Risk Evaluation for the Diesel Fuel Leak near Generator Building TRA-674 at the Advanced Test Reactor Complex

August 2017

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August 2017

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ABSTRACT

This report describes the risk-based evaluation conducted for the underground diesel fuel leak near Generator Building TRA-674 at the Advanced Test Reactor Complex, located at the Idaho National Laboratory. The risk evaluation process followed the *Idaho Risk Evaluation Manual for Petroleum Releases* (August 2012) guidance document and used the Idaho Risk Evaluation Computational Software (August 2015) to estimate the human health risks posed by residual contamination. Site-specific data were collected to estimate the representative concentrations of the soil for estimating the cumulative risk. Based on historical and current data, the site does not exceed unacceptable risk to human health receptors.

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ACRONYMS

ATR	Advanced Test Reactor
BEA	Battelle Energy Alliance, LLC
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, xylene
COC	contaminant of concern
DRO	Diesel range organics
DOE	Department of Energy
EPA	Environmental Protection Agency
gph	gallons per hour
gpm	gallons per minute
GRO	gasoline range organics
HI	hazard index
IDEQ	Idaho Department of Environmental Quality
INL	Idaho National Laboratory
PAH	polyaromatic hydrocarbons
PID	photoionization detector
ppm	parts per million
RE	risk evaluation
REM	Idaho Risk Evaluation Manual
SCM	Site Conceptual Model
SME	subject matter expert
SRPA	Snake River Plain Aquifer
SVOC	semivolatile organic compound
TPH	total petroleum hydrocarbon
USGS	United States Geological Survey
UST	underground storage tank
VOA	volatile organic analyte

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Risk Evaluation for the Diesel Fuel Leak near Generator Building TRA-674 at the Advanced Test Reactor Complex

1. INTRODUCTION

1.1 Scope

This report describes the risk-based evaluation process conducted for the diesel fuel leak from underground piping near Generator Building TRA-674 at the Advanced Test Reactor Complex located at the Idaho National Laboratory (INL). The risk evaluation process followed the *Idaho Risk Evaluation Manual* (REM) (IDEQ, 2012) guidance document and used the Idaho Risk Evaluation Computational Software v1.1.3 (IDEQ, 2015) to estimate the human health risks posed by residual contamination. Site-specific data were collected to estimate the representative concentrations of the soil for estimating the cumulative risk.

1.2 Objective

The objective of the risk evaluation (RE) is to estimate the potential human health risks posed by residual diesel fuel contamination.

2. REVIEW AND ANALYSIS OF AVAILABLE DATA

2.1 Introduction

The following information is a summary of available information that describes the site area, chronology of events, and the release scenario and source.

2.2 Site Description and Land Use

2.2.1 Location and Vicinity

The INL Site is an 890 square-mile (mi^2) Department of Energy (DOE) site located in southeastern Idaho, and is 34 miles west of Idaho Falls, 38 miles northwest of Blackfoot, and 22 miles east of Arco (see Figure 1). The INL Site is owned by the federal government and administered, managed, and controlled by DOE. It is primarily located within Butte County; however, portions of the site are also in Bingham, Jefferson, Bonneville, and Clark Counties (DOE, 2005).

The Advanced Test Reactor (ATR) complex is located in the western portion of the INL, and has been used since the early 1950s to support research and national security goals. Functions housed at the ATR complex include laboratories, test reactors, dry transfer cubicles, and engineering support services.

A leak of diesel number 2 fuel was identified in the underground diesel fuel transfer line between TRA-627 and day tank TRA-776 in 2016 during the development of a Tier 1 air monitoring report. It was determined that the leak was ongoing from 2006 to early 2016. The location of the leak is shown on Figure 2.

2.2.2 Topography

The Lost River and Lemhi Ranges and the mouths of the valleys of the Big Lost and Little Lost Rivers bound the INL site on the west and northwest. On the north, the mouth of the Birch Creek Valley and the southern tip of the Beaverhead Mountains of the Bitterroot Range bound the site on the Idaho-Montana border. Features to the south and east of the site are similar to those found on the site, characterized by relatively flat topography punctuated by several prominent volcanic buttes and numerous

basalt flows. The average surface elevation on the INL is approximately 5,000 feet [ft] above sea level, although isolated buttes reach elevations of nearly 6,600 ft (INL, 2005).

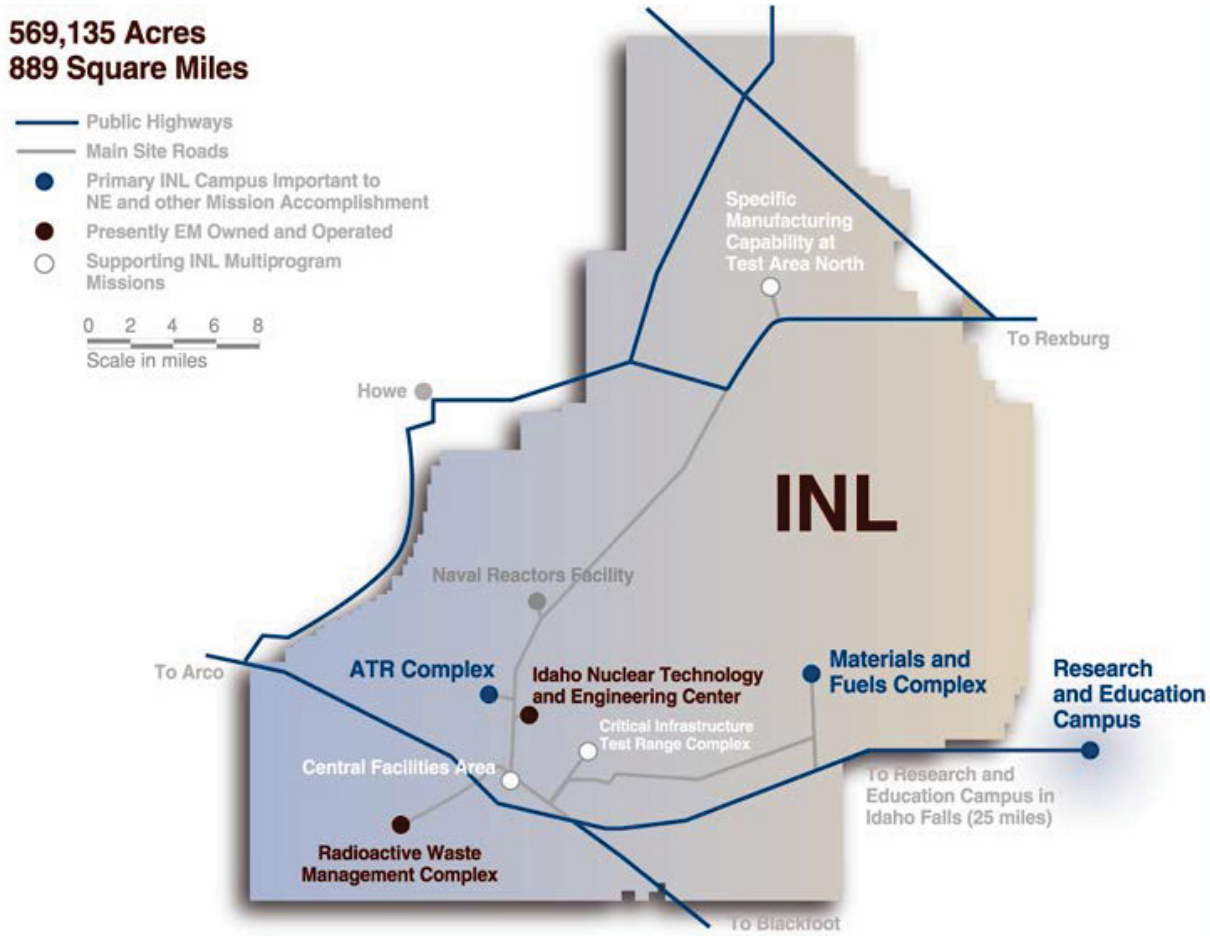

Figure 1. Map of the INL Site showing the location of ATR complex.

2.2.3 Current Land Use

Current land use at the ATR complex is industrial. The area near the release site has been under industrial use since it was withdrawn from public domain in May 1946 for use as the Naval Proving Ground.

2.2.4 Future Land Use

It is anticipated that over the next 10 years new on-site industrial development and major facility decontamination and decommissioning will continue to occur at the INL. ATR is expected to continue testing and research activities until 2050. Additionally under CERCLA, ATR will remain under an Industrial Scenario until 2095.

2.3 Chronology of Events

A chronological sequence of events is listed below for the identification of the petroleum leak.

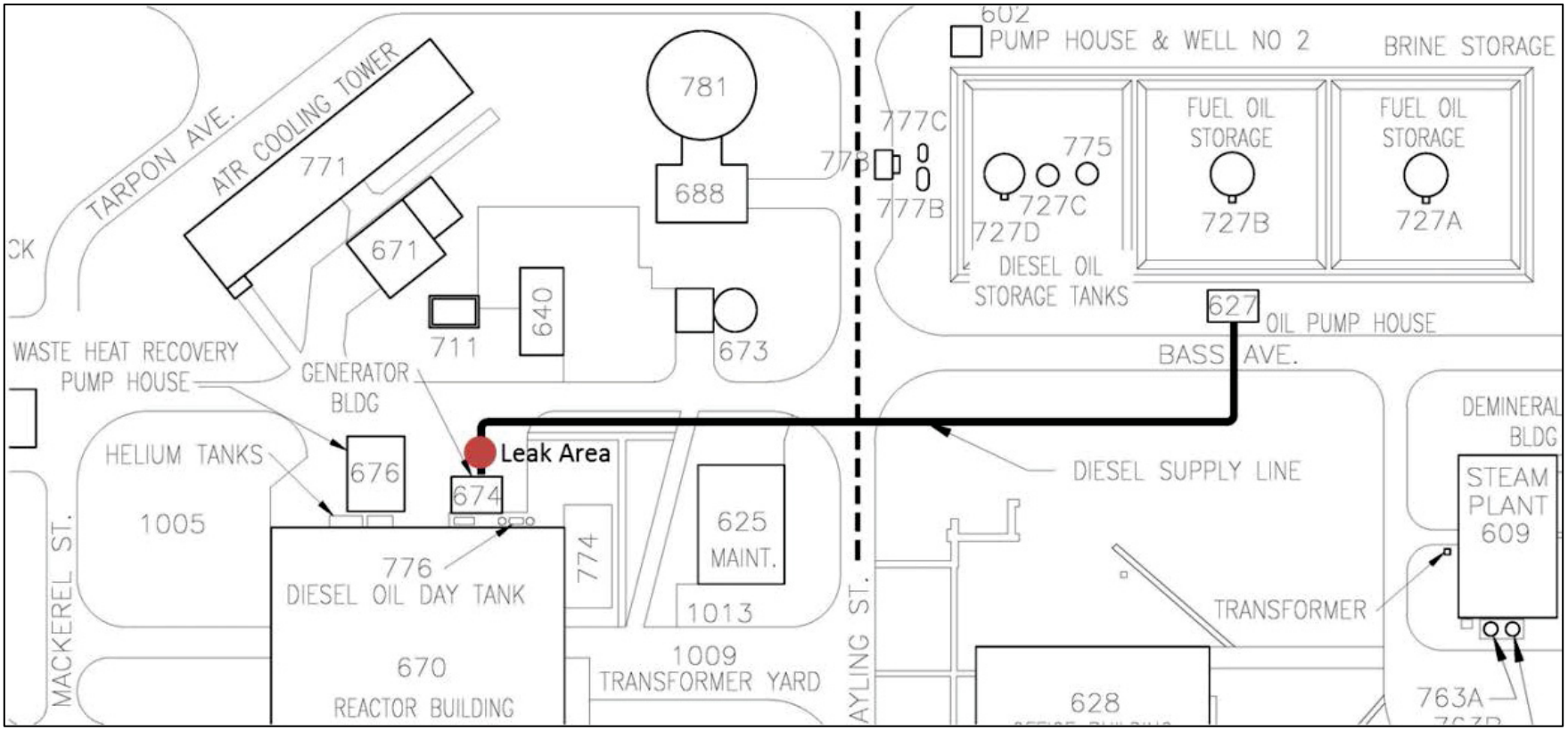

Figure 2. Location of ATR diesel fuel transfer line leak.

- 01/18/2016: ATR environmental group identified fuel usage data discrepancies during development of Tier 1 air report.
- 01/27/2016: ATR environmental group completed data analysis and confirmed leak in a diesel fuel transfer line. Reported discrepancy to the Idaho Department of Environmental Quality (IDEQ). Isolated system pending tightness testing.
- 02/08/2016: Wheeler Tank Testing Inc. representative walked down system to identify system modification required to perform tightness test.
- 02/11/2016: ATR environmental group initiated procurement of components for line isolation and modifications for tightness testing. Conducted air pressure testing on system to determine if the existing valves will support tightness testing. Valves failed.
- 02/24/2016: Water samples were collected by the United States Geological Survey (USGS) group from USGS Perched Water Well PW-13 (Figure 4) near the diesel fuel transfer line and analyzed for Total Petroleum Hydrocarbon (TPH). Results indicated no detectable levels present.
- 03/02/2016: ATR environmental group had discussions with IDEQ about the path forward for conducting tightness testing.
- 03/21/2016: Tightness testing was attempted by Wheeler Tank Testing Inc. Pump not adequate to purge air from system. Testing rescheduled.
- 03/22/2016: ATR environmental group notified IDEQ about tightness testing rescheduling.
- 03/24/2016: ATR engineering conducted system modifications to support tightness testing.
- 03/29/2016: Wheeler Tank Testing Inc. conducted tightness test. Leaks were identified in the diesel fuel transfer line; however, exact location was unknown. The test concluded that the leak in the diesel fuel transfer line to the generator had an approximate leakage of 2.84 gallons per hour (gph) at 1.5 times normal operating pressure and a rate of 0.51 gallons per hour (gph) at static pressure. Using historic operational knowledge and fuel usage rates, the ATR environmental group determined that the leak began around July 21, 2006 at a rate of 0.151 gph and notified DOE, IDEQ, and StateComm of verified leak. INL issued Occurrence Reporting and Processing System (ORPS) reportable 5.A.3.4.
- 03/31/2016: ATR environmental group conducted groundwater modeling of petroleum leak using conservative assumptions.
- 04/04/2016: INL environmental collected annual groundwater monitoring samples and evaluated potential impact to wells. No immediate impact was indicated.
- 04/05/2016: ATR environmental group contacted IDEQ to discuss results of annual groundwater monitoring and develop path forward.
- 04/07/2016: ATR environmental group conducted vapor testing using photoionization detector (PID) of manholes near diesel line. No elevated levels were detected (3-10 parts per million [ppm]).
- 04/19/2016: ATR environmental group completed work planning and conducted helium tracer test to locate leak. Sections of the diesel fuel transfer line were isolated and the helium test was conducted to identify the leak location. The leak was narrowed down to a 450-ft section of diesel fuel transfer line between TRA-627 to TRA-674.
- 04/20/2016: ATR engineering group conducted acoustic hearing testing to validate helium testing. Acoustic signals were detected in the general area around the man-way west of TRA-627.
- 04/25/2016: ATR environmental group oversaw identification of underground utilities in the proposed excavation area.

- 04/26/2016: ATR environmental group notified IDEQ of progress and set up onsite IDEQ underground storage tank (UST) subject matter expert (SME) visit.
- 04/28/2016: ATR environmental group conducted onsite walk down with IDEQ UST SME. IDEQ advised that no imminent environmental or personnel safety concerns are present due to the leak.
- 05/18/2016: ATR environmental group reached agreement with existing contractor, Sunrock, to perform vacuum excavation of soil near the diesel fuel transfer line to identify potentially oil laden soils.
- 05/20/2016: ATR environmental group updated IDEQ regional office on status of project.
- 06/28/2016: ATR maintenance conducted an air drop test on the failed diesel fuel transfer line. Sunrock began vacuum excavation of soils near TRA-674 in a 15-ft trench to allow inspection of soils and piping. The trench was approximately 8 ft below ground surface (bgs). A trench box was installed around the diesel fuel transfer line. The diesel fuel transfer line is a 1.5-inch diameter; carbon steel pipe with asbestos insulation located approximately 8 feet bgs. No diesel was identified in the soil or in the pipe.
- 08/11/216: Boreholes were installed via vacuum extraction around the diesel line to screen soils for TPH under the supervision of ATR environmental group. A total of five boreholes were dug to a depth of 9 ft bgs, spaced approximately 75 ft apart along a 450 ft section of diesel line. All samples were non-detect for TPH.
- 09/08/2016: ATR environmental group requested ATR engineering to conduct additional helium testing on the fuel oil transfer line between day tank TRA-776 and the trench box north of TRA-670.
- 10/04/2016: ATR environmental group called IDEQ to provide status on investigation activities and provide an update that diesel contaminated soil was discovered during exploratory excavation around the suspect diesel fuel transfer line approximately 15 ft north of TRA-674.
- 10/10/2016: Additional excavations were made east, west, and south of the initial excavation. PID sampling of exposed soil indicated diesel vapor in both the east and west excavations. Additional excavation was conducted and the leak was identified approximately 15 ft from TRA-674.
- 11/1/2016: Portage collected samples during the vacuum excavation activities around the suspected leak area. Samples were collected at 11, 13, and 16.5 ft bgs and sent to GEL Laboratories for benzene, toluene, ethylbenzene, xylene (BTEX), diesel range organics (DRO), gasoline range organics (GRO), and polyaromatic hydrocarbons (PAH). Results indicate the presence of DRO and GRO and low BTEX and PAH concentrations. All results were below IDEQ screening levels.
- 01/09/2017: Subcontract established with Portage to conduct soil coring activities around the diesel line and in the expected area of petroleum migration.
- 02/06/2017: Portage drilled six soil cores using a drill auger until basalt was encountered (approximately 30 ft bgs). The cores were drilled to the following depth (bgs):
  - Borehole 1 - 29 ft
  - Borehole 2 - 29.5 ft
  - Borehole 3 - 29 ft
  - Borehole 4 - 28 ft
  - Borehole 5 - 28 ft.

  Samples were collected at 5-ft intervals starting at 15 ft bgs and sent to GEL Laboratories for volatile organic analytes (VOAs), PAH, and BTEX analysis. Photographs are found in Appendix A.
- 02/08/2017: Samples arrive at the laboratory.

- 03/06/2017: Sample results indicate samples collected from Borehole 2 at a depth of 29.5 ft bgs exceed IDEQ screening levels.
- 05/20/2017: Subcontract established to perform an IDEQ Risk Evaluation.

2.4 Site Geology and Soil Stratigraphy

2.4.1 Regional Geology

The INL is located near the northeast end of the Snake River Plain. The land surface of the INL is relatively flat lying approximately 5,000 ft above sea level. Several prominent volcanic buttes and numerous basalt flows are present in the area. Despite the fact that the subsurface geology of the INL site is dominated by basalt, most soils found on the INL site are derived from older silicic volcanic and paleozoic rocks. The ground surface at the INL consists primarily of four basic soils regimes: (1) wind-blown sediments over lava flows, (2) river transported sediments deposited on alluvial plains, (3) fine-grained eroded sediments eroded into lake or playa basins, and (4) colluvial sediments originating from bordering mountains (INL, 2005).

The soil in the area of the release is primarily sand and gravel. Soil depths are approximately 30 ft bgs based on boreholes dug in the area with a clay layer atop the uppermost basalt layer. Regional data indicate that the soils in this area are primarily loess, and are characterized as having moderate infiltration rates.

2.4.2 Stratigraphy

The ATR complex is located on an alluvial plain consisting of surficial sediment with thickness ranging from 30 to 75 ft bgs. A complex sequence of basalt flows and sedimentary interbeds underlies the surficial sediments. Drill holes indicate that bedrock beneath INL facilities is composed of about 5,300 ft of alternating layers of basalt rock and loosely consolidated sediments. Sedimentary interbeds consist of deposits of clay, silt, sand, and gravel that accumulated during periods of volcanic inactivity ranging from thousands to hundreds of thousands of years. Basalt and sediment of this sequence are unsaturated to depths that range from 430 to 480 ft below land surface. Basalt and sediment in the lower part of the sequence are saturated and make up the uppermost part of the Snake River Plain Aquifer (SRPA) (DOE, 1991).

2.5 Water Sources

2.5.1 Groundwater Flow Direction and Magnitude

The SRPA lies below the INL Site. It covers an area of approximately 9,600 mi^2 in southeastern Idaho. This aquifer is the major source of drinking water for southeastern Idaho and has been designated a Sole Source Aquifer by the Environmental Protection Agency (EPA). Water in the aquifer mainly moves horizontally on a regional basis through basalt interflow zones and flows primarily toward the southwest. Water storage in the aquifer is estimated at 2 billion acre-ft, and irrigation wells can yield 7,000 gal per minute. The USGS has estimated the thickness of the active portion of the SRPA at the INL Site ranges between 250 to 820 ft. Depth to the water table ranges from approximately 200 ft below land surface in the northern part of the site to more than 900 ft in the southern part (DOE, 2006). Depth to the SRPA at the ATR complex is approximately 450 ft bgs.

