Interim Action Work Plan
Developmental Center
Tukwila, Washington

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Prepared for

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LIST OF ABBREVIATIONS AND ACRONYMS

AMEE	acetylene, methane, ethene, ethane
AOC	area of concern
Boeing	The Boeing Company
BTEX	benzene, toluene, ethylbenzene, and xylenes
cDCE	*cis*-1,2-dichloroethene
CUL	cleanup level
DC	Developmental Center
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ft	feet
bgs	below ground surface
IA	interim action
LAI	Landau Associates, Inc.
memo	technical memorandum
MNA	monitored natural attenuation
MTCA	Model Toxics Control Act
NAPL	non-aqueous phase liquid
NPDES	National Pollution Discharge Elimination System
ORC®	Oxygen Release Compound®
PCE	perchloroethene
PCUL	proposed cleanup level
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
ROI	radius of injection
SIM	selected ion monitoring
SWMU	solid waste management unit
TCE	trichloroethene
TMCL	Target Media Cleanup Level
TOC	total organic carbon
TPH-G	gasoline-range total petroleum hydrocarbons
TWA	time-weighted average
UST	underground storage tank
VC	vinyl chloride
VCP	Voluntary Cleanup Program
VOC	volatile organic compound
mg/L	milligrams per liter
µg/L	micrograms per liter

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1.0 INTRODUCTION

This document presents a summary of work plans and previous reports for the interim actions (IAs) being used to address groundwater contamination present at The Boeing Company's (Boeing) Developmental Center (DC) in Tukwila, Washington (Figure 1). The DC is a regulated facility under the Resource Conservation and Recovery Act (RCRA) with a facility identification number of WAD-09363-9946. The Washington State Department of Ecology (Ecology) is authorized by the US Environmental Protection Agency (EPA) to implement RCRA corrective action through its Model Toxics Control Act (MTCA) regulations. Boeing has performed these remedial actions at the DC under Ecology's Voluntary Cleanup Program (VCP), but this work will continue under the new Agreed Order issued for the DC and per the information presented in this Interim Action Work Plan.

1.1 Site Description

The DC (site) is located at 9725 East Marginal Way South in Tukwila, Washington near Boeing Field and the Military Flight Center (now called the Military Delivery Center; Figure 1). The site is bounded by the Duwamish Waterway on the west and East Marginal Way South on the east.

The earliest known commercial operations at the site began in 1927and since then have included various commercial and industrial activities such as a sawmill, a welding supply company, a stockyard and meat-packing plant, a compressed gas company, warehouses, office buildings, a granary, a commercial trucking operation, a staging area for heavy trucks, a grocery store, a gasoline station, a tavern, a construction yard, a commercial parking lot, and a propane distributor (LAI 2002a).

Boeing has been operating on portions of this site since 1956 (SAIC 1994) and the site currently consists of over 30 buildings on approximately 112 acres. The DC is an aircraft and aerospace research and development complex, primarily supporting projects for the US Department of Defense. Activities that have occurred at the DC facility include research & development programs including the Bomarc missile, Minuteman Intercontinental Ballistic Missile, Supersonic Transport (SST), YC-14 short takeoff/ landing transport, YF-22 fighter prototype, and the Boeing Joint Strike Fighter candidate. Manufacturing activities have included significant portions of the B-2 stealth bomber and military variants of Boeing commercial jets (Boeing 2009). Past manufacturing operations included machining of metal aircraft hardware, electroplating, chemical milling, conversion coating, painting, parts cleaning, and assembly. Experimental manufacturing shops and research laboratories were used to investigate production aspects of materials and processes for manufacturing. There were also laboratories to investigate metals technology and electronics sciences (SAIC 1994). The DC facility continues to be the primary research and development center for carbon fiber composite structures.

1.2 Background

Under its RCRA corrective action authority, the EPA conducted a RCRA Facility Assessment (RFA) in 1994 and identified 157 solid waste management units (SWMUs) and five areas of concern (AOCs) at the DC (SAIC 1994). Each of these SWMUs and AOCs were evaluated in a comprehensive Summary

Report prepared for Boeing by Landau Associates, Inc. (LAI 2002a). Ecology approved the exclusion of most SWMUs and AOCs from further investigation based on this evaluation and the demonstration that they did not pose a threat to human health or the environment.

After approving the Summary Report (LAI 2002a), Ecology determined that only two SWMUs (SWMU-17 and SWMU-20) and three AOCs (AOC-01/02, AOC-03/04, and AOC-05) remained subject to continued monitoring and evaluation. Contaminants of concern were not detected during two consecutive events (wet and dry seasons) and four consecutive quarters of monitoring at AOC-01/02 and AOC-03/04, respectively (Boeing 2002, 2003); monitoring was in accordance with the Developmental Center Groundwater Monitoring Plan (Boeing 2001). Following this additional monitoring at AOC-01/02 and AOC-03/04, Ecology agreed that no further monitoring or other remedial action was required.

The three areas requiring further remedial action (AOC-05, SWMU-17, and SWMU-20) are described in the following sections. A facility boundary map showing the locations of these three areas within the DC facility is presented on Figure 2. A site plan showing the specific areas where further remedial action is being performed, including monitoring wells and facility buildings of interest, is presented on Figure 3.

1.2.1 AOC-05

AOC-05 is located in the vicinity of Building 9-61 (Figure 3). This AOC consisted of a 1,000-gallon steel underground storage tank (UST) designated as DC-01 and an associated pump island, which were located approximately 25 to 30 feet (ft) south of the southwest corner of building 9-61. The UST, containing unleaded gasoline, was removed in 1985 after it was punctured by a measuring rod releasing approximately 830 gallons of unleaded gasoline (LAI 2004a). The contaminants of concern in AOC-05 are gasoline-range total petroleum hydrocarbons (TPH-G) and benzene, toluene, ethylbenzene, and xylenes (BTEX); these contaminants are directly associated with the gasoline release in the early 1980s.

1.2.2 SWMU-17

SWMU-17 is located west of Building 9-64 (Figure 3). This SWMU consisted of a 67-gallon sump and associated 4,000-gallon steel UST designated DC-05. Waste oil generated by the hydraulic testing shops, automotive maintenance shops, and other operations at the DC was poured into the sump, which drained to the UST. Periodically, waste oil was pumped from the UST for offsite treatment and disposal. Both the sump and UST were removed in 1986 (LAI 2004a). The contaminants of concern in SWMU-17 are volatile organic compounds (VOCs), arsenic, and copper. The specific VOCs of concern are perchloroethene (PCE) and its transformation products (trichloroethene [TCE], *cis*-1,2-dichloroethene [cDCE], and vinyl chloride [VC]).

1.2.3 SWMU-20

SWMU-20 is located at the northwest corner of Building 9-101 and just off the northeast corner of Building 9-90 (Figure 3). This SWMU consisted of a vapor degreaser located in the northwest corner of Building 9-101. PCE and TCE were reportedly used during the operation of the degreaser from 1956 to 1984. The vapor degreaser, associated piping, and other equipment were removed in 1984 and all openings through walls and floor slabs were plugged. The concrete-lined degreaser pits and sumps were backfilled with compacted sand backfill material and capped with 10 inches of concrete slab (LAI 2004a). The contaminants of concern in SWMU-20 are VOCs resulting from a suspected solvent leak from the former vapor degreaser pit. Specific VOCs of concern are PCE and TCE and transformation products (cDCE and VC), as well as benzene and naphthalene.

2.0 SELECTED INTERIM ACTIONS

IAs began in the late 1990s at AOC-05, SWMU-17, and SWMU-20 and are nearing completion. IA activities in these three areas through 2003 are summarized in the DC Evaluation Report (LAI 2004a). Since that report, IA activities and groundwater monitoring results have been summarized in various work plans, work plan addenda, semiannual reports for the site, and in annual reports for SWMU-17 and AOC-05. IA activities and documents are identified for each area in the following sections and in Table 1. Work plans and other critical documents for each area are provided as appendices to this report.

2.1 AOC-05

Bioremediation was selected as the IA in AOC-05 for the treatment of TPH-G and BTEX in groundwater. Bioremediation involves the addition of electron acceptors to enhance biodegradation of TPH-G by native micro-organisms in the aquifer. Micro-organisms can generate energy for cellular processes, like growth and reproduction, by utilizing TPH-G as an electron donor in redox reactions. Micro-organisms preferentially use oxygen then nitrate as electron acceptors for these redox reactions. However, aquifers with naturally high organic carbon and reduced redox conditions can exert a very high natural oxygen demand that makes an aerobic bioremediation approach impractical. An initial attempt to stimulate aerobic bioremediation through addition of Regenesis Oxygen Release Compound® (ORC®) was unsuccessful. Subsequent pilot testing and full-scale implementation of anaerobic bioremediation through addition of nitrate has been successful. These treatments and results are summarized below.

2.1.1 ORC® Injection

ORC was injected in 2002 in accordance with the work plan to stimulate aerobic bioremediation of TPH-G (LAI 2002b). ORC is a powdered magnesium peroxide product that slowly releases oxygen to the aquifer as it becomes hydrated in the saturated zone. ORC was mixed with water and injected as a slurry using direct-push drilling methods. A total of 1,060 pounds of ORC were injected at 13 locations in the vicinity of the former UST. ORC was ineffective at changing aquifer redox conditions or significantly reducing contaminant concentrations (LAI 2006a).

2.1.2 Aquifer Redox Evaluation

Consideration of the aquifer depositional environment and natural aquifer redox conditions outside of the area of TPH-G contamination indicated that the aquifer was naturally reducing (i.e. anoxic) and exerted a substantial natural oxygen demand. For successful aerobic bioremediation of the TPH-G to occur, this natural oxygen demand would have to be overcome, as well as the oxygen needed for aerobic bioremediation of the TPH-G. The estuarine (i.e. mudflats) depositional environment of the aquifer exerts this high natural oxygen demand because it is the source of a high natural organic carbon content and reduced metal species within the aquifer.

Evaluation of aquifer redox data collected from monitoring wells indicated that redox conditions in the contaminant source zone, and immediately downgradient, were nitrate- to sulfate-reducing.

Redox conditions farther downgradient were nitrate- to iron-reducing. The natural reducing condition of the aquifer indicates that anaerobic bioremediation through injection of nitrate or sulfate would be more effective than the aerobic approach attempted with ORC. Nitrate, which was not detected in any wells, would be fully consumed within the zone of TPH-G contamination or downgradient under natural aquifer conditions. Moderate concentrations of sulfate were present, even in the TPH-G source zone, indicating incomplete utilization of naturally available sulfate (i.e. nitrate was preferred over sulfate for stimulation of anaerobic bioremediation; LAI 2006a).

2.1.3 Nitrate Pilot Test

A pilot test was designed to determine if injection of nitrate solution would successfully enhance anaerobic biodegradation of TPH-G and BTEX (Appendix A; LAI 2006b). The pilot test began in January 2007 with injection of ammonium nitrate solution to source zone well BDC-103. Approximately 6,500 gallons of extracted groundwater amended with nitrate to a concentration of 1,000 milligrams per liter (mg/L) were injected. The injection volume was based on an estimated radius of injection (ROI) of 13.5 ft. Yeast extract was added to injection fluid to provide micro-nutrients for bacterial growth. Downgradient wells BDC-101 and BDC-102, in addition to BDC-103, were monitored for baseline data prior to injection and for performance data following injection.

In the 4 months following pilot testing, TPH-G concentrations were reduced by 49 percent from baseline and BTEX concentrations were reduced by up to 98 percent from baseline. Nitrate was fully utilized and decreased to background levels within 4 months after the injection. The pilot test successfully demonstrated that nitrate as an amendment could effectively reduce TPH-G and BTEX concentrations at AOC-05 without nitrate persisting in groundwater or being transported downgradient from the source zone. Implementation of full-scale nitrate injections was recommended based on pilot test results (LAI 2007a).

2.1.4 Full-Scale Nitrate Injections

Full-scale nitrate injections began in February 2008. These IA injections were conducted in accordance with the work plan (Appendix B; LAI 2007b) and as modified in subsequent reports based on monitoring results. The work plan covered repeated injection events because it was anticipated that multiple injections would be required for complete biodegradation of the TPH-G and BTEX present in the aqueous, sorbed, and non-aqueous phase liquid (NAPL) phases within the treatment area. Ammonium nitrate was injected to source zone wells BDC-103 and BDC-104 using similar volumes and nitrate concentrations as the pilot test. These wells and downgradient wells BDC-101 and BDC-102 were monitored for baseline data and quarterly following injection. From 2008 through 2018, 11 full-scale injections were performed at BDC-103. Five injections were performed at BDC-104, where TPH-G and BTEX were fully treated as of 2008 (LAI 2018a).

2.1.5 Interim Action Performance Evaluation

IA performance in AOC-05 has been documented in 21 semiannual reports and 10 annual reports to Boeing and Ecology since 2008—the year of the first full-scale nitrate injections. The most recent annual report covers all IA activities and results through February 2018 (LAI 2018a). The most recent semiannual report for the site includes data through November 2018 (LAI 2019). Cumulative data tables with analytical data through the most recent sampling event in November 2018 are presented in Tables 2 and 3.

Monitoring results suggest that bioremediation of TPH-G and BTEX is nearing completion in AOC-05, as indicated by the extended period of contaminant concentrations below the proposed cleanup levels (PCULs) and slower nitrate utilization. February 2018 monitoring data indicate substantial contaminant concentration reductions of more than 99 percent compared to 2008 baseline conditions (LAI 2018a).

The last injection occurred in December 2016, with nitrate persisting in groundwater through August 2018 (20 months). November 2018 results indicate nitrate depletion and a slight rebound in TPH-G and BTEX concentrations; however, all detections were below PCULs (LAI 2019). Ongoing monitoring will evaluate potential rebound of TPH-G and BTEX concentrations. In the event of substantial rebound, additional nitrate injections will be performed. Monitoring will continue in accordance with Section 4.0 of this report.

2.2 SWMU-17

Bioremediation was selected as the remedial approach in SWMU-17 for the treatment of PCE in groundwater. Anaerobic bioremediation of PCE relies on reductive dechlorination — the microbiologically mediated process by which PCE is reduced to transformation products TCE, cDCE, VC, and non-toxic end products ethene and ethane. Detections of TCE and cDCE indicated that natural redox conditions in SWMU-17 were conducive to reductive dechlorination of parent product PCE. Micro-organisms gain energy through reductive dechlorination by utilizing PCE and transformation products as electron acceptors and hydrogen gas as an electron donor. Fermentable substrates like ethyl lactate, sodium lactate, vegetable oil, and molasses can serve as indirect electron donors for this process by stimulating the growth of fermenting micro-organisms that produce hydrogen gas (LAI 2008a). Pilot testing and full-scale implementation of anaerobic bioremediation through addition of fermentable substrates has been successful. These treatments and performance results are summarized below.

2.2.1 Electron Donor Pilot Test

A pilot test work plan (Appendix C; LAI 2008a) was developed to determine if electron donor (sodium lactate and vegetable oil) and ferrous sulfate as groundwater amendments would successfully enhance anaerobic biodegradation of PCE and immobilization of copper in SWMU-17. The pilot test was also used to evaluate the effect of this approach on dissolved arsenic concentrations.

Ferrous sulfate was added along with electron donor substrates during the pilot test to stimulate removal of dissolved copper and arsenic from groundwater, and abiotic degradation of PCE via reaction with iron sulfides. Abiotic degradation of PCE is a supplemental degradation mechanism that occurs in addition to the biotic anaerobic degradation (i.e. reductive dechlorination) stimulated by electron donor amendment. Copper can be immobilized in reactions mediated by sulfate-reducing bacteria and arsenic can be immobilized by sorption or precipitation reactions (LAI 2008a).

The pilot test in SMWU-17 was performed in October 2008. Monitoring well BDC-05-02 was injected with approximately 5,300 gallons of potable water and then amended with 256 gallons of vegetable oil emulsion, 275 gallons of sodium lactate, 400 pounds of ferrous sulfate, and yeast extract. The injection volume was designed to create an ROI of 13 to 18 ft (LAI 2008a). Bioremediation of PCE at SWMU-17 was successfully stimulated by the electron donor pilot test injection. However, the relatively limited extent of PCE and TCE treatment observed during the pilot test indicated that the ROI created was smaller than anticipated and that the downgradient transport of electron donor was slow (LAI 2010a). Over the course of the pilot test, PCE and TCE concentrations decreased substantially at SWMU-17, but the lack of substantial VC, ethene, or ethane production indicated that the process of reductive dechlorination was incomplete. In addition, metals concentrations remained unchanged at most wells; copper and arsenic concentrations were within the range of pre-injection results (LAI 2010a).

2.2.2 Downgradient Data Gaps Investigation

In preparation for full-scale treatment in SWMU-17, groundwater was sampled from 74 direct-push borings in April 2009 through March 2011 to fully investigate the area downgradient of the suspected source zone. The exposed direct-push screen was centered at 18.5 ft below ground surface (bgs) to approximate the mid-point between the water table and the bottom depth of injection well BDC-05-02. Three borings within the core of the PCE and TCE plume were sampled from multiple depths to understand the vertical extent of contamination (LAI 2011).

Direct-push groundwater sampling results indicated that PCE and TCE contamination was confined to the shallow interval at approximately 18.5 ft bgs and that reductive dechlorination to VC was occurring (i.e. aquifer redox conditions were more reducing) in certain sections of the plume (LAI 2011).

2.2.3 First Full-Scale Injection

Full-scale electron donor injections were recommended after the pilot test demonstrated the effectiveness of this approach to treat PCE and TCE in groundwater at SWMU-17. A work plan for full-scale bioremediation (Appendix D; LAI 2011) was developed for the implementation of electron donor injection to the source zone in SWMU-17.

A remediation product consisting of ethyl lactate and emulsified vegetable oil (LactOil®) was injected as the electron donor to 11 wells (BDC-05-02, BDC-05-07, BDC-05-09 through BDC-05-17) along the centerline of the narrow plume in August 2011. Each of the 11 injection wells were injected with a fluid volume and electron donor mass similar to what was used in the pilot test injection. Approximately 5,600 gallons of injection fluid consisting of potable water, 320 gallons LactOil, and yeast extract were delivered to each well. A total of 61,600 gallons of fluid containing 3,520 gallons of LactOil were injected (LAI 2011).

Post-injection monitoring indicated that bioremediation was substantially enhanced over approximately 6 years following the August 2011 electron donor injection. Monitoring data provided "direct evidence" of biodegradation of PCE, TCE, and their transformation products at 16 of 22 monitored wells. PCE, TCE, cDCE, and VC concentrations were below PCULs at all but three wells as of the August 2017 sampling event; highly reduced redox conditions necessary for complete reductive dechlorination were evident as of the May 2017 sampling event (LAI 2017).

2.2.4 Second Full-Scale Injection

In anticipation of final cleanup levels (CULs) lower than the PCULs (see Section 3.0), an additional electron donor injection was proposed for five wells in SWMU-17, targeting wells with PCE and/or TCE detections greater than 1 microgram per liter (µg/L) in 2017. This focused injection was described in an addendum to the work plan (Appendix E; LAI 2017).

Five wells (BDC-05-02, BDC-05-03, BDC-05-04, BDC-05-07, and BDC-05-10) were injected with molasses in November 2017. Molasses, a more soluble electron donor, was injected instead of LactOil for this second injection. The previous use of both fast release (very soluble) lactate and slow-release (less soluble) vegetable oil contained in LactOil was intended to optimize the distribution and longevity of the injected donor for extended treatment. The optimization occurs because the lactate component is very soluble and can be transported farther downgradient, while vegetable oil, which is much less soluble, moves a shorter distance from the wells and ferments more slowly to provide a long-term source of donor to aquifer bacteria. Generally, combined use of very soluble and less soluble donor is a beneficial strategy to extend the treatment period between injection events. However, long persistence of electron donor was not the goal of this injection event because it occurred near the end of anticipated treatment. The goal of using very soluble sugar was to focus treatment on residual contaminant mass without persistent elevated total organic carbon (TOC) concentrations over time, which had the potential to delay the use of wells as points for compliance monitoring and delay the closure of SWMU-17 (LAI 2017).

The design volume of injection fluid delivered to each well was similar to the injection volumes utilized in the first full-scale injection. Each well received approximately 6,000 gallons of electron donor injection fluid containing 7,060 pounds of molasses. Injection fluid was also amended with yeast extract to provide micro-nutrients for bacterial growth and ferrous chloride to form iron sulfides in the aquifer that are beneficial for the abiotic degradation (i.e. reductive elimination) of PCE, TCE, and cDCE (LAI 2017). A total volume of 30,900 gallons of fluid containing approximately 37,240 pounds of molasses were injected.

2.2.5 Interim Action Performance Evaluation

IA performance in SWMU-17 has been documented in 16 semiannual and six annual reports to Boeing and Ecology since the first full-scale electron donor injection was performed in 2011. The most recent annual report covers all IA activities and results for calendar year 2017, including performance groundwater monitoring events, data evaluation, and the targeted electron donor injection in

November 2017 (LAI 2018b). The most recent semiannual report for the site includes data through November 2018 (LAI 2019). Cumulative data tables with analytical data through the most recent sampling event in November 2018 are presented in Tables 4 and 5.

Groundwater monitoring results show that anaerobic bioremediation in SWMU-17 continues to be enhanced, despite declining TOC concentrations. As of the November 2018 sampling event, all wells were below PCULs for PCE, TCE, cDCE, and VC. Results indicate enhanced aquifer redox conditions and enhanced reductive dechlorination. Complete reductive dechlorination is occurring, as indicated by detection of end product ethane at four of the wells monitored in SWMU-17 (LAI 2019).

Another injection is not needed in SWMU-17 at this time. Monitoring event frequency was reduced from quarterly to semiannually in March 2018 as a result of the substantial progress made in the treatment of PCE, TCE, and their transformation products. Monitoring results will continue to be used to evaluate the ongoing treatment resulting from the November 2017 molasses injection (LAI 2018b). Monitoring will continue in accordance with Section 4.0 of this report.

2.3 SWMU-20

IA in SWMU-20 has consisted of groundwater pump and treat followed by bioremediation for the treatment of PCE and TCE in groundwater. Anaerobic bioremediation of VOCs like PCE and TCE relies on reductive dechlorination—the microbiologically mediated process by which these compounds are reduced to transformation products, cDCE and VC, and non-toxic end products, ethene and ethane. Micro-organisms gain energy through reductive dechlorination by utilizing PCE, TCE, and transformation products as electron acceptors and hydrogen gas as an electron donor. Fermentable substrates like sodium lactate and vegetable oil can serve as indirect electron donors for this process by stimulating the growth of fermenting micro-organisms that produce hydrogen gas (LAI 2004a). Full-scale implementation of anaerobic bioremediation through addition of fermentable substrates has been successful. Treatment methods and performance results are summarized below. The details of the pump and treat system shutdown and indoor air modeling and sampling are also provided below.

2.3.1 Contaminant Rebound

Following soil and groundwater investigations around the former degreaser location, a groundwater treatment system was installed to remove chlorinated VOCs from groundwater for source area treatment and for the prevention of further contaminant migration. The treatment system, consisting of two extraction wells (E-1 and E-2), and a sieve tray aerating treatment system, operated from Fall 1993 to December 2001 (approximately 8 years). The groundwater treatment system processed approximately 25,000 gallons of treated water per day, which was discharged to a National Pollution Discharge Elimination System (NPDES) permitted stormwater outfall. The system was shut down in December 2001 to allow the groundwater to equilibrate for evaluation of potential rebound and evaluation of natural attenuation as a remedial alternative to achieve site PCULs (LAI 2004a).

Substantial contaminant concentration rebound was observed within 2 years following the shutdown of the groundwater treatment system. PCE and TCE rebounded above their preliminary screening levels of 9 µg/L and 81 µg/L, respectively, at wells located in the immediate vicinity of the former degreaser. No preliminary screening level was established for cDCE, but cDCE concentrations rebounded above 500 µg/L at wells located in the immediate vicinity of the former degreaser. No rebound of VC was observed (LAI 2004a).

Enhanced reductive dechlorination through electron donor amendment (i.e. bioremediation) was recommended to address the rebound in VOC concentrations observed following groundwater treatment system shutdown. This remedial approach was based on the evaluation, which indicated that the rate of concentration reduction was at least as great for most contaminants of concern under non-pumping conditions as it was under pumping conditions. In addition, the limited number of monitoring wells showing significant contaminant rebound after pumping was discontinued indicated that pumping was not necessary to hydraulically contain the plume. Bioremediation would enhance the contamination attenuation that was naturally occurring under existing site conditions (LAI 2004a).

2.3.2 Bioremediation

A series of five bioremediation injection events were performed to address contaminant concentrations near the former degreaser, downgradient, and ultimately at peripheral wells not affected by the earlier injections. Full-scale bioremediation was implemented without pilot testing. These injections are described in the following sections.

2.3.2.1 First Injection

Two extraction wells (E-1 and E-2) and six monitoring wells (MW-6A, MW-6B, MW-6C, MW-9A, MW-9B, and MW-9C) were used for the first injection in June 2004. Sodium lactate and vegetable oil emulsion were mixed with groundwater pumped from extraction wells to form a dilute injection solution. Extracted groundwater was used for the injection solution to address initial concerns regarding dilution and/or dispersion of the plume and to avoid the introduction of highly oxygenated water to the aquifer. Injection and monitoring were performed in accordance with the work plan (Appendix F; LAI 2004a). A total of approximately 10,000 gallons of injection fluid consisting of 550 gallons of sodium lactate and 257 gallons of vegetable oil emulsion were delivered to the six injection wells. The injection procedure in the work plan was modified to deliver both electron donor substrates to all injection wells, rather than three wells receiving sodium lactate only and three wells receiving vegetable oil emulsion only (LAI 2004b).

Post-injection monitoring results indicated that more reducing redox conditions had been established and that reductive dechlorination had been enhanced due to this injection. Monitoring results also indicated that injected electron donor was being rapidly depleted approximately 2 months after injection and that a second electron donor injection was advisable to maintain elevated TOC concentrations for continued bioremediation (LAI 2004b).

2.3.2.2 Second Injection

Two extraction wells (E-1 and E-2) and four monitoring wells (MW-6A, MW-6B, MW-9A, and MW-9B) were used for the second injection in December 2004. All wells received the same volume and injection solution. A total of approximately 11,000 gallons of injection solution consisting of 550 gallons of sodium lactate and 514 gallons of vegetable oil mixed with extracted groundwater were delivered to the four injection wells. The mixture of fast- and slow-release electron donor (i.e. lactate and vegetable oil) was intended to maximize the extent and longevity of treatment (LAI 2004b).

The second electron donor injection was described in a technical memorandum (memo) evaluating treatment progress following the first injection (Appendix G; LAI 2004b). This memo anticipated that a third electron donor injection would be performed 4 to 6 months following the second injection.

2.3.2.3 Third Injection

One monitoring well (MW-14A) and two extraction wells (E-1 and E-2) were used for the third injection in March 2005. Donor amendment at well MW-14A was intended to extend the treatment zone downgradient of the source and to treat relatively high concentrations of VC observed at that well following prior injections nearer the source zone. Approximately 5,600 gallons of injection solution consisting of 550 gallons of sodium lactate, 257 gallons of vegetable oil, and extracted groundwater were injected into MW-14A (LAI 2005a).

This third electron injection is described in a February 2005 memo summarizing groundwater and indoor air modeling results (Appendix H; LAI 2005a); also refer to Section 2.3.3. The memo also describes the installation of two additional monitoring wells (MW-22A and MW-23A) to monitor the effects of the third injection and to monitor treatment progress farther downgradient.

2.3.2.4 Fourth Injection

Three monitoring wells (MW-6A, MW-9A, and MW-10A) and two extraction wells (E-1 and E-2) were used for the fourth injection in August 2008. The objective of this injection was to provide additional source zone treatment. A total of approximately 15,900 gallons of injection solution consisting of 825 gallons of sodium lactate, 768 gallons of vegetable oil emulsion, and extracted groundwater were delivered to the three monitoring wells. Each well received approximately 5,300 gallons of injection solution consisting of 275 gallons of sodium lactate and 256 gallons of vegetable oil emulsion. Details of the fourth electron donor injection in SWMU-20 are provided in an addendum to the full-scale bioremediation work plan (Appendix I; LAI 2008b).

2.3.2.5 Fifth Injection

Nine monitoring wells (MW-6A, MW-6B, MW-10C, MW-15C, MW-16A, MW-16C, MW-17A, MW-20C, and MW-22A) were injected during the fifth injection at SMWU-20 in October and November 2015 to target residual contaminant mass at source zone wells and additional wells located on the fringes of the treatment area. Specifically, it targeted wells where TCE concentrations remained above the PCUL and wells where VC concentrations were greater than 0.5 µg/L. This additional injection was performed in anticipation of final CULs lower than PCULs (see Section 3.0). Injection activities were performed in accordance with an addendum to the bioremediation work plan (Appendix J; LAI 2015a).

Approximately 5,300 gallons of injection solution consisting of potable water from a nearby fire hydrant and 220 gallons of JRW Wilclear Plus™, a sodium lactate solution with added nutrients, were delivered to each well. A total of approximately 47,700 gallons of solution consisting of 1,980 gallons of Wilclear Plus were injected. In contrast to previous injection events, slow release electron donor substrate (e.g. vegetable oil) was not utilized for the fifth injection event, as was done during previous injections in order to provide rapid treatment of residual contaminant mass without persistent elevated TOC concentrations. If TOC concentrations remained elevated after the fifth injection, it would limit the usefulness of the nine injected wells as monitoring points for closure of SWMU-20 (LAI 2015a).

2.3.3 Indoor Air Evaluation and Sampling

Indoor air evaluations were performed in the vicinity of SWMU-20 to estimate potential human health risks associated with exposure to indoor air due to VOCs in the underlying shallow groundwater. These evaluations were performed for Building 9-101, which overlies the source, and Building 9-90, located hydraulically downgradient of the source (Figure 3).

Various evaluations were performed for both buildings using the Johnson-Ettinger model (Version 3.0). Assumptions and input values for the three evaluations in SWMU-20 were documented in the DC Evaluation Report (LAI 2004a). The indoor air evaluations for Buildings 9-90 and 9-101 concluded that the associated risk levels for occupational inhalation of potentially impacted indoor air were at, or below, the regulatory criteria. Ecology comments were addressed in a memo in August 2005 (LAI 2005b).

VC concentrations in groundwater at MW-14A increased during the October 2004 sampling event, resulting in further evaluation of indoor air (Appendix H; LAI 2005a). Recognizing that ongoing SMWU-20 source zone treatment (i.e., bioremediation injections) could result in higher VC concentrations at downgradient well MW-14A, the Johnson-Ettinger model was run to identify the threshold average groundwater VC concentration beneath building 9-90. Above this threshold, a potential would exist for unacceptable risks to human health from inhalation of indoor air. The model output estimated that the threshold VC groundwater concentration protective of human health was 43 µg/L. Ecology comments to this additional evaluation resulted in indoor air sampling in Building 9-90 (LAI 2005c).

Three indoor air samples were collected in the north portion of Building 9-90 along the estimated axis of the VOC groundwater plume in order to characterize potential vapor intrusion. A concurrent ambient air sample was collected outdoors near ground level to establish site-specific background air concentrations of the VOCs of interest in order to assess possible background contributions to any indoor air detections. Eight-hour, time-weight average (TWA) samples were collected at all sampling locations using Summa canisters and analyzed for PCE, TCE, cDCE, and VC using EPA Method TO-15 with selected ion monitoring (SIM). Sampling was performed in accordance with the work plan (Appendix K; LAI 2005c).

Low levels of PCE and TCE were detected in all three indoor air samples and in the outdoor ambient air sample. cDCE and VC were not detected in any sample[1]. The detected concentrations of corrected[2] indoor air results for PCE and TCE were below the MTCA Method B cleanup levels (LAI 2006c).

2.3.4 Reductions in Groundwater Monitoring

Quarterly to semiannual monitoring began in January 1994. After reviewing long-term monitoring data at SWMU-20 wells, sampling reductions were proposed in April 2010 and again in March 2015. The 2010 sampling reduction discontinued semiannual monitoring at 11 of the 29 existing SWMU-20 monitoring wells, where VOCs of concern (PCE, TCE, cDCE, and VC) had been below reporting limits for 2 years or more. The 11 wells were not abandoned so that they remain available for future monitoring should that become necessary (LAI 2010b). The 2015 sampling reduction discontinued semiannual monitoring at nine of the 18 sampled wells[3]. The nine wells retained for ongoing sampling were all wells where PCE, TCE, or VC was detected at a concentration of more than half of the PCUL in May 2014. Continued semiannual monitoring at these nine wells will be used for the foreseeable future to evaluate ongoing monitored natural attenuation (MNA) in SWMU-20 (LAI 2015b).

2.3.5 Pump and Treat System Decommissioning

The groundwater treatment system in SWMU-20 was decommissioned in June 2014. Ecology agreed that the treatment system was not likely to be needed in the future due to effective bioremediation treatment. Decommissioning was generally as described in a decommissioning memo (Appendix L; LAI 2014). The air stripper was relocated to Boeing's Queen City Farm Superfund site for reuse. Submersible pumps were removed from extraction wells and system piping was disconnected and capped. The treatment building remained at the site for future use or later removal.

2.3.6 Interim Action Performance Evaluation

IA performance in SWMU-20 has been documented in 18 semiannual reports to Boeing and Ecology since sampling was reduced for the first time in May 2010. The most recent semiannual report for the site includes data through November 2018 (LAI 2019). Cumulative data tables with analytical data through the most recent sampling event in November 2018 are presented in Tables 6 and 7.

Groundwater monitoring results indicate concentrations of PCE, TCE, and transformation products were below the PCULs at all SWMU-20 monitoring wells in November 2018. Results indicate aquifer redox conditions conducive to continued bioremediation following the fifth electron donor injection in October and November 2015 (LAI 2019). Additional electron donor injection is not anticipated.

Semiannual monitoring will continue at SWMU-20 to evaluate continued MNA. Monitoring will continue in accordance with Section 4.0 of this report.

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[1] The reporting limits for cDCE and VC were below the MTCA Method B cleanup levels.

[2] Indoor air results were corrected for ambient air contributions by subtracting the concentration of each analyte detected in the ambient air sample.

[3] The nine wells no longer being sampled were not abandoned.

3.0 PROPOSED CLEANUP LEVELS

PCULs were developed for the DC in 2013 (LAI 2013). PCULs were proposed for groundwater contaminants present in AOC-05, SWMU-17, and SWMU-20, and for VOCs in groundwater with the potential to migrate to indoor air. Cleanup standards were based on ecological and human health risk specific to site location, hydrogeology, and site use, and were developed in accordance with Washington Administrative Code (WAC) 173-340-720. The PCUL document is included as Appendix M.

LAI previously proposed that the Boeing Plant 2 Target Media Cleanup Levels (TMCLs), which were developed by Boeing and approved by the EPA for use at the Boeing Plant 2 facility, be used as groundwater CULs at the DC. Plant 2 is located 1.25 miles downstream of the DC on the east bank of the Duwamish Waterway.

The Plant 2 TMCLs were determined to be protective of groundwater beneficial uses including discharge to fresh and marine surface water, protection of aquatic life, and human ingestion of fish and shellfish. Drinking water criteria were adopted as TMCLs only for constituents for which there were no state or federal promulgated surface water criteria and insufficient information to calculate TMCLs protective of human health and aquatic life. In limited instances, Plant 2 TMCLs were based on MTCA Method A or background values (LAI 2013).

PCULs based on Plant 2 TMCLs for the VOCs of concern at the DC are as follows:

- PCE = 5.3 µg/L
- TCE = 1.4 µg/L
- cDCE = 134 µg/L
- VC = 2.4 µg/L.

PCULs will continue to be referenced and used for IA performance evaluation at the DC. However, it is anticipated that, as part of the remedial investigation and feasibility study process, final CULs will be established.

4.0 PERFORMANCE MONITORING

Performance monitoring at the DC is part of the Boeing Regional Groundwater Monitoring Program. On a quarterly to semiannual basis, 42 monitoring wells at the DC are sampled by LAI for various contaminants and aquifer redox parameters to monitor treatment progress in AOC-05, SWMU-17, and SWMU-20. Quarterly sampling at AOC-05 generally occurs in February, May, August, and November. Semiannual sampling generally occurs in May and November. It is proposed that performance monitoring for AOC-05 be reduced to semiannual and occur in May and November.

An updated performance monitoring sample matrix is provided in Table 8 and sampling locations are presented on Figure 4. As of January 2018, samples collected at the DC are sent to Analytical Resources, Inc. in Tukwila, Washington (LAI 2018c) for one or more of the following analyses:

- VOCs (EPA Method 8260C)
- Short-list VOCs – PCE, TCE, cDCE, VC (EPA Method 8260C)
- Methane, ethene, ethane (EPA RSKSOP-175, modified)
- Acetylene, methane, ethene, ethane (AMEE) (EPA RSKSOP-175, modified)
- TOC (Standard Method 5310C)
- BTEX (EPA Method 8260C)
- TPH-G (Ecology Method NWTPH-G)
- Sulfate (EPA Method 300.0)
- Nitrate, nitrite (EPA Method 300.0)
- Arsenic and copper, total and dissolved (EPA Method 200.8)

In addition to the laboratory analyses listed, field parameters are also recorded for each sample, including temperature, conductivity, dissolved oxygen, pH, oxidation-reduction potential, and ferrous iron.

Performance monitoring will continue at the DC as described in this section to evaluate IAs. The frequency, list of analytes, and monitoring wells sampled, etc. will continue to be assessed and any proposed changes to the performance monitoring plan will be coordinated with Ecology for approval.

5.0 SCHEDULE

Monitoring and reporting of IA activities for the Boeing DC will continue, and the need for additional bioremediation injection events evaluated.

Monitoring will be conducted in accordance with Section 4.0 of this report. Reporting will consistent of site-wide semiannual groundwater monitoring reports to detail work performed since the previous semiannual event, present sampling results, and discuss treatment progress. Semiannual reports will be submitted to Ecology no later than 60 days after the receipt of the previous semiannual sampling event's analytical data. One annual report will be submitted for SWMU-17, SWMU 20, and AOC-05 on May 15 each year.

6.0 USE OF THIS REPORT

This Interim Action Work Plan document has been prepared for the exclusive use of The Boeing Company for specific application to the Developmental Center site in Tukwila, Washington. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of Landau Associates. Further, the reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by Landau Associates, shall be at the user's sole risk. Landau Associates warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. We make no other warranty, either express or implied.

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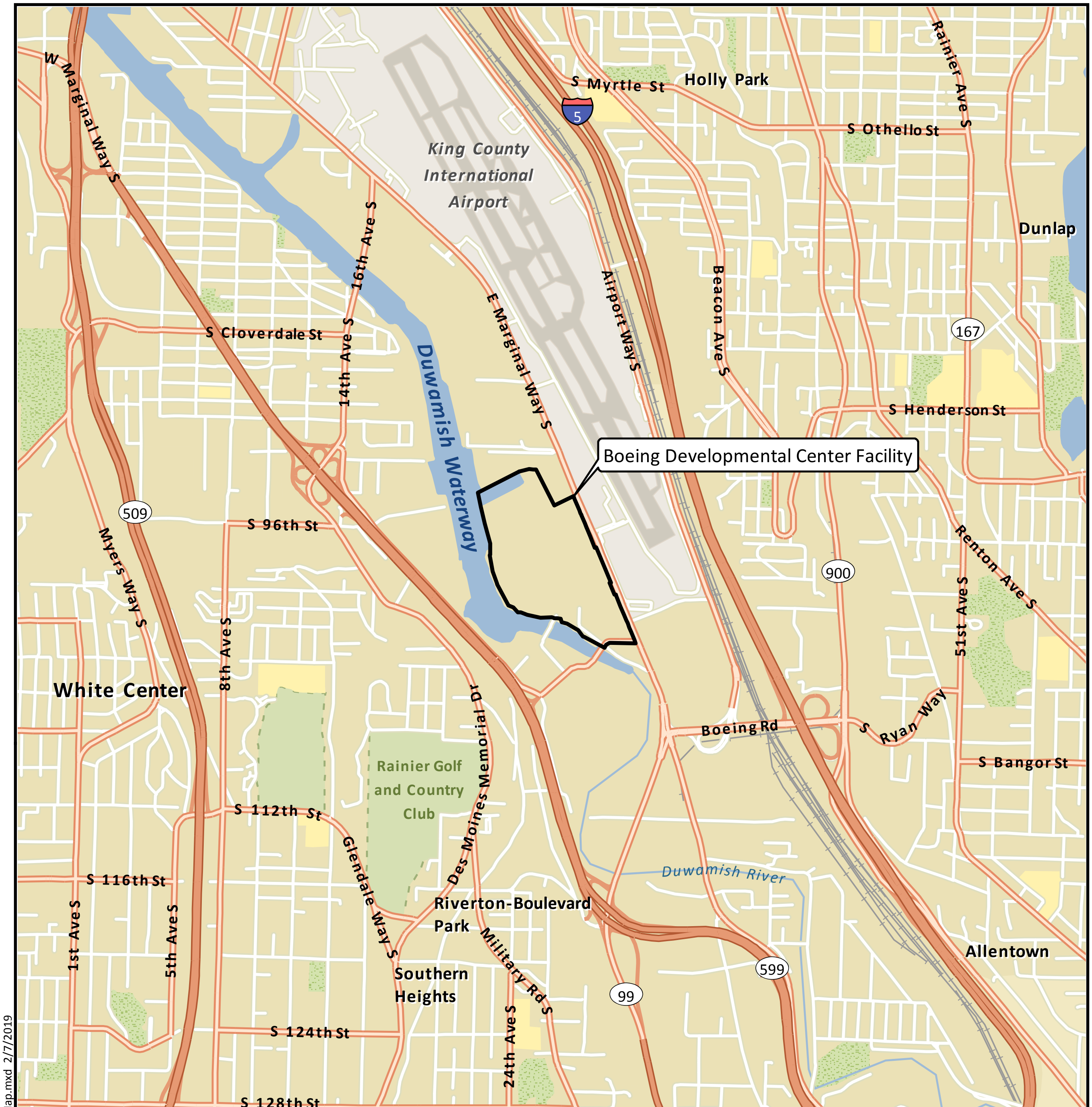

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Boeing Developmental Center Tukwila, Washington	**Vicinity Map**	Figure 1

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Legend

- Outfall
- AOCs
- SWMUs
- Drainage Areas
- Facility Boundary

0 300 600

Scale in Feet

Notes

1. Drainage Area boundaries and outfall locations are subject to change due to planned modifications required for stormwater treatment.
2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

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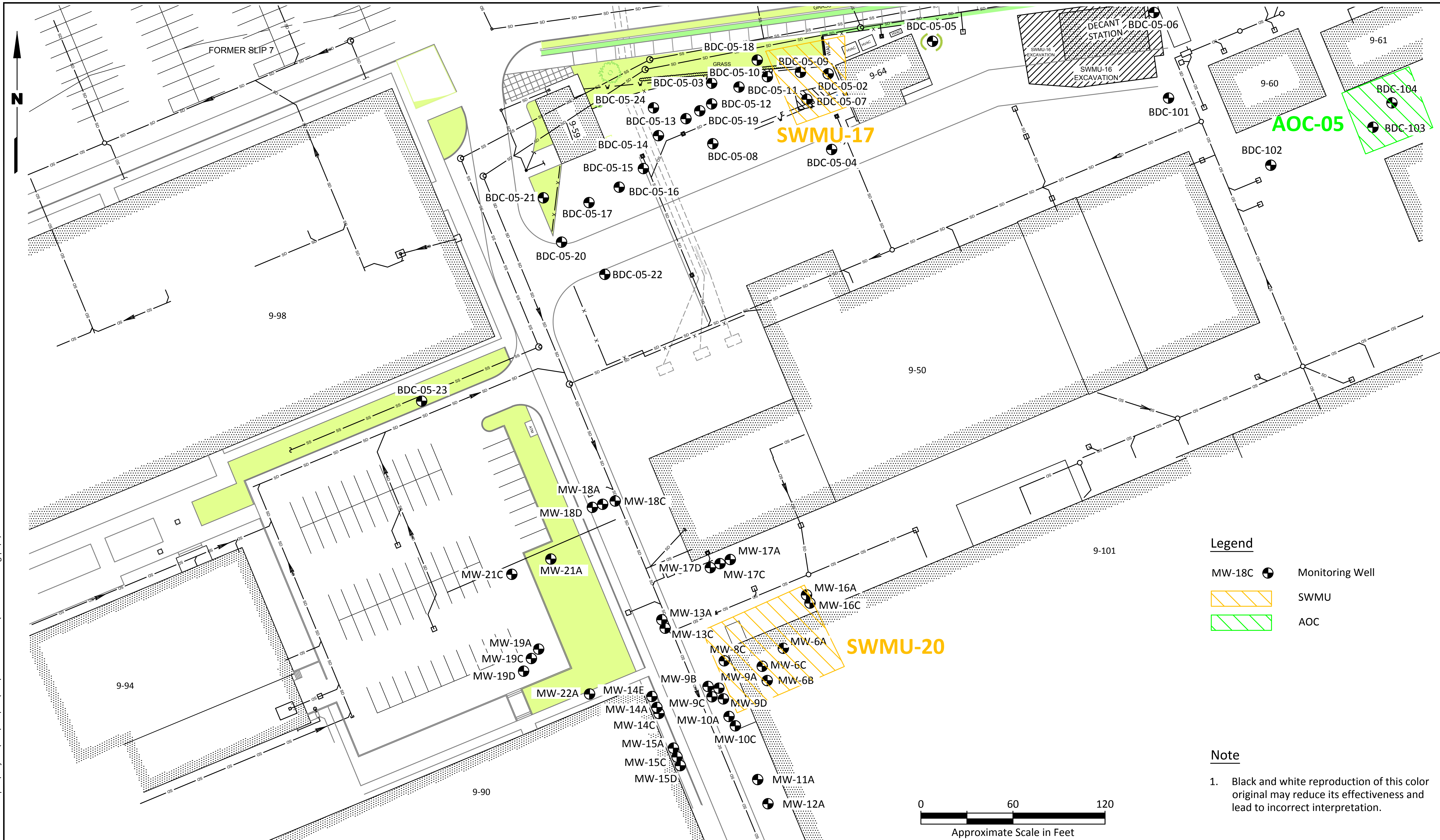
Data Sources: Boeing; Esri World Imagery.

Boeing Developmental Center Tukwila, Washington	**Facility Boundary**	Figure 2



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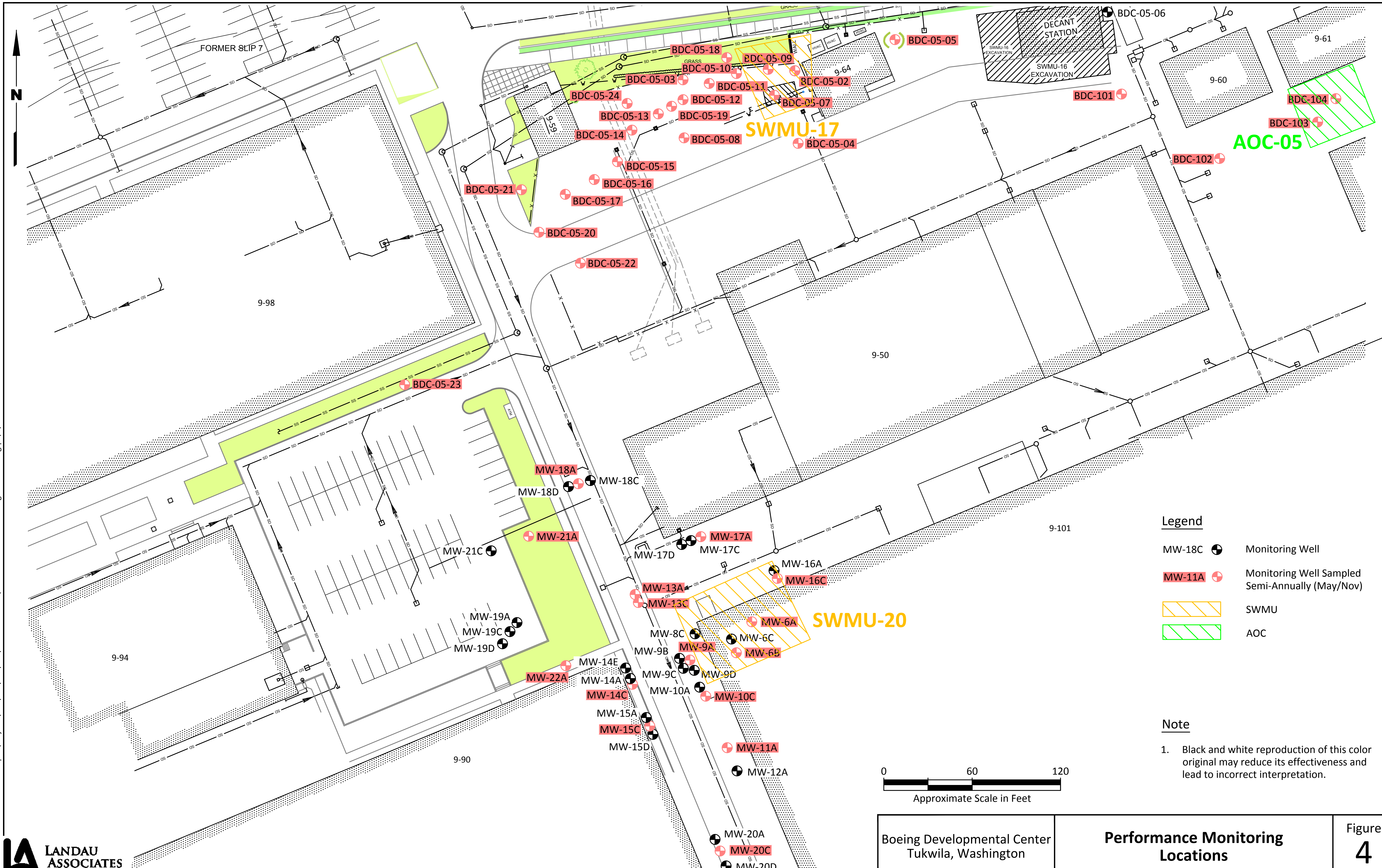
Boeing Developmental Center
Tukwila, Washington

Site Plan

Figure 3



Note

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

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Boeing Developmental Center
Tukwila, Washington

Performance Monitoring Locations

Figure 4

Table 1
Interim Action Summary
Boeing Developmental Center
Tukwila, Washington

Area	Contaminants of Concern	Suspected Source	Interim Actions	Monitoring Frequency	References
AOC-05	TPH-G and BTEX	Former UST for unleaded gasoline	ORC® injection Nitrate pilot test Full-scale nitrate injections	Semiannually	LAI 2004, 2006a Appendix A Appendix B
SWMU-17	VOCs, Arsenic and Copper	Former UST for waste oil	Electron donor pilot test Full-scale electron donor injections	Semiannually	Appendix C Appendices D, E
SWMU-20	VOCs	Former vapor degreaser in building 9-101	Groundwater pump and treat Full-scale electron donor injections Indoor air modeling and sampling	Semiannually	Appendix L Appendices F, G, H, I, J Appendix K

Abbreviations and Acronyms:
AOC = area of concern
BTEX = benzene, toluene, ethylbenzene, and xylenes
LAI = Landau Associates, Inc.
ORC® = Oxygen Release Compound®
SWMU = solid waste management unit
TPH-G = gasoline-range total petroleum hydrocarbons
UST = underground storage tank
VOCs = volatile organic compounds

Notes:
Refer to the List of Appendices in this document for the appendices cited in this table.
Refer to the List of References in this document for the reports cited in this table.

Table 2
AOC-05 Clean-Up Action Data Summary
Boeing Developmental Center
Tukwila, Washington

Well	Date	ORC Injection BDC-103 Elapsed Time from Injection (days)	Pilot Injection BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 1 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 2 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 3 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 4 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 5 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 6 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 7 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 8 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 9 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 10 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 11 BDC-103 Elapsed Time from Injection (days)
Proposed Groundwater Cleanup Levels (a)														
BDC-101	6/11/2001													
BDC-101	9/4/2001													
BDC-101	12/3/2001													
BDC-101	3/13/2002													
BDC-101	4/29/2002	-8												
BDC-101	6/3/2002	27												
BDC-101	7/1/2002	55												
BDC-101	8/1/2002	86												
BDC-101	12/2/2002	209												
BDC-101	3/10/2003	307												
BDC-101	6/3/2003	392												
BDC-101	11/19/2003	561												
BDC-101	4/28/2004	722												
BDC-101	10/18/2004	895												
BDC-101	5/10/2005	1,099												
BDC-101	11/10/2005	1,283												
BDC-101	5/15/2006	1,469												
BDC-101	11/20/2006	1,658	-59											
BDC-101	2/20/2007	1,750	33											
BDC-101	3/19/2007	1,777	60											
BDC-101	4/24/2007	1,813	96											
BDC-101	5/17/2007	1,836	119											
BDC-101	11/26/2007	2,029	312											
BDC-101	2/18/2008	2,113	396	-8										
BDC-101	3/27/2008	2,151	434	30										
BDC-101	5/15/2008	2,200	483	79	-40									
BDC-101	7/16/2008	2,262	545	141	22									
BDC-101	9/15/2008	2,323	606	202	83	-45								
BDC-101	11/20/2008	2,389	672	268	149	21								
BDC-101	1/16/2009	2,446	729	325	206	78								
BDC-101	2/11/2009	2,472	755	351	232	104								
BDC-101	3/9/2009	2,498	781	377	258	130								
BDC-101	4/16/2009	2,536	819	415	296	168								
BDC-101	5/14/2009	2,564	847	443	324	196	-34							
BDC-101	7/17/2009	2,628	911	507	388	260	30							
BDC-101	9/9/2009	2,682	965	561	442	314	84	-49						
BDC-101	11/12/2009	2,746	1,029	625	506	378	148	15						
BDC-101	2/17/2010	2,843	1,126	722	603	475	245	112						
BDC-101	5/17/2010	2,932	1,215	811	692	564	334	201						
BDC-101	8/16/2010	3,023	1,306	902	783	655	425	292	-37					
BDC-101	11/8/2010	3,107	1,390	986	867	739	509	376	47					
BDC-101	2/16/2011	3,207	1,490	1,086	967	839	609	476	147					
BDC-101	5/3/2011	3,283	1,566	1,162	1,043	915	685	552	223					
BDC-101	8/1/2011	3,373	1,656	1,252	1,133	1,005	775	642	313					
BDC-101	11/1/2011	3,465	1,748	1,344	1,225	1,097	867	734	405	-105				
BDC-101	2/19/2012	3,575	1,858	1,454	1,335	1,207	977	844	515	5				
BDC-101	5/3/2012	3,649	1,932	1,528	1,409	1,281	1,051	918	589	79				
BDC-101	9/4/2012	3,773	2,056	1,652	1,533	1,405	1,175	1,042	713	203	-49			
BDC-101	11/13/2012	3,843	2,126	1,722	1,603	1,475	1,245	1,112	783	273	21			
BDC-101	2/20/2013	3,942	2,225	1,821	1,702	1,574	1,344	1,211	882	372	120			
BDC-101	5/20/2013	4,031	2,314	1,910	1,791	1,663	1,433	1,300	971	461	209			
BDC-101	8/28/2013	4,131	2,414	2,010	1,891	1,763	1,533	1,400	1,071	561	309	-76		
BDC-101	11/19/2013	4,214	2,497	2,093	1,974	1,846	1,616	1,483	1,154	644	392	7		
BDC-101	2/11/2014	4,298	2,581	2,177	2,058	1,930	1,700	1,567	1,238	728	476	91		
BDC-101	5/6/2014	4,382	2,665	2,261	2,142	2,014	1,784	1,651	1,322	812	560	175		
BDC-101	8/7/2014	4,475	2,758	2,354	2,235	2,107	1,877	1,744	1,415	905	653	268		
BDC-101	11/4/2014	4,564	2,847	2,443	2,324	2,196	1,966	1,833	1,504	994	742	357		
BDC-101	1/21/2015	4,642	2,925	2,521	2,402	2,274	2,044	1,911	1,582	1,072	820	435		
BDC-101	4/28/2015	4,739	3,022	2,618	2,499	2,371	2,141	2,008	1,679	1,169	917	532		
BDC-101	7/20/2015	4,822	3,105	2,701	2,582	2,454	2,224	2,091	1,762	1,252	1,000	615		
BDC-101	10/26/2015	4,920	3,203	2,799	2,680	2,552	2,322	2,189	1,860	1,350	1,098	713		

Well	Date	Volatile Organic Compounds TPH-G (mg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	m,p-Xylene (µg/L)	o-Xylene (µg/L)	Total Xylenes (µg/L)	Aquifer Redox Conditions DO (mg/L)	Nitrate (mg-N/L)	Nitrite (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (µg/L)	ORP (mV)	Donor Indicators TOC (mg/L)	pH	Comments
Proposed Groundwater Cleanup Levels (a)		**0.8**	**2.0**	**1294**	**1.7**	**NA**	**NA**	**1546**										
BDC-101	6/11/2001	3.0	11.9	<1.0	113.1			109.2										
BDC-101	9/4/2001	5.0	7.13	10.7	50.4			53.8										
BDC-101	12/3/2001	6.5	95	1.6	750			650										
BDC-101	3/13/2002	<0.25	1.4	<1.0	4.4			<1.0										
BDC-101	4/29/2002	<0.25	<1.0	<1.0	2.2	<1.0	<1.0	<1.0										
BDC-101	6/3/2002	<0.25	1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-101	7/1/2002	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-101	8/1/2002	<0.25	3.1	<1.0	2.4	<1.0	<1.0	<1.0										
BDC-101	12/2/2002	0.61	4.3	<1.0	21	27	6.4	33.4										
BDC-101	3/10/2003	<0.25	1.0	<1.0	4.5	3.2	<1.0	3.2										
BDC-101	6/3/2003	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-101	11/19/2003	0.42	13	<1.0	15	35	<1.0	35	0.36	1.1	0.010	0.2	16	240	120.3			
BDC-101	4/28/2004	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-101	10/18/2004	0.64	10	<1.0	15	43	<1.0	43										
BDC-101	5/10/2005	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-101	11/10/2005	0.25	7.6	<1.0	2.6	42	<1.0	42	0.96	4.4			34.3		259	2.05		
BDC-101	5/15/2006	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.78	17.8	0.059	0.0	64.1		80			
BDC-101	11/20/2006	1.1	10	<1.0	15	72.0	<1.0	72	0.92	0.122	0.016	2.4	8.7		174			
BDC-101	2/20/2007	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.39	15.0	0.047	0.2	50.0		277		6.63	
BDC-101	3/19/2007	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5.97	8.83	0.037	0.5	38.5		213		6.60	
BDC-101	4/24/2007	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.09	9.59	0.041	0.5	34.1		136		6.46	
BDC-101	5/17/2007	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.35	9.95	0.046	0.4	35.7		297		6.55	
BDC-101	11/26/2007	<0.25	<1.0	<1.0	2.1	6.5	<1.0	6.5	2.30	5.88	0.032	0.0	26.8		287			
BDC-101	2/18/2008	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.55	8.10	0.040	0.0	31.5		341		6.29	
BDC-101	3/27/2008	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.19	9.3	<0.10	0.2	40.0		506			
BDC-101	5/15/2008	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.57	6.8	<0.10	0.0	24.6		176		6.44	
BDC-101	7/16/2008	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.34	5.3	<0.10	0.0	21.8		-232		6.52	
BDC-101	9/15/2008	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.22	5.33	0.023	0.0	28.7		153			
BDC-101	11/20/2008	0.44	1.6	<1.0	<1.0	<1.0	<1.0	<1.0	1.45	2.9	0.1	0.8	17.1		-22		6.65	
BDC-101	1/16/2009	<0.25	1.1	<1.0	<1.0	<1.0	<1.0	<1.0	0	4.40	0.042	0.4	29.5		-245		6.50	
BDC-101	2/11/2009	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.62	8.5	<0.1	0.4	39.6		-16		6.43	
BDC-101	3/9/2009	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.93	9.4	<0.1	0.0	46.8		54		6.54	
BDC-101	4/16/2009	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.69	9.0	<0.1	0.0	36.0		131		6.61	
BDC-101	5/14/2009	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.00	13.0	<0.1	0.0	44.4		68		6.81	
BDC-101	7/17/2009	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.80	12.6	<0.1	0.0	49.0		19		7.17	
BDC-101	9/9/2009	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.25	6.2	<0.1	0.0	31.7		179		6.90	
BDC-101	11/12/2009	0.35	1.8	<1.0	6.6	16	<1.0	16	1.37	11.3	<0.1	0-0.2	36.7		124		6.53	Very faint iron measurement
BDC-101	2/17/2010	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.86	13.9	<0.1	0.0	48.7		640		6.55	
BDC-101	5/17/2010	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.20	20.7	<1.0	0.0	58.7		372		6.86	
BDC-101	8/16/2010	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.21	15.6	<0.1	0.0	56.9		76		7.21	
BDC-101	11/8/2010	<0.25	2.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.02	2.2	<0.1	0.4	14.7		145		6.97	
BDC-101	2/16/2011	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	7.46	23.9	<0.1	0.0	68.2		161		7.30	
BDC-101	5/3/2011	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5.57	23.7	<0.1	0.0	66.2		208		6.99	
BDC-101	8/1/2011	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5.50	17.9	<0.1	0.0	48.1		150		7.07	
BDC-101	11/1/2011	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	6.69	6.1	<0.1	0.0	24.8		40		7.23	
BDC-101	2/19/2012	<0.25	2.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.53	6.6		0.3	27.7		12		6.81	
BDC-101	5/3/2012	<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	3.75	15.9		0.0	51.2		263		6.60	
BDC-101	9/4/2012	<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.88	13.8	<0.10	0.0	36.0		154		6.97	
BDC-101	11/13/2012	<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.41	10.3	<0.10	0.0	40.4		150		6.90	
BDC-101	2/20/2013	<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	2.55	21.3	<0.10	0.2	68.0		73		6.83	
BDC-101	5/20/2013	<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	3.35	17	<0.10	0.0	52.9		-190		6.72	
BDC-101	8/28/2013	<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	1.99	10.5	<0.10	0.0	41.5		-277		6.46	
BDC-101	11/19/2013	<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	2.53	7.6	<0.10	0.0	28.3		-173		6.67	
BDC-101	2/11/2014	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.65	7.7	<0.10	0.0	29.1		-223		6.80	
BDC-101	5/6/2014	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	6.79	19.6	<0.10	0.0	64.2		-149		6.71	
BDC-101	8/7/2014	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.25	17.2	<0.10	0.0	51.4		71		7.22	
BDC-101	11/4/2014	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.22	7.8	<0.10	0.0	29.7		77		6.72	
BDC-101	1/21/2015	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.07	21.3	<0.10	0.0	44.6		97		6.29	
BDC-101	4/28/2015	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.55	19.1	<0.10	0.0	48.4		82		6.37	
BDC-101	7/20/2015	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.96	19.7	<0.10	0.2	57.2		96		6.30	
BDC-101	10/26/2015	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.63	8.8	<0.10	0.0	38.6		92		6.64	

Table 2
AOC-05 Clean-Up Action Data Summary
Boeing Developmental Center
Tukwila, Washington

Well	Date	ORC Injection BDC-103 Elapsed Time from Injection (days)	Pilot Injection BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 1 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 2 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 3 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 4 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 5 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 6 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 7 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 8 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 9 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 10 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 11 BDC-103 Elapsed Time from Injection (days)	Volatile Organic Compounds: TPH-G (mg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	m,p-Xylene (µg/L)	o-Xylene (µg/L)	Total Xylenes (µg/L)	Aquifer Redox Conditions: DO (mg/L)	Nitrate (mg-N/L)	Nitrite (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (µg/L)	ORP (mV)	Donor Indicators: TOC (mg/L)	pH	Comments
Proposed Groundwater Cleanup Levels (a)															0.8	2.0	1294	1.7	NA	NA	1546										
BDC-101	1/27/2016	5,013	3,296	2,892	2,773	2,645	2,415	2,282	1,953	1,443	1,191	806	-56		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	7.37	12.3	<0.10	0.0	40.3		102		6.48	
BDC-101	4/13/2016	5,090	3,373	2,969	2,850	2,722	2,492	2,359	2,030	1,520	1,268	883	21		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5.94	23.7	<0.10	0.0	65.4		68		6.94	
BDC-101	8/9/2016	5,208	3,491	3,087	2,968	2,840	2,610	2,477	2,148	1,638	1,386	1,001	139		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.90	16.1	<0.10		45.8		40.6		6.36	
BDC-101	11/1/2016	5,292	3,575	3,171	3,052	2,924	2,694	2,561	2,232	1,722	1,470	1,085	223	-35	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.70	2.3	<0.10		20.0		57.9		6.45	
BDC-101	2/7/2017	5,390	3,673	3,269	3,150	3,022	2,792	2,659	2,330	1,820	1,568	1,183	321	63	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	4.26	17.1	<0.10		54.3		57		6.58	
BDC-101	5/3/2017	5,475	3,758	3,354	3,235	3,107	2,877	2,744	2,415	1,905	1,653	1,268	406	148	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5.85	24.5	<0.10		65.5		69.1		6.44	
BDC-101	8/1/2017	5,565	3,848	3,444	3,325	3,197	2,967	2,834	2,505	1,995	1,743	1,358	496	238	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.86	19.3	<0.10		58.3		119.6		6.16	
BDC-101	11/7/2017	5,663	3,946	3,542	3,423	3,295	3,065	2,932	2,603	2,093	1,841	1,456	594	336	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.78	12.3	<0.10		40.4		57.1		6.46	
BDC-101	2/5/2018	5,753	4,036	3,632	3,513	3,385	3,155	3,022	2,693	2,183	1,931	1,546	684	426	<0.1	<0.20	<0.20	<0.20	<0.40	<0.20	<0.60	5.90	9.64	<0.10		28.9		59.2		6.64	
BDC-101	5/1/2018	5,838	4,121	3,717	3,598	3,470	3,240	3,107	2,778	2,268	2,016	1,631	769	511	<0.1	<0.20	<0.20	<0.20	<0.40	<0.20	<0.60	4.48	15.9	<0.10		44.5		116.9		6.48	
BDC-101	8/6/2018	5,935	4,218	3,814	3,695	3,567	3,337	3,204	2,875	2,365	2,113	1,728	866	608	<0.1	<0.20	<0.20	<0.20	<0.40	<0.20	<0.60	2.08	11.9	<0.10		36.4		145.3		6.29	
BDC-101	11/5/2018	6,026	4,309	3,905	3,786	3,658	3,428	3,295	2,966	2,456	2,204	1,819	957	699	<0.1	<0.20	<0.20	<0.20	<0.40	<0.20	<0.60	1.29	6.90	<0.10		26.1		100.2		6.38	
BDC-102	6/11/2001														0.55	5.33	<1.0	<1.0			<1.0										
BDC-102	9/4/2001														0.38	1.61	1.89	<1.0			1.87										
BDC-102	12/3/2001														1.6	3.7	<1.0	<1.0			3.49										
BDC-102	3/13/2002														0.50	1.3	<1.0	<1.0			<1.0										
BDC-102	4/29/2002	-8													0.33	2.6	<1.0	<1.0	1.1	<1.0	1.1										
BDC-102	6/3/2002	27													<0.25	4.4	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-102	7/1/2002	55													0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-102	8/1/2002	86													<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-102	12/2/2002	209													<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-102	3/10/2003	307													0.26	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-102	6/3/2003	392													<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-102	11/19/2003	561													0.99	120	<1.0	8.5	<1.0	<1.0	<1.0	0.38	0.19	0.011	5.5	46	1100	122.2			
BDC-102	4/28/2004	722													0.40	10	<1.0	<1.0	3.0	<1.0	3.0										
BDC-102	10/18/2004	895													0.33	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-102	5/10/2005	1,099													<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-102	11/10/2005	1,283													<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.82	4.4			34.0		122	18.4		
BDC-102	5/15/2006	1,469													<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.21	4.72	0.175	2.2	35.7		-11			
BDC-102	11/20/2006	1,658	-59												<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.25	<0.250	<0.250	2.2	9.2		163			
BDC-102	2/20/2007	1,750	33												<0.25	5.8	<1.0	<1.0	<1.0	<1.0	<1.0	0.47	0.749	0.027	3.0	25.3		-145		6.54	
BDC-102	3/19/2007	1,777	60												<0.25	18	<1.0	<1.0	32	<1.0	32	0.88	0.938	0.072	3.0	31.0		-98		6.67	
BDC-102	4/24/2007	1,813	96												0.53	6.1	<1.0	3.1	100	<1.0	100	1.20	1.94	0.051	2.8	40.4		-93		6.51	
BDC-102	5/17/2007	1,836	119												<0.25	1.8	<1.0	<1.0	7.4	<1.0	7.4	0.84	2.78	0.108	2.6	33.9		286		6.52	
BDC-102	11/26/2007	2,029	312												<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.29	1.03	0.247	3.0	55.7		46			
BDC-102	2/18/2008	2,113	396	-8											<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.51	3.91	0.054	2.8	42.8		431		5.97	
BDC-102	3/27/2008	2,151	434	30											<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.85	1.3	<0.10	2.5	17.9		233			
BDC-102	5/15/2008	2,200	483	79	-40										<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.40	3.0	<0.10	3.5	19.2		-115		6.56	
BDC-102	7/16/2008	2,262	545	141	22										<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.46	2.5	<0.10	3.2	13.7		-312		6.67	
BDC-102	9/15/2008	2,323	606	202	83	-45									<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.22	4.28	0.056	3.0	31.6		191			
BDC-102	11/20/2008	2,389	672	268	149	21									<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.70	0.40	<0.10	2.0	5.6		-70		6.69	
BDC-102	1/16/2009	2,446	729	325	206	78									<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.00	<0.100	0.200	2.5	8.3		-235		6.70	
BDC-102	2/11/2009	2,472	755	351	232	104									<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.65	2.4	<0.1	3.0	20.4		-70		6.61	
BDC-102	3/9/2009	2,498	781	377	258	130									<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.00	0.9	<0.1	3.0	8.7		-46		6.65	
BDC-102	4/16/2009	2,536	819	415	296	168									<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.30	0.6	<0.1	3.0	8.3		-7		6.66	
BDC-102	5/14/2009	2,564	847	443	324	196	-34								<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.29	0.9	<0.1	3.4	9.8		-35		6.78	
BDC-102	7/17/2009	2,628	911	507	388	260	30								<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.66	4.9	<0.1	2.2	28.6		-11		6.46	
BDC-102	9/9/2009	2,682	965	561	442	314	84	-49							<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.91	0.4	<0.1	2.7	5.5		2.8		6.66	
BDC-102	11/12/2009	2,746	1,029	625	506	378	148	15							<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.93	0.2	<0.1	3.2	2.4		-42.0		6.49	
BDC-102	2/17/2010	2,843	1,126	722	603	475	245	112							<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.90	3.4	0.2	2.8	17.2		892		6.56	
BDC-102	5/17/2010	2,932	1,215	811	692	564	334	201							<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.35	8.4	<1.0	3.0	30.1		440		6.61	
BDC-102	8/16/2010	3,023	1,306	902	783	655	425	292	-37						<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.61	8.9	<0.1	3.0	27.8		82		6.60	
BDC-102	11/8/2010	3,107	1,390	986	867	739	509	376	47						<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.34	0.4	<0.1	2.0	6.9		45		7.09	
BDC-102	2/16/2011	3,207	1,490	1,086	967	839	609	476	147						<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.68	3.5	<0.1	2.2	43.3		399		6.88	
BDC-102	5/3/2011	3,283	1,566	1,162	1,043	915	685	552	223						<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.60	12.1	<0.1	2.0	32.4		40		6.70	
BDC-102	8/1/2011	3,373	1,656	1,252	1,133	1,005	775	642	313						<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	7.01	13.6	<0.1	2.1	28.7		11		6.88	
BDC-102	11/1/2011	3,465	1,748	1,344	1,225	1,097	867	734	405	-105					<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.45	9.8	<0.1	1.5	30.9		-48		7.19	

Table 2
AOC-05 Clean-Up Action Data Summary
Boeing Developmental Center
Tukwila, Washington

Well	Date	ORC Injection BDC-103 Elapsed Time from Injection (days)	Pilot Injection BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 1 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 2 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 3 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 4 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 5 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 6 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 7 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 8 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 9 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 10 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 11 BDC-103 Elapsed Time from Injection (days)	Volatile Organic Compounds: TPH-G (mg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	m,p-Xylene (µg/L)	o-Xylene (µg/L)	Total Xylenes (µg/L)	Aquifer Redox Conditions: DO (mg/L)	Nitrate (mg-N/L)	Nitrite (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (µg/L)	ORP (mV)	Donor Indicators: TOC (mg/L)	pH	Comments
Proposed Groundwater Cleanup Levels (a)															**0.8**	**2.0**	**1294**	**1.7**	**NA**	**NA**	**1546**										
BDC-102	2/19/2012	3,575	1,858	1,454	1,335	1,207	977	844	515	5					<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.25	2.4		1.0	15.4		21		6.60	
BDC-102	5/3/2012	3,649	1,932	1,528	1,409	1,281	1,051	918	589	79					<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.22	11.3		2.5	40.2		248		6.44	
BDC-102	9/4/2012	3,773	2,056	1,652	1,533	1,405	1,175	1,042	713	203	-49				<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.20	13.2	<5.0	1.5	39.2		130		6.63	
BDC-102	11/13/2012	3,843	2,126	1,722	1,603	1,475	1,245	1,112	783	273	21				<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.10	1.7	<0.10	1.6	27.7		48		6.77	
BDC-102	2/20/2013	3,942	2,225	1,821	1,702	1,574	1,344	1,211	882	372	120				<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.17	18.4	<0.10	1.0	58.5		92		6.60	
BDC-102	5/20/2013	4,031	2,314	1,910	1,791	1,663	1,433	1,300	971	461	209				<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.49	20	<0.10	1.5	62.2		-280		7.31	
BDC-102	8/28/2013	4,131	2,414	2,010	1,891	1,763	1,533	1,400	1,071	561	309	-76			<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	1.93	12.2	<0.10	1.0	39.1		-341		6.45	
BDC-102	11/19/2013	4,214	2,497	2,093	1,974	1,846	1,616	1,483	1,154	644	392	7			<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	3.89	10.6	<0.10	1.2	43.4		-254		6.54	
BDC-102	2/11/2014	4,298	2,581	2,177	2,058	1,930	1,700	1,567	1,238	728	476	91			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	4.16	19.6	<0.10	2.2	63.0		-246		6.67	
BDC-102	5/6/2014	4,382	2,665	2,261	2,142	2,014	1,784	1,651	1,322	812	560	175			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.65	14.8	<0.10	1.6	56.1		-275		6.54	
BDC-102	8/7/2014	4,475	2,758	2,354	2,235	2,107	1,877	1,744	1,415	905	653	268			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.07	26.7	<0.10	1.4	65.8		-65		7.01	
BDC-102	11/4/2014	4,564	2,847	2,443	2,324	2,196	1,966	1,833	1,504	994	742	357			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.11	22.4	<0.10	1.2	55.9		-15.3		6.47	
BDC-102	1/21/2015	4,642	2,925	2,521	2,402	2,274	2,044	1,911	1,582	1,072	820	435			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.20	12.9	<0.10	1.0	49.7		-22		6.14	
BDC-102	4/28/2015	4,739	3,022	2,618	2,499	2,371	2,141	2,008	1,679	1,169	917	532			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.22	23.1	<0.10	0.6	77.5		28		6.13	
BDC-102	7/20/2015	4,822	3,105	2,701	2,582	2,454	2,224	2,091	1,762	1,252	1,000	615			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.33	15.5	<0.10	1.0	63.3		-54		6.18	
BDC-102	10/26/2015	4,920	3,203	2,799	2,680	2,552	2,322	2,189	1,860	1,350	1,098	713			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.23	10.9	<0.10	1.0	47.5		-42		6.41	
BDC-102	1/27/2016	5,013	3,296	2,892	2,773	2,645	2,415	2,282	1,953	1,443	1,191	806	-56		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.35	0.62	<0.10	1.0	11.9		-124		6.61	
BDC-102	4/13/2016	5,090	3,373	2,969	2,850	2,722	2,492	2,359	2,030	1,520	1,268	883	21		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.70	12.8	<0.10	1.0	43.1		-48		6.61	
BDC-102	8/9/2016	5,208	3,491	3,087	2,968	2,840	2,610	2,477	2,148	1,638	1,386	1,001	139		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.32	14.0	<0.10		42.6		-79		6.2	
BDC-102	11/1/2016	5,292	3,575	3,171	3,052	2,924	2,694	2,561	2,232	1,722	1,470	1,085	223	-35	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.56	0.10	<0.10		1.4		-80.8		6.54	
BDC-102	2/7/2017	5,390	3,673	3,269	3,150	3,022	2,792	2,659	2,330	1,820	1,568	1,183	321	63	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.19	4.9	<0.10		23.8		12.3		7.78	
BDC-102	5/3/2017	5,475	3,758	3,354	3,235	3,107	2,877	2,744	2,415	1,905	1,653	1,268	406	148	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.52	25.5	<0.10		42.9		-11.4		6.29	
BDC-102	8/1/2017	5,565	3,848	3,444	3,325	3,197	2,967	2,834	2,505	1,995	1,743	1,358	496	238	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.86	37.1	<0.10		52.4		102.4		6.23	
BDC-102	11/7/2017	5,663	3,946	3,542	3,423	3,295	3,065	2,932	2,603	2,093	1,841	1,456	594	336	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.79	6.8	<0.10		28.3		67.6		6.32	
BDC-102	2/5/2018	5,753	4,036	3,632	3,513	3,385	3,155	3,022	2,693	2,183	1,931	1,546	684	426	<0.1	<0.20	<0.20	<0.20	<0.40	<0.20	<0.60	0.82	0.718	0.170		8.15		-97.4		6.50	
BDC-102	5/1/2018	5,838	4,121	3,717	3,598	3,470	3,240	3,107	2,778	2,268	2,016	1,631	769	511	<0.1	<0.20	<0.20	<0.20	<0.40	<0.20	<0.60	0.24	13.4	<0.10		29.5		172.4		6.36	
BDC-102	8/6/2018	5,935	4,218	3,814	3,695	3,567	3,337	3,204	2,875	2,365	2,113	1,728	866	608	<0.1	<0.20	<0.20	<0.20	<0.40	<0.20	<0.60	0.39	15.7	<0.10		31.7		146.6		6.35	
BDC-102	11/5/2018	6,026	4,309	3,905	3,786	3,658	3,428	3,295	2,966	2,456	2,204	1,819	957	699	<0.1	<0.20	<0.20	<0.20	<0.40	<0.20	<0.60	0.88	1.46	<0.10		16.4		-35.9		6.42	
BDC-103	6/11/2001														177	875	12,010	1,985			11,430										
BDC-103	9/4/2001														123	494	3,760	419			2,636										
BDC-103 (b)	12/3/2001														120	5,100	2,300,000	10,000			3,400,000										
BDC-103	3/13/2002														200	1,700	17,000	4,900			26,400										
BDC-103	4/29/2002	-8													200	980	16,000	5,400	20,000	7,000	27,000										
BDC-103	6/3/2002	27													200	960	17,000	5,100	20,000	7,100	27,100										
BDC-103	7/1/2002	55													240	1,300	16,000	5,200	20,000	6,800	26,800										
BDC-103	8/1/2002	86													270	4,600	18,000	5,200	19,000	6,600	25,600										
BDC-103	12/2/2002	209													250	1,400	15,000	5,000	22,000	6,900	28,900										
BDC-103	3/10/2003	307													180	780	13,000	5,200	20,000	6,700	26,700										
BDC-103	6/3/2003	392													220	900	10,000	5,000	20,000	6,600	26,600										
BDC-103	11/19/2003	561													180	850	8,300	4,500	18,000	5,500	23,500	0.38	0.012	0.011	5.5	53	630	-75.9			
BDC-103	4/28/2004	722													160	1,600	6,600	3,900	16,000	5,100	21,100										
BDC-103	10/18/2004	895													140	2,100	5,500	3,700	15,000	4,400	19,400										
BDC-103	5/10/2005	1,099													110	2,200	5,500	3,800	14,000	3,200	17,200										
BDC-103	11/10/2005	1,283													90	2,200	3,500	3,700	12,000	2,500	15,000	0.72	<1.0			11.9		147	15.4		
BDC-103	5/15/2006	1,469													84	1,600	3,800	3,100	10,000	2,200	12,000	0.92	<0.010	0.054	3.5	15.2		106			
BDC-103	11/20/2006	1,658	-59												51	2,000	730	2,200	3,900	1,000	4,900	1.23	<0.10	<0.10	2.4	28.3		202			
BDC-103	2/20/2007	1,750	33												26	460	420	140	3,600	1,600	5,200	0.31	60.8	11.1	0.5	99.2		109		6.54	
BDC-103	3/19/2007	1,777	60												30	490	88	130	3,500	1,700	5,200	0.63	27.9	8.28	0.4	141		4		6.79	
BDC-103	4/24/2007	1,813	96												36	820	440	220	3500	1800	5300	0.84	7.54	3.56	2.4	59.2		-14		6.70	
BDC-103	5/17/2007	1,836	119												77	1,400	4,300	1,100	8,300	3,200	11,500	0.61	0.138	0.079	3.6	169		244		6.82	
BDC-103	11/26/2007	2,029	312												190	3,300	21,000	4,000	11,000	4,900	15,900	3.37	0.063	0.049	3.6	49.1		-118			
BDC-103	2/18/2008	2,113	396	-8											66	1,100	2,600	700	7,500	1,900	9,400	2.06	7.75	0.134	2.8	163		552		5.97	
BDC-103	3/27/2008	2,151	434	30											84	1,500	1,900	1,100	9,700	3,000	12,700	1.60	54.1	18	4.0	115.0		182			
BDC-103	5/15/2008	2,200	483	79	-40										91	2,700	4,400	1,400	11,000	3,600	14,600	1.38	<0.10	<0.10	3.2	192		-138		7.11	
BDC-103	7/16/2008	2,262	545	141	22										79	1,800	440	490	10,000	3,100	13,100	1.61	56.1	16.6	2.8	149		-226		6.72	
BDC-103	9/15/2008	2,323	606	202	83	-45									110	2,300	7,600	1,500	10,000	3,600	13,600	0.48	0.330	0.218	3.2	218		189			
BDC-103	11/20/2008	2,389	672	268	149	21									47	1,200	260	110	7,000	2,100	9,100	0.21	152	12.5	2.0	120		-1.2		6.66	

Table 2
AOC-05 Clean-Up Action Data Summary
Boeing Developmental Center
Tukwila, Washington

Well	Date	ORC Injection BDC-103 Elapsed Time from Injection (days)	Pilot Injection BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 1 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 2 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 3 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 4 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 5 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 6 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 7 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 8 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 9 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 10 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 11 BDC-103 Elapsed Time from Injection (days)	Volatile Organic Compounds TPH-G (mg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	m,p-Xylene (µg/L)	o-Xylene (µg/L)	Total Xylenes (µg/L)	Aquifer Redox Conditions DO (mg/L)	Nitrate (mg-N/L)	Nitrite (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (µg/L)	ORP (mV)	Donor Indicators TOC (mg/L)	pH	Comments
Proposed Groundwater Cleanup Levels (a)															0.8	2.0	1294	1.7	NA	NA	1546											
BDC-103	1/16/2009	2,446	729	325	206	78									11	190	220	12	1,000	480	1,480	0.24	193	2.32	0.6	62.5		-181		6.19	
BDC-103	2/11/2009	2,472	755	351	232	104									36	820	510	<100	2,900	1,500	4,400	1.66	82.0	6.7	0.8	178		-65		6.69	
BDC-103	3/9/2009	2,498	781	377	258	130									27	1100	440	18	2,400	1,200	3,600	0	47.3	2.4	0.4	192		17		6.80	
BDC-103	4/16/2009	2,536	819	415	296	168									30	710	310	<50	2,700	1,200	3,900	0.95	64.8	5.6	0.2-0.4	194		62		6.77	
BDC-103	5/14/2009	2,564	847	443	324	196	-34								30	680	320	20	2,400	1,500	3,900	0.48	49.8	4.8	0.8	222		20		6.85	
BDC-103	7/17/2009	2,628	911	507	388	260	30								19	410	280	32	630	1,000	1,630	2.60	26.6	2.0	1.0	104		29		6.98	
BDC-103	9/9/2009	2,682	965	561	442	314	84	-49							21	620	270	83	700	1200	1,900	0.88	<0.1	<0.1	2.5	134		2.8		7.01	
BDC-103	11/12/2009	2,746	1,029	625	506	378	148	15							24	340	140	27	1,800	1,200	3,000	1.42	94.1	7.7	0.4	71.7		117		6.11	
BDC-103	2/17/2010	2,843	1,126	722	603	475	245	112							0.73	10	<1.0	<1.0	3.1	22	25	1.45	123	1.1	0.0	60.3		939		6.22	
BDC-103	5/17/2010	2,932	1,215	811	692	564	334	201							3.1	79	44	5.2	60	86	146	1.56	67.9	2.6	0.4	71.6		436		6.63	
BDC-103	8/16/2010	3,023	1,306	902	783	655	425	292	-37						8.0	740	380	110	420	320	740	2.24	2.4	0.1	2.0	72.5		184		6.96	
BDC-103	11/8/2010	3,107	1,390	986	867	739	509	376	47						6.3	240	11	1.7	180	540	720	7.46	55.8	1.5	0.0	123		199		7.05	
BDC-103	2/16/2011	3,207	1,490	1,086	967	839	609	476	147						0.28	4.6	<1.0	<1.0	<1.0	5.4	5.4	5.18	133	0.6		74.6		508		6.52	
BDC-103	5/3/2011	3,283	1,566	1,162	1,043	915	685	552	223						<0.25	9.1	<1.0	<1.0	<1.0	2.2	2.2	2.15	140	0.2	0.0	74.4		393		6.35	
BDC-103	8/1/2011	3,373	1,656	1,252	1,133	1,005	775	642	313						0.30	76	<1.0	1.8	7.8	2.5	10.3	5.67	57.6	<0.1	0.2	63.2		168		7.09	
BDC-103	11/1/2011	3,465	1,748	1,344	1,225	1,097	867	734	405	-105					33	1300	2200	780	2300	1300	3,600	1.72	<0.1	<0.1	1.2	8.1		-226		7.38	
BDC-103	2/19/2012	3,575	1,858	1,454	1,335	1,207	977	844	515	5					2.2	5.1	31	19	260	69	329	0.21	143		0.3	57.1		36		6.41	
BDC-103	5/3/2012	3,649	1,932	1,528	1,409	1,281	1,051	918	589	79					<0.25	16	1.4	<1.0	3.6	14	17.6	0.11	149	0.83	0.0	56.2		239		6.49	
BDC-103	9/4/2012	3,773	2,056	1,652	1,533	1,405	1,175	1,042	713	203	-49				0.72	530	24.0	9.4	40	42	82	0.45	7.2	<0.10	0.4	66.9		146		6.80	
BDC-103	11/13/2012	3,843	2,126	1,722	1,603	1,475	1,245	1,112	783	273	21				4.5	120	9.5	3.7	210	380	590	1.02	165	2.8	0.4	93.6		108		6.50	
BDC-103	2/20/2013	3,942	2,225	1,821	1,702	1,574	1,344	1,211	882	372	120				<0.25	<1.0	<1.0	<1.0	<2.0	3.4	3.4	0.14	161	0.60	0.2	51.6		109		6.42	
BDC-103	5/20/2013	4,031	2,314	1,910	1,791	1,663	1,433	1,300	971	461	209				<0.25	9.3	<1.0	<1.0	4.4	1.8	6.2	0.29	161	<0.10	0.0	47.1		-281		7.47	
BDC-103	8/28/2013	4,131	2,414	2,010	1,891	1,763	1,533	1,400	1,071	561	309	-76			2	210	56	47	260	91	351	1.60	17.8	0.16	0.6	54.2		-290		6.83	
BDC-103	11/19/2013	4,214	2,497	2,093	1,974	1,846	1,616	1,483	1,154	644	392	7			5.9	22	37	31	590	350	940	4.42	154	2.6	0.0	51.0		-222		6.48	
BDC-103	2/11/2014	4,298	2,581	2,177	2,058	1,930	1,700	1,567	1,238	728	476	91			<0.25	<1.0	<1.0	<1.0	4.9	3.6	8.5	2.81	79.9	0.15	0.0	99.2		-254		6.77	
BDC-103	5/6/2014	4,382	2,665	2,261	2,142	2,014	1,784	1,651	1,322	812	560	175			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.19	215	<0.10	0.0	59.8		-233		6.21	
BDC-103	8/7/2014	4,475	2,758	2,354	2,235	2,107	1,877	1,744	1,415	905	653	268			<0.25	7.8	<1.0	<1.0	2.4	<1.0	2.4	2.67	111	<0.10	0.0	59.7		-46		7.14	
BDC-103	11/4/2014	4,564	2,847	2,443	2,324	2,196	1,966	1,833	1,504	994	742	357			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.27	151	0.68	0.0	66.7		121		6.31	
BDC-103	1/21/2015	4,642	2,925	2,521	2,402	2,274	2,044	1,911	1,582	1,072	820	435			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.20	137	0.27	0.0	69.1		118		6.05	
BDC-103	4/28/2015	4,739	3,022	2,618	2,499	2,371	2,141	2,008	1,679	1,169	917	532			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.16	74.8	<0.10	0.0	90.3		44		6.23	
BDC-103	7/20/2015	4,822	3,105	2,701	2,582	2,454	2,224	2,091	1,762	1,252	1,000	615			<0.25	54	1.0	3.7	8.3	2.6	10.9	0.18	8.1	<0.10	0.2	70.9		-22		6.48	
BDC-103	10/26/2015	4,920	3,203	2,799	2,680	2,552	2,322	2,189	1,860	1,350	1,098	713			19	480	740	600	1800	850	2,650	0.11	<0.10	<0.10	1.0	0.55		-85		6.61	
BDC-103	1/27/2016	5,013	3,296	2,892	2,773	2,645	2,415	2,282	1,953	1,443	1,191	806	-56		<0.25	3.9	1.2	3.3	12	7.0	19	0.22	32.5	<0.10	0.0	102		-10		6.56	
BDC-103	4/13/2016	5,090	3,373	2,969	2,850	2,722	2,492	2,359	2,030	1,520	1,268	883	21		<0.25	<1.0	<1.0	<1.0	<1.0	2.0	2.0	0.46	102	0.43	0.0	51.0		6.7		6.59	
BDC-103	8/9/2016	5,208	3,491	3,087	2,968	2,840	2,610	2,477	2,148	1,638	1,386	1,001	139		1.7	56	4.9	42	210	51	261	0.0	<0.10	<0.10		31.1		-98.6		6.90	
BDC-103	11/1/2016	5,292	3,575	3,171	3,052	2,924	2,694	2,561	2,232	1,722	1,470	1,085	223	-35	4.5	83	24	120	360	180	540	0.3	<0.10	<0.10		0.68		-182.9		6.70	
BDC-103	2/7/2017	5,390	3,673	3,269	3,150	3,022	2,792	2,659	2,330	1,820	1,568	1,183	321	63	<0.25	<1.0	<1.0	<1.0	<1.0	2.1	2.1	0.41	194	0.15		47.4		77.2		6.27	
BDC-103	5/3/2017	5,475	3,758	3,354	3,235	3,107	2,877	2,744	2,415	1,905	1,653	1,268	406	148	<0.25	<1.0	<1.0	<1.0	<1.0	1.7	1.7	0.78	215	0.40		49.4		67.1		6.25	
BDC-103	8/1/2017	5,565	3,848	3,444	3,325	3,197	2,967	2,834	2,505	1,995	1,743	1,358	496	238	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	6.72	172	<0.10		64.4		111.1		6.23	
BDC-103	11/7/2017	5,663	3,946	3,542	3,423	3,295	3,065	2,932	2,603	2,093	1,841	1,456	594	336	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.86	71	<0.10		73.2		58.2		6.54	
BDC-103	2/5/2018	5,753	4,036	3,632	3,513	3,385	3,155	3,022	2,693	2,183	1,931	1,546	684	426	<0.1	<0.20	<0.20	<0.20	<0.40	<0.20	<0.60	1.27	128	0.319		51.7		144		5.93	
BDC-103	5/1/2018	5,838	4,121	3,717	3,598	3,470	3,240	3,107	2,778	2,268	2,016	1,631	769	511	<0.1	<0.20	<0.20	<0.20	<0.40	<0.20	<0.60	0.27	104	<0.10		71.6		184.7		5.98	
BDC-103	8/6/2018	5,935	4,218	3,814	3,695	3,567	3,337	3,204	2,875	2,365	2,113	1,728	866	608	<0.1	<0.20	<0.20	<0.20	<0.40	<0.20	<0.60	0.38	65.8	<0.10		70.0		166.9		6.44	
BDC-103	11/5/2018	6,026	4,309	3,905	3,786	3,658	3,428	3,295	2,966	2,456	2,204	1,819	957	699	0.113	1.82	<0.20	0.31	0.91	0.47	1.37	0.58	0.333	<0.10		63.1		34.1		6.74	
BDC-104	2/18/2008	2,113	396	-8											2.9	<1.0	<1.0	47	180	28	208	2.09	1.63	0.072	3.0	18.7		598			
BDC-104	3/27/2008	2,151	434	30											3.2	<1.0	<1.0	22	220	52	272	1.34	161	0.1	0.5	52.2		259			
BDC-104	5/15/2008	2,200	483	79	-40										1.0	<1.0	<1.0	7.0	26	22	48	1.24	28.7	0.7	0.4	26.6		94		6.69	
BDC-104	7/16/2008	2,262	545	141	22										2.3	<1.0	2.9	3.3	110	50	160	1.56	196	0.4	0.0	74.7		-221		7.17	
BDC-104	9/15/2008	2,323	606	202	83	-45									0.64	<1.0	2.6	<1.0	20	16	36	0.06	122	0.729	0.0	38.4		191			
BDC-104	11/20/2008	2,389	672	268	149	21									<0.25	<1.0	<1.0	<1.0	1.4	4.1	5.5	0.96	67.2	<0.10	0.2	24.3		-27		7.46	
BDC-104	1/16/2009	2,446	729	325	206	78									0.26	<1.0	<1.0	<1.0	<1.0	5.5	5.5	0.05	71.4	0.204	0.6	34.6		-164		6.86	
BDC-104	2/11/2009	2,472	755	351	232	104									<0.25	<1.0	<1.0	<1.0	1.3	1.1	2.4	1.78	95.4 J	0.1	0.2	20.1		-75		6.68	
BDC-104	3/9/2009	2,498	781	377	258	130									<0.25	<1.0	<1.0	<1.0	1.3	1.1	2.4	0	91.5	<0.1	0.0	19.2		20		6.67	
BDC-104	4/16/2009	2,536	819	415	296	168									<0.25	<1.0	<1.0	<1.0	<1.0	1.6	1.6	0.34	67.2	<0.1	0.0	21.6		67		6.63	
BDC-104	5/14/2009	2,564	847	443	324	196	-34								<0.25	<1.0	<1.0	<1.0	<1.0	1.4	1.4	0.51	63.4	<0.1	0.0	20.1		6		6.70	
BDC-104	7/17/2009	2,628	911	507	388	260	30								<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.41	21.0	0.5	1.0	30.8		-3		7.30	
BDC-104	9/9/2009	2,682	965	561	442	314	84	-49							<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.63	39.8	0.1	0.8	41.6		61		7.20	
BDC-104	11/12/2009	2,746	1,029	625	506	378	148	15							<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.99	115	1.4	0.0	24.1		68		6.49	

Table 2
AOC-05 Clean-Up Action Data Summary
Boeing Developmental Center
Tukwila, Washington

Well	Date	ORC Injection BDC-103 Elapsed Time from Injection (days)	Pilot Injection BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 1 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 2 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 3 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 4 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 5 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 6 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 7 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 8 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 9 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 10 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 11 BDC-103 Elapsed Time from Injection (days)	Volatile Organic Compounds: TPH-G (mg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	m,p-Xylene (µg/L)	o-Xylene (µg/L)	Total Xylenes (µg/L)	Aquifer Redox Conditions: DO (mg/L)	Nitrate (mg-N/L)	Nitrite (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (µg/L)	ORP (mV)	Donor Indicators: TOC (mg/L)	pH	Comments
Proposed Groundwater Cleanup Levels (a)															0.8	2.0	1294	1.7	NA	NA	1546										
BDC-104	2/17/2010	2,843	1,126	722	603	475	245	112							<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.73	119	0.1	0.0	111		868		6.93	
BDC-104	5/17/2010	2,932	1,215	811	692	564	334	201							<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.98	47.4	<1.0	0.6	30.5		482		6.74	
BDC-104	8/16/2010	3,023	1,306	902	783	655	425	292	-37						<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.59	38.4	0.2	2.5	23.6		76		6.92	
BDC-104	11/8/2010	3,107	1,390	986	867	739	509	376	47						<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.87	32.5	<0.1	0.0	18.6		115		7.23	
BDC-104	2/16/2011	3,207	1,490	1,086	967	839	609	476	147						<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.48	40.0	<0.1	0.4	24.1		423		6.71	
BDC-104	5/3/2011	3,283	1,566	1,162	1,043	915	685	552	223						<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.19	31.3	<0.1	1.2	26.8		231		6.63	
BDC-104	8/1/2011	3,373	1,656	1,252	1,133	1,005	775	642	313						<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.10	11.7	<0.1	0.0	21.2		121		7.20	
BDC-104	11/1/2011	3,465	1,748	1,344	1,225	1,097	867	734	405	-105					<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.43	14.6	<0.1	0.0	18.7		-53		7.40	
BDC-104	2/19/2012	3,575	1,858	1,454	1,335	1,207	977	844	515	5					<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.26	21.6		0.0	29.2		66		6.23	
BDC-104	5/3/2012	3,649	1,932	1,528	1,409	1,281	1,051	918	589	79					<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.06	19.4		1.5	26.5		207		6.78	
BDC-104	9/4/2012	3,773	2,056	1,652	1,533	1,405	1,175	1,042	713	203	-49				<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.68	12.3	<0.10	0.5	22.1		130		7.11	
BDC-104	11/13/2012	3,843	2,126	1,722	1,603	1,475	1,245	1,112	783	273	21				<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.24	0.80	<0.10		5.1		64		7.19	
BDC-104	2/20/2013	3,942	2,225	1,821	1,702	1,574	1,344	1,211	882	372	120				0.28	<1.0	6.5	<1.0	17	3.3	20.3	0.44	2.5	<0.10	0.2	3.6		82		6.96	
BDC-104	5/20/2013	4,031	2,314	1,910	1,791	1,663	1,433	1,300	971	461	209				<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	2.01	20.0	<0.10	0.0	20.8		-230		7.16	
BDC-104	8/28/2013	4,131	2,414	2,010	1,891	1,763	1,533	1,400	1,071	561	309	-76			<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.52	16.4	<0.10	1.0	35.3		-322		6.82	
BDC-104	11/19/2013	4,214	2,497	2,093	1,974	1,846	1,616	1,483	1,154	644	392	7			<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	8.09	0.47	<0.10	0.0	3.1		-35		7.16	
BDC-104	2/11/2014	4,298	2,581	2,177	2,058	1,930	1,700	1,567	1,238	728	476	91			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	6.11	0.54	<0.10	0.0	3.4		-135		7.04	
BDC-104	5/6/2014	4,382	2,665	2,261	2,142	2,014	1,784	1,651	1,322	812	560	175			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	8.49	0.35	<0.10	0.0	4.2		-113		6.82	
BDC-104	8/7/2014	4,475	2,758	2,354	2,235	2,107	1,877	1,744	1,415	905	653	268			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.04	2.9	<0.10	0.0	4.4		64		7.44	
BDC-104	11/4/2014	4,564	2,847	2,443	2,324	2,196	1,966	1,833	1,504	994	742	357			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.66	2.1	<0.10	0.0	10.1		39		6.50	
BDC-104	1/21/2015	4,642	2,925	2,521	2,402	2,274	2,044	1,911	1,582	1,072	820	435			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	4.02	11.3	<0.10	0.0	36.3		135		5.87	
BDC-104	4/28/2015	4,739	3,022	2,618	2,499	2,371	2,141	2,008	1,679	1,169	917	532			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.37	11.3	<0.10	0.0	74.4		85		6.09	
BDC-104	7/20/2015	4,822	3,105	2,701	2,582	2,454	2,224	2,091	1,762	1,252	1,000	615			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.18	11.7	<0.10	0.2	74.4		-22		6.48	
BDC-104	10/26/2015	4,920	3,203	2,799	2,680	2,552	2,322	2,189	1,860	1,350	1,098	713			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.20	14.1	<0.10	1.0	84.2		-2.0		6.72	
BDC-104	1/27/2016	5,013	3,296	2,892	2,773	2,645	2,415	2,282	1,953	1,443	1,191	806	-56		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.13	11.5	<0.10	0.0	69.1		16.0		6.67	
BDC-104	4/13/2016	5,090	3,373	2,969	2,850	2,722	2,492	2,359	2,030	1,520	1,268	883	21		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.65	20.2	<0.10	0.0	96.9		31		6.75	
BDC-104	8/9/2016	5,208	3,491	3,087	2,968	2,840	2,610	2,477	2,148	1,638	1,386	1,001	139		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.6	8.1	<0.10		42.2		-27.2		6.30	
BDC-104	11/1/2016	5,292	3,575	3,171	3,052	2,924	2,694	2,561	2,232	1,722	1,470	1,085	223	-35	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.91	3.4	<0.10		22.3		-9.8		6.49	
BDC-104	2/7/2017	5,390	3,673	3,269	3,150	3,022	2,792	2,659	2,330	1,820	1,568	1,183	321	63	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.03	0.58	<0.10		5.2		69.2		5.93	
BDC-104	5/3/2017	5,475	3,758	3,354	3,235	3,107	2,877	2,744	2,415	1,905	1,653	1,268	406	148	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.06	23.6	<0.10		84.3		80.9		5.85	
BDC-104	8/1/2017	5,565	3,848	3,444	3,325	3,197	2,967	2,834	2,505	1,995	1,743	1,358	496	238	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.00	7.0	<0.10		29.1		125.9		5.83	
BDC-104	11/7/2017	5,663	3,946	3,542	3,423	3,295	3,065	2,932	2,603	2,093	1,841	1,456	594	336	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	4.82	0.17	<0.10		4.5		60.4		6.89	
BDC-104	2/5/2018	5,753	4,036	3,632	3,513	3,385	3,155	3,022	2,693	2,183	1,931	1,546	684	426	<0.1	<0.20	<0.20	<0.20	<0.40	<0.20	<0.60	6.93	0.230	<0.10		4.76		90.6		6.18	
BDC-104	5/1/2018	5,838	4,121	3,717	3,598	3,470	3,240	3,107	2,778	2,268	2,016	1,631	769	511	<0.1	<0.20	<0.20	<0.20	<0.40	<0.20	<0.60	4.25	1.22	<0.10		4.05		172.3		6.09	
BDC-104	8/6/2018	5,935	4,218	3,814	3,695	3,567	3,337	3,204	2,875	2,365	2,113	1,728	866	608	<0.1	<0.20	<0.20	<0.20	<0.40	<0.20	<0.60	3.02	9.11	<0.10		36.5		149.8		6.28	
BDC-104	11/5/2018	6,026	4,309	3,905	3,786	3,658	3,428	3,295	2,966	2,456	2,204	1,819	957	699	<0.1	<0.20	<0.20	<0.20	<0.40	<0.20	<0.60	0.73	6.97	<0.10		35.4		156.6		6.09	

Abbreviations and Acronyms:

µg/L = micrograms per liter
DO = dissolved oxygen
mg/L = milligrams per liter
mg-N/L = milligrams nitrogen per liter
mV = millivolts
NA = not applicable, not available
ORP = oxidation reduction potential
TOC = total organic carbon
TPH-G = total petroleum hydrocarbon-gasoline

Notes:

(a) Proposed Cleanup Standards and Comparison to Site Data, Boeing Developmental Center, Tukwila,Washington (Landau Associates, 5/7/13).
(b) BTEX data questionable for this event. Concentrations inconsistent with TPH-G data for indicated event and BTEX data from other events.

[shaded cell] = No sample collected or sample not analyzed for specified constituent.
Box = Exceedance of proposed cleanup level

Injection Dates	Months Since Prior Injection Event	
5/7/2002		ORC
1/18/2007	57	Pilot -scale nitrate
2/26/2008	13	1st full scale injection
6/24/2008	4	2nd full scale injection
10/30/2008	4	3rd full scale injection
6/17/2009	8	4th full scale injection (start ammonium phosphate, 1/3 ammonium nitrate dose to both wells)
10/28/2009	4	5th full scale injection (103 full dose, 104 half dose)
9/22/2010	11	6th full scale injection (103 only full dose)
2/14/2012	17	7th full scale injection (103 only full dose)
10/23/2012	8	8th full scale injection (103 only 1.5x volume dose)
11/12/2013	13	9th full scale injection (103 only 1.5x volume dose)
3/23/2016	29	10th full scale injection (103 only 1.5x volume, half concentration dose)
12/6/2016	9	11th full scale injection (103 only 1.5x volume dose)

Table 3
AOC-05 Nitrate Concentrations at Downgradient Monitoring Locations
Boeing Developmental Center
Tukwila, Washington

				Aquifer Redox Conditions					
Area	Well	Date		DO (mg/L)	**Nitrate (mg-N/L)**	Iron II (mg/L)	Sulfate (mg/L)	Methane (mg/L)	ORP (mV)
SWMU-17	BDC-05-04	5/15/2006	Natural Redox Baseline		**12.3**	2.6	33.4		
SWMU-17	BDC-05-04	10/23/2008		2.45	**7.6**	0.1	31.0	0.29	73.5
SWMU-17	BDC-05-04	11/2/2008		0.59	**4.5**	0.8	25,2	0.05	-16
SWMU-17	BDC-05-04	12/16/2008		0.55	**5.5**	1.0	30.4	1.61	-98
SWMU-17	BDC-05-04	1/16/2009		0.06	**4.3**	1.0	21.8	1.48	-192
SWMU-17	BDC-05-04	2/11/2009		2.45	**5.9**	1.0	31.8	1.06	-54
SWMU-17	BDC-05-04	3/9/2009		0.27	**4.8**	1.5	30.1	0.20	35
SWMU-17	BDC-05-04	4/16/2009		1.48	**5.9**	1.4	33.6	<0.0007	68
SWMU-17	BDC-05-04	5/13/2009		0.33	**4.5**	1.6	26.6	0.37	49
SWMU-17	BDC-05-04	8/16/2009		0.86	**5.4**	2.2	30.6	<0.0007	93
SWMU-17	BDC-05-04	11/13/2009	Downgradient Monitoring Triggered	0.56	**2.2**	3.0	18.4	2.44	109
SWMU-17	BDC-05-04	2/16/2010		0.88	**<0.1**	3.3	24.6	1.49	899
SWMU-17	BDC-05-04	5/18/2010		0.75	**<0.1**	3.0	25.4	1.32	473
SWMU-17	BDC-05-04	8/17/2010		1.00	**<0.1**	2.8	17.1	3.53	108
SWMU-17	BDC-05-04	11/9/2010		2.21	**<0.1**	2.2	21.3	3.00	101
SWMU-17	BDC-05-04	2/15/2011		2.50	**<0.1**	2.4	19.4	4.46	93
SWMU-17	BDC-05-04	5/2/2011		1.69	**<0.1**	2.2	18.0	1.75	49
SWMU-17	BDC-05-04	11/2/2011		1.52	**<1.0**	1.2	<1.0		-3
SWMU-17	BDC-05-04	5/7/2012		0.16		2.0	21.5		98
SWMU-17	BDC-05-04	9/4/2012		0.21	**<0.10**		16.6		96
SWMU-17	BDC-05-04	11/13/2012		0.03	**<0.10**	1.8	16.9		64
SWMU-17	BDC-05-04	5/23/2013		0.49		1.5	13.7		-310
SWMU-17	BDC-05-04	11/19/2013		2.56	**<0.10**	1.0	13.2		-259
SWMU-17	BDC-05-04	5/6/2014		3.49	**0.40**		14.4		-299
SWMU-17	BDC-05-04	11/4/2014		0.05	**<0.10**	1.6	<1.0		-126
SWMU-17	BDC-05-04	4/28/2015		0.11	**5.0**	0.4	13.5		74
SWMU-17	BDC-05-04	10/26/2015		0.08	**<0.10**	1.5	<1.0		-101
SWMU-17	BDC-05-04	4/13/2016		0.57	**5.5**		13.9		46
SWMU-17	BDC-05-04	11/2/2016		0.39	**<0.10**		0.75		-140.5
SWMU-17	BDC-05-04	5/3/2017		0.42	**8.8**	0.6	12.0		73.8
SWMU-17	BDC-05-04	11/6/2017		0.93	**<0.050**	2.0	2.7		-28.3
SWMU-17	BDC-05-04	5/2/2018		4.25		4.7	<1.0		-107.0
SWMU-17	BDC-05-04	11/7/2018		0.97	**<0.10**	1.8	0.842	13.2	-24.8
SWMU-20	MW-17A	05/15/2006	Natural Redox Baseline		**1.37**	0.0	27.0		
SWMU-20	MW-17A	11/12/2009	Downgradient Monitoring Triggered		**0.9**				
SWMU-20	MW-17A	5/17/2010			**1.6**	0.2	21.0		
SWMU-20	MW-17A	11/8/2010			**0.1**	2.1	15.7		
SWMU-20	MW-17A	5/3/2011			**1.6**	0.0	19.8		
SWMU-20	MW-17A	8/1/2011			**0.5**	0.0	20.5		
SWMU-20	MW-17A	11/1/2011			**0.3**	0.0	23.2		
SWMU-20	MW-17A	5/3/2012			**4.4**	0.0			
SWMU-20	MW-17A	9/4/2012			**2.0**		26.8		
SWMU-20	MW-17A	11/13/2012			**0.59**	0.0	22.9		
SWMU-20	MW-17A	5/20/2013			**2.9**		26.8		
SWMU-20	MW-17A	11/19/2013			**1.3**	0.4	23.9		
SWMU-20	MW-17A	5/6/2014			**2.2**	0.0	23.7		
SWMU-20	MW-17A	11/4/2014			**0.16**	0.4	26.0		
SWMU-20	MW-17A	4/28/2015			**1.6**	0.0	26.3		
SWMU-20	MW-17A	10/26/2015		0.17	**0.91**	0.0	29.0		-11.1
SWMU-20	MW-17A	4/13/2016		0.31	**1.7**	1.8	0.90		-175
SWMU-20	MW-17A	11/1/2016		0.41	**<0.10**	1.4			-215.9
SWMU-20	MW-17A	5/3/2017		0.62	**<0.10**	2.2			-225
SWMU-20	MW-17A	11/7/2017		0.57	**<0.10**	1.8	<0.30		23.8
SWMU-20	MW-17A	5/1/2018		0.19	**<0.5**	2.4	<0.5		-127.4
SWMU-20	MW-17A	11/5/2018		0.41	**<1.0**	1.5	<0.2		-189.8

Table 3
AOC-05 Nitrate Concentrations at Downgradient Monitoring Locations
Boeing Developmental Center
Tukwila, Washington

Area	Well	Date		DO (mg/L)	**Nitrate (mg-N/L)**	Iron II (mg/L)	Sulfate (mg/L)	Methane (mg/L)	ORP (mV)
				Aquifer Redox Conditions					
SWMU-20	MW-18A	05/15/2006	Natural Redox Baseline		**0.154**	0.4	64.8		
SWMU-20	MW-18A	11/12/2009	Downgradient Monitoring Triggered		**0.8**				
SWMU-20	MW-18A	05/17/2010			**1.0**	0.4	32.2		
SWMU-20	MW-18A	11/08/2010			**0.1**	0.0	14.2		
SWMU-20	MW-18A	5/3/2011			**<0.1**	0.0	31.5		
SWMU-20	MW-18A	8/1/2011			**1.1**	0.0	42.2		
SWMU-20	MW-18A	11/1/2011			**0.7**	0.0	93.3		
SWMU-20	MW-18A	5/3/2012			**<0.10**	0.0			
SWMU-20	MW-18A	9/4/2012			**<0.10**		19.5		
SWMU-20	MW-18A	11/13/2012			**<0.10**	0.0	21.5		
SWMU-20	MW-18A	5/20/2013			**<0.10**		19.6		
SWMU-20	MW-18A	11/19/2013			**<0.10**	0.6	15.0		
SWMU-20	MW-18A	5/6/2014			**<0.10**	0.0	26.1		
SWMU-20	MW-18A	11/4/2014			**<0.10**	0.4	21.0		
SWMU-20	MW-18A	4/28/2015			**0.11**	0.0	19.1		
SWMU-20	MW-18A	10/26/2015		0.10	**<0.10**	0.6	23.4		-7.1
SWMU-20	MW-18A	4/13/2016		0.76	**0.10**	0.0	42.8		38
SWMU-20	MW-18A	11/1/2016		0.26	**<0.10**	0.4			-8.5
SWMU-20	MW-18A	5/3/2017		1.22	**0.26**	0.0			63.7
SWMU-20	MW-18A	11/7/2017		0.55	**<0.10**	0.0	14.2		7.0
SWMU-20	MW-18A	5/1/2018		0.83	**<0.10**	0.0	36.8		-15.6
SWMU-20	MW-18A	11/5/2018		0.49	**<0.10**	0.0	13.3		25.1
SWMU-20	MW-21A	05/15/2006	Natural Redox Baseline		**0.136**	0.4	54.9		
SWMU-20	MW-21A	11/12/2009	Downgradient Monitoring Triggered		**<0.1**				
SWMU-20	MW-21A	05/17/2010			**0.2**	0.0	11.9		
SWMU-20	MW-21A	11/08/2010			**<0.1**	0.0	5.9		
SWMU-20	MW-21A	5/3/2011			**0.2**	0.0	52.1		
SWMU-20	MW-21A	8/1/2011			**0.1**	0.0	26.7		
SWMU-20	MW-21A	11/1/2011			**<0.1**	0.0	9.3		
SWMU-20	MW-21A	5/3/2012			**0.17**	0.0			
SWMU-20	MW-21A	9/4/2012			**<0.10**		6.7		
SWMU-20	MW-21A	11/13/2012			**0.16**	0.0	18.5		
SWMU-20	MW-21A	5/20/2013			**0.10**	0.5	13.5		
SWMU-20	MW-21A	11/19/2013			**<0.10**	0.0	15.6		
SWMU-20	MW-21A	5/6/2014			**<0.10**	0.0	7.6		
SWMU-20	MW-21A	11/4/2014			**<0.10**	0.0	5.1		
SWMU-20	MW-21A	4/28/2015			**<0.10**	0.0	5.3		
SWMU-20	MW-21A	10/26/2015		0.33	**0.11**	0.0	3.9		10.3
SWMU-20	MW-21A	4/13/2016		2.08	**<0.10**	0.0	4.9		56
SWMU-20	MW-21A	11/1/2016		1.71	**0.10**	0.2			78
SWMU-20	MW-21A	5/3/2017		3.41	**0.19**	0.0			99.8
SWMU-20	MW-21A	11/7/2017		0.88	**<0.10**	0.0	11.0		44.2
SWMU-20	MW-21A	5/1/2018		3.49	**<0.10**	0.0	7.53		80.7
SWMU-20	MW-21A	11/5/2018		0.96	**<0.10**	0.0	4.88		141.9

Abbreviations and Acronyms:
DO = dissolved oxygen
mg/L = milligrams per liter
mg-N/L = milligrams per liter as nitrogen
mV = millivolts
ORP = oxidation-reduction potential

Notes:
Nitrate column **bolded** for emphasis of target compound. Other results included for aquifer redox evaluation.
[shaded cell] = not analyzed

Table 4
SWMU-17 VOA/Metals/Conventionals Data
November 2018
Boeing Developmental Center
Tukwila, Washington

Sample Name:	BDC-05-02	BDC-05-03	BDC-05-04	BDC-05-05	BDC-05-07	BDC-05-08	BDC-05-09	BDC-05-10	BDC-05-11	BDC-05-12	BDC-05-12-Dup	BDC-05-13	BDC-05-14	BDC-05-15	BDC-05-16	BDC-05-17	BDC-05-18	BDC-05-19	BDC-05-20	BDC-05-21	BDC-05-22	BDC-05-23	BDC-05-24	Trip Blank	Trip Blank
Lab SDG:	18K0101	18K0101	18K0103	18K0103	18K0101	18K0101	18K0101	18K0101	18K0103	18K0101	18K0101	18K0101	18K0101	18K0103	18K0101	18K0101	18K0103	18K0101	18K0103	18K0103	18K0103	18K0103	18K0101	18K0101	18K0103
Lab Sample ID:	18K0101-25	18K0101-19	18K0103-03	18K0103-01	18K0101-27	18K0101-15	18K0101-23	18K0101-21	18K0103-05	18K0101-17	18K0101-01	18K0101-11	18K0101-05	18K0103-07	18K0101-07	18K0101-09	18K0103-09	18K0101-13	18K0103-17	18K0103-11	18K0103-15	18K0103-13	18K0101-03	18K0101-29	18K0103-19
Sample Date:	11/6/2018	11/6/2018	11/7/2018	11/7/2018	11/6/2018	11/6/2018	11/6/2018	11/6/2018	11/7/2018	11/6/2018	11/6/2018	11/6/2018	11/6/2018	11/7/2018	11/6/2018	11/6/2018	11/7/2018	11/6/2018	11/7/2018	11/7/2018	11/7/2018	11/7/2018	11/6/2018	11/6/2018	11/7/2018
Test ID: VOA SW8260C (µg/L)																									
Vinyl Chloride	2.00 U	2.00 U	0.20 U	0.20 U	2.00 U	0.20 U	0.98	2.00 U	0.43	0.20 U	0.20 U	0.62	0.42	0.22	0.54	0.64	2.18	0.20 U	0.90	0.72	1.25	1.61	0.66	0.20 U	0.20 U
cis-1,2-Dichloroethene	2.00 U	5.27	5.31	0.20 U	2.01	0.20 U	0.20 U	2.00 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	6.86	0.20 U	0.20 U	0.20	11.9	1.66	0.26	0.20 U	0.20 U
Trichloroethene	2.00 U	2.00 U	0.20 U	1.17	2.00 U	0.20 U	0.20 U	2.00 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	1.01	0.20 U	0.20 U	0.20 U	0.39	0.20 U	0.20 U	0.20 U	0.20 U
Tetrachloroethene	2.00 U	2.00 U	0.20 U	0.69	2.00 U	0.20 U	0.20 U	2.00 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.90	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Test ID: Total Metals (mg/L)																									
Arsenic (EPA 200.8)	0.0439	0.0292	0.01390	0.00082	0.00449	0.00911	0.00889	0.0170	0.0143	0.0062	0.006	0.0344	0.0289	0.0417	0.0224	0.0285	0.00260	0.00642	0.0295	0.00675	0.0281	0.0215	0.00172	--	--
Copper (EPA 200.8)	0.0348	0.0457	0.00342	0.00334	0.0222	0.00326	0.0005 U	0.0243	0.0010 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0010 U	0.0005 U	0.0005 U	0.00041 J	0.0005 U	0.0010 U	0.0005 U	0.00485	0.00101	0.0005 U	--	--
Test ID: Dissolved Metals (mg/L)																									
Arsenic (EPA 200.8)	0.0328	0.0178	0.01080	0.00041	0.00348	0.00592	0.00924	0.0121	0.0150	0.00667	0.00644	0.0316	0.0306	0.0427	0.0216	0.0300	0.0014	0.00619	0.0282	0.00734	0.0297	0.0222	0.00165	--	--
Copper (EPA 200.8)	0.010 U	0.00369	0.0010 U	0.00271	0.00289	0.0005 U	0.0005 U	0.0037	0.0010 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	--	--
Test ID: Conventionals (mg/L)																									
Sulfate (EPA 300.0)	1.00 U	0.616	0.842	37.5	0.335	0.100 U	0.100 U	0.100 U	0.100 U	0.100 U	0.100 U	0.100 U	9.23	0.100 U	0.100 U	0.100 U	3.22	0.255	0.100 U	0.490	2.12	2.97	0.100 U	--	--
Total Organic Carbon (SM5310C)	1,723	940.8	119.3	2.38	207.7	8.35	39.03	303.1	43.44	23.33	23.76	20.12	22.28	15.31	14.17	11.21	2.67	15.89	9.14	5.89	5.39	6.23	12.51	--	--
Test ID: Dissolved Gases; Mod RSK-175 (µg/L)																									
Methane	9,270 J	10,500 J	13,200	--	16,300	--	15,600	18,400	20,700	24,500 J	17,300 J	14,700	23,800	19,300	16,700	13,600	14,600	20,900	24,300	10,300	--	--	17,000	--	--
Ethane	1.23 UJ	1.23 UJ	1.23 U	--	1.23 U	--	3.91	1.23 U	1.35	1.23 U	1.23 U	3.82	1.23 U	1.23 U	1.23 U	2.09	1.23 U	1.23 U	1.23 U	1.23 U	--	--	1.23 U	--	--
Ethene	1.14 UJ	1.14 UJ	1.14 U	--	1.14 U	--	1.14 U	1.14 U	1.14 U	1.14 U	1.14 U	1.14 U	1.14 U	1.14 U	1.14 U	1.14 U	1.14 U	1.14 U	1.14 U	1.14 U	--	--	1.14 U	--	--
Acetylene	1.06 UJ	1.06 UJ	1.06 U	--	1.06 U	--	1.06 U	1.06 U	1.06 U	1.06 U	1.06 U	1.06 U	1.06 U	1.06 U	1.06 U	1.06 U	1.06 U	1.06 U	1.06 U	1.06 U	--	--	1.06 U	--	--

Abbreviations and Acronyms:

µg/L = micrograms per liter
mg/L = milligrams per liter
EPA = US Environmental Protection Agency

Data Flags:

U = compound was analyzed for, but was not detected at the given detection limit
J = analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample
-- = not analyzed

Table 5
SWMU-17 Groundwater Data Cleanup Action Summary
Boeing Developmental Center
Tukwila, Washington

		Pilot Injection	Full Injection #1	Full Injection #2	Volatile Organic Compounds							Metals				Aquifer Redox Conditions						Donor Indicators		VOCs- micromoles/Liter (b)								Molar Fraction (c)				
		Elapsed Time From Injection (days)	Elapsed Time From Injection (days)	Elapsed Time From Injection (days)	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	As, Tot (mg/L)	As, Dis (mg/L)	Cu, Tot (mg/L)	Cu, Dis (mg/L)	DO (mg/L)	Nitrate (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (mg/L)	ORP (mV)	TOC (mg/L)	pH													
Proposed Groundwater Cleanup Levels (a)					5.3	1.4	134	2.4	NA	NA	NA	0.008	0.008	0.008	0.008																					
Well	Date																							PCE	TCE	c DCE	VC	Ethene	Ethane	Total Chloroethenes (d)	Ethene + Ethane	PCE	TCE	c DCE	VC	Ethene + Ethane
BDC-05-02	5/21/2007	-526			20	24	1.2	<1.0				0.003	0.002	0.004	<0.002									0.12	0.18	0.01	0.00			0.32		0.38	0.58	0.04	0.00	
(IW 2011, 2017)	11/26/2007	-337			12	14	1.3	<1.0				0.001	<0.001	<0.002	<0.002									0.07	0.11	0.01	0.00			0.19		0.38	0.55	0.07	0.00	
	5/22/2008	-159			14	20	1.2	<0.2				0.002	<0.001	0.004	<0.002									0.08	0.15	0.01	0.00			0.25		0.34	0.61	0.05	0.00	
BDC-05-02	10/23/2008	-5			31	62	2.9	<1.0	<1.1	<1.2	<1.1	0.003	0.003	0.006	<0.002	5.15	0.4	0.2	13.0	0.19	87.1	5.5	6.47	0.19	0.47	0.03	0.00	0.00	0.00	0.69	0.00	0.27	0.69	0.04	0.00	0.00
BDC-05-02	11/20/2008	23			5.1	4.2	0.7	<0.2	<1.1	<1.2	<1.1	0.017	0.011	0.008	<0.002	0.29	<0.1	1.8	64.8	3.3	-111	430	6.47	0.03	0.03	0.01	0.00	0.00	0.00	0.07	0.00	0.44	0.46	0.10	0.00	0.00
BDC-05-02	12/16/2008	49			6.6	7.3	1.3	<1.0	<1.1	<1.2	<1.1	0.024	0.017	0.030	0.003	1.28	<0.1	3.4	88.8	2.9	-225	610	6.41	0.04	0.06	0.01	0.00	0.00	0.00	0.11	0.00	0.37	0.51	0.12	0.00	0.00
BDC-05-02	1/16/2009	80			7.5	22	3.7	<1.0	<1.1	<1.2	<1.1	0.022	0.014	0.029	<0.002	0.09	<1.0	3.5	6.9	6.2	-304	732	6.10	0.05	0.17	0.04	0.00	0.00	0.00	0.25	0.00	0.18	0.67	0.15	0.00	0.00
BDC-05-02	2/11/2009	106			9.5	17	12	<1.0	<1.1	<1.2	<1.1	0.046	0.040	0.004	<0.002	2.36	<0.1	4.0	<0.1	13.2	-99	433	6.32	0.06	0.13	0.12	0.00	0.00	0.00	0.31	0.00	0.18	0.42	0.40	0.00	0.00
BDC-05-02	3/9/2009	132			9.1	8.1	25	<1.0	<1.1	<1.2	<1.1	0.041	0.036	0.004	<0.002	0.09	<1.0	3.5	<1.0	22.9	-102	317	6.43	0.05	0.06	0.26	0.00	0.00	0.00	0.37	0.00	0.15	0.16	0.69	0.00	0.00
BDC-05-02	4/16/2009	170			7.3	6.0	41	<1.0	<1.1	<1.2	<1.1	0.029	0.025	0.003	<0.002	1.78	<0.1	3.0	<0.5	26.3	-97	274	6.59	0.04	0.05	0.42	0.00	0.00	0.00	0.51	0.00	0.09	0.09	0.83	0.00	0.00
BDC-05-02	5/13/2009	197			4.4	4.6	35	1.4	<1.1	<1.2		0.024	0.019	0.004	<0.002	0.27	<0.1	5.2	<0.1	23.0	-63	215	6.61	0.03	0.04	0.36	0.02	0.00	0.00	0.44	0.00	0.06	0.08	0.81	0.05	0.00
BDC-05-02	8/16/2009	292			1.8	1.1	49	<1.0	<1.1	<1.2	<1.1	0.023	0.017	0.009	<0.002	1.58	<0.5	3.6	<0.5	22.6	-23	125	6.77	0.01	0.01	0.51	0.00	0.00	0.00	0.52	0.00	0.02	0.02	0.96	0.00	0.00
BDC-05-02	11/13/2009	381			1.0	<1.0	70	<1.0	<1.1	<1.2	<1.1	0.020	0.016	0.003	<0.002	1.07	<0.1	2.8	0.3	21.1	-26	44.1	6.05	0.01	0.00	0.72	0.00	0.00	0.00	0.73	0.00	0.01	0.00	0.99	0.00	0.00
BDC-05-02	2/16/2010	476			<1.0	<1.0	54	<1.0	<1.1	<1.2	<1.1	0.022	0.020	0.005	0.002	1.52	<0.5	2.0	0.5	22.5	763	86.7	6.87	0.00	0.00	0.56	0.00	0.00	0.00	0.56	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-02	5/18/2010	567			<1.0	1.0	32	<1.0	<1.1	<1.2	<1.1	0.013	0.012	<0.002	<0.002	1.83	<0.5	2.3	<0.5	18.4	515	20.6	6.69	0.00	0.01	0.33	0.00	0.00	0.00	0.34	0.00	0.00	0.02	0.98	0.00	0.00
BDC-05-02	8/17/2010	658			<1.0	<1.0	23	<1.0	<1.1	<1.2	<1.1	0.010	0.008	<0.002	<0.002	2.82	0.2	2.7	1.4	20.2	55	13.3	6.74	0.00	0.00	0.24	0.00	0.00	0.00	0.24	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-02	11/9/2010	742			<1.0	<1.0	14	<1.0	<1.1	<1.2	<1.1	0.006	0.005	<0.002	<0.002	2.77	<0.1	2.2	0.3	16.9	72	10.8	6.83	0.00	0.00	0.14	0.00	0.00	0.00	0.14	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-02	2/15/2011	840			<1.0	<1.0	13	<1.0	<1.1	<1.2	<1.1	0.007	0.006	0.003	<0.002	2.43	<0.1	3.0	0.7	17.8	114	13.2	6.80	0.00	0.00	0.13	0.00	0.00	0.00	0.13	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-02	5/2/2011	916			0.6	0.9	22	0.3	<1.1	<1.2	<1.1	0.008	0.007	<0.002	<0.002	2.09	<0.1	1.4	0.2	13.3	13	9.8	6.86	0.00	0.01	0.23	0.00	0.00	0.00	0.24	0.00	0.01	0.03	0.94	0.02	0.00
BDC-05-02	7/31/2011	1006	-18		<1.0	<1.0	10	<1.0	<1.1	<1.2	<1.1	0.006	0.005	<0.002	<0.002	1.97	<0.1	3.2	0.2	15.0	-35	8.7	6.82	0.00	0.00	0.10	0.00	0.00	0.00	0.10	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-02	11/2/2011	1100	76		8.4	4.8	150	1.6	<1.1	<1.2	<1.1	0.025	0.022	0.010	0.010	2.40	<0.1	3.5	1.4	9.0	-28	5360	5.43	0.05	0.04	1.55	0.03	0.00	0.00	1.66	0.00	0.03	0.02	0.93	0.02	0.00
BDC-05-02	2/19/2012	1209	185		<4.0	<4.0	220	<4.0	<1.0	<1.0	<1.0					1.37	<0.5	1.3	<1.5	8.5	-32	673	6.70	0.00	0.00	2.27	0.00	0.00	0.00	2.27	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-02	5/7/2012	1287	263		<2.0	<2.0	180	<2.0	<1.0	<1.0	<1.0	0.051	0.049	0.004	<0.002	0.60		2.2	0.8	19.0	35	412	6.71	0.00	0.00	1.86	0.00	0.00	0.00	1.86	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-02	9/5/2012	1408	384		<2.0	<2.0	57	<2.0	<1.0	<1.0	<1.0					0.11		1.8	<0.3	10.0	71	116	6.45	0.00	0.00	0.59	0.00	0.00	0.00	0.59	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-02	11/15/2012	1479	455		<2.0	<2.0	32	5.5	<1.0	<1.0	<1.0	0.014	0.013	<0.003	<0.002	0.03		1.2	<0.3	20.0	17	106	6.49	0.00	0.00	0.33	0.09	0.00	0.00	0.42	0.00	0.00	0.00	0.79	0.21	0.00
BDC-05-02	2/26/2013	1582	558		<1.0	<1.0	1.2	2.7	1.4	<1.0	<1.0					0.12		1.2	<0.30	17.0	45	32.2	6.66	0.00	0.00	0.01	0.04	0.05	0.00	0.06	0.05	0.00	0.00	0.12	0.41	0.47
BDC-05-02	5/22/2013	1667	643		0.3	0.5	0.7	0.6	<1.0	<1.0	<1.0	0.006	0.005	0.002	<0.002	0.21		1.0	0.57	15.0	-316	19.3	7.74	0.00	0.00	0.01	0.01	0.00	0.00	0.02	0.00	0.08	0.17	0.32	0.43	0.00
BDC-05-02	8/29/2013	1766	742		0.3	0.4	0.6	0.2	<1.0	<1.0	<1.0					1.96		1.4	<0.30	14.0	-303	15.7	6.34	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.13	0.21	0.43	0.22	0.00
BDC-05-02	11/13/2013	1842	818		0.4	0.5	0.9	0.6	<1.0	<1.0	<1.0	0.008	0.007	0.003	<0.002	2.52		1.8	<0.30	14.0	-272	26.8	6.42	0.00	0.00	0.01	0.01	0.00	0.00	0.03	0.00	0.10	0.15	0.37	0.38	0.00
BDC-05-02	2/11/2014	1932	908		0.8	<0.2	<0.2	<0.2	<1.0	<3.0	<1.0					4.01		2.8	<0.30	12.0	-235	7.1	6.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
BDC-05-02	5/13/2014	2023	999		0.8	1.1	1.5	2.4	5.1	<1.0	<1.0	0.023	0.019	0.003	<0.002	4.23		1.8	5.7	15.0	-380	66.5	6.62	0.00	0.01	0.02	0.04	0.18	0.00	0.07	0.18	0.02	0.03	0.06	0.15	0.73
BDC-05-02	8/6/2014	2108	1084		<1.0	<1.0	<1.0	4.1	40	11	<1.0					7.61		1.5	3.6	17.0	-215	93.4	7.20	0.00	0.00	0.00	0.07	1.43	0.37	0.07	1.79	0.00	0.00	0.00	0.04	0.96
BDC-05-02	11/11/2014	2205	1181		1.5	0.7	2.3	0.6	<1.0	12	<1.0	0.039	0.032	0.003	<0.002	0.05		1.0	1.2	13.0	-80	38.2	6.22	0.01	0.01	0.02	0.01	0.00	0.40	0.05	0.40	0.02	0.01	0.05	0.02	0.89
BDC-05-02	1/21/2015	2276	1252		1.2	0.6	1.7	1.7	<1.0	4.7	<1.0					0.16		0.6	8.9	12.0	-135	40	6.36	0.01	0.00	0.02	0.03	0.00	0.16	0.06	0.16	0.03	0.02	0.08	0.13	0.73
BDC-05-02	4/27/2015	2372	1348		2.7	1.1	1.2	3.4	3.0	6.4	<1.0	0.018	0.011	0.004	<0.002	0.07		2.0	14.3	9.8	-63	15.9	6.39	0.02	0.01	0.01	0.05	0.11	0.21	0.09	0.32	0.04	0.02	0.03	0.13	0.78
BDC-05-02	7/20/2015	2456	1432		1.8	1.4	0.7	0.7	<1.0	11	<1.0					0.15		1.9	9.5	8.0	-67	15.3	6.36	0.01	0.01	0.01	0.01	0.00	0.37	0.04	0.37	0.03	0.03	0.02	0.03	0.90
BDC-05-02	10/28/2015	2556	1532		0.8	<0.2	0.6	0.4	<1.0	<1.0	<1.0	0.002	0.002	0.006	<0.002	0.21		0.8	0.70	9.2	-5.7	3.8	6.29	0.00	0.00	0.01	0.01	0.00	0.00	0.02	0.00	0.28	0.00	0.36	0.37	0.00
BDC-05-02	1/26/2016	2646	1622		4.9	1.7	1.4	1.8	2.1	5.5	<1.0					0.22		1.4	23.7	10.0	-28	20.9	6.40	0.03	0.01	0.01	0.03	0.07	0.18	0.09	0.26	0.09	0.04	0.04	0.08	0.75
BDC-05-02	4/20/2016	2731	1707		4.2	1.4	0.8	0.6	<1.0	4.4	<1.0	0.005	0.002	0.008	0.004	0.09		1.8	14.5	8.8	-9.8	13.6	6.26	0.03	0.01	0.01	0.01	0.00	0.15	0.05	0.15	0.13	0.05	0.04	0.05	0.73
BDC-05-02	8/9/2016	2842	1818		1.6	1.6	0.3	<0.2	<1.0	4.9	<1.0	0.021	0.011	<0.002	<0.002	0.50		1.4	3.8	12.0	-101.3	14.4	6.28	0.01	0.01	0.00	0.00	0.00	0.16	0.02	0.16	0.05	0.06	0.02	0.00	0.87
BDC-05-02	11/2/2016	2927	1903		1.7	<0.2	<0.2	<0.2	<1.0	<1.0	<1.0	0.003	0.002	<0.002	<0.002	0.50		0.6	<0.30	10.0	-83.5	6.0	6.42	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	1.00	0.00	0.00	0.00	0.00
BDC-05-02	2/7/2017	3024	2000		2.1	1.6	0.5	0.5	1.2	5.4	<1.0	0.004	0.002	0.002	<0.002	0.40		2.4	18.8	9.6	-72.5	10.7	6.65	0.01	0.01	0.01	0.01	0.04	0.18	0.04	0.22	0.05	0.05	0.02	0.03	0.85
BDC-05-02	5/4/2017	3110	2086		4.2	2.0	0.4	0.4	<1.0	3.6	<1.0	0.002	0.001	0.007	0.004	0.48		0.8	23.2	5.0	27.5	15.6	6.34	0.03	0.02	0.00	0.01	0.00	0.12	0.05	0.12	0.15	0.09	0.02	0.04	0.70
BDC-05-02	8/1/2017	3199	2175		3.9	2.5	0.3	<0.2	<1.0	8.2	<1.0	0.012	0.009	<0.002	<0.002	0.13		1.6	18.4	8.0	-14.1	12.3	6.07	0.02	0.02	0.00	0.00	0.00	0.27	0.05	0.27	0.07	0.06	0.01	0.00	0.86
BDC-05-02	11/6/2017	3296	2272	-4	1.3	3.6	0.3	<0.2	<1.0	3.5	<1.0	0.013	0.011	<0.002	<0.002	1.12		1.8	13.0	10.0	-5.0	10.5	6.53	0.01	0.03	0.00	0.00	0.00	0.12	0.04	0.12	0.05	0.18	0.02	0.00	0.75
BDC-05-02	5/2/2018	3473	2449	173	3.7	3.75	15.4	1.83	<1.14	<1.23	<1.06	0.039	0.035	<0.050	<0.050	0.66		8.6	135	10.2	3.2	9629	5.16	0.02	0.03	0.16	0.03	0.00	0.00	0.24	0.00	0.09	0.12	0.66	0.12	0.00
BDC-05-02	11/6/2018	3661	2637	361	<2.0	<2.0	<2.0	<2.0	<1.14	<1.23	<1.06	0.044	0.033	0.035	<0.010	2.08		1.2	<1.0	9.3	-179.4	1723	6.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA	NA	NA	NA	NA
BDC-05-03	5/21/2007	-526			3.5	8.1	11	<1.0				0.003	<0.001	0.004	<0.002									0.02	0.06	0.11	0.00			0.20		0.11	0.31	0.58	0.00	
(IW 2017)	11/26/2007	-337			2.3	4.4	7.2	<1.0				0.002	<0.001	0.003	<0.002									0.01	0.03	0.07	0.00			0.12		0.11	0.28	0.61	0.00	
	5/22/2008	-159			3.8	8.5	13	<0.2				0.002	<0.001	0.003	<0.002									0.02	0.06	0.13	0.00			0.22		0.10	0.29	0.60	0.00	
BDC-05-03	10/23/2008	-5			4.2	8.2	17	<0.2	<1.1	<1.2	<1.1	0.004	0.002	0.004	0.002	0.37	<0.1	0.1	4.9	2.1	48.9	4.9	6.23	0.03	0.06	0.18	0.00	0.00	0.00	0.26	0.00	0.10	0.24	0.67	0.00	0.00
BDC-05-03	11/20/2008	23			1.8	2.1	2.7	<0.2	<1.1	<1.2	<1.1	0.003	0.001	0.004	<0.002	2.07	0.9	1.6	8.5	3.6	-8	7.0	6.23	0.01	0.02	0.03	0.00	0.00	0.00	0.05	0.00	0.20	0.29	0.51	0.00	0.00
BDC-05-03	12/16/2008	49			2.2	4.1	5.8	<1.0	<1.1	<1.2	<1.1	0.001	<0.001	0.002	<0.002	1.20	0.4	2.4	20.1	4.7	-67	5.4	6.44	0.01	0.03	0.06	0.00	0.00	0.00	0.10	0.00	0.13	0.30	0.57	0.00	0.00
BDC-05-03	1/16/2009	80			1.5	1.2	<1.0	<1.0	<1.1	<1.2	<1.1	0.001	<0.001	0.002	<0.002	0.71	1.7	0.4	10.3	1.5 J	-144	3.2	6.17	0.01	0.01	0.00	0.00	0.00	0.00	0.02	0.00	0.50	0.50	0.00	0.00	0.00
BDC-05-03	2/11/2009	106			1.8	3.2	4.4	<1.0	<1.1	<1.2	<1.1	0.002	<0.001	0.002	<0.002	2.43	0.9	2.4	6.2	5.4	-60	5.4	6.59	0.01	0.02	0.05	0.00	0.00	0.00	0.08	0.00	0.13	0.30	0.56	0.00	0.00
BDC-05-03	3/9/2009	132			1.3	1.7	1.4	<1.0	<1.1	<1.2	<1.1	<0.001	<0.001	<0.002	<0.002	0.86	1.0	1.0	6.6	4.3	39	4.8	6.48	0.01	0.01	0.01	0.00	0.00	0.00	0.04	0.00	0.22	0.37	0.41	0.00	0.00
BDC-05-03	4/16/2009	170			1.5	2.2	2.8	<1.0	<1.1	<1.2	<1.1	0.001	0.002	<0.002	<0.002	1.42	1.0	1.4	4.8	3.3	14	5.4	6.69	0.01	0.02	0.03	0.00	0.00	0.00	0.05	0.00	0.17	0.31	0.53	0.00	0.00
BDC-05-03	5/13/2009	197			1.2	2.1	3.4	<1.0	<1.1	<1.2		0.001	0.0004	0.004	0.002	1.06	1.0	3.0	4.8	6.9	31	5.5	6.75	0.01	0.02	0.04	0.00	0.00	0.00	0.06	0.00	0.12	0.27	0.60	0.00	0.00
BDC-05-03	8/16/2009	292			2.2	4.3	8.1	<1.0	<1.1	<1.2	<1.1	0.001	0.001	<0.002	<0.002	0.85	0.1	3.0	3.0	8.3	-42	6.5	7.11	0.01	0.03	0.08	0.00	0.00	0.00	0.13	0.00	0.10	0.25	0.64	0.00	0.00
BDC-05-03	11/13/2009	381			1.2	1.2	<1.0	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.003	<0.002	1.66	0.2	3.0	5.6	5.0	57	4.3	6.37	0.01	0.01	0.00	0.00	0.00	0.00	0.02	0.00	0.44	0.56	0.00	0.00	0.00
BDC-05-03	2/16/2010	476			1.4	1.0	<1.0	<1.0	<1.1	<1.2	<1.1	0.002	<0.001	0.005	0.005	1.25	2.5	0.0	8.6	<0.0007	663	3.5	6.30	0.01	0.01	0.00	0.00	0.00	0.00	0.02	0.00	0.53	0.47	0.00	0.00	0.00
BDC-05-03	5/18/2010	567			1.2	1.8	2.7	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.004	0.003	0.88	1.5	2.0	4.9	2.4	346	4.7	6.42	0.01	0.01	0.03	0.00	0.00	0.00	0.05	0.00	0.15	0.28	0.57	0.00	0.00
BDC-05-03	8/17/2010	658			2.3	5.2	14	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.003	<0.002	2.10	0.2	2.7	2.8	7.1	73	7.6	6.79	0.01	0.04	0.14	0.00	0.00	0.00	0.20	0.00	0.07	0.20	0.73	0.00	0.00
BDC-05-03	11/9/2010	742			1.4	1.7	3.7	<1.0	<1.1	<1.2	<1.1	0.001	0.001	0.003	<0.002	3.20	0.5	2.2	5.3	3.0	133	4.7	7.61	0.01	0.01	0.04	0.00	0.00	0.00	0.06	0.00	0.14	0.22	0.64	0.00	0.00
BDC-05-03	2/15/2011	840			1.3	<1.0	2.3	<1.0	<1.1	<1.2	<1.1	0.001	0.0003	0.005	0.003	2.86	0.7	0.0	6.2	4.6	166	5.4	7.01	0.01	0.00	0.02	0.00	0.00	0.00	0.03	0.00	0.25	0.00	0.75	0.00	0.00
BDC-05-03	5/2/2011	916	-108		1.7	1.0	0.2	<0.2	<1.1	<1.2	<1.1	0.002	0.0004	0.005	0.003	3.31	0.8	0.0	5.5	0.3	203	4.1	6.91	0.01	0.01	0.00	0.00	0.00	0.00	0.02	0.00	0.51	0.38	0.10	0.00	0.00
BDC-05-03	11/2/2011	1100	76		1.4	1.6	20	2.0				0.018	0.017	0.004	0.002	1.20	<0.1	1.6	<1.0		-60	70.0	6.72	0.01	0.01	0.21	0.03			0.26		0.03	0.05	0.80	0.12	
BDC-05-03	5/6/2012	1286	262		0.6	1.3	<0.2	0.3				0.002	0.004	0.003	0.010	0.02		1.2	10.3		82	4.9	6.26	0.00	0.01	0.00	0.00			0.02		0.20	0.54	0.00	0.26	

Table 5
SWMU-17 Groundwater Data Cleanup Action Summary
Boeing Developmental Center
Tukwila, Washington

		Pilot Injection	Full Injection #1	Full Injection #2	Volatile Organic Compounds							Metals				Aquifer Redox Conditions						Donor Indicators		VOCs- micromoles/Liter (b)								Molar Fraction (c)				
		Elapsed Time From Injection (days)	Elapsed Time From Injection (days)	Elapsed Time From Injection (days)	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	As, Tot (mg/L)	As, Dis (mg/L)	Cu, Tot (mg/L)	Cu, Dis (mg/L)	DO (mg/L)	Nitrate (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (mg/L)	ORP (mV)	TOC (mg/L)	pH													
Proposed Groundwater Cleanup Levels (a)					5.3	1.4	134	2.4	NA	NA	NA	0.008	0.008	0.008	0.008																					
Well	Date																							PCE	TCE	c DCE	VC	Ethene	Ethane	Total Chloroethenes (d)	Ethene + Ethane	PCE	TCE	c DCE	VC	Ethene + Ethane
BDC-05-03	11/13/2012	1477	453		<0.5	<0.5	<0.5	0.7				0.008	0.007	0.003	<0.002	0.01		0.3	1.2		13	8.3	6.79	0.00	0.00	0.00	0.01			0.01		0.00	0.00	0.00	1.00	
BDC-05-03	5/22/2013	1667	643		0.4	0.5	0.4	1.1				0.004	0.003	<0.002	<0.002	0.23		0.8	2.7		-264	6.6	7.57	0.00	0.00	0.00	0.02			0.03		0.09	0.14	0.15	0.63	
BDC-05-03	11/13/2013	1842	818		1.3	1.2	0.2	<0.2	<1.0	<1.0	<1.0	0.008	0.001	0.003	<0.002	3.19		1.6	10.5	0.45	-272	4.3	6.24	0.01	0.01	0.00	0.00	0.00	0.00	0.02	0.00	0.41	0.48	0.11	0.00	0.00
BDC-05-03	5/13/2014	2023	999		1.5	0.7	<0.2	<0.2	<1.0	1.1	<1.0	0.003	<0.001	0.002	<0.002	4.08		1.4	9.6	1.00	-206	5.4	6.30	0.01	0.01	0.00	0.00	0.00	0.04	0.01	0.04	0.18	0.10	0.00	0.00	0.72
BDC-05-03	11/10/2014	2204	1180		2.1	0.6	<0.2	<0.2	<1.0	<1.0	<1.0	0.002	0.001	0.003	<0.002	0.07		0.8	5.6	0.07	81	1.1	5.72	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.73	0.27	0.00	0.00	0.00
BDC-05-03	4/27/2015	2372	1348		1.5	0.4	<0.2	0.4	<1.0	<1.0	<1.0	0.002	0.003	0.004	<0.002	0.93		0.6	4.1	0.74	43	1.7	5.85	0.01	0.00	0.00	0.01	0.00	0.00	0.02	0.00	0.49	0.16	0.00	0.35	0.00
BDC-05-03	10/28/2015	2556	1532		0.6	0.4	<0.2	0.3	<1.0	1.1	<1.0	0.012	0.006	0.009	0.002	0.09		1.0	1.2	5.9	-13	6.5	6.40	0.00	0.00	0.00	0.00	0.00	0.04	0.01	0.04	0.08	0.06	0.00	0.10	0.76
BDC-05-03	4/20/2016	2731	1707		1.2	0.2	<0.2	<0.2	<1.0	<1.0	<1.0	0.002	0.002	0.003	<0.002	0.58			6.5	2.8	41	1.4	5.97	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.83	0.17	0.00	0.00	0.00
BDC-05-03	11/3/2016	2928	1904		1.4	0.3	<0.2	<0.2	<1.0	<1.0	<1.0	0.007	0.006	<0.002	<0.002	0.77		3.0	7.7	0.31	5.4	2.3	5.91	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.79	0.21	0.00	0.00	0.00
BDC-05-03	5/4/2017	3110	2086		1.4	0.3	<0.2	<0.2	<1.0	<1.0	<1.0	0.003	<0.0004	0.003	<0.002	1.95		0.0	7.2	<3.0	72.5	2.8	5.63	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.79	0.21	0.00	0.00	0.00
BDC-05-03	11/6/2017	3296	2272	-4	0.2	<0.2	<0.2	0.3	<1.0	3.4	<1.0	0.012	0.009	0.005	<0.002	0.22		3.6	<0.30	10.0	20.3	7.3	6.28	0.00	0.00	0.00	0.00	0.00	0.11	0.01	0.11	0.01	0.00	0.00	0.04	0.95
BDC-05-03	5/2/2018	3473	2449	173	<2.0	<2.0	2.49	<2.0	<1.14	<1.23	<1.06	0.027	0.019	<0.050	<0.050	0.65		7.8	<1.0	9.07	1.2	4463	5.45	0.00	0.00	0.03	0.00	0.00	0.00	0.03	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-03	11/6/2018	3661	2637	361	<2.0	<2.0	5.27	<2.0	<1.14	<1.23	<1.06	0.029	0.018	0.046	0.004	1.30		1.2	0.616	10.5	-162	940.8	6.70	0.00	0.00	0.05	0.00	0.00	0.00	0.05	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-04	5/21/2007	-526			<1.0	<1.0	1.4	<1.0				0.018	<0.001	<0.002	<0.002									0.00	0.00	0.01	0.00			0.01		0.00	0.00	1.00	0.00	
(IW 2017)	11/26/2007	-337			<1.0	<1.0	1.6	<1.0				0.009	<0.001	<0.002	<0.002									0.00	0.00	0.02	0.00			0.02		0.00	0.00	1.00	0.00	
	5/22/2008	-159			1.5	0.9	1.2	<0.2				0.018	<0.001	<0.002	<0.002									0.01	0.01	0.01	0.00			0.03		0.32	0.24	0.44	0.00	
BDC-05-04	10/23/2008	-5			1.1	0.8	2.1	<0.2	<1.1	<1.2	<1.1	0.009	<0.001	<0.002	<0.002	2.45	7.6	0.1	31.0	0.3	73.5	3.8	6.33	0.01	0.01	0.02	0.00	0.00	0.00	0.03	0.00	0.19	0.18	0.63	0.00	0.00
BDC-05-04	11/20/2008	23			1.1	0.7	3.6	<0.2	<1.1	<1.2	<1.1	0.019	<0.001	<0.002	<0.002	0.59	4.5	0.8	25,2	0.05	-16	5.1	6.25	0.01	0.01	0.04	0.00	0.00	0.00	0.05	0.00	0.14	0.11	0.76	0.00	0.00
BDC-05-04	12/16/2008	49			<1.0	<1.0	2.4	<1.0	<1.1	<1.2	<1.1	0.019	0.002	0.003	<0.002	0.55	5.5	1.0	30.4	1.6	-98	6.9	6.24	0.00	0.00	0.02	0.00	0.00	0.00	0.02	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-04	1/16/2009	80			<1.0	<1.0	2.0	<1.0	<1.1	<1.2	<1.1	0.017	<0.001	<0.002	<0.002	0.06	4.3	1.0	21.8	1.5	-192	5.1	6.23	0.00	0.00	0.02	0.00	0.00	0.00	0.02	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-04	2/11/2009	106			1.0	<1.0	1.5	<1.0	<1.1	<1.2	<1.1	0.020	<0.001	<0.002	<0.002	2.45	5.9	1.0	31.8	1.1	-54	6.8	6.17	0.01	0.00	0.02	0.00	0.00	0.00	0.02	0.00	0.28	0.00	0.72	0.00	0.00
BDC-05-04	3/9/2009	132			1.0	<1.0	1.3	<1.0	<1.1	<1.2	<1.1	0.014	0.001	0.002	<0.002	0.27	4.8	1.5	30.1	0.2	35	5.2	6.22	0.01	0.00	0.01	0.00	0.00	0.00	0.02	0.00	0.31	0.00	0.69	0.00	0.00
BDC-05-04	4/16/2009	170			1.2	<1.0	<1.0	<1.0	<1.1	<1.2	<1.1	0.011	0.001	<0.002	<0.002	1.48	5.9	1.4	33.6	<0.0007	68	5.7	6.29	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	1.00	0.00	0.00	0.00	0.00
BDC-05-04	5/13/2009	197			<1.0	<1.0	1.0	<1.0	<1.1	<1.2		0.007	0.001	0.002	0.002	0.33	4.5	1.6	26.6	0.4	49	5.2	6.37	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-04	8/16/2009	292			1.3	<1.0	<1.0	<1.0	<1.1	<1.2	<1.1	0.012	0.001	0.002	<0.002	0.86	5.4	2.2	30.6	<0.0007	93	5.0	6.97	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	1.00	0.00	0.00	0.00	0.00
BDC-05-04	11/13/2009	381			<1.0	<1.0	1.2	<1.0	<1.1	<1.2	<1.1	0.005	0.001	<0.002	<0.002	0.56	2.2	3.0	18.4	2.4	109	4.4	5.86	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-04	2/16/2010	476			<1.0	<1.0	1.1	<1.0	<1.1	<1.2	<1.1	0.004	0.002	0.012	0.002	0.88	<0.1	3.3	24.6	1.5	899	8.9	6.24	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-04	5/18/2010	567			1.1	<1.0	1.2	<1.0	<1.1	<1.2	<1.1	0.014	0.001	0.005	<0.002	0.75	<0.1	3.0	25.4	1.3	473	7.1	6.19	0.01	0.00	0.01	0.00	0.00	0.00	0.02	0.00	0.35	0.00	0.65	0.00	0.00
BDC-05-04	8/17/2010	658			<1.0	<1.0	3.0	<1.0	<1.1	<1.2	<1.1	0.012	0.002	0.006	<0.002	1.00	<0.1	2.8	17.7	3.5	108	8.7	6.48	0.00	0.00	0.03	0.00	0.00	0.00	0.03	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-04	11/9/2010	742			<1.0	<1.0	4.3	<1.0	<1.1	<1.2	<1.1	0.008	0.004	<0.002	<0.002	2.21	<0.1	2.2	21.3	3.0	101	7.2	6.84	0.00	0.00	0.04	0.00	0.00	0.00	0.04	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-04	2/15/2011	840			<1.0	<1.0	2.9	<1.0	<1.1	<1.2	<1.1	0.007	0.004	<0.002	<0.002	2.50	<0.1	2.4	19.4	4.5	93	6.9	6.85	0.00	0.00	0.03	0.00	0.00	0.00	0.03	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-04	5/2/2011	916	-108		0.4	0.5	3.1	<0.2	<1.1	<1.2	<1.1	0.008	0.004	<0.002	<0.002	1.69	<0.1	2.2	18.0	1.8	49	6.8	6.76	0.00	0.00	0.03	0.00	0.00	0.00	0.04	0.00	0.06	0.10	0.84	0.00	0.00
BDC-05-04	11/2/2011	1100	76		<1.0	<1.0	4.2	<1.0				0.007	0.006	<0.002	<0.002	1.52	<1.0	1.2	<1.0		-3	6.6	7.17	0.00	0.00	0.04	0.00			0.04		0.00	0.00	1.00	0.00	
BDC-05-04	5/7/2012	1287	263		0.4	0.6	3.6	<0.2				0.017	0.016	<0.002	<0.002	0.16		2.0	21.5		98	8.6	6.39	0.00	0.00	0.04	0.00			0.04		0.05	0.10	0.84	0.00	
BDC-05-04	11/13/2012	1477	453		<0.5	<0.5	3.3	<0.5				0.012	0.010	0.002	<0.002	0.02		1.2	14.3		27	6.5	6.65	0.00	0.00	0.03	0.00			0.03		0.00	0.00	1.00	0.00	
BDC-05-04	5/23/2013	1668	644		<0.2	<0.2	2.1	<0.2				0.026	0.027	<0.002	<0.002	0.49		1.5	13.7		-310	12.7	7.78	0.00	0.00	0.02	0.00			0.02		0.00	0.00	1.00	0.00	
BDC-05-04	11/13/2013	1842	818		<0.2	0.3	3.6	<0.2				0.016	0.015	0.002	<0.002	2.05		1.8	14.4		-262	8.1	6.48	0.00	0.00	0.04	0.00			0.04		0.00	0.06	0.94	0.00	
BDC-05-04	5/13/2014	2023	999		0.6	0.3	0.8	<0.2				0.002	0.002	0.005	0.002	3.86		0.6	14.1		-177	8.2	6.28	0.00	0.00	0.01	0.00			0.01		0.26	0.16	0.58	0.00	
BDC-05-04	11/11/2014	2205	1181		0.3	0.2	2.8	0.4				0.006	0.004	<0.002	<0.002	0.38		1.6	6.2		-58	4.8	6.25	0.00	0.00	0.03	0.01			0.04		0.05	0.04	0.75	0.17	
BDC-05-04	4/27/2015	2372	1348		1.0	0.4	1.0	<0.2				0.004	0.001	0.005	0.003	0.09		0.4	16.3		48	2.7	5.92	0.01	0.00	0.01	0.00			0.02		0.31	0.16	0.53	0.00	
BDC-05-04	10/28/2015	2556	1532		<0.2	<0.2	3.6	0.7				0.008	0.007	<0.002	<0.002	0.43		1.4	1.3		-26	6.1	6.44	0.00	0.00	0.04	0.01			0.05		0.00	0.00	0.77	0.23	
BDC-05-04	4/21/2016	2732	1708		1.0	0.3	0.4	<0.2				0.002	0.001	0.004	0.003	0.25		0.8	12.2		35	2.4	6.05	0.01	0.00	0.00	0.00			0.01		0.48	0.18	0.33	0.00	
BDC-05-04	11/2/2016	2927	1903		<0.2	<0.2	1.5	<0.2				0.008	0.008	<0.002	<0.002	0.39	<0.10	1.4	0.75		-140.5	7.4	6.51	0.00	0.00	0.02	0.00			0.02		0.00	0.00	1.00	0.00	
BDC-05-04	5/3/2017	3109	2085		1.2	0.4	0.3	<0.2				0.001	0.001	0.003	0.003	0.42	8.8	0.6	12.0		73.8	3.3	5.71	0.01	0.00	0.00	0.00			0.01		0.54	0.23	0.23	0.00	
BDC-05-04	11/6/2017	3296	2272	-4	0.3	0.3	1.1	<0.2	<1.0	<1.0	<1.0	0.012	0.010	<0.002	<0.002	0.93	<0.05	2.0	2.7	5.9	-28.3	9.2	6.71	0.00	0.00	0.01	0.00			0.02		0.12	0.15	0.73	0.00	
BDC-05-04	5/2/2018	3473	2449	173	<2.0	<2.0	4.1	<2.0	<1.14	<1.23	<1.06	0.012	0.007	<0.010	<0.010	4.25		4.7	<1.0	14	-107	1246	5.68	0.00	0.00	0.04	0.00			0.04		0.00	0.00	1.00	0.00	
BDC-05-04	11/7/2018	3662	2638	362	<0.2	<0.2	5.31	<0.2	<1.14	<1.23	<1.06	0.014	0.011	0.003	<0.001	0.97	<0.10	1.8	0.842	13.2	-24.8	119.3	6.21	0.00	0.00	0.05	0.00			0.05		0.00	0.00	1.00	0.00	
BDC-05-05	5/21/2007	-526			<1.0	<1.0	<1.0	<1.0				0.002	<0.001	0.003	<0.002									0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
(MW UG)	11/26/2007	-337			<1.0	<1.0	<1.0	<1.0				<0.001	<0.001	<0.002	<0.002									0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
	5/22/2008	-159			0.3	0.8	<0.2	<0.2				0.002	<0.001	0.003	<0.002									0.00	0.01	0.00	0.00			0.01		0.23	0.77	0.00	0.00	
BDC-05-05	10/23/2008	-5																						0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
BDC-05-05	11/20/2008	23			0.3	0.7	<0.2	<0.2				0.005	0.001	0.005	0.003	4.61					52		6.25	0.00	0.01	0.00	0.00			0.01		0.25	0.75	0.00	0.00	
BDC-05-05	12/16/2008	49																						0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
BDC-05-05	1/16/2009	80																						0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
BDC-05-05	2/11/2009	106																						0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
BDC-05-05	3/9/2009	132																						0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
BDC-05-05	4/16/2009	170																						0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
BDC-05-05	5/13/2009	197			<1.0	<1.0	<1.0	<1.0				0.003	<0.001	0.006	0.002	3.24					68		6.72	0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
BDC-05-05	8/16/2009	292																						0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
BDC-05-05	11/13/2009	381			<1.0	<1.0	<1.0	<1.0				0.001	<0.001	<0.002	<0.002	2.85	1.2	0.0	8.7		166		5.84	0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
BDC-05-05	2/16/2010	476																						0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
BDC-05-05	5/18/2010	567			<1.0	<1.0	<1.0	<1.0				0.002	0.0004	0.002	<0.002	3.47		0.0			494		6.74	0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
BDC-05-05	8/17/2010	658																						0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
BDC-05-05	11/9/2010	742			<1.0	1.1	<1.0	<1.0				0.001	0.0004	0.003	<0.002	3.20					135		6.90	0.00	0.01	0.00	0.00			0.01		0.00	1.00	0.00	0.00	
BDC-05-05	2/15/2011	840																						0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
BDC-05-05	5/2/2011	916	-108		0.3	0.8	<0.2	<0.2				0.001	0.0003	0.003	<0.002	3.40					158		6.98	0.00	0.01	0.00	0.00			0.01		0.23	0.77	0.00	0.00	
BDC-05-05	11/2/2011	1100	76		<1.0	1.2	<1.0	<1.0				0.001	0.0003	0.002	0.003	2.84	<0.1	0.0	7.5		85	1.7	7.66	0.00	0.01	0.00	0.00			0.01		0.00	1.00	0.00	0.00	

Table 5
SWMU-17 Groundwater Data Cleanup Action Summary
Boeing Developmental Center
Tukwila, Washington

		Pilot Injection	Full Injection #1	Full Injection #2	Volatile Organic Compounds							Metals				Aquifer Redox Conditions						Donor Indicators		VOCs- micromoles/Liter (b)								Molar Fraction (c)				
		Elapsed Time From Injection (days)	Elapsed Time From Injection (days)	Elapsed Time From Injection (days)	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	As, Tot (mg/L)	As, Dis (mg/L)	Cu, Tot (mg/L)	Cu, Dis (mg/L)	DO (mg/L)	Nitrate (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (mg/L)	ORP (mV)	TOC (mg/L)	pH													
Proposed Groundwater Cleanup Levels (a)					5.3	1.4	134	2.4	NA	NA	NA	0.008	0.008	0.008	0.008																					
Well	Date																							PCE	TCE	c DCE	VC	Ethene	Ethane	Total Chloroethenes (d)	Ethene + Ethane	PCE	TCE	c DCE	VC	Ethene + Ethane
BDC-05-05	5/6/2012	1286	262		0.4	0.9	<0.2	<0.2				<0.001	<0.001	0.003	<0.002	3.23		0.0	22.1		219	1.1	6.42	0.00	0.01	0.00	0.00			0.01		0.26	0.74	0.00	0.00	
BDC-05-05	11/13/2012	1477	453		<0.5	1.1	<0.5	<0.5	<1.0	<1.0	<1.0	0.001	0.0005	0.003	<0.002	1.76		0.2	20.6	<0.003	27	<1.0	6.82	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	1.00	0.00	0.00	0.00
BDC-05-05	5/23/2013	1668	644		0.3	0.9	<0.2	<0.2				0.001	0.001	<0.002	<0.002	4.69		0.7	11.7		-165	1.5	7.35	0.00	0.01	0.00	0.00			0.01		0.21	0.79	0.00	0.00	
BDC-05-05	11/14/2013	1843	819		0.5	1.1	<0.2	<0.2				<0.001	<0.001	0.003	<0.002	1.95		0.0	21.8		-219	<1.0	6.70	0.00	0.01	0.00	0.00			0.01		0.26	0.74	0.00	0.00	
BDC-05-05	5/13/2014	2023	999		0.4	0.9	<0.2	<0.2				<0.001	<0.001	<0.002	<0.002	4.35		0.0	18.6		-108	3.6	6.60	0.00	0.01	0.00	0.00			0.01		0.26	0.74	0.00	0.00	
BDC-05-05	11/11/2014	2205	1181		0.3	0.8	<0.2	<0.2				0.001	0.001	<0.002	<0.002	2.50		0.0	12.5		92	<1.0	6.25	0.00	0.01	0.00	0.00			0.01		0.23	0.77	0.00	0.00	
BDC-05-05	4/27/2015	2372	1348		0.4	1.0	<0.2	<0.2				0.001	0.001	0.003	<0.002	3.14		0.0	16.1		31	<1.0	6.25	0.00	0.01	0.00	0.00			0.01		0.24	0.76	0.00	0.00	
BDC-05-05	10/28/2015	2556	1532		0.4	0.9	<0.2	<0.2				0.001	<0.0004	<0.002	<0.002	0.81		0.3	13.2		0	<1.0	6.39	0.00	0.01	0.00	0.00			0.01		0.26	0.74	0.00	0.00	
BDC-05-05	4/21/2016	2732	1708		0.3	0.6	<0.2	<0.2				0.001	<0.0004	<0.002	<0.002	4.00		0.0	13.4		14.5	<1.0	6.37	0.00	0.00	0.00	0.00			0.01		0.28	0.72	0.00	0.00	
BDC-05-05	11/2/2016	2927	1903		0.8	1.5	<0.2	<0.2				0.001	0.0004	0.003	0.003	0.29		0.2	35.7		6.6	3.2	6.54	0.00	0.01	0.00	0.00			0.02		0.30	0.70	0.00	0.00	
BDC-05-05	5/3/2017	3109	2085		0.4	0.7	<0.2	<0.2				0.001	<0.0004	0.003	<0.002	4.43		0.0	21.3		74.9	1.9	6.29	0.00	0.01	0.00	0.00			0.01		0.31	0.69	0.00	0.00	
BDC-05-05	11/6/2017	3296	2272	-4	0.5	1.0	<0.2	<0.2				0.001	<0.0004	0.004	0.002	0.87		0.0	39.0		-29.2	2.7	6.63	0.00	0.01	0.00	0.00			0.01		0.28	0.72	0.00	0.00	
BDC-05-05	5/2/2018	3473	2449	173	0.32	0.54	<0.2	<0.2				0.001	0.0003	0.002	0.002	4.03		0.0	24.6		191.6	1.9	6.25	0.00	0.00	0.00	0.00			0.01		0.32	0.68	0.00	0.00	
BDC-05-05	11/7/2018	3662	2638	362	0.69	1.17	<0.2	<0.2				0.001	0.0004	0.003	0.003	0.66		0.0	37.5		127.8	2.38	6.33	0.00	0.01	0.00	0.00			0.01		0.32	0.68	0.00	0.00	
BDC-05-07	5/21/2007	-526			30	22	10	<1.0				0.003	<0.001	0.014	0.009									0.18	0.17	0.10	0.00			0.45		0.40	0.37	0.23	0.00	
(IW 2011, 2017)	11/26/2007	-337			28	25	11	<1.0				<0.001	<0.001	0.011	0.002									0.17	0.19	0.11	0.00			0.47		0.36	0.40	0.24	0.00	
	5/22/2008	-159			33	32	9.2	<0.2				0.002	<0.001	0.012	0.006									0.20	0.24	0.09	0.00			0.54		0.37	0.45	0.18	0.00	
BDC-05-07	10/23/2008	-5			22	24	14	<0.2	<1.1	<1.2	<1.1	0.004	0.002	0.022	0.013	9.71	9.6	0.0	33.4	0.6	86.0	7.8	6.47	0.13	0.18	0.14	0.00	0.00	0.00	0.46	0.00	0.29	0.40	0.31	0.00	0.00
BDC-05-07	11/20/2008	23			17	17	4.9	<0.2	<1.1	<1.2	<1.1	0.003	<0.001	0.016	0.010	0.60	2.2	0.4	15.8	0.2	-27	4.6	6.46	0.10	0.13	0.05	0.00	0.00	0.00	0.28	0.00	0.36	0.46	0.18	0.00	0.00
BDC-05-07	12/16/2008	49			16	25	7.2	<1.0	<1.1	<1.2	<1.1	0.003	0.001	0.016	0.012	1.20	4.8	0.0	29.4	0.6	-107	6.1	6.49	0.10	0.19	0.07	0.00	0.00	0.00	0.36	0.00	0.27	0.53	0.21	0.00	0.00
BDC-05-07	1/16/2009	80			20	23	6.4	<1.0	<1.1	<1.2	<1.1	0.002	<0.001	0.013	0.008	0.00	8.4	0.0	32.6	0.03	-182	6.3	6.38	0.12	0.18	0.07	0.00	0.00	0.00	0.36	0.00	0.33	0.48	0.18	0.00	0.00
BDC-05-07	2/11/2009	106			23	28	9.9	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.017	0.012	2.05	11.2	0.0	37.5	1.5	-68	9.3	6.37	0.14	0.21	0.10	0.00	0.00	0.00	0.45	0.00	0.31	0.47	0.22	0.00	0.00
BDC-05-07	3/9/2009	132			20	21	8.4	<1.0	<1.1	<1.2	<1.1	<0.002	<0.001	0.013	0.009	0.00	8.8	0.3	35.3	5.5	-23	6.8	6.37	0.12	0.16	0.09	0.00	0.00	0.00	0.37	0.00	0.33	0.44	0.24	0.00	0.00
BDC-05-07	4/16/2009	170			20	21	11	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.015	0.008	0.27	8.2	0.0	31.2	5.1	35	8.1	6.43	0.12	0.16	0.11	0.00	0.00	0.00	0.39	0.00	0.31	0.41	0.29	0.00	0.00
BDC-05-07	5/13/2009	197			11	13	7.5	<1.0	<1.1	<1.2		0.002	0.001	0.016	0.008	0.29	6.8	0.4	27.2	7.9	34	7.3	6.47	0.07	0.10	0.08	0.00	0.00	0.00	0.24	0.00	0.27	0.41	0.32	0.00	0.00
BDC-05-07	8/16/2009	292			11	12	13	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.010	<0.002	0.74	2.3	2.0	23.2	6.8	67	8.2	6.73	0.07	0.09	0.13	0.00	0.00	0.00	0.29	0.00	0.23	0.31	0.46	0.00	0.00
BDC-05-07	11/13/2009	381			6.5	5.3	5.6	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.004	<0.002	0.50	<0.1	2.8	5.7	4.7	16	9.1	6.48	0.04	0.04	0.06	0.00	0.00	0.00	0.14	0.00	0.29	0.29	0.42	0.00	0.00
BDC-05-07	2/16/2010	476			6.4	6.9	28	<1.0	<1.1	<1.2	<1.1	0.004	0.003	0.017	0.006	1.04	<0.1	2.5	20.4	5.2	839	14.7	6.88	0.04	0.05	0.29	0.00	0.00	0.00	0.38	0.00	0.10	0.14	0.76	0.00	0.00
BDC-05-07	5/18/2010	567			5.8	9.2	41	1.2	<1.1	<1.2	<1.1	0.009	0.003	0.009	<0.002	1.06	<0.5	2.0	16.4	6.0	525	16.8	6.77	0.03	0.07	0.42	0.02	0.00	0.00	0.55	0.00	0.06	0.13	0.77	0.04	0.00
BDC-05-07	8/17/2010	658			2.8	7.8	19	<1.0	<1.1	<1.2	<1.1	0.006	0.003	0.008	<0.002	2.30	<0.1	2.5	8.6	7.1	-15	18.8	7.34	0.02	0.06	0.20	0.00	0.00	0.00	0.27	0.00	0.06	0.22	0.72	0.00	0.00
BDC-05-07	11/9/2010	742			<1.0	9.4	20	<1.0	<1.1	<1.2	<1.1	0.008	0.005	0.009	<0.002	2.42	<0.1	2.2	15.2	5.1	13	15.2	7.35	0.00	0.07	0.21	0.00	0.00	0.00	0.28	0.00	0.00	0.26	0.74	0.00	0.00
BDC-05-07	2/15/2011	840			<1.0	8.7	20	<1.0	<1.1	<1.2	<1.1	0.013	0.010	0.012	0.002	3.02	<0.1	2.8	11.8	5.1	21	14.0	7.16	0.00	0.07	0.21	0.00	0.00	0.00	0.27	0.00	0.00	0.24	0.76	0.00	0.00
BDC-05-07	5/2/2011	916	-108		5.2	11	17	<0.2	<1.1	<1.2	<1.1	0.017	0.004	0.014	0.003	2.14	0.1	2.6	15.6	3.2	33	16.8	6.90	0.03	0.08	0.18	0.00	0.00	0.00	0.29	0.00	0.11	0.29	0.60	0.00	0.00
BDC-05-07	11/2/2011	1100	76		11	6.9	39	<1.0	<1.1	<1.2	<1.1	0.042	0.035	0.010	0.006	2.06	<0.1	2.4	<1.0	16.1	-51	1780	6.31	0.07	0.05	0.40	0.00	0.00	0.00	0.52	0.00	0.13	0.10	0.77	0.00	0.00
BDC-05-07	5/7/2012	1287	263		0.8	<0.2	23	0.9	<1.0	<1.0	<1.0	0.026	0.024	0.003	<0.002	0.17		1.6	0.4	27.0	100	48.5	6.34	0.00	0.00	0.24	0.01	0.00	0.00	0.26	0.00	0.02	0.00	0.93	0.06	0.00
BDC-05-07	11/15/2012	1479	455		<0.2	0.4	24	0.8	<1.0	<1.0	<1.0	0.016	0.017	<0.002	<0.002	0.01		1.6	<0.3	23.0	3.0	26	6.60	0.00	0.00	0.25	0.01	0.00	0.00	0.26	0.00	0.00	0.01	0.94	0.05	0.00
BDC-05-07	5/22/2013	1667	643		<0.2	0.3	8.6	0.5	<1.0	<1.0	<1.0	0.006	0.007	<0.002	<0.002	0.17		1.4	0.45	11.0	-372	10.5	8.09	0.00	0.00	0.09	0.01	0.00	0.00	0.10	0.00	0.00	0.02	0.90	0.08	0.00
BDC-05-07	11/13/2013	1842	818		<0.2	<0.2	3.4	1.6	<1.0	1.3	<1.0	0.006	0.007	<0.002	<0.002	2.12		1.2	<0.30	8.5	-276	8.8	6.70	0.00	0.00	0.04	0.03	0.00	0.04	0.06	0.04	0.00	0.00	0.34	0.25	0.42
BDC-05-07	5/13/2014	2023	999		<0.2	0.2	2.5	1.4	<1.0	<1.0	<1.0	0.004	0.004	<0.002	<0.002	3.65		2.0	1.8	3.7	-368	9.1	6.55	0.00	0.00	0.03	0.02	0.00	0.00	0.05	0.00	0.00	0.03	0.52	0.45	0.00
BDC-05-07	11/11/2014	2205	1181		<0.2	<0.2	4.1	13	26	3.0	<1.0	0.006	0.005	<0.002	<0.002	0.21		2.6	0.72	14.0	-74	17.7	6.37	0.00	0.00	0.04	0.21	0.93	0.10	0.25	1.03	0.00	0.00	0.03	0.16	0.80
BDC-05-07	4/27/2015	2372	1348		<0.2	<0.2	0.6	5.3	1.6	<1.0	<1.0	0.004	0.005	<0.002	<0.002	0.06		2.0	<0.30	3.5	-50	5.5	6.27	0.00	0.00	0.01	0.08	0.06	0.00	0.09	0.06	0.00	0.00	0.04	0.57	0.39
BDC-05-07	10/28/2015	2556	1532		0.4	<0.2	1.0	1.9	1.8	1.2	<1.0	0.004	0.004	0.002	<0.002	0.17		1.0	0.41	3.7	-9.9	5.4	6.30	0.00	0.00	0.01	0.03	0.06	0.04	0.04	0.10	0.02	0.00	0.07	0.21	0.71
BDC-05-07	4/20/2016	2731	1707		0.5	<0.2	0.2	3.2	1.3	<1.0	<1.0	0.003	0.003	<0.002	<0.002	0.11		2.0	2.0	5.4	-23	3.8	6.35	0.00	0.00	0.00	0.05	0.05	0.00	0.06	0.05	0.03	0.00	0.02	0.50	0.45
BDC-05-07	11/2/2016	2927	1903		0.8	<0.2	0.2	0.3	<1.0	1.6	<1.0	0.002	0.002	<0.002	<0.002	0.14		0.6	<0.30	8.4	-103	5.5	6.44	0.00	0.00	0.00	0.00	0.00	0.05	0.01	0.05	0.07	0.00	0.03	0.07	0.82
BDC-05-07	5/4/2017	3110	2086		1.2	0.3	0.2	0.3	<1.0	<1.0	<1.0	0.001	<0.0004	<0.002	<0.002	0.37		1.0	3.3	3.1	31.4	3.6	6.25	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.44	0.14	0.13	0.29	0.00
BDC-05-07	11/6/2017	3296	2272	-4	0.7	<0.2	<0.2	0.2	<1.0	1.9	<1.0	0.006	0.005	<0.002	<0.002	1.30		1.8	1.5	6.9	-15.8	33.3	7.06	0.00	0.00	0.00	0.00	0.00	0.06	0.01	0.06	0.06	0.00	0.00	0.05	0.89
BDC-05-07	5/2/2018	3473	2449	173	<2.0	<2.0	3.3	<2.0	<1.14	<1.23	<1.06	0.007	0.006	0.022	<0.010	3.63		7.4	<0.5	16.1	-224.6	626.6	6.57	0.00	0.00	0.03	0.00	0.00	0.00	0.03	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-07	11/6/2018	3661	2637	361	<2.0	<2.0	2.01	<2.0	<1.14	<1.23	<1.06	0.004	0.003	0.022	0.003	1.83		2.8	0.335	16.3	-45.8	207.7	6.41	0.00	0.00	0.02	0.00	0.00	0.00	0.02	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-08	10/23/2008	-5			1.1	3.7	3.5	<0.2	<1.1	<1.2	<1.1	0.007	<0.001	0.004	<0.002	1.90	0.3	0.0	8.9	4.7	-12.0	5.1	6.65	0.01	0.03	0.04	0.00	0.00	0.00	0.07	0.00	0.09	0.40	0.51	0.00	0.00
(MW 24 ft XG)	11/20/2008	23			1.1	3.4	4.2	<0.2	<1.1	<1.2	<1.1	0.035	0.004	0.036	<0.002	0.80	0.7	2.2	7.2	5.5	-43	5.9	6.63	0.01	0.03	0.04	0.00	0.00	0.00	0.08	0.00	0.09	0.34	0.57	0.00	0.00
	12/16/2008	49			1.2	4.3	4.3	<1.0	<1.1	<1.2	<1.1	0.008	0.001	0.006	<0.002	0.50	0.9	4.6	21.8	3.6	-99	5.4	6.61	0.01	0.03	0.04	0.00	0.00	0.00	0.08	0.00	0.09	0.39	0.53	0.00	0.00
BDC-05-08	1/16/2009	80			1.3	4.2	3.6	<1.0	<1.1	<1.2	<1.1	0.008	0.002	0.007	<0.002	0.25	1.7	3.0	7.0	6.9	-185	5.8	6.59	0.01	0.03	0.04	0.00	0.00	0.00	0.08	0.00	0.10	0.42	0.48	0.00	0.00
BDC-05-08	2/11/2009	106			<1.0	3.2	3.9	<1.0	<1.1	<1.2	<1.1	0.019	0.001	0.010	<0.002	2.38	0.3	4.4	4.7	4.4	-78	7.0	6.69	0.00	0.02	0.04	0.00	0.00	0.00	0.06	0.00	0.00	0.38	0.62	0.00	0.00
BDC-05-08	3/9/2009	132			<1.0	2.7	3.5	<1.0	<1.1	<1.2	<1.1	0.009	0.003	0.007	<0.002	0.07	<0.1	3.6	3.8	4.9	-4	6.7	6.65	0.00	0.02	0.04	0.00	0.00	0.00	0.06	0.00	0.00	0.36	0.64	0.00	0.00
BDC-05-08	4/16/2009	170			<1.0	2.3	4.4	<1.0	<1.1	<1.2	<1.1	0.007	0.003	0.006	<0.002	0.42	<0.1	2.0	1.7	6.7	-8	6.8	6.80	0.00	0.02	0.05	0.00	0.00	0.00	0.06	0.00	0.00	0.28	0.72	0.00	0.00
BDC-05-08	5/13/2009	197			<1.0	1.6	3.0	<1.0	<1.1	<1.2		0.009	0.003	0.007	0.002	1.77	<0.1	4.0	0.8	11.4	-13	6.0	6.87	0.00	0.01	0.03	0.00	0.00	0.00	0.04	0.00	0.00	0.28	0.72	0.00	0.00
BDC-05-08	8/16/2009	292			<1.0	2.1	3.5	<1.0	<1.1	<1.2	<1.1	0.012	0.008	<0.002	<0.002	0.87	<0.1	2.8	5.3	13.2	-20	6.1	7.15	0.00	0.02	0.04	0.00	0.00	0.00	0.05	0.00	0.00	0.31	0.69	0.00	0.00
BDC-05-08	11/13/2009	381			<1.0	1.2	3.1	<1.0	<1.1	<1.2	<1.1	0.011	0.008	0.007	<0.002	0.73	<0.1	2.8	3.3	17.4	0.8	8.4	6.44	0.00	0.01	0.03	0.00	0.00	0.00	0.04	0.00	0.00	0.22	0.78	0.00	0.00
BDC-05-08	2/16/2010	476			<1.0	<1.0	2.3	<1.0	<1.1	<1.2	<1.1	0.024	0.009	0.024	<0.002	0.63	<0.1	3.0	0.8	13.1	841	8.3	6.76	0.00	0.00	0.02	0.00	0.00	0.00	0.02	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-08	5/18/2010	567			<1.0	<1.0	2.4	<1.0	<1.1	<1.2	<1.1	0.031	0.011	0.027	<0.002	0.96	<0.1	3.0	0.8	14.9	451	7.3	6.92	0.00	0.00	0.02	0.00	0.00	0.00	0.02	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-08	8/17/2010	658			<1.0	<1.0	2.3	<1.0	<1.1	<1.2	<1.1	0.014	0.009	0.013	<0.002	2.57	<0.1	3.2	0.5	10.1	-30	7.2	7.30	0.00	0.00	0.02	0.00	0.00	0.00	0.02	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-08	11/9/2010	742			<1.0	<1.0	3.5	<1.0	<1.1	<1.2	<1.1	0.031	0.012	0.031	<0.002	2.74	<0.1	2.4	0.3	14.2	59	7.6	7.17	0.00	0.00	0.04	0.00	0.00	0.00	0.04	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-08	2/15/2011	840			<1.0	<1.0	2.1	<1.0	<1.1	<1.2	<1.1	0.021	0.010	0.016	<0.002	2.36	<0.1	5.0	0.3	14.1	66	8.7	7.08	0.00	0.00	0.02	0.00	0.00	0.00	0.02	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-08	5/2/2011	916	-108		<0.2	<0.2	2.2	<0.2	<1.1	<1.2	<1.1	0.029	0.010	0.024	<0.002	2.15	<0.1	2.4	0.7	7.8	-28	8.0	7.17	0.00	0.00	0.02	0.00	0.00	0.00	0.02	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-08	11/2/2011	1100	76		<1.0	<1.0	2.4	<1.0				0.014	0.010	0.012	0.003	1.15	<0.1	1.2	0.8		-53	7.3	6.88	0.00	0.00	0.02	0.00			0.02		0.00	0.00	1.00	0.00	
BDC-05-08	5/6/2012	1286	262		<0.2	<0.2	2.7	<0.2				0.021	0.020	0.007	0.002	0.01		2.5	0.4		42	12.4	6.77	0.00	0.00	0.03	0.00			0.03		0.00	0.00	1.00	0.00	
BDC-05-08	11/16/2012	1480	456		<0.5	<0.5	1.3	<0.5				0.014	0.010	0.005	<0.002	0.01		1.0	<0.3		5	8.1	6.91	0.00	0.00	0.01	0.00			0.01		0.00	0.00	1.00	0.00	

