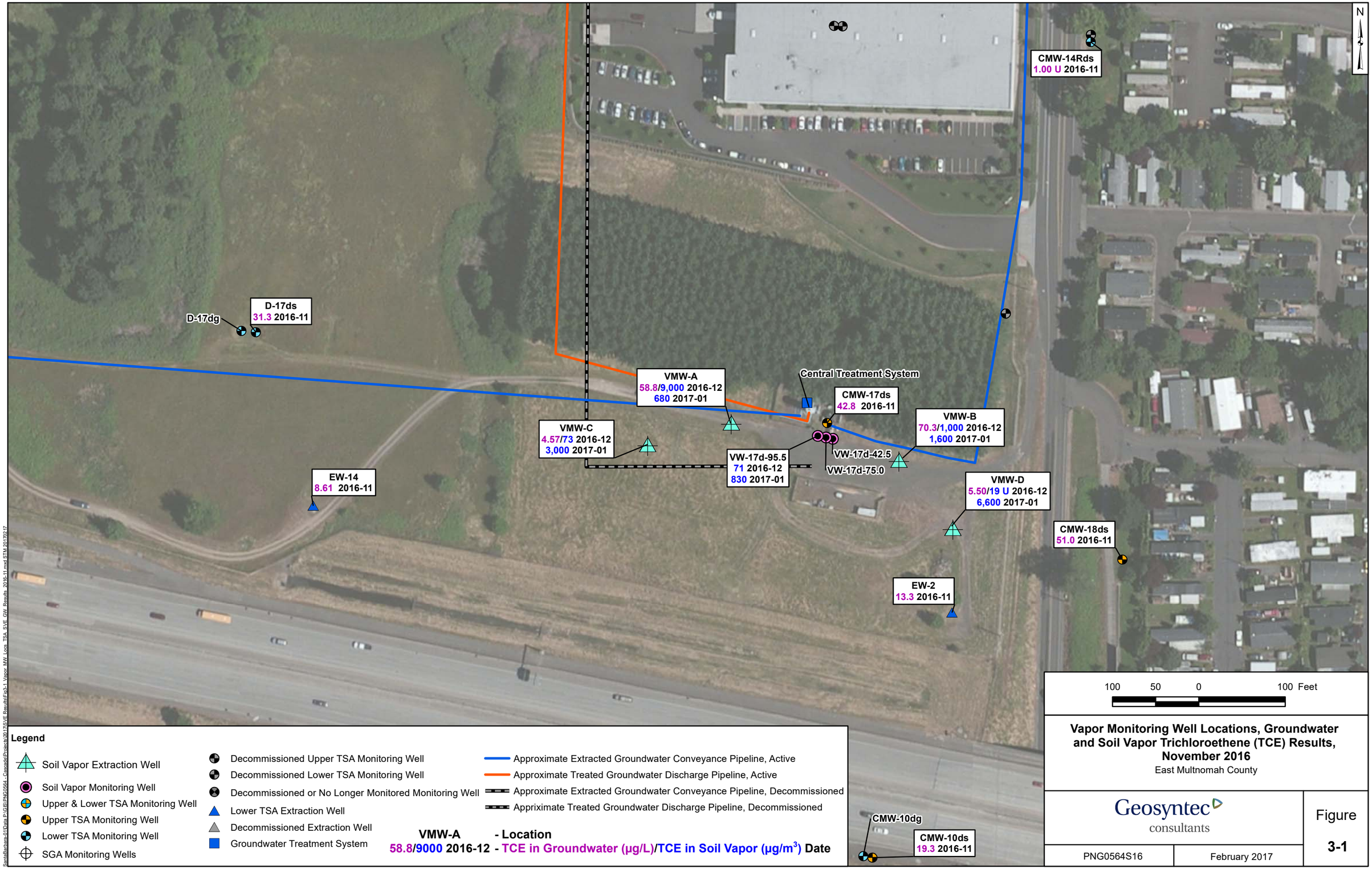
East Multnomah County

Geosyntec consultants

PNG0564S | March 2017

Figure 1-2

S:\antaBarbara-01\Data P:\GIS\PNG0564 - Cascade\Projects\2016\TSA 2016-02\Fig1-2_TSA_Monitoring_Well_Loc_Remedy_System_Layout.mxd STM 20170315



Legend

- Soil Vapor Extraction Well
- Soil Vapor Monitoring Well
- Upper & Lower TSA Monitoring Well
- Upper TSA Monitoring Well
- Lower TSA Monitoring Well
- SGA Monitoring Wells
- Decommissioned Upper TSA Monitoring Well
- Decommissioned Lower TSA Monitoring Well
- Decommissioned or No Longer Monitored Monitoring Well
- Lower TSA Extraction Well
- Decommissioned Extraction Well
- Groundwater Treatment System
- Approximate Extracted Groundwater Conveyance Pipeline, Active
- Approximate Treated Groundwater Discharge Pipeline, Active
- Approximate Extracted Groundwater Conveyance Pipeline, Decommissioned
- Appriximate Treated Groundwater Discharge Pipeline, Decommissioned

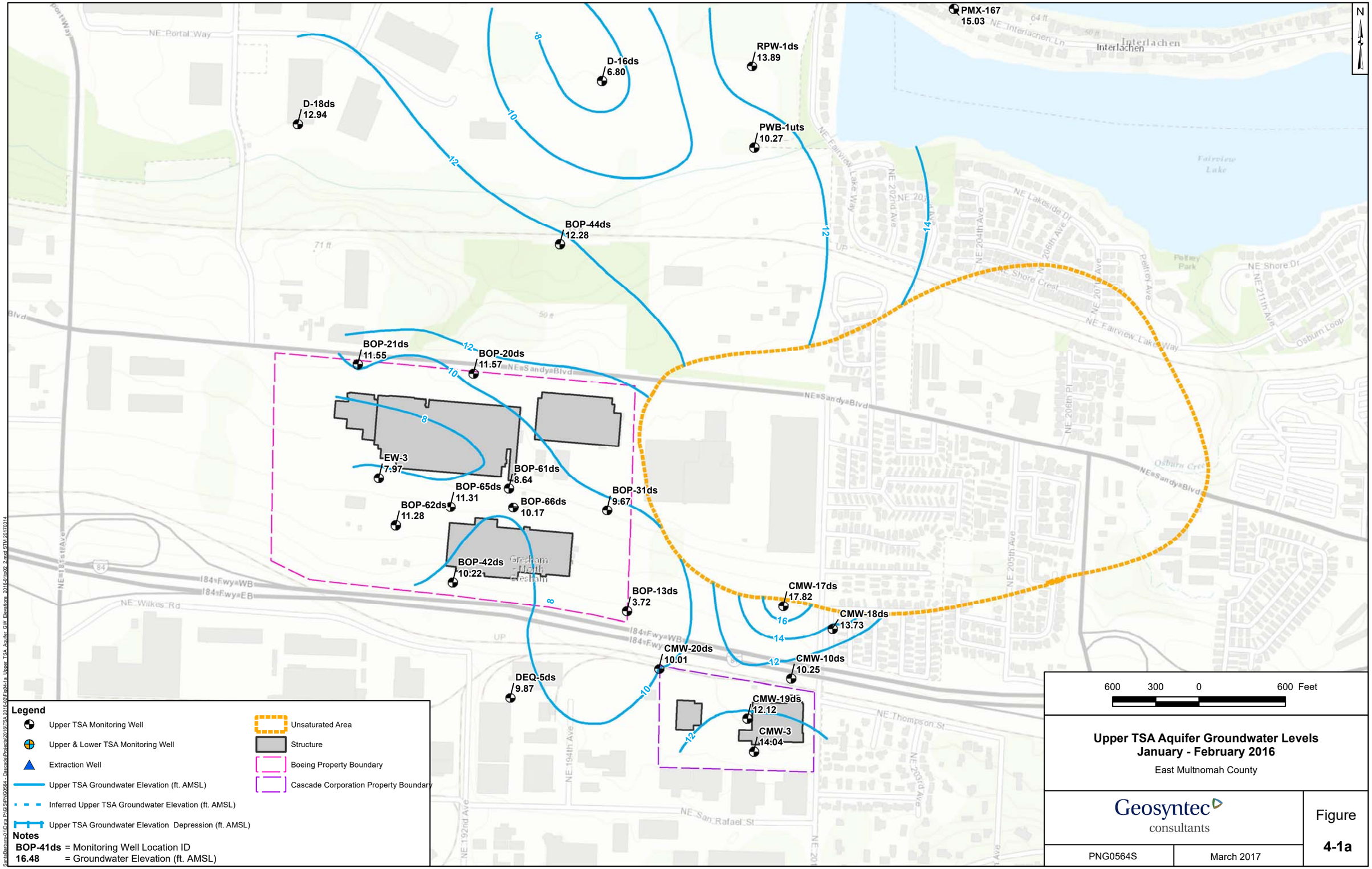
VMW-A - Location
58.8/9000 2016-12 - TCE in Groundwater (µg/L)/TCE in Soil Vapor (µg/m^3) Date

Vapor Monitoring Well Locations, Groundwater and Soil Vapor Trichloroethene (TCE) Results, November 2016

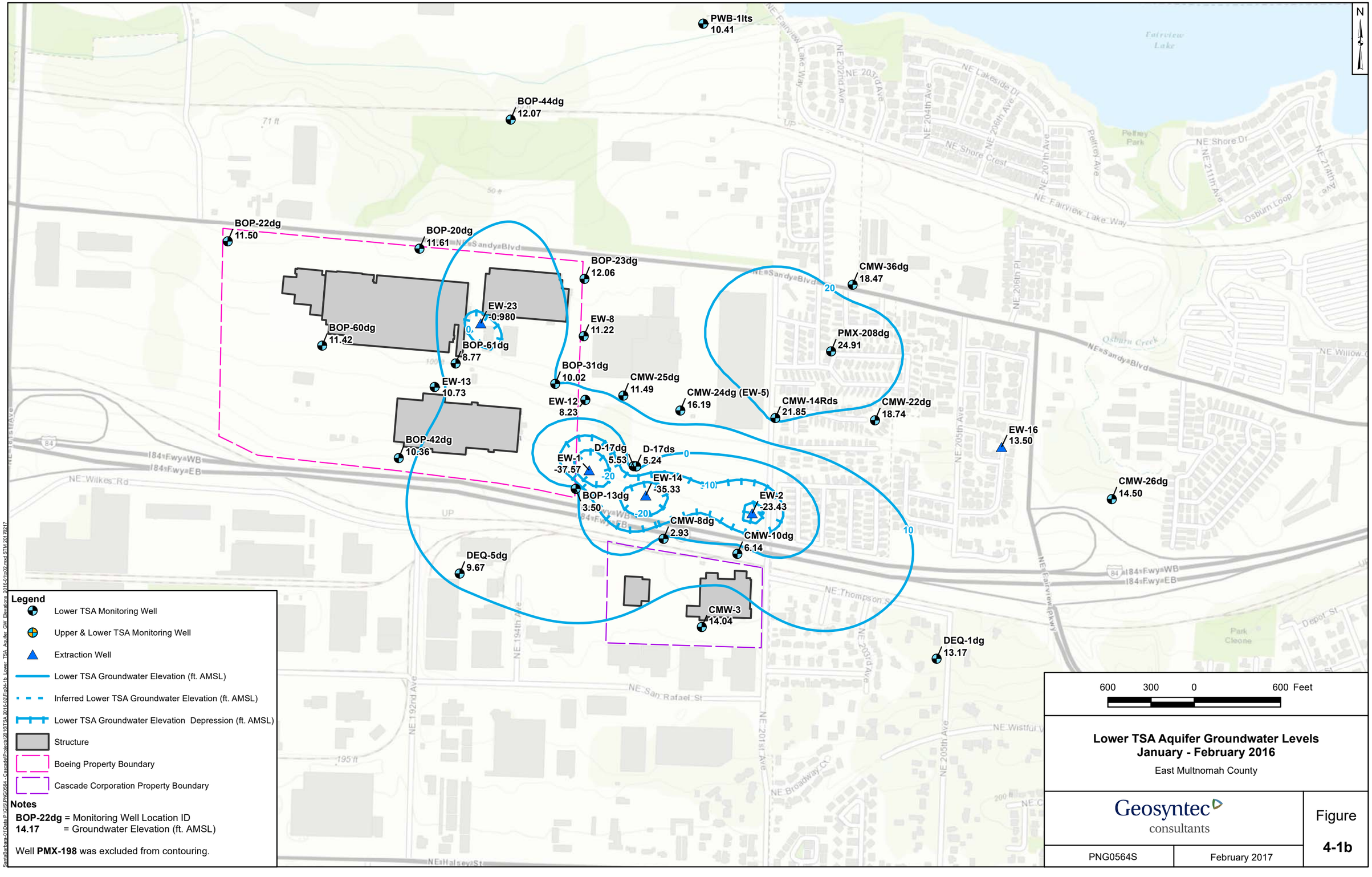
East Multnomah County

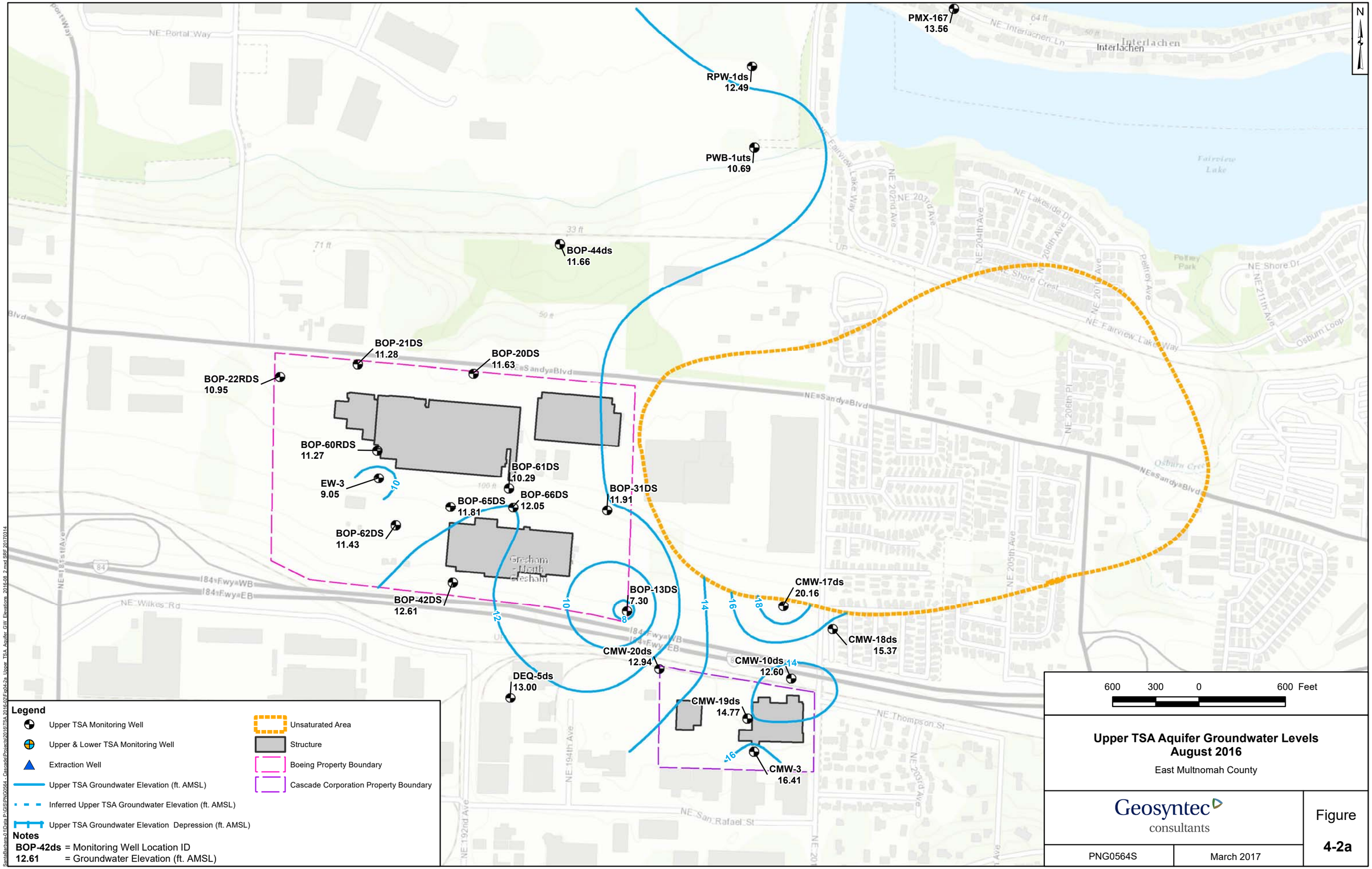
Geosyntec consultants

PNG0564S16 | February 2017 | Figure 3-1



S:\Santa Barbara\G1\Data P:\GIS\PNG\0564 - Cascade\Projects\2016\TSA 2016-02\Fig04-1a Upper TSA Aquifer GW Elevations 2016-01to02 2.mxd STM 20170314


