2017 Annual Report
AOC-05 Remedial Action
Enhanced Anaerobic Biodegradation of
Gasoline-Range Petroleum Hydrocarbons
Boeing Developmental Center
Tukwila, Washington

June 15, 2018

Prepared for

The Boeing Company
Seattle, Washington

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Project Coordinator: LJL

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LIST OF ABBREVIATIONS AND ACRONYMS

AOC	area of concern
Boeing	The Boeing Company
BTEX	benzene, toluene, ethylbenzene, and xylenes
DC	Developmental Center
DO	dissolved oxygen
Ecology	Washington State Department of Ecology
LAI	Landau Associates, Inc.
lbs	pounds
LLI	Eurofins Lancaster Laboratories Environmental, LLC
mg/L	milligrams per liter
mg-N/L	milligrams per liter as nitrogen
NAPL	non-aqueous phase liquid
ORC®	Oxygen Release Compound
ORP	oxidation-reduction potential
PCULs	proposed cleanup levels
redox	reduction-oxidation
ROIs	radii of injection
TPH	total petroleum hydrocarbons
TPH-G	gasoline-range total petroleum hydrocarbons
UST	underground storage tank
Work Plan	Remedial Action Work Plan

1.0 INTRODUCTION

This document presents the 2017 annual report for the anaerobic bioremediation remedial action performed at Area of Concern (AOC)-05 in The Boeing Company's (Boeing) Developmental Center (DC) in Tukwila, Washington (Figure 1). Remedial action is performed to stimulate anaerobic biodegradation of gasoline contamination, which resulted from a 1985 release from a former leaking underground storage tank (UST) near injection well BDC-103. AOC-05 wells and site features are shown on Figure 2. Anaerobic bioremediation remedial action was performed in general accordance with the Remedial Action Work Plan (Work Plan; Landau Associates, Inc. [LAI] 2007a). This annual report summarizes activities and results for May 2017 through February 2018.

1.1 Remedial Approach

Anaerobic bioremediation at AOC-05 is accomplished through stimulation of microorganisms present in the aquifer that can degrade petroleum hydrocarbons. The addition of nitrate (electron acceptor) allows native bacteria to utilize petroleum hydrocarbons (electron donors) as a source of energy.

Biodegradation of total petroleum hydrocarbons (TPH) occurs via microbially-mediated reduction-oxidation (redox) reactions. In these redox reactions, TPH are used as the electron donor, while various other compounds are utilized as electron acceptors when available (e.g., oxygen, nitrate, manganese [IV], ferric iron, sulfate, carbon dioxide). Microbially-mediated redox reactions can be compared to the processes that humans use to obtain energy, in which food is the electron donor and oxygen is the electron acceptor. Bacteria gain the most energy by utilizing oxygen as an electron acceptor because it is a highly-oxidized compound, meaning it can more readily accept electrons from electron donors, like TPH. When oxygen is depleted, microorganisms preferentially use less oxidized electron acceptors in the following order: nitrate, manganese (IV), ferric iron, sulfate, and carbon dioxide. In anaerobic aquifers with naturally low dissolved oxygen, like the aquifer at Boeing DC, nitrate is the next best electron acceptor, making it the ideal substrate for enhanced anaerobic bioremediation.

Biodegradation of petroleum hydrocarbons can occur under both aerobic and anaerobic conditions. An attempt was made in 2002 to stimulate aerobic bioremediation of TPH at AOC-05 through injection of Oxygen Release Compound (ORC®; LAI 2004). This attempt was unsuccessful because of the high oxygen demand in the naturally-anaerobic aquifer. As a result, the decision was made to switch to anaerobic bioremediation using nitrate as an electron acceptor. Nitrate amendment to enhance anaerobic biodegradation has been successfully implemented on other full-scale remediation projects for gasoline-range and fuel oil-range TPH, both nationally (Lozier and Hicks 2005; Wasserman et. al. 2005) and in Washington State (LAI 2012a). Following this introductory section, the report is organized into five main sections. Sections 2 and 3 provide an overview of the remedial approach and a summary of prior work, as context to activities and results in the current reporting period. Section 4 documents activities during the reporting period, and Section 5 presents a discussion of reporting period results. Section 6 provides a summary and describes planned activities.

1.2 Summary of Previous Work

Pilot testing of nitrate injection in 2007 using a single injection well (BDC-103; LAI 2006a) was expanded to full-scale treatment in 2008 utilizing existing injection well BDC-103 and new injection well BDC-104. Eleven full-scale nitrate injections have been performed to date.[1] Injection events are detailed in the Work Plan (LAI 2007a) and prior annual reports (LAI 2009, 2010, 2011, 2012b, 2013b, 2014, 2015, 2016, 2017).

1.2.1 Pilot Testing

The 2007 bioremediation pilot testing demonstrated degradation of petroleum hydrocarbons resulting from a one-time addition of ammonium nitrate (LAI 2007b). Post-injection monitoring showed that concentrations of TPH in the gasoline range (TPH-G) decreased by about 50 percent, compared to baseline, over 4 months of post-injection monitoring. Benzene, toluene, ethylbenzene, and xylene (BTEX) compounds decreased as much as 98 percent (LAI 2007b). As expected, contaminant concentrations rebounded upon depletion of injected nitrate as groundwater returned to equilibrium with sorbed mass and non-aqueous phase liquid (NAPL) mass remaining in the aquifer.

1.2.2 Well Installation and Baseline Monitoring

Full-scale implementation of anaerobic bioremediation began in February 2008 with the installation of one additional injection well (BDC-104) and baseline monitoring of all four AOC-05 wells (BDC-101, BDC-102, BDC-103, and BDC-104). The new injection well (BDC-104) was installed upgradient (east) and cross-gradient (north) of existing injection well BDC-103. BDC-103 is located within the tank pit of the former UST. BDC-104 is located near the known upgradient edge of contamination associated with the former UST (LAI 2004). Injection of both wells allowed for groundwater transport of injected nitrate solution to the area of highest contamination. Well locations and their estimated radii of injection (ROIs) are shown relative to the area of groundwater contamination on Figure 2.

Baseline monitoring was performed prior to full-scale treatment to determine initial contaminant concentrations and aquifer redox conditions at the four AOC-05 wells (BDC-101, BDC-102, BDC-103, and BDC-104). Baseline results indicated nitrate- to sulfate-reducing conditions at source zone wells BDC-103 and BDC-104, nitrate- to iron-reducing conditions at downgradient well BDC-102, and aerobic to nitrate-reducing conditions at downgradient well BDC-101. The same conditions were indicated by pre-pilot test monitoring (LAI 2006b). Baseline TPH-G concentrations at both source zone wells (BDC-103 and BDC-104) were in excess of the preliminary screening level, and baseline benzene concentrations at BDC-103 exceeded the preliminary screening level (preliminary screening levels in use at that time were developed in a prior DC site summary report [LAI 2002].) TPH-G and BTEX were

[1] Notations regarding each injection are provided in the footnotes of Table 1.

not detected at downgradient wells BDC-101 and BDC-102 during baseline sampling, but had been during prior sampling. Baseline monitoring results and proposed cleanup levels (PCULs) are included in the data summary presented in Table 1.

