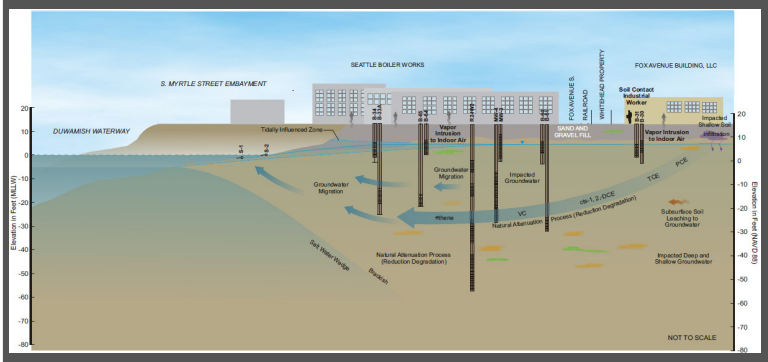
Fox Avenue Site
Seattle, Washington

2014 Annual Report



Prepared for

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Final

April 2015

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LIMITATIONS

This report has been prepared for the exclusive use of the Fox Ave Trust, their authorized agents, and regulatory agencies. It has been prepared following the described methods and information available at the time of the work. No other party should use this report for any purpose other than that originally intended, unless Floyd|Snider agrees in advance to such reliance in writing. The information contained herein should not be utilized for any purpose or project except the one originally intended. Under no circumstances shall this document be altered, updated, or revised without written authorization of Floyd|Snider.

The interpretations and conclusions contained in this report are based in part on site characterization data collected by others. Floyd|Snider cannot assure the accuracy of this information.

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List of Acronyms and Abbreviations

Acronym/ Abbreviation	Definition
°C	Degrees Celsius
1,1-DCE	1,1-Dichloroethene
AMEE	Acetylene, methane, ethene, ethane
CALIBRE	CALIBRE, Inc.
CAP	Cleanup Action Plan
cis-1,2-DCE	cis-1,2-Dichloroethene
CVOC	Chlorinated volatile organic compound
DHC	*Dehalococcoides* bacteria
Ecology	Washington State Department of Ecology
ERD	Enhanced reductive dechlorination
ERH	Electrical Resistance Heating
Landau	Landau Associates
Loading Dock	Loading Dock Source Area
MEK	Methyl ethyl ketone
µg/L	Micrograms per liter
mg/L	Milligrams per liter
NW Corner	Northwest Corner Area
PCE	Tetrachloroethene
qPCR	Qualitative polymerase chain reaction
Site	Fox Avenue Site
TCE	Trichloroethene
TOC	Total organic carbon
TPH	Total petroleum hydrocarbon
UIC	Underground Injection Control

Acronym/ Abbreviation	Definition
VC	Vinyl chloride
VOC	Volatile organic compound
WBZ	Water Bearing Zone

1.0 Introduction

1.1 PURPOSE OF REPORT

The purpose of this report, jointly prepared by Floyd|Snider, CALIBRE, Inc. (CALIBRE), and Landau Associates (Landau), is to document the cleanup activities that occurred in 2014 at the Fox Avenue Site (the Site). The work described in this report was performed in accordance with Agreed Order No. 8985 (AO) between Fox Ave LLC and the Washington State Department of Ecology (Ecology). Specifically, as called forth in Section VII, A of the Agreed Order, and as described in further detail in the Cleanup Action Plan (CAP) for the Site (Ecology 2012), bio-polishing was to be performed in the thermally-treated source areas to further treat the residual levels of chlorinated volatile organic compounds (CVOCs) left in groundwater. The Main Source Area (both 1st and 2nd WBZs) was thermally treated, as well the 1st WBZ of the Loading Dock Source Area (Loading Dock). The 2nd WBZ of the Loading Dock Source Area was not thermally treated nor was the Northwest Corner Area (NW Corner) Plume (Refer to the 2013 Remedial Investigation/Feasibility Study Report for further information on these areas). Thermal treatment occurred from January to May of 2013 and achieved its goal of reducing soil concentrations to the remediation level of an average of 10 milligrams per kilogram or less of total tetrachloroethene (PCE) and trichloroethene (TCE) concentrations. Post-thermal aquifer temperatures were too elevated to implement bio-polishing until mid-2014.

The 2014 work was conducted in accordance with the Biopolish Work Plan (Floyd|Snider 2013) and Work Plan Addendum (Floyd|Snider 2014). These work plans were jointly developed using approaches developed by Landau, CALIBRE and Bioremediation Specialists. In particular, Landau developed the approach for bio-polishing of the Main Source Area, including both the 1st and 2nd Water Bearing Zones (WBZ). CALIBRE developed the approach for bio-polishing of the 1st WBZ of the Loading Dock. Bioremediation Specialists developed the approach for bio-polishing the 2nd WBZ of the Loading Dock. In addition, 2014 activities included continuing enhanced reductive dechlorination (ERD) that was already underway as part of a prior Interim Action in the NW Corner Plume.

1.2 PERFORMANCE CRITERIA FROM CLEANUP ACTION PLAN

At the Site, three environmental media were historically impacted from releases of solvents: soil, groundwater, and indoor air. Remediation levels were established in the CAP for soil and groundwater that were technology-based. The remediation levels for site soil were achieved in 2013, following the implementation of the thermal remediation project in the Main Source Area (both 1st and 2nd WBZ) and Loading Dock (1st WBZ only) as documented in the Construction Completion Report (Floyd|Snider 2013). The cleanup level for indoor air was met in 2013 as well, also as a consequence of the thermal remediation of soil and the soil vapor extraction (SVE) system that operated in the NW Corner from 2012 through 2013. Documentation of the achievement of indoor air cleanup levels, both on- and off-site, is contained in the Construction Completion Report as well.

The CAP established a Remediation Level for groundwater as well. The groundwater Remediation Level for the Site was technology-based and set at the summed concentration of all chlorinated compounds. This total CVOC concentration shall not exceed 250 micrograms per liter (µg/L) in wells located downgradient of Fox Avenue, the conditional point of compliance for groundwater. Per the requirements of the CAP, the groundwater Remediation Level must be met within 10 years following the thermal remediation. Therefore, 2014 represents Year 1 toward this goal, with 2013 being the baseline.

Cleanup levels were established in the CAP for the individual constituents found in groundwater. These cleanup levels must be met within 15 years following thermal treatment (i.e., end of 2028) at the seeps (where shallow groundwater discharges at low tide into the Myrtle Street Embayment). Cleanup levels must be met throughout the plume for groundwater upgradient of the seeps (to the conditional point of compliance), these cleanup levels must be met within 50 years (end of 2063). The final site-wide cleanup levels for groundwater as documented in the CAP are presented in Table 1.1.

Table 1.1
Site-Wide Cleanup Levels for Groundwater

Chemical of Concern	Seep or Groundwater Cleanup Level (µg/L)
Benzene	51
1,1-DCE	3.2
Pentachlorophenol	3.0
PCE	3.3
TCE	30
TPH (Mineral Spirits to Heavy Oil Range)	500
Vinyl Chloride	2.4

Abbreviations:
1,1-DCE 1,1-Dichloroethene
TPH Total petroleum hydrocarbons

2.0 Remedial Action Implementation

The implementation of post-thermal bio-polishing at the Site started in late 2013 with the installation of two injection wells screened in the 1st WBZ of the Loading Dock. This was done because the aquifer temperatures declined rapidly following the completion of thermal treatment, to the point where substrate injections could occur as early as late 2013. One round of substrate injection was performed in the Loading Dock, as documented in the ERD Remedial Optimization of the Fox Avenue Site 2013 – Second Half Technical Memorandum (CALIBRE 2014). Injection of substrate in the Main Source Area occurred in 2014 and early 2015, as discussed in this section.

2.1 WELL INSTALLATION

Per the Biopolish Treatment Plan (Floyd|Snider 2013), additional injection and monitoring wells were installed to facilitate injection of substrate and to monitor performance. Wells were installed in both the Loading Dock and the Main Source Area as follows:

Loading Dock Source Area:

- Three new injection wells screened in the 2nd WBZ. The wells were installed in the warehouse directly upgradient of the loading dock itself.
- Three new monitoring wells downgradient of the loading dock: two screened in the 2nd WBZ and one screened in the 1st WBZ.

Main Source Area:

- 19 new injection wells: 11 screened in the 2nd WBZ and 8 screened in the 1st WBZ.
- Four new monitoring wells: three screened in the 2nd WBZ and one in the 1st WBZ.

Locations of newly-installed wells are shown on Figure 2.1. Well construction details are included in Table 2.1. Due to adequate lithologic data collected previously, soil was not logged during drilling of these wells.

2.2 UNDERGROUND INJECTION CONTROL REGISTRATION

Twenty-two new aquifer remediation wells were registered with Ecology's Underground Injection Control (UIC) program. The wells registered included the 19 injection wells in the Main Source Area and 3 injection wells in the Loading Dock. The registration was completed as an update to the pre-existing UIC registration for the Site (site number 32031). The registration submittal and confirmation letter are included as Appendix A.

2.3 PERFORMANCE MONITORING

Performance monitoring consisted of both groundwater monitoring and subsurface temperature monitoring as follows:

- **Main Source Area Injection Wells.** In February and March of 2014, pre-injection baseline samples of groundwater from all newly installed injection wells in the Main Source Area were collected. Post-injection samples from two selected 2nd WBZ injection wells were collected in May and October of 2014 and again in January of 2015.
- **Monitoring Well Groundwater.** Samples of groundwater from selected wells site-wide from both the 1st and 2nd WBZ were collected in May and June of 2014. In October of 2014 and January of 2015, post-injection sampling of selected 2nd WBZ wells both in and downgradient of the Main Source Area was performed.
- **Loading Dock Source Area Injection Wells.** In March of 2014, pre-injection baseline samples were collected of groundwater from the three 2nd WBZ injection wells installed upgradient of the Loading Dock. A sample was also collected from one of the two existing 1st WBZ injection wells prior to injection of substrate.
- **Seeps.** Samples of three seeps visible at low tide along the Myrtle Street Embayment were collected in May of 2014. Per Ecology request, two samples were collected at Seep S-3, which was expressed over a larger area. The second sample, labeled S-3b, was from a minor seep located within 10 feet of the primary S-3 seep.
- **Temperature.** Temperature of groundwater in the Main Source Area at two depths was monitored monthly in 2014 using both thermocouples left in place from the thermal remediation system and as directly measured in injection wells. Temperature monitoring was performed in the Main Source Area from the end of Electrical Resistance Heating (ERH) in June 2013 through January 2015 for evaluation of aquifer cooling. Aquifer temperatures were monitored using the E18 thermocouple remaining after completion of ERH, and by down-hole measurements of groundwater made at the top and bottom of the screened interval of each injection well. Injection well temperature data are presented in Table 2.2. Thermocouple and injection well temperature trends are plotted on Figure 2.2.

2.4 SUBSTRATE INJECTION

The following is a summary of the substrate injections that were performed in 2014 and early 2015.

1. **Northwest Corner.** One round of substrate injection was completed in three shallow injection wells in the NW Corner. Wells R1-IW8, R1-IW9, and R1-IW10 were used (all three are 1st WBZ wells). The substrate consisted of soluble sugars with other trace nutrients (nitrogen and phosphorus) were added with the substrate mix. Following substrate injection, approximately 250 gallons of chase water (with buffer) were added to each well. The substrate injection in this area was completed in May 2014. Details are presented in Table 2.3.

Table 2.3
Substrate Injection Summary

Well ID	Interval	Date	Substrate Quantity and (Type)	Total Gallons Injected	ERD Treatment Area
R1-IW16	8–13 ft	5/21/2014	800 lbs (sugar at 12% Brix)	795	Loading Dock 1st WBZ
R1-IW21	8–13 ft	5/21/2014	800 lbs (sugar at 12% Brix)	804	Loading Dock 1st WBZ
R0-IW22D	30–60 ft	6/3/14	1100 gallons (5% ethyl lactate)	2250	Loading Dock 2nd t WBZ
R0-IW23D	30–60 ft	6/3/14	1100 gallons (5% ethyl lactate)	2250	Loading Dock 2nd WBZ
R0-IW24D	30–60 ft	6/3/14	1100 gallons (5% ethyl lactate)	2250	Loading Dock 2nd WBZ
R0-IW22D	30–60 ft	11/6/14	750 lbs (ReducED-AQ)[1]	2010	Loading Dock 2nd WBZ
R0-IW23D	30–60 ft	11/6/14	750 lbs (ReducED-AQ)[1]	2010	Loading Dock 2nd WBZ
R0-IW24D	30–60 ft	11/6/14	750 lbs (ReducED-AQ)[1]	2010	Loading Dock 2nd WBZ
R1-IW8	8–13 ft	5/21/2014	700 lbs (sugar at 12% Brix)	642	NW Corner 1st WBZ
R1-IW9	8–13 ft	5/21/2014	700 lbs (sugar at 12% Brix)	703	NW Corner 1st WBZ
R1-IW10	8–13 ft	5/21/2014	700 lbs (sugar at 12% Brix)	705	NW Corner 1st WBZ

Note:
1 ReducED-AQ is a blend of multiple electron donors designed to provide a more evenly fermenting blend of organic carbon.

Abbreviations:
ft Feet
lbs Pounds
NW Northwest

2. **Loading Dock Source Area – 1st WBZ.** One round of substrate injection was completed in two shallow injection wells in the Loading Dock. Wells R1-IW16 and R1-IW21 were used (both are 1st WBZ wells). The substrate consisted of soluble sugars with other trace nutrients (nitrogen and phosphorus) added with the substrate mix. Following substrate injection, approximately 250 gallons of chase water (with buffer) were

added to each well. The substrate injection in this area was completed in May 2014. Details are presented in Table 2.3.

3. **Loading Dock Source Area – 2nd WBZ.** Two rounds of a lactose substrate (ethyl lactate) and mild surfactant were injected into the three 2nd WBZ injection wells. The first round of injections occurred in June of 2014, and the second round occurred in November of 2014. Details are presented in Table 2.3.
4. **Main Source Area – 2nd WBZ.** One round of injection of edible oil substrate and other amendments was injected into the 11 2nd WBZ injection wells in July 2014. As described in the Work Plan Addendum, substantial production of vinyl chloride (VC) in the 2nd WBZ indicated that bioaugmentation was not required in that zone and substrate injection could proceed without additional cooling of the aquifer. Details of this injection are presented in Table 2.4.
5. **Main Source Area – 1st WBZ.** One round of injection of edible oil substrate and other amendments was injected into the eight 2nd WBZ injection wells in January of 2015. As described in the Work Plan Addendum, minimal VC production in this zone indicated a need for bioaugmentation. Bioaugmentation was accomplished using a groundwater inoculum extracted from wells outside the heated zone having elevated levels of the *Dehalococcoides* bacteria (DHC). In accordance with the Work Plan Addendum, and to maximize the effectiveness of bioaugmentation, the injection of the shallow zone did not occur until 1st WBZ temperatures were near or below 35 degrees Celsius (°C). This target temperature was achieved in early January 2015 (Table 2.2, Figure 2.2), allowing the injection to proceed. The 1st WBZ injection utilized groundwater extracted from wells R1-IW3B and R1-IW5 for mixing of the injection solution in order to bioaugment the 1st WBZ; groundwater from these two wells contained DHC at 10^5 cells per milliliter. Details of this injection are presented in Table 2.5.

3.0 Remedial Action Performance Monitoring Data

3.1 SAMPLING PROCEDURES

Samples from wells in the Loading Dock and NW Corner, and along Fox Avenue were collected using low-flow sampling procedures on May 15 and 16, 2014. Wells that were sampled in the NW Corner included NW1-1 and NW2-2. Wells sampled in the Loading Dock included R1-IW21, MW-19D, B-77, and B-78. Additional selected wells along Fox Avenue were also sampled at the same time (B-22, B-58, B-59, B-60, B-61, B-62, B-63, B-18, and B-19). Well B-22 is located between the Loading Dock and NW Corner. All wells were sampled in accordance with the project work plans and all samples were analyzed for volatile organic compounds (VOCs). On the first day of sampling (May 15) the oxidation-reduction potential (ORP) probe of the water quality meter was not responsive; all other field parameters calibrated correctly. A replacement water quality instrument was used on the second day (May 16).

Due to the much lower VOC concentration detected in the low-flow sample collected in May from injection well R0-IW2D in the Main Source Area, as compared to the February sample collected at the end of well development, a three casing-volume purge was performed during the subsequent three sampling events in an attempt to reproduce the February results. Monitoring well MW-18S was sampled above mid-screen in order to be slightly above the estimated elevation of the silt horizon. A flow through cell was used to measure field parameters.

The seeps in the Myrtle Street Embayment were sampled on May 16, 2014 at a low tide condition. The Ecology project manager was present for the seep sampling. Four seeps in the area have been sampled previously. Based on the observed field conditions (and knowledge of the prior sampling results) the Ecology project manager recommended dropping the southern-most seep location (Seep 1, which had sample concentrations less than detection limits for the last sampling event) and collecting two samples from the Seep 3 area (labeled as samples Seep 3a and 3b). Seep 3 covers a diffuse area over about 15 feet of the embayment perimeter.

Samples were delivered under chain-of-custody to Fremont Analytical for analysis of selected VOCs and performance monitoring parameters including total organic carbon (TOC), sulfate, sulfide, total and dissolved iron, and dissolved gases (acetylene, methane, ethene, ethane [AMEE]. Qualitative polymerase chain reaction (qPCR) data for quantification of DHC in wells along Fox Avenue were submitted under chain-of-custody to Microbial Insights, Inc. for analysis.

All investigation-derived waste from sampling was containerized and managed in accordance with the project work plans.

3.2 SUMMARY OF DATA FROM GROUNDWATER SAMPLING

A summary of the data from samples collected in 2014 (and January 2015) is presented in Tables 3.1 and 3.2. VOC data are presented in Table 3.1 and other standard laboratory parameters analyzed by Fremont Analytical are presented in Table 3.2. qPCR data are presented in Table 3.3.

3.3 QUALITY ASSURANCE REVIEW AND ENVIRONMENTAL INFORMATION MANAGEMENT LOADING

A basic quality assurance review was performed on all of the analytical laboratory reports received. The reviews concluded that all of the laboratory data were deemed acceptable for use. Copies of the data validation memoranda are included in Appendix B. All data were subsequently uploaded to Ecology's Environmental Information Management database.

4.0 Performance Monitoring Data Discussion

Both baseline (pre-substrate injection) and performance (post-substrate injection) data were collected in 2014. Those data are discussed in this section by treatment or monitoring area.

4.1 MAIN SOURCE AREA

Baseline conditions were established by sampling groundwater from injection wells and monitoring wells prior to injection. Baseline data consist of samples collected from injection wells upon completion of well development and pre-injection sampling events conducted in May and June 2014 at the Main Source Area wells identified for ongoing performance monitoring.

Baseline data indicated that conditions were more highly reducing in the 2nd WBZ than in the 1st WBZ. This was evidenced by depleted sulfate (indicative of sulfate-reducing conditions) in deep wells compared to detections of sulfate in shallow wells. The more highly reduced condition of the 2nd WBZ is consistent with the more advanced stage of reductive dechlorination that is indicated in deep wells by lower cis-1,2-dichloroethene (cis-1,2-DCE) and higher VC concentrations than in 1st WBZ wells. End product ethane detected in baseline samples from deep wells B-21 and B-61 and shallow well B-20A likely resulted from prior sugar injections at nearby Row 1 injection wells. Figures 4.1 and 4.2 present baseline (pre-injection) total CVOC concentrations and iso-concentration contours for the 1st and 2nd WBZs, respectively; for improved spatial coverage, the iso-contours also reflect post-heating groundwater samples collected from direct-push borings in August and November 2013.

Conditions following the July 2014 2nd WBZ injection were evaluated using data from the October 2014 and January 2015 monitoring events. As of the January monitoring event (5.7 months after injection), data from all monitored wells indicate changes in aquifer conditions that are more conducive to ERD. Four of the nine wells sampled clearly show arrival of injected electron donor and other substantial changes resulting from the injection. Two additional wells show increased donor (TOC), but it is inconclusive whether this is the result of the July injection or of injections to nearby wells along Fox Avenue. The remaining three wells do not show arrival of the injected electron donor, but show changes likely resulting from the July injection. Other post-injection results are further discussed below. A cumulative summary of Main Source Area bioremediation data is presented in Table 4.1.

Increased TOC is a primary indicator that injected electron donor (i.e., vegetable oil, sugar, or volatile fatty acids resulting from fermentation of these primary substrates) has arrived at a well and that the well is within the area of enhanced biotreatment. Increases of acetone and methyl ethyl ketone (MEK) also indicate the presence of electron donor, as these ketones are known fermentation intermediaries that are short lived due to consumption by bacteria as electron donor (Suthersan et al. 2002). Six wells, consisting of the two monitored injection wells and four monitoring wells, show a substantial increase in TOC. Enhanced treatment is also indicated at four of these wells by changes in aquifer redox parameters, CVOCs, and end products. Notable changes at these six wells are indicated in the following bullets.