Table 5
SWMU-17 Groundwater Data Cleanup Action Summary
Boeing Developmental Center
Tukwila, Washington

		Pilot Injection	Full Injection #1	Full Injection #2	Volatile Organic Compounds							Metals				Aquifer Redox Conditions						Donor Indicators		VOCs- micromoles/Liter (b)								Molar Fraction (c)				
		Elapsed Time From Injection (days)	Elapsed Time From Injection (days)	Elapsed Time From Injection (days)	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	As, Tot (mg/L)	As, Dis (mg/L)	Cu, Tot (mg/L)	Cu, Dis (mg/L)	DO (mg/L)	Nitrate (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (mg/L)	ORP (mV)	TOC (mg/L)	pH	PCE	TCE	c DCE	VC	Ethene	Ethane	Total Chloroethenes (d)	Ethene + Ethane	PCE	TCE	c DCE	VC	Ethene + Ethane
Proposed Groundwater Cleanup Levels (a)					5.3	1.4	134	2.4	NA	NA	NA	0.008	0.008	0.008	0.008																					
Well	Date																																			
BDC-05-08	5/23/2013	1668	644		<0.2	<0.2	0.4	<0.2				0.008	0.007	0.002	<0.002	0.39		1.3	<0.3		-249	5.7	7.68	0.00	0.00	0.00	0.00			0.00		0.00	0.00	1.00	0.00	
BDC-05-08	11/13/2013	1842	818		<0.2	<0.2	4.3	0.8				0.012	0.010	0.003	<0.002	2.02		1.4	<0.30		-275	15.0	6.73	0.00	0.00	0.04	0.01			0.06		0.00	0.00	0.78	0.22	
BDC-05-08	5/13/2014	2023	999		<0.2	<0.2	2.9	1.8	<1.0	<1.0	<1.0	0.015	0.011	0.004	<0.002	2.02		1.4	0.31	7.7	-255	9.5	6.87	0.00	0.00	0.03	0.03	0.00	0.00	0.06	0.00	0.00	0.00	0.51	0.49	0.00
BDC-05-08	11/10/2014	2204	1180		<0.2	<0.2	3.8	16				0.017	0.015	0.003	<0.002	0.04		1.4	0.65		-104	21.6	6.26	0.00	0.00	0.04	0.26			0.30		0.00	0.00	0.13	0.87	
BDC-05-08	4/27/2015	2372	1348		<0.2	<0.2	0.8	2.3				0.019	0.011	0.004	<0.002	0.05		0.6	<0.30		-90	9.4	6.36	0.00	0.00	0.01	0.04			0.05		0.00	0.00	0.18	0.82	
BDC-05-08	10/28/2015	2556	1532		<0.2	<0.2	0.3	0.5				0.011	0.008	0.002	<0.002	0.06		1.0	<0.30		-31	8.6	6.47	0.00	0.00	0.00	0.01			0.01		0.00	0.00	0.28	0.72	
BDC-05-08	4/21/2016	2732	1708		<0.2	<0.2	0.2	1.2				0.014	0.012	0.007	<0.002	0.22			<0.30		-38	3.8	6.53	0.00	0.00	0.00	0.02			0.02		0.00	0.00	0.10	0.90	
BDC-05-08	11/3/2016	2928	1904		<0.2	<0.2	0.2	0.5								0.19		1.6	<0.30		-109.8	4.7	6.22	0.00	0.00	0.00	0.01			0.01		0.00	0.00	0.21	0.79	
BDC-05-08	5/4/2017	3110	2086		<0.2	<0.2	<0.2	0.5								0.62		1.6	0.41		-107.5	5.7	6.36	0.00	0.00	0.00	0.01			0.01		0.00	0.00	0.00	1.00	
BDC-05-08	11/6/2017	3296	2272	-4	<0.2	<0.2	<0.2	0.5				0.009	0.008	<0.002	0.004	0.50		2.2	0.90		-19.7	5.1	6.50	0.00	0.00	0.00	0.01			0.01		0.00	0.00	0.00	1.00	
BDC-05-08	5/2/2018	3473	2449	173	<0.2	<0.2	<0.2	<0.2				0.012	0.008	0.005	<0.0005	1.44		3.4	0.137		-117.4	6.0	6.46	0.00	0.00	0.00	0.00			0.00		NA	NA	NA	NA	
BDC-05-08	11/6/2018	3661	2637	361	<0.2	<0.2	<0.2	<0.2				0.009	0.006	0.003	<0.0005	0.55		3.6	<0.100		-57.6	8.35	6.39	0.00	0.00	0.00	0.00			0.00		NA	NA	NA	NA	
BDC-05-09	7/31/2011		-18		30	20	22	<1.0	<1.1	<1.2	<1.1	0.007	0.007	<0.002	<0.002	1.37	<0.1	2.5	12.1	1.4	15	5.5	6.89	0.18	0.15	0.23	0.00	0.00	0.00	0.56	0.00	0.32	0.27	0.41	0.00	0.00
(IW 2011)	11/2/2011		76		37	56	44	1.3	<1.1	<1.2	<1.1	0.042	0.040	0.009	0.006	2.80	<0.1	3.0	7.6	4.3	80	4360	5.24	0.22	0.43	0.45	0.02	0.00	0.00	1.12	0.00	0.20	0.38	0.40	0.02	0.00
	5/7/2012		263		3.0	1.1	250	3.9	<1.0	<1.0	<1.0	0.059	0.052	0.011	<0.002	0.69		2.2	0.5	18.0	85	531	6.33	0.02	0.01	2.58	0.06	0.00	0.00	2.67	0.00	0.01	0.00	0.97	0.02	0.00
BDC-05-09	11/15/2012		455		<2.0	<2.0	24	20	69	<1.0	<1.0	0.074	0.070	0.006	<0.002	0.01		1.2	<0.3	27.0	-10	266	6.71	0.00	0.00	0.25	0.32	2.46	0.00	0.57	2.46	0.00	0.00	0.08	0.11	0.81
BDC-05-09	5/22/2013		643		<0.2	<0.2	1.0	3.7	23	3.4	<1.0	0.026	0.025	0.003	<0.002	0.18		1.5	<0.3	17.0	-300	40.6	7.83	0.00	0.00	0.01	0.06	0.82	0.11	0.07	0.93	0.00	0.00	0.01	0.06	0.93
BDC-05-09	11/13/2013		818		<0.2	<0.2	3.2	14	8.6	8.3	<1.0	0.022	0.022	<0.002	<0.002	2.80		1.4	0.9	11.0	-263	36.8	6.61	0.00	0.00	0.03	0.22	0.31	0.28	0.26	0.58	0.00	0.00	0.04	0.27	0.69
BDC-05-09	5/13/2014		999		<0.2	<0.2	0.7	1.0	1.6	8.5	<1.0	0.010	0.010	<0.002	<0.002	3.66		1.5	1.9	8.0	-356	13.1	6.53	0.00	0.00	0.01	0.02	0.06	0.28	0.02	0.34	0.00	0.00	0.02	0.04	0.94
BDC-05-09	11/11/2014		1181		<0.2	<0.2	1.1	3.5	1.2	6.4	<1.0	0.018	0.017	<0.002	<0.002	0.08		2.3	0.72	8.5	-47	6.9	6.19	0.00	0.00	0.01	0.06	0.04	0.21	0.07	0.26	0.00	0.00	0.04	0.17	0.79
BDC-05-09	4/27/2015		1348		<0.2	<0.2	0.4	8.3	5.0	4.3	<1.0	0.007	0.009	<0.002	<0.002	0.04		1.4	0.68	7.5	-53	4.0	6.27	0.00	0.00	0.00	0.13	0.18	0.14	0.14	0.32	0.00	0.00	0.01	0.29	0.70
BDC-05-09	10/28/2015		1532		<0.2	<0.2	0.3	2.1	<1.0	2.0	<1.0	0.008	0.008	<0.002	<0.002	0.15		1.0	<0.30	5.3	-5.3	2.5	6.36	0.00	0.00	0.00	0.03	0.00	0.07	0.04	0.07	0.00	0.00	0.03	0.33	0.64
BDC-05-09	4/20/2016		1707		<0.2	<0.2	<0.2	2.8	1.9	8.4	<1.0	0.007	0.009	<0.002	<0.002	0.08		3.0	<0.30	6.6	-30	2.8	6.36	0.00	0.00	0.00	0.04	0.07	0.28	0.04	0.35	0.00	0.00	0.00	0.11	0.89
BDC-05-09	11/2/2016		1903		<0.2	<0.2	<0.2	1.3	1.0	9.2	<1.0	0.009	0.009	<0.002	<0.002	0.41		1.6	2.8	7.6	-82.3	5.2	6.36	0.00	0.00	0.00	0.02	0.04	0.31	0.02	0.34	0.00	0.00	0.00	0.06	0.94
BDC-05-09	5/4/2017		2086		<0.2	<0.2	0.4	2.8	1.0	9.0	<1.0	0.006	0.006	<0.002	<0.002	0.26		2.0	4.3	5.3	-83.9	4.3	6.32	0.00	0.00	0.00	0.04	0.04	0.30	0.05	0.33	0.00	0.00	0.01	0.12	0.87
BDC-05-09	11/6/2017		2272	-4	<0.2	<0.2	<0.2	1.2	<1.0	8.7	<1.0	0.005	0.005	<0.002	<0.002	0.72		2.2	0.65	4.4	-17.5	3.6	6.51	0.00	0.00	0.00	0.02	0.00	0.29	0.02	0.29	0.00	0.00	0.00	0.06	0.94
BDC-05-09	5/2/2018		2449	173	<0.2	0.33	0.9	3.32	<1.14	<1.23	<1.06	0.008	0.007	<0.0005	<0.0005	0.46		2.0	0.195	15.3	-2.3	38.8	6.15	0.00	0.00	0.01	0.05	0.00	0.00	0.06	0.00	0.00	0.04	0.14	0.82	0.00
BDC-05-09	11/6/2018		2637	361	<0.2	<0.2	<0.2	0.98	<1.14	3.91	<1.06	0.009	0.009	<0.0005	<0.0005	1.30		3.6	<0.100	15.6	-24.3	39.0	6.23	0.00	0.00	0.00	0.02	0.00	0.13	0.02	0.13	0.00	0.00	0.00	0.11	0.89
BDC-05-10	7/31/2011		-18		39	26	12	<1.0	<1.1	<1.2	<1.1	0.002	0.002	<0.002	<0.002	1.41	<0.1	2.0	19.7	0.3	76	4.5	6.84	0.24	0.20	0.12	0.00	0.00	0.00	0.56	0.00	0.42	0.36	0.22	0.00	0.00
(IW 2011, 2017)	11/2/2011		76		22	27	1.0	<1.0	1.6	1.7	<1.1	0.038	0.037	0.008	0.004	2.43	<0.1	2.2	10.9	0.1	-38	2030	5.72	0.13	0.21	0.01	0.00	0.06	0.06	0.35	0.11	0.29	0.44	0.02	0.00	0.25
	5/6/2012		262		<1.0	<1.0	120	5.4	1.1	<1.0	<1.0	0.052	0.048	0.012	<0.002	0.02		1.7	0.4	19.0	58	270	6.48	0.00	0.00	1.24	0.09	0.04	0.00	1.32	0.04	0.00	0.00	0.91	0.06	0.03
BDC-05-10	11/15/2012		455		<1.0	<1.0	4.4	49	8.5	<1.0	<1.0	0.069	0.060	0.003	<0.002	0.02		1.0	<0.3	24.0	-11	122	6.63	0.00	0.00	0.05	0.78	0.30	0.00	0.83	0.30	0.00	0.00	0.04	0.69	0.27
BDC-05-10	5/22/2013		643		<0.2	<0.2	0.3	11	14	<3.0	<1.0	0.056	0.053	0.003	<0.002	0.25		1.2	0.49	20.0	-308	50.8	7.84	0.00	0.00	0.00	0.18	0.50	0.00	0.18	0.50	0.00	0.00	0.00	0.26	0.74
BDC-05-10	11/13/2013		818		<0.2	<0.2	0.6	15	17	<1.0	<1.0	0.058	0.052	<0.002	<0.002	3.33		1.8	<0.30	23.0	-263	54.1	6.55	0.00	0.00	0.01	0.24	0.61	0.00	0.25	0.61	0.00	0.00	0.01	0.28	0.71
BDC-05-10	5/13/2014		999		<0.2	<0.2	<0.2	5.1	29	<1.0	<1.0	0.037	0.034	<0.002	<0.002	3.87		1.6	<0.30	21.0	-196	27.6	6.53	0.00	0.00	0.00	0.08	1.03	0.00	0.08	1.03	0.00	0.00	0.00	0.07	0.93
BDC-05-10	11/10/2014		1180		<0.2	<0.2	0.2	3.9	3.4	<1.0	<1.0	0.040	0.038	<0.002	<0.002	0.03		1.0	<0.30	16.0	-86	19.3	6.25	0.00	0.00	0.00	0.06	0.12	0.00	0.06	0.12	0.00	0.00	0.01	0.34	0.65
BDC-05-10	4/27/2015		1348		<0.2	<0.2	<0.2	2.9	7.2	8.3	<1.0	0.026	0.024	0.003	<0.002	0.04		0.8	<0.30	14.0	-68	10.3	6.24	0.00	0.00	0.00	0.05	0.26	0.28	0.05	0.53	0.00	0.00	0.00	0.08	0.92
BDC-05-10	10/28/2015		1532		<0.2	<0.2	<0.2	0.7	<1.0	3.2	<1.0	0.021	0.019	<0.002	<0.002	0.17		1.0	<0.30	7.4	-14	7.8	6.42	0.00	0.00	0.00	0.01	0.00	0.11	0.01	0.11	0.00	0.00	0.00	0.10	0.90
BDC-05-10	4/20/2016		1707		<0.2	<0.2	<0.2	1.8	3.9	11	<1.0	0.015	0.016	<0.002	<0.002	0.22		1.1	0.65	5.8	-17	5.0	6.22	0.00	0.00	0.00	0.03	0.14	0.37	0.03	0.50	0.00	0.00	0.00	0.05	0.95
BDC-05-10	11/2/2016		1903		<0.2	<0.2	<0.2	0.8	<1.0	19	<1.0	0.022	0.021	<0.002	<0.002	0.15		0.6	<0.30	6.1	-109	7.5	6.34	0.00	0.00	0.00	0.01	0.00	0.63	0.01	0.63	0.00	0.00	0.00	0.02	0.98
BDC-05-10	5/4/2017		2086		<0.2	<0.2	0.3	1.8	1.0	15	<1.0	0.015	0.014	<0.002	<0.002	0.23		2.0	1.7	4.0	-89.7	6.0	6.38	0.00	0.00	0.00	0.03	0.04	0.50	0.03	0.53	0.00	0.00	0.01	0.05	0.94
BDC-05-10	11/6/2017		2272	-4	<0.2	<0.2	<0.2	0.6	<1.0	12	<1.0	0.014	0.011	<0.002	<0.002	0.32		2.0	1.3	6.2	8.90	5.3	6.37	0.00	0.00	0.00	0.01	0.00	0.40	0.01	0.40	0.00	0.00	0.00	0.02	0.98
BDC-05-10	5/2/2018		2449	173	<2.0	<2.0	7.43	<2.0	<1.14	<1.23	<1.06	0.036	0.022	0.063	<0.050	0.41		4.2	<1.0	13.8	-79.8	1453	6.44	0.00	0.00	0.08	0.00	0.00	0.00	0.08	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-10	11/6/2018		2637	361	<2.0	<2.0	<2.0	<2.0	<1.14	<1.23	<1.06	0.017	0.012	0.024	0.004	1.09		1.8	<0.100	18.4	-93.2	303.1	6.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA	NA	NA	NA	NA
BDC-05-11	7/31/2011		-18		16	19	5.8	<1.0	<1.1	<1.2	<1.1	0.005	0.005	<0.002	<0.002	1.41	<0.1	2.0	4.0	1.4	65	3.9	6.93	0.10	0.14	0.06	0.00	0.00	0.00	0.30	0.00	0.32	0.48	0.20	0.00	0.00
(IW 2011)	11/2/2011		76		9.6	20	12	<1.0	<1.1	<1.2	<1.1	0.039	0.037	0.013	0.004	2.16	<0.1	1.8	<1.0	1.0	-38	1330	5.72	0.06	0.15	0.12	0.00	0.00	0.00	0.33	0.00	0.17	0.46	0.37	0.00	0.00
	5/6/2012		262		0.2	0.5	44	7.2	1.6	<1.0	<1.0	0.038	0.034	0.009	0.002	0.01		1.4	0.5	18.0	70	284	6.42	0.00	0.00	0.45	0.12	0.06	0.00	0.57	0.06	0.00	0.01	0.72	0.18	0.09
BDC-05-11	11/15/2012		455		<1.0	<1.0	6.1	5.7	7.6	<1.0	<1.0	0.043	0.038	0.003	<0.002	0.02		1.3	<0.3	26.0	-15	73.8	6.76	0.00	0.00	0.06	0.09	0.27	0.00	0.15	0.27	0.00	0.00	0.15	0.21	0.64
BDC-05-11	5/22/2013		643		<0.2	<0.2	0.3	2.9	16	3.7	<1.0	0.035	0.032	<0.002	<0.002	0.25		1.6	0.43	23.0	-299	42.1	7.71	0.00	0.00	0.00	0.05	0.57	0.12	0.05	0.69	0.00	0.00	0.00	0.06	0.93
BDC-05-11	11/13/2013		818		<0.2	<0.2	0.2	3.9	17	4.6	<1.0	0.038	0.035	0.002	<0.002	3.81		2.0	0.36	24.0	-264	48.4	6.5	0.00	0.00	0.00	0.06	0.61	0.15	0.06	0.76	0.00	0.00	0.00	0.08	0.92
BDC-05-11	5/13/2014		999		<0.2	<0.2	<0.2	2.0	9.0	7.2	<1.0	0.038	0.036	<0.002	<0.002	4.13		1.8	<0.30	24.0	-185	38.1	6.49	0.00	0.00	0.00	0.03	0.32	0.24	0.03	0.56	0.00	0.00	0.00	0.05	0.95
BDC-05-11	11/10/2014		1180		<0.2	<0.2	<0.2	2.5	1.7	1.9	<1.0	0.030	0.030	<0.002	<0.002	0.01		1.8	<0.30	8.0	-88	11.1	6.30	0.00	0.00	0.00	0.04	0.06	0.06	0.04	0.12	0.00	0.00	0.00	0.24	0.76
BDC-05-11	4/27/2015		1348		<0.2	<0.2	<0.2	3.5	2.1	<1.0	<1.0	0.019	0.017	<0.002	<0.002	0.07		0.8	0.81	6.2	-77	7.6	6.22	0.00	0.00	0.00	0.06	0.07	0.00	0.06	0.07	0.00	0.00	0.00	0.43	0.57
BDC-05-11	10/28/2015		1532		<0.2	<0.2	<0.2	1.5	1.8	2.1	<1.0	0.018	0.017	<0.002	<0.002	0.11		0.6	<0.30	15.0	-16	7.4	6.52	0.00	0.00	0.00	0.02	0.06	0.07	0.02	0.13	0.00	0.00	0.00	0.15	0.85
BDC-05-11	4/20/2016		1707		<0.2	<0.2	<0.2	1.4	3.3	2.6	<1.0	0.020	0.020	<0.002	<0.002	0.08		0.8	<0.30	13.0	-15.4	6.5	6.33	0.00	0.00	0.00	0.02	0.12	0.09	0.02	0.20	0.00	0.00	0.00	0.10	0.90
BDC-05-11	11/2/2016		1903		<0.2	<0.2	<0.2	0.4	1.8	5.8	<1.0	0.017	0.015	<0.002	<0.002	0.11		2.8	<0.30	13.0	-118.1	9.0	6.27	0.00	0.00	0.00	0.01	0.06	0.19	0.01	0.26	0.00	0.00	0.00	0.02	0.98
BDC-05-11	5/4/2017		2086		<0.2	<0.2	<0.2	0.8	2.5	6.8	<1.0	0.018	0.018	<0.002	<0.002	0.24		2.0	<0.30	9.0	-101.7	9.2	6.37	0.00	0.00	0.00	0.01	0.09	0.23	0.01	0.32	0.00	0.00	0.00	0.04	0.96
BDC-05-11	11/6/2017		2272	-4	<0.2	<0.2	<0.2	0.3	<1.0	5.1	<1.0	0.012	0.011	<0.002	<0.002	0.54		3.8	<0.30	10.0	-15.5	7.4	6.37	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.17	0.00	0.00	0.00	0.03	0.97
BDC-05-11	5/2/2018		2449	173	<0.2	<0.2	<0.2	1.12	<1.14	<1.23	<1.06	0.014	0.013	0.001	<0.0005	0.15		2.4	0.107	14.8	-5	40.8	6.27	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.00	1.00	0.00
BDC-05-11	11/7/2018		2638	362	<0.2	<0.2	<0.2	0.43	<1.14	1.35	<1.06	0.014	0.015	<0.001	<0.001	0.37		4.8	<0.100	20.7	-13.1	43.4	6.25	0.00	0.00	0.00	0.01	0.00	0.04	0.01	0.04	0.00	0.00	0.00	0.13	0.87
BDC-05-12	7/31/2011		-18		15	18	16	<1.0	<1.1	<1.2	<1.1	0.002	0.002	0.002	<0.002	1.60	0.1	2.4	8.4	4.0	26	7.0	7.02	0.09	0.14	0.17	0.00	0.00	0.00	0.39	0.00	0.23	0.35	0.42	0.00	0.00
(IW 2011)	11/2/2011		76		11	17	11	<1.0	<1.1	<1.2	<1.1	0.041	0.031	0.012	0.009	2.60	<0.1	3.5	5.6	1.0	-77	2960	5.83	0.07	0.13	0.11	0.00	0.00	0.00	0.31	0.00	0.21	0.42	0.37	0.00	0.00
	2/19/2012		185		<0.4	<0.4	53	1.8	<1.0	<1.0	<1.0					1.7	<0.5	2.0	<1.5	17.0	-2	279	6.59	0.00	0.00	0.55	0.03	0.00	0.00	0.58	0.00	0.00	0.00	0.95	0.05	0.00
BDC-05-12	5/6/2012		262		<0.2	<0.2	39	3.4	<1.0	<1.0	<1.0	0.082	0.071	0.005	<0.002	0.03		2.5	0.8	21.0	65	83.2	6.45	0.00	0.00	0.40	0.05	0.00	0.00	0.46	0.00	0.00	0.00	0.88	0.12	0.00
BDC-05-12	9/5/2012		384		<0.2	<0.2	6.5	3.3	1.0	<1.0	<1.0					0.13		1.8	<0.3	22.0	80	50.4	6.48	0.00	0.00	0.07	0.05	0.04	0.00	0.12	0.04	0.00	0.00	0.43	0.34	0.23

Table 5
SWMU-17 Groundwater Data Cleanup Action Summary
Boeing Developmental Center
Tukwila, Washington

		Pilot Injection	Full Injection #1	Full Injection #2	Volatile Organic Compounds							Metals				Aquifer Redox Conditions						Donor Indicators		VOCs- micromoles/Liter (b)								Molar Fraction (c)				
		Elapsed Time From Injection (days)	Elapsed Time From Injection (days)	Elapsed Time From Injection (days)	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	As, Tot (mg/L)	As, Dis (mg/L)	Cu, Tot (mg/L)	Cu, Dis (mg/L)	DO (mg/L)	Nitrate (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (mg/L)	ORP (mV)	TOC (mg/L)	pH													
Proposed Groundwater Cleanup Levels (a)					5.3	1.4	134	2.4	NA	NA	NA	0.008	0.008	0.008	0.008																					
Well	Date																							PCE	TCE	c DCE	VC	Ethene	Ethane	Total Chloroethenes (d)	Ethene + Ethane	PCE	TCE	c DCE	VC	Ethene + Ethane
BDC-05-12	11/15/2012		455		<1.0	<1.0	7.9	5.4	1.1	<1.0	<1.0	0.037	0.036	0.002	<0.002	0.03		1.3	<0.3	27.0	7	52.9	6.56	0.00	0.00	0.08	0.09	0.04	0.00	0.17	0.04	0.00	0.00	0.39	0.42	0.19
BDC-05-12	2/25/2013		557		<1.0	<1.0	1.7	4.4	3.8	<1.0	<1.0					0.18		2.0	<0.3	26.0	54	27.5	6.68	0.00	0.00	0.02	0.07	0.14	0.00	0.09	0.14	0.00	0.00	0.08	0.32	0.61
BDC-05-12	5/22/2013		643		<0.2	<0.2	0.8	5.0	12	<3.0	<1.0	0.022	0.022	<0.002	<0.002	0.29		1.4	<0.3	24.0	-366	35.4	8.08	0.00	0.00	0.01	0.08	0.43	0.00	0.09	0.43	0.00	0.00	0.02	0.16	0.83
BDC-05-12	8/29/2013		742		<2.0	<2.0	<2.0	<2.0	5.5	2.8	<1.0					5.25		1.6	<0.30	22.0	-320	32.6	6.53	0.00	0.00	0.00	0.00	0.20	0.09	0.00	0.29	0.00	0.00	0.00	0.00	1.00
BDC-05-12	11/13/2013		818		<2.0	<2.0	<2.0	<2.0	2.2	3.4	<1.0	0.010	0.012	<0.002	<0.002	2.61		2.6	0.39	26.0	-268	26.9	6.66	0.00	0.00	0.00	0.00	0.08	0.11	0.00	0.19	0.00	0.00	0.00	0.00	1.00
BDC-05-12	2/11/2014		908		<1.0	<1.0	<1.0	<1.0	1.1	<6.0	<1.0					4.83		2.2	0.37	23.0	-239	19.7	6.57	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.04	0.00	0.00	0.00	0.00	1.00
BDC-05-12	5/13/2014		999		<1.0	<1.0	<1.0	<1.0	1.0	5.6	<1.0	0.007	0.006	<0.002	<0.002	3.01		2.0	0.49	25.0	-299	21.5	6.60	0.00	0.00	0.00	0.00	0.04	0.19	0.00	0.22	0.00	0.00	0.00	0.00	1.00
BDC-05-12	8/6/2014		1084		<1.0	<1.0	<1.0	1.1	1.8	4.5	<1.0					7.00		1.5	<0.30	21.0	-146	43.1	7.05	0.00	0.00	0.00	0.02	0.06	0.15	0.02	0.21	0.00	0.00	0.00	0.08	0.92
BDC-05-12	11/10/2014		1180		<1.0	<1.0	<1.0	1.7	2.5	8.9	<1.0	0.017	0.018	<0.002	<0.002	0.03		0.8	<0.30	25.0	-83	30.3	6.23	0.00	0.00	0.00	0.03	0.09	0.30	0.03	0.39	0.00	0.00	0.00	0.07	0.93
BDC-05-12	1/21/2015		1252		<0.2	<0.2	<0.2	2.8	1.5	5.0	<1.0					0.12		2.2	0.45	17.0	-115	22.6	6.25	0.00	0.00	0.00	0.04	0.05	0.17	0.04	0.22	0.00	0.00	0.00	0.17	0.83
BDC-05-12	4/27/2015		1348		<0.2	<0.2	<0.2	1.4	1.2	2.2	<1.0	0.017	0.017	<0.002	<0.002	0.07		1.1	<0.30	21.0	-84	13.2	6.29	0.00	0.00	0.00	0.02	0.04	0.07	0.02	0.12	0.00	0.00	0.00	0.16	0.84
BDC-05-12	7/21/2015		1433		<0.2	<0.2	<0.2	0.7	<1.0	3.1	<1.0					0.12		1.4	<0.30	18.0	-41	15.2	6.25	0.00	0.00	0.00	0.01	0.00	0.10	0.01	0.10	0.00	0.00	0.00	0.10	0.90
BDC-05-12	10/28/2015		1532		<0.2	<0.2	<0.2	0.9	<1.0	2.6	<1.0	0.034	0.033	0.003	<0.002	0.08		1.4	<0.30	14.0	-28	29.0	6.40	0.00	0.00	0.00	0.01	0.00	0.09	0.01	0.09	0.00	0.00	0.00	0.14	0.86
BDC-05-12	1/26/2016		1622		<0.2	<0.2	<0.2	0.8	1.3	4.3	<1.0					0.11		1.1	<0.30	19.0	-129	32.7	6.52	0.00	0.00	0.00	0.01	0.05	0.14	0.01	0.19	0.00	0.00	0.00	0.06	0.94
BDC-05-12	4/20/2016		1707		<0.2	<0.2	<0.2	0.4	<1.0	4.3	<1.0	0.016	0.017	<0.002	<0.002	0.10		1.1	<0.30	16.0	-44	14.3	6.45	0.00	0.00	0.00	0.01	0.00	0.14	0.01	0.14	0.00	0.00	0.00	0.04	0.96
BDC-05-12	8/9/2016		1818		<0.2	<0.2	<0.2	0.4	<1.0	2.7	<1.0	0.004	0.008	<0.002	<0.002	0.35		2.5	<0.30	13.0	-106.8	9.4	6.11	0.00	0.00	0.00	0.01	0.00	0.09	0.01	0.09	0.00	0.00	0.00	0.07	0.93
BDC-05-12	11/3/2016		1904		<0.2	<0.2	<0.2	<0.2	<1.0	2.8	<1.0	0.016	0.014	<0.002	<0.002	0.13		3.0	<0.30	12.0	-129.0	10.6	6.44	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.09	0.00	0.00	0.00	0.00	1.00
BDC-05-12	2/8/2017		2001		<0.2	<0.2	<0.2	0.4	<1.0	1.9	<1.0	0.006	0.007	<0.002	<0.002	0.28		2.4	<0.30	12.0	-25.1	8.6	6.52	0.00	0.00	0.00	0.01	0.00	0.06	0.01	0.06	0.00	0.00	0.00	0.09	0.91
BDC-05-12	5/4/2017		2086		<0.2	<0.2	<0.2	0.3	<1.0	2.4	<1.0	0.010	0.009	<0.002	<0.002	0.22		2.2	<0.30	11.0	-94.4	8.1	6.33	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.08	0.00	0.00	0.00	0.06	0.94
BDC-05-12	8/1/2017		2175		<0.2	<0.2	<0.2	<0.2	<1.0	8.0	<1.0	0.011	0.009	<0.002	<0.002	0.08		2.3	<0.30	9.5	-85.0	7.6	6.08	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.27	0.00	0.00	0.00	0.00	1.00
BDC-05-12	11/6/2017		2272	-4	<0.2	<0.2	<0.2	0.2	<1.0	1.6	<1.0	0.005	0.005	<0.002	<0.002	0.66		3.0	<0.30	12.0	-18.5	7.0	6.41	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.05	0.00	0.00	0.00	0.06	0.94
BDC-05-12	5/2/2018		2449	173	<0.2	<0.2	<0.2	0.46	<1.14	<1.23	<1.06	0.006	0.008	<0.0005	<0.0005	0.20		4.6	0.104	14.2	-12.5	19.4	6.29	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	1.00	0.00
BDC-05-12	11/6/2018		2637	361	<0.2	<0.2	<0.2	<0.2	<1.14	<1.23	<1.06	0.006	0.007	<0.0005	<0.0005	0.56		3.8	<0.100	24.5	-64.4	23.33	6.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA	NA	NA	NA	NA
BDC-05-13	7/31/2011		-18		5.2	6.6	2.6	<1.0	<1.1	<1.2	<1.1	0.003	0.002	0.002	<0.002	1.73	<0.1	2.0	2.3	5.0	-1	6.0	7.06	0.03	0.05	0.03	0.00	0.00	0.00	0.11	0.00	0.29	0.46	0.25	0.00	0.00
(IW 2011)	11/1/2011		75		<1.0	1.2	39	<1.0	<1.1	<1.2	<1.1	0.068	0.064	0.017	0.003	1.82	<1.0	1.5	<1.0	2.2	-70	550	6.65	0.00	0.01	0.40	0.00	0.00	0.00	0.41	0.00	0.00	0.02	0.98	0.00	0.00
	5/6/2012		262		<0.2	<0.2	13	3.9	1.7	<1.0	<1.0	0.051	0.046	0.003	<0.002	0.03		3.0	0.4	19.0	78	34.2	6.40	0.00	0.00	0.13	0.06	0.06	0.00	0.20	0.06	0.00	0.00	0.52	0.24	0.24
BDC-05-13	11/15/2012		455		<1.0	<1.0	<1.0	2.3	3.7	<1.0	<1.0	0.060	0.055	<0.002	<0.002	0.04		2.2	<0.3	22.0	-9	30.2	6.75	0.00	0.00	0.00	0.04	0.13	0.00	0.04	0.13	0.00	0.00	0.00	0.22	0.78
BDC-05-13	5/22/2013		643		<0.2	<0.2	0.3	1.2	3.8	3.9	<1.0	0.019	0.019	<0.002	<0.002	0.29		1.8	0.43	23.0	-296	21.4	7.76	0.00	0.00	0.00	0.02	0.14	0.13	0.02	0.27	0.00	0.00	0.01	0.07	0.92
BDC-05-13	11/13/2013		818		<0.2	<0.2	0.3	2.1	3.6	6.4	<1.0	0.031	0.027	<0.002	<0.002	3.20		1.6	0.31	19.0	-241	24.7	6.59	0.00	0.00	0.00	0.03	0.13	0.21	0.04	0.34	0.00	0.00	0.01	0.09	0.90
BDC-05-13	5/12/2014		998		<0.2	<0.2	<0.2	2.6	4.3	6.8	<1.0	0.032	0.032	<0.002	<0.002	4.73		2.4	<0.30	19.0	-238	23.4	6.69	0.00	0.00	0.00	0.04	0.15	0.23	0.04	0.38	0.00	0.00	0.00	0.10	0.90
BDC-05-13	11/10/2014		1180		<0.2	<0.2	0.2	2.5	2.1	2.2	<1.0	0.020	0.019	<0.002	<0.002	0.02		1.0	0.33	7.1	-123	15.1	6.41	0.00	0.00	0.00	0.04	0.07	0.07	0.04	0.15	0.00	0.00	0.01	0.21	0.78
BDC-05-13	4/27/2015		1348		<0.2	<0.2	<0.2	1.9	2.5	1.6	<1.0	0.019	0.018	<0.002	<0.002	0.09		0.8	<0.30	12.0	-102	8.9	6.45	0.00	0.00	0.00	0.03	0.09	0.05	0.03	0.14	0.00	0.00	0.00	0.18	0.82
BDC-05-13	10/28/2015		1532		<0.2	<0.2	<0.2	1.1	<1.0	1.0	<1.0	0.020	0.019	<0.002	<0.002	0.20		1.2	<0.30	6.1	-32	10.8	6.54	0.00	0.00	0.00	0.02	0.00	0.03	0.02	0.03	0.00	0.00	0.00	0.35	0.65
BDC-05-13	4/20/2016		1707		<0.2	<0.2	<0.2	2.0	1.9	2.0	<1.0	0.026	0.024	<0.002	<0.002	0.10		1.0	<0.30	10.0	-36	7.6	6.60	0.00	0.00	0.00	0.03	0.07	0.07	0.03	0.13	0.00	0.00	0.00	0.19	0.81
BDC-05-13	11/3/2016		1904		<0.2	<0.2	<0.2	1.0	<1.0	2.3	<1.0	0.023	0.020	<0.002	<0.002	0.08		1.0	<0.30	15.0	-140.9	12.2	6.32	0.00	0.00	0.00	0.02	0.00	0.08	0.02	0.08	0.00	0.00	0.00	0.17	0.83
BDC-05-13	5/4/2017		2086		<0.2	<0.2	<0.2	1.1	1.4	12	<1.0	0.027	0.027	<0.002	<0.002	0.17		2.4	<0.30	14.0	-123.1	11.6	6.42	0.00	0.00	0.00	0.02	0.05	0.40	0.02	0.45	0.00	0.00	0.00	0.04	0.96
BDC-05-13	11/6/2017		2272	-4	<0.2	<0.2	<0.2	1.1	<1.0	7.0	<1.0	0.030	0.030	<0.002	<0.002	0.36		1.8	<0.30	14.0	-28.5	18.5	6.53	0.00	0.00	0.00	0.02	0.00	0.23	0.02	0.23	0.00	0.00	0.00	0.07	0.93
BDC-05-13	5/2/2018		2449	173	<0.2	<0.2	<0.2	0.6	<1.14	<1.23	<1.06	0.029	0.026	0.0005	<0.0005	0.98		1.6	0.112	16.0	-80.4	21.5	6.43	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	1.00	0.00
BDC-05-13	11/6/2018		2637	361	<0.2	<0.2	<0.2	0.62	<1.14	3.82	<1.06	0.034	0.032	<0.0005	<0.0005	0.26		2.4	<0.100	14.7	-108.6	20.12	6.52	0.00	0.00	0.00	0.01	0.00	0.13	0.01	0.13	0.00	0.00	0.00	0.07	0.93
BDC-05-14	7/31/2011		-18		2.8	6.8	2.8	<1.0	<1.1	<1.2	<1.1	0.004	0.004	0.004	<0.002	1.76	<0.1	2.0	10.1	6.5	-15	8.6	7.00	0.02	0.05	0.03	0.00	0.00	0.00	0.10	0.00	0.17	0.53	0.30	0.00	0.00
(IW 2011)	11/1/2011		75		2.5	6.7	13	<1.0	<1.1	<1.2	<1.1	0.083	0.074	0.022	0.002	1.87	<1.0	2.3	<1.0	4.0	-124	725	6.13	0.02	0.05	0.13	0.00	0.00	0.00	0.20	0.00	0.08	0.25	0.67	0.00	0.00
	5/6/2012		262		<0.2	0.4	3.0	1.1	<1.0	<1.0	<1.0	0.012	0.009	<0.002	<0.002	0.08		1.7	0.6	23.0	99	41.5	6.33	0.00	0.00	0.03	0.02	0.00	0.00	0.05	0.00	0.00	0.06	0.60	0.34	0.00
BDC-05-14	11/15/2012		455		<0.2	<0.2	1.1	2.0	1.4	<1.0	<1.0	0.022	0.019	<0.002	<0.002	0.11		2.2	<0.3	24.0	-1.4	39.9	6.66	0.00	0.00	0.01	0.03	0.05	0.00	0.04	0.05	0.00	0.00	0.12	0.34	0.54
BDC-05-14	5/22/2013		643		<0.2	<0.2	0.2	1.3	1.3	<3.0	<1.0	0.012	0.012	<0.002	<0.002	0.40		1.8	<0.3	26.0	-311	26.3	7.69	0.00	0.00	0.00	0.02	0.05	0.00	0.02	0.05	0.00	0.00	0.03	0.30	0.67
BDC-05-14	11/13/2013		818		<0.2	<0.2	0.2	1.2	1.3	2.5	<1.0	0.017	0.015	<0.002	<0.002	3.80		1.5	<0.30	24.0	-219	29.5	6.44	0.00	0.00	0.00	0.02	0.05	0.08	0.02	0.13	0.00	0.00	0.01	0.13	0.86
BDC-05-14	5/12/2014		998		<0.2	<0.2	0.2	1.5	2.2	5.0	<1.0	0.018	0.021	<0.002	<0.002	5.21		2.0	<0.30	22.0	-233	30.2	6.55	0.00	0.00	0.00	0.02	0.08	0.17	0.03	0.24	0.00	0.00	0.01	0.09	0.90
BDC-05-14	11/10/2014		1180		<0.2	<0.2	0.4	5.1	4.3	6.4	<1.0	0.017	0.017	<0.002	<0.002	0.15		1.2	2.3	19.0	-97	21.3	6.35	0.00	0.00	0.00	0.08	0.15	0.21	0.09	0.37	0.00	0.00	0.01	0.18	0.81
BDC-05-14	4/27/2015		1348		<0.2	<0.2	0.4	1.6	<1.0	1.1	<1.0	0.018	0.015	<0.002	<0.002	0.11		1.4	1.8	11.0	-88	18.9	6.25	0.00	0.00	0.00	0.03	0.00	0.04	0.03	0.04	0.00	0.00	0.06	0.39	0.55
BDC-05-14	10/28/2015		1532		<0.2	<0.2	0.3	1.4	1.1	2.4	<1.0	0.015	0.013	<0.002	<0.002	0.11		1.0	0.46	12.0	-28	21.0	6.47	0.00	0.00	0.00	0.02	0.04	0.08	0.03	0.12	0.00	0.00	0.02	0.15	0.82
BDC-05-14	4/20/2016		1707		<0.2	<0.2	0.3	0.9	<1.0	1.7	<1.0	0.016	0.016	<0.002	<0.002	0.11		2.0	3.1	11.0	-42	22.3	6.71	0.00	0.00	0.00	0.01	0.00	0.06	0.02	0.06	0.00	0.00	0.04	0.19	0.76
BDC-05-14	11/3/2016		1904		<0.2	<0.2	<0.2	<0.2	<1.0	<1.0	<1.0	0.007	0.007	<0.002	<0.002	0.32		2.6	<0.30	17.0	-111	16.0	6.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BDC-05-14	5/4/2017		2086		<0.2	<0.2	0.3	1	<2.0	8.9	<1.0	0.023	0.021	<0.002	<0.002	0.17		2.2	3.8	12.0	-125.1	21.8	6.45	0.00	0.00	0.00	0.02	0.00	0.30	0.02	0.30	0.00	0.00	0.01	0.05	0.94
BDC-05-14	11/6/2017		2272	-4	<0.2	<0.2	<0.2	0.7	<1.0	3.6	<1.0	0.020	0.020	<0.002	<0.002	0.31		2.8	3.8	14.0	-27.6	19.2	6.48	0.00	0.00	0.00	0.01	0.00	0.12	0.01	0.12	0.00	0.00	0.00	0.09	0.91
BDC-05-14	5/2/2018		2449	173	<0.2	<0.2	<0.2	0.33	<1.14	<1.23	<1.06	0.025	0.025	<0.0005	<0.0005	0.92		2.8	10.4	10.1	-98.5	20.6	6.46	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	1.00	0.00
BDC-05-14	11/6/2018		2637	361	<0.2	<0.2	<0.2	0.42	<1.14	<1.23	<1.06	0.029	0.031	<0.0005	<0.0005	0.34		4.0	9.23	23.8	-94.3	22.28	6.48	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	1.00	0.00
BDC-05-15	7/31/2011		-18		9.6	28	58	<1.0	<1.1	<1.2	<1.1	0.019	0.019	<0.002	<0.002	1.91	<0.1	1.3	18.6	0.8	-0.9	10.3	7.00	0.06	0.21	0.60	0.00	0.00	0.00	0.87	0.00	0.07	0.25	0.69	0.00	0.00
(IW 2011)	11/1/2011		75		4.8	9.8	15	<1.0	<1.1	<1.2	<1.1	0.061	0.058	0.010	0.009	2.38	<0.1	3.0	11.3	3.5	-0.1	4420	5.67	0.03	0.07	0.15	0.00	0.00	0.00	0.26	0.00	0.11	0.29	0.60	0.00	0.00
	5/6/2012		262		<2.0	<2.0	49	6.3	<1.0	<1.0	<1.0	0.057	0.047	0.009	0.004	0.07		1.8	<0.3	21.0	93	423	6.36	0.00	0.00	0.51	0.10	0.00	0.00	0.61	0.00	0.00	0.00	0.83	0.17	0.00
BDC-05-15	11/15/2012		455		<1.0	<1.0	1.5	7.5	1.8	<1.0	<1.0	0.054	0.049	<0.002	<0.002	0.02		0.8	<0.3	27.0	8	71.2	6.61	0.00	0.00	0.02	0.12	0.06	0.00	0.14	0.06	0.00	0.00	0.08	0.60	0.32
BDC-05-15	5/22/2013		643		<0.2	<0.2	0.3	16	11	<3.0	<1.0	0.065	0.061	<0.002	<0.002	0.22		1.0	0.3	25.0	-317	42.9	7.82	0.00	0.00	0.00	0.26	0.39	0.00	0.26	0.39	0.00	0.00	0.00	0.39	0.60
BDC-05-15	11/13/2013		818		<0.2	<0.2	0.2	4.9	7.2	2.5	<1.0	0.066	0.059	<0.002	<0.002	2.11		2.6	<0.30	23.0	-265	45.5	6.60	0.00	0.00	0.00	0.08	0.26	0.08	0.08	0.34	0.00	0.00	0.00	0.19	0.81
BDC-05-15	5/13/2014		999		<0.2	<0.2	<0.2	8.6	9.4	<1.0	<1.0	0.065	0.061	<0.002	<0.002	2.92		1.7	<0.30	26.0	-230	37.5	6.69	0.00	0.00	0.00	0.14	0.34	0.00	0.14	0.34	0.00	0.00	0.00	0.29	0.71
BDC-05-15	11/10/2014		1180		<0.2	<0.2	<0.2	1.3	4.6	8.6	<1.0	0.072	0.066	<0.002	<0.002	0.33		1.4	<0.30	25.0	-126	37.5	6.37	0.00	0.00	0.00	0.02	0.16	0.29	0.02	0.45	0.00	0.00	0.00	0.04	0.96
BDC-05-15	4/27/2015		1348		<0.2	<0.2	<0.2	1.9	3.2	5.1	<1.0	0.056	0.052	<0.002	<0.002	0.06		0.8	<0.30	18.0	-115	25.6	6.37	0.00	0.00	0.00	0.03	0.11	0.17	0.03	0.28	0.00	0.00	0.00	0.10	0.90
BDC-05-15	10/28/2015		1532		<0.2	<0.2	<0.2	0.7	1.2	6.0	<1.0	0.053	0.041	<0.002	<0.002	0.16		1.2	<0.30	17.0	-41	22.2	6.64	0.00	0.00	0.00	0.01	0.04	0.20	0.01	0.24	0.00	0.00	0.00	0.04	0.96
BDC-05-15	4/20/2016		1707		<0.2	<0.2	<0.2	1.1	<1.0	12	<1.0	0.057	0.051	<0.002	<0.002	0.13		0.6	<0.30	18.0	-67	27.6	6.78	0.00	0.00	0.00	0.02	0.00	0.40	0.02	0.40	0.00	0.00	0.00	0.04	0.96

Table 5
SWMU-17 Groundwater Data Cleanup Action Summary
Boeing Developmental Center
Tukwila, Washington

		Pilot Injection	Full Injection #1	Full Injection #2	Volatile Organic Compounds							Metals				Aquifer Redox Conditions						Donor Indicators		VOCs- micromoles/Liter (b)								Molar Fraction (c)				
		Elapsed Time From Injection (days)	Elapsed Time From Injection (days)	Elapsed Time From Injection (days)	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	As, Tot (mg/L)	As, Dis (mg/L)	Cu, Tot (mg/L)	Cu, Dis (mg/L)	DO (mg/L)	Nitrate (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (mg/L)	ORP (mV)	TOC (mg/L)	pH													
Proposed Groundwater Cleanup Levels (a)					5.3	1.4	134	2.4	NA	NA	NA	0.008	0.008	0.008	0.008																					
Well	Date																							PCE	TCE	c DCE	VC	Ethene	Ethane	Total Chloroethenes (d)	Ethene + Ethane	PCE	TCE	c DCE	VC	Ethene + Ethane
BDC-05-15	11/3/2016		1904		<0.2	<0.2	<0.2	<0.2	<1.0	9.4	<1.0	0.047	0.044	<0.002	0.002	0.31		1.0	<0.30	15.0	-135.7	22.5	6.44	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.31	0.00	0.00	0.00	0.00	1.00
BDC-05-15	5/4/2017		2086		<0.2	<0.2	<0.2	0.7	<1.0	17	<1.0	0.048	0.049	<0.002	0.002	0.19		1.8	0.41	10.0	-141.5	23.9	6.57	0.00	0.00	0.00	0.01	0.00	0.57	0.01	0.57	0.00	0.00	0.00	0.02	0.98
BDC-05-15	11/7/2017		2273	-3	<0.2	<0.2	<0.2	0.3	<1.0	11	<1.0	0.053	0.053	<0.002	<0.002	0.16		1.8	<0.30	8.7	-29.1	25.1	6.69	0.00	0.00	0.00	0.00	0.00	0.37	0.00	0.37	0.00	0.00	0.00	0.01	0.99
BDC-05-15	5/2/2018		2449	173	<0.2	<0.2	<0.2	0.2	<1.14	<1.23	<1.06	0.044	0.044	0.0004	<0.0005	0.88		1.8	0.108	11.3	-131.3	19.6	6.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
BDC-05-15	11/7/2018		2638	362	<0.2	<0.2	<0.2	0.22	<1.14	<1.23	<1.06	0.042	0.043	<0.001	<0.0005	0.31		2.0	<0.100	19.3	-51.8	15.31	6.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
BDC-05-16	7/31/2011		-18		9.5	17	20	<1.0	<1.1	<1.2	<1.1	0.006	0.006	0.002	<0.002	1.91	<0.1	1.5	8.9	3.1	-8	7.8	7.06	0.06	0.13	0.21	0.00	0.00	0.00	0.39	0.00	0.15	0.33	0.52	0.00	0.00
(IW 2011)	11/1/2011		75		2.6	2.8	37	<1.0	<1.1	<1.2	<1.1	0.079	0.074	0.005	0.002	2.30	<1.0	2.5	2.8	3.1	7	2250	5.51	0.02	0.02	0.38	0.00	0.00	0.00	0.42	0.00	0.04	0.05	0.91	0.00	0.00
	2/19/2012		185		<2.0	<2.0	46	7.4	<1.0	<1.0	<1.0					1.59	<0.5	2.2	<1.5	18.0	128	1270	5.12	0.00	0.00	0.47	0.12	0.00	0.00	0.59	0.00	0.00	0.00	0.80	0.20	0.00
BDC-05-16	5/6/2012		262		<0.2	0.3	6.7	24	2.5	<1.0	<1.0	0.042	0.039	0.003	<0.002	0.06		2.5	<0.3	25.0	121	207	6.28	0.00	0.00	0.07	0.38	0.09	0.00	0.46	0.09	0.00	0.00	0.13	0.71	0.16
BDC-05-16	9/5/2012		384		<0.4	<0.4	0.9	8.1	6.0	<1.0	<1.0					0.12		2.0	<0.3	22.0	64	40.6	6.67	0.00	0.00	0.01	0.13	0.21	0.00	0.14	0.21	0.00	0.00	0.03	0.37	0.61
BDC-05-16	11/15/2012		455		<1.0	<1.0	<1.0	4.9	4.0	<1.0	<1.0	0.041	0.037	<0.002	<0.002	0.02		1.0	<0.3	28.0	7	32.3	6.68	0.00	0.00	0.00	0.08	0.14	0.00	0.08	0.14	0.00	0.00	0.00	0.35	0.65
BDC-05-16	2/25/2013		557		<1.0	<1.0	<1.0	13	4.7	2.7	<1.0					0.41		2.0	<0.30	28.0	68	34.6	6.77	0.00	0.00	0.00	0.21	0.17	0.09	0.21	0.26	0.00	0.00	0.00	0.45	0.55
BDC-05-16	5/22/2013		643		<0.2	<0.2	0.2	7.7	3.9	<3.0	<1.0	0.043	0.048	<0.002	<0.002	0.19		1.0	0.38	26.0	-291	33.1	7.70	0.00	0.00	0.00	0.12	0.14	0.00	0.13	0.14	0.00	0.00	0.01	0.47	0.53
BDC-05-16	8/28/2013		741		<1.0	<1.0	<1.0	4.0	4.2	<3.0	<1.0					1.77		1.4	<0.30	26.0	-316	31.6	6.57	0.00	0.00	0.00	0.06	0.15	0.00	0.06	0.15	0.00	0.00	0.00	0.30	0.70
BDC-05-16	11/13/2013		818		<1.0	<1.0	<1.0	4.3	3.2	<1.0	<1.0	0.048	0.046	<0.002	<0.002	2.04		2.2	<0.30	24.0	-263	36.0	6.64	0.00	0.00	0.00	0.07	0.11	0.00	0.07	0.11	0.00	0.00	0.00	0.38	0.62
BDC-05-16	2/11/2014		908		<1.0	<1.0	<1.0	2.1	2.0	<7.0	<1.0					4.05		2.0	<0.30	25.0	-236	28.9	6.67	0.00	0.00	0.00	0.03	0.07	0.00	0.03	0.07	0.00	0.00	0.00	0.32	0.68
BDC-05-16	5/12/2014		998		<1.0	1.3	<1.0	4.9	4.9	<1.0	<1.0	0.044	0.041	<0.002	<0.002	3.67		1.3	<0.30	28.0	-229	28.7	6.67	0.00	0.01	0.00	0.08	0.17	0.00	0.09	0.17	0.00	0.04	0.00	0.30	0.66
BDC-05-16	8/6/2014		1084		<1.0	<1.0	<1.0	2.4	1.9	<1.0	<1.0					5.07		1.4	<0.30	23.0	-176	27.8	7.27	0.00	0.00	0.00	0.04	0.07	0.00	0.04	0.07	0.00	0.00	0.00	0.36	0.64
BDC-05-16	11/11/2014		1181		<1.0	<1.0	<1.0	4.6	3.9	5.4	<1.0	0.056	0.055	<0.002	<0.002	0.08		1.2	0.82	26.0	-104	38.7	6.24	0.00	0.00	0.00	0.07	0.14	0.18	0.07	0.32	0.00	0.00	0.00	0.19	0.81
BDC-05-16	1/21/2015		1252		<0.2	<0.2	<0.2	2.9	5.7	6.1	<1.0					0.18		1.3	0.70	21.0	-135	33.6	6.31	0.00	0.00	0.00	0.05	0.20	0.20	0.05	0.41	0.00	0.00	0.00	0.10	0.90
BDC-05-16	4/26/2015		1347		<0.2	<0.2	<0.2	2.3	2.4	5.7	<1.0	0.048	0.046	0.002	<0.002	0.11		1.4	<0.30	22.0	-118	23.8	6.40	0.00	0.00	0.00	0.04	0.09	0.19	0.04	0.28	0.00	0.00	0.00	0.12	0.88
BDC-05-16	7/21/2015		1433		<0.2	<0.2	<0.2	1.7	1.4	6.3	<1.0					0.26		2.0	<0.30	22.0	-67	28.9	6.30	0.00	0.00	0.00	0.03	0.05	0.21	0.03	0.26	0.00	0.00	0.00	0.09	0.91
BDC-05-16	10/27/2015		1531		<0.2	<0.2	<0.2	2.8	1.0	5.5	<1.0	0.047	0.044	<0.002	<0.002	0.06		1.2	<0.30	19.0	-45	28.9	6.41	0.00	0.00	0.00	0.04	0.04	0.18	0.04	0.22	0.00	0.00	0.00	0.17	0.83
BDC-05-16	1/26/2016		1622		<0.2	<0.2	<0.2	1.7	<1.0	8	<1.0					0.41			<0.30	21.0	-126	23.7	6.51	0.00	0.00	0.00	0.03	0.00	0.27	0.03	0.27	0.00	0.00	0.00	0.09	0.91
BDC-05-16	4/20/2016		1707		<0.2	<0.2	<0.2	1.3	1.4	9.0	<1.0	0.042	0.039	0.006	<0.002	0.51		1.0	<0.30	17.0	-33	17.7	6.78	0.00	0.00	0.00	0.02	0.05	0.30	0.02	0.35	0.00	0.00	0.00	0.06	0.94
BDC-05-16	8/9/2016		1818		<0.2	<0.2	<0.2	0.9	1.0	12	<1.0	0.033	0.033	<0.002	<0.002	-0.02		1.6	<0.30	15.0	-75.1	16.9	6.57	0.00	0.00	0.00	0.01	0.04	0.40	0.01	0.43	0.00	0.00	0.00	0.03	0.97
BDC-05-16	11/3/2016		1904		<0.2	<0.2	<0.2	0.6	<1.0	6.9	<1.0	0.022	0.021	<0.002	<0.002	0.32		1.6	<0.30	13.0	-90.8	13.0	6.13	0.00	0.00	0.00	0.01	0.00	0.23	0.01	0.23	0.00	0.00	0.00	0.04	0.96
BDC-05-16	2/8/2017		2001		<0.2	<0.2	<0.2	0.8	<1.0	6.7	<1.0	0.033	0.032	<0.002	<0.002	0.29		2.4	<0.30	10.0	-51.1	17.7	6.62	0.00	0.00	0.00	0.01	0.00	0.22	0.01	0.22	0.00	0.00	0.00	0.05	0.95
BDC-05-16	5/4/2017		2086		<0.2	<0.2	<0.2	1.3	1.6	12	<1.0	0.029	0.027	<0.002	<0.002	0.15		2.0	<0.30	9.1	-95.8	17.0	6.34	0.00	0.00	0.00	0.02	0.06	0.40	0.02	0.46	0.00	0.00	0.00	0.04	0.96
BDC-05-16	8/1/2017		2175		<0.2	<0.2	<0.2	0.5	<1.0	9.9	<1.0	0.031	0.029	0.003	<0.002	0.05		2.0	<0.30	7.4	-104	12.7	6.12	0.00	0.00	0.00	0.01	0.00	0.33	0.01	0.33	0.00	0.00	0.00	0.02	0.98
BDC-05-16	11/7/2017		2273	-3	<0.2	<0.2	<0.2	0.7	<1.0	4.0	<1.0	0.021	0.020	<0.002	<0.002	0.41		2.8	<0.30	9.5	-5.0	11.6	6.48	0.00	0.00	0.00	0.01	0.00	0.13	0.01	0.13	0.00	0.00	0.00	0.08	0.92
BDC-05-16	5/2/2018		2449	173	<0.2	<0.2	<0.2	0.44	<1.14	<1.23	<1.06	0.027	0.026	<0.0005	<0.0005	0.10		3.2	<0.1	12.2	-4.4	13.1	6.45	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	1.00	0.00
BDC-05-16	11/6/2018		2637	361	<0.2	<0.2	<0.2	0.54	<1.14	<1.23	<1.06	0.022	0.022	<0.0005	<0.0005	0.45		3.5	<0.100	16.7	-93.6	14.17	6.47	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	1.00	0.00
BDC-05-17	7/31/2011		-18		11	22	34	<1.0	<1.1	<1.2	<1.1	0.004	0.004	0.003	0.002	2.03	0.6	1.5	16.0	0.30	59	10.2	6.95	0.07	0.17	0.35	0.00	0.00	0.00	0.58	0.00	0.11	0.29	0.60	0.00	0.00
(IW 2011)	11/1/2011		75		3.2	4.8	5.1	<1.0	<1.1	<1.2	<1.1	0.053	0.047	0.005	<0.002	2.61	<1.0	2.4	23.9	2.8	-50	3500	5.74	0.02	0.04	0.05	0.00	0.00	0.00	0.11	0.00	0.18	0.34	0.49	0.00	0.00
	5/6/2012		262		<2.0	<2.0	9.3	5.6	<1.0	<1.0	<1.0	0.058	0.026	0.003	<0.002	0.24		2.0	0.7	15.0	182	839	6.08	0.00	0.00	0.10	0.09	0.00	0.00	0.19	0.00	0.00	0.00	0.52	0.48	0.00
BDC-05-17	11/15/2012		455		<5.0	<5.0	<5.0	5.4	2.0	<1.0	<1.0	0.081	0.062	<0.002	<0.002	0.02		1.0	<0.3	23.0	13	73.5	6.62	0.00	0.00	0.00	0.09	0.07	0.00	0.09	0.07	0.00	0.00	0.00	0.55	0.45
BDC-05-17	5/23/2013		644		<0.2	<0.2	0.7	5.1	4.3	<3.0	<1.0	0.142	0.062	<0.002	<0.002	0.44		1.2	<0.3	26.0	-259	45.8	7.54	0.00	0.00	0.01	0.08	0.15	0.00	0.09	0.15	0.00	0.00	0.03	0.34	0.63
BDC-05-17	11/13/2013		818		<0.2	<0.2	0.5	4.0	3.0	2.2	<1.0	0.057	0.037	<0.002	<0.002	2.21		2.0	<0.30	26.0	-266	49.8	6.57	0.00	0.00	0.01	0.06	0.11	0.07	0.07	0.18	0.00	0.00	0.02	0.26	0.72
BDC-05-17	5/12/2014		998		<0.2	<0.2	0.4	3.2	2.5	6.0	<1.0	0.038	0.033	<0.002	<0.002	4.60		1.8	<0.30	25.0	-368	44.1	6.64	0.00	0.00	0.00	0.05	0.09	0.20	0.06	0.29	0.00	0.00	0.01	0.15	0.84
BDC-05-17	11/11/2014		1181		<0.2	<0.2	0.3	2.7	3.9	5.9	<1.0	0.038	0.036	<0.002	<0.002	0.06		2.0	0.74	26.0	-123	52.0	6.35	0.00	0.00	0.00	0.04	0.14	0.20	0.05	0.34	0.00	0.00	0.01	0.11	0.88
BDC-05-17	4/26/2015		1347		<0.2	<0.2	0.2	1.5	2.7	3.0	<1.0	0.039	0.032	0.004	<0.002	0.25		1.4	<0.30	21.0	-127	29.0	6.44	0.00	0.00	0.00	0.02	0.10	0.10	0.03	0.20	0.00	0.00	0.01	0.11	0.88
BDC-05-17	10/27/2015		1531		<0.2	<0.2	0.2	1.6	1.0	4.5	<1.0	0.037	0.036	<0.002	<0.002	0.12		1.5	<0.30	21.0	-47	32.0	6.38	0.00	0.00	0.00	0.03	0.04	0.15	0.03	0.19	0.00	0.00	0.01	0.12	0.87
BDC-05-17	4/20/2016		1707		<0.2	<0.2	<0.2	1	1.1	6.6	<1.0	0.042	0.036	0.003	<0.002	0.44		0.8	<0.30	19.0	-77	29.0	6.84	0.00	0.00	0.00	0.02	0.04	0.22	0.02	0.26	0.00	0.00	0.00	0.06	0.94
BDC-05-17	11/3/2016		1904		<0.2	<0.2	<0.2	0.9	<1.0	7.6	<1.0	0.041	0.035	<0.002	<0.002	0.45		1.0	<0.30	19.0	-118.8	19.9	6.23	0.00	0.00	0.00	0.01	0.00	0.25	0.01	0.25	0.00	0.00	0.00	0.05	0.95
BDC-05-17	5/4/2017		2086		<0.2	<0.2	<0.2	0.9	<2.0	13	<1.0	0.044	0.037	<0.002	<0.002	0.14		1.0	<0.30	11.0	-110.4	19.2	6.29	0.00	0.00	0.00	0.01	0.00	0.43	0.01	0.43	0.00	0.00	0.00	0.03	0.97
BDC-05-17	11/7/2017		2273	-3	<0.2	<0.2	<0.2	0.8	<1.0	7.6	<1.0	0.033	0.033	<0.002	<0.002	0.47		1.8	<0.30	11.0	-2.7	15.8	6.52	0.00	0.00	0.00	0.01	0.00	0.25	0.01	0.25	0.00	0.00	0.00	0.05	0.95
BDC-05-17	5/2/2018		2449	173	<0.2	<0.2	<0.2	0.59	<1.14	<1.23	<1.06	0.032	0.032	<0.0005	<0.0005	0.13		2.8	<0.1	10.0	4.7	14.9	6.48	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	1.00	0.00
BDC-05-17	11/6/2018		2637	361	<0.2	<0.2	<0.2	0.64	<1.14	2.09	<1.06	0.029	0.030	<0.0005	<0.0005	0.33		3.2	<0.100	13.6	-94.4	11.21	6.51	0.00	0.00	0.00	0.01	0.00	0.07	0.01	0.07	0.00	0.00	0.00	0.13	0.87
BDC-05-18	7/31/2011		-18		3.6	5.0	6.6	<1.0	<1.1	<1.2	<1.1	0.019	0.020	<0.002	<0.002	1.57	<0.1	2.4	4.5	3.9	-19	3.2	7.13	0.02	0.04	0.07	0.00	0.00	0.00	0.13	0.00	0.17	0.30	0.53	0.00	0.00
(MW 12 ft XG)	11/1/2011		75		2.8	4.0	7.6	<1.0	<1.1	<1.2	<1.1	0.019	0.020	0.003	0.003	1.37	<0.1	1.2	1.2	4.3	-106	21.7	6.88	0.02	0.03	0.08	0.00	0.00	0.00	0.13	0.00	0.13	0.24	0.62	0.00	0.00
	2/19/2012		185		1.8	3.7	12	<0.2	<1.0	<1.0	<1.0					0.19	<0.5	2.2	<1.5	11.0	9	2.7	6.66	0.01	0.03	0.12	0.00	0.00	0.00	0.16	0.00	0.07	0.17	0.76	0.00	0.00
BDC-05-18	5/6/2012		262		2.0	4.0	9.6	<0.2	<1.0	<1.0	<1.0	0.013	0.013	<0.002	<0.002	0.21		2.5	2.1	7.5	132	2.5	6.39	0.01	0.03	0.10	0.00	0.00	0.00	0.14	0.00	0.09	0.22	0.70	0.00	0.00
BDC-05-18	9/5/2012		384		1.5	3.1	11	0.2	<1.0	<1.0	<1.0					0.13		1.5	2.0	7.9	58	1.8	6.91	0.01	0.02	0.11	0.00	0.00	0.00	0.15	0.00	0.06	0.16	0.76	0.02	0.00
BDC-05-18	11/15/2012		455		1.0	4.3	16	<0.5	<1.0	<1.0	<1.0	0.015	0.014	<0.002	<0.002	0.48		1.4	2.4	8.3	25	1.7	6.62	0.01	0.03	0.17	0.00	0.00	0.00	0.20	0.00	0.03	0.16	0.81	0.00	0.00
BDC-05-18	2/25/2013		557		2.0	4.6	5.7	<0.2	<1.0	<1.0	<1.0					0.25		2.0	9.2	1.3	72	2.0	6.53	0.01	0.04	0.06	0.00	0.00	0.00	0.11	0.00	0.11	0.33	0.56	0.00	0.00
BDC-05-18	5/23/2013		644		3.1	5.2	4.1	<0.2	<1.0	<1.0	<1.0	0.014	0.014	<0.002	<0.002	0.30		1.5	7.0	1.0	-262	1.3	7.24	0.02	0.04	0.04	0.00	0.00	0.00	0.10	0.00	0.19	0.39	0.42	0.00	0.00
BDC-05-18	8/28/2013		741		2.2	3.7	7.4	<0.2	<1.0	<1.0	<1.0					0.76		1.6	4.1	1.5	-309	2.2	6.25	0.01	0.03	0.08	0.00	0.00	0.00	0.12	0.00	0.11	0.24	0.65	0.00	0.00
BDC-05-18	11/14/2013		819		1.2	1.8	1.4	0.2	<1.0	<1.0	<1.0	0.006	0.002	<0.002	<0.002	2.53		1.0	4.7	0.68	-164	<1.0	7.03	0.01	0.01	0.01	0.00	0.00	0.00	0.04	0.00	0.19	0.36	0.37	0.08	0.00
BDC-05-18	2/11/2014		908		1.7	2.1	5.4	0.3	<1.0	<1.0	<1.0					2.53		1.2	3.2	3.70	-224	1.4	6.68	0.01	0.02	0.06	0.00	0.00	0.00	0.09	0.00	0.12	0.18	0.64	0.06	0.00
BDC-05-18	5/13/2014		999		2.0	2.4	4.4	0.3	<1.0	<1.0	<1.0	0.001	0.002	<0.002	<0.002	3.54		1.5	6.7	3.2	-208	2.6	6.44	0.01	0.02	0.05	0.00	0.00	0.00	0.08	0.00	0.15	0.23	0.56	0.06	0.00
BDC-05-18	8/6/2014		1084		0.7	0.9	0.5	<0.2	<1.0	<1.0	<1.0					4.21		0.4	2.9	0.012	-49	1.4	8.05	0.00	0.01	0.01	0.00	0.00	0.00	0.02	0.00	0.26	0.42	0.32	0.00	0.00
BDC-05-18	11/10/2014		1180		0.4	1.1	1.2	<0.2	<1.0	<1.0	<1.0	0.006	0.002	<0.002	<0.002	0.78		0.5	3.0	0.058	3.2	<1.0	6.56	0.00	0.01	0.01	0.00	0.00	0.00	0.02	0.00	0.10	0.36	0.53	0.00	0.00
BDC-05-18	1/21/2015		1252		0.9	1.1	1.5	<0.2	<1.0	<1.0	<1.0					0.21		1.0	2.0	1.8	11.6	1.2	6.32	0.01	0.01	0.02	0.00	0.00	0.00	0.03	0.00	0.19	0.29	0.53	0.00	0.00
BDC-05-18	4/26/2015		1347		0.8	2.0	1.0	0.3	<1.0	<1.0	<1.0	0.027	0.004	0.003	<0.002	0.28		1.0	3.6	0.95	33	4.1	6.11	0.00	0.02	0.01	0.00	0.00	0.00	0.04	0.00	0.14	0.43	0.29	0.14	0.00
BDC-05-18	7/20/2015		1432		0.4	1.0	1.4	<0.2	<1.0	<1.0	<1.0					0.45		0.6	2.8	0.29	26	<1.0	6.30	0.00	0.01	0.01	0.00	0.00	0.00	0.02	0.00	0.10	0.31	0.59	0.00	0.00

Table 5
SWMU-17 Groundwater Data Cleanup Action Summary
Boeing Developmental Center
Tukwila, Washington

		Pilot Injection	Full Injection #1	Full Injection #2	Volatile Organic Compounds							Metals				Aquifer Redox Conditions						Donor Indicators	
		Elapsed Time From Injection (days)	Elapsed Time From Injection (days)	Elapsed Time From Injection (days)	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	As, Tot (mg/L)	As, Dis (mg/L)	Cu, Tot (mg/L)	Cu, Dis (mg/L)	DO (mg/L)	Nitrate (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (mg/L)	ORP (mV)	TOC (mg/L)	pH
Proposed Groundwater Cleanup Levels (a)					5.3	1.4	134	2.4	NA	NA	NA	0.008	0.008	0.008	0.008								
Well	Date																						
BDC-05-18	10/27/2015		1531		0.7	1.3	2.4	<0.2	<1.0	<1.0	<1.0	0.014	0.001	0.006	<0.002	0.73		0.2	3.1	1.7	22	<1.0	6.43
BDC-05-18	1/26/2016		1622		2.2	2.9	1.3	<0.2	<1.0	<1.0	<1.0					1.03			5.4	0.17	-127	1.8	6.30
BDC-05-18	4/20/2016		1707		2.3	3.0	1	<0.2	<1.0	<1.0	<1.0	0.003	0.001	<0.002	<0.002	0.26		0.8	8.5	0.32	10.1	<1.0	6.51
BDC-05-18	8/9/2016		1818		1.8	2.9	2.6	<0.2	<1.0	<1.0	<1.0	0.003	0.002	<0.002	<0.002	0.42		2.8	2.5	0.74	-5.7	<1.0	6.45
BDC-05-18	11/2/2016		1903		1.2	1.6	4.1	0.4	<1.0	<1.0	<1.0	0.005	0.004	<0.002	<0.002	0.34		1.0	2.6	3.3	-11.8	2.0	6.21
BDC-05-18	2/7/2017		2000		2.8	3.4	2.4	<0.2	<1.0	<1.0	<1.0	0.011	0.003	<0.002	<0.002	0.40		3.0	5.3	0.72	32.4	1.8	6.24
BDC-05-18	5/3/2017		2085		3.6	4.6	1.3	<0.2	<1.0	<1.0	<1.0	0.007	0.002	<0.002	<0.002	1.33		2.2	8.1	0.095	81.5	1.7	5.94
BDC-05-18	8/1/2017		2175		1.9	2.4	1.1	<0.2	<1.0	<1.0	<1.0	0.047	0.001	<0.002	<0.002	1.12		2.6	5.2	3.9	-1.2	18.3	6.16
BDC-05-18	11/7/2017		2273	-3	0.6	1.7	2.6	<0.2	<1.0	<1.0	<1.0	0.112	0.003	0.004	<0.002	0.57		1.8	1.3	7.2	32.4	3.9	6.27
BDC-05-18	5/2/2018		2449	173	<0.2	0.31	6.74	3.42	<1.14	<1.23	<1.06	0.005	0.005	0.002	<0.0005	0.46		4.6	0.823	15.6	15.0	27.9	6.03
BDC-05-18	11/7/2018		2638	362	0.90	1.01	6.86	2.18	<1.14	<1.23	<1.06	0.003	0.001	0.0004	<0.0005	0.30		1.4	3.22	14.6	50.7	2.67	5.95
BDC-05-19	7/31/2011		-18		15	21	23	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.002	<0.002	1.81	0.2	2.6	5.2	4.7	34	7.3	6.97
(MW 10 ft DG)	11/1/2011		75		9.1	13	36	4.1	<1.1	<1.2	<1.1	0.020	0.020	0.007	<0.002	1.53	<1.0	1.8	2.5	4.5	-142	170	6.82
	2/19/2012		185		<1.0	1.7	68	14	1.4	<1.0	<1.0					0.85	<0.5	2.0	<1.5	22.0	36	296	6.40
BDC-05-19	5/6/2012		262		0.7	1.4	52	23	1.8	<1.0	<1.0	0.058	0.052	0.032	0.008	0.02		2.0	1.4	25.0	69	244	6.39
BDC-05-19	9/5/2012		384		<2.0	<2.0	13	15	3.9	<1.0	<1.0					0.19		1.8	1.4	19.0	73	68.0	6.43
BDC-05-19	11/15/2012		455		<1.0	1.1	9.9	15	5.5	<1.0	<1.0	0.088	0.074	0.006	<0.002	0.21		1.6	1.8	24.0	3	68.1	6.58
BDC-05-19	2/25/2013		557		<1.0	<1.0	6.9	20	6.5	<1.0	<1.0					0.25		2.0	0.31	23.0	71	53.0	6.64
BDC-05-19	5/22/2013		643		<0.2	<0.2	5.1	9.6	7.2	<3.0	<1.0	0.054	0.051	0.006	<0.002	0.28		1.6	0.85	22.0	-385	52.4	8.12
BDC-05-19	8/28/2013		741		<2.0	<2.0	6.9	7.3	7.3	2.5	<1.0					1.53		2.0	0.52	22.0	-318	60.6	6.54
BDC-05-19	11/13/2013		818		<2.0	<2.0	2.3	3.1	4.1	3.0	<1.0	0.046	0.040	0.003	<0.002	3.93		1.4	0.52	26.0	-270	57.7	6.54
BDC-05-19	2/11/2014		908		<1.0	<1.0	<1.0	2.0	2.5	5.7	<1.0					5.69		2.0	0.39	23.0	-239	64.8	6.51
BDC-05-19	5/13/2014		999		<1.0	<1.0	<1.0	1.8	2.0	5.9	<1.0	0.033	0.025	0.003	<0.002	2.51		2.2	0.37	26.0	-306	54.9	6.56
BDC-05-19	8/6/2014		1084		<1.0	<1.0	<1.0	2.6	5.4	4.6	<1.0					6.55		1.8	<0.30	21.0	-174	57.8	7.13
BDC-05-19	11/10/2014		1180		<1.0	<1.0	<1.0	1.6	2.5	7.0	<1.0	0.032	0.025	0.004	<0.002	0.03		1.8	0.31	25.0	-82	40.1	6.20
BDC-05-19	1/21/2015		1252		<0.2	<0.2	<0.2	3.8	1.3	4.0	<1.0					0.19		2.2	0.55	18.0	-102	31.4	6.19
BDC-05-19	4/27/2015		1348		<0.2	<0.2	<0.2	1.6	<1.0	3.5	<1.0	0.031	0.023	0.006	<0.002	0.06		1.4	<0.30	19.0	-74	20.1	6.15
BDC-05-19	7/21/2015		1433		<0.2	<0.2	<0.2	1.5	1.6	2.2	<1.0					0.10		1.2	<0.30	21.0	-41	20.3	6.26
BDC-05-19	10/28/2015		1532		<0.2	<0.2	<0.2	1.0	<1.0	3.3	<1.0	0.034	0.027	0.004	<0.002	0.07		0.6	<0.30	19.0	-19	28.8	6.35
BDC-05-19	1/26/2016		1622		<0.2	<0.2	<0.2	1.2	<1.0	3.4	<1.0					0.21		1.3	<0.30	18.0	-95	25.9	6.41
BDC-05-19	4/20/2016		1707		<0.2	<0.2	<0.2	0.6	<1.0	3.4	<1.0	0.025	0.021	0.003	<0.002	0.14		1.2	0.36	19.0	-43	21.3	6.45
BDC-05-19	8/9/2016		1818		<0.2	<0.2	<0.2	0.4	<1.0	3.9	<1.0	0.015	0.014	<0.002	<0.002	0.31		1.5	0.6	17.0	-109.1	12.2	6.07
BDC-05-19	11/3/2016		1904		<0.2	<0.2	<0.2	0.2	<1.0	<1.0	<1.0	0.012	0.010	<0.002	<0.002	0.08		2.6	0.30	18.0	-116.1	12.9	6.24
BDC-05-19	2/8/2017		2001		<0.2	<0.2	<0.2	0.3	<1.0	3.2	<1.0	0.023	0.011	0.003	<0.002	0.34		3.2	0.32	16.0	-33.3	12.1	6.54
BDC-05-19	5/4/2017		2086		<0.2	<0.2	<0.2	0.4	<1.0	2.3	<1.0	0.020	0.013	<0.002	<0.002	0.24		1.8	0.43	13.0	-96	11.6	6.26
BDC-05-19	8/1/2017		2175		<0.2	<0.2	<0.2	0.2	<1.0	9.3	<1.0	0.017	0.012	<0.002	<0.002	0.11		2.2	<0.30	15.0	-98.0	10.2	6.21
BDC-05-19	11/6/2017		2272	-4	<0.2	<0.2	<0.2	<0.2	<1.0	1.5	<1.0	0.006	0.004	<0.002	<0.002	0.55		3.0	0.45	15.0	-19.6	9.3	6.46
BDC-05-19	5/2/2018		2449	173	<0.2	<0.2	<0.2	<0.2	<1.14	<1.23	<1.06	0.011	0.008	<0.0005	<0.0005	1.28		3.4	0.124	13.8	-105.6	22.62	6.41
BDC-05-19	11/6/2018		2637	361	<0.2	<0.2	<0.2	<0.2	<1.14	<1.23	<1.06	0.006	0.006	<0.0005	<0.0005	0.71		4.6	0.255	20.9	-72.6	15.89	6.42
BDC-05-20	7/31/2011		-18		<1.0	7.0	45	<1.0	<1.1	<1.2	<1.1	0.011	0.011	<0.002	<0.002	2.33	<0.1	1.5	7.4	0.2	-42	10.8	7.12
(MW 31 ft DG)	11/3/2011		77		<1.0	5.7	25	1.0	<1.1	<1.2	<1.1	0.010	0.011	<0.002	<0.002	1.54	<0.1	1.0	6.0	4.6	11	8.3	7.14
	2/19/2012		185		<0.2	2.9	17	2.5	<1.0	<1.0	<1.0					0.35	<0.5	1.5	<1.5	16.0	31	8.2	6.69
BDC-05-20	5/7/2012		263		<0.2	1.8	14	2.2	<1.0	<1.0	<1.0	0.011	0.011	<0.002	<0.002	0.69		1.8	2.3	20.0	20	11.1	6.66
BDC-05-20	9/5/2012		384		<0.4	<0.4	12	2.0	<1.0	<1.0	<1.0					0.08		1.4	<0.3	14.0	67	12.1	6.75
BDC-05-20	11/16/2012		456		<0.5	0.6	17	3.5	<1.0	<1.0	<1.0	0.012	0.013	<0.002	<0.002	0.07		2.0	<0.3	18.0	0.9	13.1	6.88
BDC-05-20	2/26/2013		558		<0.2	0.5	9.8	6.1	<1.0	<1.0	<1.0					0.16		1.5	<0.3	22.0	16	16.3	6.86
BDC-05-20	5/23/2013		644		<0.2	0.4	10	8.1	1.5	<1.0	<1.0	0.016	0.017	<0.002	<0.002	0.25		1.2	<0.3	25.0	-233	16.9	7.55
BDC-05-20	8/28/2013		741		<0.2	0.2	6.5	10	2.1	<1.0	<1.0					2.38		2.6	<0.30	20.0	-317	15.4	6.70
BDC-05-20	11/14/2013		819		<0.2	0.3	8.1	8.8	2.2	<1.0	<1.0	0.021	0.021	<0.002	<0.002	2.26		1.4	<0.30	19.0	-287	17.9	6.77
BDC-05-20	2/12/2014		909		<0.2	0.2	3.9	7.8	3.0	<4.0	<1.0					2.82		1.8	<0.30	16.0	-205	16.3	6.78
BDC-05-20	5/13/2014		999		<0.2	<0.2	3.8	6.3	2.0	<1.0	<1.0	0.017	0.017	<0.002	<0.002	3.44		1.6	0.36	16.0	-213	18.7	6.79
BDC-05-20	8/6/2014		1084		<0.2	<0.2	1.3	7.5	2.1	2.0	<1.0					4.23		1.4	<0.30	12.0	-150	17.6	7.31
BDC-05-20	11/10/2014		1180		<0.2	<0.2	0.7	4.9	3.0	3.6	<1.0	0.021	0.021	<0.002	<0.002	0.08		0.8	0.97	15.0	-117	15.9	6.50
BDC-05-20	1/21/2015		1252		<0.2	<0.2	0.5	3.8	2.7	2.6	<1.0					0.27		1.0	0.59	13.0	-120	13.8	6.47
BDC-05-20	4/26/2015		1347		<0.2	<0.2	0.4	6.9	4.8	1.6	<1.0	0.028	0.023	<0.002	<0.002	0.06		0.8	<0.30	14.0	-99	11.4	6.43
BDC-05-20	7/21/2015		1433		<0.2	<0.2	0.2	2.7	4.5	3.0	<1.0					0.12		1.3	<0.30	17.0	-59	14.2	6.55
BDC-05-20	10/27/2015		1531		<0.2	<0.2	<0.2	2.0	1.5	1.1	<1.0	0.028	0.028	<0.002	<0.002	0.23		1.4	<0.30	11.0	-35	10.6	6.47
BDC-05-20	1/26/2016		1622		<0.2	<0.2	0.2	2.7	2.1	1.5	<1.0					0.26		1.3	<0.30	11.0	-109	9.9	6.63
BDC-05-20	4/21/2016		1708		<0.2	<0.2	0.3	6.8	6.1	2.5	<1.0	0.034	0.030	<0.002	<0.002	0.38		0.8	<0.30	8.8	-44	16.2	6.63
BDC-05-20	8/9/2016		1818		<0.2	<0.2	0.2	2.2	7.0	2.9	<1.0	0.030	0.028	<0.002	<0.002	-0.01		2.0	0.37	8.4	-82	12.9	6.62
BDC-05-20	11/3/2016		1904		<0.2	<0.2	<0.2	1.4	5.2	2.5	<1.0	0.027	0.028	<0.002	<0.002	0.40		1.0	<0.30	8.9	-121.9	14.1	6.60
BDC-05-20	2/8/2017		2001		<0.2	<0.2	<0.2	1.8	5.2	2.8	<1.0	0.029	0.030	<0.002	<0.002	0.39		2.8	<0.30	7.1	-44.2	13.0	6.61
BDC-05-20	5/4/2017		2086		<0.2	<0.2	<0.2	1.2	2.3	4.3	<1.0	0.027	0.026	<0.002	<0.002	0.30		1.6	1.2	4.3	-99.6	12.9	6.55
BDC-05-20	8/1/2017		2175		<0.2	<0.2	<0.2	0.9	1.4	4.6	<1.0	0.027	0.027	<0.002	<0.002	0.61		2.1	<0.30	6.4	-104.9	12.3	6.46
BDC-05-20	11/7/2017		2273	-3	<0.2	<0.2	<0.2	1.1	<1.0	1.3	<1.0	0.027	0.027	<0.002	<0.002	0.36		2.2	<0.30	8.7	6.8	7.9	6.56
BDC-05-20	5/2/2018		2449	173	<0.2	<0.2	<0.2	1.04	<1.14	<1.23	<1.06	0.028	0.028	<0.0005	0.0004	0.89		2.3	<0.1	3.9	-96.4	12.2	6.55
BDC-05-20	11/7/2018		2638	362	<0.2	<0.2	<0.2	0.90	<1.14	<1.23	<1.06	0.030	0.028	<0.001	<0.0005	0.19		2.8	<0.100	24.3	-45.2	9.14	6.54

		VOCs- micromoles/Liter (b)								Molar Fraction (c)				
Well	Date	PCE	TCE	c DCE	VC	Ethene	Ethane	Total Chloroethenes (d)	Ethene + Ethane	PCE	TCE	c DCE	VC	Ethene + Ethane
BDC-05-18	10/27/2015	0.00	0.01	0.02	0.00	0.00	0.00	0.04	0.00	0.11	0.25	0.64	0.00	0.00
BDC-05-18	1/26/2016	0.01	0.02	0.01	0.00	0.00	0.00	0.05	0.00	0.27	0.45	0.28	0.00	0.00
BDC-05-18	4/20/2016	0.01	0.02	0.01	0.00	0.00	0.00	0.05	0.00	0.29	0.49	0.22	0.00	0.00
BDC-05-18	8/9/2016	0.01	0.02	0.03	0.00	0.00	0.00	0.06	0.00	0.18	0.37	0.45	0.00	0.00
BDC-05-18	11/2/2016	0.01	0.01	0.04	0.01	0.00	0.00	0.07	0.00	0.11	0.18	0.62	0.09	0.00
BDC-05-18	2/7/2017	0.02	0.03	0.02	0.00	0.00	0.00	0.07	0.00	0.25	0.38	0.37	0.00	0.00
BDC-05-18	5/3/2017	0.02	0.04	0.01	0.00	0.00	0.00	0.07	0.00	0.31	0.50	0.19	0.00	0.00
BDC-05-18	8/1/2017	0.01	0.02	0.01	0.00	0.00	0.00	0.04	0.00	0.28	0.44	0.28	0.00	0.00
BDC-05-18	11/7/2017	0.00	0.01	0.03	0.00	0.00	0.00	0.04	0.00	0.08	0.30	0.62	0.00	0.00
BDC-05-18	5/2/2018	0.00	0.00	0.07	0.05	0.00	0.00	0.13	0.00	0.00	0.02	0.55	0.43	0.00
BDC-05-18	11/7/2018	0.01	0.01	0.07	0.03	0.00	0.00	0.12	0.00	0.05	0.06	0.60	0.29	0.00
BDC-05-19	7/31/2011	0.09	0.16	0.24	0.00	0.00	0.00	0.49	0.00	0.19	0.33	0.49	0.00	0.00
(MW 10 ft DG)	11/1/2011	0.05	0.10	0.37	0.07	0.00	0.00	0.59	0.00	0.09	0.17	0.63	0.11	0.00
	2/19/2012	0.00	0.01	0.70	0.22	0.05	0.00	0.94	0.05	0.00	0.01	0.71	0.23	0.05
BDC-05-19	5/6/2012	0.00	0.01	0.54	0.37	0.06	0.00	0.92	0.06	0.00	0.01	0.55	0.37	0.07
BDC-05-19	9/5/2012	0.00	0.00	0.13	0.24	0.14	0.00	0.37	0.14	0.00	0.00	0.26	0.47	0.27
BDC-05-19	11/15/2012	0.00	0.01	0.10	0.24	0.20	0.00	0.35	0.20	0.00	0.02	0.19	0.44	0.36
BDC-05-19	2/25/2013	0.00	0.00	0.07	0.32	0.23	0.00	0.39	0.23	0.00	0.00	0.11	0.51	0.37
BDC-05-19	5/22/2013	0.00	0.00	0.05	0.15	0.26	0.00	0.21	0.26	0.00	0.00	0.11	0.33	0.55
BDC-05-19	8/28/2013	0.00	0.00	0.07	0.12	0.26	0.08	0.19	0.34	0.00	0.00	0.13	0.22	0.65
BDC-05-19	11/13/2013	0.00	0.00	0.02	0.05	0.15	0.10	0.07	0.25	0.00	0.00	0.07	0.16	0.77
BDC-05-19	2/11/2014	0.00	0.00	0.00	0.03	0.09	0.19	0.03	0.28	0.00	0.00	0.00	0.10	0.90
BDC-05-19	5/13/2014	0.00	0.00	0.00	0.03	0.07	0.20	0.03	0.27	0.00	0.00	0.00	0.10	0.90
BDC-05-19	8/6/2014	0.00	0.00	0.00	0.04	0.19	0.15	0.04	0.35	0.00	0.00	0.00	0.11	0.89
BDC-05-19	11/10/2014	0.00	0.00	0.00	0.03	0.09	0.23	0.03	0.32	0.00	0.00	0.00	0.07	0.93
BDC-05-19	1/21/2015	0.00	0.00	0.00	0.06	0.05	0.13	0.06	0.18	0.00	0.00	0.00	0.25	0.75
BDC-05-19	4/27/2015	0.00	0.00	0.00	0.03	0.00	0.12	0.03	0.12	0.00	0.00	0.00	0.18	0.82
BDC-05-19	7/21/2015	0.00	0.00	0.00	0.02	0.06	0.07	0.02	0.13	0.00	0.00	0.00	0.16	0.84
BDC-05-19	10/28/2015	0.00	0.00	0.00	0.02	0.00	0.11	0.02	0.11	0.00	0.00	0.00	0.13	0.87
BDC-05-19	1/26/2016	0.00	0.00	0.00	0.02	0.00	0.11	0.02	0.11	0.00	0.00	0.00	0.15	0.85
BDC-05-19	4/20/2016	0.00	0.00	0.00	0.01	0.00	0.11	0.01	0.11	0.00	0.00	0.00	0.08	0.92
BDC-05-19	8/9/2016	0.00	0.00	0.00	0.01	0.00	0.13	0.01	0.13	0.00	0.00	0.00	0.05	0.95
BDC-05-19	11/3/2016	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
BDC-05-19	2/8/2017	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.11	0.00	0.00	0.00	0.04	0.96
BDC-05-19	5/4/2017	0.00	0.00	0.00	0.01	0.00	0.08	0.01	0.08	0.00	0.00	0.00	0.08	0.92
BDC-05-19	8/1/2017	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.31	0.00	0.00	0.00	0.01	0.99
BDC-05-19	11/6/2017	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.05	0.00	0.00	0.00	0.00	1.00
BDC-05-19	5/2/2018	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA	NA	NA	NA	NA
BDC-05-19	11/6/2018	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA	NA	NA	NA	NA
BDC-05-20	7/31/2011	0.00	0.05	0.46	0.00	0.00	0.00	0.52	0.00	0.00	0.10	0.90	0.00	0.00
(MW 31 ft DG)	11/3/2011	0.00	0.04	0.26	0.02	0.00	0.00	0.32	0.00	0.00	0.14	0.81	0.05	0.00
	2/19/2012	0.00	0.02	0.18	0.04	0.00	0.00	0.24	0.00	0.00	0.09	0.74	0.17	0.00
BDC-05-20	5/7/2012	0.00	0.01	0.14	0.04	0.00	0.00	0.19	0.00	0.00	0.07	0.75	0.18	0.00
BDC-05-20	9/5/2012	0.00	0.00	0.12	0.03	0.00	0.00	0.16	0.00	0.00	0.00	0.79	0.21	0.00
BDC-05-20	11/16/2012	0.00	0.00	0.18	0.06	0.00	0.00	0.24	0.00	0.00	0.02	0.74	0.24	0.00
BDC-05-20	2/26/2013	0.00	0.00	0.10	0.10	0.00	0.00	0.20	0.00	0.00	0.02	0.50	0.48	0.00
BDC-05-20	5/23/2013	0.00	0.00	0.10	0.13	0.05	0.00	0.24	0.05	0.00	0.01	0.36	0.45	0.18
BDC-05-20	8/28/2013	0.00	0.00	0.07	0.16	0.07	0.00	0.23	0.07	0.00	0.01	0.22	0.53	0.25
BDC-05-20	11/14/2013	0.00	0.00	0.08	0.14	0.08	0.00	0.23	0.08	0.00	0.01	0.27	0.46	0.26
BDC-05-20	2/12/2014	0.00	0.00	0.04	0.12	0.11	0.00	0.17	0.11	0.00	0.01	0.15	0.46	0.39
BDC-05-20	5/13/2014	0.00	0.00	0.04	0.10	0.07	0.00	0.14	0.07	0.00	0.00	0.19	0.48	0.34
BDC-05-20	8/6/2014	0.00	0.00	0.01	0.12	0.07	0.07	0.13	0.14	0.00	0.00	0.05	0.44	0.51
BDC-05-20	11/10/2014	0.00	0.00	0.01	0.08	0.11	0.12	0.09	0.23	0.00	0.00	0.02	0.25	0.73
BDC-05-20	1/21/2015	0.00	0.00	0.01	0.06	0.10	0.09	0.07	0.18	0.00	0.00	0.02	0.24	0.73
BDC-05-20	4/26/2015	0.00	0.00	0.00	0.11	0.17	0.05	0.11	0.22	0.00	0.00	0.01	0.33	0.66
BDC-05-20	7/21/2015	0.00	0.00	0.00	0.04	0.16	0.10	0.05	0.26	0.00	0.00	0.01	0.14	0.85
BDC-05-20	10/27/2015	0.00	0.00	0.00	0.03	0.05	0.04	0.03	0.09	0.00	0.00	0.00	0.26	0.74
BDC-05-20	1/26/2016	0.00	0.00	0.00	0.04	0.07	0.05	0.05	0.12	0.00	0.00	0.01	0.25	0.73
BDC-05-20	4/21/2016	0.00	0.00	0.00	0.11	0.22	0.08	0.11	0.30	0.00	0.00	0.01	0.26	0.73
BDC-05-20	8/9/2016	0.00	0.00	0.00	0.04	0.25	0.10	0.04	0.35	0.00	0.00	0.01	0.09	0.90
BDC-05-20	11/3/2016	0.00	0.00	0.00	0.02	0.19	0.08	0.02	0.27	0.00	0.00	0.00	0.08	0.92
BDC-05-20	2/8/2017	0.00	0.00	0.00	0.03	0.19	0.09	0.03	0.28	0.00	0.00	0.00	0.09	0.91
BDC-05-20	5/4/2017	0.00	0.00	0.00	0.02	0.08	0.14	0.02	0.22	0.00	0.00	0.00	0.08	0.92
BDC-05-20	8/1/2017	0.00	0.00	0.00	0.01	0.05	0.15	0.01	0.20	0.00	0.00	0.00	0.07	0.93
BDC-05-20	11/7/2017	0.00	0.00	0.00	0.02	0.00	0.04	0.02	0.04	0.00	0.00	0.00	0.29	0.71
BDC-05-20	5/2/2018	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.00	1.00	0.00
BDC-05-20	11/7/2018	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	1.00	0.00

Table 5
SWMU-17 Groundwater Data Cleanup Action Summary
Boeing Developmental Center
Tukwila, Washington

		Pilot Injection	Full Injection #1	Full Injection #2	Volatile Organic Compounds							Metals				Aquifer Redox Conditions						Donor Indicators		VOCs- micromoles/Liter (b)								Molar Fraction (c)				
		Elapsed Time From Injection (days)	Elapsed Time From Injection (days)	Elapsed Time From Injection (days)	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	As, Tot (mg/L)	As, Dis (mg/L)	Cu, Tot (mg/L)	Cu, Dis (mg/L)	DO (mg/L)	Nitrate (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (mg/L)	ORP (mV)	TOC (mg/L)	pH													
Proposed Groundwater Cleanup Levels (a)					5.3	1.4	134	2.4	NA	NA	NA	0.008	0.008	0.008	0.008																					
Well	Date																							PCE	TCE	c DCE	VC	Ethene	Ethane	Total Chloroethenes (d)	Ethene + Ethane	PCE	TCE	c DCE	VC	Ethene + Ethane
BDC-05-21	7/31/2011		-18		<1.0	<1.0	1.3	14	2.6	<1.2	<1.1	0.006	0.006	<0.002	<0.002	2.98	<0.1	3.2	0.2	5.6	-31	6.4	7.33	0.00	0.00	0.01	0.22	0.09	0.00	0.24	0.09	0.00	0.00	0.04	0.68	0.28
(MW 30 ft XG)	11/3/2011		77		<1.0	<1.0	1.0	4.7				0.005	0.005	<0.002	<0.002	1.95	<0.1	1.4	6.3		-12	5.2	7.29	0.00	0.00	0.01	0.08			0.09		0.00	0.00	0.12	0.88	
	2/19/2012		185		<0.2	0.3	0.7	5.9								0.40	<0.5	1.4	<1.5		47	7.2	6.65	0.00	0.00	0.01	0.09			0.10		0.00	0.02	0.07	0.91	
BDC-05-21	5/7/2012		263		<0.2	0.4	0.8	2.5				0.010	0.011	0.005	<0.002	0.86		1.5	1.9		-35	12.3	6.76	0.00	0.00	0.01	0.04			0.05		0.00	0.06	0.16	0.78	
BDC-05-21	9/5/2012		384		<0.2	0.3	0.6	2.9								0.08		2.5	1.4		62	9.5	6.78	0.00	0.00	0.01	0.05			0.05		0.00	0.04	0.11	0.85	
BDC-05-21	11/16/2012		456		<0.5	<0.5	0.6	2.9				0.020	0.020	<0.002	<0.002	0.02		1.5	0.6		-4	8.9	6.92	0.00	0.00	0.01	0.05			0.05		0.00	0.00	0.12	0.88	
BDC-05-21	2/26/2013		558		<0.2	0.3	0.8	3.3	<1.0	<1.0	<1.0					0.24		1.4	<0.3	18.0	-2.6	8.7	7.03	0.00	0.00	0.01	0.05	0.00	0.00	0.06	0.00	0.00	0.04	0.13	0.83	0.00
BDC-05-21	5/23/2013		644		<0.2	0.3	0.9	6.5				0.024	0.022	<0.002	<0.002	0.19		1.5	<0.3		-235	8.2	7.50	0.00	0.00	0.01	0.10			0.12		0.00	0.02	0.08	0.90	
BDC-05-21	8/28/2013		741		<0.2	0.2	0.8	7.7	6.2	1.8	<1.0					0.74		3.5	<0.30	14.0	-310	7.9	6.72	0.00	0.00	0.01	0.12	0.22	0.06	0.13	0.28	0.00	0.00	0.02	0.30	0.68
BDC-05-21	11/14/2013		819		<0.2	0.2	1.0	7.3	3.5	1.4	<1.0	0.019	0.017	<0.002	<0.002	2.84		2.0	<0.30	12.0	-239	7.7	6.78	0.00	0.00	0.01	0.12	0.12	0.05	0.13	0.17	0.00	0.01	0.03	0.39	0.57
BDC-05-21	2/12/2014		909		<0.2	0.2	3.0	3.4	1.9	2.9	<1.0					2.74		2.2	<0.30	12.0	-210	8.3	6.87	0.00	0.00	0.03	0.05	0.07	0.10	0.09	0.16	0.00	0.01	0.12	0.22	0.65
BDC-05-21	5/13/2014		999		<0.2	<0.2	1.9	2.2	2.8	2.9	<1.0	0.022	0.017	<0.002	<0.002	3.33		1.4	0.60	9.1	-259	8.6	6.82	0.00	0.00	0.02	0.04	0.10	0.10	0.05	0.20	0.00	0.00	0.08	0.14	0.78
BDC-05-21	8/6/2014		1084		<0.2	<0.2	2.3	5.6	3.8	1.8	<1.0					3.75		2.2	<0.30	6.5	-153	9.4	7.42	0.00	0.00	0.02	0.09	0.14	0.06	0.11	0.20	0.00	0.00	0.08	0.29	0.63
BDC-05-21	11/10/2014		1180		<0.2	<0.2	1.5	3.4	4.3	1.2	<1.0	0.017	0.014	<0.002	<0.002	0.24		1.4	0.99	5.8	-126	5.7	6.44	0.00	0.00	0.02	0.05	0.15	0.04	0.07	0.19	0.00	0.00	0.06	0.21	0.73
BDC-05-21	1/21/2015		1252		<0.2	<0.2	1.1	3.5	2.2	<1.0	<1.0					0.15		1.0	0.97	1.8	-124	6.3	6.43	0.00	0.00	0.01	0.06	0.08	0.00	0.07	0.08	0.00	0.00	0.08	0.38	0.54
BDC-05-21	4/27/2015		1348		<0.2	<0.2	1.5	4.4	2.7	<1.0	<1.0	0.013	0.011	<0.002	<0.002	0.28		0.8	1.9	4.8	-104	5.4	6.43	0.00	0.00	0.02	0.07	0.10	0.00	0.09	0.10	0.00	0.00	0.08	0.39	0.53
BDC-05-21	7/20/2015		1432		<0.2	<0.2	0.8	3.0	2.7	<1.0	<1.0					0.17		1.2	0.55	6.8	-84	4.5	6.41	0.00	0.00	0.01	0.05	0.10	0.00	0.06	0.10	0.00	0.00	0.05	0.31	0.63
BDC-05-21	10/27/2015		1531		<0.2	<0.2	0.5	4.1	2.1	<1.0	<1.0	0.009	0.011	<0.002	<0.002	0.08		2.0	0.49	3.0	-46	5.7	6.53	0.00	0.00	0.01	0.07	0.07	0.00	0.07	0.07	0.00	0.00	0.04	0.45	0.51
BDC-05-21	1/26/2016		1622		<0.2	<0.2	2.0	2.9	1.2	<1.0	<1.0					1.41			1.40	2.5	-119	13.8	6.50	0.00	0.00	0.02	0.05	0.04	0.00	0.07	0.04	0.00	0.00	0.19	0.42	0.39
BDC-05-21	4/21/2016		1708		<0.2	<0.2	1.7	2.4	1.6	<1.0	<1.0	0.016	0.016	<0.002	<0.002	0.18		1.0	1.1	4.6	-75	12.7	6.78	0.00	0.00	0.02	0.04	0.06	0.00	0.06	0.06	0.00	0.00	0.16	0.34	0.50
BDC-05-21	8/9/2016		1818		<0.2	<0.2	0.6	1.6	3	2.3	<1.0	0.008	0.008	<0.002	<0.002	0.05		4.0	<0.30	11.0	-99.6	6.7	6.52	0.00	0.00	0.01	0.03	0.11	0.08	0.03	0.18	0.00	0.00	0.03	0.12	0.85
BDC-05-21	11/2/2016		1903		<0.2	<0.2	0.4	1.3	1.2	1.8	<1.0	0.008	0.009	<0.002	<0.002	0.43		0.8	<0.30	8.8	-122.8	9.5	6.45	0.00	0.00	0.00	0.02	0.04	0.06	0.02	0.10	0.00	0.00	0.03	0.16	0.80
BDC-05-21	2/7/2017		2000		<0.2	<0.2	0.5	1.4	<1.0	1.6	<1.0	0.007	0.006	<0.002	<0.002	0.36		2.6	<0.30	9.1	-67.5	9.3	6.52	0.00	0.00	0.01	0.02	0.00	0.05	0.03	0.05	0.00	0.00	0.06	0.28	0.66
BDC-05-21	5/3/2017		2085		<0.2	<0.2	0.7	2.0	2.8	1.3	<1.0	0.009	0.009	<0.002	<0.002	0.46		2.0	0.64	3.4	-114.4	9.1	6.45	0.00	0.00	0.01	0.03	0.10	0.04	0.04	0.14	0.00	0.00	0.04	0.18	0.78
BDC-05-21	8/1/2017		2175		<0.2	<0.2	0.6	1.5	3.9	5.6	<1.0	0.009	0.009	<0.002	<0.002	2.53		2.8	1.1	4.9		13.9	6.11	0.00	0.00	0.01	0.02	0.14	0.19	0.03	0.33	0.00	0.00	0.02	0.07	0.92
BDC-05-21	11/7/2017		2273	-3	<0.2	<0.2	0.9	1.2	<1.0	2.5	<1.0	0.011	0.011	<0.002	<0.002	0.42		2.0	1.3	5.8	10.7	13.2	6.54	0.00	0.00	0.01	0.02	0.00	0.08	0.03	0.08	0.00	0.00	0.08	0.17	0.74
BDC-05-21	5/2/2018		2449	173	<0.2	<0.2	0.43	0.83	<1.14	<1.23	<1.06	0.008	0.008	<0.0005	<0.0005	0.10		4.0	7.32	9.1	5.6	4.95	6.40	0.00	0.00	0.00	0.01	0.00	0.00	0.02	0.00	0.00	0.00	0.25	0.75	0.00
BDC-05-21	11/7/2018		2638	362	<0.2	<0.2	0.20	0.72	<1.14	<1.23	<1.06	0.007	0.007	<0.0005	<0.0005	0.39		2.8	0.490	10.3	13.2	5.89	6.32	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.15	0.85	0.00
BDC-05-22	7/31/2011		-18		<1.0	1.1	9.6	1.0	<1.1	<1.2	<1.1	0.025	0.024	<0.002	<0.002	2.02	<0.1	2.2	14.0	5.1	-59	7.9	7.21	0.00	0.01	0.10	0.02	0.00	0.00	0.12	0.00	0.00	0.07	0.80	0.13	0.00
(MW 48 ft XG)	11/3/2011		77		<1.0	2.1	10	<1.0				0.020	0.020	<0.002	<0.002	1.46	<0.1	0.8	18.1		19	6.1	7.08	0.00	0.02	0.10	0.00			0.12		0.00	0.13	0.87	0.00	
	2/19/2012		185		<0.2	2.0	13	0.4								0.43	<0.5	1.2	17.0		110	6.2	6.73	0.00	0.02	0.13	0.01			0.16		0.00	0.10	0.86	0.04	
BDC-05-22	5/7/2012		263		<0.2	2.0	11	0.5				0.025	0.023	0.002	<0.002	0.81		1.6	19.4		32	8.4	6.68	0.00	0.02	0.11	0.01			0.14		0.00	0.11	0.83	0.06	
BDC-05-22	9/5/2012		384		<0.2	1.8	9.5	0.8								0.06		2.2	14.7		75	7.6	6.71	0.00	0.01	0.10	0.01			0.12		0.00	0.11	0.79	0.10	
BDC-05-22	11/16/2012		456		<0.5	1.6	10	0.7				0.033	0.031	<0.002	<0.002	0.02		0.8	17.8		5	7.7	6.93	0.00	0.01	0.10	0.01			0.13		0.00	0.10	0.82	0.09	
BDC-05-22	2/26/2013		558		<0.2	1.3	9.4	1.2								0.09		1.6	10.1		23	7.5	6.92	0.00	0.01	0.10	0.02			0.13		0.00	0.08	0.77	0.15	
BDC-05-22	5/23/2013		644		<0.2	1.2	10	0.6				0.029	0.029	<0.002	<0.002	0.25		1.4	6.3		-233	8.7	7.63	0.00	0.01	0.10	0.01			0.12		0.00	0.07	0.85	0.08	
BDC-05-22	8/28/2013		741		<0.2	1.2	7.3	0.2								0.65			3.5		-322	8.9	6.69	0.00	0.01	0.08	0.00			0.09		0.00	0.10	0.86	0.04	
BDC-05-22	11/14/2013		819		<0.2	1.2	6.9	<0.2				0.028	0.027	<0.002	<0.002	1.96		1.5	5.9		-240	8.8	6.74	0.00	0.01	0.07	0.00			0.08		0.00	0.11	0.89	0.00	
BDC-05-22	2/12/2014		909		<0.2	0.7	5.7	<0.2								2.67		2.0	4.9		-224	7.3	6.88	0.00	0.01	0.06	0.00			0.06		0.00	0.08	0.92	0.00	
BDC-05-22	5/13/2014		999		<0.2	1.4	6.7	<0.2				0.027	0.025	<0.002	<0.002	3.16		1.5	8.7		-183	8.4	6.68	0.00	0.01	0.07	0.00			0.08		0.00	0.13	0.87	0.00	
BDC-05-22	8/6/2014		1084		<0.2	1.2	5.5	<0.2								4.59		1.6	10.9		-137	9.6	7.31	0.00	0.01	0.06	0.00			0.07		0.00	0.14	0.86	0.00	
BDC-05-22	11/10/2014		1180		<0.2	1.2	5.8	<0.2				0.031	0.031	<0.002	<0.002	0.05		1.4	19.2		-113	6.8	6.43	0.00	0.01	0.06	0.00			0.07		0.00	0.13	0.87	0.00	
BDC-05-22	1/21/2015		1252		<0.2	0.7	4.2	<0.2								0.30		1.0	1.2		-140	7.3	6.53	0.00	0.01	0.04	0.00			0.05		0.00	0.11	0.89	0.00	
BDC-05-22	4/27/2015		1348		<0.2	0.5	4.2	<0.2				0.025	0.026	0.004	<0.002	0.14		1.8	<0.30		-115	5.2	6.44	0.00	0.00	0.04	0.00			0.05		0.00	0.08	0.92	0.00	
BDC-05-22	7/21/2015		1433		<0.2	0.7	5.5	<0.2								0.12		1.0	4.4		-47	6.1	6.38	0.00	0.01	0.06	0.00			0.06		0.00	0.09	0.91	0.00	
BDC-05-22	10/27/2015		1531		<0.2	0.6	4.5	<0.2				0.030	0.027	<0.002	<0.002	0.09		1.0	4.2		-50	6.9	6.59	0.00	0.00	0.05	0.00			0.05		0.00	0.09	0.91	0.00	
BDC-05-22	1/26/2016		1622		<0.2	0.9	7.1	<0.2								0.28		1.4	8.5		-109	6.8	6.55	0.00	0.01	0.07	0.00			0.08		0.00	0.09	0.91	0.00	
BDC-05-22	4/21/2016		1708		<0.2	0.9	7.3	<0.2				0.035	0.034	<0.002	<0.002	0.79		1.0	22.4		-39	6.0	6.44	0.00	0.01	0.08	0.00			0.08		0.00	0.08	0.92	0.00	
BDC-05-22	8/9/2016		1818		<0.2	1.1	6.2	1.5				0.029	0.030	<0.002	<0.002	0.04		2.2	6.6		-60.8	6.2	6.50	0.00	0.01	0.06	0.02			0.10		0.00	0.09	0.66	0.25	
BDC-05-22	11/3/2016		1904		<0.2	0.3	7.0	0.8				0.025	0.025	<0.002	0.004	0.60		0.8	0.57		-126.9	5.7	6.66	0.00	0.00	0.07	0.01			0.09		0.00	0.03	0.83	0.15	
BDC-05-22	2/8/2017		2001		<0.2	0.3	8.4	<0.2				0.026	0.026	<0.002	<0.002	0.54		3.4	0.3		-23.5	5.9	6.27	0.00	0.00	0.09	0.00			0.09		0.00	0.03	0.97	0.00	
BDC-05-22	5/4/2017		2086		<0.2	0.6	9.4	<0.2				0.028	0.030	<0.002	<0.002	0.24		2.6	6.6		-128	6.0	6.57	0.00	0.00	0.10	0.00			0.10		0.00	0.04	0.96	0.00	
BDC-05-22	8/1/2017		2175		<0.2	0.7	9.1	<0.2				0.032	0.030	<0.002	<0.002	1.88		2.6	1.8		-85.1	6.3	6.28	0.00	0.01	0.09	0.00			0.10		0.00	0.05	0.95	0.00	
BDC-05-22	11/7/2017		2273	-3	<0.2	<0.2	6.7	<0.2				0.021	0.021	<0.002	<0.002	0.55		1.6	<0.30		-0.8	5.9	6.60	0.00	0.00	0.07	0.00			0.07		0.00	0.00	1.00	0.00	
BDC-05-22	5/2/2018		2449	173	<0.2	0.55	10.6	1.02				0.033	0.032	<0.0005	<0.0005	0.90		3.4	10.9		-88.1	5.7	6.49	0.00	0.00	0.11	0.02			0.13		0.00	0.03	0.84	0.13	
BDC-05-22	11/7/2018		2638	362	<0.2	0.39	11.9	1.25				0.028	0.030	0.005	<0.0005	0.30		3.2	2.12		-29.0	5.39	6.47	0.00	0.00	0.12	0.02			0.15		0.00	0.02	0.84	0.14	
BDC-05-23	7/31/2011		-18		<1.0	<1.0	3.2	<1.0	<1.1	<1.2	<1.1	0.005	0.005	0.002	<0.002	2.72	<0.1	2.2	8.6	6.0	-101	9.1	7.47	0.00	0.00	0.03	0.00	0.00	0.00	0.03	0.00	0.00	0.00	1.00	0.00	0.00
(MW 170ft DG)	11/3/2011		77		<1.0	<1.0	4.8	<1.0				0.005	0.006	<0.002	<0.002	1.45	<0.1	1.0	25.2		1	8.8	7.08	0.00	0.00	0.05	0.00			0.05		0.00	0.00	1.00	0.00	
	2/19/2012		185		<0.2	0.6	4.7	0.7								0.96	<0.5	1.2	8.9		162	8.1	6.33	0.00	0.00	0.05	0.01			0.06		0.00	0.07	0.75	0.17	
BDC-05-23	5/7/2012		263		<0.2	0.7	5.4	0.8				0.008	0.008	<0.002	<0.002	0.07		2.0	15.8		45	9.3	6.70	0.00	0.01	0.06	0.01			0.07		0.00	0.07	0.75	0.17	
BDC-05-23	9/5/2012		384		<0.2	0.7	6.2	0.9								0.08		1.9	8.8		78	11.3	6.84	0.00	0.01	0.06	0.01			0.08		0.00	0.06	0.76	0.17	
BDC-05-23	11/16/2012		456		<0.5	0.8	6.9	0.5				0.012	0.010	<0.002	<0.002	0.09		1.0	4.9		-6	11.6	7.06	0.00	0.01	0.07	0.01			0.09		0.00	0.07	0.83	0.09	
BDC-05-23	2/25/2013		557		<0.2	0.5	4.2	1.0								0.08		1.5	0.87		72	9.2	6.91	0.00	0.00	0.04	0.02			0.06		0.00	0.06	0.69	0.25	
BDC-05-23	5/23/2013		644		<0.2	0.5	4.7	1.0				0.015	0.015	<0.002	<0.002	0.31		1.2	1.7		-234	11.0	7.59	0.00	0.00	0.05	0.02			0.07		0.00	0.06	0.71	0.23	
BDC-05-23	8/28/2013		741		<1.0	2.2	21	5.4								0.60		0.5	0.35		-323	10.4	6.76	0.00	0.02	0.22	0.09			0.32		0.00	0.05	0.68	0.27	
BDC-05-23	11/14/2013		819		<0.2	0.3	3.0	0.9				0.017	0.015	<0.002	<0.002	1.58		1.3	0.62		-252	11.1	6.87	0.00	0.00	0.03	0.01			0.05		0.00	0.05	0.65	0.30	
BDC-05-23	2/12/2014		909		<0.2	0.2	2.7	1.2								2.40		1.8	0.74		-229	9.3	6.86	0.00	0.00	0.03	0.02			0.05		0.00	0.03	0.57	0.40	

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Source: 12/26/2018 P:\025\093\WIP\T\Data\Master Data Tables\SWMU-17\SWMU-17 Summary Tables_New-Full_Scale_Bio_MASTER Tb1-Summary Data

Table 5
SWMU-17 Groundwater Data Cleanup Action Summary
Boeing Developmental Center
Tukwila, Washington

		Pilot Injection	Full Injection #1	Full Injection #2	Volatile Organic Compounds							Metals				Aquifer Redox Conditions						Donor Indicators		VOCs- micromoles/Liter (b)								Molar Fraction (c)				
		Elapsed Time From Injection (days)	Elapsed Time From Injection (days)	Elapsed Time From Injection (days)	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	As, Tot (mg/L)	As, Dis (mg/L)	Cu, Tot (mg/L)	Cu, Dis (mg/L)	DO (mg/L)	Nitrate (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (mg/L)	ORP (mV)	TOC (mg/L)	pH	PCE	TCE	c DCE	VC	Ethene	Ethane	Total Chloroethenes (d)	Ethene + Ethane	PCE	TCE	c DCE	VC	Ethene + Ethane
Proposed Groundwater Cleanup Levels (a)					5.3	1.4	134	2.4	NA	NA	NA	0.008	0.008	0.008	0.008																					
Well	Date																																			
BDC-05-23	5/13/2014		999		<0.2	0.3	4.5	1.0				0.023	0.023	<0.002	<0.002	3.15		1.4	3.1		-207	12.1	6.97	0.00	0.00	0.05	0.02			0.06		0.00	0.04	0.72	0.25	
BDC-05-23	8/6/2014		1084		<0.2	0.3	4.2	1.2								4.49		1.2	2.7		-149	13.3	7.35	0.00	0.00	0.04	0.02			0.06		0.00	0.04	0.67	0.30	
BDC-05-23	11/10/2014		1180		<0.2	0.3	3.9	1.0				0.023	0.021	<0.002	<0.002	0.10		1.6	1.9		-122	10.1	6.40	0.00	0.00	0.04	0.02			0.06		0.00	0.04	0.69	0.27	
BDC-05-23	1/21/2015		1252		<0.2	<0.2	2.8	1.7								0.13		1.4	0.66		-144	9.5	6.49	0.00	0.00	0.03	0.03			0.06		0.00	0.00	0.51	0.49	
BDC-05-23	4/27/2015		1348		<0.2	<0.2	2.9	2.4				0.022	0.021	<0.002	<0.002	0.19		1.6	0.74		-114	7.5	6.40	0.00	0.00	0.03	0.04			0.07		0.00	0.00	0.44	0.56	
BDC-05-23	7/20/2015		1432		<0.2	<0.2	1.5	2.7								0.22		0.9	<0.30		-84	7.1	6.40	0.00	0.00	0.02	0.04			0.06		0.00	0.00	0.26	0.74	
BDC-05-23	10/27/2015		1531		<0.2	<0.2	2.1	1.6				0.021	0.020	<0.002	<0.002	0.18		1.4	0.46		-55	7.9	6.64	0.00	0.00	0.02	0.03			0.05		0.00	0.00	0.46	0.54	
BDC-05-23	1/26/2016		1622		<0.2	<0.2	4.9	0.9								0.50			2.2		-112	7.8	6.44	0.00	0.00	0.05	0.01			0.06		0.00	0.00	0.78	0.22	
BDC-05-23	4/21/2016		1708		<0.2	<0.2	4.0	1.4				0.024	0.023	<0.002	<0.002	0.28		0.6	3.0		-72	6.3	6.83	0.00	0.00	0.04	0.02			0.06		0.00	0.00	0.65	0.35	
BDC-05-23	8/9/2016		1818		<0.2	<0.2	3.2	1.1				0.026	0.025	<0.002	<0.002	0.03		1.8	2.8		-80.3	7.3	6.64	0.00	0.00	0.03	0.02			0.05		0.00	0.00	0.65	0.35	
BDC-05-23	11/3/2016		1904		<0.2	<0.2	3.7	0.5				0.023	0.023	0.003	<0.002	0.62		0.6	4.2		-122.2	7.4	6.73	0.00	0.00	0.04	0.01			0.05		0.00	0.00	0.83	0.17	
BDC-05-23	2/7/2017		2000		<0.2	<0.2	2.1	1.3				0.016	0.016	<0.002	<0.002	0.62		3.0	2.2		-65.0	7.1	6.70	0.00	0.00	0.02	0.02			0.04		0.00	0.00	0.51	0.49	
BDC-05-23	5/3/2017		2085		<0.2	<0.2	2.0	0.5				0.026	0.026	<0.002	<0.002	0.80		2.0	10.9		-37.3	7.2	6.52	0.00	0.00	0.02	0.01			0.03		0.00	0.00	0.72	0.28	
BDC-05-23	8/1/2017		2175		<0.2	<0.2	0.9	0.5				0.017	0.019	<0.002	<0.002	1.00		2.2	4.7		-20.5	6.7	6.15	0.00	0.00	0.01	0.01			0.02		0.00	0.00	0.54	0.46	
BDC-05-23	11/7/2017		2273	-3	<0.2	<0.2	2.6	1.8				0.025	0.025	<0.002	<0.002	0.44		3.2	2.0		10.5	7.5	6.61	0.00	0.00	0.03	0.03			0.06		0.00	0.00	0.48	0.52	
BDC-05-23	5/2/2018		2449	173	<0.2	<0.2	0.31	<0.2				0.026	0.026	0.001	<0.0005	0.51		1.4	11.4		30	5.6	6.45	0.00	0.00	0.00	0.00			0.00		0.00	0.00	1.00	0.00	
BDC-05-23	11/7/2018		2638	362	<0.2	<0.2	1.66	1.61				0.022	0.022	0.001	<0.0005	0.33		1.2	2.97		-23.5	6.23	6.58	0.00	0.00	0.02	0.03			0.04		0.00	0.00	0.40	0.60	
BDC-05-24	7/31/2011		-18		<1.0	<1.0	1.6	1.6	<1.1	<1.2	<1.1	0.003	0.003	<0.002	<0.002	1.67	<0.1	2.0	1.1	7.6	-7	10.0	7.06	0.00	0.00	0.02	0.03	0.00	0.00	0.04	0.00	0.00	0.00	0.39	0.61	0.00
(MW 18 ft XG)	11/1/2011		75		<1.0	2.0	4.0	2.2				0.002	0.002	<0.002	<0.002	1.50	<0.1	1.6	0.3		-2.6	8.1	7.06	0.00	0.02	0.04	0.04			0.09		0.00	0.17	0.45	0.38	
	2/19/2012		185		<0.2	0.2	0.7	0.8								0.31	<0.5	1.8	<1.5		63	9.8	6.55	0.00	0.00	0.01	0.01			0.02		0.00	0.07	0.34	0.59	
BDC-05-24	5/6/2012		262		<0.2	1.3	2.8	1.0				0.006	0.004	<0.002	<0.002	0.03			0.9		73	9.1	6.60	0.00	0.01	0.03	0.02			0.05		0.00	0.18	0.53	0.29	
BDC-05-24	9/5/2012		384		<0.2	1.2	4.0	0.9								0.08		2.0	<0.3		67	7.4	6.67	0.00	0.01	0.04	0.01			0.06		0.00	0.14	0.64	0.22	
BDC-05-24	11/15/2012		455		<0.5	<0.5	1.2	<0.5				0.002	0.003	<0.002	<0.002	0.13		1.0	<0.3		-1.7	10.7	6.94	0.00	0.00	0.01	0.00			0.01		0.00	0.00	1.00	0.00	
BDC-05-24	2/25/2013		557		<0.2	0.7	5.1	1.9	1.1	<1.2	<1.0					0.10		1.5	1.1	9.1	87	7.2	6.72	0.00	0.01	0.05	0.03	0.04	0.00	0.09	0.04	0.00	0.04	0.41	0.24	0.31
BDC-05-24	5/22/2013		643		<0.2	0.8	7.6	2.1				0.004	0.003	<0.002	<0.002	0.58		1.4	0.82		-272	7.4	7.54	0.00	0.01	0.08	0.03			0.12		0.00	0.05	0.66	0.28	
BDC-05-24	8/28/2013		741		<0.2	0.5	4.4	1.6	<1.0	1.8	<1.0					0.78		1.4	0.47	11.0	-321	8.6	6.57	0.00	0.00	0.05	0.03	0.00	0.06	0.07	0.06	0.00	0.03	0.34	0.19	0.44
BDC-05-24	11/13/2013		818		<0.2	0.4	3.3	1.4	<1.0	1.4	<1.0	0.003	0.003	<0.002	<0.002	2.43		1.3	1.4	11.0	-219	8.7	6.54	0.00	0.00	0.03	0.02	0.00	0.05	0.06	0.05	0.00	0.03	0.32	0.21	0.44
BDC-05-24	2/12/2014		909		<0.2	0.2	1.7	0.6	1.1	3.0	<1.0					2.72		2.0	0.81	11.0	-211	7.1	6.76	0.00	0.00	0.02	0.01	0.04	0.10	0.03	0.14	0.00	0.01	0.10	0.06	0.83
BDC-05-24	5/12/2014		998		<0.2	0.3	4.8	1.6	1.0	2.3	<1.0	0.003	0.002	<0.002	<0.002	2.58		1.2	0.87	10.0	-196	8.2	6.75	0.00	0.00	0.05	0.03	0.04	0.08	0.08	0.11	0.00	0.01	0.26	0.14	0.59
BDC-05-24	8/6/2014		1084		<0.2	0.2	2.8	1.8	3.6	2.3	<1.0					4.02		1.0	0.36	9.6	-167	9.5	7.33	0.00	0.00	0.03	0.03	0.13	0.08	0.06	0.20	0.00	0.01	0.11	0.11	0.78
BDC-05-24	11/10/2014		1180		<0.2	<0.2	6.2	12	2.0	<1.0	<1.0	0.001	0.001	<0.002	<0.002	0.05		1.2	1.8	0.97	-86	4.2	6.52	0.00	0.00	0.06	0.19	0.07	0.00	0.26	0.07	0.00	0.00	0.20	0.59	0.22
BDC-05-24	1/21/2015		1252		<0.2	0.4	2.1	1.6	2.5	<1.0	<1.0					0.14		2.0	2.3	5.4	-65	3.8	6.31	0.00	0.00	0.02	0.03	0.09	0.00	0.05	0.09	0.00	0.02	0.16	0.18	0.64
BDC-05-24	4/27/2015		1348		<0.2	0.5	0.9	2.5	2.5	<1.0	<1.0	0.003	0.003	<0.002	<0.002	0.08		0.8	0.97	3.2	-27	3.2	6.22	0.00	0.00	0.01	0.04	0.09	0.00	0.05	0.09	0.00	0.03	0.07	0.28	0.63
BDC-05-24	7/21/2015		1433		<0.2	0.3	1.3	3.9	<1.0	<1.0	<1.0					0.09		1.8	6.2	0.45	-23	2.2	6.27	0.00	0.00	0.01	0.06	0.00	0.00	0.08	0.00	0.00	0.03	0.17	0.80	0.00
BDC-05-24	10/28/2015		1532		<0.2	0.5	0.7	1.3	<1.0	<1.0	<1.0	0.003	0.004	<0.002	<0.002	0.47		1.0	5.1	1.4	-3.1	2.9	6.54	0.00	0.00	0.01	0.02	0.00	0.00	0.03	0.00	0.00	0.12	0.23	0.65	0.00
BDC-05-24	1/26/2016		1622		<0.2	<0.2	0.4	1.9	<1.0	1.2	<1.0					0.34		1.0	0.43	12.0	-76	8.3	6.47	0.00	0.00	0.00	0.03	0.00	0.04	0.03	0.04	0.00	0.00	0.06	0.41	0.54
BDC-05-24	4/20/2016		1707		<0.2	0.2	0.5	0.7	<1.0	1.8	<1.0	0.004	0.002	<0.002	<0.002	0.28			1.3	7.5	-3.8	4.6	6.44	0.00	0.00	0.01	0.01	0.00	0.06	0.02	0.06	0.00	0.02	0.07	0.14	0.77
BDC-05-24	8/9/2016		1818		<0.2	0.7	1.9	2.2	3.6	3.6	<1.0	0.005	0.003	<0.002	<0.002	0.15			2.2	6.0	-34.6	2.6	5.85	0.00	0.01	0.02	0.04	0.13	0.12	0.06	0.25	0.00	0.02	0.06	0.11	0.80
BDC-05-24	11/3/2016		1904		<0.2	0.2	0.7	0.8	1.9	1.3	<1.0	0.002	0.002	<0.002	<0.002	0.34		1.8	0.80	12.0	-86.4	4.9	5.95	0.00	0.00	0.01	0.01	0.07	0.04	0.02	0.11	0.00	0.01	0.05	0.10	0.84
BDC-05-24	2/8/2017		2001		<0.2	0.3	1.3	2.1	2.7	3.2	<1.0	0.003	0.002	<0.002	0.004	0.34		2.2	1.8	5.9	-6.4	4.0	6.41	0.00	0.00	0.01	0.03	0.10	0.11	0.05	0.20	0.00	0.01	0.05	0.13	0.80
BDC-05-24	5/4/2017		2086		<0.2	<0.2	0.4	0.5	<1.0	3.7	<1.0	0.004	0.003	<0.002	<0.002	0.20		2.4	1.5	5.9	-36.4	4.8	6.22	0.00	0.00	0.00	0.01	0.00	0.12	0.01	0.12	0.00	0.00	0.03	0.06	0.91
BDC-05-24	8/1/2017		2175		<0.2	<0.2	0.4	0.5	1.1	<1.0	<1.0	0.003	0.002	<0.002	<0.002	0.11		2.0	1.3	11.0	-51.1	5.7	5.92	0.00	0.00	0.00	0.01	0.04	0.00	0.01	0.04	0.00	0.00	0.08	0.16	0.76
BDC-05-24	11/7/2017		2273	-3	<0.2	<0.2	<0.2	0.5	<1.0	1.3	<1.0	0.002	0.001	<0.002	<0.002	0.37		1.8	<0.30	12.0	-10.7	8.4	6.42	0.00	0.00	0.00	0.01	0.00	0.04	0.01	0.04	0.00	0.00	0.00	0.16	0.84
BDC-05-24	5/2/2018		2449	173	<0.2	<0.2	<0.2	<0.2	<1.14	<1.23	<1.06	0.001	0.001	<0.0005	<0.0005	1.13		3.2	<0.1	7.24	-106.1	10.9	6.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA	NA	NA	NA	NA
BDC-05-24	11/6/2018		2637	361	<0.2	<0.2	0.26	0.66	<1.14	<1.23	<1.06	0.002	0.002	<0.0005	<0.0005	0.30		5.0	<0.100	17.0	-56.4	12.51	6.23	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.20	0.80	0.00

Abbreviations and Acronyms:

PCE = tetrachloroethene
TCE = trichloroethene
cDCE = cis-1,2-dichloroethene
VC = vinyl chloride
As = arsenic
Cu = copper
Tot = total
Dis = dissolved
DO = dissolved oxygen
ORP = oxidation reduction potential
TOC = total organic carbon
NA = not applicable, not available
µg/L = micrograms per liter
mg/L = milligrams per liter
IW = Injection Well
MW = Monitoring Well
DG = Downgradient; distance from nearest injection well
UG = Upgradient; distance from nearest injection well
XG = Crossgradient; distance from nearest injection well

Notes:

(a) Proposed Cleanup Standards and Comparison to Site Data, Boeing Developmental Center, Tukwila,Washington (Landau Associates, 5/7/13).
(c) Indicates the fraction of total ethenes due to each compound.
(d) Calculated by dividing the concentration in groundwater by the molecular weight of the compound. Reporting limits for non-detect results replaced with zero.
(e) Sum of PCE, TCE, cDCE, and VC.
(b) Calculated by dividing the concentration in groundwater by the molecular weight of the compound. Reporting limits for non-detect results replaced with zero.
(c) Indicates the fraction of total ethenes (PCE+TCE+cDCE+VC+ethene/ethane) due to each individual compound on a molar basis.
(d) Sum of PCE, TCE, cDCE, and VC.

Box = exceedance of proposed cleanup level

(green shading) = not analyzed
(blue shading) = Highlights the predominant ethene

Injection Dates:

10/28/2008 Pilot Injection: BDC-05-02 only
8/18/2011 Full Injection #1: BDC-05-02, BDC-05-07, and BDC-05-09 through BDC-05-17; performed 8/15/11-8/18/11
11/10/2017 Full Injection #2: BDC-05-02, BDC-05-03, BDC-05-04, BDC-05-07, and BDC-05-10; performed 11/7/17-11/10/2017

Table 6
SWMU-20 Cleanup Action
Summary Source Zone
Boeing Developmental Center
Tukwila, Washington

Well	Date	Elapsed Time from Injections (a) (days)					Volatile Organic Compounds						Aquifer Redox Conditions					Donor Parameters		Notes
							Proposed Groundwater Cleanup Levels (d)													
							5.3	1.4	134	2.4	---	---								
		1st Injection	2nd Injection	3rd (b) Injection	4th Injection	5th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	DO (mg/L)	ORP (mV)	Iron II mg/L	Sulfate (mg/L)	Methane (µg/L)	pH	TOC (mg/L)	Notes
06A (c)	06/15/2004	-2					<1.0	**1.0**	**23**	**4.0**	<0.50	<0.50	6.34	-19.6	0.8	58.9	<0.50	6.5	18.8	---
06A (c)	08/23/2004	67					<1.0	<1.0	**45**	**5.9**	<0.50	<0.50	0.46	92	3.5	40.7	21	7.0	288	Hazy brown
06A (c)	10/19/2004	124	-58				<1.0	<1.0	**2.6**	**31**	<0.50	<0.50	0.70	54	3.0	44.8	530	6.8	80.8	---
06A (c)	02/22/2005	250	68				<1.0	<1.0	**3.3**	<1.0	<0.50	<0.50	1.15	187	2.4	<0.1	130	6.8	244	---
06A (c)	05/16/2005	333	151				<1.0	<1.0	**2.6**	<1.0	<0.50	<0.50	1.25	58	3.0	0.1	10000	6.9	145	---
06A (c)	08/22/2005	431	249				<1.0	<1.0	**1.6**	<1.0	<0.50	<0.50	1.26	212	2.7	3.1	390	6.8	54.2	Clear, with yellow tint
06A (c)	11/14/2005	515	333				<1.0	<1.0	**1.3**	**1.2**	<0.50	<0.50	0.93	108	3.0	0.1	3700	6.9	31.8	---
06A (c)	02/22/2006	615	433				<1.0	<1.0	**1.4**	**4.8**	<11.4	<12.3	0.80	186	2.6	60.4	10100	6.4	15.5	---
06A (c)	05/18/2006	700	518				<1.0	<1.0	<1.0	**1.6**	<11	<12	6.41	1	3.0	20.9	16000	6.6	23.9	---
06A (c)	08/16/2006	790	608				<1.0	<1.0	<1.0	**1.5**	<1.1	<1.2	0.89	240	2.2	23.1	18800	6.5	23.2	---
06A (c)	11/29/2006	895	713				<0.2	<0.2	**0.4**	**2.1**	<1.1	<1.2	2.09	102	2.6	33.1	20200	6.5	31.4	---
06A (c)	02/23/2007	981	799				<1.0	<1.0	<1.0	**6.7**	<1.1	<1.2	0.65	-97	4.5	26.2	17400	6.5	24.6	---
06A (c)	05/24/2007	1071	889				<1.0	<1.0	<1.0	**2.9**	<1.1	**2.0**	0.56	184	4.0	21.0	18300	6.7	21.5	---
06A (c)	11/30/2007	1261	1079				<0.2	<0.2	<0.2	**1.2**	<1.1	**2.2**	0.80	173	3.0	29.1	21900	6.7	22.6	---
06A (c)	05/21/2008	1434	1252		-96		<1.0	<1.0	<1.0	**1.4**	<1.1	**1.3**	2.11	-82	2.5	21.0	13200	6.9	20.1	---
06A (c)	11/25/2008	1622	1440		92		<1.0	<1.0	**1.7**	<1.0	<1.1	<1.2	1.71	-73	3.4	0.1	19700	6.5	150	---
06A (c)	05/20/2009	1798	1616		268		<4.0	<4.0	<4.0	<4.0	<1.1	<1.2	0.52	-45	4.0	<0.5	19500	6.8	38.2	---
06A (c)	11/19/2009	1981	1799		451		<1.0	<1.0	**1.9**	<1.0	<1.1	<1.2	2.66	6	2.8	0.8	20100	6.2	25.4	---
06A (c)	5/24/2010	2167	1985		637		<1.0	<1.0	**1.3**	**1.9**	<1.1	<1.2	3.56	448	2.0	16	19900	6.6	19.3	---
06A (c)	11/11/2010	2338	2156		808		<1.0	<1.0	<1.0	**1.7**	<1.1	<1.2	4.75	106	2.6	0.4	24700	7.0	20.2	---
06A (c)	5/4/2011	2512	2330		982		<1.0	<1.0	<1.0	**1.4**	<1.1	<1.2	2.14	22	2.5	<0.2	21400	7.1	13.6	---
06A (c)	11/13/2011	2705	2523		1175		<0.2	<0.2	**0.3**	**0.8**	<1.1	<1.2	5.80	-54	1.0	0.3	6370	7.2	12.7	---
06A (c)	5/15/2012	2889	2707		1359		<0.2	<0.2	**0.4**	**1.2**	<1.0	<1.0	0.08	66	2.0	4.3	13000	6.7	11.6	---
06A (c)	11/14/2012	3072	2890		1542		<0.2	<0.2	**0.3**	**0.8**	<1.0	<4.0	0.02	-0.5	1.5	<0.30	13000	6.9	9.0	---
06A (c)	5/21/2013	3260	3078		1730		<0.5	<0.5	<0.5	**1.3**	<1.0	<1.0	0.17	-434	2.6	3.3	5200	7.9	8.8	---
06A (c)	11/12/2013	3435	3253		1905		<0.2	<0.2	**0.4**	**2.4**	<1.0	<1.0	2.68	-298	1.2	5.8	3500	6.8	8.3	---
06A (c)	5/7/2014	3611	3429		2081		<0.2	<0.2	**0.4**	**1.5**	<1.0	<1.0	3.60	-386	1.5	11.2	1300	7.1	7.2	---
06A (c)	11/5/2014	3793	3611		2263		<0.2	<0.2	**0.4**	**2.7**	<1.0	<1.0	0.28	-89	1.0	13.9	770	6.7	7.2	---
06A (c)	4/29/2015	3968	3786		2438		<0.2	<0.2	**0.6**	**3.3**	<1.0	<1.0	0.36	-54	3.0	17.5	430	6.7	5.2	---
06A (c)	10/26/2015	4148	3966		2618	-16	<0.2	<0.2	**0.2**	**2.5**	<1.0	<1.0	0.17	-66	0.8	19.7	410	6.6	6.5	---
06A (c)	4/19/2016	4324	4142		2794	160	<0.2	<0.2	**1**	**0.7**	<100	<100	0.06	-118	1.0	<0.30	18000	7.0	203	Cola brown
06A (c)	11/1/2016	4520	4338		2990	356	<0.2	<0.2	**0.5**	**0.7**	<100	<100	0.35	-154.9	NM	0.47	20000	7.1	121	Opaque dark brown/amber color
06A (c)	5/2/2017	4702	4520		3172	538	<0.2	<0.2	**0.3**	**0.4**	<1.0	**1.4**	0.26	-151.5	NM	<0.30	18000	7.2	124	Turbid, dark brown/amber color, strong injection fluid odor, no sheen
06A (c)	11/8/2017	4892	4710		3362	728	<0.2	<0.2	**0.3**	**0.3**	<1.0	**3.4**	0.41	-56.1	NM	16.1	13000	7.1	99.5	Cloudy, amber, injection fluid odor, no sheen (slight effervescence)
06A (c)	5/1/2018	5066	4884		3536	902	<2.0	<2.0	<2.0	<2.0	<1.14	<1.23	0.15	-28.7	NM	0.342	6130	7.2	149.3	Slightly turbid, amber color, strong injection fluid odor, no sheen (effervescent)
06A (c)	11/6/2018	5255	5073		3725	1091	<0.2	<0.2	<0.2	<0.2	<1.14	**1.55**	0.50	-61.9	NM	0.476	5090	7.0	116.1	Turbid with particulates, amber color, slight iron odor, no sheen
06B	05/04/2004	-44					**9.5**	**3.2**	**10**	**9.4**	<0.50	<0.50	0.36	179	4.5	18.7	130	6.8	25.6	Clear, yellow tint
06B	08/23/2004	67					**1.9**	**1.2**	**13**	**2.3**	<0.50	<0.50	0.45	115	3.2	33.8	1100	6.9	177	Yellow-brown tint (nearly clear)
06B	10/19/2004	124	-58				<1.0	<1.0	**10**	**3.6**	<0.50	<0.50	0.61	217	3.5	14.8	590	6.7	53.6	Yellow tint
06B	02/22/2005	250	68				<1.0	<1.0	**11**	<1.0	<0.50	<0.50	0.79	224	2.6	<0.5	3800	6.9	968	---
06B	05/16/2005	333	151				<2.0	<2.0	**5.5**	<2.0	<0.50	<0.50	1.51	133	3.5	<0.5	2300	6.9	336	Clear, yellow-brown tint
06B	08/22/2005	431	249				<1.0	<1.0	**1.8**	**1.6**	<0.50	<0.50	1.21	217	2.8	<0.1	440	6.9	100	Clear, with yellow tint
06B	11/14/2005	515	333				<1.0	<1.0	**1.1**	**1.3**	<0.50	<0.50	1.05	241	2.8	<0.1	2900	6.9	64.4	---
06B	02/22/2006	615	433				<1.0	<1.0	<1.0	**1.4**	**53.5**	<12.3	0.74	184	2.6	14.8	13000	6.4	30.4	---
06B	05/18/2006	700	518				<1.0	<1.0	<1.0	**1.3**	<11	<12	2.25	52	3.2	13.6	16000	6.6	25.9	---
06B	08/16/2006	790	608				<1.0	<1.0	<1.0	**1.1**	<1.1	<1.2	0.82	225	2.4	12.9	21700	6.5	14.7	---
06B	11/29/2006	895	713				<0.2	<0.2	**1.4**	**2.6**	<1.1	<1.2	1.82	111	2.4	10.9	22000	6.5	25.2	---
06B	02/23/2007	981	799				<1.0	<1.0	**3.8**	**9.5**	<1.1	<1.2	0.75	-66	5.0	25.0	17700	6.5	21.1	---
06B	05/24/2007	1071	889				<1.0	<1.0	**1.4**	**6.5**	<1.1	<1.2	0.58	151	3.0	11.3	18500	6.6	21.4	---
06B	11/30/2007	1261	1079				<0.2	<0.2	<0.2	**1.0**	<1.1	**4.0**	0.83	135	4.0	26.3	24900	6.4	26.5	---
06B	05/21/2008	1434	1252		-96		<1.0	<1.0	<1.0	<1.0	<1.1	**4.9**	2.66	-61	3.4	21.1	12700	6.7	20.4	---
06B	11/25/2008	1622	1440		92		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	2.53	-68	2.4	0.2	18400	6.6	19.6	---
06B	05/20/2009	1798	1616		268		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.33	-36	4.0	<0.5	25300	6.9	20.9	---

Table 6
SWMU-20 Cleanup Action
Summary Source Zone
Boeing Developmental Center
Tukwila, Washington

		Elapsed Time from Injections (a) (days)					Volatile Organic Compounds						Aquifer Redox Conditions					Donor Parameters		
							Proposed Groundwater Cleanup Levels (d)													
							5.3	1.4	134	2.4	---	---								
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	5th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	DO (mg/L)	ORP (mV)	Iron II mg/L	Sulfate (mg/L)	Methane (µg/L)	pH	TOC (mg/L)	Notes
06B	11/19/2009	1981	1799		451		<1.0	<1.0	<1.0	<1.0	<1.1	**6.7**	1.01	10	2.8	0.1	22500	6.9	20.0	---
06B	5/24/2010	2167	1985		637		<1.0	<1.0	<1.0	**4.2**	<1.1	**1.6**	3.05	417	2.0	3.0	7110	7.0	19.1	---
06B	11/11/2010	2338	2156		808		<1.0	<1.0	<1.0	**5.4**	<1.1	**1.4**	3.40	112	2.0	8.6	4600	7.1	15.8	---
06B	5/4/2011	2512	2330		982		<1.0	<1.0	<1.0	**5.2**	<1.1	<1.2	2.55	57	2.2	19.7	2120	7.1	12.6	---
06B	11/13/2011	2705	2523		1175		<0.2	<0.2	<0.2	**0.8**	<1.1	<1.2	6.10	-34	1.5	0.3	2260	7.3	14.8	---
06B	5/15/2012	2889	2707		1359		<0.2	<0.2	**0.5**	**6.0**	<1.0	**1.3**	0.14	71	1.8	10.9	2200	6.6	11.4	---
06B	11/14/2012	3072	2890		1542		<0.2	<0.2	<0.2	**3.7**	<1.0	**1.8**	0.02	10	2.0	7.0	2300	6.8	13.7	---
06B	5/21/2013	3260	3078		1730		<0.5	<0.5	<0.5	**4.3**	<1.0	<1.0	0.17	-427	2.5	20.1	720	7.7	11.0	---
06B	11/12/2013	3435	3253		1905		<0.2	<0.2	<0.2	**2.5**	<1.0	<1.0	2.62	-309	1.5	4.0	350	7.0	15.5	---
06B	5/7/2014	3611	3429		2081		<0.2	<0.2	<0.2	**2.4**	<1.0	<1.0	3.50	-320	1.6	2.8	1200	7.1	10.2	---
06B	11/5/2014	3793	3611		2263		<0.2	<0.2	<0.2	**1.8**	<1.0	<1.0	0.30	-54	1.7	4.7	2200	6.8	6.9	---
06B	4/29/2015	3968	3786		2438		<0.2	<0.2	<0.2	**1.8**	<1.0	<1.0	0.52	-39	1.0	0.99	1300	6.6	4.0	---
06B	10/26/2015	4148	3966		2618	-16	<0.2	<0.2	<0.2	**1.0**	<1.0	<1.0	0.99	-39	1.0	2.0	1900	6.6	4.9	---
06B	4/19/2016	4324	4142		2794	160	<2.0	<2.0	<2.0	<2.0	<100	<100	0.06	-78	NM	0.3	17000	6.8	306	---
06B	11/1/2016	4520	4338		2990	356	<0.2	<0.2	**0.5**	**0.2**	<100	<100	0.32	-148.5	NM	0.71	23000	7.24	274	Opaque dark brown/black color
06B	5/2/2017	4702	4520		3172	538	<0.2	<0.2	<0.2	**0.3**	<1.0	<1.0	0.17	-129.6	NM	1.3	21000	7.38	149	Turbid, dark brown/black color, strong injection fluid odor, no sheen
06B	11/8/2017	4892	4710		3362	728	<0.2	<0.2	<0.2	**0.6**	<1.0	**2.4**	0.10	-45.5	NM	<30.0	18000	6.88	320	Turbid, black, strong injection fluid odor
06B	5/1/2018	5066	4884		3536	902	<2.0	<2.0	<2.0	<2.0	<1.14	<1.23	1.05	14.0	NM	<0.5	5370	6.71	4147	Very turbid, black, no odor, no sheen
06B	11/6/2018	5255	5073		3725	1091	<0.2	<0.2	<0.2	<0.2	<1.14	<1.23	3.43	69.4	NM	1.01	4870	6.51	1740	Very turbid, dark brown/black color, slight iron odor, no sheen
06C	05/04/2004	-44					<1.0	<1.0	<1.0	<1.0	<0.50	**0.6**	0.40	93	5.0	20.7	360	6.7	29.0	---
06C	08/23/2004	67					<1.0	<1.0	**1.4**	<1.0	**5.7**	**5.9**	0.63	95	2.5	42.7	3100	6.3	1560	White froth on surface of purge water
06C	10/19/2004	124	-58				<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	2.00	206	3.0	18.1	450	6.3	464	Yellow tint
06C	02/22/2005	250	68				<1.0	<1.0	**3.6**	<1.0	<0.50	<0.50	0.82	198	2.6	<0.5	2400	6.9	858	---
06C	05/16/2005	333	151				<1.0	<1.0	**1.1**	<1.0	<0.50	<0.50	1.94	98	3.0	0.2	2700	7.0	111	Clear, with yellow tint
06C	08/22/2005	431	249				<1.0	<1.0	**1.1**	<1.0	<0.50	<0.50	1.36	194	2.8	<0.1	510	7.0	68.7	Clear, with yellow tint
06C	11/14/2005	515	333				<1.0	<1.0	**1.1**	<1.0	<0.50	<0.50	1.07	258	2.0	<0.1	2900	7.0	48.3	---
06C	02/22/2006	615	433				<1.0	<1.0	<1.0	<1.0	**47.7**	<12.3	0.88	247	1.4	47.5	12300	6.6	93.4	---
06C	05/18/2006	700	518				<1.0	<1.0	<1.0	<1.0	<11	<12	4.88	129	2.0	30.6	15000	6.6	36.6	---
06C	08/16/2006	790	608				<1.0	<1.0	<1.0	<1.0	<1.1	**2.3**	0.93	231	1.6	31.8	18900	6.6	13.4	---
06C	11/29/2006	895	713				<0.2	<0.2	**0.3**	<0.2	<1.1	**1.4**	2.25	192	1.8	27.3	20600	6.6	46.4	---
06C	02/23/2007	981	799				<1.0	<1.0	<1.0	<1.0	<1.1	**1.7**	1.08	-46	4.0	25.9	18900	6.4	39.0	---
06C	05/24/2007	1071	889				<1.0	<1.0	<1.0	<1.0	<1.1	**2.0**	0.72	216	3.5	20.8	20800	6.5	34.0	---
06C	11/30/2007	1261	1079				<0.2	<0.2	**0.2**	**0.3**	<1.1	**2.8**	1.58	174	4.2	32.6	30500	6.2	40.2	---
06C	05/21/2008	1434	1252		-96		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	2.91	-16	2.5	21.0	23800	6.3	31.9	---
06C	11/25/2008	1622	1440		92		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	3.39	-66	2.6	<0.1	28700	6.8	634	---
06C	05/20/2009	1798	1616		268		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.66	-28	3.5	<0.8	20600	6.9	39.2	---
06C	11/19/2009	1981	1799		451		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	1.89	26	NM	<0.1	25600	6.2	42.8	---
09A	05/03/2004	-45					**150**	**230**	**970**	**37**	<0.50	<0.50	0.46	287	1.0	64.2	8.4	6.7	16.2	Clear, yellow tint
09A	08/23/2004	67					<3.0	**11**	**370**	**150**	**4.2**	<0.50	0.40	143	2.6	51.8	4.7	7.1	56.8	Clear with black tint, H2S odor
09A	10/19/2004	124	-58				<5.0	**19**	**460**	**220**	**2.7**	<0.50	0.53	219	4.0	77.4	17	6.9	19.6	Clear, slightly yellow tint
09A	02/21/2005	249	67				<10	<10	**41**	**37**	**1.9**	<0.50	0.78	169	2.0	<0.5	1500	7.1	2110	Hazy, yellow color
09A	05/11/2005	328	146				<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	1.53	141	2.0	<0.5	1700	7.2	1260	Hazy, yellow-brown tint
09A	08/22/2005	431	249				<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	1.58	141	2.8	<0.1	460	6.8	156	Clear, yellow-brown tint
09A	11/14/2005	515	333				<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	1.07	238	2.0	<0.1	2600	6.9	62.8	---
09A	02/21/2006	614	432				<1.0	<1.0	<1.0	<1.0	<11.4	<12.3	0.94	332	2.6	0.2	5650	6.3	58.8	---
09A	05/15/2006	697	515				<1.0	<1.0	<1.0	<1.0	<11	<12	1.35	193	2.2	63.4	15000	6.4	44.4	---
09A	08/16/2006	790	608				<1.0	<1.0	<1.0	**1.2**	<1.1	**2.1**	1.55	175	2.0	56.8	16800	6.4	50.0	---
09A	11/27/2006	893	711				<0.2	<0.2	**0.3**	**1.1**	**1.9**	**6.3**	2.09	211	3.2	52.5	15200	6.6	51.0	---
09A	02/22/2007	980	798				<1.0	<1.0	<1.0	<1.0	<1.1	**7.8**	0.65	-107	4.6	0.3	15300	6.4	48.8	---
09A	05/22/2007	1069	887				<1.0	<1.0	<1.0	**2.8**	<1.1	**4.8**	0.75	91	2.6	0.1	16700	6.6	43.1	---
09A	11/29/2007	1260	1078				<1.0	<1.0	<1.0	<1.0	<1.1	**24.5**	1.01	147	3.8	45.4	27600	6.4	40.6	---
09A	05/19/2008	1432	1250		-98		<0.2	**0.2**	**110**	**85**	**7.8**	**35.6**	2.26	-82	3.0	29.4	17100	6.7	31.0	---
09A	11/24/2008	1621	1439		91		**1.9**	**4.6**	**160**	**42**	**4.0**	**2.1**	2.61	-52	3.0	<2.0	13700	6.2	5600	---
09A	05/18/2009	1796	1614		266		<10	<10	<10	<10	<1.1	<1.2	0.44	-88	2.5	<2.0	18100	7.1	1620	---
09A	11/16/2009	1978	1796		448		<5.0	<1.0	<5.0	<5.0	<1.1	<1.2	1.23	-61	2.6	<1.0	16600	6.6	403	---
09A	5/20/2010	2163	1981		633		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	11.09	515	2.2	<1.0	18700	7.0	72.8	Duffy: Interference w/DO sensor?

Table 6
SWMU-20 Cleanup Action
Summary Source Zone
Boeing Developmental Center
Tukwila, Washington

Well	Date	Elapsed Time from Injections (a) (days)					Volatile Organic Compounds						Aquifer Redox Conditions					Donor Parameters		Notes
							Proposed Groundwater Cleanup Levels (d)													
							5.3	1.4	134	2.4	---	---								
		1st Injection	2nd Injection	3rd (b) Injection	4th Injection	5th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	DO (mg/L)	ORP (mV)	Iron II mg/L	Sulfate (mg/L)	Methane (µg/L)	pH	TOC (mg/L)	Notes
09A	11/10/2010	2337	2155		807		<1.0	<1.0	<1.0	<1.0	<1.1	**2.0**	3.92	118	2.2	0.3	24400	7.0	70.0	---
09A	5/3/2011	2511	2329		981		<2.0	<2.0	<2.0	<2.0	<1.1	**2.0**	2.55	33	2.0	<0.2	17800	6.9	44.4	---
09A	11/13/2011	2705	2523		1175		<0.2	<0.2	**0.2**	<0.2	<1.1	**1.2**	2.23	-66	1.2	0.4	11800	7.0	39.4	---
09A	5/14/2012	2888	2706		1358		<0.2	<0.2	**0.2**	<0.2	<1.0	**13**	0.57	91	1.5	0.40	22000	6.4	30.5	---
09A	11/14/2012	3072	2890		1542		<2.0	<2.0	<2.0	<2.0	<1.0	**11**	0.02	-4	2.0	0.53	21000	6.6	30.9	---
09A	5/21/2013	3260	3078		1730		<2.0	<2.0	<2.0	<2.0	<1.0	**16**	0.32	-399	1.8	<0.30	24000	7.8	33.0	---
09A	11/12/2013	3435	3253		1905		<2.0	<2.0	<2.0	<2.0	<1.0	**10**	3.87	-258	1.7	0.41	18000	6.5	30.2	---
09A	5/7/2014	3611	3429		2081		<2.0	<2.0	<2.0	<2.0	<1.0	**29**	4.46	-322	1.4	0.50	26000	6.7	21.5	---
09A	11/5/2014	3793	3611		2263		<0.2	<0.2	<0.2	<0.2	<1.0	**15**	0.12	-90	2.0	<0.30	25000	6.6	24.8	---
09A	4/29/2015	3968	3786		2438		<0.2	<0.2	<0.2	<0.2	<1.0	**28**	0.20	-63	1.4	0.58	27000	6.4	17.8	---
09A	10/26/2015	4148	3966		2618	-16	<0.2	<0.2	<0.2	<0.2	<1.0	**49**	0.10	-38	1.0	0.57	21000	6.3	21.7	---
09A	4/19/2016	4324	4142		2794	160	<0.2	<0.2	<0.2	**0.7**	<1.0	**34**	0.15	-105	0.8	<0.30	22000	6.7	33.3	---
09A	11/1/2016	4520	4338		2990	356	<0.2	<0.2	<0.2	<0.2	<1.0	**120**	0.73	-89	NM	<0.30	19000	6.46	17.5	Slight yellow/greenish tint
09A	5/2/2017	4702	4520		3172	538	<0.2	<0.2	<0.2	<0.2	<1.0	**430**	1.03	-118.2	NM	<0.30	20000	6.58	22.3	Clear, yellow tint, injection fluid odor, no sheen
09A	11/8/2017	4892	4710		3362	728	<0.2	<0.2	<0.2	**0.4**	**51**	**230**	0.34	17.6	NM	0.85	21000	6.59	16.7	Clear, colorless, slight injection fluid-like odor, no sheen
09A	5/1/2018	5066	4884		3536	902	<0.2	<0.2	<0.2	**2.23**	**3.54**	**575**	0.08	-37.1	NM	0.107	14900	6.59	25.22	Clear, golden/yellow tint, no odor, no sheen
09A	11/5/2018	5254	5072		3724	1090	<0.2	<0.2	<0.2	<0.2	<1.14	**402**	0.33	-102.4	NM	0.409	9960	6.64	22.61	Clear, golden tint, slightest injection fluid odor, no sheen
09B	05/03/2004	-45					<3.0	**4.2**	**250**	<3.0	<0.50	<0.50	0.37	269	4.0	61.4	2.7	6.8	20.7	Clear, yellow tint
09B	08/23/2004	67					<5.0	**16**	**530**	**100**	**0.76**	<0.50	0.34	174	1.4	73.0	23	7.4	29.7	Clear, yellow-brown tint, H2S odor
09B	10/19/2004	124	-58				<5.0	**17**	**300**	**340**	**1.4**	<0.50	0.30	219	1.0	59.6	29	7.5	24.3	Clear with yellow color
09B	02/21/2005	249	67				<10	<10	**890**	**520**	**1.7**	<0.50	0.56	160	2.8	1.0	2000	6.8	608	Hazy, tan brown color
09B	05/11/2005	328	146				<1.0	<1.0	**12**	**24**	<0.50	<0.50	1.48	158	3.5	0.4	9600	7.0	219	Hazy, yellow-brown tint
09B	08/22/2005	431	249				<1.0	<1.0	<1.0	**1.7**	<0.50	<0.50	1.45	224	2.5	<0.1	400	6.7	17.6	Clear, with yellow-brown tint
09B	11/14/2005	515	333				<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	1.24	235	1.4	<0.1	3100	6.8	51.2	---
09B	02/21/2006	614	432				<1.0	<1.0	<1.0	**1.3**	<11.4	<12.3	0.90	329	2.8	<0.1	8730	6.3	46.4	---
09B	05/15/2006	697	515				<1.0	<1.0	<1.0	<1.0	<11	<12	1.11	191	1.8	33.9	17000	6.3	45.6	---
09B	08/16/2006	790	608				<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.94	188	1.6	55.4	19300	6.3	250	---
09B	11/27/2006	893	711				<0.2	<0.2	**0.3**	**0.5**	<1.1	<1.2	1.76	190	2.8	50.2	21800	6.5	78.2	---
09B	02/22/2007	980	798				<1.0	<1.0	<1.0	<1.0	<1.1	**1.6**	0.67	-80	3.5	0.2	16100	6.3	64.0	---
09B	05/22/2007	1069	887				<1.0	<1.0	<1.0	<1.0	<1.1	**1.4**	0.76	154	3.0	<0.1	18700	6.5	35.3	---
09B	11/29/2007	1260	1078				<1.0	<1.0	<1.0	<1.0	<1.1	**3.8**	1.29	238	2.2	58.3	29800	6.2	44.5	---
09B	05/19/2008	1432	1250		-98		<0.2	<0.2	**0.2**	**0.4**	<1.1	**3.0**	2.34	-78	3.4	39.1	12900	6.4	37.3	---
09B	11/24/2008	1621	1439		91		<1.0	<1.0	<1.0	<1.0	<1.1	**17.6**	2.22	-47	3.0	<1.0	27000	6.7	27.0	---
09B	05/18/2009	1796	1614		266		<1.0	<1.0	<1.0	<1.0	<1.1	**6.9**	0.38	-38	3.5	<0.5	19700	6.9	37.1	---
09B	11/16/2009	1978	1796		448		<1.0	<1.0	<1.0	<1.0	<1.1	**16.1**	1.27	12	3.5	<0.1	24500	6.2	28.1	---
09C	05/03/2004	-45					<1.0	<1.0	**4.0**	**3.3**	**1.9**	**0.7**	0.33	229	4.0	19.1	350	6.8	28.5	Clear, yellow tint
09C	08/23/2004	67					<1.0	<1.0	**1.7**	<1.0	**1.1**	**2.8**	0.47	114	2.6	23.2	610	6.7	302	Clear, H2S odor
09C	10/19/2004	124	-58				<1.0	<1.0	<1.0	**1.5**	**1.1**	<0.50	0.60	185	3.0	12.2	620	7.0	99.6	Near clear, yellow tint
09C	02/21/2005	249	67				<1.0	<1.0	**1.7**	<1.0	<0.50	**1.6**	0.60	154	2.0	<0.1	3500	6.6	300	Clear with yellow tint
09C	05/11/2005	328	146				<1.0	<1.0	**1.2**	<1.0	<0.50	<0.50	1.34	138	2.5	<0.1	2700	6.4	44.6	Yellow-brown tint
09C	08/22/2005	431	249				<1.0	<1.0	**7.6**	**2.2**	<0.50	<0.50	1.31	230	2.5	<0.1	360	6.7	52.0	---
09C	11/14/2005	515	333				<1.0	<1.0	**1.2**	<1.0	<0.50	<0.50	1.41	228	2.4	<0.1	7300	6.9	50.6	---
09C	02/21/2006	614	432				<1.0	<1.0	<1.0	<1.0	<11.4	<12.3	0.78	326	2.4	<0.1	10300	6.5	44.2	---
09C	05/15/2006	697	515				<1.0	<1.0	<1.0	<1.0	<11	<12	1.01	192	2.0	27.9	21000	7.0	42.1	---
09C	08/16/2006	790	608				<1.0	<1.0	<1.0	<1.0	<1.1	**1.6**	0.80	199	1.2	28.8	22900	6.5	33.0	---
09C	11/27/2006	893	711				<0.2	<0.2	<0.2	<0.2	<1.1	**9.1**	1.40	289	2.4	26.7	23500	6.5	44.0	---
09C	02/22/2007	980	798				<1.0	<1.0	<1.0	<1.0	<1.1	**3.9**	0.75	-32	3.6	0.2	17700	6.5	33.8	---
09C	05/22/2007	1069	887				<1.0	<1.0	<1.0	<1.0	<1.1	**5.4**	0.52	123	3.5	<0.1	20600	6.6	25.4	---
09C	11/29/2007	1260	1078				<1.0	<1.0	<1.0	<1.0	<1.1	**5.4**	0.81	147	3.6	27.3	30000	6.5	27.1	---
09C	05/19/2008	1432	1250		-98		<0.2	<0.2	<0.2	**0.2**	<1.1	**15.2**	2.11	-57	4.6	18.6	22800	6.5	22.3	---
09C	11/24/2008	1621	1439		91		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	2.92	-44	1.8	<2.0	17700	6.6	334	---
09C	05/18/2009	1796	1614		266		<1.0	<1.0	<1.0	<1.0	<1.1	**4.3**	0.45	-44	3.5	<0.5	21400	7.0	24.0	---
09C	11/16/2009	1978	1796		448		<3.0	<3.0	<3.0	<3.0	<1.1	**1.9**	1.27	-7	3.0	<0.1	22400	6.4	20.7	---
10A	05/03/2004	-45					**29**	**27**	**80**	**6.4**	<0.50	<0.50	0.60	108	2.0	37.8	2.8	6.8	20.0	Clear, yellow tint

Table 6
SWMU-20 Cleanup Action
Summary Source Zone
Boeing Developmental Center
Tukwila, Washington

		Elapsed Time from Injections (a) (days)					Volatile Organic Compounds						Aquifer Redox Conditions					Donor Parameters		
							Proposed Groundwater Cleanup Levels (d)													
							5.3	1.4	134	2.4	---	---								
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	5th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	DO (mg/L)	ORP (mV)	Iron II mg/L	Sulfate (mg/L)	Methane (µg/L)	pH	TOC (mg/L)	Notes
10A	08/23/2004	67					**14**	**12**	**170**	**4.0**	<0.50	<0.50	0.49	181	3.5	38.9	1.1	7.0	59.6	Clear, black tint
10A	10/19/2004	124	-58				**15**	**15**	**100**	**23**	<0.50	<0.50	0.66	224	4.0	37.8	2.7	7.0	24.0	Clear
10A	02/21/2005	249	67				**4.7**	**4.8**	**24**	**6.8**	<0.50	**0.54**	0.53	166	3.6	24.3	430	7.0	22.4	Clear, yellow color
10A	05/11/2005	328	146				**4.2**	**5.4**	**26**	**7.2**	<0.50	<0.50	0.95	47	3.0	27.9	540	7.2	25.9	Clear, yellow-brown tint
10A	08/22/2005	431	249				**2.7**	**6.3**	**48**	**76**	<0.50	<0.50	0.73	177	2.0	48.8	240	7.0	31.4	Clear, with yellow-brown tint
10A	11/14/2005	515	333				**3.3**	**6.7**	**47**	**73**	<0.50	<0.50	0.91	178	2.0	50.6	370	7.1	34.1	---
10A	02/21/2006	614	432				**3.7**	**9.6**	**42**	**150**	<11.4	<12.3	0.54	320	2.0	53.9	1130	6.8	45.8	---
10A	05/15/2006	697	515				**1.8**	**3.7**	**63**	**19**	<11	<12	0.67	190	1.8	57.4	3100	6.8	49.2	---
10A	08/16/2006	790	608				**1.6**	**1.6**	**38**	**20**	<1.1	<1.2	1.50	201	1.4	57.5	1620	6.7	50.8	---
10A	11/27/2006	893	711				<0.2	<0.2	**7.4**	**9.2**	**2.6**	**2.6**	2.67	201	3.0	57.9	1650	6.9	56.0	---
10A	02/22/2007	980	798				**1.2**	<1.0	**32**	**35**	<1.1	<1.2	0.57	-176	4.6	20.4	1370	6.8	56.4	---
10A	05/22/2007	1069	887				**1.1**	<1.0	**28**	**44**	<1.1	**1.4**	0.88	73	3.0	10.2	2590	6.9	47.3	---
10A	11/29/2007	1260	1078				**1.2**	<1.0	**22**	**78**	**4.4**	**3.7**	0.80	106	4.2	47.9	4810	6.9	47.8	---
10A	05/19/2008	1432	1250		-98		<1.0	<1.0	**22**	**180**	**7.9**	**4.4**	2.19	-177	4.0	32.5	4870	7.0	33.3	---
10A	11/24/2008	1621	1439		91		<1.0	<1.0	**1.6**	**5.0**	<1.1	<1.2	2.29	-87	3.4	1.3	16900	7.1	1200	---
10A	05/18/2009	1796	1614		266		<2.0	<2.0	<2.0	<2.0	<1.1	<1.2	0.66	-80	3.3	<1.0	17900	6.9	168	---
10A	11/16/2009	1978	1796		448		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	3.14	-40	4.2	<1.0	18200	6.3	69.2	---
10A	5/20/2010	2163	1981		633		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	16.23	341	3.0	<1.0	17600	6.8	60.4	Duffy: Replace DO electrolic membrane
10A	11/10/2010	2337	2155		807		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	4.09	67	2.4	0.5	22800	6.9	56.8	---
10A	5/3/2011	2511	2329		981		<2.0	<2.0	<2.0	<2.0	<1.1	<1.2	2.47	-21	2.5	<0.2	20700	6.9	41.6	---
10A	11/13/2011	2705	2523		1175		<0.2	<0.2	**0.2**	**0.4**	<1.1	<1.2	2.45	-38	2.0	0.3	15400	7.1	33.8	---
10A	5/14/2012	2888	2706		1358		<0.2	<0.2	**0.2**	**0.4**	<1.0	<1.0	0.57	88	2.5	0.32	20000	6.4	38.0	---
10A	11/14/2012	3072	2890		1542		<0.2	<0.2	**0.3**	**0.4**	<1.0	<1.0	0.03	-16	2.0	<0.30	19000	6.6	30.6	---
10A	5/21/2013	3260	3078		1730		<0.2	<0.2	**0.2**	**0.3**	<1.0	<3.0	0.35	-340	1.8	<0.30	26000	7.5	29.5	---
10A	11/12/2013	3435	3253		1905		<0.2	<0.2	**0.2**	**0.4**	<1.0	**2.5**	3.53	-242	1.4	0.38	16000	6.5	29.1	---
10A	5/7/2014	3611	3429		2081		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	4.06	-305	2.1	<0.30	26000	6.7	27.9	---
10A	11/5/2014	3793	3611		2263		<0.2	<0.2	**0.2**	**0.3**	<1.0	**5.5**	0.17	-134	2.0	<0.30	25000	6.5	26.1	---
14A	05/04/2004	-44					<1.0	<1.0	**140**	**110**	<0.50	<0.50	0.53	-8	7.5	38.9	590	6.8	20.7	Clear, yellow tint
14A	08/23/2004	67					<1.0	**2.9**	**560**	**180**	**0.89**	**0.67**	0.54	162	3.2	30.1	810	6.8	22.6	---
14A	10/19/2004	124	-58				<5.0	**39**	**1200**	**650**	<0.50	<0.50	0.64	69	3.0	43.3	350	6.9	20.6	---
14A	02/21/2005	249	67	-24			<5.0	<5.0	**300**	**1000**	**13**	**2.7**	0.41	101	1.8	3.8	1700	6.9	44.0	Clear, yellow tint
14A	05/16/2005	333	151	60			<10	<10	<10	<10	<0.50	<0.50	5.90	45	4.0	<2.0	590	6.4	8620	---
14A	08/22/2005	431	249	158			<10	<10	<10	<10	<0.50	<0.50	1.62	234	3.0	<2.0	220	6.8	5380	Clear, yellow-brown
14A	11/15/2005	516	334	243			<3.0	<3.0	**6.0**	<3.0	<0.50	<0.50	1.26	257	2.0	<0.1	2500	6.4	602	---
14A	02/21/2006	614	432	341			<1.0	<1.0	<1.0	<1.0	<11.4	<12.3	1.36	335	2.0	<0.1	5400	7.4	180	---
14A	05/17/2006	699	517	426			<2.0	<2.0	**2.1**	<2.0	<11	<12	1.78	76	2.8	12.0	9400	6.4	67.1	---
14A	08/16/2006	790	608	517			<1.0	<1.0	**3.0**	<1.0	<1.1	<1.2	1.16	240	1.2	16.5	6320	6.5	66.0	---
14A	11/29/2006	895	713	622			<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	1.57	248	2.8	11.8	11100	6.3	72.0	---
14A	02/22/2007	980	798	707			<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.89	-56	7.0	0.2	7670	6.2	34.9	---
14A	05/23/2007	1070	888	797			<1.0	<1.0	**1.5**	<1.0	<1.1	<1.2	1.11	165	3.0	8.6	10100	6.3	27.5	---
14A	12/03/2007	1264	1082	991			<1.0	<1.0	**1.6**	<1.0	<1.1	<1.2	2.29	-86	3.2	15.9	14500	6.4	55.6	---
14A	05/20/2008	1433	1251	1160	-97		<1.0	<1.0	**1.2**	<1.0	<1.1	<1.2	3.45	-88	3.6	<0.1	12100	6.3	26.3	---
14A	11/24/2008	1621	1439	1348	91		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	2.79	-70	3.0	194	14500	6.1	8.68	---
14A	05/20/2009	1798	1616	1525	268		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.41	-95	3.5	20.0	14400	6.3	9.83	---
14A	11/17/2009	1979	1797	1706	449		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.81	-18	3.2	165	15800	5.7	6.22	---
14A	5/24/2010	2167	1985	1894	637		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	4.29	311	2.8	5.1	14600	6.4	8.07	---
14A	11/10/2010	2337	2155	2064	807		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	2.47	171	2.6	38.6	14300	6.8	6.88	---
14A	5/5/2011	2513	2331	2240	983		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	2.96	83	1.8	8.4	15100	7.1	3.28	---
14A	11/13/2011	2705	2523	2432	1175		<0.2	<0.2	**0.6**	<0.2	<1.1	<1.2	2.04	-52	1.5	<0.1	7510	6.9	8.05	---
14A	5/14/2012	2888	2706	2615	1358		<0.2	<0.2	**0.3**	**0.2**	<1.0	**8.7**	0.13	62	2.6	3.4	16000	6.4	5.9	---
14A	11/14/2012	3072	2890	2799	1542		<0.2	<0.2	**0.6**	<0.2	<1.0	**5.0**	0.03	31	1.5	79.0	16000	6.4	6.5	---
14A	5/21/2013	3260	3078	2987	1730		<0.5	<0.5	<0.5	<0.5	<1.0	**4.8**	0.24	-428	2.4	2.3	18000	7.4	6.5	---
14A	11/12/2013	3435	3253	3162	1905		<0.2	<0.2	**0.5**	<0.2	<1.0	**6.3**	4.46	-286	1.3	0.52	14000	6.4	8.0	---
14A	5/7/2014	3611	3429	3338	2081		<0.2	<0.2	**0.3**	**0.3**	<1.0	**4.6**	4.39	-427	1.6	19.9	15000	6.8	6.5	---
14A	11/5/2014	3793	3611	3520	2263		<0.2	<0.2	**0.4**	**0.2**	<1.0	**10**	0.04	-48	2.0	23.6	15000	6.5	6.8	---
15A	05/03/2004	-45					<5.0	<5.0	<5.0	<5.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	---
15A	10/26/2004	131	-51				<5.0	<5.0	<5.0	<5.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	---

Table 6
SWMU-20 Cleanup Action
Summary Source Zone
Boeing Developmental Center
Tukwila, Washington

		Elapsed Time from Injections (a) (days)					Volatile Organic Compounds						Aquifer Redox Conditions					Donor Parameters		
							Proposed Groundwater Cleanup Levels (d)													
							5.3	1.4	134	2.4	---	---								
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	5th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	DO (mg/L)	ORP (mV)	Iron II mg/L	Sulfate (mg/L)	Methane (µg/L)	pH	TOC (mg/L)	Notes
15A	05/16/2005	333	151				<5.0	<5.0	<5.0	<5.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	---
15A	11/15/2005	516	334				<5.0	<5.0	<5.0	<5.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	---
15A	05/17/2006	699	517				<5.0	<5.0	<5.0	<5.0	NA	NA	0.79	131	NA	NA	NA	6.7	NA	---
15A	11/29/2006	895	713				<3.0	<3.0	<3.0	<3.0	NA	NA	1.26	513	NA	NA	NA	6.6	NA	---
15A	05/23/2007	1070	888				<1.0	<1.0	**1.4**	**2.6**	NA	NA	1.19	144	NA	NA	NA	6.7	NA	---
15A	12/03/2007	1264	1082				<1.0	<1.0	<1.0	**1.3**	NA	NA	1.31	-105	NA	NA	NA	6.6	NA	---
15A	05/20/2008	1433	1251		-97		<3.0	<3.0	<3.0	<3.0	NA	NA	2.57	-135	NA	NA	NA	6.7	NA	---
15A	11/24/2008	1621	1439		91		<1.0	<1.0	<1.0	<2.0	NA	NA	2.07	-61	NA	NA	NA	6.8	NA	---
15A	05/19/2009	1797	1615		267		<3.0	<3.0	<3.0	<3.0	NA	NA	0.35	-33	NA	NA	NA	6.9	NA	---
15A	11/18/2009	1980	1798		450		<1.0	<1.0	<1.0	**1.4**	NA	NA	0.72	-0.1	NA	NA	NA	6.3	NA	---
15A	5/20/2010	2163	1981		633		<1.0	<1.0	<1.0	**1.6**	NA	NA	1.10	606	NA	NA	NA	6.8	NA	---
15A	11/10/2010	2337	2155		807		<1.0	<1.0	<1.0	**1.4**	NA	NA	2.42	118	NA	NA	NA	7.1	NA	---
15A	5/5/2011	2513	2331		983		<10	<10	<10	<10	NA	NA	4.83	-19	NA	NA	NA	7.2	NA	---
15A	11/13/2011	2705	2523		1175		<0.2	<0.2	**0.3**	**1.0**	NA	NA	4.01	-41	NA	NA	NA	7.3	NA	---
15A	5/14/2012	2888	2706		1358		<1.0	<1.0	<1.0	**1.2**	NA	NA	0.64	56	NA	NA	NA	6.7	NA	---
15A	11/13/2012	3071	2889		1541		<0.2	<0.2	**0.4**	**0.8**	NA	NA	0.03	23	NA	NA	NA	6.8	NA	---
15A	5/21/2013	3260	3078		1730		<0.5	<0.5	**0.6**	**1.1**	NA	NA	0.20	-394	NA	NA	NA	7.4	NA	---
15A	11/12/2013	3435	3253		1905		<0.2	<0.2	**0.5**	**0.8**	NA	NA	3.38	-267	NA	NA	NA	6.7	NA	---
15A	5/7/2014	3611	3429		2081		<0.2	<0.2	**0.6**	**1.0**	NA	NA	3.86	-351	NA	NA	NA	6.9	NA	---
15A	11/5/2014	3793	3611		2263		<0.2	<0.2	**0.4**	**0.5**	NA	NA	0.09	-126	NA	NA	NA	6.8	NA	---
19A	05/02/2004	-46	-228				<1.0	<1.0	<1.0	<1.0	NA	NA	0.33	-3	NA	NA	NA	6.5	NA	---
19A	02/21/2005	249	67				<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	0.65	180	NA	47.4	17	6.7	15.5	---
19A	05/12/2005	329	147				<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	0.63	169	3.0	31.3	9.1	6.8	14.2	Clear, colorless
19A	08/22/2005	431	249				<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	0.74	106	3.0	68.3	16	6.6	10.5	Clear, colorless
19A	11/15/2005	516	334				<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	0.56	201	2.6	95.9	35	6.8	9.30	---
19A	02/22/2006	615	433				<1.0	<1.0	<1.0	<1.0	<11.4	<12.3	0.77	65	3.0	124.0	111	6.6	31.3	---
19A	05/17/2006	699	517				<1.0	<1.0	<1.0	<1.0	<11	<12	1.14	56	2.0	73.4	230	6.4	15.7	---
19A	08/15/2006	789	607				<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.60	229	2.0	47.3	202	6.4	11.5	---
19A	11/27/2006	893	711				<0.2	**0.2**	**0.3**	<0.2	<1.1	<1.2	0.88	264	2.0	41.9	186	6.4	13.6	---
19A	02/22/2007	980	798				<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.42	-23	3.0	20.7	248	6.2	19.8	---
19A	05/22/2007	1069	887				<1.0	<1.0	<1.0	<1.0	<1.1	**5.2**	0.34	277	3.5	30.8	179	6.4	15.4	---
19A	11/29/2007	1260	1078				<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.67	243	2.2	37.2	235	6.2	14.3	---
19A	05/20/2008	1433	1251		-97		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	3.23	-79	3.8	20.9	134	6.4	11.5	---
19A	11/23/2008	1620	1438		90		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	1.62	-61	2.0	46.1	97.8	6.4	10.6	---
19A	05/19/2009	1797	1615		267		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.30	-28	3.2	28.6	127	6.8	12.8	---
19A	11/18/2009	1980	1798		450		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	1.58	-2	3.4	22.1	122	6.5	10.7	---
22A	03/21/2005	277	95	4			<1.0	<1.0	**3.5**	**2.0**	<0.50	<0.50	1.86	53	2.8	12.8	280	7.0	11.1	Hazy, suspended silt
22A	05/12/2005	329	147	56			<1.0	<1.0	**2.3**	**2.9**	<0.50	<0.50	0.83	155	2.6	1.3	300	7.1	31.3	---
22A	08/22/2005	431	249	158			<1.0	<1.0	**2.3**	**3.2**	<0.50	<0.50	0.70	170	2.6	3.0	230	6.9	26.5	Clear, slight yellow-brown tint
22A	11/16/2005	517	335	244			<1.0	<1.0	**1.4**	**2.2**	<0.50	<0.50	1.67	321	2.4	1.3	1300	6.3	29.9	---
22A	02/22/2006	615	433	342			<1.0	<1.0	**1.4**	**3.3**	<11.4	<12.3	0.69	97	2.0	59.0	1940	6.8	32.0	---
22A	05/17/2006	699	517	426			<1.0	<1.0	**2.4**	**1.7**	<11	<12	0.67	102	2.6	32.7	3600	6.8	17.6	---
22A	08/15/2006	789	607	516			<1.0	<1.0	**1.8**	**2.4**	<1.1	<1.2	0.65	239	2.0	54.7	5700	6.7	24.0	---
22A	11/30/2006	896	714	623			<0.2	**0.3**	**2.2**	**2.4**	<1.1	<1.2	2.15	286	2.6	40.0	4020	6.6	25.2	---

Table 6
SWMU-20 Cleanup Action
Summary Source Zone
Boeing Developmental Center
Tukwila, Washington

Well	Date	Elapsed Time from Injections (a) (days)					Volatile Organic Compounds						Aquifer Redox Conditions					Donor Parameters		Notes
							Proposed Groundwater Cleanup Levels (d)													
							5.3	1.4	134	2.4	---	---								
		1st Injection	2nd Injection	3rd (b) Injection	4th Injection	5th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	DO (mg/L)	ORP (mV)	Iron II mg/L	Sulfate (mg/L)	Methane (µg/L)	pH	TOC (mg/L)	
22A	02/22/2007	980	798	707			<1.0	<1.0	**2.5**	**2.3**	<1.1	<1.2	0.53	-76	5.0	<0.1	3000	6.6	22.4	---
22A	05/23/2007	1070	888	797			<1.0	<1.0	**2.5**	**2.7**	<1.1	<1.2	0.30	51	3.0	27.3	3510	6.8	18.2	---
22A	12/03/2007	1264	1082	991			<1.0	<1.0	**2.0**	**1.3**	<1.1	<1.2	0.61	41	2.6	12.3	2030	6.6	16.0	---
22A	05/20/2008	1433	1251	1160	-97		<1.0	<1.0	**2.6**	**1.9**	<1.1	<1.2	2.83	-103	4.0	20.2	1540	6.7	13.8	---
22A	11/23/2008	1620	1438	1347	90		<1.0	<1.0	**2.2**	**3.1**	<1.1	<1.2	1.13	-70	1.8	2.6	3100	6.8	19.2	---
22A	05/19/2009	1797	1615	1524	267		<1.0	<1.0	**2.5**	**2.5**	<1.1	<1.2	0.26	-43	3.2	3.4	3490	7.0	21.0	---
22A	11/18/2009	1980	1798	1707	450		<1.0	<1.0	**2.1**	**1.8**	<1.1	<1.2	0.43	-3.3	3.0	2.1	2060	6.4	13.8	---
22A	5/24/2010	2167	1985	1894	637		<1.0	<1.0	**1.7**	**1.7**	<1.1	<1.2	6.58	204	2.4	0.6	2370	7.0	15.1	---
22A	11/11/2010	2338	2156	2065	808		<1.0	<1.0	**1.2**	**2.7**	<1.1	<1.2	3.27	113	2.2	0.5	4650	7.0	21.8	---
22A	5/4/2011	2512	2330	2239	982		<1.0	<1.0	**1.1**	**2.2**	<1.1	<1.2	1.96	4	2.0	0.6	6350	7.0	22.4	---
22A	11/13/2011	2705	2523	2432	1175		<0.2	<0.2	**0.9**	**1.7**	<1.1	<1.2	2.89	-38	1.2	0.4	2510	7.3	17.6	---
22A	5/14/2012	2888	2706	2615	1358		<0.2	<0.2	**0.6**	**2.0**	<1.0	**3.3**	0.03	45	2.2	<0.30	5100	6.8	25.4	---
22A	11/14/2012	3072	2890	2799	1542		<0.2	<0.2	**0.5**	**1.8**	<1.0	**1.7**	0.03	1	1.8	<0.30	4400	6.9	22.7	---
22A	5/20/2013	3259	3077	2986	1729		<0.2	<0.2	**0.4**	**2.0**	<1.0	**1.6**	0.24	-404	1.0	<0.30	6100	7.7	24.6	---
22A	11/12/2013	3435	3253	3162	1905		<0.2	<0.2	**0.5**	**1.7**	<1.0	**1.1**	3.69	-289	1.4	1.8	3500	6.7	19.8	---
22A	5/7/2014	3611	3429	3338	2081		<0.2	<0.2	**0.5**	**1.6**	<1.0	<1.0	4.8	-368	1.3	0.66	4200	6.8	23.6	---
22A	11/5/2014	3793	3611	3520	2263		<0.2	<0.2	**0.4**	**1.5**	<1.0	**1.5**	0.13	-131	1.5	0.39	4800	6.8	25.8	---
22A	4/29/2015	3968	3786	3695	2438		<0.2	<0.2	**0.6**	**1.5**	<1.0	<1.0	0.09	-87	1.0	2.0	4300	6.5	14.8	---
22A	10/27/2015	4149	3967	3876	2619	-15	<0.2	<0.2	**0.5**	**1.5**	<1.0	<1.0	0.07	-64	2.0	2.6	3500	6.6	16.7	---
22A	4/19/2016	4324	4142	4051	2794	160	<0.2	<0.2	**0.5**	<0.2	<100	<100	0.14	-163	1.0	1.9	15000	7.0	2980	---
22A	11/2/2016	4521	4339	4248	2991	357	<0.2	<0.2	**0.5**	<0.2	<100	<100	0.37	-252.6	NM	<0.30	18000	7.34	542	Clear dark brown/amber color
22A	5/2/2017	4702	4520	4429	3172	538	<0.2	<0.2	**0.4**	**0.3**	<1.0	<1.0	0.41	-206.8	NM	<0.30	18000	7.24	300	Clear, dark brown/amber color, injection fluid odor, no sheen, very effervescent
22A	11/8/2017	4892	4710	4619	3362	728	<0.2	<0.2	**0.6**	**0.3**	<1.0	**1.8**	0.32	-17.5	NM	<15.0	17000	7.10	277	Clear, dark amber tint, injection fluid odor, no sheen (slight effervescence)
22A	5/1/2018	5066	4884	4793	3536	902	<2.0	<2.0	<2.0	<2.0	<1.14	<1.23	0.08	-94.7	NM	<0.5	18800	7.12	297.2	Turbid, amber color, strong injection fluid odor, no sheen (very effervescent)
22A	11/5/2018	5254	5072	4981	3724	1090	<2.0	<2.0	<2.0	<2.0	<1.14	<1.23	0.89	-161.9	NM	<0.10	13100	6.98	191.6	Clear, dark amber tint, injection fluid odor, no sheen
23A	03/21/2005	277	95	4			<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	0.63	81	2.0	0.4	410	7.0	33.0	Slight yellow tint
23A	05/12/2005	329	147	56			<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	0.58	158	2.0	<0.1	260	7.2	39.9	---
23A	08/22/2005	431	249	158			<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	0.75	130	3.4	1.5	98	7.0	21.0	---
23A	11/16/2005	517	335	244			<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	0.49	291	2.6	4.1	140	7.2	30.8	---
23A	02/22/2006	615	433	342			<1.0	<1.0	<1.0	<1.0	<11.4	<12.3	0.60	127	2.2	91.8	1520	6.4	34.5	---
23A	05/17/2006	699	517	426			<1.0	<1.0	<1.0	<1.0	<11	<12	0.60	120	3.0	38.8	1700	6.7	30.0	---
23A	08/15/2006	789	607	516			<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.77	256	2.2	63.9	3080	6.7	32.6	---
23A	11/30/2006	896	714	623			<0.2	<0.2	<0.2	<0.2	<1.1	<1.2	1.96	287	2.5	40.7	1930	6.2	45.2	---
23A	02/22/2007	980	798	707			<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.40	-58	2.0	2.9	1360	6.5	34.6	---
23A	05/23/2007	1070	888	797			<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.41	193	3.3	52.7	1850	6.4	38.7	---
23A	11/30/2007	1261	1079	988			<0.2	<0.2	**0.3**	<0.2	<1.1	<1.2	0.55	159	2.2	81.1	4430	6.6	38.6	---
23A	05/21/2008	1434	1252	1161	-96		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	3.12	-28	2.2	31.7	1570	6.1	29.6	---
23A	11/25/2008	1622	1440	1349	92		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	4.22	-68	1.8	<0.1	3270	6.8	39.0	---
23A	05/19/2009	1797	1615	1524	267		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.31	-3	3.2	0.1	2370	6.5	39.1	---
23A	11/18/2009	1980	1798	1707	450		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.41	1	2.4	1.6	1970	6.5	30.9	---

Abbreviations and Acronyms:

µg/L = micrograms per liter
cDCE = cis-1,2-dichloroethene
DO = dissolved oxygen
mg/L = milligrams per liter
mV = millivolts
NA = not analyzed
NM = not measured
ORP = oxidation reduction potential
PCE = tetrachloroethene
TCE = trichloroethene
TOC = total organic carbon
VC = vinyl chloride

Notes:

(a) Injections occurred on:
6/17/04 (6A, B, C; 9A, B, C)
12/16-17/04 (6A, 6B;9A,9B)
3/17/05 (14A)
8/25-28/08 (6A, 9A, 10A)
10/27-11/11/15 (6A, 6B, 10C, 15C, 16A, 16C, 17A, 20C, 22A)
(b) Conducted at Well MW-14A only.
(c) MW-06A installed June 2004.
(d) Proposed Cleanup Standards and Comparison to Site Data, Boeing Developmental Center, Tukwila,Washington (Landau Associates, 5/7/13).