1.2.3 Prior Full-Scale Nitrate Injections and Performance Results

Eleven full-scale nitrate injections have been performed to date at AOC-05. Performance monitoring results from 2008 through February 2017 indicated effective treatment of TPH-G and BTEX at source zone wells BDC-103 and BDC-104, while maintaining relatively low or non-detect contaminant levels at downgradient wells BDC-101 and BDC-102. As was observed during the pilot test, contaminant concentrations have demonstrated some degree of rebound at well BDC-103 following the depletion of injected nitrate, prompting another nitrate injection. Rebound will continue to occur as long as contaminant mass remains in the sorbed-phase or as NAPL within the aquifer or in upper portions of the smear zone that are periodically contacted by the water table. The historical remediation timeline is summarized as follows:

- Nitrate solution was injected to wells BDC-103 and BDC-104 three times during 2008 (February, June, and October) and twice during 2009 (June and October).
- After 2009, nitrate injections were only required at BDC-103, as concentrations at BDC-104 had declined below PCULs.
- Following the September 2010 injection, in February 2011 contaminant concentrations at BDC-103 decreased to historical lows.
- Cycles of nitrate depletion and contaminant rebound prompted injections in 2012 (February and October) and 2013 (November). This was followed by a period of slow nitrate consumption, and an additional injection was not required until March 2016.
- In February 2013, contaminant concentrations at all wells declined below the PCULs for the first time since treatment began.
- In May 2014, contaminant concentrations at all wells declined to below their reporting limits for the first time since treatment began.
- Contaminant concentrations once again rebounded in August and November 2016 at BDC-103, which prompted a nitrate injection in December 2016. This was the eleventh injection to date at AOC-05.

Periods of substantial TPH rebound followed periods of increased groundwater levels. It is suspected that the higher water table caused groundwater to contact higher portions of the contaminant smear zone not treated by prior injection events, resulting in increased TPH concentrations measured in groundwater. Groundwater elevations over time at AOC-05 are shown on Figure 3. Cumulative performance monitoring results are presented in Table 1.

In accordance with the Work Plan (LAI 2007a), nitrate injections initially utilized 6,500 gallons of 1,000 milligrams per liter (mg/L) nitrate solution (approximately 225 mg/L as nitrogen [mg-N/L]). As treatment progressed, modifications were made to this approach as follows:

- Starting in June 2009, less effective treatment suggested that biodegradation had become nutrient-limited. To provide additional nutrients for microorganisms, ammonium phosphate was added to the injection solution, and the amount of yeast extract was increased from 2 to 4 pounds (lbs) per well. During the June 2009 injection event only, the nitrate concentration injected was decreased by two-thirds to 330 mg/L nitrate (75 mg-N/L) to evaluate the effects of added nutrients.
- Beginning in October 2012, injections used a 50 percent increased volume (approximately 9,800 gallons total) of 1,000 mg/L nitrate solution (226 mg-N/L). The larger volume is intended to distribute nitrate more extensively in the source zone and to achieve more mounding of injection fluid into the high smear zone.
- The March 2016 injection used a reduced nitrate concentration of 500 mg/L (113 mg-N/L), with the larger injection volume (9,800 gallons).

As indicated in the Work Plan (LAI 2007a), the Washington State Department of Ecology (Ecology) required an action level for nitrate of 10 mg-N/L for the AOC-05 remedial action. Detection of nitrate above the action level at either of the two nearest downgradient wells (BDC-101 or BDC-102) for two consecutive sampling events triggers implementation of additional groundwater monitoring at four wells located farther downgradient (BDC-05-04, MW-17A, MW-18A, and MW-21A). Semiannual monitoring for nitrate is required to continue at these four downgradient wells for 1 year after nitrate at wells BDC-101 and BDC-102 decreases below 10 mg-N/L. Based on continued periodic exceedances of the action level at wells BDC-101 and BDC-102, semiannual nitrate monitoring has been performed at the four downgradient wells since November 2009. Nitrate has not been detected at the four downgradient wells (BDC-05-04, MW-17A, MW-18A, and MW-21A) above the 10 mg-N/L action level since the semiannual monitoring was first triggered. Cumulative downgradient nitrate monitoring results are included in Table 2.

2.0 DESCRIPTION OF ACTIVITIES DURING THIS REPORTING PERIOD

This section describes remediation activities and monitoring events for the current reporting period of May 2017 through February 2018. This reporting period included four quarterly monitoring events and two semiannual monitoring events to measure nitrate at downgradient wells.

The progress of petroleum hydrocarbon biodegradation was evaluated through quarterly performance groundwater monitoring at the four AOC-05 wells (BDC-101 through BDC-104). Monitoring was performed in May, August, and November 2017 and in February 2018. Groundwater levels were measured in May and November. In accordance with the Work Plan (LAI 2007a), samples were 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). Samples were also analyzed for nitrite, a product of nitrate reduction. Groundwater elevation contours for May and November 2017 are presented on Figures 4 and 5, respectively. A summary of monitoring results for the four AOC-05 wells (BDC-101 through BDC-104) is presented with cumulative data in Table 1.

Semiannual monitoring for nitrate continued in May and November 2017 at the four monitoring wells located farther downgradient of AOC-05 (MW-17A, MW-18A, MW-21A, and BDC-05-04). These results are presented with cumulative data in Table 2. Semiannual monitoring for nitrate is required to continue at these four downgradient wells for 1 year after nitrate at wells BDC-101 and BDC-102 is no longer detected above an action level of 10 mg-N/L.

TPH-G, BTEX, nitrate, nitrite, and sulfate were analyzed in the laboratory, while other parameters (DO, ORP, ferrous iron, and pH) were measured in the field. Laboratory analysis was performed by Eurofins Lancaster Laboratories Environmental, LLC (LLI).