- **Injection Wells R0-IW02D and R0-IW06D.** As expected, TOC increased substantially at injection wells, from less than 4 µg/L to over 2,000 µg/L, indicating the presence of electron donor. Substantial increases, then decreases, of acetone and MEK indicate fermentation of electron donor and utilization of these intermediaries. Iron and sulfate also increased substantially due to injected ferrous sulfate. Methane increased somewhat, indicating development of a more reduced aquifer redox condition; however, additional sulfate reduction, which is more energetically favorable, will need to occur before methane production becomes more pronounced. Sulfate reduction is indicated at these wells by decreasing sulfate concentrations from the maximums detected in October 2014 to lower results in January 2015.
- **MW-15D (located approximately midway between IWs R0-IW01D and R0-IW02D).** Arrival of electron donor is indicated by a substantial increase in TOC from 13 milligrams per liter (mg/L) to 359 mg/L and increased concentrations of acetone and MEK. Substantial increases in iron and sulfate have not yet occurred. Detected sulfide and increased methane indicate a more reduced aquifer redox condition. Biodegradation has been substantially enhanced, as indicated by decreased concentrations of PCE, TCE, and cis-1,2-DCE, and dramatic increases in degradation breakdown product VC (from 121 µg/L to 6,510 µg/L) and end products ethene + ethane (from <5 µg/L to 900 µg/L). On a molar basis, the percentage of total ethenes (PCE + TCE + cis-1,2-DCE + VC + ethene + ethane) composed of the non-toxic end products ethene + ethene increased from 0 percent during baseline sampling to 25 percent in January 2015. The observed changes at this well confirm that the design injection volumes were adequate to achieve the desired overlapping radii of injection between injection wells.
- **MW-16D (located 35 feet downgradient of the 2nd row of injection wells [IW-04D to IW-07D]).** TOC increased from 7.4 mg/L to over 1,000 mg/L and acetone and MEK also increased. Increases in iron and sulfate following injection also indicate arrival of injection fluid. Methane has not increased to concentrations greater than the relatively high baseline concentration, but detected sulfide indicates sulfate reduction. Increased VC indicates enhanced biodegradation. On a molar basis, VC increased from 41 percent (baseline) to 70 percent of total ethenes and replaced cis-1,2-DCE as the predominant ethene.
- **MWs B-59D and B-61D (located on Fox Avenue, 150 feet and 145 feet downgradient of the third row of injection wells, respectively).** TOC increased at both wells and concentrations of cis-1,2-DCE and/or VC changed somewhat. However, although TOC increased at both wells, from 12 to 30 mg/L (B-59D) and from 4 to 22 mg/L (B-61D), it is not clear whether these TOC changes resulted from the July injection to Main Source Area injection wells (Row 0) or result from sugar injections to wells on the east side of Fox Avenue (Row 1 injection wells, last injected in September 2013). With no other substantial changes observed at these two monitoring wells and no substantial increases in TOC at the wells between the Main Source Area injection wells and Fox Avenue (wells B-45D and MW17D, as described below), it is not conclusive, at this

time, that electron donor from the Main Source Area injection has reached Fox Avenue. Subsequent monitoring data and expansion of the parameter list at these two wells to include AMEE may allow a more conclusive interpretation for these two wells.

Although the remaining three deep wells monitored post-injection have not yet shown substantial change in TOC, other changes indicate enhanced biodegradation. Data suggest that these wells are near the fringes of the developing biotreatment zone, with biodegradation beginning to be enhanced at the well or occurring somewhat upgradient. Notable changes at these wells are as follows:

- **MW-10D (located 75 feet downgradient of the third row of injection wells [IW-08D to IW-11D])**. VC increased from 274 to 1440 µg/L and on a molar basis from 5 percent to 34 percent of total ethenes.
- **MW-17D (located 35 feet downgradient of the third row of injection wells).** The concentration of cis-1,2-DCE decreased substantially (69 to 3 µg/L), and the concentration of VC decreased to a lesser degree (54 to 22 µg/L). With this change, VC increased from 47 to 92 percent of total ethenes on a molar basis. Iron increased and sulfide was detected.
- **B-45D (located 75 feet downgradient of the third row of injection wells).** A substantial increase then decrease in cis-1,2-DCE (998 to 7,270 to 1,870 µg/L) and VC (1,030 to 10,700 to 3,220 µg/L) corresponded to an increase in ethene from 36 to 392 µg/L. Ethene + ethane increased from 6 to 18 percent of total ethenes on a molar basis.

4.2 LOADING DOCK SOURCE AREA

The performance monitoring data from this area (i.e., the 1st WBZ near and downgradient from the loading dock) demonstrate effective ERD treatment. The PCE concentrations in well R1-IW-21 have declined by 99.9 percent and the total CVOC concentrations have declined by 96 percent from the post-thermal baseline sampling. Increases in the ratio of dechlorination daughter products are also observed (cis-1,2-DCE and VC). Other wells, both 1st WBZ and 2nd WBZ wells, in the immediate area and downgradient were sampled between April and May 2014. All samples from wells in this area had concentrations less than the Remediation Level of 250 µg/L CVOCs. The 2014 sampling included R1-IW-21, MW-19D, B-78, B-79, R0-IW22D (35- and 55-foot depth), R0-IW23D (35- and 55-foot depth), and R0-IW24D (35- and 55-foot depth); all samples were less than ½ of the Remediation Level.

4.3 NORTHWEST CORNER

Two 1st WBZ wells in the NW Corner were sampled in this reporting period: NW1-1 and NW1-2. Analytical results from these two wells were less than the Remediation Level of 250 µg/L total CVOCs. These results are consistent with the results reported in 2013, which included sampling of many more wells in this area. The CVOC concentrations in these two wells declined from the

2013 sampling. The performance monitoring data from this area demonstrate effective ERD treatment. Figure 4.1 contains time trend plots of the concentrations of the four main VOCs of concern at Fox Avenue (PCE, TCE, cis-1,2-DCE, and VC) beginning in 2009 for well NW1-1.

4.4 DOWNGRADIENT PLUME

Several wells in the downgradient plume area were sampled in this reporting period including B-22, MW-19D, B-77, B-78, B-58, B-59, B-60, B-61, B-62, B-63, B-18, and B-19. The results for MW-19D, B-77, and B-78 were discussed in Section 4.2.

Analytical results from B-59, B-61, B-62, and B-63 along Fox Avenue were less than the Remediation Level of 250 µg/L total CVOCs. Wells B-62 and B-63 have not been sampled since late 2010. The current results (2014 sampling) indicate total CVOC concentration reductions of greater than 99.7 percent.

Analytical results from other wells along Fox Avenue, especially B-22, B-58, B-60, B-18, and B-19, contained total CVOC concentrations greater than the Remediation Level of 250 µg/L. Figure 4.1 contains time trend plots of the concentrations of the four main VOCs of concern at Fox Avenue (PCE, TCE, cis-1,2-DCE, and VC) beginning in 2009. For the most part, these plots demonstrate that concentrations of VOCs along Fox Avenue have declined significantly since 2009 when the ERD interim action began, especially for PCE and TCE.

Monitoring well B-22 is located just north of the area thermally heated in the Loading Dock; cis-1,2-DCE concentrations increased in this area after the thermal heating. Temperature measurements were not collected in this well, but this area is anticipated to have been heated to temperatures greater than 35 °C based on temperature measurements from other nearby wells.

Monitoring wells B-58 and B-60 are located on the west side of Fox Avenue and temperature measurements in this area (in September 2013) indicated temperatures greater than 40 °C, with temperatures greater than 50 °C on the east side of Fox Avenue. The primary CVOC detected in these two wells is cis-1,2-DCE.

Monitoring wells B-18 and B-19 are located on the east side of Fox Avenue near the intersection with Myrtle Street; this part of the plume lies well away from the Main Source Area, so it is not expected to be influenced by thermal heating or other source control measures. The primary CVOC detected in these two wells is cis-1,2-DCE.

4.5 SEEPS

The four seep samples showed results similar to those measured in 2013, prior to thermal remediation. Seep samples S-2 and S-4 were both non-detect for VOCs. These seeps are located north and south of S-3 (refer to Figure 2.1). Seep samples S-3 and S-3b (located close to S-3) both contained comparable concentrations of VOCs, with a total CVOC concentration of 458 and 485 µg/L, respectively. This compares to a total CVOC concentration of 75 µg/L in 2013, a significant increase. The primary VOCs found in S-3 or S-3b at concentrations greater than cleanup levels are VC and PCE.

5.0 Conclusions and Recommendations

5.1 CONCLUSIONS

Overall, the results of the first year of post-thermal bio-polishing are encouraging, with total CVOC concentrations in many wells along the conditional point of compliance along Fox Avenue at or less than the remediation level of 250 µg/L total CVOCs. Little PCE or TCE remains at the Site; the primary contaminants now are cis-1,2-DCE and VC.

The following are conclusions regarding each of the targeted treatment areas, as well as downgradient areas and seeps.

5.1.1 Northwest Corner Area

Two of the three monitoring wells in the NW Corner Plume (one upgradient [NW1-2], the other at the point of compliance [NW1-1]) demonstrate compliance with the groundwater remediation level of 250 µg/L. However, well B-22, which is located midway between the area of ERD treatment for the loading dock and the NW Corner Plume, has not been treated to date. The concentration of total CVOCs remains greater than the Remediation Level with a concentration of 454 µg/L, mainly due to an elevated concentration of cis-1,2-DCE.

5.1.2 Loading Dock

All samples collected in the 1st and 2nd WBZ of the Loading Dock, in both the injection wells and the downgradient monitoring wells, indicate compliance with the groundwater remediation level. Total CVOC concentrations in any of the six wells sampled did not exceed 45 µg/L.

5.1.3 Main Source Area

In the Main Source Area, injections to both WBZs were completed as planned. Initial results indicate biodegradation has been substantially enhanced in the 2nd WBZ following the July 2014 injection. The effects of the January 2015 injection to the 1st WBZ will be evaluated based on subsequent monitoring.

5.1.4 Fox Avenue

Six wells were sampled along Fox Avenue downgradient of the Main Source Area. Concentrations of total CVOCs in the three 2nd WBZ wells were all in compliance with the groundwater Remediation Level. Two of the three 1st WBZ wells, however, had total CVOC concentrations greater than the Remediation Level, at concentrations similar to prior years, but significantly reduced compared to results prior to the initiation of ERD in 2009. This zone was heated above 40 °C with the thermal treatment of the Main Source Area.

5.1.5 Seeps

Two of the three seeps sampled were in compliance with the groundwater cleanup levels. The third seep, S-3, and its secondary sample, S-3b, both contained primarily VC at concentrations greater than cleanup levels. Seeps S-3 and S-3b also contained PCE at concentrations greater than cleanup levels. Total CVOC concentrations in S-3 increased significantly from 2013 but are less then concentrations measured in prior years. Further monitoring is necessary to establish if this increase was anomalous or not.

5.1.6 Site-Wide Groundwater

Site-wide groundwater trends are illustrated in Figures 5.1 through 5.6, which display side-by-side figures showing concentration of parent (PCE + TCE), daughter (VC), and total CVOC groundwater concentrations in wells site-wide collected just prior to thermal treatment as well after thermal but before 2014 bio-polish injections. These figures illustrate significant reductions in PCE + TCE concentrations. The main area of groundwater concern along Fox Avenue, the conditional point of compliance, now appears to be the concentrations of daughter products in the 1st WBZ along Fox Avenue. These daughter products are being targeted by the bio-polish program implemented in 2014.

5.2 RECOMMENDATIONS

Recommendations for 2015 include a site-wide sampling event in May of 2015. This sampling event should include a total of approximately 30 selected wells site-wide including the NW Corner, the Loading Dock, along Fox Avenue, downgradient of Fox Avenue, and within the Seattle Boiler Works property (4 wells). This sampling event should be coordinated with a low tide to allow sampling of Seep S-3 in the Myrtle Street Embayment. Due to a -2.5-foot tide on May 19, this site-wide sampling event is planned for the week of May 18.

For upgradient wells associated with the Main Source Area injection, quarterly monitoring described in the Work Plan Addendum will continue through 2015, with minor modification. Based on evaluation of baseline and post-injection data from 2nd WBZ wells, modification of the monitoring plan is recommended as follows:

- Wells B-20A and B-21 will be added to regularly monitoring all parameters. This shallow and deep well pair was sampled as an add-on to baseline sampling. Deep well B-21 bounds the 2nd WBZ plume (Figure 5.7). Shallow well B-20A is within the 1st WBZ plume based on 1,394 µg/L of total CVOCs detected during baseline monitoring. The 1st WBZ plume is bounded further to the south by shallow well B-62 (Figure 5.8).
- Addition of AMEE analysis to the three deep Fox Avenue monitoring wells will allow a better understanding of the extent of enhanced treatment resulting from the 2nd WBZ injection.

- Laboratory analysis of sulfide and of total and dissolved iron is added for each well to better evaluate the reduction of injected ferrous sulfate and resulting precipitation of iron sulfides. These analyses were added starting in May and October 2014, respectively.

Table 5.1 presents these changes in a modified monitoring matrix for the Main Source Area.

Specific recommendations for additional substrate injections and performance monitoring may be made to Ecology after review of the site-wide data planned for collection in May 2015. In addition to supplemental injections of substrate, ERD optimization may occur and could include bio-augmentation in areas that were heated to temperatures greater than 35 °C and bio-stimulation (substrate injection) in areas where VOCs are present at concentrations greater than Remediation Levels and remaining TOC is low.

6.0 References

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Tables

Table 2.1
Summary of Well Construction Details

Well ID	Casing Diameter (in)	Total Depth (ft bgs)	Screen Slot Size (in)	Screened Interval (ft bgs)	Sand Pack (ft bgs)	Bentonite Chips (ft bgs)	Cement/ Bentonite Grout (ft bgs)	Monument
Main Source Area Wells								
Injection Wells								
R0-IW1D	2	64	0.020	44–64	42.5–64	38–42.5	2–38	Flush
R0-IW2D	2	64	0.020	44–64	42–64	41–42	2–41	Flush
R0-IW3D	2	65.5	0.020	45.5–65.5	43–65.5	38–43	2–38	Flush
R0-IW4D	2	64	0.020	44–64	42–64	41–42	2–41	Flush
R0-IW4S	2	19	0.020	14–19	13.5–19	10–13.5	2–10	Flush
R0-IW5D	2	65	0.020	45–65	43–65	42–43	2–42	Flush
R0-IW5S	2	20	0.020	15–20	13–20	10–13	2–10	Flush
R0-IW6D	2	65.5	0.020	45.5–65.5	42.5–65.5	41.5–42.5	2–41.5	Flush
R0-IW6S	2	20	0.020	15–20	13–20	10–13	2–10	Flush
R0-IW7D	2	65	0.020	45–65	42–65	38–42	2–38	Flush
R0-IW7S	2	20	0.020	15–20	13–20	10–13	2–10	Flush
R0-IW8D	2	64	0.020	44–64	42–64	38–42	2–38	Flush
R0-IW8S	2	20	0.020	15–20	13.5–20	10.5–13.5	2–10.5	Flush
R0-IW9D	2	65.5	0.020	45.5–65.5	42–65.5	38–42	2–38	Flush
R0-IW9S	2	20	0.020	15–20	13–20	11–13	2–11	Flush
R0-IW10D	2	65	0.020	45–65	43–65	42–43	2–42	Flush
R0-IW10S	2	20	0.020	15–20	13.5–20	12.5–13.5	2–12.5	Flush
R0-IW11D	2	65	0.020	45–65	43.5–65	40–43.5	2–40	Flush
R0-IW11S	2	20	0.020	15–20	14–20	11–14	2–11	Flush
Monitoring Wells								
MW-15D	2	65	0.020	55–65	53–65	50–53	2–50	Flush
MW-16D	2	65	0.020	55–65	53–65	50–53	2–50	Flush
MW-17D	2	65	0.020	55–65	53–65	2–53	None	Flush
MW-18S	2	20	0.020	10–20	8–20	6–8	2–6	Flush
Loading Dock Wells								
Injection Wells								
R0-IW22D	2	60	0.020	30–60	28–60	25–28	4–25	Flush
R0-IW23D	2	60	0.020	30–60	28–60	25–28	4–25	Flush
R0-IW24D	2	60	0.020	30–60	28–60	25–28	4–25	Flush
Monitoring Wells								
MW-19D	2	55	0.020	40–55	38–55	2–38	None	Flush
B-77	2	15	0.020	10–15	8–15	2–8	None	Flush
B-78	2	55	0.020	40–55	38–55	2–38	None	Flush

Abbreviations:
bgs Below ground surface
ft Feet
in Inches

TABLE 2.2
GROUNDWATER TEMPERATURE DATA
MAIN SOURCE AREA INJECTION WELLS
CASCADE COLUMBIA/FOX AVENUE

Well ID	2/26/2014	3/18/2014		5/15/2014		7/8/2014		9/19/2014		11/17/2014		1/13/2015-1/21/2015	
		Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg
R0-IW4S	57	57.3	56.4	51.6	50.9	47.3	47.1	41.3	40.9	39.0	39.0	35.7	35.5
R0-IW5S	53	57.3	57.7	52.2	51.9	46.6	46.3	41.5	40.9	38.3	38.3	34.9	34.8
R0-IW6S	53	57.1	56.4	52.3	51.8	46.1	45.6	41.1	40.9	37.7	37.6	34.3	34.2
R0-IW7S	54	55.7	55.3	49.0	48.6	43.5	43.2	37.9	37.6	34.7	34.7	30.9	30.9
R0-IW8S	53	58.6	57.6	53.7	52.9	48.7	48.0	44.1	43.6	41.7	41.5	38.3	37.9
R0-IW9S	49	56.5	56.0	47.2	46.5	46.8	46.5	43.9	43.7	38.4	38.0	33.1	32.6
R0-IW10S	49	50.7	49.4	44.6	42.6	43.2	42.4	41.8	41.6	37.0	37.0	32.7	32.7
R0-IW11S	44	54.2	52.8	48.6	47.4	44.2	42.9	42.1	42.0	39.1	38.3	35.5	34.7
R0-IW1D	44	48.1	41.8	44.1	43.2	40.1	38.6	36.5	34.1	34.4	32.5	32.2	30.2
R0-IW2D	26	29.9	29.3	27.3	26.9	26.3	25.2	-	-	25.8	25.0	24.7	24.1
R0-IW3D	22	29.4	26.1	24.9	23.3	23.0	22.1	22.0	21.5	20.7	20.7	23.5	21.8
R0-IW4D	48	50.6	50.4	50.5	50.4	48.8	47.7	44.5	43.9	44.2	43.7	43.1	41.3
R0-IW5D	39	43.1	43.6	41.9	40.5	38.0	37.2	38.1	36.7	36.6	35.8	35.9	35.0
R0-IW6D	30	39.8	35.2	32.7	31.6	29.7	29.3	29.3	29.1	28.5	28.4	28.1	28.0
R0-IW7D	20	38.1	29.7	28.9	24.8	26.2	23.6	25.7	24.1	26.6	24.7	23.8	22.8
R0-IW8D	41	49.9	45.2	42.3	40.6	39.8	38.8	39.9	38.7	38.5	37.8	38.1	37.7
R0-IW9D	28	46.0	43.0	39.7	38.2	38.1	36.4	35.7	35.0	35.0	34.2	34.6	33.9
R0-IW10D	31	45.0	40.4	38.4	35.9	35.8	33.7	33.6	32.2	32.6	31.6	32.7	31.5
R0-IW11D	32	39.0	32.2	32.4	28.5	31.1	27.9	30.1	27.4	28.8	26.7	29.7	27.0

Max = maximum

Avg = Average

Note: Temperature measurements were taken at the top and bottom of the screen, for all events except for the round of readings taken 2/26/14.
These measurements were used to calculate the maximum and average.

TABLE 2.4
INJECTION DATA SUMMARY
MAIN SOURCE AREA 2nd WBZ
CASCADE COLUMBIA/FOX AVENUE

Well ID	Injection Order (a)	Injection Date	Injection Volume (gallon)										Oil Concentration of Emulsion and Mid/Post Flush Volume (%) (c)	Injection Rate (gpm)			Pressure Range (psi)
			Pre-Emulsion Flush (b)	Total 25% $FeSO_4$ Solution	10% Sugar Water	Yeast (lb)	TBR	Water (b)	Emulsion Total	Mid-Emulsion Flush	Post-Emulsion Flush (b)	Emulsion and Mid/Post Flushes		Pre-Emulsion Flush	Emulsion	Post-Emulsion Flush	
R0-IW01D	2	7/11-14/14	456	855	990	7.0	594	7,605	10,043	621	366	11,030	5.4%	30	7-34	37	<1
R0-IW02D	2	7/11-14/14	331	867	1,024	7.2	616	7,491	9,998	904	411	11,313	5.4%	22	11-38	41	<1
R0-IW03D	3	7/15-21/14	96	727	1,027	6.8	478	7,765	9,996	-	384	10,380	4.6%	8	7-19	23	<1-5
R0-IW04D	3	7/15-21/14	180	758	1,021	6.6	469	7,709	9,957	-	421	10,378	4.5%	15	5-22	25	<1-8
R0-IW05D	3	7/15-21/14	226	773	1,041	7.2	489	7,695	9,998	-	423	10,421	4.7%	19	10-22	25	<1
R0-IW06D	2	7/11-14/14	336	943	1,025	7.3	604	7,423	9,995	905	384	11,284	5.4%	22	17-34	38	<1
R0-IW07D	3	7/15-21/14	365	883	1,030	7.1	480	7,478	9,871	-	446	10,317	4.7%	30	10-25	26	<1
R0-IW08D	3	7/15-21/14	211	868	1,056	7.4	469	7,581	9,974	-	393	10,367	4.5%	18	6-25	23	<1
R0-IW09D	3	7/15-21/14	213	791	1,035	6.8	471	7,782	10,080	-	280	10,360	4.5%	18	8-23	16	<1
R0-IW010D	1	7/9-10/14	284	965	1,224	11.0	796	9,040	12,025	-	303	12,328	6.5%	22	10-28	23	<1-6
R0-IW011D	1	7/9-10/14	317	980	1,214	11.4	804	9,023	12,020	-	394	12,414	6.5%	24	9-34	30	<1-6
			601	**9,410**	**11,685**	**86**	**6,270**	**86,592**	**113,957**			**120,592**					

TBR = Textrol BR (90 percent vegetable oil, 10 percent soy-based lecithin surfactant)
psi = pounds per square inch
lb = pound
gpm = gallons per minute

(a) Wells were injected in three groups with wells manifolded together for simultaneous injection.
(b) All water used for injection was City tap water.
(c) Based on total TBR volume, including the soy-based lecithin surfactant.

