FINAL

REMEDIAL INVESTIGATION/FEASIBILITY STUDY FOR SITE-WIDE GROUNDWATER AT THE FORMER BADGER ARMY AMMUNITION PLANT, BARABOO, WISCONSIN

Prepared for:
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Appendix A

Summary of WDNR Conditions of Approval

Summary of WDNR Conditions of Approval

The Wisconsin Department of Natural Resources (WDNR) June 28, 2012 Final Determination of Feasibility for an Alternative Groundwater Remedial Strategy approval letter established specific requirements (conditions) to be satisfied by the Army. The Army has addressed these conditions and provided appropriate documentation to the WDNR. The following summarizes the conditions of approval (*italics*) and the Army's subsequent activities (**bold**) to address these conditions.

Conditions of Approval

Condition 1: The Army shall continue operation of the Interim Remedial Measures (IRM) and Modified Interim Remedial Measures (MIRM) systems, as currently required, to collect and treat contaminated groundwater until modifications are approved by the Department in writing.

Army Action: The Army submitted an Interim Remedial Measures (IRM) Shutdown Plan in October 2012 that outlined a systematic approach to restoring natural groundwater conditions so that PBG Plume dynamics and attenuation could be evaluated. Based on the WDNR's December 11, 2012 approval letter, the IRM was shut down on December 17, 2012. The Army's June 17, 2014 letter to the WDNR summarized the monitoring activities conducted during 2013 and 2014 and requested that the IRM system be dismantled. The WDNR's August 4, 2014 letter approved the dismantling of the IRM system. During 2014, the IRM extraction wells were abandoned and the IRM treatment building was demolished.

The Army submitted a Modified Interim Remedial Measures Shutdown Plan (MIRM) in January 2014 that outlined a systematic approach to restoring natural groundwater conditions so that PBG Plume dynamics and attenuation could be evaluated. Based on the WDNR's August 4, 2014 approval letter, the MIRM was completely shut down on August 31, 2015. The Army's June 27, 2016 letter to the WDNR summarized the monitoring activities conducted between 2014 and 2016 and requested that the MIRM system be dismantled. The WDNR's July 15, 2016 letter approved the dismantling of the MIRM system. During 2016, the MIRM extraction wells were abandoned. Ownership of the MIRM treatment building was transferred from the Army to the Bluffview Sanitary District in July 2016.

Condition 2: Prior to requesting modification or termination of the operation of the IRM or MIRM systems, the Army shall propose to the Department a process by which the effects of the requested changes can be predicted and evaluated. This proposal will be reviewed by the Department. Written Department approval will be required before any modifications are implemented.

Army Action: **See response to Condition 1. Both the IRM and MIRM Shutdown Plans provided a summary of the groundwater treatment operations, contaminant mass removal data, hydrogeologic conditions, contaminant trends in monitoring wells, and proposed shutdown activities.**

Condition 3: *As part of the workplan for the phased shutdown of the IRM/MIRM, the Army shall prepare a comprehensive written report evaluating the effectiveness of the MIRM and IRM systems in preventing offsite groundwater contaminant migration. The evaluation shall include, but not be limited to, delineation of hydraulic capture zones, contaminant trends in select on- and off-site monitoring wells, calculations of contaminant travel times, and a concise statement concerning the effectiveness of the remedial systems in preventing offsite contaminant movement. Also included in the report shall be a description of the maintenance activities taken to keep the MIRM and IRM systems operational such as well chlorination and pump replacements.*

Army Action: **See response to Conditions 1 and 2.**

Condition 4: *The IRM and MIRM systems and all associated appurtenances shall be maintained in operational condition until such time that the Army obtains written Department approval to abandon or dismantle either or both systems.*

Army Action: **Routine maintenance of the IRM and MIRM systems was performed prior to obtaining WDNR approval to dismantle each system.**

Condition 5: *The Army shall propose an investigation and monitoring program to define the degree and extent to which contaminated groundwater is entering the Wisconsin River, Lake Wisconsin and/or other surface waters. This shall include, but not be limited to, installation of additional groundwater monitoring wells in addition to those already being used to monitor the plume(s) and may include the sampling of surface water.*

Army Action: **On October 31, 2012, the Army provided to the WDNR the Surface Waters Impact Investigation workplan. The WDNR provided verbal approval of the workplan on January 4, 2013. The field investigation was conducted in June 2013 and the results were summarized in the Surface Waters Impact Investigation Report. The report was provided to the WDNR on November 21, 2013. The investigation involved collecting groundwater samples from temporary wells located near Weigand's Bay for the DBG Plume and near the Wisconsin River for the PBG Plume.**

Condition 6: *The BAAP groundwater monitoring program currently implemented by the Army shall continue until modifications are approved by the Department.*

Army Action: **The Army has continued their groundwater monitoring efforts consistent will all plan approvals and subsequent modifications.**

Condition 7: *By July 1, 2013, the Army shall propose modifications to the groundwater monitoring program with the goal of providing data on the long-term effectiveness of natural attenuation as a remedial alternative. The requested changes in the monitoring program to evaluate natural attenuation shall encompass all three known groundwater contaminant plumes (propellant burning ground (PBG), deterrent burning ground (DBG) and central plumes). The proposal shall include (but not be limited to) a map or maps showing the names and locations of all monitoring wells associated with the property investigation and those that will be included in the groundwater monitored natural attenuation (MNA) network. The Army shall identify any locations where new wells will be installed to address any gaps in data collection to support monitored natural attenuation. The modification proposal shall include cross-sections, a table or tables providing information about the wells (by name or number identifier and/or associated license number) in the network, which plume(s) the wells are associated with, the parameters for which groundwater will be monitored, test methods used, and the frequency of sampling. The Army shall obtain written Department approval prior to implementing the modification to the groundwater monitoring network.*

Army Action: The Army, under separate covers, made three requests related to the groundwater monitoring modifications. The requested modifications related to data validation on April 4, 2013, private well sampling reduction dated May 14, 2013 and monitoring well sampling schedule on June 24, 2013. The WDNR approved these requests in a letter dated September 4, 2013.

Condition 8: *A groundwater narrative summary report similar in format to those submitted in the past several years shall be submitted to the Department annually for each calendar year by May 1 of the following year. Contents of the report shall focus on the results of work performed to evaluate monitored natural attenuation.*

Army Action: Groundwater narrative summary reports are completed annually and submitted to the WDNR.

Condition 9: *The Army shall conduct adequate saturated and unsaturated soil sampling, for all appropriate parameters, within the PBG, DBG and Central plumes to determine the nature and extent of site contaminants adsorbed onto the soil. Because back-diffusion of adsorbed waste constituents appears to be a major contributor to the groundwater plumes' stability, fully characterizing the adsorbed waste mass is necessary to evaluate natural attenuation as a possible remedial alternative.*

Army Action: Sampling within the final cap area associated with the PBG and DBG would compromise the barrier component of these systems. The barrier components of the PBG final cap consist of clay and geomembrane. The barrier components of the DBG final cap consist of geosynthetic clay and

geomembrane. These barrier components would need to be penetrated for samples to be obtained. In addition, the final cap layers above the barrier layer including the sand drainage layer, geotextile filter fabric, frost protection layer, and topsoil would need to be excavated at an angle for adequate access and subsequent cover repair/replacement.

Both the PBG and DBG have conditions of approval that strictly prohibit activities that would impact the integrity of the final cap system. Because of these factors and the conditions of approval for these facilities, the Army has not pursued sampling within the final cap area of the PBG or DBG.

The Army has conducted numerous soil investigations and remedial actions in the potential source areas of the Central Plume. These soil investigations and remedial actions are summarized in multiple reports submitted to the WDNR. The WDNR has provided the Army with multiple site closures related to the source areas for the Central Plume.

Condition 10: In conducting the required descriptions of plume configuration and behavior as well as the impact of past or future remedial efforts (as required in conditions 3, 5, 7 and 9, above) the Army shall consider that the plumes at Badger are three dimensional entities. All investigations and analyses described in this section shall be implemented to fully characterize in three dimensions the characteristics of all flow systems.

Army Action: Investigations and analyses have been completed to characterize plume configurations and tendencies.

Condition 11: Within 30 days of the date of approval, the Army shall provide a proposed schedule of events regarding the efforts to obtain local approval of the municipal water supply system. Inform the Department's Remediation and Redevelopment and Drinking Water and Groundwater programs, in writing, of any unforeseen delays in obtaining local approvals. Updates shall be submitted at least every 60 days.

Army Action: The Army submitted the first proposed schedule of events on July 25, 2012. The Army's final submission was on November 8, 2016. These submissions were ceased in 2017 when the Army choose to not install a municipal water supply system.

Condition 12: The source control action taken at the PBG and DBG shall be maintained as required in past approvals from the Department. Specifically, these approvals are Condition 6 of the October 14, 2002 approval for the PBG and Condition 5 of the March 17, 2008 approval for the DBG.

Army Action: The Army completes annual cap inspections for the PBG and DBG and addresses corrective action as necessary. In addition, the Army controls

vegetation at these waste containment facilities through annual mowing. An annual cap and cover report containing inspection results, corrective actions and annual maintenance is completed and provided to the WDNR in January of each year for the previous year's activities.

Condition 13: If approved by local units of government, the Army shall obtain the Department's approval of plans for the municipal water supply system prior to commencing construction. Please be aware that you will also need approvals from the Public Service Commission of Wisconsin. Please contact them directly.

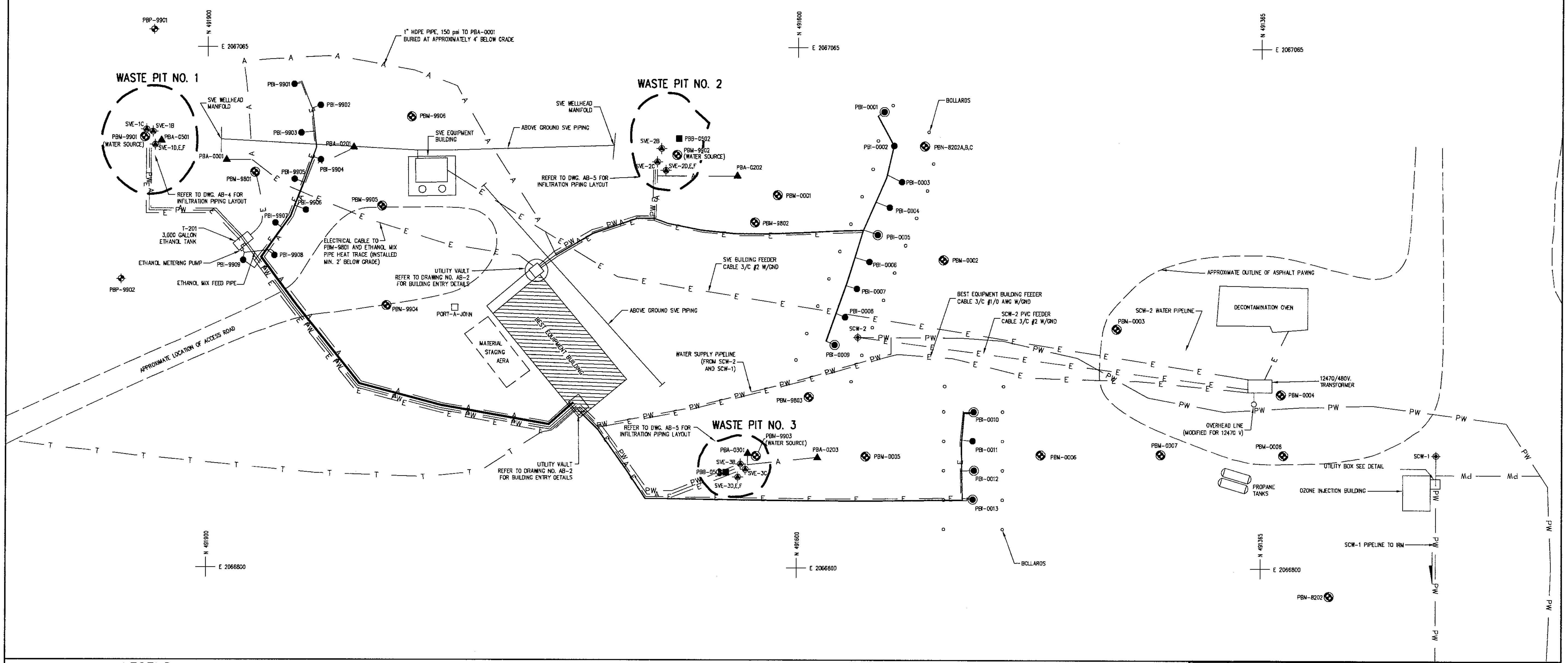
Army Action: The Army has determined that they neither have the legal nor funding authority to authorize a municipal water system. The Army's Supplemental Remedial Investigation/Feasibility Study is being provided within this document to outline remedial alternatives for groundwater contamination.

Condition 14: If the chosen remedy is not effective, the Department has the authority to require the Army to take additional actions to address contamination at the site.

Army Action: No action required.

Appendix B

PBG Waste Pits Soil Investigation Information (2005)



LEGEND

— — — —	TEMPORARY ACCESS ROAD
━━━━	WASTE PIT BOUNDARY
SVE-1A ⊕	SVE WELL/AIR INJECTION WELL
PBP-9902 ⊕	PIEZOMETER
SCW-2 ⊕	SOURCE CONTROL WELL
PBA-0001 ▲	AIR INJECTION WELL
PBM-0005 ⊗	MONITORING WELL
PBI-0001 ◉	CARBOHYDRATE INJECTION AND MONITORING WELL
PBI-0002 ●	CARBOHYDRATE INJECTION WELL
PBB-0502 ■	EVALUATION SOIL BORING
—— A ——	AIR LINE
—— E ——	ELECTRICAL CABLE
—— T ——	TELEPHONE CABLE
—— PW ——	WATER SUPPLY PIPELINE
————	CARBOHYDRATE INJECTION LINE

0 25 50

SCALE: 1" = 50'

A	ISSUED TO ARMY	AE	DJR	06/03/05
REVISION	DESCRIPTION	CHECKED	APPROVED	DATE

U.S. ARMY
CORPS OF ENGINEERS
OMAHA DISTRICT

BADGER ARMY AMMUNITION PLANT

FIGURE NUMBER 1

PROPELLANT BURNING GROUND
BEST SYSTEM LAYOUT

Shaw™ Environmental, Inc.

	BY	DATE		BY	DATE	PROJECT NO.	REV.	FILE NAME
DSND	AE	06/02/05	CHKD	AE	06/02/05	843333.0150	A	3333F04A
DRAWN	MEC	06/02/05	APPR	DJR	06/02/05			

THU, JUN 02, 2005 10:20 A MEC O:\BADGER\843333\F-0150\REV-A\3333F04A.DWG

TABLE 1
WASTE PIT 1 SAMPLE NUMBERS AND ANALYSES

Sample Number	Sample Interval (ft bgs)	Analyses							Comment
		VOC Headspace	VOCs	SVOCs	TOC	Select Metals	Select Anions	pH	
PBB 0501 010	20 - 30	X			X	X	X	X	Duplicate of PBB 0501 030
PBB 0501 022	21 - 22		X	X					
PBB 0501 026	25 - 26		X	X					
PBB 0501 030	20 - 30	X			X	X	X	X	
PBB 0501 031	30 - 31		X	X					
PBB 0501 040	30 - 40	X			X	X	X	X	
PBB 0501 041	40 - 41		X	X					
PBB 0501 050	40 - 50	X			X	X	X	X	
PBB 0501 051	50 - 51		X	X					
PBB 0501 060	50 - 60	X			X	X	X	X	
PBB 0501 061	60 - 61		X	X					
PBB 0501 070	60 -70	X			X	X	X	X	
PBB 0501 071	70 - 71		X	X					
PBB 0501 080	70 - 80	X			X	X	X	X	
PBB 0501 080	90 - 91		X	X					Duplicate of PBB 0501 091 (VOCs & SVOCs only)
PBB 0501 090	80 - 90	X			X	X	X	X	
PBB 0501 091	90 - 91		X	X					
PBB 0501 100	90 - 100	X			X	X	X	X	

Notes:
ft bgs = feet below ground surface
SVOC = semivolatile organic compound
TOC = total organic carbon
VOC = volatile organic compound

TABLE 2
WASTE PIT 2 SAMPLE NUMBERS AND ANALYSES

Sample Number	Sample Interval (ft bgs)	Analyses							Comment
		VOC Headspace	VOCs	SVOCs	TOC	Select Metals	Select Anions	pH	
PBB 0502 010	104 - 105				X	X	X	X	Duplicate of PBB 0502 105
PBB 0502 023	22 - 23		X	X					
PBB 0502 029	28 - 29		X	X					
PBB 0502 030	20 - 30	X			X	X	X	X	
PBB 0502 035	34 - 35		X	X					
PBB 0502 040	30 - 40	X			X	X	X	X	
PBB 0502 050	40 - 50	X			X	X	X	X	
PBB 0502 053	52 - 53		X	X					
PBB 0502 060	50 - 60	X			X	X	X	X	
PBB 0502 070	60 -70	X	X	X	X	X	X	X	
PBB 0502 080	70 - 80	X			X	X	X	X	
PBB 0502 080	80 - 90		X						Duplicate of PBB 0502 090 (VOCs only)
PBB 0502 090	80 - 90	X	X	X	X	X	X	X	
PBB 0502 100	90 - 100	X			X	X	X	X	
PBB 0502 105	104 - 105		X	X	X	X	X	X	

Notes:
ft bgs = feet below ground surface
SVOC = semivolatile organic compound
TOC = total organic carbon
VOC = volatile organic compound

TABLE 3
WASTE PIT 3 SAMPLE NUMBERS AND ANALYSES

Sample Number	Sample Interval (ft bgs)	Analyses							Comment
		VOC Headspace	VOCs	SVOCs	TOC	Select Metals	Select Anions	pH	
PBB-0503 010	60 -70				X	X	X	X	Duplicate of PBB 0503 070
PBB 0503 013	12 - 13		X	X					
PBB 0503 020	10 - 20	X	X	X	X	X	X	X	
PBB 0503 030	20 - 30	X	X	X	X	X	X	X	
PBB 0503 040	30 - 40	X			X	X	X	X	
PBB 0503 050	40 - 50	X			X	X	X	X	
PBB 0503 055	54 - 55		X	X					
PBB 0503 060	50 - 60	X			X	X	X	X	
PBB 0503 070	60 -70	X	X	X	X	X	X	X	
PBB 0503 080	70 - 80	X	X	X	X	X	X	X	Duplicate of PBB 0503 090
PBB 0503 090	80 - 90	X	X	X	X	X	X	X	
PBB 0503 100	90 - 100	X			X	X	X	X	
PBB 0503 105	100 - 105	X			X	X	X	X	

Notes:
ft bgs = feet below ground surface
SVOC = semivolatile organic compound
TOC = total organic carbon
VOC = volatile organic compound

TABLE 4
WASTE PIT 1 SOIL RESULTS COMPARISON

Depth (ft)	Oct-91				Feb-97	Aug-02				Dec-03				Jan-05			
	2,3-DNT (mg/kg)	2,4-DNT (mg/kg)	2,6-DNT (mg/kg)	2,4- & 2,6-DNT (mg/kg)	2,4- & 2,6-DNT (mg/kg)	2,3-DNT (mg/kg)	2,4-DNT (mg/kg)	2,6-DNT (mg/kg)	2,4- & 2,6-DNT (mg/kg)	2,3-DNT (mg/kg)	2,4-DNT (mg/kg)	2,6-DNT (mg/kg)	2,4- & 2,6-DNT (mg/kg)	2,3-DNT (mg/kg)	2,4-DNT (mg/kg)	2,6-DNT (mg/kg)	2,4- & 2,6-DNT (mg/kg)
20	NA	NA	NA		19,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
22	NA	NA	NA		--	NA	33,000	260	33,260	<340	47,000	<380	47,380	<120	13,000	<140	13,140
26	NA	56,000	ND	56000	--	NA	14,000	160	14,160	120	4,300	290	4,590	<31	5,000	<35	5,035
31	NA	8,200	ND	8200	--	NA	2,200	380	2,580	120	5,900	240	6,140	<30	5,100	<33	5,133
41	NA	5,700	1,000	6700	--	NA	15,000	1,500	16,500	<15	1,500	110	1,610	<0.61	48	4.7	53
51	NA	4,700	1,000	5700	--	NA	39,000	1,400	40,400	<61	8,300	360	8,660	4.4	53	36	89
61	NA	8,500	1,000	9500	--	NA	8,200	200	8,400	350	9,200	2,000	11,200	13	8.2	41	49
71	NA	1,900	830	2730	--	NA	3	28	31	140	4,100	1,100	5,200	2.6	5.2	29	34
91	NA	58	12	70	--	NA	1	20	21	6	130	48	178	0.7	2.2	1.1	3
Total				88,900					115,352				84,958				23,536

Notes:
DNT = dinitrotoluene
ft = feet
mg/kg = milligram(s) per kilogram
NA = not analyzed
ND = not detected
-- = no data

TABLE 5
WASTE PIT 2 SOIL RESULTS COMPARISON

Depth (ft)	Feb-97			Dec-03				Jan-05			
	2,4- & 2,6-DNT (mg/kg)			2,3-DNT (mg/kg)	2,4-DNT (mg/kg)	2,6-DNT (mg/kg)	2,4- & 2,6-DNT (mg/kg)	2,3-DNT (mg/kg)	2,4-DNT (mg/kg)	2,6-DNT (mg/kg)	2,4- & 2,6-DNT
23	--	--	11,000	1.20	35	<0.36	35	<16	2,800	<18	2,818
25	25,000	--	--	NA	NA	NA	NA	NA	NA	NA	NA
29	--	--	20,000	<0.79	130	<0.87	131	52	3,200	1,200	4,400
30	--	3,500	--	NA	NA	NA	NA	NA	NA	NA	NA
35	--	--	--	<6.6	1,200	<7.3	1,207	30	3,700	320	4,020
53	--	--	11,000	<120	10,000	890	10,890	1.90	5	31	36
70	--	--	5,300	15	640	100	740	9	570	160	730
90	--	--	290	3	5.60	33	39	0.23	0.13	0.36	0.5
105	--	--	3	0.23	0.17	0.16	0.33	0.045	0.087	<0.032	0.12
Total	76,093						13,042				12,005

Notes:
DNT = dinitrotoluene
ft = feet
mg/kg = milligram(s) per kilogram
NA = not analyzed
-- = no data

TABLE 6
WASTE PIT 3 SOIL RESULTS COMPARISON

Depth (ft)	**Feb-97**			**Dec-03**				**Jan-05**			
	2,4- & 2,6-DNT (mg/kg)			**2,3-DNT (mg/kg)**	**2,4-DNT (mg/kg)**	**2,6-DNT (mg/kg)**	**2,4- & 2,6-DNT (mg/kg)**	**2,3-DNT (mg/kg)**	**2,4-DNT (mg/kg)**	**2,6-DNT (mg/kg)**	**2,4- & 2,6-DNT**
13	--	--	64,000	<15	2,800	<17	2,817	<160	16,000	<180	16,180
20	5,300	16,000	39,000	<6.2	1,100	<6.8	1,107	<120	16,000	<130	16,130
30	--	--	6,900	120	3,400	470	3,870	0.17	12	0.74	13
55	--	--	7,200	74	2,500	440	2,940	9.7	4.7	67	72
70	--	--	14,000	14	340	66	406	6.1	<1.1	160	161
80	--	--	--	0.75	17	3.6	20.6	0.29	0.19	1.9	2
90	--	--	2	0.17	0.35	0.18	0.53	0.23	0.24	16	16
Total	131,102						11,161				32,574

Notes:
DNT = dinitrotoluene
ft = feet
mg/kg = milligram(s) per kilogram
-- = no data

Appendix C

Groundwater Quality Regulations

National Primary Drinking Water Regulations

Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
⬡ Acrylamide	TT[4]	Nervous system or blood problems; increased risk of cancer	Added to water during sewage/ wastewater treatment	**zero**
⬡ Alachlor	0.002	Eye, liver, kidney, or spleen problems; anemia; increased risk of cancer	Runoff from herbicide used on row crops	**zero**
☢ Alpha/photon emitters	15 picocuries per Liter (pCi/L)	Increased risk of cancer	Erosion of natural deposits of certain minerals that are radioactive and may emit a form of radiation known as alpha radiation	**zero**
⚛ Antimony	0.006	Increase in blood cholesterol; decrease in blood sugar	Discharge from petroleum refineries; fire retardants; ceramics; electronics; solder	**0.006**
⚛ Arsenic	0.010	Skin damage or problems with circulatory systems, and may have increased risk of getting cancer	Erosion of natural deposits; runoff from orchards; runoff from glass & electronics production wastes	**0**
⚛ Asbestos (fibers >10 micrometers)	7 million fibers per Liter (MFL)	Increased risk of developing benign intestinal polyps	Decay of asbestos cement in water mains; erosion of natural deposits	**7 MFL**
⬡ Atrazine	0.003	Cardiovascular system or reproductive problems	Runoff from herbicide used on row crops	**0.003**
⚛ Barium	2	Increase in blood pressure	Discharge of drilling wastes; discharge from metal refineries; erosion of natural deposits	**2**
⬡ Benzene	0.005	Anemia; decrease in blood platelets; increased risk of cancer	Discharge from factories; leaching from gas storage tanks and landfills	**zero**
⬡ Benzo(a)pyrene (PAHs)	0.0002	Reproductive difficulties; increased risk of cancer	Leaching from linings of water storage tanks and distribution lines	**zero**
⚛ Beryllium	0.004	Intestinal lesions	Discharge from metal refineries and coal-burning factories; discharge from electrical, aerospace, and defense industries	**0.004**
☢ Beta photon emitters	4 millirems per year	Increased risk of cancer	Decay of natural and man-made deposits of certain minerals that are radioactive and may emit forms of radiation known as photons and beta radiation	**zero**
⚗ Bromate	0.010	Increased risk of cancer	Byproduct of drinking water disinfection	**zero**
⚛ Cadmium	0.005	Kidney damage	Corrosion of galvanized pipes; erosion of natural deposits; discharge from metal refineries; runoff from waste batteries and paints	**0.005**
⬡ Carbofuran	0.04	Problems with blood, nervous system, or reproductive system	Leaching of soil fumigant used on rice and alfalfa	**0.04**

LEGEND
🧴 DISINFECTANT
⚗ DISINFECTION BYPRODUCT
⚛ INORGANIC CHEMICAL
🦠 MICROORGANISM
⬡ ORGANIC CHEMICAL
☢ RADIONUCLIDES

Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
⬡ Carbon tetrachloride	0.005	Liver problems; increased risk of cancer	Discharge from chemical plants and other industrial activities	**zero**
🧴 Chloramines (as Cl_2)	MRDL=4.0[1]	Eye/nose irritation; stomach discomfort; anemia	Water additive used to control microbes	**MRDLG=4[1]**
⬡ Chlordane	0.002	Liver or nervous system problems; increased risk of cancer	Residue of banned termiticide	**zero**
🧴 Chlorine (as Cl_2)	MRDL=4.0[1]	Eye/nose irritation; stomach discomfort	Water additive used to control microbes	**MRDLG=4[1]**
🧴 Chlorine dioxide (as ClO_2)	MRDL=0.8[1]	Anemia; infants, young children, and fetuses of pregnant women: nervous system effects	Water additive used to control microbes	**MRDLG=0.8[1]**
⚗ Chlorite	1.0	Anemia; infants, young children, and fetuses of pregnant women: nervous system effects	Byproduct of drinking water disinfection	**0.8**
⬡ Chlorobenzene	0.1	Liver or kidney problems	Discharge from chemical and agricultural chemical factories	**0.1**
⚛ Chromium (total)	0.1	Allergic dermatitis	Discharge from steel and pulp mills; erosion of natural deposits	**0.1**
⚛ Copper	TT[5]; Action Level=1.3	Short-term exposure: Gastrointestinal distress. Long-term exposure: Liver or kidney damage. People with Wilson's Disease should consult their personal doctor if the amount of copper in their water exceeds the action level	Corrosion of household plumbing systems; erosion of natural deposits	**1.3**
🦠 *Cryptosporidium*	TT[7]	Short-term exposure: Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste	**zero**
⚛ Cyanide (as free cyanide)	0.2	Nerve damage or thyroid problems	Discharge from steel/metal factories; discharge from plastic and fertilizer factories	**0.2**
⬡ 2,4-D	0.07	Kidney, liver, or adrenal gland problems	Runoff from herbicide used on row crops	**0.07**
⬡ Dalapon	0.2	Minor kidney changes	Runoff from herbicide used on rights of way	**0.2**
⬡ 1,2-Dibromo-3-chloropropane (DBCP)	0.0002	Reproductive difficulties; increased risk of cancer	Runoff/leaching from soil fumigant used on soybeans, cotton, pineapples, and orchards	**zero**
⬡ o-Dichlorobenzene	0.6	Liver, kidney, or circulatory system problems	Discharge from industrial chemical factories	**0.6**
⬡ p-Dichlorobenzene	0.075	Anemia; liver, kidney, or spleen damage; changes in blood	Discharge from industrial chemical factories	**0.075**
⬡ 1,2-Dichloroethane	0.005	Increased risk of cancer	Discharge from industrial chemical factories	**zero**

LEGEND

- 🧴 DISINFECTANT
- ⚗ DISINFECTION BYPRODUCT
- ⚛ INORGANIC CHEMICAL
- 🦠 MICROORGANISM
- ⬡ ORGANIC CHEMICAL
- ☢ RADIONUCLIDES

	Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
⬡	1,1-Dichloroethylene	0.007	Liver problems	Discharge from industrial chemical factories	**0.007**
⬡	cis-1,2-Dichloroethylene	0.07	Liver problems	Discharge from industrial chemical factories	**0.07**
⬡	trans-1,2, Dichloroethylene	0.1	Liver problems	Discharge from industrial chemical factories	**0.1**
⬡	Dichloromethane	0.005	Liver problems; increased risk of cancer	Discharge from industrial chemical factories	**zero**
⬡	1,2-Dichloropropane	0.005	Increased risk of cancer	Discharge from industrial chemical factories	**zero**
⬡	Di(2-ethylhexyl) adipate	0.4	Weight loss, liver problems, or possible reproductive difficulties	Discharge from chemical factories	**0.4**
⬡	Di(2-ethylhexyl) phthalate	0.006	Reproductive difficulties; liver problems; increased risk of cancer	Discharge from rubber and chemical factories	**zero**
⬡	Dinoseb	0.007	Reproductive difficulties	Runoff from herbicide used on soybeans and vegetables	**0.007**
⬡	Dioxin (2,3,7,8-TCDD)	0.00000003	Reproductive difficulties; increased risk of cancer	Emissions from waste incineration and other combustion; discharge from chemical factories	**zero**
⬡	Diquat	0.02	Cataracts	Runoff from herbicide use	**0.02**
⬡	Endothall	0.1	Stomach and intestinal problems	Runoff from herbicide use	**0.1**
⬡	Endrin	0.002	Liver problems	Residue of banned insecticide	**0.002**
⬡	Epichlorohydrin	TT[4]	Increased cancer risk; stomach problems	Discharge from industrial chemical factories; an impurity of some water treatment chemicals	**zero**
⬡	Ethylbenzene	0.7	Liver or kidney problems	Discharge from petroleum refineries	**0.7**
⬡	Ethylene dibromide	0.00005	Problems with liver, stomach, reproductive system, or kidneys; increased risk of cancer	Discharge from petroleum refineries	**zero**
🦠	Fecal coliform and *E. coli*	MCL[6]	Fecal coliforms and *E. coli* are bacteria whose presence indicates that the water may be contaminated with human or animal wastes. Microbes in these wastes may cause short term effects, such as diarrhea, cramps, nausea, headaches, or other symptoms. They may pose a special health risk for infants, young children, and people with severely compromised immune systems.	Human and animal fecal waste	**zero[6]**

LEGEND

- 🧴 DISINFECTANT
- ⚗ DISINFECTION BYPRODUCT
- ⚛ INORGANIC CHEMICAL
- 🦠 MICROORGANISM
- ⬡ ORGANIC CHEMICAL
- ☢ RADIONUCLIDES

Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
Fluoride	4.0	Bone disease (pain and tenderness of the bones); children may get mottled teeth	Water additive which promotes strong teeth; erosion of natural deposits; discharge from fertilizer and aluminum factories	**4.0**
Giardia lamblia	TT[7]	Short-term exposure: Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste	**zero**
Glyphosate	0.7	Kidney problems; reproductive difficulties	Runoff from herbicide use	**0.7**
Haloacetic acids (HAA5)	0.060	Increased risk of cancer	Byproduct of drinking water disinfection	**n/a[9]**
Heptachlor	0.0004	Liver damage; increased risk of cancer	Residue of banned termiticide	**zero**
Heptachlor epoxide	0.0002	Liver damage; increased risk of cancer	Breakdown of heptachlor	**zero**
Heterotrophic plate count (HPC)	TT[7]	HPC has no health effects; it is an analytic method used to measure the variety of bacteria that are common in water. The lower the concentration of bacteria in drinking water, the better maintained the water system is.	HPC measures a range of bacteria that are naturally present in the environment	**n/a**
Hexachlorobenzene	0.001	Liver or kidney problems; reproductive difficulties; increased risk of cancer	Discharge from metal refineries and agricultural chemical factories	**zero**
Hexachlorocyclopentadiene	0.05	Kidney or stomach problems	Discharge from chemical factories	**0.05**
Lead	TT[5]; Action Level=0.015	Infants and children: Delays in physical or mental development; children could show slight deficits in attention span and learning abilities; Adults: Kidney problems; high blood pressure	Corrosion of household plumbing systems; erosion of natural deposits	**zero**
Legionella	TT[7]	Legionnaire's Disease, a type of pneumonia	Found naturally in water; multiplies in heating systems	**zero**
Lindane	0.0002	Liver or kidney problems	Runoff/leaching from insecticide used on cattle, lumber, and gardens	**0.0002**
Mercury (inorganic)	0.002	Kidney damage	Erosion of natural deposits; discharge from refineries and factories; runoff from landfills and croplands	**0.002**
Methoxychlor	0.04	Reproductive difficulties	Runoff/leaching from insecticide used on fruits, vegetables, alfalfa, and livestock	**0.04**
Nitrate (measured as Nitrogen)	10	Infants below the age of six months who drink water containing nitrate in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits	**10**

LEGEND

- DISINFECTANT
- DISINFECTION BYPRODUCT
- INORGANIC CHEMICAL
- MICROORGANISM
- ORGANIC CHEMICAL
- RADIONUCLIDES

Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
⚛ Nitrite (measured as Nitrogen)	1	Infants below the age of six months who drink water containing nitrite in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits	**1**
⬡ Oxamyl (Vydate)	0.2	Slight nervous system effects	Runoff/leaching from insecticide used on apples, potatoes, and tomatoes	**0.2**
⬡ Pentachlorophenol	0.001	Liver or kidney problems; increased cancer risk	Discharge from wood-preserving factories	**zero**
⬡ Picloram	0.5	Liver problems	Herbicide runoff	**0.5**
⬡ Polychlorinated biphenyls (PCBs)	0.0005	Skin changes; thymus gland problems; immune deficiencies; reproductive or nervous system difficulties; increased risk of cancer	Runoff from landfills; discharge of waste chemicals	**zero**
☢ Radium 226 and Radium 228 (combined)	5 pCi/L	Increased risk of cancer	Erosion of natural deposits	**zero**
⚛ Selenium	0.05	Hair or fingernail loss; numbness in fingers or toes; circulatory problems	Discharge from petroleum and metal refineries; erosion of natural deposits; discharge from mines	**0.05**
⬡ Simazine	0.004	Problems with blood	Herbicide runoff	**0.004**
⬡ Styrene	0.1	Liver, kidney, or circulatory system problems	Discharge from rubber and plastic factories; leaching from landfills	**0.1**
⬡ Tetrachloroethylene	0.005	Liver problems; increased risk of cancer	Discharge from factories and dry cleaners	**zero**
⚛ Thallium	0.002	Hair loss; changes in blood; kidney, intestine, or liver problems	Leaching from ore-processing sites; discharge from electronics, glass, and drug factories	**0.0005**
⬡ Toluene	1	Nervous system, kidney, or liver problems	Discharge from petroleum factories	**1**
🦠 Total Coliforms	5.0 percent[8]	Coliforms are bacteria that indicate that other, potentially harmful bacteria may be present. See fecal coliforms and *E. coli*	Naturally present in the environment	**zero**
⚗ Total Trihalomethanes (TTHMs)	0.080	Liver, kidney, or central nervous system problems; increased risk of cancer	Byproduct of drinking water disinfection	**n/a[9]**
⬡ Toxaphene	0.003	Kidney, liver, or thyroid problems; increased risk of cancer	Runoff/leaching from insecticide used on cotton and cattle	**zero**
⬡ 2,4,5-TP (Silvex)	0.05	Liver problems	Residue of banned herbicide	**0.05**
⬡ 1,2,4-Trichlorobenzene	0.07	Changes in adrenal glands	Discharge from textile finishing factories	**0.07**

LEGEND

🧴 DISINFECTANT

⚗ DISINFECTION BYPRODUCT

⚛ INORGANIC CHEMICAL

🦠 MICROORGANISM

⬡ ORGANIC CHEMICAL

☢ RADIONUCLIDES

Contaminant	MCL or TT[1] (mg/L)[2]	Potential health effects from long-term[3] exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)[2]
1,1,1-Trichloroethane	0.2	Liver, nervous system, or circulatory problems	Discharge from metal degreasing sites and other factories	**0.2**
1,1,2-Trichloroethane	0.005	Liver, kidney, or immune system problems	Discharge from industrial chemical factories	**0.003**
Trichloroethylene	0.005	Liver problems; increased risk of cancer	Discharge from metal degreasing sites and other factories	**zero**
Turbidity	TT[7]	Turbidity is a measure of the cloudiness of water. It is used to indicate water quality and filtration effectiveness (e.g., whether disease-causing organisms are present). Higher turbidity levels are often associated with higher levels of disease-causing microorganisms such as viruses, parasites, and some bacteria. These organisms can cause short term symptoms such as nausea, cramps, diarrhea, and associated headaches.	Soil runoff	**n/a**
Uranium	30μg/L	Increased risk of cancer, kidney toxicity	Erosion of natural deposits	**zero**
Vinyl chloride	0.002	Increased risk of cancer	Leaching from PVC pipes; discharge from plastic factories	**zero**
Viruses (enteric)	TT[7]	Short-term exposure: Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste	**zero**
Xylenes (total)	10	Nervous system damage	Discharge from petroleum factories; discharge from chemical factories	**10**

LEGEND

DISINFECTANT

DISINFECTION BYPRODUCT

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MICROORGANISM

ORGANIC CHEMICAL

RADIONUCLIDES

NOTES

1 Definitions

- **Maximum Contaminant Level Goal (MCLG):** The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals.
- **Maximum Contaminant Level (MCL):** The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to MCLGs as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable standards.
- **Maximum Residual Disinfectant Level Goal (MRDLG):** The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contaminants.
- **Maximum Residual Disinfectant Level (MRDL):** The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.
- **Treatment Technique (TT):** A required process intended to reduce the level of a contaminant in drinking water.

2 Units are in milligrams per liter (mg/L) unless otherwise noted. Milligrams per liter are equivalent to parts per million (ppm).

3 Health effects are from long-term exposure unless specified as short-term exposure.

4 Each water system must certify annually, in writing, to the state (using third-party or manufacturers certification) that when it uses acrylamide and/or epichlorohydrin to treat water, the combination (or product) of dose and monomer level does not exceed the levels specified, as follows: Acrylamide = 0.05 percent dosed at 1 mg/L (or equivalent); Epichlorohydrin = 0.01 percent dosed at 20 mg/L (or equivalent).

5 Lead and copper are regulated by a Treatment Technique that requires systems to control the corrosiveness of their water. If more than 10 percent of tap water samples exceed the action level, water systems must take additional steps. For copper, the action level is 1.3 mg/L, and for lead is 0.015 mg/L.

6 A routine sample that is fecal coliform-positive or E. coli-positive triggers repeat samples--if any repeat sample is total coliform-positive, the system has an acute MCL violation. A routine sample that is total coliform-positive and fecal coliform-negative or E. coli-negative triggers repeat samples--if any repeat sample is fecal coliform-positive or E. coli-positive, the system has an acute MCL violation. See also Total Coliforms.

7 EPA's surface water treatment rules require systems using surface water or ground water under the direct influence of surface water to (1) disinfect their water, and (2) filter their water or meet criteria for avoiding filtration so that the following contaminants are controlled at the following levels:

- ***Cryptosporidium*:** 99 percent removal for systems that filter. Unfiltered systems are required to include Cryptosporidium in their existing watershed control provisions.
- ***Giardia lamblia*:** 99.9 percent removal/inactivation
- **Viruses:** 99.9 percent removal/inactivation
- ***Legionella*:** No limit, but EPA believes that if *Giardia* and viruses are removed/inactivated, according to the treatment techniques in the surface water treatment rule, *Legionella* will also be controlled.
- **Turbidity:** For systems that use conventional or direct filtration, at no time can turbidity (cloudiness of water) go higher than 1 nephelometric turbidity unit (NTU), and samples for turbidity must be less than or equal to 0.3 NTU in at least 95 percent of the samples in any month. Systems that use filtration other than the conventional or direct filtration must follow state limits, which must include turbidity at no time exceeding 5 NTU.
- **HPC:** No more than 500 bacterial colonies per milliliter
- **Long Term 1 Enhanced Surface Water Treatment:** Surface water systems or ground water systems under the direct influence of surface water serving fewer than 10,000 people must comply with the applicable Long Term 1 Enhanced Surface Water Treatment Rule provisions (e.g. turbidity standards, individual filter monitoring, *Cryptosporidium* removal requirements, updated watershed control requirements for unfiltered systems).
- **Long Term 2 Enhanced Surface Water Treatment:** This rule applies to all surface water systems or ground water systems under the direct influence of surface water. The rule targets additional *Cryptosporidium* treatment requirements for higher risk systems and includes provisions to reduce risks from uncovered finished water storages facilities and to ensure that the systems maintain microbial protection as they take steps to reduce the formation of disinfection byproducts. (Monitoring start dates are staggered by system size. The largest systems (serving at least 100,000 people) will begin monitoring in October 2006 and the smallest systems (serving fewer than 10,000 people) will not begin monitoring until October 2008. After completing monitoring and determining their treatment bin, systems generally have three years to comply with any additional treatment requirements.)
- **Filter Backwash Recycling:** The Filter Backwash Recycling Rule requires systems that recycle to return specific recycle flows through all processes of the system's existing conventional or direct filtration system or at an alternate location approved by the state.

8 No more than 5.0 percent samples total coliform-positive in a month. (For water systems that collect fewer than 40 routine samples per month, no more than one sample can be total coliform-positive per month.) Every sample that has total coliform must be analyzed for either fecal coliforms or E. coli. If two consecutive TC-positive samples, and one is also positive for E. coli or fecal coliforms, system has an acute MCL violation.

9 Although there is no collective MCLG for this contaminant group, there are individual MCLGs for some of the individual contaminants:

- **Haloacetic acids:** dichloroacetic acid (zero); trichloroacetic acid (0.3 mg/L)
- **Trihalomethanes:** bromodichloromethane (zero); bromoform (zero); dibromochloromethane (0.06 mg/L)

NATIONAL SECONDARY DRINKING WATER REGULATION

National Secondary Drinking Water Regulations are non-enforceable guidelines regarding contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. EPA recommends secondary standards to water systems but does not require systems to comply. However, some states may choose to adopt them as enforceable standards.

Contaminant	Secondary Maximum Contaminant Level
Aluminum	0.05 to 0.2 mg/L
Chloride	250 mg/L
Color	15 (color units)
Copper	1.0 mg/L
Corrosivity	Noncorrosive
Fluoride	2.0 mg/L
Foaming Agents	0.5 mg/L
Iron	0.3 mg/L
Manganese	0.05 mg/L
Odor	3 threshold odor number
pH	6.5-8.5
Silver	0.10 mg/L
Sulfate	250 mg/L
Total Dissolved Solids	500 mg/L
Zinc	5 mg/L

FOR MORE INFORMATION ON EPA'S SAFE DRINKING WATER:

visit: **epa.gov/safewater**

call: **(800) 426-4791**

ADDITIONAL INFORMATION:

To order additional posters or other ground water and drinking water publications, please contact the National Service Center for Environmental Publications at: **(800) 490-9198**, or email: **nscep@bps-lmit.com**.

Chapter NR 140

GROUNDWATER QUALITY

Subchapter I — General

NR 140.01 Purpose. The purpose of this chapter is to establish groundwater quality standards for substances detected in or having a reasonable probability of entering the groundwater resources of the state; to specify scientifically valid procedures for determining if a numerical standard has been attained or exceeded; to specify procedures for establishing points of standards application, and for evaluating groundwater monitoring data; to establish ranges of responses the department may require if a groundwater standard is attained or exceeded; and to provide for exemptions for facilities, practices and activities regulated by the department.

History: Cr. Register, September, 1985, No. 357, eff. 10−1−85.

NR 140.02 Regulatory framework. **(1)** This chapter supplements the regulatory authority elsewhere in the statutes and administrative rules. The department will continue to exercise the powers and duties in those regulatory programs, consistent with the enforcement standards and preventive action limits for substances in groundwater under this chapter. This chapter provides guidelines and procedures for the exercise of regulatory authority which is established elsewhere in the statutes and administrative rules, and does not create independent regulatory authority.

(2) The department may adopt regulations which establish specific design and management criteria for regulated facilities or activities, if the regulations will ensure that the regulated facilities and activities will not cause the concentration of a substance in groundwater affected by the facilities or activities to exceed the enforcement standards and preventive action limits under this chapter at a point of standards application. The department may adopt more stringent regulations under authority elsewhere in the statutes based on the best currently available technology for regulated activities and practices which ensure a greater degree of groundwater protection or when necessary to comply with state or federal laws.

(3) Preventive action limits serve to inform the department of potential groundwater contamination problems, establish the level of groundwater contamination at which the department is required to commence efforts to control the contamination and provide a basis for design and management practice criteria in administrative rules. Preventive action limits are applicable both to controlling new releases of contamination as well as to restoring groundwater quality contaminated by past releases of contaminants. Although a preventive action limit is not intended to always require remedial action, activities affecting groundwater must be regulated to minimize the level of substances to the extent technically and economically feasible, and to maintain compliance with the preventive action limits unless compliance with the preventive action limits is not technically and economically feasible.

(4) The department may take any actions within the context of regulatory programs established in statutes or rules outside of this chapter, if those actions are necessary to protect public health and welfare or prevent a significant damaging effect on groundwater or surface water quality for present or future consumptive or nonconsumptive uses, whether or not an enforcement standard and preventive action limit for a substance have been adopted under this chapter. Nothing in this chapter authorizes an impact on groundwater quality which would cause surface water quality standards contained in chs. NR 102 to 105 to be attained or exceeded.

History: Cr. Register, January, 1992, No. 433, eff. 2−1−92; reprinted to restore dropped copy, Register, March, 1992, No. 435.

NR 140.03 Applicability. This subchapter and subch. II apply to all facilities, practices, and activities which may affect groundwater quality and which are regulated under chs. 85, 93, 94, 101, 145, 281, 283, 287, 289, 291, and 292, Stats., by the department of agriculture, trade and consumer protection, the department of safety and professional services, the department of transportation, or the department of natural resources, as well as to facilities, practices, and activities which may affect groundwater quality which are regulated by other regulatory agencies. Health−related enforcement standards adopted in s. NR 140.10 also apply to bottled drinking water manufactured, bottled, sold, or distributed in this state as required by s. 97.34 (2) (b), Stats., and to determining eligibility for the well compensation program under s. 281.75, Stats. Subchapter III applies to all facilities, practices, and activities which may affect groundwater quality and which are regulated by the department under ch. 281, 283, 287, 289, 291, 292, 295, or 299, Stats. This chapter applies to ferrous metallic mining operations and mining sites, including mining waste sites, as defined in s. 295.41 (31), Stats., but only to the extent that it does not conflict with subch. III of ch. 295, Stats. Groundwater quality standards, consisting of enforcement standards and preventive action limits contained in ss. NR 140.10 and 140.12, and preventive action limits for indicator parameters identified under s. NR 140.20 (2), apply to ferrous metallic mining operations and mining sites, as defined in s. 295.41 (31), Stats., including mining waste sites, regulated under subch. III of ch. 295, Stats. This chapter does not apply to any facilities, practices, or activities on a nonferrous metallic mining prospecting site or mining site regulated under ch. 293, Stats., because those facilities, practices, and activities are subject to the groundwater quality requirements of chs. NR 131, 132, and 182. The department may promulgate new rules or amend rules governing facilities, practices or activities regulated under ch. 293, Stats., if the department determines that the amendment or promulgation of rules is necessary to protect public health, safety, or welfare. The requirements of this chapter are in addition to the requirements of any other statutes and rules, except as provided in s. 295.645 (9), Stats.

Note: The groundwater standards in this chapter do not replace the maximum contaminant levels applicable to public water systems contained in ch. NR 809. Drinking water maximum contaminant levels and health advisory levels may take into account such factors as treatment costs and feasibility for public water systems.

History: Cr. Register, September, 1985, No. 357, eff. 10−1−85; am. Register, December, 1998, No. 516, eff. 1−1−99; correction made under s. 13.93 (2m) (b) 7., Stats., Register, March, 2000, No. 531; correction made under s. 13.92 (4) (b) 6., Stats., Register January 2012 No. 673; CR 13−057: am. Register July 2015 No. 715, eff. 8−1−15.

NR 140.05 Definitions. (1) "Accuracy" means the closeness of a measured value to its generally accepted value or its value based upon an accepted reference standard.

(1m) "Alternative concentration limit" means the concentration of a substance in groundwater established by the department for a site to replace a preventive action limit or enforcement standard or both, from Table 1 or 2, when an exemption is granted in accordance with s. NR 140.28.

(1s) "Approval" means written acceptance by the department of a plan, report or other document that has been submitted to the department for review.

(1u) "Aquifer storage recovery" or "ASR" means placement of treated drinking water underground through a well for the purpose of storing and later recovering the water through the same well for potable use.

Note: Underground placement of water for the purpose of restoring an aquifer is not included in the definition of "aquifer storage recovery" or "ASR".

(1w) "ASR displacement zone" means the 3−dimensional subsurface region surrounding an aquifer storage recovery well into which treated drinking water is placed for storage and later recovery.

(1y) "ASR system" means all of the ASR wells, ASR monitoring wells and related appurtenances within a municipal well system and any interconnected public water system served by the municipal water system.

(2) "Attain or exceed" means that the concentration of a substance is determined to be equal to or greater than the preventive action limit or enforcement standard for that substance.

(3) "Background water quality" or "background concentration" means groundwater quality at or near a facility, practice or activity which has not been affected by that facility, practice or activity.

(4) "Certified laboratory" means a laboratory which performs tests for hire in connection with a covered program and which receives certification under s. 299.11 (7), Stats., or receives reciprocal recognition under s. 299.11 (5), Stats.

(5) "Department" means the department of natural resources.

(6) "Design management zone" means a 3−dimensional boundary surrounding each regulated facility, practice or activity established under s. NR 140.22 (3).

(7) "Enforcement standard" means a numerical value expressing the concentration of a substance in groundwater which is adopted under s. 160.07, Stats., and s. NR 140.10 or s. 160.09, Stats., and s. NR 140.12.

(8) "Facility, practice or activity" means any source or potential source of a substance which is detected in or has a reasonable probability of entering the groundwater resources of the state.

(9) "Groundwater" means any of the waters of the state, as defined in s. 281.01 (18), Stats., occurring in a saturated subsurface geological formation of rock or soil.

(10) "Indicator parameter" means a substance for which a preventive action limit has been established under s. NR 140.20, which is used to indicate the potential for a preventive action limit established under s. NR 140.10 or 140.12 to be attained or exceeded and for which an enforcement standard has not been established under s. NR 140.10 or 140.12.

(10e) "Infiltration" means the underground emplacement of substances or remedial material, or both, into an excavation that is wider than deep so as to percolate or move through unsaturated material to groundwater.

(10s) "Injection" means the underground emplacement of substances or remedial material, or both, into a borehole or other excavation that is deeper than wide so as to percolate or move through unsaturated material to groundwater or to enter groundwater directly.

(11) "Land disposal system" means a facility for disposing of liquid wastes consisting of:

(a) An absorption or seepage pond system,

(b) A ridge and furrow system;

(c) A spray irrigation system,

(d) An overland flow system,

(e) A subsurface field absorption system,

(f) A land spreading system, or

(g) Any other land area receiving liquid waste discharges.

(12) "Limit of detection" means the lowest concentration level that can be determined to be statistically different from a blank.

(13) "Limit of quantitation" means the level above which quantitative results may be obtained with a specified degree of confidence.

Note: The limit of quantitation is 10/3 or 3.333 times the limit of detection.

(14) "Monitoring" means all procedures used to collect data on groundwater, surface water or soils.

(14m) "Natural attenuation" means the reduction in the concentration and mass of a substance and its breakdown products in groundwater, due to naturally occurring physical, chemical, and biological processes without human intervention or enhancement. These processes include, but are not limited to, dispersion, diffusion, sorption and retardation, and degradation processes such as biodegradation, abiotic degradation and radioactive decay.

(15) "Point of standards application" means the specific location, depth or distance from a facility, activity or practice at which the concentration of a substance in groundwater is measured for purposes of determining whether a preventive action limit or an enforcement standard has been attained or exceeded.

(16) "Precision" means the closeness of repeated measurements of the same parameter within a sample.

(17) "Preventive action limit" means a numerical value expressing the concentration of a substance in groundwater which is adopted under s. 160.15, Stats., and s. NR 140.10, 140.12 or 140.20.

(18) "Property boundary" means the boundary of the total contiguous parcel of land owned or leased by a common owner or lessor, regardless of whether public or private roads run through the parcel.

(19) "Registered laboratory" means a laboratory which is registered under s. 299.11 (8), Stats., or receives reciprocal recognition under s. 299.11 (5), Stats.

(20) "Regulatory agency" means the department of agriculture, trade and consumer protection, the department of safety and professional services, the department of transportation, the department of natural resources and other state agencies which regulate activities, facilities or practices which are related to substances which have been detected in or have reasonable probability of entering the groundwater resources of the state.

(20h) "Remedial action" means a response which is taken to achieve compliance with groundwater quality standards established under this chapter. This term includes, but is not limited to, actions designed to prevent or minimize the further discharge or release of substances to groundwater and actions designed to renovate or restore groundwater quality.

(20k) "Remedial material" means any solid, liquid, semi−solid or gaseous material, either naturally occurring or manmade, in its original form or as a metabolite or degradation product, or naturally occurring non−pathogenic biological organisms which have not undergone human induced genetic alteration, which enhances the restoration of soil or groundwater quality, or both.

(20m) "Response" means any action taken to respond to an attainment or exceedance of a preventive action limit or enforcement standard as required by s. NR 140.24 or 140.26.

Note: A response may include a remedial action.

(20s) "Specified substance" means one of the following: chloroform, bromodichloromethane, dibromochloromethane or bromoform.

(21) "Substance" means any solid, liquid, semisolid, dissolved solid or gaseous material, naturally occurring or man−made chemical, parameter for measurement of water quality or biological organism which, in its original form, or as a metabolite or a degradation or waste product, may decrease the quality of groundwater.

(22) "Wastewater and sludge storage or treatment lagoon" means a natural or man−made containment structure, constructed primarily of earthen materials for the treatment or storage of wastewater or sludge, which is not a land disposal system.

History: Cr. Register, September, 1985, No. 357, eff. 10−1−85; cr. (1m), am. (7), (17) and (18), Register, October, 1988, No. 394, eff. 11−1−88; am. (6), cr. (20h) and (20m), Register, March, 1994, No. 459, eff. 4−1−94; cr. (1s), (10e), (10s), (20k), r. and recr. (12), (13), Register, August, 1995, No. 476, eff. 9−1−95; cr. (14m), Register, October, 1996, No. 490, eff. 11−1−96; am. (20), Register, December, 1998, No. 516, eff. 1−1−99; correction in (9) made under s. 13.93 (2m) (b) 7., Stats., Register, April, 2001, No. 544; CR 02−134: cr. (1u), (1w), (1y) and (20s) Register June 2003 No. 570, eff. 7−1−03; correction in (20) made under s. 13.92 (4) (b) 6., Stats., Register January 2012 No. 673.

Subchapter II — Groundwater Quality Standards

NR 140.10 Public health related groundwater standards. The groundwater quality standards for substances of public health concern are listed in Table 1.

Note: For all substances that have carcinogenic, mutagenic or teratogenic properties or interactive effects, the preventive action limit is 10% of the enforcement standard. The preventive action limit is 20% of the enforcement standard for all other substances that are of public health concern. Enforcement standards and preventive action limits for additional substances will be added to Table I as recommendations are developed pursuant to ss. 160.07, 160.13 and 160.15, Stats.

Table 1
Public Health Groundwater Quality Standards

Substance[1]	Enforcement Standard (micrograms per liter − except as noted)	Preventive Action Limit (micrograms per liter − except as noted)
Acetochlor	7	0.7
Acetochlor ethane sulfonic acid + oxanilic acid (Acetochlor − ESA + OXA)	230	46
Acetone	9 mg/1	1.8 mg/1
Alachlor	2	0.2
Alachlor ethane sulfonic acid (Alachlor − ESA)	20	4
Aldicarb	10	2
Aluminum	200	40
Ammonia (as N)	9.7 mg/l	0.97 mg/l
Antimony	6	1.2
Anthracene	3000	600
Arsenic	10	1
Asbestos	7 million fibers per liter (MFL)	0.7 MFL
Atrazine, total chlorinated residues	3[2]	0.3[2]
Bacteria, Total Coliform	0[3]	0[3]
Barium	2 milligrams/liter (mg/l)	0.4 mg/l
Bentazon	300	60
Benzene	5	0.5
Benzo(b)fluoranthene	0.2	0.02
Benzo(a)pyrene	0.2	0.02
Beryllium	4	0.4
Boron	1000	200
Bromodichloromethane	0.6	0.06
Bromoform	4.4	0.44
Bromomethane	10	1
Butylate	400	80
Cadmium	5	0.5
Carbaryl	40	4
Carbofuran	40	8
Carbon disulfide	1000	200
Carbon tetrachloride	5	0.5
Chloramben	150	30
Chlordane	2	0.2
Chlorodifluoromethane	7 mg/l	0.7 mg/l
Chloroethane	400	80
Chloroform	6	0.6
Chlorpyrifos	2	0.4
Chloromethane	30	3
Chromium (total)	100	10
Chrysene	0.2	0.02

Table 1 − Continued
Public Health Groundwater Quality Standards

Substance[1]	**Enforcement Standard (micrograms per liter − except as noted)**	**Preventive Action Limit (micrograms per liter − except as noted)**
Cobalt	40	8
Copper	1300	130
Cyanazine	1	0.1
Cyanide, free[4]	200	40
Dacthal	70	14
1,2−Dibromoethane (EDB)	0.05	0.005
Dibromochloromethane	60	6
1,2−Dibromo−3−chloropropane (DBCP)	0.2	0.02
Dibutyl phthalate	1000	100
Dicamba	300	60
1,2−Dichlorobenzene	600	60
1,3−Dichlorobenzene	600	120
1,4−Dichlorobenzene	75	15
Dichlorodifluoromethane	1000	200
1,1−Dichloroethane	850	85
1,2−Dichloroethane	5	0.5
1,1−Dichloroethylene	7	0.7
1,2−Dichloroethylene (cis)	70	7
1,2−Dichloroethylene (trans)	100	20
2,4−Dichlorophenoxyacetic Acid (2,4−D)	70	7
1,2−Dichloropropane	5	0.5
1,3−Dichloropropene (cis/trans)	0.4	0.04
Di (2−ethylhexyl) phthalate	6	0.6
Dimethenamid/Dimethenamid−P	50	5
Dimethoate	2	0.4
2,4−Dinitrotoluene	0.05	0.005
2,6−Dinitrotoluene	0.05	0.005
Dinitrotoluene, Total Residues[5]	0.05	0.005
Dinoseb	7	1.4
1,4−Dioxane	3	0.3
Dioxin (2, 3, 7, 8−TCDD)	0.00003	0.000003
Endrin	2	0.4
EPTC	250	50
Ethylbenzene	700	140
Ethyl ether	1000	100
Ethylene glycol	14 mg/l	2.8 mg/l
Fluoranthene	400	80
Fluorene	400	80
Fluoride	4 mg/l	0.8 mg/l
Fluorotrichloromethane	3490	698
Formaldehyde	1000	100
Heptachlor	0.4	0.04
Heptachlor epoxide	0.2	0.02
Hexachlorobenzene	1	0.1
N−Hexane	600	120
Hydrogen sulfide	30	6
Lead	15	1.5
Lindane	0.2	0.02
Manganese	300	60
Mercury	2	0.2

Table 1 − Continued
Public Health Groundwater Quality Standards

Substance^1	**Enforcement Standard (micrograms per liter − except as noted)**	**Preventive Action Limit (micrograms per liter − except as noted)**
Methanol	5000	1000
Methoxychlor	40	4
Methylene chloride	5	0.5
Methyl ethyl ketone (MEK)	4 mg/l	0.8 mg/l
Methyl isobutyl ketone (MIBK)	500	50
Methyl tert−butyl ether (MTBE)	60	12
Metolachlor/s−Metolachlor	100	10
Metolachlor ethane sulfonic acid + oxanilic acid (Metolachlor − ESA + OXA)	1.3 mg/l	0.26 mg/l
Metribuzin	70	14
Molybdenum	40	8
Monochlorobenzene	100	20
Naphthalene	100	10
Nickel	100	20
Nitrate (as N)	10 mg/l	2 mg/l
Nitrate + Nitrite (as N)	10 mg/l	2 mg/l
Nitrite (as N)	1 mg/l	0.2 mg/l
N−Nitrosodiphenylamine	7	0.7
Pentachlorophenol (PCP)	1	0.1
Perchlorate	1	0.1
Phenol	2 mg/l	0.4 mg/l
Picloram	500	100
Polychlorinated biphenyls (PCBs)	0.03	0.003
Prometon	100	20
Propazine	10	2
Pyrene	250	50
Pyridine	10	2
Selenium	50	10
Silver	50	10
Simazine	4	0.4
Styrene	100	10
Tertiary Butyl Alcohol (TBA)	12	1.2
1,1,1,2−Tetrachloroethane	70	7
1,1,2,2−Tetrachloroethane	0.2	0.02
Tetrachloroethylene	5	0.5
Tetrahydrofuran	50	10
Thallium	2	0.4
Toluene	800	160
Toxaphene	3	0.3
1,2,4−Trichlorobenzene	70	14
1,1,1−Trichloroethane	200	40
1,1,2−Trichloroethane	5	0.5
Trichloroethylene (TCE)	5	0.5
2,4,5−Trichlorophenoxy−propionic acid (2,4,5−TP)	50	5
1,2,3−Trichloropropane	60	12
Trifluralin	7.5	0.75
Trimethylbenzenes (1,2,4− and 1,3,5− combined)	480	96
Vanadium	30	6

Table 1 − Continued
Public Health Groundwater Quality Standards

Substance[1]	Enforcement Standard (micrograms per liter − except as noted)	Preventive Action Limit (micrograms per liter − except as noted)
Vinyl chloride	0.2	0.02
Xylene[6]	2 mg/l	0.4 mg/l

[1] Appendix I contains Chemical Abstract Service (CAS) registry numbers, common synonyms and trade names for most substances listed in Table 1.

[2] Total chlorinated atrazine residues includes parent compound and the following metabolites of health concern: 2−chloro−4−amino−6−isopropylamino−s−triazine (formerly deethylatrazine), 2−chloro−4−amino−6−ethylamino−s−triazine (formerly deisopropylatrazine) and 2−chloro−4,6−diamino−s−triazine (formerly diaminoatrazine).

[3] Total coliform bacteria may not be present in any 100 ml sample using either the membrane filter (MF) technique, the presence−absence (P−A) coliform test, the minimal medium ONPG−MUG (MMO−MUG) test or not present in any 10 ml portion of the 10−tube multiple tube fermentation (MTF) technique.

[4] "Cyanide, free" refers to the simple cyanides (HCN, CN⁻) and /or readily dissociable metal−cyanide complexes. Free cyanide is regulatorily equivalent to cyanide quantified by approved analytical methods for "amenable cyanide" or "available cyanide".

[5] Dinitrotoluene, Total Residues includes the dinitrotoluene (DNT) isomers: 2,3−DNT, 2,4−DNT, 2,5−DNT, 2,6−DNT, 3,4−DNT and 3,5−DNT.

[6] Xylene includes meta−, ortho−, and para−xylene combined.

History: Cr. Register, September, 1985, No. 357, eff. 10−1−85; am. table 1, Register, October, 1988, No. 394, eff. 11−1−88; am. table 1, Register, September, 1990, No. 417, eff. 10−1−90; am. Register, January, 1992, No. 433, eff. 2−1−92; am. Table 1, Register, March, 1994, No. 459, eff. 4−1−94; am. Table 1, Register, August, 1995, No. 476, eff. 9−1−95; am. Table 1, Register, December, 1998, No. 516, eff. 1−1−99; am. Table 1, boron, Register, December, 1998, No. 516, eff. 12−31−99; am. Table 1, Register, March, 2000, No. 531, eff. 4−1−00; CR 03−063: am Table 1, Register February 2004 No. 578, eff. 3−1−04; CR 02−095: am. Table 1, Register November 2006 No. 611, eff. 12−1−06; reprinted to correct errors in Table 1, Register January 2007 No. 613; CR 07−034: am. Table 1 Register January 2008 No. 625, eff. 2−1−08; CR 09−102: am. Table 1 Register December 2010 No. 660, eff. 1−1−11.

NR 140.12 Public welfare related groundwater standards. The groundwater quality standards for substances of public welfare concern are listed in Table 2.

Note: For each substance of public welfare concern, the preventive action limit is 50% of the established enforcement standard.

Table 2
Public Welfare Groundwater Quality Standards

Substance	Enforcement Standard (milligrams per liter − except as noted)	Preventive Action Limit (milligrams per liter − except as noted)
Chloride	250	125
Color	15 color units	7.5 color units
Foaming agents MBAS (Methylene−Blue Active Substances)	0.5	0.25
Iron	0.3	0.15
Manganese	0.05	0.025
Odor	3 (Threshold Odor No.)	1.5 (Threshold Odor No.)
Sulfate	250	125
Zinc	5	2.5

History: Cr. Register, September, 1985, No. 357, eff. 10−1−85; am. table 2, Register, October, 1990, No. 418, eff. 11−1−90; am. Table 2, Register, March, 1994, No. 459, eff. 4−1−94.

NR 140.14 Statistical procedures. **(1)** If a preventive action limit or an enforcement standard for a substance listed in Table 1 or 2, an alternative concentration limit issued in accordance with s. NR 140.28 or a preventive action limit for an indicator parameter established according to s. NR 140.20 (2) is attained or exceeded at a point of standards application:

(a) The owner or operator of the facility, practice or activity at which a standard is attained or exceeded shall notify the appropriate regulatory agency that a standard has been attained or exceeded; and

(b) The regulatory agency shall require a response in accordance with the rules promulgated under s. 160.21, Stats. No response shall be required if it is demonstrated to the satisfaction of the appropriate regulatory agency that a scientifically valid determination cannot be made that the preventive action limit or enforcement standard for a substance in Table 1 or 2 has been attained or exceeded based on consideration of sampling procedures or laboratory precision and accuracy, at a significance level of 0.05.

(2) The regulatory agency shall use one or more valid statistical procedures to determine if a change in the concentration of a substance has occurred. A significance level of 0.05 shall be used for all tests.

(3) In addition to sub. (2), the following applies when a preventive action limit or enforcement standard is equal to or less than the limit of quantitation:

(a) If a substance is not detected in a sample, the regulatory agency may not consider the preventive action limit or enforcement standard to have been attained or exceeded.

(b) If the preventive action limit or enforcement standard is less than the limit of detection, and the concentration of a substance is reported between the limit of detection and the limit of quantitation, the regulatory agency shall consider the preventive action limit or enforcement standard to be attained or exceeded only if:

1. The substance has been analytically confirmed to be present in the same sample using an equivalently sensitive analytical method or the same analytical method, and

2. The substance has been statistically confirmed to be present above the preventive action limit or enforcement standard, determined by an appropriate statistical test with sufficient samples at a significance level of 0.05.

(c) If the preventive action limit or enforcement standard is between the limit of detection and the limit of quantitation, the regulatory agency shall consider the preventive action limit or enforcement standard to be attained or exceeded if the concentration of a substance is reported at or above the limit of quantitation.

History: Cr. Register, September, 1985, No. 357, eff. 10−1−85; am. (1) (intro.) and (b), r. and recr. (2), Register, October, 1988, No. 394, eff. 11−1−88; am. (1) (b), (2) and (3) (b), Register, September, 1990, No. 417, eff. 10−1−90; am. (1) (b), Register, March, 1994, No. 459, eff. 4−1−94; r. and recr. (3) (intro.), (a), (b), renum. (3) (c) to be 140.16 (5) and am., Register, August, 1995, No. 476, eff. 9−1−95.

NR 140.16 Monitoring and laboratory data requirements. **(1)** (a) All groundwater quality samples collected to determine compliance with ch. 160, Stats., shall comply with this section except as noted.

(b) *Groundwater sampling requirements.* All groundwater quality samples shall be collected and handled in accordance with procedures specified by the applicable regulatory agency or, where no sampling procedures are specified by that agency, in accordance with the sampling procedures referenced in par. (c). The sampling procedures specified by a regulatory agency may include requirements for field filtration.

(c) *Department groundwater sampling procedures.* 1. If sampling procedures are not specified by the applicable regulatory agency pursuant to par. (b), all groundwater quality samples shall be collected and handled in accordance with the sampling procedures contained in the following publications:

a. Groundwater Sampling Desk Reference. Wisconsin Department of Natural Resources, PUBL−DG−037−96, September, 1996.

b. Groundwater Sampling Field Manual. Wisconsin Department of Natural Resources, PUBL−DG−038−96, September, 1996.

Note: Copies of these publications may be purchased from:

Wisconsin Department of Administration
Document Sales Unit
4622 University Avenue
Madison, WI 53705−2156

These publications are available for inspection at the offices of the department, the secretary of state and the legislative reference bureau.

2. Where no procedure for collecting a particular groundwater quality sample is specified by the appropriate regulatory agency or in the publications referenced in subd. 1., other published scientifically valid groundwater sampling procedures may be used.

(d) *Laboratory requirements.* All groundwater quality samples, except samples collected for total coliform bacteria analysis and field analyses for pH, specific conductance and temperature, shall be analyzed in accordance with provisions of ch. NR 149 by a laboratory certified or registered under ch. NR 149. Samples for total coliform bacteria analysis shall be analyzed by the state laboratory of hygiene or at a laboratory approved or certified by the department of agriculture, trade and consumer protection.

Note: Refer to s. NR 149.46 for sample preservation procedures and holding times.

(e) *Data submittal.* The results of the analysis of groundwater quality samples shall be submitted to the department and any applicable regulatory agency. Except as provided in s. NR 205.07 (3) (c) for wastewater permittees, this section does not require the submission of groundwater monitoring data which is collected voluntarily and is not required to be collected to determine compliance with this chapter or another rule or statute.

(2) The laboratory shall select the analytical methodology which:

(a) Is specified in rules or approved by the regulatory agency, and

(b) Is appropriate for the concentration of the sample, and

(c) Is one of the following:

1. Has a limit of detection and limit of quantitation below the preventive action limit, or

2. Produces the lowest available limit of detection and limit of quantitation if the limit of detection and limit of quantitation are above the preventive action limit.

