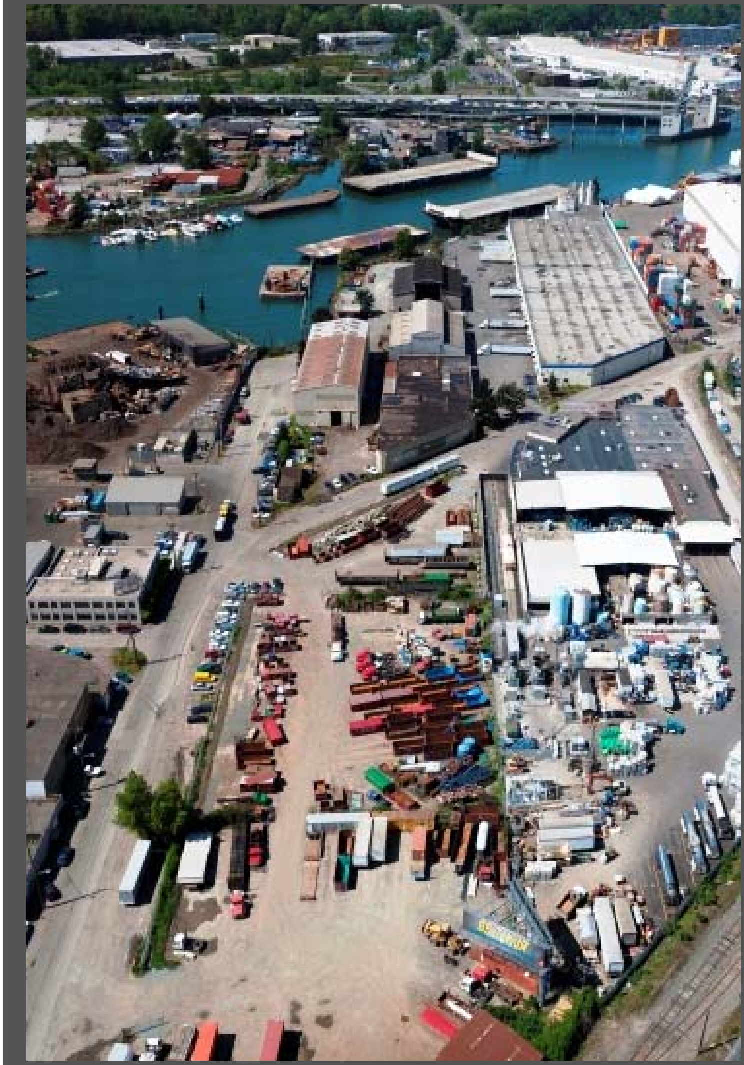
Fox Avenue Site
Seattle, Washington



Construction Completion Report

Prepared for

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

September 2013

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List of Abbreviations and Acronyms

Abbreviation/ Acronym	Definition
1,1-DCE	1,1-Dichloroethene
AST	Aboveground storage tank
bgs	Below ground surface
BTEX	Benzene, toluene, ethylbenzene, and xylenes
CAA	Cleanup Action Area
CAP	Cleanup Action Plan
Cascade Columbia	Cascade Columbia Distribution Co.
COC	Chemical of concern
CPOC	Conditional point of compliance
CPVC	Chlorinated polyvinyl chloride
CVOC	Chlorinated volatile organic compound
DCE	Dichloroethene
Ecology	Washington State Department of Ecology
EDR	Engineering Design Report
ERD	Enhanced reductive dechlorination
ERH	Electrical Resistance Heating
GAC	Granular activated carbon
GWCC	Great Western International Chemical Company
KCIW	King County Industrial Waste Program
LDW	Lower Duwamish Waterway

Abbreviation/ Acronym	**Definition**
LGAC	Liquid-phase granular activated carbon
MNA	Monitored Natural Attenuation
O&M	Operations and Maintenance
PCE	Tetrachloroethene
Penta	Pentachlorophenol
PID	Photoionization detector
ppm	Parts per million
ppmv	Parts per million by volume
RI/FS	Remedial Investigation/Feasibility Study
scfm	Standard cubic feet per minute
SH	Silt Horizon
Site	Fox Avenue Site
SVE	Soil vapor extraction
TCE	Trichloroethene
TPH	Total petroleum hydrocarbons
TPH-G	Gasoline-range total petroleum hydrocarbons
TRS	TRS Group, Inc.
UCL	Upper confidence level
USEPA	U.S. Environmental Protection Agency
UST	Underground storage tank
VC	Vinyl chloride
VGAC	Vapor-phase granular activated carbon
VOC	Volatile organic compound
VR	Vapor recovery
WBZ	Water Bearing Zone

1.0 Introduction

This report documents the construction, installation, and operation of the thermal and soil vapor extraction (SVE) remediation systems for the Fox Avenue Site (Site). The Site is the former location of the Great Western International Chemical Company (GWCC) and is currently in operation as the Cascade Columbia Distribution Co. (Cascade Columbia) Facility located at 6900 Fox Avenue S. in Seattle, Washington (Figure 1.1). These cleanup actions were implemented to fulfill the requirements of the final Cleanup Action Plan (CAP; Ecology 2012) for the Fox Avenue Site.

This Construction Completion Report provides documentation of the following information:

- Remediation system construction, start-up, and testing
- Remediation system operation and performance monitoring
- Remediation system compliance sampling
- Protection monitoring and sampling during active remediation

1.1 GENERAL SITE DESCRIPTION AND CURRENT FACILITY USE

The Site currently includes the Cascade Columbia Facility located at 6900 Fox Avenue S. and certain downgradient properties under which groundwater travels and eventually discharges to the Lower Duwamish Waterway (LDW). The Cascade Columbia Facility occupies approximately 2.5 acres of flat land located approximately 400 feet from the S. Myrtle Street Embayment of the LDW. The property is bordered to the north by S. Willow Street, to the south by the Whitehead property, to the east by East Marginal Way South, and to the west by Fox Avenue S. Active rail lines also cross the site area. The area is zoned for heavy industry and a large number of commercial and industrial operations are located nearby, including: Seattle Iron and Metals Corporation, a metals recycler; Seattle Boiler Works, a fabricator of steel pressure vessels; Schultz Fuel Distributing, a distributor of petroleum products; and Dawn Foods Distribution, a warehouse distributor of food products (refer to Figure 1.2).

Cascade Columbia warehouses, packages, and distributes mainly liquid and solid bulk chemicals for the aerospace, electronics, food manufacturing, personal care, water treatment, and metal plating industries. Product is received either by rail tanker via a rail spur on the south side of the facility or truck via a main loading dock on the northeast side of the warehouse and a smaller loading dock along Fox Avenue S. Product is offloaded and stored in bermed aboveground storage tanks (ASTs) or in a variety of sacks, bags, drums, and containers. Currently there are no active underground storage tanks (USTs) at the facility and Cascade Columbia does not repackage bulk chlorinated solvents.

1.2 CHEMICALS OF CONCERNAND CLEANUP ACTION AREAS

GWCC handled the following chemical classes and product types:

Class	Product Type
Ketones	Methyl ethyl ketone, methyl *iso*-butyl ketone, and acetone
Monocyclic Aromatic Solvents	Toluene and xylenes

Class	Product Type
Alcohols and Glycols	Isopropyl alcohol, ethyl alcohol, methyl alcohol, ethylene glycol, and propylene glycol
Mineral Spirits/Petroleum Solvents	Chevron solvents 325, 350-B, 410 and 450, and kerosene
Chlorinated Compounds	Methylene chloride, tetrachloroethene, pentachlorophenol, trichloroethene, and 1,1,1-trichloroethane
Acids	Nitric, sulfuric, and muriatic (hydrochloric) acids
Dry Products	Phosphates, soda ash, titanium dioxide, borax, and boric acid
Miscellaneous	Ferric and ammonium chloride etchants, phenols, hydrogen peroxide, and linseed oil

Additionally, GWCC began handling pentachlorophenol (Penta) on the property sometime in 1966. Penta was stored in one of the 12,000-gallon tank compartments and, for a period of 1 to 2 years only, it was blended with Stoddard solvents or mineral spirits in a small AST north and west of the drum shed. From 1969 until the late 1970s or early 1980s, GWCC purchased mixed Penta in drums from outside vendors. Product was delivered to customers in vendor-packaged drums or transferred to a tanker truck and delivered in bulk.

After extensive investigations of soil and groundwater conditions by GWCC beginning in 1990 and ending in 2009, the following primary chemicals of concern (COCs) were identified at the Site as exceeding applicable cleanup levels: tetrachloroethene (PCE) in soil, groundwater, and air; trichloroethene (TCE) in groundwater and air; benzene in soil and groundwater; and 1,1-dichloroethene (1,1-DCE), Penta, total petroleum hydrocarbons (TPH, mineral spirits to heavy oil-range), and vinyl chloride (VC) in groundwater and air. The benzene is believed to have originated not from releases of pure product, but rather from dissolution to groundwater as a result of releases of mineral spirits, which typically contain a small fraction of benzene.

The majority of contamination at the Site originated from well-defined source areas. Volatile organic compounds (VOCs) have migrated in groundwater and reached the S. Myrtle Street Embayment, but non-mobile contaminants, such as Penta, remained more localized. Of the VOCs that have migrated to the S. Myrtle Street Embayment, only PCE, TCE, and VC have historically exceeded their respective cleanup levels in groundwater discharging to the embayment.

Extensive sampling of the S. Myrtle Street Embayment in the late 1990s indicated that the sediments and surface water of the S. Myrtle Street Embayment were not contaminated by site releases.

As shown on Figure 1.3, the Site has been divided into the following Cleanup Action Areas (CAAs):

- **Main Source Area:** The Main Source Area represents those areas of the Site where past releases have occurred and the underlying soil was the source of the plume found in downgradient groundwater. Contaminants in soil and groundwater included PCE, TCE, the dichloroethene (DCE) isomers, VC, aromatic VOCs (benzene, toluene, ethylbenzene, and xylenes [BTEX], for example), TPH (as mineral spirits), and Penta. The Main Source Area extends from under the Flammables Shed and Production Area to the southern part of the Site beneath the railroad tracks on Frontenac Street SW (the rail corridor). Soil contamination in this area impacted groundwater in the 1st Water Bearing Zone (WBZ) and deeper 2nd WBZ. The 1st WBZ is the uppermost groundwater-bearing unit. This zone is primarily composed of native alluvial deposits of fine to medium sand to slightly silty to very silty, fine to medium sand. The 1st WBZ is unconfined, with the depth to the water table ranging from approximately 7 to 13 feet bgs. Where present, the Silt Horizon (SH) serves as the base for the 1st WBZ throughout most of the Site. Where absent, the 1st WBZ grades into the underlying 2nd WBZ with no identifiable marker. The 1st WBZ is 3 to 8 feet thick in sections where the 1st SH is present.

The 2nd WBZ is contained within a semi-confined (i.e., locally unconfined) estuarine/deltaic aquifer that consists of fine to medium, silty sands with interbeds, stringers, and lenses of dense to very dense, very silty, fine sand to soft to medium stiff, sandy silt. In general, estuarine/deltaic deposits become fine-grained with depth, but often show repeated sequences of silt to silty sand to sand. The 2nd WBZ ranges in depth from approximately 15 to at least 80 feet bgs.

- The Loading Dock Source Area: The Loading Dock Source Area is a subarea of the Main Source Area. Contamination in this area was limited to the vadose zone and 1st WBZ and does not extend to the 2nd WBZ.
- **Northwest Corner Plume:** The Northwest Corner Plume is a smaller separate groundwater plume that is not commingled with the Main Source Area, and is located in the northwest corner of the Site, in the parking lot. A distinct soil contamination source to groundwater has not been identified for the Northwest Corner Plume and its origin is thought to be related to several minor surface spills that occurred along the S. Willow Street rail line. The Northwest Corner Plume is composed primarily of PCE and TCE and is confined to 1st WBZ groundwater. Soil impacts greater than the selected remediation levels have not been identified in this area.
- **Downgradient Groundwater Plume:** The Downgradient Groundwater Plume extends from the multiple source areas described above and travels southwest toward the S. Myrtle Street Embayment. There is no associated soil contamination in the Downgradient Groundwater Plume cleanup area. The groundwater plume is composed primarily of PCE and TCE in the 1st WBZ groundwater, and DCE and VC in the 2nd WBZ groundwater. There are also occurrences of 1,1-DCE, benzene, Penta, and TPH in this plume. The Penta is primarily found in 1st WBZ groundwater upgradient from Fox Avenue S. Since 2009, this plume has been subjected to enhanced reductive dechlorination (ERD) to stimulate the natural biological destruction of the chlorinated solvents by injection of easily fermentable waste sugars into the aquifer. The ERD injection and monitoring programs are still ongoing and indicate significant improvements in groundwater quality including acceleration in the conversion of parent PCE to the daughter products TCE, DCE, and VC, as well as the increased production of non-toxic ethene gas, the end product of dechlorination.

1.3 SUMMARY OF CLEANUP ACTIONS

The following table is from the CAP and provides a general summary of the cleanup actions along with estimated remediation timeframes. Refer to Section 2.0 for further information on site cleanup levels and remediation levels.

Cleanup Action Area	**Applied To**	**Technology**	**Implemented until Compliance with RL or CUL Achieved**	**Approximate Time Frame Required**
Main Source Area	Vadose, 1st WBZ, 1st SH, 2nd WBZ soil (to 65 feet bgs)	Electrical Resistance Heating (Primary)	RL: 10 mg/kg Total PCE+TCE in soil	1 year of active heating
	1st and 2nd WBZ soil > 10 mg/kg or groundwater > 1,000 µg/L	ERD (Polish)	RL: 250 µg/L Total CVOCs in groundwater (measured at the CPOC)	5 years (post-thermal)
Downgradient Groundwater Plume	1st and 2nd WBZ groundwater (to 70 feet bgs) with total CVOCs > 100 µg/L along Fox Avenue S.	ERD	RL: 250 µg/L Total CVOCs in groundwater (as measured in the designated monitoring well network) and CULs are met at the seeps	10–15 years (post-thermal)
		MNA	CUL: Refer to table in Section 2.1 in the EDR; and as measured in the designated monitoring well network	50 years (post-ERD)
Northwest Corner Plume	1st WBZ groundwater with total CVOC concentrations > 250 µg/L	ERD/SVE	RL: 250 µg/L total CVOCs in groundwater (measured at CPOC)	5 years (post-SVE)
	1st WBZ groundwater with total CVOC concentrations < 250 µg/L	MNA	CUL: Refer to table in Section 2.1 in the EDR; and as measured in the designated monitoring well network	50 years (post-ERD)

Abbreviations:

<	Less than
>	Greater than
bgs	Below ground surface
CPOC	Conditional point of compliance
CUL	Cleanup level
CVOC	Chlorinated volatile organic carbon
EDR	Engineering Design Report
ERD	Enhanced reductive dechlorination
µg/L	Micrograms per liter
mg/kg	Milligrams per kilogram
MNA	Monitored natural attenuation
PCE	Tetrachloroethene
RL	Remediation level
SH	Silt Horizon
SVE	Soil vapor extraction
TCE	Trichloroethene
WBZ	Water Bearing Zone

2.0 Main Source Area Thermal Treatment

Electrical Resistance Heating (ERH) acts to enhance the volatilization of VOCs in the subsurface by passing an electrical current through the soil between subsurface electrodes throughout the treatment area. The electrical current heats the subsurface, and a vapor recovery and treatment system connected to a network of vapor recovery wells collects and treats the steam and chlorinated volatile organic compound (CVOC) vapors generated by the ERH system. Thermal treatment system design, construction, and operation were completed by the TRS Group, Inc. (TRS), the vendor chosen by the Fox Avenue Trust to implement the thermal remedy. Further details on the equipment components installed and a description of how the system was constructed and operated are included in TRS's August 2013 Final Report—Electrical Resistance Heating (referred to in this document as the TRS Final Report) included in Appendix A. A brief summary is included in the following sections, along with a summary of performance monitoring and compliance monitoring completed during thermal system operations.

2.1 THERMAL TREATMENT AREAS

The area that was thermally treated was defined by the estimated limits of soil containing greater than 1 milligram per kilogram (mg/kg) PCE+TCE in soil, as shown on Figure 2.1. Therefore, by plan, areas of the Site with soil contamination less than the remediation level of 10 mg/kg PCE+TCE were treated. This was done to further reduce the residual mass of solvent at the Site as well as insure that the limits of thermal treatment were conservatively placed. The thermal footprint was divided into five thermal treatment areas as shown on Figure 2.2, each with a unique treatment depth to capture the variability in depth of soil contamination that was found within each area. These treatment areas and the associated thermal treatment depths are as follows:

- Area 1, West Rail Area: Ground surface to 17 feet below ground surface (bgs)
- Area 2, Loading Dock: Ground surface to 15 feet bgs
- Area 3, East Rail Area/East Flammables Shed Area: Ground surface to 22 feet bgs
- Area 4, Former Pump House and West Flammables Shed Area: Ground surface to 65 feet bgs
- Area 5, Alkaline Shed and Production Treatment Area: 15 to 65 feet bgs

Together, these five areas represent a soil volume of approximately 42,000 cubic yards that was thermally treated. Data collected during the Remedial Investigation indicated that the majority of soil contamination was in the upper 20 feet of soil with elevated concentrations found in very shallow soils within the vadose zone, the 1st WBZ, and the 1st SH. In addition, there was a smaller mass of PCE and TCE found between 45 to 65 feet bgs in deeper 2nd WBZ soils.

2.2 THERMAL SYSTEM COMPONENTS

The TRS thermal system design layout is shown on Figure 2.3. The main components of the subsurface thermal system were electrodes used to input current into the subsurface, recovery wells or trenches used to capture steam and vapors, and temperature monitoring points used to verify that the subsurface soil has achieved its targeted temperature. Figure 2.3 also shows an approximately 5- to 7-foot radius outside of the electrode area that was also heated to near the boiling point by conduction, and was therefore subjected to thermal remediation. This additional

5- to 7-foot buffer provides added confidence that the limits of source area contamination were within the identified treatment area. This buffer also extends vertically because heating occurred below the base of the electrodes to approximately 70 feet bgs, which is below the zone of deeper contamination.

Electrodes were designed by TRS in several ways to achieve specific design goals and remediation objectives at the Site. Some electrode points were single purpose, and were designed solely to deliver current to the subsurface at the correct depth intervals. Others were multi-purpose, functioning both as vapor extraction wells and electrodes. In some other locations, slotted horizontal piping was used for vapor recovery. Electrodes were surrounded by conductive backfill such as graphite or steel shot to better distribute current to the subsurface soil. Details of the electrode layout are contained within Appendix A.

The steam and vapors were removed from slotted electrodes/piping via the vapor recovery (VR) system. The VR system consisted of two positive displacement blowers that extracted vapors from each vapor extraction/electrode along a system of chlorinated polyvinyl chloride (CPVC) piping that was manifolded to one of two main headers. The extracted steam and vapor from each header passed through one of two condensers where the steam condensed back to water. Condensate was treated with liquid-phase granular activated carbon (LGAC) and discharged to the sanitary sewer.

