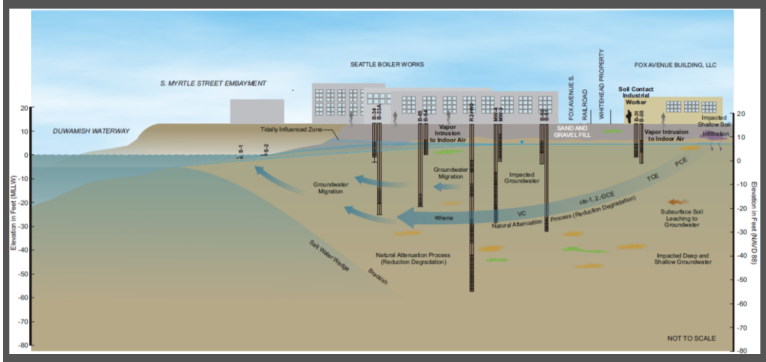
Fox Avenue Site
Seattle, Washington



2015 Annual Report

Prepared for

Fox Avenue Building LLC
6900 Fox Avenue S.
Seattle, Washington 98108

March 2015

FLOYD | SNIDER
strategy • science • engineering
Two Union Square • 601 Union Street • Suite 600
Seattle, Washington 98101 • tel: 206.292.2078

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.

Table of Contents

List of Tables

List of Figures

List of Acronyms and Abbreviations

Acronym/ Abbreviation	Definition
CALIBRE	CALIBRE, Inc.
CAP	Cleanup Action Plan
cis-1,2-DCE	cis-1,2-Dichloroethene
AMEE	Acetylene, methane, ethane, ethene
CVOC	Chlorinated volatile organic compound
Ecology	Washington State Department of Ecology
ERD	Enhanced reductive dechlorination
Landau	Landau Associates
Loading Dock	Loading Dock Source Area
µg/L	Micrograms per liter
mg/L	Milligrams per liter
NW Corner	Northwest Corner Area
PCE	Tetrachloroethene
RL	Remediation Level
Site	Fox Avenue Site
TCE	Trichloroethene
TOC	Total organic carbon
TPH	Total petroleum hydrocarbon
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 Systems, Inc. (CALIBRE), and Landau Associates (Landau), is to document the cleanup activities and monitoring that occurred in 2015 at the Fox Avenue Site (the Site, Figure 1.1). The work described in this report was performed in accordance with Agreed Order No. 8985 between Fox Ave LLC and the Washington State Department of Ecology (Ecology; Ecology 2012). Per the Cleanup Action Plan (CAP) for the Site, bio-polishing is to be performed following thermal treatment of the chlorinated volatile organic compounds (CVOCs) until the groundwater remediation level is met. The Main Source Area was thermally treated, as well the Loading Dock Source Area (Loading Dock). One source area, the Northwest Corner Area (NW Corner), was not thermally treated; instead, this area underwent soil vapor extraction. Thermal treatment occurred from January to May of 2013 and achieved its goal of reducing source area soil contaminant concentrations to the thermal remediation level of an average of 10 milligrams per kilogram (mg/kg) or less of the sum of tetrachloroethene (PCE) and trichloroethene (TCE) concentrations. Following thermal treatment, aquifer temperatures in the Main Source Area were too elevated to implement bio-polishing until mid-2014, as summarized in the 2014 Annual Report (Floyd|Snider 2015).

1.2 GROUNDWATER 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 (RLs) were established in the CAP for soil and groundwater that were technology-based.

The groundwater RL was set at a total CVOC concentration of 250 micrograms per liter (µg/L) as measured in wells located downgradient of Fox Avenue S., the conditional point of compliance for groundwater. Per the requirements of the CAP, the groundwater RL must be met within 10 years following the thermal remediation. Therefore, 2015 represents the second year toward this goal.

In addition to the RL for groundwater, cleanup levels were established for the individual constituents found in groundwater. These cleanup levels must be met at the seeps along the Myrtle Street Embayment within 15 years following thermal treatment (i.e., end of 2028). Cleanup levels must also be met throughout the plume upgradient of the seeps to the conditional point of compliance along Fox Avenue S. 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.

The RLs for site soil were achieved in 2013 as documented in the *Construction Completion Report* (Floyd|Snider 2013). Documentation of the achievement of indoor air cleanup levels, both on- and off-site, is contained in the *Construction Completion Report* as well.

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 (VC)	2.4

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

2.0 Remedial Actions Undertaken

Remedial actions implemented in 2015 included injection of soluble sugar substrate in selected wells, bio-augmentation in selected wells, and performance monitoring of groundwater in areas that had already been injected with soluble sugar or edible oil in 2014. The following sections summarize the work completed in 2015. All monitoring/laboratory analysis, substrate injection, and bio-augmentation were completed in accordance with previously submitted project work plans.

2.1 PERFORMANCE MONITORING

Performance monitoring of bio-polishing primarily involved the collection of groundwater samples over multiple sampling events as follows:

- **Main Source Area Injection Wells.** Samples from three selected injection wells in the Main Source Area were collected in January, May, and September of 2015.
- **Fox Avenue S., S. Myrtle Street, and Seattle Boiler Works Injection Wells.** Samples from selected injection wells along Fox Avenue S., S. Myrtle Street, and within Seattle Boiler Works were collected in May and November of 2015. Sample results from those events were used to identify areas of the Site that would benefit from further substrate injections.
- **Groundwater Monitoring.** Samples of site-wide groundwater from selected monitoring wells were collected in January, May, September, and November of 2015. The May event was the largest of the four events.
- **Loading Dock and Northwest Corner Source Area Wells.** Injection wells and monitoring wells in both of these areas were not sampled in 2015, as RLs were met in these areas in 2014.
- **Seeps.** Samples of four groundwater seeps visible at a minus low tide along the Myrtle Street Embayment were collected in May of 2015.

2.2 SUBSTRATE INJECTION

Table 2.1 provides a summary of the substrate injections completed in 2015.

Table 2.1
Substrate Injection Summary

Well ID	Interval (ft bgs)	Date	Substrate Quantity (Type)	Total Gallons Injected	ERD Treatment Area
R2-IW1	15–20, 25–35, 40–50, 55–70	5/2015	1,328 lbs (sugar at 7% Brix)	2,375	Seattle Boiler Works
R2-IW2	15–20, 25–35, 40–50, 55–70	5/2015	1,418 lbs (sugar at 7% Brix)	2,541	Seattle Boiler Works
R2-IW8	10–15, 20–30, 35–45, 50–65	5/2015	1,428 lbs (sugar at 7% Brix)	2,541	Seattle Boiler Works
R2-IW9	10–15, 20–30, 35–45, 50–65	5/2015	1,428 lbs (sugar at 7% Brix)	2,542	Seattle Boiler Works
R2-IW10	7–12, 17–27, 32–42, 47–62	5/2015	2,212 lbs (sugar at 20.5% Brix)	1,300	Seattle Boiler Works
R1-IW15	10–15, 20–30, 35–45, 50–60, 65–75	7/2015	2,950 lbs (sugar at 12% Brix)	2,865	Fox Avenue near Loading Dock
R2-IW3	15–20, 25–35, 40–50, 55–70	7/2015	1,736 lbs (sugar at 9% Brix)	2,500	Myrtle Street cul-de-sac

Well ID	Interval (ft bgs)	Date	Substrate Quantity (Type)	Total Gallons Injected	ERD Treatment Area
R2-IW4	15–20, 25–35, 40–50, 55–70	7/2015	1,716 lbs (sugar at 8% Brix)	2,500	Myrtle Street cul-de-sac
R2-IW5	15–20, 25–35, 40–50, 55–70	7/2015	1,716 lbs (sugar at 8% Brix)	2,500	Myrtle Street cul-de-sac
R1-IW3a	7–12	11/2015	296 lbs (sugar at 10% Brix)	376	Fox Avenue
R1-IW4a	9–14	11/2015	620 lbs (sugar at 9% Brix)	925	Fox Avenue
R1-IW4b[1]	25–35, 40–50, 55–70	11/2015	1,446 lbs (sugar at 9% Brix)	2,041	Fox Avenue
R1-IW5[1]	7–12, 32–42, 47–63	11/2015	1,818 lbs (sugar at 8% Brix)	2,586	Fox Avenue
R1-IW6[1]	15–20, 25–35, 40–50, 55–70	11/2015	1,839 lbs (sugar at 9% Brix)	2,511	Fox Avenue
R1-IW7[1]	15–20, 25–35, 40–50, 55–70	11/2015	1,834 lbs (sugar at 9% Brix)	2,500	Fox Avenue
R1-IW17	10–15, 20–30, 35–45, 50–60, 65–75	11/2015	1,736 lbs (sugar at 7% Brix)	3,100	Fox Avenue

Well ID	Interval (ft bgs)	Date	Substrate Quantity (Type)	Total Gallons Injected	ERD Treatment Area
R1-IW18	10–15, 20–30, 35–45, 50–65	11/2015	1,389 lbs (sugar at 7% Brix)	2,507	Fox Avenue
R1-IW19	10–15, 20–30, 35–45, 50–65	11/2015	1,390 lbs (sugar at 7% Brix)	2,501	Fox Avenue
R2-IW1	15–20, 25–35, 40–50, 55–70	11/2015	1,607 lbs (sugar at 8% Brix)	2,456	Seattle Boiler Works
R2-IW2	15–20, 25–35, 40–50, 55–70	11/2015	1,654 lbs (sugar at 8% Brix)	2,511	Seattle Boiler Works
R2-IW8	10–15, 20–30, 35–45, 50–65	11/2015	1,620 lbs (sugar at 8% Brix)	2,500	Seattle Boiler Works
R2-IW10	7–12, 17–27, 32–42, 47–62	11/2015	1,664 lbs (sugar at 8% Brix)	2,382	Seattle Boiler Works

Note:

1 In November 2015, bio-augmentation source water was pulled from R1-IW3B at 50 ft bgs and injected into R1-IW4b, R1-IW5, R1-IW6, and R1-IW7. A total of 250 gallons of source water was injected into each of the four wells.

Abbreviations:

ERD Enhanced reductive dechlorination
ft Feet
lbs Pounds
bgs Below ground surface

Seattle Boiler Works – 1st and 2nd Water Bearing Zone (WBZ). Substrate was injected in five wells (R2-IW1, R2-IW2, R2-IW8, R2-IW9, and R2-IW10) in May 2015 and four wells in November 2015 (the same wells listed above except R2-IW9). Each of the wells used are screened in the 1st and 2nd WBZ. The substrate consisted of soluble sugars with buffer (sodium bicarbonate) added.

Following substrate injection, approximately 500 gallons of chase water (with buffer) were added to each well. The substrate injections in this area were completed in May and November 2015. Details are presented in Table 2.1.

Myrtle Street Cul-de-Sac – 1st and 2nd WBZ. One round of substrate injection was completed in July 2015 in the Myrtle Street cul-de-sac. This remedial action was implemented after the seep sampling event in May 2015. Wells R2-IW3, R2-IW4, and R2-IW5 were injected for this event (each well is screened in the 1st and 2nd WBZ). Details are presented in Table 2.1.

Fox Avenue – 1st and 2nd WBZ. Substrate was injected in one well (R1-IW15) in July 2015 and nine wells (R1-IW3A, R1-IW4A, R1-IW4B, R1-IW5, R1-IW6, R1-IW7, R1-IW17, R1-IW18, and R1-IW19) in November 2015. Details are presented in Table 2.1.

Main Source Area – 1st WBZ. As previously reported, one round of injection of edible oil substrate and other amendments was injected into the eight 1st WBZ injection wells in January of 2015. Details were presented in the 2014 Annual Report.

2.3 BIO-AUGMENTATION

Bio-augmentation using *Dehalococcoides* bacteria was performed at the center of plume wells R1-IW4B, R1-IW5, R1-IW6, and R1-IW7 in November 2015. Bio-augmentation was implemented using approximately 250 gallons of microbe-rich water that was extracted from well R1-IW3B and added to each of the four wells listed above. Bacterial census data collected previously showed abundant dechlorinating bacteria present in groundwater at this well (Floyd|Snider 2015).

3.0 Remedial Action Performance Monitoring Data

3.1 SAMPLING PROCEDURES

Samples from wells were collected using low-flow sampling procedures in accordance with the project work plans. All samples were analyzed for the selected list of volatile organic compounds (VOCs) found at the Site. Additional performance monitoring parameters were analyzed for in selected wells in the Main Source Area as well as downgradient on the former Whitehead property (now owned by Seattle Iron & Metals) and along Fox Avenue S. These additional parameters included redox indicators such as total and dissolved iron, sulfate, sulfide, acetylene, methane, ethene, and ethane (AMEE), as well as total organic carbon (TOC) as an indicator of substrate availability. In addition, the seeps in the Myrtle Street Embayment were sampled for VOCs during low tide on May 18, 2015.

Samples were delivered under chain-of-custody to Fremont Analytical 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

VOC data are presented in Table 3.1 and other performance parameters are presented in Table 3.2.

3.3 QUALITY ASSURANCE REVIEW AND ENVIRONMENTAL INFORMATION MANAGEMENT LOADING

A basic quality assurance review was performed by Floyd|Snider on all of the analytical laboratory reports received. The reviews concluded that all of the laboratory data were deemed acceptable for use. All data were subsequently uploaded to Ecology's Environmental Information Management database.

4.0 Performance Monitoring Data Discussion

Performance data that were collected in 2015 are discussed in this section by treatment area. Figures 4.1 and 4.2 show the site-wide results of the sum of PCE and TCE concentrations in the 1st and 2nd WBZ wells, respectively. Similarly, Figures 4.3 and 4.4 show the distribution of the sum of cis-1,2-dichloroethene (cis-1,2-DCE) and VC concentrations in the 1st and 2nd WBZ wells. Figures 4.5 and 4.6 show the sum of all CVOCs in the 1st and 2nd WBZ wells.