3.0 RESULTS AND DISCUSSION

Performance monitoring results for sampling performed in May 2017 through February 2018 indicate continued effective treatment of TPH-G and BTEX at AOC-05. Highlights are as follows:

- Contaminant concentrations at all four AOC-05 wells have remained below the PCULs and/or below the laboratory reporting limits since February 2017, indicating enduring and effective biodegradation. At BDC-103, TPH-G and BTEX concentrations have been reduced by more than 99 percent compared to baseline.
- Nitrate at BDC-103 has remained elevated since the injection in December 2016. Nitrate reached an all-time maximum of 215 mg-N/L in May 2017, approximately 5 months after the prior injection, and persisted at 128 mg/L in February 2018, 14 months post-injection. This slower utilization of injected nitrate suggests that treatment of TPH-G and BTEX mass near BDC-103 is nearing completion in the current saturated zone. It is uncertain if additional TPH mass remains above the high water table levels observed during 2014 through 2018 (Figure 3).
- Groundwater elevations in February 2018 were the second highest since treatment began, providing contact of injected nitrate with remaining contaminant mass that may be present in the higher smear zone (Figure 3).
- Per the Work Plan (LAI 2007a), detection of nitrate above the action level of 10 mg-N/L at either BDC-101 or BDC-102 for two consecutive sampling events triggers additional groundwater monitoring at farther downgradient wells MW-17A, MW-18A, MW-21A, and BDC-05-04. Nitrate concentrations at BDC-101 exceeded the action level during the May, August, and November 2017 monitoring events, but was below the action level in February 2018. Nitrate concentrations at BDC-102 exceeded the action level during the May and August 2017 monitoring events, but was below the action level in November 2017 and February 2018. As a result, the downgradient monitoring continued during this reporting period. All downgradient detections remained below the 10 mg-N/L action level, with the highest detection occurring at BDC-05-04 (8.8 mg-N/L) in May 2017. Per the Work Plan, semiannual monitoring for nitrate will continue at the four down-gradient wells for one year after nitrate at wells BDC-101 and BDC-102 drops below 10 mg-N/L.
- Detection of low levels of nitrite is a result of nitrate reduction. Nitrite is a highly reactive, short-lived compound that is further reduced to nitrous oxide, nitric oxide, and finally nitrogen gas (Environment Agency 2005). Nitrite has been commonly detected at injection wells since the start of full-scale injection activities. The maximum nitrite concentration detected during this reporting period was 0.40 mg-N/L at injection well BDC-103 in May 2017. Nitrite was also detected at downgradient well BDC-102 (0.17 mg-N/L), but it was not detected at wells BDC-104 or BDC-101 during this reporting period. This data confirms that nitrite continues to be reduced in the treatment area.

Monitoring results are presented in the following tables and figures. Concentrations of TPH-G, benzene, and nitrate at BDC-103 and BDC-104 over time are presented on Figures 6 and 7, respectively. Cumulative monitoring results for wells BDC-101 through BDC-104 are presented on Table 1; results are compared to PCULs (LAI 2013a) and contaminant concentrations above PCULs are boxed. Cumulative monitoring results for downgradient nitrate monitoring are presented in Table 2 and summarized on Figure 8.

4.0 SUMMARY AND PLANNED ACTIVITIES

Data suggest that bioremediation treatment of TPH is nearing completion in AOC-05, as indicated by the extended period of contaminant concentrations below the PCULs and slower nitrate utilization. February 2018 monitoring data indicate substantial contaminant concentration reductions of more than 99 percent compared to 2008 baseline conditions. Potential rebound of TPH-G and BTEX concentrations at BDC-103 will be evaluated when nitrate concentrations return to near background levels, signaling the end of enhanced treatment.

Following the December 2016 injection event, another injection is not needed at this time. However, additional injections may be scheduled if monitoring results indicate rebound of contaminant concentrations following depletion of nitrate. Modification of the injection approach will be evaluated on an ongoing basis, using the most current monitoring data. Ammonium phosphate (to prevent a nutrient stall), higher injection rates (to achieve mounding of injectate for contact with higher portions of the smear zone), and a larger injection volume (to extend the ROI and increase the longevity of treatment) will likely continue to be utilized for any future injections.

Groundwater monitoring will continue on a quarterly basis at the four AOC-05 wells and at the four downgradient wells to evaluate contaminant treatment and nitrate consumption. The four AOC-05 wells will continue to be sampled for the parameters indicated in the Work Plan (LAI 2007a) and for nitrite. Semiannual monitoring for nitrate only at downgradient wells MW-17A, MW-18A, MW-21A, and BDC-05-04, triggered by nitrate concentrations at wells BDC-101 and BDC-102, will continue per the Work Plan (LAI 2007a).

5.0 USE OF THIS REPORT

This annual evaluation report has been prepared for the exclusive use of The Boeing Company 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 LAI. 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 LAI, shall be at the user’s sole risk. LAI 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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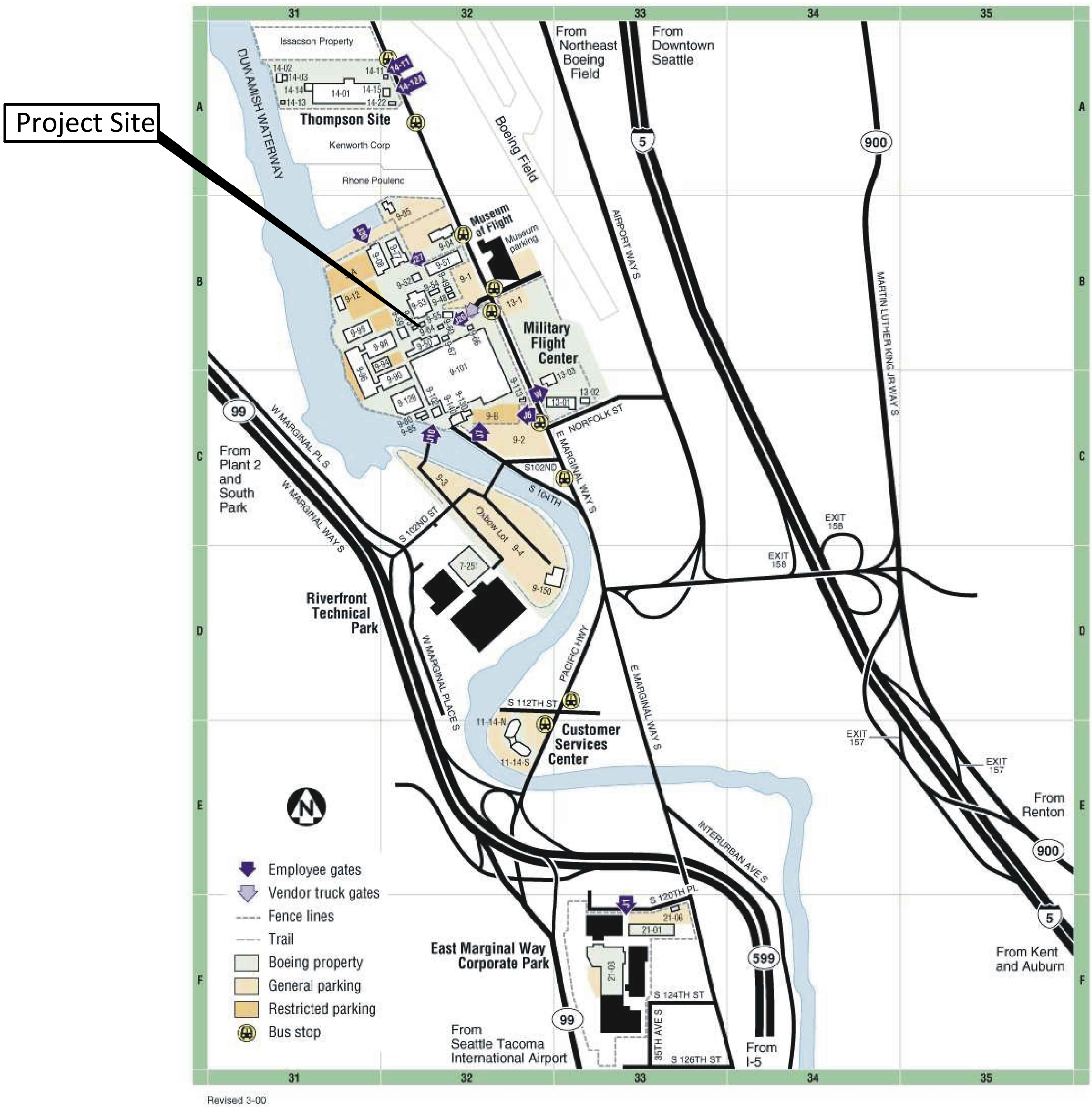