The twin vapor recovery (VR) system was designed so as to separate areas with expected high VOC concentration vapors from areas of the Site where lower concentration vapors were expected. This allowed for more cost effective vapor treatment. The high VOC header flow of approximately 500 standard cubic feet per minute (scfm) was routed to the thermal oxidizer/acid gas scrubber and the lower VOC concentration flow of approximately 500 scfm routed to three vapor-phase granular activated carbon (VGAC) vessels. One vessel served as the primary adsorber (7,000 pounds) and the others as the secondary and tertiary adsorbers (1,500 pounds each). The aboveground equipment was located in a treatment compound on the east side of the Cascade Columbia warehouse. Figure 2.4 is an aerial photograph of the treatment system.

2.3 EQUIPMENT INSTALLATION, START-UP, AND TESTING

Prior to the installation of the thermal system, Cascade Columbia personnel removed, via excavation, all subsurface metallic objects in the treatment area that, if left in place, would cause potential short-circuiting of electrical current. This included the six abandoned chemical USTs in the Flammables Shed, an abandoned former gasoline UST in the loading dock, and horizontal stainless steel groundwater extraction piping installed along the rail spur in 1990. Following removal of these metallic elements and some additional utility relocation work in the Rail Spur Area, TRS mobilized to the Site and began the installation process. The thermal process required a significant amount of time (5 months) for electrode installation, assembly of aboveground system components, and testing. Power application to the subsurface commenced on January 8, 2013 and then was continuous until May 13, 2013, with the exception of minor system adjustments, routine maintenance, unexpected shutdowns, and scheduled soil sampling events. More detail on equipment installation, the start-up process, and testing can be found in the TRS Final Report (Appendix A).

2.4 PERMITS

2.4.1 King County Industrial Discharge Permit

Discharge of condensate as well as scrubber blowdown to the sewer system was permitted under Wastewater Discharge Authorization No. 4237-01 by the King County Industrial Waste Program (KCIW). The permit allowed for the discharge of limited amounts of industrial wastewater into King County's sewer system in accordance with the effluent limitations and other requirements. Weekly sampling of the scrubber (Process 14) and the combined condensate (IW1131A) discharge streams for various organic chemical parameters and pH was required. LGAC was changed out when breakthrough was indicated. Laboratory analytical reports for the weekly compliance sampling are included in Appendix B.

2.4.2 Puget Sound Clean Air Agency Permit

Discharge of treated vapors from both the thermal oxidizer and granular activated carbon (GAC) systems was permitted under the Puget Sound Clean Air Agency (PSCAA) Notice of Construction Number 10529. Under the permit, treated vapors were allowed to be discharged to the atmosphere after meeting a minimum of 98 percent destruction efficiency and other permit conditions. Weekly photoionization detector (PID) measurements of the influent, midpoint, and effluent of the carbon were required to monitor for and prevent breakthrough. Every 2 weeks, samples were collected from the influent and effluent streams from both the oxidizer and the carbon in order to determine the concentrations of PCE, TCE, and benzene, as well as to maintain the 98 percent destruction efficiency required by the permit. Carbon was changed out a total of six times during the life of the project. Laboratory analytical reports for the bi-weekly compliance sampling are included in Appendix B.

2.5 THERMAL SYSTEM OPERATION SUMMARY

Full-scale ERH system operation, which consisted of power application to each of the five treatment areas, commenced on January 8, 2013. Power application to the treatment areas ended on May 13, 2013; however vapor recovery continued until May 31, 2013. The key ERH system operation parameters, consumable usages, and waste water discharge quantities throughout system operation are presented in Table 2.1. Further details on all activities, as well as system shutdown, are included in the TRS Final Report (Appendix A).

2.6 THERMAL SYSTEM PERFORMANCE MONITORING SUMMARY

The performance monitoring associated with the thermal remedy included the collection of routine system operational data necessary to optimize system performance and to assist with permit compliance.

Performance monitoring for the ERH system included the following data collection activities conducted by representatives from TRS and Floyd|Snider. TRS collected operational data on the ERH system; Floyd|Snider was responsible for the sampling necessary to demonstrate compliance with the air permit and the wastewater discharge permit. The following performance monitoring tasks were conducted during operation of the thermal remediation system:

- ERH system operations data collection was conducted by TRS. In general, subsurface temperature, electrical parameters, and flow conditions were collected electronically. Manual monitoring of system process pressures, flow rates, and total flows of both liquid and vapor streams were measured on a daily basis. Measurement of system amperage and voltage was measured to verify the electrical current to each individual electrode. This information was useful to determine proper functionality of the system, but is not reported. System voltage measurements were conducted as a safety measure. Voltage measurements included monitoring around the perimeter of the system on a regular schedule and following any increases in power application to the system.

- Vapor recovery performance monitoring was conducted during the operational phase of the project at the influent vapor streams (post-condenser), the mid-point of the GAC treatment stream and the treatment effluent streams (post-oxidizer and post-GAC treatment) on a weekly basis. The samples were screened in the field using a PID. The screening data collected was used as a relative measure of oxidizer and GAC system's performance. In addition, samples of influent and effluent vapors for both the oxidizer and GAC were collected and analyzed by Tedlar bag to verify permit compliance for hazardous air pollutants regulated by the air permitting agency (refer to Section 2.7 below for details).
- Groundwater temperature monitoring was completed by both TRS and Floyd|Snider to monitor temperature downgradient of the treatment zone.

2.7 SOIL COMPLIANCE SAMPLING

Compliance soil samples were collected by Floyd|Snider in two stages with the first stage occurring mid-way through the heating process in March 2013 and the second stage occurring in mid-May 2013 after 83 percent of the design energy of 9,400,000 kilowatts per hour (kWh) was applied. Stage 1 sampling included the collection of soil samples from two areas that TRS believed were close to being in compliance with the remediation level. Stage 2 soil sampling included collection of soil samples from all treatment areas except the one area that was verified during Stage 1 testing to be in compliance, as further described in Section 2.7.3. The five treatment areas and compliance sampling locations are shown on Figure 2.5. The soil sample collection frequency and depths per area are summarized in the following table from the Engineering Design Report.

Treatment Area	Square Footage	Treatment Interval (feet bgs)	Number of Borings	Samples Per Boring	Total
Loading Dock	2,300	0 to 15 feet	5	1 per vadose zone 1 per 1st WBZ 1 per 1st SH, if present	15
West Rail Siding	4,500	0 to 17 feet	8	1 per vadose zone/1st WBZ 1 per 1st SH/2nd WBZ	16
East Rail/ East Flammables	4,600	0 to 22 feet	8	1 per vadose zone/1st WBZ 1 per 1st SH/2nd WBZ	16
Former Pump House/Flammables Shed	7,500	0 to 65 feet	10	1 per vadose zone/1st WBZ 1 per 1st SH/top 2nd WBZ 3 (every 5 feet starting at 45 feet bgs)	50

Treatment Area	Square Footage	Treatment Interval (feet bgs)	Number of Borings	Samples Per Boring	Total
Production Area/Alkaline Shed	4,400	15 to 65 feet	7	3 (every 5 feet, starting at 45 feet bgs)	21
		TOTAL	**38**		**118**

Abbreviations:

bgs	Below ground surface
SH	Silt Horizon
WBZ	Water Bearing Zone

2.7.1 General Soil Sampling Procedures

Floyd|Snider provided oversight to Cascade Drilling for the advancement of soil borings using a direct-push drilling method (GeoProbe®) adapted for hot conditions. The soil borings were advanced from the ground surface to a maximum total depth of 65 feet bgs as outlined in the previous table. Collection of soil samples was conducted in accordance with the TRS Hot Soil Sampling Standard Operation Procedure (SOP) included in Appendix D of the Engineering Design Report (EDR; Floyd|Snider 2012).

Soil samples were collected continuously in 5-foot-long segments from each boring using heat-resistant Teflon-wrapped stainless steel or Teflon liners. Sample sleeves were capped immediately upon collection and placed into an ice bath until the soil neared an ambient temperature. Cooled soil was collected at approximately 2-foot intervals and placed into a sealed plastic bag for field screening using the headspace method. Soil samples were screened using a PID to identify the highest intervals potentially contaminated with VOCs for analytical testing. Soil was also examined for staining, sheens, odors, or anthropogenic materials.

Based on PID screening and visual observations, soil samples were collected using U.S. Environmental Protection Agency (USEPA) Method 5035A for VOCs. Samples were placed in a cooler and packed with ice. Standard chain-of-custody procedures were followed. The soil compliance samples were analyzed for PCE and TCE by USEPA Method 8260C. Selected samples were also analyzed for gasoline-range TPH (TPH-G) and Penta. Samples were submitted to Fremont Analytical, Inc. in Seattle, Washington. Additional details regarding analytical methods and the laboratory quality assurance/quality control requirements were included in the Quality Assurance Project Plan appended to the EDR.

2.7.2 Stage 1 Soil Sampling and Analyses

Stage 1 soil sampling activities in the West Rail and Loading Dock Areas (refer to Figure 2.5) occurred after approximately 50 percent of the design energy was applied to the subsurface. A total of 30 soil samples were analyzed from 12 borings during this event. The analytical results are summarized in Table 2.2, and the soil boring locations are shown on Figure 2.5. The results indicated that the West Rail Area had been treated to levels much less than the remediation level. As a result, the West Rail Area electrodes were removed from service on March 26, 2013. Vapor recovery continued throughout the West Rail Area to maintain vapor capture until March 29, 2013.

In contrast, several locations in the Loading Dock Area remained greater than the remediation level, indicating that continued treatment in the Loading Dock Area was necessary.

2.7.3 Stage 2 Soil Sampling and Analyses

Stage 2 soil sampling activities were performed by Floyd|Snider May 13 through May 22, 2013 to assess the performance of the ERH system in the Loading Dock, East Rail, Production Treatment, and Flammables Shed Areas after approximately 83 percent of the design energy was applied to the subsurface. A total of 104 soil samples were analyzed from 31 Geoprobe borings during the 8 days of sampling. Soil was collected continuously and screened with a PID across each 5-foot-long segment. PID readings were generally low, however, and all soil appeared to be visually free of contamination. Within each of the targeted depth zones (i.e, vadose, 1st WBZ, SH, 2nd WBZ [refer the previous table]), the specific interval to be sampled was primarily e selected based more on prior depths of historical detections than PID indications given the low PID readings observed. Of these 31 borings, three were repeat borings in the Loading Dock Area, in locations that were not in compliance during the March sampling effort. An additional three borings (noted with an “a” in the sample name) were drilled as secondary borings to a specific location due to poor sample recovery (in some locations due to loss of sample because of steam overpressurization during sample core opening) or refusal.

A summary of all the PCE and TCE analytical results is included in Table 2.3. Results indicated that all areas of the Site were treated to levels much less than the 10 parts per million (ppm) average cleanup goals for PCE+TCE in each treatment area. Concentration in only three individual samples out of the 104 analyzed exceeded the remediation level, with all three of these samples from vadose zone soil in the Flammables Shed. This goal was achieved using significantly less energy than expected (84 percent of design energy) and in a shorter timeframe than expected (4 months of power application compared to the 5 to 6 months expected). These data were provided to the Washington State Department of Ecology (Ecology) and a request was made to terminate thermal operations. Ecology approved of the termination of thermal operations on May 30, 2013. Vapor extraction continued until May 31, 2013. The extracted vapors at the time of shutdown contained very little VOC concentrations as indicated by PID and Tedlar bag sampling.

In addition to PCE and TCE analysis, selected soil samples were also analyzed for TPH and Penta. Samples were collected in areas where these constituents were previously detected to evaluate removal efficiency, even though there is not a site-specific remediation level for either of these constituents. The results from that analysis are presented in Table 2.4. Comparisons to concentrations reported in the Remedial Investigation/Feasibility (RI/FS) report (Floyd|Snider 2011) indicate significantly lower concentrations of both TPH and Penta following thermal treatment. Laboratory analytical reports for soil are included in Appendix C.

2.7.4 Comparison of Soil Data to Remediation Levels

According to the CAP, the 95 percent upper confidence level (UCL) of the mean PCE + TCE concentration in each treatment area was compared to the remediation level of 10 ppm to judge compliance.[1] Each treatment area was assessed separately (i.e., the data collected in one area were not used in calculating the average in other areas). The calculated 95 percent UCL for each area is included in Table 2.3. Figure 2.6 graphically presents the number of samples in various concentration ranges for each of the five treatment areas. In addition, Figure 2.7 shows the comparison of maximum PCE+TCE concentrations in soil both pre- and post-thermal, and Figures 2.8 and 2.9 show the pre- and post-thermal PCE+TCE concentrations at various depth intervals. The post-thermal data indicate nearly complete removal of contaminants from the treatment areas with all individual samples at levels less than the 10 mg/kg remediation goal

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[1] The determination of the 95 percent UCL was in accordance with current Ecology guidance.

except for two samples in the Flammables Shed Areaand one in the East Rail Area, which were all shallow vadose zone soil.[2] The maximum concentration of PCE in these three samples was 29 mg/kg.[3]

2.8 THERMAL SYSTEM MASS AND PERCENT REMOVAL

In order to ascertain the efficiency of the thermal treatment process, an estimate was made of the mass of solvent removed via the thermal system as well as an estimate of remaining mass of solvent in the subsurface. Two methodologies were used for estimating the mass of solvent removed by the thermal system. The first uses vapor influent data and the second uses the consumption of sodium hydroxide by the acid gas scrubber. Each methodology is discussed below.

2.8.1 Mass Removal

The analytical data collected bi-weekly of the influent vapor to the carbon and to the oxidizer, combined with their respective flow rates, were used to provide a rough estimate of the associated mass removal of contaminants from the subsurface. Vapor samples were analyzed for individual VOCs, as well as TPH-G, given the presence of mineral spirits at the Site. Analytical results from the vapor samples are presented in Table 2.5 for the most abundant compounds detected. Using the influent mass for each compound and the flow rate to the treatment units, the estimated mass removal in pounds per day of VOCs and TPH-G for the GAC and the thermal oxidizer were calculated and are presented in Table 2.5.

Based on analytical data, which were averaged for each month, the following mass removal for primary COCs was estimated as the following:

- The GAC removed a total of 2,430 pounds of CVOCs (primarily PCE) and the oxidizer destroyed a total of 1,810 pounds of CVOCs (primarily PCE) for a total chlorinated mass removal of 4,240 pounds.
- The GAC removed a total of 10,330 pounds of TPH-G and the oxidizer destroyed 9,230 pounds for a total of 19,560 pounds of TPH.

However, mass estimates using this methodology are considered less reliable given the infrequent sampling interval in which vapor samples were collected and the nature of the ERH process, which removes highly variable quantities of mass during very short time periods. This is especially the case as the soil nears the point of solvent volatilization, when large spikes in mass removal occur in very short intervals that are not always captured by the infrequent vapor samplesis.

A more precise estimate of the amount of chlorinated compounds that are removed can be obtained based on sodium hydroxide consumption, as consumption of sodium hydroxide is directly related to the quantity of acid gas produced by the thermal oxidizer based on the oxidation of PCE and its subsequent neutralization. The molar conversion and mass balance indicate that 3 pounds of PCE are destroyed for every gallon of sodium hydroxide used. Therefore, based on the 2,000 gallons of sodium hydroxide consumed by the acid gas scrubber:

- The oxidizer destroyed a total of 5,700 pounds of CVOCs (primarily PCE).

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[2] According to TRS, the upper 3–5 feet of soil is more difficult to treat due to limited heating in the soil directly below ground surface combined with the loss of heat removed via the vapor recovery system.

[3] While these samples had individual concentrations at levels greater than the remediation level, they did not impact the average concentration to be greater than the remediation level.

Assuming that this estimate is more accurate than the estimate based upon influent vapor data and assuming that the carbon also removed a similar mass given the identical flow rates and similar influent concentrations, the total amount of PCE removed by the thermal system was, at maximum, 11,400 pounds.

The RI/FS estimated that there was approximately 10,000 pounds of PCE+TCE in the subsurface soil before the start of thermal treatment using soil contouring. This pre-thermal estimate is reasonably close to the actual mass removed using the sodium hydroxide consumption methodology.

2.8.2 Mass Remaining and Percent Removal

Using a similar contouring method as used in the RI/FS for calculating the initial mass, the soil confirmational data were used to generate soil contours and from that, mass estimates. This methodology, as detailed in Appendix D, results in an estimated 40 pounds of PCE+TCE remaining in the soil after thermal treatment. Nearly all of this residual mass lies in the vadose zone, based on the several samples collected from the Flammables Shed and East Rail Areas with PCE concentration greater than 10 mg/kg as noted in Section 2.7.4. This correlates to an approximate percent removal of 99.6 percent, based on an initial mass of 10,000 pounds.

Another methodology for estimating the percent removal is based on a comparison of the pre- and post-thermal average soil concentration of PCE+TCE. As presented in Appendix D, the average site pre-thermal PCE+TCE concentration in the areas treated on-site was 141 mg/kg. After thermal treatment, the average concentration is 0.53 mg/kg. This correlates to a percent decrease of 99.6 percent, which correlates well to the 99.6 percent removal based on mass. Note that both the pre- and post-thermal mass estimates for PCE+TCE only included concentrations greater than 1 mg/kg as that is where the majority of the mass resides. However, for thoroughness, based on the post-thermal detected concentrations less than 1 mg/kg, it was determined that approximately 14 additional pounds of PCE+TCE remain in the soil for a total mass remaining of 56 pounds of PCE + TCE. All mass remaining calculations can be found in Appendix D.

3.0 Northwest Corner Soil Vapor Extraction System

SVE was implemented in the Northwest Corner Plume to remove PCE from the vadose zone that would otherwise act as a long-term source of groundwater contamination. The SVE system consists of four vertical SVE wells placed in the parking lot located in the Northwest Corner Plume and along S. Willow Street. SVE system piping is bundled in shallow trenches, and extends above the ground surface at a central manifold location, where piping from individual wells is connected to a vacuum blower. The vapor stream is vented through two 1,200-pound VGAC vessels piped in series prior to discharge to the atmosphere. The aboveground components of the SVE system are contained within a portable trailer that is located adjacent to the Cascade Columbia warehouse. An electrical service was extended from the warehouse to service the blower and controls. Figure 3.1 shows the layout of the SVE system that was installed.

3.1 SOIL VAPOR EXTRACTION OPERATION SUMMARY

The four vertical SVE wells (SVE-1 through SVE-4) were installed in June 2012 and connected via subsurface piping in early August 2012. The manifold was built by Floyd|Snider and the subsurface system was connected to the portable trailer in late August and early September 2012. The SVE system was activated on September 19, 2012, for continuous operation. Floyd|Snider personnel conducted routine Operations and Maintenance (O&M) visits to monitor system operation and performance. The system operated continuously, with the exception of minor temporary deactivations for maintenance or power outages. The system was deactivated by Floyd|Snider on July 10, 2013, for a rebound analysis as further described in Section 3.3 and was permanently deactivated on August 28, 2013.