PWB-1lts
10.41
BOP-44dg
12.07
BOP-22dg
11.50
BOP-20dg
11.61
BOP-23dg
12.06
CMW-36dg
18.47
EW-23
-0.980
BOP-60dg
11.42
EW-8
11.22
BOP-61dg
8.77
PMX-208dg
24.91
BOP-31dg
10.02
CMW-25dg
11.49
EW-13
10.73
EW-12
8.23
CMW-24dg (EW-5)
16.19
CMW-14Rds
21.85
CMW-22dg
18.74
EW-16
13.50
BOP-42dg
10.36
D-17dg
5.53
D-17ds
5.24
EW-1
-37.57
EW-14
-35.33
BOP-13dg
3.50
EW-2
-23.43
CMW-26dg
14.50
CMW-8dg
2.93
CMW-10dg
6.14
DEQ-5dg
9.67
CMW-3
14.04
DEQ-1dg
13.17
NE Fairview Lake Way
NE Sandy Blvd
NE Wilkes Rd
I84 Fwy WB
I84 Fwy EB
NE Thompson St
NE San Rafael St
NE Halsey St
NE Shore Dr
NE Lakeside Dr
NE Shore Crest
Osburn Loop
Osburn Creek
Pettey Park
Park Cleone
NE 192nd Ave
NE 194th Ave
NE 201st Ave
NE 205th Ave
NE 206th Pl
Legend
Lower TSA Monitoring Well
Upper & Lower TSA Monitoring Well
Extraction Well
Lower TSA Groundwater Elevation (ft. AMSL)
Inferred Lower TSA Groundwater Elevation (ft. AMSL)
Lower TSA Groundwater Elevation Depression (ft. AMSL)
Structure
Boeing Property Boundary
Cascade Corporation Property Boundary
Notes
BOP-22dg = Monitoring Well Location ID
14.17 = Groundwater Elevation (ft. AMSL)
Well PMX-198 was excluded from contouring.
600 300 0 600 Feet
Lower TSA Aquifer Groundwater Levels
January - February 2016
East Multnomah County
Geosyntec consultants
Figure
4-1b
PNG0564S
February 2017
N
SantaBarbara-01\Data P:\GIS\PNG0564 - Cascade\Projects\2016TSA 2016-02\Fig04-1b Lower TSA Aquifer GW Elevations 2016-01to02.mxd STM 2017/2/17



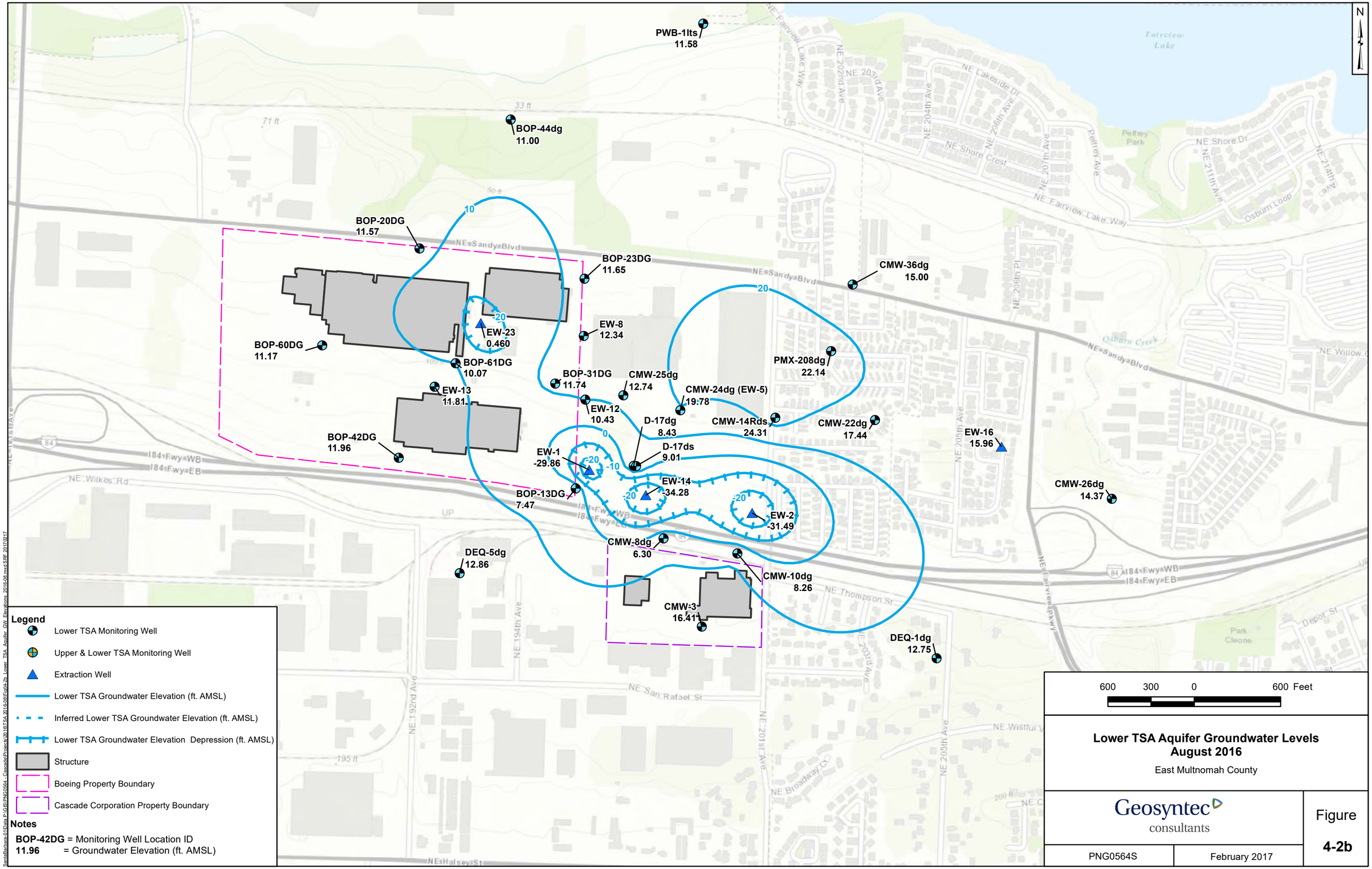
Upper TSA Aquifer Groundwater Levels August 2016

East Multnomah County

Geosyntec consultants

PNG0564S | March 2017

Figure 4-2a



EW-3
< 0.20

BOP-61ds
7.6

BOP-65ds
1.1

BOP-66ds
1.9

BOP-31ds
< 0.20

BOP-13ds
3.4

CMW-17ds
52.1

CMW-18ds
56.3

CMW-10ds
25.4 J

CMW-19ds
3.20

55
45
35
25
15
5

N

500 250 0 500 Feet

Legend

- Upper TSA Monitoring Well
- Upper & Lower TSA Monitoring Well
- Upper TSA Trichloroethene Contour (µg/L)
- Inferred Upper TSA Trichloroethene Contour (µg/L)
- Unsaturated Area
- Structure
- Boeing Property Boundary
- Cascade Corporation Property Boundary

Notes

CMW-10ds = Monitoring Well Location ID
22 = TCE Concentration (µg/L)

Maximum values are reported for locations with field duplicates and/or multiple depths.
If analyte was not detected, the minimum reporting limit was shown.

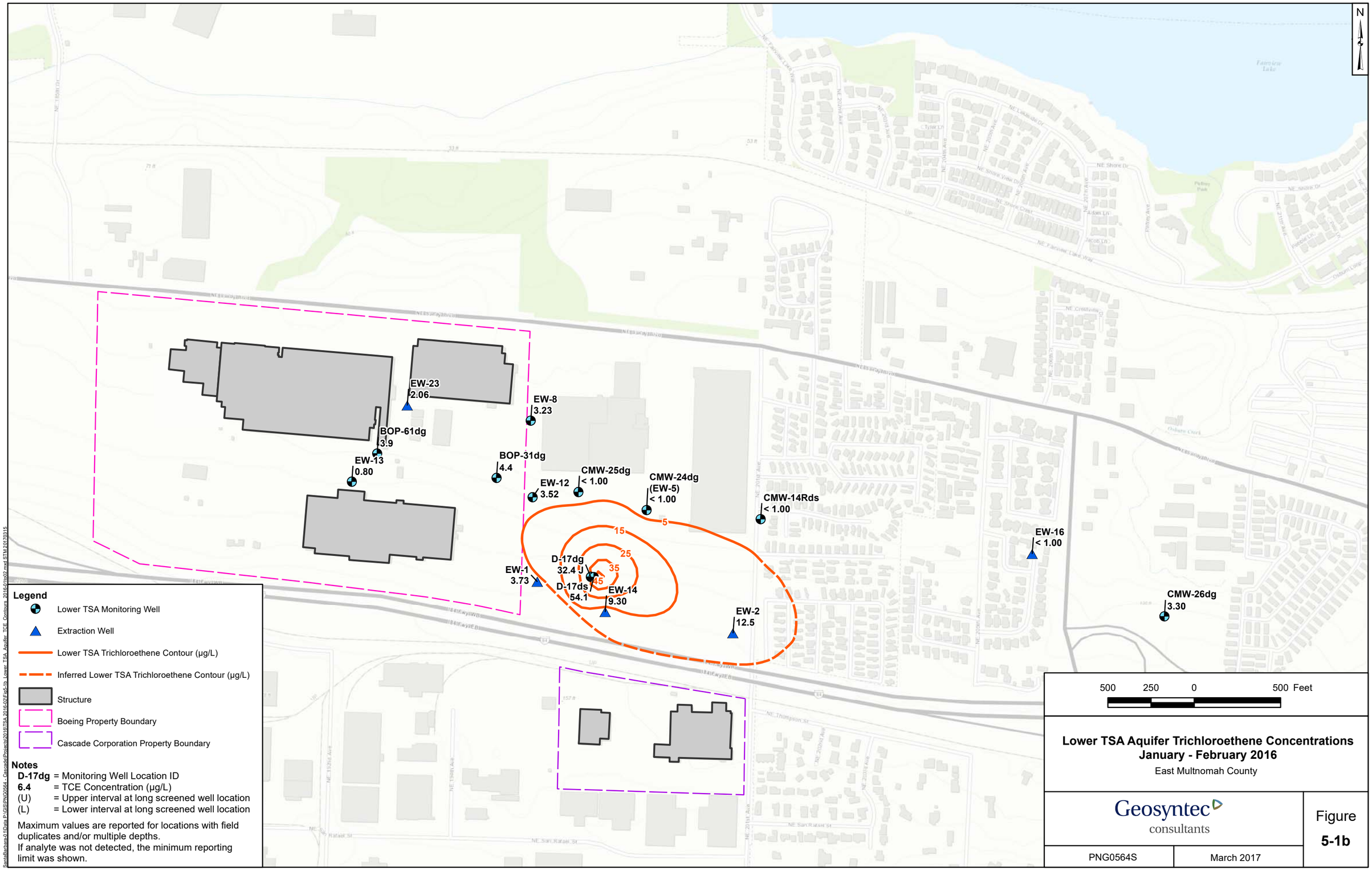
Upper TSA Aquifer Trichloroethene Concentrations January - February 2016

East Multnomah County

Geosyntec consultants

PNG0564S | February 2017

Figure **5-1a**


N
EW-23
2.06
EW-8
3.23
BOP-61dg
3.9
EW-13
0.80
BOP-31dg
4.4
EW-12
3.52
CMW-25dg
< 1.00
CMW-24dg
(EW-5)
< 1.00
CMW-14Rds
< 1.00
EW-16
< 1.00
CMW-26dg
3.30
D-17dg
32.4 J
D-17ds
54.1
EW-1
3.73
EW-14
9.30
EW-2
12.5
5
15
25
35
45
Legend
Lower TSA Monitoring Well
Extraction Well
Lower TSA Trichloroethene Contour (µg/L)
Inferred Lower TSA Trichloroethene Contour (µg/L)
Structure
Boeing Property Boundary
Cascade Corporation Property Boundary
Notes
D-17dg = Monitoring Well Location ID
6.4 = TCE Concentration (µg/L)
(U) = Upper interval at long screened well location
(L) = Lower interval at long screened well location
Maximum values are reported for locations with field duplicates and/or multiple depths.
If analyte was not detected, the minimum reporting limit was shown.
500 250 0 500 Feet
Lower TSA Aquifer Trichloroethene Concentrations
January - February 2016
East Multnomah County
Geosyntec consultants
Figure
5-1b
PNG0564S
March 2017
SantaBarbara:d:\Data P:\GIS\PNG\0564 - Cascade\Projects\2016\TSA 2016-02\Fig5-1b Lower TSA Aquifer TCE Contours 2016-01to02.mxd STM 20170315

BOP-22Rds
< 0.20

BOP-21ds
< 0.20

BOP-20ds
0.20

EW-3
< 0.20

BOP-61ds
5.8

BOP-66ds
1.1

BOP-65ds
0.90

BOP-31ds
< 0.20

BOP-62ds
0.60

BOP-42ds
< 0.20

BOP-13ds
2.9

CMW-17ds
38.6

CMW-18ds
78.7 J

CMW-20ds
< 1.00

CMW-10ds
21.0

CMW-19ds
< 1.00

75
65
55
45
35
25
15
5

Legend

- Upper TSA Monitoring Well
- Upper & Lower TSA Monitoring Well
- Upper TSA Trichloroethene Countour (µg/L)
- Inferred Upper TSA Trichloroethene Countour (µg/L)
- Unsaturated Area
- Structure
- Boeing Property Boundary
- Cascade Corporation Property Boundary

Notes

CMW-10ds = Monitoring Well Location ID
21.0 = TCE Concentration (µg/L)

Maximum values are reported for locations with field duplicates and/or multiple depths.
If analyte was not detected, the minimum reporting limit was shown.