2.5.2 Surface Water

The current water use at the INL and surrounding area is used for drinking, industrial, and irrigation. There are three main surface waters located near the INL, which include the Big and Little Lost Rivers and Birch Creek. These three streams are intermittent and drain from the mountain areas to the north and west of the INL Site, although most flow is diverted for irrigation in the summer months before it reaches the site boundaries. Flow that reaches the INL Site infiltrates the ground surface along the length of the streambeds in the spreading areas at the southern end of the site, and if stream flow is sufficient, in the

ponding areas (playas or sinks) in the northern portion of the site. Other than the three intermittent streams, the only other surface water bodies on the site include natural wetland-like ponds and man-made percolation and evaporation ponds (DOE, 2006). The nearest evaporation ponds are approximately 0.75 mi from the leak.

2.5.3 Perched Water Table

Shallow and deep perched water tables have formed at ATR due to the former evaporation and infiltration ponds, which have since been lined, located outside of the ATR fenced area. The perched tables are created by lenses of low permeability silts and clays within an interbedded basalt-sediment sequence overlying the primary basalt flows (DOE, 2005). The shallow perched water table is located at depth of approximately 50 ft bgs, while the deep perched water table is located at approximately 140 ft bgs. Figure 3 shows the approximate location of the deep perched water table. Water from the perched tables is not utilized for domestic, industrial, or agricultural use.

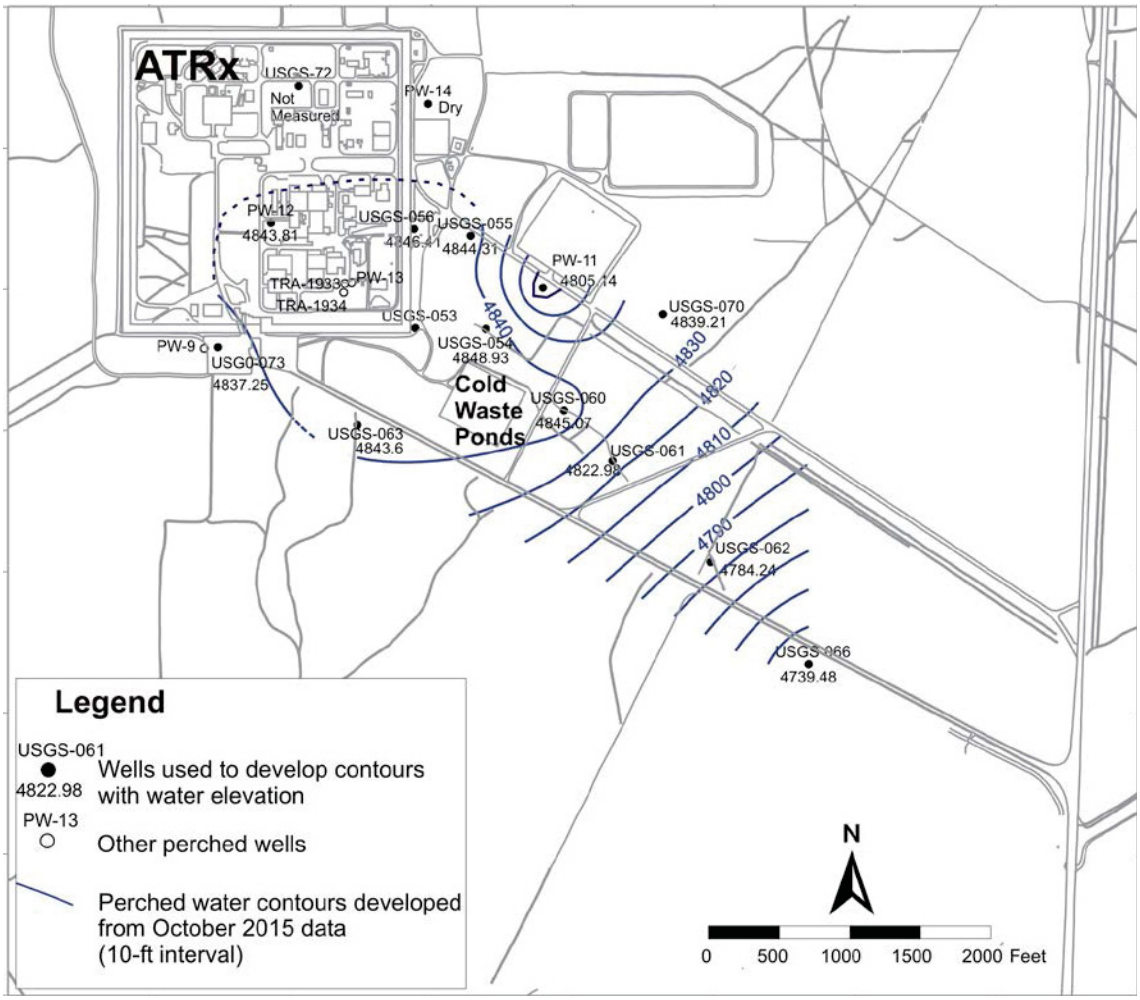

Figure 3. October 2015 water level contour map for perched water (DOE, 2016).

2.6 Release Scenario and Source

During a routine ATR system shut-down in January 2016, an air report was developed and a discrepancy in fuel usage was identified. The fuel is stored in a diesel tank (TRA-727C and TRA-775) and transferred through the diesel fuel oil transfer line approximately 1,000 ft to the diesel day tank (TRA-776). Testing, including tightness testing, helium testing, vapor testing, and acoustic testing, was

conducted to locate the suspected leak in the supply line. Tightness testing conducted in March concluded that the leak was approximately 2.841 gph in size when the line was pressurized to 1.5 times operating pressure and 0.51 gph at static pressure (Appendix B). Based on the leak rate, normal operating conditions, and historic operating conditions, ATR engineering has estimated the total release has been approximately 29,000 gallons since July 21, 2006. The calculations are found in Appendix C.

In October 2016, soils were excavated around the diesel fuel transfer line near the suspected leak to a depth of approximately 15 ft bgs to visually inspect the line for the leak. Some staining and odor were noticed on the soils. A total of approximately 476 cubic feet (ft^3) of impacted soils were excavated from around the leaking diesel fuel transfer line and will be shipped offsite for disposal.

It is likely that some fuel is captured in cracks and crevices in the basalt. It is also likely that due to the low leak rate over the 10 years, that degradation of the hydrocarbons has occurred.

2.6.1 Chemicals of Concern

The chemical of concern is a known release of number 2 diesel fuel, and the contaminants of concern (COCs) are PAHs and BTEX, which are listed in Table 1.

Table 1. Contaminants of concern.

Volatile Compounds	Semi-volatile-PAH
Benzene	Acenaphthene
Ethylbenzene	Anthracene
Toluene	Benz(a)anthracene
m-xylene & p-xylene	Benzo(b)fluoranthene
0-xylene	Benzo(k)fluoranthene
	Benzo(ghi)perylene
	Benzo(a)pyrene
	Chrysene
	Fluoranthene
	Fluorene
	Naphthalene
	Phenanthrene
	Pyrene

2.6.2 Distribution of Chemicals

2.6.2.1 Historic Chemicals in Perched Water

In 1990, free-phase diesel was noted in the perched water table during installation of monitoring well PW-13. Additional monitoring indicated a reoccurrence of free-phase fuel, likely due to subsurface cycling of diesel fuel from a historical leak from a diesel fuel transfer line. The cycling is likely due to fuel that migrated into drill holes and is trapped in cavities and/or dead end fractures by water levels and migrates with the changing water levels.

Following historical data gathering and monitoring, it was determined that the diesel fuel was likely due to a leak in the TRA-57 transfer line in 1980 and 1981, as shown in Figure 4. The well was sampled intermittently from 1990 to 2004, with varying levels of free product identified (no product to 3.07 ft of diesel) (DOE, 2005). Sample results from DRO and GRO in PW-13 are found in Table 2. Two additional wells, TRA-1933 and TRA-1934, were emplaced in 2004 to provide additional information on the free

product. Data were also collected from surrounding perched wells and are included in Table 3. DRO was not detected in the SRPA wells, indicating diesel had not reached the SRPA. Based on sampling results, it was determined that free-phase diesel was only present in the perched water wells in the immediate vicinity of the 1981 release site. It was recommended that petroleum traps be installed in the three perched water wells near the 1981 release site (PW-13, TRA-1933, TRA-1934) and monitoring continue. Based on sampling results following the emplacement of the free-product removal system, free-product and BTEX trends have been declining, and in the Groundwater Monitoring Report (DOE, 2016), it was recommended to end free-product recovery operations.

Perched water well PW-13 was sampled February 21, 2016 for TPH after the ATR diesel leak was identified. Results were non-detect for TPH (Appendix D).

PW-13 is located approximately 1,750 feet southwest of the TRA-674 diesel fuel transfer line leak.

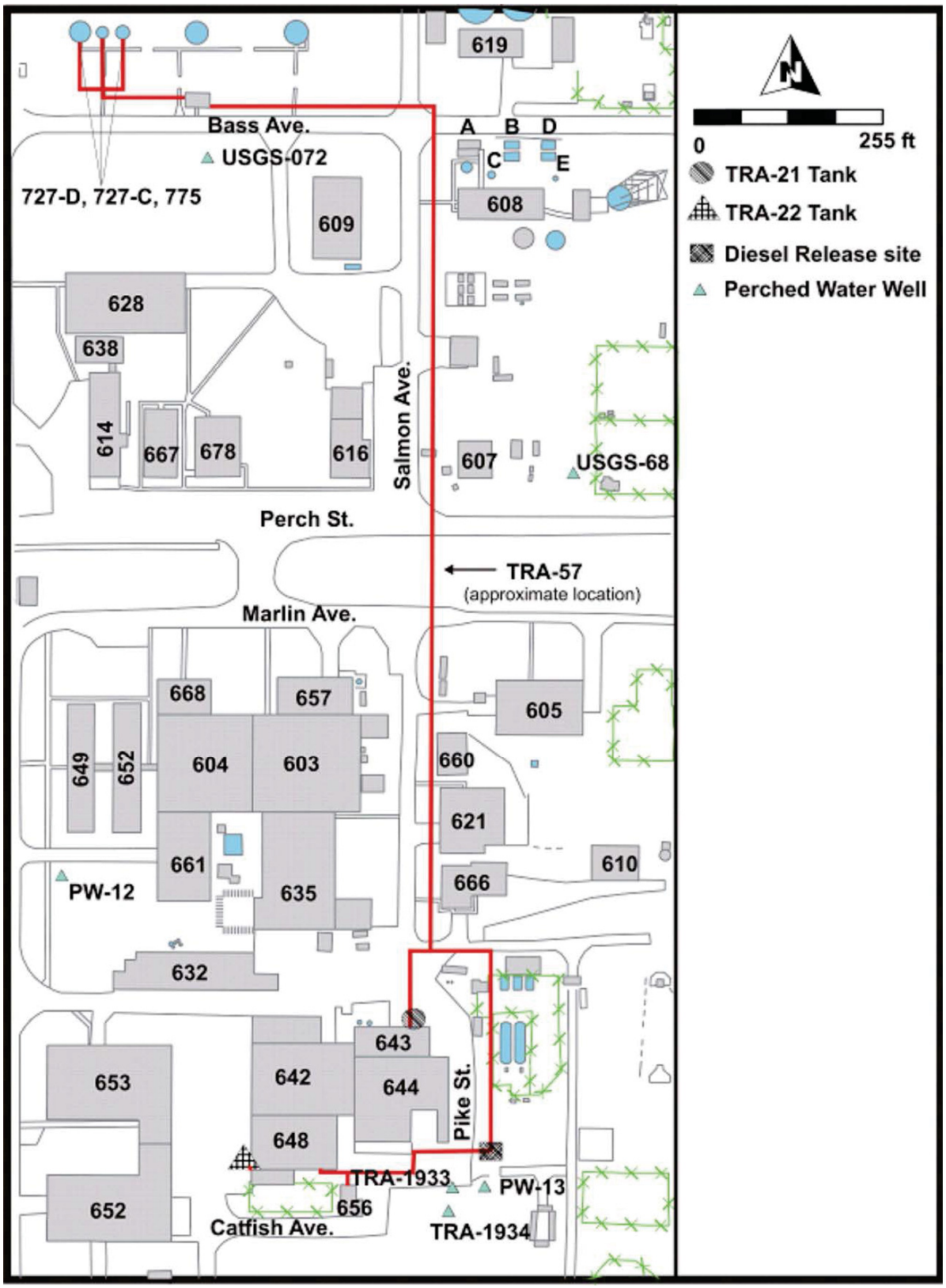

Figure 4. Location of 1981 diesel leak.

Table 2. PW-13 DRO and GRO sampling results.

Sample Date	GRO (mg/L)	DRO (mg/L)
3/17/2004	0.309	4.7
3/17/2004	0.0863	-
3/17/2004	0.087	-
10/30/2004	1.610	83
3/16/2005	1.07	226
10/10/2007	0.0788	76.1
10/10/2007	0.102	25.2
10/23/2008	0.101	1.07
10/23/2008	0.0825	2.4
10/21/2009	0.19	2.5
10/21/2009	0.17	2.8
10/20/2010	0.14	1.5
10/20/2010	0.15	1.8
10/18/2011	0.065	16.3
10/18/2011	0.0788	7.74
10/15/2012	0.132	23.9
10/15/2012	0.119	15.5
10/14/2013	0.0699	6.06
10/14/2013	0.0726	7.28
10/8/2014	0.0756	2.67
10/8/2014	0.126	2.86
10/20/2015	0.308	1.25
10/20/2015	0.299	1.28

Results of BTEX, GRO, and DRO for perched water wells are found in Table 3. Based on trends of DRO, GRO, and BTEX from the perched water wells, petroleum contamination from the ATR diesel leak has not impacted the wells, and historic contamination from the 1981 leak is declining. Figure 4 shows the locations of PW-13 and the transfer line leak.

2.6.2.2 Historic Chemicals in Groundwater

Numerous groundwater monitoring wells installed within the SRPA around the ATR complex are monitored annually and are shown in Figure 5.

BTEX data gathered from a number of groundwater monitoring wells around the ATR complex are tabulated in Table 4. Data from 2000-2015 were used to characterize historic trends and identify any potential impacts from the ATR diesel petroleum release. Only very low levels of toluene have been detected above reporting limits in the SRPA monitoring wells near ATR. All other BTEX analytes were below method detection limits.

Based on historic trends, the ATR diesel spill has not impacted the groundwater near ATR.

Table 3. DRO, GRO, and BTEX results from perched water wells.

Well ID	Sample Collection Date	Screened Interval (ft)	DRO (mg/L)	GRO (mg/L)	Benzene (µg/L)	Ethylbenzene (µg/L)	Toluene (µg/L)	Xylene (µg/L)
TRA-1933	04/21/2004	60-90	0.83	0.264	1 U	2	1 U	8.9
	10/20/2015		0.192	0.0208J	1 U	1 U	1 U	3 U
TRA-1934	04/21/2004	65-95	1.3	0.206	1 U	2.4	1 U	3.6
	04/21/2004		1.2	0.163	1 U	2.5	1 U	3.6
	10/20/2015		.0902	0.0172 J	1 U	1 U	1 U	3 U
PW-11	11/20/2000	109-129	-	-	5 U	5 U	5 U	5 U
PW-12	11/20/2000	108-128	-	-	5 U	5 U	5 U	5 U
	03/17/2004		0.3 J	-	-	-	-	-
PW-13	11/20/2000	57.5-87.5	-	-	5 U	2 J	5 U	1 J
	6/4/2001		-	-	10 U	10 U	10 U	10 U
	6/4/2001		-	-	0.6 J	1 U	1 U	2
	3/17/2004		4.7	0 .309	1 U	0.25 J	1U	0.6 J
	3/17/2004		-	0.087	1 U	0.25 J	1 U	0.7 J
	10/20/2015		1.25	0.299	1 U	1.36	1 U	0.36 J
	10/20/2016		1.28	0.308	1 U	1.41	1 U	0.32 J
IDEQ Screening Levels for Groundwater (ingestion) (µg/L)			**-**	**-**	***5***	***700***	***1,000***	***10,000***

J = Estimated
- = not analyzed
U= Undetected (below method detection limit)

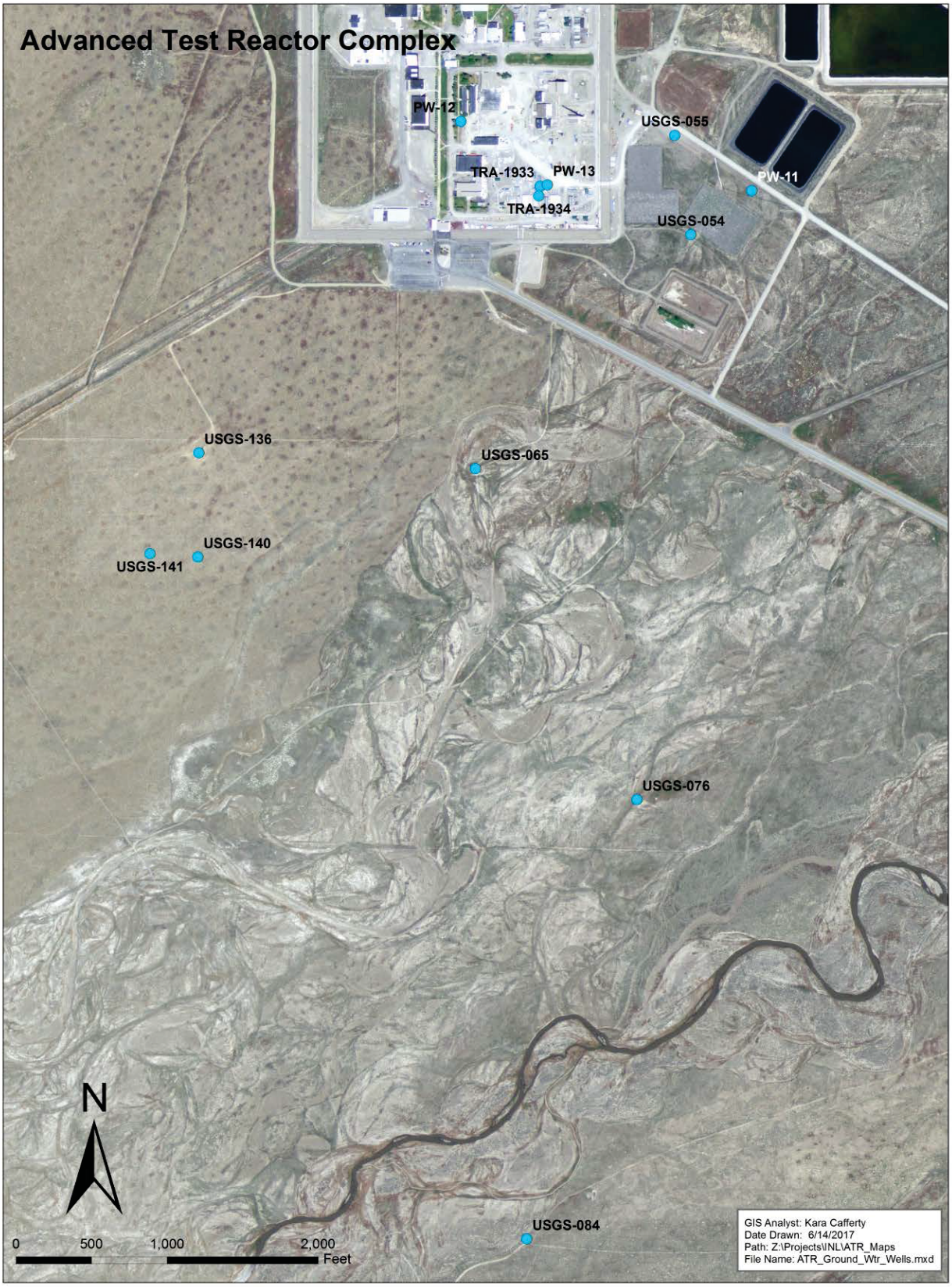

Figure 5. Location of SRPA groundwater wells.

Table 4. Historic BTEX data from SRPA groundwater wells.

