

# Technical Memorandum

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**TO:** Mr. Kenneth Thiessen, Oregon Department of Environmental Quality  
Mr. Nick Garson, The Boeing Company

**FROM:** Christine Kimmel, LG; and Clint Jacob, PE, LG

**DATE:** October 17, 2017

**RE:** **Addendum No. 3**  
**Source Area Bioremediation Work Plan**  
**Combined Treatment of TGA Source Wells and Permeable Reactive Barrier**  
**Building 85-001 Former Vapor Degreaser Source Area**  
**Boeing Portland Facility**  
**Project No. 0025116.117**  
**ECSI #13**

## Introduction

This technical memorandum presents Addendum No. 3 to the above-indicated work plan (Landau Associates; LAI 2013) for bioremediation at the Troutdale Groundwater Aquifer (TGA) Former Degreaser Source Area in the northwest portion of Building 85-001 at The Boeing Company (Boeing) Facility in Gresham, Oregon. The Former Degreaser Source Area is an area of the TGA with the highest trichloroethene (TCE) concentrations and has responded favorably to bioremediation, as evidenced by the reduced plume size and the lowering of TCE concentrations to near the cleanup level. This addendum provides procedures to conduct another injection to accelerate TGA remedy cleanup. This addendum describes a fourth injection of electron donor substrate solution (donor solution) to source area wells and a sixth injection to maintain the permeable reactive barrier (PRB) on the downgradient edge of the source area. Two PRB injections, which preceded injection of source wells located closer to and just upgradient of the former vapor degreasers, are described in the prior PRB work plan (LAI 2011) and PRB Addendum No. 1 (LAI 2012). The source area bioremediation work plan (LAI 2013) describes the initial injection to source area wells and presents a combined groundwater monitoring program to monitor the effects of both PRB injection and injection of source area wells. As described in Source Area Bioremediation Work Plan Addendums No. 1 and No. 2 (LAI 2014, 2015), the injection programs for the PRB and source area wells are now a combined bioremediation program for the Former Vapor Degreaser Source Area. This work plan addendum is submitted on behalf of The Boeing Company under the State of Oregon Department of Environmental Quality (ODEQ) Order on Consent (Order) DEQ No. LQSR-NWR-04-12.

This Addendum No. 3 incorporates the previously ODEQ-approved Addendum No. 2 referenced above. Background and detailed information presented in the prior documents are not repeated here.

## Previous Injections Summary and Results

Source area bioremediation consists of a PRB created through the injection of donor solution to well BOP-74(i) and to the seven multiple-purpose source wells [BOP-78(i), BOP-79(i), and BOP-84(i) through BOP-88(i)] located closer to the former vapor degreasers. Table 1 presents a summary of the injection events.

As designed, the PRB injections and injection of the seven multiple-purpose source area wells have resulted in a comingled treatment zone with overlapping radii of injection (ROI) of injected donor. The treatment zone has been further expanded to the north due to downgradient transport of electron donor in a northerly groundwater flow direction. The resulting source and downgradient treatment zone is approximately 140 ft wide (north to south) and 150 to 160 ft thick (east to west). Well locations and the estimated treatment zone are presented on Figure 1.

The progress of the bioremediation remedy within and downgradient of the treatment zone is primarily demonstrated by enhanced dechlorination evidenced by the decrease in trichloroethene (TCE) concentrations and the increase in breakdown daughter products [cis-1,2-dichloroethene (cDCE) and vinyl chloride (VC)], and in non-toxic end products ethane and ethene. This continues to be evident on the time versus concentration plot for BOP-73(i) groundwater presented on Figure 2. Data from monitoring well BOP-73(i) is helpful in understanding the progression of treatment in the source area, as the highest TCE concentrations were consistently detected at this well, the well has not received donor material, and it is centrally located within the extent of source area contamination. Electron donor and enhanced aquifer redox conditions for bioremediation are indicated by increasing total organic carbon (TOC), ferrous iron, sulfide, and methane; and decreasing nitrate and sulfate. Evaluation of ferrous iron and sulfate data must also take into account increases in both due to inclusion of ferrous sulfate in the injection fluid for the July 2014 and June 2015 injections. The most recent evaluation of monitoring results is presented in the 2016 Annual Report and Five-Year Performance Evaluation Report (LAI 2017). The cumulative results through August 2017 are presented in Table 2.

## PRB and Source Well Injection

PRB injection well BOP-74(i) and eight source area wells will be injected in 2017 to continue bioremediation in the source area and downgradient. The prior injection performed in June 2015 was nearly 2.5 years ago and the beneficial effects of that injection event are waning. A primary indicator of the need for an additional injection is the rebound in TCE breakdown products observed in August 2017 at the historically highest-concentration well BOP-73(i). VC chloride increased from 1.9 micrograms per liter ( $\mu\text{g/L}$ ) in May 2017 to 1,200  $\mu\text{g/L}$  in August 2017, and cDCE exhibited a more moderate rebound (1.3  $\mu\text{g/L}$  to 24  $\mu\text{g/L}$ ) over the same period. Complete reductive dechlorination continues at BOP-73(i), as indicated by over 3,000  $\mu\text{g/L}$  of ethene+ethane and continued ethene+ethane predominance on a molar basis (85 percent molar fraction) in August 2017. However, this recent rebound in VC is evidence that continued source zone treatment is needed due to consumption of previously injected substrates.

The 2017 injection will essentially be a repeat of the combined injections completed in 2014 and 2015 (see Table 1), with the addition of injection to BOP-75(i). Injection at BOP-75(i) will increase the width of the treatment zone to the west and address low, but persistent, contaminant concentrations at this well located on the fringe of the source area. Injection solution for the combined injection event will again contain vegetable oil, glycerin, and ferrous sulfate. The total injection solution volume for the combined injection will be approximately 54,300 gallons [same as the June 2015 injection event with the addition of

4,300 gallons for well BOP-75(i)]. The target injection volumes are 20,000 gallons for the PRB well [BOP-74 (i)] and 34,300 gallons for the eight source wells<sup>1</sup>.

Injection substrates will consist of Textrol BR (TBR, a soy bean oil and soy lecithin mix, Solae LLC) and crude glycerin (Cascade Columbia Distribution) as electron donor substrates; and ferrous sulfate (Cascade Columbia Distribution) to stimulate abiotic degradation of TCE and cDCE. Yeast extract will also be included to provide micro-nutrients. The donor solution will consist of tap water mixed with 2.8 percent volume (% vol) TBR, 4.5% vol glycerin, 8.3% vol of 25 percent ferrous sulfate solution (equivalent to 2.1 % weight ferrous sulfate), and 1 pound (lb) of yeast extract per 1,000 gallons of solution. This injection solution design is presented in Table 3.

Each injection well will be injected with a flush of clear water prior to and post-injection. The clear water injections will consist of approximately 200 to 300 gallons for each well.

Mixing and injection will occur at the mixing station near the source area. The mixing station consists of a potable water tap; a 4,000-gallon batch tank; an electric pump (120 volt); a donor staging area; and a multi-well injection manifold. The injection manifold connects to sub-grade conveyance lines leading to the seven multi-purpose injection wells; the PRB well [BOP-74(i)] and added source well BOP-75(i) will be injected through individual hose runs. The 4,000-gallon batch tank will be cleaned thoroughly prior to mixing to remove dried residue of injection fluid from the 2015 injection. To remove potential particulates in the crude glycerin<sup>2</sup>, the mixture of crude glycerin and water will be passed through a bag filter (10-micron), as described below. Secondary containment is provided for the mixing station, as shown on Figure 3.

Injection solution will be mixed in 13 batches in the 4,000-gallon storage tank as follows:

- Mixing tank will be filled with approximately 3,515 gallons of potable water.
- Tank water will be dechlorinated by adding a pond water dechlorinating product containing sodium thiosulfite (Chlor-No-More, [www.PondRX.com](http://www.PondRX.com)) per product directions.
- While recirculating water from the tank through the filter and back to the tank with the electric pump, 0.7 totes (188 gallons) of glycerin will be added using a hose and drop tube extended from the suction side of the pump. A small amount of liquid, food-grade defoaming agent (*NO FOAM* distributed by Wilbur-Ellis) will be added, as needed, to minimize foaming of the injection solution.
- Following addition of glycerin and adequate recirculation for mixing, the tank contents will be injected to the wells, with valves adjusted to bypass the filter. During injection, the following substrates will be added inline to the flow (i.e., metered in on the suction site of the pump); substrates will be added proportionally during the injection period:
  - Approximately 2.5 drums (118 gallons) of TBR. Passing water and TBR together through the pump will create the vegetable oil emulsion for injection. In-line mixing and direct injection minimizes any standing time for the emulsion to coalesce into larger oil droplets. TBR will be added at an approximate rate of 3.2 gallons per 100 gallons of tank mixture.

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<sup>1</sup> These targets are consistent with the June 2015 injection event, when reduced injection flow rates at BOP-74(i) was the reason for redistribution of 10,000 gallons intended for this PRB well to the seven source wells. In 2015, BOP-74(i) received 20,000 gallons and the source area wells received a total of 30,000 gallons.

<sup>2</sup> Soft particles were observed in injection fluid during the 2015 injection that may have been from the crude glycerin or dried flakes of donor residue in the batch tank from prior injections.

- Approximately 1.3 totes (355 gallons) of ferrous sulfate (33% solution). In-line addition of ferrous sulfate prevents settling of fine iron sediments present in the totes. Ferrous sulfate will be added at an approximate rate of 9.6 gallons per 100 gallons of tank mixture.
- 4.2 lbs of yeast extract mixed with water will be added to the ferrous sulfate tote for in-line addition. The yeast extract is added to provide micronutrient to the natural occurring bacteria material.

Precautions will be taken to prevent unplanned leaks of injection fluid. A tank level alarm will be utilized for all tank filling operations. Injection hose Kamlock connections will be strapped closed and the hose will be monitored for leaks. The well seal of injection wells and surrounding floor and any nearby subsurface vaults will be monitored for potential water discharge indicative of injection short-circuiting to the surface. If any potential, minor leaks occur when disconnecting hoses, these will be collected and contained using buckets and a wet/dry vacuum. Potential incidental spills inside the secondary containment due to mixing operations will be cleaned up using the wet/dry vacuum. A spill kit will be set up at the injection location and will contain: cat litter, adsorbent pads, and berming material to contain larger spills.

## Performance Groundwater Monitoring

Performance groundwater monitoring for wells located in and downgradient of the source area will continue on a semiannual basis. Groundwater monitoring parameters will include analysis of chemicals of concern, aquifer redox, and electron donor, as summarized in Table 4.

## Schedule

Injection activities are currently planned to occur in November 2017. Monitoring will continue as regularly scheduled, with semiannual monitoring in February and August.

LANDAU ASSOCIATES, INC.



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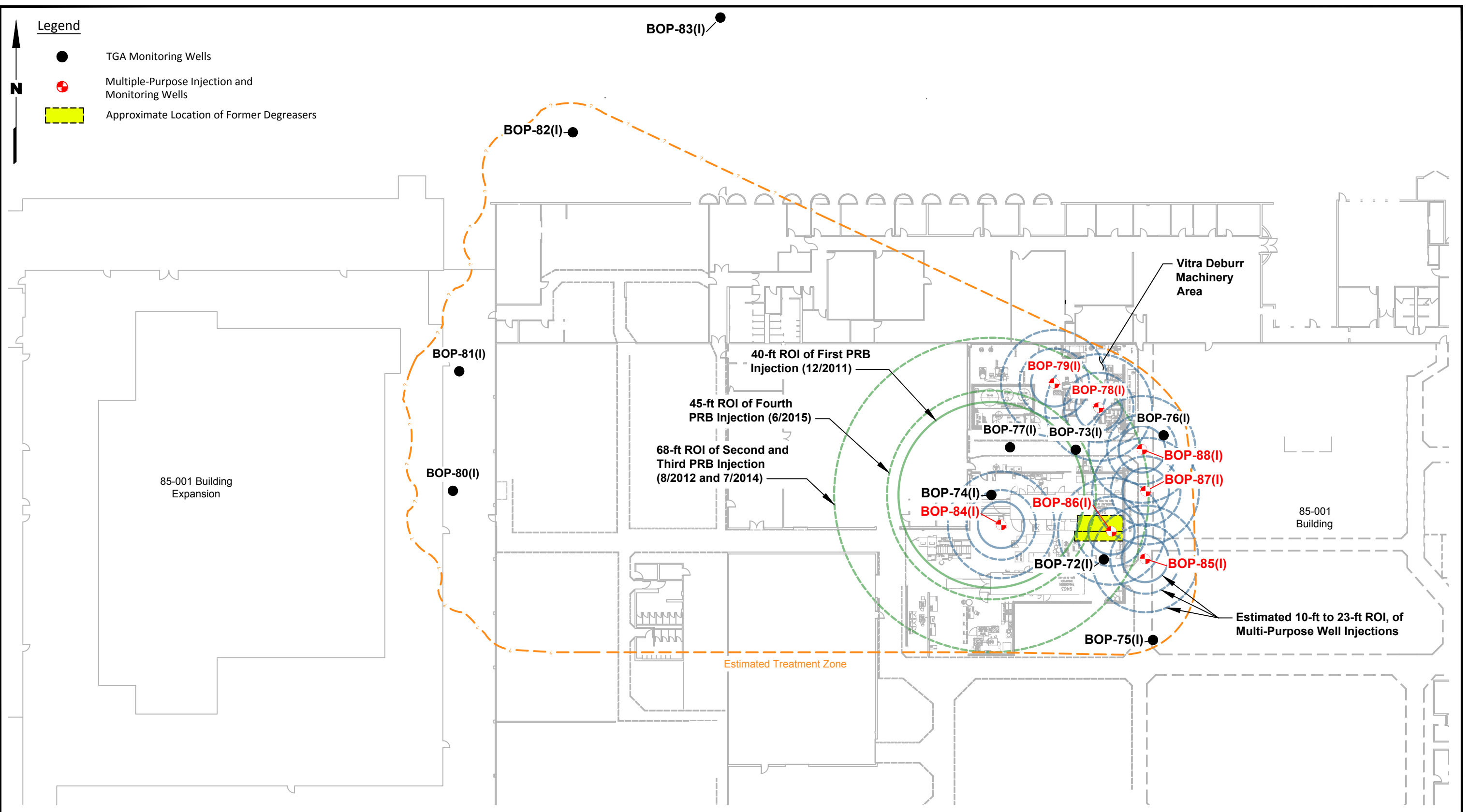
## Attachments

Figure 1	Former Degreaser Source Control Area Bioremediation Injection Wells
Figure 2	Time versus Concentration Plot – BOP-73(i)
Figure 3	Injection and Mixing Station
Table 1	Summary of Injection Events
Table 2	Bioremediation Progress Results
Table 3	Injection Design
Table 4	Bioremediation Monitoring Parameters

## References

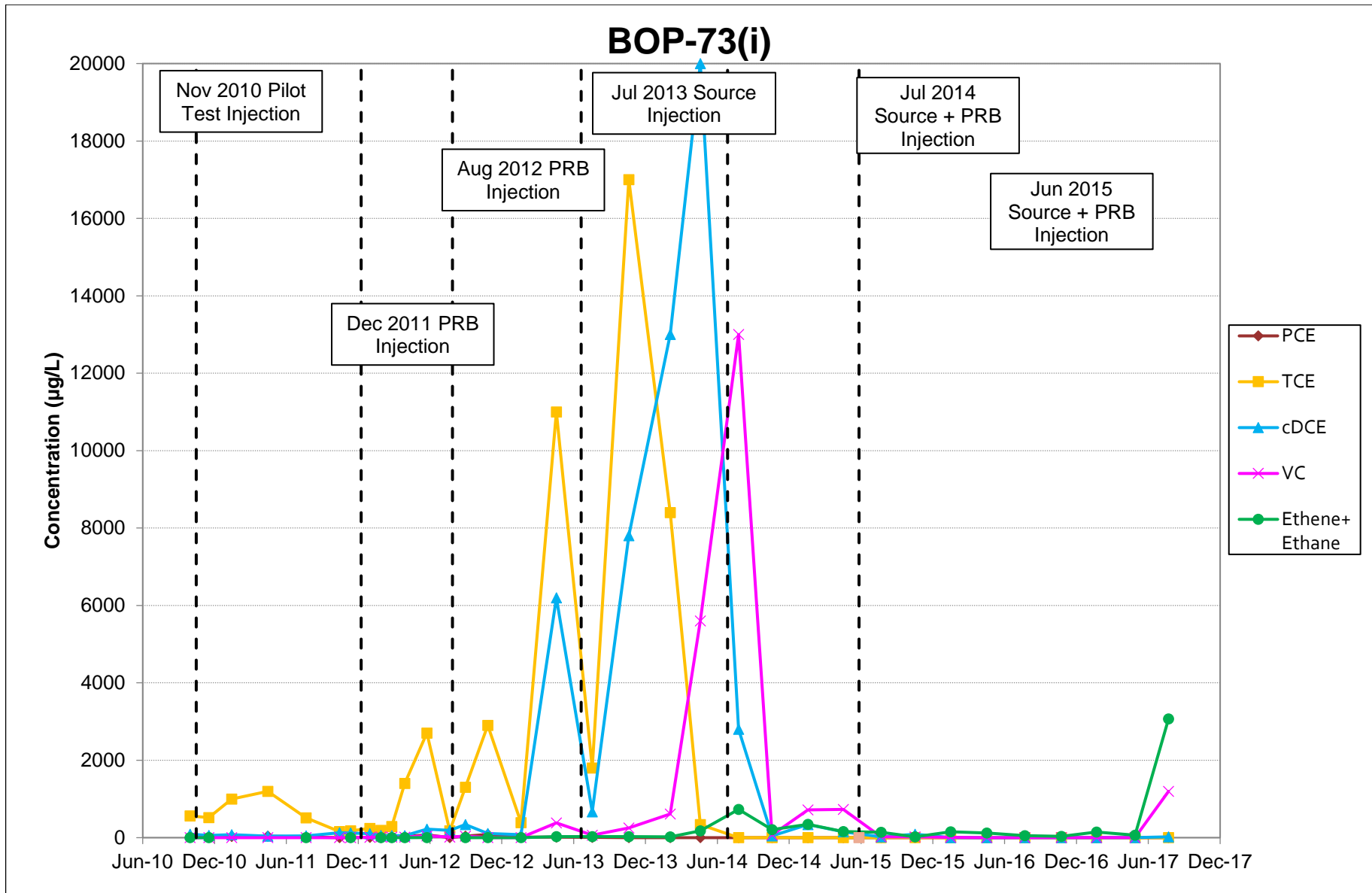
- LAI. 2011. Work Plan, Bioremediation Permeable Reactive Barrier, Building 85-001, Former Degreaser Area, Boeing Portland Facility, Portland, Oregon. Landau Associates, Inc. November 16.
- LAI. 2012. Technical Memorandum: Addendum No. 1, Bioremediation Permeable Reactive Barrier Work Plan, Building 85-001 Former Degreaser Area, Boeing Portland Facility, Portland, Oregon. Clint Jacob PE LG, Christine, Kimmel LG. June 5.
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- LAI. 2015. 2014 Progress and Performance Evaluation, Troutdale Gravel Aquifer, Boeing Portland Facility, Gresham, Oregon. Landau Associates, Inc. March 16.
- LAI. 2017. Troutdale Gravel Aquifer Corrective Measure Five-Year Performance Evaluation 2012-2016, Boeing Portland Facility, Gresham, Oregon. Landau Associates, Inc. April 25.