(3) If the owner or operator of a facility, practice or activity believes that a sample result does not represent groundwater quality in the vicinity of the facility, practice or activity, the owner or operator shall resample the appropriate well or wells to obtain a representative sample at the earliest possible time. All sample results shall be submitted to the department and the appropriate regulatory agency with an explanation of why the owner or operator believes that all or some of the results are invalid.

(4) The department may reject groundwater quality data that does not meet the requirements of the approved or designated analytical methods.

(5) The owner or operator of the facility, practice or activity shall report the limit of detection and the limit of quantitation with the sample results. If a substance is detected below the limit of quantitation, the owner or operator shall report the detected value with the appropriate qualifier to the regulatory agency.

History: Cr. Register, September, 1985, No. 357, eff. 10−1−85; am. (1), Register, September, 1990, No. 417, eff. 10−1−90; am. (1), r. and recr. (2), Register, March, 1994, No. 459, eff. 4−1−94; (5) renum. from NR 140.14 (3) (c), cr. (4), Register, August, 1995, No. 476, eff. 9−1−95; r. and recr. (1), Register, December, 1998, No. 516, eff. 1−1−99.

Subchapter III — Evaluation and Response Procedures

NR 140.20 Indicator parameter groundwater standards. **(1)** ESTABLISHING BACKGROUND WATER QUALITY. Background water quality at a facility, practice or activity at which monitoring is required shall be established by sampling one or more monitoring points at locations and depths sufficient to yield groundwater samples that are representative of background water quality at or near the facility, practice or activity. Background water quality shall be determined for indicator parameters specified by the department. Background water quality for indicator parameters shall be established by averaging a minimum of 8 sample results from each well. The department may exclude any sample result which is nonrepresentative of background water quality. In making the calculations required in this section, the department may use as many representative sample points as are available.

(2) ESTABLISHING PREVENTIVE ACTION LIMITS FOR INDICATOR PARAMETERS. For each indicator parameter for which groundwater monitoring is required by the department, the preventive action limit shall be established based upon a change of water quality with respect to background water quality according to the methodology specified in pars. (a) to (c) and in Table 3.

(a) For field pH, the preventive action limit shall be one pH unit above or below the pH of the background water quality.

(b) For field temperature, the preventive action limit shall be 3 standard deviations or 10ºF (5.6ºC), whichever is greater, above or below the temperature of the background water quality.

(c) For all other indicator parameters, the preventive action limit shall be the background water quality for that parameter plus 3 standard deviations or the background water quality plus the increase of that parameter listed in Table 3, whichever is greater.

Note: The standard deviation for a group of samples is equal to the square root of: the value of the sum of the squares of the difference between each sample in the sample group and the mean for that sample group divided by the number of samples in the sample group where the sample group has 30 or more samples and by one less than the number of samples in the sample group where the sample group has less than 30 samples.

Table 3
Methodology for Establishing Preventive Action Limit for Indicator Parameters

Parameter	*Minimum Increase (mg/l)*
Alkalinity	100
Biochemical oxygen demand (BOD_5)	25
Calcium	25
Chemical oxygen demand (COD)	25
Magnesium	25
Nitrogen series	
Ammonia nitrogen	2
Organic nitrogen	2
Total nitrogen	5
Potassium	5
Sodium	10
Field specific conductance	200 microSiemens/cm
Total dissolved solids (TDS)	200
Total hardness	100
Total organic carbon (TOC)	1
Total organic halogen (TOX)	0.25

History: Cr. Register, September, 1985, No. 357, eff. 10−1−85; am. table 3, Register, October, 1990, No. 418, eff. 11−1−90; am. Table 3, Register, December, 1998, No. 516, eff. 1−1−99; CR 09−102: am. Table 3 Register December 2010 No. 660, eff. 1−1−11.

NR 140.22 Point of standards application for design and compliance. (1) DESIGN. Except as specified in sub. (1m), facilities, practices or activities regulated by the department, including remedial actions, shall be designed to minimize the level of substances in groundwater and to comply with the preventive action limits to the extent technically and economically feasible at all the following locations:

(a) Any point of present groundwater use.

(b) Any point beyond the boundary of the property on which the facility, practice or activity is located.

(c) Any point within the property boundaries beyond the 3−dimensional design management zone if one is established by the department at each facility, practice or activity under sub. (3).

(d) Every point at which groundwater is monitored to determine if a preventive action limit or enforcement standard has been attained or exceeded for sites identified under s. NR 140.22 (2) (c).

(1m) DESIGN OF ASR SYSTEMS; SPECIFIED SUBSTANCES. The point of standards application to determine if the design of an aquifer storage recovery system, regulated under ch. 280 or 281, Stats., complies with the preventive action limits for a specified substance is 1,200 feet from an aquifer storage and recovery well and at any other well that is not part of the ASR system and that is within 1,200 feet of an aquifer storage recovery well.

(2) COMPLIANCE. (a) Except as specified in par. (d), the point of standards application to determine if a preventive action limit has been attained or exceeded is any point at which groundwater is monitored.

(b) Except as specified in par. (d), the point of standards application to determine whether an enforcement standard has been attained or exceeded shall be the following locations:

1. Any point of present groundwater use;

2. Any point beyond the boundary of the property on which the facility, practice or activity is located;

3. Any point within the property boundaries beyond the 3 dimensional design management zone if one is established by the department at each facility, practice or activity under sub. (3).

Note: The boundary beyond which the enforcement standards apply is the closer of the property boundary or the design management zone boundary to the waste boundary for the facility, practice or activity.

(c) For discharges, releases, sites or facilities regulated under s. 292.11, 291.29 or 291.37, Stats., or s. NR 600.07, for which a design management zone has not been established in sub. (3), Table 4, the point of standards application shall be every point at which groundwater is monitored to determine if a preventive action limit or enforcement standard has been attained or exceeded.

Note: Section NR 600.07 no longer exists.

(d) The point of standards application to determine if a preventive action limit or enforcement standard for a specified substance has been attained or exceeded at an aquifer storage recovery well, regulated under ch. 280 or 281, Stats., is 1,200 feet from the aquifer storage and recovery well and at any other well that is not part of the ASR system and that is within 1,200 feet of the aquifer storage recovery well.

(3) DESIGN MANAGEMENT ZONE. (a) The design management zone for facilities, practices or activities subject to regulation by the department shall be an area enclosed by vertical boundaries which extend from the land surface downward through all saturated geological formations. The design management zone shall extend horizontally beyond the waste boundary or ASR displacement zone to the distance indicated in Table 4 for the specific type of facility, practice or activity. The waste boundary shall be the outermost limit at which waste from a facility, practice or activity has been stored, applied or disposed of, or permitted or approved for storage, application or disposal. For hazardous waste facilities regulated under ch. 291, Stats., the waste boundary shall include the horizontal space taken up by any liner, dike or other barrier to contain waste.

(b) In issuing or reissuing a permit, license or approval, the department may consider an expansion or reduction of the design management zone at a regulated or proposed facility, practice or activity by a horizontal distance not to exceed 50% of the distance listed in Table 4.

(c) The department shall consider the following factors in determining whether to expand or reduce the design management zone:

1. Nature, thickness and permeability of unconsolidated materials, including topography;

2. Nature and permeability of bedrock;

3. Groundwater depth, flow direction and velocity;

4. Waste volume, waste type and characteristics, including waste loading;

5. Contaminant mobility;

6. Distances to property boundary and surface waters;

7. Engineering design of the facility, practice or activity;

8. Life span of the facility, practice or activity;

9. Present and anticipated uses of land and groundwater; and

10. Potential abatement options if an enforcement standard is exceeded.

(d) The design management zone may not be expanded or reduced unless it has been demonstrated to the satisfaction of the department that the preventive action limits and enforcement standards will be met at the adjusted design management zone.

The design management zone may not be expanded unless it has been demonstrated to the satisfaction of the department that the preventive action limits and enforcement standards cannot be met at the design management zone specified in Table 4.

Table 4

Type of Facility, Practice or Activity	*Horizontal Distances for the Design Management Zone*
Land disposal systems regulated under ch. 283, Stats.	250 feet
Wastewater and sludge storage or treatment lagoons regulated under ch. 281 or 283, Stats.	100 feet
Solid waste disposal facilities regulated under ch. 289, Stats., which have feasibility reports approved after October 1, 1985.	150 feet
All other solid waste disposal facilities regulated under ch. 289, Stats.	300 feet
Hazardous waste disposal facilities, waste piles, landfills and surface impoundments subject to regulation under ss. NR 665.0090 to 665.0094	300 feet
Hazardous waste disposal facilities, waste piles, landfills and surface impoundments subject to regulation under ss. NR 664.0090 to 664.0100.	0 feet
Aquifer storage recovery systems regulated under ch. 280 or 281, Stats.	0 feet

History: Cr. Register, September, 1985, No. 357, eff. 10–1–85; am. (1) (b), Register, October, 1988, No. 394, eff. 11–1–88; am. (4) and table 4, Register, January, 1992, No. 433, eff. 2–1–92; am. (1), cr. (1) (d), renum. (2) to (5) to be (2) (a), (b), (c) and (3) and am. (2) (b) 3., Register, March, 1994, No. 459, eff. 4–1–94; CR 02–134: am. (1) (intro.), (2) (a), (b) (intro.), (3) (a) and Table 4, cr. (1m) and (2) (d) Register June 2003 No. 570, eff. 7–1–03; correction in Table 4 made under s. 13.93 (2m) (b) 7., Stats., Register November 2006 No. 611.

NR 140.24 Responses when a preventive action limit is attained or exceeded.

(1) NOTIFICATION AND ASSESSMENT. If the concentration of a substance, including indicator parameters, in groundwater attains or exceeds a preventive action limit at a point of standards application as described in s. NR 140.22 (2):

(a) The owner or operator of the facility, practice or activity shall notify the department in writing when monitoring data is submitted that a preventive action limit has been attained or exceeded in accordance with any deadlines in applicable statutes, rules, permits or plan approvals. Where no deadlines are imposed, the owner or operator shall notify the department as soon as practical after the results are received. When the results of any private well sampling attain or exceed a preventive action limit, the owner or operator of the facility, practice or activity shall notify the department within 10 days after the results are received. The notification shall provide a preliminary analysis of the cause and significance of the concentration.

Note: Section 292.11 (2) (a), Stats., requires that the department be notified immediately of hazardous substance discharges.

Note: See s. NR 140.27.

(b) Upon receipt of the notice under par. (a), the department shall evaluate the information and, if further information is required to make the assessment under par. (c), direct the owner or operator to prepare and submit a report by a specified deadline. The report shall assess the cause and significance of the increased concentration based on a consideration of the factors identified in par. (c) and shall propose a response to meet the objectives of sub. (2).

(c) The department shall assess the cause and significance of the concentration of the substance in determining the appropriate response to meet the objectives of sub. (2). In addition to all other relevant information, the department shall consider the information submitted under par. (b) and the following factors where applicable:

1. Background water quality. a. The department shall compare background water quality data and monitoring data from wells downgradient of the facility, practice or activity to determine if downgradient water quality is adversely affected. If the background water quality at a facility, practice or activity is not known or is inadequately defined, the department may require additional sampling of existing wells, or installation and sampling of additional wells, or both.

b. Except for substances which are carcinogenic, teratogenic or mutagenic in humans, before requiring a response at a site where the background concentration of a substance is determined to be equal to or greater than the preventive action limit, the department shall determine that the proposed remedial action will protect or substantially improve groundwater quality notwithstanding the background concentrations of naturally occurring substances.

2. Reliability of sampling data. As part of its review of the quality of the sampling data, the department shall evaluate the sampling procedures, precision and accuracy of the analytical test, size of the data set, and the quality control and quality assurance procedures used. If there is insufficient information to evaluate the reliability of the sampling data, the department may require additional samples or other changes in the monitoring program at the facility, practice or activity.

3. Public health, welfare and environmental effects of the substance. The department shall consider the public health, welfare and environmental effects of the substance, including but not limited to its mobility in the subsurface, environmental fate, the risks considered when the standard was adopted and whether it is carcinogenic, mutagenic, teratogenic or has interactive effects with other substances.

4. Probability that a preventive action limit or an enforcement standard may be attained or exceeded outside the design management zone. In evaluating the probability that a preventive action limit or an enforcement standard may be attained or exceeded outside the design management zone, the department shall consider, at a minimum, geologic conditions, groundwater flow rate and direction, contaminant mobility in the subsurface and environmental fate.

5. Performance of the facility, practice or activity. The department shall consider whether the facility, practice or activity is performing as designed in accordance with the design requirements in s. NR 140.22 (1). The department shall consider the type, age and size of the facility, practice or activity; the type of design, if applicable; the operational history; and other factors related to performance of the facility, practice or activity as appropriate.

6. Location of the monitoring point. The department shall consider the location of the monitoring point in relation to the facility, practice or activity and the design management zone in assessing the appropriate response.

7. Other known or suspected sources of the substance in the area. If other known or suspected sources are present in the vicinity of a facility, practice or activity of concern, the department shall evaluate the probability of contributions from other sources of the substance. The department shall consider, at a minimum, the number, size, type and age of nearby sources; the groundwater flow patterns; and the substances involved.

8. Hydrogeologic conditions. The department shall consider the geologic and groundwater conditions, including but not limited to the nature, thickness and permeability of the unconsolidated materials; the nature and permeability of bedrock; the depth

to the water table; groundwater flow gradients, both vertical and horizontal; the position of the facility, practice or activity within the groundwater flow system; and the present and potential groundwater use in the vicinity of the facility, practice or activity at which an exceedance occurs. If there is insufficient hydrogeologic information, the department may require additional information.

9. Extent of groundwater contamination. The department shall consider the current and anticipated future extent of groundwater contamination in 3 dimensions. If water supplies are affected or threatened, the department shall evaluate the existing effects and potential risks of the substance on the potable water supplies. If the extent of contamination is not known, the department may require further documentation of the extent of contamination.

10. Alternate responses. The department shall evaluate alternate responses, including consideration of the technical and economic feasibility of alternate responses from Table 5 or 6 or both, the practicality of stopping the further release of the substance and the risks and benefits of continued operation of the facility, practice or activity and the ability of a response to meet other applicable environmental protection laws.

(2) RESPONSE OBJECTIVES. Based on its evaluation of the report required under sub. (1), and the assessment criteria of sub. (1) (c), the department shall specify the responses to be implemented by the owner or operator of the facility, practice or activity designed to the extent technically and economically feasible to prevent any new releases of the substance from traveling beyond the design management zone or other applicable points of standards application described in s. NR 140.22 and restore contaminated groundwater within a reasonable period of time, considering the criteria specified in s. NR 722.07. Both the source control and the groundwater restoration components of the response shall be designed and implemented to:

(a) Minimize the concentration of the substance in groundwater at the point of standards application where technically and economically feasible;

(b) Regain and maintain compliance with the preventive action limit. If the department determines that compliance with the preventive action limit is either not technically or economically feasible, the owner or operator shall achieve compliance with the lowest possible concentration which is technically and economically feasible; and

(c) Ensure that the enforcement standard is not attained or exceeded at the point of standards application.

(3) RANGE OF RESPONSES FOR INDICATOR PARAMETERS. Except as otherwise provided in this subsection, the range of responses which the department may take or may require if a preventive action limit for an indicator parameter identified in Table 3 has been attained or exceeded, is one or more of the responses in items 1 to 4 in Table 5. The range of responses is one or more of the responses in items 1 to 6 of Table 5 in the event the department determines that:

(a) There is a threat to public health or welfare as a result of a preventive action limit for an indicator parameter being attained or exceeded; or

(b) The results demonstrate a significant design flaw or failure of the facility to contain substances, such that the facility can be expected to emit one or more of the substances on Table 1 or 2 in excess of a preventive action limit at a point of standards application.

(4) RANGE OF RESPONSES FOR SUBSTANCES OF PUBLIC HEALTH OR WELFARE CONCERN. The range of responses which the department may take or may require the owner or operator of a facility, practice or activity to take if a preventive action limit for a substance of health or welfare concern has been attained or exceeded are listed in Table 5. More than one response may be taken or required by the department.

Table 5

Range of Responses for Exceedances of a Preventive Action Limit for Indicator Parameters and Substances of Health or Welfare Concern

1. No action pursuant to s. NR 140.24 (5) and consistent with s. 160.23, Stats.
2. Require the installation and sampling of groundwater monitoring wells.
3. Require a change in the monitoring program, including increased monitoring.
4. Require an investigation of the extent of groundwater contamination.
5. Require a revision of the operational procedures at the facility, practice or activity.
6. Require a change in the design or construction of the facility, practice or activity.
7. Require an alternate method of waste treatment or disposal.
8. Require prohibition or closure and abandonment of a facility, practice or activity in accordance with sub. (6).
9. Require remedial action to renovate or restore groundwater quality.
10. Require remedial action to prevent or minimize the further discharge or release of the substance to groundwater.
11. Revise rules or criteria on facility design, location or management practices.
12. Require the collection and evaluation of data to determine whether natural attenuation can be effective to restore groundwater quality within a reasonable period of time, considering applicable criteria specified in ss. NR 140.24, 722.07 and 722.09 or 722.11, and require monitoring to determine whether or not natural attenuation is occurring in compliance with the response objectives in s. NR 140.24 (2).

(5) NO ACTION RESPONSE CRITERIA. For facilities, practices and activities with a design management zone specified in s. NR 140.22 (3) Table 4, the department may determine that no response is necessary and that an exemption under s. NR 140.28 is not required when either of the following conditions is met:

(a) The concentration of a substance within a design management zone is detected above the preventive action limit, the enforcement standard has not been attained or exceeded within the design management zone, and the department determines that there is no indication that the preventive action limit will be attained or exceeded at any point outside the design management zone, or

(b) The background concentration of a substance is greater than the preventive action limit, the anticipated or detected incremental increase in the concentration of a substance which results from a specific facility, practice or activity is not greater than the preventive action limit, and the anticipated or detected concentration is not greater than the enforcement standard either within or outside of the design management zone.

(6) PROHIBITION AND CLOSURE CRITERIA. The department may not impose a prohibition on a practice or activity or require closure of a facility which produces the substance unless the department:

(a) Bases its decision upon reliable test data;

(b) Determines, to a reasonable certainty, by the greater weight of the credible evidence, that no other remedial action would prevent the violation of the enforcement standard at the point of standards application;

(c) Establishes the basis for the boundary and duration of the prohibition; and

(d) Ensures that any prohibition imposed shall be reasonably related in time and scope to maintaining compliance with the enforcement standard at the point of standards application.

History: Cr. Register, September, 1985, No. 357, eff. 10−1−85; am. (5) (intro.) and (6) (intro.), Register, October, 1988, No. 394, eff. 11−1−88; am. (1) (intro.), (a), (b), (c) (intro.), 5. and 10., (2) (intro.), and (5) (intro.), renum. (7) to be NR 104.02 (4), Register, January, 1992, No. 433, eff. 2−1−92; am. (1) (intro.), (c) (intro.), (3) (intro.) and Table 5, Register, March, 1994, No. 459, eff. 4−1−94; am. (1) (a), (5) (intro.), Register, August, 1995, No. 476, eff. 9−1−95; am. (2) (intro.), (4) and Table 5, Register, October, 1996, No. 490, eff. 11−1−96; am. (1) (a), Register, December, 1998, No. 516, eff. 1−1−99.

NR 140.26 Responses when an enforcement standard is attained or exceeded. (1) NOTIFICATION AND ASSESSMENT. If the concentration of a substance in groundwater attains or exceeds an enforcement standard at a point of standards application as described in s. NR 140.22 (2):

(a) The owner or operator of the facility, practice or activity shall notify the department in writing when monitoring data is submitted that an enforcement standard has been attained or exceeded in accordance with any deadlines in applicable statutes, rules, permits or plan approvals. Where no deadlines are imposed, the owner or operator shall notify the department as soon as practical after the results are received. When the results of any private well sampling attain or exceed an enforcement standard or preventive action limit, the owner or operator of the facility, practice or activity shall notify the department within 10 days after the results are received. The notification shall provide a preliminary analysis of the cause and significance of the concentration.

Note: Section 292.11 (2) (a), Stats., requires that the department be notified immediately of hazardous substance discharges.

Note: See s. NR 140.27.

(b) Upon receipt of the notice under par. (a), the department shall evaluate the information and, if further information is required to make the assessment under par. (c), direct the owner or operator to prepare and submit a report by a specified deadline. The report shall assess the cause and significance of the increased concentration based on a consideration of the factors identified in s. NR 140.24 (1) (c) and shall propose a response to achieve compliance with the enforcement standard at the point of standards application and to comply with sub. (4).

(c) The department shall assess the cause and significance of the concentration of the substance in determining the appropriate response measures to achieve compliance with the enforcement standard at the point of standards application and to comply with sub. (4). In addition to all other relevant information, the department shall consider the information submitted under sub. (1) and the factors listed in s. NR 140.24 (1) (c), where applicable.

(2) REGULATORY RESPONSES. (a) If a facility, activity or practice is regulated under subch. IV of ch. 283, Stats., ch. 289, 291, or 292, Stats., the department shall require responses as necessary, based on the evaluation of the increased concentration as outlined in sub. (1), to prevent any new releases of the substance from traveling beyond the design management zone or other applicable point of standards application described in s. NR 140.22 and restore contaminated groundwater within a reasonable period of time, considering the criteria specified in s. NR 722.07. Both the source control and the groundwater restoration components of the response shall be designed to achieve compliance with the enforcement standard at the point of standards application and to achieve compliance with the preventive action limit at the point of standards application unless compliance with the preventive action limit is not technically and economically feasible. The range of responses which the department may take or may require the owner or operator of a facility, practice or activity to take if an enforcement standard for a substance of public health or welfare concern has been attained or exceeded at a point of standards application is listed in Table 6. More than one response listed in Table 6 may be required by the department. In addition, the department may take or may require the owner or operator of a facility, practice or activity to take one or more responses from Table 5, except response number one.

Table 6
Range of Responses for Exceedance of Enforcement Standards for Substances of Health or Welfare Concern

1. Require a revision of the operational procedures at a facility, practice or activity.
2. Require a change in the design or construction of the facility, practice or activity.
3. Require an alternate method of waste treatment or disposal.
4. Require prohibition or closure and abandonment of a facility, practice or activity.
5. Require remedial action to renovate or restore groundwater quality.
6. Require remedial action to prevent or minimize the further release of the substance to groundwater.
7. Revise rules or criteria on facility design, location or management practices.
8. Require the collection and evaluation of data to determine whether natural attenuation can be effective to restore groundwater quality within a reasonable period of time, considering applicable criteria specified in ss. NR 140.24, 722.07 and 722.09 or 722.11, and require monitoring to determine whether or not natural attenuation is occurring in compliance with the requirements of s. NR 140.26 (2) (a).

(b) If an activity or practice is not subject to regulation under subch. IV of ch. 283, Stats., ch. 289, 291, or 292, Stats., and if the concentration of a substance in groundwater attains or exceeds an enforcement standard at a point of standards application, the department shall take the following responses unless it can be shown to the department that, to a reasonable certainty, by the greater weight of the credible evidence, an alternative response will achieve compliance with the enforcement standard at the point of standards application:

1. Prohibit the activity or practice which uses or produces the substance; and

2. Require remedial actions with respect to the specific site in accordance with this chapter.

(3) RESPONSES FOR NITRATE AND SUBSTANCES OF PUBLIC WELFARE CONCERN. If nitrates or any substance of welfare concern only attains or exceeds an enforcement standard, the department is not required to impose a prohibition or close a facility if it determines that:

(a) The enforcement standard was attained or exceeded, in whole or in part, because of high background concentrations of the substance; and

(b) The additional concentration does not represent a public welfare concern.

(4) COMPLIANCE WITH PREVENTIVE ACTION LIMITS. When compliance with the enforcement standard is achieved at the point of standards application, s. NR 140.24 applies.

History: Cr. Register, September, 1985, No. 357, eff. 10−1−85; am. (1) (intro.), (a), (b), (2), r. (6), Register, January, 1992, No. 433, eff. 2−1−92; am. (1) (intro.) and Table 6, renum. (2) to (5) to be (2) (a), (b), (3) and (4), Register, March, 1994, No. 459, eff. 4−1−94; am. (1) (a), Register, August, 1995, No. 476, eff. 9−1−95; correction in (1) (b) and (c) made under s. 13.93 (2m) (b) 7., Stats., Register, August, 1995, No. 476; am. (2) (a) and Table 6, Register, October, 1996, No. 490, eff. 11−1−96; am. (1) (a), Register, December, 1998, No. 516, eff. 1−1−99; **correction in (2) (a), (b) (intro.) made under s. 13.92 (4) (b) 7., Stats., Register February 2017 No. 734.**

NR 140.27 Responses when an enforcement standard is attained or exceeded at a location other than a point of standards application. If the concentration of a substance in groundwater attains or exceeds an enforcement standard at a location other than a point of standards application for an enforcement standard, s. NR 140.24 shall apply.

History: Cr. Register, October, 1988, No. 394, eff. 11−1−88.

NR 140.28 Exemptions. (1) APPLICABILITY. (a) The department may not approve a proposed facility, practice or activity at a location where a preventive action limit or enforcement standard adopted under s. NR 140.10 or 140.12 has been attained or exceeded unless an exemption has been granted under this section.

(b) For an existing facility, practice or activity, a response is required under s. NR 140.24 (2) or 140.26 (2) when a preventive action limit or an enforcement standard has been attained or exceeded at a point of standards application unless an exemption has been granted under this section or the criteria of s. NR 140.24 (5) (a) or (b) are met.

(c) For an existing facility, practice or activity that has taken or is taking a response under s. NR 140.24 (2) or 140.26 (2), a continued response is required unless a substance no longer attains or exceeds a preventive action limit or an exemption has been granted under this section.

(d) If a substance or remedial material is to be infiltrated or injected into groundwater at a concentration which attains or exceeds a preventive action limit, or at any concentration for a substance or remedial material for which a groundwater quality standard has not been established under this chapter, a temporary exemption is required under sub. (5).

(2) CRITERIA FOR GRANTING EXEMPTIONS WHERE THE BACKGROUND CONCENTRATION IS BELOW THE PREVENTIVE ACTION LIMIT. (a) The department may grant an exemption under this section to a facility, practice or activity which is regulated by the department in an area where the background concentration of nitrate or a substance of public welfare concern is below the preventive action limit if the facility, practice or activity is designed and implemented to achieve the lowest possible concentration for that substance which is technically and economically feasible and the existing or anticipated increase in the concentration of that substance does not present a threat to public health or welfare.

(b) The department may grant an exemption under this section to a facility, practice or activity which is regulated by the department in an area where the background concentration of a substance of public health concern, other than nitrate, is below the preventive action limit for that substance if all of the following occur:

1. The measured or anticipated increase in the concentration of the substance will be minimized to the extent technically and economically feasible.

2. Compliance with the preventive action limit is either not technically or economically feasible.

3. The enforcement standard for that substance will not be attained or exceeded at the point of standards application.

4. Any existing or projected increase in the concentration of the substance above the background concentration does not present a threat to public health or welfare.

Note: An exemption may be considered under this subsection even if monitoring data indicates no detectable background concentration of the substance.

(3) CRITERIA FOR GRANTING EXEMPTIONS WHERE THE BACKGROUND CONCENTRATION IS ABOVE A PREVENTIVE ACTION LIMIT. (a) The department may grant an exemption under this section to a facility, practice or activity which is regulated by the department in an area where the background concentration of nitrate or a substance of public welfare concern attains or exceeds the preventive action limit if the facility, practice or activity is designed to achieve the lowest possible concentration for that substance which is technically and economically feasible and the existing or anticipated increase in the concentration of the substance does not present a threat to public health or welfare.

(b) The department may grant an exemption under this section to a facility, practice or activity which is regulated by the department in an area where the background concentration of a substance of public health concern, other than nitrate, attains or exceeds a preventive action limit for that substance:

1. If the facility, practice or activity has not caused and will not cause the further release of that substance into the environment; or

2. If the background concentration of the substance does not exceed the enforcement standard for that substance, the facility, practice or activity has not caused and will not cause the concentration of the substance to exceed the enforcement standard for that substance at a point of standards application and the facility, practice or activity is designed to achieve the lowest possible concentration of that substance which is technically and economically feasible.

(4) CRITERIA FOR GRANTING EXEMPTIONS WHERE THE BACKGROUND CONCENTRATION IS ABOVE AN ENFORCEMENT STANDARD. (a) The department may grant an exemption under this section to a facility, practice or activity which is regulated by the department in an area where the background concentration of nitrate or a substance of public welfare concern attains or exceeds an enforcement standard if the facility, practice or activity is designed to achieve the lowest possible concentration for that substance which is technically and economically feasible and the existing or anticipated increase in the concentration of the substance does not present a threat to public health or welfare.

(b) The department may grant an exemption under this section to a facility, practice or activity which is regulated by the department in an area where the background concentration of a substance of public health concern, other than nitrate, attains or exceeds the enforcement standard for that substance if:

1. The facility has not caused and will not cause the further release of that substance into the environment; or

2. a. The facility is designed to achieve the lowest possible concentration of that substance which is technically and economically feasible; and

b. The existing or anticipated increase in the concentration of the substance has not caused or will not cause an increased threat to public health or welfare; and

c. The existing or anticipated incremental increase in the concentration of the substance by itself, has not exceeded or will not exceed the preventive action limit.

(c) The department shall take action under s. NR 140.26 if it determines that the increase in the concentration of the substance causes an increased threat to public health or welfare or it determines that the incremental increase in the concentration of the substance, by itself, exceeds the preventive action limit.

(5) CRITERIA FOR GRANTING A TEMPORARY EXEMPTION WHERE INFILTRATION OR INJECTION IS UTILIZED FOR A REMEDIAL ACTION. (a) *General.* In lieu of an exemption granted in compliance with the criteria in subs. (2) to (4), the department may grant a temporary exemption if the criteria in this subsection are complied with. This exemption applies to the owner or operator of a facility, practice or activity that is undertaking a remedial action that: includes the infiltration or injection of contaminated groundwater or remedial material, has been approved by the department, and will comply with the applicable response objectives under s. NR 140.24 or 140.26 within a reasonable period of time. The owner or operator of the facility, practice or activity may submit a temporary exemption request to the department at the same time or after the department has approved the remedial action.

(b) *Exemption request.* The owner or operator of the facility, practice or activity shall submit a request for a temporary exemption to the department. As part of the request, the applicant shall indicate how the exemption prerequisites under par. (c) and applicable remedial design, operational and monitoring criteria under par. (d) will be met.

Note: For most remedial actions, a microcosm or treatability study, or other bench scale or pilot scale study will be required by the department prior to consideration of an exemption for the full−scale remedial action under this section. If a pilot scale study is deemed necessary before an exemption for a full−scale remedial action can be granted, a separate temporary exemption issued under this section is required before the pilot scale study can begin.

(c) *Exemption prerequisites.* As part of the temporary exemption request, the owner or operator shall demonstrate to the satisfaction of the department that all of the following requirements will be met:

1. The remedial action for restoring contaminated soil or groundwater, and any infiltrated or injected contaminated water and remedial material, shall achieve the applicable response objectives required by s. NR 140.24 (2) or 140.26 (2) within a reasonable period of time.

2. The type, concentration and volume of substances or remedial material to be infiltrated or injected shall be minimized to the extent that is necessary for restoration of the contaminated soil or groundwater and be approved by the department prior to use.

3. Any infiltration or injection of contaminated water or remedial material into soil or groundwater will not significantly increase the threat to public health or welfare.

4. No uncontaminated or contaminated water, substance or remedial material will be infiltrated or injected into an area where a floating non−aqueous phase liquid is present in the contaminated soil or groundwater.

5. There will be no expansion of soil or groundwater contamination, or migration of any infiltrated or injected contaminated water or remedial material, beyond the edges of previously contaminated areas, except that infiltration or injection into previously uncontaminated areas may be allowed if the department determines that expansion into adjacent, previously uncontaminated areas is necessary for the restoration of the contaminated soil or groundwater, and the requirements of subd. 1. will be met.

6. All necessary federal, state and local licenses, permits and other approvals are obtained and all applicable environmental protection requirements will be complied with.

Note: The issuance of a wastewater discharge permit by the department is required prior to the infiltration or injection of substances or remedial material into unsaturated soil or groundwater for discharges, as defined by s. 283.01 (4), Stats. A wastewater discharge permit establishes the effluent or injection limits for substances or remedial material which may be infiltrated or injected into unsaturated soil or groundwater. A temporary exemption granted under this subsection applies to substances or remedial material which may enter groundwater or may be detected at a point of standards applications; it does not apply to substances or remedial material infiltrated or injected into unsaturated soil.

(d) *Remedial action design, operation and monitoring criteria.* In addition to providing information on how the requirements under par. (c) will be met, the application shall specify the following information where applicable.

1. The remedial action design, operation and soil and groundwater monitoring procedures to insure compliance with the requirements under par. (c) and applicable criteria under this paragraph.

2. The level of pre−treatment for contaminated groundwater prior to reinfiltration or reinjection.

3. The types and concentrations of substances or remedial material being proposed for infiltration or injection.

4. The volume and rate of infiltration or injection of contaminated groundwater or remedial material.

5. The location where the contaminated groundwater or remedial material will be infiltrated or injected.

(e) *Granting an exemption.* The department may only grant a temporary exemption under this subsection at the same time or after the department has approved the remedial action. When the department grants an exemption under this subsection, it shall follow the exemption procedures included in sub. (6) and shall require the owner or operator of the facility, practice or activity to comply with the requirements and criteria in pars. (c) and (d). The temporary exemption shall also include:

1. The expiration date of the temporary exemption. The expiration date shall be selected to achieve the applicable response objectives required by s. NR 140.24 (2) or 140.26 (2) within a reasonable period of time, not to exceed 5 years from the effective date of the exemption. The temporary exemption may be reissued following a department review of information documenting the performance of the remedial action and a successful demonstration that reissuance of the exemption is necessary to achieve the response objectives required by s. NR 140.24 (2) or 140.26 (2).necessary relating to the temporary exemption.

(f) *Responses to exemption violations.* If the department determines that the conditions or requirements specified in the temporary exemption are not being met, the department may:

1. Require that the owner or operator of the facility, practice or activity revise the remedial action design, operation or monitoring procedures in accordance with par. (d). All revisions shall comply with the requirements established under pars. (c) and (e) and may require approval from the department prior to implementation.

2. Revoke the exemption and require implementation of an alternate remedial action to restore soil or groundwater quality.

(6) EXEMPTION PROCEDURES. If the department grants an exemption under this section for a substance or a remedial material, it shall specify:

(a) The substance or remedial material to which the exemption applies;

(b) The terms and conditions of the exemption, which may include an alternative concentration limit, under which the department may seek a response under s. NR 140.24 or 140.26 relating to the substance or remedial material; and

(c) Any other conditions relating to the exemption.

History: Cr. Register, September, 1985, No. 357, eff. 10−1−85; am. (1) (a) and (b), (3) (a), (b) (intro.) and 2., (4) (a) and (b) 1. and (5) (b), Register, October, 1988, No. 394, eff. 11−1−88; am. (1) (b), Register, January, 1992, No. 433, eff. 2−1−92; correction in (4) (b) made under s. 13.93 (2m) (b) 1., Stats., Register, January, 1992, No. 433; am. (1) (b) and (5) (b), Register, March, 1994, No. 459, eff. 4−1−94; renum. (5) to be (6), cr. (5), Register, August, 1995, No. 476, eff. 9−1−95; cr. (1) (c), (d), am. (2) (intro.), (5) (a), (6) (intro.), (a) and (b), Register, December, 1998, No. 516, eff. 1−1−99; r. and recr. (2), Register, March, 2000, No. 531, eff. 4−1−00.

CHAPTER NR 140
APPENDIX I TO TABLE 1
PUBLIC HEALTH GROUNDWATER QUALITY STANDARDS

Substance	**CAS RN**[1]	**Common synonyms/*Tradename***[2]
Acetochlor	34256−82−1	*Cadence, Degree, Harness, Keystone, Overtime, Volley*
Acetochlor ethane sulfonic acid + oxanilic acid	187022−11−3 (ESA) 184992−44−4 (OXA)	Acetochlor − ESA + OXA
Acetone	67−64−1	*Propanone*
Alachlor	15972−60−8	*Lasso*
Alachlor ethane sulfonic acid	142363−53−9	Alachlor−ESA, Alachlor Ethane Sulfonate, MON 5775
Aldicarb	116−06−3	*Temik*
Aluminum	7429−90−5	
Ammonia	7664−41−7	
Anthracene	120−12−7	Para−naphthalene
Asbestos	1332−21−4	
Bentazon	25057−89−0	*Basagran*
Benzene	71−43−2	
Benzo(b)fluoranthene	205−99−2	B(b)F,3,4−Benzofluoranthene
Benzo(a)pyrene	50−32−8	BaP, B(a)P
Boron	7440−42−8	
Bromodichloromethane	75−27−4	Dichlorobromomethane, BDCM
Bromoform	75−25−2	Tribromomethane
Bromomethane	74−83−9	Methyl bromide
Butylate	2008−41−5	S−ethyl di−isobutylthiocarbamate, *Sutan+*
Carbaryl	63−25−2	*Sevin*
Carbofuran	1563−66−2	*Furadan*
Carbon disulfide	75−15−0	Carbon bisulfide
Carbon tetrachloride	56−23−5	Tetrachloromethane, Perchloroethane
Chloramben	133−90−4	
Chlordane	57−74−9	
Chlorodifluoromethane	75−45−6	HCFC−22, Freon 22
Chloroethane	75−00−3	Ethyl chloride, Monochloroethane
Chloroform	67−66−3	Trichloromethane
Chlorpyrifos	2921−88−2	*Dursban, Lorsban, Warhawk, Hatchet, Yuma, Whirlwind, Eraser*
Chloromethane	74−87−3	Methyl chloride
Chromium (total)	7440−47−3	
Chrysene	218−01−9	1,2−Benzphenanthrene
Cobalt	7440−48−4	
Cyanazine	21725−46−2	*Bladex* , 2−chloro−4−ethylamino−6−nitriloisopropylamino−s−triazine
Cyanide, free	57−12−5	
Dacthal	1861−32−1	DPCA, Chlorothal, *Dacthalor*, 1,4−benzenedicarboxylic acid
Dibromochloromethane	124−48−1	Chlorodibromomethane, DBCM
1,2−Dibromo−3−chloropropane	96−12−8	DBCP, Dibromochloropropane
1,2−Dibromoethane	106−93−4	EDB, Ethylene dibromide, Dibromoethane
Dibutyl phthalate	84−74−2	DP, Di−*n*−butyl phthalate, *n*−Butyl phthalate
Dicamba	1918−00−9	*Banvel*
1,2−Dichlorobenzene	95−50−1	o−Dichlorobenzene, o−DCB
1,3−Dichlorobenzene	541−73−1	m−Dichlorobenzene, m−DCB
1,4−Dichlorobenzene	106−46−7	p−Dichlorobenzene, p−DCB
Dichlorodifluoromethane	75−71−8	*Freon 12*
1,1,−Dichloroethane	75−34−3	Ethylidine chloride
1,2−Dichloroethane	107−06−2	1,2−DCA, Ethylene dichloride

Substance	CAS RN[1]	Common synonyms/*Tradename*[2]
1,1−Dichloroethylene	75−35−4	1,1−DCE, 1,1−Dichloroethene, Vinylidene chloride
1,2−Dichloroethylene (cis)	156−59−2	cis−Dichloroethylene, 1,2−Dichloroethene (cis)
1,2−Dichloroethylene (trans)	156−60−5	trans−1,2−Dichloroethylene
2,4−Dichlorophenoxyacetic acid	94−75−7	2,4−D
1,2−Dichloropropane	78−87−5	Propylene dichloride
1,3−Dichloropropene (cis/trans)[3]	542−75−6	*Telone,* DCP, Dichloropropylene
Di(2−ethylhexyl) phthalate	117−81−7	DEHP, Bis(2−ethylhexyl) phthalate, 1,2−Benzenedicarboxylic acid, Bis (2−ethylhexyl)ester
Dimethenamid/Dimethinamid−P	87674−68−8 163515−14−8 (−P)	*Frontier, Outlook, Propel, Establish, Sortie, Tower*
Dimethoate	60−51−5	
2,4−Dinitrotoluene	121−14−2	2,4−DNT, 1−methyl−2,4−dinitrobenzene
2,6−Dinitrotoluene	606−20−2	2,6−DNT, 2−methyl−1,3−dinitrobenzene
Dinitrotoluene, Total Residues	25321−14−6	Dinitrotoluene, DNT
Dinoseb	88−85−7	2−(1−methylpropyl)−4,6−dinitrophenol
1,4−Dioxane	123−91−1	*p*−Dioxane
Dioxin	1746−01−6	2,3,7,8−TCDD,2,3,7,8−Tetrachlorodibenzo−p−dioxin
Endrin	72−20−8	
EPTC	759−94−4	*Eptam, Eradicane*
Ethylbenzene	100−41−4	Phenylethane, EB
Ethyl ether	60−29−7	Diethyl Ether
Ethylene glycol	107−21−1	
Fluoranthene	206−44−0	Benzo(jk)fluorene
Fluorene	86−73−7	2,3−Benzidine, Diphenylenemethane
Fluoride	7681−49−4	
Fluorotrichloromethane	75−69−4	*Freon11*, Trichlorofluoromethane
Formaldehyde	50−00−0	
Heptachlor	76−44−8	*Velsicol*
Heptachlor epoxide	1024−57−3	
Hexachlorobenzene	118−74−1	Perchlorobenzene, *Granox*
N−Hexane	110−54−3	Hexane, Skellysolve B
Hydrogen sulfide	7783−06−4	Dihydrogen sulfide
Lindane	58−89−9	
Manganese	7439−96−5	
Mercury	7439−97−6	
Methanol	67−56−1	Methyl alcohol, Wood alcohol
Methoxychlor	72−43−5	
Methylene chloride	75−09−2	Dichloromethane, Methylene dichloride
Methyl ethyl ketone	78−93−3	MEK, 2−Butanone
Methyl isobutyl ketone	108−10−1	MIBK, 4−Methyl−2−pentanone, Isopropylacetone, *Hexone*
Methyl tert−butyl ether	1634−04−4	MTBE, 2−Methoxy−2−methyl−propane, tert−Butyl methyl ether
Metolachlor/s−Metolachlor	51218−45−2 87392−12−9 (s−)	*Dual, Bicep, Milocep, Stalwart, Parallel, Prefix, Charger, Brawl, Cinch, Dual Magnum, Boundary*
Metolachlor ethane sulfonic acid + oxanilic acid	171118−09−5 (ESA) 152019−73−3 (OXA)	Metolachlor − ESA + OXA
Metribuzin	21087−64−9	Sencor, Lexone
Molybdenum	7439−98−7	
Monochlorobenzene	108−90−7	Chlorobenzene
Naphthalene	91−20−3	

Substance	**CAS RN[1]**	**Common synonyms/*Tradename*[2]**
N−Nitrosodiphenylamine	86−30−6	NDPA
Pentachlorophenol	87−86−5	PCP, Pentachlorohydroxybenzene
Perchlorate	14797−73−0	Perchlorate and perchlorate salts, Perchlorate ion
Phenol	108−95−2	
Picloram	1918−02−1	*Tordon*, 4−amino−3,5,6−trichloropicolinic acid
Polychlorinated biphenyls[4]		PCBs
Prometon	1610−18−0	*Pramitol, Prometone*
Pyrene	129−00−0	Benzo(def)phenanthrene
Pyridine	110−86−1	Azabenzene
Simazine	122−34−9	*Princep,* 2−chloro−4,6−diethylamino− s−triazine
Styrene	100−42−5	Ethenylbenzene, Vinylbenzene
Tertiary Butyl Alcohol	75−65−0	TBA
1,1,1,2−Tetrachlorethane	630−20−6	1,1,1,2−TCA, 1,1,1,2−PCA
1,1,2,2,−Tetrachloroethane	79−34−5	1,1,2,2−TCA, 1,1,2,2−PCA
Tetrachloroethylene	127−18−4	Perchloroethylene, PERC, Tetrachloroethene
Tetrahydrofuran	109−99−9	THF
Toluene	108−88−3	Methylbenzene
Toxaphene	8001−35−2	
1,2,4−Trichlorobenzene	120−82−1	
1,1,1−Trichloroethane	71−55−6	Methyl chloroform, 1,1,1−TCA
1,1,2−Trichloroethane	79−00−5	1,1,2−TCA, Vinyl trichloride
Trichloroethylene	79−01−6	TCE, Chloroethene
2,4,5−Trichlorophenoxy−propionic acid	93−72−1	2,4,5−TP,*Silvex*
1,2,3−Trichloropropane	96−18−4	1,2,3−TCP, Glycerol trichlorohyrin
Trifluralin	1582−09−8	*Treflan*
1,2,4−Trimethylbenzene	95−63−6	
1,3,5−Trimethylbenzene	108−67−8	
Vanadium	7440−62−2	
Vinyl chloride	75−01−4	VC, Chloroethene
Xylene[5]		

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[1] Chemical Abstracts Service (CAS) registry numbers are unique numbers assigned to a chemical substance. The CAS registry numbers were published by the U.S. Environmental Protection Agency in 40 CFR Part 264, Appendix IV

[2] Common synonyms include those widely used in government regulations, scientific publications, commerce and the general public. A trade name, also known as the proprietary name, is the specific, registered name given by a manufacturer to a product. Trade names are listed in *italics*. Common synonyms and trade names should be cross−referenced with CAS registry number to ensure the correct substance is identified.

[3] This is a combined chemical substance which includes cis 1,3−Dichloropropene (CAS RN 10061−01−5) and trans 1,3−Dichloropropene (CAS RN 10061−02−6).

[4] Polychlorinated biphenyls (CAS RN 1336−36−3); this category contains congener chemicals (same molecular composition, different molecular structure and formula), including constituents of Aroclor−1016 (CAS RN12674−11−2), Aroclor−1221 (CAS RN 11104−28−2), Aroclor−1232 (CAS RN 11141−16−5), Aroclor−1242 (CAS RN 53469−21−9), Aroclor−1248 (CAS RN 12672−29−6), Aroclor−1254 (CAS RN 11097−69−1), and Aroclor−1260 (CAS RN 11096−82−5).

[5] Xylene (CAS RN 1330−20−7) refers to a mixture of three isomers, meta−xylene (CAS RN 108−38−3), ortho−xylene (CAS RN 95−47−6), and para−xylene (CAS RN 106−42−3)

Key: I = IRIS; P = PPRTV; D = DWSHA; O = OPP; A = ATSDR; C = Cal EPA; X = APPENDIX PPRTV SCREEN (See FAQ #29); H = HEAST; F = See FAQ; E = see user guide Section 2.3.5; W = see user guide Section 2.3.6; L = see user guide on lead; M = mutagen; S = see user guide Section 5; V = volatile; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; n = noncancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; SSL values are based on DAF=1; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide)

Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer CHILD Hazard Index (HI) = 0.1				
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD$_o$ (mg/kg-day)	key	RfC$_i$ (mg/m^3)	key	vol	muta-gen	LOGP	GIABS	FA	In EPD?	Analyte	CAS No.	Ingestion SL TR=1E-06 (ug/L)	Dermal SL TR=1E-06 (ug/L)	Inhalation SL TR=1E-06 (ug/L)	Carcinogenic SL TR=1E-06 (ug/L)	Ingestion SL Child THQ=0.1 (ug/L)	Dermal SL Child THQ=0.1 (ug/L)	Inhalation SL Child THQ=0.1 (ug/L)	Noncarcinogenic SL Child THI=0.1 (ug/L)	MCL (ug/L)
				1.2E-03	O					-0.85	1	1	Yes	Acephate	30560-19-1					2.4E+00	3.4E+03		2.4E+00	
		2.2E-06	I			9.0E-03	I	V		-0.34	1	1	Yes	Acetaldehyde	75-07-0			2.6E+00	2.6E+00			1.9E+00	1.9E+00	
				2.0E-02	I					3.03	1	0.9	Yes	Acetochlor	34256-82-1					4.0E+01	2.9E+02		3.5E+01	
				9.0E-01	I	3.1E+01	A	V		-0.24	1	1	Yes	Acetone	67-64-1					1.8E+03	4.4E+05	6.4E+03	1.4E+03	
						2.0E-03	X			-0.03	1	1	Yes	Acetone Cyanohydrin	75-86-5									
						6.0E-02	I	V		-0.34	1	1	Yes	Acetonitrile	75-05-8							1.3E+01	1.3E+01	
				1.0E-01	I			V		1.58	1	1	Yes	Acetophenone	98-86-2					2.0E+02	4.6E+03		1.9E+02	
3.8E+00	C	1.3E-03	C							3.12	1	1	Yes	Acetylaminofluorene, 2-	53-96-3	2.1E-02	6.7E-02		1.6E-02					
				5.0E-04	I	2.0E-05	I	V		-0.01	1	1	Yes	Acrolein	107-02-8					1.0E+00	1.7E+02	4.2E-03	4.2E-03	
5.0E-01	I	1.0E-04	I	2.0E-03	I	6.0E-03	I		M	-0.67	1	1	Yes	Acrylamide	79-06-1	5.0E-02	2.3E+01		5.0E-02	4.0E+00	2.1E+03		4.0E+00	
				5.0E-01	I	1.0E-03	I	V		0.35	1	1	Yes	Acrylic Acid	79-10-7					1.0E+03	1.1E+05	2.1E-01	2.1E-01	
5.4E-01	I	6.8E-05	I	4.0E-02	A	2.0E-03	I	V		0.25	1	1	Yes	Acrylonitrile	107-13-1	1.4E-01	1.4E+01	8.3E-02	5.2E-02	8.0E+01	8.9E+03	4.2E-01	4.1E-01	
						6.0E-03	P			-0.32	1	1	Yes	Adiponitrile	111-69-3									
5.6E-02	C			1.0E-02	I					3.52	1	0.9	Yes	Alachlor	15972-60-8	1.4E+00	4.4E+00		1.1E+00	2.0E+01	6.9E+01		1.6E+01	2.0E+00
				1.0E-03	I					1.13	1	1	Yes	Aldicarb	116-06-3					2.0E+00	1.4E+02		2.0E+00	3.0E+00
				1.0E-03	I					-0.57	1	1	Yes	Aldicarb Sulfone	1646-88-4					2.0E+00	2.4E+03		2.0E+00	2.0E+00
										-0.78	1	1	Yes	Aldicarb sulfoxide	1646-87-3									4.0E+00
1.7E+01	I	4.9E-03	I	3.0E-05	I			V		6.5	1	1	No	Aldrin	309-00-2	4.6E-03		1.1E-03	9.2E-04	6.0E-02			6.0E-02	
				5.0E-03	I	1.0E-04	X	V		0.17	1	1	Yes	Allyl Alcohol	107-18-6					1.0E+01	1.3E+03	2.1E-02	2.1E-02	
2.1E-02	C	6.0E-06	C			1.0E-03	I	V		1.93	1	1	Yes	Allyl Chloride	107-05-1	3.7E+00	3.5E+01	9.4E-01	7.3E-01			2.1E-01	2.1E-01	
				1.0E+00	P	5.0E-03	P				1	1	Yes	Aluminum	7429-90-5					2.0E+03	4.6E+05		2.0E+03	
				4.0E-04	I						1	1	Yes	Aluminum Phosphide	20859-73-8					8.0E-01	1.8E+02		8.0E-01	
				9.0E-03	I					2.98	1	1	Yes	Ametryn	834-12-8					1.8E+01	9.8E+01		1.5E+01	
2.1E+01	C	6.0E-03	C							2.86	1	1	Yes	Aminobiphenyl, 4-	92-67-1	3.7E-03	1.5E-02		3.0E-03					
				8.0E-02	P					0.21	1	1	Yes	Aminophenol, m-	591-27-5					1.6E+02	2.8E+04		1.6E+02	
				4.0E-03	X					0.62	1	1	Yes	Aminophenol, o-	95-55-6					8.0E+00	7.5E+02		7.9E+00	
				2.0E-02	P					0.04	1	1	Yes	Aminophenol, p-	123-30-8					4.0E+01	9.1E+03		4.0E+01	
				2.5E-03	I					5.5	1	0.9	Yes	Amitraz	33089-61-1					5.0E+00	9.8E-01		8.2E-01	
						5.0E-01	I	V		0.23	1	1		Ammonia	7664-41-7									
				2.0E-01	I						1	1	Yes	Ammonium Sulfamate	7773-06-0					4.0E+02	9.1E+04		4.0E+02	
						3.0E-03	X	V		0.89	1	1	Yes	Amyl Alcohol, tert-	75-85-4							6.3E-01	6.3E-01	
5.7E-03	I	1.6E-06	C	7.0E-03	P	1.0E-03	I			0.9	1	1	Yes	Aniline	62-53-3	1.4E+01	6.9E+02		1.3E+01	1.4E+01	7.7E+02		1.4E+01	
4.0E-02	P			2.0E-03	X					3.39	1	0.9	Yes	Anthraquinone, 9,10-	84-65-1	1.9E+00	5.1E+00		1.4E+00	4.0E+00	1.1E+01		3.0E+00	
				4.0E-04	I						0.15	1	Yes	Antimony (metallic)	7440-36-0					8.0E-01	2.7E+01		7.8E-01	6.0E+00
				5.0E-04	H						0.15	1	Yes	Antimony Pentoxide	1314-60-9					1.0E+00	3.4E+01		9.7E-01	
				4.0E-04	H						0.15	1	Yes	Antimony Tetroxide	1332-81-6					8.0E-01	2.7E+01		7.8E-01	
						2.0E-04	I				0.15	1	Yes	Antimony Trioxide	1309-64-4									
1.5E+00	I	4.3E-03	I	3.0E-04	I	1.5E-05	C				1	1	Yes	Arsenic, Inorganic	7440-38-2	5.2E-02	9.7E+00		5.2E-02	6.0E-01	1.4E+02		6.0E-01	1.0E+01
				3.5E-06	C	5.0E-05	I				1	1	Yes	Arsine	7784-42-1					7.0E-03	1.6E+00		7.0E-03	
				3.6E-02	O					-0.27	1	1	Yes	Asulam	3337-71-1					7.2E+01	5.8E+04		7.2E+01	
2.3E-01	C			3.5E-02	I					2.61	1	1	Yes	Atrazine	1912-24-9	3.4E-01	2.8E+00		3.0E-01	7.0E+01	6.2E+02		6.3E+01	3.0E+00
8.8E-01	C	2.5E-04	C							2.98	1	0.9	Yes	Auramine	492-80-8	8.9E-02	2.7E-01		6.7E-02					
				4.0E-04	I					4.48	1	1	No	Avermectin B1	65195-55-3					8.0E-01			8.0E-01	
				3.0E-03	A	1.0E-02	A			2.75	1	1	Yes	Azinphos-methyl	86-50-0					6.0E+00	8.3E+01		5.6E+00	
1.1E-01	I	3.1E-05	I					V		3.82	1	1	Yes	Azobenzene	103-33-3	7.1E-01	7.3E-01	1.8E-01	1.2E-01					
				1.0E+00	P	7.0E-06	P			-1.7	1	1	Yes	Azodicarbonamide	123-77-3					2.0E+03	6.8E+06		2.0E+03	
				2.0E-01	I	5.0E-04	H				0.07	1	Yes	Barium	7440-39-3					4.0E+02	6.4E+03		3.8E+02	2.0E+03
				5.0E-03	O			V		5.29	1	0.8	Yes	Benfluralin	1861-40-1					1.0E+01	4.0E+00		2.8E+00	
				5.0E-02	I					2.12	1	1	Yes	Benomyl	17804-35-2					1.0E+02	3.0E+03		9.7E+01	
				2.0E-01	I					2.18	1	1	Yes	Bensulfuron-methyl	83055-99-6					4.0E+02	2.4E+04		3.9E+02	
				3.0E-02	I					2.34	1	1	Yes	Bentazon	25057-89-0					6.0E+01	9.4E+02		5.7E+01	
4.0E-03	P			1.0E-01	I			V		1.48	1	1	Yes	Benzaldehyde	100-52-7	1.9E+01	4.4E+02		1.9E+01	2.0E+02	4.9E+03		1.9E+02	
5.5E-02	I	7.8E-06	I	4.0E-03	I	3.0E-02	I	V		2.13	1	1	Yes	Benzene	71-43-2	1.4E+00	9.8E+00	7.2E-01	4.6E-01	8.0E+00	6.1E+01	6.3E+00	3.3E+00	5.0E+00
1.0E-01	X			3.0E-04	X					-3.7267	1	1	No	Benzenediamine-2-methyl sulfate, 1,4-	6369-59-1	7.8E-01			7.8E-01	6.0E-01			6.0E-01	
				1.0E-03	P			V		2.52	1	1	Yes	Benzenethiol	108-98-5					2.0E+00	1.0E+01		1.7E+00	
2.3E+02	I	6.7E-02	I	3.0E-03	I				M	1.34	1	1	Yes	Benzidine	92-87-5	1.1E-04	5.0E-03		1.1E-04	6.0E+00	3.0E+02		5.9E+00	
				4.0E+00	I					1.87	1	1	Yes	Benzoic Acid	65-85-0					8.0E+03	1.2E+05		7.5E+03	
1.3E+01	I							V		3.9	1	1	Yes	Benzotrichloride	98-07-7	6.0E-03	6.0E-03		3.0E-03					
				1.0E-01	P					1.1	1	1	Yes	Benzyl Alcohol	100-51-6					2.0E+02	8.9E+03		2.0E+02	
1.7E-01	I	4.9E-05	C	2.0E-03	P	1.0E-03	P	V		2.3	1	1	Yes	Benzyl Chloride	100-44-7	4.6E-01	3.4E+00	1.1E-01	8.9E-02	4.0E+00	3.2E+01	2.1E-01	2.0E-01	
		2.4E-03	I	2.0E-03	I	2.0E-05	I				0.007	1	Yes	Beryllium and compounds	7440-41-7					4.0E+00	6.4E+00		2.5E+00	4.0E+00
				9.0E-03	P					4.48	1	0.9	Yes	Bifenox	42576-02-3					1.8E+01	2.3E+01		1.0E+01	
				1.5E-02	I					6	1	0	Yes	Biphenthrin	82657-04-3					3.0E+01			3.0E+01	
8.0E-03	I			5.0E-01	I	4.0E-04	X	V		4.01	1	1	Yes	Biphenyl, 1,1'-	92-52-4	9.7E+00	6.5E+00		3.9E+00	1.0E+03	7.3E+02	8.3E-02	8.3E-02	
				4.0E-02	I			V		2.48	1	1	Yes	Bis(2-chloro-1-methylethyl) ether	108-60-1					8.0E+01	6.5E+02		7.1E+01	
				3.0E-03	P					1.3	1	1	Yes	Bis(2-chloroethoxy)methane	111-91-1					6.0E+00	3.0E+02		5.9E+00	
1.1E+00	I	3.3E-04	I					V		1.29	1	1	Yes	Bis(2-chloroethyl)ether	111-44-4	7.1E-02	2.7E+00	1.7E-02	1.4E-02					

TR=1E-06
HQ=0.1

Key: I = IRIS; P = PPRTV; D = DWSHA; O = OPP; A = ATSDR; C = Cal EPA; X = APPENDIX PPRTV SCREEN (See FAQ #29); H = HEAST; F = See FAQ; E = see user guide Section 2.3.5; W = see user guide Section 2.3.6; L = see user guide on lead; M = mutagen; S = see user guide Section 5; V = volatile; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; n = noncancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; SSL values are based on DAF=1; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide)

Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer CHILD Hazard Index (HI) = 0.1				
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD$_o$ (mg/kg-day)	key	RfC$_i$ (mg/m^3)	key	vol	muta-gen	LOGP	GIABS	FA	In EPD?	Analyte	CAS No.	Ingestion SL TR=1E-06 (ug/L)	Dermal SL TR=1E-06 (ug/L)	Inhalation SL TR=1E-06 (ug/L)	Carcinogenic SL TR=1E-06 (ug/L)	Ingestion SL Child THQ=0.1 (ug/L)	Dermal SL Child THQ=0.1 (ug/L)	Inhalation SL Child THQ=0.1 (ug/L)	Noncarcinogenic SL Child THI=0.1 (ug/L)	MCL (ug/L)
2.2E+02	I	6.2E-02	I					V		0.57	1	1	Yes	Bis(chloromethyl)ether	542-88-1	3.5E-04	3.4E-02	9.1E-05	7.2E-05					
				5.0E-02	I					3.32	1	1	Yes	Bisphenol A	80-05-7					1.0E+02	3.2E+02		7.7E+01	
				2.0E-01	I	2.0E-02	H				1	1	Yes	Boron And Borates Only	7440-42-8					4.0E+02	9.1E+04		4.0E+02	
				2.0E+00	P	2.0E-02	P	V		1.16	1	1	Yes	Boron Trichloride	10294-34-5					4.0E+03	9.1E+05	4.2E+00	4.2E+00	
				4.0E-02	C	1.3E-02	C	V		0.22	1	1	Yes	Boron Trifluoride	7637-07-2					8.0E+01	1.8E+04	2.7E+00	2.6E+00	
7.0E-01	I			4.0E-03	I						1	1	Yes	Bromate	15541-45-4	1.1E-01	2.1E+01		1.1E-01	8.0E+00	1.8E+03		8.0E+00	1.0E+01
2.0E+00	X	6.0E-04	X					V		1.92	1	1	Yes	Bromo-2-chloroethane, 1-	107-04-0	3.9E-02	5.7E-01	9.4E-03	7.4E-03					
				3.0E-04	X			V		2.92	1	1	Yes	Bromo-3-fluorobenzene, 1-	1073-06-9					6.0E-01	2.6E+00		4.9E-01	
				3.0E-04	X			V		3.08	1	1	Yes	Bromo-4-fluorobenzene, 1-	460-00-4					6.0E-01	2.0E+00		4.6E-01	
				8.0E-03	I	6.0E-02	I	V		2.99	1	1	Yes	Bromobenzene	108-86-1					1.6E+01	5.4E+01	1.3E+01	6.2E+00	
						4.0E-02	X	V		1.41	1	1	Yes	Bromochloromethane	74-97-5							8.3E+00	8.3E+00	
6.2E-02	I	3.7E-05	C	2.0E-02	I			V		2	1	1	Yes	Bromodichloromethane	75-27-4	1.3E+00	1.9E+01	1.5E-01	1.3E-01	4.0E+01	6.5E+02		3.8E+01	8.0E+01(F)
7.9E-03	I	1.1E-06	I	2.0E-02	I			V		2.4	1	1	Yes	Bromoform	75-25-2	9.9E+00	1.4E+02	5.1E+00	3.3E+00	4.0E+01	6.2E+02		3.8E+01	8.0E+01(F)
				1.4E-03	I	5.0E-03	I	V		1.19	1	1	Yes	Bromomethane	74-83-9					2.8E+00	1.0E+02	1.0E+00	7.5E-01	
				5.0E-03	H			V		5.21	1	0.8	Yes	Bromophos	2104-96-3					1.0E+01	5.5E+00		3.5E+00	
						1.0E-01	A	V		2.1	1	1	Yes	Bromopropane, 1-	106-94-5							2.1E+01	2.1E+01	
1.0E-01	O			1.5E-02	O					2.8	1	0.9	Yes	Bromoxynil	1689-84-5	7.6E-01	3.1E+00		6.1E-01	3.0E+01	1.3E+02		2.5E+01	
				1.5E-02	O			V		5.4	1	0.8	Yes	Bromoxynil Octanoate	1689-99-2					3.0E+01	1.6E+01		1.0E+01	
3.4E+00	C	3.0E-05	I			2.0E-03	I	V		1.99	1	1	Yes	Butadiene, 1,3-	106-99-0	2.3E-02	1.6E-01	1.9E-01	1.8E-02			4.2E-01	4.2E-01	
				3.0E-02	O					3.53	1	0.9	Yes	Butanoic acid, 4-(2,4-dichlorophenoxy)-	94-82-6					6.0E+01	1.8E+02		4.5E+01	
				1.0E-01	I			V		0.88	1	1	Yes	Butanol, N-	71-36-3					2.0E+02	1.0E+04		2.0E+02	
				2.0E+00	P	3.0E+01	P	V		0.61	1	1	Yes	Butyl alcohol, sec-	78-92-2					4.0E+03	3.0E+05	6.3E+03	2.4E+03	
				5.0E-02	I			V		4.15	1	1	Yes	Butylate	2008-41-5					1.0E+02	8.5E+01		4.6E+01	
2.0E-04	C	5.7E-08	C							3.5	1	0.8	Yes	Butylated hydroxyanisole	25013-16-5	3.9E+02	2.5E+02		1.5E+02					
3.6E-03	P			3.0E-01	P					5.1	1	1	Yes	Butylated hydroxytoluene	128-37-0	2.2E+01	4.0E+00		3.4E+00	6.0E+02	1.2E+02		1.0E+02	
				5.0E-02	P			V		4.38	1	1	No	Butylbenzene, n-	104-51-8					1.0E+02			1.0E+02	
				1.0E-01	X			V		4.57	1	1	No	Butylbenzene, sec-	135-98-8					2.0E+02			2.0E+02	
				1.0E-01	X			V		4.11	1	1	Yes	Butylbenzene, tert-	98-06-6					2.0E+02	1.1E+02		6.9E+01	
				2.0E-02	A					0.36	1	1	Yes	Cacodylic Acid	75-60-5					4.0E+01	6.7E+03		4.0E+01	
		1.8E-03	I	1.0E-03	I	1.0E-05	A				0.025	1		Cadmium (Diet)	7440-43-9									
		1.8E-03	I	5.0E-04	I	1.0E-05	A				0.05	1	Yes	Cadmium (Water)	7440-43-9					1.0E+00	1.1E+01		9.2E-01	5.0E+00
				5.0E-01	I	2.2E-03	C			-0.19	1	1	Yes	Caprolactam	105-60-2					1.0E+03	9.0E+04		9.9E+02	
1.5E-01	C	4.3E-05	C	2.0E-03	I					3.8	1	0.9	Yes	Captafol	2425-06-1	5.2E-01	1.8E+00		4.0E-01	4.0E+00	1.5E+01		3.2E+00	
2.3E-03	C	6.6E-07	C	1.3E-01	I					2.8	1	1	Yes	Captan	133-06-2	3.4E+01	3.6E+02		3.1E+01	2.6E+02	3.0E+03		2.4E+02	
				1.0E-01	I					2.36	1	1	Yes	Carbaryl	63-25-2					2.0E+02	2.4E+03		1.8E+02	
				5.0E-03	I					2.32	1	1	Yes	Carbofuran	1563-66-2					1.0E+01	1.4E+02		9.4E+00	4.0E+01
				1.0E-01	I	7.0E-01	I	V		1.94	1	1	Yes	Carbon Disulfide	75-15-0					2.0E+02	2.0E+03	1.5E+02	8.1E+01	
7.0E-02	I	6.0E-06	I	4.0E-03	I	1.0E-01	I	V		2.83	1	1	Yes	Carbon Tetrachloride	56-23-5	1.1E+00	4.3E+00	9.4E-01	4.6E-01	8.0E+00	3.4E+01	2.1E+01	4.9E+00	5.0E+00
						1.0E-01	P	V		-1.33	1	1	Yes	Carbonyl Sulfide	463-58-1							2.1E+01	2.1E+01	
				1.0E-02	I					5.57	1	0.8	Yes	Carbosulfan	55285-14-8					2.0E+01	6.9E+00		5.1E+00	
				1.0E-01	I					2.14	1	1	Yes	Carboxin	5234-68-4					2.0E+02	4.1E+03		1.9E+02	
						9.0E-04	I				1	1	Yes	Ceric oxide	1306-38-3									
				1.0E-01	I			V		0.99	1	1	Yes	Chloral Hydrate	302-17-0					2.0E+02	1.5E+04		2.0E+02	
				1.5E-02	I					1.9	1	1	Yes	Chloramben	133-90-4					3.0E+01	7.4E+02		2.9E+01	
4.0E-01	H									2.22	1	1	Yes	Chloranil	118-75-2	1.9E-01	3.5E+00		1.8E-01					
3.5E-01	I	1.0E-04	I	5.0E-04	I	7.0E-04	I	V		6.16	1	0.7	Yes	Chlordane	12789-03-6	2.2E-01	3.6E-02	5.6E-02	2.0E-02	1.0E+00	1.8E-01	1.5E-01	7.4E-02	2.0E+00
1.0E+01	I	4.6E-03	C	3.0E-04	I					5.41	1	0.8	Yes	Chlordecone (Kepone)	143-50-0	7.8E-03	6.5E-03		3.5E-03	6.0E-01	5.4E-01		2.9E-01	
				7.0E-04	A					3.81	1	0.9	Yes	Chlorfenvinphos	470-90-6					1.4E+00	5.6E+00		1.1E+00	
				9.0E-02	O					2.5	1	1	Yes	Chlorimuron, Ethyl-	90982-32-4					1.8E+02	6.8E+03		1.8E+02	
				1.0E-01	I	1.5E-04	A	V		0.85	1	1	Yes	Chlorine	7782-50-5					2.0E+02	4.6E+04	3.0E-02	3.0E-02	
				3.0E-02	I	2.0E-04	I	V			1	1	Yes	Chlorine Dioxide	10049-04-4					6.0E+01	1.4E+04	4.2E-02	4.2E-02	
				3.0E-02	I						1	1	Yes	Chlorite (Sodium Salt)	7758-19-2					6.0E+01	1.4E+04		6.0E+01	1.0E+03
						5.0E+01	I	V		2.05	1	1	Yes	Chloro-1,1-difluoroethane, 1-	75-68-3							1.0E+04	1.0E+04	
		3.0E-04	I	2.0E-02	H	2.0E-02	I	V		2.53	1	1	Yes	Chloro-1,3-butadiene, 2-	126-99-8			1.9E-02	1.9E-02	4.0E+01	1.8E+02	4.2E+00	3.7E+00	
4.6E-01	H									2.27	1	1	Yes	Chloro-2-methylaniline HCl, 4-	3165-93-3	1.7E-01	5.1E+02		1.7E-01					
1.0E-01	P	7.7E-05	C	3.0E-03	X					2.27	1	1	Yes	Chloro-2-methylaniline, 4-	95-69-2	7.8E-01	6.6E+00		7.0E-01	6.0E+00	5.6E+01		5.4E+00	
2.7E-01	X							V		0.09	1	1	Yes	Chloroacetaldehyde, 2-	107-20-0	2.9E-01	4.6E+01		2.9E-01					
										0.22	1	1	Yes	Chloroacetic Acid	79-11-8									6.0E+01
						3.0E-05	I			1.93	1	1	Yes	Chloroacetophenone, 2-	532-27-4									
2.0E-01	P			4.0E-03	I					1.83	1	1	Yes	Chloroaniline, p-	106-47-8	3.9E-01	5.9E+00		3.7E-01	8.0E+00	1.3E+02		7.6E+00	
				2.0E-02	I	5.0E-02	P	V		2.84	1	1	Yes	Chlorobenzene	108-90-7					4.0E+01	1.3E+02	1.0E+01	7.8E+00	1.0E+02
				1.0E-01	X					-0.52	1	1	Yes	Chlorobenzene sulfonic acid, p-	98-66-8					2.0E+02	1.8E+05		2.0E+02	
1.1E-01	C	3.1E-05	C	2.0E-02	I					4.74	1	0.8	Yes	Chlorobenzilate	510-15-6	7.1E-01	5.6E-01		3.1E-01	4.0E+01	3.5E+01		1.9E+01	
				3.0E-02	X					2.65	1	1	Yes	Chlorobenzoic Acid, p-	74-11-3					6.0E+01	3.4E+02		5.1E+01	
				3.0E-03	P	3.0E-01	P	V		3.6	1	1	Yes	Chlorobenzotrifluoride, 4-	98-56-6					6.0E+00	9.3E+00	6.3E+01	3.5E+00	
				4.0E-02	P			V		2.64	1	1	Yes	Chlorobutane, 1-	109-69-3					8.0E+01	3.1E+02		6.4E+01	
						5.0E+01	I	V		1.08	1	1	Yes	Chlorodifluoromethane	75-45-6							1.0E+04	1.0E+04	