Box = exceedance of proposed cleanup level
Bold = detected compund

Table 7
SWMU-20 Cleanup Action Summary
Non-Source Zone
Boeing Developmental Center
Tukwila, Washington

Well	Date	Elapsed Time from Injections (a) (days)					Volatile Organic Compounds			
							Proposed Groundwater Cleanup Levels (c)			
							5.3	**1.4**	**134**	**2.4**
		1st Injection	2nd Injection	3rd (b) Injection	4th Injection	5th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)
MW-8C	5/3/2004	-45					<1.0	<1.0	<1.0	**2.8**
MW-8C	10/25/2004	130	-52				<1.0	<1.0	<1.0	**3.5**
MW-8C	5/12/2005	329	147				<1.0	<1.0	<1.0	<1.0
MW-8C	11/14/2005	515	333				<1.0	<1.0	<1.0	<1.0
MW-8C	5/15/2006	697	515				<10	<10	<10	<10
MW-8C	11/27/2006	893	711				<5.0	<5.0	<5.0	<5.0
MW-8C	5/21/2007	1068	886				<3.0	<3.0	<3.0	<3.0
MW-8C	11/29/2007	1260	1078				<5.0	<5.0	<5.0	<5.0
MW-8C	5/19/2008	1432	1250		-98		<5.0	<5.0	<5.0	<5.0
MW-8C	11/23/2008	1620	1438		90		<5.0	<5.0	<5.0	<5.0
MW-8C	05/18/2009	1796	1614		266		<1.0	<1.0	<1.0	<1.0
MW-8C	11/16/2009	1978	1796		448		<3.0	<3.0	<3.0	<3.0
MW-9D	5/3/2004	-45					<1.0	<1.0	<1.0	<1.0
MW-9D	10/19/2004	124	-58				<1.0	<1.0	<1.0	<1.0
MW-9D	5/11/2005	328	146				<1.0	<1.0	<1.0	<1.0
MW-9D	11/14/2005	515	333				<1.0	<1.0	<1.0	<1.0
MW-9D	5/15/2006	697	515				<1.0	<1.0	<1.0	<1.0
MW-9D	11/27/2006	893	711				<1.0	<1.0	<1.0	<1.0
MW-9D	5/22/2007	1069	887				<1.0	<1.0	<1.0	<1.0
MW-9D	11/29/2007	1260	1078				<1.0	<1.0	<1.0	<1.0
MW-9D	5/19/2008	1432	1250		-98		<0.2	<0.2	<0.2	<0.2
MW-9D	11/24/2008	1621	1439		91		<1.0	<1.0	<1.0	<1.0
MW-9D	05/18/2009	1796	1614		266		<1.0	<1.0	<1.0	<1.0
MW-9D	11/16/2009	1978	1796		448		<1.0	<1.0	<1.0	<1.0
MW-10C	5/3/2004	-45					<1.0	<1.0	**4.3**	**4.0**
MW-10C	10/19/2004	124	-58				<1.0	<1.0	**6.4**	**11**
MW-10C	5/11/2005	328	146				<1.0	<1.0	**4.0**	**1.9**
MW-10C	11/14/2005	515	333				<1.0	<1.0	<1.0	**1.0**
MW-10C	5/15/2006	697	515				<1.0	<1.0	**1.5**	**2.2**
MW-10C	11/27/2006	893	711				<0.2	<0.2	**1.9**	**2.6**
MW-10C	5/22/2007	1069	887				<1.0	<1.0	**6.7**	**5.8**
MW-10C	11/29/2007	1260	1078				<1.0	<1.0	**7.2**	**5.6**
MW-10C	5/19/2008	1432	1250		-98		<0.2	<0.2	**15**	**6.9**
MW-10C	11/24/2008	1621	1439		91		<1.0	<1.0	**8.5**	**7.5**
MW-10C	05/18/2009	1796	1614		266		<1.0	<1.0	<1.0	<1.0
MW-10C	11/16/2009	1978	1796		448		<1.0	<1.0	<1.0	<1.0
MW-10C	5/20/2010	2163	1981		633		<1.0	<1.0	<1.0	<1.0
MW-10C	11/10/2010	2337	2155		807		<1.0	<1.0	**3.5**	**4.4**
MW-10C	5/3/2011	2511	2329		981		<1.0	<1.0	**5.8**	**4.7**
MW-10C	11/13/2011	2705	2523		1175		<0.2	<0.2	**3.7**	**4.3**
MW-10C	5/14/2012	2888	2706		1358		<0.2	<0.2	**5.4**	**4.0**
MW-10C	11/14/2012	3072	2890		1542		<0.2	<0.2	**6.1**	**4.4**
MW-10C	5/21/2013	3260	3078		1730		<0.2	<0.2	**6.0**	**4.5**
MW-10C	11/12/2013	3435	3253		1905		<0.2	<0.2	**3.5**	**3.7**
MW-10C	5/7/2014	3611	3429		2081		<0.2	<0.2	**5.4**	**2.9**
MW-10C	11/5/2014	3793	3611		2263		<0.2	<0.2	**2.6**	**2.5**
MW-10C	4/28/2015	3967	3785		2437		<0.2	<0.2	**2.2**	**1.7**
MW-10C	10/26/2015	4148	3966		2618	-16	<0.2	<0.2	**1.0**	**1.1**
MW-10C	4/19/2016	4324	4142		2794	160	<0.2	<0.2	**0.5**	<0.2
MW-10C	11/1/2016	4520	4338		2990	356	<0.2	<0.2	**0.5**	<0.2
MW-10C	5/2/2017	4702	4520		3172	538	<0.2	<0.2	**0.4**	**0.2**
MW-10C	11/8/2017	4892	4710		3362	728	<0.2	<0.2	**0.5**	**0.2**
MW-10C	5/1/2018	5066	4884		3536	902	<0.2	<0.2	**0.55**	**0.39**
MW-10C	11/5/2018	5254	5072		3724	1090	<0.2	<0.2	**0.39**	**0.22**
MW-11A	5/2/2004	-46					<1.0	**2.1**	**21**	<1.0
MW-11A	10/25/2004	130	-52				<1.0	**2.0**	**20**	<1.0
MW-11A	5/12/2005	329	147				<1.0	**2.0**	**20**	<1.0

Table 7
SWMU-20 Cleanup Action Summary
Non-Source Zone
Boeing Developmental Center
Tukwila, Washington

							Volatile Organic Compounds			
							Proposed Groundwater Cleanup Levels (c)			
		Elapsed Time from Injections (a) (days)					5.3	1.4	134	2.4
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	5th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)
MW-11A	11/15/2005	516	334				<1.0	2.0	22	<1.0
MW-11A	5/16/2006	698	516				<1.0	1.1	20	<1.0
MW-11A	11/26/2006	892	710				<1.0	1.5	24	<1.0
MW-11A	5/22/2007	1069	887				<1.0	1.5	26	<1.0
MW-11A	11/27/2007	1258	1076				<1.0	1.1	27	<1.0
MW-11A	5/19/2008	1432	1250		-98		<0.2	1.2	26	0.2
MW-11A	11/23/2008	1620	1438		90		<1.0	1.2	33	<1.0
MW-11A	05/18/2009	1796	1614		266		<1.0	<1.0	26	<1.0
MW-11A	11/17/2009	1979	1797		449		<1.0	1.0	30	<1.0
MW-11A	5/19/2010	2162	1980		632		<1.0	1.1	26	<1.0
MW-11A	11/8/2010	2335	2153		805		<1.0	<1.0	22	<1.0
MW-11A	5/3/2011	2511	2329		981		<1.0	<1.0	22	<1.0
MW-11A	11/13/2011	2705	2523		1175		<0.2	0.5	23	0.4
MW-11A	5/14/2012	2888	2706		1358		<0.2	0.7	24	0.4
MW-11A	11/14/2012	3072	2890		1542		<2.0	<2.0	25	<2.0
MW-11A	5/21/2013	3260	3078		1730		<2.0	<2.0	22	<2.0
MW-11A	11/12/2013	3435	3253		1905		<2.0	<2.0	24	<2.0
MW-11A	5/7/2014	3611	3429		2081		<2.0	<2.0	19	<2.0
MW-11A	11/4/2014	3792	3610		2262		<0.2	0.4	24	0.4
MW-11A	4/28/2015	3967	3785		2437		<0.2	0.5	21	0.3
MW-11A	10/26/2015	4148	3966		2618	-16	0.2	0.2	19	0.4
MW-11A	4/19/2016	4324	4142		2794	160	<0.2	0.3	20	0.4
MW-11A	11/1/2016	4520	4338		2990	356	<0.2	<0.2	15	0.5
MW-11A	5/2/2017	4702	4520		3172	538	<0.2	0.4	18	0.6
MW-11A	11/8/2017	4892	4710		3362	728	<0.2	0.2	21	0.5
MW-11A	5/1/2018	5066	4884		3536	902	0.26	0.26	11.8	0.35
MW-11A	11/5/2018	5254	5072		3724	1090	<0.2	<0.2	13.9	0.40
MW-12A	5/2/2004	-46					<1.0	<1.0	1.8	<1.0
MW-12A	10/25/2004	130	-52				<1.0	<1.0	4.4	<1.0
MW-12A	5/12/2005	329	147				<1.0	<1.0	2.0	<1.0
MW-12A	11/15/2005	516	334				<1.0	<1.0	3.8	<1.0
MW-12A	5/16/2006	698	516				<1.0	<1.0	1.5	<1.0
MW-12A	11/26/2006	892	710				<0.2	0.7	4.4	<0.2
MW-12A	5/22/2007	1069	887				<1.0	<1.0	2.4	<1.0
MW-12A	11/27/2007	1258	1076				<1.0	<1.0	3.2	<1.0
MW-12A	5/19/2008	1432	1250		-98		<0.2	0.6	3.2	<0.2
MW-12A	11/23/2008	1620	1438		90		<1.0	<1.0	4.7	<1.0
MW-12A	05/18/2009	1796	1614		266		<1.0	<1.0	1.4	<1.0
MW-12A	11/17/2009	1979	1797		449		<1.0	<1.0	4.7	<1.0
MW-12A	5/19/2010	2162	1980		632		<1.0	<1.0	<1.0	<1.0
MW-12A	11/8/2010	2335	2153		805		<1.0	<1.0	4.3	<1.0
MW-12A	5/3/2011	2511	2329		981		<1.0	<1.0	<1.0	<1.0
MW-12A	11/13/2011	2705	2523		1175		<0.2	0.6	3.1	<0.2
MW-12A	5/14/2012	2888	2706		1358		0.2	<0.2	<0.2	<0.2
MW-12A	11/14/2012	3072	2890		1542		<0.2	0.4	2.1	<0.2
MW-12A	5/21/2013	3260	3078		1730		<0.2	<0.2	0.5	<0.2
MW-12A	11/12/2013	3435	3253		1905		<0.2	0.5	2.2	<0.2
MW-12A	5/7/2014	3611	3429		2081		0.3	<0.2	<0.2	<0.2
MW-12A	11/4/2014	3792	3610		2262		0.3	<0.2	0.3	<0.2
MW-13A	5/2/2004	-46					5.1	4.6	<1.0	<1.0
MW-13A	10/25/2004	130	-52				4.3	4.0	<1.0	<1.0
MW-13A	5/12/2005	329	147				6.1	4.6	<1.0	<1.0
MW-13A	11/14/2005	515	333				6.0	4.5	<1.0	<1.0
MW-13A	5/16/2006	698	516				7.1	4.6	<1.0	<1.0
MW-13A	11/27/2006	893	711				8.3	6.5	0.3	<0.2
MW-13A	5/21/2007	1068	886				8.2	7.0	0.4	<0.2
MW-13A	11/28/2007	1259	1077				6.4	4.2	<1.0	<1.0
MW-13A	5/19/2008	1432	1250		-98		8.7	6.8	0.3	<0.2

Table 7
SWMU-20 Cleanup Action Summary
Non-Source Zone
Boeing Developmental Center
Tukwila, Washington

		Elapsed Time from Injections (a) (days)					Volatile Organic Compounds			
							Proposed Groundwater Cleanup Levels (c)			
							5.3	1.4	134	2.4
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	5th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)
MW-13A	11/23/2008	1620	1438		90		**6.5**	**3.7**	<1.0	<1.0
MW-13A	05/18/2009	1796	1614		266		**7.7**	**5.6**	<1.0	<1.0
MW-13A	11/17/2009	1979	1797		449		**9.2**	**6.0**	<1.0	<1.0
MW-13A	5/20/2010	2163	1981		633		**9.4**	**5.3**	<1.0	<1.0
MW-13A	11/10/2010	2337	2155		807		**3.6**	**2.8**	<1.0	<1.0
MW-13A	5/4/2011	2512	2330		982		**3.9**	**2.4**	<1.0	<1.0
MW-13A	11/3/2011	2695	2513		1165		**1.6**	<1.0	<1.0	<1.0
MW-13A	5/14/2012	2888	2706		1358		**2.3**	**0.8**	<0.2	<0.2
MW-13A	11/13/2012	3071	2889		1541		**2.2**	**0.8**	<0.2	<0.2
MW-13A	5/21/2013	3260	3078		3078		**4.5**	**2.5**	**0.5**	<0.2
MW-13A	11/12/2013	3435	3253		3253		**2.2**	**0.6**	<0.2	<0.2
MW-13A	5/7/2014	3611	3429		3429		**3.1**	**1.3**	<0.2	<0.2
MW-13A	11/4/2014	3792	3610		3610		**2.3**	**0.5**	<0.2	<0.2
MW-13A	4/28/2015	3967	3785		3785		**1.8**	**0.4**	<0.2	<0.2
MW-13A	10/27/2015	4149	3967		3967	-15	**1.5**	**0.3**	<0.2	<0.2
MW-13A	4/19/2016	4324	4142		4142	160	**1.6**	**0.3**	<0.2	<0.2
MW-13A	11/1/2016	4520	4338		4338	356	**2.3**	**0.7**	<0.2	<0.2
MW-13A	5/2/2017	4702	4520		4520	538	**1.1**	<0.2	<0.2	<0.2
MW-13A	11/8/2017	4892	4710		4710	728	**1.6**	**0.3**	<0.2	<0.2
MW-13A	5/1/2018	5066	4884		4884	902	**1.45**	**0.43**	<0.2	<0.2
MW-13A	11/5/2018	5254	5072		5072	1090	**1.91**	**0.58**	<0.2	<0.2
MW-13C	5/2/2004	-46					<1.0	<1.0	<1.0	**2.5**
MW-13C	10/25/2004	130	-52				<1.0	<1.0	<1.0	**3.3**
MW-13C	5/12/2005	329	147				<1.0	<1.0	<1.0	<1.0
MW-13C	11/14/2005	515	333				<1.0	<1.0	<1.0	**3.8**
MW-13C	5/16/2006	698	516				<1.0	<1.0	<1.0	**2.2**
MW-13C	11/27/2006	893	711				<0.2	<0.2	**0.8**	**3.4**
MW-13C	5/21/2007	1068	886				<0.2	<0.2	**0.8**	**4.4**
MW-13C	11/28/2007	1259	1077				<1.0	<1.0	<1.0	**2**
MW-13C	5/19/2008	1432	1250		-98		<0.2	<0.2	**0.2**	**0.6**
MW-13C	11/23/2008	1620	1438		90		<1.0	<1.0	<1.0	**2.2**
MW-13C	05/18/2009	1796	1614		266		<1.0	<1.0	<1.0	<1.0
MW-13C	11/17/2009	1979	1797		449		<1.0	<1.0	<1.0	<1.0
MW-13C	5/20/2010	2163	1981		633		<1.0	<1.0	<1.0	<1.0
MW-13C	11/10/2010	2337	2155		807		<1.0	<1.0	<1.0	<1.0
MW-13C	5/4/2011	2512	2330		982		<1.0	<1.0	<1.0	<1.0
MW-13C	11/3/2011	2695	2513		1165		<1.0	<1.0	<1.0	<1.0
MW-13C	5/14/2012	2888	2706		1358		<0.2	<0.2	<0.2	**0.3**
MW-13C	11/13/2012	3071	2889		1541		<2.0	<2.0	<2.0	<2.0
MW-13C	5/21/2013	3260	3078		1730		<2.0	<2.0	<2.0	<2.0
MW-13C	11/12/2013	3435	3253		1905		<2.0	<2.0	<2.0	<2.0
MW-13C	5/7/2014	3611	3429		2081		<1.0	<1.0	<1.0	<1.0
MW-13C	11/4/2014	3792	3610		2262		<0.2	<0.2	<0.2	**0.2**
MW-13C	4/28/2015	3967	3785		2437		<0.2	<0.2	<0.2	**0.3**
MW-13C	10/27/2015	4149	3967		2619	-15	<0.2	<0.2	<0.2	**0.2**
MW-13C	4/19/2016	4324	4142		2794	160	<0.2	<0.2	<0.2	**0.3**
MW-13C	11/1/2016	4520	4338		2990	356	<0.2	<0.2	<0.2	**0.2**
MW-13C	5/2/2017	4702	4520		3172	538	<0.2	<0.2	<0.2	**0.3**
MW-13C	11/8/2017	4892	4710		3362	728	<0.2	<0.2	<0.2	**0.3**
MW-13C	5/1/2018	5066	4884		3536	902	<0.2	<0.2	<0.2	**0.25**
MW-13C	11/5/2018	5254	5072		3724	1090	<0.2	<0.2	<0.2	<0.2
MW-14C	5/4/2004	-44					<1.0	<1.0	**63**	**44**
MW-14C	10/26/2004	131	-51	-142			<1.0	<1.0	**22**	**75**
MW-14C	5/16/2005	333	151	60			<1.0	<1.0	**11**	**6.1**
MW-14C	11/15/2005	516	334	243			<1.0	<1.0	<1.0	**1.8**
MW-14C	5/17/2006	699	517	426			<1.0	<1.0	<1.0	<1.0
MW-14C	11/29/2006	895	713	622			<0.2	<0.2	<0.2	**1.0**
MW-14C	5/23/2007	1070	888	797			<1.0	<1.0	<1.0	**2.5**

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SWMU-20 Cleanup Action Summary
Non-Source Zone
Boeing Developmental Center
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							Volatile Organic Compounds			
							Proposed Groundwater Cleanup Levels (c)			
		Elapsed Time from Injections (a) (days)					5.3	1.4	134	2.4
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	5th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)
MW-14C	12/3/2007	1264	1082	991			<1.0	<1.0	**1.1**	**11**
MW-14C	5/20/2008	1433	1251	1160	-97		<1.0	<1.0	**1.4**	**22**
MW-14C	11/24/2008	1621	1439	1348	91		<1.0	<1.0	<1.0	**4.3**
MW-14C	05/20/2009	1798	1616	1525	268		<1.0	<1.0	<1.0	**1.1**
MW-14C	11/17/2009	1979	1797	1706	449		<1.0	<1.0	<1.0	<1.0
MW-14C	5/24/2010	2167	1985	1894	637		<1.0	<1.0	<1.0	<1.0
MW-14C	11/10/2010	2337	2155	2064	807		<1.0	<1.0	<1.0	<1.0
MW-14C	5/5/2011	2513	2331	2240	983		<1.0	<1.0	<1.0	<1.0
MW-14C	11/13/2011	2705	2523	2432	1175		<0.2	<0.2	<0.2	<0.2
MW-14C	5/14/2012	2888	2706	2615	1358		<0.2	<0.2	<0.2	<0.2
MW-14C	11/14/2012	3072	2890	2799	1542		<2.0	<2.0	<2.0	<2.0
MW-14C	5/21/2013	3260	3078	2987	1730		<2.0	<2.0	<2.0	<2.0
MW-14C	11/12/2013	3435	3253	3162	1905		<2.0	<2.0	<2.0	<2.0
MW-14C	5/7/2014	3611	3429	3338	2081		<1.0	<1.0	<1.0	<1.0
MW-14C	11/5/2014	3793	3611	3520	2263		<0.2	<0.2	<0.2	<0.2
MW-14C	4/29/2015	3968	3786	3695	2438		<0.2	<0.2	<0.2	<0.2
MW-14C	10/27/2015	4149	3967	3876	2619	-15	<0.2	<0.2	<0.2	<0.2
MW-14C	4/19/2016	4324	4142	4051	2794	160	<0.2	<0.2	<0.2	**0.3**
MW-14C	11/2/2016	4521	4339	4248	2991	357	<0.2	<0.2	<0.2	<0.2
MW-14C	5/2/2017	4702	4520	4429	3172	538	<0.2	<0.2	<0.2	**0.2**
MW-14C	11/8/2017	4892	4710	4619	3362	728	<0.2	<0.2	**0.2**	**0.2**
MW-14C	5/1/2018	5066	4884	4793	3536	902	<0.2	<0.2	**0.22**	<0.2
MW-14C	11/6/2018	5255	5073	4982	3725	1091	<0.2	<0.2	<0.2	<0.2
MW-14E	5/4/2004	-44					<1.0	<1.0	<1.0	<1.0
MW-14E	10/26/2004	131	-51	-142			<1.0	<1.0	<1.0	<1.0
MW-14E	5/16/2005	333	151	60			<1.0	<1.0	<1.0	<1.0
MW-14E	11/15/2005	516	334	243			<1.0	<1.0	<1.0	<1.0
MW-14E	5/17/2006	699	517	426			<1.0	<1.0	<1.0	<1.0
MW-14E	11/29/2006	895	713	622			<0.2	<0.2	<0.2	<0.2
MW-14E	5/23/2007	1070	888	797			<1.0	<1.0	<1.0	<1.0
MW-14E	12/3/2007	1264	1082	991			<1.0	<1.0	<1.0	<1.0
MW-14E	5/20/2008	1433	1251	1160	-97		<1.0	<1.0	<1.0	<1.0
MW-14E	11/24/2008	1621	1439	1348	91		<1.0	<1.0	<1.0	<1.0
MW-14E	05/20/2009	1798	1616	1525	268		<1.0	<1.0	<1.0	<1.0
MW-14E	11/17/2009	1979	1797	1706	449		<1.0	<1.0	<1.0	<1.0
MW-15C	5/3/2004	-45					<1.0	<1.0	**9.1**	**11**
MW-15C	10/26/2004	131	-51				<1.0	<1.0	**11**	**17**
MW-15C	5/16/2005	333	151				<1.0	<1.0	**13**	**6.4**
MW-15C	11/15/2005	516	334				<1.0	<1.0	<1.0	<1.0
MW-15C	5/17/2006	699	517				<1.0	<1.0	<1.0	<1.0
MW-15C	11/29/2006	895	713				<0.2	<0.2	<0.2	<0.2
MW-15C	5/23/2007	1070	888				<1.0	<1.0	<1.0	**2.2**
MW-15C	12/3/2007	1264	1082				<1.0	<1.0	<1.0	**2.5**
MW-15C	5/20/2008	1433	1251		-97		<1.0	<1.0	**1.8**	**6.6**
MW-15C	11/24/2008	1621	1439		91		<1.0	<1.0	**1.9**	**6.6**
MW-15C	05/19/2009	1797	1615		267		<1.0	<1.0	<1.0	<1.0
MW-15C	11/18/2009	1980	1798		450		<1.0	<1.0	<1.0	<1.0
MW-15C	5/20/2010	2163	1981		633		<1.0	<1.0	<1.0	<1.0
MW-15C	11/10/2010	2337	2155		807		<1.0	<1.0	<1.0	<1.0
MW-15C	5/5/2011	2513	2331		983		<1.0	<1.0	<1.0	<1.0
MW-15C	11/13/2011	2705	2523		1175		<0.2	<0.2	<0.2	<0.2
MW-15C	5/14/2012	2888	2706		1358		<0.2	<0.2	<0.2	<0.2
MW-15C	11/13/2012	3071	2889		1541		<2.0	**3.2**	<2.0	<2.0
MW-15C	5/21/2013	3260	3078		1730		<5.0	<5.0	<5.0	<5.0
MW-15C	11/12/2013	3435	3253		1905		<2.0	<2.0	<2.0	**2.3**
MW-15C	5/7/2014	3611	3429		2081		<2.0	<2.0	<2.0	**2.9**
MW-15C	11/5/2014	3793	3611		2263		<0.2	<0.2	**0.5**	**2.5**
MW-15C	4/29/2015	3968	3786		2438		<0.2	<0.2	**0.6**	**2.4**

Table 7
SWMU-20 Cleanup Action Summary
Non-Source Zone
Boeing Developmental Center
Tukwila, Washington

		Elapsed Time from Injections (a) (days)					Volatile Organic Compounds			
							Proposed Groundwater Cleanup Levels (c)			
							5.3	1.4	134	2.4
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	5th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)
MW-15C	10/27/2015	4149	3967		2619	-15	<0.2	<0.2	**0.5**	**2.0**
MW-15C	4/19/2016	4324	4142		2794	160	<0.2	**0.6**	**1.2**	**0.5**
MW-15C	11/2/2016	4521	4339		2991	357	<0.2	**0.3**	**1.7**	**0.7**
MW-15C	5/2/2017	4702	4520		3172	538	<0.2	<0.2	**1.2**	**0.5**
MW-15C	11/8/2017	4892	4710		3362	728	<0.2	<0.2	**1.3**	**0.4**
MW-15C	5/1/2018	5066	4884		3536	902	<2.0	<2.0	<2.0	<2.0
MW-15C	11/5/2018	5254	5072		3724	1090	<2.0	<2.0	<2.0	<2.0
MW-15D	5/3/2004	-45					<1.0	<1.0	<1.0	<1.0
MW-15D	10/26/2004	131	-51				<1.0	<1.0	<1.0	<1.0
MW-15D	5/16/2005	333	151				<1.0	<1.0	<1.0	<1.0
MW-15D	11/15/2005	516	334				<1.0	<1.0	<1.0	<1.0
MW-15D	5/17/2006	699	517				<1.0	<1.0	<1.0	<1.0
MW-15D	11/29/2006	895	713				<1.0	<1.0	<1.0	<1.0
MW-15D	5/23/2007	1070	888				<1.0	<1.0	<1.0	<1.0
MW-15D	12/3/2007	1264	1082				<1.0	<1.0	<1.0	<1.0
MW-15D	5/20/2008	1433	1251		-97		<1.0	<1.0	<1.0	<1.0
MW-15D	11/24/2008	1621	1439		91		<1.0	<1.0	<1.0	<1.0
MW-15D	05/19/2009	1797	1615		267		<1.0	<1.0	<1.0	<1.0
MW-15D	11/18/2009	1980	1798		450		<1.0	<1.0	<1.0	<1.0
MW-16A	5/2/2004	-46					**1.2**	**1.2**	**2.3**	<1.0
MW-16A	10/25/2004	130	-52				**1.2**	**1.3**	**1.8**	<1.0
MW-16A	5/12/2005	329	147				**1.2**	**1.8**	**2.6**	<1.0
MW-16A	11/15/2005	516	334				**1.3**	**2.2**	**2.1**	<1.0
MW-16A	5/16/2006	698	516				**1.0**	**1.4**	**2.3**	<1.0
MW-16A	11/26/2006	892	710				<0.2	**0.8**	**4.2**	<0.2
MW-16A	5/22/2007	1069	887				**1.1**	**1.3**	**1.9**	<1.0
MW-16A	11/28/2007	1259	1077				**1.7**	**1.2**	**1.2**	<1.0
MW-16A	5/19/2008	1432	1250		-98		**1.2**	**1.3**	**1.2**	<0.2
MW-16A	11/23/2008	1620	1438		90		**1.5**	**1.4**	**1.0**	<1.0
MW-16A	05/18/2009	1796	1614		266		**1.6**	**1.6**	<1.0	<1.0
MW-16A	11/16/2009	1978	1796		448		**2.2**	**1.5**	<1.0	<1.0
MW-16A	5/20/2010	2163	1981		633		**1.4**	**1.4**	<1.0	<1.0
MW-16A	11/10/2010	2337	2155		807		**1.3**	**1.1**	<1.0	<1.0
MW-16A	5/4/2011	2512	2330		982		**1.6**	**1.4**	<1.0	<1.0
MW-16A	11/13/2011	2705	2523		1175		**1.4**	**1.3**	**0.5**	<0.2
MW-16A	5/14/2012	2888	2706		1358		**1.6**	**1.7**	**0.5**	<0.2
MW-16A	11/14/2012	3072	2890		1542		**1.1**	**1.5**	**0.6**	<0.2
MW-16A	5/21/2013	3260	3078		1730		**1.4**	**1.5**	<0.5	<0.5
MW-16A	11/12/2013	3435	3253		1905		**2.1**	**1.8**	**0.3**	<0.2
MW-16A	5/8/2014	3612	3430		2082		**1.4**	**1.6**	**0.4**	<0.2
MW-16A	11/5/2014	3793	3611		2263		**1.6**	**1.5**	**0.4**	<0.2
MW-16A	4/28/2015	3967	3785		2437		**1.4**	**1.4**	**0.3**	<0.2
MW-16A	10/26/2015	4148	3966		2618	-16	**1.5**	**1.5**	**0.3**	<0.2
MW-16A	4/19/2016	4324	4142		2794	160	**0.8**	**0.7**	**10**	<0.2
MW-16A	11/2/2016	4521	4339		2991	357	**0.6**	**0.3**	**14**	**0.5**
MW-16A	5/2/2017	4702	4520		3172	538	**0.7**	**0.2**	**5.7**	**3.1**
MW-16A	11/8/2017	4892	4710		3362	728	<0.2	<0.2	**0.7**	**0.7**
MW-16A	5/1/2018	5066	4884		3536	902	<2.0	<2.0	<2.0	<2.0
MW-16A	11/5/2018	5254	5072		3724	1090	<2.0	<2.0	<2.0	<2.0
MW-16C	5/2/2004	-46					<1.0	<1.0	**1.7**	**5.4**
MW-16C	10/25/2004	130	-52				<1.0	<1.0	**2.4**	**8.5**
MW-16C	5/12/2005	329	147				<1.0	<1.0	**2.8**	**7.7**
MW-16C	11/15/2005	516	334				<1.0	<1.0	**4.6**	**12**
MW-16C	5/16/2006	698	516				<1.0	<1.0	**5.2**	**6.3**
MW-16C	11/26/2006	892	710				**1.2**	**2.3**	**2.0**	<0.2
MW-16C	5/22/2007	1069	887				<1.0	<1.0	**8.8**	**10**
MW-16C	11/28/2007	1259	1077				<1.0	<1.0	**7**	**8.9**
MW-16C	5/19/2008	1432	1250		-98		<0.2	<0.2	**7.8**	**7.9**

Table 7
SWMU-20 Cleanup Action Summary
Non-Source Zone
Boeing Developmental Center
Tukwila, Washington

		Elapsed Time from Injections (a) (days)					Volatile Organic Compounds — Proposed Groundwater Cleanup Levels (c)			
							5.3	1.4	134	2.4
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	5th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)
MW-16C	11/23/2008	1620	1438		90		<1.0	<1.0	**5.3**	**8.8**
MW-16C	05/18/2009	1796	1614		266		<1.0	<1.0	**5.0**	**6.3**
MW-16C	11/16/2009	1978	1796		448		<1.0	<1.0	**4.9**	**5.6**
MW-16C	5/20/2010	2163	1981		633		<1.0	<1.0	**3.7**	**3.4**
MW-16C	11/10/2010	2337	2155		807		<1.0	<1.0	**3.3**	**2.8**
MW-16C	5/4/2011	2512	2330		982		<1.0	<1.0	**3.7**	**3.2**
MW-16C	11/13/2011	2705	2523		1175		<0.2	<0.2	**3.3**	**2.5**
MW-16C	5/14/2012	2888	2706		1358		<0.2	<0.2	**4.8**	**4.2**
MW-16C	11/14/2012	3072	2890		1542		<0.2	<0.2	**4.9**	**3.8**
MW-16C	5/21/2013	3260	3078		1730		<0.5	<0.5	**3.9**	**2.8**
MW-16C	11/12/2013	3435	3253		1905		<0.2	<0.2	**4.4**	**2.1**
MW-16C	5/8/2014	3612	3430		2082		<0.2	<0.2	**3.4**	**1.2**
MW-16C	11/5/2014	3793	3611		2263		<0.2	<0.2	**3.4**	**1.3**
MW-16C	4/28/2015	3967	3785		2437		<0.2	<0.2	**2.2**	**1.2**
MW-16C	10/26/2015	4148	3966		2618	-16	<0.2	<0.2	**2.7**	**1.1**
MW-16C	4/19/2016	4324	4142		2794	160	<0.2	<0.2	**0.9**	**0.3**
MW-16C	11/2/2016	4521	4339		2991	357	<0.2	<0.2	**1.9**	**0.3**
MW-16C	5/2/2017	4702	4520		3172	538	<0.2	<0.2	**0.4**	**0.2**
MW-16C	11/8/2017	4892	4710		3362	728	<0.2	<0.2	**0.7**	**0.4**
MW-16C	5/1/2018	5066	4884		3536	902	<0.2	<0.2	<0.2	<0.2
MW-16C	11/5/2018	5254	5072		3724	1090	<0.2	<0.2	**0.50**	**0.28**
MW-17A	5/2/2004	-46					**4.8**	**6.5**	**1.0**	<1.0
MW-17A	10/25/2004	130	-52				**5.2**	**4.8**	**1.2**	<1.0
MW-17A	11/15/2005	516	334				**4.0**	**5.4**	**1.1**	<1.0
MW-17A	5/15/2006	697	515				**4.2**	**4.4**	<1.0	<1.0
MW-17A	11/27/2006	893	711				**2.2**	**6.3**	**1.0**	<0.2
MW-17A	5/21/2007	1068	886				**4.7**	**5.3**	**1.0**	<0.2
MW-17A	11/29/2007	1260	1078				**4.2**	**4.3**	<1.0	<1.0
MW-17A	5/19/2008	1432	1250		-98		**4.3**	**5.1**	**0.8**	<0.2
MW-17A	11/23/2008	1620	1438		90		**4.2**	**5.2**	**1.2**	<1.0
MW-17A	05/19/2009	1797	1615		267		**3.2**	**4.9**	**1.4**	<1.0
MW-17A	11/12/2009	1974	1792		444		**3.7**	**4.5**	**1.1**	<1.0
MW-17A	5/20/2010	2163	1981		633		**4.0**	**3.1**	<1.0	<1.0
MW-17A	11/8/2010	2335	2153		805		**2.3**	**4.8**	**2.3**	<1.0
MW-17A	5/3/2011	2511	2329		981		**3.1**	**2.2**	**1.5**	<1.0
MW-17A	11/3/2011	2695	2513		1165		**2.6**	**2.8**	**1.0**	<1.0
MW-17A	5/14/2012	2888	2706		1358		**3.1**	**2.0**	**0.5**	<0.2
MW-17A	11/13/2012	3071	2889		1541		**2.8**	**3.5**	**0.9**	<0.2
MW-17A	5/20/2013	3259	3077		1729		**3.6**	**2.8**	**0.8**	<0.2
MW-17A	11/4/2014	3792	3610		2262		**3.9**	**3.4**	**1.0**	<0.2
MW-17A	5/6/2014	3610	3428		2080		**3.6**	**2.6**	**0.4**	<0.2
MW-17A	11/4/2014	3792	3610		2262		**2.9**	**3.1**	**0.9**	<0.2
MW-17A	4/28/2015	3967	3785		2437		**3.4**	**2.3**	**0.4**	<0.2
MW-17A	10/26/2015	4148	3966		2618	-16	**3.4**	**2.6**	**1.1**	<0.2
MW-17A	4/19/2016	4324	4142		2794	160	<2.0	<2.0	**8**	<2.0
MW-17A	11/1/2016	4520	4338		2990	356	<2.0	**0.4**	**8.2**	**0.8**
MW-17A	5/3/2017	4703	4521		3173	539	<0.2	<0.2	**0.8**	**2.2**
MW-17A	11/7/2017	4891	4709		3361	727	<0.2	<0.2	**1.3**	**5.9**
MW-17A	5/1/2018	5066	4884		3536	902	<2.0	<2.0	<2.0	**2.82**
MW-17A	11/5/2018	5254	5072		3724	1090	<2.0	<2.0	<2.0	<2.0
MW-18A	5/2/2004	-46	-228				<1.0	<1.0	<1.0	<1.0
MW-18C	5/2/2004	-46					<1.0	<1.0	<1.0	<1.0
MW-18C	10/25/2004	130	-52				<1.0	<1.0	<1.0	<1.0
MW-18C	5/12/2005	329	147				<1.0	<1.0	<1.0	<1.0
MW-18C	11/15/2005	516	334				<1.0	<1.0	<1.0	<1.0
MW-18C	5/17/2006	699	517				<1.0	<1.0	<1.0	<1.0
MW-18C	11/27/2006	893	711				<0.2	<0.2	<0.2	<0.2
MW-18C	5/21/2007	1068	886				<0.2	<0.2	<0.2	**0.2**

Table 7
SWMU-20 Cleanup Action Summary
Non-Source Zone
Boeing Developmental Center
Tukwila, Washington

		Elapsed Time from Injections (a) (days)					Volatile Organic Compounds			
							Proposed Groundwater Cleanup Levels (c)			
							5.3	1.4	134	2.4
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	5th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)
MW-18C	11/28/2007	1259	1077				<1.0	<1.0	<1.0	<1.0
MW-18C	5/19/2008	1432	1250		-98		<0.2	<0.2	<0.2	**0.2**
MW-18C	11/23/2008	1620	1438		90		<1.0	<1.0	<1.0	<1.0
MW-18C	05/19/2009	1797	1615		267		<1.0	<1.0	<1.0	<1.0
MW-18C	11/17/2009	1979	1797		449		<1.0	<1.0	<1.0	<1.0
MW-19C	5/2/2004	-46					<1.0	<1.0	<1.0	<1.0
MW-19C	10/25/2004	130	-52				<1.0	<1.0	<1.0	<1.0
MW-19C	5/12/2005	329	147				<1.0	<1.0	<1.0	<1.0
MW-19C	11/15/2005	516	334				<1.0	<1.0	<1.0	<1.0
MW-19C	5/17/2006	699	517				<1.0	<1.0	<1.0	<1.0
MW-19C	11/27/2006	893	711				<0.2	<0.2	**0.3**	<0.2
MW-19C	5/22/2007	1069	887				<1.0	<1.0	<1.0	<1.0
MW-19C	11/29/2007	1260	1078				<1.0	<1.0	<1.0	<1.0
MW-19C	5/20/2008	1433	1251		-97		<1.0	<1.0	<1.0	<1.0
MW-19C	11/23/2008	1620	1438		90		<1.0	<1.0	<1.0	<1.0
MW-19C	05/19/2009	1797	1615		267		<1.0	<1.0	<1.0	<1.0
MW-19C	11/18/2009	1980	1798		450		<1.0	<1.0	<1.0	<1.0
MW-20C	5/3/2004	-45					<1.0	<1.0	**1.4**	**2.4**
MW-20C	10/25/2004	130	-52				<1.0	<1.0	**1.7**	**4.6**
MW-20C	5/12/2005	329	147				<1.0	<1.0	**1.7**	**2.3**
MW-20C	11/15/2005	516	334				<1.0	<1.0	**2.1**	**2.9**
MW-20C	5/17/2006	699	517				<1.0	<1.0	**1.8**	**1.6**
MW-20C	11/29/2006	895	713				<0.2	**0.2**	**2.1**	**1.5**
MW-20C	5/21/2007	1068	886				<0.2	<0.2	**1.6**	**1.8**
MW-20C	11/29/2007	1260	1078				<1.0	<1.0	**1.6**	**1.3**
MW-20C	5/20/2008	1433	1251		-97		<1.0	<1.0	**1.6**	**2.5**
MW-20C	11/23/2008	1620	1438		90		<1.0	<1.0	**1.5**	**2.7**
MW-20C	05/19/2009	1797	1615		267		<1.0	<1.0	**1.4**	**2.0**
MW-20C	11/18/2009	1980	1798		450		<1.0	<1.0	**1.7**	**2.3**
MW-20C	5/20/2010	2163	1981		633		<1.0	<1.0	**1.3**	**1.8**
MW-20C	11/8/2010	2335	2153		805		<1.0	<1.0	**1.4**	**1.4**
MW-20C	5/4/2011	2512	2330		982		<1.0	<1.0	**1.1**	**1.8**
MW-20C	11/3/2011	2695	2513		1165		<1.0	<1.0	**1.3**	**2.1**
MW-20C	5/14/2012	2888	2706		1358		<0.2	<0.2	**1.2**	**1.5**
MW-20C	11/13/2012	3071	2889		1541		<2.0	<2.0	<2.0	<2.0
MW-20C	5/21/2013	3260	3078		1730		<5.0	<5.0	<5.0	<5.0
MW-20C	11/12/2013	3435	3253		1905		<2.0	<2.0	<2.0	<2.0
MW-20C	5/7/2014	3611	3429		2081		<2.0	<2.0	<2.0	<2.0
MW-20C	11/5/2014	3793	3611		2263		<0.2	<0.2	**0.9**	**0.7**
MW-20C	4/28/2015	3967	3785		2437		<0.2	<0.2	**0.7**	**1.0**
MW-20C	10/27/2015	4149	3967		2619	-15	<0.2	<0.2	**1.0**	**0.9**
MW-20C	4/19/2016	4324	4142		2794	160	<0.2	**0.2**	**2.2**	**0.3**
MW-20C	11/2/2016	4521	4339		2991	357	<0.2	**0.2**	**0.6**	**0.5**
MW-20C	5/2/2017	4702	4520		3172	538	<0.2	<0.2	**1.5**	**0.4**
MW-20C	11/8/2017	4892	4710		3362	728	<0.2	<0.2	**1.5**	**0.5**
MW-20C	5/1/2018	5066	4884		3536	902	<0.2	<0.2	**1.09**	<0.2
MW-20C	11/5/2018	5254	5072		3724	1090	<0.2	<0.2	**1.02**	**0.25**

Abbreviations and Acronyms:

PCE = tetrachloroethene
TCE = trichloroethene
cDCE = cis-1,2-dichloroethene
VC = vinyl chloride
µg/L = micrograms per liter

Box = Exceedance of proposed cleanup level
Bold = detected compund

Notes:

(a) Injections occurred on:
6/17/04 (6A, B, C; 9A, B, C)
12/16-17/04 (6A, 6B;9A,9B)
3/17/05 (14A)
8/25-28/08 (6A, 9A, 10A)
10/27-11/11/15 (6A, 6B, 10C, 15C, 16A, 16C, 17A, 20C, 22A)
(b) Conducted at Well MW-14A only.
(c) Proposed Cleanup Standards and Comparison to Site Data, Boeing Developmental Center, Tukwila,Washington (Landau Associates, 5/7/13).

Table 8
Performance Monitoring Matrix
Boeing Developmental Center
Tukwila, Washington

Well ID	Frequency	Month(s)	VOCs (8260C)	VOCs (8260C) [Non-preserved]	Short-list VOCs - PCE, TCE, cDCE, VC (8260C)	Short-List VOCs - PCE, TCE, cDCE, VC (8260C) [Non-preserved]	Methane, Ethane, Ethene (RSKSOP-175, modified)	AMEE (RSKSOP-175, modified)	TOC (SM5310C)	BTEX (8260C)	TPH-G (NWTPH-G)	Sulfate (EPA 300.0)	Nitrate, Nitrite (EPA 300.0)	Nitrate (EPA 300.0)	Total and Dissolved Arsenic/Copper (200.8 ICP-MS)	Ferrous Iron (Field measurement)	Notes
AOC-5																	
BDC-101	Semiannual	May/Nov								X	X	X	X				
BDC-102	Semiannual	May/Nov								X	X	X	X				
BDC-103	Semiannual	May/Nov								X	X	X	X				
BDC-104	Semiannual	May/Nov								X	X	X	X				
MW-17A	Semiannual	May/Nov	X									X		X		X	Nitrate contingency monitoring location
MW-18A	Semiannual	May/Nov										X		X		X	Nitrate contingency monitoring location
MW-21A	Semiannual	May/Nov										X		X		X	Nitrate contingency monitoring location
SWMU-17																	
BDC-05-02	Semiannual	May/Nov				X		X	X			X			X	X	
BDC-05-03	Semiannual	May/Nov				X		X	X			X			X	X	
BDC-05-04	Semiannual	May/Nov				X		X	X			X	X		X	X	Nitrate contingency monitoring location
BDC-05-05	Semiannual	May/Nov				X			X			X			X	X	
BDC-05-07	Semiannual	May/Nov				X		X	X			X			X	X	
BDC-05-08	Semiannual	May/Nov				X			X			X			X	X	
BDC-05-09	Semiannual	May/Nov				X		X	X			X			X	X	
BDC-05-10	Semiannual	May/Nov				X		X	X			X			X	X	
BDC-05-11	Semiannual	May/Nov				X		X	X			X			X	X	
BDC-05-12	Semiannual	May/Nov				X		X	X			X			X	X	
BDC-05-13	Semiannual	May/Nov				X		X	X			X			X	X	
BDC-05-14	Semiannual	May/Nov				X		X	X			X			X	X	
BDC-05-15	Semiannual	May/Nov				X		X	X			X			X	X	
BDC-05-16	Semiannual	May/Nov				X		X	X			X			X	X	
BDC-05-17	Semiannual	May/Nov				X		X	X			X			X	X	
BDC-05-18	Semiannual	May/Nov				X		X	X			X			X	X	
BDC-05-19	Semiannual	May/Nov				X		X	X			X			X	X	
BDC-05-20	Semiannual	May/Nov				X		X	X			X			X	X	
BDC-05-21	Semiannual	May/Nov				X		X	X			X			X	X	
BDC-05-22	Semiannual	May/Nov				X			X			X			X	X	
BDC-05-23	Semiannual	May/Nov				X			X			X			X	X	
BDC-05-24	Semiannual	May/Nov				X		X	X			X			X	X	

Table 8
Performance Monitoring Matrix
Boeing Developmental Center
Tukwila, Washington

Well ID	Frequency	Month(s)	VOCs (8260C)	VOCs (8260C) [Non-preserved]	Short-list VOCs - PCE, TCE, cDCE, VC (8260C)	Short-List VOCs - PCE, TCE, cDCE, VC (8260C) [Non-preserved]	Methane, Ethane, Ethene (RSKSOP-175, modified)	AMEE (RSKSOP-175, modified)	TOC (SM5310C)	BTEX (8260C)	TPH-G (NWTPH-G)	Sulfate (EPA 300.0)	Nitrate, Nitrite (EPA 300.0)	Nitrate (EPA 300.0)	Total and Dissolved Arsenic/Copper (200.8 ICP-MS)	Ferrous Iron (Field measurement)	Notes
SWMU-20																	
MW-6A	Semiannual	May/Nov		X			X		X			X					MNA monitoring location
MW-6B	Semiannual	May/Nov		X			X		X			X					MNA monitoring location
MW-9A	Semiannual	May/Nov		X			X		X			X					MNA monitoring location
MW-10C	Semiannual	May/Nov		X													
MW-11A	Semiannual	May/Nov		X													
MW-13A	Semiannual	May/Nov		X													
MW-13C	Semiannual	May/Nov		X													
MW-14C	Semiannual	May/Nov		X													
MW-15C	Semiannual	May/Nov		X													
MW-16A	Semiannual	May/Nov		X													
MW-16C	Semiannual	May/Nov		X													
MW-20C	Semiannual	May/Nov		X													
MW-22A	Semiannual	May/Nov		X			X		X			X					MNA monitoring location

Notes:

Analytical method designated in paretheses following each anaylte name (e.g. "8260C").
Laboratory services changed to Analytical Resources, Inc. per client (January 2018).
Nitrate contingency monitoring locations are only sampled for nitrate if upgradient action levels are exceeded.

Abbreviations and Acronyms:

AMEE = acetylene, methane, ethane, and ethene
AOC = area of concern
BTEX = benzene, toluene, ethylbenzene, and xylenes
cDCE = *cis* -1,2-dichloroethene
MNA = monitored natural attenuation
PCE = perchloroethene
SWMU = solid waste management unit
TCE = trichloroethene
TOC = total organic carbon
VC = vinyl chloride
VOCs = volatile organic compounds

APPENDIX A

2006 Work Plan, AOC-05 Pilot Test, Enhanced Anaerobic Biodegradation of Gasoline-Range Petroleum Hydrocarbons

Work Plan
AOC-05 Pilot Test
Enhanced Anaerobic Biodegradation of Gasoline-Range Petroleum Hydrocarbons
Boeing Developmental Center
Tukwila, Washington

March 6, 2006

Prepared for

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1.0 INTRODUCTION

This document presents a work plan to conduct pilot testing in the vicinity of a former gasoline underground storage tank (UST) at The Boeing Company (Boeing) Developmental Center (DC). The DC is located at 9725 East Marginal Way South, Tukwila, Washington (Figure 1). The DC is a regulated facility under the Resource Conservation and Recovery Act (RCRA) with a facility identification number of WAD-09363-9946. The Washington State Department of Ecology (Ecology) is authorized by the U.S. Environmental Protection Agency (EPA) to implement RCRA corrective action through its Model Toxics Control Act (MTCA) regulations. Boeing is performing remedial actions at the DC under Ecology's voluntary cleanup program (VCP). Preparation of this pilot test work plan is authorized under Work Order No. ENV-G-05DC-035.

Pilot testing will consist of electron acceptor (nitrate) amendment of groundwater and performance monitoring. Nitrate amendment will enhance anaerobic degradation of total petroleum hydrocarbons (TPH) as gasoline (TPH-G) and benzene, toluene, ethylbenzene, and xylenes (BTEX). TPH and BTEX will be biologically degraded by native denitrifying bacteria. Activities described in this work plan will be performed in accordance with the procedures provided in the Health and Safety Plan (Appendix A).

2.0 BACKGROUND

The former gasoline UST (DC-01) was removed in 1985 after the tank was punctured by a measuring rod, releasing approximately 830 gallons of unleaded gasoline to the shallow unconfined aquifer. During the tank removal, approximately 500 to 600 gallons of floating product were recovered and additional gasoline was removed with excavated soil (Boeing 2001). In 1994, the former UST was identified as area of concern (AOC)-05 in the RCRA Facility Assessment (RFA) completed for the EPA (SAIC 1994). The former UST was located approximately 20 to 30 ft southeast of the southwestern corner of Building 9-61 near current monitoring well BDC-103 (Figure 2).

Subsequent investigation in 2001 identified remaining contamination (IT Corporation, 2001a, 2001b). Wells BDC-101 and BDC-102 were installed hydraulically downgradient of the former UST, and well BDC-103 was installed immediately adjacent to the former UST in May 2001. Between January and June 2001, groundwater was sampled from twelve soil borings and from the three monitoring wells (BDC-101, BDC-102, and BDC-103). The groundwater analytical data (IT Corporation 2001) indicated that residual TPH-G and BTEX were present at concentrations in excess of preliminary screening levels. Ecology (2001) indicated that further investigation and/or remediation activities would be required at AOC-05. Remedial actions associated with the tank removal and the subsequent investigation activities are summarized in the Corrective Action Summary Report (Summary Report, Landau Associates 2002a).

In November 2001, Ecology and Boeing agreed that Oxygen Release Compound (ORC®) injection and subsequent groundwater monitoring would be performed at AOC-05. Baseline groundwater monitoring and ORC® injection were performed in April and May 2002, respectively, in general accordance with the *ORC® Injection Plan: AOC-05* (Landau Associates 2002b). Following the injection, groundwater sampling was conducted monthly, then quarterly, and later seminannually. Monitoring results indicated that the ORC® treatment was ineffective in changing aquifer redox conditions or significantly decreasing concentrations of TPH-G and BTEX. The ineffectiveness of the ORC® injection is attributed to the natural occurrence of elevated concentrations of organic carbon and anaerobic aquifer conditions (Landau Associates 2004).

3.0 EVIDENCE OF CONTAMINANT ATTENUATION

Groundwater monitoring data suggest that groundwater contamination is being slowly attenuated through anaerobic biodegradation, preventing growth of the plume. Contaminant concentration trends for 2001 through 2005 are consistent with a stable or shrinking plume. Aquifer redox parameters (e.g., nitrate, ferrous iron, sulfate) indicate reduced aquifer conditions conducive to anaerobic biodegradation of petroleum constituents.

TPH-G and benzene are the only constituents to exceed preliminary screening levels during 2001 through 2005, with the exception of toluene detected at well BDC-103 in December 2001. Preliminary screening levels were established in the Summary Report (Landau Associates 2002a) and are listed on Table 1. With the exception of TPH-G and benzene detected at well BDC-102 in November 2003, all constituents have been below preliminary screening levels at downgradient wells BDC-101 and BDC-102 since March 2002. This shows a decreasing trend compared to 2001, during which one or more constituents exceeded preliminary cleanup levels at both downgradient wells. At source zone well BDC-103, TPH-G has exhibited a decreasing trend beginning in August 2002. Benzene concentrations at BDC-103 increased from November 2003 to October 2004, but since then have remained relatively stable; current concentrations remain less than half of the concentrations detected in December 2001 and August 2002. TPH-G and BTEX data for 2001 through 2005 are presented in Table 1. Time plots of TPH-G and benzene concentrations for wells BDC-101, BDC-102, and BDC-103 are presented on Figures 3 through 5, respectively.

Aquifer redox conditions at all three monitoring wells are conducive to anaerobic biodegradation of petroleum constituents. Various aquifer redox parameters were measured in November 2003 and November 2005. Dissolved oxygen (DO) concentrations are less than 1 mg/L at each well, indicating anaerobic aquifer conditions. Aquifer conditions are most reduced at source zone well BDC-103, where very low nitrate, elevated ferrous iron, and low sulfate have been measured, indicating nitrate-reducing to iron-reducing conditions with some sulfate reduction suggested by the 2005 data. Nitrate and ferrous iron concentrations measured in 2003 at the downgradient wells indicate nitrate-reducing to iron-reducing conditions at well BDC-102 and nitrate-reducing conditions at well BDC-101. Higher nitrate concentrations observed at both downgradient wells in 2005 are likely the result of lower TPH-G and benzene concentrations in November 2005. Aquifer redox conditions are expected to fluctuate with TPH concentrations, as TPH is the electron donor that causes reduction of aquifer electron acceptors (DO, nitrate, ferric iron, sulfate, carbon dioxide). Aquifer redox data are presented in Table 2.

Previous monitoring of wells located downgradient of AOC-05 also indicates naturally anaerobic aquifer conditions conducive to nitrate reduction. Low nitrate concentration (1.1 mg/L) was detected at downgradient well BDC-05-5 (Landau Associates 2003). Elevated natural organic carbon and reduced aquifer conditions have been observed at Building 9-101 wells located beyond the Solid Waste Management Unit (SWMU)-20 trichloroethene (TCE) groundwater plume and the associated treatment area created through electron donor amendment. At well MW-19A, total organic carbon (TOC) has ranged from 9.3 to 15.5 mg/L and ferrous iron has been detected at 2.6 to 3 mg/L, indicating iron-reducing conditions (Landau Associates 2003). At well MW-23A, TOC has ranged from 21 to 40 mg/L and concentrations of ferrous iron (2 to 3.4 mg/L), sulfate (<0.1 to 4.1 mg/L), and methane (98 to 410 µg/L) indicate sulfate-reducing to methanogenic (carbon dioxide-reducing) conditions (Landau Associates 2005). Monitoring well locations are shown on Figure 6.

4.0 PILOT TEST OBJECTIVE

The pilot test objective is to evaluate enhanced anaerobic biodegradation through nitrate amendment as a remedy for remaining petroleum hydrocarbon contamination in AOC-05. Nitrate will be added to the aquifer in the TPH source zone to stimulate enhanced anaerobic degradation of TPH under nitrate-reducing conditions. Nitrate will serve as the electron acceptor needed for natural aquifer bacteria to degrade the TPH electron donor. Nitrate addition should improve the slow rate of contaminant degradation currently observed in the TPH source zone (Section 3.0).

Biodegradation of TPH occurs through microbially mediated reactions whereby microorganisms obtain energy by oxidation-reduction (redox) reactions. TPH is utilized as the electron donor together with various electron acceptors [oxygen, nitrate, manganese (IV), ferrric iron, sulfate, and carbon dioxide]. These redox reactions can be compared to the process whereby humans obtain energy through consumption of food (electron donor) and oxygen (electron acceptor). Bacteria obtain the greatest energy yield by using oxygen as an acceptor, as it is highly oxidized and, therefore, can be reduced easily and to a large extent. When oxygen is depleted, bacteria sequentially utilize the less oxidized electron acceptors in the following order: nitrate, manganese (IV), ferric iron, sulfate, and carbon dioxide.

It is widely known that biodegradation of petroleum hydrocarbons occurs under aerobic conditions; although less well known, TPH anerobic biodegradation also occurs and has been shown to be an effective remedy for petroleum contamination of groundwater (Wiedemeier 1999). Nitrate amendment to enhance anaerobic biodegradation has been successfully implemented on two recent full-scale remediation projects for gasoline-range and fuel oil-range TPH (Lozier and Hicks 2005; Wasserman et al. 2005). Lozier and Hicks (2005) injected a solution of ammonium nitrate fertilizer (NH_4NO_3) to enhance BTEX degradation; fourteen months after the injection, BTEX in the source area had declined from 19 mg/L to 0.0113 mg/L. Wasserman et al. (2005) injected a proprietary nitrogen-based solution for treatment of No. 2 fuel oil contamination; approximately 1 year after the initial treatment, soil and groundwater concentrations were reduced by 50 to 60 percent.

Given the naturally anaerobic aquifer conditions present in AOC-05, stimulation of anaerobic TPH degradation is more likely to be successful than attempts to stimulate aerobic degradation. Due to the mud-flats depositional environment of the aquifer, the aquifer contains high organic content and reduced metals that represent a significant demand for any introduced oxygen. This oxygen demand is evidenced by the lack of treatment or change in aquifer DO resulting from the previous ORC injection (Section 2.0).

Nitrate has advantages over oxygen as an electron donor for groundwater remediation. Nitrate is a weaker oxidizing agent than oxygen, which means that demand for nitrate represented by natural aquifer organics and reduced metals is less than the demand for oxygen. As a result, nitrate will have a greater longevity than oxygen and a larger portion of the injected electron acceptor will be utilized for TPH degradation. Additionally, the solubility of nitrate is much greater than oxygen. This greater solubility allows a higher initial concentration of electron acceptor at the injection point, resulting in a greater downgradient extent of treatment.

Nitrate and nitrite are regulated as groundwater contaminants [Federal Maximum Contaminant Level (MCL) of 10 mg/L and 1 mg/L, respectively]; therefore, addition of nitrate as an electron acceptor is only appropriate in anaerobic aquifers where nitrate will be transformed by nitrate-reduction through nitrite to nitrogen gas (Wiedemeier et al., 1999). As described in Section 3.0, nitrate-reducing aquifer conditions have been observed in AOC-05 and at wells located farther downgradient in the vicinity of Building 9-90. As a precaution, the amount of nitrate added will not be the required amount to treat all TPH and BTEX present at AOC-05, but should be enough to observe contaminant reduction and estimate feasibility of a larger full scale injection.

5.0 PILOT TEST IMPLEMENTATION

Three existing monitoring wells (BDC-101, BDC-102, and BDC-103) will be utilized for the AOC-05 pilot test. Ammonium nitrate will be injected as nitrate electron acceptor to source zone well BDC-103. Downgradient wells BDC-101 and BDC-102, and source zone well BDC-103, will be monitored for baseline data prior to injection and for performance data following injection.

5.1 USE OF AMMONIUM NITRATE

Ammonium nitrate (NH_4NO_3) fertilizer with a nitrogen-phosphorous-potassium (NPK) ratio of 34:0:0 will be used to provide nitrate electron acceptor. Ammonium nitrate is a relatively inexpensive nitrate source and has a very high solubility (~984lbs/100 gal). When dissolved, the nitrate ion will act as the terminal electron acceptor (TEA) for microorganisms to degrade TPH present in the aquifer and the ammonium ion may act as a nutrient for cellular growth.

The reaction for benzene mineralization using nitrate as the TEA (below) is used to estimate the mass of nitrate required for degradation of TPH components.

Benzene: $$6NO_3^- + 6H^+ + C_6H_6 \rightarrow 6CO_2 + 6H_2O + 3N_2$$

As indicated in the formula above, six moles of nitrate are necessary to degrade one mole of benzene. The formula weights for nitrate and benzene are 62 gram/mole and 78 gram/mole, respectively. Therefore, 4.77 grams of nitrate [6 moles x nitrate molecular weight (62)/ benzene molecular weight (78)] are required for degradation of 1 gram of benzene. Similar ratios apply for toluene (4.71:1), ethylbenzene (4.67:1), and xylenes (4.67:1), and comparable ratios are expected for other gas-range petroleum hydrocarbons. The resulting mass ratio of approximately 5:1 (nitrate:BTEX/TPH) is based on the assumption that all nitrate is used by microorganisms to obtain energy through degradation of TPH components. However, in field applications, additional nitrate will be utilized for other purposes, such as bacterial cell growth and degradation of natural organic matter. In a previous successful field application (Lozier and Hicks 2005), nitrate was injected at an 18:1 ratio with total BTEX present in groundwater.

5.2 INJECTION VOLUME AND NITRATE CONCENTRATION

A total of 6,500 gallons of groundwater amended with nitrate to a concentration of 1,000 mg/L will be injected to source zone well BDC-103, based on the estimated radius of injection (ROI) and the dissolved-phase TPH mass present in groundwater within that ROI. The proposed 1,000 mg/L concentration of nitrate in the injection solution is considered adequate to observe some reduction in TPH concentrations, but not sufficient for degradation of all TPH mass present in the source zone. The nitrate concentration is based on TPH-G and BTEX concentrations measured in groundwater at well BDC-103, but does not account for additional nitrate demand including TPH mass sorbed to soil, TPH mass possibly present as non-aqueous phase liquid (NAPL), and natural aquifer organics. In addition, significant TPH mass is certainly present beyond the limited ROI, which is estimated to extend just beyond the former tank pit excavation.

The 6,500-gallon injection volume is estimated to result in a ROI of approximately 13.5 ft. This ROI estimate is based on an assumed effective porosity of 0.15 [i.e., half of the total aquifer porosity (0.3) will transmit injection fluid] and a saturated treatment zone thickness of 10 ft based on the 10-ft long well screen located below the water table at BDC-103. Following injection, it is anticipated that injection solution will be distributed through dispersion/diffusion into the 13,000-gallon total pore volume within the ROI, resulting in an effective dilution of the 1,000 mg/L nitrate concentration of the injection solution to 500 mg/L.

The most recent analytical results for BDC-103 (November 2005) indicate an estimated nitrate demand for dissolved-phase TPH degradation of more than 570 mg/L, with no allowance for other nitrate demands. November 2005 groundwater concentrations at well BDC-103 were 24 mg/L and 90 mg/L for total BTEX and TPH-G, respectively. Based on the 5:1 nitrate to BTEX mass ratio described in Section 4.1, a minimum of 120 mg/L of nitrate will be required to degrade the aqueous phase BTEX. Assuming that a 5:1 ratio of nitrate to TPH-G will be required to degrade the additional compounds represented by the TPH-G groundwater concentration results in an additional nitrate demand of 450 mg/L. This assumed 5:1 ratio is a conservatively low estimate of the nitrate demand for TPH-G degradation, given the numerous gasoline-range petroleum hydrocarbon compounds in addition to BTEX that are represented by the TPH-G concentration. The total nitrate demand estimated for degradation of dissolved-phase TPH (570 mg/L) is slightly greater than the anticipated nitrate concentration in the treatment zone of 500 mg/L. As explained in section 4.0 the purpose of injecting less than the required amount of electron acceptors is to test the feasibility, but at the same time to be conservative regarding nitrate and nitrite MCL levels.

5.3 INJECTION PROCEDURES

Groundwater (6,500 gallons) extracted from well BDC-103 will be mixed with 70 pounds of ammonium nitrate fertilizer in a temporary Baker tank, and injected back into BDC-103. Two pounds of yeast extract will also be added to the injection solution to provide micronutrients for bacterial growth. A gasoline-powered centrifugal pump will be used for groundwater extraction and injection. Injection pressures will be maintained below 20 pounds per square inch (psi). The Underground Injection Control

(UIC) registration for the site (#20128) will be amended to include nitrate injection for stimulation of anaerobic biodegradation of TPH.

5.4 GROUNDWATER MONITORING

AOC-05 pilot test monitoring will consist of baseline and performance monitoring. Prior to the nitrate injection, baseline groundwater monitoring for contaminant and aquifer redox parameters will be conducted at the three AOC-05 wells (BDC-101, BDC-102, and BDC-103). Baseline groundwater monitoring for aquifer redox parameters will also be performed at downgradient wells BDC-05-4, MW-17A, MW-18A, and MW-21A to confirm downgradient nitrate reducing conditions (Figure 7). Performance monitoring will be performed monthly for the first 3 months following injection, then transition to quarterly monitoring. Quarterly performance monitoring will coincide with regular semiannual monitoring performed at the DC (May and November) and additional quarterly monitoring that is currently performed in SWMU-20 (February and August). If nitrate is detected at concentrations greater than 10 mg/l at downgradient well BDC-101 or BDC-102 for two consecutive sampling events, semiannual nitrate monitoring will also be performed at wells BDC-05-4, MW-17A, MW-18A, and MW-21A located farther downgradient. If implemented, nitrate monitoring would continue at these four downgradient wells for 1 year after nitrate concentrations at wells BDC-101 and BDC-102 have been reduced to less than 10 mg/L.

Samples collected for baseline and performance monitoring will be analyzed for contaminant concentrations (TPH-G and BTEX) and parameters indicative of aquifer redox conditions [DO, ORP, nitrate, ferrous iron, sulfate, and pH]. Laboratory analysis will be performed by Analytical Resources, Inc (ARI) for the TPH-G, BTEX, nitrate, and sulfate. Other parameters [DO, ORP, ferrous iron, and pH] will be measured in the field. Table 3 presents a comprehensive list of the monitoring parameters and information provided by each parameter.

6.0 DATA EVALUATION AND REPORTING

Analytical data will be evaluated to determine the efficiency of nitrate amendment to stimulate the biodegradation of BTEX and TPH-G. The concentrations of TPH-G and BTEX will be the primary indicators of successful biostimulation. Redox parameters [ORP, DO, nitrate, ferrous iron, and sulfate] and pH will be used to evaluate aquifer redox conditions. Nitrate data will also facilitate evaluation of the effectiveness of nitrate as an electron acceptor, its longevity, and its downgradient distribution. Data will allow optimization of the amount of nitrate, frequency of injection, and spacing of injection points to be used for a potential full-scale application.

Data will be reported semiannually and a final report will be prepared at the conclusion of the pilot test. Quarterly monitoring data will be reported in the regular semiannual reports prepared for the DC. A final pilot test report will be prepared at the conclusion of the pilot test to document results, provide data interpretation, and make recommendations for a potential full-scale application.

7.0 SCHEDULE

We propose to perform the pilot test injection during the first or second week of May 2006. The nitrate injection will be preceded by baseline monitoring performed in early April, 2006. It is anticipated that performance monitoring and data evaluation will be conducted for at least four quarters following injection. The final pilot test report may be prepared as soon as mid-2007, depending on performance monitoring results.

* * * * *

This document has been prepared under the supervision and direction of the following key staff.

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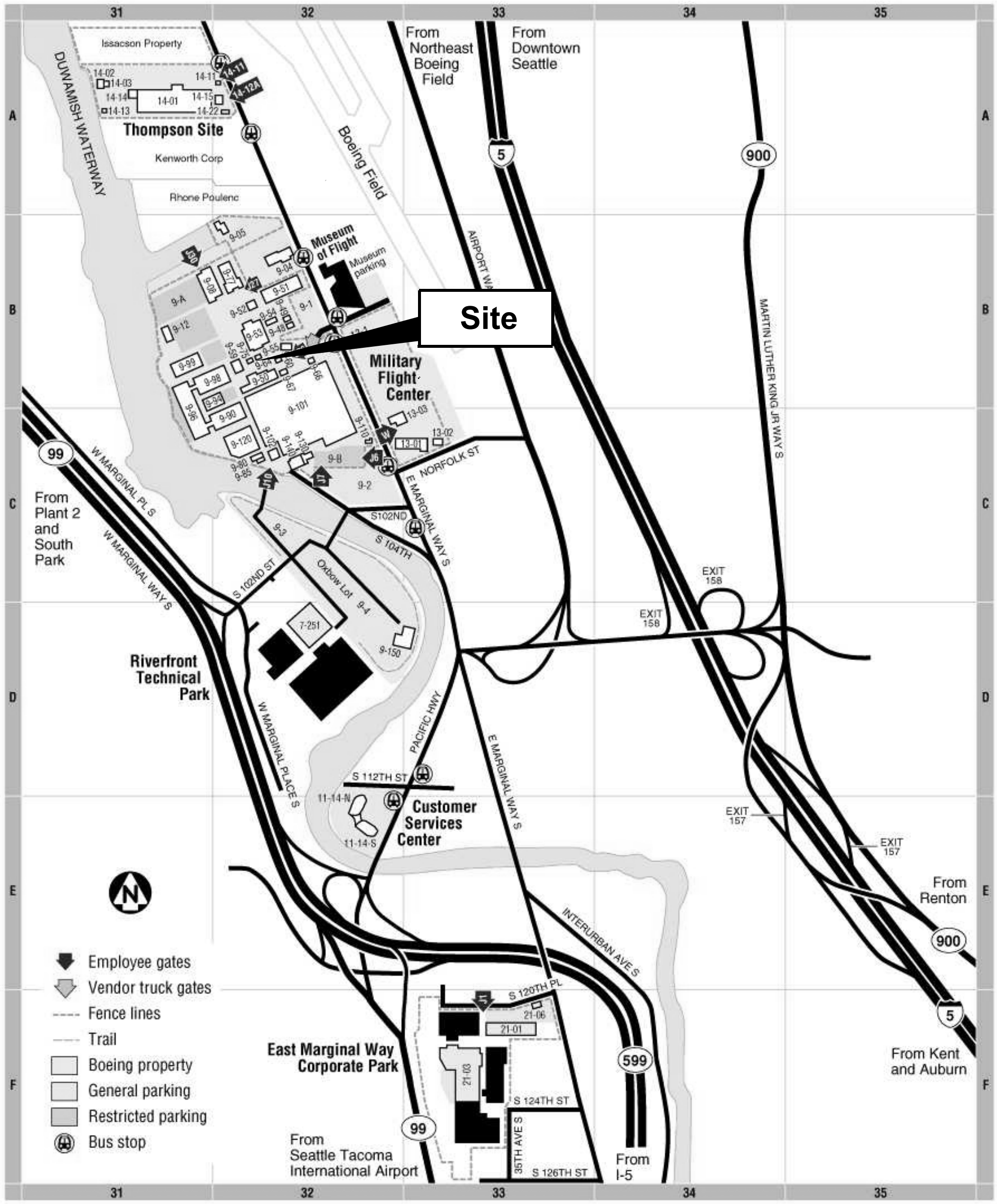
Washington – Developmental Center

9725 East Marginal Way South, Seattle, WA 98108



Revised 3-00

Map provided by Boeing, March 2000

Not To Scale

Boeing/Developmental Center/Work Plan | T:\025\093\040\AOC-5 Nitrate Pilot Test Work Plan\Fig1.cdr (C) 2/17/2006

LANDAU ASSOCIATES

Boeing Developmental Center Tukwila, Washington	**Site Location Map**	Figure 1

0 200 400

Approximate Scale in Feet

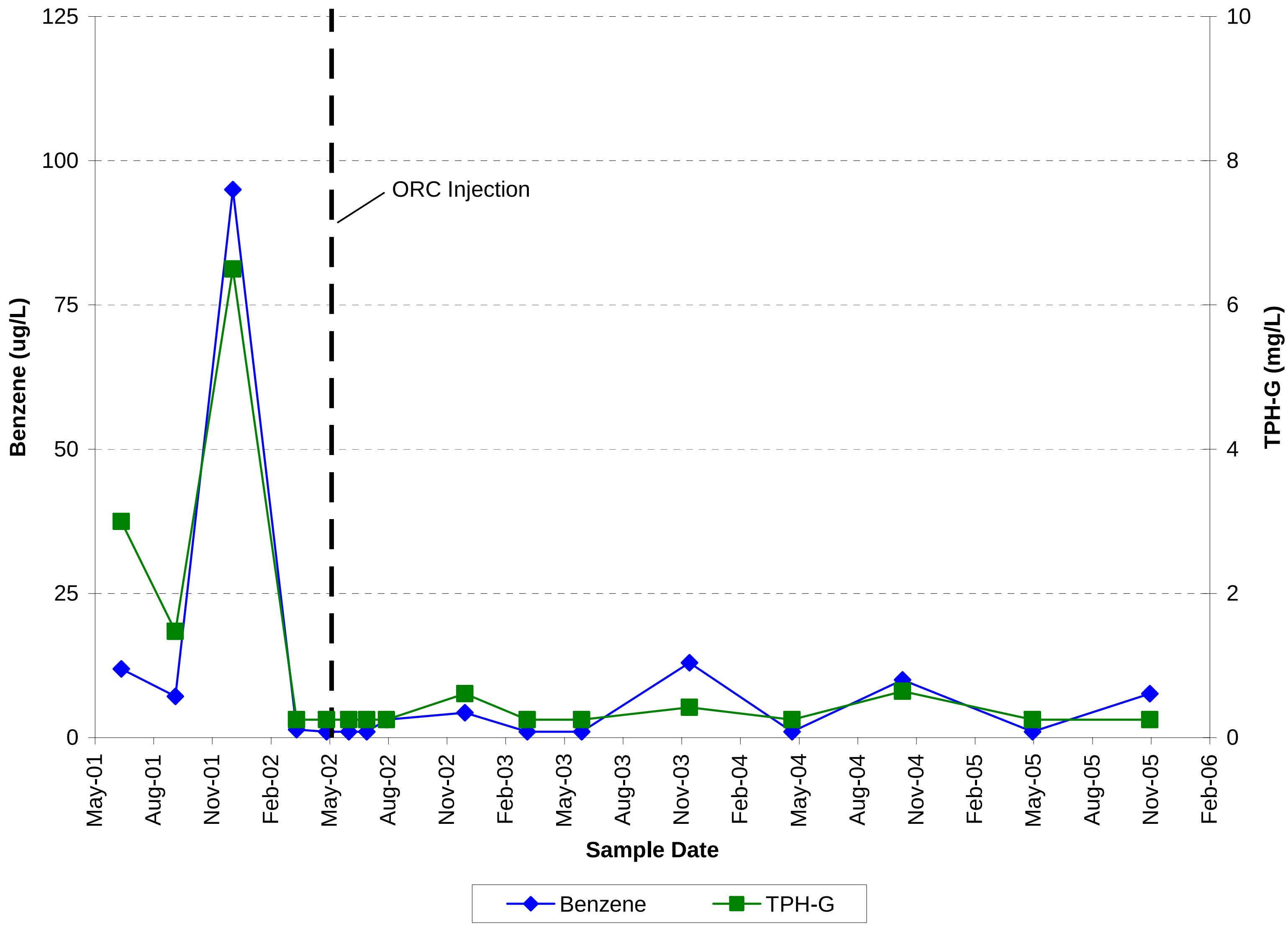
LANDAU ASSOCIATES

Boeing Developmental Center
Tukwila, Washington

SWMU & AOC Locations

Figure
2

Boeing/Developmental Center | T:\025\093\040\AOC-5 Nitrate Pilot Test Work Plan\Fig2.dwg (A) "Figure 2" 3/6/2006



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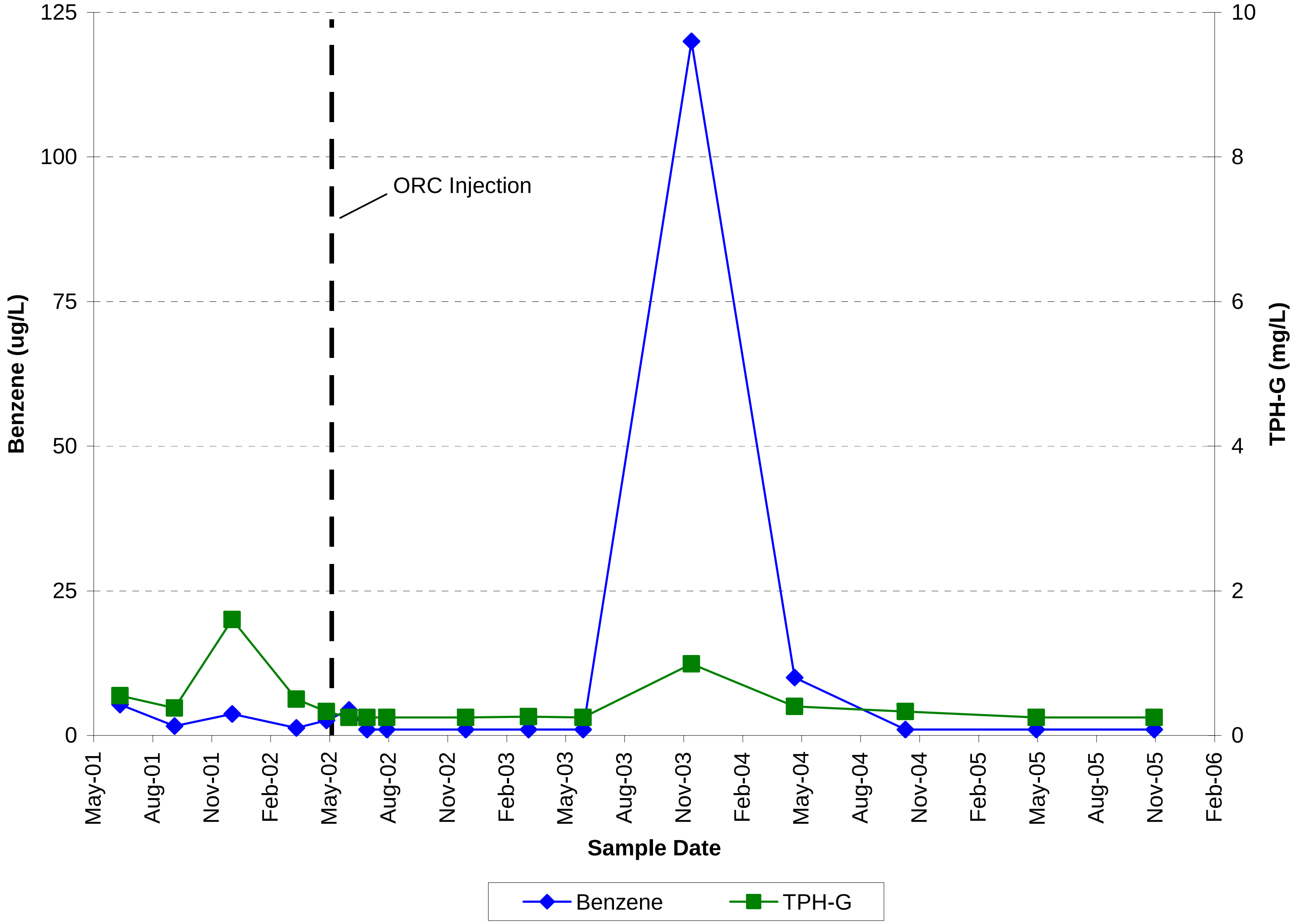
Boeing Developmental Center
Tukwila, Washington

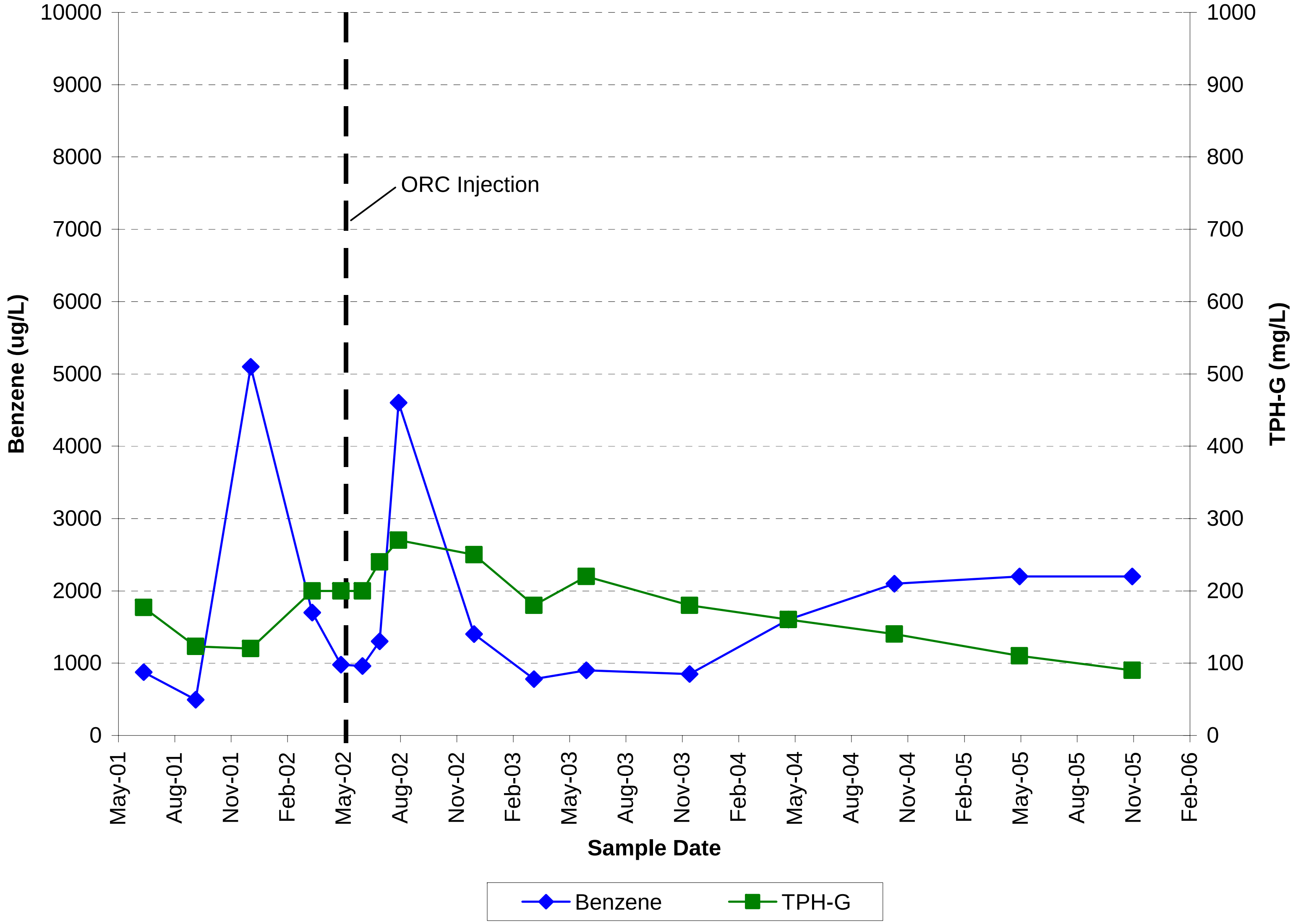
BDC-101 TPH-G and Benzene

Figure
3



LANDAU ASSOCIATES

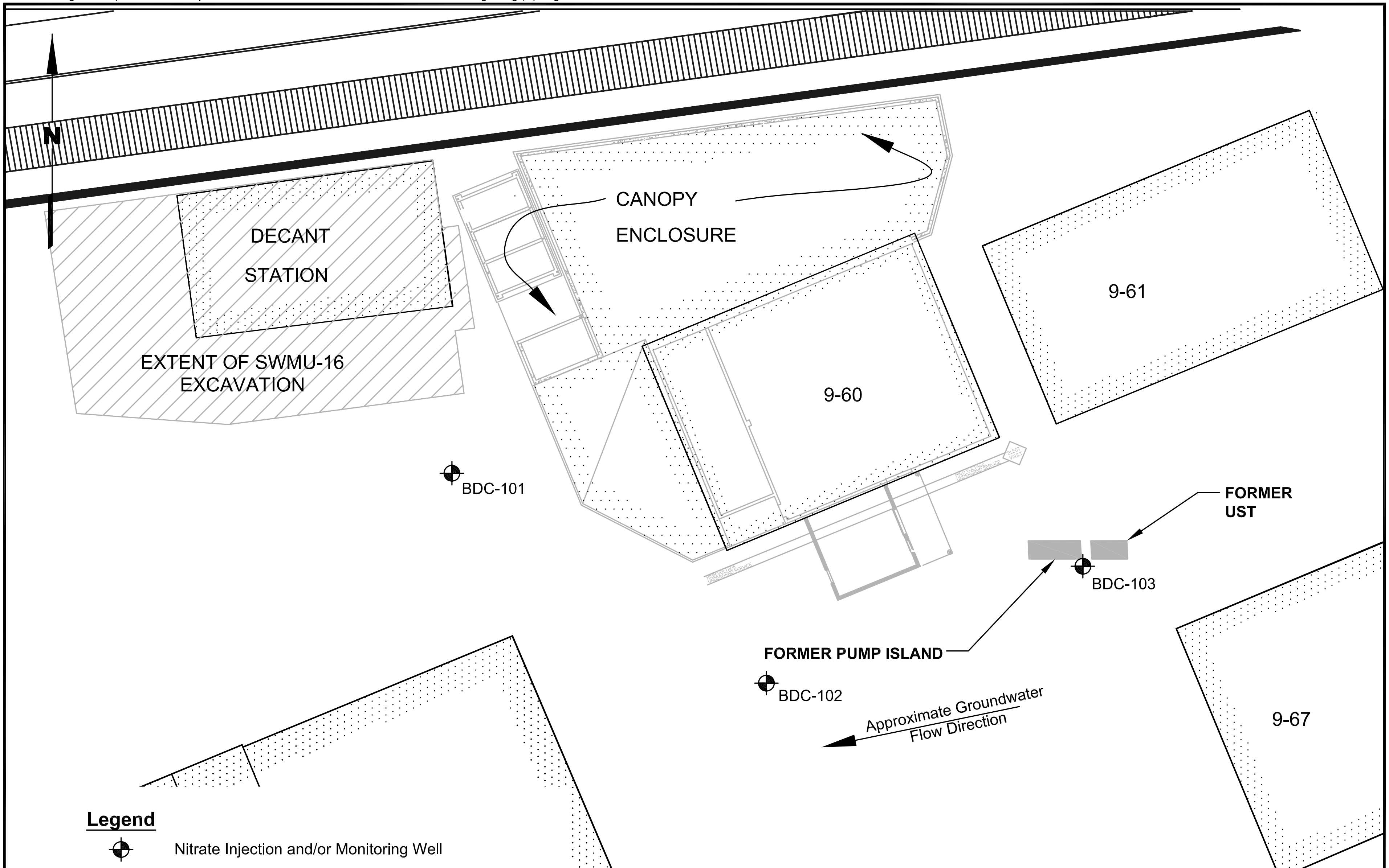
Boeing Developmental Center Tukwila, Washington	**BDC-102 TPH-G and Benzene**	Figure 4



Landau Associates

Boeing Developmental Center Tukwila, Washington	**BDC-103 TPH-G and Benzene**	Figure 5

Boeing/Developmental Center | T:\025\093\040\AOC-5 Nitrate Pilot Test Work Plan\Fig6.dwg (A) "Figure 6" 3/6/2006



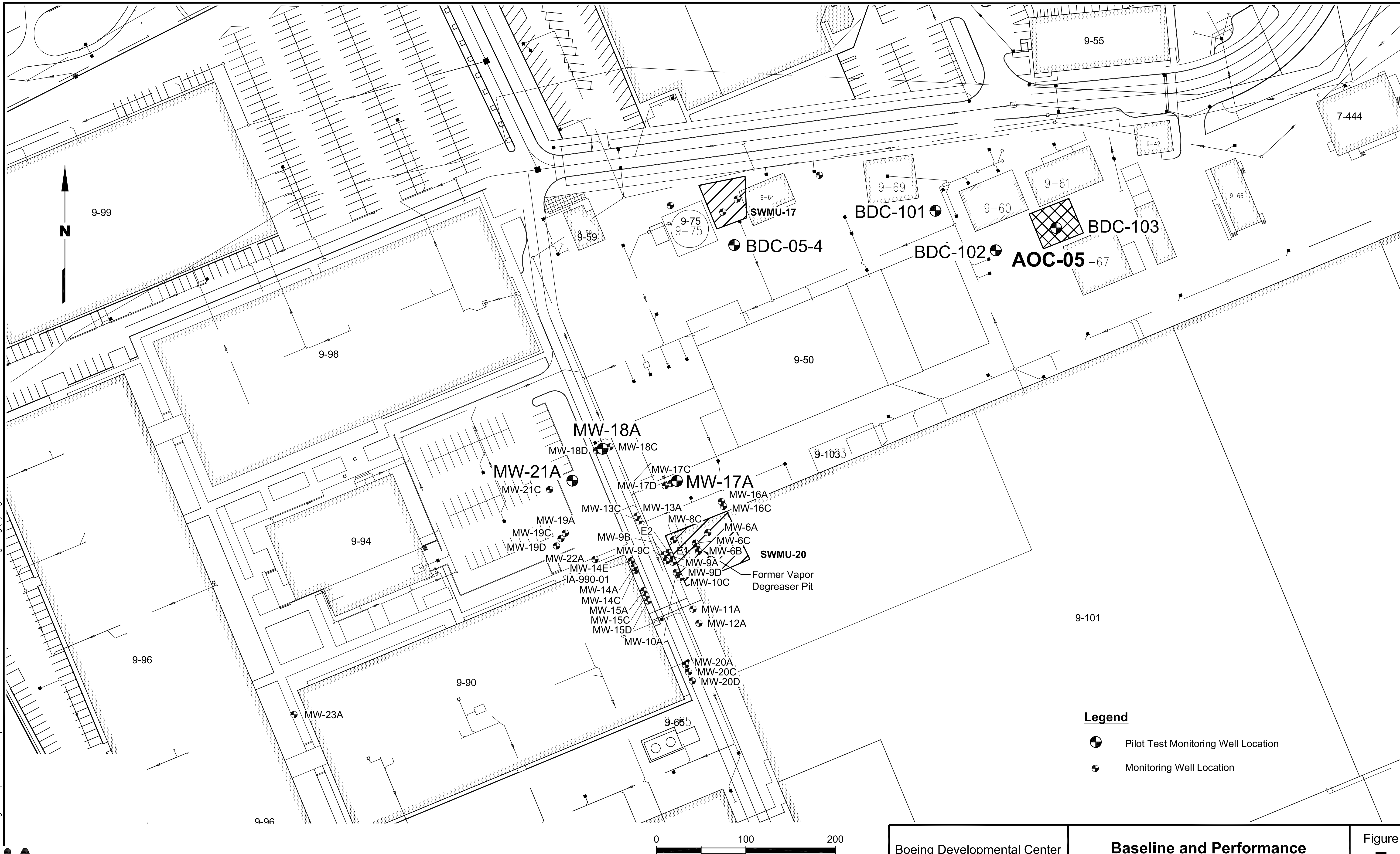
LANDAU ASSOCIATES

0 30 60
Scale in Feet

Boeing Developmental Center
Tukwila, Washington

Nitrate Pilot Test Injection and Groundwater Sample Locations

Figure
6



Boeing/Developmental Center | T:\025\093\040\AOC-5 Nitrate Pilot Test Work Plan\Fig7.dwg (A) "Figure 7" 3/6/2006

LANDAU ASSOCIATES

Boeing Developmental Center
Tukwila, Washington

Baseline and Performance Monitoring Locations

Figure 7

TABLE 1
GROUNDWATER CONTAMINANT DATA
AOC-05
BOEING DEVELOPMENTAL CENTER

	Preliminary Groundwater Screening Levels (a)	Pre-ORC Injection (c)					Post ORC Injection (c)										
		BDC-101 6/11/2001	BDC-101 9/4/2001	BDC-101 12/3/2001	BDC-101 3/13/2002	BDC-101 4/29/2002 EH92A	BDC-101 6/3/2002 EK68A	BDC-101 7/1/2002 EN04A	BDC-101 8/1/2002 EP36A	BDC-101 12/2/2002 FA41A	BDC-101 3/10/2003 FH27A	BDC-101 6/3/2003 FN40A	BDC-101 11/19/2003 GB17B	BDC-101 4/28/2004 GO82A	BDC-101 10/18/2004 HF76A	BDC-101 5/10/2005 IA83A	BDC-101 11/10/2005 IS89A
Total Petroleum Hydrocarbons (mg/L)																	
Gasoline	0.8	3	5	6.5	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.61	0.25 U	0.25 U	0.42 J	0.25 U	0.64	0.25 U	0.25
BTEX (µg/L)																	
Benzene	71	11.9	7.13 J	95	1.4	1 U	1	1 U	3.1	4.3	1	1 U	13 J	1 U	10	1 U	7.6
Toluene	200,000	1 U	10.7	1.6	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	1.0 U
Ethylbenzene	29,000	113.1	50.4	750	4.4	2.2	1 U	1 U	2.4	21	4.5	1 U	15 J	1 U	15	1 U	2.6
m,p-Xylene	NA					1 U	1 U	1 U	1 U	27	3.2	1 U	35 J	1 U	43	1 U	42
o-Xylene	NA					1 U	1 U	1 U	1 U	6.4	1 U	1 U	1 UJ	1 U	1 U	1 U	1.0 U
Total Xylenes	NA	109.2	53.8	650	2 U	1 U	1 U	1 U	1 U	33.4	3.2	1 U	35 J	1 U	43	1 U	42

TABLE 1
GROUNDWATER CONTAMINANT DATA
AOC-05
BOEING DEVELOPMENTAL CENTER

	Preliminary Groundwater Screening Levels (a)	Pre-ORC Injection (c)					Post ORC Injection (c)										
		BDC-102 6/11/2001	BDC-102 9/4/2001	BDC-102 12/3/2001	BDC-102 3/13/2002	BDC-102 4/29/2002 EH92B	BDC-102 6/3/2002 EK68B	BDC-102 7/1/2002 EN04B	BDC-102 8/1/2002 EP36B	BDC-102 12/2/2002 FA41B	BDC-102 3/10/2003 FH27B	BDC-102 6/3/2003 FN40B	BDC-102 11/19/2003 GB17C	BDC-102 4/28/2004 GO82B	BDC-102 10/18/2004 HF76B	BDC-102 5/10/2005 IA83B	BDC-102 11/10/2005 IS89B
Total Petroleum Hydrocarbons (mg/L)																	
Gasoline	0.8	0.55	0.38	1.6	0.5	0.33	0.25 U	0.25	0.25 U	0.25 U	0.26	0.25 U	0.99 J	0.40	0.33	0.25 U	0.25 U
BTEX (µg/L)																	
Benzene	71	5.33 J	1.61 J	3.7	1.3	2.6	4.4	1 U	1 U	1 U	1 U	1 U	120 J	10	1 U	1 U	1.0 U
Toluene	200,000	1 U	1.89 J	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	1.0 U
Ethylbenzene	29,000	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	8.5 J	1 U	1 U	1 U	1.0 U
m,p-Xylene	NA					1.1	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ	3	1 U	1 U	1.0 U
o-Xylene	NA					1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	1.0 U
Total Xylenes	NA	2 U	1.87 J	3.49 J	1 U	1.1	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ	3	1 U	1 U	2.0 U

TABLE 1
GROUNDWATER CONTAMINANT DATA
AOC-05
BOEING DEVELOPMENTAL CENTER

	Preliminary Groundwater Screening Levels (a)	Pre-ORC Injection (c)					Post ORC Injection (c)										
		BDC-103 6/11/2001	BDC-103 9/4/2001	BDC-103 12/3/2001 (b)	BDC-103 3/13/2002	BDC-103 4/29/2002 EH92C	BDC-103 6/3/2002 EK68C	BDC-103 7/1/2002 EN04C	BDC-103 8/1/2002 EP36C	BDC-103 12/2/2002 FA41C	BDC-103 3/10/2003 FH27C	BDC-103 6/3/2003 FN40C	BDC-103 11/19/2003 GB17D	BDC-103 4/28/2004 GO82C	BDC-103 10/18/2004 HF76C	BDC-103 5/10/2005 IA83C	BDC-103 11/10/2005 IS89C
Total Petroleum Hydrocarbons (mg/L)																	
Gasoline	0.8	177	123	120	200	200	200	240	270	250	180	220	180	160	140	110	90
BTEX (µg/L)																	
Benzene	71	875 J	494 J	5,100	1,700	980	960	1,300	4,600	1,400	780	900	850 J	1,600	2,100	2,200	2,200
Toluene	200,000	12,010	3,760	2,300,000	17,000	16,000	17,000	16,000	18,000	15,000	13,000	10,000	8,300 J	6,600	5,500	5,500	3,500
Ethylbenzene	29,000	1,985 J	419 J	10,000	4,900	5,400	5,100	5,200	5,200	5,000	5,200	5,000	4,500 J	3,900	3,700	3,800	3,700
m,p-Xylene	NA					20,000	20,000	20,000	19,000	22,000	20,000	20,000	18,000 J	16,000	15,000	14,000	12,000
o-Xylene	NA					7,000	7,100	6,800	6,600	6,900	6,700	6,600	5,500 J	5,100	4,400	3,200	2,500
Total Xylenes	NA	11,430	2,636	3,400,000	26,400	27,000	27,100	26,800	25,600	28,900	26,700	26,600	23,500 J	21,100	19,400	17,200	15,000

NA = no preliminary cleanup level available.

U = compound was not detected at given reporting limit.

J = indicates the analyte was positively identified, and the concentration listed is an estimate.

-- = Not Measured.

Boxed value indicates concentration above preliminary cleanup level.

(a) Landau Associates 2002a.

(b) BTEX data questionable for this event. Concentrations inconsistent with TPH-G data for indicated event and BTEX data from other events.

(c) ORC injection in April and May 2002.

TABLE 2
AQUIFER REDOX DATA
AOC-05
BOEING DEVELOPMENTAL CENTER

Sample Name: ARI Sample ID: Sample Date:	BDC-101 GB17B 11/19/2003	BDC-101 IS89A 11/10/2005	BDC-102 GB17C 11/19/2003	BDC-102 IS89B 11/10/2005	BDC-103 GB17D 11/19/2003	BDC-103 IS89C 11/10/2005
Test ID: Conventional Parameters						
Dissolved Oxygen (mg/L)	NA	0.96	NA	0.82	NA	0.72
ORP (mV)	NA	259	NA	122	NA	147
N-Nitrate (mg-N/L)	1.1	4.4	0.19	4.4	0.012	1.0 U
Ferrous Iron (mg/L)	0.2	NA	5.5	NA	5.5	NA
Sulfate (mg/L)	16	34.3	46	34.0	53	11.9
Methane (ug/L)	240	NA	1100	NA	630	NA
Total Organic Carbon (mg/L)	NA	2.05	NA	18.4	NA	15.4

U = Indicates compound was analyzed for, but was not detected at the given detection limit.
NA=Not analyzed

TABLE 3
PERFORMANCE MONITORING PARAMETERS
AOC-05 PILOT TEST
BOEING DEVELOPMENTAL CENTER

Field Parameters	Information Provided
Dissolved Oxygen (DO) [field meter and single-use reactive ampoules] (a)	Aquifer is considered anaerobic at DO concentrations less than 1.0 mg/L.
Oxidation Reduction Potential (Redox) [field meter] (a)	Negative values indicate reducing conditions.
pH [field meter] (a)	Optimum conditions for biological activity is within the range of 6 to 8.
Ferrous Iron [Hach test kit]	Concentrations above background indicate iron-reducing conditions.
Laboratory Analyses	**Information Provided**
Total Petroleum Hydrocarbons as Gasoline (TPH-G) [Method NWTPH-Gx][3 40 ml VOA-H2SO4] [Holding time - 14 days]	Decreasing concentrations are an indication of anaerobic biotransformations of TPH-G.
BTEX [Method EPA 8021B][3 40 ml VOA-H2SO4] [Holding time - 14 days]	Decreasing concentrations are an indication of anaerobic biotransformations of BTEX.
Nitrate (b) [IC Method E300][500 ml poly] [Holding time - 48 hours]	Concentrations below background indicate nitrate-reducing conditions.
Sulfate [IC Method E300][500 ml poly] [Holding time - 28 days]	Concentrations below background indicate sulfate-reducing conditions that may result from depletion of nitrate.

(a) Measured using a flow-through cell.

(b) Nitrate sample can be combined with sulfate sample; nitrate analysis must be performed within 48-hour holding time.

APPENDIX A

Health and SafetyPlan

LANDAU ASSOCIATES
ENVIRONMENTAL | GEOTECHNICAL | NATURAL RESOURCES

WORK LOCATION PERSONNEL PROTECTION AND SAFETY EVALUATION FORM

Attach Pertinent Documents/Data
Fill in Blanks As Appropriate

Job No.:	025093.005.040		
Prepared by:	Benni Jonsson	Reviewed by:	Clint Jacob
Date:	February 10, 2006	Date:	February, 13, 2006

A. WORK LOCATION DESCRIPTION

1. **Project Name:** Boeing AOC-O5 Former Gasoline Underground Storage Tank, Ammonium Nitrate Injection
2. **Location:** 9725 East Marginal Way S., Tukwila, Washington
3. **Anticipated Activities:** Groundwater sampling and injection of ammonium nitrate fertilizer
4. **Surrounding Population:** Industrial
5. **Buildings/Homes/Industry:** Industrial buildings, office buildings
6. **Topography:** Mostly flat river valley bottom
7. **Anticipated Weather:** Partly clear, 35º to 60º F
8. **Unusual Features:** N/A
9. **Site History:** Site is a portion of Boeing Developmental Center.

B. HAZARD DESCRIPTION

1. Background Review: ☒ Complete ☐ Partial

If partial, why?

2. Hazardous Level: ☐ B ☐ C ☒ D ☐ Unknown

Justification: Possible petroleum hydrocarbon contamination.

3. Types of Hazards: (Attach additional sheets as necessary)

A. ☒ Chemical ☒ Inhalation ☒ Explosive
☐ Biological ☒ Ingestion ☐ O_2 Def. ☒ Skin Contact

Describe: Direct contact with contaminated soil or groundwater, accidental ingestion of contaminated soil or groundwater, or inhalation of vapors.

B. ☒ Physical ☒ Cold Stress ☒ Noise ☐ Heat Stress ☐ Other

Describe: Hazards associated with working with pressurized hoses. Cold stress conditions related to exposure.

C. ☐ Radiation

Describe: NA

4. Nature of Hazards:

☒ Air Describe: Dust from contaminated soil material. Inhalation of vapors.

☐ Soil Describe: NA

☐ Surface Water Describe: NA

☒ Groundwater Describe: Direct contact with or ingestion of contaminated groundwater.

☐ Other Describe: NA

5. Chemical Contaminants of Concern ☐ N/A

Contaminant	PEL (ppm)	I.D.L.H. (ppm)	Source/Quantity Characteristics	Route of Exposure	Symptoms of Acute Exposure	Instruments Used to Monitor Contaminant
Total Petroleum Hydrocarbons	NA	Unknown	May encounter petroleum hydrocarbons during groundwater pumping and sampling	Dermal contact, inhalation	Skin and mucous membrane irritation, dizziness, nausea	Olfactory, visual, PID, LEL
Ammonium nitrate	NA	Unknown	Possible exposure when ammonium nitrate is mixed with groundwater in a Baker tank.	Dermal contact, inhalation, ingestion	Eye, skin, and respiratory irritant. Harmful if swallowed.	Olfactory, visual.
Benzene	0.1	500	May encounter benzene during groundwater pumping and sampling	Dermal contact, inhalation, ingestion	Irritated eyes, skin, nose, and respiratory system; giddiness; headache; nausea; staggered gait; dermatitis; fatigue	Olfactory, visual, PID, LEL, Drager Tube
Toluene	100	500	May encounter benzene during groundwater pumping and sampling	Dermal contact, inhalation, ingestion	Skin, nose, throat irritation; dizziness; vomiting	Olfactory, visual, PID, LEL
Xylene	100	900	May encounter benzene during groundwater pumping and sampling	Dermal contact, inhalation, ingestion	Skin, nose, eye, throat irritation; dizziness; drowsiness; excitement; vomiting, abdominal pain	Olfactory, visual, PID, LEL
Ethylbenzene	100	800	May encounter benzene during groundwater pumping and sampling	Dermal contact, inhalation, ingestion	Eye, skin, mucous membrane irritation; headache, narcosis	Olfactory, visual, PID, LEL

6. Physical Hazards of Concern ☐ N/A

Hazard	Description	Location	Procedures Used to Monitor Hazard
Hazards associated with pressurized hoses	Injection of groundwater and ammonium nitrate mixture	Area of injection wells	Personnel will observe pressure and make sure it is low before disconnecting hoses

7. Work Location Instrument Readings ☐ N/A

Location: ____________________

Percent O_2: ____________________ Percent LEL: ____________________

Radioactivity: ____________________ PID: ____________________

FID: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Location: ____________________

Percent O_2: ____________________ Percent LEL: ____________________

Radioactivity: ____________________ PID: ____________________

FID: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Location: ____________________

Percent O_2: ____________________ Percent LEL: ____________________

Radioactivity: ____________________ PID: ____________________

FID: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Location: ____________________

Percent O_2: ____________________ Percent LEL: ____________________

Radioactivity: ____________________ PID: ____________________

FID: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

8. Hazards Expected In Preparation For Work Assignment ☒ N/A

Describe:

C. PERSONAL PROTECTIVE EQUIPMENT

1. Level of Protection

Primary: ☐ A ☐ B ☐ C ☒ D

Upgrade: ☐ A ☐ B ☒ C ☐ D

Location/Activity: All locations; upgrade to Level C (half-face respirator with organic vapor/HEPA cartridge and poly Tyvek coverall) if air monitoring action levels are exceeded (see Attachment A).

2. Protective Equipment (specify probable quantity required)

Respirator ☐ N/A

- ☐ SCBA, Airline
- ☐ Full-Face Respirator
- ☒ Half-Face Respirator (Cart. organic vapor/HEPA) (Only if upgrade to Level C)
- ☐ Escape mask
- ☐ None
- ☐ Other:
- ☐ Other:

Clothing ☐ N/A

- ☐ Fully Encapsulating Suit
- ☐ Chemically Resistant Splash Suit
- ☐ Apron, Specify:
- ☒ Tyvek Coverall (for Level C upgrade)

(or)

- ☐ Saranex Coverall
- ☐ Coverall, Specify
- ☒ Other: Dedicated field clothing

Head & Eye ☐ N/A

- ☐ Hard Hat
- ☐ Goggles
- ☐ Face Shield
- ☒ Safety Eyeglasses
- ☒ Other: Ear muffs or plugs

Hand Protection ☐ N/A

- ☒ Undergloves; Type: nitrile/neoprene
- ☐ Gloves; Type:
- ☐ Overgloves; Type:
- ☐ None
- ☐ Other:

Foot Protection ☐ N/A

- ☐ Neoprene Safety Boots with Steel Toe/Shank
- ☐ Disposable Overboots
- ☒ Other: Steel-toe boots

3. Monitoring Equipment ☐ N/A

☐ CGI ☒ PID

☐ O_2 Meter ☐ FID

☐ Rad Survey ☒ Other: LEL

☐ Detector Tubes (optional)

Type:

D. PERSONNEL DECONTAMINATION

☒ Required (soap and water – hands) ☐ Not Required

EQUIPMENT DECONTAMINATION

☒ Required ☐ Not Required

If required, describe and list equipment:

All non-dedicated water sampling equipment will be washed with Trisodium Phosphate soap and rinsed with tap water.

E. PERSONNEL

	Name	Work Location Title/Task	Medical Current	Fit Test Current
1.	**To be determined**	**Injection and Groundwater sampling**	☐	☐
2.			☐	☐
3.			☐	☐
4.			☐	☐
5.			☐	☐
6.			☐	☐
7.			☐	☐
8.			☐	☐
9.			☐	☐
10.			☐	☐

Site Safety Coordinator: To be determined

F. ACTIVITIES COVERED UNDER THIS PLAN

Task No.	Description	Preliminary Schedule
1	Baseline groundwater sampling	
2	Ammonium nitrate injection	
3	Follow-up groundwater monitoring (monthly to quarterly)	

G. SUBCONTRACTOR'S HEALTH AND SAFETY PROGRAM EVALUATION

☒ N/A

Name and Address of Subcontractor:

EVALUATION CRITERIA

Item	Adequate	Inadequate	Comments
Medical Surveillance Program	☐	☐	
Personal Protective Equipment Availability	☐	☐	
Onsite Monitoring Equipment Availability	☐	☐	
Safe Working Procedures Specification	☐	☐	
Training Protocols	☐	☐	
Ancillary Support Procedures (if any)	☐	☐	
Emergency Procedures	☐	☐	
Evacuation Procedures Contingency Plan	☐	☐	
Decontamination Procedures Equipment	☐	☐	
Decontamination Procedures Personnel	☐	☐	

GENERAL HEALTH AND SAFETY PROGRAM EVALUATION: ☐ Adequate ☐ Inadequate

Additional Comments:

Evaluation Conducted By: ______________________________ Date: ______________

EMERGENCY FACILITIES AND NUMBERS

Hospital: Harborview Medical Center
325 9th Avenue
Seattle, WA
206-731-3000

Directions: Exit at front gate and turn left onto E. Marginal Way S. Go southeast on E. Marginal Way S towards S NORFOLK ST. Turn LEFT onto S BOEING ACCESS RD. Merge onto I-5 N toward SEATTLE. Take the DEARBORN ST. / JAMES ST. exit- EXIT 164A- toward MADISON ST. Take the JAMES ST exit. Turn RIGHT onto JAMES ST. Turn right on Boren Avenue and drive 3 blocks to Broadway. Turn right, and then make a quick right turn onto Alder St. Continue for three blocks to 8th Avenue. (See route map attached to front of health and safety plan.)

Telephone: Field technician will maintain a mobile phone.

Emergency Transportation Systems (Fire, Police, Ambulance) – 911

Emergency Contacts:

Poison Control Center: 526-2121

Landau Project Manager: 425-778-0907
Boeing Environmental Affairs (Jim Bet): 425-865-5348

In the event of an emergency, do the following:

1. Call for help as soon as possible. Call 911. Give the following information:
   - WHERE the emergency is – use cross streets or landmarks
   - PHONE NUMBER you are calling from
   - WHAT HAPPENED – type of injury
   - WHAT is being done for the victim(s)
   - YOU HANG UP LAST – let the person you called hang up first.

2. If the victim can be moved, paramedics will transport to the hospital. If the injury or exposure is not life threatening, decontaminate the individual first. If decontamination is not feasible, wrap the individual in a blanket or sheet of plastic prior to transport.

3. Notify Landau Associates project manager.

4. Notify Boeing Environmental Affairs.

HEALTH AND SAFETY PLAN
APPROVAL/SIGN OFF FORMAT

I have read, understood, and agreed with the information set forth in this Health and Safety Plan (and attachments) and discussed in the Personnel Health and Safety briefing.

Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Project Manager	Signature	Date

Personnel Health and Safety Briefing Conducted By:

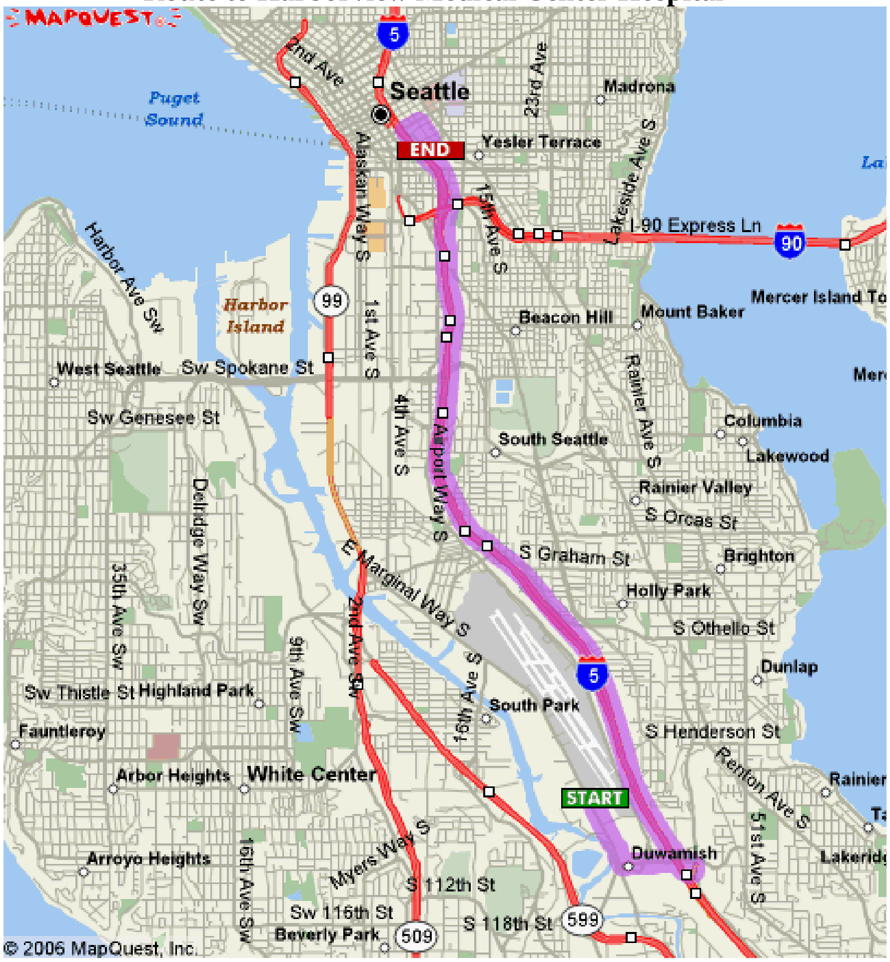
Name	Signature	Date

ATTACHMENT A

ACTION LEVELS FOR RESPIRATORY PROTECTION

Monitoring Parameter	Reading	Level of Protection
Organic vapors (during pumping of contaminated groundwater for injection)	PID reading >20 ppm in breathing zone for more than 20 minutes.	Evacuate area, use institutional control or upgrade to Level C
Organic vapors (during pumping of contaminated groundwater for injection)	PID reading >35 ppm for momentary peak.	Evacuate area, use institutional control or upgrade to Level C
Benzene (during pumping of contaminated groundwater for injection)	Drager Tube reading >0.5 ppm in breathing zone.	Evacuate area, use institutional control or upgrade to Level C
Organic vapors (during pumping of contaminated groundwater for injection)	PID reading >500 ppm in breathing zone.	Leave the work area.
Explosive environment (during pumping of contaminated groundwater for injection)	LEL reading >10%	Leave the work area.

Route to Harborview Medical Center Hospital



DIRECTIONS

1. Start out going SOUTHEAST on E MARGINAL WAY S toward S NORFOLK ST.
2. Turn LEFT onto S BOEING ACCESS RD.
3. Merge onto I-5 N toward SEATTLE.
4. Take the DEARBORN ST. / JAMES ST. exit- EXIT 164A- toward MADISON ST
5. Take the JAMES ST exit.
6. Turn RIGHT onto JAMES ST.
7. Turn right on Boren Avenue and drive 3 blocks to Broadway
8. Turn right, and then make a quick right turn onto Alder St
9. Continue for three blocks to 8th Avenue

APPENDIX B

2007 Work Plan, AOC-05 Remedial Action Plan, Enhanced Anaerobic Biodegradation of Gasoline-Range Petroleum Hydrocarbons

Work Plan
AOC-05 Remedial Action Plan
Enhanced Anaerobic Biodegradation of Gasoline-Range Petroleum Hydrocarbons
Boeing Developmental Center
Tukwila, Washington

November 16, 2007

Prepared for

The Boeing Company
Seattle, Washington

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1.0 INTRODUCTION

This document presents a work plan for full-scale bioremediation of petroleum hydrocarbons in the vicinity of a former gasoline underground storage tank (UST) at The Boeing Company (Boeing) Developmental Center (DC). The DC is located at 9725 East Marginal Way South, Tukwila, Washington (Figure 1). The DC is a regulated facility under the Resource Conservation and Recovery Act (RCRA) with a facility identification number of WAD-09363-9946. The Washington State Department of Ecology (Ecology) is authorized by the U.S. Environmental Protection Agency (EPA) to implement RCRA corrective action through its Model Toxics Control Act regulations. Boeing is performing remedial actions at the DC under Ecology's voluntary cleanup program. Preparation of this full-scale work plan is authorized under Work Order No. ENV-G-07DC-006.

Full-scale implementation of anaerobic bioremediation will consist of electron acceptor (nitrate) amendment of groundwater and performance monitoring. Nitrate amendment will enhance biological anaerobic degradation (denitrification) of total petroleum hydrocarbons (TPH) as gasoline (TPH-G) and benzene, toluene, ethylbenzene, and xylenes (BTEX). Groundwater performance monitoring data will be used to evaluate contaminant reduction and the longevity and distribution of nitrate and nitrite. Activities described in this work plan will be performed in accordance with the procedures provided in the Health and Safety Plan (Appendix A).

2.0 BACKGROUND

Various investigations and remedial actions have been performed over the last 20 years at AOC-05. Investigation and remediation activities centers on former gasoline underground storage tank (UST).

The former UST (DC-01) was removed in 1985 after the tank was punctured by a measuring rod, releasing approximately 830 gallons (gal) of unleaded gasoline to the shallow, unconfined aquifer. During the tank removal, approximately 500 to 600 gal of floating product were recovered and additional gasoline was removed with excavated soil (Boeing 2001). In 1994, the former UST was identified as area of concern (AOC)-05 in the RCRA Facility Assessment completed for the EPA (SAIC 1994). The former UST was located approximately 20 to 30 ft southeast of the southwestern corner of Building 9-61 near current monitoring well BDC-103 (Figure 2).

A subsequent investigation in 2001 characterized the remaining contamination (IT Corporation, 2001a,b). Between January and June 2001, groundwater was sampled from 12 soil borings and from the three monitoring wells (BDC-101, BDC-102, and BDC-103). Wells BDC-101 and BDC-102 were installed hydraulically downgradient of the former UST, and well BDC-103 was installed immediately adjacent to the former UST in May 2001. The groundwater analytical data (IT Corporation 2001a,b) indicated that residual TPH-G and BTEX were present at concentrations in excess of preliminary screening levels. In 2001, Ecology indicated that further investigation and/or remediation activities would be required at AOC-05. Remedial actions associated with the tank removal and the subsequent investigation are summarized in the Corrective Action Summary Report (Landau Associates 2002a).

In November 2001, Ecology and Boeing agreed that Oxygen Release Compound (ORC®) injection and subsequent groundwater monitoring would be performed at AOC-05. Baseline groundwater monitoring and ORC® injection were performed in April and May 2002, respectively, in general accordance with the *ORC® Injection Plan: AOC-05* (Landau Associates 2002b). Following the injection, groundwater sampling was conducted monthly, then quarterly, and later semiannually. Monitoring results indicated that the ORC® treatment was ineffective in changing aquifer redox conditions or significantly decreasing concentrations of TPH-G and BTEX. The ineffectiveness of the ORC® injection is attributed to the natural occurrence of elevated concentrations of organic carbon and naturally anaerobic aquifer conditions (Landau Associates 2004).

In January 2007, following a baseline monitoring event, pilot testing was performed using nitrate amendment to enhance biological degradation of TPH-G and BTEX under naturally anaerobic conditions at the site. Baseline monitoring in May 2006 indicated iron- to sulfate-reducing conditions at BDC-103 and nitrate- to iron-reducing conditions at downgradient wells (Landau Associates 2006a). These baseline aquifer redox conditions are conducive to enhanced TPH degradation through nitrate amendment. Baseline conditions also indicated that nitrate would be reduced under natural conditions should injected nitrate move beyond the zone of TPH contamination. Pilot testing consisted of injecting 88 lbs of ammonium nitrate fertilizer with a nitrogen-phosphorus-potassium ratio of 27:0:0. The 4 months of post-injection monitoring showed that TPH-G concentrations decreased by about 50 percent compared to baseline, while BTEX compounds decreased as much as 98 percent (Landau Associates 2007). Contaminant concentrations rebounded to background levels as injected nitrate became depleted and treatment slowed at 4 months post-injection. Rebound of contaminant concentrations is the result of equilibrium being re-established between groundwater and TPH present in the sorbed and nonaqueous phase liquid (NAPL) phases. Tables 1 and 2 show contaminant concentrations and redox data (wells BDC-101, BDC-102, and BDC-103) for the period prior to and following nitrate injection.

3.0 TREATMENT APPLICATION OBJECTIVE

The objective of the full-scale treatment is to enhance anaerobic biodegradation of TPH-G and BTEX at AOC-05 through the nitrate amendment of the aquifer. Nitrate will serve as the electron acceptor which, under the existing nitrate-reducing conditions, will be used by native bacteria to degrade the TPH electron donor. The mechanism for anaerobic bioremediation of petroleum hydrocarbons was described in detail in the pilot test work plan (Landau Associates 2006b), but briefly summarized below.

Biodegradation of TPH occurs through microbially mediated reactions whereby microorganisms obtain energy by oxidation-reduction (redox) reactions. In these reactions, electron donors (i.e., TPH) are used together with various electron acceptors [i.e., oxygen, nitrate, manganese (IV), ferric iron, sulfate, and carbon dioxide]. Redox reactions can be compared to the process whereby humans obtain energy through consumption of food (electron donor) and oxygen (electron acceptor). Bacteria obtain the greatest energy yield by using oxygen as an acceptor, as it is highly oxidized and, therefore, can be reduced easily and to a large extent. When oxygen is depleted, bacteria sequentially use the less oxidized electron acceptors in the following order: nitrate, manganese (IV), ferric iron, sulfate, and carbon dioxide.

It is commonly known that biodegradation of petroleum hydrocarbons can occur under aerobic conditions; however, anaerobic biodegradation of TPH can also occur and has been shown to be an effective remedy for petroleum contamination in reduced aquifers (Wiedemeier et al. 1999). Nitrate amendment to enhance anaerobic biodegradation has been successfully implemented on two recent full-scale remediation projects for gasoline-range and fuel oil-range TPH (Lozier and Hicks 2005; Wasserman et al. 2005). Lozier and Hicks (2005) injected a solution of ammonium nitrate fertilizer (NH_4NO_3) to enhance BTEX degradation; 14 months after the injection, concentrations of BTEX in the source area had declined from 19 milligrams per liter (mg/L) to 0.0113 mg/L. Wasserman et al. (2005) injected a proprietary nitrogen-based solution for treatment of No. 2 fuel oil contamination; approximately 1 year after the initial treatment, soil and groundwater contaminant concentrations were reduced by 50 to 60 percent. Furthermore, as described in Section 2.0, the recent pilot testing of nitrate amendment at AOC-05 was successful, showing significant degradation of TPH-G and BTEX.

4.0 FULL-SCALE IMPLEMENTATION

Three existing monitoring wells (BDC-101, BDC-102, and BDC-103) and one new well (BDC-104) will be used for the AOC-05 full-scale application. Ammonium nitrate will be injected as nitrate electron acceptor to source zone wells BDC-103 and BDC-104. The four wells will be monitored for baseline data prior to injection and for performance data following injection.

4.1 TREATMENT AREA AND INJECTION WELLS

The targeted treatment area is based on contaminant concentrations in groundwater measured during direct-push sampling performed prior to the ORC® injection in 2002, together with pre-nitrate injection baseline monitoring well data. During the ORC® injection in 2002, groundwater samples from 13 direct-push borings were analyzed for TPH-G and BTEX. The direct-push and baseline monitoring data indicate that the most highly contaminated area is near well BDC-103 and encompasses nearby direct-push borings ORC-7 and ORC-10. Known contamination extends about 30 ft downgradient and 35 ft crossgradient from well BDC-103. Concentrations of TPH-G and benzene in groundwater for direct-push borings (April and May 2002) and monitoring wells (May 2006) are shown on Figure 3.

We estimate that nitrate injection at well BDC-103 and at one additional well (BDC-104) will be adequate for treatment of the contaminated area. Well BDC-104 will be installed approximately 30 ft northeast of BDC-103. BDC-103 and BDC-104 are both located in the upgradient portion of the contaminated area, allowing for downgradient transport of injected nitrate solution to the known area of contamination. The well locations and their estimated radii of injection (ROIs) are shown on Figure 4. The ROIs also extend beyond the area of known contamination to address potential contamination there. Estimation of ROIs is discussed in further detail in the following section.

4.2 USE OF NITRATE AND ESTIMATED NITRATE DEMAND

Ammonium nitrate (NH_4NO_3) fertilizer will be used as the nitrate source. The same mass of nitrate used in the pilot test will be delivered to each of the two injection wells (BDC-103 and BDC-104). This mass is based on monitoring data and stoichiometry of nitrate required for TPH degradation.

Ammonium nitrate fertilizer with a nitrogen-phosphorus-potassium ratio of 27:0:0 (product name CAN-27) will be used as the nitrate electron acceptor source. Ammonium nitrate is a relatively inexpensive nitrate source and has a very high solubility (~984 lbs/100 gal). When dissolved, the nitrate ion will primarily act as the terminal electron acceptor for microorganisms to degrade TPH present in the aquifer. The ammonium ion may also act as a nutrient for cellular growth.

Stochiometry indicates that the mass of nitrate required for TPH degradation is at least five times greater than the mass of petroleum hydrocarbons. This is demonstrated by reaction for complete biodegradation (mineralization) of benzene (just one of the many compounds making up gasoline-range petroleum hydrocarbons).

Benzene: $$6NO_3^- + 6H^+ + C_6H_6 \rightarrow 6CO_2 + 6H_2O + 3N_2$$

As indicated in the formula, six moles of nitrate are required to degrade one mole of benzene. The formula weights for nitrate (62 gram/mole) and benzene (78 gram/mole) are used to put this ratio in terms of mass. It follows that, 4.77 grams of nitrate [6 moles x nitrate molecular weight (62)/benzene molecular weight (78)] are required for degradation of 1 gram of benzene. Similar ratios apply for toluene (4.71:1), ethylbenzene (4.67:1), and xylenes (4.67:1), and comparable ratios are expected for the numerous other gasoline-range petroleum hydrocarbons.

The stochiometric mass ratio of approximately 5:1 (nitrate:BTEX/TPH) is based on the assumption that all nitrate is used by microorganisms to obtain energy through degradation of TPH components. However, in field applications, additional nitrate will be used for other purposes, such as bacterial cell growth and degradation of natural organic matter. This means that the actual nitrate demand is greater than the stochiometric ratio of 5:1. In a previous successful field application (Lozier and Hicks 2005), nitrate was injected at a much higher ratio (18:1) compared to total BTEX present in groundwater.

The 5:1 ratio (nitrate:BTEX/TPH) is applied to AOC-05 groundwater data from May 2007 to make a conservatively low estimate of nitrate demand. A conservatively low estimate is desired to avoid injection of significantly more nitrate than will be used for TPH degradation. The most recent groundwater analytical results for BDC-103 (May 2007) indicate an estimated nitrate demand for aqueous-phase TPH degradation of more than 475 mg/L, as follows. May 2007 groundwater concentrations at well BDC-103 were 18 mg/L and 77 mg/L for total BTEX and TPH-G, respectively (Table 1). Based on the 5:1 ratio, a minimum of 90 mg/L of nitrate will be required to degrade the aqueous phase BTEX and an additional 385 mg/L of nitrate will be required to degrade the numerous additional compounds represented by the TPH-G groundwater concentration (475 mg/L total).

The 475 mg/L estimate of nitrate demand in AOC-05 based on the 5:1 stochiometric ratio is a conservatively low estimate of actual nitrate demand because it is based on aqueous phase TPH demand only. The estimate makes no allowance for other background nitrate demands, including bacterial cell growth and degradation of natural organic matter. The estimate does not account for the demand of sorbed-phase and NAPL-phase TPH degradation. Sorbed-phase and NAPL-phase petroleum contamination typically represent a much larger mass than is present in the aqueous phase.

4.3 INJECTION FLUID CONCENTRATION AND VOLUME

The injection fluid nitrate concentration and the volume of injection fluid delivered to each well will be the same as was used in the pilot test. This concentration and volume resulted in treatment of

TPH at injected well BDC-103 without exceeding action levels for nitrate or nitrate in downgradient wells that would require additional monitoring at wells located further downgradient (Landau Associates 2007).

A 6,500-gal injection volume of 1,000 mg/L nitrate solution will be delivered to both injection wells. This volume is estimated to result in a ROI of approximately 13.5 ft, based on an assumed effective porosity of 0.15 [i.e., half of the total aquifer porosity (0.3) will transmit injection fluid] and a saturated treatment zone thickness of 10 ft. During and following injection, it is anticipated that injection solution will be distributed through *in situ* mixing/dispersion/diffusion into the 13,000-gal total pore volume within the ROI, resulting in an effective dilution of the 1,000 mg/L nitrate concentration of the injection solution to 500 mg/L.

4.4 INJECTION PROCEDURES

Injection procedures will be similar to those used during the pilot test. Approximately 88 lbs of CAN-27 ammonium nitrate fertilizer and 2 lbs of yeast extract will be delivered to each injection well (176 lbs fertilizer and 4 lbs yeast extract total).

The fertilizer and yeast extract to be delivered to each well will be premixed with potable water in a 55-gal drum. The solution will be left to sit for at least 2 hours to allow the dolomite (fill material in the fertilizer) to settle out prior to injection.

The concentrated solution of fertilizer and yeast extract will be further diluted with potable water in a Baker tank. Four batches of dilute solution (3,250 gal each) will be mixed in the Baker Tank using ¼ of the premixed concentrated solution. Two batches of dilute solution will be injected to each well for an injection volume of 6,500 gal per well.

The solution will be injected to the wells using a gasoline-powered centrifugal pump. Injection pressures will be maintained below 20 pounds per square inch (psi).

4.5 REPEATED INJECTION EVENTS

It is anticipated that repeated injections of nitrate will be required for complete treatment of TPH-G and BTEX present in the aqueous, sorbed, and NAPL phases within the treatment area. Based on nitrate longevity during the pilot test, injections are expected to take place approximately every 4 months. However, the frequency of repeat injections will be determined by groundwater monitoring of nitrate concentrations. It is anticipated that repeated injections over 1 to 2 years may be required for treatment of aqueous-, sorbed-, and NAPL-phase TPH.

5.0 GROUNDWATER MONITORING

Monitoring of full-scale bioremediation will consist of baseline and bimonthly sampling. Prior to the nitrate injection, baseline groundwater monitoring for contaminant and aquifer redox parameters will be conducted at the four AOC-05 wells (BDC-101, BDC-102, BDC-103, and BDC-104). Performance monitoring will be performed every other month beginning 1 to 2 months after injection depending on when injection occurs relative to semiannual monitoring. Two monitoring events will coincide with regular semiannual monitoring performed in May and November. At the end of the treatment, it is anticipated that semiannual sampling will be performed for an additional year to document clean conditions.

The same contingent monitoring of additional groundwater wells that was described in the pilot test work plan (Landau Associates 2006b) will be implemented. If nitrate is detected at concentrations greater than 10 mg/L at downgradient wells BDC-101 or BDC-102 for two consecutive sampling events, contingent nitrate monitoring will also be performed at wells BDC-05-4, MW-17A, MW-18A, and MW-21A located further downgradient (Figure 5). If implemented, contingent nitrate monitoring will be performed semiannually at these four wells for 1 year after nitrate concentrations at wells BDC-101 and BDC-102 have been reduced to less than 10 mg/L.

Samples collected for baseline and performance monitoring will be analyzed for contaminant concentrations (TPH-G and BTEX) and parameters indicative of aquifer redox conditions [dissolved oxygen (DO), oxidation-reduction potential (ORP), nitrate, ferrous iron, sulfate, and pH]. Laboratory analysis will be performed by Analytical Resources, Inc for TPH-G, BTEX, nitrate, and sulfate. Other parameters [DO, ORP, ferrous iron, and pH] will be measured in the field. Table 3 presents a comprehensive list of the monitoring parameters and information provided by each parameter.

6.0 DATA EVALUATION AND REPORTING

Analytical data will be evaluated to monitor degradation of TPH-G and BTEX and to schedule injections. The concentrations of TPH-G and BTEX will be the primary indicators of successful biostimulation. Redox parameters (DO, ORP, nitrate, ferrous iron, and sulfate) and pH will be used to evaluate aquifer redox conditions. Nitrate data will also be used to evaluate its longevity to determine when additional injections are required and its downgradient distribution.

Data will be reported semiannually and an evaluation report will be prepared annually during implementation. Bimonthly monitoring data will be reported in the regular semiannual reports prepared for the DC. Evaluation of data will be presented in an annual report and a final report will be prepared at the conclusion of the treatment.

7.0 SCHEDULE

We propose to perform the first full-scale injection during February 2008. The nitrate injection will be preceded by installation of well BDC-104 and baseline monitoring performed in January 2008. It is anticipated that injections will be required every fourth month through 2008 and into 2009.

8.0 USE OF THIS WORK PLAN

This work plan has been prepared for the exclusive use of The Boeing Company for specific application to the full-scale bioremediation of petroleum hydrocarbons at AOC-05 at the Boeing Developmental Center in Tukwila, Washington. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of Landau Associates. Further, the reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by Landau Associates, shall be at the user's sole risk. Landau Associates warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. We make no other warranty, either express or implied.

This document has been prepared under the supervision and direction of the following key staff.

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BJ/CLJ/ccy

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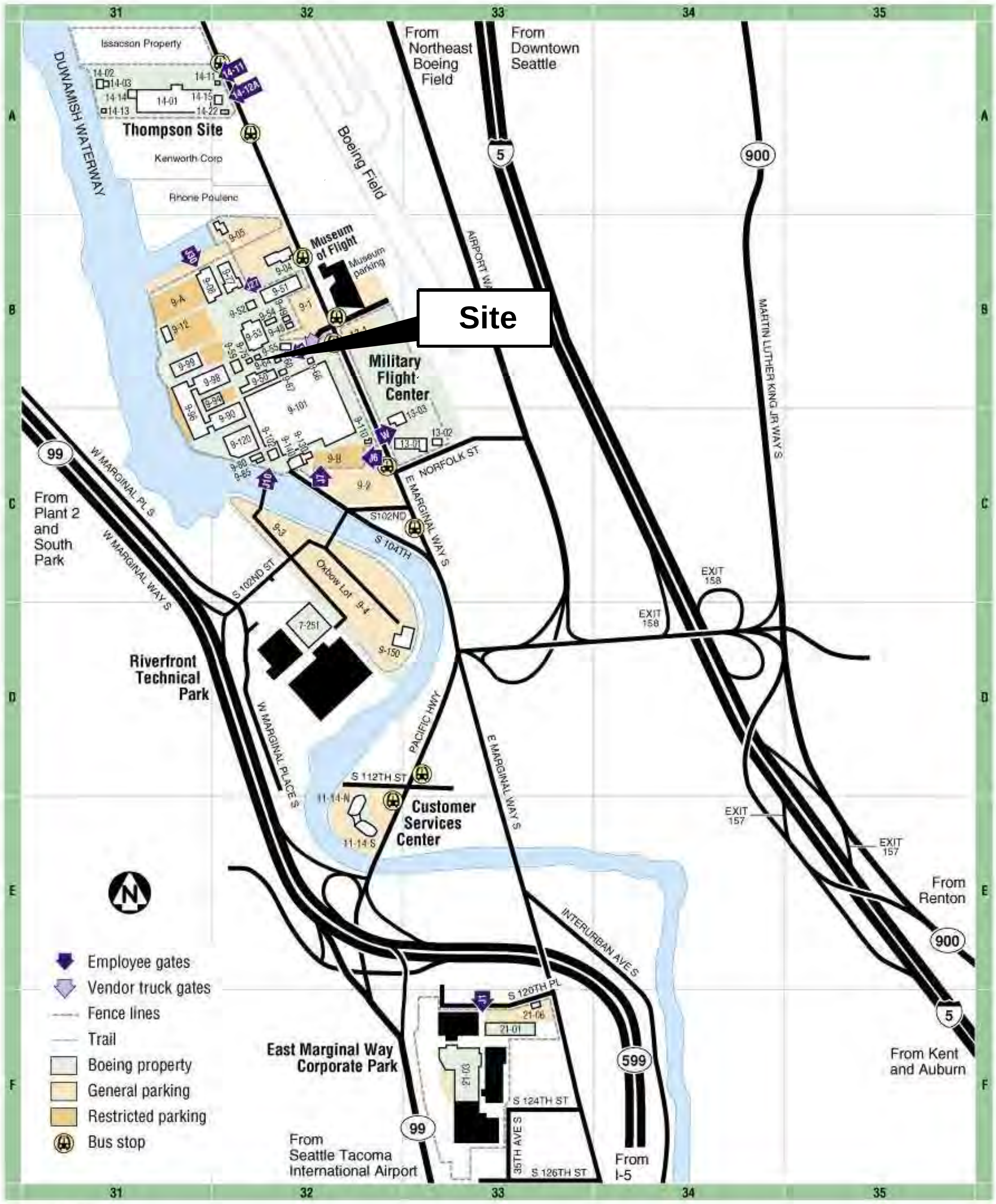

Map provided by Boeing, March 2000

Not To Scale

Boeing/Developmental Center | V:\025\093\040\D\AOC-05 Nitrate Full Scale Work Plan\Fig1.cdr 9/25/2007

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Boeing Developmental Center Tukwila, Washington	**Site Location Map**	Figure 1

Boeing/Developmental Center | V:\025\093\040\D\AOC-05 Nitrate Full Scale Work Plan\Figure 2.dwg (A) "Figure 2" 9/27/2007

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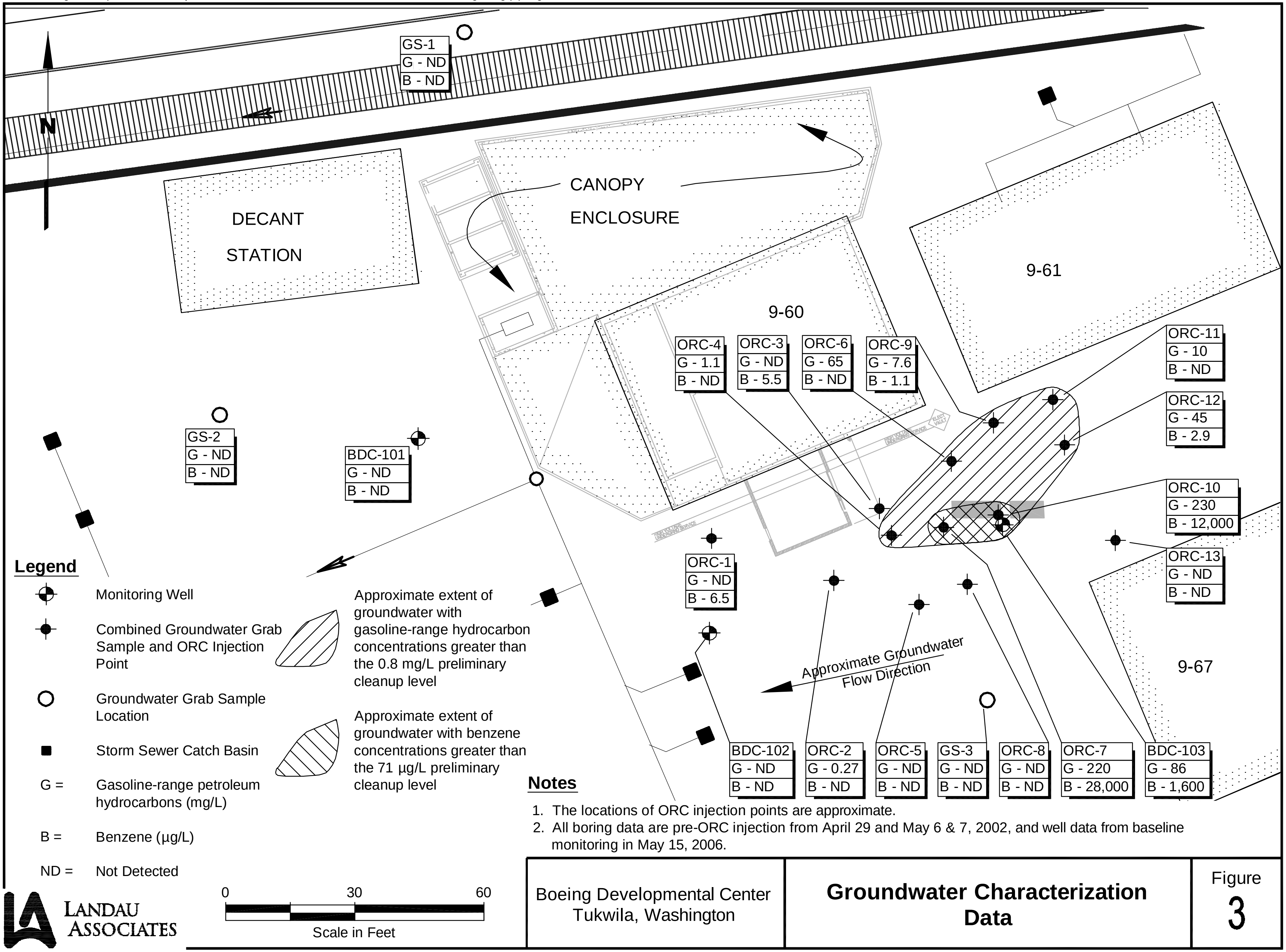
0 200 400
Approximate Scale in Feet

Boeing Developmental Center Tukwila, Washington	**SWMU & AOC Locations**	Figure 2



Notes

1. The locations of ORC injection points are approximate.
2. All boring data are pre-ORC injection from April 29 and May 6 & 7, 2002, and well data from baseline monitoring in May 15, 2006.

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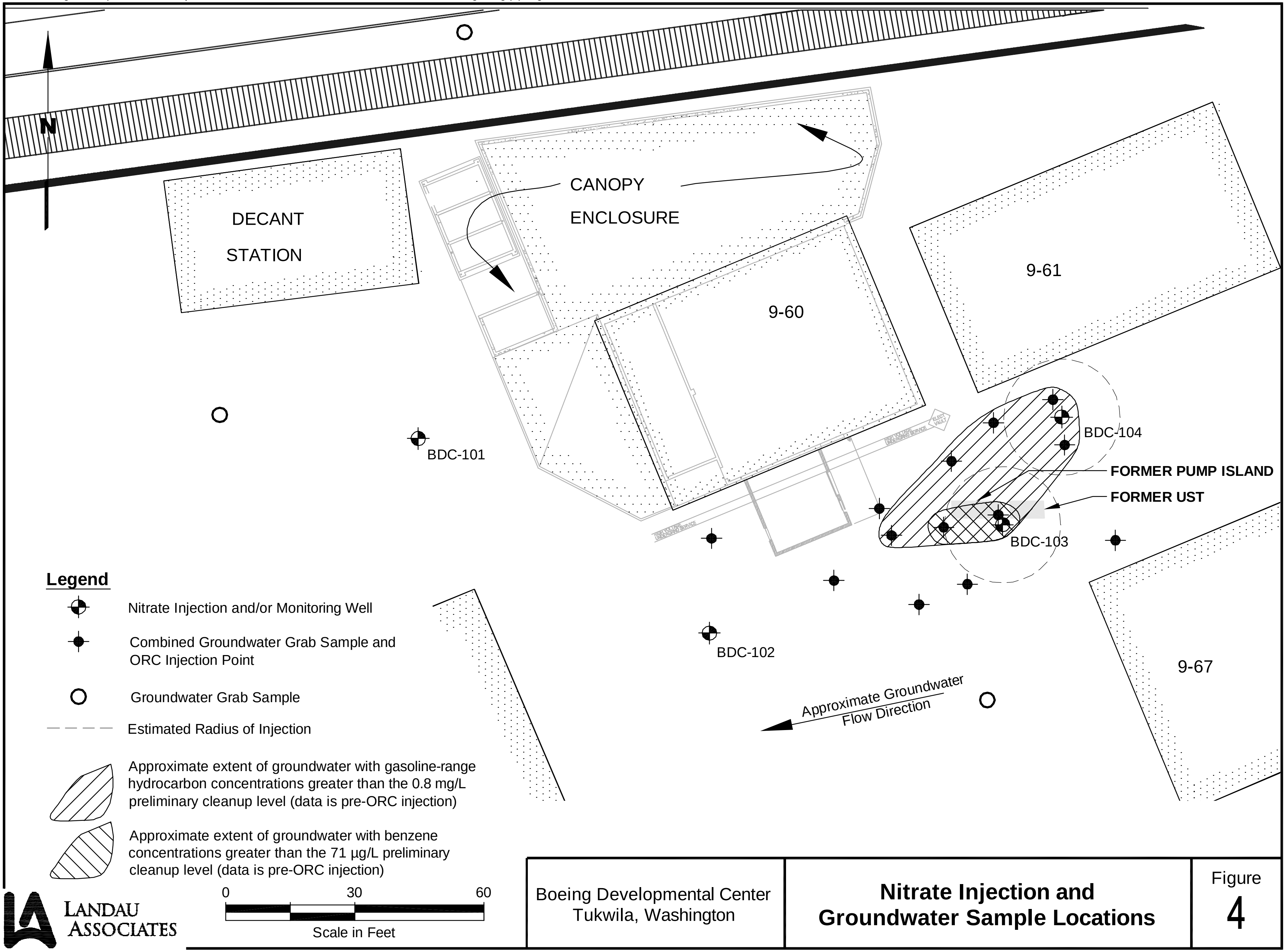
Boeing Developmental Center Tukwila, Washington	**Groundwater Characterization Data**	Figure 3

Boeing/Developmental Center | V:\025\093\040\D\AOC-05 Nitrate Full Scale Work Plan\Fig4.dwg (A) "Figure 4" 9/28/2007



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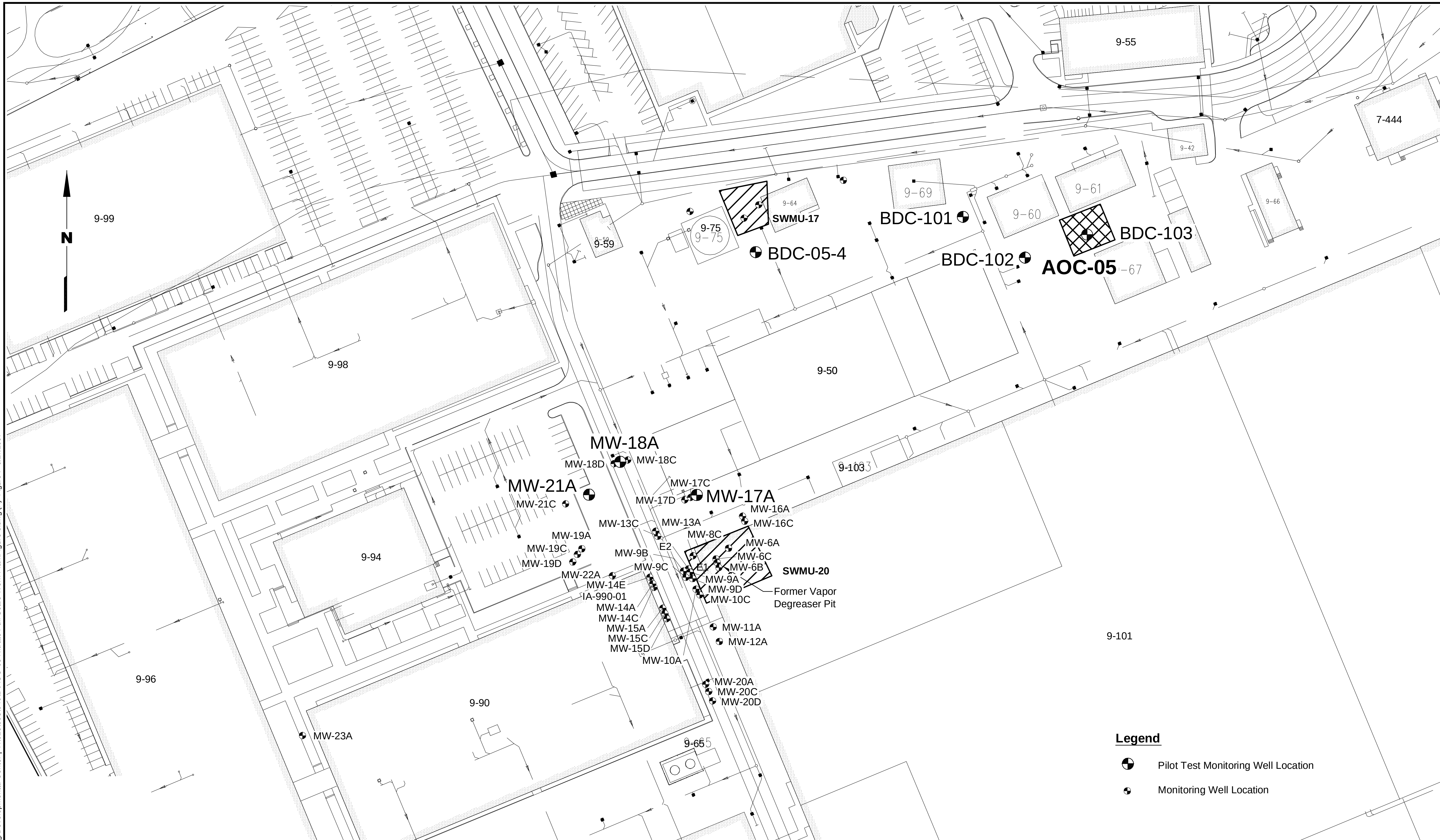
Boeing Developmental Center
Tukwila, Washington

Nitrate Injection and Groundwater Sample Locations

Figure 4



0 100 200

Approximate Scale in Feet

Landau Associates

Boeing Developmental Center
Tukwila, Washington

Potential Downgradient Monitoring Locations

Figure 5

Boeing/Developmental Center | V:\025\093\040\D\AOC-05 Nitrate Full Scale Work Plan\Figure 5.dwg (A) "Figure 7" 9/27/2007

TABLE 1
GROUNDWATER CONTAMINANT DATA
AOC-05
BOEING DEVELOPMENTAL CENTER

	Preliminary Groundwater Levels (a) Screening	Pre-ORC Injection (b) BDC-101 06/11/01	BDC-101 09/04/01	BDC-101 12/03/01	BDC-101 03/13/02	BDC-101 EH92A 04/29/02	Post ORC Injection (b) BDC-101 EK68A 06/03/02	BDC-101 EN04A 07/01/02	BDC-101 EP36A 08/01/02	BDC-101 FA41A 12/02/02	BDC-101 FH27A 03/10/03	BDC-101 FN40A 06/03/03	BDC-101 GB17B 11/19/03	BDC-101 GO82A 04/28/04	BDC-101 HF76A 10/18/04	BDC-101 IA83A 05/10/05	BDC-101 IS89A 11/10/05	BDC-101 JJ26B 05/15/06	BDC-101 KG20B 11/20/06
Total Petroleum Hydrocarbons (mg/L)																			
Gasoline	0.8	3	5	6.5	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.61	0.25 U	0.25 U	0.42 J	0.25 U	0.64	0.25 U	0.25	0.25 U	1.1
BTEX (µg/L)																			
Benzene	71	11.9	7.13 J	95	1.4	1 U	1	1 U	3.1	4.3	1	1 U	13 J	1 U	10	1 U	7.6	1.0 U	10
Toluene	200,000	1 U	10.7	1.6	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	1.0 U	1.0 U	1.0 U
Ethylbenzene	29,000	113.1	50.4	750	4.4	2.2	1 U	1 U	2.4	21	4.5	1 U	15 J	1 U	15	1 U	2.6	1.0 U	15
m,p-Xylene	NA					1 U	1 U	1 U	1 U	27	3.2	1 U	35 J	1 U	43	1 U	42	1.0 U	72.0
o-Xylene	NA					1 U	1 U	1 U	1 U	6.4	1 U	1 U	1 UJ	1 U	1 U	1 U	1.0 U	1.0 U	1.0 U
Total Xylenes	NA	109.2	53.8	650	2 U	1 U	1 U	1 U	1 U	33.4	3.2	1 U	35 J	1 U	43	1 U	42	1.0 U	72

	Preliminary Groundwater Levels (a) Screening	Post-Nitrate Injection (c) BDC-101 KO95A 02/20/07	BDC-101 KR82A 03/19/07	BDC-101 KV95A 04/24/07	BDC-101 KZ41A 05/17/07
Total Petroleum Hydrocarbons (mg/L)					
Gasoline	0.8	0.25 U	0.25 U	0.25 U	0.25 U
BTEX (µg/L)					
Benzene	71	1.0 U	1.0 U	1.0 U	1.0 U
Toluene	200,000	1.0 U	1.0 U	1.0 U	1.0 U
Ethylbenzene	29,000	1.0 U	1.0 U	1.0 U	1.0 U
m,p-Xylene	NA	1.0 U	1.0 U	1.0 U	1.0 U
o-Xylene	NA	1.0 U	1.0 U	1.0 U	1.0 U
Total Xylenes	NA	1.0 U	1.0 U	1.0 U	1.0 U

TABLE 1
GROUNDWATER CONTAMINANT DATA
AOC-05
BOEING DEVELOPMENTAL CENTER

	Preliminary Groundwater Levels (a) Screening	Pre-ORC Injection (b) BDC-102 06/11/01	BDC-102 09/04/01	BDC-102 12/03/01	BDC-102 03/13/02	BDC-102 EH92B 04/29/02
Total Petroleum Hydrocarbons (mg/L)						
Gasoline	0.8	0.55	0.38	1.6	0.5	0.33
BTEX (µg/L)						
Benzene	71	5.33 J	1.61 J	3.7	1.3	2.6
Toluene	200,000	1 U	1.89 J	1 U	1 U	1 U
Ethylbenzene	29,000	1 U	1 U	1 U	1 U	1 U
m,p-Xylene	NA					1.1
o-Xylene	NA					1 U
Total Xylenes	NA	2 U	1.87 J	3.49 J	1 U	1.1

	Post ORC Injection (b) BDC-102 EK68B 06/03/02	BDC-102 EN04B 07/01/02	BDC-102 EP36B 08/01/02	BDC-102 FA41B 12/02/02	BDC-102 FH27B 03/10/03	BDC-102 FN40B 06/03/03	BDC-102 GB17C 11/19/03	BDC-102 GO82B 04/28/04	BDC-102 HF76B 10/18/04	BDC-102 IA83B 05/10/05	BDC-102 IS89B 11/10/05	BDC-102 JJ26A 05/15/06	BDC-102 KG20A 11/20/06
Total Petroleum Hydrocarbons (mg/L)													
Gasoline	0.25 U	0.25	0.25 U	0.25 U	0.26	0.25 U	0.99 J	0.40	0.33	0.25 U	0.25 U	0.25 U	0.25 U
BTEX (µg/L)													
Benzene	4.4	1 U	1 U	1 U	1 U	1 U	120 J	10	1 U	1 U	1.0 U	1.0 U	1.0 U
Toluene	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	1.0 U	1.0 U	1.0 U
Ethylbenzene	1 U	1 U	1 U	1 U	1 U	1 U	8.5 J	1 U	1 U	1 U	1.0 U	1.0 U	1.0 U
m,p-Xylene	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ	3	1 U	1 U	1.0 U	1.0 U	1.0 U
o-Xylene	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	1.0 U	1.0 U	1.0 U
Total Xylenes	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ	3	1 U	1 U	1.0 U	1.0 U	1.0 U

	Preliminary Groundwater Levels (a) Screening	Post-Nitrate Injection (c) BDC-102 K095B 02/20/07	BDC-102 KR82B 03/19/07	BDC-102 KV95B 04/24/07	BDC-102 KZ41B 05/17/07
Total Petroleum Hydrocarbons (mg/L)					
Gasoline	0.8	0.25 U	0.25 U	0.53	0.25 U
BTEX (µg/L)					
Benzene	71	5.8	18	6.1	1.8
Toluene	200,000	1.0 U	1.0 U	1.0 U	1.0 U
Ethylbenzene	29,000	1.0 U	1.0 U	3.1	1.0 U
m,p-Xylene	NA	1.0 U	32	100	7.4
o-Xylene	NA	1.0 U	1.0 U	1.0 U	1.0 U
Total Xylenes	NA	1.0 U	32	100	7.4

TABLE 1
GROUNDWATER CONTAMINANT DATA
AOC-05
BOEING DEVELOPMENTAL CENTER

	Preliminary Groundwater Levels (a) Screening	Pre-ORC Injection (b)					Post ORC Injection (b)													
		BDC-103	BDC-103	BDC-103 (d)	BDC-103	BDC-103 EH92C	BDC-103 EK68C	BDC-103 EN04C	BDC-103 EP36C	BDC-103 FA41C	BDC-103 FH27C	BDC-103 FN40C	BDC-103 GB17D	BDC-103 GO82C	BDC-103 HF76C	BDC-103 IA83C	BDC-103 IS89C	BDC-103 JJ26C	BDC-103 JJ26H	BDC-103 KG20C
		06/11/01	09/04/01	12/03/01	03/13/02	04/29/02	06/03/02	07/01/02	08/01/02	12/02/02	03/10/03	06/03/03	11/19/03	04/28/04	10/18/04	05/10/05	11/10/05	05/15/06	05/15/06	11/20/06
Total Petroleum Hydrocarbons (mg/L)																				
Gasoline	0.8	177	123	120	200	200	200	240	270	250	180	220	180	160	140	110	90	84	86	51
BTEX (µg/L)																				
Benzene	71	875 J	494 J	5,100	1,700	980	960	1,300	4,600	1,400	780	900	850 J	1,600	2,100	2,200	2,200	1,600	1,600	2,000
Toluene	200,000	12,010	3,760	2,300,000	17,000	16,000	17,000	16,000	18,000	15,000	13,000	10,000	8,300 J	6,600	5,500	5,500	3,500	3,800	3,800	730
Ethylbenzene	29,000	1,985 J	419 J	10,000	4,900	5,400	5,100	5,200	5,200	5,000	5,200	5,000	4,500 J	3,900	3,700	3,800	3,700	3,100	3,100	2,200
m,p-Xylene	NA					20,000	20,000	20,000	19,000	22,000	20,000	20,000	18,000 J	16,000	15,000	14,000	12,000	10,000	10,000	3,900
o-Xylene	NA					7,000	7,100	6,800	6,600	6,900	6,700	6,600	5,500 J	5,100	4,400	3,200	2,500	2,200	2,200	1,000
Total Xylenes	NA	11,430	2,636	3,400,000	26,400	27,000	27,100	26,800	25,600	28,900	26,700	26,600	23,500 J	21,100	19,400	17,200	15,000	12,000	12,000	4,900

	Preliminary Groundwater Levels (a) Screening	Post-Nitrate Injection (c)			
		BDC-103 KO95C 02/20/07	BDC-103 KR82C 03/19/07	BDC-103 KV95C 04/24/07	BDC-103 KZ41C 05/17/07
Total Petroleum Hydrocarbons (mg/L)					
Gasoline	0.8	26	30	36	77
BTEX (µg/L)					
Benzene	71	460	490	820	1,400
Toluene	200,000	420	88	440	4,300
Ethylbenzene	29,000	140	130	220	1,100
m,p-Xylene	NA	3,600	3,500	3500	8,300
o-Xylene	NA	1,600	1,700	1800	3,200
Total Xylenes	NA	5,200	5,200	5300	11,500

NA = no preliminary cleanup level available.
U = compound was not detected at given reporting limit.
J = indicates the analyte was positively identified, and the concentration listed is an estimate.
UJ = The analyte was not detected in the sample; the reported sample reporting limit is an estimate.

-- = Not Measured.
Boxed value indicates concentration above preliminary cleanup level.

(a) Landau Associates 2002.
(b) ORC injection in April and May 2002.
(c) Ammonium nitrate solution injected to well on 1/17-18/07.
(d) BTEX data questionable for this event. Concentrations inconsistent with TPH-G data for indicated event and BTEX data from other events.

TABLE 2
AQUIFER REDOX DATA
AOC-05
BOEING DEVELOPMENTAL CENTER

					Post-Nitrate Injection (a)			
Sample Name:	BDC-101	BDC-101	BDC-101	BDC-101	BDC-101	BDC-101	BDC-101	BDC-101
ARI Sample ID:	GB17B	IS89A	JJ26B	KG20B	KO95A	KL82A	KV95A	KZ41A
Sample Date:	11/19/2003	11/10/2005	5/15/2006	11/20/2006	2/20/2007	3/19/2007	4/24/2007	5/17/2007
Test ID: Conventional Parameters								
Dissolved Oxygen (mg/L)	0.36	0.96	2.78	0.92	2.39	5.97	3.09	2.35
ORP (mV)	120.3	259	80	174	277	213	136	297
N-Nitrate (mg-N/L)	1.1	4.4	17.8	0.122	15.0	8.83	9.59	9.95
N-Nitrite (mg-N/L)	0.010 U	NA	0.059	0.016	0.047	0.037	0.041	0.046
Ferrous Iron (mg/L)	0.2	NM	0	2.4	0.2	0.5	0.5	0.4
Sulfate (mg/L)	16	34.3	64.1	8.7	50.0	38.5	34.1	35.7
Methane (ug/L)	240	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon (mg/L)	NA	2.05	NA	NA	NA	NA	NA	NA

TABLE 2
AQUIFER REDOX DATA
AOC-05
BOEING DEVELOPMENTAL CENTER

					Post-Nitrate Injection (a)			
Sample Name:	BDC-102	BDC-102	BDC-102	BDC-102	BDC-102	BDC-102	BDC-102	BDC-102
ARI Sample ID:	GB17C	IS89B	JJ26A	KG20A	KO95B	KR82B	KV95B	KZ41B
Sample Date:	11/19/2003	11/10/2005	5/15/2006	11/20/2006	2/20/2007	3/19/2007	4/24/2007	5/17/2007
Test ID: Conventional Parameters								
Dissolved Oxygen (mg/L)	0.38	0.82	2.21	1.25	0.47	0.88	1.20	0.84
ORP (mV)	122.2	122	-11	163	-145	-98	-93	286
N-Nitrate (mg-N/L)	0.19	4.4	4.72	0.250 U	0.749	0.938	1.94	2.78
N-Nitrite (mg-N/L)	0.011	NA	0.175	0.250 U	0.027	0.072	0.051	0.108
Ferrous Iron (mg/L)	5.5	NM	2.2	2.2	3.0	3.0	2.8	2.6
Sulfate (mg/L)	46	34.0	35.7	9.2	25.3	31.0	40.4	33.9
Methane (ug/L)	1100	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon (mg/L)	NA	18.4	NA	NA	NA	NA	NA	NA

TABLE 2
AQUIFER REDOX DATA
AOC-05
BOEING DEVELOPMENTAL CENTER

					Post-Nitrate Injection (a)			
Sample Name:	BDC-103	BDC-103	BDC-103	BDC-103	BDC-103	BDC-103	BDC-103	BDC-103
ARI Sample ID:	GB17D	IS89C	JJ26C	KG20C	KO95B	KR82C	KV95C	KZ41C
Sample Date:	11/19/2003	11/10/2005	5/15/2006	11/20/2006	2/20/2007	3/19/2007	4/24/2007	5/17/2007
Test ID: Conventional Parameters								
Dissolved Oxygen (mg/L)	0.38	0.72	0.92	1.23	0.31	0.63	0.84	0.61
ORP (mV)	-75.9	147	106	202	109	4	-14	244
N-Nitrate (mg-N/L)	0.012	1.0 U	0.010 U	0.100 U	60.8	27.9	7.54	0.138
N-Nitrite (mg-N/L)	0.011	NA	0.054	0.100 U	11.1	8.28	3.56	0.079
Ferrous Iron (mg/L)	5.5	NM	3.5	2.4	0.5	0.4	2.4	3.6
Sulfate (mg/L)	53	11.9	15.2	28.3	99.2	141	59.2	169
Methane (ug/L)	630	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon (mg/L)	NA	15.4	NA	NA	NA	NA	NA	NA

U = Indicates compound was analyzed for, but was not detected at the given detection limit.
NA = Not analyzed.
NM = Not measured.
(a) Ammonium nitrate solution injected to well on January 17-18, 2007.

TABLE 3
PERFORMANCE MONITORING PARAMETERS
AOC-05
BOEING DEVELOPMENTAL CENTER

Field Parameters	Information Provided
Dissolved Oxygen (DO) [field meter and single-use reactive ampoules] (a)	Aquifer is considered anaerobic at DO concentrations less than 1.0 mg/L.
Oxidation Reduction Potential (Redox) [field meter] (a)	Negative values indicate reducing conditions.
pH [field meter] (a)	Optimum conditions for biological activity is within the range of 6 to 8.
Ferrous Iron [Hach test kit]	Concentrations above background indicate iron-reducing conditions.
Laboratory Analyses	**Information Provided**
Total Petroleum Hydrocarbons as Gasoline (TPH-G) [Method NWTPH-Gx][3 40 ml VOA-H2SO4] [Holding time - 14 days]	Decreasing concentrations are an indication of anaerobic biotransformations of TPH-G.
BTEX [Method EPA 8021B][3 40 ml VOA-H2SO4] [Holding time - 14 days]	Decreasing concentrations are an indication of anaerobic biotransformations of BTEX.
Nitrate (b) [IC Method E300][500 ml poly] [Holding time - 48 hours]	Concentrations below background indicate nitrate-reducing conditions.
Sulfate [IC Method E300][500 ml poly] [Holding time - 28 days]	Concentrations below background indicate sulfate-reducing conditions that may result from depletion of nitrate.

(a) Measured using a flow-through cell.

(b) Nitrate sample can be combined with sulfate sample; nitrate analysis must be performed within 48-hour holding time.

APPENDIX A

Health and Safety Plan

WORK LOCATION PERSONNEL PROTECTION AND SAFETY EVALUATION FORM

Attach Pertinent Documents/Data
Fill in Blanks As Appropriate

Job No.:	025093.005.040		
Prepared by:	Benni Jonsson	Reviewed by:	Clint Jacob
Date:	September 20, 2007	Date:	September, 27, 2007

A. WORK LOCATION DESCRIPTION

1. **Project Name:** Boeing AOC-O5 Former Gasoline Underground Storage Tank, Ammonium Nitrate Injection
2. **Location:** 9725 East Marginal Way S., Tukwila, Washington
3. **Anticipated Activities:** Drilling, well installation, groundwater sampling, and injection of ammonium nitrate fertilizer
4. **Surrounding Population:** Industrial
5. **Buildings/Homes/Industry:** Industrial buildings, office buildings
6. **Topography:** Mostly flat river valley bottom
7. **Anticipated Weather:** Partly clear, 35º to 60º F
8. **Unusual Features:** N/A
9. **Site History:** Site is a portion of Boeing Developmental Center, contaminated with TPH-G and BTEX.

B. HAZARD DESCRIPTION

1. Background Review: ☒ Complete ☐ Partial

If partial, why?

2. Hazardous Level: ☐ B ☐ C ☒ D ☐ Unknown

Justification: Possible petroleum hydrocarbon contamination.

3. Types of Hazards: (Attach additional sheets as necessary)

A. ☒ Chemical ☒ Inhalation ☒ Explosive
☐ Biological ☒ Ingestion ☐ O_2 Def. ☒ Skin Contact

Describe: Direct contact with contaminated soil or groundwater, accidental ingestion of contaminated soil or groundwater, or inhalation of vapors.

B. ☒ Physical ☒ Cold Stress ☒ Noise ☐ Heat Stress ☐ Other

Describe: Hazards associated with working with pressurized hoses. Cold stress conditions related to exposure. Noise from running trash pump.