N

500 250 0 500 Feet

Upper TSA Aquifer Trichloroethene Concentrations August 2016

East Multnomah County

Geosyntec consultants

PNG0564S | March 2017

Figure **5-2a**

SantaBarbara-01\Data P:\GIS\PNG0564 - Cascade\Projects\20161ETSA 2016-08\Fig5-2a Upper TSA Aquifer TCE Contours 2016-08.mxd SRF 20170307

BOP-20dg
< 0.20

BOP-23dg
1.0

EW-23
2.06

BOP-60dg
2.3

BOP-61dg
5.6

EW-8
< 1.00

EW-13
0.60

BOP-31dg
4.5

CMW-25dg
< 1.00

CMW-24dg
(EW-5)
< 1.00

CMW-14Rds
< 1.00

EW-12
1.22 J (U) / 3.65 J (L)

BOP-42dg
1.5

EW-1
4.26

D-17dg
2.86 J

D-17ds
22.0 J

BOP-13dg
1.3

EW-14
7.77

EW-2
11.5

CMW-10dg
< 1.00

EW-16
2.98

CMW-26dg
2.85

CMW-36dg
< 1.00

5

15

N

Legend

- Lower TSA Monitoring Well
- Extraction Well
- Lower TSA Trichloroethene Countour (µg/L)
- Structure
- Boeing Property Boundary
- Cascade Corporation Property Boundary

Notes

D-17dg = Monitoring Well Location ID
6.4 = TCE Concentration (µg/L)
(U) = Upper interval at long screened well location
(L) = Lower interval at long screened well location

Maximum values are reported for locations with field duplicates and/or multiple depths.
If analyte was not detected, the minimum reporting limit was shown.

500 250 0 500 Feet

Lower TSA Aquifer Trichloroethene Concentrations August 2016

East Multnomah County

Geosyntec consultants

PNG0564S | March 2017

Figure **5-2b**

SantaBarbara-0:\Data P:\GIS\PNG0564 - Cascade\Projects\2016\TSA 2016-08\Fig5-2b_Lower_TSA_Aquifer_TCE_Contours_2016-08.mxd SRF 2017/03/15

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**
EW-23	*28*	*28*	*29*	*27*	*29*	*29*	*29*	*29*	*29*	*29*	*26*	*27*	*30*
Zone C	**98**	**113**	**107**	**102**	**98**	**91**	**78**	**114**	**107**	**98**	**94**	**96**	**84**
EW-1	*49*	*60*	*54*	*49*	*45*	*40*	*28*	*67*	*63*	*54*	*52*	*51*	*43*
EW-2	*26*	*34*	*34*	*32*	*32*	*30*	*29*	*26*	*24*	*24*	*24*	*24*	*22*
EW-14	*20*	*19*	*19*	*20*	*21*	*22*	*21*	*21*	*19*	*20*	*19*	*20*	*19*
Zone D	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
EW-16	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
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	—	ºF	—	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	—	ºF	—	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	—	ºF	—	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	—	ºF	—	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	—	ºF	—	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

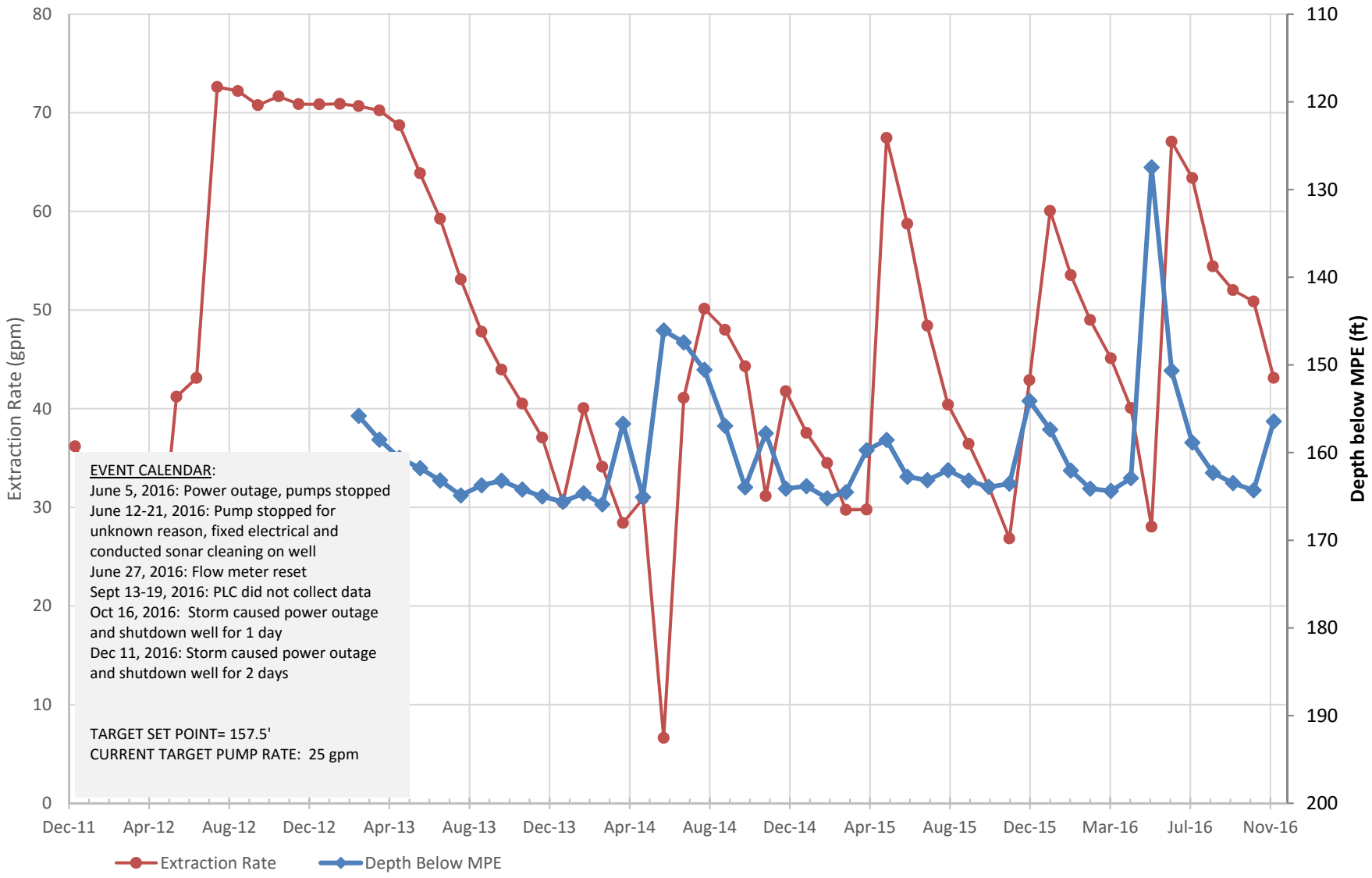
Parameter	Discharge Limitations[a]	Unit	Sample Date	System Discharge			Number of Exceedances	Sample Frequency
				Min	Avg	Max		
June 2016								
pH	6.0 – 9.0	su	—	7.60	7.65	7.70	0	Weekly
Temperature	—	ºF	—	56	57	58	—	Weekly
Flow[#]	—	gpm	—	-	143	-	—	Daily
July 2016								
pH	6.0 – 9.0	su	—	7.60	7.75	7.80	0	Weekly
Temperature	—	ºF	—	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	—	ºF	—	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	—	ºF	—	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	—	ºF	—	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	—	ºF	—	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	—	ºF	—	46	56	60	—	Weekly
Flow[#]	—	gpm	—	-	141	-	—	Daily

NOTES:

[a]Discharge 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.

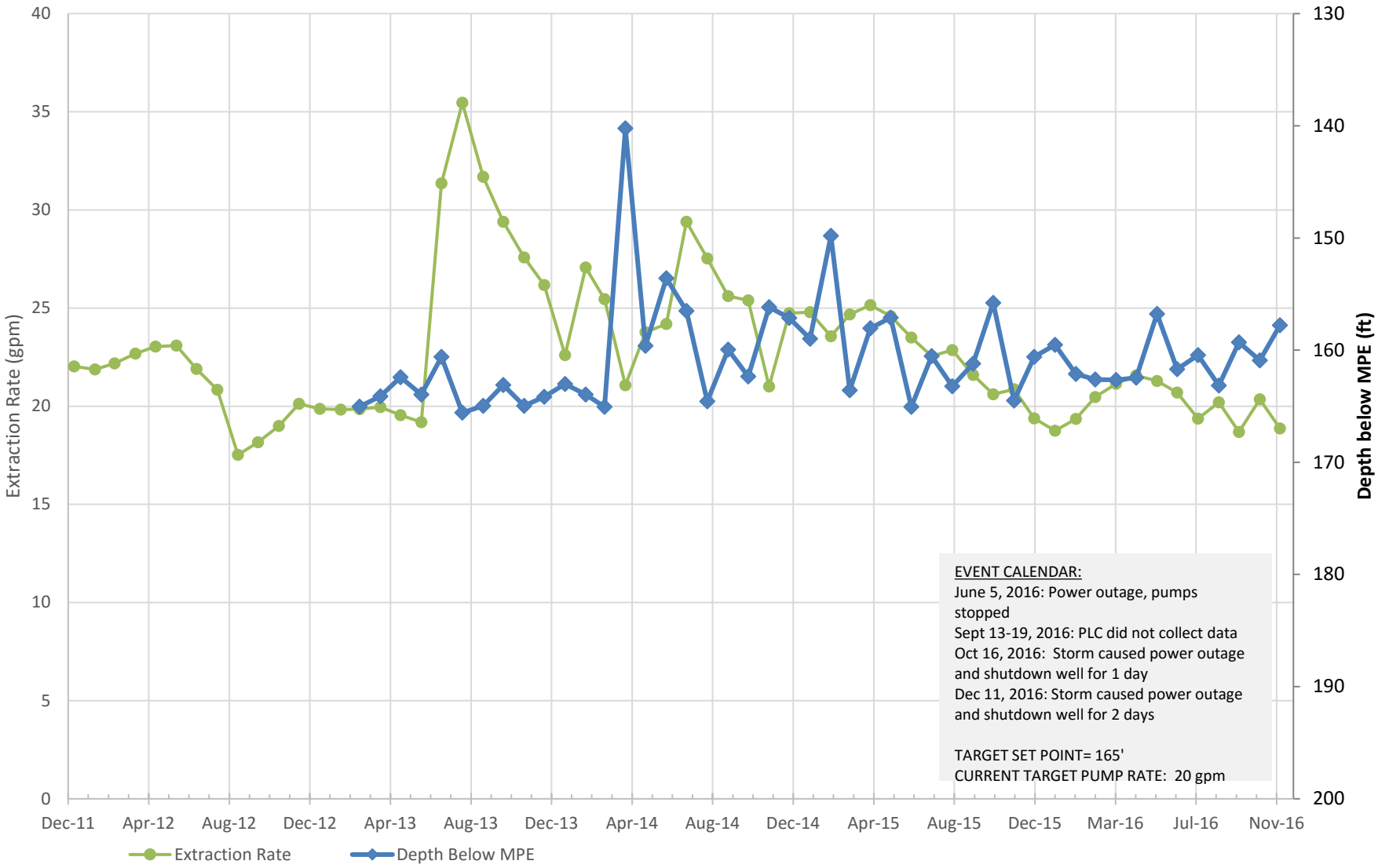
[#]Flow includes EW-1, EW-2, EW-14, and EW-23.

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



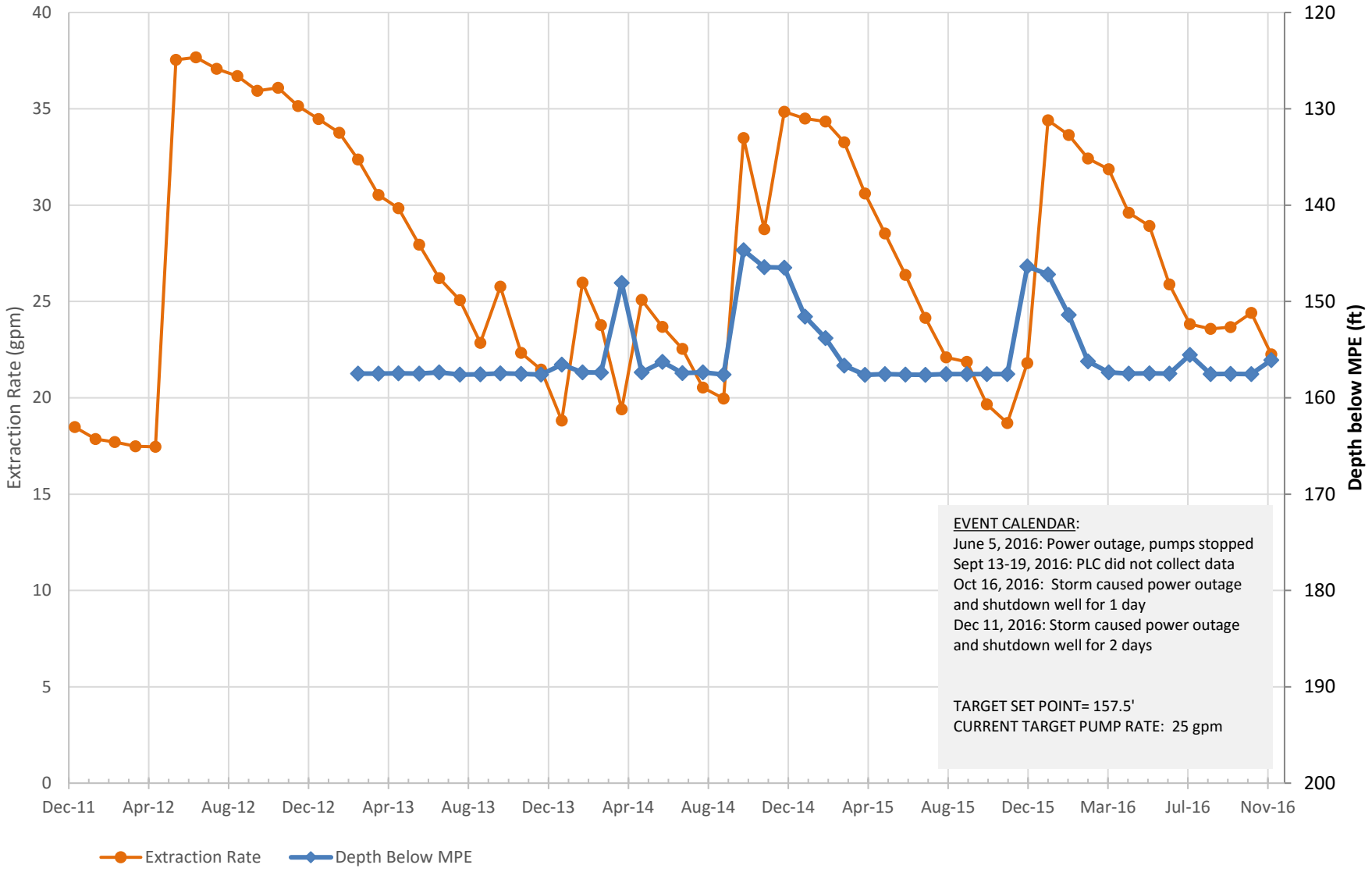
Geosyntec consultants

Cascade Corporation Gresham, Oregon	**EW-1 Monthly Average Extraction Rate** **TSA Remedy**	Figure A-1