TR=1E-06
THQ=0.1

Key: I = IRIS; P = PPRTV; D = DWSHA; O = OPP; A = ATSDR; C = Cal EPA; X = APPENDIX PPRTV SCREEN (See FAQ #29); H = HEAST; F = See FAQ; E = see user guide Section 2.3.5; W = see user guide Section 2.3.6; L = see user guide on lead; M = mutagen; S = see user guide Section 5; V = volatile; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; n = noncancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; SSL values are based on DAF=1; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide)

Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer CHILD Hazard Index (HI) = 0.1				
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD$_o$ (mg/kg-day)	key	RfC$_i$ (mg/m^3)	key	vol	mutagen	LOGP	GIABS	FA	In EPD?	Analyte	CAS No.	Ingestion SL TR=1E-06 (ug/L)	Dermal SL TR=1E-06 (ug/L)	Inhalation SL TR=1E-06 (ug/L)	Carcinogenic SL TR=1E-06 (ug/L)	Ingestion SL Child THQ=0.1 (ug/L)	Dermal SL Child THQ=0.1 (ug/L)	Inhalation SL Child THQ=0.1 (ug/L)	Noncarcinogenic SL Child THI=0.1 (ug/L)	MCL (ug/L)
				2.0E-02	P			V		0.03	1	1	Yes	Chloroethanol, 2-	107-07-3					4.0E+01	7.7E+03		4.0E+01	
3.1E-02	C	2.3E-05	I	1.0E-02	I	9.8E-02	A	V		1.97	1	1	Yes	Chloroform	67-66-3	2.5E+00	2.9E+01	2.4E-01	2.2E-01	2.0E+01	2.5E+02	2.0E+01	9.7E+00	8.0E+01(F)
						9.0E-02	I	V		0.91	1	1	Yes	Chloromethane	74-87-3							1.9E+01	1.9E+01	
2.4E+00	C	6.9E-04	C					V		0.32	1	1	Yes	Chloromethyl Methyl Ether	107-30-2	3.2E-02	3.7E+00	8.1E-03	6.5E-03					
3.0E-01	P			3.0E-03	P	1.0E-05	X			2.24	1	1	Yes	Chloronitrobenzene, o-	88-73-3	2.6E-01	2.6E+00		2.4E-01	6.0E+00	6.4E+01		5.5E+00	
6.0E-02	P			7.0E-04	P	2.0E-03	P			2.39	1	1	Yes	Chloronitrobenzene, p-	100-00-5	1.3E+00	1.0E+01		1.2E+00	1.4E+00	1.2E+01		1.3E+00	
				5.0E-03	I			V		2.15	1	1	Yes	Chlorophenol, 2-	95-57-8					1.0E+01	1.0E+02		9.1E+00	
						4.0E-04	C	V		2.09	1	1	Yes	Chloropicrin	76-06-2							8.3E-02	8.3E-02	
3.1E-03	C	8.9E-07	C	1.5E-02	I					3.05	1	0.9	Yes	Chlorothalonil	1897-45-6	2.5E+01	1.6E+02		2.2E+01	3.0E+01	2.1E+02		2.6E+01	
				2.0E-02	I			V		3.42	1	1	Yes	Chlorotoluene, o-	95-49-8					4.0E+01	5.8E+01		2.4E+01	
				2.0E-02	X			V		3.33	1	1	Yes	Chlorotoluene, p-	106-43-4					4.0E+01	6.6E+01		2.5E+01	
2.4E+02	C	6.9E-02	C							-1.02	1	1	Yes	Chlorozotocin	54749-90-5	3.2E-04	1.0E+00		3.2E-04					
				5.0E-02	O					3.51	1	0.9	Yes	Chlorpropham	101-21-3					1.0E+02	2.5E+02		7.1E+01	
				1.0E-03	A					4.96	1	0.8	Yes	Chlorpyrifos	2921-88-2					2.0E+00	1.5E+00		8.4E-01	
				1.0E-02	H					4.31	1	0.9	Yes	Chlorpyrifos Methyl	5598-13-0					2.0E+01	2.9E+01		1.2E+01	
				2.0E-02	O					2	1	1	Yes	Chlorsulfuron	64902-72-3					4.0E+01	2.3E+03		3.9E+01	
				1.0E-02	I					4.28	1	0.9	Yes	Chlorthal-dimethyl	1861-32-1					2.0E+01	3.3E+01		1.2E+01	
				8.0E-04	H					5.8	1	0.8	Yes	Chlorthiophos	60238-56-4					1.6E+00	3.4E-01		2.8E-01	
				1.5E+00	I						0.013	1	Yes	Chromium(III), Insoluble Salts	16065-83-1					3.0E+03	8.9E+03		2.2E+03	
5.0E-01	C	8.4E-02	S	3.0E-03	I	1.0E-04	I		M		0.025	1	Yes	Chromium(VI)	18540-29-9	5.0E-02	1.2E-01		3.5E-02	6.0E+00	1.7E+01		4.4E+00	
											0.013	1	Yes	Chromium, Total	7440-47-3									1.0E+02
				1.3E-02	I					3.1	1	0.9	Yes	Clofentezine	74115-24-5					2.6E+01	2.1E+02		2.3E+01	
		9.0E-03	P	3.0E-04	P	6.0E-06	P				1	1	Yes	Cobalt	7440-48-4					6.0E-01	3.4E+02		6.0E-01	
		6.2E-04	I					V	M		1	0		Coke Oven Emissions	8007-45-2									
				4.0E-02	H						1	1	Yes	Copper	7440-50-8					8.0E+01	1.8E+04		8.0E+01	1.3E+03
				5.0E-02	I	6.0E-01	C			1.96	1	1	Yes	Cresol, m-	108-39-4					1.0E+02	1.2E+03		9.3E+01	
				5.0E-02	I	6.0E-01	C			1.95	1	1	Yes	Cresol, o-	95-48-7					1.0E+02	1.2E+03		9.3E+01	
				1.0E-01	A	6.0E-01	C			1.94	1	1	Yes	Cresol, p-	106-44-5					2.0E+02	2.5E+03		1.9E+02	
				1.0E-01	A					3.1	1	1	Yes	Cresol, p-chloro-m-	59-50-7					2.0E+02	5.2E+02		1.4E+02	
				1.0E-01	A	6.0E-01	C			1.95	1	0.9	Yes	Cresols	1319-77-3					2.0E+02	6.7E+02		1.5E+02	
1.9E+00	H			1.0E-03	P			V		0.6	1	1	Yes	Crotonaldehyde, trans-	123-73-9	4.1E-02	2.7E+00		4.0E-02	2.0E+00	1.5E+02		2.0E+00	
				1.0E-01	I	4.0E-01	I	V		3.66	1	1	Yes	Cumene	98-82-8					2.0E+02	1.9E+02	8.3E+01	4.5E+01	
2.2E-01	C	6.3E-05	C							-1.73	1	1	Yes	Cupferron	135-20-6	3.5E-01	1.3E+04		3.5E-01					
8.4E-01	H			2.0E-03	H					2.22	1	1	Yes	Cyanazine	21725-46-2	9.3E-02	1.6E+00		8.8E-02	4.0E+00	7.6E+01		3.8E+00	
														Cyanides										
				1.0E-03	I						1	1	Yes	~Calcium Cyanide	592-01-8					2.0E+00	4.6E+02		2.0E+00	
				5.0E-03	I						1	1	Yes	~Copper Cyanide	544-92-3					1.0E+01	2.3E+03		1.0E+01	
				6.0E-04	I	8.0E-04	S	V			1	1	Yes	~Cyanide (CN-)	57-12-5					1.2E+00	2.7E+02	1.7E-01	1.5E-01	2.0E+02
				1.0E-03	I			V		0.07	1	1	Yes	~Cyanogen	460-19-5					2.0E+00	5.1E+02		2.0E+00	
				9.0E-02	I			V			1	1	Yes	~Cyanogen Bromide	506-68-3					1.8E+02	1.6E+05		1.8E+02	
				5.0E-02	I			V			1	1	Yes	~Cyanogen Chloride	506-77-4					1.0E+02	5.8E+04		1.0E+02	
				6.0E-04	I	8.0E-04	I	V		-0.25	1	1	Yes	~Hydrogen Cyanide	74-90-8					1.2E+00	2.7E+02	1.7E-01	1.5E-01	
				2.0E-03	I						1	1	Yes	~Potassium Cyanide	151-50-8					4.0E+00	4.6E+02		4.0E+00	
				5.0E-03	I						0.04	1	Yes	~Potassium Silver Cyanide	506-61-6					1.0E+01	4.6E+01		8.2E+00	
				1.0E-01	I						0.04	1	Yes	~Silver Cyanide	506-64-9					2.0E+02	1.8E+03		1.8E+02	
				1.0E-03	I						1	1	Yes	~Sodium Cyanide	143-33-9					2.0E+00	4.6E+02		2.0E+00	2.0E+02
				2.0E-04	P						1	0	Yes	~Thiocyanates	E1790664					4.0E-01	9.1E+01		4.0E-01	
				2.0E-04	X			V		0.58	1	1	Yes	~Thiocyanic Acid	463-56-9					4.0E-01	9.1E+01		4.0E-01	
				5.0E-02	I						1	1	Yes	~Zinc Cyanide	557-21-1					1.0E+02	3.8E+04		1.0E+02	
						6.0E+00	I	V		3.44	1	1	Yes	Cyclohexane	110-82-7							1.3E+03	1.3E+03	
2.0E-02	X			2.0E-02	X					4.72	1	0.9	Yes	Cyclohexane, 1,2,3,4,5-pentabromo-6-chloro-	87-84-3	3.9E+00	9.6E+00		2.8E+00	4.0E+01	1.1E+02		2.9E+01	
				5.0E+00	I	7.0E-01	P	V		0.81	1	1	Yes	Cyclohexanone	108-94-1					1.0E+04	6.5E+05	1.5E+02	1.4E+02	
				5.0E-03	P	1.0E+00	X	V		2.86	1	1	Yes	Cyclohexene	110-83-8					1.0E+01	2.5E+01	2.1E+02	7.0E+00	
				2.0E-01	I			V		1.49	1	1	Yes	Cyclohexylamine	108-91-8					4.0E+02	9.3E+03		3.8E+02	
				2.5E-02	I					5.95	1	0.7	Yes	Cyfluthrin	68359-37-5					5.0E+01	1.6E+01		1.2E+01	
				1.0E-03	O					6.9	1	0.5	No	Cyhalothrin	68085-85-8					2.0E+00			2.0E+00	
				6.0E-02	O					6.6	1	0.7	No	Cypermethrin	52315-07-8					1.2E+02			1.2E+02	
				1.5E-02	O					-0.061	1	1	Yes	Cyromazine	66215-27-8					3.0E+01	2.4E+03		3.0E+01	
2.4E-01	I	6.9E-05	C	3.0E-05	X					6.02	1	0.8	Yes	DDD, p,p`- (DDD)	72-54-8	3.2E-01	3.5E-02		3.2E-02	6.0E-02	7.1E-03		6.3E-03	
3.4E-01	I	9.7E-05	C	3.0E-04	X			V		6.51	1	0.8	No	DDE, p,p'-	72-55-9	2.3E-01		5.8E-02	4.6E-02	6.0E-01			6.0E-01	
3.4E-01	I	9.7E-05	I	5.0E-04	I					6.91	1	0.7	No	DDT	50-29-3	2.3E-01			2.3E-01	1.0E+00			1.0E+00	
				3.0E-02	I					0.78	1	1	Yes	Dalapon	75-99-0					6.0E+01	5.5E+03		6.0E+01	2.0E+02
1.8E-02	C	5.1E-06	C	1.5E-01	I					-1.5	1	1	Yes	Daminozide	1596-84-5	4.3E+00	1.3E+04		4.3E+00	3.0E+02	1.0E+06		3.0E+02	
7.0E-04	I			7.0E-03	I					12.11	1	0	No	Decabromodiphenyl ether, 2,2',3,3',4,4',5,5',6,6'- (BDE-209)	1163-19-5	1.1E+02			1.1E+02	1.4E+01			1.4E+01	
				4.0E-05	I					3.21	1	0.8	Yes	Demeton	8065-48-3					8.0E-02	8.8E-02		4.2E-02	
1.2E-03	I			6.0E-01	I					6.11	1	0	Yes	Di(2-ethylhexyl)adipate	103-23-1	6.5E+01			6.5E+01	1.2E+03			1.2E+03	4.0E+02
6.1E-02	H									4.49	1	0.9	Yes	Diallate	2303-16-4	1.3E+00	9.2E-01		5.4E-01					

TR=1E-06
THQ=0.1

Key: I = IRIS; P = PPRTV; D = DWSHA; O = OPP; A = ATSDR; C = Cal EPA; X = APPENDIX PPRTV SCREEN (See FAQ #29); H = HEAST; F = See FAQ; E = see user guide Section 2.3.5; W = see user guide Section 2.3.6; L = see user guide on lead; M = mutagen; S = see user guide Section 5; V = volatile; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; n = noncancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; SSL values are based on DAF=1; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide)

Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer CHILD Hazard Index (HI) = 0.1				
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD$_o$ (mg/kg-day)	key	RfC$_i$ (mg/m^3)	key	vol	mutagen	LOGP	GIABS	FA	In EPD?	Analyte	CAS No.	Ingestion SL TR=1E-06 (ug/L)	Dermal SL TR=1E-06 (ug/L)	Inhalation SL TR=1E-06 (ug/L)	Carcinogenic SL TR=1E-06 (ug/L)	Ingestion SL Child THQ=0.1 (ug/L)	Dermal SL Child THQ=0.1 (ug/L)	Inhalation SL Child THQ=0.1 (ug/L)	Noncarcinogenic SL Child THI=0.1 (ug/L)	MCL (ug/L)
				7.0E-04	A					3.81	1	0.9	Yes	Diazinon	333-41-5					1.4E+00	3.9E+00		1.0E+00	
				1.0E-02	X			V		4.38	1	1	Yes	Dibenzothiophene	132-65-0					2.0E+01	9.6E+00		6.5E+00	
8.0E-01	P	6.0E-03	P	2.0E-04	P	2.0E-04	I	V	M	2.96	1	1	Yes	Dibromo-3-chloropropane, 1,2-	96-12-8	3.1E-02	1.7E-01	3.4E-04	3.3E-04	4.0E-01	2.4E+00	4.2E-02	3.7E-02	2.0E-01
				4.0E-04	X			V		3.75	1	0.9	Yes	Dibromobenzene, 1,3-	108-36-1					8.0E-01	1.6E+00		5.3E-01	
				1.0E-02	I			V		3.79	1	0.9	Yes	Dibromobenzene, 1,4-	106-37-6					2.0E+01	3.7E+01		1.3E+01	
8.4E-02	I			2.0E-02	I			V		2.16	1	1	Yes	Dibromochloromethane	124-48-1	9.3E-01	1.4E+01		8.7E-01	4.0E+01	6.7E+02		3.8E+01	8.0E+01(F)
2.0E+00	I	6.0E-04	I	9.0E-03	I	9.0E-03	I	V		1.96	1	1	Yes	Dibromoethane, 1,2-	106-93-4	3.9E-02	7.1E-01	9.4E-03	7.5E-03	1.8E+01	3.6E+02	1.9E+00	1.7E+00	5.0E-02
						4.0E-03	X	V		1.7	1	1	Yes	Dibromomethane (Methylene Bromide)	74-95-3							8.3E-01	8.3E-01	
				3.0E-04	P						1	0	No	Dibutyltin Compounds	E1790660					6.0E-01			6.0E-01	
				3.0E-02	I					2.21	1	1	Yes	Dicamba	1918-00-9					6.0E+01	1.0E+03		5.7E+01	
		4.2E-03	P					V		2.6	1	1	Yes	Dichloro-2-butene, 1,4-	764-41-0			1.3E-03	1.3E-03					
		4.2E-03	P					V		2.6	1	1	Yes	Dichloro-2-butene, cis-1,4-	1476-11-5			1.3E-03	1.3E-03					
		4.2E-03	P					V		2.6	1	1	Yes	Dichloro-2-butene, trans-1,4-	110-57-6			1.3E-03	1.3E-03					
5.0E-02	I			4.0E-03	I					0.92	1	1	Yes	Dichloroacetic Acid	79-43-6	1.6E+00	9.6E+01		1.5E+00	8.0E+00	5.4E+02		7.9E+00	6.0E+01
				9.0E-02	I	2.0E-01	H	V		3.43	1	1	Yes	Dichlorobenzene, 1,2-	95-50-1					1.8E+02	2.9E+02	4.2E+01	3.0E+01	6.0E+02
5.4E-03	C	1.1E-05	C	7.0E-02	A	8.0E-01	I	V		3.44	1	1	Yes	Dichlorobenzene, 1,4-	106-46-7	1.4E+01	2.1E+01	5.1E-01	4.8E-01	1.4E+02	2.2E+02	1.7E+02	5.7E+01	7.5E+01
4.5E-01	I	3.4E-04	C							3.51	1	1	Yes	Dichlorobenzidine, 3,3'-	91-94-1	1.7E-01	4.5E-01		1.3E-01					
				9.0E-03	X					4.44	1	0.9	Yes	Dichlorobenzophenone, 4,4'-	90-98-2					1.8E+01	1.4E+01		7.8E+00	
				2.0E-01	I	1.0E-01	X	V		2.16	1	1	Yes	Dichlorodifluoromethane	75-71-8					4.0E+02	3.8E+03	2.1E+01	2.0E+01	
5.7E-03	C	1.6E-06	C	2.0E-01	P			V		1.79	1	1	Yes	Dichloroethane, 1,1-	75-34-3	1.4E+01	1.8E+02	3.5E+00	2.8E+00	4.0E+02	5.8E+03		3.8E+02	
9.1E-02	I	2.6E-05	I	6.0E-03	X	7.0E-03	P	V		1.48	1	1	Yes	Dichloroethane, 1,2-	107-06-2	8.6E-01	1.8E+01	2.2E-01	1.7E-01	1.2E+01	2.8E+02	1.5E+00	1.3E+00	5.0E+00
				5.0E-02	I	2.0E-01	I	V		2.13	1	1	Yes	Dichloroethylene, 1,1-	75-35-4					1.0E+02	8.5E+02	4.2E+01	2.8E+01	7.0E+00
				2.0E-03	I			V		1.86	1	1	Yes	Dichloroethylene, 1,2-cis-	156-59-2					4.0E+00	3.6E+01		3.6E+00	7.0E+01
				2.0E-02	I			V		2.09	1	1	Yes	Dichloroethylene, 1,2-trans-	156-60-5					4.0E+01	3.6E+02		3.6E+01	1.0E+02
				3.0E-03	I					3.06	1	1	Yes	Dichlorophenol, 2,4-	120-83-2					6.0E+00	1.9E+01		4.6E+00	
				1.0E-02	I					2.81	1	1	Yes	Dichlorophenoxy Acetic Acid, 2,4-	94-75-7					2.0E+01	1.4E+02		1.7E+01	7.0E+01
3.7E-02	P	3.7E-06	P	4.0E-02	P	4.0E-03	I	V		1.98	1	1	Yes	Dichloropropane, 1,2-	78-87-5	2.1E+00	2.3E+01	1.5E+00	8.5E-01	8.0E+01	9.6E+02	8.3E-01	8.2E-01	5.0E+00
				2.0E-02	P			V		2	1	1	Yes	Dichloropropane, 1,3-	142-28-9					4.0E+01	4.6E+02		3.7E+01	
				3.0E-03	I					0.78	1	1	Yes	Dichloropropanol, 2,3-	616-23-9					6.0E+00	5.0E+02		5.9E+00	
1.0E-01	I	4.0E-06	I	3.0E-02	I	2.0E-02	I	V		2.04	1	1	Yes	Dichloropropene, 1,3-	542-75-6	7.8E-01	7.8E+00	1.4E+00	4.7E-01	6.0E+01	6.6E+02	4.2E+00	3.9E+00	
2.9E-01	I	8.3E-05	C	5.0E-04	I	5.0E-04	I			1.43	1	1	Yes	Dichlorvos	62-73-7	2.7E-01	1.4E+01		2.6E-01	1.0E+00	5.6E+01		9.9E-01	
				7.0E-05	O					0	1	1	Yes	Dicrotophos	141-66-2					1.4E-01	7.7E+01		1.4E-01	
				8.0E-02	P	3.0E-04	X	V		3.16	1	1	Yes	Dicyclopentadiene	77-73-6					1.6E+02	3.5E+02	6.3E-02	6.3E-02	
1.6E+01	I	4.6E-03	I	5.0E-05	I					5.4	1	0.8	Yes	Dieldrin	60-57-1	4.9E-03	2.7E-03		1.8E-03	1.0E-01	6.1E-02		3.8E-02	
		3.0E-04	C			5.0E-03	I				1	0		Diesel Engine Exhaust	E17136615									
				2.0E-03	P	2.0E-04	P			-1.43	1	1	Yes	Diethanolamine	111-42-2					4.0E+00	8.4E+03		4.0E+00	
				3.0E-02	P	1.0E-04	P			0.56	1	1	Yes	Diethylene Glycol Monobutyl Ether	112-34-5					6.0E+01	8.7E+03		6.0E+01	
				6.0E-02	P	3.0E-04	P			-0.54	1	1	Yes	Diethylene Glycol Monoethyl Ether	111-90-0					1.2E+02	7.8E+04		1.2E+02	
				1.0E-03	P			V		0.05	1	1	Yes	Diethylformamide	617-84-5					2.0E+00	4.3E+02		2.0E+00	
3.5E+02	C	1.0E-01	C							5.07	1	0.9	Yes	Diethylstilbestrol	56-53-1	2.2E-04	6.6E-05		5.1E-05					
				8.3E-02	O					0.65	1	1	Yes	Difenzoquat	43222-48-6					1.7E+02	7.5E+04		1.7E+02	
				2.0E-02	I					3.88	1	0.9	Yes	Diflubenzuron	35367-38-5					4.0E+01	1.0E+02		2.9E+01	
						4.0E+01	I	V		0.75	1	1	Yes	Difluoroethane, 1,1-	75-37-6							8.3E+03	8.3E+03	
						3.0E+01	X	V		2.29	1	1	Yes	Difluoropropane, 2,2-	420-45-1							6.3E+03	6.3E+03	
4.4E-02	C	1.3E-05	C					V		3.58	1	1	Yes	Dihydrosafrole	94-58-6	1.8E+00	2.3E+00	4.3E-01	3.0E-01					
						7.0E-01	P	V		1.52	1	1	Yes	Diisopropyl Ether	108-20-3							1.5E+02	1.5E+02	
				8.0E-02	I			V		1.03	1	1	Yes	Diisopropyl Methylphosphonate	1445-75-6					1.6E+02	1.3E+04		1.6E+02	
				2.2E-02	O					-0.17	1	1	Yes	Dimethipin	55290-64-7					4.4E+01	2.6E+04		4.4E+01	
				2.2E-03	O					0.78	1	1	Yes	Dimethoate	60-51-5					4.4E+00	7.0E+02		4.4E+00	
1.6E+00	P									1.81	1	1	Yes	Dimethoxybenzidine, 3,3'-	119-90-4	4.9E-02	1.6E+00		4.7E-02					
1.7E-03	P			6.0E-02	P					-0.61	1	1	Yes	Dimethyl methylphosphonate	756-79-6	4.6E+01	2.8E+04		4.6E+01	1.2E+02	8.1E+04		1.2E+02	
4.6E+00	C	1.3E-03	C							4.58	1	1	Yes	Dimethylamino azobenzene [p-]	60-11-7	1.7E-02	7.2E-03		5.0E-03					
5.8E-01	H									2.17	1	1	Yes	Dimethylaniline HCl, 2,4-	21436-96-4	1.3E-01	5.2E+02		1.3E-01					
2.0E-01	P			2.0E-03	X					1.68	1	1	Yes	Dimethylaniline, 2,4-	95-68-1	3.9E-01	7.1E+00		3.7E-01	4.0E+00	8.0E+01		3.8E+00	
2.7E-02	P			2.0E-03	I			V		2.31	1	1	Yes	Dimethylaniline, N,N-	121-69-7	2.9E+00	2.0E+01		2.5E+00	4.0E+00	3.1E+01		3.5E+00	
1.1E+01	P									2.34	1	1	Yes	Dimethylbenzidine, 3,3'-	119-93-7	7.1E-03	8.5E-02		6.5E-03					
				1.0E-01	P	3.0E-02	I	V		-1.01	1	1	Yes	Dimethylformamide	68-12-2					2.0E+02	1.8E+05	6.3E+00	6.1E+00	
				1.0E-04	X	2.0E-06	X	V		-1.19	1	1	Yes	Dimethylhydrazine, 1,1-	57-14-7					2.0E-01	3.5E+02	4.2E-04	4.2E-04	
5.5E+02	C	1.6E-01	C					V		-0.54	1	1	Yes	Dimethylhydrazine, 1,2-	540-73-8	1.4E-04	5.0E-02	3.5E-05	2.8E-05					
				2.0E-02	I					2.3	1	1	Yes	Dimethylphenol, 2,4-	105-67-9					4.0E+01	3.1E+02		3.6E+01	
				6.0E-04	I					2.36	1	1	Yes	Dimethylphenol, 2,6-	576-26-1					1.2E+00	8.5E+00		1.1E+00	
				1.0E-03	I					2.23	1	1	Yes	Dimethylphenol, 3,4-	95-65-8					2.0E+00	1.7E+01		1.8E+00	
4.5E-02	C	1.3E-05	C					V		2.58	1	1	Yes	Dimethylvinylchloride	513-37-1	1.7E+00	6.5E+00	4.3E-01	3.3E-01					
				8.0E-05	X					2.13	1	1	Yes	Dinitro-o-cresol, 4,6-	534-52-1					1.6E-01	2.6E+00		1.5E-01	
				2.0E-03	I					4.12	1	0.9	Yes	Dinitro-o-cyclohexyl Phenol, 4,6-	131-89-5					4.0E+00	5.4E+00		2.3E+00	
				1.0E-04	P					1.69	1	1	Yes	Dinitrobenzene, 1,2-	528-29-0					2.0E-01	5.3E+00		1.9E-01	
				1.0E-04	I					1.49	1	1	Yes	Dinitrobenzene, 1,3-	99-65-0					2.0E-01	7.3E+00		2.0E-01	

TR=1E-06
HQ=0.1

Key: I = IRIS; P = PPRTV; D = DWSHA; O = OPP; A = ATSDR; C = Cal EPA; X = APPENDIX PPRTV SCREEN (See FAQ #29); H = HEAST; F = See FAQ; E = see user guide Section 2.3.5; W = see user guide Section 2.3.6; L = see user guide on lead; M = mutagen; S = see user guide Section 5; V = volatile; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; n = noncancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; SSL values are based on DAF=1; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide)

Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer CHILD Hazard Index (HI) = 0.1				
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD$_o$ (mg/kg-day)	key	RfC$_i$ (mg/m^3)	key	vol	mutagen	LOGP	GIABS	FA	In EPD?	Analyte	CAS No.	Ingestion SL TR=1E-06 (ug/L)	Dermal SL TR=1E-06 (ug/L)	Inhalation SL TR=1E-06 (ug/L)	Carcinogenic SL TR=1E-06 (ug/L)	Ingestion SL Child THQ=0.1 (ug/L)	Dermal SL Child THQ=0.1 (ug/L)	Inhalation SL Child THQ=0.1 (ug/L)	Noncarcinogenic SL Child THI=0.1 (ug/L)	MCL (ug/L)
				1.0E-04	P					1.46	1	1	Yes	Dinitrobenzene, 1,4-	100-25-4					2.0E-01	7.6E+00		2.0E-01	
				2.0E-03	I					1.67	1	1	Yes	Dinitrophenol, 2,4-	51-28-5					4.0E+00	1.2E+02		3.9E+00	
6.8E-01	I									2.18	1	1	Yes	Dinitrotoluene Mixture, 2,4/2,6-	E1615210	1.1E-01	1.5E+00		1.1E-01					
3.1E-01	C	8.9E-05	C	2.0E-03	I					1.98	1	1	Yes	Dinitrotoluene, 2,4-	121-14-2	2.5E-01	4.3E+00		2.4E-01	4.0E+00	7.5E+01		3.8E+00	
1.5E+00	P			3.0E-04	X					2.1	1	1	Yes	Dinitrotoluene, 2,6-	606-20-2	5.2E-02	7.4E-01		4.9E-02	6.0E-01	9.3E+00		5.7E-01	
				2.0E-03	S					1.84	1	1	Yes	Dinitrotoluene, 2-Amino-4,6-	35572-78-2					4.0E+00	1.0E+02		3.9E+00	
				2.0E-03	S					1.84	1	1	Yes	Dinitrotoluene, 4-Amino-2,6-	19406-51-0					4.0E+00	1.0E+02		3.9E+00	
4.5E-01	X			9.0E-04	X					2.18	1	0.8	Yes	Dinitrotoluene, Technical grade	25321-14-6	1.7E-01	2.6E-01		1.0E-01	1.8E+00	3.0E+00		1.1E+00	
				1.0E-03	I					3.56	1	0.9	Yes	Dinoseb	88-85-7					2.0E+00	5.4E+00		1.5E+00	7.0E+00
1.0E-01	I	5.0E-06	I	3.0E-02	I	3.0E-02	I	V		-0.27	1	1	Yes	Dioxane, 1,4-	123-91-1	7.8E-01	2.3E+02	1.1E+00	4.6E-01	6.0E+01	1.9E+04	6.3E+00	5.7E+00	
														Dioxins										
6.2E+03	I	1.3E+00	I							8.21	1	0	No	~Hexachlorodibenzo-p-dioxin, Mixture		1.3E-05			1.3E-05					
1.3E+05	C	3.8E+01	C	7.0E-10	I	4.0E-08	C	V		6.8	1	0.5	No	~TCDD, 2,3,7,8-	1746-01-6	6.0E-07		1.5E-07	1.2E-07	1.4E-06		8.3E-06	1.2E-06	3.0E-05
				3.0E-02	I					2.17	1	1	Yes	Diphenamid	957-51-7					6.0E+01	4.2E+02		5.3E+01	
						4.0E-04	X	V		4.21	1	1	Yes	Diphenyl Ether	101-84-8							8.3E-02	8.3E-02	
				8.0E-04	X					2.4	1	1	Yes	Diphenyl Sulfone	127-63-9					1.6E+00	2.0E+01		1.5E+00	
				1.0E-01	O					3.5	1	1	Yes	Diphenylamine	122-39-4					2.0E+02	3.4E+02		1.3E+02	
8.0E-01	I	2.2E-04	I							2.94	1	1	Yes	Diphenylhydrazine, 1,2-	122-66-7	9.7E-02	3.9E-01		7.8E-02					
				2.2E-03	I					-4.6	1	1	No	Diquat	85-00-7					4.4E+00			4.4E+00	2.0E+01
7.1E+00	C	1.4E-01	C							4.9	1	1	No	Direct Black 38	1937-37-7	1.1E-02			1.1E-02					
7.4E+00	C	1.4E-01	C							2.6	1	1	No	Direct Blue 6	2602-46-2	1.1E-02			1.1E-02					
6.7E+00	C	1.4E-01	C							-6.53	1	1	No	Direct Brown 95	16071-86-6	1.2E-02			1.2E-02					
				4.0E-05	I					4.02	1	0.9	Yes	Disulfoton	298-04-4					8.0E-02	1.3E-01		5.0E-02	
				1.0E-02	I			V		0.77	1	1	Yes	Dithiane, 1,4-	505-29-3					2.0E+01	1.6E+03		2.0E+01	
				2.0E-03	I					2.68	1	1	Yes	Diuron	330-54-1					4.0E+00	3.6E+01		3.6E+00	
				2.0E-02	O					1.15	1	1	Yes	Dodine	2439-10-3					4.0E+01	5.3E+03		4.0E+01	
				5.0E-02	O			V		3.21	1	1	Yes	EPTC	759-94-4					1.0E+02	3.0E+02		7.5E+01	
				6.0E-03	I			V		3.83	1	0.9	Yes	Endosulfan	115-29-7					1.2E+01	6.3E+01		1.0E+01	
				2.0E-02	I					1.91	1	1	Yes	Endothall	145-73-3					4.0E+01	8.5E+02		3.8E+01	1.0E+02
				3.0E-04	I					5.2	1	0.8	Yes	Endrin	72-20-8					6.0E-01	3.7E-01		2.3E-01	2.0E+00
9.9E-03	I	1.2E-06	I	6.0E-03	P	1.0E-03	I	V		0.45	1	1	Yes	Epichlorohydrin	106-89-8	7.9E+00	7.9E+02	4.7E+00	2.9E+00	1.2E+01	1.3E+03	2.1E-01	2.0E-01	
						2.0E-02	I	V		0.86	1	1	Yes	Epoxybutane, 1,2-	106-88-7							4.2E+00	4.2E+00	
				4.0E-02	P					-1.18	1	1	Yes	Ethanol, 2-(2-methoxyethoxy)-	111-77-3					8.0E+01	3.9E+04		8.0E+01	
				5.0E-03	I					-0.22	1	1	Yes	Ethephon	16672-87-0					1.0E+01	4.2E+03		1.0E+01	
				5.0E-04	I					5.07	1	0.8	Yes	Ethion	563-12-2					1.0E+00	7.7E-01		4.3E-01	
				1.0E-01	P	6.0E-02	P	V		0.59	1	1	Yes	Ethoxyethanol Acetate, 2-	111-15-9					2.0E+02	2.3E+04	1.3E+01	1.2E+01	
				9.0E-02	P	2.0E-01	I	V		-0.32	1	1	Yes	Ethoxyethanol, 2-	110-80-5					1.8E+02	6.3E+04	4.2E+01	3.4E+01	
				9.0E-01	I	7.0E-02	P	V		0.73	1	1	Yes	Ethyl Acetate	141-78-6					1.8E+03	1.2E+05	1.5E+01	1.4E+01	
				5.0E-03	P	8.0E-03	P	V		1.32	1	1	Yes	Ethyl Acrylate	140-88-5					1.0E+01	3.0E+02	1.7E+00	1.4E+00	
						1.0E+01	I	V		1.43	1	1	Yes	Ethyl Chloride (Chloroethane)	75-00-3							2.1E+03	2.1E+03	
				2.0E-01	I			V		0.89	1	1	Yes	Ethyl Ether	60-29-7					4.0E+02	2.0E+04		3.9E+02	
						3.0E-01	P	V		1.94	1	1	Yes	Ethyl Methacrylate	97-63-2							6.3E+01	6.3E+01	
				1.0E-05	I					4.78	1	0.8	Yes	Ethyl-p-nitrophenyl Phosphonate	2104-64-5					2.0E-02	1.6E-02		8.9E-03	
1.1E-02	C	2.5E-06	C	1.0E-01	I	1.0E+00	I	V		3.15	1	1	Yes	Ethylbenzene	100-41-4	7.1E+00	1.2E+01	2.2E+00	1.5E+00	2.0E+02	3.8E+02	2.1E+02	8.1E+01	7.0E+02
				7.0E-02	P					-0.94	1	1	Yes	Ethylene Cyanohydrin	109-78-4					1.4E+02	1.1E+05		1.4E+02	
				9.0E-02	P			V		-2.04	1	1	No	Ethylene Diamine	107-15-3					1.8E+02			1.8E+02	
				2.0E+00	I	4.0E-01	C			-1.36	1	1	Yes	Ethylene Glycol	107-21-1					4.0E+03	5.7E+06		4.0E+03	
				1.0E-01	I	1.6E+00	I			0.83	1	1	Yes	Ethylene Glycol Monobutyl Ether	111-76-2					2.0E+02	1.4E+04		2.0E+02	
3.1E-01	C	3.0E-03	I			3.0E-02	C	V	M	-0.3	1	1	Yes	Ethylene Oxide	75-21-8	8.1E-02	1.7E+01	6.8E-04	6.7E-04			6.3E+00	6.3E+00	
4.5E-02	C	1.3E-05	C	8.0E-05	I					-0.66	1	1	Yes	Ethylene Thiourea	96-45-7	1.7E+00	1.0E+03		1.7E+00	1.6E-01	1.0E+02		1.6E-01	
6.5E+01	C	1.9E-02	C					V		-0.28	1	1	Yes	Ethyleneimine	151-56-4	1.2E-03	2.5E-01	3.0E-04	2.4E-04					
				3.0E+00	I					2.19	1	1	Yes	Ethylphthalyl Ethyl Glycolate	84-72-0					6.0E+03	1.5E+05		5.8E+03	
				2.5E-04	I					3.23	1	0.9	Yes	Fenamiphos	22224-92-6					5.0E-01	3.4E+00		4.4E-01	
				2.5E-02	I					5.7	1	0.8	Yes	Fenpropathrin	39515-41-8					5.0E+01	7.3E+00		6.4E+00	
				2.5E-02	I					6.2	1	0.7	No	Fenvalerate	51630-58-1					5.0E+01			5.0E+01	
				1.3E-02	I					2.42	1	1	Yes	Fluometuron	2164-17-2					2.6E+01	3.4E+02		2.4E+01	
				4.0E-02	C	1.3E-02	C				1	1	Yes	Fluoride	16984-48-8					8.0E+01	1.8E+04		8.0E+01	
				6.0E-02	I	1.3E-02	C				1	1	Yes	Fluorine (Soluble Fluoride)	7782-41-4					1.2E+02	2.7E+04		1.2E+02	4.0E+03
				8.0E-02	I					3.16	1	0.9	Yes	Fluridone	59756-60-4					1.6E+02	1.4E+03		1.4E+02	
				1.5E-02	O					3.34	1	0.9	Yes	Flurprimidol	56425-91-3					3.0E+01	1.8E+02		2.6E+01	
				2.0E-03	O					3.7	1	0.9	Yes	Flusilazole	85509-19-9					4.0E+00	1.4E+01		3.1E+00	
				5.0E-01	O					3.7	1	0.9	Yes	Flutolanil	66332-96-5					1.0E+03	3.7E+03		7.9E+02	
				1.0E-02	I					6.81	1	0.6	No	Fluvalinate	69409-94-5					2.0E+01			2.0E+01	
				9.0E-02	O					2.85	1	1	Yes	Folpet	133-07-3					1.8E+02	1.9E+03		1.6E+02	
				2.5E-03	O					2.9	1	1	Yes	Fomesafen	72178-02-0					5.0E+00	1.2E+02		4.8E+00	
				2.0E-03	I					3.94	1	0.9	Yes	Fonofos	944-22-9					4.0E+00	6.3E+00		2.4E+00	
		1.3E-05	I	2.0E-01	I	9.8E-03	A	V		0.35	1	1	Yes	Formaldehyde	50-00-0			4.3E-01	4.3E-01	4.0E+02	3.2E+04	2.0E+00	2.0E+00	

TR=1E-06
THQ=0.1

Key: I = IRIS; P = PPRTV; D = DWSHA; O = OPP; A = ATSDR; C = Cal EPA; X = APPENDIX PPRTV SCREEN (See FAQ #29); H = HEAST; F = See FAQ; E = see user guide Section 2.3.5; W = see user guide Section 2.3.6; L = see user guide on lead; M = mutagen; S = see user guide Section 5; V = volatile; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; n = noncancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; SSL values are based on DAF=1; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide)

Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer CHILD Hazard Index (HI) = 0.1				
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD$_o$ (mg/kg-day)	key	RfC$_i$ (mg/m^3)	key	vol	mutagen	LOGP	GIABS	FA	In EPD?	Analyte	CAS No.	Ingestion SL TR=1E-06 (ug/L)	Dermal SL TR=1E-06 (ug/L)	Inhalation SL TR=1E-06 (ug/L)	Carcinogenic SL TR=1E-06 (ug/L)	Ingestion SL Child THQ=0.1 (ug/L)	Dermal SL Child THQ=0.1 (ug/L)	Inhalation SL Child THQ=0.1 (ug/L)	Noncarcinogenic SL Child THI=0.1 (ug/L)	MCL (ug/L)
				9.0E-01	P	3.0E-04	X	V		-0.54	1	1	Yes	Formic Acid	64-18-6					1.8E+03	6.4E+05	6.3E-02	6.3E-02	
				2.5E+00	O					-2.4	1	1	No	Fosetyl-AL	39148-24-8					5.0E+03			5.0E+03	
														Furans										
				1.0E-03	X			V		4.12	1	1	Yes	~Dibenzofuran	132-64-9					2.0E+00	1.3E+00		7.9E-01	
				1.0E-03	I			V		1.34	1	1	Yes	~Furan	110-00-9					2.0E+00	4.8E+01		1.9E+00	
				9.0E-01	I	2.0E+00	I	V		0.46	1	1	Yes	~Tetrahydrofuran	109-99-9					1.8E+03	1.7E+05	4.2E+02	3.4E+02	
3.8E+00	H									-0.04	1	1	Yes	Furazolidone	67-45-8	2.1E-02	1.0E+01		2.0E-02					
				3.0E-03	I	5.0E-02	H	V		0.41	1	1	Yes	Furfural	98-01-1					6.0E+00	7.1E+02	1.0E+01	3.8E+00	
1.5E+00	C	4.3E-04	C							1.8	1	1	Yes	Furium	531-82-8	5.2E-02	1.9E+00		5.1E-02					
3.0E-02	I	8.6E-06	C							4.38	1	0.9	Yes	Furmecyclox	60568-05-0	2.6E+00	2.0E+00		1.1E+00					
				6.0E-03	O					-4.81	1	1	No	Glufosinate, Ammonium	77182-82-2					1.2E+01			1.2E+01	
				1.0E-01	A	8.0E-05	C			-0.33	1	1	Yes	Glutaraldehyde	111-30-8					2.0E+02	6.0E+04		2.0E+02	
				4.0E-04	I	1.0E-03	H	V		-0.12	1	1	Yes	Glycidyl	765-34-4					8.0E-01	1.8E+02	2.1E-01	1.7E-01	
				1.0E-01	I					-3.4	1	1	No	Glyphosate	1071-83-6					2.0E+02			2.0E+02	7.0E+02
				1.0E-02	X			V		-1.63	1	1	Yes	Guanidine	113-00-8					2.0E+01	4.2E+04		2.0E+01	
				2.0E-02	P					-3.56	1	1	No	Guanidine Chloride	50-01-1					4.0E+01			4.0E+01	
				3.0E-02	X					-8.35	1	1	No	Guanidine Nitrate	506-93-4					6.0E+01			6.0E+01	
				5.0E-05	I					4.07	1	0.9	Yes	Haloxyfop, Methyl	69806-40-2					1.0E-01	3.1E-01		7.6E-02	
4.5E+00	I	1.3E-03	I	5.0E-04	I			V		6.1	1	0.8	Yes	Heptachlor	76-44-8	1.7E-02	2.3E-03	4.3E-03	1.4E-03	1.0E+00	1.5E-01		1.3E-01	4.0E-01
9.1E+00	I	2.6E-03	I	1.3E-05	I			V		4.98	1	0.8	Yes	Heptachlor Epoxide	1024-57-3	8.6E-03	7.1E-03	2.2E-03	1.4E-03	2.6E-02	2.4E-02		1.2E-02	2.0E-01
						3.0E-03	X	V		2.29	1	1	Yes	Heptanal, n-	111-71-7							6.3E-01	6.3E-01	
				3.0E-04	X	4.0E-01	P	V		4.66	1	1	No	Heptane, N-	142-82-5					6.0E-01		8.3E+01	6.0E-01	
				2.0E-03	I			V		6.07	1	0.7	No	Hexabromobenzene	87-82-1					4.0E+00			4.0E+00	
				2.0E-04	I						1	0	No	Hexabromodiphenyl ether, 2,2',4,4',5,5'- (BDE-153)	68631-49-2					4.0E-01			4.0E-01	
1.6E+00	I	4.6E-04	I	8.0E-04	I			V		5.73	1	0.9	No	Hexachlorobenzene	118-74-1	4.9E-02		1.2E-02	9.8E-03	1.6E+00			1.6E+00	1.0E+00
7.8E-02	I	2.2E-05	I	1.0E-03	P			V		4.78	1	0.9	Yes	Hexachlorobutadiene	87-68-3	1.0E+00	4.4E-01	2.6E-01	1.4E-01	2.0E+00	9.5E-01		6.5E-01	
6.3E+00	I	1.8E-03	I	8.0E-03	A					3.8	1	0.9	Yes	Hexachlorocyclohexane, Alpha-	319-84-6	1.2E-02	1.8E-02		7.2E-03	1.6E+01	2.5E+01		9.7E+00	
1.8E+00	I	5.3E-04	I							3.78	1	0.9	Yes	Hexachlorocyclohexane, Beta-	319-85-7	4.3E-02	6.1E-02		2.5E-02					
1.1E+00	C	3.1E-04	C	3.0E-04	I					3.72	1	0.9	Yes	Hexachlorocyclohexane, Gamma- (Lindane)	58-89-9	7.1E-02	1.0E-01		4.2E-02	6.0E-01	9.3E-01		3.6E-01	2.0E-01
1.8E+00	I	5.1E-04	I							4.14	1	0.9	Yes	Hexachlorocyclohexane, Technical	608-73-1	4.3E-02	6.1E-02		2.5E-02					
				6.0E-03	I	2.0E-04	I	V		5.04	1	0.9	Yes	Hexachlorocyclopentadiene	77-47-4					1.2E+01	4.2E+00	4.2E-02	4.1E-02	5.0E+01
4.0E-02	I	1.1E-05	C	7.0E-04	I	3.0E-02	I	V		4.14	1	1	Yes	Hexachloroethane	67-72-1	1.9E+00	1.7E+00	5.1E-01	3.3E-01	1.4E+00	1.4E+00	6.3E+00	6.2E-01	
				3.0E-04	I					7.54	1	0	No	Hexachlorophene	70-30-4					6.0E-01			6.0E-01	
1.1E-01	I			3.0E-03	I					0.87	1	1	Yes	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	7.1E-01	8.6E+01		7.0E-01	6.0E+00	8.0E+02		6.0E+00	
						1.0E-05	I	V		3.2	1	1	Yes	Hexamethylene Diisocyanate, 1,6-	822-06-0							2.1E-03	2.1E-03	
				4.0E-04	P					0.28	1	1	Yes	Hexamethylphosphoramide	680-31-9					8.0E-01	2.0E+02		8.0E-01	
						7.0E-01	I	V		3.9	1	1	Yes	Hexane, N-	110-54-3							1.5E+02	1.5E+02	
				2.0E+00	P					0.08	1	1	Yes	Hexanedioic Acid	124-04-9					4.0E+03	1.1E+06		4.0E+03	
				5.0E-03	I	3.0E-02	I	V		1.38	1	1	Yes	Hexanone, 2-	591-78-6					1.0E+01	2.8E+02	6.3E+00	3.8E+00	
				3.3E-02	I					1.85	1	1	Yes	Hexazinone	51235-04-2					6.6E+01	2.4E+03		6.4E+01	
				2.5E-02	I					5.57	1	0.8	Yes	Hexythiazox	78587-05-0					5.0E+01	1.4E+01		1.1E+01	
				1.7E-02	O					2.31	1	1	Yes	Hydramethylnon	67485-29-4					3.4E+01	2.9E+03		3.4E+01	
3.0E+00	I	4.9E-03	I			3.0E-05	P	V		-2.07	1	1	Yes	Hydrazine	302-01-2	2.6E-02	1.1E+02	1.1E-03	1.1E-03			6.3E-03	6.3E-03	
3.0E+00	I	4.9E-03	I								1	1	Yes	Hydrazine Sulfate	10034-93-2	2.6E-02	4.9E+00		2.6E-02					
						2.0E-02	I	V			1	1	Yes	Hydrogen Chloride	7647-01-0							4.2E+00	4.2E+00	
				4.0E-02	C	1.4E-02	C	V		0.23	1	1	Yes	Hydrogen Fluoride	7664-39-3					8.0E+01	1.8E+04	2.9E+00	2.8E+00	
						2.0E-03	I	V		0.23	1	1	Yes	Hydrogen Sulfide	7783-06-4							4.2E-01	4.2E-01	
6.0E-02	P			4.0E-02	P					0.59	1	1	Yes	Hydroquinone	123-31-9	1.3E+00	1.2E+02		1.3E+00	8.0E+01	7.9E+03		7.9E+01	
6.1E-02	O			2.5E-03	O					3.82	1	0.9	Yes	Imazalil	35554-44-0	1.3E+00	3.1E+00		9.0E-01	5.0E+00	1.3E+01		3.6E+00	
				2.5E-01	I					1.86	1	1	Yes	Imazaquin	81335-37-7					5.0E+02	2.6E+04		4.9E+02	
				2.5E+00	O					1.49	1	1	Yes	Imazethapyr	81335-77-5					5.0E+03	7.2E+04		4.7E+03	
				1.0E-02	A					2.49	1	1	Yes	Iodine	7553-56-2					2.0E+01	4.6E+03		2.0E+01	
				4.0E-02	I					3	1	0.9	Yes	Iprodione	36734-19-7					8.0E+01	9.1E+02		7.4E+01	
				7.0E-01	P						1	1	Yes	Iron	7439-89-6					1.4E+03	3.2E+05		1.4E+03	
				3.0E-01	I			V		0.76	1	1	Yes	Isobutyl Alcohol	78-83-1					6.0E+02	3.6E+04		5.9E+02	
9.5E-04	I			2.0E-01	I	2.0E+00	C			1.7	1	1	Yes	Isophorone	78-59-1	8.2E+01	1.6E+03		7.8E+01	4.0E+02	8.6E+03		3.8E+02	
				1.5E-02	I			V		5.8	1	0.8	Yes	Isopropalin	33820-53-0					3.0E+01	4.6E+00		4.0E+00	
				2.0E+00	P	2.0E-01	P	V		0.05	1	1	Yes	Isopropanol	67-63-0					4.0E+03	6.5E+05	4.2E+01	4.1E+01	
				1.0E-01	I					0.27	1	1	Yes	Isopropyl Methyl Phosphonic Acid	1832-54-8					2.0E+02	3.9E+04		2.0E+02	
				5.0E-02	I					3.94	1	0.9	Yes	Isoxaben	82558-50-7					1.0E+02	2.7E+02		7.3E+01	
						3.0E-01	A	V		8	1	0	No	JP-7	E1737665							6.3E+01	6.3E+01	
				8.0E-03	O					4.81	1	0.9	Yes	Lactofen	77501-63-4					1.6E+01	2.7E+01		1.0E+01	
				2.0E-04	X					-0.94	1	1	Yes	Lactonitrile	78-97-7					4.0E-01	3.2E+02		4.0E-01	
														Lead Compounds										
8.5E-03	C	1.2E-05	C								1	0.8	Yes	~Lead Phosphate	7446-27-7	9.2E+00	1.7E+03		9.1E+00					
8.5E-03	C	1.2E-05	C							-0.08	1	1	Yes	~Lead acetate	301-04-2	9.2E+00	9.1E+03		9.2E+00					
											1	1	Yes	~Lead and Compounds	7439-92-1								1.5E+01	1.5E+01

TR=1E-06
THQ=0.1

Key: I = IRIS; P = PPRTV; D = DWSHA; O = OPP; A = ATSDR; C = Cal EPA; X = APPENDIX PPRTV SCREEN (See FAQ #29); H = HEAST; F = See FAQ; E = see user guide Section 2.3.5; W = see user guide Section 2.3.6; L = see user guide on lead; M = mutagen; S = see user guide Section 5; V = volatile; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; n = noncancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; SSL values are based on DAF=1; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide)

Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer CHILD Hazard Index (HI) = 0.1				
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD$_o$ (mg/kg-day)	key	RfC$_i$ (mg/m^3)	key	vol	mutagen	LOGP	GIABS	FA	In EPD?	Analyte	CAS No.	Ingestion SL TR=1E-06 (ug/L)	Dermal SL TR=1E-06 (ug/L)	Inhalation SL TR=1E-06 (ug/L)	Carcinogenic SL TR=1E-06 (ug/L)	Ingestion SL Child THQ=0.1 (ug/L)	Dermal SL Child THQ=0.1 (ug/L)	Inhalation SL Child THQ=0.1 (ug/L)	Noncarcinogenic SL Child THI=0.1 (ug/L)	MCL (ug/L)
8.5E-03	C	1.2E-05	C							-4	1	1	No	~Lead subacetate	1335-32-6	9.2E+00			9.2E+00					
				1.0E-07	I			V		4.15	1	0.9	Yes	~Tetraethyl Lead	78-00-2					2.0E-04	3.8E-04		1.3E-04	
				5.0E-06	P			V		2.56	1	1	Yes	Lewisite	541-25-3					1.0E-02	9.1E-02		9.0E-03	
				7.7E-03	O					3.2	1	0.9	Yes	Linuron	330-55-2					1.5E+01	7.6E+01		1.3E+01	
				2.0E-03	P						1	1	Yes	Lithium	7439-93-2					4.0E+00	9.1E+02		4.0E+00	
				5.0E-04	I					3.25	1	1	Yes	MCPA	94-74-6					1.0E+00	3.0E+00		7.5E-01	
				4.4E-03	O					2.79	1	0.9	Yes	MCPB	94-81-5					8.8E+00	2.4E+01		6.5E+00	
				1.0E-03	I					3.13	1	1	Yes	MCPP	93-65-2					2.0E+00	7.1E+00		1.6E+00	
				2.0E-02	I					2.36	1	1	Yes	Malathion	121-75-5					4.0E+01	1.1E+03		3.9E+01	
				1.0E-01	I	7.0E-04	C			1.62	1	1	Yes	Maleic Anhydride	108-31-6					2.0E+02	3.8E+03		1.9E+02	
				5.0E-01	I					-0.84	1	1	Yes	Maleic Hydrazide	123-33-1					1.0E+03	8.9E+05		1.0E+03	
				1.0E-04	P					-0.6	1	1	Yes	Malononitrile	109-77-3					2.0E-01	9.2E+01		2.0E-01	
				3.0E-02	H					1.33	1	0.9	Yes	Mancozeb	8018-01-7					6.0E+01	4.9E+02		5.4E+01	
				5.0E-03	I					0.62	1	1	Yes	Maneb	12427-38-2					1.0E+01	3.6E+02		9.8E+00	
				1.4E-01	I	5.0E-05	I				1	1		Manganese (Diet)	7439-96-5									
				2.4E-02	S	5.0E-05	I				0.04	1	Yes	Manganese (Non-diet)	7439-96-5					4.8E+01	4.4E+02		4.3E+01	
				9.0E-05	H					1.04	1	1	Yes	Mephosfolan	950-10-7					1.8E-01	2.5E+01		1.8E-01	
				3.0E-02	I					-2.82	1	1	No	Mepiquat Chloride	24307-26-4					6.0E+01			6.0E+01	
1.1E-02	P			4.0E-03	P					2.42	1	1	Yes	Mercaptobenzothiazole, 2-	149-30-4	7.1E+00	5.6E+01		6.3E+00	8.0E+00	6.9E+01		7.2E+00	
														Mercury Compounds										
				3.0E-04	I	3.0E-04	S			-0.22	0.07	1	Yes	~Mercuric Chloride (and other Mercury salts)	7487-94-7					6.0E-01	9.6E+00		5.7E-01	2.0E+00
						3.0E-04	I	V		0.62	1	1	Yes	~Mercury (elemental)	7439-97-6							6.3E-02	6.3E-02	2.0E+00
				1.0E-04	I						1	1	Yes	~Methyl Mercury	22967-92-6					2.0E-01	4.6E+01		2.0E-01	
				8.0E-05	I					0.71	1	1	Yes	~Phenylmercuric Acetate	62-38-4					1.6E-01	5.7E+01		1.6E-01	
				3.0E-05	I			V		7.67	1	0.3	No	Merphos	150-50-5					6.0E-02			6.0E-02	
				1.0E-04	O					5.7	1	0.9	Yes	Merphos Oxide	78-48-8					2.0E-01	3.3E-02		2.8E-02	
				6.0E-02	I					1.65	1	1	Yes	Metalaxyl	57837-19-1					1.2E+02	6.4E+03		1.2E+02	
				1.0E-04	I	3.0E-02	P	V		0.68	1	1	Yes	Methacrylonitrile	126-98-7					2.0E-01	1.3E+01	6.3E+00	1.9E-01	
				5.0E-05	I					-0.8	1	1	Yes	Methamidophos	10265-92-6					1.0E-01	1.0E+02		1.0E-01	
				2.0E+00	I	2.0E+01	I	V		-0.77	1	1	Yes	Methanol	67-56-1					4.0E+03	1.8E+06	4.2E+03	2.0E+03	
				1.5E-03	O					2.2	1	1	Yes	Methidathion	950-37-8					3.0E+00	8.7E+01		2.9E+00	
				2.5E-02	I					0.6	1	1	Yes	Methomyl	16752-77-5					5.0E+01	6.8E+03		5.0E+01	
4.9E-02	C	1.4E-05	C							1.47	1	1	Yes	Methoxy-5-nitroaniline, 2-	99-59-2	1.6E+00	5.4E+01		1.5E+00					
				5.0E-03	I					5.08	1	0.8	Yes	Methoxychlor	72-43-5					1.0E+01	5.9E+00		3.7E+00	4.0E+01
				8.0E-03	P	1.0E-03	P	V		0.1	1	1	Yes	Methoxyethanol Acetate, 2-	110-49-6					1.6E+01	3.5E+03	2.1E-01	2.1E-01	
				5.0E-03	P	2.0E-02	I	V		-0.77	1	1	Yes	Methoxyethanol, 2-	109-86-4					1.0E+01	6.3E+03	4.2E+00	2.9E+00	
				1.0E+00	X			V		0.18	1	1	Yes	Methyl Acetate	79-20-9					2.0E+03	2.9E+05		2.0E+03	
						2.0E-02	P	V		0.8	1	1	Yes	Methyl Acrylate	96-33-3							4.2E+00	4.2E+00	
				6.0E-01	I	5.0E+00	I	V		0.29	1	1	Yes	Methyl Ethyl Ketone (2-Butanone)	78-93-3					1.2E+03	1.5E+05	1.0E+03	5.6E+02	
		1.0E-03	X	1.0E-03	P	2.0E-05	X	V		-1.05	1	1	Yes	Methyl Hydrazine	60-34-4			5.6E-03	5.6E-03	2.0E+00	1.5E+03	4.2E-03	4.2E-03	
						3.0E+00	I	V		1.31	1	1	Yes	Methyl Isobutyl Ketone (4-methyl-2-pentanone)	108-10-1							6.3E+02	6.3E+02	
						1.0E-03	C	V		0.79	1	1	Yes	Methyl Isocyanate	624-83-9							2.1E-01	2.1E-01	
				1.4E+00	I	7.0E-01	I	V		1.38	1	1	Yes	Methyl Methacrylate	80-62-6					2.8E+03	7.7E+04	1.5E+02	1.4E+02	
				2.5E-04	I					2.86	1	1	Yes	Methyl Parathion	298-00-0					5.0E-01	4.1E+00		4.5E-01	
				6.0E-02	X					-0.7	1	1	Yes	Methyl Phosphonic Acid	993-13-5					1.2E+02	1.2E+05		1.2E+02	
				6.0E-03	H	4.0E-02	H	V		3.44	1	0.8	Yes	Methyl Styrene (Mixed Isomers)	25013-15-4					1.2E+01	4.3E+00	8.3E+00	2.3E+00	
9.9E-02	C	2.8E-05	C							-0.66	1	1	Yes	Methyl methanesulfonate	66-27-3	7.9E-01	4.8E+02		7.9E-01					
1.8E-03	C	2.6E-07	C			3.0E+00	I	V		0.94	1	1	Yes	Methyl tert-Butyl Ether (MTBE)	1634-04-4	4.3E+01	2.0E+03	2.2E+01	1.4E+01			6.3E+02	6.3E+02	
				3.0E-04	X					-2.06	1	1	Yes	Methyl-1,4-benzenediamine dihydrochloride, 2-	615-45-2					6.0E-01	5.9E+03		6.0E-01	
						3.0E+00	X	V		1.43	1	1	Yes	Methyl-2-Pentanol, 4-	108-11-2							6.3E+02	6.3E+02	
9.0E-03	P			2.0E-02	X					1.87	1	1	Yes	Methyl-5-Nitroaniline, 2-	99-55-8	8.7E+00	1.4E+02		8.2E+00	4.0E+01	7.3E+02		3.8E+01	
8.3E+00	C	2.4E-03	C							-0.92	1	1	Yes	Methyl-N-nitro-N-nitrosoguanidine, N-	70-25-7	9.4E-03	1.1E+01		9.4E-03					
1.3E-01	C	3.7E-05	C							1.62	1	1	Yes	Methylaniline Hydrochloride, 2-	636-21-5	6.0E-01	3.9E+03		6.0E-01					
				1.0E-02	A					-1.18	1	1	Yes	Methylarsonic acid	124-58-3					2.0E+01	3.6E+04		2.0E+01	
				2.0E-04	X						1	0	No	Methylbenzene,1-4-diamine monohydrochloride, 2-	74612-12-7					4.0E-01			4.0E-01	
1.0E-01	X			3.0E-04	X						1	0	No	Methylbenzene-1,4-diamine sulfate, 2-	615-50-9	7.8E-01			7.8E-01	6.0E-01			6.0E-01	
2.2E+01	C	6.3E-03	C						M	6.42	1	0.8	No	Methylcholanthrene, 3-	56-49-5	1.1E-03			1.1E-03					
2.0E-03	I	1.0E-08	I	6.0E-03	I	6.0E-01	I	V	M	1.25	1	1	Yes	Methylene Chloride	75-09-2	1.3E+01	3.5E+02	2.0E+02	1.1E+01	1.2E+01	3.7E+02	1.3E+02	1.1E+01	5.0E+00
1.0E-01	P	4.3E-04	C	2.0E-03	P				M	3.91	1	0.9	Yes	Methylene-bis(2-chloroaniline), 4,4'-	101-14-4	2.5E-01	4.3E-01		1.6E-01	4.0E+00	7.5E+00		2.6E+00	
4.6E-02	I	1.3E-05	C							4.37	1	1	Yes	Methylene-bis(N,N-dimethyl) Aniline, 4,4'-	101-61-1	1.7E+00	6.7E-01		4.8E-01					
1.6E+00	C	4.6E-04	C			2.0E-02	C			1.59	1	1	Yes	Methylenebisbenzenamine, 4,4'-	101-77-9	4.9E-02	1.7E+00		4.7E-02					
						6.0E-04	I			5.22	1	0.9	Yes	Methylenediphenyl Diisocyanate	101-68-8									
				7.0E-02	H			V		3.48	1	1	Yes	Methylstyrene, Alpha-	98-83-9					1.4E+02	1.7E+02		7.8E+01	
				1.5E-01	I					3.13	1	1	Yes	Metolachlor	51218-45-2					3.0E+02	2.6E+03		2.7E+02	
				2.5E-02	I					1.7	1	1	Yes	Metribuzin	21087-64-9					5.0E+01	1.8E+03		4.9E+01	
				2.5E-01	I					2.2	1	1	Yes	Metsulfuron-methyl	74223-64-6					5.0E+02	2.4E+04		4.9E+02	
				3.0E+00	P			V		6.1	1	1	No	Mineral oils	8012-95-1					6.0E+03			6.0E+03	

TR=1E-06
THQ=0.1

Key: I = IRIS; P = PPRTV; D = DWSHA; O = OPP; A = ATSDR; C = Cal EPA; X = APPENDIX PPRTV SCREEN (See FAQ #29); H = HEAST; F = See FAQ; E = see user guide Section 2.3.5; W = see user guide Section 2.3.6; L = see user guide on lead; M = mutagen; S = see user guide Section 5; V = volatile; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; n = noncancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; SSL values are based on DAF=1; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide)

TR=1E-06
THQ=0.1

Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer CHILD Hazard Index (HI) = 0.1				
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD$_o$ (mg/kg-day)	key	RfC$_i$ (mg/m^3)	key	vol	mutagen	LOGP	GIABS	FA	In EPD?	Analyte	CAS No.	Ingestion SL TR=1E-06 (ug/L)	Dermal SL TR=1E-06 (ug/L)	Inhalation SL TR=1E-06 (ug/L)	Carcinogenic SL TR=1E-06 (ug/L)	Ingestion SL Child THQ=0.1 (ug/L)	Dermal SL Child THQ=0.1 (ug/L)	Inhalation SL Child THQ=0.1 (ug/L)	Noncarcinogenic SL Child THI=0.1 (ug/L)	MCL (ug/L)
1.8E+01	C	5.1E-03	C	2.0E-04	I			V		6.89	1	0.5	No	Mirex	2385-85-5	4.3E-03		1.1E-03	8.8E-04	4.0E-01			4.0E-01	
				2.0E-03	I					3.21	1	1	Yes	Molinate	2212-67-1					4.0E+00	1.2E+01		3.0E+00	
				5.0E-03	I						1	1	Yes	Molybdenum	7439-98-7					1.0E+01	2.3E+03		1.0E+01	
				1.0E-01	I						1	1	Yes	Monochloramine	10599-90-3					2.0E+02	4.6E+04		2.0E+02	4.0E+03
				2.0E-03	P					1.66	1	1	Yes	Monomethylaniline	100-61-8					4.0E+00	7.5E+01		3.8E+00	
				2.5E-02	I					2.94	1	1	Yes	Myclobutanil	88671-89-0					5.0E+01	4.7E+02		4.5E+01	
				3.0E-04	X					4.04	1	0.9	Yes	N,N'-Diphenyl-1,4-benzenediamine	74-31-7					6.0E-01	8.9E-01		3.6E-01	
				2.0E-03	I			V		1.38	1	1	Yes	Naled	300-76-5					4.0E+00	6.8E+02		4.0E+00	
				3.0E-02	X	1.0E-01	P	V			1	0	No	Naphtha, High Flash Aromatic (HFAN)	64742-95-6					6.0E+01		2.1E+01	1.5E+01	
1.8E+00	C	0.0E+00	C							2.28	1	1	Yes	Naphthylamine, 2-	91-59-8	4.3E-02	3.6E-01		3.9E-02					
				1.2E-01	O					3.36	1	0.9	Yes	Napropamide	15299-99-7					2.4E+02	1.1E+03		2.0E+02	
		2.6E-04	C	1.1E-02	C	1.4E-05	C			-1.38	1	1	Yes	Nickel Acetate	373-02-4					2.2E+01	6.8E+04		2.2E+01	
		2.6E-04	C	1.1E-02	C	1.4E-05	C			-2.12	1	1	Yes	Nickel Carbonate	3333-67-3					2.2E+01	1.4E+05		2.2E+01	
		2.6E-04	C	1.1E-02	C	1.4E-05	C	V			1	0	Yes	Nickel Carbonyl	13463-39-3			2.2E-02	2.2E-02	2.2E+01		2.9E-03	2.9E-03	
		2.6E-04	C	1.1E-02	C	1.4E-05	C				0.04	1	Yes	Nickel Hydroxide	12054-48-7					2.2E+01	2.0E+02		2.0E+01	
		2.6E-04	C	1.1E-02	C	2.0E-05	C				0.04	1	Yes	Nickel Oxide	1313-99-1					2.2E+01	2.0E+02		2.0E+01	
		2.4E-04	I	1.1E-02	C	1.4E-05	C				0.04	0	Yes	Nickel Refinery Dust	E715532					2.2E+01	1.0E+03		2.2E+01	
		2.6E-04	C	2.0E-02	I	9.0E-05	A				0.04	1	Yes	Nickel Soluble Salts	7440-02-0					4.0E+01	1.8E+03		3.9E+01	
1.7E+00	C	4.8E-04	I	1.1E-02	C	1.4E-05	C				0.04	1	Yes	Nickel Subsulfide	12035-72-2	4.6E-02	1.7E+00		4.5E-02	2.2E+01	1.0E+03		2.2E+01	
		2.6E-04	C	1.1E-02	C	1.4E-05	C				1	0	Yes	Nickelocene	1271-28-9					2.2E+01			2.2E+01	
				1.6E+00	I						1	1	Yes	Nitrate	14797-55-8					3.2E+03	7.3E+05		3.2E+03	1.0E+04
											1	0	Yes	Nitrate + Nitrite (as N)	E701177									1.0E+04
				1.0E-01	I						1	1	Yes	Nitrite	14797-65-0					2.0E+02	4.6E+04		2.0E+02	1.0E+03
				1.0E-02	X	5.0E-05	X			1.85	1	1	Yes	Nitroaniline, 2-	88-74-4					2.0E+01	3.4E+02		1.9E+01	
2.0E-02	P			4.0E-03	P	6.0E-03	P			1.39	1	1	Yes	Nitroaniline, 4-	100-01-6	3.9E+00	1.2E+02		3.8E+00	8.0E+00	2.8E+02		7.8E+00	
		4.0E-05	I	2.0E-03	I	9.0E-03	I	V		1.85	1	1	Yes	Nitrobenzene	98-95-3			1.4E-01	1.4E-01	4.0E+00	6.2E+01	1.9E+00	1.3E+00	
				3.0E+03	P					-4.56	1	1	No	Nitrocellulose	9004-70-0					6.0E+06			6.0E+06	
				7.0E-02	H					-0.47	1	1	Yes	Nitrofurantoin	67-20-9					1.4E+02	1.6E+05		1.4E+02	
1.3E+00	C	3.7E-04	C							0.23	1	1	Yes	Nitrofurazone	59-87-0	6.0E-02	1.7E+01		6.0E-02					
1.7E-02	P			1.0E-04	P					1.62	1	1	Yes	Nitroglycerin	55-63-0	4.6E+00	1.8E+02		4.5E+00	2.0E-01	8.7E+00		2.0E-01	
				1.0E-01	I					-0.89	1	1	Yes	Nitroguanidine	556-88-7					2.0E+02	1.8E+05		2.0E+02	
		8.8E-06	P			5.0E-03	P	V		-0.35	1	1	Yes	Nitromethane	75-52-5			6.4E-01	6.4E-01			1.0E+00	1.0E+00	
		2.7E-03	H			2.0E-02	I	V		0.93	1	1	Yes	Nitropropane, 2-	79-46-9			2.1E-03	2.1E-03			4.2E+00	4.2E+00	
2.7E+01	C	7.7E-03	C						M	0.23	1	1	Yes	Nitroso-N-ethylurea, N-	759-73-9	9.3E-04	1.5E-01		9.2E-04					
1.2E+02	C	3.4E-02	C						M	-0.03	1	1	Yes	Nitroso-N-methylurea, N-	684-93-5	2.1E-04	4.6E-02		2.1E-04					
5.4E+00	I	1.6E-03	I					V		2.63	1	1	Yes	Nitroso-di-N-butylamine, N-	924-16-3	1.4E-02	7.9E-02	3.5E-03	2.7E-03					
7.0E+00	I	2.0E-03	C							1.36	1	1	Yes	Nitroso-di-N-propylamine, N-	621-64-7	1.1E-02	3.5E-01		1.1E-02					
2.8E+00	I	8.0E-04	C							-1.28	1	1	Yes	Nitrosodiethanolamine, N-	1116-54-7	2.8E-02	8.1E+01		2.8E-02					
1.5E+02	I	4.3E-02	I						M	0.48	1	1	Yes	Nitrosodiethylamine, N-	55-18-5	1.7E-04	1.7E-02		1.7E-04					
5.1E+01	I	1.4E-02	I	8.0E-06	P	4.0E-05	X	V	M	-0.57	1	1	Yes	Nitrosodimethylamine, N-	62-75-9	4.9E-04	2.0E-01	1.4E-04	1.1E-04	1.6E-02	7.4E+00	8.3E-03	5.5E-03	
4.9E-03	I	2.6E-06	C							3.13	1	1	Yes	Nitrosodiphenylamine, N-	86-30-6	1.6E+01	5.2E+01		1.2E+01					
2.2E+01	I	6.3E-03	C					V		0.04	1	1	Yes	Nitrosomethylethylamine, N-	10595-95-6	3.5E-03	6.4E-01	8.9E-04	7.1E-04					
6.7E+00	C	1.9E-03	C							-0.44	1	1	Yes	Nitrosomorpholine [N-]	59-89-2	1.2E-02	5.3E+00		1.2E-02					
9.4E+00	C	2.7E-03	C							0.36	1	1	Yes	Nitrosopiperidine [N-]	100-75-4	8.3E-03	1.1E+00		8.2E-03					
2.1E+00	I	6.1E-04	I							-0.19	1	1	Yes	Nitrosopyrrolidine, N-	930-55-2	3.7E-02	1.0E+01		3.7E-02					
				1.0E-04	X					2.45	1	1	Yes	Nitrotoluene, m-	99-08-1					2.0E-01	1.4E+00		1.7E-01	
2.2E-01	P			9.0E-04	P			V		2.3	1	1	Yes	Nitrotoluene, o-	88-72-2	3.5E-01	2.8E+00		3.1E-01	1.8E+00	1.5E+01		1.6E+00	
1.6E-02	P			4.0E-03	P					2.37	1	1	Yes	Nitrotoluene, p-	99-99-0	4.9E+00	3.4E+01		4.3E+00	8.0E+00	6.2E+01		7.1E+00	
				3.0E-04	X	2.0E-02	P	V		5.65	1	1	No	Nonane, n-	111-84-2					6.0E-01		4.2E+00	5.3E-01	
				1.5E-02	O					2.3	1	1	Yes	Norflurazon	27314-13-2					3.0E+01	7.5E+02		2.9E+01	
				3.0E-03	I					8.71	1	0.3	No	Octabromodiphenyl Ether	32536-52-0					6.0E+00			6.0E+00	
				5.0E-02	I					0.16	1	1	Yes	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	2691-41-0					1.0E+02	6.3E+04		1.0E+02	
				2.0E-03	H					-1.01	1	1	Yes	Octamethylpyrophosphoramide	152-16-9					4.0E+00	1.4E+04		4.0E+00	
7.8E-03	O			1.4E-01	O					3.73	1	0.9	Yes	Oryzalin	19044-88-3	1.0E+01	3.8E+01		7.9E+00	2.8E+02	1.2E+03		2.3E+02	
				5.0E-03	I					4.8	1	0.8	Yes	Oxadiazon	19666-30-9					1.0E+01	9.0E+00		4.7E+00	
				2.5E-02	I					-0.47	1	1	Yes	Oxamyl	23135-22-0					5.0E+01	5.1E+04		5.0E+01	2.0E+02
7.3E-02	O			3.0E-02	O					4.73	1	0.8	Yes	Oxyfluorfen	42874-03-3	1.1E+00	1.1E+00		5.4E-01	6.0E+01	6.7E+01		3.2E+01	
				1.3E-02	I					3.2	1	0.9	Yes	Paclobutrazol	76738-62-0					2.6E+01	1.7E+02		2.3E+01	
				4.5E-03	I					-4.5	1	1	No	Paraquat Dichloride	1910-42-5					9.0E+00			9.0E+00	
				6.0E-03	H					3.83	1	0.9	Yes	Parathion	56-38-2					1.2E+01	3.0E+01		8.6E+00	
				5.0E-02	H			V		3.83	1	1	Yes	Pebulate	1114-71-2					1.0E+02	1.3E+02		5.6E+01	
				3.0E-02	O					5.2	1	0.9	Yes	Pendimethalin	40487-42-1					6.0E+01	1.8E+01		1.4E+01	
				2.0E-03	I			V		6.84	1	0.6	No	Pentabromodiphenyl Ether	32534-81-9					4.0E+00			4.0E+00	
				1.0E-04	I					7.66	1	0.6	No	Pentabromodiphenyl ether, 2,2',4,4',5- (BDE-99)	60348-60-9					2.0E-01			2.0E-01	
				8.0E-04	I			V		5.17	1	0.9	Yes	Pentachlorobenzene	608-93-5					1.6E+00	3.9E-01		3.2E-01	
9.0E-02	P							V		3.22	1	1	Yes	Pentachloroethane	76-01-7	8.7E-01	2.5E+00		6.5E-01					
2.6E-01	H			3.0E-03	I			V		4.64	1	0.9	Yes	Pentachloronitrobenzene	82-68-8	3.0E-01	2.0E-01		1.2E-01	6.0E+00	4.4E+00		2.6E+00	