Well ID	Sample Collection Date	Well Depth (ft bgs)	Benzene (µg/L)	Ethylbenzene (µg/L)	Toluene (µg/L)	Xylene (µg/L)
USGS-084	04/04/2000	496.64	<0.2	<0.2	<0.2	<0.2
	10/26/2000		<0.2	<0.2	<0.2	<0. 2
	04/30/2001		<0.2	<0.2	<0.2	<0.2
	10/25/2001		<0.2	<0.2	<0.2	<0.2
	04/03/2002		<0.2	<0.2	<0.2	<0.2
	09/30/2002		<0.2	<0.2	<0.2	<0.2
	04/16/2003		<0.2	<0.2	<0.2	<0.2
	10/09/2003		<0.1	<0.1	<0.1	<0.1
	10/06/2004		<0.1	<0.1	<0.1	<0.2
	04/25/2007		<0.1	<0.1	<0.1	<0.2
	10/17/2007		<0.1	<0.1	<0.1	<0.2
	10/15/2008		<0.1	<0.1	<0.1	<0.2
	10/06/2009		<0.1	<0.1	<0.1	<0.2
	10/06/2010		<0.1	<0.1	<0.1	<0.2
	10/04/2011		<0.1	<0.1	<0.1	<0.2
	10/18/2012		<0.1	<0.1	<0.1	<0.2
	10/24/2013		<0.1	<0.1	<0.1	<0.2
	10/22/2014		<0.1	<0.1	<0.1	<0.2
	10/21/2015		<0.1	<0.1	<0.1	<0.2
USGS-054	11/20/2000	74.61	5 U	5 U	5 U	5 U
USGS-055	11/27/2000	78.25	5 U	5 U	5 U	5 U
USGS-065	04/06/2000	476.21	<0.2	<0.2	<0.2	<0.2
	10/03/2000		<0.2	<0.2	<0.2	<0.2
	04/05/2001		<0.2	<0.2	<0.2	<0.2
	10/23/2001		<0.2	<0.2	<0.2	<0.2
	04/09/2002		<0.2	<0.2	<0.2	<0.2
	10/15/2002		<0.2	<0.2	<0.2	<0.2
	04/14/2003		<0.2	<0.2	<0.2	<0.2
	11/04/2003		<0.1	<0.1	1.615	<0.2
	04/07/2007		<0.1	<0.1	<0.1	<0.2
	04/14/2005		<0.1	<0.1	<0.1	<0.2
	04/24/2006		<0.1	<0.1	<0.1	<0.2
	04/23/2007		<0.1	<0.1	<0.1	<0.2
	04/15/2008		<0.1	<0.1	0.2506	<0.2
	04/13/2009		<0.1	<0.1	<0.1	<0.2
	04/28/2010		<0.1	<0.1	<0.1	<0.2
	04/18/2011		<0.1	<0.1	<0.1	<0.2
	04/12/2012		<0.1	<0.1	<0.1	<0.2
	04/17/2013		<0.1	<0.1	<0.1	<0.2
	04/14/2014		<0.1	<0.1	<0.1	<0.2
	04/02/2015		<0.1	<0.1	<0.1	<0.2

Table 4. (continued).

Well ID	Sample Collection Date	Well Depth (ft bgs)	Benzene (µg/L)	Ethylbenzene (µg/L)	Toluene (µg/L)	Xylene (µg/L)
USGS-076	04/02/2003	488.35	1 U	1 U	1 U	3 U
USGS-136	09/01/2011		<0.1	<0.1	0.2801	<0.2
	10/25/2011		<0.1	<0.1	<0.1	<0.2
USGS-140	07/31/2013	496.45	<0.1	<0.1	0.194	<0.2
USGS-141	07/31/2013	497.4	<0.1	<0.1	1.038	<0.2
IDEQ Screening Levels for Groundwater (ingestion) (µg/L)			***5***	***700***	***1,000***	***10,000***

- = not analyzed
U= Undetected (below method detection limit)

2.6.2.3 Chemicals in Soil

Three preliminary boreholes were vacuum excavated from three depths (11, 13, and 16.5 ft bgs) within the excavation on November 1, 2016. A single sample from each well was analyzed for DRO, BTEX, and semivolatile organic compounds (SVOCs). Due to vacuum extraction, it is likely that the concentrations of the VOC compounds are slightly less than in situ concentrations. The results are shown in Tables 5, 6, and 7 and are compared to the most restrictive IDEQ Screening Levels for Soil, which includes vapor intrusion, direct contact, and groundwater protection pathways. All samples were below IDEQ soil screening levels for BTEX constituents. Benzene was not detected above the MDL in all three samples. The MDLs were 34.0, 28.6, and 30.8 ug/kg in the three samples, which are above screening levels.

All three samples exceeded the IDEQ soil screening levels for benzo(a)anthracene, benzo(a)pyrene, and naphthalene. The laboratory data package is provided in Appendix E.

Table 5. Preliminary BTEX concentrations in soil samples collected November 1, 2016.

Sample ID	Sample Depth	Benzene (µg/kg)	Ethylbenzene (µg/kg)	Naphthalene (µg/kg)	Toluene (µg/kg)	Xylene (µg/kg)
ATRN160041	11 ft	102 U	117	**331**	48.9 J	1,400
ATRN160042	13 ft	85.9 U	150	**626**	53.3 J	2,220
ATRN160043	16.5 ft	92.4 U	120	**879**	65.6 J	3,320
IDEQ Soil Screening Levels (µg/kg)		*25*	*250*	*120*	*6,600*	*27,000*

U= Analyte not detected above MDL
J= Estimated
BOLD = exceeds screening level

Table 6. Preliminary GRO concentrations in soil samples collected November 1, 2016.

Sample ID	Sample Depth	GRO (mg/kg)
ATRN160041	11 ft	2,430 B
ATRN160042	13 ft	3,340 B
ATRN160043	16.5 ft	4,050 B

B= Analyte detected in the blank.

Table 7. Preliminary SVOC concentrations in soil samples collected November 1, 2016.

Sample ID	Sample Depth	Acenaphthene (mg/kg)	Anthracene (mg/kg)	Benzo(a) anthracene (mg/kg)	Benzo(a) pyrene (mg/kg)	Benzo(b) fluoranthene (mg/kg)	Benzon(k) fluoranthene (mg/kg)	Chrysene (mg/kg)	Fluoranthene (mg/kg)	Fluorene (mg/kg)	Pyrene (mg/kg)
ATRN160041	11 ft	0.0353 U	0.0353 U	**0.166**	**0.120**	0.169	0.169	0.159	0.331	0.00353 U	0.448
ATRN160042	13 ft	0.0353 U	0.0353 U	**0.134**	**0.0954**	0.134	0.053	0.124	0.318	0.0535 U	0.544
ATRN160043	16.5 ft	0.035 U	0.035 U	**0.049**	**0.035**	0.0455	0.0175 J	0.042	0.119	0.294	0.336
IDEQ Soil Screening Levels (µg/kg)		*200*	*3,200*	*0.09*	*0.02*	*0.31*	*0.19*	*9.5*	*1,400*	*240*	*1,100*

U= Analyte not detected above MDL
J= Estimated
BOLD = exceeds screening level

To determine the extent of contamination, five additional boreholes located near the suspected leaking diesel fuel transfer line were dug on February 6, 2017. The first 15 ft of soil was removed via vacuum excavator and then a power auger was used to core to bedrock (approximately 30 ft bgs). Starting at 15 ft bgs, core samples were collected at 5-ft intervals to determine the extent of contamination. The borehole locations are shown in Figure 6.

A total of 19 samples were collected from the cores and sent to GEL laboratories for BTEX, naphthalene, and PAH analysis.

On March 6, 2017, data results were received for the COCs. BTEX was not detected at any boreholes at 15 ft bgs. BTEX constituents were detected from 20 to 30 ft bgs in boreholes 1, 2, and 3. No analytes were detected in boreholes 4 and 5, except low concentrations of xylene in borehole 5. Borehole 2, at a depth of 30 ft bgs, displayed the most consistent and highest levels of BTEX contamination. During coring activities, it was noted that approximately 6-inches of clay was present atop the basalt layer in borehole 2. Noticeable staining was present above the clay layer, as shown in Figure 7. The clay layer is a confining layer in the area of borehole 2 that has likely captured some of the diesel fuel, resulting in elevated levels of BTEX that are present at borehole 2. Minimal clay and staining was identified in the other boreholes.

See Tables 8 and 9 for a list of the detected analytes and Appendix E for laboratory data packages.

Table 8. BTEX analytical results for soil sampling conducted on February 6, 2017.

Sample ID	Sample Depth	Benzene (µg/kg)	Ethylbenzene (µg/kg)	Naphthalene (µg/kg)	Toluene (µg/kg)	Xylene (µg/kg)
Borehole 1						
ATRN170011	15 ft	ND	ND	ND	ND	ND
ATRN170012	20 ft	ND	**2,890**	**1,600**	4,520	**37,200**
ATRN170013	25 ft	ND	**264**	86.8	298	4,730
ATRN170014	29 ft	ND	**2,070**	**789**	2,900	**33,500**
Borehole 2						
ATRN170021	15 ft	ND	ND	ND	ND	ND
ATRN170022	20 ft	ND	188	ND	195	4,800
ATRN170023	25 ft	ND	ND	ND	41 J	1,770
ATRN170024	29.5 ft	ND	**8,730**	**2,810**	**18,400**	**129,000**
Borehole 3						
ATRN170031	15 ft	ND	ND	ND	0.500 J	ND
ATRN170032	20 ft	ND	ND	ND	ND	ND
ATRN170033	25 ft	ND	ND	ND	ND	ND
ATRN170034	29 ft	0.522	3.44	ND	4.21	57.4
Borehole 4						
ATRN170041	15 ft	No Sample Collected				
ATRN170042	20 ft	ND	ND	ND	ND	ND
ATRN170043	25 ft	ND	ND	ND	ND	ND
ATRN170044	28 ft	ND	ND	ND	ND	ND
Borehole 5						
ATRN170051	15 ft	ND	ND	ND	0.363 J	3.72
ATRN170052	20 ft	ND	ND	ND	ND	ND
ATRN170053	25 ft	ND	0.485 J	0.591 J	ND	5.8
ATRN170054	28 ft	ND	ND	ND	ND	ND
IDEQ Soil Screening Levels (µg/kg)		*25*	*250*	*120*	*6,600*	*27,000*

U= Analyte not detected above MDL
J= Estimated
BOLD = exceeds screening level

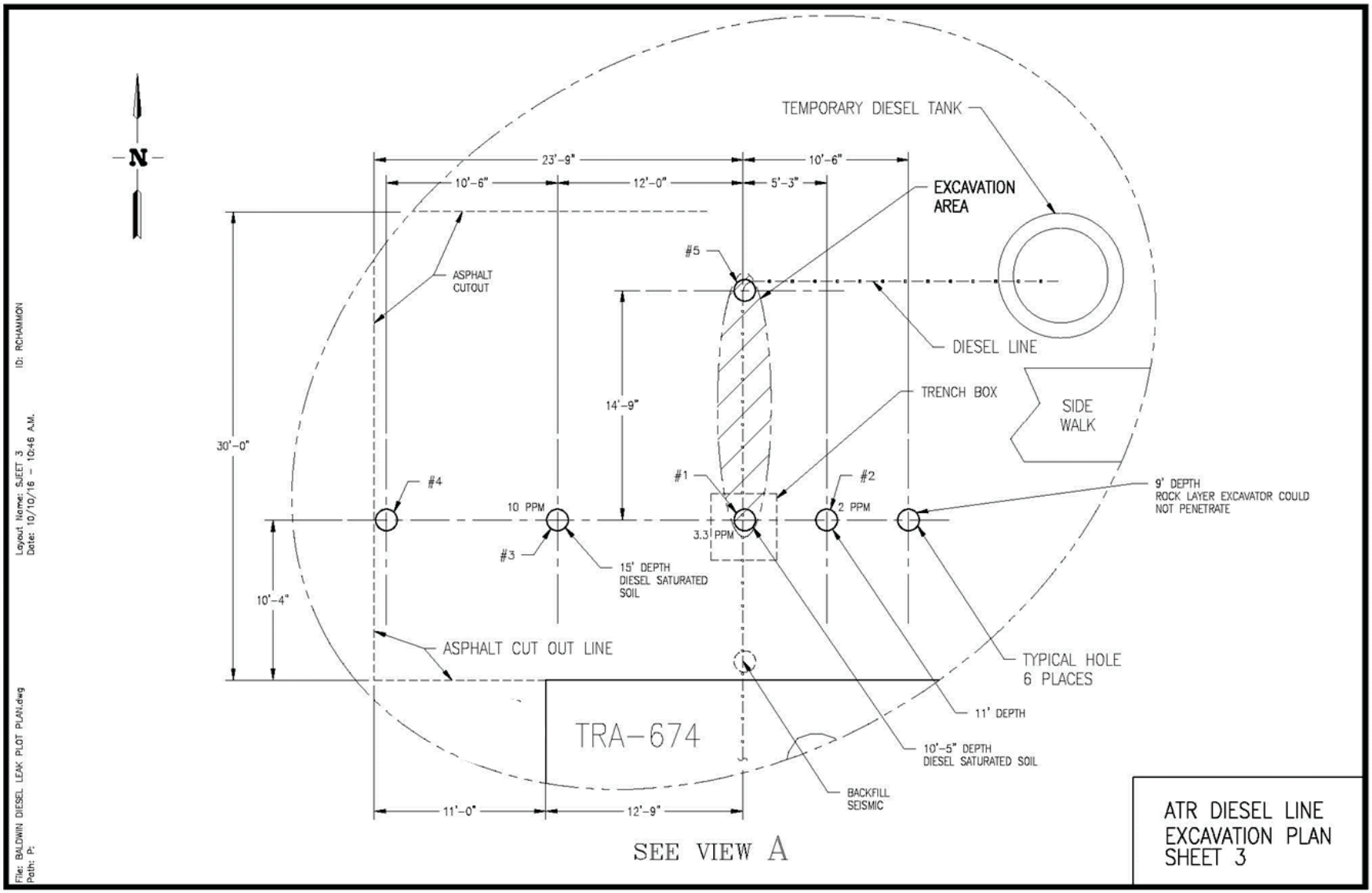

Figure 6. Location of collected borehole samples.

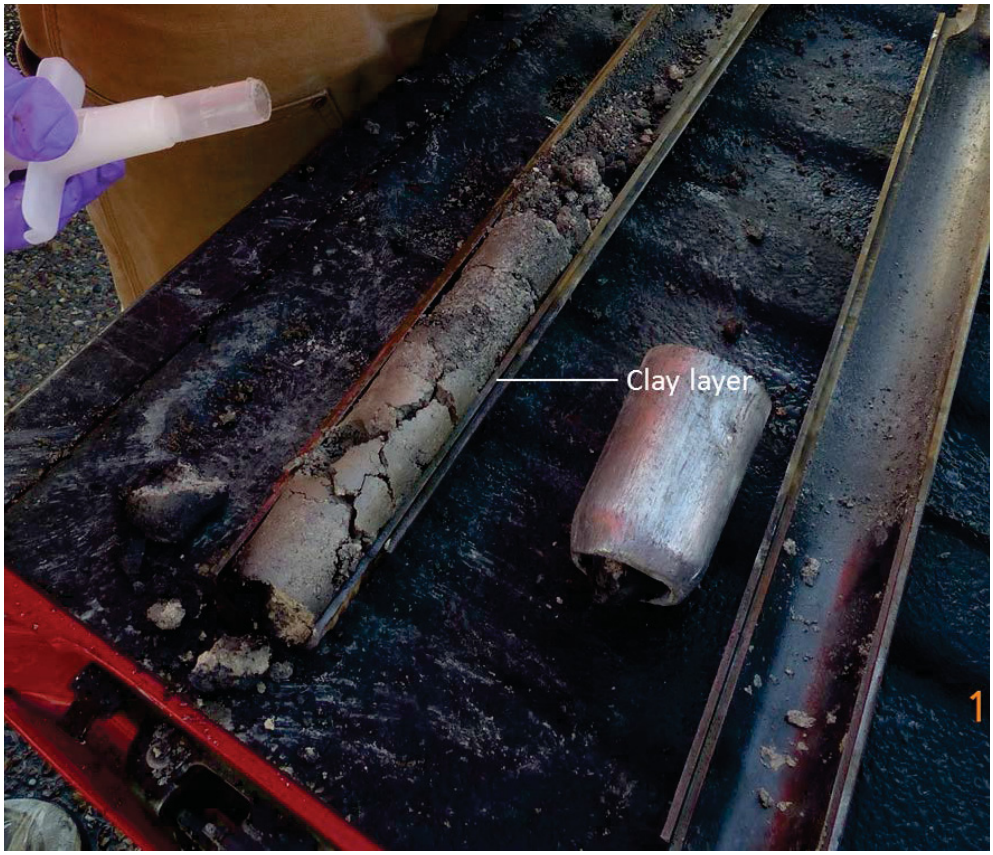

Figure 7. Location of clay layer in borehole 2.

Table 9. PAH analytical results for soil sampled collected on February 6, 2017.

Sample ID	Sample Depth	Acenaphthene (mk/kg)	Anthracene (mg/kg)	Benzo(a) anthracene (mg/kg)	Benzo(a) pyrene (mg/kg)	Benzo(b) fluoranthene (mg/kg)	Benzon(k) fluoranthene (mg/kg)	Chrysene (mg/kg)	Fluoranthene (mg/kg)	Fluorene (mg/kg)	Pyrene (mg/kg)
Borehole 1											
ATRN170011	15 ft	ND	ND	ND	ND	ND	ND	ND	ND	0.185	0.384
ATRN170012	20 ft	0.143	ND	ND	ND	ND	ND	ND	ND	0.714	0.813
ATRN170013	25 ft	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.270
ATRN170014	29 ft	0.161	ND	ND	ND	ND	ND	ND	ND	0.821	0.806
Borehole 2											
ATRN170021	15 ft	ND	ND	ND	ND	ND	ND	ND	ND	0.202	0.303
ATRN170022	20 ft	ND	ND	ND	ND	ND	ND	ND	ND	0.570	0.442
ATRN170023	25 ft	ND	ND	ND	ND	ND	ND	ND	0.386	0.386	0.828
ATRN170024	29.5 ft	0.508	0.537	ND	ND	ND	ND	ND	ND	2.010	2.540
Borehole 3											
ATRN170031	15 ft	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.021 J
ATRN170032	20 ft	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.141
ATRN170033	25 ft	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.013
ATRN170034	29 ft	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.143
Borehole 4											
ATRN170041	No Samples Collected										
ATRN170042	20 ft	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ATRN170043	25 ft	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ATRN170044	28 ft	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Borehole 5											
ATRN170051	15 ft	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0036
ATRN170052	20 ft	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0024 J
ATRN170053	25 ft	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00482
ATRN170054	28 ft	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
IDEQ Soil Screening Levels (mg/kg)		*200*	*3,200*	*0.09*	*0.02*	*0.19*	*1.9*	*9.5*	*1,400*	*240*	*1,100*

3. SCREENING LEVEL EVALUATION

Data collected from the core sampling were used to determine if the site may pose a threat to human health or require additional evaluation. A screening level evaluation was conducted using analytical data from the verification sampling. The analytical results from the verification sampling were compared to the IDEQ screening levels.

3.1 Comparison with Screening Levels

The analytical data obtained from the core samples were used to compare to IDEQ screening levels. Borehole 1, at a depth of 20 ft bgs, shows ethylbenzene at 2,890 µg/kg, naphthalene at 1,600 µg/kg, toluene at 4,520 µg/kg, and xylene at 37,200 µg/kg. Ethylbenzene, naphthalene, and xylene concentrations are above IDEQ soil screening levels. Borehole 1, at a depth of 25 ft bgs, shows ethylbenzene at 264 µg/kg, naphthalene at 86.8 µg/kg, toluene at 298 µg/kg, and xylene at 4,730 µg/kg. Ethylbenzene concentrations are above IDEQ soil screening levels. Borehole 1, at a depth of 25 ft bgs, show ethylbenzene at 2,070 µg/kg, naphthalene at 789 µg/kg, toluene at 2,900 µg/kg, and xylene at 33,500 µg/kg. Ethylbenzene, naphthalene, and xylene concentrations are above IDEQ soil screening levels. Borehole 2, at a depth of 20 ft bgs, shows ethylbenzene at 188 µg/kg, toluene at 195 µg/kg, and xylene at 4,800 µg/kg. All concentrations are below IDEQ screening levels. Borehole 2, at a depth of 29.5 ft bgs, show of ethylbenzene at 8,730 µg/kg, toluene at 18,400 µg/kg, and xylene at 129,000 µg/kg. All concentrations exceed the IDEQ soil screening levels. Groundwater results did not exceed groundwater screening levels.

See Tables 8 and 9 for a list of the detected analytes and Appendix E for a copy of the laboratory analytical results.

An initial screening level evaluation was completed using the data gathered from the core samples to determine if the site may pose a threat to human health or require additional evaluation. The maximum COC concentrations from the core samples were evaluated against the IDEQ soil screening levels using the Idaho Risk Evaluation Computational Software (IDEQ, 2012). Based on the analytical results, an additional site-specific risk evaluation is required. The results are found in Appendix F.

3.2 Recommendations

Since the maximum concentrations of some of the COCs exceeded the IDEQ soil screening levels, a site-specific evaluation is recommended.

4. SITE CONCEPTUAL MODEL

The Site Conceptual Model (SCM) provides an overall summary of the site and important assumptions. It also identifies potential sources of contamination, potential exposure pathways of contamination, and potential receptors at the site. Figure 2 from the Risk Evaluation Manual for Petroleum Releases (IDEQ, 2012) demonstrates the site conceptual model that the site-specific risk evaluation follows.