C. ☐ Radiation

Describe: NA

4. Nature of Hazards:

☒ Air Describe: Dust from contaminated soil material. Inhalation of vapors.

☐ Soil Describe: NA

☐ Surface Water Describe: NA

☒ Groundwater Describe: Direct contact with or ingestion of contaminated groundwater.

☐ Other Describe: NA

5. Chemical Contaminants of Concern ☐ N/A

Contaminant	PEL (ppm)	I.D.L.H. (ppm)	Source/Quantity Characteristics	Route of Exposure	Symptoms of Acute Exposure	Instruments Used to Monitor Contaminant
Total Petroleum Hydrocarbons	NA	Unknown	May encounter petroleum hydrocarbons during drilling, groundwater pumping, and sampling	Dermal contact, inhalation	Skin and mucous membrane irritation, dizziness, nausea	Olfactory, visual, PID, LEL
Ammonium nitrate	NA	Unknown	Possible exposure when ammonium nitrate is mixed with groundwater in a Baker tank.	Dermal contact, inhalation, ingestion	Eye, skin, and respiratory irritant. Harmful if swallowed.	Olfactory, visual.
Benzene	0.5	500	May encounter benzene during drilling, groundwater pumping, and sampling	Dermal contact, inhalation, ingestion	Irritated eyes, skin, nose, and respiratory system; giddiness; headache; nausea; staggered gait; dermatitis; fatigue	Olfactory, visual, PID, LEL, Drager Tube
Toluene	100	500	May encounter benzene during drilling, groundwater pumping, and sampling	Dermal contact, inhalation, ingestion	Skin, nose, throat irritation; dizziness; vomiting	Olfactory, visual, PID, LEL
Xylene	100	900	May encounter benzene during drilling, groundwater pumping, and sampling	Dermal contact, inhalation, ingestion	Skin, nose, eye, throat irritation; dizziness; drowsiness; excitement; vomiting, abdominal pain	Olfactory, visual, PID, LEL
Ethylbenzene	100	800	May encounter benzene during drilling, groundwater pumping, and sampling	Dermal contact, inhalation, ingestion	Eye, skin, mucous membrane irritation; headache, narcosis	Olfactory, visual, PID, LEL

6. Physical Hazards of Concern ☐ N/A

Hazard	Description	Location	Procedures Used to Monitor Hazard
Hazards associated with pressurized hoses	Injection of groundwater and ammonium nitrate mixture	Area of injection wells	Personnel will observe pressure and make sure it is low before disconnecting hoses.
Moving parts of drill rig, falling and flying objects	Drilling and installation of well	Near drill rig	Alert observation of surroundings; minimize time spent near drill rig; no loose clothing; use of safety glasses, hard hat, and steel toes boots.

7. Work Location Instrument Readings ☐ N/A

Location: ______________________

Percent O_2: ______________________ Percent LEL: ______________________

Radioactivity: ______________________ PID: ______________________

FID: ______________________ Other: ______________________

Other: ______________________ Other: ______________________

Other: ______________________ Other: ______________________

Location: ______________________

Percent O_2: ______________________ Percent LEL: ______________________

Radioactivity: ______________________ PID: ______________________

FID: ______________________ Other: ______________________

Other: ______________________ Other: ______________________

Other: ______________________ Other: ______________________

Location: ______________________

Percent O_2: ______________________ Percent LEL: ______________________

Radioactivity: ______________________ PID: ______________________

FID: ______________________ Other: ______________________

Other: ______________________ Other: ______________________

Other: ______________________ Other: ______________________

Location: ______________________

Percent O_2: ______________________ Percent LEL: ______________________

Radioactivity: ______________________ PID: ______________________

FID: ______________________ Other: ______________________

Other: ______________________ Other: ______________________

Other: ______________________ Other: ______________________

8. Hazards Expected In Preparation For Work Assignment ☒ N/A

Describe:

C. PERSONAL PROTECTIVE EQUIPMENT

1. Level of Protection

Primary: ☐ A ☐ B ☐ C ☒ D

Upgrade: ☐ A ☐ B ☐ C ☒ D modified

Location/Activity: All locations; upgrade to Level C (half-face respirator with organic vapor/HEPA cartridge if air monitoring action levels are exceeded (see Attachment A).

2. Protective Equipment (specify probable quantity required)

Respirator ☐ N/A

☐ SCBA, Airline

☐ Full-Face Respirator

☒ Half-Face Respirator (Cart. organic vapor/HEPA) (Only if upgrade to Level C)

☐ Escape mask

☐ None

☐ Other:

☐ Other:

Clothing ☐ N/A

☐ Fully Encapsulating Suit

☐ Chemically Resistant Splash Suit

☐ Apron, Specify:

☒ Tyvek Coverall (for Level C upgrade)
(or)

☐ Saranex Coverall

☐ Coverall, Specify

☒ Other: Dedicated field clothing

Head & Eye ☐ N/A

☐ Hard Hat

☐ Goggles

☐ Face Shield

☒ Safety Eyeglasses

☒ Other: Ear muffs or plugs

Hand Protection ☐ N/A

☒ Undergloves; Type: nitrile/neoprene

☐ Gloves; Type:

☐ Overgloves; Type:

☐ None

☐ Other:

Foot Protection ☐ N/A

☐ Neoprene Safety Boots with Steel Toe/Shank

☐ Disposable Overboots

☒ Other: Steel-toe boots

3. Monitoring Equipment ☐ N/A

☐ CGI	☒ PID
☐ O_2 Meter	☐ FID
☐ Rad Survey	☒ Other: LEL
☐ Detector Tubes (optional)	

Type:

D. PERSONNEL DECONTAMINATION

☒ Required (soap and water – hands) ☐ Not Required

EQUIPMENT DECONTAMINATION

☒ Required ☐ Not Required

If required, describe and list equipment:

All non-dedicated water sampling equipment will be washed with Trisodium Phosphate soap and rinsed with tap water.

E. PERSONNEL

	Name	Work Location Title/Task	Medical Current	Fit Test Current
1.	**To be determined**	**Injection and Groundwater sampling**	☐	☐
2.			☐	☐
3.			☐	☐
4.			☐	☐
5.			☐	☐
6.			☐	☐
7.			☐	☐
8.			☐	☐
9.			☐	☐
10.			☐	☐

Site Safety Coordinator: To be determined

F. ACTIVITIES COVERED UNDER THIS PLAN

Task No.	Description	Preliminary Schedule
1	Drilling and well installation	
2	Baseline groundwater sampling	
3	Ammonium nitrate injection	
4	Follow-up groundwater monitoring (monthly to quarterly)	

G. SUBCONTRACTOR'S HEALTH AND SAFETY PROGRAM EVALUATION

☒ N/A

Name and Address of Subcontractor: Cascade Drilling
PO Box 1184
Woodinville, WA 98072

EVALUATION CRITERIA

Item	Adequate	Inadequate	Comments
Medical Surveillance Program	☒	☐	
Personal Protective Equipment Availability	☒	☐	
Onsite Monitoring Equipment Availability	☒	☐	
Safe Working Procedures Specification	☒	☐	
Training Protocols	☒	☐	
Ancillary Support Procedures (if any)	☒	☐	
Emergency Procedures	☒	☐	
Evacuation Procedures Contingency Plan	☒	☐	
Decontamination Procedures Equipment	☒	☐	
Decontamination Procedures Personnel	☒	☐	

GENERAL HEALTH AND SAFETY PROGRAM EVALUATION: ☒ Adequate ☐ Inadequate

Additional Comments: Review based on previous experience with contractor and contractor's experience at the site.

Evaluation Conducted By: Clint Jacob

Date: September, 27, 2007

EMERGENCY FACILITIES AND NUMBERS

Hospital: Harborview Medical Center
325 9th Avenue
Seattle, WA
206-731-3000

Directions: Exit at front gate and turn left onto E. Marginal Way S. Go southeast on E. Marginal Way S towards S NORFOLK ST. Turn LEFT onto S BOEING ACCESS RD. Merge onto I-5 N toward SEATTLE. Take the DEARBORN ST. / JAMES ST. exit- EXIT 164A- toward MADISON ST. Take the JAMES ST exit. Turn RIGHT onto JAMES ST. Turn right on Boren Avenue and drive 3 blocks to Broadway. Turn right, and then make a quick right turn onto Alder St. Continue for three blocks to 8th Avenue. (See route map attached to front of health and safety plan.)

Telephone: Field technician will maintain a mobile phone.

Emergency Transportation Systems (Fire, Police, Ambulance) – 911

Emergency Contacts:

Poison Control Center: 526-2121

Landau Project Manager: 425-778-0907
Boeing Environmental Affairs (Jim Bet): 425-865-5348

<u>In the event of an emergency, do the following:</u>

1. Call for help as soon as possible. Call 911. Give the following information:
   - WHERE the emergency is – use cross streets or landmarks
   - PHONE NUMBER you are calling from
   - WHAT HAPPENED – type of injury
   - WHAT is being done for the victim(s)
   - YOU HANG UP LAST – let the person you called hang up first.

2. If the victim can be moved, paramedics will transport to the hospital. If the injury or exposure is not life threatening, decontaminate the individual first. If decontamination is not feasible, wrap the individual in a blanket or sheet of plastic prior to transport.

3. Notify Landau Associates project manager.

4. Notify Boeing Environmental Affairs.

HEALTH AND SAFETY PLAN
APPROVAL/SIGN OFF FORMAT

I have read, understood, and agreed with the information set forth in this Health and Safety Plan (and attachments) and discussed in the Personnel Health and Safety briefing.

Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Project Manager	Signature	Date

Personnel Health and Safety Briefing Conducted By:

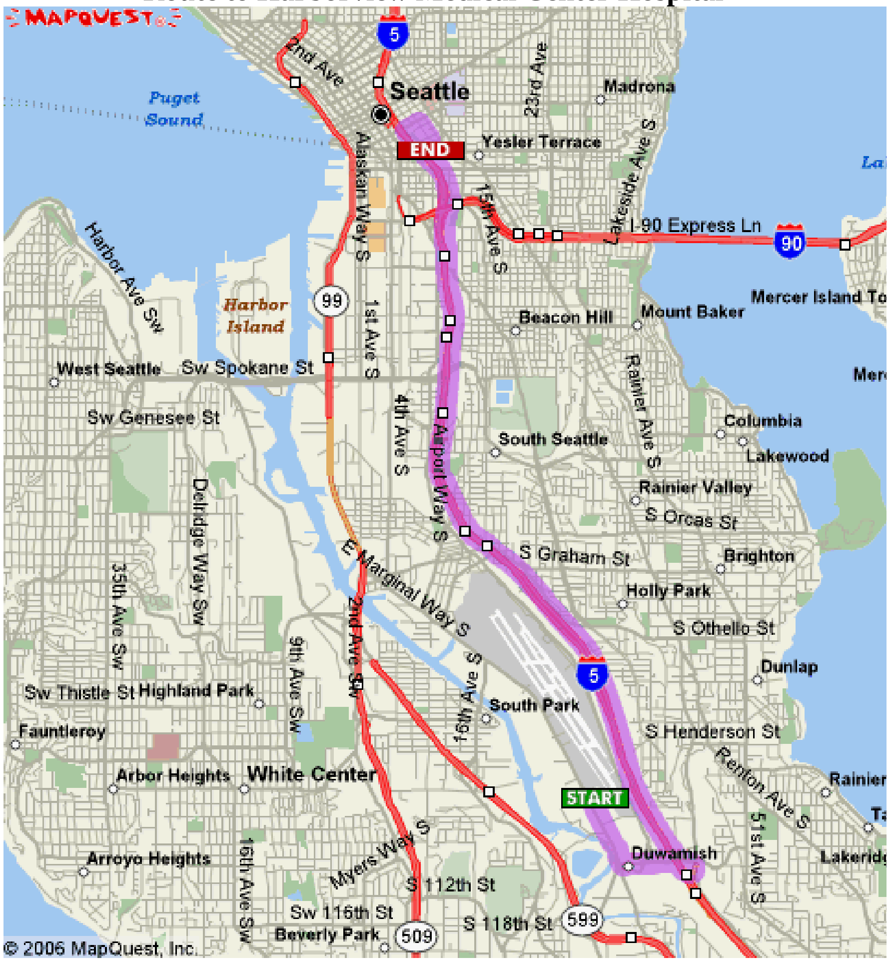
Name	Signature	Date

ATTACHMENT A

ACTION LEVELS FOR RESPIRATORY PROTECTION

Monitoring Parameter	Reading	Level of Protection
Organic vapors	PID reading >20 ppm in breathing zone for more than 20 minutes.	Evacuate area, use institutional control or upgrade to Level D modified.
Organic vapors	PID reading >35 ppm for momentary peak.	Evacuate area, use institutional control or upgrade to Level D modified.
Benzene	Drager Tube reading >0.25 ppm in breathing zone.	Evacuate area, use institutional control or upgrade to Level D modified.
Organic vapors	PID reading >500 ppm in breathing zone.	Evacuate the work area.
Explosive environment	LEL reading >10%	Evacuate the work area.

Route to Harborview Medical Center Hospital



DIRECTIONS

1. Start out going SOUTHEAST on E MARGINAL WAY S toward S NORFOLK ST.
2. Turn LEFT onto S BOEING ACCESS RD.
3. Merge onto I-5 N toward SEATTLE.
4. Take the DEARBORN ST. / JAMES ST. exit- EXIT 164A- toward MADISON ST
5. Take the JAMES ST exit.
6. Turn RIGHT onto JAMES ST.
7. Turn right on Boren Avenue and drive 3 blocks to Broadway
8. Turn right, and then make a quick right turn onto Alder St
9. Continue for three blocks to 8th Avenue

APPENDIX C

2008 Work Plan, SWMU-17 Pilot Test

Work Plan
SWMU-17 Pilot Test
Boeing Developmental Center
Tukwila, Washington

October 2, 2008

Prepared for

The Boeing Company
Seattle, WA

Landau Associates
130 2nd Avenue South
Edmonds, WA 98020
(425) 778-0907

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1.0 INTRODUCTION

This document presents a work plan to conduct pilot testing at Solid Waste Management Unit (SWMU)-17 at The Boeing Company (Boeing) Developmental Center (DC). The DC is located at 9725 East Marginal Way South, Tukwila, Washington (Figure 1). The DC is a regulated facility under the Resource Conservation and Recovery Act (RCRA) with a facility identification number of WAD-09363-9946. The Washington State Department of Ecology (Ecology) is authorized by the U.S. Environmental Protection Agency (EPA) to implement RCRA corrective action through its Model Toxics Control Act (MTCA) regulations. Boeing is performing remedial actions at the DC under Ecology's voluntary cleanup program (VCP). Preparation of this pilot test work plan is authorized under Boeing Work Order No. ENV-G-08DC-037.

Pilot testing will consist of electron donor (sodium lactate and vegetable oil) and ferrous sulfate amendment of the groundwater aquifer and performance monitoring. Electron donor amendment will enhance anaerobic degradation of tetrachloroethene (PCE) and immobilization of copper. It is anticipated that PCE will be reduced to innocuous end products through biotic and abiotic degradation processes, and that copper will be reduced to an insoluble form. An additional groundwater monitoring well will be installed in SWMU-17 for pilot test performance monitoring. Activities described in this work plan will be performed in accordance with the procedures provided in the Health and Safety Plan (Appendix A).

2.0 BACKGROUND

Following operation and removal of a sump and underground storage tank (UST) at SMWU-17 in 1986, concentrations of arsenic, copper, and PCE in groundwater have remained above preliminary screening levels. Although the sump and UST were removed more than 20 years ago, subsequent monitoring indicates relatively low, but persistent, concentrations of these contaminants.

SWMU-17 is a former 67-gallon sump and associated 4,000-gallon steel UST (designated DC-05), located west of Building 9-64 (Figure 2). Waste oil generated by hydraulic testing shops, automotive maintenance shops, and various other operations at the DC was poured into the sump and flowed into the UST. Periodically, the waste oil was pumped from the UST for offsite treatment and disposal (SAIC 1994). The sump and UST were installed in 1957 and removed in late March or early April 1986 (Landau Associates 1987).

Minor amounts of hydrocarbons present in soil samples collected prior to and following UST removal led to the installation of three monitoring wells (BDC-05-1, BDC-05-2, and BDC-05-3) during 1986 (Norton Corrosion Limited, Inc. 1985; Landau Associates 1987). Three additional monitoring wells (BDC-05-4, BDC-05-5, and BDC-05-6) were installed in January 1987 and an additional well, BDC-05-7, was installed in March 1987. In December 1987, Ecology requested that additional groundwater sampling be conducted. Following one to two sampling events at each well for analysis of volatile organic compounds (VOCs) and priority pollutant metals, Ecology stated in August 1988 that no further work was required at this SWMU and that monitoring wells could be abandoned (Ecology 1988). Crossgradient/upgradient, unimpacted monitoring wells BDC-05-1 and BDC-05-6 were subsequently abandoned.

From 1996 through 2003, groundwater samples from the five remaining wells (BDC-05-2, BDC-05-3, BDC-05-4, BDC-05-5, and BDC-05-7) were analyzed on an annual or semiannual basis for VOCs, total petroleum hydrocarbon (TPH), and metals. Split samples collected in December 2001 were sent to Analytical Resources, Inc. (ARI) of Seattle, Washington, as well as to the Boeing laboratory used for analysis of previous samples. Metals concentrations in the ARI samples were significantly lower than the concentrations reported by the Boeing laboratory, indicating that the elevated concentrations of metals in previous samples may have been inaccurate. It was determined that samples submitted to the Boeing laboratory in December 2001 and during previous sampling events had been collected in reused METRO sample bottles that had not been acid washed by the laboratory and were, therefore, a possible source of metals contamination. Groundwater samples have been submitted to ARI since December 2001.

Groundwater concentrations of PCE, as well as dissolved and/or total copper and arsenic, have exceeded preliminary screening levels consisting of marine and fresh surface water criteria. The highest concentrations of PCE (33 μg/L), total copper (0.018 mg/L), and dissolved copper (0.012 mg/L) have been detected at well BDC-05-7, which is located closest to SMWU-17 of all monitoring wells. Screening levels have been exceeded on more than one occasion at other wells for PCE (BDC-05-2) and total copper (BDC-05-2, BDC-05-3, BDC-05-5). Total arsenic has exceeded screening levels on more than one occasion at BDC-05-4 and BDC-05-5, but dissolved arsenic has not exceeded screening levels at any SWMU-17 wells. Cumulative data for these constituents is compared to screening levels in Table 1.

A previous report (Landau Associates 2004) asserted that dissolved metals concentrations were more representative of groundwater discharging to surface water. The report recommended continued monitoring of PCE only, due to dissolved arsenic concentrations being below screening levels at all wells and only two wells exceeding one or both screening levels for copper (sceening levels consisting of marine and fresh surface water criteria). However, given that cleanup levels have not been determined for the site, Boeing elected to continue semiannual metals monitoring (Table 1).

3.0 PILOT TEST OBJECTIVE

The pilot test objective is to evaluate enhanced anaerobic bioremediation as a remedy for PCE and copper present in SWMU-17 groundwater and to evaluate the affect of this approach on dissolved arsenic concentrations. Electron donor (vegetable oil and sodium lactate) and ferrous sulfate will be injected in the source area to stimulate biotic and abiotic degradation of PCE, and immobilization of copper and arsenic through transformation of these metals to more insoluble forms.

Reductive dechlorination of PCE occurs through microbially mediated (biotic) reactions whereby microorganisms obtain energy through oxidation-reduction (redox) reactions. Electron donors (hydrogen, fatty acids, etc.) are used by the microbe together with various electron acceptors [oxygen, nitrate, manganese (IV), ferric iron, sulfate, and carbon dioxide]. These redox reactions can be compared to the process whereby humans obtain energy through consumption of food (electron donor) and oxygen (electron acceptor). Bacteria obtain the greatest energy yield by using oxygen as an acceptor, as it is highly oxidized and, therefore, can be reduced easily and to a large degree. When oxygen is depleted in an uncontaminated aquifer, bacteria sequentially use the less oxidized electron acceptors in the following order: nitrate, manganese (IV), iron (III) (i.e., ferric iron), sulfate, and carbon dioxide. Chloroethenes can also be used as electron acceptors by specific microorganisms and degraded to harmless products. During the degradation, chlorine ions present on the chlorinated hydrocarbon molecule are replaced with hydrogen, resulting in the successive formation of less chlorinated molecules. By this process, PCE is degraded to less chlorinated breakdown products trichloroethene (TCE), *cis*-1,2-dichloroethene (*c*DCE), and vinyl chloride (VC), and then to innocuous end products ethene and ethane. PCE is the most oxidized electron acceptor in groundwater systems after oxygen (Vogel et al. 1987) and, therefore, could theoretically be reduced as soon as oxygen is depleted. TCE, *c*DCE, and VC, however, require successively more reducing aquifer conditions for degradation. TCE can be degraded under iron-reducing conditions (Chapelle 1996); *c*DCE can be degraded under sulfate-reducing or methanogenic conditions (Chapelle 1996; Vogel et al. 1987); and VC can be degraded only under highly reducing carbon dioxide (CO_2)-reducing (methanogenic) conditions (Ballapragada et al. 1997; Freedman and Gosset 1989; Maymó-Gatell et al. 1995; Vogel and McCarthy 1985).

Reductive dechlorination is enhanced through injection of electron donor substrates (e.g., vegetable oil and lactate) as a food source for the bacteria. Electron donor substrates are injected into the contaminated aquifer where indigenous bacteria ferment the substrate to fatty acids and hydrogen, which are then used by microorganisms for reduction of natural electron acceptors and chloroethenes. Depletion of natural electron acceptors (e.g., oxygen, iron, sulfate, CO_2) creates the highly reducing aquifer conditions (sulfate-reducing to methanogenic conditions) required for complete reductive dechlorination of PCE and breakdown products. Hydrogen is the required electron donor for VC and *c*DCE degraders (i.e., *Dehalococcoides* [DHC] strains) to degrade these PCE breakdown products to harmless non-chlorinated products. Other anaerobic dechlorinating organisms are typically common and widespread, and many can utilize the fatty acids directly as electron donor.

Ferrous sulfate will be added along with electron donor substrates to stimulate removal of dissolved copper and arsenic from groundwater, and abiotic degradation of PCE through reaction with iron sulfides. Abiotic degradation of PCE is a supplemental degradation mechanism that occurs in addition to the biotic anaerobic degradation stimulated by electron donor amendment. The mechanisms for removal of dissolved copper and arsenic and abiotic destruction of PCE under anaerobic (i.e., reduced) aquifer conditions are described below:

- Copper: Laboratory and field studies have shown that sulfate-reducing bacteria can remove dissolved copper by producing hydrogen sulfide that reacts with the dissolved copper (II) to form insoluble copper sulfide (Tabak et al. 2003; Steed et al. 2000; McGregor et al. 2008; Greenwood and Earnshaw 1997). Sulfate-reducing bacteria (SRB) use natural or added electron donor to reduce sulfate electron acceptor to hydrogen sulfide. Tabak (2003) showed in a bench-scale study that 99.1 percent of dissolved copper was reducted to insoluble copper sulfide in an SRB bioreactor. In a Toronto, Ontario full-scale field application, McGregor et al. (2008) injected electron donor (EHC-M) and hydrogen sulfide/nitrogen gas mixture to treat dissolved metals copper, cobalt, and nickel; copper concentrations in the groundwater decreased from a maximum of 86 µg/L to 23 µg/L (below the remediation objective) within 10 days.

- Arsenic: Under reduced aquifer conditions, dissolved arsenic concentrations can initially increase as iron minerals are reduced, followed by re-immobilization of arsenic through subsequent precipitation and/or adsorption processes. Under aerobic or mildly reducing aquifer conditions [i.e., nitrate-reducing, as exists naturally at the BDC (Landau Associates 2006)], arsenic is typically immobilized by sorption to iron (III) oxides. If the aquifer becomes iron-reducing (e.g., through addition of electron donor substrates), the insoluble ferric iron in the iron oxides is reduced to soluble ferrous iron, resulting in the release of the sorbed arsenic (USGS 1999, Lee et al. 2004). However, as aquifer conditions are further reduced to sulfate-reducing conditions, arsenic is again immobilized through formation of various metal complexes and sorption to various metal minerals, such as iron(II) hydroxides, and iron(II) sulfides, and/or arsenic sulfides (Lee et al. 2004). Arsenic is also immobilized through sorption to iron(III) oxides where it passes from the aquifer zone that has been artificially reduced through donor addition to a downgradient zone that is mildly reducing or aerobic. O'Day et al. (2004) demonstrated that under sulfate reducing conditions, dissolved arsenic forms arsenic sulfides or adsorbs to iron sulfide and pyrite, and under mildly reducing conditions adsorbs or reacts with iron hydroxides. Mueller et al. (2007) also indicated that arsenic can be immobilized under reducing conditions by precipitation to iron hydroxides and/or as arsenic sulfides and iron-arsenic sulfides. Przepiora et al. (2008) treated 0.5-2.5 mg/L of arsenic in a laboratory column with EHC-M (a commercially available compound containing electron donor, zero valent iron, and sulfate) with >98 percent removal efficiency. Przepiora et al. (2008) indicated that the main removal mechanism is co-precipitation of arsenic with iron oxides/oxyhydroxides and sulfides (e.g. As_2S_3, As, and FeAsS). The objective of zero valent iron addition (ZVI; Fe^0) is oxidization of ZVI by water to form ferrous iron, which then reacts with hydroxides (OH^-) to form ferrous hydroxides or further

- PCE: PCE and breakdown products TCE and *c*DCE can be abiotically (i.e., chemically) degraded through reductive elimination and hydrogenolysis reactions with iron sulfides. Reductive elimination and hydrogenolysis reactions are the same reactions that occur in zero valent iron permeable reactive barriers (PRBs). Reductive elimination, or β-elimination as it is also called, is the most common reaction and results in short-lived intermediates chloroacetylene and acetylene, which break down quickly to CO_2 (Shen and Wilson 2007), and possibly other products. Acetylene is sometime detected infrequently and at low concentrations where reductive elimination is occurring. Reductive elimination occurs under anaerobic aquifer conditions, where hydrogen sulfide and iron-sulfides formed biotically through iron- and sulfate-reduction then act as electron donors for abiotic reactions. Abiotic degradation can be limited by the availability of natural sulfate in the aquifer for formation of iron-sulfides. As described above for arsenic treatment, studies have demonstrated that the injection of Epsom salt or of ferrous sulfate along with electron donor substrates provides a supplemental source of sulfate or of iron and sulfate to maximize the formation of desired iron-sulfides (Kennedy et al. 2006, Lee et al. 2004).

4.0 PILOT TEST IMPLEMENTATION

Four existing monitoring wells (BDC-05-2, BDC-05-3, BDC-05-4, and BDC-05-7) and one new monitoring well (BDC-05-8) will be utilized for the SWMU-17 pilot test. Well BDC-05-2 will be utilized as an injection well, with other wells used for monitoring. Injection well BDC-05-2 has the second most frequent detections of the target contaminants and is located approximately 25 ft upgradient of the well BDC-05-7 where maximum concentrations of target contaminants occur (Section 2.0). Injection at well BDC-05-2 is expected to result in treatment at that well and at downgradient well BDC-05-7, which is located closest to SWMU-17. Injection well BDC-05-2 and the four downgradient wells will be monitored for baseline data prior to injection and for performance data following injection.

4.1 NEW MONITORING WELL

One new monitoring well will be installed downgradient of the injection well BDC-05-2 for collection of pilot test data. New well BDC-05-8 will be installed approximately 40 ft directly south of existing monitoring well BDC-05-3 (Figure 2). This location closes the gap between existing downgradient wells BDC-05-3 and BDC-05-4.

Well BDC-05-8 will be constructed to a total depth of 29.5 ft. The well will be constructed of 2-inch-diameter, flush-threaded, PVC well casing and screen (0.020-inch slot size), with the screen extending from 17.5 to 27.5 ft below ground surface (BGS). A sand pack of 2/12 Colorado sand will extend 2 ft below and 2 ft above the screen (i.e., the boring will be drilled to 29.5 ft BGS and sand pack material extended from the bottom of the boring up to a point 2 ft above the top of the screen). The well seal will consist of hydrated bentonite chips or pellets extending from the top of the sand pack to the surface completion. The wells will be completed with flush-mount well monument set in concrete. A private utility locator will clear the area of the new well for subsurface utilities prior to drilling.

The new well will be developed following construction by surging with a bailer or surge block and by over pumping. At least 10 casing volumes of groundwater will be removed and development will continue up to 100 gallons or until water is reasonably clear. Development water may be treated or disposed of or stored in drums onsite for use in mixing the injection fluid.

4.2 INJECTION VOLUME AND RADIUS OF INJECTION (ROI)

A total of approximately 5,300 gallons of groundwater or potable water will be amended with vegetable oil, sodium lactate, ferrous sulfate, and yeast extract and injected to well BDC-05-2. The injection volume is estimated to result in a radius of injection (ROI) of approximately 13 to 18 ft. This ROI estimate is based on an assumed effective porosity for flow of 0.05 to 0.10 and a saturated treatment zone thickness of 13.5 ft (based on the 10-ft long well screen and additional 3.5 ft distance above the screen to the water table where solution is expected to spread during injection).

4.3 INJECTION FLUID AND INJECTION PROCEDURES

Vegetable oil, sodium lactate, ferrous sulfate, and yeast extract will be added to water for injection into BDC-05-2. A temporary Baker Tank will be filled with 4,320 gallons of groundwater pumped from SWMU17 wells, or with the same volume of potable water if it is determined that groundwater cannot be extracted at a reasonable rate. One tote of Newman Zone 46 percent vegetable oil emulsion (approximately 256 gallons, 2,100 lbs); five drums of 60 percent sodium lactate (approximately 275 gallons, 3,000 lbs); 400 lbs of ferrous sulfate (8 bags); and 2 lbs of yeast extract will be injected. Ferrous sulfate will be added to water in the Baker Tank with other amendments added in line during injection. The solubility of ferrous sulfate is about 2.14 lbs/gallon (Chemblink 2008). Ferrous sulfate will be mixed with water in an empty drum to create a concentrated solution prior to being added to the Baker tank, mixing approximately 385 gallons of water (i.e., seven drums) with the 400 lbs of ferrous sulfate. The vegetable oil, sodium lactate, and yeast extract will be added in-line as water from the tank is pumped to the injection well. The concentrations of vegetable oil and sodium lactate are similar to what is used at the ongoing full scale treatment at BDC SMWU-20 located about 350 ft south of SWMU-17. Ferrous sulfate will constitute approximately 1 percent by weight of injection solution, similar to the Epsom salt concentration used in a successful field demonstration (Kennedy et al. 2006).

Injection will be performed utilizing a gasoline-powered, centrifugal injection pump (3-inch, 8 horsepower (hp), 290 gpm). Drawdown in the water tank and in the sodium lactate drums and the tote of vegetable oil emulsion will be monitored to sustain equal amendment concentration throughout the injection and adjustments will be made periodically to water and electron donor valves on the mixing manifold, as needed. Water and admendments will be mixed by passage through the pump and a static, helical vane, in-line mixer. The injection pump will be operated at a reduced throttle, as needed, to keep injection pressures below 15 pounds per square inch (psi), as measured at the top of the well. This injection pressure is intended to minimize short-circuiting of injection fluid to the ground surface, as observed during previous injections at SMWU-20, while maintaining a pressurized well screen for uniform application of injection fluid. Approximately 50 to 100 gallon of unamended water will be injected following donor solution to flush the well and sandpack to prevent biofouling.

5.0 GROUNDWATER MONITORING

Pilot test monitoring will consist of baseline and monthly or bimonthly performance sampling. Baseline monitoring and post-injection performance monitoring will be conducted at five SWMU-17 wells (BDC-05-2, BDC-05-3, BDC-05-4, BDC-05-7, BDC-05-8). Performance monitoring will be performed monthly for the first 4 to 6 months, with anticipated transition to bimonthly sampling. Two monitoring events will coincide with regular semiannual monitoring performed in May and November. Regular semiannual monitoring will continue at upgradient well BDC-05-5. It is anticipated that performance monitoring will be performed for a year or more following electron donor injection.

Samples collected for baseline and performance monitoring will be analyzed for target contaminants (VOCs for PCE and breakdown products; ethene, ethane, and acetylene; total and dissolved copper; total and dissolved arsenic), parameters indicative of aquifer redox conditions [dissolved oxygen (DO), oxidation-reduction potential (ORP), nitrate, ferrous iron, sulfate, methane, and pH], and total organic carbon (TOC), indicative of electron donor. Laboratory analysis will be performed by Analytical Resources, Inc for PCE and breakdown products; total and dissolved copper and arsenic; nitrate; sulfate; ethene, ethane, acetylene, and methane; and TOC. Other parameters (DO, ORP, ferrous iron, and pH) will be measured in the field. Table 2 presents a comprehensive list of the monitoring parameters and information provided by each parameter.

6.0 DATA EVALUATION AND REPORTING

Analytical data will be evaluated to determine the effectiveness of this approach for biodegradation of PCE, and immobilization of copper and arsenic. Primary indicators of success will be concentrations of PCE; PCE breakdown products cDCE and VC; PCE end products ethene and ethane, and abiotic intermediate acetylene; and total and dissolved copper and arsenic. It is anticipated that concentrations of dissolved arsenic may initially increase, followed by decreasing concentrations due to immobilization (Section 3.0). Redox parameters [ORP, DO, nitrate, ferrous iron, sulfate, and methane] and pH will be used to evaluate if the desired aquifer redox conditions have developed. TOC data will facilitate evaluation of electron donor longevity and downgradient distribution. Collected data will allow optimization of the amount of electron donor, frequency of injection, and spacing of injection points to be used for a potential full-scale application.

Data will be reported semiannually and a final report will be prepared at the conclusion of the pilot test. Monitoring data will be reported in the regular semiannual reports prepared for the DC. A final pilot test report will be prepared at the conclusion of the pilot test to document results, provide data interpretation, and make recommendations for a potential full-scale application.

7.0 SCHEDULE

We propose to perform the pilot test injection at the end of October 2008. The electron donor injection will be preceded by monitoring well installation and baseline monitoring performed in early October 2008. It is anticipated that performance monitoring and data evaluation will be conducted for at least one year following injection. The final pilot test report may be prepared in 2009 or 2010, depending on treatment longevity and performance monitoring results.

* * * * *

This document has been prepared under the supervision and direction of the following key staff.

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CLJ/BJ/tam

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Washington – Developmental Center

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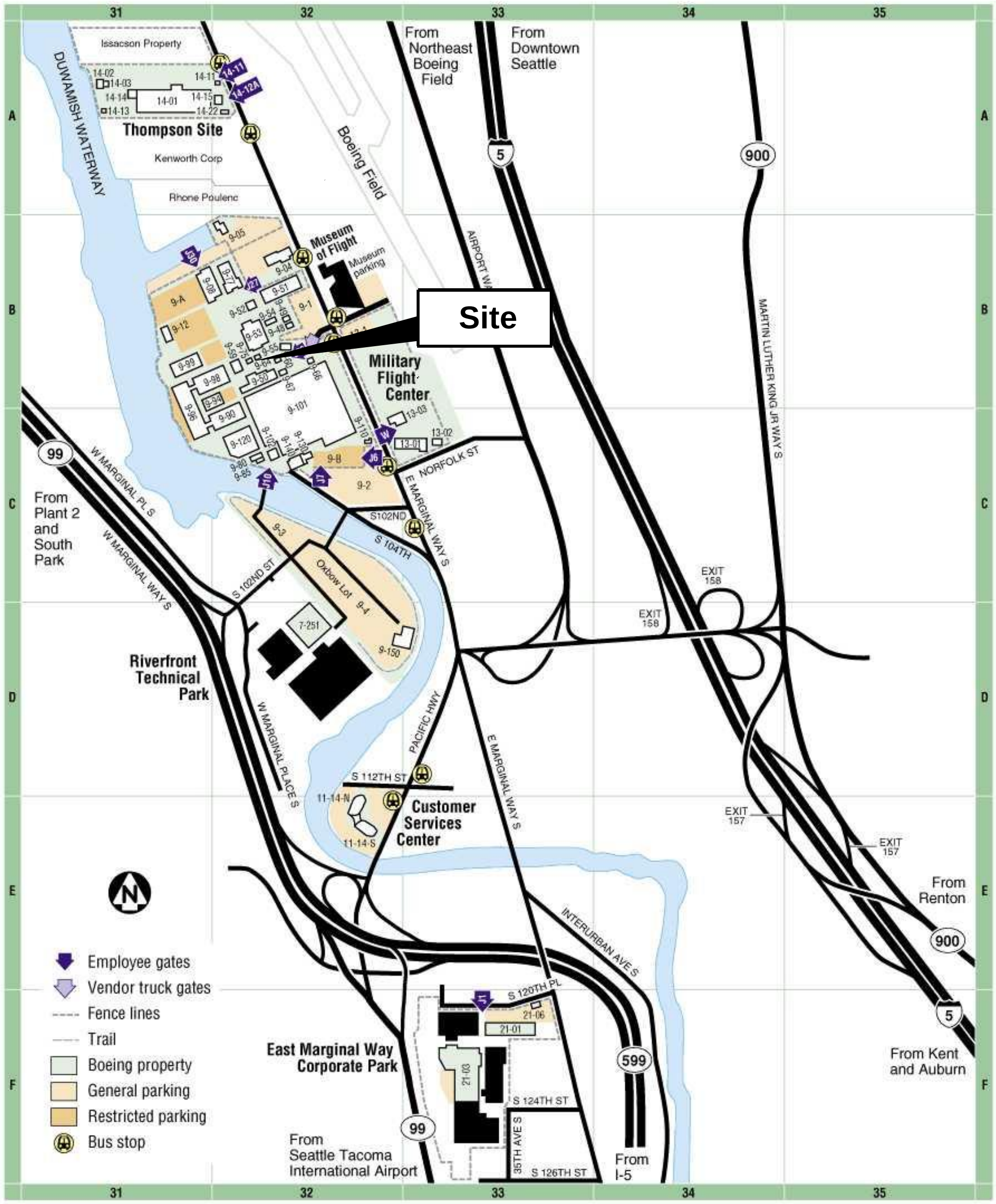


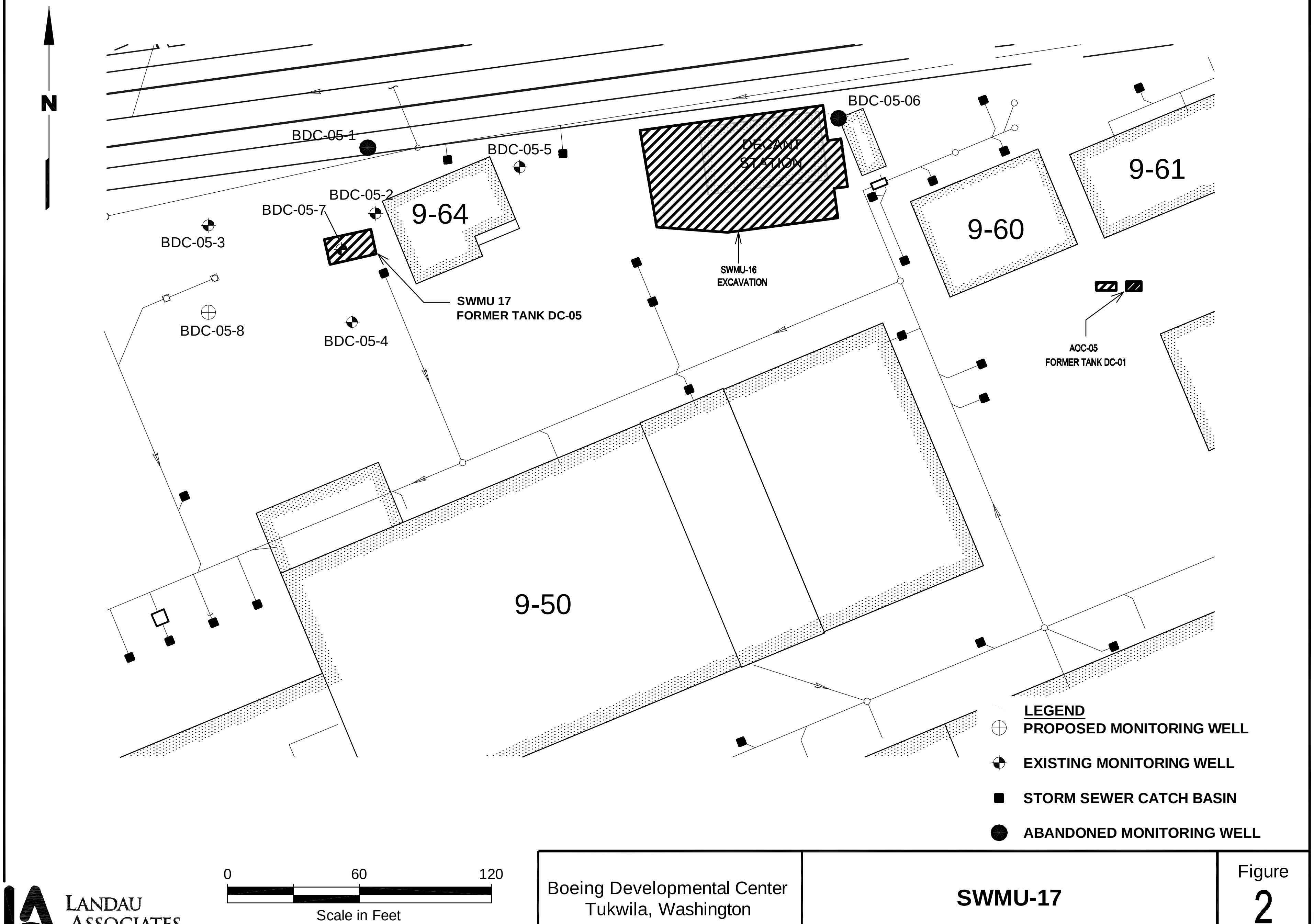
Map provided by Boeing, March 2000

Not To Scale

Boeing/Developmental Center/Evaluation Report | T:\025\093\040\Evaluation Report\Fig1.cdr (C) 10/2/2008

Landau Associates

Boeing Developmental Center Tukwila, Washington	**Site Location Map**	Figure 1



LANDAU ASSOCIATES

Boeing Developmental Center
Tukwila, Washington

SWMU-17

Figure
2

TABLE 1
CUMULATIVE DATA SUMMARY
SWMU-17
BOEING DEVELOPMENTAL CENTER

	Method B Preliminary Screening Level Marine Surface Water	Method B Preliminary Screening Level Fresh Surface Water	Jun-02	Dec-02	Jun-03	Nov-03	Apr-04	Oct-04	May-05	Nov-05	May-06	Nov-06	May-07	Nov-07	May-08
TOTAL ARSENIC (mg/L)	0.005	0.005													
BDC-05-2			0.05 U	0.05 U	0.001 U	0.001 U	0.002	0.002	0.001	0.002	0.001	0.002	0.003	0.001	0.002
BDC-05-3			0.05 U	0.05 U	0.004	0.001 U	0.002	0.002	0.001 U	0.002	0.007	0.002	0.003	0.002	0.002
BDC-05-4			0.05 U	0.05 U	0.011	0.018	0.019	0.016	0.008	0.018	0.018	0.002	0.018	0.009	0.018
BDC-05-5			0.05 U	0.05 U	0.002	0.001	0.003	0.007	0.003	0.006	0.009	0.001	0.002	0.001 U	0.002
BDC-05-7			0.05 U	0.05 U	0.002	0.001 U	0.001	0.001	0.001	0.002	0.002	0.001	0.003	0.001 U	0.002
DISSOLVED ARSENIC (mg/L)	0.005	0.005													
BDC-05-2			0.05 U	0.05 U	0.001 U	0.001 U	0.001	0.001 U	0.001	0.001	0.001	0.001	0.003	0.001 U	0.002
BDC-05-3			0.05 U	0.05 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.002	0.001 U	0.001
BDC-05-4			0.05 U	0.05 U	0.001 U	0.001	0.001	0.001 U	0.001 U	0.001	0.001 U	0.001 U	0.002	0.001 U	0.001 U
BDC-05-5			0.05 U	0.05 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001	0.001 U	0.001 U
BDC-05-7			0.05 U	0.05 U	0.001 U	0.001 U	0.001	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.002	0.001 U	0.001 U
TOTAL COPPER (mg/L)	0.0034	0.0089													
BDC-05-2			0.002 U	0.002	0.002	0.002 U	0.003	0.002	0.003	0.003	0.004	0.002 U	0.006	0.002 U	0.004
BDC-05-3			0.002 U	0.003	0.004	0.002	0.003	0.003	0.003	0.004	0.010	0.002	0.004	0.002	0.002
BDC-05-4			0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.004	0.002 U	0.002	0.002 U	0.002 U	0.002 U	0.002 U
BDC-05-5			0.003	0.004	0.004	0.003	0.004	0.006	0.005	0.007	0.014	0.002 U	0.003	0.002 U	0.003
BDC-05-7			0.004	0.007	0.008	0.011	0.008	0.010	0.012	0.012	0.018	0.008	0.016	0.014	0.016
DISSOLVED COPPER (mg/L)	0.0034	0.0089 (a)													
BDC-05-2			0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002	0.002 U	0.002 U	0.002 U	0.002 U
BDC-05-3			0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.003	0.003	0.002 U	0.002 U	0.002 U
BDC-05-4			0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
BDC-05-5			0.002 U	0.002	0.007	0.002 U	0.002 U	0.002 U	0.002 U	0.004	0.002	0.002	0.002 U	0.002 U	0.003
BDC-05-7			0.003	0.004	0.004	0.005	0.006	0.007	0.007	0.008	0.009	0.009	0.012	0.009	0.010
TETRACHLOROETHENE (µg/L)	9	9													
BDC-05-2			23	4.7	17	6.5	32	9.2	22	10	30	6.2	20	12	14
BDC-05-3			4.1	4.4	3.3	4.5	3.4	5.1	2.3	3.8	3.2	1.7	3.5	2.3	3.8
BDC-05-4			1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.4	1.0 U	1.0 U	1.5
BDC-05-5			1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.8	1.0 U	1.0 U	0.3
BDC-05-7			13	12	15	20	23	27	25	31	29	24	30	28	33
TRICHLOROETHENE (µg/L)	81														
BDC-05-2			38	7.2	30	10	45	15	28	16	31	8.2	24	14	20
BDC-05-3			11	11	9.9	12	8.6	11	5.3	6.7	6.4	2.4	8.1	4.4	8.5
BDC-05-4			1.2	1.1	1.0 U	1.0	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0	1.0 U	1.0 U	0.9
BDC-05-5			1.6	1.4	1.7	1.5	1.5	1.3	1.4	1.5	1.4	1.1	1.0 U	1.0 U	0.8
BDC-05-7			28	26	29	41	31	37	31	34	23	29	22	25	32

U = Indicates compound was analyzed for, but was not detected at the reported sample detection limit.
Bold indicates detected compound.
Box indicates exceedance of screening level.

TABLE 2
PERFORMANCE MONITORING PARAMETERS
SWMU-17
BOEING DEVELOPMENTAL CENTER

Field Parameters	Information Provided
Dissolved Oxygen (DO) [field meter and single-use reactive ampoules] (a)	Aquifer is considered anaerobic at DO concentrations less than 1.0 mg/L.
Oxidation Reduction Potential (Redox) [field meter] (a)	Negative values indicate reducing conditions.
pH [field meter] (a)	Optimum conditions for biological activity is within the range of 6 to 8. May decrease due to injected donor. Considered acceptable for reductive dechlorination when greater than 4.0 at injection wells and greater than 5 at monitoring wells (Suthersan et al. 2002)
Ferrous Iron [Hach test kit]	Concentrations above background indicate iron-reducing conditions.

Laboratory Analyses	Information Provided
Volatile Organic Compounds (VOCs) (b) [Method 8260] [3-40 mL VOA-HCl] © [Holding time - 14 days]	Concentrations of chlorinated VOCs and breakdown products are indicative of reductive dechlorination and pathways.
Ethene/Ethane/Methane/Acetylene [RSK SOP 175 MOD] [2-40 ml VOA] (c) [Holding time - 7 days]	Concentrations of ethene and ethane are indicative of reductive dechlorination and pathways. Increasing methane concentrations indicate methanogenic conditions. Acetylne concentrations are indicative of abiotic degradation of PCE, TCE, *c* DCE.
Total and Dissolved Copper [Method EPA 200.8] [1 500 mL HDPE-HNO_3] [Holding time - 6 months]	Decreasing concentrations of dissolved copper are an indication of anaerobic biotransformations of dissolved copper.
Total and Dissolved Arsenic [Method EPA 200.8] [1 500 mL HDPE-HNO_3] [Holding time - 6 months]	Decreasing concentrations of dissolved arsenic are an indication of anaerobic immobilization of dissolved arsenic.
Total Organic Carbon (TOC) [Method 415.1] [250 mL Amber-H_2SO_4] [Holding time - 14 days]	Will increase due to arrival of volatile fatty acids released from injected sodium lactate and vegetable oil.
Nitrate (d) [IC Method E300] [500 mL poly] [Holding time - 48 hours]	Concentrations below background indicate nitrate-reducing conditions.
Sulfate [IC Method E300] [500 mL poly] [Holding time - 28 days]	Concentrations below background indicate sulfate-reducing conditions that may result from depletion of nitrate.

(a) Measured using a flow-through cell.
(b) Abbreviated list consisting of PCE, TCE, *cis* -1,2-DCE, *trans* -1,2-DCE, 1,1-DCE, and vinyl chloride.
(c) Care to be taken during sample collection to minimize aeration and volatilization. Sample collected with no headspace.
(d) Nitrate sample can be combined with sulfate sample; nitrate analysis must be performed within 48-hour holding time.

Suthersan, S.S., C.C. Lutes, P.L. Palmer, F. Lenzo, F.C. Payne, D.S. Liles, and J. Burdick. 2002. *Final Technical Protocol for Using Soluble Carbohydrates to Enhance Reductive Dechlorination of Chlorinated Aliphatic Hydrocarbons.* Submitted to ESTCP and AFCEE under Contract #41624-99-C-8032. December 19.

APPENDIX A

Health and Safety Plan

LANDAU ASSOCIATES
ENVIRONMENTAL | GEOTECHNICAL | NATURAL RESOURCES

WORK LOCATION PERSONNEL PROTECTION AND SAFETY EVALUATION FORM

Attach Pertinent Documents/Data
Fill in Blanks As Appropriate

Job No.:	025093.030		
Prepared by:	Benni Jonsson	Reviewed by:	Clint Jacob
Date:	August 20, 2008	Date:	August 26, 2008

A. WORK LOCATION DESCRIPTION

1. **Project Name:** Boeing SWMU-17, Electron donor injection
2. **Location:** 9725 East Marginal Way S., Tukwila, Washington
3. **Anticipated Activities:** Drilling, well installation, groundwater sampling, and injection of vegetable oil, sodium lactate, and ferrous sulfate
4. **Surrounding Population:** Industrial
5. **Buildings/Homes/Industry:** Industrial buildings, office buildings
6. **Topography:** Mostly flat river valley bottom
7. **Anticipated Weather:** Partly clear, 35º to 80º F
8. **Unusual Features:** N/A
9. **Site History:** Site is a portion of Boeing Developmental Center, with PCE, copper, and arsenic present in groundwater at concentrations above site screening levels.

B. HAZARD DESCRIPTION

1. Background Review: ☒ Complete ☐ Partial

If partial, why?

2. Hazardous Level: ☐ B ☐ C ☒ D ☐ Unknown

Justification: Possible petroleum hydrocarbon contamination.

3. Types of Hazards: (Attach additional sheets as necessary)

A. ☒ Chemical ☒ Inhalation ☐ Explosive
☐ Biological ☒ Ingestion ☐ O_2 Def. ☒ Skin Contact

Describe: Direct contact with contaminated soil or groundwater, accidental ingestion of contaminated soil or groundwater, or inhalation of vapors during drilling, sampling, and injection.

B. ☒ Physical ☒ Cold Stress ☒ Noise ☒ Heat Stress ☐ Other

Describe: Noise and physical hazards associated with working around a drill rig. Hazards associated with working with pressurized hoses during injection (max 40 psi). Cold stress conditions related to exposure. Noise from running injection pump.

C. ☐ Radiation

Describe: NA

4. Nature of Hazards:

☒ Air	Describe: Dust from contaminated soil material during drilling. Inhalation of vapors during drilling, injection, and sampling.
☒ Soil	Describe: Potential for contact with or ingestion of contaminated soil during drilling and installation of well.
☐ Surface Water	Describe: NA
☒ Groundwater	Describe: Direct contact with or ingestion of contaminated groundwater.
☐ Other	Describe: NA

5. Chemical Contaminants of Concern ☐ N/A

Contaminant	PEL	I.D.L.H.	Source/Quantity Characteristics	Route of Exposure	Symptoms of Acute Exposure	Instruments Used to Monitor Contaminant
Tetrachloroethene			Present in groundwater and possibly soil	Inhalation, ingestion, dermal contact,		PID
Trichloroethene	50 ppm	1,000 ppm	Present in groundwater and possibly soil	Inhalation, ingestion, dermal contact	Eye, nose, and throat irritation; headache; nausea	PID
cis-1,2-dichloroethene	200 ppm	4,000 ppm	Present in groundwater and possibly soil	Inhalation, ingestion, dermal contact	Dizziness, nausea, dermatitis, irritation of mucous membranes	PID
Vinyl Chloride	1 ppm	Unknown (carcinogen)	Present in groundwater and possibly soil	Inhalation, ingestion, dermal contact	Weakness, abdominal pain	PID
Copper	1 mg/m^3	100 mg/m^3	Present in groundwater and possibly soil	Inhalation (dust), ingestion, dermal contact	Eye, nose, and throat irritation; nasal septum perforation; metallic taste; dermatitis	Visual (Dust)
Arsenic	0.010 mg/m^3	5 mg/m^3 (carcinogen)	Present in groundwater and possibly soil	Inhalation (dust), ingestion, dermal contact	Ulceration of nasal septum, dermatitis, gastrointestinal disturbances, peripheral neuropathy, respiratory irritation, hyperpigmentation of skin	Visual (Dust)

6. Physical Hazards of Concern ☐ N/A

Hazard	Description	Location	Procedures Used to Monitor Hazard
Hazards associated with pressurized hoses	Injection of groundwater and ammonium nitrate mixture	Area of injection wells	Personnel will observe pressure and make sure it is low before disconnecting hoses.
Moving parts of drill rig, falling and flying objects	Drilling and installation of well	Near drill rig	Alert observation of surroundings; minimize time spent near drill rig; no loose clothing; use of safety glasses, hard hat, and steel toes boots.
Vehicles and heavy equipment used at the site	Drilling and installation of well	Any area	Alert observation of surroundings.
Cold Stress	Any activity	Any area	Wear warm clothing. Observe for hypothermia and frostbite.

7. Work Location Instrument Readings ☐ N/A

Location: ____________________

Percent O_2: ____________________ Percent LEL: ____________________

Radioactivity: ____________________ PID: ____________________

FID: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Location: ____________________

Percent O_2: ____________________ Percent LEL: ____________________

Radioactivity: ____________________ PID: ____________________

FID: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Location: ____________________

Percent O_2: ____________________ Percent LEL: ____________________

Radioactivity: ____________________ PID: ____________________

FID: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Location: ____________________

Percent O_2: ____________________ Percent LEL: ____________________

Radioactivity: ____________________ PID: ____________________

FID: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

8. Hazards Expected In Preparation For Work Assignment ☒ N/A

Describe:

C. PERSONAL PROTECTIVE EQUIPMENT

1. Level of Protection

Primary: ☐ A ☐ B ☐ C ☒ D

Upgrade: ☐ A ☐ B ☒ C ☒ D modified

Location/Activity: All locations; upgrade to Level D modified (half-face respirator with organic vapor/HEPA cartridge) if air monitoring VOC action levels are exceeded.

2. Protective Equipment (specify probable quantity required)

Respirator ☐ N/A

☐ SCBA, Airline

☐ Full-Face Respirator

☒ Half-Face Respirator (Cart. organic vapor/HEPA) (Only if upgrade to Level C or D modified)

☐ Escape mask

☐ None

☐ Other:

☐ Other:

Clothing ☐ N/A

☐ Fully Encapsulating Suit

☐ Chemically Resistant Splash Suit

☐ Apron, Specify:

☐ Tyvek Coverall

☐ Saranex Coverall

☐ Coverall, Specify

☒ Other: Dedicated field clothing

Head & Eye ☐ N/A

☒ Hard Hat (around drill rig)

☐ Goggles

☐ Face Shield

☒ Safety Eyeglasses (around drill rig)

☒ Other: Ear muffs or plugs (around drill rig)

Hand Protection ☐ N/A

☒ Undergloves; Type: nitrile/neoprene

☐ Gloves; Type:

☐ Overgloves; Type:

☐ None

☐ Other:

Foot Protection ☐ N/A

☐ Neoprene Safety Boots with Steel Toe/Shank

☐ Disposable Overboots

☒ Other: Steel-toe boots

3. Monitoring Equipment ☐ N/A

☐ CGI ☒ PID

☐ O_2 Meter ☐ FID

☐ Rad Survey ☐ Other:

☐ Detector Tubes (optional)

Type:

D. PERSONNEL DECONTAMINATION

☒ Required (soap and water – hands) ☐ Not Required

EQUIPMENT DECONTAMINATION

☒ Required ☐ Not Required

If required, describe and list equipment:

All non-dedicated water sampling equipment will be washed with Trisodium Phosphate soap and rinsed with tap water.

E. PERSONNEL

Name	Work Location Title/Task	Medical Current	Fit Test Current
1.	Drilling, Injection, and Groundwater sampling	☐	☐
2.	Drilling, Injection, and Groundwater sampling	☐	☐
3.	Drilling, Injection, and Groundwater sampling	☐	☐
4.		☐	☐
5.		☐	☐
6.		☐	☐
7.		☐	☐
8.		☐	☐
9.		☐	☐
10.		☐	☐

Site Safety Coordinator: Benni Jonsson

F. ACTIVITIES COVERED UNDER THIS PLAN

Task No.	Description	Preliminary Schedule
1	Drilling and well installation	September 2008
2	Groundwater sampling	September 2008 and ongoing
3	Injection to monitoring wells	October 2008

G. SUBCONTRACTOR'S HEALTH AND SAFETY PROGRAM EVALUATION ☒ N/A

Name and Address of Subcontractor: Cascade Drilling
PO Box 1184
Woodinville, WA 98072

EVALUATION CRITERIA

Item	Adequate	Inadequate	Comments
Medical Surveillance Program	☒	☐	
Personal Protective Equipment Availability	☒	☐	
Onsite Monitoring Equipment Availability	☒	☐	
Safe Working Procedures Specification	☒	☐	
Training Protocols	☒	☐	
Ancillary Support Procedures (if any)	☒	☐	
Emergency Procedures	☒	☐	
Evacuation Procedures Contingency Plan	☒	☐	
Decontamination Procedures Equipment	☒	☐	
Decontamination Procedures Personnel	☒	☐	

GENERAL HEALTH AND SAFETY PROGRAM EVALUATION: ☒ Adequate ☐ Inadequate

Additional Comments: Review based on previous experience with contractor and contractor's experience at the site.

Evaluation Conducted By: Clint Jacob Date: 8/26/08

EMERGENCY FACILITIES AND NUMBERS

Hospital: Harborview Medical Center
325 9th Avenue
Seattle, WA
206-731-3000

Directions: Exit at front gate and turn left onto E. Marginal Way S. Go southeast on E. Marginal Way S towards S NORFOLK ST. Turn LEFT onto S BOEING ACCESS RD. Merge onto I-5 N toward SEATTLE. Take the DEARBORN ST. / JAMES ST. exit- EXIT 164A- toward MADISON ST. Take the JAMES ST exit. Turn RIGHT onto JAMES ST. Turn right on Boren Avenue and drive 3 blocks to Broadway. Turn right, and then make a quick right turn onto Alder St. Continue for three blocks to 8th Avenue. (See route map on next page)

Telephone: Field technician will maintain a mobile phone.

Emergency Transportation Systems (Fire, Police, Ambulance) – 911

Emergency Contacts:

Poison Control Center: 526-2121

Landau Project Manager: 425-778-0907
Boeing Environmental Affairs (Jim Bet): 425-865-5348

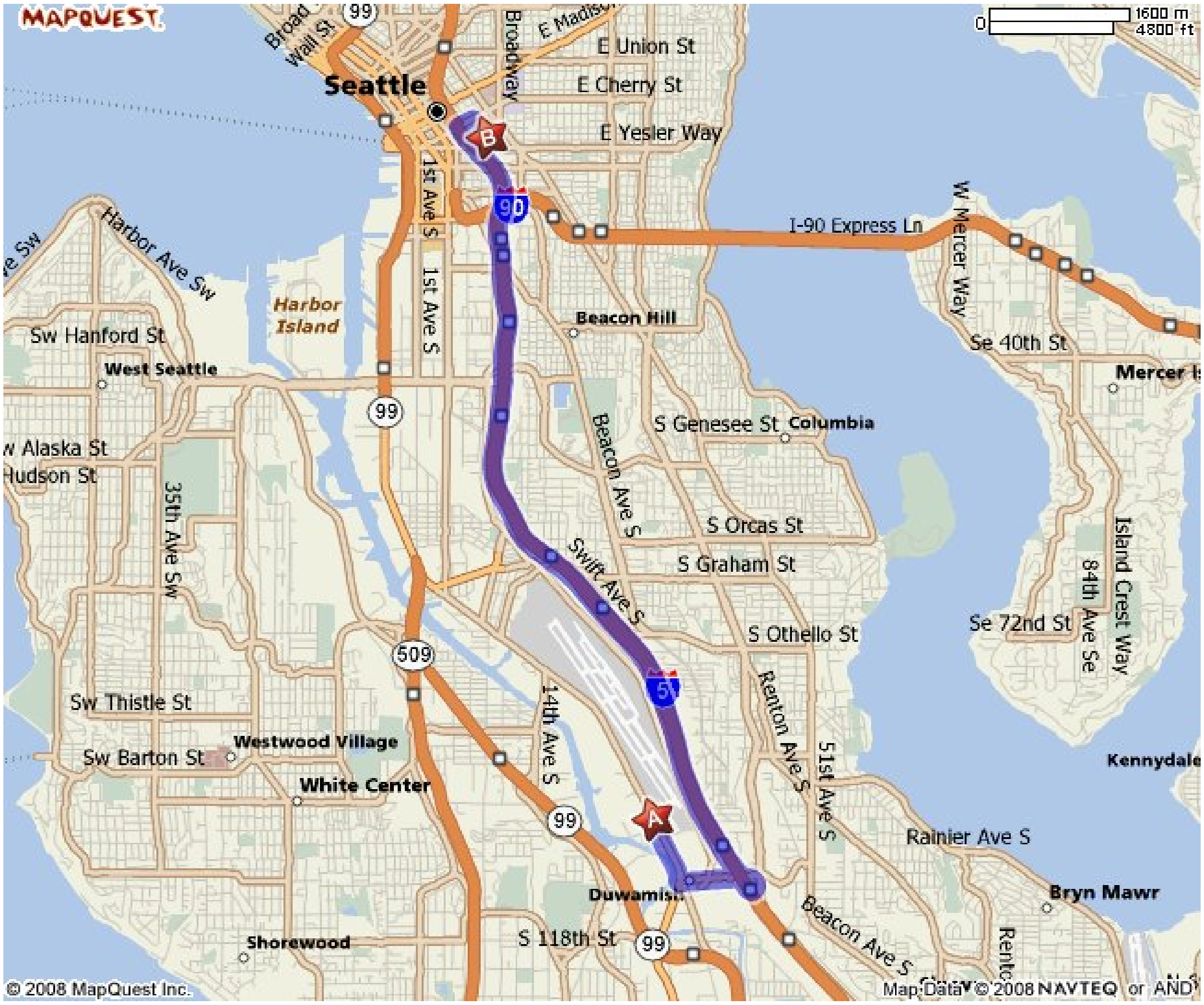
<u>In the event of an emergency, do the following:</u>

1. Call for help as soon as possible. Call 911. Give the following information:
   - WHERE the emergency is – use cross streets or landmarks
   - PHONE NUMBER you are calling from
   - WHAT HAPPENED – type of injury
   - WHAT is being done for the victim(s)
   - YOU HANG UP LAST – let the person you called hang up first.

2. If the victim can be moved, paramedics will transport to the hospital. If the injury or exposure is not life threatening, decontaminate the individual first. If decontamination is not feasible, wrap the individual in a blanket or sheet of plastic prior to transport.

3. Notify Landau Associates project manager.

4. Notify Boeing Environmental Affairs.


MAPQUEST
Seattle
E Union St
E Cherry St
E Yesler Way
Broadway
1st Ave S
I-90 Express Ln
W Mercer Way
Harbor Ave Sw
Harbor Island
Beacon Hill
Sw Hanford St
West Seattle
Se 40th St
S Genesee St
Columbia
Beacon Ave S
S Orcas St
S Graham St
Swift Ave S
S Othello St
35th Ave Sw
Se 72nd St
84th Ave Se
Island Crest Way
Sw Thistle St
Westwood Village
Sw Barton St
White Center
14th Ave S
Renton Ave S
51st Ave S
Kennydale
Rainier Ave S
Duwamish
Bryn Mawr
S 118th St
Shorewood
Beacon Ave S
1600 m
4800 ft
© 2008 MapQuest Inc.
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HEALTH AND SAFETY PLAN
APPROVAL/SIGN OFF FORMAT

I have read, understood, and agreed with the information set forth in this Health and Safety Plan (and attachments) and discussed in the Personnel Health and Safety briefing.

Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Project Manager	Signature	Date

Personnel Health and Safety Briefing Conducted By:

Name	Signature	Date

ATTACHMENT A

ACTION LEVELS FOR RESPIRATORY PROTECTION

Monitoring Parameter	Reading	Level of Protection
Organic vapors	PID reading >20 ppm in breathing zone for more than 20 minutes.	Evacuate area, use institutional control or upgrade to Level D modified.
Organic vapors	PID reading >35 ppm for momentary peak.	Evacuate area, use institutional control or upgrade to Level D modified.
Dust	Visual Dust	Wet cuttings at drill auger to prevent dust generation.

APPENDIX D

2011 Report: SWMU-17 Remedial Action Work Plan, Enhanced Anaerobic Bioremediation

SWMU-17 Remedial Action Work Plan
Enhanced Anaerobic Bioremediation
Boeing Developmental Center
Tukwila, Washington

June 3, 2011

Prepared for

The Boeing Company
Seattle, Washington

LANDAU ASSOCIATES
130 2nd Avenue South
Edmonds, WA 98020
(425) 778-0907

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APPENDICES

1.0 INTRODUCTION

This document presents a remedial action work plan to conduct full-scale bioremediation at Solid Waste Management Unit (SWMU)-17 at The Boeing Company (Boeing) Developmental Center (DC). The DC is located at 9725 East Marginal Way South, Tukwila, Washington (Figure 1). The DC is a regulated facility under the Resource Conservation and Recovery Act (RCRA) with a facility identification number of WAD-09363-9946. The Washington State Department of Ecology (Ecology) is authorized by the U.S. Environmental Protection Agency (EPA) to implement RCRA corrective action through its Model Toxics Control Act (MTCA) regulations. Boeing is performing remedial actions at the DC under Ecology's voluntary cleanup program (VCP). Preparation of this full-scale work plan is authorized under Boeing Work Order No. ENV-G-11DC-039.

Full-scale implementation of anaerobic bioremediation in SWMU-17 will consist of electron donor amendment to enhance reductive dechlorination of tetrachloroethene (PCE) and trichloroethene (TCE) present in groundwater due to historic site use. A solution of emulsified vegetable oil and ethyl lactate will comprise the electron donor injected to the aquifer. It is anticipated that PCE and TCE will be reductively dechlorinated to breakdown products and innocuous end products. Groundwater performance monitoring will be performed to evaluate contaminant reduction, availability, and longevity of injected donor, and aquifer oxidation-reduction (redox) conditions. Activities described in this work plan will be performed in accordance with the procedures provided in the Health and Safety Plan (Appendix A).

2.0 BACKGROUND

SWMU-17 comprises the general area of a former 67-gallon sump and associated 4,000-gallon steel underground storage tank (UST; designated DC-05), located west of Building 9-64 (Figure 2). Waste oil generated by hydraulic testing shops, automotive maintenance shops, and various other operations at the DC was discharged to the sump, which flowed into the UST. Periodically, waste oil was pumped from the UST for offsite treatment and disposal (SAIC 1994). The sump and UST were installed in 1957 and removed in late March or early April 1986 (Landau Associates 1987).

2.1 HISTORIC MONITORING RESULTS

Following removal of the sump and UST and initial phases of the investigation (Landau Associates 2004), groundwater monitoring has focused on chlorinated volatile organic compounds (CVOCs) and selected metals (copper and arsenic). CVOCs of interest include PCE, TCE, and reductive dechlorination breakdown products cis-1,2-dichloroethene (*c*DCE) and vinyl chloride (VC). Preliminary screening levels (Landau Associates 2002) were exceeded for PCE and intermittently for dissolved metals (copper only) and total metals (both copper and arsenic); total metals concentrations have historically been substantially higher than dissolved concentrations. Through May 2008, prior to bioremediation pilot testing, the highest concentrations of PCE and TCE were detected at wells BDC-05-02 and BDC-05-07 (Landau Associates 2008a). Groundwater concentrations of PCE ranged from approximately 5 to 33 micrograms per liter (µg/L) at BDC-05-07 and BDC-05-02; TCE at these two wells ranged from 7 to 45 µg/L. Background levels (Landau Associates 2010a) for total and dissolved copper and total arsenic were exceeded in groundwater at multiple wells. Cumulative data for these constituents are presented for existing SWMU-17 wells in Tables 1 and 2. Screening levels presented in Table 1 are those screening levels proposed for the site in the 2002 *Corrective Action Summary Report* (Landau Associates 2002).

2.2 BIOREMEDIATION PILOT TEST

Bioremediation pilot testing of electron donor amendment to enhance biological degradation of PCE and TCE began in October 2008. The pilot test began with installation of an additional downgradient monitoring well (BDC-05-08) and a baseline monitoring event. Baseline monitoring indicated variable aquifer redox conditions and moderate organic carbon concentrations across the pilot test study area (Landau Associates 2010b). Redox data indicated aerobic conditions at wells near the former UST (BDC-05-04 and BDC-05-07); mildly anaerobic (i.e., nitrate-reducing) conditions at upgradient well BDC-05-02; and highly reduced (i.e., sulfate-reducing to methanogenic) conditions at downgradient wells BDC-05-03 and BDC-05-08. Baseline total organic carbon (TOC) concentrations ranged from approximately 4 milligrams per liter (mg/L) to 8 mg/L, somewhat below the minimum 10 mg/L TOC concentration that is thought to be required for substantial reductive dechlorination to occur (Major et al. 2003). Baseline TOC concentrations demonstrate the need for electron donor amendment of the aquifer to stimulate substantial reductive dechlorination of PCE and TCE.

On October 28, 2008, 5,300 total gallons of water amended with electron donor substrates, nutrients, and ferrous sulfate was injected to well BCC-05-02. Donor substrates consisted of 2,100 lbs of vegetable oil and 3,000 lbs of sodium lactate. Yeast extract (2 lbs) was included to provide micronutrients. Ferrous sulfate (400 lbs) was included in the injection solution in an attempt to stimulate removal of dissolved copper and arsenic from groundwater and abiotic degradation of PCE and TCE through reaction with formed iron sulfides.

Bioremediation stimulated by electron donor injection was successful in substantially reducing PCE and TCE at the injected well and, with time, at the nearest downgradient well. At the end of pilot testing (February 2010), PCE and TCE were reduced to below detection limits at injection well BDC-05-02 and were reduced to approximately 25 percent of baseline at well BDC-05-07, located 20 ft downgradient (Landau Associates 2010b). Treatment was slow to occur at downgradient well BDC-05-07, with substantial aquifer redox changes occurring 10 months after donor injection and substantial concentration reductions observed between 6 to 13 months after injection. As of February 2010, PCE concentrations at BDC-05-02 and BDC-05-07 decreased from a baseline of 31 and 22 μg/L to <1 and 6 μg/L, respectively (below the Method B preliminary screening level of 9 μg/L). TCE decreased from a baseline of 62 and 24 μg/L to <1 and 7 μg/L, respectively, at these two wells (well below the Method B preliminary screening level of 81 μg/L). No rebound in PCE or TCE concentrations was observed through the last sampling event in February 2011. PCE and TCE concentration decreases occurred by biotic reductive dechlorination to *c*DCE.

Through the pilot testing period (October 2008 to February 2010), *c*DCE was detected at maximum concentrations of 70 and 28 μg/L at BDC-05-02 and BDC-05-07, respectively, but decreased to 13 and 20 μg/L, respectively, by February 2011. *c*DCE was not further dechlorinated to subsequent breakdown product VC, or to innocuous end products ethene or ethane. There was no evidence of substantial abiotic degradation of PCE or TCE, nor was there enhanced decrease in the concentrations of dissolved or total metals. A summary of bioremediation pilot test data is presented in Table 2.

On April 9, 2009, a direct-push investigation was implemented as a supplemental component to the pilot test scope (Landau Associates 2010b). Approximately 5 months had transpired since the injection event without expected changes (i.e., increased TOC and/or substantial changes in the concentrations of PCE, TCE, or breakdown products) being observed at the downgradient wells including well BDC-05-07 located just 20 ft from the injection well. In an effort to determine if these expected changes had occurred in an unexpected direction from the injection well, seven direct-push borings (DPS17-1 through DPS17-7) were advanced to the west and south of injection point BDC-05-02 (Figure 3). Elevated TOC or substantial changes in the concentrations of PCE, TCE, or breakdown products were not clearly observed at these nearby direct-push borings, indicating a limited extent of treatment. It was also noteworthy that one of the seven borings (DPS17-1) had concentrations of PCE (23 µg/L) and TCE (26 µg/L) that were comparable to concentrations observed at wells BDC-05-02 and BDC-05-07, which were targeted for treatment. This finding indicated that the extent of contamination was larger than previously understood and led to additional characterization efforts (Section 2.3). Direct-push data are presented in Table 3.

The relatively limited extent of PCE and TCE treatment observed during the pilot test and subsequent direct-push investigation indicated a smaller than anticipated radius of influence (ROI) and very slow downgradient transport of injected electron donor. These results indicate that full-scale treatment would be most effective by injecting at multiple wells located on relatively close spacing throughout the contaminated area to achieve adequate treatment coverage.

2.3 ADDITIONAL PLUME CHARACTERIZATION

In preparation for full-scale treatment, it was necessary to fully investigate all of the SWMU-17 downgradient area so that the proposed treatment area could be identified. Toward that goal, groundwater was sampled from 67 additional direct-push borings (DPS17-8 through DPS17-33 and DPS17-35 through DPS17-75; DPS17-34 was not sampled due to refusal) during the period from August 18, 2010 to March 17, 2011 (Figure 3). For collection of samples, the exposed direct-push screen was centered at 18.5 ft below ground surface (BGS) to approximate the mid-point between the water table and the bottom depth of injection well BDC-05-02. In addition to characterizing the horizontal extent of groundwater contamination, groundwater was sampled from multiple depths (18.5, 28.5, and 38.5 ft BGS) at three different direct-push boring locations located within the core of the PCE/TCE plume (DPS17-1, DPS17-19, and DPS17-36) to characterize the vertical extent of contamination. All direct-push analytical data are presented in Table 3.

Direct-push sample results showed that groundwater concentrations of PCE and TCE comparable to those detected at source area wells BDC-05-02 and BDC-05-07 prior to pilot testing (i.e., PCE and/or TCE of 20 µg/L or more) extend farther downgradient toward the west than previously believed. Concentrations of PCE and/or TCE of 20 µg/L or more were found at 13 direct-push boring locations (DPS17-1, DPS17-5, DPS17-8, DPS17-19, DPS17-21, DPS17-22, DPS17-23, DPS17-24, DPS17-25, DPS17-36, DPS17-41, DPS17-42, and DPS17-51), with predominance of PCE or TCE varying from well to well. Since both PCE and TCE are parent products targeted for remediation, isoconcentration contours were prepared that represent concentrations of PCE and/or TCE. Figure 3 presents direct-push boring locations and approximate contours representing PCE and/or TCE concentrations greater than 1, 10, and 20 µg/L. Although most of the information presented on Figure 3 is based on recent direct-push sample results, data shown for wells BDC-05-02 and BDC-05-07 are from pre-pilot test results. PCE and TCE concentrations at these two wells were reduced following bioremediation pilot testing in October 2008. Figure 4 presents PCE and TCE data used to develop the PCE-TCE plume contours shown on Figure 3. Direct-push data are presented in Table 3.

Data from the three borings where multiple depth samples were collected (at borings DPS17-1, DPS17-19, and DPS17-36) indicate that contamination is restricted to the shallow interval defined by the 18.5-ft samples. PCE and TCE concentrations in the deeper samples were at or below reporting limits (Table 3).

As groundwater characterization extended westward toward the 9-98 building, possible drilling locations were limited by underground utilities. Three transects of borings (DPS17-33-51-52, DPS17-53-59, and DPS17-60-66) characterize the western extent of the plume. Three transects of borings (DPS17-62-66, DPS17-67-71, and DPS17-72-75) characterize the southern extent of the plume. The results of these explorations indicate PCE/TCE concentrations extending across the roadways to the west and south are all less than 3 µg/L. The highest concentrations to the west and south of the roadways are of TCE at DPS17-61 (2.3 µg/L) and DPS17-68 (2.3 µg/L).

Results for TCE breakdown product cDCE (Figure 5) also confirm the general west to southwest alignment of the contaminant plume. *c*DCE in groundwater commonly extends beyond the extent of PCE/TCE groundwater contamination due to a lower retardation factor (i.e., lower partitioning coefficient). The highest concentrations of cDCE downgradient of the main PCE/TCE plume are just south of the 9-98 building at borings DPS17-60 and DPS17-61.

The next breakdown product, VC, was detected at low levels in 14 of the 75 direct-push borings. VC detections are relatively low, ranging from 0.3 to 8.2 µg/L VC concentrations adjacent to Site Buildings 9-59 and 9-98 are at the lower end of the range, with concentrations from 0.3 to 4.9 µg/L. Most VC detections are grouped to the north of the 20 µg/L PCE/TCE concentration contour, suggesting a zone of lower aquifer redox conditions where cDCE is degraded to VC. TOC was analyzed from groundwater samples at many of the direct-push locations, but VC detections do not coincide with elevated TOC. Detected VC concentrations are shown in relationship to the PCE/TCE plume on Figure 6.

2.4 EVALUATION OF CONTAMINANT DISTRIBUTION

The observed west to southwesterly contaminant distribution is due to groundwater discharge to the Duwamish River, with some variability in localized flow directions and preferential flow paths.

Preferential flow paths may result from variability in natural deposition and from variable backfilling in the historic meander of the former Duwamish River, which was present in this portion of the DC prior to channelization. Other potential effects on plume distribution that were evaluated include storm drain and sewer lines to the north, the presence of backfilled Slip 7 of the Duwamish River to the northwest (Figure 3), and prior groundwater extraction activities in SWMU-20 to the southwest.

PCE/TCE concentrations at borings DPS17-21 and DPS17-22 led to evaluation of possible plume influence by the storm drain or the sanitary sewer lines that run east-west in vicinity north of SWMU-17. Invert elevations of the storm and sewer utilities were measured for comparison to historic groundwater elevations at SWMU-17. In the past 3 years, groundwater at the six SWMU-17 wells fluctuated between 1.88 and 2.55 ft above sea level (vertical datum NGVD29), or 12.79 to 11.89 ft BGS. Just north of SWMU-17, the invert elevations of the storm drain (8.03 to 8.64 ft) and sanitary sewer (4.88 to 5.57 ft) are substantially higher (at least 2.3 ft) than the seasonal high groundwater levels. This evaluation indicates that groundwater could not be infiltrating into either utility (i.e., the plume is not drawn toward the utilities). It was also evaluated whether the sanitary sewer or storm drain could be sources of the PCE/TCE groundwater plume. However, low to non-detect concentrations of PCE/TCE at borings DPS17-27 and DPS17-28 to the north of the utilities indicate that the storm and sanitary sewer utilities are not sources of observed groundwater contamination, as similar PCE/TCE concentrations would be expected to the north if either utility was a source. Results of this evaluation are consistent with the long-standing conceptual model that the SWMU-17 sump and/or UST are the source of PCE/TCE.

Direct-push borings to the north and northwest of the plume serve to evaluate whether backfilled Slip 7 (Figure 3) could serve as a preferential flow path for groundwater and, thereby, draw the plume to the north. Fourteen direct-push borings between the plume and former Slip 7 have PCE/TCE concentrations that are less than 10 μg/L and decreasing with distance to the north; concentrations are commonly below reporting limits. These results indicate that the plume does not extend toward former Slip 7.

Direct-push borings to the south of the plume serve to evaluate whether prior groundwater extraction in SWMU-20 (from 1994 to 2001) could have pulled the plume to the south. South of the plume, direct-push borings were located in three transects [one south of the 9-98 building (borings DPS17-62-66) and two south of the east-west roadway between the 9-59 and the 9-50 buildings (borings DPS17-67-71 and DPS17-72-75)]. PCE/TCE concentrations at these borings were less than 10 μg/L and decreased with distance to the south. The results indicate that the plume does not extend toward SWMU-20.

3.0 TREATMENT OBJECTIVE AND APPROACH

The objective of full-scale treatment is to enhance anaerobic biodegradation of PCE and TCE present in SWMU-17 groundwater through electron donor amendment of the aquifer. Electron donor (vegetable oil and ethyl lactate) will be injected through the core of the plume to stimulate biotic reductive dechlorination of PCE and TCE. More than one injection may be required. This is the same bioremediation approach applied in SWMU-20 at the Site for effective treatment of PCE/TCE and of resulting breakdown products cDCE and VC (Landau Associates 2008b, 2010c).

Reductive dechlorination of PCE and TCE occurs through microbially mediated (biotic) reactions whereby micro-organisms obtain energy through oxidation-reduction (redox) reactions. Electron donors (hydrogen, fatty acids, etc.) are used by microbes together with various electron acceptors [oxygen, nitrate, manganese (IV), ferric iron, sulfate, and carbon dioxide]. These redox reactions can be compared to the process whereby humans obtain energy through consumption of food (electron donor) and oxygen (electron acceptor). Bacteria obtain the greatest energy yield by using oxygen as an acceptor, as it is highly oxidized and, therefore, can be reduced easily and to a large degree. When oxygen is depleted in an uncontaminated aquifer, bacteria sequentially use the less oxidized electron acceptors in the following order: nitrate, manganese (IV), iron (III) (i.e., ferric iron), sulfate, and carbon dioxide.

Chloroethenes can also be used as electron acceptors by specific micro-organisms and degraded to harmless products. During the degradation, chlorine ions present on the chlorinated hydrocarbon molecule are replaced with hydrogen, resulting in the formation of successively less chlorinated molecules. By this process, PCE and TCE are degraded to less chlorinated breakdown products *c*DCE, and VC, and then to innocuous end products ethene and ethane. PCE is the most oxidized electron acceptor in groundwater systems after oxygen (Vogel et al. 1987) and, therefore, could theoretically be reduced as soon as oxygen is depleted. TCE, *c*DCE, and VC, however, require successively more reducing aquifer conditions for degradation. TCE can be degraded under iron-reducing conditions (Chapelle 1996); *c*DCE can be degraded under sulfate-reducing or methanogenic conditions (Chapelle 1996; Vogel et al. 1987); and VC can be degraded only under highly reducing carbon dioxide (CO_2)-reducing (methanogenic) conditions (Ballapragada et al. 1997; Freedman and Gosset 1989; Maymó-Gatell et al. 1995; Vogel and McCarthy 1985).

Reductive dechlorination is enhanced through injection of electron donor substrates (e.g., vegetable oil and lactate) as a food source for the bacteria. Electron donor substrates are injected into the contaminated aquifer where indigenous bacteria ferment the substrate to fatty acids and hydrogen, which are then used by micro-organisms for reduction of natural electron acceptors and chloroethenes. Depletion of natural electron acceptors (e.g., oxygen, iron, sulfate, CO_2) creates the highly reducing aquifer conditions (sulfate-reducing to methanogenic conditions) required for complete reductive dechlorination of PCE and breakdown products. Hydrogen is the required electron donor for VC and *c*DCE degraders [i.e., *Dehalococcoides* (DHC) strains] to degrade these PCE breakdown products to harmless non-chlorinated products. Other anaerobic dechlorinating organisms are typically common and widespread, and many can utilize the fatty acids directly as electron donor.

As was observed in the SWMU-17 pilot test (Landau Associates 2010b), it may be that PCE and TCE will be converted to *c*DCE without further conversion to subsequent breakdown product VC and non-toxic end products ethene and ethane. Despite the *c*DCE stall observed during the pilot test, effective treatment was achieved for PCE and TCE, as conversion of PCE and TCE to *c*DCE represents a substantial reduction in overall toxicity. Accumulation of cDCE is not a concern for full-scale treatment at SWMU-17, since the likely cleanup level for cDCE is much higher than could result from complete conversion of the relatively low levels of PCE and TCE; the maximum concentration of *c*DCE resulting from the pilot test was 70 µg/L (Section 2.2). Although cleanup levels have not been agreed upon for the DC, there are no ambient water quality criteria available for *c*DCE, and a preliminary calculation using the formula in the MTCA regulation indicates that the cleanup level is likely to be in the range of 1,200 to 16,000 µg/L (Landau Associates 2010a). VC detected during the 2010 and 2011 direct-push characterization of the plume (Section 2.3) indicates that aquifer micro-organisms are capable of further degradation beyond cDCE, suggesting that innocuous end products ethene and ethane may be achieved through biotreatment.

Ferrous sulfate will not be added to the aquifer amendment during full-scale injection due to pilot test results that showed no discernible benefit from its inclusion. Concentrations of total and dissolved arsenic and total copper have been intermittently above the 0.008 mg/L background level (Landau Associates 2010a) at more than one well in 2010. It is not certain whether full-scale injection activities will have beneficial effects on metals. Monitoring for metals will be performed during full-scale monitoring.

4.0 FULL SCALE IMPLEMENTATION

Six existing SMWU-17 wells (BDC-05-02 through BDC-05-05, BDC-05-07, and BDC-05-08) and sixteen new wells (BDC-05-09 through BDC-05-24) will be utilized for the SWMU-17 full-scale treatment. Two existing wells (BDC-05-02 and BDC-05-07) and nine new wells (BDC-05-09 through BDC-05-17) will be utilized as injection wells. This configuration of injection wells is designed to achieve treatment of contaminants in the immediate vicinity of the former waste oil sump and through the plume area where PCE/TCE concentrations were detected above 20 µg/L. Four existing wells (BDC-05-03 through BDC-05-05, and BDC-05-08) and seven new wells (BDC-05-18 and BDC-05-24) will be used for monitoring only. Monitoring will also be performed less frequently at wells used for injection. The locations of all injection and monitoring wells are presented relative to the PCE/TCE plume on Figure 7.

4.1 NEW INJECTION AND MONITORING WELLS

Based on pilot test results, the spacing of injection wells is relatively close (generally 15 to 20 ft) to achieve adequate treatment coverage. The nine new injection wells (BDC-05-09 through BDC-05-17) will be installed east to west within the 20 µg/L PCE/TCE isoconcentration contour. Existing wells BDC-05-02 and BDC-05-07 will be injected to achieve treatment in the immediate vicinity of the former waste oil sump.

Existing monitoring wells will be supplemented by new monitoring wells to monitor treatment within the core and at the margins of the plume. Existing wells BDC-05-03 through BDC-05-05 and BDC-05-08 are wells with extensive historical data in the vicinity of the SWMU-17 sump that will be used to monitor treatment. Two new monitoring wells (BDC-05-18 and BDC-05-19) will be installed between or adjacent to injection wells within the core of the plume to monitor treatment within the targeted treatment area. Five new monitoring wells located along the downgradient and crossgradient margins of the plume (BDC-05-20 through BDC-05-24) will monitor for potential expansion of the plume and biodegradation breakdown products. Three of these wells, BDC-05-21 through BDC-05-23, are located at the downgradient edge of the plume beyond the 10 µg/L contour. Wells BDC-05-22 and BDC-05-23 are located at direct-push borings with the highest TCE concentration beyond the 10 µg/L contour, and well BDC-05-24 will be located at boring DP-17-44, where the highest concentration of VC (8.2 µg/L) was detected.

The sixteen new wells will be constructed to a total depth of 25 ft with screens extending from 15 to 25 ft BGS. Wells will be constructed of 2-inch-diameter, flush-threaded, PVC well casing and screen (0.020-inch slot size). A sand pack of 2/12 Monterey or 10-20 Colorado sand will extend from the bottom of the screen to 2 ft above the screen (i.e., the boring will be drilled to 25 ft BGS and sand pack material extended from the bottom of the boring up to a point 2 ft above the top of the screen). A well seal will consist of 2 ft of bentonite pellets immediately on top of the sand pack with cement/bentonite grout (5 percent bentonite gel in Portland cement) extending to the surface completion; the cement/bentonite grout is resistant to shrinkage and cracking and creates a high-strength seal resistant to injection pressures. Each well will be completed with a flush-mount well monument set in concrete. Well locations will be cleared for subsurface utilities prior to drilling. Injection wells will be registered with the Washington State Underground Injection Control (UIC) program.

Due to access limitations, the construction of monitoring well BDC-05-18 may vary somewhat from what is described above. This well is to be located within a fenced area where the only access is through a narrow covered walkway. Well BDC-05-18 may be installed using either a small (limited access) direct-push drill rig or by angle drilling from outside the fenced area. A direct-push installation would likely involve a smaller diameter casing and screen (e.g., 1 inch) and pre-packed sand pack. An installation using angle drilling would start the boring south of the fence and angle beneath the fence to place the well screen at approximately 10 ft north of the fence (at the approximate location shown on Figure 7); the sand pack and the well seal of bentonite pellets would be as described above. By either method, the surface seal would be of cement bentonite grout.

The new wells will be developed a minimum of 2 days after construction (to allow for curing of grout seal) by surging with a bailer or surge block and by over-pumping. It is anticipated that 30 to 100 gallons will be pumped from each well or until water is reasonably clear. Development water will be handled for appropriate disposal by Boeing.

4.2 INJECTION FLUID AND INJECTION PROCEDURES

Each of the eleven injection wells will be injected with a similar fluid volume and electron donor mass as was performed during the pilot test injection. Approximately 5,600 gallons of injection fluid will be injected to each well. Each dose of injection fluid will consist of the following:

- 5,300 gallons of water from a nearby fire hydrant
- 6 drums (320 gal) of LactOil™
- 2 lbs yeast extract.

Total injection solution quantities will be 58,300 gallons water, 66 drums of LactOil™, and 22 lbs of yeast extract. Each injection volume will also be preceded and followed by a clear water flush as described below.

LactOil™ will replace the combination of Wilclear sodium lactate and Newman Zone vegetable oil emulsion that was used for the pilot test. LactOil™ is composed of 34 percent ethyl lactate and

49 percent vegetable oil by volume, with the remaining volume composed of water. LactOil™ has the advantage of providing both soluble lactate and insoluble vegetable oil in a single, cost-effective product. LactOil™ has been used successfully by Landau Associates at other sites. Addition of six drums of LactOil™ to 5,300 gallons of water will result in an injection fluid containing approximately 2.0 percent ethyl lactate and 2.9 percent vegetable oil. This approximates the electron donor contained in the pilot test injection solution, which was composed of 3.0 percent sodium lactate and 2.4 percent vegetable oil.

To conduct the injection, each batch of injection fluid will be mixed in a temporary Baker Tank. Water for the injection fluid will come from an onsite fire hydrant. LactOil™ and yeast extract will be pumped with water through the injection pump to the batch tank to achieve proper mixing and emulsification of the vegetable oil. A flush of approximately 100 to 200 gallons of unamended hydrant water will precede and follow injection of the batch of donor solution at each well. Flushing the well and sandpack after donor injection will minimize biofouling. A gasoline-powered, centrifugal injection pump [3-inch, 8 horsepower (hp), 290 gpm] will be used. Flow meters and/or drawdown in the injection fluid tank will be monitored over time to measure injection rates. The injection pump will be operated at a reduced throttle, as needed, to keep injection pressures below approximately 15 to 20 pounds per square inch (psi), as measured at the top of the well. This injection pressure is intended to minimize short-circuiting of injection fluid to the ground surface, as observed during previous injections at nearby SMWU-20, while maintaining a pressurized well screen for uniform application of injection fluid. Injection rates and pressures will be recorded. Approximately 50 to 100 gallons of unamended hydrant water will be injected following donor solution to flush the well and sandpack to minimize biofouling. Injection of the 11 wells will occur in two passes, with every other well injected; this will allow groundwater mounding caused by injection to dissipate before injecting the next adjacent well.

5.0 GROUNDWATER MONITORING

Monitoring will consist of baseline sampling and of quarterly and semiannual performance sampling. Baseline monitoring will be performed at all wells, with the exception of the four existing wells (BDC-05-03 through BDC-05-05, and BDC-05-08) for which extensive historical data is available. Quarterly monitoring will be performed at 10 wells within the plume and at the fringes of the plume. The 10 quarterly monitoring locations include three representative injection wells and the three monitoring wells located within the core of the plume between injection wells; these locations will facilitate evaluation of treatment progress. Quarterly monitoring will also be performed at the four downgradient and crossgradient wells in order to monitor for potential expansion of the plume and the extent of treatment effects including biodegradation breakdown products. Semiannual sampling will be performed at all wells. A monitoring matrix specifying the wells to be sampled during each monitoring event and the analyses to be performed at each well is presented in Table 4.

Samples collected for baseline and performance monitoring will be analyzed for target contaminants and breakdown products (PCE, TCE, *c*DCE, and VC); non-toxic end products (ethene and ethane); parameters indicative of aquifer redox conditions [dissolved oxygen (DO), oxidation-reduction potential (ORP), nitrate, ferrous iron, sulfate, and methane]; and TOC and pH indicative of electron donor. As presented in Table 4, laboratory analysis of methane/ethane/ethene/acetylene is performed at selected representative wells where changes in these parameters are likely to occur. Metals analysis for total and dissolved copper and arsenic will be performed at all wells during baseline and semiannual monitoring. Laboratory analysis will be performed by Analytical Resources Inc. (ARI). Other parameters (DO, ORP, ferrous iron, and pH) will be measured in the field. Table 5 presents a comprehensive list of the monitoring parameters and information provided by each parameter.

It is anticipated that performance monitoring may be performed for 1 to 2 years following electron donor injection(s). Depending on monitoring results, the number of wells monitored may be reduced, and the frequency of monitoring may be reduced to semiannually after one year of quarterly monitoring.

6.0 DATA EVALUATION AND REPORTING

Analytical data will be evaluated to monitor biodegradation of PCE and TCE, and to schedule subsequent donor injection, if needed. Primary indicators of success will be concentrations of PCE and TCE, breakdown products *c*DCE and VC, and end products ethene and ethane. Redox parameters (ORP, DO, nitrate, ferrous iron, sulfate, and methane) and pH will be used to evaluate development of desired aquifer redox conditions. TOC data will facilitate evaluation of electron donor longevity and distribution. Collected data will enable optimization of future injection, if needed, including adjustment of the amount of electron donor and the timing of injection. Total and dissolved copper and arsenic will continue to be evaluated to determine the effects of injection, if any.

Monitoring data will be reported in the regular semiannual reports prepared for the DC, and an evaluation report will be prepared annually during implementation. A final report will be prepared at the conclusion of the treatment.

7.0 SCHEDULE

We propose to proceed with implementation of this work plan in 2011. Drilling is tentatively scheduled to begin in June, followed by well development and baseline sampling in July. Donor injection is planned to occur in August and/or September. A schedule for future injection, if needed, will be based on monitoring results.

8.0 USE OF THIS WORK PLAN

This work plan has been prepared for the exclusive use of The Boeing Company for specific application to the full-scale bioremediation at SWMU-17 of the Boeing Developmental Center in Tukwila, Washington. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of Landau Associates. Further, the reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by Landau Associates, shall be at the user's sole risk. Landau Associates warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. We make no other warranty, either express or implied.

This document has been prepared under the supervision and direction of the following key staff.

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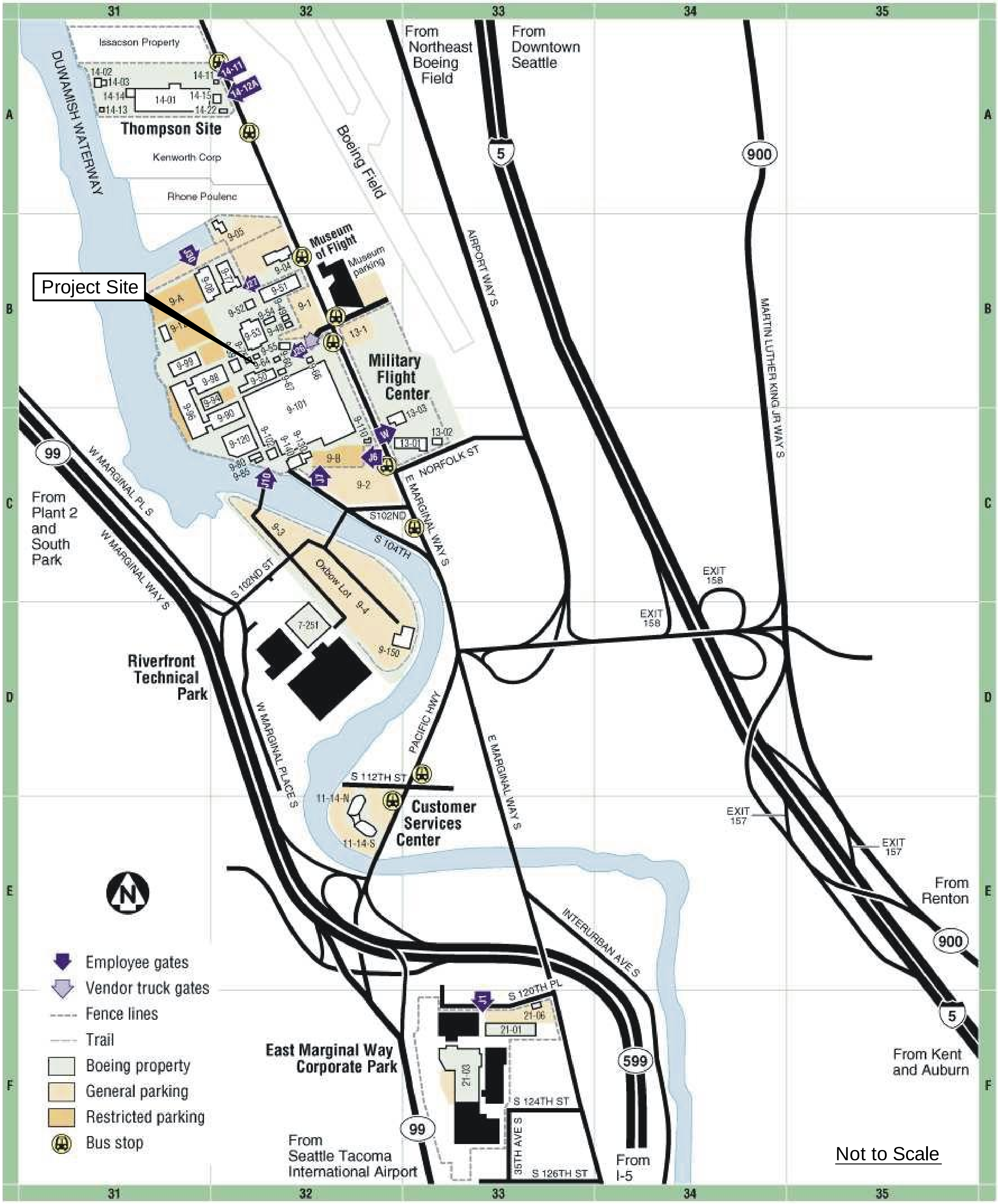


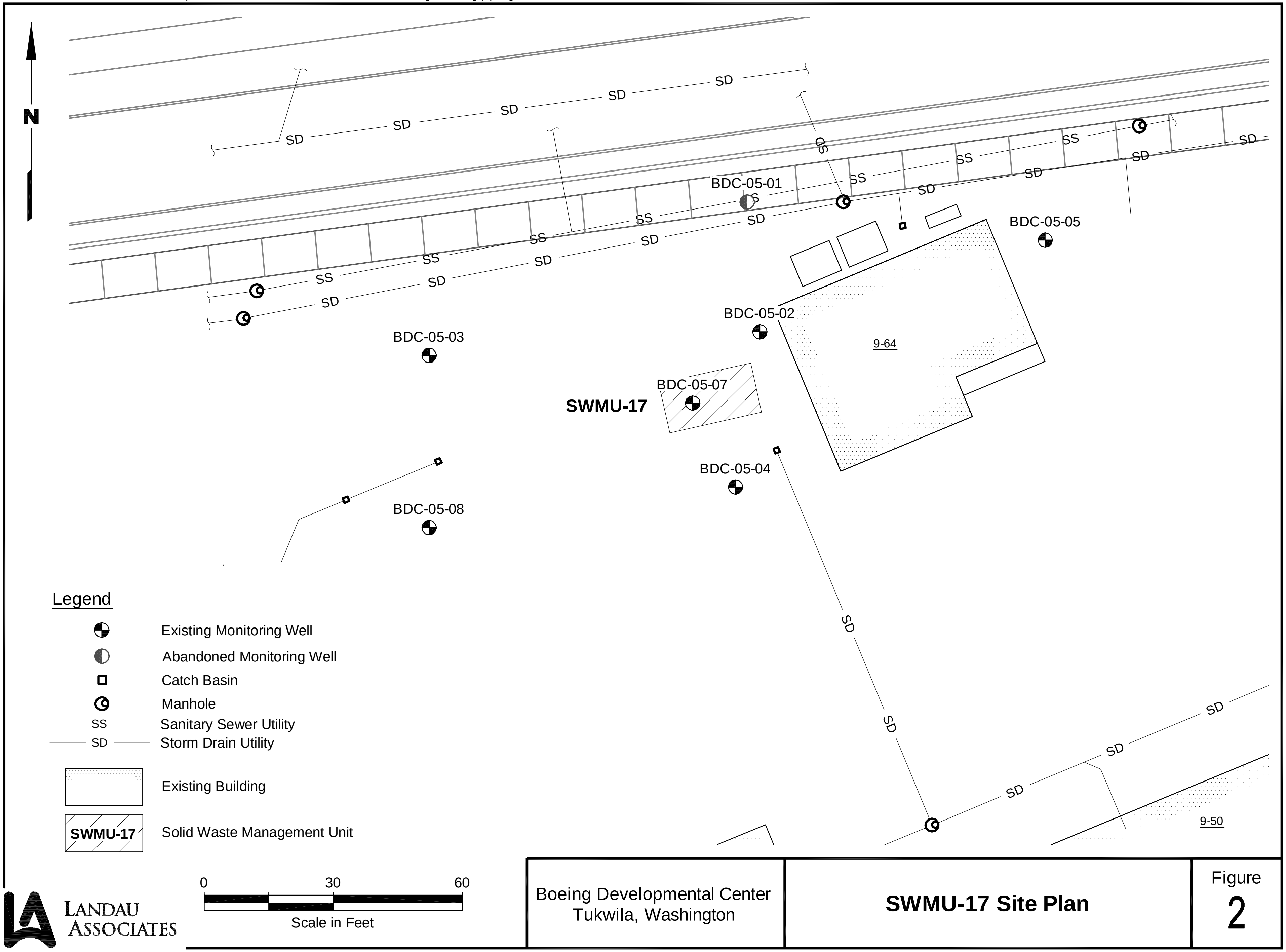
Map Provided by Boeing, March 2000

Boeing/Developmental Center/Evaluation Report | V:\025\093\111.030\SWMU-17 Full Scale WP\Figure 1.dwg (A) "Figure 1" 6/2/2011

LANDAU ASSOCIATES

Boeing Developmental Center Tukwila, Washington	**Vicinity Map**	Figure 1

LANDAU ASSOCIATES, INC. | V:\025\093\111.030\SWMU-17 Full Scale WP\Figure 2.dwg (A) "Figure 2" 6/2/2011



LANDAU ASSOCIATES

Boeing Developmental Center
Tukwila, Washington

SWMU-17 Site Plan

Figure
2

Legend

- Existing Monitoring Well
- Direct-push Boring Location
- Abandoned Monitoring Well
- Catch Basin
- Manhole
- Sanitary Sewer Utility
- Storm Drain Utility
- Electrical Utility
- Water Utility
- Existing Fence
- 20 — Concentration Contours for PCE and/or TCE (µg/L)
- Groundwater Flow Direction (May 2009)
- SWMU-17 — Solid Waste Management Unit

Note

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

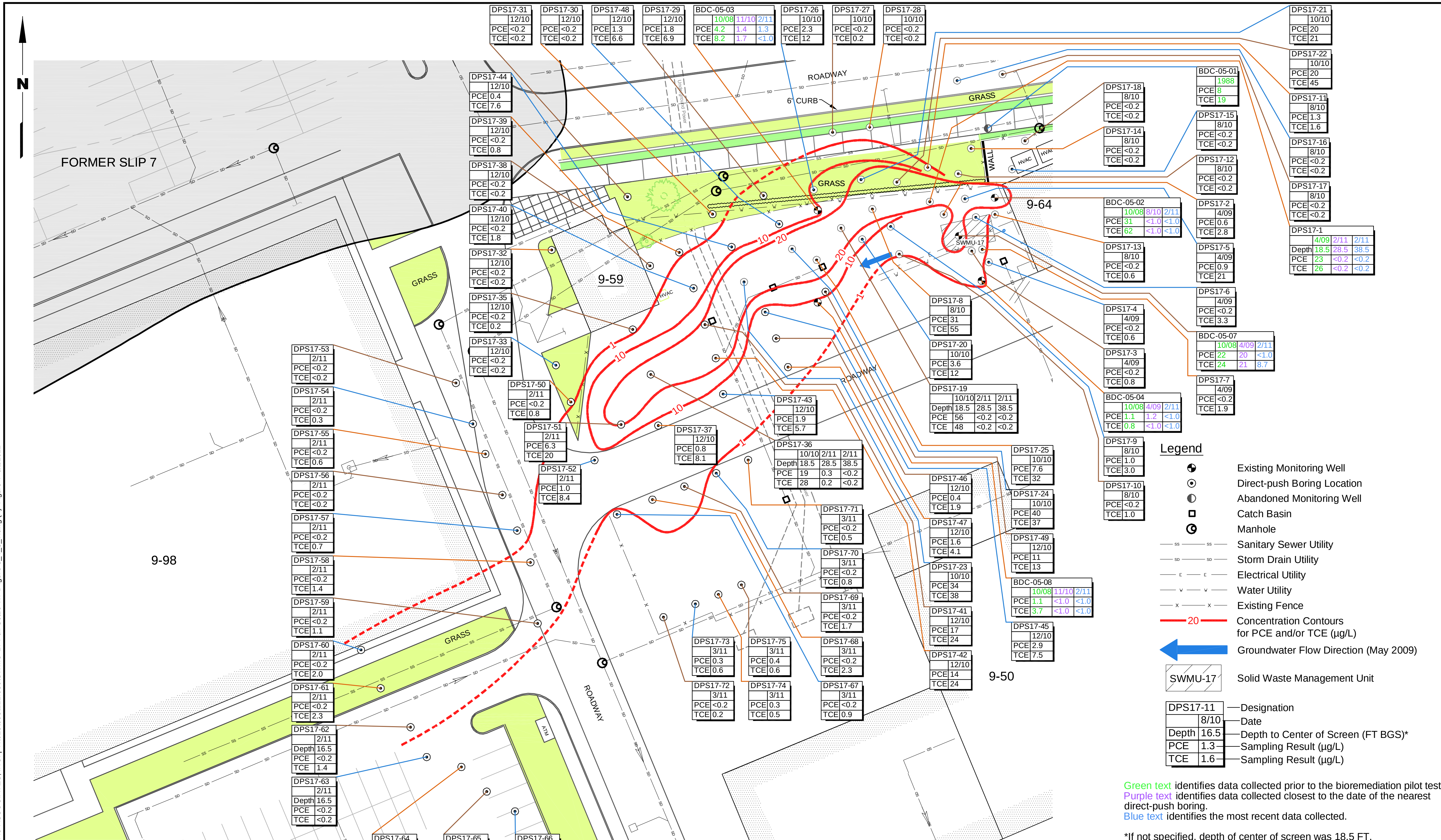
0 40 80
Scale in Feet

LANDAU ASSOCIATES

Boeing Developmental Center
Tukwila, Washington

PCE/TCE Groundwater Plumes and Investigation Locations

Figure
3



Note

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

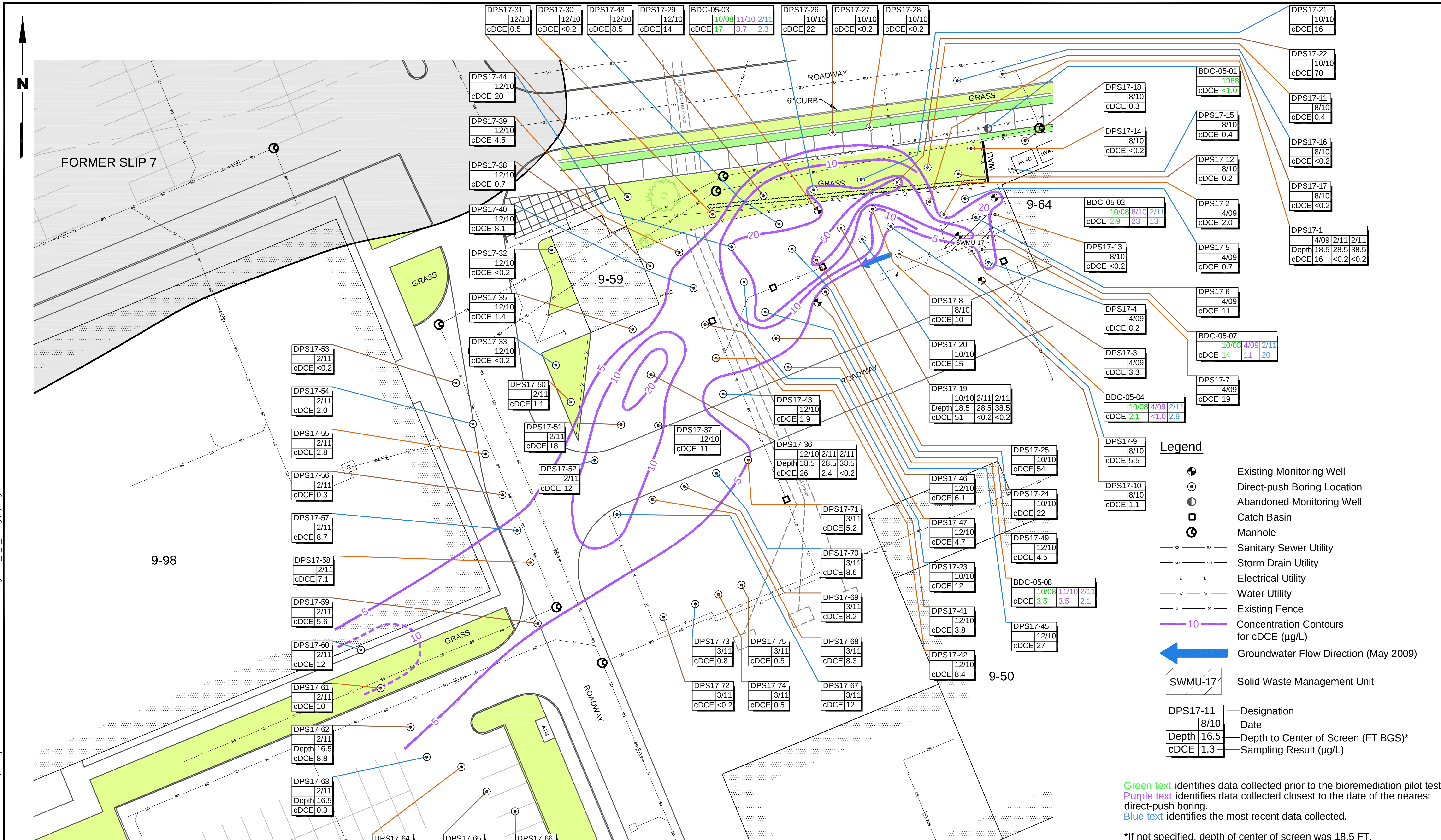
0 40 80
Scale in Feet

LANDAU ASSOCIATES

Boeing Developmental Center
Tukwila, Washington

PCE/TCE Groundwater Data

Figure 4



LANDAU ASSOCIATES, INC. | V:\025\093\111.030\SWMU-17 Full Scale WP\Figure 3_4_5_7.dwg (A) "Figure 5" 6/2/2011

Note

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

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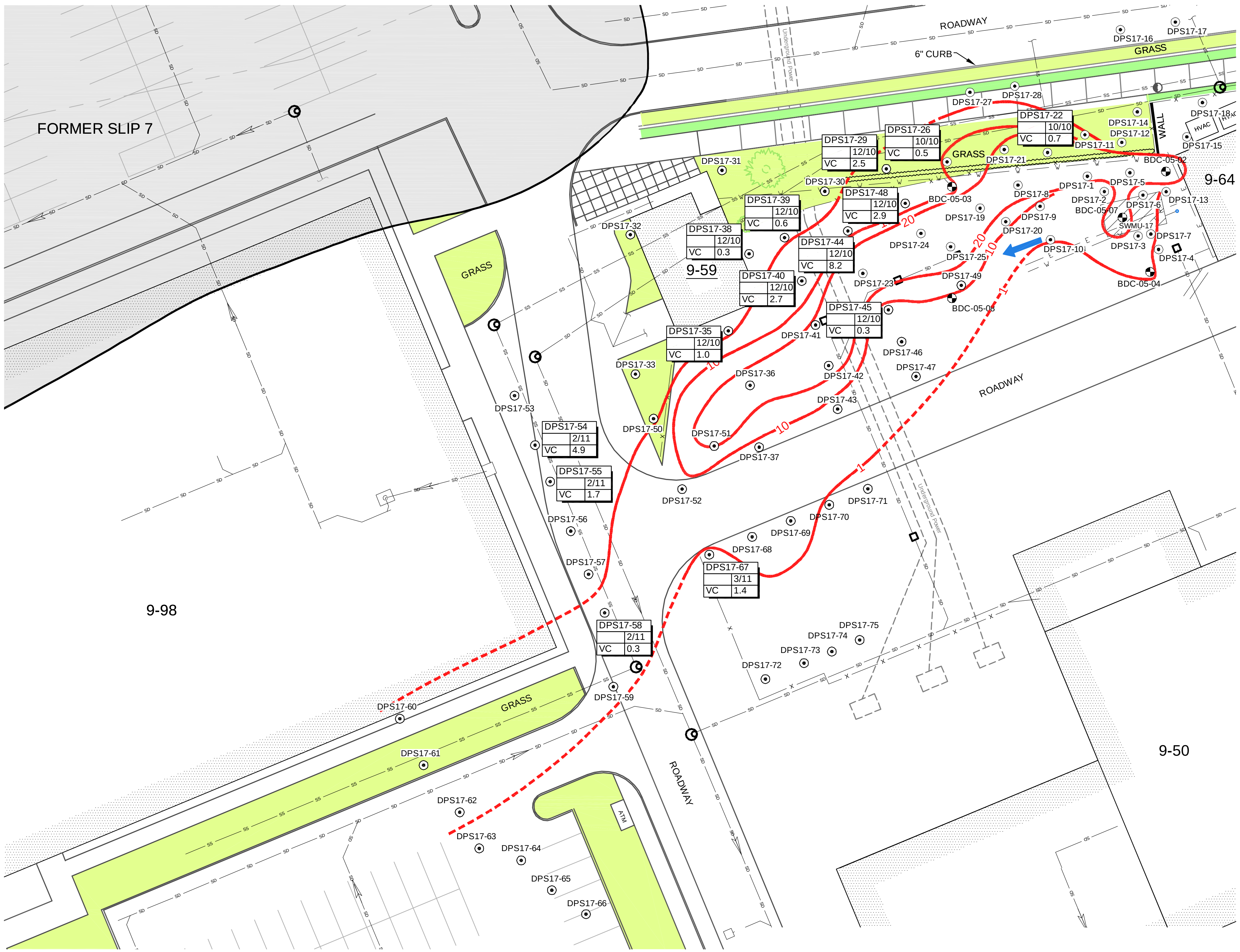
Boeing Developmental Center
Tukwila, Washington

cDCE Groundwater Data

Figure 5



LANDAU ASSOCIATES, INC. | V:\025\093\111.030\SWMU-17 Full Scale WP\Figure 6.dwg (A) "Figure 6" 6/2/2011

Legend

- Existing Monitoring Well
- Direct-push Boring Location
- Abandoned Monitoring Well
- Catch Basin
- Manhole
- Sanitary Sewer Utility
- Storm Drain Utility
- Electrical Utility
- Water Utility
- Existing Fence
- 20 Concentration Contours for PCE and/or TCE (µg/L)
- Groundwater Flow Direction (May 2009)
- SWMU-17 Solid Waste Management Unit
- DPS17-40 — Designation; 12/10 — Date; VC 2.7 — Sampling Result (µg/L)

Notes

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.
2. VC data shown only where detected. At locations without data shown, VC was not detected at a reporting limit of 0.2 µg/L.

Note

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

0 40 80
Scale in Feet

LANDAU ASSOCIATES

Boeing Developmental Center
Tukwila, Washington

VC in Groundwater Relative to PCE/TCE Plume

Figure 6

LANDAU ASSOCIATES, INC. | V:\025\093\111.030\SWMU-17 Full Scale WP\Figure 3_4_5_7.dwg (A) "Figure 7" 6/2/2011

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Note

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

Boeing Developmental Center
Tukwila, Washington

Remedial Action
Injection and Monitoring Wells

Figure
7

TABLE 1
CUMULATIVE MONITORING WELL DATA
SWMU-17
BOEING DEVELOPMENTAL CENTER

	Method B Preliminary Screening Level Marine Surface Water	Method B Preliminary Screening Level Fresh Surface Water	Background Concentrations (a)	Jun-02	Dec-02	Jun-03	Nov-03	Apr-04	Oct-04	May-05	Nov-05	May-06	Nov-06	May-07	Nov-07	May-08	Oct-08	Nov-08	Dec-08	Jan-09
TETRACHLOROETHENE (µg/L)	9	9																		
BDC-05-02				23	4.7	17	6.5	32	9.2	22	10	30	6.2	20	12	14	31	5.1	6.6	7.5
BDC-05-03				4.1	4.4	3.3	4.5	3.4	5.1	2.3	3.8	3.2	1.7	3.5	2.3	3.8	4.2	1.8	2.2	1.5
BDC-05-04				1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.4	1.0 U	1.0 U	1.5	1.1	1.1	1.0 U	1.0 U
BDC-05-05				1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.8	1.0 U	1.0 U	0.3	NM	0.3	NM	NM
BDC-05-07				13	12	15	20	23	27	25	31	29	24	30	28	33	22	17	16	20
BDC-05-08				(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	1.1	1.1	1.2	1.3
TRICHLOROETHENE (µg/L)	81																			
BDC-05-02				38	7.2	30	10	45	15	28	16	31	8.2	24	14	20	62	4.2	7.3	22
BDC-05-03				11	11	9.9	12	8.6	11	5.3	6.7	6.4	2.4	8.1	4.4	8.5	8.2	2.1	4.1	1.2
BDC-05-04				1.2	1.1	1.0 U	1.0	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0	1.0 U	1.0 U	0.9	0.8	0.7	1.0 U	1.0 U
BDC-05-05				1.6	1.4	1.7	1.5	1.5	1.3	1.4	1.5	1.4	1.1	1.0 U	1.0 U	0.8	NM	0.7	NM	NM
BDC-05-07				28	26	29	41	31	37	31	34	23	29	22	25	32	24	17	25	23
BDC-05-08				(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	3.7	3.4	4.3	4.2
TOTAL ARSENIC (mg/L)	0.005	0.005	0.008																	
BDC-05-02				0.05 U	0.05 U	0.001 U	0.001 U	0.002	0.002	0.001	0.002	0.001	0.002	0.003	0.001	0.002	0.003	0.017	0.024	0.022
BDC-05-03				0.05 U	0.05 U	0.004	0.001 U	0.002	0.002	0.001 U	0.002	0.007	0.002	0.003	0.002	0.002	0.004	0.003	0.001	0.001
BDC-05-04				0.05 U	0.05 U	0.011	0.018	0.019	0.016	0.008	0.018	0.018	0.002	0.018	0.009	0.018	0.009	0.019	0.019	0.017
BDC-05-05				0.05 U	0.05 U	0.002	0.001	0.003	0.007	0.003	0.006	0.009	0.001	0.002	0.001 U	0.002	NM	0.005	NM	NM
BDC-05-07				0.05 U	0.05 U	0.002	0.001 U	0.001	0.001	0.001	0.002	0.002	0.001	0.003	0.001 U	0.002	0.004	0.003	0.003	0.002
BDC-05-08				(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	0.007	0.035	0.008	0.008
DISSOLVED ARSENIC (mg/L)	0.005	0.005	0.008																	
BDC-05-02				0.05 U	0.05 U	0.001 U	0.001 U	0.001	0.001 U	0.001	0.001	0.001	0.001	0.003	0.001 U	0.002	0.001 U	0.011	0.014	0.017
BDC-05-03				0.05 U	0.05 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.002	0.001 U	0.001	0.001 U	0.001 U	0.001 U	0.001 U
BDC-05-04				0.05 U	0.05 U	0.001 U	0.001	0.001	0.001 U	0.001 U	0.001	0.001 U	0.001 U	0.002	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
BDC-05-05				0.05 U	0.05 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001	0.001 U	0.001 U	NM	0.001 U	NM	NM
BDC-05-07				0.05 U	0.05 U	0.001 U	0.001 U	0.001	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.002	0.001 U	0.001 U	0.001	0.001 U	0.001 U	0.001 U
BDC-05-08				(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	0.001 U	0.004	0.002	0.001
TOTAL COPPER (mg/L)	0.0034	0.0089	0.008																	
BDC-05-02				0.002 U	0.002	0.002	0.002 U	0.003	0.002	0.003	0.003	0.004	0.002 U	0.006	0.002 U	0.004	0.004	0.030	0.029	0.008
BDC-05-03				0.002 U	0.003	0.004	0.002	0.003	0.003	0.003	0.004	0.010	0.002	0.004	0.002	0.002	0.004	0.003	0.003	0.004
BDC-05-04				0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.004	0.002 U	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.003	0.002 U
BDC-05-05				0.003	0.004	0.004	0.003	0.004	0.006	0.005	0.007	0.014	0.002 U	0.003	0.002 U	0.003	NM	0.005	NM	NM
BDC-05-07				0.004	0.007	0.008	0.011	0.008	0.010	0.012	0.012	0.018	0.008	0.016	0.014	0.016	0.022	0.011	0.012	0.013
BDC-05-08				(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	0.004	0.036	0.006	0.007
DISSOLVED COPPER (mg/L)	0.0034	0.0089 (b)	0.008																	
BDC-05-02				0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002	0.002 U	0.002 U	0.002 U	0.002 U	0.003	0.002 U	0.002 U	0.002 U
BDC-05-03				0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.003	0.003	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002	0.002 U
BDC-05-04				0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
BDC-05-05				0.002 U	0.002	0.007	0.002 U	0.002 U	0.002 U	0.002 U	0.004	0.002	0.002	0.002 U	0.002 U	0.003	NM	0.002 U	NM	NM
BDC-05-07				0.003	0.004	0.004	0.005	0.006	0.007	0.007	0.008	0.009	0.009	0.012	0.009	0.010	0.013	0.002	0.006	0.008
BDC-05-08				(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	0.002 U	0.002 U	0.002 U	0.002 U

TABLE 1
CUMULATIVE MONITORING WELL DATA
SWMU-17
BOEING DEVELOPMENTAL CENTER

	Method B Preliminary Screening Level Marine Surface Water	Method B Preliminary Screening Level Fresh Surface Water	Background Concentrations (a)	Feb-09	Mar-09	Apr-09	May-09	Aug-09	Nov-09	Feb-10	May-10	Aug-10	Nov-10	Feb-11
TETRACHLOROETHENE (µg/L)	9	9												
BDC-05-02				9.5	9.1	7.3	4.4	1.8	1.0	1.0 UJ	1.0 U	1.0 U	1.0 U	1.0 U
BDC-05-03				1.8	1.3	1.5	1.2	2.2	1.2	1.4	1.2	2.3	1.4 J	1.3
BDC-05-04				1.0	1.0	1.2	1.0 U	1.3	1.0 U	1.0 U	1.1	1.0 U	1.0 U	1.0 U
BDC-05-05				NM	NM	NM	1.0 U	NM	1.0 U	NM	1.0 U	NM	1.0 U	NM
BDC-05-07				23	20	20	11	11	6.5	6.4	5.8	2.8	1.0 U	1.0 U
BDC-05-08				1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
TRICHLOROETHENE (µg/L)	81													
BDC-05-02				17	8.1	6.0	4.6	1.1	1.0 U	1.0 UJ	1.0	1.0 U	1.0 U	1.0 U
BDC-05-03				3.2	1.7	2.2	2.1	4.3	1.2	1.0	1.8	5.2	1.7 J	1.0 U
BDC-05-04				1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
BDC-05-05				NM	NM	NM	1.0 U	NM	1.0 U	NM	1.0 U	NM	1.1 J	NM
BDC-05-07				28	21	21	13	12	5.3	6.9	9.2	7.8	9.4 J	8.7
BDC-05-08				3.2	2.7	2.3	1.6	2.1	1.2	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
TOTAL ARSENIC (mg/L)	0.005	0.005	0.008											
BDC-05-02				0.046	0.041	0.029	0.024	0.023	0.020	0.022	0.013	0.010	0.006	0.007
BDC-05-03				0.002	0.001 U	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.001	0.001
BDC-05-04				0.020	0.014	0.011	0.007	0.012	0.005	0.004	0.014	0.012	0.008	0.007
BDC-05-05				NM	NM	NM	0.003	NM	0.001	NM	0.002	NM	0.001	NM
BDC-05-07				0.002	0.002 U	0.002	0.002	0.002	0.002	0.004	0.009	0.006	0.008	0.013
BDC-05-08				0.019	0.009	0.007	0.009	0.012	0.011	0.024	0.031	0.014	0.031	0.021
DISSOLVED ARSENIC (mg/L)	0.005	0.005	0.008											
BDC-05-02				0.040	0.036	0.025	0.019	0.017	0.016	0.020	0.012	0.008	0.005	0.006
BDC-05-03				0.001 U	0.001 U	0.002	0.0004	0.001	0.001	0.0004	0.001	0.001	0.001	0.0003
BDC-05-04				0.001 U	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.002	0.004	0.004
BDC-05-05				NM	NM	NM	0.0004	NM	0.0003	NM	0.0004	NM	0.0004	NM
BDC-05-07				0.001	0.001 U	0.001	0.001	0.001	0.001	0.003	0.003	0.003	0.005	0.010
BDC-05-08				0.001	0.003	0.003	0.003	0.008	0.008	0.009	0.011	0.009	0.012	0.010
TOTAL COPPER (mg/L)	0.0034	0.0089	0.008											
BDC-05-02				0.004	0.004	0.003	0.004	0.009	0.003	0.005	0.002 U	0.002 U	0.002 U	0.003
BDC-05-03				0.002	0.002 U	0.002 U	0.004	0.002 U	0.003	0.005	0.004	0.003	0.003	0.005
BDC-05-04				0.002 U	0.002	0.002 U	0.002	0.002	0.002 U	0.012	0.005	0.006	0.002 U	0.002 U
BDC-05-05				NM	NM	NM	0.006	NM	0.002 U	NM	0.002	NM	0.003	NM
BDC-05-07				0.017	0.013	0.015	0.016	0.010	0.004	0.017	0.009	0.008	0.009	0.012
BDC-05-08				0.010	0.007	0.006	0.007	0.002 U	0.007	0.024	0.027	0.013	0.031	0.016
DISSOLVED COPPER (mg/L)	0.0034	0.0089 (b)	0.008											
BDC-05-02				0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
BDC-05-03				0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.005	0.003	0.002 U	0.002 U	0.003
BDC-05-04				0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
BDC-05-05				NM	NM	NM	0.002 U	NM	0.002 U	NM	0.002 U	NM	0.002 U	NM
BDC-05-07				0.012	0.009	0.008	0.008	0.002 U	0.002 U	0.006	0.002 U	0.002 U	0.002 U	0.002
BDC-05-08				0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U

U = Indicates compound was analyzed for, but was not detected at the reported sample detection limit.
J = Indicates the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
UJ = The analyte was not detected in the sample; the reported sample reporting limit is an estimate.
NM = Not measured.
Bold indicates detected compound.
Box indicates exceedance of lowest Method B screening level.
Bold and red indicates exceedance of Background Concentration.

(a) Source: Environmental Partners, Inc., Floyd/Snider, and Golder Associates Inc. 2006. *Boeing Plant 2, Seattle/Tukwila, Washington, Technical Memorandum: Development and Use of Background Values.* Prepared for The Boeing Company. March 30.
(b) Hardness dependent; hardness assumed to be 75.4 mg/L.
(c) BDC-05-08 installed in October 2008.

TABLE 2
SUMMARY OF BIOREMEDIATION PILOT TEST DATA
SWMU-17
BOEING DEVELOPMENTAL CENTER

			Volatile Organic Compounds (all units in ug/L)							Metals (mg/L)				Aquifer Redox Conditions						Donor Indicators		
Well	Date	Elapsed Time from Injection (days)	PCE (µg/L)	TCE (µg/L)	*c* DCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	As, Tot (mg/L)	As, Dis (mg/L)	Cu, Tot (mg/L)	Cu, Dis (mg/L)	DO (mg/L)	Nitrate (mg/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (mg/L)	ORP (mV)	TOC (mg/L)	pH	Comments
BDC-05-02	5/21/2007	-526	20	24	1.2	<1.0				0.003	0.002	0.004	<0.002									
BDC-05-02	11/26/2007	-337	12	14	1.3	<1.0				0.001	<0.001	<0.002	<0.002									
BDC-05-02	5/22/2008	-159	14	20	1.2	<0.2				0.002	<0.001	0.004	<0.002									
BDC-05-02	10/23/2008	-5	31	62	2.9	<1.0	<1.1	<1.2	<1.1	0.003	0.003	0.006	<0.002	5.15	0.4	0.2	13.0	0.19	87.1	5.54	6.47	
BDC-05-02	11/2/2008	5	5.1	4.2	0.7	<0.2	<1.1	<1.2	<1.1	0.017	0.011	0.008	<0.002	0.29	<0.1	1.8	64.8	3.3	-111	430	6.47	
BDC-05-02	12/16/2008	49	6.6	7.3	1.3	<1.0	<1.1	<1.2	<1.1	0.024	0.017	0.030	0.003	1.28	<0.1	3.4	88.8	2.9	-225	610	6.41	
BDC-05-02	1/16/2009	80	7.5	22	3.7	<1.0	<1.1	<1.2	<1.1	0.022	0.014	0.029	<0.002	0.09	<1.0	3.5	6.9	6.2	-304	732	6.10	
BDC-05-02	2/11/2009	106	9.5	17	12	<1.0	<1.1	<1.2	<1.1	0.046	0.04	0.004	<0.002	2.36	<0.1	4.0	<0.1	13.2	-99	433	6.32	
BDC-05-02	3/9/2009	132	9.1	8.1	25	<1.0	<1.1	<1.2	<1.1	0.041	0.036	0.004	<0.002	0.09	<1.0	3.5	<1.0	22.9	-102	317	6.43	
BDC-05-02	4/16/2009	170	7.3	6.0	41	<1.0	<1.1	<1.2	<1.1	0.029	0.025	0.003	<0.002	1.78	<0.1	3.0	<0.5	26.3	-97	274	6.59	
BDC-05-02	5/13/2009	197	4.4	4.6	35	1.4	<1.1	<1.2		0.024	0.019	0.004	0.002	0.27	<0.1	5.2	<0.1	23.0	-63	215	6.61	
BDC-05-02	8/16/2009	292	1.8	1.1	49	<1.0	<1.1	<1.2	<1.1	0.023	0.017	0.009	<0.002	1.58	<0.5	3.6	<0.5	22.6	-23	125	6.77	Black tint, black flakes, suspended solids
BDC-05-02	11/13/2009	381	1.0	<1.0	70	<1.0	<1.1	<1.2	<1.1	0.020	0.016	0.003	<0.002	1.07	<0.1	2.8	0.3	21.1	-26	44.1	6.05	Black tint
BDC-05-02	2/16/2010	476	<1.0	<1.0	54	<1.0	<1.1	<1.2	<1.1	0.022	0.020	0.005	0.002	1.52	<0.5	2.0	0.5	22.5	763	86.7	6.87	
BDC-05-02	5/18/2010	567	<1.0	1.0	32	<1.0	<1.1	<1.2	<1.1	0.013	0.012	<0.002	<0.002	1.83	<0.5	2.3	<0.5	18.4	515	20.6	6.69	
BDC-05-02	8/17/2010	658	<1.0	<1.0	23	<1.0	<1.1	<1.2	<1.1	0.010	0.008	<0.002	<0.002	2.82	0.2	2.7	1.4	20.2	55	13.3	6.74	
BDC-05-02	11/9/2010	742	<1.0	<1.0	14	<1.0	<1.1	<1.2	<1.1	0.006	0.005	<0.002	<0.002	2.77	<0.1	2.2	0.3	16.9	72	10.8	6.83	
BDC-05-02	2/15/2011	840	<1.0	<1.0	13	<1.0	<1.1	<1.2	<1.1	0.007	0.006	0.003	<0.002	2.43	<0.1	3.0	0.7	17.8	114	13.2	6.80	
BDC-05-03	5/21/2007	-526	3.5	8.1	11	<1.0				0.003	<0.001	0.004	<0.002									
BDC-05-03	11/26/2007	-337	2.3	4.4	7.2	<1.0				0.002	<0.001	0.003	<0.002									
BDC-05-03	5/22/2008	-159	3.8	8.5	13	<0.2				0.002	<0.001	0.003	<0.002									
BDC-05-03	10/23/2008	-5	4.2	8.2	17	<0.2	<1.1	<1.2	<1.1	0.004	0.002	0.004	0.002	0.37	<0.1	0.1	4.9	2.1	48.9	4.86	6.23	
BDC-05-03	11/2/2008	5	1.8	2.1	2.7	<0.2	<1.1	<1.2	<1.1	0.003	0.001	0.004	<0.002	2.07	0.9	1.6	8.5	3.6	-8	7.02	6.23	
BDC-05-03	12/16/2008	49	2.2	4.1	5.8	<1.0	<1.1	<1.2	<1.1	0.001	<0.001	0.002	<0.002	1.20	0.4	2.4	20.1	4.7	-67	5.38	6.44	
BDC-05-03	1/16/2009	80	1.5	1.2	<1.0	<1.0	<1.1	<1.2	<1.1	0.001	<0.001	0.002	<0.002	0.71	1.7	0.4	10.3	1.5 J	-144	3.21	6.17	
BDC-05-03	2/11/2009	106	1.8	3.2	4.4	<1.0	<1.1	<1.2	<1.1	0.002	<0.001	0.002	<0.002	2.43	0.9	2.4	6.2	5.4	-60	5.39	6.59	
BDC-05-03	3/9/2009	132	1.3	1.7	1.4	<1.0	<1.1	<1.2	<1.1	<0.001	<0.001	<0.002	<0.002	0.86	1.0	1.0	6.6	4.3	39	4.81	6.48	
BDC-05-03	4/16/2009	170	1.5	2.2	2.8	<1.0	<1.1	<1.2	<1.1	0.001	0.002	<0.002	<0.002	1.42	1.0	1.4	4.8	3.3	14	5.37	6.69	
BDC-05-03	5/13/2009	197	1.2	2.1	3.4	<1.0	<1.1	<1.2		0.001	0.0004	0.004	0.002	1.06	1.0	3.0	4.8	6.9	31	5.45	6.75	
BDC-05-03	8/16/2009	292	2.2	4.3	8.1	<1.0	<1.1	<1.2	<1.1	0.001	0.001	<0.002	<0.002	0.85	0.1	3.0	3.0	8.3	-42	6.47	7.11	
BDC-05-03	11/13/2009	381	1.2	1.2	<1.0	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.003	<0.002	1.66	0.2	3.0	5.6	5.0	57	4.34	6.37	
BDC-05-03	2/16/2010	476	1.4	1.0	<1.0	<1.0	<1.1	<1.2	<1.1	0.002	<0.001	0.005	0.005	1.25	2.5	0.0	8.6	<0.0007	663	3.47	6.30	
BDC-05-03	5/18/2010	567	1.2	1.8	2.7	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.004	0.003	0.88	1.5	2.0	4.9	2.4	346	4.73	6.42	
BDC-05-03	8/17/2010	658	2.3	5.2	14	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.003	<0.002	2.10	0.2	2.7	2.8	7.1	73	7.57	6.79	
BDC-05-03	11/9/2010	742	1.4	1.7	3.7	<1.0	<1.1	<1.2	<1.1	0.001	0.001	0.003	<0.002	3.20	0.5	2.2	5.3	3.0	133	4.73	7.61	
BDC-05-03	2/15/2011	840	1.3	<1.0	2.3	<1.0	<1.1	<1.2	<1.1	0.001	0.0003	0.005	0.003	2.86	0.7	0.0	6.2	4.6	166	5.42	7.01	
BDC-05-04	5/21/2007	-526	<1.0	<1.0	1.4	<1.0				0.018	<0.001	<0.002	<0.002									
BDC-05-04	11/26/2007	-337	<1.0	<1.0	1.6	<1.0				0.009	<0.001	<0.002	<0.002									
BDC-05-04	5/22/2008	-159	1.5	0.9	1.2	<0.2				0.018	<0.001	<0.002	<0.002									
BDC-05-04	10/23/2008	-5	1.1	0.8	2.1	<0.2	<1.1	<1.2	<1.1	0.009	<0.001	<0.002	<0.002	2.45	7.6	0.1	31.0	0.29	73.5	3.80	6.33	
BDC-05-04	11/2/2008	5	1.1	0.7	3.6	<0.2	<1.1	<1.2	<1.1	0.019	<0.001	<0.002	<0.002	0.59	4.5	0.8	25,2	0.05	-16	5.11	6.25	
BDC-05-04	12/16/2008	49	<1.0	<1.0	2.4	<1.0	<1.1	1.2	<1.1	0.019	0.002	0.003	<0.002	0.55	5.5	1.0	30.4	1.6	-98	6.94	6.24	
BDC-05-04	1/16/2009	80	<1.0	<1.0	2.0	<1.0	<1.1	<1.2	<1.1	0.017	<0.001	<0.002	<0.002	0.06	4.3	1.0	21.8	1.5	-192	5.07	6.23	
BDC-05-04	2/11/2009	106	1.0	<1.0	1.5	<1.0	<1.1	<1.2	<1.1	0.020	<0.001	<0.002	<0.002	2.45	5.9	1.0	31.8	1.1	-54	6.76	6.17	
BDC-05-04	3/9/2009	132	1.0	<1.0	1.3	<1.0	<1.1	<1.2	<1.1	0.014	0.001	0.002	<0.002	0.27	4.8	1.5	30.1	0.2	35	5.23	6.22	
BDC-05-04	4/16/2009	170	1.2	<1.0	<1.0	<1.0	<1.1	<1.2	<1.1	0.011	0.001	<0.002	<0.002	1.48	5.9	1.4	33.6	<0.0007	68	5.69	6.29	
BDC-05-04	5/13/2009	197	<1.0	<1.0	1.0	<1.0	<1.1	<1.2		0.007	0.001	0.002	0.002	0.33	4.5	1.6	26.6	0.4	49	5.24	6.37	
BDC-05-04	8/16/2009	292	1.3	<1.0	<1.0	<1.0	<1.1	<1.2	<1.1	0.012	0.001	0.002	<0.002	0.86	5.4	2.2	30.6	<0.0007	93	4.99	6.97	
BDC-05-04	11/13/2009	381	<1.0	<1.0	1.2	<1.0	<1.1	<1.2	<1.1	0.005	0.001	<0.002	<0.002	0.56	2.2	3.0	18.4	2.4	109	4.36	5.86	
BDC-05-04	2/16/2010	476	<1.0	<1.0	1.1	<1.0	<1.1	<1.2	<1.1	0.004	0.002	0.012	0.002	0.88	<0.1	3.3	24.6	1.5	899	8.86	6.24	
BDC-05-04	5/18/2010	567	1.1	<1.0	1.2	<1.0	<1.1	<1.2	<1.1	0.014	0.001	0.005	<0.002	0.75	<0.1	3.0	25.4	1.3	473	7.12	6.19	
BDC-05-04	8/17/2010	658	<1.0	<1.0	3.0	<1.0	<1.1	<1.2	<1.1	0.012	0.002	0.006	<0.002	1.00	<0.1	2.8	17.7	3.5	108	8.72	6.48	
BDC-05-04	11/9/2010	742	<1.0	<1.0	4.3	<1.0	<1.1	<1.2	<1.1	0.008	0.004	<0.002	<0.002	2.21	<0.1	2.2	21.3	3.0	101	7.19	6.84	
BDC-05-04	2/15/2011	840	<1.0	<1.0	2.9	<1.0	<1.1	<1.2	<1.1	0.007	0.004	<0.002	<0.002	2.50	<0.1	2.4	19.4	4.5	93	6.88	6.85	
BDC-05-05	5/21/2007	-526	<1.0	<1.0	<1.0	<1.0				0.002	<0.001	0.003	<0.002									
BDC-05-05	11/26/2007	-337	<1.0	<1.0	<1.0	<1.0				<0.001	<0.001	<0.002	<0.002									
BDC-05-05	5/22/2008	-159	0.3	0.8	<0.2	<0.2				0.002	<0.001	0.003	<0.002									
BDC-05-05	10/23/2008	-5																				
BDC-05-05	11/2/2008	5	0.3	0.7	<0.2	<0.2				0.005	0.001	0.005	0.003	4.61					52		6.25	
BDC-05-05	12/16/2008	49																				
BDC-05-05	1/16/2009	80																				
BDC-05-05	2/11/2009	106																				
BDC-05-05	3/9/2009	132																				

TABLE 2
SUMMARY OF BIOREMEDIATION PILOT TEST DATA
SWMU-17
BOEING DEVELOPMENTAL CENTER

			Volatile Organic Compounds (all units in ug/L)							Metals (mg/L)				Aquifer Redox Conditions						Donor Indicators		
Well	Date	Elapsed Time from Injection (days)	PCE (µg/L)	TCE (µg/L)	*c* DCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	As, Tot (mg/L)	As, Dis (mg/L)	Cu, Tot (mg/L)	Cu, Dis (mg/L)	DO (mg/L)	Nitrate (mg/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (mg/L)	ORP (mV)	TOC (mg/L)	pH	Comments
BDC-05-05	4/16/2009	170																				
BDC-05-05	5/13/2009	197	<1.0	<1.0	<1.0	<1.0				0.003	<0.001	0.006	0.002	3.24					68.0		6.72	
BDC-05-05	8/16/2009	292																				
BDC-05-05	11/13/2009	381	<1.0	<1.0	<1.0	<1.0				0.001	<0.001	<0.002	<0.002	2.85	1.2	0.0	8.7		166		5.84	
BDC-05-05	2/16/2010	476																				
BDC-05-05	5/18/2010	567	<1.0	<1.0	<1.0	<1.0				0.002	0.0004	0.002	<0.002	3.47		0.0			494		6.74	
BDC-05-05	8/17/2010	658																				
BDC-05-05	11/9/2010	742	<1.0	1.1	<1.0	<1.0				0.001	0.0004	0.003	<0.002	3.20					135		6.90	
BDC-05-05	2/15/2011	840																				
BDC-05-07	5/21/2007	-526	30	22	10	<1.0				0.003	<0.001	0.014	0.009									
BDC-05-07	11/26/2007	-337	28	25	11	<1.0				<0.001	<0.001	0.011	0.002									
BDC-05-07	5/22/2008	-159	33	32	9.2	<0.2				0.002	<0.001	0.012	0.006									
BDC-05-07	10/23/2008	-5	22	24	14	<0.2	<1.1	<1.2	<1.1	0.004	0.002	0.022	0.013	9.71	9.6	0.0	33.4	0.62	86.0	7.81	6.47	
BDC-05-07	11/2/2008	5	17	17	4.9	<0.2	<1.1	<1.2	<1.1	0.003	<0.001	0.016	0.010	0.60	2.2	0.4	15.8	0.16	-27	4.59	6.46	
BDC-05-07	12/16/2008	49	16	25	7.2	<1.0	<1.1	1.2	<1.1	0.003	0.001	0.016	0.012	1.20	4.8	0.0	29.4	0.64	-107	6.08	6.49	
BDC-05-07	1/16/2009	80	20	23	6.4	<1.0	<1.1	<1.2	<1.1	0.002	<0.001	0.013	0.008	0.00	8.4	0.0	32.6	0.03	-182	6.26	6.38	
BDC-05-07	2/11/2009	106	23	28	9.9	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.017	0.012	2.05	11.2	0.0	37.5	1.5	-68	9.34	6.37	
BDC-05-07	3/9/2009	132	20	21	8.4	<1.0	<1.1	<1.2	<1.1	<0.002	<0.001	0.013	0.009	0.00	8.8	0.3	35.3	5.5	-23	6.77	6.37	
BDC-05-07	4/16/2009	170	20	21	11	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.015	0.008	0.27	8.2	0.0	31.2	5.1	35	8.14	6.43	
BDC-05-07	5/13/2009	197	11	13	7.5	<1.0	<1.1	<1.2		0.002	0.001	0.016	0.008	0.29	6.8	0.4	27.2	7.9	34	7.32	6.47	
BDC-05-07	8/16/2009	292	11	12	13	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.010	<0.002	0.74	2.3	2.0	23.2	6.8	67	8.20	6.73	
BDC-05-07	11/13/2009	381	6.5	5.3	5.6	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.004	<0.002	0.50	<0.1	2.8	5.7	4.7	16	9.12	6.48	
BDC-05-07	2/16/2010	476	6.4	6.9	28	<1.0	<1.1	<1.2	<1.1	0.004	0.003	0.017	0.006	1.04	<0.1	2.5	20.4	5.2	839	14.7	6.88	
BDC-05-07	5/18/2010	567	5.8	9.2	41	1.2	<1.1	<1.2	<1.1	0.009	0.003	0.009	<0.002	1.06	<0.5	2.0	16.4	6.0	525	14.8	6.77	
BDC-05-07	8/17/2010	658	2.8	7.8	19	<1.0	<1.1	<1.2	<1.1	0.006	0.003	0.008	<0.002	2.30	<0.1	2.5	8.6	7.1	-15	18.8	7.34	
BDC-05-07	11/9/2010	742	<1.0	9.4	20	<1.0	<1.1	<1.2	<1.1	0.008	0.005	0.009	<0.002	2.42	<0.1	2.2	15.2	5.1	13	15.2	7.35	
BDC-05-07	2/15/2011	840	<1.0	8.7	20	<1.0	<1.1	<1.2	<1.1	0.013	0.010	0.012	0.002	3.02	<0.1	2.8	11.8	5.1	21	14.0	7.16	
BDC-05-08	10/23/2008	-5	1.1	3.7	3.5	<0.2	<1.1	<1.2	<1.1	0.007	<0.001	0.004	<0.002	1.90	0.3	0.0	8.9	4.7	-12.0	5.07	6.65	
BDC-05-08	11/2/2008	5	1.1	3.4	4.2	<0.2	<1.1	<1.2	<1.1	0.035	0.004	0.036	<0.002	0.80	0.7	2.2	7.2	5.5	-43	5.85	6.63	
BDC-05-08	12/16/2008	49	1.2	4.3	4.3	<1.0	<1.1	1.2	<1.1	0.008	0.001	0.006	<0.002	0.50	0.9	4.6	21.8	3.6	-99	5.38	6.61	
BDC-05-08	1/16/2009	80	1.3	4.2	3.6	<1.0	<1.1	<1.2	<1.1	0.008	0.002	0.007	<0.002	0.25	1.7	3.0	7.0	6.9	-185	5.77	6.59	
BDC-05-08	2/11/2009	106	<1.0	3.2	3.9	<1.0	<1.1	<1.2	<1.1	0.019	0.001	0.010	<0.002	2.38	0.3	4.4	4.7	4.4	-78	7.01	6.69	
BDC-05-08	3/9/2009	132	<1.0	2.7	3.5	<1.0	<1.1	<1.2	<1.1	0.009	0.003	0.007	<0.002	0.07	<0.1	3.6	3.8	4.9	-4	6.70	6.65	
BDC-05-08	4/16/2009	170	<1.0	2.3	4.4	<1.0	<1.1	<1.2	<1.1	0.007	0.003	0.006	<0.002	0.42	<0.1	2.0	1.7	6.7	-8	6.83	6.80	
BDC-05-08	5/13/2009	197	<1.0	1.6	3.0	<1.0	<1.1	<1.2		0.009	0.003	0.007	0.002	1.77	<0.1	4.0	0.8	11.4	-13	6.03	6.87	
BDC-05-08	8/16/2009	292	<1.0	2.1	3.5	<1.0	<1.1	<1.2	<1.1	0.012	0.008	<0.002	<0.002	0.87	<0.1	2.8	5.3	13.2	-20	6.14	7.15	
BDC-05-08	11/13/2009	381	<1.0	1.2	3.1	<1.0	<1.1	<1.2	<1.1	0.011	0.008	0.007	<0.002	0.73	<0.1	2.8	3.3	17.4	0.8	8.41	6.44	
BDC-05-08	2/16/2010	476	<1.0	<1.0	2.3	<1.0	<1.1	<1.2	<1.1	0.024	0.009	0.024	<0.002	0.63	<0.1	3.0	0.8	13.1	841	8.25	6.76	
BDC-05-08	5/18/2010	567	<1.0	<1.0	2.4	<1.0	<1.1	<1.2	<1.1	0.031	0.011	0.027	<0.002	0.96	<0.1	3.0	0.8	14.9	451	7.30	6.92	
BDC-05-08	8/17/2010	658	<1.0	<1.0	2.3	<1.0	<1.1	<1.2	<1.1	0.014	0.009	0.013	<0.002	2.57	<0.1	3.2	0.5	10.1	-30	7.16	7.3	
BDC-05-08	11/9/2010	742	<1.0	<1.0	3.5	<1.0	<1.1	<1.2	<1.1	0.031	0.012	0.031	<0.002	2.74	<0.1	2.4	0.3	14.2	59	7.59	7.17	
BDC-05-08	2/15/2011	840	<1.0	<1.0	2.1	<1.0	<1.1	<1.2	<1.1	0.021	0.010	0.016	<0.002	2.36	<0.1	5.0	0.3	14.1	66	8.72	7.08	

PCE = Tetrachloroethene	Tot = Total
TCE = Trichloroethene	Dis = Dissolved
cDCE = cis-1,2-Dichloroethene	DO = Dissolved Oxygen
VC = Vinyl Chloride	ORP = Oxidation Reduction Potential
As = Arsenic	TOC = Total Organic Carbon
Cu = Copper	Blank = No sample collected or sample not analyzed for specified constituent.

Notes:
10/28/2008 injected in BDC-05-02

TABLE 3
DIRECT PUSH DATA
SWMU-17
BOEING DEVELOPMENTAL CENTER

			VOLATILES (µg/L) Method SW8260B/C				CONVENTIONALS (mg/L) Method EPA415.1
Location	Date	Depth to Center of Screen (ft BGS)	PCE	TCE	*c*DCE	VC	TOC
DPS17-1	4/9/2009	18.5	**23**	**26**	**16**	0.2 U	**3.08**
DPS17-1(28.5)	2/10/2011	28.5	0.2 U	0.2 U	0.2 U	0.2 U	**18.8**
DPS17-1(38.5)	2/10/2011	38.5	0.2 U	0.2 U	0.2 U	0.2 U	**20.6**
DPS17-2	4/9/2009	18.5	**0.6**	**2.8**	**2.0**	0.2 U	**3.28**
DPS17-3	4/9/2009	18.5	0.2 U	**0.8**	**3.3**	0.2 U	**4.25**
DPS17-4	4/9/2009	18.5	0.2 U	**0.6**	**8.2**	0.2 U	**6.43**
DPS17-5	4/9/2009	18.5	**0.9**	**2.1**	**0.7**	0.2 U	**1.94**
DPS17-6	4/9/2009	18.5	0.2 U	**3.3**	**11**	0.2 U	**2.80**
DPS17-7	4/9/2009	18.5	0.2 U	**1.9**	**19**	0.2 U	**10.3**
DPS17-8	8/18/2010	18.5	**31**	**55**	**10**	0.2 U	**4.88**
DPS17-9	8/18/2010	18.5	**1.0**	**3.0**	**5.5**	0.2 U	**4.21**
DPS17-10	8/18/2010	18.5	0.2 U	**1.0**	**1.1**	0.2 U	**5.04**
DPS17-11	8/18/2010	18.5	**1.3**	**1.6**	**0.4**	0.2 U	**4.18**
DPS17-12	8/18/2010	18.5	0.2 U	0.2 U	**0.2**	0.2 U	**5.76**
DPS17-13	8/18/2010	18.5	0.2 U	**0.6**	0.2 U	0.2 U	**2.33**
Dup of DPS17-13	8/18/2010	18.5	0.2 U	**0.6**	0.2 U	0.2 U	**2.29**
DPS17-14	8/18/2010	18.5	0.2 U	0.2 U	0.2 U	0.2 U	**5.80**
DPS17-15	8/18/2010	18.5	0.2 U	0.2 U	**0.4**	0.2 U	**5.76**
DPS17-16	8/18/2010	18.5	0.2 U	0.2 U	0.2 U	0.2 U	**5.00**
DPS17-17	8/18/2010	18.5	0.2 U	0.2 U	0.2 U	0.2 U	**6.19**
DPS17-18	8/18/2010	18.5	0.2 U	0.2 U	**0.3**	0.2 U	**3.62**
DPS17-19	10/8/2010	18.5	**56**	**48**	**51**	0.2 U	**5.89**
Dup of DPS17-19	10/8/2010	18.5	**53**	**47**	**47**	0.2 U	**4.88**
DPS17-19(28.5)	2/10/2011	28.5	0.2 U	0.2 U	0.2 U	0.2 U	**25.4**
DPS17-19(38.5)	2/10/2011	38.5	0.2 U	0.2 U	0.2 U	0.2 U	**24.2**
DPS17-20	10/8/2010	18.5	**3.6**	**12**	**15**	0.2 U	**3.81**
DPS17-21	10/8/2010	18.5	**20**	**21**	**16**	0.2 U	**3.57**
DPS17-22	10/8/2010	18.5	**20**	**45**	**70**	**0.7**	**5.89**
DPS17-23	10/25/2010	18.5	0.2 U	0.2 U	0.2 U	0.2 U	**6.85**
DPS17-24	10/25/2010	18.5	**35**	**37**	**11** J	0.2 U	**8.57**
Dup of DPS17-24	10/25/2010	18.5	**40**	**35**	**20** J	0.2 U	**7.47**
DPS17-25	10/25/2010	18.5	**41**	**36**	**21**	0.2 U	**8.54**
DPS17-26	10/25/2010	18.5	**2.3**	**12**	**22**	**0.5**	**4.83**
DPS17-27	10/25/2010	18.5	**3.1**	0.2 U	**0.2**	0.2 U	**5.31**
DPS17-28	10/25/2010	18.5	0.2 U	0.2 U	0.2 U	0.2 U	**5.71**
DPS17-29	12/7/2010	18.5	**1.8**	**6.9**	**14**	**2.5**	**5.05**
DPS17-30	12/7/2010	18.5	0.2 U	0.2 U	0.2 U	0.2 U	**5.23**
DPS17-31	12/7/2010	18.5	0.2 U	**2.1**	**0.5**	0.2 U	**2.14**
DPS17-32	12/7/2010	18.5	0.2 U	0.2 U	0.2 U	0.2 U	**7.98**
DPS17-33	12/7/2010	18.5	0.2 U	0.2 U	0.2 U	0.2 U	**5.87**
DPS17-35	12/7/2010	18.5	0.2 U	**0.2**	**1.4**	**1.0**	**9.09**
DPS17-36	12/7/2010	18.5	**19**	**28**	**26**	0.2 U	**8.98**
DPS17-36(28.5)	2/9/2011	28.5	0.2 U	**0.3**	**2.3**	0.2 U	
Dup of DPS17-36(28.5)	2/9/2011	28.5	**0.2**	**0.3**	**2.4**	0.2 U	
DPS17-36(38.5)	2/9/2011	38.5	0.2 U	0.2 U	0.2 U	0.2 U	
DPS17-37	12/8/2010	18.5	**0.8**	**8.1**	**11**	0.2 U	**10.2**
DPS17-38	12/8/2010	18.5	0.2 U	0.2 U	**0.7**	**0.3**	**7.42**
DPS17-39	12/8/2010	18.5	0.2 U	**0.8**	**4.5**	**0.6**	**7.23**
DPS17-40	12/8/2010	18.5	0.2 U	**1.8**	**8.1**	**2.7**	**5.45**
DPS17-41	12/7/2010	18.5	**17**	**24**	**3.8**	0.2 U	**4.44**
DPS17-42	12/8/2010	18.5	**14**	**24**	**8.4**	0.2 U	**11.9**

TABLE 3
DIRECT PUSH DATA
SWMU-17
BOEING DEVELOPMENTAL CENTER

			VOLATILES (µg/L) Method SW8260B/C				CONVENTIONALS (mg/L) Method EPA415.1
Location	Date	Depth to Center of Screen (ft BGS)	PCE	TCE	*c*DCE	VC	TOC
DPS17-43	12/8/2010	18.5	**1.9**	**5.7**	**1.9**	0.2 U	**8.64**
DPS17-44	12/8/2010	18.5	**0.4**	**7.6**	**20**	**8.2**	**4.88**
DPS17-45	12/8/2010	18.5	**2.7**	**7.2**	**27**	**0.3**	**9.38**
Dup of DPS17-45	12/8/2010	18.5	**2.9**	**7.5**	**27**	**0.3**	**10.7**
DPS17-46	12/8/2010	18.5	**0.4**	**1.9**	**6.1**	0.2 U	**14.8**
DPS17-47	12/8/2010	18.5	**1.6**	**4.1**	**4.7**	0.2 U	**12.5**
DPS17-48	12/8/2010	18.5	**1.3**	**6.6**	**8.5**	**2.9**	**4.89**
DPS17-49	12/8/2010	18.5	**11**	**13**	**4.5**	0.2 U	**7.71**
DPS17-50	2/9/2011	18.5	0.2 U	**0.8**	**1.1**	0.2 U	
DPS17-51	2/9/2011	18.5	**6.2**	**19**	**18**	0.2 U	
Dup of DPS17-51	2/9/2011	18.5	**6.3**	**20**	**17**	0.2 U	
DPS17-52	2/8/2011	18.5	**1.0**	**8.4**	**12**	0.2 U	
DPS17-53	2/8/2011	18.5	0.2 U	0.2 U	0.2 U	0.2 U	
DPS17-54	2/8/2011	18.5	0.2 U	**0.3**	**2.0**	**4.9**	
DPS17-55	2/8/2011	18.5	0.2 U	**0.6**	**2.8**	**1.7**	
DPS17-56	2/8/2011	18.5	0.2 U	0.2 U	**0.3**	0.2 U	
DPS17-57	2/8/2011	18.5	0.2 U	**0.7**	**8.7**	0.2 U	
DPS17-58	2/8/2011	18.5	0.2 U	**1.4**	**7.1**	**0.3**	
DPS17-59	2/8/2011	18.5	0.2 U	**1.1**	**5.6**	0.2 U	
DPS17-60	2/9/2011	18.5	0.2 U	**2.0**	**12**	0.2 U	
DPS17-61	2/9/2011	18.5	0.2 U	**2.3**	**10**	0.2 U	
DPS17-62	2/9/2011	16.5	0.2 U	**1.4**	**8.8**	0.2 U	
DPS17-63	2/9/2011	16.5	0.2 U	0.2 U	**0.3**	0.2 U	
DPS17-64	2/9/2011	16.5	0.2 U	0.2 U	0.2 U	0.2 U	
DPS17-65	2/8/2011	16.5	0.2 U	**0.3**	**0.2**	0.2 U	
DPS17-66	2/8/2011	16.5	0.2 U	0.2 U	0.2 U	0.2 U	
DPS17-67	3/17/2011	18.5	0.2 U	**0.9**	**12**	**1.4**	
Dup of DPS17-67	3/17/2011	18.5	0.2 U	**0.8**	**10**	**1.2**	
DPS17-68	3/17/2011	18.5	0.2 U	**2.3**	**8.3**	0.2 U	
DPS17-69	3/17/2011	18.5	0.2 U	**1.7**	**8.2**	0.2 U	
DPS17-70	3/17/2011	18.5	0.2 U	**0.8**	**8.6**	0.2 U	
DPS17-71	3/17/2011	18.5	0.2 U	**0.5**	**5.2**	0.2 U	
DPS17-72	3/17/2011	18.5	0.2 U	**0.2**	0.2 U	0.2 U	
DPS17-73	3/17/2011	18.5	**0.3**	**0.6**	**0.8**	0.2 U	
DPS17-74	3/17/2011	18.5	**0.3**	**0.5**	**0.5**	0.2 U	
DPS17-75	3/17/2011	18.5	**0.4**	**0.6**	**0.5**	0.2 U	

U = Indicates the compound was undetected at the reported concentration.
J = Indicates the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
Bold = Detected compound.
Blank = Sample not analyzed for specified constituent.
DPS17-1 through DPS17-7 and DPS17-50 through DPS17-75 used 4 ft screens.
DPS17-8 through DPS17-49 used 3 ft screens.

TABLE 4
BIOREMEDIATION GROUNDWATER MONITORING MATRIX
SMWU-17 - BOEING DEVELOPMENTAL CENTER

BDC-05-	Baseline	Quarterly	Semiannual	Explanation
Injection Wells				
02	(a) (b) (c)	(a) (c)	(a) (b) (c)	existing well
07	(a) (b) (c)		(a) (b) (c)	existing well
09	(a) (b) (c)		(a) (b) (c)	new well
10	(a) (b) (c)		(a) (b) (c)	new well
11	(a) (b) (c)		(a) (b) (c)	new well
12	(a) (b) (c)	(a) (c)	(a) (b) (c)	new well
13	(a) (b) (c)		(a) (b) (c)	new well
14	(a) (b) (c)		(a) (b) (c)	new well
15	(a) (b) (c)		(a) (b) (c)	new well
16	(a) (b) (c)	(a) (c)	(a) (b) (c)	new well
17	(a) (b) (c)		(a) (b) (c)	new well
Monitoring Wells				
03	existing data		(a) (b)	existing monitoring well
04	existing data		(a) (b)	existing monitoring well
05	existing data		(a) (b)	existing monitoring well
08	existing data		(a) (b)	existing monitoring well
18	(a) (b) (c)	(a) (c)	(a) (b) (c)	new core of plume well
19	(a) (b) (c)	(a) (c)	(a) (b) (c)	new core of plume well
20	(a) (b) (c)	(a) (c)	(a) (b) (c)	new downgradient well
21	(a) (b) (c)	(a)	(a) (b)	new downgradient well
22	(a) (b) (c)	(a)	(a) (b)	new downgradient well
23	(a) (b) (c)	(a)	(a) (b)	new downgradient well
24	(a) (b) (c)	(a)	(a) (b)	new crossgradient well

(a) Laboratory Parameters (method): VOC Short List (8260) - PCE, TCE, cDCE, VC; TOC (415.1); Sulfate/Nitrate (E300);
Field Parameters: Fe2; pH, DO, ORP, Temp.
(b) Laboratory Parameters (method): total (nonfiltered) and dissolved (field filtered) Cu (3010A) and As (200.8 ICP-MS).
(c) Laboratory Parameters (method): Methane/Ethane/Ethene/Acetylene (RSK-175).

TABLE 5
PERFORMANCE MONITORING PARAMETERS
SWMU-17
BOEING DEVELOPMENTAL CENTER

Field Parameters	Information Provided
Dissolved Oxygen (DO) [field meter and single-use reactive ampoules] (a)	Aquifer is considered anaerobic at DO concentrations less than 1.0 mg/L.
Oxidation Reduction Potential (Redox) [field meter] (a)	Negative values indicate reducing conditions.
pH [field meter] (a)	Optimum conditions for biological activity is within the range of 6 to 8. May decrease due to injected donor. Considered acceptable for reductive dechlorination when greater than 4 at injection wells and greater than 5 at monitoring wells (b)
Ferrous Iron [Hach test kit]	Concentrations above background indicate iron-reducing conditions.

Laboratory Analyses	Information Provided
Volatile Organic Compounds (VOCs) (c) [Method 8260] [3-40 mL VOA-HCl] (d) [Holding time - 14 days]	Concentrations of chlorinated VOCs and breakdown products are indicative of reductive dechlorination and pathways.
Ethene/Ethane/Methane/Acetylene [RSK SOP 175 MOD] [2-40 ml VOA] (d) [Holding time - 14 days]	Concentrations of ethene and ethane are indicative of reductive dechlorination and pathways. Increasing methane concentrations indicate methanogenic conditions. Increasing acetylene indicates abiotic destruction of TCE and cDCE through contact with iron sulfides.
Total Organic Carbon (TOC) [Method 415.1] [250 mL Amber-H_2SO_4] [Holding time - 14 days]	Will increase due to arrival of volatile fatty acids released from injected sodium lactate and vegetable oil.
Nitrate (e) [IC Method E300] [500 mL poly] [Holding time - 48 hours]	Concentrations below background indicate nitrate-reducing conditions.
Sulfate [IC Method E300] [500 mL poly] [Holding time - 28 days]	Concentrations below background indicate sulfate-reducing conditions that may result from depletion of nitrate.
Total and Dissolved Copper [Method EPA 200.8] [1 500 mL HDPE-HNO_3] [Holding time - 6 months]	Concentrations of total and dissolved copper will inform potential future actions related to metals at SWMU-17.
Total and Dissolved Arsenic [Method EPA 200.8] [1 500 mL HDPE-HNO_3] [Holding time - 6 months]	Concentrations of total and dissolved arsenic will inform potential future actions related to metals at SWMU-17.

(a) Measured using a flow-through cell.
(b) Suthersan, S.S., C.C. Lutes, P.L. Palmer, F. Lenzo, F.C. Payne, D.S. Liles, and J. Burdick. 2002. *Final Technical Protocol for Using Soluble Carbohydrates to Enhance Reductive Dechlorination of Chlorinated Aliphatic Hydrocarbons. Submitted to ESTCP and AFCEE under Contract #41624-99-C-8032* . December 19.
(c) Abbreviated list consisting of PCE, TCE, *c* DCE, and vinyl chloride.
(d) Care to be taken during sample collection to minimize aeration and volatilization. Sample collected with no headspace.
(e) Nitrate sample can be combined with sulfate sample; nitrate analysis must be performed within 48-hour holding time.

APPENDIX A

Health and Safety Plan

WORK LOCATION PERSONNEL PROTECTION AND SAFETY EVALUATION FORM

Attach Pertinent Documents/Data
Fill in Blanks As Appropriate

Job No.:	025093.111.030		
Prepared by:	Martin Valeri	Reviewed by:	Clint Jacob
Date:	April 12, 2011	Date:	April 29, 2011

A. WORK LOCATION DESCRIPTION

1. **Project Name:** Boeing SWMU-17, Bioremediation
2. **Location:** 9725 East Marginal Way S., Tukwila, Washington
3. **Anticipated Activities:** Drilling, well installation, groundwater sampling, and injection of vegetable oil and ethyl lactate
4. **Surrounding Population:** Industrial
5. **Buildings/Homes/Industry:** Industrial buildings, office buildings
6. **Topography:** Mostly flat river valley bottom
7. **Anticipated Weather:** Partly clear, 35º to 80º F
8. **Unusual Features:** N/A
9. **Site History:** Site is a portion of Boeing Developmental Center, with PCE, copper, and arsenic present in groundwater at concentrations above site screening levels. TCE and *c*DCE are also present in site groundwater.

B. HAZARD DESCRIPTION

1. Background Review: ☒ Complete ☐ Partial

If partial, why?

2. Hazardous Level: ☐ B ☐ C ☒ D ☐ Unknown

Justification: Site monitoring results indicate groundwater concentrations as high as 56 µg/L PCE, 62 µg/L TCE, 0.046 mg/L total arsenic, and 0.036 mg/L total copper.

3. Types of Hazards: (Attach additional sheets as necessary)

A. ☒ Chemical ☒ Inhalation ☐ Explosive
☐ Biological ☒ Ingestion ☐ O_2 Def. ☒ Skin Contact

Describe: Direct contact with contaminated soil or groundwater; accidental ingestion of contaminated soil or groundwater; or inhalation of vapors during drilling, sampling, and injection.

B. ☒ Physical ☒ Cold Stress ☒ Noise ☒ Heat Stress ☒ Other

Describe: Noise and physical hazards associated with working around a drill rig. Hazards associated with working with pressurized hoses during injection. Cold stress conditions related to exposure. Noise from running injection pump.

C. ☐ Radiation

Describe: NA

4. Nature of Hazards:

☒ Air — Describe: Inhalation of vapors during drilling and sampling.

☒ Soil — Describe: Potential for contact with or ingestion of contaminated soil during drilling and installation of wells.

☐ Surface Water — Describe: NA

☒ Groundwater — Describe: Direct contact with or ingestion of contaminated groundwater.

☐ Other — Describe: NA

5. Chemical Contaminants of Concern ☐ N/A

Contaminant	PEL	I.D.L.H.	Source/Quantity Characteristics	Route of Exposure	Symptoms of Acute Exposure	Instruments Used to Monitor Contaminant
Tetrachloroethene	25 ppm	150 ppm	Present in groundwater and possibly soil	Inhalation, ingestion, dermal/eye contact	Eye, skin, nose, throat, and respiratory system irritation; nausea; flush face, neck; dizziness, incoordination; headache, drowsiness; skin redness	PID
Trichloroethene	50 ppm	1,000 ppm	Present in groundwater and possibly soil	Inhalation, ingestion, dermal/eye contact	Eye and skin irritation; headache; visual disturbance; weakness, dizziness, tremors, drowsiness; nausea; vomiting; dermatitis; cardiac arrhythmias, numbness	PID
cis-1,2-dichloroethene	200 ppm	1,000 ppm	Present in groundwater and possibly soil	Inhalation, ingestion, dermal/eye contact	Eye and respiratory system irritation; central nervous system depression	PID
Vinyl Chloride	1 ppm	Unknown (carcinogen)	Not currently present in groundwater; may develop as a result of treatment	Inhalation, ingestion, dermal/eye contact	Weakness; abdominal pain; pallor or cyanosis of extremities	PID
Copper	1 mg/m^3	100 mg/m^3	Present in groundwater and possibly soil	Inhalation (dust), ingestion, dermal/eye contact	Eye, nose, and throat irritation; nasal septum perforation; metallic taste; dermatitis	Visual (Dust)
Arsenic	0.010 mg/m^3	5 mg/m^3	Present in groundwater and possibly soil	Inhalation (dust), ingestion, dermal/eye contact	Ulceration of nasal septum, dermatitis, gastrointestinal disturbances, peripheral neuropathy, respiratory irritation, hyperpigmentation of skin	Visual (Dust)

*

6. Physical Hazards of Concern ☐ N/A

Hazard	Description	Location	Procedures Used to Monitor Hazard
Hazards associated with pressurized hoses	Injection of groundwater and electron donor amendment (vegetable oil and ethyl lactate)	Area of injection wells	Personnel will observe pressure and make sure it is low before disconnecting hoses.
Moving parts of drill rig, falling and flying objects	Drilling and installation of wells	Near drill rig	Alert observation of surroundings; minimize time spent near drill rig; no loose clothing; use of safety glasses, hard hat, and steel-toe boots.
Vehicles and heavy equipment used at the site	Any activity	Any area	Alert observation of surroundings.
Cold Stress	Any activity	Any area	Wear warm clothing. Observe for hypothermia and frostbite.

7. Work Location Instrument Readings ☐ N/A

Location: ____________________

Percent O_2: ____________________ Percent LEL: ____________________

Radioactivity: ____________________ PID: ____________________

FID: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Location: ____________________

Percent O_2: ____________________ Percent LEL: ____________________

Radioactivity: ____________________ PID: ____________________

FID: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Location: ____________________

Percent O_2: ____________________ Percent LEL: ____________________

Radioactivity: ____________________ PID: ____________________

FID: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Location: ____________________

Percent O_2: ____________________ Percent LEL: ____________________

Radioactivity: ____________________ PID: ____________________

FID: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

Other: ____________________ Other: ____________________

8. Hazards Expected In Preparation For Work Assignment ☒ N/A

Describe:

C. PERSONAL PROTECTIVE EQUIPMENT

1. Level of Protection

Primary: ☐ A ☐ B ☐ C ☒ D

Upgrade: ☐ A ☐ B ☐ C ☒ D modified

Location/Activity: All locations; upgrade to Level D modified (half-face respirator with organic vapor/HEPA cartridge) if air monitoring VOC action levels are exceeded.

2. Protective Equipment (specify probable quantity required)

Respirator ☐ N/A

☐ SCBA, Airline

☐ Full-Face Respirator

☒ Half-Face Respirator (Cart. organic vapor/HEPA) (Only if upgrade to Level C or D modified)

☐ Escape mask

☐ None

☐ Other:

☐ Other:

Clothing ☐ N/A

☐ Fully Encapsulating Suit

☐ Chemically Resistant Splash Suit

☐ Apron, Specify:

☐ Tyvek Coverall

☐ Saranex Coverall

☐ Coverall, Specify

☒ Other: Dedicated field clothing

Head & Eye ☐ N/A

☒ Hard Hat (around drill rig)

☐ Goggles

☐ Face Shield

☒ Safety Eyeglasses (around drill rig)

☒ Other: Ear muffs or plugs (around drill rig)

Hand Protection ☐ N/A

☒ Undergloves; Type: nitrile/neoprene

☐ Gloves; Type:

☐ Overgloves; Type:

☐ None

☐ Other:

Foot Protection ☐ N/A

☐ Neoprene Safety Boots with Steel Toe/Shank

☐ Disposable Overboots

☒ Other: Steel-toe boots

3. Monitoring Equipment ☐ N/A

☐ CGI

☐ O_2 Meter

☐ Rad Survey

☐ Detector Tubes (optional)

Type:

☒ PID

☐ FID

☐ Other:

D. PERSONNEL DECONTAMINATION

☒ Required (soap and water – hands) ☐ Not Required

EQUIPMENT DECONTAMINATION

☒ Required ☐ Not Required

If required, describe and list equipment:

All non-dedicated water sampling equipment will be washed with Alconox soap and rinsed with tap water.

E. PERSONNEL

	Name	Work Location Title/Task	Medical Current	Fit Test Current
1.	**Martin Valeri**	Drilling, Injection, and Groundwater sampling	☒	☒
2.	**Christophe Venot**	Drilling, Injection, and Groundwater sampling	☒	☒
3.	**Alan Starr**	Drilling, Injection, and Groundwater sampling	☒	☒
4.	**Susan Dickerson**	Drilling, Injection, and Groundwater sampling	☒	☒
5.	**Dylan Frazer**	Drilling, Injection, and Groundwater sampling	☒	☒
6.			☐	☐
7.			☐	☐
8.			☐	☐
9.			☐	☐
10.			☐	☐

Site Safety Coordinator: Martin Valeri

F. ACTIVITIES COVERED UNDER THIS PLAN

Task No.	Description	Preliminary Schedule
1	Drilling and well installation	June 2011
2	Groundwater sampling	July 2011 and ongoing
3	Injection to monitoring wells	August/September 2011 and ongoing

G. SUBCONTRACTOR'S HEALTH AND SAFETY PROGRAM EVALUATION

☐ N/A

Name and Address of Subcontractor: Cascade Drilling
PO Box 1184
Woodinville, WA 98072

EVALUATION CRITERIA

Item	Adequate	Inadequate	Comments
Medical Surveillance Program	☒	☐	
Personal Protective Equipment Availability	☒	☐	
Onsite Monitoring Equipment Availability	☒	☐	
Safe Working Procedures Specification	☒	☐	
Training Protocols	☒	☐	
Ancillary Support Procedures (if any)	☒	☐	
Emergency Procedures	☒	☐	
Evacuation Procedures Contingency Plan	☒	☐	
Decontamination Procedures Equipment	☒	☐	
Decontamination Procedures Personnel	☒	☐	

GENERAL HEALTH AND SAFETY PROGRAM EVALUATION: ☒ Adequate ☐ Inadequate

Additional Comments: Review based on previous experience with contractor and contractor's experience at the site.

Evaluation Conducted By: Clint Jacob Date: 4/29/11

EMERGENCY FACILITIES AND NUMBERS

Hospital: Harborview Medical Center
325 9th Avenue
Seattle, WA
206-731-3000

Directions: Exit at front gate and turn left onto E. Marginal Way S. Go southeast on E. Marginal Way S towards S NORFOLK ST. Turn LEFT onto S BOEING ACCESS RD. Merge onto I-5 N toward SEATTLE. Take the DEARBORN ST. / JAMES ST. exit- EXIT 164A- toward MADISON ST. Take the JAMES ST exit. Turn RIGHT onto JAMES ST. Turn right onto 9th AVE. The ER is on the corner of 9th and Jefferson. (See route map on next page)

Telephone: Field technician will maintain a mobile phone.

Emergency Transportation Systems (Fire, Police, Ambulance) – (206)655-2222

Emergency Contacts:

Poison Control Center: 526-2121

Landau Project Manager: 425-778-0907
Boeing Environmental Affairs (Jim Bet): 425-865-5348

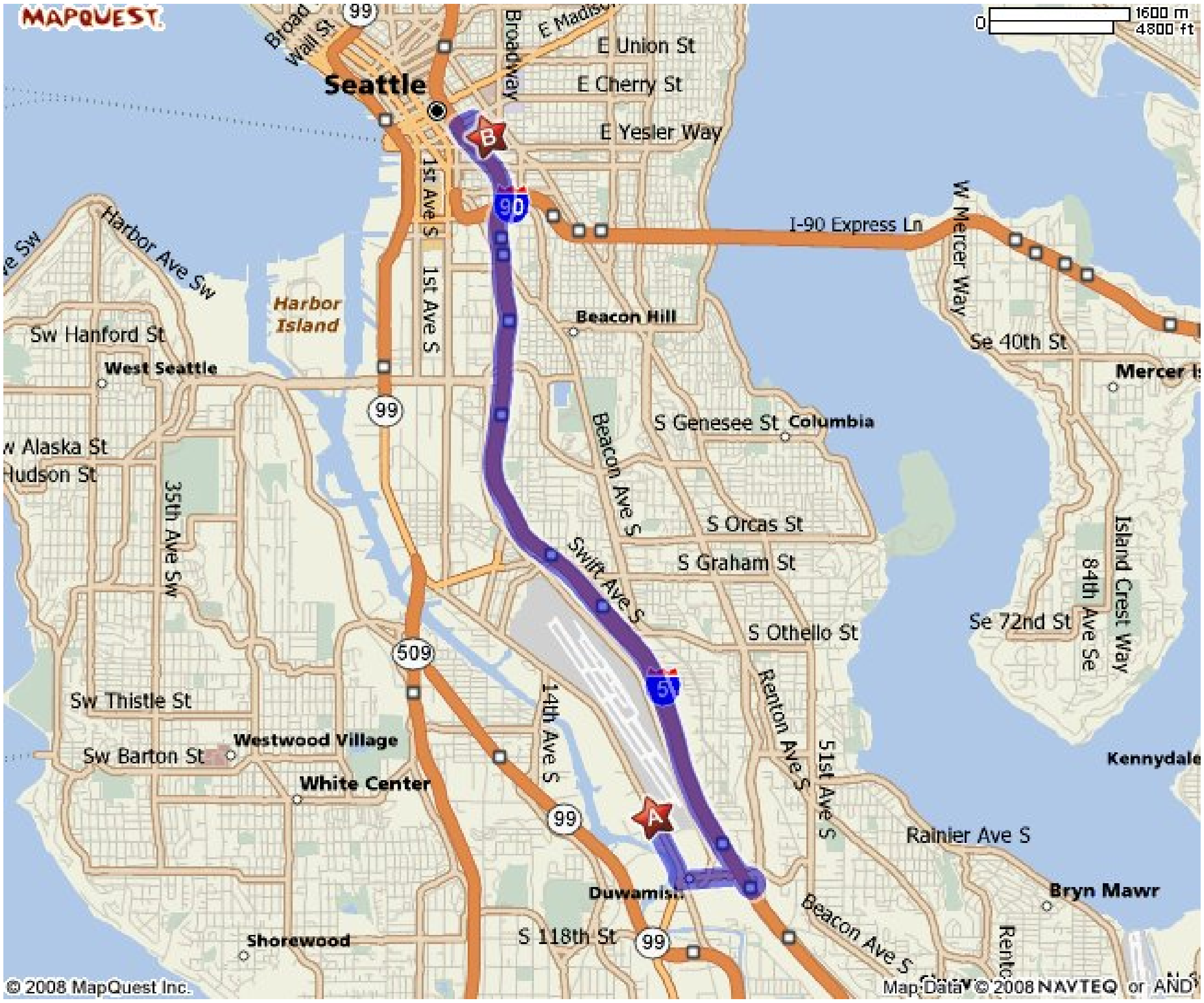
<u>In the event of an emergency, do the following:</u>

1. Call for help as soon as possible. Call Boeing Emergency at (206)655-2222. Give the following information:
   - WHERE the emergency is – use building numbers and other landmarks
   - PHONE NUMBER you are calling from
   - WHAT HAPPENED – type of injury
   - WHAT is being done for the victim(s)
   - YOU HANG UP LAST – let the person you called hang up first.