Landau Associates, Inc. | G:\Projects\025116\116\210\Injection WPI\F01 Former Degreaser.dwg | 10/16/17



Data Source: The Boeing Company

Boeing Portland Gresham, Oregon	<b>Former Degreaser Source Control Area Bioremediation Injection Wells</b>	Figure <b>1</b>
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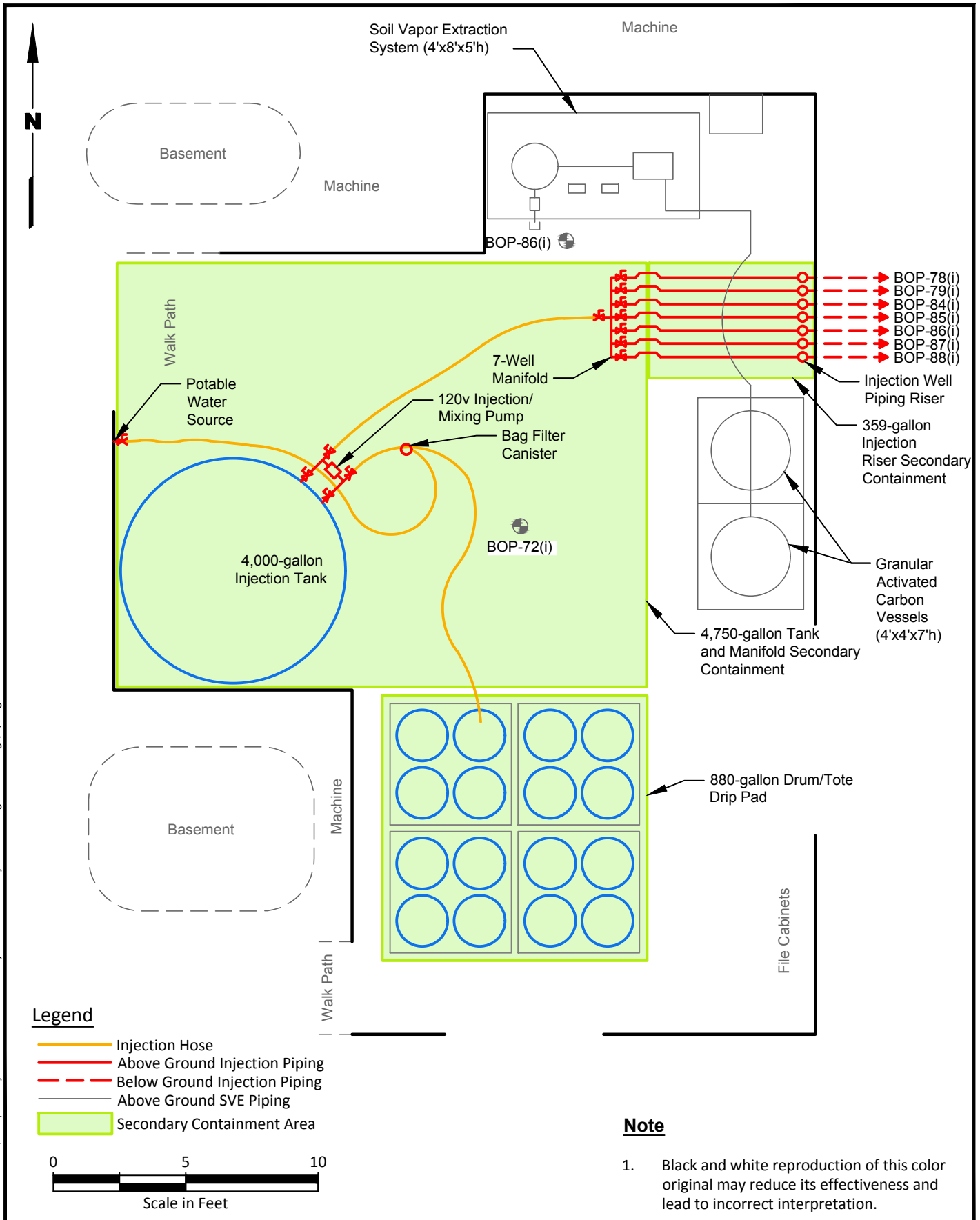
Boeing Portland  
Gresham, Oregon

**Time versus Concentration  
Plot-BOP-73(i)**

Figure  
**2**



Landau Associates, Inc. | G:\Projects\025\116\116\210\Injection WPI\F03 Injection Mixing Station.dwg (A) "Figure 2" 2/22/2017



**Legend**

- Injection Hose
- Above Ground Injection Piping
- - - Below Ground Injection Piping
- Above Ground SVE Piping
- Secondary Containment Area



**Note**

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



Boeing Portland  
Gresham, Oregon

**Injection and Mixing Station**

Figure  
**3**

**Table 1**  
**Summary of Injection Events**  
**Former Degreaser Source Area**  
**Boeing Portland**

Injection Event	Well(s)	Amount of Injection Solution (Electron Donor + Potable Water)
(Pilot Injection) November 2010	BOP-72(i)	900 gallons (LactOil)
(PRB) December 2011	BOP-74(i)	15,000 gallons (LactOil)
(PRB) August 2012	BOP-74(i)	30,000 gallons (LactOil)
(Source Wells) July 2013	BOP-78(i), BOP-79(i), and BOP-84(i) though BOP-88(i)	1,400 gallons (lactOil) per well 9,800 gallons Total - seven source wells
(Source Wells + PRB) July 2014	BOP-74(i) + (seven Source Wells)	20,000 gallons (Glycerin, Ferrous Sulfate, and Textrol BR) – seven source wells 30,000 gallons (Glycerin, Ferrous Sulfate, and Textrol BR) – PRB 50,000 gallons total
(Source Wells + PRB) July 2015	BOP-74(i) + (seven Source Wells)	30,000 gallons (Glycerin, Ferrous Sulfate, and Textrol BR) – seven source wells 20,000 gallons (Glycerin, Ferrous Sulfate, and Textrol BR) – PRB 50,000 gallons total



**Table 2**  
**Bioremediation Progress Results**  
**Former Degreaser Source Area**  
**Boeing Portland**

Well	Date	Elapsed Time from Injections (days)						Comments	VOCs- micromoles/Liter							Molar Fraction									
		Injection (a)	Injection (b)	Injection (c)	Injection (d)	Injection (e)	Injection (f)		PCE	TCE	CIS	VC	Ethene	Ethane	PCE+TCE+cD CE+VC	Max Compound	PCE	TCE	CIS	VC	Ethene	Ethane	E+E for plots	Total	
		Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	Source Zone Wells + PRB Injection																		
BOP-72(i)	10/19/2010	-16							0.02	0.21	0.10	0.00	0.00	0.00	0.33	0.21	0.06	0.64	0.31	0.00	0.00	0.00	0.00	0.00	1.00
Monitoring Well	12/6/2010	32						Light gray, med, no odor	0.00	0.03	0.00	0.00	0.00	0.89	0.18	0.03	0.89	0.00	0.02	0.00	0.00	0.81	0.16	1.00	
BOP-72(i)	2/2/2011	90						Brown, high, sodium lactate odor, no sheen	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	--	--	0.00	
BOP-72(i)	5/5/2011	182						Dark brown color, very high turbidity, strong odor	0.00	0.00	0.06	0.00	0.00	0.00	0.06	0.06	0.00	0.00	0.00	0.00	0.00	--	--	1.00	
BOP-72(i)	8/10/2011	279							0.00	0.00	0.10	0.00	0.00	0.00	0.10	0.10	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00	
BOP-72(i)	11/3/2011	364	-55						0.00	0.00	0.03	0.11	0.00	0.00	0.14	0.11	0.00	0.00	0.22	0.78	--	--	--	1.00	
BOP-72(i)	2/8/2012	461	42					Dark brown, high, malty odor, no sheen, extremely effervescent with HCL	0.00	0.00	0.00	0.12	0.00	0.00	0.12	0.12	0.00	0.00	0.00	1.00	0.00	0.00	--	--	1.00
BOP-72(i)	5/4/2012	547	128					Clear, dark brown, slight "organic" odor no sheen, extremely effervescent	0.00	0.00	0.00	0.14	0.00	0.00	0.14	0.14	0.00	0.00	0.00	1.00	--	--	--	1.00	
BOP-72(i)	8/9/2012	644	225	-7				Clear, low, no odor, no sheen	0.00	0.00	0.00	0.16	0.00	0.00	0.16	0.16	0.00	0.00	0.00	1.00	--	--	--	1.00	
BOP-72(i)	11/8/2012	735	316	84				Clear, colorless, no odor, no sheen	0.00	0.00	0.00	0.08	0.00	0.00	0.08	0.08	0.00	0.00	0.02	0.98	--	--	--	1.00	
BOP-72(i)	2/5/2013	824	405	173					0.00	0.00	0.00	0.05	0.00	0.00	0.06	0.05	0.00	0.00	0.05	0.95	--	--	--	1.00	
BOP-72(i)	5/2/2013	910	491	259	-68			Clear, colorless, no odor, no sheen	0.00	0.00	0.00	0.05	0.00	0.00	0.05	0.05	0.00	0.00	0.04	0.96	--	--	--	1.00	
BOP-72(i)	8/6/2013	1006	587	355	28			Light red-brown, clear, spicy odor, no sheen	0.00	0.00	0.01	0.04	0.18	0.00	0.05	0.18	0.00	0.00	0.03	0.19	0.78	0.00	--	1.00	
BOP-72(i)	11/7/2013	1099	680	448	121			Clear, yellow, effervescent, spicy odor, no sheen	0.00	0.00	0.00	0.03	0.00	0.00	0.03	0.03	0.00	0.00	0.09	0.91	0.00	0.00	--	1.00	
BOP-72(i)	2/5/2014	1189	770	538	211			Clear, low, no odor, no sheen	0.00	0.00	0.00	0.03	0.00	0.00	0.03	0.03	0.00	0.00	0.06	0.94	--	--	--	1.00	
BOP-72(i)	5/7/2014	1280	861	629	302	-70		Clear, low turbidity, no odor, no sheen	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.02	0.00	0.00	0.00	1.00	--	--	--	1.00	
BOP-72(i)	8/13/2014	1378	959	727	400	28		Light brown/yellow, low, no sheen	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.02	0.00	0.00	0.10	0.90	0.00	0.00	--	1.00	
BOP-72(i)	11/6/2014	1463	1044	812	485	113		Light yellow, medium, no odor, no sheen	0.00	0.00	0.00	0.03	0.00	0.00	0.03	0.03	0.00	0.00	0.09	0.91	0.00	0.00	--	1.00	
BOP-72(i)	2/5/2015	1554	1135	903	576	204		Light brown, medium, no odor, no sheen	0.00	0.00	0.01	0.05	0.22	0.00	0.07	0.22	0.00	0.00	0.04	0.18	0.77	0.00	--	1.00	
BOP-72(i)	5/6/2015	1644	1225	993	666	294	-74	Clear, low, no odor, no sheen	0.00	0.02	0.06	0.15	0.00	0.00	0.22	0.15	0.00	0.07	0.26	0.67	0.00	0.00	--	1.00	
BOP-72(i)	8/10/2015	1740	1321	1089	762	390	22	Black flauc, injection odor, no sheen	0.00	0.00	0.00	0.03	0.00	0.00	0.03	0.03	0.00	0.00	0.12	0.88	0.00	0.00	--	1.00	
BOP-72(i)	11/4/2015	1826	1407	1175	848	476	108	Black flauc, medium, no odor, no sheen	0.00	0.00	0.01	0.05	0.00	0.00	0.06	0.05	0.00	0.00	0.20	0.80	0.00	0.00	--	1.00	
BOP-72(i)	2/3/2016	1917	1498	1266	939	567	199	Clear, slight odor, no sheen	0.00	0.00	0.02	0.05	0.00	0.00	0.07	0.05	0.00	0.00	0.30	0.70	0.00	0.00	--	1.00	
BOP-72(i)	5/4/2016	2008	1589	1357	1030	658	290	Clear, veg oil odor, PDB fizzy, no sheen	0.00	0.01	0.02	0.05	0.00	0.00	0.08	0.05	0.00	0.10	0.30	0.60	--	--	--	1.00	
BOP-72(i)	8/9/2016	2105	1686	1454	1127	755	387	Clear, low, veg odor, no sheen	0.00	0.02	0.07	0.08	0.00	0.00	0.17	0.08	0.00	0.12	0.39	0.49	0.00	0.00	--	1.00	
BOP-72(i)	11/10/2016	2198	1779	1547	1220	848	480	Clear, low, some veg odor, slightly fizzy, no sheen	0.00	0.05	0.14	0.05	0.00	0.00	0.24	0.14	0.00	0.21	0.59	0.20	0.00	0.00	--	1.00	
BOP-72(i)	2/7/2017	2287	1868	1636	1309	937	569		0.00	0.04	0.17	0.04	0.00	0.00	0.25	0.17	0.00	0.15	0.67	0.18	0.00	0.00	--	1.00	
BOP-72(i)	5/16/2017	2385	1966	1734	1407	1035	667		0.00	0.01	0.17	0.10	0.00	0.00	0.28	0.17	0.00	0.05	0.59	0.36	0.00	0.00	--	1.00	
BOP-72(i)	8/9/2017	2470	2051	1819	1492	1120	752	Clear, low veg odor, no sheen	0.00	0.01	0.18	0.13	0.00	0.00	0.32	0.18	0.00	0.04	0.54	0.41	0.00	0.00	--	1.00	
BOP-73(i)	10/19/2010	-16							0.07	4.26	0.93	0.00	0.00	0.00	5.26	4.26	0.01	0.81	0.18	0.00	0.00	0.00	0.00	0.00	1.00
Monitoring Well	12/6/2010	32						Slight gray tint, low, no odor	0.11	3.96	0.61	0.00	0.00	0.00	4.68	3.96	0.02	0.85	0.13	0.00	0.00	0.00	0.00	0.00	1.00
BOP-73(i)	2/2/2011	90						gray, moderately turbid, no smell, no sheen	0.22	7.61	0.80	0.00	0.00	0.00	8.64	7.61	0.03	0.88	0.09	0.00	--	--	--	1.00	
BOP-73(i)	5/5/2011	182						Light brown, medium-high turbidity, TPH odor, little sheen	0.26	9.13	0.43	0.00	0.00	0.00	9.83	9.13	0.03	0.93	0.04	0.00	--	--	--	1.00	
BOP-73(i)	8/10/2011	279							0.11	3.88	0.50	0.00	0.00	0.00	4.49	3.88	0.02	0.87	0.11	0.00	0.00	0.00	0.00	1.00	
BOP-73(i)	11/3/2011	364							0.03	1.22	1.34	0.00	0.00	0.00	2.59	1.34	0.01	0.47	0.52	0.00	--	--	--	1.00	
BOP-73(i)	12/1/2011	392	-27					gray, moderate, no odor, no sheen	0.03	1.37	1.24	0.00	0.00	0.00	2.64	1.37	0.01	0.52	0.47	0.00	0.00	0.00	0.00	1.00	
BOP-73(i)	1/19/2012	441	22					Cloudy, gray, high turbidity, slight H2S odor, no sheen	0.05	1.83	1.03	0.19	0.00	0.00	3.10	1.83	0.02	0.59	0.33	0.06	--	--	--	1.00	
BOP-73(i)	2/16/2012	469	50					Cloudy, gray, medium turbidity, no odor, no sheen	0.02	1.45	0.61	0.38	0.00	0.00	2.46	1.45	0.01	0.59	0.25	0.16	0.00	0.00	0.00	1.00	
BOP-73(i)	3/15/2012	497	78					Cloudy, med turbidity, slight H2D odor, no sheen	0.04	2.21	0.55	0.21	0.00	0.00	3.00	2.21	0.01	0.74	0.18	0.07	0.00	0.00	0.00	1.00	
BOP-73(i)	4/17/2012	530	111					Clear, low turbidity, no odor, no sheen	0.16	10.66	0.52	0.22	0.00	0.00	11.55	10.66	0.01	0.92	0.04	0.02	0.00	0.00	0.00	1.00	
BOP-73(i)	6/12/2012	586	167					Slightly cloudy, low turbidity, no odor, no sheen	0.43	20.55	2.27	0.72	0.10	0.00	23.97	20.55	0.02	0.85	0.09	0.03	0.00	0.00	0.00	1.00	
BOP-73(i)	8/9/2012	644	225	-7				Clear, low, no odor, no sheen	0.01	1.37	1.96	0.21	0.00	0.00	3.55	1.96	0.00	0.39	0.55	0.06	--	--	--	1.00	
BOP-73(i)	9/18/2012	684	265	33				Slightly cloudy, low turbidity, slight H2S odor, no sheen	0.25	9.89	3.51	0.61	0.00	0.00	14.26	9.89	0.02	0.69	0.25	0.04	0.00	0.00	0.00	1.00	
BOP-73(i)	11/14/2012	741	322	90				Clear, low turbidity, slight BO odor, no sheen	0.50	22.07	1.13	0.04	0.00	0.00	23.75	22.07	0.02	0.93	0.05	0.00	0.00	0.00	0.00	1.00	
BOP-73(i)	2/6/2013	825	406	174				Clear w/trace sediment, low turbidity, no odor, no sheen	0.08	2.97	0.79	0.08	0.00	0.00	3.92	2.97	0.02	0.76	0.20	0.02	0.00	0.00	0.00	1.00	
BOP-73(i)	5/7/2013	915	496	264	-63			Slightly cloudy, gray, stale odor, no sheen	0.10	83.72	63.95	6.08	1.03	0.00	153.85	83.72	0.00	0.54	0.41	0.04	0.01	0.00	0.01	1.00	
BOP-73(i)	8/6/2013	1006	587	355	28			Clear, colorless, slight bio odor, no sheen	0.04	13.70	6.91	1.04	0.96	0.00	21.69	13.70	0.00	0.60	0.31	0.05	0.04	0.00	0.04	1.00	
BOP-73(i)	11/7/2013	1099	680	448	121			Clear, colorless, bio odor, no sheen	0.00	129.39	80														