4.1 Source Assessment

The source assessment discusses the nature, location, timing, and magnitude of the petroleum release.

4.1.1 Location of Release

After a number of tests, including tightness, helium, acoustic, and vapor, the leak was tracked to a location approximately 15 ft north of TRA-674 under an asphalt walking area approximately 9 ft bgs. The leak is in the diesel fuel transfer line between TRA-627 and the day tank TRA-776. Approximately 476 ft^3 of impacted soil was excavated around the leaking diesel fuel transfer line and will be shipped to a reuse facility where it will be reused in paving operations.

4.1.2 Magnitude of Release

Based on operational records, the leak started July 2006 and continued until January 2016 when the diesel fuel transfer line was isolated. It was estimated, based on operational knowledge, that approximately 29,000 gallons of fuel was released over a period of approximately 10 years.

The leak was limited to number 2 diesel fuel; therefore, only analytes associated with number 2 diesel fuel are identified as COCs. Based on borehole samples, some BTEX constituents have been detected in the preliminary samples and screening samples.

4.2 Exposure Assessment

4.3 Introduction

The exposure assessment covers the potential exposure pathways associated with the petroleum contaminated soil and groundwater. For a pathway to be complete, there must be a source of the chemical, mechanism by which the chemical is released, medium through which a chemical travels from the point of release to the receptor location, and a route of exposure by which a chemical enters the receptor's body.

4.3.1 Site Stratigraphy and Hydrogeology

During core sampling, a basalt layer was encountered at approximately 30 ft bgs. Depth to the SRPA is approximately 450 ft bgs below the ATR Complex. Perched water tables formed from water from the former evaporation and infiltration ponds, which have since been lined, are located at approximately 50 ft bgs and 140 ft bgs, respectively. Water travels through the basalt layers through fractures and cracks within the basalt layers. Based on the most current mapping of the perched water table from 2015, the edge of the deep perched water body is located southeast of the leak area by approximately 200 ft.

4.3.2 Source

The source of contamination is the residual petroleum contamination in soils from the diesel fuel that has been leaking from the diesel line. The analytical results for soil samples collected on February 6, 2017 indicate that petroleum contamination has migrated into deep soils (to at least 30 ft bgs). The sources of contamination in surface soil, subsurface soil, and groundwater are included below:

- Surface Soil (less than 1 ft deep): The leak is located under an asphalt area and occurred at approximately 9 ft bgs. Surface soils demonstrate no sign of petroleum contamination.
- Subsurface Soil (greater than 1 ft deep): Contaminated subsurface soil was below 20 ft bgs to a depth of approximately 30 ft when basalt was encountered. Approximately 476 ft^3 of impacted soil has been removed.
- Groundwater: Based on historic groundwater monitoring results, petroleum COCs concentrations are well below drinking water standards and have not increased in the aquifer under the ATR Complex.

4.3.3 Transport Mechanisms

Potential transport mechanisms for surface soil, subsurface soil, and groundwater are included below:

- Surface Soil: The transport mechanisms for the surface soil, if the asphalt was removed, are wind erosion/dispersion and volatilization/vapor migration.
- Subsurface Soil: The transport mechanisms for the subsurface soil contamination are volatilization/vapor migration, inhalation of vapors/particulates, and dermal contact and ingestion for construction workers.
- Groundwater: The transport mechanisms for groundwater are volatilization/vapor migration.

4.3.4 Exposure Routes

Potential exposure routes for surface soil, subsurface soil, and groundwater are included below:

- Surface Soil: The exposure route for the surface soil is leaching to groundwater. Outdoor air/particulate inhalation, dermal contact, and ingestion would be viable exposure routes if the asphalt were removed in the future.
- Subsurface Soil: The exposure routes for the subsurface soil are indoor air inhalation and leaching to groundwater and construction worker in halation of vapors/particulates and dermal contact and ingestion.
- Groundwater: The exposure routes for groundwater include ingestion and inhalation of vapor emissions.

4.3.5 Site Conceptual Exposure Models

The site conceptual exposure models for current and future land use are as follows:

- Current Land Use: The site is currently an industrial facility; therefore, the potential receptors are non-residential workers and construction workers:
  - Surface Soil - Inhalation, Dermal Contact, and Ingestion: pathway is incomplete because contamination is not located in surface soils and surface soil is covered with asphalt.
  - Surface Soil - Leaching to Groundwater: pathway is incomplete because contamination is not located in surface soils.
  - Subsurface Soil - Volatilization and Indoor Air Inhalation: pathway is complete.
  - Subsurface Soil - Leaching to Groundwater: pathway is complete.
  - Groundwater- Ingestion: pathway is complete.
  - Groundwater- Volatilization: pathway is complete.
- Future Land Use: The DOE projects that the ATR complex will remain an industrial facility through at least 2105 (INL, 2005); however, as a conservative estimate it is assumed that the site may be used for residential use within 10 years as stated in Section 5.2. Therefore, the foreseeable future receptors are residential, non-residential, and construction workers.
  - Surface Soil - Inhalation, Dermal Contact, and Ingestion: No contamination, pathway incomplete.
  - Surface Soil - Leaching to Groundwater: No contamination, pathway incomplete.
  - Subsurface Soil - Volatilization and Indoor Air Inhalation: pathway is complete.
  - Subsurface Soil - Leaching to Groundwater: pathway is complete.
  - Groundwater- Ingestion: pathway is complete.
  - Groundwater- Volatilization: pathway is complete.

4.4 Groundwater Protection

Although there is a drinking well within 0.5 miles of the leak area, it is upgradient of the leak site and therefore will not be impacted by any petroleum products in the groundwater. There are two drinking water wells located approximately 2 miles downgradient of the leak area. As a conservative estimate, the groundwater at the site was classified as “Groundwater with Current Use or High Probability of Future Use as Drinking Water” in the risk evaluation. The maximum contaminant levels were used as the target concentrations for groundwater ingestion.

5. INPUT PARAMETERS FOR RISK EVALUATION-1 AND RISK ASSESSMENT RESULTS

The Site- Specific Risk Evaluation was performed using the most current version of the Idaho Risk Evaluation Computational Software (IDEQ, 2015). The results for the evaluation are included in Appendix F.

5.1 Justification of Site-Specific Fate and Transport Parameters

For the Site-Specific Risk Evaluation, the conservative default fate and transport parameters were used for most variables. Site-specific information was included for the distance from the building to groundwater, the distance from the bottom of the building to the top of the source, and fraction of vegetative cover.

5.2 Calculation of Representative Contaminant Concentrations in Soil

In order to account for concentrations of COCs present in the soil in 10 years that may affect future residential users, EPA modeling software EMSOFT (2002) was used to calculate the concentrations of xylene and ethylbenzene. The program uses the chemical and soil properties to estimate its concentration remaining in the soil after a giving amount of time. The model inputs for each chemical are found in Appendix G. Chemical properties were collected from EPA sources and if needed, corrected for soil temperature (Henry's Law constant). When chemical or soil properties were not available, conservative estimates, as recommended by EMSOFT, were used. After a 10 year period EMSOFT estimated concentrations of xylene at 0.453 mg/kg and ethylbenzene at 0.00325 mg/kg

The estimated concentrations of xylene and ethylbenzene along with the highest contaminant concentrations that were detected in the core samples collected in January 2017 and February 2017 were considered in the risk evaluation. The representative contaminant concentrations in the subsurface soil for all exposure scenarios were set as the maximum concentrations detected in the subsurface samples and the 10-yr estimated concentrations for xylene and ethylbenzene(Table 10). This approach should provide a generally conservative estimate of the representative concentrations because including the non-detects in the calculations would tend to lower the average. No samples were collected from surficial samples

Table 10. Analyte concentrations used in the Site-Specific Risk Evaluation for current and future users.

	Residential, Non-Residential and Construction Worker Soil Exposure Point Concentrations	**Groundwater/Surface Water Protection**
Contaminant of Concern	**Maximum Concentration (mg/kg)**	**Maximum Concentration (mg/L)**
Benzene	0.00522	0.006
Toluene	18.4	0
Ethylbenzene	0.00325	0.0025
Xylenes	0.453	0.0089
Naphthalene	2.81	0
Acenaphthene	0.508	0
Anthracene	0.537	0
Benzo(a)anthracene	0.166	0

Benzo(a)pyrene	0.12	0
Benzo(b)fluoranthene	0.169	0
Benzo(k)fluoranthene	0.169	0
Chrysene	0.159	0
Fluoranthene	0.386	0
Fluorene	2.01	0
Pyrene	2.54	0

5.3 Comparison of Calculated Risk With Target Risk Criteria

The estimated cumulative risk and hazard index (HI) determined from the Site-Specific Risk Evaluation using the Idaho Risk Computational Software are summarized Table 11. The estimated risk of 5.67E-6 for the residential subsurface soil scenario, 3.82E-9 for the residential groundwater scenario, 7.31E-7 for the non-residential subsurface soil scenario, 7.30E-10 for the non-residential groundwater scenario, and 1.16E-8 for the construction worker direct contact soil scenario are less than the IDEQ target risk level of 1E-05. The calculated HIs of 2.55E-1 for the residential subsurface scenario, 7.85E-5 for the residential groundwater scenario, 4.58E-2 for the non-residential subsurface soil scenario, 1.79E-5 for the non-residential groundwater scenario, and 2.57E-3 for the construction worker direct contact scenario were also less than the IDEQ target HI of 1. Appendix F provides the complete results from the Site-Specific Risk Evaluation.

Table 11. Summary of the estimated cumulative risk from the Site-Specific Risk Evaluation.

	RECEPTOR		
	Residential	**Non-Residential**	**Construction Worker**
ROUTES OF EXPOSURE	**Risk**	**Risk**	**Risk**
Direct Contact Soil: Ingestion of soil, outdoor inhalation of vapor emissions and particulates, and dermal contact with soil	NA	NA	1.16 E-08
Subsurface Soil: Indoor inhalation of vapors	5.67E-6	7.31E-7	NA
Groundwater: Indoor inhalation of vapor emissions	3.82E-9	7.30E-10	NA
Soil-Vapor: Indoor inhalation of vapor emissions	NA	NA	NA
Site Risk	5.67E-6	7.32E-7	1.16E-8
IDEQ Target Risk	1E-05	1E-05	1E-05

IDEQ Target Site Exceeded?	**No**	**No**	**No**

Table 12. Summary of the estimated HI from the Site-Specific Risk Evaluation.

	RECEPTOR		
	Residential	**Non-Residential**	**Construction Worker**
ROUTES OF EXPOSURE	**HI**	**HI**	**HI**
Direct Contact Soil: Ingestion of soil, outdoor inhalation of vapor emissions and particulates, and dermal contact with soil	NA	NA	2.57E-3
Subsurface Soil: Indoor inhalation of vapors	2.55E-1	4.58E-2	NA
Groundwater: Indoor inhalation of vapor emissions	7.85E-5	1.79E-5	NA
Soil-Vapor: Indoor inhalation of vapor emissions	NA	NA	NA
Site HI	2.55E-1	4.59E-5	2.57E-3
IDEQ Target Hazard Index	1.0	1.0	1.0
IDEQ Target Hazard Index Exceeded?	**No**	**No**	**No**

6. CONCLUSIONS AND RECOMMENDATIONS

The analytical results obtained from the January 2017 and February 2017 sampling events were used to conduct the risk evaluation per IDEQ (2012). The RE-1 predicted that the residual contamination at the site will not pose an unacceptable risk to drinking water, construction workers, or future residential and non-residential users. The Site-Specific Risk Evaluation results generated from the Idaho Risk Evaluation Computational Software are included in Appendix F.

Based on the Site-Specific Risk Evaluation, it is recommended that IDEQ issue a “no further action” determination for the area located behind building TRA-674 where the diesel fuel transfer line leak occurred.

7. REFERENCES

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DOE, 2005, *Response to the First Five-Year Review Report for the test Reactor Area, Operable Unit 2-13, at the Idaho National Engineering and Environmental Laboratory*, DOE/NE-ID-11189, May 2005.

DOE, 2006, "Draft Environmental Assessment of the Remote Treatment Project," DOE/EA-01386, July 2006.

DOE, 2016, *Annual Groundwater Monitoring Status Report for Waste Area Group 2 for Fiscal Year 2016*, DOE-ID-11553, July 2016.

IDEQ, 2012, *Idaho Risk Evaluation Manual for Petroleum Releases*, Idaho Department of Environmental Quality, August 2012.

IDEQ, 2015, *Idaho Risk Evaluation Computational Software*, Idaho Department of Environmental Quality, August 2012.

INL, 2005, *Idaho National Laboratory Comprehensive Land Use and Environmental Stewardship Report*, INL/EXT-05-00726, September, 2005.

USGS, 1985, *National Water Summary, Hydrologic Events, Selected Water- Quality Trends, and Groundwater Resources*: USGS 2275, 1985

Appendix A
Photographic Log

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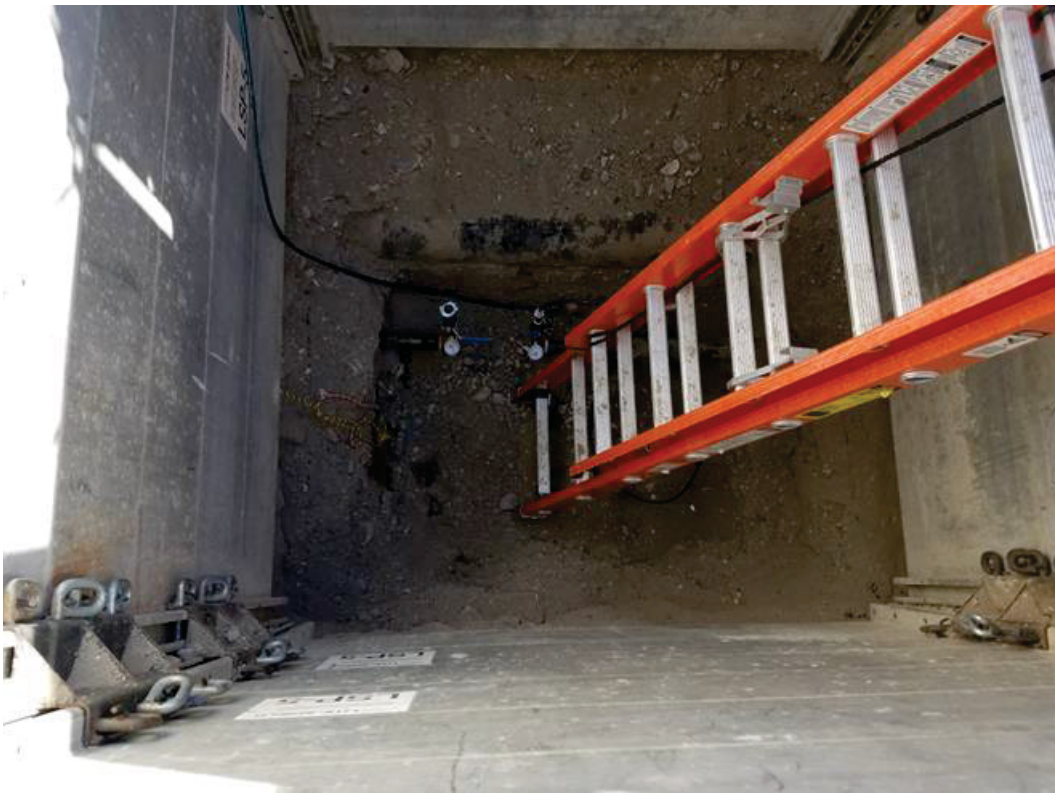
Photograph A-1. ATR PST Leak Site Center Hole.

Photograph A-2. ATR PST Leak Site Center Hole.



Photograph A-3. ATR PST Trenchbox 2.

Photograph A-4. ATR PST Leak Site.

Photograph A-5. ATR PST Leak Site.

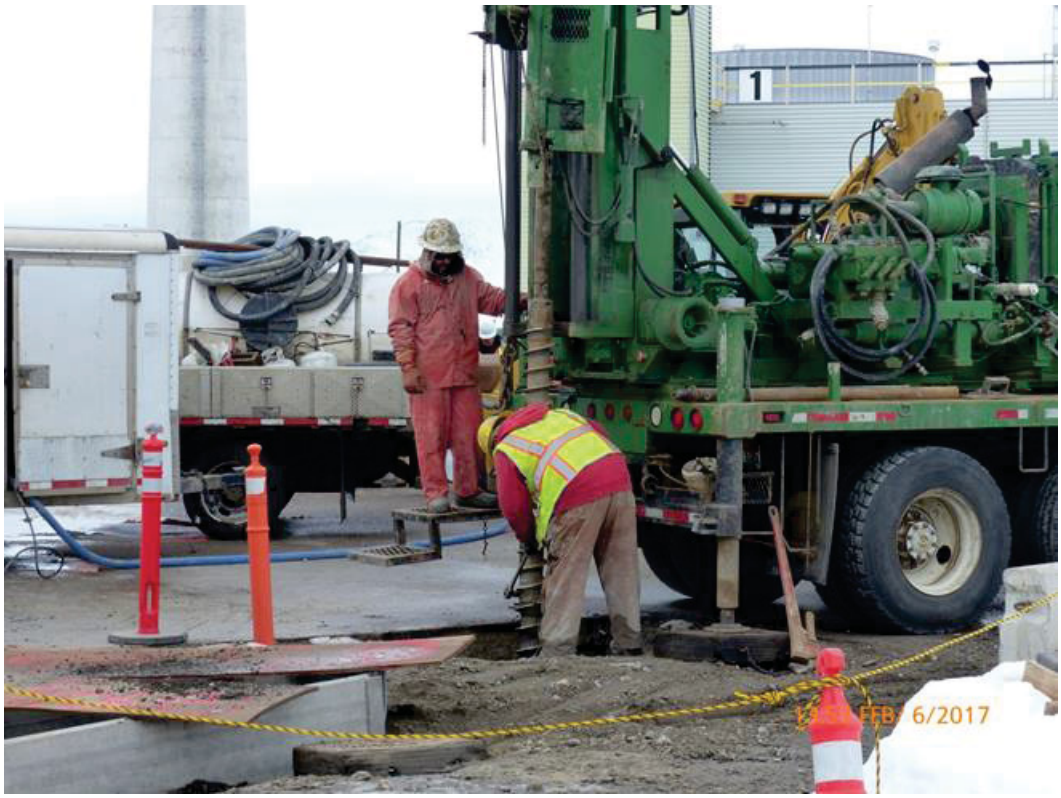
Photograph A-6. ATR PST Leak Site.

Photograph A-7. ATR PST Leak Site.

Photograph A-8. ATR PST Leak Site.

Photograph A-9. Core #2 (~29 ft bgs clay).

Photograph A-10. Core #2 (~29 ft bgs clay).



Photograph A-11. Core #5 Drilling.

Appendix B
Tightness Test Data

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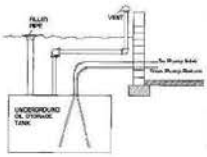
Wheeler Tank Testing Inc.
Line Tightness Test Report



UST Compliance
Inspections
Leak Detectors
Line Tightness
Cathodic Protection
Tank Tightness

Wheeler Tank Testing Inc.
P.O. Box 1008
Blackfoot , Idaho
83221

Phone: 208-684-9297
Fax: 208-684-9296

Station	Idaho National Laboratory
Address	ATR
City State	Scoville, ID
Zip	

Product Line Test Report
Leak Detector Testing Report
Estabrook's EZY Chek

Date: Mar 29, 2016

Product Type	Diesel Supply to Generator				
Time	**Data**	**-/+**	**GPL**	**RES**	**GPH**
1018	39	-0-	.0037	-0-	-0-
1023	65	-64	.0037	-.2386	notes!!

Product Type	Diesel to Generator revised				
Time	**Data**	**-/+**	**GPL**	**RES**	**GPH**
T zero	na	0	0	0	0
T 1	-192	-192	.0037	-.7104	-2.841

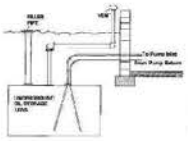
Product Type	Diesel line to Tanks				
Time	**Data**	**-/+**	**GPL**	**RES**	**GPH**
1030	24	-0-	.0037	-0-	-0-
1045	22	-2	.0037	-.0074	-.0296
1100	20	-2	.0037	-.0074	-.0296
1115	19	-1	.0037	-.0037	-.0148

Product Type					
Time	**Data**	**-/+**	**GPL**	**RES**	**GPH**

Product Type					
Time	**Data**	**-/+**	**GPL**	**RES**	**GPH**

Product Type					
Time	**Data**	**-/+**	**GPL**	**RES**	**GPH**

Wheeler Tank Testing Inc.
Line Tightness Test Report



UST Compliance
Inspections
Leak Detectors
Line Tightness
Cathodic Protection
Tank Tightness

Wheeler Tank Testing Inc.
P.O. Box 1008
Blackfoot , Idaho
83221

Phone: 208-684-9297
Fax: 208-684-9296

Station	Idaho National Laboratory
Address	ATR
City State	Scoville, ID
Zip	

Date: Mar 29, 2016

Product Line Test
Final Results

Product Type	Line ID	GPH	Pass/Fail
DSL to Gen		-2.841	FAIL!!
DSL to Tanks		-.0148	Pass

Leak Detector Testing
Final Results

Product Type	Leak Detector Make	Detected GPH	Pass/Fail

Comments: Diesel line to Generator did not pass the test. The leak rate is too fast to calculate readings according to protocol. Reading was taken 5 minutes after pressure stabilization resulting in a change of -64 marks on the line tester sight glass. 39 to 0/90, and from 90 to 65. In the revised data field I multiplied the 5 minute reading by 3 to simulate what the result would be with a steady rate over a 15 minute interval. A 15 minute interval would be consistent with protocol. A change in tester volume of -192 marks in 15 minutes would yield an hourly leak rate of -2.841 gph. The test was performed a second time to re-affirm, with nearly identical results. -65 marks in 5 minutes.