2. If the victim can be moved, paramedics will transport to the hospital. If the injury or exposure is not life threatening, decontaminate the individual first. If decontamination is not feasible, wrap the individual in a blanket or sheet of plastic prior to transport.

3. Notify Landau Associates project manager.

4. Notify Boeing Environmental Affairs.



MAPQUEST
Seattle
E Union St
E Cherry St
E Yesler Way
Broadway
1st Ave S
I-90 Express Ln
W Mercer Way
Harbor Ave Sw
Harbor Island
Sw Hanford St
West Seattle
Beacon Hill
Se 40th St
S Genesee St
Columbia
Beacon Ave S
S Orcas St
S Graham St
Swift Ave S
S Othello St
35th Ave Sw
Se 72nd St
84th Ave Se
Island Crest Way
Sw Thistle St
Sw Barton St
Westwood Village
White Center
14th Ave S
Renton Ave S
51st Ave S
Kennydale
Rainier Ave S
Duwamish
Bryn Mawr
S 118th St
Shorewood
Beacon Ave S
© 2008 MapQuest Inc.
Map Data © 2008 NAVTEQ
1600 m
4800 ft

HEALTH AND SAFETY PLAN
APPROVAL/SIGN OFF FORMAT

I have read, understood, and agreed with the information set forth in this Health and Safety Plan (and attachments) and discussed in the Personnel Health and Safety briefing.

Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Project Manager	Signature	Date

Personnel Health and Safety Briefing Conducted By:

Name	Signature	Date

ATTACHMENT A

ACTION LEVELS FOR RESPIRATORY PROTECTION

Monitoring Parameter	Reading	Level of Protection
Organic vapors	PID reading >20 ppm in breathing zone for more than 20 minutes.	Evacuate area, use institutional control or upgrade to Level D modified.
Organic vapors	PID reading >35 ppm for momentary peak.	Evacuate area, use institutional control or upgrade to Level D modified.
Dust	Visual Dust	Wet cuttings at drill auger to prevent dust generation.

APPENDIX E

2017 Technical Memorandum Re: Addendum No. 1, SWMU-17 Remedial Action Work Plan, Enhanced Anaerobic Bioremediation

Technical Memorandum

TO: Carl Bach, The Boeing Company

FROM: Clint Jacob, PE, LG

DATE: October 18, 2017

RE: **Addendum No. 1 – Revised**
SWMU-17 Remedial Action Work Plan
Enhanced Anaerobic Bioremediation
Boeing Developmental Center
Tukwila, Washington
Project No. 0025093.117

Introduction

This document presents an addendum to the remedial action work plan for full-scale bioremediation at Solid Waste Management Unit (SWMU)-17 at The Boeing Company (Boeing) Developmental Center (DC). The DC is located at 9725 East Marginal Way South, Tukwila, Washington (Figure 1). The DC formerly operated as an interim status Treatment, Storage, and Disposal Facility under the Resource Conservation and Recovery Act (RCRA) with a facility identification number of WAD 093 639 946. Currently the site is operated as a generator only facility (waste accumulation less than 90 days). The Washington State Department of Ecology (Ecology) is authorized by the US Environmental Protection Agency (EPA) to implement RCRA corrective action through its Model Toxics Control Act (MTCA) regulations. Boeing is performing remedial actions at the DC under Ecology's voluntary cleanup program (VCP).

This addendum (Addendum No. 1) to the work plan (LAI 2011) describes additional electron donor injection to selected SMWU-17 wells in areas where further treatment is desired. The goal of the injection program is to continue treating source area tetrachloroethene (PCE) and trichloroethene (TCE) concentrations in order to reduce downgradient vinyl chloride (VC) concentrations. A sugar solution will be injected to selected wells to stimulate further reductive dechlorination of PCE/TCE and breakdown products as a follow up to a prior electron donor injection in 2011. Groundwater monitoring data will be used to evaluate contaminant reduction, availability and longevity of injected donor, and aquifer oxidation-reduction (redox) conditions. Activities described in this work plan will be performed in general accordance with the procedures provided in the work plan, including the Health and Safety Plan (work plan Appendix A).

Background

This section provides an overview of prior bioremediation injection activities and results in SWMU-17. Additional background regarding contamination in SWMU-17, prior pilot testing, remedial approach, and baseline conditions is presented in the work plan and is not repeated in this addendum.

A combination of vegetable oil and lactate electron donor solution was injected into 11 wells in August 2011. Each of the 11 wells (BDC-05-02, BDC-05-07, and BDC-05-09 through BDC-05-17) was injected with approximately 5,600 gallons of donor injection fluid, targeting an 11-foot radius of injection (ROI). Injection volume at each well consisted of approximately 5,300 gallons of potable water from an onsite hydrant, 320 gallons of LactOil™ donor substrate, and 2 pounds (lbs) of yeast extract; this corresponds to a LactOil concentration of 5.7 percent by volume. A total of 66,800 gallons was injected, including clear flush water. LactOil is a combination donor substrate containing both soluble (fast-release) ethyl lactate and low-solubility (slow-release) soybean oil. SWMU-17 injection wells (IWs) and monitoring wells (MWs) are shown on Figure 2. No further injection has been performed since 2011.

Post-injection monitoring indicates that bioremediation had been substantially enhanced due to the 2011 electron donor injection (LAI 2017a). Monitoring data provided "direct evidence" of biodegradation of PCE, TCE, and breakdown products at 16 of 22 monitored wells, including the 11 IWs and 5 downgradient or crossgradient MWs. Direct evidence consisted of elevated total organic carbon (TOC); more highly reduced aquifer redox conditions; and changes in concentrations of PCE, TCE, or breakdown products. Increases in one or more breakdown or end products (cis-1,2-dichloroethene [cDCE], VC, and ethene) were observed at all IWs following injection. Bioremediation was substantially enhanced at the farthest downgradient well (BDC-05-23 at 170 feet [ft] downgradient) and up to 30 ft crossgradient of IWs at MW BDC-05-21. Five additional MWs showed "some evidence" of enhanced bioremediation consisting of elevated TOC or a change in concentrations of PCE, TCE, or breakdown products, but not both indicators; "some evidence" of bioremediation occurred at MWs located up to 48 ft crossgradient (BDC-05-22) of IWs. Only BDC-05-05, which is upgradient of the injection and not expected to be affected, has shown no evidence of enhanced bioremediation. Monitoring results for February and May 2017 were documented in the most recent semiannual report for the site (LAI 2017b).

During the February through August 2017 sampling events, PCE, TCE, cDCE, and VC concentrations were below proposed cleanup levels (CULs) at all but three wells. TCE concentrations at BDC-05-02 and BDC-05-18, ranged from 1.6 to 4.6 micrograms per liter (μg/L), which exceed the proposed CUL (1.4 μg/L). VC at well BDC-05-09 (2.8 μg/L in May) was just above the proposed CUL (2.4 μg/L). Complete reductive dechlorination beyond VC continues, as indicated by end products ethene and/or ethane, which were detected and predominant on a molar basis at 14 of 17 wells analyzed in May 2017. Cumulative data is presented in Table 1.

May 2017 data also indicated a continuation of the highly reduced aquifer redox conditions required for complete dechlorination, despite TOC having decreased to near background levels at most wells. Low sulfate and elevated concentrations of methane persisted at most wells. TOC at IWs ranged from 1.7 to 24 milligrams per liter (mg/L).

Proposed CULs for the DC were presented in a prior document (LAI 2013). Proposed site CULs for these VOC contaminants are as follows:

- PCE 5.3 µg/L
- TCE 1.4 µg/L
- cDCE 134 µg/L
- VC 2.4 µg/L

However, Boeing's goal is to adopt DC CULs that are consistent with final CULs for other Duwamish sites, which have not yet been determined. It is expected that final TCE and VC CULs may be lower than proposed CULs.

Electron Donor Injection

Additional electron donor injection will be performed at a total of five wells. This injection is to focus additional treatment in the source area where PCE and/or TCE concentrations were detected greater than 1 µg/L in 2017.

Target Areas

The five wells with detections of PCE and/or TCE greater than 1 µg/L from January through August 2017 will be injected. These five wells are located near the head (east end) of the plume. These wells are described below and shown on Figure 3; detections of PCE and TCE greater than 1 µg/L in 2017 are indicated:

- BDC-05-02 (4.2 µg/L PCE, 2.5 µg/L TCE)
- BDC-05-03(1.4 µg/L PCE)
- BDC-05-04 (1.2 µg/L PCE)
- BDC-05-07 (1.2 µg/L PCE)
- BDC-05-10 (targets treatment at nearby well BDC-05-18 (3.6 µg/L PCE, 4.6 µg/L TCE), which is closer to the storm drain and, therefore, less favorable for a direct injection of electron donor).

Electron donor injection is intended to stimulate additional treatment at near IWs and downgradient where lower concentrations of VC are present. VC concentrations for January through August 2017 ranged from 0.2 to 2.8 µg/L.

Two of these wells (BDC-05-03 and BDC-05-04) were not injected in 2011, but were used for monitoring only; these two wells will be added to the Underground Injection Control (UIC) registration for the site. The remaining three wells to be injected were previously injected in 2011 and are included in the existing UIC registration

Donor and Injection Volume

The electron donor substrate for this injection will be sugar in the form of molasses. Sugar is a completely soluble electron donor, unlike the low-solubility, slow-release vegetable oil component of LactOil used for the prior injection at SMWU-17. Molasses, containing approximately 79.5 percent sugar (i.e., 79.5 degrees Brix), will be diluted with water to create an injection fluid with approximately 8 percent sugar by weight. An approximate total of 35,300 lbs of molasses will be injected to the five wells. Molasses will be delivered in a tank truck and offloaded to an onsite 4,000-gallon Baker Tank.

The previous use of both fast release (soluble) lactate and slow-release (insoluble) vegetable oil contained in LactOil was intended to optimize the distribution and longevity of the injected donor for extended treatment. The optimization occurs because the lactate component is soluble and transported further downgradient, while vegetable oil, which is insoluble, moves a shorter distance from the wells and ferments more slowly to provide a longer term source of donor to aquifer bacteria. Generally, combined use of soluble and insoluble donor is a beneficial strategy to extend the treatment period between injection events. However, long persistence of electron donor is not desired for this injection event occurring near the end of anticipated treatment. The use of soluble sugar should result in the desired focused treatment of residual mass without persistent elevated TOC concentrations over time, which could delay the use of wells as monitoring points for compliance monitoring and closure of SWMU-17.

The design volume of injection fluid delivered to each well will be similar to injection volumes utilized during the prior injection. Each well will receive 6,000 gallons of donor injection fluid based on a desired ROI of approximately 12 ft.

Ferrous chloride ($FeCl_2$) will be added to the injection fluid to form iron sulfides in the aquifer that are beneficial for abiotic degradation (i.e., reductive elimination) of PCE, TCE, and cDCE (Kennedy et al. 2006). According to manufacture specifications, the molasses product (Cincinnati Can e 2007) contains 0.49 percent sulfur in the form of sulfate. Therefore, the design quantity of molasses contains 516 lbs (114 moles) of sulfate. A nearly equivalent molar mass of ferrous iron (105 moles) will be added in the form of three drums (1,890 lbs) of 33 percent $FeCl_2$ solution. The sulfate from the molasses will be biologically reduced in the aquifer to sulfide, which will complex with provided ferrous iron and naturally occurring ferrous iron to form iron sulfide precipitates within the aquifer matrix. Abiotic destruction occurs through chemical reaction between the iron sulfides and PCE, TCE, and cDCE. Degradation of these chlorinated compounds results in the non-toxic intermediaries dichloroacetylene, chloroacetylene, and acetylene, which are unstable compounds that break down quickly to ethene and carbon dioxide. Due to high reactivity, acetylene is detected infrequently or at low concentrations even when reductive elimination is occurring. This abiotic destruction mechanism is complimentary and occurs concurrently with biological (i.e., biotic) reductive dechlorination of TCE.

Addition of ferrous iron will also prevent the accumulation of sulfide which can be inhibitory to reductive dechlorination (Parsons 2004)

Yeast extract will be added to provide micronutrients for bacterial function. Yeast extract will be added at 1 lb per 1,000 gallons, for a total of 58 lbs injected.

Injection Procedures

A flush of approximately 100 to 200 gallons of hydrant water will precede and follow injection of the batch of donor solution at each well. The yeast extract will be added to the pre-injection flush instead of mixing yeast extract with the batch of water and sugar[1]. Flushing the well and sandpack after donor injection will minimize biofouling.

$FeCl_2$ will be added directly to wells following the clear flush and immediately prior to injection of the molasses solution at each well. Approximately 30 gallons of the 33 percent aqueous solution of $FeCl_2$ will be added to each well. Direct injection to wells instead of mixing with the molasses solution will prevent removal of any iron precipitates by the bag filters (below).

Molasses will be mixed with tap water in a temporary 6,500-gallon Baker Tank immediately prior to injection. Water for the injection fluid will come from an onsite fire hydrant. Approximately 1,000 gallons of water will be added to the batch tank, followed by 600 gallons of molasses. The remaining water (4,400 gallons) will be added and the batch recirculated in the tank with the pump as needed to achieve proper mixing. A gasoline-powered, centrifugal injection pump (3-inch, 8 horsepower [hp], 290 gallons per minute) will be used for mixing and injection. Molasses will be delivered warm (approximately 100 degrees Fahrenheit) for reduced viscosity for handling and mixing.

The batched molasses solution will be filtered and injected to one or more wells at time depending on achieved injection rates. A multi-channel injection manifold will be used to inject multiple wells. Individual pressure gages and flow meters will be monitored and readings recorded at each well. The injection pump will be operated at a reduced throttle, as needed, to keep injection pressures below approximately 15 to 20 pounds per square inch (psi), as measured at the top of the well. This injection pressure is intended to minimize short-circuiting of injection fluid to the ground surface, while maintaining a pressurized well screen for uniform application of the injection fluid. The solution will be filtered to remove solids and potential bacterial growth in the injection fluid that could foul the wells, by connecting a dual bag filter unit (10-micron) located in-line between the pump and injection well manifold. Filters will be operated one at a time so that a clogged filter can be replaced while injection continues through the other filter. A reduction in flow rate or differential pressures greater

[1] This avoids removal of the yeast extract that could occur if batched with sugar and water, which will pass through an in-line bag filter.

than 15–18 psi across the filter housing are indications that the filter needs to be changed. If needed, filter changes will occur as follows:

1) Open valves on the dual filter housing to direct flow through the other filter and close valves to isolate the clogged filter.
2) Slowly release pressure in clogged filter housing by partially unscrewing the lid; allow pressure to dissipate before removing lid.
3) Remove filter for inspection.
4) Install new 10-micron filter.
5) Slightly open inlet and outlet valves to allow filter housing to fill with water to within 3–4 inches of the top of the housing before tightening the lid back down on the top of the filter housing to seal the filter assembly.
6) Flow can be diverted to the new filter when the other filter becomes plugged.

Spill control measures will be implemented during injection. The molasses tank, batch tank, bag filter, and mixing/injection pump will be located within a single secondary containment. A shop vacuum will be used to collect fluids within the secondary containment and injection fluid that might daylight near wells. Nearby storm drain manholes will be observed for potential infiltration of mounded groundwater with injection fluid to storm drain lines. Nearby storm drain catch basins, if any, will be covered with a foam rubber drain mat.

Groundwater Monitoring

Monitoring will consist of semiannual performance sampling at all 22 SWMU-17 wells. Prior monitoring included semiannual monitoring at these 22 and also quarterly monitoring at 10 select wells[2]. This reduction is appropriate given the progress of treatment since the 2011 injection. A monitoring matrix specifying the wells to be sampled and the analyses performed is presented in Table 2.

The same parameters will continue to be measured at each well. Samples from all wells will be analyzed for target contaminants and breakdown products (PCE, TCE, cDCE, and VC); parameters indicative of aquifer redox conditions (dissolved oxygen [DO], oxidation-reduction potential [ORP], nitrate, ferrous iron, and sulfate); and TOC and pH indicative of electron donor. Selected wells will also continue to be analyzed for methane/ethane/ethene/acetylene; this analysis was added at BDC-05-04 to be injected in 2017. Metals analysis for total and dissolved copper and arsenic will continue to be performed at all wells. DO, ORP, ferrous iron, and pH will be measured in the field with other parameters measured by laboratory analysis by Eurofins or Test America. Depending on monitoring results, further sampling reduction may be proposed.

[2] For prior monitoring program see Table 4 of the original work plan (LAI 2011).

Data Evaluation and Reporting

Analytical data will be evaluated to monitor biodegradation of PCE, TCE, and breakdown products. Primary indicators of success will be concentrations of PCE and TCE, breakdown products cDCE and VC, and end products ethene and ethane. Redox parameters (ORP, DO, nitrate, ferrous iron, sulfate, and methane) and pH will be used to evaluate development of desired aquifer redox conditions. TOC data will facilitate evaluation of electron donor longevity and distribution. Total and dissolved copper and arsenic will continue to be evaluated to determine the effects of injection, if any.

Monitoring data will be reported in the regular semiannual reports prepared for the DC, and an evaluation report will be prepared annually during implementation. A final report will be prepared at the conclusion of the treatment.

Schedule

We propose to proceed with implementation of this work plan in 2017. Donor injection is planned to occur in early November. The injection schedule is dependent on UIC registration and site access during this period.

LANDAU ASSOCIATES, INC.

Clinton L. Jacob, PE, LG
Principal

CLJ/ljl
[P:\025\093\FILERM\R\SWMU-17\SWMU17 FULL SCALE WP ADD 1\S17 BIO WORK PLAN ADD 1_FINAL REVISED.DOCX]

Attachments

Figure 1 Vicinity Map
Figure 2 SWMU-17 Site Plan
Figure 3 2017 Injection Locations
Table 1 Groundwater Data Summary
Table 2 Bioremediation Groundwater Monitoring Matrix

References

Kennedy, L.G., J.W. Everett, E. Becvar, D. DeFeo. 2006. "Field-scale Demonstration of Induced Biogeochemical Reductive Dechlorination at Dover Air Force Base, Dover, Delaware." *Journal of Contaminant Hydrology* 88:119-136.

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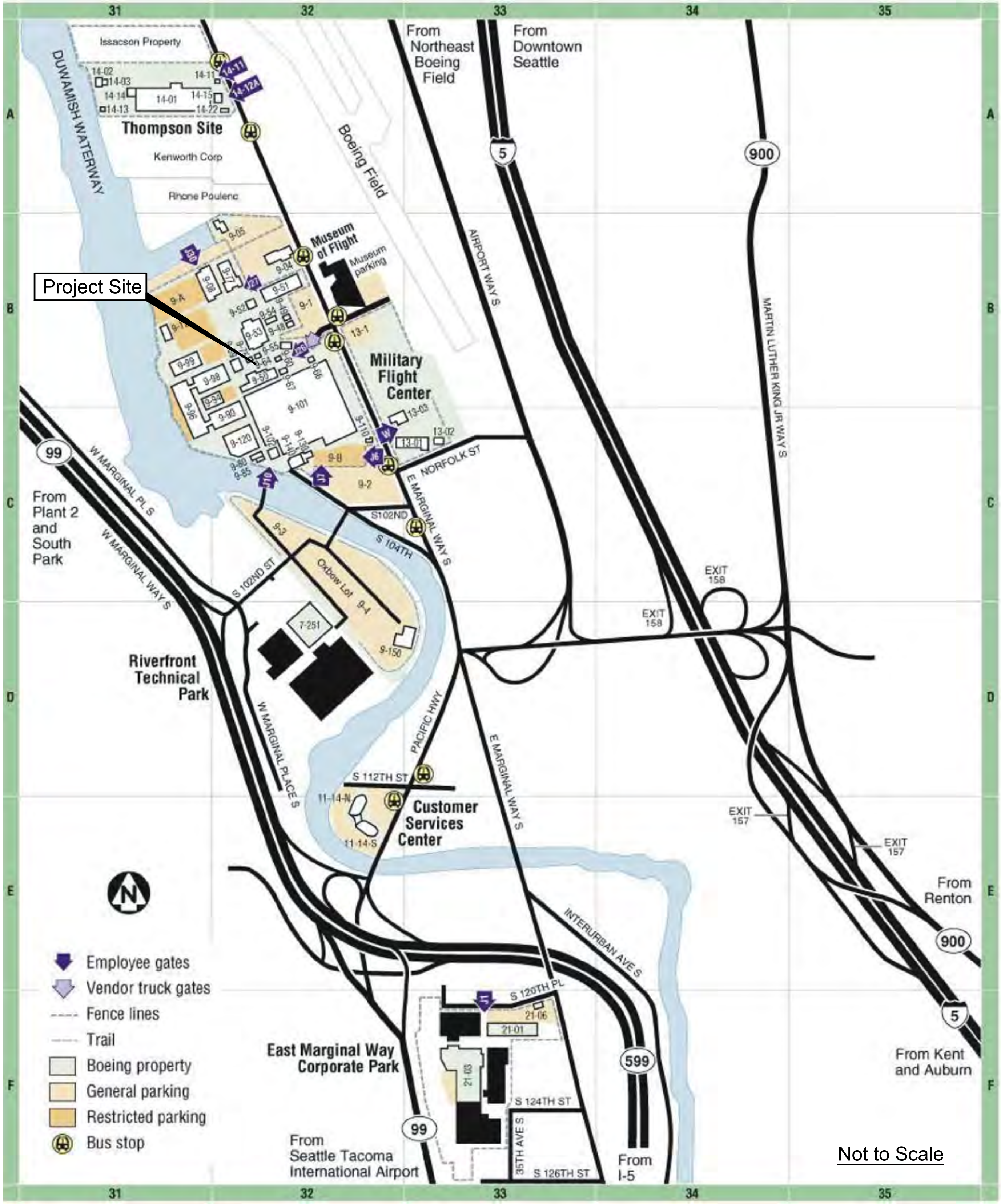
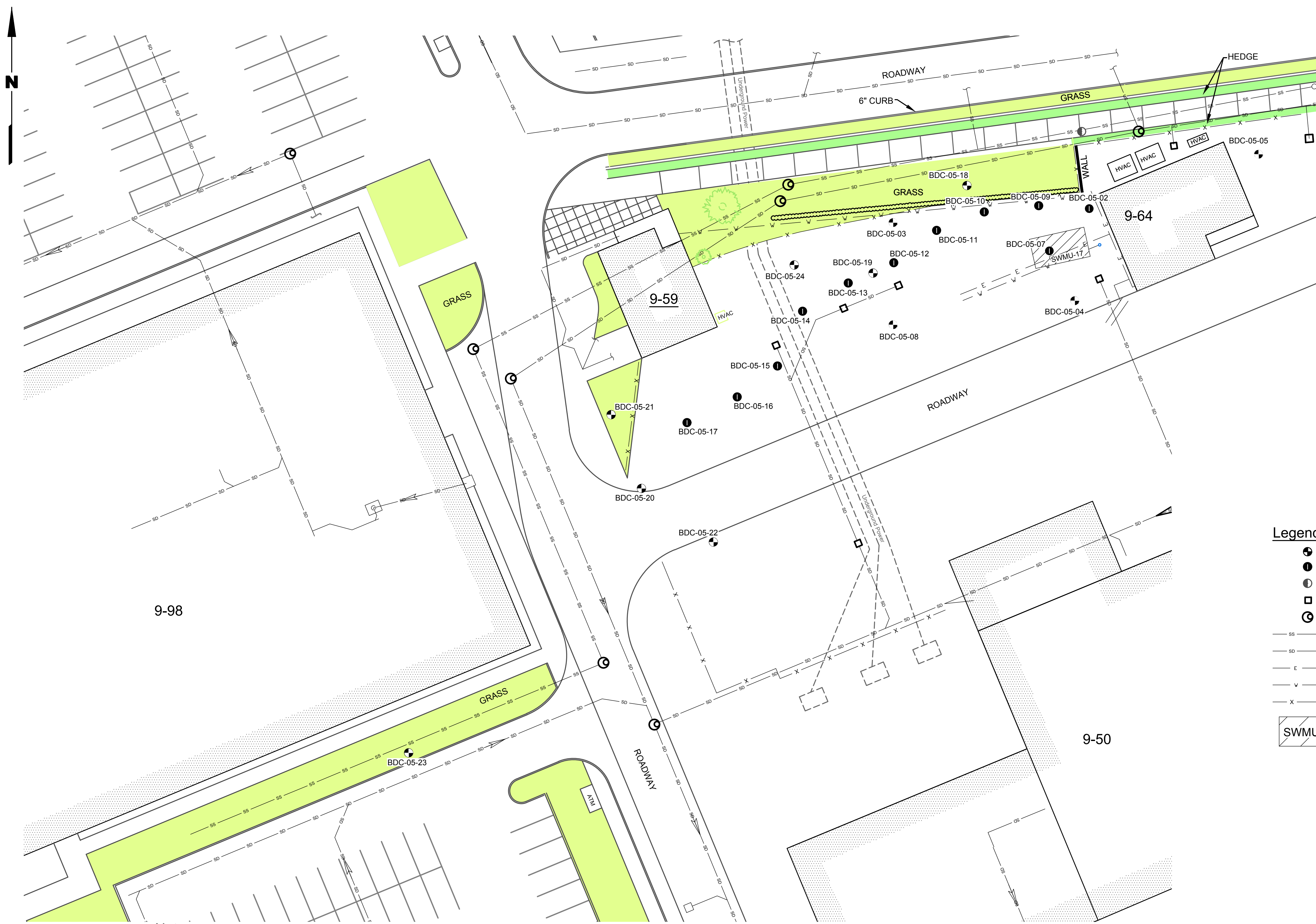


Map Provided by Boeing, March 2000

LANDAU ASSOCIATES	Boeing Developmental Center Tukwila, Washington	□c□n□t□ M□□	Figure 1

Boeing/Developmental Center/Evaluation Report | G:\Projects\025\093\117\021\S17 Bio WP Add1\F01 VicMap.dwg (A) "Figure 1" 9/20/2017



Legend

- Monitoring Well
- 2011 Injection Wells
- Abandoned Monitoring Well
- Catch Basin
- Manhole
- Sanitary Sewer Utility
- Storm Drain Utility
- Electrical Utility
- Water Utility
- Existing Fence
- SWMU-17 Solid Waste Management Unit

Note

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

0 40 80
Scale in Feet

LANDAU ASSOCIATES

Boeing Developmental Center
Tukwila, Washington

SWMU-□□ S□te □l□n

Figure 2

Legend

(0.8/<0.2)	Vinyl Chloride Concentration (*Max*/*Min*) for 1/2016 through 8/2017 (µg/L)
	Monitoring Well
	2017 Injection Wells (ROI = Radius of Injection)
	Abandoned Monitoring Well
	Catch Basin
	Manhole
— SS — SS —	Sanitary Sewer Utility
— SD — SD —	Storm Drain Utility
— E — E —	Electrical Utility
— W — W —	Water Utility
— X — X —	Existing Fence
SWMU-17	Solid Waste Management Unit

Notes

1. Proposed cleanup level for vinyl chloride is 2.4 µg/L.
2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

0 40 80
Scale in Feet

LANDAU ASSOCIATES

Boeing Developmental Center
Tukwila, Washington

2017 Injection Locations

Figure 3

Table 1
Groundwater Data Summary
Boeing Developmental Center
SWMU-17

Well	Date	Pilot Injection Elapsed Time From Injection (days)	Full Injection #1 Elapsed Time From Injection (days)	Volatile Organic Compounds PCE (µg/L)	TCE (µg/L)	c DCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	Metals As, Tot (mg/L)	As, Dis (mg/L)	Cu, Tot (mg/L)	Cu, Dis (mg/L)	Aquifer Redox Conditions DO (mg/L)	Nitrate (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (mg/L)	ORP (mV)	Donor Indicators TOC (mg/L)	pH	Comments	VOCs- micromoles/Liter (b) PCE	TCE	c DCE	VC	Ethene	Ethane	Total Chloroethenes (d)	Ethene + Ethane	Molar Fraction (c) PCE	TCE	c DCE	VC	Ethene + Ethane
Proposed Groundwater Cleanup Levels (a)				5.3	1.4	134	2.4	NA	NA	NA	0.008	0.008	0.008	0.008																						
BDC-05-02	5/21/2007	-526		20	24	1.2	<1.0				0.003	0.002	0.004	<0.002										0.12	0.18	0.01	0.00			0.32		0.38	0.58	0.04	0.00	
(IW)	11/26/2007	-337		12	14	1.3	<1.0				0.001	<0.001	<0.002	<0.002										0.07	0.11	0.01	0.00			0.19		0.38	0.55	0.07	0.00	
	5/22/2008	-159		14	20	1.2	<0.2				0.002	<0.001	0.004	<0.002										0.08	0.15	0.01	0.00			0.25		0.34	0.61	0.05	0.00	
BDC-05-02	10/23/2008	-5		31	62	2.9	<1.0	<1.1	<1.2	<1.1	0.003	0.003	0.006	<0.002	5.15	0.4	0.2	13.0	0.19	87.1	5.5	6.47		0.19	0.47	0.03	0.00	0.00	0.00	0.69	0.00	0.27	0.69	0.04	0.00	0.00
BDC-05-02	11/20/2008	23		5.1	4.2	0.7	<0.2	<1.1	<1.2	<1.1	0.017	0.011	0.008	<0.002	0.29	<0.1	1.8	64.8	3.3	-111	430	6.47		0.03	0.03	0.01	0.00	0.00	0.00	0.07	0.00	0.44	0.46	0.10	0.00	0.00
BDC-05-02	12/16/2008	49		6.6	7.3	1.3	<1.0	<1.1	<1.2	<1.1	0.024	0.017	0.030	0.003	1.28	<0.1	3.4	88.8	2.9	-225	610	6.41		0.04	0.06	0.01	0.00	0.00	0.00	0.11	0.00	0.37	0.51	0.12	0.00	0.00
BDC-05-02	1/16/2009	80		7.5	22	3.7	<1.0	<1.1	<1.2	<1.1	0.022	0.014	0.029	<0.002	0.09	<1.0	3.5	6.9	6.2	-304	732	6.10		0.05	0.17	0.04	0.00	0.00	0.00	0.25	0.00	0.18	0.67	0.15	0.00	0.00
BDC-05-02	2/11/2009	106		9.5	17	12	<1.0	<1.1	<1.2	<1.1	0.046	0.040	0.004	<0.002	2.36	<0.1	4.0	<0.1	13.2	-99	433	6.32		0.06	0.13	0.12	0.00	0.00	0.00	0.31	0.00	0.18	0.42	0.40	0.00	0.00
BDC-05-02	3/9/2009	132		9.1	8.1	25	<1.0	<1.1	<1.2	<1.1	0.041	0.036	0.004	<0.002	0.09	<1.0	3.5	<1.0	22.9	-102	317	6.43		0.05	0.06	0.26	0.00	0.00	0.00	0.37	0.00	0.15	0.16	0.69	0.00	0.00
BDC-05-02	4/16/2009	170		7.3	6.0	41	<1.0	<1.1	<1.2	<1.1	0.029	0.025	0.003	<0.002	1.78	<0.1	3.0	<0.5	26.3	-97	274	6.59		0.04	0.05	0.42	0.00	0.00	0.00	0.51	0.00	0.09	0.09	0.83	0.00	0.00
BDC-05-02	5/13/2009	197		4.4	4.6	35	1.4	<1.1	<1.2		0.024	0.019	0.004	0.002	0.27	<0.1	5.2	<0.1	23.0	-63	215	6.61		0.03	0.04	0.36	0.02	0.00	0.00	0.44	0.00	0.06	0.08	0.81	0.05	0.00
BDC-05-02	8/16/2009	292		1.8	1.1	49	<1.0	<1.1	<1.2	<1.1	0.023	0.017	0.009	<0.002	1.58	<0.5	3.6	<0.5	22.6	-23	125	6.77	Black tint, black flakes, suspended solids	0.01	0.01	0.51	0.00	0.00	0.00	0.52	0.00	0.02	0.02	0.96	0.00	0.00
BDC-05-02	11/13/2009	381		1.0	<1.0	70	<1.0	<1.1	<1.2	<1.1	0.020	0.016	0.003	<0.002	1.07	<0.1	2.8	0.3	21.1	-26	44.1	6.05	Black tint	0.01	0.00	0.72	0.00	0.00	0.00	0.73	0.00	0.01	0.00	0.99	0.00	0.00
BDC-05-02	2/16/2010	476		<1.0	<1.0	54	<1.0	<1.1	<1.2	<1.1	0.022	0.020	0.005	0.002	1.52	<0.5	2.0	0.5	22.5	763	86.7	6.87		0.00	0.00	0.56	0.00	0.00	0.00	0.56	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-02	5/18/2010	567		<1.0	1.0	32	<1.0	<1.1	<1.2	<1.1	0.013	0.012	<0.002	<0.002	1.83	<0.5	2.3	<0.5	18.4	515	20.6	6.69		0.00	0.01	0.33	0.00	0.00	0.00	0.34	0.00	0.00	0.02	0.98	0.00	0.00
BDC-05-02	8/17/2010	658		<1.0	<1.0	23	<1.0	<1.1	<1.2	<1.1	0.010	0.008	<0.002	<0.002	2.82	0.2	2.7	1.4	20.2	55	13.3	6.74		0.00	0.00	0.24	0.00	0.00	0.00	0.24	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-02	11/9/2010	742		<1.0	<1.0	14	<1.0	<1.1	<1.2	<1.1	0.006	0.005	<0.002	<0.002	2.77	<0.1	2.2	0.3	16.9	72	10.8	6.83		0.00	0.00	0.14	0.00	0.00	0.00	0.14	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-02	2/15/2011	840		<1.0	<1.0	13	<1.0	<1.1	<1.2	<1.1	0.007	0.006	0.003	<0.002	2.43	<0.1	3.0	0.7	17.8	114	13.2	6.80		0.00	0.00	0.13	0.00	0.00	0.00	0.13	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-02	5/2/2011	916		0.6	0.9	22	0.3	<1.1	<1.2	<1.1	0.008	0.007	<0.002	<0.002	2.09	<0.1	1.4	0.2	13.3	13	9.8	6.86		0.00	0.01	0.23	0.00	0.00	0.00	0.24	0.00	0.01	0.03	0.94	0.02	0.00
BDC-05-02	7/31/2011	1006	-18	<1.0	<1.0	10	<1.0	<1.1	<1.2	<1.1	0.006	0.005	<0.002	<0.002	1.97	<0.1	3.2	0.2	15.0	-35	8.7	6.82		0.00	0.00	0.10	0.00	0.00	0.00	0.10	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-02	11/2/2011	1100	76	8.4	4.8	150	1.6	<1.1	<1.2	<1.1	0.025	0.022	0.010	0.010	2.40	<0.1	3.5	1.4	9.0	-28	5360	5.43		0.05	0.04	1.55	0.03	0.00	0.00	1.66	0.00	0.03	0.02	0.93	0.02	0.00
BDC-05-02	2/19/2012	1209	185	<4.0	<4.0	220	<4.0	<1.0	<1.0	<1.0					1.37	<0.5	1.3	<1.5	8.5	-32	673	6.70		0.00	0.00	2.27	0.00	0.00	0.00	2.27	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-02	5/7/2012	1287	263	<2.0	<2.0	180	<2.0	<1.0	<1.0	<1.0	0.051	0.049	0.004	<0.002	0.60		2.2	0.8	19.0	35	412	6.71		0.00	0.00	1.86	0.00	0.00	0.00	1.86	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-02	9/5/2012	1408	384	<2.0	<2.0	57	<2.0	<1.0	<1.0	<1.0					0.11		1.8	<0.3	10.0	71	116	6.45		0.00	0.00	0.59	0.00	0.00	0.00	0.59	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-02	11/15/2012	1479	455	<2.0	<2.0	32	5.5	<1.0	<1.0	<1.0	0.014	0.013	<0.003	<0.002	0.03		1.2	<0.3	20.0	17	106	6.49		0.00	0.00	0.33	0.09	0.00	0.00	0.42	0.00	0.00	0.00	0.79	0.21	0.00
BDC-05-02	2/26/2013	1582	558	<1.0	<1.0	1.2	2.7	1.4	<1.0	<1.0					0.12		1.2	<0.30	17.0	45	32.2	6.66		0.00	0.00	0.01	0.04	0.05	0.00	0.06	0.05	0.00	0.00	0.12	0.41	0.47
BDC-05-02	5/22/2013	1667	643	0.3	0.5	0.7	0.6	<1.0	<1.0	<1.0	0.006	0.005	0.002	<0.002	0.21		1.0	0.57	15.0	-316	19.3	7.74		0.00	0.00	0.01	0.01	0.00	0.00	0.02	0.00	0.08	0.17	0.32	0.43	0.00
BDC-05-02	8/29/2013	1766	742	0.3	0.4	0.6	0.2	<1.0	<1.0	<1.0					1.96		1.4	<0.30	14.0	-303	15.7	6.34		0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.13	0.21	0.43	0.22	0.00
BDC-05-02	11/13/2013	1842	818	0.4	0.5	0.9	0.6	<1.0	<1.0	<1.0	0.008	0.007	0.003	<0.002	2.52		1.8	<0.30	14.0	-272	26.8	6.42		0.00	0.00	0.01	0.01	0.00	0.00	0.03	0.00	0.10	0.15	0.37	0.38	0.00
BDC-05-02	2/11/2014	1932	908	0.8	<0.2	<0.2	<0.2	<1.0	<3.0	<1.0					4.01		2.8	<0.30	12.0	-235	7.1	6.75		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
BDC-05-02	5/13/2014	2023	999	0.8	1.1	1.5	2.4	5.1	<1.0	<1.0	0.023	0.019	0.003	<0.002	4.23		1.8	5.7	15.0	-380	66.5	6.62		0.00	0.01	0.02	0.04	0.18	0.00	0.07	0.18	0.02	0.03	0.06	0.15	0.73
BDC-05-02	8/6/2014	2108	1084	<1.0	<1.0	<1.0	4.1	40	11	<1.0					7.61		1.5	3.6	17.0	-215	93.4	7.20		0.00	0.00	0.00	0.07	1.43	0.37	0.07	1.79	0.00	0.00	0.00	0.04	0.96
BDC-05-02	11/11/2014	2205	1181	1.5	0.7	2.3	0.6	<1.0	12	<1.0	0.039	0.032	0.003	<0.002	0.05		1.0	1.2	13.0	-80	38.2	6.22		0.01	0.01	0.02	0.01	0.00	0.40	0.05	0.40	0.02	0.01	0.05	0.02	0.89
BDC-05-02	1/21/2015	2276	1252	1.2	0.6	1.7	1.7	<1.0	4.7	<1.0					0.16		0.6	8.9	12.0	-135	40	6.36		0.01	0.00	0.02	0.03	0.00	0.16	0.06	0.16	0.03	0.02	0.08	0.13	0.73
BDC-05-02	4/27/2015	2372	1348	2.7	1.1	1.2	3.4	3.0	6.4	<1.0	0.018	0.011	0.004	<0.002	0.07		2.0	14.3	9.8	-63	15.9	6.39		0.02	0.01	0.01	0.05	0.11	0.21	0.09	0.32	0.04	0.02	0.03	0.13	0.78
BDC-05-02	7/20/2015	2456	1432	1.8	1.4	0.7	0.7	<1.0	11	<1.0					0.15		1.9	9.5	8.0	-67	15.3	6.36		0.01	0.01	0.01	0.01	0.00	0.37	0.04	0.37	0.03	0.03	0.02	0.03	0.90
BDC-05-02	10/28/2015	2556	1532	0.8	<0.2	0.6	0.4	<1.0	<1.0	<1.0	0.002	0.002	0.006	<0.002	0.21		0.8	0.70	9.2	-5.7	3.8	6.29		0.00	0.00	0.01	0.01	0.00	0.00	0.02	0.00	0.28	0.00	0.36	0.37	0.00
BDC-05-02	1/26/2016	2646	1622	4.9	1.7	1.4	1.8	2.1	5.5	<1.0					0.22		1.4	23.7	10.0	-28	20.9	6.40		0.03	0.01	0.01	0.03	0.07	0.18	0.09	0.26	0.09	0.04	0.04	0.08	0.75
BDC-05-02	4/20/2016	2731	1707	4.2	1.4	0.8	0.6	<1.0	4.4	<1.0	0.005	0.002	0.008	0.004	0.09		1.8	14.5	8.8	-9.8	13.6	6.26		0.03	0.01	0.01	0.01	0.00	0.15	0.05	0.15	0.13	0.05	0.04	0.05	0.73
BDC-05-02	8/9/2016	2842	1818	1.6	1.6	0.3	<0.2	<1.0	4.9	<1.0	0.021	0.011	<0.002	<0.002	0.50		1.4	3.8	12.0	-101.3	14.4	6.28		0.01	0.01	0.00	0.00	0.00	0.16	0.02	0.16	0.05	0.06	0.02	0.00	0.87
BDC-05-02	11/2/2016	2927	1903	1.7	<0.2	<0.2	<0.2	<1.0	<1.0	<1.0	0.003	0.002	<0.002	<0.002	0.50		0.6	<0.30	10.0	-83.5	6.0	6.42		0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	1.00	0.00	0.00	0.00	0.00
BDC-05-02	2/7/2017	3024	2000	2.1	1.6	0.5	0.5	1.2	5.4	<1.0	0.004	0.002	0.002	<0.002	0.40		2.4	18.8	9.6	-72.5	10.7	6.65		0.01	0.01	0.01	0.01	0.04	0.18	0.04	0.22	0.05	0.05	0.02	0.03	0.85
BDC-05-02	5/4/2017	3110	2086	4.2	2.0	0.4	0.4	<1.0	3.6	<1.0	0.002	0.001	0.007	0.004	0.48		0.8	23.2	5.0	27.5	15.6	6.34		0.03	0.02	0.00	0.01	0.00	0.12	0.05	0.12	0.15	0.09	0.02	0.04	0.70
BDC-05-02	8/1/2017	3199	2175	3.9	2.5	0.3	<0.2	<1.0	8.2	<1.0	0.012	0.009	<0.002	<0.002	0.13		1.6	18.4	8.0	-14.1	12.3	6.07		0.02	0.02	0.00	0.00	0.00	0.27	0.05	0.27	0.07	0.06	0.01	0.00	0.86
BDC-05-03	5/21/2007	-526		3.5	8.1	11	<1.0				0.003	<0.001	0.004	<0.002										0.02	0.06	0.11	0.00			0.20		0.11	0.31	0.58	0.00	
(MW 17 ft DG)	11/26/2007	-337		2.3	4.4	7.2	<1.0				0.002	<0.001	0.003	<0.002										0.01	0.03	0.07	0.00			0.12		0.11	0.28	0.61	0.00	
	5/22/2008	-159		3.8	8.5	13	<0.2				0.002	<0.001	0.003	<0.002										0.02	0.06	0.13	0.00			0.22		0.10	0.29	0.60	0.00	
BDC-05-03	10/23/2008	-5		4.2	8.2	17	<0.2	<1.1	<1.2	<1.1	0.004	0.002	0.004	0.002	0.37	<0.1	0.1	4.9	2.1	48.9	4.9	6.23		0.03	0.06	0.18	0.00	0.00	0.00	0.26	0.00	0.10	0.24	0.67	0.00	0.00
BDC-05-03	11/20/2008	23		1.8	2.1	2.7	<0.2	<1.1	<1.2	<1.1	0.003	0.001	0.004	<0.002	2.07	0.9	1.6	8.5	3.6	-8	7.0	6.23		0.01	0.02	0.03	0.00	0.00	0.00	0.05	0.00	0.20	0.29	0.51	0.00	0.00
BDC-05-03	12/16/2008	49		2.2	4.1	5.8	<1.0	<1.1	<1.2	<1.1	0.001	<0.001	0.002	<0.002	1.20	0.4	2.4	20.1	4.7	-67	5.4	6.44		0.01	0.03	0.06	0.00	0.00	0.00	0.10	0.00	0.13	0.30	0.57	0.00	0.00
BDC-05-03	1/16/2009	80		1.5	1.2	<1.0	<1.0	<1.1	<1.2	<1.1	0.001	<0.001	0.002	<0.002	0.71	1.7	0.4	10.3	1.5 J	-144	3.2	6.17		0.01	0.01	0.00	0.00	0.00	0.00	0.02	0.00	0.50	0.50	0.00	0.00	0.00
BDC-05-03	2/11/2009	106		1.8	3.2	4.4	<1.0	<1.1	<1.2	<1.1	0.002	<0.001	0.002	<0.002	2.43	0.9	2.4	6.2	5.4	-60	5.4	6.59		0.01	0.02	0.05	0.00	0.00	0.00	0.08	0.00	0.13	0.30	0.56	0.00	0.00
BDC-05-03	3/9/2009	132		1.3	1.7	1.4	<1.0	<1.1	<1.2	<1.1	<0.001	<0.001	<0.002	<0.002	0.86	1.0	1.0	6.6	4.3	39	4.8	6.48		0.01	0.01	0.01	0.00	0.00	0.00	0.04	0.00	0.22	0.37	0.41	0.00	0.00
BDC-05-03	4/16/2009	170		1.5	2.2	2.8	<1.0	<1.1	<1.2	<1.1	0.001	0.002	<0.002	<0.002	1.42	1.0	1.4	4.8	3.3	14	5.4	6.69		0.01	0.02	0.03	0.00	0.00	0.00	0.05	0.00	0.17	0.31	0.53	0.00	0.00
BDC-05-03	5/13/2009	197		1.2	2.1	3.4	<1.0	<1.1	<1.2		0.001	0.0004	0.004	0.002	1.06	1.0	3.0	4.8	6.9	31	5.5	6.75		0.01	0.02	0.04	0.00	0.00	0.00	0.06	0.00	0.12	0.27	0.60	0.00	0.00
BDC-05-03	8/16/2009	292		2.2	4.3	8.1	<1.0	<1.1	<1.2	<1.1	0.001	0.001	<0.002	<0.002	0.85	0.1	3.0	3.0	8.3	-42	6.5	7.11		0.01	0.03	0.08	0.00	0.00	0.00	0.13	0.00	0.10	0.25	0.64	0.00	0.00
BDC-05-03	11/13/2009	381		1.2	1.2	<1.0	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.003	<0.002	1.66	0.2	3.0	5.6	5.0	57	4.3	6.37		0.01	0.01	0.00	0.00	0.00	0.00	0.02	0.00	0.44	0.56	0.00	0.00	0.00
BDC-05-03	2/16/2010	476		1.4	1.0	<1.0	<1.0	<1.1	<1.2	<1.1	0.002	<0.001	0.005	0.005	1.25	2.5	0.0	8.6	<0.0007	663	3.5	6.30		0.01	0.01	0.00	0.00	0.00	0.00	0.02	0.00	0.53	0.47	0.00	0.00	0.00
BDC-05-03	5/18/2010	567		1.2	1.8	2.7	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.004	0.003	0.88	1.5	2.0	4.9	2.4	346	4.7	6.42		0.01	0.01	0.03	0.00	0.00	0.00	0.05	0.00	0.15	0.28	0.57	0.00	0.00
BDC-05-03	8/17/2010	658		2.3	5.2	14	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.003	<0.002	2.10	0.2	2.7	2.8	7.1	73	7.6	6.79		0.01	0.04	0.14	0.00	0.00	0.00	0.20	0.00	0.07	0.20	0.73	0.00	0.00
BDC-05-03	11/9/2010	742		1.4	1.7	3.7	<1.0	<1.1	<1.2	<1.1	0.001	0.001	0.003	<0.002	3.20	0.5	2.2	5.3	3.0	133	4.7	7.61		0.01	0.01	0.04	0.00	0.00	0.00	0.06	0.00	0.14	0.22	0.64	0.00	0.00
BDC-05-03	2/15/2011	840		1.3	<1.0	2.3	<1.0	<1.1	<1.2	<1.1	0.001	0.0003	0.005	0.003	2.86	0.7	0.0	6.2	4.6	166	5.4	7.01		0.01	0.00	0.02	0.00	0.00	0.00	0.03	0.00	0.25	0.00	0.75	0.00	0.00
BDC-05-03	5/2/2011	916	-108	1.7	1.0	0.2	<0.2	<1.1	<1.2	<1.1	0.002	0.0004	0.005	0.003	3.31	0.8	0.0	5.5	0.3	203	4.1	6.91		0.01	0.01	0.00	0.00	0.00	0.00	0.02	0.00	0.51	0.38	0.10	0.00	0.00
BDC-05-03	11/2/2011	1100	76	1.4	1.6	20	2.0				0.018	0.017	0.004	0.002	1.20	<0.1	1.6	<1.0		-60	70.0	6.72		0.01	0.01	0.21	0.03			0.26		0.03	0.05	0.80	0.12	
BDC-05-03	5/6/2012	1286	262	0.6	1.3	<0.2	0.3				0.002	0.004	0.003	0.010	0.02		1.2	10.3		82	4.9	6.26		0.00	0.01	0.00	0.00			0.02		0.20	0.54	0.00	0.26	
BDC-05-03	11/13/2012	1477	453	<0.5	<0.5	<0.5	0.7				0.008	0.007	0.003	<0.002	0.01		0.3	1.2		13	8.3	6.79		0.00	0.00	0.00	0.01			0.01		0.00	0.00	0.00	1.00	
BDC-05-03	5/22/2013	1667	643	0.4	0.5	0.4	1.1				0.004	0.003	<0.002	<0.002	0.23		0.8	2.7		-264	6.6	7.57		0.00	0.00	0.00	0.02			0.03		0.09	0.14	0.15	0.63	
BDC-05-03	11/13/2013	1842	818	1.3	1.2	0.2	<0.2	<1.0	<1.0	<1.0	0.008	0.001	0.003	<0.002	3.19		1.6	10.5	0.45	-272	4.3	6.24		0.01	0.01	0.00	0.00	0.00	0.00	0.02	0.00	0.41	0.48	0.11	0.00	0.00
BDC-05-03	5/13/2014	2023	999	1.5	0.7	<0.2	<0.2	<1.0	1.1	<1.0	0.003	<0.001	0.002	<0.002	4.08		1.4	9.6	1.00	-206	5.4	6.30		0.01	0.01	0.00	0.00	0.00	0.04	0.01	0.04	0.18	0.10	0.00	0.00	0.72
BDC-05-03	11/10/2014	2204	1180	2.1	0.6	<0.2	<0.2	<1.0	<1.0	<1.0	0.002	0.001	0.003	<0.002	0.07		0.8	5.6	0.07	81	1.1	5.72		0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.73	0.27	0.00	0.00	0.00
BDC-05-03	4/27/2015	2372	1348	1.5	0.4	<0.2	0.4	<1.0	<1.0	<1.0	0.002	0.003	0.004	<0.002	0.93		0.6	4.1	0.74	43	1.7	5.85		0.01	0.00	0.00	0.01	0.00	0.00	0.02	0.00	0.49	0.16	0.00	0.35	0.00

Table 1
Groundwater Data Summary
Boeing Developmental Center
SWMU-17

Well	Date	Pilot Injection	Full Injection #1	Volatile Organic Compounds							Metals				Aquifer Redox Conditions						Donor Indicators	
		Elapsed Time From Injection (days)	Elapsed Time From Injection (days)	PCE (µg/L)	TCE (µg/L)	c DCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	As, Tot (mg/L)	As, Dis (mg/L)	Cu, Tot (mg/L)	Cu, Dis (mg/L)	DO (mg/L)	Nitrate (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (mg/L)	ORP (mV)	TOC (mg/L)	pH
Proposed Groundwater Cleanup Levels (a)				5.3	1.4	134	2.4	NA	NA	NA	0.008	0.008	0.008	0.008								
BDC-05-03	10/28/2015	2556	1532	0.6	0.4	<0.2	0.3	<1.0	1.1	<1.0	0.012	0.006	0.009	0.002	0.09		1.0	1.2	5.9	-13	6.5	6.40
BDC-05-03	4/20/2016	2731	1707	1.2	0.2	<0.2	<0.2	<1.0	<1.0	<1.0	0.002	0.002	0.003	<0.002	0.58			6.5	2.8	41	1.4	5.97
BDC-05-03	11/3/2016	2928	1904	1.4	0.3	<0.2	<0.2	<1.0	<1.0	<1.0	0.007	0.006	<0.002	<0.002	0.77		3.0	7.7	0.31	5.4	2.3	5.91
BDC-05-03	5/4/2017	3110	2086	1.4	0.3	<0.2	<0.2	<1.0	<1.0	<1.0	0.003	<0.0004	0.003	<0.002	1.95		0.0	7.2	<3.0	72.5	2.8	5.63
BDC-05-04	5/21/2007	-526		<1.0	<1.0	1.4	<1.0				0.018	<0.001	<0.002	<0.002								
(MW 22 ft XG)	11/26/2007	-337		<1.0	<1.0	1.6	<1.0				0.009	<0.001	<0.002	<0.002								
	5/22/2008	-159		1.5	0.9	1.2	<0.2				0.018	<0.001	<0.002	<0.002								
BDC-05-04	10/23/2008	-5		1.1	0.8	2.1	<0.2	<1.1	<1.2	<1.1	0.009	<0.001	<0.002	<0.002	2.45	7.6	0.1	31.0	0.3	73.5	3.8	6.33
BDC-05-04	11/20/2008	23		1.1	0.7	3.6	<0.2	<1.1	<1.2	<1.1	0.019	<0.001	<0.002	<0.002	0.59	4.5	0.8	25,2	0.05	-16	5.1	6.25
BDC-05-04	12/16/2008	49		<1.0	<1.0	2.4	<1.0	<1.1	<1.2	<1.1	0.019	0.002	0.003	<0.002	0.55	5.5	1.0	30.4	1.6	-98	6.9	6.24
BDC-05-04	1/16/2009	80		<1.0	<1.0	2.0	<1.0	<1.1	<1.2	<1.1	0.017	<0.001	<0.002	<0.002	0.06	4.3	1.0	21.8	1.5	-192	5.1	6.23
BDC-05-04	2/11/2009	106		1.0	<1.0	1.5	<1.0	<1.1	<1.2	<1.1	0.020	<0.001	<0.002	<0.002	2.45	5.9	1.0	31.8	1.1	-54	6.8	6.17
BDC-05-04	3/9/2009	132		1.0	<1.0	1.3	<1.0	<1.1	<1.2	<1.1	0.014	0.001	0.002	<0.002	0.27	4.8	1.5	30.1	0.2	35	5.2	6.22
BDC-05-04	4/16/2009	170		1.2	<1.0	<1.0	<1.0	<1.1	<1.2	<1.1	0.011	0.001	<0.002	<0.002	1.48	5.9	1.4	33.6	<0.0007	68	5.7	6.29
BDC-05-04	5/13/2009	197		<1.0	<1.0	1.0	<1.0	<1.1	<1.2		0.007	0.001	0.002	0.002	0.33	4.5	1.6	26.6	0.4	49	5.2	6.37
BDC-05-04	8/16/2009	292		1.3	<1.0	<1.0	<1.0	<1.1	<1.2	<1.1	0.012	0.001	0.002	<0.002	0.86	5.4	2.2	30.6	<0.0007	93	5.0	6.97
BDC-05-04	11/13/2009	381		<1.0	<1.0	1.2	<1.0	<1.1	<1.2	<1.1	0.005	0.001	<0.002	<0.002	0.56	2.2	3.0	18.4	2.4	109	4.4	5.86
BDC-05-04	2/16/2010	476		<1.0	<1.0	1.1	<1.0	<1.1	<1.2	<1.1	0.004	0.002	0.012	0.002	0.88	<0.1	3.3	24.6	1.5	899	8.9	6.24
BDC-05-04	5/18/2010	567		1.1	<1.0	1.2	<1.0	<1.1	<1.2	<1.1	0.014	0.001	0.005	<0.002	0.75	<0.1	3.0	25.4	1.3	473	7.1	6.19
BDC-05-04	8/17/2010	658		<1.0	<1.0	3.0	<1.0	<1.1	<1.2	<1.1	0.012	0.002	0.006	<0.002	1.00	<0.1	2.8	17.7	3.5	108	8.7	6.48
BDC-05-04	11/9/2010	742		<1.0	<1.0	4.3	<1.0	<1.1	<1.2	<1.1	0.008	0.004	<0.002	<0.002	2.21	<0.1	2.2	21.3	3.0	101	7.2	6.84
BDC-05-04	2/15/2011	840		<1.0	<1.0	2.9	<1.0	<1.1	<1.2	<1.1	0.007	0.004	<0.002	<0.002	2.50	<0.1	2.4	19.4	4.5	93	6.9	6.85
BDC-05-04	5/2/2011	916	-108	0.4	0.5	3.1	<0.2	<1.1	<1.2	<1.1	0.008	0.004	<0.002	<0.002	1.69	<0.1	2.2	18.0	1.8	49	6.8	6.76
BDC-05-04	11/2/2011	1100	76	<1.0	<1.0	4.2	<1.0				0.007	0.006	<0.002	<0.002	1.52	<1.0	1.2	<1.0		-3	6.6	7.17
BDC-05-04	5/7/2012	1287	263	0.4	0.6	3.6	<0.2				0.017	0.016	<0.002	<0.002	0.16		2.0	21.5		98	8.6	6.39
BDC-05-04	11/13/2012	1477	453	<0.5	<0.5	3.3	<0.5				0.012	0.010	0.002	<0.002	0.02		1.2	14.3		27	6.5	6.65
BDC-05-04	5/23/2013	1668	644	<0.2	<0.2	2.1	<0.2				0.026	0.027	<0.002	<0.002	0.49		1.5	13.7		-310	12.7	7.78
BDC-05-04	11/13/2013	1842	818	<0.2	0.3	3.6	<0.2				0.016	0.015	0.002	<0.002	2.05		1.8	14.4		-262	8.1	6.48
BDC-05-04	5/13/2014	2023	999	0.6	0.3	0.8	<0.2				0.002	0.002	0.005	0.002	3.86		0.6	14.1		-177	8.2	6.28
BDC-05-04	11/11/2014	2205	1181	0.3	0.2	2.8	0.4				0.006	0.004	<0.002	<0.002	0.38		1.6	6.2		-58	4.8	6.25
BDC-05-04	4/27/2015	2372	1348	1.0	0.4	1.0	<0.2				0.004	0.001	0.005	0.003	0.09		0.4	16.3		48	2.7	5.92
BDC-05-04	10/28/2015	2556	1532	<0.2	<0.2	3.6	0.7				0.008	0.007	<0.002	<0.002	0.43		1.4	1.3		-26	6.1	6.44
BDC-05-04	4/21/2016	2732	1708	1.0	0.3	0.4	<0.2				0.002	0.001	0.004	0.003	0.25		0.8	12.2		35	2.4	6.05
BDC-05-04	11/2/2016	2927	1903	<0.2	<0.2	1.5	<0.2				0.008	0.008	<0.002	<0.002	0.39	<0.10	1.4	0.75		-140.5	7.4	6.51
BDC-05-04	5/3/2017	3109	2085	1.2	0.4	0.3	<0.2				0.001	0.001	0.003	0.003	0.42	8.8	0.6	12.0		73.8	3.3	5.71
BDC-05-05	5/21/2007	-526		<1.0	<1.0	<1.0	<1.0				0.002	<0.001	0.003	<0.002								
(MW UG)	11/26/2007	-337		<1.0	<1.0	<1.0	<1.0				<0.001	<0.001	<0.002	<0.002								
	5/22/2008	-159		0.3	0.8	<0.2	<0.2				0.002	<0.001	0.003	<0.002								
BDC-05-05	10/23/2008	-5																				
BDC-05-05	11/20/2008	23		0.3	0.7	<0.2	<0.2				0.005	0.001	0.005	0.003	4.61					52		6.25
BDC-05-05	12/16/2008	49																				
BDC-05-05	1/16/2009	80																				
BDC-05-05	2/11/2009	106																				
BDC-05-05	3/9/2009	132																				
BDC-05-05	4/16/2009	170																				
BDC-05-05	5/13/2009	197		<1.0	<1.0	<1.0	<1.0				0.003	<0.001	0.006	0.002	3.24					68		6.72
BDC-05-05	8/16/2009	292																				
BDC-05-05	11/13/2009	381		<1.0	<1.0	<1.0	<1.0				0.001	<0.001	<0.002	<0.002	2.85	1.2	0.0	8.7		166		5.84
BDC-05-05	2/16/2010	476																				
BDC-05-05	5/18/2010	567		<1.0	<1.0	<1.0	<1.0				0.002	0.0004	0.002	<0.002	3.47		0.0			494		6.74
BDC-05-05	8/17/2010	658																				
BDC-05-05	11/9/2010	742		<1.0	1.1	<1.0	<1.0				0.001	0.0004	0.003	<0.002	3.20					135		6.90
BDC-05-05	2/15/2011	840																				
BDC-05-05	5/2/2011	916	-108	0.3	0.8	<0.2	<0.2				0.001	0.0003	0.003	<0.002	3.40					158		6.98
BDC-05-05	11/2/2011	1100	76	<1.0	1.2	<1.0	<1.0				0.001	0.0003	0.002	0.003	2.84	<0.1	0.0	7.5		85	1.7	7.66
BDC-05-05	5/6/2012	1286	262	0.4	0.9	<0.2	<0.2				<0.001	<0.001	0.003	<0.002	3.23		0.0	22.1		219	1.1	6.42
BDC-05-05	11/13/2012	1477	453	<0.5	1.1	<0.5	<0.5	<1.0	<1.0	<1.0	0.001	0.0005	0.003	<0.002	1.76		0.2	20.6	<0.003	27	<1.0	6.82
BDC-05-05	5/23/2013	1668	644	0.3	0.9	<0.2	<0.2				0.001	0.001	<0.002	<0.002	4.69		0.7	11.7		-165	1.5	7.35
BDC-05-05	11/14/2013	1843	819	0.5	1.1	<0.2	<0.2				<0.001	<0.001	0.003	<0.002	1.95		0.0	21.8		-219	<1.0	6.70
BDC-05-05	5/13/2014	2023	999	0.4	0.9	<0.2	<0.2				<0.001	<0.001	<0.002	<0.002	4.35		0.0	18.6		-108	3.6	6.60
BDC-05-05	11/11/2014	2205	1181	0.3	0.8	<0.2	<0.2				0.001	0.001	<0.002	<0.002	2.50		0.0	12.5		92	<1.0	6.25
BDC-05-05	4/27/2015	2372	1348	0.4	1.0	<0.2	<0.2				0.001	0.001	0.003	<0.002	3.14		0.0	16.1		31	<1.0	6.25
BDC-05-05	10/28/2015	2556	1532	0.4	0.9	<0.2	<0.2				0.001	<0.0004	<0.002	<0.002	0.81		0.3	13.2		0	<1.0	6.39
BDC-05-05	4/21/2016	2732	1708	0.3	0.6	<0.2	<0.2				0.001	<0.0004	<0.002	<0.002	4.00		0.0	13.4		14.5	<1.0	6.37
BDC-05-05	11/2/2016	2927	1903	0.8	1.5	<0.2	<0.2				0.001	0.0004	0.003	0.003	0.29		0.2	35.7		6.6	3.2	6.54
BDC-05-05	5/3/2017	3109	2085	0.4	0.7	<0.2	<0.2				0.001	<0.0004	0.003	<0.002	4.43		0.0	21.3		74.9	1.9	6.29

Well	Date	Comments	VOCs- micromoles/Liter (b)								Molar Fraction (c)				
			PCE	TCE	c DCE	VC	Ethene	Ethane	Total Chloroethenes (d)	Ethene + Ethane	PCE	TCE	c DCE	VC	Ethene + Ethane
BDC-05-03	10/28/2015		0.00	0.00	0.00	0.00	0.00	0.04	0.01	0.04	0.08	0.06	0.00	0.10	0.76
BDC-05-03	4/20/2016		0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.83	0.17	0.00	0.00	0.00
BDC-05-03	11/3/2016		0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.79	0.21	0.00	0.00	0.00
BDC-05-03	5/4/2017		0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.79	0.21	0.00	0.00	0.00
BDC-05-04	5/21/2007		0.00	0.00	0.01	0.00			0.01		0.00	0.00	1.00	0.00	
(MW 22 ft XG)	11/26/2007		0.00	0.00	0.02	0.00			0.02		0.00	0.00	1.00	0.00	
	5/22/2008		0.01	0.01	0.01	0.00			0.03		0.32	0.24	0.44	0.00	
BDC-05-04	10/23/2008		0.01	0.01	0.02	0.00	0.00	0.00	0.03	0.00	0.19	0.18	0.63	0.00	0.00
BDC-05-04	11/20/2008		0.01	0.01	0.04	0.00	0.00	0.00	0.05	0.00	0.14	0.11	0.76	0.00	0.00
BDC-05-04	12/16/2008		0.00	0.00	0.02	0.00	0.00	0.00	0.02	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-04	1/16/2009		0.00	0.00	0.02	0.00	0.00	0.00	0.02	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-04	2/11/2009		0.01	0.00	0.02	0.00	0.00	0.00	0.02	0.00	0.28	0.00	0.72	0.00	0.00
BDC-05-04	3/9/2009		0.01	0.00	0.01	0.00	0.00	0.00	0.02	0.00	0.31	0.00	0.69	0.00	0.00
BDC-05-04	4/16/2009		0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	1.00	0.00	0.00	0.00	0.00
BDC-05-04	5/13/2009		0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-04	8/16/2009		0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	1.00	0.00	0.00	0.00	0.00
BDC-05-04	11/13/2009		0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-04	2/16/2010		0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-04	5/18/2010		0.01	0.00	0.01	0.00	0.00	0.00	0.02	0.00	0.35	0.00	0.65	0.00	0.00
BDC-05-04	8/17/2010		0.00	0.00	0.03	0.00	0.00	0.00	0.03	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-04	11/9/2010		0.00	0.00	0.04	0.00	0.00	0.00	0.04	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-04	2/15/2011		0.00	0.00	0.03	0.00	0.00	0.00	0.03	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-04	5/2/2011		0.00	0.00	0.03	0.00	0.00	0.00	0.04	0.00	0.06	0.10	0.84	0.00	0.00
BDC-05-04	11/2/2011		0.00	0.00	0.04	0.00			0.04		0.00	0.00	1.00	0.00	
BDC-05-04	5/7/2012		0.00	0.00	0.04	0.00			0.04		0.05	0.10	0.84	0.00	
BDC-05-04	11/13/2012		0.00	0.00	0.03	0.00			0.03		0.00	0.00	1.00	0.00	
BDC-05-04	5/23/2013		0.00	0.00	0.02	0.00			0.02		0.00	0.00	1.00	0.00	
BDC-05-04	11/13/2013		0.00	0.00	0.04	0.00			0.04		0.00	0.06	0.94	0.00	
BDC-05-04	5/13/2014		0.00	0.00	0.01	0.00			0.01		0.26	0.16	0.58	0.00	
BDC-05-04	11/11/2014		0.00	0.00	0.03	0.01			0.04		0.05	0.04	0.75	0.17	
BDC-05-04	4/27/2015		0.01	0.00	0.01	0.00			0.02		0.31	0.16	0.53	0.00	
BDC-05-04	10/28/2015		0.00	0.00	0.04	0.01			0.05		0.00	0.00	0.77	0.23	
BDC-05-04	4/21/2016		0.01	0.00	0.00	0.00			0.01		0.48	0.18	0.33	0.00	
BDC-05-04	11/2/2016		0.00	0.00	0.02	0.00			0.02		0.00	0.00	1.00	0.00	
BDC-05-04	5/3/2017		0.01	0.00	0.00	0.00			0.01		0.54	0.23	0.23	0.00	
BDC-05-05	5/21/2007		0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
(MW UG)	11/26/2007		0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
	5/22/2008		0.00	0.01	0.00	0.00			0.01		0.23	0.77	0.00	0.00	
BDC-05-05	10/23/2008		0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
BDC-05-05	11/20/2008		0.00	0.01	0.00	0.00			0.01		0.25	0.75	0.00	0.00	
BDC-05-05	12/16/2008		0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
BDC-05-05	1/16/2009		0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
BDC-05-05	2/11/2009		0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
BDC-05-05	3/9/2009		0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
BDC-05-05	4/16/2009		0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
BDC-05-05	5/13/2009		0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
BDC-05-05	8/16/2009		0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
BDC-05-05	11/13/2009		0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
BDC-05-05	2/16/2010		0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
BDC-05-05	5/18/2010		0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
BDC-05-05	8/17/2010		0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
BDC-05-05	11/9/2010		0.00	0.01	0.00	0.00			0.01		0.00	1.00	0.00	0.00	
BDC-05-05	2/15/2011		0.00	0.00	0.00	0.00			0.00		0.00	0.00	0.00	0.00	
BDC-05-05	5/2/2011		0.00	0.01	0.00	0.00			0.01		0.23	0.77	0.00	0.00	
BDC-05-05	11/2/2011		0.00	0.01	0.00	0.00			0.01		0.00	1.00	0.00	0.00	
BDC-05-05	5/6/2012		0.00	0.01	0.00	0.00			0.01		0.26	0.74	0.00	0.00	
BDC-05-05	11/13/2012		0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	1.00	0.00	0.00	0.00
BDC-05-05	5/23/2013		0.00	0.01	0.00	0.00			0.01		0.21	0.79	0.00	0.00	
BDC-05-05	11/14/2013		0.00	0.01	0.00	0.00			0.01		0.26	0.74	0.00	0.00	
BDC-05-05	5/13/2014		0.00	0.01	0.00	0.00			0.01		0.26	0.74	0.00	0.00	
BDC-05-05	11/11/2014		0.00	0.01	0.00	0.00			0.01		0.23	0.77	0.00	0.00	
BDC-05-05	4/27/2015		0.00	0.01	0.00	0.00			0.01		0.24	0.76	0.00	0.00	
BDC-05-05	10/28/2015		0.00	0.01	0.00	0.00			0.01		0.26	0.74	0.00	0.00	
BDC-05-05	4/21/2016		0.00	0.00	0.00	0.00			0.01		0.28	0.72	0.00	0.00	
BDC-05-05	11/2/2016		0.00	0.01	0.00	0.00			0.02		0.30	0.70	0.00	0.00	
BDC-05-05	5/3/2017		0.00	0.01	0.00	0.00			0.01		0.31	0.69	0.00	0.00	

Table 1
Groundwater Data Summary
Boeing Developmental Center
SWMU-17

Well	Date	Pilot Injection Elapsed Time From Injection (days)	Full Injection #1 Elapsed Time From Injection (days)	Volatile Organic Compounds PCE (µg/L)	TCE (µg/L)	c DCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	Metals As, Tot (mg/L)	As, Dis (mg/L)	Cu, Tot (mg/L)	Cu, Dis (mg/L)	Aquifer Redox Conditions DO (mg/L)	Nitrate (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (mg/L)	ORP (mV)	Donor Indicators TOC (mg/L)	pH	Comments
Proposed Groundwater Cleanup Levels (a)				5.3	1.4	134	2.4	NA	NA	NA	0.008	0.008	0.008	0.008									
BDC-05-07	5/21/2007	-526		30	22	10	<1.0				0.003	<0.001	0.014	0.009									
(IW)	11/26/2007	-337		28	25	11	<1.0				<0.001	<0.001	0.011	0.002									
	5/22/2008	-159		33	32	9.2	<0.2				0.002	<0.001	0.012	0.006									
BDC-05-07	10/23/2008	-5		22	24	14	<0.2	<1.1	<1.2	<1.1	0.004	0.002	0.022	0.013	9.71	9.6	0.0	33.4	0.6	86.0	7.8	6.47	
BDC-05-07	11/20/2008	23		17	17	4.9	<0.2	<1.1	<1.2	<1.1	0.003	<0.001	0.016	0.010	0.60	2.2	0.4	15.8	0.2	-27	4.6	6.46	
BDC-05-07	12/16/2008	49		16	25	7.2	<1.0	<1.1	<1.2	<1.1	0.003	0.001	0.016	0.012	1.20	4.8	0.0	29.4	0.6	-107	6.1	6.49	
BDC-05-07	1/16/2009	80		20	23	6.4	<1.0	<1.1	<1.2	<1.1	0.002	<0.001	0.013	0.008	0.00	8.4	0.0	32.6	0.03	-182	6.3	6.38	
BDC-05-07	2/11/2009	106		23	28	9.9	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.017	0.012	2.05	11.2	0.0	37.5	1.5	-68	9.3	6.37	
BDC-05-07	3/9/2009	132		20	21	8.4	<1.0	<1.1	<1.2	<1.1	<0.002	<0.001	0.013	0.009	0.00	8.8	0.3	35.3	5.5	-23	6.8	6.37	
BDC-05-07	4/16/2009	170		20	21	11	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.015	0.008	0.27	8.2	0.0	31.2	5.1	35	8.1	6.43	
BDC-05-07	5/13/2009	197		11	13	7.5	<1.0	<1.1	<1.2		0.002	0.001	0.016	0.008	0.29	6.8	0.4	27.2	7.9	34	7.3	6.47	
BDC-05-07	8/16/2009	292		11	12	13	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.010	<0.002	0.74	2.3	2.0	23.2	6.8	67	8.2	6.73	
BDC-05-07	11/13/2009	381		6.5	5.3	5.6	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.004	<0.002	0.50	<0.1	2.8	5.7	4.7	16	9.1	6.48	
BDC-05-07	2/16/2010	476		6.4	6.9	28	<1.0	<1.1	<1.2	<1.1	0.004	0.003	0.017	0.006	1.04	<0.1	2.5	20.4	5.2	839	14.7	6.88	
BDC-05-07	5/18/2010	567		5.8	9.2	41	1.2	<1.1	<1.2	<1.1	0.009	0.003	0.009	<0.002	1.06	<0.5	2.0	16.4	6.0	525	14.8	6.77	
BDC-05-07	8/17/2010	658		2.8	7.8	19	<1.0	<1.1	<1.2	<1.1	0.006	0.003	0.008	<0.002	2.30	<0.1	2.5	8.6	7.1	-15	18.8	7.34	
BDC-05-07	11/9/2010	742		<1.0	9.4	20	<1.0	<1.1	<1.2	<1.1	0.008	0.005	0.009	<0.002	2.42	<0.1	2.2	15.2	5.1	13	15.2	7.35	
BDC-05-07	2/15/2011	840		<1.0	8.7	20	<1.0	<1.1	<1.2	<1.1	0.013	0.010	0.012	0.002	3.02	<0.1	2.8	11.8	5.1	21	14.0	7.16	
BDC-05-07	5/2/2011	916	-108	5.2	11	17	<0.2	<1.1	<1.2	<1.1	0.017	0.004	0.014	0.003	2.14	0.1	2.6	15.6	3.2	33	16.8	6.90	
BDC-05-07	11/2/2011	1100	76	11	6.9	39	<1.0	<1.1	<1.2	<1.1	0.042	0.035	0.010	0.006	2.06	<0.1	2.4	<1.0	16.1	-51	1780	6.31	
BDC-05-07	5/7/2012	1287	263	0.8	<0.2	23	0.9	<1.0	<1.0	<1.0	0.026	0.024	0.003	<0.002	0.17		1.6	0.4	27.0	100	48.5	6.34	
BDC-05-07	11/15/2012	1479	455	<0.2	0.4	24	0.8	<1.0	<1.0	<1.0	0.016	0.017	<0.002	<0.002	0.01		1.6	<0.3	23.0	3.0	26	6.60	
BDC-05-07	5/22/2013	1667	643	<0.2	0.3	8.6	0.5	<1.0	<1.0	<1.0	0.006	0.007	<0.002	<0.002	0.17		1.4	0.45	11.0	-372	10.5	8.09	
BDC-05-07	11/13/2013	1842	818	<0.2	<0.2	3.4	1.6	<1.0	1.3	<1.0	0.006	0.007	<0.002	<0.002	2.12		1.2	<0.30	8.5	-276	8.8	6.70	
BDC-05-07	5/13/2014	2023	999	<0.2	0.2	2.5	1.4	<1.0	<1.0	<1.0	0.004	0.004	<0.002	<0.002	3.65		2.0	1.8	3.7	-368	9.1	6.55	
BDC-05-07	11/11/2014	2205	1181	<0.2	<0.2	4.1	13	26	3.0	<1.0	0.006	0.005	<0.002	<0.002	0.21		2.6	0.72	14.0	-74	17.7	6.37	
BDC-05-07	4/27/2015	2372	1348	<0.2	<0.2	0.6	5.3	1.6	<1.0	<1.0	0.004	0.005	<0.002	<0.002	0.06		2.0	<0.30	3.5	-50	5.5	6.27	
BDC-05-07	10/28/2015	2556	1532	0.4	<0.2	1.0	1.9	1.8	1.2	<1.0	0.004	0.004	0.002	<0.002	0.17		1.0	0.41	3.7	-9.9	5.4	6.30	
BDC-05-07	4/20/2016	2731	1707	0.5	<0.2	0.2	3.2	1.3	<1.0	<1.0	0.003	0.003	<0.002	<0.002	0.11		2.0	2.0	5.4	-23	3.8	6.35	
BDC-05-07	11/2/2016	2927	1903	0.8	<0.2	0.2	0.3	<1.0	1.6	<1.0	0.002	0.002	<0.002	<0.002	0.14		0.6	<0.30	8.4	-103	5.5	6.44	
BDC-05-07	5/4/2017	3110	2086	1.2	0.3	0.2	0.3	<1.0	<1.0	<1.0	0.001	<0.0004	<0.002	<0.002	0.37		1.0	3.3	3.1	31.4	3.6	6.25	
BDC-05-08	10/23/2008	-5		1.1	3.7	3.5	<0.2	<1.1	<1.2	<1.1	0.007	<0.001	0.004	<0.002	1.90	0.3	0.0	8.9	4.7	-12.0	5.1	6.65	
(MW 24 ft XG)	11/20/2008	23		1.1	3.4	4.2	<0.2	<1.1	<1.2	<1.1	0.035	0.004	0.036	<0.002	0.80	0.7	2.2	7.2	5.5	-43	5.9	6.63	
	12/16/2008	49		1.2	4.3	4.3	<1.0	<1.1	<1.2	<1.1	0.008	0.001	0.006	<0.002	0.50	0.9	4.6	21.8	3.6	-99	5.4	6.61	
BDC-05-08	1/16/2009	80		1.3	4.2	3.6	<1.0	<1.1	<1.2	<1.1	0.008	0.002	0.007	<0.002	0.25	1.7	3.0	7.0	6.9	-185	5.8	6.59	
BDC-05-08	2/11/2009	106		<1.0	3.2	3.9	<1.0	<1.1	<1.2	<1.1	0.019	0.001	0.010	<0.002	2.38	0.3	4.4	4.7	4.4	-78	7.0	6.69	
BDC-05-08	3/9/2009	132		<1.0	2.7	3.5	<1.0	<1.1	<1.2	<1.1	0.009	0.003	0.007	<0.002	0.07	<0.1	3.6	3.8	4.9	-4	6.7	6.65	
BDC-05-08	4/16/2009	170		<1.0	2.3	4.4	<1.0	<1.1	<1.2	<1.1	0.007	0.003	0.006	<0.002	0.42	<0.1	2.0	1.7	6.7	-8	6.8	6.80	
BDC-05-08	5/13/2009	197		<1.0	1.6	3.0	<1.0	<1.1	<1.2		0.009	0.003	0.007	0.002	1.77	<0.1	4.0	0.8	11.4	-13	6.0	6.87	
BDC-05-08	8/16/2009	292		<1.0	2.1	3.5	<1.0	<1.1	<1.2	<1.1	0.012	0.008	<0.002	<0.002	0.87	<0.1	2.8	5.3	13.2	-20	6.1	7.15	
BDC-05-08	11/13/2009	381		<1.0	1.2	3.1	<1.0	<1.1	<1.2	<1.1	0.011	0.008	0.007	<0.002	0.73	<0.1	2.8	3.3	17.4	0.8	8.4	6.44	
BDC-05-08	2/16/2010	476		<1.0	<1.0	2.3	<1.0	<1.1	<1.2	<1.1	0.024	0.009	0.024	<0.002	0.63	<0.1	3.0	0.8	13.1	841	8.3	6.76	
BDC-05-08	5/18/2010	567		<1.0	<1.0	2.4	<1.0	<1.1	<1.2	<1.1	0.031	0.011	0.027	<0.002	0.96	<0.1	3.0	0.8	14.9	451	7.3	6.92	
BDC-05-08	8/17/2010	658		<1.0	<1.0	2.3	<1.0	<1.1	<1.2	<1.1	0.014	0.009	0.013	<0.002	2.57	<0.1	3.2	0.5	10.1	-30	7.2	7.30	
BDC-05-08	11/9/2010	742		<1.0	<1.0	3.5	<1.0	<1.1	<1.2	<1.1	0.031	0.012	0.031	<0.002	2.74	<0.1	2.4	0.3	14.2	59	7.6	7.17	
BDC-05-08	2/15/2011	840		<1.0	<1.0	2.1	<1.0	<1.1	<1.2	<1.1	0.021	0.010	0.016	<0.002	2.36	<0.1	5.0	0.3	14.1	66	8.7	7.08	
BDC-05-08	5/2/2011	916	-108	<0.2	<0.2	2.2	<0.2	<1.1	<1.2	<1.1	0.029	0.010	0.024	<0.002	2.15	<0.1	2.4	0.7	7.8	-28	8.0	7.17	
BDC-05-08	11/2/2011	1100	76	<1.0	<1.0	2.4	<1.0				0.014	0.010	0.012	0.003	1.15	<0.1	1.2	0.8		-53	7.3	6.88	
BDC-05-08	5/6/2012	1286	262	<0.2	<0.2	2.7	<0.2				0.021	0.020	0.007	0.002	0.01		2.5	0.4		42	12.4	6.77	
BDC-05-08	11/16/2012	1480	456	<0.5	<0.5	1.3	<0.5				0.014	0.010	0.005	<0.002	0.01		1.0	<0.3		5	8.1	6.91	
BDC-05-08	5/23/2013	1668	644	<0.2	<0.2	0.4	<0.2				0.008	0.007	0.002	<0.002	0.39		1.3	<0.3		-249	5.7	7.68	
BDC-05-08	11/13/2013	1842	818	<0.2	<0.2	4.3	0.8				0.012	0.010	0.003	<0.002	2.02		1.4	<0.30		-275	15.0	6.73	
BDC-05-08	5/13/2014	2023	999	<0.2	<0.2	2.9	1.8	<1.0	<1.0	<1.0	0.015	0.011	0.004	<0.002	2.02		1.4	0.31	7.7	-255	9.5	6.87	
BDC-05-08	11/10/2014	2204	1180	<0.2	<0.2	3.8	16				0.017	0.015	0.003	<0.002	0.04		1.4	0.65		-104	21.6	6.26	
BDC-05-08	4/27/2015	2372	1348	<0.2	<0.2	0.8	2.3				0.019	0.011	0.004	<0.002	0.05		0.6	<0.30		-90	9.4	6.36	
BDC-05-08	10/28/2015	2556	1532	<0.2	<0.2	0.3	0.5				0.011	0.008	0.002	<0.002	0.06		1.0	<0.30		-31	8.6	6.47	
BDC-05-08	4/21/2016	2732	1708	<0.2	<0.2	0.2	1.2				0.014	0.012	0.007	<0.002	0.22			<0.30		-38	3.8	6.53	
BDC-05-08	11/3/2016	2928	1904	<0.2	<0.2	0.2	0.5								0.19		1.6	<0.30		-109.8	4.7	6.22	
BDC-05-08	5/4/2017	3110	2086	<0.2	<0.2	<0.2	0.5								0.62		1.6	0.41		-107.5	5.7	6.36	

Well	Date	VOCs- micromoles/Liter (b) PCE	TCE	c DCE	VC	Ethene	Ethane	Total Chloroethenes (d)	Ethene + Ethane	Molar Fraction (c) PCE	TCE	c DCE	VC	Ethene + Ethane
BDC-05-07	5/21/2007	0.18	0.17	0.10	0.00			0.45		0.40	0.37	0.23	0.00	
(IW)	11/26/2007	0.17	0.19	0.11	0.00			0.47		0.36	0.40	0.24	0.00	
	5/22/2008	0.20	0.24	0.09	0.00			0.54		0.37	0.45	0.18	0.00	
BDC-05-07	10/23/2008	0.13	0.18	0.14	0.00	0.00	0.00	0.46	0.00	0.29	0.40	0.31	0.00	0.00
BDC-05-07	11/20/2008	0.10	0.13	0.05	0.00	0.00	0.00	0.28	0.00	0.36	0.46	0.18	0.00	0.00
BDC-05-07	12/16/2008	0.10	0.19	0.07	0.00	0.00	0.00	0.36	0.00	0.27	0.53	0.21	0.00	0.00
BDC-05-07	1/16/2009	0.12	0.18	0.07	0.00	0.00	0.00	0.36	0.00	0.33	0.48	0.18	0.00	0.00
BDC-05-07	2/11/2009	0.14	0.21	0.10	0.00	0.00	0.00	0.45	0.00	0.31	0.47	0.22	0.00	0.00
BDC-05-07	3/9/2009	0.12	0.16	0.09	0.00	0.00	0.00	0.37	0.00	0.33	0.44	0.24	0.00	0.00
BDC-05-07	4/16/2009	0.12	0.16	0.11	0.00	0.00	0.00	0.39	0.00	0.31	0.41	0.29	0.00	0.00
BDC-05-07	5/13/2009	0.07	0.10	0.08	0.00	0.00	0.00	0.24	0.00	0.27	0.41	0.32	0.00	0.00
BDC-05-07	8/16/2009	0.07	0.09	0.13	0.00	0.00	0.00	0.29	0.00	0.23	0.31	0.46	0.00	0.00
BDC-05-07	11/13/2009	0.04	0.04	0.06	0.00	0.00	0.00	0.14	0.00	0.29	0.29	0.42	0.00	0.00
BDC-05-07	2/16/2010	0.04	0.05	0.29	0.00	0.00	0.00	0.38	0.00	0.10	0.14	0.76	0.00	0.00
BDC-05-07	5/18/2010	0.03	0.07	0.42	0.02	0.00	0.00	0.55	0.00	0.06	0.13	0.77	0.04	0.00
BDC-05-07	8/17/2010	0.02	0.06	0.20	0.00	0.00	0.00	0.27	0.00	0.06	0.22	0.72	0.00	0.00
BDC-05-07	11/9/2010	0.00	0.07	0.21	0.00	0.00	0.00	0.28	0.00	0.00	0.26	0.74	0.00	0.00
BDC-05-07	2/15/2011	0.00	0.07	0.21	0.00	0.00	0.00	0.27	0.00	0.00	0.24	0.76	0.00	0.00
BDC-05-07	5/2/2011	0.03	0.08	0.18	0.00	0.00	0.00	0.29	0.00	0.11	0.29	0.60	0.00	0.00
BDC-05-07	11/2/2011	0.07	0.05	0.40	0.00	0.00	0.00	0.52	0.00	0.13	0.10	0.77	0.00	0.00
BDC-05-07	5/7/2012	0.00	0.00	0.24	0.01	0.00	0.00	0.26	0.00	0.02	0.00	0.93	0.06	0.00
BDC-05-07	11/15/2012	0.00	0.00	0.25	0.01	0.00	0.00	0.26	0.00	0.00	0.01	0.94	0.05	0.00
BDC-05-07	5/22/2013	0.00	0.00	0.09	0.01	0.00	0.00	0.10	0.00	0.00	0.02	0.90	0.08	0.00
BDC-05-07	11/13/2013	0.00	0.00	0.04	0.03	0.00	0.04	0.06	0.04	0.00	0.00	0.34	0.25	0.42
BDC-05-07	5/13/2014	0.00	0.00	0.03	0.02	0.00	0.00	0.05	0.00	0.00	0.03	0.52	0.45	0.00
BDC-05-07	11/11/2014	0.00	0.00	0.04	0.21	0.93	0.10	0.25	1.03	0.00	0.00	0.03	0.16	0.80
BDC-05-07	4/27/2015	0.00	0.00	0.01	0.08	0.06	0.00	0.09	0.06	0.00	0.00	0.04	0.57	0.39
BDC-05-07	10/28/2015	0.00	0.00	0.01	0.03	0.06	0.04	0.04	0.10	0.02	0.00	0.07	0.21	0.71
BDC-05-07	4/20/2016	0.00	0.00	0.00	0.05	0.05	0.00	0.06	0.05	0.03	0.00	0.02	0.50	0.45
BDC-05-07	11/2/2016	0.00	0.00	0.00	0.00	0.00	0.05	0.01	0.05	0.07	0.00	0.03	0.07	0.82
BDC-05-07	5/4/2017	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.44	0.14	0.13	0.29	0.00
BDC-05-08	10/23/2008	0.01	0.03	0.04	0.00	0.00	0.00	0.07	0.00	0.09	0.40	0.51	0.00	0.00
(MW 24 ft XG)	11/20/2008	0.01	0.03	0.04	0.00	0.00	0.00	0.08	0.00	0.09	0.34	0.57	0.00	0.00
	12/16/2008	0.01	0.03	0.04	0.00	0.00	0.00	0.08	0.00	0.09	0.39	0.53	0.00	0.00
BDC-05-08	1/16/2009	0.01	0.03	0.04	0.00	0.00	0.00	0.08	0.00	0.10	0.42	0.48	0.00	0.00
BDC-05-08	2/11/2009	0.00	0.02	0.04	0.00	0.00	0.00	0.06	0.00	0.00	0.38	0.62	0.00	0.00
BDC-05-08	3/9/2009	0.00	0.02	0.04	0.00	0.00	0.00	0.06	0.00	0.00	0.36	0.64	0.00	0.00
BDC-05-08	4/16/2009	0.00	0.02	0.05	0.00	0.00	0.00	0.06	0.00	0.00	0.28	0.72	0.00	0.00
BDC-05-08	5/13/2009	0.00	0.01	0.03	0.00	0.00	0.00	0.04	0.00	0.00	0.28	0.72	0.00	0.00
BDC-05-08	8/16/2009	0.00	0.02	0.04	0.00	0.00	0.00	0.05	0.00	0.00	0.31	0.69	0.00	0.00
BDC-05-08	11/13/2009	0.00	0.01	0.03	0.00	0.00	0.00	0.04	0.00	0.00	0.22	0.78	0.00	0.00
BDC-05-08	2/16/2010	0.00	0.00	0.02	0.00	0.00	0.00	0.02	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-08	5/18/2010	0.00	0.00	0.02	0.00	0.00	0.00	0.02	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-08	8/17/2010	0.00	0.00	0.02	0.00	0.00	0.00	0.02	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-08	11/9/2010	0.00	0.00	0.04	0.00	0.00	0.00	0.04	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-08	2/15/2011	0.00	0.00	0.02	0.00	0.00	0.00	0.02	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-08	5/2/2011	0.00	0.00	0.02	0.00	0.00	0.00	0.02	0.00	0.00	0.00	1.00	0.00	0.00
BDC-05-08	11/2/2011	0.00	0.00	0.02	0.00			0.02		0.00	0.00	1.00	0.00	
BDC-05-08	5/6/2012	0.00	0.00	0.03	0.00			0.03		0.00	0.00	1.00	0.00	
BDC-05-08	11/16/2012	0.00	0.00	0.01	0.00			0.01		0.00	0.00	1.00	0.00	
BDC-05-08	5/23/2013	0.00	0.00	0.00	0.00			0.00		0.00	0.00	1.00	0.00	
BDC-05-08	11/13/2013	0.00	0.00	0.04	0.01			0.06		0.00	0.00	0.78	0.22	
BDC-05-08	5/13/2014	0.00	0.00	0.03	0.03	0.00	0.00	0.06	0.00	0.00	0.00	0.51	0.49	0.00
BDC-05-08	11/10/2014	0.00	0.00	0.04	0.26			0.30		0.00	0.00	0.13	0.87	
BDC-05-08	4/27/2015	0.00	0.00	0.01	0.04			0.05		0.00	0.00	0.18	0.82	
BDC-05-08	10/28/2015	0.00	0.00	0.00	0.01			0.01		0.00	0.00	0.28	0.72	
BDC-05-08	4/21/2016	0.00	0.00	0.00	0.02			0.02		0.00	0.00	0.10	0.90	
BDC-05-08	11/3/2016	0.00	0.00	0.00	0.01			0.01		0.00	0.00	0.21	0.79	
BDC-05-08	5/4/2017	0.00	0.00	0.00	0.01			0.01		0.00	0.00	0.00	1.00	

Table 1
Groundwater Data Summary
Boeing Developmental Center
SWMU-17

Well	Date	Pilot Injection Elapsed Time From Injection (days)	Full Injection #1 Elapsed Time From Injection (days)	Volatile Organic Compounds: PCE (µg/L)	TCE (µg/L)	c DCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	Metals: As, Tot (mg/L)	As, Dis (mg/L)	Cu, Tot (mg/L)	Cu, Dis (mg/L)	Aquifer Redox Conditions: DO (mg/L)	Nitrate (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (mg/L)	ORP (mV)	Donor Indicators: TOC (mg/L)	pH	Comments
Proposed Groundwater Cleanup Levels (a)				5.3	1.4	134	2.4	NA	NA	NA	0.008	0.008	0.008	0.008									
BDC-05-09	7/31/2011		-18	30	20	22	<1.0	<1.1	<1.2	<1.1	0.007	0.007	<0.002	<0.002	1.37	<0.1	2.5	12.1	1.4	15	5.5	6.89	
(IW)	11/2/2011		76	37	56	44	1.3	<1.1	<1.2	<1.1	0.042	0.040	0.009	0.006	2.80	<0.1	3.0	7.6	4.3	80	4360	5.24	
	5/7/2012		263	3.0	1.1	250	3.9	<1.0	<1.0	<1.0	0.059	0.052	0.011	<0.002	0.69		2.2	0.5	18.0	85	531	6.33	
BDC-05-09	11/15/2012		455	<2.0	<2.0	24	20	69	<1.0	<1.0	0.074	0.070	0.006	<0.002	0.01		1.2	<0.3	27.0	-10	266	6.71	
BDC-05-09	5/22/2013		643	<0.2	<0.2	1.0	3.7	23	3.4	<1.0	0.026	0.025	0.003	<0.002	0.18		1.5	<0.3	17.0	-300	40.6	7.83	
BDC-05-09	11/13/2013		818	<0.2	<0.2	3.2	14	8.6	8.3	<1.0	0.022	0.022	<0.002	<0.002	2.80		1.4	0.9	11.0	-263	36.8	6.61	
BDC-05-09	5/13/2014		999	<0.2	<0.2	0.7	1.0	1.6	8.5	<1.0	0.010	0.010	<0.002	<0.002	3.66		1.5	1.9	8.0	-356	13.1	6.53	
BDC-05-09	11/11/2014		1181	<0.2	<0.2	1.1	3.5	1.2	6.4	<1.0	0.018	0.017	<0.002	<0.002	0.08		2.3	0.72	8.5	-47	6.9	6.19	
BDC-05-09	4/27/2015		1348	<0.2	<0.2	0.4	8.3	5.0	4.3	<1.0	0.007	0.009	<0.002	<0.002	0.04		1.4	0.68	7.5	-53	4.0	6.27	
BDC-05-09	10/28/2015		1532	<0.2	<0.2	0.3	2.1	<1.0	2.0	<1.0	0.008	0.008	<0.002	<0.002	0.15		1.0	<0.30	5.3	-5.3	2.5	6.36	
BDC-05-09	4/20/2016		1707	<0.2	<0.2	<0.2	2.8	1.9	8.4	<1.0	0.007	0.009	<0.002	<0.002	0.08		3.0	<0.30	6.6	-30	2.8	6.36	
BDC-05-09	11/2/2016		1903	<0.2	<0.2	<0.2	1.3	1.0	9.2	<1.0	0.009	0.009	<0.002	<0.002	0.41		1.6	2.8	7.6	-82.3	5.2	6.36	
BDC-05-09	5/4/2017		2086	<0.2	<0.2	0.4	2.8	1.0	9.0	<1.0	0.006	0.006	<0.002	<0.002	0.26		2.0	4.3	5.3	-83.9	4.3	6.32	
BDC-05-10	7/31/2011		-18	39	26	12	<1.0	<1.1	<1.2	<1.1	0.002	0.002	<0.002	<0.002	1.41	<0.1	2.0	19.7	0.3	76	4.5	6.84	
(IW)	11/2/2011		76	22	27	1.0	<1.0	1.6	1.7	<1.1	0.038	0.037	0.008	0.004	2.43	<0.1	2.2	10.9	0.1	-38	2030	5.72	
	5/6/2012		262	<1.0	<1.0	120	5.4	1.1	<1.0	<1.0	0.052	0.048	0.012	<0.002	0.02		1.7	0.4	19.0	58	270	6.48	
BDC-05-10	11/15/2012		455	<1.0	<1.0	4.4	49	8.5	<1.0	<1.0	0.069	0.060	0.003	<0.002	0.02		1.0	<0.3	24.0	-11	122	6.63	
BDC-05-10	5/22/2013		643	<0.2	<0.2	0.3	11	14	<3.0	<1.0	0.056	0.053	0.003	<0.002	0.25		1.2	0.49	20.0	-308	50.8	7.84	
BDC-05-10	11/13/2013		818	<0.2	<0.2	0.6	15	17	<1.0	<1.0	0.058	0.052	<0.002	<0.002	3.33		1.8	<0.30	23.0	-263	54.1	6.55	
BDC-05-10	5/13/2014		999	<0.2	<0.2	<0.2	5.1	29	<1.0	<1.0	0.037	0.034	<0.002	<0.002	3.87		1.6	<0.30	21.0	-196	27.6	6.53	
BDC-05-10	11/10/2014		1180	<0.2	<0.2	0.2	3.9	3.4	<1.0	<1.0	0.040	0.038	<0.002	<0.002	0.03		1.0	<0.30	16.0	-86	19.3	6.25	
BDC-05-10	4/27/2015		1348	<0.2	<0.2	<0.2	2.9	7.2	8.3	<1.0	0.026	0.024	0.003	<0.002	0.04		0.8	<0.30	14.0	-68	10.3	6.24	
BDC-05-10	10/28/2015		1532	<0.2	<0.2	<0.2	0.7	<1.0	3.2	<1.0	0.021	0.019	<0.002	<0.002	0.17		1.0	<0.30	7.4	-14	7.8	6.42	
BDC-05-10	4/20/2016		1707	<0.2	<0.2	<0.2	1.8	3.9	11	<1.0	0.015	0.016	<0.002	<0.002	0.22		1.1	0.65	5.8	-17	5.0	6.22	
BDC-05-10	11/2/2016		1903	<0.2	<0.2	<0.2	0.8	<1.0	19	<1.0	0.022	0.021	<0.002	<0.002	0.15		0.6	<0.30	6.1	-109	7.5	6.34	
BDC-05-10	5/4/2017		2086	<0.2	<0.2	0.3	1.8	1.0	15	<1.0	0.015	0.014	<0.002	<0.002	0.23		2.0	1.7	4.0	-89.7	6.0	6.38	
BDC-05-11	7/31/2011		-18	16	19	5.8	<1.0	<1.1	<1.2	<1.1	0.005	0.005	<0.002	<0.002	1.41	<0.1	2.0	4.0	1.4	65	3.9	6.93	
(IW)	11/2/2011		76	9.6	20	12	<1.0	<1.1	<1.2	<1.1	0.039	0.037	0.013	0.004	2.16	<0.1	1.8	<1.0	1.0	-38	1330	5.72	
	5/6/2012		262	0.2	0.5	44	7.2	1.6	<1.0	<1.0	0.038	0.034	0.009	0.002	0.01		1.4	0.5	18.0	70	284	6.42	
BDC-05-11	11/15/2012		455	<1.0	<1.0	6.1	5.7	7.6	<1.0	<1.0	0.043	0.038	0.003	<0.002	0.02		1.3	<0.3	26.0	-15	73.8	6.76	
BDC-05-11	5/22/2013		643	<0.2	<0.2	0.3	2.9	16	3.7	<1.0	0.035	0.032	<0.002	<0.002	0.25		1.6	0.43	23.0	-299	42.1	7.71	
BDC-05-11	11/13/2013		818	<0.2	<0.2	0.2	3.9	17	4.6	<1.0	0.038	0.035	0.002	<0.002	3.81		2.0	0.36	24.0	-264	48.4	6.5	
BDC-05-11	5/13/2014		999	<0.2	<0.2	<0.2	2.0	9.0	7.2	<1.0	0.038	0.036	<0.002	<0.002	4.13		1.8	<0.30	24.0	-185	38.1	6.49	
BDC-05-11	11/10/2014		1180	<0.2	<0.2	<0.2	2.5	1.7	1.9	<1.0	0.030	0.030	<0.002	<0.002	0.01		1.8	<0.30	8.0	-88	11.1	6.30	
BDC-05-11	4/27/2015		1348	<0.2	<0.2	<0.2	3.5	2.1	<1.0	<1.0	0.019	0.017	<0.002	<0.002	0.07		0.8	0.81	6.2	-77	7.6	6.22	
BDC-05-11	10/28/2015		1532	<0.2	<0.2	<0.2	1.5	1.8	2.1	<1.0	0.018	0.017	<0.002	<0.002	0.11		0.6	<0.30	15.0	-16	7.4	6.52	
BDC-05-11	4/20/2016		1707	<0.2	<0.2	<0.2	1.4	3.3	2.6	<1.0	0.020	0.020	<0.002	<0.002	0.08		0.8	<0.30	13.0	-15.4	6.5	6.33	
BDC-05-11	11/2/2016		1903	<0.2	<0.2	<0.2	0.4	1.8	5.8	<1.0	0.017	0.015	<0.002	<0.002	0.11		2.8	<0.30	13.0	-118.1	9.0	6.27	
BDC-05-11	5/4/2017		2086	<0.2	<0.2	<0.2	0.8	2.5	6.8	<1.0	0.018	0.018	<0.002	<0.002	0.24		2.0	<0.30	9.0	-101.7	9.2	6.37	
BDC-05-12	7/31/2011		-18	15	18	16	<1.0	<1.1	<1.2	<1.1	0.002	0.002	0.002	<0.002	1.60	0.1	2.4	8.4	4.0	26	7.0	7.02	
(IW)	11/2/2011		76	11	17	11	<1.0	<1.1	<1.2	<1.1	0.041	0.031	0.012	0.009	2.60	<0.1	3.5	5.6	1.0	-77	2960	5.83	
	2/19/2012		185	<0.4	<0.4	53	1.8	<1.0	<1.0	<1.0					1.7	<0.5	2.0	<1.5	17.0	-2	279	6.59	
BDC-05-12	5/6/2012		262	<0.2	<0.2	39	3.4	<1.0	<1.0	<1.0	0.082	0.071	0.005	<0.002	0.03		2.5	0.8	21.0	65	83.2	6.45	
BDC-05-12	9/5/2012		384	<0.2	<0.2	6.5	3.3	1.0	<1.0	<1.0					0.13		1.8	<0.3	22.0	80	50.4	6.48	
BDC-05-12	11/15/2012		455	<1.0	<1.0	7.9	5.4	1.1	<1.0	<1.0	0.037	0.036	0.002	<0.002	0.03		1.3	<0.3	27.0	7	52.9	6.56	
BDC-05-12	2/25/2013		557	<1.0	<1.0	1.7	4.4	3.8	<1.0	<1.0					0.18		2.0	<0.3	26.0	54	27.5	6.68	
BDC-05-12	5/22/2013		643	<0.2	<0.2	0.8	5.0	12	<3.0	<1.0	0.022	0.022	<0.002	<0.002	0.29		1.4	<0.3	24.0	-366	35.4	8.08	
BDC-05-12	8/29/2013		742	<2.0	<2.0	<2.0	<2.0	5.5	2.8	<1.0					5.25		1.6	<0.30	22.0	-320	32.6	6.53	
BDC-05-12	11/13/2013		818	<2.0	<2.0	<2.0	<2.0	2.2	3.4	<1.0	0.010	0.012	<0.002	<0.002	2.61		2.6	0.39	26.0	-268	26.9	6.66	
BDC-05-12	2/11/2014		908	<1.0	<1.0	<1.0	<1.0	1.1	<6.0	<1.0					4.83		2.2	0.37	23.0	-239	19.7	6.57	
BDC-05-12	5/13/2014		999	<1.0	<1.0	<1.0	<1.0	1.0	5.6	<1.0	0.007	0.006	<0.002	<0.002	3.01		2.0	0.49	25.0	-299	21.5	6.60	
BDC-05-12	8/6/2014		1084	<1.0	<1.0	<1.0	1.1	1.8	4.5	<1.0					7.00		1.5	<0.30	21.0	-146	43.1	7.05	
BDC-05-12	11/10/2014		1180	<1.0	<1.0	<1.0	1.7	2.5	8.9	<1.0	0.017	0.018	<0.002	<0.002	0.03		0.8	<0.30	25.0	-83	30.3	6.23	
BDC-05-12	1/21/2015		1252	<0.2	<0.2	<0.2	2.8	1.5	5.0	<1.0					0.12		2.2	0.45	17.0	-115	22.6	6.25	
BDC-05-12	4/27/2015		1348	<0.2	<0.2	<0.2	1.4	1.2	2.2	<1.0	0.017	0.017	<0.002	<0.002	0.07		1.1	<0.30	21.0	-84	13.2	6.29	
BDC-05-12	7/21/2015		1433	<0.2	<0.2	<0.2	0.7	<1.0	3.1	<1.0					0.12		1.4	<0.30	18.0	-41	15.2	6.25	
BDC-05-12	10/28/2015		1532	<0.2	<0.2	<0.2	0.9	<1.0	2.6	<1.0	0.034	0.033	0.003	<0.002	0.08		1.4	<0.30	14.0	-28	29.0	6.40	
BDC-05-12	1/26/2016		1622	<0.2	<0.2	<0.2	0.8	1.3	4.3	<1.0					0.11		1.1	<0.30	19.0	-129	32.7	6.52	
BDC-05-12	4/20/2016		1707	<0.2	<0.2	<0.2	0.4	<1.0	4.3	<1.0	0.016	0.017	<0.002	<0.002	0.10		1.1	<0.30	16.0	-44	14.3	6.45	
BDC-05-12	8/9/2016		1818	<0.2	<0.2	<0.2	0.4	<1.0	2.7	<1.0	0.004	0.008	<0.002	<0.002	0.35		2.5	<0.30	13.0	-106.8	9.4	6.11	
BDC-05-12	11/3/2016		1904	<0.2	<0.2	<0.2	<0.2	<1.0	2.8	<1.0	0.016	0.014	<0.002	<0.002	0.13		3.0	<0.30	12.0	-129.0	10.6	6.44	
BDC-05-12	2/8/2017		2001	<0.2	<0.2	<0.2	0.4	<1.0	1.9	<1.0	0.006	0.007	<0.002	<0.002	0.28		2.4	<0.30	12.0	-25.1	8.6	6.52	
BDC-05-12	5/4/2017		2086	<0.2	<0.2	<0.2	0.3	<1.0	2.4	<1.0	0.010	0.009	<0.002	<0.002	0.22		2.2	<0.30	11.0	-94.4	8.1	6.33	
BDC-05-12	8/1/2017		2175	<0.2	<0.2	<0.2	<0.2	<1.0	8.0	<1.0	0.011	0.009	<0.002	<0.002	0.08		2.3	<0.30	9.5	-85.0	7.6	6.08	

Well	Date	VOCs- micromoles/Liter (b): PCE	TCE	c DCE	VC	Ethene	Ethane	Total Chloroethenes (d)	Ethene + Ethane	Molar Fraction (c): PCE	TCE	c DCE	VC	Ethene + Ethane
BDC-05-09	7/31/2011	0.18	0.15	0.23	0.00	0.00	0.00	0.56	0.00	0.32	0.27	0.41	0.00	0.00
(IW)	11/2/2011	0.22	0.43	0.45	0.02	0.00	0.00	1.12	0.00	0.20	0.38	0.40	0.02	0.00
	5/7/2012	0.02	0.01	2.58	0.06	0.00	0.00	2.67	0.00	0.01	0.00	0.97	0.02	0.00
BDC-05-09	11/15/2012	0.00	0.00	0.25	0.32	2.46	0.00	0.57	2.46	0.00	0.00	0.08	0.11	0.81
BDC-05-09	5/22/2013	0.00	0.00	0.01	0.06	0.82	0.11	0.07	0.93	0.00	0.00	0.01	0.06	0.93
BDC-05-09	11/13/2013	0.00	0.00	0.03	0.22	0.31	0.28	0.26	0.58	0.00	0.00	0.04	0.27	0.69
BDC-05-09	5/13/2014	0.00	0.00	0.01	0.02	0.06	0.28	0.02	0.34	0.00	0.00	0.02	0.04	0.94
BDC-05-09	11/11/2014	0.00	0.00	0.01	0.06	0.04	0.21	0.07	0.26	0.00	0.00	0.04	0.17	0.79
BDC-05-09	4/27/2015	0.00	0.00	0.00	0.13	0.18	0.14	0.14	0.32	0.00	0.00	0.01	0.29	0.70
BDC-05-09	10/28/2015	0.00	0.00	0.00	0.03	0.00	0.07	0.04	0.07	0.00	0.00	0.03	0.33	0.64
BDC-05-09	4/20/2016	0.00	0.00	0.00	0.04	0.07	0.28	0.04	0.35	0.00	0.00	0.00	0.11	0.89
BDC-05-09	11/2/2016	0.00	0.00	0.00	0.02	0.04	0.31	0.02	0.34	0.00	0.00	0.00	0.06	0.94
BDC-05-09	5/4/2017	0.00	0.00	0.00	0.04	0.04	0.30	0.05	0.33	0.00	0.00	0.01	0.12	0.87
BDC-05-10	7/31/2011	0.24	0.20	0.12	0.00	0.00	0.00	0.56	0.00	0.42	0.36	0.22	0.00	0.00
(IW)	11/2/2011	0.13	0.21	0.01	0.00	0.06	0.06	0.35	0.11	0.29	0.44	0.02	0.00	0.25
	5/6/2012	0.00	0.00	1.24	0.09	0.04	0.00	1.32	0.04	0.00	0.00	0.91	0.06	0.03
BDC-05-10	11/15/2012	0.00	0.00	0.05	0.78	0.30	0.00	0.83	0.30	0.00	0.00	0.04	0.69	0.27
BDC-05-10	5/22/2013	0.00	0.00	0.00	0.18	0.50	0.00	0.18	0.50	0.00	0.00	0.00	0.26	0.74
BDC-05-10	11/13/2013	0.00	0.00	0.01	0.24	0.61	0.00	0.25	0.61	0.00	0.00	0.01	0.28	0.71
BDC-05-10	5/13/2014	0.00	0.00	0.00	0.08	1.03	0.00	0.08	1.03	0.00	0.00	0.00	0.07	0.93
BDC-05-10	11/10/2014	0.00	0.00	0.00	0.06	0.12	0.00	0.06	0.12	0.00	0.00	0.01	0.34	0.65
BDC-05-10	4/27/2015	0.00	0.00	0.00	0.05	0.26	0.28	0.05	0.53	0.00	0.00	0.00	0.08	0.92
BDC-05-10	10/28/2015	0.00	0.00	0.00	0.01	0.00	0.11	0.01	0.11	0.00	0.00	0.00	0.10	0.90
BDC-05-10	4/20/2016	0.00	0.00	0.00	0.03	0.14	0.37	0.03	0.50	0.00	0.00	0.00	0.05	0.95
BDC-05-10	11/2/2016	0.00	0.00	0.00	0.01	0.00	0.63	0.01	0.63	0.00	0.00	0.00	0.02	0.98
BDC-05-10	5/4/2017	0.00	0.00	0.00	0.03	0.04	0.50	0.03	0.53	0.00	0.00	0.01	0.05	0.94
BDC-05-11	7/31/2011	0.10	0.14	0.06	0.00	0.00	0.00	0.30	0.00	0.32	0.48	0.20	0.00	0.00
(IW)	11/2/2011	0.06	0.15	0.12	0.00	0.00	0.00	0.33	0.00	0.17	0.46	0.37	0.00	0.00
	5/6/2012	0.00	0.00	0.45	0.12	0.06	0.00	0.57	0.06	0.00	0.01	0.72	0.18	0.09
BDC-05-11	11/15/2012	0.00	0.00	0.06	0.09	0.27	0.00	0.15	0.27	0.00	0.00	0.15	0.21	0.64
BDC-05-11	5/22/2013	0.00	0.00	0.00	0.05	0.57	0.12	0.05	0.69	0.00	0.00	0.00	0.06	0.93
BDC-05-11	11/13/2013	0.00	0.00	0.00	0.06	0.61	0.15	0.06	0.76	0.00	0.00	0.00	0.08	0.92
BDC-05-11	5/13/2014	0.00	0.00	0.00	0.03	0.32	0.24	0.03	0.56	0.00	0.00	0.00	0.05	0.95
BDC-05-11	11/10/2014	0.00	0.00	0.00	0.04	0.06	0.06	0.04	0.12	0.00	0.00	0.00	0.24	0.76
BDC-05-11	4/27/2015	0.00	0.00	0.00	0.06	0.07	0.00	0.06	0.07	0.00	0.00	0.00	0.43	0.57
BDC-05-11	10/28/2015	0.00	0.00	0.00	0.02	0.06	0.07	0.02	0.13	0.00	0.00	0.00	0.15	0.85
BDC-05-11	4/20/2016	0.00	0.00	0.00	0.02	0.12	0.09	0.02	0.20	0.00	0.00	0.00	0.10	0.90
BDC-05-11	11/2/2016	0.00	0.00	0.00	0.01	0.06	0.19	0.01	0.26	0.00	0.00	0.00	0.02	0.98
BDC-05-11	5/4/2017	0.00	0.00	0.00	0.01	0.09	0.23	0.01	0.32	0.00	0.00	0.00	0.04	0.96
BDC-05-12	7/31/2011	0.09	0.14	0.17	0.00	0.00	0.00	0.39	0.00	0.23	0.35	0.42	0.00	0.00
(IW)	11/2/2011	0.07	0.13	0.11	0.00	0.00	0.00	0.31	0.00	0.21	0.42	0.37	0.00	0.00
	2/19/2012	0.00	0.00	0.55	0.03	0.00	0.00	0.58	0.00	0.00	0.00	0.95	0.05	0.00
BDC-05-12	5/6/2012	0.00	0.00	0.40	0.05	0.00	0.00	0.46	0.00	0.00	0.00	0.88	0.12	0.00
BDC-05-12	9/5/2012	0.00	0.00	0.07	0.05	0.04	0.00	0.12	0.04	0.00	0.00	0.43	0.34	0.23
BDC-05-12	11/15/2012	0.00	0.00	0.08	0.09	0.04	0.00	0.17	0.04	0.00	0.00	0.39	0.42	0.19
BDC-05-12	2/25/2013	0.00	0.00	0.02	0.07	0.14	0.00	0.09	0.14	0.00	0.00	0.08	0.32	0.61
BDC-05-12	5/22/2013	0.00	0.00	0.01	0.08	0.43	0.00	0.09	0.43	0.00	0.00	0.02	0.16	0.83
BDC-05-12	8/29/2013	0.00	0.00	0.00	0.00	0.20	0.09	0.00	0.29	0.00	0.00	0.00	0.00	1.00
BDC-05-12	11/13/2013	0.00	0.00	0.00	0.00	0.08	0.11	0.00	0.19	0.00	0.00	0.00	0.00	1.00
BDC-05-12	2/11/2014	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.04	0.00	0.00	0.00	0.00	1.00
BDC-05-12	5/13/2014	0.00	0.00	0.00	0.00	0.04	0.19	0.00	0.22	0.00	0.00	0.00	0.00	1.00
BDC-05-12	8/6/2014	0.00	0.00	0.00	0.02	0.06	0.15	0.02	0.21	0.00	0.00	0.00	0.08	0.92
BDC-05-12	11/10/2014	0.00	0.00	0.00	0.03	0.09	0.30	0.03	0.39	0.00	0.00	0.00	0.07	0.93
BDC-05-12	1/21/2015	0.00	0.00	0.00	0.04	0.05	0.17	0.04	0.22	0.00	0.00	0.00	0.17	0.83
BDC-05-12	4/27/2015	0.00	0.00	0.00	0.02	0.04	0.07	0.02	0.12	0.00	0.00	0.00	0.16	0.84
BDC-05-12	7/21/2015	0.00	0.00	0.00	0.01	0.00	0.10	0.01	0.10	0.00	0.00	0.00	0.10	0.90
BDC-05-12	10/28/2015	0.00	0.00	0.00	0.01	0.00	0.09	0.01	0.09	0.00	0.00	0.00	0.14	0.86
BDC-05-12	1/26/2016	0.00	0.00	0.00	0.01	0.05	0.14	0.01	0.19	0.00	0.00	0.00	0.06	0.94
BDC-05-12	4/20/2016	0.00	0.00	0.00	0.01	0.00	0.14	0.01	0.14	0.00	0.00	0.00	0.04	0.96
BDC-05-12	8/9/2016	0.00	0.00	0.00	0.01	0.00	0.09	0.01	0.09	0.00	0.00	0.00	0.07	0.93
BDC-05-12	11/3/2016	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.09	0.00	0.00	0.00	0.00	1.00
BDC-05-12	2/8/2017	0.00	0.00	0.00	0.01	0.00	0.06	0.01	0.06	0.00	0.00	0.00	0.09	0.91
BDC-05-12	5/4/2017	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.08	0.00	0.00	0.00	0.06	0.94
BDC-05-12	8/1/2017	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.27	0.00	0.00	0.00	0.00	1.00

Table 1
Groundwater Data Summary
Boeing Developmental Center
SWMU-17

Well	Date	Pilot Injection: Elapsed Time From Injection (days)	Full Injection #1: Elapsed Time From Injection (days)	Volatile Organic Compounds: PCE (µg/L)	TCE (µg/L)	c DCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	Metals: As, Tot (mg/L)	As, Dis (mg/L)	Cu, Tot (mg/L)	Cu, Dis (mg/L)	Aquifer Redox Conditions: DO (mg/L)	Nitrate (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (mg/L)	ORP (mV)	Donor Indicators: TOC (mg/L)	pH	Comments
Proposed Groundwater Cleanup Levels (a)				5.3	1.4	134	2.4	NA	NA	NA	0.008	0.008	0.008	0.008									
BDC-05-13	7/31/2011		-18	5.2	6.6	2.6	<1.0	<1.1	<1.2	<1.1	0.003	0.002	0.002	<0.002	1.73	<0.1	2.0	2.3	5.0	-1	6.0	7.06	
(IW)	11/1/2011		75	<1.0	1.2	39	<1.0	<1.1	<1.2	<1.1	0.068	0.064	0.017	0.003	1.82	<1.0	1.5	<1.0	2.2	-70	550	6.65	
	5/6/2012		262	<0.2	<0.2	13	3.9	1.7	<1.0	<1.0	0.051	0.046	0.003	<0.002	0.03		3.0	0.4	19.0	78	34.2	6.40	
BDC-05-13	11/15/2012		455	<1.0	<1.0	<1.0	2.3	3.7	<1.0	<1.0	0.060	0.055	<0.002	<0.002	0.04		2.2	<0.3	22.0	-9	30.2	6.75	
BDC-05-13	5/22/2013		643	<0.2	<0.2	0.3	1.2	3.8	3.9	<1.0	0.019	0.019	<0.002	<0.002	0.29		1.8	0.43	23.0	-296	21.4	7.76	
BDC-05-13	11/13/2013		818	<0.2	<0.2	0.3	2.1	3.6	6.4	<1.0	0.031	0.027	<0.002	<0.002	3.20		1.6	0.31	19.0	-241	24.7	6.59	
BDC-05-13	5/12/2014		998	<0.2	<0.2	<0.2	2.6	4.3	6.8	<1.0	0.032	0.032	<0.002	<0.002	4.73		2.4	<0.30	19.0	-238	23.4	6.69	
BDC-05-13	11/10/2014		1180	<0.2	<0.2	0.2	2.5	2.1	2.2	<1.0	0.020	0.019	<0.002	<0.002	0.02		1.0	0.33	7.1	-123	15.1	6.41	
BDC-05-13	4/27/2015		1348	<0.2	<0.2	<0.2	1.9	2.5	1.6	<1.0	0.019	0.018	<0.002	<0.002	0.09		0.8	<0.30	12.0	-102	8.9	6.45	
BDC-05-13	10/28/2015		1532	<0.2	<0.2	<0.2	1.1	<1.0	1.0	<1.0	0.020	0.019	<0.002	<0.002	0.20		1.2	<0.30	6.1	-32	10.8	6.54	
BDC-05-13	4/20/2016		1707	<0.2	<0.2	<0.2	2.0	1.9	2.0	<1.0	0.026	0.024	<0.002	<0.002	0.10		1.0	<0.30	10.0	-36	7.6	6.60	
BDC-05-13	11/3/2016		1904	<0.2	<0.2	<0.2	1.0	<1.0	2.3	<1.0	0.023	0.020	<0.002	<0.002	0.08		1.0	<0.30	15.0	-140.9	12.2	6.32	
BDC-05-13	5/4/2017		2086	<0.2	<0.2	<0.2	1.1	1.4	12	<1.0	0.027	0.027	<0.002	<0.002	0.17		2.4	<0.30	14.0	-123.1	11.6	6.42	
BDC-05-14	7/31/2011		-18	2.8	6.8	2.8	<1.0	<1.1	<1.2	<1.1	0.004	0.004	0.004	<0.002	1.76	<0.1	2.0	10.1	6.5	-15	8.6	7.00	
(IW)	11/1/2011		75	2.5	6.7	13	<1.0	<1.1	<1.2	<1.1	0.083	0.074	0.022	0.002	1.87	<1.0	2.3	<1.0	4.0	-124	725	6.13	
	5/6/2012		262	<0.2	0.4	3.0	1.1	<1.0	<1.0	<1.0	0.012	0.009	<0.002	<0.002	0.08		1.7	0.6	23.0	99	41.5	6.33	
BDC-05-14	11/15/2012		455	<0.2	<0.2	1.1	2.0	1.4	<1.0	<1.0	0.022	0.019	<0.002	<0.002	0.11		2.2	<0.3	24.0	-1.4	39.9	6.66	
BDC-05-14	5/22/2013		643	<0.2	<0.2	0.2	1.3	1.3	<3.0	<1.0	0.012	0.012	<0.002	<0.002	0.40		1.8	<0.3	26.0	-311	26.3	7.69	
BDC-05-14	11/13/2013		818	<0.2	<0.2	0.2	1.2	1.3	2.5	<1.0	0.017	0.015	<0.002	<0.002	3.80		1.5	<0.30	24.0	-219	29.5	6.44	
BDC-05-14	5/12/2014		998	<0.2	<0.2	0.2	1.5	2.2	5.0	<1.0	0.018	0.021	<0.002	<0.002	5.21		2.0	<0.30	22.0	-233	30.2	6.55	
BDC-05-14	11/10/2014		1180	<0.2	<0.2	0.4	5.1	4.3	6.4	<1.0	0.017	0.017	<0.002	<0.002	0.15		1.2	2.3	19.0	-97	21.3	6.35	
BDC-05-14	4/27/2015		1348	<0.2	<0.2	0.4	1.6	<1.0	1.1	<1.0	0.018	0.015	<0.002	<0.002	0.11		1.4	1.8	11.0	-88	18.9	6.25	
BDC-05-14	10/28/2015		1532	<0.2	<0.2	0.3	1.4	1.1	2.4	<1.0	0.015	0.013	<0.002	<0.002	0.11		1.0	0.46	12.0	-28	21.0	6.47	
BDC-05-14	4/20/2016		1707	<0.2	<0.2	0.3	0.9	<1.0	1.7	<1.0	0.016	0.016	<0.002	<0.002	0.11		2.0	3.1	11.0	-42	22.3	6.71	
BDC-05-14	11/3/2016		1904	<0.2	<0.2	<0.2	<0.2	<1.0	<1.0	<1.0	0.007	0.007	<0.002	<0.002	0.32		2.6	<0.30	17.0	-111	16.0	6.45	
BDC-05-14	5/4/2017		2086	<0.2	<0.2	0.3	1	<2.0	8.9	<1.0	0.023	0.021	<0.002	<0.002	0.17		2.2	3.8	12.0	-125.1	21.8	6.45	
BDC-05-15	7/31/2011		-18	9.6	28	58	<1.0	<1.1	<1.2	<1.1	0.019	0.019	<0.002	<0.002	1.91	<0.1	1.3	18.6	0.8	-0.9	10.3	7.00	
(IW)	11/1/2011		75	4.8	9.8	15	<1.0	<1.1	<1.2	<1.1	0.061	0.058	0.010	0.009	2.38	<0.1	3.0	11.3	3.5	-0.1	4420	5.67	
	5/6/2012		262	<2.0	<2.0	49	6.3	<1.0	<1.0	<1.0	0.057	0.047	0.009	0.004	0.07		1.8	<0.3	21.0	93	423	6.36	
BDC-05-15	11/15/2012		455	<1.0	<1.0	1.5	7.5	1.8	<1.0	<1.0	0.054	0.049	<0.002	<0.002	0.02		0.8	<0.3	27.0	8	71.2	6.61	
BDC-05-15	5/22/2013		643	<0.2	<0.2	0.3	16	11	<3.0	<1.0	0.065	0.061	<0.002	<0.002	0.22		1.0	0.3	25.0	-317	42.9	7.82	
BDC-05-15	11/13/2013		818	<0.2	<0.2	0.2	4.9	7.2	2.5	<1.0	0.066	0.059	<0.002	<0.002	2.11		2.6	<0.30	23.0	-265	45.5	6.60	
BDC-05-15	5/13/2014		999	<0.2	<0.2	<0.2	8.6	9.4	<1.0	<1.0	0.065	0.061	<0.002	<0.002	2.92		1.7	<0.30	26.0	-230	37.5	6.69	
BDC-05-15	11/10/2014		1180	<0.2	<0.2	<0.2	1.3	4.6	8.6	<1.0	0.072	0.066	<0.002	<0.002	0.33		1.4	<0.30	25.0	-126	37.5	6.37	
BDC-05-15	4/27/2015		1348	<0.2	<0.2	<0.2	1.9	3.2	5.1	<1.0	0.056	0.052	<0.002	<0.002	0.06		0.8	<0.30	18.0	-115	25.6	6.37	
BDC-05-15	10/28/2015		1532	<0.2	<0.2	<0.2	0.7	1.2	6.0	<1.0	0.053	0.041	<0.002	<0.002	0.16		1.2	<0.30	17.0	-41	22.2	6.64	
BDC-05-15	4/20/2016		1707	<0.2	<0.2	<0.2	1.1	<1.0	12	<1.0	0.057	0.051	<0.002	<0.002	0.13		0.6	<0.30	18.0	-67	27.6	6.78	
BDC-05-15	11/3/2016		1904	<0.2	<0.2	<0.2	<0.2	<1.0	9.4	<1.0	0.047	0.044	<0.002	0.002	0.31		1.0	<0.30	15.0	-135.7	22.5	6.44	
BDC-05-15	5/4/2017		2086	<0.2	<0.2	<0.2	0.7	<1.0	17	<1.0	0.048	0.049	<0.002	0.002	0.19		1.8	0.41	10.0	-141.5	23.9	6.57	
BDC-05-16	7/31/2011		-18	9.5	17	20	<1.0	<1.1	<1.2	<1.1	0.006	0.006	0.002	<0.002	1.91	<0.1	1.5	8.9	3.1	-8	7.8	7.06	
(IW)	11/1/2011		75	2.6	2.8	37	<1.0	<1.1	<1.2	<1.1	0.079	0.074	0.005	0.002	2.30	<1.0	2.5	2.8	3.1	7	2250	5.51	
	2/19/2012		185	<2.0	<2.0	46	7.4	<1.0	<1.0	<1.0					1.59	<0.5	2.2	<1.5	18.0	128	1270	5.12	
BDC-05-16	5/6/2012		262	<0.2	0.3	6.7	24	2.5	<1.0	<1.0	0.042	0.039	0.003	<0.002	0.06		2.5	<0.3	25.0	121	207	6.28	
BDC-05-16	9/5/2012		384	<0.4	<0.4	0.9	8.1	6.0	<1.0	<1.0					0.12		2.0	<0.3	22.0	64	40.6	6.67	
BDC-05-16	11/15/2012		455	<1.0	<1.0	<1.0	4.9	4.0	<1.0	<1.0	0.041	0.037	<0.002	<0.002	0.02		1.0	<0.3	28.0	7	32.3	6.68	
BDC-05-16	2/25/2013		557	<1.0	<1.0	<1.0	13	4.7	2.7	<1.0					0.41		2.0	<0.30	28.0	68	34.6	6.77	
BDC-05-16	5/22/2013		643	<0.2	<0.2	0.2	7.7	3.9	<3.0	<1.0	0.043	0.048	<0.002	<0.002	0.19		1.0	0.38	26.0	-291	33.1	7.70	
BDC-05-16	8/28/2013		741	<1.0	<1.0	<1.0	4.0	4.2	<3.0	<1.0					1.77		1.4	<0.30	26.0	-316	31.6	6.57	
BDC-05-16	11/13/2013		818	<1.0	<1.0	<1.0	4.3	3.2	<1.0	<1.0	0.048	0.046	<0.002	<0.002	2.04		2.2	<0.30	24.0	-263	36.0	6.64	
BDC-05-16	2/11/2014		908	<1.0	<1.0	<1.0	2.1	2.0	<7.0	<1.0					4.05		2.0	<0.30	25.0	-236	28.9	6.67	
BDC-05-16	5/12/2014		998	<1.0	1.3	<1.0	4.9	4.9	<1.0	<1.0	0.044	0.041	<0.002	<0.002	3.67		1.3	<0.30	28.0	-229	28.7	6.67	
BDC-05-16	8/6/2014		1084	<1.0	<1.0	<1.0	2.4	1.9	<1.0	<1.0					5.07		1.4	<0.30	23.0	-176	27.8	7.27	
BDC-05-16	11/11/2014		1181	<1.0	<1.0	<1.0	4.6	3.9	5.4	<1.0	0.056	0.055	<0.002	<0.002	0.08		1.2	0.82	26.0	-104	38.7	6.24	
BDC-05-16	1/21/2015		1252	<0.2	<0.2	<0.2	2.9	5.7	6.1	<1.0					0.18		1.3	0.70	21.0	-135	33.6	6.31	
BDC-05-16	4/26/2015		1347	<0.2	<0.2	<0.2	2.3	2.4	5.7	<1.0	0.048	0.046	0.002	<0.002	0.11		1.4	<0.30	22.0	-118	23.8	6.40	
BDC-05-16	7/21/2015		1433	<0.2	<0.2	<0.2	1.7	1.4	6.3	<1.0					0.26		2.0	<0.30	22.0	-67	28.9	6.30	
BDC-05-16	10/27/2015		1531	<0.2	<0.2	<0.2	2.8	1.0	5.5	<1.0	0.047	0.044	<0.002	<0.002	0.06		1.2	<0.30	19.0	-45	28.9	6.41	
BDC-05-16	1/26/2016		1622	<0.2	<0.2	<0.2	1.7	<1.0	8	<1.0					0.41			<0.30	21.0	-126	23.7	6.51	
BDC-05-16	4/20/2016		1707	<0.2	<0.2	<0.2	1.3	1.4	9.0	<1.0	0.042	0.039	0.006	<0.002	0.51		1.0	<0.30	17.0	-33	17.7	6.78	
BDC-05-16	8/9/2016		1818	<0.2	<0.2	<0.2	0.9	1.0	12	<1.0	0.033	0.033	<0.002	<0.002	-0.02		1.6	<0.30	15.0	-75.1	16.9	6.57	
BDC-05-16	11/3/2016		1904	<0.2	<0.2	<0.2	0.6	<1.0	6.9	<1.0	0.022	0.021	<0.002	<0.002	0.32		1.6	<0.30	13.0	-90.8	13.0	6.13	
BDC-05-16	2/8/2017		2001	<0.2	<0.2	<0.2	0.8	<1.0	6.7	<1.0	0.033	0.032	<0.002	<0.002	0.29		2.4	<0.30	10.0	-51.1	17.7	6.62	
BDC-05-16	5/4/2017		2086	<0.2	<0.2	<0.2	1.3	1.6	12	<1.0	0.029	0.027	<0.002	<0.002	0.15		2.0	<0.30	9.1	-95.8	17.0	6.34	
BDC-05-16	8/1/2017		2175	<0.2	<0.2	<0.2	0.5	<1.0	9.9	<1.0	0.031	0.029	0.003	<0.002	0.05		2.0	<0.30	7.4	-104	12.7	6.12	

Well	Date	VOCs- micromoles/Liter (b): PCE	TCE	c DCE	VC	Ethene	Ethane	Total Chloroethenes (d)	Ethene + Ethane	Molar Fraction (c): PCE	TCE	c DCE	VC	Ethene + Ethane
BDC-05-13	7/31/2011	0.03	0.05	0.03	0.00	0.00	0.00	0.11	0.00	0.29	0.46	0.25	0.00	0.00
(IW)	11/1/2011	0.00	0.01	0.40	0.00	0.00	0.00	0.41	0.00	0.00	0.02	0.98	0.00	0.00
	5/6/2012	0.00	0.00	0.13	0.06	0.06	0.00	0.20	0.06	0.00	0.00	0.52	0.24	0.24
BDC-05-13	11/15/2012	0.00	0.00	0.00	0.04	0.13	0.00	0.04	0.13	0.00	0.00	0.00	0.22	0.78
BDC-05-13	5/22/2013	0.00	0.00	0.00	0.02	0.14	0.13	0.02	0.27	0.00	0.00	0.01	0.07	0.92
BDC-05-13	11/13/2013	0.00	0.00	0.00	0.03	0.13	0.21	0.04	0.34	0.00	0.00	0.01	0.09	0.90
BDC-05-13	5/12/2014	0.00	0.00	0.00	0.04	0.15	0.23	0.04	0.38	0.00	0.00	0.00	0.10	0.90
BDC-05-13	11/10/2014	0.00	0.00	0.00	0.04	0.07	0.07	0.04	0.15	0.00	0.00	0.01	0.21	0.78
BDC-05-13	4/27/2015	0.00	0.00	0.00	0.03	0.09	0.05	0.03	0.14	0.00	0.00	0.00	0.18	0.82
BDC-05-13	10/28/2015	0.00	0.00	0.00	0.02	0.00	0.03	0.02	0.03	0.00	0.00	0.00	0.35	0.65
BDC-05-13	4/20/2016	0.00	0.00	0.00	0.03	0.07	0.07	0.03	0.13	0.00	0.00	0.00	0.19	0.81
BDC-05-13	11/3/2016	0.00	0.00	0.00	0.02	0.00	0.08	0.02	0.08	0.00	0.00	0.00	0.17	0.83
BDC-05-13	5/4/2017	0.00	0.00	0.00	0.02	0.05	0.40	0.02	0.45	0.00	0.00	0.00	0.04	0.96
BDC-05-14	7/31/2011	0.02	0.05	0.03	0.00	0.00	0.00	0.10	0.00	0.17	0.53	0.30	0.00	0.00
(IW)	11/1/2011	0.02	0.05	0.13	0.00	0.00	0.00	0.20	0.00	0.08	0.25	0.67	0.00	0.00
	5/6/2012	0.00	0.00	0.03	0.02	0.00	0.00	0.05	0.00	0.00	0.06	0.60	0.34	0.00
BDC-05-14	11/15/2012	0.00	0.00	0.01	0.03	0.05	0.00	0.04	0.05	0.00	0.00	0.12	0.34	0.54
BDC-05-14	5/22/2013	0.00	0.00	0.00	0.02	0.05	0.00	0.02	0.05	0.00	0.00	0.03	0.30	0.67
BDC-05-14	11/13/2013	0.00	0.00	0.00	0.02	0.05	0.08	0.02	0.13	0.00	0.00	0.01	0.13	0.86
BDC-05-14	5/12/2014	0.00	0.00	0.00	0.02	0.08	0.17	0.03	0.24	0.00	0.00	0.01	0.09	0.90
BDC-05-14	11/10/2014	0.00	0.00	0.00	0.08	0.15	0.21	0.09	0.37	0.00	0.00	0.01	0.18	0.81
BDC-05-14	4/27/2015	0.00	0.00	0.00	0.03	0.00	0.04	0.03	0.04	0.00	0.00	0.06	0.39	0.55
BDC-05-14	10/28/2015	0.00	0.00	0.00	0.02	0.04	0.08	0.03	0.12	0.00	0.00	0.02	0.15	0.82
BDC-05-14	4/20/2016	0.00	0.00	0.00	0.01	0.00	0.06	0.02	0.06	0.00	0.00	0.04	0.19	0.76
BDC-05-14	11/3/2016	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BDC-05-14	5/4/2017	0.00	0.00	0.00	0.02	0.00	0.30	0.02	0.30	0.00	0.00	0.01	0.05	0.94
BDC-05-15	7/31/2011	0.06	0.21	0.60	0.00	0.00	0.00	0.87	0.00	0.07	0.25	0.69	0.00	0.00
(IW)	11/1/2011	0.03	0.07	0.15	0.00	0.00	0.00	0.26	0.00	0.11	0.29	0.60	0.00	0.00
	5/6/2012	0.00	0.00	0.51	0.10	0.00	0.00	0.61	0.00	0.00	0.00	0.83	0.17	0.00
BDC-05-15	11/15/2012	0.00	0.00	0.02	0.12	0.06	0.00	0.14	0.06	0.00	0.00	0.08	0.60	0.32
BDC-05-15	5/22/2013	0.00	0.00	0.00	0.26	0.39	0.00	0.26	0.39	0.00	0.00	0.00	0.39	0.60
BDC-05-15	11/13/2013	0.00	0.00	0.00	0.08	0.26	0.08	0.08	0.34	0.00	0.00	0.00	0.19	0.81
BDC-05-15	5/13/2014	0.00	0.00	0.00	0.14	0.34	0.00	0.14	0.34	0.00	0.00	0.00	0.29	0.71
BDC-05-15	11/10/2014	0.00	0.00	0.00	0.02	0.16	0.29	0.02	0.45	0.00	0.00	0.00	0.04	0.96
BDC-05-15	4/27/2015	0.00	0.00	0.00	0.03	0.11	0.17	0.03	0.28	0.00	0.00	0.00	0.10	0.90
BDC-05-15	10/28/2015	0.00	0.00	0.00	0.01	0.04	0.20	0.01	0.24	0.00	0.00	0.00	0.04	0.96
BDC-05-15	4/20/2016	0.00	0.00	0.00	0.02	0.00	0.40	0.02	0.40	0.00	0.00	0.00	0.04	0.96
BDC-05-15	11/3/2016	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.31	0.00	0.00	0.00	0.00	1.00
BDC-05-15	5/4/2017	0.00	0.00	0.00	0.01	0.00	0.57	0.01	0.57	0.00	0.00	0.00	0.02	0.98
BDC-05-16	7/31/2011	0.06	0.13	0.21	0.00	0.00	0.00	0.39	0.00	0.15	0.33	0.52	0.00	0.00
(IW)	11/1/2011	0.02	0.02	0.38	0.00	0.00	0.00	0.42	0.00	0.04	0.05	0.91	0.00	0.00
	2/19/2012	0.00	0.00	0.47	0.12	0.00	0.00	0.59	0.00	0.00	0.00	0.80	0.20	0.00
BDC-05-16	5/6/2012	0.00	0.00	0.07	0.38	0.09	0.00	0.46	0.09	0.00	0.00	0.13	0.71	0.16
BDC-05-16	9/5/2012	0.00	0.00	0.01	0.13	0.21	0.00	0.14	0.21	0.00	0.00	0.03	0.37	0.61
BDC-05-16	11/15/2012	0.00	0.00	0.00	0.08	0.14	0.00	0.08	0.14	0.00	0.00	0.00	0.35	0.65
BDC-05-16	2/25/2013	0.00	0.00	0.00	0.21	0.17	0.09	0.21	0.26	0.00	0.00	0.00	0.45	0.55
BDC-05-16	5/22/2013	0.00	0.00	0.00	0.12	0.14	0.00	0.13	0.14	0.00	0.00	0.01	0.47	0.53
BDC-05-16	8/28/2013	0.00	0.00	0.00	0.06	0.15	0.00	0.06	0.15	0.00	0.00	0.00	0.30	0.70
BDC-05-16	11/13/2013	0.00	0.00	0.00	0.07	0.11	0.00	0.07	0.11	0.00	0.00	0.00	0.38	0.62
BDC-05-16	2/11/2014	0.00	0.00	0.00	0.03	0.07	0.00	0.03	0.07	0.00	0.00	0.00	0.32	0.68
BDC-05-16	5/12/2014	0.00	0.01	0.00	0.08	0.17	0.00	0.09	0.17	0.00	0.04	0.00	0.30	0.66
BDC-05-16	8/6/2014	0.00	0.00	0.00	0.04	0.07	0.00	0.04	0.07	0.00	0.00	0.00	0.36	0.64
BDC-05-16	11/11/2014	0.00	0.00	0.00	0.07	0.14	0.18	0.07	0.32	0.00	0.00	0.00	0.19	0.81
BDC-05-16	1/21/2015	0.00	0.00	0.00	0.05	0.20	0.20	0.05	0.41	0.00	0.00	0.00	0.10	0.90
BDC-05-16	4/26/2015	0.00	0.00	0.00	0.04	0.09	0.19	0.04	0.28	0.00	0.00	0.00	0.12	0.88
BDC-05-16	7/21/2015	0.00	0.00	0.00	0.03	0.05	0.21	0.03	0.26	0.00	0.00	0.00	0.09	0.91
BDC-05-16	10/27/2015	0.00	0.00	0.00	0.04	0.04	0.18	0.04	0.22	0.00	0.00	0.00	0.17	0.83
BDC-05-16	1/26/2016	0.00	0.00	0.00	0.03	0.00	0.27	0.03	0.27	0.00	0.00	0.00	0.09	0.91
BDC-05-16	4/20/2016	0.00	0.00	0.00	0.02	0.05	0.30	0.02	0.35	0.00	0.00	0.00	0.06	0.94
BDC-05-16	8/9/2016	0.00	0.00	0.00	0.01	0.04	0.40	0.01	0.43	0.00	0.00	0.00	0.03	0.97
BDC-05-16	11/3/2016	0.00	0.00	0.00	0.01	0.00	0.23	0.01	0.23	0.00	0.00	0.00	0.04	0.96
BDC-05-16	2/8/2017	0.00	0.00	0.00	0.01	0.00	0.22	0.01	0.22	0.00	0.00	0.00	0.05	0.95
BDC-05-16	5/4/2017	0.00	0.00	0.00	0.02	0.06	0.40	0.02	0.46	0.00	0.00	0.00	0.04	0.96
BDC-05-16	8/1/2017	0.00	0.00	0.00	0.01	0.00	0.33	0.01	0.33	0.00	0.00	0.00	0.02	0.98

Table 1
Groundwater Data Summary
Boeing Developmental Center
SWMU-17

Well	Date	Pilot Injection Elapsed Time From Injection (days)	Full Injection #1 Elapsed Time From Injection (days)	Volatile Organic Compounds PCE (µg/L)	TCE (µg/L)	c DCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	Metals As, Tot (mg/L)	As, Dis (mg/L)	Cu, Tot (mg/L)	Cu, Dis (mg/L)	Aquifer Redox Conditions DO (mg/L)	Nitrate (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (mg/L)	ORP (mV)	Donor Indicators TOC (mg/L)	pH	Comments
Proposed Groundwater Cleanup Levels (a)				5.3	1.4	134	2.4	NA	NA	NA	0.008	0.008	0.008	0.008									
BDC-05-17	7/31/2011		-18	11	22	34	<1.0	<1.1	<1.2	<1.1	0.004	0.004	0.003	0.002	2.03	0.6	1.5	16.0	0.30	59	10.2	6.95	
(IW)	11/1/2011		75	3.2	4.8	5.1	<1.0	<1.1	<1.2	<1.1	0.053	0.047	0.005	<0.002	2.61	<1.0	2.4	23.9	2.8	-50	3500	5.74	
	5/6/2012		262	<2.0	<2.0	9.3	5.6	<1.0	<1.0	<1.0	0.058	0.026	0.003	<0.002	0.24		2.0	0.7	15.0	182	839	6.08	
BDC-05-17	11/15/2012		455	<5.0	<5.0	<5.0	5.4	2.0	<1.0	<1.0	0.081	0.062	<0.002	<0.002	0.02		1.0	<0.3	23.0	13	73.5	6.62	
BDC-05-17	5/23/2013		644	<0.2	<0.2	0.7	5.1	4.3	<3.0	<1.0	0.142	0.062	<0.002	<0.002	0.44		1.2	<0.3	26.0	-259	45.8	7.54	
BDC-05-17	11/13/2013		818	<0.2	<0.2	0.5	4.0	3.0	2.2	<1.0	0.057	0.037	<0.002	<0.002	2.21		2.0	<0.30	26.0	-266	49.8	6.57	
BDC-05-17	5/12/2014		998	<0.2	<0.2	0.4	3.2	2.5	6.0	<1.0	0.038	0.033	<0.002	<0.002	4.60		1.8	<0.30	25.0	-368	44.1	6.64	
BDC-05-17	11/11/2014		1181	<0.2	<0.2	0.3	2.7	3.9	5.9	<1.0	0.038	0.036	<0.002	<0.002	0.06		2.0	0.74	26.0	-123	52.0	6.35	
BDC-05-17	4/26/2015		1347	<0.2	<0.2	0.2	1.5	2.7	3.0	<1.0	0.039	0.032	0.004	<0.002	0.25		1.4	<0.30	21.0	-127	29.0	6.44	
BDC-05-17	10/27/2015		1531	<0.2	<0.2	0.2	1.6	1.0	4.5	<1.0	0.037	0.036	<0.002	<0.002	0.12		1.5	<0.30	21.0	-47	32.0	6.38	
BDC-05-17	4/20/2016		1707	<0.2	<0.2	<0.2	1	1.1	6.6	<1.0	0.042	0.036	0.003	<0.002	0.44		0.8	<0.30	19.0	-77	29.0	6.84	
BDC-05-17	11/3/2016		1904	<0.2	<0.2	<0.2	0.9	<1.0	7.6	<1.0	0.041	0.035	<0.002	<0.002	0.45		1.0	<0.30	19.0	-118.8	19.9	6.23	
BDC-05-17	5/4/2017		2086	<0.2	<0.2	<0.2	0.9	<2.0	13	<1.0	0.044	0.037	<0.002	<0.002	0.14		1.0	<0.30	11.0	-110.4	19.2	6.29	
BDC-05-18	7/31/2011		-18	3.6	5.0	6.6	<1.0	<1.1	<1.2	<1.1	0.019	0.020	<0.002	<0.002	1.57	<0.1	2.4	4.5	3.9	-19	3.2	7.13	
(MW 12 ft XG)	11/1/2011		75	2.8	4.0	7.6	<1.0	<1.1	<1.2	<1.1	0.019	0.020	0.003	0.003	1.37	<0.1	1.2	1.2	4.3	-106	21.7	6.88	
	2/19/2012		185	1.8	3.7	12	<0.2	<1.0	<1.0	<1.0					0.19	<0.5	2.2	<1.5	11.0	9	2.7	6.66	
BDC-05-18	5/6/2012		262	2.0	4.0	9.6	<0.2	<1.0	<1.0	<1.0	0.013	0.013	<0.002	<0.002	0.21		2.5	2.1	7.5	132	2.5	6.39	
BDC-05-18	9/5/2012		384	1.5	3.1	11	0.2	<1.0	<1.0	<1.0					0.13		1.5	2.0	7.9	58	1.8	6.91	
BDC-05-18	11/15/2012		455	1.0	4.3	16	<0.5	<1.0	<1.0	<1.0	0.015	0.014	<0.002	<0.002	0.48		1.4	2.4	8.3	25	1.7	6.62	
BDC-05-18	2/25/2013		557	2.0	4.6	5.7	<0.2	<1.0	<1.0	<1.0					0.25		2.0	9.2	1.3	72	2.0	6.53	
BDC-05-18	5/23/2013		644	3.1	5.2	4.1	<0.2	<1.0	<1.0	<1.0	0.014	0.014	<0.002	<0.002	0.30		1.5	7.0	1.0	-262	1.3	7.24	
BDC-05-18	8/28/2013		741	2.2	3.7	7.4	<0.2	<1.0	<1.0	<1.0					0.76		1.6	4.1	1.5	-309	2.2	6.25	
BDC-05-18	11/14/2013		819	1.2	1.8	1.4	0.2	<1.0	<1.0	<1.0	0.006	0.002	<0.002	<0.002	2.53		1.0	4.7	0.68	-164	<1.0	7.03	
BDC-05-18	2/11/2014		908	1.7	2.1	5.4	0.3	<1.0	<1.0	<1.0					2.53		1.2	3.2	3.70	-224	1.4	6.68	
BDC-05-18	5/13/2014		999	2.0	2.4	4.4	0.3	<1.0	<1.0	<1.0	0.001	0.002	<0.002	<0.002	3.54		1.5	6.7	3.2	-208	2.6	6.44	
BDC-05-18	8/6/2014		1084	0.7	0.9	0.5	<0.2	<1.0	<1.0	<1.0					4.21		0.4	2.9	0.012	-49	1.4	8.05	
BDC-05-18	11/10/2014		1180	0.4	1.1	1.2	<0.2	<1.0	<1.0	<1.0	0.006	0.002	<0.002	<0.002	0.78		0.5	3.0	0.058	3.2	<1.0	6.56	
BDC-05-18	1/21/2015		1252	0.9	1.1	1.5	<0.2	<1.0	<1.0	<1.0					0.21		1.0	2.0	1.8	11.6	1.2	6.32	
BDC-05-18	4/26/2015		1347	0.8	2.0	1.0	0.3	<1.0	<1.0	<1.0	0.027	0.004	0.003	<0.002	0.28		1.0	3.6	0.95	33	4.1	6.11	
BDC-05-18	7/20/2015		1432	0.4	1.0	1.4	<0.2	<1.0	<1.0	<1.0					0.45		0.6	2.8	0.29	26	<1.0	6.30	
BDC-05-18	10/27/2015		1531	0.7	1.3	2.4	<0.2	<1.0	<1.0	<1.0	0.014	0.001	0.006	<0.002	0.73		0.2	3.1	1.7	22	<1.0	6.43	
BDC-05-18	1/26/2016		1622	2.2	2.9	1.3	<0.2	<1.0	<1.0	<1.0					1.03			5.4	0.17	-127	1.8	6.30	
BDC-05-18	4/20/2016		1707	2.3	3.0	1	<0.2	<1.0	<1.0	<1.0	0.003	0.001	<0.002	<0.002	0.26		0.8	8.5	0.32	10.1	<1.0	6.51	
BDC-05-18	8/9/2016		1818	1.8	2.9	2.6	<0.2	<1.0	<1.0	<1.0	0.003	0.002	<0.002	<0.002	0.42		2.8	2.5	0.74	-5.7	<1.0	6.45	
BDC-05-18	11/2/2016		1903	1.2	1.6	4.1	0.4	<1.0	<1.0	<1.0	0.005	0.004	<0.002	<0.002	0.34		1.0	2.6	3.3	-11.8	2.0	6.21	
BDC-05-18	2/7/2017		2000	2.8	3.4	2.4	<0.2	<1.0	<1.0	<1.0	0.011	0.003	<0.002	<0.002	0.40		3.0	5.3	0.72	32.4	1.8	6.24	
BDC-05-18	5/3/2017		2085	3.6	4.6	1.3	<0.2	<1.0	<1.0	<1.0	0.007	0.002	<0.002	<0.002	1.33		2.2	8.1	0.095	81.5	1.7	5.94	
BDC-05-18	8/1/2017		2175	1.9	2.4	1.1	<0.2	<1.0	<1.0	<1.0	0.047	0.001	<0.002	<0.002	1.12		2.6	5.2	3.9	-1.2	18.3	6.16	
BDC-05-19	7/31/2011		-18	15	21	23	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.002	<0.002	1.81	0.2	2.6	5.2	4.7	34	7.3	6.97	
(MW 10 ft DG)	11/1/2011		75	9.1	13	36	4.1	<1.1	<1.2	<1.1	0.020	0.020	0.007	<0.002	1.53	<1.0	1.8	2.5	4.5	-142	170	6.82	
	2/19/2012		185	<1.0	1.7	68	14	1.4	<1.0	<1.0					0.85	<0.5	2.0	<1.5	22.0	36	296	6.40	
BDC-05-19	5/6/2012		262	0.7	1.4	52	23	1.8	<1.0	<1.0	0.058	0.052	0.032	0.008	0.02		2.0	1.4	25.0	69	244	6.39	
BDC-05-19	9/5/2012		384	<2.0	<2.0	13	15	3.9	<1.0	<1.0					0.19		1.8	1.4	19.0	73	68.0	6.43	
BDC-05-19	11/15/2012		455	<1.0	1.1	9.9	15	5.5	<1.0	<1.0	0.088	0.074	0.006	<0.002	0.21		1.6	1.8	24.0	3	68.1	6.58	
BDC-05-19	2/25/2013		557	<1.0	<1.0	6.9	20	6.5	<1.0	<1.0					0.25		2.0	0.31	23.0	71	53.0	6.64	
BDC-05-19	5/22/2013		643	<0.2	<0.2	5.1	9.6	7.2	<3.0	<1.0	0.054	0.051	0.006	<0.002	0.28		1.6	0.85	22.0	-385	52.4	8.12	
BDC-05-19	8/28/2013		741	<2.0	<2.0	6.9	7.3	7.3	2.5	<1.0					1.53		2.0	0.52	22.0	-318	60.6	6.54	
BDC-05-19	11/13/2013		818	<2.0	<2.0	2.3	3.1	4.1	3.0	<1.0	0.046	0.040	0.003	<0.002	3.93		1.4	0.52	26.0	-270	57.7	6.54	
BDC-05-19	2/11/2014		908	<1.0	<1.0	<1.0	2.0	2.5	5.7	<1.0					5.69		2.0	0.39	23.0	-239	64.8	6.51	
BDC-05-19	5/13/2014		999	<1.0	<1.0	<1.0	1.8	2.0	5.9	<1.0	0.033	0.025	0.003	<0.002	2.51		2.2	0.37	26.0	-306	54.9	6.56	
BDC-05-19	8/6/2014		1084	<1.0	<1.0	<1.0	2.6	5.4	4.6	<1.0					6.55		1.8	<0.30	21.0	-174	57.8	7.13	
BDC-05-19	11/10/2014		1180	<1.0	<1.0	<1.0	1.6	2.5	7.0	<1.0	0.032	0.025	0.004	<0.002	0.03		1.8	0.31	25.0	-82	40.1	6.20	
BDC-05-19	1/21/2015		1252	<0.2	<0.2	<0.2	3.8	1.3	4.0	<1.0					0.19		2.2	0.55	18.0	-102	31.4	6.19	
BDC-05-19	4/27/2015		1348	<0.2	<0.2	<0.2	1.6	<1.0	3.5	<1.0	0.031	0.023	0.006	<0.002	0.06		1.4	<0.30	19.0	-74	20.1	6.15	
BDC-05-19	7/21/2015		1433	<0.2	<0.2	<0.2	1.5	1.6	2.2	<1.0					0.10		1.2	<0.30	21.0	-41	20.3	6.26	
BDC-05-19	10/28/2015		1532	<0.2	<0.2	<0.2	1.0	<1.0	3.3	<1.0	0.034	0.027	0.004	<0.002	0.07		0.6	<0.30	19.0	-19	28.8	6.35	
BDC-05-19	1/26/2016		1622	<0.2	<0.2	<0.2	1.2	<1.0	3.4	<1.0					0.21		1.3	<0.30	18.0	-95	25.9	6.41	
BDC-05-19	4/20/2016		1707	<0.2	<0.2	<0.2	0.6	<1.0	3.4	<1.0	0.025	0.021	0.003	<0.002	0.14		1.2	0.36	19.0	-43	21.3	6.45	
BDC-05-19	8/9/2016		1818	<0.2	<0.2	<0.2	0.4	<1.0	3.9	<1.0	0.015	0.014	<0.002	<0.002	0.31		1.5	0.6	17.0	-109.1	12.2	6.07	
BDC-05-19	11/3/2016		1904	<0.2	<0.2	<0.2	0.2	<1.0	<1.0	<1.0	0.012	0.010	<0.002	<0.002	0.08		2.6	0.30	18.0	-116.1	12.9	6.24	
BDC-05-19	2/8/2017		2001	<0.2	<0.2	<0.2	0.3	<1.0	3.2	<1.0	0.023	0.011	0.003	<0.002	0.34		3.2	0.32	16.0	-33.3	12.1	6.54	
BDC-05-19	5/4/2017		2086	<0.2	<0.2	<0.2	0.4	<1.0	2.3	<1.0	0.020	0.013	<0.002	<0.002	0.24		1.8	0.43	13.0	-96	11.6	6.26	
BDC-05-19	8/1/2017		2175	<0.2	<0.2	<0.2	0.2	<1.0	9.3	<1.0	0.017	0.012	<0.002	<0.002	0.11		2.2	<0.30	15.0	-98.0	10.2	6.21	
BDC-05-20	7/31/2011		-18	<1.0	7.0	45	<1.0	<1.1	<1.2	<1.1	0.011	0.011	<0.002	<0.002	2.33	<0.1	1.5	7.4	0.2	-42	10.8	7.12	
(MW 31 ft DG)	11/3/2011		77	<1.0	5.7	25	1.0	<1.1	<1.2	<1.1	0.010	0.011	<0.002	<0.002	1.54	<0.1	1.0	6.0	4.6	11	8.3	7.14	
	2/19/2012		185	<0.2	2.9	17	2.5	<1.0	<1.0	<1.0					0.35	<0.5	1.5	<1.5	16.0	31	8.2	6.69	
BDC-05-20	5/7/2012		263	<0.2	1.8	14	2.2	<1.0	<1.0	<1.0	0.011	0.011	<0.002	<0.002	0.69		1.8	2.3	20.0	20	11.1	6.66	
BDC-05-20	9/5/2012		384	<0.4	<0.4	12	2.0	<1.0	<1.0	<1.0					0.08		1.4	<0.3	14.0	67	12.1	6.75	
BDC-05-20	11/16/2012		456	<0.5	0.6	17	3.5	<1.0	<1.0	<1.0	0.012	0.013	<0.002	<0.002	0.07		2.0	<0.3	18.0	0.9	13.1	6.88	
BDC-05-20	2/26/2013		558	<0.2	0.5	9.8	6.1	<1.0	<1.0	<1.0					0.16		1.5	<0.3	22.0	16	16.3	6.86	
BDC-05-20	5/23/2013		644	<0.2	0.4	10	8.1	1.5	<1.0	<1.0	0.016	0.017	<0.002	<0.002	0.25		1.2	<0.3	25.0	-233	16.9	7.55	

Well	Date	VOCs- micromoles/Liter (b) PCE	TCE	c DCE	VC	Ethene	Ethane	Total Chloroethenes (d)	Ethene + Ethane	Molar Fraction (c) PCE	TCE	c DCE	VC	Ethene + Ethane
BDC-05-17	7/31/2011	0.07	0.17	0.35	0.00	0.00	0.00	0.58	0.00	0.11	0.29	0.60	0.00	0.00
(IW)	11/1/2011	0.02	0.04	0.05	0.00	0.00	0.00	0.11	0.00	0.18	0.34	0.49	0.00	0.00
	5/6/2012	0.00	0.00	0.10	0.09	0.00	0.00	0.19	0.00	0.00	0.00	0.52	0.48	0.00
BDC-05-17	11/15/2012	0.00	0.00	0.00	0.09	0.07	0.00	0.09	0.07	0.00	0.00	0.00	0.55	0.45
BDC-05-17	5/23/2013	0.00	0.00	0.01	0.08	0.15	0.00	0.09	0.15	0.00	0.00	0.03	0.34	0.63
BDC-05-17	11/13/2013	0.00	0.00	0.01	0.06	0.11	0.07	0.07	0.18	0.00	0.00	0.02	0.26	0.72
BDC-05-17	5/12/2014	0.00	0.00	0.00	0.05	0.09	0.20	0.06	0.29	0.00	0.00	0.01	0.15	0.84
BDC-05-17	11/11/2014	0.00	0.00	0.00	0.04	0.14	0.20	0.05	0.34	0.00	0.00	0.01	0.11	0.88
BDC-05-17	4/26/2015	0.00	0.00	0.00	0.02	0.10	0.10	0.03	0.20	0.00	0.00	0.01	0.11	0.88
BDC-05-17	10/27/2015	0.00	0.00	0.00	0.03	0.04	0.15	0.03	0.19	0.00	0.00	0.01	0.12	0.87
BDC-05-17	4/20/2016	0.00	0.00	0.00	0.02	0.04	0.22	0.02	0.26	0.00	0.00	0.00	0.06	0.94
BDC-05-17	11/3/2016	0.00	0.00	0.00	0.01	0.00	0.25	0.01	0.25	0.00	0.00	0.00	0.05	0.95
BDC-05-17	5/4/2017	0.00	0.00	0.00	0.01	0.00	0.43	0.01	0.43	0.00	0.00	0.00	0.03	0.97
BDC-05-18	7/31/2011	0.02	0.04	0.07	0.00	0.00	0.00	0.13	0.00	0.17	0.30	0.53	0.00	0.00
(MW 12 ft XG)	11/1/2011	0.02	0.03	0.08	0.00	0.00	0.00	0.13	0.00	0.13	0.24	0.62	0.00	0.00
	2/19/2012	0.01	0.03	0.12	0.00	0.00	0.00	0.16	0.00	0.07	0.17	0.76	0.00	0.00
BDC-05-18	5/6/2012	0.01	0.03	0.10	0.00	0.00	0.00	0.14	0.00	0.09	0.22	0.70	0.00	0.00
BDC-05-18	9/5/2012	0.01	0.02	0.11	0.00	0.00	0.00	0.15	0.00	0.06	0.16	0.76	0.02	0.00
BDC-05-18	11/15/2012	0.01	0.03	0.17	0.00	0.00	0.00	0.20	0.00	0.03	0.16	0.81	0.00	0.00
BDC-05-18	2/25/2013	0.01	0.04	0.06	0.00	0.00	0.00	0.11	0.00	0.11	0.33	0.56	0.00	0.00
BDC-05-18	5/23/2013	0.02	0.04	0.04	0.00	0.00	0.00	0.10	0.00	0.19	0.39	0.42	0.00	0.00
BDC-05-18	8/28/2013	0.01	0.03	0.08	0.00	0.00	0.00	0.12	0.00	0.11	0.24	0.65	0.00	0.00
BDC-05-18	11/14/2013	0.01	0.01	0.01	0.00	0.00	0.00	0.04	0.00	0.19	0.36	0.37	0.08	0.00
BDC-05-18	2/11/2014	0.01	0.02	0.06	0.00	0.00	0.00	0.09	0.00	0.12	0.18	0.64	0.06	0.00
BDC-05-18	5/13/2014	0.01	0.02	0.05	0.00	0.00	0.00	0.08	0.00	0.15	0.23	0.56	0.06	0.00
BDC-05-18	8/6/2014	0.00	0.01	0.01	0.00	0.00	0.00	0.02	0.00	0.26	0.42	0.32	0.00	0.00
BDC-05-18	11/10/2014	0.00	0.01	0.01	0.00	0.00	0.00	0.02	0.00	0.10	0.36	0.53	0.00	0.00
BDC-05-18	1/21/2015	0.01	0.01	0.02	0.00	0.00	0.00	0.03	0.00	0.19	0.29	0.53	0.00	0.00
BDC-05-18	4/26/2015	0.00	0.02	0.01	0.00	0.00	0.00	0.04	0.00	0.14	0.43	0.29	0.14	0.00
BDC-05-18	7/20/2015	0.00	0.01	0.01	0.00	0.00	0.00	0.02	0.00	0.10	0.31	0.59	0.00	0.00
BDC-05-18	10/27/2015	0.00	0.01	0.02	0.00	0.00	0.00	0.04	0.00	0.11	0.25	0.64	0.00	0.00
BDC-05-18	1/26/2016	0.01	0.02	0.01	0.00	0.00	0.00	0.05	0.00	0.27	0.45	0.28	0.00	0.00
BDC-05-18	4/20/2016	0.01	0.02	0.01	0.00	0.00	0.00	0.05	0.00	0.29	0.49	0.22	0.00	0.00
BDC-05-18	8/9/2016	0.01	0.02	0.03	0.00	0.00	0.00	0.06	0.00	0.18	0.37	0.45	0.00	0.00
BDC-05-18	11/2/2016	0.01	0.01	0.04	0.01	0.00	0.00	0.07	0.00	0.11	0.18	0.62	0.09	0.00
BDC-05-18	2/7/2017	0.02	0.03	0.02	0.00	0.00	0.00	0.07	0.00	0.25	0.38	0.37	0.00	0.00
BDC-05-18	5/3/2017	0.02	0.04	0.01	0.00	0.00	0.00	0.07	0.00	0.31	0.50	0.19	0.00	0.00
BDC-05-18	8/1/2017	0.01	0.02	0.01	0.00	0.00	0.00	0.04	0.00	0.28	0.44	0.28	0.00	0.00
BDC-05-19	7/31/2011	0.09	0.16	0.24	0.00	0.00	0.00	0.49	0.00	0.19	0.33	0.49	0.00	0.00
(MW 10 ft DG)	11/1/2011	0.05	0.10	0.37	0.07	0.00	0.00	0.59	0.00	0.09	0.17	0.63	0.11	0.00
	2/19/2012	0.00	0.01	0.70	0.22	0.05	0.00	0.94	0.05	0.00	0.01	0.71	0.23	0.05
BDC-05-19	5/6/2012	0.00	0.01	0.54	0.37	0.06	0.00	0.92	0.06	0.00	0.01	0.55	0.37	0.07
BDC-05-19	9/5/2012	0.00	0.00	0.13	0.24	0.14	0.00	0.37	0.14	0.00	0.00	0.26	0.47	0.27
BDC-05-19	11/15/2012	0.00	0.01	0.10	0.24	0.20	0.00	0.35	0.20	0.00	0.02	0.19	0.44	0.36
BDC-05-19	2/25/2013	0.00	0.00	0.07	0.32	0.23	0.00	0.39	0.23	0.00	0.00	0.11	0.51	0.37
BDC-05-19	5/22/2013	0.00	0.00	0.05	0.15	0.26	0.00	0.21	0.26	0.00	0.00	0.11	0.33	0.55
BDC-05-19	8/28/2013	0.00	0.00	0.07	0.12	0.26	0.08	0.19	0.34	0.00	0.00	0.13	0.22	0.65
BDC-05-19	11/13/2013	0.00	0.00	0.02	0.05	0.15	0.10	0.07	0.25	0.00	0.00	0.07	0.16	0.77
BDC-05-19	2/11/2014	0.00	0.00	0.00	0.03	0.09	0.19	0.03	0.28	0.00	0.00	0.00	0.10	0.90
BDC-05-19	5/13/2014	0.00	0.00	0.00	0.03	0.07	0.20	0.03	0.27	0.00	0.00	0.00	0.10	0.90
BDC-05-19	8/6/2014	0.00	0.00	0.00	0.04	0.19	0.15	0.04	0.35	0.00	0.00	0.00	0.11	0.89
BDC-05-19	11/10/2014	0.00	0.00	0.00	0.03	0.09	0.23	0.03	0.32	0.00	0.00	0.00	0.07	0.93
BDC-05-19	1/21/2015	0.00	0.00	0.00	0.06	0.05	0.13	0.06	0.18	0.00	0.00	0.00	0.25	0.75
BDC-05-19	4/27/2015	0.00	0.00	0.00	0.03	0.00	0.12	0.03	0.12	0.00	0.00	0.00	0.18	0.82
BDC-05-19	7/21/2015	0.00	0.00	0.00	0.02	0.06	0.07	0.02	0.13	0.00	0.00	0.00	0.16	0.84
BDC-05-19	10/28/2015	0.00	0.00	0.00	0.02	0.00	0.11	0.02	0.11	0.00	0.00	0.00	0.13	0.87
BDC-05-19	1/26/2016	0.00	0.00	0.00	0.02	0.00	0.11	0.02	0.11	0.00	0.00	0.00	0.15	0.85
BDC-05-19	4/20/2016	0.00	0.00	0.00	0.01	0.00	0.11	0.01	0.11	0.00	0.00	0.00	0.08	0.92
BDC-05-19	8/9/2016	0.00	0.00	0.00	0.01	0.00	0.13	0.01	0.13	0.00	0.00	0.00	0.05	0.95
BDC-05-19	11/3/2016	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
BDC-05-19	2/8/2017	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.11	0.00	0.00	0.00	0.04	0.96
BDC-05-19	5/4/2017	0.00	0.00	0.00	0.01	0.00	0.08	0.01	0.08	0.00	0.00	0.00	0.08	0.92
BDC-05-19	8/1/2017	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.31	0.00	0.00	0.00	0.01	0.99
BDC-05-20	7/31/2011	0.00	0.05	0.46	0.00	0.00	0.00	0.52	0.00	0.00	0.10	0.90	0.00	0.00
(MW 31 ft DG)	11/3/2011	0.00	0.04	0.26	0.02	0.00	0.00	0.32	0.00	0.00	0.14	0.81	0.05	0.00
	2/19/2012	0.00	0.02	0.18	0.04	0.00	0.00	0.24	0.00	0.00	0.09	0.74	0.17	0.00
BDC-05-20	5/7/2012	0.00	0.01	0.14	0.04	0.00	0.00	0.19	0.00	0.00	0.07	0.75	0.18	0.00
BDC-05-20	9/5/2012	0.00	0.00	0.12	0.03	0.00	0.00	0.16	0.00	0.00	0.00	0.79	0.21	0.00
BDC-05-20	11/16/2012	0.00	0.00	0.18	0.06	0.00	0.00	0.24	0.00	0.00	0.02	0.74	0.24	0.00
BDC-05-20	2/26/2013	0.00	0.00	0.10	0.10	0.00	0.00	0.20	0.00	0.00	0.02	0.50	0.48	0.00
BDC-05-20	5/23/2013	0.00	0.00	0.10	0.13	0.05	0.00	0.24	0.05	0.00	0.01	0.36	0.45	0.18

Table 1
Groundwater Data Summary
Boeing Developmental Center
SWMU-17

Well	Date	Pilot Injection: Elapsed Time From Injection (days)	Full Injection #1: Elapsed Time From Injection (days)	Volatile Organic Compounds: PCE (µg/L)	TCE (µg/L)	c DCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	Metals: As, Tot (mg/L)	As, Dis (mg/L)	Cu, Tot (mg/L)	Cu, Dis (mg/L)	Aquifer Redox Conditions: DO (mg/L)	Nitrate (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (mg/L)	ORP (mV)	Donor Indicators: TOC (mg/L)	pH
Proposed Groundwater Cleanup Levels (a)				5.3	1.4	134	2.4	NA	NA	NA	0.008	0.008	0.008	0.008								
BDC-05-20	8/28/2013		741	<0.2	0.2	6.5	10	2.1	<1.0	<1.0					2.38		2.6	<0.30	20.0	-317	15.4	6.70
BDC-05-20	11/14/2013		819	<0.2	0.3	8.1	8.8	2.2	<1.0	<1.0	0.021	0.021	<0.002	<0.002	2.26		1.4	<0.30	19.0	-287	17.9	6.77
BDC-05-20	2/12/2014		909	<0.2	0.2	3.9	7.8	3.0	<4.0	<1.0					2.82		1.8	<0.30	16.0	-205	16.3	6.78
BDC-05-20	5/13/2014		999	<0.2	<0.2	3.8	6.3	2.0	<1.0	<1.0	0.017	0.017	<0.002	<0.002	3.44		1.6	0.36	16.0	-213	18.7	6.79
BDC-05-20	8/6/2014		1084	<0.2	<0.2	1.3	7.5	2.1	2.0	<1.0					4.23		1.4	<0.30	12.0	-150	17.6	7.31
BDC-05-20	11/10/2014		1180	<0.2	<0.2	0.7	4.9	3.0	3.6	<1.0	0.021	0.021	<0.002	<0.002	0.08		0.8	0.97	15.0	-117	15.9	6.50
BDC-05-20	1/21/2015		1252	<0.2	<0.2	0.5	3.8	2.7	2.6	<1.0					0.27		1.0	0.59	13.0	-120	13.8	6.47
BDC-05-20	4/26/2015		1347	<0.2	<0.2	0.4	6.9	4.8	1.6	<1.0	0.028	0.023			0.06		0.8	<0.30	14.0	-99	11.4	6.43
BDC-05-20	7/21/2015		1433	<0.2	<0.2	0.2	2.7	4.5	3.0	<1.0					0.12		1.3	<0.30	17.0	-59	14.2	6.55
BDC-05-20	10/27/2015		1531	<0.2	<0.2	<0.2	2.0	1.5	1.1	<1.0	0.028	0.028	<0.002	<0.002	0.23		1.4	<0.30	11.0	-35	10.6	6.47
BDC-05-20	1/26/2016		1622	<0.2	<0.2	0.2	2.7	2.1	1.5	<1.0					0.26		1.3	<0.30	11.0	-109	9.9	6.63
BDC-05-20	4/21/2016		1708	<0.2	<0.2	0.3	6.8	6.1	2.5	<1.0	0.034	0.030	<0.002	<0.002	0.38		0.8	<0.30	8.8	-44	16.2	6.63
BDC-05-20	8/9/2016		1818	<0.2	<0.2	0.2	2.2	7.0	2.9	<1.0	0.030	0.028	<0.002	<0.002	-0.01		2.0	0.37	8.4	-82	12.9	6.62
BDC-05-20	11/3/2016		1904	<0.2	<0.2	<0.2	1.4	5.2	2.5	<1.0	0.027	0.028	<0.002	<0.002	0.40		1.0	<0.30	8.9	-121.9	14.1	6.60
BDC-05-20	2/8/2017		2001	<0.2	<0.2	<0.2	1.8	5.2	2.8	<1.0	0.029	0.030	<0.002	<0.002	0.39		2.8	<0.30	7.1	-44.2	13.0	6.61
BDC-05-20	5/4/2017		2086	<0.2	<0.2	<0.2	1.2	2.3	4.3	<1.0	0.027	0.026	<0.002	<0.002	0.30		1.6	1.2	4.3	-99.6	12.9	6.55
BDC-05-20	8/1/2017		2175	<0.2	<0.2	<0.2	0.9	1.4	4.6	<1.0	0.027	0.027	<0.002	<0.002	0.61		2.1	<0.30	6.4	-104.9	12.3	6.46
BDC-05-21	7/31/2011		-18	<1.0	<1.0	1.3	14	2.6	<1.2	<1.1	0.006	0.006	<0.002	<0.002	2.98	<0.1	3.2	0.2	5.6	-31	6.4	7.33
(MW 30 ft XG)	11/3/2011		77	<1.0	<1.0	1.0	4.7				0.005	0.005	<0.002	<0.002	1.95	<0.1	1.4	6.3		-12	5.2	7.29
	2/19/2012		185	<0.2	0.3	0.7	5.9								0.40	<0.5	1.4	<1.5		47	7.2	6.65
BDC-05-21	5/7/2012		263	<0.2	0.4	0.8	2.5				0.010	0.011	0.005	<0.002	0.86		1.5	1.9		-35	12.3	6.76
BDC-05-21	9/5/2012		384	<0.2	0.3	0.6	2.9								0.08		2.5	1.4		62	9.5	6.78
BDC-05-21	11/16/2012		456	<0.5	<0.5	0.6	2.9				0.020	0.020	<0.002	<0.002	0.02		1.5	0.6		-4	8.9	6.92
BDC-05-21	2/26/2013		558	<0.2	0.3	0.8	3.3	<1.0	<1.0	<1.0					0.24		1.4	<0.3	18.0	-2.6	8.7	7.03
BDC-05-21	5/23/2013		644	<0.2	0.3	0.9	6.5				0.024	0.022	<0.002	<0.002	0.19		1.5	<0.3		-235	8.2	7.50
BDC-05-21	8/28/2013		741	<0.2	0.2	0.8	7.7	6.2	1.8	<1.0					0.74		3.5	<0.30	14.0	-310	7.9	6.72
BDC-05-21	11/14/2013		819	<0.2	0.2	1.0	7.3	3.5	1.4	<1.0	0.019	0.017	<0.002	<0.002	2.84		2.0	<0.30	12.0	-239	7.7	6.78
BDC-05-21	2/12/2014		909	<0.2	0.2	3.0	3.4	1.9	2.9	<1.0					2.74		2.2	<0.30	12.0	-210	8.3	6.87
BDC-05-21	5/13/2014		999	<0.2	<0.2	1.9	2.2	2.8	2.9	<1.0	0.022	0.017	<0.002	<0.002	3.33		1.4	0.60	9.1	-259	8.6	6.82
BDC-05-21	8/6/2014		1084	<0.2	<0.2	2.3	5.6	3.8	1.8	<1.0					3.75		2.2	<0.30	6.5	-153	9.4	7.42
BDC-05-21	11/10/2014		1180	<0.2	<0.2	1.5	3.4	4.3	1.2	<1.0	0.017	0.014	<0.002	<0.002	0.24		1.4	0.99	5.8	-126	5.7	6.44
BDC-05-21	1/21/2015		1252	<0.2	<0.2	1.1	3.5	2.2	<1.0	<1.0					0.15		1.0	0.97	1.8	-124	6.3	6.43
BDC-05-21	4/27/2015		1348	<0.2	<0.2	1.5	4.4	2.7	<1.0	<1.0	0.013	0.011	<0.002	<0.002	0.28		0.8	1.9	4.8	-104	5.4	6.43
BDC-05-21	7/20/2015		1432	<0.2	<0.2	0.8	3.0	2.7	<1.0	<1.0					0.17		1.2	0.55	6.8	-84	4.5	6.41
BDC-05-21	10/27/2015		1531	<0.2	<0.2	0.5	4.1	2.1	<1.0	<1.0	0.009	0.011	<0.002	<0.002	0.08		2.0	0.49	3.0	-46	5.7	6.53
BDC-05-21	1/26/2016		1622	<0.2	<0.2	2.0	2.9	1.2	<1.0	<1.0					1.41			1.40	2.5	-119	13.8	6.50
BDC-05-21	4/21/2016		1708	<0.2	<0.2	1.7	2.4	1.6	<1.0	<1.0	0.016	0.016	<0.002	<0.002	0.18		1.0	1.1	4.6	-75	12.7	6.78
BDC-05-21	8/9/2016		1818	<0.2	<0.2	0.6	1.6	3	2.3	<1.0	0.008	0.008	<0.002	<0.002	0.05		4.0	<0.30	11.0	-99.6	6.7	6.52
BDC-05-21	11/2/2016		1903	<0.2	<0.2	0.4	1.3	1.2	1.8	<1.0	0.008	0.009	<0.002	<0.002	0.43		0.8	<0.30	8.8	-122.8	9.5	6.45
BDC-05-21	2/7/2017		2000	<0.2	<0.2	0.5	1.4	<1.0	1.6	<1.0	0.007	0.006	<0.002	<0.002	0.36		2.6	<0.30	9.1	-67.5	9.3	6.52
BDC-05-21	5/3/2017		2085	<0.2	<0.2	0.7	2.0	2.8	1.3	<1.0	0.009	0.009	<0.002	<0.002	0.46		2.0	0.64	3.4	-114.4	9.1	6.45
BDC-05-21	8/1/2017		2175	<0.2	<0.2	0.6	1.5	3.9	5.6	<1.0	0.009	0.009	<0.002	<0.002	2.53		2.8	1.1	4.9		13.9	6.11
BDC-05-22	7/31/2011		-18	<1.0	1.1	9.6	1.0	<1.1	<1.2	<1.1	0.025	0.024	<0.002	<0.002	2.02	<0.1	2.2	14.0	5.1	-59	7.9	7.21
(MW 48 ft XG)	11/3/2011		77	<1.0	2.1	10	<1.0				0.020	0.020	<0.002	<0.002	1.46	<0.1	0.8	18.1		19	6.1	7.08
	2/19/2012		185	<0.2	2.0	13	0.4								0.43	<0.5	1.2	17.0		110	6.2	6.73
BDC-05-22	5/7/2012		263	<0.2	2.0	11	0.5				0.025	0.023	0.002	<0.002	0.81		1.6	19.4		32	8.4	6.68
BDC-05-22	9/5/2012		384	<0.2	1.8	9.5	0.8								0.06		2.2	14.7		75	7.6	6.71
BDC-05-22	11/16/2012		456	<0.5	1.6	10	0.7				0.033	0.031	<0.002	<0.002	0.02		0.8	17.8		5	7.7	6.93
BDC-05-22	2/26/2013		558	<0.2	1.3	9.4	1.2								0.09		1.6	10.1		23	7.5	6.92
BDC-05-22	5/23/2013		644	<0.2	1.2	10	0.6				0.029	0.029	<0.002	<0.002	0.25		1.4	6.3		-233	8.7	7.63
BDC-05-22	8/28/2013		741	<0.2	1.2	7.3	0.2								0.65			3.5		-322	8.9	6.69
BDC-05-22	11/14/2013		819	<0.2	1.2	6.9	<0.2				0.028	0.027	<0.002	<0.002	1.96		1.5	5.9		-240	8.8	6.74
BDC-05-22	2/12/2014		909	<0.2	0.7	5.7	<0.2								2.67		2.0	4.9		-224	7.3	6.88
BDC-05-22	5/13/2014		999	<0.2	1.4	6.7	<0.2				0.027	0.025	<0.002	<0.002	3.16		1.5	8.7		-183	8.4	6.68
BDC-05-22	8/6/2014		1084	<0.2	1.2	5.5	<0.2								4.59		1.6	10.9		-137	9.6	7.31
BDC-05-22	11/10/2014		1180	<0.2	1.2	5.8	<0.2				0.031	0.031	<0.002	<0.002	0.05		1.4	19.2		-113	6.8	6.43
BDC-05-22	1/21/2015		1252	<0.2	0.7	4.2	<0.2								0.30		1.0	1.2		-140	7.3	6.53
BDC-05-22	4/27/2015		1348	<0.2	0.5	4.2	<0.2				0.025	0.026	0.004	<0.002	0.14		1.8	<0.30		-115	5.2	6.44
BDC-05-22	7/21/2015		1433	<0.2	0.7	5.5	<0.2								0.12		1.0	4.4		-47	6.1	6.38
BDC-05-22	10/27/2015		1531	<0.2	0.6	4.5	<0.2				0.030	0.027	<0.002	<0.002	0.09		1.0	4.2		-50	6.9	6.59
BDC-05-22	1/26/2016		1622	<0.2	0.9	7.1	<0.2								0.28		1.4	8.5		-109	6.8	6.55
BDC-05-22	4/21/2016		1708	<0.2	0.9	7.3	<0.2				0.035	0.034	<0.002	<0.002	0.79		1.0	22.4		-39	6.0	6.44
BDC-05-22	8/9/2016		1818	<0.2	1.1	6.2	1.5				0.029	0.030	<0.002	<0.002	0.04		2.2	6.6		-60.8	6.2	6.50
BDC-05-22	11/3/2016		1904	<0.2	0.3	7.0	0.8				0.025	0.025	<0.002	0.004	0.60		0.8	0.57		-126.9	5.7	6.66
BDC-05-22	2/8/2017		2001	<0.2	0.3	8.4	<0.2				0.026	0.026	<0.002	<0.002	0.54		3.4	0.3		-23.5	5.9	6.27
BDC-05-22	5/4/2017		2086	<0.2	0.6	9.4	<0.2				0.028	0.030	<0.002	<0.002	0.24		2.6	6.6		-128	6.0	6.57
BDC-05-22	8/1/2017		2175	<0.2	0.7	9.1	<0.2				0.032	0.030	<0.002	<0.002	1.88		2.6	1.8		-85.1	6.3	6.28
BDC-05-23	7/31/2011		-18	<1.0	<1.0	3.2	<1.0	<1.1	<1.2	<1.1	0.005	0.005	0.002	<0.002	2.72	<0.1	2.2	8.6	6.0	-101	9.1	7.47
(MW 170ft DG)	11/3/2011		77	<1.0	<1.0	4.8	<1.0				0.005	0.006	<0.002	<0.002	1.45	<0.1	1.0	25.2		1	8.8	7.08
	2/19/2012		185	<0.2	0.6	4.7	0.7								0.96	<0.5	1.2	8.9		162	8.1	6.33
BDC-05-23	5/7/2012		263	<0.2	0.7	5.4	0.8				0.008	0.008	<0.002	<0.002	0.07		2.0	15.8		45	9.3	6.70