TABLE 2.5
INJECTION DATA SUMMARY
MAIN SOURCE AREA 1st WBZ
CASCADE COLUMBIA/FOX AVENUE

Well ID	Injection Order (a)	Injection Date	Injection Volume (gallon)									Oil Concentration of Emulsion and Post Flush Vol (%) (c)	Injection Rate (gpm) (d)					Pressure Range (psi)
			Pre-Emulsion Flush (Tap)	25% $FeSO_4$ Solution	10% Sugar Water	TBR	Yeast (lb)	Water (GW) (b)	Emulsion Total	Post-Emulsion Flush (GW)	Emulsion and Post Flushes		Pre-Emulsion Flush	$FeSO_4$ Solution	10% Sugar Water	Emulsion	Post-Emulsion Flush	
R0-IW04S	2	1/28/15	70	136	181	46	1.3	1,172	1,218	291	1,509	3.0%	8	5-12	5-10	13-22	9-16	3.5-5.5
R0-IW05S	2	1/28/15	122	136	177	56	1.6	1,411	1,467	66	1,533	3.7%	14	6-13	7-10	18-28	13	4
R0-IW06S	2	1/28/15	140	136	173	57	1.6	1,408	1,465	72	1,537	3.7%	18	7-8	8	22-23	14	4.5-6
R0-IW07S	2	1/28/15	66	136	170	57	1.6	1,408	1,465	79	1,544	3.7%	8	9	5-7	18-26	16	6.5-10
R0-IW08S	1	1/26-27/15	200	136	170	50	1.4	1,084	1,134	313	1,447	3.4%	5	6	3	7-8	8	3-5.5
R0-IW09S	1	1/26-27/15	85	126	182	60	1.7	1,327	1,387	54	1,441	4.1%	1-2	1-2	4	8-11	7	5.5-7.5
R0-IW10S	1	1/26-27/15	125	136	139	47	1.3	1,028	1,075	416	1,491	3.1%	2	2-4	3	7	3-12	1-3.5
R0-IW11S	1	1/26-27/15	95	137	175	60	1.7	1,358	1,418	63	1,481	4.1%	3	1-4	3	8-13	20	5-8.5
			903	**1079**	**1,367**	**432**	**12**	**10,197**	**10,629**		**11,983**							

Tap = City tap water
TBR = Textrol BR (90 percent vegetable oil, 10 percent soy-based lecithin surfactant)
GW = Groundwater extracted from R1-IW3B and R1-IW5
psi = pounds per square inch
lb = pound
gpm = gallons per minute

(a) Wells were injected in three groups with wells manifolded together for simultaneous injection
(b) Combined extraction flow rates from the two wells ranged from approximately 20 to 30 gpm.
(c) Based on total TBR volume, including the soy-based lecithin surfactant
(d) For all eight wells, the highest flow rates, which are most indicative of aquifer injectability, occurred during the emulsion injection due to the higher volume of this injection step and the corresponding ability to increase the pump speed. The pre-emulsion flush for the first four wells injected (R0-IW08S, 9S, 10S, and 11S) was conducted under gravity flow, resulting in lower injection rates. All remaining injection steps were conducted using a pump. Flow rates during the pre-emulsion flush (2nd well grouping), and the steps of iron sulfate injection and sugar water injection were lower due to smaller injection volumes and air becoming entrained in the injection hoses and pump.

Table 3.1
Summary of Volatile Organic Compound Data in Groundwater

				Non-Chlorinated Volatile Organic Compounds									Chlorinated Volatile Organic Compounds								
			Analyte	Acetone	Benzene	EB	MEK	Naphthalene	Toluene	1,2,4-TMBZ	Xylene	Xylene (ortho)	1,1-DCA	1,1-DCE	1,2-DCA	cis-1,2-DCE	PCE	trans-1,2-DCE	TCE	VC	Total CVOCs
			Unit	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Location	**Sample ID**	**WBZ**	**Sample Date**																		
Monitoring Wells																					
Fox Avenue																					
B-18	B-18-051514	1st	5/15/2014	5 U	11.8	12	5 U	2.59	84.9	10	15.4	9.89	1.87	1 U	1.79	115	1 U	5.91	1.38	193	319
B-19	B-19-051514	2nd	5/15/2014	5 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	3.08	1 U	656	1 U	2.36	0.5 U	241	902
B-20A	B-20A-062014	1st	6/20/2014	5.69	11.8	31	5 U	2.56	32	10.1	18.7	9.81	1 U	2.23	1 U	1,280 J	1 U	51.2	11.5	102 J	1,450 J
	DUP-1-062014	1st	6/20/2014	5 U	12	31	5 U	2.5	31.9	10.2	18.7	9.66	1 U	2.21	1 U	1,270 J	1 U	50.2	11.7	97.7 J	1,430 J
B-21	B-21-062014	2nd	6/20/2014	7.06	1.87	1.7	5 U	1 U	16.4	1 U	1 U	1.43	2.17	1 U	1 U	3.24	1 U	1 U	0.5 U	0.2 U	5.41
B-58	B-58-051514	1st	5/15/2014	5 U	1.7	2.9	5 U	1 U	7.01	1 U	1.24	1.53	1 U	1 U	1 U	305	5.43	2.64	3.04	145	461
B-59	B-59-051514	2nd	5/15/2014	5 U	1.79	1 U	5 U	1 U	10.8	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	3.29	3.29
	B-59-102214	2nd	10/22/2014	5 U	1.55	1 U	5 U	1 U	1.98	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	26.8	26.8
	B-59-010915	2nd	1/9/2015	5 U	1.69	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	8.01	8.01
B-60	B-60-051514	1st	5/15/2014	5 U	3.48	16	5 U	2.95	13.4	2.89	2.38	4.12	1 U	1 U	1 U	1,500	1 U	15.4	3.51	52	1,570
B-61	B-61-051514	2nd	5/15/2014	5 U	2.33	1.1	5 U	1 U	1 U	1 U	1 U	1.43	1.71	1 U	1 U	15.8	1 U	1 U	0.5 U	17.4	34.9
	B-61-102214	2nd	10/22/2014	7.29	3.06	1.1	5 U	1 U	1 U	1 U	1 U	1.54	2.26	1 U	1 U	9.64	1 U	1 U	0.5 U	2.77	14.7
	B-61-010915	2nd	1/9/2015	5 U	4.22	2	5 U	1 U	1 U	1 U	1	2.19	4.94	1 U	1 U	6.92	1 U	1 U	0.5 U	1.69	13.6
B-62	B-62-051514	1st	5/15/2014	5 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	5.93	1.52	1 U	1.13	0.2 U	8.58
B-63	B-63-051514	2nd	5/15/2014	5 U	1 U	1 U	9.54	1 U	1 U	1 U	1 U	1 U	2.66	1 U	1 U	4.18	1 U	1 U	0.5 U	65.3	72.1
B-22	B-22-051614	1st	5/16/2014	5 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	1.29	1.94	276	135	3.55	33.8	2.8	454
NW 1-1	NW1-1-051514	1st	5/15/2014	20	1 U	1 U	169	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	61.2	49.1	1 U	34.8	11.6	157
NW 1-2	NW1-2-051514	1st	5/15/2014	5 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	35.5	85.6	1 U	15.2	2.51	139
Loading Dock																					
B-77	B-77-051614	1st	5/16/2014	5 U	1.07	2.1	5 U	2.61	1 U	3.1	1.77	2.18	1 U	1 U	1 U	15.5	12.8	1 U	2.31	0.934	31.5
B-78	B-78-051614	2nd	5/16/2014	5 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	10.2	1 U	1 U	0.5 U	30	40.2
Main Source Area																					
MW-09	MW-9-051414	1st	5/14/2014	5 U	8.71	1 U	5 U	1 U	12.2	1.42	1.64	1 U	1 U	2.54	1 U	1,000	11.8	20.2	162	36.4	1,230
MW-10	MW-10-051414	2nd	5/14/2014	9.27	3.64	35	5 U	7.32	69.2	38.5	35.3	10.4	1 U	1 U	1 U	7,520	1 U	44.8	0.5 U	274	7,840
	MW-10-102214	2nd	10/22/2014	5 U	3.94	43	5 U	9.72	166	47	59.5	19.7	1 U	3.95	1 U	6,670	5.5	12.5	2.46	1,630	8,320
	MW-10-010915	2nd	1/9/2015	5 U	3.57	42	5 U	6.47	81.8	39.2	49	16.6	1 U	2.56	1 U	4,190	5.03	17.3	1.21	1,440	5,660
MW-15D	MW-15D-051414	2nd	5/14/2014	5 U	1 U	1 U	5 U	1 U	1.34	1 U	1 U	1 U	1 U	1.36	1 U	578	150	4	118	121	972
	Dup1-051414	2nd	5/14/2014	5.04	1 U	1 U	5 U	1 U	1.59	1.01	1 U	1 U	1 U	1.67	1 U	567	134	4.86	103	114	925
	MW-15-102314	2nd	10/23/2014	646	1 U	2.3	880	1 U	6.03	6.06	2.92	1.6	1 U	1 U	1 U	1 U	1.28	8.67	0.5 U	926	936
	MW-15-010815	2nd	1/8/2015	779	1 U	3.2	647	1 U	9.49	11.5	5.14	2.46	1 U	1 U	1 U	2.64	1.24	16.8	0.5 U	6,510	6,530
	DUP-1-010815	2nd	1/8/2015	499	1 U	3.3	471	1 U	9.28	10.5	4.88	2.43	1 U	1 U	1 U	2.09	1.21	15.2	0.5 U	6,380	6,400
MW-16D	MW-16D-051414	2nd	5/14/2014	5 U	1 U	1 U	5 U	1 U	5.66	1 U	1 U	4.18	1 U	3.24	1 U	4,600	1 U	82.5	0.5 U	2,240	6,930
	MW-16-102314	2nd	10/23/2014	1,750	1 U	55	5 U	1.39	9	33.1	18.1	3.07	1 U	1.68	1 U	1,660	1.42	33	8.11	1,080	2,780
	MW-16-010815	2nd	1/8/2015	961	1 U	58	1,690	1.33	17.1	29.2	19.8	3.14	1 U	4.07	1 U	2,460	1.99	74.8	8.51	4,210	6,760
MW-17D	MW-17D-051414	2nd	5/14/2014	5 U	2.04	1 U	5 U	1 U	1.45	1 U	1 U	1 U	1 U	1 U	1 U	69.3	1 U	1 U	0.738	53.5	124
	MW-17-102314	2nd	10/23/2014	5 U	8.96	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	3.99	1 U	1 U	0.5 U	17.4	21.4
	MW-17-010815	2nd	1/8/2015	5 U	9.61	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	2.75	1 U	1 U	0.5 U	21.8	24.6
MW-18S	MW-18S-051514	1st	5/15/2014	29.3	1.18	1 U	5 U	1 U	6.64	2.05	2.64	1.15	1 U	2.85	1 U	712	145	5.66	50.1	4.71	920
	MW-18-102214	1st	10/23/2014	5 U	1.92	1 U	5 U	1 U	11.1	1 U	1 U	1 U	1 U	3.98	1 U	1,870	17.7	10.7	23.2	41.4	1,970
MW-19D	MW-19D-051614	2nd	5/16/2014	5 U	1 U	1 U	54.4	1 U	1 U	1 U	1 U	1 U	1 U	1 U	13.8	11.3	1 U	1 U	0.5 U	20.7	45.8
Whitehead																					
B-45	B-45-051414	2nd	5/14/2014	5 U	1.59	1 U	5 U	1 U	1 U	1 U	1 U	1 U	2.02	1 U	1 U	998	1 U	17.2	0.83	1,030	2,050
	B-45-102214	2nd	10/22/2014	5 U	3.13	1 U	5 U	1 U	2.27	1 U	1 U	1 U	4.06	7.66	1 U	7,270	1.55	66.5	3.03	10,700	18,100
	B-45-010915	2nd	1/9/2015	5 U	1.61	1 U	5 U	1 U	3.61	1 U	1.2	1 U	2.04	2.73	1 U	1,870	1 U	40	2.26	3,220	5,140
B-49	B-49-051414	1st	5/14/2014	7.89	1 U	1 U	5 U	1 U	1.05	1 U	1 U	1 U	1 U	1.16	1 U	484	98.6	12.6	42.2	5.14	644
	B-49-102314	1st	10/23/2014	5 U	1.47	1 U	5 U	1 U	1.28	1 U	1.07	1 U	1 U	1.65	1 U	1,170	13	12.8	26.1	17.2	1,240

Table 3.1
Summary of Volatile Organic Compound Data in Groundwater

				Non-Chlorinated Volatile Organic Compounds									Chlorinated Volatile Organic Compounds								
			Analyte	Acetone	Benzene	EB	MEK	Naphthalene	Toluene	1,2,4-TMBZ	Xylene	Xylene (ortho)	1,1-DCA	1,1-DCE	1,2-DCA	cis-1,2-DCE	PCE	trans-1,2-DCE	TCE	VC	Total CVOCs
			Unit	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Location	Sample ID	WBZ	Sample Date																		
Injection Wells																					
Main Source Area																					
R0-IW1D	R0-IW1D-022514	2nd	2/25/2014		1 U	1 U		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	850	1 U	2.9	91	6.7	951
R0-IW2D	R0-IW2D-022514	2nd	2/25/2014		1 U	1.1		1 U	1.2	8.6	2.2	1 U	1 U	2.3	1 U	1,100	650	19	1,000	69	2,840
	R0-IW02D-051414	2nd	5/14/2014	5 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	10.9	1 U	1 U	0.77	0.2 U	11.7
	R0-IW02D-062014	2nd	6/20/2014	5 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	9.63	1 U	1 U	0.664	1.25	11.5
	R0-IW02D-102214	2nd	10/22/2014	333	1 U	1 U	678	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.75	0.75
	R0-IW02D-010815	2nd	1/8/2015	139	1 U	1 U	174	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	13.1	1 U	1 U	0.63	7.41	21.1
R0-IW3D	R0-IW3D-022514	2nd	2/25/2014		1 U	1 U		1 U	1 U	1.2	1 U	1 U	1 U	1 U	1 U	84	110	1.4	170	4.9	370
R0-IW4D	R0-IW4D-022514	2nd	2/25/2014		9.9	1 U		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	190	1 U	2.2	0.5 U	1.1	193
	R0-IWDUP-022514	2nd	2/25/2014		10	1 U		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	100	1 U	1.3	0.5 U	0.2 U	101
R0-IW4S	R0-IW4S-022514	1st	2/25/2014		4.3	2.2		1 U	3.9	1 U	3.7	1.3	1 U	1 U	1 U	730	1 U	1 U	2.3	5.8	738
R0-IW5D	R0-IW5D-022514	2nd	2/25/2014		1.8	1 U		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	27	1 U	1 U	1.5	22	50.5
R0-IW5S	R0-IW5S-022514	1st	2/25/2014		4.8	3.4		1 U	8.4	1.3	4.4	1 U	1 U	1 U	1 U	380	1 U	1 U	0.5 U	3.5	384
R0-IW6D	R0-IW6D-022514	2nd	2/25/2014		1 U	1 U		1 U	3.4	1 U	1 U	1 U	1 U	1 U	1 U	600	1 U	3.1	0.5 U	620	1,220
	R0-IW06D-051414	2nd	5/14/2014	5 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	2.95	1 U	1 U	0.5 U	5.18	8.13
	R0-IW06D-102314	2nd	10/23/2014	1130	1 U	1 U	647	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.72	8	8.72
	DUP-1-102314	2nd	10/23/2014	909	1 U	1 U	657	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	8.05	8.05
	R0-IW06D-010815	2nd	1/8/2015	332	1 U	1 U	218	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	10	1 U	1 U	1.28	15.3	26.6
R0-IW6S	R0-IW6S-030314	1st	3/3/2014	5 U	5.3	4.3	5 U	1 U	6.9	1.8	4.9	1.7	1 U	1 U	1 U	850 J	1 U	1 U	3.2	3.6	857 J
R0-IW7D	R0-IW7D-022614	2nd	2/26/2014		1 U	2.6		1 U	1 U	14	4.3	1 U	1 U	1 U	1 U	74	150	4	120	21	369
R0-IW7S	R0-IW7S-022614	1st	2/26/2014		2.7	2.5		1 U	2.5	1 U	2.9	1 U	1 U	1 U	1 U	500	1 U	1 U	3.8	1.9	506
R0-IW8D	R0-IW8D-022614	2nd	2/26/2014		4.4	3.5		1 U	2.6	1 U	2.2	1 U	1 U	1.6	1 U	1,100	1 U	7.5	3.2	370	1,480
R0-IW8S	R0-IW8S-022614	1st	2/26/2014		3.1	1.8		1 U	19	1	3.3	2.1	1 U	2.2	1 U	680	58	18	55	8.1	821
R0-IW9D	R0-IW9D-022614	2nd	2/26/2014		6.1	3.9		1 U	4.2	1 U	1.6	1 U	1 U	1 U	1 U	360	1 U	2.4	0.5 U	2,200	2,560
R0-IW9S	R0-IW9S-022614	1st	2/26/2014		1.4	1 U		1 U	7.3	1 U	1 U	1 U	1 U	1.8	1 U	700	56	5.6	34	5.6	803
	R0-IW09S-051414	1st	5/14/2014	5 U	1.08	1 U	5 U	1 U	2.32	1 U	1 U	1 U	1 U	4.25	1 U	657	105	4.7	66.6	6.35	844
R0-IW10D	R0-IW10D-022614	2nd	2/26/2014		3.9	28		1 U	20	2.5	9	4	1 U	1 U	1 U	170	1 U	1.5	0.5 U	1,800	1,970
R0-IW10S	R0-IW10S-022614	1st	2/26/2014		1.7	9.4		1 U	11	1 U	5.2	2.8	1 U	1 U	1 U	510	16	1 U	7.7	4.8	539
R0-IW11D	R0-IW11D-022614	2nd	2/26/2014		1 U	32		1 U	2.2	8.8	7.2	1.5	1 U	1 U	1 U	7.8	1 U	1.3	0.5 U	590	599
R0-IW11S	R0-IW11S-030314	1st	3/3/2014	20	1.3	8.6	5 U	1.7 J	6.3	1.6	4.9	2.8	1 U	1 U	1 U	510	1.9	2.3	21	2.5	538 J
Loading Dock																					
R0-IW22	R0-IW22D-35-030314	2nd	3/3/2014	5 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1.5	1 U	1 U	1 U	1.8	0.2 U	3.3
	R0-IW22D-55-030314	2nd	3/3/2014	5 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1.4	1 U	1 U	1 U	0.5 U	1.3	2.7
R0-IW23	R0-IW23D-35-030314	2nd	3/3/2014	55	1 U	1 U	100	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1.9	12	1 U	1 U	1.3	3.1	18.3
	R0-IW23D-55-030314	2nd	3/3/2014	17	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	3	15	1 U	1 U	0.5 U	6.9	24.9
R0-IW24	R0-IW24D-35-030314	2nd	3/3/2014	5 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	3.4	35	1 U	1 U	5.1	47	90.5
	R0-IW24D-55-030314	2nd	3/3/2014	5 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	3.3	38	1 U	1 U	3.5	57	102
R1-IW21	R1-IW21-051514	1st	5/15/2014	88.6	2.53	1.5	90.9	2.23	2.53	2.65	2.08	2.48	1 U	1 U	4.61	35.8	1.37	6.26	2.56	47.5	98.1
	Dup1-051514	1st	5/15/2014	95.8	2.58	1.4	88.2	1.85	2.45	2.43	2.35	2.56	1 U	1 U	4.68	37.4	1 U	7.17	2.61	52.7	105
Seep Data																					
S-2	SP-02-051614		05/16/2014	5 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1.6	1 U	1 U	0.5 U	0.2 U	1.6
S-13 (Calibre S-3)	SP-03-051614		05/16/2014	5 U	9.31	1 U	5 U	1 U	1.14	1 U	1 U	1.98	16.2	1 U	1.39	67.6	1 U	1 U	0.805	372	458
S-3b	SP-03b-051614		05/16/2014	5 U	1.39	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1.95	1 U	2.92	290	16.7	29.5	7.55	136	485
S-16 (Calibre S-4)	SP-04-051614		05/16/2014	5 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.2 U	1 U

Abbreviations:

CVOC Chlorinated volatile organic compound
DCA Dichloroethane
DCE Dichloroethene
EB Ethylbenzene
MEK Methyl ethyl ketone
µg/L Micrograms per liter
PCE Tetrachloroethene
TCE Trichloroethene
TMBZ Trimethylbenzene
VC Vinyl chloride
WBZ Water bearing zone

Qualifiers:

J Analyte is detected, the concentration is estimated.
U Analyte is not detected at the associated reporting limit.