**Table 2**  
**Bioremediation Progress Results**  
**Former Degreaser Source Area**  
**Boeing Portland**

Well	Date	Elapsed Time from Injections (a) (days)	Elapsed Time from Injection (b) (days)	Elapsed Time from Injection (c) (days)	Elapsed Time from Injection (d) (days)	Elapsed Time from Injection (e) (days)	Elapsed Time from Injection (f) (days)	Volatile Organic Compounds Analytical Results										Fermentation Product		Aquifer Redox Conditions								Donor Indicators							
								Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	Source Zone Wells + PRB Injection	PCE (µg/L)	TCE (µg/L)	CIS (µg/L)	VC (µg/L)	Carbon Tet (µg/L)	Chloro-form (µg/L)	Carbon Disulfide (µg/L)	Meth Chloride (µg/L)	Ethene (µg/L)	Ethane (µg/L)	E+E for plots (µg/L)	Acetylene (µg/L)	2-Butanone (µg/L)	Acetone (µg/L)	DO (mg/L)	ORP (mV)	Nitrate (mg/L)	Iron II (mg/L)	Iron, Tot (mg/L)	Iron, Diss (mg/L)	Sulfate (mg/L)	Sulfide (mg/L)
BOP-74(i)	5/5/2011	182						2.0	26	8.0	<1.0	<1.0	<1.0	<2.0	--	--	--	--	<5.0	<10	0.25	56.5	--	--	--	--	--	--	--	--	--	--	--	--	6.23
BOP-74(i)	8/10/2011	279						<1.0	8.9	7.2	<1.0	<1.0	<1.0	<2.0	<1.1	<1.2	--	<1.1	<5.0	<10	0.50	-124.9	<0.1	2.0	--	--	6.6	--	4.3	2.69	6.42				
BOP-74(i)	11/3/2011	364						<1.0	3.1	16	<1.0	<1.0	<1.0	<2.0	--	--	--	--	<5.0	<10	0.10	-21.2	--	--	--	--	--	--	--	--	--	--	6.46		
BOP-74(i)	12/1/2011	392	-27					<1.0	8.6	17	<1.0	<1.0	<1.0	<2.0	<1.1	<1.2	--	<1.1	<5.0	<10	0.01	-302.2	<0.1	1.6	--	--	6.7	--	1.8	3.03	7.03				
BOP-74(i)	1/19/2012	441	22					<1.0	11	18	<1.0	<1.0	1.2	<1.0	<2.0	<1.1	1.6	--	<1.1	62	24	0.21	-170	<1.0	2.0	--	--	<1.0	--	2.6	1450	5.48			
BOP-74(i)	2/16/2012	469	50					<1.0	2.4	44	1.6	<1.0	<1.0	<1.0	<2.0	<1.1	<1.2	--	<1.1	70	43	0.93	-154	<0.5	3.8	--	--	<0.5	--	6.68	668	5.23			
BOP-74(i)	3/15/2012	497	78					<1.0	1.4	210	3.2	<1.0	<1.0	<1.0	<2.0	<1.1	<1.2	--	<1.1	41	23	0.10	-244	<0.5	4.8	--	--	<0.5	--	8.41	330	6.40			
BOP-74(i)	4/17/2012	530	111					<5.0	<5.0	79	50	<5.0	<5.0	<5.0	<1.0	<1.1	<1.2	--	<1.1	32	<5.0	0.13	-276.9	<0.1	1.8	--	--	0.8	--	8.8	72.0	6.83			
BOP-74(i)	6/12/2012	586	167					<1.0	<1.0	1.2	14	<1.0	<1.0	<1.0	<2.0	<1.1	<1.2	--	<1.1	23	20	0.72	-9.9	<0.1	4.8	--	--	<0.1	--	5.72	67.6	5.78			
BOP-74(i)	8/9/2012	644	225	-7				<1.0	<1.0	<1.0	1.9	<1.0	<1.0	<2.0	--	--	--	--	<5.0	<10	--	--	--	--	--	--	--	--	--	--	--	--			
BOP-74(i)	9/19/2012	685	266	34				<0.2	4.5	60	2.9	<0.2	<0.2	<0.5	0.9	<5.0	<5.0	--	<5.0	23	17	1.20	18.0	<0.10	4.0	--	--	<1.0	--	13	1280	4.86			
BOP-74(i)	11/14/2012	741	322	90				<0.2	0.6	6.9	18	<0.2	<0.2	<0.5	<0.5	<5.0	<7.0	--	<5.0	<5.0	6.1	5.92	93.6	<0.10	4.0	--	--	<1.0	--	22	145	5.96			
BOP-74(i)	2/6/2013	825	406	174				<0.2	0.5	1.7	2.9	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0	--	<5.0	21	29	0.28	-21.3	<0.10	5.0	--	--	<1.0	--	27	83.7	6.15			
BOP-74(i)	5/7/2013	915	496	264	-63			<0.2	4.0	2.7	1.8	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0	--	<5.0	5.7	9.7	1.21	-53.0	<0.10	3.0	--	--	<1.0	--	21	128	6.04			
BOP-74(i)	8/6/2013	1006	587	355	28			<0.2	0.6	14	8.1	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0	--	<5.0	5.1	26	2.35	-25.0	<0.10	3.5	--	--	<1.0	--	26	669	5.07			
BOP-74(i)	11/7/2013	1099	680	448	121			<0.2	<0.2	3.6	1.6	<0.2	<0.2	<0.5	<0.5	7.3	<5.0	--	<5.0	6.5	1.49	95.6	<0.10	3.5	--	--	<1.0	--	17	330	6.05				
BOP-74(i)	2/20/2014	1204	785	553	226			<0.2	<0.2	2.4	0.9	<0.2	<0.2	<0.5	<0.5	<5.0	5.0	--	<5.0	7.1	24	0.92	-71.6	<0.10	6.0	--	--	<1.0	--	22	66.2	6.37			
BOP-74(i)	5/8/2014	1281	862	630	303	-69		<0.2	<0.2	2.8	3.3	<0.2	<0.2	<0.5	<0.5	5.9	<5.0	--	<5.0	5.0	24	1.15	-33.7	<0.10	3.0	--	--	<1.0	--	19	32.8	6.58			
BOP-74(i)	11/6/2014	1463	1044	812	485	113		<0.2	0.3	11	2.1	<0.2	0.8	<0.5	2.2	<5.0	<5.0	--	<5.0	9.9	46	0.12	-134.5	0.63	7.0	592	578	501	10.5	21	2860	4.16			
BOP-74(i)	2/6/2015	1555	1136	904	577	205		<0.2	0.4	15	1.9	<0.2	<0.2	<0.5	1.4	<5.0	<5.0	--	<5.0	29	61	0.23	-95.9	0.54	7.0	291	317	626	4.0	21	2230	4.86			
BOP-74(i)	5/6/2015	1644	1225	993	666	294	-74	<0.2	0.5	15	1.6	<0.2	<0.2	0.6	0.7	<5.0	<5.0	--	<5.0	22	29	0.79	-107.6	0.27	7.0	228	226	247	9.0	1240	4.92				
BOP-74(i)	11/4/2015	1826	1407	1175	848	476	108	<0.2	<0.2	5.3	2.9	<0.2	3.1	0.5	1.0	--	--	--	<5.0	<5.0	--	--	--	--	--	--	--	--	--	--	--	--			
BOP-74(i)	2/3/2016	1917	1498	1266	939	567	199	<0.2	<0.2	11	3.1	<0.2	2.6	0.8	0.8	<5.0	<5.0	--	<5.0	32	<5.0	1.68	60.4	<1.0	7.0	964	961	1460	5.1	21	4200	5.5			
BOP-74(i)	5/4/2016	2008	1589	1357	1030	658	290	<0.2	0.2	11	2.6	<0.2	2.5	0.6	0.8	<5.0	<5.0	--	<5.0	57	<5.0	0.52	-21.6	<1.0	7.0	534.0	482.0	601.0	31.9	19.0	2480	4.57			
BOP-74(i)	8/9/2016	2105	1686	1454	1127	755	387	<0.2	0.2	11	1.6	<0.2	2.0	0.6	0.8	<5.0	<5.0	--	<5.0	58	65	--	-36.9	0.45	7.0	443	493	453	5.4	18	1840	4.72			
BOP-74(i)	11/10/2016	2198	1779	1547	1220	848	480	<0.2	0.2	9.9	1.3	<0.2	1.7	0.7	0.8	<5.0	<5.0	--	<5.0	36	21	0.34	-9.0	0.16	7.0	264	311	225	7.5	22	1430	4.87			
BOP-74(i)	2/7/2017	2288	1869	1637	1310	938	570	<0.2	0.2	8.7	1.3	<0.2	1.2	0.6	1.2	<5.0	<5.0	--	<5.0	33	88	0.33	-18.1	0.24	7.0	322	365	110	58.9	23	1690	5.00			
BOP-74(i)	5/16/2017	2385	1966	1734	1407	1035	667	<0.2	<0.2	7.5	1.1	<0.2	0.9	1	1.2	<5.0	<5.0	--	<5.0	200	250	0.39	-35.7	0.26	2.0	414	388	147	13.2	28	1580	5.04			
BOP-74(i)	8/9/2017	2471	2052	1820	1493	1121	753	<0.2	<0.2	7.1	1	<0.2	0.7	0.7	1.3	<5.0	<5.0	--	<5.0	44	80	0.4	-22.3	0.19	7.0	272	283	42.2	10.3	23	1310	5.0			
BOP-75(i)	2/2/2011	90						2.5	87	11	<1.0	<1.0	<1.0	<1.0	<2.0	--	--	--	<5.0	<10	--	--	--	--	--	--	--	--	--	--	--	--			
Upgradient Well	5/5/2011	182						1.1	52	11	<1.0	<1.0	<1.0	<1.0	<2.0	--	--	--	<5.0	<10	--	--	--	--	--	--	13.5	--	--	4.77	--				
BOP-75(i)	8/10/2011	279						1.6	59	11	<1.0	<1.0	<1.0	<1.0	<2.0	<1.1	<1.2	--	<1.1	<5.0	<10	1.76	-16.3	1.1	2.4	--	--	<0.0007	--	6.24	--				
BOP-75(i)	11/3/2011	364	-55					1.2	58	10	<1.0	<1.0	<1.0	<1.0	<2.0	--	--	--	<5.0	<10	--	--	--	--	--	--	--	--	--	--	--	--			
BOP-75(i)	2/8/2012	461	42					1.3	55	9.7	<1.0	<1.0	<1.0	<1.0	<2.0	--	--	--	<5.0	<10	--	--	--	--	--	--	--	--	--	--	--	--			
BOP-75(i)	5/4/2012	547	128					<1.0	52	10	<1.0	<1.0	<1.0	<1.0	<2.0	--	--	--	<5.0	<10	--	--	--	--	--	--	--	--	--	--	--	--			
BOP-75(i)	8/9/2012	644	225	-7				1.6	39	7.2	<1.0	<1.0	<1.0	<1.0	<2.0	--	--	--	<5.0	<10	--	--	--	--	--	--	--	--	--	--	--	--			
BOP-75(i)	11/8/2012	735	316	84				1.0	35	6.9	<0.2	<0.2	0.4	<0.5	<0.5	--	--	--	<5.0	<5.0	--	--	--	--	--	--	--	--	--	--	--	--			
BOP-75(i)	2/5/2013	824	405	173				1.0	54	9.5	<0.2	<0.2	0.3	<0.5	<0.5	--	--	--	<5.0	15	--	--	--	--	--	--	--	--	--	--	--	--			
BOP-75(i)	5/2/2013	910	491	259				0.8	42	7.5	<0.2	<0.2	0.2	<0.5	<0.5	--	--	--	<5.0	9.8	--	--	--	--	--	--	--	--	--	--	--	--			
BOP-75(i)	6/17/2013	956	537	305	-22			0.7	35	9.8	<0.2	<0.2	0.3	<0.5	<0.5	<5.0	<5.0	--	<5.0	14	1.91	73.6	1.7	0.0	--	--	13.6	--	<0.005	2.3	6.25				
BOP-75(i)	8/6/2013	1006	587	355	28			0.2	1.3	37	0.2	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0	--	<5.0	19	2.32	-159.5	<0.10	3.0	--	--	<1.0	--	0.39	51.3	6.43				
BOP-75(i)	11/7/2013	1099	680	448	121			<0.2	2.2	2.4	25	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0	--	<5.0	9.7	0.77	-167.0	<0.10	3.5	--	--	4.5	--	12	5.5	6.55				
BOP-75(i)	2/5/2014	1189	770	538	211			<0.2	2.6	1.3	18	<0.2	<0.2	<0.5	<0.5	--	--	--	<5.0	10	--	--	--	--	--	--	--	--	--	--	--	--			
BOP-75(i)	5/7/2014	1280	861	629	302	-70		<0.2	7.4	2.7	14	<0.2	<0.2	<0.5	<0.5	--	--	--	<5.0	22	--	--	--	--	--	--	--	--	--	--	--	--			
BOP-75(i)	8/13/2014	1378	959	727	400	28		<0.2	6.2	9.5	10	<0.2	<0.2</																						

**Table 2**  
**Bioremediation Progress Results**  
**Former Degreaser Source Area**  
**Boeing Portland**

Well	Date	Elapsed Time						Comments	VOCs- micromoles/Liter							Molar Fraction								
		from Injections (a) (days)	from Injection (b) (days)	from Injection (c) (days)	from Injection (d) (days)	from Injection (e) (days)	from Injection (f) (days)		PCE	TCE	CIS	VC	Ethene	Ethane	PCE+TCE+cD CE+VC	Max Compound	PCE	TCE	CIS	VC	Ethene	Ethane	E+E for plots	Total
		Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	Source Zone Wells + PRB Injection																	
BOP-74(i)	5/5/2011	182						Light brown color, medium-high turbidity, slight odor	0.01	0.20	0.08	0.00	0.00	0.00	0.29	0.20	0.04	0.68	0.28	0.00	0.00	0.00		1.00
BOP-74(i)	8/10/2011	279							0.00	0.07	0.07	0.00	0.00	0.00	0.14	0.07	0.00	0.48	0.52	0.00	0.00	0.00		1.00
BOP-74(i)	11/3/2011	364							0.00	0.02	0.17	0.00	0.00	0.00	0.19	0.17	0.00	0.13	0.87	0.00	--	--		1.00
BOP-74(i)	12/1/2011	392	-27					Gray, moderate, no odor, no sheen	0.00	0.07	0.18	0.00	0.00	0.00	0.24	0.18	0.00	0.27	0.73	0.00	0.00	0.00		1.00
BOP-74(i)	1/19/2012	441	22					Yellow, cloudy, med turbidity, floating colloids, slight H2S /veg oil odor, no	0.00	0.08	0.19	0.00	0.00	0.05	0.27	0.19	0.00	0.26	0.58	0.00	0.00	0.16		1.00
BOP-74(i)	2/16/2012	469	50					Yellowish, cloudy, high turbidity, rotten cheese odor, emulsion (fizz), no	0.00	0.02	0.45	0.03	0.00	0.00	0.50	0.45	0.00	0.04	0.91	0.05	0.00	0.00		1.00
BOP-74(i)	3/15/2012	497	78					Brownish cloudy, high turbidity, rotten eggs/smelly veg oil odor, no sheen	0.00	0.01	2.17	0.05	0.00	0.00	2.23	2.17	0.00	0.00	0.97	0.02	0.00	0.00		1.00
BOP-74(i)	4/17/2012	530	111					Brown, high turbidity, no sheen, rotten veg oil odor	0.00	0.00	0.81	0.80	0.00	0.00	1.61	0.81	0.00	0.00	0.50	0.50	0.00	0.00		1.00
BOP-74(i)	6/12/2012	586	167					gray, cloudy, silty, high turbidity, rotten oil odor, no sheen	0.00	0.00	0.01	0.22	0.00	0.00	0.24	0.22	0.00	0.00	0.05	0.95	0.00	0.00		1.00
BOP-74(i)	8/9/2012	644	225	-7				Clear, low, no odor, no sheen	0.00	0.00	0.00	0.03	0.00	0.00	0.03	0.03	0.00	0.00	1.00	--	--		1.00	
BOP-74(i)	9/19/2012	685	266	34				Light gray, clear, strong veg odor, slight gray sheen	0.00	0.03	0.62	0.05	0.00	0.00	0.70	0.62	0.00	0.05	0.88	0.07	0.00	0.00		1.00
BOP-74(i)	11/14/2012	741	322	90				Cloudy with yellow hue, medium turbidity, strong BO odor, no sheen	0.00	0.00	0.07	0.29	0.00	0.00	0.36	0.29	0.00	0.01	0.20	0.79	0.00	0.00		1.00
BOP-74(i)	2/6/2013	825	406	174				cloudy, med turbidity, BO odor, no sheen	0.00	0.00	0.02	0.05	0.00	0.00	0.07	0.05	0.00	0.06	0.26	0.68	0.00	0.00		1.00
BOP-74(i)	5/7/2013	915	496	264	-63			Slightly cloudy, light gray, stale odor, slight froth, sheen	0.00	0.030	0.028	0.029	0.00	0.00	0.09	0.03	0.00	0.35	0.32	0.33	0.00	0.00		1.00
BOP-74(i)	8/6/2013	1006	587	355	28			Light gray, slightly cloudy, strong bio odor, frothy sheen on purge water	0.00	0.005	0.14	0.130	0.00	0.00	0.28	0.14	0.00	0.02	0.52	0.47	0.00	0.00		1.00
BOP-74(i)	11/7/2013	1099	680	448	121			Clear, colorless, bio odor, no sheen	0.00	0.000	0.04	0.026	0.26	0.00	0.06	0.26	0.00	0.00	0.11	0.08	0.81	0.00		1.00
BOP-74(i)	2/20/2014	1204	785	553	226			Clear, med, veg oil odor, no sheen	0.00	0.000	0.02	0.014	0.00	0.17	0.04	0.17	0.00	0.00	0.12	0.07	0.00	0.81		1.00
BOP-74(i)	5/8/2014	1281	862	630	303	-69		Clear, low turbidity, slight H2S odor, no sheen	0.00	0.000	0.03	0.053	0.21	0.00	0.08	0.21	0.00	0.00	0.10	0.18	0.72	0.00		1.00
BOP-74(i)	11/6/2014	1463	1044	812	485	113		Yellow, high, thick veg oil, sheen present	0.00	0.002	0.11	0.034	0.00	0.00	0.15	0.11	0.00	0.02	0.76	0.22	0.00	0.00		1.00
BOP-74(i)	2/6/2015	1555	1136	904	577	205		Clear, medium, veg odor, veg sheen	0.00	0.003	0.15	0.030	0.00	0.00	0.19	0.15	0.00	0.02	0.82	0.16	0.00	0.00		1.00
BOP-74(i)	5/6/2015	1644	1225	993	666	294	-74	Light brown/yellow, veg odor, veg sheen	0.00	0.004	0.15	0.026	0.00	0.00	0.18	0.15	0.00	0.02	0.84	0.14	0.00	0.00		1.00
BOP-74(i)	11/4/2015	1826	1407	1175	848	476	108	Brown, veggie oil, veggie smell	0.00	0.000	0.05	0.046	0.00	0.00	0.10	0.05	0.00	0.00	0.54	0.46	--	--		1.00
BOP-74(i)	2/3/2016	1917	1498	1266	939	567	199	Oil rich, veg odor, veg sheen, medium	0.00	0.000	0.11	0.050	0.00	0.00	0.16	0.11	0.00	0.00	0.70	0.30	0.00	0.00		1.00
BOP-74(i)	5/4/2016	2008	1589	1357	1030	658	290	Light yellow, low, veg oil/sheen	0.00	0.002	0.11	0.042	0.00	0.00	0.16	0.11	0.00	0.01	0.72	0.27	--	--		1.00
BOP-74(i)	8/9/2016	2105	1686	1454	1127	755	387	Very oil rich lact oil, veg odor, veg sheen, yellow-red	0.00	0.002	0.11	0.026	0.00	0.00	0.14	0.11	0.00	0.01	0.81	0.18	0.00	0.00		1.00
BOP-74(i)	11/10/2016	2198	1779	1547	1220	848	480	Light yellow, low-med, veg odor/sheen	0.00	0.002	0.10	0.021	0.00	0.00	0.12	0.10	0.00	0.01	0.82	0.17	0.00	0.00		1.00
BOP-74(i)	2/7/2017	2288	1869	1637	1310	938	570		0.00	0.002	0.09	0.021	0.00	0.00	0.11	0.09	0.00	0.01	0.80	0.19	0.00	0.00		1.00
BOP-74(i)	5/16/2017	2385	1966	1734	1407	1035	667		0.00	0.000	0.08	0.018	0.00	0.00	0.09	0.08	0.00	0.00	0.81	0.19	0.00	0.00		1.00
BOP-74(i)	8/9/2017	2471	2052	1820	1493	1121	753	Fizzy PDB, light yellow medium-low turbidity, veg odor, veg sheen	0.00	0.000	0.07	0.016	0.00	0.00	0.09	0.07	0.00	0.00	0.82	0.18	0.00	0.00		1.00
BOP-75(i)	2/2/2011	90						Clear, non turbid, no smell, no sheen	0.02	0.66	0.11	0.00	0.00	0.00	0.79	0.66	0.02	0.84	0.14	0.00	--	--		1.00
Upgradient Well	5/5/2011	182						Clear, low, no odor, no sheen	0.01	0.40	0.11	0.00	0.00	0.00	0.52	0.40	0.01	0.77	0.22	0.00	--	--		1.00
BOP-75(i)	8/10/2011	279							0.01	0.45	0.11	0.00	0.00	0.00	0.57	0.45	0.02	0.78	0.20	0.00	0.00	0.00		1.00
BOP-75(i)	11/3/2011	364	-55						0.01	0.44	0.10	0.00	0.00	0.00	0.55	0.44	0.01	0.80	0.19	0.00	--	--		1.00
BOP-75(i)	2/8/2012	461	42					Clear, colorless, no odor, no sheen	0.01	0.42	0.10	0.00	0.00	0.00	0.53	0.42	0.01	0.80	0.19	0.00	--	--		1.00
BOP-75(i)	5/4/2012	547	128						0.00	0.40	0.10	0.00	0.00	0.00	0.50	0.40	0.00	0.79	0.21	0.00	--	--		1.00
BOP-75(i)	8/9/2012	644	225	-7				Clear, low, no odor, no sheen	0.01	0.30	0.07	0.00	0.00	0.00	0.38	0.30	0.03	0.78	0.20	0.00	--	--		1.00
BOP-75(i)	11/8/2012	735	316	84				Clear, colorless, no odor, no sheen	0.01	0.27	0.07	0.00	0.00	0.00	0.34	0.27	0.02	0.78	0.21	0.00	--	--		1.00
BOP-75(i)	2/5/2013	824	405	173					0.01	0.41	0.10	0.00	0.00	0.00	0.52	0.41	0.01	0.80	0.19	0.00	--	--		1.00
BOP-75(i)	5/2/2013	910	491	259				Clear, colorless, no odor, no sheen	0.00	0.32	0.08	0.00	0.00	0.00	0.40	0.32	0.01	0.80	0.19	0.00	--	--		1.00
BOP-75(i)	6/17/2013	956	537	305	-22				0.00	0.27	0.10	0.00	0.00	0.00	0.37	0.27	0.01	0.72	0.27	0.00	0.00	0.00		1.00
BOP-75(i)	8/6/2013	1006	587	355	28			Clear, colorless, slight veg oil (bio) odor, no sheen	0.00	0.01	0.38	0.00	0.00	0.00	0.40	0.38	0.00	0.02	0.96	0.01	0.00	0.00		1.00
BOP-75(i)	11/7/2013	1099	680	448	121			Clear, colorless, strong sulfur odor, no sheen	0.00	0.02	0.02	0.40	0.00	0.00	0.44	0.40	0.00	0.04	0.06	0.91	0.00	0.00		1.00
BOP-75(i)	2/5/2014	1189	770	538	211			Clear, low, no odor, no sheen	0.00	0.02	0.01	0.29	0.00	0.00	0.32	0.29	0.00	0.06	0.04	0.90	--	--		1.00
BOP-75(i)	5/7/2014	1280	861	629	302	-70		Clear, low turbidity, no odor, no sheen	0.00	0.06	0.03	0.22	0.00	0.00	0.31	0.22	0.00	0.18	0.09	0.73	--	--		1.00
BOP-75(i)	8/13/2014	1378	959	727	400	28		Clear/light gray	0.00	0.05	0.10	0.16	0.00	0.00	0.31	0.16	0.00	0.15	0.32	0.52	0.00	0.00		1.00
BOP-75(i)	11/5/2014	1462	1043	811	484	112		Clear, low, no odor, no sheen	0.00	0.00	0.04	0.18	0.00	0.00	0.22	0.18	0.00	0.00	0.20	0.80	--	--		1.00
BOP-75(i)	2/6/2015	1555	1136	904	577	205		Clear, low, no odor, no sheen	0.00	0.07	0.09	0.07	0.00	0.00	0.23	0.09	0.00	0.31	0.39	0.30	0.00	0.00		1.00
BOP-75(i)	5/4/2015	1642	1223	991	664	292	-76	Clear, low, no odor, no sheen	0.00	0.10	0.07	0.07	0.00	0.00	0.23	0.10	0.00							