Key: I = IRIS; P = PPRTV; D = DWSHA; O = OPP; A = ATSDR; C = Cal EPA; X = APPENDIX PPRTV SCREEN (See FAQ #29); H = HEAST; F = See FAQ; E = see user guide Section 2.3.5; W = see user guide Section 2.3.6; L = see user guide on lead; M = mutagen; S = see user guide Section 5; V = volatile; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; n = noncancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; SSL values are based on DAF=1; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide)

Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer CHILD Hazard Index (HI) = 0.1				
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD$_o$ (mg/kg-day)	key	RfC$_i$ (mg/m^3)	key	vol	muta-gen	LOGP	GIABS	FA	In EPD?	Analyte	CAS No.	Ingestion SL TR=1E-06 (ug/L)	Dermal SL TR=1E-06 (ug/L)	Inhalation SL TR=1E-06 (ug/L)	Carcinogenic SL TR=1E-06 (ug/L)	Ingestion SL Child THQ=0.1 (ug/L)	Dermal SL Child THQ=0.1 (ug/L)	Inhalation SL Child THQ=0.1 (ug/L)	Noncarcinogenic SL Child THI=0.1 (ug/L)	MCL (ug/L)
4.0E-01	I	5.1E-06	C	5.0E-03	I					5.12	1	0.9	Yes	Pentachlorophenol	87-86-5	1.9E-01	5.2E-02		4.1E-02	1.0E+01	2.9E+00		2.3E+00	1.0E+00
4.0E-03	X			2.0E-03	P					2.38	1	1	Yes	Pentaerythritol tetranitrate (PETN)	78-11-5	1.9E+01	4.3E+02		1.9E+01	4.0E+00	9.6E+01		3.9E+00	
						1.0E+00	P	V		3.39	1	1	Yes	Pentane, n-	109-66-0							2.1E+02	2.1E+02	
														Perchlorates										
				7.0E-04	I						1	1	Yes	~Ammonium Perchlorate	7790-98-9					1.4E+00	3.2E+02		1.4E+00	
				7.0E-04	I						1	1	Yes	~Lithium Perchlorate	7791-03-9					1.4E+00	3.2E+02		1.4E+00	
				7.0E-04	I						1	1	Yes	~Perchlorate and Perchlorate Salts	14797-73-0					1.4E+00	3.2E+02		1.4E+00	1.5E+01(F)
				7.0E-04	I						1	1	Yes	~Potassium Perchlorate	7778-74-7					1.4E+00	1.6E+02		1.4E+00	
				7.0E-04	I						1	1	Yes	~Sodium Perchlorate	7601-89-0					1.4E+00	3.2E+02		1.4E+00	
				2.0E-02	P						1	0	Yes	Perfluorobutane sulfonic acid (PFBS)	375-73-5					4.0E+01			4.0E+01	
				2.0E-02	P						1	0	Yes	Perfluorobutanesulfonate	45187-15-3					4.0E+01			4.0E+01	
				5.0E-02	I					6.5	1	0.6	No	Permethrin	52645-53-1					1.0E+02			1.0E+02	
2.2E-03	C	6.3E-07	C							1.58	1	1	Yes	Phenacetin	62-44-2	3.5E+01	1.1E+03		3.4E+01					
				2.4E-01	O					3.59	1	0.9	Yes	Phenmedipham	13684-63-4					4.8E+02	1.8E+03		3.8E+02	
				3.0E-01	I	2.0E-01	C			1.46	1	1	Yes	Phenol	108-95-2					6.0E+02	1.4E+04		5.8E+02	
				4.0E-03	I					1.52	1	1	Yes	Phenol, 2-(1-methylethoxy)-, methylcarbamate	114-26-1					8.0E+00	3.6E+02		7.8E+00	
				5.0E-04	X					4.15	1	1	Yes	Phenothiazine	92-84-2					1.0E+00	7.6E-01		4.3E-01	
				2.0E-04	X			V		3.28	1	1	Yes	Phenyl Isothiocyanate	103-72-0					4.0E-01	7.6E-01		2.6E-01	
				6.0E-03	I					-0.33	1	1	Yes	Phenylenediamine, m-	108-45-2					1.2E+01	4.8E+03		1.2E+01	
1.2E-01	P			4.0E-03	P					0.15	1	1	Yes	Phenylenediamine, o-	95-54-5	6.5E-01	1.1E+02		6.5E-01	8.0E+00	1.5E+03		8.0E+00	
				1.0E-03	X					-0.3	1	1	Yes	Phenylenediamine, p-	106-50-3					2.0E+00	7.6E+02		2.0E+00	
1.9E-03	H									3.09	1	1	Yes	Phenylphenol, 2-	90-43-7	4.0E+01	1.2E+02		3.0E+01					
				2.0E-04	H					3.56	1	0.9	Yes	Phorate	298-02-2					4.0E-01	1.2E+00		3.0E-01	
						3.0E-04	I	V		-0.71	1	1		Phosgene	75-44-5									
				2.0E-02	I					2.78	1	1	Yes	Phosmet	732-11-6					4.0E+01	5.3E+02		3.7E+01	
														Phosphates, Inorganic										
				4.9E+01	P						1	1	Yes	~Aluminum metaphosphate	13776-88-0					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	0	Yes	~Ammonium polyphosphate	68333-79-9					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	1	Yes	~Calcium pyrophosphate	7790-76-3					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	1	Yes	~Diammonium phosphate	7783-28-0					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	1	Yes	~Dicalcium phosphate	7757-93-9					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	1	Yes	~Dimagnesium phosphate	7782-75-4					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	1	Yes	~Dipotassium phosphate	7758-11-4					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	1	Yes	~Disodium phosphate	7558-79-4					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	1	Yes	~Monoaluminum phosphate	13530-50-2					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	1	Yes	~Monoammonium phosphate	7722-76-1					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	1	Yes	~Monocalcium phosphate	7758-23-8					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	1	Yes	~Monomagnesium phosphate	7757-86-0					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	1	Yes	~Monopotassium phosphate	7778-77-0					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	1	Yes	~Monosodium phosphate	7558-80-7					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	1	Yes	~Polyphosphoric acid	8017-16-1					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	0.9	Yes	~Potassium tripolyphosphate	13845-36-8					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	1	Yes	~Sodium acid pyrophosphate	7758-16-9					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	1	Yes	~Sodium aluminum phosphate (acidic)	7785-88-8					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	0	Yes	~Sodium aluminum phosphate (anhydrous)	10279-59-1					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	0.8	Yes	~Sodium aluminum phosphate (tetrahydrate)	10305-76-7					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	0.9	Yes	~Sodium hexametaphosphate	10124-56-8					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	1	Yes	~Sodium polyphosphate	68915-31-1					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	1	Yes	~Sodium trimetaphosphate	7785-84-4					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	1	Yes	~Sodium tripolyphosphate	7758-29-4					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	1	Yes	~Tetrapotassium phosphate	7320-34-5					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	1	Yes	~Tetrasodium pyrophosphate	7722-88-5					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	0.8	Yes	~Trialuminum sodium tetra decahydrogenoctaorthophosphate (dihydrate)	15136-87-5					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	1	Yes	~Tricalcium phosphate	7758-87-4					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	1	Yes	~Trimagnesium phosphate	7757-87-1					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	1	Yes	~Tripotassium phosphate	7778-53-2					9.7E+04	2.2E+07		9.7E+04	
				4.9E+01	P						1	1	Yes	~Trisodium phosphate	7601-54-9					9.7E+04	2.2E+07		9.7E+04	
				3.0E-04	I	3.0E-04	I	V		-0.27	1	1	Yes	Phosphine	7803-51-2					6.0E-01	1.4E+02	6.3E-02	5.7E-02	
				4.9E+01	P	1.0E-02	I				1	1	Yes	Phosphoric Acid	7664-38-2					9.7E+04	2.2E+07		9.7E+04	
				2.0E-05	I			V		3.08	1	1	Yes	Phosphorus, White	7723-14-0					4.0E-02	9.1E+00		4.0E-02	
														Phthalates										
1.4E-02	I	2.4E-06	C	2.0E-02	I					7.6	1	0.8	No	~Bis(2-ethylhexyl)phthalate	117-81-7	5.6E+00			5.6E+00	4.0E+01			4.0E+01	6.0E+00
1.9E-03	P			2.0E-01	I					4.73	1	0.9	Yes	~Butyl Benzyl Phthalate	85-68-7	4.1E+01	2.7E+01		1.6E+01	4.0E+02	2.9E+02		1.7E+02	
				1.0E+00	I					4.15	1	0.9	Yes	~Butylphthalyl Butylglycolate	85-70-1					2.0E+03	4.1E+03		1.3E+03	
				1.0E-01	I					4.5	1	0.9	Yes	~Dibutyl Phthalate	84-74-2					2.0E+02	1.6E+02		9.0E+01	
				8.0E-01	I					2.42	1	1	Yes	~Diethyl Phthalate	84-66-2					1.6E+03	2.0E+04		1.5E+03	
				1.0E-01	I			V		2.25	1	1	Yes	~Dimethylterephthalate	120-61-6					2.0E+02	2.7E+03		1.9E+02	

TR=1E-06
HQ=0.1

TR=1E-06
THQ=0.1

Key: I = IRIS; P = PPRTV; D = DWSHA; O = OPP; A = ATSDR; C = Cal EPA; X = APPENDIX PPRTV SCREEN (See FAQ #29); H = HEAST; F = See FAQ; E = see user guide Section 2.3.5; W = see user guide Section 2.3.6; L = see user guide on lead; M = mutagen; S = see user guide Section 5; V = volatile; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; n = noncancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; SSL values are based on DAF=1; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide)

Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer CHILD Hazard Index (HI) = 0.1				
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD$_o$ (mg/kg-day)	key	RfC$_i$ (mg/m^3)	key	vol	mutagen	LOGP	GIABS	FA	In EPD?	Analyte	CAS No.	Ingestion SL TR=1E-06 (ug/L)	Dermal SL TR=1E-06 (ug/L)	Inhalation SL TR=1E-06 (ug/L)	Carcinogenic SL TR=1E-06 (ug/L)	Ingestion SL Child THQ=0.1 (ug/L)	Dermal SL Child THQ=0.1 (ug/L)	Inhalation SL Child THQ=0.1 (ug/L)	Noncarcinogenic SL Child THI=0.1 (ug/L)	MCL (ug/L)
				1.0E-02	P					8.1	1	0	No	~Octyl Phthalate, di-N-	117-84-0					2.0E+01			2.0E+01	
				1.0E+00	H					2	1	1	Yes	~Phthalic Acid, P-	100-21-0					2.0E+03	3.3E+04		1.9E+03	
				2.0E+00	I	2.0E-02	C			1.6	1	1	Yes	~Phthalic Anhydride	85-44-9					4.0E+03	1.1E+05		3.9E+03	
				7.0E-02	I					1.9	1	1	Yes	Picloram	1918-02-1					1.4E+02	4.3E+03		1.4E+02	5.0E+02
				1.0E-04	X					0.93	1	1	Yes	Picramic Acid (2-Amino-4,6-dinitrophenol)	96-91-3					2.0E-01	2.1E+01		2.0E-01	
				9.0E-04	X					1.44	1	1	Yes	Picric Acid (2,4,6-Trinitrophenol)	88-89-1					1.8E+00	1.2E+02		1.8E+00	
				6.7E-05	O					4.2	1	0.9	Yes	Pirimiphos, Methyl	29232-93-7					1.3E-01	2.1E-01		8.1E-02	
3.0E+01	C	8.6E-03	C	7.0E-06	H						1	0	No	Polybrominated Biphenyls	59536-65-1	2.6E-03			2.6E-03	1.4E-02			1.4E-02	
														Polychlorinated Biphenyls (PCBs)										
7.0E-02	S	2.0E-05	S	7.0E-05	I			V		5.69	1	0	No	~Aroclor 1016	12674-11-2	1.1E+00		2.8E-01	2.2E-01	1.4E-01			1.4E-01	
2.0E+00	S	5.7E-04	S					V		4.65	1	1	Yes	~Aroclor 1221	11104-28-2	3.9E-02	1.2E-02	9.8E-03	4.7E-03					
2.0E+00	S	5.7E-04	S					V		4.4	1	1	Yes	~Aroclor 1232	11141-16-5	3.9E-02	1.2E-02	9.8E-03	4.7E-03					
2.0E+00	S	5.7E-04	S					V		6.34	1	0.7	No	~Aroclor 1242	53469-21-9	3.9E-02		9.8E-03	7.8E-03					
2.0E+00	S	5.7E-04	S					V		6.2	1	0	No	~Aroclor 1248	12672-29-6	3.9E-02		9.8E-03	7.8E-03					
2.0E+00	S	5.7E-04	S	2.0E-05	I			V		6.5	1	0.5	No	~Aroclor 1254	11097-69-1	3.9E-02		9.8E-03	7.8E-03	4.0E-02			4.0E-02	
2.0E+00	S	5.7E-04	S					V		7.55	1	0	No	~Aroclor 1260	11096-82-5	3.9E-02		9.8E-03	7.8E-03					
				6.0E-04	X			V		6.34	1	0.7	No	~Aroclor 5460	11126-42-4					1.2E+00			1.2E+00	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E	V		8.27	1	0	No	~Heptachlorobiphenyl, 2,3,3',4,4',5,5'- (PCB 189)	39635-31-9	2.0E-02		4.9E-03	4.0E-03	4.7E-02		2.8E-01	4.0E-02	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E	V		7.5	1	0	No	~Hexachlorobiphenyl, 2,3',4,4',5,5'- (PCB 167)	52663-72-6	2.0E-02		4.9E-03	4.0E-03	4.7E-02		2.8E-01	4.0E-02	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E	V		7.6	1	0	No	~Hexachlorobiphenyl, 2,3,3',4,4',5'- (PCB 157)	69782-90-7	2.0E-02		4.9E-03	4.0E-03	4.7E-02		2.8E-01	4.0E-02	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E	V		7.6	1	0	No	~Hexachlorobiphenyl, 2,3,3',4,4',5- (PCB 156)	38380-08-4	2.0E-02		4.9E-03	4.0E-03	4.7E-02		2.8E-01	4.0E-02	
3.9E+03	E	1.1E+00	E	2.3E-08	E	1.3E-06	E	V		7.41	1	0.1	No	~Hexachlorobiphenyl, 3,3',4,4',5,5'- (PCB 169)	32774-16-6	2.0E-05		4.9E-06	4.0E-06	4.7E-05		2.8E-04	4.0E-05	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E	V		6.98	1	0.4	No	~Pentachlorobiphenyl, 2',3,4,4',5- (PCB 123)	65510-44-3	2.0E-02		4.9E-03	4.0E-03	4.7E-02		2.8E-01	4.0E-02	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E	V		7.12	1	0.3	No	~Pentachlorobiphenyl, 2,3',4,4',5- (PCB 118)	31508-00-6	2.0E-02		4.9E-03	4.0E-03	4.7E-02		2.8E-01	4.0E-02	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E	V		6.79	1	0.5	No	~Pentachlorobiphenyl, 2,3,3',4,4'- (PCB 105)	32598-14-4	2.0E-02		4.9E-03	4.0E-03	4.7E-02		2.8E-01	4.0E-02	
3.9E+00	E	1.1E-03	E	2.3E-05	E	1.3E-03	E	V		6.98	1	0.4	No	~Pentachlorobiphenyl, 2,3,4,4',5- (PCB 114)	74472-37-0	2.0E-02		4.9E-03	4.0E-03	4.7E-02		2.8E-01	4.0E-02	
1.3E+04	E	3.8E+00	E	7.0E-09	E	4.0E-07	E	V		6.98	1	0.4	No	~Pentachlorobiphenyl, 3,3',4,4',5- (PCB 126)	57465-28-8	6.0E-06		1.5E-06	1.2E-06	1.4E-05		8.3E-05	1.2E-05	
2.0E+00	I	5.7E-04	I					V		7.1	1	0.7		~Polychlorinated Biphenyls (high risk)	1336-36-3									5.0E-01
4.0E-01	I	1.0E-04	I					V		7.1	1	0.7	No	~Polychlorinated Biphenyls (low risk)	1336-36-3	1.9E-01		5.6E-02	4.4E-02					5.0E-01
7.0E-02	I	2.0E-05	I					V		7.1	1	0.7		~Polychlorinated Biphenyls (lowest risk)	1336-36-3									5.0E-01
1.3E+01	E	3.8E-03	E	7.0E-06	E	4.0E-04	E			6.63	1	0.6	No	~Tetrachlorobiphenyl, 3,3',4,4'- (PCB 77)	32598-13-3	6.0E-03			6.0E-03	1.4E-02			1.4E-02	
3.9E+01	E	1.1E-02	E	2.3E-06	E	1.3E-04	E	V		6.34	1	0.7	No	~Tetrachlorobiphenyl, 3,4,4',5- (PCB 81)	70362-50-4	2.0E-03		4.9E-04	4.0E-04	4.7E-03		2.8E-02	4.0E-03	
						6.0E-04	I			10.46	1	0	No	Polymeric Methylene Diphenyl Diisocyanate (PMDI)	9016-87-9									
														Polynuclear Aromatic Hydrocarbons (PAHs)										
				6.0E-02	I			V		3.92	1	1	Yes	~Acenaphthene	83-32-9					1.2E+02	9.6E+01		5.3E+01	
				3.0E-01	I			V		4.45	1	1	Yes	~Anthracene	120-12-7					6.0E+02	2.5E+02		1.8E+02	
1.0E-01	E	6.0E-05	E					V	M	5.76	1	1	No	~Benz[a]anthracene	56-55-3	2.5E-01		3.4E-02	3.0E-02					
1.2E+00	C	1.1E-04	C							6.11	1	0.9	No	~Benzo(j)fluoranthene	205-82-3	6.5E-02			6.5E-02					
1.0E+00	I	6.0E-04	I	3.0E-04	I	2.0E-06	I		M	6.13	1	1	No	~Benzo[a]pyrene	50-32-8	2.5E-02			2.5E-02	6.0E-01			6.0E-01	2.0E-01
1.0E-01	E	6.0E-05	E						M	5.78	1	1	No	~Benzo[b]fluoranthene	205-99-2	2.5E-01			2.5E-01					
1.0E-02	E	6.0E-06	E						M	6.11	1	0.9	No	~Benzo[k]fluoranthene	207-08-9	2.5E+00			2.5E+00					
				8.0E-02	I			V		3.9	1	1	Yes	~Chloronaphthalene, Beta-	91-58-7					1.6E+02	1.4E+02		7.5E+01	
1.0E-03	E	6.0E-07	E						M	5.81	1	1	No	~Chrysene	218-01-9	2.5E+01			2.5E+01					
1.0E+00	E	6.0E-04	E						M	6.75	1	0.6	No	~Dibenz[a,h]anthracene	53-70-3	2.5E-02			2.5E-02					
1.2E+01	C	1.1E-03	C							7.71	1	0.3	No	~Dibenzo(a,e)pyrene	192-65-4	6.5E-03			6.5E-03					
2.5E+02	C	7.1E-02	C						M	5.8	1	0.9	No	~Dimethylbenz(a)anthracene, 7,12-	57-97-6	1.0E-04			1.0E-04					
				4.0E-02	I					5.16	1	1	No	~Fluoranthene	206-44-0					8.0E+01			8.0E+01	
				4.0E-02	I			V		4.18	1	1	Yes	~Fluorene	86-73-7					8.0E+01	4.6E+01		2.9E+01	
1.0E-01	E	6.0E-05	E						M	6.7	1	0.6	No	~Indeno[1,2,3-cd]pyrene	193-39-5	2.5E-01			2.5E-01					
2.9E-02	P			7.0E-02	A			V		3.87	1	1	Yes	~Methylnaphthalene, 1-	90-12-0	2.7E+00	2.0E+00		1.1E+00	1.4E+02	1.1E+02		6.2E+01	
				4.0E-03	I			V		3.86	1	1	Yes	~Methylnaphthalene, 2-	91-57-6					8.0E+00	6.5E+00		3.6E+00	
		3.4E-05	C	2.0E-02	I	3.0E-03	I	V		3.3	1	1	Yes	~Naphthalene	91-20-3			1.7E-01	1.7E-01	4.0E+01	7.0E+01	6.3E-01	6.1E-01	
1.2E+00	C	1.1E-04	C							4.75	1	0.9	Yes	~Nitropyrene, 4-	57835-92-4	6.5E-02	2.7E-02		1.9E-02					
				3.0E-02	I			V		4.88	1	1	Yes	~Pyrene	129-00-0					6.0E+01	1.5E+01		1.2E+01	
				2.0E-02	P						1	0	Yes	Potassium Perfluorobutane Sulfonate	29420-49-3					4.0E+01			4.0E+01	
1.5E-01	I			9.0E-03	I					4.1	1	0.9	Yes	Prochloraz	67747-09-5	5.2E-01	1.4E+00		3.8E-01	1.8E+01	5.1E+01		1.3E+01	
				6.0E-03	H			V		5.58	1	0.8	Yes	Profluralin	26399-36-0					1.2E+01	3.3E+00		2.6E+00	
				1.5E-02	I					2.99	1	1	Yes	Prometon	1610-18-0					3.0E+01	1.6E+02		2.5E+01	
				4.0E-02	O					3.51	1	0.9	Yes	Prometryn	7287-19-6					8.0E+01	2.3E+02		6.0E+01	
				1.3E-02	I					2.18	1	1	Yes	Propachlor	1918-16-7					2.6E+01	4.3E+02		2.5E+01	
				5.0E-03	I					3.07	1	1	Yes	Propanil	709-98-8					1.0E+01	4.4E+01		8.2E+00	
3.3E-02	O			4.0E-02	O					5	1	0.8	Yes	Propargite	2312-35-8	2.4E+00	1.5E+00		9.2E-01	8.0E+01	5.5E+01		3.3E+01	
				2.0E-03	I			V		-0.38	1	1	Yes	Propargyl Alcohol	107-19-7					4.0E+00	1.2E+03		4.0E+00	
				2.0E-02	I					2.93	1	1	Yes	Propazine	139-40-2					4.0E+01	2.4E+02		3.4E+01	
				2.0E-02	I					2.6	1	1	Yes	Propham	122-42-9					4.0E+01	2.8E+02		3.5E+01	
				1.0E-01	O					3.72	1	0.9	Yes	Propiconazole	60207-90-1					2.0E+02	8.2E+02		1.6E+02	
						8.0E-03	I	V		0.59	1	1	Yes	Propionaldehyde	123-38-6							1.7E+00	1.7E+00	

Key: I = IRIS; P = PPRTV; D = DWSHA; O = OPP; A = ATSDR; C = Cal EPA; X = APPENDIX PPRTV SCREEN (See FAQ #29); H = HEAST; F = See FAQ; E = see user guide Section 2.3.5; W = see user guide Section 2.3.6; L = see user guide on lead; M = mutagen; S = see user guide Section 5; V = volatile; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; n = noncancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; SSL values are based on DAF=1; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide)

Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer CHILD Hazard Index (HI) = 0.1				
SFO $(mg/kg\text{-}day)^{-1}$	key	IUR $(ug/m^3)^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	vol	mutagen	LOGP	GIABS	FA	In EPD?	Analyte	CAS No.	Ingestion SL TR=1E-06 (ug/L)	Dermal SL TR=1E-06 (ug/L)	Inhalation SL TR=1E-06 (ug/L)	Carcinogenic SL TR=1E-06 (ug/L)	Ingestion SL Child THQ=0.1 (ug/L)	Dermal SL Child THQ=0.1 (ug/L)	Inhalation SL Child THQ=0.1 (ug/L)	Noncarcinogenic SL Child THI=0.1 (ug/L)	MCL (ug/L)
				1.0E-01	X	1.0E+00	X	V		3.69	1	1	Yes	Propyl benzene	103-65-1					2.0E+02	1.8E+02	2.1E+02	6.6E+01	
						3.0E+00	C	V		1.77	1	1	Yes	Propylene	115-07-1							6.3E+02	6.3E+02	
				2.0E+01	P					-0.92	1	1	Yes	Propylene Glycol	57-55-6					4.0E+04	3.2E+07		4.0E+04	
						2.7E-04	A			1.83	1	1	Yes	Propylene Glycol Dinitrate	6423-43-4									
				7.0E-01	H	2.0E+00	I	V		-0.49	1	1	Yes	Propylene Glycol Monomethyl Ether	107-98-2					1.4E+03	3.9E+05	4.2E+02	3.2E+02	
2.4E-01	I	3.7E-06	I			3.0E-02	I	V		0.03	1	1	Yes	Propylene Oxide	75-56-9	3.2E-01	4.7E+01	1.5E+00	2.7E-01			6.3E+00	6.3E+00	
				7.5E-02	I					3.43	1	0.9	Yes	Propyzamide	23950-58-5					1.5E+02	5.5E+02		1.2E+02	
				1.0E-03	I			V		0.65	1	1	Yes	Pyridine	110-86-1					2.0E+00	1.5E+02		2.0E+00	
				5.0E-04	I					4.44	1	0.9	Yes	Quinalphos	13593-03-8					1.0E+00	1.0E+00		5.1E-01	
3.0E+00	I									2.03	1	1	Yes	Quinoline	91-22-5	2.6E-02	2.9E-01		2.4E-02					
				9.0E-03	I					4.28	1	0.9	Yes	Quizalofop-ethyl	76578-14-8					1.8E+01	3.8E+01		1.2E+01	
						3.0E-02	A				1	0	Yes	Refractory Ceramic Fibers	E715557									
				3.0E-02	I					6.14	1	0.7	Yes	Resmethrin	10453-86-8					6.0E+01	7.6E+00		6.7E+00	
				5.0E-02	H			V		4.88	1	0.8	Yes	Ronnel	299-84-3					1.0E+02	6.8E+01		4.1E+01	
				4.0E-03	I					4.1	1	0.9	Yes	Rotenone	83-79-4					8.0E+00	2.6E+01		6.1E+00	
2.2E-01	C	6.3E-05	C						M	3.45	1	1	Yes	Safrole	94-59-7	1.1E-01	6.0E-01		9.6E-02					
				5.0E-03	I						1	1	Yes	Selenious Acid	7783-00-8					1.0E+01	2.3E+03		1.0E+01	
				5.0E-03	I	2.0E-02	C				1	1	Yes	Selenium	7782-49-2					1.0E+01	2.3E+03		1.0E+01	5.0E+01
				5.0E-03	C	2.0E-02	C				1	1	Yes	Selenium Sulfide	7446-34-6					1.0E+01	2.3E+03		1.0E+01	
				1.4E-01	O					4.38	1	0.9	Yes	Sethoxydim	74051-80-2					2.8E+02	3.8E+02		1.6E+02	
						3.0E-03	C				1	1	Yes	Silica (crystalline, respirable)	7631-86-9									
				5.0E-03	I						0.04	1	Yes	Silver	7440-22-4					1.0E+01	1.5E+02		9.4E+00	
1.2E-01	H			5.0E-03	I					2.18	1	1	Yes	Simazine	122-34-9	6.5E-01	9.3E+00		6.1E-01	1.0E+01	1.6E+02		9.4E+00	4.0E+00
				1.3E-02	I					0.37	1	1	Yes	Sodium Acifluorfen	62476-59-9					2.6E+01	2.1E+04		2.6E+01	
				4.0E-03	I						1	1	Yes	Sodium Azide	26628-22-8					8.0E+00	1.8E+03		8.0E+00	
2.7E-01	H			3.0E-02	I					-1.43	1	1	Yes	Sodium Diethyldithiocarbamate	148-18-5	2.9E-01	8.5E+02		2.9E-01	6.0E+01	1.9E+05		6.0E+01	
				5.0E-02	A	1.3E-02	C				1	1	Yes	Sodium Fluoride	7681-49-4					1.0E+02	2.3E+04		1.0E+02	
				2.0E-05	I					-3.78	1	1	No	Sodium Fluoroacetate	62-74-8					4.0E-02			4.0E-02	
				1.0E-03	H						1	1	Yes	Sodium Metavanadate	13718-26-8					2.0E+00	4.6E+02		2.0E+00	
				8.0E-04	P						1	1	Yes	Sodium Tungstate	13472-45-2					1.6E+00	3.6E+02		1.6E+00	
				8.0E-04	P						1	1	Yes	Sodium Tungstate Dihydrate	10213-10-2					1.6E+00	3.6E+02		1.6E+00	
2.4E-02	H			3.0E-02	I					3.53	1	0.9	Yes	Stirofos (Tetrachlorovinphos)	961-11-5	3.2E+00	1.9E+01		2.8E+00	6.0E+01	3.8E+02		5.2E+01	
				6.0E-01	I						1	1	Yes	Strontium, Stable	7440-24-6					1.2E+03	2.7E+05		1.2E+03	
				3.0E-04	I					1.93	1	1	Yes	Strychnine	57-24-9					6.0E-01	3.2E+01		5.9E-01	
				2.0E-01	I	1.0E+00	I	V		2.95	1	1	Yes	Styrene	100-42-5					4.0E+02	1.0E+03	2.1E+02	1.2E+02	1.0E+02
				3.0E-03	P					3.1	1	1	Yes	Styrene-Acrylonitrile (SAN) Trimer						6.0E+00	2.4E+01		4.8E+00	
				1.0E-03	P	2.0E-03	X			-0.77	1	1	Yes	Sulfolane	126-33-0					2.0E+00	1.7E+03		2.0E+00	
				8.0E-04	P					3.9	1	0.9	Yes	Sulfonylbis(4-chlorobenzene), 1,1'-	80-07-9					1.6E+00	3.5E+00		1.1E+00	
						1.0E-03	C	V			1	1	Yes	Sulfur Trioxide	7446-11-9							2.1E-01	2.1E-01	
						1.0E-03	C				1	1	Yes	Sulfuric Acid	7664-93-9									
2.5E-02	I	7.1E-06	I	5.0E-02	H					4.82	1	0.8	Yes	Sulfurous acid, 2-chloroethyl 2-[4-(1,1-dimethylethyl)phenoxy]-1-methylethyl ester	140-57-8	3.1E+00	2.3E+00		1.3E+00	1.0E+02	8.2E+01		4.5E+01	
				3.0E-02	H					3.3	1	0.9	Yes	TCMTB	21564-17-0					6.0E+01	2.4E+02		4.8E+01	
				7.0E-02	I					1.79	1	1	Yes	Tebuthiuron	34014-18-1					1.4E+02	4.7E+03		1.4E+02	
				2.0E-02	H					5.96	1	0.7	No	Temephos	3383-96-8					4.0E+01			4.0E+01	
				1.3E-02	I					1.89	1	1	Yes	Terbacil	5902-51-2					2.6E+01	7.0E+02		2.5E+01	
				2.5E-05	H			V		4.48	1	0.9	Yes	Terbufos	13071-79-9					5.0E-02	4.5E-02		2.4E-02	
				1.0E-03	I					3.74	1	0.9	Yes	Terbutryn	886-50-0					2.0E+00	4.1E+00		1.3E+00	
				1.0E-04	I					6.77	1	0.6	No	Tetrabromodiphenyl ether, 2,2',4,4'- (BDE-47)	5436-43-1					2.0E-01			2.0E-01	
				3.0E-04	I			V		4.64	1	1	Yes	Tetrachlorobenzene, 1,2,4,5-	95-94-3					6.0E-01	2.4E-01		1.7E-01	
2.6E-02	I	7.4E-06	I	3.0E-02	I			V		2.93	1	1	Yes	Tetrachloroethane, 1,1,1,2-	630-20-6	3.0E+00	1.1E+01	7.6E-01	5.7E-01	6.0E+01	2.4E+02		4.8E+01	
2.0E-01	I	5.8E-05	C	2.0E-02	I			V		2.39	1	1	Yes	Tetrachloroethane, 1,1,2,2-	79-34-5	3.9E-01	3.3E+00	9.7E-02	7.6E-02	4.0E+01	3.6E+02		3.6E+01	
2.1E-03	I	2.6E-07	I	6.0E-03	I	4.0E-02	I	V		3.4	1	1	Yes	Tetrachloroethylene	127-18-4	3.7E+01	6.5E+01	2.2E+01	1.1E+01	1.2E+01	2.3E+01	8.3E+00	4.1E+00	5.0E+00
				3.0E-02	I					4.45	1	0.9	Yes	Tetrachlorophenol, 2,3,4,6-	58-90-2					6.0E+01	3.9E+01		2.4E+01	
2.0E+01	H							V		4.54	1	0.9	Yes	Tetrachlorotoluene, p- alpha, alpha, alpha-	5216-25-1	3.9E-03	2.0E-03		1.3E-03					
				5.0E-04	I					3.99	1	0.9	Yes	Tetraethyl Dithiopyrophosphate	3689-24-5					1.0E+00	2.4E+00		7.1E-01	
						8.0E+01	I	V		1.68	1	1	Yes	Tetrafluoroethane, 1,1,1,2-	811-97-2							1.7E+04	1.7E+04	
				2.0E-03	P					1.64	1	1	Yes	Tetryl (Trinitrophenylmethylnitramine)	479-45-8					4.0E+00	2.5E+02		3.9E+00	
				2.0E-05	S						1	0.9	Yes	Thallic Oxide	1314-32-5					4.0E-02	9.1E+00		4.0E-02	
				1.0E-05	X						1	1	Yes	Thallium (I) Nitrate	10102-45-1					2.0E-02	4.6E+00		2.0E-02	
				1.0E-05	X						1	1	Yes	Thallium (Soluble Salts)	7440-28-0					2.0E-02	4.6E+00		2.0E-02	2.0E+00
				1.0E-05	X			V		-0.17	1	1	Yes	Thallium Acetate	563-68-8					2.0E-02	1.7E+01		2.0E-02	
				2.0E-05	X			V		-0.86	1	1	Yes	Thallium Carbonate	6533-73-9					4.0E-02	9.3E+03		4.0E-02	
				1.0E-05	X						1	1	Yes	Thallium Chloride	7791-12-0					2.0E-02	4.6E+00		2.0E-02	
				1.0E-05	S						1	1	Yes	Thallium Selenite	12039-52-0					2.0E-02	4.6E+00		2.0E-02	
				2.0E-05	X						1	0.9	Yes	Thallium Sulfate	7446-18-6					4.0E-02	9.1E+00		4.0E-02	
				4.3E-02	O					1.56	1	1	Yes	Thifensulfuron-methyl	79277-27-3					8.6E+01	1.2E+04		8.6E+01	
				1.0E-02	I					3.4	1	0.9	Yes	Thiobencarb	28249-77-6					2.0E+01	7.7E+01		1.6E+01	

TR=1E-06
HQ=0.1

Key: I = IRIS; P = PPRTV; D = DWSHA; O = OPP; A = ATSDR; C = Cal EPA; X = APPENDIX PPRTV SCREEN (See FAQ #29); H = HEAST; F = See FAQ; E = see user guide Section 2.3.5; W = see user guide Section 2.3.6; L = see user guide on lead; M = mutagen; S = see user guide Section 5; V = volatile; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; n = noncancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; SSL values are based on DAF=1; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide)

Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer CHILD Hazard Index (HI) = 0.1				
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD$_o$ (mg/kg-day)	key	RfC$_i$ (mg/m^3)	key	vol	mutagen	LOGP	GIABS	FA	In EPD?	Analyte	CAS No.	Ingestion SL TR=1E-06 (ug/L)	Dermal SL TR=1E-06 (ug/L)	Inhalation SL TR=1E-06 (ug/L)	Carcinogenic SL TR=1E-06 (ug/L)	Ingestion SL Child THQ=0.1 (ug/L)	Dermal SL Child THQ=0.1 (ug/L)	Inhalation SL Child THQ=0.1 (ug/L)	Noncarcinogenic SL Child THI=0.1 (ug/L)	MCL (ug/L)
				7.0E-02	X					-0.63	1	1	Yes	Thiodiglycol	111-48-8					1.4E+02	9.7E+04		1.4E+02	
				3.0E-04	H					2.16	1	1	Yes	Thiofanox	39196-18-4					6.0E-01	4.4E+00		5.3E-01	
1.2E-02	O			2.7E-02	O					1.4	1	1	Yes	Thiophanate, Methyl	23564-05-8	6.7E+00	7.9E+02		6.7E+00	5.4E+01	6.8E+03		5.3E+01	
				1.5E-02	O					1.73	1	1	Yes	Thiram	137-26-8					3.0E+01	1.2E+03		2.9E+01	
				6.0E-01	H						1	1	Yes	Tin	7440-31-5					1.2E+03	2.7E+05		1.2E+03	
						1.0E-04	A	V			1	1	Yes	Titanium Tetrachloride	7550-45-0							2.1E-02	2.1E-02	
				8.0E-02	I	5.0E+00	I	V		2.73	1	1	Yes	Toluene	108-88-3					1.6E+02	5.3E+02	1.0E+03	1.1E+02	1.0E+03
		1.1E-05	C			8.0E-06	C	V		3.74	1	1	Yes	Toluene-2,4-diisocyanate	584-84-9			5.1E-01	5.1E-01			1.7E-03	1.7E-03	
1.8E-01	X			2.0E-04	X					0.16	1	1	Yes	Toluene-2,5-diamine	95-70-5	4.3E-01	8.2E+01		4.3E-01	4.0E-01	8.3E+01		4.0E-01	
		1.1E-05	C			8.0E-06	C	V		3.74	1	1	Yes	Toluene-2,6-diisocyanate	91-08-7			5.1E-01	5.1E-01			1.7E-03	1.7E-03	
				5.0E-03	P					2.27	1	1	Yes	Toluic Acid, p-	99-94-5					1.0E+01	8.9E+01		9.0E+00	
1.6E-02	P	5.1E-05	C							1.32	1	1	Yes	Toluidine, o- (Methylaniline, 2-)	95-53-4	4.9E+00	1.4E+02		4.7E+00					
3.0E-02	P			4.0E-03	X					1.39	1	1	Yes	Toluidine, p-	106-49-0	2.6E+00	6.8E+01		2.5E+00	8.0E+00	2.3E+02		7.7E+00	
				3.0E+00	P			V		6.1	1	1	No	Total Petroleum Hydrocarbons (Aliphatic High)	E1790670					6.0E+03			6.0E+03	
						6.0E-01	P	V		3.9	1	1	Yes	Total Petroleum Hydrocarbons (Aliphatic Low)	E1790666							1.3E+02	1.3E+02	
				1.0E-02	X	1.0E-01	P	V		5.65	1	1	No	Total Petroleum Hydrocarbons (Aliphatic Medium)	E1790668					2.0E+01		2.1E+01	1.0E+01	
				4.0E-02	P					5.16	1	1	No	Total Petroleum Hydrocarbons (Aromatic High)	E1790676					8.0E+01			8.0E+01	
				4.0E-03	P	3.0E-02	P	V		2.13	1	1	Yes	Total Petroleum Hydrocarbons (Aromatic Low)	E1790672					8.0E+00	6.1E+01	6.3E+00	3.3E+00	
				4.0E-03	P	3.0E-03	P	V		3.58	1	1	Yes	Total Petroleum Hydrocarbons (Aromatic Medium)	E1790674					8.0E+00	9.0E+00	6.3E-01	5.5E-01	
1.1E+00	I	3.2E-04	I							5.9	1	0.8	No	Toxaphene	8001-35-2	7.1E-02			7.1E-02					3.0E+00
				7.5E-03	I					7.56	1	0.5	No	Tralomethrin	66841-25-6					1.5E+01			1.5E+01	
				3.0E-04	A			V		4.1	1	0.9	Yes	Tri-n-butyltin	688-73-3					6.0E-01	9.9E-01		3.7E-01	
				8.0E+01	X					0.25	1	1	Yes	Triacetin	102-76-1					1.6E+05	5.3E+07		1.6E+05	
				3.4E-02	O					2.77	1	1	Yes	Triadimefon	43121-43-3					6.8E+01	7.8E+02		6.3E+01	
7.2E-02	O			2.5E-02	O			V		4.6	1	0.9	Yes	Triallate	2303-17-5	1.1E+00	8.3E-01		4.7E-01	5.0E+01	4.2E+01		2.3E+01	
				1.0E-02	I					1.1	1	1	Yes	Triasulfuron	82097-50-5					2.0E+01	6.0E+03		2.0E+01	
				8.0E-03	I					0.78	1	1	Yes	Tribenuron-methyl	101200-48-0					1.6E+01	5.0E+02		1.6E+01	
				5.0E-03	I			V		4.66	1	0.9	Yes	Tribromobenzene, 1,2,4-	615-54-3					1.0E+01	8.1E+00		4.5E+00	
				9.0E-03	X					4.13	1	0.9	Yes	Tribromophenol, 2,4,6-	118-79-6					1.8E+01	3.7E+01		1.2E+01	
9.0E-03	P			1.0E-02	P					4	1	0.9	Yes	Tributyl Phosphate	126-73-8	8.7E+00	1.3E+01		5.2E+00	2.0E+01	3.3E+01		1.2E+01	
				3.0E-04	P						1	0	No	Tributyltin Compounds	E1790678					6.0E-01			6.0E-01	
				3.0E-04	I					4.05	1	1	Yes	Tributyltin Oxide	56-35-9					6.0E-01	9.5E+00		5.7E-01	
				3.0E+01	I	5.0E+00	P	V		3.16	1	1	Yes	Trichloro-1,2,2-trifluoroethane, 1,1,2-	76-13-1					6.0E+04	1.9E+05	1.0E+03	1.0E+03	
7.0E-02	I			2.0E-02	I					1.33	1	1	Yes	Trichloroacetic Acid	76-03-9	1.1E+00	4.6E+01		1.1E+00	4.0E+01	1.8E+03		3.9E+01	6.0E+01
2.9E-02	H									-0.67	1	1	Yes	Trichloroaniline HCl, 2,4,6-	33663-50-2	2.7E+00	3.7E+03		2.7E+00					
7.0E-03	X			3.0E-05	X					3.52	1	1	Yes	Trichloroaniline, 2,4,6-	634-93-5	1.1E+01	2.0E+01		7.1E+00	6.0E-02	1.2E-01		4.0E-02	
				8.0E-04	X			V		4.05	1	1	Yes	Trichlorobenzene, 1,2,3-	87-61-6					1.6E+00	1.3E+00		7.0E-01	
2.9E-02	P			1.0E-02	I	2.0E-03	P	V		4.02	1	1	Yes	Trichlorobenzene, 1,2,4-	120-82-1	2.7E+00	2.0E+00		1.2E+00	2.0E+01	1.6E+01	4.2E-01	4.0E-01	7.0E+01
				2.0E+00	I	5.0E+00	I	V		2.49	1	1	Yes	Trichloroethane, 1,1,1-	71-55-6					4.0E+03	2.5E+04	1.0E+03	8.0E+02	2.0E+02
5.7E-02	I	1.6E-05	I	4.0E-03	I	2.0E-04	X	V		1.89	1	1	Yes	Trichloroethane, 1,1,2-	79-00-5	1.4E+00	2.0E+01	3.5E-01	2.8E-01	8.0E+00	1.3E+02	4.2E-02	4.1E-02	5.0E+00
4.6E-02	I	4.1E-06	I	5.0E-04	I	2.0E-03	I	V	M	2.42	1	1	Yes	Trichloroethylene	79-01-6	1.2E+00	7.4E+00	9.6E-01	4.9E-01	1.0E+00	6.9E+00	4.2E-01	2.8E-01	5.0E+00
				3.0E-01	I			V		2.53	1	1	Yes	Trichlorofluoromethane	75-69-4					6.0E+02	3.6E+03		5.2E+02	
				1.0E-01	I					3.72	1	1	Yes	Trichlorophenol, 2,4,5-	95-95-4					2.0E+02	2.9E+02		1.2E+02	
1.1E-02	I	3.1E-06	I	1.0E-03	P					3.69	1	1	Yes	Trichlorophenol, 2,4,6-	88-06-2	7.1E+00	9.8E+00		4.1E+00	2.0E+00	3.0E+00		1.2E+00	
				1.0E-02	I					3.31	1	0.9	Yes	Trichlorophenoxyacetic Acid, 2,4,5-	93-76-5					2.0E+01	8.7E+01		1.6E+01	
				8.0E-03	I					3.8	1	0.9	Yes	Trichlorophenoxypropionic acid, -2,4,5	93-72-1					1.6E+01	3.6E+01		1.1E+01	5.0E+01
				5.0E-03	I			V		2.43	1	1	Yes	Trichloropropane, 1,1,2-	598-77-6					1.0E+01	7.5E+01		8.8E+00	
3.0E+01	I			4.0E-03	I	3.0E-04	I	V	M	2.27	1	1	Yes	Trichloropropane, 1,2,3-	96-18-4	8.4E-04	7.3E-03		7.5E-04	8.0E+00	7.7E+01	6.3E-02	6.2E-02	
				3.0E-03	X	3.0E-04	P	V		2.78	1	1	Yes	Trichloropropene, 1,2,3-	96-19-5					6.0E+00	2.6E+01	6.3E-02	6.2E-02	
				2.0E-02	A					5.11	1	0.8	Yes	Tricresyl Phosphate (TCP)	1330-78-5					4.0E+01	2.6E+01		1.6E+01	
				3.0E-03	I					5.18	1	0.8	Yes	Tridiphane	58138-08-2					6.0E+00	2.6E+00		1.8E+00	
						7.0E-03	I	V		1.45	1	1	Yes	Triethylamine	121-44-8							1.5E+00	1.5E+00	
				2.0E+00	P					-1.75	1	1	Yes	Triethylene Glycol	112-27-6					4.0E+03	1.8E+07		4.0E+03	
						2.0E+01	P	V		1.74	1	1	Yes	Trifluoroethane, 1,1,1-	420-46-2							4.2E+03	4.2E+03	
7.7E-03	I			7.5E-03	I			V		5.34	1	0.8	Yes	Trifluralin	1582-09-8	1.0E+01	3.4E+00		2.6E+00	1.5E+01	5.5E+00		4.0E+00	
2.0E-02	P			1.0E-02	P					-0.65	1	1	Yes	Trimethyl Phosphate	512-56-1	3.9E+00	2.8E+03		3.9E+00	2.0E+01	1.6E+04		2.0E+01	
				1.0E-02	I	6.0E-02	I	V		3.66	1	1	Yes	Trimethylbenzene, 1,2,3-	526-73-8					2.0E+01	1.9E+01	1.3E+01	5.5E+00	
				1.0E-02	I	6.0E-02	I	V		3.63	1	1	Yes	Trimethylbenzene, 1,2,4-	95-63-6					2.0E+01	2.0E+01	1.3E+01	5.6E+00	
				1.0E-02	I	6.0E-02	I	V		3.42	1	1	Yes	Trimethylbenzene, 1,3,5-	108-67-8					2.0E+01	2.8E+01	1.3E+01	6.0E+00	
				1.0E-02	X			V		4.08	1	1	Yes	Trimethylpentene, 2,4,4-	25167-70-8					2.0E+01	9.6E+00		6.5E+00	
				3.0E-02	I					1.18	1	1	Yes	Trinitrobenzene, 1,3,5-	99-35-4					6.0E+01	4.7E+03		5.9E+01	
3.0E-02	I			5.0E-04	I					1.6	1	1	Yes	Trinitrotoluene, 2,4,6-	118-96-7	2.6E+00	1.1E+02		2.5E+00	1.0E+00	4.5E+01		9.8E-01	
				2.0E-02	P					2.83	1	1	Yes	Triphenylphosphine Oxide	791-28-6					4.0E+01	3.8E+02		3.6E+01	
				2.0E-02	A					3.65	1	0.9	Yes	Tris(1,3-Dichloro-2-propyl) Phosphate	13674-87-8					4.0E+01	3.2E+02		3.6E+01	
				1.0E-02	X					2.59	1	1	Yes	Tris(1-chloro-2-propyl)phosphate	13674-84-5					2.0E+01	3.8E+02		1.9E+01	
2.3E+00	C	6.6E-04	C					V		4.29	1	1	No	Tris(2,3-dibromopropyl)phosphate	126-72-7	3.4E-02		8.5E-03	6.8E-03					
2.0E-02	P			7.0E-03	P					1.44	1	1	Yes	Tris(2-chloroethyl)phosphate	115-96-8	3.9E+00	3.0E+02		3.8E+00	1.4E+01	1.2E+03		1.4E+01	

TR=1E-06
THQ=0.1

Key: I = IRIS; P = PPRTV; D = DWSHA; O = OPP; A = ATSDR; C = Cal EPA; X = APPENDIX PPRTV SCREEN (See FAQ #29); H = HEAST; F = See FAQ; E = see user guide Section 2.3.5; W = see user guide Section 2.3.6; L = see user guide on lead; M = mutagen; S = see user guide Section 5; V = volatile; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; n = noncancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; SSL values are based on DAF=1; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide)

Toxicity and Chemical-specific Information														Contaminant		Carcinogenic Target Risk (TR) = 1E-06				Noncancer CHILD Hazard Index (HI) = 0.1				
SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD$_o$ (mg/kg-day)	key	RfC$_i$ (mg/m^3)	key	vol	muta-gen	LOGP	GIABS	FA	In EPD?	Analyte	CAS No.	Ingestion SL TR=1E-06 (ug/L)	Dermal SL TR=1E-06 (ug/L)	Inhalation SL TR=1E-06 (ug/L)	Carcinogenic SL TR=1E-06 (ug/L)	Ingestion SL Child THQ=0.1 (ug/L)	Dermal SL Child THQ=0.1 (ug/L)	Inhalation SL Child THQ=0.1 (ug/L)	Noncarcinogenic SL Child THI=0.1 (ug/L)	MCL (ug/L)
3.2E-03	P			1.0E-01	P					9.49	1	0	No	Tris(2-ethylhexyl)phosphate	78-42-2	2.4E+01			2.4E+01	2.0E+02			2.0E+02	
				8.0E-04	P						1	1	Yes	Tungsten	7440-33-7					1.6E+00	3.6E+02		1.6E+00	
				2.0E-04	A	4.0E-05	A				1	1	Yes	Uranium (Soluble Salts)	E715565					4.0E-01	9.1E+01		4.0E-01	3.0E+01
1.0E+00	C	2.9E-04	C						M	-0.15	1	1	Yes	Urethane	51-79-6	2.5E-02	6.1E+00		2.5E-02					
		8.3E-03	P	9.0E-03	I	7.0E-06	P				0.026	1	Yes	Vanadium Pentoxide	1314-62-1					1.8E+01	1.1E+02		1.5E+01	
				5.0E-03	S	1.0E-04	A				0.026	1	Yes	Vanadium and Compounds	7440-62-2					1.0E+01	6.0E+01		8.6E+00	
				1.0E-03	I			V		3.84	1	1	Yes	Vernolate	1929-77-7					2.0E+00	2.5E+00		1.1E+00	
				1.2E-03	O					3.1	1	0.9	Yes	Vinclozolin	50471-44-8					2.4E+00	1.8E+01		2.1E+00	
				1.0E+00	H	2.0E-01	I	V		0.73	1	1	Yes	Vinyl Acetate	108-05-4					2.0E+03	1.4E+05	4.2E+01	4.1E+01	
		3.2E-05	H			3.0E-03	I	V		1.57	1	1	Yes	Vinyl Bromide	593-60-2			1.8E-01	1.8E-01			6.3E-01	6.3E-01	
7.2E-01	I	4.4E-06	I	3.0E-03	I	1.0E-01	I	V	M	1.38	1	1	Yes	Vinyl Chloride	75-01-4	2.1E-02	2.8E-01	3.4E-01	1.9E-02	6.0E+00	8.9E+01	2.1E+01	4.4E+00	2.0E+00
				3.0E-04	I					2.7	1	1	Yes	Warfarin	81-81-2					6.0E-01	8.4E+00		5.6E-01	
				2.0E-01	S	1.0E-01	S	V		3.15	1	1	Yes	Xylene, P-	106-42-3					4.0E+02	7.6E+02	2.1E+01	1.9E+01	
				2.0E-01	S	1.0E-01	S	V		3.2	1	1	Yes	Xylene, m-	108-38-3					4.0E+02	7.1E+02	2.1E+01	1.9E+01	
				2.0E-01	S	1.0E-01	S	V		3.12	1	1	Yes	Xylene, o-	95-47-6					4.0E+02	8.0E+02	2.1E+01	1.9E+01	
				2.0E-01	I	1.0E-01	I	V		3.16	1	1	Yes	Xylenes	1330-20-7					4.0E+02	7.5E+02	2.1E+01	1.9E+01	1.0E+04
				3.0E-04	I						1	1	Yes	Zinc Phosphide	1314-84-7					6.0E-01	2.3E+02		6.0E-01	
				3.0E-01	I						1	1	Yes	Zinc and Compounds	7440-66-6					6.0E+02	2.3E+05		6.0E+02	
				5.0E-02	I					1.3	1	1	Yes	Zineb	12122-67-7					1.0E+02	9.7E+03		9.9E+01	
				8.0E-05	X						1	1	Yes	Zirconium	7440-67-7					1.6E-01	3.6E+01		1.6E-01	

TR=1E-06
THQ=0.1

Appendix D

Groundwater Sampling Schedules (2019-2020)

April 2019
Groundwater Sampling Schedule

Well Name	Well ID	Plume Area	Nitrates	Sulfate	VOC	DNT	Well Type	Sample Frequency
WE-ZE512	437	Central			1	1	Residential Well	Quarterly
Purcell-D	163	DBG			1	1	Residential Well	Quarterly
ELN-8203A	210	DBG		1	1	1	Monitoring Well	Semi-Annual
ELN-8203B	211	DBG		1	1	1	Monitoring Well	Semi-Annual
ELN-8203C	212	DBG		1	1	1	Monitoring Well	Semi-Annual
ELM-8901	216	DBG		1	1	1	Monitoring Well	Semi-Annual
ELM-8907	220	DBG		1	1	1	Monitoring Well	Semi-Annual
ELM-8908	221	DBG		1	1	1	Monitoring Well	Semi-Annual
ELM-8909	222	DBG		1	1	1	Monitoring Well	Semi-Annual
ELN-8902B	224	DBG		1	1	1	Monitoring Well	Semi-Annual
ELN-9107A	227	DBG		1	1	1	Monitoring Well	Semi-Annual
ELN-9107B	228	DBG		1	1	1	Monitoring Well	Semi-Annual
ELN-9402AR	231	DBG		1	1	1	Monitoring Well	Semi-Annual
ELM-9501	234	DBG			1	1	Monitoring Well	Semi-Annual
S1134R	236	DBG		1	1	1	Monitoring Well	Semi-Annual
DBM-8201	301	DBG		1	1	1	Monitoring Well	Semi-Annual
DBM-8202	302	DBG		1	1	1	Monitoring Well	Semi-Annual
DBM-8903	306	DBG			1	1	Monitoring Well	Semi-Annual
DBN-9501A	314	DBG			1	1	Monitoring Well	Semi-Annual
DBN-9501B	315	DBG			1	1	Monitoring Well	Semi-Annual
DBN-9501C	316	DBG			1	1	Monitoring Well	Semi-Annual
DBN-9501E	317	DBG			1	1	Monitoring Well	Semi-Annual
ELN-0801B	455	DBG			1	1	Monitoring Well	Semi-Annual
ELN-0801C	456	DBG			1	1	Monitoring Well	Semi-Annual
ELN-0801E	457	DBG			1	1	Monitoring Well	Semi-Annual
ELN-1001B	460	DBG			1	1	Monitoring Well	Semi-Annual
ELN-1001C	461	DBG			1	1	Monitoring Well	Semi-Annual
ELN-1001E	462	DBG			1	1	Monitoring Well	Semi-Annual
ELN-1002A	463	DBG			1	1	Monitoring Well	Semi-Annual
ELN-1002B	464	DBG			1	1	Monitoring Well	Semi-Annual
ELN-1002C	465	DBG			1	1	Monitoring Well	Semi-Annual
ELN-1002E	466	DBG			1	1	Monitoring Well	Semi-Annual
ELN-1003A	467	DBG			1	1	Monitoring Well	Quarterly
ELN-1003B	468	DBG			1	1	Monitoring Well	Quarterly
ELN-1003C	469	DBG			1	1	Monitoring Well	Quarterly
ELN-1003E	470	DBG			1	1	Monitoring Well	Quarterly
DBN-1001B	472	DBG			1	1	Monitoring Well	Semi-Annual
DBN-1001C	473	DBG			1	1	Monitoring Well	Semi-Annual
DBN-1001E	474	DBG			1	1	Monitoring Well	Semi-Annual
DBN-1002C	476	DBG		1	1	1	Monitoring Well	Semi-Annual
DBN-1002E	477	DBG		1	1	1	Monitoring Well	Semi-Annual
S1121	755	DBG			1	1	Monitoring Well	Semi-Annual
ELN-1502A	533	DBG			1	1	Monitoring Well	Semi-Annual
ELN-1502C	534	DBG			1	1	Monitoring Well	Semi-Annual
ELN-1503A	535	DBG			1	1	Monitoring Well	Semi-Annual
ELN-1503C	536	DBG			1	1	Monitoring Well	Semi-Annual
ELN-1504B	537	DBG			1	1	Monitoring Well	Quarterly
RIM-0705	442	NC Area				1	Monitoring Well	Semi-Annual
RIM-1002	478	NC Area				1	Monitoring Well	Semi-Annual
RIN-1001A	480	NC Area				1	Monitoring Well	Semi-Annual
S1125	504	NC Area				1	Monitoring Well	Semi-Annual
PBM-0001	367	PBG	1		1	1	Monitoring Well	Semi-Annual
PBM-0002	368	PBG	1		1	1	Monitoring Well	Semi-Annual

April 2019
Groundwater Sampling Schedule

Well Name	Well ID	Plume Area	Nitrates	Sulfate	VOC	DNT	Well Type	Sample Frequency
PBM-0006	372	PBG	1		1	1	Monitoring Well	Semi-Annual
PBM-0008	374	PBG			1	1	Monitoring Well	Semi-Annual
PBN-9101C	561	PBG			1	1	Monitoring Well	Semi-Annual
SWN-9103B	571	PBG			1	1	Monitoring Well	Semi-Annual
SWN-9103C	572	PBG			1	1	Monitoring Well	Semi-Annual
SWN-9103D	573	PBG			1	1	Monitoring Well	Semi-Annual
SWN-9103E	574	PBG			1	1	Monitoring Well	Semi-Annual
SWN-9104C	575	PBG			1	1	Monitoring Well	Semi-Annual
SWN-9104D	576	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1001C	595	PBG			1	1	Monitoring Well	Semi-Annual
PBN-8202A	613	PBG			1	1	Monitoring Well	Semi-Annual
PBN-8202B	614	PBG			1	1	Monitoring Well	Semi-Annual
PBN-8202C	615	PBG			1	1	Monitoring Well	Semi-Annual
PBN-8205A	622	PBG			1	1	Monitoring Well	Semi-Annual
PBN-8205B	623	PBG			1	1	Monitoring Well	Semi-Annual
PBN-8205C	624	PBG			1	1	Monitoring Well	Semi-Annual
PBN-8502A	632	PBG			1	1	Monitoring Well	Semi-Annual
PBN-8503A	633	PBG			1	1	Monitoring Well	Semi-Annual
PBN-8902C	645	PBG			1	1	Monitoring Well	Semi-Annual
PBN-8903B	646	PBG			1	1	Monitoring Well	Semi-Annual
PBN-8903C	647	PBG			1	1	Monitoring Well	Semi-Annual
PBN-8912A	654	PBG			1	1	Monitoring Well	Semi-Annual
PBN-8912B	655	PBG			1	1	Monitoring Well	Semi-Annual
PBN-9112C	665	PBG			1	1	Monitoring Well	Semi-Annual
PBN-9112D	666	PBG			1	1	Monitoring Well	Semi-Annual
PBN-9301B	668	PBG			1	1	Monitoring Well	Semi-Annual
PBN-9301C	669	PBG			1	1	Monitoring Well	Semi-Annual
PBN-9303B	673	PBG			1	1	Monitoring Well	Semi-Annual
PBN-9303C	674	PBG			1	1	Monitoring Well	Semi-Annual
PBN-9303D	675	PBG			1	1	Monitoring Well	Semi-Annual
PBN-9304D	687	PBG			1	1	Monitoring Well	Semi-Annual
PBN-9902D	691	PBG			1	1	Monitoring Well	Semi-Annual
PBN-9903A	692	PBG			1	1	Monitoring Well	Semi-Annual
PBN-9903B	693	PBG			1	1	Monitoring Well	Semi-Annual
PBN-9903C	694	PBG			1	1	Monitoring Well	Semi-Annual
PBN-9903D	695	PBG			1	1	Monitoring Well	Semi-Annual
S1147	709	PBG			1	1	Monitoring Well	Semi-Annual
S1148	710	PBG			1	1	Monitoring Well	Semi-Annual
SPN-8903B	718	PBG			1	1	Monitoring Well	Semi-Annual
SPN-8903C	719	PBG			1	1	Monitoring Well	Semi-Annual
SPN-8904B	720	PBG			1	1	Monitoring Well	Semi-Annual
SPN-8904C	721	PBG			1	1	Monitoring Well	Semi-Annual
SPN-9103D	725	PBG			1	1	Monitoring Well	Semi-Annual
SPN-9104D	726	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1302A	770	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1302B	771	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1302C	772	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1302D	773	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1303A	774	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1303B	775	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1303C	776	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1303D	777	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1304A	778	PBG			1	1	Monitoring Well	Semi-Annual

Well Name	Well ID	Plume Area	Nitrates	Sulfate	VOC	DNT	Well Type	Sample Frequency
PBN-1304B	779	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1304C	780	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1304D	781	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1401A	782	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1401B	783	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1401C	784	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1404B	791	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1404C	792	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1404D	793	PBG			1	1	Monitoring Well	Semi-Annual
PBN-8902BR	795	PBG			1	1	Monitoring Well	Semi-Annual
PBM-9001D	981	PBG			1	1	Monitoring Well	Semi-Annual
Totals			3	16	113	117		

June 2019
Groundwater Sampling Schedule

Well Name	Well ID	Plume Area	VOC	DNT	Well Type	Sample Frequency
Purcell-D	163	DBG	1	1	Residential Well	Quarterly
ELN-1003A	467	DBG		1	Monitoring Well	Quarterly
ELN-1003B	468	DBG		1	Monitoring Well	Quarterly
ELN-1003C	469	DBG		1	Monitoring Well	Quarterly
ELN-1003E	470	DBG		1	Monitoring Well	Quarterly
ELN-1504B	537	DBG		1	Monitoring Well	Quarterly
WE-ZE512	437	Central	1	1	Residential Well	Quarterly
SEN-0501A	580	Central	1	1	Monitoring Well	Semi-Annual
SEN-0501B	581	Central	1	1	Monitoring Well	Semi-Annual
SEN-0501D	582	Central	1	1	Monitoring Well	Semi-Annual
SEN-0502A	583	Central	1	1	Monitoring Well	Semi-Annual
SEN-0502D	584	Central	1	1	Monitoring Well	Semi-Annual
SEN-0503A	585	Central	1	1	Monitoring Well	Semi-Annual
SEN-0503B	586	Central	1	1	Monitoring Well	Semi-Annual
SEN-0503D	587	Central	1	1	Monitoring Well	Semi-Annual
NLN-1001A	331	Central		1	Monitoring Well	Annual
NLN-1001C	332	Central		1	Monitoring Well	Annual
NLN-8203A	258	Central		1	Monitoring Well	Annual
NLN-8203B	259	Central		1	Monitoring Well	Annual
NLN-8203C	260	Central		1	Monitoring Well	Annual
NPM-8901	506	Central		1	Monitoring Well	Annual
RIM-1003	491	Central		1	Monitoring Well	Annual
RIM-1004	494	Central		1	Monitoring Well	Annual
RIN-0701C	443	Central		1	Monitoring Well	Annual
RIN-0702C	444	Central		1	Monitoring Well	Annual
RIN-0703C	445	Central		1	Monitoring Well	Annual
RIN-1002A	492	Central		1	Monitoring Well	Annual
RIN-1002C	493	Central		1	Monitoring Well	Annual
RIN-1003A	495	Central		1	Monitoring Well	Annual
RIN-1004B	498	Central		1	Monitoring Well	Semi-Annual
RIN-1005A	496	Central		1	Monitoring Well	Annual
RIN-1005C	497	Central		1	Monitoring Well	Annual
RPM-8901	507	Central		1	Monitoring Well	Annual
S1111	751	Central		1	Monitoring Well	Annual
RIN-1501B	538	Central		1	Monitoring Well	Annual
RIN-1501C	539	Central		1	Monitoring Well	Annual
RIN-1501D	540	Central		1	Monitoring Well	Annual
RIN-1502B	541	Central		1	Monitoring Well	Annual
RIN-1502C	542	Central		1	Monitoring Well	Annual
RIN-1502D	543	Central		1	Monitoring Well	Annual
Totals			10	40		

Well Name	Well ID	Plume Area	VOC	DNT	Well Type	Sample Frequency
Purcell-D	163	DBG	1	1	Residential Well	Quarterly
Anderson-R	411	DBG	1	1	Residential Well	Annual
Curto	412	DBG	1	1	Residential Well	Annual
Wenger	414	DBG	1	1	Residential Well	Annual
Grosse	415	DBG	1	1	Residential Well	Annual
Gruber-D	417	DBG	1	1	Residential Well	Annual
Hendershot	418	DBG	1	1	Residential Well	Annual
Howery	419	DBG	1	1	Residential Well	Annual
Osterland	422	DBG	1	1	Residential Well	Annual
Melum	423	DBG	1	1	Residential Well	Annual
Raschein	424	DBG	1	1	Residential Well	Annual
Revers	425	DBG	1	1	Residential Well	Annual
Roll	426	DBG	1	1	Residential Well	Annual
Reif	427	DBG	1	1	Residential Well	Annual
Schumann	428	DBG	1	1	Residential Well	Annual
Spear	803	DBG	1	1	Residential Well	Annual
Brey	817	DBG	1	1	Residential Well	Annual
Gibbs	839	DBG	1	1	Residential Well	Annual
Groth	842	DBG	1	1	Residential Well	Annual
Lukens	860	DBG	1	1	Residential Well	Annual
Kopras	874	DBG	1	1	Residential Well	Annual
Nowotarski	891	DBG	1	1	Residential Well	Annual
Olah	904	DBG	1	1	Residential Well	Annual
Purcell-G	916	DBG	1	1	Residential Well	Annual
Zurbachen-A	967	DBG	1	1	Residential Well	Annual
USDA 3	126	Central		1	Residential Well	Annual
USDA 6	128	Central		1	Residential Well	Annual
USDA 1	828	Central		1	Residential Well	Annual
USDA 2	829	Central		1	Residential Well	Annual
WE-TM599	129	Central		1	Residential Well	Annual
WE-RM383	153	Central		1	Residential Well	Annual
WE-RR542	156	Central		1	Residential Well	Annual
WE-QR441	157	Central	1	1	Residential Well	Annual
WE-QN039	158	Central	1	1	Residential Well	Annual
WE-RD430	159	Central		1	Residential Well	Annual
WE-SQ017	164	Central	1	1	Residential Well	Annual
WE-SQ001	165	Central	1	1	Residential Well	Annual
WE-RR598	169	Central		1	Residential Well	Annual
WE-SQ002	170	Central		1	Residential Well	Annual
WE-TF023	174	Central		1	Residential Well	Annual
WE-UK125	431	Central		1	Residential Well	Annual
WE-ZE512	437	Central	1	1	Residential Well	Quarterly
WE-UA297	433	Central		1	Residential Well	Annual
WE-XD828	434	Central		1	Residential Well	Annual
WE-XK342	435	Central		1	Residential Well	Annual
WE-YW972	436	Central	1	1	Residential Well	Annual
Delaney	152	PBG	1	1	Residential Well	Annual
Mittenzwei	800	PBG	1	1	Residential Well	Annual
Judd	862	PBG	1	1	Residential Well	Annual
Krumenauer	875	PBG	1	1	Residential Well	Annual