3.2 SOIL VAPOR EXTRACTION PERFORMANCE MONITORING SUMMARY

Performance monitoring for the SVE system includes the following data collection activities:

- Collection of PID field measurements for total volatile organic vapors for the GAC vessel at the influent and effluent ports to verify CVOC vapor removal by the carbon, and to detect breakthrough from the primary carbon adsorption vessel.
- Collection of vapor samples from the influent and effluent ports of the GAC units for laboratory analysis of CVOCs, to determine system removal efficiency and vapor stream concentrations.
- Collection of PID measurements from three existing sub-slab soil vapor points, SV-1 through SV-3, located within the Cascade Columbia Facility buildings, to evaluate SVE system effectiveness in reducing sub-slab soil vapor CVOC concentrations.
- Collection of soil vapor samples from the three existing sub-slab soil vapor points, SV-1 through SV-3, for laboratory analysis of CVOCs to confirm PID field measurements and to evaluate the effectiveness of the SVE system in reducing soil vapor concentrations beneath the Cascade Columbia building.
- Collection of vacuum measurements at selected nearby wellheads using magnehelic gauges as well as at two existing sub-slab soil vapor points in the Cascade Columbia office, SV-1 and SV-2, to evaluate the radius of influence for the SVE system.

3.2.1 Soil Vapor Sample Collection

The GAC system consists of a primary carbon vessel and a secondary carbon vessel piped in series. Off-gas vapors from the SVE system were routinely field screened with a PID before the primary vessel (influent) and after the secondary vessel (effluent). Vapor samples were periodically collected for laboratory analysis from the influent sample port to determine vapor stream concentrations of PCE. In addition, soil vapor samples were also collected from existing sub-slab vapor points (SV-1 through SV-3) installed 6 inches beneath the concrete slab of the Cascade Columbia building to evaluate system performance and the effectiveness of SVE in reducing sub-slab building concentrations. These sampling locations are shown on Figure 3.1. The soil vapor samples from the GAC system and the sub-slab soil vapor points were collected into Tedlar bags and were analyzed for CVOCs by USEPA Method 8260C by Fremont Analytical, Inc., in Seattle, Washington.

3.3 REBOUND ANALYSIS AND SYSTEM SHUT-DOWN

The vapor samples indicated that the system had reached asymptotic conditions several months after start up. On July 10, 2013, the SVE system was temporarily shut down to perform a rebound analysis. The SVE system remained inactive for approximately 1 month. On August 14, 2013, the system was turned back on to assess rebound. A full SVE O&M check was performed as soon as the system was turned back on and then again an hour later to determine any changes. No significant changes were noted over the hour. The system continued to run for 2 days and on August 16, 2013, another O&M check was performed and a vapor sample was collected. The results of the vapor sample showed a slight increase greater than asymptotic baseline. Following Ecology approval, the system was permanently shut down on August 28, 2013.

3.4 SOIL VAPOR EXTRACTION MASS REMOVAL

The SVE system operation parameters for the duration of the project are summarized in Table 3.1. A summary of general operating parameters follows:

- System influent (pre-carbon) concentrations (as measured with a PID and corrected for PCE) were between 2.85 and 66.1 parts per million by volume (ppmv).
- System effluent (post-carbon) concentrations (as measured with a PID) were between 0 and 3.5 ppmv.
- System flow rate was measured at 260 scfm for the first 3 months of operation; however, it was then decreased to 180 scfm to accommodate a new blower reconfiguration.
- Soil vapor samples were periodically collected from the influent sample port of the SVE system to document system performance and to estimate mass removal. A summary of detected compounds for each sample is provided in Table 3.2.
- An estimated mass removal (pounds per day) of CVOCs during SVE system operation is also provided in Table 3.1.
- An estimated 111.3 pounds of CVOCs were removed from the subsurface since system activation on September 19, 2012.

4.0 Indoor Air Monitoring

Samples of indoor air, as well as sub-slab vapors, were collected before, during, and after thermal remediation activities at both the Seattle Boiler Works property and within the Cascade Columbia warehouse. Analytical results for each event were provided to Ecology in separate memorandums subsequent to each sampling event. The memoranda, including results for both Seattle Boiler Works and Cascade Columbia, are included in Appendix E. Results from both facilities indicate compliance with their respective indoor air cleanup levels.

5.0 Post-thermal Remediation Activities

With the completion of ERH in the Main Source Area and SVE in the Northwest Corner Plume, several aspects of the project are now complete. Continuing post-thermal work in the Main Source Area includes the collection of groundwater samples to evaluate post-thermal groundwater quality in the treated zones and develop a plan for post-thermal ERD polish. In addition, ongoing ERD for the Downgradient Groundwater Plume will continue, along with routine site-wide groundwater monitoring and seep monitoring. Groundwater monitoring and ERD activities are separately reported to Ecology by CALIBRE Systems, Inc. Additional indoor air sampling needs to occur at the Cascade Columbia office in September 2013 to verify that indoor air is in compliance with the cleanup levels following the shutdown of the SVE system. In addition, the SVE trailer will be moved to extract vapors from the electrodes in the Flammables Shed Area near where the three samples with elevated concentration of PCE remain in vadose zone soils. This will further remove residual PCE mass from the Site. Details will be provided to Ecology in the routine monthly reports.

6.0 Waste Management

Soil and water investigation-derived waste and remediation waste were generated during construction of the remedy components and operation of the thermal system. The following sections describe the management of generated waste during system construction and operation.

6.1 SOIL MANAGEMENT

Excess soil requiring management was generated during thermal electrode installation, SVE well installation, trenching for thermal and SVE subsurface piping networks, ERD injection well installation, and confirmation soil sampling within the thermal treatment area.

6.1.1 Thermal System Wells and Piping

Excess soils were generated during the installation of electrodes (via drilling) and subsurface trenching and piping during thermal system connection activities. In addition, trenching also generated general construction waste, such as concrete debris. Most soil cuttings and trenching spoils were used to backfill the open excavation created by removal of the former chemical USTs in the Flammables Shed Area. This soil was subsequently treated via ERH. A smaller quantity of soil cuttings that were not able to be used as backfill in that area were stockpiled and characterized for off-site disposal. Based on the results of this profiling, 125 tons of stockpile soil was designated as hazardous waste and transported off-site for disposal at a Subtitle C hazardous waste landfill in accordance with appropriate regulations.

Construction waste such as metal and concrete debris was segregated, cleaned to remove loose soil particles, and hauled off-site for disposal as construction debris. One small concrete vault containing 20 gallons of liquid PCE was discovered in the Rail Spur Area during utility relocation work prior to the installation of the thermal system. The PCE was pumped out and the concrete vault removed and demolished. The liquid PCE was sent off for incineration and the concrete debris was sent to a hazardous waste landfill.

6.1.2 Soil Vapor Extraction Wells and Piping

Soil excavated during trenching in the Northwest Corner Plume was reused as backfill and bedding material following placement of the SVE system piping. Soil cuttings generated during SVE well installations, along with excess soil generated during trenching and piping activities, were used to backfill the UST graves in the Flammables Shed Area. Based on PID screening and visual and olfactory observations, soils did not appear to be impacted. Regardless, Ecology concurred that this reuse on-site was appropriate, as the area the soil was used as fill in (the Flammables Shed Area tank pit) was subsequently thermally treated.

6.1.3 Enhanced Reductive Dechlorination Injection Wells

ERD injection well installation drilling cuttings that were combined with soils generated during thermal system installation were either placed in the UST excavation in the Flammables Shed Area for treatment or co-mingled and stockpiled with the excess soil generated during thermal system installation and profiled for off-site disposal as described in Section 6.1.1.

6.1.4 Thermal Compliance Soil Sampling

Soil cuttings generated during soil compliance sampling events were containerized into three 55-gallon drums and placed in a secure area for subsequent disposal. The drums will be transported off-site for disposal at a Subtitle D landfill in accordance with Ecology's "contained-in" policy.

6.2 WATER MANAGEMENT

6.2.1 Well Development, Decontamination, and Purge Water

Purge water and development water generated during ERD well installation was containerized and subsequently treated through the LGAC units prior to discharge to the sanitary sewer system under the KCIW permit.

6.2.2 Thermal and Soil Vapor Extraction System Condensate

During ERH, steam was collected from the subsurface and removed from the recovered vapor stream using two blowers and steam condensers. Condensate was formed in the condensers and treated with LGAC before being discharged to the sanitary sewer system under applicable permitting requirements, as discussed in Section 2.4.

In addition, during SVE system operation, vapor removed from the subsurface passed through a moisture separator, where a small amount of condensate was formed. Condensate was collected in a moisture separator, and then manually drained to a container as needed during routine system maintenance. The containerized condensate was then transported by Cascade Columbia staff to the ERH equipment enclosure and combined with the ERH condensate waste stream for treatment with LGAC prior to discharge to the sanitary sewer system under the KCIW permit.

6.3 SPENT GRANULAR ACTIVATED CARBON

Over the course of the project, the VGAC in the three vessels (totaling 10,000 pounds) was initially bedded by Seimens and then changed out six times due to breakthrough, for a total usage of approximately 70,000 pounds of VGAC. Spent VGAC was removed by Seimens during the delivery of each new set of carbon.

Due to breakthrough, the four 55-gallon LGAC vessels were changed out twice during the duration of the project. Spent LGAC was also removed by Seimens during the delivery of each new set of carbon.

7.0 References

Floyd|Snider. 2011. *Remedial Investigation/Feasibility Study, Fox Avenue Site, Seattle, Washington.* Prepared for Fox Avenue Building, LLC.10 June.

———. 2012. *Fox Avenue Site Engineering Design Report*. Prepared for Fox Avenue Building, LLC. 9 October.

Washington State Department of Ecology (Ecology). 2012. *Final Cleanup Action Plan.* June.

Fox Avenue Site

Construction Completion Report

Tables

Table 2.1
ERH System Operation Summary

Date	1/7/2013	1/14/2013	1/21/2013	1/28/2013	2/4/2013	2/11/2013	2/19/2013	2/25/2013	3/4/2013	3/11/2013	3/18/2013
Parameter											
ERH System Operating Parameters											
Weekly Average Power (kW)	0	1,011	2,080	2,270	2,410	2,311	2,463	2,567	2,567	2,987	2,905
Cumulative Energy Applied (kWh), Cleanup Goal = 9,400,00 kWh	0	148,360	530,000	857,000	1,204,000	1,576,000	1,965,200	2,458,000	2,873,000	3,333,000	3,751,000
Average Subsurface Temperature (°C)	12	14.2	26.7	42.5	52	54.3	61.5	67.2	73	80.1	83.9
Weekly Average Influent Vapor System Flow Rate—High VOC Header (scfm)	0	500	500	500	500	500	500	500	500	500	500
Weekly Average Influent Vapor System Flow Rate—Low VOC Header (scfm)	0	500	500	500	500	500	500	500	500	500	500
Water and Sodium Hydroxide Consumption											
Total Water Consumption (cumulative gal)	2,389	8,555	58,826	129,282	194,488	279,090	359,257	422,824	492,061	563,353	637,580
Sodium Hydroxide Consumed (cumulative gal)	0	300	600	794	1,076	1,255	1,355	1,395	1,438	1,495	1,558
Estimated Pounds of Chlorinated VOCs Destroyed in the Oxidizer (cumulative)	0	875	1,750	2,316	3,139	3,661	3,952	4,069	4,195	4,361	4,545
Condensate Generation											
Total Discharge (gal/reporting period)	0	15,986	34,089	43,101	69,213	44,161	77,142	66,187	68,169	75,048	75,642
Total Discharge (cumulative gal)	0	15,986	50,075	93,176	162,389	206,550	283,692	349,879	467,909	542,957	618,599
PID Measurements											
Oxidizer—Influent (ppmv)	311	152	198	779	390	133	610	390	290	450	293
Oxidizer—Effluent (ppmv)	11.3	13.2	9.7	8.9	38	7.2	15.5	5	7	0.7	1
Carbon—Influent (ppmv)	--	200	647	>1,280	1,000	336	371	1,400	376	1,130	281
Carbon—Midpoint (ppmv)	--	1.4	48	966	254	311	7.6	299	165	5	35.5
Carbon—Effluent (ppmv)	--	1.4	6.4	111	3.7	145	1.6	3	55	0	2.5

Note:

-- Measurements not taken during this time.

Abbreviations:

°C	Degrees Celsius
ERH	Electrical Resistance Heating
gal	Gallon
kW	Kilowatt
kWh	Kilowatt hour
PID	Photoionization detector
ppmv	Parts per million by volume
scfm	Standard cubic feet per minute
VOC	Volatile organic compound

Table 2.1
ERH System Operation Summary

Date	3/25/2013	4/1/2013	4/8/2013	4/15/2013	4/22/2013	4/29/2013	5/6/2013	5/13/2013	5/20/2013	5/27/2013
Parameter										
ERH System Operating Parameters										
Weekly Average Power (kW)	2,760	2,720	2,859	2,733	3,438	3,150	3,578	2,540	0	0
Cumulative Energy Applied (kWh), Cleanup Goal = 9,400,00 kWh	4,148,000	4,556,000	4,982,000	5,392,000	5,894,000	6,398,000	6,958,000	7,377,000	7,377,000	7,377,000
Average Subsurface Temperature (°C)	85.2	87.1	89	89.9	91.8	94.6	95.3	95.2	--	--
Weekly Average Influent Vapor System Flow Rate—High VOC Header (scfm)	500	500	500	500	500	500	500	500	500	500
Weekly Average Influent Vapor System Flow Rate—Low VOC Header (scfm)	500	500	500	500	500	500	500	500	500	500
Water and Sodium Hydroxide Consumption										
Total Water Consumption (cumulative gal)	744,540	828,585	918,251	999,227	1,100,659	1,205,111	1,297,228	1,414,602	1,414,602	1,414,602
Sodium Hydroxide Consumed (cumulative gal)	1,641	1,698	1,748	1,771	1,801	1,838	1,894	1,954	1,954	1,954
Estimated Pounds of Chlorinated VOCs Destroyed in the Oxidizer (cumulative)	4,787	4,953	5,099	5,166	5,253	5,361	5,525	5,700	5,700	5,700
Condensate Generation										
Total Discharge (gal/reporting period)	75,362	84,479	100,078	101,126	122,948	122,900	90,953	130,351	61,514	0
Total Discharge (cumulative gal)	693,961	778,440	878,518	979,644	1,102,592	1,225,492	1,316,445	1,446,796	1,508,310	1,508,310
PID Measurements										
Oxidizer—Influent (ppmv)	378	146	103	150	103	111	217	192	45.7	--
Oxidizer—Effluent (ppmv)	5.2	4.4	6.3	7.3	5.4	8	7.8	1.5	5.3	--
Carbon—Influent (ppmv)	325	178	151	178	131	384	237	263	33	--
Carbon—Midpoint (ppmv)	9.8	80.1	9.4	4	7	26.1	2.1	19.2	7.4	--
Carbon—Effluent (ppmv)	1.4	30.1	6.2	3.2	4.9	14	0	2.4	0.9	--

Note:

-- Measurements not taken during this time.

Abbreviations:

°C	Degrees Celsius
ERH	Electrical Resistance Heating
gal	Gallon
kW	Kilowatt
kWh	Kilowatt hour
PID	Photoionization detector
ppmv	Parts per million by volume
scfm	Standard cubic feet per minute
VOC	Volatile organic compound

Table 2.2
ERH Soil Analytical Summary
(March Only)

Location	Treatment Area	Sample Date	Depth (ft bgs)	Tetrachloroethene (mg/kg)	Trichloroethene (mg/kg)	PCE+TCE (mg/kg)
LD1	Loading Dock	03/14/2013	12	12.2	0.428	12.628
LD1	Loading Dock	03/14/2013	14.5	0.0738	0.0385 U	0.1123
LD1	Loading Dock	03/14/2013	7.5	1520	0.882	1,520.88
LD2	Loading Dock	03/14/2013	12	13	0.0521	13.0521
LD2	Loading Dock	03/14/2013	15	0.0501	0.038 U	0.0881
LD2	Loading Dock	03/14/2013	7	1630	0.775	1,630.78
LD3	Loading Dock	03/14/2013	10	0.0406	0.0369 U	0.0775
LD3	Loading Dock	03/14/2013	14.5	0.0209 U	0.0313 U	0.0522 U
LD3	Loading Dock	03/14/2013	8	0.108	0.0424 U	0.1504
LD4	Loading Dock	03/14/2013	12	6.58	0.0517	6.6317
LD4	Loading Dock	03/14/2013	15	0.0435	0.0353 U	0.0788
LD4	Loading Dock	03/14/2013	7	11	0.0517	11.0517
LD5	Loading Dock	03/14/2013	12	0.0848	0.0306	0.1154
LD5	Loading Dock	03/14/2013	8.5	0.265	0.0686	0.3336
Average With 95% Confidence						**527.6**
WR1	West Rail	03/14/2013	14.5	0.0336	0.0666	0.1002
WR1	West Rail	03/14/2013	9	0.505	0.0827	0.5877
WR2	West Rail	03/13/2013	16	0.0267 U	0.04 U	0.0667
WR2	West Rail	03/13/2013	8	1.59	0.19	1.78
WR3	West Rail	03/14/2013	14	0.33	0.0478 U	0.3778
WR3	West Rail	03/14/2013	9	0.0414 U	0.0621 U	0.1035 U
WR4	West Rail	03/13/2013	15.5	0.0283 U	0.0425 U	0.0708 U
WR4	West Rail	03/13/2013	7.5	0.0211 U	0.0317 U	0.0528 U
WR5	West Rail	03/14/2013	14	0.0253 U	0.0379 U	0.0632 U
WR5	West Rail	03/14/2013	8.5	0.0389 U	0.0584 U	0.0973 U
WR6	West Rail	03/13/2013	14	0.0281 U	0.0422 U	0.0703 U
WR6	West Rail	03/13/2013	8	0.0339 U	0.0508 U	0.0847 U
WR7	West Rail	03/13/2013	15	0.0494 U	0.0741 U	0.1235 U
WR7	West Rail	03/13/2013	6.5	0.0324 U	0.0485 U	0.0809 U
WR8	West Rail	03/13/2013	11–12	0.0547 U	0.0821 U	0.1368 U
WR8	West Rail	03/13/2013	16.5–17	0.023 U	0.0345 U	0.0575 U
Average With 95% Confidence						**0.5**

Abbreviations:

ERH	Electrical Resistance Heating
ft bgs	Feet below ground surface
mg/kg	Milligrams per kilogram
PCE	Tetrachloroethene
TCE	Trichloroethene

Qualifier:

U Analyte not detected at given reporting limit

Table 2.3
ERH Soil Analytical Summary—Final Samples

Table 2.3: ERH Soil Analytical Summary

Location and Depth[1]	Treatment Area	Sample Date	Tetrachloroethene (mg/kg)	Trichloroethene (mg/kg)	PCE+TCE (mg/kg)
LD1 (10)	Loading Dock	05/13/2013	0.0229 U	0.0343 U	0.0286 U
LD1 (10.5)	Loading Dock	05/13/2013	0.0216 U	0.0325 U	0.0271 U
LD2 (10.5)	Loading Dock	05/13/2013	0.0995	0.0364 U	0.118
LD2 (7.5)	Loading Dock	05/13/2013	0.642	0.0354 U	0.66
LD3 (10)	Loading Dock	03/14/2013	0.0406	0.0369 U	0.0591
LD3 (14.5)	Loading Dock	03/14/2013	0.0209 U	0.0313 U	0.0261 U
LD3 (8)	Loading Dock	03/14/2013	0.108	0.0424 U	0.129
LD4 (10)	Loading Dock	05/13/2013	0.021 U	0.0315 U	0.0263 U
LD4 (5)	Loading Dock	05/13/2013	6.04 D	0.0408 U	6.06
LD5 (12)	Loading Dock	03/14/2013	0.0848	0.0306	0.115
LD5 (8.5)	Loading Dock	03/14/2013	0.265	0.0686	0.334
				Average With 95% Confidence	**1.75**
ER1 (15–17.5)	East Rail	05/16/2013	0.0237 U	0.0355 U	0.0296 U
ER1 (3.5–5)	East Rail	05/16/2013	2	0.53	2.53
ER2 (16–18)	East Rail	05/16/2013	0.0239 U	0.0358 U	0.0299 U
ER2 (3–5)	East Rail	05/16/2013	1.29	0.236	1.53
ER3 (16-18)	East Rail	05/16/2013	0.234	0.0659	0.3
ER3 (3–5)	East Rail	05/16/2013	8.91 D	1.09	10
ER4 (18–20)	East Rail	05/16/2013	0.0286 U	0.0429 U	0.0358 U
ER4 (2.5–5)	East Rail	05/16/2013	14.8 D	0.574	15.4
ER5 (13–15)	East Rail	05/15/2013	0.0215 U	0.0323 U	0.0269 U
ER5 (3–5)	East Rail	05/15/2013	0.738	0.0299 U	0.753
ER6 (13–15)	East Rail	05/15/2013	0.026 U	0.0389 U	0.0325 U
ER6 (2–3.5)	East Rail	05/15/2013	0.416	0.0449	0.461
ER7 (11.5–13.5)	East Rail	05/15/2013	0.0293	0.0325 U	0.0456
ER7 (2–3.5)	East Rail	05/15/2013	0.665	0.0386 U	0.685
ER8 (11.5–13)	East Rail	05/15/2013	0.0253 U	0.0379 U	0.0316 U
ER8 (13–15)	East Rail	05/15/2013	0.0234 U	0.0351 U	0.0293 U
				Average With 95% Confidence	**4.13**
FS1 (3–5)	Flammables Shed	05/16/2013	0.0253 U	0.0379 U	0.0316 U
FS1 (36–38)	Flammables Shed	05/16/2013	0.0269 U	0.149	0.162
FS1 (51–53)	Flammables Shed	05/16/2013	0.0256 U	0.141	0.154
FS1 (55.5–58)	Flammables Shed	05/16/2013	0.027 U	0.0406 U	0.0338 U
FS1 (6.5–8)	Flammables Shed	05/16/2013	0.0372	0.0328 U	0.0536
FS10 (15–17.5)	Flammables Shed	05/20/2013	0.0162 J	0.0343 U	0.0334
FS10 (2.5–5)	Flammables Shed	05/20/2013	3.02	0.184	3.204
FS10 (43–45)	Flammables Shed	05/20/2013	0.0246 U	0.0368 U	0.0307 U
FS10 (46.5–48)	Flammables Shed	05/20/2013	0.0239 U	0.0359 U	0.0299 U
FS10 (60.5–62.5	Flammables Shed	05/20/2013	0.0253 U	0.0379 U	0.0316 U
FS2 (15.5–17.5)	Flammables Shed	05/22/2013	0.0227 U	0.0341 U	0.0284 U
FS2 (3.5–5)	Flammables Shed	05/22/2013	1.07	0.078	1.15
FS2 (46.5–48)	Flammables Shed	05/22/2013	0.29	0.0398 U	0.31
FS2 (51.5–53)	Flammables Shed	05/22/2013	0.103	0.0694	0.172
FS2 (55–60)	Flammables Shed	05/22/2013	0.0244 U	0.0366 U	0.0305 U

Table 2.3
ERH Soil Analytical Summary—Final Samples

Location and Depth[1]	Treatment Area	Sample Date	Tetrachloroethene (mg/kg)	Trichloroethene (mg/kg)	PCE+TCE (mg/kg)
FS3 (17.5–20)	Flammables Shed	05/17/2013	0.0269 U	0.0404 U	0.0337 U
FS3 (3.5–5)	Flammables Shed	05/17/2013	0.126	0.0299 U	0.141
FS3 (48–50)	Flammables Shed	05/17/2013	0.0241 U	0.0362 U	0.0302 U
FS3 (53–55)	Flammables Shed	05/17/2013	0.0286 U	0.0429 U	0.0358 U
FS3 (57.5–60)	Flammables Shed	05/17/2013	0.026 U	0.039 U	0.0325 U
FS4 (15.5–17.5)	Flammables Shed	05/17/2013	0.233	0.0456 U	0.256
FS4 (3–5)	Flammables Shed	05/17/2013	1.34	0.267	1.61
FS4 (48–50)	Flammables Shed	05/17/2013	0.0298 U	0.0447 U	0.0373 U
FS4 (59–60)	Flammables Shed	05/17/2013	0.0245 U	0.0367 U	0.0306 U
FS4 (64–65)	Flammables Shed	05/17/2013	0.0242 U	0.0363 U	0.0303 U
FS4a (55.5–57.5	Flammables Shed	05/22/2013	0.0205 U	0.0307 U	0.0256 U
FS4a (63–65)	Flammables Shed	05/22/2013	0.0218 U	0.0328 U	0.0273 U
FS5 (15.5–17.5)	Flammables Shed	05/20/2013	0.026 U	0.039 U	0.0325 U
FS5 (46.5–48)	Flammables Shed	05/20/2013	0.37	0.0363 U	0.388
FS5 (56.5–58)	Flammables Shed	05/20/2013	0.0239 U	0.0359 U	0.0299 U
FS5 (63–65)	Flammables Shed	05/20/2013	0.0265 U	0.0397 U	0.0331 U
FS5 (8.5–10)	Flammables Shed	05/20/2013	0.0771	0.0345 U	0.0944
FS5a (0–5)	Flammables Shed	05/21/2013	2.68 U	0.0485	2.73
FS5a (5–10)	Flammables Shed	05/21/2013	0.0334 U	0.0339 U	0.0504
FS5a (10–15)	Flammables Shed	05/21/2013	0.0264 U	0.0396 U	0.033 U
FS5a (15–20)	Flammables Shed	05/21/2013	0.0259 U	0.0389 U	0.0324 U
FS6 (12–13.5)	Flammables Shed	05/16/2013	0.102	0.0335 U	0.119
FS6 (18–20)	Flammables Shed	05/16/2013	0.0248 J	0.0373 U	0.0311
FS6 (37.5–40)	Flammables Shed	05/16/2013	0.472	0.273	0.745
FS6 (58–60)	Flammables Shed	05/17/2013	0.0272 U	0.0408 U	0.034 U
FS6 (63–65)	Flammables Shed	05/17/2013	0.0262 U	0.0393 U	0.0328 U
FS7 (17–18.5)	Flammables Shed	05/17/2013	0.0329 U	0.0494 U	0.0412 U
FS7 (3–5)	Flammables Shed	05/17/2013	24	0.441	24.4
FS7 (45.5–47.5)	Flammables Shed	05/17/2013	0.0258	0.0387 U	0.0323
FS7 (58–60)	Flammables Shed	05/17/2013	0.0247	0.0371 U	0.0309
FS7 (63–65)	Flammables Shed	05/17/2013	0.0258	0.0388 U	0.0323
FS8 (16.5–18)	Flammables Shed	05/22/2013	0.0219 U	0.0328 U	0.0274 U
FS8 (48–50)	Flammables Shed	05/22/2013	0.0246 U	0.0369 U	0.0308 U
FS8 (51–53)	Flammables Shed	05/22/2013	0.0247	0.0371 U	0.0309
FS8 (56.5–58)	Flammables Shed	05/22/2013	0.027 U	0.0405 U	0.0338 U
FS8 (7–8.5)	Flammables Shed	05/22/2013	0.0244 U	0.0366 U	0.0305 U
FS9 (7–8.5)	Flammables Shed	05/21/2013	26.8	0.0623	26.9
FS9 (16–18)	Flammables Shed	05/21/2013	0.0216	0.0324 U	0.027 U
FS9 (18–20)	Flammables Shed	05/21/2013	0.0262	0.0394 U	0.0328 U
FS9 (48.5–50)	Flammables Shed	05/21/2013	0.0194 U	0.0291 U	0.0243 U
FS9 (53.5–55)	Flammables Shed	05/21/2013	0.0324 U	0.0382 U	0.0515
FS9 (55–60)	Flammables Shed	05/21/2013	0.0227 U	0.034 U	0.0284 U
FS9 (63–65)	Flammables Shed	05/21/2013	0.0252 U	0.0378 U	0.0315 U
				Average With 95% Confidence	**2.32**

Table 2.3
ERH Soil Analytical Summary—Final Samples

Location and Depth[1]	Treatment Area	Sample Date	Tetrachloroethene (mg/kg)	Trichloroethene (mg/kg)	PCE+TCE (mg/kg)
PA1 (48–50)	Production Area	05/16/2013	0.0238 U	0.0357 U	0.0298 U
PA1 (57.5–60)	Production Area	05/16/2013	0.273	3.91	4.18
PA1 (61–63)	Production Area	05/16/2013	0.029 U	0.0436 U	0.0363 U
PA2 (46–48)	Production Area	05/17/2013	0.0361 U	0.0541 U	0.0451 U
PA2 (51–53)	Production Area	05/17/2013	0.0269 U	0.0404 U	0.0337 U
PA2 (58–60)	Production Area	05/17/2013	0.0291 U	0.0437 U	0.0364 U
PA3 (36.5–38)	Production Area	05/14/2013	0.0293 U	0.044 U	0.0367 U
PA3 (48–50)	Production Area	05/14/2013	0.027 U	0.0405 U	0.0338 U
PA3 (63–65)	Production Area	05/14/2013	0.514	0.303	0.817
PA4 (51.5–53.5)	Production Area	05/14/2013	0.0247 U	0.0371 U	0.0309 U
PA4 (58–60)	Production Area	05/14/2013	0.0234 U	0.0351 U	0.0293 U
PA4 (61–63)	Production Area	05/14/2013	0.0256 U	0.104	0.117
PA5 (38–40)	Production Area	05/13/2013	0.0246 U	0.0369 U	0.0308 U
PA5 (48–50)	Production Area	05/13/2013	0.0941	0.0392 U	0.114
PA5 (58–59)	Production Area	05/13/2013	0.126	0.0355 U	0.144
PA5 (62–63)	Production Area	05/13/2013	0.025 U	0.0375 U	0.0313 U
PA6 (36–38)	Production Area	05/15/2013	0.0264 U	0.0396 U	0.033 U
PA6 (52–53.5)	Production Area	05/15/2013	0.0383	0.0965	0.135
PA6 (53.5–55)	Production Area	05/15/2013	0.0273 U	0.0409 U	0.0341 U
PA6a (57.5–60)	Production Area	05/22/2013	0.0254 U	0.0381 U	0.0318 U
PA6a (62.5–65)	Production Area	05/22/2013	0.0848	0.302	0.387
PA7 (48.5–50)	Production Area	05/15/2013	0.0267 U	0.04 U	0.0334 U
PA7 (53–55)	Production Area	05/15/2013	0.0661	0.168	0.234
PA7 (58–60)	Production Area	05/15/2013	0.0241 U	0.0362 U	0.0302 U
Average With 95% Confidence					**0.62**
WR1 (14.5)	West Rail	03/14/2013	0.0336	0.0666	0.1
WR1 (9)	West Rail	03/14/2013	0.505	0.0827	0.588
WR2 (16)	West Rail	03/13/2013	0.0267 U	0.04 U	0.0334 U
WR2 (8)	West Rail	03/13/2013	1.59	0.19	1.78
WR3 (14)	West Rail	03/14/2013	0.33	0.0478 U	0.354
WR3 (9)	West Rail	03/14/2013	0.0414 U	0.0621 U	0.0518 U
WR4 (15.5)	West Rail	03/13/2013	0.0283 U	0.0425 U	0.0354 U
WR4 (7.5)	West Rail	03/13/2013	0.0211 U	0.0317 U	0.0264 U
WR5 (14)	West Rail	03/14/2013	0.0253 U	0.0379 U	0.0316 U
WR5 (8.5)	West Rail	03/14/2013	0.0389 U	0.0584 U	0.0487 U
WR6 (14)	West Rail	03/13/2013	0.0281 U	0.0422 U	0.0352 U
WR6 (8)	West Rail	03/13/2013	0.0339 U	0.0508 U	0.0424 U
WR7 (15)	West Rail	03/13/2013	0.0494 U	0.0741 U	0.0618 U
WR7 (6.5)	West Rail	03/13/2013	0.0324 U	0.0485 U	0.0405 U
WR8 (11–12)	West Rail	03/13/2013	0.0547 U	0.0821 U	0.0684 U
WR8 (16.5–17)	West Rail	03/13/2013	0.023 U	0.0345 U	0.0288 U
Average With 95% Confidence					**0.43**

Table 2.3
ERH Soil Analytical Summary—Final Samples

Note:

1	Depth interval is in parentheses and has units ft bgs.

Abbreviations:

ERH	Electrical Resistance Heating
ft bgs	Feet below ground surface
mg/kg	Milligrams per kilogram
PCE	Tetrachloroethene
TCE	Trichloroethene

Qualifiers:

D	Dilution was required
J	Analyte detected below quantitation limit
U	Analyte not detected at given reporting limit

Table 2.4
TPH and Penta Soil Analytical Summary

			Analyte	Diesel #2	Gasoline-range Organics	Lube Oil	Mineral Spirits	Paraffin Oils	Penta
			Unit	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Location	**Sample ID**	**Date**	**Depth (ft bgs)**						
PA5	PA5 (38-40)	5/13/2013	38–40	--	6.14 U	--	--	--	--
FS6	FS6 (37.5-40)	5/16/2013	37.5–40	--	6.88 U	--	6.88 U	--	--
FS7	FS7 (17-18.5)	5/17/2013	17–18.5	--	8.23 U	--	8.23 U	--	--
FS10	FS10 (15-17.5)	5/20/2013	15–17.5	--	5.71 U	--	5.71 U	--	--
FS9	FS9 (16-18)	5/21/2013	16–18	--	5.4 U	--	106	--	2.51
FS9	FS9 (18-20)	5/21/2013	18–20	--		--	--	--	0.327
FS9	FS9 (7-8.5)	5/21/2013	7–8.5	--	6.1 U	--	76.9	--	9.53
FS2	FS2 (15.5-17.5)	5/22/2013	15.5–17.5	--	5.68 U	--	5.68 U	--	--
FS5	FS5 (15.5-17.5)	5/20/2013	15.5–17.5	--	6.5 U	--	37.3	--	--
FS5a	FS5a (0-5)	5/21/2013	0–5	--	5.16 U	--	104	--	--
FS5a	FS5a (15-20)	5/21/2013	15–20	--	6.49 U	--	6.49 U	--	--
FS8	FS8 (16.5-18)	5/22/2013	16.5–18	--	5.47 U	--	5.47 U	--	--
FS8	FS8 (51-53)	5/22/2013	51–53	--	6.18 U	--	6.18 U	--	--
PA6a	PA6a (57.5-60)	5/22/2013	57.5–60	--	6.34 U	--	6.34 U	--	--
PA6a	PA6a (62.5-65)	5/22/2013	62.5–65	--	6.38 U	--	6.38 U	--	--
GP-40	GP-140 9-10	12/12/2008	9–10	20 U	10 U	50 U	--	40 U	--
GP-40	GP-40 17.5-18.5	12/12/2008	17.5–18.5	20 U	10 U	50 U	--	40 U	--
GP-40	GP-40 22-23	12/12/2008	22–23	20 U	540	50 U	--	40 U	--
GP-40	GP-40 29-30	12/12/2008	29–30	20 U	10 U	50 U	--	40 U	--
GP-40	GP-40 42-43	12/12/2008	42–43	20 U	10 U	50 U	--	40 U	--
GP-40	GP-40 50-51	12/12/2008	50–51	20 U	10 U	50 U	--	40 U	--
GP-40	GP-40 57-58	12/12/2008	57–58	20 U	10 U	50 U	--	40 U	--
GP-40	GP-40 59-60	12/12/2008	59–60	20 U	10 U	50 U	--	40 U	--
GP-40	GP-40 9-10	12/12/2008	9–10	20 U	10 U	50 U	--	40 U	--
GP-57	GP-57 15-17	12/29/2008	15–17	20 U	--	50 U	1,000	40 U	--
GP-57	GP-57 17-18	12/29/2008	17–18	20 U	--	50 U	22	40 U	--
GP-57	GP-57 28-30	12/29/2008	28–30	20 U	--	50 U	20 U	40 U	--
SB-52a	SB-52a 11.5	12/30/2008	11.5	20 U	--	50 U	20 U	40 U	--
SB-52a	SB-52a 3	12/30/2008	3	20 U	--	50 U	20 U	40 U	--

Table 2.4
TPH and Penta Soil Analytical Summary

Note:

--	Not analyzed.

Abbreviations:

ft bgs	Feet below ground surface
mg/kg	Milligrams per kilogram
Penta	Pentachlorophenol
TPH	Total petroleum hydrocarbons

Qualifier:

U	Analyte not detected at given reporting limit

Table 2.5

ERH Vapor Analytical Summary and Mass Removal Estimates[1]

	1/14/2013						1/28/2013					
	Carbon—Influent			Oxidizer—Influent			Carbon—Influent			Oxidizer—Influent		
Analyte	**µg/L**	**ppmv**	**Mass removal rate[1] (lbs/day)**	**µg/L**	**ppmv**	**Mass removal rate[1] (lbs/day)**	**µg/L**	**ppmv**	**Mass removal rate[1] (lbs/day)**	**µg/L**	**ppmv**	**Mass removal rate[1] (lbs/day)**
VOCs[2] (via USEPA 8260)												
Chlorinated Ethenes and Ethanes												
Tetrachloroethene (PCE)	81.2	12.0	3.8	41.1	6.1	1.9	545	80.3	25.3	463	68.3	21.5
Trichloroethene (TCE)	18.1	3.4	0.84	13.3	2.5	0.62	73.6	13.7	3.4	78.2	14.6	3.6
Vinyl Chloride	0.87	0.34	0.04	0.60	0.23	0.03	6.1	2.4	0.28	5.9	2.3	0.27
cis-1,2-Dichloroethene	10.7	2.7	0.50	18.6	4.7	0.86	47.8	12.1	2.2	63.1	15.9	2.93
1,1-Dichloroethene	0.82	0.21	0.04	0.50	0.13	0.02	2.1	0.54	0.10	2.45	0.62	0.11
trans-1,2-Dichloroethene	0.58	0.15	0.03	0.80	0.20	0.04	0.9	0.23	0.04	1.49	0.38	0.07
Other VOCs												
Acetone	ND	ND	ND	ND	ND	ND	1.00	0.42	0.046	22.4	9.4	1.04
Chloromethane	ND	ND	ND	0.42	0.20	0.02	ND	ND	ND	1.69	0.82	0.08
2-Butanone (MEK)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total VOCs	112	18.7	5.2	75.3	14.0	3.5	677	110	31.4	638	112	29.6
Total Petroleum Hydrocarbons (TPH)												
Total Petroleum Hydrocarbons (via TPH-Gx)												
Gasoline-range Organics[3,4]	--	--	--	--	--	--	2,810	687	131	2,530	619	118
Total VOCs+TPH	--	--	--	--	--	--	3,487	797	162	3,168	731	147

Notes:

-- Samples not analyzed for gasoline-range organics during this time.