Well	Date	Comments	VOCs- micromoles/Liter (b): PCE	TCE	c DCE	VC	Ethene	Ethane	Total Chloroethenes (d)	Ethene + Ethane	Molar Fraction (c): PCE	TCE	c DCE	VC	Ethene + Ethane
BDC-05-20	8/28/2013		0.00	0.00	0.07	0.16	0.07	0.00	0.23	0.07	0.00	0.01	0.22	0.53	0.25
BDC-05-20	11/14/2013		0.00	0.00	0.08	0.14	0.08	0.00	0.23	0.08	0.00	0.01	0.27	0.46	0.26
BDC-05-20	2/12/2014		0.00	0.00	0.04	0.12	0.11	0.00	0.17	0.11	0.00	0.01	0.15	0.46	0.39
BDC-05-20	5/13/2014		0.00	0.00	0.04	0.10	0.07	0.00	0.14	0.07	0.00	0.00	0.19	0.48	0.34
BDC-05-20	8/6/2014		0.00	0.00	0.01	0.12	0.07	0.07	0.13	0.14	0.00	0.00	0.05	0.44	0.51
BDC-05-20	11/10/2014		0.00	0.00	0.01	0.08	0.11	0.12	0.09	0.23	0.00	0.00	0.02	0.25	0.73
BDC-05-20	1/21/2015		0.00	0.00	0.01	0.06	0.10	0.09	0.07	0.18	0.00	0.00	0.02	0.24	0.73
BDC-05-20	4/26/2015		0.00	0.00	0.00	0.11	0.17	0.05	0.11	0.22	0.00	0.00	0.01	0.33	0.66
BDC-05-20	7/21/2015		0.00	0.00	0.00	0.04	0.16	0.10	0.05	0.26	0.00	0.00	0.01	0.14	0.85
BDC-05-20	10/27/2015		0.00	0.00	0.00	0.03	0.05	0.04	0.03	0.09	0.00	0.00	0.00	0.26	0.74
BDC-05-20	1/26/2016		0.00	0.00	0.00	0.04	0.07	0.05	0.05	0.12	0.00	0.00	0.01	0.25	0.73
BDC-05-20	4/21/2016		0.00	0.00	0.00	0.11	0.22	0.08	0.11	0.30	0.00	0.00	0.01	0.26	0.73
BDC-05-20	8/9/2016		0.00	0.00	0.00	0.04	0.25	0.10	0.04	0.35	0.00	0.00	0.01	0.09	0.90
BDC-05-20	11/3/2016		0.00	0.00	0.00	0.02	0.19	0.08	0.02	0.27	0.00	0.00	0.00	0.08	0.92
BDC-05-20	2/8/2017		0.00	0.00	0.00	0.03	0.19	0.09	0.03	0.28	0.00	0.00	0.00	0.09	0.91
BDC-05-20	5/4/2017		0.00	0.00	0.00	0.02	0.08	0.14	0.02	0.22	0.00	0.00	0.00	0.08	0.92
BDC-05-20	8/1/2017		0.00	0.00	0.00	0.01	0.05	0.15	0.01	0.20	0.00	0.00	0.00	0.07	0.93
BDC-05-21	7/31/2011		0.00	0.00	0.01	0.22	0.09	0.00	0.24	0.09	0.00	0.00	0.04	0.68	0.28
(MW 30 ft XG)	11/3/2011		0.00	0.00	0.01	0.08			0.09		0.00	0.00	0.12	0.88	
	2/19/2012		0.00	0.00	0.01	0.09			0.10		0.00	0.02	0.07	0.91	
BDC-05-21	5/7/2012		0.00	0.00	0.01	0.04			0.05		0.00	0.06	0.16	0.78	
BDC-05-21	9/5/2012		0.00	0.00	0.01	0.05			0.05		0.00	0.04	0.11	0.85	
BDC-05-21	11/16/2012		0.00	0.00	0.01	0.05			0.05		0.00	0.00	0.12	0.88	
BDC-05-21	2/26/2013		0.00	0.00	0.01	0.05	0.00	0.00	0.06	0.00	0.00	0.04	0.13	0.83	0.00
BDC-05-21	5/23/2013		0.00	0.00	0.01	0.10			0.12		0.00	0.02	0.08	0.90	
BDC-05-21	8/28/2013		0.00	0.00	0.01	0.12	0.22	0.06	0.13	0.28	0.00	0.00	0.02	0.30	0.68
BDC-05-21	11/14/2013		0.00	0.00	0.01	0.12	0.12	0.05	0.13	0.17	0.00	0.01	0.03	0.39	0.57
BDC-05-21	2/12/2014		0.00	0.00	0.03	0.05	0.07	0.10	0.09	0.16	0.00	0.01	0.12	0.22	0.65
BDC-05-21	5/13/2014		0.00	0.00	0.02	0.04	0.10	0.10	0.05	0.20	0.00	0.00	0.08	0.14	0.78
BDC-05-21	8/6/2014		0.00	0.00	0.02	0.09	0.14	0.06	0.11	0.20	0.00	0.00	0.08	0.29	0.63
BDC-05-21	11/10/2014		0.00	0.00	0.02	0.05	0.15	0.04	0.07	0.19	0.00	0.00	0.06	0.21	0.73
BDC-05-21	1/21/2015		0.00	0.00	0.01	0.06	0.08	0.00	0.07	0.08	0.00	0.00	0.08	0.38	0.54
BDC-05-21	4/27/2015		0.00	0.00	0.02	0.07	0.10	0.00	0.09	0.10	0.00	0.00	0.08	0.39	0.53
BDC-05-21	7/20/2015		0.00	0.00	0.01	0.05	0.10	0.00	0.06	0.10	0.00	0.00	0.05	0.31	0.63
BDC-05-21	10/27/2015		0.00	0.00	0.01	0.07	0.07	0.00	0.07	0.07	0.00	0.00	0.04	0.45	0.51
BDC-05-21	1/26/2016		0.00	0.00	0.02	0.05	0.04	0.00	0.07	0.04	0.00	0.00	0.19	0.42	0.39
BDC-05-21	4/21/2016		0.00	0.00	0.02	0.04	0.06	0.00	0.06	0.06	0.00	0.00	0.16	0.34	0.50
BDC-05-21	8/9/2016		0.00	0.00	0.01	0.03	0.11	0.08	0.03	0.18	0.00	0.00	0.03	0.12	0.85
BDC-05-21	11/2/2016		0.00	0.00	0.00	0.02	0.04	0.06	0.02	0.10	0.00	0.00	0.03	0.16	0.80
BDC-05-21	2/7/2017		0.00	0.00	0.01	0.02	0.00	0.05	0.03	0.05	0.00	0.00	0.06	0.28	0.66
BDC-05-21	5/3/2017		0.00	0.00	0.01	0.03	0.10	0.04	0.04	0.14	0.00	0.00	0.04	0.18	0.78
BDC-05-21	8/1/2017		0.00	0.00	0.01	0.02	0.14	0.19	0.03	0.33	0.00	0.00	0.02	0.07	0.92
BDC-05-22	7/31/2011		0.00	0.01	0.10	0.02	0.00	0.00	0.12	0.00	0.00	0.07	0.80	0.13	0.00
(MW 48 ft XG)	11/3/2011		0.00	0.02	0.10	0.00			0.12		0.00	0.13	0.87	0.00	
	2/19/2012		0.00	0.02	0.13	0.01			0.16		0.00	0.10	0.86	0.04	
BDC-05-22	5/7/2012		0.00	0.02	0.11	0.01			0.14		0.00	0.11	0.83	0.06	
BDC-05-22	9/5/2012		0.00	0.01	0.10	0.01			0.12		0.00	0.11	0.79	0.10	
BDC-05-22	11/16/2012		0.00	0.01	0.10	0.01			0.13		0.00	0.10	0.82	0.09	
BDC-05-22	2/26/2013		0.00	0.01	0.10	0.02			0.13		0.00	0.08	0.77	0.15	
BDC-05-22	5/23/2013		0.00	0.01	0.10	0.01			0.12		0.00	0.07	0.85	0.08	
BDC-05-22	8/28/2013		0.00	0.01	0.08	0.00			0.09		0.00	0.10	0.86	0.04	
BDC-05-22	11/14/2013		0.00	0.01	0.07	0.00			0.08		0.00	0.11	0.89	0.00	
BDC-05-22	2/12/2014		0.00	0.01	0.06	0.00			0.06		0.00	0.08	0.92	0.00	
BDC-05-22	5/13/2014		0.00	0.01	0.07	0.00			0.08		0.00	0.13	0.87	0.00	
BDC-05-22	8/6/2014		0.00	0.01	0.06	0.00			0.07		0.00	0.14	0.86	0.00	
BDC-05-22	11/10/2014		0.00	0.01	0.06	0.00			0.07		0.00	0.13	0.87	0.00	
BDC-05-22	1/21/2015		0.00	0.01	0.04	0.00			0.05		0.00	0.11	0.89	0.00	
BDC-05-22	4/27/2015		0.00	0.00	0.04	0.00			0.05		0.00	0.08	0.92	0.00	
BDC-05-22	7/21/2015		0.00	0.01	0.06	0.00			0.06		0.00	0.09	0.91	0.00	
BDC-05-22	10/27/2015		0.00	0.00	0.05	0.00			0.05		0.00	0.09	0.91	0.00	
BDC-05-22	1/26/2016		0.00	0.01	0.07	0.00			0.08		0.00	0.09	0.91	0.00	
BDC-05-22	4/21/2016		0.00	0.01	0.08	0.00			0.08		0.00	0.08	0.92	0.00	
BDC-05-22	8/9/2016		0.00	0.01	0.06	0.02			0.10		0.00	0.09	0.66	0.25	
BDC-05-22	11/3/2016		0.00	0.00	0.07	0.01			0.09		0.00	0.03	0.83	0.15	
BDC-05-22	2/8/2017		0.00	0.00	0.09	0.00			0.09		0.00	0.03	0.97	0.00	
BDC-05-22	5/4/2017		0.00	0.00	0.10	0.00			0.10		0.00	0.04	0.96	0.00	
BDC-05-22	8/1/2017		0.00	0.01	0.09	0.00			0.10		0.00	0.05	0.95	0.00	
BDC-05-23	7/31/2011		0.00	0.00	0.03	0.00	0.00	0.00	0.03	0.00	0.00	0.00	1.00	0.00	0.00
(MW 170ft DG)	11/3/2011		0.00	0.00	0.05	0.00			0.05		0.00	0.00	1.00	0.00	
	2/19/2012		0.00	0.00	0.05	0.01			0.06		0.00	0.07	0.75	0.17	
BDC-05-23	5/7/2012		0.00	0.01	0.06	0.01			0.07		0.00	0.07	0.75	0.17	

Table 1
Groundwater Data Summary
Boeing Developmental Center
SWMU-17

Well	Date	Pilot Injection Elapsed Time From Injection (days)	Full Injection #1 Elapsed Time From Injection (days)	Volatile Organic Compounds: PCE (µg/L)	TCE (µg/L)	c DCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	Metals: As, Tot (mg/L)	As, Dis (mg/L)	Cu, Tot (mg/L)	Cu, Dis (mg/L)	Aquifer Redox Conditions: DO (mg/L)	Nitrate (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (mg/L)	ORP (mV)	Donor Indicators: TOC (mg/L)	pH	Comments
Proposed Groundwater Cleanup Levels (a)				5.3	1.4	134	2.4	NA	NA	NA	0.008	0.008	0.008	0.008									
BDC-05-23	9/5/2012		384	<0.2	0.7	6.2	0.9								0.08		1.9	8.8		78	11.3	6.84	
BDC-05-23	11/16/2012		456	<0.5	0.8	6.9	0.5				0.012	0.010	<0.002	<0.002	0.09		1.0	4.9		-6	11.6	7.06	
BDC-05-23	2/25/2013		557	<0.2	0.5	4.2	1.0								0.08		1.5	0.87		72	9.2	6.91	
BDC-05-23	5/23/2013		644	<0.2	0.5	4.7	1.0				0.015	0.015	<0.002	<0.002	0.31		1.2	1.7		-234	11.0	7.59	
BDC-05-23	8/28/2013		741	<1.0	2.2	21	5.4								0.60		0.5	0.35		-323	10.4	6.76	
BDC-05-23	11/14/2013		819	<0.2	0.3	3.0	0.9				0.017	0.015	<0.002	<0.002	1.58		1.3	0.62		-252	11.1	6.87	
BDC-05-23	2/12/2014		909	<0.2	0.2	2.7	1.2								2.40		1.8	0.74		-229	9.3	6.86	
BDC-05-23	5/13/2014		999	<0.2	0.3	4.5	1.0				0.023	0.023	<0.002	<0.002	3.15		1.4	3.1		-207	12.1	6.97	
BDC-05-23	8/6/2014		1084	<0.2	0.3	4.2	1.2								4.49		1.2	2.7		-149	13.3	7.35	
BDC-05-23	11/10/2014		1180	<0.2	0.3	3.9	1.0				0.023	0.021	<0.002	<0.002	0.10		1.6	1.9		-122	10.1	6.40	
BDC-05-23	1/21/2015		1252	<0.2	<0.2	2.8	1.7								0.13		1.4	0.66		-144	9.5	6.49	
BDC-05-23	4/27/2015		1348	<0.2	<0.2	2.9	2.4				0.022	0.021	<0.002	<0.002	0.19		1.6	0.74		-114	7.5	6.40	
BDC-05-23	7/20/2015		1432	<0.2	<0.2	1.5	2.7								0.22		0.9	<0.30		-84	7.1	6.40	
BDC-05-23	10/27/2015		1531	<0.2	<0.2	2.1	1.6				0.021	0.020	<0.002	<0.002	0.18		1.4	0.46		-55	7.9	6.64	
BDC-05-23	1/26/2016		1622	<0.2	<0.2	4.9	0.9								0.50			2.2		-112	7.8	6.44	
BDC-05-23	4/21/2016		1708	<0.2	<0.2	4.0	1.4				0.024	0.023	<0.002	<0.002	0.28		0.6	3.0		-72	6.3	6.83	
BDC-05-23	8/9/2016		1818	<0.2	<0.2	3.2	1.1				0.026	0.025	<0.002	<0.002	0.03		1.8	2.8		-80.3	7.3	6.64	
BDC-05-23	11/3/2016		1904	<0.2	<0.2	3.7	0.5				0.023	0.023	0.003	<0.002	0.62		0.6	4.2		-122.2	7.4	6.73	
BDC-05-23	2/7/2017		2000	<0.2	<0.2	2.1	1.3				0.016	0.016	<0.002	<0.002	0.62		3.0	2.2		-65.0	7.1	6.70	
BDC-05-23	5/3/2017		2085	<0.2	<0.2	2.0	0.5				0.026	0.026	<0.002	<0.002	0.80		2.0	10.9		-37.3	7.2	6.52	
BDC-05-23	8/1/2017		2175	<0.2	<0.2	0.9	0.5				0.017	0.019	<0.002	<0.002	1.00		2.2	4.7		-20.5	6.7	6.15	
BDC-05-24	7/31/2011		-18	<1.0	<1.0	1.6	1.6	<1.1	<1.2	<1.1	0.003	0.003	<0.002	<0.002	1.67	<0.1	2.0	1.1	7.6	-7	10.0	7.06	
(MW 18 ft XG)	11/1/2011		75	<1.0	2.0	4.0	2.2				0.002	0.002	<0.002	<0.002	1.50	<0.1	1.6	0.3		-2.6	8.1	7.06	
	2/19/2012		185	<0.2	0.2	0.7	0.8								0.31	<0.5	1.8	<1.5		63	9.8	6.55	
BDC-05-24	5/6/2012		262	<0.2	1.3	2.8	1.0				0.006	0.004	<0.002	<0.002	0.03			0.9		73	9.1	6.60	
BDC-05-24	9/5/2012		384	<0.2	1.2	4.0	0.9								0.08		2.0	<0.3		67	7.4	6.67	
BDC-05-24	11/15/2012		455	<0.5	<0.5	1.2	<0.5				0.002	0.003	<0.002	<0.002	0.13		1.0	<0.3		-1.7	10.7	6.94	
BDC-05-24	2/25/2013		557	<0.2	0.7	5.1	1.9	1.1	<1.2	<1.0					0.10		1.5	1.1	9.1	87	7.2	6.72	
BDC-05-24	5/22/2013		643	<0.2	0.8	7.6	2.1				0.004	0.003	<0.002	<0.002	0.58		1.4	0.82		-272	7.4	7.54	
BDC-05-24	8/28/2013		741	<0.2	0.5	4.4	1.6	<1.0	1.8	<1.0					0.78		1.4	0.47	11.0	-321	8.6	6.57	
BDC-05-24	11/13/2013		818	<0.2	0.4	3.3	1.4	<1.0	1.4	<1.0	0.003	0.003	<0.002	<0.002	2.43		1.3	1.4	11.0	-219	8.7	6.54	
BDC-05-24	2/12/2014		909	<0.2	0.2	1.7	0.6	1.1	3.0	<1.0					2.72		2.0	0.81	11.0	-211	7.1	6.76	
BDC-05-24	5/12/2014		998	<0.2	0.3	4.8	1.6	1.0	2.3	<1.0	0.003	0.002	<0.002	<0.002	2.58		1.2	0.87	10.0	-196	8.2	6.75	
BDC-05-24	8/6/2014		1084	<0.2	0.2	2.8	1.8	3.6	2.3	<1.0					4.02		1.0	0.36	9.6	-167	9.5	7.33	
BDC-05-24	11/10/2014		1180	<0.2	<0.2	6.2	12	2.0	<1.0	<1.0	0.001	0.001	<0.002	<0.002	0.05		1.2	1.8	0.97	-86	4.2	6.52	
BDC-05-24	1/21/2015		1252	<0.2	0.4	2.1	1.6	2.5	<1.0	<1.0					0.14		2.0	2.3	5.4	-65	3.8	6.31	
BDC-05-24	4/27/2015		1348	<0.2	0.5	0.9	2.5	2.5	<1.0	<1.0	0.003	0.003	<0.002	<0.002	0.08		0.8	0.97	3.2	-27	3.2	6.22	
BDC-05-24	7/21/2015		1433	<0.2	0.3	1.3	3.9	<1.0	<1.0	<1.0					0.09		1.8	6.2	0.45	-23	2.2	6.27	
BDC-05-24	10/28/2015		1532	<0.2	0.5	0.7	1.3	<1.0	<1.0	<1.0	0.003	0.004	<0.002	<0.002	0.47		1.0	5.1	1.4	-3.1	2.9	6.54	
BDC-05-24	1/26/2016		1622	<0.2	<0.2	0.4	1.9	<1.0	1.2	<1.0					0.34		1.0	0.43	12.0	-76	8.3	6.47	
BDC-05-24	4/20/2016		1707	<0.2	0.2	0.5	0.7	<1.0	1.8	<1.0	0.004	0.002	<0.002	<0.002	0.28			1.3	7.5	-3.8	4.6	6.44	
BDC-05-24	8/9/2016		1818	<0.2	0.7	1.9	2.2	3.6	3.6	<1.0	0.005	0.003	<0.002	<0.002	0.15			2.2	6.0	-34.6	2.6	5.85	
BDC-05-24	11/3/2016		1904	<0.2	0.2	0.7	0.8	1.9	1.3	<1.0	0.002	0.002	<0.002	<0.002	0.34		1.8	0.80	12.0	-86.4	4.9	5.95	
BDC-05-24	2/8/2017		2001	<0.2	0.3	1.3	2.1	2.7	3.2	<1.0	0.003	0.002	<0.002	0.004	0.34		2.2	1.8	5.9	-6.4	4.0	6.41	
BDC-05-24	5/4/2017		2086	<0.2	<0.2	0.4	0.5	<1.0	3.7	<1.0	0.004	0.003	<0.002	<0.002	0.20		2.4	1.5	5.9	-36.4	4.8	6.22	
BDC-05-24	8/1/2017		2175	<0.2	<0.2	0.4	0.5	1.1	<1.0	<1.0	0.003	0.002	<0.002	<0.002	0.11		2.0	1.3	11.0	-51.1	5.7	5.92	

Well	Date	VOCs- micromoles/Liter (b): PCE	TCE	c DCE	VC	Ethene	Ethane	Total Chloroethenes (d)	Ethene + Ethane	Molar Fraction (c): PCE	TCE	c DCE	VC	Ethene + Ethane
BDC-05-23	9/5/2012	0.00	0.01	0.06	0.01			0.08		0.00	0.06	0.76	0.17	
BDC-05-23	11/16/2012	0.00	0.01	0.07	0.01			0.09		0.00	0.07	0.83	0.09	
BDC-05-23	2/25/2013	0.00	0.00	0.04	0.02			0.06		0.00	0.06	0.69	0.25	
BDC-05-23	5/23/2013	0.00	0.00	0.05	0.02			0.07		0.00	0.06	0.71	0.23	
BDC-05-23	8/28/2013	0.00	0.02	0.22	0.09			0.32		0.00	0.05	0.68	0.27	
BDC-05-23	11/14/2013	0.00	0.00	0.03	0.01			0.05		0.00	0.05	0.65	0.30	
BDC-05-23	2/12/2014	0.00	0.00	0.03	0.02			0.05		0.00	0.03	0.57	0.40	
BDC-05-23	5/13/2014	0.00	0.00	0.05	0.02			0.06		0.00	0.04	0.72	0.25	
BDC-05-23	8/6/2014	0.00	0.00	0.04	0.02			0.06		0.00	0.04	0.67	0.30	
BDC-05-23	11/10/2014	0.00	0.00	0.04	0.02			0.06		0.00	0.04	0.69	0.27	
BDC-05-23	1/21/2015	0.00	0.00	0.03	0.03			0.06		0.00	0.00	0.51	0.49	
BDC-05-23	4/27/2015	0.00	0.00	0.03	0.04			0.07		0.00	0.00	0.44	0.56	
BDC-05-23	7/20/2015	0.00	0.00	0.02	0.04			0.06		0.00	0.00	0.26	0.74	
BDC-05-23	10/27/2015	0.00	0.00	0.02	0.03			0.05		0.00	0.00	0.46	0.54	
BDC-05-23	1/26/2016	0.00	0.00	0.05	0.01			0.06		0.00	0.00	0.78	0.22	
BDC-05-23	4/21/2016	0.00	0.00	0.04	0.02			0.06		0.00	0.00	0.65	0.35	
BDC-05-23	8/9/2016	0.00	0.00	0.03	0.02			0.05		0.00	0.00	0.65	0.35	
BDC-05-23	11/3/2016	0.00	0.00	0.04	0.01			0.05		0.00	0.00	0.83	0.17	
BDC-05-23	2/7/2017	0.00	0.00	0.02	0.02			0.04		0.00	0.00	0.51	0.49	
BDC-05-23	5/3/2017	0.00	0.00	0.02	0.01			0.03		0.00	0.00	0.72	0.28	
BDC-05-23	8/1/2017	0.00	0.00	0.01	0.01			0.02		0.00	0.00	0.54	0.46	
BDC-05-24	7/31/2011	0.00	0.00	0.02	0.03	0.00	0.00	0.04	0.00	0.00	0.00	0.39	0.61	0.00
(MW 18 ft XG)	11/1/2011	0.00	0.02	0.04	0.04			0.09		0.00	0.17	0.45	0.38	
	2/19/2012	0.00	0.00	0.01	0.01			0.02		0.00	0.07	0.34	0.59	
BDC-05-24	5/6/2012	0.00	0.01	0.03	0.02			0.05		0.00	0.18	0.53	0.29	
BDC-05-24	9/5/2012	0.00	0.01	0.04	0.01			0.06		0.00	0.14	0.64	0.22	
BDC-05-24	11/15/2012	0.00	0.00	0.01	0.00			0.01		0.00	0.00	1.00	0.00	
BDC-05-24	2/25/2013	0.00	0.01	0.05	0.03	0.04	0.00	0.09	0.04	0.00	0.04	0.41	0.24	0.31
BDC-05-24	5/22/2013	0.00	0.01	0.08	0.03			0.12		0.00	0.05	0.66	0.28	
BDC-05-24	8/28/2013	0.00	0.00	0.05	0.03	0.00	0.06	0.07	0.06	0.00	0.03	0.34	0.19	0.44
BDC-05-24	11/13/2013	0.00	0.00	0.03	0.02	0.00	0.05	0.06	0.05	0.00	0.03	0.32	0.21	0.44
BDC-05-24	2/12/2014	0.00	0.00	0.02	0.01	0.04	0.10	0.03	0.14	0.00	0.01	0.10	0.06	0.83
BDC-05-24	5/12/2014	0.00	0.00	0.05	0.03	0.04	0.08	0.08	0.11	0.00	0.01	0.26	0.14	0.59
BDC-05-24	8/6/2014	0.00	0.00	0.03	0.03	0.13	0.08	0.06	0.20	0.00	0.01	0.11	0.11	0.78
BDC-05-24	11/10/2014	0.00	0.00	0.06	0.19	0.07	0.00	0.26	0.07	0.00	0.00	0.20	0.59	0.22
BDC-05-24	1/21/2015	0.00	0.00	0.02	0.03	0.09	0.00	0.05	0.09	0.00	0.02	0.16	0.18	0.64
BDC-05-24	4/27/2015	0.00	0.00	0.01	0.04	0.09	0.00	0.05	0.09	0.00	0.03	0.07	0.28	0.63
BDC-05-24	7/21/2015	0.00	0.00	0.01	0.06	0.00	0.00	0.08	0.00	0.00	0.03	0.17	0.80	0.00
BDC-05-24	10/28/2015	0.00	0.00	0.01	0.02	0.00	0.00	0.03	0.00	0.00	0.12	0.23	0.65	0.00
BDC-05-24	1/26/2016	0.00	0.00	0.00	0.03	0.00	0.04	0.03	0.04	0.00	0.00	0.06	0.41	0.54
BDC-05-24	4/20/2016	0.00	0.00	0.01	0.01	0.00	0.06	0.02	0.06	0.00	0.02	0.07	0.14	0.77
BDC-05-24	8/9/2016	0.00	0.01	0.02	0.04	0.13	0.12	0.06	0.25	0.00	0.02	0.06	0.11	0.80
BDC-05-24	11/3/2016	0.00	0.00	0.01	0.01	0.07	0.04	0.02	0.11	0.00	0.01	0.05	0.10	0.84
BDC-05-24	2/8/2017	0.00	0.00	0.01	0.03	0.10	0.11	0.05	0.20	0.00	0.01	0.05	0.13	0.80
BDC-05-24	5/4/2017	0.00	0.00	0.00	0.01	0.00	0.12	0.01	0.12	0.00	0.00	0.03	0.06	0.91
BDC-05-24	8/1/2017	0.00	0.00	0.00	0.01	0.04	0.00	0.01	0.04	0.00	0.00	0.08	0.16	0.76

PCE = tetrachloroethene
TCE = trichloroethene
c DCE = cis-1,2-dichloroethene
VC = vinyl chloride
As = arsenic
Cu = copper
Tot = total

Dis = dissolved
DO = dissolved oxygen
ORP = oxidation reduction potential
TOC = total organic carbon
NA = not applicable, not available
µg/L = micrograms per liter
mg/L = milligrams per liter

IW = Injection Well
MW = Monitoring Well
DG = Downgradient; distance from nearest injection well
UG = Upgradient; distance from nearest injection well
XG = Crossgradient; distance from nearest injection well
(green shading) not analyzed
(blue shading) = Highlights the predominant ethene

Box = exceedance of proposed cleanup level

(a) Proposed Cleanup Standards and Comparison to Site Data, Boeing Developmental Center, Tukwila,Washington (Landau Associates, 5/7/13).
(b) Calculated by dividing the concentration in groundwater by the molecular weight of the compound. Reporting limits for non-detect results replaced with zero.
(c) Indicates the fraction of total ethenes (PCE+TCE+cDCE+VC+ethene/ethane) due to each individual compound on a molar basis.
(d) Sum of PCE, TCE, cDCE, and VC.

Injection Dates:
10/28/2008 Pilot Injection: BDC-05-02 only
8/18/2011 Full Injection #1: BDC-05-02, BDC-05-07, and BDC-05-09 through BDC-05-17; performed 8/15/11-8/18/11

Table 2
Bioremediation Groundwater Monitoring Matrix
SMWU-17
Boeing Developmental Center

BDC-05- Injection Wells	Injected 2011	Injected 2017	Semiannual
02	X	X	(a) (b) (c)
07	X	X	(a) (b) (c)
09	X		(a) (b) (c)
10	X	X	(a) (b) (c)
11	X		(a) (b) (c)
12	X		(a) (b) (c)
13	X		(a) (b) (c)
14	X		(a) (b) (c)
15	X		(a) (b) (c)
16	X		(a) (b) (c)
17	X		(a) (b) (c)
03		X	(a) (b) (c)
04		X	(a) (b) (c)
05			(a) (b)
08			(a) (b)
18			(a) (b) (c)
19			(a) (b) (c)
20			(a) (b) (c)
21			(a) (b) (c)
22			(a) (b)
23			(a) (b)
24			(a) (b) (c)

(a) Laboratory Parameters (method): VOC Short List (8260) - PCE, TCE, cDCE, VC; TOC (415.1); Sulfate (E300);
Field Parameters: Fe2; pH, DO, ORP, Temp.

(b) Laboratory Parameters (method): Total (nonfiltered) and dissolved (field filtered) Cu (3010A) and As (200.8 ICP-MS).

(c) Laboratory Parameters (method):
Methane/Ethane/Ethene/Acetylene (RSK-175).

APPENDIX F

2004 Evaluation Report, SWMU-17, SWMU-20, & AOC-05, Appendix A: SWMU-20 Electron Donor Amendment Work Plan

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1.0 INTRODUCTION

This document presents a work plan to conduct active remediation at Solid Waste Management Unit (SWMU) -20 at the Boeing Developmental Center in Tukwila, Washington. The BDC is a Resource Conservation and Recovery Act (RCRA) corrective action site with remedial activities conducted under the Washington State Department of Ecology (Ecology) Voluntary Cleanup Program (VCP). Preparation of this work plan was authorized under Work Order No. ENV-G-04DC-019.

Groundwater at SWMU-20 contains the dissolved volatile organic compounds (VOCs) tetrachloroethene (PCE), trichloroethene (TCE), and breakdown products cis-1,2-dichloroethene (cis-1,2-DCE) and vinyl chloride. PCE and TCE were released from a former vapor degreaser located in Building 9-101 (Figure A-1) (Landau Associates 2002). A groundwater treatment system was operated at SWMU-20 between Fall 1993 and December 14, 2001, when the system was shut down to evaluate natural attenuation as a remedial alternative to achieve cleanup objectives. Based on rebound of VOC concentrations in a number of monitoring wells that are located in the immediate vicinity of the former vapor degreaser, Boeing has proposed active remediation by enhanced *in situ* reductive dechlorination through electron donor amendment (Landau Associates 2003). This work plan describes injection of electron donors sodium lactate and vegetable (soybean) oil emulsion and outlines groundwater monitoring to be performed before and after injection.

2.0 ELECTRON DONOR AMENDMENT

This section describes the general objectives of electron donor amendment, evaluates existing reductive dechlorination and redox conditions in SWMU-20, and describes proposed injection at SWMU-20.

2.1 GENERAL OBJECTIVES

Electron donor amendment is designed to enhance and maintain the reducing aquifer conditions required for reductive dechlorination of PCE, TCE, and associated breakdown products. Electron donor amendment stimulates reducing aquifer conditions that are required for reductive dechlorination, and provides organic carbon needed for bacterial growth. Hydrogen provided by fermentation of organic carbon reduces aquifer conditions. Hydrogen is the electron used to replace chlorine atoms on the chlorinated hydrocarbon compound through reductive dechlorination. Following donor amendment to an aquifer, ubiquitous aerobic and anaerobic bacteria utilize the hydrogen to consume any electron acceptors that may be present in the aquifer, including dissolved oxygen (DO), nitrate, manganese (IV), iron (III), sulfate, and CO_2. These electron acceptors are consumed in sequentially-occurring redox processes (chemical or biochemical processes in which electrons are transferred) known as oxygen reduction, nitrate reduction (denitrification), iron reduction, sulfate reduction, and CO_2 reduction (methanogenesis). Electron acceptors are consumed in this order because the use of each successive electron acceptor releases less energy, and bacteria preferentially use electron acceptors that provide the greatest energy return. Upon depletion of dissolved oxygen, an aquifer is anaerobic and becomes more reducing with the depletion of each successive electron acceptor.

Chlorinated compounds (e.g., PCE, TCE, cis-1,2-DCE, and vinyl chloride) are electron acceptors in the process known as reductive dechlorination. In successive steps of reductive dechlorination, individual chlorine atoms on the chlorinated hydrocarbon compound are replaced with hydrogen from the electron donor. Through reductive dechlorination, PCE is reduced to sequential breakdown products TCE, cis-1,2-DCE, vinyl chloride, ethene, and ethane, which ultimately degrades to CO_2 and water. Each sequential breakdown step requires more highly reducing conditions than the previous step (i.e., cis-1,2-DCE reduction to vinyl chloride requires more reducing conditions than TCE reduction to cis-1,2-DCE). PCE and TCE are highly oxidized (chlorinated) compounds that can be degraded under slightly reducing conditions (nitrate and iron reducing conditions), while reductive dechlorination of less oxidized breakdown products cis-1,2-DCE and vinyl chloride, requires sulfate-reducing to methanogenic conditions (Lu et al. 2001, ITRC 1998).

2.2 EXISTING CONDITIONS AT SWMU-20

Naturally-occurring reductive dechlorination processes are ongoing at SWMU-20, as evidenced by the incidence of PCE and TCE breakdown products cis-1,2-DCE and vinyl chloride (Landau Associates 2002, 2003). Observed reductive dechlorination indicates an existing source of organic carbon, sulfate-reducing to methanogenic aquifer redox conditions, and the presence of bacteria required for complete reductive dechlorination.

Reductive dechlorination in SWMU-20 is currently supported by naturally-occurring organic carbon. Total organic carbon (TOC) concentrations of 247 mg/kg to 1,456 mg/kg were measured in soil samples collected previously during the installation of five SWMU-20 monitoring wells. These soil samples were collected at depths ranging from 20 to 37.5 ft below ground surface (BGS) within Duwamish River alluvium (Landau Associates 1992).

The occurrence of vinyl chloride at SWMU-20 indicates sulfate-reducing to methanogenic redox conditions and the presence of bacteria required for complete reductive dechlorination. Reductive dechlorination of cis-1,2-DCE to vinyl chloride requires sulfate reducing to methanogenic conditions (Lu et al. 2001, ITRC 1998). While bacteria capable of reductive dechlorination of PCE and TCE are ubiquitous and varied in the environment, *Dehalococcoides* bacteria capable of cis-1,2-DCE dechlorination to vinyl chloride are less commonly occurring (Ellis et al. 2000). An extensive survey of *Dehalococcoides* at multiple contaminated sites indicated that the bacterium was present at all sites where complete reductive dechlorination of TCE occurred and, conversely, the survey did not find *Dehalococcoides* at any sites where reductive dechlorination was stalled at cis-1,2-DCE (Major et al. 2003).

Donor injection has significantly enhanced reductive dechlorination at a similar site where naturally-occurring organic carbon is present and reductive dechlorination was previously occurring. A pilot test injection of sodium lactate enhanced reductive dechlorination at the nearby former Boeing Electronics Manufacturing Facility (EMF) within Boeing Plant 2, where baseline sampling indicated sulfate-reducing to methanogenic redox conditions and production of ethene. Over the four-month period following sodium lactate injection, total VOC concentrations decreased 85 to 92 percent at three injection wells, and decreased 94 percent at a monitoring well located 75 ft downgradient. The cell density of *Dehalococcoides* bacteria also increased two to four orders of magnitude compared to baseline (PPC 2004).

2.3 INJECTION AT SWMU-20

Electron donor consisting of food-grade sodium lactate and vegetable oil emulsion will be injected at wells in the immediate vicinity of the former vapor degreaser. The combined application of soluble (fast-release) sodium lactate and relatively insoluble (slow-release) vegetable oil is designed to address both downgradient impacts and residual source material in the release area.

Sodium lactate and vegetable oil emulsion will be mixed with groundwater pumped from extraction wells E1 and E2 (Figure A-1) to form dilute solutions for injection at wells MW-9A, MW-9B, MW-9C, MW-6B, MW-6C, and a new A-Horizon well to be installed near MW-6B and MW-6C. In accordance with Washington Administrative Code (WAC 173-218) the site will be registered with Ecology's Underground Injection Control (UIC) program. Given the large volume injections described in the following section, groundwater pumped from E1 and E2 is preferred over tap water to avoid dilution and/or dispersion of the plume, and to avoid the introduction of highly oxygenated water. United Stated Environmental Protection Agency (EPA) policy allows for reinjection of groundwater extracted from a contaminated area, provided groundwater is treated to substantially reduce hazardous constituents prior to reinjection, with reduction of hazardous constituents occurring prior to or following injection (EPA 2000).

2.3.1 SODIUM LACTATE INJECTION

Sodium lactate is an innocuous, food-grade amendment that has been widely used as an electron donor for injection to groundwater. Sodium lactate is the salt of lactic acid. Lactate occurs naturally in milk, and is used by the dairy industry during fermentation processes used to manufacture buttermilk, yogurt, and other dairy products. Sodium lactate is completely soluble in groundwater causing it to move with the flow of groundwater. Although the advance of lactate is somewhat retarded due to consumption, any retardation is expected to be less than of the VOC compounds targeted for remediation. Lactate is fermented to hydrogen and intermediates, including propionate and pyruvate, which also ferment to hydrogen.

Groundwater pumped from extraction well E2 will be used to dilute sodium lactate for injection into monitoring wells MW-9A, MW-9B, and MW-9C (Figure A-1). Approximately 5000 gallons of groundwater will be mixed with 550 gallons (10 drums) of 60 percent sodium lactate solution to create a 6 percent solution for injection. Monitoring wells MW-9A, MW-9B, and MW-9C are screened from 11 to 21.5 ft, 22 to 27 ft, and 29 to 39.5 ft, respectively (Figure A-2). Due to an observed decrease in concentration with depth (Landau Associates 2002, 2003), 50 percent of the solution (3025 gallons) will be injected at well MW-9A and 25 percent (1512 gallons) will be injected at each of wells MW-9B, and MW-9C.

2.3.2 VEGETABLE OIL INJECTION

Vegetable oil is an innocuous, food-grade amendment that has been widely used as an electron donor for injection to groundwater. Soybean oil is typically used because of its low cost relative to other vegetable oils. The concentrated emulsion to be used at SWMU-20 is composed of soybean oil (50 percent by volume), lactic acid (4 percent by volume), water, and food-grade emulsifying agents. The emulsion has a reported oil droplet size of 0.5 micron, which will allow the oil droplets to pass through pore spaces in the aquifer and move out radially from the injection points. These very small oil droplets will adsorb to soil particles as they move with groundwater flow, forming a permeable barrier of vegetable oil at residual saturation within the aquifer. Over time, oil will break down to hydrogen and intermediate volatile organic acids that will move downgradient with groundwater flow for stimulation of reductive dechlorination.

Groundwater pumped from extraction well E1 will be used to dilute the vegetable oil emulsion for injection into monitoring wells MW-6B, MW-6C, and a new A-Horizon well to be installed just upgradient (east) of the former vapor degreaser (Figure A-1). As an A-Horizon monitoring well is not present near wells MW-6B and MW-6C, we propose to construct a new well screened from 10 to 20 ft BGS for injection and monitoring (Figure A-2). The new well will allow donor injection to the A Horizon beneath the former vapor degreaser. Although the depth to groundwater was approximately 13 ft BGS near the former degreaser in November 2003, groundwater has been observed in the past at depths above the base of the former degreaser, indicating seasonal saturation of underlying soil (Landau Associates 2002). Existing monitoring wells MW-6B and MW-6C are screened below the A Horizon at depths of 22 to 27.5 ft and 30 to 40.5 ft, respectively (Figure A-2). Approximately 4750 gallons of groundwater will be mixed with 257 gallons of concentrated emulsion (50 percent oil) to create an injection solution containing 2.5 percent oil. Due to an observed decrease in VOC concentrations with depth (Landau Associates 2002, 2003), 50 percent of the solution (2500 gallons) will be injected at the new A-horizon well and 25 percent (1250 gallons) will be injected at each of wells MW-6B, and MW-6C. The created permeable barrier of vegetable oil is designed to provide a steady supply of hydrogen to potential source material beneath the former degreaser and to the area near wells MW-9A and MW-9B, where some of the highest VOC concentrations have been observed.

The new A-Horizon well (to be identified as MW-6A) will be located inside Building 9-101 near the east end of the former vapor degreaser. Well MW-6A will be constructed of threaded 2-inch diameter schedule PVC casing and screen. The screen (0.010-in slot size) will extend from 10 to 20 ft BGS, and a sandpack consisting of 10/20 sand will extend from 8 to 20 ft BGS. An annular seal will be constructed of hydrated bentonite chips from 1.5 to 8 ft BGS, and the well will be completed with a flush-mount monument.

3.0 GROUNDWATER MONITORING

Groundwater monitoring will be performed at SWMU-20 wells to evaluate the effects of donor injection and to evaluate the need for subsequent donor amendment. Prior to injection, groundwater monitoring will be performed at regularly sampled SWMU-20 wells and new well MW-6A to establish baseline conditions. Subsequent to donor injection, regular semiannual monitoring will be performed and select SWMU-20 wells will also be sampled quarterly.

Groundwater monitoring will consist of groundwater sampling for measurement of field parameters and laboratory analysis. Oxidation reduction potential (ORP), pH, DO, and dissolved ferrous iron (iron II) will be measured in the field. Samples will also be submitted for laboratory analyses of VOCs, total organic carbon (TOC), sulfate, ethene, ethane, and methane. Field and laboratory methods are listed for each parameter in Table A-1, along with a brief description of the information obtained from each parameter. Analytical Resources Inc. (ARI) of Seattle, Washington will perform or subcontract the remaining analyses under their existing contract with Boeing.

3.1 BASELINE MONITORING

The purpose of baseline monitoring is to evaluate VOC concentrations and aquifer redox conditions prior to donor amendment. Baseline monitoring will be performed at regularly sampled SWMU-20 wells and new well MW-6A during the next semiannual sampling event scheduled for June 2004.

3.2 FOLLOWING ELECTRON DONOR AMENDMENT

Following electron donor injection, monitoring will be conducted at SWMU-20 wells to evaluate the effectiveness of injected donor at stimulating more reduced aquifer redox conditions and enhanced reductive dechlorination. Monitoring results will also be used to evaluate the need for subsequent injections of vegetable oil and/or sodium lactate electron donor. Regular semiannual monitoring will be performed at SWMU-20 wells. Quarterly monitoring will be performed at the six injection wells (the new A-Horizon well MW-6A, MW-6B, MW-6C, MW-9A, MW-9B, and MW-9C) and at downgradient well MW-14A and crossgradient well MW-10A, where rebound of one or more VOCs has been observed since shutdown of the groundwater treatment system.

4.0 DATA EVALUATION

The primary measure of enhanced reductive dechlorination will be an ultimate decrease in the concentrations of PCE, TCE and breakdown products cis-1,2-DCE and vinyl chloride. The rate and effectiveness of enhanced reductive dechlorination will be assessed through changes in concentrations of PCE, TCE and breakdown products. PCE breakdown products TCE, cis-1,2-DCE, and vinyl chloride may initially increase, then decrease in concentration.

Aquifer redox conditions will be evaluated based on ORP, and concentrations of DO, iron II, sulfate, and methane. Three degrees of aquifer redox (aerobic, transitional, and anaerobic and reducing) will be evaluated as follows (Beil et al. 2002):

Aerobic	DO > 1 mg/L, ORP > 0 mV
Transitional	DO < 1 mg/L, ORP > 0 mV
Anaerobic and Reducing	DO < 1 mg/L, ORP < 0 mV

As described in Section 2.2, current conditions appear to be sulfate-reducing to methanogenic, which is considered anaerobic and reducing. DO and ORP are often less-than-reliable indicators of redox conditions as they are difficult to measure consistently and accurately. Therefore, aquifer redox conditions will also be evaluated based on observed iron-reducing conditions (increasing concentrations of iron II), sulfate-reducing conditions (decreasing concentrations of sulfate), and methanogenesis (increasing concentrations of methane).

Increasing TOC concentrations are considered the most reliable indicators of the downgradient extent of electron donor. Observed changes in other parameters may result from aquifer changes that occurred upgradient and were carried by groundwater flow to downgradient monitoring locations. Concentrations of TOC above background indicate the presence of volatile organic acids with hydrogen available to enhance reductive dechlorination at the monitoring location. TOC groundwater concentrations of less than 10 mg/L are considered to be TOC depleted (Maierle and Cota 2001).

5.0 SCHEDULE

We propose to install the new A-Horizon well (MW-6A) during May 2004 so it can be included in baseline sampling to be conducted during semiannual monitoring in June 2004. Following collection of baseline data, donor injection will be completed in June or July 2004. Regular semiannual monitoring will continue to be performed in December and June. Select wells will also be monitored quarterly in September and March (Section 3.2). Based on monitoring data, subsequent injections of electron donor may be required, which would need two to four days for each event.

6.0 REPORTING

Monitoring results will be provided in semiannual groundwater monitoring reports regularly prepared for the Developmental Center.

7.0 USE OF THIS REPORT

This Work Plan has been prepared for the exclusive use of the Boeing Company for specific application to SWMU-20 at the Boeing Developmental Center. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of Landau Associates. Further, the reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by Landau Associates, shall be at the user's sole risk. Landau Associates warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. We make no other warranty, either express or implied.

This document has been prepared under the supervision and direction of the following key staff.

LANDAU ASSOCIATES, INC.

Clinton L. Jacob, P.E.
Senior Project Engineer

CLJ/JRN/tam/pcs

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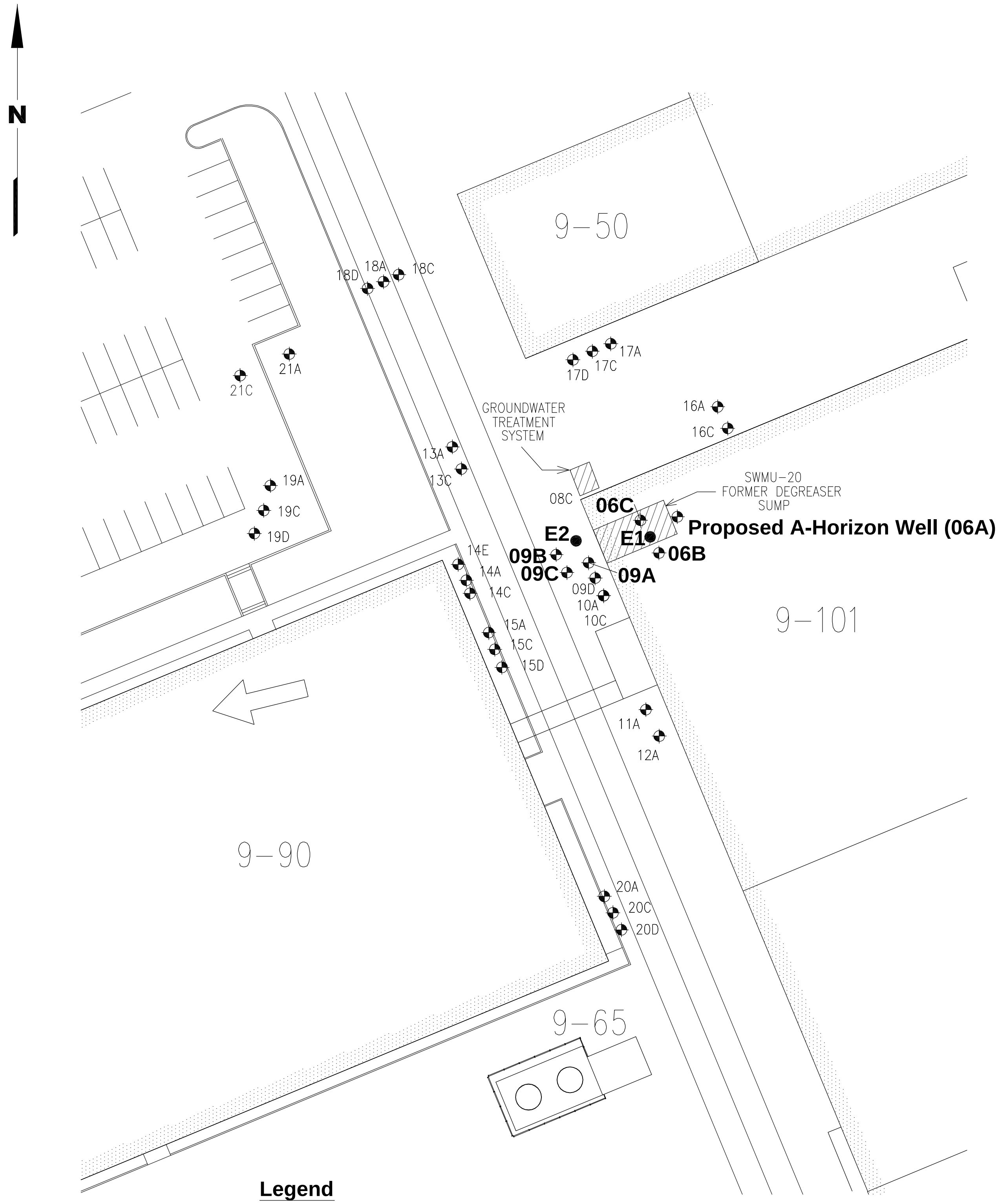


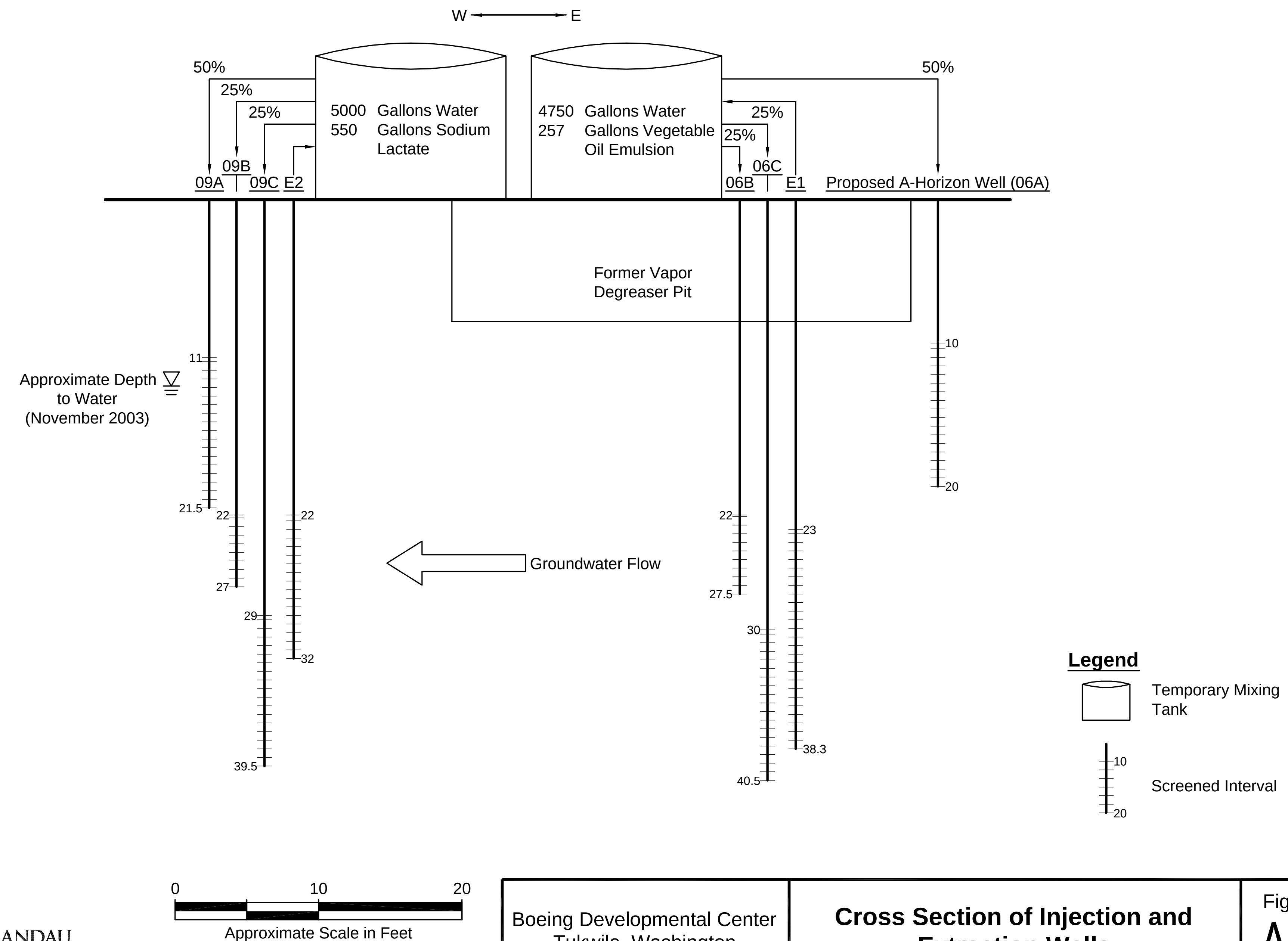
Legend

- Monitoring Well
- Extraction Well
- Inferred Groundwater Flow Direction

Note

Extraction and injection wells are bolded

LANDAU ASSOCIATES	Boeing Developmental Center Tukwila, Washington	SWMU-20	Figure A-1



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Boeing Developmental Center
Tukwila, Washington

Cross Section of Injection and Extraction Wells

Figure
A-2

TABLE A-1
BOEING DEVELOPMENT CENTER SWMU-20
GROUNDWATER MONITORING PARAMETERS

Field Parameters	Information Provided
Dissolved Oxygen (DO) [field meter and single-use reactive ampoules] (a)	Aquifer is considered anaerobic at DO concentrations less than 1.0 mg/L.
Oxidation Reduction Potential (Redox) [field meter] (a)	Negative values indicate reducing conditions.
pH [field meter] (a)	May decrease due to injected donor. Ideal for reductive dechlorination in the range of 6 to 8.
Iron(II) [Hach test kit]	Concentrations above background indicate iron reducing conditions.
Laboratory Analyses	**Information Provided**
Volatile Organic Compounds (VOCs) [Method 8260] [3-40 ml VOA-HCl] (b)	Concentrations of chlorinated VOCs and breakdown products are indicative of reductive dechlorination and pathways.
Total Organic Carbon (TOC) [Method 415.1][250 ml Amber-H2SO4]	Will increase due to arrival of volatile fatty acids released from injected sodium lactate and vegetable oil.
Sulfate [IC Method E300][500 ml poly]	Decreasing concentrations indicate sulfate reducing conditions.
Ethene/Ethane/Methane [Method 8015 Mod] [3-40 ml VOA] (b)	Concentrations of ethene and ethane are indicative of reductive dechlorination and pathways. Increasing methane concentrations indicate methanogenic conditions.

Notes:
(a) Measured using a flow-through cell.
(b) Care to be taken during sample collection to minimize aeration and volatilization.

APPENDIX G

2004 Technical Memorandum Re: SWMU-20 Well Installation and First Electron Donor Injection

TECHNICAL MEMORANDUM

TO: Jim Bet, The Boeing Company

FROM: Clint Jacob, P.E.

DATE: December 13, 2004

**RE: SWMU-20 WELL INSTALLATION AND FIRST ELECTRON DONOR INJECTION
BOEING DEVELOPMENTAL CENTER
TUKWILA, WASHINGTON**

INTRODUCTION

This technical memorandum documents the installation of monitoring well MW-6A, the first injection of electron donor substrates in Solid Waste Management Unit 20 (SWMU-20), and provides an evaluation of the initial monitoring results. These activities were described in the SWMU-20 Electron Donor Amendment Work Plan (work plan) that was included as Appendix A in the March 2004 Evaluation Report (Landau Associates 2004). Electron donor injection was performed in SWMU-20 to stimulate enhanced reductive dechlorination of trichloroethene (TCE) and tetrachloroethene (PCE) present near a former vapor degreaser that was located near the northwest corner on Building 9-101. Groundwater concentrations of TCE and PCE rebounded after the SWMU-20 pump and treat system was shut down in December 2001 following 8 years of operation. This technical memorandum also describes the second injection of electron donor substrates to be performed in December 2004.

MONITORING WELL MW-6A

New monitoring well MW-6A was installed inside Building 9-101 to facilitate electron donor injection to the A-Horizon in the immediate vicinity of the former vapor degreaser. Well MW-6A was installed on June 8, 2004, following two unsuccessful installation attempts. Significant drilling difficulty resulted from the variable size of granular backfill within the former degreaser sump and the need to advance the boring through the concrete bottom of the former sump. Installation was initially attempted on May 10, 2004 with a limited access, hollow-stem auger drill rig, but cobble size granular backfill was encountered within the former degreaser sump, resulting in drilling refusal. During a second attempt, performed on June 4, 2004 with a limited access, air-rotary drill rig, the well boring was advanced through the former sump to a total depth of 25 ft. However, cobbles were not encountered at the new location, and the well could not be installed due to heaving sand conditions that prevented retraction of the under reamer through the drill casing. Both failed borings were abandoned with bentonite chips.

On the third attempt, the well boring was completed to 25 ft with a limited access, hollow-stem auger drill rig and the well was installed. The successful boring utilizes a cored hole in the concrete slab floor of the former degreaser sump that was cut during the air-rotary drilling attempt. As described in the work plan, the well was constructed of Schedule 40 PVC screen (0.064-inch slot size) and casing, with 8/12 Colorado sand pack. All of the well screen and sand pack material were installed below the slab floor of the former degreaser sump. Well development was performed by surging and over-pumping. The location of MW-6A is shown on Figure 1. The boring log and well construction diagram for MW-6A is presented on Figure 2, and a Soil Classification System and Key is presented on Figure 3.

FIRST INJECTION OF ELECTRON DONOR SUBSTRATES

The injection of the electron donor substrates was completed on June 17, 2004. A total of 550 gallons of sodium lactate, 257 gallons of vegetable oil emulsion, and 1 kilogram of yeast extract was mixed with groundwater pumped from extraction wells E1 and E2 for a total solution volume of approximately 10,000 gallons. The solution was then injected into wells MW-6A, -6B, -6C, -9A, -9B, and -9C after complete mixing. The injection procedure outlined in the work plan was modified to deliver a total of 275 gallons of sodium lactate and 257 gallons of vegetable oil emulsion to the MW-6 wells (A, B, and C), located closest to the former degreaser, and a total of 275 gallons of sodium lactate to the MW-9 wells (A, B, and C), located slightly downgradient. As described in the work plan, the injection volume delivered to each of the A-horizon wells (MW-6A and MW-9A) was twice the volume that was delivered to each of the B- and C-horizon wells, in order to target the higher concentrations of PCE and TCE present in the A-horizon.

Well MW-9A was the first well to be injected and some leakage of injection solution occurred through pavement cracks and the annular well seal within minutes after beginning the injection. The injection rate and pressure were then reduced at MW-9A and during subsequent injection at the other wells to prevent leakage of injection solution to the surface. Reduced injection rates varied from 50 to 100 gallons per minute (gpm) with corresponding injection pressures ranging from 2 to 15 pounds per square inch (psi), as measured at the top of the well.

MONITORING RESULTS

Monitoring was performed in general accordance with the work plan. Baseline monitoring was performed during May and June. Following the injection work completed June 17th, quarterly monitoring was performed in August and October 2004. A summary of baseline and quarterly monitoring results is presented in Table 1.

Results from quarterly monitoring show that more reducing aquifer redox conditions have been established and that reductive dechlorination has been enhanced. The data is also consistent with enhanced desorption of contaminants from aquifer solids. Data evaluation is summarized below:

- **Aquifer redox:** Ferrous iron (iron II) concentrations have increased at shallow wells MW-06A, -9A, and -10A, indicating iron reducing conditions. Sulfate concentrations have not decreased significantly, but methane concentrations have increased significantly at all the wells listed on the attached table, except for MW-10A. Increasing methane indicates the onset of methanogenic conditions. Significant decreases in DO and ORP have not been observed; however, both parameters are difficult to measure accurately and are considered to be less reliable than iron II, sulfate, and methane data.

- **Enhanced reductive dechlorination:** Enhanced reductive dechlorination is evidenced by significant decreases in PCE and TCE; increases in breakdown products cis-1,2-dichloroethene (cis-1,2-DCE) and vinyl chloride; and/or increases in non-toxic end products ethene and ethane at wells MW-06A, -09A, and -10A. The most significant changes in the concentrations of parent, breakdown, and end products are observed at MW-09A, which had the highest baseline concentrations of PCE and TCE (see Table 1).

- **Enhanced desorption:** Enhanced desorption is evidenced by increasing concentrations of parent compounds and/or breakdown products. Enhanced desorption of contaminants from the soil phase is desired, as it shortens the time required for source zone treatment. Increasing concentrations of TCE and breakdown compounds were observed at wells MW-09B and MW-14A. At both wells, the increase in the concentration of breakdown products is much greater than the changes in TCE concentration, indicating concurrent enhanced desorption and reductive dechlorination. The concentrations of cis-1,2-DCE and vinyl chloride show the greatest increase above baseline at well MW-14A, but still remain below the maximum historical concentrations of cis-1,2-DCE (2,500 μg/L) and vinyl chloride (1,587 μg/L) in SWMU-20 monitoring wells. Enhanced desorption is the result of a number of processes (Suthersan et al., 2002; Parsons, 2004; Henry et al., 2004) that are likely occurring at SWMU-20. These processes include:,

  - Cosolvency effects of injected oil and of fermentation products [e.g., acids, alcohols, acetone, and 2-butanone (MEK)]. These compounds result from the fermentation of the high concentrations of soluble electron donor (e.g., sodium lactate) and, although relatively short lived, will enhance removal of TCE and PCE from the aquifer soils. Acetone and/or MEK were observed in August and/or October 2004 at wells MW-6A, -6B, -6C, -8C, -9C, -9D, -11A, -12A, and -13C. Maximum detected concentrations are 98 mg/L and 360 mg/L for acetone and MEK, respectively. These compounds were not detected in baseline samples.

  - Enhanced partitioning from soil to groundwater due to aqueous-phase carbon flooding. Electron donor injection results in higher organic carbon content in the groundwater than in the soil and the resulting equilibrium partitioning transfers the volatile organic compounds (VOCs) to the aqueous phase carbon where it is immediately accessible for biodegradation. Because VOCs are oleophilic (i.e., having a strong affinity for oils instead of water), preferential partitioning also occurs to the droplets of the injected oil.

- Progressive decrease in the organic partition coefficient (K_{OC}) values of sequential breakdown products that result in the breakdown products being less susceptible to sorption than the parent compounds. The respective K_{OC} values are PCE (265), TCE (94), DCE (36), and vinyl chloride (19).

- Biosurfactants produced by stimulated microbes. Microbes use biosurfactants to emulsify sorbed VOCs where they are accessible in the dissolved phase for assimilation.

- Increased concentration gradient from soil to groundwater, resulting from decreasing groundwater concentrations of VOCs. Groundwater concentrations decrease as a result of groundwater treatment.

Monitoring results also indicate that injected electron donor is being depleted and that a second injection of electron donor is advisable. Total organic carbon (TOC) is a measure of injected lactate and oil, and of the volatile fatty acids resulting from fermentation of these electron donor substrates. In October (67 days after the first injection), TOC concentrations were 3.5 times to 54 times greater than baseline concentrations. TOC concentrations measured during October at crossgradient/downgradient wells MW-10A and MW-14A indicate that injected donor reached MW-10A, but not MW-14A. The October data also show that TOC concentrations have returned to near baseline conditions at wells MW-9A, -9B, and -10A.

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SECOND INJECTION OF ELECTRON DONOR SUBSTRATES

A second injection of sodium lactate and oil emulsion is planned for December 2004. The second injection will target only the A- and B-Horizons, due to the absence of PCE and TCE and the very low concentrations of breakdown products present in C-Horizon wells MW-06C and MW-09C. During this second injection event, vegetable oil emulsion will be injected to MW-9A and MW-9B, as well as to MW-6A and MW-6B. Injection of additional slow-release donor substrate (vegetable oil) is intended to extend the interval between subsequent injections. Following the basic procedures outlined in the work plan, two batches of approximately 4,750 gallons of groundwater, 550 gallons of sodium lactate, and 257 gallons of vegetable oil emulsion will be mixed in a temporary tank for injection to wells MW-6A, -6B, -9A, and -9B. Each of these wells will receive an equal amount of the total 11,114-gallon injection volume. Groundwater for mixing the injection solution may be extracted from MW-9A and MW-9B, as well as from extraction wells E1 and E2, to supplement the relatively low combined flow previously obtained from the extraction wells (16 gpm). We anticipate this injection will take place during the week of December 13, 2004.

It is anticipated that a third injection of donor substrates may be performed within 4 to 6 months after the second injection. The actual timing of the third injection will be based on monitoring results.

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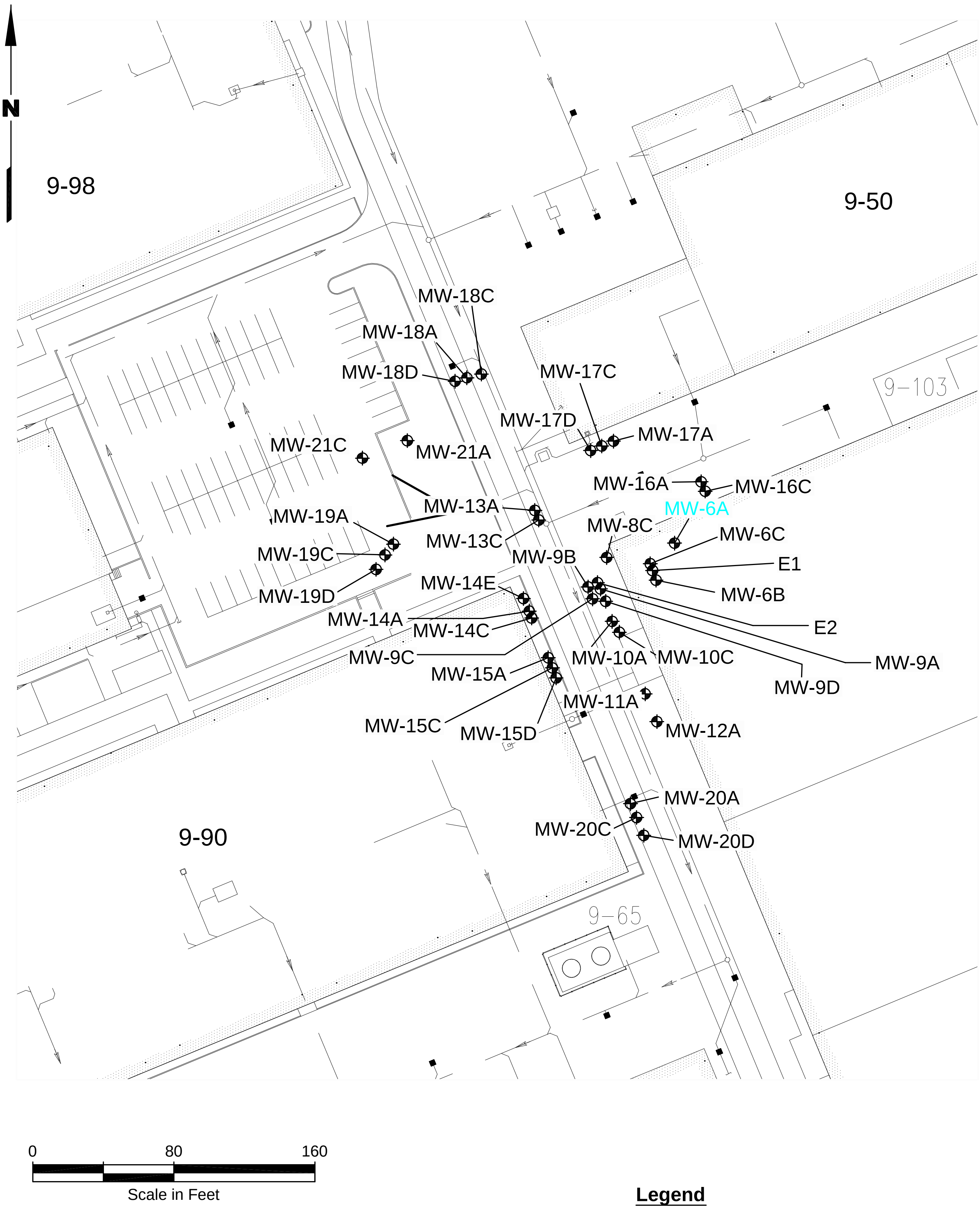

Legend

Monitoring Well Location

Boeing/Developmental Center/Tech Memo | X:\025\093\020\SWMU-20 Tech Memo 2004\Fig1.dwg (A) "Figure 1" 12/7/2004

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Boeing Developmental Center Tukwila, Washington	**SWMU-20** **Monitoring Wells**	Figure 1

MW-06A

SAMPLE DATA / SOIL PROFILE / GROUNDWATER

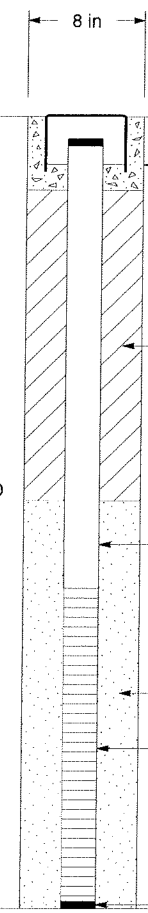
Drilling Method: Hollow-stem Auger

Ground Elevation (ft):

Drilled By: Cascade Drilling Inc.

Depth (ft)	Elevation	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	USCS Symbol	Description	Water Level
0						CONC	Concrete slab	
						SP	Fine to medium SAND with coarse gravel and cobbles, trace silt (damp) (CDF)	
5		1	b2		14.7			
						CONC	Concrete slab	
10		2	b2		12.0	SM	Light brown, silty SAND (moist) (no odor)	
						SP		ATD
15		3	b2	24	17.6		Dark gray to black, fine to medium SAND, trace silt (medium dense, wet)	
20								
25								

Monitoring Well Detail



Boring Completed 06/08/04
Total Depth of Boring = 24.7 ft.

Monitoring Well Completed 06/08/04
Total Depth of Monitoring Well = 24.7 ft.

30

35

40

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

25093.70 12/7/04 \\EDMDATA\GINT\GINT6\PROJECTS\025093.GPJ WELL LOG W/ ELEVATION

LANDAU ASSOCIATES

Boeing Developmental Center Tukwila, Washington	Log of Monitoring Well MW-06A	Figure 2

Soil Classification System

MAJOR DIVISIONS			GRAPHIC SYMBOL	USCS LETTER SYMBOL[1]	TYPICAL DESCRIPTIONS[2][3]
COARSE-GRAINED SOIL (More than 50% of material is larger than No. 200 sieve size)	GRAVEL AND GRAVELLY SOIL (More than 50% of coarse fraction retained on No. 4 sieve)	CLEAN GRAVEL (Little or no fines)		GW	Well-graded gravel; gravel/sand mixture(s); little or no fines
				GP	Poorly graded gravel; gravel/sand mixture(s); little or no fines
		GRAVEL WITH FINES (Appreciable amount of fines)		GM	Silty gravel; gravel/sand/silt mixture(s)
				GC	Clayey gravel; gravel/sand/clay mixture(s)
	SAND AND SANDY SOIL (More than 50% of coarse fraction passed through No. 4 sieve)	CLEAN SAND (Little or no fines)		SW	Well-graded sand; gravelly sand; little or no fines
				SP	Poorly graded sand; gravelly sand; little or no fines
		SAND WITH FINES (Appreciable amount of fines)		SM	Silty sand; sand/silt mixture(s)
				SC	Clayey sand; sand/clay mixture(s)
FINE-GRAINED SOIL (More than 50% of material is smaller than No. 200 sieve size)	SILT AND CLAY (Liquid limit less than 50)			ML	Inorganic silt and very fine sand; rock flour; silty or clayey fine sand or clayey silt with slight plasticity
				CL	Inorganic clay of low to medium plasticity; gravelly clay; sandy clay; silty clay; lean clay
				OL	Organic silt; organic, silty clay of low plasticity
	SILT AND CLAY (Liquid limit greater than 50)			MH	Inorganic silt; micaceous or diatomaceous fine sand
				CH	Inorganic clay of high plasticity; fat clay
				OH	Organic clay of medium to high plasticity; organic silt
	HIGHLY ORGANIC SOIL			PT	Peat; humus; swamp soil with high organic content

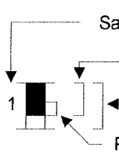
OTHER MATERIALS	GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
PAVEMENT		AC or PC	Asphalt concrete pavement or Portland cement pavement
ROCK		RK	Rock (See Rock Classification)
WOOD		WD	Wood, lumber, wood chips
DEBRIS		DB	Construction debris, garbage

Notes:
1. USCS letter symbols correspond to the symbols used by the Unified Soil Classification System and ASTM classification methods. Dual letter symbols (e.g., SP-SM) for a sand or gravel indicate a soil with an estimated 5-15% fines. Multiple letter symbols (e.g., ML/CL) indicate borderline or multiple soil classifications.
2. Soil descriptions are based on the general approach presented in the *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*, as outlined in ASTM D 2488. Where laboratory index testing has been conducted, soil classifications are based on the *Standard Test Method for Classification of Soils for Engineering Purposes*, as outlined in ASTM D 2487.
3. Soil description terminology is based on visual estimates (in the absence of laboratory test data) of the percentages of each soil type and is defined as follows:

Primary Constituent:	> 50%	"GRAVEL," "SAND," "SILT," "CLAY," etc.
Secondary Constituents:	> 30% and ≤ 50%	"very gravelly," "very sandy," "very silty," etc.
	> 15% and ≤ 30%	"gravelly," "sandy," "silty," etc.
Additional Constituents:	> 5% and ≤ 15%	"with gravel," "with sand," "with silt," etc.
	≤ 5%	"trace gravel," "trace sand," "trace silt," etc., or not noted.

Drilling and Sampling Key

SAMPLE NUMBER & INTERVAL



SAMPLER TYPE

Code	Description
a	3.25-inch O.D., 2.42-inch I.D. Split Spoon
b	2.00-inch O.D., 1.50-inch I.D. Split Spoon
c	Shelby Tube
d	Grab Sample
e	Other - See text if applicable
1	300-lb Hammer, 30-inch Drop
2	140-lb Hammer, 30-inch Drop
3	Pushed
4	Other - See text if applicable

Groundwater

▽ ATD — Approximate water elevation at time of drilling (ATD) or on date noted. Groundwater levels can fluctuate due to precipitation, seasonal conditions, and other factors.

Field and Lab Test Data

Code	Description
PP = 1.0	Pocket Penetrometer, tsf
TV = 0.5	Torvane, tsf
PID = 100	Photoionization Detector VOC screening, ppm
W = 10	Moisture Content, %
D = 120	Dry Density, pcf
-200 = 60	Material smaller than No. 200 sieve, %
GS	Grain Size - See separate figure for data
AL	Atterberg Limits - See separate figure for data
GT	Other Geotechnical Testing
CA	Chemical Analysis

12/7/04 \\EDMDATA\GINT\GINT6\PROJECTS\025093.GPJ SOIL CLASS SHEET

LANDAU ASSOCIATES

Boeing Developmental Center
Tukwila, Washington

Soil Classification System and Key

Figure 3

TABLE 1
BOEING DEVELOPMENTAL CENTER
SWMU-20 CLEANUP ACTION SUMMARY

			Volatile Organic Compounds						Aquifer Redox Conditions					Donor Parameters		
Well	Date	Elapsed Time from Injection (a) (days)	PCE (µg/L)	TCE (µg/L)	CIS (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	DO (mg/L)	ORP (mV)	Iron II (mg/L)	Sulfate (mg/L)	Methane (µg/L)	pH	TOC (mg/L)	Notes
06A (b)	06/15/2004	-2	<1.0	**1.0**	**23**	**4.0**	<0.50	<0.50	6.34	-19.6	0.8	58.9	<0.50	6.5	18.8	---
	08/23/2004	67	<1.0	<1.0	**45**	**5.9**	<0.50	<0.50	0.46	92	3.5	40.7	**21**	7.0	288	Hazy brown
	10/19/2004	124	<1.0	<1.0	**2.6**	**31**	<0.50	<0.50	0.70	54	3.0	44.8	**530**	6.8	80.8	---
06B	05/04/2004	-44	**9.5**	**3.2**	**10**	**9.4**	<0.50	<0.50	0.36	179	4.5	18.7	**130**	6.8	25.6	Clear, yellow tint
	08/23/2004	67	**1.9**	**1.2**	**13**	**2.3**	<0.50	<0.50	0.45	115	3.2	33.8	**1100**	6.9	177	Yellowish brown tint (nearly clear)
	10/19/2004	124	<1.0	<1.0	**10**	**3.6**	<0.50	<0.50	0.61	217	3.5	14.8	**590**	6.7	53.6	Yellow tint
06C	05/04/2004	-44	<1.0	<1.0	<1.0	<1.0	<0.50	**0.6**	0.40	93	5.0	20.7	**360**	6.7	29.0	---
	08/23/2004	67	<1.0	<1.0	**1.4**	<1.0	**5.7**	**5.9**	0.63	95	2.5	42.7	**3100**	6.3	1560	White froth on surface of purge water
	10/19/2004	124	<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	2.00	206	3.0	18.1	**450**	6.3	464	Yellow tint
09A	05/03/2004	-45	**150**	**230**	**970**	**37**	<0.50	<0.50	0.46	287	1.0	64.2	**8.4**	6.7	16.2	Clear, yellow tint
	08/23/2004	67	<3.0	**11**	**370**	**150**	**4.2**	<0.50	0.40	143	2.6	51.8	**4.7**	7.1	56.8	Clear with black tint, H2S odor
	10/19/2004	124	<5.0	**19**	**460**	**220**	**2.7**	<0.50	0.53	219	4.0	77.4	**17**	6.9	19.6	Clear, slightly yellow tint
09B	05/03/2004	-45	<3.0	**4.2**	**250**	<3.0	<0.50	<0.50	0.37	269	4.0	61.4	**2.7**	6.8	20.7	Clear, yellow tint
	08/23/2004	67	<5.0	**16**	**530**	**100**	**0.76**	<0.50	0.34	174	1.4	73.0	**23**	7.4	29.7	Clear, yellow brown tint, H2S odor
	10/19/2004	124	<5.0	**17**	**300**	**340**	**1.4**	<0.50	0.30	219	1.0	59.6	**29**	7.5	24.3	Clear with yellow color
09C	05/03/2004	-45	<1.0	<1.0	**4.0**	**3.3**	**1.9**	**0.7**	0.33	229	4.0	19.1	**350**	6.8	28.5	Clear, yellow tint
	08/23/2004	67	<1.0	<1.0	**1.7**	<1.0	**1.1**	**2.8**	0.47	114	2.6	23.2	**610**	6.7	302	Clear, H2S odor
	10/19/2004	124	<1.0	<1.0	<1.0	**1.5**	**1.1**	<0.50	0.60	185	3.0	12.2	**620**	7.0	99.6	Near clear, yellowish tint
10A	05/03/2004	-45	**29**	**27**	**80**	**6.4**	<0.50	<0.50	0.60	108	2.0	37.8	**2.8**	6.8	20.0	Clear, yellow tint
	08/23/2004	67	**14**	**12**	**170**	**4.0**	<0.50	<0.50	0.49	181	3.5	38.9	**1.1**	7.0	59.6	Clear, black tint
	10/19/2004	124	**15**	**15**	**100**	**23**	<0.50	<0.50	0.66	224	4.0	37.8	**2.7**	7.0	24.0	Clear
14A	05/04/2004	-44	<1.0	<1.0	**140**	**110**	<0.50	<0.50	0.53	-8	7.5	38.9	**590**	6.8	20.7	Clear, yellow tint
	08/23/2004	67	<1.0	**2.9**	**560**	**180**	**0.89**	**0.67**	0.54	162	3.2	30.1	**810**	6.8	22.6	---
	10/19/2004	124	<5.0	**39**	**1200**	**650**	<0.50	<0.50	0.64	69	3.0	43.3	**350**	6.9	20.6	---

(a) Injection occurred on 6/17/04.
(b) MW-06A installed June 2004

APPENDIX H

2005 Technical Memorandum Re: SWMU-20 Groundwater and Indoor Air Modeling and Recommended Actions

TECHNICAL MEMORANDUM

TO: Jim Bet, The Boeing Company

FROM: Chip Halbert, P.E. and Clint Jacob, P.E.

DATE: February 23, 2005

RE: SWMU-20 GROUNDWATER AND INDOOR AIR MODELING AND RECOMMENDED ACTIONS BOEING DEVELOPMENTAL CENTER TUKWILA, WASHINGTON

INTRODUCTION

This technical memorandum documents the results of groundwater and indoor air modeling performed for Solid Waste Management Unit 20 (SWMU-20) at the Boeing Developmental Center in Tukwila, Washington, to evaluate potential environmental and human health impacts associated with chlorinated hydrocarbons in groundwater. This technical memorandum also recommends the expansion of electron donor amendment and installation of two additional monitoring wells. Two injections of electron donor substrates (sodium lactate and vegetable oil emulsion) were performed at SWMU-20 in June and December 2004 near a former vapor degreaser that was located near the northwest corner of Building 9-101 (Figure 1). Electron donor amendment was performed at source area wells MW-6A, MW-6B, MW-6C, and MW-9A, MW-9B, MW-9C to stimulate enhanced reductive dechlorination of tetrachloroethene (PCE) and trichloroethene (TCE) and of breakdown products cis-1,2-dichloroethene (cis-1,2-DCE) and vinyl chloride. Monitoring results indicate that donor amendment has resulted in more reducing aquifer redox conditions, enhanced reductive dechlorination, and enhanced desorption of contaminants from aquifer soil within the source zone (Landau Associates 2004a).

Groundwater and indoor air modeling were performed in response to an elevated groundwater concentration of vinyl chloride that was observed in October 2004 at monitoring well MW-14A. Well MW-14A is located downgradient of the former degreaser and immediately upgradient of Building 9-90. Increasing vinyl chloride concentrations at well MW-14A are the result of enhanced reductive dechlorination within the source zone and subsequent downgradient transport. The October 2004 concentration of vinyl chloride (650 µg/L) represents a maximum for well MW-14A, but is lower than concentrations historically detected at wells MW-10A, MW-13C, MW-14C, and MW-15C, which range from 651 to 1,587 µg/L. Groundwater data for total organic carbon (TOC) and aquifer redox parameters indicate that well MW-14A is outside the active treatment zone created by injection of electron donor substrates at the MW-6 and MW-9 source area wells. Monitoring well locations and vinyl chloride groundwater concentrations for October 2004 are presented on Figure 1.

GROUNDWATER MODELING

Groundwater modeling was performed to estimate the lateral extent to which a vinyl chloride plume could develop based on the maximum concentration of chlorinated hydrocarbons detected in monitoring well MW-14A during the most recent (October 2004) groundwater sampling event. BIOCHLOR Version 2.2, a screening model that simulates the natural attenuation of dissolved solvents in groundwater, was used to model plume development. The BIOCHLOR model takes into consideration one-dimensional advection, three-dimensional dispersion, linear adsorption, biotransformation, and source decay as it simulates expansion and contraction of the dissolved phase plume.

BIOCHLOR is dependent on a number of site-specific and chemical-specific input parameters and has varying degrees of sensitivity to each of those parameters. Modeling was performed using the mid-range value for each input parameter; the range of variable parameters is presented in Table 1 for informational purposes. For the purposes of this evaluation, well MW-14A was modeled as the source of the plume using the decaying source model function and the maximum concentration measured at monitoring well MW-14A in October 2004 as the initial source concentration. Site-specific degradation constants (calculated from historic VOC data from August 1989 to January 1994) were applied to model source degradation. Based on the BIOCHLOR simulation, the maximum extent of the vinyl chloride plume, as shown on Figure A1-1 of Attachment 1, is expected to be attained in October 2014, 10 years after the maximum vinyl chloride concentration was detected at well MW-14A. At its maximum extent, the 100 µg/L contour of the modeled plume extends approximately 45 ft downgradient of well MW-14A, the 10 µg/L contour extends 250 ft downgradient, and the 1 µg/L contour is at approximately 590 ft downgradient. The BIOCHLOR model output (Attachment 1) shows the plume expanding until it reaches the extent shown on Figure A1-1, then contracting until the plume dissipates completely after approximately 100 years as a result of natural biotransformation processes. This plume model accounts for naturally occurring biotransformation processes, but does not account for accelerated degradation expected to result from the recommended expansion of electron donor amendment.

INDOOR AIR MODELING

An indoor air evaluation based on the Johnson-Ettinger model was performed in March 2004 (Landau Associates 2004b) to estimate potential risks to human health based on occupational inhalation of indoor air in Buildings 9-101 and 9-90 that could be impacted by the volatilization of chlorinated hydrocarbons from the SWMU-20 groundwater plume. The evaluation for buildings 9-90 and 9-101, which were based on conservative (i.e., high concentrations) assumptions about the extent of the plume beneath those buildings (assumptions documented in the referenced report), resulted in the conclusion that the associated risk levels were at, or below, the regulatory criteria. Due to the increase in vinyl chloride concentrations in monitoring well MW-14A during the October 2004 sampling event, the indoor air evaluation for Building 9-90 was revisited to determine whether the increase in groundwater concentrations warrants further investigation by indoor air sampling.

Recognizing that ongoing SWMU-20 source zone treatment could result in higher vinyl chloride concentrations at downgradient well MW-14A, the Johnson-Ettinger model was conducted to identify the threshold average groundwater concentration beneath Building 9-90, above which a potential exists for unacceptable risks to human health via inhalation of indoor air. Johnson-Ettinger model output (Attachment 2) estimated that the threshold vinyl chloride groundwater concentration protective of human health is 43 μg/L.

The results of the BIOCHLOR groundwater modeling described above were used to estimate the average concentration of vinyl chloride beneath Building 9-90. Based on the plume contour presented on Figure A1-1, approximately 2 percent of building footprint overlies plume concentrations between 100 and 650 μg/L (average 375 μg/L); approximately 20 percent overlies plume concentrations between 10 and 100 μg/L (average 55 μg/L); approximately 45 percent overlies plume concentrations between 1 and 10 μg/L (average 5.5 μg/L); and approximately 33 percent overlies concentrations less than 1 μg/L (average 0.5 μg/L). The corresponding weighted average vinyl chloride concentration beneath Building 9-90 is 21 μg/L, which is less than half of the 43 μg/L threshold concentration protective of human health via indoor air inhalation. Use of the weighted average vinyl chloride concentration in groundwater beneath the entire building is a standard approach that accounts for circulation of indoor air resulting from operation of the building's ventilation system.

Based on this evaluation, confirmation sampling of indoor air is not warranted at the present time. We recommend that any additional increases in the groundwater concentrations of vinyl chloride at well MW-14A be used to estimate a new weighted average concentration beneath Building 9-90 for comparison to the 43 μg/L threshold value. This evaluation will be performed on a quarterly basis as quarterly monitoring data become available.

RECOMMENDED EXPANSION OF ELECTRON DONOR AMENDMENT

We recommend injection of electron donor substrates at well MW-14A to establish an active treatment zone downgradient of the source zone. Donor amendment at well MW-14A will supplement the donor amendment occurring within the source zone (wells MW-6 and MW-9) and will provide treatment for TCE and breakdown products cis-1,2-DCE and vinyl chloride that are transported beyond the source zone treatment area. Groundwater data for downgradient well MW-14A (Landau Associates 2004a) shows transport of TCE to that well resulting from enhanced desorption within the source zone and transport of breakdown products cis-1,2-DCE and vinyl chloride created through enhanced reductive dechlorination within the source zone. Monitoring results at MW-14A indicate that redox parameters and TOC concentrations have remained near background at that well following electron donor injection in the source zone. These background conditions are only marginally conducive to complete reductive dechlorination, although complete dechlorination has occurred to a limited degree, as evidenced by detections of end products ethene and ethane at MW-14A in August 2004.

We propose to inject sodium lactate and oil emulsion electron donor substrates at well MW-14A to create the downgradient treatment zone. Following the basic procedures outlined in the work plan (Landau Associates 2004b), approximately 4,750 gallons of groundwater, 550 gallons of sodium lactate, and 257 gallons of vegetable oil emulsion will be mixed in a temporary tank for injection to well MW-14A. Consistent with the two source zone injection events performed in June and December 2004, groundwater for mixing the injection solution will be obtained from extraction wells E1 and E2. We anticipate this injection will take place the week of March 14, 2005.

It is anticipated that a third injection of donor substrates may be performed at source zone wells MW-6 and MW-9, and at downgradient well MW-14A in or around April to June 2005. The actual timing of the third injection will be based on quarterly monitoring results.

ADDITIONAL MONITORING WELLS

We recommend installation of two additional A-Horizon monitoring wells. We propose to construct monitoring well MW-22A on the north side of Building 9-90, between the MW-14 wells and the MW-19 wells, to monitor the effects of electron donor injection at well MW-14A. We propose to construct monitoring well MW-23A near the northwest corner of Building 9-90 to provide a far-downgradient monitoring point. Wells will be constructed of threaded 2-inch diameter schedule PVC casing and screen. The screen (0.010-in slot size) will extend from 10 to 20 ft below ground surface (BGS), and a sandpack consisting of 10/20 sand will extend from 8 to 20 ft BGS. An annular seal will be constructed of hydrated bentonite chips from 1.5 to 8 ft BGS, and the well will be completed with a flush-mount monument. Wells will be developed by surging with a stainless-steel bailer and overpumping with a centrifugal pump. We anticipate that monitoring well construction and development will take place the week of March 14, 2005.

REFERENCES

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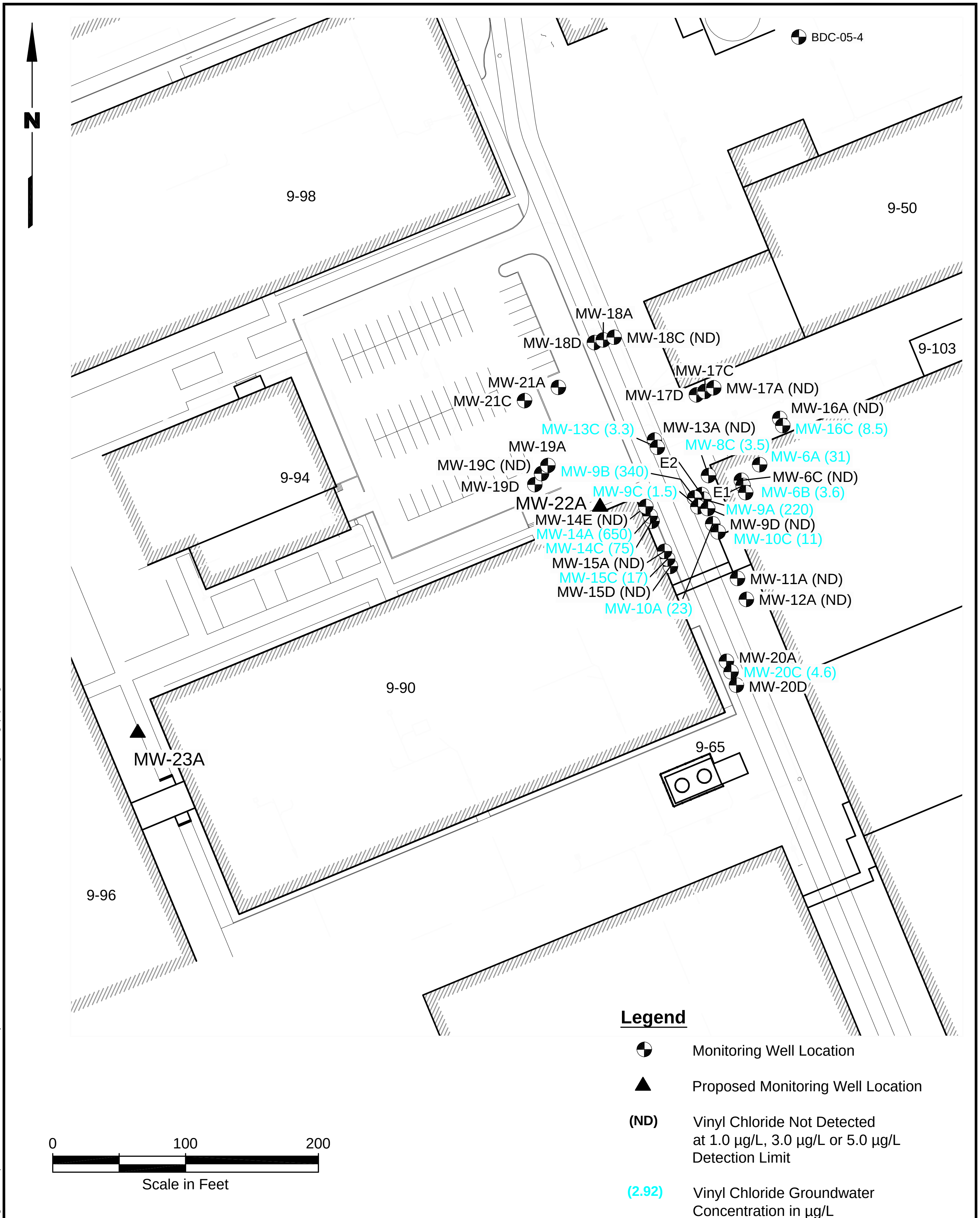


Boeing/Developmental Center/Tech Memo | X:\025\093\004\070\SWMU-20 Feb 05 Tech Memo\Fig1.dwg (A) "Figure 1" 2/23/2005

LANDAU ASSOCIATES	Boeing Developmental Center Tukwila, Washington	**SWMU-20 Vinyl Chloride October 2004 Groundwater Concentrations**	Figure 1

TABLE 1
BIOCHLOR MODEL INPUT PARAMETERS

Input Parameters	Minimum	1st Quartile	Mid-Range	3rd Quartile	Maximum	Source of Data
Hydraulic conductivity (K, cm/s)	0.038	0.04	0.042	0.044	0.046	Corrective Action Summary Report (Landau Associates 2002)
Hydraulic gradient (i, ft/ft)	0.0004	0.0005	0.0006	0.0007	0.0008	Corrective Action Summary Report (Landau Associates 2002)
Effective porosity (n, unitless)	--	--	0.25	--	--	Corrective Action Summary Report (Landau Associates 2002)
Longitudinal dispersivity (α_x, unitless)	70	57.5	45	32.5	20	Refer to Note 2.
Transverse dispersivity ratio (α_y/α_x, unitless)	--	--	0.1	--	--	BIOCHLOR User's Manual (EPA 2000) / BIOCHLOR Version 2.2 (EPA 2000)
Vertical dispersivity ratio (α_z/α_x, unitless)	--	--	1E-99	--	--	BIOCHLOR User's Manual (EPA 2000) / BIOCHLOR Version 2.2 (EPA 2000)
Soil bulk density (ρ, kg/L)	--	--	1.7	--	--	BIOCHLOR User's Manual (EPA 2000) / BIOCHLOR Version 2.2 (EPA 2000)
Fraction organic carbon (f_{oc}, unitless)	0.0015	0.00119	0.00088	0.0006	0.00025	SWMU-17, SWMU-20, and AOC-05 Evaluation Report (Landau Associates 2004b)
Organic carbon partition coefficient (K_{oc}, L/kg)	--------------------	--------------------	--------------------	--------------------	--------------------	--------------------
PCE	--	--	426	--	--	BIOCHLOR User's Manual (EPA 2000) / BIOCHLOR Version 2.2 (EPA 2000)
TCE	--	--	130	--	--	BIOCHLOR User's Manual (EPA 2000) / BIOCHLOR Version 2.2 (EPA 2000)
DCE	--	--	125	--	--	BIOCHLOR User's Manual (EPA 2000) / BIOCHLOR Version 2.2 (EPA 2000)
VC	--	--	29.6	--	--	BIOCHLOR User's Manual (EPA 2000) / BIOCHLOR Version 2.2 (EPA 2000)
First order decay coefficient (λ, yr^{-1})	--------------------	--------------------	--------------------	--------------------	--------------------	--------------------
PCE	2.4	2.00	1.60	1.20	0.8	BIOCHLOR User's Manual (EPA 2000) / BIOCHLOR Version 2.2 (EPA 2000)
TCE	2.4	1.88	1.35	0.83	0.3	BIOCHLOR User's Manual (EPA 2000) / BIOCHLOR Version 2.2 (EPA 2000)
DCE	2.2	1.68	1.15	0.63	0.1	BIOCHLOR User's Manual (EPA 2000) / BIOCHLOR Version 2.2 (EPA 2000)
VC	4.9	3.78	2.65	1.53	0.4	BIOCHLOR User's Manual (EPA 2000) / BIOCHLOR Version 2.2 (EPA 2000)
Simulation time (yr)	--	--	variable	--	--	Refer to Note 3.
Modeled area width (ft)	--	--	variable	--	--	Refer to Note 4.
Modeled area length (ft)	--	--	800	--	--	Refer to Note 5.
Source thickness in saturated zone (ft)	--	--	27	--	--	Refer to Note 6.
Source width in saturated zone (ft)	--	--	25	--	--	Refer to Note 7.
Source decay rate constant (k_s, yr^{-1})	--	--	0.0732	--	--	Refer to Note 8.
Source concentration (mg/L)	--------------------	--------------------	--------------------	--------------------	--------------------	--------------------
PCE	--	--	ND	--	--	Refer to Note 9.
TCE	--	--	0.039	--	--	Refer to Note 9.
DCE	--	--	1.2	--	--	Refer to Note 9.
VC	--	--	0.65	--	--	Refer to Note 9.

Notes:

1. The minimum/maximum range is established based on impact to plume size, not numerical value. In other words, the "minimum" value may sometimes be numerically greater than the "maximum" value; however, it will result in a smaller size of contaminant plume based on the BIOCHLOR model.
2. The longitudinal dispersivity coefficient is assumed to be 10 percent of the estimated plume length as per the BIOCHLOR User's Manual (EPA 2000). The minimum range for estimated plume length was identified based on data presented for vinyl chloride in the BIOCHLOR Chlorinated Solvent Plume Database Report (AFCEE 2000); the maximum range was established as the distance from the source area to the Duwamish Waterway.
3. The simulation time was evaluated over a range of years to model the maximum extent of the plume. Based on the range of simulations identified above, the maximum extent of the plume is expected to be achieved within 4 to 10 years of the release.
4. Modeled area width was selected to include the outer boundary of vinyl chloride concentrations greater than or equal to 1 µg/L.
5. Modeled area length was selected to include the area extending from the source to the Duwamish Waterway.
6. Source thickness is based on apparent impacts to A and B horizons in October 2004 sampling data. The A and B horizons are assumed to constitute two-thirds of the shallow unconfined aquifer described in the Corrective Action Summary Report (Landau Associates 2002).
7. Source width is assumed based on available data regarding the original source area and the existing data showing a narrow plume.
8. Source decay rate constant for chlorinated solvents calculated as described in the BIOCHLOR User's Manual Addendum (NRMRL 2002) is based on source area data from monitoring well MW-09A collected August 1989 to January 1994.
9. Although the historical source area is understood to be beneath the northwest corner of Building 9-101, the greatest concentrations of chlorinated solvents were detected in monitoring well MW-14A during the October 2004 groundwater monitoring event. Source concentrations are assumed to be those concentrations present at monitoring well MW-14A.

ATTACHMENT 1

Biochlor Model Output

Boeing Developmental Center
Mid-Range Plume Parameter Model
BIOCHLOR 22-2000_BDC_mid_SourceDecay
Maximum Plume Extent at 10 years

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Boeing Developmental Center
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ or 2. Calculate by filling in gray
0.02 cells. Press Enter, then (C)
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes (●) Ethanes ( )

1. ADVECTION

Seepage Velocity*	Vs	104.3	(ft/yr)
or		↑	
Hydraulic Conductivity	K	4.2E-02	(cm/sec)
Hydraulic Gradient	i	0.0006	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	45	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R
or

Soil Bulk Density, rho	1.7	(kg/L)		
FractionOrganicCarbon, foc	8.8E-4	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)	3.53	(-)
TCE	130	(L/kg)	1.77	(-)
DCE	125	(L/kg)	1.74	(-)
VC	30	(L/kg)	1.18	(-)
ETH	302	(L/kg)	2.80	(-)

Common R (used in model)* = 1.77

4. BIOTRANSFORMATION **-1st Order Decay Coefficient***

Zone 1	λ (1/yr)		half-life (yrs)	Yield
PCE → TCE	1.600	←		0.79
TCE → DCE	1.350	←		0.74
DCE → VC	1.150	←		0.64
VC → ETH	2.650	←		0.45

Zone 2	λ (1/yr)		half-life (yrs)
PCE → TCE	0.000	←	
TCE → DCE	0.000	←	
DCE → VC	0.000	←	
VC → ETH	0.000	←	

λ HELP

5. GENERAL

Simulation Time*	10	(yr)
Modeled Area Width*	250	(ft)
Modeled Area Length*	800	(ft)
Zone 1 Length*	800	(ft)
Zone 2 Length*	0	(ft)

L, W
Zone 2= L - Zone 1

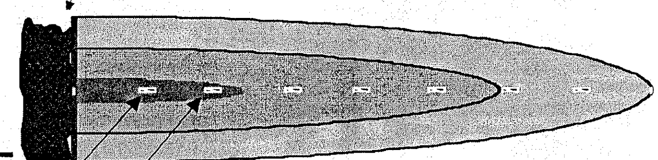
6. SOURCE DATA TYPE: Decaying Single Planar

Source Options

Source Thickness in Sat. Zone* 27 (ft)

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations

	Y1	
Width* (ft)	25	
Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.073
TCE	.039	0.073
DCE	1.2	0.073
VC	.65	0.073
ETH		0.073



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)											
TCE Conc. (mg/L)	.039										
DCE Conc. (mg/L)	1.2										
VC Conc. (mg/L)	0.7										
ETH Conc. (mg/L)											
Distance from Source (ft)	0										
Date Data Collected	2004										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

Start Here → ○ PCE
○ TCE
○ DCE
◉ VC
○ ETH

DISSOLVED SOLVENT CONCENTRATIONS IN PLUME

Transverse Distance (ft) / ***Distance from Source (ft)***

	0	80	160	240	320	400	480	560	640	720	800
80	0.000	0.001	0.003	0.003	0.002	0.001	0.001	0.000	0.000	0.000	0.000
40	0.000	0.021	0.014	0.008	0.004	0.002	0.001	0.001	0.000	0.000	0.000
0	0.313	0.060	0.024	0.011	0.005	0.003	0.001	0.001	0.000	0.000	0.000
-40	0.000	0.021	0.014	0.008	0.004	0.002	0.001	0.001	0.000	0.000	0.000
-80	0.000	0.001	0.003	0.003	0.002	0.001	0.001	0.000	0.000	0.000	0.000
MASS RATE (mg/day)	4.3E+2	2.3E+2	1.2E+2	6.7E+1	3.6E+1	2.0E+1	1.0E+1	5.6E+0	2.9E+0	1.5E+0	7.3E-1

Show No Degradation

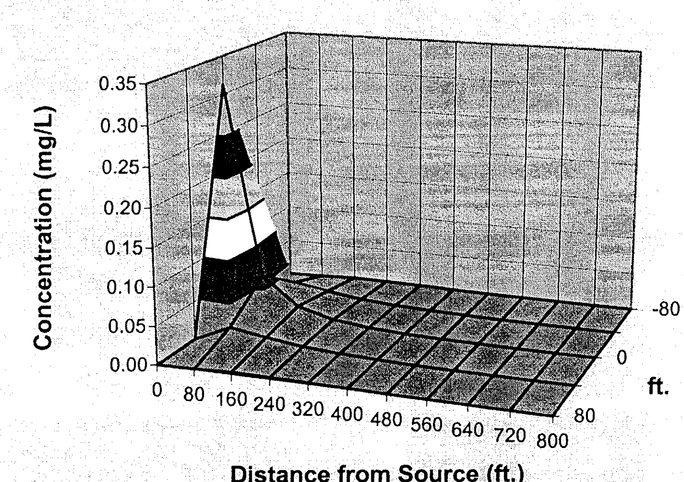
Show Biotransformation

Time: 10 yr

Target Level: **0.002** mg/L

Displayed Model: **Biotransformation**

Displayed Compound: **VC**



Plume Mass (Order-of-Magnitude Accuracy)

See Gallons

Plume Mass If No Degradation	2.2	*(Kg)*
- Plume Mass If Biotransformation/Production	0.4	*(Kg)*
Mass Removed	1.8	*(Kg)*
% Biotransformed =	**+80.9%**	
% Change in Mass Rate =	**99.8 %**	(source to edge)

If "Can't Calc.", make model area longer

See acre-ft

Current Volume of Ground Water in Plume	1.78	*MGal*
Flow Rate of Water Through Source Area	0.000	*MGD*

Compare to Pump and Treat

Pumping Rate		*(gpm)*
# Pore Volumes Removed Per Yr.	0.00	
# Pore Volumes to Clean-Up		
Clean-Up Time		*(yr)*

Mass HELP **To Centerline** **Return to Input**

Plot All Data Plot Data > Target

Start Here → ○ PCE ○ TCE ○ DCE ◉ VC ○ ETH

DISSOLVED SOLVENT CONCENTRATIONS IN PLUME

Transverse Distance (ft) ↓ / *Distance from Source (ft)* →	0	80	160	240	320	400	480	560	640	720	800
100	0.000	0.000	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
50	0.000	0.012	0.010	0.006	0.003	0.002	0.001	0.001	0.000	0.000	0.000
0	0.313	0.060	0.024	0.011	0.005	0.003	0.001	0.001	0.000	0.000	0.000
-50	0.000	0.012	0.010	0.006	0.003	0.002	0.001	0.001	0.000	0.000	0.000
-100	0.000	0.000	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
MASS RATE (mg/day)	4.3E+2	2.3E+2	1.3E+2	6.9E+1	3.8E+1	2.1E+1	1.1E+1	6.1E+0	3.2E+0	1.7E+0	8.3E-1

Show No Degradation

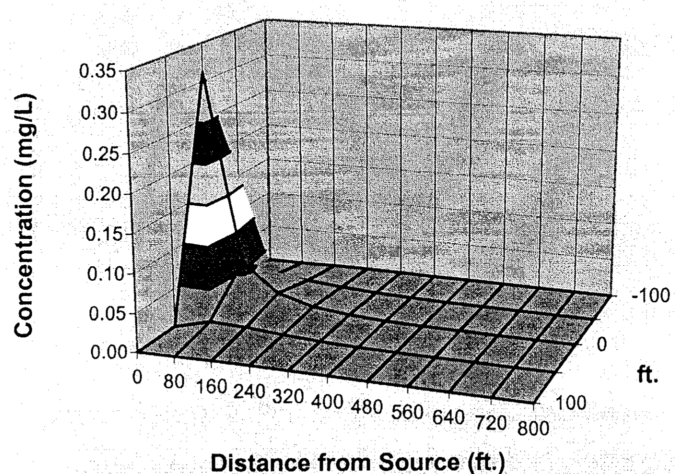
Show Biotransformation

Time: 10 yr

Target Level: **0.002** mg/L

Displayed Model: **Biotransformation**

Displayed Compound: **VC**



Plume Mass (Order-of-Magnitude Accuracy)

See Gallons

Plume Mass If No Degradation	2.3	*(Kg)*
- Plume Mass If Biotransformation/Production	0.5	*(Kg)*
Mass Removed	1.9	*(Kg)*
% Biotransformed =	**+80.2%**	
% Change in Mass Rate =	**99.8 %**	(source to edge)

If "Can't Calc.", make model area longer

See acre-ft

Current Volume of Ground Water in Plume	2.22	*MGal*
Flow Rate of Water Through Source Area	0.000	*MGD*

Compare to Pump and Treat

Pumping Rate		*(gpm)*
# Pore Volumes Removed Per Yr.	0.00	
# Pore Volumes to Clean-Up		
Clean-Up Time		*(yr)*

Plot All Data | Plot Data > Target | **Mass HELP** | **To Centerline** | **Return to Input**

Start Here → ○ PCE
○ TCE
○ DCE
◉ VC
○ ETH

DISSOLVED SOLVENT CONCENTRATIONS IN PLUME

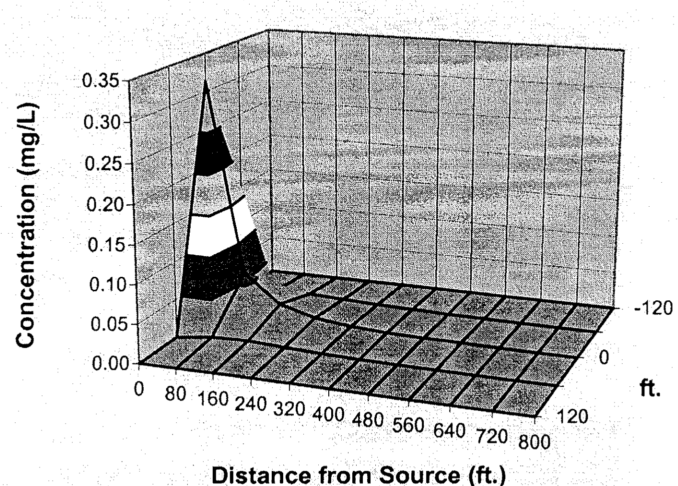
Transverse Distance (ft) ↓ ***Distance from Source (ft)***

	0	80	160	240	320	400	480	560	640	720	800
120	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
60	0.000	0.006	0.007	0.005	0.003	0.002	0.001	0.000	0.000	0.000	0.000
0	0.313	0.060	0.024	0.011	0.005	0.003	0.001	0.001	0.000	0.000	0.000
-60	0.000	0.006	0.007	0.005	0.003	0.002	0.001	0.000	0.000	0.000	0.000
-120	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MASS RATE (mg/day)	4.3E+2	2.4E+2	1.3E+2	6.9E+1	3.8E+1	2.1E+1	1.2E+1	6.4E+0	3.4E+0	1.8E+0	8.9E-1

Show No Degradation

Show Biotransformation

Time: 10 yr Target Level: **0.002** mg/L Displayed Model: **Biotransformation** Displayed Compound: **VC**



Plume Mass (Order-of-Magnitude Accuracy)

See Gallons

Plume Mass If No Degradation	2.4	*(Kg)*
- Plume Mass If Biotransformation/Production	0.5	*(Kg)*
Mass Removed	1.9	*(Kg)*
% Biotransformed =	**+79.1%**	
% Change in Mass Rate =	**99.8 %**	(source to edge)

If "Can't Calc.", make model area longer

See acre-ft

Current Volume of Ground Water in Plume	2.18	*MGal*
Flow Rate of Water Through Source Area	0.000	*MGD*

Compare to Pump and Treat

Pumping Rate		*(gpm)*
# Pore Volumes Removed Per Yr.	0.00	
# Pore Volumes to Clean-Up		
Clean-Up Time		*(yr)*

Plot All Data | Plot Data > Target | **Mass HELP** | **To Centerline** | **Return to Input**

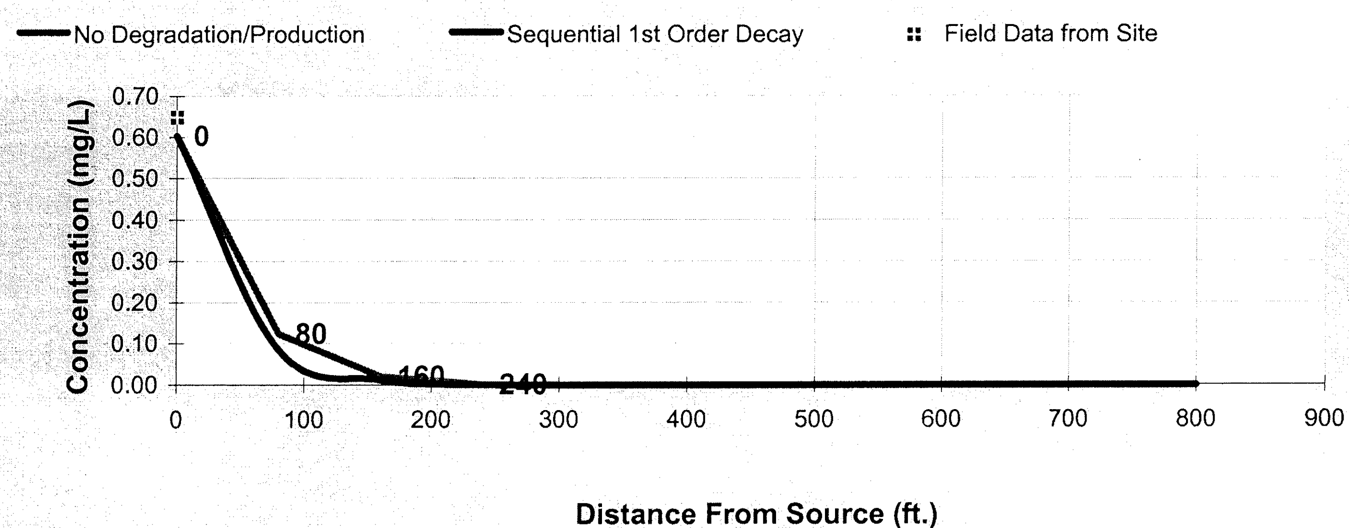
DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

VC	0	80	160	240	320	400	480	560	640	720	800
No Degradation	0.604	0.124	0.021	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biotransformation	0.6041	0.086	0.012	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Monitoring Well Locations (ft)

	0										
Field Data from Site	0.650										



See PCE

See TCE

See DCE

See VC

See ETH

Replay

Time:

1.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

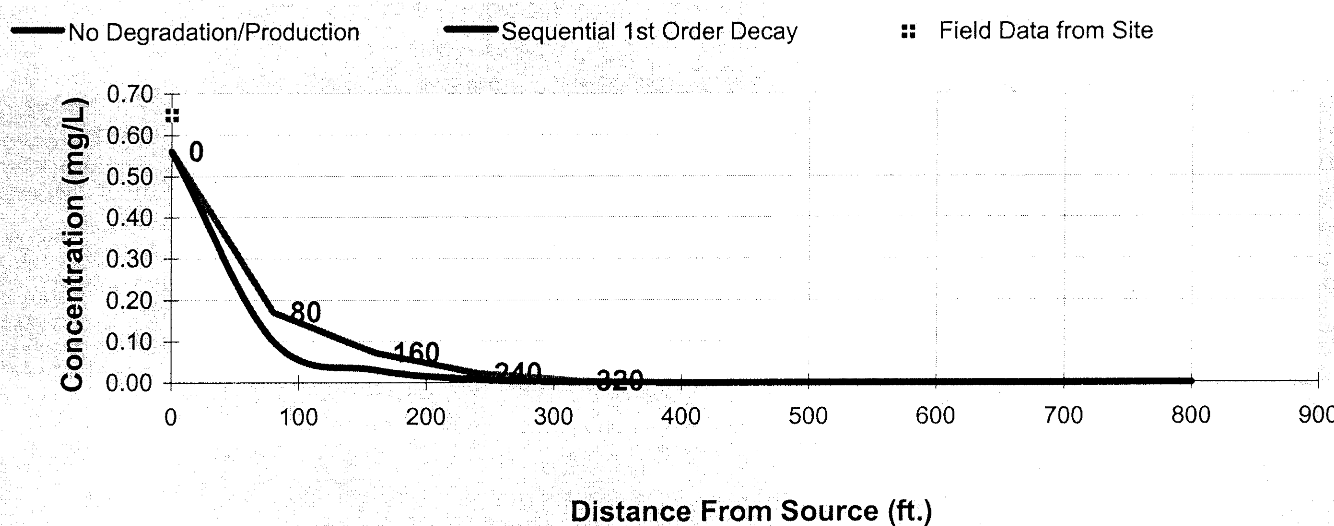
DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

VC	0	80	160	240	320	400	480	560	640	720	800
No Degradation	0.561	0.172	0.074	0.023	0.004	0.001	0.000	0.000	0.000	0.000	0.000
Biotransformation	0.5615	0.102	0.031	0.008	0.001	0.000	0.000	0.000	0.000	0.000	0.000

Monitoring Well Locations (ft)

	0										
Field Data from Site	0.650										



See PCE

See TCE

See DCE

See VC

See ETH

Replay

Time:

2.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

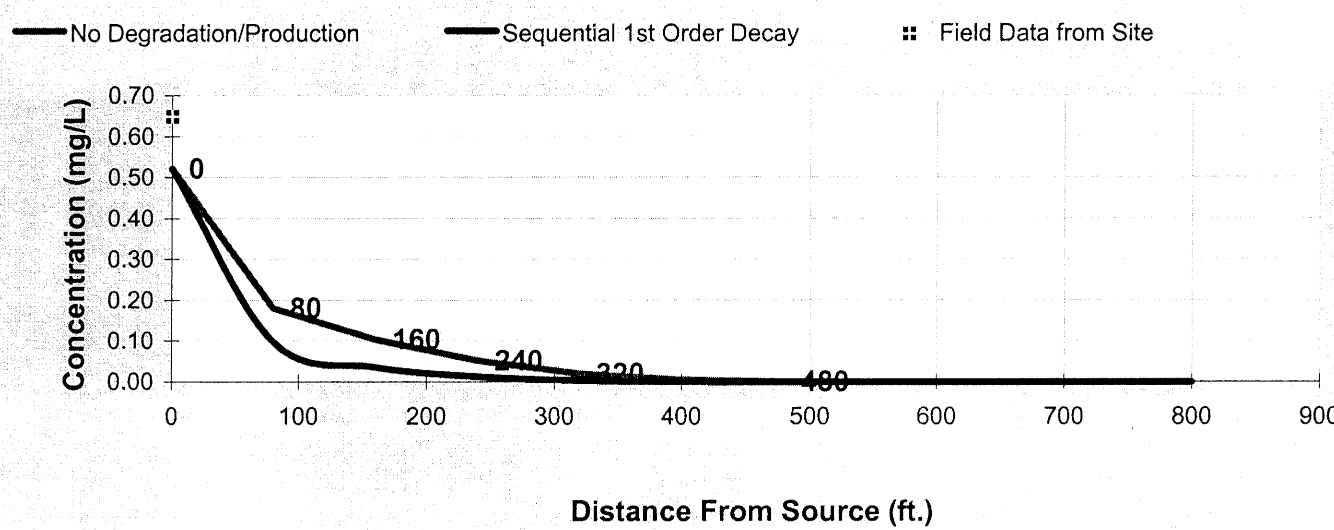
DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

VC	0	80	160	240	320	400	480	560	640	720	800
No Degradation	0.522	0.182	0.104	0.052	0.020	0.006	0.001	0.000	0.000	0.000	0.000
Biotransformation	0.5218	0.099	0.036	0.013	0.004	0.001	0.000	0.000	0.000	0.000	0.000

Monitoring Well Locations (ft)

	0										
Field Data from Site	0.650										



See PCE

See TCE

See DCE

See VC

See ETH

Replay

Time:

3.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

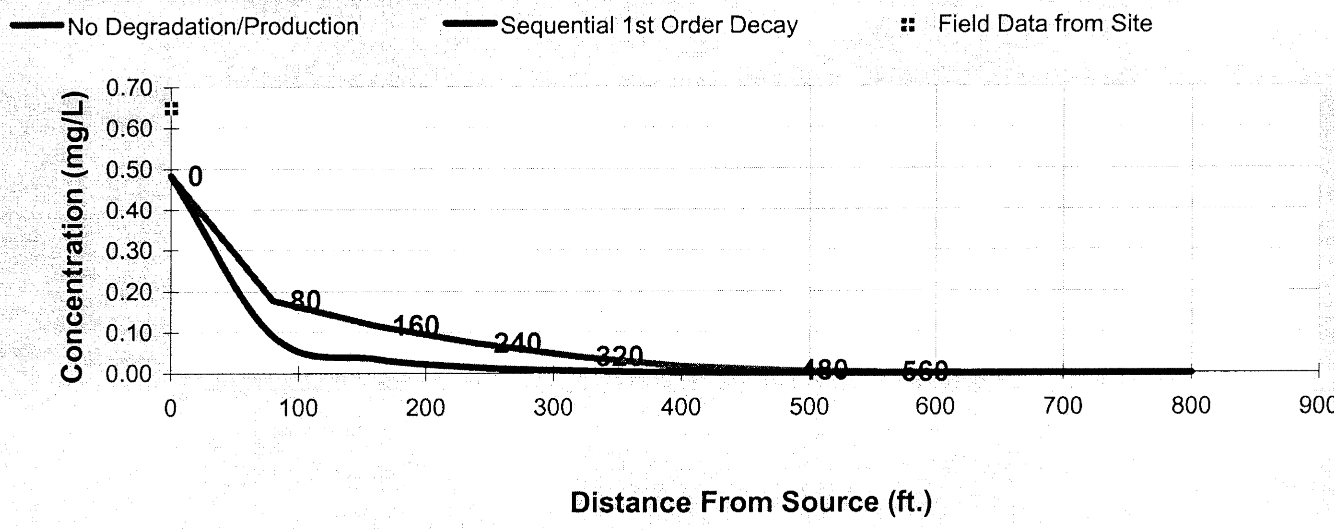
DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

VC	0	80	160	240	320	400	480	560	640	720	800
No Degradation	0.485	0.179	0.118	0.074	0.040	0.018	0.006	0.002	0.000	0.000	0.000
Biotransformation	0.4850	0.093	0.036	0.015	0.006	0.002	0.001	0.000	0.000	0.000	0.000

Monitoring Well Locations (ft)

	0										
Field Data from Site	0.650										



See PCE

See TCE

See DCE

See VC

See ETH

Replay

Time:

4.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

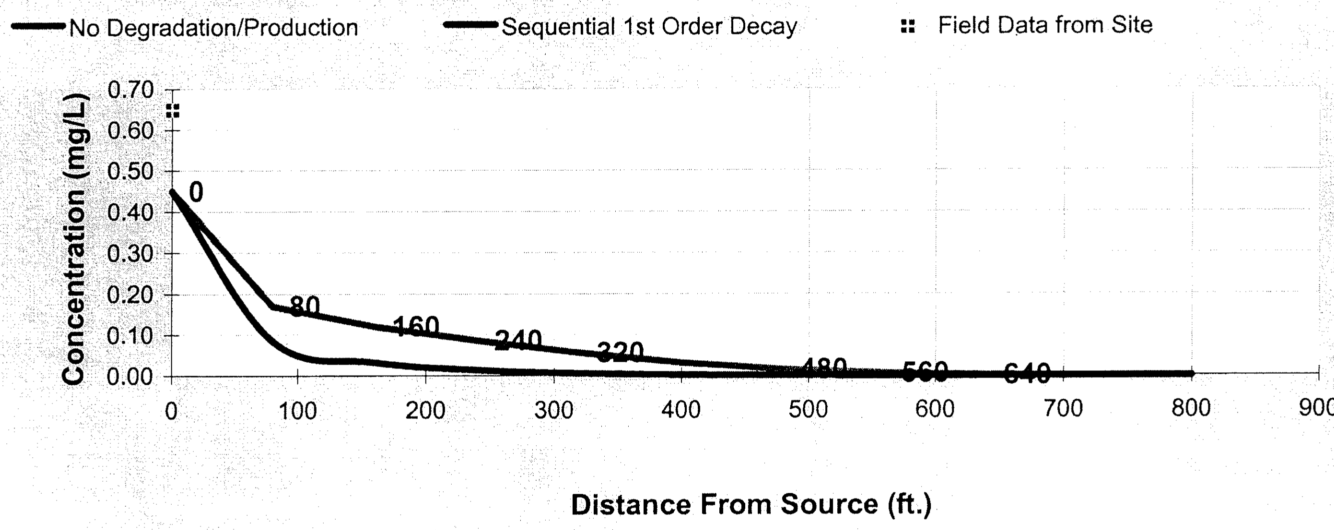
DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

VC	0	80	160	240	320	400	480	560	640	720	800
No Degradation	0.451	0.171	0.121	0.087	0.057	0.032	0.015	0.006	0.002	0.000	0.000
Biotransformation	0.4508	0.087	0.034	0.015	0.007	0.003	0.001	0.000	0.000	0.000	0.000

Monitoring Well Locations (ft)

	0										
Field Data from Site	0.650										



See PCE

See TCE

See DCE

See VC

See ETH

Replay

Time:

5.0 Years

Log ⟺ Linear

Return to Input

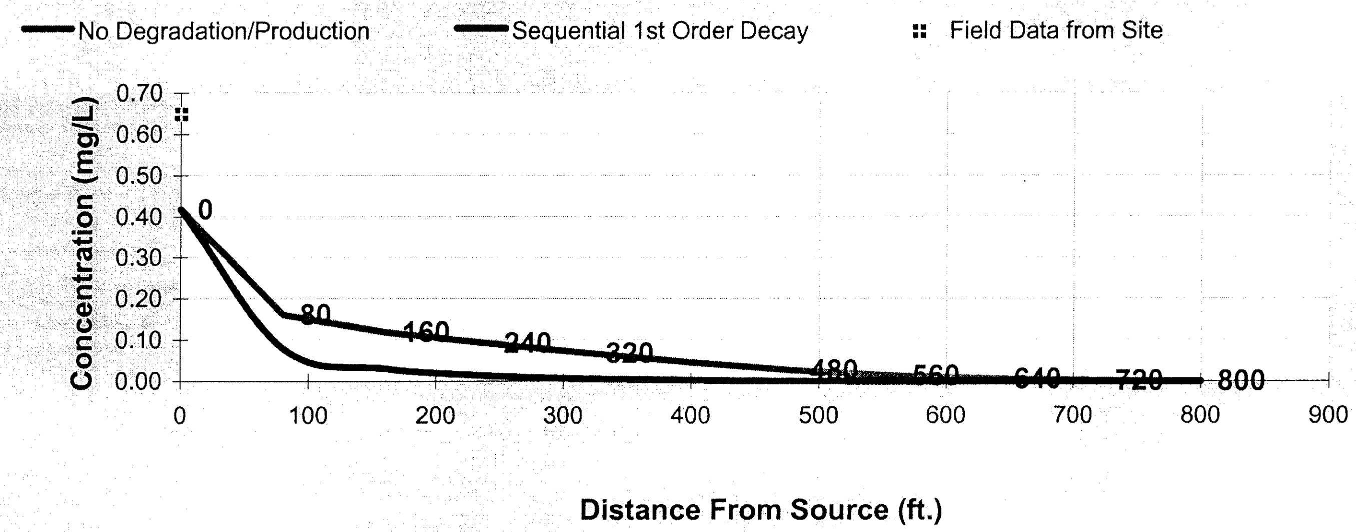
To All

To Array

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

VC	Distance from Source (ft)										
	0	80	160	240	320	400	480	560	640	720	800
No Degradation	0.419	0.162	0.120	0.093	0.069	0.046	0.027	0.014	0.006	0.002	0.001
Biotransformation	0.4190	0.081	0.032	0.014	0.007	0.003	0.001	0.001	0.000	0.000	0.000

	Monitoring Well Locations (ft)										
	0										
Field Data from Site	0.650										



See PCE

See TCE

See DCE

See VC

See ETH

Replay

Time:
6.0 Years

Log ⟺ Linear

Return to Input

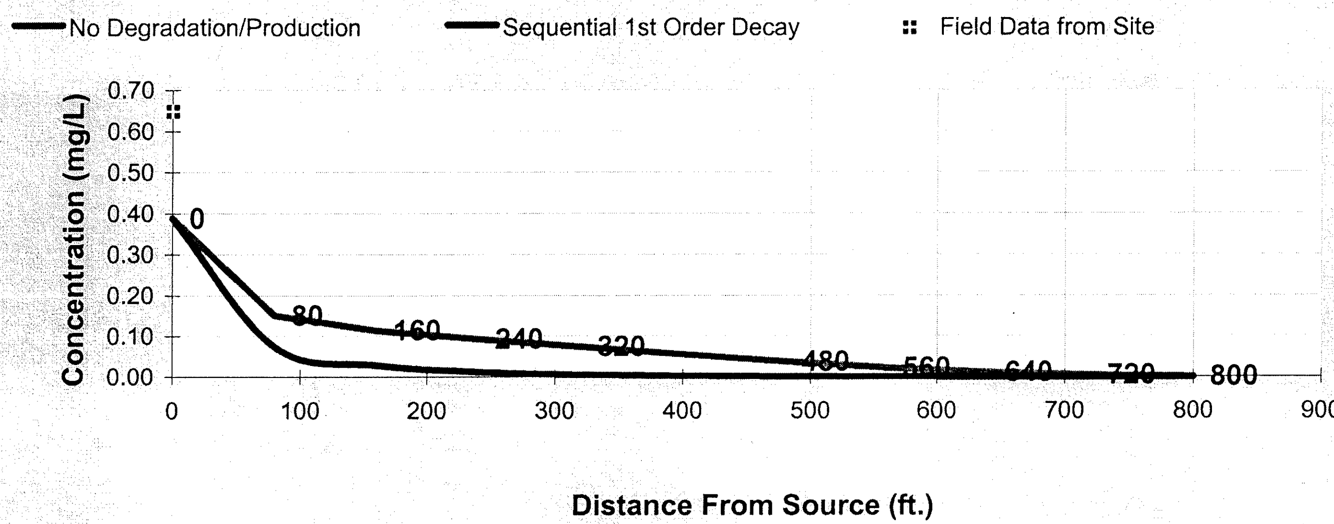
To All

To Array

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

VC	Distance from Source (ft)										
	0	80	160	240	320	400	480	560	640	720	800
No Degradation	0.389	0.152	0.115	0.095	0.076	0.056	0.038	0.023	0.012	0.005	0.002
Biotransformation	0.3894	0.075	0.030	0.013	0.006	0.003	0.001	0.001	0.000	0.000	0.000

	Monitoring Well Locations (ft)										
	0										
Field Data from Site	0.650										



See PCE

See TCE

See DCE

See VC

See ETH

Replay

Time:

7.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

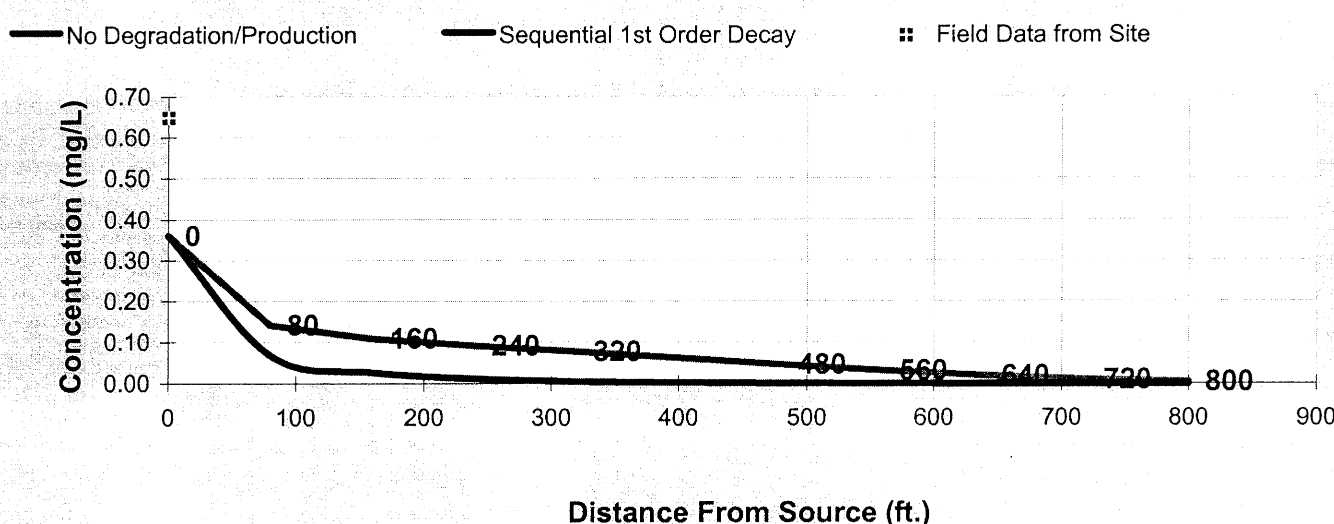
DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

VC	0	80	160	240	320	400	480	560	640	720	800
No Degradation	0.362	0.142	0.110	0.093	0.078	0.063	0.047	0.032	0.020	0.011	0.005
Biotransformation	0.3619	0.070	0.027	0.012	0.006	0.003	0.001	0.001	0.000	0.000	0.000

Monitoring Well Locations (ft)

	0										
Field Data from Site	0.650										



See PCE

See TCE

See DCE

See VC

See ETH

Replay

Time:

8.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

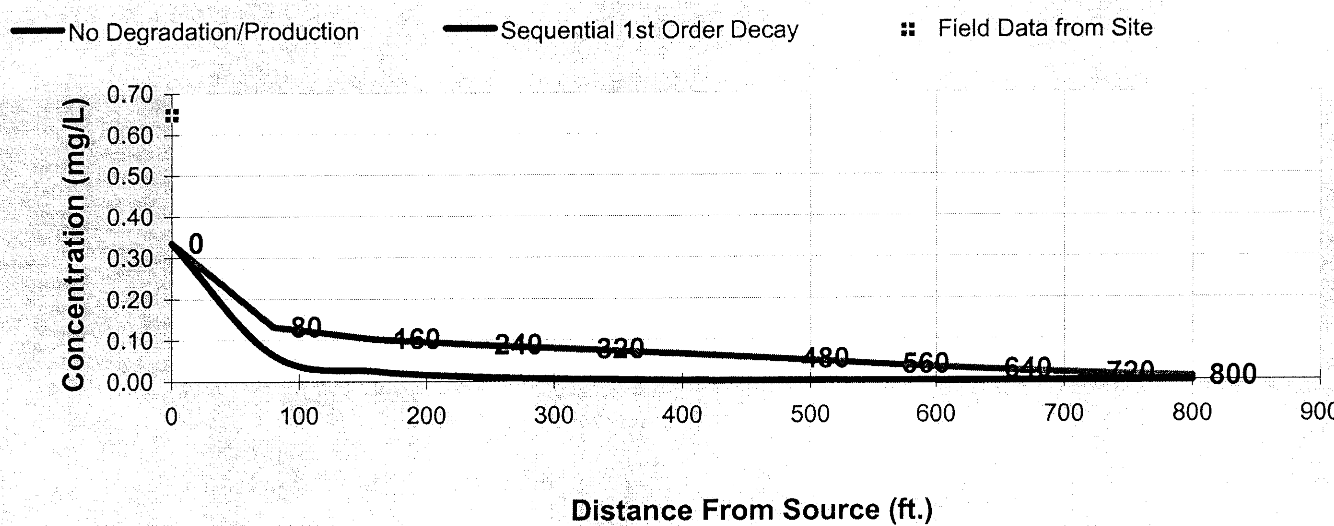
DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

VC

Distance from Source (ft)	0	80	160	240	320	400	480	560	640	720	800
No Degradation	0.336	0.133	0.104	0.090	0.079	0.067	0.054	0.040	0.028	0.017	0.010
Biotransformation	0.3364	0.065	0.026	0.012	0.006	0.003	0.001	0.001	0.000	0.000	0.000

Monitoring Well Locations (ft)

	0										
Field Data from Site	0.650										



See PCE

See TCE

See DCE

See VC

See ETH

Replay

Time:

9.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

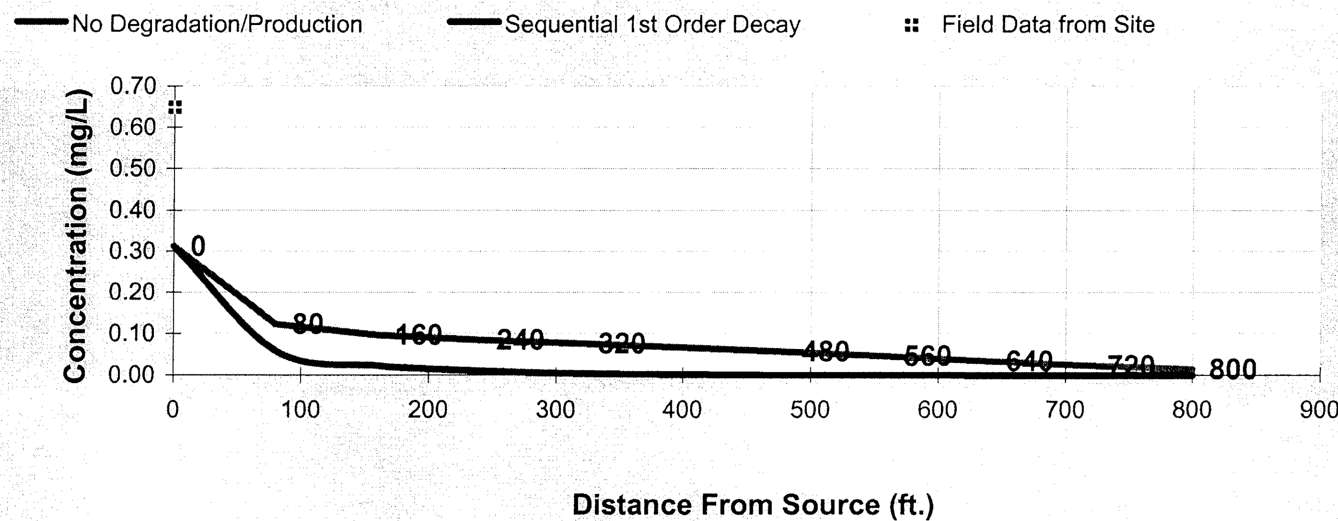
DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

VC	0	80	160	240	320	400	480	560	640	720	800
No Degradation	0.313	0.124	0.097	0.086	0.077	0.068	0.058	0.047	0.035	0.024	0.015
Biotransformation	0.3126	0.060	0.024	0.011	0.005	0.003	0.001	0.001	0.000	0.000	0.000

Monitoring Well Locations (ft)

	0										
Field Data from Site	0.650										



See PCE

See TCE

See DCE

See VC

See ETH

Replay

Time:

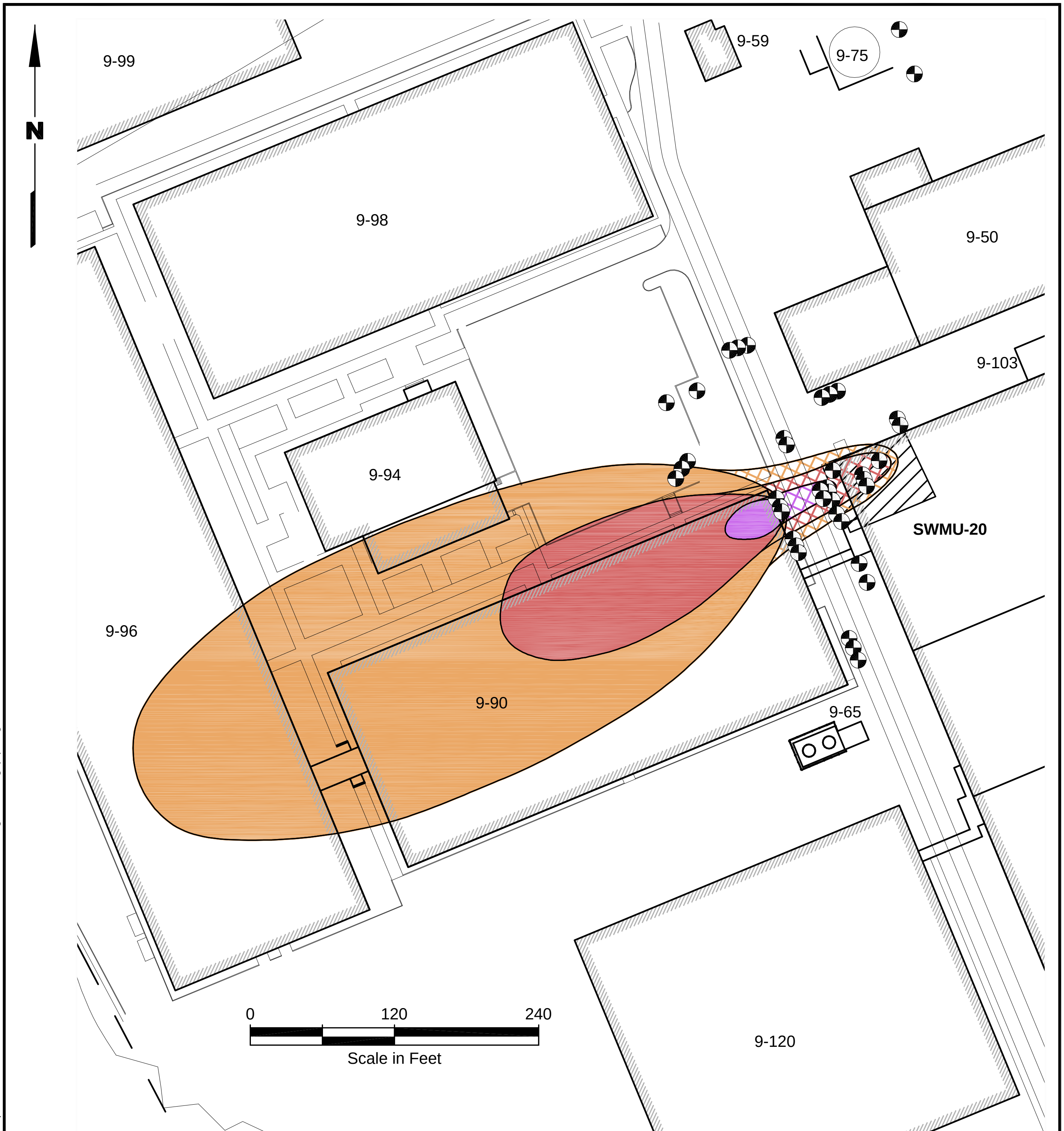
10.0 Years

Log ⟺ Linear

Return to Input

To All

To Array



Legend

Monitoring Well Location

Vinyl Chloride ≧ 1 µg/L

Vinyl Chloride ≧ 10 µg/L

Vinyl Chloride ≧ 100 µg/L

Notes:

1. Solid pattern denotes Biochlor modeling results for the future maximum extent of the plume based on use of the greatest plume concentrations (from MW-14A) in October 2004 as the plume source.
2. Cross-hatched pattern denotes existing plume area based on data from the October 2004 groundwater sampling event.

Landau Associates

Boeing Developmental Center
Tukwila, Washington

Modeled Maximum Extent of Vinyl Chloride Plume (October 2014)

Figure A1-1

Boeing/Developmental Center/Tech Memo | X:\025\093\004\070\SWMU-20 Feb 05 Tech Memo\FigA1-1.dwg (A) "Figure A1-1" 2/18/2005

ATTACHMENT 2

Johnson-Ettinger Model Output

DATA ENTRY SHEET - BUILDING 9-90

GW-ADV
Version 3.0; 02/03

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
75014	6.12E+01	Vinyl chloride (chloroethene)

MORE ↓

Totals must add up to value of L_{WT} (cell G28)

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
10	15	300	125	175	0	B	SI	S		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
S	1.66	0.375	0.054	SI	1.35	0.489	0.167		Error	Error	Error

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
15	40	12000	5300	850	0.1	0.5	

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	250	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3$)$^{-1}$	Reference conc., RfC (mg/m^3)
1.06E-01	1.23E-05	2.69E-02	25	5,250	259.25	432.00	1.86E+01	8.80E+03	8.8E-06	1.0E-01

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
9.46E+08	285	0.321	0.322	#VALUE!	0.003	9.92E-08	0.998	9.91E-08	163.04	0.489	0.107	0.382	34,600

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
7.51E+06	6.36E+07	5.44E-05	15	5,000	1.72E-02	7.41E-01	1.75E-04	1.71E-02	1.02E-02	0.00E+00	2.65E-04	4.58E-04	285

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	7.41E+02	0.10	8.61E+02	1.71E-02	3.46E+03	3.95E+94	1.22E-05	9.01E-03	8.8E-06	1.0E-01

END

RESULTS SHEET - BUILDING 9-90

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
4.29E+01	1.62E+04	4.29E+01	8.80E+06	4.29E+01

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

APPENDIX I

2008 Technical Memorandum Re: SWMU-20 Work Plan Addendum Fourth Electron Donor Injection

LANDAU ASSOCIATES

July 30, 2008

Byung Maeng
Washington State Department of Ecology
Northwest Regional Office
3190 160th Avenue SE
Bellevue WA 98008-5452

**RE: SWMU-20 WORK PLAN ADDENDUM
FOURTH ELECTRON DONOR INJECTION
BOEING DEVELOPMENTAL CENTER, TUKWILA, WASHINGTON**

Dear Byung:

This Solid Waste Management Unit (SWMU)-20 work plan addendum is submitted on behalf of The Boeing Company. The work plan addendum describes an additional injection of electron donor to be performed as a continuation of bioremediation activities in SWMU-20. The electron donor injection will stimulate additional treatment of the trichloroethene (TCE) source near the former degreaser. The need for additional source zone treatment is evidenced by an increasing trend over the last year in vinyl chloride (VC) concentration at well MW-10A and rebound of VC in MW-9A, both located on the fringe of the area treated by previous injections.

We plan to perform the injection event described in the work plan addendum in late August or early September. To meet this schedule, we will be ordering donor substrates immediately and beginning other planning and coordination for this injection event.

Please call or email me if you have any questions or if you would like to discuss anything contained in the addendum.

LANDAU ASSOCIATES, INC.

Clinton L. Jacob, P.E.
Associate Engineer

CLJ/tam
7/30/08 \\Edmdata\projects\025\093\FileRm\R\SWMU-20 WP Adden\SWMU-20 WP Addend 08 Inj_Ltr.doc
Enclosures

cc: James Bet, The Boeing Company

TECHNICAL MEMORANDUM

LANDAU ASSOCIATES
ENVIRONMENTAL | GEOTECHNICAL | NATURAL RESOURCES

TO: Jim Bet, The Boeing Company

FROM: Benni Jonsson and Clint Jacob, P.E.

DATE: July 30, 2008

**RE: SWMU-20 WORK PLAN ADDENDUM
FOURTH ELECTRON DONOR INJECTION
BOEING DEVELOPMENTAL CENTER
TUKWILA, WASHINGTON**

This technical memorandum presents an addendum to the Solid Waste Management Unit (SWMU)-20 work plan (work plan) that was included in the Evaluation Report dated March 10, 2004 (Landau Associates 2004a). This addendum addresses a fourth injection of sodium lactate and emulsified vegetable oil electron donor substrate for treatment of trichloroethene (TCE) and breakdown products *cis*-1,2-dichloroethene (*c*DCE) and vinyl chloride (VC). Procedures not specifically described in this addendum, including health and safety, will be performed in accordance with the work plan. Wells and site features in SWMU-20 are presented on Figure 1.

BACKGROUND

Tetrachloroethene (PCE) and TCE were released at SWMU-20 from a former vapor degreaser located in Building 9-101 (Landau Associates 2002), resulting in initiation of remedial actions. A groundwater treatment system was operated at SWMU-20 between Fall 1993 and December 14, 2001, followed by a 2-year period of system shutdown to evaluate natural attenuation as a remedial alternative to achieve cleanup objectives. Based on rebound of volatile organic compounds (VOC) concentrations in a number of monitoring wells located in the immediate vicinity of the former vapor degreaser, Boeing proposed active remediation by enhanced *in situ* reductive dechlorination through electron donor amendment (Landau Associates 2004a); three electron donor injections were conducted. The first two injections addressed source zone treatment and the last injections targeted elevated VC at well MW-14A. These previous injection activities are summarized below:

- <u>1st Injection (June 2004)</u>: The first injection targeted A-, B- and C-horizon wells in the source area. A total of 550 gallons of sodium lactate, 257 gallons of vegetable oil emulsion, and 1 kilogram of yeast extract was mixed with groundwater pumped from extraction wells E1 and E2 for a total solution volume of approximately 10,000 gallons (Landau Associates 2004b). A total of 275 gallons of sodium lactate and 257 gallons of vegetable oil emulsion were distributed to the three MW-6 wells (A, B, and C) and a total of 275 gallons of sodium lactate to the MW-9 wells (A, B, and C). The injection volume delivered to each of the A-horizon wells (MW-6A and MW-9A) was twice the volume that was delivered to the

B- and C-horizon wells, in order to target the higher concentrations of PCE and TCE present in the A-horizon.

- 2nd Injection (December 2004): The second injection targeted only the A- and B-Horizons, due to the absence of PCE and TCE and the very low concentrations of breakdown products present in C-Horizon wells MW-6C and MW-9C. A total of 9,500 gallons of groundwater, 275 gallons of sodium lactate, and 257 gallons of vegetable oil emulsion were injected to wells MW-6A, MW-6B, MW-9A, and MW-9B (Landau Associates 2004b). Each of these wells received an equal amount of the total 11,114-gallon injection volume, mixed in two batches in a temporary tank. Groundwater for mixing the injection solution was extracted from extraction wells E1 and E2 at approximately 16 gpm.

- 3rd Injection (March 2005): To treat VC observed in downgradient well MW-14, approximately 5,280 gallons of groundwater from extraction wells E1 and E2 was mixed with 275 gallons sodium lactate and 257 gallons of vegetable oil emulsion in a temporary tank and injected to well MW-14A (Landau Associates 2005). Injection solution was delivered to the well under gravity flow to minimize leakage that occurred around the well casing when injection was performed using a centrifugal pump.

RESULTS OF BIOLOGICAL TREATMENT

The previous electron donor injections have successfully decreased TCE and breakdown products at the site, but rebound has occurred at some wells. The most recent data from May 2008 show no substantial rebound in the majority of wells that represent the treated area, but does indicate an increasing trend over the last year in VC concentration at well MW-10A and rebound of VC in MW-9A, both located on the fringe of the treated area. Wells MW-9A and MW-10A are located in the downgradient and crossgradient fringes of the known source area; VC observed at these wells is the result of some remaining source material in the vicinity of the former vapor degreaser. The May 2008 data also show some lower VC increases in downgradient and crossgradient C wells. The observed rebound of VC reflects slowing treatment of residual source material due to an inadequate amount of electron donor; additional substrate is required to continue treatment.

As described above, seven wells (MW-6A, MW-6B, MW-6C, MW-9A, MW-9B, MW-9C, and MW-14A) have been injected with electron donor one or more times for source zone treatment and to address downgradient increases in VC concentrations (i.e., injection at MW-14A). At these wells, except MW-9A, concentrations of TCE and breakdown products have decreased and remained nondetect or low (VC detected < 5 μg/L). Current concentrations of total organic carbon (TOC), sulfate, and ferrous iron suggest that the aquifer conditions have returned to natural baseline conditions at previously injected wells except MW-9B, where TOC (> 35 mg/L) remains above background and some level of iron-reduction appears to continue. Low to moderate levels of treatment appear to continue at wells MW-6A, MW-6B, MW-9A, MW-9B, MW-9C, and MW-10 as indicated by the generation of low levels of the degradation end products ethene and/or ethane (1.3-35.6 μg/L).

Inadequate treatment of VC is currently occurring around wells MW-10A and MW-9A due to low TOC and less than ideal redox conditions. In February 2006, 150 μg/L of VC was detected in MW-10A; however, concentrations were lower over the next three quarters (lowest was 9.2 μg/L in November 2006). During quarterly and semiannual sampling performed in 2007 and 2008, VC at MW-10A has risen steadily to 180 μg/L. Some treatment of the observed VC is currently occurring, as evidenced by detections of end products ethene (7.9 μg/L) and ethane (4.4 μg/L) in May 2008. The VC detected at MW-10A does not extend very far, as VC is not detected at the nearest wells across the street (MW-14A and MW-15A). At MW-9A, concentrations of VC have been low (< 3 μg/L) since May 2005, but 85 μg/L VC was detected in May 2008. Observed VC is due to inadequate treatment resulting from low available electron donor. TOC concentrations at MW-10A and MW-9A were 33.3 mg/L and 31.0 mg/L in May 2008 (slightly above background), but only 20.1 mg/L at the nearest upgradient well MW-6A in the source area. Current (May 2008) concentrations of sulfate in MW-10A and MW-9A (32.5 mg/L and 29.4 mg/L) also indicate that ideal redox conditions for VC degradation (sulfate-reducing to methanogenic) are not currently present.

The VC detected at MW-10A and MW-9A represent remaining source material hydraulically upgradient of these wells. VC molar concentrations at MW-10A have been greater than the molar concentrations of parent product *cis*-1,2-dichloroethene (*c*DCE) over the past 1.5 yrs [0.07-0.65 micromolar (μM) *c*DCE compared to 0.15-2.9 μM VC], indicating that *c*DCE is being degraded to VC upgradient of MW-10A. A similar conclusion can be made at MW-9A, where 1.1 μM *c*DCE was detected in May 2008, less than half of the 2.5 μM of observed breakdown products (1.4 μM VC and 1.2 μM ethane).

In addition to VC increases observed at wells 10A and 9A, the most recent sampling (May 2008) showed slight increases of *c*DCE and VC in some downgradient and crossgradient C-horizon wells. In MW-10C, *c*DCE approximately doubled from 7.2 μg/L in November 2007 to 15 μg/L in May 2008. VC about doubled in May 2008 at MW-14C (to 22 μg/L) and at MW-15C (to 6.6 μg/L).

FOURTH ELECTRON DONOR INJECTION

A fourth injection of electron donor will be performed, targeting wells MW-6A, MW-9A, and MW-10A. The purpose of this injection is to provide treatment of source material present near and upgradient of well MW-10A and MW-9A. It is anticipated that treatment of this zone will also address lower VC concentrations at nearby C-Horizon wells (MW-10C, MW-14C, and MW-15C). The volume of injection fluid and mass of electron donor substrates will be double what was used in previous injections to achieve a larger radius of injection (ROI) at each well and thereby treat the portion(s) of source zone that were inadequately treated by previous injection events. The electron donor substrates utilized for this fourth injection are the same substrates used in previous injections in SWMU-20.

Injection Fluid and Injection Procedures

Emulsified vegetable oil and sodium lactate will be mixed with extracted groundwater to create the electron donor injection solution that will be injected using a gasoline-powered centrifugal pump [3-inch, 8 horsepower (hp), 290 gpm] and by slower gravity injection, if needed. Injection solution will be distributed equally to wells MW-10A, MW-6A and MW-9A. Each of the three wells will receive a volume of injection solution consisting of approximately 4,750 gallons of groundwater, five drums of 60 percent sodium lactate solution (approximately 275 gallons, 3,000 lbs), one tote of Newman Zone 46 percent vegetable oil emulsion (approximately 256 gallons, 2,100 lbs), and 2 lbs of yeast extract. The injection solution will be premixed in three batches (one per well) in a temporary 6,500 gallon Baker tank. Groundwater used for mixing the injection solution will be taken from extraction wells E1 and E2 using dedicated extraction pumps. Approximately 400 gallons of unamended water will be injected to each well following injection of donor solution to flush the well and prevent biofouling.

The injection pump will be operated at a reduced throttle to keep injection pressures low and avoid leakage of injection fluid up through the pavement, as was observed during previous injection events. Injection pressures will be maintained below 10 pounds per square inch (psi), as measured at the top of the well. If leakage occurs around the well casing during injection, the pressure will be reduced further by throttling the pump or stopping the pump, if needed, to perform injection under gravity flow from the tank.

PERFORMANCE MONITORING

Performance groundwater monitoring will be performed in general accordance with the work plan (Landau Associates 2004a), as detailed below. Performance monitoring will consist of regular semiannual monitoring, with select wells sampled for additional parameters. All SWMU-20 wells will be monitored for oxidation reduction potential (ORP), pH, dissolved oxygen (DO), and VOCs. In addition to these parameters, source zone wells (MW-6A, MW-6B, MW-6C, MW-9A, MW-9B, and MW-9C) and selected downgradient wells (MW-10A and MW-14A) will be monitored for dissolved ferrous iron, TOC, sulfate, ethene, ethane, and methane. ORP, pH, DO, and ferrous iron will be measured in the field. Samples will be submitted to Analytical Resources Inc. (ARI) for laboratory analyses of VOCs, TOC, sulfate, ethene, ethane, and methane.

SCHEDULE

The electron donor injection work described in this addendum is anticipated to take place in late August or early September 2008. Regular semiannual monitoring will continue to be performed in May and November. It is anticipated that the additional sampling parameters collected at selected wells will continue for about 2 years and will be discontinued when monitoring indicates end of active treatment.

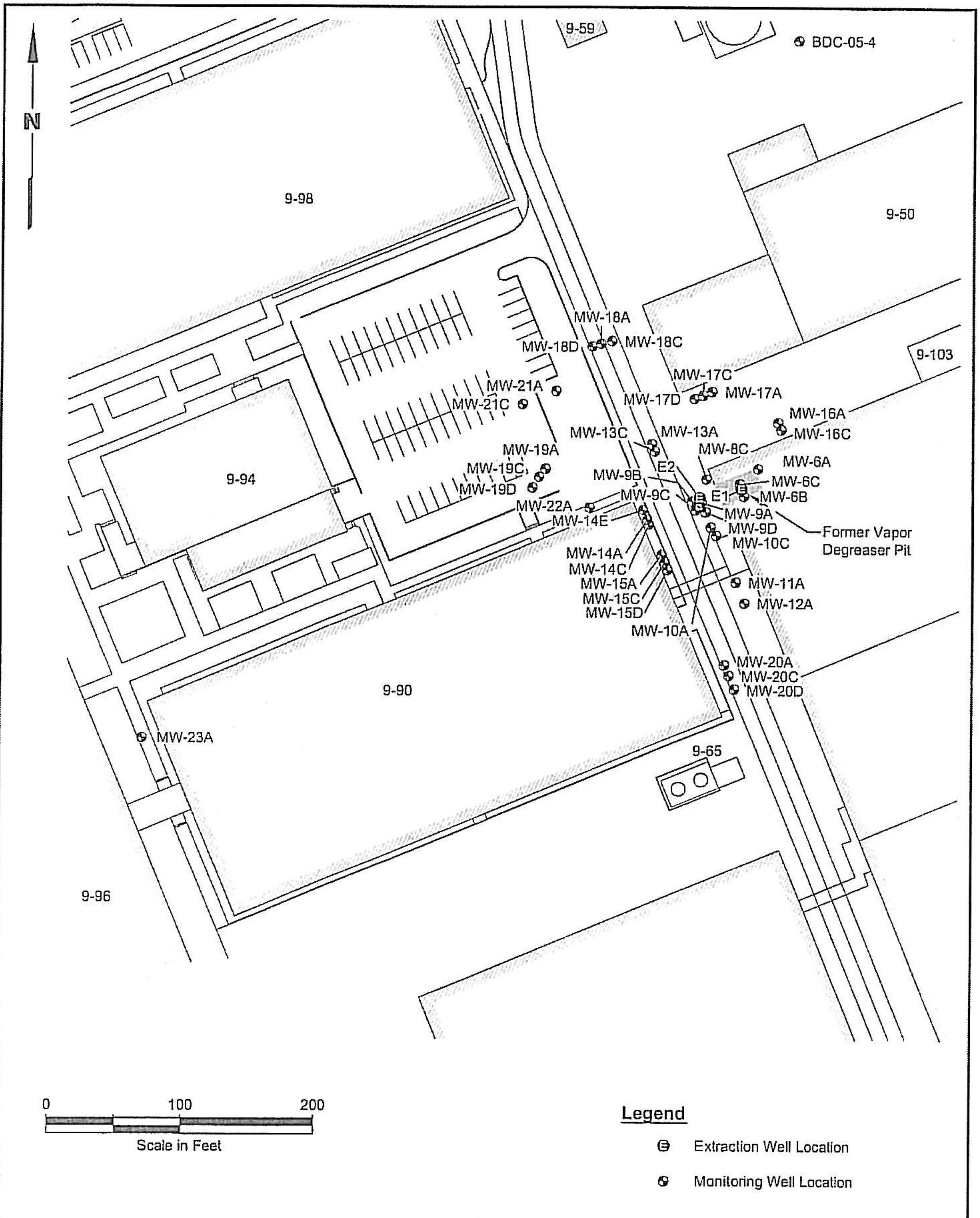
REFERENCES

Landau Associates. 2005. SWMU-20 Modeling Response to Comments and Remedial Action Update, Boeing Developmental Center, Tukwila, Washington. August 18.

Landau Associates. 2004a. Evaluation Report, SWMU-17, SWMU-20, and AOC-05, Boeing Developmental Center, Tukwila, Washington. March 10.

Landau Associates. 2004b. SMWU-20 Well Installation and First Electron Donor Injection, Boeing Developmental Center, Tukwila, Washington. December 13.

Landau Associates. 2002. Summary Report, Corrective Action, Boeing Developmental Center. February 27.



Boeing/Developmental Center/Workplan | V:\025\093\070\Report\Fig1.dwg (A) "Figure 1" 6/10/2008

Landau Associates	Boeing Developmental Center Tukwila, Washington	**SWMU-20 Details**	Figure 1

APPENDIX J

2015 Technical Memorandum Re: SWMU-20 Work Plan Addendum Fifth Electron Donor Injection

Landau Associates
Environmental | Geotechnical | Natural Resources

TECHNICAL MEMORANDUM

TO: Jim Bet, The Boeing Company

FROM: Brandon Duncan, P.E., and Clint Jacob, P.E.

DATE: September 10, 2015

RE: SWMU-20 WORK PLAN ADDENDUM
FIFTH ELECTRON DONOR INJECTION
BOEING DEVELOPMENTAL CENTER
TUKWILA, WASHINGTON

This technical memorandum presents an addendum to the Solid Waste Management Unit (SWMU)-20 work plan (work plan) that was included in the Evaluation Report dated March 10, 2004 (Landau Associates 2004a). This addendum addresses a fifth injection of electron donor substrate for treatment of trichloroethene (TCE) and breakdown products *cis*-1,2-dichloroethene (*c*DCE) and vinyl chloride (VC). Procedures not specifically described in this addendum, including health and safety, will be performed in accordance with the work plan. Wells and site features in SWMU-20 are presented on Figure 1.

BACKGROUND

Tetrachloroethene (PCE) and TCE were released at SWMU-20 from a former vapor degreaser located in Building 9-101 (Landau Associates 2002), resulting in initiation of remedial actions. A groundwater treatment system was operated at SWMU-20 between Fall 1993 and December 14, 2001, followed by a 2-year period of system shutdown to evaluate natural attenuation as a remedial alternative to achieve cleanup objectives. Based on rebound of volatile organic compounds (VOC) concentrations in a number of monitoring wells located in the immediate vicinity of the former vapor degreaser, Boeing proposed active remediation by enhanced *in situ* reductive dechlorination through electron donor amendment (Landau Associates 2004a, 2008); electron donor was injected during four prior events. The first two injections addressed source zone treatment, the third injection targeted elevated VC at well MW-14A, and the fourth injection targeted remaining source material near and upgradient of wells MW-9A and MW-10A. Wells are shown on Figure 1 and previous injection activities are summarized below:

- 1st Injection (June 2004): The first injection targeted A-, B-, and C-horizon wells in the source area. A total of 550 gallons of sodium lactate, 257 gallons of vegetable oil emulsion, and 1 kilogram of yeast extract were mixed with groundwater pumped from extraction wells E1 and E2 for a total solution volume of approximately 10,000 gallons (Landau Associates 2004b). Of the total electron donor volume, 275 gallons of sodium lactate and 257 gallons of vegetable oil emulsion were distributed to the three MW-6 wells (A, B, and C), and

275 gallons of sodium lactate was distributed to the MW-9 wells (A, B, and C). The injection volume delivered to each of the A-horizon wells (MW-6A and MW-9A) was twice the volume that was delivered to the B- and C-horizon wells, in order to target the higher concentrations of PCE and TCE present in the A-horizon.

- 2nd Injection (December 2004): The second injection targeted only the A- and B-Horizon wells, due to the absence of PCE and TCE and the very low concentrations of breakdown products present in C-Horizon wells MW-6C and MW-9C. A total of 9,500 gallons of groundwater, 275 gallons of sodium lactate, and 257 gallons of vegetable oil emulsion were injected to wells MW-6A, MW-6B, MW-9A, and MW-9B (Landau Associates 2004b). Each of these wells received approximately a quarter of the total 11,114-gallon injection volume, mixed in two batches in a temporary tank. Groundwater for mixing the injection solution was from extraction wells E1 and E2.
- 3rd Injection (March 2005): To treat VC observed in downgradient well MW-14, electron donor solution was injected to that well. Approximately 5,280 gallons of groundwater (from extraction wells E1 and E2) was mixed with 275 gallons sodium lactate and 257 gallons of vegetable oil emulsion in a temporary tank and injected to well MW-14A (Landau Associates 2005).
- 4th Injection (August 2008): The fourth injection targeted remaining VC concentrations upgradient of wells MW-9A and MW-10A, and lower VC concentrations at nearby C-Horizon wells (MW-10C, MW-14C, and MW-15C), through an injection of wells MW-6A, MW-9A, and MW-10A. A total of approximately 14,000 gallons of groundwater (from E1 and E2) was mixed with 825 gallons sodium lactate solution and 768 gallons vegetable oil emulsion in a temporary tank and injected into wells MW-6A, MW-9A, and MW-10A (Landau Associates 2008). Each well received a third of the approximate 15,593-gallon total injection fluid volume. The injection was conducted using a centrifugal pump, which was operated at a reduced throttle to minimize injection well pressure and prevent leakage at the surface.

Proposed cleanup levels (CULs) for the Developmental Center were the same as Boeing Plant 2 Target Media Cleanup Levels (TMCLs), as presented in a prior document (Landau Associates 2013). Proposed CULs for VOC contaminants present in SWMU-20 are as follows:

PCE 5.3 micrograms per liter (µg/L)

TCE 1.4 µg/L

cDCE 130 µg/L

VC 2.4 µg/L.

Boeing's goal is to adopt DC CULs that are consistent with final CULs for Boeing Plant 2 and Isaacson-Thompson. Ongoing development of CULs at the Plant 2 and Isaacson-Thompson sites suggest that the final CUL for VC may be somewhat lower than proposed CUL, while the CULs for PCE, TCE, and cDCE are likely to remain as proposed.

RESULTS OF BIOLOGICAL TREATMENT

At SWMU-20, *in situ* anaerobic bioremediation continues for treatment of PCE, TCE, and breakdown products following the last electron donor injection performed in August 2008. Groundwater monitoring results indicate that enhanced treatment continues at and near injection wells, as indicated by the persistence of sulfate-reducing to methanogenic aquifer redox conditions, total organic carbon (TOC) levels generally above 10 milligrams per liter (mg/L), and the detection of end product ethane at several wells. SWMU-20 wells are designated as source or non-source wells depending on their proximity to the former degreaser and contaminant concentrations during and following the period of pump and treat. At all source-zone wells (Table 1), PCE and TCE remain below reporting limits and breakdown products cis-1,2-dichloroethene (cDCE) and vinyl chloride (VC) are either below reporting limits or are detected at low concentrations. cDCE concentrations are below reporting limits or less than 1 µg/L at all locations, well below the proposed CUL (134 µg/L). VC detections at source zone wells are below the proposed CUL (2.4 µg/L) with the exception of well MW-06A. Based on these results, the bioremediation effort in the SWMU-20 source area is considered successful.

The highest remaining SWMU-20 contaminant concentrations, although relatively low, are now present at non-source zone wells (Table 2), which are located on the fringes of the treatment zone created by prior injections. PCE, cDCE, and VC were all at or below the proposed CULs at all wells in April 2015. TCE detections in April were at or above the proposed CUL (1.4 µg/L) at only two upgradient or crossgradient wells (MW-16A and MW-17A).

Fifth Electron Donor Injection

A fifth injection of electron donor will be conducted for bioremediation of residual mass at selected non-source wells located within and on the fringes of the original treatment area. This donor injection will target a total of nine wells, two where TCE remains above the CUL (MW-16A and MW17A), and seven where VC is greater than 0.5 µg/L (MW-6A, MW-6B, MW-10C, MW-15C, MW-16C, MW-20C, and MW-22A). These well locations are shown on Figure 1.

The electron donor substrate utilized for this fifth injection will be solely composed of sodium lactate, a completely soluble electron donor, without addition of a slow release substrate (e.g., vegetable oil) as has previously been incorporated in the injection fluids at SMWU-20. The previous use of both fast release (soluble) sodium lactate and slow-release (insoluble) vegetable oil was intended to optimize the distribution and longevity of the injected donor. The optimization occurs because lactate is soluble and is transported farther from injection wells and is used more quickly by bacteria. In contrast, vegetable oil, which is insoluble, moves a shorter distance from the wells and ferments more slowly to soluble organic acids, providing a longer term source of donor to aquifer bacteria. Generally, combined use of soluble and insoluble donor is a beneficial strategy to extend the treatment period between injection events. However, long persistence of electron donor is not desired for this injection event, which will inject electron donor solution directly to monitoring wells. The use of soluble lactate only should provide relatively rapid treatment of residual mass without persistent elevated TOC concentrations, which would limit the usefulness of the wells as monitoring points for closure of SWMU-20. The volume of injection fluid delivered to each well will be similar to injection volumes utilized during the third and fourth injections to achieve a large radius of injection (ROI) at each well.

Injection Fluid and Injection Procedures

Each well will receive injection fluid consisting of approximately 5,000 gallons of tap water from a nearby hydrant mixed with four drums of JRW Wilclear Plus™ (WC+) sodium lactate solution (approximately 220 gallons). WC+ contains a higher percentage of fermentable material (61%) than the sodium lactate used previously at the site (40%) and contains nutrients for bacterial growth.

The design injection fluid described above is equivalent to approximately 3 percent electron donor by volume (%vol), compared to approximately 6%vol that was applied effectively to much higher contaminant concentrations during the 3rd and 4th SWMU-20 injection events (described above) and during PCE/TCE bioremediation also being conducted at the Developmental Center in SWMU-17 (Landau Associates 2011). The injection solution will be batched in and injected from a temporary 6,500-gallon Baker tank. A pond dechlorinator product (sodium thiosulfite) will be added to the tap water per product directions to remove (chemically reduce) residual chlorine prior to addition of Wilclear.

Donor fluid will be mixed and injected using a gasoline-powered centrifugal pump [3-inch, 8 horsepower (hp), 290 gpm]. The injection pump will be operated at a reduced throttle to keep injection pressures low, below 10 pounds per square inch (psi), to avoid leakage of injection fluid up through the pavement, as was observed occasionally during previous injection events. If leakage occurs, the pressure will be reduced further by throttling down the pump or, if necessary, the pump will be stopped and the injection will continue under gravity flow from the tank. After the injection of donor solution, each well will be flushed with 100 to 200 gallons of unamended tap water to minimize potential biofouling of the well.

PERFORMANCE MONITORING

SWMU-20 groundwater monitoring will continue to be conducted in general accordance with Washington State Department of Ecology (Ecology) comments to the technical memorandum *Additional Reduction in SWMU-20 Groundwater Monitoring* (Landau Associates 2015), as summarized in Table 3. Monitoring will consist of regular semiannual monitoring of VOCs at the indicated wells, which include all of wells injected during the 5th injection event. In accordance with the table and prior monitoring, wells MW-6A, MW-6B, and MW-22A will be monitored for additional field and lab parameters indicative of electron donor availability, aquifer redox conditions, and further breakdown of VC to non-toxic end products ethene and ethane. Monitoring of donor availability and aquifer redox conditions at these three wells will be indicative of conditions at the other wells, as they will all be injected with the same approximate volume and concentration of electron donor solution. Samples will continue to be submitted to Eurofins Lancaster Laboratories Environmental for laboratory analyses.

SCHEDULE

The electron donor injection work described in this addendum is anticipated to take place in late 2015 or early 2016 dependent on site access and weather considerations. Regular semiannual monitoring will continue to be performed in May and November.

It is anticipated that biodegradation stimulated by this fifth injection will result in VOC concentrations below anticipated final CULs all SWMU-20 wells. Once TOC concentrations have fallen below approximately twice the baseline concentration at monitored wells, it is anticipated that 1 to 2 years of semiannual monitoring will be required to demonstrate no rebound of VOCs above CULs before requesting a No Further Action (NFA) determination for SWMU-20. This schedule also anticipates finalization of Developmental Center CULs within a similar time frame.