Well Name	Well ID	Plume Area	VOC	DNT	Well Type	Sample Frequency
PDS-3	911	PBG	1	1	Residential Well	Annual
Ramaker-J	917	PBG	1	1	Residential Well	Annual
Schlender	931	PBG	1	1	Residential Well	Annual
Apel	998	PBG	1	1	Residential Well	Annual
Totals			39	54		

Well Name	Well ID	Plume Area	Nitrates	VOC	DNT	Well Type	Sample Frequency
ELN-8203A	210	DBG			1	Monitoring Well	Semi-Annual
ELN-8203B	211	DBG			1	Monitoring Well	Semi-Annual
ELN-8203C	212	DBG			1	Monitoring Well	Semi-Annual
ELM-8901	216	DBG			1	Monitoring Well	Semi-Annual
ELM-8907	220	DBG			1	Monitoring Well	Semi-Annual
ELM-8908	221	DBG			1	Monitoring Well	Semi-Annual
ELM-8909	222	DBG			1	Monitoring Well	Semi-Annual
ELN-8902B	224	DBG			1	Monitoring Well	Semi-Annual
ELN-9107A	227	DBG			1	Monitoring Well	Semi-Annual
ELN-9107B	228	DBG			1	Monitoring Well	Semi-Annual
ELN-9402AR	231	DBG			1	Monitoring Well	Semi-Annual
ELM-9501	234	DBG			1	Monitoring Well	Semi-Annual
S1134R	236	DBG			1	Monitoring Well	Semi-Annual
DBM-8201	301	DBG			1	Monitoring Well	Semi-Annual
DBM-8202	302	DBG			1	Monitoring Well	Semi-Annual
DBM-8903	306	DBG			1	Monitoring Well	Semi-Annual
DBN-9501A	314	DBG			1	Monitoring Well	Semi-Annual
DBN-9501B	315	DBG			1	Monitoring Well	Semi-Annual
DBN-9501C	316	DBG			1	Monitoring Well	Semi-Annual
DBN-9501E	317	DBG			1	Monitoring Well	Semi-Annual
ELN-0801B	455	DBG			1	Monitoring Well	Semi-Annual
ELN-0801C	456	DBG			1	Monitoring Well	Semi-Annual
ELN-0801E	457	DBG			1	Monitoring Well	Semi-Annual
ELN-1001B	460	DBG			1	Monitoring Well	Semi-Annual
ELN-1001C	461	DBG			1	Monitoring Well	Semi-Annual
ELN-1001E	462	DBG			1	Monitoring Well	Semi-Annual
ELN-1002A	463	DBG			1	Monitoring Well	Semi-Annual
ELN-1002B	464	DBG			1	Monitoring Well	Semi-Annual
ELN-1002C	465	DBG			1	Monitoring Well	Semi-Annual
ELN-1002E	466	DBG			1	Monitoring Well	Semi-Annual
ELN-1003A	467	DBG			1	Monitoring Well	Quarterly
ELN-1003B	468	DBG			1	Monitoring Well	Quarterly
ELN-1003C	469	DBG			1	Monitoring Well	Quarterly
ELN-1003E	470	DBG			1	Monitoring Well	Quarterly
DBN-1001B	472	DBG			1	Monitoring Well	Semi-Annual
DBN-1001C	473	DBG			1	Monitoring Well	Semi-Annual
DBN-1001E	474	DBG			1	Monitoring Well	Semi-Annual
DBN-1002C	476	DBG			1	Monitoring Well	Semi-Annual
DBN-1002E	477	DBG			1	Monitoring Well	Semi-Annual
S1121	755	DBG			1	Monitoring Well	Semi-Annual
ELN-1502A	533	DBG			1	Monitoring Well	Semi-Annual
ELN-1502C	534	DBG			1	Monitoring Well	Semi-Annual
ELN-1503A	535	DBG			1	Monitoring Well	Semi-Annual
ELN-1503C	536	DBG			1	Monitoring Well	Semi-Annual
ELN-1504B	537	DBG			1	Monitoring Well	Quarterly
RIM-0703	440	NC Area			1	Monitoring Well	Annual
RIM-0705	442	NC Area			1	Monitoring Well	Semi-Annual
RIM-1002	478	NC Area			1	Monitoring Well	Semi-Annual
RIN-1007C	479	NC Area			1	Monitoring Well	Annual
RIN-1001A	480	NC Area			1	Monitoring Well	Semi-Annual
RIN-1001C	481	NC Area			1	Monitoring Well	Annual

Well Name	Well ID	Plume Area	Nitrates	VOC	DNT	Well Type	Sample Frequency
S1125	504	NC Area			1	Monitoring Well	Semi-Annual
PBM-9801	360	PBG		1	1	Monitoring Well	Annual
PBM-0001	367	PBG	1	1	1	Monitoring Well	Semi-Annual
PBM-0002	368	PBG	1	1	1	Monitoring Well	Semi-Annual
PBM-0006	372	PBG	1	1	1	Monitoring Well	Semi-Annual
PBM-0008	374	PBG		1	1	Monitoring Well	Semi-Annual
PBN-9101C	561	PBG		1	1	Monitoring Well	Semi-Annual
SWN-9102C	569	PBG		1	1	Monitoring Well	Annual
SWN-9102D	570	PBG		1	1	Monitoring Well	Annual
SWN-9103B	571	PBG		1	1	Monitoring Well	Semi-Annual
SWN-9103C	572	PBG		1	1	Monitoring Well	Semi-Annual
SWN-9103D	573	PBG		1	1	Monitoring Well	Semi-Annual
SWN-9103E	574	PBG		1	1	Monitoring Well	Semi-Annual
SWN-9104C	575	PBG		1	1	Monitoring Well	Semi-Annual
SWN-9104D	576	PBG		1	1	Monitoring Well	Semi-Annual
SWN-9105B	577	PBG		1	1	Monitoring Well	Annual
SWN-9105C	578	PBG		1	1	Monitoring Well	Annual
SWN-9105D	579	PBG		1	1	Monitoring Well	Annual
PBN-1003C	592	PBG		1	1	Monitoring Well	Annual
PBN-1001C	595	PBG		1	1	Monitoring Well	Semi-Annual
PBN-8202A	613	PBG		1	1	Monitoring Well	Semi-Annual
PBN-8202B	614	PBG		1	1	Monitoring Well	Semi-Annual
PBN-8202C	615	PBG		1	1	Monitoring Well	Semi-Annual
PBN-8205A	622	PBG		1	1	Monitoring Well	Semi-Annual
PBN-8205B	623	PBG		1	1	Monitoring Well	Semi-Annual
PBN-8205C	624	PBG		1	1	Monitoring Well	Semi-Annual
PBN-8502A	632	PBG		1	1	Monitoring Well	Semi-Annual
PBN-8503A	633	PBG		1	1	Monitoring Well	Semi-Annual
PBM-8907	637	PBG		1	1	Monitoring Well	Annual
PBN-8902C	645	PBG		1	1	Monitoring Well	Semi-Annual
PBN-8903B	646	PBG		1	1	Monitoring Well	Semi-Annual
PBN-8903C	647	PBG		1	1	Monitoring Well	Semi-Annual
PBN-8912A	654	PBG		1	1	Monitoring Well	Semi-Annual
PBN-8912B	655	PBG		1	1	Monitoring Well	Semi-Annual
PBN-9112C	665	PBG		1	1	Monitoring Well	Semi-Annual
PBN-9112D	666	PBG		1	1	Monitoring Well	Semi-Annual
PBN-9301B	668	PBG		1	1	Monitoring Well	Semi-Annual
PBN-9301C	669	PBG		1	1	Monitoring Well	Semi-Annual
PBN-9303B	673	PBG		1	1	Monitoring Well	Semi-Annual
PBN-9303C	674	PBG		1	1	Monitoring Well	Semi-Annual
PBN-9303D	675	PBG		1	1	Monitoring Well	Semi-Annual
PBN-9304D	687	PBG		1	1	Monitoring Well	Semi-Annual
PBN-9902D	691	PBG		1	1	Monitoring Well	Semi-Annual
PBN-9903A	692	PBG		1	1	Monitoring Well	Semi-Annual
PBN-9903B	693	PBG		1	1	Monitoring Well	Semi-Annual
PBN-9903C	694	PBG		1	1	Monitoring Well	Semi-Annual
PBN-9903D	695	PBG		1	1	Monitoring Well	Semi-Annual
S1147	709	PBG		1	1	Monitoring Well	Semi-Annual
S1148	710	PBG		1	1	Monitoring Well	Semi-Annual
SPN-8903B	718	PBG		1	1	Monitoring Well	Semi-Annual
SPN-8903C	719	PBG		1	1	Monitoring Well	Semi-Annual

September 2019
Groundwater Sampling Schedule

Well Name	Well ID	Plume Area	Nitrates	VOC	DNT	Well Type	Sample Frequency
SPN-8904B	720	PBG		1	1	Monitoring Well	Semi-Annual
SPN-8904C	721	PBG		1	1	Monitoring Well	Semi-Annual
SPN-9103D	725	PBG		1	1	Monitoring Well	Semi-Annual
SPN-9104D	726	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1302A	770	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1302B	771	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1302C	772	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1302D	773	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1303A	774	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1303B	775	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1303C	776	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1303D	777	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1304A	778	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1304B	779	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1304C	780	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1304D	781	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1401A	782	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1401B	783	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1401C	784	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1404B	791	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1404C	792	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1404D	793	PBG		1	1	Monitoring Well	Semi-Annual
PBN-8902BR	795	PBG		1	1	Monitoring Well	Semi-Annual
PBM-9001D	981	PBG		1	1	Monitoring Well	Semi-Annual
Totals			3	74	126		

November 2019
Groundwater Sampling Schedule

Well Name	Well ID	Plume Area	VOC	DNT	Well Type	Sample Frequency
SEN-0501A	580	Central	1	1	Monitoring Well	Semi-Annual
SEN-0501B	581	Central	1	1	Monitoring Well	Semi-Annual
SEN-0501D	582	Central	1	1	Monitoring Well	Semi-Annual
SEN-0502A	583	Central	1	1	Monitoring Well	Semi-Annual
SEN-0502D	584	Central	1	1	Monitoring Well	Semi-Annual
SEN-0503A	585	Central	1	1	Monitoring Well	Semi-Annual
SEN-0503B	586	Central	1	1	Monitoring Well	Semi-Annual
SEN-0503D	587	Central	1	1	Monitoring Well	Semi-Annual
RIN-1004B	498	Central		1	Monitoring Well	Semi-Annual
WE-ZE512	437	Central	1	1	Residential Well	Quarterly
Purcell-D	163	DBG	1	1	Residential Well	Quarterly
ELN-1003A	467	DBG		1	Monitoring Well	Quarterly
ELN-1003B	468	DBG		1	Monitoring Well	Quarterly
ELN-1003C	469	DBG		1	Monitoring Well	Quarterly
ELN-1003E	470	DBG		1	Monitoring Well	Quarterly
ELN-1504B	537	DBG		1	Monitoring Well	Quarterly
Totals			10	16		

April 2020
Groundwater Sampling Schedule

Well Name	Well ID	Plume Area	Nitrates	Sulfate	VOC	DNT	Well Type	Sample Frequency
WE-ZE512	437	Central			1	1	Residential Well	Quarterly
Purcell-D	163	DBG			1	1	Residential Well	Quarterly
ELN-8203A	210	DBG		1	1	1	Monitoring Well	Semi-Annual
ELN-8203B	211	DBG		1	1	1	Monitoring Well	Semi-Annual
ELN-8203C	212	DBG		1	1	1	Monitoring Well	Semi-Annual
ELM-8901	216	DBG		1	1	1	Monitoring Well	Semi-Annual
ELM-8907	220	DBG		1	1	1	Monitoring Well	Semi-Annual
ELM-8908	221	DBG		1	1	1	Monitoring Well	Semi-Annual
ELM-8909	222	DBG		1	1	1	Monitoring Well	Semi-Annual
ELN-8902B	224	DBG		1	1	1	Monitoring Well	Semi-Annual
ELN-9107A	227	DBG		1	1	1	Monitoring Well	Semi-Annual
ELN-9107B	228	DBG		1	1	1	Monitoring Well	Semi-Annual
ELN-9402AR	231	DBG		1	1	1	Monitoring Well	Semi-Annual
ELM-9501	234	DBG			1	1	Monitoring Well	Semi-Annual
S1134R	236	DBG		1	1	1	Monitoring Well	Semi-Annual
DBM-8201	301	DBG		1	1	1	Monitoring Well	Semi-Annual
DBM-8202	302	DBG		1	1	1	Monitoring Well	Semi-Annual
DBM-8903	306	DBG			1	1	Monitoring Well	Semi-Annual
DBN-9501A	314	DBG			1	1	Monitoring Well	Semi-Annual
DBN-9501B	315	DBG			1	1	Monitoring Well	Semi-Annual
DBN-9501C	316	DBG			1	1	Monitoring Well	Semi-Annual
DBN-9501E	317	DBG			1	1	Monitoring Well	Semi-Annual
ELN-0801B	455	DBG			1	1	Monitoring Well	Semi-Annual
ELN-0801C	456	DBG			1	1	Monitoring Well	Semi-Annual
ELN-0801E	457	DBG			1	1	Monitoring Well	Semi-Annual
ELN-1001B	460	DBG			1	1	Monitoring Well	Semi-Annual
ELN-1001C	461	DBG			1	1	Monitoring Well	Semi-Annual
ELN-1001E	462	DBG			1	1	Monitoring Well	Semi-Annual
ELN-1002A	463	DBG			1	1	Monitoring Well	Semi-Annual
ELN-1002B	464	DBG			1	1	Monitoring Well	Semi-Annual
ELN-1002C	465	DBG			1	1	Monitoring Well	Semi-Annual
ELN-1002E	466	DBG			1	1	Monitoring Well	Semi-Annual
ELN-1003A	467	DBG			1	1	Monitoring Well	Quarterly
ELN-1003B	468	DBG			1	1	Monitoring Well	Quarterly
ELN-1003C	469	DBG			1	1	Monitoring Well	Quarterly
ELN-1003E	470	DBG			1	1	Monitoring Well	Quarterly
DBN-1001B	472	DBG			1	1	Monitoring Well	Semi-Annual
DBN-1001C	473	DBG			1	1	Monitoring Well	Semi-Annual
DBN-1001E	474	DBG			1	1	Monitoring Well	Semi-Annual
DBN-1002C	476	DBG		1	1	1	Monitoring Well	Semi-Annual
DBN-1002E	477	DBG		1	1	1	Monitoring Well	Semi-Annual
S1121	755	DBG			1	1	Monitoring Well	Semi-Annual
ELN-1502A	533	DBG			1	1	Monitoring Well	Semi-Annual
ELN-1502C	534	DBG			1	1	Monitoring Well	Semi-Annual
ELN-1503A	535	DBG			1	1	Monitoring Well	Semi-Annual
ELN-1503C	536	DBG			1	1	Monitoring Well	Semi-Annual
ELN-1504B	537	DBG			1	1	Monitoring Well	Quarterly
RIM-0705	442	NC Area				1	Monitoring Well	Semi-Annual
RIM-1002	478	NC Area				1	Monitoring Well	Semi-Annual
RIN-1001A	480	NC Area				1	Monitoring Well	Semi-Annual
S1125	504	NC Area				1	Monitoring Well	Semi-Annual
PBM-0001	367	PBG	1		1	1	Monitoring Well	Semi-Annual
PBM-0002	368	PBG	1		1	1	Monitoring Well	Semi-Annual
PBM-0006	372	PBG	1		1	1	Monitoring Well	Semi-Annual

Well Name	Well ID	Plume Area	Nitrates	Sulfate	VOC	DNT	Well Type	Sample Frequency
PBM-0008	374	PBG			1	1	Monitoring Well	Semi-Annual
PBN-9101C	561	PBG			1	1	Monitoring Well	Semi-Annual
SWN-9103B	571	PBG			1	1	Monitoring Well	Semi-Annual
SWN-9103C	572	PBG			1	1	Monitoring Well	Semi-Annual
SWN-9103D	573	PBG			1	1	Monitoring Well	Semi-Annual
SWN-9103E	574	PBG			1	1	Monitoring Well	Semi-Annual
SWN-9104C	575	PBG			1	1	Monitoring Well	Semi-Annual
SWN-9104D	576	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1001C	595	PBG			1	1	Monitoring Well	Semi-Annual
PBN-8202A	613	PBG			1	1	Monitoring Well	Semi-Annual
PBN-8202B	614	PBG			1	1	Monitoring Well	Semi-Annual
PBN-8202C	615	PBG			1	1	Monitoring Well	Semi-Annual
PBN-8205A	622	PBG			1	1	Monitoring Well	Semi-Annual
PBN-8205B	623	PBG			1	1	Monitoring Well	Semi-Annual
PBN-8205C	624	PBG			1	1	Monitoring Well	Semi-Annual
PBN-8502A	632	PBG			1	1	Monitoring Well	Semi-Annual
PBN-8503A	633	PBG			1	1	Monitoring Well	Semi-Annual
PBN-8902C	645	PBG			1	1	Monitoring Well	Semi-Annual
PBN-8903B	646	PBG			1	1	Monitoring Well	Semi-Annual
PBN-8903C	647	PBG			1	1	Monitoring Well	Semi-Annual
PBN-8912A	654	PBG			1	1	Monitoring Well	Semi-Annual
PBN-8912B	655	PBG			1	1	Monitoring Well	Semi-Annual
PBN-9112C	665	PBG			1	1	Monitoring Well	Semi-Annual
PBN-9112D	666	PBG			1	1	Monitoring Well	Semi-Annual
PBN-9301B	668	PBG			1	1	Monitoring Well	Semi-Annual
PBN-9301C	669	PBG			1	1	Monitoring Well	Semi-Annual
PBN-9303B	673	PBG			1	1	Monitoring Well	Semi-Annual
PBN-9303C	674	PBG			1	1	Monitoring Well	Semi-Annual
PBN-9303D	675	PBG			1	1	Monitoring Well	Semi-Annual
PBN-9304D	687	PBG			1	1	Monitoring Well	Semi-Annual
PBN-9902D	691	PBG			1	1	Monitoring Well	Semi-Annual
PBN-9903A	692	PBG			1	1	Monitoring Well	Semi-Annual
PBN-9903B	693	PBG			1	1	Monitoring Well	Semi-Annual
PBN-9903C	694	PBG			1	1	Monitoring Well	Semi-Annual
PBN-9903D	695	PBG			1	1	Monitoring Well	Semi-Annual
S1147	709	PBG			1	1	Monitoring Well	Semi-Annual
S1148	710	PBG			1	1	Monitoring Well	Semi-Annual
SPN-8903B	718	PBG			1	1	Monitoring Well	Semi-Annual
SPN-8903C	719	PBG			1	1	Monitoring Well	Semi-Annual
SPN-8904B	720	PBG			1	1	Monitoring Well	Semi-Annual
SPN-8904C	721	PBG			1	1	Monitoring Well	Semi-Annual
SPN-9103D	725	PBG			1	1	Monitoring Well	Semi-Annual
SPN-9104D	726	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1302A	770	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1302B	771	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1302C	772	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1302D	773	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1303A	774	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1303B	775	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1303C	776	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1303D	777	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1304A	778	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1304B	779	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1304C	780	PBG			1	1	Monitoring Well	Semi-Annual

April 2020

Groundwater Sampling Schedule

Well Name	Well ID	Plume Area	Nitrates	Sulfate	VOC	DNT	Well Type	Sample Frequency
PBN-1304D	781	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1401A	782	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1401B	783	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1401C	784	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1404B	791	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1404C	792	PBG			1	1	Monitoring Well	Semi-Annual
PBN-1404D	793	PBG			1	1	Monitoring Well	Semi-Annual
PBN-8902BR	795	PBG			1	1	Monitoring Well	Semi-Annual
PBM-9001D	981	PBG			1	1	Monitoring Well	Semi-Annual
Totals			3	16	113	117		

June 2020
Groundwater Sampling Schedule

Well Name	Well ID	Plume Area	VOC	DNT	Well Type	Sample Frequency
Purcell-D	163	DBG	1	1	Residential Well	Quarterly
ELN-1003A	467	DBG		1	Monitoring Well	Quarterly
ELN-1003B	468	DBG		1	Monitoring Well	Quarterly
ELN-1003C	469	DBG		1	Monitoring Well	Quarterly
ELN-1003E	470	DBG		1	Monitoring Well	Quarterly
ELN-1504B	537	DBG		1	Monitoring Well	Quarterly
WE-ZE512	437	Central	1	1	Residential Well	Quarterly
SEN-0501A	580	Central	1	1	Monitoring Well	Semi-Annual
SEN-0501B	581	Central	1	1	Monitoring Well	Semi-Annual
SEN-0501D	582	Central	1	1	Monitoring Well	Semi-Annual
SEN-0502A	583	Central	1	1	Monitoring Well	Semi-Annual
SEN-0502D	584	Central	1	1	Monitoring Well	Semi-Annual
SEN-0503A	585	Central	1	1	Monitoring Well	Semi-Annual
SEN-0503B	586	Central	1	1	Monitoring Well	Semi-Annual
SEN-0503D	587	Central	1	1	Monitoring Well	Semi-Annual
NLN-1001A	331	Central		1	Monitoring Well	Annual
NLN-1001C	332	Central		1	Monitoring Well	Annual
NLN-8203A	258	Central		1	Monitoring Well	Annual
NLN-8203B	259	Central		1	Monitoring Well	Annual
NLN-8203C	260	Central		1	Monitoring Well	Annual
NPM-8901	506	Central		1	Monitoring Well	Annual
RIM-1003	491	Central		1	Monitoring Well	Annual
RIM-1004	494	Central		1	Monitoring Well	Annual
RIN-0701C	443	Central		1	Monitoring Well	Annual
RIN-0702C	444	Central		1	Monitoring Well	Annual
RIN-0703C	445	Central		1	Monitoring Well	Annual
RIN-1002A	492	Central		1	Monitoring Well	Annual
RIN-1002C	493	Central		1	Monitoring Well	Annual
RIN-1003A	495	Central		1	Monitoring Well	Annual
RIN-1004B	498	Central		1	Monitoring Well	Semi-Annual
RIN-1005A	496	Central		1	Monitoring Well	Annual
RIN-1005C	497	Central		1	Monitoring Well	Annual
RPM-8901	507	Central		1	Monitoring Well	Annual
S1111	751	Central		1	Monitoring Well	Annual
RIN-1501B	538	Central		1	Monitoring Well	Annual
RIN-1501C	539	Central		1	Monitoring Well	Annual
RIN-1501D	540	Central		1	Monitoring Well	Annual
RIN-1502B	541	Central		1	Monitoring Well	Annual
RIN-1502C	542	Central		1	Monitoring Well	Annual
RIN-1502D	543	Central		1	Monitoring Well	Annual
Totals			10	40		

Well Name	Well ID	Plume Area	VOC	DNT	Well Type	Sample Frequency
Purcell-D	163	DBG	1	1	Residential Well	Quarterly
Anderson-R	411	DBG	1	1	Residential Well	Annual
Curto	412	DBG	1	1	Residential Well	Annual
Wenger	414	DBG	1	1	Residential Well	Annual
Grosse	415	DBG	1	1	Residential Well	Annual
Gruber-D	417	DBG	1	1	Residential Well	Annual
Hendershot	418	DBG	1	1	Residential Well	Annual
Howery	419	DBG	1	1	Residential Well	Annual
Osterland	422	DBG	1	1	Residential Well	Annual
Melum	423	DBG	1	1	Residential Well	Annual
Raschein	424	DBG	1	1	Residential Well	Annual
Revers	425	DBG	1	1	Residential Well	Annual
Roll	426	DBG	1	1	Residential Well	Annual
Reif	427	DBG	1	1	Residential Well	Annual
Schumann	428	DBG	1	1	Residential Well	Annual
Spear	803	DBG	1	1	Residential Well	Annual
Brey	817	DBG	1	1	Residential Well	Annual
Gibbs	839	DBG	1	1	Residential Well	Annual
Groth	842	DBG	1	1	Residential Well	Annual
Lukens	860	DBG	1	1	Residential Well	Annual
Kopras	874	DBG	1	1	Residential Well	Annual
Nowotarski	891	DBG	1	1	Residential Well	Annual
Olah	904	DBG	1	1	Residential Well	Annual
Purcell-G	916	DBG	1	1	Residential Well	Annual
Zurbachen-A	967	DBG	1	1	Residential Well	Annual
USDA 3	126	Central		1	Residential Well	Annual
USDA 6	128	Central		1	Residential Well	Annual
USDA 1	828	Central		1	Residential Well	Annual
USDA 2	829	Central		1	Residential Well	Annual
WE-TM599	129	Central		1	Residential Well	Annual
WE-RM383	153	Central		1	Residential Well	Annual
WE-RR542	156	Central		1	Residential Well	Annual
WE-QR441	157	Central	1	1	Residential Well	Annual
WE-QN039	158	Central	1	1	Residential Well	Annual
WE-RD430	159	Central		1	Residential Well	Annual
WE-SQ017	164	Central	1	1	Residential Well	Annual
WE-SQ001	165	Central	1	1	Residential Well	Annual
WE-RR598	169	Central		1	Residential Well	Annual
WE-SQ002	170	Central		1	Residential Well	Annual
WE-TF023	174	Central		1	Residential Well	Annual
WE-UK125	431	Central		1	Residential Well	Annual
WE-ZE512	437	Central	1	1	Residential Well	Quarterly
WE-UA297	433	Central		1	Residential Well	Annual
WE-XD828	434	Central		1	Residential Well	Annual
WE-XK342	435	Central		1	Residential Well	Annual
WE-YW972	436	Central	1	1	Residential Well	Annual
Delaney	152	PBG	1	1	Residential Well	Annual
Mittenzwei	800	PBG	1	1	Residential Well	Annual
Judd	862	PBG	1	1	Residential Well	Annual
Krumenauer	875	PBG	1	1	Residential Well	Annual

August 2020

Groundwater Sampling Schedule

Well Name	Well ID	Plume Area	VOC	DNT	Well Type	Sample Frequency
PDS-3	911	PBG	1	1	Residential Well	Annual
Ramaker-J	917	PBG	1	1	Residential Well	Annual
Schlender	931	PBG	1	1	Residential Well	Annual
Apel	998	PBG	1	1	Residential Well	Annual
Totals			39	54		

Well Name	Well ID	Plume Area	Nitrates	VOC	DNT	Well Type	Sample Frequency
ELN-8203A	210	DBG			1	Monitoring Well	Semi-Annual
ELN-8203B	211	DBG			1	Monitoring Well	Semi-Annual
ELN-8203C	212	DBG			1	Monitoring Well	Semi-Annual
ELM-8901	216	DBG			1	Monitoring Well	Semi-Annual
ELM-8907	220	DBG			1	Monitoring Well	Semi-Annual
ELM-8908	221	DBG			1	Monitoring Well	Semi-Annual
ELM-8909	222	DBG			1	Monitoring Well	Semi-Annual
ELN-8902B	224	DBG			1	Monitoring Well	Semi-Annual
ELN-9107A	227	DBG			1	Monitoring Well	Semi-Annual
ELN-9107B	228	DBG			1	Monitoring Well	Semi-Annual
ELN-9402AR	231	DBG			1	Monitoring Well	Semi-Annual
ELM-9501	234	DBG			1	Monitoring Well	Semi-Annual
S1134R	236	DBG			1	Monitoring Well	Semi-Annual
DBM-8201	301	DBG			1	Monitoring Well	Semi-Annual
DBM-8202	302	DBG			1	Monitoring Well	Semi-Annual
DBM-8903	306	DBG			1	Monitoring Well	Semi-Annual
DBN-9501A	314	DBG			1	Monitoring Well	Semi-Annual
DBN-9501B	315	DBG			1	Monitoring Well	Semi-Annual
DBN-9501C	316	DBG			1	Monitoring Well	Semi-Annual
DBN-9501E	317	DBG			1	Monitoring Well	Semi-Annual
ELN-0801B	455	DBG			1	Monitoring Well	Semi-Annual
ELN-0801C	456	DBG			1	Monitoring Well	Semi-Annual
ELN-0801E	457	DBG			1	Monitoring Well	Semi-Annual
ELN-0802A	458	DBG		1	1	Monitoring Well	Biennial
ELN-0802C	459	DBG		1	1	Monitoring Well	Biennial
ELN-1001B	460	DBG			1	Monitoring Well	Semi-Annual
ELN-1001C	461	DBG			1	Monitoring Well	Semi-Annual
ELN-1001E	462	DBG			1	Monitoring Well	Semi-Annual
ELN-1002A	463	DBG			1	Monitoring Well	Semi-Annual
ELN-1002B	464	DBG			1	Monitoring Well	Semi-Annual
ELN-1002C	465	DBG			1	Monitoring Well	Semi-Annual
ELN-1002E	466	DBG			1	Monitoring Well	Semi-Annual
ELN-1003A	467	DBG			1	Monitoring Well	Quarterly
ELN-1003B	468	DBG			1	Monitoring Well	Quarterly
ELN-1003C	469	DBG			1	Monitoring Well	Quarterly
ELN-1003E	470	DBG			1	Monitoring Well	Quarterly
DBN-1001B	472	DBG			1	Monitoring Well	Semi-Annual
DBN-1001C	473	DBG			1	Monitoring Well	Semi-Annual
DBN-1001E	474	DBG			1	Monitoring Well	Semi-Annual
DBN-1002C	476	DBG			1	Monitoring Well	Semi-Annual
DBN-1002E	477	DBG			1	Monitoring Well	Semi-Annual
S1121	755	DBG			1	Monitoring Well	Semi-Annual
ELN-1502A	533	DBG			1	Monitoring Well	Semi-Annual
ELN-1502C	534	DBG			1	Monitoring Well	Semi-Annual
ELN-1503A	535	DBG			1	Monitoring Well	Semi-Annual
ELN-1503C	536	DBG			1	Monitoring Well	Semi-Annual
ELN-1504B	537	DBG			1	Monitoring Well	Quarterly
RIM-0703	440	NC Area			1	Monitoring Well	Annual
RIM-0705	442	NC Area			1	Monitoring Well	Semi-Annual
RIM-1002	478	NC Area			1	Monitoring Well	Semi-Annual
RIN-1007C	479	NC Area			1	Monitoring Well	Annual
RIN-1001A	480	NC Area			1	Monitoring Well	Semi-Annual
RIN-1001C	481	NC Area			1	Monitoring Well	Annual

September 2020
Groundwater Sampling Schedule

Well Name	Well ID	Plume Area	Nitrates	VOC	DNT	Well Type	Sample Frequency
S1125	504	NC Area			1	Monitoring Well	Semi-Annual
PBM-9801	360	PBG		1	1	Monitoring Well	Annual
PBM-0001	367	PBG	1	1	1	Monitoring Well	Semi-Annual
PBM-0002	368	PBG	1	1	1	Monitoring Well	Semi-Annual
PBM-0006	372	PBG	1	1	1	Monitoring Well	Semi-Annual
PBM-0008	374	PBG		1	1	Monitoring Well	Semi-Annual
PBN-9101C	561	PBG		1	1	Monitoring Well	Semi-Annual
PBN-9102B	562	PBG		1	1	Monitoring Well	Biennial
PBN-9102C	563	PBG		1	1	Monitoring Well	Biennial
SWN-9102C	569	PBG		1	1	Monitoring Well	Annual
SWN-9102D	570	PBG		1	1	Monitoring Well	Annual
SWN-9103B	571	PBG		1	1	Monitoring Well	Semi-Annual
SWN-9103C	572	PBG		1	1	Monitoring Well	Semi-Annual
SWN-9103D	573	PBG		1	1	Monitoring Well	Semi-Annual
SWN-9103E	574	PBG		1	1	Monitoring Well	Semi-Annual
SWN-9104C	575	PBG		1	1	Monitoring Well	Semi-Annual
SWN-9104D	576	PBG		1	1	Monitoring Well	Semi-Annual
SWN-9105B	577	PBG		1	1	Monitoring Well	Annual
SWN-9105C	578	PBG		1	1	Monitoring Well	Annual
SWN-9105D	579	PBG		1	1	Monitoring Well	Annual
PBN-1003C	592	PBG		1	1	Monitoring Well	Annual
PBN-1001C	595	PBG		1	1	Monitoring Well	Semi-Annual
PBN-8202A	613	PBG		1	1	Monitoring Well	Semi-Annual
PBN-8202B	614	PBG		1	1	Monitoring Well	Semi-Annual
PBN-8202C	615	PBG		1	1	Monitoring Well	Semi-Annual
PBN-8205A	622	PBG		1	1	Monitoring Well	Semi-Annual
PBN-8205B	623	PBG		1	1	Monitoring Well	Semi-Annual
PBN-8205C	624	PBG		1	1	Monitoring Well	Semi-Annual
PBN-8502A	632	PBG		1	1	Monitoring Well	Semi-Annual
PBN-8503A	633	PBG		1	1	Monitoring Well	Semi-Annual
PBM-8907	637	PBG		1	1	Monitoring Well	Annual
PBM-8909	639	PBG		1	1	Monitoring Well	Biennial
PBN-8902C	645	PBG		1	1	Monitoring Well	Semi-Annual
PBN-8903B	646	PBG		1	1	Monitoring Well	Semi-Annual
PBN-8903C	647	PBG		1	1	Monitoring Well	Semi-Annual
PBN-8912A	654	PBG		1	1	Monitoring Well	Semi-Annual
PBN-8912B	655	PBG		1	1	Monitoring Well	Semi-Annual
PBN-9112C	665	PBG		1	1	Monitoring Well	Semi-Annual
PBN-9112D	666	PBG		1	1	Monitoring Well	Semi-Annual
PBN-9301B	668	PBG		1	1	Monitoring Well	Semi-Annual
PBN-9301C	669	PBG		1	1	Monitoring Well	Semi-Annual
PBN-9303B	673	PBG		1	1	Monitoring Well	Semi-Annual
PBN-9303C	674	PBG		1	1	Monitoring Well	Semi-Annual
PBN-9303D	675	PBG		1	1	Monitoring Well	Semi-Annual
PBN-9304D	687	PBG		1	1	Monitoring Well	Semi-Annual
PBN-9902D	691	PBG		1	1	Monitoring Well	Semi-Annual
PBN-9903A	692	PBG		1	1	Monitoring Well	Semi-Annual
PBN-9903B	693	PBG		1	1	Monitoring Well	Semi-Annual
PBN-9903C	694	PBG		1	1	Monitoring Well	Semi-Annual
PBN-9903D	695	PBG		1	1	Monitoring Well	Semi-Annual
S1147	709	PBG		1	1	Monitoring Well	Semi-Annual
S1148	710	PBG		1	1	Monitoring Well	Semi-Annual
SPN-8903B	718	PBG		1	1	Monitoring Well	Semi-Annual

Well Name	Well ID	Plume Area	Nitrates	VOC	DNT	Well Type	Sample Frequency
SPN-8903C	719	PBG		1	1	Monitoring Well	Semi-Annual
SPN-8904B	720	PBG		1	1	Monitoring Well	Semi-Annual
SPN-8904C	721	PBG		1	1	Monitoring Well	Semi-Annual
SPN-9103D	725	PBG		1	1	Monitoring Well	Semi-Annual
SPN-9104D	726	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1302A	770	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1302B	771	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1302C	772	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1302D	773	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1303A	774	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1303B	775	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1303C	776	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1303D	777	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1304A	778	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1304B	779	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1304C	780	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1304D	781	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1401A	782	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1401B	783	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1401C	784	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1404B	791	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1404C	792	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1404D	793	PBG		1	1	Monitoring Well	Semi-Annual
PBN-1405F	794	PBG		1	1	Monitoring Well	Biennial
PBN-8902BR	795	PBG		1	1	Monitoring Well	Semi-Annual
PBM-9001D	981	PBG		1	1	Monitoring Well	Semi-Annual
PBM-9002D	982	PBG		1	1	Monitoring Well	Biennial
Totals			3	81	133		

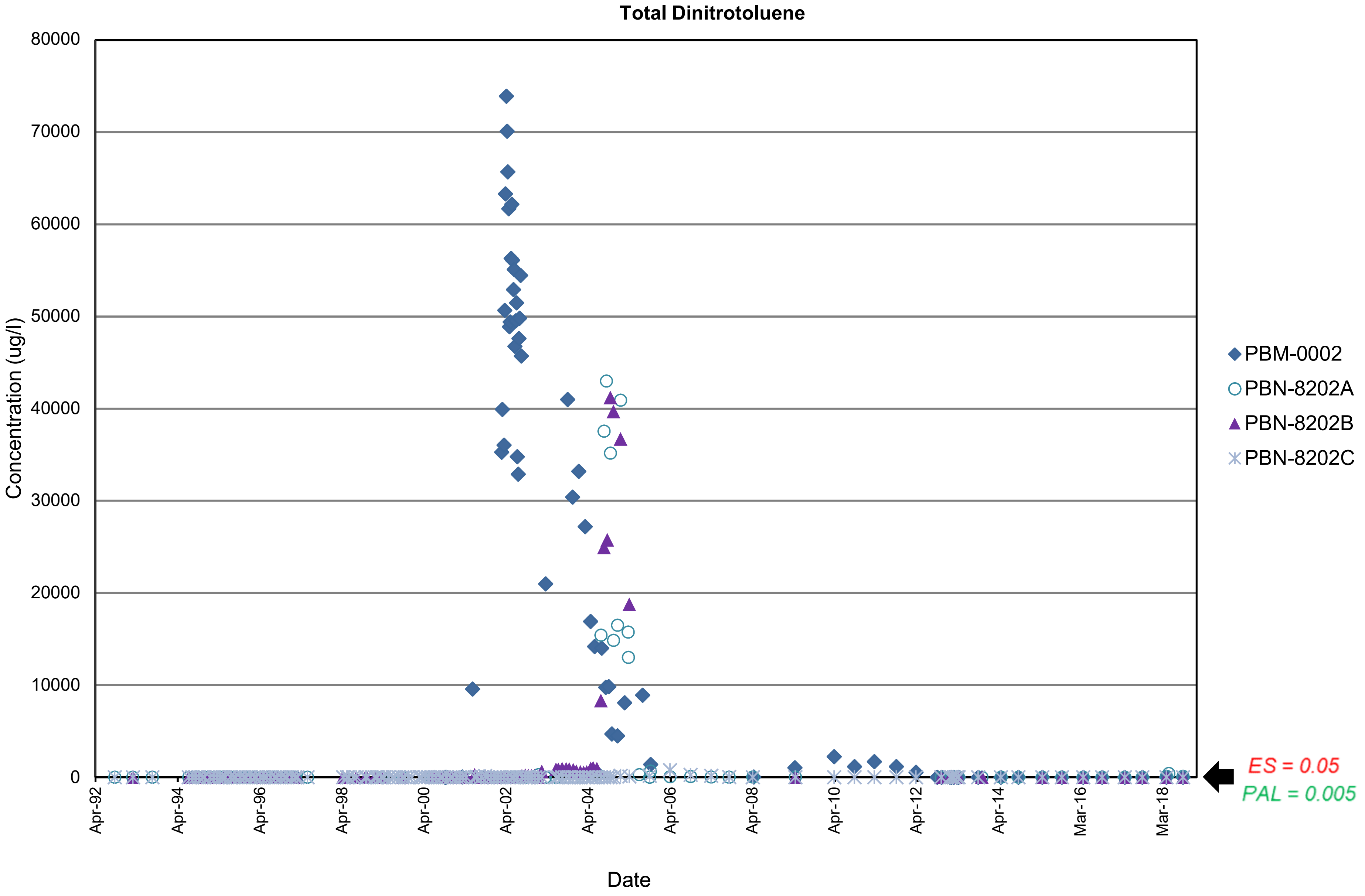
November 2020
Groundwater Sampling Schedule

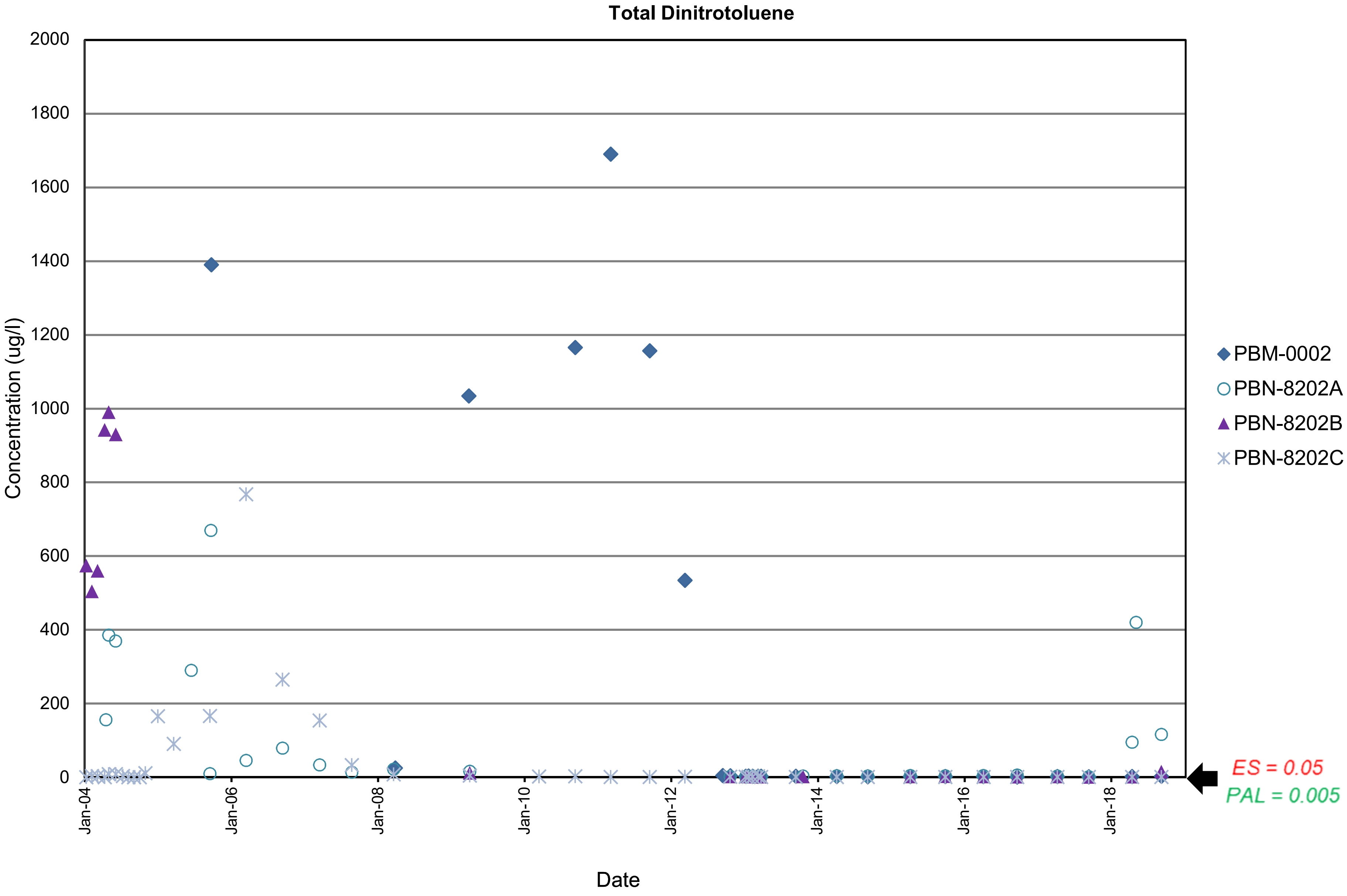
Well Name	Well ID	Plume Area	VOC	DNT	Well Type	Sample Frequency
SEN-0501A	580	Central	1	1	Monitoring Well	Semi-Annual
SEN-0501B	581	Central	1	1	Monitoring Well	Semi-Annual
SEN-0501D	582	Central	1	1	Monitoring Well	Semi-Annual
SEN-0502A	583	Central	1	1	Monitoring Well	Semi-Annual
SEN-0502D	584	Central	1	1	Monitoring Well	Semi-Annual
SEN-0503A	585	Central	1	1	Monitoring Well	Semi-Annual
SEN-0503B	586	Central	1	1	Monitoring Well	Semi-Annual
SEN-0503D	587	Central	1	1	Monitoring Well	Semi-Annual
RIN-1004B	498	Central		1	Monitoring Well	Semi-Annual
WE-ZE512	437	Central	1	1	Residential Well	Quarterly
Purcell-D	163	DBG	1	1	Residential Well	Quarterly
ELN-1003A	467	DBG		1	Monitoring Well	Quarterly
ELN-1003B	468	DBG		1	Monitoring Well	Quarterly
ELN-1003C	469	DBG		1	Monitoring Well	Quarterly
ELN-1003E	470	DBG		1	Monitoring Well	Quarterly
ELN-1504B	537	DBG		1	Monitoring Well	Quarterly
Totals			10	16		

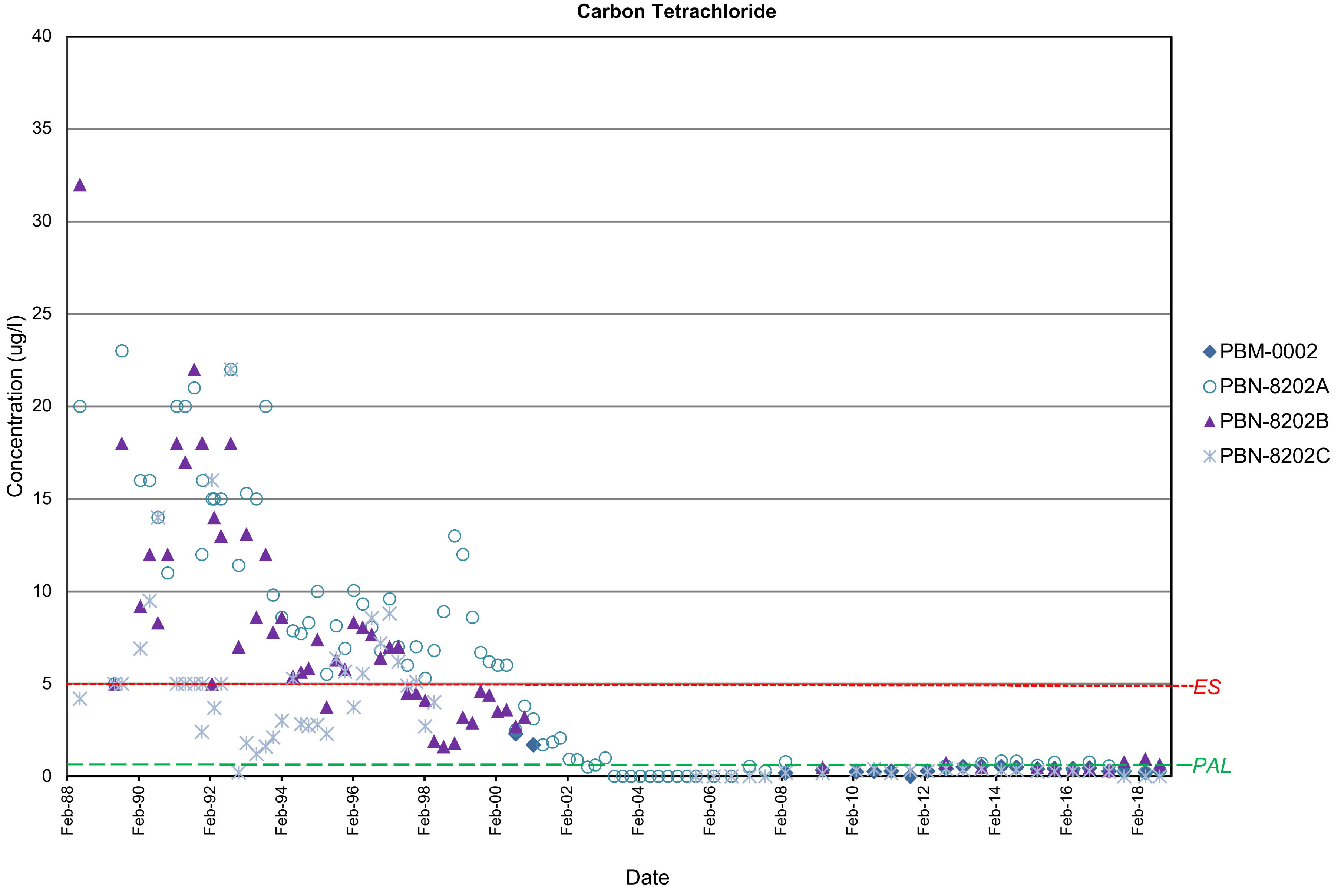
Appendix E

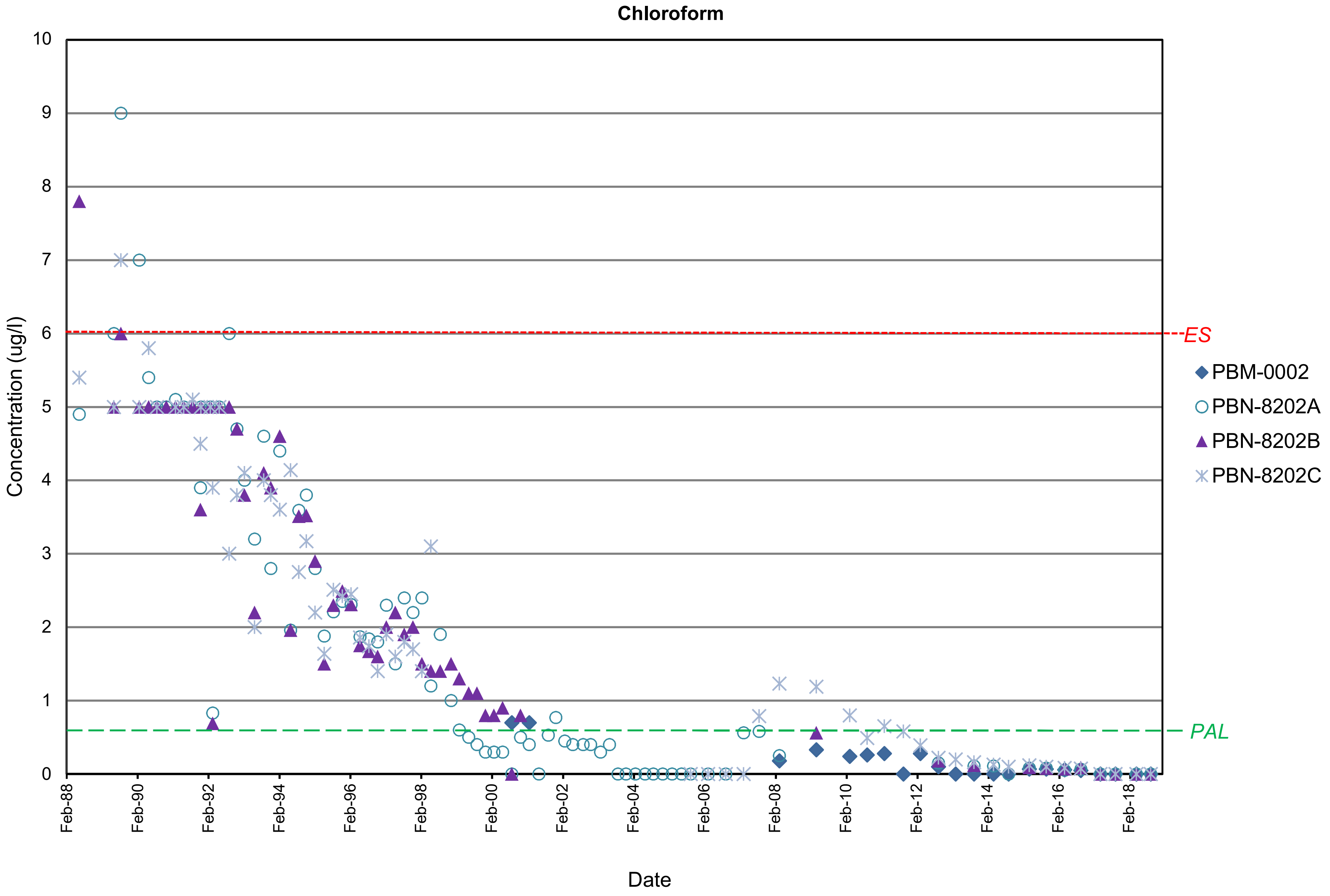
Plume Concentration Over Time Graphs

Concentration Graphs
Propellant Burning Ground Plume

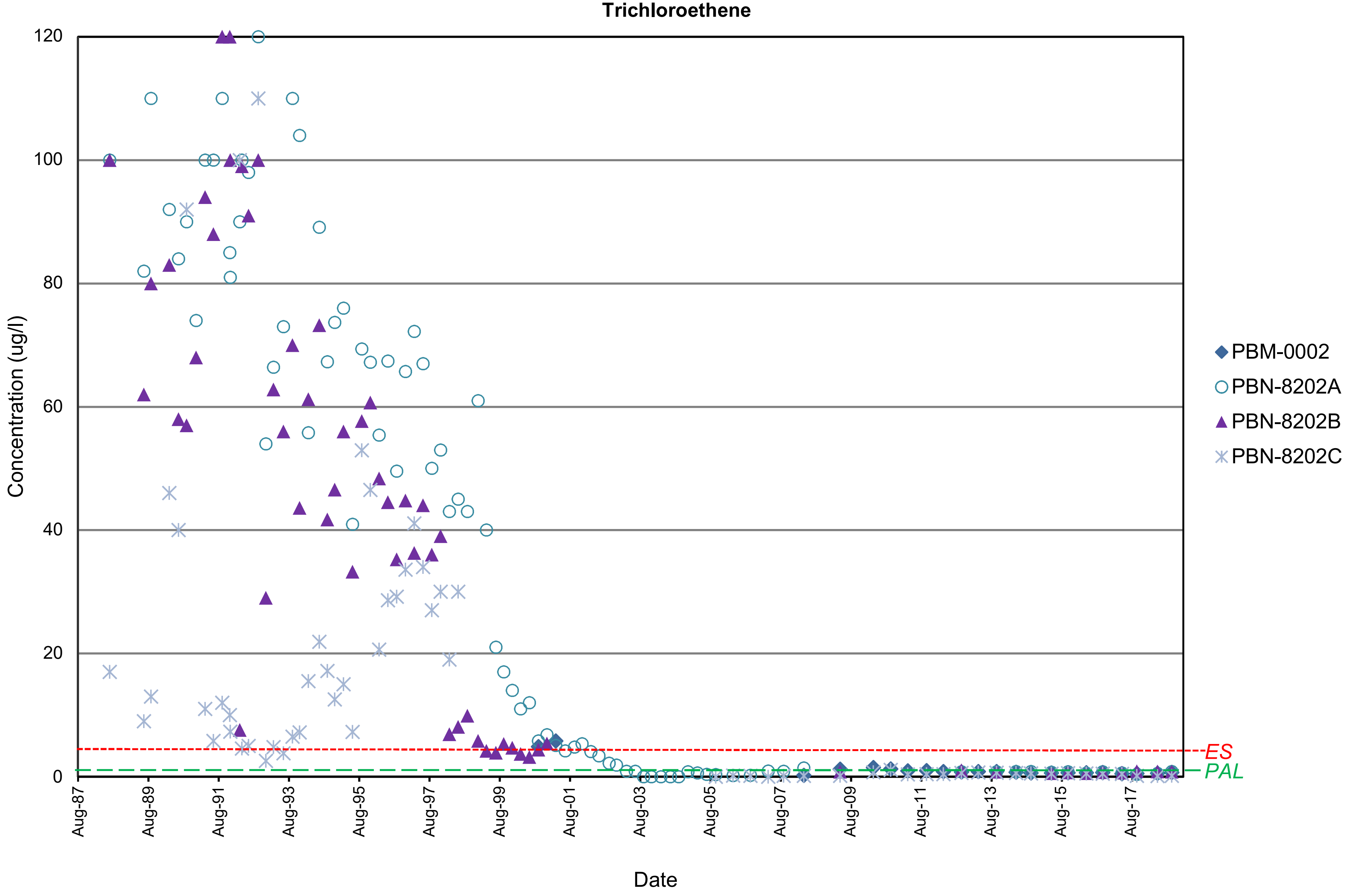

Total Dinitrotoluene
Concentration (ug/l)
80000
70000
60000
50000
40000
30000
20000
10000
0
Apr-92
Apr-94
Apr-96
Apr-98
Apr-00
Apr-02
Apr-04
Apr-06
Apr-08
Apr-10
Apr-12
Apr-14
Mar-16
Mar-18
Date
◆ PBM-0002
○ PBN-8202A
▲ PBN-8202B
✳ PBN-8202C
ES = 0.05
PAL = 0.005


Total Dinitrotoluene
Concentration (ug/l)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16
Jan-18
Date
◆ PBM-0002
○ PBN-8202A
▲ PBN-8202B
✳ PBN-8202C
ES = 0.05
PAL = 0.005

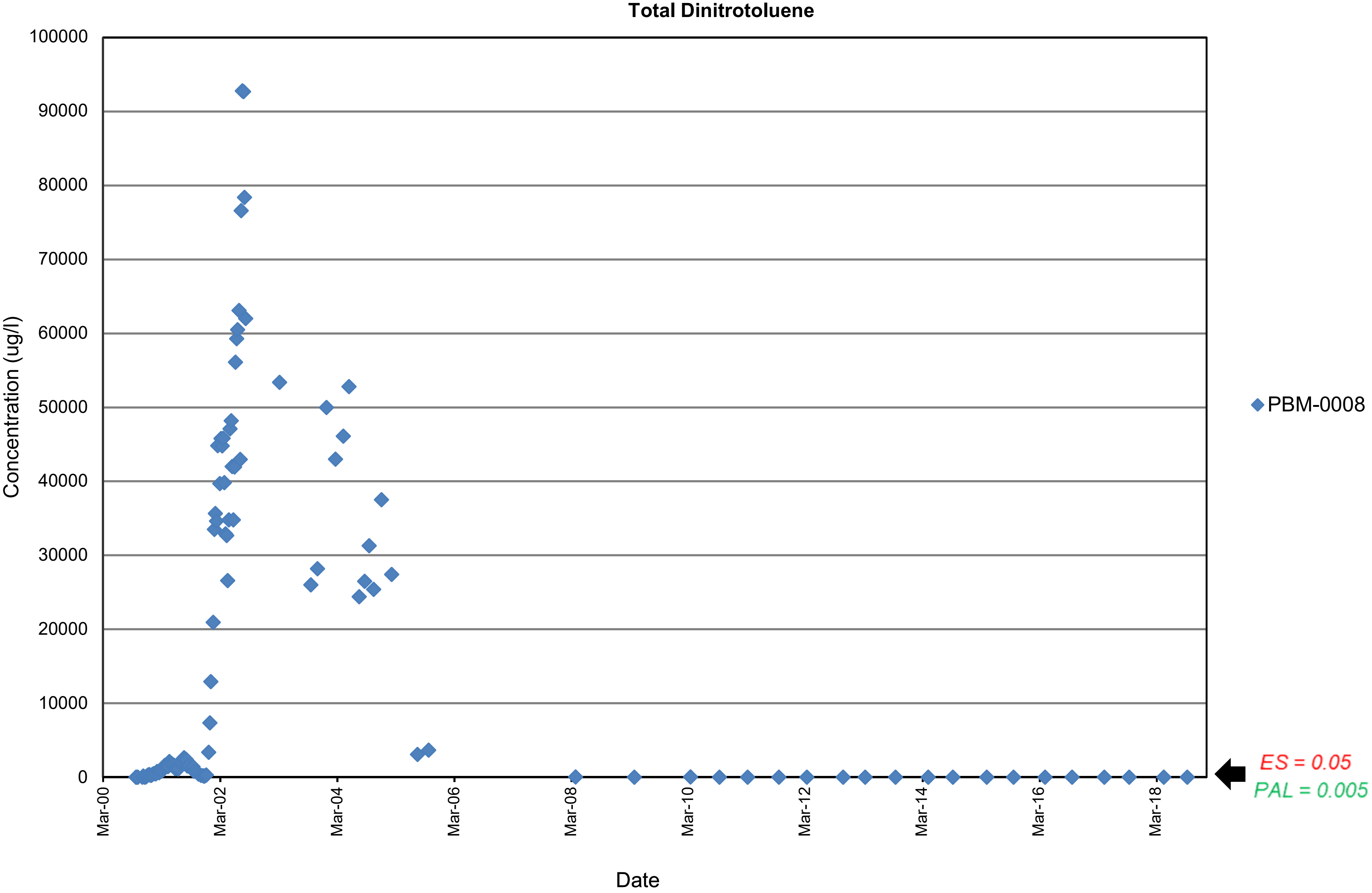

Carbon Tetrachloride
Concentration (ug/l)
0
5
10
15
20
25
30
35
40
Date
Feb-88
Feb-90
Feb-92
Feb-94
Feb-96
Feb-98
Feb-00
Feb-02
Feb-04
Feb-06
Feb-08
Feb-10
Feb-12
Feb-14
Feb-16
Feb-18
ES
PAL
PBM-0002
PBN-8202A
PBN-8202B
PBN-8202C


Chloroform
Concentration (ug/l)
10
9
8
7
6
5
4
3
2
1
0
ES
PAL
PBM-0002
PBN-8202A
PBN-8202B
PBN-8202C
Feb-88
Feb-90
Feb-92
Feb-94
Feb-96
Feb-98
Feb-00
Feb-02
Feb-04
Feb-06
Feb-08
Feb-10
Feb-12
Feb-14
Feb-16
Feb-18
Date

BAAP Groundwater Data | Propellant Burning Ground | Source Area

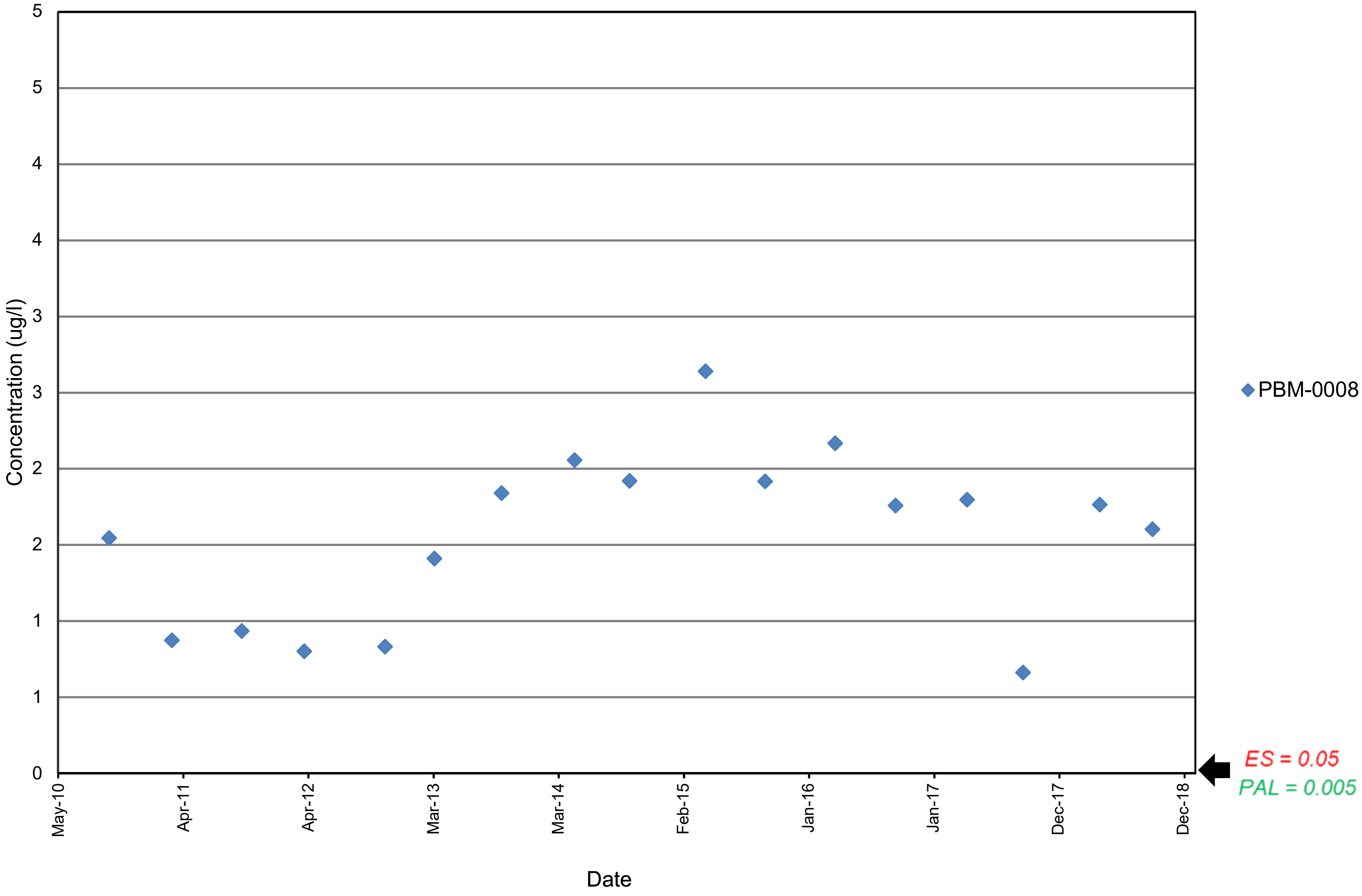


BAAP Groundwater Data Propellant Burning Ground Source Area

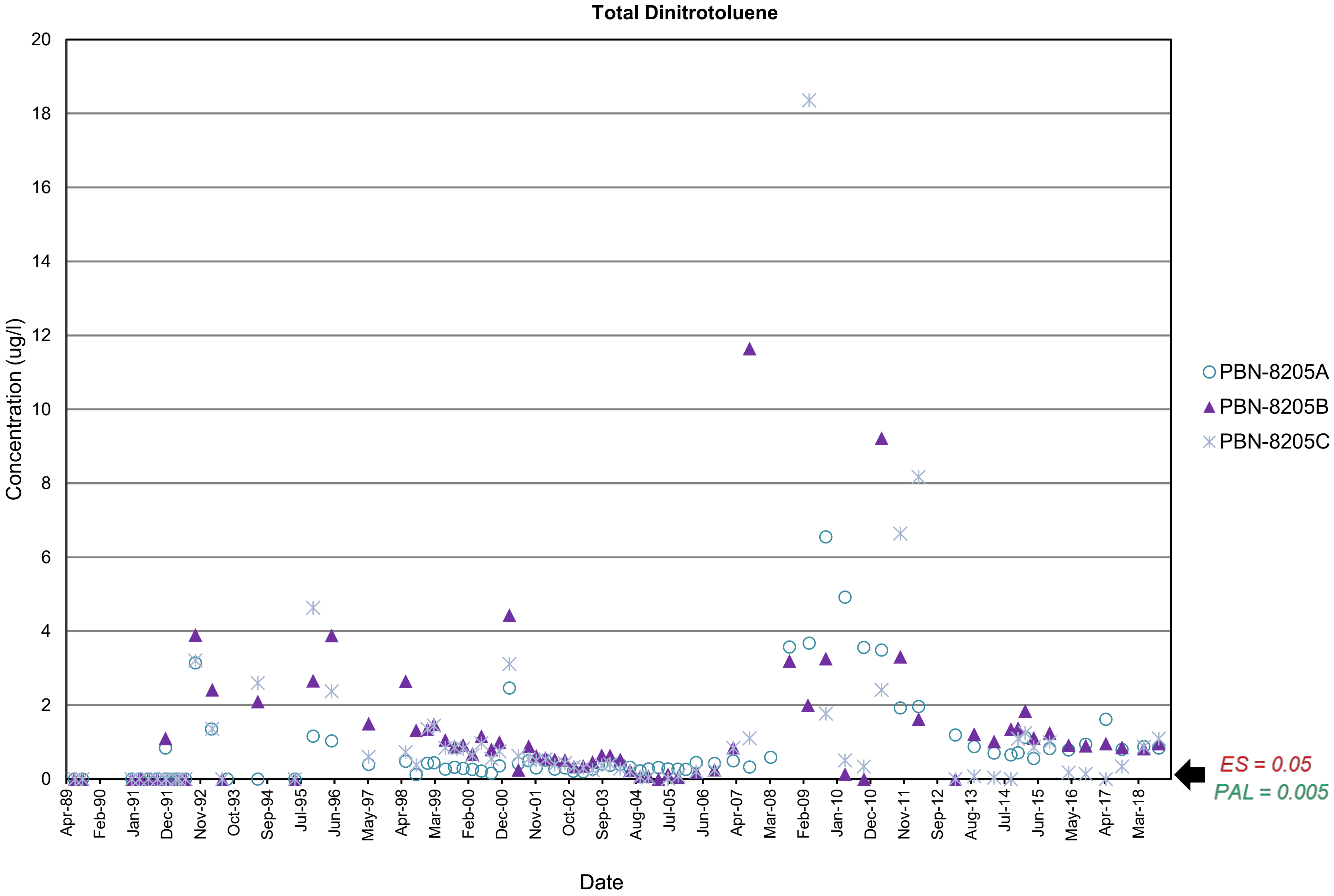


BAAP Groundwater Data Propellant Burning Ground Source Area

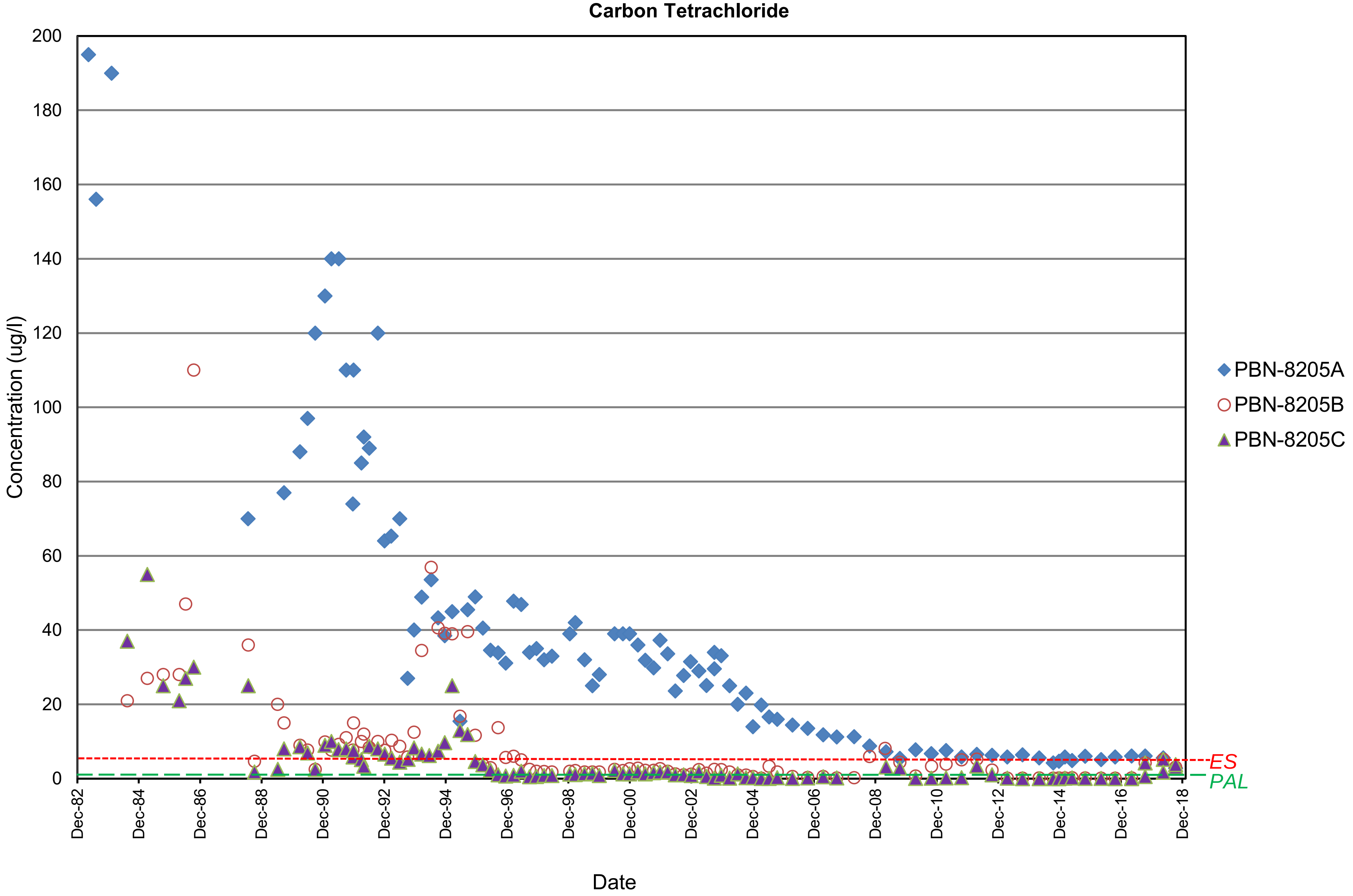
Total Dinitrotoluene

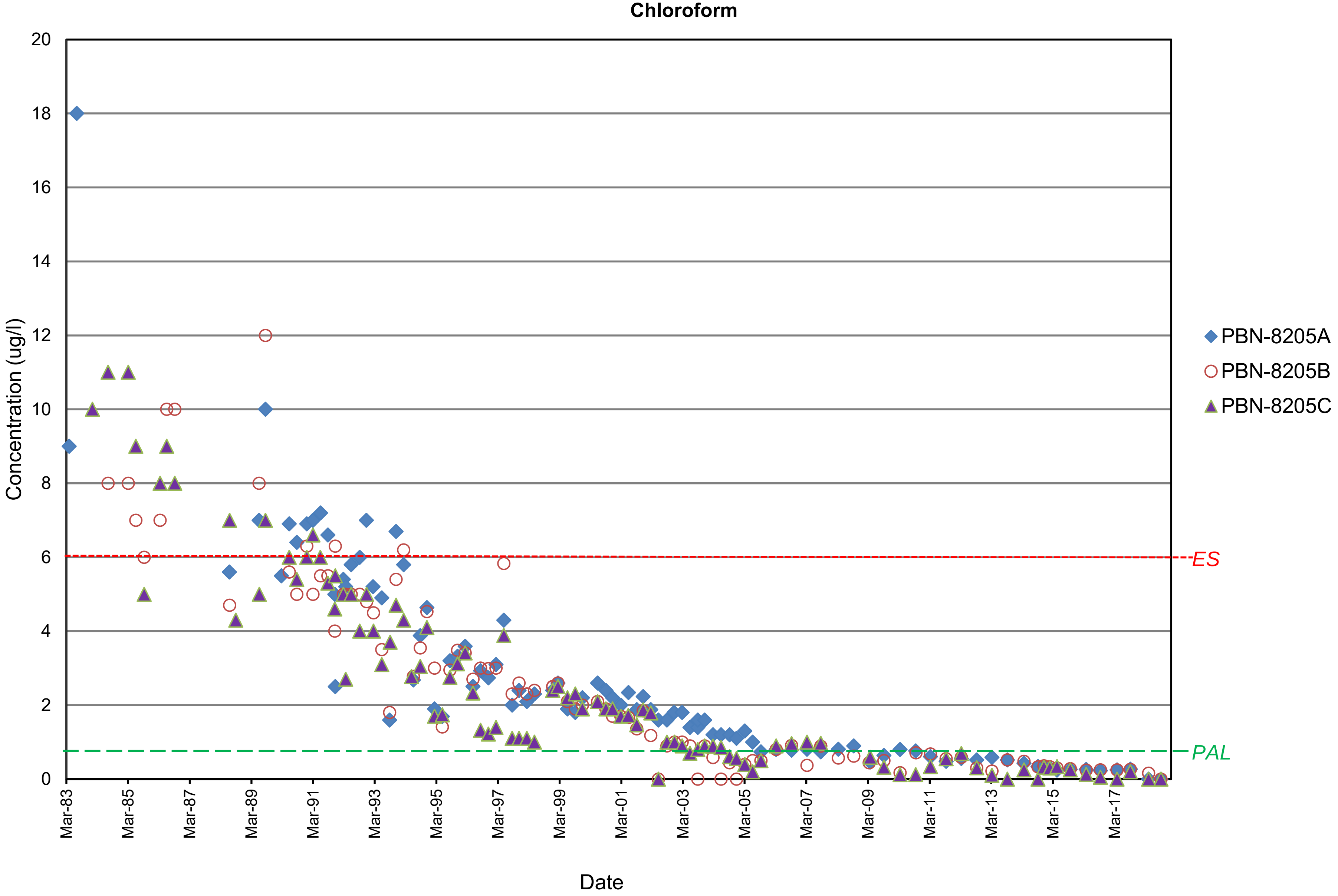


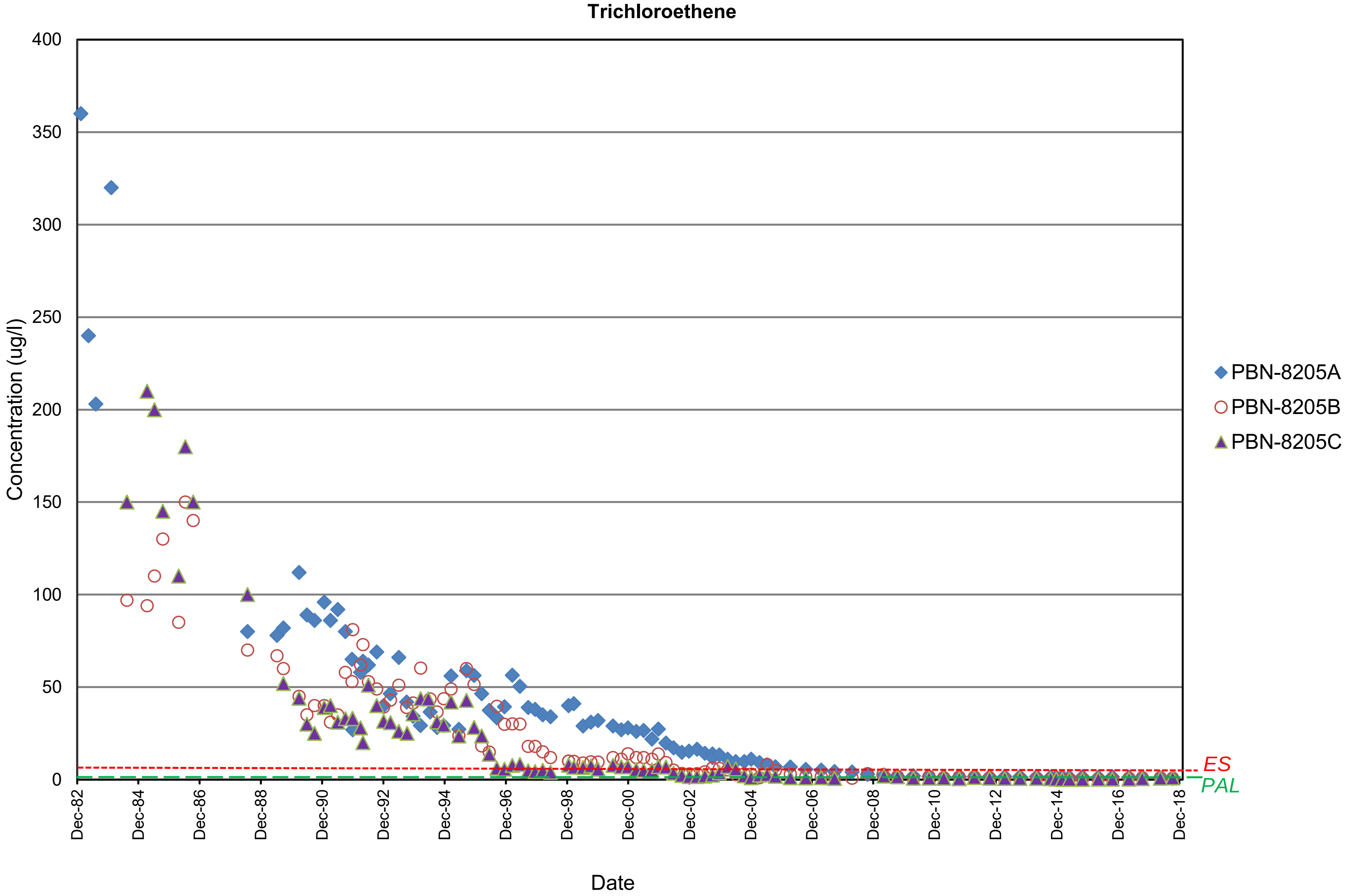
BAAP Groundwater Data | Propellant Burning Ground | Plume Center