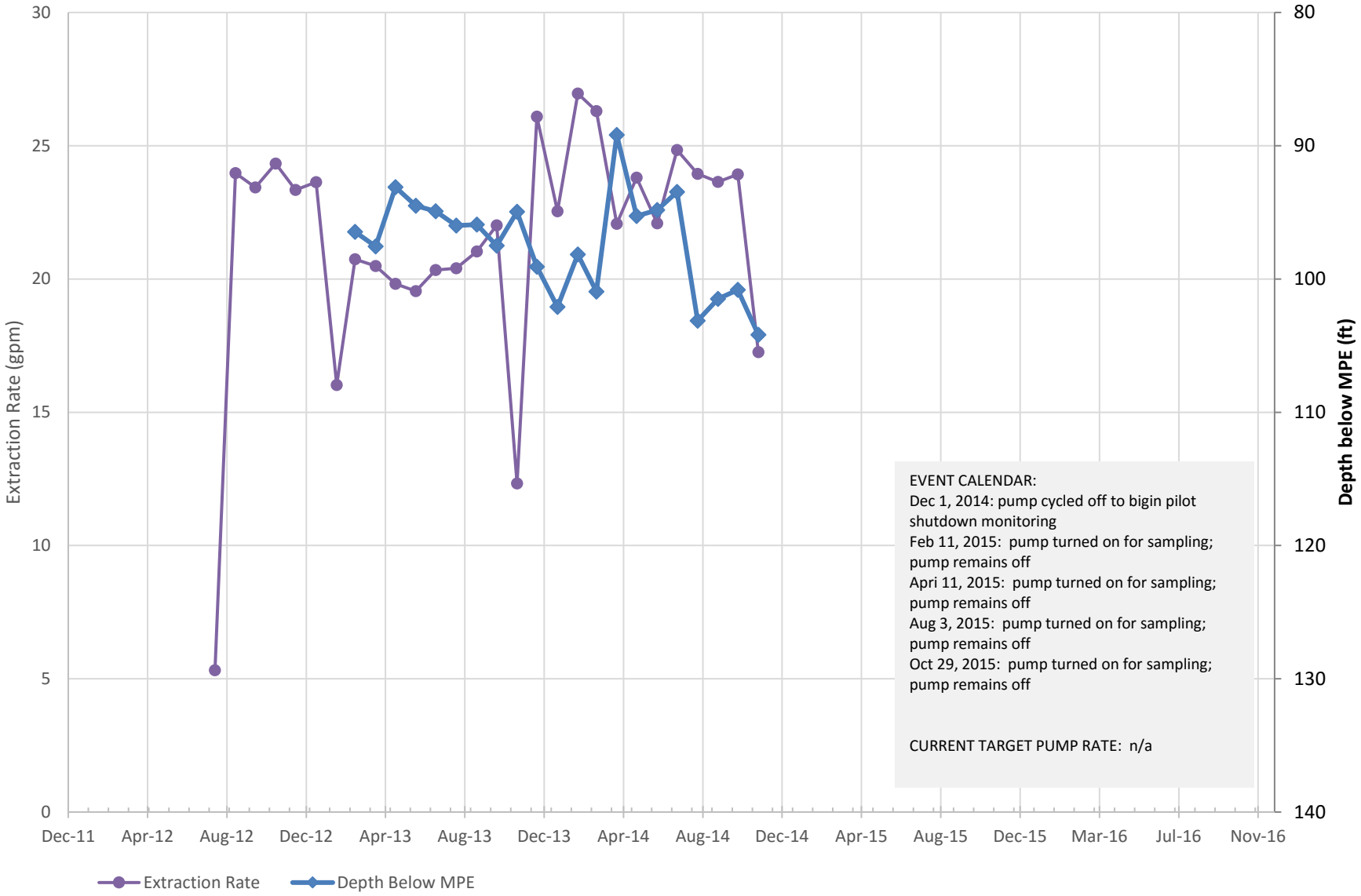
Geosyntec consultants

Cascade Corporation Gresham, Oregon	**EW-14 Monthly Average Extraction Rate** **TSA Remedy**	Figure A-3



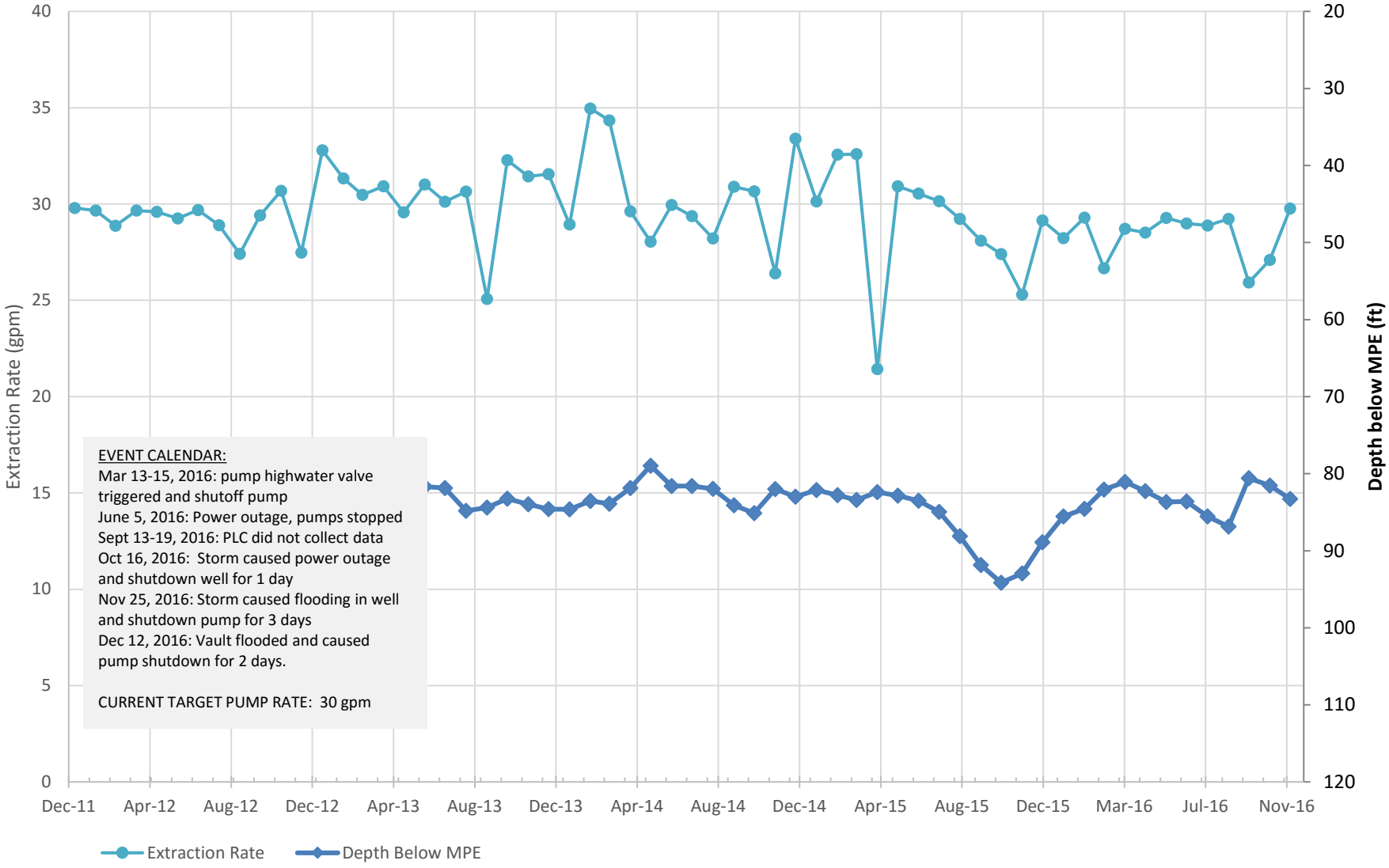
Geosyntec consultants

Cascade Corporation Gresham, Oregon	**EW-2 Monthly Average Extraction Rate** **TSA Remedy**	Figure A-2



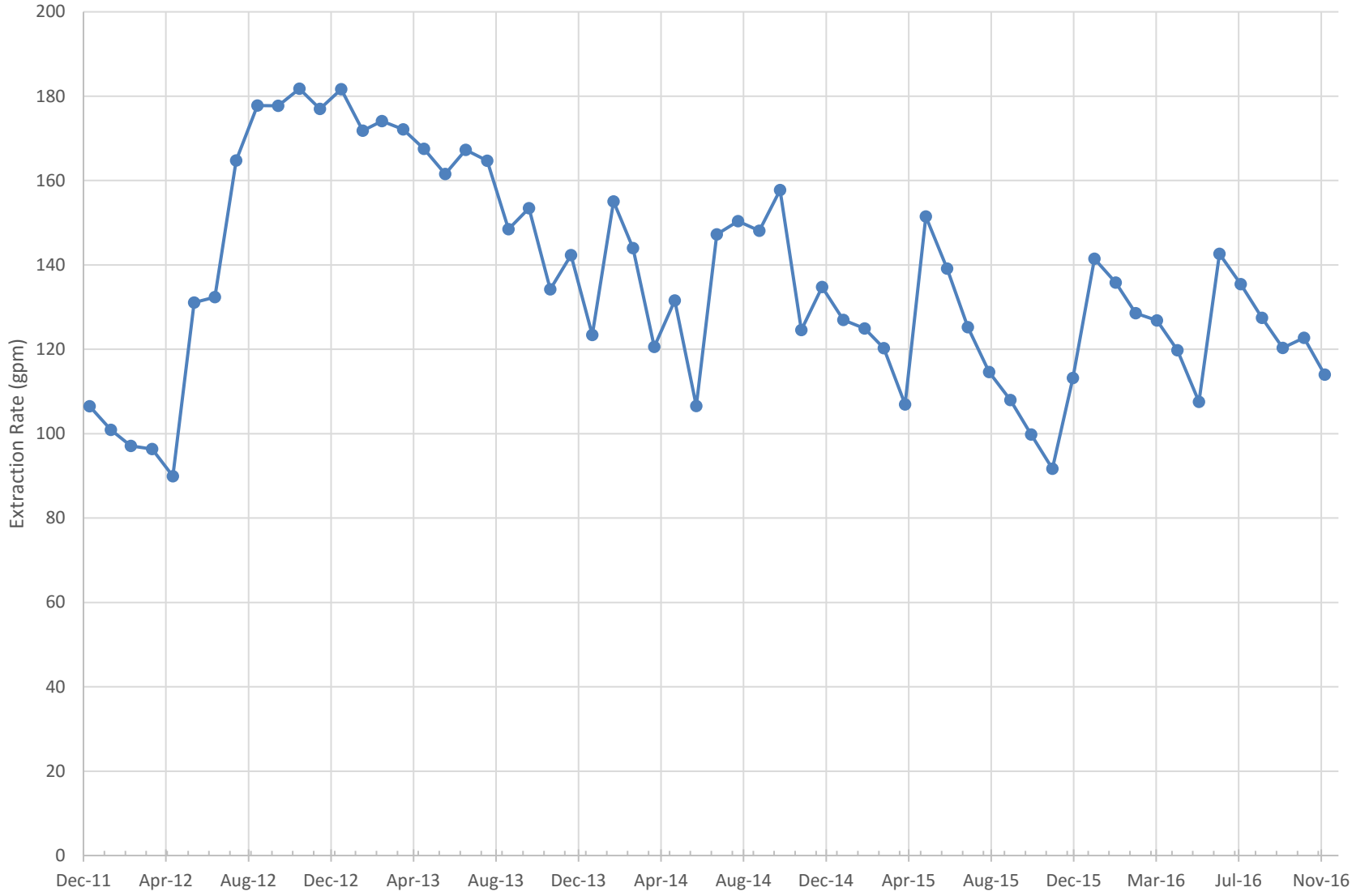
Geosyntec consultants

Cascade Corporation Gresham, Oregon	**EW-16 Monthly Average Extraction Rate** **TSA Remedy**	Figure A-4



Geosyntec consultants

Cascade Corporation Gresham, Oregon	**EW-23 Monthly Average Extraction Rate** **TSA Remedy**	Figure A-5



Geosyntec consultants

Cascade Corporation Gresham, Oregon	**Total Extraction Rate for Remedy Wells** **TSA Remedy**	Figure A-6