**Table 2**  
**Bioremediation Progress Results**  
**Former Degreaser Source Area**  
**Boeing Portland**

Well	Date	Elapsed Time from Injections (a) (days)		Elapsed Time from Injections (b) (days)		Elapsed Time from Injections (c) (days)		Elapsed Time from Injections (d) (days)		Elapsed Time from Injections (e) (days)		Elapsed Time from Injections (f) (days)		Volatile Organic Compounds Analytical Results										Fermentation Product		Aquifer Redox Conditions										Donor Indicators	
		Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	Source Zone Wells + PRB Injection	PCE (µg/L)	TCE (µg/L)	CIS (µg/L)	VC (µg/L)	Carbon Tet (µg/L)	Chloro-form (µg/L)	Carbon Disulfide (µg/L)	Meth Chloride (µg/L)	Ethene (µg/L)	Ethane (µg/L)	E+E for plots (µg/L)	Acetylene (µg/L)	2-Butanone (µg/L)	Acetone (µg/L)	DO (mg/L)	ORP (mV)	Nitrate (mg/L)	Iron II (mg/L)	Iron, Tot (mg/L)	Iron, Diss (mg/L)	Sulfate (mg/L)	Sulfide (mg/L)	Methane (b) (mg/L)	TOC (mg/L)	pH					
BOP-76(i)	5/2/2013	910	491	259			1.4	22	1.7	<0.2	<0.2	1.7	<0.5	<0.5	--	--	--	--	<5.0	14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
BOP-76(i)	6/17/2013	956	537	305	-22		1.1	26	1.9	<0.2	<0.2	1.8	<0.5	<0.5	<5.0	<5.0	--	--	<5.0	15	1.34	75.5	3.7	0.0	--	--	11.0	--	<0.005	1.6	6.18						
BOP-76(i)	8/6/2013	1006	587	355	28		<0.2	1.0	100	8.3	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0	--	--	<5.0	23	2.24	-130.0	<0.10	3.5	--	--	<1.0	--	3.4	111	6.14						
BOP-76(i)	11/7/2013	1099	680	448	121		2.4	140	37	42	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0	--	--	<5.0	13	1.51	-204.2	<0.10	3.5	--	--	3.5	--	11	6.9	6.44						
BOP-76(i)	2/5/2014	1189	770	538	211		1.0	45	5.8	8.5	<0.2	<0.2	<0.5	<0.5	--	--	--	--	<5.0	7.8	--	--	--	--	--	--	--	--	--	--	--	--	--				
BOP-76(i)	5/7/2014	1280	861	629	302	-70	<0.2	7.2	1.2	4.6	<0.2	0.2	<0.5	<0.5	--	--	--	--	<5.0	30	--	--	--	--	--	--	--	--	--	--	--	--	--	--			
BOP-76(i)	8/13/2014	1378	959	727	400	28	0.3	13	24	4.1	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0	--	--	<5.0	15	25	0.45	1.8	<0.10	7.0	--	--	3.2	--	7.6	170	5.27					
BOP-76(i)	11/6/2014	1463	1044	812	485	113	<0.2	1.4	9.5	2.1	<0.2	<0.2	<0.5	<0.5	15	<5.0	--	--	<5.0	25	0.20	-104.7	0.20	1.5	14.4	14.5	3.2	<2.0	21	51.2	5.88						
BOP-76(i)	2/5/2015	1554	1135	903	576	204	<0.2	1.0	7.0	2.2	<0.2	<0.2	<0.5	<0.5	30	<5.0	--	--	<5.0	24	0.23	-154.7	0.21	2.75	10.1	8.99	5.1	<2.0	19	12.7	6.08						
BOP-76(i)	5/7/2015	1645	1226	994	667	295	<0.2	0.6	6.6	3.9	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0	--	--	<5.0	42	1.52	-124.1	<0.10	4.0	17.0	14	5.5	2.2	20	7.5	6.14						
BOP-76(i)	8/10/2015	1740	1321	1089	762	390	<0.2	2.2	14	2.0	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0	--	--	<5.0	8.0	42	0.43	-190.8	<0.10	7.0	126.0	121	108	6.0	12	659	5.54					
BOP-76(i)	11/4/2015	1826	1407	1175	848	476	<0.2	0.9	14	2.0	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0	--	--	<5.0	16	0.83	-86.1	<0.10	7.0	26.2	28	4.0	2.7	15	115	6.15						
BOP-76(i)	2/3/2016	1917	1498	1266	939	567	<0.2	1.0	9.8	1.6	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0	--	--	<5.0	53	1.13	-85.0	<0.10	7.0	14.6	8.01	6.3	3.9	16	5.0	7.16						
BOP-76(i)	5/4/2016	2008	1589	1357	1030	658	<0.2	0.5	10	3.8	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0	--	--	<5.0	17	8.65	-227.8	<0.10	7.0	11.7	9.91	4.5	3.1	18	26.4	6.15						
BOP-76(i)	8/9/2016	2105	1686	1454	1127	755	<0.2	1.1	11	4.2	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0	--	--	<5.0	56	0.81	-136.0	<0.10	7.0	9.40	7.15	6.7	<2.0	14	7.8	6.13						
BOP-76(i)	11/10/2016	2198	1779	1547	1220	848	<0.2	3.5	7.4	2.5	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0	--	--	<5.0	33	0.40	-31.5	<0.10	7.0	9.19	8.88	21.9	<2.0	14	3.4	6.14						
BOP-76(i)	2/7/2017	2287	1868	1636	1309	937	<0.2	4.8	4.6	1.8	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0	--	--	<5.0	75	0.57	-0.4	<0.10	7.0	10.9	7.54	21.2	<2.0	12	4.1	6.31						
BOP-76(i)	5/16/2017	2385	1966	1734	1407	1035	<0.2	2.1	5.3	2.5	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0	--	--	<5.0	<5.0	0.75	-12.1	<0.10	3.0	11.4	10.5	17.8	<2.0	17	4.6	6.29						
BOP-76(i)	8/9/2017	2470	2051	1819	1492	1120	<0.2	1.7	5.1	2.5	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0	--	--	<5.0	<5.0	1.0	-51.5	<0.10	7.0	12.7	11.5	16.6	<2.0	13	4.6	6.1						
BOP-77(i)	2/2/2011	90					1.7	88	2.7	<1.0	<1.0	<1.0	<1.0	<2.0	--	--	--	--	<5.0	<10	--	--	--	--	--	--	--	--	--	--	--	--	--	--			
Monitoring Well	5/5/2011	182					<1.0	41	3.8	<1.0	<1.0	<1.0	<1.0	<2.0	--	--	--	--	<5.0	<10	--	--	--	--	--	--	--	--	--	--	--	--	--	--			
BOP-77(i)	8/10/2011	279					1.8	17	1.6	<1.0	<1.0	1.3	<1.0	<2.0	--	--	--	--	<5.0	<10	--	--	--	--	--	--	--	--	--	--	--	--	--	--			
BOP-77(i)	11/3/2011	364					<1.0	11	6.7	<1.0	<1.0	<1.0	<1.0	<2.0	--	--	--	--	<5.0	<10	--	--	--	--	--	--	--	--	--	--	--	--	--	--			
BOP-77(i)	12/1/2011	392	-27				1.1	32	7.1	<1.0	<1.0	<1.0	<1.0	<2.0	<1.1	<1.2	--	--	<5.0	<10	0.0	-274.8	0.2	0.8	--	--	8.4	--	<0.0007	2.41	6.77						
BOP-77(i)	12/28/2011	419	0				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	12100	--			
BOP-77(i)	12/28/2011	419	0				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	13800	--			
BOP-77(i)	1/19/2012	441	22				<20	21	<20	<20	<20	<20	<20	<40	--	--	--	--	170	<200	1.09	-154.4	<1.0	2.1	--	--	4.0	--	--	3800	5.40						
BOP-77(i)	2/16/2012	469	50				<1.0	8.4	48	1.8	<1.0	<1.0	<1.0	<2.0	<1.1	<1.2	--	--	<5.0	49	42	0.58	-154.4	<0.5	5.0	--	--	<0.5	--	6.6	884	5.69					
BOP-77(i)	3/15/2012	497	78				<1.0	2.2	120	4.6	<1.0	<1.0	<1.0	<2.0	<1.1	<1.2	--	--	<5.0	64	64	0.72	-261.9	<0.5	4.4	--	--	<0.5	--	10	148	6.96					
BOP-77(i)	4/17/2012	530	111				<3.0	<3.0	21	62	<3.0	<3.0	<3.0	<6.0	<1.1	<1.2	--	--	<5.0	35	40	0.40	-274.5	<0.1	5.6	--	--	0.6	--	12.2	208	7.12					
BOP-77(i)	6/12/2012	586	167				<1.0	1.4	1.2	60	<1.0	<1.0	<1.0	<2.0	<1.1	<1.2	--	--	<5.0	54	35	0.67	-50.4	<0.1	4.3	--	--	<0.1	--	0.314	314	6.36					
BOP-77(i)	8/9/2012	644	225				<1.0	<1.0	<1.0	59	<1.0	<1.0	<1.0	<2.0	--	--	--	--	<5.0	6.1	<10	--	--	--	--	--	--	--	--	--	--	--	--	--			
BOP-77(i)	8/16/2012	651	232				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	23,800	--	--			
BOP-77(i)	9/18/2012	684	265	33			<4.0	<4.0	28	4.1	<4.0	<4.0	<10	<5.0	<5.0	<5.0	<5.0	880	<100	0.78	25.8	<0.50	3.8	--	--	6.3	--	9.2	4670	4.66							
BOP-77(i)	11/14/2012	741	322	90			<0.2	17	150	15	<0.2	<0.2	<0.5	1.5	<5.0	<6.0	--	--	<5.0	9.7	1.49	160.5	<1.0	3.5	--	--	<10.0	--	22	2270	5.66						
BOP-77(i)	2/6/2013	825	406	174			<0.4	11	31	3.2	<0.4	<0.4	<1.0	<1.0	5.5	<5.0	--	--	<5.0	83	190	0.35	6.4	<0.10	2.5	--	--	4.1	--	15	1136	5.76					
BOP-77(i)	5/7/2013	915	496	264	-63		<0.2	18	17	11	<0.2	<0.2	<0.5	<0.5	13	<5.0	--	--	<5.0	7.5	9.7	1.52	-74.9	<0.10	2.5	--	--	<1.0	--	23	112	6.15					
BOP-77(i)	8/6/2013	1006	587	355	28		<0.2	0.7	14	13	<0.2	<0.2	<0.5	0.5	8.6	<5.0	--	--	<5.0	7.2	29	1.14	-44.3	<0.10	3.5	--	--	<1.0	--	17	888	5.38					
BOP-77(i)	11/7/2013	1099	680	448	121		<0.2	<0.2	9.5	19	<0.2	<0.2	<0.5	<0.5	22	<5.0	--	--	<5.0	7.0	0.91	-106.7	<0.10	3.5	--	--	<1.0	--	20	111	6.21						
BOP-77(i)	2/20/2014	1204	785	553	226		<0.2	2.7	6.1	7.6	<0.2	<0.2	<0.5	<0.5	22	<5.0	--	--	<5.0	10	1.14	-8.9	<0.10	3.5	--	--	<1.0	--	19	40	6.29						
BOP-77(i)	5/8/2014	1281	862	630	303	-69	<0.2	0.2	5.1	14	<0.2	<0.2	<0.5	<0.5	58	6.4	--	--	<5.0	<5.0	0.76	-16.4	<0.10	3.0	--	--	<1.0	--	23	36.4	6.41						
BOP-77(i)	8/13/2014	1378	959	727	400	28	<0.2	0.6	81	17	<0.2	<0.2	<0.5	1.7	24	<5.0	--	--	<5.0	14	0.88	71.4	<0.50	6.0	--	--	2750	--	15	10100	4.32						
BOP-77(i)	11/6/2014	1463	1044	812	485	113	<0.2	2.7	200	24	<0.2	<0.2	<0.5	1.0	63	<5.0	--	--	<5.0	5.8	28	0.17	-165.8	<0.50	7.0	961	981	1850	11.3	22	4920						

**Table 2**  
**Bioremediation Progress Results**  
**Former Degreaser Source Area**  
**Boeing Portland**

Well	Date	Elapsed Time from Injections (days)						Source Zone Wells	Source Zone Wells + PRB	Source Zone Wells + PRB	Comments	VOCs- micromoles/Liter							Molar Fraction								
		Injection (a)	Injection (b)	Injection (c)	Injection (d)	Injection (e)	Injection (f)					PCE	TCE	CIS	VC	Ethene	Ethane	PCE+TCE+cD CE+VC	Max Compound	PCE	TCE	CIS	VC	Ethene	Ethane	E+E for plots	Total
		Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone 1st Injection	Source Zone Wells + PRB Injection	Source Zone Wells + PRB Injection																				
BOP-76(i)	5/2/2013	910	491	259							Clear, colorless, no odor, no sheen	0.01	0.17	0.02	0.00	0.00	0.00	0.19	0.17	0.04	0.87	0.09	0.00	--	--		1.00
BOP-76(i)	6/17/2013	956	537	305	-22						Clear, colorless, no odor, no sheen	0.01	0.20	0.02	0.00	0.00	0.00	0.22	0.20	0.03	0.88	0.09	0.00	0.00	0.00		1.00
BOP-76(i)	8/6/2013	1006	587	355	28						Gray, slightly cloudy, slight bio odor, no sheen	0.00	0.01	1.03	0.13	0.00	0.00	1.17	1.03	0.00	0.01	0.88	0.11	0.00	0.00		1.00
BOP-76(i)	11/7/2013	1099	680	448	121						Clear, colorless, strong sulfur odor, no sheen	0.01	1.07	0.38	0.67	0.00	0.00	2.13	1.07	0.01	0.50	0.18	0.31	0.00	0.00		1.00
BOP-76(i)	2/5/2014	1189	770	538	211						Clear, low, no odor, no sheen	0.01	0.34	0.06	0.14	0.00	0.00	0.54	0.34	0.01	0.63	0.11	0.25	--	--		1.00
BOP-76(i)	5/7/2014	1280	861	629	302	-70					Clear, low turbidity, no odor, no sheen	0.00	0.05	0.01	0.07	0.00	0.00	0.14	0.07	0.00	0.39	0.09	0.52	--	--		1.00
BOP-76(i)	8/13/2014	1378	959	727	400	28					Clear/light gray, low turbidity, oil sheen, slight bio odor	0.00	0.10	0.25	0.07	0.00	0.00	0.41	0.25	0.00	0.24	0.60	0.16	0.00	0.00		1.00
BOP-76(i)	11/6/2014	1463	1044	812	485	113					Clear, medium, veg odor, veg sheen	0.00	0.01	0.10	0.03	0.53	0.00	0.14	0.53	0.00	0.02	0.14	0.05	0.79	0.00		1.00
BOP-76(i)	2/5/2015	1554	1135	903	576	204					Gray, high, veg odor (slight), no sheen	0.00	0.01	0.07	0.04	1.07	0.00	0.12	1.07	0.00	0.01	0.06	0.03	0.90	0.00		1.00
BOP-76(i)	5/7/2015	1645	1226	994	667	295	-73				Gray high/black, veg odor, veg sheen	0.00	0.00	0.07	0.06	0.00	0.00	0.14	0.07	0.00	0.03	0.50	0.46	0.00	0.00		1.00
BOP-76(i)	8/10/2015	1740	1321	1089	762	390	22				Slightly black, low, veg odor, no sheen	0.00	0.02	0.14	0.03	0.00	0.00	0.19	0.14	0.00	0.09	0.75	0.17	0.00	0.00		1.00
BOP-76(i)	11/4/2015	1826	1407	1175	848	476	108				Black flauc, low, veg odor, no sheen	0.00	0.01	0.14	0.03	0.00	0.00	0.18	0.14	0.00	0.04	0.79	0.17	0.00	0.00		1.00
BOP-76(i)	2/3/2016	1917	1498	1266	939	567	199				Clear, black flac, slight odor, no sheen	0.00	0.01	0.10	0.03	0.00	0.00	0.13	0.10	0.00	0.06	0.75	0.19	0.00	0.00		1.00
BOP-76(i)	5/4/2016	2008	1589	1357	1030	658	290				Clear, black flac, veg odor, no sheen	0.00	0.00	0.10	0.06	0.00	0.00	0.17	0.10	0.00	0.02	0.61	0.36	--	--		1.00
BOP-76(i)	8/9/2016	2105	1686	1454	1127	755	387				Clear, black flecks, veg odor, no sheen	0.00	0.01	0.11	0.07	0.00	0.00	0.19	0.11	0.00	0.04	0.60	0.36	0.00	0.00		1.00
BOP-76(i)	11/10/2016	2198	1779	1547	1220	848	480				Clear, low, some odor, no sheen	0.00	0.03	0.08	0.04	0.00	0.00	0.14	0.08	0.00	0.19	0.53	0.28	0.00	0.00		1.00
BOP-76(i)	2/7/2017	2287	1868	1636	1309	937	569					0.00	0.04	0.05	0.03	0.00	0.00	0.11	0.05	0.00	0.32	0.42	0.26	0.00	0.00		1.00
BOP-76(i)	5/16/2017	2385	1966	1734	1407	1035	667					0.00	0.02	0.05	0.04	0.00	0.00	0.11	0.05	0.00	0.14	0.49	0.36	0.00	0.00		1.00
BOP-76(i)	8/9/2017	2470	2051	1819	1492	1120	752				Clear, low, no odor, no sheen	0.00	0.01	0.05	0.04	0.00	0.00	0.11	0.05	0.00	0.12	0.50	0.38	0.00	0.00		1.00
BOP-77(i)	2/2/2011	90									Clear, non turbid, no smell, no sheen	0.01	0.67	0.03	0.00	0.00	0.00	0.71	0.67	0.01	0.95	0.04	0.00	--	--		1.00
Monitoring Well	5/5/2011	182									Clear, low, no odor, no sheen	0.00	0.31	0.04	0.00	0.00	0.00	0.35	0.31	0.00	0.89	0.11	0.00	--	--		1.00
BOP-77(i)	8/10/2011	279										0.01	0.13	0.02	0.00	0.00	0.00	0.16	0.13	0.07	0.83	0.11	0.00	--	--		1.00
BOP-77(i)	11/3/2011	364										0.00	0.08	0.07	0.00	0.00	0.00	0.15	0.08	0.00	0.55	0.45	0.00	--	--		1.00
BOP-77(i)	12/1/2011	392	-27								Dark gray, high, no odor, no sheen	0.01	0.24	0.07	0.00	0.00	0.00	0.32	0.24	0.02	0.75	0.23	0.00	0.00	0.00		1.00
BOP-77(i)	12/28/2011	419	0								Yellow, completely Donor Substrate (veg oil), 1 batch of DS injected ~5,000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	--	--	--	--	--	--		0.00
BOP-77(i)	12/28/2011	419	0								Brown-yellow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	--	--	--	--	--	--		0.00
BOP-77(i)	1/19/2012	441	22								Cloudy, yellow, med-high turbidity, veg oil odor, no sheen	0.00	0.16	0.00	0.00	0.00	0.00	0.16	0.16	0.00	1.00	0.00	0.00	--	--		1.00
BOP-77(i)	2/16/2012	469	50								Cloudy, gray, emulsion (fizz), medium turbidity, rotten cheese odor	0.00	0.06	0.50	0.03	0.00	0.00	0.59	0.50	0.00	0.11	0.84	0.05	0.00	0.00		1.00
BOP-77(i)	3/15/2012	497	78								Cloudy, med/high turbidity, veg oil/H2S odor, no sheen	0.00	0.02	1.24	0.07	0.00	0.00	1.33	1.24	0.00	0.01	0.93	0.06	0.00	0.00		1.00
BOP-77(i)	4/17/2012	530	111								Cloudy/yellowish, med-high turbidity, no sheen, rotten veg oil odor	0.00	0.00	0.22	0.99	0.00	0.00	1.21	0.99	0.00	0.00	0.18	0.82	0.00	0.00		1.00
BOP-77(i)	6/12/2012	586	167								Cloudy, low/med turbidity, slight veg oil odor, no sheen	0.00	0.01	0.01	0.96	0.00	0.00	0.98	0.96	0.00	0.01	0.01	0.98	0.00	0.00		1.00
BOP-77(i)	8/9/2012	644	225								Clear, low, no odor, no sheen	0.00	0.00	0.00	0.94	0.00	0.00	0.94	0.94	0.00	0.00	0.00	1.00	--	--		1.00
BOP-77(i)	8/16/2012	651	232									--	--	--	--	--	--	--	--	--	--	--	--	--	--		--
BOP-77(i)	9/18/2012	684	265	33							Cloudy, yellowish, high turbidity, rotten veg oil odor, emulsion visible, no	0.00	0.00	0.29	0.07	0.00	0.00	0.35	0.29	0.00	0.00	0.81	0.19	0.00	0.00		1.00
BOP-77(i)	11/14/2012	741	322	90							Cloudy, slight yellow hue, medium turbidity, fizzy, strong BO odor, no sheen	0.00	0.13	1.55	0.24	0.00	0.00	1.92	1.55	0.00	0.07	0.81	0.13	0.00	0.00		1.00
BOP-77(i)	2/6/2013	825	406	174							Cloudy, yellowish hue, med turbidity, BO odor, no sheen	0.00	0.08	0.32	0.05	0.20	0.00	0.45	0.32	0.00	0.13	0.49	0.08	0.30	0.00		1.00
BOP-77(i)	5/7/2013	915	496	264	-63						Slightly cloudy, gray, stale odor, no sheen	0.00	0.14	0.175	0.176	0.46	0.00	0.49	0.46	0.00	0.14	0.184	0.185	0.49	0.00		1.00
BOP-77(i)	8/6/2013	1006	587	355	28						Gray, slightly cloudy, strong bio odor, slight sheen on purge water, slight	0.00	0.01	0.144	0.208	0.31	0.00	0.36	0.31	0.00	0.01	0.217	0.313	0.46	0.00		1.00
BOP-77(i)	11/7/2013	1099	680	448	121						Clear, colorless, bio odor, no sheen, slightly effervescent	0.00	0.00	0.098	0.304	0.78	0.00	0.40	0.78	0.00	0.00	0.083	0.256	0.66	0.00		1.00
BOP-77(i)	2/20/2014	1204	785	553	226						Clear, low, no odor, no sheen	0.00	0.02	0.063	0.122	0.78	0.00	0.21	0.78	0.00	0.02	0.064	0.123	0.79	0.00		1.00
BOP-77(i)	5/8/2014	1281	862	630	303	-69					Clear, low turbidity, slight H2S odor, no sheen	0.00	0.00	0.053	0.224	2.07	0.21	0.28	2.07	0.00	0.00	0.021	0.088	0.81	0.08		1.00
BOP-77(i)	8/13/2014	1378	959	727	400	28					Milky brown, high turbidity, no sheen, bio odor	0.00	0.00	0.836	0.272	0.86	0.00	1.11	0.86	0.00	0.00	0.42	0.138	0.43	0.00		1.00
BOP-77(i)	11/6/2014	1463	1044	812	485	113					Light yellow, high, veg oil odor, sheen present	0.00	0.02	2.063	0.384	2.25	0.00	2.47	2.25	0.00	0.00	0.44	0.081	0.48	0.00		1.00
BOP-77(i)	2/6/2015	1555	1136	904	577	205					Light yellow, low/med, veg odor, veg sheen	0.00	0.03	1.238	0.384	2.07	0.00	1.65	2.07	0.00	0.01	0.33	0.103	0.56	0.00		1.00
BOP-77(i)	5/6/2015	1644	1225	993	666	294	-74				Light yellow, cloudy, low, veg odor, veg sheen	0.00	0.05	2.269	0.320	1.											