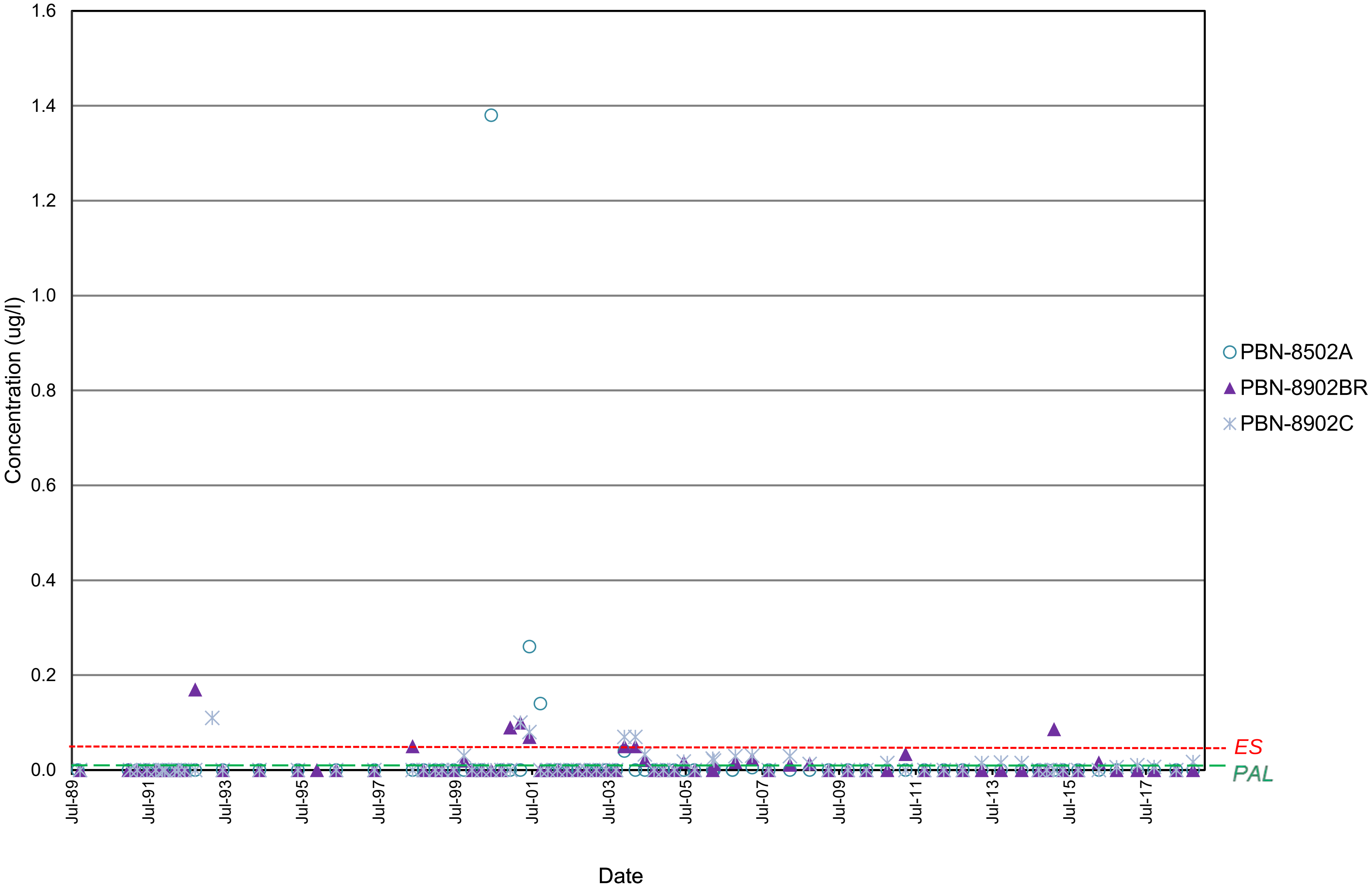
BAAP Groundwater Data | Propellant Burning Ground | Plume Center



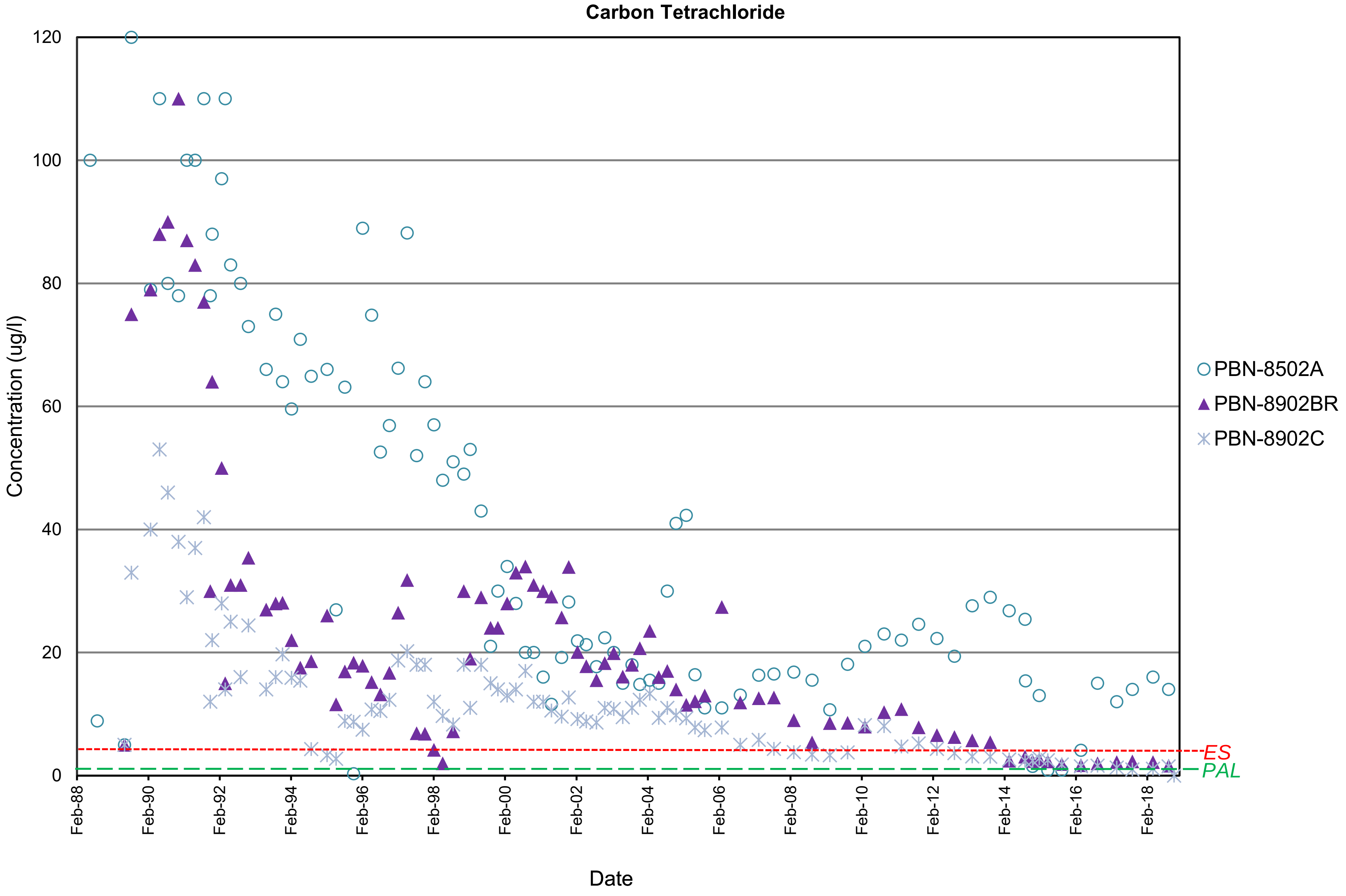

Chloroform
Concentration (ug/l)
0
2
4
6
8
10
12
14
16
18
20
Date
Mar-83
Mar-85
Mar-87
Mar-89
Mar-91
Mar-93
Mar-95
Mar-97
Mar-99
Mar-01
Mar-03
Mar-05
Mar-07
Mar-09
Mar-11
Mar-13
Mar-15
Mar-17
ES
PAL
◆ PBN-8205A
○ PBN-8205B
▲ PBN-8205C

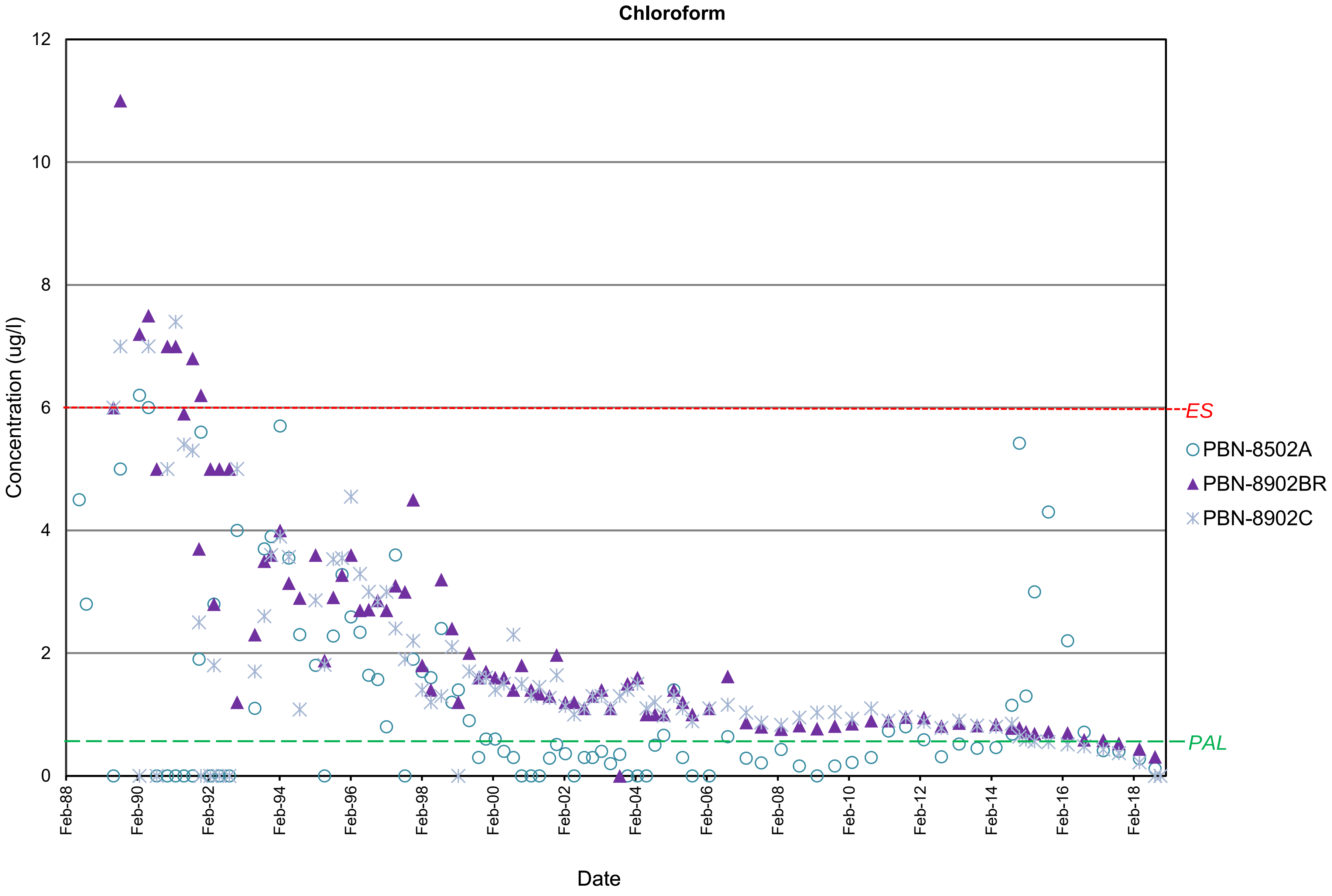

Trichloroethene
Concentration (ug/l)
400
350
300
250
200
150
100
50
0
Dec-82
Dec-84
Dec-86
Dec-88
Dec-90
Dec-92
Dec-94
Dec-96
Dec-98
Dec-00
Dec-02
Dec-04
Dec-06
Dec-08
Dec-10
Dec-12
Dec-14
Dec-16
Dec-18
Date
ES
PAL
PBN-8205A
PBN-8205B
PBN-8205C

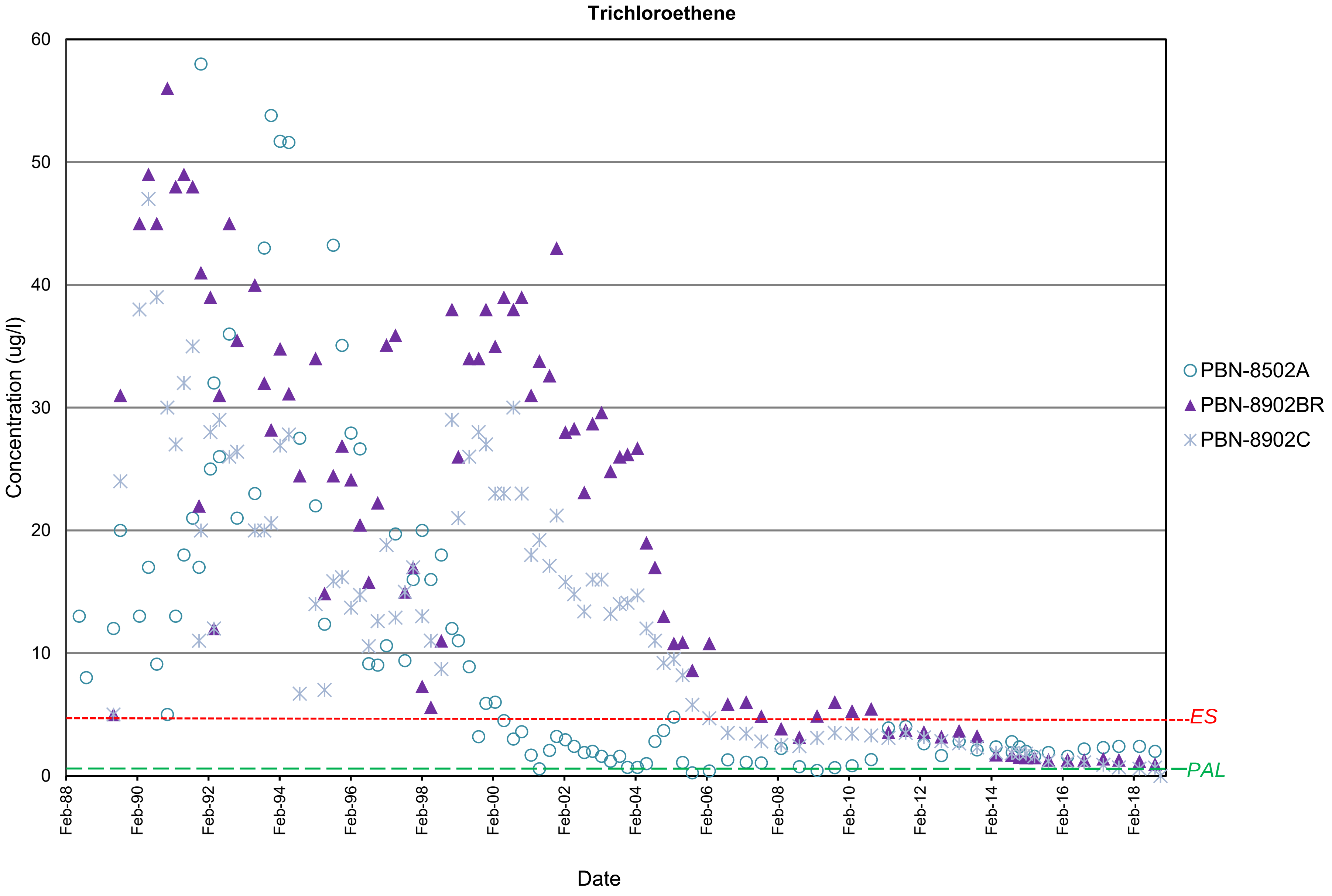
Total Dinitrotoluene



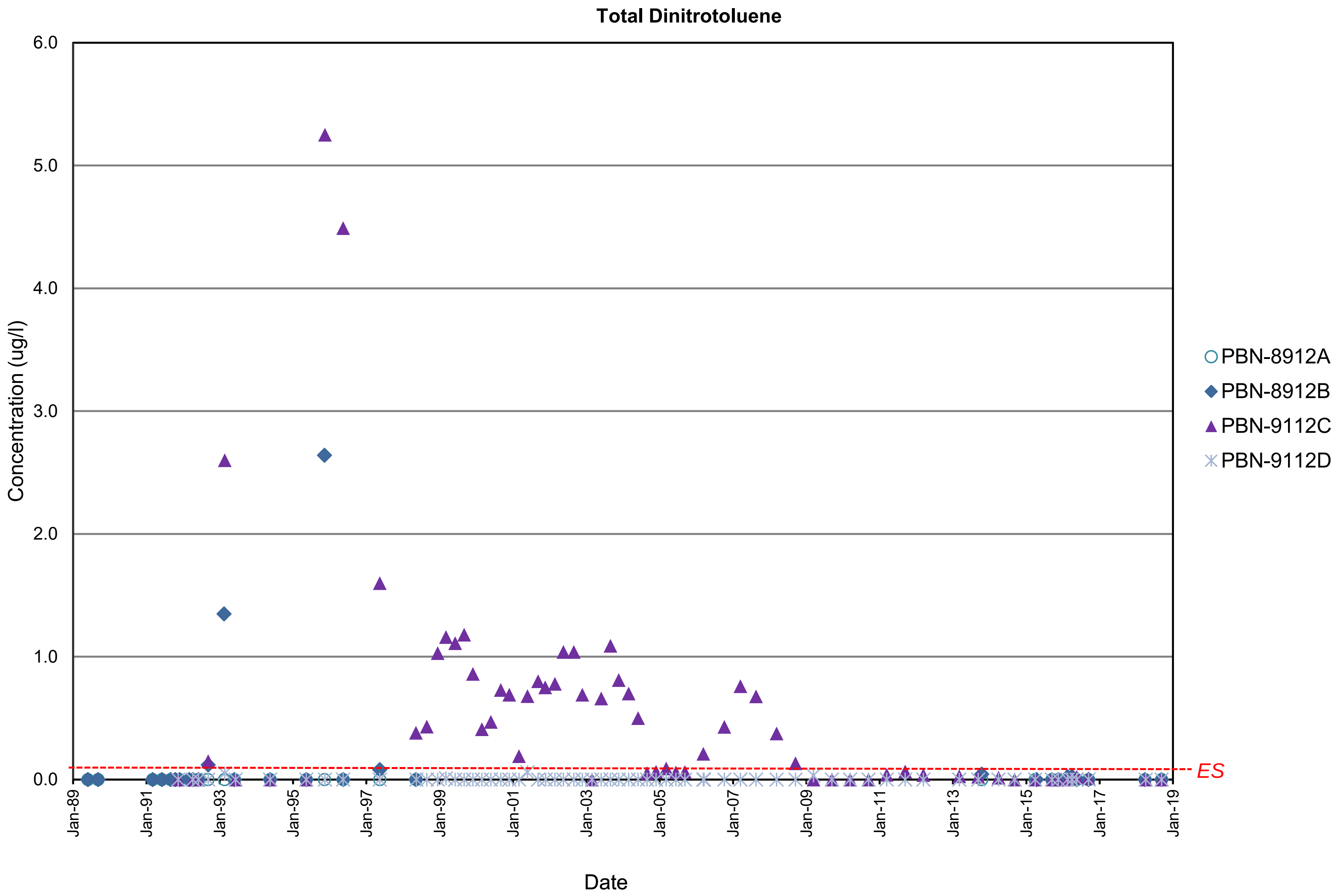
BAAP Groundwater Data | Propellant Burning Ground | Plume Center

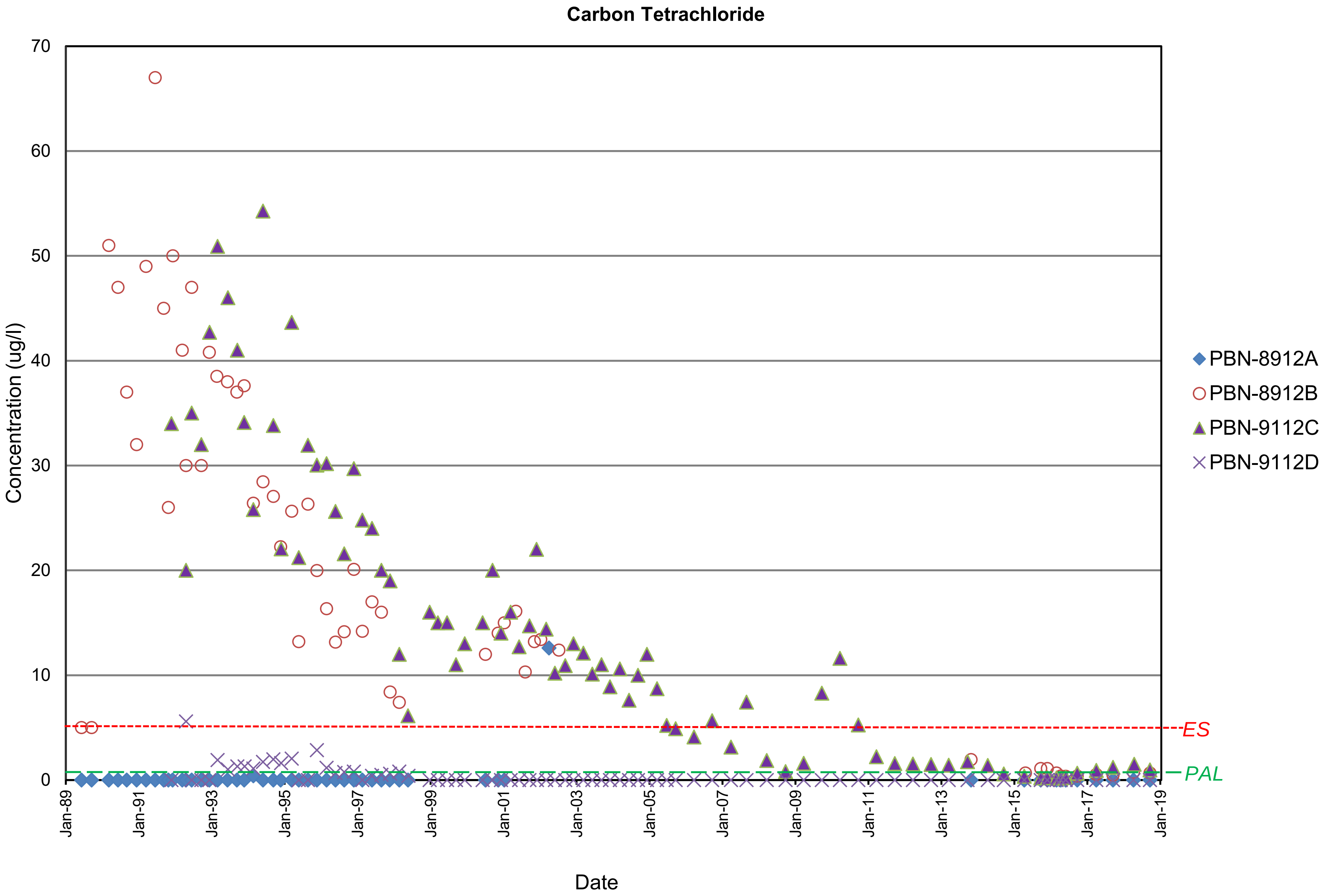



Chloroform
Concentration (ug/l)
0
2
4
6
8
10
12
Feb-88
Feb-90
Feb-92
Feb-94
Feb-96
Feb-98
Feb-00
Feb-02
Feb-04
Feb-06
Feb-08
Feb-10
Feb-12
Feb-14
Feb-16
Feb-18
Date
ES
PAL
○ PBN-8502A
▲ PBN-8902BR
✳ PBN-8902C

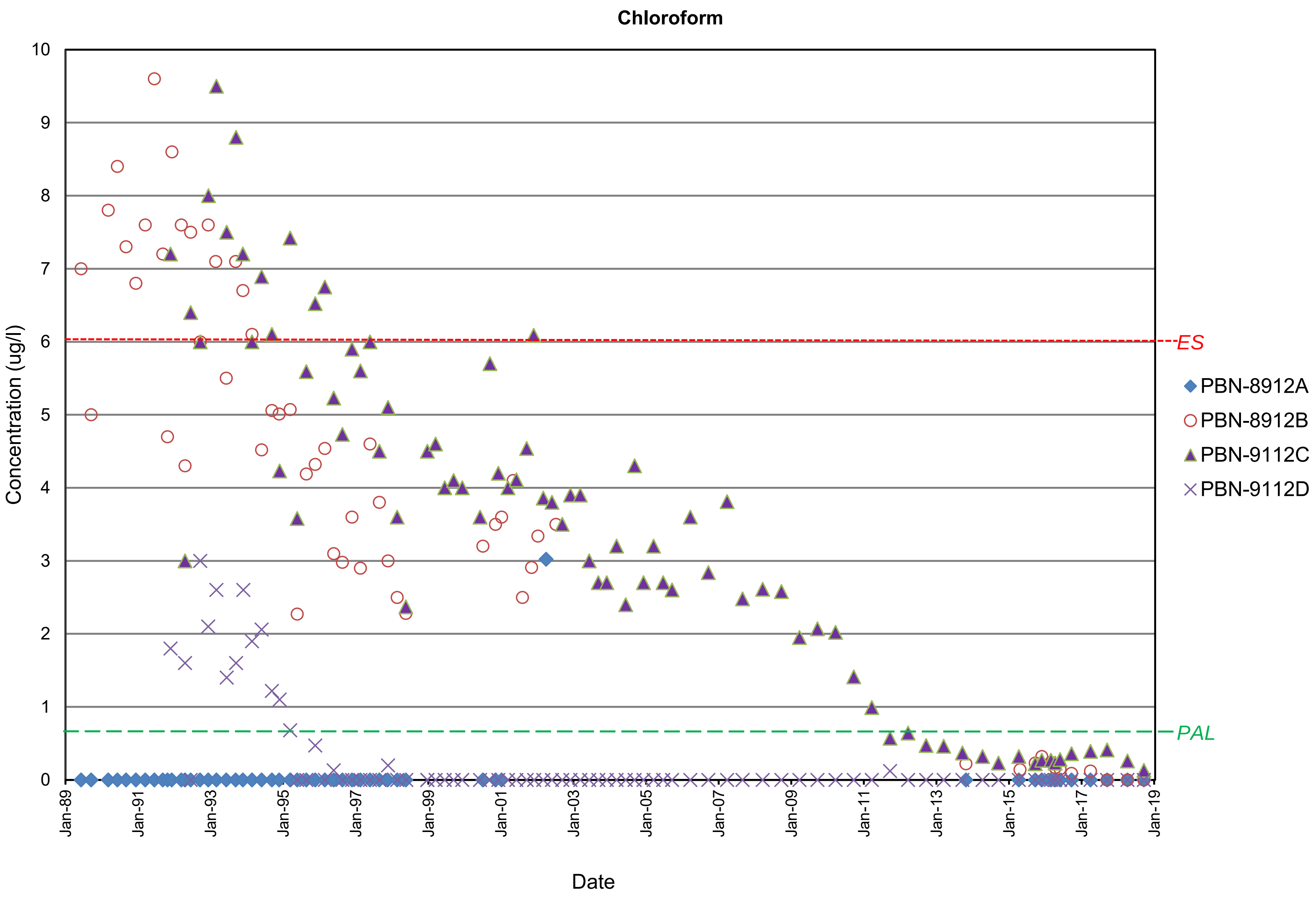

Trichloroethene
Concentration (ug/l)
0
10
20
30
40
50
60
Feb-88
Feb-90
Feb-92
Feb-94
Feb-96
Feb-98
Feb-00
Feb-02
Feb-04
Feb-06
Feb-08
Feb-10
Feb-12
Feb-14
Feb-16
Feb-18
Date
ES
PAL
○ PBN-8502A
▲ PBN-8902BR
✳ PBN-8902C

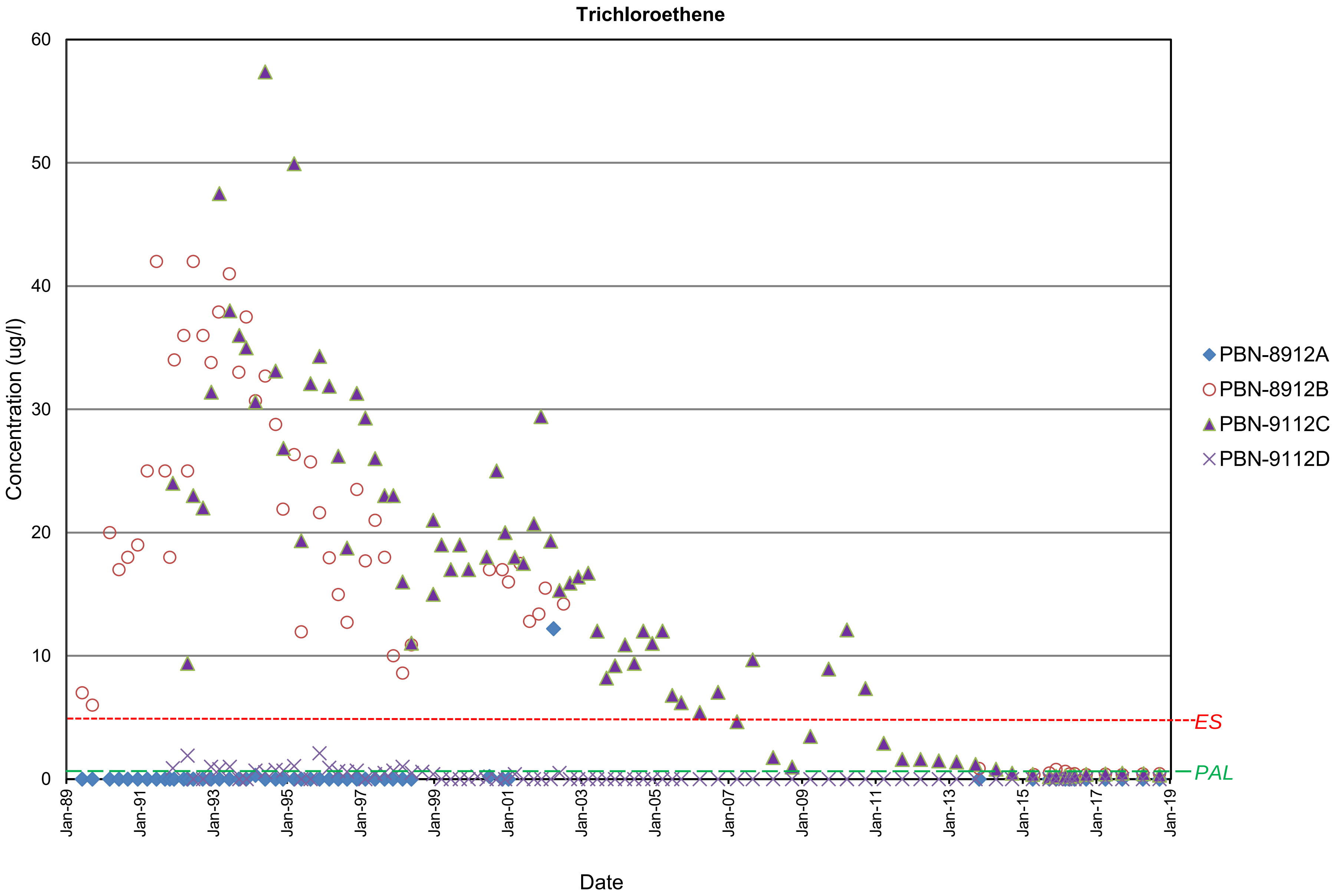
BAAP Groundwater Data Propellant Burning Ground Plume Center

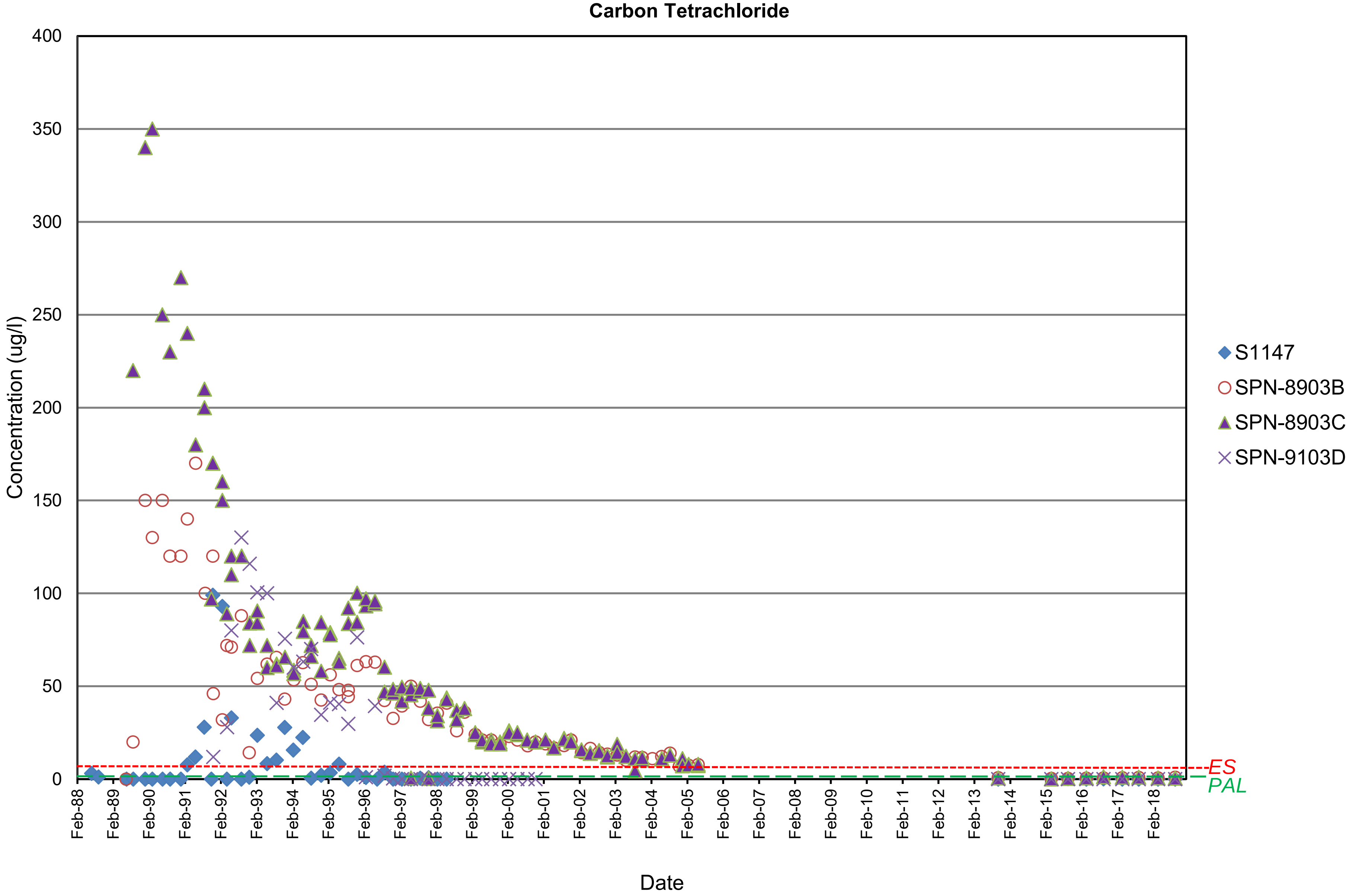


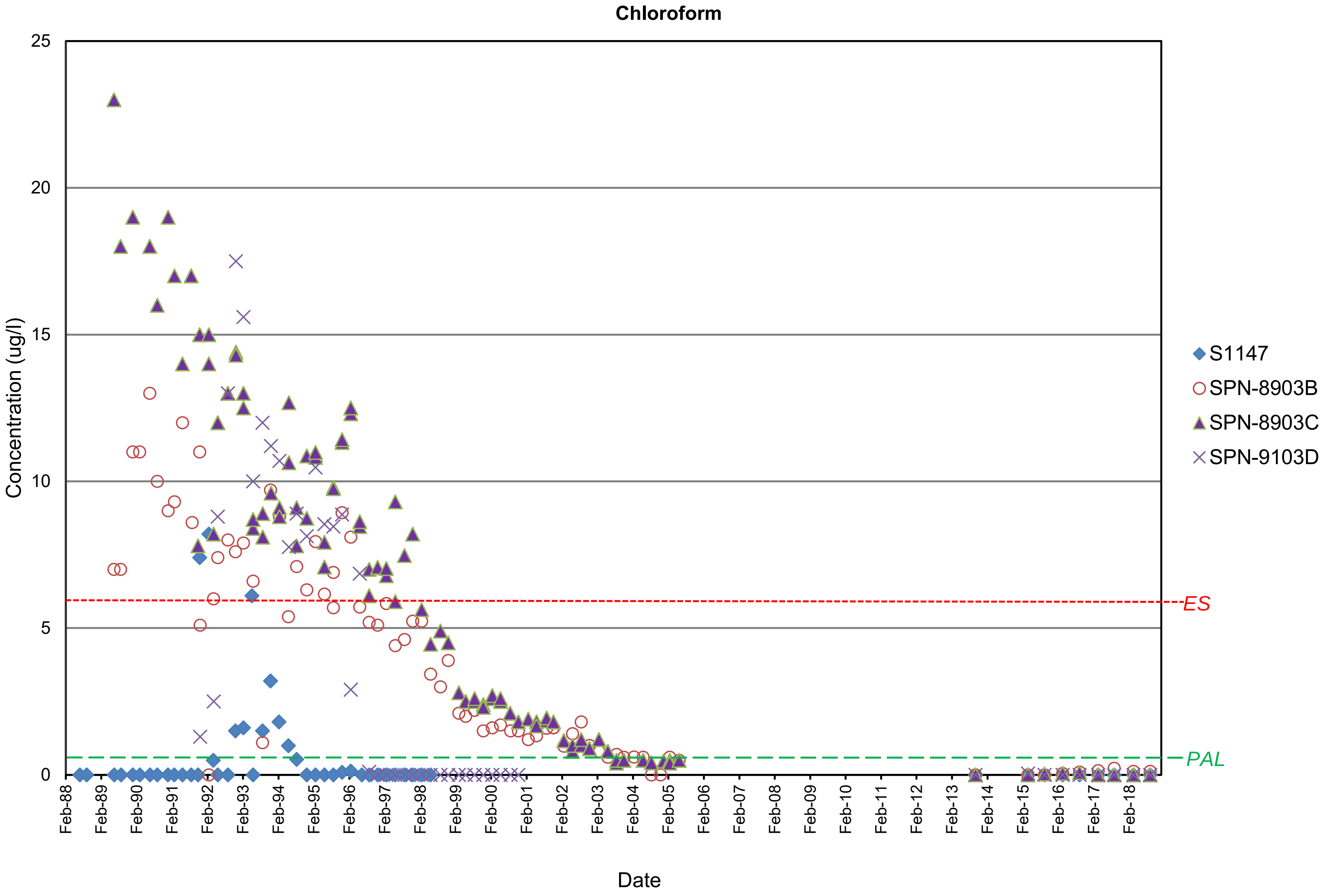

Carbon Tetrachloride
Concentration (ug/l)
70
60
50
40
30
20
10
0
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05
Jan-07
Jan-09
Jan-11
Jan-13
Jan-15
Jan-17
Jan-19
Date
ES
PAL
◆ PBN-8912A
○ PBN-8912B
▲ PBN-9112C
× PBN-9112D

BAAP Groundwater Data Propellant Burning Ground Plume Center

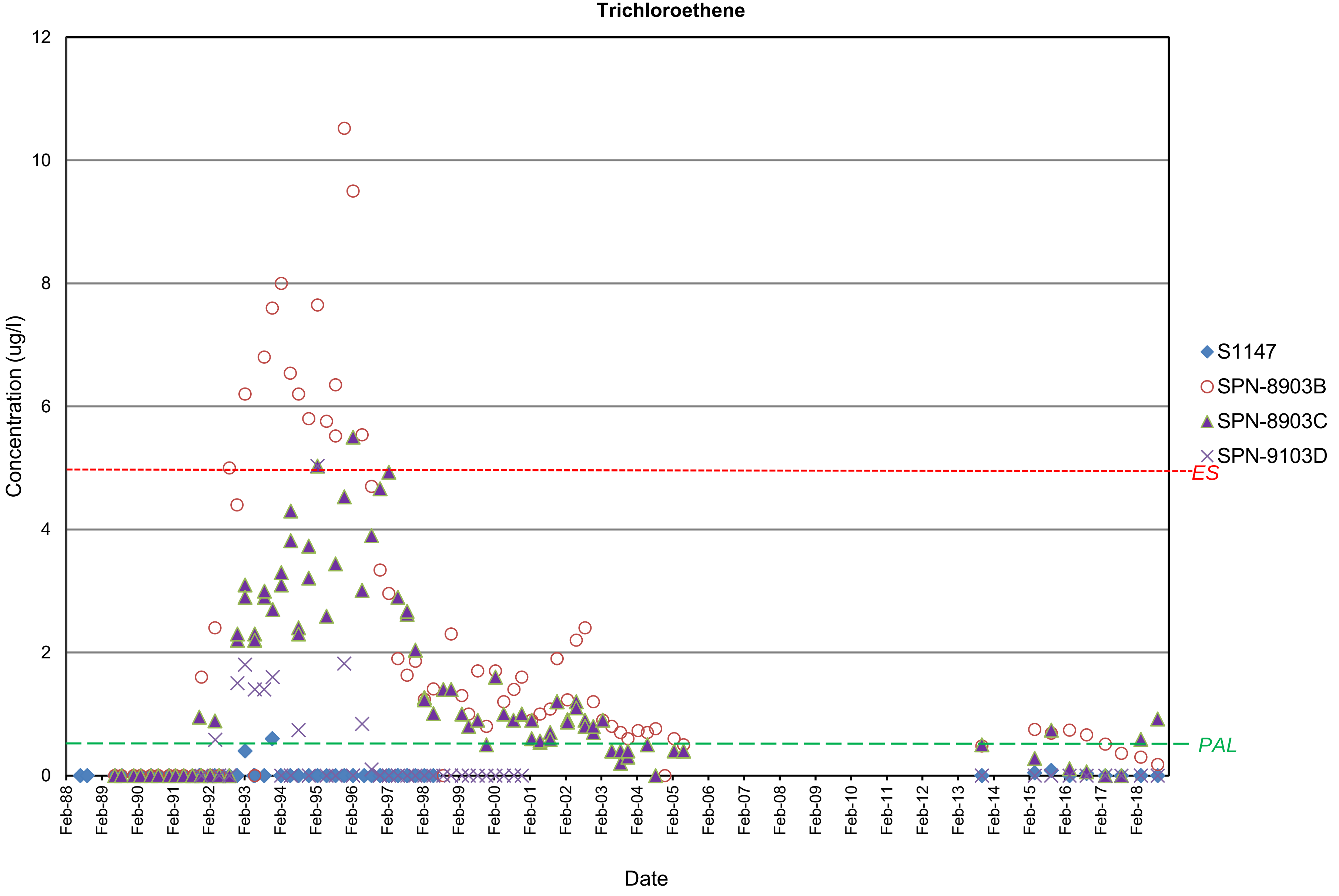



Trichloroethene
Concentration (ug/l)
60
50
40
30
20
10
0
Jan-89
Jan-91
Jan-93
Jan-95
Jan-97
Jan-99
Jan-01
Jan-03
Jan-05
Jan-07
Jan-09
Jan-11
Jan-13
Jan-15
Jan-17
Jan-19
Date
ES
PAL
PBN-8912A
PBN-8912B
PBN-9112C
PBN-9112D

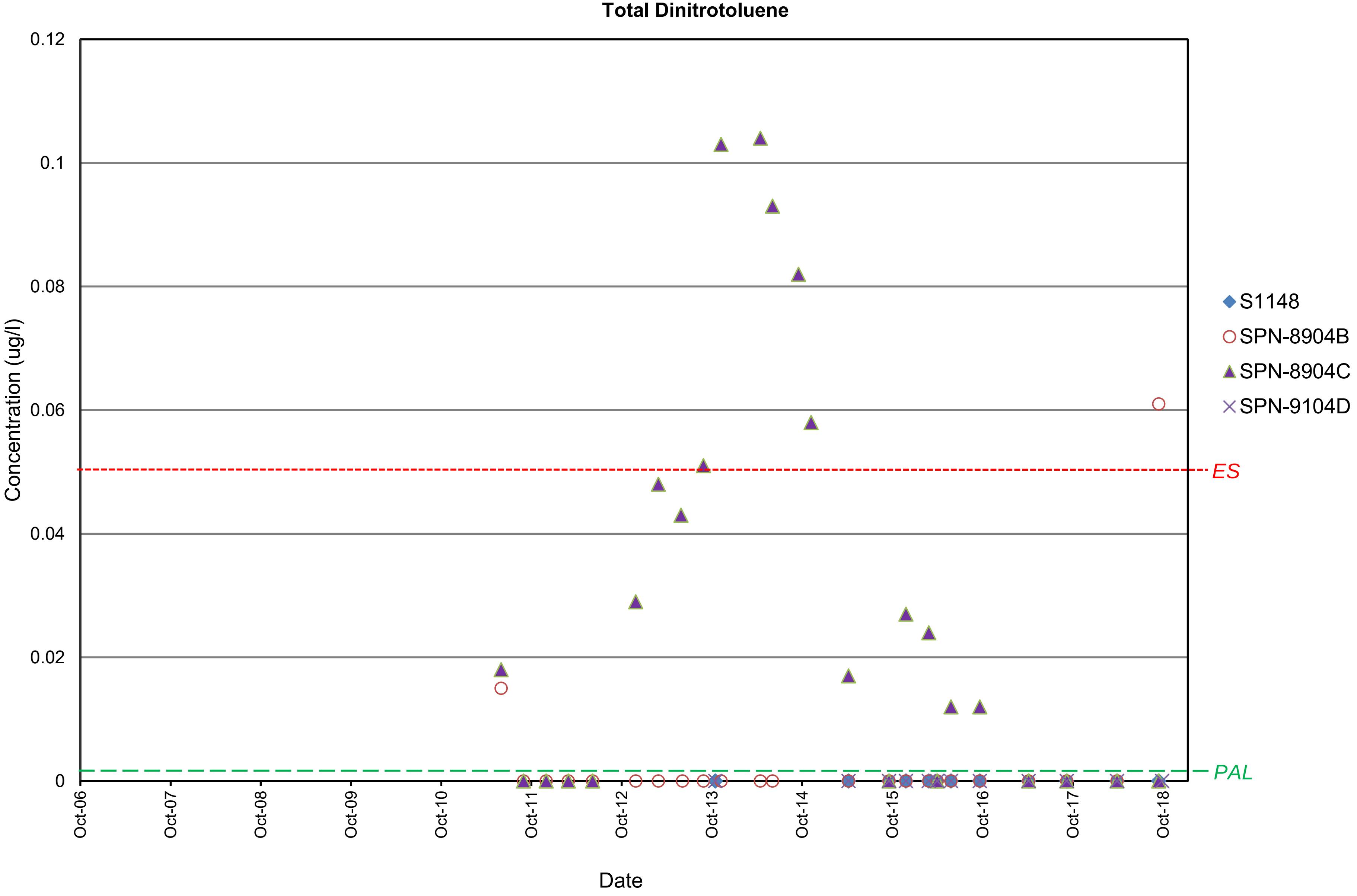

Carbon Tetrachloride
Concentration (ug/l)
400
350
300
250
200
150
100
50
0
Feb-88
Feb-89
Feb-90
Feb-91
Feb-92
Feb-93
Feb-94
Feb-95
Feb-96
Feb-97
Feb-98
Feb-99
Feb-00
Feb-01
Feb-02
Feb-03
Feb-04
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Date
ES
PAL
S1147
SPN-8903B
SPN-8903C
SPN-9103D

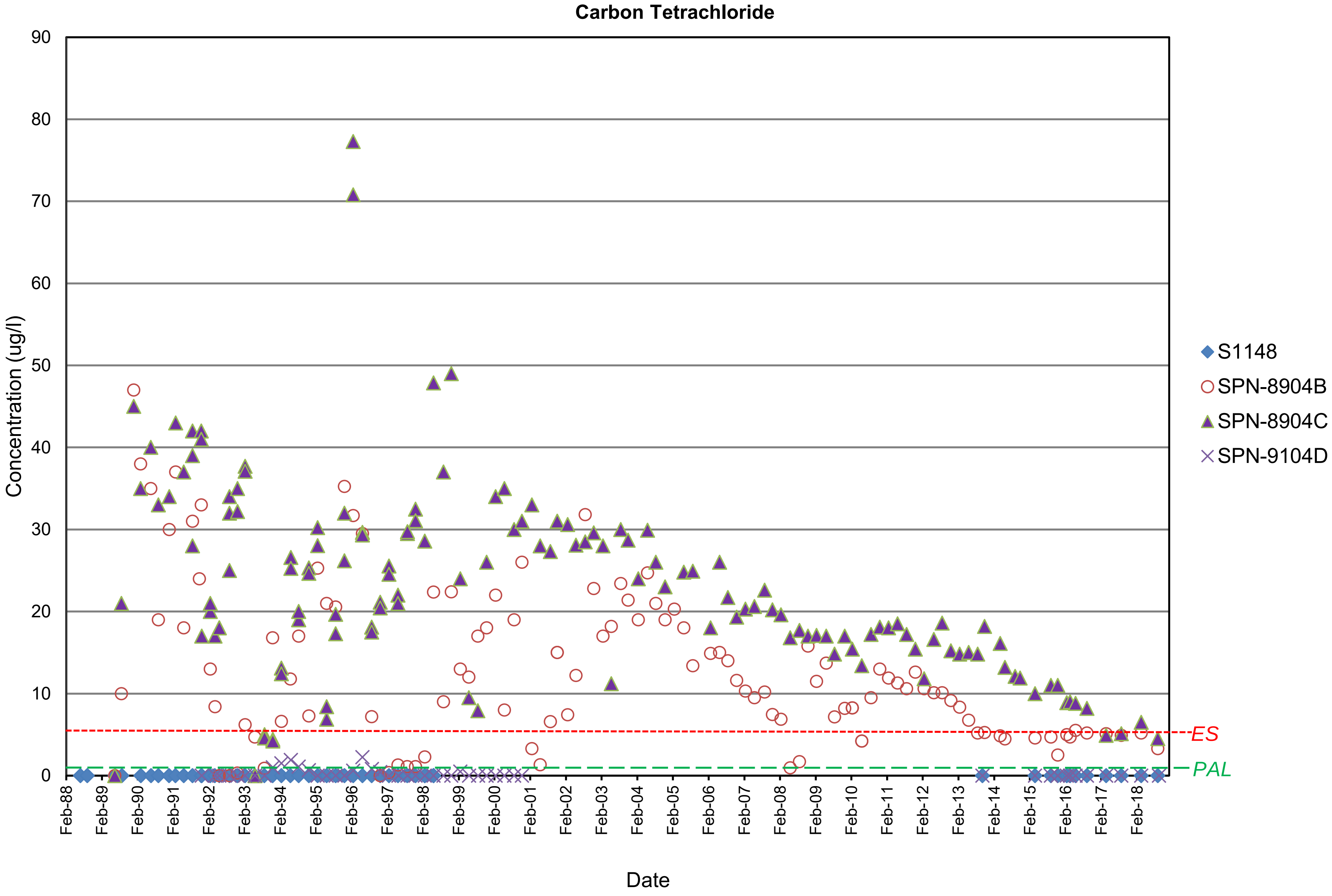

Chloroform
Concentration (ug/l)
25
20
15
10
5
0
ES
PAL
Feb-88
Feb-89
Feb-90
Feb-91
Feb-92
Feb-93
Feb-94
Feb-95
Feb-96
Feb-97
Feb-98
Feb-99
Feb-00
Feb-01
Feb-02
Feb-03
Feb-04
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Date
◆ S1147
○ SPN-8903B
▲ SPN-8903C
× SPN-9103D

BAAP Groundwater Data | Propellant Burning Ground | Plume Edge - Onsite

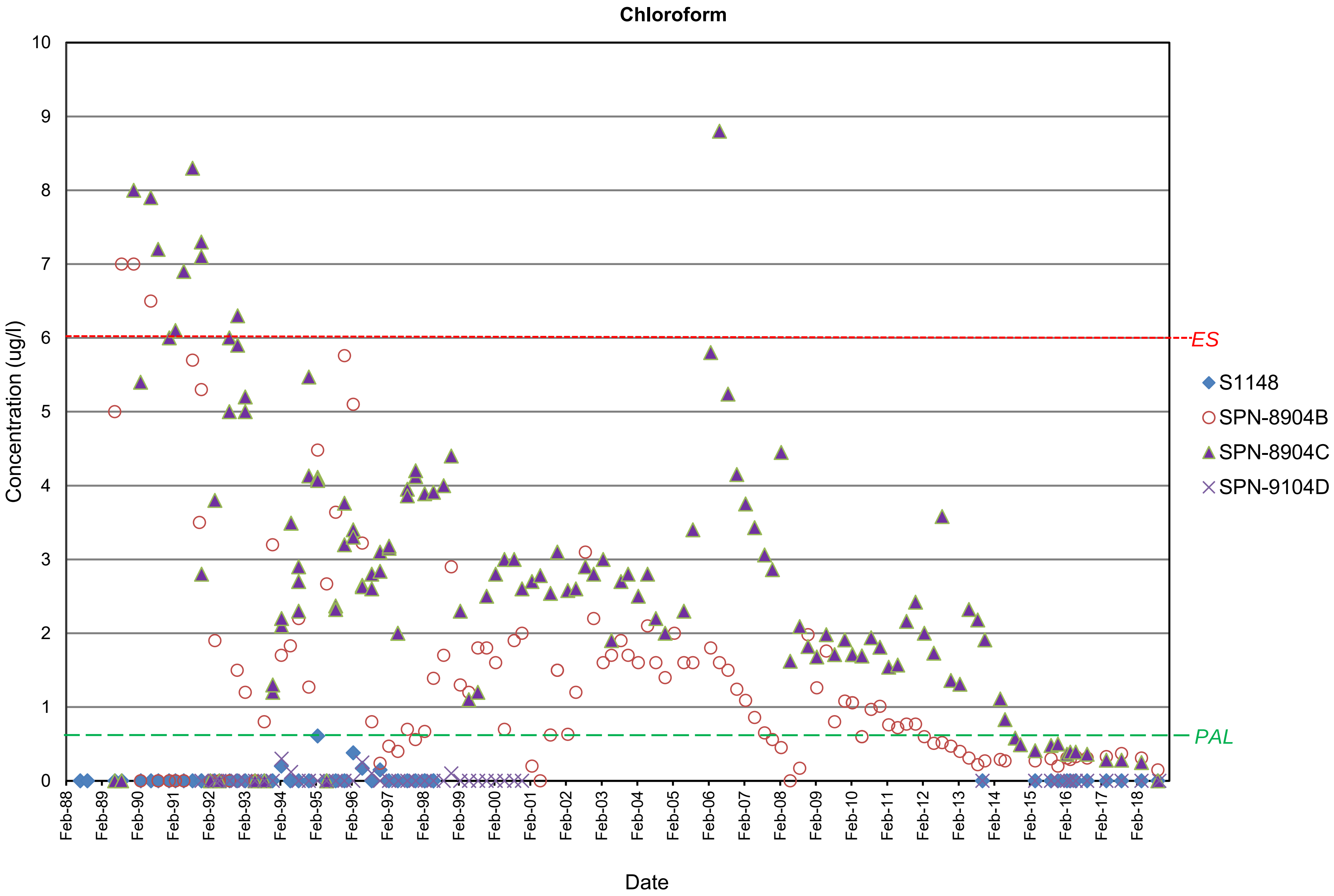


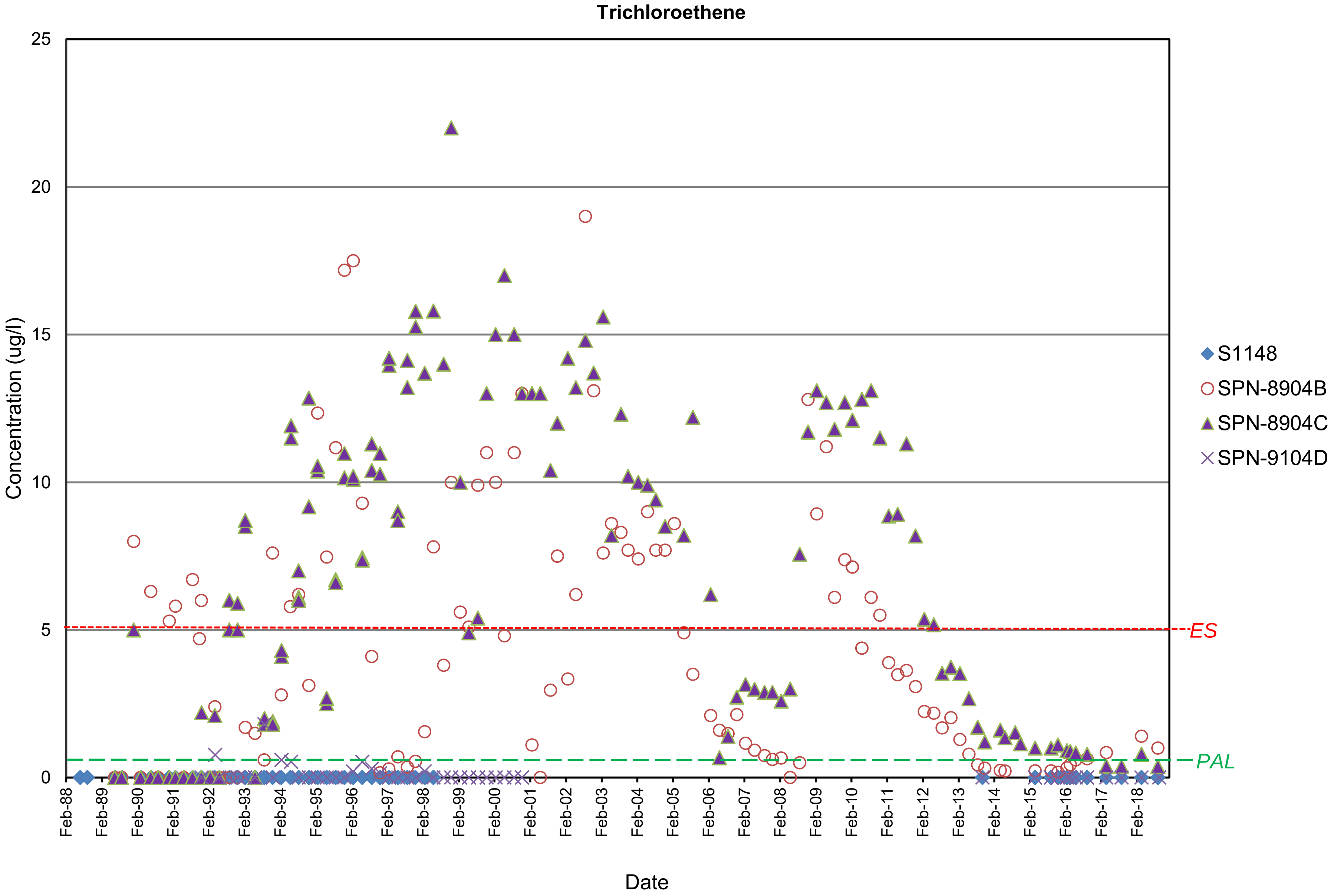
BAAP Groundwater Data Propellant Burning Ground Plume Center - Onsite




Carbon Tetrachloride
Concentration (ug/l)
0
10
20
30
40
50
60
70
80
90
Feb-88
Feb-89
Feb-90
Feb-91
Feb-92
Feb-93
Feb-94
Feb-95
Feb-96
Feb-97
Feb-98
Feb-99
Feb-00
Feb-01
Feb-02
Feb-03
Feb-04
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Date
ES
PAL
◆ S1148
○ SPN-8904B
▲ SPN-8904C
× SPN-9104D