Not to Scale

Map Provided by Boeing, March 2000

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

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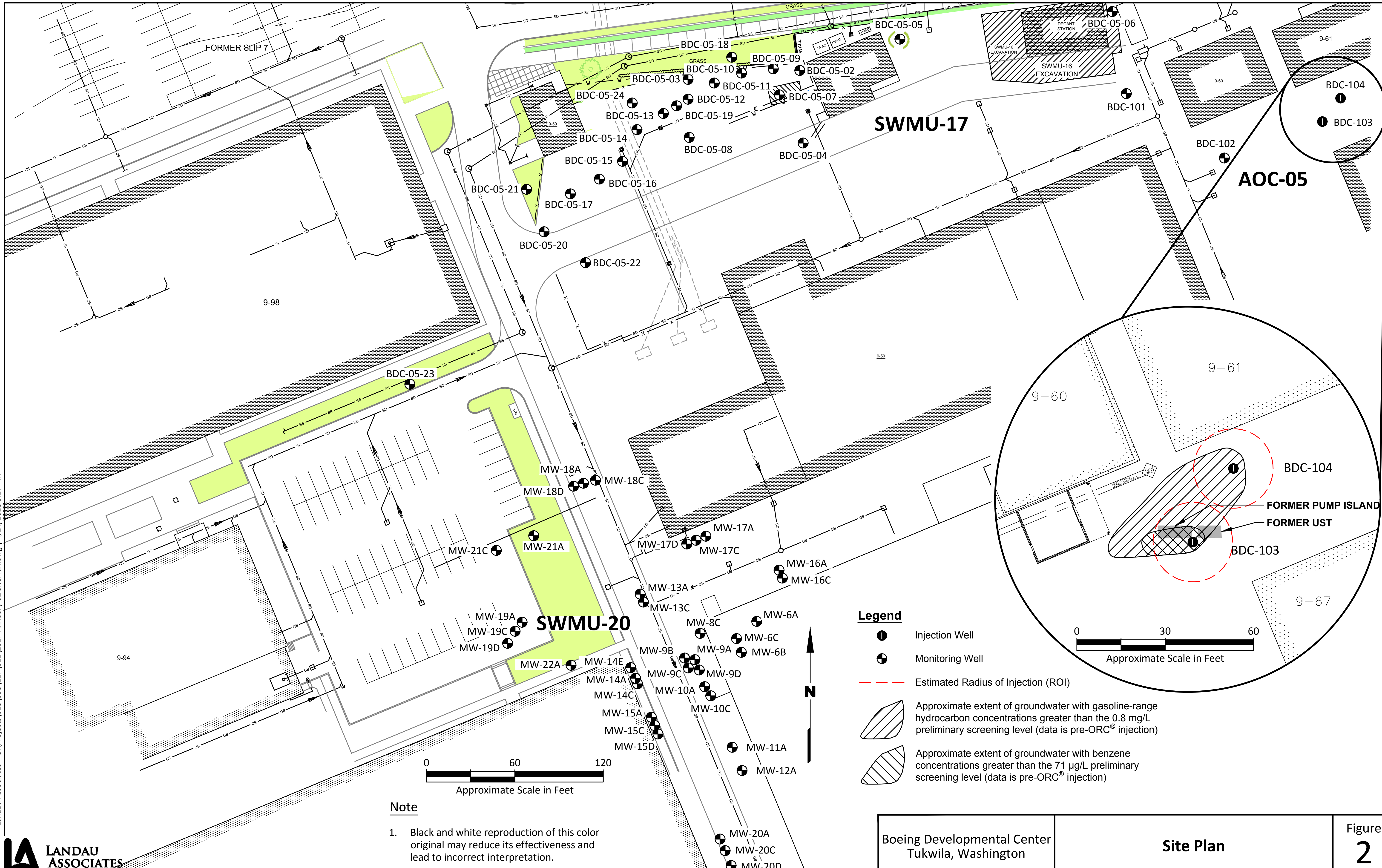
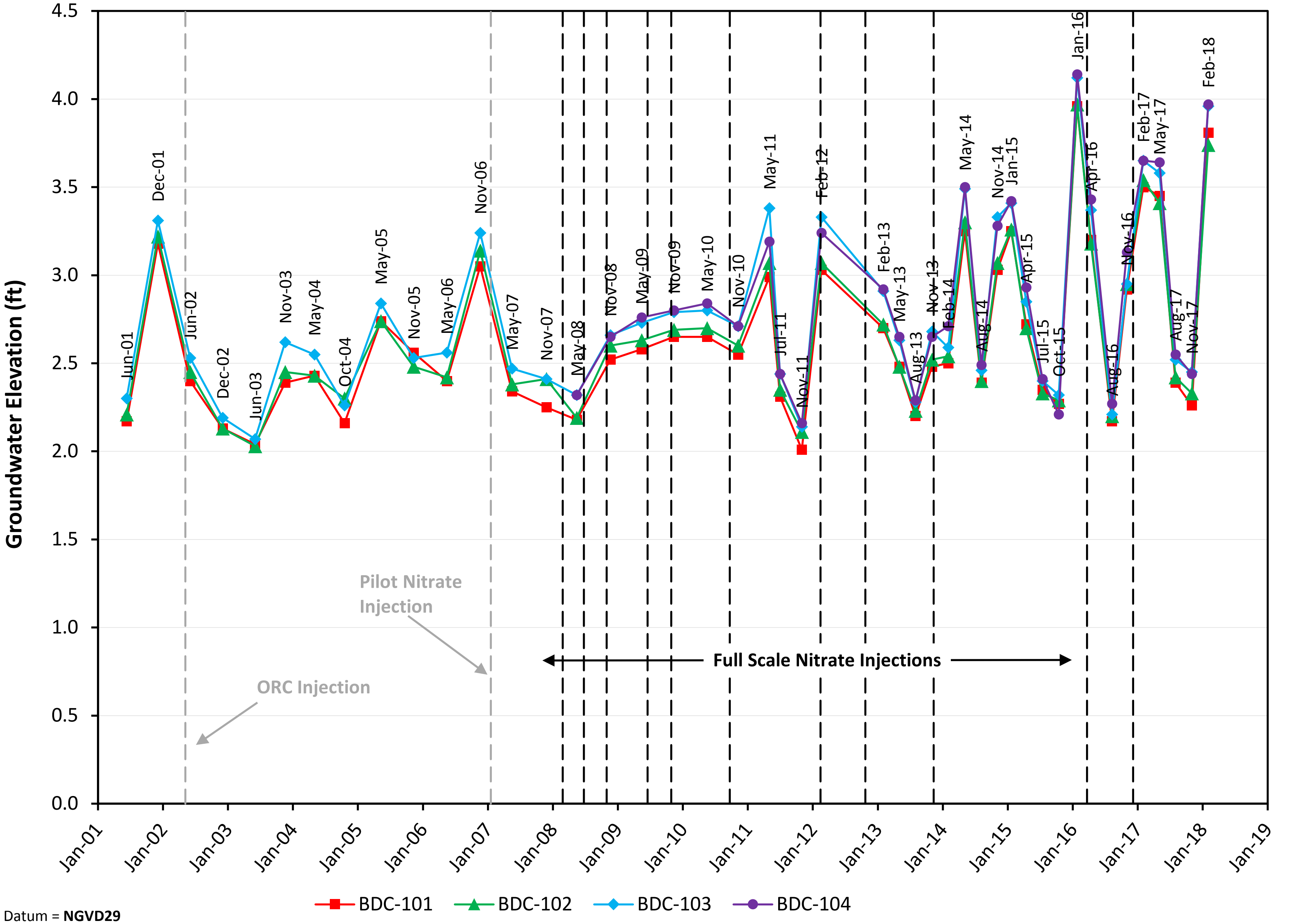