1 Mass Removal Rate = concentration (ppm) x flow rate (cfm) x 1,440 minutes/day x MW ÷ Mair ÷ 1,000,000.

2 Only analytes whose mass was 1 percent or more of the total mass detected were included.

3 Aromatic compounds reported in the USEPA 8260 analysis that also would have been detected in gasoline-range organics analysis were not included.

4 Gasoline-range organics approximate the mass of mineral spirits in waste stream.

Abbreviations:

cfm	Cubic feet per minute
ERH	Electrical Resistance Heating
lbs	Pounds
Mair	379 ft^3 air/lb-mole air at standard temperature and pressure
MEK	Methyl ethyl ketone
µg/L	Micrograms per liter
MW	Molecular weight
ND	Non-detect
ppm	Parts per million
ppmv	Parts per million by volume
USEPA	U.S. Environmental Protection Agency
VOC	Volatile organic compound

Table 2.5

ERH Vapor Analytical Summary and Mass Removal Estimates[1]

	2/4/2013						2/20/2013					
	Carbon—Influent			Oxidizer—Influent			Carbon—Influent			Oxidizer—Influent		
Analyte	**µg/L**	**ppmv**	**Mass Removal Rate[1] (lbs/day)**	**µg/L**	**ppmv**	**Mass Removal Rate[1] (lbs/day)**	**µg/L**	**ppmv**	**Mass Removal Rate[1] (lbs/day)**	**µg/L**	**ppmv**	**Mass Removal Rate[1] (lbs/day)**
VOCs[2] (via USEPA 8260)												
Chlorinated Ethenes and Ethanes												
Tetrachloroethene (PCE)	426.0	62.8	19.8	256.0	37.7	11.9	116.0	17.1	5.4	142.0	20.9	6.6
Trichloroethene (TCE)	48.7	9.1	2.3	36.0	6.7	1.7	14.1	2.6	0.7	22.8	4.2	1.1
Vinyl Chloride	4.6	1.8	0.2	1.9	0.7	0.1	2.5	1.0	0.1	1.4	0.5	0.1
cis-1,2-Dichloroethene	43.8	11.0	2.0	39.4	9.9	1.8	18.2	4.6	0.8	20.7	5.2	1.0
1,1-Dichloroethene	0.7	0.2	0.0	0.6	0.1	0.0	0.2	0.0	0.0	0.2	0.1	0.0
trans-1,2-Dichloroethene	0.7	0.2	0.0	0.7	0.2	0.0	0.4	0.1	0.0	0.5	0.1	0.0
Other VOCs												
Acetone	1.5	0.6	0.1	5.2	2.2	0.2	3.7	1.6	0.2	9.3	3.9	0.4
Chloromethane	0.2	0.1	0.0	1.9	0.9	0.1	ND	ND	ND	1.4	0.7	0.1
2-Butanone (MEK)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total VOCs	526.2	85.8	24.4	341.5	58.5	15.9	155.1	27.0	7.2	198.3	35.7	9.2
Total Petroleum Hydrocarbons (TPH)												
Total Petroleum Hydrocarbons (via TPH-Gx)												
Gasoline-range Organics[3,4]	1,850	452	86	1,360	333	63	1,370	335	64	1,700	416	79
Total VOCs+TPH	2,376	538	110	1,702	391	79	1,525	362	71	1,898	451	88

Notes:

-- Samples not analyzed for gasoline-range organics during this time.

1 Mass Removal Rate = concentration (ppm) x flow rate (cfm) x 1,440 minute/day x MW ÷ Mair ÷ 1,000,000.

2 Only analytes whose mass was 1 percent or more of the total mass detected were included.

3 Aromatic compounds reported in the USEPA 8260 analysis that also would have been detected in gasoline-range organics analysis were not included.

4 Gasoline-range organics approximate the mass of mineral spirits in waste stream.

Abbreviations:

cfm	Cubic feet per minute
ERH	Electrical Resistance Heating
lbs	Pounds
Mair	379 ft^3 air/lb-mole air at standard temperature and pressure
µg/L	Micrograms per liter
MW	Molecular weight
ND	Non-detect
ppm	Parts per million
ppmv	Parts per million by volume
USEPA	U.S. Environmental Protection Agency
VOC	Volatile organic compound

Table 2.5

ERH Vapor Analytical Summary and Mass Removal Estimates[1]

	3/4/2013						3/18/2013					
	Carbon—Influent			Oxidizer—Influent			Carbon—Influent			Oxidizer—Influent		
Analyte	**µg/L**	**ppmv**	**Mass Removal Rate[1] (lbs/day)**	**µg/L**	**ppmv**	**Mass Removal Rate[1] (lbs/day)**	**µg/L**	**ppmv**	**Mass Removal Rate[1] (lbs/day)**	**µg/L**	**ppmv**	**Mass Removal Rate[1] (lbs/day)**
VOCs[2] (via USEPA 8260)												
Chlorinated Ethenes and Ethanes												
Tetrachloroethene (PCE)	127.0	18.7	5.9	36.7	5.4	1.7	136.0	20.0	6.3	74.4	11.0	3.5
Trichloroethene (TCE)	14.2	2.6	0.7	13.3	2.5	0.6	51.4	9.6	2.4	31.6	5.9	1.5
Vinyl Chloride	1.6	0.6	0.1	0.7	0.3	0.0	2.6	1.0	0.1	0.9	0.4	0.0
cis-1,2-Dichloroethene	15.0	3.8	0.7	10.4	2.6	0.5	32.2	8.1	1.5	21.7	5.5	1.0
1,1-Dichloroethene	0.2	0.0	0.0	0.1	0.0	0.0	ND	ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	0.3	0.1	0.0	0.2	0.1	0.0	0.5	0.1	0.0	0.4	0.1	0.0
Other VOCs												
Acetone	5.3	2.2	0.2	4.0	1.7	0.2	5.8	2.4	0.3	6.6	2.8	0.3
Chloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Butanone (MEK)	2.8	0.9	0.1	1.9	0.6	0.1	ND	ND	ND	ND	ND	ND
Total VOCs	166.4	29.1	7.7	67.3	13.2	3.1	228.5	41.3	10.6	135.6	25.5	6.3
Total Petroleum Hydrocarbons (TPH)												
Total Petroleum Hydrocarbons (via TPH-G)												
Gasoline-range Organics[3,4]	1,200	293	56	798	195	37	1,960	479	91	1,920	469	89
Total VOCs+TPH	1,366	322	63	865	208	40	2,188	521	102	2,056	495	95

Notes:

-- Samples not analyzed for gasoline-range organics during this time.

1 Mass Removal Rate = concentration (ppm) x flow rate (cfm) x 1,440 minute/day x MW ÷ Mair ÷ 1,000,000.

2 Only analytes whose mass was 1 percent or more of the total mass detected were included.

3 Aromatic compounds reported in the USEPA 8260 analysis that also would have been detected in gasoline-range organics analysis were not included.

4 Gasoline-range organics approximate the mass of mineral spirits in waste stream.

Abbreviations:

cfm	Cubic feet per minute
ERH	Electrical Resistance Heating
lbs	Pounds
Mair	379 ft^3 air/lb-mole air at standard temperature and pressure
µg/L	Micrograms per liter
MW	Molecular weight
ND	Non-detect
ppm	Parts per million
ppmv	Parts per million by volume
USEPA	U.S. Environmental Protection Agency
VOC	Volatile organic compound

Table 2.5
ERH Vapor Analytical Summary and Mass Removal Estimates[1]

	4/15/2013						4/30/2013					
	Carbon—Influent			Oxidizer—Influent			Carbon—Influent			Oxidizer—Influent		
Analyte	**µg/L**	**ppmv**	**Mass Removal Rate[1] (lbs/day)**	**µg/L**	**ppmv**	**Mass Removal Rate[1] (lbs/day)**	**µg/L**	**ppmv**	**Mass Removal Rate[1] (lbs/day)**	**µg/L**	**ppmv**	**Mass Removal Rate[1] (lbs/day)**
VOCs[2] (via USEPA 8260)												
Chlorinated Ethenes and Ethanes												
Tetrachloroethene (PCE)	103	15.2	4.8	121	17.8	5.6	149	22.0	6.9	92.9	13.7	4.3
Trichloroethene (TCE)	11.1	2.1	0.5	12.1	2.3	0.6	13.6	2.5	0.6	13.1	2.4	0.6
Vinyl Chloride	3.5	1.4	0.2	2.0	0.8	0.1	3.6	1.4	0.2	1.3	0.5	0.1
cis-1,2-Dichloroethene	16.4	4.1	0.8	17.9	4.5	0.8	19.8	5.0	0.9	16.0	4.0	0.7
1,1-Dichloroethene	0.1	0.03	0.01	0.6	0.1	0.03	0.3	0.1	0.01	0.2	0.04	0.01
trans-1,2-Dichloroethene	0.4	0.1	0.02	0.6	0.2	0.03	0.5	0.1	0.02	0.4	0.1	0.02
Other VOCs												
Acetone	5.4	2.3	0.3	10.3	4.3	0.5	5.2	2.2	0.2	10.7	4.5	0.5
Chloromethane	0.1	0.1	0.005	0.2	0.1	0.01	ND	ND	ND	ND	ND	ND
2-Butanone (MEK)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total VOCs	140	25.2	6.5	164.7	30.1	7.7	191.9	33.3	8.9	134.5	25.3	6.2
Total Petroleum Hydrocarbons (TPH)												
Total Petroleum Hydrocarbons (via TPH-G)												
Gasoline-range Organics[3,4]	330	81	15	312	76	14	399	98	19	368	90	17
Total VOCs+TPH	470	106	22	477	106	22	591	131	27	503	115	23

Notes:

-- Samples not analyzed for gasoline-range organics during this time.
1 Mass Removal Rate = concentration (ppm) x flow rate (cfm) x 1,440 minute/day x MW ÷ Mair ÷ 1,000,000.
2 Only analytes whose mass was 1 percent or more of the total mass detected were included.
3 Aromatic compounds reported in the USEPA 8260 analysis that also would have been detected in gasoline-range organics analysis were not included.
4 Gasoline-range organics approximate the mass of mineral spirits in waste stream.

Abbreviations:

cfm	Cubic feet per minute
ERH	Electrical Resistance Heating
lbs	Pounds
Mair	379 ft^3 air/lb-mole air at standard temperature and pressure
µg/L	Micrograms per liter
MW	Molecular weight
ND	Non-detect
ppm	Parts per million
ppmv	Parts per million by volume
USEPA	U.S. Environmental Protection Agency
VOC	Volatile organic compound

Table 2.5

ERH Vapor Analytical Summary and Mass Removal Estimates[1]

	5/14/2013					
	Carbon—Influent			Oxidizer—Influent		
Analyte	**µg/L**	**ppmv**	**Mass Removal Rate[1] (lbs/day)**	**µg/L**	**ppmv**	**Mass Removal Rate[1] (lbs/day)**
VOCs2 (via USEPA 8260)						
Chlorinated Ethenes and Ethanes						
Tetrachloroethene (PCE)	188	27.72	8.73	95.2	14.03	4.42
Trichloroethene (TCE)	31.10	5.79	1.44	21.4	3.98	0.99
Vinyl Chloride	12.20	4.77	0.57	5.81	2.27	0.27
cis-1,2-Dichloroethene	54.9	13.85	2.55	42.1	10.62	1.96
1,1-Dichloroethene	0.30	0.08	0.01	0.21	0.05	0.01
trans-1,2-Dichloroethene	1.08	0.27	0.05	0.70	0.18	0.03
Other Volatile Organic Compounds						
Acetone	8.66	3.65	0.40	13.4	5.64	0.62
Chloromethane	ND	ND	ND	ND	ND	ND
2-Butanone (MEK)	ND	ND	ND	ND	ND	ND
Total VOCs	296	56.1	13.8	179	36.8	8.3
Total Petroleum Hydrocarbons (TPH)						
Total Petroleum Hydrocarbons (via TPH-G)						
Gasoline-range Organics[3,4]	1,070	262	49.7	721	176	33
Total VOCs+TPH	1,366	318	63.5	900	213	42

Notes:

-- Samples not analyzed for gasoline-range organics during this time.

1 Mass Removal Rate = concentration (ppm) x flow rate (cfm) x 1,440 minute/day x MW ÷ Mair ÷ 1,000,000.

2 Only analytes whose mass was 1 percent or more of the total mass detected were included.

3 Aromatic compounds reported in the USEPA 8260 analysis that also would have been detected in gasoline-range organics analysis were not included.

4 Gasoline-range organics approximate the mass of mineral spirits in waste stream.

Abbreviations:

cfm	Cubic feet per minute
ERH	Electrical Resistance Heating
lbs	Pounds
Mair	379 ft^3 air/lb-mole air at standard temperature and pressure
µg/L	Micrograms per liter
MW	Molecular weight
ND	Non-detect
ppm	Parts per million
ppmv	Parts per million by volume
USEPA	U.S. Environmental Protection Agency
VOC	Volatile organic compound

Table 3.1
SVE System Operation Parameters

Date	9/17/2012	9/19/2012	9/21/2012	9/24/2012	10/1/2012	10/8/2012	10/17/2012	10/22/2012	10/29/2012	11/8/2012	11/16/2012	11/29/2012
Days of Operation (since last visit)	0.05	0.125	2	3	7	7	9	5	7	10	8	12
Total SVE Air Flow (scfm)	250	270	260	260	260	260	260	260	260	260	260	--
VOC Measurements (ppmv)[1]												
Influent	43	66	60	28	14	16	14	16	14	6.4	9.6	--
Effluent	0	0	3.5	2.3	1.3	1.5	1.1	1.0	0.9	0.5	0.6	--
Percent Removal	100	100	94	92	91	91	92	93	94	92	94	--
Vacuum (inches of water)												
SVE-1	14	17	17	17	19	19	21	23	25+	25+	25+	--
SVE-2	--	--	--	--	19	19	21.5	23.5	25+	25+	25+	--
SVE-3	14	17	16.5	16.5	19	18.5	21	23	25+	25+	25+	--
SVE-4	14	18	17.5	17.5	20	19.5	22	23.5	25+	25+	25+	--
Total Manifold	--	--	--	--	21	21	23	25	25+	25+	25+	--
Mass Removal Estimates[2]												
Mass Removal (lbs/day)	6.50	4.17	3.60	1.68	0.86	0.96	0.60	0.67	0.62	0.27	0.41	0.41
Mass Removal (cumulative, total lbs)	0.3	4.2	11.4	16.4	22.4	29.1	34.5	37.9	42.2	44.9	48.2	53.1
O&M Notes	SVE test.	SVE activated at 9:00 am; influent vapor sample collected.					Influent vapor sample collected.					O&M not performed. System not running upon arrival.

Notes:

-- O&M not completed.

[1] VOCs measured with a PID.

[2] Mass removal estimates are based on a correlation between influent VOC measurements and mass removal calculations completed using influent analytical data.

Abbreviations:

lbs	Pounds
O&M	Operations and Maintenance
PID	Photoionization detector
ppmv	Parts per million by volume
scfm	Standard cubic feet per minute
SVE	Soil vapor extraction
VOC	Volatile organic compound

Table 3.1
SVE System Operation Parameters

Date	12/3/2012	12/14/2012	12/26/2012	1/7/2013	1/14/2013	1/21/2013	1/28/2013	2/4/2013	2/11/2013	2/18/2013	3/4/2013	3/11/2013
Days of Operation (since last visit)	4	11	12	12	7	7	7	4	7	7	14	7
Total SVE Air Flow (scfm)	180	180	180	180	180	180	180	180	180	180	180	180
VOC Measurements (ppmv)[1]												
Influent	7.4	5.9	4.8	3.8	3.6	3.5	2.9	3.4	5.9	6.4	4.0	--
Effluent	0.6	0.6	0.5	0.3	0.3	0.3	0.3	0.3	0.6	0.5	0.2	--
Percent (%) Removal	91	90	90	91	92	92	90	92	90	93	96	--
Vacuum (inches of water)												
SVE-1	25+	24.5	25+	24.5	--	21.5	23	17	20.5	17	17.5	17.5
SVE-2	25+	24.5	25+	24.5	--	22	23	17	21	17.5	18	18
SVE-3	25+	24.5	25+	24.5	--	21.5	23	17	20.5	17	17.5	17.5
SVE-4	25+	25	25+	24.5	--	22	23	17	21	17.5	18	18
Total Manifold	25+	25	25+	25	--	22	23.5	18	21.5	18	18.5	18
Mass Removal Estimates[2]												
Mass Removal (lbs/day)	0.22	0.18	0.14	0.08	0.08	0.07	0.06	0.07	0.12	0.13	0.16	0.16
Mass Removal (cumulative, total lbs)	54.0	55.9	57.6	58.6	59.1	59.6	60.0	60.3	61.2	62.1	64.3	65.5
O&M Notes				Influent vapor sample collected.							Influent vapor sample collected.	PID malfunction.

Notes:

-- O&M not completed.

1 VOCs measured with a PID.

2 Mass removal estimates are based on a correlation between influent VOC measurements and mass removal calculations completed using influent analytical data.

Abbreviations:

lbs	Pounds
O&M	Operations and Maintenance
PID	Photoionization detector
ppmv	Parts per million by volume
scfm	Standard cubic feet per minute
SVE	Soil vapor extraction
VOC	Volatile organic compound

Table 3.1
SVE System Operation Parameters

Date	3/18/2013	4/15/2013	5/20/2013	5/31/2013	6/18/2013	7/10/2013	8/14/2013	8/16/2013
Days of Operation (since last visit)	7	28	35	11	18	22	35	2
Total SVE Air Flow (scfm)	180	180	180	180	180	180	180	180
VOC Measurements (ppmv)[1]								
Influent	3.6	7.5	7.8	13.9	8.0	5.7	7.5	7.5
Effluent	0	0.68	0.68	1.77	1.03	0.68	0.57	1.1
Percent (%) Removal	100	91	91	87	87	88	92	86
Vacuum (inches of water)								
SVE-1	17.5	19	--	15.5	14	13.5	11	11.5
SVE-2	17.5	19.5	--	15.5	14.5	14	11	11.5
SVE-3	17.5	19	--	15	14	14.5	10.5	11.5
SVE-4	17.5	19.5	--	15.5	14.5	14	11	11.5
Total Manifold	18	20	--	16	15	15	11.5	12
Mass Removal Estimates[2]								
Mass Removal (lbs/day)	0.14	0.38	0.39	0.54	0.31	0.36	--	0.36
Mass Removal (cumulative, total lbs)	66.5	77.1	90.9	96.8	102.3	110.3	--	111.3
O&M Notes		Influent vapor sample collected.		Influent vapor sample collected.		Influent vapor sample collected. System shut down for rebound analysis.	System turned back on to assess rebound.	Influent vapor sample collected.

Notes:

-- O&M not completed.

1 VOCs measured with a PID.

2 Mass removal estimates are based on a correlation between influent VOC measurements and mass removal calculations completed using influent analytical data.