Table 3.2
Summary of Monitoring Standard Laboratory Data in Groundwater

				Conventionals			Dissolved Gases			Metals	
			Analyte	Total Organic Carbon	Sulfate	Sulfide	Ethane	Ethene	Methane	Iron, Dissolved	Iron, Total
			Unit	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L
Location	Sample ID	WBZ	Sample Date								
Monitoring Wells											
Fox Avenue											
B-18	B-18-051514	1st	5/15/2014								
B-19	B-19-051514	2nd	5/15/2014								
B-20A	B-20A-062014	1st	6/20/2014	36.1	10.3	0.5 U	0.005 U	0.0216	4.39		
	DUP-1-062014	1st	6/20/2014	30.5	10.8	0.5 U	0.005 U	0.0246	4.35		
B-21	B-21-062014	2nd	6/20/2014	9.13	1.5 U	0.5 U	0.0365	0.005 U	5.75 J		
B-58	B-58-051514	1st	5/15/2014								
B-59	B-59-051514	2nd	5/15/2014								
	B-59-102214	2nd	10/22/2014	12	65.1	0.5 U				156,000	164,000
	B-59-010915	2nd	1/9/2015	29.7	53.9	0.5 U				110,000	120,000
B-60	B-60-051514	1st	5/15/2014								
	B-60-062014	1st	6/20/2014	9.53	24	0.5 U	0.005 U	0.005 U	6.2 J		
B-61	B-61-051514	2nd	5/15/2014								
	B-61-062014	2nd	6/20/2014	4.05	0.3 U	0.5 U	0.0263	0.005 U	11.6 J		
	B-61-102214	2nd	10/22/2014	9.07	3 U	0.5 U				38,300	40,700
	B-61-010915	2nd	1/9/2015	21.9	3 U	0.8				40,300	37,700
B-62	B-62-051514	1st	5/15/2014								
B-63	B-63-051514	2nd	5/15/2014								
B-22	B-22-051614	1st	5/16/2014								
NW 1-1	NW1-1-051514	1st	5/15/2014								
NW 1-2	NW1-2-051514	1st	5/15/2014								
Loading Dock											
B-77	B-77-051614	1st	5/16/2014								
B-78	B-78-051614	2nd	5/16/2014	0.5 U	0.3 U		0.0407	0.0067	5.07		
MW-07	MW-7 041114	1st	4/11/2014								
Main Source Area											
MW-09	MW-9-051414	1st	5/14/2014	49.8	39.9	0.5 U	0.005 U	0.005 U	1.32		
MW-10	MW-10-051414	2nd	5/14/2014	45.8	0.3 U	0.5 U	0.005 U	0.0171	2.17		
	MW-10-102214	2nd	10/22/2014	20	1.5 U	0.5 U				3,430	4,580
	MW-10-010915	2nd	1/9/2015	21.6	1.5 U	0.5 U	0.005 U	0.037	1.42	7,960	8,650
MW-15D	MW-15D-051414	2nd	5/14/2014	12.8	7.35	0.5 U	0.005 U	0.005 U	1.63		
	Dup1-051414	2nd	5/14/2014	13.3	7.27	0.5 U	0.005 U	0.005 U	1.08		
	MW-15-102314	2nd	10/23/2014	2.31	3 U	0.5 U				13,000	13,800
	MW-15-010815	2nd	1/8/2015	359	3 U	0.8	0.0239	0.875	2.6	17,100	18,500
	DUP-1-010815	2nd	1/8/2015	361	3 U	0.5 U	0.0205	0.853	3.1	16,300	18,200
MW-16D	MW-16D-051414	2nd	5/14/2014	7.35	42.5	0.5 U	0.0201	0.0862	1.76		
	MW-16-102314	2nd	10/23/2014	16	102	2.5				80,500	76,000
	MW-16-010815	2nd	1/8/2015	1,010	30.7	0.8	0.005 U	0.0716	0.702	107,000	138,000
MW-17D	MW-17D-051414	2nd	5/14/2014	40.9	0.823	0.5 U	0.005 U	0.0061	3.29		
	MW-17-102314	2nd	10/23/2014	17.5	1.5 U	0.5 U				711	992
	MW-17-010815	2nd	1/8/2015	21.2	1.5 U	0.8	0.005 U	0.005 U	3.31	1,020	1,150
MW-18S	MW-18S-051514	1st	5/15/2014	89.2	239	0.5 U	0.005 U	0.005 U	0.271		
	MW-18-102214	1st	10/23/2014								
MW-19D	MW-19D-051614	2nd	5/16/2014	7.85	97.3		0.005 U	0.005 U	1.58		
Whitehead											
B-45	B-45-051414	2nd	5/14/2014	9.36	26.1	0.5 U	0.01	0.0356	1.37		
	B-45-102214	2nd	10/22/2014	6.1	3.35	0.5 U				7,560	8,780
	B-45-010915	2nd	1/9/2015	7.73	11.5	0.5 U	0.0199	0.392	1.21	7,250	8,250
B-49	B-49-051414	1st	5/14/2014	11.4	14.9	0.5 U	0.005 U	0.005 U	0.532		
	B-49-102314	1st	10/23/2014								

Table 3.2
Summary of Monitoring Standard Laboratory Data in Groundwater

				Conventionals			Dissolved Gases			Metals	
			Analyte	Total Organic Carbon	Sulfate	Sulfide	Ethane	Ethene	Methane	Iron, Dissolved	Iron, Total
			Unit	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L
Injection Wells											
Main Source Area											
R0-IW1D	R0-IW1D-022514	2nd	2/25/2014	3.41	4.22						
R0-IW2D	R0-IW2D-022514	2nd	2/25/2014	6.45	38.9						
	R0-IW02D-051414	2nd	5/14/2014	2.6	38.7	0.5 U	0.005 U	0.005 U	0.131		
	R0-IW02D-062014	2nd	6/20/2014								
	R0-IW02D-102214	2nd	10/22/2014	31.6	699	0.5 U				890,000	953,000
	R0-IW02D-010815	2nd	1/8/2015	2,180	178	0.5 U	0.005 U	0.005 U	0.432	542,000	566,000
R0-IW3D	R0-IW3D-022514	2nd	2/25/2014	3.16	14.3						
R0-IW4D	R0-IW4D-022514	2nd	2/25/2014	8.31	0.487						
	R0-IWDUP-022514	2nd	2/25/2014	11.8	1.05						
R0-IW4S	R0-IW4S-022514	1st	2/25/2014	19.7	5.97						
R0-IW5D	R0-IW5D-022514	2nd	2/25/2014	4.11	16.9						
R0-IW5S	R0-IW5S-022514	1st	2/25/2014	53.5	0.3 U						
R0-IW6D	R0-IW6D-022514	2nd	2/25/2014	9.83	16.2						
	R0-IW06D-051414	2nd	5/14/2014	3.81	35.4	0.5 U	0.005 U	0.005 U	0.38		
	R0-IW06D-102314	2nd	10/23/2014	26.7	1,360	0.5 U				1,480,000	1,390,000
	DUP-1-102314	2nd	10/23/2014	28.8	1,470	0.5 U				1,400,000	1,360,000
	R0-IW06D-010815	2nd	1/8/2015	2,810	860	5.2	0.005 U	0.005 U	0.837	821,000	807,000
R0-IW6S	R0-IW6S-030314	1st	3/3/2014	27	0.3 U						
R0-IW7D	R0-IW7D-022614	2nd	2/26/2014	4.93	4.12						
R0-IW7S	R0-IW7S-022614	1st	2/26/2014	25.4	0.3 U						
R0-IW8D	R0-IW8D-022614	2nd	2/26/2014	6.98	2.45						
R0-IW8S	R0-IW8S-022614	1st	2/26/2014	131	156						
R0-IW9D	R0-IW9D-022614	2nd	2/26/2014	33.9	2.93						
R0-IW9S	R0-IW9S-022614	1st	2/26/2014	30.5	29						
	R0-IW09S-051414	1st	5/14/2014	13.6	31.9	0.5 U	0.005 U	0.005 U	1.08		
R0-IW10D	R0-IW10D-022614	2nd	2/26/2014	7.43	1.22						
R0-IW10S	R0-IW10S-022614	1st	2/26/2014	15.6	41.7						
R0-IW11D	R0-IW11D-022614	2nd	2/26/2014	4.93	0.418						
R0-IW11S	R0-IW11S-030314	1st	3/3/2014	17.2	11.2						
Loading Dock											
R0-IW22	R0-IW22D-35-030314	2nd	3/3/2014	2.9	95.2		0.005 U	0.005 U	0.024		
	R0-IW22D-55-030314	2nd	3/3/2014	3.03	87.7		0.005 U	0.005 U	0.125		
R0-IW23	R0-IW23D-35-030314	2nd	3/3/2014	3.4	97.1		0.005 U	0.005 U	0.088		
	R0-IW23D-55-030314	2nd	3/3/2014	3.18	90		0.005 U	0.005 U	0.215		
R0-IW24	R0-IW24D-35-030314	2nd	3/3/2014	9.05	106		0.005 U	0.005 U	0.549		
	R0-IW24D-55-030314	2nd	3/3/2014	10.2	108		0.005 U	0.005 U	0.659		
R1-IW21	R1-IW21-051514	1st	5/15/2014								
	Dup1-051514	1st	5/15/2014								

Note:

Blank cells represent non-detects.

Abbreviations:

µg/L Micrograms per liter
mg/L Milligrams per liter
WBZ Water bearing zone

Qualifiers:

J Analyte is detected, the concentration is estimated.
U Analyte is not detected at the associated reporting limit.

TABLE 3.3
qPCR DATA SUMMARY
CASCADE COLUMBIA/FOX AVENUE

Location	Sample Depth (feet)	Date Collected	DHC (cells/mL)
RI-IW2	55	5/15/2014	9.88E+03
RI-IW3B	55	5/15/2014	1.42E+05
RI-IW5	55	5/15/2014	2.36E+05
RI-IW6	55	5/15/2014	7.09E+04
RI-IW7	55	5/15/2014	1.44E+05

mL = milliliter

TABLE 4.1
GROUNDWATER DATA SUMMARY
MAIN SOURCE AREA
CASCADE COLUMBIA/FOX AVENUE

			Volatile Organic Compounds								Aquifer Redox Conditions								Donor Indicators				Other		VOCs- micromoles/Liter(b)						VOCs - Molar Fraction (c)						
Well	Date	Elapsed Time from Injection (days) (a)	Sum cVOCs (c) (µg/L)	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	DO (mg/L)	ORP (mV)	Iron II (mg/L)	Iron (T) (mg/L)	Iron (D) (mg/L)	Sulfate (mg/L)	Sulfide (mg/L)	Methane (mg/L)	TOC (mg/L)	Acetone (µg/L)	MEK (µg/L)	pH	Temp (deg C)	Comments	PCE	TCE	cDCE	VC	Ethene/ Ethane	Total Chloroethenes (d)	PCE	TCE	cDCE	VC	Ethene/ Ethane		Max
RO-IW01D	2/25/2014	-146	952	<1.01	91.0	854	6.65						0.8			4.2			3.41				44.4		0.00	0.69	8.8	0.11	0.00	9.6	0.00	0.07	0.92	0.01		1.00	0.92
RO-IW02D	2/25/2014	-146	2808	649	1000	1090	68.7						2.0			38.9			6.45				25.6		3.9	7.6	11	1.1	0.00	24	0.16	0.32	0.47	0.05		1.00	0.47
	5/14/2014	-68	12	<1	0.77	10.9	<0.2	<5	<5	ND	0.41	-76.5	2.2			38.7	<0.5	0.131	2.60	<5	<5	9.39	28.3	Clear, low, no odor/no sheen	0.00	0.01	0.11	0.00	0.00	0.12	0.00	0.05	0.95	0.00	0.00	1.00	0.95
	6/20/2014	-31	12	<1	0.664	9.63	1.25				0.59	-72.9								<5	<5	6.76	24.3	Clear, low, no odor/no sheen	0.00	0.01	0.10	0.02	0.00	0.12	0.00	0.04	0.80	0.16		1.00	0.80
	10/22/2014	93	0.8	<1	<0.5	<1	0.75				3.34		7.5	953	890	699	<0.5		31.6	333	678	4.79	24.2	Cloudy, turbid, vomit-like smell, NS, well under very high pressure, water meter collected orange particulate and oil, effervescent	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	1.00		1.00	1.00
	1/8/2015	171	21.1	<1	0.63	13.1	7.41	<5	<5	ND	6.64		5.6	566	542	178	<0.5	0.432	2180	139	174	4.79	19.5	Light orange, low-med turbidity, vomit like odor, NS, efferevescent	0.00	0.00	0.14	0.12	0.00	0.26	0.00	0.02	0.52	0.46	0.00	1.00	0.52
RO-IW03D	2/25/2014	-146	369	109	171	84.3	4.88						2.4			14.3			3.16				21.7		0.66	1.3	0.87	0.08	0.00	2.9	0.23	0.45	0.30	0.03		1.00	0.45
RO-IW04S	2/25/2014	-337	742	<1.00	2.25	734	5.84						1.6			6.0			19.7				57.2		0.00	0.02	7.6	0.09	0.00	7.7	0.00	0.00	0.99	0.01		1.00	0.99
RO-IW04D	2/25/2014	-146	192	<1.00	<0.500	191	1.06						1.8			0.5			8.31				48.3		0.00	0.00	2.0	0.02	0.00	2.0	0.00	0.00	0.99	0.01		1.00	0.99
RO-IW05S	2/25/2014	-337	385	<1.00	<0.500	381	3.51						0.4			<0.300			53.5				52.8		0.00	0.00	3.9	0.06	0.00	4.0	0.00	0.00	0.99	0.01		1.00	0.99
RO-IW05D	2/25/2014	-146	50	<1.00	1.46	27.1	21.6						1.4			16.9			4.11				39.4		0.00	0.01	0.28	0.35	0.00	0.64	0.00	0.02	0.44	0.54		1.00	0.54
RO-IW06S	3/3/2014	-331	856	<1.00	3.23	849	3.55						1.6			<0.300			27.0				52.2		0.00	0.02	8.8	0.06	0.00	8.8	0.00	0.00	0.99	0.01		1.00	0.99
RO-IW06D	2/25/2014	-146	1219	<1.00	<0.500	598	621						0.2			16.2			9.83				29.4		0.00	0.00	6.2	9.9	0.00	16	0.00	0.00	0.38	0.62		1.00	0.62
	5/14/2014	-68	8.1	<1	<0.5	2.95	5.18	<5	<5	ND	0.05	-107.0	0.0			35.4	<0.5	0.380	3.81	<5	<5	6.92	33.1	Clear, low, no odor/no sheen, effervescent	0.00	0.00	0.03	0.08	0.00	0.11	0.00	0.00	0.27	0.73	0.00	1.00	0.73
	10/23/2014	94	8.7	<1	0.72	<1	8				1.74	-45.2	3.2	1390	1480	1360	<0.5		26.7	1130	647	4.76	27.6	Cloudy, light orange, moderate turbidity, vomit-like odor, NS, orange particulate on probe, well under pressure, effervescent	0.00	0.01	0.00	0.13	0.00	0.13	0.00	0.04	0.00	0.96		1.00	0.96
	1/8/2015	171	26.6	<1	1.28	10.0	15.3	<5	<5	ND	1.91	-23.4	2.4	807	821	860	5.20	0.837	2810	332	218	4.83	26.1	Orange, low-med turbidity, vomit like odor, NS, orange particles, effervescent	0.00	0.01	0.10	0.24	0.00	0.36	0.00	0.03	0.29	0.68	0.00	1.00	0.68
RO-IW07S	2/26/2014	-336	505	<1.00	3.83	499	1.88						0.8			<0.300			25.4				54.4		0.00	0.03	5.1	0.03	0.00	5.2	0.00	0.01	0.99	0.01		1.00	0.99
RO-IW07D	2/26/2014	-145	359	147	116	74.3	21.3						2.0			4.12			4.93				20.6		0.89	0.88	0.77	0.34	0.00	2.9	0.31	0.31	0.27	0.12		1.00	0.31
RO-IW08S	2/26/2014	-336	799	58.3	55.2	677	8.08						0.2			156			131				52.8		0.35	0.42	7.0	0.13	0.00	7.9	0.04	0.05	0.89	0.02		1.00	0.89
RO-IW08D	2/26/2014	-145	1466	<1.01	3.17	1090	373						1.4			2.5			6.98				41.7		0.00	0.02	11	6.0	0.00	17	0.00	0.00	0.65	0.35		1.00	0.65
RO-IW09S	2/26/2014	-336	800	56.9	34.0	704	5.57						0.2			29.0			30.5				48.9		0.34	0.26	7.3	0.09	0.00	8.0	0.04	0.03	0.91	0.01		1.00	0.91
	5/14/2014	-259	835	105	66.6	657	6.35	<5	<5	ND	0.11	-130.2	0.2			31.9	<0.5	1.08	13.6	<5	<5	9.68	41.2	Slight amber color, low turb, no odor/no sheen, effervescent	0.63	0.51	6.8	0.10	0.00	8.02	0.08	0.06	0.85	0.01	0.00	1.00	0.85
RO-IW09D	2/26/2014	-145	2593	<1.01	<0.500	363	2230						1.8			2.9			33.9				27.8		0.00	0.00	3.7	36	0.00	39	0.00	0.00	0.09	0.91		1.00	0.91
RO-IW10S	2/26/2014	-336	543	17.3	7.66	513	4.82						1.2			41.7			15.6				48.9		0.10	0.06	5.3	0.08	0.00	5.5	0.02	0.01	0.96	0.01		1.00	0.96
RO-IW10D	2/26/2014	-145	1929	<1.01	<0.500	169	1760						1.6			1.2			7.43				31.1		0.00	0.00	1.7	28	0.00	30	0.00	0.00	0.06	0.94		1.00	0.94
RO-IW11S	3/3/2014	-331	536	1.88	21.4	510	2.50						0.0			11.2			17.2				43.9		0.01	0.16	5.3	0.04	0.00	5.5	0.00	0.03	0.96	0.01		1.00	0.96
RO-IW11D	2/26/2014	-145	593	<1.00	<0.500	7.80	585						2.0			0.4			4.93				32.2		0.00	0.00	0.08	9.36	0.00	9.4	0.00	0.00	0.01	0.99		1.00	0.99
MW-9S	5/14/2014	-259	1210	11.8	162	1,000	36.4	<5	<5	ND	0.19	-116.1	2.0			39.9	<0.5	1.32	49.8	<5	<5	8.76	44.6	Clear, low turb, no odor/no sheen, effervescent	0.07	1.2	10	0.58	0.00	12	0.01	0.10	0.85	0.05	0.00	1.00	0.85
MW-10D	5/14/2014	-68	7794	<1	<0.5	7,520	274	17.1	<5	ND	0.00	-86.2	1.8			<0.3	<0.5	2.17	45.8	9.27	<5	6.48	30.8	Slight amber color, low turb, no odor/no sheen, effervescent	0.00	0.00	78	4.4	0.66	82	0.00	0.00	0.94	0.05	0.01	1.00	0.94
(75 ft DG)	10/22/2014	93	8308	5.5	2.46	6670	1630				0.32	-131.7	2.6	4.58	3.43	<1.50	<0.5		20.0	<5	<5	6.58	41.3	Clear, low turbidity, egg like odor, NS, effervescent	0.03	0.02	69	26	0.00	95	0.00	0.00	0.72	0.27		1.00	0.72
	1/9/2015	172	5636	5.03	1.21	4190	1440	37	<5	ND	0.43	-104.7	3.6	8.65	7.96	<1.50	<0.5	1.42	21.6	<5	<5	6.27	39.6	Slight sulfur like odor	0.03	0.01	43	23	1.4	66	0.00	0.00	0.64	0.34	0.02	1.00	0.64
MW-15D	5/14/2014	-68	967	150	118	578	121	<5	<5	ND	0.03	-93.8	0.0			7.35	<0.5	1.63	12.8	<5	<5	7.12	30.7	Clear, low turb, no odor/no sheen, effervescent	0.90	0.90	6.0	1.9	0.00	9.7	0.09	0.09	0.61	0.20	0.00	1.00	0.61
(between IW)	10/23/2014	94	927	1.28	<0.5	<1	926				0.28	-159.3	5.4	13.8	13	<3	<0.5		2.31	646	880	6.58	25.3	Clear, low turbidity, vomit odor, NS, effervescent	0.01	0.00	0.00	15	0.00	15	0.00	0.00	0.00	1.00		1.00	1.00
	1/8/2015	171	6514	1.24	<0.5	2.64	6510	875	23.9	ND	2.41	-126.9	3.0	18.5	17.1	<3	0.800	2.60	359	779	647	6.63	20.3	Amber (initially) to gray, low, slight vomit odor, NS, effervescent	0.01	0.00	0.03	104	34	104	0.00	0.00	0.00	0.75	0.25	1.00	0.75
MW-16D	5/14/2014	-68	6840	<1	<0.5	4,600	2,240	86.2	20.1	ND	0.17	-84.3	0.2			43	<0.5	1.760	7.4	<5	<5	9.85	35.9	Clear, low turb, no odor/no sheen, effervescent	0.00	0.00	47	36	4.03	83	0.00	0.00	0.54	0.41	0.05	1.00	0.54
(35 ft DG)	10/23/2014	94	2750	1.42	8.11	1660	1080				0.66	-186.7	4.0	76	80.5	102	2.5		16	1750	<5	5.96	30.2	Pumped out clear but turned gray over time, low-medium turbidity, egg odor, NS, effervescent	0.01	0.06	17	17	0.00	34	0.00	0.00	0.50	0.50		1.00	0.50
	1/8/2015	171	6681	1.99	8.51	2460	4210	71.6	<5	ND	2.17	-122.0		138	107	31	0.800	0.702	1010	961	1690	5.98	28.3	Clear, low, slight vomit odor, NS	0.01	0.06	25	67	2.8	93	0.00	0.00	0.27	0.70	0.03	1.00	0.70
MW-17D	5/14/2014	-68	124	<1	0.738	69.3	53.5	6.11	<5	ND	0.19	-79.8	0.6			0.823	<0.5	3.29	40.9	<5	<5	9.79	42.5	Clear, low turb, no odor/no sheen, effervescent	0.00	0.01	0.71	0.86	0.23	1.6	0.00	0.00	0.39	0.47	0.13	1.00	0.47
(35 ft DG)	10/23/2014	94	21	<1	<0.5	3.99	17.4				0.29	-144.2	2.2	0.992	0.711	<1.50	<0.5		17.5	<5	<5	6.92	34.8	Clear to very slight yellow, low turbidity, slight egg odor, NS, effervescent	0.00	0.00	0.04	0.28	0.00	0.32	0.00	0.00	0.13	0.87		1.00	0.87
	1/8/2015	171	25	<1	<0.5	2.75	21.8	<5	<5	ND	0.65	-170.2	4.2	1.15	1.02	<1.50	0.800	3.31	21.2	<5	<5	6.88	33.0	Clear, low, very slight sulfur odor, NS, effervescent	0.00	0.00	0.03	0.35	0.00	0.38	0.00	0.00	0.08	0.92	0.00	1.00	0.92