BAAP Groundwater Data | Propellant Burning Ground | Plume Center - Onsite




Trichloroethene
Concentration (ug/l)
25
20
15
10
5
0
Date
Feb-88
Feb-89
Feb-90
Feb-91
Feb-92
Feb-93
Feb-94
Feb-95
Feb-96
Feb-97
Feb-98
Feb-99
Feb-00
Feb-01
Feb-02
Feb-03
Feb-04
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
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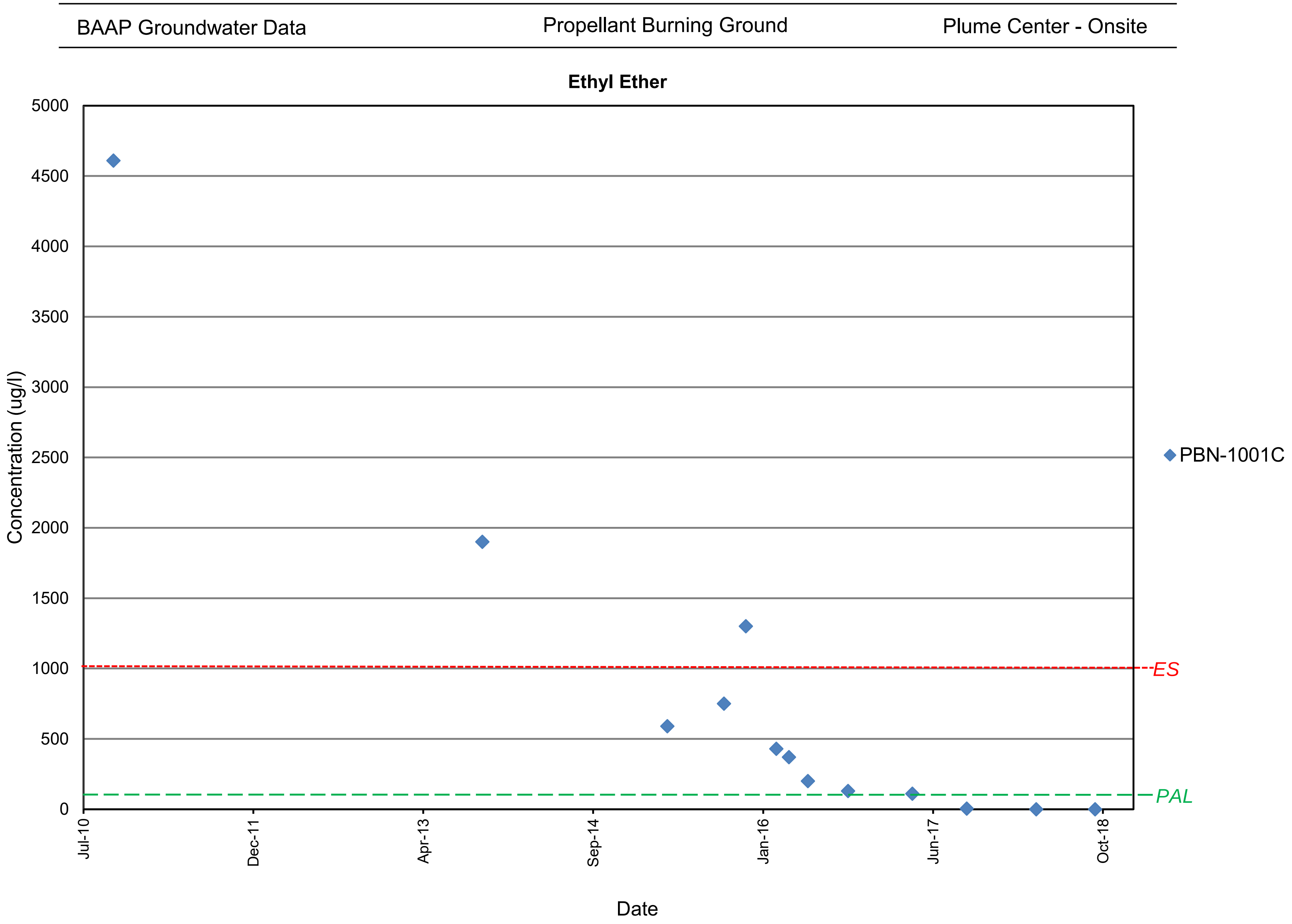
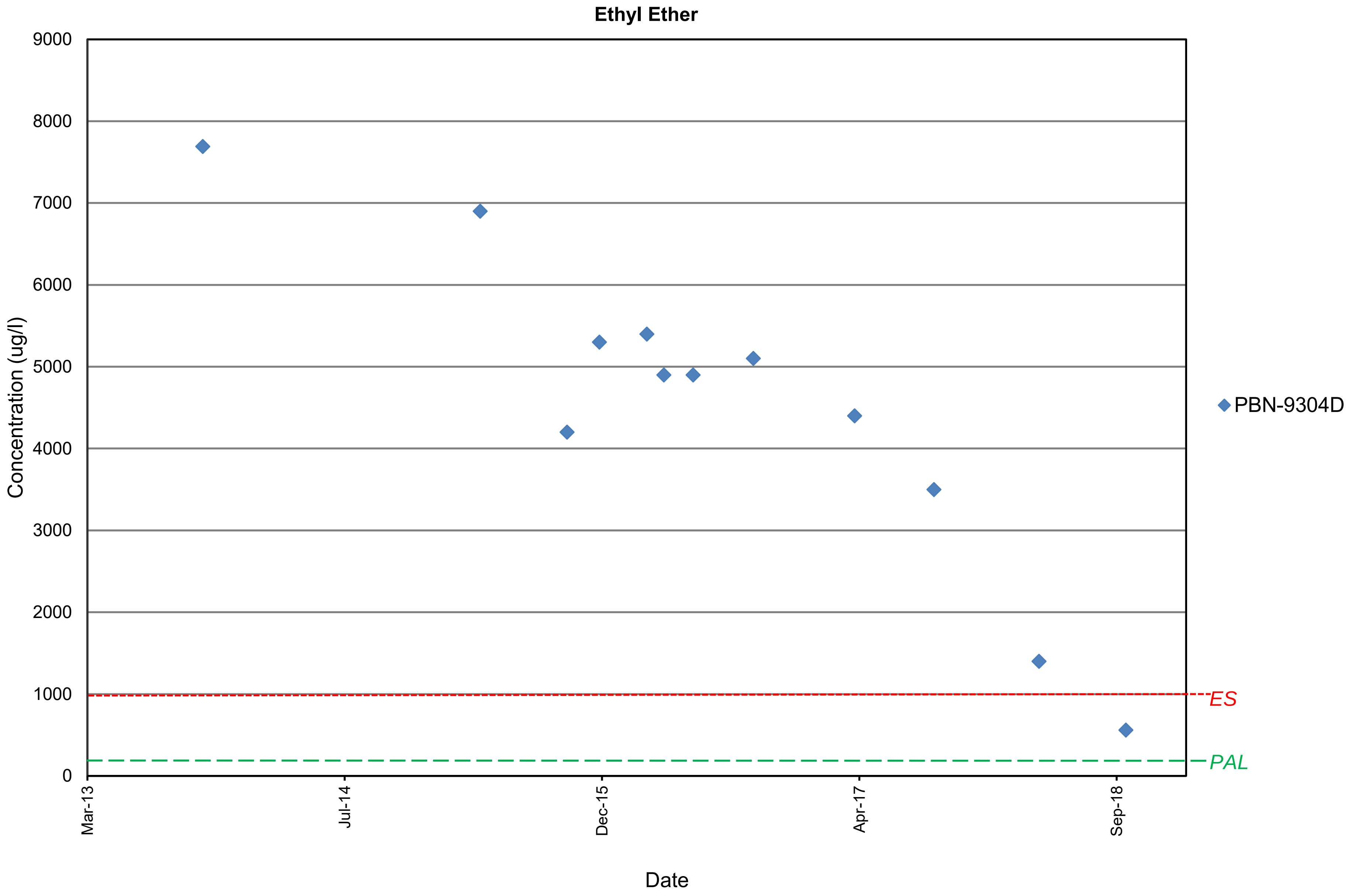
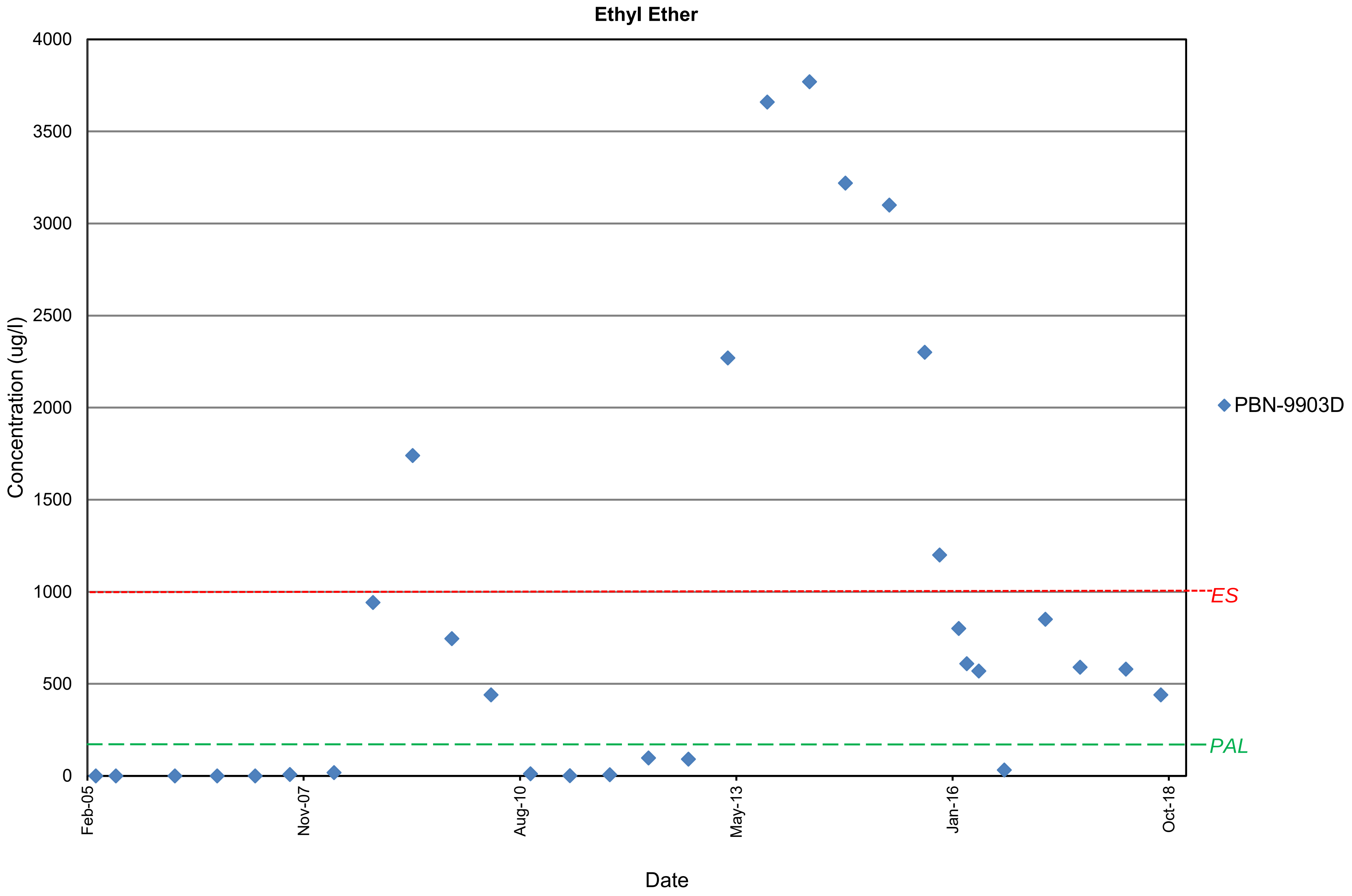
SPN-8904C
SPN-9104D


BAAP Groundwater Data
Propellant Burning Ground
Plume Center - Onsite
Ethyl Ether
Concentration (ug/l)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Jul-10
Dec-11
Apr-13
Sep-14
Jan-16
Jun-17
Oct-18
Date
PBN-1001C
ES
PAL

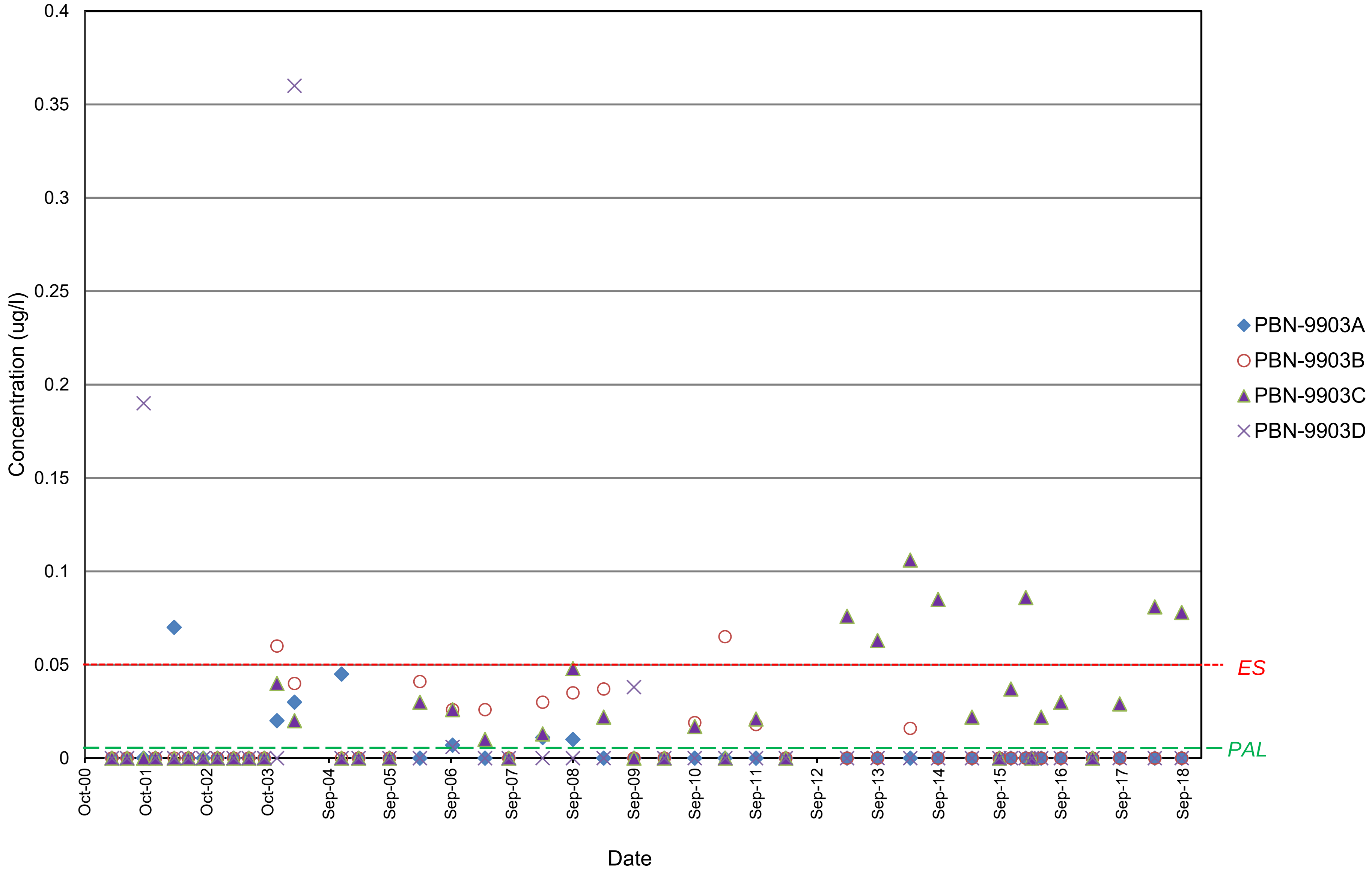
BAAP Groundwater Data Propellant Burning Ground Plume Center - Onsite



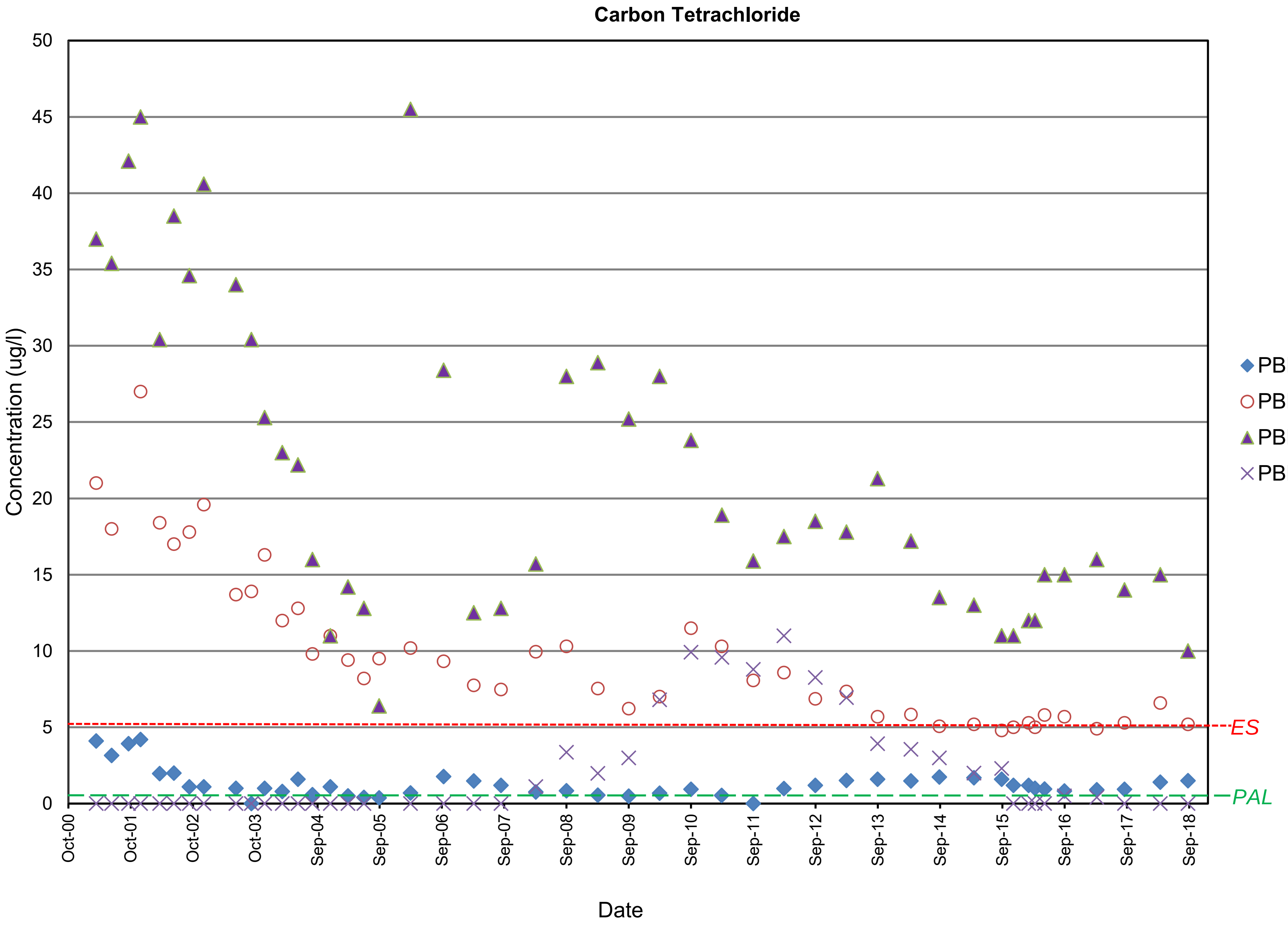
BAAP Groundwater Data | Propellant Burning Ground | Plume Center - Offsite



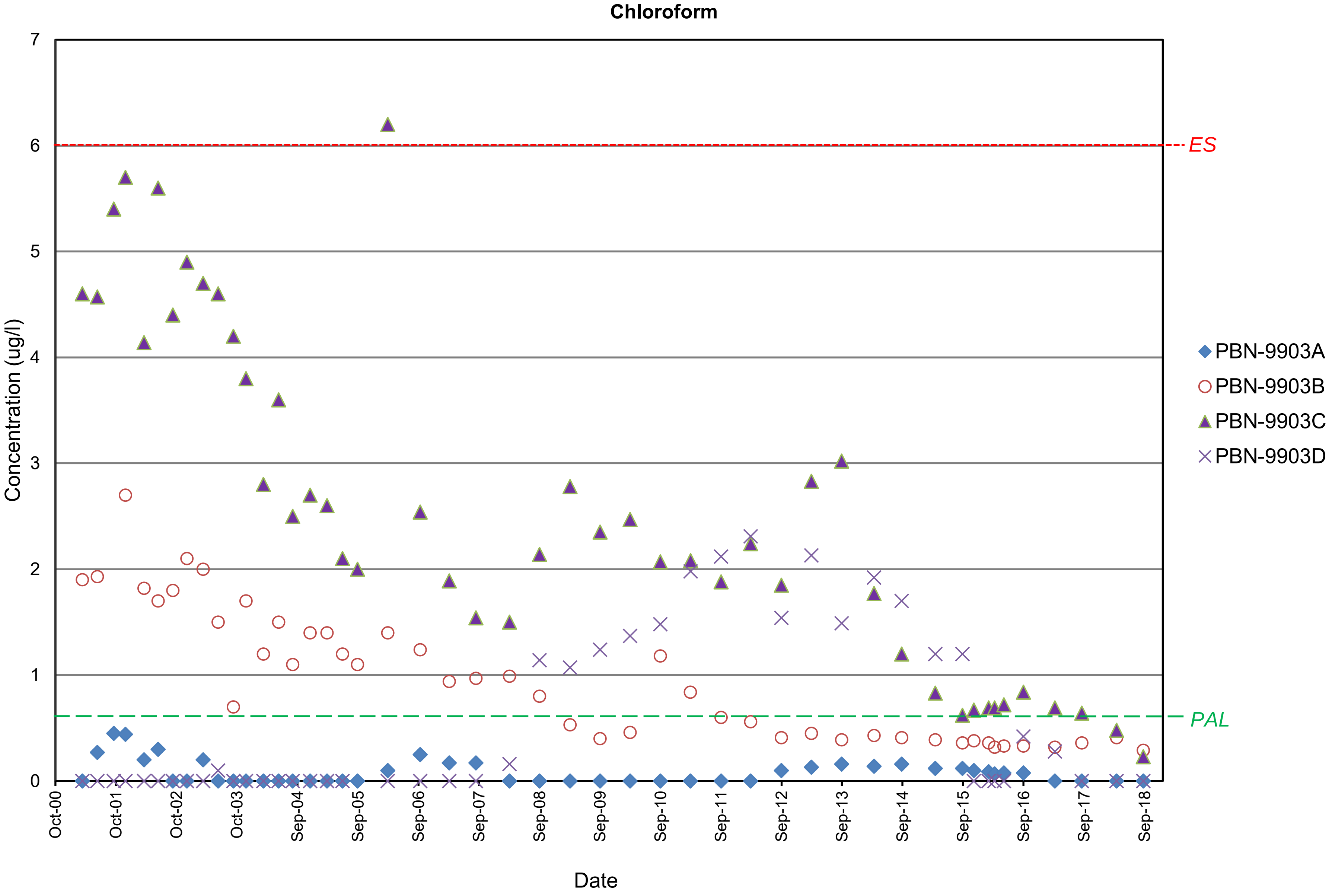
BAAP Groundwater Data | Propellant Burning Ground | Plume Center - Offsite



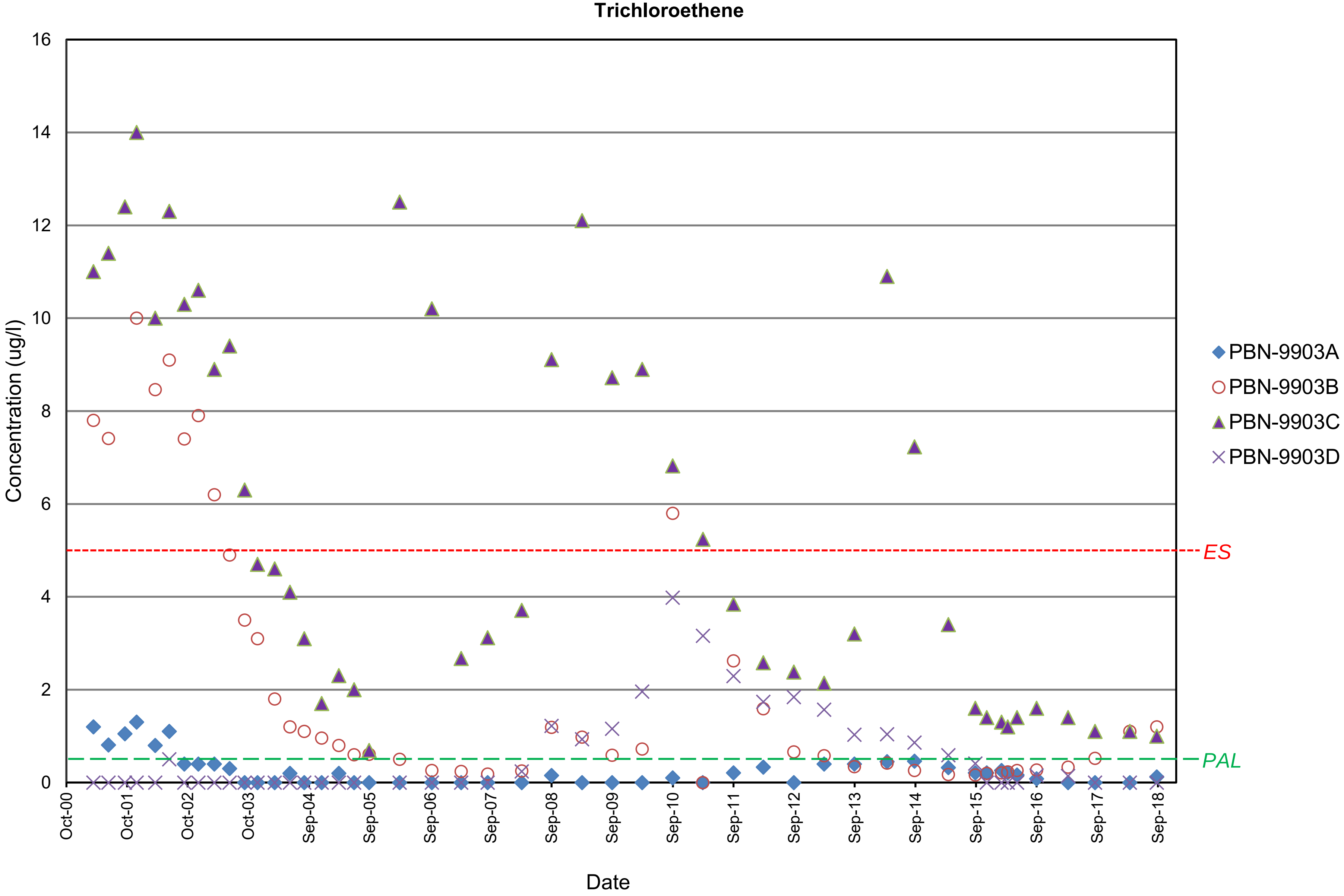
BAAP Groundwater Data | Propellant Burning Ground | Plume Center - Offsite

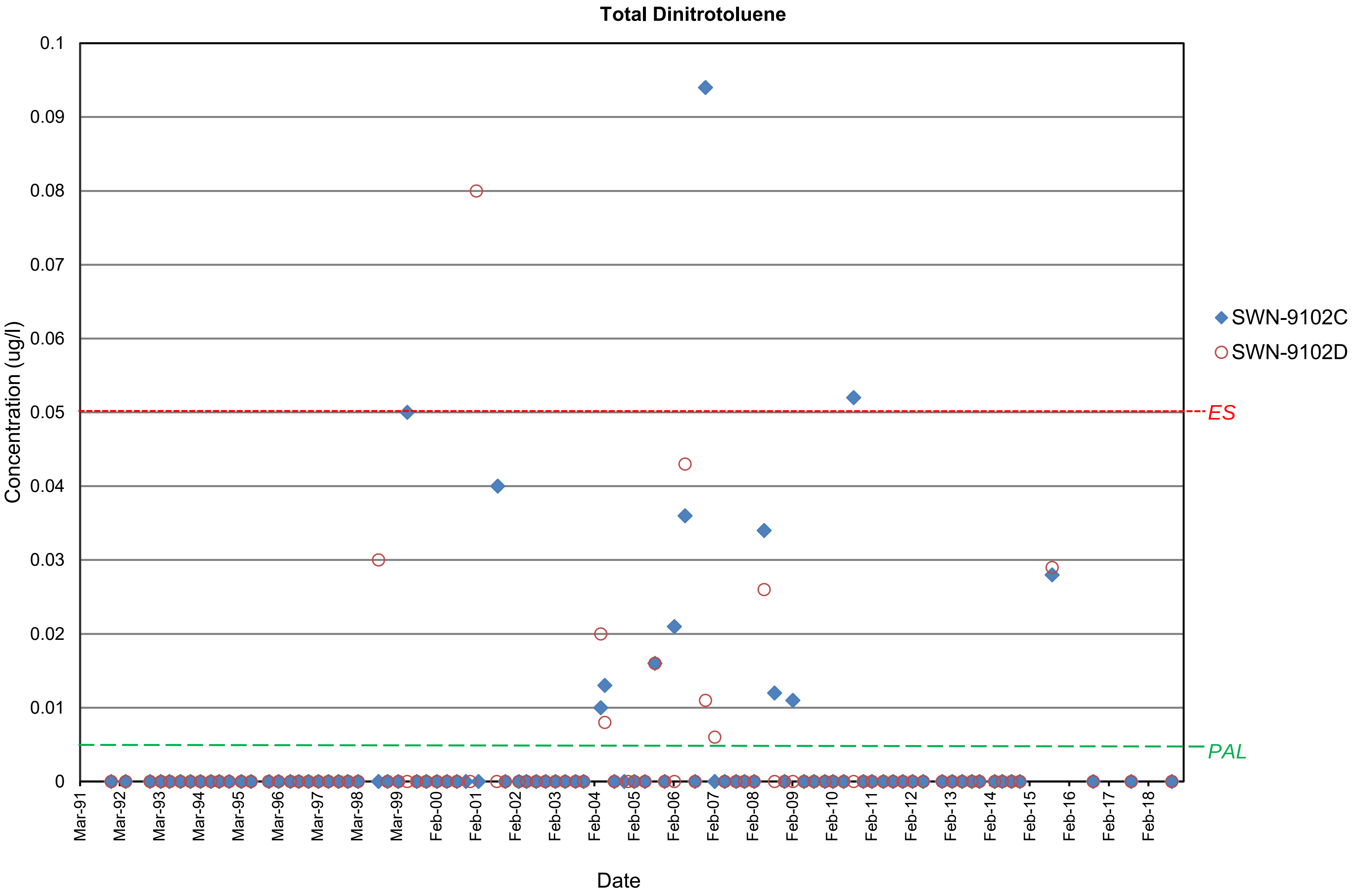


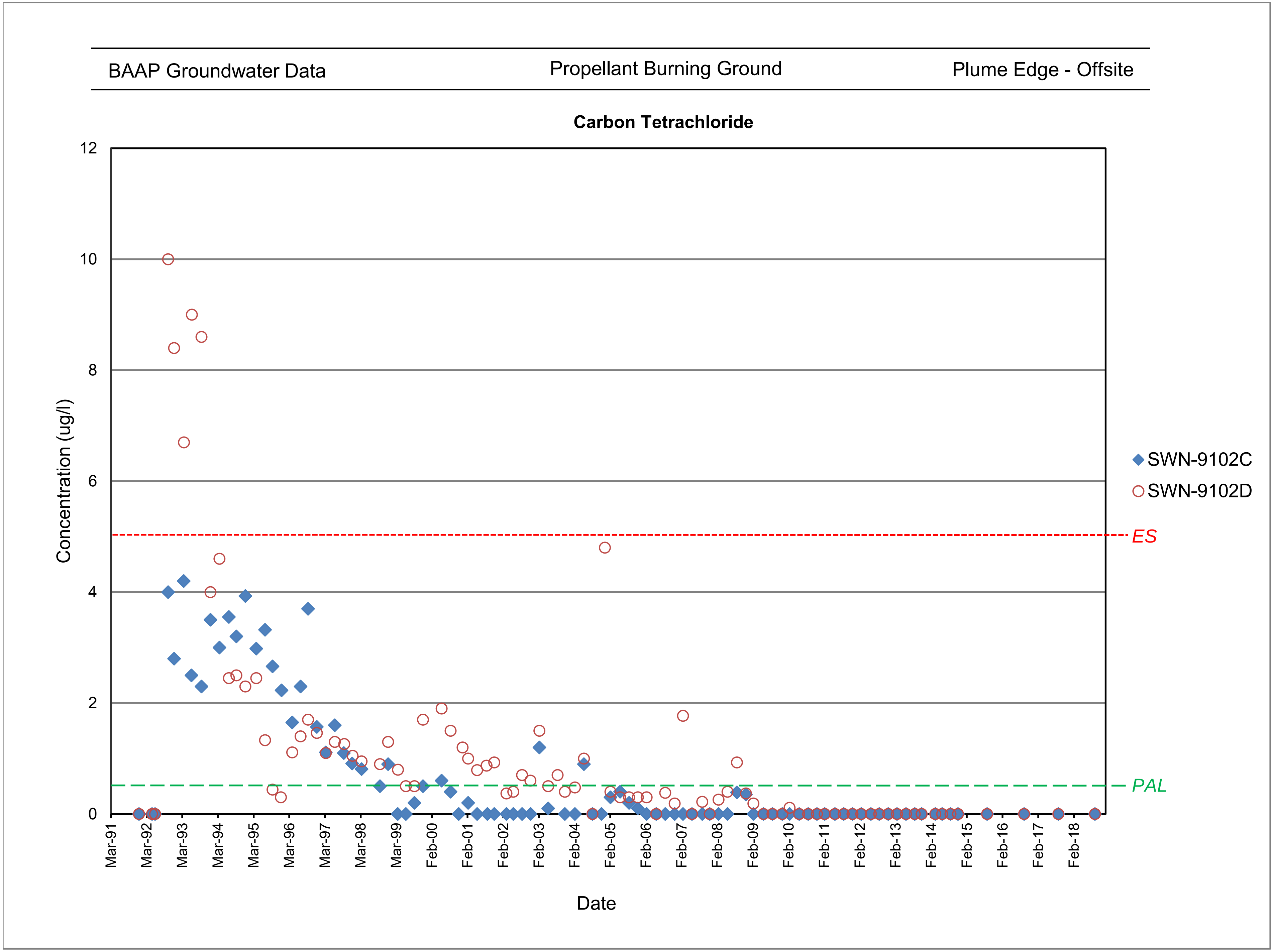
BAAP Groundwater Data Propellant Burning Ground Plume Center - Offsite



BAAP Groundwater Data | Propellant Burning Ground | Plume Center - Offsite




Total Dinitrotoluene
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Concentration (ug/l)
Mar-91
Mar-92
Mar-93
Mar-94
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
Feb-00
Feb-01
Feb-02
Feb-03
Feb-04
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Date
◆ SWN-9102C
○ SWN-9102D
ES
PAL


BAAP Groundwater Data
Propellant Burning Ground
Plume Edge - Offsite
Carbon Tetrachloride
Concentration (ug/l)
0
2
4
6
8
10
12
Date
Mar-91
Mar-92
Mar-93
Mar-94
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
Feb-00
Feb-01
Feb-02
Feb-03
Feb-04
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
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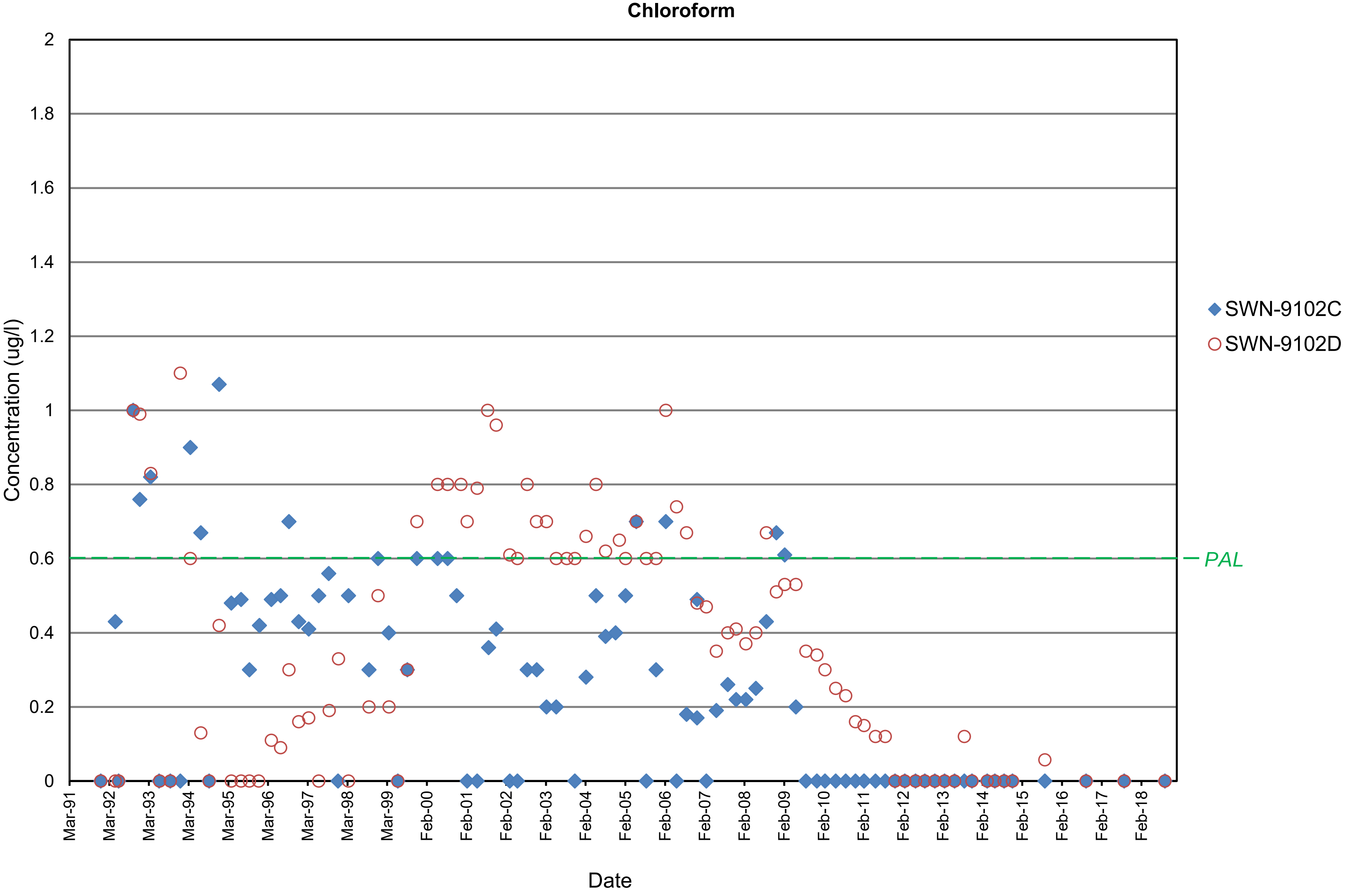
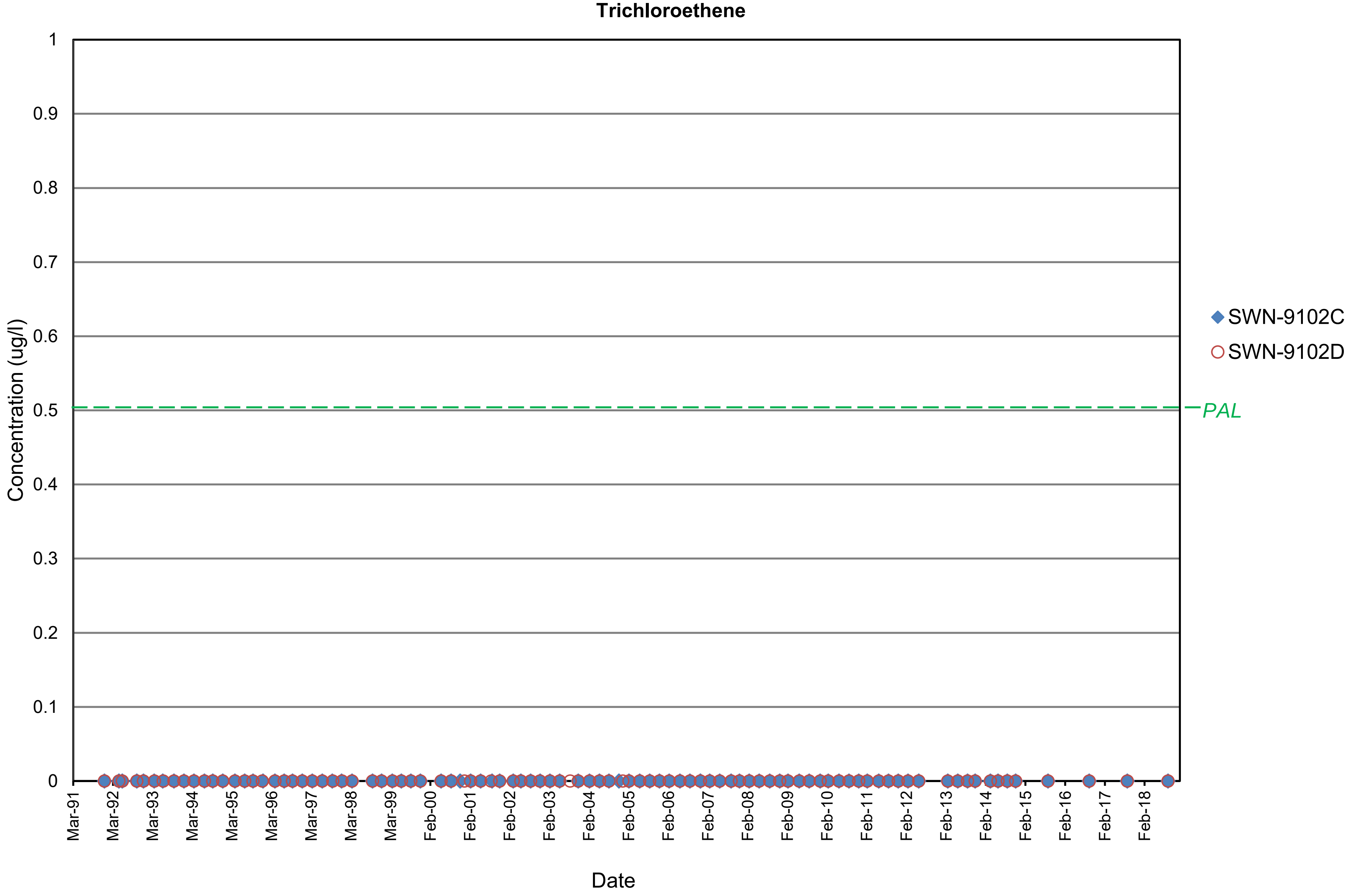
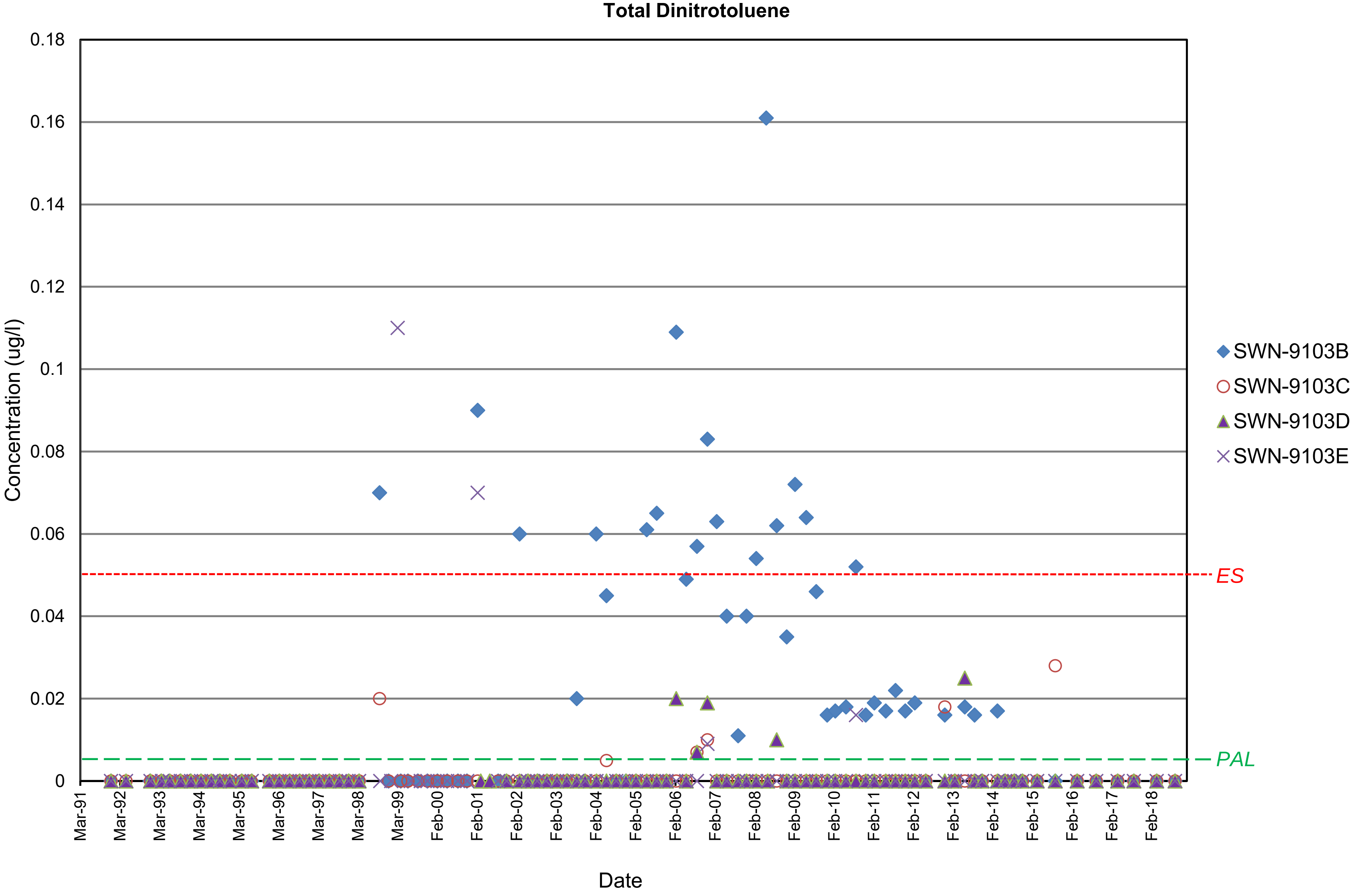
Feb-18
◆ SWN-9102C
○ SWN-9102D
ES
PAL


Chloroform
Concentration (ug/l)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Mar-91
Mar-92
Mar-93
Mar-94
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
Feb-00
Feb-01
Feb-02
Feb-03
Feb-04
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Date
◆ SWN-9102C
○ SWN-9102D
PAL

BAAP Groundwater Data | Propellant Burning Ground | Plume Edge - Offsite

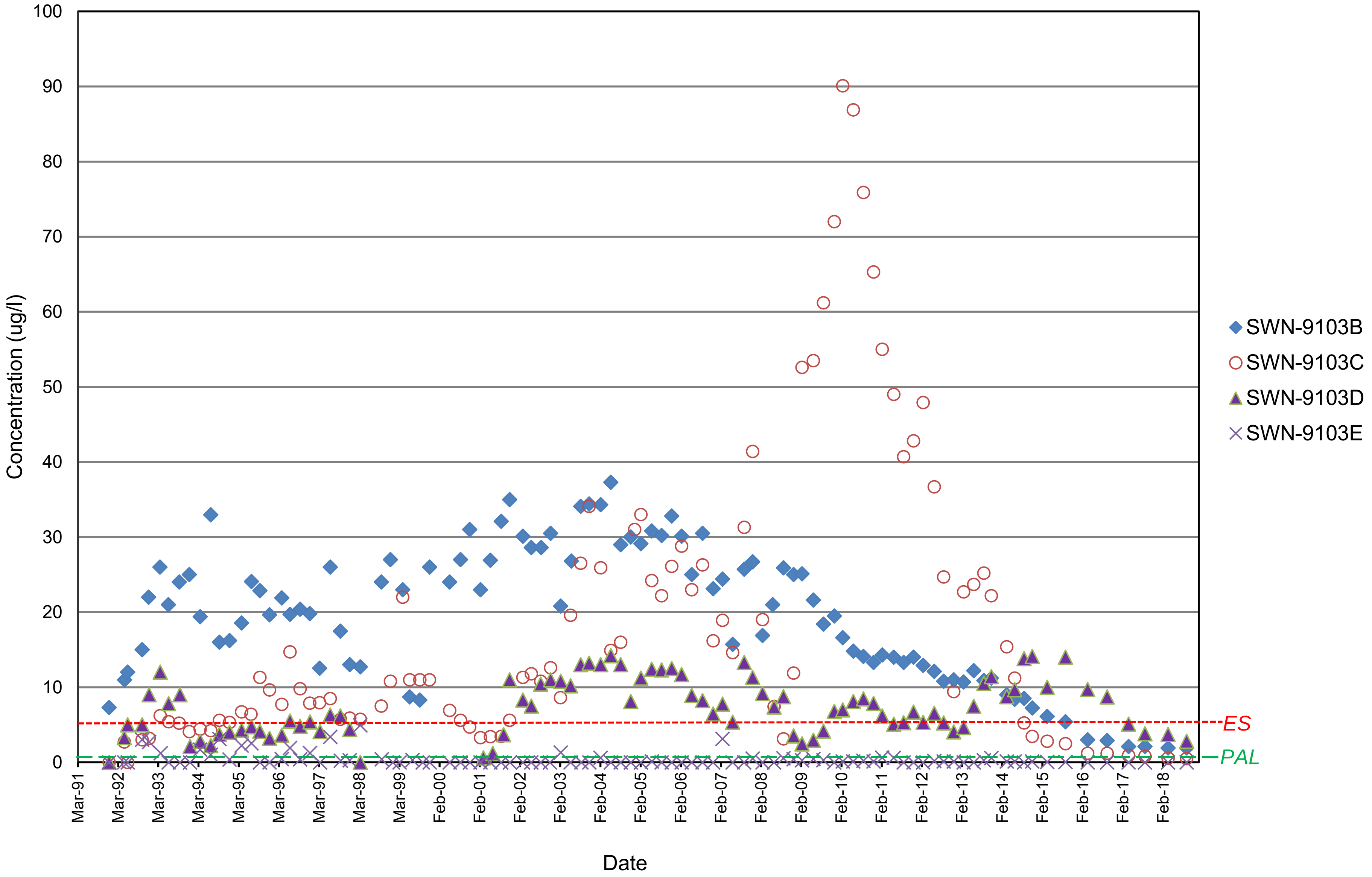


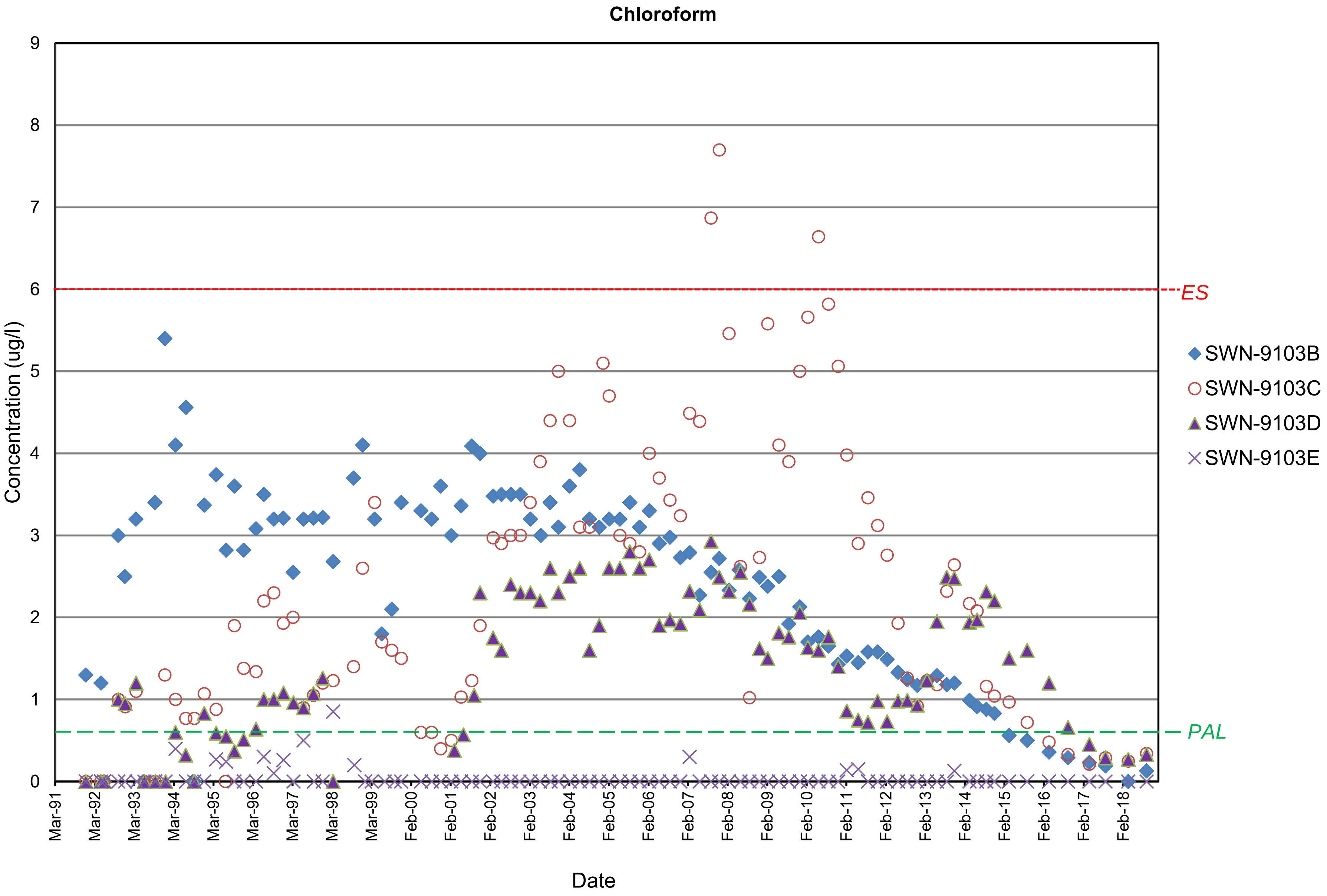
BAAP Groundwater Data | Propellant Burning Ground | Plume Center - Offsite

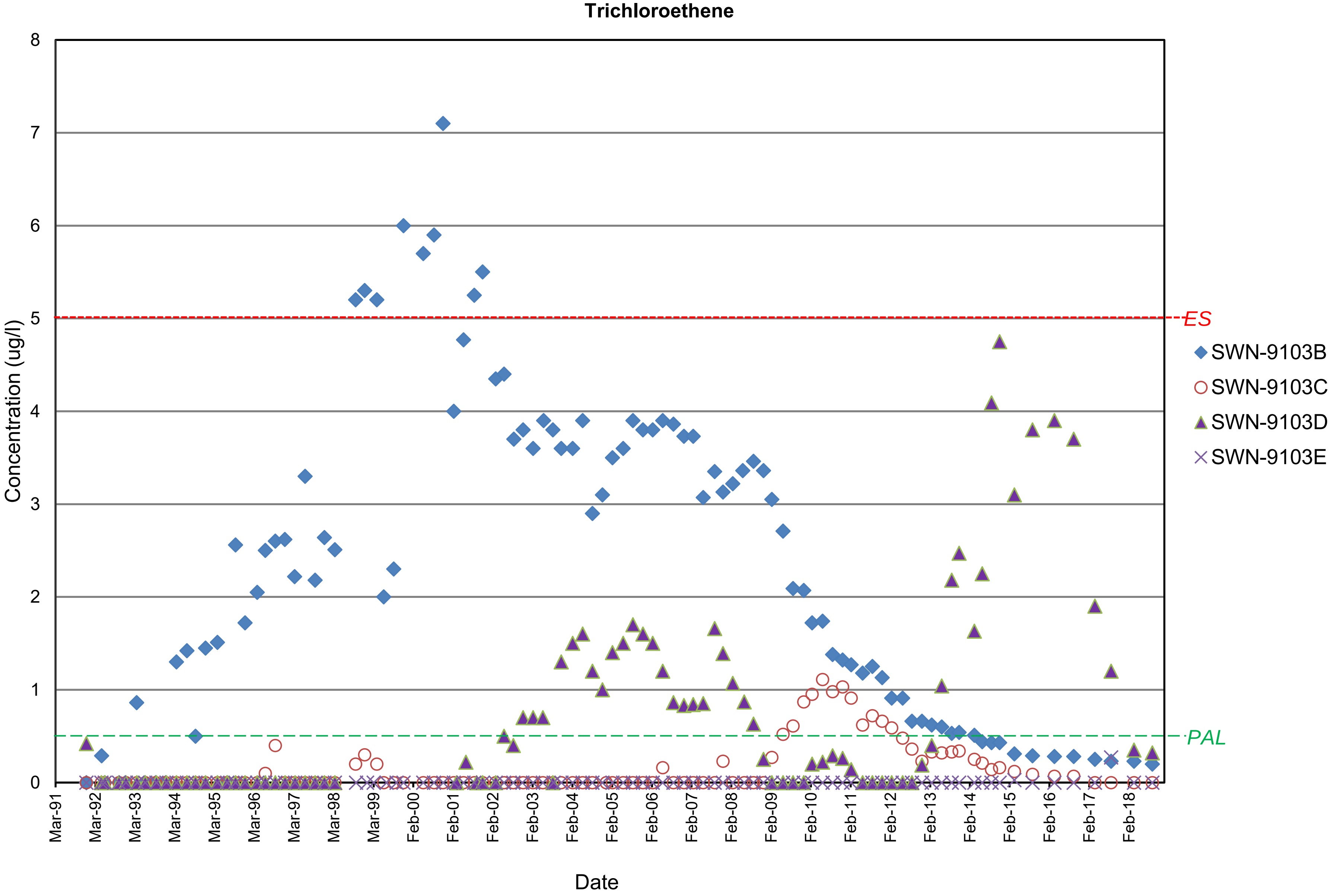


BAAP Groundwater Data Propellant Burning Ground Plume Center - Offsite

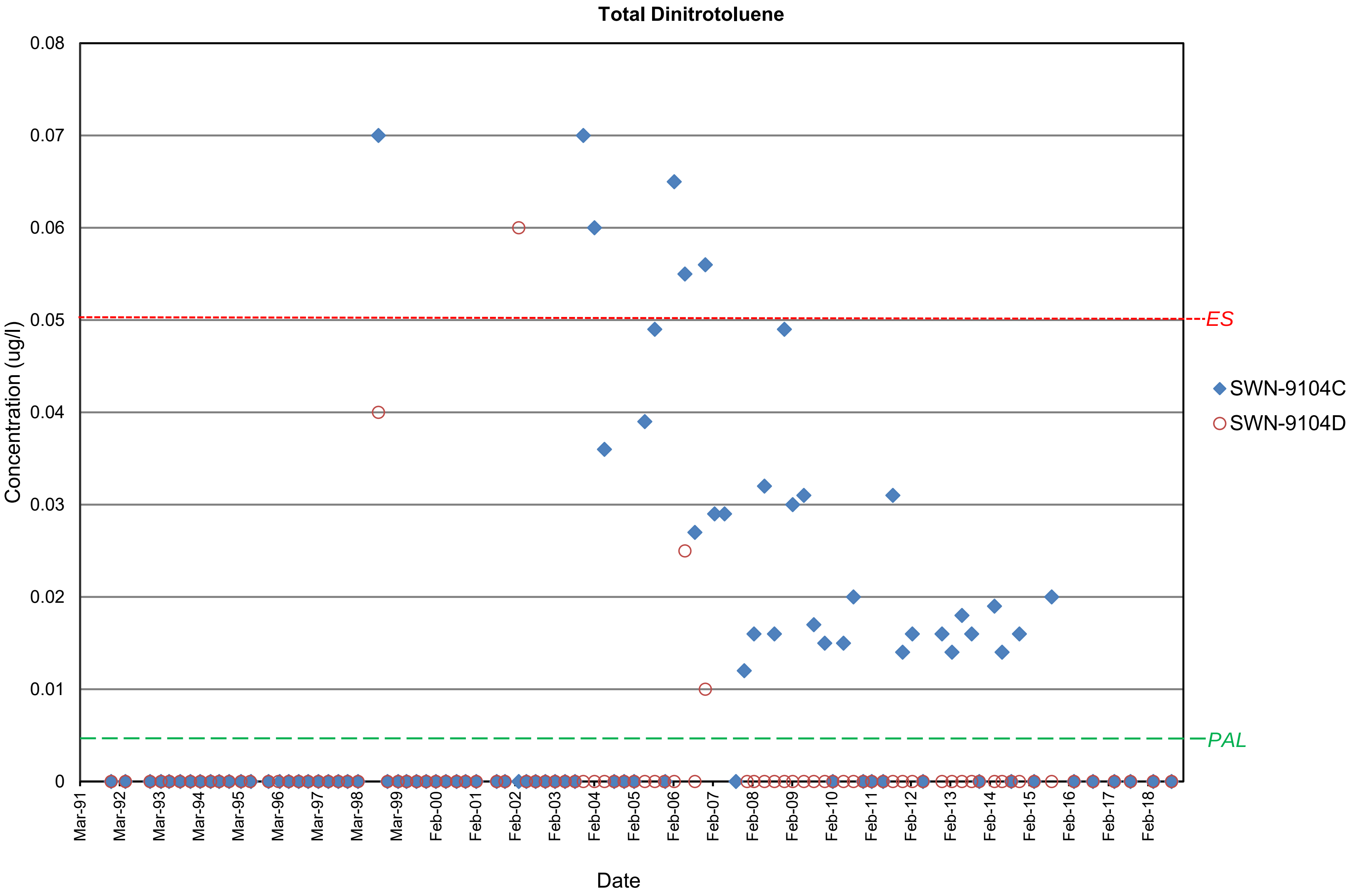
Carbon Tetrachloride

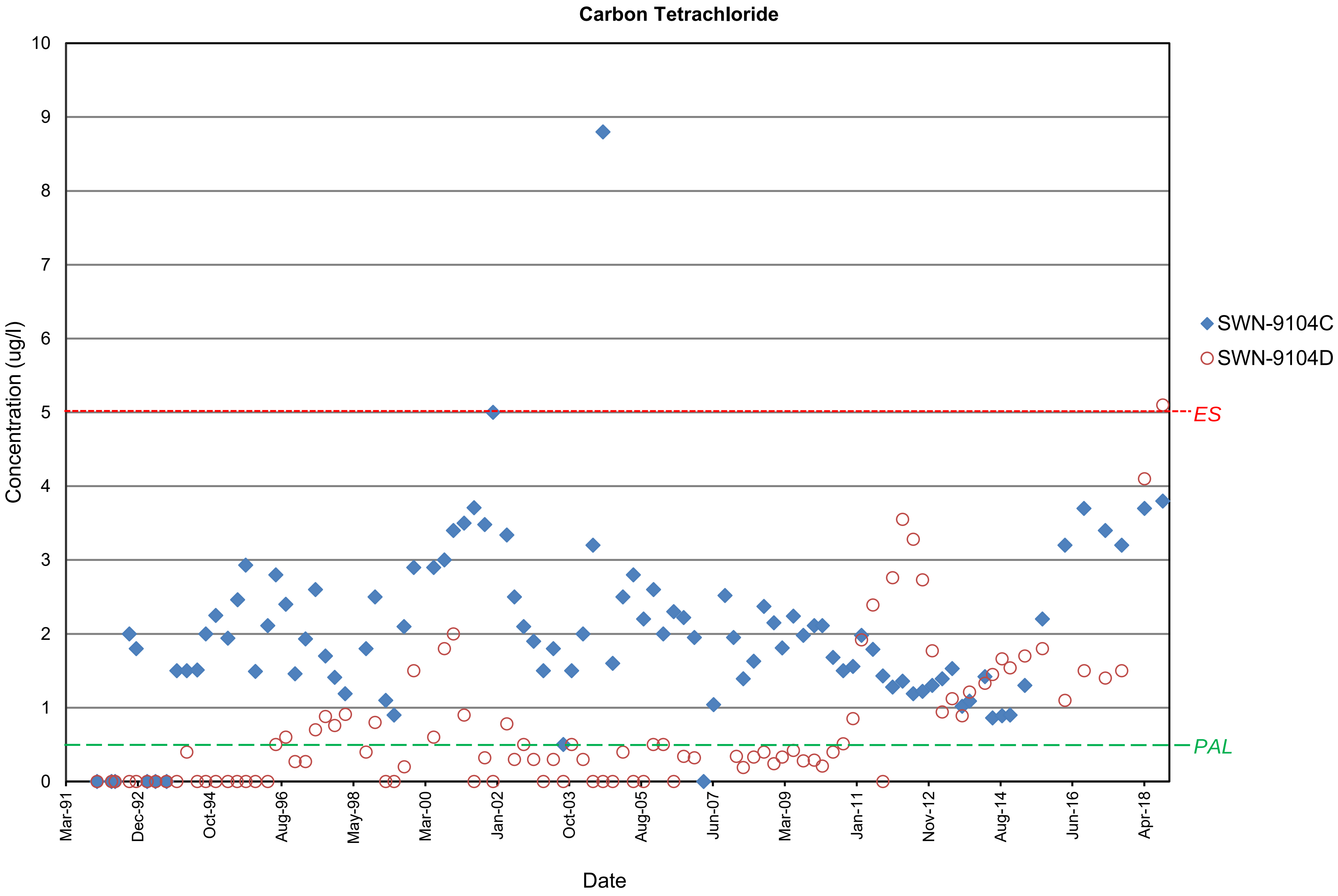



Chloroform
Concentration (ug/l)
0
1
2
3
4
5
6
7
8
9
ES
PAL
Mar-91
Mar-92
Mar-93
Mar-94
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
Feb-00
Feb-01
Feb-02
Feb-03
Feb-04
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Date
◆ SWN-9103B
○ SWN-9103C
▲ SWN-9103D
× SWN-9103E

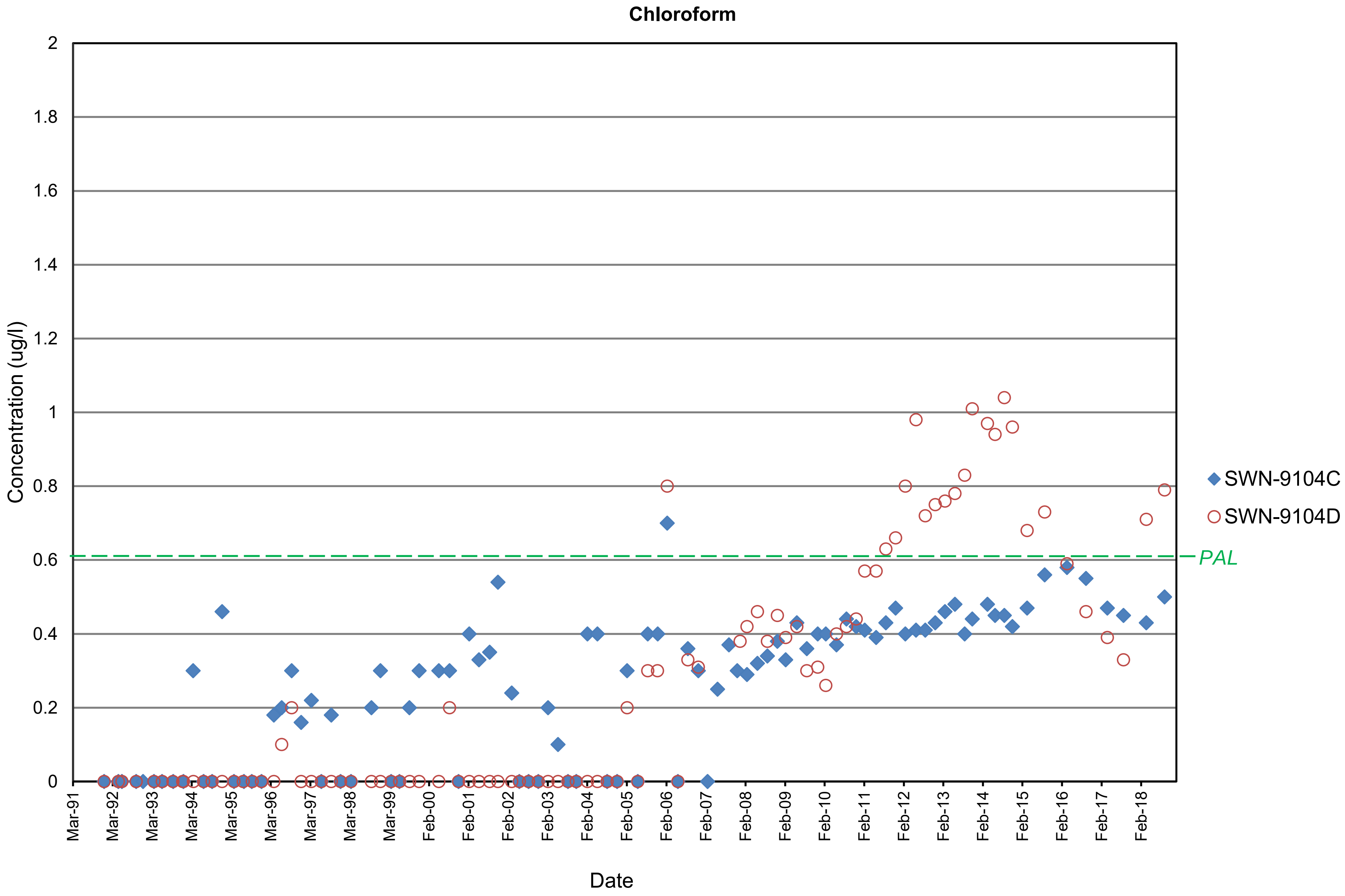

Trichloroethene
Concentration (ug/l)
0
1
2
3
4
5
6
7
8
Date
Mar-91
Mar-92
Mar-93
Mar-94
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
Feb-00
Feb-01
Feb-02
Feb-03
Feb-04
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
ES
PAL
◆ SWN-9103B
○ SWN-9103C
▲ SWN-9103D
× SWN-9103E

BAAP Groundwater Data | Propellant Burning Ground | Plume Center - Offsite

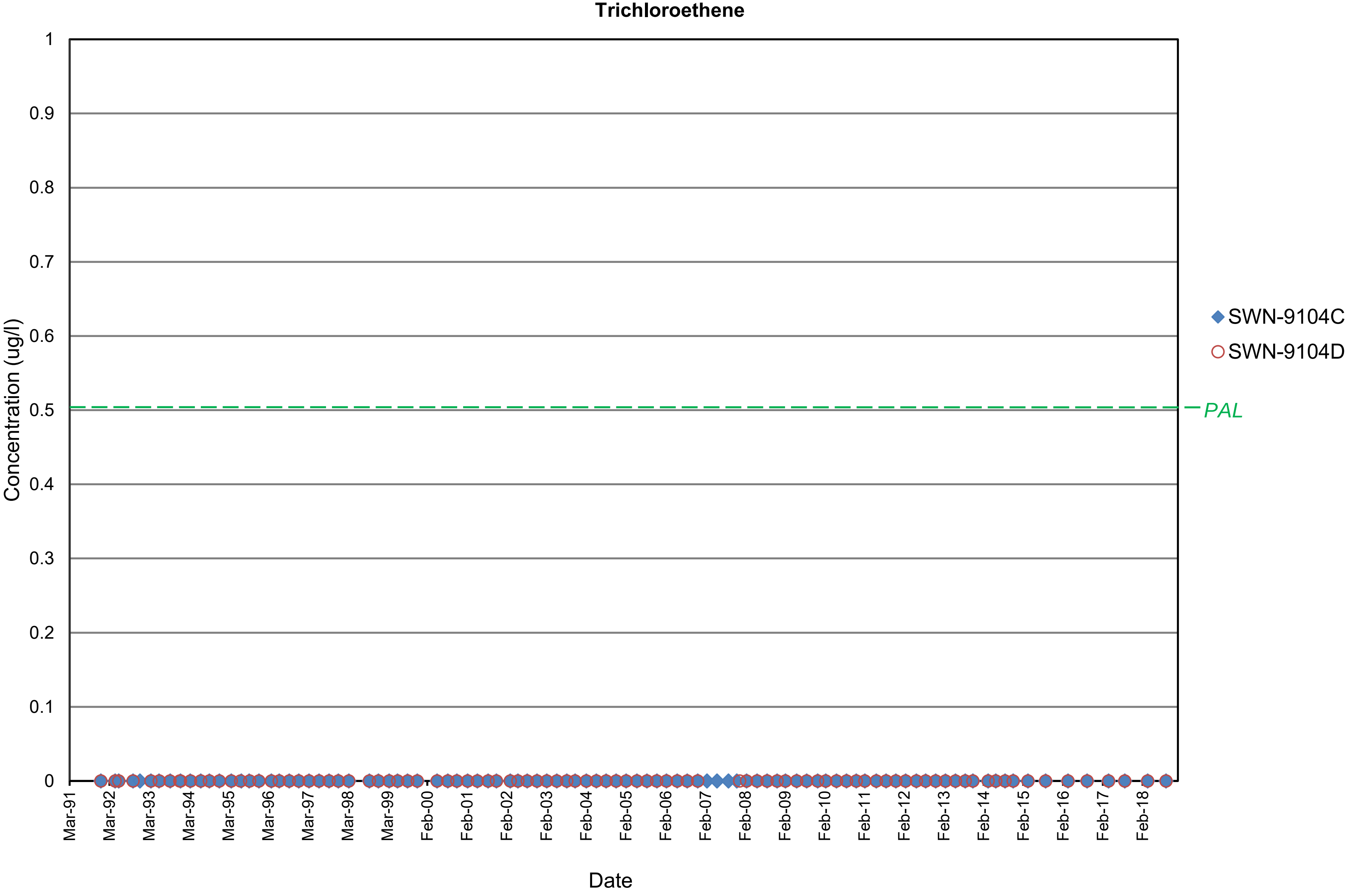


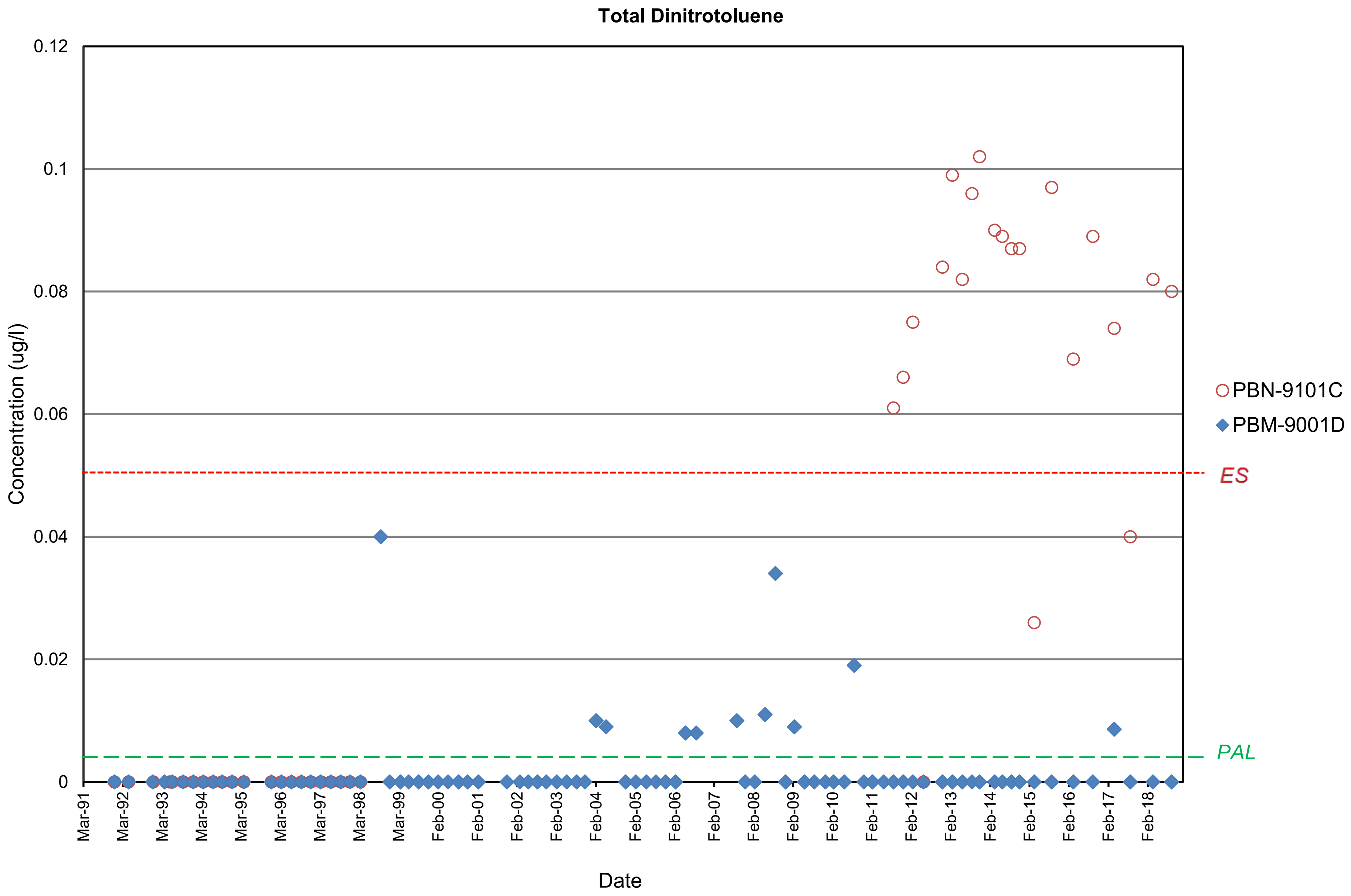


Carbon Tetrachloride


Chloroform
Concentration (ug/l)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Mar-91
Mar-92
Mar-93
Mar-94
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
Feb-00
Feb-01
Feb-02
Feb-03
Feb-04
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Date
◆ SWN-9104C
○ SWN-9104D
PAL