4.1 MAIN SOURCE AREA AND DOWNGRADIENT TO FOX AVENUE S.[1]

Current aquifer conditions for both the 1st and 2nd WBZ were evaluated by comparing performance monitoring groundwater data collected from injection and monitoring wells to baseline data collected prior to the injection of substrate in the Main Source Area following thermal treatment. 2015 conditions in both WBZs were evaluated using data from the January, May, and September 2015 monitoring events. The January 2015 monitoring event was also discussed in the 2014 Annual Report.

Based on evaluation of monitoring data, wells were separated into three categories to describe the level of effect donor injection has had on the well. The three categories are direct effects, secondary effects, or no effects, described as follows:

- The indicators for the direct effects of enhanced bioremediation are:
  - Increased TOC concentrations. Increased TOC concentrations are the 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 the well. It is expected that a TOC increase will be followed by both reduced aquifer redox conditions, and changed concentrations of CVOCs and end products.
  - Reduced aquifer redox conditions.
  - Changed concentrations of CVOCs and non-chlorinated end products ethene and ethane.
- Secondary effects are evidenced primarily by changes in VOC concentrations without substantial or sustained changes in TOC concentrations or aquifer redox conditions.
- No effects are indicated by a lack of significant changes in concentrations of TOC, aquifer redox, CVOCs, or end products.

As of the September 2015 monitoring event, there were very good signs of continued treatment in both WBZs, especially a decrease in the concentrations and extent of total CVOCs and conversion of chlorinated compounds to ethene and ethane. The September 2015 sampling event occurred 8 months after the 1st WBZ injection and 14 months after the 2nd WBZ injection. Isoconcentration contours for total CVOCs showed a substantial size reduction of the high concentration core of the plume compared to baseline in both the 1st WBZ (Figures 4.7 and 4.8)

[1] This section prepared by Landau.

and the 2nd WBZ (Figures 4.9 and 4.10). Ethene and/or ethane concentrations were detected at every one of the 13 wells where the analysis was performed, indicating complete reductive dechlorination to these non-toxic end products. The aquifer redox condition has become more reducing. Data from all monitored wells indicated either direct or secondary treatment effects, as described above.

Although September 2015 data indicated aquifer redox conditions remained conducive to continued biodegradation, the extent of TOC concentrations greater than baseline was decreasing and some Fox Avenue wells remained above the remediation level of 250 µg/L. TOC concentrations (indicative of electron donor) peaked prior to September and are now decreasing at wells along Fox Avenue S. (B21-D, B-60S, and B-61D). Total CVOC concentrations have decreased substantially at many wells upgradient of Fox Avenue S. (e.g., MW-16D, MW-17D, and MW-18S), but some Fox Avenue S. well concentrations remained greater than the remediation level of 250 µg/L. Total CVOC concentrations along Fox Avenue S. have decreased somewhat at the three 1st WBZ wells (B-58S, B-60S, and B-20AS) and at 2nd WBZ well B-59D, but have increased at 2nd WBZ well B-61D due primarily to increasing VC concentrations. A more detailed data evaluation below is grouped into the two WBZs, and progresses sequentially from injection wells to the downgradient monitoring wells along Fox Avenue S. A cumulative summary of Main Source Area data is presented in Table 4.1.

Seven wells were sampled for performance monitoring of the 1st WBZ. Data from the two source area wells (R0-IW09S and MW-18S) indicated direct effects of enhanced bioremediation, while data from the five downgradient wells showed evidence of secondary effects. A comparison of post-injection data to baseline (i.e., pre-injection) data shows a substantial shift from chlorinated compounds to the non-chlorinated reductive dechlorination end products ethene and ethane. Data from three of the four 1st WBZ wells where ethene/ethane was analyzed for (R0-IW09S, MW-18S, and B-49S) indicated that ethene/ethane was predominant on a molar basis in September 2015 (i.e., the percentage of total ethenes [defined as PCE + TCE + cis-1,2-DCE + VC + ethene + ethane] composed of the non-toxic end products [ethene + ethane] was larger than the percentage of any individual CVOC). Baseline data from these same three wells indicated that cis-1,2-DCE was the predominant ethene (85 to 96 percent cis-1,2-DCE on a molar basis). Notable developments at the seven 1st WBZ wells through September 2015 are indicated as follows:

- **Injection Well R0-IW09S.** Results from R0-IW09S showed direct treatment effects as TOC concentrations continued to rise (30.5 µg/L baseline to 75.6 µg/L). Elevated sulfate and iron concentrations were observed in May 2015 but declined by September; these data are consistent with sulfate reduction and reaction of sulfide and ferrous iron for formation of iron sulfides, as desired to stimulate abiotic contaminant treatment. The PCE concentration remained less than the detection limit for the second quarter in a row and TCE was not detected. September concentrations were less than prior peaks for TCE (66.6 µg/L [May 2014] to <0.5 µg/L), cis-1,2-DCE (704 µg/L [February 2014] to 11 µg/L), and VC (16.6 µg/L [May 2015] to 2.71 µg/L). On a molar basis, ethene/ethane was predominant at this well (91 percent total ethenes).

- **MW-18S (located between Injection Wells R0-IW08S and R0-IW09S).** Results from MW-18S showed direct effects from the January 2015 injection, including continued elevated TOC concentrations, which peaked in May 2015 (154 milligrams per liter [mg/L]). CVOC concentrations in September continued to decline as compared to prior sampling events. Ethene/ethane was the predominant ethene on a molar basis (55 percent).
- **MW-9S and B-49S (located 75 feet downgradient of the second row of injection wells [RO-IW08S to RO-IW11S]).** Results from both wells showed secondary treatment effects. At MW-9S, PCE concentrations increased due to enhanced desorption of mass, and VC concentrations increased due to reductive dechlorination. Substantial ethene/ethane concentrations (15 percent molar fraction) indicated complete reduction dechlorination. Total CVOC concentrations (1,230 µg/L) remained near baseline and greater than the remediation level applicable to downgradient wells along Fox Avenue S.

  Well B-49S data transitioned from VC predominance to ethene/ethane predominance (45 percent). The total CVOC concentration (202 µg/L) decreased from baseline (1,226 µg/L) to concentrations less than the Site remediation goal.
- **B-20AS, B-58S, and B-60S (located along Fox Avenue S. and approximately 150 feet downgradient of the second row of injection wells).** All three of these wells have shown evidence of secondary treatment effects, primarily changes in cis-1,2-DCE and VC and reduction in total CVOCs. Increased sulfate at B-20AS and B-58S was also noted, likely resulting from ferrous sulfate injection to the Main Source Area injection wells. Total CVOCs at B-20A (1,151 µg/L) and B-60S (610 µg/L) remained greater than the remediation level. Total CVOC concentrations at B-58S (131 µg/L) decreased to less than the remediation level.

Ten wells were sampled for performance monitoring of the 2nd WBZ. Direct effects of enhanced bioremediation have been evident at all four of the source area wells (R0-IW02D, R0-IW06D, MW-15D, and MW-16D) and two of the downgradient wells located along Fox Avenue S. (B-21D and B-61D). The remaining downgradient wells showed evidence of secondary effects. A comparison of post-injection data to baseline (i.e., pre-injection) data shows a substantial shift from chlorinated compounds to the non-chlorinated reductive dechlorination end products ethene/ethane. Ethene/ethane were detected at all nine wells where analyzed and were predominant at seven wells (R0-IW02D, MW-15D, MW-16D, B-21D, MW-17D, B-45D, and B-59D). Baseline data indicated a predominance of cis-1,2-DCE or VC at these wells, with the exception of B-21D, where ethane was predominant prior to injection. Notable developments at the 10 2nd WBZ wells through September 2015 are indicated as follows:

- **Injection Wells R0-IW02D and R0-IW06D.** Data from both wells indicated direct treatment effects. At R0-IW02D, TOC concentrations rose to a new peak of 2,720 mg/L, indicative of the continued presence of elevated electron donor. Detections of acetone and 2-butanone also continued at this well. These compounds are fermentation byproducts of injected electron donor substrates and are good

indicators of donor presence along with TOC; acetone and 2-butanone will be utilized as electron donor and are not expected to persist. Iron and sulfate concentrations remained elevated due to injected ferrous sulfate. Methane concentrations increased substantially, indicating the establishment of more highly reduced aquifer redox conditions. Ethene/ethane were detected for the first time in September 2015 and were predominant on a molar basis (52 percent).

Due to some accumulation of injected vegetable oil in R0-IW06D, the sample collected in September 2015 was mostly oil and the laboratory was not able to analyze it as a water sample. However, analytical results from the May 2015 sampling event indicated trends similar to R0-IW02D. This well, and other injection wells where accumulated vegetable oil were observed, were flushed with tap water in December 2015 to move the vegetable oil into the aquifer.

- **MW-15D (located approximately midway between IWs R0-IW01D and R0-IW02D).** Results from MW-15D showed direct treatment effects. TOC concentrations peaked in January 2015, but remained elevated through September. Biodegradation has been substantially enhanced, as indicated by: decreased PCE, TCE, and cis-1,2-DCE concentrations from baseline levels of 150 µg/L, 118 µg/L, and 578 µg/L, respectively, to less than detection limits; decreased VC concentrations from the January peak of 6,510 µg/L to 0.4 µg/L; and continued ethene/ethane production. Ethene/ethane was predominant in September (greater than 99 percent).
- **MW-16D (located 35 feet downgradient of the second row of injection wells [RO-IW04D to RO-IW07D]).** Data indicated direct treatment effects. TOC concentrations peaked in January 2015 (1,010 µg/L) but remained adequate (37.3 µg/L) for continued treatment. Beginning in May, PCE and TCE concentrations were less than detection limits. September concentrations were less than prior peaks for cis-1,2-DCE (4,600 µg/L [May 2014] to 1.37 µg/L) and VC (4,210 µg/L [January 2015] to 0.328 µg/L). On a molar basis, the well was ethene/ethane predominant (99 percent), increasing from an ethene/ethane baseline molar fraction of 5 percent.
- **MW-17D (located 35 feet downgradient of the third row of injection wells [RO-IW08D to RO-IW11D]).** Results from MW-17D showed evidence of secondary effects. PCE and TCE concentrations remained less than detection limits, while cis-1,2-DCE was non-detect for the first time, and VC concentrations continued to decline. There was also notable ethene/ethane production at this location, with a transition from VC predominance to ethene/ethane predominance (96 percent).
- **MW-10D (located 75 feet downgradient of the third row of injection wells).** Results from MW-10D showed evidence of secondary effects. cis-1,2-DCE concentrations declined to 131 µg/L from a baseline of 7,520 µg/L. VC (782 µg/L) remained at concentrations much less than the peak (1,630 µg/L) from October 2014. This well transitioned from cis-1,2-DCE to VC predominance (77 percent), with substantial ethene/ethane production (15 percent). The total CVOC concentration (915 µg/L) was substantially decreased from the October peak (8,308 µg/L) but remained greater than the remediation level applicable to downgradient wells along Fox Avenue S.

- **B-45D (located 75 feet downgradient of the third row of injection wells).** At B-45D, results showed evidence of secondary effects with continued substantial declines in concentrations of cis-1,2-DCE (7,270 µg/L to 49 µg/L) and VC (10,700 µg/L to 164 µg/L), compared to post-injection peak concentrations in October 2014. Ethene/ethane were predominant (71 percent).
- **MWs B-21D, B-59D, and B-61D (located on Fox Avenue S., approximately 145 to 150 feet downgradient of the third row of injection wells).** Results from all three wells showed increases in TOC concentrations following donor injection in the Main Source Area. This is considered a direct effect of injection and suggests that Fox Avenue S. was the approximate maximum downgradient extent of electron donor distribution resulting from the source area injection. Well B-21D was sampled as a part of the baseline event and was added to the routine monitoring plan in 2015. Direct effects included a temporary increase in TOC concentrations in May. VC concentrations fell from a peak of 286 µg/L (May 2015) to 41.4 µg/L. Ethene/ethane increased substantially and were predominant in September (90 percent). With the exception of May 2015 (290 µg/L), total CVOC concentrations have remained less than the 250 µg/L remediation level.

  At well B-59D, total CVOC concentrations have remained low since baseline testing. TOC concentrations increased in January, then decreased to less than baseline in September. Ethene/ethane was predominant when first analyzed in September (97 percent).

  At B-61D, TOC concentrations increased substantially in January 2015 then decreased to near baseline by September 2015. Maximum concentrations of cis-1,2-DCE (463 µg/L) and VC (1,100 µg/L) were detected in September 2015. VC was predominant (66 percent), but substantial ethene/ethane (16 percent molar fraction) indicated complete reductive dechlorination. Total CVOC concentrations increased in May (802 µg/L) and September (1,564 µg/L) to levels greater than baseline.

4.2 FOX AVENUE S.[2]

A total of nine injection wells and monitoring wells along Fox Avenue S. were sampled in May and November 2015. Wells sampled spanned a portion of Fox Avenue S. starting from R1-IW2 (near the Cascade Columbia loading dock) to the B-18/B-19 monitoring well pair near the intersection of Fox Avenue S. and S. Myrtle St. Results from both 2015 events showed total CVOC concentrations less than the RL of 250 µg/L (R1-IW2 [2nd WBZ], R1-IW3a [1st WBZ], R1-IW4a [1st WBZ], R1-IW4b [2nd WBZ], R1-IW5 [2nd WBZ], R1-IW7 [2nd WBZ], R1-IW17 [1st and 2nd WBZ], B-18 [1st WBZ], and B-19 [2nd WBZ]). Most of these wells were last sampled for VOCs in 2013 and 2014, and each shows significant reductions in the chemicals of concern since the previous sampling events.

[2] This section prepared by CALIBRE.

Notable wells include R1-IW2 with a 99.9+ percent reduction in total CVOCs (from 2009 baseline results); R1-IW3a, R1-IW4a, R1-IW4b, and R1-IW7 with a 99+ percent reduction in total CVOCs (R1-IW3a since 2013, R1IW4a/b since 2009/2010, and R1-IW7 since 2010); and R1-IW17 with a 97 percent reduction in total CVOCs (from 2012 baseline results). The two CVOCs detected at these wells are primarily cis-1,2-DCE and VC.