TABLE 4.1
GROUNDWATER DATA SUMMARY
MAIN SOURCE AREA
CASCADE COLUMBIA/FOX AVENUE

			Volatile Organic Compounds								Aquifer Redox Conditions								Donor Indicators				Other		VOCs- micromoles/Liter(b)						VOCs - Molar Fraction (c)						
		Elapsed Time from Injection (days) (a)	Sum cVOCs (c) (µg/L)	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	DO (mg/L)	ORP (mV)	Iron II (mg/L)	Iron (T) (mg/L)	Iron (D) (mg/L)	Sulfate (mg/L)	Sulfide (mg/L)	Methane (mg/L)	TOC (mg/L)	Acetone (µg/L)	MEK (µg/L)	pH	Temp (deg C)		PCE	TCE	cDCE	VC	Ethene/ Ethane	Total Chloroethenes (d)	PCE	TCE	cDCE	VC	Ethene/ Ethane		
Well	Date																							Comments													Max
MW-18S	5/15/2014	-258	912	145	50.1	712	4.71	<5	<5	ND	0.00	47.3	0.0			239	<0.5	0.271	89.2	29.3	<5	7.05	47.0	Slightly cloudy, low turb, no odor/no sheen, effervescent	0.87	0.38	7.3	0.08	0.00	8.7	0.10	0.04	0.85	0.01	0.00	1.00	0.85
(between IWs)	10/22/2014	-98	1952	17.7	23.2	1870	41.4				0.20	-200.4								<5	<5	6.99	39.0	Slight amber color, low turbidity, slight egg odor, NS, effervescent	0.11	0.18	19	0.66	0.00	20	0.01	0.01	0.95	0.03		1.00	0.95
B-20AS	6/20/2014	-222	1394	<1	11.5	1,280	102	21.6	<5	<5	0.13	-101.8	3.0			10.3	<0.5	4.39	36.1	5.69	<5	6.62	39.3	Clear, low turb, no odor, no sheen	0.00	0.09	13	1.6	0.83	15	0.00	0.01	0.84	0.10	0.05	1.00	0.84
B-21D	6/20/2014	-31	3.24	<1	<0.5	3.24	<0.2	<5	36.5	<5	0.21	-61.6	2.6			<1.50	<0.5	5.75	9.13	7.06	<5	6.42	33.4	Dark gray, moderately high, fermented sugar water odor, no sheen	0.00	0.00	0.03	0.00	1.3	0.03	0.00	0.00	0.03	0.00	0.97	1.00	0.03
B-45D	5/14/2014	-68	2029	<1	0.830	998	1,030	35.6	10	ND	0.00	-80.9	1.8			26.1	<0.5	1.37	9.36	<5	<5	6.34	34.3	Clear, moderately low turb, no odor/no sheen, effervescent	0.00	0.01	10	16	1.7	27	0.00	0.00	0.36	0.58	0.06	1.00	0.58
(75 ft DG)	10/22/2014	93	17975	1.55	3.03	7270	10700				0.32	-140.7	5.6	8.78	7.56	3.35	<0.5		6.1	<5	<5	6.56	31.5	Clear, low turbidity, egg odor, NS, effervescent	0.01	0.02	75	171	0.00	246	0.00	0.00	0.30	0.70		1.00	0.70
	1/9/2015	172	5092	<1	2.26	1870	3220	392	19.9	ND	0.42	-106.4	2.3	8.25	7.25	11.5	<0.5	1.21	7.73	<5	<5	6.57	30.5	Clear, low, slight sulfur odor, NS	0.00	0.02	19	52	16	71	0.00	0.00	0.22	0.59	0.18	1.00	0.59
B-49S	5/14/2014	-259	630	98.6	42.2	484	5.14	<5	<5	ND	0.21	-82.2	0.4			14.9	<0.5	0.532	11.4	7.89	<5	9.76	32.9	Clear, low turb, no odor/no sheen, effervescent	0.59	0.32	5.0	0.08	0.00	6.0	0.10	0.05	0.83	0.01	0.00	1.00	0.83
(60 ft DG)	10/23/2014	-97	1226	13	26.1	1170	17.2				0.26	-180.3								<5	<5	6.72	35.5	Clear, low turb, egg odor, NS, effervescent	0.08	0.20	12	0.28	0.00	13	0.01	0.02	0.96	0.02		1.00	0.96
B-58S	5/15/2014	-258	458	5.43	3.04	305	145				2.17											6.07	26.0	sampled by Calibre	0.03	0.02	3.1	2.3		5.5	0.01	0.00	0.57	0.42		1.00	0.57
B-59D	5/15/2014	-67	3.29	<1	<0.5	<1	3.29				1.57											5.79	25.1	sampled by Calibre	0.00	0.00	0.00	0.05		0.05	0.00	0.00	0.00	1.00		1.00	1.00
(150 ft DG)	10/22/2014	93	27	<1	<0.5	<1	26.8				0.93	-85.6	4.2	164	156	65.1	<0.5		12	<5	<5	5.78	23.1	Clear, low turbidity, slight egg odor, NS, effervescent	0.00	0.00	0.00	0.43		0.43	0.00	0.00	0.00	1.00		1.00	1.00
	1/9/2015	172	8	<1	<0.5	<1	8.01				2.28	-37.3	2.8	120	110	53.9	<0.5		29.7	<5	<5	5.98	22.6	Slightly cloudy, low-moderate turbidity, slight sulfur odor, NS	0.00	0.00	0.00	0.13		0.13	0.00	0.00	0.00	1.00		1.00	1.00
B-60S	5/15/2014	-258	1556	<1	3.51	1500	52.0				1.09											6.13	33.6	sampled by Calibre	0.00	0.03	15	0.83		16	0.00	0.00	0.95	0.05		1.00	0.95
(145 ft DG)	6/20/2014	-222						<5	<5	<5	0.21	-87.3	2.4			24.0	<0.5	6.20	9.53			6.66	34.6	Slight amber color, low turb, smells bad, no sheen					0.00								
B-61D	5/15/2014	-67	33	<1	<0.5	15.8	17.4				1.13											5.99	31.3	sampled by Calibre	0.00	0.00	0.16	0.28	0.00	0.44	0.00	0.00	0.37	0.63		1.00	0.63
(145 ft DG)	6/20/2014	-31						<5	26.3	<5	0.44	-57.5	2.0			<0.3	<0.5	11.6	4.05			6.36	27.0	Clear, low turb, no odor, no sheen, effervescent													
	10/22/2014	93	12	<1	<0.5	9.64	2.77				0.41	-96.0	4.5	40.7	38.3	<3	<0.5		9.07	7.29	<5	6.30	29.2	Clear, low turbidity, slight egg odor, NS, effervescent	0.00	0.00	0.10	0.04	0.00	0.14	0.00	0.00	0.69	0.31		1.00	0.69
	1/9/2015	172	9	<1	<0.5	6.92	1.69				1.60	-77.9	2.4	37.7	40.3	<3	0.800		21.90	<5	<5	6.14	26.1	Slightly cloudy, low to moderate turbidity, slight vomit-like odor, NS	0.00	0.00	0.07	0.03	0.00	0.10	0.00	0.00	0.73	0.27		1.00	0.73

PCE = Tetrachloroethene
TCE = Trichloroethene
cDCE = cis-1,2-Dichloroethene
VC = Vinyl Chloride
MEK = Methyl ethyl ketone

ORP = Oxidation Reduction Potential
TOC = Total Organic Carbon
DO = Dissolved Oxygen
Iron (T) = Total Iron
Iron (D) = Dissolved Iron

IW = Injection Well
S = Shallow
D = Deep
not analyzed or measured

(a) Elapsed time for shallow and deep wells is relative to the January 2015 WBZ#1 injection and the July 2014 WBZ#2 injection, respectively.
(b) Calculated by dividing the concentration in groundwater by the molecular weight of the compound. Reporting limits for non-detect results replaced with zero.
(c) Indicates the fraction of total ethenes due to each compound.
(d) Sum of PCE, TCE, cDCE, and VC.

Dates for Elapsed Time
7/21/2014 1st injection to WBZ#2
1/28/2015 1st injection to WBZ#1

TABLE 5.1
REVISED BIOREMEDIATION MONITORING MATRIX
MAIN SOURCE AREA
CASCADE COLUMBIA/FOX AVENUE

Well	Baseline	Post-Injection		Comments
		Quarterly	Semiannual	
Injection Wells:				
R0-IW09S	(a) (b)	(a)	(a) (b)	
R0-IW02D	(a) (b)	(a)	(a) (b)	
R0-IW06D	(a) (b)	(a)	(a) (b)	
Source Monitoring Wells:				
MW-15 (D)	(a) (b)	(a)	(a) (b)	
MW-16 (D)	(a) (b)	(a)	(a) (b)	
MW-17 (D)	(a) (b)	(a)	(a) (b)	
MW-18 (S)	(a) (b)	(a)	(a) (b)	
Downgradient Monitoring Wells:				
MW-9 (S)	(a) (b)	(a)	(a) (b)	Whitehead
MW-10 (D)	(a) (b)	(a)	(a) (b)	Whitehead
MW-49 (S)	(a) (b)	(a)	(a) (b)	Whitehead
MW-45 (D)	(a) (b)	(a)	(a) (b)	Whitehead
B-58 (S)	(a) (b)	(a)	(a)	Fox Avenue
B-59 (D)	(a) (b)	(a)	(a) (b)	Fox Avenue
B-60 (S)	(a) (b)	(a)	(a)	Fox Avenue
B-61 (D)	(a) (b)	(a)	(a) (b)	Fox Avenue
B-20A (S)	(a) (b)	(a)	(a)	Fox Avenue
B-21 (D)	(a) (b)	(a)	(a) (b)	Fox Avenue

VOCs = Volatile Organic Compounds
ORP = Oxidation Reduction Potential
TOC = Total Organic Carbon
DO = Dissolved Oxygen

(a) Laboratory Parameters (method): VOCs (8260); TOC (5310C); Sulfate (E300); Sulfide (4500-S2-F); Total and Dissolved Iron (200.8)
Field Parameters: Fe2; pH, DO, ORP, Temp.

(b) Additional Laboratory Parameter (method): Acetylene/Methane/Ethane/Ethene (RSK-175).

Red indicates changes made to monitoring matrix in February 2015.

Fox Avenue Site

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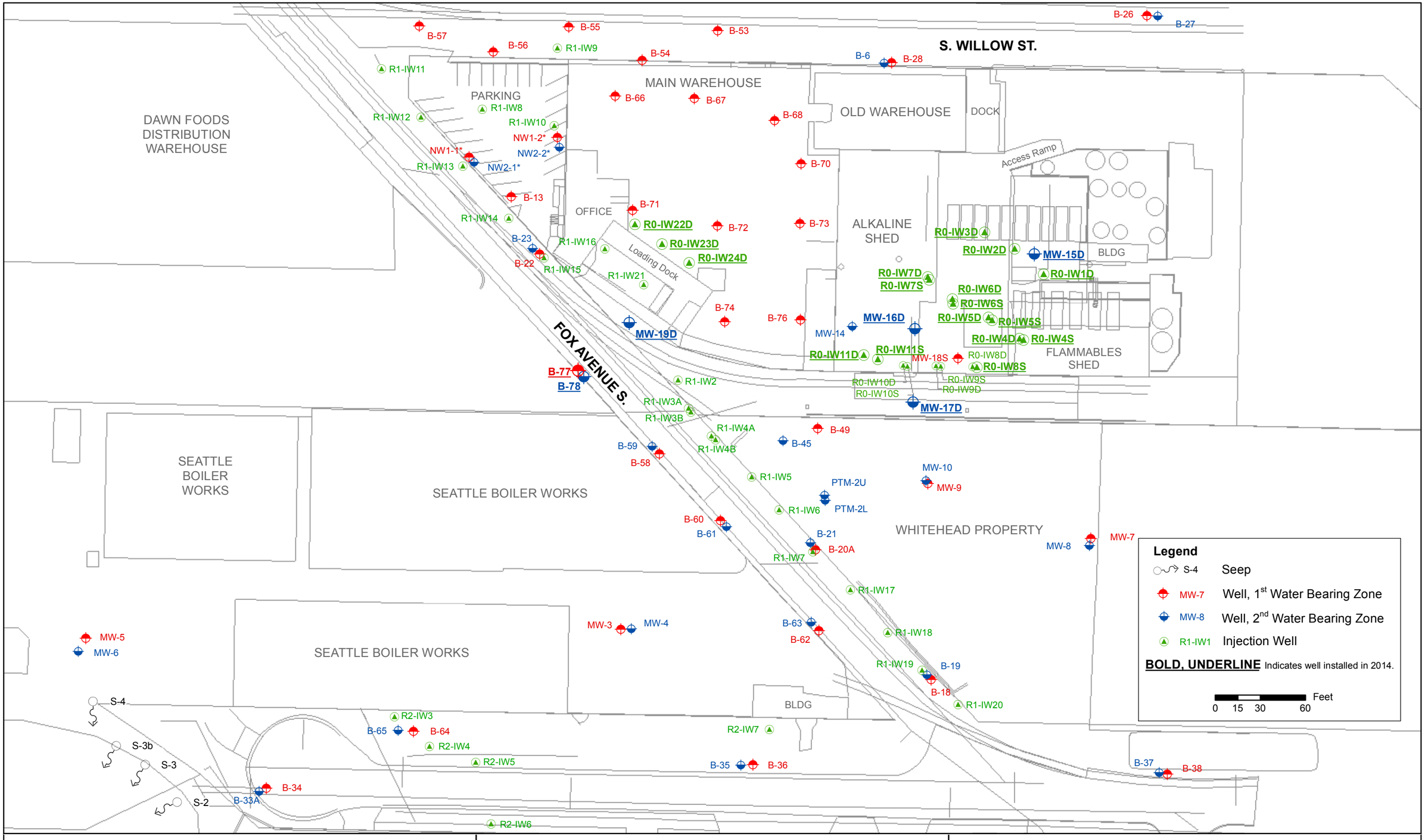
Figures



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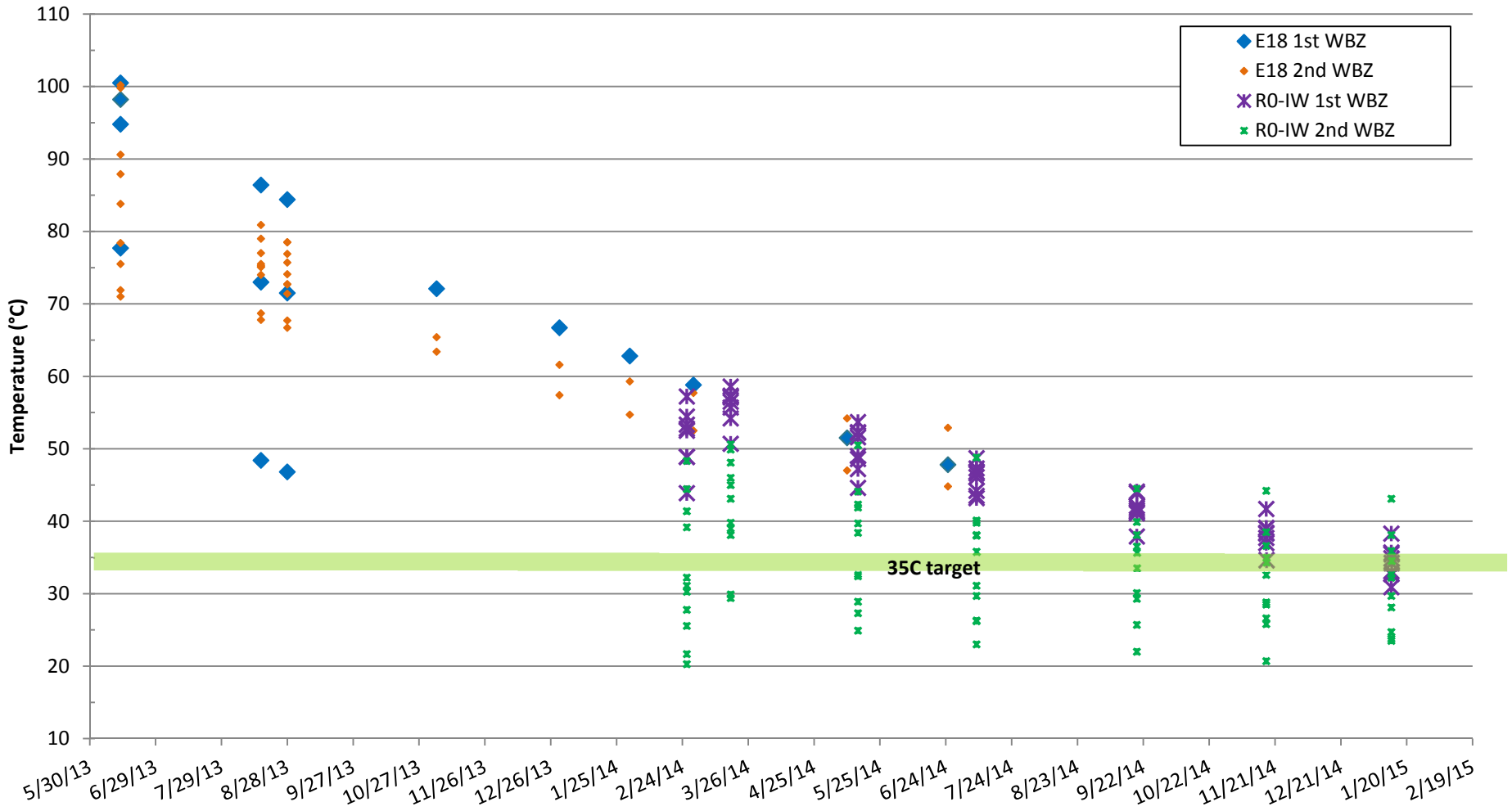
Seattle, Washington

Figure 2.1
Site Plan

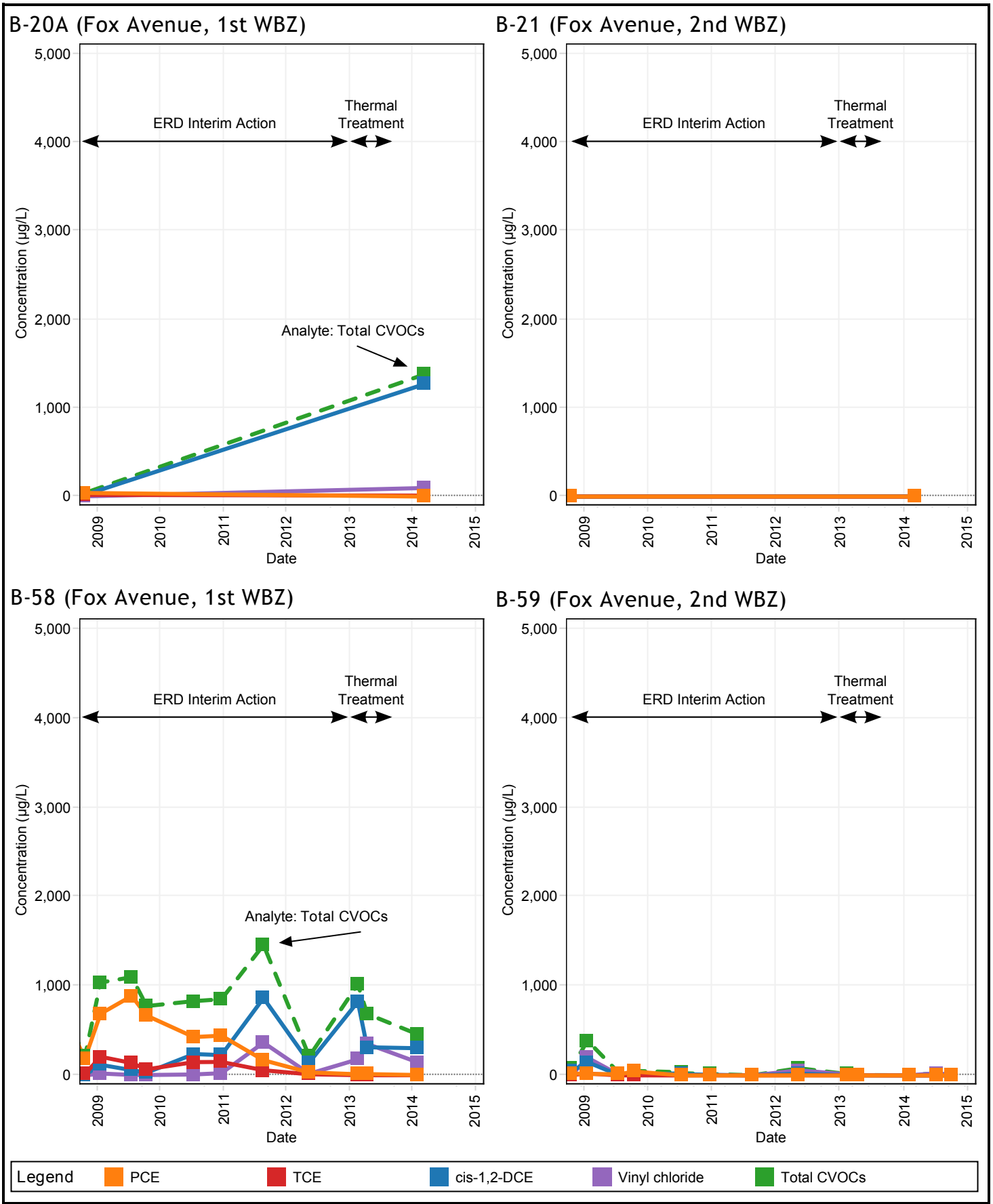
I:\GIS\Projects\FOXAVE-RA\MXD\2014 Annual Report\Figure 2.1 Site Plan.mxd
3/31/2015



Note: Electrical Resistance Heating was completed in May 2013

LANDAU ASSOCIATES

Fox Avenue Remediation Trust Fox Avenue Site Seattle, Washington	**Main Source Area Temperature Trends**	Figure 2.2