Boeing Developmental Center
Tukwila, Washington

Site Plan

Figure 2



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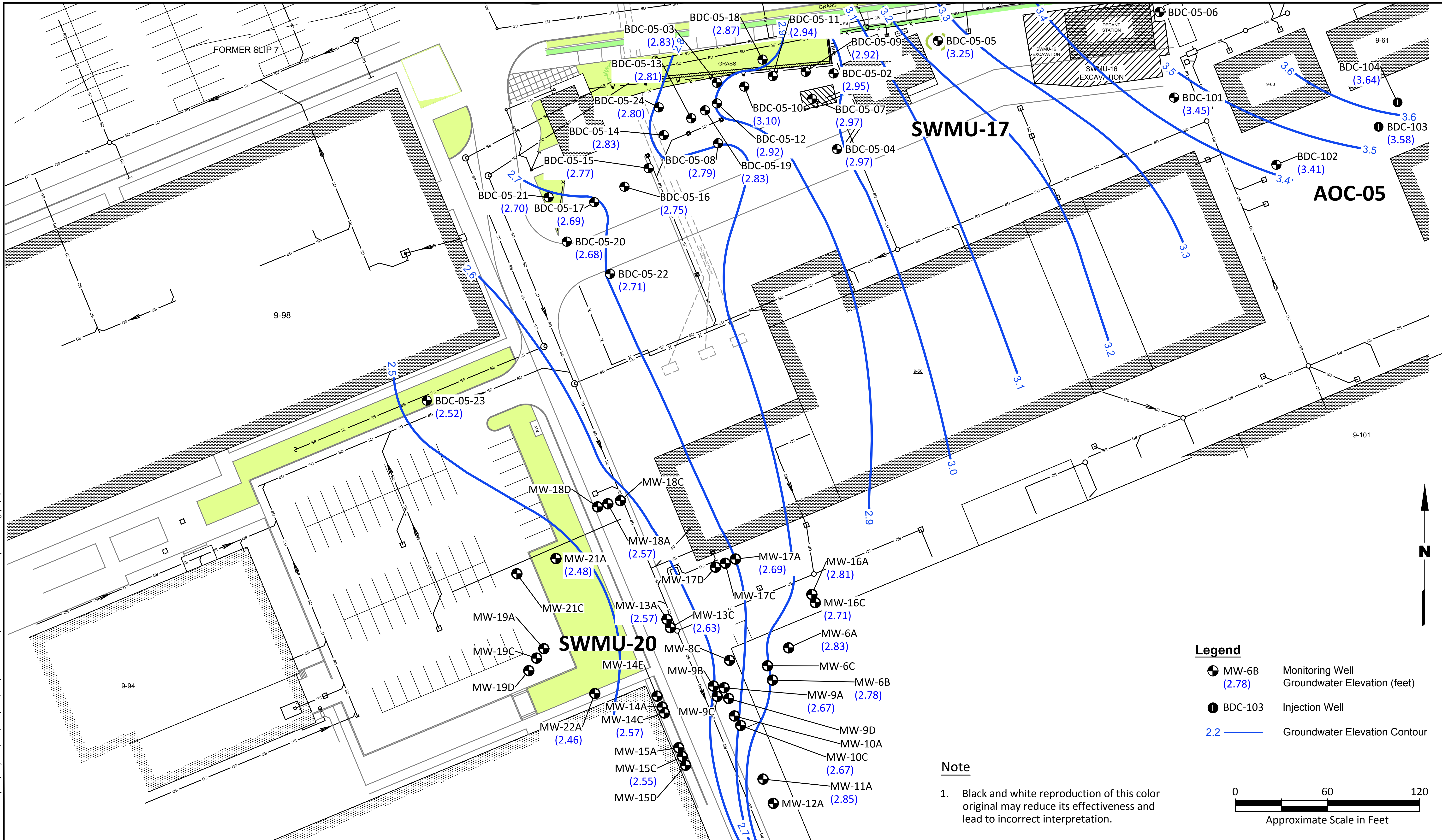
Groundwater Elevations