Monitoring wells B-20A (1st WBZ), B-60 (1st WBZ), and B-61 (2nd WBZ) showed concentrations of total CVOCs greater than the RL in May and September 2015, with a maximum concentration of 1,564 µg/L observed at B-61. These wells are located within the central area of the plume, which underwent significant increases in groundwater temperature. For remedial optimization purposes, ERD substrate injections and bio-augmentation were implemented in the area of these wells in November 2015.

Figures 4.5 and 4.6 show the location of all wells with their respective total CVOC concentrations in both the 1st and 2nd WBZ, respectively.

4.3 DOWNGRADIENT OF THE FOX AVENUE SITE[3]

Wells sampled downgradient of the Site included both injection wells and monitoring wells on Seattle Boiler Works and also along S. Myrtle Street. Monitoring was completed in these areas in May and November 2015. Monitoring wells MW-3 and MW-4 (downgradient of the Site near the center of Seattle Boiler Works) were not sampled in 2014 but were sampled twice in 2015. Results from both 2015 events showed total CVOC concentrations less than the RL of 250 µg/L. The current results indicate total CVOC concentration reductions of 99.2 percent (for MW-3 reduction from recent high concentrations detected in 2005) and 99.8 percent (for MW-4 reduction since recent high concentrations detected in 2010) at these two wells. Of the four injection wells in Seattle Boiler Works that were sampled in May of 2015, only one well (R2-IW1) showed total CVOC concentrations greater than the groundwater RL in both the 1st and 2nd WBZ. Although the CVOCs in this well remain greater than the RL, treatment with ERD is continuing at this location (all ERD substrate injections were implemented after this monitoring) and concentrations are expected to continue to decline. Current total CVOC concentrations are the lowest recorded to date for the 1st WBZ and second lowest for the 2nd WBZ with reductions of 96.6 and 95.4 percent, respectively, at R2-IW1. Concentrations of total CVOCs were less than the RL in the other three injection wells (R2-IW2 [1st and 2nd WBZ], R2-IW8 [2nd WBZ], and R2-IW11 [1st WBZ]), with a maximum of 11.2 µg/L detected at R2-IW8.

Injection wells R2-IW3 and R2-IW4, in the 2nd WBZ, showed the lowest total CVOC concentrations to date with 99.6 and 99.9 percent reductions, respectively. Both wells are less than the RL as well. Nearby monitoring wells in S. Myrtle Street showed slightly higher total CVOC concentrations, with one well (B-65 in the 2nd WBZ) having a total CVOC concentration of 418 µg/L, which is greater than the RL. Monitoring well B-33a, which is nearest to the Myrtle

[3] This section prepared by CALIBRE.

Street Embayment, showed a 99.99+ percent reduction in total CVOC concentrations. VC was the only chemical of concern detected at this well, with a concentration of 0.7 µg/L.

Following the monitoring events, ERD substrate injections were implemented on Seattle Boiler Works and S. Myrtle St. to promote further degradation, with substrate injections completed in May, July, and November 2015 for these areas.

Figures 4.5 and 4.6 show the location of all wells with their respective total CVOC concentrations in both the 1st and 2nd WBZ, respectively.

4.4 SEEPS

Results from the seeps are compared to cleanup levels for the individual chemicals of concern, and not the remediation level. One of the four seeps, S-4, was essentially non-detect for VOCs. In the remaining three seeps, VC was the primary VOC detected at concentrations greater than cleanup levels. The concentration of VC was significantly less in two of the three seeps compared to 2014 results, as demonstrated in Table 4.2. The remaining seep, S-2, showed an increase in VC concentrations. However, all VC concentrations were less than 100 µg/L, which is the first time this has occurred since routine monitoring of the seeps began in 2009.

Table 4.2
Vinyl Chloride Concentrations in 2014 and 2015

Seep	2014 VC Concentration (µg/L)	2015 (May 18, 2015) VC Concentration (µg/L)
S-2	ND	30.9
S-3	372	7.5
S-3b	136	72.8

Abbreviation:
ND Non-detect

ERD substrate injections were implemented in May, July, and November 2015 in areas upgradient of these seeps following the May 2015 monitoring event.

5.0 Conclusions and Recommendations

5.1 CONCLUSIONS

Overall, the results of the second year of post-thermal bio-polishing are encouraging, with total CVOC concentrations in most wells less than the remediation level of 250 µg/L total CVOCs. Little PCE or TCE remains at the Site; the primary contaminants now are the daughter products of reductive dechlorination, namely cis-1,2-DCE and VC. Continued biodegradation of cis-1,2-DCE and VC to ethene and ethane is observed site-wide based on dissolved gases data.

The following paragraphs present conclusions based on 2015 data in the Main Source Area and other areas downgradient of the seeps.

5.1.1 Main Source Area of the Fox Avenue Site

In the Main Source Area, the combination of thermal treatment plus 1 year (1st WBZ) and 1.5 years (2nd WBZ) of bio-polishing have substantially reduced contaminant concentrations. Concentrations of CVOCs immediately downgradient of the source area on the former Whitehead property have declined significantly in 2015, but still remain elevated in certain wells. Downgradient wells along Fox Avenue S. (B-20AS, B-58S, and B-60S in the 1st WBZ; B-21D, B-59D, and B-61D in the 2nd WBZ) mark the approximate downgradient extent of electron donor distribution resulting from the source area injection. At three Fox Avenue S. wells (B-20AS, B-60S, and B-61D), total CVOC concentrations were greater than the 250 µg/L remediation level in September 2015. Further monitoring in 2016 will establish if CVOC concentrations in site wells are declining following additional injection of substrate to Row 1 (R1) injection wells along Fox Avenue S. in November 2015.

5.1.2 Downgradient of the Fox Avenue Site

Wells sampled downgradient of the Site indicate that one area within Seattle Boiler Works and nearby in S. Myrtle Street has contaminant concentrations that remain at levels greater than RLs. This area was the subject of additional substrate injections in May, July, and November of 2015.

5.1.3 Seeps

Concentrations of VC have decreased significantly in two of the three seeps as compared to 2014 results and increased in one of the three seeps. VOCs were not detected in the remaining fourth seep. No other VOCs were detected at concentrations greater than site cleanup levels in any of the seep samples. Additional substrate injections were completed upgradient of this area following the May 2015 monitoring event.

5.2 2016 RECOMMENDATIONS

Recommendations include a site-wide sampling event in May of 2016 with substrate injections to follow. This sampling event should include the wells that were sampled routinely as described

below, plus approximately 20 additional selected wells including wells in the NW Corner, the Loading Dock, and within the Seattle Boiler Works property. This sampling event should be coordinated with a low tide to allow sampling of Seeps S-2, S-3, and S-3b in the Myrtle Street Embayment.

For wells in the Main Source Area and extending downgradient to Fox Avenue S., the next monitoring event will be performed in May 2016 with minor modifications to the current monitoring matrix.

Specific wells to be targeted for treatment s in 2016 will be identified after review of the data following the semi-annual groundwater sampling events planned for May and November 2016.

6.0 References

Floyd|Snider. 2013. *Construction Completion Report*. Fox Avenue Site, Seattle, Washington. Prepared for Fox Avenue Building LLC, Seattle, Washington. 3 October.

_____. 2015. *2014 Annual Report*. Fox Avenue Site, Seattle, Washington. Prepared for Fox Avenue Building LLC, Seattle, Washington. April.

Washington State Department of Ecology (Ecology). 2012. *Agreed Order No. DE 8985 in the Matter of Remedial Action by Fox Avenue Building, LLC*. 18 June.

Fox Avenue Site
Seattle, Washington

2015 Annual Report

Tables

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)	1,1,2-TCE	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	µg/L
Location	Sample ID	WBZ	Sample Date																			
Monitoring Wells																						
Fox Avenue																						
B-18	B-18-052715	1st	5/27/2015	5 U	3.76	3.6	5 U	1 U	12.3	2.72	4.45	2.58	1 U	1 U	1 U	1 U	32.8	1 U	1 U	0.5 U	136	169
B-19	B-19-052715	2nd	5/27/2015	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	94.8	1 U	1.54	0.5 U	47.9	144
	DUP-03-052715	2nd	5/27/2015	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	98.2	1 U	1.89	0.5 U	44.2	144
B-20A	B-20A-051315	1st	5/13/2015	5 U	3.61	2.06	5 U	1 U	8.34	2.51	2.8	1 U	1 U	1 U	1.59	1 U	1,410	1 U	21.2	5.23	61.5	1,500
	B-20A-092915	1st	9/29/2015	5 U	3.9	1 U	5 U	1 U	2.81	1 U	1.03	1 U	1 U	1 U	1.57	1 U	972	1 U	31.4	0.5 U	179	1,180
B-21	B-21-051315	2nd	5/13/2015	5 U	3.14	3.16	5 U	1 U	6.7	1 U	2	2.72	1 U	3.37	1 U	1 U	4.06	1 U	1 U	0.5 U	286	293
	B-21-092915	2nd	9/29/2015	5 U	5.99	2.81	5 U	1 U	6.26	1.12	2.62	3.18	1 U	4.17	1 U	1 U	1 U	1 U	1 U	0.5 U	41.4	45.6
B-58	B-58-051315	1st	5/13/2015	5 U	1.29	1 U	5 U	1 U	1.37	1 U	1 U	1 U	1 U	1 U	1 U	1 U	120	1 U	1.2	0.5 U	62	183
	B-58S-092915	1st	9/29/2015	5 U	1.37	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	78.8	1 U	1.83	1.77	50.2	133
B-59	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	1 U	0.5 U	8.01	8.01
	B-59-051315	2nd	5/13/2015	5 U	1.57	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	1 U	0.5 U	1.06	1.06
	B-59D-092915	2nd	9/29/2015	5 U	1.15	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	1 U	0.5 U	3.29	3.29
B-60	B-60-051315	1st	5/13/2015	5 U	1.52	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	2.01	1 U	648	2.11	8.33	22.6	47.6	731
	B-60S-093015	1st	9/30/2015	5 U	1.06	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	2.56	1 U	463	1 U	7.62	12.7	134	620
B-61	B-61-010915	2nd	1/9/2015	5 U	4.22	1.98	5 U	1 U	1 U	1 U	1	2.19	1 U	4.94	1 U	1 U	6.92	1 U	1 U	0.5 U	1.69	13.6
	B-61-051315	2nd	5/13/2015	5 U	5.4	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	5.96	1 U	1 U	165	1 U	1.52	0.5 U	637	809
	B-61D-093015	2nd	9/30/2015	5 U	5.95	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	4.99	1.01	1 U	463	1 U	16.1	0.82	1,100	1,590
	B-61-110415	2nd	11/4/2015																			
Main Source Area																						
MW-15D	MW-15-010815	2nd	1/8/2015	779	1 U	3.23	647	1 U	9.49	11.5	5.14	2.46	1 U	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	3.34	471	1 U	9.28	10.5	4.88	2.43	1 U	1 U	1 U	1 U	2.09	1.21	15.2	0.5 U	6,380	6,400
	MW-15D-051415	2nd	5/14/2015	616	1 U	2.97	235	1 U	11	11.7	4.14	2.13	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	23.8	23.8
	MW-15D-092915	2nd	9/29/2015	526	1 U	2.18	160	1 U	9.64	9.93	2.98	1.48	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.405	0.405
MW-16D	MW-16-010815	2nd	1/8/2015	961	1 U	57.7	1,690	1.33	17.1	29.2	19.8	3.14	1 U	1 U	4.07	1 U	2,460	1.99	74.8	8.51	4,210	6,760
	MW-16D-051315	2nd	5/13/2015	932	1 U	61.6	538	1.13 JB	15.2	24.8	18.3	2.87	1 U	1 U	1 U	1 U	2.57	1 U	1.07	0.5 U	75.8	79.4
	MW-16D-092815	2nd	9/28/2015	209	1 U	49.8	185	1 U	8.85	20.9	12.7	2.19	1 U	1 U	1 U	1 U	1.37	1 U	1 U	0.5 U	0.328	1.7
MW-17D	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	1 U	2.75	1 U	1 U	0.5 U	21.8	24.6
	MW-17-051515	2nd	5/15/2015	5 U	7.26	1 U	5 U	1 U	1.04	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1.11	1 U	1 U	0.5 U	6.01	7.12
	MW-17D-092915	2nd	9/29/2015	5 U	11.2	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	1 U	0.5 U	2.56	2.56
MW-18S	MW-18S-051415	1st	5/14/2015	14.1	1.27	2.51	5 U	1 U	12.4	1 U	2.62	1.64	1 U	1.11	1.02	1 U	82.8	1.4	1.77	0.74	123	212
	MW-18S-092815	1st	9/28/2015	5.36	1.37	2.44	5 U	1 U	27.5	1 U	4.21	1.56	1 U	1.61	1 U	1 U	48.5	3.19	1 U	1.1	66	120
Myrtle Street																						
B-33A	B-33a-052715	2nd	5/27/2015	5 U	13.2	1.33	5 U	1 UJ	1 U	1 U	1 U	1.36	1 U	8.23	1 U	1 U	1 U	1 U	1 U	0.5 U	0.66	8.89
B-64	B-64-052715	1st	5/27/2015	5 U	1.19	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	1.13	1 U	1 U	178	1.11	2.35	1.79	47.7	232
B-65	B-65-052715	2nd	5/27/2015	5 U	1.16	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	3.48	1 U	1 U	67.6	1 U	1 U	0.5 U	347	418