**Table 2**  
**Bioremediation Progress Results**  
**Former Degreaser Source Area**  
**Boeing Portland**

Well	Date	Elapsed Time from Injections (days)						Comments	VOCs- micromoles/Liter							Molar Fraction									
		Injection (a)	Injection (b)	Injection (c)	Injection (d)	Injection (e)	Injection (f)		PCE	TCE	CIS	VC	Ethene	Ethane	PCE+TCE+cD CE+VC	Max Compound	PCE	TCE	CIS	VC	Ethene	Ethane	E+E for plots	Total	
		Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	Source Zone Wells + PRB Injection																		
BOP-78(i)	11/6/2015	1828	1409	1177	850	478	110	Clear, low, fizzy, veg odor, no sheen	0.00	0.002	0.03	0.022	0.00	0.00	0.06	0.03	0.00	0.03	0.57	0.40	--	--		1.00	
BOP-78(i)	2/4/2016	1918	1499	1267	940	568	200		0.00	0.002	0.04	0.035	0.00	0.00	0.08	0.04	0.00	0.03	0.54	0.44	--	--		1.00	
BOP-78(i)	5/5/2016	2009	1590	1358	1031	659	291		0.00	0.003	0.10	0.098	0.00	0.00	0.20	0.10	0.00	0.01	0.51	0.48	--	--		1.00	
BOP-78(i)	8/8/2016	2104	1685	1453	1126	754	386	Clear, low, veg odor, no sheen, fizzy	0.00	0.007	0.25	0.208	0.00	0.00	0.46	0.25	0.00	0.01	0.54	0.45	--	--		1.00	
BOP-78(i)	11/4/2016	2193	1774	1542	1215	843	475		0.00	0.005	0.12	0.120	0.00	0.00	0.25	0.12	0.00	0.02	0.50	0.48	--	--		1.00	
BOP-78(i)	2/8/2017	2288	1869	1637	1310	938	570		0.00	0.005	0.10	0.176	0.00	0.00	0.28	0.18	0.00	0.02	0.36	0.62	--	--		1.00	
BOP-78(i)	5/16/2017	2386	1967	1735	1408	1036	668		0.00	0.005	0.09	0.176	0.00	0.00	0.27	0.18	0.00	0.02	0.33	0.65	--	--		1.00	
BOP-78(i)	8/9/2017	2471	2052	1820	1493	1121	753		0.00	0.010	0.17	0.288	0.00	0.00	0.46	0.29	0.00	0.02	0.36	0.62	--	--		1.00	
BOP-79(i)	11/21/2011	382	-37					Clear, colorless, no odor or sheen	0.01	0.32	0.05	0.00	0.00	0.00	0.38	0.32	0.03	0.84	0.13	0.00	--	--		1.00	
Injection Well	8/9/2012	644	225	-7				Clear, colorless, no odor or sheen	0.01	0.72	0.12	0.00	0.00	0.00	0.86	0.72	0.02	0.84	0.14	0.00	--	--		1.00	
BOP-79(i)	11/8/2012	735	316	84				Clear, colorless, slight bio odor, no sheen	0.00	0.00	0.04	1.09	0.00	0.00	1.13	1.09	0.00	0.00	0.03	0.96	--	--		1.00	
BOP-79(i)	2/6/2013	825	406	174					0.00	0.00	0.01	0.09	0.00	0.00	0.10	0.09	0.00	0.02	0.06	0.92	--	--		1.00	
BOP-79(i)	5/2/2013	910	491	259	-68			Clear, colorless, no odor or sheen	0.00	0.00	0.25	0.66	0.00	0.00	0.91	0.66	0.00	0.00	0.27	0.72	--	--		1.00	
BOP-79(i)	8/7/2013	1007	588	356	29				0.00	0.01	0.38	0.32	0.00	0.00	0.71	0.38	0.00	0.01	0.54	0.45	--	--		1.00	
BOP-79(i)	11/8/2013	1100	681	449	122			Clear, colorless, bio odor, no sheen	0.00	0.01	0.13	0.26	0.00	0.00	0.40	0.26	0.00	0.04	0.33	0.63	--	--		1.00	
BOP-79(i)	2/5/2014	1189	770	538	211			Clear, low, no odor, no sheen	0.00	0.03	0.18	0.12	0.00	0.00	0.32	0.18	0.00	0.08	0.55	0.36	--	--		1.00	
BOP-79(i)	5/7/2014	1280	861	629	302	-70		Clear, low turbidity, no odor, no sheen	0.01	0.44	0.44	0.24	0.00	0.00	1.13	0.44	0.00	0.39	0.39	0.21	--	--		1.00	
BOP-79(i)	11/7/2014	1464	1045	813	486	114			0.00	0.01	0.22	0.09	0.00	0.00	0.32	0.22	0.00	0.04	0.68	0.28	--	--		1.00	
BOP-79(i)	2/5/2015	1554	1135	903	576	204		Clear, low, no odor, no sheen	0.00	0.02	0.10	0.06	0.00	0.00	0.18	0.10	0.00	0.09	0.57	0.34	--	--		1.00	
BOP-79(i)	5/4/2015	1642	1223	991	664	292	-76	Clear, low, veg odor/sheen	0.00	0.00	0.02	0.03	0.00	0.00	0.06	0.03	0.00	0.05	0.39	0.55	--	--		1.00	
BOP-79(i)	11/6/2015	1828	1409	1177	850	478	110	Clear, low, fizzy, veg odor, no sheen	0.00	0.00	0.09	0.07	0.00	0.00	0.16	0.09	0.00	0.02	0.55	0.43	--	--		1.00	
BOP-79(i)	2/4/2016	1918	1499	1267	940	568	200		0.00	0.00	0.05	0.06	0.00	0.00	0.11	0.06	0.00	0.03	0.44	0.53	--	--		1.00	
BOP-79(i)	5/5/2016	2009	1590	1358	1031	659	291		0.00	0.00	0.04	0.06	0.00	0.00	0.10	0.06	0.00	0.04	0.38	0.58	--	--		1.00	
BOP-79(i)	8/8/2016	2104	1685	1453	1126	754	386	Clear, low, veg odor, no sheen	0.00	0.01	0.04	0.05	0.00	0.00	0.10	0.05	0.00	0.05	0.42	0.53	--	--		1.00	
BOP-79(i)	11/4/2016	2193	1774	1542	1215	843	475		0.00	0.00	0.05	0.06	0.00	0.00	0.11	0.06	0.00	0.04	0.43	0.53	--	--		1.00	
BOP-79(i)	2/8/2017	2288	1869	1637	1310	938	570		0.00	0.00	0.04	0.06	0.00	0.00	0.11	0.06	0.00	0.04	0.37	0.59	--	--		1.00	
BOP-79(i)	5/16/2017	2386	1967	1735	1408	1036	668		0.00	0.01	0.05	0.08	0.00	0.00	0.14	0.08	0.00	0.04	0.40	0.57	--	--		1.00	
BOP-79(i)	8/9/2017	2471	2052	1820	1493	1121	753		0.00	0.01	0.04	0.05	0.00	0.00	0.10	0.05	0.00	0.05	0.42	0.53	--	--		1.00	
BOP-80(i)	11/21/2011	382						Clear, colorless, no odor or sheen	0.00	0.02	0.07	0.11	0.00	0.00	0.20	0.11	0.00	0.09	0.36	0.55	--	--		1.00	
Downgradient Well	12/1/2011	392	-27					Dark gray, high, no sheen, organic odor	0.00	0.11	0.06	0.08	0.10	0.00	0.26	0.11	0.00	0.31	0.17	0.23	0.28	0.00	0.28		1.00
BOP-80(i)	1/9/2012	431	12					Cloudy, gray, high, slight H2S odor, no sheen	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.02	0.00	0.00	0.00	1.00	--	--		1.00	
BOP-80(i)	2/16/2012	469	50					Clear, low turbidity, some SS, no sheen, slight H2S odor	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00		1.00	
BOP-80(i)	3/15/2012	497	78					Clear, low turbidity, H2S odor, no sheen	0.00	0.00	0.00	0.03	0.06	0.08	0.03	0.08	0.00	0.00	0.00	0.17	0.35	0.49	0.83		1.00
BOP-80(i)	4/17/2012	530	111					Clear with some SS (yellow sediment), low turbidity, no sheen, H2S odor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ND	ND	ND	ND	ND	ND	0.00	0.00	
BOP-80(i)	6/12/2012	586	167	-65				Clear, low, H2S odor, no sheen	0.00	0.00	0.00	0.03	0.10	0.15	0.03	0.15	0.00	0.00	0.00	0.10	0.37	0.53	0.90		1.00
BOP-80(i)	9/18/2012	684	265	33				Cloudy, low turbidity, very slight H2S odor, no sheen	0.01	1.22	0.36	0.22	0.00	0.24	1.81	1.22	0.01	0.59	0.18	0.11	0.00	0.12	0.12		1.00
BOP-80(i)	11/14/2012	741	322	90				Cloudy with brownish/yellow hue, medium to high turbidity, no odor, no	0.02	4.64	2.48	0.53	0.00	0.20	7.66	4.64	0.00	0.59	0.31	0.07	0.00	0.03	0.03		1.00
BOP-80(i)	2/6/2013	825	406	174				Gray, cloudy, low/med turbidity, no odor, no sheen	0.00	0.01	0.00	0.01	0.00	0.17	0.02	0.17	0.00	0.06	0.00	0.03	0.00	0.91	0.91		1.00
BOP-80(i)	5/9/2013	917	498	266	-61			Clear, light gray, stale odor, no sheen	0.00	0.01	0.00	0.01	0.00	0.40	0.02	0.40	0.00	0.01	0.00	0.03	0.00	0.96	0.96		1.00
BOP-80(i)	8/19/2013	1019	600	368	41			Slightly cloudy, light gray, slight bio odor, no sheen	0.00	0.00	0.00	0.01	0.00	0.32	0.01	0.32	0.00	0.00	0.00	0.02	0.00	0.98	0.98		1.00
BOP-80(i)	11/11/2013	1103	684	452	125			Clear, colorless, slight bio odor, no sheen	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.47	0.00	0.00	0.01	0.00	0.99	0.99		1.00	
BOP-80(i)	2/21/2014	1205	786	554	227			Clear, low, no odor, no sheen	0.02	0.18	0.00	0.00	0.00	0.00	0.20	0.18	0.08	0.90	0.02	0.00	0.00	0.00	0.00		1.00
BOP-80(i)	5/7/2014	1280	861	629	302	-70		Clear with slight cloud/gray silt, low/med turbidity, H2S odor, no sheen	0.00	0.02	0.00	0.00	0.00	0.57	0.02	0.57	0.00	0.03	0.00	0.00	0.00	0.97	0.97		1.00
BOP-80(i)	8/14/2014	1379	960	728	401	29		Light brown, medium, slight oil sheen, oil smell	0.00	0.00	0.01	0.05	0.00	0.30	0.06	0.30	0.00	0.01	0.03	0.14	0.00	0.82	0.82		1.00
BOP-80(i)	11/6/2014	1463	1044	812	485	113		Gray, medium, no odor, no sheen	0.00	0.49	3.71	1.01	0.00	0.00	5.22	3.71	0.00	0.09	0.71	0.19	0.00	0.00	0.00		1.00
BOP-80(i)	2/6/2015	1555	1136	904	577	205		Clear, low, no odor, no sheen	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.19	0.00	0.00	0.00	0.03	0.00	0.97	0.97		1.00
BOP-80(i)	5/6/2015	1644	1225	993	666	294	-74	Light gray, medium, no odor, no sheen	0.00	0.00	0.00	0.01	0.00	0.50	0.01	0.50	0.00	0.00	0.00	0.02	0.00	0.98	0.98		1.00
BOP-80(i)	8/10/2015	1740	1321	1089																					

**Table 2**  
**Bioremediation Progress Results**  
**Former Degreaser Source Area**  
**Boeing Portland**

Well	Date	Elapsed Time from Injections (days)						Volatile Organic Compounds Analytical Results											Fermentation Product		Aquifer Redox Conditions										Donor Indicators	
		Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	Source Zone Wells + PRB Injection	PCE (µg/L)	TCE (µg/L)	CIS (µg/L)	VC (µg/L)	Carbon Tet (µg/L)	Chloro-form (µg/L)	Carbon Disulfide (µg/L)	Meth Chloride (µg/L)	Ethene (µg/L)	Ethane (µg/L)	E+E for plots (µg/L)	Acetylene (µg/L)	2-Butanone (µg/L)	Acetone (µg/L)	DO (mg/L)	ORP (mV)	Nitrate (mg/L)	Iron II (mg/L)	Iron, Tot (mg/L)	Iron, Diss (mg/L)	Sulfate (mg/L)	Sulfide (mg/L)	Methane (b) (mg/L)	TOC (mg/L)	pH
BOP-81(i)	9/18/2012	684	265	33			<0.2	<0.2	<0.2	0.6	<0.2	<0.2	<0.5	<0.5	<5.0	8.4		<5.0	<5.0	<5.0	0.21	-125	<0.10	1.7	--	--	<1.0	--	18.0	3.0	6.49	
BOP-81(i)	11/14/2012	741	322	90			<0.2	<0.2	<0.2	0.5	<0.2	<0.2	<0.5	<0.5	<5.0	8.6		<5.0	<5.0	<5.0	0.60	42.7	0.11	2.0	--	--	1.4	--	15.0	<1.0	6.49	
BOP-81(i)	2/6/2013	825	406	174			<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	<5.0	0.56	-93.4	0.12	2.0	--	--	2.0	--	30.0	<1.0	6.55	
BOP-81(i)	5/9/2013	917	498	266	-61		<0.2	0.3	<0.2	0.5	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	<5.0	2.65	-18.1	0.39	1.5	--	--	7.4	--	7.1	<1.0	6.49	
BOP-81(i)	8/19/2013	1019	600	368	41		<0.2	<0.2	<0.2	0.9	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	19	3.96	-24.4	1.2	0.0	--	--	16.4	--	3.4	<1.0	6.74	
BOP-81(i)	11/11/2013	1103	684	452	125		<0.2	<0.2	<0.2	0.4	<0.2	<0.2	<0.5	<0.5	<5.0	8.9		<5.0	<5.0	6.6	0.42	-75.1	0.26	4.5	--	--	3.8	--	20.0	1.2	6.04	
BOP-81(i)	2/21/2014	1205	786	554	227		0.6	0.6	<0.2	<0.2	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	8.4	3.55	74.1	0.61	0.5	--	--	13.5	--	0.33	1.4	6.14	
BOP-81(i)	5/7/2014	1280	861	629	302	-70	<0.2	0.2	<0.2	<0.2	<0.2	<0.2	<0.5	<0.5	<5.0	5.2		<5.0	<5.0	<5.0	0.65	-49.9	<0.10	2.0	--	--	2.3	--	24.0	2.0	6.73	
BOP-81(i)	8/14/2014	1379	960	728	401	29	<0.2	<0.2	<0.2	0.4	<0.2	<0.2	<0.5	<0.5	<5.0	6.0		<5.0	<5.0	7.2	8.5	1.17	-140.9	<0.10	4.5	--	--	49.7	--	12.0	225	5.76
BOP-81(i)	11/6/2014	1463	1044	812	485	113	<0.2	<0.2	<0.2	0.3	<0.2	<0.2	<0.5	<0.5	<5.0	11		<5.0	<5.0	33	0.50	-85.6	<0.10	2.5	21.4	10.9	<1.0	<2.0	25.0	1.5	6.33	
BOP-81(i)	2/6/2015	1555	1136	904	577	205	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	30	0.10	-128.8	<0.10	5.0	10.1	3.71	6.7	<2.0	20.0	1.0	6.34	
BOP-81(i)	5/6/2015	1644	1225	993	666	294	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	24	0.82	-74.0	<0.10	7.0	11.6	4.58	2.5	<2.0	22.0	<1.0	6.33	
BOP-81(i)	8/11/2015	1741	1322	1090	763	391	<0.2	<0.2	0.6	1.2	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	25	1.49	-130.0	0.14	7.0	33.5	9.9	4.2	<2.0	13.0	1.6	6.19	
BOP-81(i)	11/4/2015	1826	1407	1175	848	476	<0.2	<0.2	0.3	0.7	<0.2	<0.2	<0.5	<0.5	<5.0	5.4		<5.0	<5.0	6.3	0.54	-42.6	<0.10	6.5	29.2	10.5	1.7	<2.0	20.0	1.6	6.34	
BOP-81(i)	2/4/2016	1918	1499	1267	940	568	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	22	1.93	-4.5	<0.10	5.0	4.19	2.86	7.1	<2.0	10	<1.0	6.90	
BOP-81(i)	5/4/2016	2009	1590	1358	1031	659	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	12	2.88	-47.0	<0.10	7.0	17.4	3.8	3.8	<2.0	21.0	<1.0	6.15	
BOP-81(i)	8/11/2016	2107	1688	1456	1129	757	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	76	0.25	-83.7	<0.10	7.0	12.3	8.98	<1.0	<2.0	22	2.1	6.12	
BOP-81(i)	11/11/2016	2199	1780	1548	1221	849	<0.2	<0.2	<0.2	0.3	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	22	0.51	17.4	<0.10	7.0	7.23	6.52	1.2	<2.0	23	1.3	6.22	
BOP-81(i)	2/7/2017	2288	1869	1637	1310	938	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	64	1.56	4.0	<0.10	1.5	5.42	3.08	5.4	<2.0	11	1.5	6.26	
BOP-81(i)	5/16/2017	2386	1967	1735	1408	1036	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	36	0.23	-7	<0.10	1.5	5.01	2.54	5.2	<2.0	11	1.3	6.36	
BOP-81(i)	8/10/2017	2472	2053	1821	1494	1122	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	36	0.4	40.1	<0.10	7.0	11.3	6.03	<1.0	<2.0	23	1.6	6.2	
BOP-82(i)	11/21/2011	382					4.6	91	1.6	<1.0	<1.0	1.2	<1.0	<2.0	--	--		<5.0	<10	--	--	--	--	--	--	--	--	--	--	--	--	
Downgradient Well	12/1/2011	392	-27				4.0	66	1.4	<1.0	<1.0	1.0	<1.0	<2.0	<1.1	<1.2		<5.0	<10	0.0	-152.8	3.3	1.1	--	--	9.4	--	<0.0007	<1.50	6.36		
BOP-82(i)	12/28/2011	419	0				--	--	--	--	--	--	--	--	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	
BOP-82(i)	1/9/2012	431	12				2.6	47	1.0	<1.0	<1.0	<1.0	<1.0	<2.0	<1.1	<1.2		<5.0	<10	0.31	-238.8	<0.2	2.1	--	--	7.3	--	--	9.81	6.74		
BOP-82(i)	2/16/2012	469	50				1.9	38	6.8	<1.0	<1.0	<1.0	<1.0	<2.0	<1.1	<1.2		<5.0	<10	1.61	-196.5	1.7	0.1	--	--	10.3	--	0.0144	4.85	6.94		
BOP-82(i)	3/15/2012	497	78				2.0	36	11	<1.0	<1.0	<1.0	<1.0	<2.0	<1.1	<1.2		<5.0	<10	0.82	-183.5	1.3	1.5	--	--	10.0	--	<0.0007	3.25	6.97		
BOP-82(i)	4/17/2012	530	111				1.6	29	4.5	<1.0	<1.0	<1.0	<1.0	<2.0	<1.1	<1.2		<5.0	<10	1.29	-219.3	1.8	0.6	--	--	10.6	--	<0.0007	2.46	6.78		
BOP-82(i)	6/12/2012	586	167	-65			1.3	24	2.5	<1.0	<1.0	<1.0	<1.0	<2.0	<1.1	<1.2		<5.0	<10	2.76	145.6	1.8	0.1	--	--	9.9	--	<0.0007	2.56	5.54		
BOP-82(i)	8/16/2012	651	232	0			--	--	--	--	--	--	--	--	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	
BOP-82(i)	9/18/2012	684	265	33			1.0	19	1.6	0.5	<0.2	0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	2.75	-0.5	1.8	1.0	--	--	9.9	--	<0.015	1.4	6.45		
BOP-82(i)	11/14/2012	741	322	90			1.6	24	1.6	0.3	<0.2	0.3	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	3.03	72.7	1.8	0.0	--	--	10.3	--	0.036	<1.0	6.61		
BOP-82(i)	2/6/2013	825	406	174			1.5	15	1.8	0.4	<0.2	0.3	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	3.53	93.9	1.3	0.0	--	--	10.7	--	0.036	<1.0	6.50		
BOP-82(i)	5/6/2013	914	495	263	-64		1.1	17	0.9	0.3	<0.2	0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	4.24	202.8	1.0	0.0	--	--	11.6	--	0.48	<1.0	6.26		
BOP-82(i)	8/19/2013	1019	600	368	41		1.4	19	0.5	<0.2	<0.2	0.3	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	21	--	14.2	1.1	0.0	--	--	11.5	--	0.11	<1.0	6.24	
BOP-82(i)	11/7/2013	1099	680	448	121		1.1	17	0.5	<0.2	<0.2	0.2	<0.5	<0.5	--	--		<5.0	6.0	--	--	--	--	--	--	--	--	--	--	--	--	
BOP-82(i)	2/21/2014	1205	786	554	227		1.0	14	0.4	<0.2	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	67	3.15	189.6	0.88	0.5	--	--	9.2	--	1.3	2.5	6.08	
BOP-82(i)	5/7/2014	1280	861	629	302	-70	0.7	12	0.5	<0.2	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	1.29	82.9	0.30	0.0	--	--	8.4	--	1.0	1.9	6.25		
BOP-82(i)	8/14/2014	1379	960	728	401	29	1.0	12	0.6	<0.2	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	9.5	0.45	-135.4	<0.10	7.0	--	--	8.8	--	1.5	36.4	5.82	
BOP-82(i)	11/7/2014	1464	1045	813	486	114	0.6	8.1	2.7	0.7	<0.2	<0.2	<0.5	<0.5	--	--		<5.0	18	--	--	--	--	--	--	--	--	--	--	--	--	
BOP-82(i)	2/6/2015	1555	1136	904	577	205	0.7	11	1.7	0.5	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	35	0.68	-62.7	0.36	3.0	8.96	2.09	13.2	<2.0	3.0	1.8	6.25	
BOP-82(i)	5/4/2015	1642	1223	991	664	292	0.7	9.7	1.3	<0.2	<0.2	<0.2	<0.5	<0.5	--	--		<5.0	17	--	--	--	--	--	--	--	--	--	--	--	--	
BOP-82(i)	8/11/2015	1741	1322	1090	763	391	0.6	8.6	1.4	0.6	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	30	1.06	-186.1	<0.10	7.0	6.87	4.67	5.5	<2.0	7.5	9.5	6.26	
BOP-82(i)	11/6/2015	1828	1409	1177	85																											