Figure
3



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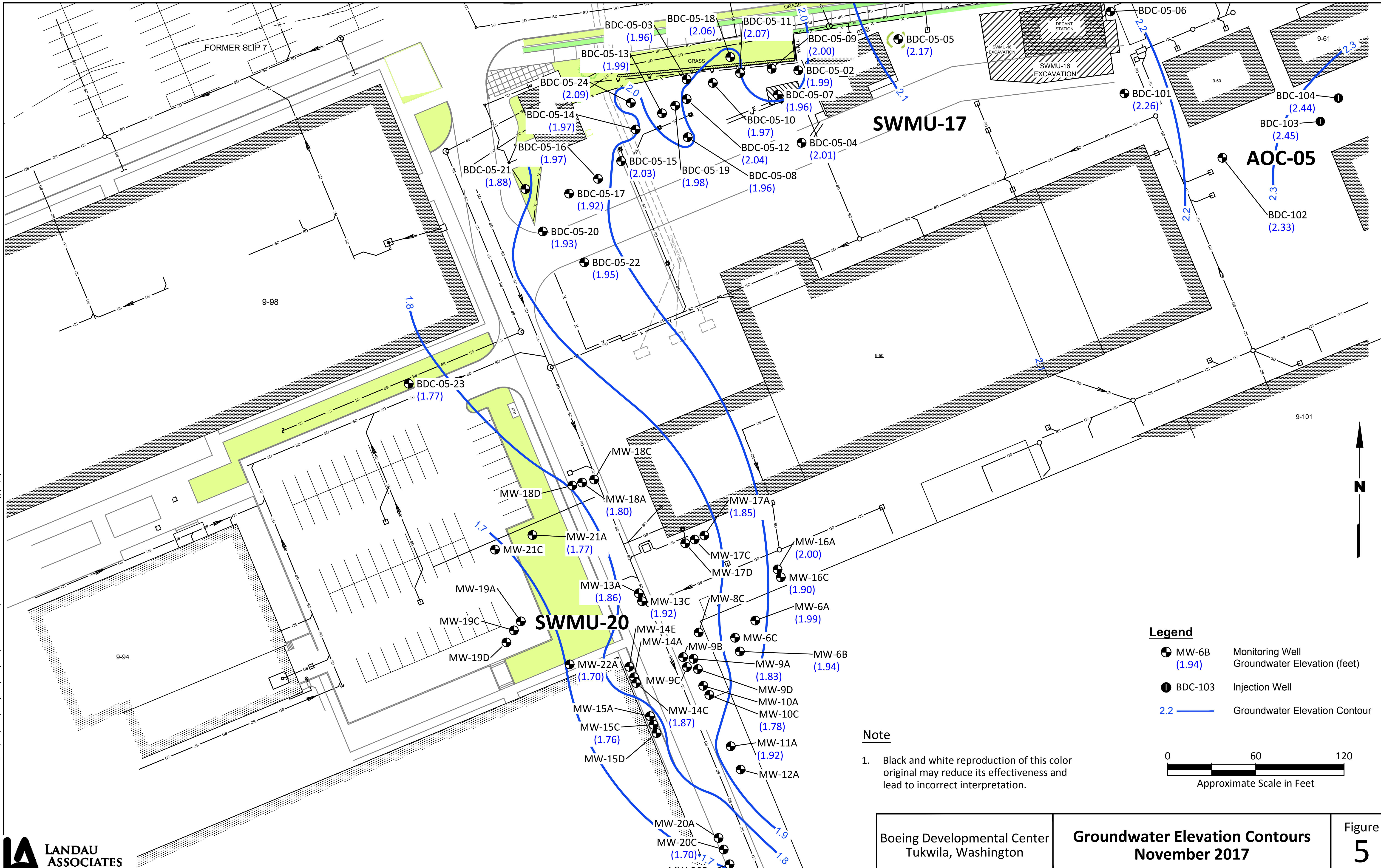
Groundwater Elevation Contours May 2017

Figure 4



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Groundwater Elevation Contours November 2017

Figure 5

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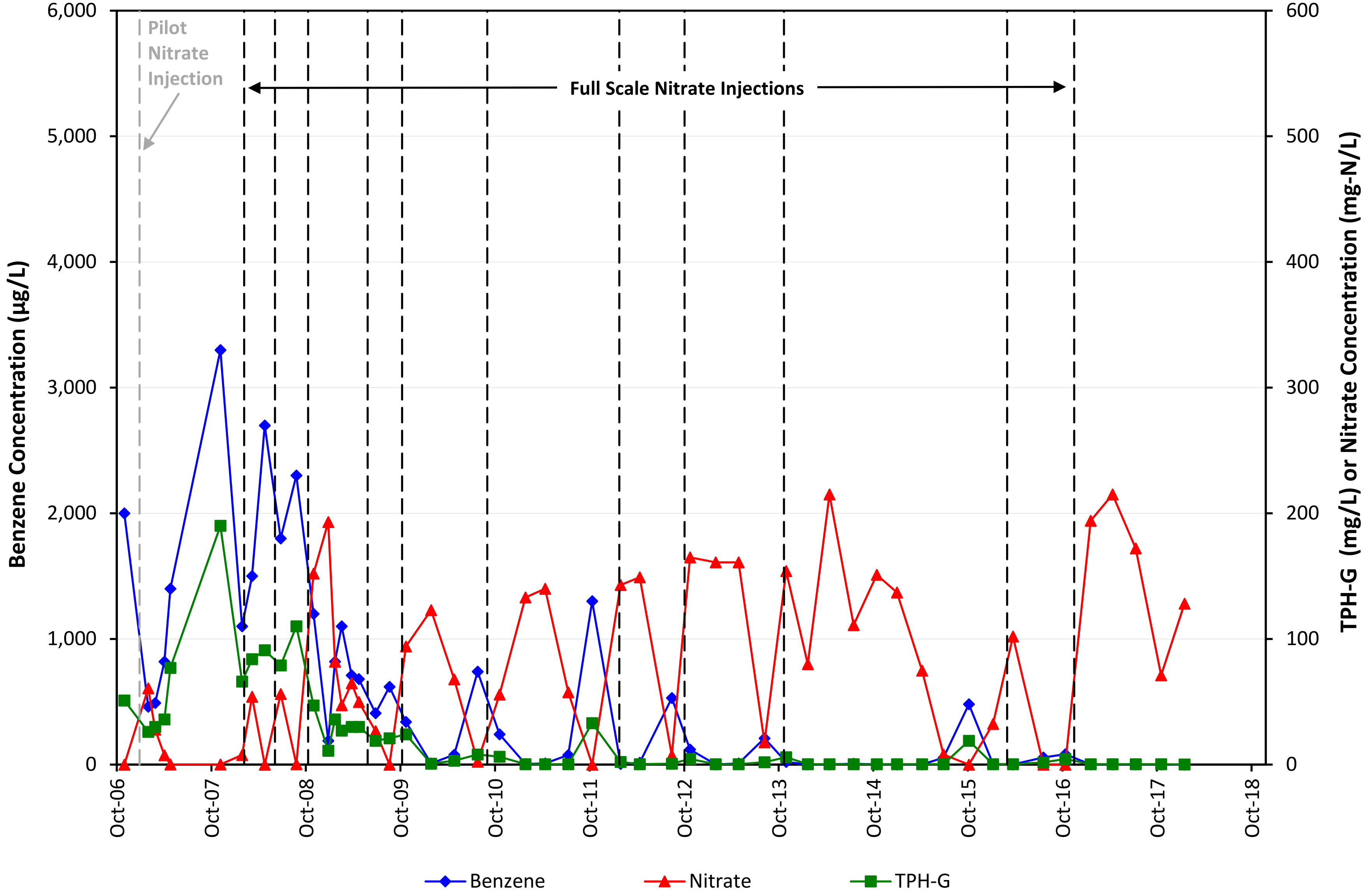