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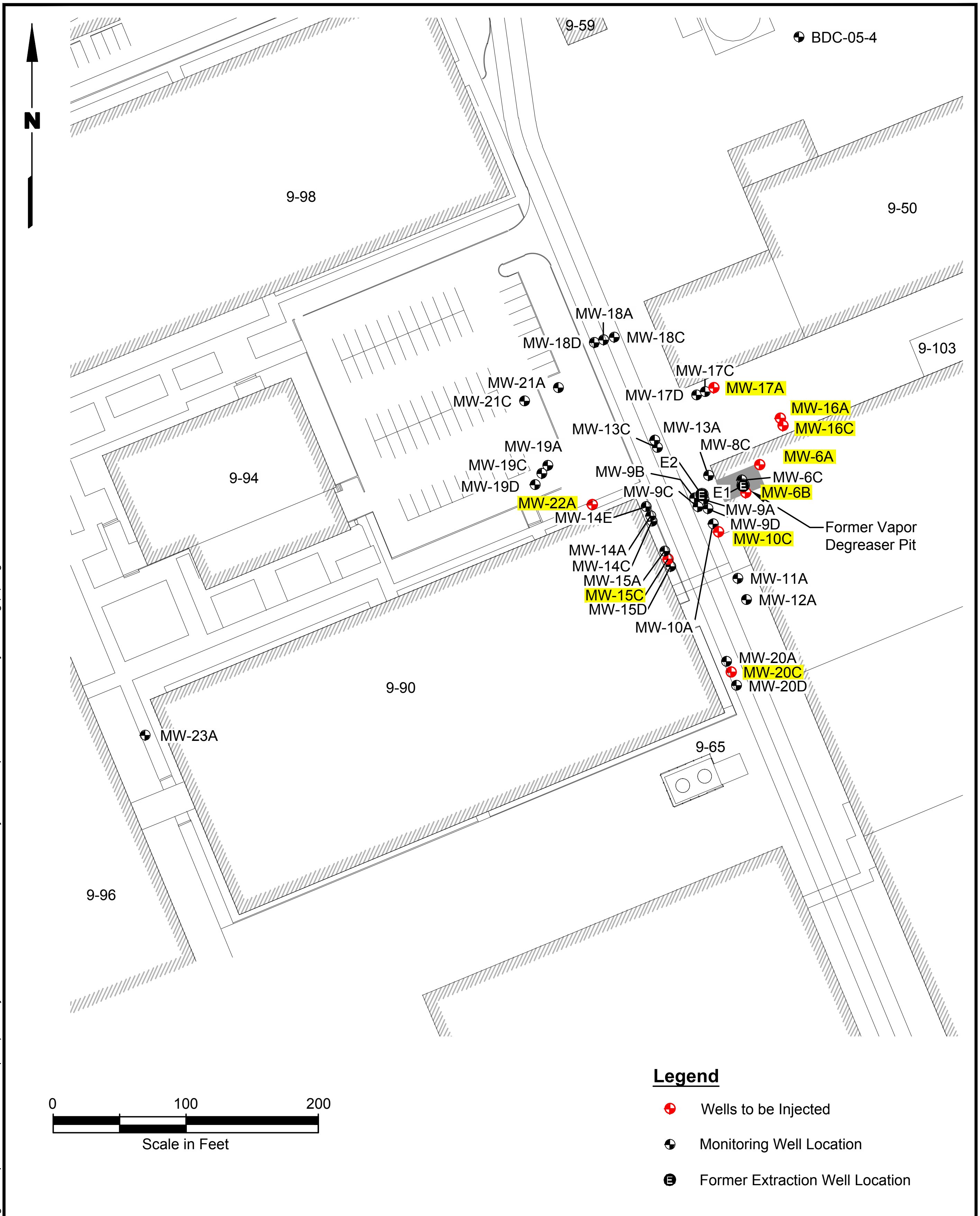

Boeing/Developmental Center/Workplan | G:\Projects\025\093\115\SMMU-20 Fifth Injection Workplan\F01 WellstobeInjected.dwg (A) "Figure 1" 8/20/2015

LANDAU ASSOCIATES

Boeing Developmental Center
Tukwila, Washington

SWMU-20 Wells to be Injected

Figure
1

SWMU-20 CLEANUP ACTION SUMMARY - SOURCE ZONE
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

		Elapsed Time from Injections (a) (days)				Volatile Organic Compounds						Aquifer Redox Conditions					Donor Parameters		
						Proposed Groundwater Cleanup Levels (d)													
						5.3	1.4	134	2.4	---	---								
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	DO (mg/L)	ORP (mV)	Iron II mg/L	Sulfate (mg/L)	Methane (µg/L)	pH	TOC (mg/L)	Notes
06A (c)	06/15/2004	-2				<1.0	**1.0**	**23**	**4.0**	<0.50	<0.50	6.34	-19.6	0.8	58.9	<0.50	6.5	18.8	---
06A (c)	08/23/2004	67				<1.0	<1.0	**45**	**5.9**	<0.50	<0.50	0.46	92	3.5	40.7	21	7.0	288	Hazy brown
06A (c)	10/19/2004	124	-58			<1.0	<1.0	**2.6**	**31**	<0.50	<0.50	0.70	54	3.0	44.8	530	6.8	80.8	---
06A (c)	02/22/2005	250	68			<1.0	<1.0	**3.3**	<1.0	<0.50	<0.50	1.15	187	2.4	<0.1	130	6.8	244	---
06A (c)	05/16/2005	333	151			<1.0	<1.0	**2.6**	<1.0	<0.50	<0.50	1.25	58	3.0	0.1	10000	6.9	145	---
06A (c)	08/22/2005	431	249			<1.0	<1.0	**1.6**	<1.0	<0.50	<0.50	1.26	212	2.7	3.1	390	6.8	54.2	Clear, with yellow tint
06A (c)	11/14/2005	515	333			<1.0	<1.0	**1.3**	**1.2**	<0.50	<0.50	0.93	108	3.0	0.1	3700	6.9	31.8	---
06A (c)	02/22/2006	615	433			<1.0	<1.0	**1.4**	**4.8**	<11.4	<12.3	0.80	186	2.6	60.4	10100	6.4	15.5	---
06A (c)	05/18/2006	700	518			<1.0	<1.0	<1.0	**1.6**	<11	<12	6.41	1	3.0	20.9	16000	6.6	23.9	---
06A (c)	08/16/2006	790	608			<1.0	<1.0	<1.0	**1.5**	<1.1	<1.2	0.89	240	2.2	23.1	18800	6.5	23.2	---
06A (c)	11/29/2006	895	713			<0.2	<0.2	**0.4**	**2.1**	<1.1	<1.2	2.09	102	2.6	33.1	20200	6.5	31.4	---
06A (c)	02/23/2007	981	799			<1.0	<1.0	<1.0	**6.7**	<1.1	<1.2	0.65	-97	4.5	26.2	17400	6.5	24.6	---
06A (c)	05/24/2007	1071	889			<1.0	<1.0	<1.0	**2.9**	<1.1	**2.0**	0.56	184	4.0	21.0	18300	6.7	21.5	---
06A (c)	11/30/2007	1261	1079			<0.2	<0.2	<0.2	**1.2**	<1.1	**2.2**	0.80	173	3.0	29.1	21900	6.7	22.6	---
06A (c)	05/21/2008	1434	1252		-96	<1.0	<1.0	<1.0	**1.4**	<1.1	**1.3**	2.11	-82	2.5	21.0	13200	6.9	20.1	---
06A (c)	11/25/2008	1622	1440		92	<1.0	<1.0	**1.7**	<1.0	<1.1	<1.2	1.71	-73	3.4	0.1	19700	6.5	150	---
06A (c)	05/20/2009	1798	1616		268	<4.0	<4.0	<4.0	<4.0	<1.1	<1.2	0.52	-45	4.0	<0.5	19500	6.8	38.2	---
06A (c)	11/19/2009	1981	1799		451	<1.0	<1.0	**1.9**	<1.0	<1.1	<1.2	2.66	6	2.8	0.8	20100	6.2	25.4	---
06A (c)	5/24/2010	2167	1985		637	<1.0	<1.0	**1.3**	**1.9**	<1.1	<1.2	3.56	448	2.0	16	19900	6.6	19.3	---
06A (c)	11/11/2010	2338	2156		808	<1.0	<1.0	<1.0	**1.7**	<1.1	<1.2	4.75	106	2.6	0.4	24700	7.0	20.2	---
06A (c)	5/4/2011	2512	2330		982	<1.0	<1.0	<1.0	**1.4**	<1.1	<1.2	2.14	22	2.5	<0.2	21400	7.1	13.6	---
06A (c)	11/13/2011	2705	2523		1175	<0.2	<0.2	**0.3**	**0.8**	<1.1	<1.2	5.80	-54	1.0	0.3	6370	7.2	12.7	---
06A (c)	5/15/2012	2889	2707		1359	<0.2	<0.2	**0.4**	**1.2**	<1.0	<1.0	0.08	66	2.0	4.3	13000	6.7	11.6	---
06A (c)	11/14/2012	3072	2890		1542	<0.2	<0.2	**0.3**	**0.8**	<1.0	<4.0	0.02	-0.5	1.5	<0.30	13000	6.9	9.0	---
06A (c)	5/21/2013	3260	3078		1730	<0.5	<0.5	<0.5	**1.3**	<1.0	<1.0	0.17	-434	2.6	3.3	5200	7.9	8.8	---
06A (c)	11/12/2013	3435	3253		1905	<0.2	<0.2	**0.4**	**2.4**	<1.0	<1.0	2.68	-298	1.2	5.8	3500	6.8	8.3	---
06A (c)	5/7/2014	3611	3429		2081	<0.2	<0.2	**0.4**	**1.5**	<1.0	<1.0	3.60	-386	1.5	11.2	1300	7.1	7.2	---
06A (c)	11/5/2014	3793	3611		2263	<0.2	<0.2	**0.4**	**2.7**	<1.0	<1.0	0.28	-89	1.0	13.9	770	6.7	7.2	---
06A (c)	4/29/2015	3968	3786		2438	<0.2	<0.2	**0.6**	**3.3**	<1.0	<1.0	0.36	-54	3.0	17.5	430	6.7	5.2	---
06B	05/04/2004	-44				**9.5**	**3.2**	**10**	**9.4**	<0.50	<0.50	0.36	179	4.5	18.7	130	6.8	25.6	Clear, yellow tint
06B	08/23/2004	67				**1.9**	**1.2**	**13**	**2.3**	<0.50	<0.50	0.45	115	3.2	33.8	1100	6.9	177	Yellow-brown tint (nearly clear)
06B	10/19/2004	124	-58			<1.0	<1.0	**10**	**3.6**	<0.50	<0.50	0.61	217	3.5	14.8	590	6.7	53.6	Yellow tint
06B	02/22/2005	250	68			<1.0	<1.0	**11**	<1.0	<0.50	<0.50	0.79	224	2.6	<0.5	3800	6.9	968	---
06B	05/16/2005	333	151			<2.0	<2.0	**5.5**	<2.0	<0.50	<0.50	1.51	133	3.5	<0.5	2300	6.9	336	Clear, yellow-brown tint
06B	08/22/2005	431	249			<1.0	<1.0	**1.8**	**1.6**	<0.50	<0.50	1.21	217	2.8	<0.1	440	6.9	100	Clear, with yellow tint
06B	11/14/2005	515	333			<1.0	<1.0	**1.1**	**1.3**	<0.50	<0.50	1.05	241	2.8	<0.1	2900	6.9	64.4	---
06B	02/22/2006	615	433			<1.0	<1.0	<1.0	**1.4**	**53.5**	<12.3	0.74	184	2.6	14.8	13000	6.4	30.4	---
06B	05/18/2006	700	518			<1.0	<1.0	<1.0	**1.3**	<11	<12	2.25	52	3.2	13.6	16000	6.6	25.9	---
06B	08/16/2006	790	608			<1.0	<1.0	<1.0	**1.1**	<1.1	<1.2	0.82	225	2.4	12.9	21700	6.5	14.7	---
06B	11/29/2006	895	713			<0.2	<0.2	**1.4**	**2.6**	<1.1	<1.2	1.82	111	2.4	10.9	22000	6.5	25.2	---
06B	02/23/2007	981	799			<1.0	<1.0	**3.8**	**9.5**	<1.1	<1.2	0.75	-66	5.0	25.0	17700	6.5	21.1	---
06B	05/24/2007	1071	889			<1.0	<1.0	**1.4**	**6.5**	<1.1	<1.2	0.58	151	3.0	11.3	18500	6.6	21.4	---
06B	11/30/2007	1261	1079			<0.2	<0.2	<0.2	**1.0**	<1.1	**4.0**	0.83	135	4.0	26.3	24900	6.4	26.5	---
06B	05/21/2008	1434	1252		-96	<1.0	<1.0	<1.0	<1.0	<1.1	**4.9**	2.66	-61	3.4	21.1	12700	6.7	20.4	---
06B	11/25/2008	1622	1440		92	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	2.53	-68	2.4	0.2	18400	6.6	19.6	---

SWMU-20 CLEANUP ACTION SUMMARY - SOURCE ZONE
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

		Elapsed Time from Injections (a) (days)				Volatile Organic Compounds						Aquifer Redox Conditions					Donor Parameters		
						Proposed Groundwater Cleanup Levels (d)													
						5.3	1.4	134	2.4	---	---								
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	DO (mg/L)	ORP (mV)	Iron II mg/L	Sulfate (mg/L)	Methane (µg/L)	pH	TOC (mg/L)	Notes
06B	05/20/2009	1798	1616		268	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.33	-36	4.0	<0.5	25300	6.9	20.9	---
06B	11/19/2009	1981	1799		451	<1.0	<1.0	<1.0	<1.0	<1.1	**6.7**	1.01	10	2.8	0.1	22500	6.9	20.0	---
06B	5/24/2010	2167	1985		637	<1.0	<1.0	<1.0	**4.2**	<1.1	**1.6**	3.05	417	2.0	3.0	7110	7.0	19.1	---
06B	11/11/2010	2338	2156		808	<1.0	<1.0	<1.0	**5.4**	<1.1	**1.4**	3.40	112	2.0	8.6	4600	7.1	15.8	---
06B	5/4/2011	2512	2330		982	<1.0	<1.0	<1.0	**5.2**	<1.1	<1.2	2.55	57	2.2	19.7	2120	7.1	12.6	---
06B	11/13/2011	2705	2523		1175	<0.2	<0.2	<0.2	**0.8**	<1.1	<1.2	6.10	-34	1.5	0.3	2260	7.3	14.8	---
06B	5/15/2012	2889	2707		1359	<0.2	<0.2	**0.5**	**6.0**	<1.0	**1.3**	0.14	71	1.8	10.9	2200	6.6	11.4	---
06B	11/14/2012	3072	2890		1542	<0.2	<0.2	<0.2	**3.7**	<1.0	**1.8**	0.02	10	2.0	7.0	2300	6.8	13.7	---
06B	5/21/2013	3260	3078		1730	<0.5	<0.5	<0.5	**4.3**	<1.0	<1.0	0.17	-427	2.5	20.1	720	7.7	11.0	---
06B	11/12/2013	3435	3253		1905	<0.2	<0.2	<0.2	**2.5**	<1.0	<1.0	2.62	-309	1.5	4.0	350	7.0	15.5	---
06B	5/7/2014	3611	3429		2081	<0.2	<0.2	<0.2	**2.4**	<1.0	<1.0	3.50	-320	1.6	2.8	1200	7.1	10.2	---
06B	11/5/2014	3793	3611		2263	<0.2	<0.2	<0.2	**1.8**	<1.0	<1.0	0.30	-54	1.7	4.7	2200	6.8	6.9	---
06B	4/29/2015	3968	3786		2438	<0.2	<0.2	<0.2	**1.8**	<1.0	<1.0	0.52	-39	1.0	0.99	1300	6.6	4.0	---
06C	05/04/2004	-44				<1.0	<1.0	<1.0	<1.0	<0.50	**0.6**	0.40	93	5.0	20.7	360	6.7	29.0	---
06C	08/23/2004	67				<1.0	<1.0	**1.4**	<1.0	**5.7**	**5.9**	0.63	95	2.5	42.7	3100	6.3	1560	White froth on surface of purge water
06C	10/19/2004	124	-58			<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	2.00	206	3.0	18.1	450	6.3	464	Yellow tint
06C	02/22/2005	250	68			<1.0	<1.0	**3.6**	<1.0	<0.50	<0.50	0.82	198	2.6	<0.5	2400	6.9	858	---
06C	05/16/2005	333	151			<1.0	<1.0	**1.1**	<1.0	<0.50	<0.50	1.94	98	3.0	0.2	2700	7.0	111	Clear, with yellow tint
06C	08/22/2005	431	249			<1.0	<1.0	**1.1**	<1.0	<0.50	<0.50	1.36	194	2.8	<0.1	510	7.0	68.7	Clear, with yellow tint
06C	11/14/2005	515	333			<1.0	<1.0	**1.1**	<1.0	<0.50	<0.50	1.07	258	2.0	<0.1	2900	7.0	48.3	---
06C	02/22/2006	615	433			<1.0	<1.0	<1.0	<1.0	**47.7**	<12.3	0.88	247	1.4	47.5	12300	6.6	93.4	---
06C	05/18/2006	700	518			<1.0	<1.0	<1.0	<1.0	<11	<12	4.88	129	2.0	30.6	15000	6.6	36.6	---
06C	08/16/2006	790	608			<1.0	<1.0	<1.0	<1.0	<1.1	**2.3**	0.93	231	1.6	31.8	18900	6.6	13.4	---
06C	11/29/2006	895	713			<0.2	<0.2	**0.3**	<0.2	<1.1	**1.4**	2.25	192	1.8	27.3	20600	6.6	46.4	---
06C	02/23/2007	981	799			<1.0	<1.0	<1.0	<1.0	<1.1	**1.7**	1.08	-46	4.0	25.9	18900	6.4	39.0	---
06C	05/24/2007	1071	889			<1.0	<1.0	<1.0	<1.0	<1.1	**2.0**	0.72	216	3.5	20.8	20800	6.5	34.0	---
06C	11/30/2007	1261	1079			<0.2	<0.2	**0.2**	**0.3**	<1.1	**2.8**	1.58	174	4.2	32.6	30500	6.2	40.2	---
06C	05/21/2008	1434	1252		-96	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	2.91	-16	2.5	21.0	23800	6.3	31.9	---
06C	11/25/2008	1622	1440		92	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	3.39	-66	2.6	<0.1	28700	6.8	634	---
06C	05/20/2009	1798	1616		268	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.66	-28	3.5	<0.8	20600	6.9	39.2	---
06C	11/19/2009	1981	1799		451	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	1.89	26	NM	<0.1	25600	6.2	42.8	---
09A	05/03/2004	-45				**150**	**230**	**970**	**37**	<0.50	<0.50	0.46	287	1.0	64.2	8.4	6.7	16.2	Clear, yellow tint
09A	08/23/2004	67				<3.0	**11**	**370**	**150**	**4.2**	<0.50	0.40	143	2.6	51.8	4.7	7.1	56.8	Clear with black tint, H2S odor
09A	10/19/2004	124	-58			<5.0	**19**	**460**	**220**	**2.7**	<0.50	0.53	219	4.0	77.4	17	6.9	19.6	Clear, slightly yellow tint
09A	02/21/2005	249	67			<10	<10	**41**	**37**	**1.9**	<0.50	0.78	169	2.0	<0.5	1500	7.1	2110	Hazy, yellow color
09A	05/11/2005	328	146			<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	1.53	141	2.0	<0.5	1700	7.2	1260	Hazy, yellow-brown tint
09A	08/22/2005	431	249			<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	1.58	141	2.8	<0.1	460	6.8	156	Clear, yellow-brown tint
09A	11/14/2005	515	333			<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	1.07	238	2.0	<0.1	2600	6.9	62.8	---
09A	02/21/2006	614	432			<1.0	<1.0	<1.0	<1.0	<11.4	<12.3	0.94	332	2.6	0.2	5650	6.3	58.8	---
09A	05/15/2006	697	515			<1.0	<1.0	<1.0	<1.0	<11	<12	1.35	193	2.2	63.4	15000	6.4	44.4	---
09A	08/16/2006	790	608			<1.0	<1.0	<1.0	**1.2**	<1.1	**2.1**	1.55	175	2.0	56.8	16800	6.4	50.0	---
09A	11/27/2006	893	711			<0.2	<0.2	**0.3**	**1.1**	**1.9**	**6.3**	2.09	211	3.2	52.5	15200	6.6	51.0	---
09A	02/22/2007	980	798			<1.0	<1.0	<1.0	<1.0	<1.1	**7.8**	0.65	-107	4.6	0.3	15300	6.4	48.8	---
09A	05/22/2007	1069	887			<1.0	<1.0	<1.0	**2.8**	<1.1	**4.8**	0.75	91	2.6	0.1	16700	6.6	43.1	---
09A	11/29/2007	1260	1078			<1.0	<1.0	<1.0	<1.0	<1.1	**24.5**	1.01	147	3.8	45.4	27600	6.4	40.6	---

SWMU-20 CLEANUP ACTION SUMMARY - SOURCE ZONE
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

		Elapsed Time from Injections (a) (days)				Volatile Organic Compounds						Aquifer Redox Conditions					Donor Parameters		
						Proposed Groundwater Cleanup Levels (d)													
						5.3	1.4	134	2.4	---	---								
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	DO (mg/L)	ORP (mV)	Iron II mg/L	Sulfate (mg/L)	Methane (µg/L)	pH	TOC (mg/L)	Notes
09A	05/19/2008	1432	1250		-98	<0.2	**0.2**	**110**	**85**	**7.8**	**35.6**	2.26	-82	3.0	29.4	17100	6.7	31.0	---
09A	11/24/2008	1621	1439		91	**1.9**	**4.6**	**160**	**42**	**4.0**	**2.1**	2.61	-52	3.0	<2.0	13700	6.2	5600	---
09A	05/18/2009	1796	1614		266	<10	<10	<10	<10	<1.1	<1.2	0.44	-88	2.5	<2.0	18100	7.1	1620	---
09A	11/16/2009	1978	1796		448	<5.0	<1.0	<5.0	<5.0	<1.1	<1.2	1.23	-61	2.6	<1.0	16600	6.6	403	---
09A	5/20/2010	2163	1981		633	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	11.09	515	2.2	<1.0	18700	7.0	72.8	Duffy: Interference w/DO sensor?
09A	11/10/2010	2337	2155		807	<1.0	<1.0	<1.0	<1.0	<1.1	**2.0**	3.92	118	2.2	0.3	24400	7.0	70.0	---
09A	5/3/2011	2511	2329		981	<2.0	<2.0	<2.0	<2.0	<1.1	**2.0**	2.55	33	2.0	<0.2	17800	6.9	44.4	---
09A	11/13/2011	2705	2523		1175	<0.2	<0.2	**0.2**	<0.2	<1.1	**1.2**	2.23	-66	1.2	0.4	11800	7.0	39.4	---
09A	5/14/2012	2888	2706		1358	<0.2	<0.2	**0.2**	<0.2	<1.0	**13**	0.57	91	1.5	0.40	22000	6.4	30.5	---
09A	11/14/2012	3072	2890		1542	<2.0	<2.0	<2.0	<2.0	<1.0	**11**	0.02	-4	2.0	0.53	21000	6.6	30.9	---
09A	5/21/2013	3260	3078		1730	<2.0	<2.0	<2.0	<2.0	<1.0	**16**	0.32	-399	1.8	<0.30	24000	7.8	33.0	---
09A	11/12/2013	3435	3253		1905	<2.0	<2.0	<2.0	<2.0	<1.0	**10**	3.87	-258	1.7	0.41	18000	6.5	30.2	---
09A	5/7/2014	3611	3429		2081	<2.0	<2.0	<2.0	<2.0	<1.0	**29**	4.46	-322	1.4	0.50	26000	6.7	21.5	---
09A	11/5/2014	3793	3611		2263	<0.2	<0.2	<0.2	<0.2	<1.0	**15**	0.12	-90	2.0	<0.30	25000	6.6	24.8	---
09A	4/29/2015	3968	3786		2438	<0.2	<0.2	<0.2	<0.2	<1.0	**28**	0.20	-63	1.4	0.58	27000	6.4	17.8	---
09B	05/03/2004	-45				<3.0	**4.2**	**250**	<3.0	<0.50	<0.50	0.37	269	4.0	61.4	2.7	6.8	20.7	Clear, yellow tint
09B	08/23/2004	67				<5.0	**16**	**530**	**100**	**0.76**	<0.50	0.34	174	1.4	73.0	23	7.4	29.7	Clear, yellow-brown tint, H2S odor
09B	10/19/2004	124	-58			<5.0	**17**	**300**	**340**	**1.4**	<0.50	0.30	219	1.0	59.6	29	7.5	24.3	Clear with yellow color
09B	02/21/2005	249	67			<10	<10	**890**	**520**	**1.7**	<0.50	0.56	160	2.8	1.0	2000	6.8	608	Hazy, tan brown color
09B	05/11/2005	328	146			<1.0	<1.0	**12**	**24**	<0.50	<0.50	1.48	158	3.5	0.4	9600	7.0	219	Hazy, yellow-brown tint
09B	08/22/2005	431	249			<1.0	<1.0	<1.0	**1.7**	<0.50	<0.50	1.45	224	2.5	<0.1	400	6.7	17.6	Clear, with yellow-brown tint
09B	11/14/2005	515	333			<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	1.24	235	1.4	<0.1	3100	6.8	51.2	---
09B	02/21/2006	614	432			<1.0	<1.0	<1.0	**1.3**	<11.4	<12.3	0.90	329	2.8	<0.1	8730	6.3	46.4	---
09B	05/15/2006	697	515			<1.0	<1.0	<1.0	<1.0	<11	<12	1.11	191	1.8	33.9	17000	6.3	45.6	---
09B	08/16/2006	790	608			<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.94	188	1.6	55.4	19300	6.3	250	---
09B	11/27/2006	893	711			<0.2	<0.2	**0.3**	**0.5**	<1.1	<1.2	1.76	190	2.8	50.2	21800	6.5	78.2	---
09B	02/22/2007	980	798			<1.0	<1.0	<1.0	<1.0	<1.1	**1.6**	0.67	-80	3.5	0.2	16100	6.3	64.0	---
09B	05/22/2007	1069	887			<1.0	<1.0	<1.0	<1.0	<1.1	**1.4**	0.76	154	3.0	<0.1	18700	6.5	35.3	---
09B	11/29/2007	1260	1078			<1.0	<1.0	<1.0	<1.0	<1.1	**3.8**	1.29	238	2.2	58.3	29800	6.2	44.5	---
09B	05/19/2008	1432	1250		-98	<0.2	<0.2	**0.2**	**0.4**	<1.1	**3.0**	2.34	-78	3.4	39.1	12900	6.4	37.3	---
09B	11/24/2008	1621	1439		91	<1.0	<1.0	<1.0	<1.0	<1.1	**17.6**	2.22	-47	3.0	<1.0	27000	6.7	27.0	---
09B	05/18/2009	1796	1614		266	<1.0	<1.0	<1.0	<1.0	<1.1	**6.9**	0.38	-38	3.5	<0.5	19700	6.9	37.1	---
09B	11/16/2009	1978	1796		448	<1.0	<1.0	<1.0	<1.0	<1.1	**16.1**	1.27	12	3.5	<0.1	24500	6.2	28.1	---
09C	05/03/2004	-45				<1.0	<1.0	**4.0**	**3.3**	**1.9**	**0.7**	0.33	229	4.0	19.1	350	6.8	28.5	Clear, yellow tint
09C	08/23/2004	67				<1.0	<1.0	**1.7**	<1.0	**1.1**	**2.8**	0.47	114	2.6	23.2	610	6.7	302	Clear, H2S odor
09C	10/19/2004	124	-58			<1.0	<1.0	<1.0	**1.5**	**1.1**	<0.50	0.60	185	3.0	12.2	620	7.0	99.6	Near clear, yellow tint
09C	02/21/2005	249	67			<1.0	<1.0	**1.7**	<1.0	<0.50	**1.6**	0.60	154	2.0	<0.1	3500	6.6	300	Clear with yellow tint
09C	05/11/2005	328	146			<1.0	<1.0	**1.2**	<1.0	<0.50	<0.50	1.34	138	2.5	<0.1	2700	6.4	44.6	Yellow-brown tint
09C	08/22/2005	431	249			<1.0	<1.0	**7.6**	**2.2**	<0.50	<0.50	1.31	230	2.5	<0.1	360	6.7	52.0	---
09C	11/14/2005	515	333			<1.0	<1.0	**1.2**	<1.0	<0.50	<0.50	1.41	228	2.4	<0.1	7300	6.9	50.6	---
09C	02/21/2006	614	432			<1.0	<1.0	<1.0	<1.0	<11.4	<12.3	0.78	326	2.4	<0.1	10300	6.5	44.2	---
09C	05/15/2006	697	515			<1.0	<1.0	<1.0	<1.0	<11	<12	1.01	192	2.0	27.9	21000	7.0	42.1	---
09C	08/16/2006	790	608			<1.0	<1.0	<1.0	<1.0	<1.1	**1.6**	0.80	199	1.2	28.8	22900	6.5	33.0	---
09C	11/27/2006	893	711			<0.2	<0.2	<0.2	<0.2	<1.1	**9.1**	1.40	289	2.4	26.7	23500	6.5	44.0	---
09C	02/22/2007	980	798			<1.0	<1.0	<1.0	<1.0	<1.1	**3.9**	0.75	-32	3.6	0.2	17700	6.5	33.8	---

SWMU-20 CLEANUP ACTION SUMMARY - SOURCE ZONE
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

		Elapsed Time from Injections (a) (days)				Volatile Organic Compounds						Aquifer Redox Conditions					Donor Parameters		
						Proposed Groundwater Cleanup Levels (d)													
						5.3	1.4	134	2.4	---	---								
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	DO (mg/L)	ORP (mV)	Iron II mg/L	Sulfate (mg/L)	Methane (µg/L)	pH	TOC (mg/L)	Notes
09C	05/22/2007	1069	887			<1.0	<1.0	<1.0	<1.0	<1.1	**5.4**	0.52	123	3.5	<0.1	20600	6.6	25.4	---
09C	11/29/2007	1260	1078			<1.0	<1.0	<1.0	<1.0	<1.1	**5.4**	0.81	147	3.6	27.3	30000	6.5	27.1	---
09C	05/19/2008	1432	1250		-98	<0.2	<0.2	<0.2	**0.2**	<1.1	**15.2**	2.11	-57	4.6	18.6	22800	6.5	22.3	---
09C	11/24/2008	1621	1439		91	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	2.92	-44	1.8	<2.0	17700	6.6	334	---
09C	05/18/2009	1796	1614		266	<1.0	<1.0	<1.0	<1.0	<1.1	**4.3**	0.45	-44	3.5	<0.5	21400	7.0	24.0	---
09C	11/16/2009	1978	1796		448	<3.0	<3.0	<3.0	<3.0	<1.1	**1.9**	1.27	-7	3.0	<0.1	22400	6.4	20.7	---
10A	05/03/2004	-45				**29**	**27**	**80**	**6.4**	<0.50	<0.50	0.60	108	2.0	37.8	2.8	6.8	20.0	Clear, yellow tint
10A	08/23/2004	67				**14**	**12**	**170**	**4.0**	<0.50	<0.50	0.49	181	3.5	38.9	1.1	7.0	59.6	Clear, black tint
10A	10/19/2004	124	-58			**15**	**15**	**100**	**23**	<0.50	<0.50	0.66	224	4.0	37.8	2.7	7.0	24.0	Clear
10A	02/21/2005	249	67			**4.7**	**4.8**	**24**	**6.8**	<0.50	**0.54**	0.53	166	3.6	24.3	430	7.0	22.4	Clear, yellow color
10A	05/11/2005	328	146			**4.2**	**5.4**	**26**	**7.2**	<0.50	<0.50	0.95	47	3.0	27.9	540	7.2	25.9	Clear, yellow-brown tint
10A	08/22/2005	431	249			**2.7**	**6.3**	**48**	**76**	<0.50	<0.50	0.73	177	2.0	48.8	240	7.0	31.4	Clear, with yellow-brown tint
10A	11/14/2005	515	333			**3.3**	**6.7**	**47**	**73**	<0.50	<0.50	0.91	178	2.0	50.6	370	7.1	34.1	---
10A	02/21/2006	614	432			**3.7**	**9.6**	**42**	**150**	<11.4	<12.3	0.54	320	2.0	53.9	1130	6.8	45.8	---
10A	05/15/2006	697	515			**1.8**	**3.7**	**63**	**19**	<11	<12	0.67	190	1.8	57.4	3100	6.8	49.2	---
10A	08/16/2006	790	608			**1.6**	**1.6**	**38**	**20**	<1.1	<1.2	1.50	201	1.4	57.5	1620	6.7	50.8	---
10A	11/27/2006	893	711			<0.2	<0.2	**7.4**	**9.2**	**2.6**	**2.6**	2.67	201	3.0	57.9	1650	6.9	56.0	---
10A	02/22/2007	980	798			**1.2**	<1.0	**32**	**35**	<1.1	<1.2	0.57	-176	4.6	20.4	1370	6.8	56.4	---
10A	05/22/2007	1069	887			**1.1**	<1.0	**28**	**44**	<1.1	**1.4**	0.88	73	3.0	10.2	2590	6.9	47.3	---
10A	11/29/2007	1260	1078			**1.2**	<1.0	**22**	**78**	**4.4**	**3.7**	0.80	106	4.2	47.9	4810	6.9	47.8	---
10A	05/19/2008	1432	1250		-98	<1.0	<1.0	**22**	**180**	**7.9**	**4.4**	2.19	-177	4.0	32.5	4870	7.0	33.3	---
10A	11/24/2008	1621	1439		91	<1.0	<1.0	**1.6**	**5.0**	<1.1	<1.2	2.29	-87	3.4	1.3	16900	7.1	1200	---
10A	05/18/2009	1796	1614		266	<2.0	<2.0	<2.0	<2.0	<1.1	<1.2	0.66	-80	3.3	<1.0	17900	6.9	168	---
10A	11/16/2009	1978	1796		448	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	3.14	-40	4.2	<1.0	18200	6.3	69.2	---
10A	5/20/2010	2163	1981		633	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	16.23	341	3.0	<1.0	17600	6.8	60.4	Duffy: Replace DO electrolic membrane
10A	11/10/2010	2337	2155		807	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	4.09	67	2.4	0.5	22800	6.9	56.8	---
10A	5/3/2011	2511	2329		981	<2.0	<2.0	<2.0	<2.0	<1.1	<1.2	2.47	-21	2.5	<0.2	20700	6.9	41.6	---
10A	11/13/2011	2705	2523		1175	<0.2	<0.2	**0.2**	**0.4**	<1.1	<1.2	2.45	-38	2.0	0.3	15400	7.1	33.8	---
10A	5/14/2012	2888	2706		1358	<0.2	<0.2	**0.2**	**0.4**	<1.0	<1.0	0.57	88	2.5	0.32	20000	6.4	38.0	---
10A	11/14/2012	3072	2890		1542	<0.2	<0.2	**0.3**	**0.4**	<1.0	<1.0	0.03	-16	2.0	<0.30	19000	6.6	30.6	---
10A	5/21/2013	3260	3078		1730	<0.2	<0.2	**0.2**	**0.3**	<1.0	<3.0	0.35	-340	1.8	<0.30	26000	7.5	29.5	---
10A	11/12/2013	3435	3253		1905	<0.2	<0.2	**0.2**	**0.4**	<1.0	**2.5**	3.53	-242	1.4	0.38	16000	6.5	29.1	---
10A	5/7/2014	3611	3429		2081	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	4.06	-305	2.1	<0.30	26000	6.7	27.9	---
10A	11/5/2014	3793	3611		2263	<0.2	<0.2	**0.2**	**0.3**	<1.0	**5.5**	0.17	-134	2.0	<0.30	25000	6.5	26.1	---
14A	05/04/2004	-44				<1.0	<1.0	**140**	**110**	<0.50	<0.50	0.53	-8	7.5	38.9	590	6.8	20.7	Clear, yellow tint
14A	08/23/2004	67				<1.0	**2.9**	**560**	**180**	**0.89**	**0.67**	0.54	162	3.2	30.1	810	6.8	22.6	---
14A	10/19/2004	124	-58			<5.0	**39**	**1200**	**650**	<0.50	<0.50	0.64	69	3.0	43.3	350	6.9	20.6	---
14A	02/21/2005	249	67	-24		<5.0	<5.0	**300**	**1000**	**13**	**2.7**	0.41	101	1.8	3.8	1700	6.9	44.0	Clear, yellow tint
14A	05/16/2005	333	151	60		<10	<10	<10	<10	<0.50	<0.50	5.90	45	4.0	<2.0	590	6.4	8620	---
14A	08/22/2005	431	249	158		<10	<10	<10	<10	<0.50	<0.50	1.62	234	3.0	<2.0	220	6.8	5380	Clear, yellow-brown
14A	11/15/2005	516	334	243		<3.0	<3.0	**6.0**	<3.0	<0.50	<0.50	1.26	257	2.0	<0.1	2500	6.4	602	---
14A	02/21/2006	614	432	341		<1.0	<1.0	<1.0	<1.0	<11.4	<12.3	1.36	335	2.0	<0.1	5400	7.4	180	---
14A	05/17/2006	699	517	426		<2.0	<2.0	**2.1**	<2.0	<11	<12	1.78	76	2.8	12.0	9400	6.4	67.1	---
14A	08/16/2006	790	608	517		<1.0	<1.0	**3.0**	<1.0	<1.1	<1.2	1.16	240	1.2	16.5	6320	6.5	66.0	---
14A	11/29/2006	895	713	622		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	1.57	248	2.8	11.8	11100	6.3	72.0	---

SWMU-20 CLEANUP ACTION SUMMARY - SOURCE ZONE
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

		Elapsed Time from Injections (a) (days)				Volatile Organic Compounds						Aquifer Redox Conditions					Donor Parameters		
						Proposed Groundwater Cleanup Levels (d)													
						5.3	1.4	134	2.4	---	---								
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	DO (mg/L)	ORP (mV)	Iron II mg/L	Sulfate (mg/L)	Methane (µg/L)	pH	TOC (mg/L)	Notes
14A	02/22/2007	980	798	707		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.89	-56	7.0	0.2	7670	6.2	34.9	---
14A	05/23/2007	1070	888	797		<1.0	<1.0	**1.5**	<1.0	<1.1	<1.2	1.11	165	3.0	8.6	10100	6.3	27.5	---
14A	12/03/2007	1264	1082	991		<1.0	<1.0	**1.6**	<1.0	<1.1	<1.2	2.29	-86	3.2	15.9	14500	6.4	55.6	---
14A	05/20/2008	1433	1251	1160	-97	<1.0	<1.0	**1.2**	<1.0	<1.1	<1.2	3.45	-88	3.6	<0.1	12100	6.3	26.3	---
14A	11/24/2008	1621	1439	1348	91	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	2.79	-70	3.0	194	14500	6.1	8.68	---
14A	05/20/2009	1798	1616	1525	268	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.41	-95	3.5	20.0	14400	6.3	9.83	---
14A	11/17/2009	1979	1797	1706	449	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.81	-18	3.2	165	15800	5.7	6.22	---
14A	5/24/2010	2167	1985	1894	637	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	4.29	311	2.8	5.1	14600	6.4	8.07	---
14A	11/10/2010	2337	2155	2064	807	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	2.47	171	2.6	38.6	14300	6.8	6.88	---
14A	5/5/2011	2513	2331	2240	983	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	2.96	83	1.8	8.4	15100	7.1	3.28	---
14A	11/13/2011	2705	2523	2432	1175	<0.2	<0.2	**0.6**	<0.2	<1.1	<1.2	2.04	-52	1.5	<0.1	7510	6.9	8.05	---
14A	5/14/2012	2888	2706	2615	1358	<0.2	<0.2	**0.3**	**0.2**	<1.0	**8.7**	0.13	62	2.6	3.4	16000	6.4	5.9	---
14A	11/14/2012	3072	2890	2799	1542	<0.2	<0.2	**0.6**	<0.2	<1.0	**5.0**	0.03	31	1.5	79.0	16000	6.4	6.5	---
14A	5/21/2013	3260	3078	2987	1730	<0.5	<0.5	<0.5	<0.5	<1.0	**4.8**	0.24	-428	2.4	2.3	18000	7.4	6.5	---
14A	11/12/2013	3435	3253	3162	1905	<0.2	<0.2	**0.5**	<0.2	<1.0	**6.3**	4.46	-286	1.3	0.52	14000	6.4	8.0	---
14A	5/7/2014	3611	3429	3338	2081	<0.2	<0.2	**0.3**	**0.3**	<1.0	**4.6**	4.39	-427	1.6	19.9	15000	6.8	6.5	---
14A	11/5/2014	3793	3611	3520	2263	<0.2	<0.2	**0.4**	**0.2**	<1.0	**10**	0.04	-48	2.0	23.6	15000	6.5	6.8	---
15A	05/03/2004	-45				<5.0	<5.0	<5.0	<5.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	
15A	10/26/2004	131	-51			<5.0	<5.0	<5.0	<5.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	
15A	05/16/2005	333	151			<5.0	<5.0	<5.0	<5.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	
15A	11/15/2005	516	334			<5.0	<5.0	<5.0	<5.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	
15A	05/17/2006	699	517			<5.0	<5.0	<5.0	<5.0	NA	NA	0.79	131	NA	NA	NA	6.7	NA	---
15A	11/29/2006	895	713			<3.0	<3.0	<3.0	<3.0	NA	NA	1.26	513	NA	NA	NA	6.6	NA	---
15A	05/23/2007	1070	888			<1.0	<1.0	**1.4**	**2.6**	NA	NA	1.19	144	NA	NA	NA	6.7	NA	---
15A	12/03/2007	1264	1082			<1.0	<1.0	<1.0	**1.3**	NA	NA	1.31	-105	NA	NA	NA	6.6	NA	---
15A	05/20/2008	1433	1251		-97	<3.0	<3.0	<3.0	<3.0	NA	NA	2.57	-135	NA	NA	NA	6.7	NA	---
15A	11/24/2008	1621	1439		91	<1.0	<1.0	<1.0	<2.0	NA	NA	2.07	-61	NA	NA	NA	6.8	NA	---
15A	05/19/2009	1797	1615		267	<3.0	<3.0	<3.0	<3.0	NA	NA	0.35	-33	NA	NA	NA	6.9	NA	---
15A	11/18/2009	1980	1798		450	<1.0	<1.0	<1.0	**1.4**	NA	NA	0.72	-0.1	NA	NA	NA	6.3	NA	---
15A	5/20/2010	2163	1981		633	<1.0	<1.0	<1.0	**1.6**	NA	NA	1.10	606	NA	NA	NA	6.8	NA	---
15A	11/10/2010	2337	2155		807	<1.0	<1.0	<1.0	**1.4**	NA	NA	2.42	118	NA	NA	NA	7.1	NA	---
15A	5/5/2011	2513	2331		983	<10	<10	<10	<10	NA	NA	4.83	-19	NA	NA	NA	7.2	NA	---
15A	11/13/2011	2705	2523		1175	<0.2	<0.2	**0.3**	**1.0**	NA	NA	4.01	-41	NA	NA	NA	7.3	NA	---
15A	5/14/2012	2888	2706		1358	<1.0	<1.0	<1.0	**1.2**	NA	NA	0.64	56	NA	NA	NA	6.7	NA	---
15A	11/13/2012	3071	2889		1541	<0.2	<0.2	**0.4**	**0.8**	NA	NA	0.03	23	NA	NA	NA	6.8	NA	---
15A	5/21/2013	3260	3078		1730	<0.5	<0.5	**0.6**	**1.1**	NA	NA	0.20	-394	NA	NA	NA	7.4	NA	---
15A	11/12/2013	3435	3253		1905	<0.2	<0.2	**0.5**	**0.8**	NA	NA	3.38	-267	NA	NA	NA	6.7	NA	---
15A	5/7/2014	3611	3429		2081	<0.2	<0.2	**0.6**	**1.0**	NA	NA	3.86	-351	NA	NA	NA	6.9	NA	---
15A	11/5/2014	3793	3611		2263	<0.2	<0.2	**0.4**	**0.5**	NA	NA	0.09	-126	NA	NA	NA	6.8	NA	---
19A	05/02/2004	-46	-228			<1.0	<1.0	<1.0	<1.0	NA	NA	0.33	-3	NA	NA	NA	6.5	NA	---
19A	02/21/2005	249	67			<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	0.65	180	NA	47.4	17	6.7	15.5	---
19A	05/12/2005	329	147			<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	0.63	169	3.0	31.3	9.1	6.8	14.2	Clear, colorless
19A	08/22/2005	431	249			<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	0.74	106	3.0	68.3	16	6.6	10.5	Clear, colorless
19A	11/15/2005	516	334			<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	0.56	201	2.6	95.9	35	6.8	9.30	---
19A	02/22/2006	615	433			<1.0	<1.0	<1.0	<1.0	<11.4	<12.3	0.77	65	3.0	124.0	111	6.6	31.3	---
19A	05/17/2006	699	517			<1.0	<1.0	<1.0	<1.0	<11	<12	1.14	56	2.0	73.4	230	6.4	15.7	---

SWMU-20 CLEANUP ACTION SUMMARY - SOURCE ZONE
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

Well	Date	Elapsed Time from Injections (a) (days)				Volatile Organic Compounds						Aquifer Redox Conditions					Donor Parameters		Notes
						Proposed Groundwater Cleanup Levels (d)													
						5.3	1.4	134	2.4	---	---								
		1st Injection	2nd Injection	3rd (b) Injection	4th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	DO (mg/L)	ORP (mV)	Iron II mg/L	Sulfate (mg/L)	Methane (µg/L)	pH	TOC (mg/L)	
19A	08/15/2006	789	607			<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.60	229	2.0	47.3	202	6.4	11.5	---
19A	11/27/2006	893	711			<0.2	**0.2**	**0.3**	<0.2	<1.1	<1.2	0.88	264	2.0	41.9	186	6.4	13.6	---
19A	02/22/2007	980	798			<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.42	-23	3.0	20.7	248	6.2	19.8	---
19A	05/22/2007	1069	887			<1.0	<1.0	<1.0	<1.0	<1.1	**5.2**	0.34	277	3.5	30.8	179	6.4	15.4	---
19A	11/29/2007	1260	1078			<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.67	243	2.2	37.2	235	6.2	14.3	---
19A	05/20/2008	1433	1251		-97	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	3.23	-79	3.8	20.9	134	6.4	11.5	---
19A	11/23/2008	1620	1438		90	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	1.62	-61	2.0	46.1	97.8	6.4	10.6	---
19A	05/19/2009	1797	1615		267	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.30	-28	3.2	28.6	127	6.8	12.8	---
19A	11/18/2009	1980	1798		450	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	1.58	-2	3.4	22.1	122	6.5	10.7	---
22A	03/21/2005	277	95	4		<1.0	<1.0	**3.5**	**2.0**	<0.50	<0.50	1.86	53	2.8	12.8	280	7.0	11.1	Hazy, suspended silt
22A	05/12/2005	329	147	56		<1.0	<1.0	**2.3**	**2.9**	<0.50	<0.50	0.83	155	2.6	1.3	300	7.1	31.3	---
22A	08/22/2005	431	249	158		<1.0	<1.0	**2.3**	**3.2**	<0.50	<0.50	0.70	170	2.6	3.0	230	6.9	26.5	Clear, slight yellow-brown tint
22A	11/16/2005	517	335	244		<1.0	<1.0	**1.4**	**2.2**	<0.50	<0.50	1.67	321	2.4	1.3	1300	6.3	29.9	---
22A	02/22/2006	615	433	342		<1.0	<1.0	**1.4**	**3.3**	<11.4	<12.3	0.69	97	2.0	59.0	1940	6.8	32.0	---
22A	05/17/2006	699	517	426		<1.0	<1.0	**2.4**	**1.7**	<11	<12	0.67	102	2.6	32.7	3600	6.8	17.6	---
22A	08/15/2006	789	607	516		<1.0	<1.0	**1.8**	**2.4**	<1.1	<1.2	0.65	239	2.0	54.7	5700	6.7	24.0	---
22A	11/30/2006	896	714	623		<0.2	**0.3**	**2.2**	**2.4**	<1.1	<1.2	2.15	286	2.6	40.0	4020	6.6	25.2	---
22A	02/22/2007	980	798	707		<1.0	<1.0	**2.5**	**2.3**	<1.1	<1.2	0.53	-76	5.0	<0.1	3000	6.6	22.4	---
22A	05/23/2007	1070	888	797		<1.0	<1.0	**2.5**	**2.7**	<1.1	<1.2	0.30	51	3.0	27.3	3510	6.8	18.2	---
22A	12/03/2007	1264	1082	991		<1.0	<1.0	**2.0**	**1.3**	<1.1	<1.2	0.61	41	2.6	12.3	2030	6.6	16.0	---
22A	05/20/2008	1433	1251	1160	-97	<1.0	<1.0	**2.6**	**1.9**	<1.1	<1.2	2.83	-103	4.0	20.2	1540	6.7	13.8	---
22A	11/23/2008	1620	1438	1347	90	<1.0	<1.0	**2.2**	**3.1**	<1.1	<1.2	1.13	-70	1.8	2.6	3100	6.8	19.2	---
22A	05/19/2009	1797	1615	1524	267	<1.0	<1.0	**2.5**	**2.5**	<1.1	<1.2	0.26	-43	3.2	3.4	3490	7.0	21.0	---
22A	11/18/2009	1980	1798	1707	450	<1.0	<1.0	**2.1**	**1.8**	<1.1	<1.2	0.43	-3.3	3.0	2.1	2060	6.4	13.8	---
22A	5/24/2010	2167	1985	1894	637	<1.0	<1.0	**1.7**	**1.7**	<1.1	<1.2	6.58	204	2.4	0.6	2370	7.0	15.1	---
22A	11/11/2010	2338	2156	2065	808	<1.0	<1.0	**1.2**	**2.7**	<1.1	<1.2	3.27	113	2.2	0.5	4650	7.0	21.8	---
22A	5/4/2011	2512	2330	2239	982	<1.0	<1.0	**1.1**	**2.2**	<1.1	<1.2	1.96	4	2.0	0.6	6350	7.0	22.4	---
22A	11/13/2011	2705	2523	2432	1175	<0.2	<0.2	**0.9**	**1.7**	<1.1	<1.2	2.89	-38	1.2	0.4	2510	7.3	17.6	---
22A	5/14/2012	2888	2706	2615	1358	<0.2	<0.2	**0.6**	**2.0**	<1.0	**3.3**	0.03	45	2.2	<0.30	5100	6.8	25.4	---
22A	11/14/2012	3072	2890	2799	1542	<0.2	<0.2	**0.5**	**1.8**	<1.0	**1.7**	0.03	1	1.8	<0.30	4400	6.9	22.7	---
22A	5/20/2013	3259	3077	2986	1729	<0.2	<0.2	**0.4**	**2.0**	<1.0	**1.6**	0.24	-404	1.0	<0.30	6100	7.7	24.6	---
22A	11/12/2013	3435	3253	3162	1905	<0.2	<0.2	**0.5**	**1.7**	<1.0	**1.1**	3.69	-289	1.4	1.8	3500	6.7	19.8	---
22A	5/7/2014	3611	3429	3338	2081	<0.2	<0.2	**0.5**	**1.6**	<1.0	<1.0	4.8	-368	1.3	0.66	4200	6.8	23.6	---
22A	11/5/2014	3793	3611	3520	2263	<0.2	<0.2	**0.4**	**1.5**	<1.0	**1.5**	0.13	-131	1.5	0.39	4800	6.8	25.8	---
22A	4/29/2015	3968	3786	3695	2438	<0.2	<0.2	**0.6**	**1.5**	<1.0	<1.0	0.09	-87	1.0	2.0	4300	6.5	14.8	---
23A	03/21/2005	277	95	4		<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	0.63	81	2.0	0.4	410	7.0	33.0	Slight yellow tint
23A	05/12/2005	329	147	56		<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	0.58	158	2.0	<0.1	260	7.2	39.9	---
23A	08/22/2005	431	249	158		<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	0.75	130	3.4	1.5	98	7.0	21.0	---
23A	11/16/2005	517	335	244		<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	0.49	291	2.6	4.1	140	7.2	30.8	---
23A	02/22/2006	615	433	342		<1.0	<1.0	<1.0	<1.0	<11.4	<12.3	0.60	127	2.2	91.8	1520	6.4	34.5	---
23A	05/17/2006	699	517	426		<1.0	<1.0	<1.0	<1.0	<11	<12	0.60	120	3.0	38.8	1700	6.7	30.0	---
23A	08/15/2006	789	607	516		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.77	256	2.2	63.9	3080	6.7	32.6	---
23A	11/30/2006	896	714	623		<0.2	<0.2	<0.2	<0.2	<1.1	<1.2	1.96	287	2.5	40.7	1930	6.2	45.2	---
23A	02/22/2007	980	798	707		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.40	-58	2.0	2.9	1360	6.5	34.6	---
23A	05/23/2007	1070	888	797		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.41	193	3.3	52.7	1850	6.4	38.7	---
23A	11/30/2007	1261	1079	988		<0.2	<0.2	**0.3**	<0.2	<1.1	<1.2	0.55	159	2.2	81.1	4430	6.6	38.6	---

SWMU-20 CLEANUP ACTION SUMMARY - SOURCE ZONE
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

		Elapsed Time from Injections (a) (days)				Volatile Organic Compounds						Aquifer Redox Conditions					Donor Parameters		
						Proposed Groundwater Cleanup Levels (d)													
						5.3	1.4	134	2.4	---	---								
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	DO (mg/L)	ORP (mV)	Iron II mg/L	Sulfate (mg/L)	Methane (µg/L)	pH	TOC (mg/L)	Notes
23A	05/21/2008	1434	1252	1161	-96	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	3.12	-28	2.2	31.7	1570	6.1	29.6	---
23A	11/25/2008	1622	1440	1349	92	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	4.22	-68	1.8	<0.1	3270	6.8	39.0	---
23A	05/19/2009	1797	1615	1524	267	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.31	-3	3.2	0.1	2370	6.5	39.1	---
23A	11/18/2009	1980	1798	1707	450	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.41	1	2.4	1.6	1970	6.5	30.9	---

PCE = Tetrachloroethene
TCE = Trichloroethene
cDCE = cis-1,2-Dichloroethene
VC = Vinyl Chloride
DO = Dissolved Oxygen
ORP = Oxidation Reduction Potential
TOC = Total Organic Carbon

Bold = Detect
µg/L = micrograms pr liter
mg/L = milligrams per liter
mV = millivolts
NA = Not analyzed
Box = Exceedance of proposed CUL

(a) Injections occurred on:
- 6/17/04 (6A, B, C; 9A, B, C) — 6/17/2004 for elapsed time relative to injection
- 12/16-17/04 (6A, 6B;9A,9B) — 12/16/2004 for elapsed time relative to injection
- 3/17/05 (14A) — 3/17/2005 for elapsed time relative to injection
- 8/25-28/08 (6A, 9A, 10A) — 8/25/2008 for elapsed time relative to injection

(b) Conducted at Well MW-14A only.
(c) MW-06A installed June 2004.
(d) Proposed Cleanup Standards and Comparison to Site Data, Boeing Developmental Center, Tukwila,Washington (Landau Associates, 5/7/13).

SWMU-20 CLEANUP ACTION SUMMARY - NON SOURCE ZONE
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

						Volatile Organic Compounds			
						Proposed Groundwater Cleanup Levels (c)			
		Elapsed Time from Injections (a) (days)				**5.3**	**1.4**	**134**	**2.4**
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)
MW-8C	5/3/2004	-45				<1.0	<1.0	<1.0	**2.8**
MW-8C	10/25/2004	130	-52			<1.0	<1.0	<1.0	**3.5**
MW-8C	5/12/2005	329	147			<1.0	<1.0	<1.0	<1.0
MW-8C	11/14/2005	515	333			<1.0	<1.0	<1.0	<1.0
MW-8C	5/15/2006	697	515			<10	<10	<10	<10
MW-8C	11/27/2006	893	711			<5.0	<5.0	<5.0	<5.0
MW-8C	5/21/2007	1068	886			<3.0	<3.0	<3.0	<3.0
MW-8C	11/29/2007	1260	1078			<5.0	<5.0	<5.0	<5.0
MW-8C	5/19/2008	1432	1250		-98	<5.0	<5.0	<5.0	<5.0
MW-8C	11/23/2008	1620	1438		90	<5.0	<5.0	<5.0	<5.0
MW-8C	05/18/2009	1796	1614		266	<1.0	<1.0	<1.0	<1.0
MW-8C	11/16/2009	1978	1796		448	<3.0	<3.0	<3.0	<3.0
MW-9D	5/3/2004	-45				<1.0	<1.0	<1.0	<1.0
MW-9D	10/19/2004	124	-58			<1.0	<1.0	<1.0	<1.0
MW-9D	5/11/2005	328	146			<1.0	<1.0	<1.0	<1.0
MW-9D	11/14/2005	515	333			<1.0	<1.0	<1.0	<1.0
MW-9D	5/15/2006	697	515			<1.0	<1.0	<1.0	<1.0
MW-9D	11/27/2006	893	711			<1.0	<1.0	<1.0	<1.0
MW-9D	5/22/2007	1069	887			<1.0	<1.0	<1.0	<1.0
MW-9D	11/29/2007	1260	1078			<1.0	<1.0	<1.0	<1.0
MW-9D	5/19/2008	1432	1250		-98	<0.2	<0.2	<0.2	<0.2
MW-9D	11/24/2008	1621	1439		91	<1.0	<1.0	<1.0	<1.0
MW-9D	05/18/2009	1796	1614		266	<1.0	<1.0	<1.0	<1.0
MW-9D	11/16/2009	1978	1796		448	<1.0	<1.0	<1.0	<1.0
MW-10C	5/3/2004	-45				<1.0	<1.0	**4.3**	**4.0**
MW-10C	10/19/2004	124	-58			<1.0	<1.0	**6.4**	**11**
MW-10C	5/11/2005	328	146			<1.0	<1.0	**4.0**	**1.9**
MW-10C	11/14/2005	515	333			<1.0	<1.0	<1.0	**1.0**
MW-10C	5/15/2006	697	515			<1.0	<1.0	**1.5**	**2.2**
MW-10C	11/27/2006	893	711			<0.2	<0.2	**1.9**	**2.6**
MW-10C	5/22/2007	1069	887			<1.0	<1.0	**6.7**	**5.8**
MW-10C	11/29/2007	1260	1078			<1.0	<1.0	**7.2**	**5.6**
MW-10C	5/19/2008	1432	1250		-98	<0.2	<0.2	**15**	**6.9**
MW-10C	11/24/2008	1621	1439		91	<1.0	<1.0	**8.5**	**7.5**
MW-10C	05/18/2009	1796	1614		266	<1.0	<1.0	<1.0	<1.0
MW-10C	11/16/2009	1978	1796		448	<1.0	<1.0	<1.0	<1.0
MW-10C	5/20/2010	2163	1981		633	<1.0	<1.0	<1.0	<1.0
MW-10C	11/10/2010	2337	2155		807	<1.0	<1.0	**3.5**	**4.4**
MW-10C	5/3/2011	2511	2329		981	<1.0	<1.0	**5.8**	**4.7**
MW-10C	11/13/2011	2705	2523		1175	<0.2	<0.2	**3.7**	**4.3**
MW-10C	5/14/2012	2888	2706		1358	<0.2	<0.2	**5.4**	**4.0**
MW-10C	11/14/2012	3072	2890		1542	<0.2	<0.2	**6.1**	**4.4**
MW-10C	5/21/2013	3260	3078		1730	<0.2	<0.2	**6.0**	**4.5**
MW-10C	11/12/2013	3435	3253		1905	<0.2	<0.2	**3.5**	**3.7**
MW-10C	5/7/2014	3611	3429		2081	<0.2	<0.2	**5.4**	**2.9**
MW-10C	11/5/2014	3793	3611		2263	<0.2	<0.2	**2.6**	**2.5**
MW-10C	4/28/2015	3967	3785		2437	<0.2	<0.2	**2.2**	**1.7**

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DEVELOPMENTAL CENTER GROUNDWATER MONITORING

		Elapsed Time from Injections (a) (days)				Volatile Organic Compounds			
						Proposed Groundwater Cleanup Levels (c)			
						5.3	1.4	134	2.4
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)
MW-11A	5/2/2004	-46				<1.0	**2.1**	**21**	<1.0
MW-11A	10/25/2004	130	-52			<1.0	**2.0**	**20**	<1.0
MW-11A	5/12/2005	329	147			<1.0	**2.0**	**20**	<1.0
MW-11A	11/15/2005	516	334			<1.0	**2.0**	**22**	<1.0
MW-11A	5/16/2006	698	516			<1.0	**1.1**	**20**	<1.0
MW-11A	11/26/2006	892	710			<1.0	**1.5**	**24**	<1.0
MW-11A	5/22/2007	1069	887			<1.0	**1.5**	**26**	<1.0
MW-11A	11/27/2007	1258	1076			<1.0	**1.1**	**27**	<1.0
MW-11A	5/19/2008	1432	1250		-98	<0.2	**1.2**	**26**	**0.2**
MW-11A	11/23/2008	1620	1438		90	<1.0	**1.2**	**33**	<1.0
MW-11A	05/18/2009	1796	1614		266	<1.0	<1.0	**26**	<1.0
MW-11A	11/17/2009	1979	1797		449	<1.0	**1.0**	**30**	<1.0
MW-11A	5/19/2010	2162	1980		632	<1.0	**1.1**	**26**	<1.0
MW-11A	11/8/2010	2335	2153		805	<1.0	<1.0	**22**	<1.0
MW-11A	5/3/2011	2511	2329		981	<1.0	<1.0	**22**	<1.0
MW-11A	11/13/2011	2705	2523		1175	<0.2	**0.5**	**23**	**0.4**
MW-11A	5/14/2012	2888	2706		1358	<0.2	**0.7**	**24**	**0.4**
MW-11A	11/14/2012	3072	2890		1542	<2.0	<2.0	**25**	<2.0
MW-11A	5/21/2013	3260	3078		1730	<2.0	<2.0	**22**	<2.0
MW-11A	11/12/2013	3435	3253		1905	<2.0	<2.0	**24**	<2.0
MW-11A	5/7/2014	3611	3429		2081	<2.0	<2.0	**19**	<2.0
MW-11A	11/4/2014	3792	3610		2262	<0.2	**0.4**	**24**	**0.4**
MW-11A	4/28/2015	3967	3785		2437	<0.2	**0.5**	**21**	**0.3**
MW-12A	5/2/2004	-46				<1.0	<1.0	**1.8**	<1.0
MW-12A	10/25/2004	130	-52			<1.0	<1.0	**4.4**	<1.0
MW-12A	5/12/2005	329	147			<1.0	<1.0	**2.0**	<1.0
MW-12A	11/15/2005	516	334			<1.0	<1.0	**3.8**	<1.0
MW-12A	5/16/2006	698	516			<1.0	<1.0	**1.5**	<1.0
MW-12A	11/26/2006	892	710			<0.2	**0.7**	**4.4**	<0.2
MW-12A	5/22/2007	1069	887			<1.0	<1.0	**2.4**	<1.0
MW-12A	11/27/2007	1258	1076			<1.0	<1.0	**3.2**	<1.0
MW-12A	5/19/2008	1432	1250		-98	<0.2	**0.6**	**3.2**	<0.2
MW-12A	11/23/2008	1620	1438		90	<1.0	<1.0	**4.7**	<1.0
MW-12A	05/18/2009	1796	1614		266	<1.0	<1.0	**1.4**	<1.0
MW-12A	11/17/2009	1979	1797		449	<1.0	<1.0	**4.7**	<1.0
MW-12A	5/19/2010	2162	1980		632	<1.0	<1.0	<1.0	<1.0
MW-12A	11/8/2010	2335	2153		805	<1.0	<1.0	**4.3**	<1.0
MW-12A	5/3/2011	2511	2329		981	<1.0	<1.0	<1.0	<1.0
MW-12A	11/13/2011	2705	2523		1175	<0.2	**0.6**	**3.1**	<0.2
MW-12A	5/14/2012	2888	2706		1358	**0.2**	<0.2	<0.2	<0.2
MW-12A	11/14/2012	3072	2890		1542	<0.2	**0.4**	**2.1**	<0.2
MW-12A	5/21/2013	3260	3078		1730	<0.2	<0.2	**0.5**	<0.2
MW-12A	11/12/2013	3435	3253		1905	<0.2	**0.5**	**2.2**	<0.2
MW-12A	5/7/2014	3611	3429		2081	**0.3**	<0.2	<0.2	<0.2
MW-12A	11/4/2014	3792	3610		2262	**0.3**	<0.2	**0.3**	<0.2
MW-13A	5/2/2004	-46				**5.1**	**4.6**	<1.0	<1.0
MW-13A	10/25/2004	130	-52			**4.3**	**4.0**	<1.0	<1.0
MW-13A	5/12/2005	329	147			**6.1**	**4.6**	<1.0	<1.0
MW-13A	11/14/2005	515	333			**6.0**	**4.5**	<1.0	<1.0
MW-13A	5/16/2006	698	516			**7.1**	**4.6**	<1.0	<1.0
MW-13A	11/27/2006	893	711			**8.3**	**6.5**	**0.3**	<0.2
MW-13A	5/21/2007	1068	886			**8.2**	**7.0**	**0.4**	<0.2
MW-13A	11/28/2007	1259	1077			**6.4**	**4.2**	<1.0	<1.0

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		Elapsed Time from Injections (a) (days)				Volatile Organic Compounds			
						Proposed Groundwater Cleanup Levels (c)			
						5.3	1.4	134	2.4
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)
MW-13A	5/19/2008	1432	1250		-98	**8.7**	**6.8**	**0.3**	<0.2
MW-13A	11/23/2008	1620	1438		90	**6.5**	**3.7**	<1.0	<1.0
MW-13A	05/18/2009	1796	1614		266	**7.7**	**5.6**	<1.0	<1.0
MW-13A	11/17/2009	1979	1797		449	**9.2**	**6.0**	<1.0	<1.0
MW-13A	5/20/2010	2163	1981		633	**9.4**	**5.3**	<1.0	<1.0
MW-13A	11/10/2010	2337	2155		807	**3.6**	**2.8**	<1.0	<1.0
MW-13A	5/4/2011	2512	2330		982	**3.9**	**2.4**	<1.0	<1.0
MW-13A	11/3/2011	2695	2513		1165	**1.6**	<1.0	<1.0	<1.0
MW-13A	5/14/2012	2888	2706		1358	**2.3**	**0.8**	<0.2	<0.2
MW-13A	11/13/2012	3071	2889		1541	**2.2**	**0.8**	<0.2	<0.2
MW-13A	5/21/2013	3260	3078		3078	**4.5**	**2.5**	**0.5**	<0.2
MW-13A	11/12/2013	3435	3253		3253	**2.2**	**0.6**	<0.2	<0.2
MW-13A	5/7/2014	3611	3429		3429	**3.1**	**1.3**	<0.2	<0.2
MW-13A	11/4/2014	3792	3610		3610	**2.3**	**0.5**	<0.2	<0.2
MW-13A	4/28/2015	3967	3785		3785	**1.8**	**0.4**	<0.2	<0.2
MW-13C	5/2/2004	-46				<1.0	<1.0	<1.0	**2.5**
MW-13C	10/25/2004	130	-52			<1.0	<1.0	<1.0	**3.3**
MW-13C	5/12/2005	329	147			<1.0	<1.0	<1.0	<1.0
MW-13C	11/14/2005	515	333			<1.0	<1.0	<1.0	**3.8**
MW-13C	5/16/2006	698	516			<1.0	<1.0	<1.0	**2.2**
MW-13C	11/27/2006	893	711			<0.2	<0.2	**0.8**	**3.4**
MW-13C	5/21/2007	1068	886			<0.2	<0.2	**0.8**	**4.4**
MW-13C	11/28/2007	1259	1077			<1.0	<1.0	<1.0	**2**
MW-13C	5/19/2008	1432	1250		-98	<0.2	<0.2	**0.2**	**0.6**
MW-13C	11/23/2008	1620	1438		90	<1.0	<1.0	<1.0	**2.2**
MW-13C	05/18/2009	1796	1614		266	<1.0	<1.0	<1.0	<1.0
MW-13C	11/17/2009	1979	1797		449	<1.0	<1.0	<1.0	<1.0
MW-13C	5/20/2010	2163	1981		633	<1.0	<1.0	<1.0	<1.0
MW-13C	11/10/2010	2337	2155		807	<1.0	<1.0	<1.0	<1.0
MW-13C	5/4/2011	2512	2330		982	<1.0	<1.0	<1.0	<1.0
MW-13C	11/3/2011	2695	2513		1165	<1.0	<1.0	<1.0	<1.0
MW-13C	5/14/2012	2888	2706		1358	<0.2	<0.2	<0.2	**0.3**
MW-13C	11/13/2012	3071	2889		1541	<2.0	<2.0	<2.0	<2.0
MW-13C	5/21/2013	3260	3078		1730	<2.0	<2.0	<2.0	<2.0
MW-13C	11/12/2013	3435	3253		1905	<2.0	<2.0	<2.0	<2.0
MW-13C	5/7/2014	3611	3429		2081	<1.0	<1.0	<1.0	<1.0
MW-13C	11/4/2014	3792	3610		2262	<0.2	<0.2	<0.2	**0.2**
MW-13C	4/28/2015	3967	3785		2437	<0.2	<0.2	<0.2	**0.3**
MW-14C	5/4/2004	-44				<1.0	<1.0	**63**	**44**
MW-14C	10/26/2004	131	-51	-142		<1.0	<1.0	**22**	**75**
MW-14C	5/16/2005	333	151	60		<1.0	<1.0	**11**	**6.1**
MW-14C	11/15/2005	516	334	243		<1.0	<1.0	<1.0	**1.8**
MW-14C	5/17/2006	699	517	426		<1.0	<1.0	<1.0	<1.0
MW-14C	11/29/2006	895	713	622		<0.2	<0.2	<0.2	**1.0**
MW-14C	5/23/2007	1070	888	797		<1.0	<1.0	<1.0	**2.5**
MW-14C	12/3/2007	1264	1082	991		<1.0	<1.0	**1.1**	**11**
MW-14C	5/20/2008	1433	1251	1160	-97	<1.0	<1.0	**1.4**	**22**
MW-14C	11/24/2008	1621	1439	1348	91	<1.0	<1.0	<1.0	**4.3**
MW-14C	05/20/2009	1798	1616	1525	268	<1.0	<1.0	<1.0	**1.1**
MW-14C	11/17/2009	1979	1797	1706	449	<1.0	<1.0	<1.0	<1.0
MW-14C	5/24/2010	2167	1985	1894	637	<1.0	<1.0	<1.0	<1.0
MW-14C	11/10/2010	2337	2155	2064	807	<1.0	<1.0	<1.0	<1.0
MW-14C	5/5/2011	2513	2331	2240	983	<1.0	<1.0	<1.0	<1.0

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		Elapsed Time from Injections (a) (days)				Volatile Organic Compounds			
						Proposed Groundwater Cleanup Levels (c)			
						5.3	**1.4**	**134**	**2.4**
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)
MW-14C	11/13/2011	2705	2523	2432	1175	<0.2	<0.2	<0.2	<0.2
MW-14C	5/14/2012	2888	2706	2615	1358	<0.2	<0.2	<0.2	<0.2
MW-14C	11/14/2012	3072	2890	2799	1542	<2.0	<2.0	<2.0	<2.0
MW-14C	5/21/2013	3260	3078	2987	1730	<2.0	<2.0	<2.0	<2.0
MW-14C	11/12/2013	3435	3253	3162	1905	<2.0	<2.0	<2.0	<2.0
MW-14C	5/7/2014	3611	3429	3338	2081	<1.0	<1.0	<1.0	<1.0
MW-14C	11/5/2014	3793	3611	3520	2263	<0.2	<0.2	<0.2	<0.2
MW-14C	4/29/2015	3968	3786	3695	2438	<0.2	<0.2	<0.2	<0.2
MW-14E	5/4/2004	-44				<1.0	<1.0	<1.0	<1.0
MW-14E	10/26/2004	131	-51	-142		<1.0	<1.0	<1.0	<1.0
MW-14E	5/16/2005	333	151	60		<1.0	<1.0	<1.0	<1.0
MW-14E	11/15/2005	516	334	243		<1.0	<1.0	<1.0	<1.0
MW-14E	5/17/2006	699	517	426		<1.0	<1.0	<1.0	<1.0
MW-14E	11/29/2006	895	713	622		<0.2	<0.2	<0.2	<0.2
MW-14E	5/23/2007	1070	888	797		<1.0	<1.0	<1.0	<1.0
MW-14E	12/3/2007	1264	1082	991		<1.0	<1.0	<1.0	<1.0
MW-14E	5/20/2008	1433	1251	1160	-97	<1.0	<1.0	<1.0	<1.0
MW-14E	11/24/2008	1621	1439	1348	91	<1.0	<1.0	<1.0	<1.0
MW-14E	05/20/2009	1798	1616	1525	268	<1.0	<1.0	<1.0	<1.0
MW-14E	11/17/2009	1979	1797	1706	449	<1.0	<1.0	<1.0	<1.0
MW-15C	5/3/2004	-45				<1.0	<1.0	**9.1**	**11**
MW-15C	10/26/2004	131	-51			<1.0	<1.0	**11**	**17**
MW-15C	5/16/2005	333	151			<1.0	<1.0	**13**	**6.4**
MW-15C	11/15/2005	516	334			<1.0	<1.0	<1.0	<1.0
MW-15C	5/17/2006	699	517			<1.0	<1.0	<1.0	<1.0
MW-15C	11/29/2006	895	713			<0.2	<0.2	<0.2	<0.2
MW-15C	5/23/2007	1070	888			<1.0	<1.0	<1.0	**2.2**
MW-15C	12/3/2007	1264	1082			<1.0	<1.0	<1.0	**2.5**
MW-15C	5/20/2008	1433	1251		-97	<1.0	<1.0	**1.8**	**6.6**
MW-15C	11/24/2008	1621	1439		91	<1.0	<1.0	**1.9**	**6.6**
MW-15C	05/19/2009	1797	1615		267	<1.0	<1.0	<1.0	<1.0
MW-15C	11/18/2009	1980	1798		450	<1.0	<1.0	<1.0	<1.0
MW-15C	5/20/2010	2163	1981		633	<1.0	<1.0	<1.0	<1.0
MW-15C	11/10/2010	2337	2155		807	<1.0	<1.0	<1.0	<1.0
MW-15C	5/5/2011	2513	2331		983	<1.0	<1.0	<1.0	<1.0
MW-15C	11/13/2011	2705	2523		1175	<0.2	<0.2	<0.2	<0.2
MW-15C	5/14/2012	2888	2706		1358	<0.2	<0.2	<0.2	<0.2
MW-15C	11/13/2012	3071	2889		1541	<2.0	**3.2**	<2.0	<2.0
MW-15C	5/21/2013	3260	3078		1730	<5.0	<5.0	<5.0	<5.0
MW-15C	11/12/2013	3435	3253		1905	<2.0	<2.0	<2.0	**2.3**
MW-15C	5/7/2014	3611	3429		2081	<2.0	<2.0	<2.0	**2.9**
MW-15C	11/5/2014	3793	3611		2263	<0.2	<0.2	**0.5**	**2.5**
MW-15C	4/29/2015	3968	3786		2438	<0.2	<0.2	**0.6**	**2.4**
MW-15D	5/3/2004	-45				<1.0	<1.0	<1.0	<1.0
MW-15D	10/26/2004	131	-51			<1.0	<1.0	<1.0	<1.0
MW-15D	5/16/2005	333	151			<1.0	<1.0	<1.0	<1.0
MW-15D	11/15/2005	516	334			<1.0	<1.0	<1.0	<1.0
MW-15D	5/17/2006	699	517			<1.0	<1.0	<1.0	<1.0
MW-15D	11/29/2006	895	713			<1.0	<1.0	<1.0	<1.0
MW-15D	5/23/2007	1070	888			<1.0	<1.0	<1.0	<1.0
MW-15D	12/3/2007	1264	1082			<1.0	<1.0	<1.0	<1.0
MW-15D	5/20/2008	1433	1251		-97	<1.0	<1.0	<1.0	<1.0
MW-15D	11/24/2008	1621	1439		91	<1.0	<1.0	<1.0	<1.0

SWMU-20 CLEANUP ACTION SUMMARY - NON SOURCE ZONE
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

		Elapsed Time from Injections (a) (days)				Volatile Organic Compounds			
						Proposed Groundwater Cleanup Levels (c)			
						5.3	**1.4**	**134**	**2.4**
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)
MW-15D	05/19/2009	1797	1615		267	<1.0	<1.0	<1.0	<1.0
MW-15D	11/18/2009	1980	1798		450	<1.0	<1.0	<1.0	<1.0
MW-16A	5/2/2004	-46				**1.2**	**1.2**	**2.3**	<1.0
MW-16A	10/25/2004	130	-52			**1.2**	**1.3**	**1.8**	<1.0
MW-16A	5/12/2005	329	147			**1.2**	**1.8**	**2.6**	<1.0
MW-16A	11/15/2005	516	334			**1.3**	**2.2**	**2.1**	<1.0
MW-16A	5/16/2006	698	516			**1.0**	**1.4**	**2.3**	<1.0
MW-16A	11/26/2006	892	710			<0.2	**0.8**	**4.2**	<0.2
MW-16A	5/22/2007	1069	887			**1.1**	**1.3**	**1.9**	<1.0
MW-16A	11/28/2007	1259	1077			**1.7**	**1.2**	**1.2**	<1.0
MW-16A	5/19/2008	1432	1250		-98	**1.2**	**1.3**	**1.2**	<0.2
MW-16A	11/23/2008	1620	1438		90	**1.5**	**1.4**	**1.0**	<1.0
MW-16A	05/18/2009	1796	1614		266	**1.6**	**1.6**	<1.0	<1.0
MW-16A	11/16/2009	1978	1796		448	**2.2**	**1.5**	<1.0	<1.0
MW-16A	5/20/2010	2163	1981		633	**1.4**	**1.4**	<1.0	<1.0
MW-16A	11/10/2010	2337	2155		807	**1.3**	**1.1**	<1.0	<1.0
MW-16A	5/4/2011	2512	2330		982	**1.6**	**1.4**	<1.0	<1.0
MW-16A	11/13/2011	2705	2523		1175	**1.4**	**1.3**	**0.5**	<0.2
MW-16A	5/14/2012	2888	2706		1358	**1.6**	**1.7**	**0.5**	<0.2
MW-16A	11/14/2012	3072	2890		1542	**1.1**	**1.5**	**0.6**	<0.2
MW-16A	5/21/2013	3260	3078		1730	**1.4**	**1.5**	<0.5	<0.5
MW-16A	11/12/2013	3435	3253		1905	**2.1**	**1.8**	**0.3**	<0.2
MW-16A	5/8/2014	3612	3430		2082	**1.4**	**1.6**	**0.4**	<0.2
MW-16A	11/5/2014	3793	3611		2263	**1.6**	**1.5**	**0.4**	<0.2
MW-16A	4/28/2015	3967	3785		2437	**1.4**	**1.4**	**0.3**	<0.2
MW-16C	5/2/2004	-46				<1.0	<1.0	**1.7**	**5.4**
MW-16C	10/25/2004	130	-52			<1.0	<1.0	**2.4**	**8.5**
MW-16C	5/12/2005	329	147			<1.0	<1.0	**2.8**	**7.7**
MW-16C	11/15/2005	516	334			<1.0	<1.0	**4.6**	**12**
MW-16C	5/16/2006	698	516			<1.0	<1.0	**5.2**	**6.3**
MW-16C	11/26/2006	892	710			**1.2**	**2.3**	**2.0**	<0.2
MW-16C	5/22/2007	1069	887			<1.0	<1.0	**8.8**	**10**
MW-16C	11/28/2007	1259	1077			<1.0	<1.0	**7**	**8.9**
MW-16C	5/19/2008	1432	1250		-98	<0.2	<0.2	**7.8**	**7.9**
MW-16C	11/23/2008	1620	1438		90	<1.0	<1.0	**5.3**	**8.8**
MW-16C	05/18/2009	1796	1614		266	<1.0	<1.0	**5.0**	**6.3**
MW-16C	11/16/2009	1978	1796		448	<1.0	<1.0	**4.9**	**5.6**
MW-16C	5/20/2010	2163	1981		633	<1.0	<1.0	**3.7**	**3.4**
MW-16C	11/10/2010	2337	2155		807	<1.0	<1.0	**3.3**	**2.8**
MW-16C	5/4/2011	2512	2330		982	<1.0	<1.0	**3.7**	**3.2**
MW-16C	11/13/2011	2705	2523		1175	<0.2	<0.2	**3.3**	**2.5**
MW-16C	5/14/2012	2888	2706		1358	<0.2	<0.2	**4.8**	**4.2**
MW-16C	11/14/2012	3072	2890		1542	<0.2	<0.2	**4.9**	**3.8**
MW-16C	5/21/2013	3260	3078		1730	<0.5	<0.5	**3.9**	**2.8**
MW-16C	11/12/2013	3435	3253		1905	<0.2	<0.2	**4.4**	**2.1**
MW-16C	5/8/2014	3612	3430		2082	<0.2	<0.2	**3.4**	**1.2**
MW-16C	11/5/2014	3793	3611		2263	<0.2	<0.2	**3.4**	**1.3**
MW-16C	4/28/2015	3967	3785		2437	<0.2	<0.2	**2.2**	**1.2**
MW-17A	5/2/2004	-46				**4.8**	**6.5**	**1.0**	<1.0
MW-17A	10/25/2004	130	-52			**5.2**	**4.8**	**1.2**	<1.0
MW-17A	11/15/2005	516	334			**4.0**	**5.4**	**1.1**	<1.0
MW-17A	5/15/2006	697	515			**4.2**	**4.4**	<1.0	<1.0
MW-17A	11/27/2006	893	711			**2.2**	**6.3**	**1.0**	<0.2

SWMU-20 CLEANUP ACTION SUMMARY - NON SOURCE ZONE
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

		Elapsed Time from Injections (a) (days)				Volatile Organic Compounds			
						Proposed Groundwater Cleanup Levels (c)			
						5.3	**1.4**	**134**	**2.4**
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)
MW-17A	5/21/2007	1068	886			**4.7**	**5.3**	**1.0**	<0.2
MW-17A	11/29/2007	1260	1078			**4.2**	**4.3**	<1.0	<1.0
MW-17A	5/19/2008	1432	1250		-98	**4.3**	**5.1**	**0.8**	<0.2
MW-17A	11/23/2008	1620	1438		90	**4.2**	**5.2**	**1.2**	<1.0
MW-17A	05/19/2009	1797	1615		267	**3.2**	**4.9**	**1.4**	<1.0
MW-17A	11/12/2009	1974	1792		444	**3.7**	**4.5**	**1.1**	<1.0
MW-17A	5/20/2010	2163	1981		633	**4.0**	**3.1**	<1.0	<1.0
MW-17A	11/8/2010	2335	2153		805	**2.3**	**4.8**	**2.3**	<1.0
MW-17A	5/3/2011	2511	2329		981	**3.1**	**2.2**	**1.5**	<1.0
MW-17A	11/3/2011	2695	2513		1165	**2.6**	**2.8**	**1.0**	<1.0
MW-17A	5/14/2012	2888	2706		1358	**3.1**	**2.0**	**0.5**	<0.2
MW-17A	11/13/2012	3071	2889		1541	**2.8**	**3.5**	**0.9**	<0.2
MW-17A	5/20/2013	3259	3077		1729	**3.6**	**2.8**	**0.8**	<0.2
MW-17A	11/4/2014	3792	3610		2262	**3.9**	**3.4**	**1.0**	<0.2
MW-17A	5/6/2014	3610	3428		2080	**3.6**	**2.6**	**0.4**	<0.2
MW-17A	11/4/2014	3792	3610		2262	**2.9**	**3.1**	**0.9**	<0.2
MW-17A	4/28/2015	3967	3785		2437	**3.4**	**2.3**	**0.4**	<0.2
MW-18A	5/2/2004	-46	-228			<1.0	<1.0	<1.0	<1.0
MW-18C	5/2/2004	-46				<1.0	<1.0	<1.0	<1.0
MW-18C	10/25/2004	130	-52			<1.0	<1.0	<1.0	<1.0
MW-18C	5/12/2005	329	147			<1.0	<1.0	<1.0	<1.0
MW-18C	11/15/2005	516	334			<1.0	<1.0	<1.0	<1.0
MW-18C	5/17/2006	699	517			<1.0	<1.0	<1.0	<1.0
MW-18C	11/27/2006	893	711			<0.2	<0.2	<0.2	<0.2
MW-18C	5/21/2007	1068	886			<0.2	<0.2	<0.2	**0.2**
MW-18C	11/28/2007	1259	1077			<1.0	<1.0	<1.0	<1.0
MW-18C	5/19/2008	1432	1250		-98	<0.2	<0.2	<0.2	**0.2**
MW-18C	11/23/2008	1620	1438		90	<1.0	<1.0	<1.0	<1.0
MW-18C	05/19/2009	1797	1615		267	<1.0	<1.0	<1.0	<1.0
MW-18C	11/17/2009	1979	1797		449	<1.0	<1.0	<1.0	<1.0
MW-19C	5/2/2004	-46				<1.0	<1.0	<1.0	<1.0
MW-19C	10/25/2004	130	-52			<1.0	<1.0	<1.0	<1.0
MW-19C	5/12/2005	329	147			<1.0	<1.0	<1.0	<1.0
MW-19C	11/15/2005	516	334			<1.0	<1.0	<1.0	<1.0
MW-19C	5/17/2006	699	517			<1.0	<1.0	<1.0	<1.0
MW-19C	11/27/2006	893	711			<0.2	<0.2	**0.3**	<0.2
MW-19C	5/22/2007	1069	887			<1.0	<1.0	<1.0	<1.0
MW-19C	11/29/2007	1260	1078			<1.0	<1.0	<1.0	<1.0
MW-19C	5/20/2008	1433	1251		-97	<1.0	<1.0	<1.0	<1.0
MW-19C	11/23/2008	1620	1438		90	<1.0	<1.0	<1.0	<1.0
MW-19C	05/19/2009	1797	1615		267	<1.0	<1.0	<1.0	<1.0
MW-19C	11/18/2009	1980	1798		450	<1.0	<1.0	<1.0	<1.0
MW-20C	5/3/2004	-45				<1.0	<1.0	**1.4**	**2.4**
MW-20C	10/25/2004	130	-52			<1.0	<1.0	**1.7**	**4.6**
MW-20C	5/12/2005	329	147			<1.0	<1.0	**1.7**	**2.3**
MW-20C	11/15/2005	516	334			<1.0	<1.0	**2.1**	**2.9**
MW-20C	5/17/2006	699	517			<1.0	<1.0	**1.8**	**1.6**
MW-20C	11/29/2006	895	713			<0.2	**0.2**	**2.1**	**1.5**
MW-20C	5/21/2007	1068	886			<0.2	<0.2	**1.6**	**1.8**
MW-20C	11/29/2007	1260	1078			<1.0	<1.0	**1.6**	**1.3**
MW-20C	5/20/2008	1433	1251		-97	<1.0	<1.0	**1.6**	**2.5**
MW-20C	11/23/2008	1620	1438		90	<1.0	<1.0	**1.5**	**2.7**

SWMU-20 CLEANUP ACTION SUMMARY - NON SOURCE ZONE
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

		Elapsed Time from Injections (a) (days)				Volatile Organic Compounds Proposed Groundwater Cleanup Levels (c)			
						5.3	**1.4**	**134**	**2.4**
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)
MW-20C	05/19/2009	1797	1615		267	<1.0	<1.0	**1.4**	**2.0**
MW-20C	11/18/2009	1980	1798		450	<1.0	<1.0	**1.7**	**2.3**
MW-20C	5/20/2010	2163	1981		633	<1.0	<1.0	**1.3**	**1.8**
MW-20C	11/8/2010	2335	2153		805	<1.0	<1.0	**1.4**	**1.4**
MW-20C	5/4/2011	2512	2330		982	<1.0	<1.0	**1.1**	**1.8**
MW-20C	11/3/2011	2695	2513		1165	<1.0	<1.0	**1.3**	**2.1**
MW-20C	5/14/2012	2888	2706		1358	<0.2	<0.2	**1.2**	**1.5**
MW-20C	11/13/2012	3071	2889		1541	<2.0	<2.0	<2.0	<2.0
MW-20C	5/21/2013	3260	3078		1730	<5.0	<5.0	<5.0	<5.0
MW-20C	11/12/2013	3435	3253		1905	<2.0	<2.0	<2.0	<2.0
MW-20C	5/7/2014	3611	3429		2081	<2.0	<2.0	<2.0	<2.0
MW-20C	11/5/2014	3793	3611		2263	<0.2	<0.2	**0.9**	**0.7**
MW-20C	4/28/2015	3967	3785		2437	<0.2	<0.2	**0.7**	**1.0**

PCE = Tetrachloroethene
TCE = Trichloroethene
cDCE = cis-1,2-Dichloroethene
VC = Vinyl Chloride
µg/L - micrograms per liter
Bold = Detect
Box = Exceedance of proposed CUL

(a) Injections occurred on:

6/17/04 (6A, B, C; 9A, B, C)	6/17/2004	for elapsed time relative to injection
12/16-17/04 (6A, 6B;9A,9B)	12/16/2004	for elapsed time relative to injection
3/17/05 (14A)	3/17/2005	for elapsed time relative to injection
8/25-28/08 (6A, 9A, 10A)	8/25/2008	for elapsed time relative to injection

(b) Conducted at Well MW-14A only.

(c) Proposed Cleanup Standards and Comparison to Site Data, Boeing Developmental Center, Tukwila,Washington (Landau Associates, 5/7/13).

TABLE 3
BIOREMEDIATION GROUNDWATER MONITORING MATRIX
(REVISED 4/8/15 PER ECOLOGY COMMENTS ON SAMPLING REDUCTION)
BOEING DEVELOPMENTAL CENTER SMWU-20

	Semiannual
Source Wells	
MW-6A	(a)
MW-6B	(a)
MW-9A	(a)
MW-22A	(a)
Non-Source Wells	
MW-10C	(b)
MW-11A	(b)
MW-13A	(b)
MW-13C	(b)
MW-14C	(b)
MW-15C	(b)
MW-16A	(b)
MW-16C	(b)
MW-17A	(b)
MW-20C	(b)

(a) Laboratory Parameters (method): Volatile Organic Compounds (VOCs) Short List (8260) - tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (cDCE), vinyl chloride (VC), total organic carbon (TOC; SM5310C), sulfate (E300), Methane/Ethane/Ethene (RSK-175).
Field Parameters: Fe2; pH, dissolved oxygen (DO), oxygen reduction potential (ORP).

(b) Laboratory Parameters (method): VOCs Short List (8260) PCE, TCE, cDCE, VC

APPENDIX K

2005 Technical Memorandum Re: Work Plan for Indoor Air Sampling SWMU-20 Building 9-90

LANDAU ASSOCIATES
ENVIRONMENTAL | GEOTECHNICAL | NATURAL RESOURCES

TECHNICAL MEMORANDUM

TO: Jim Bet, The Boeing Company

FROM: Clint Jacob, P.E. and Chip Halbert, P.E.

DATE: December 9, 2005

RE: WORK PLAN FOR INDOOR AIR SAMPLING
SWMU-20 BUILDING 9-90
BOEING DEVELOPMENTAL CENTER
TUKWILA, WASHINGTON

INTRODUCTION

This technical memorandum presents a work plan for indoor air sampling to be conducted at Building 9-90 of the Boeing Developmental Center in Tukwila, Washington. Concern over indoor air quality in Building 9-90 results from the historical release of volatile organic compounds (VOCs) associated with a former vapor degreaser that was located near the northwest corner of Building 9-101. The former vapor degreaser, which was used from about 1956 to 1984, has been identified as Solid Waste Management Unit (SWMU)-20. This work plan and the proposed sampling are in response to Washington State Department of Ecology (Ecology) comments regarding previous indoor air sampling at Building 9-90 that was performed by Boeing in March 2005 (Ecology 2005).

SAMPLING LOCATIONS

Indoor air samples will be collected to characterize potential vapor intrusion that may result from the VOC groundwater plume that extended southwest from the former vapor degreaser and beneath Building 9-90 in the vicinity of monitoring well MW-14A. Three indoor air samples will be collected in the northern portion of Building 9-90 along the estimated axis of the VOC groundwater plume. The plume axis is estimated based on groundwater flow direction and on current and historical VOC concentrations in groundwater monitoring wells located upgradient and adjacent to Building 9-90 (Landau Associates 2005). The plume is relatively narrow beneath the northeast corner of Building 9-90, as delineated by wells MW-14A, MW15A, and MW-22A. Site features and monitoring wells are shown on Figure 1.

A concurrent ambient air sample will be collected outdoors to establish site-specific background air concentrations of the VOCs of interest in order to assess possible background contributions to any indoor air detections. The ambient sample will be collected near ground level in a secure location near Building 9-90.

SAMPLING AND ANALYSIS

Eight-hour, time-weighted average (TWA) samples will be collected at the three indoor air sample locations and at the outdoor, ambient air sample location. Samples will be collected using integrated, passive air samplers consisting of a laboratory-certified, evacuated SUMMA canister. Each SUMMA canister will be equipped with a pressure gauge and a calibrated critical orifice air flow controller for collection of the TWA samples. Canister inlet valves will be placed approximately 5 ft above ground surface in order to sample breathing space air. Canisters will be clearly labeled with signs indicating the purpose of the canisters and that the canisters are not to be interfered with or moved. Unique sample identifiers will be used as shown on Figure 1; a duplicate sample (IA-990-01A) will be collected in the same location as sample IA-990-01.

Samples will be collected following U.S. Environmental Protection Agency (EPA) Method TO 15 with selection ion monitoring (SIM) and consistent with guidance provided by Air Toxics Ltd. laboratory (attached). Six-liter volume SUMMA canisters, evacuated to a vacuum pressure of 25 to 30 inches mercury (Hg) by Air Toxics Ltd., will be used to collect a sample over an 8-hour period. A final vacuum pressure reading greater than ambient (i.e., zero inches Hg) indicates a valid sample. Canister pressures will be checked within 1 to 2 hours after beginning sampling to evaluate whether air flow controllers are functioning properly. Observed hourly pressure loss greater than 1/8 of the initial pressure will be indicative of a faulty flow controller. Any canisters observed to have a faulty flow controller will be replaced with a backup canister and flow controller.

Sample containers will be shipped under chain-of-custody procedures to the Air Toxics Ltd. laboratory for analysis of tetrachloroethene (PCE), trichloroethene (TCE), and vinyl chloride by EPA Method TO-15 SIM modified. Analysis by this method results in the lowest achievable reporting limits for comparison to Model Toxics Control Act (MTCA) Method B cleanup levels that will be applied as screening levels. Reporting limits listed below are based on dilution of a 5-liter sample and assume no matrix interference from other VOCs; the reporting limit is equal to the practical quantitation limit (PQL) for each compound. Air samples will not be analyzed for TCE breakdown product cis-1,2-dichloroethene (cis-1,2-DCE) because a MTCA Method B cleanup level for air is not promulgated for this compound.

Analyte	Reporting Limit (µg/m^3)	Screening Level (µg/m^3)
PCE	0.14	0.42
TCE	0.016	0.022
Vinyl chloride	0.026	0.28

QUALITY ASSURANCE/QUALITY CONTROL

Quality assurance/quality control (QA/QC) will include sample documentation, collection of a duplicate sample, chain-of-custody procedures, and laboratory quality control. Sampling information, including the initial and final canister vacuum readings, and serial numbers of each canister and flow controller will be recorded on an air sampling form (Table 1, attached) and on the chain-of-custody form. Canister pressures measured in the field will be compared to pressures measured at the laboratory both prior to shipment and after receiving samples to determine if canisters leaked during transit. A single duplicate sample will be collected, as described above. The sampler will be responsible for the care and custody of samples until they are shipped to the laboratory. A completed chain-of-custody record will accompany samples in a sealed shipping container to the laboratory. Laboratory QA/QC will consist of laboratory blanks, continuing calibration verification (CCV), laboratory control standard (LCS), laboratory duplicates, and surrogates. Laboratory blanks, CCV, LCS, and surrogates will be performed with every analyzed sample; a laboratory duplicate will be performed for every 10 samples.

Data validation will be performed to evaluate the precision, accuracy, representativeness, completeness, and comparability of the data as defined in EPA guidance (EPA 1998). Results for the laboratory duplicates will be compared to laboratory acceptance limits generated according to EPA guidelines. Control limits for the field duplicates will be 20 percent unless the duplicate sample values are within five times the quantitation limit, in which case the control limit interval will be plus or minus the quantitation limit. Control limits for surrogate and LCS recovery will be laboratory acceptance limits generated according to EPA guidelines. Validation will be performed in accordance with the appropriate sections of the *U.S. EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review* (EPA 1994). Analytical results will be qualified, as needed.

SCHEDULE

It is anticipated that indoor air sampling will be conducted by Landau Associates in December 2005. A technical memorandum documenting sampling activities and analytical data will be submitted to Ecology within 60 days of receiving final data.

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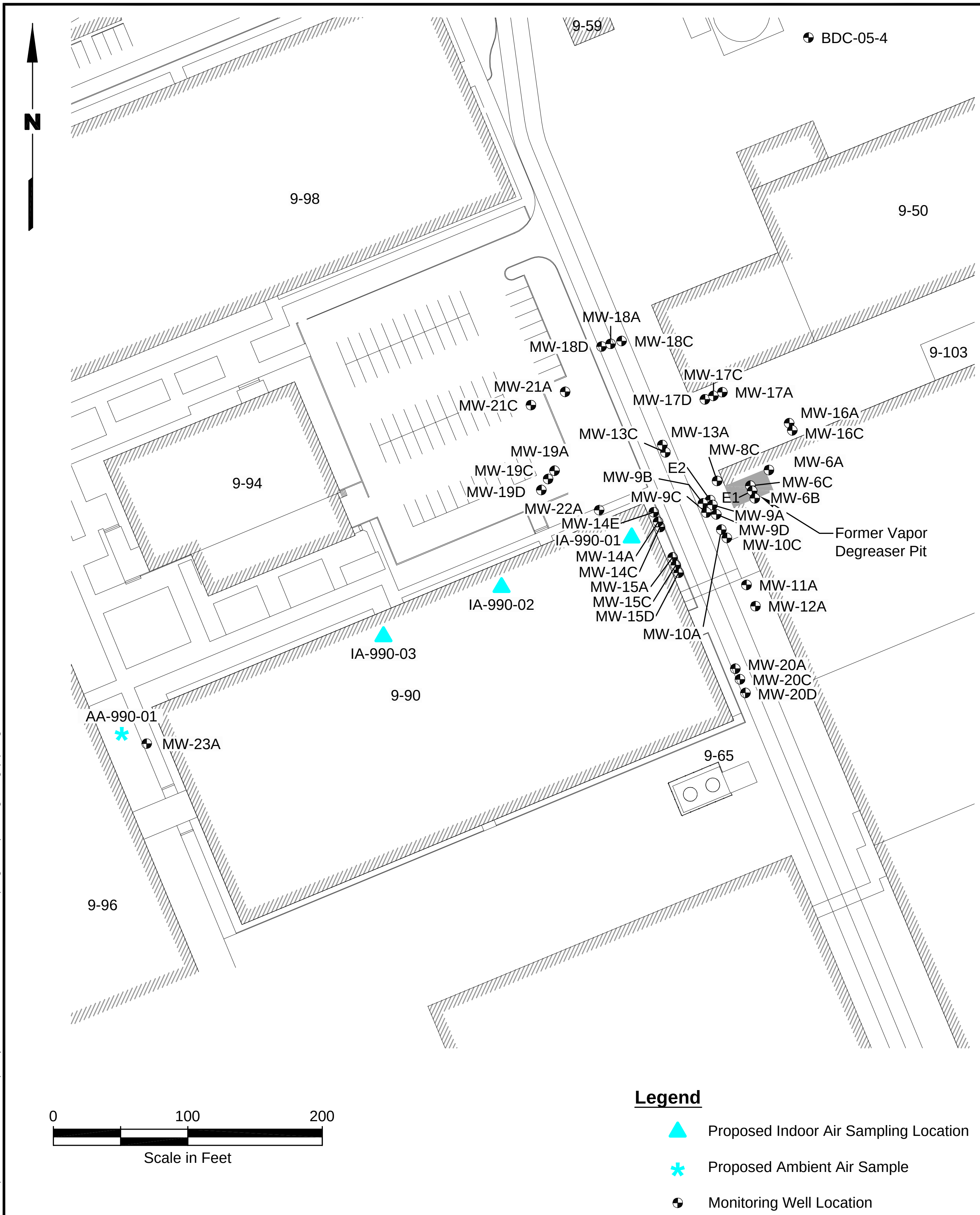


Boeing/Developmental Center/Workplan | V:\025\093\070\Indoor Air Sampling Workplan\Fig1.dwg (A) "Figure 1" 12/9/2005

LANDAU ASSOCIATES

Boeing Developmental Center Tukwila, Washington	**Proposed Indoor Air Sampling Locations**	Figure 1

TABLE 1
AIR SAMPLING FORM
BOEING DEVELOPMENTAL CENTER
SWMU-20

Sample ID	Date	Canister Number	Flow Controller Number	Initial Pressure (Hg) /Time	Check Pressure (Hg) /Time	Final Pressure (Hg) /Time	Analytes	Comments
IA-990-01							PCE, TCE, vinyl chloride	
IA-990-01A							PCE, TCE, vinyl chloride	
IA-990-02							PCE, TCE, vinyl chloride	
IA-990-03							PCE, TCE, vinyl chloride	
AA-990-01							PCE, TCE, vinyl chloride	

ATTACHMENT

Guide to Air Sampling & Analysis – Canisters and Tedlar Bags (Air Toxics Ltd.)

Air Toxics Ltd.

An Environmental Analytical Laboratory

Guide To Air Sampling & Analysis

Canisters and Tedlar Bags

Fifth Edition

Table of Contents

Tables

Section 1.0 Introduction

Air Toxics Ltd. presents this guide as a resource for individuals engaged in air sampling. Air sampling can be more involved than water or soil sampling due to the reactivity of chemical compounds in the gas matrix and sample interaction with the sampling equipment and media. Ensuring that air samples are collected properly is an important step in acquiring meaningful analytical results. This guide is not a substitute for experience and cannot sufficiently address the multitude of field conditions. Note that this guide is intended for projects involving whole air sampling of volatile organic compounds (VOCs) in canisters and Tedlar bags. Air Toxics Ltd. provides the "Guide to Air Sampling and Analysis - Sorbents, Solutions, and Filters" for other types of sampling.

1.1 Whole Air Sampling of VOCs

There are four general ways to collect compounds in a gas phase sample. A sampler can collect the gas in a container or draw the gas through a sorbent, solution, or filter. This guide focuses on collecting a sample in the most common air sampling containers, Summa canisters and Tedlar bags. The sample can be collected in the container either passively (i.e., by evacuating the canister prior to sampling) or actively (i.e., using a pump). The container is subsequently sealed and transported to the laboratory for analysis. The sample is referred to as a "whole air sample" and the compounds remain in the gas matrix (e.g., ambient air) inside the container.

As a general rule, whole air sampling is best when target compounds are chemically stable and have vapor pressures greater than 0.1 torr at 25deg and 760mm Hg, although exceptions to this rule can be found. Recovery of any given compound in a whole air sample is very much dependent upon the humidity of the sample, the chemical activity of the sample matrix, and the degree of inertness of the container.

1.2 Choosing Between Canisters and Tedlar Bags

Table 1.2 compares the features of canisters and Tedlar bags. Canisters have superior inertness, hold time to analysis and ruggedness. They also do not require a sampling pump. Tedlar bags can be purchased inexpensively in bulk, carried to a sampling site in a briefcase, filled in seconds, and shipped easily to the laboratory for analysis. Call Client Services at 800-985-5955 if you have questions regarding sampling media.

Table 1.2. Comparison of Canisters to Tedlar Bags

	Canisters	Tedlar Bags
Common Volumes	1 and 6 L	1, 3, and 5 L
Type of Sampling	Passive (vacuum)	Active (pump required)
Sample Handling	Room temperature	Room temperature
Media Hold Time	Up to 30 days recommended	Indefinite
Hold Time to Analysis	14-30 days	3 days
Surface Inertness	Excellent	Fair
Cleanliness	10% or 100% certified to ppbv/pptv levels	Some VOCs present at 0.5 to 45 ppbv
Sampling Application	Ambient/indoor air, soil/landfill gas, stationary source	Ambient air (fixed gases only), soil/landfill gas, stationary source
Rule of Thumb	"ppbv device"	"ppmv device"
Advantages	Inertness, hold time, ruggedness, no pump	Purchase/shipping cost, availability, convenience

Section 2. Canisters and Associated Media

This section provides a description of air sampling canisters, practical considerations for sampling, and step-by-step instructions for collecting a grab and integrated sample. Photographs illustrate the correct way to assemble the various sampling components. Tables provide detailed information on many operational factors that ultimately influence the quality of the data obtained from a canister sample.

2.1 Introduction to Canisters

An air sampling canister is a container for collecting a whole air sample for ambient and indoor air applications. A canister can be spherical or cylindrical and is constructed of stainless steel. The canister is prepared for sampling by evacuating the contents to a vacuum of approximately 29.9 inches of Mercury (in. Hg). Opening the stainless steel bellows valve allows the air sample to enter the canister. When the target volume of sample is collected, the valve is closed and the canister is returned to the laboratory.

Canisters can range in volume from less than 1 liter (L) to greater than 6 L. At Air Toxics Ltd., 6 L canisters are used for ambient air samples and for taking integrated samples. 1 L canisters are normally used for taking high concentration (i.e., greater than 5 ppbv) grab samples, although exceptions to these guidelines are common.

2.1.1 Summa Canister

A Summa canister is a stainless steel container that has had the internal surfaces specially passivated using a "Summa" process. This process combines an electropolishing step with a chemical deactivation step to produce a surface that is nearly chemically inert. A Summa surface has the appearance of a mirror: bright, shiny, and smooth. The degree of chemical inertness of a whole air sample container is crucial to minimizing reactions with the sample and maximizing recovery of target compounds from the container. Air Toxics Ltd. maintains a large inventory of Summa canisters in 6 and 1 L volumes.

2.1.2 Canister Cleaning

Air Toxics Ltd. provides two types of canister cleaning certification, 10% and 100%, depending upon the requirements of the project. The 10% certification process is appropriate for routine ambient air applications and high concentration applications such as soil vapor and landfill gas monitoring. The 10% certification process begins by cleaning canisters using a combination of dilution, heat, and high vacuum. After completing the cleaning steps, 10% of the canisters are certified each day. Canisters are certified for approximately 60 VOCs using GC/MS. The 10% certification process requires that target compound concentrations be below 0.2 ppbv using GC/MS analysis. Alternatively, the 100% certification (i.e., individual certification) process is appropriate for ambient and indoor air applications driven by risk assessment or litigation that require pptv (parts per trillion by volume) sensitivity. Similar to the 10% certification, the 100% certification also begins with the canister cleaning process. The difference with the 100% certification is that canisters are individually certified for a client-specific list of target compounds using GC/MS. The 100% certified canisters are shipped with analytical documentation demonstrating that they are free of the target compounds down to the project reporting limits. When sampling with certified media it is important to note that all media is certified as a train and must be sampled as such (ie. a particular flow controller goes with a particular canister).

⇨ Specify whether your project requires 10% or 100% canister cleaning certification.

2.1.3 Canister Hold Time

Media Hold Time : Canister sampling differs considerably from collecting a water sample in a VOA vial or a soil sample in an amber jar in that the container (valued at over $450) is cleaned and reused. Air Toxics Ltd. requires that our canisters be returned within 14 days of receipt to effectively manage our inventory. Once a canister is cleaned, certified, and evacuated we recommend the canister be used for sample collection within 30 days. Over time, low-level (pptv) concentrations of typical VOCs may off-gas from the canister surface resulting in potential artifacts in the sample results.

Sample Hold Time : Although 30 days is the most commonly cited hold time for a canister sample, the hold time is compound specific. For example, compounds such as chloroform, benzene, and vinyl chloride are stable in a canister for at least 30 days. In fact, EPA Method TO-15 states: "Fortunately, under conditions of normal usage for sampling ambient air, most VOCs can be recovered from canisters near their original concentrations for after storage times of up to thirty days". However, some VOCs such as bis(Chloromethyl)ether degrade quickly and demonstrate low recovery even after 7 days. The standard VOC list reported by Air Toxics is stable up to 30 days after sample collection. Some projects require a more rigorous 14 day hold time.

2.2 Associated Canister Hardware

Associated hardware used with the canister includes the valve, brass cap, particulate filter, and vacuum gauge.

2.2.1 Valve

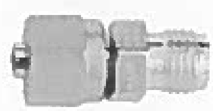
An industry standard, 1/4 in. stainless steel bellows valve (manufactured by Swagelok or Parker Instruments) is mounted at the top of the canister. The valve allows vacuum to be maintained in the canister prior to sampling and seals off the canister once the sample has been collected. No more than a half turn by hand is required to open the valve. Do not over-tighten the valve after sampling or it may become damaged. A damaged valve can leak and possibly compromise the sample. Some canisters have a metal cage near the top to protect the valve.

2.2.2 Brass Cap

Each canister comes with a brass cap (i.e., Swagelok 1/4 in. plug) secured to the inlet of the valve assembly. The cap serves two purposes. First, it ensures that there is no loss of vacuum due to a leaky valve or valve that is accidentally opened during handling. Second, it prevents dust and other particulate matter from fouling the valve. The cap is removed prior to sampling and replaced following sample collection.

⇨ Always replace the brass cap following canister sampling.

7 Micron



2 Micron

2.2.3 Particulate Filter

Particulate filters should always be used when sampling with a canister. Separate filters are provided to clients taking a grab sample. Filters are included in the flow controllers for clients taking integrated samples. Air Toxics Ltd. provides either a 2 micron filter or a 7 micron filter. These devices filter particulate matter greater than 2 and 7 micron in diameter respectively. The shorter 2 micron filter is a fritted stainless steel disk that has been pressed into a conventional Swagelok adapter and is disposed of after each single use. This device has a relatively high pressure drop across the fritted disk and restricts the flow into the canister. The 2 micron filter is standard for clients taking integrated samples. The longer 7 micron filter is cleaned in a similar manner as the stainless steel canisters after each single use and does not significantly restrict the flow rate into the canister. The 7 micron filter is primarily used with grab samples. Both the 2 and 7 micron filters are not calibrated devices and therefore the flow rates can and do vary for each filter.

⇨ Always use the particulate filter for canister sampling.

2.2.4 Vacuum Gauge

A vacuum gauge is used to measure the initial vacuum of the canister before sampling and the final vacuum upon completion. A gauge can also be used to monitor the fill rate of the canister when collecting an integrated sample. Air Toxics Ltd. provides 2 types of gauges. For grab sampling, a glycerine gauge is provided for checking initial and final vacuums only and is not to be sampled through. For integrated sampling a gauge is built into the flow controller and can be used for monitoring initial and final vacuums, as well as monitoring the fill rate of the canister. In special cases a pressure/vacuum gauge can be provided upon request. **Air Toxic Ltd's gauges are provided only to obtain a relative measure of "change." Individuals with work plans that outline specific gauge reading requirements are strongly encouraged to purchase and maintain their own gauges.**

⇨ **The gauges that Air Toxics Ltd. provides are for rough estimates only.**

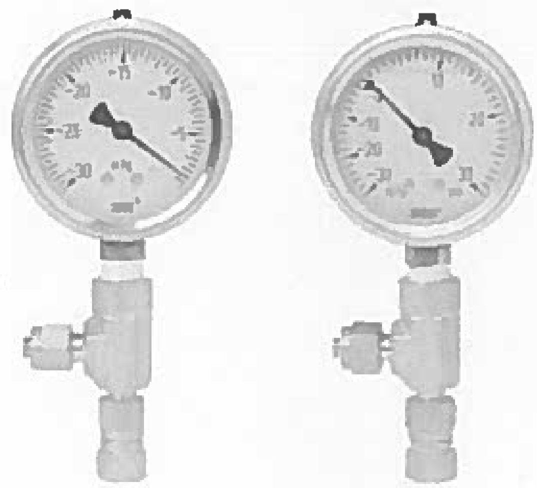


Table 2.2.3 Fill Times for Canisters

CANISTER VOLUME	7 micron filter	2 micron filter
6 L	16 sec	3 min
1 L	3 sec	30 sec

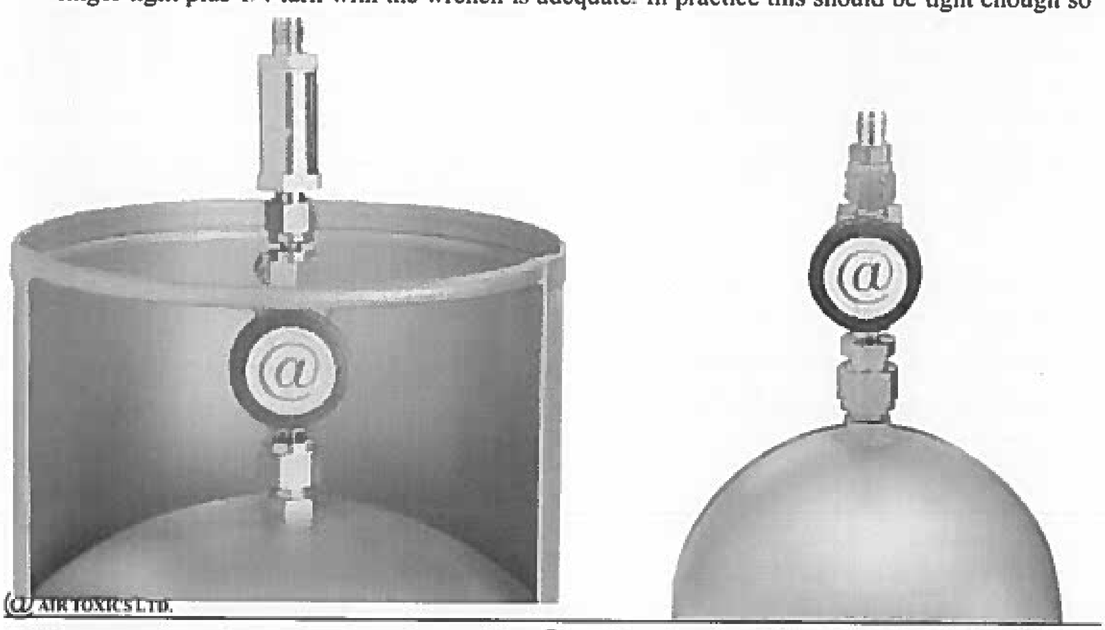
Section 3.0 Sampling with Canisters

There are two basic modes of canister sampling: grab and integrated. A grab sample is taken over a short interval (i.e., 1-5 minutes) while an integrated sample is taken over an extended period (e.g., 0.5-2 hours for a 1 L canister and 0.5-24 hours for a 6 L canister). In both modes the canister vacuum is used to draw sample into the canister. This is commonly referred to as passive sampling. Active sampling utilizes a pump to fill the canister. The most common hardware configuration used to take a grab sample are illustrated in the following figure. A particulate filter is used to prevent particulate matter from fouling the valve and entering the canister.

3.1 Considerations for Grab Sampling With Canisters

The following are some considerations for collecting a grab sample in a canister.

- **Avoid Leaks in Sampling Train:** All fittings on the sampling hardware are 1/4 in. Swagelok. A 9/16 in. wrench is used to assemble the hardware. It is not necessary to over tighten the fittings; finger tight plus 1/4 turn with the wrench is adequate. In practice this should be tight enough so



that the various pieces of equipment, when assembled, cannot be rotated by hand.

- **Verify Gauge Operation**: If the indicator does not read "zero" upon arrival, the gauge either needs to equilibrated or the gauge may be damaged and unusable. Equilibrate the gauge by "cracking" the rubber plug on top of the gauge. For more details on the equilibration procedure, see instructions included with the gauge or call Client Services at 800-985-5955.

- **Verify Initial Vacuum of Canister**: Prior to shipment, each canister is checked for mechanical integrity. However, it is still important to check the vacuum of the canister prior to use and record the initial vacuum on the chain-of-custody. The initial vacuum of the canister should be greater than 25 in. Hg. If the canister vacuum is less than 25 in. Hg, do not use it. Call Client Services at 800-985-5955 and arrange for a replacement canister. If sampling at altitude, there are special considerations for gauge readings and sampling (see Section 5.2). The procedure to verify the initial vacuum of a canister is simple, but unforgiving.

  1. Confirm that valve is closed (knob should already be tightened clockwise).
  2. Remove the brass cap.
  3. Attach gauge.
  4. Attach brass cap to side of gauge tee fitting.
  5. Open and close valve quickly (a few seconds).
  6. Read vacuum on the gauge.
  7. Record gauge reading on "Initial Vacuum" column of chain-of-custody.
  8. Verify that canister valve is closed and remove gauge.
  9. Replace the brass cap.

- **Leave Residual Vacuum**: A grab sample can be collected either by allowing the canister to reach ambient conditions or by leaving some residual vacuum (e.g., 5 in. Hg) in the canister. In either case, the final vacuum should be noted on the "Final Vacuum" column on the chain-of-custody. This will enable the laboratory to compare the final vacuum with the receipt vacuum (i.e., the vacuum measured upon arrival at the laboratory). If the two readings differ significantly, Client Services will contact you for instructions on how to proceed.

3.1.1 Step-By-Step Procedures for Canister Grab Sampling

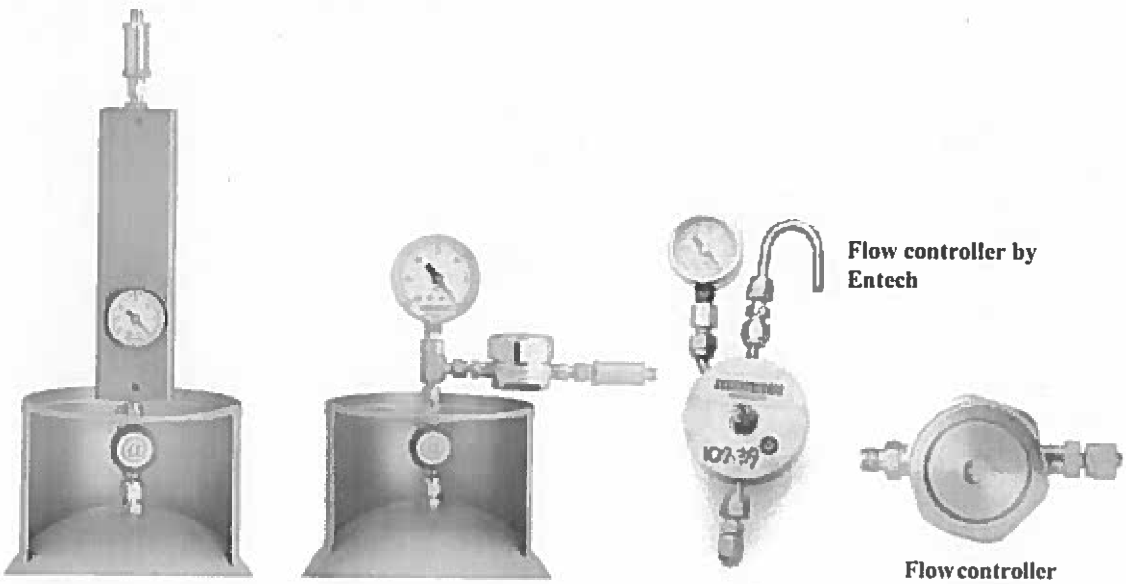
These procedures are for a typical ambient air sampling application and actual field conditions and procedures may vary.

Before you get to the field:

1. Verify contents of the shipped package (e.g., chain-of-custody, canister, particulate filter, and gauge – if requested).
2. Verify that gauge is working properly.
3. Verify and record initial vacuum of canister.

When ready to sample:

4. Remove brass cap.
5. Attach particulate filter to canister.
6. Open valve 1/2 turn (6 L canister normally takes about 16 sec to fill).
7. Close valve by hand tightening knob clockwise.
8. Verify and record final vacuum of canister (repeat steps used to verify initial vacuum).
9. Replace brass cap.
10. Fill out canister sample tag.
11. Return canister in box provided
    - Unreturned canister charge of $450 each
12. Return sample media in packaging provided. Unreturned equipment charges:
    - $45 per particulate filter
    - $45 per gauge
13. Fill out chain-of-custody and relinquish samples properly.
14. Place chain-of-custody in box and retain pink copy.



Flow controller by Entech

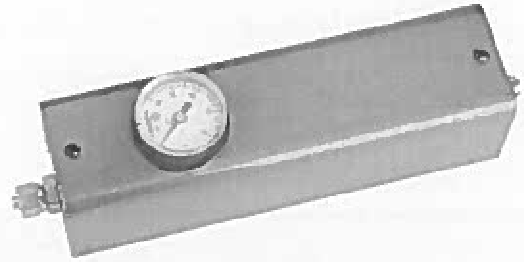
Flow controller by Veriflo

15. Tape box shut and affix custody seal (if applicable) across flap.
16. Ship accordingly to meet method holding times.

3.2 Integrated Sampling with Canisters and Flow Controllers

An air sample collected over more than a few minutes is referred to as an integrated sample and can provide information on compound concentrations in air averaged or composited over time. An 8- or 10-hour integrated sample can be used to determine indoor air quality in the workplace. Similarly, a

24-hour integrated sample can be an economical and practical approach to determine residential exposure to indoor or outdoor air sources. The most common hardware configurations used to take an integrated sample are illustrated.



Flow controllers are devices that regulate the flow of air during sampling into an evacuated canister. Also known as flow restrictors, these devices enable a sampler to achieve a desired flow rate and thus, a sampling interval. Air Toxics Ltd. provides two general types of flow controllers: mass flow controllers and critical orifice devices. Both devices are driven by differential pressure between ambient conditions and vacuum in the canister.

3.2.1 Mass Flow Controller

A mass flow controller employs a diaphragm that actively compensates to maintain a constant mass flow rate. As the differential pressure decreases, the flow rate tends to decrease and the diaphragm responds by opening up to allow more air to pass through. Mass flow controllers can be adjustable or fixed and can provide integrated samples with intervals ranging from hours to days. Air Toxics Ltd. provides a fixed mass flow controller that is calibrated at the laboratory for 24-hour sampling. Adjustable mass flow controllers have a knob that can be adjusted in the field to provide integrated samples with intervals ranging from one to 24 hours. The rugged conditions of field sampling are not usually compatible with adjustable mass flow controllers and Air Toxics Ltd. designed a more reliable flow controller based on a critical orifice design.

3.2.2 Critical Orifice Device

Air Toxics Ltd. designed a critical orifice flow restrictor to provide (time weighted) samples with intervals from 0.5 to 8 hours. The device restricts air flow by forcing the sample to enter a capillary column of minute radius. This device is passive compared to an actively compensating diaphragm and the flow rate decreases as the driving force (differential pressure) decreases. For sampling intervals from 0.5 to 8 hours, however, the flow rate is time weighted. The main advantages of the Air Toxics Ltd. flow restrictors are improved ruggedness and cleanliness. With no moving or adjustable parts, the Air Toxics Ltd. design is unlikely to lose its flow setting. In addition, a vacuum gauge is built in to the device to monitor sampling progress. To ensure there are no contamination issues from previous use, the capillary column is replaced before shipping to the field.

3.2.3 Sampling Interval and Flow Controller Setting

When you request canisters and flow controllers from Air Toxics Ltd., you will be asked for the sampling interval, and the flow controllers will be pre-set prior to shipment according to the table

Table 3.2.3 Flow Rates for Selected Sampling Intervals (mL/min)

Sampling Interval (hrs)	0.5	1	2	4	8	12	24
6 L Canister	167	83.3	41.7	20.8	11.5	7.6	3.5
1 L Canister	26.6	13.3	6.7	-	-	-	-

Note: Target fill volumes for 6 L and 1 L canisters are 5,000 mL and 800 mL, respectively.

below. The flow controller is set to collect 5 L of sample over the sample interval. Final canister vacuum is targeted at 5 in. Hg. The flow rate is set at standard atmospheric conditions (approximately sea level). If the air sample is a process (pressurized or under vacuum) or is collected at elevation, the canister will fill faster or slower depending on sample conditions. If you specify the source at project set-up, we can set the flow controller accordingly. See Section 5.2 for a discussion of collecting a sample at elevation. The 24-hr flow controllers should not be used for process or source samples.

3.2.4 Final Canister Vacuum and Flow Controller Performance

Ideally the final vacuum of a 6 L canister should be 5 in. Hg or greater. As long as the differential pressure is greater than 4 in. Hg ambient pressure, then the flow through the device will remain approximately constant as the canister fills. If there is insufficient differential pressure, the flow through the controller will decrease as the canister pressure approaches ambient. Because of the normal fluctuations in the flow rate (due to changes in ambient temperature, pressure, and diaphragm instabilities) during sampling, the final vacuum will range between 2 and 10 in. Hg.

- **If the residual canister vacuum is greater than 5 in. Hg** (i.e., more vacuum), the flow rate was low and less than 5 L of sample was collected. When the canister is pressurized to 5 psig prior to analysis, sample dilution will be greater than normal. This will result in elevated reporting limits.

- **If the residual canister vacuum is less than 5 in. Hg** (i.e., less vacuum), the initial flow rate

Table 3.2.4 Relationship Between Final Canister Vacuum, Volume Sampled, and Dilution Factor (6 L Canister)

Final Vacuum (in. Hg)	**0**	**2.5**	**5**	**7.5**	**10**	**12.5**	**15**	**17.5**	**20**
Volume Sampled (L)	6	5.5	5	4.5	4	3.5	3	2.5	2
Dilution Factor*	1.34	1.46	1.61	1.79	2.01	2.30	2.68	3.22	4.02

* Canister pressurized to 5 psig for analysis

was high. Once the vacuum decreases below 5 in. Hg, the flow rate begins to drop significantly. This scenario indicates that the sample is skewed in favor of the first portion of the sampling interval.

- **If the final vacuum is near ambient** (i.e., less than 1 in. Hg), there is inadequate differential pressure to drive the flow controller. The sampler cannot be certain the desired sampling interval was achieved before the canister arrived at ambient conditions. The sample could have been acquired over a 1-hour interval (which would be the case if the connection between the canister and flow controller leaked or if the flow controller malfunctioned) or a 24-hour interval. Although the actual sampling interval is uncertain, the canister still contains sample from the site.

3.2.5 Considerations for Integrated Sampling with Canisters

Collecting an integrated air sample is more involved than collecting a grab sample. Sampling considerations include verifying that the sampling train is properly configured, monitoring the integrated sampling progress, and avoiding contamination.

- **Avoid Leaks in the Sampling Train:** See Section 3.1 for instructions on how to securely assemble sampling hardware. A leak in any one of these connections means that some air will be pulled in through the leak and not through the flow controller. A final pressure near ambient is one indication that there may have been a leak.

- **Verify Initial Vacuum of Canister:** See Section 3.1 for instructions on verifying initial canister vacuum. If you are using an Air Toxics Ltd. critical orifice flow controller, note that you can use the built-in gauge. It is important to note both the canister and flow controller serial numbers on the chain-of-custody.

- **Monitor Integrated Sampling Progress**: It is a good idea to monitor the progress of the integrated sampling during the sampling interval. The volume of air sampled is a linear function of canister vacuum. For example, halfway (4 hours) into an 8-hour sampling interval, the canister should be half filled (2.5 L) and the gauge should read approximately 17 in. Hg. More vacuum than 17 in. Hg indicates that the canister is filling too slowly; less than 17 in. Hg and the canister is filling too quickly. If the canister is filling too slowly, a valid sample can still be collected (see Section 3.2.4). If the canister is filling too quickly because of a leak or incorrect flow controller setting, corrective action can be taken. Ensuring all connections are tight may eliminate a leak. It is possible to take an intermittent sample. The time interval need not be continuous.

- **Avoid Contamination**: Flow controllers should be cleaned between uses. This is normally accomplished by returning them to the laboratory. For large air sampling projects, Air Toxics Ltd. has designed a field conditioning program for 24-hour flow controllers involving a purge manifold. This arrangement provides the sampler with scheduling flexibility, inventory control, and convenience in the field. Air Toxics Ltd. will provide the 24-hour flow controllers, a purge manifold, Teflon tubing, rubber ferrules, vacuum pump, and flow meter. The sampler will need to provide the certified nitrogen cylinder and the certified high pressure regulator. Call Client Services at 800-985-5955 if you are interested in the field conditioning program.

- **Keep Sampling Train Out of Direct Sunlight**: The sampling train should be kept out of direct sunlight during sampling. There will be some minor flow rate drift if the temperature of the controllers is allowed to vary significantly.

3.2.6 Step-by-Step Procedures for Integrated Sampling

These procedures are for a typical ambient air sampling application and actual field conditions and procedures may vary.

Before you get to the field:

1. Verify contents of the shipped package (e.g., chain-of-custody, canister, particulate filter, and flow controller).
2. Verify initial vacuum of canister.

When ready to sample:

3. Remove brass cap.
4. Attach flow controller to canister.
5. Open valve 1/2 turn.
6. Monitor integrated sampling progress periodically.

At end of sampling interval:

7. Verify and record final vacuum of canister (for 24-hr flow controller repeat steps used to verify initial vacuum and for critical orifice device simply read built-in gauge).
8. Close valve by hand tightening knob clockwise.
9. Replace brass cap.
10. Fill out canister sample tag.
11. Return canisters in boxes provided.
    - Unreturned canister charge of $450 each
12. Return sample media in packaging provided. Unreturned equipment charges:
    - $45 per particulate filter
    - $50-500 per flow controller
13. Fill out chain-of-custody and relinquish samples properly.
14. Place chain-of-custody in box and retain pink copy.
15. Tape box shut and affix custody seal (if applicable) across flap.
16. Ship accordingly to meet method holding times.

Important Information for Canister Sampling

@ DO NOT use canister to collect explosive substances, radiological or biological agents, corrosives, extremely toxic substances, or other hazardous materials. It is illegal to ship such substances and you will be liable for damages.

@ ALWAYS use a filter when sampling. NEVER allow liquids (including water) or corrosive vapors to enter canister.

@ DO NOT attach labels to the surface of the canister.

@ DO NOT over tighten the valve and remember to replace the brass cap.

@ IF the canister is returned in unsatisfactory condition, you will be liable for damages.

For help call Client Services at 800-985-5955

Section 4. Sampling with Tedlar Bags

This section provides a description of Tedlar bags, practical considerations for sampling, and step-by-step instructions for collecting a grab sample. Photographs illustrate the correct way to assemble the various sampling components.

4.1 Introduction to Tedlar Bags

A Tedlar bag is a container used to collect a whole air sample for landfill gas, soil gas, and stationary source applications. The Tedlar bag is best suited for projects involving analysis of compounds in the ppmv range. However, Tedlar bags can be used for other applications such as ambient air monitoring for atmospheric/ fixed gases. They can be used to collect sulfur compounds, but only if the fittings are non-metallic (e.g., polypropylene, Teflon, or Nylon).

A Tedlar bag is made of two plies of Tedlar film sealed together at the edges and features a valve that allows the interior to be filled. Sample collection requires a pressurized sampling port, a low flow rate pump, or a lung sampler. The bag expands as sample enters. When the target volume of sample is collected, the valve is closed and the Tedlar bag is returned to the laboratory. Air Toxics Ltd. maintains a limited inventory of Tedlar bags in 1 L , 3 L, and 5 L volumes.

4.1.1 Tedlar Film

Tedlar is a trade name for polyvinyl fluoride film developed by DuPont Corporation in the 1960's. This patented fluoropolymer has been used in a wide variety of applications including protective surfacing for signs, exterior wall panels, and aircraft interiors. Tedlar film is tough, yet flexible and retains its impressive mechanical properties over a wide range of temperatures (well below freezing to over 200° F). Tedlar exhibits low permeability to gases, good chemical inertness, good weathering resistance, and low off-gassing.

4.1.2 How "Active" is the Surface of a Tedlar Bag?

The surface of a Tedlar bag is a work in progress. The surface of a new bag is essentially free of VOCs at the single digit ppbv level. Compounds detected from analyzing new Tedlar bags include methylene chloride, toluene, acetone, ethanol, and 2-propanol. Note that 2-propanol has been detected in some new bags up to 45 ppbv. Once the Tedlar bag is used, however, the surface has been exposed to moisture and possibly VOCs. It may irreversibly adsorb many VOCs at the low ppbv level. A series of purges with certified gas may not remove the VOCs from the surface. $15 for a new bag is a small price to pay for peace of mind.

⇨ **Never reuse a Tedlar bag when sampling for ppbv level compounds.**

4.1.3 Hold Time for a Tedlar Bag

The media hold time for a Tedlar bag is indefinite if stored out of sunlight in a cool, dry location. Tedlar bags can be used to collect samples containing common solvents, hydrocarbons, chlorinated solvents, sulfur compounds, and many other classes of compounds. The sample hold time to analysis varies for different classes of compounds:

- **24 hours**: Sulfur compounds (e.g., hydrogen sulfide and methyl mercaptan) and chemically active compounds (e.g., 1,3-butadiene).
- **72 hours**: Chlorinated solvents, aromatic compounds, and atmospheric/fixed gases (oxygen, nitrogen, carbon dioxide).

4.2 Tedlar Bag Sampling

Using a Tedlar bag to collect an air sample normally involves "active" sampling, unlike an evacuated canister that can be filled "passively" by simply opening the valve. There are two methods commonly used to fill a Tedlar bag: using a pump or a lung sampler.

- ***Sampling with a Pump***: The most common method to fill a Tedlar bag is to use a small pump with low flow rates (50-200 mL/min) and tubing to fill the bag. Air Toxics Ltd. does not provide pumps but they can be rented from equipment providers or purchased from manufacturers such as Neuberger or Gilian.

Pump

Air to be Sampled

Sealed Chamber

- ***Sampling with a Lung Sampler***: Alternatively to using a pump, a "lung sampler" can be used to fill a Tedlar bag. Although a little more complicated than simply using a pump, the main advantage to using a lung sampler is that it avoids potential pump contamination. A Tedlar bag with attached tubing is placed in a small airtight chamber (even a 5-gallon bucket can work) with the tubing protruding from the chamber. The sealed chamber is then evacuated with a pump causing the bag to expand and drawing the sample through the protruding tube into the bag. The sample air never touches the wetted surfaces of the pump. Air Toxics Ltd. does not provide lung samplers, but they can be rented from equipment suppliers or purchased by manufacturers such as SKC Inc.

4.2.1 Considerations for Tedlar Bag Sampling

The following are some considerations for collecting a Tedlar bag sample.

- **Fill the Tedlar bag no more than 2/3 full:** Allow for possible expansion due to an increase in temperature or decrease in atmospheric pressure (e.g., the cargo hold of a plane).

- **Keep the Tedlar bag out of sunlight:** Tedlar film is transparent to ultraviolet light (although opaque versions are available) and the sample should be kept out of sunlight to avoid any photochemical reactions.

- **Protect the Tedlar bag:** Store and ship the Tedlar bag samples in a protective box at room temperature. An ice chest can be used, but DO NOT CHILL.

- **Fill out the Tedlar bag label:** It is much easier to write the sample information on the label before the Tedlar bag is inflated.

- **Provide a second Tedlar bag:** Consider filling two bags per location in the rare occasion that a defective bag deflates before analysis.

- **Avoid Contamination:** Care should be taken to avoid contamination introduced by the pump or tubing. Begin sampling at locations with the lowest compound concentrations (e.g., sample the SVE effluent before the influent). Decontaminate the pump between uses by purging with certified air for an extended period; better yet, use a lung sampler. Use shortest length possible of Teflon tubing or other inert tubing. Do not reuse tubing. If long lengths of tubing are used, consider purging the tubing with several volumes worth before sampling. If you are concerned about sampling for trace compounds, you shouldn't be using a Tedlar bag (see Section 1.2).

- **Don't Sample Dangerous Compounds in a Tedlar Bag:** Do not ship any explosive substances, radiological or biological agents, corrosives, or extremely hazardous materials to Air Toxics Ltd.

Tedlar bag rupture during transit to the laboratory is possible and the sampler assumes full liability.

4.2.2 Step-by-Step Procedures for Tedlar Bag Sampling (Pump)

Note: These procedures are for a typical stationary source (e.g., SVE system) sampling application; actual field conditions and procedures may vary. See additional sampling considerations in Section 5.3 for sampling soil gas or landfill gas.

Before you get to the field:

1. Verify contents of the shipped package (e.g., chain-of-custody, Tedlar bag, and tubing/fittings – if requested).
2. Verify pump cleanliness and operation (Air Toxics Ltd. does not provide pumps).

When ready to sample:

3. Purge sample port.
4. Attach new Teflon tubing from sample port or probe to low flow rate pump.
5. Purge tubing.
6. Fill out Tedlar bag sample tag.
7. Attach additional new Teflon tubing from the pump outlet to the Tedlar bag valve.
8. Open Tedlar bag valve.
9. Collect sample (FILL NO MORE THAN 2/3 FULL).
10. Close Tedlar bag valve by hand tightening valve clockwise.
11. Return Tedlar bag in boxes provided (DO NOT CHILL).
12. Fill out chain-of-custody and relinquish samples properly.
13. Place chain-of-custody in box and retain pink copy.
14. Tape box shut and affix custody seal (if applicable) across flap.
15. Ship priority overnight to meet method holding times. 3 DAY HOLD TIME TO ANALYSIS (most analyses).

Section 5. Special Sampling Considerations

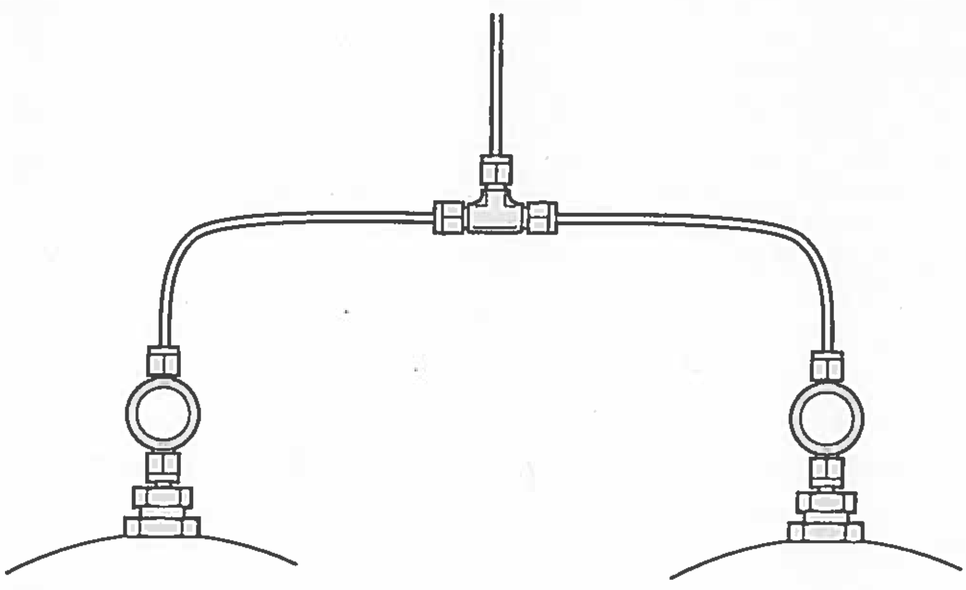
This section provides considerations for special sampling configurations that a sampler may collect in the field such as a field duplicates or an ambient blank. This section also provides considerations for sampling at altitude, soil/landfill gas sampling, and sample cylinder sampling.

5.1 Special Sampling Configurations

Special sampling configurations include a field duplicate, field split, field blank, ambient blank, trip blank, and an equipment rinse. Call Client Services at 800-985-5955 if your project involves any of these special sampling configurations.

5.1.1 Field Duplicate

A field duplicate is a second sample collected in the field simultaneously with the primary sample at one sampling location. The results of the duplicate sample can be compared (e.g., calculate relative percent difference) with the primary sample to provide information on consistency and reproducibility of field sampling procedures. Due to the nature of the gas phase, duplicate samples should be collected from a common inlet. The configuration for collecting a field duplicate includes stainless steel or Teflon tubing connected to a Swagelok "tee".



5.1.2 Field Blank

A field blank is a sample collected in the field from a certified air source. Analysis of the field blank can provide information on the decontamination procedures used in the field. Clean stainless steel or Teflon tubing and a certified regulator should be used. It is imperative that individually certified canisters (the sample canister and the source canister/cylinder, if applicable) be used to collect a field blank.

5.1.3 Ambient Blank

An ambient blank is an ambient air grab sample collected in the field normally used in conjunction with soil gas or stationary source (e.g., SVE system) sampling. Analysis of the ambient blank can provide information on the ambient levels of site contaminants. It is imperative that an individually certified canister be used to collect an ambient blank.

5.1.4 Trip Blank

When sampling for contaminants in water, the laboratory prepares a trip blank by filling a VOA vial with clean, de-ionized water. The trip blank is sent to the field in a cooler with new sample vials. After sampling, the filled sample vials are placed back in the cooler next to the trip blank and returned to the laboratory. Analysis of the trip blank provides information on decontamination and sample handling procedures in the field as well as the cleanliness of the cooler and packaging.

When sampling for compounds in air, a trip blank provides little, if any, of the information above. A trip blank canister can be individually certified, evacuated, and sent to the field in a box with the sample canisters. Since the valve is closed and the brass cap tightened, it is questionable if the trip blank canister contents are ever "exposed" to sampling conditions. At the laboratory, the trip blank canister will be pressurized prior to analysis with dry, nitrogen – a matrix that may be entirely different than the sampled air. The recovery of target compounds can vary by matrix (e.g., moisture, carbon dioxide) rendering the trip blank results meaningless. **Air Toxics Ltd. does not recommend analyzing a trip blank for air sampling.**

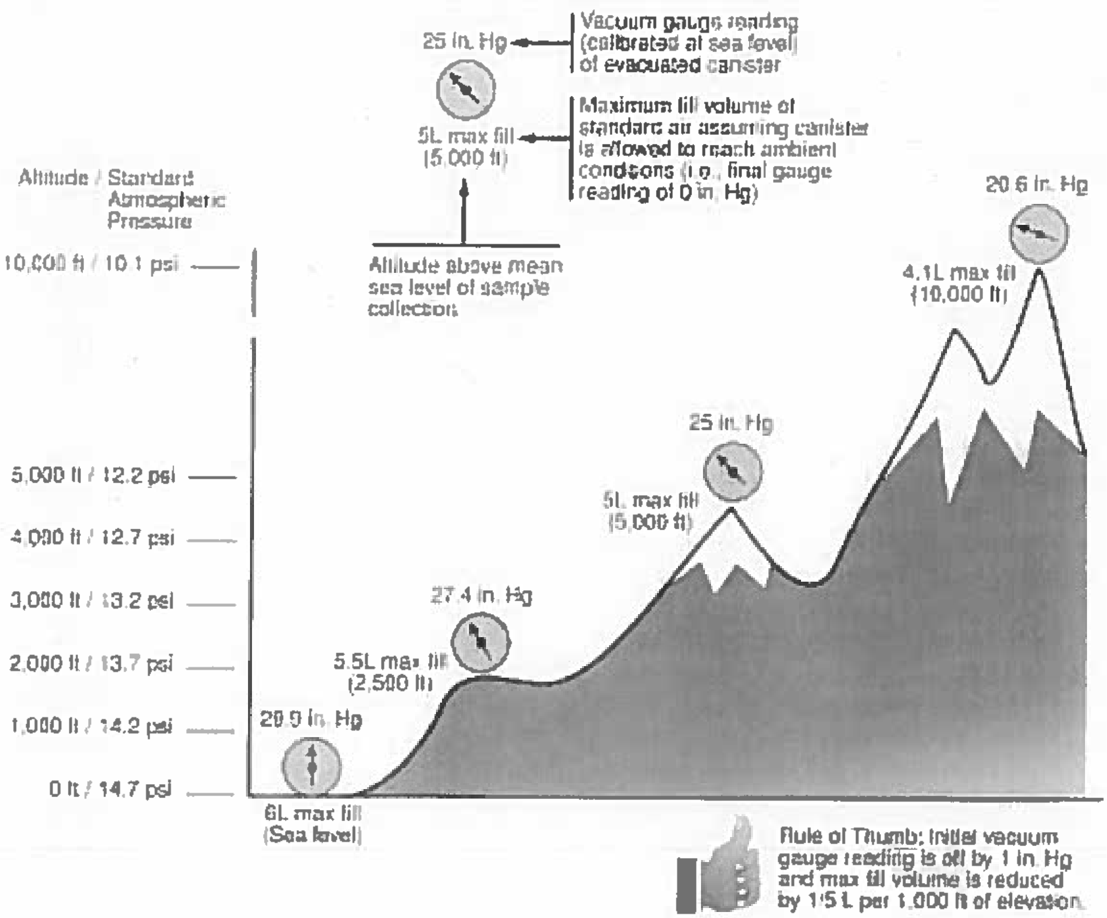
5.2 Considerations for Sampling at Altitude

Sampling at altitudes significantly above sea level is similar to sampling a stationary source under vacuum in that target fill volumes may be difficult to achieve. The figure below illustrates the relationship between increasing altitude and decreasing atmospheric pressure. Ambient conditions in Denver at 5,000 ft altitude are quite different than ambient conditions at sea level. Canister sampling is driven by the differential pressure between ambient conditions and the vacuum in the canister. There is less atmospheric pressure in Denver and 5 L is the maximum fill volume of standard air assuming the canister is allowed to reach ambient conditions (i.e., final gauge reading of 0 in. Hg). Theoretically, if you sample high enough (e.g., in space), no sample would enter the canister because there is no pressure difference between the evacuated canister and ambient conditions. To fill a canister to 6 L in Denver, you would need to use an air pump.

Sampling at altitude also affects gauge readings. The gauges supplied by Air Toxics Ltd. (see Section 2.2.4) measure canister vacuum relative to atmospheric pressure and are calibrated at approximately sea level. Before sampling at altitude, the gauges should be equilibrated (see Section 3.1). But even after equilibrating the gauge, verifying the initial vacuum of a canister at altitude is misleading. In Denver at 5,000 ft, expect the gauge to read 25, not 29.9 in. Hg. You do not have a bad canister (i.e., leaking or not evacuated properly). The canister is ready for sampling and the gauge is working properly.

⇨ Rule of Thumb: For every 1,000 ft of elevation, the gauge will be off by 1 in. Hg and the fill volume will be reduced by 1/5 L.

If you have questions about sampling at altitude, please call Client Services at 800-985-5955.



5.3 Considerations for Soil/Landfill Gas Sampling

There are some additional sampling considerations for collecting grab samples (canister or Tedlar bag) from a soil boring, landfill boring, SVE system, or landfill gas (LFG) collection system. The general challenge with these samples arises from the need to employ long lengths of tubing to direct the soil gas, landfill gas, or process air to the canister or Tedlar bag. Tubing introduces the potential for contamination and diluting the sample.

- **Use inert tubing.** Teflon tubing is recommended. Tubing with an outer diameter of 1/4 in. works best with the fittings on the particulate filter.

- **Do not reuse tubing.** $2 per foot for new tubing is a small price to pay for peace of mind.

- **Purge tubing adequately.** A long length of tubing has significant volume of "dead air" inside. Without purging, this air will enter the canister and dilute the sample. Consider using a hand-held PID/FID to confirm that you have purged the tubing and are drawing sample air through the tubing.

- **Avoid leaks in the sampling train.** Leaks of ambient air through fittings between pieces of the sampling train (e.g., tubing to particulate filter) will dilute the sample.

- **Don't sample water.** If moisture is visible in the sample tubing, the soil gas sample may be compromised. Soil gas probes should be at an appropriate depth to avoid reaching the water table. Additionally, subsurface vapor should not be collected immediately after measurable precipitation.

- **Purge the sample port.** A sample port on a SVE system or LFG collection system can accumulate solids or liquids depending upon the location of the port in the process and the orientation of the port. An influent sample port located upstream of a filter or moisture knock-out can be laden with particulates or saturated with water vapor. Heavy particulate matter can clog the particulate filter and foul the canister valve. It is important to prevent liquids from entering the canister. A sample port oriented downward may have liquid standing in the valve. Purge the sample port adequately before connecting the sampling train.

- **Consider the effects of sampling a process under vacuum or pressure.** When collecting a grab sample from a stationary source such as an SVE system or LFG collection system, some sample ports may be under vacuum or pressure relative to ambient conditions. When the sample port is under vacuum, such as the header pipe from the extraction well network, it may be difficult to fill the canister with the desired volume of sample. A vacuum pump can be used to collect a canister grab sample from a sample port under considerable vacuum. See the related discussion on sampling at altitude in Section 5.2. When the sample port is under pressure, such as the effluent stack downstream of the blower and treatment system, you may inadvertently pressurize the canister. Only a DOT-approved sample cylinder should be used to transport pressurized air samples (see Section 5.4). Under no circumstances should an Air Toxics Ltd. canister be pressurized more than 5 psig for a 6 L canister and 15 psig for a 1 L canister. Bleed off excess pressure by opening the valve temporarily while monitoring the canister with a pressure gauge.

5.4 Considerations for Sample Cylinder Sampling

Sample cylinders, also known as "sample bombs", are DOT-approved, high pressure, thick-walled, stainless steel cylinders with a valve at each end. They were intended for collecting a pressurized sample for petroleum gas applications. Sample cylinders differ from sample canisters in that they do not have a Summa-passivated interior surface and are not evacuated prior to shipment. Sample cylinders are not suitable for analysis of hydrocarbons at ppbv levels. Sample cylinders can be used for analysis of natural gas by ASTM D-1945 and calculation of Btu by ASTM D-3588. Air Toxics Ltd. assumes that clients requesting a sample cylinder have a pressurized process and sample port with a built-in gauge and 1/4 in. Swagelock fitting to attach to the sample cylinder. Air Toxics Ltd. has an inventory of 500 mL sample cylinders that are particularly suited for landfill gas collection systems (i.e., LFG to energy applications). This section provides step-by-step procedures for sampling with a sample cylinder.

Step-by-Step Procedures for Sample Cylinder Sampling

These procedures are for a typical stationary source sampling application and actual field conditions and procedures may vary. Follow all precautions in the site Health and Safety Plan when dealing with a pressurized sample port and sample cylinder.

1. Verify contents of the shipped package (e.g., chain-of-custody, sample cylinder, particulate filter).
2. Verify that gauge on sample port is working properly.
3. Purge sample port.
4. Remove brass caps on either end of cylinder.
5. Attach particulate filter to upstream valve.
6. Attach filter/cylinder assembly directly to the sample port.
7. Open both valves 1/2 turn.
8. Allow sample air to flow through sample cylinder (approximately 10 L for a 500 mL cylinder).

9. Close downstream valve of sample cylinder by hand tightening knob clockwise.
10. Allow sample cylinder to pressurize to process pressure (max 100 psig).
11. Close upstream valve of sample cylinder and sample port.
12. Detach filter/cylinder assembly from sample port and remove particulate filter.
13. Replace brass caps.
14. Fill out sample cylinder sample tag.
15. Return sample cylinder in box provided.
    - Unreturned sample cylinder charge of $650 each
16. Return sample media in packaging provided. Unreturned equipment charges:
    - $45 per particulate filter
17. Fill out chain-of-custody and relinquish samples properly.
18. Place chain-of-custody in box and retain pink copy.
19. Tape box shut and affix custody seal (if applicable) across flap.
20. Ship accordingly to meet method holding times.

APPENDIX L

2014 Technical Memorandum Re: Groundwater Treatment System Decommissioning SWMU-20

The Boeing Company
P.O. Box 3707
Seattle, WA 98124-2207

May16, 2014
9L-22-N410-JNB-062

BY EMAIL

Mr. Byung Maeng
WA Department of Ecology
Hazardous Waste & Toxics Reduction Program
Northwest Regional Office

Subject: Tech Memo describing the removal of the Pump & Treat System formally used at SWMU-20 at Boeing Developmental Center

Dear Mr. Maeng,

As we discussed by telephone on May 15th, attached to this cover letter is a Technical Memorandum prepared by Landau Associates documenting our plan for decommission and removal of the groundwater treatment system that was used at Solid Waste Management Unit-20 (SWMU-20) at the Boeing Developmental Center. As the Tech Memo explains, the system was installed during the fall of 1993 and operated until December 2003, when the system was shut off after the bulk of remaining VOCs had been removed by the system. Groundwater monitoring in SWMU-20 has continued since the system shutoff and between 2004 and 2008 there have been four electron donor injection events completed in response to relatively low-level VOC rebound. Monitoring results show that the injections are very effective in controlling rebound. We believe there is very low risk associate with the removal of the SWMU-20 treatment system since in situ bioremediation through electron donor amendment has worked so well in managing rebound. Semiannual groundwater monitoring will continue at SWMU-20 and we will of course continue to provide regular reports to Ecology summarizing sample results and we will keep you informed if any future injection work might be needed.

We plan to start the decommission work in about mid-June. Can you please call me if you have any concerns or questions about proceeding with this work? Thank you very much for your consideration in this matter.

Sincerely,

James Bet
Developmental Center Remediation Project Manager
Boeing Environmental Remediation
PO Box 3707, M/C 1W-12
Seattle, WA 98124-2207

Cc: Clint Jacobs – Landau Associates

TECHNICAL MEMORANDUM

LANDAU ASSOCIATES
ENVIRONMENTAL | GEOTECHNICAL | NATURAL RESOURCES

TO: Jim Bet, The Boeing Company

FROM: Clint Jacob, P.E., L.G.

DATE: May 16, 2014

RE: GROUNDWATER TREATMENT SYSTEM DECOMMISSIONING
SWMU-20 – BOEING DEVELOPMENTAL CENTER
TUKWILA, WASHINGTON

INTRODUCTION

This technical memorandum documents The Boeing Company's (Boeing) plan to decommission the groundwater treatment system in Solid Waste Management Unit 20 (SWMU-20) at the Developmental Center (DC) in Tukwila, Washington. The DC, located at 9725 East Marginal Way South, is a regulated facility under the Resource Conservation and Recovery Act (RCRA) with a facility identification number of WAD-09363-9946. The Washington State Department of Ecology (Ecology) is authorized by the U.S. Environmental Protection Agency (EPA) to implement RCRA corrective action through its Model Toxics Control Act (MTCA) regulations. Boeing is performing remedial actions at the DC under Ecology's voluntary cleanup program (VCP).

The groundwater treatment system will be removed from the DC for reuse at Boeing's Queen City Farm (QCF) site near Maple Valley, Washington. QCF is a Superfund site administered by the EPA.

DC SWMU-20 BACKGROUND

Historic release of tetrachloroethene (PCE) and trichloroethene (TCE) in SWMU-20 from a former vapor degreaser in Building 9-101 (Landau Associates 2002) resulted in implementation of remedial actions beginning in 1989. Approximately 1,400 tons of contaminated soil was excavated in 1989. A groundwater treatment system was constructed in fall 1993 and operated through December 14, 2001. Groundwater pump and treat achieved plume containment and contaminant mass removal, with mass removal becoming asymptotic near the end of system operation. Groundwater monitoring during a 2-year period following system shutdown served to evaluate potential rebound of contaminant concentrations in groundwater.

Following rebound of volatile organic compound (VOC) concentrations in monitoring wells located in the immediate vicinity of the former vapor degreaser, Boeing commenced active remediation by *in situ* bioremediation through electron donor amendment. Four electron donor injection events were conducted in 2004 through 2008 at wells in and near the source zone (Landau Associates 2008) accompanied by performance groundwater monitoring. Bioremediation was highly effective in reducing contaminant concentrations in targeted wells. In recognition of effective source zone treatment and decreasing contaminant concentrations at SWMU-20 wells, Ecology approved a plan for reduced groundwater monitoring in 2010 (Landau Associates 2010). In addition, the NPDES permit which was obtained for the discharge of treated water processed by the SWMU-20 treatment system was allowed to expire in 2003 (Boeing 2003) as it became clear that bioremediation would be an effective mechanism to mange VOC rebound. Since then, we have continued to use bioremediation and even though additional rebound is not expected, we are confident that bioremediation would continue to be an effective method to manage any rebound near SWMU-20 in the future.

SWMU-20 groundwater monitoring results indicate that bioremediation continues to be enhanced at and near source injection wells. Ongoing semiannual groundwater monitoring in SWMU-20 constitutes MNA with enhancement of natural attenuation continuing due to residual effects of prior donor injections. Electron donor injections for further stimulation of bioremediation within SWMU-20 are not anticipated at this time.

SYSTEM DECOMMISSIONING

The system consists of two extraction wells connected to a treatment building containing the automated treatment system. Extracted groundwater was passed through a tray air stripper for treatment, and then discharged to a stormwater outfall under a national pollution discharge elimination system (NPDES) permit.

Decommissioning activities will consist of removal of the treatment building will all contained equipment for offsite reuse; extraction pumps will also be removed. Electrical service to the treatment building will be disconnected. Extraction well piping will be disconnected and capped at the wells. The extraction wells will remain at the Site, to be decommissioned at a future time. System discharge piping will be disconnected and capped. A fire suppression line and bracing from the adjacent bag filter stand will also be disconnected. The air discharge stack will be disconnected from Building 9-101. Pavement beneath and around the building will be patched, as needed.

Boeing (Jim Bet) initially discussed decommissioning of the SWMU-20 system with Ecology (Byung Maeng) in May 2011. Ecology agreed that the pump and treat system was not likely to be needed in the future due to treatment resulting from in situ bioremediation. Ecology requested that the extraction wells not be decommissioned at this time.

SCHEDULE

It is anticipated that system decommissioning/removal will be completed in June 2014.

CLJ/rgm

REFERENCES

Boeing. 2003. Letter from James Bet to Byung Maeng (Washington Department of Ecology) *re: SWMU-20 Pump and Treat Remediation System and Site NPDES Permit No. WA-003148-8 Status, Boeing Developmental Center, Tukwila, WA.* May 7.

Landau Associates. 2013. *Proposed Cleanup Standards and Comparison to Site Data, Boeing Developmental Center, Tukwila, Washington.* May 3.

Landau Associates. 2010. Technical Memorandum: *Reduction-SWMU-20 Groundwater Monitoring Program (Revised to Address Ecology Conditional Approval), Boeing Developmental Center, 9725 East Marginal Way South, Tukwila, Washington*. April 1.

Landau Associates. 2008. Technical Memorandum: *SWMU-20 Work Plan Addendum, Fourth Electron Donor Injection, Boeing Developmental Center, Tukwila, Washington*. July 30.

Landau Associates. 2002. *Summary Report, Corrective Action, Boeing Developmental Center*. February 27.

APPENDIX M

2013 Report: Proposed Cleanup Standards and Comparison to Site Data

Proposed Cleanup Standards and Comparison to Site Data Boeing Developmental Center Tukwila,Washington

May 7, 2013

Prepared for

The Boeing Company

LANDAU ASSOCIATES
130 2nd Avenue South
Edmonds, WA 98020
(425) 778-0907

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FIGURES

TABLES

1.0 INTRODUCTION

This document presents proposed cleanup standards for The Boeing Company (Boeing) Developmental Center (DC) and compares site data to proposed standards. The DC is located at 9725 East Marginal Way South, Tukwila, Washington (Figure 1). The DC is a regulated facility under the Resource Conservation and Recovery Act (RCRA) with a facility identification number of WAD-09363-9946. The Washington State Department of Ecology (Ecology) is authorized by the U.S. Environmental Protection Agency (EPA) to implement RCRA corrective action through its Model Toxics Control Act (MTCA) regulations. Boeing is performing remedial actions at the DC under Ecology's voluntary cleanup program (VCP).

1.1 BACKGROUND

Under its RCRA corrective action authority, the EPA conducted a RCRA Facility Assessment (RFA) in 1994 and identified 157 Solid Waste Management Units (SWMUs) and 5 Areas of Concern (AOCs) at the DC (SAIC 1994). Ecology approved exclusion of most SWMUs and AOCs from further investigation based on the determination that they do not pose a threat to human health or the environment. The status of each SWMU and AOC was documented in a previous summary report (Summary Report) prepared by Landau Associates (Landau Associates 2002).

As described in the Summary Report (Landau Associates 2002), only two SWMUs (SWMU-17 and SWMU-20) and three AOCs (AOC-01/02, AOC-03/04, and AOC-5) remained subject to continued groundwater monitoring and evaluation. Groundwater monitoring was completed at AOC-01/02 and AOC-03/04, in accordance with the *Developmental Center Groundwater Monitoring Plan* (Boeing 2001), which required two consecutive quarters and four consecutive quarters, respectively, during which contaminants of concern were not detected (Boeing 2002, 2003; Ecology 2002).

Groundwater monitoring and treatment has continued at the remaining AOC and two SWMUs as summarized below. Additional detail regarding the history, contamination, and remedial actions pertaining to these three areas is provided in a 2004 evaluation report (Landau Associates 2004) and in more recent reports as summarized below. Substantial vadose zone soil contamination was not observed or was removed during early stages of remedial action. Furthermore, aquifer bioremediation injections in the source areas resulted in groundwater mounding for treatment of residual contamination if present above the water table. The extent of groundwater contamination ends well upgradient of the Duwamish Waterway; therefore, surface water and sediment are not potentially impacted media. The extent of the SWMU-20 groundwater plume led to evaluation of indoor air in a downgradient office building. The remaining AOC and two SWMU locations are shown on Figure 2.

- AOC-05: AOC-05 is a former 1,000-gallon unleaded gasoline underground storage tank (UST, DC-01) with an associated pump island that was located near the southwest corner of Building 9-61. After being punctured by a measuring rod, the steel UST was removed in 1985. Free product was recovered and contaminated soil removed at the time of UST decommissioning. Oxygen Release Compound (ORC®) was injected in May 2002 to stimulate aerobic biodegradation of gasoline-range petroleum hydrocarbons (TPH-G) and benzene, toluene, ethylbenzene, and xylenes (BTEX) present in groundwater. However, monitoring results indicated that ORC stimulation of aerobic bioremediation was ineffective in changing aquifer conditions or decreasing contaminant concentrations, due to naturally high organic carbon content in the aquifer and reduced aquifer redox conditions. An alternative approach using injected nitrate to stimulate anaerobic bioremediation was successfully pilot tested in 2007. Full-scale biotreatment consisting of nitrate injection to two AOC-05 wells was conducted. Eight full-scale injections performed in 2008-2012 have resulted in substantial contaminant concentration reduction. The most recent evaluation of data is presented in the AOC-05 2011 annual report (Landau Associates 2012a).

- SWMU-17: SWMU-17 is a former 67-gallon sump and associated 4,000-gallon steel UST (DC-05) used to accumulate waste oil. The sump and UST, located east of the Building 9-75 water tank, were removed in 1986. Substantial soil contamination was not observed during sump and UST removal. Monitoring wells were subsequently installed and relatively low levels (<40 µg/L) of tetrachloroethene (PCE) and trichloroethene (TCE) and breakdown product cis-dichloroethene (cDCE) were detected in groundwater. Petroleum hydrocarbons were not detected in groundwater. Metals (copper and arsenic) were detected and identified for additional groundwater monitoring. Pilot testing was performed in 2008-2010 to evaluate injection of electron donors to stimulate anaerobic bioremediation. Substantial reduction of PCE and TCE was achieved at the injection well and nearest downgradient well without substantial accumulation of subsequent breakdown products cDCE and vinyl chloride (VC); treatment effects on copper and arsenic were not definitive. Additional characterization was performed in 2010 and 2011 to further delineate the groundwater plume for treatment. Electron donor was injected to 11 wells within the plume in August 2011. Post-injection data indicated enhanced bioremediation at all injection wells and some nearby wells. Additional details regarding plume characterization and pilot-scale and full-scale treatment are presented in the full-scale work plan (Landau Associates 2011). The most recent evaluation of data is presented in the 2011-2012 annual report (Landau Associates 2013a).

- SWMU-20: SWMU-20 is a former vapor degreaser located in the northwest corner of Building 9-101. The degreaser pit and sumps were decommissioned in 1984 by plugging all openings, backfilling with clean fill, and covering with a concrete slab. During building upgrades in 1989, approximately 1,400 tons of PCE- and TCE-impacted soil was removed from around the former degreaser pit and sumps. The excavation extended somewhat below the water table, which was above the base of the degreaser pit. A groundwater pump and treat system was constructed in 1993 to treat the contaminant plume. After approximately 8 years of operation, the size of the contaminant plume was substantially reduced and the system was shut down in December 2001 to evaluate monitored natural attenuation as a remedial alternative to reach site cleanup concentrations for residual PCE and TCE. Two years of semiannual post-treatment monitoring data indicated a greater rate of PCE and TCE concentration reduction under non-pumping conditions than had been achieved during the period of pumping and treatment. Following this 2-year evaluation period, natural attenuation was enhanced through source injection of electron donor substrates to 8 wells located in the immediate vicinity of the vapor degreaser and nearby downgradient wells. Four donor injection events in 2004, 2005, and 2008 stimulated reductive dechlorination and substantial concentration reduction of PCE, TCE, and breakdown products cDCE and VC. Subsequent groundwater monitoring constitutes monitored natural attenuation (MNA). The most recent evaluation of data is presented in the November 2012 semiannual monitoring report for the site (Landau Associates 2013b).

1.2 OBJECTIVES

The objectives of this document are as follows:

1. Develop cleanup standards consisting of contaminant cleanup levels (CULs) and the point of compliance (POC) at which CULs will apply (Section 3.0). Cleanup standards are proposed for groundwater contaminants in AOC-05, SWMU-17, and SWMU-20 and for volatile organic compounds (VOCs) in groundwater with the potential to migrate to indoor air. Cleanup standards are based on ecological and human health risk specific to the site location, hydrogeology, and site use, and are developed in accordance with WAC 173-340 Part VII.
2. Compare contaminant concentrations in the remaining site SWMUs and AOC to the proposed cleanup standards (Section 5.0).
3. Provide evaluation of cleanup actions underway in the three active areas. Active treatment resulting from bioremediation injections in SWMU-20 has been followed by a period of MNA. Similarly, active treatment still underway in AOC-05 and SWMU-17 following more recent bioremediation injections is anticipated to be followed by a later period of MNA. The combination of active treatment and MNA is anticipated to achieve cleanup standards in each area. Active bioremediation performed in each area enhances continued natural attenuation during the MNA phase. It is also anticipated that deed restrictions or other restrictive covenants may be applied at the site to prevent human exposure.

2.0 SITE SETTING

The DC is located at 9725 East Marginal Way South in Tukwila, Washington (Figure 1). The DC is primarily an aircraft and aerospace research and development complex with most of the work supporting U. S. Department of Defense projects. The facility consists of approximately 60 buildings on 118.9 acres of property. Boeing owns 89.1 acres and leases the remaining 29.8 acres. This acreage does not include 5.4 acres previously owned by Boeing near the northeast corner of the site that was donated to the Museum of Flight.

The DC is bounded by the Duwamish Waterway to the south and west; by the former Rhone Poulenc Company chemical manufacturing facility (current Container Properties LLC and Museum of Flight properties) to the north; and by East Marginal Way South on the east (Figure 1). The Military Flight Center and Museum of Flight are located east of the DC, across East Marginal Way South, with the Boeing Field King County Airport located farther east. An additional 39.7 acres of Boeing-leased property on the west side of the Duwamish Waterway (the Oxbow lease) is not considered part of the RCRA facility.

2.1 REGIONAL GEOLOGY AND HYDROGEOLOGY

This section presents a summary of regional geology and hydrogeology to provide background for land and water use discussions. A detailed description of regional and site geology/hydrogeology is presented in the summary report (Landau Associates 2002).

The DC is located within the Duwamish Valley lowland along the floodplain of the Duwamish Waterway. The Duwamish/Green River Valley is a relict subglacial meltwater channel eroded during the retreat of the Puget lobe of the most recent glaciation (Vashon Stade of the Fraser Glaciation) about 14,000 years ago. With the retreat of the lobe, the Duwamish/Green River Valley was occupied by a deep embayment of Puget Sound that extended inland to near present day Sumner, Washington. Marine sedimentation occurred in the embayment until about 5,000 years ago when a large volcanic mudflow off of Mount Rainier (the Osceola Mudflow) swept down the Puyallup and Whiter River Valleys, partially spilling into the Duwamish/Green River Valley and out into Puget Sound, extending sediment deposition to near present day Tukwila and the DC. Subsequent channel incision and erosion resulted in increased sediment loads, river aggradation, and delta progradation that eventually filled the valley with estuarine sediments. Within the last 100 years, natural meanders of the Duwamish River have been filled to channelize the river, including the section adjacent to the DC (Bortleson et. al, 1980).

The Duwamish River is a regional lowland stream that represents a regional groundwater discharge zone. In the vicinity of the DC, the river is separated from Puget Sound to the west by the West Seattle and Des Moines Uplands, and from Lake Washington to the east by Beacon Hill and the Skyway

Upland (Galaster and Laprade 1991). Regional groundwater flow is from these upland areas toward the river and Elliott Bay. In the shallow unconfined aquifer, groundwater flow in the valley lowland is toward the river. Regional vertical groundwater flow is upward from deep aquifers toward the river. Adjacent to the Lower Duwamish Waterway (LDW), DC groundwater is tidally influenced, which affects groundwater flow and quality (e.g., salinity). Even at valley locations distant from the LDW, groundwater in deeper portions of the shallow unconfined aquifer is brackish connate water due to the marine and estuarine depositional environment.

The LDW is comprised of both marine and fresh surface water. Following the initial dredging and realignment of the LDW, saltwater from the Puget Sound extended back into the waterway and infiltrated the upland groundwater (ERM and Exponent 2000). As a result of the saltwater intrusion into the LDW, a saltwater wedge extends to the upper turning basin located south of the DC (Windward Environmental 2010). The saltwater wedge consists of fresh water on top of denser saltwater. The saltwater has also intruded from the LDW to the DC and other shoreline properties.

2.2 CURRENT AND FUTURE LAND USE

The DC meets the MTCA criteria for an industrial property [WAC 173-340-745(1)]. The DC is located within a large contiguous industrial land use area, which extends from Harbor Island to near the head of navigation of the Duwamish Waterway (King County 2008). This zone represents one of the largest contiguous industrial areas within Washington State. Comprehensive Plans for Seattle and Tukwila identify this industrial area as critical to continued manufacturing jobs in the region (City of Seattle 2005; City of Tukwila 2008). In addition, the DC is zoned as manufacturing industrial center/heavy industrial by the City of Tukwila, which is conducting land use planning under the Growth Management Act. Boeing has no plans to relinquish ownership of the property.

The DC meets the exclusion from a terrestrial ecological evaluation requirement based on WAC 173-340-7491(1). Impacted soil at the site is covered by buildings and pavement that prevent plants or wildlife from being exposed to the soil.

2.3 BENEFICIAL GROUNDWATER USE

Given the location of the site within the Duwamish Valley and adjacent to the LDW, the highest beneficial use for groundwater at the Site is considered to be discharge to surface water that is not a drinking water source. Groundwater at the DC meets the criteria listed in WAC 173-340-720(2)(d), which support this designation. Each of the criteria is discussed below:

- **The groundwater does not serve as a current source of drinking water.** There are no known municipal or domestic water wells within at least ½ mile of the DC. Two municipal supply wells are located approximately ¾ mile west and 1 mile south of the DC, respectively. These wells are located on the opposite side of the LDW from the DC and on the West

Seattle Upland, not in the Duwamish Valley lowland. Given the regional flow of groundwater toward the river from the highlands on both sides of the valley, these wells would not be impacted by constituents in DC groundwater.

- **It is unlikely that hazardous substances will be transported from the contaminated groundwater to groundwater that is a current or potential future source of drinking water.** Groundwater in the vicinity of the DC is not a current or potential future source of drinking water due to an established municipal water supply in the Duwamish Valley and due to the proximity of the LDW (i.e., saltwater intrusion). The City of Tukwila Public Works Department, Water Utility Division, supplies water provided by Seattle Public Utilities, which comes from the Cedar River Watershed. The water utility is required to provide retail water service to all new connections within its water service area (WAC 246-290-106). Any new water user in the valley must connect to the public water system (King County Board of Health Title 12.32). Washington Department of Health guidelines (WDOH 2001) identify wells within a half mile of a marine shoreline, with pumped water level below sea level, to be at risk for saltwater intrusion. As described in Section 2.1, shallow groundwater at the DC is tidally influenced and deeper portions of the unconfined aquifer consist of brackish connate water. Shallow groundwater in the unconfined aquifer discharges to the LDW. Groundwater from deeper portions of the unconfined aquifer discharges upward to shallow groundwater and to the LDW.
- **There are known or projected points of entry of the groundwater into the surface water.** The DC is a shoreline site along the LDW and shallow groundwater at the site flows west to discharge to the waterway.
- **The surface water is not classified as a suitable domestic water supply source.** The LDW adjacent to and downstream of the site consists of fresh water overlying salt water (Windward Environmental 2010) and is not considered a suitable domestic water supply source (WAC 173-201A-602).
- **The groundwater is sufficiently hydraulically connected to the surface water that the groundwater is not practicable to use as a drinking water source.** The shallow unconfined aquifer at the site is hydraulically connected to the Duwamish Waterway as evidenced by the tidal response observed in site monitoring wells (Landau Associates 1987; Tetra Tech 1996).

Designated uses of the LDW (WAC 173-201A-602) are salmonid rearing and migration, secondary contact recreation, industrial/agricultural water supply, stock watering, wildlife habitat, harvesting, commerce and navigation, boating, and aesthetics. The LDW is not designated as a potential drinking water source. These uses are expected to continue. Although WAC 173-201A designates the Duwamish River as fresh surface water, it is well understood that the LDW consists of a layer of fresh water overlying tidally controlled marine water with variable amounts of each depending on the river flow and tidal stage (Windward Environmental 2010).

3.0 CONTAMINANTS OF CONCERN

This section presents contaminants of concern (COCs) for the remaining AOC (AOC-05) and SWMUs (SWMU-17 and SWMU-20).

COCs for groundwater are based on the nature of releases that occurred in each area (Section 1.1; Landau Associates 2002, 2004) and the results of extensive groundwater monitoring in each area (Landau Associates 2002, 2012c). For SWMU-17, COCs are PCE, TCE, cDCE, VC, and the metals arsenic and copper. For SWMU-20, COCs are the same VOCs (PCE, TCE, cDCE, VC) plus benzene and naphthalene. COCs for AOC-05 are TPH-G plus BETX; xylenes are evaluated as total xylenes. Nitrate, injected for bioremediation in AOC-05, and potential breakdown product nitrite, are also considered COCs. Additionally, any other constituents detected in groundwater in the one and a half year period ending February 2013 (includes November 2011 through February 2013 quarterly and semiannual monitoring data) are included as COCs for the purpose of CUL development. The comprehensive list of DC groundwater COCs for which CULs will be developed is presented in Table 1.

COCs for indoor air consist of the volatile groundwater COCs. This includes the primary groundwater COCs based on the nature of releases and extensive groundwater monitoring. It also includes VOCs detected in groundwater from November 2011 through August 2012. The comprehensive list of DC indoor air COCs for which CULs will be developed is presented in Table 2.

4.0 PROPOSED CLEANUP STANDARDS

This section proposes cleanup standards for groundwater and indoor air. Cleanup standards are not developed for soil, surface water, or sediment. As described in Section 1.1, substantial vadose zone soil contamination was not observed or was removed during early stages of remedial action. The extent of contamination in groundwater ends well upgradient of the Duwamish Waterway; therefore, surface water and sediment are not potentially impacted media.

These cleanup standards will be used for comparison with concentrations of groundwater contaminants in AOC-05, SWMU-17, and SWMU-20 and for indoor air concentrations of VOCs. Proposed cleanup standards include both CULs and POC. Proposed CULs are developed in accordance with WAC 173-340-720. Approved cleanup standards will be used to evaluate whether site conditions are protective of human health and the environment.

4.1 GROUNDWATER

We propose to use Boeing Plant 2 Target Media Cleanup Levels (TMCLs) as groundwater CULs for the DC. The TMCLs were developed by Boeing and approved by EPA for use at the Boeing Plant 2 facility (Boeing 2011; EPA 2011a,b). Boeing subsequently submitted revised TMCLs to EPA based on updated toxicity information and other factors for 1,1 dichloroethene, methylene chloride, PCE, TCE, VC, aluminum, and barium (Floyd Snider 2013), and it is anticipated that the revisions will be approved as part of approval of final media cleanup levels. The proposed groundwater CULs for the DC COCs are presented in Table 3.

The Plant 2 TMCLs are being used at other nearby properties adjacent to the LDW. Using them as CULs for the DC results in DC CULs consistent with nearby properties. Plant 2 is located on the east bank of the LDW about one and a quarter miles downstream from the DC. Boeing is also proposing to use Plant 2 TMCLs as screening levels in a draft RI Report being prepared for the Boeing Isaacson-Thompson MTCA site, located on the east bank of the Duwamish Waterway about one-half mile downstream from the DC.

The Plant 2 TMCLs are protective of groundwater beneficial uses including discharge to fresh and marine surface water, protection of aquatic life, and human ingestion of fish and shellfish. Drinking water criteria were adopted as TMCLs only for constituents for which there were no state or federal promulgated surface water criteria and insufficient information to calculate TMCLs protective of human health and aquatic life. In limited instances, Plant 2 TMCLs are based on MTCA Method A or background values. MTCA Method A values are used for petroleum hydrocarbons in accordance with

WAC 173-340-730(3)(b)(iii)(C). TMCLs for several naturally occurring metals are based on background levels previously approved by EPA for use along the LDW including arsenic and copper (EPA 2006).

TMCL calculations to determine criteria protective of human health exposure pathways were modified to be protective of sensitive populations [Northwest American Indian Tribes and Asian and Pacific Islanders (A&PI)] with greater than average consumption of fish and shellfish. Modifications were as described in the Plant 2 TMCL Technical Memorandum (Boeing 2011).

Under MTCA, the POC is the point or points where the CULs must be attained. It is anticipated that CULs can be achieved for all or most site COCs at the standard POC, which is throughout groundwater at the Site from the uppermost level of the saturated zone to the lowest depth that could be impacted in accordance with WAC 173-340-720(8). However, the Plant 2 TMCLs are based on groundwater discharge to surface water and utilize a conditional POC near the groundwater/surface water interface. Boeing may propose use of conditional POCs, in accordance with WAC 173-340-720(8). The potential need to propose conditional POCs at the DC will be re-evaluated as groundwater cleanup actions continue at the AOC and the two SWMUs that remain active.

4.2 INDOOR AIR

In January 2006, Boeing performed indoor air sampling in Building 9-90, located downgradient of bioremediation in the SWMU-20 source area. Vinyl chloride concentrations at well MW-14A near Building 9-90 increased to maximum concentrations of 650 micrograms per liter (μg/L) (October 2004) and 1,000 μg/L (February 2005) as a result of source area bioremediation injections. Indoor air analytical results were below MTCA Method B and C cleanup levels used as preliminary screening levels (Landau Associates 2006). Following injection of electron donor to well MW-14A in March 2005, VC concentrations decreased substantially and have remained at or below the reporting limit.

We propose to use Plant 2 TMCLs for industrial/worker exposure to indoor air as the indoor air CULs for the DC. As indicated above, these TMCLs were developed by Boeing and approved by EPA for use at the Boeing Plant 2 facility (Boeing 2011, EPA 2011a,b); TMCLs for selected constituents were subsequently updated and submitted to EPA (Floyd Snider 2013). The proposed indoor CULs are presented for indoor air COCs in Table 4.

The POC for indoor air is the breathing space within occupied buildings. Breathing space is commonly understood to be approximately 5 ft above ground surface. It is understood that any indoor air concentrations measured at the site would be corrected for background air concentrations using results from an upwind, outdoor sampling location for comparison of corrected levels to CULs.

5.0 EVALUATION AND CONCLUSIONS

This section evaluates the remaining site SWMUs (SWMU-17 and SWMU-20) and AOC-05 compared to proposed cleanup standards. Conclusions are provided regarding the progress of active treatment toward achieving treatment goals in these areas.

5.1 AOC-05

In situ anaerobic bioremediation continues for treatment of TPH-G and BTEX in AOC-05. AOC-05 wells and site features are shown on Figure 3.

Eight full-scale injections performed since 2008 have resulted in substantial contaminant concentration reduction (Landau Associates 2012a). Contaminant concentrations have decreased to below proposed CULs at three of four AOC-05 wells (BDC-101, BDC-102, and BDC-104); concentrations have been below proposed CULs at all three wells since July 2008, with the exception of a single low-level detection of ethylbenzene at BDC-101. TPH-G and BTEX concentrations have also decreased substantially at well BDC-103 located in the former UST excavation, but still periodically exceed proposed CULs. Contaminant concentrations rebounded substantially at BDC-103 in November 2011 as a result of depleted nitrate and of groundwater coming in contact with a higher portion of the smear zone; groundwater levels prior to the November sampling event were the highest observed during the 3.7 years since biotreatment began in AOC-05 (Landau Associates 2012a). An additional injection event was performed in February 2012 and subsequent monitoring results showed substantial contaminant concentration decrease and abundant nitrate for continued treatment. This was followed by another nitrate injection in October 2012 due to depletion of the nitrate injected in February 2012. During the most recent monitoring event in February 2013, all TPH-G and BTEX results were below reporting limits, with the exception of a minor detection of o-xylene; benzene was below the reporting limit for the first time since monitoring began in June 2001. Despite the November 2011 spike in concentrations, significant treatment progress at BDC-103 is demonstrated by the following:

- TPH-G concentrations have been below the proposed CUL (0.800 mg/L) during 7 of 13 sampling events beginning in February 2010 and TPH-G was not detected during three of these events. The reporting limit represents a decrease of 99.6 percent from the February 2008 baseline concentration.
- Prior to the February 2013 result (<1.0 µg/L), benzene concentrations remained consistently above the proposed CUL (2 µg/L), but were below the 2008 baseline (1,100 µg/L) during 16 of 17 sampling events from March 2009 through November 2012. Benzene at <1.0 µg/L in February 2012 is the lowest concentration since monitoring began in 2001 and represents a 99.9 percent decrease from the 2008 baseline.
- Toluene concentrations have been below the proposed CUL (1,300 µg/L) during 21 of 22 sampling events since September 2008 and toluene was not detected during 5 of these events. The reporting limit represents a 99.9 percent decrease from the 2008 baseline.