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)	1,1,2-TCE	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	µg/L
Location	**Sample ID**	**WBZ**	**Sample Date**																			
Monitoring Wells (Cont.)																						
Seattle Boiler Works																						
MW-03	MW-3-052715	1st	5/27/2015	5 U	5.22	1.41	5 U	1 U	1.78	1 U	1.26	2.96	1 U	2.24	1 U	1 U	89.6	1 U	1 U	2.35	100	194
	MW-3-111615	1st	11/16/2015	5 U	4.71	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	2.5	1 U	1 U	45.3	1 U	1 U	0.5 U	36.5	84.3
	DUP01-111615	1st	11/16/2015	5 U	4.69	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	2.55	1 U	1 U	44.2	1 U	1 U	0.5 U	33.8	80.6
MW-04	MW-4-052715	2nd	5/27/2015	5 U	10.6	57.5	5 U	1.62 J	1.18	3.29	8.93	18.4	1 U	11.5	1 U	1 U	1 U	1 U	1 U	0.5 U	0.9	12.4
	MW-4-111615	2nd	11/16/2015	5 U	6.69	36.4	5 U	1 U	1 U	2.81	3.78	9.64	1 U	6.36	1 U	1 U	1 U	1 U	1 U	0.5 U	14.9	21.3
Whitehead																						
B-45	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	1 U	2.04	2.73	1 U	1,870	1 U	40	2.26	3,220	5,140
	B-45-051315	2nd	5/13/2015	5 U	1.56	1.49	5 U	1 U	4.53	1 U	1.04	1 U	1 U	1 U	1.99	1 U	1,660	1 U	25.5	2.05	2,220	3,910
	B-45-093015	2nd	9/30/2015	5 U	2	1.66	5 U	1 U	4.23	1 U	1 U	1 U	1 U	1 U	1 U	1 U	49	1.38	2.74	0.53	164	218
B-49	B-49-051315	1st	5/13/2015	5 U	1 U	2.12	5 U	1 U	6.67	1 U	1.5	1.2	1 U	1 U	1.23	1 U	375	11.7	2.39	8.32	460	859
	B-49-093015	1st	9/30/2015	20	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	132	17.4	2.33	17	35.2	204
MW-09	MW-9-051515	1st	5/15/2015	5 U	5.22	1 U	5 U	1 U	12.4	1 U	1.64	1 U	2.21	1 U	1.33	1 U	566	114	6.24	35.1	412	1,140
	MW-9-093015	1st	9/30/2015	5 U	4.6	1 U	5 U	1 U	7.48	1 U	1 U	1 U	1 U	1 U	1.82	1 U	856	130	19.4	84.1	160	1,250
MW-10	MW-10-010915	2nd	1/9/2015	5 U	3.57	42.2	5 U	6.47	81.8	39.2	49	16.6	1 U	1 U	2.56	1 U	4,190	5.03	17.3	1.21	1,440	5,660
	MW-10-051515	2nd	5/15/2015	5 U	2.74	17.2	5 U	3.79 JB	33.8	18.2	17.3	6.54	1 U	1 U	1.06	1 U	1,560	2.89	1.17	0.5 U	469	2,030
	DUP-1-051515	2nd	5/15/2015	5 U	2.95	16.9	5 U	3.82 JB	35.5	17	16.8	6.61	1 U	1 U	1.15	1 U	1,740	2.73	1.16	0.5 U	529	2,270
	MW-10-093015	2nd	9/30/2015	5 U	2.12	5.02	24	2.4	10	7.46	6.51	2.69	1 U	1 U	1 U	1 U	131	1.57	1 U	0.5 U	782	915
	DUP-1-093015	2nd	9/30/2015	5 U	2.14	5.42	5 U	2.18	9.87	7.93	6.79	2.54	1 U	1 U	1 U	1 U	126	1.33	1 U	0.5 U	742	869
Injection Wells																						
Fox Avenue																						
R1-IW2	R1-IW2-60-051815	2nd	5/18/2015	5 U	1 U	1 U	5 U	1 U	19.5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.86	0.86
R1-IW3A	R1-IW3A-12-051815	1st	5/18/2015	5 U	1 U	1 U	5 U	1 U	1.04	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1.33	3.8	5.13
R1-IW4A	R1-IW4A-11-051815	1st	5/18/2015	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	32.4	1 U	1 U	1.92	51.9	86.2
	DUP01-051815	1st	5/18/2015	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	32.4	1 U	1 U	2.02	46.8	81.2
R1-IW4B	R1-IW4B-50-051815	2nd	5/18/2015	5 U	1 U	1.7	5 U	1 U	1.47	1 U	1.03	1 U	1 U	1 U	1 U	1 U	1.11	1 U	1 U	0.5 U	19.3	20.4
R1-IW5	R1-IW5-60-110415	2nd	11/4/2015	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	1 U	0.5 U	1.51	1.51
	Dup01-110415	2nd	11/4/2015	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	1 U	0.5 U	1.41	1.41
R1-IW7	R1-IW7-60-110415	2nd	11/4/2015	5 U	1.37	1.93	5 U	1 U	1 U	1.65	1.01	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	7.6	7.6
R1-IW17	R1-IW17-12-051815	1st	5/18/2015	5 U	1.56	7.95	5 U	2.45	6.61	1 U	1 U	2.37	1 U	1 U	1 U	1 U	1.98	1 U	1 U	0.5 U	32.2	34.2
	R1-IW17-55-051815	2nd	5/18/2015	5 U	1 U	3.88	5 U	1.83	1.1	2.05	1.51	1.02	1 U	1 U	1 U	1 U	2.59	1 U	1 U	0.5 U	16.3	18.9
Main Source Area																						
R0-IW2D	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	1 U	13.1	1 U	1 U	0.63	7.41	21.1
	R0-IW2D-051415	2nd	5/14/2015	188	1 U	1 U	285	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	35.4	1 U	1 U	1.02	92.8	129
	R0-IW2D-092915	2nd	9/29/2015	147	1 U	1 U	265	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	64.2	1 U	1.01	0.87	69.8	136
R0-IW6D	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	1 U	10	1 U	1 U	1.28	15.3	26.6
	R0-IW6D-051415	2nd	5/14/2015	558	50 U	50 U	250 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	96	50 U	50 U	32.5	45	174
R0-IW9S	R0-IW9S-051315	1st	5/13/2015	31,100	1 U	1 U	4,030	1 U	2.26	1 U	1 U	1 U	1 U	1 U	1 U	1 U	88.8	1 U	1 U	0.66	16.6	106
	R0-IW9S-092815	1st	9/28/2015	11.5	1 U	1 U	5 U	1 U	2.12	1 U	1 U	1 U	1 U	1 U	1 U	1 U	11	1 U	1 U	0.5 U	2.71	13.7

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)	1,1,2-TCE	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	µg/L
Location	**Sample ID**	**WBZ**	**Sample Date**																			
Injection Wells (Cont.)																						
Myrtle Street																						
R2-IW3	R2-IW3-30-052715	2nd	5/27/2015	93.3	8.93	12.8	1,300	1 U	3.29	1 U	2.48	4.46	1 U	5.1	1 U	1 U	9.19	1 U	1 U	0.5 U	80	94.3
R2-IW4	R2-IW4-45-052715	2nd	5/27/2015	193	3.09	2.14	313	1 U	14.4	1 U	1 U	1 U	1 U	1.67	1 U	1 U	2.87	1 U	1 U	0.5 U	1.25	5.79
Seattle Boiler Works																						
R2-IW1	R2-IW1-17-051915	1st	5/19/2015	5 U	2.07	1 U	5 U	1 U	46.9	1 U	1 U	1 U	1 U	1.51	1 U	1 U	154	1 U	1 U	0.5 U	416	572
	R2-IW1-45-051915	2nd	5/19/2015	5 U	2.15	1 U	5 U	1 U	97	1 U	1 U	1 U	1 U	1.73	1 U	1 U	216	1 U	1 U	0.5 U	582	800
R2-IW2	R2-IW2-17-051915	1st	5/19/2015	5 U	1 U	1 U	9.16	1 U	15.2	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.96	0.96
	R2-IW2-45-051915	2nd	5/19/2015	5 U	1 U	1 U	5 U	1 U	28.8	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	2.03	2.03
R2-IW8	R2-IW8-63-051915	2nd	5/19/2015	5 U	2.47	5.38	5 U	1 U	1 U	1 U	1.34	1.38	1 U	2.59	1 U	1 U	2.24	1 U	1 U	0.5 U	8.98	13.8
	DUP02-051915	2nd	5/19/2015	5 U	2.37	5.56	5 U	1 U	1 U	1 U	1.3	1.32	1 U	2.52	1 U	1 U	2.19	1 U	1 U	0.5 U	8.61	13.3
R2-IW11	R2-IW11-12-052615	1st	5/26/2015	5 U	1 U	1 U	6.09	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	8.46	1 U	1 U	0.5 U	13.9	22.4
Seep Data																						
S-2	SP-02-051815		5/18/2015	5 U	1.25	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	1.51	1 U	1 U	4	1 U	1 U	0.5 U	30.9	36.4
S-13 (Calibre S-3)	SP-03-051518		5/18/2015	5 U	5.24	1 U	5 U	1.8	1 U	1 U	1 U	1 U	1 U	4.23	1 U	1 U	9.64	1 U	1 U	0.67	7.49	22
S-3b	SP-03B-051815		5/18/2015	5 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	1.01	1 U	2.95	279	9.67	17.4	6.74	72.8	390
S-16 (Calibre S-4)	SP-04-051815		5/18/2015	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	1 U	0.5 U	0.2 U	1 U

Note:

Blank cells indicate analyte was not analyzed for the sample.

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, concentration is estimated.
JB Analyte is detected, concentration is estimated due to potential blank contamination.
U Analyte is not detected at the associated reporting limit.
UJ Analyte is not detected at the associated reporting limit which is estimated.

Table 3.2
Summary of Performance Parameters 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-18-052715	1st	5/27/2015								
B-19	B-19-052715	2nd	5/27/2015								
	DUP-03-052715	2nd	5/27/2015								
B-20A	B-20A-051315	1st	5/13/2015	39.9	25.9	0.5 U				6,940	7,510
	B-20A-092915	1st	9/29/2015	31.5	21.3	0.5 U				7,810	8,210
B-21	B-21-051315	2nd	5/13/2015	21.3	1.5 U	4.8				22,700	46,000
	B-21-092915	2nd	9/29/2015	12.3	20.1	1 U	0.0771	0.0775	2.69	21,800	30,100
B-58	B-58-051315	1st	5/13/2015	27.4	24.5	0.5 U				17,100	16,300
	B-58S-092915	1st	9/29/2015	18	63.4	0.5 U				10,900	12,900
B-59	B-59-010915	2nd	1/9/2015	29.7	53.9	0.5 U				110,000	120,000
	B-59-051315	2nd	5/13/2015	15.9	39.5	0.5 U				39,900	39,400
	B-59D-092915	2nd	9/29/2015	5.25	97.3	0.5 U	0.0276	0.0201	3.4	174,000	183,000
B-60	B-60-051315	1st	5/13/2015	16.4	19.5	0.5 U				9,000	8,800
	B-60S-093015	1st	9/30/2015	8.84	16.1	0.5 U				10,400	12,100
B-61	B-61-010915	2nd	1/9/2015	21.9	3 U	0.8				40,300	37,700
	B-61-051315	2nd	5/13/2015	13.4	39.5	0.5 U				38,300	38,800
	B-61D-093015	2nd	9/30/2015	6.45	111	0.5 U	0.0715	0.0475	3.24	40,500	45,000
	B-61-110415	2nd	11/4/2015		154						
Main Source Area											
MW-15D	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-15D-051415	2nd	5/14/2015	222	60 U	6.8				16,800	17,600
	MW-15D-092915	2nd	9/29/2015	157	1.05 JQ	0.5 U	0.0667	0.0568	4.75	16,400	15,100
MW-16D	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-16D-051315	2nd	5/13/2015	472	60 U	0.5 U				35,300	74,200
	MW-16D-092815	2nd	9/28/2015	37.3	1.14 JQ	0.5 U	0.0518	0.0379	2.72	67,600	73,900
MW-17D	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-17-051515	2nd	5/15/2015	21	1.5 U	1.6				2,190	1,860
	MW-17D-092915	2nd	9/29/2015	10.9	0.908 JQ	0.5 U	0.0244	0.005 U	3.72	1,900	2,250
MW-18S	MW-18S-051415	1st	5/14/2015	154	158	3.6				1,510	1,450
	MW-18S-092815	1st	9/28/2015	125	361	0.5	0.0258	0.0256	2.51	3,330	3,530
Myrtle Street											
B-33A	B-33a-052715	2nd	5/27/2015								
B-64	B-64-052715	1st	5/27/2015								
B-65	B-65-052715	2nd	5/27/2015								

Table 3.2
Summary of Performance Parameters 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 (Cont.)											
Seattle Boiler Works											
MW-03	MW-3-052715	1st	5/27/2015								
	MW-3-111615	1st	11/16/2015		13.2						
	DUP01-111615	1st	11/16/2015								
MW-04	MW-4-052715	2nd	5/27/2015								
	MW-4-111615	2nd	11/16/2015		0.3 U						
Whitehead											
B-45	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-45-051315	2nd	5/13/2015	5.43	2.21	0.5 U				11,400	12,700
	B-45-093015	2nd	9/30/2015	3.87	2.97	0.5 U	0.137	0.0752	3.23	21,600	23,900
B-49	B-49-051315	1st	5/13/2015	7.23	8.17	0.5 U				9,930	10,800
	B-49-093015	1st	9/30/2015	12	40.5	0.5 U	0.0239	0.024	0.852	7,230	7,400
MW-09	MW-9-051515	1st	5/15/2015	43.1	41.8	0.5 U				7,010	6,830
	MW-9-093015	1st	9/30/2015	22.7	23.6	0.5 U	0.0254	0.0347	1.83	7,350	9,030
MW-10	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-10-051515	2nd	5/15/2015	21	1.5 U	0.5 U				10,700	10,800
	DUP-1-051515	2nd	5/15/2015	19.8	1.5 U	0.5 U				10,800	10,900
	MW-10-093015	2nd	9/30/2015	9.48	1.52	0.5 U	0.0258	0.0383	2.03	11,600	12,400
	DUP-1-093015	2nd	9/30/2015	9.79	1.51	0.5 U	0.0262	0.0401	2.41	11,100	12,000
Injection Wells											
Fox Avenue											
R1-IW2	R1-IW2-60-051815	2nd	5/18/2015	22							
R1-IW3A	R1-IW3A-12-051815	1st	5/18/2015								
R1-IW4A	R1-IW4A-11-051815	1st	5/18/2015	59.2			0.005 U	0.005 U	0.858		
	DUP01-051815	1st	5/18/2015								
R1-IW4B	R1-IW4B-50-051815	2nd	5/18/2015	15.6							
R1-IW5	R1-IW5-60-110415	2nd	11/4/2015		22.3						
	Dup01-110415	2nd	11/4/2015								
R1-IW7	R1-IW7-60-110415	2nd	11/4/2015		0.6 U						
R1-IW17	R1-IW17-12-051815	1st	5/18/2015	13.4			0.005 U	0.005 U	1.39		
	R1-IW17-55-051815	2nd	5/18/2015	9.48							
Main Source Area											
R0-IW2D	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-IW2D-051415	2nd	5/14/2015	2,500	162	2.4				650,000	642,000
	R0-IW2D-092915	2nd	9/29/2015	2,720	241	0.5 U	0.0243	0.0288	2.33	870,000	823,000
R0-IW6D	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-IW6D-051415	2nd	5/14/2015	5,070	974	16.8				1,030,000	849,000
R0-IW9S	R0-IW9S-051315	1st	5/13/2015	23.3	1,550	24.8				1,270,000	1,120,000
	R0-IW9S-092815	1st	9/28/2015	75.6	2.83	0.5 U	0.0223	0.0208	2.09	87,300	101,000