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

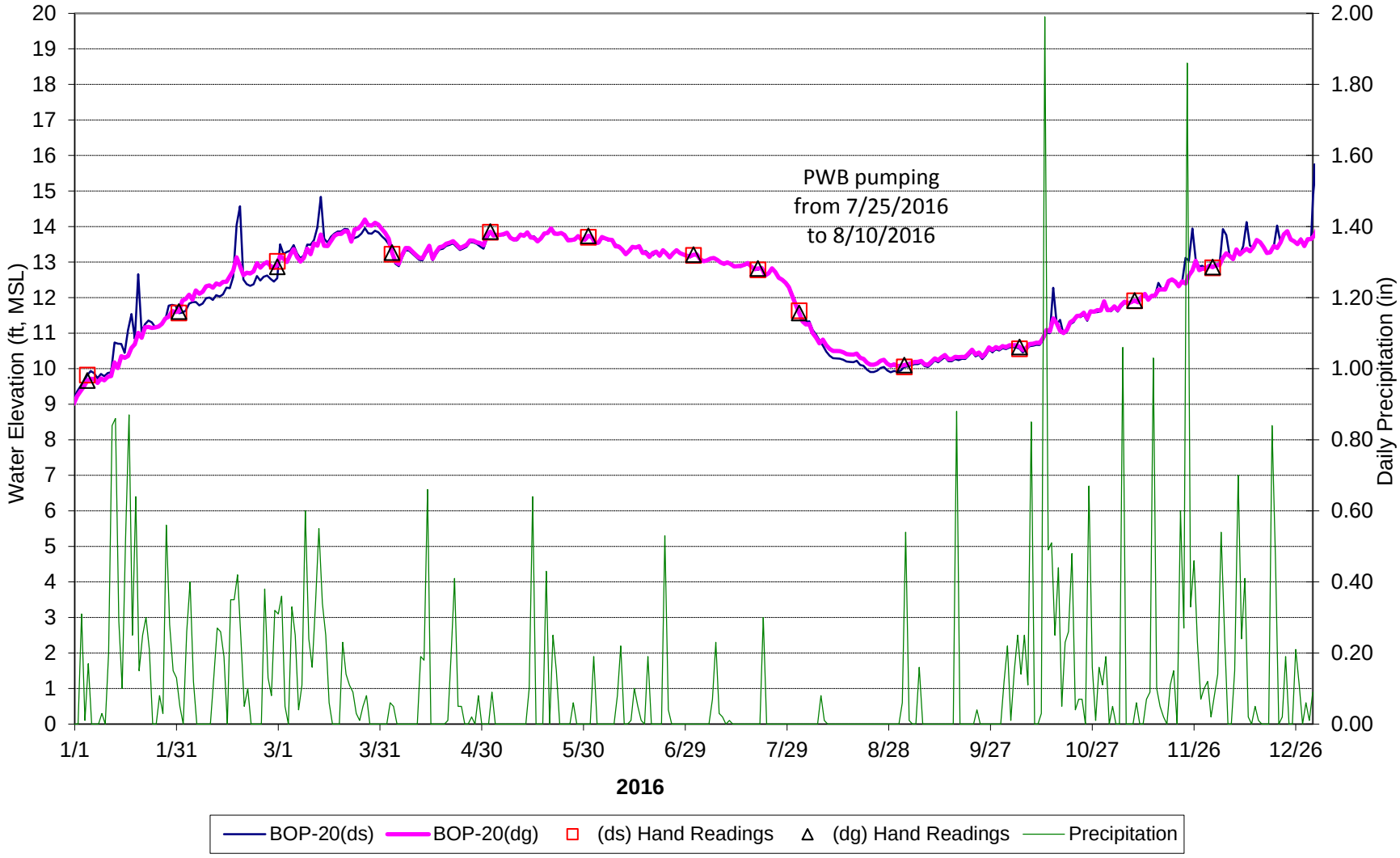
TSA Zone	Well ID	Date	Time	Top of Casing Elevation (ft MSL)	Depth to Water (ft below TOC)	Groundwater Elevation (ft MSL)
Upper	BOP-31ds	2/1/2016	14:19	99.04	89.37	9.67
Upper	BOP-31ds	5/2/2016	8:11	99.04	86.12	12.92
Upper	BOP-31ds	8/2/2016	12:17	99.04	87.13	11.91
Upper	BOP-31ds	11/16/2016	12:05	99.04	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

Notes:
ft MSL = feet above mean sea level
TOC = top of casing

Source: \\edmdata01\projects\025\116\WIP\T\Dataloggers\2016



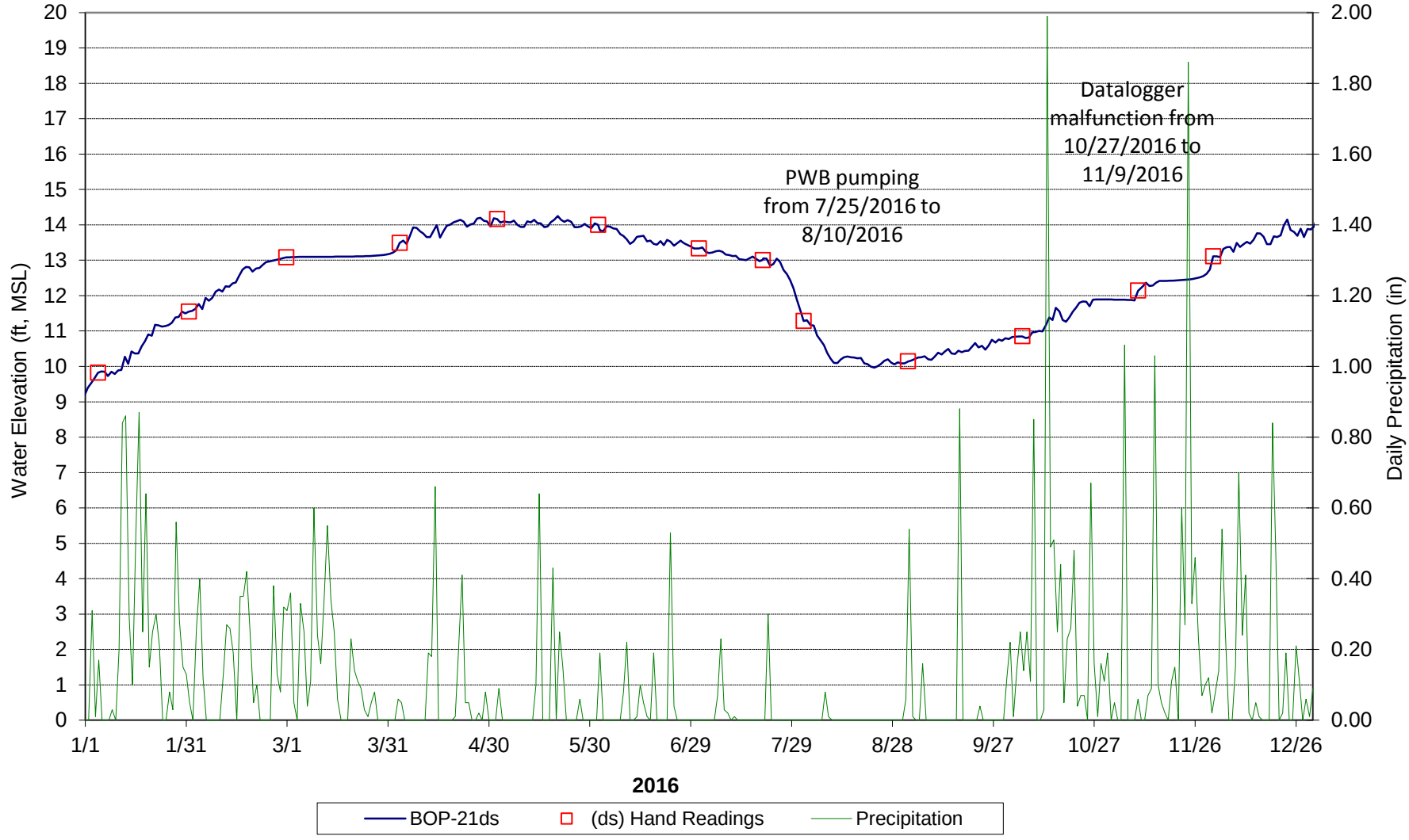
LANDAU ASSOCIATES

Boeing Portland
Gresham, Oregon

Hydrograph for TSA Well BOP-20(ds, dg)

Figure
B-1

Source: \\edmdata01\projects\025\116\WIP\T\Dataloggers\2016

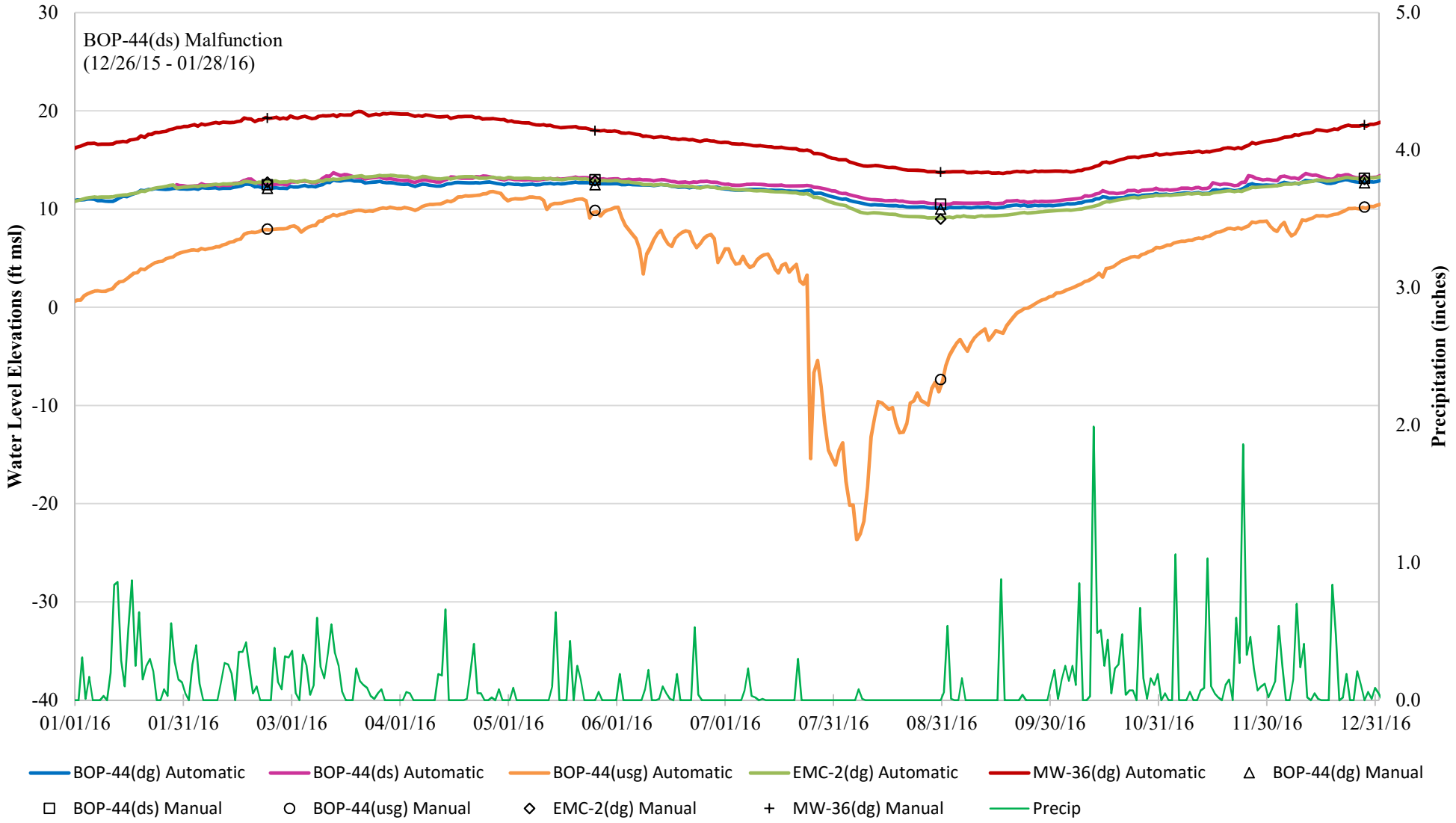


LANDAU ASSOCIATES

Boeing Portland
Gresham, Oregon

Hydrograph for TSA Well BOP-21(ds)