- Total xylenes have been below the proposed CUL during 12 of 13 sampling events since November 2009. The 2.2 µg/L detection in May 2011 was the lowest concentration since monitoring began in 2001 and represents a 99.9 percent decline from the 2008 baseline.

Table 5 presents cumulative AOC-05 cleanup action data and proposed CULs. Well BDC-103 contaminant concentrations versus time are presented on Figure 4.

Based on this evaluation, we recommend continued bioremediation treatment in AOC-05. Additional periodic nitrate injections will be performed at well BDC-103 to achieve contaminant concentrations which are consistently closer to the proposed CULs at that source area well. It is anticipated that a period of MNA may follow active treatment to achieve CULs.

5.2 SWMU-17

In situ anaerobic bioremediation is underway for treatment of PCE, TCE, and breakdown products in SWMU-17. Biotreatment began with injection of electron donor to 11 wells within the plume in August 2011. SWMU-17 wells and site features are shown on Figure 5. Figure 5 also shows iso-concentration contours based on the highest of either PCE or TCE concentrations at direct-push borings sampled for plume characterization prior to full scale treatment (Landau Associates 2011).

Post-injection data through the February 2013 quarterly sampling event (18.5 months post-injection) indicates bioremediation occurring at all injection wells and at some nearby wells (Landau Associates 2012b). PCE and TCE concentrations have decreased at most wells, with corresponding increases in concentrations of sequential breakdown products cDCE and VC. As of February 2013 sampling, PCE concentrations were below the proposed CUL at all SWMU-17 wells and TCE was below the proposed CUL at 21 of 22 wells; the exception is well BDC-05-17 located crossgradient of the injected treatment area. As of February 2013, concentrations of sequential breakdown products cDCE and/or VC had increased to above proposed CULs at 11 wells. End product ethene has been detected post-injection at 12 wells, indicating complete reductive dechlorination through breakdown products to this non-toxic end product. Table 6 presents cumulative SWMU-17 cleanup action groundwater monitoring data and proposed CULs.

As anticipated from earlier pilot testing results, groundwater concentrations of arsenic and/or copper increased post-injection at most injection wells and at some crossgradient and downgradient wells. Based on pilot test results, concentrations of these metals are expected to decrease with time.

Based on this evaluation, bioremediation treatment is progressing well and additional time is needed to achieve proposed CULs in SWMU-17. Treatment will continue for some additional period as a result of the August 2011 donor injection. Additional electron donor injection may be performed, if needed, based on monitoring results. It is anticipated that a period of MNA may follow active treatment to achieve CULs.

5.3 SWMU-20

In situ anaerobic bioremediation of PCE, TCE, and breakdown products continues in the SWMU-20 source zone following four donor injection events in 2004, 2005, and 2008. SWMU-20 wells and site features are shown on Figure 6. Figure 6 reflects the reduction in monitoring approved by Ecology in 2010 (Landau Associates 2010).

Groundwater monitoring results indicate that biotreatment continues at and near injection wells, as indicated by the persistence of reducing aquifer redox conditions, total organic carbon (TOC) levels above background at 5 of 12 source wells, and continued detection of end product ethane at 6 wells.

- Over the last 45 months (since May 2009), PCE/TCE and breakdown product concentrations have been below proposed CULs at all source-zone wells with a two exceptions for VC. VC concentrations at well MW-06B were above the CUL (2.4 µg/L) 5 of 7 times during this period, ranging from 4.2 to 6.0 µg/L and VC was dectected at 2.7 µg/L in November 2010 at well MW-22A. PCE and TCE are consistently not detected at source zone wells. Low levels of breakdown products cDCE and/or VC are detected at 5 of 12 wells. End product ethane continues to be detected at half of the wells. Data for source zone wells and proposed CULs are presented in Table 7.
- Donor injection to source-zone wells and the resulting source zone bioremediation has reduced contaminant concentrations at other nearby wells. Following source zone bioremediation, the highest PCE and TCE concentrations are at wells located crossgradient (north) (MW-13A and MW-17A) or upgradient (east) (MW-16A) of the treated source zone. However, concentrations in these wells are relatively low, with PCE concentrations below the proposed CUL at all wells in November 2012, and TCE concentrations just above the CUL (1.4 µg/L) at only 3 of 18 wells, consisting of MW-16A (1.5 µg/L), MW-17A (3.5 µg/L), and MW-15C (3.2 µg/L). cDCE is below the proposed CUL at all wells and VC is slightly above the CUL (2.4 µg/L) at two wells (MW-10C and MW-16C); VC concentrations at these wells May 2012 were 4.4 and 3.8 µg/L respectively. Data for these crossgradient and downgradient wells is presented with proposed CULs in Table 8.

Ongoing semiannual groundwater monitoring in SWMU-20 constitutes MNA with enhancement of natural attenuation due to residual effects of prior injections. It is not anticipated that additional SWMU-20 injections will be required to achieve proposed treatment goals.

The results of prior indoor air sampling at Building 9-90 (January 2006), located downgradient of the SWMU-20 bioremediation area, are well below proposed indoor air CULs. This data, corrected for outdoor ambient air results, are presented on Table 9. Due to the unusually high VC concentrations (650 and 1,000 µg/L) detected in groundwater at well MW-14A near Building 9-90 prior to this sampling event, January 2006 indoor air results represent a worst case scenario for soil vapor migration to indoor air of Building 9-90. Following injection of electron donor to well MW-14A in March 2005, VC concentrations decreased substantially and have remained at or below the reporting limit.

6.0 USE OF THIS DOCUMENT

This Proposed Cleanup Standards document has been prepared for the exclusive use of The Boeing Company and applicable regulatory agencies for specific application to the Boeing Developmental Center. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of Landau Associates. Further, the reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by Landau Associates, shall be at the user's sole risk. Landau Associates warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. We make no other warranty, either express or implied.

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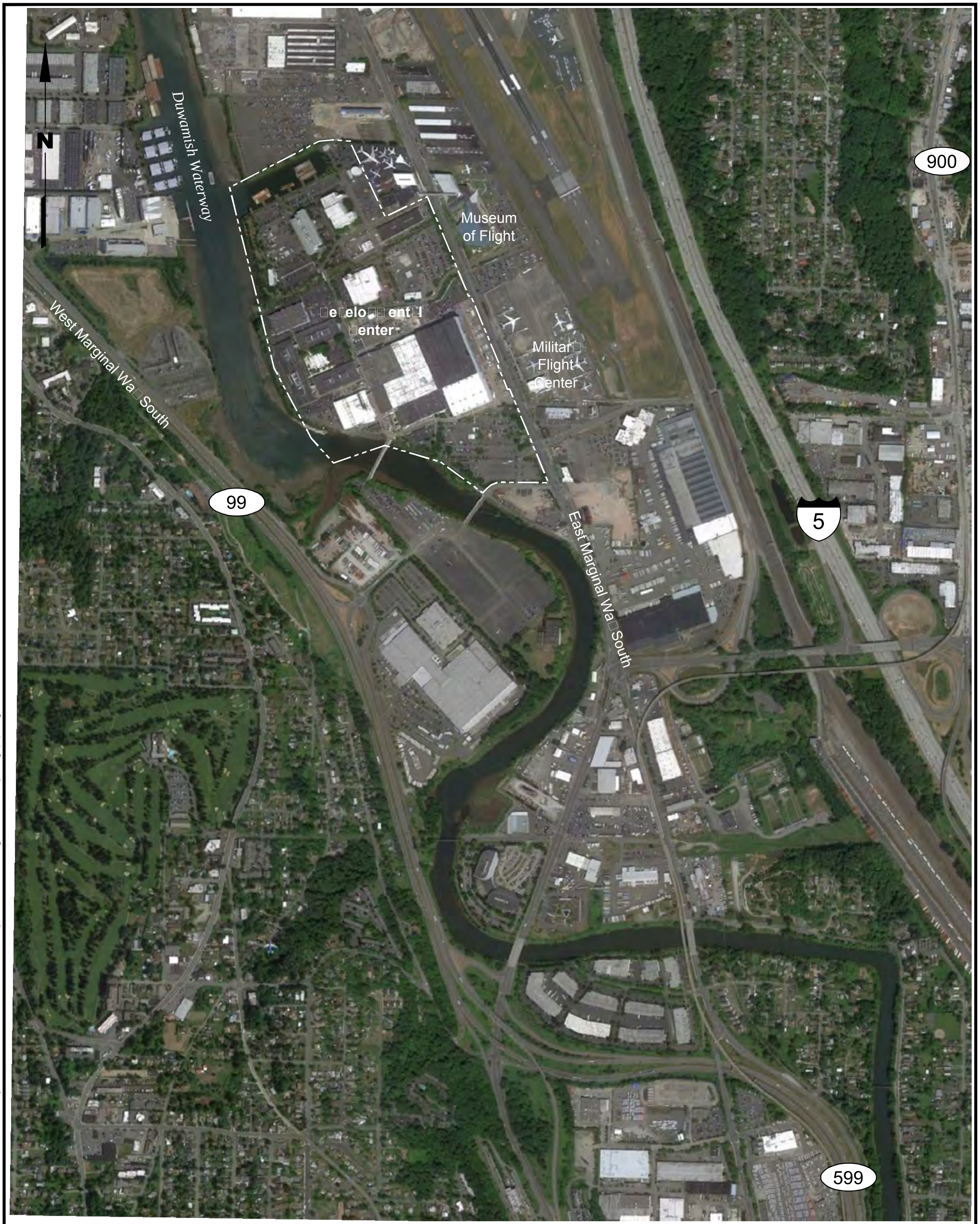

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LANDAU ASSOCIATES	Boeing Development Center Tukwila, Washington	**Site Location Map**	Figure 1

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Approximate Scale in Feet

Boeing Developmental Center Tukwila, Washington	SWMU □ □□□ Loc□t□ons	Figure 2

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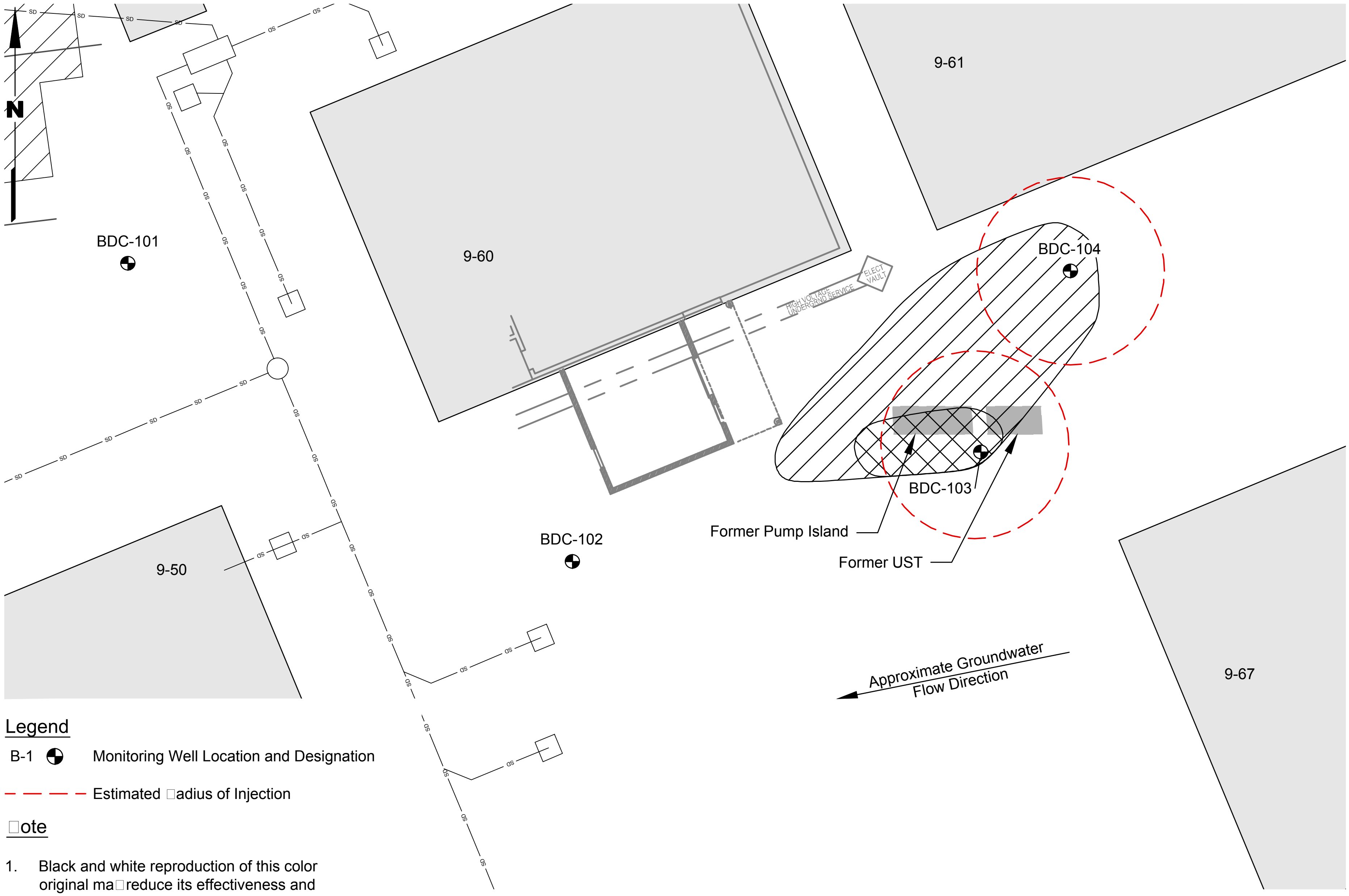

Legend

B-1 Monitoring Well Location and Designation

Estimated □adius of Injection

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1. Black and white reproduction of this color original ma□ reduce its effectiveness and lead to incorrect interpretation.

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Scale in Feet

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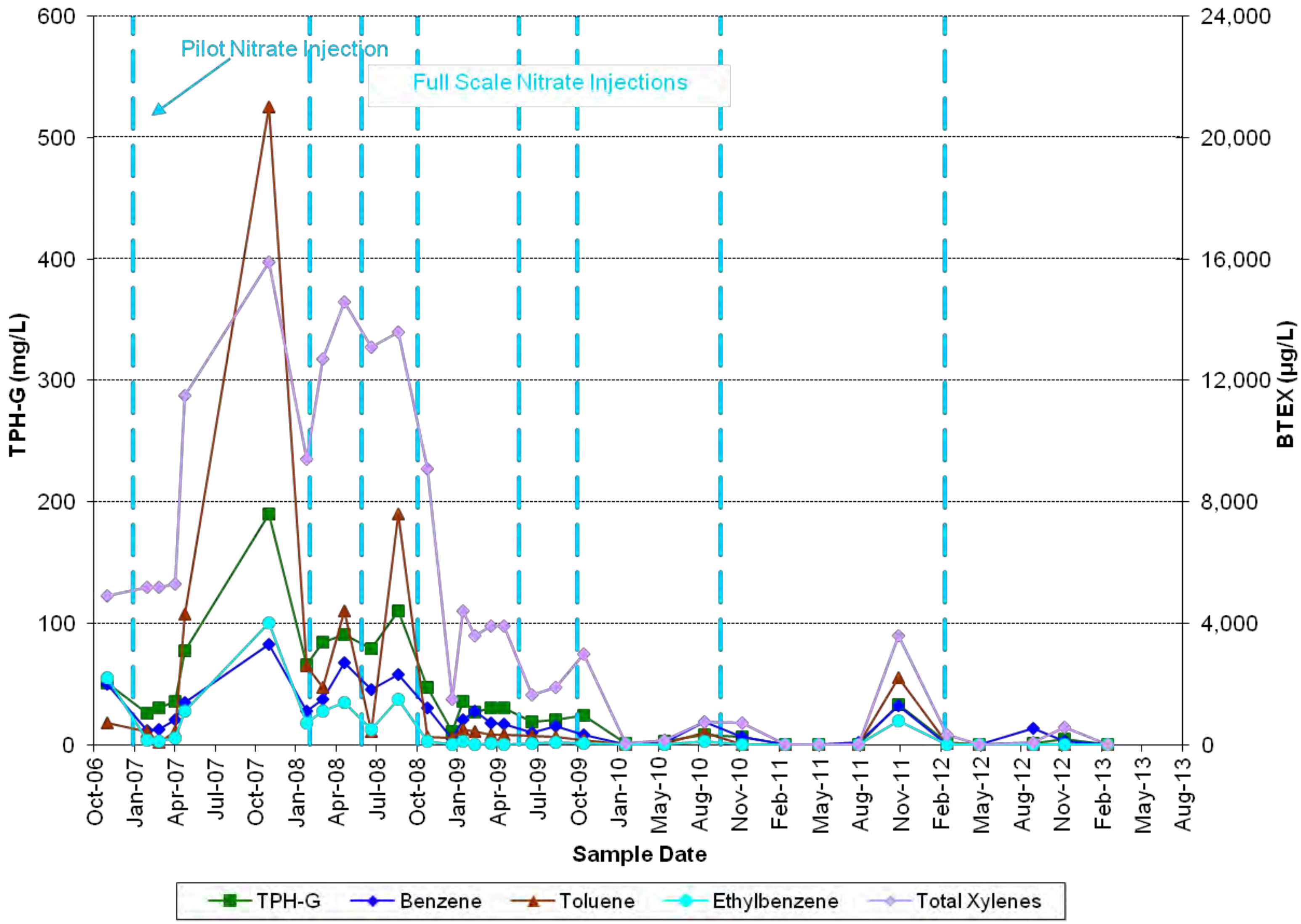
Boeing Developmental Center Tukwila, Washington	□□□-0□	Figure 3



LANDAU ASSOCIATES

Boeing Developmental Center Tukwila, Washington	**Time Plot for AOC-05 Well BDC-103**	Figure 4

Note

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

0 40 80

Scale in Feet

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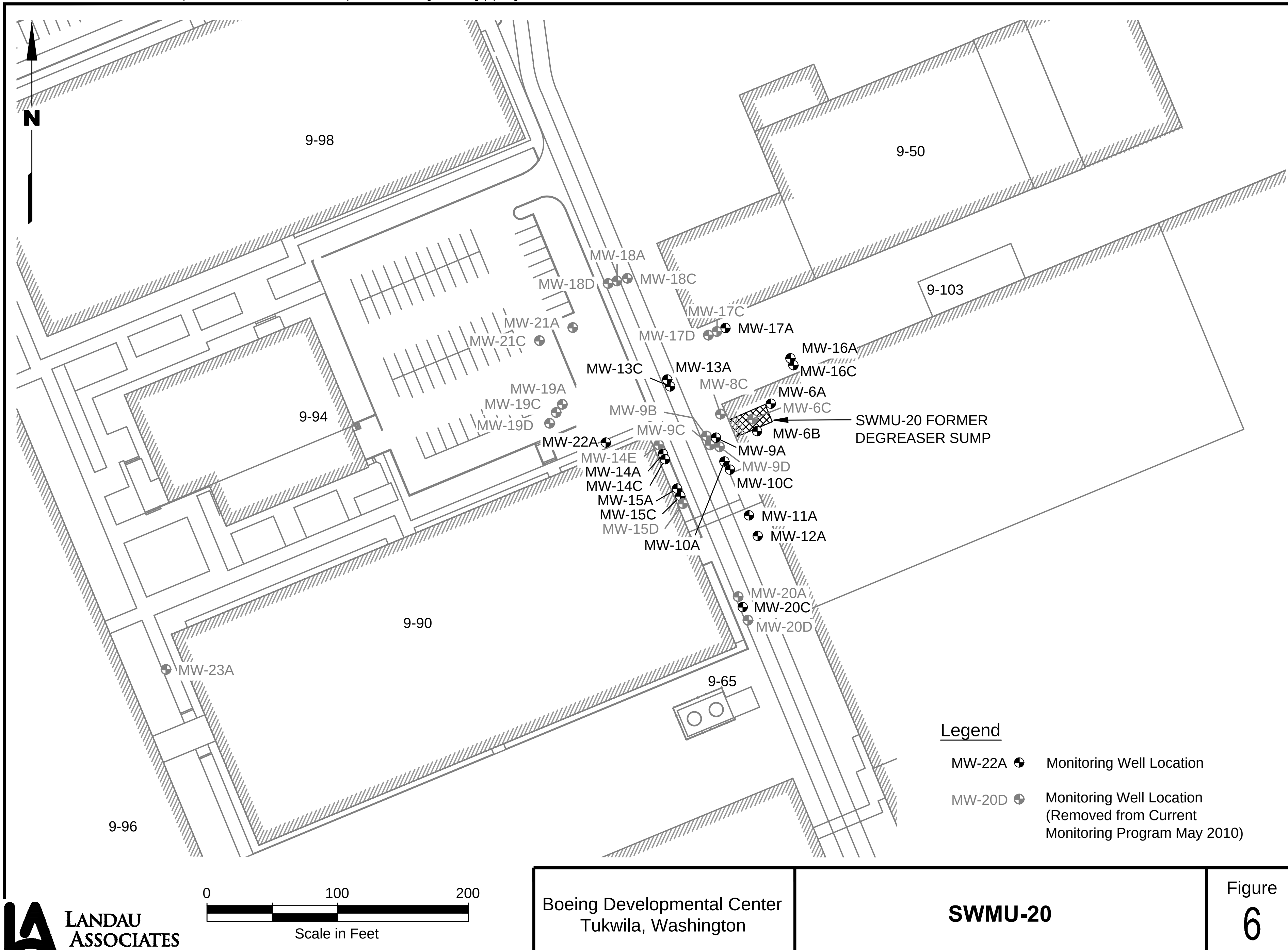
Tukwila, Washington

SWMU-□□

Figure
5



Landau Associates

Boeing Developmental Center
Tukwila, Washington

SWMU-20

Figure 6

TABLE 1
GROUNDWATER COCs
BOEING DEVELOPMENTAL CENTER

Primary COCs	Other Compounds detected Nov 2011-Feb 2013
VOLATILE ORGANIC COMPOUNDS	**VOLATILE ORGANIC COMPOUNDS**
Benzene	Acetone
cis-1,2-Dichloroethene	Carbon Disulfide
Ethylbenzene	Chloroform
m,p-Xylene	1,1-Dichloroethene
Naphthalene	trans-1,2-Dichloroethene
o-Xylene	Isopropylbenzene
Tetrachloroethene	1,2,4-Trimethylbenzene
Toluene	1,3,5-Trimethylbenzene
Trichloroethene	
Vinyl Chloride	**CONVENTIONALS**
	Ammonia
METALS	
Arsenic	
Copper	
PETROLEUM HYDROCARBONS	
Gasoline-Range Organics	
CONVENTIONALS	
Nitrate	
Nitrite	

TABLE 2
INDOOR AIR COCs
BOEING DEVELOPMENTAL CENTER

Primary COCs	Other Compounds detected in Groundwater Nov 2011-Feb 2013
VOLATILE ORGANIC COMPOUNDS	**VOLATILE ORGANIC COMPOUNDS**
AS	Acetone
cis-1,2-Dichloroethene	Carbon Disulfide
Ethylbenzene	Chloroform
m,p-Xylene	1,1-Dichloroethene
Naphthalene	trans-1,2-Dichloroethene
o-Xylene	Isopropylbenzene
Tetrachloroethene	1,2,4-Trimethylbenzene
Toluene	1,3,5-Trimethylbenzene
Trichloroethene	
Vinyl Chloride	**CONVENTIONALS**
	Ammonia
PETROLEUM HYDROCARBONS	
Gasoline-Range Organics	

TABLE 3
PROPOSED GROUNDWATER CLEANUP LEVELS
BOEING DEVELOPMENTAL CENTER

CAS Number	Chemical	Proposed Groundwater Cleanup Level (µg/L)	Exposure Pathway Basis of TMCL
VOLATILE ORGANIC COMPOUNDS			
67-64-1	Acetone	1.1E+05	EPA R10 Tribal Consumption of Seafood.
71-43-2	Benzene	2.0E+00	EPA R10 Tribal Consumption of Seafood.
75-15-0	Carbon Disulfide	3.9E+03	EPA R10 Tribal Consumption of Seafood.
67-66-3	Chloroform	9.4E+00	EPA R10 Tribal Consumption of Seafood.
156-59-2	*cis* -1,2-Dichloroethene	1.3E+02	EPA R10 Tribal Consumption of Seafood.
156-60-5	*trans* -1,2-Dichloroethene	9.4E+02	EPA R10 Tribal Consumption of Seafood.
75-35-4	1,1-Dichloroethene	2.3E+03	EPA R10 Tribal Consumption of Seafood.
100-41-4	Ethylbenzene	1.7E+00	EPA R10 Tribal Consumption of Seafood.
98-82-8	Isopropylbenzene(cumene)	2.7E+02	EPA R10 Tribal Consumption of Seafood.
91-20-3	Naphthalene	2.6E+01	EPA R10 Tribal Consumption of Seafood.
127-18-4	Tetrachloroethene (PCE)	5.3E+00	EPA R10 Tribal Consumption of Seafood
108-88-3	Toluene	1.3E+03	EPA R10 Tribal Consumption of Seafood.
79-01-6	Trichloroethene (TCE)	1.4E+00	EPA R10 Tribal Consumption of Seafood
95-63-6	1,2,4-Trimethylbenzene	--	--
108-67-8	1,3,5-Trimethylbenzene	--	--
75-01-4	Vinyl chloride	2.4E+00	EPA AWQC to protect human consumption of seafood.
10330-20-7	Xylenes (total)	1.5E+03	EPA R10 Tribal Consumption of Seafood.
METALS			
7440-38-2	Arsenic (inorganic)	8.0E+00	Lower Duwamish Waterway Groundwater Background.
7440-50-8	Copper	8.0E+00	Lower Duwamish Waterway Groundwater Background.
PETROLEUM HYDROCARBONS			
--	TPH - Gasoline (Benzene Present)	8.0E+02	Surrogate Value: MTCA A Groundwater Cleanup Level.
CONVENTIONALS			
7664-41-7	Ammonia	--	--
14797-55-8	Nitrate	--	--
14797-65-0	Nitrite	--	--

Abbreviations:

CAS Chemcial abstract number
EPA U.S. Environmental Protection Agency
MTCA Model Toxics Control Act
NTR National Toxics Rule
RSL Regional screening level
TMCL Boeing Plant 2 Target Media Cleanup Levels

TABLE 4
PROPOSED INDOOR AIR CLEANUP LEVELS
BOEING DEVELOPMENTAL CENTER

CAS Number	Chemical	Proposed Indoor Air Cleanup Level Industrial/Worker (1,2,3) ($\mu g/m^3$)	Source
VOLATILE ORGANIC COMPOUNDS			
67-64-1	Acetone	1.4E+05	Modified EPA RSL
71-43-2	Benzene	1.6E+01	Modified EPA RSL
75-15-0	Carbon Disulfide	3.1E+03	Modified EPA RSL
67-66-3	Chloroform	5.3E+00	Modified EPA RSL
75-35-4	1,1-Dichloroethene	8.8E+02	Modified EPA RSL
156-59-2	*cis* -1,2-Dichloroethene (4)	--	--
156-60-5	*trans* -1,2-Dichloroethene (4)	--	--
100-41-4	Ethylbenzene	4.9E+01	Modified EPA RSL
98-82-8	Isopropylbenzene(cumene)	1.8E+03	Modified EPA RSL
91-20-3	Naphthalene	3.6E+00	Modified EPA RSL
127-18-4	Tetrachloroethene (PCE)	4.7E+02	Modified EPA RSL
108-88-3	Toluene	2.2E+04	Modified EPA RSL
79-01-6	Trichloroethene (TCE)	8.4E+00	EPA RSL Subchronic
95-63-6	1,2,4-Trimethylbenzene	NA	NA
108-67-8	1,3,5-Trimethylbenzene	NA	NA
75-01-4	Vinyl chloride (5)	2.8E+01	Modified EPA RSL
10330-20-7	Xylenes (total)	4.4E+02	Modified EPA RSL
PETROLEUM HYDROCARBONS			
8006-61-9	Gasoline	--	--
CONVENTIONALS			
7664-41-7	Ammonia	--	--

Notes:

1. EPA Region 10 (R10) made a risk management decision to use a 1 in 100,000 excess indiviual lifetime risk for cancer for workers at Boeing Plant 2. Calculations are based on the EPA RSL equations modified for a total risk of 1.0E-5.
2. Ecology worker exposure was modified from full time (365 days/year x 24 hours/day) to the work week allowed under industrial soil exposure (10 hours/day x 7 days/week x 50 weeks/year).
3. Proposed cleanup levels are equal to Boeing Plant 2 TMCLs for industrial workers.
4. No inhalation toxicity factors are available.
5. Vinyl chloride is considered mutagenic by EPA; its values are from the May 2012 EPA RSL Tables for residential exposure; http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/pdf/resair_sl_table_run_MAY2012.pdf. For industrial exposure, values have been modified.

Abbreviations:

CAS Chemical abstract number
EPA U.S. Environmental Protection Agency
RSL Regional screening level
TMCL Boeing Plant 2 Target Media Cleanup Levels

TABLE 5
AOC-05 CLEANUP ACTION SUMMARY
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

Well	Date	ORC Injection Elapsed Time from Injection (days)	Pilot Injection Elapsed Time from Injection (days)	Full Scale Injection 1 Elapsed Time from Injection (days)	Full Scale Injection 2 Elapsed Time from Injection (days)	Full Scale Injection 3 Elapsed Time from Injection (days)	Full Scale Injection 4 Elapsed Time from Injection (days)	Full Scale Injection 5 Elapsed Time from Injection (days)	Full Scale Injection 6 Elapsed Time from Injection (days)	Full Scale Injection 7 Elapsed Time from Injection (days)	Volatile Organic Compounds (all units in ug/L): TPH-G (mg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	m,p-Xylene (µg/L)	o-Xylene (µg/L)	Total Xylenes (µg/L)	Aquifer Redox Conditions: DO (mg/L)	Nitrate (mg-N/L)	Nitrite (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (µg/L)	ORP (mV)	Donor Indicators: TOC (mg/L)	pH	Comments
Proposed Groundwater Cleanup Levels (a)											0.8	2.0	1300	1.7	NA	NA	1500										
BDC-101	6/11/2001										3.0	11.9	<1.0	113.1			109.2										
BDC-101	9/4/2001										5.0	7.13	10.7	50.4			53.8										
BDC-101	12/3/2001										6.5	95	1.6	750			650										
BDC-101	3/13/2002										<0.25	1.4	<1.0	4.4			<1.0										
BDC-101	4/29/2002	-8									<0.25	<1.0	<1.0	2.2	<1.0	<1.0	<1.0										
BDC-101	6/3/2002	27									<0.25	1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-101	7/1/2002	55									<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-101	8/1/2002	86									<0.25	3.1	<1.0	2.4	<1.0	<1.0	<1.0										
BDC-101	12/2/2002	209									0.61	4.3	<1.0	21	27	6.4	33.4										
BDC-101	3/10/2003	307									<0.25	1.0	<1.0	4.5	3.2	<1.0	3.2										
BDC-101	6/3/2003	392									<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-101	11/19/2003	561									0.42	13	<1.0	15	35	<1.0	35	0.4	1.1	0.010	0.2	16	240	120.3			
BDC-101	4/28/2004	722									<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-101	10/18/2004	895									0.64	10	<1.0	15	43	<1.0	43										
BDC-101	5/10/2005	1099									<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-101	11/10/2005	1283									0.25	7.6	<1.0	2.6	42	<1.0	42	1.0	4.4			34.3		259	2.05		
BDC-101	5/15/2006	1469									<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.8	17.8	0.059	0.0	64.1		80			
BDC-101	11/20/2006	1658	-59								1.1	10	<1.0	15	72.0	<1.0	72	0.9	0.122	0.016	2.4	8.7		174			
BDC-101	2/20/2007	1750	33								<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.4	15.0	0.047	0.2	50.0		277		6.63	
BDC-101	3/19/2007	1777	60								<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	6.0	8.83	0.037	0.5	38.5		213		6.60	
BDC-101	4/24/2007	1813	96								<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.1	9.59	0.041	0.5	34.1		136		6.46	
BDC-101	5/17/2007	1836	119								<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.4	9.95	0.046	0.4	35.7		297		6.55	
BDC-101	11/26/2007	2029	312								<0.25	<1.0	<1.0	2.1	6.5	<1.0	6.5	2.3	5.88	0.032	0.0	26.8		287			
BDC-101	2/18/2008	2113	396	-8							<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.6	8.10	0.040	0.0	31.5		341		6.29	
BDC-101	3/27/2008	2151	434	30							<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.2	9.3	<0.10	0.2	40.0		506			
BDC-101	5/15/2008	2200	483	79	-40						<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.6	6.8	<0.10	0.0	24.6		176		6.44	
BDC-101	7/16/2008	2262	545	141	22						<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.3	5.3	<0.10	0.0	21.8		-232		6.52	
BDC-101	9/15/2008	2323	606	202	83	-45					<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.2	5.33	0.023	0.0	28.7		153			
BDC-101	11/20/2008	2389	672	268	149	21					0.44	1.6	<1.0	<1.0	<1.0	<1.0	<1.0	1.5	2.9	0.1	0.8	17.1		-22		6.65	
BDC-101	1/16/2009	2446	729	325	206	78					<0.25	1.1	<1.0	<1.0	<1.0	<1.0	<1.0	0	4.40	0.042	0.4	29.5		-245		6.50	
BDC-101	2/11/2009	2472	755	351	232	104					<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.6	8.5	<0.1	0.4	39.6		-16		6.43	
BDC-101	3/9/2009	2498	781	377	258	130					<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.9	9.4	<0.1	0.0	46.8		54		6.54	
BDC-101	4/16/2009	2536	819	415	296	168					<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.7	9.0	<0.1	0.0	36.0		131		6.61	
BDC-101	5/14/2009	2564	847	443	324	196	-34				<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	13.0	<0.1	0.0	44.4		68		6.81	
BDC-101	7/17/2009	2628	911	507	388	260	30				<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.8	12.6	<0.1	0.0	49.0		19		7.17	
BDC-101	9/9/2009	2682	965	561	442	314	84	-49			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.3	6.2	<0.1	0.0	31.7		179		6.90	
BDC-101	11/12/2009	2746	1029	625	506	378	148	15			0.35	1.8	<1.0	6.6	16	<1.0	16	1.4	11.3	<0.1	0-0.2	36.7		124		6.53	Very faint iron measurement
BDC-101	2/17/2010	2843	1126	722	603	475	245	112			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.9	13.9	<0.1	0.0	48.7		640		6.55	
BDC-101	5/17/2010	2932	1215	811	692	564	334	201			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.2	20.7	<1.0	0.0	58.7		372		6.86	
BDC-101	8/16/2010	3023	1306	902	783	655	425	292	-37		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.2	15.6	<0.1	0.0	56.9		76		7.21	
BDC-101	11/8/2010	3107	1390	986	867	739	509	376	47		<0.25	2.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.0	2.2	<0.1	0.4	14.7		145		6.97	
BDC-101	2/16/2011	3207	1490	1086	967	839	609	476	147		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	7.5	23.9	<0.1	0.0	68.2		161		7.30	
BDC-101	5/3/2011	3283	1566	1162	1043	915	685	552	223		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5.6	23.7	<0.1	0.0	66.2		208		6.99	
BDC-101	8/1/2011	3373	1656	1252	1133	1005	775	642	313		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5.5	17.9	<0.1	0.0	48.1		150		7.07	
BDC-101	11/1/2011	3465	1748	1344	1225	1097	867	734	405	-105	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	6.7	6.1	<0.1	0.0	24.8		40		7.23	
BDC-101	2/19/2012	3575	1858	1454	1335	1207	977	844	515	5	<0.25	2.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.5	6.6		0.3	27.7		12		6.81	
BDC-101	5/3/2012	3649	1932	1528	1409	1281	1051	918	589	79	<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	3.8	15.9		0.0	51.2		263		6.60	
BDC-101	9/4/2012	3773	2056	1652	1533	1405	1175	1042	713	203	<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.9	13.8	<0.10	0.0	36.0		154		6.97	
BDC-101	11/13/2012	3843	2126	1722	1603	1475	1245	1112	783	273	<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.41	10.3	<0.10	0.0	40.4		150		6.90	
BDC-101	2/20/2013	3942	2225	1821	1702	1574	1344	1211	882	372	<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	2.6	21.3	<0.10	0.2	68.0		73		6.83	
BDC-102	6/11/2001										0.55	5.33	<1.0	<1.0			<1.0										
BDC-102	9/4/2001										0.38	1.61	1.89	<1.0			1.87										
BDC-102	12/3/2001										1.6	3.7	<1.0	<1.0			3.49										
BDC-102	3/13/2002										0.50	1.3	<1.0	<1.0			<1.0										
BDC-102	4/29/2002	-8									0.33	2.6	<1.0	<1.0	1.1	<1.0	1.1										

TABLE 5
AOC-05 CLEANUP ACTION SUMMARY
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

Well	Date	ORC Injection Elapsed Time from Injection (days)	Pilot Injection Elapsed Time from Injection (days)	Full Scale Injection 1 Elapsed Time from Injection (days)	Full Scale Injection 2 Elapsed Time from Injection (days)	Full Scale Injection 3 Elapsed Time from Injection (days)	Full Scale Injection 4 Elapsed Time from Injection (days)	Full Scale Injection 5 Elapsed Time from Injection (days)	Full Scale Injection 6 Elapsed Time from Injection (days)	Full Scale Injection 7 Elapsed Time from Injection (days)	Volatile Organic Compounds (all units in ug/L) TPH-G (mg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	m,p-Xylene (µg/L)	o-Xylene (µg/L)	Total Xylenes (µg/L)	Aquifer Redox Conditions DO (mg/L)	Nitrate (mg-N/L)	Nitrite (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (µg/L)	ORP (mV)	Donor Indicators TOC (mg/L)	pH	Comments
Proposed Groundwater Cleanup Levels (a)											**0.8**	**2.0**	**1300**	**1.7**	**NA**	**NA**	**1500**										
BDC-102	6/3/2002	27									<0.25	4.4	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-102	7/1/2002	55									0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-102	8/1/2002	86									<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-102	12/2/2002	209									<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-102	3/10/2003	307									0.26	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-102	6/3/2003	392									<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-102	11/19/2003	561									0.99	120	<1.0	8.5	<1.0	<1.0	<1.0	0.4	0.19	0.011	5.5	46	1100	122.2			
BDC-102	4/28/2004	722									0.40	10	<1.0	<1.0	3.0	<1.0	3.0										
BDC-102	10/18/2004	895									0.33	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-102	5/10/2005	1099									<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-102	11/10/2005	1283									<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.8	4.4			34.0		122	18.4		
BDC-102	5/15/2006	1469									<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.2	4.72	0.175	2.2	35.7		-11			
BDC-102	11/20/2006	1658	-59								<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.3	<0.250	<0.250	2.2	9.2		163			
BDC-102	2/20/2007	1750	33								<0.25	5.8	<1.0	<1.0	<1.0	<1.0	<1.0	0.5	0.749	0.027	3.0	25.3		-145		6.54	
BDC-102	3/19/2007	1777	60								<0.25	18	<1.0	<1.0	32	<1.0	32	0.9	0.938	0.072	3.0	31.0		-98		6.67	
BDC-102	4/24/2007	1813	96								0.53	6.1	<1.0	3.1	100	<1.0	100	1.2	1.94	0.051	2.8	40.4		-93		6.51	
BDC-102	5/17/2007	1836	119								<0.25	1.8	<1.0	<1.0	7.4	<1.0	7.4	0.8	2.78	0.108	2.6	33.9		286		6.52	
BDC-102	11/26/2007	2029	312								<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.3	1.03	0.247	3.0	55.7		46			
BDC-102	2/18/2008	2113	396	-8							<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.5	3.91	0.054	2.8	42.8		431		5.97	
BDC-102	3/27/2008	2151	434	30							<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.9	1.3	<0.10	2.5	17.9		233			
BDC-102	5/15/2008	2200	483	79	-40						<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.4	3.0	<0.10	3.5	19.2		-115		6.56	
BDC-102	7/16/2008	2262	545	141	22						<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.5	2.5	<0.10	3.2	13.7		-312		6.67	
BDC-102	9/15/2008	2323	606	202	83	-45					<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.2	4.28	0.056	3.0	31.6		191			
BDC-102	11/20/2008	2389	672	268	149	21					<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.7	0.40	<0.10	2.0	5.6		-70		6.69	
BDC-102	1/16/2009	2446	729	325	206	78					<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	<0.100	0.200	2.5	8.3		-235		6.70	
BDC-102	2/11/2009	2472	755	351	232	104					<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.7	2.4	<0.1	3.0	20.4		-70		6.61	
BDC-102	3/9/2009	2498	781	377	258	130					<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0	0.9	<0.1	3.0	8.7		-46		6.65	
BDC-102	4/16/2009	2536	819	415	296	168					<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.3	0.6	<0.1	3.0	8.3		-7		6.66	
BDC-102	5/14/2009	2564	847	443	324	196	-34				<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.3	0.9	<0.1	3.4	9.8		-35		6.78	
BDC-102	7/17/2009	2628	911	507	388	260	30				<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.7	4.9	<0.1	2.2	28.6		-11		6.46	
BDC-102	9/9/2009	2682	965	561	442	314	84	-49			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.9	0.4	<0.1	2.7	5.5		2.8		6.66	
BDC-102	11/12/2009	2746	1029	625	506	378	148	15			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.9	0.2	<0.1	3.2	2.4		-42.0		6.49	
BDC-102	2/17/2010	2843	1126	722	603	475	245	112			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.9	3.4	0.2	2.8	17.2		892		6.56	
BDC-102	5/17/2010	2932	1215	811	692	564	334	201			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.4	8.4	<1.0	3.0	30.1		440		6.61	
BDC-102	8/16/2010	3023	1306	902	783	655	425	292	-37		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.6	8.9	<0.1	3.0	27.8		82		6.60	
BDC-102	11/8/2010	3107	1390	986	867	739	509	376	47		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.3	0.4	<0.1	2.0	6.9		45		7.09	
BDC-102	2/16/2011	3207	1490	1086	967	839	609	476	147		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.7	3.5	<0.1	2.2	43.3		399		6.88	
BDC-102	5/3/2011	3283	1566	1162	1043	915	685	552	223		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.6	12.1	<0.1	2.0	32.4		40		6.70	
BDC-102	8/1/2011	3373	1656	1252	1133	1005	775	642	313		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	7.0	13.6	<0.1	2.1	28.7		11		6.88	
BDC-102	11/1/2011	3465	1748	1344	1225	1097	867	734	405	-105	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.5	9.8	<0.1	1.5	30.9		-48		7.19	
BDC-102	2/19/2012	3575	1858	1454	1335	1207	977	844	515	5	<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.3	2.4		1.0	15.4		21		6.60	
BDC-102	5/3/2012	3649	1932	1528	1409	1281	1051	918	589	79	<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.2	11.3		2.5	40.2		248		6.44	
BDC-102	9/4/2012	3773	2056	1652	1533	1405	1175	1042	713	203	<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.2	13.2	<5.0	1.5	39.2		130		6.63	
BDC-102	11/13/2012	3843	2126	1722	1603	1475	1245	1112	783	273	<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.10	1.7	<0.10	1.6	27.7		48		6.77	
BDC-102	2/20/2013	3942	2225	1821	1702	1574	1344	1211	882	372	<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.17	18.4	<0.1	1.0	58.5		92		6.60	
BDC-103	6/11/2001										177	875	12,010	1,985			11,430										
BDC-103	9/4/2001										123	494	3,760	419			2,636										
BDC-103 (b)	12/3/2001										120	5,100	2,300,000	10,000			3,400,000										
BDC-103	3/13/2002										200	1,700	17,000	4,900			26,400										
BDC-103	4/29/2002	-8									200	980	16,000	5,400	20,000	7,000	27,000										
BDC-103	6/3/2002	27									200	960	17,000	5,100	20,000	7,100	27,100										
BDC-103	7/1/2002	55									240	1,300	16,000	5,200	20,000	6,800	26,800										
BDC-103	8/1/2002	86									270	4,600	18,000	5,200	19,000	6,600	25,600										
BDC-103	12/2/2002	209									250	1,400	15,000	5,000	22,000	6,900	28,900										
BDC-103	3/10/2003	307									180	780	13,000	5,200	20,000	6,700	26,700										

TABLE 5
AOC-05 CLEANUP ACTION SUMMARY
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

Well	Date	ORC Injection Elapsed Time from Injection (days)	Pilot Injection Elapsed Time from Injection (days)	Full Scale Injection 1 Elapsed Time from Injection (days)	Full Scale Injection 2 Elapsed Time from Injection (days)	Full Scale Injection 3 Elapsed Time from Injection (days)	Full Scale Injection 4 Elapsed Time from Injection (days)	Full Scale Injection 5 Elapsed Time from Injection (days)	Full Scale Injection 6 Elapsed Time from Injection (days)	Full Scale Injection 7 Elapsed Time from Injection (days)	Volatile Organic Compounds (all units in ug/L): TPH-G (mg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	m,p-Xylene (µg/L)	o-Xylene (µg/L)	Total Xylenes (µg/L)	Aquifer Redox Conditions: DO (mg/L)	Nitrate (mg-N/L)	Nitrite (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (µg/L)	ORP (mV)	Donor Indicators: TOC (mg/L)	pH	Comments
Proposed Groundwater Cleanup Levels (a)											**0.8**	**2.0**	**1300**	**1.7**	**NA**	**NA**	**1500**										
BDC-103	6/3/2003	392									220	900	10,000	5,000	20,000	6,600	26,600										
BDC-103	11/19/2003	561									180	850	8,300	4,500	18,000	5,500	23,500	0.4	0.012	0.011	5.5	53	630	-75.9			
BDC-103	4/28/2004	722									160	1,600	6,600	3,900	16,000	5,100	21,100										
BDC-103	10/18/2004	895									140	2,100	5,500	3,700	15,000	4,400	19,400										
BDC-103	5/10/2005	1099									110	2,200	5,500	3,800	14,000	3,200	17,200										
BDC-103	11/10/2005	1283									90	2,200	3,500	3,700	12,000	2,500	15,000	0.7	<1.0			11.9		147	15.4		
BDC-103	5/15/2006	1469									84	1,600	3,800	3,100	10,000	2,200	12,000	0.9	<0.010	0.054	3.5	15.2		106			
BDC-103	11/20/2006	1658	-59								51	2,000	730	2,200	3,900	1,000	4,900	1.2	<0.10	<0.10	2.4	28.3		202			
BDC-103	2/20/2007	1750	33								26	460	420	140	3,600	1,600	5,200	0.3	60.8	11.1	0.5	99.2		109		6.54	
BDC-103	3/19/2007	1777	60								30	490	88	130	3,500	1,700	5,200	0.6	27.9	8.28	0.4	141		4		6.79	
BDC-103	4/24/2007	1813	96								36	820	440	220	3500	1800	5300	0.8	7.54	3.56	2.4	59.2		-14		6.70	
BDC-103	5/17/2007	1836	119								77	1,400	4,300	1,100	8,300	3,200	11,500	0.6	0.138	0.079	3.6	169		244		6.82	
BDC-103	11/26/2007	2029	312								190	3,300	21,000	4,000	11,000	4,900	15,900	3.4	0.063	0.049	3.6	49.1		-118			
BDC-103	2/18/2008	2113	396	-8							66	1,100	2,600	700	7,500	1,900	9,400	2.1	7.75	0.134	2.8	163		552		5.97	
BDC-103	3/27/2008	2151	434	30							84	1,500	1,900	1,100	9,700	3,000	12,700	1.6	54.1	18	4.0	115.0		182			
BDC-103	5/15/2008	2200	483	79	-40						91	2,700	4,400	1,400	11,000	3,600	14,600	1.4	<0.10	<0.10	3.2	192		-138		7.11	
BDC-103	7/16/2008	2262	545	141	22						79	1,800	440	490	10,000	3,100	13,100	1.6	56.1	16.6	2.8	149		-226		6.72	
BDC-103	9/15/2008	2323	606	202	83	-45					110	2,300	7,600	1,500	10,000	3,600	13,600	0.5	0.330	0.218	3.2	218		189			
BDC-103	11/20/2008	2389	672	268	149	21					47	1,200	260	110	7,000	2,100	9,100	0.2	152	12.5	2.0	120		-1.2		6.66	
BDC-103	1/16/2009	2446	729	325	206	78					11	190	220	12	1,000	480	1,480	0.2	193	2.32	0.6	62.5		-181		6.19	
BDC-103	2/11/2009	2472	755	351	232	104					36	820	510	<100	2,900	1,500	4,400	1.7	82.0	6.7	0.8	178		-65		6.69	
BDC-103	3/9/2009	2498	781	377	258	130					27	1100	440	18	2,400	1,200	3,600	0	47.3	2.4	0.4	192		17		6.80	
BDC-103	4/16/2009	2536	819	415	296	168					30	710	310	<50	2,700	1,200	3,900	1.0	64.8	5.6	0.2-0.4	194		62		6.77	
BDC-103	5/14/2009	2564	847	443	324	196	-34				30	680	320	20	2,400	1,500	3,900	0.5	49.8	4.8	0.8	222		20		6.85	
BDC-103	7/17/2009	2628	911	507	388	260	30				19	410	280	32	630	1,000	1,630	2.6	26.6	2.0	1.0	104		29		6.98	
BDC-103	9/9/2009	2682	965	561	442	314	84	-49			21	620	270	83	700	1200	1,900	0.9	<0.1	<0.1	2.5	134		2.8		7.01	
BDC-103	11/12/2009	2746	1029	625	506	378	148	15			24	340	140	27	1,800	1,200	3,000	1.4	94.1	7.7	0.4	71.7		117		6.11	
BDC-103	2/17/2010	2843	1126	722	603	475	245	112			0.73	10	<1.0	<1.0	3.1	22	25	1.5	123	1.1	0.0	60.3		939		6.22	
BDC-103	5/17/2010	2932	1215	811	692	564	334	201			3.1	79	44	5.2	60	86	146	1.6	67.9	2.6	0.4	71.6		436		6.63	
BDC-103	8/16/2010	3023	1306	902	783	655	425	292	-37		8.0	740	380	110	420	320	740	2.2	2.4	0.1	2.0	72.5		184		6.96	
BDC-103	11/8/2010	3107	1390	986	867	739	509	376	47		6.3	240	11	1.7	180	540	720	7.5	55.8	1.5	0.0	123		199		7.05	
BDC-103	2/16/2011	3207	1490	1086	967	839	609	476	147		0.28	4.6	<1.0	<1.0	<1.0	5.4	5.4	5.2	133	0.6		74.6		508		6.52	
BDC-103	5/3/2011	3283	1566	1162	1043	915	685	552	223		<0.25	9.1	<1.0	<1.0	<1.0	2.2	2.2	2.2	140	0.2	0.0	74.4		393		6.35	
BDC-103	8/1/2011	3373	1656	1252	1133	1005	775	642	313		0.30	76	<1.0	1.8	7.8	2.5	10.3	5.7	57.6	<0.1	0.2	63.2		168		7.09	
BDC-103	11/1/2011	3465	1748	1344	1225	1097	867	734	405	-105	33	1300	2200	780	2300	1300	3,600	1.7	<0.1	<0.1	1.2	8.1		-226		7.38	
BDC-103	2/19/2012	3575	1858	1454	1335	1207	977	844	515	5	2.2	5.1	31	19	260	69	329	0.2	143		0.3	57.1		36		6.41	
BDC-103	5/3/2012	3649	1932	1528	1409	1281	1051	918	589	79	<0.25	16	1.4	<1.0	3.6	14	17.6	0.1	149	0.83	0.0	56.2		239		6.49	
BDC-103	9/4/2012	3773	2056	1652	1533	1405	1175	1042	713	203	0.72	530	24.0	9.4	40	42	82	0.5	7.2	<0.10	0.4	66.9		146		6.80	
BDC-103	11/13/2012	3843	2126	1722	1603	1475	1245	1112	783	273	4.5	120	9.5	3.7	210	380	590	1.02	165	2.8	0.4	93.6		108		6.50	
BDC-103	2/20/2013	3942	2225	1821	1702	1574	1344	1211	882	372	<0.25	<1.0	<1.0	<1.0	<2.0	3.4	3.4	0.1	161	0.60	0.2	51.6		109		6.42	
BDC-104	2/18/2008	2113	396	-8							2.9	<1.0	<1.0	47	180	28	208	2.1	1.63	0.072	3.0	18.7		598			
BDC-104	3/27/2008	2151	434	30							3.2	<1.0	<1.0	22	220	52	272	1.3	161	0.1	0.5	52.2		259			
BDC-104	5/15/2008	2200	483	79	-40						1.0	<1.0	<1.0	7.0	26	22	48	1.2	28.7	0.7	0.4	26.6		94		6.69	
BDC-104	7/16/2008	2262	545	141	22						2.3	<1.0	2.9	3.3	110	50	160	1.6	196	0.4	0.0	74.7		-221		7.17	
BDC-104	9/15/2008	2323	606	202	83	-45					0.64	<1.0	2.6	<1.0	20	16	36	0.1	122	0.729	0.0	38.4		191			
BDC-104	11/20/2008	2389	672	268	149	21					<0.25	<1.0	<1.0	<1.0	1.4	4.1	5.5	1.0	67.2	<0.10	0.2	24.3		-27		7.46	
BDC-104	1/16/2009	2446	729	325	206	78					0.26	<1.0	<1.0	<1.0	<1.0	5.5	5.5	0.1	71.4	0.204	0.6	34.6		-164		6.86	
BDC-104	2/11/2009	2472	755	351	232	104					<0.25	<1.0	<1.0	<1.0	1.3	1.1	2.4	1.8	95.4 J	0.1	0.2	20.1		-75		6.68	
BDC-104	3/9/2009	2498	781	377	258	130					<0.25	<1.0	<1.0	<1.0	1.3	1.1	2.4	0	91.5	<0.1	0.0	19.2		20		6.67	
BDC-104	4/16/2009	2536	819	415	296	168					<0.25	<1.0	<1.0	<1.0	<1.0	1.6	1.6	0.3	67.2	<0.1	0.0	21.6		67		6.63	
BDC-104	5/14/2009	2564	847	443	324	196	-34				<0.25	<1.0	<1.0	<1.0	<1.0	1.4	1.4	0.5	63.4	<0.1	0.0	20.1		6		6.70	
BDC-104	7/17/2009	2628	911	507	388	260	30				<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.4	21.0	0.5	1.0	30.8		-3		7.30	
BDC-104	9/9/2009	2682	965	561	442	314	84	-49			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.6	39.8	0.1	0.8	41.6		61		7.20	
BDC-104	11/12/2009	2746	1029	625	506	378	148	15			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	115	1.4	0.0	24.1		68		6.49	
BDC-104	2/17/2010	2843	1126	722	603	475	245	112			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.7	119	0.1	0.0	111		868		6.93	

TABLE 5
AOC-05 CLEANUP ACTION SUMMARY
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

Well	Date	ORC Injection Elapsed Time from Injection (days)	Pilot Injection Elapsed Time from Injection (days)	Full Scale Injection 1 Elapsed Time from Injection (days)	Full Scale Injection 2 Elapsed Time from Injection (days)	Full Scale Injection 3 Elapsed Time from Injection (days)	Full Scale Injection 4 Elapsed Time from Injection (days)	Full Scale Injection 5 Elapsed Time from Injection (days)	Full Scale Injection 6 Elapsed Time from Injection (days)	Full Scale Injection 7 Elapsed Time from Injection (days)	TPH-G (mg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	m,p-Xylene (µg/L)	o-Xylene (µg/L)	Total Xylenes (µg/L)	DO (mg/L)	Nitrate (mg-N/L)	Nitrite (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (µg/L)	ORP (mV)	TOC (mg/L)	pH	Comments
											Volatile Organic Compounds (all units in ug/L)							Aquifer Redox Conditions							Donor Indicators		
Proposed Groundwater Cleanup Levels (a)											0.8	2.0	1300	1.7	NA	NA	1500										
BDC-104	5/17/2010	2932	1215	811	692	564	334	201			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	47.4	<1.0	0.6	30.5		482		6.74	
BDC-104	8/16/2010	3023	1306	902	783	655	425	292	-37		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.6	38.4	0.2	2.5	23.6		76		6.92	
BDC-104	11/8/2010	3107	1390	986	867	739	509	376	47		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.9	32.5	<0.1	0.0	18.6		115		7.23	
BDC-104	2/16/2011	3207	1490	1086	967	839	609	476	147		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.5	40.0	<0.1	0.4	24.1		423		6.71	
BDC-104	5/3/2011	3283	1566	1162	1043	915	685	552	223		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.2	31.3	<0.1	1.2	26.8		231		6.63	
BDC-104	8/1/2011	3373	1656	1252	1133	1005	775	642	313		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.1	11.7	<0.1	0.0	21.2		121		7.20	
BDC-104	11/1/2011	3465	1748	1344	1225	1097	867	734	405	-105	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.4	14.6	<0.1	0.0	18.7		-53		7.40	
BDC-104	2/19/2012	3575	1858	1454	1335	1207	977	844	515	5	<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.3	21.6		0.0	29.2		66		6.23	
BDC-104	5/3/2012	3649	1932	1528	1409	1281	1051	918	589	79	<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.1	19.4		1.5	26.5		207		6.78	
BDC-104	9/4/2012	3773	2056	1652	1533	1405	1175	1042	713	203	<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.7	12.3	<0.10	0.5	22.1		130		7.11	
BDC-104	11/13/2012	3843	2126	1722	1603	1475	1245	1112	783	273	<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.24	0.80	<0.10		5.1		64		7.19	
BDC-104	2/20/2013	3942	2225	1821	1702	1574	1344	1211	882	372	0.28	<1.0	6.5	<1.0	17	3.3	20.3	0.44	2.5	<0.10	0.2	3.6		82		6.96	

TPH-G = Total Petroleum Hydrocarbon-Gasoline
DO = Dissolved Oxygen
ORP = Oxidation Reduction Potential
TOC = Total Organic Carbon
NA = Not Applicable, not available
µg/L = micrograms pr liter
mg/L = milligrams per liter
mV = millivolts
NA = Not Analyzed
[shaded] = No sample collected or sample not analyzed for specified constituent.
TMCL = Target Media Cleanup Level.
Box = Exceedance of TMCL.

(a) Plant 2 TMCLs , Boeing 2011, Floyd Snider 2012 (Industrial/Worker)
(b) BTEX data questionable for this event. Concentrations inconsistent with TPH-G data for indicated event and previous BTEX data from other events.

Injection dates

5/7/2002	ORC
1/18/2007	Pilot -scale nitrate
2/26/2008	1st full scale injection
6/24/2008	2nd full scale injection
10/30/2008	3rd full scale injection
6/17/2009	4th full scale injection (start ammonium phosphate, 1/3 ammonium nitrate dose to both wells)
10/28/2009	5th full scale injection (103 full dose, 104 half dose)
9/22/2010	6th full scale injection (103 only full dose)
2/14/2012	7th full scale injection (103 only full dose)

TABLE 6
SWMU-17 CLEANUP ACTION SUMMARY
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

		Pilot Injection	Full Injection #1	Volatile Organic Compounds							Metals				Aquifer Redox Conditions						Donor Indicators		
		Elapsed Time From Injection (days)	Elapsed Time From Injection (days)	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	As, Tot (mg/L)	As, Dis (mg/L)	Cu, Tot (mg/L)	Cu, Dis (mg/L)	DO (mg/L)	Nitrate (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (mg/L)	ORP (mV)	TOC (mg/L)	pH	
Proposed Groundwater Cleanup Levels (a)				5.3	1.4	134	2.4	NA	NA	NA	0.008	0.008	0.008	0.008									
Well	Date																						Comments
BDC-05-02	5/21/2007	-526		20	24	1.2	<1.0				0.003	0.002	0.004	<0.002									
(IW)	11/26/2007	-337		12	14	1.3	<1.0				0.001	<0.001	<0.002	<0.002									
	5/22/2008	-159		14	20	1.2	<0.2				0.002	<0.001	0.004	<0.002									
	10/23/2008	-5		31	62	2.9	<1.0	<1.1	<1.2	<1.1	0.003	0.003	0.006	<0.002	5.2	0.4	0.2	13.0	0.19	87.1	5.5	6.47	
	11/20/2008	23		5.1	4.2	0.7	<0.2	<1.1	<1.2	<1.1	0.017	0.011	0.008	<0.002	0.3	<0.1	1.8	64.8	3.3	-111	430	6.47	
	12/16/2008	49		6.6	7.3	1.3	<1.0	<1.1	<1.2	<1.1	0.024	0.017	0.030	0.003	1.3	<0.1	3.4	88.8	2.9	-225	610	6.41	
	1/16/2009	80		7.5	22	3.7	<1.0	<1.1	<1.2	<1.1	0.022	0.014	0.029	<0.002	0.1	<1.0	3.5	6.9	6.2	-304	732	6.10	
	2/11/2009	106		9.5	17	12	<1.0	<1.1	<1.2	<1.1	0.046	0.040	0.004	<0.002	2.4	<0.1	4.0	<0.1	13.2	-99	433	6.32	
	3/9/2009	132		9.1	8.1	25	<1.0	<1.1	<1.2	<1.1	0.041	0.036	0.004	<0.002	0.1	<1.0	3.5	<1.0	22.9	-102	317	6.43	
	4/16/2009	170		7.3	6.0	41	<1.0	<1.1	<1.2	<1.1	0.029	0.025	0.003	<0.002	1.8	<0.1	3.0	<0.5	26.3	-97	274	6.59	
	5/13/2009	197		4.4	4.6	35	1.4	<1.1	<1.2		0.024	0.019	0.004	0.002	0.3	<0.1	5.2	<0.1	23.0	-63	215	6.61	
	8/16/2009	292		1.8	1.1	49	<1.0	<1.1	<1.2	<1.1	0.023	0.017	0.009	<0.002	1.6	<0.5	3.6	<0.5	22.6	-23	125	6.77	Black tint, black flakes, suspended solids
	11/13/2009	381		1.0	<1.0	70	<1.0	<1.1	<1.2	<1.1	0.020	0.016	0.003	<0.002	1.1	<0.1	2.8	0.3	21.1	-26	44.1	6.05	Black tint
	2/16/2010	476		<1.0	<1.0	54	<1.0	<1.1	<1.2	<1.1	0.022	0.020	0.005	0.002	1.5	<0.5	2.0	0.5	22.5	763	86.7	6.87	
	5/18/2010	567		<1.0	1.0	32	<1.0	<1.1	<1.2	<1.1	0.013	0.012	<0.002	<0.002	1.8	<0.5	2.3	<0.5	18.4	515	20.6	6.69	
	8/17/2010	658		<1.0	<1.0	23	<1.0	<1.1	<1.2	<1.1	0.010	0.008	<0.002	<0.002	2.8	0.2	2.7	1.4	20.2	55	13.3	6.74	
	11/9/2010	742		<1.0	<1.0	14	<1.0	<1.1	<1.2	<1.1	0.006	0.005	<0.002	<0.002	2.8	<0.1	2.2	0.3	16.9	72	10.8	6.83	
	2/15/2011	840		<1.0	<1.0	13	<1.0	<1.1	<1.2	<1.1	0.007	0.006	0.003	<0.002	2.4	<0.1	3.0	0.7	17.8	114	13.2	6.80	
	5/2/2011	916		0.6	0.9	22	0.3	<1.1	<1.2	<1.1	0.008	0.007	<0.002	<0.002	2.1	<0.1	1.4	0.2	13.3	13	9.8	6.86	
	7/31/2011	1006	-18	<1.0	<1.0	10	<1.0	<1.1	<1.2	<1.1	0.006	0.005	<0.002	<0.002	2.0	<0.1	3.2	0.2	15.0	-35	8.7	6.82	
	11/2/2011	1100	76	8.4	4.8	150	1.6	<1.1	<1.2	<1.1	0.025	0.022	0.010	0.010	2.4	<0.1	3.5	1.4	9.0	-28	5360	5.43	
	2/19/2012	1209	185	<4.0	<4.0	220	<4.0	<1.0	<1.0	<1.0					1.4	<0.5	1.3	<1.5	8.5	-32	673	6.70	
	5/7/2012	1287	263	<2.0	<2.0	180	<2.0	<1.0	<1.0	<1.0	0.051	0.049	0.004	<0.002	0.6		2.2	0.8	19.0	35	412	6.71	
	9/5/2012	1408	384	<2.0	<2.0	57	<2.0	<1.0	<1.0	<1.0					0.1		1.8	<0.30	10.0	71	116	6.45	
	11/15/2012	1479	455	<2.0	<2.0	32	5.5	<1.0	<1.0	<1.0	0.014	0.013	<0.003	<0.002	0.03		1.2	<0.3	0.0	17	106	6.49	
	2/26/2013	1582	558	<1.0	<1.0	1.2	2.7	1.4	<1.0	<1.0					0.12		1.2	<0.30	17.0	45	32.2	6.66	
BDC-05-03	5/21/2007	-526		3.5	8.1	11	<1.0				0.003	<0.001	0.004	<0.002									
(MW 17 ft DG)	11/26/2007	-337		2.3	4.4	7.2	<1.0				0.002	<0.001	0.003	<0.002									
	5/22/2008	-159		3.8	8.5	13	<0.2				0.002	<0.001	0.003	<0.002									
	10/23/2008	-5		4.2	8.2	17	<0.2	<1.1	<1.2	<1.1	0.004	0.002	0.004	0.002	0.4	<0.1	0.1	4.9	2.1	48.9	4.9	6.23	
	11/20/2008	23		1.8	2.1	2.7	<0.2	<1.1	<1.2	<1.1	0.003	0.001	0.004	<0.002	2.1	0.9	1.6	8.5	3.6	-8	7.0	6.23	
	12/16/2008	49		2.2	4.1	5.8	<1.0	<1.1	<1.2	<1.1	0.001	<0.001	0.002	<0.002	1.2	0.4	2.4	20.1	4.7	-67	5.4	6.44	
	1/16/2009	80		1.5	1.2	<1.0	<1.0	<1.1	<1.2	<1.1	0.001	<0.001	0.002	<0.002	0.7	1.7	0.4	10.3	1.5 J	-144	3.2	6.17	
	2/11/2009	106		1.8	3.2	4.4	<1.0	<1.1	<1.2	<1.1	0.002	<0.001	0.002	<0.002	2.4	0.9	2.4	6.2	5.4	-60	5.4	6.59	
	3/9/2009	132		1.3	1.7	1.4	<1.0	<1.1	<1.2	<1.1	<0.001	<0.001	<0.002	<0.002	0.9	1.0	1.0	6.6	4.3	39	4.8	6.48	
	4/16/2009	170		1.5	2.2	2.8	<1.0	<1.1	<1.2	<1.1	0.001	0.002	<0.002	<0.002	1.4	1.0	1.4	4.8	3.3	14	5.4	6.69	
	5/13/2009	197		1.2	2.1	3.4	<1.0	<1.1	<1.2		0.001	0.0004	0.004	0.002	1.1	1.0	3.0	4.8	6.9	31	5.5	6.75	
	8/16/2009	292		2.2	4.3	8.1	<1.0	<1.1	<1.2	<1.1	0.001	0.001	<0.002	<0.002	0.9	0.1	3.0	3.0	8.3	-42	6.5	7.11	
	11/13/2009	381		1.2	1.2	<1.0	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.003	<0.002	1.7	0.2	3.0	5.6	5.0	57	4.3	6.37	
	2/16/2010	476		1.4	1.0	<1.0	<1.0	<1.1	<1.2	<1.1	0.002	<0.001	0.005	0.005	1.3	2.5	0.0	8.6	<0.0007	663	3.5	6.30	
	5/18/2010	567		1.2	1.8	2.7	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.004	0.003	0.9	1.5	2.0	4.9	2.4	346	4.7	6.42	
	8/17/2010	658		2.3	5.2	14	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.003	<0.002	2.1	0.2	2.7	2.8	7.1	73	7.6	6.79	
	11/9/2010	742		1.4	1.7	3.7	<1.0	<1.1	<1.2	<1.1	0.001	0.001	0.003	<0.002	3.2	0.5	2.2	5.3	3.0	133	4.7	7.61	
	2/15/2011	840		1.3	<1.0	2.3	<1.0	<1.1	<1.2	<1.1	0.001	0.0003	0.005	0.003	2.9	0.7	0.0	6.2	4.6	166	5.4	7.01	
	5/2/2011	916	-108	1.7	1.0	0.2	<0.2	<1.1	<1.2	<1.1	0.002	0.0004	0.005	0.003	3.3	0.8	0.0	5.5	0.3	203	4.1	6.91	
	11/2/2011	1100	76	1.4	1.6	20	2.0				0.018	0.017	0.004	0.002	1.2	<0.1	1.6	<1.0		-60	70.0	6.72	
	5/6/2012	1286	262	0.6	1.3	<0.2	0.3				0.002	0.004	0.003	0.010	0		1.2	10.3		82	4.9	6.26	
	11/15/2012	1479	455	<0.5	<0.5	<0.5	0.7				0.008	0.007	0.003	<0.002	0.01		0.3	1.2		13	8.3	6.79	
BDC-05-04	5/21/2007	-526		<1.0	<1.0	1.4	<1.0				0.018	<0.001	<0.002	<0.002									
(MW 40 ft XG)	11/26/2007	-337		<1.0	<1.0	1.6	<1.0				0.009	<0.001	<0.002	<0.002									
	5/22/2008	-159		1.5	0.9	1.2	<0.2				0.018	<0.001	<0.002	<0.002									
	10/23/2008	-5		1.1	0.8	2.1	<0.2	<1.1	<1.2	<1.1	0.009	<0.001	<0.002	<0.002	2.5	7.6	0.1	31.0	0.3	73.5	3.8	6.33	
	11/20/2008	23		1.1	0.7	3.6	<0.2	<1.1	<1.2	<1.1	0.019	<0.001	<0.002	<0.002	0.6	4.5	0.8	25,2	0.05	-16	5.1	6.25	
	12/16/2008	49		<1.0	<1.0	2.4	<1.0	<1.1	<1.2	<1.1	0.019	0.002	0.003	<0.002	0.6	5.5	1.0	30.4	1.6	-98	6.9	6.24	
	1/16/2009	80		<1.0	<1.0	2.0	<1.0	<1.1	<1.2	<1.1	0.017	<0.001	<0.002	<0.002	0.1	4.3	1.0	21.8	1.5	-192	5.1	6.23	
	2/11/2009	106		1.0	<1.0	1.5	<1.0	<1.1	<1.2	<1.1	0.020	<0.001	<0.002	<0.002	2.5	5.9	1.0	31.8	1.1	-54	6.8	6.17	

TABLE 6
SWMU-17 CLEANUP ACTION SUMMARY
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

		Pilot Injection	Full Injection #1	Volatile Organic Compounds							Metals				Aquifer Redox Conditions						Donor Indicators		
		Elapsed Time From Injection (days)	Elapsed Time From Injection (days)	PCE (µg/L)	TCE (µg/L)	*c* DCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	As, Tot (mg/L)	As, Dis (mg/L)	Cu, Tot (mg/L)	Cu, Dis (mg/L)	DO (mg/L)	Nitrate (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (mg/L)	ORP (mV)	TOC (mg/L)	pH	
Proposed Groundwater Cleanup Levels (a)				5.3	1.4	134	2.4	NA	NA	NA	0.008	0.008	0.008	0.008									
Well	Date																						Comments
	3/9/2009	132		1.0	<1.0	1.3	<1.0	<1.1	<1.2	<1.1	0.014	0.001	0.002	<0.002	0.3	4.8	1.5	30.1	0.2	35	5.2	6.22	
	4/16/2009	170		1.2	<1.0	<1.0	<1.0	<1.1	<1.2	<1.1	0.011	0.001	<0.002	<0.002	1.5	5.9	1.4	33.6	<0.0007	68	5.7	6.29	
	5/13/2009	197		<1.0	<1.0	1.0	<1.0	<1.1	<1.2		0.007	0.001	0.002	0.002	0.3	4.5	1.6	26.6	0.4	49	5.2	6.37	
	8/16/2009	292		1.3	<1.0	<1.0	<1.0	<1.1	<1.2	<1.1	0.012	0.001	0.002	<0.002	0.9	5.4	2.2	30.6	<0.0007	93	5.0	6.97	
	11/13/2009	381		<1.0	<1.0	1.2	<1.0	<1.1	<1.2	<1.1	0.005	0.001	<0.002	<0.002	0.6	2.2	3.0	18.4	2.4	109	4.4	5.86	
	2/16/2010	476		<1.0	<1.0	1.1	<1.0	<1.1	<1.2	<1.1	0.004	0.002	0.012	0.002	0.9	<0.1	3.3	24.6	1.5	899	8.9	6.24	
	5/18/2010	567		1.1	<1.0	1.2	<1.0	<1.1	<1.2	<1.1	0.014	0.001	0.005	<0.002	0.8	<0.1	3.0	25.4	1.3	473	7.1	6.19	
	8/17/2010	658		<1.0	<1.0	3.0	<1.0	<1.1	<1.2	<1.1	0.012	0.002	0.006	<0.002	1.0	<0.1	2.8	17.7	3.5	108	8.7	6.48	
	11/9/2010	742		<1.0	<1.0	4.3	<1.0	<1.1	<1.2	<1.1	0.008	0.004	<0.002	<0.002	2.2	<0.1	2.2	21.3	3.0	101	7.2	6.84	
	2/15/2011	840		<1.0	<1.0	2.9	<1.0	<1.1	<1.2	<1.1	0.007	0.004	<0.002	<0.002	2.5	<0.1	2.4	19.4	4.5	93	6.9	6.85	
	5/2/2011	916	-108	0.4	0.5	3.1	<0.2	<1.1	<1.2	<1.1	0.008	0.004	<0.002	<0.002	1.7	<0.1	2.2	18.0	1.8	49	6.8	6.76	
	11/2/2011	1100	76	<1.0	<1.0	4.2	<1.0				0.007	0.006	<0.002	<0.002	1.5	<1.0	1.2	<1.0		-3	6.6	7.17	
	5/7/2012	1287	263	0.4	0.6	3.6	<0.2				0.017	0.016	<0.002	<0.002	0.2		2.0	21.5		98	8.6	6.39	
	11/16/2012	1480	456	<0.5	<0.5	3.3	<0.5				0.012	0.010	0.002	<0.002	0.02		1.2	14.3		27	6.5	6.65	
BDC-05-05	5/21/2007	-526		<1.0	<1.0	<1.0	<1.0				0.002	<0.001	0.003	<0.002									
(MW UG)	11/26/2007	-337		<1.0	<1.0	<1.0	<1.0				<0.001	<0.001	<0.002	<0.002									
	5/22/2008	-159		0.3	0.8	<0.2	<0.2				0.002	<0.001	0.003	<0.002									
	10/23/2008	-5																					
	11/20/2008	23		0.3	0.7	<0.2	<0.2				0.005	0.001	0.005	0.003	4.6					52		6.25	
	12/16/2008	49																					
	1/16/2009	80																					
	2/11/2009	106																					
	3/9/2009	132																					
	4/16/2009	170																					
	5/13/2009	197		<1.0	<1.0	<1.0	<1.0				0.003	<0.001	0.006	0.002	3.2					68		6.72	
	8/16/2009	292																					
	11/13/2009	381		<1.0	<1.0	<1.0	<1.0				0.001	<0.001	<0.002	<0.002	2.9	1.2	0.0	8.7		166		5.84	
	2/16/2010	476																					
	5/18/2010	567		<1.0	<1.0	<1.0	<1.0				0.002	0.0004	0.002	<0.002	3.5		0.0			494		6.74	
	8/17/2010	658																					
	11/9/2010	742		<1.0	1.1	<1.0	<1.0				0.001	0.0004	0.003	<0.002	3.2					135		6.90	
	2/15/2011	840																					
	5/2/2011	916	-108	0.3	0.8	<0.2	<0.2				0.001	0.0003	0.003	<0.002	3.4					158		6.98	
	11/2/2011	1100	76	<1.0	1.2	<1.0	<1.0				0.001	0.0003	0.002	0.003	2.8	<0.1	0.0	7.5		85	1.7	7.66	
	5/6/2012	1286	262	0.4	0.9	<0.2	<0.2				<0.001	<0.001	0.003	<0.002	3.2		0.0	22.1		219	1.1	6.42	
	11/16/2012	1480	456	<0.5	1.1	<0.5	<0.5	<1.0	<1.0	<1.0	0.001	0.0005	0.003	<0.002	1.76		0.2	20.6	<0.003	27	<1.0	6.82	
BDC-05-07	5/21/2007	-526		30	22	10	<1.0				0.003	<0.001	0.014	0.009									
(IW)	11/26/2007	-337		28	25	11	<1.0				<0.001	<0.001	0.011	0.002									
	5/22/2008	-159		33	32	9.2	<0.2				0.002	<0.001	0.012	0.006									
	10/23/2008	-5		22	24	14	<0.2	<1.1	<1.2	<1.1	0.004	0.002	0.022	0.013	9.7	9.6	0.0	33.4	0.6	86.0	7.8	6.47	
	11/20/2008	23		17	17	4.9	<0.2	<1.1	<1.2	<1.1	0.003	<0.001	0.016	0.010	0.6	2.2	0.4	15.8	0.2	-27	4.6	6.46	
	12/16/2008	49		16	25	7.2	<1.0	<1.1	<1.2	<1.1	0.003	0.001	0.016	0.012	1.2	4.8	0.0	29.4	0.6	-107	6.1	6.49	
	1/16/2009	80		20	23	6.4	<1.0	<1.1	<1.2	<1.1	0.002	<0.001	0.013	0.008	0	8.4	0.0	32.6	0.03	-182	6.3	6.38	
	2/11/2009	106		23	28	9.9	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.017	0.012	2.1	11.2	0.0	37.5	1.5	-68	9.3	6.37	
	3/9/2009	132		20	21	8.4	<1.0	<1.1	<1.2	<1.1	<0.002	<0.001	0.013	0.009	0.0	8.8	0.3	35.3	5.5	-23	6.8	6.37	
	4/16/2009	170		20	21	11	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.015	0.008	0.3	8.2	0.0	31.2	5.1	35	8.1	6.43	
	5/13/2009	197		11	13	7.5	<1.0	<1.1	<1.2		0.002	0.001	0.016	0.008	0.3	6.8	0.4	27.2	7.9	34	7.3	6.47	
	8/16/2009	292		11	12	13	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.010	<0.002	0.7	2.3	2.0	23.2	6.8	67	8.2	6.73	
	11/13/2009	381		6.5	5.3	5.6	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.004	<0.002	0.5	<0.1	2.8	5.7	4.7	16	9.1	6.48	
	2/16/2010	476		6.4	6.9	28	<1.0	<1.1	<1.2	<1.1	0.004	0.003	0.017	0.006	1.0	<0.1	2.5	20.4	5.2	839	14.7	6.88	
	5/18/2010	567		5.8	9.2	41	1.2	<1.1	<1.2	<1.1	0.009	0.003	0.009	<0.002	1.1	<0.5	2.0	16.4	6.0	525	14.8	6.77	
	8/17/2010	658		2.8	7.8	19	<1.0	<1.1	<1.2	<1.1	0.006	0.003	0.008	<0.002	2.3	<0.1	2.5	8.6	7.1	-15	18.8	7.34	
	11/9/2010	742		<1.0	9.4	20	<1.0	<1.1	<1.2	<1.1	0.008	0.005	0.009	<0.002	2.4	<0.1	2.2	15.2	5.1	13	15.2	7.35	
	2/15/2011	840		<1.0	8.7	20	<1.0	<1.1	<1.2	<1.1	0.013	0.010	0.012	0.002	3.0	<0.1	2.8	11.8	5.1	21	14.0	7.16	
	5/2/2011	916	-108	5.2	11	17	<0.2	<1.1	<1.2	<1.1	0.017	0.004	0.014	0.003	2.1	0.1	2.6	15.6	3.2	33	16.8	6.90	
	11/2/2011	1100	76	11	6.9	39	<1.0	<1.1	<1.2	<1.1	0.042	0.035	0.010	0.006	2.1	<0.1	2.4	<1.0	16.1	-51	1780	6.31	
	5/7/2012	1287	263	0.8	<0.2	23	0.9	<1.0	<1.0	<1.0	0.026	0.024	0.003	<0.002	0.2		1.6	0.4	27.0	100	48.5	6.34	
	11/15/2012	1479	455	<0.2	0.4	24	0.8	<1.0	<1.0	<1.0	0.016	0.017	<0.002	<0.002	0.01		1.6	<0.3	0.0	3.0	26	6.60	

TABLE 6
SWMU-17 CLEANUP ACTION SUMMARY
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

		Pilot Injection	Full Injection #1	Volatile Organic Compounds							Metals				Aquifer Redox Conditions						Donor Indicators		
		Elapsed Time From Injection (days)	Elapsed Time From Injection (days)	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	As, Tot (mg/L)	As, Dis (mg/L)	Cu, Tot (mg/L)	Cu, Dis (mg/L)	DO (mg/L)	Nitrate (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (mg/L)	ORP (mV)	TOC (mg/L)	pH	
Proposed Groundwater Cleanup Levels (a)				5.3	1.4	134	2.4	NA	NA	NA	0.008	0.008	0.008	0.008									
Well	Date																						Comments
BDC-05-08	10/23/2008	-5		1.1	3.7	3.5	<0.2	<1.1	<1.2	<1.1	0.007	<0.001	0.004	<0.002	1.9	0.3	0.0	8.9	4.7	-12.0	5.1	6.65	
(MW 20 ft XG)	11/20/2008	23		1.1	3.4	4.2	<0.2	<1.1	<1.2	<1.1	0.035	0.004	0.036	<0.002	0.8	0.7	2.2	7.2	5.5	-43	5.9	6.63	
	12/16/2008	49		1.2	4.3	4.3	<1.0	<1.1	<1.2	<1.1	0.008	0.001	0.006	<0.002	0.5	0.9	4.6	21.8	3.6	-99	5.4	6.61	
	1/16/2009	80		1.3	4.2	3.6	<1.0	<1.1	<1.2	<1.1	0.008	0.002	0.007	<0.002	0.3	1.7	3.0	7.0	6.9	-185	5.8	6.59	
	2/11/2009	106		<1.0	3.2	3.9	<1.0	<1.1	<1.2	<1.1	0.019	0.001	0.010	<0.002	2.4	0.3	4.4	4.7	4.4	-78	7.0	6.69	
	3/9/2009	132		<1.0	2.7	3.5	<1.0	<1.1	<1.2	<1.1	0.009	0.003	0.007	<0.002	0.1	<0.1	3.6	3.8	4.9	-4	6.7	6.65	
	4/16/2009	170		<1.0	2.3	4.4	<1.0	<1.1	<1.2	<1.1	0.007	0.003	0.006	<0.002	0.4	<0.1	2.0	1.7	6.7	-8	6.8	6.80	
	5/13/2009	197		<1.0	1.6	3.0	<1.0	<1.1	<1.2		0.009	0.003	0.007	0.002	1.8	<0.1	4.0	0.8	11.4	-13	6.0	6.87	
	8/16/2009	292		<1.0	2.1	3.5	<1.0	<1.1	<1.2	<1.1	0.012	0.008	<0.002	<0.002	0.9	<0.1	2.8	5.3	13.2	-20	6.1	7.15	
	11/13/2009	381		<1.0	1.2	3.1	<1.0	<1.1	<1.2	<1.1	0.011	0.008	0.007	<0.002	0.7	<0.1	2.8	3.3	17.4	0.8	8.4	6.44	
	2/16/2010	476		<1.0	<1.0	2.3	<1.0	<1.1	<1.2	<1.1	0.024	0.009	0.024	<0.002	0.6	<0.1	3.0	0.8	13.1	841	8.3	6.76	
	5/18/2010	567		<1.0	<1.0	2.4	<1.0	<1.1	<1.2	<1.1	0.031	0.011	0.027	<0.002	1.0	<0.1	3.0	0.8	14.9	451	7.3	6.92	
	8/17/2010	658		<1.0	<1.0	2.3	<1.0	<1.1	<1.2	<1.1	0.014	0.009	0.013	<0.002	2.6	<0.1	3.2	0.5	10.1	-30	7.2	7.30	
	11/9/2010	742		<1.0	<1.0	3.5	<1.0	<1.1	<1.2	<1.1	0.031	0.012	0.031	<0.002	2.7	<0.1	2.4	0.3	14.2	59	7.6	7.17	
	2/15/2011	840		<1.0	<1.0	2.1	<1.0	<1.1	<1.2	<1.1	0.021	0.010	0.016	<0.002	2.4	<0.1	5.0	0.3	14.1	66	8.7	7.08	
	5/2/2011	916	-108	<0.2	<0.2	2.2	<0.2	<1.1	<1.2	<1.1	0.029	0.010	0.024	<0.002	2.2	<0.1	2.4	0.7	7.8	-28	8.0	7.17	
	11/2/2011	1100	76	<1.0	<1.0	2.4	<1.0				0.014	0.010	0.012	0.003	1.2	<0.1	1.2	0.8		-53	7.3	6.88	
	5/6/2012	1286	262	<0.2	<0.2	2.7	<0.2				0.021	0.020	0.007	0.002	0		2.5	0.4		42	12.4	6.77	
	11/16/2012	1480	456	<0.5	<0.5	1.3	<0.5				0.014	0.010	0.005	<0.002	0.01		1.0	<0.3		5	8.1	6.91	
BDC-05-09	7/31/2011		-18	30	20	22	<1.0	<1.1	<1.2	<1.1	0.007	0.007	<0.002	<0.002	1.4	<0.1	2.5	12.1	1.4	15	5.5	6.89	
(IW)	11/2/2011		76	37	56	44	1.3	<1.1	<1.2	<1.1	0.042	0.040	0.009	0.006	2.8	<0.1	3.0	7.6	4.3	80	4360	5.24	
	5/7/2012		263	3.0	1.1	250	3.9	<1.0	<1.0	<1.0	0.059	0.052	0.011	<0.002	0.7		2.2	0.5	18.0	85	531	6.33	
	11/15/2012		455	<2.0	<2.0	24	20	69	<1.0	<1.0	0.074	0.070	0.006	<0.002	0.01		1.2	<0.3	0.0	-10	266	6.71	
BDC-05-10	7/31/2011		-18	39	26	12	<1.0	<1.1	<1.2	<1.1	0.002	0.002	<0.002	<0.002	1.4	<0.1	2.0	19.7	0.3	76	4.5	6.84	
(IW)	11/2/2011		76	22	27	1.0	<1.0	1.6	1.7	<1.1	0.038	0.037	0.008	0.004	2.4	<0.1	2.2	10.9	0.1	-38	2030	5.72	
	5/6/2012		262	<1.0	<1.0	120	5.4	1.1	<1.0	<1.0	0.052	0.048	0.012	<0.002	0		1.7	0.4	19.0	58	270	6.48	
	11/15/2012		455	<1.0	<1.0	4.4	49	8.5	<1.0	<1.0	0.069	0.060	0.003	<0.002	0.02		1.0	<0.3	0.0	-11	122	6.63	
BDC-05-11	7/31/2011		-18	16	19	5.8	<1.0	<1.1	<1.2	<1.1	0.005	0.005	<0.002	<0.002	1.4	<0.1	2.0	4.0	1.4	65	3.9	6.93	
(IW)	11/2/2011		76	9.6	20	12	<1.0	<1.1	<1.2	<1.1	0.039	0.037	0.013	0.004	2.2	<0.1	1.8	<1.0	1.0	-38	1330	5.72	
	5/6/2012		262	0.2	0.5	44	7.2	1.6	<1.0	<1.0	0.038	0.034	0.009	0.002	0		1.4	0.5	18.0	70	284	6.42	
	11/15/2012		455	<1.0	<1.0	6.1	5.7	7.6	<1.0	<1.0	0.043	0.038	0.003	<0.002	0.02		1.3	<0.3	0.0	-15	73.8	6.76	
BDC-05-12	7/31/2011		-18	15	18	16	<1.0	<1.1	<1.2	<1.1	0.002	0.002	0.002	<0.002	1.6	0.1	2.4	8.4	4.0	26	7.0	7.02	
(IW)	11/2/2011		76	11	17	11	<1.0	<1.1	<1.2	<1.1	0.041	0.031	0.012	0.009	2.6	<0.1	3.5	5.6	1.0	-77	2960	5.83	
	2/19/2012		185	<0.4	<0.4	53	1.8	<1.0	<1.0	<1.0					1.7	<0.5	2.0	<1.5	17.0	-2	279	6.59	
	5/6/2012		262	<0.2	<0.2	39	3.4	<1.0	<1.0	<1.0	0.082	0.071	0.005	<0.002	0		2.5	0.8	21.0	65	83.2	6.45	
	9/5/2012		384	<0.2	<0.2	6.5	3.3	1.0	<1.0	<1.0					0.1		1.8	<0.30	22.0	80	50.4	6.48	
	11/15/2012		455	<1.0	<1.0	7.9	5.4	1.1	<1.0	<1.0	0.037	0.036	0.002	<0.002	0.03		1.3	<0.3	0.0	7	52.9	6.56	
	2/25/2013		557	<1.0	<1.0	1.7	4.4	3.8	<1.0	<1.0					0.18		2.0	<0.30	26.0	54	27.5	6.68	
BDC-05-13	7/31/2011		-18	5.2	6.6	2.6	<1.0	<1.1	<1.2	<1.1	0.003	0.002	0.002	<0.002	1.7	<0.1	2.0	2.3	5.0	-1	6.0	7.06	
(IW)	11/1/2011		75	<1.0	1.2	39	<1.0	<1.1	<1.2	<1.1	0.068	0.064	0.017	0.003	1.8	<1.0	1.5	<1.0	2.2	-70	550	6.65	
	5/6/2012		262	<0.2	<0.2	13	3.9	1.7	<1.0	<1.0	0.051	0.046	0.003	<0.002	0		3.0	0.4	19.0	78	34.2	6.40	
	11/15/2012		455	<1.0	<1.0	<1.0	2.3	3.7	<1.0	<1.0	0.060	0.055	<0.002	<0.002	0.04		2.2	<0.3	0.0	-9	30.2	6.75	
BDC-05-14	7/31/2011		-18	2.8	6.8	2.8	<1.0	<1.1	<1.2	<1.1	0.004	0.004	0.004	<0.002	1.8	<0.1	2.0	10.1	6.5	-15	8.6	7.00	
(IW)	11/1/2011		75	2.5	6.7	13	<1.0	<1.1	<1.2	<1.1	0.083	0.074	0.022	0.002	1.9	<1.0	2.3	<1.0	4.0	-124	725	6.13	
	5/6/2012		262	<0.2	0.4	3.0	1.1	<1.0	<1.0	<1.0	0.012	0.009	<0.002	<0.002	0.1		1.7	0.6	23.0	99	41.5	6.33	
	11/15/2012		455	<0.2	<0.2	1.1	2.0	1.4	<1.0	<1.0	0.022	0.019	<0.002	<0.002	0.11		2.2	<0.3	0.0	-1.4	39.9	6.66	
BDC-05-15	7/31/2011		-18	9.6	28	58	<1.0	<1.1	<1.2	<1.1	0.019	0.019	<0.002	<0.002	1.9	<0.1	1.3	18.6	0.8	-0.9	10.3	7.00	
(IW)	11/1/2011		75	4.8	9.8	15	<1.0	<1.1	<1.2	<1.1	0.061	0.058	0.010	0.009	2.4	<0.1	3.0	11.3	3.5	-0.1	4420	5.67	
	5/6/2012		262	<2.0	<2.0	49	6.3	<1.0	<1.0	<1.0	0.057	0.047	0.009	0.004	0.1		1.8	<0.3	21.0	93	423	6.36	
	11/15/2012		455	<1.0	<1.0	1.5	7.5	1.8	<1.0	<1.0	0.054	0.049	<0.002	<0.002	0.02		0.8	<0.3	0.0	8	71.2	6.61	

TABLE 6
SWMU-17 CLEANUP ACTION SUMMARY
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

		Pilot Injection	Full Injection #1	Volatile Organic Compounds							Metals				Aquifer Redox Conditions						Donor Indicators		
		Elapsed Time From Injection (days)	Elapsed Time From Injection (days)	PCE (µg/L)	TCE (µg/L)	*c*DCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	As, Tot (mg/L)	As, Dis (mg/L)	Cu, Tot (mg/L)	Cu, Dis (mg/L)	DO (mg/L)	Nitrate (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (mg/L)	ORP (mV)	TOC (mg/L)	pH	
Proposed Groundwater Cleanup Levels (a)				5.3	1.4	134	2.4	NA	NA	NA	0.008	0.008	0.008	0.008									
Well	Date																						Comments
BDC-05-16	7/31/2011		-18	9.5	17	20	<1.0	<1.1	<1.2	<1.1	0.006	0.006	0.002	<0.002	1.9	<0.1	1.5	8.9	3.1	-8	7.8	7.06	
(IW)	11/1/2011		75	2.6	2.8	37	<1.0	<1.1	<1.2	<1.1	0.079	0.074	0.005	0.002	2.3	<1.0	2.5	2.8	3.1	7	2250	5.51	
	2/19/2012		185	<2.0	<2.0	46	7.4	<1.0	<1.0	<1.0					1.6	<0.5	2.2	<1.5	18.0	128	1270	5.12	
	5/6/2012		262	<0.2	0.3	6.7	24	2.5	<1.0	<1.0	0.042	0.039	0.003	<0.002	0.1		2.5	<0.3	25.0	121	207	6.28	
	9/5/2012		384	<0.4	<0.4	0.9	8.1	6.0	<1.0	<1.0					0.1		2.0	<0.30	22.0	64	40.6	6.67	
	11/15/2012		455	<1.0	<1.0	<1.0	4.9	4.0	<1.0	<1.0	0.041	0.037	<0.002	<0.002	0.02		1.0	<0.3	0.0	7	32.3	6.68	
	2/25/2013		557	<1.0	<1.0	<1.0	13	4.7	2.7	<1.0					0.41		2.0	<0.30	28.0	68	34.6	6.77	
BDC-05-17	7/31/2011		-18	11	22	34	<1.0	<1.1	<1.2	<1.1	0.004	0.004	0.003	0.002	2.0	0.6	1.5	16.0	0.30	59	10.2	6.95	
(IW)	11/1/2011		75	3.2	4.8	5.1	<1.0	<1.1	<1.2	<1.1	0.053	0.047	0.005	<0.002	2.6	<1.0	2.4	23.9	2.8	-50	3500	5.74	
	5/6/2012		262	<2.0	<2.0	9.3	5.6	<1.0	<1.0	<1.0	0.058	0.026	0.003	<0.002	0.2		2.0	0.7	15.0	182	839	6.08	
	11/15/2012		455	<5.0	<5.0	<5.0	5.4	2.0	<1.0	<1.0	0.081	0.062	<0.002	<0.002	0.02		1.0	<0.3	0.0	13	73.5	6.62	
BDC-05-18	7/31/2011		-18	3.6	5.0	6.6	<1.0	<1.1	<1.2	<1.1	0.019	0.020	<0.002	<0.002	1.6	<0.1	2.4	4.5	3.9	-19	3.2	7.13	
(MW 10 ft XG)	11/1/2011		75	2.8	4.0	7.6	<1.0	<1.1	<1.2	<1.1	0.019	0.020	0.003	0.003	1.4	<0.1	1.2	1.2	4.3	-106	21.7	6.88	
	2/19/2012		185	1.8	3.7	12	<0.2	<1.0	<1.0	<1.0					0.2	<0.5	2.2	<1.5	11.0	9	2.7	6.66	
	5/6/2012		262	2.0	4.0	9.6	<0.2	<1.0	<1.0	<1.0	0.013	0.013	<0.002	<0.002	0.2		2.5	2.1	7.5	132	2.5	6.39	
	9/5/2012		384	1.5	3.1	11	0.2	<1.0	<1.0	<1.0					0.1		1.5	2.0	7.9	58	1.8	6.91	
	11/15/2012		455	1.0	4.3	16	<0.5	<1.0	<1.0	<1.0	0.015	0.014	<0.002	<0.002	0.48		1.4	2.4	0.0	25	1.7	6.62	
	2/25/2013		557	2.0	4.6	5.7	<0.2	<1.0	<1.0	<1.0					0.25		2.0	9.2	1.3	72	2.0	6.53	
BDC-05-19	7/31/2011		-18	15	21	23	<1.0	<1.1	<1.2	<1.1	0.002	0.001	0.002	<0.002	1.8	0.2	2.6	5.2	4.7	34	7.3	6.97	
(MW 10 ft DG)	11/1/2011		75	9.1	13	36	4.1	<1.1	<1.2	<1.1	0.020	0.020	0.007	<0.002	1.5	<1.0	1.8	2.5	4.5	-142	170	6.82	
	2/19/2012		185	<1.0	1.7	68	14	1.4	<1.0	<1.0					0.9	<0.5	2.0	<1.5	22.0	36	296	6.40	
	5/6/2012		262	0.7	1.4	52	23	1.8	<1.0	<1.0	0.058	0.052	0.032	0.008	0		2.0	1.4	25.0	69	244	6.39	
	9/5/2012		384	<2.0	<2.0	13	15	3.9	<1.0	<1.0					0.2		1.8	1.4	19.0	73	68.0	6.43	
	11/15/2012		455	<1.0	1.1	9.9	15	5.5	<1.0	<1.0	0.088	0.074	0.006	<0.002	0.21		1.6	1.8	0.0	3	68.1	6.58	
	2/25/2013		557	<1.0	<1.0	6.9	20	6.5	<1.0	<1.0					0.25		2.0	0.31	23.0	71	53.0	6.64	
BDC-05-20	7/31/2011		-18	<1.0	7.0	45	<1.0	<1.1	<1.2	<1.1	0.011	0.011	<0.002	<0.002	2.3	<0.1	1.5	7.4	0.2	-42	10.8	7.12	
(MW 23 ft DG)	11/3/2011		77	<1.0	5.7	25	1.0	<1.1	<1.2	<1.1	0.010	0.011	<0.002	<0.002	1.5	<0.1	1.0	6.0	4.6	11	8.3	7.14	
	2/19/2012		185	<0.2	2.9	17	2.5	<1.0	<1.0	<1.0					0.4	<0.5	1.5	<1.5	16.0	31	8.2	6.69	
	5/7/2012		263	<0.2	1.8	14	2.2	<1.0	<1.0	<1.0	0.011	0.011	<0.002	<0.002	0.7		1.8	2.3	20.0	20	11.1	6.66	
	9/5/2012		384	<0.4	<0.4	12	2.0	<1.0	<1.0	<1.0					0.1		1.4	<0.30	14.0	67	12.1	6.75	
	11/16/2012		456	<0.5	0.6	17	3.5	<1.0	<1.0	<1.0	0.012	0.013	<0.002	<0.002	0.07		2.0	<0.3	0.0	0.9	13.1	6.88	
	2/26/2013		558	<0.2	0.5	9.8	6.1	<1.0	<1.0	<1.0					0.16		1.5	<0.30	22.0	16	16.3	6.86	
BDC-05-21	7/31/2011		-18	<1.0	<1.0	1.3	14	2.6	<1.2	<1.1	0.006	0.006	<0.002	<0.002	3.0	<0.1	3.2	0.2	5.6	-31	6.4	7.33	
(MW 25 ft XG)	11/3/2011		77	<1.0	<1.0	1.0	4.7				0.005	0.005	<0.002	<0.002	2.0	<0.1	1.4	6.3		-12	5.2	7.29	
	2/19/2012		185	<0.2	0.3	0.7	5.9								0.4	<0.5	1.4	<1.5		47	7.2	6.65	
	5/7/2012		263	<0.2	0.4	0.8	2.5				0.010	0.011	0.005	<0.002	0.9		1.5	1.9		-35	12.3	6.76	
	9/5/2012		384	<0.2	0.3	0.6	2.9								0.1		2.5	1.4		62	9.5	6.78	
	11/16/2012		456	<0.5	<0.5	0.6	2.9				0.020	0.020	<0.002	<0.002	0.02		1.5	0.6		-4	8.9	6.92	
	2/26/2013		558	<0.2	0.3	0.8	3.3	<1.0	<1.0	<1.0					0.24		1.4	<0.30	18.0	-2.6	8.7	7.03	
BDC-05-22	7/31/2011		-18	<1.0	1.1	9.6	1.0	<1.1	<1.2	<1.1	0.025	0.024	<0.002	<0.002	2.0	<0.1	2.2	14.0	5.1	-59	7.9	7.21	
(MW 30 ft XG)	11/3/2011		77	<1.0	2.1	10	<1.0				0.020	0.020	<0.002	<0.002	1.5	<0.1	0.8	18.1		19	6.1	7.08	
	2/19/2012		185	<0.2	2.0	13	0.4								0.4	<0.5	1.2	17.0		110	6.2	6.73	
	5/7/2012		263	<0.2	2.0	11	0.5				0.025	0.023	0.002	<0.002	0.8		1.6	19.4		32	8.4	6.68	
	9/5/2012		384	<0.2	1.8	9.5	0.8								0.1		2.2	14.7		75	7.6	6.71	
	11/16/2012		456	<0.5	1.6	10	0.7				0.033	0.031	<0.002	<0.002	0.02		0.8	17.8		5	7.7	6.93	
	2/26/2013		558	<0.2	1.3	9.4	1.2								0.09		1.6	10.1		23	7.5	6.92	
BDC-05-23	7/31/2011		-18	<1.0	<1.0	3.2	<1.0	<1.1	<1.2	<1.1	0.005	0.005	0.002	<0.002	2.7	<0.1	2.2	8.6	6.0	-101	9.1	7.47	
(MW 170ft DG)	11/3/2011		77	<1.0	<1.0	4.8	<1.0				0.005	0.006	<0.002	<0.002	1.5	<0.1	1.0	25.2		1	8.8	7.08	
	2/19/2012		185	<0.2	0.6	4.7	0.7								1.0	<0.5	1.2	8.9		162	8.1	6.33	
	5/7/2012		263	<0.2	0.7	5.4	0.8				0.008	0.008	<0.002	<0.002	0.1		2.0	15.8		45	9.3	6.70	
	9/5/2012		384	<0.2	0.7	6.2	0.9								0.1		1.9	8.8		78	11.3	6.84	
	11/16/2012		456	<0.5	0.8	6.9	0.5				0.012	0.010	<0.002	<0.002	0.09		1.0	4.9		-6	11.6	7.06	
	2/25/2013		557	<0.2	0.5	4.2	1.0								0.08		1.5	8.7		72	9.2	6.91	

TABLE 6
SWMU-17 CLEANUP ACTION SUMMARY
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

		Pilot Injection	Full Injection #1	Volatile Organic Compounds							Metals				Aquifer Redox Conditions						Donor Indicators		
		Elapsed Time From Injection (days)	Elapsed Time From Injection (days)	PCE (µg/L)	TCE (µg/L)	*c* DCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	As, Tot (mg/L)	As, Dis (mg/L)	Cu, Tot (mg/L)	Cu, Dis (mg/L)	DO (mg/L)	Nitrate (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (mg/L)	ORP (mV)	TOC (mg/L)	pH	
Proposed Groundwater Cleanup Levels (a)				5.3	1.4	134	2.4	NA	NA	NA	0.008	0.008	0.008	0.008									
Well	Date																						Comments
BDC-05-24	7/31/2011		-18	<1.0	<1.0	1.6	1.6	<1.1	<1.2	<1.1	0.003	0.003	<0.002	<0.002	1.7	<0.1	2.0	1.1	7.6	-7	10.0	7.06	
(MW 20 ft XG)	11/1/2011		75	<1.0	2.0	4.0	2.2				0.002	0.002	<0.002	<0.002	1.5	<0.1	1.6	0.3		-2.6	8.1	7.06	
	2/19/2012		185	<0.2	0.2	0.7	0.8								0.3	<0.5	1.8	<1.5		63	9.8	6.55	
	5/6/2012		262	<0.2	1.3	2.8	1.0				0.006	0.004	<0.002	<0.002	0			0.9		73	9.1	6.60	
	9/5/2012		384	<0.2	1.2	4.0	0.9								0.1		2.0	<0.30		67	7.4	6.67	
	11/15/2012		455	<0.5	<0.5	1.2	<0.5				0.002	0.003	<0.002	<0.002	0.13		1.0	<0.3		-1.7	10.7	6.94	
	2/25/2013		557	<0.2	0.7	5.1	1.9	1.1	1.2	<1.0					0.10		1.5	1.1	9.1	87	7.2	6.72	

PCE = Tetrachloroethene
TCE = Trichloroethene
c DCE = cis-1,2-Dichloroethene
VC = Vinyl Chloride
As = Arsenic
Cu = Copper
Tot = Total

Dis = Dissolved
DO = Dissolved Oxygen
ORP = Oxidation Reduction Potential
TOC = Total Organic Carbon
NA = Not Applicable, not available
µg/L = micrograms pr liter
mg/L = milligrams per liter

IW = Injection Well
MW = Monitoring Well
DG = Downgradient of injection wells
UG = Upgradient of injection wells
XG = Crossgradient of injection wells
(shaded) '= No sample collected or sample not analyzed for specified constituent.
TMCL = Target Media Cleanup Level.
Box = Exceedance of TMCL.

(a) Plant 2 TMCLs , Boeing 2011, Floyd Snider 2012 (Industrial/worker).

Injection Dates:
10/28/2008 Pilot Injection: BDC-05-02 only
8/18/2011 Full Injection #1: BDC-05-02, BDC-05-07, and BDC-05-09 through BDC-05-17; performed 8/15/11-8/18/11

TABLE 7
SWMU-20 CLEANUP ACTION SUMMARY - SOURCE ZONE
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

Well	Date	Elapsed Time from Injections (a) (days)				Volatile Organic Compounds						Aquifer Redox Conditions					Donor Parameters		Notes
						Proposed Groundwater Cleanup Levels (d)													
						5.3	1.4	134	2.4	---	---								
		1st Injection	2nd Injection	3rd (b) Injection	4th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	DO (mg/L)	ORP (mV)	Iron II (mg/L)	Sulfate (mg/L)	Methane (µg/L)	pH	TOC (mg/L)	
06A (c)	06/15/2004	-2				<1.0	**1.0**	**23**	**4.0**	<0.50	<0.50	6.34	-19.6	0.8	58.9	<0.50	6.5	18.8	---
06A (c)	08/23/2004	67				<1.0	<1.0	**45**	**5.9**	<0.50	<0.50	0.46	92	3.5	40.7	21	7.0	288	Hazy brown
06A (c)	10/19/2004	124	-58			<1.0	<1.0	**2.6**	**31**	<0.50	<0.50	0.70	54	3.0	44.8	530	6.8	80.8	---
06A (c)	02/22/2005	250	68			<1.0	<1.0	**3.3**	<1.0	<0.50	<0.50	1.15	187	2.4	<0.1	130	6.8	244	---
06A (c)	05/16/2005	333	151			<1.0	<1.0	**2.6**	<1.0	<0.50	<0.50	1.25	58	3.0	0.1	10000	6.9	145	---
06A (c)	08/22/2005	431	249			<1.0	<1.0	**1.6**	<1.0	<0.50	<0.50	1.26	212	2.7	3.1	390	6.8	54.2	Clear, with yellow tint
06A (c)	11/14/2005	515	333			<1.0	<1.0	**1.3**	**1.2**	<0.50	<0.50	0.93	108	3.0	0.1	3700	6.9	31.8	---
06A (c)	02/22/2006	615	433			<1.0	<1.0	**1.4**	**4.8**	<11.4	<12.3	0.80	186	2.6	60.4	10100	6.4	15.5	---
06A (c)	05/18/2006	700	518			<1.0	<1.0	<1.0	**1.6**	<11	<12	6.41	1	3.0	20.9	16000	6.6	23.9	---
06A (c)	08/16/2006	790	608			<1.0	<1.0	<1.0	**1.5**	<1.1	<1.2	0.89	240	2.2	23.1	18800	6.5	23.2	---
06A (c)	11/29/2006	895	713			<0.2	<0.2	**0.4**	**2.1**	<1.1	<1.2	2.09	102	2.6	33.1	20200	6.5	31.4	---
06A (c)	02/23/2007	981	799			<1.0	<1.0	<1.0	**6.7**	<1.1	<1.2	0.65	-97	4.5	26.2	17400	6.5	24.6	---
06A (c)	05/24/2007	1071	889			<1.0	<1.0	<1.0	**2.9**	<1.1	**2.0**	0.56	184	4.0	21.0	18300	6.7	21.5	---
06A (c)	11/30/2007	1261	1079			<0.2	<0.2	<0.2	**1.2**	<1.1	**2.2**	0.80	173	3.0	29.1	21900	6.7	22.6	---
06A (c)	05/21/2008	1434	1252		-96	<1.0	<1.0	<1.0	**1.4**	<1.1	**1.3**	2.11	-82	2.5	21.0	13200	6.9	20.1	---
06A (c)	11/25/2008	1622	1440		92	<1.0	<1.0	**1.7**	<1.0	<1.1	<1.2	1.71	-73	3.4	0.1	19700	6.5	150	---
06A (c)	05/20/2009	1798	1616		268	<4.0	<4.0	<4.0	<4.0	<1.1	<1.2	0.52	-45	4.0	<0.5	19500	6.8	38.2	---
06A (c)	11/19/2009	1981	1799		451	<1.0	<1.0	**1.9**	<1.0	<1.1	<1.2	2.66	6	2.8	0.8	20100	6.2	25.4	---
06A (c)	5/24/2010	2167	1985		637	<1.0	<1.0	**1.3**	**1.9**	<1.1	<1.2	3.56	448	2.0	16	19900	6.6	19.3	---
06A (c)	11/11/2010	2338	2156		808	<1.0	<1.0	<1.0	**1.7**	<1.1	<1.2	4.75	106	2.6	0.4	24700	7.0	20.2	---
06A (c)	5/4/2011	2512	2330		982	<1.0	<1.0	<1.0	**1.4**	<1.1	<1.2	2.14	22	2.5	<0.2	21400	7.1	13.6	---
06A (c)	11/13/2011	2705	2523		1175	<0.2	<0.2	**0.3**	**0.8**	<1.1	<1.2	5.80	-54	1.0	0.3	6370	7.2	12.7	---
06A (c)	5/15/2012	2889	2707		1359	<0.2	<0.2	**0.4**	**1.2**	<1.0	<1.0	0.08	66	2.0	4.3	13000	6.7	11.6	---
06A (c)	11/14/2012	3072	2890		1542	<0.2	<0.2	**0.3**	**0.8**	<1.0	<4.0	0.02	-0.5	1.5	<0.30	13000	6.9	9.0	---
06B	05/04/2004	-44				**9.5**	**3.2**	**10**	**9.4**	<0.50	<0.50	0.36	179	4.5	18.7	130	6.8	25.6	Clear, yellow tint
06B	08/23/2004	67				**1.9**	**1.2**	**13**	**2.3**	<0.50	<0.50	0.45	115	3.2	33.8	1100	6.9	177	Yellow-brown tint (nearly clear)
06B	10/19/2004	124	-58			<1.0	<1.0	**10**	**3.6**	<0.50	<0.50	0.61	217	3.5	14.8	590	6.7	53.6	Yellow tint
06B	02/22/2005	250	68			<1.0	<1.0	**11**	<1.0	<0.50	<0.50	0.79	224	2.6	<0.5	3800	6.9	968	---
06B	05/16/2005	333	151			<2.0	<2.0	**5.5**	<2.0	<0.50	<0.50	1.51	133	3.5	<0.5	2300	6.9	336	Clear, yellow-brown tint
06B	08/22/2005	431	249			<1.0	<1.0	**1.8**	**1.6**	<0.50	<0.50	1.21	217	2.8	<0.1	440	6.9	100	Clear, with yellow tint
06B	11/14/2005	515	333			<1.0	<1.0	**1.1**	**1.3**	<0.50	<0.50	1.05	241	2.8	<0.1	2900	6.9	64.4	---
06B	02/22/2006	615	433			<1.0	<1.0	<1.0	**1.4**	**53.5**	<12.3	0.74	184	2.6	14.8	13000	6.4	30.4	---
06B	05/18/2006	700	518			<1.0	<1.0	<1.0	**1.3**	<11	<12	2.25	52	3.2	13.6	16000	6.6	25.9	---
06B	08/16/2006	790	608			<1.0	<1.0	<1.0	**1.1**	<1.1	<1.2	0.82	225	2.4	12.9	21700	6.5	14.7	---
06B	11/29/2006	895	713			<0.2	<0.2	**1.4**	**2.6**	<1.1	<1.2	1.82	111	2.4	10.9	22000	6.5	25.2	---
06B	02/23/2007	981	799			<1.0	<1.0	**3.8**	**9.5**	<1.1	<1.2	0.75	-66	5.0	25.0	17700	6.5	21.1	---
06B	05/24/2007	1071	889			<1.0	<1.0	**1.4**	**6.5**	<1.1	<1.2	0.58	151	3.0	11.3	18500	6.6	21.4	---
06B	11/30/2007	1261	1079			<0.2	<0.2	<0.2	**1.0**	<1.1	**4.0**	0.83	135	4.0	26.3	24900	6.4	26.5	---
06B	05/21/2008	1434	1252		-96	<1.0	<1.0	<1.0	<1.0	<1.1	**4.9**	2.66	-61	3.4	21.1	12700	6.7	20.4	---
06B	11/25/2008	1622	1440		92	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	2.53	-68	2.4	0.2	18400	6.6	19.6	---
06B	05/20/2009	1798	1616		268	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.33	-36	4.0	<0.5	25300	6.9	20.9	---
06B	11/19/2009	1981	1799		451	<1.0	<1.0	<1.0	<1.0	<1.1	**6.7**	1.01	10	2.8	0.1	22500	6.9	20.0	---
06B	5/24/2010	2167	1985		637	<1.0	<1.0	<1.0	**4.2**	<1.1	**1.6**	3.05	417	2.0	3.0	7110	7.0	19.1	---
06B	11/11/2010	2338	2156		808	<1.0	<1.0	<1.0	**5.4**	<1.1	**1.4**	3.40	112	2.0	8.6	4600	7.1	15.8	---
06B	5/4/2011	2512	2330		982	<1.0	<1.0	<1.0	**5.2**	<1.1	<1.2	2.55	57	2.2	19.7	2120	7.1	12.6	---

TABLE 7
SWMU-20 CLEANUP ACTION SUMMARY - SOURCE ZONE
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

		Elapsed Time from Injections (a) (days)				Volatile Organic Compounds						Aquifer Redox Conditions					Donor Parameters		
						Proposed Groundwater Cleanup Levels (d)													
						5.3	1.4	134	2.4	---	---								
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	DO (mg/L)	ORP (mV)	Iron II (mg/L)	Sulfate (mg/L)	Methane (µg/L)	pH	TOC (mg/L)	Notes
06B	11/13/2011	2705	2523		1175	<0.2	<0.2	<0.2	**0.8**	<1.1	<1.2	6.10	-34	1.5	0.3	2260	7.3	14.8	---
06B	5/15/2012	2889	2707		1359	<0.2	<0.2	**0.5**	**6.0**	<1.0	**1.3**	0.14	71	1.8	10.9	2200	6.6	11.4	---
06B	11/14/2012	3072	2890		1542	<0.2	<0.2	<0.2	**3.7**	<1.0	**1.8**	0.02	10	2.0	7.0	2300	6.8	**13.7**	---
06C	05/04/2004	-44				<1.0	<1.0	<1.0	<1.0	<0.50	**0.6**	0.40	93	5.0	20.7	360	6.7	29.0	---
06C	08/23/2004	67				<1.0	<1.0	**1.4**	<1.0	**5.7**	**5.9**	0.63	95	2.5	42.7	3100	6.3	1560	White froth on surface of purge water
06C	10/19/2004	124	-58			<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	2.00	206	3.0	18.1	450	6.3	464	Yellow tint
06C	02/22/2005	250	68			<1.0	<1.0	**3.6**	<1.0	<0.50	<0.50	0.82	198	2.6	<0.5	2400	6.9	858	---
06C	05/16/2005	333	151			<1.0	<1.0	**1.1**	<1.0	<0.50	<0.50	1.94	98	3.0	0.2	2700	7.0	111	Clear, with yellow tint
06C	08/22/2005	431	249			<1.0	<1.0	**1.1**	<1.0	<0.50	<0.50	1.36	194	2.8	<0.1	510	7.0	68.7	Clear, with yellow tint
06C	11/14/2005	515	333			<1.0	<1.0	**1.1**	<1.0	<0.50	<0.50	1.07	258	2.0	<0.1	2900	7.0	48.3	---
06C	02/22/2006	615	433			<1.0	<1.0	<1.0	<1.0	**47.7**	<12.3	0.88	247	1.4	47.5	12300	6.6	93.4	---
06C	05/18/2006	700	518			<1.0	<1.0	<1.0	<1.0	<11	<12	4.88	129	2.0	30.6	15000	6.6	36.6	---
06C	08/16/2006	790	608			<1.0	<1.0	<1.0	<1.0	<1.1	**2.3**	0.93	231	1.6	31.8	18900	6.6	13.4	---
06C	11/29/2006	895	713			<0.2	<0.2	**0.3**	<0.2	<1.1	**1.4**	2.25	192	1.8	27.3	20600	6.6	46.4	---
06C	02/23/2007	981	799			<1.0	<1.0	<1.0	<1.0	<1.1	**1.7**	1.08	-46	4.0	25.9	18900	6.4	39.0	---
06C	05/24/2007	1071	889			<1.0	<1.0	<1.0	<1.0	<1.1	**2.0**	0.72	216	3.5	20.8	20800	6.5	34.0	---
06C	11/30/2007	1261	1079			<0.2	<0.2	**0.2**	**0.3**	<1.1	**2.8**	1.58	174	4.2	32.6	30500	6.2	40.2	---
06C	05/21/2008	1434	1252		-96	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	2.91	-16	2.5	21.0	23800	6.3	31.9	---
06C	11/25/2008	1622	1440		92	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	3.39	-66	2.6	<0.1	28700	6.8	634	---
06C	05/20/2009	1798	1616		268	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.66	-28	3.5	<0.8	20600	6.9	39.2	---
06C	11/19/2009	1981	1799		451	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	1.89	26	NM	<0.1	25600	6.2	42.8	---
09A	05/03/2004	-45				**150**	**230**	**970**	**37**	<0.50	<0.50	0.46	287	1.0	64.2	8.4	6.7	16.2	Clear, yellow tint
09A	08/23/2004	67				<3.0	**11**	**370**	**150**	**4.2**	<0.50	0.40	143	2.6	51.8	4.7	7.1	56.8	Clear with black tint, H2S odor
09A	10/19/2004	124	-58			<5.0	**19**	**460**	**220**	**2.7**	<0.50	0.53	219	4.0	77.4	17	6.9	19.6	Clear, slightly yellow tint
09A	02/21/2005	249	67			<10	<10	**41**	**37**	**1.9**	<0.50	0.78	169	2.0	<0.5	1500	7.1	2110	Hazy, yellow color
09A	05/11/2005	328	146			<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	1.53	141	2.0	<0.5	1700	7.2	1260	Hazy, yellow-brown tint
09A	08/22/2005	431	249			<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	1.58	141	2.8	<0.1	460	6.8	156	Clear, yellow-brown tint
09A	11/14/2005	515	333			<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	1.07	238	2.0	<0.1	2600	6.9	62.8	---
09A	02/21/2006	614	432			<1.0	<1.0	<1.0	<1.0	<11.4	<12.3	0.94	332	2.6	0.2	5650	6.3	58.8	---
09A	05/15/2006	697	515			<1.0	<1.0	<1.0	<1.0	<11	<12	1.35	193	2.2	63.4	15000	6.4	44.4	---
09A	08/16/2006	790	608			<1.0	<1.0	<1.0	**1.2**	<1.1	**2.1**	1.55	175	2.0	56.8	16800	6.4	50.0	---
09A	11/27/2006	893	711			<0.2	<0.2	**0.3**	**1.1**	**1.9**	**6.3**	2.09	211	3.2	52.5	15200	6.6	51.0	---
09A	02/22/2007	980	798			<1.0	<1.0	<1.0	<1.0	<1.1	**7.8**	0.65	-107	4.6	0.3	15300	6.4	48.8	---
09A	05/22/2007	1069	887			<1.0	<1.0	<1.0	**2.8**	<1.1	**4.8**	0.75	91	2.6	0.1	16700	6.6	43.1	---
09A	11/29/2007	1260	1078			<1.0	<1.0	<1.0	<1.0	<1.1	**24.5**	1.01	147	3.8	45.4	27600	6.4	40.6	---
09A	05/19/2008	1432	1250		-98	<0.2	**0.2**	**110**	**85**	**7.8**	**35.6**	2.26	-82	3.0	29.4	17100	6.7	31.0	---
09A	11/24/2008	1621	1439		91	**1.9**	**4.6**	**160**	**42**	**4.0**	**2.1**	2.61	-52	3.0	<2.0	13700	6.2	5600	---
09A	05/18/2009	1796	1614		266	<10	<10	<10	<10	<1.1	<1.2	0.44	-88	2.5	<2.0	18100	7.1	1620	---
09A	11/16/2009	1978	1796		448	<5.0	<1.0	<5.0	<5.0	<1.1	<1.2	1.23	-61	2.6	<1.0	16600	6.6	403	---
09A	5/20/2010	2163	1981		633	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	11.09	515	2.2	<1.0	18700	7.0	72.8	Duffy: Interference w/DO sensor?
09A	11/10/2010	2337	2155		807	<1.0	<1.0	<1.0	<1.0	<1.1	**2.0**	3.92	118	2.2	0.3	24400	7.0	70.0	---
09A	5/3/2011	2511	2329		981	<2.0	<2.0	<2.0	<2.0	<1.1	**2.0**	2.55	33	2.0	<0.2	17800	6.9	44.4	---
09A	11/13/2011	2705	2523		1175	<0.2	<0.2	**0.2**	<0.2	<1.1	**1.2**	2.23	-66	1.2	0.4	11800	7.0	39.4	---
09A	5/14/2012	2888	2706		1358	<0.2	<0.2	**0.2**	<0.2	<1.0	**13**	0.57	91	1.5	0.40	22000	6.4	30.5	---
09A	11/14/2012	3072	2890		1542	<2.0	<2.0	<2.0	<2.0	<1.0	**11**	0.02	-4	2.0	0.53	21000	6.6	30.9	---

TABLE 7
SWMU-20 CLEANUP ACTION SUMMARY - SOURCE ZONE
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

		Elapsed Time from Injections (a) (days)				Volatile Organic Compounds						Aquifer Redox Conditions					Donor Parameters		
						Proposed Groundwater Cleanup Levels (d)													
						5.3	1.4	134	2.4	---	---								
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	DO (mg/L)	ORP (mV)	Iron II (mg/L)	Sulfate (mg/L)	Methane (µg/L)	pH	TOC (mg/L)	Notes
09B	05/03/2004	-45				<3.0	**4.2**	**250**	<3.0	<0.50	<0.50	0.37	269	4.0	61.4	2.7	6.8	20.7	Clear, yellow tint
09B	08/23/2004	67				<5.0	**16**	**530**	**100**	**0.76**	<0.50	0.34	174	1.4	73.0	23	7.4	29.7	Clear, yellow-brown tint, H2S odor
09B	10/19/2004	124	-58			<5.0	**17**	**300**	**340**	**1.4**	<0.50	0.30	219	1.0	59.6	29	7.5	24.3	Clear with yellow color
09B	02/21/2005	249	67			<10	<10	**890**	**520**	**1.7**	<0.50	0.56	160	2.8	1.0	2000	6.8	608	Hazy, tan brown color
09B	05/11/2005	328	146			<1.0	<1.0	**12**	**24**	<0.50	<0.50	1.48	158	3.5	0.4	9600	7.0	219	Hazy, yellow-brown tint
09B	08/22/2005	431	249			<1.0	<1.0	<1.0	**1.7**	<0.50	<0.50	1.45	224	2.5	<0.1	400	6.7	17.6	Clear, with yellow-brown tint
09B	11/14/2005	515	333			<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	1.24	235	1.4	<0.1	3100	6.8	51.2	---
09B	02/21/2006	614	432			<1.0	<1.0	<1.0	**1.3**	<11.4	<12.3	0.90	329	2.8	<0.1	8730	6.3	46.4	---
09B	05/15/2006	697	515			<1.0	<1.0	<1.0	<1.0	<11	<12	1.11	191	1.8	33.9	17000	6.3	45.6	---
09B	08/16/2006	790	608			<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.94	188	1.6	55.4	19300	6.3	250	---
09B	11/27/2006	893	711			<0.2	<0.2	**0.3**	**0.5**	<1.1	<1.2	1.76	190	2.8	50.2	21800	6.5	78.2	---
09B	02/22/2007	980	798			<1.0	<1.0	<1.0	<1.0	<1.1	**1.6**	0.67	-80	3.5	0.2	16100	6.3	64.0	---
09B	05/22/2007	1069	887			<1.0	<1.0	<1.0	<1.0	<1.1	**1.4**	0.76	154	3.0	<0.1	18700	6.5	35.3	---
09B	11/29/2007	1260	1078			<1.0	<1.0	<1.0	<1.0	<1.1	**3.8**	1.29	238	2.2	58.3	29800	6.2	44.5	---
09B	05/19/2008	1432	1250		-98	<0.2	<0.2	**0.2**	**0.4**	<1.1	**3.0**	2.34	-78	3.4	39.1	12900	6.4	37.3	---
09B	11/24/2008	1621	1439		91	<1.0	<1.0	<1.0	<1.0	<1.1	**17.6**	2.22	-47	3.0	<1.0	27000	6.7	27.0	---
09B	05/18/2009	1796	1614		266	<1.0	<1.0	<1.0	<1.0	<1.1	**6.9**	0.38	-38	3.5	<0.5	19700	6.9	37.1	---
09B	11/16/2009	1978	1796		448	<1.0	<1.0	<1.0	<1.0	<1.1	**16.1**	1.27	12	3.5	<0.1	24500	6.2	28.1	---
09C	05/03/2004	-45				<1.0	<1.0	**4.0**	**3.3**	**1.9**	**0.7**	0.33	229	4.0	19.1	350	6.8	28.5	Clear, yellow tint
09C	08/23/2004	67				<1.0	<1.0	**1.7**	<1.0	**1.1**	**2.8**	0.47	114	2.6	23.2	610	6.7	302	Clear, H2S odor
09C	10/19/2004	124	-58			<1.0	<1.0	<1.0	**1.5**	**1.1**	<0.50	0.60	185	3.0	12.2	620	7.0	99.6	Near clear, yellow tint
09C	02/21/2005	249	67			<1.0	<1.0	**1.7**	<1.0	<0.50	**1.6**	0.60	154	2.0	<0.1	3500	6.6	300	Clear with yellow tint
09C	05/11/2005	328	146			<1.0	<1.0	**1.2**	<1.0	<0.50	<0.50	1.34	138	2.5	<0.1	2700	6.4	44.6	Yellow-brown tint
09C	08/22/2005	431	249			<1.0	<1.0	**7.6**	**2.2**	<0.50	<0.50	1.31	230	2.5	<0.1	360	6.7	52.0	---
09C	11/14/2005	515	333			<1.0	<1.0	**1.2**	<1.0	<0.50	<0.50	1.41	228	2.4	<0.1	7300	6.9	50.6	---
09C	02/21/2006	614	432			<1.0	<1.0	<1.0	<1.0	<11.4	<12.3	0.78	326	2.4	<0.1	10300	6.5	44.2	---
09C	05/15/2006	697	515			<1.0	<1.0	<1.0	<1.0	<11	<12	1.01	192	2.0	27.9	21000	7.0	42.1	---
09C	08/16/2006	790	608			<1.0	<1.0	<1.0	<1.0	<1.1	**1.6**	0.80	199	1.2	28.8	22900	6.5	33.0	---
09C	11/27/2006	893	711			<0.2	<0.2	<0.2	<0.2	<1.1	**9.1**	1.40	289	2.4	26.7	23500	6.5	44.0	---
09C	02/22/2007	980	798			<1.0	<1.0	<1.0	<1.0	<1.1	**3.9**	0.75	-32	3.6	0.2	17700	6.5	33.8	---
09C	05/22/2007	1069	887			<1.0	<1.0	<1.0	<1.0	<1.1	**5.4**	0.52	123	3.5	<0.1	20600	6.6	25.4	---
09C	11/29/2007	1260	1078			<1.0	<1.0	<1.0	<1.0	<1.1	**5.4**	0.81	147	3.6	27.3	30000	6.5	27.1	---
09C	05/19/2008	1432	1250		-98	<0.2	<0.2	<0.2	**0.2**	<1.1	**15.2**	2.11	-57	4.6	18.6	22800	6.5	22.3	---
09C	11/24/2008	1621	1439		91	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	2.92	-44	1.8	<2.0	17700	6.6	334	---
09C	05/18/2009	1796	1614		266	<1.0	<1.0	<1.0	<1.0	<1.1	**4.3**	0.45	-44	3.5	<0.5	21400	7.0	24.0	---
09C	11/16/2009	1978	1796		448	<3.0	<3.0	<3.0	<3.0	<1.1	**1.9**	1.27	-7	3.0	<0.1	22400	6.4	20.7	---
10A	05/03/2004	-45				**29**	**27**	**80**	**6.4**	<0.50	<0.50	0.60	108	2.0	37.8	2.8	6.8	20.0	Clear, yellow tint
10A	08/23/2004	67				**14**	**12**	**170**	**4.0**	<0.50	<0.50	0.49	181	3.5	38.9	1.1	7.0	59.6	Clear, black tint
10A	10/19/2004	124	-58			**15**	**15**	**100**	**23**	<0.50	<0.50	0.66	224	4.0	37.8	2.7	7.0	24.0	Clear
10A	02/21/2005	249	67			**4.7**	**4.8**	**24**	**6.8**	<0.50	**0.54**	0.53	166	3.6	24.3	430	7.0	22.4	Clear, yellow color
10A	05/11/2005	328	146			**4.2**	**5.4**	**26**	**7.2**	<0.50	<0.50	0.95	47	3.0	27.9	540	7.2	25.9	Clear, yellow-brown tint
10A	08/22/2005	431	249			**2.7**	**6.3**	**48**	**76**	<0.50	<0.50	0.73	177	2.0	48.8	240	7.0	31.4	Clear, with yellow-brown tint
10A	11/14/2005	515	333			**3.3**	**6.7**	**47**	**73**	<0.50	<0.50	0.91	178	2.0	50.6	370	7.1	34.1	---
10A	02/21/2006	614	432			**3.7**	**9.6**	**42**	**150**	<11.4	<12.3	0.54	320	2.0	53.9	1130	6.8	45.8	---
10A	05/15/2006	697	515			**1.8**	**3.7**	**63**	**19**	<11	<12	0.67	190	1.8	57.4	3100	6.8	49.2	---
10A	08/16/2006	790	608			**1.6**	**1.6**	**38**	**20**	<1.1	<1.2	1.50	201	1.4	57.5	1620	6.7	50.8	---

TABLE 7
SWMU-20 CLEANUP ACTION SUMMARY - SOURCE ZONE
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

		Elapsed Time from Injections (a) (days)				Volatile Organic Compounds						Aquifer Redox Conditions					Donor Parameters		
						Proposed Groundwater Cleanup Levels (d)													
						5.3	1.4	134	2.4	---	---								
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	DO (mg/L)	ORP (mV)	Iron II (mg/L)	Sulfate (mg/L)	Methane (µg/L)	pH	TOC (mg/L)	Notes
10A	11/27/2006	893	711			<0.2	<0.2	7.4	9.2	2.6	2.6	2.67	201	3.0	57.9	1650	6.9	56.0	---
10A	02/22/2007	980	798			1.2	<1.0	32	35	<1.1	<1.2	0.57	-176	4.6	20.4	1370	6.8	56.4	---
10A	05/22/2007	1069	887			1.1	<1.0	28	44	<1.1	1.4	0.88	73	3.0	10.2	2590	6.9	47.3	---
10A	11/29/2007	1260	1078			1.2	<1.0	22	78	4.4	3.7	0.80	106	4.2	47.9	4810	6.9	47.8	---
10A	05/19/2008	1432	1250		-98	<1.0	<1.0	22	180	7.9	4.4	2.19	-177	4.0	32.5	4870	7.0	33.3	---
10A	11/24/2008	1621	1439		91	<1.0	<1.0	1.6	5.0	<1.1	<1.2	2.29	-87	3.4	1.3	16900	7.1	1200	---
10A	05/18/2009	1796	1614		266	<2.0	<2.0	<2.0	<2.0	<1.1	<1.2	0.66	-80	3.3	<1.0	17900	6.9	168	---
10A	11/16/2009	1978	1796		448	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	3.14	-40	4.2	<1.0	18200	6.3	69.2	---
10A	5/20/2010	2163	1981		633	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	16.23	341	3.0	<1.0	17600	6.8	60.4	Duffy: Replace DO electrolic membrane
10A	11/10/2010	2337	2155		807	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	4.09	67	2.4	0.5	22800	6.9	56.8	---
10A	5/3/2011	2511	2329		981	<2.0	<2.0	<2.0	<2.0	<1.1	<1.2	2.47	-21	2.5	<0.2	20700	6.9	41.6	---
10A	11/13/2011	2705	2523		1175	<0.2	<0.2	0.2	0.4	<1.1	<1.2	2.45	-38	2.0	0.3	15400	7.1	33.8	---
10A	5/14/2012	2888	2706		1358	<0.2	<0.2	0.2	0.4	<1.0	<1.0	0.57	88	2.5	0.32	20000	6.4	38.0	---
10A	11/14/2012	3072	2890		1542	<0.2	<0.2	0.3	0.4	<1.0	<1.0	0.03	-16	2.0	<0.30	19000	6.6	30.6	---
14A	05/04/2004	-44				<1.0	<1.0	140	110	<0.50	<0.50	0.53	-8	7.5	38.9	590	6.8	20.7	Clear, yellow tint
14A	08/23/2004	67				<1.0	2.9	560	180	0.89	0.67	0.54	162	3.2	30.1	810	6.8	22.6	---
14A	10/19/2004	124	-58			<5.0	39	1200	650	<0.50	<0.50	0.64	69	3.0	43.3	350	6.9	20.6	---
14A	02/21/2005	249	67	-24		<5.0	<5.0	300	1000	13	2.7	0.41	101	1.8	3.8	1700	6.9	44.0	Clear, yellow tint
14A	05/16/2005	333	151	60		<10	<10	<10	<10	<0.50	<0.50	5.90	45	4.0	<2.0	590	6.4	8620	---
14A	08/22/2005	431	249	158		<10	<10	<10	<10	<0.50	<0.50	1.62	234	3.0	<2.0	220	6.8	5380	Clear, yellow-brown
14A	11/15/2005	516	334	243		<3.0	<3.0	6.0	<3.0	<0.50	<0.50	1.26	257	2.0	<0.1	2500	6.4	602	---
14A	02/21/2006	614	432	341		<1.0	<1.0	<1.0	<1.0	<11.4	<12.3	1.36	335	2.0	<0.1	5400	7.4	180	---
14A	05/17/2006	699	517	426		<2.0	<2.0	2.1	<2.0	<11	<12	1.78	76	2.8	12.0	9400	6.4	67.1	---
14A	08/16/2006	790	608	517		<1.0	<1.0	3.0	<1.0	<1.1	<1.2	1.16	240	1.2	16.5	6320	6.5	66.0	---
14A	11/29/2006	895	713	622		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	1.57	248	2.8	11.8	11100	6.3	72.0	---
14A	02/22/2007	980	798	707		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.89	-56	7.0	0.2	7670	6.2	34.9	---
14A	05/23/2007	1070	888	797		<1.0	<1.0	1.5	<1.0	<1.1	<1.2	1.11	165	3.0	8.6	10100	6.3	27.5	---
14A	12/03/2007	1264	1082	991		<1.0	<1.0	1.6	<1.0	<1.1	<1.2	2.29	-86	3.2	15.9	14500	6.4	55.6	---
14A	05/20/2008	1433	1251	1160	-97	<1.0	<1.0	1.2	<1.0	<1.1	<1.2	3.45	-88	3.6	<0.1	12100	6.3	26.3	---
14A	11/24/2008	1621	1439	1348	91	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	2.79	-70	3.0	194	14500	6.1	8.68	---
14A	05/20/2009	1798	1616	1525	268	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.41	-95	3.5	20.0	14400	6.3	9.83	---
14A	11/17/2009	1979	1797	1706	449	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.81	-18	3.2	165	15800	5.7	6.22	---
14A	5/24/2010	2167	1985	1894	637	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	4.29	311	2.8	5.1	14600	6.4	8.07	---
14A	11/10/2010	2337	2155	2064	807	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	2.47	171	2.6	38.6	14300	6.8	6.88	---
14A	5/5/2011	2513	2331	2240	983	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	2.96	83	1.8	8.4	15100	7.1	3.28	---
14A	11/13/2011	2705	2523	2432	1175	<0.2	<0.2	0.6	<0.2	<1.1	<1.2	2.04	-52	1.5	<0.1	7510	6.9	8.05	---
14A	5/14/2012	2888	2706	2615	1358	<0.2	<0.2	0.3	0.2	<1.0	8.7	0.13	62	2.6	3.4	16000	6.4	5.9	---
14A	11/14/2012	3072	2890	2799	1542	<0.2	<0.2	0.6	<0.2	<1.0	5.0	0.03	31	1.5	79.0	16000	6.4	6.5	---
15A	05/03/2004	-45				<5.0	<5.0	<5.0	<5.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	
15A	10/26/2004	131	-51			<5.0	<5.0	<5.0	<5.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	
15A	05/16/2005	333	151			<5.0	<5.0	<5.0	<5.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	
15A	11/15/2005	516	334			<5.0	<5.0	<5.0	<5.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	
15A	05/17/2006	699	517			<5.0	<5.0	<5.0	<5.0	NA	NA	0.79	131	NA	NA	NA	6.7	NA	---
15A	11/29/2006	895	713			<3.0	<3.0	<3.0	<3.0	NA	NA	1.26	513	NA	NA	NA	6.6	NA	---
15A	05/23/2007	1070	888			<1.0	<1.0	1.4	2.6	NA	NA	1.19	144	NA	NA	NA	6.7	NA	---
15A	12/03/2007	1264	1082			<1.0	<1.0	<1.0	1.3	NA	NA	1.31	-105	NA	NA	NA	6.6	NA	---

TABLE 7
SWMU-20 CLEANUP ACTION SUMMARY - SOURCE ZONE
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

		Elapsed Time from Injections (a) (days)				Volatile Organic Compounds						Aquifer Redox Conditions					Donor Parameters		
						Proposed Groundwater Cleanup Levels (d)													
						5.3	1.4	134	2.4	---	---								
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	DO (mg/L)	ORP (mV)	Iron II (mg/L)	Sulfate (mg/L)	Methane (µg/L)	pH	TOC (mg/L)	Notes
15A	05/20/2008	1433	1251		-97	<3.0	<3.0	<3.0	<3.0	NA	NA	2.57	-135	NA	NA	NA	6.7	NA	---
15A	11/24/2008	1621	1439		91	<1.0	<1.0	<1.0	<2.0	NA	NA	2.07	-61	NA	NA	NA	6.8	NA	---
15A	05/19/2009	1797	1615		267	<3.0	<3.0	<3.0	<3.0	NA	NA	0.35	-33	NA	NA	NA	6.9	NA	---
15A	11/18/2009	1980	1798		450	<1.0	<1.0	<1.0	**1.4**	NA	NA	0.72	-0.1	NA	NA	NA	6.3	NA	---
15A	5/20/2010	2163	1981		633	<1.0	<1.0	<1.0	**1.6**	NA	NA	1.10	606	NA	NA	NA	6.8	NA	---
15A	11/10/2010	2337	2155		807	<1.0	<1.0	<1.0	**1.4**	NA	NA	2.42	118	NA	NA	NA	7.1	NA	---
15A	5/5/2011	2513	2331		983	<10	<10	<10	<10	NA	NA	4.83	-19	NA	NA	NA	7.2	NA	---
15A	11/13/2011	2705	2523		1175	<0.2	<0.2	**0.3**	**1.0**	NA	NA	4.01	-41	NA	NA	NA	7.3	NA	---
15A	5/14/2012	2888	2706		1358	<1.0	<1.0	<1.0	**1.2**	NA	NA	0.64	56	NA	NA	NA	6.7	NA	---
15A	11/13/2012	3071	2889		1541	<0.2	<0.2	**0.4**	**0.8**	NA	NA	0.03	23	NA	NA	NA	6.8	NA	---
19A	05/02/2004	-46	-228			<1.0	<1.0	<1.0	<1.0	NA	NA	0.33	-3	NA	NA	NA	6.5	NA	---
19A	02/21/2005	249	67			<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	0.65	180	NA	47.4	17	6.7	15.5	---
19A	05/12/2005	329	147			<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	0.63	169	3.0	31.3	9.1	6.8	14.2	Clear, colorless
19A	08/22/2005	431	249			<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	0.74	106	3.0	68.3	16	6.6	10.5	Clear, colorless
19A	11/15/2005	516	334			<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	0.56	201	2.6	95.9	35	6.8	9.30	---
19A	02/22/2006	615	433			<1.0	<1.0	<1.0	<1.0	<11.4	<12.3	0.77	65	3.0	124.0	111	6.6	31.3	---
19A	05/17/2006	699	517			<1.0	<1.0	<1.0	<1.0	<11	<12	1.14	56	2.0	73.4	230	6.4	15.7	---
19A	08/15/2006	789	607			<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.60	229	2.0	47.3	202	6.4	11.5	---
19A	11/27/2006	893	711			<0.2	**0.2**	**0.3**	<0.2	<1.1	<1.2	0.88	264	2.0	41.9	186	6.4	13.6	---
19A	02/22/2007	980	798			<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.42	-23	3.0	20.7	248	6.2	19.8	---
19A	05/22/2007	1069	887			<1.0	<1.0	<1.0	<1.0	<1.1	**5.2**	0.34	277	3.5	30.8	179	6.4	15.4	---
19A	11/29/2007	1260	1078			<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.67	243	2.2	37.2	235	6.2	14.3	---
19A	05/20/2008	1433	1251		-97	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	3.23	-79	3.8	20.9	134	6.4	11.5	---
19A	11/23/2008	1620	1438		90	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	1.62	-61	2.0	46.1	97.8	6.4	10.6	---
19A	05/19/2009	1797	1615		267	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.30	-28	3.2	28.6	127	6.8	12.8	---
19A	11/18/2009	1980	1798		450	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	1.58	-2	3.4	22.1	122	6.5	10.7	---
22A	03/21/2005	277	95	4		<1.0	<1.0	**3.5**	**2.0**	<0.50	<0.50	1.86	53	2.8	12.8	280	7.0	11.1	Hazy, suspended silt
22A	05/12/2005	329	147	56		<1.0	<1.0	**2.3**	**2.9**	<0.50	<0.50	0.83	155	2.6	1.3	300	7.1	31.3	---
22A	08/22/2005	431	249	158		<1.0	<1.0	**2.3**	**3.2**	<0.50	<0.50	0.70	170	2.6	3.0	230	6.9	26.5	Clear, slight yellow-brown tint
22A	11/16/2005	517	335	244		<1.0	<1.0	**1.4**	**2.2**	<0.50	<0.50	1.67	321	2.4	1.3	1300	6.3	29.9	---
22A	02/22/2006	615	433	342		<1.0	<1.0	**1.4**	**3.3**	<11.4	<12.3	0.69	97	2.0	59.0	1940	6.8	32.0	---
22A	05/17/2006	699	517	426		<1.0	<1.0	**2.4**	**1.7**	<11	<12	0.67	102	2.6	32.7	3600	6.8	17.6	---
22A	08/15/2006	789	607	516		<1.0	<1.0	**1.8**	**2.4**	<1.1	<1.2	0.65	239	2.0	54.7	5700	6.7	24.0	---
22A	11/30/2006	896	714	623		<0.2	**0.3**	**2.2**	**2.4**	<1.1	<1.2	2.15	286	2.6	40.0	4020	6.6	25.2	---
22A	02/22/2007	980	798	707		<1.0	<1.0	**2.5**	**2.3**	<1.1	<1.2	0.53	-76	5.0	<0.1	3000	6.6	22.4	---
22A	05/23/2007	1070	888	797		<1.0	<1.0	**2.5**	**2.7**	<1.1	<1.2	0.30	51	3.0	27.3	3510	6.8	18.2	---
22A	12/03/2007	1264	1082	991		<1.0	<1.0	**2.0**	**1.3**	<1.1	<1.2	0.61	41	2.6	12.3	2030	6.6	16.0	---
22A	05/20/2008	1433	1251	1160	-97	<1.0	<1.0	**2.6**	**1.9**	<1.1	<1.2	2.83	-103	4.0	20.2	1540	6.7	13.8	---
22A	11/23/2008	1620	1438	1347	90	<1.0	<1.0	**2.2**	**3.1**	<1.1	<1.2	1.13	-70	1.8	2.6	3100	6.8	19.2	---
22A	05/19/2009	1797	1615	1524	267	<1.0	<1.0	**2.5**	**2.5**	<1.1	<1.2	0.26	-43	3.2	3.4	3490	7.0	21.0	---
22A	11/18/2009	1980	1798	1707	450	<1.0	<1.0	**2.1**	**1.8**	<1.1	<1.2	0.43	-3.3	3.0	2.1	2060	6.4	13.8	---
22A	5/24/2010	2167	1985	1894	637	<1.0	<1.0	**1.7**	**1.7**	<1.1	<1.2	6.58	204	2.4	0.6	2370	7.0	15.1	---
22A	11/11/2010	2338	2156	2065	808	<1.0	<1.0	**1.2**	**2.7**	<1.1	<1.2	3.27	113	2.2	0.5	4650	7.0	21.8	---
22A	5/4/2011	2512	2330	2239	982	<1.0	<1.0	**1.1**	**2.2**	<1.1	<1.2	1.96	4	2.0	0.6	6350	7.0	22.4	---
22A	11/13/2011	2705	2523	2432	1175	<0.2	<0.2	**0.9**	**1.7**	<1.1	<1.2	2.89	-38	1.2	0.4	2510	7.3	17.6	---
22A	5/14/2012	2888	2706	2615	1358	<0.2	<0.2	**0.6**	**2.0**	<1.0	**3.3**	0.03	45	2.2	<0.30	5100	6.8	25.4	---
22A	11/14/2012	3072	2890	2799	1542	<0.2	<0.2	**0.5**	**1.8**	<1.0	**1.7**	0.03	1	1.8	<0.30	4400	6.9	22.7	---

TABLE 7
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DEVELOPMENTAL CENTER GROUNDWATER MONITORING

		Elapsed Time from Injections (a) (days)				Volatile Organic Compounds						Aquifer Redox Conditions					Donor Parameters		
						Proposed Groundwater Cleanup Levels (d)													
						5.3	1.4	134	2.4	---	---								
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	DO (mg/L)	ORP (mV)	Iron II (mg/L)	Sulfate (mg/L)	Methane (µg/L)	pH	TOC (mg/L)	Notes
23A	03/21/2005	277	95	4		<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	0.63	81	2.0	0.4	410	7.0	33.0	Slight yellow tint
23A	05/12/2005	329	147	56		<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	0.58	158	2.0	<0.1	260	7.2	39.9	---
23A	08/22/2005	431	249	158		<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	0.75	130	3.4	1.5	98	7.0	21.0	---
23A	11/16/2005	517	335	244		<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	0.49	291	2.6	4.1	140	7.2	30.8	---
23A	02/22/2006	615	433	342		<1.0	<1.0	<1.0	<1.0	<11.4	<12.3	0.60	127	2.2	91.8	1520	6.4	34.5	---
23A	05/17/2006	699	517	426		<1.0	<1.0	<1.0	<1.0	<11	<12	0.60	120	3.0	38.8	1700	6.7	30.0	---
23A	08/15/2006	789	607	516		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.77	256	2.2	63.9	3080	6.7	32.6	---
23A	11/30/2006	896	714	623		<0.2	<0.2	<0.2	<0.2	<1.1	<1.2	1.96	287	2.5	40.7	1930	6.2	45.2	---
23A	02/22/2007	980	798	707		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.40	-58	2.0	2.9	1360	6.5	34.6	---
23A	05/23/2007	1070	888	797		<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.41	193	3.3	52.7	1850	6.4	38.7	---
23A	11/30/2007	1261	1079	988		<0.2	<0.2	**0.3**	<0.2	<1.1	<1.2	0.55	159	2.2	81.1	4430	6.6	38.6	---
23A	05/21/2008	1434	1252	1161	-96	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	3.12	-28	2.2	31.7	1570	6.1	29.6	---
23A	11/25/2008	1622	1440	1349	92	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	4.22	-68	1.8	<0.1	3270	6.8	39.0	---
23A	05/19/2009	1797	1615	1524	267	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.31	-3	3.2	0.1	2370	6.5	39.1	---
23A	11/18/2009	1980	1798	1707	450	<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	0.41	1	2.4	1.6	1970	6.5	30.9	---

PCE = Tetrachloroethene
TCE = Trichloroethene
cDCE = cis-1,2-Dichloroethene
VC = Vinyl Chloride
DO = Dissolved Oxygen
ORP = Oxidation Reduction Potential
TOC = Total Organic Carbon

Bold = Detect
µg/L = micrograms pr liter
mg/L = milligrams per liter
mV = millivolts
NA = Not analyzed
TMCL = Target Media Cleanup Level.
Box = Exceedance of TMCL.

(a) Injections occurred on:
6/17/04 (6A, B, C; 9A, B, C) — 6/17/2004 for elapsed time relative to injection
12/16-17/04 (6A, 6B;9A,9B) — 12/16/2004 for elapsed time relative to injection
3/17/05 (14A) — 3/17/2005 for elapsed time relative to injection
8/25-28/08 (6A, 9A, 10A) — 8/25/2008 for elapsed time relative to injection
(b) Conducted at Well MW-14A only.
(c) MW-06A installed June 2004.
(d) Plant 2 TMCLs , Boeing 2011, Floyd Snider 2012 (Industrial/Worker).

TABLE 8
SWMU-20 CLEANUP ACTION SUMMARY - NON SOURCE ZONE
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

						Volatile Organic Compounds			
						Proposed Groundwater Cleanup Levels (c)			
		Elapsed Time from Injections (a) (days)				**5.3**	**1.4**	**134**	**2.4**
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)
MW-8C	5/3/2004	-45				<1.0	<1.0	<1.0	**2.8**
MW-8C	10/25/2004	130	-52			<1.0	<1.0	<1.0	**3.5**
MW-8C	5/12/2005	329	147			<1.0	<1.0	<1.0	<1.0
MW-8C	11/14/2005	515	333			<1.0	<1.0	<1.0	<1.0
MW-8C	5/15/2006	697	515			<10	<10	<10	<10
MW-8C	11/27/2006	893	711			<5.0	<5.0	<5.0	<5.0
MW-8C	5/21/2007	1068	886			<3.0	<3.0	<3.0	<3.0
MW-8C	11/29/2007	1260	1078			<5.0	<5.0	<5.0	<5.0
MW-8C	5/19/2008	1432	1250		-98	<5.0	<5.0	<5.0	<5.0
MW-8C	11/23/2008	1620	1438		90	<5.0	<5.0	<5.0	<5.0
MW-8C	05/18/2009	1796	1614		266	<1.0	<1.0	<1.0	<1.0
MW-8C	11/16/2009	1978	1796		448	<3.0	<3.0	<3.0	<3.0
MW-9D	5/3/2004	-45				<1.0	<1.0	<1.0	<1.0
MW-9D	10/19/2004	124	-58			<1.0	<1.0	<1.0	<1.0
MW-9D	5/11/2005	328	146			<1.0	<1.0	<1.0	<1.0
MW-9D	11/14/2005	515	333			<1.0	<1.0	<1.0	<1.0
MW-9D	5/15/2006	697	515			<1.0	<1.0	<1.0	<1.0
MW-9D	11/27/2006	893	711			<1.0	<1.0	<1.0	<1.0
MW-9D	5/22/2007	1069	887			<1.0	<1.0	<1.0	<1.0
MW-9D	11/29/2007	1260	1078			<1.0	<1.0	<1.0	<1.0
MW-9D	5/19/2008	1432	1250		-98	<0.2	<0.2	<0.2	<0.2
MW-9D	11/24/2008	1621	1439		91	<1.0	<1.0	<1.0	<1.0
MW-9D	05/18/2009	1796	1614		266	<1.0	<1.0	<1.0	<1.0
MW-9D	11/16/2009	1978	1796		448	<1.0	<1.0	<1.0	<1.0
MW-10C	5/3/2004	-45				<1.0	<1.0	**4.3**	**4.0**
MW-10C	10/19/2004	124	-58			<1.0	<1.0	**6.4**	**11**
MW-10C	5/11/2005	328	146			<1.0	<1.0	**4.0**	**1.9**
MW-10C	11/14/2005	515	333			<1.0	<1.0	<1.0	**1.0**
MW-10C	5/15/2006	697	515			<1.0	<1.0	**1.5**	**2.2**
MW-10C	11/27/2006	893	711			<0.2	<0.2	**1.9**	**2.6**
MW-10C	5/22/2007	1069	887			<1.0	<1.0	**6.7**	**5.8**
MW-10C	11/29/2007	1260	1078			<1.0	<1.0	**7.2**	**5.6**
MW-10C	5/19/2008	1432	1250		-98	<0.2	<0.2	**15**	**6.9**
MW-10C	11/24/2008	1621	1439		91	<1.0	<1.0	**8.5**	**7.5**
MW-10C	05/18/2009	1796	1614		266	<1.0	<1.0	<1.0	<1.0
MW-10C	11/16/2009	1978	1796		448	<1.0	<1.0	<1.0	<1.0
MW-10C	5/20/2010	2163	1981		633	<1.0	<1.0	<1.0	<1.0
MW-10C	11/10/2010	2337	2155		807	<1.0	<1.0	**3.5**	**4.4**
MW-10C	5/3/2011	2511	2329		981	<1.0	<1.0	**5.8**	**4.7**
MW-10C	11/13/2011	2705	2523		1175	<0.2	<0.2	**3.7**	**4.3**
MW-10C	5/14/2012	2888	2706		1358	<0.2	<0.2	**5.4**	**4.0**
MW-10C	11/14/2012	3072	2890		1542	<0.2	<0.2	**6.1**	**4.4**
MW-11A	5/2/2004	-46				<1.0	**2.1**	**21**	<1.0
MW-11A	10/25/2004	130	-52			<1.0	**2.0**	**20**	<1.0
MW-11A	5/12/2005	329	147			<1.0	**2.0**	**20**	<1.0
MW-11A	11/15/2005	516	334			<1.0	**2.0**	**22**	<1.0
MW-11A	5/16/2006	698	516			<1.0	**1.1**	**20**	<1.0
MW-11A	11/26/2006	892	710			<1.0	**1.5**	**24**	<1.0
MW-11A	5/22/2007	1069	887			<1.0	**1.5**	**26**	<1.0
MW-11A	11/27/2007	1258	1076			<1.0	**1.1**	**27**	<1.0

TABLE 8
SWMU-20 CLEANUP ACTION SUMMARY - NON SOURCE ZONE
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

		Elapsed Time from Injections (a) (days)				Volatile Organic Compounds			
						Proposed Groundwater Cleanup Levels (c)			
						5.3	**1.4**	**134**	**2.4**
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)
MW-11A	5/19/2008	1432	1250		-98	<0.2	**1.2**	**26**	**0.2**
MW-11A	11/23/2008	1620	1438		90	<1.0	**1.2**	**33**	<1.0
MW-11A	05/18/2009	1796	1614		266	<1.0	<1.0	**26**	<1.0
MW-11A	11/17/2009	1979	1797		449	<1.0	**1.0**	**30**	<1.0
MW-11A	5/19/2010	2162	1980		632	<1.0	**1.1**	**26**	<1.0
MW-11A	11/8/2010	2335	2153		805	<1.0	<1.0	**22**	<1.0
MW-11A	5/3/2011	2511	2329		981	<1.0	<1.0	**22**	<1.0
MW-11A	11/13/2011	2705	2523		1175	<0.2	**0.5**	**23**	**0.4**
MW-11A	5/14/2012	2888	2706		1358	<0.2	**0.7**	**24**	**0.4**
MW-11A	11/14/2012	3072	2890		1542	<2.0	<2.0	**25**	<2.0
MW-12A	5/2/2004	-46				<1.0	<1.0	**1.8**	<1.0
MW-12A	10/25/2004	130	-52			<1.0	<1.0	**4.4**	<1.0
MW-12A	5/12/2005	329	147			<1.0	<1.0	**2.0**	<1.0
MW-12A	11/15/2005	516	334			<1.0	<1.0	**3.8**	<1.0
MW-12A	5/16/2006	698	516			<1.0	<1.0	**1.5**	<1.0
MW-12A	11/26/2006	892	710			<0.2	**0.7**	**4.4**	<0.2
MW-12A	5/22/2007	1069	887			<1.0	<1.0	**2.4**	<1.0
MW-12A	11/27/2007	1258	1076			<1.0	<1.0	**3.2**	<1.0
MW-12A	5/19/2008	1432	1250		-98	<0.2	**0.6**	**3.2**	<0.2
MW-12A	11/23/2008	1620	1438		90	<1.0	<1.0	**4.7**	<1.0
MW-12A	05/18/2009	1796	1614		266	<1.0	<1.0	**1.4**	<1.0
MW-12A	11/17/2009	1979	1797		449	<1.0	<1.0	**4.7**	<1.0
MW-12A	5/19/2010	2162	1980		632	<1.0	<1.0	<1.0	<1.0
MW-12A	11/8/2010	2335	2153		805	<1.0	<1.0	**4.3**	<1.0
MW-12A	5/3/2011	2511	2329		981	<1.0	<1.0	<1.0	<1.0
MW-12A	11/13/2011	2705	2523		1175	<0.2	**0.6**	**3.1**	<0.2
MW-12A	5/14/2012	2888	2706		1358	**0.2**	<0.2	<0.2	<0.2
MW-12A	11/14/2012	3072	2890		1542	<0.2	**0.4**	**2.1**	<0.2
MW-13A	5/2/2004	-46				**5.1**	**4.6**	<1.0	<1.0
MW-13A	10/25/2004	130	-52			**4.3**	**4.0**	<1.0	<1.0
MW-13A	5/12/2005	329	147			**6.1**	**4.6**	<1.0	<1.0
MW-13A	11/14/2005	515	333			**6.0**	**4.5**	<1.0	<1.0
MW-13A	5/16/2006	698	516			**7.1**	**4.6**	<1.0	<1.0
MW-13A	11/27/2006	893	711			**8.3**	**6.5**	**0.3**	<0.2
MW-13A	5/21/2007	1068	886			**8.2**	**7.0**	**0.4**	<0.2
MW-13A	11/28/2007	1259	1077			**6.4**	**4.2**	<1.0	<1.0
MW-13A	5/19/2008	1432	1250		-98	**8.7**	**6.8**	**0.3**	<0.2
MW-13A	11/23/2008	1620	1438		90	**6.5**	**3.7**	<1.0	<1.0
MW-13A	05/18/2009	1796	1614		266	**7.7**	**5.6**	<1.0	<1.0
MW-13A	11/17/2009	1979	1797		449	**9.2**	**6.0**	<1.0	<1.0
MW-13A	5/20/2010	2163	1981		633	**9.4**	**5.3**	<1.0	<1.0
MW-13A	11/10/2010	2337	2155		807	**3.6**	**2.8**	<1.0	<1.0
MW-13A	5/4/2011	2512	2330		982	**3.9**	**2.4**	<1.0	<1.0
MW-13A	11/3/2011	2695	2513		1165	**1.6**	<1.0	<1.0	<1.0
MW-13A	5/14/2012	2888	2706		1358	**2.3**	**0.8**	<0.2	<0.2
MW-13A	11/13/2012	3071	2889		1541	**2.2**	**0.8**	<0.2	<0.2
MW-13C	5/2/2004	-46				<1.0	<1.0	<1.0	**2.5**
MW-13C	10/25/2004	130	-52			<1.0	<1.0	<1.0	**3.3**
MW-13C	5/12/2005	329	147			<1.0	<1.0	<1.0	<1.0
MW-13C	11/14/2005	515	333			<1.0	<1.0	<1.0	**3.8**
MW-13C	5/16/2006	698	516			<1.0	<1.0	<1.0	**2.2**

TABLE 8
SWMU-20 CLEANUP ACTION SUMMARY - NON SOURCE ZONE
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

		Elapsed Time from Injections (a) (days)				Volatile Organic Compounds			
						Proposed Groundwater Cleanup Levels (c)			
						5.3	1.4	134	2.4
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)
MW-13C	11/27/2006	893	711			<0.2	<0.2	**0.8**	**3.4**
MW-13C	5/21/2007	1068	886			<0.2	<0.2	**0.8**	**4.4**
MW-13C	11/28/2007	1259	1077			<1.0	<1.0	<1.0	**2**
MW-13C	5/19/2008	1432	1250		-98	<0.2	<0.2	**0.2**	**0.6**
MW-13C	11/23/2008	1620	1438		90	<1.0	<1.0	<1.0	**2.2**
MW-13C	05/18/2009	1796	1614		266	<1.0	<1.0	<1.0	<1.0
MW-13C	11/17/2009	1979	1797		449	<1.0	<1.0	<1.0	<1.0
MW-13C	5/20/2010	2163	1981		633	<1.0	<1.0	<1.0	<1.0
MW-13C	11/10/2010	2337	2155		807	<1.0	<1.0	<1.0	<1.0
MW-13C	5/4/2011	2512	2330		982	<1.0	<1.0	<1.0	<1.0
MW-13C	11/3/2011	2695	2513		1165	<1.0	<1.0	<1.0	<1.0
MW-13C	5/14/2012	2888	2706		1358	<0.2	<0.2	<0.2	**0.3**
MW-13C	11/13/2012	3071	2889		1541	<2.0	<2.0	<2.0	<2.0
MW-14C	5/4/2004	-44				<1.0	<1.0	**63**	**44**
MW-14C	10/26/2004	131	-51	-142		<1.0	<1.0	**22**	**75**
MW-14C	5/16/2005	333	151	60		<1.0	<1.0	**11**	**6.1**
MW-14C	11/15/2005	516	334	243		<1.0	<1.0	<1.0	**1.8**
MW-14C	5/17/2006	699	517	426		<1.0	<1.0	<1.0	<1.0
MW-14C	11/29/2006	895	713	622		<0.2	<0.2	<0.2	**1.0**
MW-14C	5/23/2007	1070	888	797		<1.0	<1.0	<1.0	**2.5**
MW-14C	12/3/2007	1264	1082	991		<1.0	<1.0	**1.1**	**11**
MW-14C	5/20/2008	1433	1251	1160	-97	<1.0	<1.0	**1.4**	**22**
MW-14C	11/24/2008	1621	1439	1348	91	<1.0	<1.0	<1.0	**4.3**
MW-14C	05/20/2009	1798	1616	1525	268	<1.0	<1.0	<1.0	**1.1**
MW-14C	11/17/2009	1979	1797	1706	449	<1.0	<1.0	<1.0	<1.0
MW-14C	5/24/2010	2167	1985	1894	637	<1.0	<1.0	<1.0	<1.0
MW-14C	11/10/2010	2337	2155	2064	807	<1.0	<1.0	<1.0	<1.0
MW-14C	5/5/2011	2513	2331	2240	983	<1.0	<1.0	<1.0	<1.0
MW-14C	11/13/2011	2705	2523	2432	1175	<0.2	<0.2	<0.2	<0.2
MW-14C	5/14/2012	2888	2706	2615	1358	<0.2	<0.2	<0.2	<0.2
MW-14C	11/14/2012	3072	2890	2799	1542	<2.0	<2.0	<2.0	<2.0
MW-14E	5/4/2004	-44				<1.0	<1.0	<1.0	<1.0
MW-14E	10/26/2004	131	-51	-142		<1.0	<1.0	<1.0	<1.0
MW-14E	5/16/2005	333	151	60		<1.0	<1.0	<1.0	<1.0
MW-14E	11/15/2005	516	334	243		<1.0	<1.0	<1.0	<1.0
MW-14E	5/17/2006	699	517	426		<1.0	<1.0	<1.0	<1.0
MW-14E	11/29/2006	895	713	622		<0.2	<0.2	<0.2	<0.2
MW-14E	5/23/2007	1070	888	797		<1.0	<1.0	<1.0	<1.0
MW-14E	12/3/2007	1264	1082	991		<1.0	<1.0	<1.0	<1.0
MW-14E	5/20/2008	1433	1251	1160	-97	<1.0	<1.0	<1.0	<1.0
MW-14E	11/24/2008	1621	1439	1348	91	<1.0	<1.0	<1.0	<1.0
MW-14E	05/20/2009	1798	1616	1525	268	<1.0	<1.0	<1.0	<1.0
MW-14E	11/17/2009	1979	1797	1706	449	<1.0	<1.0	<1.0	<1.0
MW-15C	5/3/2004	-45				<1.0	<1.0	**9.1**	**11**
MW-15C	10/26/2004	131	-51			<1.0	<1.0	**11**	**17**
MW-15C	5/16/2005	333	151			<1.0	<1.0	**13**	**6.4**
MW-15C	11/15/2005	516	334			<1.0	<1.0	<1.0	<1.0
MW-15C	5/17/2006	699	517			<1.0	<1.0	<1.0	<1.0
MW-15C	11/29/2006	895	713			<0.2	<0.2	<0.2	<0.2
MW-15C	5/23/2007	1070	888			<1.0	<1.0	<1.0	**2.2**
MW-15C	12/3/2007	1264	1082			<1.0	<1.0	<1.0	**2.5**

TABLE 8
SWMU-20 CLEANUP ACTION SUMMARY - NON SOURCE ZONE
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

						Volatile Organic Compounds			
						Proposed Groundwater Cleanup Levels (c)			
		Elapsed Time from Injections (a) (days)				5.3	1.4	134	2.4
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)
MW-15C	5/20/2008	1433	1251		-97	<1.0	<1.0	**1.8**	**6.6**
MW-15C	11/24/2008	1621	1439		91	<1.0	<1.0	**1.9**	**6.6**
MW-15C	05/19/2009	1797	1615		267	<1.0	<1.0	<1.0	<1.0
MW-15C	11/18/2009	1980	1798		450	<1.0	<1.0	<1.0	<1.0
MW-15C	5/20/2010	2163	1981		633	<1.0	<1.0	<1.0	<1.0
MW-15C	11/10/2010	2337	2155		807	<1.0	<1.0	<1.0	<1.0
MW-15C	5/5/2011	2513	2331		983	<1.0	<1.0	<1.0	<1.0
MW-15C	11/13/2011	2705	2523		1175	<0.2	<0.2	<0.2	<0.2
MW-15C	5/14/2012	2888	2706		1358	<0.2	<0.2	<0.2	<0.2
MW-15C	11/13/2012	3071	2889		1541	<2.0	**3.2**	<2.0	<2.0
MW-15D	5/3/2004	-45				<1.0	<1.0	<1.0	<1.0
MW-15D	10/26/2004	131	-51			<1.0	<1.0	<1.0	<1.0
MW-15D	5/16/2005	333	151			<1.0	<1.0	<1.0	<1.0
MW-15D	11/15/2005	516	334			<1.0	<1.0	<1.0	<1.0
MW-15D	5/17/2006	699	517			<1.0	<1.0	<1.0	<1.0
MW-15D	11/29/2006	895	713			<1.0	<1.0	<1.0	<1.0
MW-15D	5/23/2007	1070	888			<1.0	<1.0	<1.0	<1.0
MW-15D	12/3/2007	1264	1082			<1.0	<1.0	<1.0	<1.0
MW-15D	5/20/2008	1433	1251		-97	<1.0	<1.0	<1.0	<1.0
MW-15D	11/24/2008	1621	1439		91	<1.0	<1.0	<1.0	<1.0
MW-15D	05/19/2009	1797	1615		267	<1.0	<1.0	<1.0	<1.0
MW-15D	11/18/2009	1980	1798		450	<1.0	<1.0	<1.0	<1.0
MW-16A	5/2/2004	-46				**1.2**	**1.2**	**2.3**	<1.0
MW-16A	10/25/2004	130	-52			**1.2**	**1.3**	**1.8**	<1.0
MW-16A	5/12/2005	329	147			**1.2**	**1.8**	**2.6**	<1.0
MW-16A	11/15/2005	516	334			**1.3**	**2.2**	**2.1**	<1.0
MW-16A	5/16/2006	698	516			**1.0**	**1.4**	**2.3**	<1.0
MW-16A	11/26/2006	892	710			<0.2	**0.8**	**4.2**	<0.2
MW-16A	5/22/2007	1069	887			**1.1**	**1.3**	**1.9**	<1.0
MW-16A	11/28/2007	1259	1077			**1.7**	**1.2**	**1.2**	<1.0
MW-16A	5/19/2008	1432	1250		-98	**1.2**	**1.3**	**1.2**	<0.2
MW-16A	11/23/2008	1620	1438		90	**1.5**	**1.4**	**1.0**	<1.0
MW-16A	05/18/2009	1796	1614		266	**1.6**	**1.6**	<1.0	<1.0
MW-16A	11/16/2009	1978	1796		448	**2.2**	**1.5**	<1.0	<1.0
MW-16A	5/20/2010	2163	1981		633	**1.4**	**1.4**	<1.0	<1.0
MW-16A	11/10/2010	2337	2155		807	**1.3**	**1.1**	<1.0	<1.0
MW-16A	5/4/2011	2512	2330		982	**1.6**	**1.4**	<1.0	<1.0
MW-16A	11/13/2011	2705	2523		1175	**1.4**	**1.3**	**0.5**	<0.2
MW-16A	5/14/2012	2888	2706		1358	**1.6**	**1.7**	**0.5**	<0.2
MW-16A	11/14/2012	3072	2890		1542	**1.1**	**1.5**	**0.6**	<0.2
MW-16C	5/2/2004	-46				<1.0	<1.0	**1.7**	**5.4**
MW-16C	10/25/2004	130	-52			<1.0	<1.0	**2.4**	**8.5**
MW-16C	5/12/2005	329	147			<1.0	<1.0	**2.8**	**7.7**
MW-16C	11/15/2005	516	334			<1.0	<1.0	**4.6**	**12**
MW-16C	5/16/2006	698	516			<1.0	<1.0	**5.2**	**6.3**
MW-16C	11/26/2006	892	710			**1.2**	**2.3**	**2.0**	<0.2
MW-16C	5/22/2007	1069	887			<1.0	<1.0	**8.8**	**10**
MW-16C	11/28/2007	1259	1077			<1.0	<1.0	**7**	**8.9**
MW-16C	5/19/2008	1432	1250		-98	<0.2	<0.2	**7.8**	**7.9**
MW-16C	11/23/2008	1620	1438		90	<1.0	<1.0	**5.3**	**8.8**
MW-16C	05/18/2009	1796	1614		266	<1.0	<1.0	**5.0**	**6.3**

TABLE 8
SWMU-20 CLEANUP ACTION SUMMARY - NON SOURCE ZONE
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

		Elapsed Time from Injections (a) (days)				Volatile Organic Compounds Proposed Groundwater Cleanup Levels (c)			
						5.3	1.4	134	2.4
Well	Date	1st Injection	2nd Injection	3rd (b) Injection	4th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)
MW-16C	11/16/2009	1978	1796		448	<1.0	<1.0	**4.9**	**5.6**
MW-16C	5/20/2010	2163	1981		633	<1.0	<1.0	**3.7**	**3.4**
MW-16C	11/10/2010	2337	2155		807	<1.0	<1.0	**3.3**	**2.8**
MW-16C	5/4/2011	2512	2330		982	<1.0	<1.0	**3.7**	**3.2**
MW-16C	11/13/2011	2705	2523		1175	<0.2	<0.2	**3.3**	**2.5**
MW-16C	5/14/2012	2888	2706		1358	<0.2	<0.2	**4.8**	**4.2**
MW-16C	11/14/2012	3072	2890		1542	<0.2	<0.2	**4.9**	**3.8**
MW-17A	5/2/2004	-46				**4.8**	**6.5**	**1.0**	<1.0
MW-17A	10/25/2004	130	-52			**5.2**	**4.8**	**1.2**	<1.0
MW-17A	11/15/2005	516	334			**4.0**	**5.4**	**1.1**	<1.0
MW-17A	5/15/2006	697	515			**4.2**	**4.4**	<1.0	<1.0
MW-17A	11/27/2006	893	711			**2.2**	**6.3**	**1.0**	<0.2
MW-17A	5/21/2007	1068	886			**4.7**	**5.3**	**1.0**	<0.2
MW-17A	11/29/2007	1260	1078			**4.2**	**4.3**	<1.0	<1.0
MW-17A	5/19/2008	1432	1250		-98	**4.3**	**5.1**	**0.8**	<0.2
MW-17A	11/23/2008	1620	1438		90	**4.2**	**5.2**	**1.2**	<1.0
MW-17A	05/19/2009	1797	1615		267	**3.2**	**4.9**	**1.4**	<1.0
MW-17A	11/12/2009	1974	1792		444	**3.7**	**4.5**	**1.1**	<1.0
MW-17A	5/20/2010	2163	1981		633	**4.0**	**3.1**	<1.0	<1.0
MW-17A	11/8/2010	2335	2153		805	**2.3**	**4.8**	**2.3**	<1.0
MW-17A	5/3/2011	2511	2329		981	**3.1**	**2.2**	**1.5**	<1.0
MW-17A	11/3/2011	2695	2513		1165	**2.6**	**2.8**	**1.0**	<1.0
MW-17A	5/14/2012	2888	2706		1358	**3.1**	**2.0**	**0.5**	<0.2
MW-17A	11/13/2012	3071	2889		1541	**2.8**	**3.5**	**0.9**	<0.2
MW-18A	5/2/2004	-46	-228			<1.0	<1.0	<1.0	<1.0
MW-18C	5/2/2004	-46				<1.0	<1.0	<1.0	<1.0
MW-18C	10/25/2004	130	-52			<1.0	<1.0	<1.0	<1.0
MW-18C	5/12/2005	329	147			<1.0	<1.0	<1.0	<1.0
MW-18C	11/15/2005	516	334			<1.0	<1.0	<1.0	<1.0
MW-18C	5/17/2006	699	517			<1.0	<1.0	<1.0	<1.0
MW-18C	11/27/2006	893	711			<0.2	<0.2	<0.2	<0.2
MW-18C	5/21/2007	1068	886			<0.2	<0.2	<0.2	**0.2**
MW-18C	11/28/2007	1259	1077			<1.0	<1.0	<1.0	<1.0
MW-18C	5/19/2008	1432	1250		-98	<0.2	<0.2	<0.2	**0.2**
MW-18C	11/23/2008	1620	1438		90	<1.0	<1.0	<1.0	<1.0
MW-18C	05/19/2009	1797	1615		267	<1.0	<1.0	<1.0	<1.0
MW-18C	11/17/2009	1979	1797		449	<1.0	<1.0	<1.0	<1.0
MW-19C	5/2/2004	-46				<1.0	<1.0	<1.0	<1.0
MW-19C	10/25/2004	130	-52			<1.0	<1.0	<1.0	<1.0
MW-19C	5/12/2005	329	147			<1.0	<1.0	<1.0	<1.0
MW-19C	11/15/2005	516	334			<1.0	<1.0	<1.0	<1.0
MW-19C	5/17/2006	699	517			<1.0	<1.0	<1.0	<1.0
MW-19C	11/27/2006	893	711			<0.2	<0.2	**0.3**	<0.2
MW-19C	5/22/2007	1069	887			<1.0	<1.0	<1.0	<1.0
MW-19C	11/29/2007	1260	1078			<1.0	<1.0	<1.0	<1.0
MW-19C	5/20/2008	1433	1251		-97	<1.0	<1.0	<1.0	<1.0
MW-19C	11/23/2008	1620	1438		90	<1.0	<1.0	<1.0	<1.0
MW-19C	05/19/2009	1797	1615		267	<1.0	<1.0	<1.0	<1.0
MW-19C	11/18/2009	1980	1798		450	<1.0	<1.0	<1.0	<1.0

TABLE 8
SWMU-20 CLEANUP ACTION SUMMARY - NON SOURCE ZONE
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

Well	Date	Elapsed Time from Injections (a) (days)				Volatile Organic Compounds			
						Proposed Groundwater Cleanup Levels (c)			
						5.3	**1.4**	**134**	**2.4**
		1st Injection	2nd Injection	3rd (b) Injection	4th Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)
MW-20C	5/3/2004	-45				<1.0	<1.0	**1.4**	**2.4**
MW-20C	10/25/2004	130	-52			<1.0	<1.0	**1.7**	**4.6**
MW-20C	5/12/2005	329	147			<1.0	<1.0	**1.7**	**2.3**
MW-20C	11/15/2005	516	334			<1.0	<1.0	**2.1**	**2.9**
MW-20C	5/17/2006	699	517			<1.0	<1.0	**1.8**	**1.6**
MW-20C	11/29/2006	895	713			<0.2	**0.2**	**2.1**	**1.5**
MW-20C	5/21/2007	1068	886			<0.2	<0.2	**1.6**	**1.8**
MW-20C	11/29/2007	1260	1078			<1.0	<1.0	**1.6**	**1.3**
MW-20C	5/20/2008	1433	1251		-97	<1.0	<1.0	**1.6**	**2.5**
MW-20C	11/23/2008	1620	1438		90	<1.0	<1.0	**1.5**	**2.7**
MW-20C	05/19/2009	1797	1615		267	<1.0	<1.0	**1.4**	**2.0**
MW-20C	11/18/2009	1980	1798		450	<1.0	<1.0	**1.7**	**2.3**
MW-20C	5/20/2010	2163	1981		633	<1.0	<1.0	**1.3**	**1.8**
MW-20C	11/8/2010	2335	2153		805	<1.0	<1.0	**1.4**	**1.4**
MW-20C	5/4/2011	2512	2330		982	<1.0	<1.0	**1.1**	**1.8**
MW-20C	11/3/2011	2695	2513		1165	<1.0	<1.0	**1.3**	**2.1**
MW-20C	5/14/2012	2888	2706		1358	<0.2	<0.2	**1.2**	**1.5**
MW-20C	11/13/2012	3071	2889		1541	<2.0	<2.0	<2.0	<2.0

PCE = Tetrachloroethene
TCE = Trichloroethene
cDCE = cis-1,2-Dichloroethene
VC = Vinyl Chloride
µg/L - micrograms per liter
Bold = Detect

(a) Injections occurred on:

Injection dates	Date used	
6/17/04 (6A, B, C; 9A, B, C)	6/17/2004	for elapsed time relative to injection
12/16-17/04 (6A, 6B;9A,9B)	12/16/2004	for elapsed time relative to injection
3/17/05 (14A)	3/17/2005	for elapsed time relative to injection
8/25-28/08 (6A, 9A, 10A)	8/25/2008	for elapsed time relative to injection

(b) Conducted at Well MW-14A only.
(c) Plant 2 TMCLs , Boeing 2011, Floyd Snider 2012 (Industrial/Worker).
TMCL = Target Media Cleanup Level.
Box = Exceedance of TMCL.

TABLE 9
BUILDING 9-90
INDOOR AIR SAMPLING RESULTS
BOEING DEVELOPMENTAL CENTER

Lab ID	Field Sample ID (Location)		Date Collected	PCE (µg/m³)	TCE (µg/m³)	cis-1,2-DCE (µg/m³)	Vinyl chloride (µg/m³)
Indoor Air Results:							
01A	IA-990-01		1/18/2006	0.39	0.13	0.14 U	0.045 U
02A	IA-990-01A	Dup of IA-990-01	1/18/2006	0.39	0.12	0.13 U	0.042 U
03A	IA-990-02		1/18/2006	0.44	0.13	0.14 U	0.045 U
Outdoor Ambient Air Results:							
04A	AA-990-01		1/18/2006	0.41	0.11	0.13 U	0.041 U
Indoor Air Results Corrected For Ambient Contribution:							
Proposed Indoor Air Cleanup Levels (a)				**470**	**8.4**	**--**	**28**
01A	IA-990-01		1/18/2006	(b)	0.02	0.14 U	0.045 U
02A	IA-990-01A	Dup of IA-990-01	1/18/2006	(b)	0.01	0.13 U	0.042 U
03A	IA-990-02		1/18/2006	0.03	0.02	0.14 U	0.045 U

U = Not detected above the reporting limit.

(a) Plant 2 TMCLs , Boeing 2011, Floyd Snider 2012 (Industrial/Worker).
(b) Value is less than the ambient air concentration.