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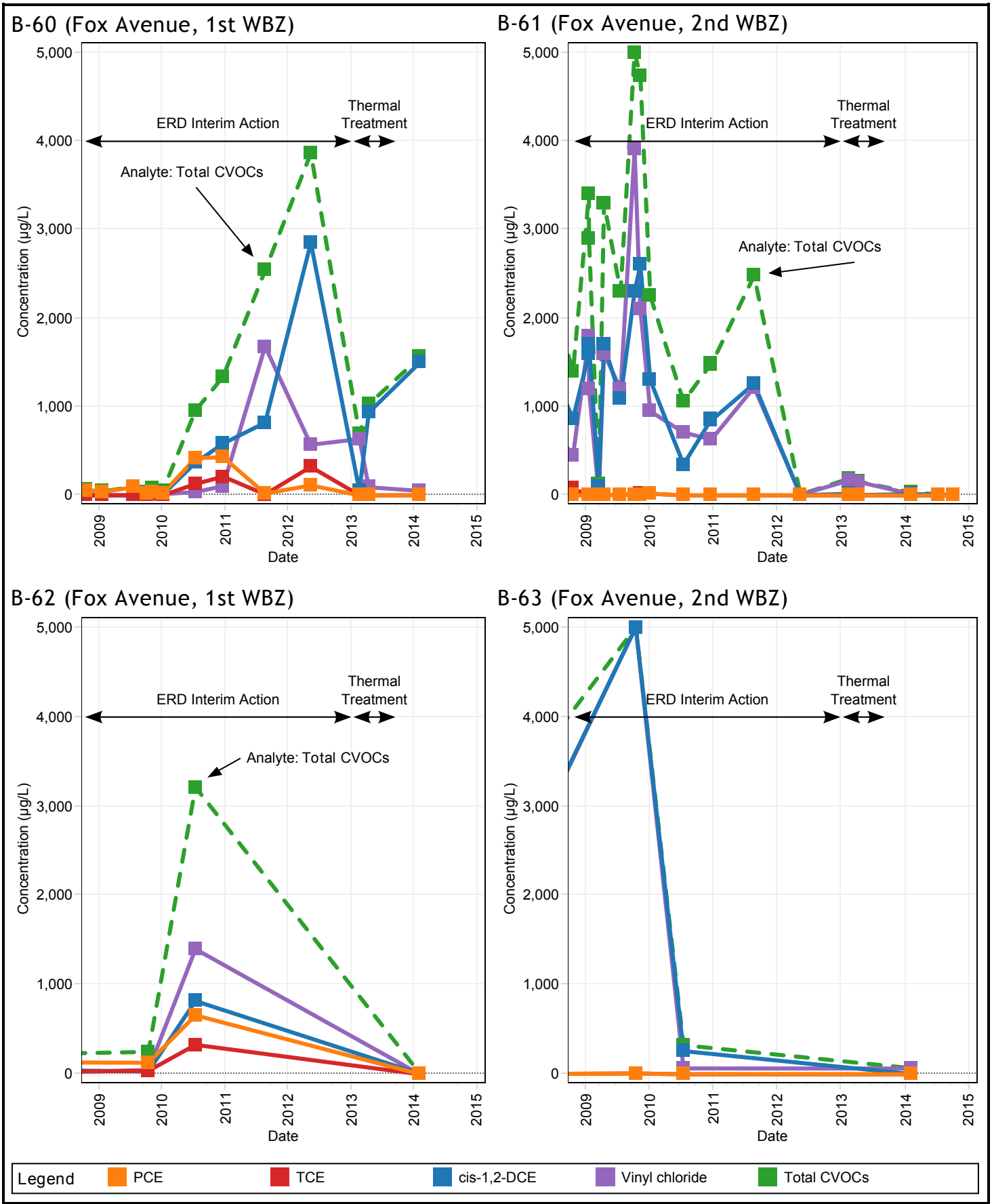
Seattle, Washington

Figure 4.1a
VOC Trend Plots for PCE, TCE, cis-1,2-DCE, and Vinyl Chloride

F:\data\projects\FoxAve-RA\Annual Reports\2014 Annual Report\03 Figures\Figure Components\Figure 4.3

3/31/2015



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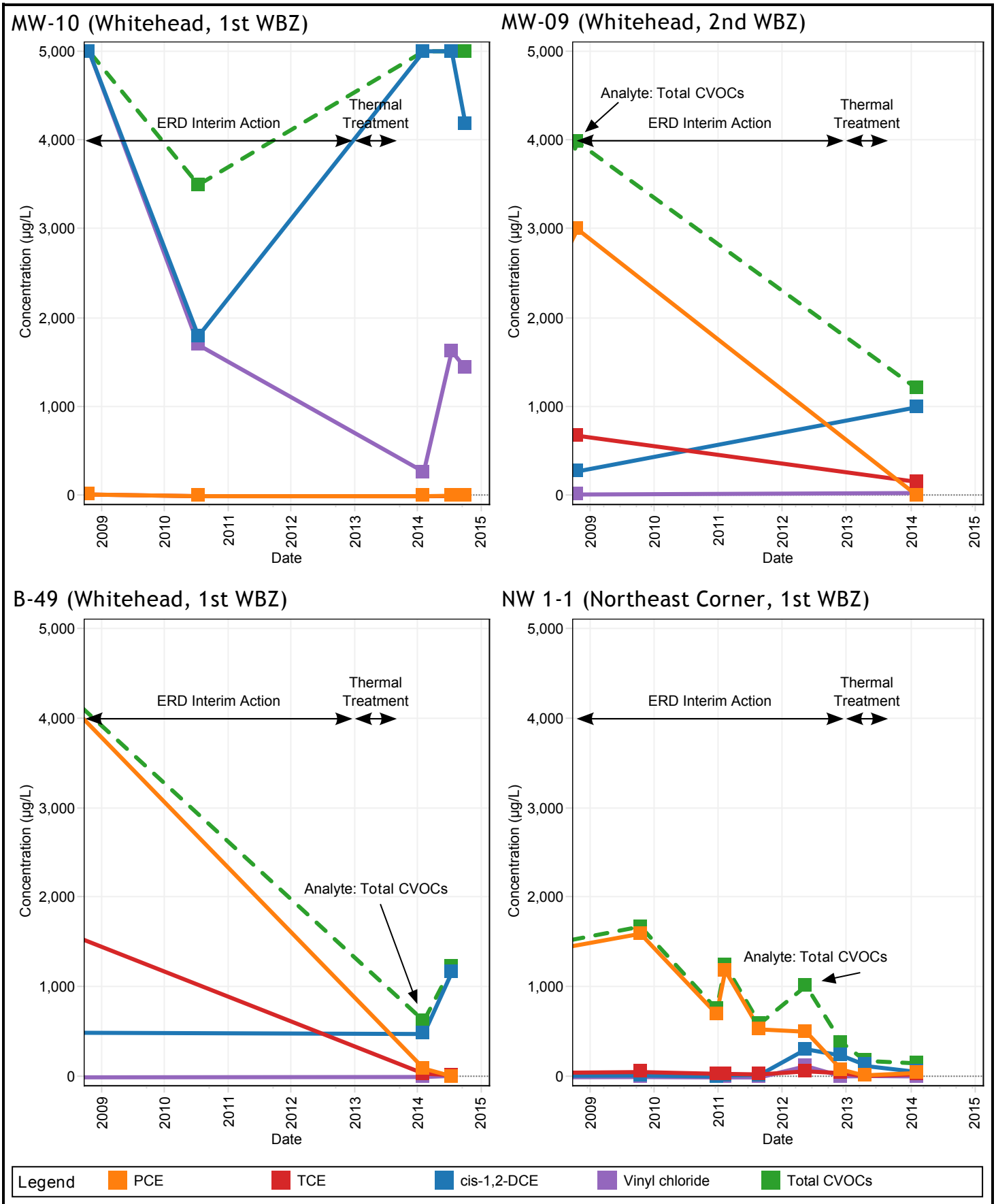
Seattle, Washington

Figure 4.1b
VOC Trend Plots for PCE, TCE, cis-1,2-DCE, and Vinyl Chloride



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Seattle, Washington

Figure 4.1c
VOC Trend Plots for PCE, TCE, cis-1,2-DCE, and Vinyl Chloride

Pre-Thermal (2010–2012)

Post–Thermal (July 2013–May 2014)

S. WILLOW ST.

MAIN WAREHOUSE

OLD WAREHOUSE

DOCK

FOX AVENUE BUILDING

ACCESS RAMP

OFFICE

LOADING DOCK

COVERED PARKING AREA

RAMP

BLDG.

PARKING

FOX AVENUE S.

S. MYRTLE ST.

SEATTLE BOILER WORKS

WHITEHEAD PROPERTY

BLDG.

GP-100 7.6 J
B-57 150
B-56 240
R1-IW9 42
R1-IW11 99
GP-101 190
R1-IW12 10
R1-IW8 17
R1-IW10 .31
NW 2-1 2,000
NW 1-1 580
R1-IW13 140
NW-1-2 240
B-13 990
R1-IW14 350
B-22 190
R1-IW15 1 U
GP-102 840
R1-IW1 35
B-10A 18
R1-IW2 2.4
B-52 17
B-39 3,200
B-11 1,700
R1-IW3A 6
R1-IW4A 5.3
B-58 48
R1-IW5 4.9
R1-IW6 5.1
B-60 440
R1-IW7 630
R1-IW17 16
B-62 990
R1-IW18 27
GP-104 0.55
R1-IW19 9.14
B-18 1
GP-105 220
R1-IW20 110
R2-IW1 1 U
R2-IW2 1 U
MW-03 58
R2-IW3 100 U
B-64
R2-IW7 1 U
B-36 26

B-56 290
R1-IW9 11
R1-IW11 20
B-66 110
R1-IW10 5.4
NW 1-2 100
R1-IW8 5.5
NW 1-1 84
R1-IW13 6.4
B-71 310
B-22 170
R1-IW16 890
R1-IW15 120
R1-IW21A 3.9
R0-IW7S 3.8
R0-IW6S 3.2
R0-IW5S 1 U
R0-IW4S 2.3
R0-IW11S 23
R0-IW10S 24
MW-18S 200
R0-IW8S 110
R0-IW9S 170
B-77 15
R1-IW2 1 U
R1-IW3A 59
R1-IW4A 5.4
B-49 140
B-58 8.5
MW-09 170
B-60 3.5
B-20A 12
R1-IW7 1 U
MW-07 120
B-62 2.6
R1-IW18 2.5
SE-MW04 160
B-18 1.4
R1-IW20 1 U
SE-MW01 2.3
B-64 16
B-34 7.1
SE-B-38 1 U
SE-MW06 130
SE-MW07 1 U

Legend

PCE + TCE Conc. in µg/L

- 0–1
- 1.01–10
- 10.01–100
- 100.01–1,000
- 1,000.01–10,000
- 10,000.01–100,000

Sample Not Detected at Method Detection Limit

Notes:
- Pre-thermal data from 2010–2012 include Geoprobe and well sample locations.
- Thermal treatment period from January–May 2013.
- Post-thermal data from July 2013–May 2014 include well sample locations only.
- The 1st Water Bearing Zone is defined as the vertical region ≥ -2.346 ft NAVD 88.

Abbreviations:
- ft = Foot
- µg/L = Micrograms per liter
- NAVD 88 =North American Vertical Datum of 1988
- PCE = Tetrachloroethene
- TCE = Trichloroethene

Qualifier:
- U = The analyte was not detected greater than or equal to the concentration reported.

N

0 80 160

Scale in Feet

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Figure 5.1
Pre-Thermal and Post-Thermal Comparison: PCE + TCE Concentrations in Groundwater – 1st Water Bearing Zone

File: I:\GIS\Projects\FOXAVE-RA\MXD\2014 Annual Report\Figure 5.1 Post Thermal Conditions PCE_TCE 1 WBZ.mxd
Date: 4/3/2015

Pre-Thermal (2010–2012)

Post-Thermal (July 2013–May 2014)

S. WILLOW ST.

MAIN WAREHOUSE

OLD WAREHOUSE

DOCK

PARKING

FOX AVENUE BUILDING

ACCESS RAMP

OFFICE

LOADING DOCK

COVERED PARKING AREA

RAMP

BLDG.

FOX AVENUE S.

SEATTLE BOILER WORKS

WHITEHEAD PROPERTY

S. MYRTLE ST.

GP-101 1 U

NW 2-2 1 U

NW 2-1 1 U

B-23 7.8

R1-IW15 1 U

GP-102 0.64

R1-IW1 47

R1-IW2 1.3

B-59 2.4

R1-IW4B 2.2

R1-IW5 6.3

R1-IW6 5.1

PTM-2L 140

B-61 1 U

R1-IW7 2

GP-103 1 U

R1-IW17 10

B-63 1 U

R1-IW18 11

GP-104 1 U

R1-IW19 1.3

B-19 3.2

GP-105 0.36

R1-IW20 23

GP-106 1 U

MW-14 0.94

MW-13 75

MW-10 1 U

MW-04 1 U

R2-IW1 1 U

R2-IW2 1 U

R2-IW3 1 U

B-65 1 U

R2-IW7 1 U

R0-IW22 1.8

R0-IW23 1.3

R0-IW24 5.1

R0-IW3D 280

MW-15D 270

R0-IW2D 0.66

R0-IW1D 97

R0-IW7D 270

R0-IW6D 1 U

R0-IW5D 1.5

R0-IW4D 1 U

MW-16D 1 U

R0-IW9D 1 U

R0-IW8D 3.2

MW-17D 0.74

R0-IW11D 1 U

R0-IW10D 1 U

MW-19D 1 U

B-78 1 U

B-45 0.83

B-21 1 U

Legend

PCE + TCE Conc. in µg/L

- 0–1
- 1.01–10
- 10.01–100
- 100.01–1,000
- 1,000.01–10,000
- 10,000.01–100,000

Sample Not Detected at Method Detection Limit

Notes:
- Pre-thermal data from 2010–2012 include Geoprobe and well sample locations.
- Thermal treatment period from January–May 2013.
- Post-thermal data from July 2013–May 2014 include well sample locations only.

Abbreviations:
- µg/L = Micrograms per liter
- PCE = Tetrachloroethene
- TCE = Trichloroethene

Qualifier:
- U = The analyte was not detected greater than or equal to the concentration reported.

N

0 80 160

Scale in Feet

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Fox Avenue Site
Seattle, Washington

Figure 5.2
Pre-Thermal and Post-Thermal Comparison: PCE + TCE Concentrations in Groundwater – 2nd Water Bearing Zone

File: I:\GIS\Projects\FOXAVE-RA\MXD\2014 Annual Report\Figure 5.2 Post Thermal Conditions PCE_TCE 2 WBZ.mxd
Date: 3/31/2015

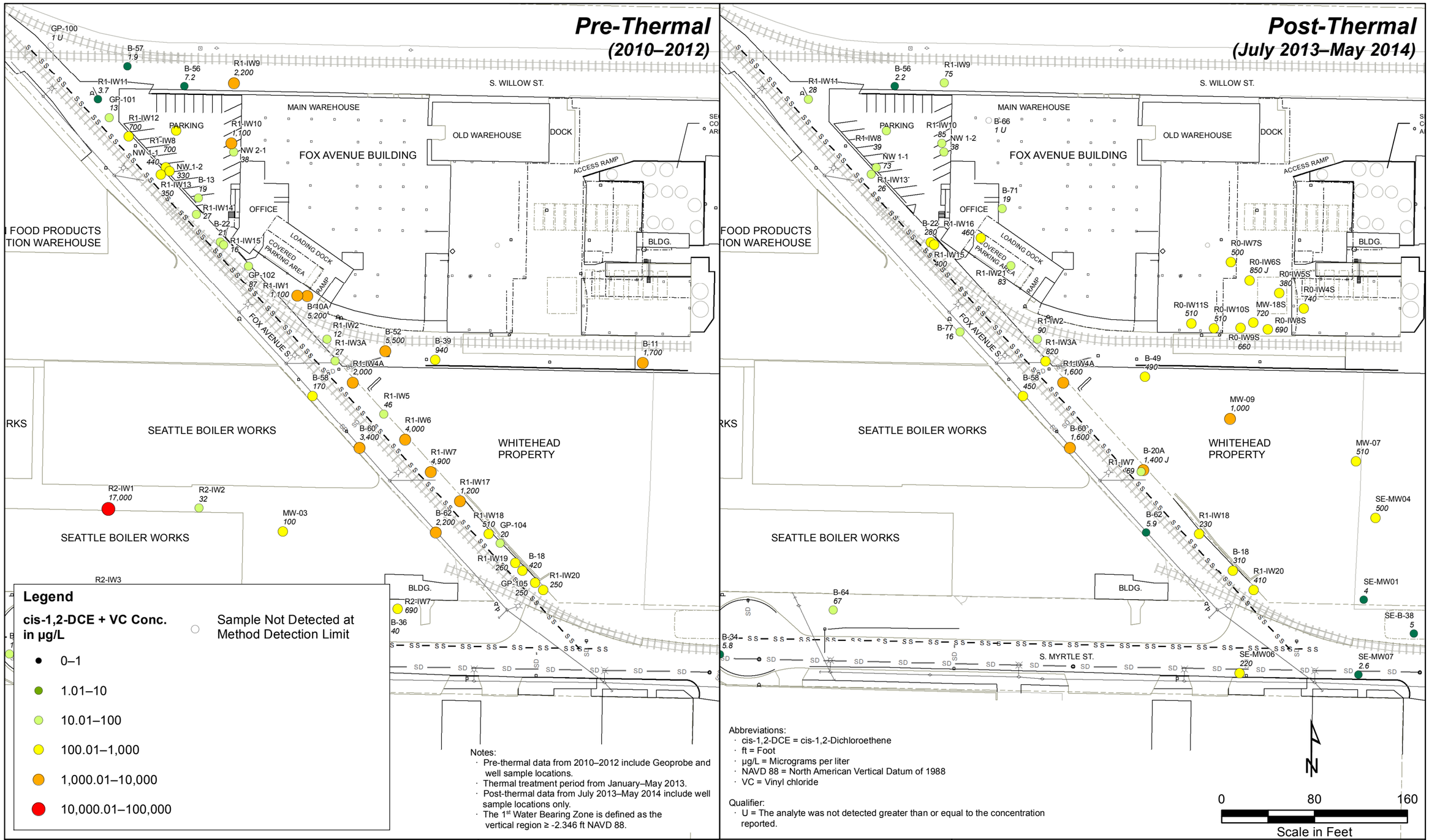

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Figure 5.3
Pre-Thermal and Post-Thermal Comparison:
cis-1,2-DCE and VC
Concentrations in Groundwater – 1st Water Bearing Zone

File: I:\GIS\Projects\FOXAVE-RA\MXD\2014 Annual Report\Figure 5.3 Post Thermal Conditions cis_VC 1 WBZ.mxd
Date: 4/3/2015

Pre-Thermal (2010–2012)

Post-Thermal (July 2013–May 2014)

S. WILLOW ST.

MAIN WAREHOUSE

OLD WAREHOUSE

DOCK

FOX AVENUE BUILDING

PARKING

OFFICE

ACCESS RAMP

LOADING DOCK

COVERED PARKING AREA

RAMP

BLDG.

FOX AVENUE S.

SEATTLE BOILER WORKS

WHITEHEAD PROPERTY

S. MYRTLE ST.

GP-101 1 U

NW 2-1 1 U

NW 2-2 1 U

B-23 13

R1-IW15 240

GP-102 44

R1-IW1 1,600

R1-IW2 15

MW-14 1,800

MW-13 4,100

B-59 79

R1-IW4B 120

R1-IW5 53

R1-IW6 3,500

PTM-2L 2,100

B-61 12

R1-IW7 230

GP-103 19

MW-10 3,500

R1-IW17 660

B-63 330

R1-IW18 610

GP-104 0.47

R1-IW19 190

B-19 86

GP-105 470

R1-IW20 330

GP-106 1 U

R2-IW1 17,000

R2-IW2 37

MW-04 6.8

R2-IW3 430

B-65

R2-IW7 560

R0-IW22 1.3

R0-IW23 22

R0-IW24 82

R1-IW15 200

R0-IW3D 89

MW-15D 680

R0-IW2D 11

R0-IW7D 95

R0-IW6D 8.1

R0-IW1D 860

R0-IW5D 49

R0-IW4D 190

MW-14 280

MW-16D 6,800

R0-IW10D 2,000

R0-IW9D 2,600

R0-IW8D 1,500

R0-IW11D 600

MW-17D 120

MW-19D 32

R1-IW2 170

B-78 40

B-59 3.3

R1-IW4B 190

B-45 2,000

MW-10 7,800

B-61 33

B-21 3.2

R1-IW7 69

B-63 69

R1-IW18 280

B-19 900

R1-IW20 350

B-65 130

Legend

cis-1,2-DCE+VC Conc. in µg/L

- 0–1
- 1.01–10
- 10.01–100
- 100.01–1,000
- 1,000.01–10,000
- 10,000.01–100,000

Sample Not Detected at Method Detection Limit

Notes:
- Pre-thermal data from 2010–2012 include Geoprobe and well sample locations.
- Thermal treatment period from January–May 2013.
- Post-thermal data from July 2013–May 2014 include well sample locations only.

Abbreviations:
- cis-1,2-DCE = cis-1,2-Dichloroethene
- µg/L = Micrograms per liter
- VC = Vinyl chloride

Qualifier:
- U = The analyte was not detected greater than or equal to the concentration reported.