The line from the pump house back to the tanks passed the test. We did however find a very small leak in the piping fittings above ground which could account for the small change in volume during testing.

AMENDED as of 6/28/17.
During testing at this location an observation was made on the DSL to GEN line where we left the test equipment hooked up on the piping to observe any product loss under static conditions only. It was determined that a loss rate of approximately .51GPH would occur. This test would be reflective of leakage that would occur if no equipment were running, and would vary according to the height of fuel level in the above ground storage tank.

Technician Name And Number: Kevin Wheeler 699145 Kevin Wheeler

Appendix C
Quantity Calculations

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Appendix D

PW-13 Certificate of Analysis Report

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GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 – (843) 556-8171 – www.gel.com

Certificate of Analysis Report
for

POEN002 Portage, Inc.

Client SDG: 391565 GEL Work Order: 391565

The Qualifiers in this report are defined as follows:

* A quality control analyte recovery is outside of specified acceptance criteria

** Analyte is a Tracer compound

** Analyte is a surrogate compound

U Analyte was analyzed for, but not detected above the MDL, MDA, MDC or LOD.

Where the analytical method has been performed under NELAP certification, the analysis has met all of the requirements of the NELAC standard unless qualified on the Certificate of Analysis.

The designation ND, if present, appears in the result column when the analyte concentration is not detected above the limit as defined in the 'U' qualifier above.

This data report has been prepared and reviewed in accordance with GEL Laboratories LLC standard operating procedures. Please direct any questions to your Project Manager, Edith Kent.

Reviewed by Edith M. Kent

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: February 24, 2016

Company :	Portage, Inc.
Address :	1075 South Utah Ave. Suite 200 Idaho Falls, Idaho 83402
Contact:	Ms. Jill Lundell
Project:	TOS-157

Client Sample ID:	ATRN160001 - Perched Water	Project:	POENTOS157
Sample ID:	391565001	Client ID:	POEN002
Matrix:	Water		
Collect Date:	17-FEB-16 09:50		
Receive Date:	18-FEB-16		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Oil & Grease Analysis											
EPA 1664A TPH "As Received"											
Total Petroleum Hydrocarbons	U	ND	1.18	4.20	mg/L		DXB7	02/22/16	0728	1546571	1

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 1664A/1664B	

Notes:

GEL LABORATORIES LLC

2040 Savage Road Charleston, SC 29407 - (843) 556-8171 - www.gel.com

QC Summary

Report Date: February 24, 2016

Portage, Inc.
1075 South Utah Ave.
Suite 200
Idaho Falls, Idaho

Contact: Ms. Jill Lundell

Workorder: 391565

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date Time
Oil & Grease Analysis										
Batch 1546571										
QC1203493872 LCS										
Total Petroleum Hydrocarbons	20.0			14.2	mg/L		71	(69%-102%)	DXB7	02/22/16 07:28
QC1203494248 LCSD										
Total Petroleum Hydrocarbons	20.0			13.9	mg/L	0.707	69.5	(0%-23%)		02/22/16 07:28
QC1203493871 MB										
Total Petroleum Hydrocarbons			U	ND	mg/L					02/22/16 07:28

Notes:

The Qualifiers in this report are defined as follows:

- < Result is less than value reported
- > Result is greater than value reported
- B The target analyte was detected in the associated blank.
- E General Chemistry--Concentration of the target analyte exceeds the instrument calibration range
- H Analytical holding time was exceeded
- J Value is estimated
- N/A RPD or %Recovery limits do not apply.
- N1 See case narrative
- ND Analyte concentration is not detected above the detection limit
- NJ Consult Case Narrative, Data Summary package, or Project Manager concerning this qualifier
- Q One or more quality control criteria have not been met. Refer to the applicable narrative or DER.
- R Per section 9.3.4.1 of Method 1664 Revision B, due to matrix spike recovery issues, this result may not be reported or used for regulatory compliance purposes.
- R Sample results are rejected
- U Analyte was analyzed for, but not detected above the MDL, MDA, MDC or LOD.
- X Consult Case Narrative, Data Summary package, or Project Manager concerning this qualifier
- Z Paint Filter Test--Particulates passed through the filter, however no free liquids were observed.
- ^ RPD of sample and duplicate evaluated using +/-RL. Concentrations are <5X the RL. Qualifier Not Applicable for Radiochemistry.
- d 5-day BOD--The 2:1 depletion requirement was not met for this sample
- e 5-day BOD--Test replicates show more than 30% difference between high and low values. The data is qualified per the method and can be used for reporting purposes
- h Preparation or preservation holding time was exceeded

GEL LABORATORIES LLC
2040 Savage Road Charleston, SC 29407 - (843) 556-8171 - www.gel.com

QC Summary

Workorder: 391565

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time

N/A indicates that spike recovery limits do not apply when sample concentration exceeds spike conc. by a factor of 4 or more or %RPD not applicable.
^ The Relative Percent Difference (RPD) obtained from the sample duplicate (DUP) is evaluated against the acceptance criteria when the sample is greater than five times (5X) the contract required detection limit (RL). In cases where either the sample or duplicate value is less than 5X the RL, a control limit of +/- the RL is used to evaluate the DUP result.
* Indicates that a Quality Control parameter was not within specifications.
For PS, PSD, and SDILT results, the values listed are the measured amounts, not final concentrations.

Where the analytical method has been performed under NELAP certification, the analysis has met all of the requirements of the NELAC standard unless qualified on the QC Summary.

Appendix E

Laboratory Analytical Results
(included on CD)

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Appendix F
Risk Evaluation Results

SITE INFORMATION

Facility ID	ATR Complex
Site Name	ATR Complex Diesel Spill
Date	Aug 09, 2017
Name of Preparer	Saige Ballock-Dixon
Address	
Latitude	43.588544
Longitude	-112.965508

PHYSICAL AND CHEMICAL PROPERTIES

CHEMICAL PROPERTIES

	Molecular Weight	Water Solubility	Henry's Law Constant	Organic Carbon Adsorption Coefficient	Soil-Water Sorption Coefficient	Soil-Water Sorption	Diffusion Coefficients	
	[--]	[--]	[--]	[--]	[--]	[mL-water/g-soil]	Diffusion Coefficient in Air [cm^2/s]	Diffusion Coefficient in Water [cm^2/s]
Benzene	7.81E+01	1.79E+03	2.30E-01	1.46E+02	1.00E+00	1.46E-01	9.00E-02	1.00E-05
Toluene	9.21E+01	5.26E+02	2.70E-01	2.34E+02	*NPCP*	2.34E-01	7.80E-02	9.20E-06
Ethylbenzene	1.06E+02	1.69E+02	3.20E-01	4.46E+02	1.00E+00	4.46E-01	6.80E-02	8.50E-06
Xylenes	1.06E+02	1.06E+02	2.10E-01	3.83E+02	*NPCP*	3.83E-01	8.50E-02	9.90E-06
Naphthalene	1.28E+02	3.10E+01	1.80E-02	1.54E+03	1.00E+00	1.54E+00	6.00E-02	8.40E-06
MTBE	8.82E+01	5.10E+04	2.40E-02	1.20E+01	1.00E+00	1.20E-02	7.50E-02	8.60E-06
1,2-Dichloroethane	9.90E+01	8.60E+03	4.80E-02	4.00E+01	1.00E+00	4.00E-02	8.60E-02	1.00E-05
Ethylene Dibromide	1.88E+02	3.91E+03	2.70E-02	4.00E+01	1.00E+00	4.00E-02	4.30E-02	1.00E-05
Acenaphthene	1.54E+02	3.90E+00	7.50E-03	5.03E+03	*NPCP*	5.03E+00	5.10E-02	8.30E-06
Anthracene	1.78E+02	4.34E-02	2.30E-03	1.64E+04	*NPCP*	1.64E+01	3.90E-02	7.90E-06
Benz(a)anthracene	2.28E+02	9.40E-03	4.90E-04	1.77E+05	1.00E+01	1.77E+02	5.10E-02	5.90E-06
Benzo(a)pyrene	2.52E+02	1.60E-03	1.90E-05	5.87E+05	1.00E+01	5.87E+02	4.80E-02	5.60E-06
Benzo(b)fluoranthene	2.52E+02	1.50E-03	2.70E-05	5.99E+05	1.00E+01	5.99E+02	4.80E-02	5.60E-06
Benzo(k)fluoranthene	2.52E+02	8.00E-04	2.40E-05	5.87E+05	1.00E+01	5.87E+02	4.80E-02	5.60E-06
Chrysene	2.28E+02	2.00E-03	2.10E-04	1.81E+05	1.00E+01	1.81E+02	2.60E-02	6.70E-06
Fluoranthene	2.02E+02	2.60E-01	3.60E-04	5.55E+04	*NPCP*	5.55E+01	2.80E-02	7.20E-06
Fluorene	1.66E+02	1.69E+00	3.90E-03	9.16E+03	*NPCP*	9.16E+00	4.40E-02	7.90E-06
Pyrene	2.02E+02	1.35E-01	4.90E-04	5.43E+04	*NPCP*	5.43E+01	2.80E-02	7.20E-06

NOTES:
NPCP: A physical-chemical parameter, required in the calculation of the value, is not available.

TOXICITY VALUES

CHEMICAL PROPERTIES

	Carcinogenic Effects		Non-Carcinogenic Effects		Oral Relative Absorption Factor	Dermal Relative Absorption Factor	Maximum Contaminant Level	Aquatic Life Criterion		Human Health Risk from Consumption of:		Early Childhood Mutagen?
	Oral Slope Factor [--]	Inhalation Unit Risk [--]	Oral Reference Dose [--]	Inhalation Reference Concentration [--]	[--]	[--]	[--]	Acute Criteria [--]	Chronic Criteria [--]	Water & Organisms [--]	Organisms Only [--]	[1=Yes, 0=No]
Benzene	5.50E-02	7.80E-06	4.00E-03	3.00E-02	1.00E+00	0.00E+00	5.00E-03	*NTOX*	*NTOX*	2.20E+00	5.10E+01	0.00E+00
Toluene	*NTOX*	*NTOX*	8.00E-02	5.00E+00	1.00E+00	0.00E+00	1.00E+00	*NTOX*	*NTOX*	1.30E+03	1.50E+04	0.00E+00
Ethylbenzene	1.10E-02	2.50E-06	1.00E-01	1.00E+00	1.00E+00	0.00E+00	7.00E-01	*NTOX*	*NTOX*	5.30E+02	2.10E+03	0.00E+00
Xylenes	*NTOX*	*NTOX*	2.00E-01	1.00E-01	1.00E+00	0.00E+00	1.00E+01	*NTOX*	*NTOX*	*NTOX*	*NTOX*	0.00E+00
Naphthalene	*NTOX*	3.40E-05	2.00E-02	3.00E-03	1.00E+00	1.30E-01	*NTOX*	*NTOX*	*NTOX*	*NTOX*	*NTOX*	0.00E+00
MTBE	1.80E-03	2.60E-07	*NTOX*	3.00E+00	1.00E+00	0.00E+00	*NTOX*	*NTOX*	*NTOX*	*NTOX*	*NTOX*	0.00E+00
1,2-Dichloroethane	9.10E-02	2.60E-05	6.00E-03	7.00E-03	1.00E+00	0.00E+00	5.00E-03	*NTOX*	*NTOX*	3.80E-01	3.70E+01	0.00E+00
Ethylene Dibromide	2.00E+00	6.00E-04	9.00E-03	9.00E-03	1.00E+00	0.00E+00	5.00E-05	*NTOX*	*NTOX*	*NTOX*	*NTOX*	0.00E+00
Acenaphthene	*NTOX*	*NTOX*	6.00E-02	*NTOX*	1.00E+00	1.30E-01	*NTOX*	*NTOX*	*NTOX*	6.70E+02	9.90E+02	0.00E+00
Anthracene	*NTOX*	*NTOX*	3.00E-01	*NTOX*	1.00E+00	1.30E-01	*NTOX*	*NTOX*	*NTOX*	8.30E+03	4.00E+04	0.00E+00
Benz(a)anthracene	7.30E-01	1.10E-04	*NTOX*	*NTOX*	1.00E+00	1.30E-01	*NTOX*	*NTOX*	*NTOX*	3.80E-03	1.80E-02	1.00E+00
Benzo(a)pyrene	7.30E+00	1.10E-03	*NTOX*	*NTOX*	1.00E+00	1.30E-01	2.00E-04	*NTOX*	*NTOX*	3.80E-03	1.80E-02	1.00E+00
Benzo(b)fluoranthene	7.30E-01	1.10E-04	*NTOX*	*NTOX*	1.00E+00	1.30E-01	*NTOX*	*NTOX*	*NTOX*	3.80E-03	1.80E-02	1.00E+00
Benzo(k)fluoranthene	7.30E-02	1.10E-04	*NTOX*	*NTOX*	1.00E+00	1.30E-01	*NTOX*	*NTOX*	*NTOX*	3.80E-03	1.80E-02	1.00E+00
Chrysene	7.30E-03	1.10E-05	*NTOX*	*NTOX*	1.00E+00	1.30E-01	*NTOX*	*NTOX*	*NTOX*	3.80E-03	1.80E-02	1.00E+00
Fluoranthene	*NTOX*	*NTOX*	4.00E-02	*NTOX*	1.00E+00	1.30E-01	*NTOX*	*NTOX*	*NTOX*	1.30E+02	1.40E+02	0.00E+00
Fluorene	*NTOX*	*NTOX*	4.00E-02	*NTOX*	1.00E+00	1.30E-01	*NTOX*	*NTOX*	*NTOX*	1.10E+03	5.30E+03	0.00E+00
Pyrene	*NTOX*	*NTOX*	3.00E-02	*NTOX*	1.00E+00	1.30E-01	*NTOX*	*NTOX*	*NTOX*	8.30E+02	4.00E+03	0.00E+00

NOTES:
NTOX: A toxicity parameter required in the calculation of the value is not available.

COMPARISON CHART

SCREENING EVALUATION

	Soil mg/kg				Groundwater mg/L			Deep Soil Vapor µg/m³		
	Max Site Concentration	Vapor Intrusion	Direct Contact	Groundwater Protection	Max Site Concentration	Vapor Intrusion	Ingestion	Max Site Concentration	Unrestricted Use Vapor Intrusion	Commercial/ Industrial Vapor Intrusion
Benzene	0.000522	0.08	8.3	**0.025**		0.044	**0.005**		**31**	160
Toluene	18.4	1300	7930	**6.6**		340	**1**		**520000**	2200000
Ethylbenzene	8.73	**0.25**	39	7.4	0.0025	**0.05**	0.7		**97**	490
Xylenes	129	**27**	6170	91	0.0089	**8.7**	10		**10000**	44000
Naphthalene	2.81	**0.12**	44	9.2		**0.07**	0.73		**7**	36
Acenaphthene	0.508	NA	4470	**200**		NA	**2.2**		NA	NA
Anthracene	0.537	NA	22300	**3200**		NA	**11**		NA	NA
Benz(a)anthracene	0	NA	0.19	**0.09**		NA	**3E-05**		NA	NA
Benzo(a)pyrene	0	NA	**0.02**	2.1		NA	**0.0002**		NA	NA
Benzo(b)fluoranthene	0	NA	**0.19**	0.31		NA	**3E-05**		NA	NA
Benzo(k)fluoranthene	0	NA	**1.9**	3.1		NA	**0.0003**		NA	NA
Chrysene	0	NA	19	**9.5**		NA	**0.006**		NA	NA
Fluoranthene	0.386	NA	2970	**1400**		NA	**1.5**		NA	NA
Fluorene	2.01	NA	2970	**240**		NA	**1.5**		NA	NA
Pyrene	2.54	NA	2230	**1000**		NA	**1.1**		NA	NA

NOTES: Except where indicated as Commercial/Industrial, the comparison concentrations are for unrestricted use.
All screening levels are taken from Table 2 in the Petroleum Guidance Document.

LEGEND:

8.4	Shaded cells indicate an exceedance of the screening levels for one or more pathways for a given chemical and media.
8.4	Bolded text indicates the most restrictive Residential Use Screening Level (RUSL) in the Petroleum Rule for each chemical and media.

SITE CONCEPTUAL MODEL (SCM)

The development of a site conceptual model is crucial to the completion of an accurate risk evaluation. By identifying impacted media, transport mechanisms, exposure routes, and receptors, the most appropriate data can be collected and applied to the evaluation of risk. This page is provided for the benefit of the user to aid in completing this step and is not connected to any input screens within the application. A detailed discussion of the site conceptual model is provided in Section 4.1 of the Guidance document.

Ecological receptors

DETAILED RISK EVALUATION

POTENTIAL RECEPTORS

IMPACTED MEDIA	TRANSPORT MECHANISMS	EXPOSURE ROUTES	Current Land Use – On Site: Residential	Current Land Use – On Site: Non-Residential	Current Land Use – On Site: Construction Worker	Current Land Use – Off Site: Residential	Current Land Use – Off Site: Non-Residential	Current Land Use – Off Site: Construction Worker	Future Land Use – On Site: Residential	Future Land Use – On Site: Non-Residential	Future Land Use – On Site: Construction Worker	Future Land Use – Off Site: Residential	Future Land Use – Off Site: Non-Residential	Future Land Use – Off Site: Construction Worker
Surficial Soil	Wind Erosion Dispersion Volaltilization	Direct Contact: Vapors/Particulate Inhalation Dermal Contact-Ingestion	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		Leaching to Ground Water	☐	☐		☐	☐		☐	☐		☐	☐	
Subsurface Soil	Volatilization	Indoor Inhalation	☐	☑		☐	☐		☑	☑		☐	☐	
	Construction Activity Wind Erosion Dispersion Volatilization	Direct Contact: Vapors/Particulate Inhalation Dermal Contact-Ingestion	☐	☐	☑	☐	☐	☐	☑	☑	☑	☐	☐	☐
		Leaching to Ground Water	☐	☑		☐	☐		☑	☑		☐	☐	
Groundwater	Volatilization	Indoor Inhalation	☐	☑		☐	☐		☑	☑		☐	☐	
		Ingestion	☐	☐		☐	☐		☐	☐		☐	☐	
		Surface Water Impacts	☐	☐		☐	☐		☐	☐		☐	☐	

RECEPTORS AND ROUTES OF EXPOSURE

DETAILED RISK EVALUATION

ROUTES OF EXPOSURE BY MEDIA	Residential	Non-Residential	Construction Worker
Direct Contact Soil Ingestion of Soil, Outdoor Inhalation of Vapor Emissions and Particulates, and Dermal Contact with Soil	☐	☐	☑
Subsurface Soil Indoor Inhalation of Vapor Emissions	☑	☑	
Groundwater Indoor Inhalation of Vapor Emissions	☑	☑	
Soil-Vapor Indoor Inhalation of Vapor Emissions	☐	☐	

Construction worker direct contact exposure is for expected depth of construction.
Depending on the data available for evaluation of indoor inhalation risk, check either A) subsurface soil and/or groundwater data, or B) soil vapor, but not all three.

Groundwater Protection

The Maximum Contaminant Levels (MCLs) are used as the target concentrations at the POE. For chemicals without MCLs, risk-based ingestion standards are calculated.

Surface Water Protection

If a surface water body is impacted or threatened, complete the following. Refer to the Idaho Water Quality Standards (IDAPA 58.01.02) sections 109 through 160 for designated beneficial uses of specific Idaho surface water bodies.