Abbreviations:

lbs	Pounds
O&M	Operations and Maintenance
PID	Photoionization detector
ppmv	Parts per million by volume
scfm	Standard cubic feet per minute
SVE	Soil vapor extraction
VOC	Volatile organic compound

Table 3.2

SVE Influent Vapor Analytical Summary and Mass Removal Estimates[1,2]

Sample Date	9/19/2012	10/17/2012	1/7/2013	3/4/2013	4/15/2013	5/31/2013	7/10/2013	8/16/2013
Detected Compound	(µg/L)							
Vinyl Chloride	3.6	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
1,1-Dichloroethene	0.16	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Methylene Chloride	0.11	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
trans-1,2-Dichloroethene	0.18	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
cis-1,2-Dichloroethene	13	0.818	0.342	0.253	0.392	<0.1	0.22	0.58
1,1,1-Trichloroethane (TCA)	<0.1	0.118	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Trichloroethene (TCE)	8.9	1.71	0.342	1.34	0.993	0.688	0.604	1.33
Tetrachloroethene (PCE)	146	23.1	4.52	8.56	22	32.4	21.2	31.2
Total Detected CVOCs	172	26	5	10	23	33	22	33
SVE Flow Rate (scfm)	270	260	180	180	180	180	180	180
Mass Removal Rate (lbs/d)[3]	4.17	0.60	0.08	0.16	0.38	0.54	0.36	0.54

Notes:

1 Vapor sample collected in Tedlar bag and analyzed by USEPA Method 8260B.

2 Only detected compounds are included in this summary. Other compounds were at levels less than laboratory method detection limits.

3 Mass removal = (concentration µg/L * 28.32 *flow scfm * 0.002205 lbs/gm/1,000,000 µg/gm)*1,440 min/d.

Abbreviations:

CVOC	Chlorinated volatile organic compound
lbs/d	Pounds per day
lbs/gm	Pounds per gram
µg/gm	Micrograms per gram
µg/L	Micrograms per liter
min/d	Minutes per day
scfm	Standard cubic feet per minute
SVE	Soil vapor extraction
USEPA	U.S. Environmental Protection Agency

Fox Avenue Site

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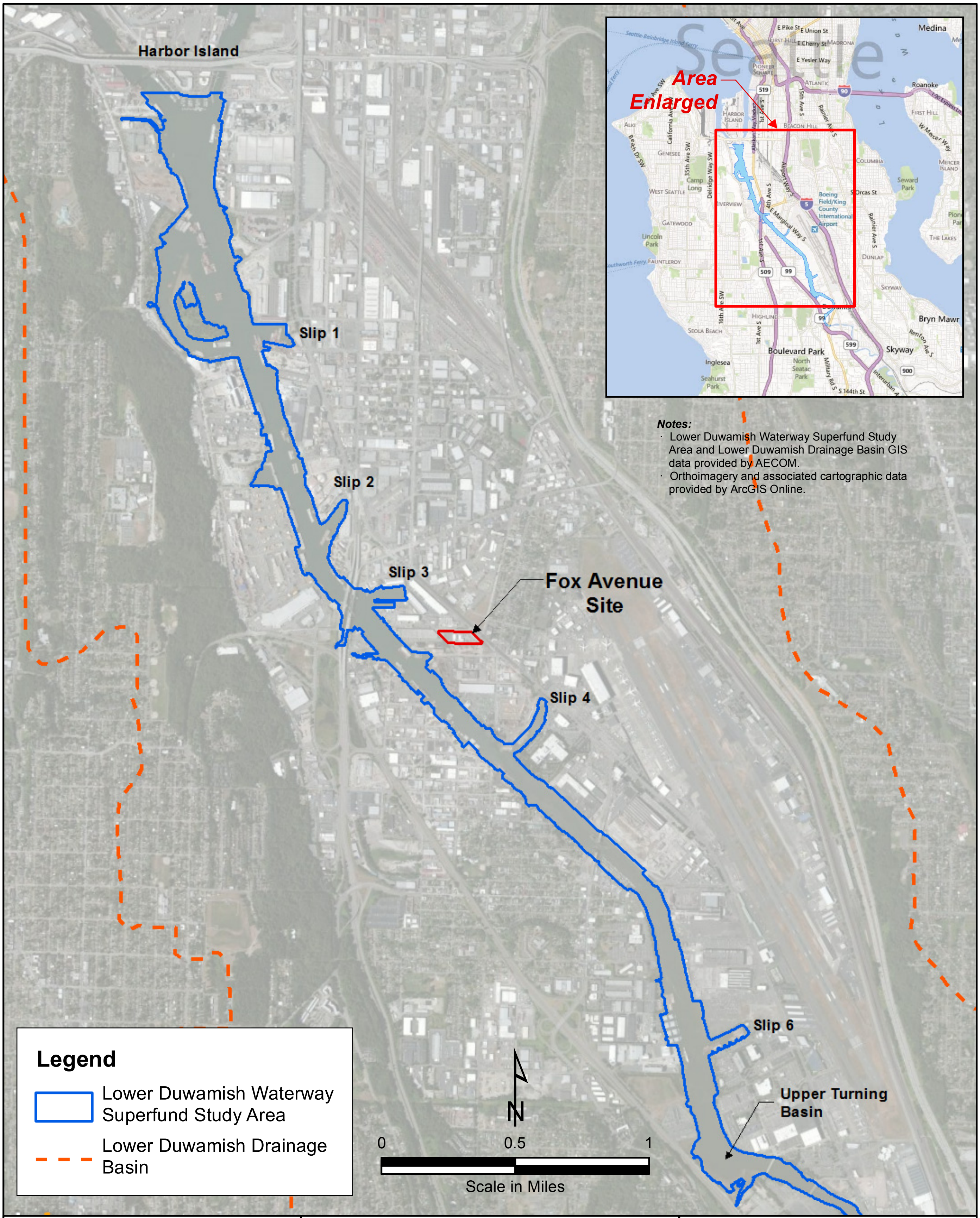
Figures



Notes:
- Lower Duwamish Waterway Superfund Study Area and Lower Duwamish Drainage Basin GIS data provided by AECOM.
- Orthoimagery and associated cartographic data provided by ArcGIS Online.

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Figure 1.1
Location Map

Path: I:\GIS\Projects\FOXAVE-RA\MXD\Report 2013 Construction Completion\Figure 1.1 (Location Map).mxd 8/28/2013

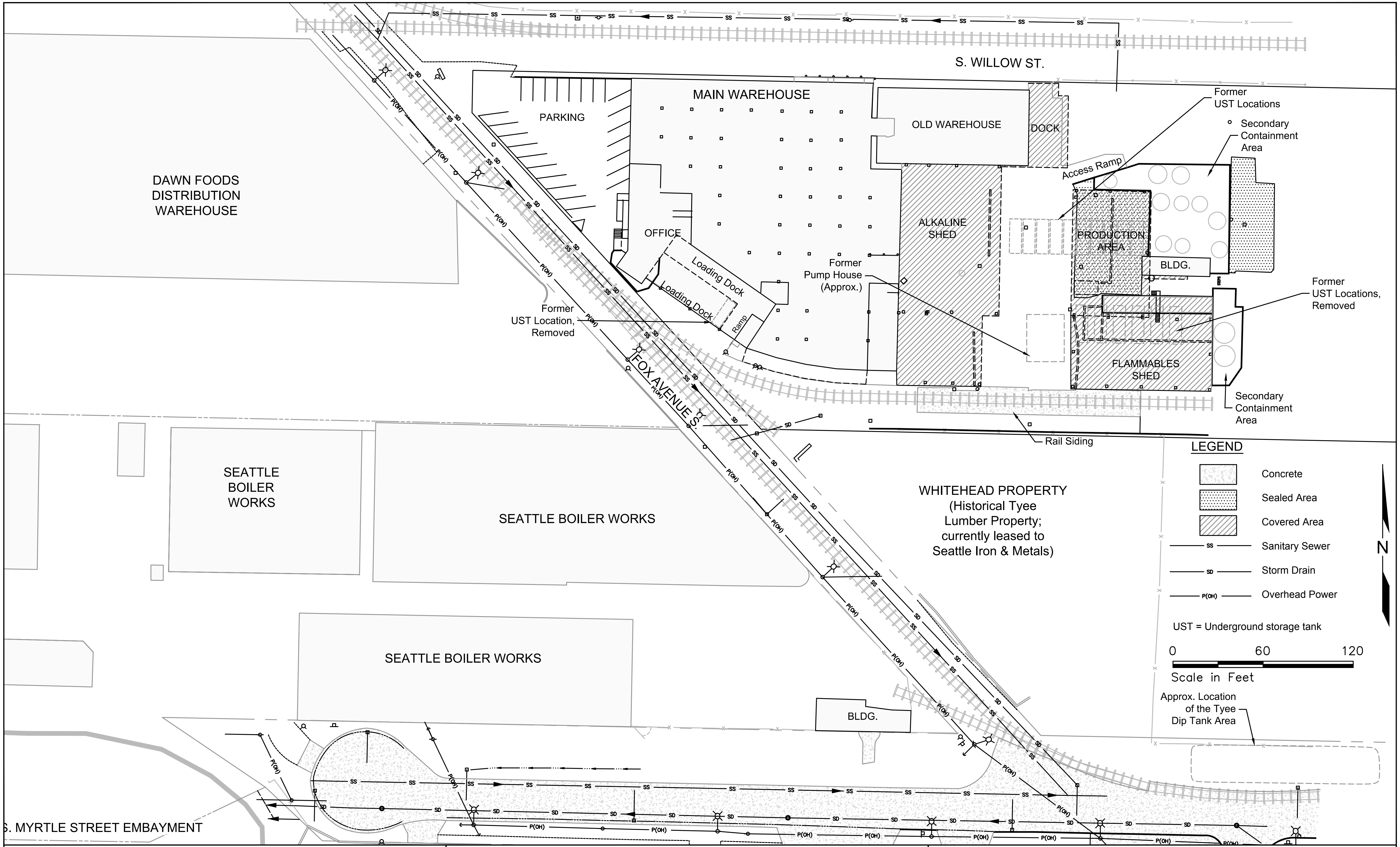

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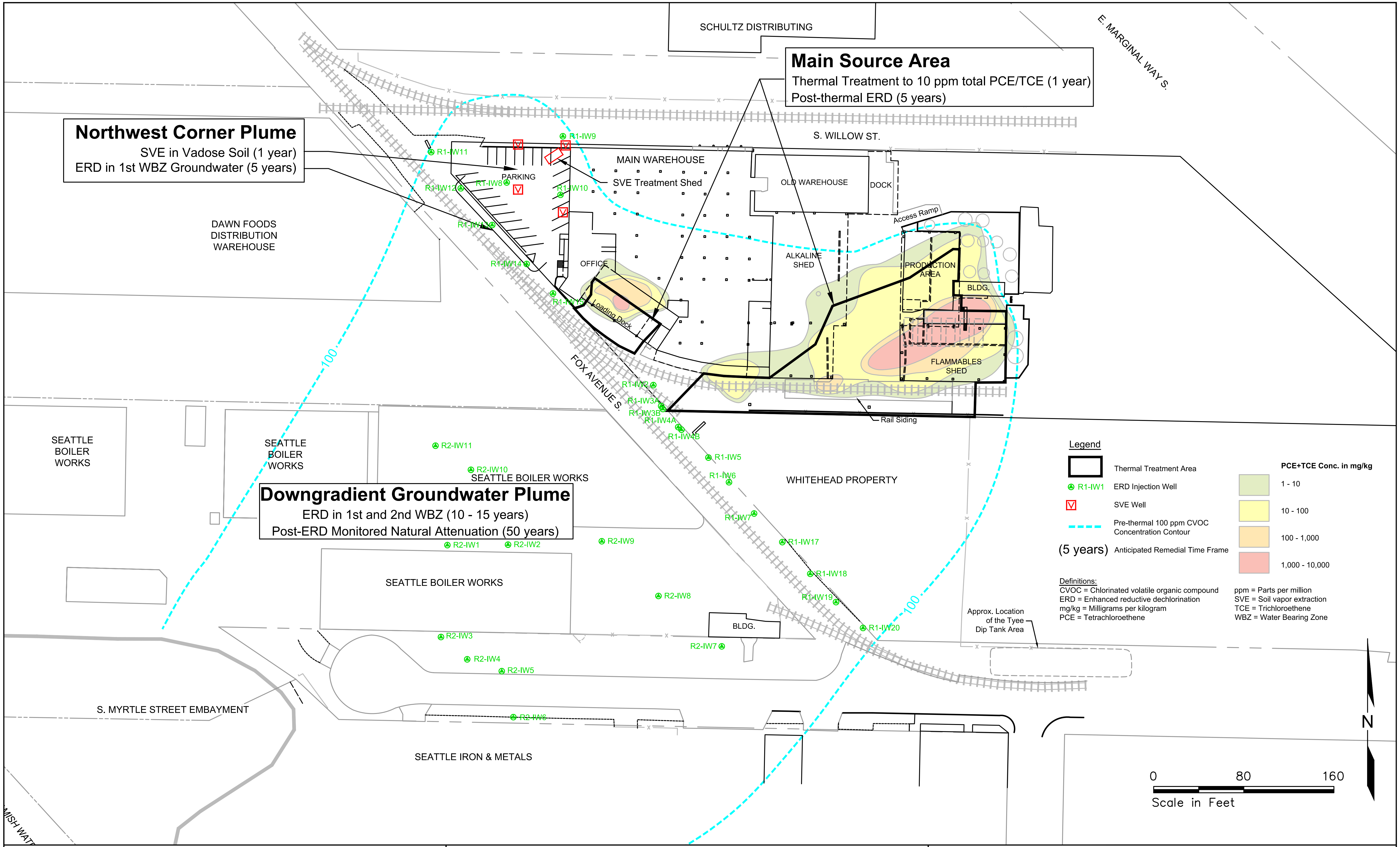
Figure 1.2
Site Plan

DWG NAME: K:\Project\clients\Floyd and Snider\Fox Ave 2012\CAD\FoxAve2012_017.dwg
DATE: 8/27/2013 3:07 PM



Legend

▭	Thermal Treatment Area		PCE+TCE Conc. in mg/kg
● R1-IW1	ERD Injection Well	🟩	1 - 10
☒	SVE Well	🟨	10 - 100
- - -	Pre-thermal 100 ppm CVOC Concentration Contour	🟧	100 - 1,000
(5 years)	Anticipated Remedial Time Frame	🟥	1,000 - 10,000

Definitions:

CVOC = Chlorinated volatile organic compound
ERD = Enhanced reductive dechlorination
mg/kg = Milligrams per kilogram
PCE = Tetrachloroethene
ppm = Parts per million
SVE = Soil vapor extraction
TCE = Trichloroethene
WBZ = Water Bearing Zone

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Figure 1.3
Selected Remedy Elements

DWG NAME: K:\Project\clients\Floyd and Snider\Fox Ave 2012\CAD\FoxAve2012_018.dwg
DATE: 8/30/2013 11:30 AM

Definitions:
AST = Aboveground storage tank
mg/kg = Milligrams per kilogram
UST = Underground storage tank

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Figure 2.1
Pre-thermal PCE+TCE Concentrations in Soil

DWG NAME: K:\Project\clients\Floyd and Snider\Fox Ave 2012\CAD\FoxAve2012_015.dwg
DATE: 8/27/2013 3:39 PM