N

0 80 160

Scale in Feet

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Figure 5.4
Pre-Thermal and Post-Thermal Comparison:
cis-1,2-DCE and VC
Concentrations in Groundwater – 2nd Water Bearing Zone

File: I:\GIS\Projects\FOXAVE-RA\MXD\2014 Annual Report\Figure 5.4 Post Thermal Conditions cis_VC 2 WBZ.mxd
Date: 3/31/2015

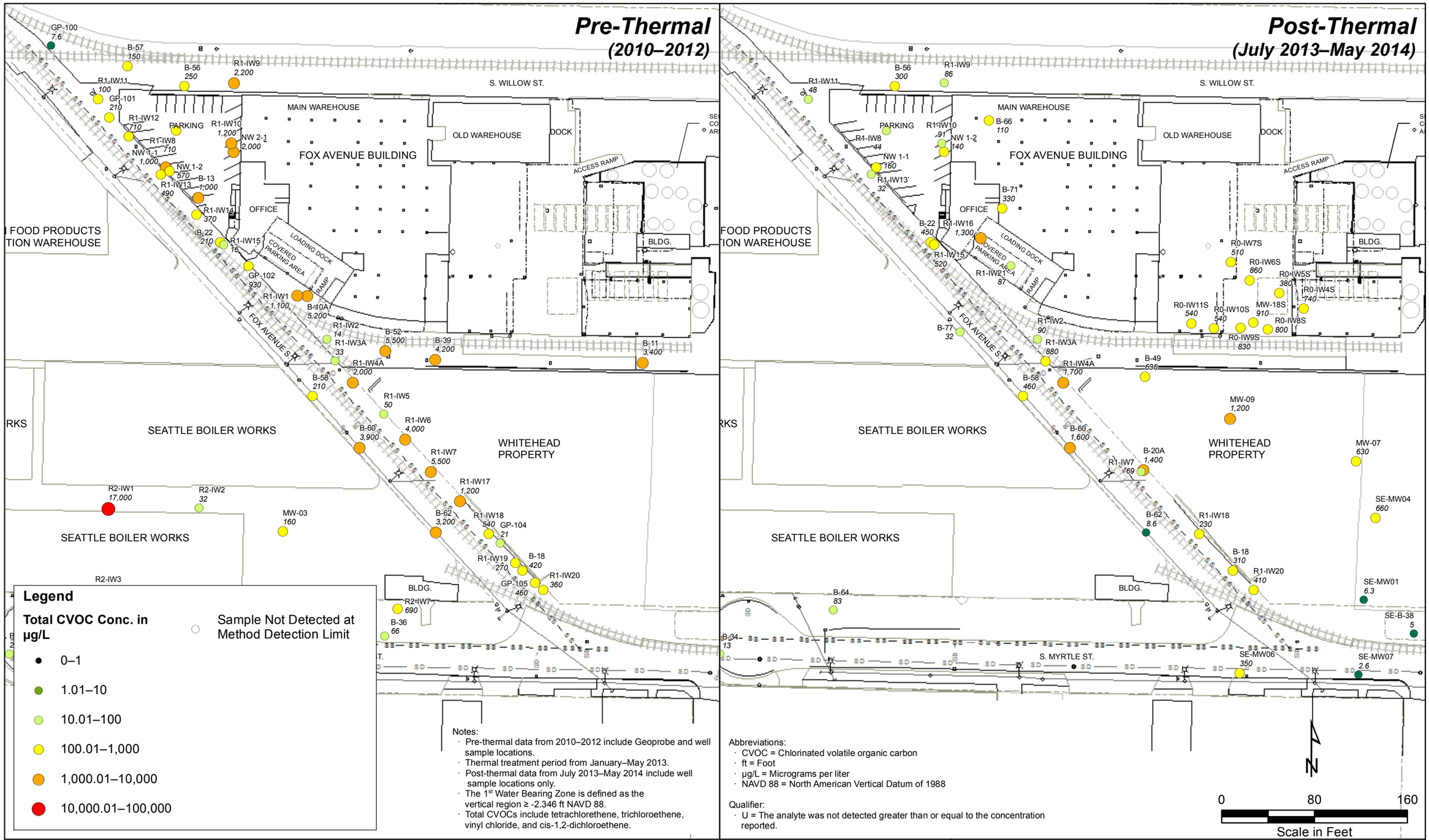

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Figure 5.5
Pre-Thermal and Post-Thermal Comparison: Total CVOC Concentrations in Groundwater – 1st Water Bearing Zone

File: I:\GIS\Projects\FOXAVE-RA\MXD\2014 Annual Report\Figure 5.5 Post Thermal Conditions TotalVOCs 1 WBZ.mxd
Date: 4/3/2015

Pre-Thermal (2010–2012)

Post-Thermal (July 2013–May 2014)

S. WILLOW ST.

MAIN WAREHOUSE

PARKING

FOX AVENUE BUILDING

OLD WAREHOUSE

DOCK

ACCESS RAMP

OFFICE

LOADING DOCK

COVERED PARKING AREA

RAMP

BLDG.

FOX AVENUE S.

S. MYRTLE ST.

SEATTLE BOILER WORKS

WHITEHEAD PROPERTY

FOOD PRODUCTS

TION WAREHOUSE

RKS

GP-101 1 U

NW 2-1 1 U

NW 2-2 1 U

B-23 21

R1-IW15 240

GP-102 45

R1-IW1 1,600

R1-IW2 16

B-59 82

R1-IW4B 120

R1-IW5 59

R1-IW6 3,500

PTM-2L 2,200

B-61 12

R1-IW7 230

GP-103 19

R1-IW17 670

B-63 330

R1-IW18 620

GP-104 0.47

R1-IW19 190

B-19 89

GP-105 470

R1-IW20 350

GP-106 1 U

MW-14 1,800

MW-13 4,100

MW-10 3,500

R2-IW1 17,000

R2-IW2 37

MW-04 6.8

R2-IW3 430

B-65

R2-IW7 560

B-35 1,200

R0-IW22 1.8

R0-IW23 22

R0-IW24 99

R1-IW15 280

R0-IW3D 370

MW-15D 920

R0-IW7D 370

R0-IW2D 12

R0-IW6D 8.1

R0-IW1D 950

R0-IW5D 51

R0-IW4D 190

MW-14 280

MW-16D 6,800

R0-IW10D 2,000

R0-IW9D 2,600

R0-IW11D 600

R0-IW8D 1,500

MW-17D 120

MW-19D 32

R1-IW2 170

B-78 40

B-59 3.3

R1-IW4B 190

B-45 2,000

MW-10 7,800

B-61 33

B-21 3.2

R1-IW7 69

B-63 69

R1-IW18 280

B-19 900

R1-IW20 350

B-65 130

Legend

Total CVOC Conc. in µg/L

- 0–1
- 1.01–10
- 10.01–100
- 100.01–1,000
- 1,000.01–10,000
- 10,000.01–100,000

Sample Not Detected at Method Detection Limit

Notes:

- Pre-thermal data from 2010–2012 include Geoprobe and well sample locations.
- Thermal treatment period from January–May 2013.
- Post-thermal data from July 2013–May 2014 include well sample locations only.
- Total CVOCs include tetrachloroethene, trichloroethene, vinyl chloride, and cis-1,2-dichloroethene.

Abbreviations:

- CVOC = Chlorinated volatile organic carbon
- µg/L = Micrograms per liter

Qualifier:

- U = The analyte was not detected greater than or equal to the concentration reported.

N

0 80 160

Scale in Feet

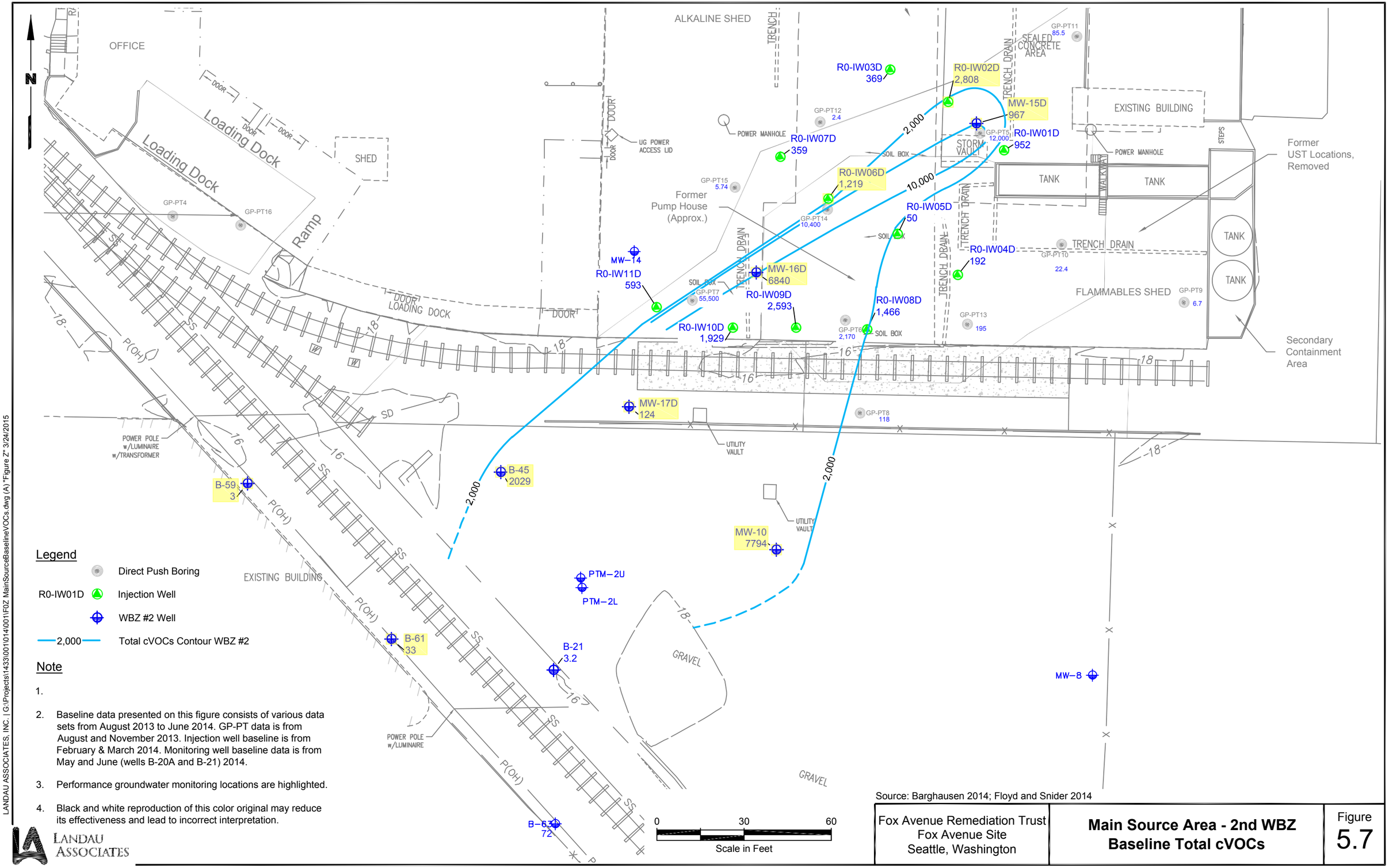
FLOYD | SNIDER

strategy ▪ science ▪ engineering

2014 Annual Report
Fox Avenue Site
Seattle, Washington

Figure 5.6
Pre-Thermal and Post-Thermal Comparison: Total CVOC Concentrations in Groundwater – 2nd Water Bearing Zone

File: I:\GIS\Projects\FOXAVE-RA\MXD\2014 Annual Report\Figure 5.6 Post Thermal Conditions TotalVOCs 2 WBZ.mxd
Date: 3/31/2015



Legend

- Direct Push Boring
- R0-IW01D — Injection Well
- WBZ #2 Well
- 2,000 — Total cVOCs Contour WBZ #2

Note

1.

2. Baseline data presented on this figure consists of various data sets from August 2013 to June 2014. GP-PT data is from August and November 2013. Injection well baseline is from February & March 2014. Monitoring well baseline data is from May and June (wells B-20A and B-21) 2014.

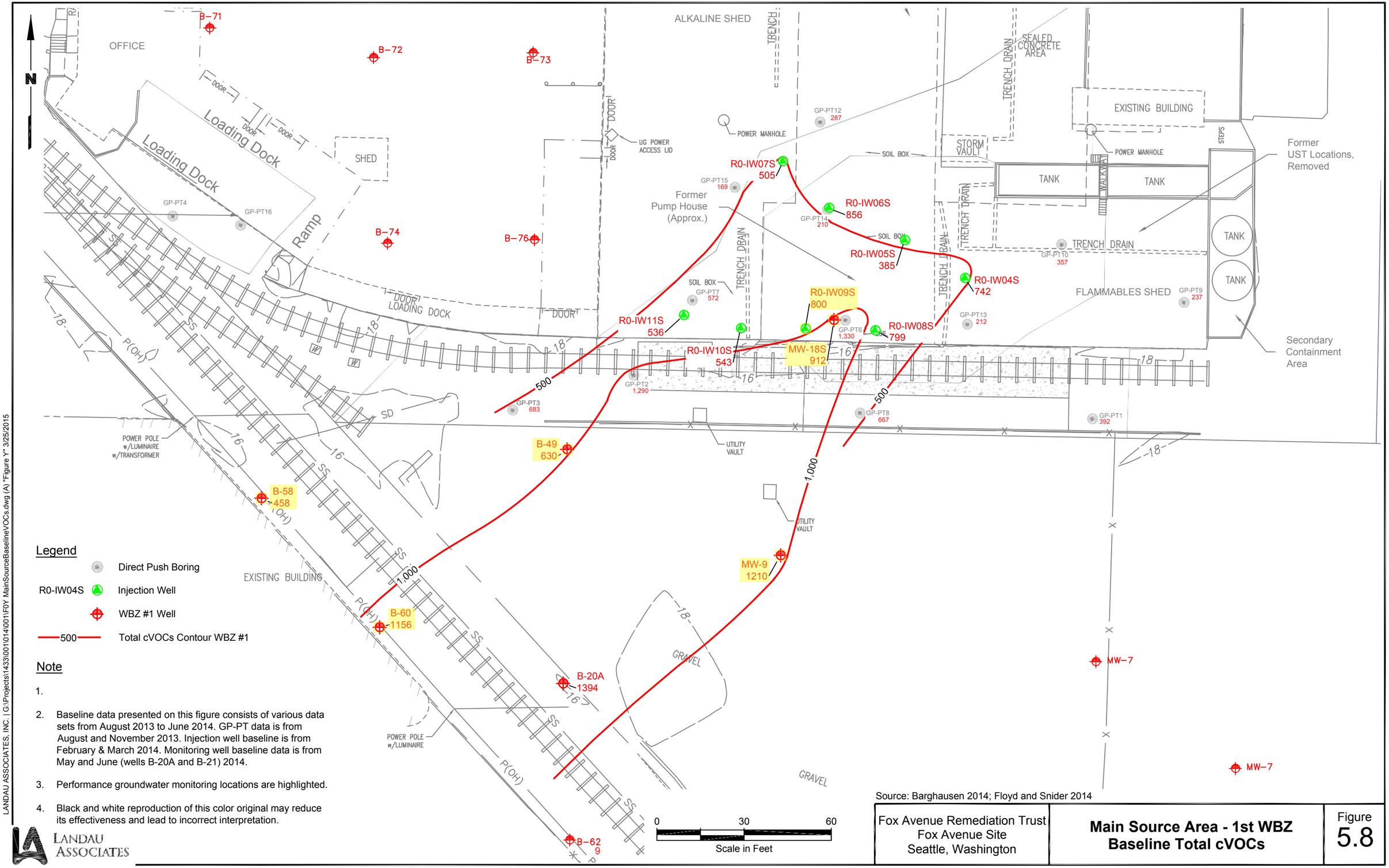
3. Performance groundwater monitoring locations are highlighted.

4. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Source: Barghausen 2014; Floyd and Snider 2014

LANDAU ASSOCIATES

Fox Avenue Remediation Trust Fox Avenue Site Seattle, Washington	**Main Source Area - 2nd WBZ Baseline Total cVOCs**	Figure 5.7



Legend

- Direct Push Boring
- R0-IW04S — Injection Well
- WBZ #1 Well
- 500 — Total cVOCs Contour WBZ #1

Note

1.
2. Baseline data presented on this figure consists of various data sets from August 2013 to June 2014. GP-PT data is from August and November 2013. Injection well baseline is from February & March 2014. Monitoring well baseline data is from May and June (wells B-20A and B-21) 2014.
3. Performance groundwater monitoring locations are highlighted.
4. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

0 30 60
Scale in Feet

Source: Barghausen 2014; Floyd and Snider 2014

LANDAU ASSOCIATES

Fox Avenue Remediation Trust
Fox Avenue Site
Seattle, Washington

Main Source Area - 1st WBZ Baseline Total cVOCs

Figure 5.8

Fox Avenue Site

2014 Annual Report

Appendix A
Underground Injection Control Registration Documentation

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
PO Box 47600 • Olympia, WA 98504-7600 • 360-407-6000
711 for Washington Relay Service • Persons with a speech disability can call 877-833-6341

January 29, 2015

Mr. Bob Code
Cascade Columbia Distribution
6900 Fox Ave South
Seattle, WA 98108

RE: Registration with the Underground Injection Control (UIC) Program, Cascade Columbia Distribution, 6900 Fox Ave S., Seattle, WA

Dear Mr. Code:

This letter is to acknowledge receipt of your registration form received June 11, 2014 to register the above-mentioned site with the UIC program. The UIC wells are rule authorized and do not need a State Waste Discharge Permit to operate. The UIC site number is 30502.

Cascade Columbia Distribution is working with Ecology's Model Toxic Control Program (MTCA) under Agreed Order DE 6486 to remediate the soil and groundwater contamination at the site. Remediation projects under a MTCA legal agreement have to meet the substantive requirements of other laws which groundwater protection is one. Meeting the substantive requirements will fulfill the groundwater protection requirement of the UIC Program.

Please refer to the UIC site number in all correspondence concerning this site. Also contact us if the property owner changes or the use of the well.

Please call me at (360) 407-6143 if you have any questions. Additional information can also be found at our website http://www.ecy.wa.gov/programs/wq/grndwtr/uic/index.html.

Sincerely,

MSHansen

Mary Shaleen-Hansen
UIC Coordinator
Water Quality Program

Cc: Clint Jacob, Landau Associates, Inc.

Underground Injection Control (UIC) Well Registration Form for Voluntary or Independent Cleanup Sites

The purpose of this form is to register with the Department of Ecology UIC wells used at voluntary clean up sites that inject products or treated ground water

A. Facility Name and Location

Facility Name: Cascade Columbia Distribution
Facility Address: 6900 Fox Ave S
City: Seattle State: WA ZIP: 98108
Phone at the facility: 206.282.6334

County: King
Township, Range, Section, Quarter-Quarter: T24N, R4E, Sec 29, NW1/4, SW 1/4

B. Contact Information

Well Owner

Name: Bob Code
Organization: Cascade Columbia Distribution
Address: 6900 Fox Ave S
City: Seattle State: WA ZIP: 98108
Phone: 206.282.6334
Email: bobc@cascadecolumbia.com

Property Owner

Same as Well Owner: ☒
If not the same, complete below:
Name:
Organization:
Address:
City: State: ZIP:
Phone:

Technical Contact Person, if applicable (Engineer, Contractor, Consultant)

Name: Tom Colligan
Organization: Floyd Snider
Address: 601 East Union Street
City: Seattle State: WA ZIP: 98101
Phone: 206.292.2078
Email: tom.colligan@floydsnider.com

Facility Description

List the Primary Standard Industrial Classification Code (SIC) or NAIC Code for your facility (http://www.census.gov/epcd/www/naics.html)

SIC Code: or NAIC Code: 424690

Briefly describe the type or nature of business at this facility:
Chemical Distribution

C. Site and Project information

The following information is required to determine rule authorization for UIC wells used at a **voluntary clean up site**. Please attach this information with your registration.

1. Describe the overall process. The table in Section E provides a place to list injection substances, amounts by weight, estimated volumes and the estimated maximum concentrations as the substance leaves the injection well. Alternatively, you may attach this information on a separate sheet.
2. Site map including the location of monitoring wells, UIC wells, the plume and ground water flow direction.
3. Drill logs and as-built drawings of monitoring wells.
4. Characterization of the hydrogeology at the site; include the depth to ground water, flow direction and hydraulic gradient.
5. Detailed evaluation of whether injected products and by products will be contained on site or not. Include a brief description of the monitoring plan, include the monitoring frequency, list of monitored wells and analytes tested.
6. Description of potential by-products.
7. Description of existing ground water quality.
8. Copy of access agreement if working on neighboring property

Approximately when will the injection project start? June

Approximately when will the injection project end? to be determined based on monitoring, possibly several years

Distance from property line to nearest of surface water, to the nearest foot: 400

Distance from property line to nearest drinking water well, to the nearest foot: none within 1 mile, nearest 4 miles SW

Which drinking water supply wellhead protection area or source water intake protection area is the site located in (See the Washington State Department of Health website for protection areas in each county: Department of Health wellhead mapping? List the water district or none. None

Dept. of Ecology Voluntary Cleanup Program Site Manager: Sunny Becker

Agreed Order No. DE 6486

Facility Site ID No. 2282

Dept. of Ecology Voluntary Cleanup Program Site Number Cleanup Site ID No. 5082

E. Other UIC Well Information

	1	2	3	4	5	6	7
Well ID Name or Number	See Table 1 for Main Source Wells (19 wells)	See Table 2 for Loading Dock Water Bearing Zone Wells (3 wells)					
Latitude (decimal)							
Longitude (decimal)							
Construction Date							
EPA Well Type (see table)	5x26	5x26					
Status (Active, Unused, Closed, Proposed)	P	P					
Depth of UIC well							
Injectate Information (Use this table or attach on a separate sheet)							
Injection substance							
Mass							
Mass Units							
Volume[1]							
Volume Units							
Concentration[2]							
Concentration Units							

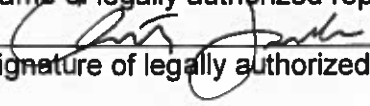
[1] Volume includes water or other liquid that is mixed with the injectate prior to injection.
[2] Estimate what the maximum concentration would be as the substance leaves the injection well.

EPA Class V Well Types

5A19 Cooling Water Return	5A6 Geothermal Heat	5W11 Septic System	
5D2 Stormwater	5R21 Aquifer Recharge	5W20 Industrial Process Water	5X26 Aquifer Remediation
5D4 Industrial Storm Runoff	5W9 Untreated Sewage	5W31 Septic System (well disposal)	5X27 Other Wells
5G30 Special Drainage Water	5W10 Cesspool	5W32 Septic System (drainfield)	5X28 Motor Vehicle Waste

Signature of authorized representative

I hereby certify that the information contained in this registration is true and correct to the best of by knowledge.

Clint Jacob	Consultant, Landau Associates
Name of legally authorized representative	Title
	6/6/2014
Signature of legally authorized representative	Date

For Department Use Only	
Site ID:	
Date received:	
Date acknowledged:	
Date Entered:	
Final Disposition:	

Please send completed form to:
UIC Coordinator
Water Quality Program,
Washington Department of Ecology
P.O. Box 47600
Olympia, WA 98504-7600

If you need this document in a format for the visually impaired, call the Water Quality Program at 360-407-6404. Persons with hearing loss can call 711 for Washington Relay Service. Persons with a speech disability can call 877-833-6341.

Instructions for the UIC Well Registration Form for Voluntary Cleanup Site

A. Facility Name and Location

Provide the name, address, and phone number of the facility where the UIC wells are or will be located. Provide the county parcel number for the facility.

B. Contact Information

Well Owner: Provide the well owner's name, organization, address and phone number.
Property Owner: Complete if different then the Well owner

Technical Contact: Provide the name, organization, address, and telephone number of the person to contact in case there are any questions about this registration.

C. Facility Description

SIC or NAIC Codes for your industry or commercial business: Enter the Standard Industrial Classification (SIC) four-digit code **or** North American Industry Classification System five or six-digit code (NAICS) for the facility.

These codes are used to describe the primary activity at the facility that generates the most money and may be found on fire marshal reports, insurance papers, or tax forms. The NAICS codes replaced the SIC system in 1997; however, it is usually easy to convert between the two systems so either code is acceptable. SIC or NAICS information is also available from the U.S. Census Bureau at 1-888-756-2427 or at http://www.naics.com/search.htm. Include a secondary code if applicable.