Table 3.2
Summary of Performance Parameters 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								
Injection Wells											
Myrtle Street											
R2-IW3	R2-IW3-30-052715	2nd	5/27/2015								
R2-IW4	R2-IW4-45-052715	2nd	5/27/2015								
Seattle Boiler Works											
R2-IW1	R2-IW1-17-051915	1st	5/19/2015								
	R2-IW1-45-051915	2nd	5/19/2015								
R2-IW2	R2-IW2-17-051915	1st	5/19/2015								
	R2-IW2-45-051915	2nd	5/19/2015								
R2-IW8	R2-IW8-63-051915	2nd	5/19/2015	12.4			0.0304	0.005 U	2.12		
	DUP02-051915	2nd	5/19/2015								
R2-IW11	R2-IW11-12-052615	1st	5/26/2015	15.9							
Seep Data											
S-2	SP-02-051815		5/18/2015								
S-13 (Calibre S-3)	SP-03-051518		5/18/2015								
S-3b	SP-03B-051815		5/18/2015								
S-16 (Calibre S-4)	SP-04-051815		5/18/2015								

Note:
Blank cells indicate analyte was not analyzed for the sample.

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

Qualifiers:
JQ Analyte is detected between the method detection limit and method reporting limit, the concentration is estimated.
U Analyte is not detected at the associated reporting limit.

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 (d)						
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		9.6	0.00	0.07	0.92	0.01		1.00	0.92
RO-IW02D	2/25/2014	-146	2808	649	1,000	1,090	68.7						2.0			38.9			6.45				25.6		3.9	7.6	11	1.1		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		0.12	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, no sheen, well under very high pressure, water meter collected orange particulate and oil, effervescent	0.00	0.00	0.00	0.01		0.01	0.00	0.00	0.00	1.00		1.00	1.00
	1/8/2015	171	21	<1	0.63	13.1	7.41	<5	<5	ND	6.64		5.6	566	542	178	<0.5	0.432	2,180	139	174	4.79	19.5	Light orange, low-med turbidity, vomit like odor, no sheen, effervescent	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
	5/14/2015	297	129	<1	1.02	35.4	92.8				1.82	-96.0	5.0	642	650	162	2.40		2,500	188	285	9.77	15.1	Slightly turbid, colorless, no sheen, organic odor, slight effervescence	0.00	0.01	0.37	1.48		1.86	0.00	0.00	0.20	0.80		1.00	0.80
	9/29/2015	435	135	<1	0.87	64.2	69.8	28.8	24.3	<5	0.61	-28.4	5.6	823	870	241	<0.5	2.33	2,720	147	265	4.50	15.3	Clear, colorless, no sheen, strong vomit-like odor, effervescent	0.00	0.01	0.66	1.12	1.97	1.79	0.00	0.00	0.18	0.30	0.52	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		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		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		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		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		0.64	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		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		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	1,390	1,480	1,360	<0.5		26.7	1,130	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		0.13	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	2,810	332	218	4.83	26.1	Orange, low-med turbidity, vomit like odor, no sheen, 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
	5/14/2015	297	173.5	<50	32.5	96	45						0.8	849	1,030	974	16.8		5,070	558	<250			Orange, oily, organic, vomit-like odor, no sheen	0.00	0.25	0.99	0.72		1.96	0.00	0.13	0.51	0.37		1.00	0.51
	9/28/2015																						21.6	Orange, oily, vomit-like odor, no sheen; oil content too high for lab to analyze as a water sample													
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		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		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		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	1,090	373						1.4			2.5			6.98				41.7		0.00	0.02	11	6.0		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		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
	5/13/2015	105	106	<1	0.66	88.8	16.6				1.85	-76.9	3.8	1,120	1,270	1,550	24.8		23.3	31,100	4,030	5.45	21.8	Clear, grayish color, organic decaying odor, no sheen, very effervescent	0.00	0.01	0.9	0.27		1.19	0.00	0.00	0.77	0.22		1.00	0.77
	9/28/2015	243	14	<1	<0.5	11	2.71	20.8	22.3	<5	0.10	-62.0	3.4	101	87.3	2.83	<0.5	2.09	75.6	11.5	<5	6.90	25.2	Turbid, vomit-like odor, no sheen, slightly effervescent	0.00	0.00	0.1	0.04	1.59	0.16	0.00	0.00	0.06	0.02	0.91	1.00	0.91
RO-IW09D	2/26/2014	-145	2593	<1.01	<0.500	363	2,230						1.8			2.9			33.9				27.8		0.00	0.00	3.7	36		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		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	1,760						1.6			1.2			7.43				31.1		0.00	0.00	1.7	28		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		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		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
	5/15/2015	107	1127	114	35.1	566	412				0.09	-233.3	2.0	6.83	7.01	41.8	<0.5		43.1	<5	<5	6.65	30.3	Clear, colorless, no sheen, organic decay odor, effervescent	0.69	0.3	6	6.59		13	0.05	0.02	0.44	0.49		1.00	0.49
	9/30/2015	245	1230	130	84.1	856	160	34.7	25.4	<5	0.67	-15.9	4.0	9.03	7.35	23.6	<0.5	1.83	22.7	<5	<5	7.02	30.1	Clear, yellowish, no sheen, slight diesel-like odor	0.78	0.6	9	2.56	2.24	13	0.05	0.04	0.59	0.17	0.15	1.00	0.59
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	6,670	1,630				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, no sheen, effervescent	0.03	0.02	69	26		95	0.00	0.00	0.72	0.27		1.00	0.72
	1/9/2015	172	5636	5.03	1.21	4,190	1,440	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
	5/15/2015	298	2032	2.89	<0.5	1,560	469				0.15	-188.4	4.2	10.8	10.7	<1.5	<0.5		21	<5	<5	6.41	37.1	Slightly turbid, colorless, no sheen, rotten egg-like odor	0.02	0.00	16	8		24	0.00	0.00	0.68	0.32		1.00	0.68
	9/30/2015	436	915	1.57	<0.5	131	782	38.3	25.8	<5	0.12	-85.4	4.8	12.4	11.6	1.52	<0.5	2.03	9.48	<5	24	6.18	29.6	Clear, colorless, no sheen, slight diesel-like odor, slight effervescence	0.01	0.00	1	13	2.4	14	0.00	0.00	0.08	0.77	0.15	1.00	0.77
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, no sheen, effervescent	0.01	0.00	0.00	15		15	0.00	0.00	0.00	1.00		1.00	1.00

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 (d)						
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
	1/8/2015	171	6514	1.24	<0.5	2.64	6,510	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, no sheen, effervescent	0.01	0.00	0.03	104	34	104	0.00	0.00	0.00	0.75	0.25	1.00	0.75
	5/14/2015	297	24	<1	<0.5	<1	23.8				1.68	-118.3	1.8	17.6	16.8	<60	6.8		222	616	235	9.16	18.3	Slightly turbid, yellow, no sheen, very effervescent, organic odor	0.00	0.00	0.00	0		0	0.00	0.00	0.00	1.00		1.00	1.00
	9/29/2015	435	0.405	<1	<0.5	<1	0.405	56.8	66.7	<5	0.95	-169.3	2.6	15.1	16.4	1.05	<0.5	4.75	157	526	160	6.91	15.3	Lightly turbid, colorless at first then turned yellow and black (preservative dependent), no sheen, slight diesel-like odor, very effervescent	0.00	0.00	0.00	0	5	0	0.00	0.00	0.00	0.0014	1.00	1.00	1.00
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	1,660	1,080				0.66	-186.7	4.0	76	80.5	102	2.5		16	1,750	<5	5.96	30.2	Pumped out clear but turned gray over time, low-medium turbidity, egg odor, no sheen, effervescent	0.01	0.06	17	17		34	0.00	0.00	0.50	0.50		1.00	0.50
	1/8/2015	171	6681	1.99	8.51	2,460	4,210	71.6	<5	ND	2.17	-122.0		138	107	31	0.800	0.702	1,010	961	1,690	5.98	28.3	Clear, low, slight vomit odor, no sheen	0.01	0.06	25	67	2.8	93	0.00	0.00	0.27	0.70	0.03	1.00	0.70
	5/13/2015	296	78	<1	<0.5	2.57	75.8				0.12	-173.3	2.4	74.2	35.3	<60	<0.5		472	932	538	6.74	25.7	Clear, colorless, no sheen, decaying organic odor, very effervescent	0.00	0.00	0	1		1.2	0.00	0.00	0.02	0.98		1.00	0.98
	9/28/2015	434	1.7	<1	<0.5	1.37	0.328	37.9	51.8	<5	0.09	-21.5	3.6	73.9	67.6	1.14	<0.5	2.72	37.3	209	185	6.7	23.6	Clear, colorless, no sheen, slight organic odor, no sheen, slightly effervescent	0.00	0.00	0	0	3.3	0.0	0.00	0.00	0.004	0.002	0.99	1.00	0.99
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, no sheen, effervescent	0.00	0.00	0.04	0.28		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
	5/15/2015	298	7	<1	<0.5	1.11	6.01				0.08	-229.1	2.4	1.86	2.19	<1.5	1.60		21	<5	<5	7.03	31.1	Slightly turbid, yellow, no sheen, effervescent, organic odor	0.00	0.00	0.01	0.10		0.11	0.00	0.00	0.11	0.89		1.00	0.89
	9/29/2015	435	2.56	<1	<0.5	<1	2.56	<5	24.4	<5	0.28	-138.2	1.8	2.25	1.90	0.908	<0.5	3.72	10.9	<5	<5	6.97	29.3	Slightly turbid, colorless to yellow in air, no sheen, slight egg-like odor, slight effervescence	0.00	0.00	0.00	0.04	0.87	0.04	0.00	0.00	0.00	0.04	0.96	1.00	0.96
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	1,870	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		20	0.01	0.01	0.95	0.03		1.00	0.95
	5/14/2015	106	208	1.4	0.74	82.8	123				0.16	-203.3	1.2	1.45	1.51	158	3.60		154	14.1	<5	5.96	28.7	Clear, slightly yellow, effervescent, organic odor, no sheen	0.01	0.01	1	1.97		3	0.00	0.00	0.30	0.69		1.00	0.69
	9/28/2015	243	119	3.19	1.1	48.5	66	25.6	25.8	<5	0.07	-28.4	3.0	3.53	3.33	361	<0.5	2.51	125	5.36	<5	7.20	25.5	Clear, yellowish, slight diesel-like odor, no sheen, slightly effervescent	0.02	0.01	1	1.06	1.90	2	0.01	0.00	0.14	0.30	0.55	1.00	0.55
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
	5/13/2015	105	1477	<1	5.23	1,410	61.5				0.08	-208.7	2.8	7.51	6.94	25.9	<0.5		39.9	<5	<5	6.86	30.7	Clear, slightly yellow, no sheen, petroleum-like odor	0.00	0.04	15	1.0		16	0.00	0.00	0.93	0.06		1.00	0.93
	9/29/2015	244	1151	<1	<0.5	972	179				0.05	-56.8	3.0	8.21	7.81	21.3	<0.5		31.5	<5	<5	6.88	32.4	Clear, colorless, no sheen, slight diesel-like odor	0.00	0.00	10	2.9		13	0.00	0.00	0.78	0.22		1.00	0.78
B-21D	6/20/2014	-31	3.2	<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	0.97
	5/13/2015	296	290	<1	<0.5	4.06	286				0.53	-111.4	3.0	46	22.7	<1.5	4.8		21.3	<5	<5	6.49	30.9	Clear, turned dark gray, moderate turbidity, pungent, unbearable smell, no sheen	0.00	0.00	0.04	4.58		4.62	0.00	0.00	0.01	0.99		1.00	0.99
	9/29/2015	435	41	<1	<0.5	<1	41.4	77.5	77.1	<5	0.21	-117.4	3.4	30.1	21.8	20.1	<1	2.69	12.3	<5	<5	6.24	32.1	Clear, yellow to gray in oxygen, effervescent, black floating solids, no sheen, diesel-like odor	0.00	0.00	0.00	0.66	5.7	0.66	0.00	0.00	0.00	0.10	0.90	1.00	0.90
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	7,270	10,700				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, no sheen, effervescent	0.01	0.02	75	171		246	0.00	0.00	0.30	0.70		1.00	0.70
	1/9/2015	172	5092	<1	2.26	1,870	3,220	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, no sheen	0.00	0.02	19	52	16	71	0.00	0.00	0.22	0.59	0.18	1.00	0.59
	5/13/2015	296	3882	<1	2.05	1,660	2,220				0.34	-142.4	2.4	12.7	11.4	2.21	<0.5		5.43	<5	<5	6.8	28.6	Clear, colorless, no sheen, petroleum-like odor	0.00	0.02	17	36		53	0.00	0.00	0.33	0.67		1.00	0.67
	9/30/2015	436	215	1.38	0.53	49	164	75.2	137	<5	0.14	-118.5	3.6	23.9	21.6	2.97	<0.5	3.23	3.87	<5	<5	6.38	27.2	Clear, colorless, no sheen, very slight diesel-like odor, slight effervescence	0.01	0.00	1	3	8	3	0.00	0.00	0.05	0.24	0.71	1.00	0.71
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	1,170	17.2				0.26	-180.3								<5	<5	6.72	35.5	Clear, low turb, egg odor, no sheen, effervescent	0.08	0.20	12	0.28	0.00	13	0.01	0.02	0.96	0.02	0.00	1.00	0.96
	5/13/2015	105	855	11.7	8.32	375	460				1.39	-115.1	0.6	10.8	9.93	8.17	<0.5		7.23	<5	<5	6.7	22.5	Clear, low turbidity, fermented sugar water odor, no sheen	0.07	0.06	4	7.36		11	0.01	0.01	0.34	0.65		1.00	0.65
	9/30/2015	245	202	17.4	17	132	35.2	24	23.9	<5	0.65	1.6	5.4	7.4	7.23	40.5	<0.5	0.852	12	20	<5	7.14	26.2	Clear, colorless, no sheen, diesel-like odor	0.10	0.13	1	0.56	1.77	2	0.03	0.03	0.35	0.14	0.45	1.00	0.45
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
	5/13/2015	105	182	<1	<0.5	120	62				0.42	-182.1	2.4	16.3	17.1	24.5	<0.5		27.4	<5	<5	7.23	19.2	Clear, slightly yellow, no odor, no sheen	0.00	0.00	1.2	1.0		2.2	0.00	0.00	0.56	0.44		1.00	0.56
	9/29/2015	244	131	<1	1.77	78.8	50.2				0.10	-55.9	1.4	12.9	10.9	63.4	<0.5		18	<5	<5	6.80	23.2	Slightly turbid and yellow, no sheen, slight diesel-like odor	0.00	0.01	0.8	0.8		1.6	0.00	0.01	0.50	0.49		1.00	0.50
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, no sheen, 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	8.0	<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, no sheen	0.00	0.00	0.00	0.13		0.13	0.00	0.00	0.00	1.00		1.00	1.00
	5/13/2015	296	1.1	<1	<0.5	<1	1.06				1.54	-83.3	2.4	39.4	39.9	39.5	<0.5		15.9	<5	<5	6.17	21.1	Clear, colorless, rotten egg-like odor, no sheen, effervescent	0.00	0.00	0.00	0.02		0.02	0.00	0.00	0.00	1.00		1.00	1.00
	9/29/2015	435	3.3	<1	<0.5	<1	3.29	20.1	27.6	<5	0.48	-91.2	3.6	183	174	97.3	<0.5	3.4	5.25	<5	<5	5.76	22.7	Clear, colorless, no sheen, slight diesel-like odor, slightly effervescent	0.00	0.00	0.00	0.05	1.76	0.05	0.00	0.00	0.00	0.03	0.97	1.00	0.97
B-60S	5/15/2014	-258	1556	<1	3.51	1,500	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								
	5/13/2015	105	720	2.11	22.6	648	47.6				0.85	-91.3	1.8	8.8	9	19.5	<0.5		16.4	<5	<5	6.70	23.3	Clear, very slight yellow, petroleum-like odor, no sheen, effervescent	0.01	0.17	7	0.76		8	0.00	0.02	0.88	0.10		1.00	0.88
	9/30/2015	245	610	<1	12.7	463	134				0.57	-12.3	2.0	12.1	10.4	16.1	<0.5		8.84	<5	<5	7.24	25.6	Clear, colorless, no sheen, strong diesel-like odor	0.00	0.10	5	2.14		7	0.00	0.01	0.68	0.31		1.00	0.68
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		0.44	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, no sheen, effervescent	0.00	0.00	0.10	0.04		0.14	0.00	0.00	0.69	0.31		1.00	0.69