Figure
B-2



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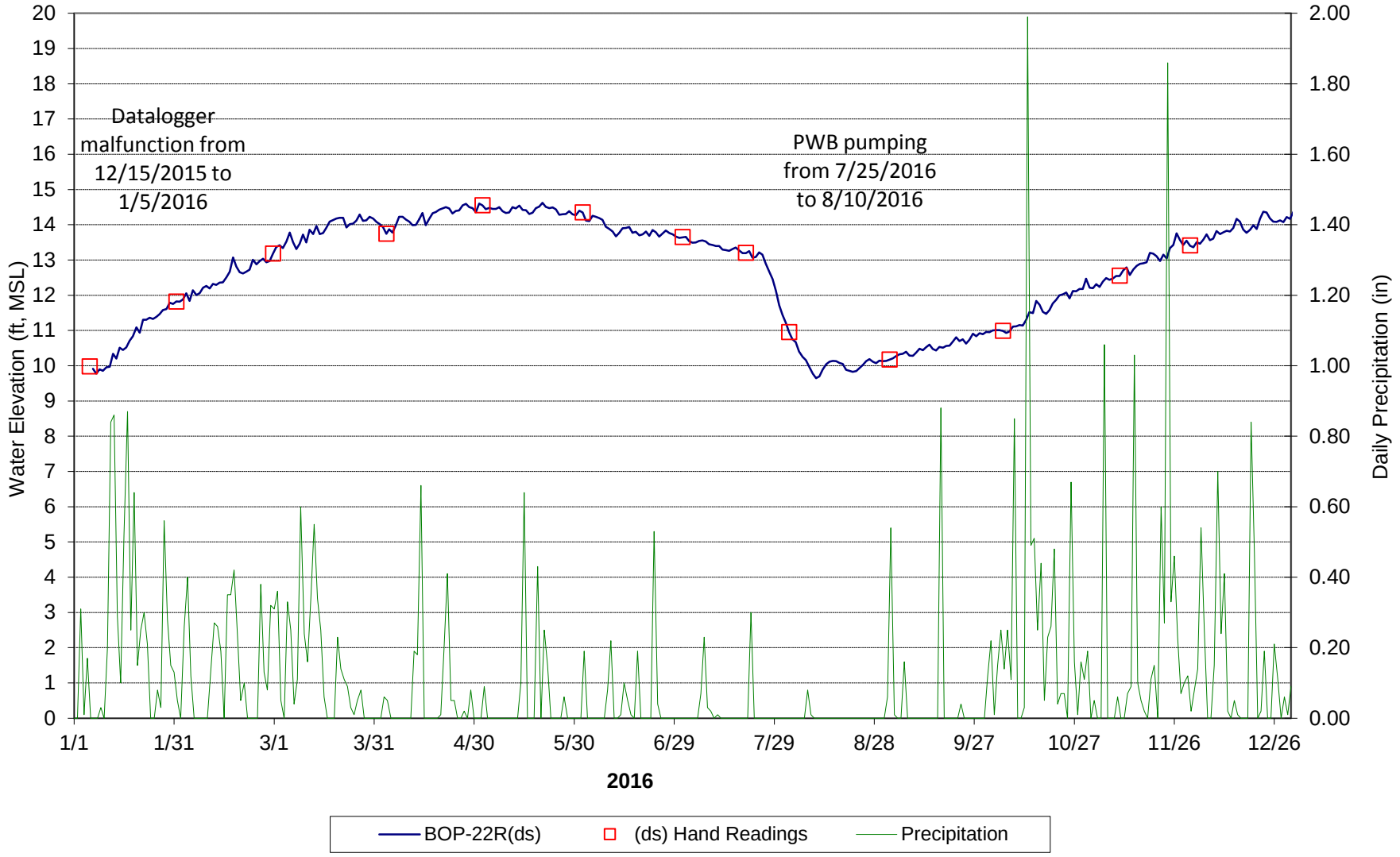
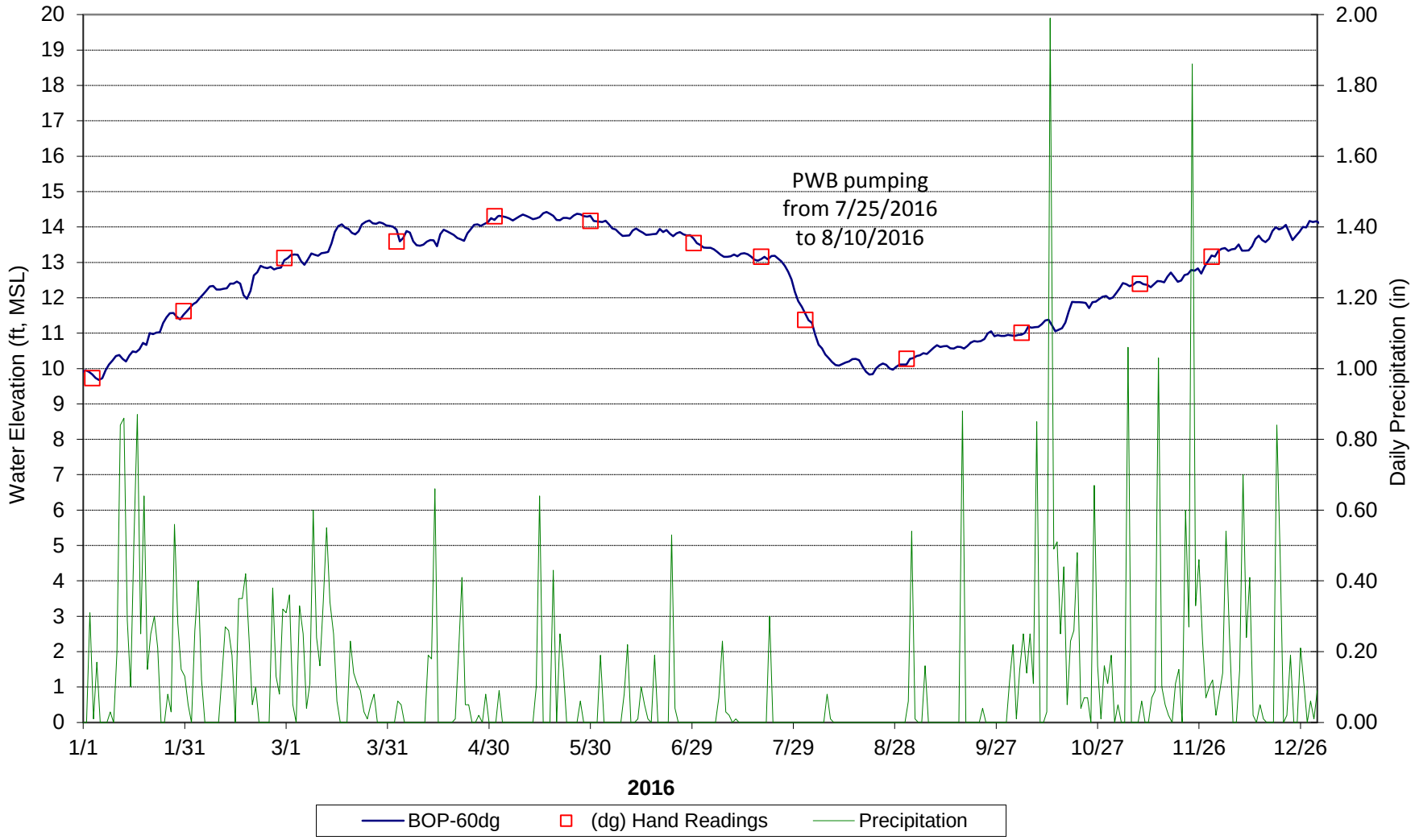
Cascade Corporation Gresham, Oregon	**Hydrograph for TSA Wells January - December 2016**	Figure B-3



LANDAU ASSOCIATES

Boeing Portland Gresham, Oregon	**Hydrograph for TSA Well BOP-22R(ds)**	Figure B-4

Source: \\edmdata01\projects\025\116\WIP\T\Dataloggers\2016

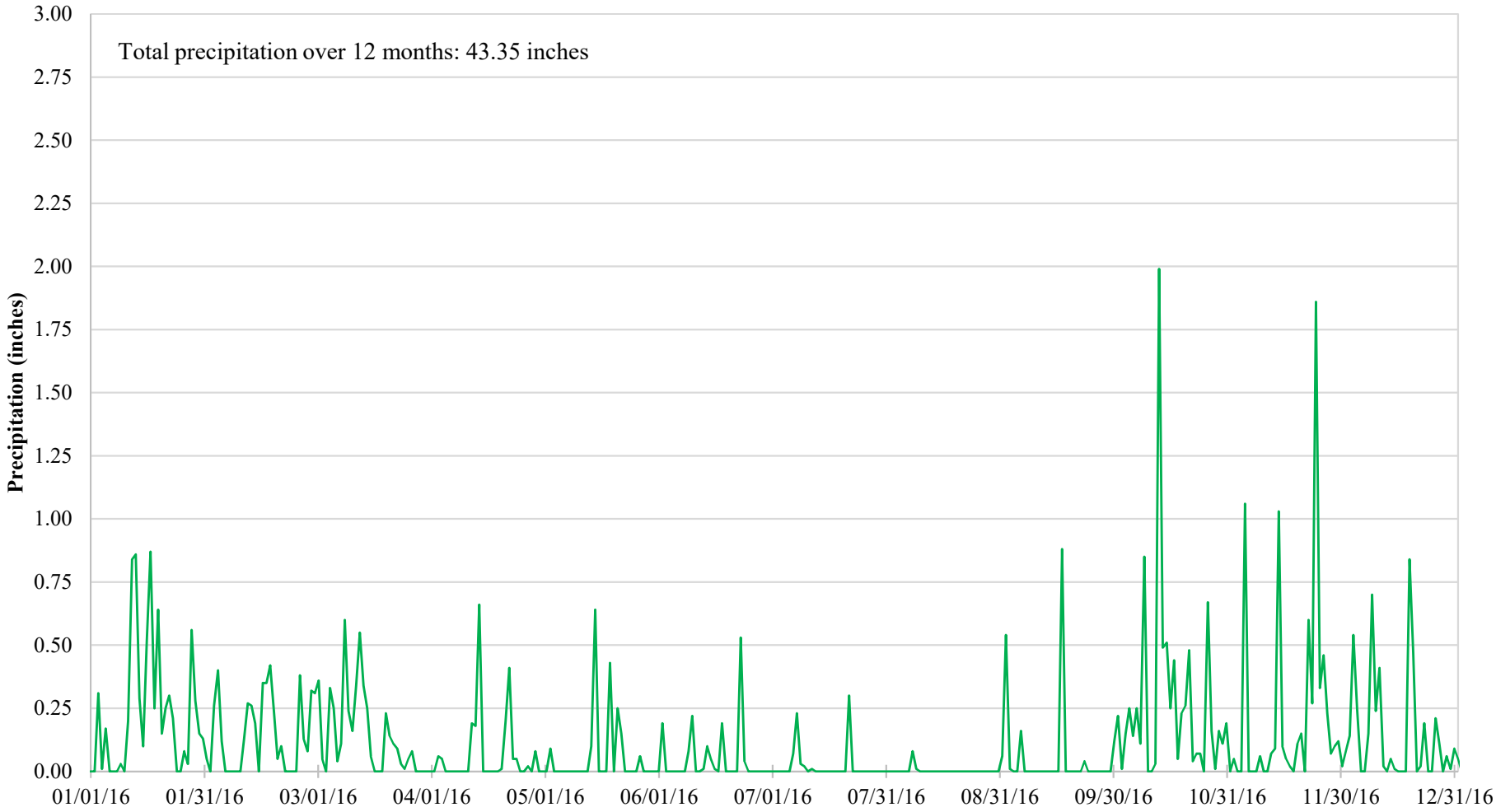


LANDAU ASSOCIATES

Boeing Portland
Gresham, Oregon

Hydrograph for TSA Well BOP-60(dg)

Figure
B-5



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

Geosyntec consultants

Cascade Corporation Gresham, Oregon	**Precipitation** **January - December 2016**	Figure B-6

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.

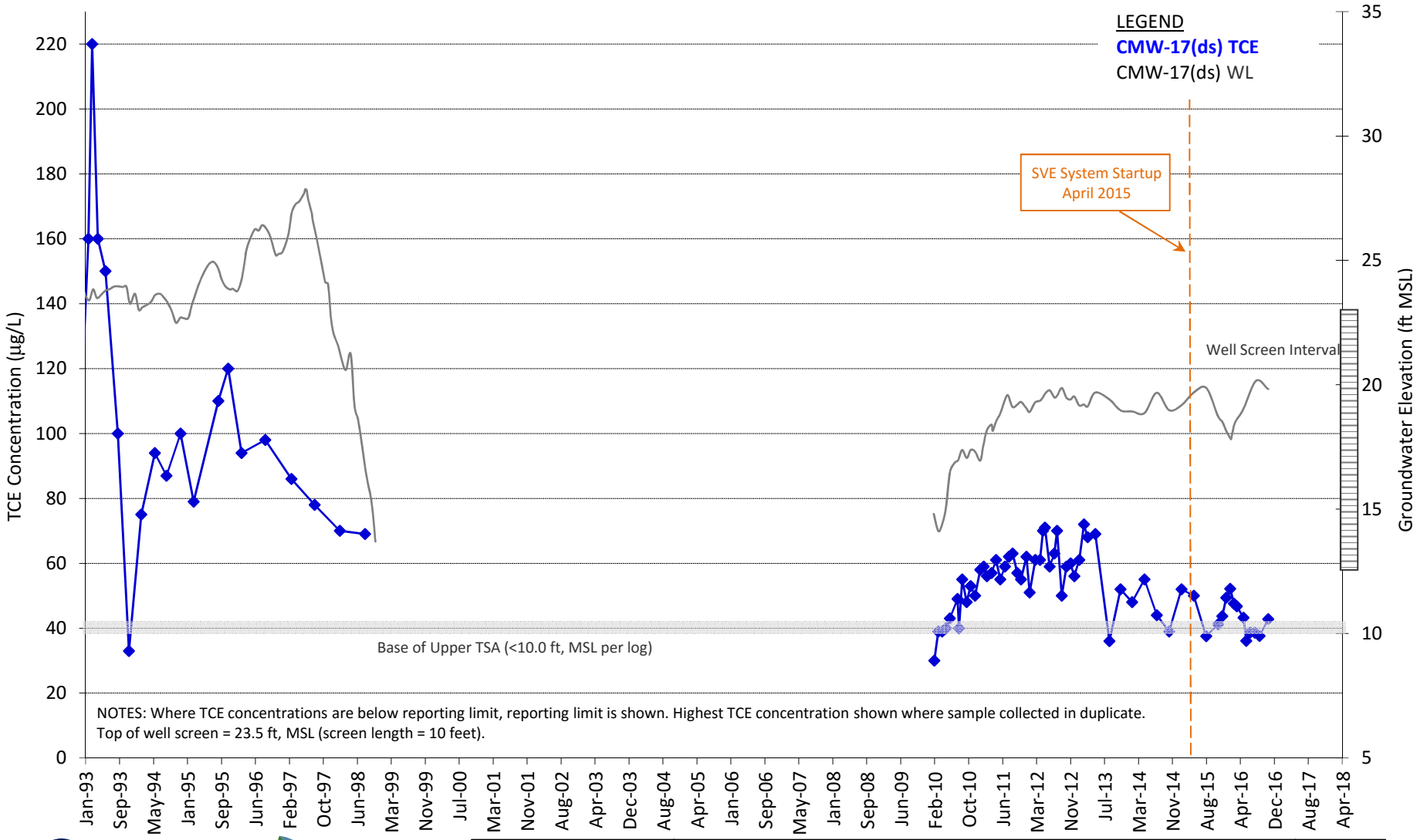
Sample ID with "U" indicates sample collected from the upper portion of the screened interval.

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 = 23.5 ft, MSL (screen length = 10 feet).

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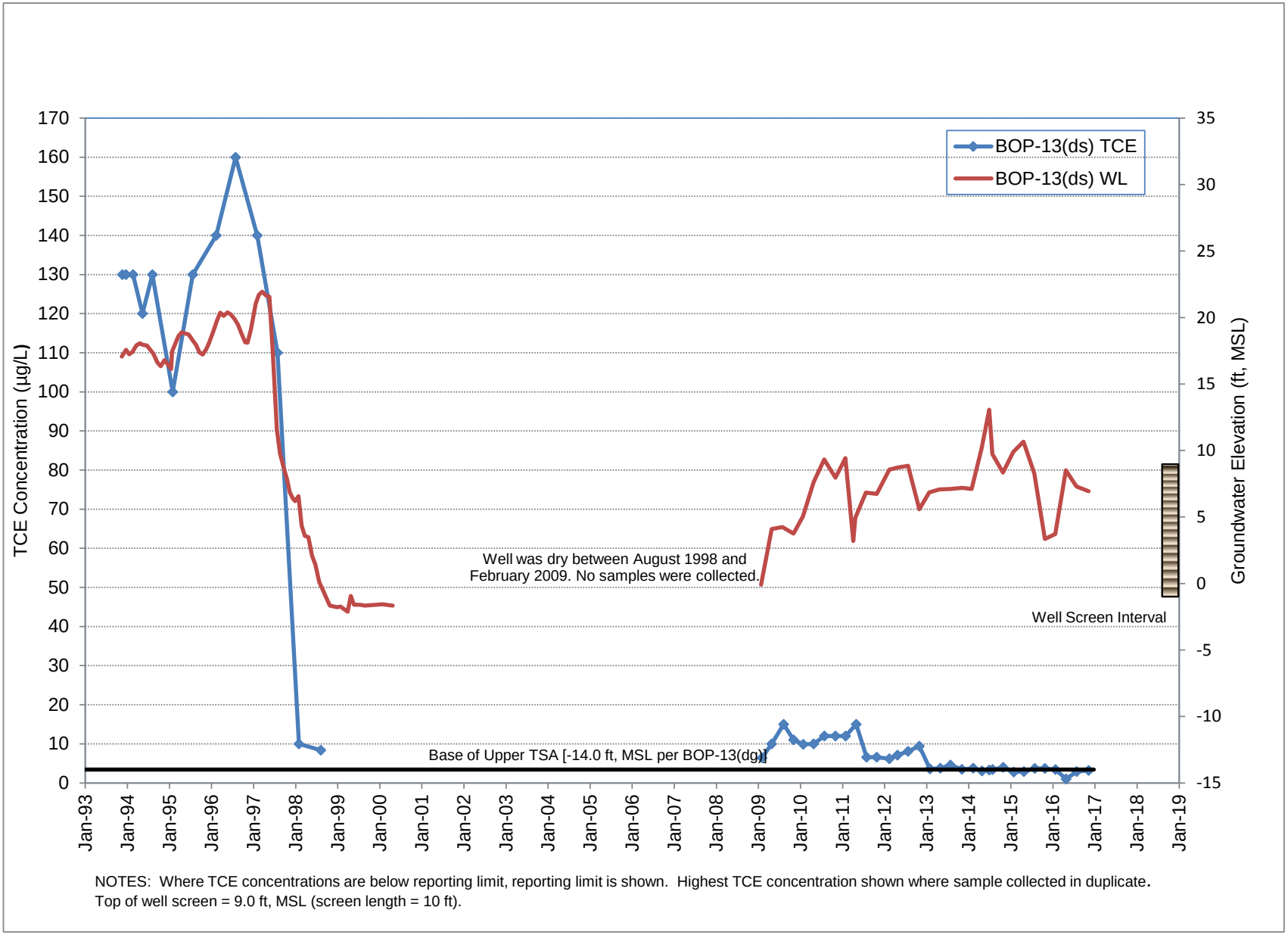
Cascade Corporation Gresham, Oregon	**TCE Concentration Profile CMW-17(ds)** **TSA Remedy**	Figure C-1



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).