Briefly describe the type or nature of business at this facility: For example, a gas station, rental business for the home, yard, and contractor equipment with in-house maintenance shop, or retail convenience store.

D. Site and Project Information

Provide the answers to questions, section D as an attachment. Some of the questions can be answered in section E. Ecology will contact you if the additional information is needed**.**

E. Other UIC Well Information

- Well ID: Provide your well identification name or number.
- Latitude and longitude: Enter the latitude and longitude in decimal degrees for each UIC well. Visit http://ww4.doh.wa.gov/scripts/esrimap.dll?Name=geoview&Cmd=Map and type the address in at the bottom of the screen. Locational information including, latitude and longitude will be found in a table below the map.
- Construction Date: Provide the approximate date the well was installed. EPA well type:
- EPA well types are listed in the table 1 below.
- Status: Active if the well is in use; unused if well is not in use, closed, or proposed if the well is in the design phase.
- Well depth: Provide the approximate well depth.
- Injection substance: provide name of product to be injected.
- Provide mass of injected substance and mass units.
- Provide the mass units of the injected substance.
- Provide the volume, volume units, concentration of the injected fluid and the concentration units.

If you need *this document in a format for the visually impaired, call the Water Quality Program at 360-407-6404. Persons with hearing loss can call 711 for Washington Relay Service. Persons with a speech disability can call 877-833-6341.*

TABLE 1
MAIN SOURCE INJECTION DETAILS
FOX AVENUE SITE
SEATTLE, WASHINGTON

						Injection Solution Components							Resulting Injection Fluid Concentrations		
Well ID (R0-IW___)	WBZ	Lat	Long	Constr. Date	Depth (ft)	FeSO4 - 25%wt (gallons)	Textrol (gallons) (a)	Textrol (drums)	Diluted Corn Syrup-10%wt Sugar (gallons)	Yeast Extract (lb)	Mix Water (gallons)	Combined Injection volume (gallons) (b)	FeSO4 (% wt)	Vegetable Oil Emulsion (%vol) (c)	Sugar (%wt) (d)
1D	2	47.540365	-122.325568	2/21/2014	64	800	645	12.0	1,000	7	7550	**9,995**	2%	6.5%	1%
2D	2	47.540386	-122.325640	2/20/2014	64	800	645	12.0	1,000	7	7550	**9,995**	2%	6.5%	1%
3D	2	47.540434	-122.325743	2/12/2014	65.5	800	484	9.0	1,000	7	7550	**9,834**	2%	4.9%	1%
4D	2	47.540234	-122.325640	2/20/2014	64	800	484	9.0	1,000	7	7550	**9,834**	2%	4.9%	1%
5D	2	47.540273	-122.325720	2/14/2014	65	800	484	9.0	1,000	7	7550	**9,834**	2%	4.9%	1%
6D	2	47.540309	-122.325816	2/12/2014	65.5	800	645	12.0	1,000	7	7550	**9,995**	2%	6.5%	1%
7D	2	47.540357	-122.325892	2/19/2014	65	800	484	9.0	1,000	7	7550	**9,834**	2%	4.9%	1%
8D	2	47.540208	-122.325743	2/18/2014	64	800	484	9.0	1,000	7	7550	**9,834**	2%	4.9%	1%
9D	2	47.540203	-122.325831	2/13/2014	65.5	800	484	9.0	1,000	7	7550	**9,834**	2%	4.9%	1%
10D	2	47.540201	-122.325934	2/24/2014	65	960	860	16.0	1,200	9	9000	**12,020**	2%	7.2%	1%
11D	2	47.5540209	-122.326048	2/21/2014	65	960	860	16.0	1,200	9	9000	**12,020**	2%	7.2%	1%
4S	1	47.540234	-122.325640	2/19/2014	19	136	54	1.0	170	1.5	1350	**1,710**	2%	3.1%	1%
5S	1	47.540273	-122.325720	2/14/2014	20	136	54	1.0	170	1.5	1350	**1,710**	2%	3.1%	1%
6S	1	47.540309	-122.325816	2/12/2014	20	136	54	1.0	170	1.5	1350	**1,710**	2%	3.1%	1%
7S	1	47.540357	-122.325892	2/19/2014	20	136	54	1.0	170	1.5	1350	**1,710**	2%	3.1%	1%
8S	1	47.540208	-122.325743	2/13/2014	20	136	54	1.0	170	1.5	1350	**1,710**	2%	3.1%	1%
9S	1	47.540203	-122.325831	2/13/2014	20	136	54	1.0	170	1.5	1350	**1,710**	2%	3.1%	1%
10S	1	47.540201	-122.325934	2/24/2014	20	136	54	1.0	170	1.5	1350	**1,710**	2%	3.1%	1%
11S	1	47.540208	-122.326002	2/24/2014	20	136	54	1.0	170	1.5	1350	**1,710**	2%	3.1%	1%
Totals						10,208	6,988	130	12,760	93	96,750	**126,706**			

(a) Textrol contains approximately 90 percent soybean oil and 10 percent surfactant. This column describes product purchased as Textrol, or product created on site with soy oil and SOLEC E surfactant. Each 450 lb drum contains 53.75 gallons
(b) Includes FeSO4 concentrated solution, Textrol, and mix water. Does not include pre- and post-injection clear water flushes of 50-100 gallons at each WBZ#1 well or 200-400 gallons at each WBZ#2 well. Dechlorinated tap water used for WBZ#2 injections, site groundwater with dechlorinating bacteria used for WBZ#1 injections.

(c) Calculation accounts for Textrol as 100 percent vegetable oil since the surfact is soy lecithin and constitutes electron donor as well.

(d) Based on 70% corn syrup pre-mixed with water to 10% sugar (Brix of 10), approximately 15,000lb of corn syrup total.

Note: Design and injection by Landau Associates.

TABLE 2
DEEP LOADING DOCK INJECTION DETAILS
FOX AVENUE SITE
SEATTLE, WASHINGTON

						Injection Solution Components						Resulting Injection Fluid Concentrations				
Well ID (R0-IW___)	WBZ	Lat	Long	Constr. Date	Depth (ft)	Ethyl Lactate (lbs)(a)	ReducED AQ (lbs) (a)	AM3-S (b)	ReleaseSE-Gx (lbs) (c)	BounTA (lbs)(d)	Combined Injection volume (gallons)	Ethyl Lactate (%wt)	ReducED AQ (%wt)	AM3-S (%wt)	ReleaseSE-Gx (%wt)	BounTA (%wt)
22D	2	47.540446	-122.326664	2/25/2014	60	1455	750	8.3	10	7550	**10,760**	2%	0.84%	0.01%	0.01%	1.11%
23D	2	47.540405	-122.326592	2/25/2014	60	1455	750	8.3	10	7550	**10,760**	2%	0.84%	0.01%	0.01%	1.11%
24D	2	47.540366	-122.326515	2/26/2014	60	1455	750	8.3	10	7550	**10,760**	2%	0.84%	0.01%	0.01%	1.11%
	Totals					4,365	2,250	25	30	22,650	**32,280**					

(a) Electron donor

(b) Dry powder blend of nitrate and sulfate reducing microbes

(c) Non-ionic and biologically derived surtactant

(d) Dry powder blend of micro- and macro-nutrients and pH buffer

Note: Design by Hart Crowser, injection by Cascade Columbia

Fox Avenue Site

2014 Annual Report

Appendix B
Data Validation Memorandums

Fox Avenue Site
May 2014 Groundwater and
ERD Performance Monitoring Event

Data Validation Report

Prepared for

Fox Avenue Building LLC
6900 Fox Avenue
Seattle, Washington

Prepared by

Floyd|Snider
601 Union Street
Suite 600
Seattle, Washington 98101

June 2014

Table of Contents

List of Attachments

List of Abbreviations and Acronyms

Abbreviation/ Acronym	Definition
ERD	Enhanced reductive dechlorination
Fremont Analytical	Fremont Analytical, Inc.
LCS	Laboratory control sample
LCSD	Laboratory control sample
MS	Matrix spike
MSD	Matrix spike duplicate
RPD	Relative percent difference
QA	Quality assurance
QC	Quality control
USEPA	U. S. Environmental Protection Agency
VOC	Volatile organic compound

1.0 Project Narrative

1.1 OVERVIEW OF DATA VALIDATION

This report summarizes the results of the Compliance Screening (Level I) performed on the groundwater sample data for the May 2014 Groundwater and Enhanced Reductive Dechlorination (ERD) Performance Monitoring Event. A complete list of samples is provided below.

Project Sample Index

SDG (Batch)	Sample ID	Lab ID	USEPA 8260	RSK 175
FA1405155	RO-IW02D-051414	1405155-001	X	X
FA1405155	MW-15D-051414	1405155-002	X	X
FA1405155	RO-IW06D-051414	1405155-003	X	X
FA1405155	RO-IW09S-051414	1405155-004	X	X
FA1405155	MW-16D-051414	1405155-005	X	X
FA1405155	MW-10-051414	1405155-006	X	X
FA1405155	MW-9-051414	1405155-007	X	X
FA1405155	B-49-051414	1405155-008	X	X
FA1405155	B-45-051414	1405155-009	X	X
FA1405155	MW-17D-051414	1405155-010	X	X
FA1405155	DUP-1-051414	1405155-011	X	X
FA1405155	MW-18S-051514	1405155-012	X	X
FA1405155	Trip Blank	1405155-013	X	
FA1405160	NW1-1-051514	1405160-001	X	
FA1405160	NW-1-2-051514	1405160-002	X	
FA1405160	B-59-051514	1405160-003	X	
FA1405160	B-58-051514	1405160-004	X	
FA1405160	B-60-051514	1405160-005	X	
FA1405160	B-61-051514	1405160-006	X	
FA1405160	B-63-051514	1405160-007	X	
FA1405160	B-62-051514	1405160-008	X	
FA1405160	B-19-051514	1405160-009	X	
FA1405160	B-18-051514	1405160-010	X	
FA1405160	R1-IW21-051514	1405160-011	X	
FA1405160	B-78-051614	1405160-012	X	X

SDG (Batch)	Sample ID	Lab ID	USEPA 8260	RSK 175
FA1405160	B-77-051614	1405160-013	X	
FA1405160	MW-19D-051614	1405160-014	X	X
FA1405160	B-22-051614	1405160-015	X	
FA1405160	SP-04-051614	1405160-016	X	
FA1405160	SP-03b-051614	1405160-017	X	
FA1405160	SP-02-051614	1405160-018	X	X
FA1405160	SP-03-051614	1405160-019	X	
FA1405160	Dup-1-051514	1405160-020	X	
FA1405160	Trip Blank	1405160-021	X	
FA1405160	Trip Blank	1405160-022	X	

Abbreviation:
SDG Sample delivery group

The chemical analyses were performed by Fremont Analytical, Inc. (Fremont Analytical) in Seattle, Washington. A total of 27 groundwater samples, 4 seep samples, and 3 quality control (QC) samples were collected between May 14, 2014 and May 16, 2014 and submitted to Fremont Analytical for chemical analyses of volatile organic compounds (VOCs) by U.S. Environmental Protection Agency (USEPA) Method 8260 and dissolved gasses by USEPA Method RSK-175.

The data were reviewed using guidance and QC criteria documented in the analytical methods and the USEPA 1999 and 2008 *National Functional Guidelines for Organic Data Review*.

The conventional parameters total organic carbon, nitrate, sulfate, and sulfide were also analyzed; however, they do not have data quality compliance requirements, and, therefore, the results were not included in this data validation report.

Floyd|Snider's goal in assigning data assessment qualifiers is to assist in proper data interpretation. If values are estimated (J or UJ), data may be used for site evaluation and risk assessment purposes, but reasons for data qualification should be taken into consideration when interpreting sample concentrations. If values are assigned an R, the data are to be rejected and should not be used for any site evaluation purposes. When compounds are analyzed at multiple dilutions or by multiple analysis methods, select results will be assigned a Do Not Report (DNR) qualification as a more appropriate result is reported from another dilution or analysis method. If values have no data qualifier assigned, then the data meet the data quality objectives as stated in the documents and methods referenced above.

Data qualifier definitions, reasons, and validation criteria are included as Attachment 1. As no data were qualified for this data set, the standard Qualified Data Summary Table was not populated, and has not been included as an attachment. Data validation worksheets (excel worksheets) will be kept on file at Floyd|Snider.

2.0 Data Validation Report VOCs by USEPA Method 8260

This report documents the review of analytical data from the analyses of groundwater samples and the associated laboratory QC samples. Samples were analyzed by Fremont Analytical. Compliance Screening (Level I) was performed on all analytical results by Chell Black as the primary data reviewer, and secondary review was performed by Jessi Massingale.

2.1 DATA PACKAGE COMPLETENESS

The laboratory submitted all required deliverables. The laboratory followed adequate corrective action processes and all anomalies were discussed in the case narrative.

2.2 TECHNICAL DATA VALIDATION

The QC requirements that were reviewed are listed below.

QC Requirements

Cooler temperature and preservation	[1] Matrix Spike (MS) and MS Duplicate (MSD)
Extraction and analysis holding times	Laboratory Control Sample (LCS)
Blank contamination	Lab sample duplicate relative percent difference (RPD)
Surrogate recoveries	Reporting limits and reported results

Note:
1 QC results are discussed below, but no data were qualified.

Attachment 1 presents data validation criteria tables for organic compound analysis. QC requirements that were met without exception are not discussed below. QC requirements that required further evaluation and had exceptions to the validation criteria are discussed below.

2.2.1 Matrix Spike

For SDG FA1405155, the MS and MSD recoveries for three analytes, acetone, cis-1,2-dichloroethene, and 2-butanone, and the MSD recovery for one analyte, naphthalene, were outside laboratory control limits. The LCS recoveries for these analytes were within laboratory control limits. Per USEPA guidelines, no results are qualified based on MS data alone, and as all other quality assurance (QA)/QC requirements for these analytes were met, it is with professional judgment that no results be qualified based on this recovery information.

For SDG FA1405160, the MS recoveries for three analytes, acetone, 2-butanone, and naphthalene, were outside laboratory control limits. The LCS recoveries for these analytes were within laboratory control limits. Per USEPA guidelines, no results are qualified based on MS data alone, and as all other QA/QC requirements for these analytes were met, it is with professional judgment that no results be qualified based on this recovery information.

2.3 OVERALL ASSESSMENT

As was determined by this evaluation, the laboratory followed the specified analytical method. Accuracy was acceptable, as demonstrated by the MS and LCS percent recovery values. Precision was acceptable, as demonstrated by the MS/MSD RPDs and LCS/laboratory control sample duplicate (LSCD) RPDs.

All data, as reported by the laboratory, are acceptable for use.

3.0 Data Validation Report
Dissolved Gases by USEPA Method RSK-175

This report documents the review of analytical data from the analyses of groundwater samples and the associated laboratory QC samples. Samples were analyzed by Fremont Analytical. Compliance Screening (Level I) was performed on all analytical results by Chell Black as the primary data reviewer, and secondary review was performed by Jessi Massingale.

3.1 DATA PACKAGE COMPLETENESS

The laboratory submitted all required deliverables. The laboratory followed adequate corrective action processes and all anomalies were discussed in the case narrative.

3.2 TECHNICAL DATA VALIDATION

The QC requirements that were reviewed are listed below.

QC Requirements

Cooler temperature and preservation	LCS
Extraction and analysis holding times	Lab sample duplicate RPD
Blank contamination	Reporting limits and reported results

All QC requirements were met without exception, and did not require further evaluation.

3.3 OVERALL ASSESSMENT

As was determined by this evaluation, the laboratory followed the specified analytical method. Accuracy was acceptable, as demonstrated by the LCS percent recovery values. Precision was acceptable as demonstrated by the lab sample/lab sample duplicate RPDs.

All data, as reported by the laboratory, are acceptable for use.

4.0 References

U.S. Environmental Protection Agency (USEPA), 1999. *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review, OSWER* 9240.1-05A-P. EPA540/R-99/008. October.

U.S. Environmental Protection Agency (USEPA). 2008. *USEPA Contract Laboratory Program, National Functional Guidelines for Organic Data Review*. EPA-540/R-99/008. October.

Fox Avenue Site
May 2014 Groundwater and
ERD Performance Monitoring Event

Data Validation Report

Attachment 1
Data Qualifier Definitions and Criteria Tables

DATA VALIDATION QUALIFIER CODES
National Functional Guidelines

The following definitions provide brief explanations of the qualifiers assigned to results in the data review process.

U	The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
J	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
N	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a “tentative identification”.
NJ	The analysis indicates the presence of an analyte that has been “tentatively identified” and the associated numerical value represents the approximate concentration.
UJ	The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
R	The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

The following is a Floyd|Snider qualifier that may also be assigned during the data review process:

DNR	Do not report; a more appropriate result is reported from another analysis or dilution.

Floyd|Snider Validation Guidelines for Volatile Analysis by GC/MS (Based on Organic NFG 1999)

Validation QC Element	Acceptance Criteria	Action
Cooler Temperature	4°C±2°C Water: HCl to pH < 2	J/UJ if greater than 6 deg. C (Floyd|Snider PJ)
Hold Time	Waters: 14 days preserved 7 Days: unpreserved (for aromatics) Solids: 14 Days	J/UJ if hold times exceeded If exceeded by > 3X HT: J/R (Floyd|Snider PJ)
Tuning	BFB Beginning of each 12 hour period Method acceptance criteria	R all analytes in all samples associated with the tune
Initial Calibration (Minimum 5 stds.)	RRF > 0.05	(Floyd|Snider PJ) If MDL= reporting limit: J/R if RRF < 0.05 If reporting limit > MDL: note in worksheet if RRF <0.05
	%RSD < 30%	(Floyd|Snider PJ) J if %RSD > 30%
Continuing Calibration (Prior to each 12 hr. shift)	RRF > 0.05	(Floyd|Snider PJ) If MDL= reporting limit: J/R if RRF < 0.05 If reporting limit > MDL: note in worksheet if RRF <0.05
	%D <25%	(Floyd|Snider PJ) If > +/-90%: J/RIf -90% to -26%: J (high bias) If 26% to 90%: J/UJ (low bias)
Method Blank	One per matrix per batch No results > CRQL	U if sample result is less than CRQL and less than appropriate 5X or 10X rule (raise sample value to CRQL)
		U if sample result is greater than or equal to CRQL and less than appropriate 5X and 10X rule (at reported sample value)
	No TICs present	R TICs using 10X rule
Storage Blank	One per SDG <CRQL	U the specific analyte(s) results in all assoc. samples using the 5x or 10x rule

Validation QC Element	**Acceptance Criteria**	**Action**
Trip Blank	Frequency as per project QAPP	Same as method blank for positive results remaining in trip blank after method blank qualifiers are assigned
Field Blanks (if required in QAPP)	No results > CRQL	Apply 5X/10X rule; U < action level
MS/MSD (recovery)	One per matrix per batch Use method acceptance criteria	Qualify parent only unless other QC indicates systematic problems: J if both %R > UCL J/UJ if both %R < LCL J/R if both %R < 10% PJ if only one %R outlier
MS/MSD (RPD)	One per matrix per batch Use method acceptance criteria	J in parent sample if RPD > CL
LCS *low conc. H2O VOA*	One per lab batch Within method control limits	J assoc. cmpd if > UCL J/R assoc. cmpd if < LCL J/R all cmpds if half are < LCL
LCS *regular VOA (H2O & solid)*	One per lab batch Lab or method control limits	J if %R > UCL J/UJ if %R <LCL J/R if %R < 10% (Floyd|Snider PJ)
LCS/LCSD *(if required)*	One set per matrix and batch of 20 samples RPD < 35%	J/UJ assoc. cmpd. in all samples
Surrogates	Added to all samples Within method control limits	J if %R >UCL J/UJ if %R <LCL but >10% J/R if <10%
Internal Standard (IS)	Added to all samples Acceptable Range: IS area 50% to 200% of CCAL area RT within 30 seconds of CC RT	J if > 200% J/UJ if < 50% J/R if < 25% RT>30 seconds, narrate and Notify PM
Field Duplicates	Use QAPP limits. If no QAPP: Solids: RPD <50% OR absolute diff. < 2X RL (for results < 5X RL) Aqueous: RPD <35% OR absolute diff. < 1X RL (for results < 5X RL)	Narrate and qualify if required by project (Floyd|Snider PJ)
TICs	Major ions (>10%) in reference must be present in sample; intensities agree within 20%; check identification	NJ the TIC unless: R common laboratory contaminants See Technical Director for ID issues

Validation QC Element	Acceptance Criteria	Action
Quantitation/ Identification	RRT within 0.06 of standard RRT Ion relative intensity within 20% of standard All ions in std. at > 10% intensity must be present in sample	See Technical Director if outliers

Notes:

PJ[1] No action if there are 4+ surrogates and only 1 outlier

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Tier I Data Validation Summary

Prepared by/Reviewed by: Chell Black/Erin Cosnowski
Date: November 17, 2014
Project No: Fox Avenue
Sample Event(s): Bio polish Monitoring October 2014
Sample Delivery Group(s): FA1410278
Sample Media: Groundwater

A Compliance Screening, Tier 1 data quality review was performed on volatile organic compounds (VOCs), total and dissolved iron, and sulfate data resulting from laboratory analysis. The analytical data was validated in accordance with the USEPA National Functional Guidelines for Superfund Organic Methods Data Review (2014) and USEPA National Functional Guidelines for Inorganic Superfund Data Review (2014). The conventional parameters sulfide and total organic carbon were also analyzed; however, these analyses do not have data quality compliance requirements.

A total of 12 groundwater samples and one trip blank were submitted in one sample delivery group, FA1410278, to Fremont Analytical of Seattle, Washington for chemical analysis by USEPA Methods 8260 for VOCs, 200.8 for total and dissolved iron, and 300.0 for sulfate. For all analytical methods the holding times were met and the method blanks had no detections. The surrogate, matrix spike (MS), matrix spike duplicate (MSD) and laboratory control sample recoveries, and MS/MSD and sample/sample duplicate relative percent differences all met USEPA requirements.

No qualifiers were added to the analytical results based on the data quality review. Data are determined to be of acceptable quality for use as reported by the lab.