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 (d)						
		Elapsed Time	Sum																																		
		From Injection	cVOCs (c)	PCE	TCE	cDCE	VC	Ethene	Ethane	Acetylene	DO	ORP	Iron II	Iron (T)	Iron (D)	Sulfate	Sulfide	Methane	TOC	Acetone	MEK	pH	Temp		PCE	TCE	cDCE	VC	Ethene/ Ethane	Total Chloroethenes (d)	PCE	TCE	cDCE	VC	Ethene/ Ethane		
		(days) (a)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(mg/L)	(mV)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(µg/L)	(µg/L)		(deg C)															
Well	Date																							Comments													Max
	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, no sheen	0.00	0.00	0.07	0.03		0.10	0.00	0.00	0.73	0.27		1.00	0.73
	5/13/2015	296	802	<1	<0.5	165	637				0.13	-143.5	2.6	38.8	38.3	39.5	<0.5		13.4	<5	<5	6.39	27.6	Clear, low turbidity, vomit-like odor, no sheen	0.00	0.00	1.70	10.19		11.89	0.00	0.00	0.14	0.86		1.00	0.86
	9/30/2015	436	1564	<1	0.82	463	1,100	47.5	71.5	<5	0.23	-90.9	5.0	45.0	40.5	111	<0.5	3.24	6.45	<5	<5	6.09	26.2	Clear, colorless, very slight diesel-like odor, no sheen	0.00	0.01	4.78	17.60	4.37	22.38	0.00	0.00	0.18	0.66	0.16	1.00	0.66

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

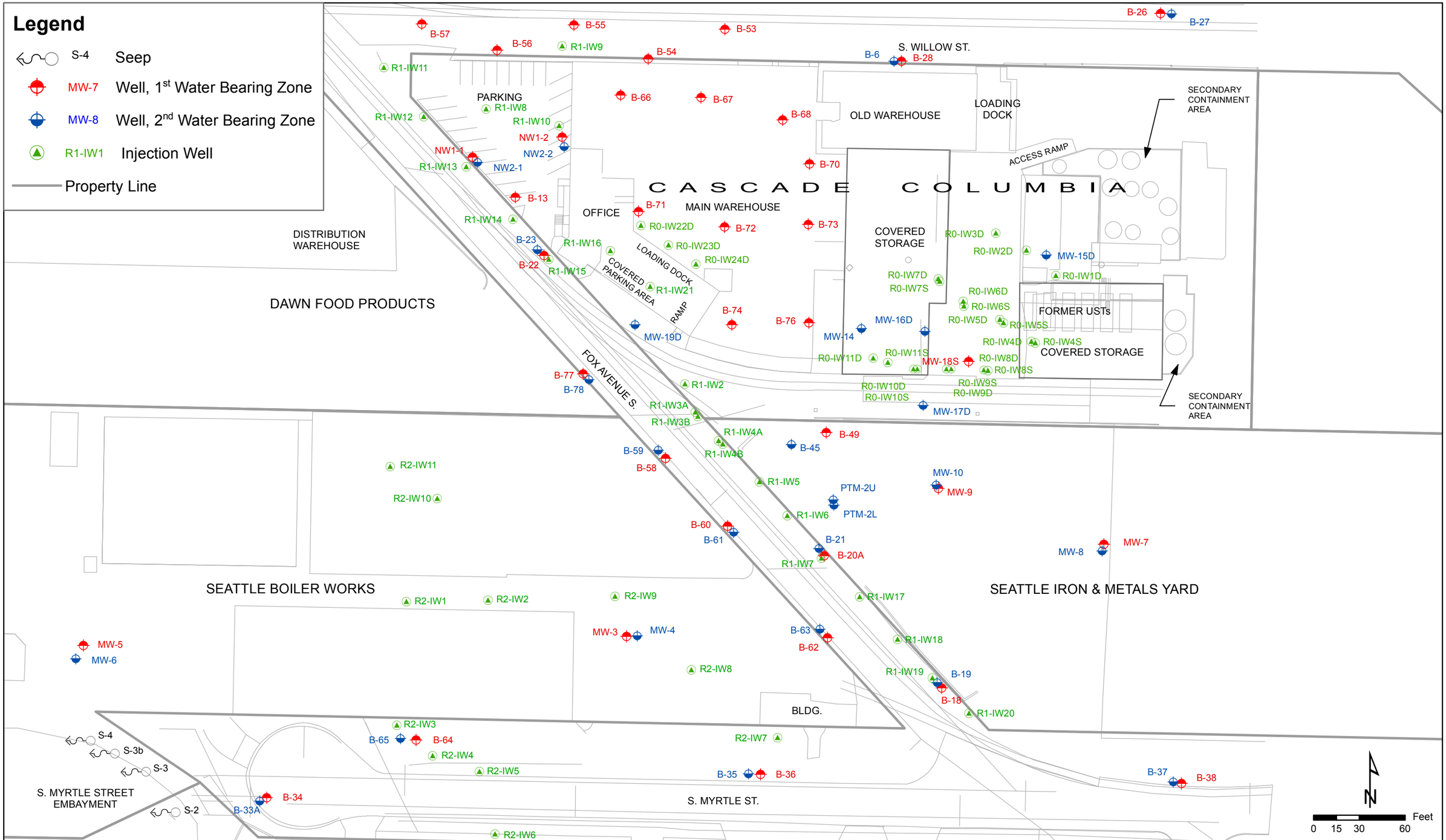
(a) Elapsed time for shallow and deep wells is relative to the January 2015 WBZ#1 source area injection and the July 2014 WBZ#2 source area injection, respectively.
(b) Calculated by dividing the concentration in groundwater by the molecular weight of the compound. Reporting limits for non-detect results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

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

Fox Avenue Site
Seattle, Washington

2015 Annual Report

Figures



FLOYD | SNIDER
strategy ▪ science ▪ engineering

2015 Annual Report
Fox Avenue Site
Seattle, Washington

Figure 1.1
Site Plan

I:\GIS\Projects\FOXAVE-RA\MXD\2015 Annual Report\Figure 1.1 Site Plan.mxd
3/1/2016

Legend

Conc. in µg/L

- 0-1
- 1.01-10
- 10.01-100
- 100.01-1,000
- 1,000.01-10,000
- Property Line

Notes:
- Thermal treatment period from January–May 2013.
- Total CVOCs include tetrachlorethene (PCE), trichloroethene (TCE), vinyl chloride (VC), and cis-1,2-dichloroethene (cis-DCE).

Abbreviations:
- CVOC = Chlorinated volatile organic compound
- µg/L = Micrograms per liter
- UST = Underground Storage Tank

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

N

0 50 100

Scale in Feet

S. WILLOW ST.

PARKING

OLD WAREHOUSE

LOADING DOCK

SECONDARY CONTAINMENT AREA

ACCESS RAMP

C A S C A D E C O L U M B I A

MAIN WAREHOUSE

OFFICE

COVERED STORAGE

DISTRIBUTION WAREHOUSE

LOADING DOCK

COVERED PARKING AREA

RAMP

DAWN FOOD PRODUCTS

FORMER USTs

COVERED STORAGE

R0-IW9S
1.00 U

MW-18S
4.29

FOX AVENUE S.

R1-IW3A
1.33

R1-IW4A
2.02

B-49
34.4

B-58
1.77

R2-IW11
1.00 U

MW-09
214

B-60
12.7

B-20A
1.00 U

R1-IW17
1.00 U

SEATTLE BOILER WORKS

R2-IW1
1.00 U

R2-IW2
1.00 U

MW-03
1.00 U

SEATTLE IRON & METALS YARD

B-18
1.00 U

BLDG.

B-64
2.90

S. MYRTLE STREET EMBAYMENT

S. MYRTLE ST.

FLOYD | SNIDER

strategy ▪ science ▪ engineering

2015 Annual Report
Fox Avenue Site
Seattle, Washington

Figure 4.1
PCE + TCE Concentrations in Groundwater
1st Water Bearing Zone

File: I:\GIS\Projects\FOXAVE-RA\MXD\2015 Annual Report\Figure 4.1 PCE_TCE WBZ1.mxd
Date: 3/1/2016

Legend

Conc. in µg/L

- 0-1
- 1.01-10
- 10.01-100
- 100.01-1,000
- 1,000.01-10,000
- Property Line

Notes:
- Thermal treatment period from January–May 2013.
- Total CVOCs include tetrachlorethene (PCE), trichloroethene (TCE), vinyl chloride (VC), and cis-1,2-dichloroethene (cis-DCE).

Abbreviations:
- CVOC = Chlorinated volatile organic compound
- µg/L = Micrograms per liter
- UST = Underground Storage Tank

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

N

0 50 100

Scale in Feet

S. WILLOW ST.

PARKING

OLD WAREHOUSE

LOADING DOCK

SECONDARY CONTAINMENT AREA

ACCESS RAMP

C A S C A D E C O L U M B I A

MAIN WAREHOUSE

OFFICE

DISTRIBUTION WAREHOUSE

COVERED STORAGE

R0-IW2D 0.870

MW-15D 1.00 U

LOADING DOCK

COVERED PARKING AREA

RAMP

R0-IW6D 32.5

DAWN FOOD PRODUCTS

MW-16D 1.00 U

FORMER USTs

COVERED STORAGE

FOX AVENUE S.

R1-IW2 1.00 U

MW-17D 1.00 U

SECONDARY CONTAINMENT AREA

B-59 1.00 U

R1-IW4B 1.00 U

B-45 1.91

R1-IW5 1.00 U

MW-10 1.57

B-61 0.820

B-21 1.00 U

R1-IW7 1.00 U

R1-IW17 1.00 U

SEATTLE BOILER WORKS

R2-IW1 1.00 U

R2-IW2 1.00 U

SEATTLE IRON & METALS YARD

MW-04 1.00 U

R2-IW8 1.00 U

B-19 1.00 U

BLDG.