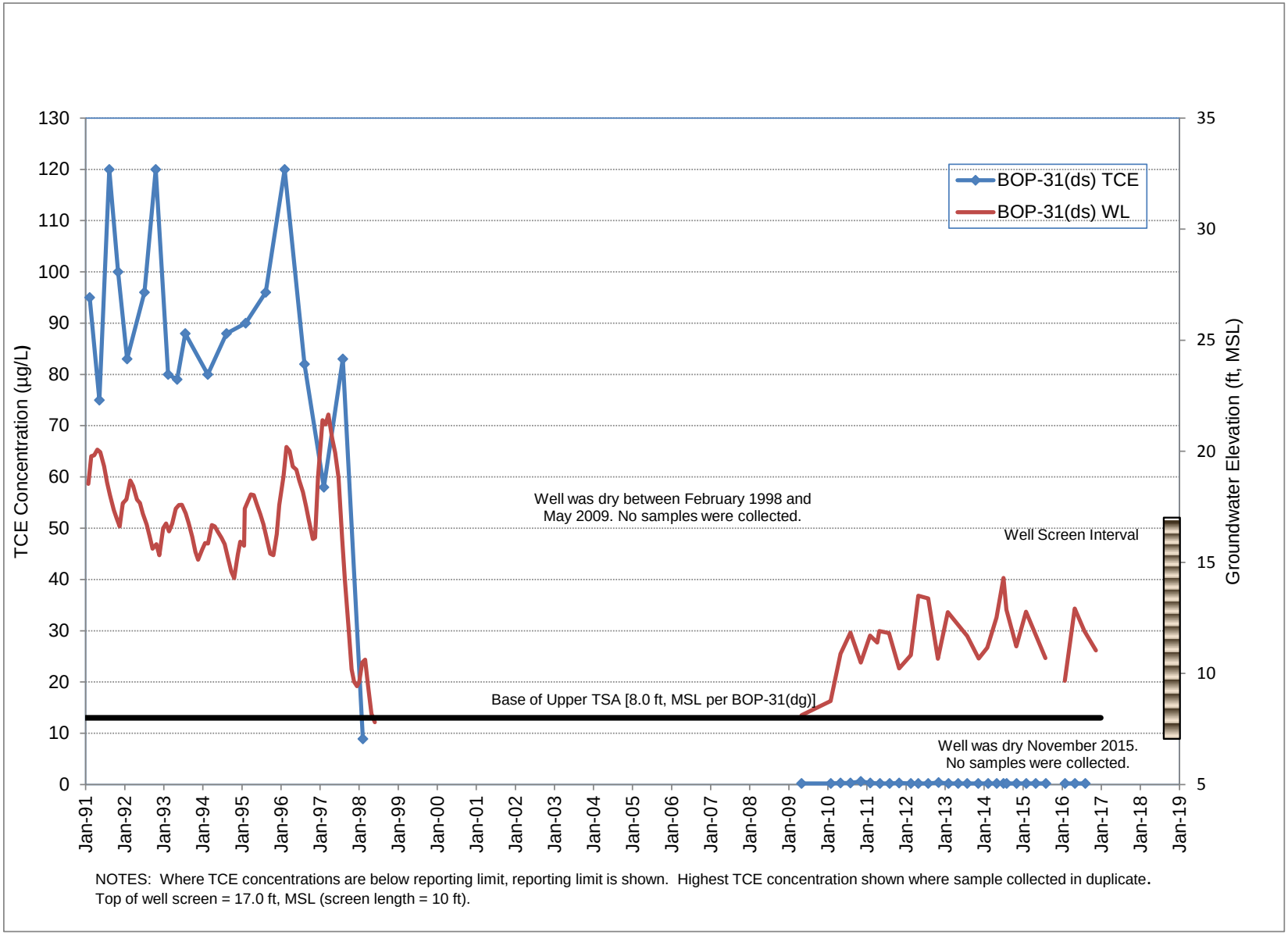
LANDAU ASSOCIATES

Boeing Portland
Gresham, Oregon

BOP-13(ds) TCE Concentration Profile
TSA Remedy – East Multnomah County

Figure
C-2

Source: \\edmdata01\projects\025\116\WIP\T\TSA\BOP13ds-BOP31ds-TCE-WL.xlsx



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 = 17.0 ft, MSL (screen length = 10 ft).

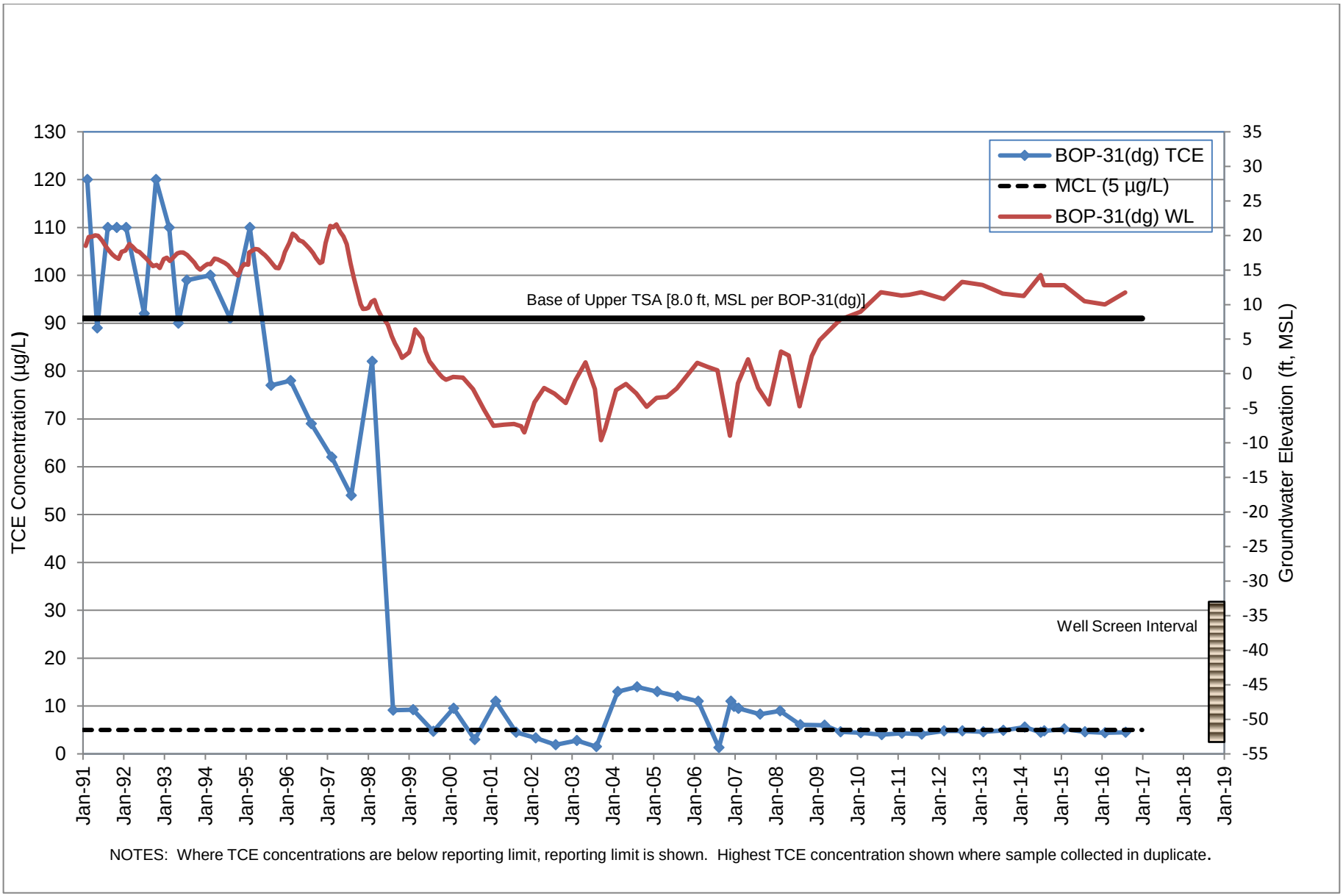
LANDAU ASSOCIATES

Boeing Portland
Gresham, Oregon

BOP-31(ds) TCE Concentration Profile
TSA Remedy – East Multnomah County

Figure
C-3

Source: \\edmdata01\projects\025\116\WIP\T\TSA\BOP13ds-BOP31ds-TCE-WL.xlsx



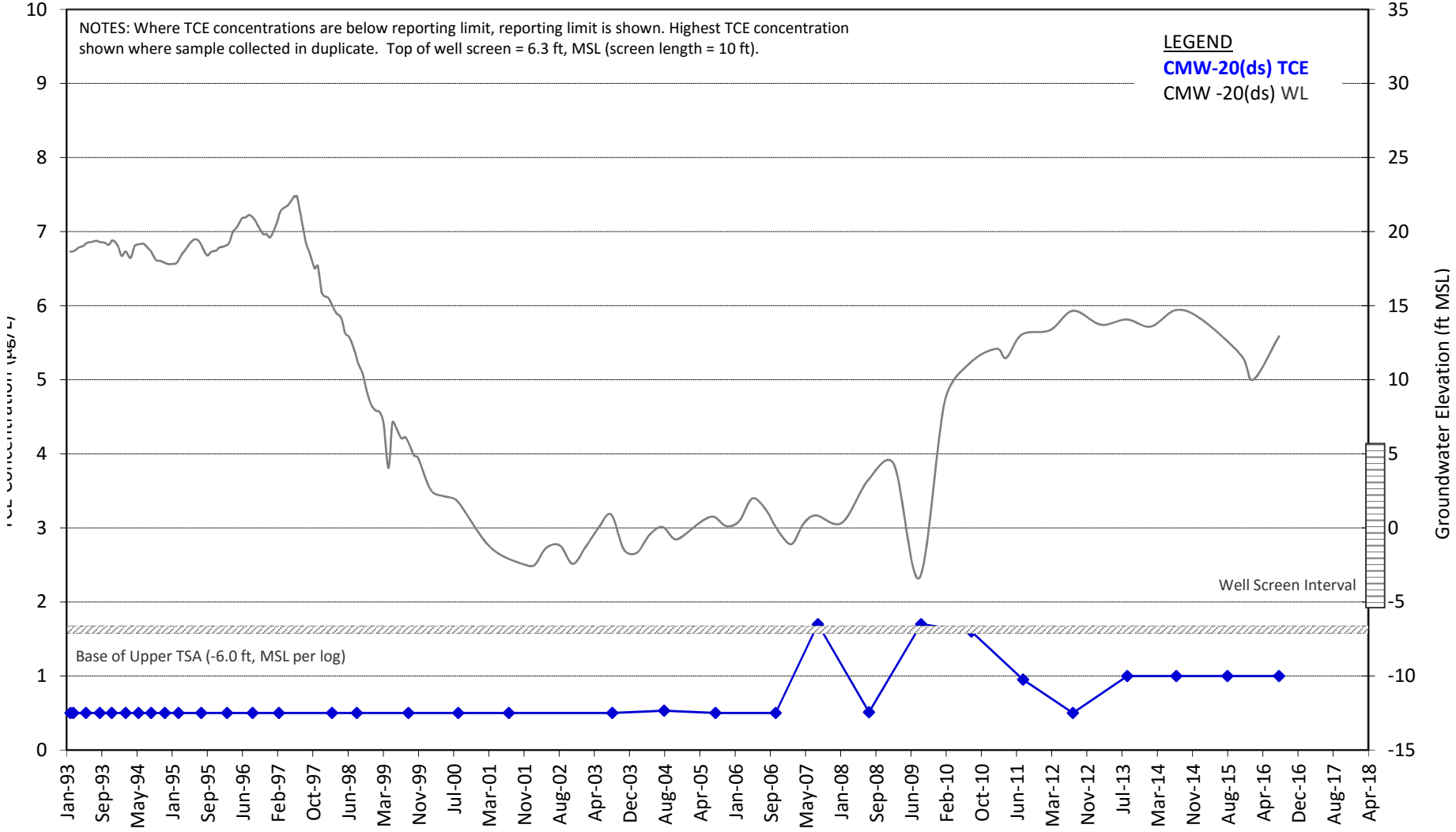
NOTES: Where TCE concentrations are below reporting limit, reporting limit is shown. Highest TCE concentration shown where sample collected in duplicate.