**Table 2**  
**Bioremediation Progress Results**  
**Former Degreaser Source Area**  
**Boeing Portland**

Well	Date	Elapsed Time from Injections (days)						Source Zone Wells	Source Zone Wells + PRB	Source Zone Wells + PRB	Comments	VOCs- micromoles/Liter							Molar Fraction								
		Injection (a)	Injection (b)	Injection (c)	Injection (d)	Injection (e)	Injection (f)					PCE	TCE	CIS	VC	Ethene	Ethane	PCE+TCE+cD CE+VC	Max Compound	PCE	TCE	CIS	VC	Ethene	Ethane	E+E for plots	Total
		Pilot Injection	PRB 1st Injection	PRB 2nd Injection	1st Injection	2nd Injection	3rd Injection																				
BOP-81(i)	9/18/2012	684	265	33						Gray, cloudy, high turbidity, no odor, no sheen	0.00	0.00	0.00	0.01	0.00	0.28	0.01	0.28	0.00	0.00	0.00	0.03	0.00	0.97		1.00	
BOP-81(i)	11/14/2012	741	322	90						Cloudy, Gray, high turbidity, no odor, no sheen	0.00	0.00	0.00	0.01	0.00	0.29	0.01	0.29	0.00	0.00	0.00	0.03	0.00	0.97		1.00	
BOP-81(i)	2/6/2013	825	406	174						Gray, very silty, high turbidity, slight H2S odor, no sheen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ND	ND	ND	ND	ND	ND		ND	
BOP-81(i)	5/9/2013	917	498	266	-61					Gray, moderate, stale odor, no sheen	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.22	0.00	0.78	0.00	0.00	1.00	
BOP-81(i)	8/19/2013	1019	600	368	41					Clear, colorless, slight bio odor, no sheen	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00	1.00	0.00	0.00		1.00	
BOP-81(i)	11/11/2013	1103	684	452	125					Slightly cloudy, Gray, bio odor, no sheen	0.00	0.00	0.00	0.01	0.00	0.30	0.01	0.30	0.00	0.00	0.00	0.02	0.00	0.98		1.00	
BOP-81(i)	2/21/2014	1205	786	554	227					Clear, low, no odor, no sheen	0.0036	0.0046	0.0000	0.0000	0.0000	0.0000	0.01	0.00	0.44	0.56	0.00	0.00	0.00	0.00		1.00	
BOP-81(i)	5/7/2014	1280	861	629	302	-70				Gray, cloudy, high turbidity, H2S odor, no sheen	0.0000	0.0015	0.0000	0.0000	0.0000	0.1729	0.00	0.17	0.00	0.01	0.00	0.00	0.00	0.99		1.00	
BOP-81(i)	8/14/2014	1379	960	728	401	29				Clear/light gray, low/med turbidity, no odor, no sheen	0.0000	0.0000	0.0000	0.0064	0.0000	0.1995	0.01	0.20	0.00	0.00	0.00	0.03	0.00	0.97		1.00	
BOP-81(i)	11/6/2014	1463	1044	812	485	113				Gray, medium, no odor, no sheen	0.0000	0.0000	0.0000	0.0048	0.0000	0.3658	0.00	0.37	0.00	0.00	0.00	0.01	0.00	0.99		1.00	
BOP-81(i)	2/6/2015	1555	1136	904	577	205				Clear to light gray, medium, no odor, no sheen	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.00	ND	ND	ND	ND	ND	ND		ND	
BOP-81(i)	5/6/2015	1644	1225	993	666	294	-74			Gray, medium, veg odor, no sheen	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.00	ND	ND	ND	ND	ND	ND		ND	
BOP-81(i)	8/11/2015	1741	1322	1090	763	391	23			Light gray, med, no odor, no sheen	0.0000	0.0000	0.0062	0.0192	0.0000	0.0000	0.03	0.02	0.00	0.00	0.24	0.76	0.00	0.00		ND	
BOP-81(i)	11/4/2015	1826	1407	1175	848	476	108			Light gray, med, no odor, no sheen	0.0000	0.0000	0.0031	0.0112	0.0000	0.1796	0.01	0.18	0.00	0.00	0.02	0.06	0.00	0.93		ND	
BOP-81(i)	2/4/2016	1918	1499	1267	940	568	200			Gray medium, veg odor, slight veg sheen	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.00	ND	ND	ND	ND	ND	ND		ND	
BOP-81(i)	5/4/2016	2009	1590	1358	1031	659	291			Light gray, low/med, slight veg odor/sheen	0.0000	0.0000	0.0000	0.0000	0.0000	0.2228	0.00	0.22	ND	ND	ND	ND	ND	--		ND	
BOP-81(i)	8/11/2016	2107	1688	1456	1129	757	389			Light gray, med, no odor, no sheen	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.00	ND	ND	ND	ND	ND	ND		ND	
BOP-81(i)	11/11/2016	2199	1780	1548	1221	849	481			Light gray, med, veg odor, no sheen	0.0000	0.0000	0.0000	0.0048	0.0000	0.0000	0.00	0.00	0.00	0.00	0.00	0.00	1.00	--		ND	
BOP-81(i)	2/7/2017	2288	1869	1637	1310	938	570				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.00	ND	ND	ND	ND	--		ND		
BOP-81(i)	5/16/2017	2386	1967	1735	1408	1036	668				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.00	ND	ND	ND	ND	--		ND		
BOP-81(i)	8/10/2017	2472	2053	1821	1494	1122	754			gray, medium-high, veg odor, no sheen	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.00	ND	ND	ND	ND	--		ND		
BOP-82(i)	11/21/2011	382								Clear, colorless, no odor or sheen	0.03	0.69	0.02	0.00	0.00	0.00	0.74	0.27	0.04	0.94	0.02	0.00	--	--		1.00	
Downgradient Well	12/1/2011	392	-27							Light brown-gray, low to moderate, no odor, no sheen	0.02	0.50	0.01	0.00	0.00	0.00	0.54	0.22	0.04	0.93	0.03	0.00	0.00	0.00		1.00	
BOP-82(i)	12/28/2011	419	0							Light brown, no odor, no sheen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	--	--	--	--	--	--		0.00	
BOP-82(i)	1/9/2012	431	12							Brown, cloudy, high, no odor, no sheen	0.02	0.36	0.01	0.00	0.00	0.00	0.38		0.04	0.93	0.03	0.00	--	--		1.00	
BOP-82(i)	2/16/2012	469	50							Brown, med/high turbidity, no sheen, slight rotten egg odor, some SS	0.01	0.29	0.07	0.00	0.00	0.00	0.37	0.14	0.03	0.78	0.19	0.00	0.00	0.00		1.00	
BOP-82(i)	3/15/2012	497	78							Brown, cloudy, high turbidity, no odor, no sheen, floating solids	0.01	0.27	0.11	0.00	0.00	0.00	0.40	0.18	0.03	0.69	0.28	0.00	0.00	0.00		1.00	
BOP-82(i)	4/17/2012	530	111							Cloudy with org-yellow SS, no odor, no sheen	0.01	0.22	0.05	0.00	0.00	0.00	0.28	0.11	0.03	0.80	0.17	0.00	0.00	0.00		1.00	
BOP-82(i)	6/12/2012	586	167	-65						Brownish-orange, lots of SS, high turbidity, no odor, no sheen	0.01	0.18	0.03	0.00	0.00	0.00	0.22	0.13	0.04	0.84	0.12	0.00	0.00	0.00		1.00	
BOP-82(i)	8/16/2012	651	232	0							--	--	--	--	--	--	--	0.14	--	--	--	--	--	--		--	
BOP-82(i)	9/18/2012	684	265	33						Brown, cloudy, SS, high turbidity, no odor, no sheen	0.01	0.14	0.02	0.01	0.00	0.00	0.18	0.13	0.03	0.83	0.09	0.05	0.00	0.00		1.00	
BOP-82(i)	11/14/2012	741	322	90						Clear, low turbidity, no odor, no sheen	0.01	0.18	0.02	0.00	0.00	0.00	0.21	0.11	0.05	0.86	0.08	0.02	0.00	0.00		1.00	
BOP-82(i)	2/6/2013	825	406	174						Slightly cloudy, low/med turbidity, no odor, no sheen	0.01	0.11	0.02	0.01	0.00	0.00	0.15	0.09	0.06	0.77	0.13	0.04	0.00	0.00		1.00	
BOP-82(i)	5/6/2013	914	495	263	-64					Slightly cloudy, light brown, no odor, no sheen	0.01	0.13	0.01	0.00	0.00	0.00	0.15	0.09	0.04	0.86	0.06	0.03	0.00	0.00		1.00	
BOP-82(i)	8/19/2013	1019	600	368	41					Clear, colorless, no odor, no sheen	0.01	0.14	0.01	0.00	0.00	0.00	0.16	0.06	0.05	0.91	0.03	0.00	0.00	0.00		1.00	
BOP-82(i)	11/7/2013	1099	680	448	121					Clear, colorless, no odor, no sheen	0.01	0.13	0.01	0.00	0.00	0.00	0.14	0.08	0.05	0.92	0.04	0.00	--	--		1.00	
BOP-82(i)	2/21/2014	1205	786	554	227					Clear, low, no odor, no sheen	0.01	0.11	0.00	0.00	0.00	0.00	0.12	0.07	0.05	0.91	0.04	0.00	0.00	0.00		1.00	
BOP-82(i)	5/7/2014	1280	861	629	302	-70				Clear with trace sediment, low turbidity, no odor, no sheen	0.00	0.09	0.01	0.00	0.00	0.00	0.10	0.07	0.04	0.91	0.05	0.00	0.00	0.00		1.00	
BOP-82(i)	8/14/2014	1379	960	728	401	29				Clear, low, no odor, oil sheen	0.01	0.09	0.01	0.00	0.00	0.00	0.10	0.05	0.06	0.88	0.06	0.00	0.00	0.00		1.00	
BOP-82(i)	11/7/2014	1464	1045	813	486	114				Clear, low, no odor, oil sheen	0.00	0.06	0.03	0.01	0.00	0.00	0.10	0.06	0.03	0.59	0.27	0.11	--	--		1.00	
BOP-82(i)	2/6/2015	1555	1136	904	577	205				Clear, medium?, no odor, no sheet	0.00	0.08	0.02	0.01	0.00	0.00	0.11	0.06	0.04	0.74	0.15	0.07	0.00	0.00		1.00	
BOP-82(i)	5/4/2015	1642	1223	991	664	292	-76			Clear, low, no odor, no sheen	0.00	0.07	0.01	0.00	0.00	0.00	0.09	0.07	0.05	0.81	0.15	0.00	--	--		1.00	
BOP-82(i)	8/11/2015	1741	1322	1090	763	391	23			Clear with black sediment, silt size, no odor, no sheen	0.00	0.07	0.01	0.01	0.00	0.00	0.09	0.07	0.04	0.70	0.16	0.10	0.00	0.00		1.00	
BOP-82(i)	11/6/2015	1828	1409	1177	850	478	110			Clear, low, no odor, no sheen	0.00	0.05	0.03	0.02	0.00	0.00	0.09	0.05	0.02	0.49	0.28	0.21	--	--		1.00	
BOP-82(i)	2/4/2016	1918	1499	1267	940	568	200			Light brown, medium, no odor, no sheen	0.00	0.06	0.01	0.01	0.00	0.00	0.09	0.05	0.03	0.73	0.16	0.07	0.00	0.00		1.00	
BOP-82(i)	5/3/2016	2007	1588	1356	1029																						

**Table 2**  
**Bioremediation Progress Results**  
**Former Degreaser Source Area**  
**Boeing Portland**

Well	Date	Elapsed Time from Injections (days)						Volatile Organic Compounds Analytical Results											Fermentation Product		Aquifer Redox Conditions										Donor Indicators	
		Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	Source Zone Wells + PRB Injection	PCE (µg/L)	TCE (µg/L)	CIS (µg/L)	VC (µg/L)	Carbon Tet (µg/L)	Chloro-form (µg/L)	Carbon Disulfide (µg/L)	Meth Chloride (µg/L)	Ethene (µg/L)	Ethane (µg/L)	E+E for plots (µg/L)	Acetylene (µg/L)	2-Butanone (µg/L)	Acetone (µg/L)	DO (mg/L)	ORP (mV)	Nitrate (mg/L)	Iron II (mg/L)	Iron, Tot (mg/L)	Iron, Diss (mg/L)	Sulfate (mg/L)	Sulfide (mg/L)	Methane (b) (mg/L)	TOC (mg/L)	pH
BOP-83(i)	2/21/2014	1205	786	554	227		<0.2	2.3	<0.2	<0.2	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	<5.0	4.09	177.4	5.4	0.5	--	--	11.3	--	<0.005	<1.0	6.33	
BOP-83(i)	5/7/2014	1280	861	629	302	-70	0.4	5.7	0.4	<0.2	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	<5.0	6.91	136.0	4.3	0.0	--	--	11.1	--	0.19	1.2	6.43	
BOP-83(i)	8/14/2014	1379	960	728	401	29	<0.2	2.2	<0.2	<0.2	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	<5.0	7.3	7.68	-80.8	4.6	0.5	--	--	11.6	--	0.041	1.5	6.05
BOP-83(i)	11/11/2014	1468	1049	817	490	118	<0.2	2.1	<0.2	<0.2	<0.2	<0.2	<0.5	<0.5	--	--		<5.0	<5.0	<5.0	31	--	--	--	--	--	--	--	--	--	--	
BOP-83(i)	2/6/2015	1555	1136	904	577	205	0.4	12	1.0	<0.2	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	<5.0	7.69	52.6	3.6	0.0	11.9	<0.400	8.9	<2.0	0.38	<1.0	6.35	
BOP-83(i)	5/4/2015	1642	1223	991	664	292	<0.2	2.0	<0.2	<0.2	<0.2	<0.2	<0.5	<0.5	--	--		<5.0	<5.0	<5.0	23	--	--	--	--	--	--	--	--	--	--	
BOP-83(i)	8/11/2015	1741	1322	1090	763	391	<0.2	2.0	<0.2	<0.2	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	<5.0	45	7.66	50.1	4.2	0.5	30.0	1.22	10	<2.0	0.1	<1.0	6.47
BOP-83(i)	11/6/2015	1828	1409	1177	850	478	<0.2	1.9	<0.2	<0.2	<0.2	<0.2	<0.5	<0.5	--	--		<5.0	<5.0	<5.0	7.9	--	--	--	--	--	--	--	--	--	--	
BOP-83(i)	2/4/2016	1918	1499	1267	940	568	<0.2	1.7	<0.2	<0.2	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	<5.0	18	7.46	51.8	3.3	1.0	19.2	0.628	7.5	<2.0	0.36	<1.0	7.33
BOP-83(i)	5/6/2016	2010	1591	1359	1032	660	<0.2	2.4	<0.2	<0.2	<0.2	<0.2	<0.5	<0.5	--	--		<5.0	<5.0	<5.0	9.8	--	--	--	--	--	--	--	--	--	--	
BOP-83(i)	8/11/2016	2107	1688	1456	1129	757	<0.2	2.6	<0.2	<0.2	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	<5.0	46	7.02	89.5	3.3	0.5	4.33	0.440	9.1	<2.0	0.0069	<1.0	6.01
BOP-83(i)	11/16/2016	2205	1786	1554	1227	855	0.5	10	4.5	<0.2	<0.2	<0.2	<0.5	<0.5	--	--		<5.0	<5.0	<5.0	19	--	--	--	--	--	--	--	--	--	--	
BOP-83(i)	2/13/2017	2293	1874	1642	1315	943	<0.2	2.7	<0.2	<0.2	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	<5.0	62	6.24	176.8	2.7	0.5	9.37	<0.400	9.4	<2.0	<0.005	<1.0	6.56
BOP-83(i)	5/12/2017	2382	1963	1731	1404	1032	0.3	3.2	<0.2	<0.2	<0.2	<0.2	<0.5	<0.5	--	--		<5.0	<5.0	<5.0	12	--	--	--	--	--	--	--	--	--	--	
BOP-83(i)	8/10/2017	2472	2053	1821	1494	1122	0.2	3.3	<0.2	<0.2	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	<5.0	30	3.1	58.6	2.1	0.5	8.64	<0.400	8.9	<2.0	<0.0050	<1.0	6.4
BOP-84(i)	2/8/2012	461	42				<1.0	7.1	55	1.4	<1.0	<1.0	<1.0	<2.0	--	--		<5.0	<10	<10	--	--	--	--	--	--	--	--	--	--	--	
Injection Well	5/4/2012	547	128				<1.0	<1.0	1.8	150	<1.0	<1.0	<1.0	<2.0	--	--		<5.0	<10	<10	--	--	--	--	--	--	--	--	--	--	--	
BOP-84(i)	6/12/2012	586	167				<1.0	<1.0	1.2	14	<1.0	<1.0	<1.0	<2.0	13.6	<1.2		<1.1	<5.0	<10	0.65	-37.3	<0.1	3.7	--	--	<0.1	--	9.82	16.7	6.33	
BOP-84(i)	8/9/2012	644	225	-7			<1.0	<1.0	1.3	8.4	<1.0	<1.0	<1.0	<2.0	--	--		<5.0	<10	<10	--	--	--	--	--	--	--	--	--	--	--	
BOP-84(i)	8/16/2012	651	232	0			--	--	--	--	--	--	--	--	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--	--	
BOP-84(i)	9/19/2012	685	266	34			<0.4	4.1	69	2.9	<0.4	<0.4	<1.0	1.1	<5.0	<5.0		<5.0	<10	<10	0.28	17.7	<0.10	3.5	--	--	<1.0	--	14	2620	4.57	
BOP-84(i)	11/8/2012	735	316	84			<0.2	0.5	11	35	<0.2	<0.2	<0.5	<0.5	<5.0	5.7		<5.0	<5.0	9.5	--	--	<0.10	--	--	<1.0	--	22	276	--	--	
BOP-84(i)	11/9/2012	736	317	85			--	--	--	--	--	--	--	--	--	--		--	--	--	0.81	131.2	--	3.0	--	--	--	--	--	--	6.36	
BOP-84(i)	2/5/2013	824	405	173			<0.2	0.5	0.7	2.3	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	19	0.97	-43.9	<0.10	2.0	--	--	<1.0	--	26	80.5	6.29	
BOP-84(i)	5/6/2013	914	495	263	-64		<0.2	0.4	0.5	1.6	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	11	1.92	-75.2	<0.10	2.0	--	--	<1.0	--	21	102	6.12	
BOP-84(i)	8/7/2013	1007	588	356	29		<0.2	2.2	18	15	<0.2	0.5	<0.5	2.9	--	--		<5.0	<5.0	28	--	--	--	--	--	--	--	--	--	--	--	
BOP-84(i)	11/8/2013	1100	681	449	122		<0.2	0.7	3.3	1.3	<0.2	<0.2	<0.5	<0.5	--	--		<5.0	<5.0	37	7.9	--	--	--	--	--	--	--	--	--	--	
BOP-84(i)	2/5/2014	1189	770	538	211		<0.2	0.2	2.5	0.6	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0		<5.0	<5.0	17	40	2.03	-118.7	<0.10	5.5	--	--	<1.0	--	19	378	6.54
BOP-84(i)	5/8/2014	1281	862	630	303	-69	<0.2	<0.2	2.0	1.9	<0.2	<0.2	<0.5	<0.5	7.4	<5.0		<5.0	<5.0	39	1.16	-32.6	<0.10	--	--	<1.0	--	14	40.1	6.61		
BOP-84(i)	11/7/2014	1464	1045	813	486	114	<0.2	<0.2	8.0	2.9	<0.2	1.5	0.6	2.2	--	--		<5.0	<5.0	11	60	--	--	--	--	--	--	--	--	--	--	
BOP-84(i)	2/3/2015	1552	1133	901	574	202	<0.2	0.5	15	3.4	<0.2	0.5	<0.5	2.3	--	--		<5.0	<5.0	24	31	--	--	--	--	--	--	--	--	--	--	
BOP-84(i)	5/4/2015	1642	1223	991	664	292	<0.2	0.3	8.9	3.1	<0.2	<0.2	<0.5	0.6	--	--		<5.0	<5.0	25	26	--	--	--	--	--	--	--	--	--	--	
BOP-84(i)	11/6/2015	1828	1409	1177	850	478	<0.2	<0.2	2.8	2.1	<0.2	3.0	0.6	0.6	--	--		<5.0	<5.0	14	44	--	--	--	--	--	--	--	--	--	--	
BOP-84(i)	2/4/2016	1918	1499	1267	940	568	<0.2	<0.2	3.4	2.0	<0.2	2.0	0.7	0.5	--	--		<5.0	<5.0	31	<5.0	--	--	--	--	--	--	--	--	--	--	
BOP-84(i)	5/5/2016	2009	1590	1358	1031	659	<0.2	<0.2	3.8	2.2	<0.2	1.8	0.6	0.5	--	--		<5.0	<5.0	45	<5.0	--	--	--	--	--	--	--	--	--	--	
BOP-84(i)	8/8/2016	2104	1685	1453	1126	754	<0.2	<0.2	4.6	1.7	<0.2	2.0	0.7	0.7	--	--		<5.0	<5.0	75	<5.0	--	--	--	--	--	--	--	--	--	--	
BOP-84(i)	11/4/2016	2193	1774	1542	1215	843	<0.2	<0.2	4.6	1.5	<0.2	1.9	0.7	0.8	--	--		<5.0	<5.0	220	<5.0	--	--	--	--	--	--	--	--	--	--	
BOP-84(i)	2/8/2017	2289	1870	1638	1311	939	<0.2	0.2	4.0	2.3	<0.2	1.8	0.6	0.7	--	--		<5.0	<5.0	270	50	--	--	--	--	--	--	--	--	--	--	
BOP-84(i)	5/16/2017	2386	1967	1735	1408	1036	<0.2	0.3	4.3	2.1	<0.2	1.8	0.5	0.8	--	--		<5.0	<5.0	210	61	--	--	--	--	--	--	--	--	--	--	
BOP-84(i)	8/9/2017	2471	2052	1820	1493	1121	<0.2	0.2	4.1	1.5	<0.2	1.8	0.6	0.7	--	--		<5.0	<5.0	48	29	--	--	--	--	--	--	--	--	--	--	
BOP-85(i)	2/8/2012	461	42				1.6	3																								