R2-IW3 1.00 U

B-65 1.00 U

R2-IW4 1.00 U

S. MYRTLE STREET EMBAYMENT

B-33A 1.00 U

S. MYRTLE ST.

FLOYD | SNIDER

strategy ▪ science ▪ engineering

2015 Annual Report
Fox Avenue Site
Seattle, Washington

Figure 4.2
PCE + TCE Concentrations in Groundwater
2nd Water Bearing Zone

File: I:\GIS\Projects\FOXAVE-RA\MXD\2015 Annual Report\Figure 4.2 PCE_TCE WBZ2.mxd
Date: 3/1/2016

Legend

Conc. in µg/L

- 0-1
- 1.01-10
- 10.01-100
- 100.01-1,000
- 1,000.01-10,000
- Property Line

Notes:
- Thermal treatment period from January–May 2013.
- Total CVOCs include tetrachlorethene (PCE), trichloroethene (TCE), vinyl chloride (VC), and cis-1,2-dichloroethene (cis-DCE).

Abbreviations:
- CVOC = Chlorinated volatile organic compound
- µg/L = Micrograms per liter
- UST = Underground Storage Tank

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

N

0 50 100

Scale in Feet

S. WILLOW ST.

PARKING

OLD WAREHOUSE

LOADING DOCK

SECONDARY CONTAINMENT AREA

ACCESS RAMP

CASCADE COLUMBIA

OFFICE

MAIN WAREHOUSE

DISTRIBUTION WAREHOUSE

COVERED STORAGE

LOADING DOCK

COVERED PARKING AREA

RAMP

DAWN FOOD PRODUCTS

FORMER USTs

COVERED STORAGE

R0-IW9S *13.7*

MW-18S *114*

FOX AVENUE S.

R1-IW3A *3.80*

R1-IW4A *84.3*

B-49 *167*

B-58 *129*

R2-IW11 *22.4*

MW-09 *1020*

B-60 *597*

B-20A *1150*

R1-IW17 *34.2*

SEATTLE BOILER WORKS

R2-IW1 *570*

R2-IW2 *0.960*

MW-03 *81.8*

SEATTLE IRON & METALS YARD

B-18 *169*

BLDG.

B-64 *226*

S. MYRTLE STREET EMBAYMENT

S. MYRTLE ST.

FLOYD | SNIDER

strategy ▪ science ▪ engineering

2015 Annual Report
Fox Avenue Site
Seattle, Washington

Figure 4.3
cis-DCE + VC Concentrations in Groundwater
1st Water Bearing Zone

File: I:\GIS\Projects\FOXAVE-RA\MXD\2015 Annual Report\Figure 4.3 cis_VC WBZ1.mxd
Date: 3/1/2016

Legend

Conc. in µg/L

- 0-1
- 1.01-10
- 10.01-100
- 100.01-1,000
- 1,000.01-10,000
- Property Line

Notes:
- Thermal treatment period from January–May 2013.
- Total CVOCs include tetrachlorethene (PCE), trichloroethene (TCE), vinyl chloride (VC), and cis-1,2-dichloroethene (cis-DCE).

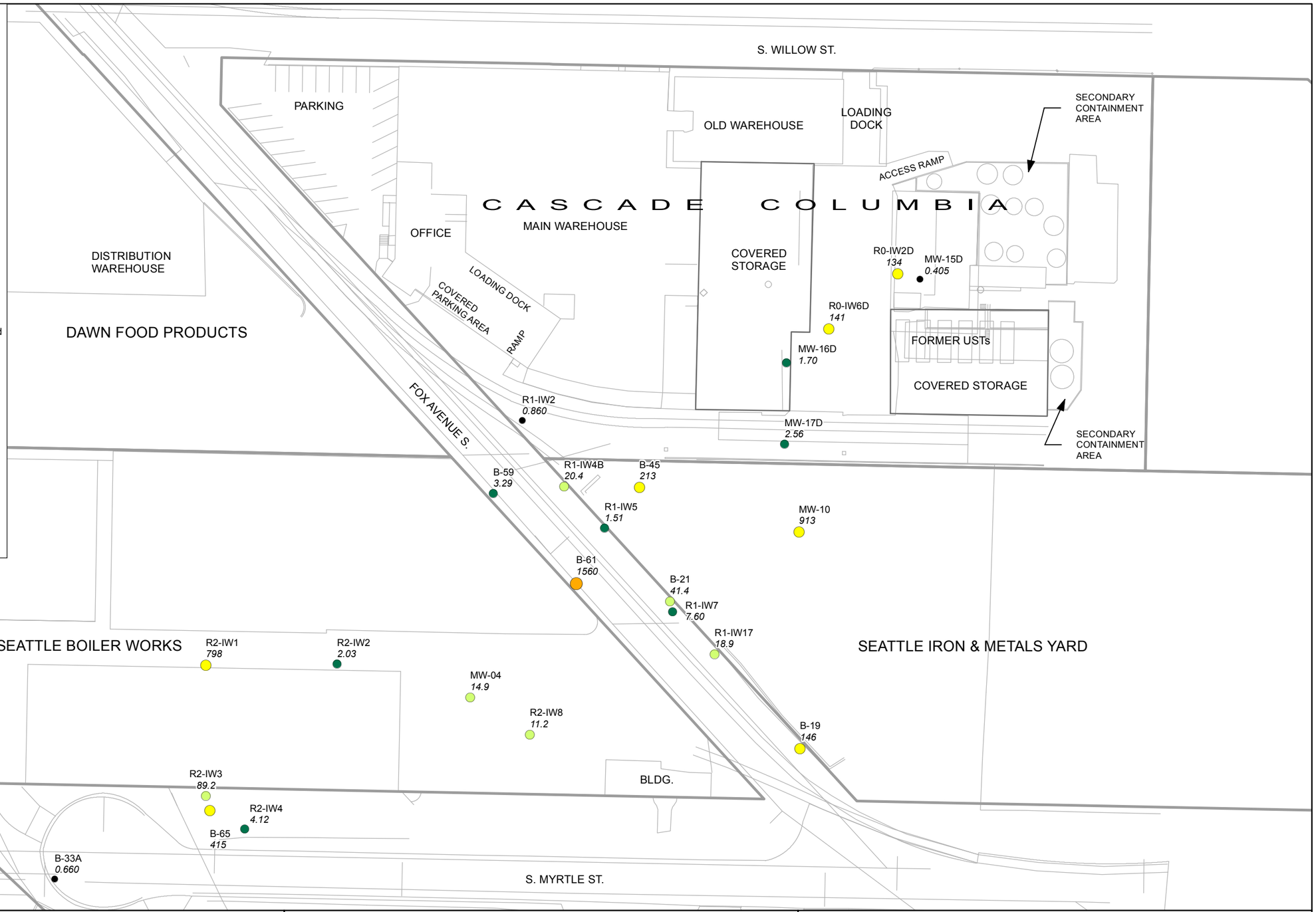
Abbreviations:
- CVOC = Chlorinated volatile organic compound
- µg/L = Micrograms per liter
- UST = Underground Storage Tank

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

N

0 50 100

Scale in Feet



FLOYD | SNIDER
strategy ▪ science ▪ engineering

2015 Annual Report
Fox Avenue Site
Seattle, Washington

Figure 4.4
cis-DCE + VC Concentrations in Groundwater
2nd Water Bearing Zone

File: I:\GIS\Projects\FOXAVE-RA\MXD\2015 Annual Report\Figure 4.4 cis_VC WBZ2.mxd
Date: 3/1/2016

Legend

Property Line

Total CVOCs > Groundwater Remediation Level of 250 µg/L

Analyte Pie

VC + cis-DCE

TCE + PCE

Notes:
- Thermal treatment period from January–May 2013.
- Total CVOCs include tetrachloroethene (PCE), trichloroethene (TCE), vinyl chloride (VC), and cis-1,2-dichloroethene (cis-DCE).

Abbreviations:
- CVOC = Chlorinated volatile organic compound
- µg/L = Micrograms per liter
- UST = Underground Storage Tank

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

N

0 50 100

Scale in Feet

S. WILLOW ST.

PARKING

OLD WAREHOUSE

LOADING DOCK

SECONDARY CONTAINMENT AREA

ACCESS RAMP

C A S C A D E C O L U M B I A

MAIN WAREHOUSE

OFFICE

COVERED STORAGE

DISTRIBUTION WAREHOUSE

LOADING DOCK

COVERED PARKING AREA

RAMP

DAWN FOOD PRODUCTS

FORMER USTs

COVERED STORAGE

R0-IW9S
13.7

MW-18S
119

FOX AVENUE S.

R1-IW3A
5.13

R1-IW4A
86.3

B-49
202

B-58
131

SECONDARY CONTAINMENT AREA

R2-IW11
22.4

MW-09
1230

B-60
610

B-20A
1150

R1-IW17
34.2

SEATTLE BOILER WORKS

R2-IW1
570

R2-IW2
0.960

MW-03
81.8

SEATTLE IRON & METALS YARD

B-18
169

BLDG.

B-64
229

S. MYRTLE STREET EMBAYMENT

S. MYRTLE ST.

FLOYD | SNIDER
strategy ▪ science ▪ engineering

2015 Annual Report
Fox Avenue Site
Seattle, Washington

Figure 4.5
Total CVOCs Concentrations in Groundwater
1st Water Bearing Zone

File: I:\GIS\Projects\FOXAVE-RA\MXD\2015 Annual Report\Figure 4.5 Total CVOCs WBZ1.mxd
Date: 3/1/2016

Legend

Property Line

Total CVOCs > Groundwater Remediation Level of 250 µg/L

Analyte Pie

VC + cis-DCE

TCE + PCE

Notes:
- Thermal treatment period from January–May 2013.
- Total CVOCs include tetrachlorethene (PCE), trichloroethene (TCE), vinyl chloride (VC), and cis-1,2-dichloroethene (cis-DCE).

Abbreviations:
- CVOC = Chlorinated volatile organic compound
- µg/L = Micrograms per liter
- UST = Underground Storage Tank

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

N

0 50 100

Scale in Feet

S. WILLOW ST.

PARKING

OLD WAREHOUSE

LOADING DOCK

SECONDARY CONTAINMENT AREA

ACCESS RAMP

C A S C A D E C O L U M B I A

OFFICE

MAIN WAREHOUSE

COVERED STORAGE

DISTRIBUTION WAREHOUSE

LOADING DOCK

COVERED PARKING AREA

RAMP

DAWN FOOD PRODUCTS

FOX AVENUE S.

FORMER USTs

COVERED STORAGE

SECONDARY CONTAINMENT AREA

R0-IW2D *135*

MW-15D *0.405*

R0-IW6D *174*

MW-16D *1.70*

MW-17D *2.56*

R1-IW2 *0.860*

B-59 *3.29*

R1-IW4B *20.4*

B-45 *215*

R1-IW5 *1.51*

MW-10 *915*

B-61 *1560*

B-21 *41.4*

R1-IW7 *7.60*

R1-IW17 *18.9*

SEATTLE BOILER WORKS

SEATTLE IRON & METALS YARD

R2-IW1 *798*

R2-IW2 *2.03*

MW-04 *14.9*

R2-IW8 *11.2*

B-19 *146*

BLDG.

R2-IW3 *89.2*

B-65 *415*

R2-IW4 *4.12*

B-33A *0.660*

S. MYRTLE STREET EMBAYMENT

S. MYRTLE ST.

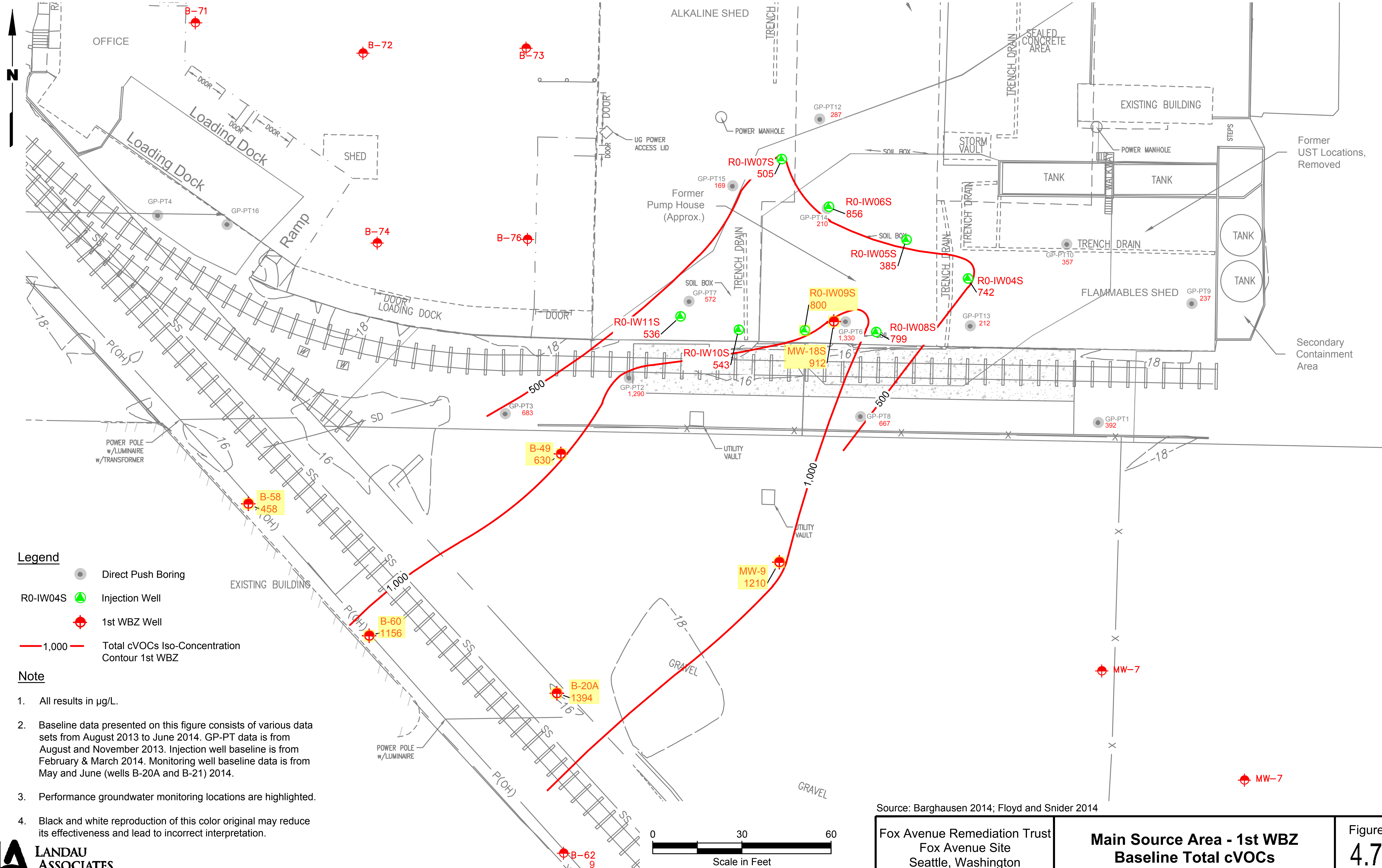
FLOYD | SNIDER

strategy ▪ science ▪ engineering

2015 Annual Report
Fox Avenue Site
Seattle, Washington

Figure 4.6
Total CVOCs Concentrations in Groundwater
2nd Water Bearing Zone

File: I:\GIS\Projects\FOXAVE-RA\MXD\2015 Annual Report\Figure 4.6 Total CVOCs WBZ2.mxd
Date: 3/1/2016