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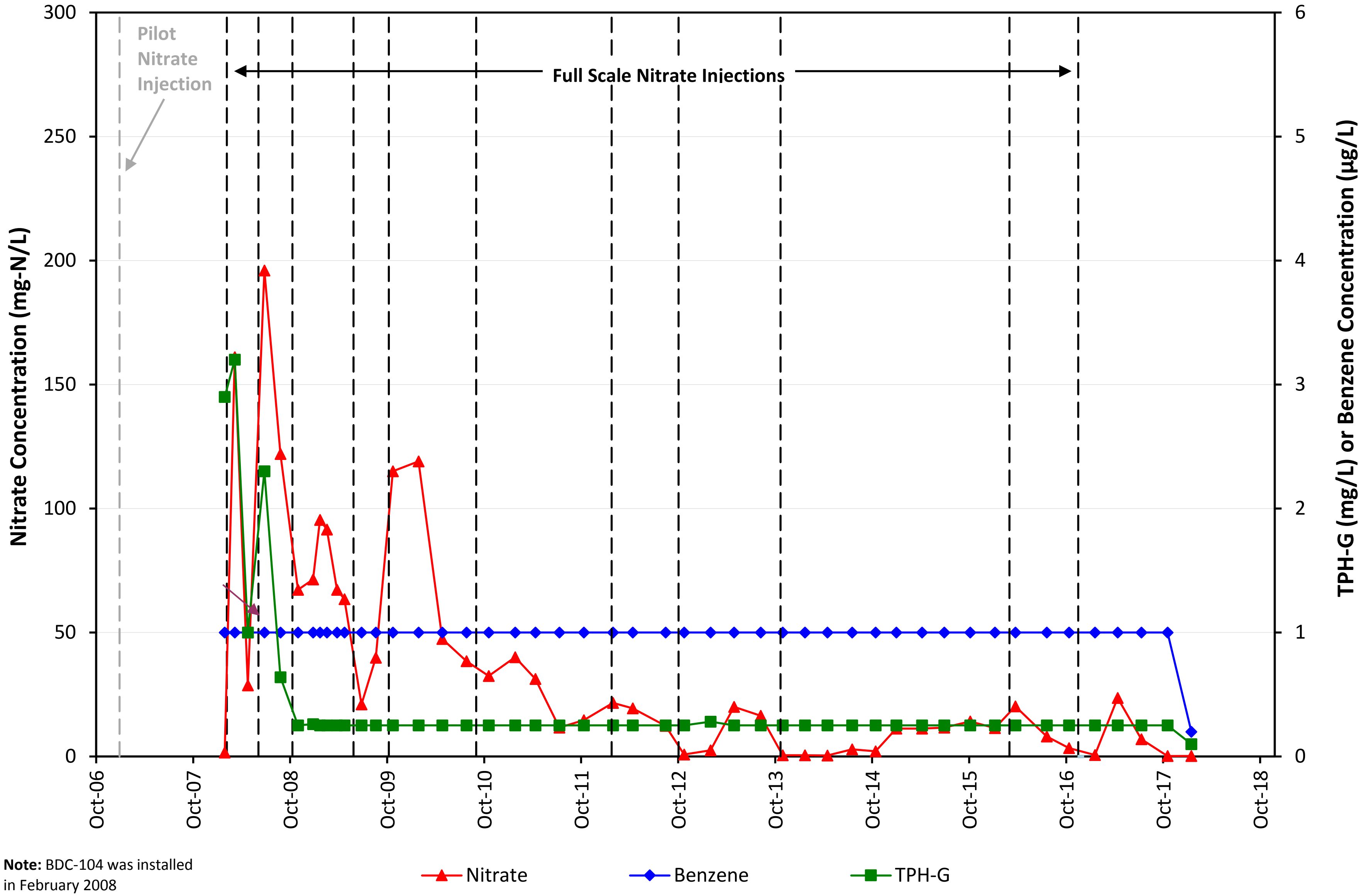
BDC-103 Nitrate, TPH-G, and Benzene Concentrations

Figure 6



Note: BDC-104 was installed in February 2008

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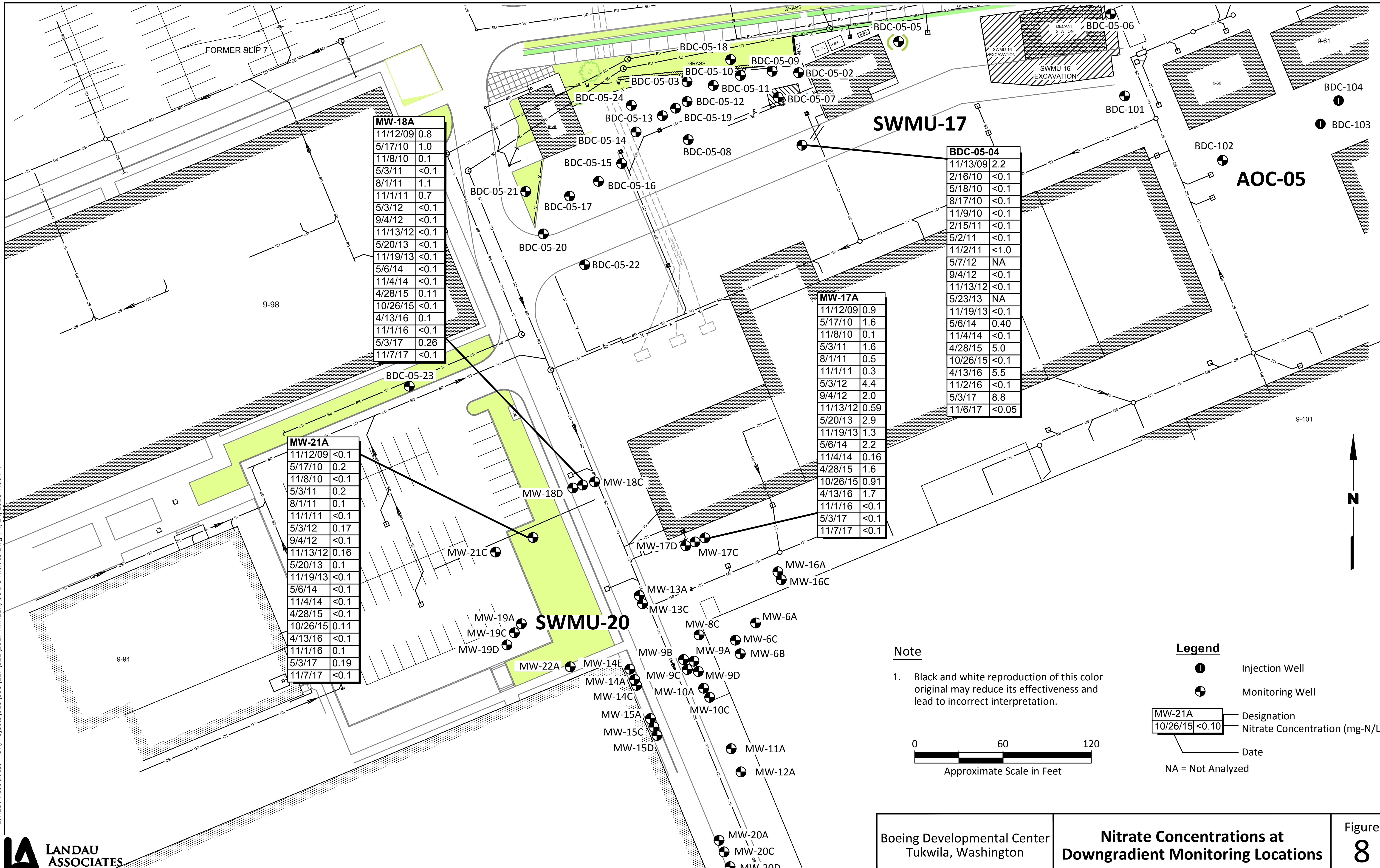
Boeing Developmental Center Tukwila, Washington	**BDC-104 Nitrate, TPH-G, and Benzene Concentrations**	Figure 7