**Table 2**  
**Bioremediation Progress Results**  
**Former Degreaser Source Area**  
**Boeing Portland**

Well	Date	Elapsed Time from Injections (days)						Comments	VOCs- micromoles/Liter							Molar Fraction								
		Injection (a)	Injection (b)	Injection (c)	Injection (d)	Injection (e)	Injection (f)		PCE	TCE	CIS	VC	Ethene	Ethane	PCE+TCE+cD CE+VC	Max Compound	PCE	TCE	CIS	VC	Ethene	Ethane	E+E for plots	Total
		Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	Source Zone Wells + PRB Injection																	
BOP-83(i)	2/21/2014	1205	786	554	227			Clear, low, no odor, no sheen	0.00	0.02	0.00	0.00	0.00	0.00	0.02	0.02	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00
BOP-83(i)	5/7/2014	1280	861	629	302	-70		Gray, cloudy, silty, high turbidity, no odor, no sheen	0.00	0.04	0.00	0.00	0.00	0.00	0.05	0.04	0.05	0.87	0.08	0.00	0.00	0.00	0.00	1.00
BOP-83(i)	8/14/2014	1379	960	728	401	29		Clear, med turbidity, no odor, oil sheen	0.00	0.02	0.00	0.00	0.00	0.00	0.02	0.02	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00
BOP-83(i)	11/11/2014	1468	1049	817	490	118		Clear, low, no odor, oil sheen	0.00	0.02	0.00	0.00	0.00	0.00	0.02	0.02	0.00	1.00	0.00	0.00	--	--	--	1.00
BOP-83(i)	2/6/2015	1555	1136	904	577	205		Light brown, medium, no odor, no sheen	0.00	0.09	0.01	0.00	0.00	0.00	0.10	0.09	0.02	0.88	0.10	0.00	0.00	0.00	0.00	1.00
BOP-83(i)	5/4/2015	1642	1223	991	664	292	-76	Clear, low, no odor, no sheen	0.00	0.02	0.00	0.00	0.00	0.00	0.02	0.02	0.00	1.00	0.00	0.00	--	--	--	1.00
BOP-83(i)	8/11/2015	1741	1322	1090	763	391	23	Light brown, med, no odor, no sheen	0.00	0.02	0.00	0.00	0.00	0.00	0.02	0.02	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00
BOP-83(i)	11/6/2015	1828	1409	1177	850	478	110	Clear, low, no odor, no sheen	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.00	1.00	0.00	0.00	--	--	--	1.00
BOP-83(i)	2/4/2016	1918	1499	1267	940	568	200	Clear-light brown, no odor, no sheen	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00
BOP-83(i)	5/6/2016	2010	1591	1359	1032	660	292	Clear, low, no odor, no sheen	0.00	0.02	0.00	0.00	0.00	0.00	0.02	0.02	0.00	1.00	0.00	0.00	--	--	--	1.00
BOP-83(i)	8/11/2016	2107	1688	1456	1129	757	389	Light brown/clear, low/med, no odor, no sheen	0.00	0.02	0.00	0.00	0.00	0.00	0.02	0.02	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00
BOP-83(i)	11/16/2016	2205	1786	1554	1227	855	487		0.00	0.08	0.05	0.00	0.00	0.00	0.13	0.08	0.02	0.61	0.37	0.00	--	--	--	1.00
BOP-83(i)	2/13/2017	2293	1874	1642	1315	943	575		0.00	0.02	0.00	0.00	0.00	0.00	0.02	0.02	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00
BOP-83(i)	5/12/2017	2382	1963	1731	1404	1032	664		0.00	0.02	0.00	0.00	0.00	0.00	0.03	0.02	0.07	0.93	0.00	0.00	0.00	0.00	0.00	1.00
BOP-83(i)	8/10/2017	2472	2053	1821	1494	1122	754	Clear, veg odor, slight sheen, medium with sediment	0.00	0.03	0.00	0.00	0.00	0.00	0.03	0.03	0.05	0.95	0.00	0.00	0.00	0.00	0.00	1.00
BOP-84(i)	2/8/2012	461	42					Clear, colorless, strong lactate odor, no sheen	0.00	0.05	0.57	0.02	0.00	0.00	0.64	0.57	0.00	0.08	0.88	0.03	--	--	--	1.00
Injection Well	5/4/2012	547	128						0.00	0.00	0.02	2.40	0.00	0.00	2.42	2.40	0.00	0.00	0.01	0.99	--	--	--	1.00
BOP-84(i)	6/12/2012	586	167					Cloudy, low turbidity, rotten veg oil odor/H2S odor, no sheen	0.00	0.00	0.01	0.22	0.48	0.00	0.24	0.48	0.00	0.00	0.02	0.31	0.67	0.00	--	1.00
BOP-84(i)	8/9/2012	644	225	-7				Clear, low, slight BO odor, no sheen	0.00	0.00	0.01	0.13	0.00	0.00	0.15	0.13	0.00	0.00	0.09	0.91	--	--	--	1.00
BOP-84(i)	8/16/2012	651	232	0					--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BOP-84(i)	9/19/2012	685	266	34				Gray, clear, veg oil odor, frothy light gray sheen	0.00	0.03	0.71	0.05	0.00	0.00	0.79	0.71	0.00	0.04	0.90	0.06	0.00	0.00	0.00	1.00
BOP-84(i)	11/8/2012	735	316	84				Clear, colorless, strong bio odor, no sheen	0.00	0.00	0.11	0.56	0.00	0.19	0.68	0.56	0.00	0.00	0.13	0.65	0.00	0.22	--	1.00
BOP-84(i)	11/9/2012	736	317	85				Clear, colorless, moderate bio odor, frothy sheen on purge water	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BOP-84(i)	2/5/2013	824	405	173				Clear, colorless, strong bio odor, no sheen	0.00	0.00	0.01	0.04	0.00	0.00	0.05	0.04	0.00	0.08	0.15	0.77	0.00	0.00	0.00	1.00
BOP-84(i)	5/6/2013	914	495	263	-64			Clear, colorless, slight organic odor, no sheen	0.00	0.00	0.01	0.03	0.00	0.00	0.03	0.03	0.00	0.09	0.15	0.76	0.00	0.00	0.00	1.00
BOP-84(i)	8/7/2013	1007	588	356	29				0.00	0.02	0.19	0.24	0.00	0.00	0.44	0.24	0.00	0.04	0.42	0.54	--	--	--	1.00
BOP-84(i)	11/8/2013	1100	681	449	122			Clear, colorless, strong bio odor, no sheen	0.00	0.01	0.03	0.02	0.00	0.00	0.06	0.03	0.00	0.09	0.57	0.35	--	--	--	1.00
BOP-84(i)	2/5/2014	1189	770	538	211			Clear, med, veg odor, no sheen	0.00	0.00	0.03	0.01	0.00	0.00	0.04	0.03	0.00	0.04	0.70	0.26	0.00	0.00	0.00	1.00
BOP-84(i)	5/8/2014	1281	862	630	303	-69		Slightly cloudy, low/med turbidity, no odor, no sheen	0.00	0.00	0.02	0.03	0.26	0.00	0.05	0.26	0.00	0.00	0.07	0.10	0.84	0.00	0.00	1.00
BOP-84(i)	11/7/2014	1464	1045	813	486	114		Clear, low, veg odor, slight sheen	0.00	0.00	0.08	0.05	0.00	0.00	0.13	0.08	0.00	0.00	0.64	0.36	--	--	--	1.00
BOP-84(i)	2/3/2015	1552	1133	901	574	202		Clear, low, veg odor, no sheen	0.00	0.00	0.15	0.05	0.00	0.00	0.21	0.15	0.00	0.02	0.73	0.26	--	--	--	1.00
BOP-84(i)	5/4/2015	1642	1223	991	664	292	-76	Clear, low, veg odor/sheen	0.00	0.00	0.09	0.05	0.00	0.00	0.14	0.09	0.00	0.02	0.64	0.35	--	--	--	1.00
BOP-84(i)	11/6/2015	1828	1409	1177	850	478	110	Clear, low, veg odor/veg sheen	0.00	0.00	0.03	0.03	0.00	0.00	0.06	0.03	0.00	0.00	0.46	0.54	--	--	--	1.00
BOP-84(i)	2/4/2016	1918	1499	1267	940	568	200		0.00	0.00	0.04	0.03	0.00	0.00	0.07	0.04	0.00	0.00	0.52	0.48	--	--	--	1.00
BOP-84(i)	5/5/2016	2009	1590	1358	1031	659	291	Clear, low, veg odor, fizzy	0.00	0.00	0.04	0.04	0.00	0.00	0.07	0.04	0.00	0.00	0.53	0.47	--	--	--	1.00
BOP-84(i)	8/8/2016	2104	1685	1453	1126	754	386	Clear, low, veg odor, no sheen	0.00	0.00	0.05	0.03	0.00	0.00	0.07	0.05	0.00	0.00	0.64	0.36	--	--	--	1.00
BOP-84(i)	11/4/2016	2193	1774	1542	1215	843	475		0.00	0.00	0.05	0.02	0.00	0.00	0.07	0.05	0.00	0.00	0.66	0.34	--	--	--	1.00
BOP-84(i)	2/8/2017	2289	1870	1638	1311	939	571		0.00	0.00	0.04	0.04	0.00	0.00	0.08	0.04	0.00	0.02	0.52	0.46	--	--	--	1.00
BOP-84(i)	5/16/2017	2386	1967	1735	1408	1036	668		0.00	0.00	0.04	0.03	0.00	0.00	0.08	0.04	0.00	0.03	0.55	0.42	--	--	--	1.00
BOP-84(i)	8/9/2017	2471	2052	1820	1493	1121	753		0.00	0.00	0.04	0.02	0.00	0.00	0.07	0.04	0.00	0.02	0.62	0.35	--	--	--	1.00
BOP-85(i)	2/8/2012	461	42					Clear, colorless, no odor, no sheen	0.01	0.25	0.07	0.00	0.00	0.00	0.33	0.25	0.03	0.77	0.20	0.00	--	--	--	1.00
Injection Well	5/4/2012	547	128						0.00	0.22	0.07	0.00	0.00	0.00	0.29	0.22	0.00	0.77	0.23	0.00	--	--	--	1.00
BOP-85(i)	8/9/2012	644	225	-7				Clear, colorless, no odor, no sheen	0.01	0.24	0.06	0.00	0.00	0.00	0.31	0.24	0.02	0.79	0.19	0.00	--	--	--	1.00
BOP-85(i)	11/8/2012	735	316	84				Clear, colorless, no odor, no sheen	0.01	0.15	0.04	0.00	0.00	0.00	0.20	0.15	0.03	0.75	0.22	0.00	--	--	--	1.00
BOP-85(i)	2/6/2013	825	406	174					0.00	0.28	0.07	0.00	0.00	0.00	0.36	0.28	0.01	0.79	0.20	0.00	--	--	--	1.00
BOP-85(i)	5/2/2013	910	491	259	-68			Clear, colorless, no odor, no sheen	0.01	0.23	0.06	0.00	0.00	0.00	0.29	0.23	0.02	0.77	0.20	0.00	--	--	--	1.00
BOP-85(i)	8/7/2013	1007	588	356	29				0.00	0.01	0.23	0.01	0.00	0.00	0.25	0.23	0.01	0.04	0.89	0.05	--	--	--	1.00
BOP-85(i)	11/8/2013	1100	681	449	122			Clear, colorless, spicy odor, no sheen	0.00	0.00	0.02	0.03	0.00	0.00	0.06	0.03	0.00	0.03	0.41					

**Table 2**  
**Bioremediation Progress Results**  
**Former Degreaser Source Area**  
**Boeing Portland**

Well	Date	Elapsed Time from Injections (days)						Volatile Organic Compounds Analytical Results											Fermentation Product		Aquifer Redox Conditions										Donor Indicators	
		Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	Source Zone Wells + PRB Injection	PCE (µg/L)	TCE (µg/L)	CIS (µg/L)	VC (µg/L)	Carbon Tet (µg/L)	Chloro-form (µg/L)	Carbon Disulfide (µg/L)	Meth Chloride (µg/L)	Ethene (µg/L)	Ethane (µg/L)	E+E for plots (µg/L)	Acetylene (µg/L)	2-Butanone (µg/L)	Acetone (µg/L)	DO (mg/L)	ORP (mV)	Nitrate (mg/L)	Iron II (mg/L)	Iron, Tot (mg/L)	Iron, Diss (mg/L)	Sulfate (mg/L)	Sulfide (mg/L)	Methane (b) (mg/L)	TOC (mg/L)	pH
BOP-86(i)	2/6/2013	825	406	174			0.6	31	6.2	<0.2	<0.2	0.4	<0.5	<0.5	--	--	--	--	<5.0	<5.0	--	--	--	--	--	--	--	--	--	--	--	--
BOP-86(i)	5/2/2013	910	491	259	-68		0.7	35	7.4	<0.2	<0.2	0.2	<0.5	<0.5	--	--	--	--	<5.0	10	--	--	--	--	--	--	--	--	--	--	--	
BOP-86(i)	8/7/2013	1007	588	356	29		0.6	9.1	15	1.0	<0.2	0.3	<0.5	2.3	--	--	--	--	<5.0	13	--	--	--	--	--	--	--	--	--	--	--	
BOP-86(i)	11/8/2013	1100	681	449	122		<0.2	1.4	2.0	2.6	<0.2	<0.2	<0.5	<0.5	--	--	--	--	10	27	--	--	--	--	--	--	--	--	--	--	--	
BOP-86(i)	2/5/2014	1189	770	538	211		0.3	0.4	0.4	0.6	<0.2	<0.2	<0.5	<0.5	--	--	--	--	<5.0	6.9	--	--	--	--	--	--	--	--	--	--	--	
BOP-86(i)	5/7/2014	1280	861	629	302	-70	<0.2	0.4	1.3	0.8	<0.2	<0.2	<0.5	<0.5	--	--	--	--	<5.0	37	--	--	--	--	--	--	--	--	--	--	--	
BOP-86(i)	11/5/2014	1462	1043	811	484	112	<0.2	0.6	4.6	3.0	<0.2	0.7	1.6	2.6	--	--	--	--	<5.0	49	--	--	--	--	--	--	--	--	--	--	--	
BOP-86(i)	2/3/2015	1552	1133	901	574	202	<0.2	0.9	5.5	3.5	<0.2	1.3	2.4	2.8	--	--	--	--	58	83	--	--	--	--	--	--	--	--	--	--	--	
BOP-86(i)	5/4/2015	1642	1223	991	664	292	<0.2	3.5	5.0	2.8	<0.2	0.3	1.0	2.8	--	--	--	--	38	64	--	--	--	--	--	--	--	--	--	--	--	
BOP-86(i)	11/6/2015	1828	1409	1177	850	478	<0.2	0.3	1.6	2.8	<0.2	3.9	0.8	0.9	--	--	--	--	<5.0	72	--	--	--	--	--	--	--	--	--	--	--	
BOP-86(i)	2/4/2016	1918	1499	1267	940	568	<0.2	0.3	1.9	2.2	<0.2	4.2	1.1	1.5	--	--	--	--	15	<5.0	--	--	--	--	--	--	--	--	--	--	--	
BOP-86(i)	5/5/2016	2009	1590	1358	1031	659	<0.2	0.4	2.0	<0.2	<0.2	3.4	1.2	2.4	--	--	--	--	98	25	--	--	--	--	--	--	--	--	--	--	--	
BOP-86(i)	8/8/2016	2104	1685	1453	1126	754	<0.2	0.6	2.5	1.7	<0.2	1.4	1.1	5.0	--	--	--	--	45	38	--	--	--	--	--	--	--	--	--	--	--	
BOP-86(i)	11/4/2016	2192	1773	1541	1214	842	<0.2	0.6	2.3	1.6	<0.2	1.6	1	4.7	--	--	--	--	85	100	--	--	--	--	--	--	--	--	--	--	--	
BOP-86(i)	2/8/2017	2289	1870	1638	1311	939	<0.2	0.6	2.2	1.3	<0.2	1.7	0.7	4.0	--	--	--	--	100	97	--	--	--	--	--	--	--	--	--	--	--	
BOP-86(i)	5/16/2017	2386	1967	1735	1408	1036	<0.2	0.7	2.4	0.9	<0.2	1.9	1.1	4.0	--	--	--	--	330	110	--	--	--	--	--	--	--	--	--	--	--	
BOP-86(i)	8/9/2017	2471	2052	1820	1493	1121	<0.2	0.6	2.0	0.9	<0.2	1.5	1.0	3.8	--	--	--	--	340	87	--	--	--	--	--	--	--	--	--	--	--	
BOP-87(i)	2/8/2012	461	42				1.3	14	1.8	<1.0	<1.0	1.7	<1.0	<2.0	--	--	--	--	<5.0	<10	--	--	--	--	--	--	--	--	--	--	--	
Injection Well	5/4/2012	547	128				<1.0	24	1.4	<1.0	<1.0	1.6	<1.0	<2.0	--	--	--	--	<5.0	<10	--	--	--	--	--	--	--	--	--	--	--	
BOP-87(i)	8/9/2012	644	225	-7			2.2	52	2.6	<1.0	<1.0	<1.0	<1.0	<2.0	--	--	--	--	<5.0	<10	--	--	--	--	--	--	--	--	--	--	--	
BOP-87(i)	11/8/2012	735	316	84			1.2	9.7	1.6	<0.2	<0.2	1.8	<0.5	<0.5	--	--	--	--	<5.0	9.1	--	--	--	--	--	--	--	--	--	--	--	
BOP-87(i)	2/6/2013	825	406	174			0.4	8.5	1.2	<0.2	<0.2	1.6	<0.5	<0.5	--	--	--	--	<5.0	<5.0	--	--	--	--	--	--	--	--	--	--	--	
BOP-87(i)	5/2/2013	910	491	259	-68		0.2	7.1	1.2	<0.2	<0.2	1.3	<0.5	<0.5	--	--	--	--	<5.0	12	--	--	--	--	--	--	--	--	--	--	--	
BOP-87(i)	8/7/2013	1007	588	356	29		0.7	21	6.3	0.3	<0.2	<0.2	<0.5	1.5	--	--	--	--	<5.0	14	--	--	--	--	--	--	--	--	--	--	--	
BOP-87(i)	11/8/2013	1100	681	449	122		<0.2	0.6	6.2	0.6	<0.2	<0.2	<0.5	<0.5	--	--	--	--	21	75	--	--	--	--	--	--	--	--	--	--	--	
BOP-87(i)	2/5/2014	1189	770	538	211		<0.2	0.3	1.2	1.0	<0.2	<0.2	<0.5	<0.5	--	--	--	--	8.1	17	--	--	--	--	--	--	--	--	--	--	--	
BOP-87(i)	5/7/2014	1280	861	629	302	-70	<0.2	<0.2	0.3	0.5	<0.2	<0.2	<0.5	<0.5	--	--	--	--	<5.0	40	--	--	--	--	--	--	--	--	--	--	--	
BOP-87(i)	11/5/2014	1462	1043	811	484	112	<0.2	0.6	1.5	0.8	<0.2	<0.2	<0.5	3.1	--	--	--	--	16	52	--	--	--	--	--	--	--	--	--	--	--	
BOP-87(i)	2/3/2015	1552	1133	901	574	202	<0.2	2.1	2.2	0.9	<0.2	<0.2	0.5	1.0	--	--	--	--	23	30	--	--	--	--	--	--	--	--	--	--	--	
BOP-87(i)	5/4/2015	1642	1223	991	664	292	<0.2	1.4	2.8	0.7	<0.2	<0.2	<0.5	<0.5	--	--	--	--	50	66	--	--	--	--	--	--	--	--	--	--	--	
BOP-87(i)	11/6/2015	1828	1409	1177	850	478	<0.2	<0.2	0.3	0.5	<0.2	3.3	1.1	1.4	--	--	--	--	<5.0	40	--	--	--	--	--	--	--	--	--	--	--	
BOP-87(i)	2/4/2016	1918	1499	1267	940	568	<0.2	<0.2	0.5	0.6	<0.2	3.9	1.3	1.8	--	--	--	--	38	28	--	--	--	--	--	--	--	--	--	--	--	
BOP-87(i)	5/5/2016	2009	1590	1358	1031	659	<0.2	0.2	0.6	1.0	<0.2	2.6	0.7	2.3	--	--	--	--	49	20	--	--	--	--	--	--	--	--	--	--	--	
BOP-87(i)	8/8/2016	2104	1685	1453	1126	754	<0.2	0.3	0.9	0.8	<0.2	2.7	0.8	2.0	--	--	--	--	35	68	--	--	--	--	--	--	--	--	--	--	--	
BOP-87(i)	11/4/2016	2192	1773	1541	1214	842	<0.2	0.3	1.0	0.8	<0.2	2.4	0.7	1.8	--	--	--	--	33	27	--	--	--	--	--	--	--	--	--	--	--	
BOP-87(i)	2/8/2017	2289	1870	1638	1311	939	<0.2	0.4	1.3	1.1	<0.2	2.1	<0.5	1.5	--	--	--	--	280	50	--	--	--	--	--	--	--	--	--	--	--	
BOP-87(i)	5/16/2017	2386	1967	1735	1408	1036	<0.2	0.5	1.9	1	<0.2	1.8	0.6	1.3	--	--	--	--	230	60	--	--	--	--	--	--	--	--	--	--	--	
BOP-87(i)	8/9/2017	2471	2052	1820	1493	1121	<0.2	0.4	1.6	0.9	<0.2	1.5	0.6	0.9	--	--	--	--	140	57	--	--	--	--	--	--	--	--	--	--	--	
BOP-88(i)	2/8/2012	461	42				2.0	26	2.2	<1.0	<1.0	1.4	<1.0	<2.0	--	--	--	--	<5.0	<10	--	--	--	--	--	--	--	--	--	--	--	
Injection Well	5/4/2012	547	128				<1.0	19	2.5	<1.0	<1.0	1.1	<1.0	<2.0	--	--	--	--	<5.0	<10	--	--	--	--	--	--	--	--	--	--	--	
BOP-88(i)	8/9/2012	644	225	-7			2.8	130	8.9	<1.0	<1.0	<1.0	<1.0	<2.0	--	--	--	--	<5.0	<10	--	--	--	--	--	--	--	--	--	--	--	
BOP-88(i)	11/8/2012	735	316	84			1.2	11	1.5	<0.2	<0.2	1.9	<0.5	<0.5	--	--	--	--	27	11	--	--	--	--	--	--	--	--	--	--	--	
BOP-88(i)	2/6/2013	825	406	174			0.9	11	1.4	0.2	<0.2	1.7	<0.5	<0.5	--	--	--	--	<5.0	11	--	--	--	--	--	--	--	--	--	--	--	
BOP-88(i)	5/2/2013	910	491	259	-68		0.6	14	2.2	1.2	<0.2	1.6	<0.5	<0.5	--	--	--	--	<5.0	9.9	--	--	--	--	--	--	--	--	--	--	--	
BOP-88(i)	8/7/2013	1007	588	356	29		0.8	7.8	11	0.2	<0.2	<0.2	<0.5	0.6	<5.0	<5.0	<5.0	<5.0	21	1.19	-133.4	<0.10	2.0	--	--	<1.0	--	1.9	294	5.88		
BOP-88(i)	11/11/2013	1103	684	452	125		<0.2	0.2	85	4.1	<0.2	<0.2	<0.5	<0.5	<5.0	<5.0	<5.0	15	36	1.21	-90.1	<0.10	4.0	--	--	<1.0	--	17	458	6.20		
BOP-88(i)	2/5/2014	1189	770	538	211		<0.2	0.9	3.0	27	<0.2	<0.2	<0.5	<0.5	--	--	--	--	<5.0	7.5	--	--	--	--	--	--	--	--	--	--	--	
BOP-88(i)	5/7/2014	1280	861	629	302	-70	<0.2	1.0	3.5	7.7	<0.2	<0.2	<0.5	<0.5	--	--	--	--	<5.0	39	--	--	--	--	--	--	--	--	--	--	--	
BOP-88(i)	11/11/2014	1468	1049	817	490	118	<0.2	1.9	30	4.2	<0.2	<0.2	0.8	3.0	<5.0	<5.0	<5.0	28	84	1.36	-208.2	<1.0	4.0	639	624	276	9.7	13	3150	4.56		
BOP-88(i)	2/9/2015	1558	1139	907	580	208	0.3	12	90	4.0	<0.2	<0.2	1.3	1.1	<5.0	<5.0	<5.0	160	110	0.46	-94.9	<1.0	7.0	829	775	243	16.5	12	3990	4.90		
BOP-88(i)	5/6/2015	1644	1225	993	666	294	1.0	28	150	8.5	<0.2	<0.2	0.6	0.7	7.4																	