Legend

- Direct Push Boring
- R0-IW04S — Injection Well
- 1st WBZ Well
- 1,000 — Total cVOCs Iso-Concentration Contour 1st WBZ

Note

1. All results in µg/L.
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

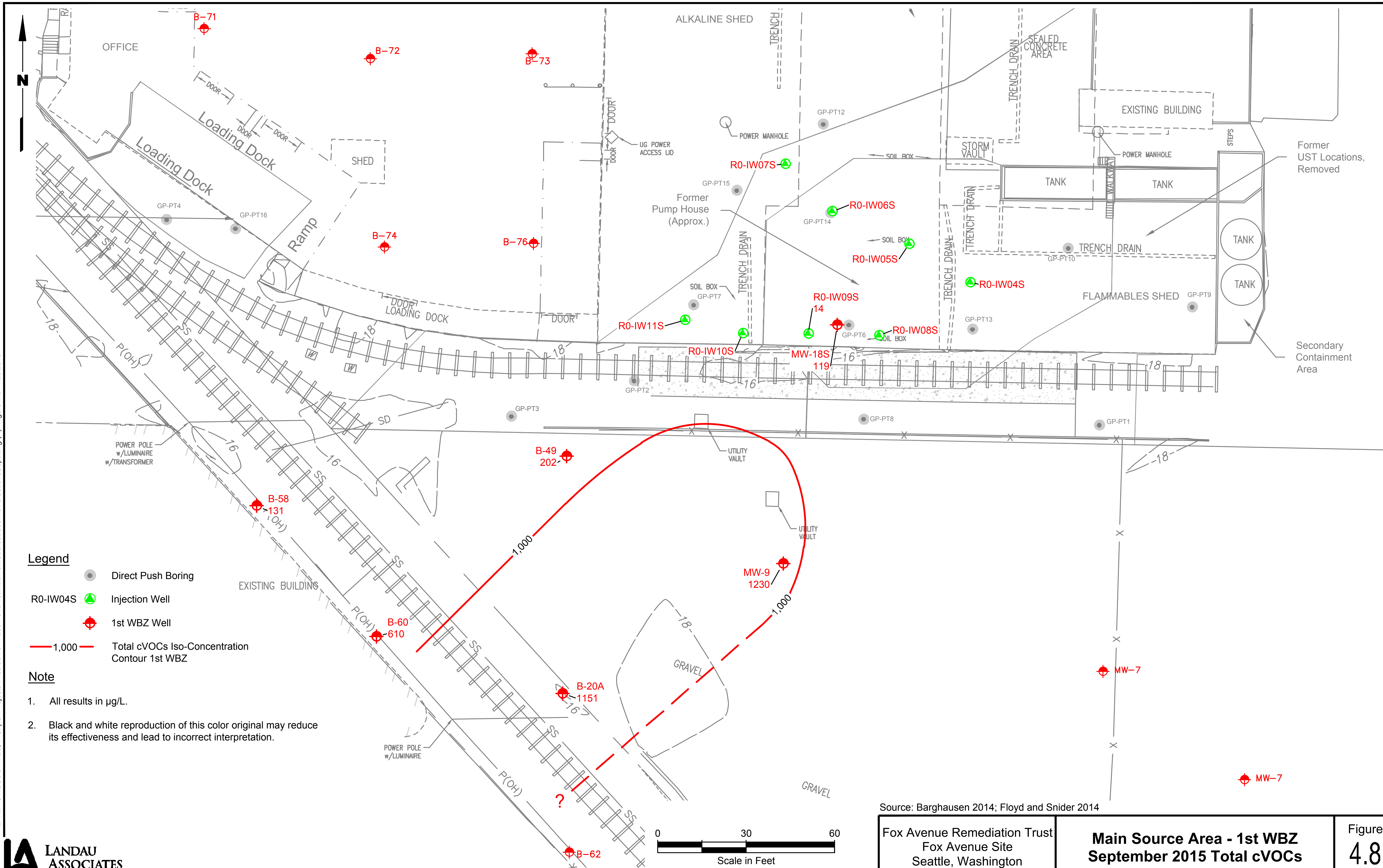
Source: Barghausen 2014; Floyd and Snider 2014

LANDAU ASSOCIATES

Fox Avenue Remediation Trust
Fox Avenue Site
Seattle, Washington

Main Source Area - 1st WBZ Baseline Total cVOCs

Figure 4.7

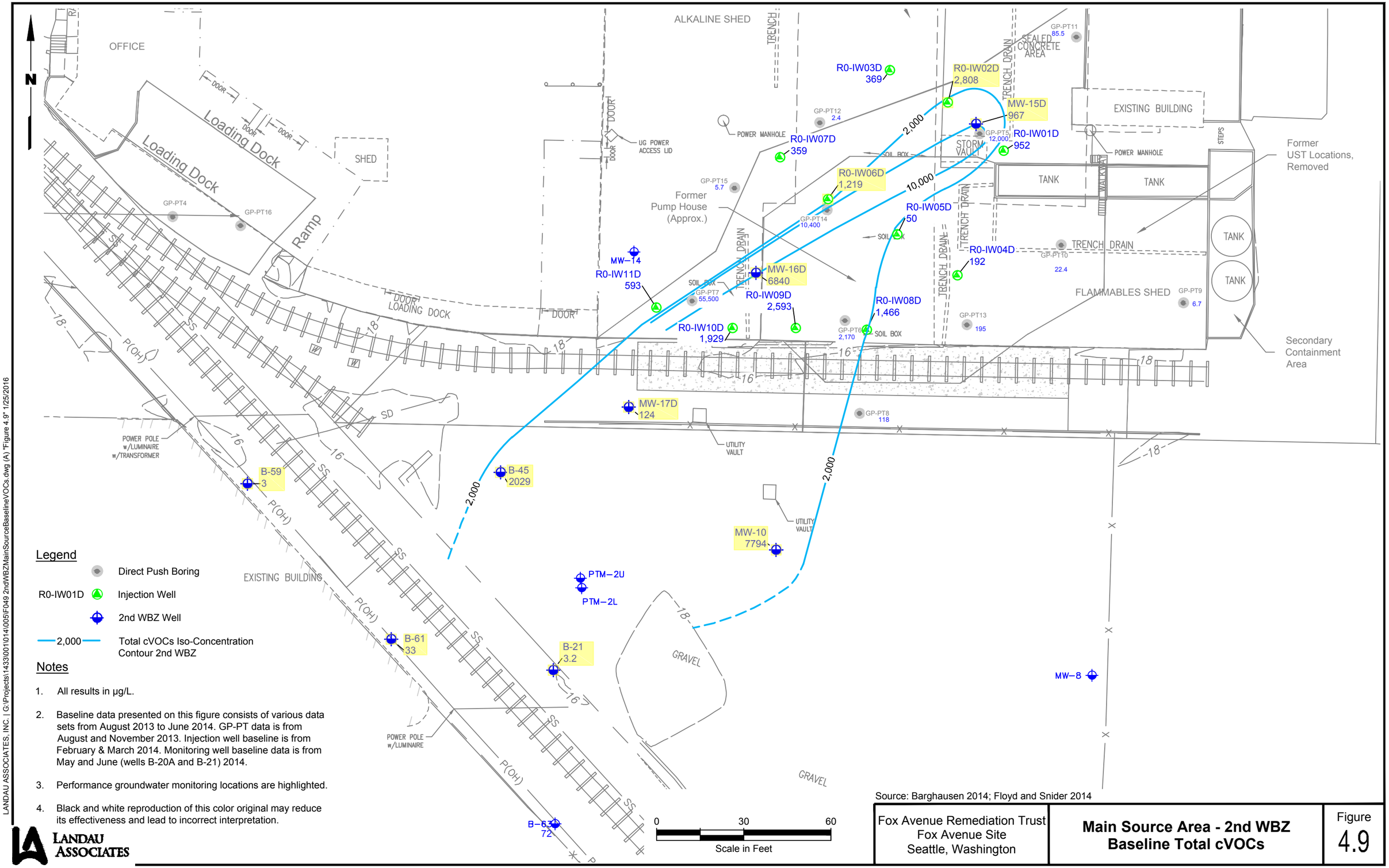


Source: Barghausen 2014; Floyd and Snider 2014

Fox Avenue Remediation Trust Fox Avenue Site Seattle, Washington	**Main Source Area - 1st WBZ** **September 2015 Total cVOCs**	Figure 4.8

LANDAU ASSOCIATES

LANDAU ASSOCIATES, INC. | G:\Projects\1433\001\014\005\F048 1stWBZMainSourceBaselineVOCs2015Sept.dwg (A) "Figure 4.8" 1/25/2016



Legend

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

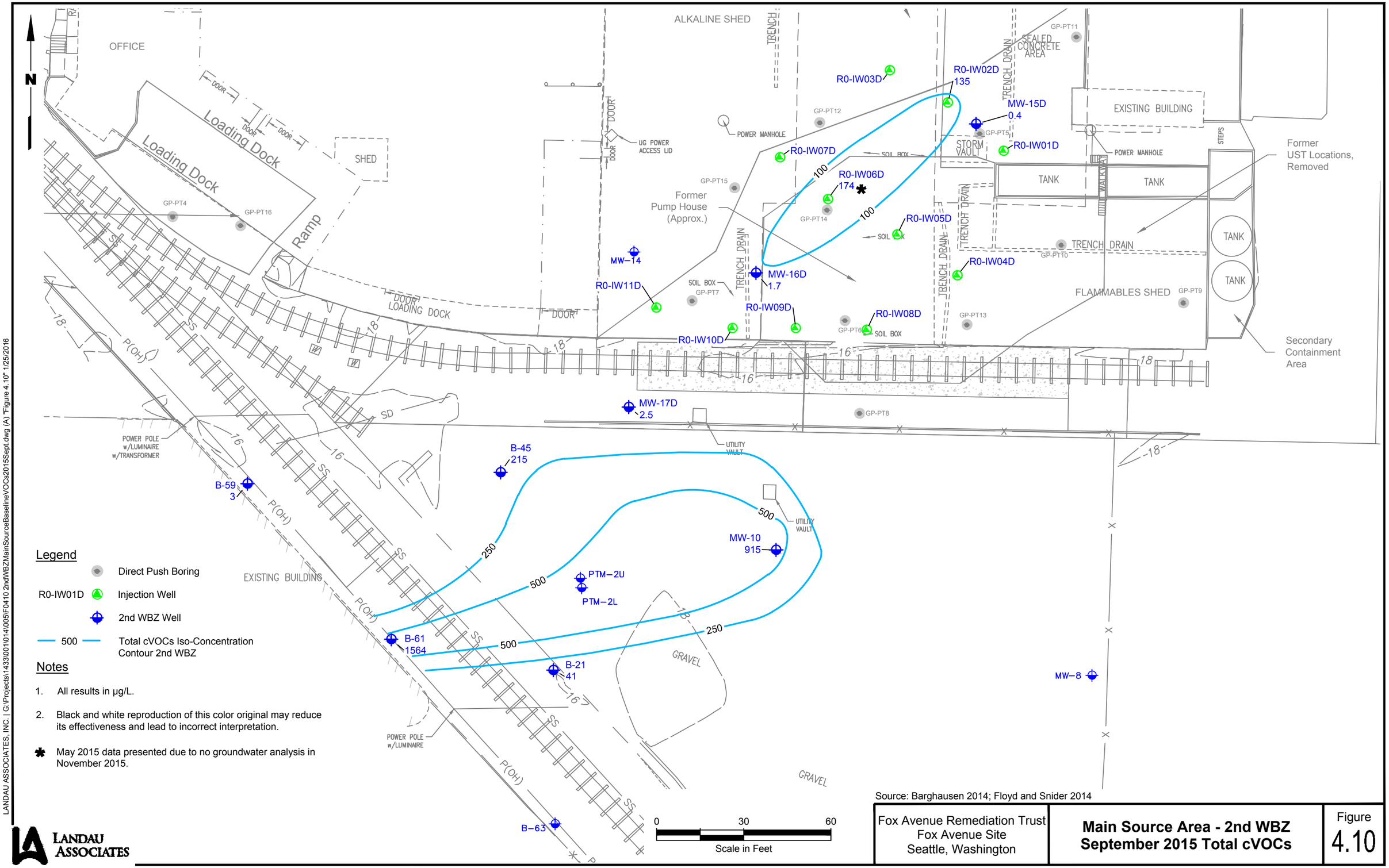
Notes

1. All results in µg/L.
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 4.9



Legend

- Direct Push Boring
- R0-IW01D — Injection Well
- 2nd WBZ Well
- 500 — Total cVOCs Iso-Concentration Contour 2nd WBZ

Notes

1. All results in µg/L.
2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

* May 2015 data presented due to no groundwater analysis in November 2015.

Source: Barghausen 2014; Floyd and Snider 2014

LANDAU ASSOCIATES

Fox Avenue Remediation Trust
Fox Avenue Site
Seattle, Washington

Main Source Area - 2nd WBZ
September 2015 Total cVOCs

Figure 4.10