LANDAU ASSOCIATES

Boeing Portland
Gresham, Oregon

BOP-31(dg) TCE Concentration Profile
TSA Remedy – East Multnomah County

Figure
C-4



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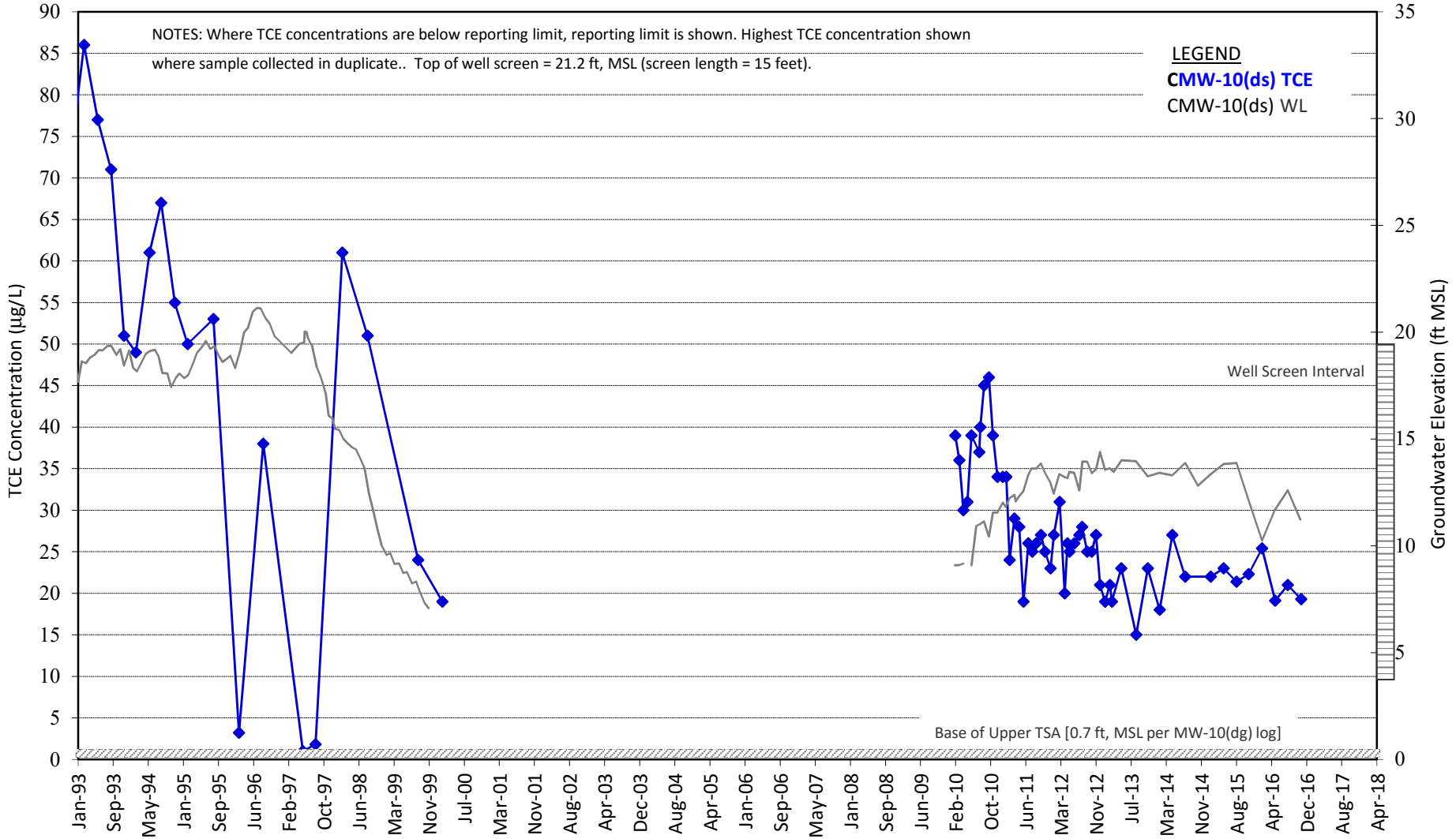
Cascade Corporation Gresham, Oregon	**TCE Concentration Profile CMW-20(ds) TSA Remedy**	Figure C-5



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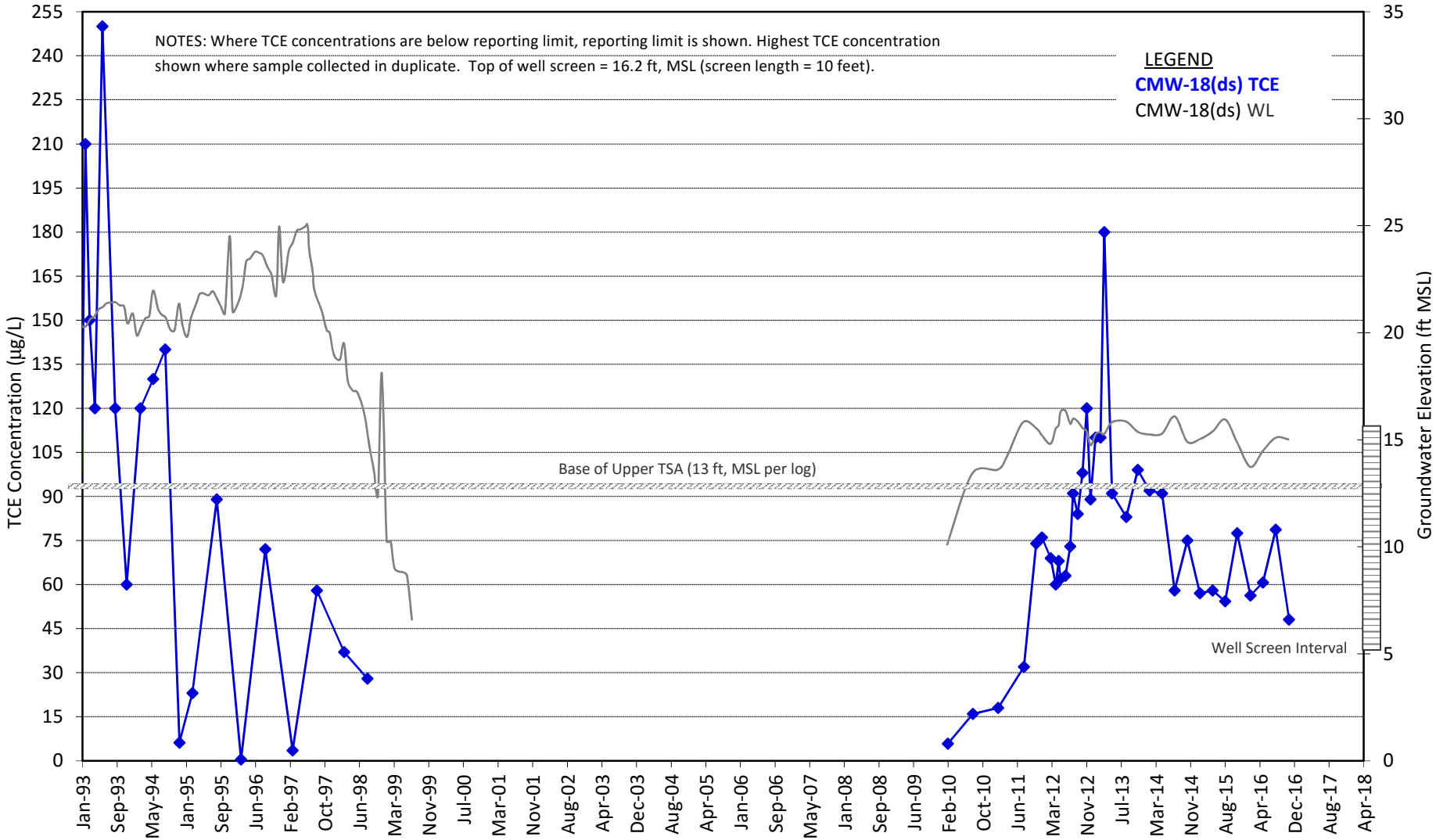
Cascade Corporation Gresham, Oregon	**TCE Concentration Profile CMW-10(ds) TSA Remedy**	Figure C-6



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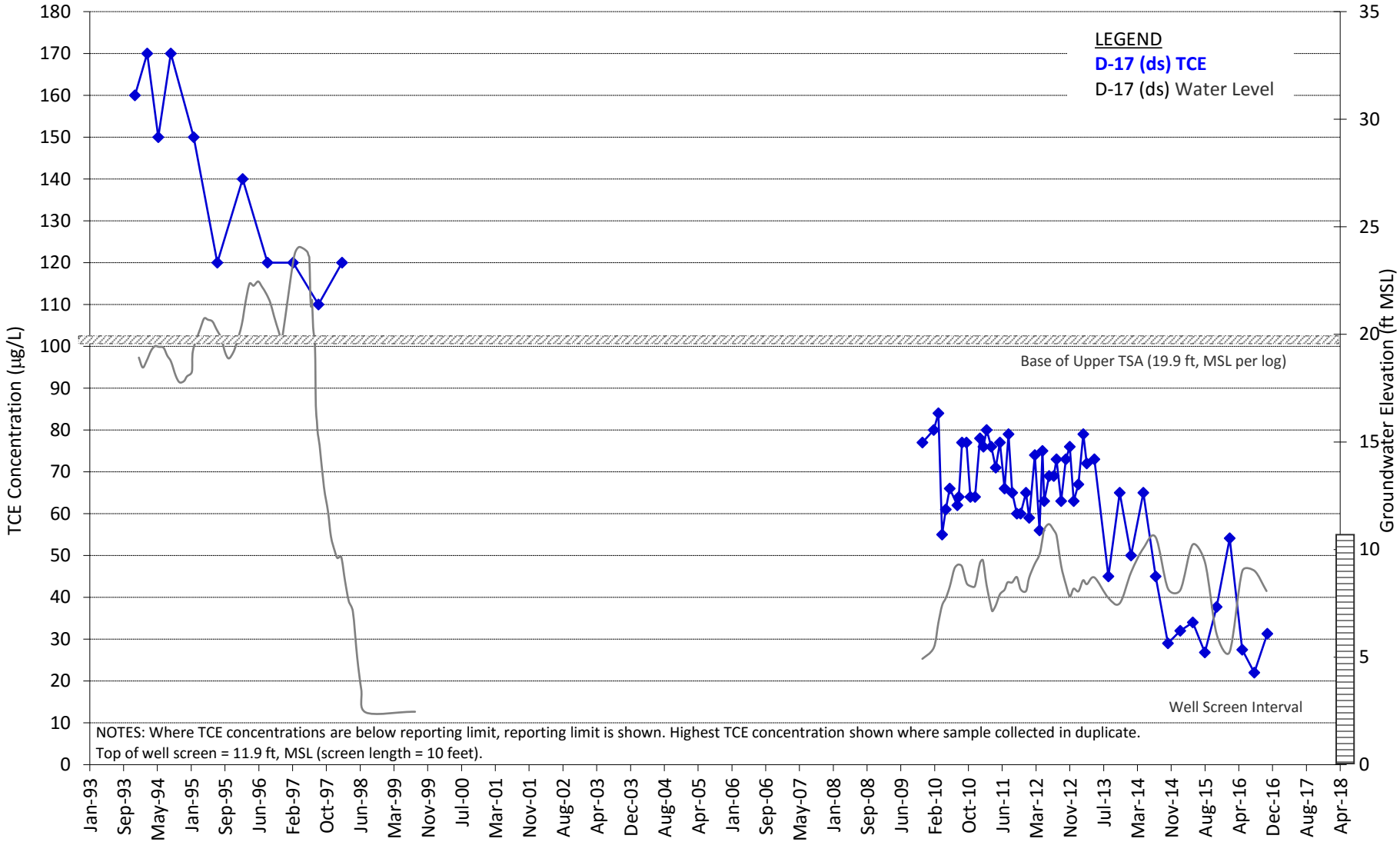
Cascade Corporation Gresham, Oregon	**TCE Concentration Profile CMW-18(ds) TSA Remedy**	Figure C-7



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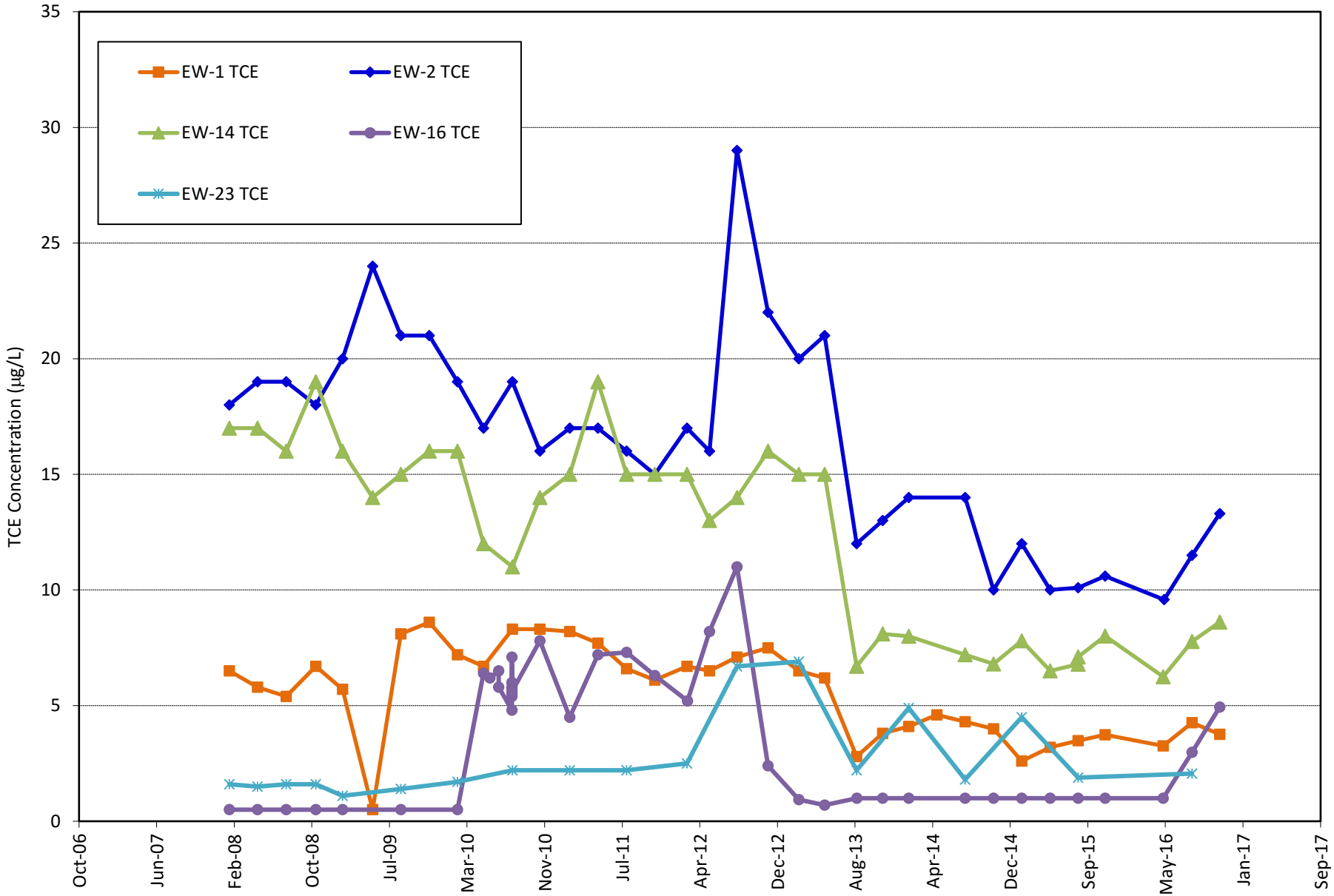
Cascade Corporation Gresham, Oregon	**TCE Concentration Profile D-17(ds) TSA Remedy**	Figure C-8



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Cascade Corporation Gresham, Oregon	**Operating Extraction Wells TCE Concentration Profiles TSA Remedy**	Figure C-9