Designated for use as domestic water supply?	☐
Designated for aquatic life or recreation use?	☐

EXPOSURE POINT CONCENTRATIONS: RESIDENTIAL

Chemical	Subsurface Soil	Groundwater
	Indoor Inhalation of Vapor Emissions	Indoor Inhalation of Vapor Emissions
	Representative Concentration [mg/kg]	Representative Concentration [mg/L]
Benzene	0.000522	0.0006
Toluene	18.4	
Ethylbenzene	0.00325	0.0025
Xylenes	0.453	0.0089
Naphthalene	0.86	
Acenaphthene	0.508	
Anthracene	0.537	
Benz(a)anthracene	0.166	
Benzo(a)pyrene	0.12	
Benzo(b)fluoranthene	0.169	
Benzo(k)fluoranthene	0.169	
Chrysene	0.169	
Fluoranthene	0.386	
Fluorene	2.01	
Pyrene	2.54	

EXPOSURE POINT CONCENTRATIONS: NON-RESIDENTIAL

Chemical	Subsurface Soil	Groundwater
	Indoor Inhalation of Vapor Emissions	Indoor Inhalation of Vapor Emissions
	Representative Concentration [mg/kg]	Representative Concentration [mg/L]
Benzene	0.000522	0.0006
Toluene	18.4	
Ethylbenzene	0.00325	0.0025
Xylenes	0.453	0.0089
Naphthalene	0.86	
Acenaphthene	0.508	
Anthracene	0.537	
Benz(a)anthracene	0.166	
Benzo(a)pyrene	0.12	
Benzo(b)fluoranthene	0.169	
Benzo(k)fluoranthene	0.169	
Chrysene	0.169	
Fluoranthene	0.386	
Fluorene	2.01	
Pyrene	2.54	

EXPOSURE POINT CONCENTRATIONS: CONSTRUCTION WORKER

Chemical	Direct Contact Soil
	Ingestion of Soil, Outdoor Inhalation of Vapor Emissions and Particulates, and Dermal Contact with Soil
	Representative Concentration [mg/kg]
Benzene	0.000522
Toluene	18.4
Ethylbenzene	0.00325
Xylenes	0.453
Naphthalene	0.86
Acenaphthene	0.508
Anthracene	0.537
Benz(a)anthracene	0.166
Benzo(a)pyrene	0.12
Benzo(b)fluoranthene	0.169
Benzo(k)fluoranthene	0.169
Chrysene	0.169
Fluoranthene	0.386
Fluorene	2.01
Pyrene	2.54

EXPOSURE POINT CONCENTRATIONS: GROUNDWATER / SURFACE WATER PROTECTION

Chemical	Groundwater and/or Surface Water Protection		
	Representative Groundwater Concentration at the Source [mg/L]	Representative Soil Concentration at the Source [mg/kg]	Representative Groundwater Concentration at the POC [mg/L]
		NOT USED IN CALCULATIONS	
Benzene	0.0006		
Toluene			
Ethylbenzene	0.0025		
Xylenes	0.0089		
Naphthalene			
Acenaphthene			
Anthracene			
Benz(a)anthracene			
Benzo(a)pyrene			
Benzo(b)fluoranthene			
Benzo(k)fluoranthene			
Chrysene			
Fluoranthene			
Fluorene			
Pyrene			
	Paste Values...	Paste Values...	Paste Values...

Direct Contact

Parameter	Symbol	Unit	Default Value	Value Used	Justification
Cowherd Particulate Emission Model					
Parameters					
Site size for calculation of Q/C parameter		acres	0.5		Default
Inverse of Mean Concentration in the Middle of a Square Source	Q/C			69.4	Calculated
Fraction of Vegetative Cover	V	m^2/m^2	~~0.5~~	0	asphalt
Mean Annual Wind Speed	U_m	m/s	3.98		Default
Equivalent Threshold Value of Windspeed at 7m	U_t	m/s	11.3		Default
Windspeed Distribution Function from Cowherd et. al, 1985	$F_{(x)}$		0.0495		Default
Soil Properties					
Immediately Below the Building					
Soil Bulk Density	ρ_{sA}	cm^3	1.64		Default
Total Porosity	Θ_{TA}	cm^3/cm^3-soil	0.39		Default
Fractional Organic Carbon Content	foc_A	g-C/g-soil	0.001		Default
Volumetric Water Content	Θ_{wsA}	cm^3/cm^3	0.17		Default
Volumetric Air Content	Θ_{asA}	cm^3/cm^3		0.22	Calculated

Groundwater / Surface Water Protection

Parameter	Symbol	Unit	Default Value	Value Used	Justification
Common Water Inputs					
Source Zone Soil Properties					
Dry Soil Bulk Density of the source zone soil	ρ_s	g/cm^3	1.64		Default
Fractional Organic Carbon Content in the source zone soil	foc	g-C/g-soil	0.001		Default
Total Soil Porosity of the source zone soil	Θ_T	cm^3/cm^3-soil	0.39		Default
Volumetric Water Content in the source zone soil	Θ_{ws}	cm^3/cm^3	0.17		Default
Volumetric Air Content in the source zone soil	Θ_{as}	cm^3/cm^3		0.22	Calculated
Saturated Zone Soil Properties					
Dry Soil Bulk Density of the saturated zone soil	ρ_{ss}	g/cm^3	1.64		Default
Fractional Organic Carbon Content in the saturated zone soil	focs	g-C/g-soil	0.001		Default
Total Soil Porosity in the saturated zone soil	Θ_{Ts}	cm^3/cm^3-soil	0.39		Default
Source Area Parameters					
Groundwater Darcy Velocity	U_{gw}	ft/year	110		Default
Groundwater Mixing Zone Length	L_{mz}	ft	40		Default
Groundwater Mixing Zone Thickness	δ_{gw}	ft	5.02		Default
Groundwater Mixing Zone Width	W_{gw}	ft	40		Default
Infiltration Rate	I	ft/year	0.82		Default

Exposure and Compliance Point Distances from Source

Groundwater / Surface Water Protection

Parameter	Symbol	Unit	Default Value	Value Used	Justification
Groundwater Protection Parameters					
Distance to Point of Exposure (POE)	$X_{poe,gw}$	ft	0		Default
Longitudinal dispersivity	α_x	ft		0	Calculated
Transverse dispersivity	α_y	ft		0	Calculated
Vertical dispersivity	α_z	ft		0	Calculated
Distance to the Point of Compliance (POC)	$X_{poc,gw}$	ft	0		Default
Longitudinal dispersivity	α_x	ft		0	Calculated
Transverse dispersivity	α_y	ft		0	Calculated
Vertical dispersivity	α_z	ft		0	Calculated
Surface Water Protection Parameters					
Distance to the Point of Discharge	$X_{poe,sw}$	ft	0		Default
Longitudinal dispersivity	α_x	ft		0	Calculated
Transverse dispersivity	α_y	ft		0	Calculated
Vertical dispersivity	α_z	ft		0	Calculated
Distance to the Point of Compliance	$X_{poc,sw}$	ft	0		Default
Longitudinal dispersivity	α_x	ft		0	Calculated
Transverse dispersivity	α_y	ft		0	Calculated
Vertical dispersivity	α_z	ft		0	Calculated
pH of the receiving surface water	pH		7		Default
Temperature of the receiving surface water	T	°C	15		Default
Hardness of the receiving surface water	H	mg/L	25		Default

Vapor Intrusion: Soil and Source

Parameter	Symbol	Unit	Default Value	Value Used	Justification

Interview Questions

Which of the following best describes the building?	**Slab on grade**

The model does not accommodate structures with crawl spaces or dirt floors. Contact DEQ for more information on how to address these types of situations.

Soil Strata Parameters

Soil Source					
What is the number of soil strata between the building and top of the source (up to 3)?	N_S		1		Default
Source Thickness					
Distance from top of the soil source to bottom of building	L_{TS}	cm	~~30~~	240	
Distance from bottom of soil source to bottom of building	L_{TS-B}	cm	~~183~~	915	
Thickness of Soil Strata between the top of the source and the bottom of the building					
Stratum A (Immediately below the building)	h_A	cm	~~30~~	240	
Groundwater Source					
What is the number of soil strata between the building and the capillary fringe (up to 3)?	N_{GW}		~~1~~	2	
Thickness of Soil Strata between groundwater and the bottom of the building					
Distance from top of groundwater to bottom of building	L_{TGW}	cm	~~30~~	13,716	
Stratum A (Immediately below the building)	h_A	cm	~~5~~	915	
Stratum B	h_B	cm	~~0~~	12,776	
Stratum D (Capillary fringe)	h_{cap}	cm		25	Calculated

Vapor Intrusion: Soil and Source

Parameter	Symbol	Unit	Default Value	Value Used	Justification
Stratum-Specific Properties					
Stratum A (Immediately below the building)					
Fractional Organic Carbon Content	foc_A	g-C/g-soil	0.001		Default
Dry Soil Bulk Density	ρ_{sA}	cm^3	1.64		Default
Vapor permeability	K_v	cm^2	0.000000005		Default
Total Soil Porosity	Θ_{TA}	cm^3/cm^3-soil	0.39		Default
Volumetric Air Content in Stratum A	Θ_{asA}	cm^3/cm^3		0.22	Calculated
Volumetric Water Content in Stratum A	Θ_{wsA}	cm^3/cm^3	0.17		Default
Stratum B					
Fractional Organic Carbon Content	foc_B	g-C/g-soil	0.001		Default
Dry Soil Bulk Density	ρ_{sB}	g/cm^3	1.64		Default
Total Soil Porosity	Θ_{TB}	cm^3/cm^3-soil	0.39		Default
Volumetric Air Content in Stratum B	Θ_{asB}	cm^3/cm^3		0.22	Calculated
Volumetric Water Content in Stratum B	Θ_{wsB}	cm^3/cm^3	0.17		Default
Stratum D (Capillary fringe)					
Fractional Organic Carbon Content	foc_F	g-C/g-soil	0.001		Default
Soil Texture (USDA)	**Sandy loam**				
van Genutchen soil water retention parameter	N			1.45	Calculated
Mean Particle Diameter	D	cm		0.03	Calculated
Residual water content in capillary fringe soil				0.04	Calculated
Dry Soil Bulk Density	ρ_{sF}	g/cm^3		1.64	Calculated
Total Soil Porosity	Θ_{Tcap}	cm^3/cm^3-soil		0.39	Calculated
Volumetric Air Content in Stratum capillary fringe	Θ_{acap}	cm^3/cm^3		0.0676	Calculated
Volumetric Water Content in Stratum capillary fringe	Θ_{wcap}			0.322	Calculated

Air Parameters

Viscosity of Air	μ	g/cm-s	0.00018		Default

Vapor Intrusion: Enclosed Space

Parameter	Symbol	Unit	Default Value	Value Used	Justification
Enclosed Space Parameters					
Enclosed Space Foundation/Wall Thickness					
Enclosed Space Foundation/Wall Thickness Residential	L_{crack}	cm	15		Default
Enclosed Space Foundation/Wall Thickness Non-residential	L_{crack}	cm	15		Default
Number of air exchanges per hour					
Number of air exchanges per hour Residential	ER	1/hr	1		Default
Number of air exchanges per hour Non-residential	ER	1/hr	1		Default
Depth below grade to bottom of enclosed space floor					
Depth below grade to bottom of enclosed space floor Residential	L_B	cm	15		Default
Depth below grade to bottom of enclosed space floor Non-residential	L_B	cm	15		Default
Length of enclosed space					
Length of enclosed space Residential	L_B	cm	1,220		Default
Length of enclosed space Non-residential	L_B	cm	2,160		Default
Width of enclosed space					
Width of enclosed space Residential	W_B	cm	1,220		Default
Width of enclosed space Non-residential	W_B	cm	2,160		Default
Height of enclosed space					
Height of enclosed space Residential	H_B	cm	244		Default
Height of enclosed space Non-residential	H_B	cm	244		Default
Pressure differential between enclosed space and soil surface beneath	ΔP	g/cm-s^2	40		Default
Area of the enclosed space below grade					
Area of the enclosed space below grade Residential	A_B	cm^2		1,490,000	Calculated
Area of the enclosed space below grade Non-residential	A_B	cm^2		4,650,000	Calculated

Vapor Intrusion: Enclosed Space

Parameter	Symbol	Unit	Default Value	Value Used	Justification
Floor-wall seam perimeter					
Floor-wall seam perimeter Residential	X_{crack}	cm^2/cm^2		4,880	Calculated
Floor-wall seam perimeter Non-residential	X_{crack}	cm^2/cm^2		8,630	Calculated
Total area of cracks					
Total area of cracks Residential	A_{crack}	cm^2		744	Calculated
Total area of cracks Non-residential	A_{crack}	cm^2		2,330	Calculated
Crack Depth Below Grade					
Crack Depth Below Grade Residential	Z_{crack}	cm		15	Calculated
Crack Depth Below Grade Non-residential	Z_{crack}	cm		15	Calculated
Building Crack Ratio					
Building Crack Ratio Residential	n			0.0005	Calculated
Building Crack Ratio Non-residential	n			0.0005	Calculated
Equivalent Crack Width					
Equivalent Crack Width Residential	r_{crack}	cm		0.1	Calculated
Equivalent Crack Width Non-residential	r_{crack}	cm		0.1	Calculated
Building ventilation rate					
Building ventilation rate Residential	$Q_{building}$	cm^3/s		101,000	Calculated
Building ventilation rate Non-residential	$Q_{building}$	cm^3/s		315,000	Calculated
Volumetric flow rate of soil gas into the enclosed space					
Volumetric flow rate of soil gas into the enclosed space Residential	Q_{soil}	cm^3/s		5.97	Calculated
Volumetric flow rate of soil gas into the enclosed space Non-Residential	Q_{soil}	cm^3/s		10.6	Calculated

DECAY RATES

Enter site-specific decay rates for this site if they vary from the default values.

	First Order Decay Rate [day^{-1}]		Unsaturated Zone DAF	
	Default Value	Site-Specific Value	Default Value	Site-Specific Value
Benzene	0		1	
Toluene	0		1	
Ethylbenzene	0		1	
Xylenes	0		1	
Naphthalene	0		1	
Acenaphthene	0		1	
Anthracene	0		1	
Benz(a)anthracene	0		1	
Benzo(a)pyrene	0		1	
Benzo(b)fluoranthene	0		1	
Benzo(k)fluoranthene	0		1	
Chrysene	0		1	
Fluoranthene	0		1	
Fluorene	0		1	
Pyrene	0		1	

Parameter	Symbol	Unit	Default Value	Value Used	Justification
Averaging Time					
Averaging Time for Carcinogens	AT_c	year	70		Default
Averaging Time for Non-Carcinogens, Adult	AT_{nc}	year		30	Calculated
Averaging Time for Non-Carcinogens, Age Adjusted Adult	AT_{nc}	year		24	Calculated
Averaging Time for Non-Carcinogens, Child	AT_{nc}	year		6	Calculated
Averaging Time for Non-Carcinogens, Non-residential	AT_{nc}	year		25	Calculated
Averaging Time for Non-Carcinogens, Construction Worker	AT_{nc}	year		1	Calculated
Body Weight					
Body Weight Resident Adult	BW_a	kg	70		Default
Body Weight Resident Child	BW_c	kg	15		Default
Body Weight Non-residential	BW_{com}	kg	70		Default
Body Weight Construction Worker	BW_{con}	kg	70		Default
Exposure Duration					
Exposure Duration Resident Adult	ED_a	year	30		Default
Exposure Duration Resident Age Adjusted Adult	ED_{aa}	year	24		Default
Exposure Duration Resident Child	ED_c	year	6		Default
Exposure Duration Non-residential	ED_{com}	year	25		Default
Exposure Duration Construction Worker	ED_{con}	year	1		Default
Exposure Frequency for Indirect Pathways					
Exposure Frequency for Indirect Pathway Resident Child	EF_c	day/year	350		Default
Exposure Frequency for Indirect Pathway Resident Adult	EF_a	day/year	350		Default
Exposure Frequency for Indirect Pathway Non-residential	EF_{com}	day/year	250		Default
Exposure Frequency for Indirect Pathway Construction Worker	EF_{con}	day/year	30		Default

Parameter	Symbol	Unit	Default Value	Value Used	Justification
Exposure Frequency for Direct Contact Pathways					
Exposure Frequency for Direct Contact Pathways Resident Adult	EF_{da}	day/year	270		Default
Exposure Frequency for Direct Contact Pathways Non-residential	EF_{dcom}	day/year	180		Default
Exposure Frequency for Direct Contact Pathways Construction Worker	EF_{dcon}	day/year	30		Default
Exposure Frequency for Direct Contact Pathways Resident Child	EF_{dc}	day/year	270		Default
Indoor Exposure Time					
Indoor Exposure Time Resident Adult	ET_{i-a}	hrs/day	24		Default
Indoor Exposure Time Resident Child	ET_{i-c}	hrs/day	24		Default
Indoor Exposure Time Non-residential	ET_{i-com}	hrs/day	8		Default
Outdoor Exposure Time					
Outdoor Exposure Time Resident Adult	ET_{o-a}	hrs/day	2		Default
Outdoor Exposure Time Resident Child	ET_{o-c}	hrs/day	2		Default
Outdoor Exposure Time Non-residential	ET_{o-com}	hrs/day	6		Default
Outdoor Exposure Time Construction Worker	ET_{o-con}	hrs/day	10		Default
Soil Ingestion Rate					
Soil Ingestion Rate Age-adjusted	IR_{s-aa}	mg/day		114	Calculated
Soil Ingestion Rate Age-Adjusted Mutagenic Chemicals	IR_{s-aam}	mg-yr/kg-day		490	Calculated
Soil Ingestion Rate Resident Adult	IR_{s-a}	mg/day	100		Default
Soil Ingestion Ingestion Rate Resident Child	IR_{s-c}	mg/day	200		Default
Soil Ingestion Rate Non-residential	IR_{s-com}	mg/day	100		Default
Soil Ingestion Rate Construction Worker	IR_{s-con}	mg/day	330		Default

Parameter	Symbol	Unit	Default Value	Value Used	Justification
Groundwater Ingestion Rate					
Groundwater Ingestion RateAge-adjusted	IR_{w-aa}	L-yr/kg-day		1.09	Calculated
Groundwater Ingestion Rate Age-Adjusted Mutagenic Chemicals	IR_{w-aam}	L-yr/kg-day		3.39	Calculated
Groundwater Ingestion Rate Resident Adult	IR_{w-a}	L/day	2		Default
Groundwater Ingestion Rate Resident Child	IR_{w-c}	L/day	1		Default
Groundwater Ingestion Rate Non-residential	IR_{w-com}	L/day	1		Default
Skin Surface Area					
Skin Surface Area Age-adjusted	SA_{aa}	mg-yr/kg-day		361	Calculated
Skin Surface AreaAge-Adjusted Mutagenic Dermal	SA_{aam}	mg-yr/kg-day		1,450	Calculated
Skin Surface Area Resident Adult	SA_a	cm^2/day	5,700		Default
Skin Surface Area Resident Child	SA_c	cm^2/day	2,800		Default
Skin Surface Area Non-residential	SA_{com}	cm^2/day	3,300		Default
Skin Surface Area Construction Worker	SA_{con}	cm^2/day	3,300		Default
Soil to Skin Adherence Factor					
Soil to Skin Adherence Resident Adult	M_a	mg/cm^2	0.07		Default
Soil to Skin Adherence Resident Child	M_c	mg/cm^2	0.2		Default
Soil to Skin Adherence Non-residential	M_{com}	mg/cm^2	0.2		Default
Soil to Skin Adherence Construction Worker	M_{con}	mg/cm^2	0.3		Default
Averaging Time for Vapor Flux					
Averaging Time for Vapor Flux Resident Adult	τ	s		946,000,000	Calculated
Averaging Time for Vapor Flux Age-adjusted Resident	τ	s		757,000,000	Calculated
Averaging Time for Vapor Flux Resident Child	τ	s		189,000,000	Calculated
Averaging Time for Vapor Flux Commercial Worker	τ	s		788,000,000	Calculated
Averaging Time for Vapor Flux Construction Worker	τ	s		31,500,000	Calculated
Target Hazard Index	THI		1		Default

Parameter	Symbol	Unit	Default Value	Value Used	Justification
Target Risk	TR		0.00001		Default

RISK/HAZARD QUOTIENT: RESIDENTIAL

RISK EVALUATION RESULTS

Red highlight indicates highest risk and hazard

	Subsurface Soil			Groundwater			Total Risk Estimate & Hazard Index by Chemical	
	Indoor Inhalation of Vapor Emissions			Indoor Inhalation of Vapor Emissions				
	EPC	Risk	HI	EPC	Risk	HI	Risk	HI
Benzene	5.22E-04	2.89E-08	2.88E-04	6.00E-04	1.58E-09	1.57E-05	3.05E-08	3.04E-04
Toluene	1.84E+01	*NTOX*	6.09E-02	*Missing*	*NCOC*	*NCOC*	*NA*	6.09E-02
Ethylbenzene	3.25E-03	5.76E-08	5.38E-05	2.50E-03	2.25E-09	2.10E-06	5.99E-08	5.59E-05
Xylenes	4.53E-01	*NTOX*	6.58E-02	8.90E-03	*NTOX*	6.07E-05	*NA*	6.58E-02
Naphthalene	8.60E-01	5.58E-06	1.28E-01	*Missing*	*NCOC*	*NCOC*	5.58E-06	1.28E-01
Acenaphthene	5.08E-01	*NTOX*	*NTOX*	*Missing*	*NCOC*	*NCOC*	*NA*	*NA*
Anthracene	5.37E-01	*NTOX*	*NTOX*	*Missing*	*NCOC*	*NCOC*	*NA*	*NA*
Benz(a)anthracene	1.66E-01	2.22E-09	*NTOX*	*Missing*	*NCOC*	*NCOC*	2.22E-09	*NA*
Benzo(a)pyrene	1.20E-01	2.33E-10	*NTOX*	*Missing*	*NCOC*	*NCOC*	2.33E-10	*NA*
Benzo(b)fluoranthene	1.69E-01	4.42E-11	*NTOX*	*Missing*	*NCOC*	*NCOC*	4.42E-11	*NA*
Benzo(k)fluoranthene	1.69E-01	4.06E-11	*NTOX*	*Missing*	*NCOC*	*NCOC*	4.06E-11	*NA*
Chrysene	1.69E-01	8.47E-11	*NTOX*	*Missing*	*NCOC*	*NCOC*	8.47E-11	*NA*
Fluoranthene	3.86E-01	*NTOX*	*NTOX*	*Missing*	*NCOC*	*NCOC*	*NA*	*NA*
Fluorene	2.01E+00	*NTOX*	*NTOX*	*Missing*	*NCOC*	*NCOC*	*NA*	*NA*
Pyrene	2.54E+00	*NTOX*	*NTOX*	*Missing*	*NCOC*	*NCOC*	*NA*	*NA*
Totals by Pathway		5.67E-06	2.55E-01		3.82E-09	7.85E-05	**5.67E-06**	**2.55E-01**

NOTES:
Missing: A value necessary to calculate this value was not provided.
NTOX: A toxicity parameter required in the calculation of the value is not available.
NCOC: The chemical is not a COC for the pathway because, although it was selected, no representative concentration was entered.