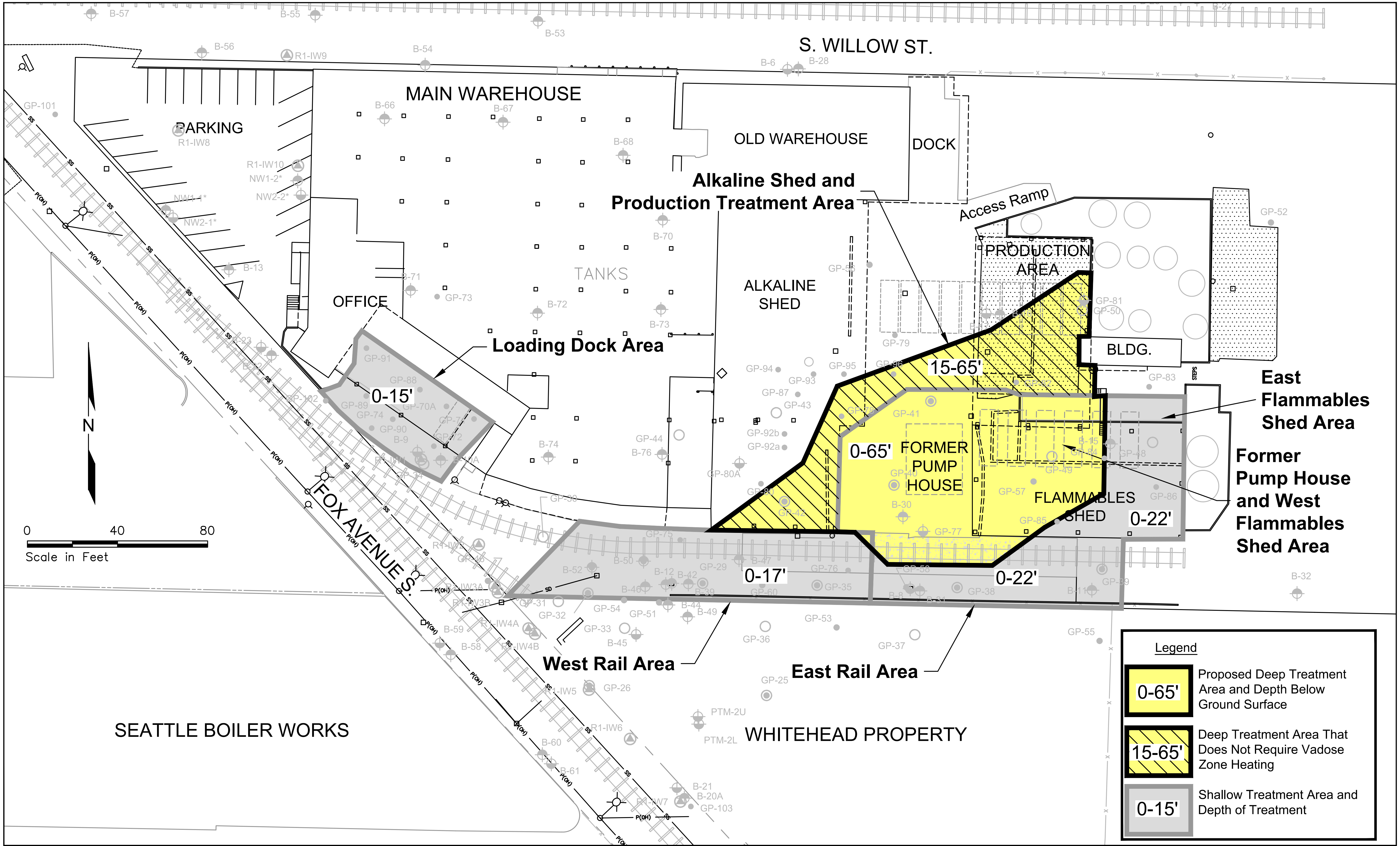

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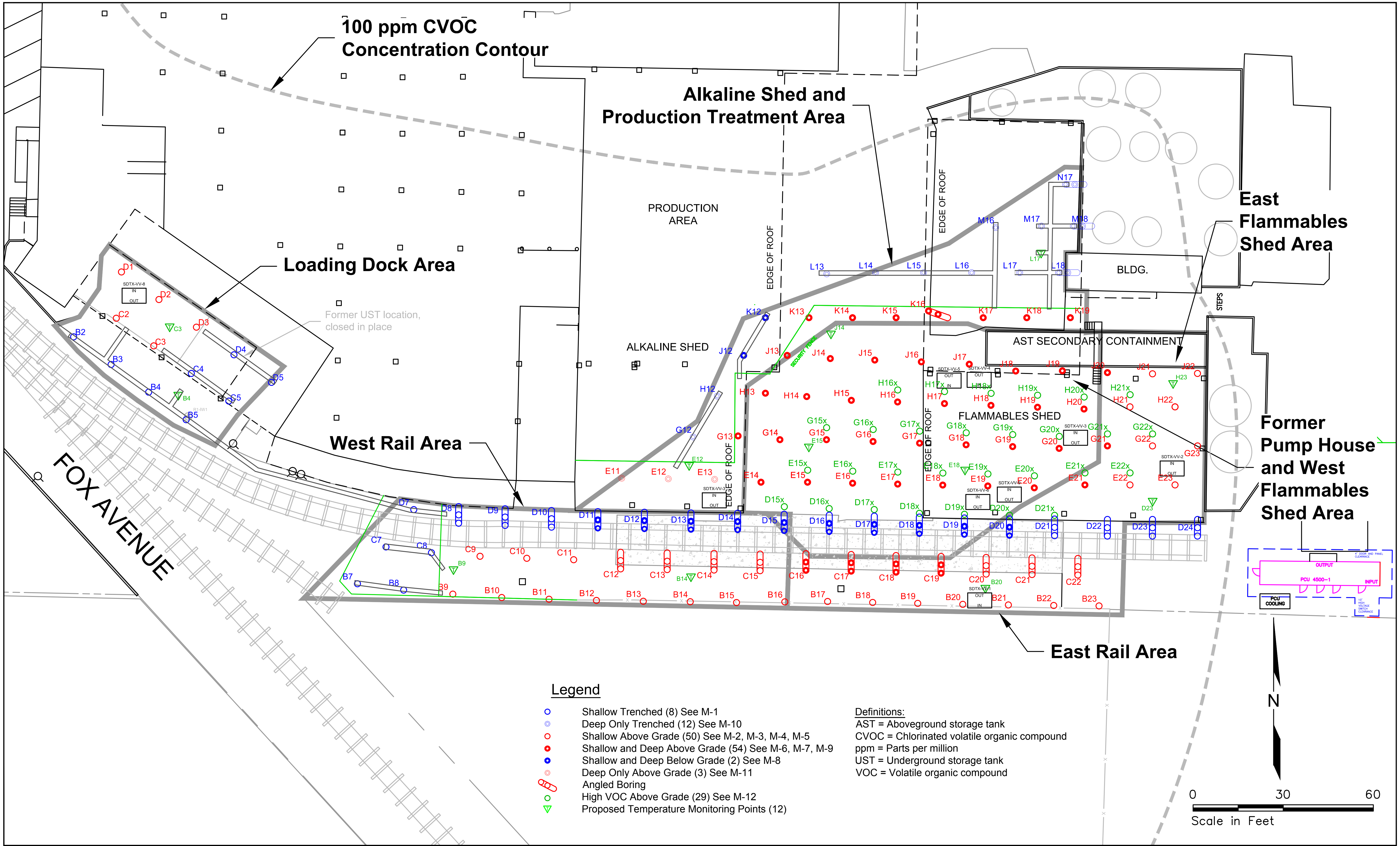
Figure 2.2
Thermal Treatment Areas

DWG NAME: K:\Project\clients\Floyd and Snider\Fox Ave 2012\CAD\FoxAve2012_016.dwg
DATE: 8/23/2013 4:19 PM



Legend

○	Shallow Trenched (8) See M-1
◎	Deep Only Trenched (12) See M-10
○	Shallow Above Grade (50) See M-2, M-3, M-4, M-5
●	Shallow and Deep Above Grade (54) See M-6, M-7, M-9
●	Shallow and Deep Below Grade (2) See M-8
◎	Deep Only Above Grade (3) See M-11
⊘	Angled Boring
○	High VOC Above Grade (29) See M-12
▽	Proposed Temperature Monitoring Points (12)

Definitions:

AST = Aboveground storage tank
CVOC = Chlorinated volatile organic compound
ppm = Parts per million
UST = Underground storage tank
VOC = Volatile organic compound

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Figure 2.3
Thermal System Electrode Layout

DWG NAME: K:\Project\clients\Floyd and Snider\Fox Ave 2012\CAD\FoxAve2012_014.dwg
DATE: 8/27/2013 3:44 PM

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Figure 2.4
Aerial Photograph of the Treatment System

August 2013

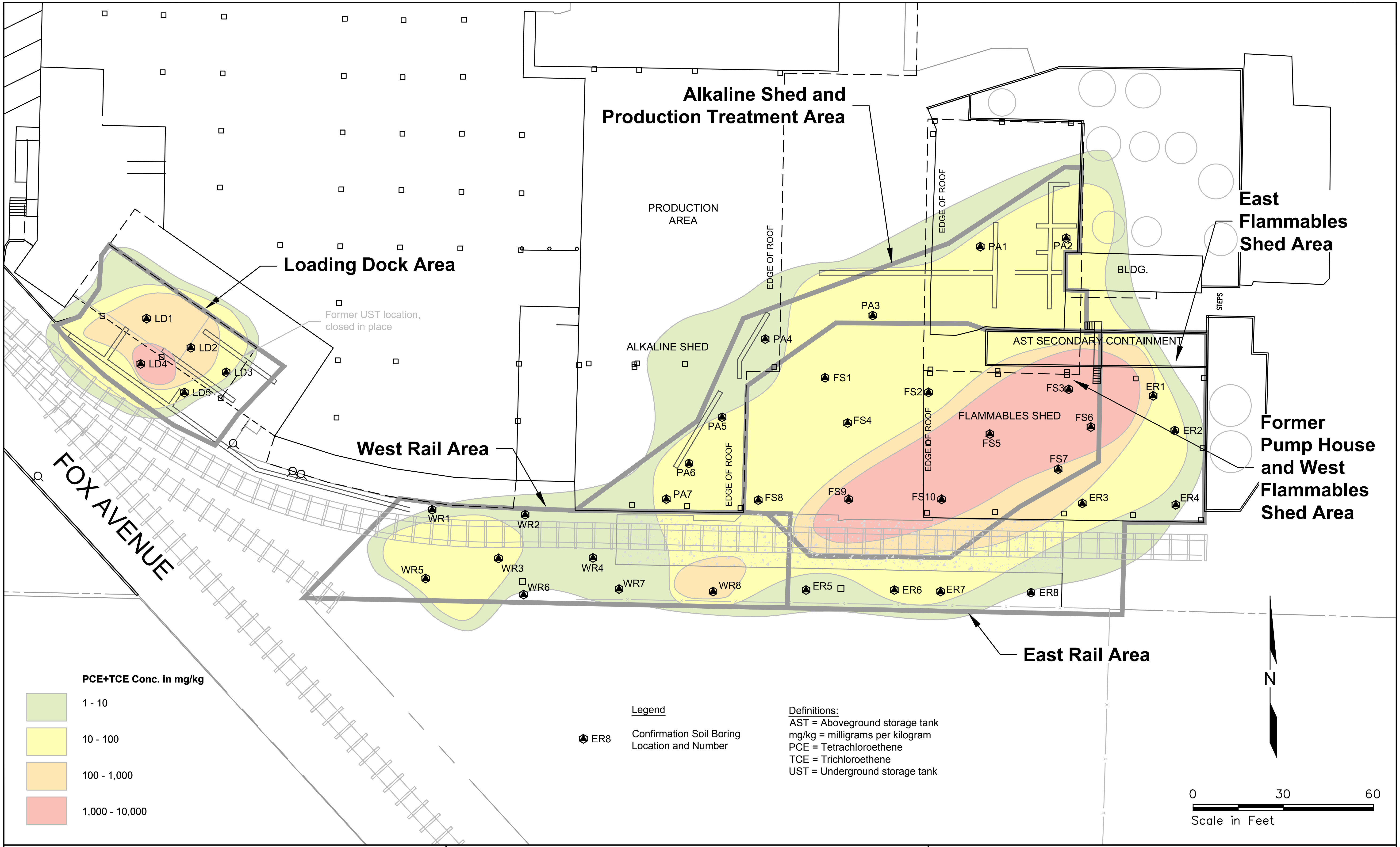

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Figure 2.5
Confirmation Soil Boring Locations

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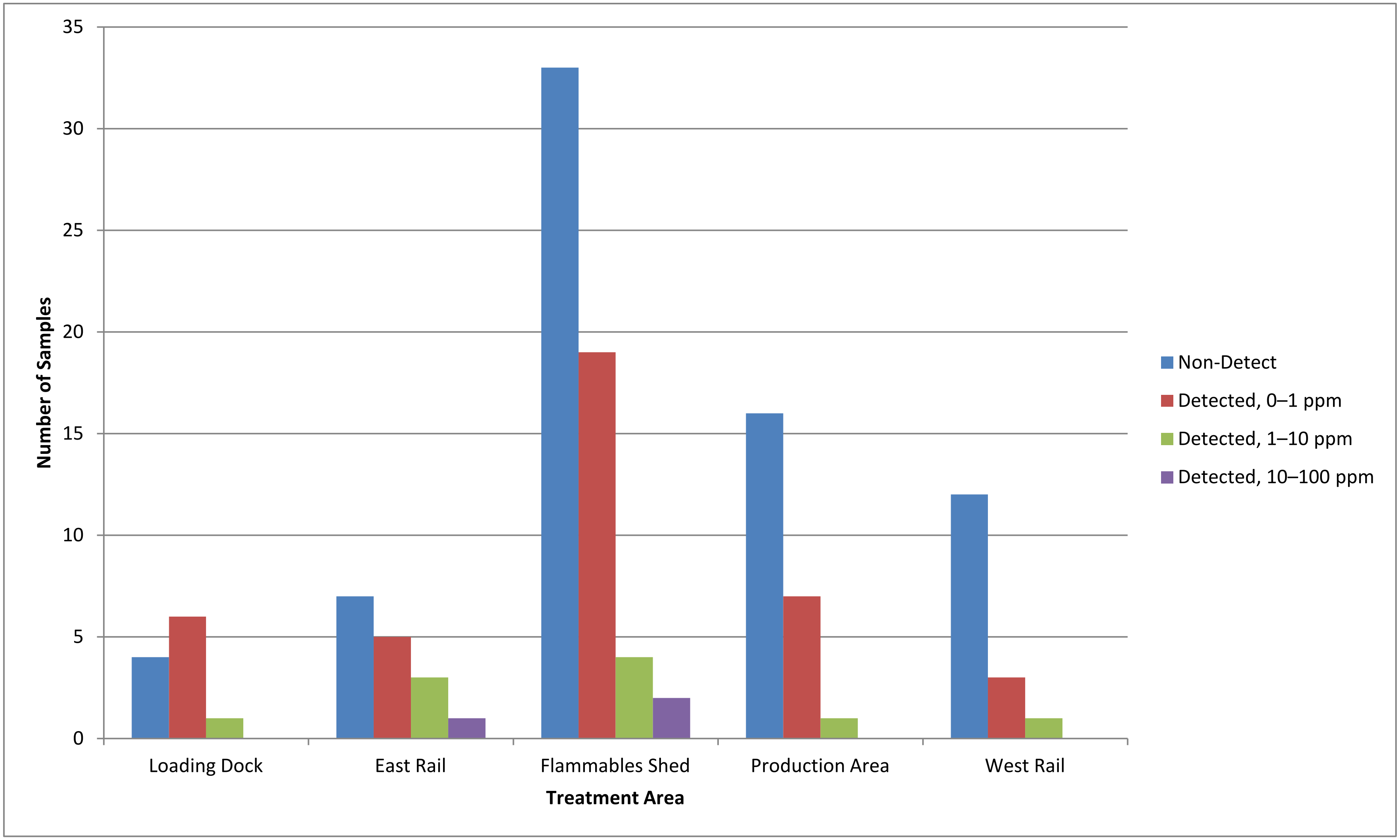
DATE: 8/27/2013 3:49 PM



Abbreviations: PCE = Tetrachloroethylene, ppm = Parts per million, TCE = Trichloroethylene

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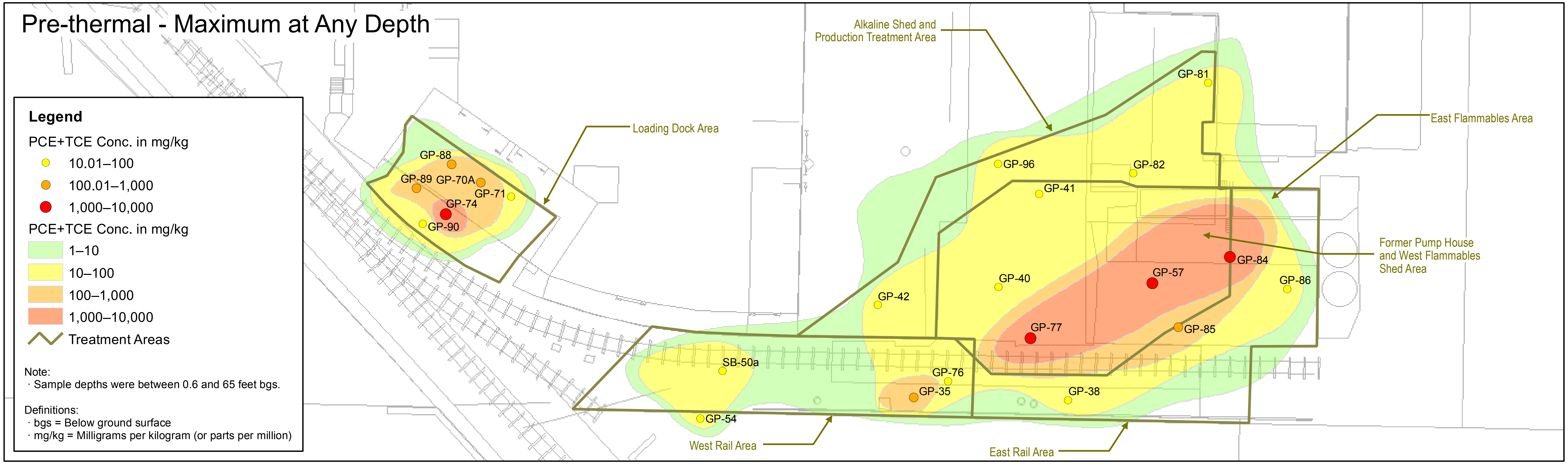
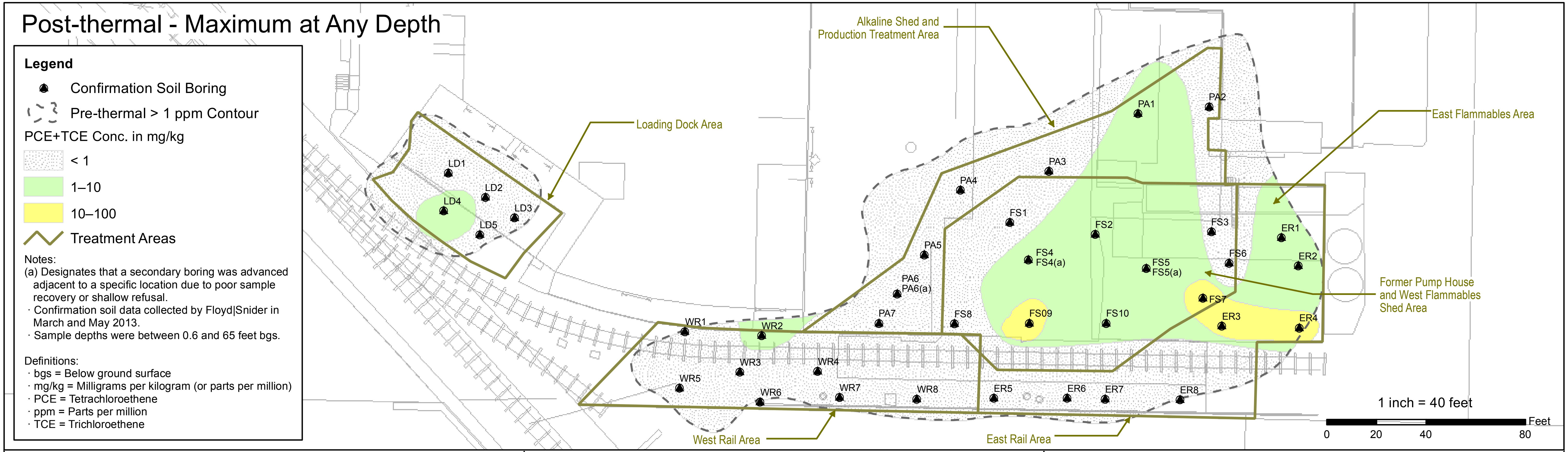


Note:
- Sample depths were between 0.6 and 65 feet bgs.

Definitions:
- bgs = Below ground surface
- mg/kg = Milligrams per kilogram (or parts per million)



Notes:
(a) Designates that a secondary boring was advanced adjacent to a specific location due to poor sample recovery or shallow refusal.
- Confirmation soil data collected by Floyd|Snider in March and May 2013.
- Sample depths were between 0.6 and 65 feet bgs.