**Table 2**  
**Bioremediation Progress Results**  
**Former Degreaser Source Area**  
**Boeing Portland**

Well	Date	Elapsed Time from Injections						Source Zone Wells	Source Zone Wells + PRB	Source Zone Wells + PRB	Comments	VOCs- micromoles/Liter							Molar Fraction									
		Injection (a) (days)	Injection (b) (days)	Injection (c) (days)	Injection (d) (days)	Injection (e) (days)	Injection (f) (days)					PCE	TCE	CIS	VC	Ethene	Ethane	PCE+TCE+cD CE+VC	Max Compound	PCE	TCE	CIS	VC	Ethene	Ethane	E+E for plots	Total	
		Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	Source Zone Wells + PRB Injection																					
BOP-86(i)	2/6/2013	825	406	174							Clear, colorless, no odor, no sheen	0.00	0.24	0.06	0.00	0.00	0.00	0.30	0.24	0.01	0.78	0.21	0.00	--	--			1.00
BOP-86(i)	5/2/2013	910	491	259	-68						Clear, colorless, no odor, no sheen	0.00	0.27	0.08	0.00	0.00	0.00	0.35	0.27	0.01	0.77	0.22	0.00	--	--			1.00
BOP-86(i)	8/7/2013	1007	588	356	29						Clear, colorless, strong bio odor, no sheen	0.00	0.07	0.15	0.02	0.00	0.00	0.24	0.15	0.01	0.28	0.64	0.07	--	--			1.00
BOP-86(i)	11/8/2013	1100	681	449	122						Clear, colorless, strong bio odor, no sheen	0.00	0.01	0.02	0.04	0.00	0.00	0.07	0.04	0.00	0.15	0.28	0.57	--	--			1.00
BOP-86(i)	2/5/2014	1189	770	538	211						Clear, low, no odor, no sheen	0.00	0.00	0.00	0.01	0.00	0.00	0.02	0.01	0.10	0.16	0.22	0.52	--	--			1.00
BOP-86(i)	5/7/2014	1280	861	629	302	-70					Clear, low turbidity, no odor, no sheen	0.00	0.00	0.0134	0.0128	0.00	0.00	0.03	0.01	0.00	0.10	0.46	0.44	--	--			1.00
BOP-86(i)	11/5/2014	1462	1043	811	484	112					Clear, low, no odor, no sheen	0.00	0.00	0.0475	0.0480	0.00	0.00	0.10	0.05	0.00	0.05	0.47	0.48	--	--			1.00
BOP-86(i)	2/3/2015	1552	1133	901	574	202					Clear, low, no odor, no sheen	0.00	0.01	0.0567	0.0560	0.00	0.00	0.12	0.06	0.00	0.06	0.47	0.47	--	--			1.00
BOP-86(i)	5/4/2015	1642	1223	991	664	292	-76				Clear, low (veg odor/sheen - on DBS)	0.00	0.03	0.0516	0.0448	0.00	0.00	0.12	0.05	0.00	0.22	0.42	0.36	--	--			1.00
BOP-86(i)	11/6/2015	1828	1409	1177	850	478	110				Clear, low, fizzy, veg odor, veg sheen	0.00	0.00	0.0165	0.0448	0.00	0.00	0.06	0.04	0.00	0.04	0.26	0.70	--	--			1.00
BOP-86(i)	2/4/2016	1918	1499	1267	940	568	200				Clear, low, veg odor, no sheen	0.00	0.00	0.0196	0.0352	0.00	0.00	0.06	0.04	0.00	0.04	0.34	0.62	--	--			1.00
BOP-86(i)	5/5/2016	2009	1590	1358	1031	659	291				Clear, low, veg odor, no sheen	0.00	0.00	0.0206	0.0000	0.00	0.00	0.02	0.02	0.00	0.13	0.87	0.00	--	--			1.00
BOP-86(i)	8/8/2016	2104	1685	1453	1126	754	386				Clear, low, veg odor, slight sheet, slightly fizzy	0.00	0.00	0.0258	0.0272	0.00	0.00	0.06	0.03	0.00	0.08	0.45	0.47	--	--			1.00
BOP-86(i)	11/4/2016	2192	1773	1541	1214	842	474				Clear, low, veg odor, no sheen	0.00	0.00	0.0237	0.0256	0.00	0.00	0.05	0.03	0.00	0.08	0.44	0.48	--	--			1.00
BOP-86(i)	2/8/2017	2289	1870	1638	1311	939	571				Clear, low, veg odor, no sheen	0.00	0.00	0.0227	0.0208	0.00	0.00	0.05	0.02	0.00	0.10	0.47	0.43	--	--			1.00
BOP-86(i)	5/16/2017	2386	1967	1735	1408	1036	668				Clear, low, veg odor, no sheen	0.00	0.01	0.0248	0.0144	0.00	0.00	0.04	0.02	0.00	0.12	0.56	0.32	--	--			1.00
BOP-86(i)	8/9/2017	2471	2052	1820	1493	1121	753				Clear, low, veg odor, no sheen	0.00	0.00	0.0206	0.0144	0.00	0.00	0.04	0.02	0.00	0.12	0.52	0.36	--	--			1.00
BOP-87(i)	2/8/2012	461	42								Clear, colorless, no odor, no sheen	0.01	0.11	0.02	0.00	0.00	0.00	0.13	0.11	0.06	0.80	0.14	0.00	--	--			1.00
Injection Well	5/4/2012	547	128								Clear, colorless, no odor, no sheen	0.00	0.18	0.01	0.00	0.00	0.00	0.20	0.18	0.00	0.93	0.07	0.00	--	--			1.00
BOP-87(i)	8/9/2012	644	225	-7							Clear, colorless, no odor, no sheen	0.01	0.40	0.03	0.00	0.00	0.00	0.44	0.40	0.03	0.91	0.06	0.00	--	--			1.00
BOP-87(i)	11/8/2012	735	316	84							Clear, colorless, no odor, no sheen	0.01	0.07	0.02	0.00	0.00	0.00	0.10	0.07	0.07	0.76	0.17	0.00	--	--			1.00
BOP-87(i)	2/6/2013	825	406	174							Clear, colorless, no odor, no sheen	0.00	0.06	0.01	0.00	0.00	0.00	0.08	0.06	0.03	0.81	0.16	0.00	--	--			1.00
BOP-87(i)	5/2/2013	910	491	259	-68						Clear, colorless, no odor, no sheen	0.00	0.05	0.01	0.00	0.00	0.00	0.07	0.05	0.02	0.80	0.18	0.00	--	--			1.00
BOP-87(i)	8/7/2013	1007	588	356	29						Clear, colorless, strong bio odor, no sheen, some effervescence	0.00	0.16	0.06	0.00	0.00	0.00	0.23	0.16	0.02	0.68	0.28	0.02	--	--			1.00
BOP-87(i)	11/8/2013	1100	681	449	122						Clear, low, no odor, no sheen	0.00	0.00	0.06	0.01	0.00	0.00	0.08	0.06	0.00	0.06	0.82	0.12	--	--			1.00
BOP-87(i)	2/5/2014	1189	770	538	211						Clear, low, no odor, no sheen	0.00	0.00	0.01	0.02	0.00	0.00	0.03	0.02	0.00	0.07	0.40	0.52	--	--			1.00
BOP-87(i)	5/7/2014	1280	861	629	302	-70					Clear, low turbidity, no odor, no sheen	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.28	0.72	--	--			1.00
BOP-87(i)	11/5/2014	1462	1043	811	484	112					Clear, low, no odor, no sheen	0.00	0.00	0.02	0.01	0.00	0.00	0.03	0.02	0.00	0.14	0.47	0.39	--	--			1.00
BOP-87(i)	2/3/2015	1552	1133	901	574	202					Clear, low, no odor, no sheen	0.00	0.02	0.02	0.01	0.00	0.00	0.05	0.02	0.00	0.30	0.43	0.27	--	--			1.00
BOP-87(i)	5/4/2015	1642	1223	991	664	292	-76				Clear, low (veg odor/sheen - on DBS)	0.00	0.01	0.03	0.01	0.00	0.00	0.05	0.03	0.00	0.21	0.57	0.22	--	--			1.00
BOP-87(i)	11/6/2015	1828	1409	1177	850	478	110				Clear, low, veg odor, veg sheen on DBS	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.28	0.72	--	--			1.00
BOP-87(i)	2/4/2016	1918	1499	1267	940	568	200				Clear, low, veg odor, no sheen	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.35	0.65	--	--			1.00
BOP-87(i)	5/5/2016	2009	1590	1358	1031	659	291				Clear, low, veg odor, fizzy	0.00	0.00	0.01	0.02	0.00	0.00	0.02	0.02	0.00	0.06	0.26	0.67	--	--			1.00
BOP-87(i)	8/8/2016	2104	1685	1453	1126	754	386				Clear, low, veg odor, fizzy, no sheen	0.00	0.00	0.01	0.01	0.00	0.00	0.02	0.01	0.00	0.09	0.38	0.53	--	--			1.00
BOP-87(i)	11/4/2016	2192	1773	1541	1214	842	474				Clear, low, veg odor, no sheen	0.00	0.00	0.01	0.01	0.00	0.00	0.03	0.01	0.00	0.09	0.41	0.50	--	--			1.00
BOP-87(i)	2/8/2017	2289	1870	1638	1311	939	571				Clear, low, veg odor, no sheen	0.00	0.00	0.01	0.02	0.00	0.00	0.03	0.02	0.00	0.09	0.39	0.52	--	--			1.00
BOP-87(i)	5/16/2017	2386	1967	1735	1408	1036	668				Clear, low, veg odor, no sheen	0.00	0.00	0.02	0.02	0.00	0.00	0.04	0.02	0.00	0.10	0.50	0.41	--	--			1.00
BOP-87(i)	8/9/2017	2471	2052	1820	1493	1121	753				Clear, low, veg odor, no sheen	0.00	0.00	0.02	0.01	0.00	0.00	0.03	0.02	0.00	0.09	0.49	0.42	--	--			1.00
BOP-88(i)	2/8/2012	461	42								Clear, colorless, no odor, no sheen	0.01	0.20	0.02	0.00	0.00	0.00	0.23	0.20	0.05	0.85	0.10	0.00	--	--	0.0		1.00
Injection Well	5/4/2012	547	128								Clear, colorless, no odor, no sheen	0.00	0.14	0.03	0.00	0.00	0.00	0.17	0.14	0.00	0.85	0.15	0.00	--	--	0.0		1.00
BOP-88(i)	8/9/2012	644	225	-7							Clear, colorless, no odor, no sheen	0.02	0.99	0.09	0.00	0.00	0.00	1.10	0.99	0.02	0.90	0.08	0.00	--	--	0.0		1.00
BOP-88(i)	11/8/2012	735	316	84							Clear, colorless, no odor, no sheen	0.01	0.08	0.02	0.00	0.00	0.00	0.11	0.08	0.07	0.79	0.15	0.00	--	--	0.0		1.00
BOP-88(i)	2/6/2013	825	406	174							Clear, colorless, no odor, no sheen	0.01	0.08	0.01	0.00	0.00	0.00	0.11	0.08	0.05	0.78	0.14	0.03	--	--	0.0		1.00
BOP-88(i)	5/2/2013	910	491	259	-68						Clear, colorless, moderate bio odor, no sheen	0.00	0.11	0.02	0.02	0.00	0.00	0.15	0.11	0.02	0.70	0.15	0.13	--	--	0.0		1.00
BOP-88(i)	8/7/2013	1007	588	356	29						Clear, colorless, moderate bio odor, no sheen	0.00	0.06	0.11	0.00	0.00	0.00	0.18	0.11	0.03	0.33	0.63	0.02	0.00	0.00	0.00	0.00	1.00
BOP-88(i)	11/11/2013	1103	684	452	125						Slightly cloudy, gray, bio odor, no sheen	0.00	0.00	0.88	0.07	0.00	0.00	0.94	0.88	0.00	0.00	0.93	0.07	0.00	0.00	0.00	0.00	1.00
BOP-88(i)	2/5/2014	1189	770	538	211						Clear, low, no odor, no sheen	0.00	0.01	0.03	0.43	0.00	0.00	0.47	0.43	0.00	0.01	0.07	0.92	--	--	0.0		1.00
BOP-88(i)	5/7/2014	1280	861	629	302	-70					Clear, low turbidity, no odor, no sheen	0.00	0.01	0.04	0.12	0.00	0.00	0.17	0.12	0.00	0.05	0.22	0.74	--	--	0.0		1.00
BOP-88(i)	11/11/2014	1468	1049	817	490	118					Light brown, medium, veg sheen, veg odor	0.00	0.01	0.31	0.07	0.00	0.00	0.39	0.31	0.00	0.04	0.79	0.17	0.00	0.00	0.00	0.00	1.00
BOP-88(i)	2/9/2015	1558	1139	907	580	208																						

**Table 2**  
**Bioremediation Progress Results**  
**Former Degreaser Source Area**  
**Boeing Portland**

cis = 1,2-dichloroethene	ORP = oxygen reduction potential
Diss = dissolved	PCE = tetrachloroethene
DO = dissolved oxygen	PRB = permeable reactive barrier
gpm = gallons per minute	TOC = total organic carbon
µg/L = micrograms per liter	TCE = trichloroethene
mg/L = milligrams per liter	VC = vinyl chloride

Injection Notes

- a) November 4-9, 2010: Conduct pilot injection test at BOP-72(i) with 900 gal of water mixed with 3/4 drum of Wilclear sodium lactate.
- b) December 28, 2011: PRB injection at BOP-74(i). Injected 15 drums of LactOil, Newman Zone vegetable oil emulsion, and Wilclear sodium lactate with 15,000 gallons of water. Injection rates were between 70 to 80 gpm.
- c) August 18, 2012: Conducted PRB injection at BOP-74(i) with 30,000 gallons of lactoil and water mixture.
- d) July 2-9, 2013: Conducted gravity injection at seven source area zone injection wells (BOP-78, 79, 84, 85, 86, 87, 88). Injection of 10,000 gallons total lactoil donor and water. Average injection rates ranged from 4.8 to 11.7 gpm.
- e) July 12-16, 2014: Conducted source area zone injection by gravity flow to seven multi-purpose injection wells and pump flow to PRB well BOP-74(i). Injection consisted of 50,000-gallon mixture of water, Textrol BR, glycerin, and ferrous sulfate.
- f) June 8-19, 2015: Conducted source area zone injection by gravity flow to seven multi-purpose injection wells and pump flow to PRB well BOP-74(i). Injection consisted of 50,000-gallon mixture of water, Textrol BR, glycerin, and ferrous sulfate.

Notes:

-- Data not collected or analyzed

Blue highlighted values indicate the compound with the highest micromoles per event, ethene and ethane combined are considered for maximum molar fraction. Compounds with 2 percent of maximum compound are also highlighted due to potential laboratory variability.

**Table 3**  
**Injection Design**  
**Former Degreaser Source Area**  
**Boeing Portland**

Well ID	Injection Solution Composition								Combined Injection Solution Volume (gallons) (a)	Resulting Injection Fluid Concentrations		
	FeSO4 25% wt Solution (gallons)	FeSO4 25% wt Solution (totes)	Textrol (gallons)	TBR (drums)	Glycerin (gallons)	Glycerin (totes)	Yeast Extract (lb)	Potable Water (gallons)		FeSO <sub>4</sub> (% wt) (b)	Textrol (%vol)	Glycerin (%vol)
BOP-74(i)	1,684	6.19	565	<b>11.83</b>	903	3.3	20	16,848	<b>20,000</b>	2.1%	2.8%	4.5%
BOP-78(i)	367	1.35	121	<b>2.52</b>	193	0.71	4	3,605	<b>4,286</b>	2.1%	2.8%	4.5%
BOP-79(i)	367	1.35	121	<b>2.52</b>	193	0.71	4	3,605	<b>4,286</b>	2.1%	2.8%	4.5%
BOP-84(i)	367	1.35	121	<b>2.52</b>	193	0.71	4	3,605	<b>4,286</b>	2.1%	2.8%	4.5%
BOP-85(i)	367	1.35	121	<b>2.52</b>	193	0.71	4	3,605	<b>4,286</b>	2.1%	2.8%	4.5%
BOP-86(i)	367	1.35	121	<b>2.52</b>	193	0.71	4	3,605	<b>4,286</b>	2.1%	2.8%	4.5%
BOP-87(i)	367	1.35	121	<b>2.52</b>	193	0.71	4	3,605	<b>4,286</b>	2.1%	2.8%	4.5%
BOP-88(i)	367	1.35	121	<b>2.52</b>	193	0.71	4	3,605	<b>4,286</b>	2.1%	2.8%	4.5%
BOP-75(i) (c)	367	1.35	121	<b>2.52</b>	193	0.71	4	3,605	<b>4,286</b>	2.1%	2.8%	4.5%
<b>Totals</b>	<b>4,620</b>	<b>17.0</b>	<b>1,529</b>	<b>32.0</b>	<b>2,448</b>	<b>9.0</b>	<b>54</b>	<b>45,691</b>	<b>54,288</b>			

**Acronyms/Abbreviations:**

ID = identification  
 % = percent  
 lb = pounds  
 vol = volume  
 wt = weight

**Notes:**

- (a) Does not include pre- and post-injection potable water flushes.  
 (b) Weight percent dry FeSO<sub>4</sub>\*7H<sub>2</sub>O in combined injection volume.  
 (c) Added for first time during 2017 injection.

**Table 4**  
**Bioremediation Monitoring Parameters**  
**Former Degreaser Source Area**  
**Boeing Portland**

Field Parameters	Information Provided
Dissolved Oxygen (DO) [field meter] (a)	Aquifer is considered anaerobic at DO concentrations less than 1.0 milligram per liter (mg/L).
Oxidation Reduction Potential (Redox) [field meter] (a)	Negative values indicate reducing conditions.
pH [field meter] (a)	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).
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 SM 5310 C-2000][250 ml Amber-H2SO4]	Levels will increase due to arrival of volatile fatty acids released from injected donor substrate.
Nitrate (c) [IC Method E300][500 ml poly]	Decreasing concentrations indicate nitrate-reducing conditions.
Sulfate [IC Method E300][500 ml poly]	Decreasing concentrations indicate sulfate-reducing conditions.
Sulfide [IC Method E376.1][500 ml glass-NaOH, ZnAC]	Increasing concentrations indicate sulfate-reducing conditions and stimulate iron sulfide production resulting in abiotic reduction.
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 aquifer redox conditions.
Total and Dissolved Iron [Method SW 846 6010C][2-250 ml poly-NHO3]	Increasing concentrations will complex with sulfide and precipitate resulting in abiotic degradation.

**Acronyms/Abbreviations:**

ACFEE = Air Force Center for Environmental Excellence  
ESTCP = Environmental Security Technology Certification Program

**Notes:**

- (a) Measured using a flow-through cell.
- (b) Care to be taken during sample collection to minimize aeration and volatilization. Sample collected with no headspace.
- (c) Nitrate sample can be combined with sulfate sample; nitrate analysis to be performed within 48 holding time.

**Information Sources:**

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 ACFEE under Contract #41624-99-C-8032. December 19.