RISK/HAZARD QUOTIENT: NON-RESIDENTIAL

RISK EVALUATION RESULTS

Red highlight indicates highest risk and hazard

	Subsurface Soil			Groundwater			Total Risk Estimate & Hazard Index by Chemical	
	Indoor Inhalation of Vapor Emissions			Indoor Inhalation of Vapor Emissions				
	EPC	Risk	HI	EPC	Risk	HI	Risk	HI
Benzene	5.22E-04	6.80E-09	8.14E-05	6.00E-04	2.99E-10	3.58E-06	7.10E-09	8.50E-05
Toluene	1.84E+01	*NTOX*	1.49E-02	*Missing*	*NCOC*	*NCOC*	*NA*	1.49E-02
Ethylbenzene	3.25E-03	8.82E-09	9.87E-06	2.50E-03	4.30E-10	4.82E-07	9.25E-09	1.04E-05
Xylenes	4.53E-01	*NTOX*	1.12E-02	8.90E-03	*NTOX*	1.38E-05	*NA*	1.12E-02
Naphthalene	8.60E-01	7.15E-07	1.96E-02	*Missing*	*NCOC*	*NCOC*	7.15E-07	1.96E-02
Acenaphthene	5.08E-01	*NTOX*	*NTOX*	*Missing*	*NCOC*	*NCOC*	*NA*	*NA*
Anthracene	5.37E-01	*NTOX*	*NTOX*	*Missing*	*NCOC*	*NCOC*	*NA*	*NA*
Benz(a)anthracene	1.66E-01	1.12E-10	*NTOX*	*Missing*	*NCOC*	*NCOC*	1.12E-10	*NA*
Benzo(a)pyrene	1.20E-01	1.09E-11	*NTOX*	*Missing*	*NCOC*	*NCOC*	1.09E-11	*NA*
Benzo(b)fluoranthene	1.69E-01	2.09E-12	*NTOX*	*Missing*	*NCOC*	*NCOC*	2.09E-12	*NA*
Benzo(k)fluoranthene	1.69E-01	1.91E-12	*NTOX*	*Missing*	*NCOC*	*NCOC*	1.91E-12	*NA*
Chrysene	1.69E-01	4.46E-12	*NTOX*	*Missing*	*NCOC*	*NCOC*	4.46E-12	*NA*
Fluoranthene	3.86E-01	*NTOX*	*NTOX*	*Missing*	*NCOC*	*NCOC*	*NA*	*NA*
Fluorene	2.01E+00	*NTOX*	*NTOX*	*Missing*	*NCOC*	*NCOC*	*NA*	*NA*
Pyrene	2.54E+00	*NTOX*	*NTOX*	*Missing*	*NCOC*	*NCOC*	*NA*	*NA*
Totals by Pathway		7.31E-07	4.58E-02		7.30E-10	1.79E-05	**7.32E-07**	**4.59E-02**

NOTES:
Missing: A value necessary to calculate this value was not provided.
NTOX: A toxicity parameter required in the calculation of the value is not available.
NCOC: The chemical is not a COC for the pathway because, although it was selected, no representative concentration was entered.

RISK/HAZARD QUOTIENT: CONSTRUCTION WORKER

RISK EVALUATION RESULTS

Red highlight indicates highest risk and hazard

	Direct Contact Soil			Total Risk Estimate & Hazard Index by Chemical	
	Ingestion of Soil, Outdoor Inhalation of Vapor Emissions and Particulates, and Dermal Contact with Soil				
	EPC	Risk	HI	Risk	HI
Benzene	5.22E-04	4.29E-12	1.29E-06	4.29E-12	1.29E-06
Toluene	1.84E+01	*NTOX*	3.18E-04	*NA*	3.18E-04
Ethylbenzene	3.25E-03	6.02E-12	1.76E-07	6.02E-12	1.76E-07
Xylenes	4.53E-01	*NTOX*	2.22E-04	*NA*	2.22E-04
Naphthalene	8.60E-01	2.80E-09	1.95E-03	2.80E-09	1.95E-03
Acenaphthene	5.08E-01	*NTOX*	4.56E-06	*NA*	4.56E-06
Anthracene	5.37E-01	*NTOX*	9.64E-07	*NA*	9.64E-07
Benz(a)anthracene	1.66E-01	9.59E-10	*NTOX*	9.59E-10	*NA*
Benzo(a)pyrene	1.20E-01	6.78E-09	*NTOX*	6.78E-09	*NA*
Benzo(b)fluoranthene	1.69E-01	9.55E-10	*NTOX*	9.55E-10	*NA*
Benzo(k)fluoranthene	1.69E-01	1.00E-10	*NTOX*	1.00E-10	*NA*
Chrysene	1.69E-01	1.10E-11	*NTOX*	1.10E-11	*NA*
Fluoranthene	3.86E-01	*NTOX*	5.20E-06	*NA*	5.20E-06
Fluorene	2.01E+00	*NTOX*	2.71E-05	*NA*	2.71E-05
Pyrene	2.54E+00	*NTOX*	4.56E-05	*NA*	4.56E-05
Totals by Pathway		1.16E-08	2.57E-03	**1.16E-08**	**2.57E-03**

NOTES:
NTOX: A toxicity parameter required in the calculation of the value is not available.

RISK/HAZARD QUOTIENT: SUMMARY

RISK EVALUATION RESULTS

Red highlight indicates target Risk or Hazard Index exceeded for receptor.

Routes of Exposure	Receptor					
	Residential		Non-Residential		Construction Worker	
	Risk	HI	Risk	HI	Risk	HI
Direct Contact Soil Ingestion of Soil, Outdoor Inhalation of Vapor Emissions and Particulates, and Dermal Contact with Soil	*NA*	*NA*	*NA*	*NA*	1.16E-08	2.57E-03
Subsurface Soil Indoor Inhalation of Vapor Emissions	5.67E-06	2.55E-01	7.31E-07	4.58E-02	*NA*	*NA*
Groundwater Indoor Inhalation of Vapor Emissions	3.82E-09	7.85E-05	7.30E-10	1.79E-05	*NA*	*NA*
Soil-Vapor Indoor Inhalation of Vapor Emissions	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
Site Risk	5.67E-06		7.32E-07		1.16E-08	
Site Hazard Index		2.55E-01		4.59E-02		2.57E-03
Target Risk/HI Exceeded?	NO	NO	NO	NO	NO	NO

RATLs Not Required

Site meets Target Risk and Hazard Index for this receptor.

Red highlight indicates concentration exceeding target level.

	Subsurface Soil		Groundwater	
	Indoor Inhalation of Vapor Emissions		Indoor Inhalation of Vapor Emissions	
	Concentration [mg/kg]	Target Level	Concentration [mg/L]	Target Level [mg/L]
Benzene	5.22E-04	1.81E-02	6.00E-04	3.80E-01
Toluene	1.84E+01	3.78E+01	*Missing*	*Missing*
Ethylbenzene	3.25E-03	5.64E-02	2.50E-03	1.11E+00
Xylenes	4.53E-01	8.61E-01	8.90E-03	1.83E+01
Naphthalene	8.60E-01	1.54E-01	*Missing*	*Missing*
Acenaphthene	5.08E-01	*NTOX*	*Missing*	*Missing*
Anthracene	5.37E-01	*NTOX*	*Missing*	*Missing*
Benz(a)anthracene	1.66E-01	7.48E+01	*Missing*	*Missing*
Benzo(a)pyrene	1.20E-01	5.16E+02	*Missing*	*Missing*
Benzo(b)fluoranthene	1.69E-01	3.82E+03	*Missing*	*Missing*
Benzo(k)fluoranthene	1.69E-01	4.17E+03	*Missing*	*Missing*
Chrysene	1.69E-01	2.00E+03	*Missing*	*Missing*
Fluoranthene	3.86E-01	*NTOX*	*Missing*	*Missing*
Fluorene	2.01E+00	*NTOX*	*Missing*	*Missing*
Pyrene	2.54E+00	*NTOX*	*Missing*	*Missing*

NOTES:
Missing: A value necessary to calculate this value was not provided.
NTOX: A toxicity parameter required in the calculation of the value is not available.

RATLs Not Required

Site meets Target Risk and Hazard Index for this receptor.

Red highlight indicates concentration exceeding target level.

	Subsurface Soil		Groundwater	
	Indoor Inhalation of Vapor Emissions		Indoor Inhalation of Vapor Emissions	
	Concentration [mg/kg]	Target Level	Concentration [mg/L]	Target Level [mg/L]
Benzene	5.22E-04	7.68E-02	6.00E-04	2.00E+00
Toluene	1.84E+01	1.54E+02	*Missing*	*Missing*
Ethylbenzene	3.25E-03	3.69E-01	2.50E-03	5.81E+00
Xylenes	4.53E-01	5.06E+00	8.90E-03	8.04E+01
Naphthalene	8.60E-01	1.20E+00	*Missing*	*Missing*
Acenaphthene	5.08E-01	*NTOX*	*Missing*	*Missing*
Anthracene	5.37E-01	*NTOX*	*Missing*	*Missing*
Benz(a)anthracene	1.66E-01	1.48E+03	*Missing*	*Missing*
Benzo(a)pyrene	1.20E-01	1.11E+04	*Missing*	*Missing*
Benzo(b)fluoranthene	1.69E-01	8.09E+04	*Missing*	*Missing*
Benzo(k)fluoranthene	1.69E-01	8.86E+04	*Missing*	*Missing*
Chrysene	1.69E-01	3.79E+04	*Missing*	*Missing*
Fluoranthene	3.86E-01	*NTOX*	*Missing*	*Missing*
Fluorene	2.01E+00	*NTOX*	*Missing*	*Missing*
Pyrene	2.54E+00	*NTOX*	*Missing*	*Missing*

NOTES:
Missing: A value necessary to calculate this value was not provided.
NTOX: A toxicity parameter required in the calculation of the value is not available.

RATLs Not Required

Site meets Target Risk and Hazard Index for this receptor.

Red highlight indicates concentration exceeding target level.

	Direct Contact Soil	
	Ingestion of Soil, Outdoor Inhalation of Vapor Emissions and Particulates, and Dermal Contact with Soil	
	Concentration [mg/kg]	Target Level
Benzene	5.22E-04	4.05E+01
Toluene	1.84E+01	5.79E+03
Ethylbenzene	3.25E-03	6.75E+02
Xylenes	4.53E-01	2.04E+02
Naphthalene	8.60E-01	4.42E+01
Acenaphthene	5.08E-01	1.11E+04
Anthracene	5.37E-01	5.57E+04
Benz(a)anthracene	1.66E-01	2.16E+02
Benzo(a)pyrene	1.20E-01	2.21E+01
Benzo(b)fluoranthene	1.69E-01	2.21E+02
Benzo(k)fluoranthene	1.69E-01	2.11E+03
Chrysene	1.69E-01	1.92E+04
Fluoranthene	3.86E-01	7.43E+03
Fluorene	2.01E+00	7.43E+03
Pyrene	2.54E+00	5.57E+03

	Inputs				Results										
	Groundwater Standard	First Order Decay Rate	Unsaturated Zone DAF	Source Area Groundwater Concentration	Mixing Zone DAF	Saturated Zone DAF		Overall DAF		Allowable Groundwater concentration protective of POE:		Existing Source Soil Concentration	Soil concentration directly beneath the source protective of GW at POE	Predicted Groundwater Concentration at POC	Predicted Groundwater Concentration at POE
	[mg/L]	[day^{-1}]	[--]	[mg/L]	[--]	at POC [--]	at POE [--]	at POC [--]	at POE [--]	at POC [mg/L]	at Source [mg/L]	[mg/kg]	[mg/kg]	[mg/L]	[mg/L]
Benzene	5.00E-03	0.00E+00	1.00E+00	6.00E-04	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	5.00E-03	5.00E-03	*Missing*	2.49E-02	6.00E-04	6.00E-04
Toluene	1.00E+00	0.00E+00	1.00E+00	1.00E-03	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	1.00E+00	1.00E+00	*Missing*	6.64E+00	1.00E-03	1.00E-03
Ethylbenzene	7.00E-01	0.00E+00	1.00E+00	2.50E-03	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	7.00E-01	7.00E-01	*Missing*	7.36E+00	2.50E-03	2.50E-03
Xylenes	1.00E+01	0.00E+00	1.00E+00	8.90E-03	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	1.00E+01	1.00E+01	*Missing*	9.14E+01	8.90E-03	8.90E-03
Naphthalene	7.30E-01	0.00E+00	1.00E+00	1.00E-03	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	7.30E-01	7.30E-01	*Missing*	2.14E+01	1.00E-03	1.00E-03
Acenaphthene	2.19E+00	0.00E+00	1.00E+00	1.00E-03	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	2.19E+00	2.19E+00	*Missing*	2.00E+02	1.00E-03	1.00E-03
Anthracene	1.10E+01	0.00E+00	1.00E+00	1.00E-03	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	1.10E+01	1.10E+01	*Missing*	3.21E+03	1.00E-03	1.00E-03
Benz(a)anthracene	2.95E-05	0.00E+00	1.00E+00	1.00E-03	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	2.95E-05	2.95E-05	*Missing*	9.27E-02	1.00E-03	1.00E-03
Benzo(a)pyrene	2.00E-04	0.00E+00	1.00E+00	1.00E-03	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	2.00E-04	2.00E-04	*Missing*	2.09E+00	1.00E-03	1.00E-03
Benzo(b)fluoranthene	2.95E-05	0.00E+00	1.00E+00	1.00E-03	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	2.95E-05	2.95E-05	*Missing*	3.14E-01	1.00E-03	1.00E-03
Benzo(k)fluoranthene	2.95E-04	0.00E+00	1.00E+00	1.00E-03	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	2.95E-04	2.95E-04	*Missing*	3.08E+00	1.00E-03	1.00E-03
Chrysene	2.95E-03	0.00E+00	1.00E+00	1.00E-03	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	2.95E-03	2.95E-03	*Missing*	9.46E+00	1.00E-03	1.00E-03
Fluoranthene	1.46E+00	0.00E+00	1.00E+00	1.00E-03	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	1.46E+00	1.46E+00	*Missing*	1.44E+03	1.00E-03	1.00E-03
Fluorene	1.46E+00	0.00E+00	1.00E+00	1.00E-03	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	1.46E+00	1.46E+00	*Missing*	2.40E+02	1.00E-03	1.00E-03
Pyrene	1.10E+00	0.00E+00	1.00E+00	1.00E-03	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	1.10E+00	1.10E+00	*Missing*	1.06E+03	1.00E-03	1.00E-03

NOTES:
Missing: A value necessary to calculate this value was not provided.

SURFACE WATER PROTECTION

	Inputs				Results										
	Surface Water Standard	First Order Decay Rate	Unsaturated Zone DAF	Source Area Groundwater Concentration	Mixing Zone DAF	Saturated Zone DAF		Overall DAF		Allowable Groundwater Concentration protective of surface water:		Existing Source Soil Concentration	Soil concentration at the source protective of surface water	Predicted Groundwater Concentration at POC	Predicted Groundwater Concentration at Discharge to SW
	[mg/L]	[day^{-1}]	[--]	[mg/L]	[--]	at POC [--]	at POE [--]	at POC [--]	at POE [--]	at POC [mg/L]	at Source [mg/L]	[--]	[mg/kg]	[mg/L]	[mg/L]
Benzene	*NSWSTD*	0.00E+00	1.00E+00	6.00E-04	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	*NSWSTD*	*NSWSTD*	*Missing*	*NSWSTD*	*NSWSTD*	*NSWSTD*
Toluene	*NSWSTD*	0.00E+00	1.00E+00	1.00E-03	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	*NSWSTD*	*NSWSTD*	*Missing*	*NSWSTD*	*NSWSTD*	*NSWSTD*
Ethylbenzene	*NSWSTD*	0.00E+00	1.00E+00	2.50E-03	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	*NSWSTD*	*NSWSTD*	*Missing*	*NSWSTD*	*NSWSTD*	*NSWSTD*
Xylenes	*NSWSTD*	0.00E+00	1.00E+00	8.90E-03	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	*NSWSTD*	*NSWSTD*	*Missing*	*NSWSTD*	*NSWSTD*	*NSWSTD*
Naphthalene	*NSWSTD*	0.00E+00	1.00E+00	1.00E-03	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	*NSWSTD*	*NSWSTD*	*Missing*	*NSWSTD*	*NSWSTD*	*NSWSTD*
Acenaphthene	*NSWSTD*	0.00E+00	1.00E+00	1.00E-03	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	*NSWSTD*	*NSWSTD*	*Missing*	*NSWSTD*	*NSWSTD*	*NSWSTD*
Anthracene	*NSWSTD*	0.00E+00	1.00E+00	1.00E-03	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	*NSWSTD*	*NSWSTD*	*Missing*	*NSWSTD*	*NSWSTD*	*NSWSTD*
Benz(a)anthracene	*NSWSTD*	0.00E+00	1.00E+00	1.00E-03	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	*NSWSTD*	*NSWSTD*	*Missing*	*NSWSTD*	*NSWSTD*	*NSWSTD*
Benzo(a)pyrene	*NSWSTD*	0.00E+00	1.00E+00	1.00E-03	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	*NSWSTD*	*NSWSTD*	*Missing*	*NSWSTD*	*NSWSTD*	*NSWSTD*
Benzo(b)fluoranthene	*NSWSTD*	0.00E+00	1.00E+00	1.00E-03	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	*NSWSTD*	*NSWSTD*	*Missing*	*NSWSTD*	*NSWSTD*	*NSWSTD*
Benzo(k)fluoranthene	*NSWSTD*	0.00E+00	1.00E+00	1.00E-03	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	*NSWSTD*	*NSWSTD*	*Missing*	*NSWSTD*	*NSWSTD*	*NSWSTD*
Chrysene	*NSWSTD*	0.00E+00	1.00E+00	1.00E-03	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	*NSWSTD*	*NSWSTD*	*Missing*	*NSWSTD*	*NSWSTD*	*NSWSTD*
Fluoranthene	*NSWSTD*	0.00E+00	1.00E+00	1.00E-03	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	*NSWSTD*	*NSWSTD*	*Missing*	*NSWSTD*	*NSWSTD*	*NSWSTD*
Fluorene	*NSWSTD*	0.00E+00	1.00E+00	1.00E-03	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	*NSWSTD*	*NSWSTD*	*Missing*	*NSWSTD*	*NSWSTD*	*NSWSTD*
Pyrene	*NSWSTD*	0.00E+00	1.00E+00	1.00E-03	1.78E+01	1.00E+00	1.00E+00	1.78E+01	1.78E+01	*NSWSTD*	*NSWSTD*	*Missing*	*NSWSTD*	*NSWSTD*	*NSWSTD*

NOTES:
NSWSTD: No surface water standard is available or calculated for the chemical.
Missing: A value necessary to calculate this value was not provided.