Definitions:
- bgs = Below ground surface
- mg/kg = Milligrams per kilogram (or parts per million)
- PCE = Tetrachloroethene
- ppm = Parts per million
- TCE = Trichloroethene

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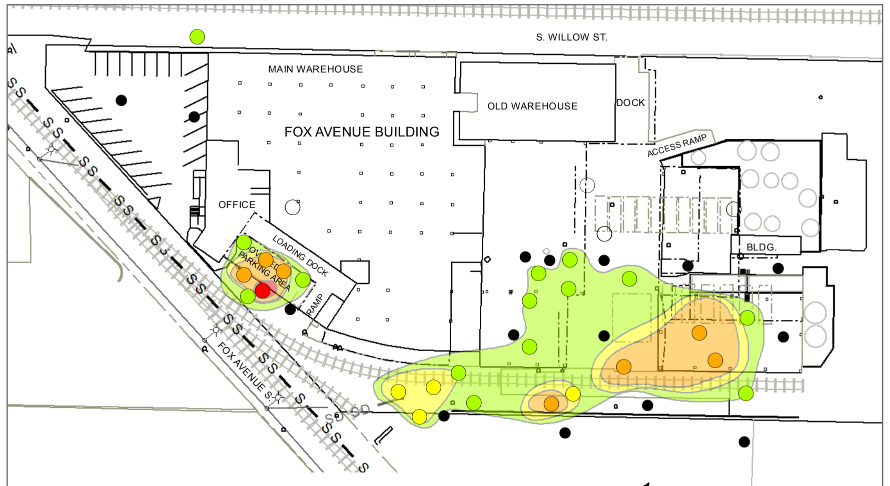
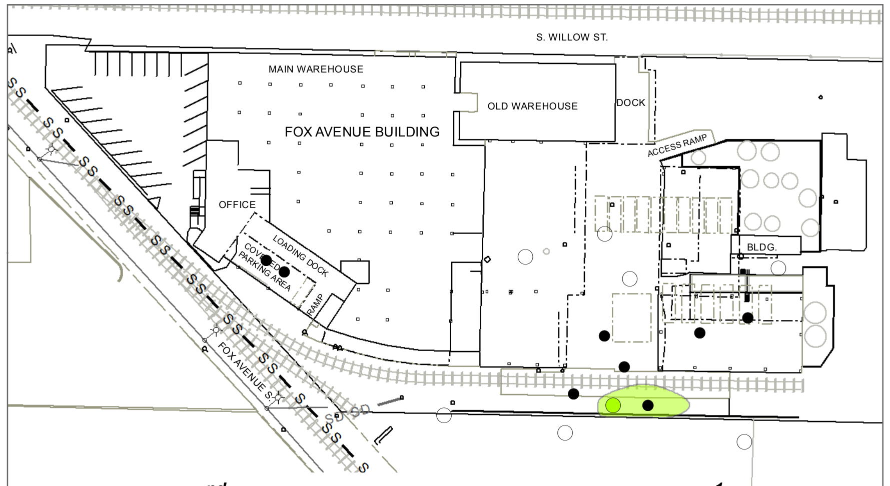
Figure 2.7
Comparison of Pre- and Post-thermal
PCE+TCE Concentrations in Soil

I:\GIS\Projects\FOXAVE-RA\MXD\Report 2013 Construction Completion\Figure 2.7 (Comparison of Pre- and Post-thermal PCE+TCE Concentrations in Soil).mxd 8/28/2013

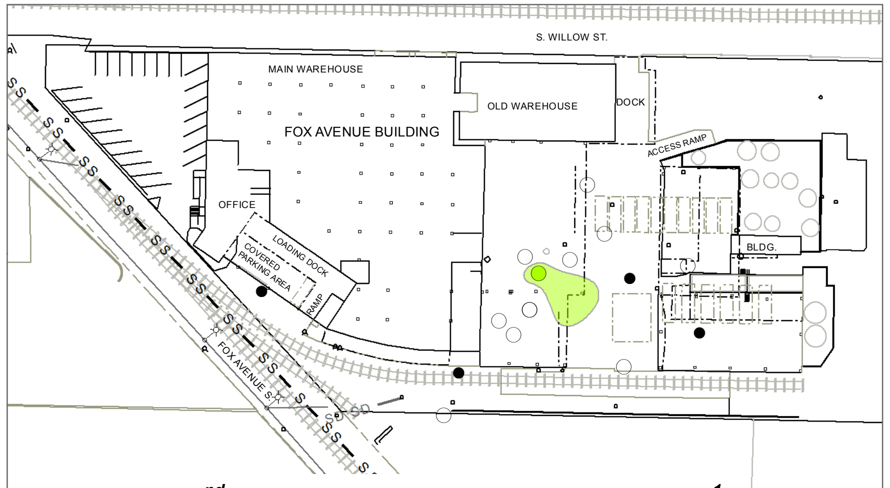


Vadose Zone: 0.6–13 feet bgs[1]

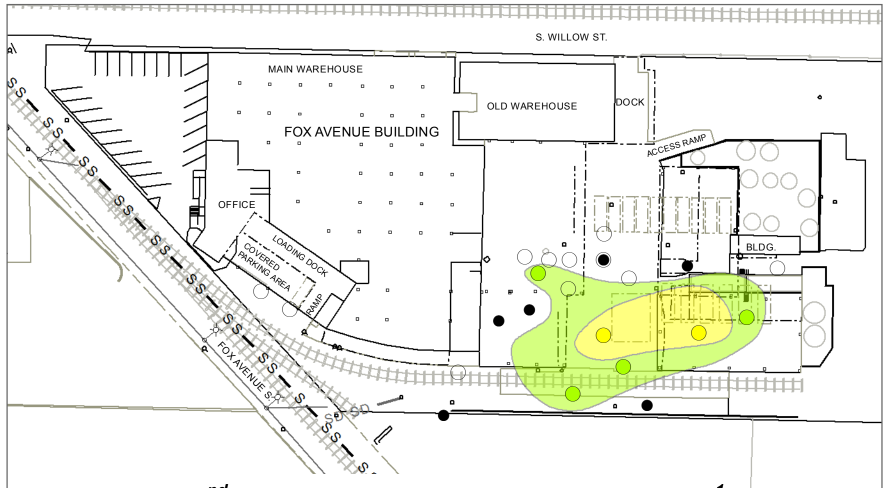
1st Water Bearing Zone: 8.5–18.5 feet bgs[1]



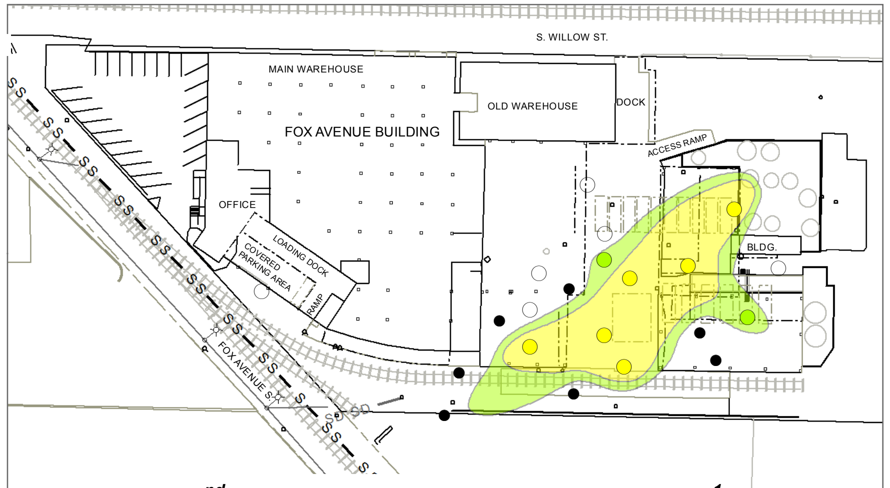
2nd Water Bearing Zone: 15.5–31 feet bgs[1]



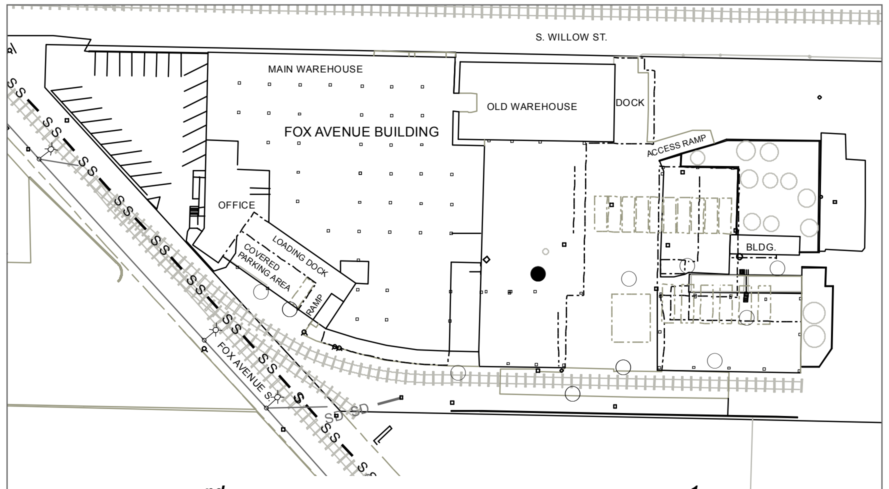
2nd Water Bearing Zone: 28.5–40 feet bgs[1]



2nd Water Bearing Zone: 42–51.5 feet bgs[1]



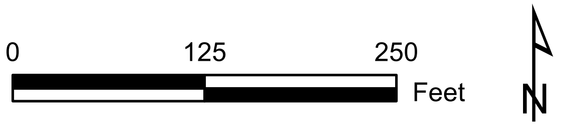
2nd Water Bearing Zone: 50–61.5 feet bgs[1]



2nd Water Bearing Zone: 61–68 feet bgs[1]

Legend

PCE+TCE Conc. in mg/kg		**PCE+TCE Conc. in mg/kg**	
●	0–1	🟩	1–10
●	1.01–10	🟨	10–100
●	10.01–100	🟧	100–1,000
●	100.01–1,000	🟥	1,000–10,000
●	1,000.01–10,000		
○	Sample was not detected at the concentration shown		



Note:
1. Measured from ground surface; ground surface is elevated in areas with loading docks and related structures.
· Soil data sourced from 2008–2010.
· Maximum concentratuion per boring/depth interval shown.

Definitions:
· bgs = Below ground surface
· mg/kg = Milligrams per kilogram
· PCE = Tetrachloroethene
· TCE = Trichloroethene

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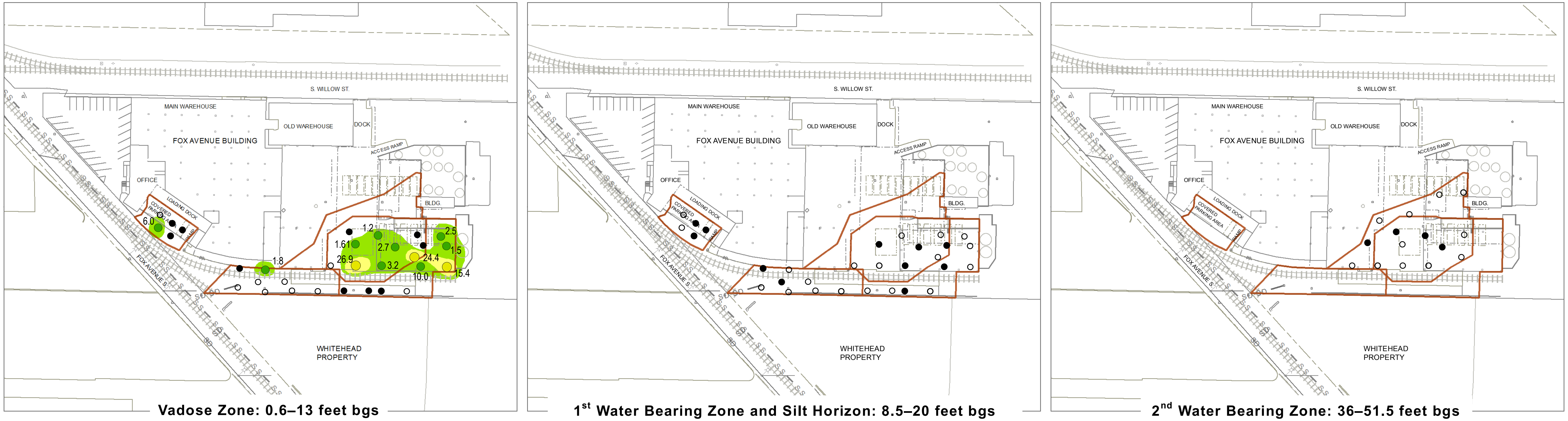
Figure 2.8
Pre-thermal PCE+TCE Soil Concentrations:
Variation with Depth

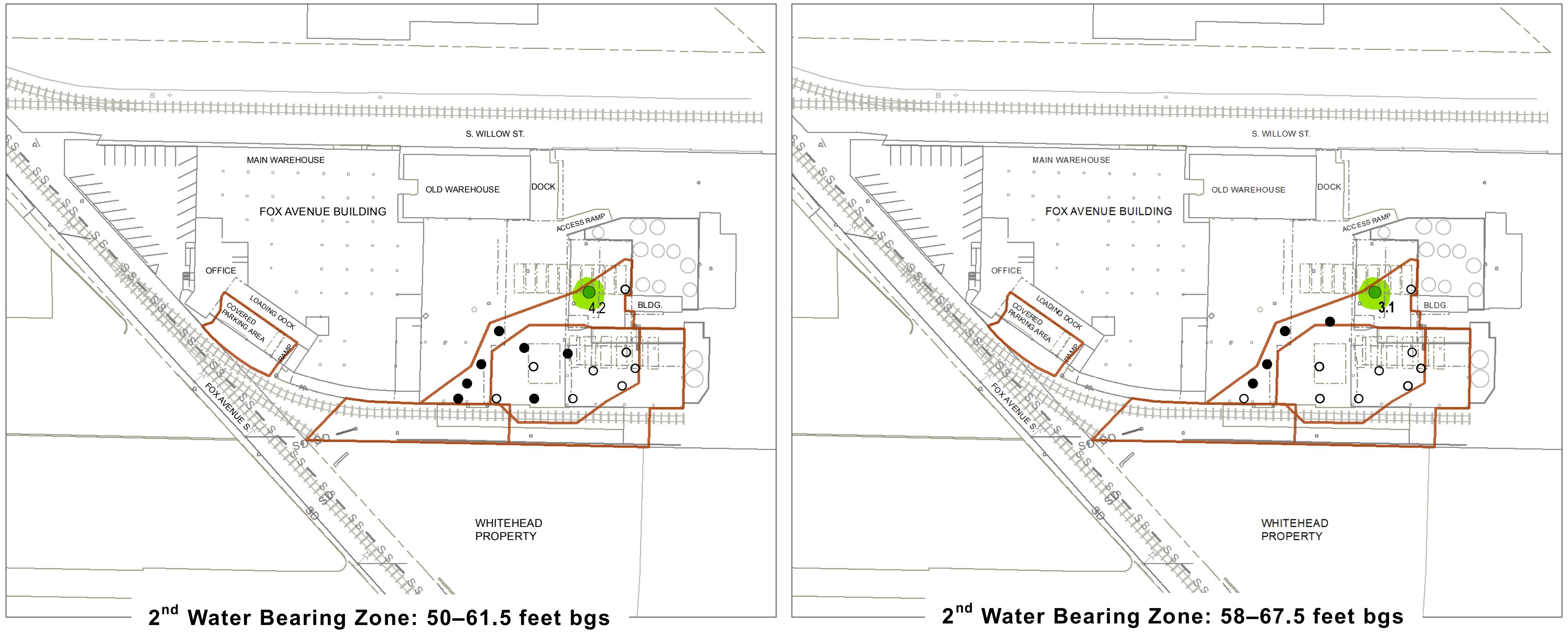
I:\GIS\Projects\FOXAVE-RA\MXD\Report 2013 Construction Completion\Figure 2.8 (Pre-Thermal PCE plus TCE Soil Concentrations Variation with Depth).mxd 8/28/2013



Vadose Zone: 0.6–13 feet bgs

1st Water Bearing Zone and Silt Horizon: 8.5–20 feet bgs

2nd Water Bearing Zone: 36–51.5 feet bgs



2nd Water Bearing Zone: 50–61.5 feet bgs

2nd Water Bearing Zone: 58–67.5 feet bgs

Legend

PCE+TCE Conc. in mg/kg		PCE+TCE Conc. in mg/kg	
●	0–1	🟩	1.01–10
●	1.01–10	🟨	10.01–100
●	10.01–100		Treatment Area
○	Sample was not detected at the concentration shown		

0 125 250 Feet

N

Notes:
1. Measured from ground surface; ground surface is elevated in areas with loading docks and related structures.
- Maximum concentration per boring/depth interval shown.
- No samples collected between 20 and 38 feet bgs.

Definitions:
- bgs = Below ground surface
- mg/kg = Milligrams per kilogram
- PCE = Tetrachloroethene
- TCE = Trichloroethene

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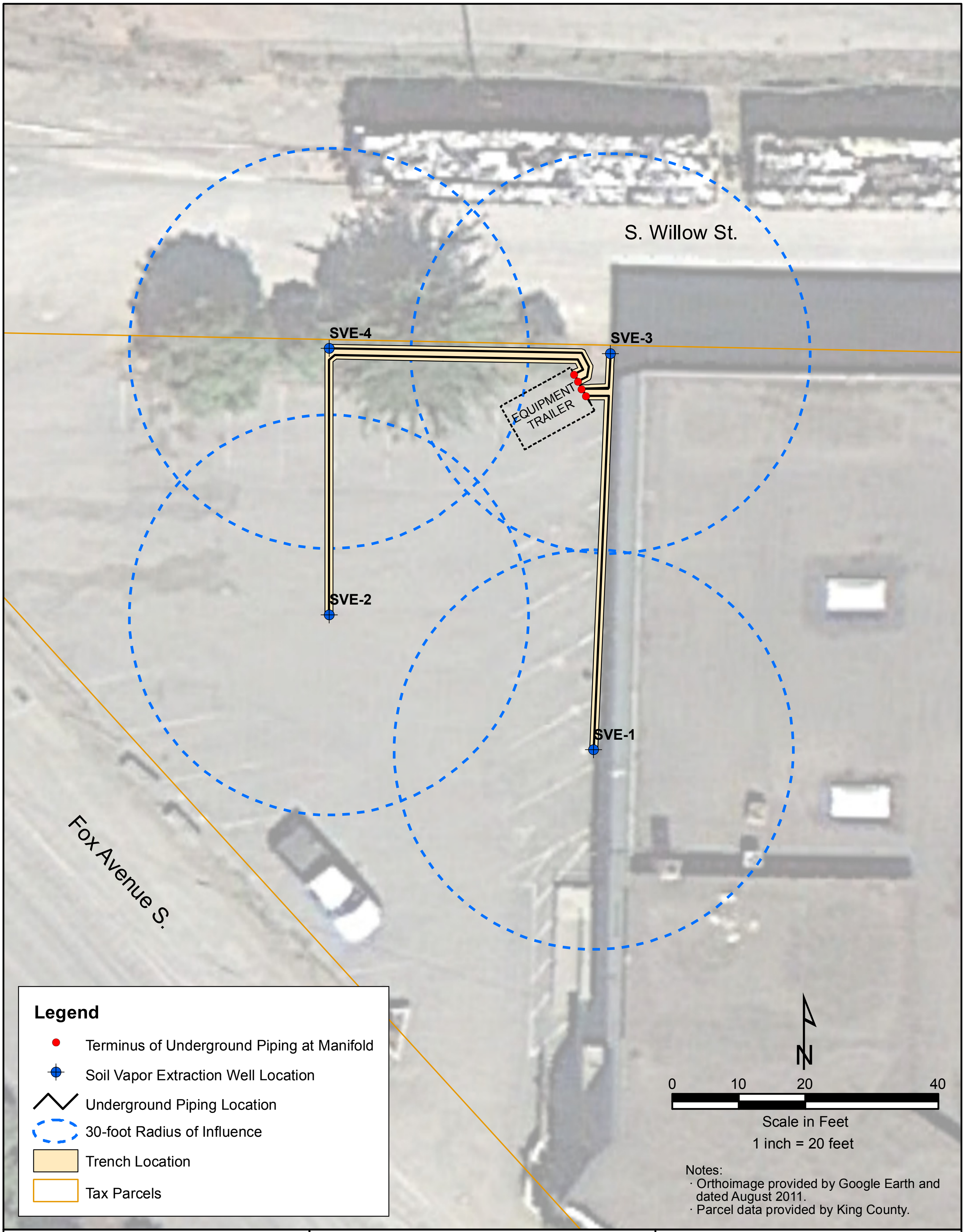
Figure 2.9
Post-thermal PCE+TCE Soil Concentrations:
Variation with Depth

I:\GIS\Projects\FOXAVE-RA\MXD\Report 2013 Construction Completion\Figure 2.9 (Post-Thermal PCE plus TCE Soil Concentrations Variation with Depth).mxd 8/28/2013



Notes:
· Orthoimage provided by Google Earth and dated August 2011.
· Parcel data provided by King County.

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Figure 3.1
Soil Vapor Extraction
System Layout
Northwest Corner Plume

F:\projects\FoxAve-RA\GIS\MXD\Construction Completion Report\Figure 3.1 (Soil Vapor Extraction System Layout NW Corner).mxd 9/24/2013