MW-18A	
11/12/09	0.8
5/17/10	1.0
11/8/10	0.1
5/3/11	<0.1
8/1/11	1.1
11/1/11	0.7
5/3/12	<0.1
9/4/12	<0.1
11/13/12	<0.1
5/20/13	<0.1
11/19/13	<0.1
5/6/14	<0.1
11/4/14	<0.1
4/28/15	0.11
10/26/15	<0.1
4/13/16	0.1
11/1/16	<0.1
5/3/17	0.26
11/7/17	<0.1

MW-21A	
11/12/09	<0.1
5/17/10	0.2
11/8/10	<0.1
5/3/11	0.2
8/1/11	0.1
11/1/11	<0.1
5/3/12	0.17
9/4/12	<0.1
11/13/12	0.16
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11/4/14	<0.1
4/28/15	<0.1
10/26/15	0.11
4/13/16	<0.1
11/1/16	0.1
5/3/17	0.19
11/7/17	<0.1

MW-17A	
11/12/09	0.9
5/17/10	1.6
11/8/10	0.1
5/3/11	1.6
8/1/11	0.5
11/1/11	0.3
5/3/12	4.4
9/4/12	2.0
11/13/12	0.59
5/20/13	2.9
11/19/13	1.3
5/6/14	2.2
11/4/14	0.16
4/28/15	1.6
10/26/15	0.91
4/13/16	1.7
11/1/16	<0.1
5/3/17	<0.1
11/7/17	<0.1

BDC-05-04	
11/13/09	2.2
2/16/10	<0.1
5/18/10	<0.1
8/17/10	<0.1
11/9/10	<0.1
2/15/11	<0.1
5/2/11	<0.1
11/2/11	<1.0
5/7/12	NA
9/4/12	<0.1
11/13/12	<0.1
5/23/13	NA
11/19/13	<0.1
5/6/14	0.40
11/4/14	<0.1
4/28/15	5.0
10/26/15	<0.1
4/13/16	5.5
11/2/16	<0.1
5/3/17	8.8
11/6/17	<0.05

Note

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

Legend

Injection Well

Monitoring Well

MW-21A	
10/26/15	<0.10

Designation
Nitrate Concentration (mg-N/L)
Date

NA = Not Analyzed

Landau Associates | G:\Projects\025\093\117\022\2017 Annual\F08 DG Nitrate.dwg | 4/24/2018 4:00 PM

LANDAU ASSOCIATES

Boeing Developmental Center
Tukwila, Washington

Nitrate Concentrations at Downgradient Monitoring Locations

Figure 8

Table 1
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)
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 1
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-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	
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	

Table 1
AOC-05 Clean-Up Action Data Summary
Boeing Developmental Center
Tukwila, Washington

		ORC Injection BDC-103	Pilot Injection BDC-103	Full Scale Injection 1 BDC-103/104	Full Scale Injection 2 BDC-103/104	Full Scale Injection 3 BDC-103/104	Full Scale Injection 4 BDC-103/104	Full Scale Injection 5 BDC-103/104	Full Scale Injection 6 BDC-103	Full Scale Injection 7 BDC-103	Full Scale Injection 8 BDC-103	Full Scale Injection 9 BDC-103	Full Scale Injection 10 BDC-103	Full Scale Injection 11 BDC-103	Volatile Organic Compounds							Aquifer Redox Conditions							Donor Indicators		
		Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	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	
Proposed Groundwater Cleanup Levels (a)															0.8	2.0	1294	1.7	NA	NA	1546										
Well	Date																														Comments
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-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	
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	

Table 1
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	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-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	
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	

Table 1
AOC-05 Clean-Up Action Data Summary
Boeing Developmental Center
Tukwila, Washington

		ORC Injection BDC-103	Pilot Injection BDC-103	Full Scale Injection 1 BDC-103/104	Full Scale Injection 2 BDC-103/104	Full Scale Injection 3 BDC-103/104	Full Scale Injection 4 BDC-103/104	Full Scale Injection 5 BDC-103/104	Full Scale Injection 6 BDC-103	Full Scale Injection 7 BDC-103	Full Scale Injection 8 BDC-103	Full Scale Injection 9 BDC-103	Full Scale Injection 10 BDC-103	Full Scale Injection 11 BDC-103	Volatile Organic Compounds							Aquifer Redox Conditions							Donor Indicators		
		Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	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	
Proposed Groundwater Cleanup Levels (a)															**0.8**	**2.0**	**1294**	**1.7**	**NA**	**NA**	**1546**										
Well	Date																														Comments
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	

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

[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)

(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.

Table 2
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-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

Table 2
Nitrate Concentrations at Downgradient Monitoring Locations
Boeing Developmental Center
Tukwila, Washington

Area	Well	Date		Aquifer Redox Conditions DO (mg/L)	Nitrate (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (mg/L)	ORP (mV)
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-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

DO = dissolved oxygen
mg/L = milligrams per liter
mg-N/L = milligrams per liter as nitrogen
mV = millivolts
ORP = oxidation-reduction potential
Nitrate column bolded for emphasis of target compound. Other results included for aquifer redox evaluation.
[shaded] = not analyzed