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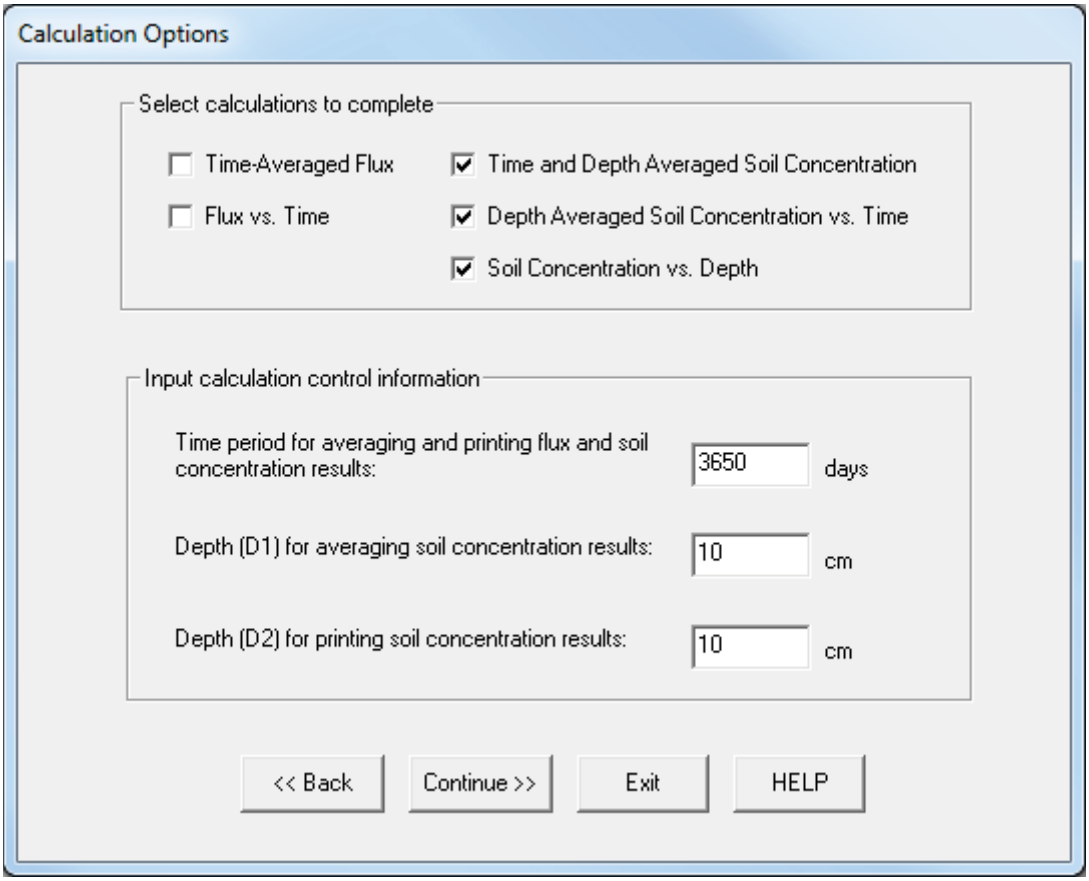
Appendix G
EMSOFT Inputs and Outputs

Ethylbenzene EM Soft Run 8/24/2017

Inputs:



Chemical Data

Chemical Name	Ethylbenzene	
Organic Carbon Partition Coefficient	165	mL/g
Henry's law constant	0.123119	dimensionless
Air diffusion coefficient	6480	cm^2/day
Aqueous diffusion coefficient	.67392	cm^2/day
Half life	1000000	days
Number of layers of contamination	1	

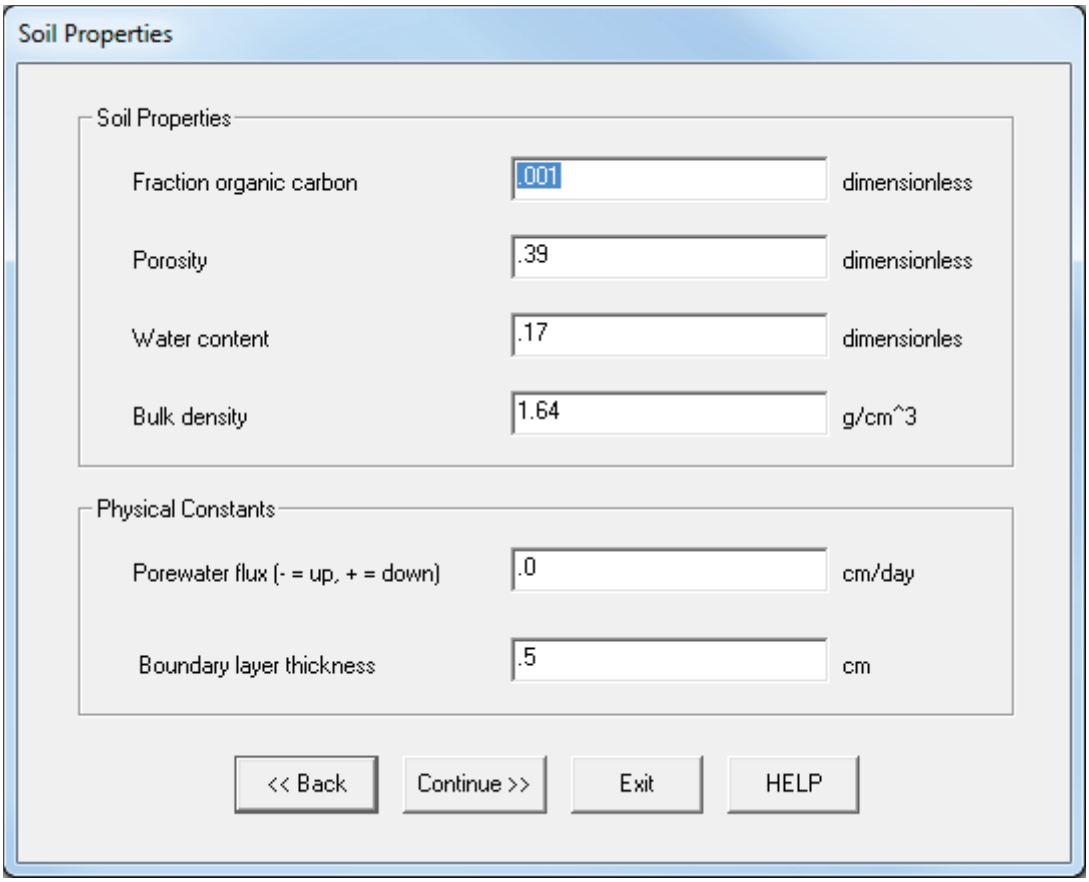
Save chemical data ...

<< Back | Continue >> | Exit | HELP

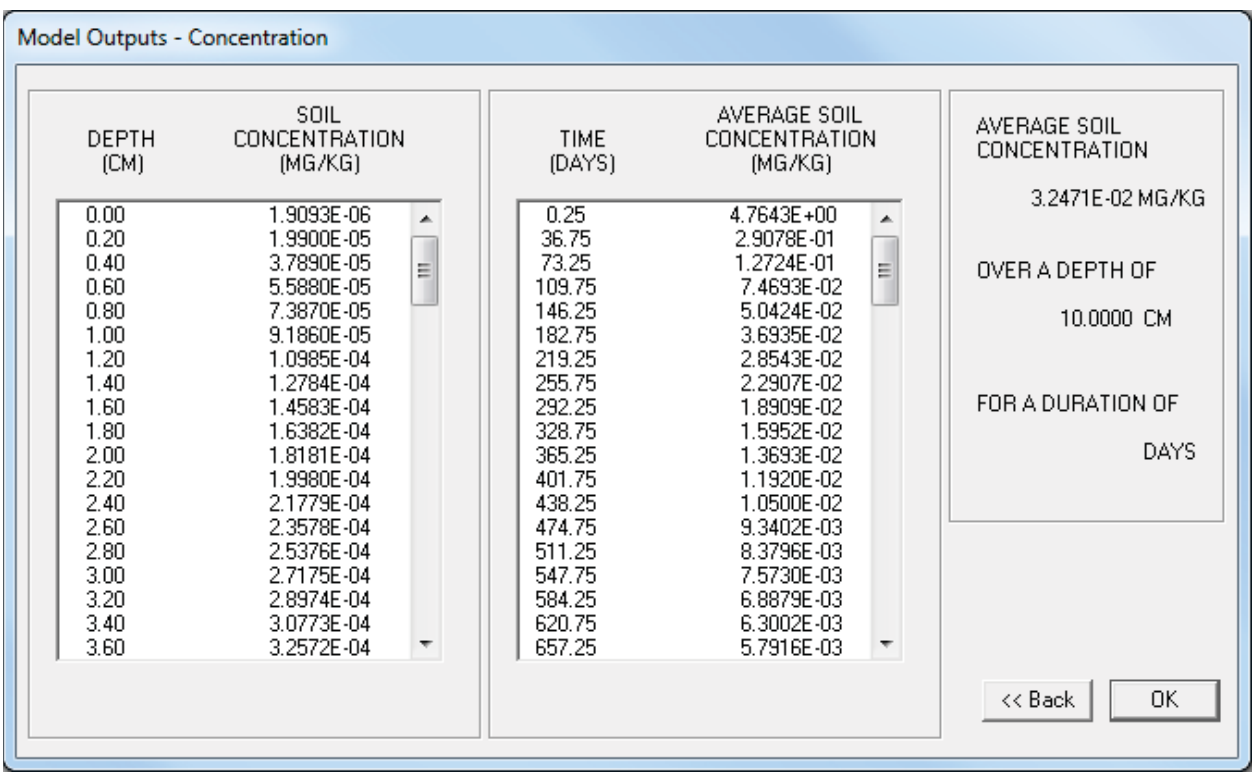
Layer Properties

	COVER/LAYER THICKNESS (CM)	CONTAMINANT CONCENTRATION (MG/KG)
COVER	.0	
LAYER 1	100	8.73

<< Back | Continue >> | Exit | HELP



Ethylbenzene Output Concentration after 10 year.



Model Outputs - Concentration

DEPTH (CM)	SOIL CONCENTRATION (MG/KG)
0.00	1.9093E-06
0.20	1.9900E-05
0.40	3.7890E-05
0.60	5.5880E-05
0.80	7.3870E-05
1.00	9.1860E-05
1.20	1.0985E-04
1.40	1.2784E-04
1.60	1.4583E-04
1.80	1.6382E-04
2.00	1.8181E-04
2.20	1.9980E-04
2.40	2.1779E-04
2.60	2.3578E-04
2.80	2.5376E-04
3.00	2.7175E-04
3.20	2.8974E-04
3.40	3.0773E-04
3.60	3.2572E-04

TIME (DAYS)	AVERAGE SOIL CONCENTRATION (MG/KG)
2993.25	6.0767E-04
3029.75	5.9676E-04
3066.25	5.8617E-04
3102.75	5.7588E-04
3139.25	5.6589E-04
3175.75	5.5619E-04
3212.25	5.4676E-04
3248.75	5.3760E-04
3285.25	5.2869E-04
3321.75	5.2002E-04
3358.25	5.1158E-04
3394.75	5.0338E-04
3431.25	4.9538E-04
3467.75	4.8760E-04
3504.25	4.8002E-04
3540.75	4.7263E-04
3577.25	4.6543E-04
3613.75	4.5841E-04

AVERAGE SOIL CONCENTRATION

3.2471E-02 MG/KG

OVER A DEPTH OF

10.0000 CM

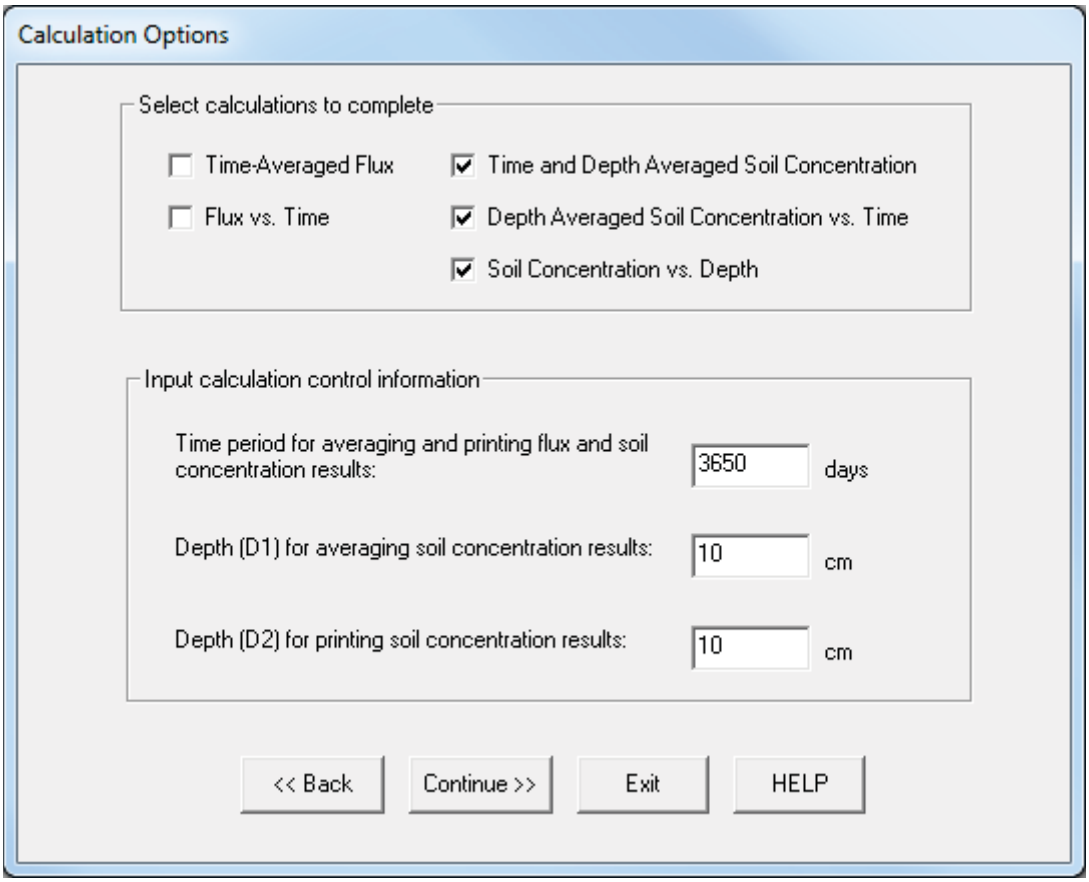
FOR A DURATION OF

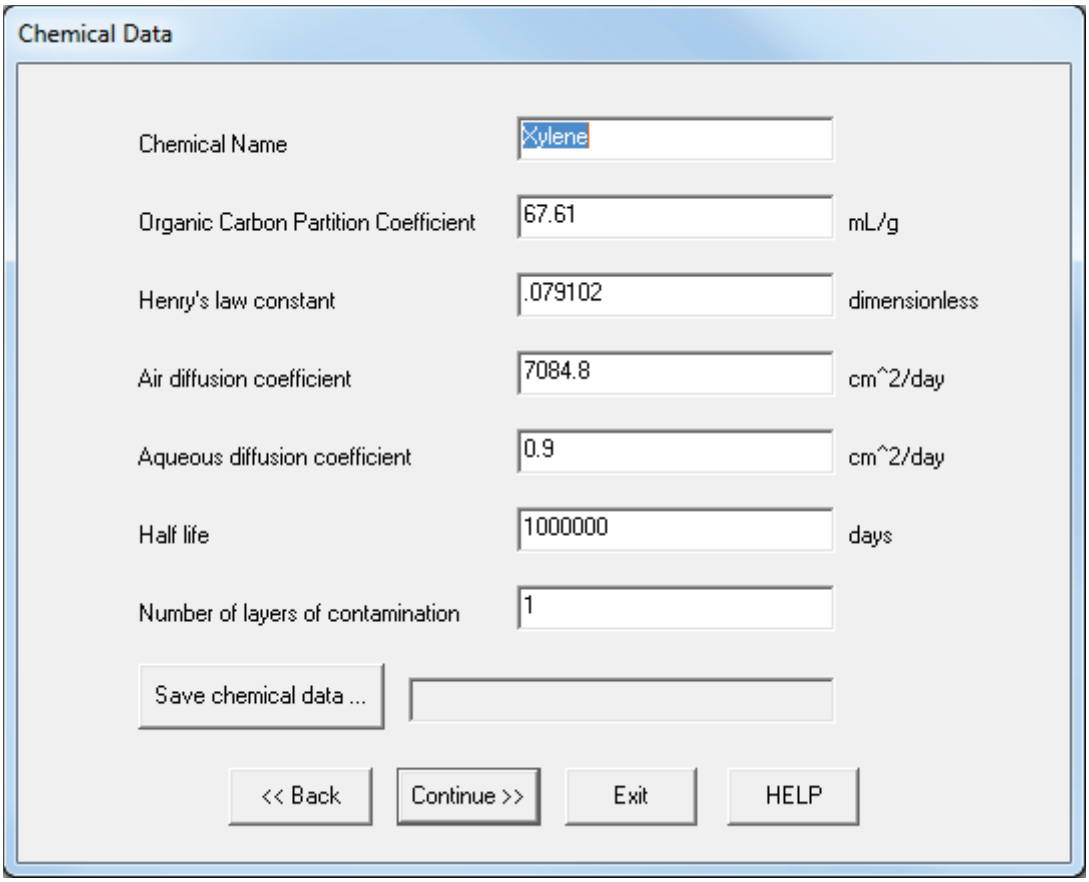
DAYS

<< Back OK

Xylene EM Soft Model Run 8/24/21017

Inputs:




Chemical Data
Chemical Name
Xylene
Organic Carbon Partition Coefficient
67.61
mL/g
Henry's law constant
.079102
dimensionless
Air diffusion coefficient
7084.8
cm^2/day
Aqueous diffusion coefficient
0.9
cm^2/day
Half life
1000000
days
Number of layers of contamination
1
Save chemical data ...
<< Back
Continue >>
Exit
HELP

Soil Properties

Soil Properties

Fraction organic carbon	.001	dimensionless
Porosity	.39	dimensionless
Water content	.17	dimensionles
Bulk density	1.64	g/cm^3

Physical Constants

Porewater flux (- = up, + = down)	.0	cm/day
Boundary layer thickness	.5	cm

<< Back | Continue >> | Exit | HELP

Layer Properties

	COVER/LAYER THICKNESS (CM)	CONTAMINANT CONCENTRATION (MG/KG)
COVER	.0	
LAYER 1	100	129

<< Back | Continue >> | Exit | HELP

Xylene Output Concentration after 10 year:

Model Outputs - Concentration

DEPTH (CM)	SOIL CONCENTRATION (MG/KG)
0.00	2.4415E-05
0.20	2.5441E-04
0.40	4.8440E-04
0.60	7.1440E-04
0.80	9.4439E-04
1.00	1.1744E-03
1.20	1.4044E-03
1.40	1.6344E-03
1.60	1.8643E-03
1.80	2.0943E-03
2.00	2.3243E-03
2.20	2.5543E-03
2.40	2.7843E-03
2.60	3.0143E-03
2.80	3.2442E-03
3.00	3.4742E-03
3.20	3.7042E-03
3.40	3.9342E-03
3.60	4.1641E-03

TIME (DAYS)	AVERAGE SOIL CONCENTRATION (MG/KG)
0.25	6.8147E+01
36.75	3.8564E+00
73.25	1.6592E+00
109.75	9.6778E-01
146.25	6.5115E-01
182.75	4.7599E-01
219.25	3.6733E-01
255.75	2.9451E-01
292.25	2.4293E-01
328.75	2.0482E-01
365.25	1.7572E-01
401.75	1.5292E-01
438.25	1.3465E-01
474.75	1.1975E-01
511.25	1.0741E-01
547.75	9.7048E-02
584.25	8.8254E-02
620.75	8.0711E-02
657.25	7.4185E-02

AVERAGE SOIL CONCENTRATION

4.5337E-01 MG/KG

OVER A DEPTH OF

10.0000 CM

FOR A DURATION OF

DAYS

<< Back OK

Model Outputs - Concentration

DEPTH (CM)	SOIL CONCENTRATION (MG/KG)
0.00	2.4415E-05
0.20	2.5441E-04
0.40	4.8440E-04
0.60	7.1440E-04
0.80	9.4439E-04
1.00	1.1744E-03
1.20	1.4044E-03
1.40	1.6344E-03
1.60	1.8643E-03
1.80	2.0943E-03
2.00	2.3243E-03
2.20	2.5543E-03
2.40	2.7843E-03
2.60	3.0143E-03
2.80	3.2442E-03
3.00	3.4742E-03
3.20	3.7042E-03
3.40	3.9342E-03
3.60	4.1641E-03

TIME (DAYS)	AVERAGE SOIL CONCENTRATION (MG/KG)
2993.25	7.7694E-03
3029.75	7.6298E-03
3066.25	7.4943E-03
3102.75	7.3628E-03
3139.25	7.2351E-03
3175.75	7.1110E-03
3212.25	6.9904E-03
3248.75	6.8732E-03
3285.25	6.7593E-03
3321.75	6.6484E-03
3358.25	6.5405E-03
3394.75	6.4355E-03
3431.25	6.3333E-03
3467.75	6.2338E-03
3504.25	6.1369E-03
3540.75	6.0424E-03
3577.25	5.9503E-03
3613.75	5.8606E-03

AVERAGE SOIL CONCENTRATION

4.5337E-01 MG/KG

OVER A DEPTH OF

10.0000 CM

FOR A DURATION OF

DAYS

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