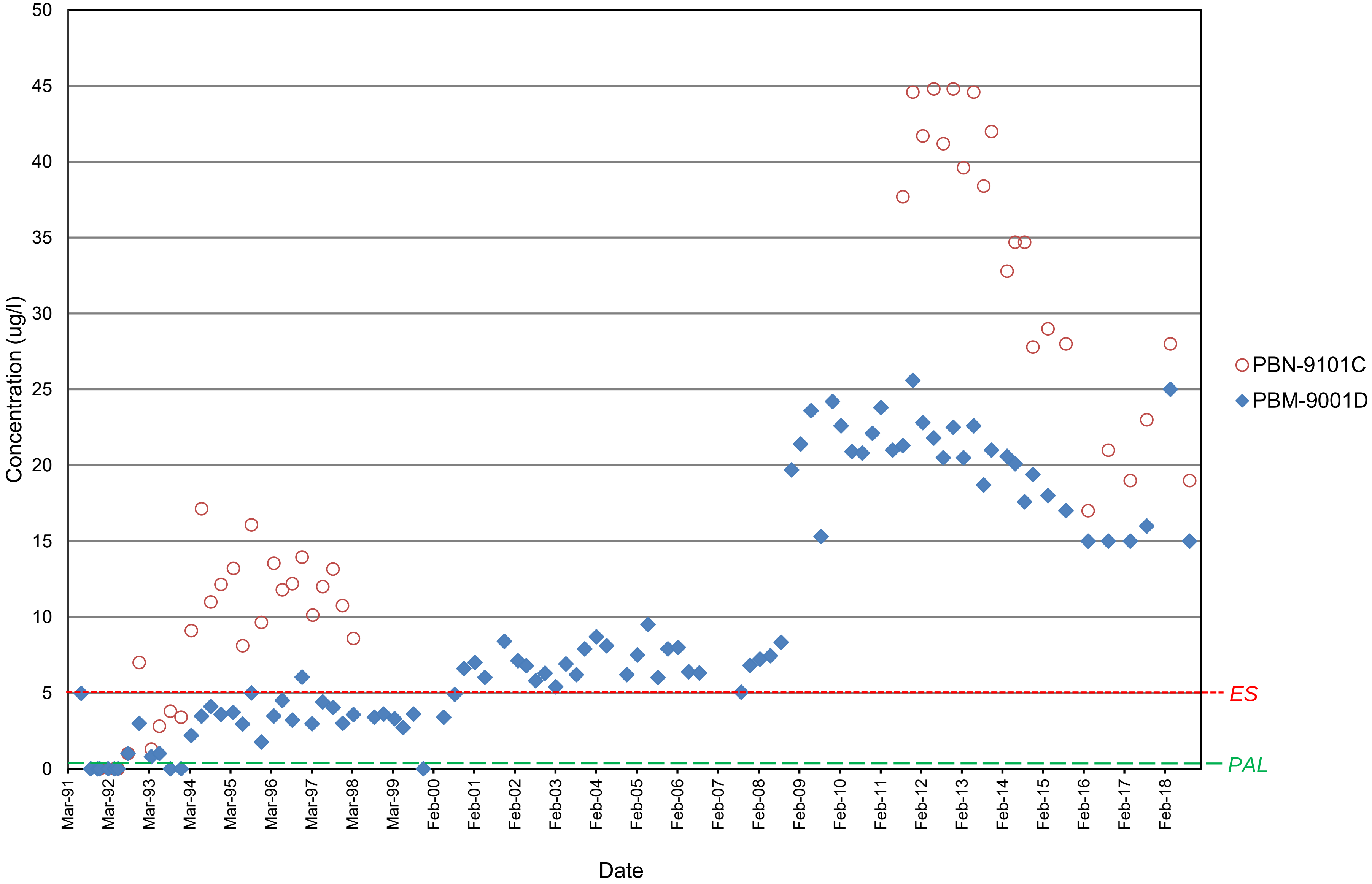
BAAP Groundwater Data Propellant Burning Ground Plume Edge - Offsite

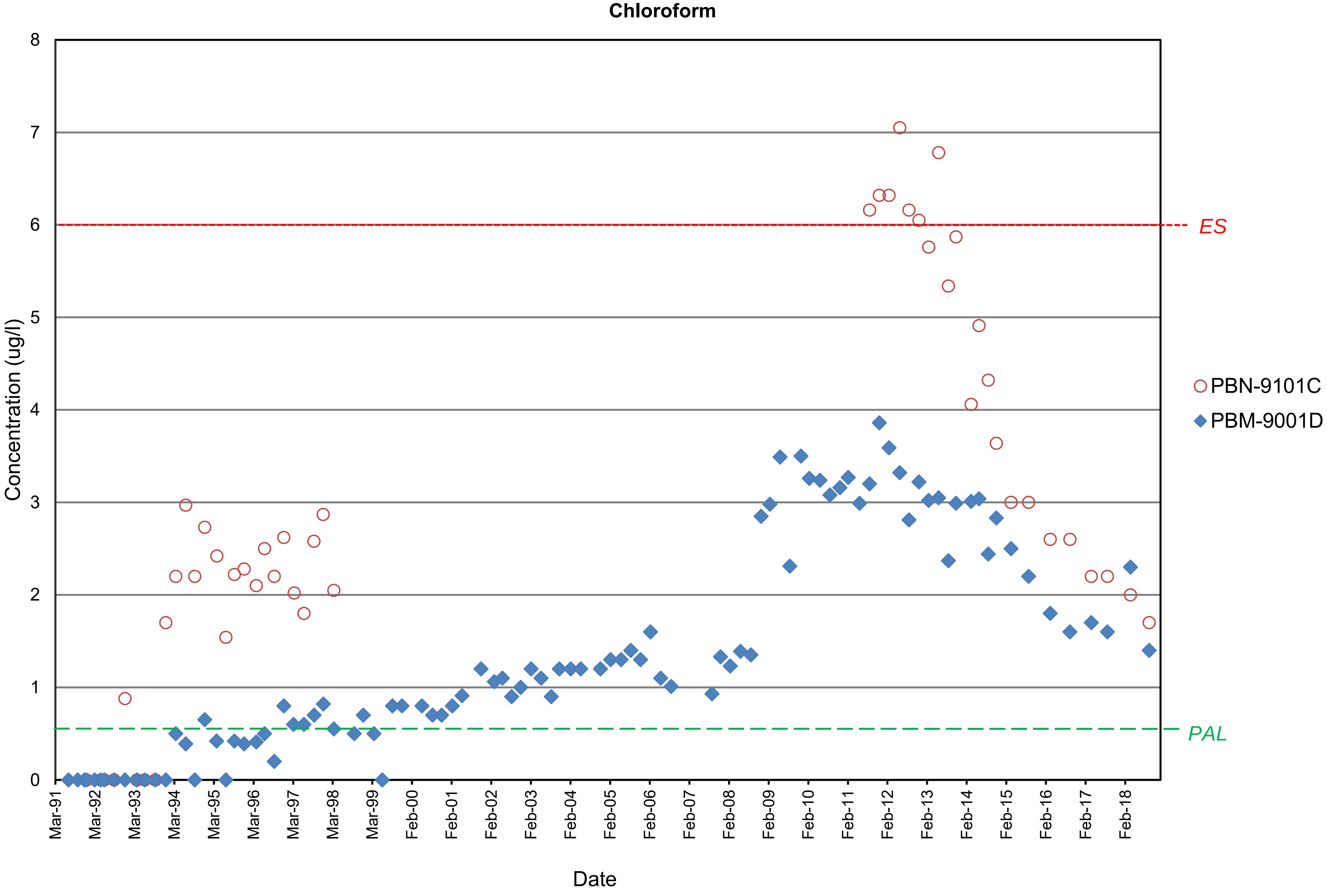



Total Dinitrotoluene
Concentration (ug/l)
0.12
0.1
0.08
0.06
0.04
0.02
0
Mar-91
Mar-92
Mar-93
Mar-94
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
Feb-00
Feb-01
Feb-02
Feb-03
Feb-04
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Date
○ PBN-9101C
◆ PBM-9001D
ES
PAL

BAAP Groundwater Data | Propellant Burning Ground | Plume Leading Edge - Offsite

Carbon Tetrachloride




Chloroform
Concentration (ug/l)
0
1
2
3
4
5
6
7
8
ES
PAL
○ PBN-9101C
◆ PBM-9001D
Date
Mar-91
Mar-92
Mar-93
Mar-94
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
Feb-00
Feb-01
Feb-02
Feb-03
Feb-04
Feb-05
Feb-06
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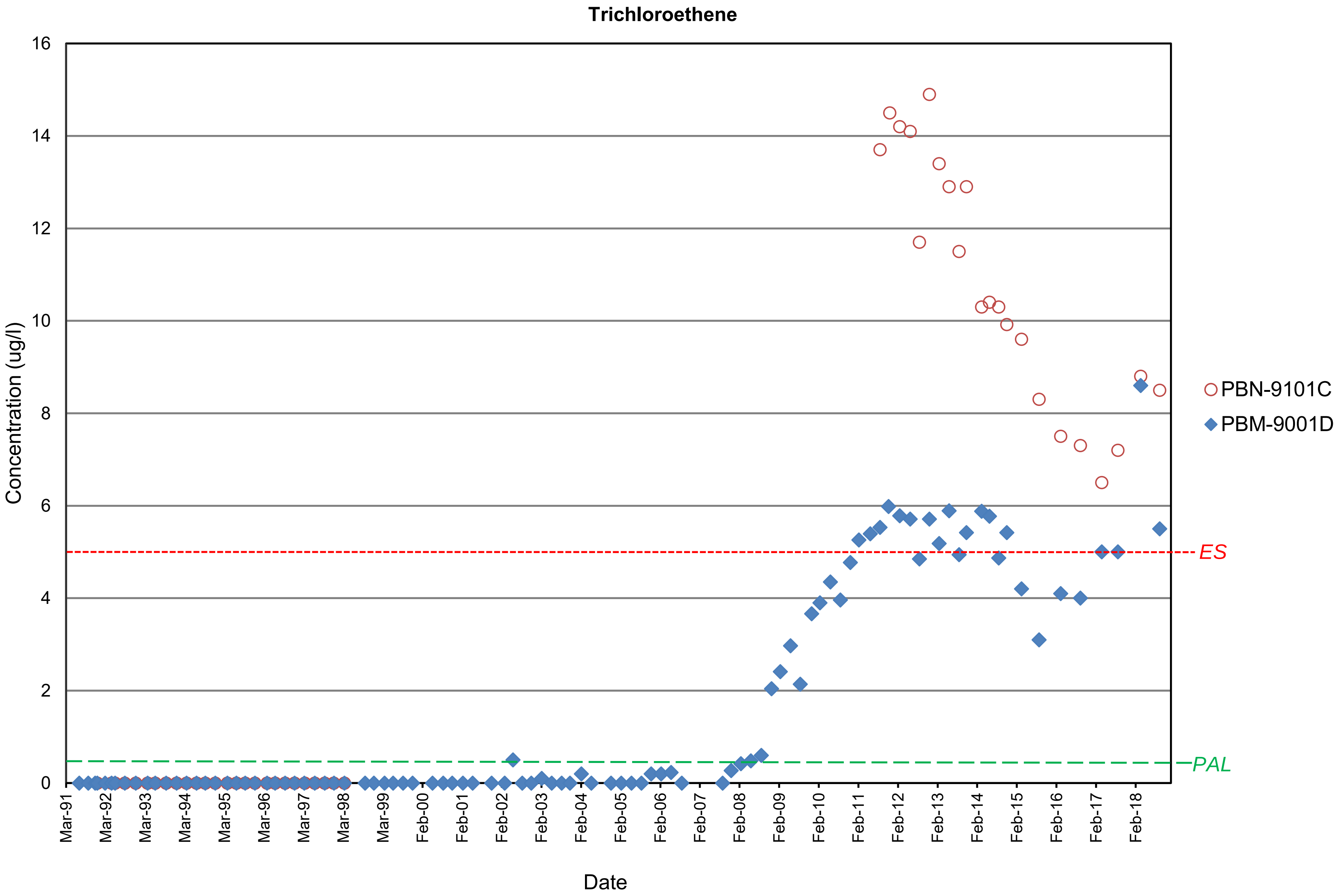
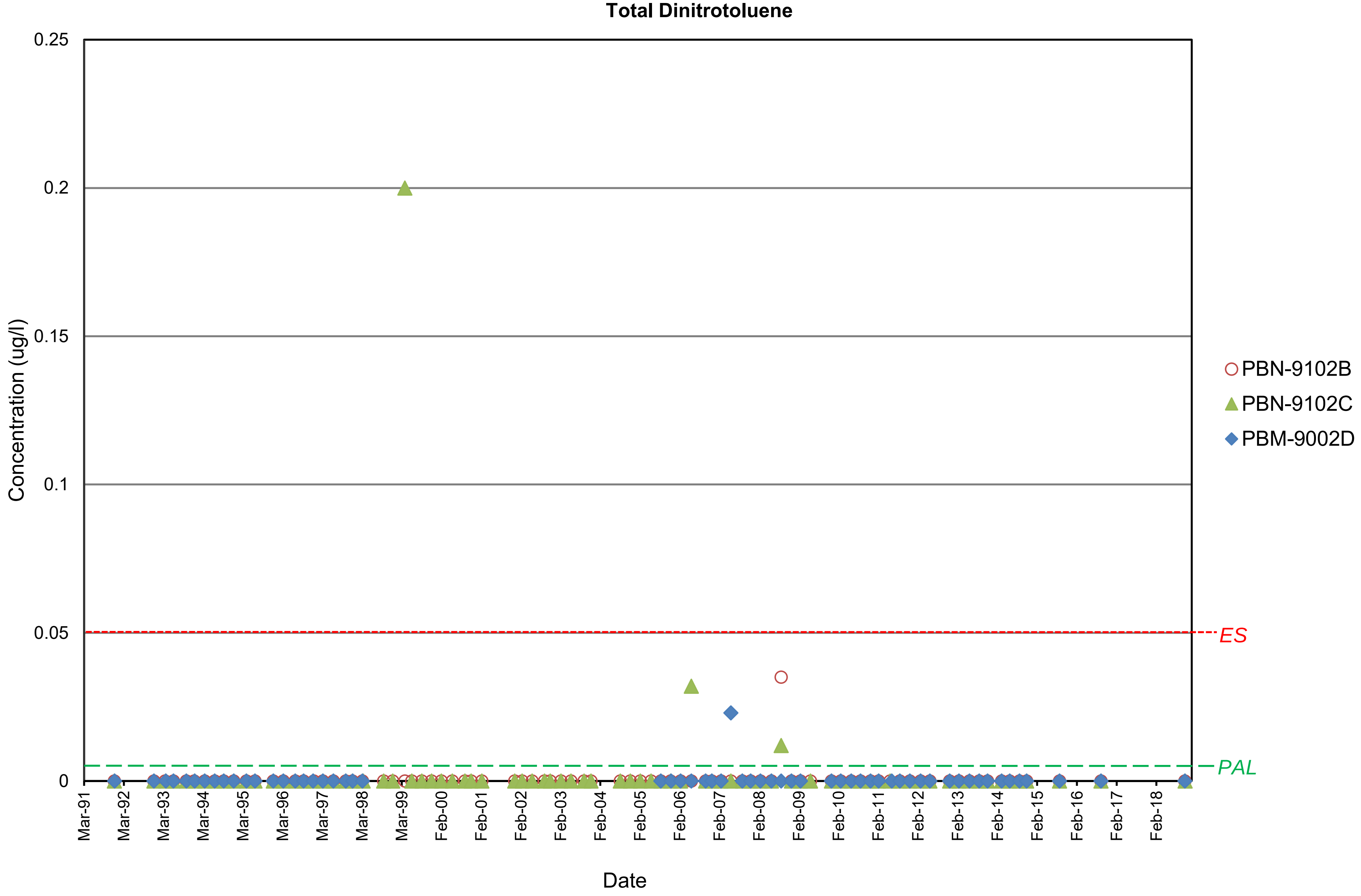
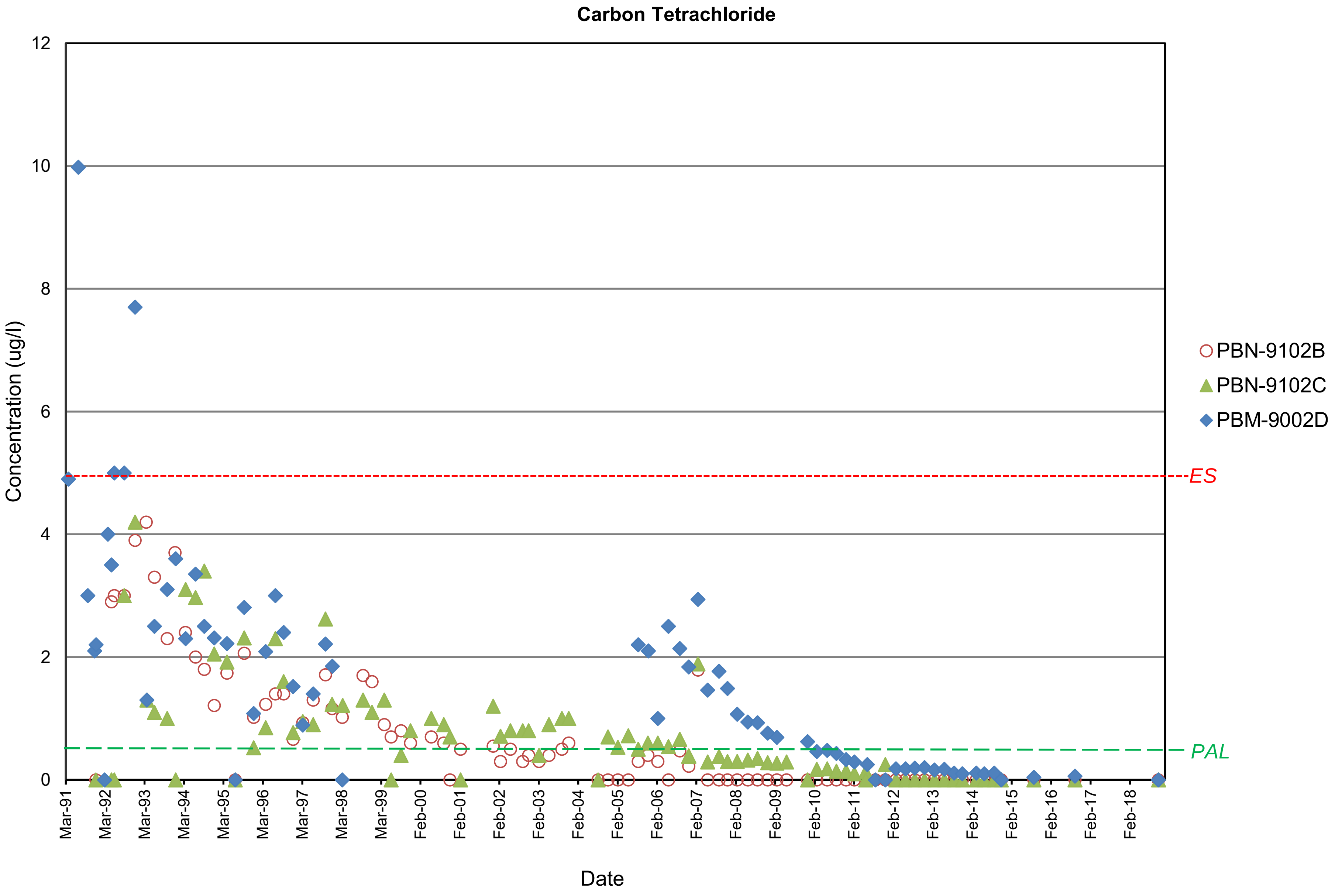
Feb-16
Feb-17
Feb-18


Trichloroethene
Concentration (ug/l)
16
14
12
10
8
6
4
2
0
Date
Mar-91
Mar-92
Mar-93
Mar-94
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
Feb-00
Feb-01
Feb-02
Feb-03
Feb-04
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
ES
PAL
○ PBN-9101C
◆ PBM-9001D

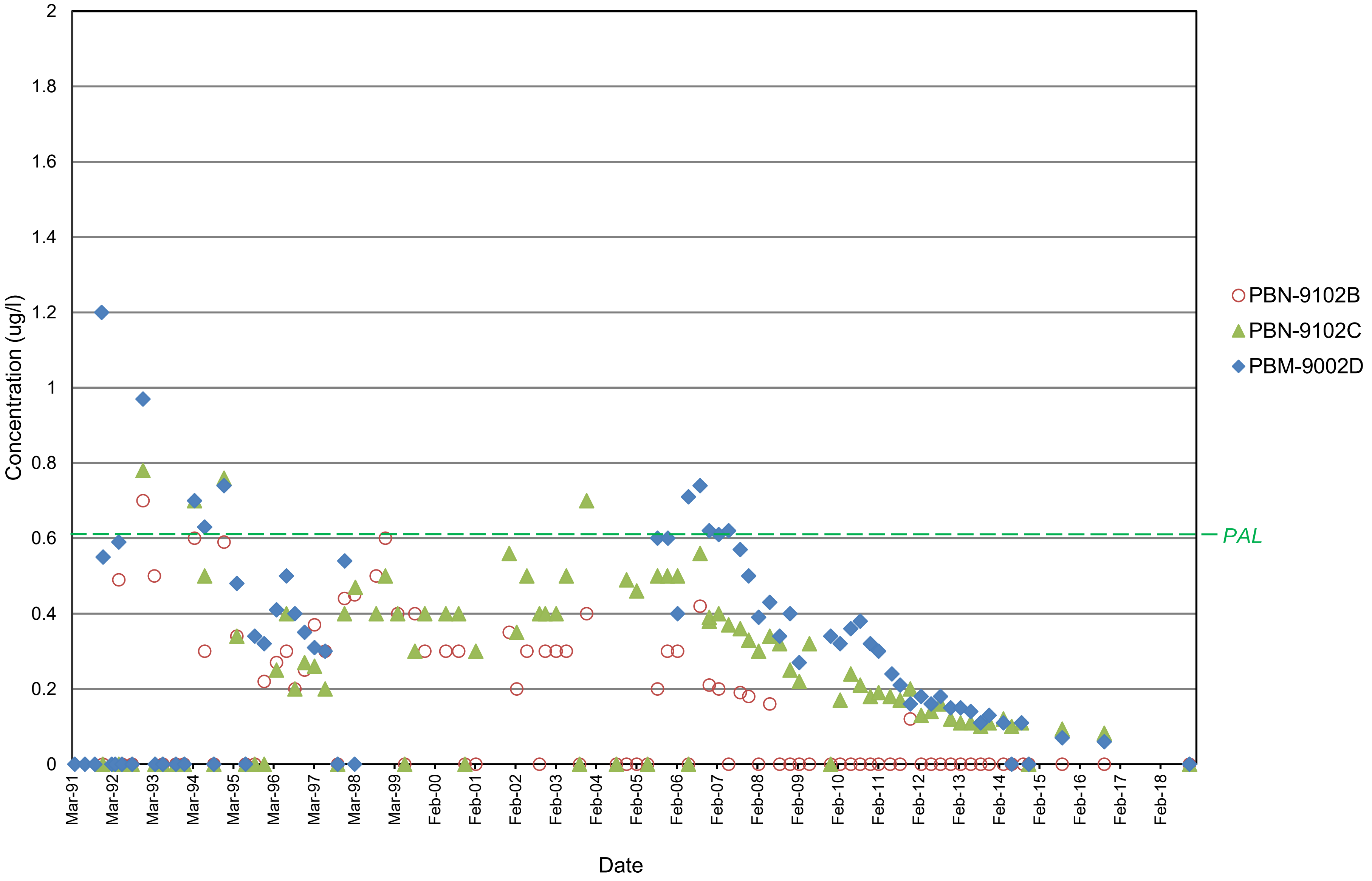
BAAP Groundwater Data | Propellant Burning Ground | Plume Edge - Offsite



BAAP Groundwater Data | Propellant Burning Ground | Plume Edge - Offsite

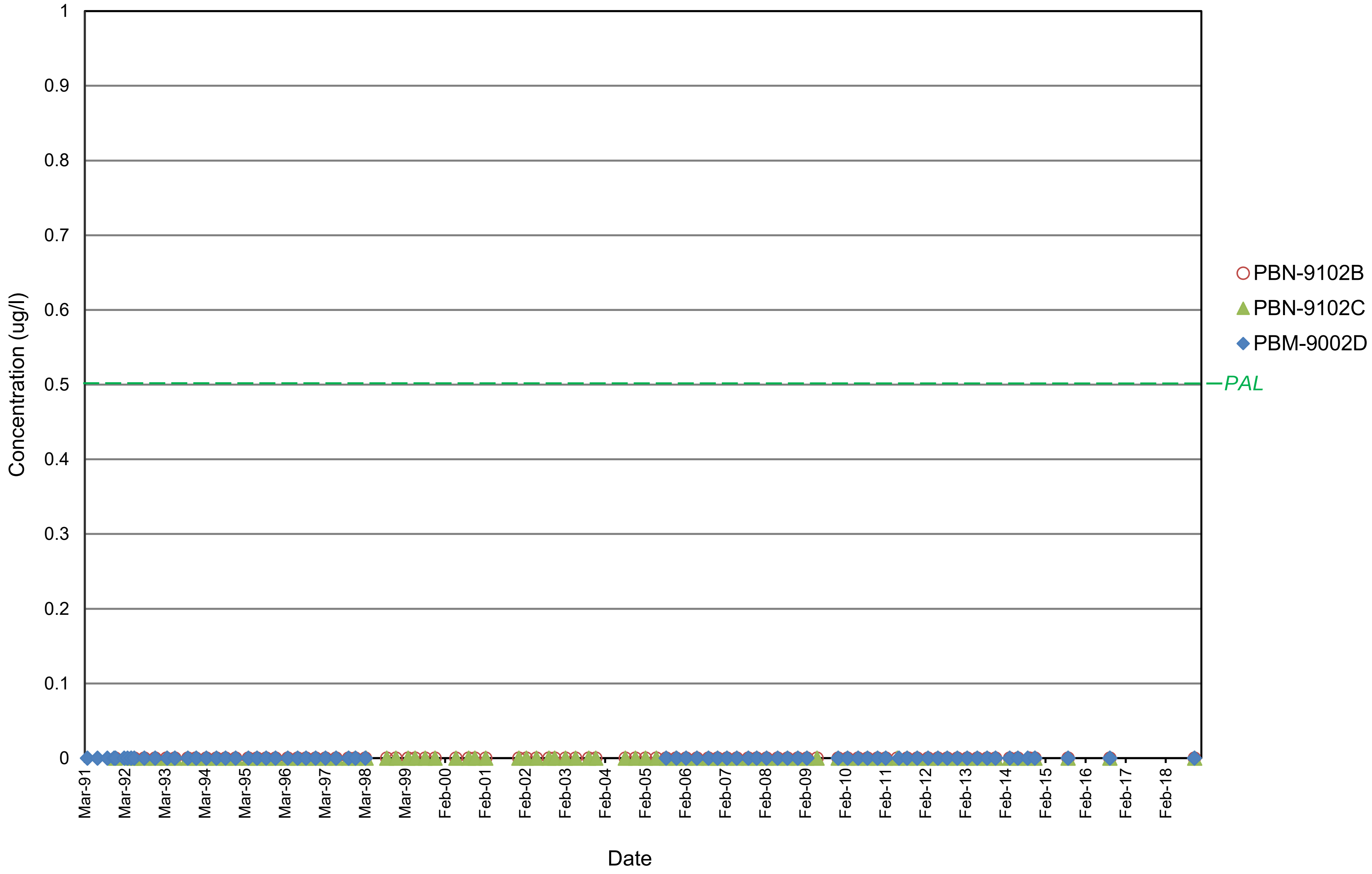


Chloroform

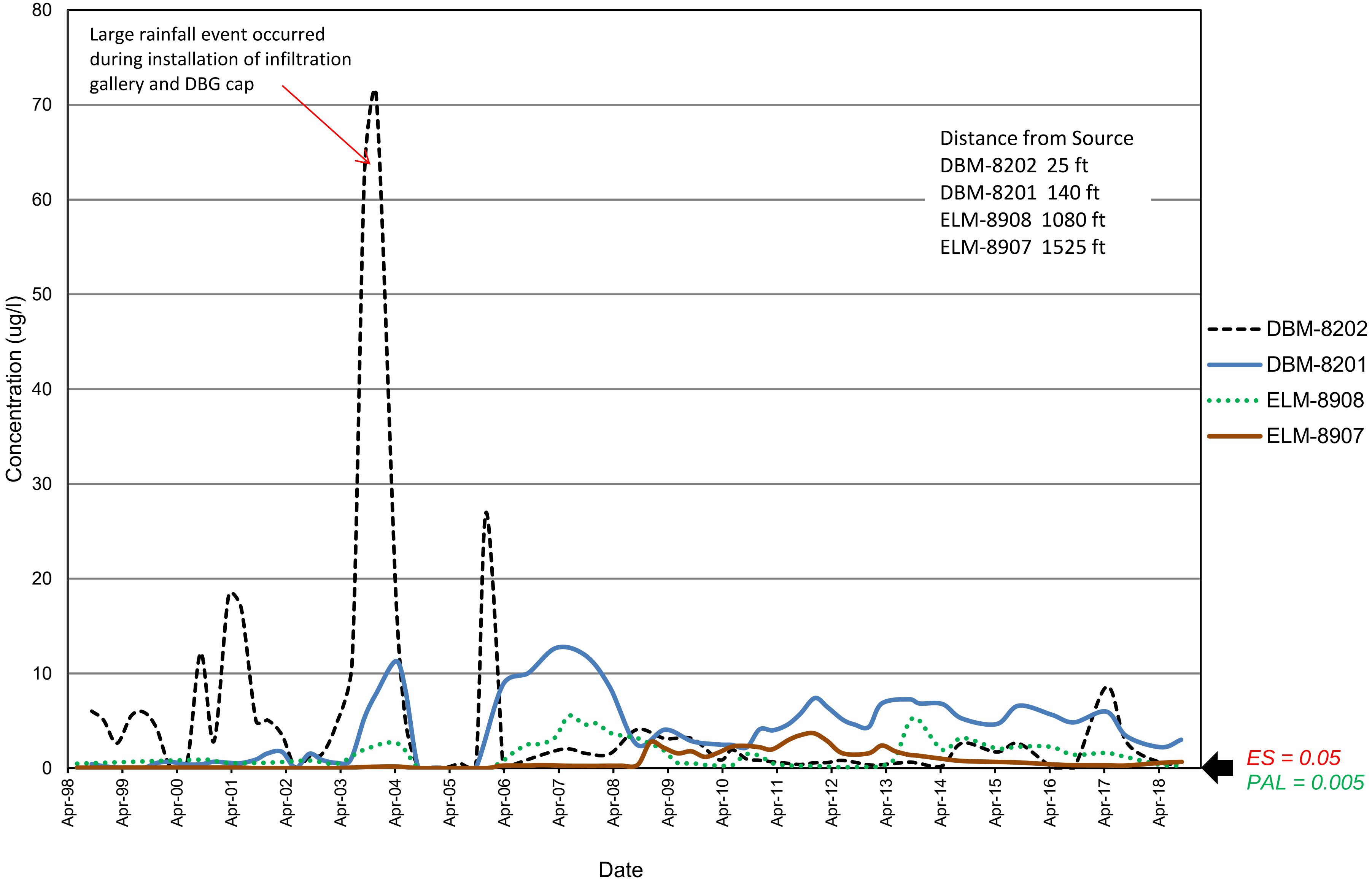

2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Concentration (ug/l)
PAL
Mar-91
Mar-92
Mar-93
Mar-94
Mar-95
Mar-96
Mar-97
Mar-98
Mar-99
Feb-00
Feb-01
Feb-02
Feb-03
Feb-04
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Date
○ PBN-9102B
▲ PBN-9102C
◆ PBM-9002D

BAAP Groundwater Data | Propellant Burning Ground | Plume Edge - Offsite

Trichloroethene



Concentration Graphs
Deterrent Burning Ground Plume



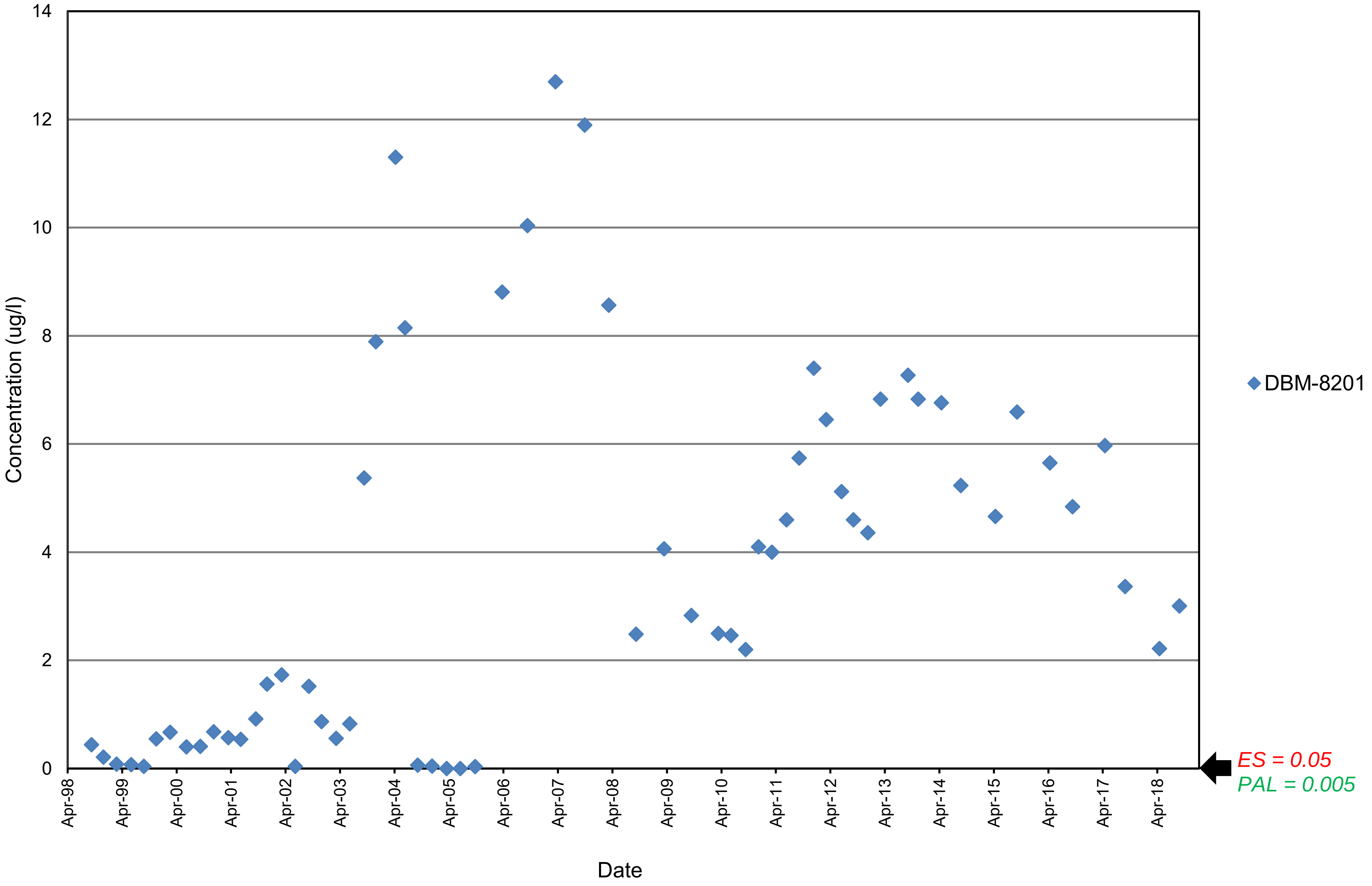
Total Dinitrotoluene

Large rainfall event occurred during installation of infiltration gallery and DBG cap

Distance from Source
DBM-8202 25 ft
DBM-8201 140 ft
ELM-8908 1080 ft
ELM-8907 1525 ft

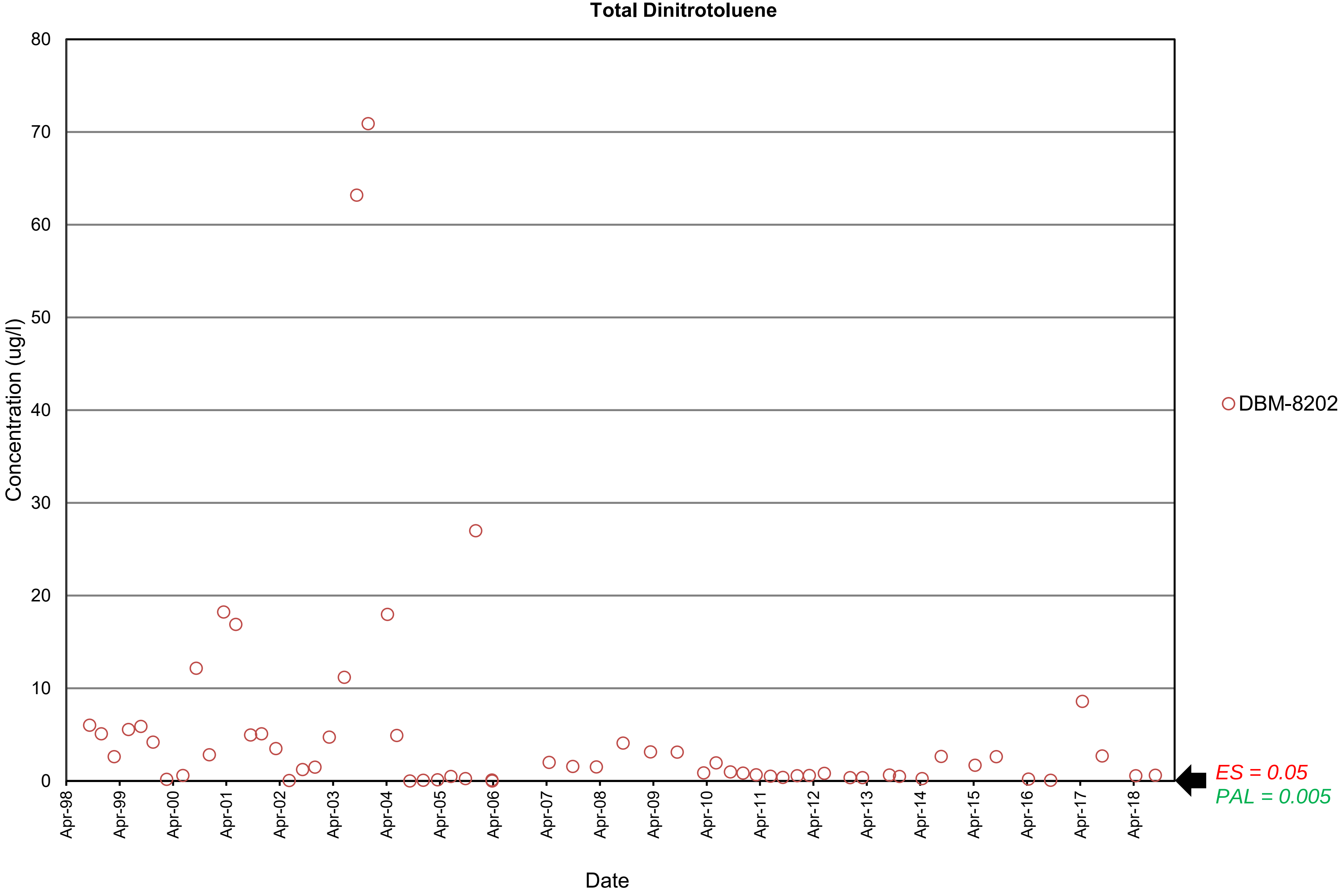
ES = 0.05
PAL = 0.005

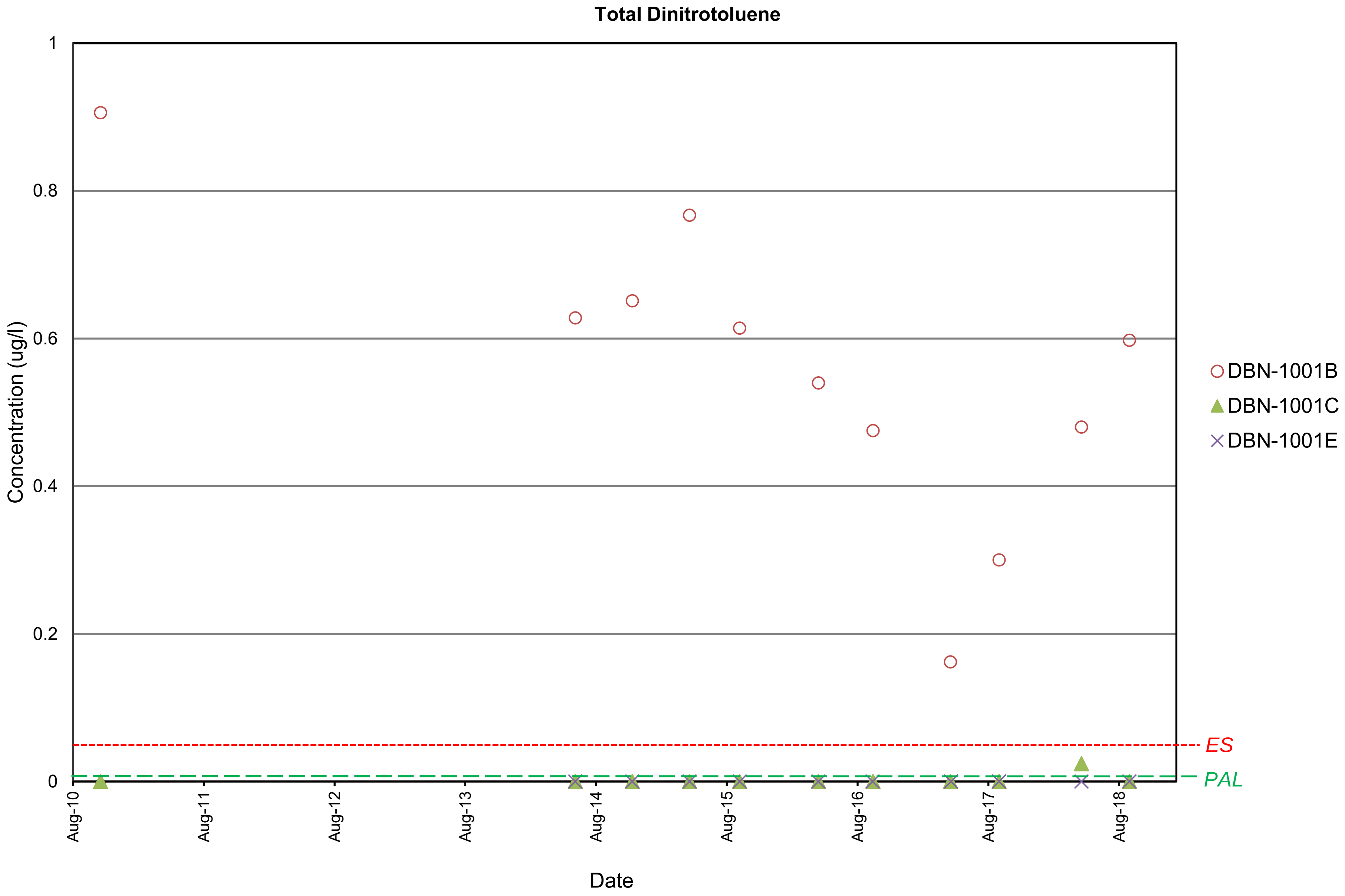
BAAP Groundwater Data | Deterrent Burning Ground | Source Area

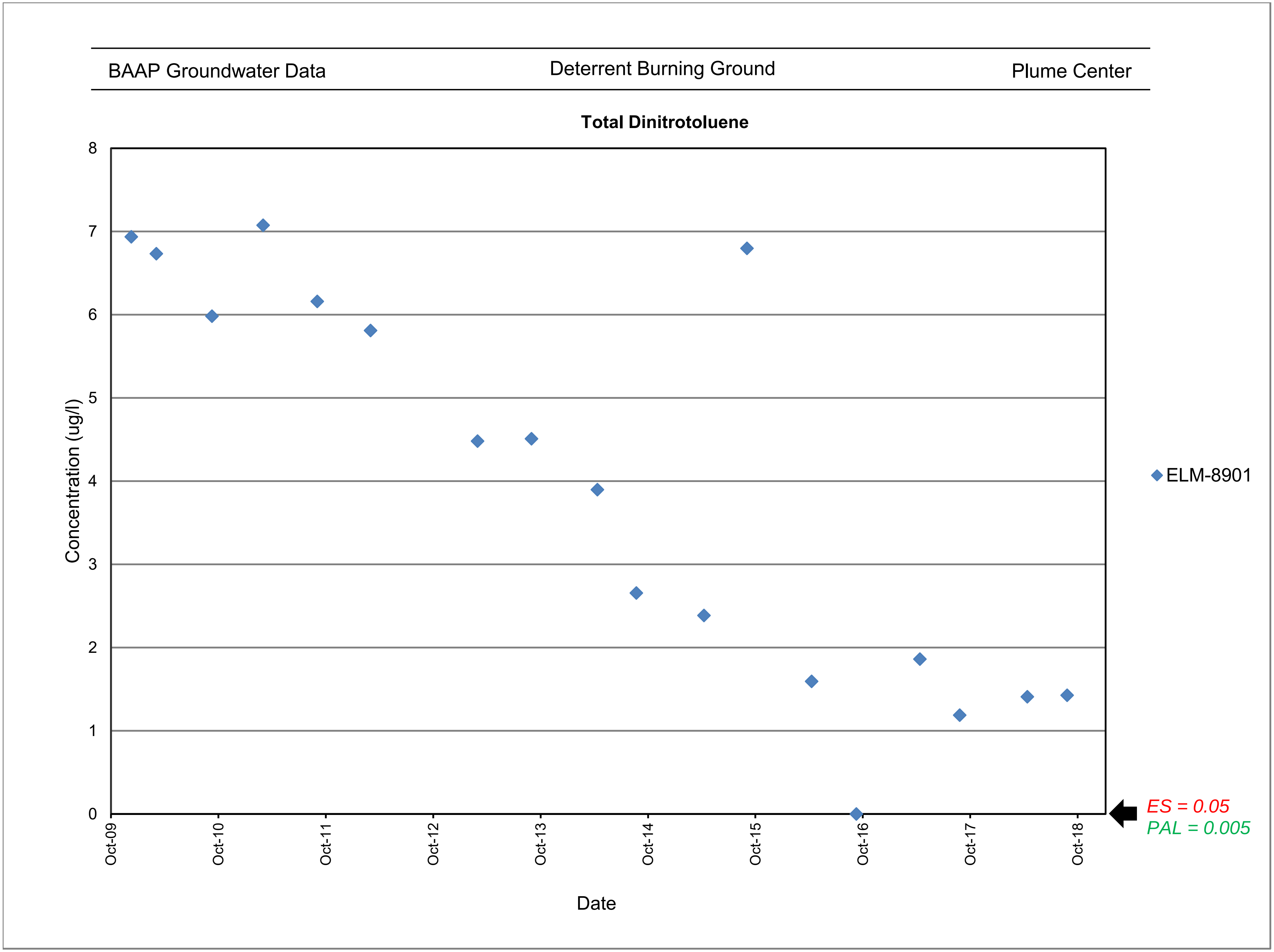


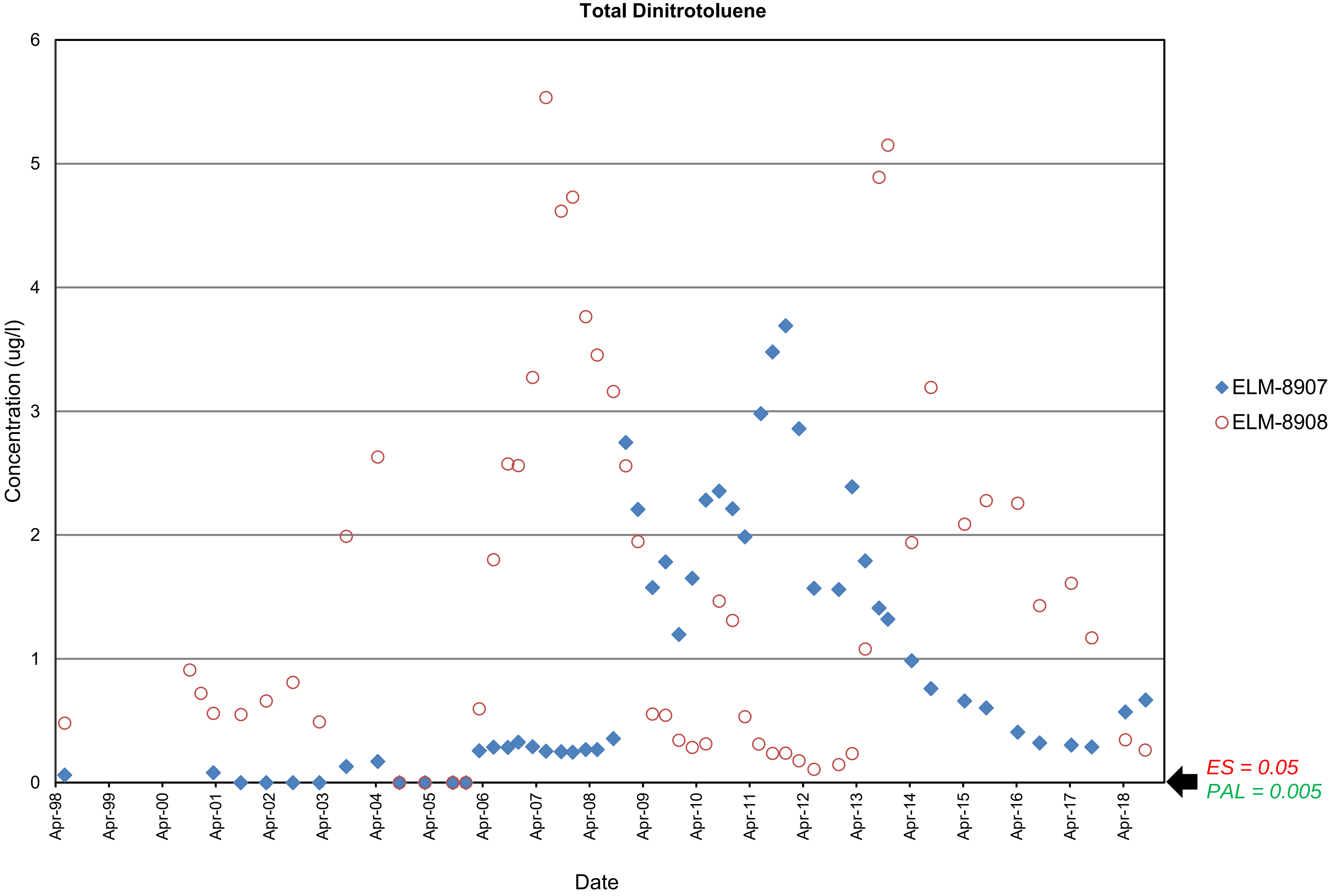
Total Dinitrotoluene

BAAP Groundwater Data | Deterrent Burning Ground | Source Area

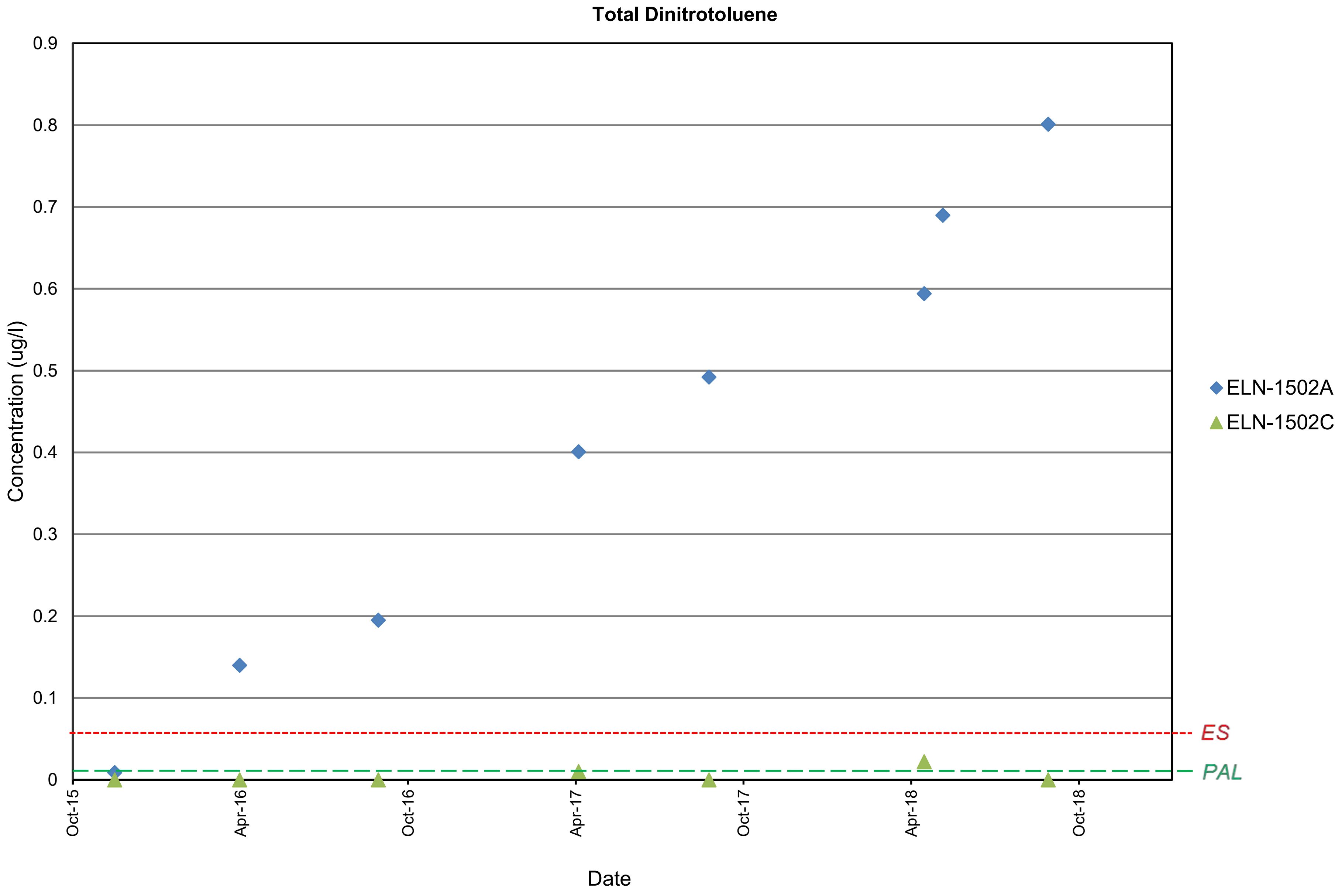



Total Dinitrotoluene
Concentration (ug/l)
1
0.8
0.6
0.4
0.2
0
Aug-10
Aug-11
Aug-12
Aug-13
Aug-14
Aug-15
Aug-16
Aug-17
Aug-18
Date
ES
PAL
○ DBN-1001B
▲ DBN-1001C
× DBN-1001E

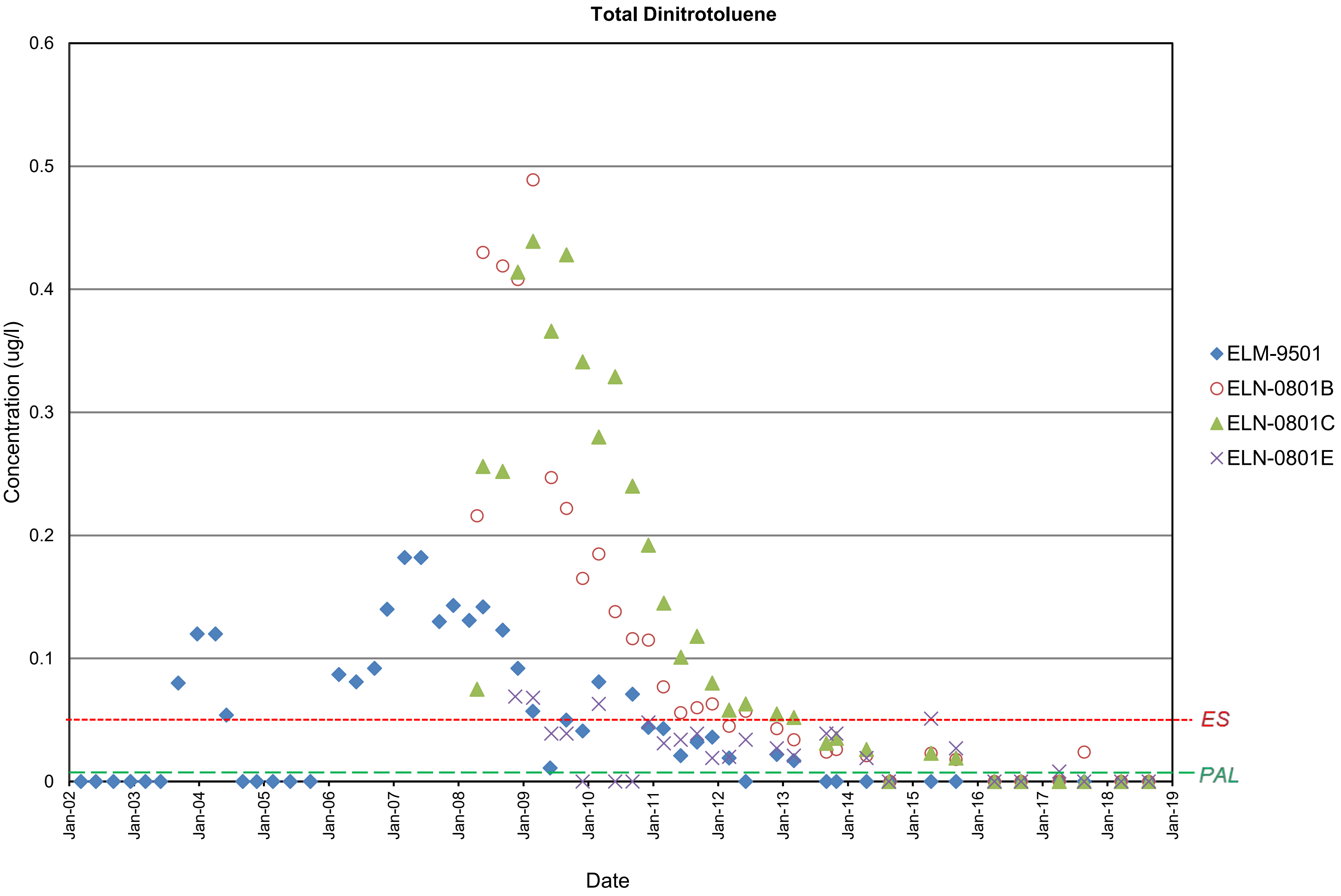

BAAP Groundwater Data
Deterrent Burning Ground
Plume Center
Total Dinitrotoluene
Concentration (ug/l)
0
1
2
3
4
5
6
7
8
Oct-09
Oct-10
Oct-11
Oct-12
Oct-13
Oct-14
Oct-15
Oct-16
Oct-17
Oct-18
Date
◆ ELM-8901
ES = 0.05
PAL = 0.005

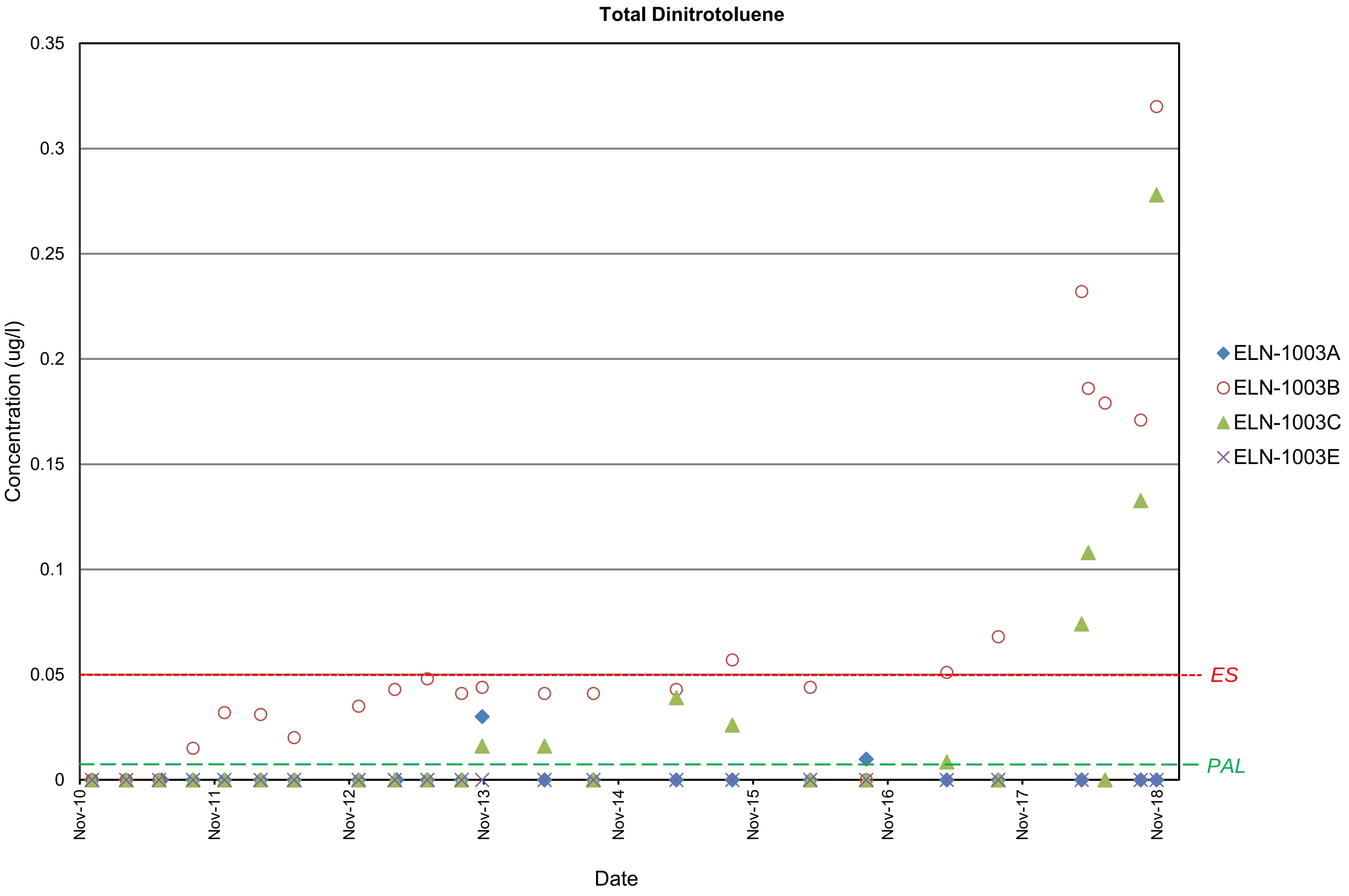

Total Dinitrotoluene
Concentration (ug/l)
0
1
2
3
4
5
6
Apr-98
Apr-99
Apr-00
Apr-01
Apr-02
Apr-03
Apr-04
Apr-05
Apr-06
Apr-07
Apr-08
Apr-09
Apr-10
Apr-11
Apr-12
Apr-13
Apr-14
Apr-15
Apr-16
Apr-17
Apr-18
Date
◆ ELM-8907
○ ELM-8908
ES = 0.05
PAL = 0.005

BAAP Groundwater Data Deterrent Burning Ground Plume Center - Downgradient



BAAP Groundwater Data | Deterrent Burning Ground | Plume Center - Downgradient



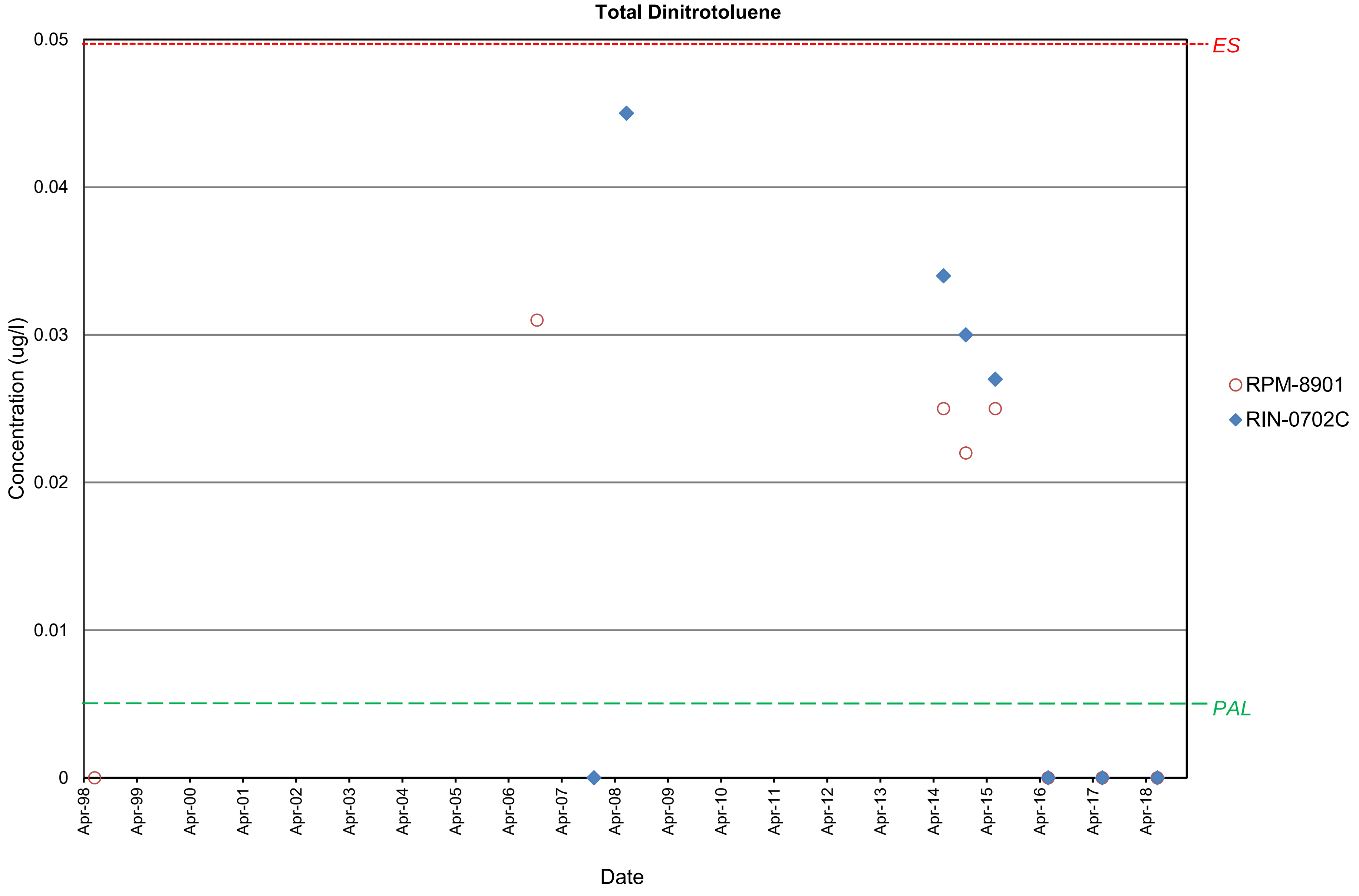

Total Dinitrotoluene
Concentration (ug/l)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Nov-10
Nov-11
Nov-12
Nov-13
Nov-14
Nov-15
Nov-16
Nov-17
Nov-18
Date
ES
PAL
◆ ELN-1003A
○ ELN-1003B
▲ ELN-1003C
× ELN-1003E

Concentration Graphs
Central Plume

On-Site Downgradient Wells	Compound	Year Range	Page
RPM-8901, RIN-0702C	DNT	1998 - 2018	1
NPM-8901, RIN-0701C	DNT	1998 - 2018	2
NLN-1001A, C	DNT	2010 - 2018	3
RIN-1002A, C, RIN-1501D	DNT	2010 - 2018	4
RIN-1005A, C	DNT	2010 - 2018	5
USDA 6, RIN-1003A, RIN-0703C	DNT	2006 - 2018	6
RIN-1004B	DNT	2010 - 2018	7

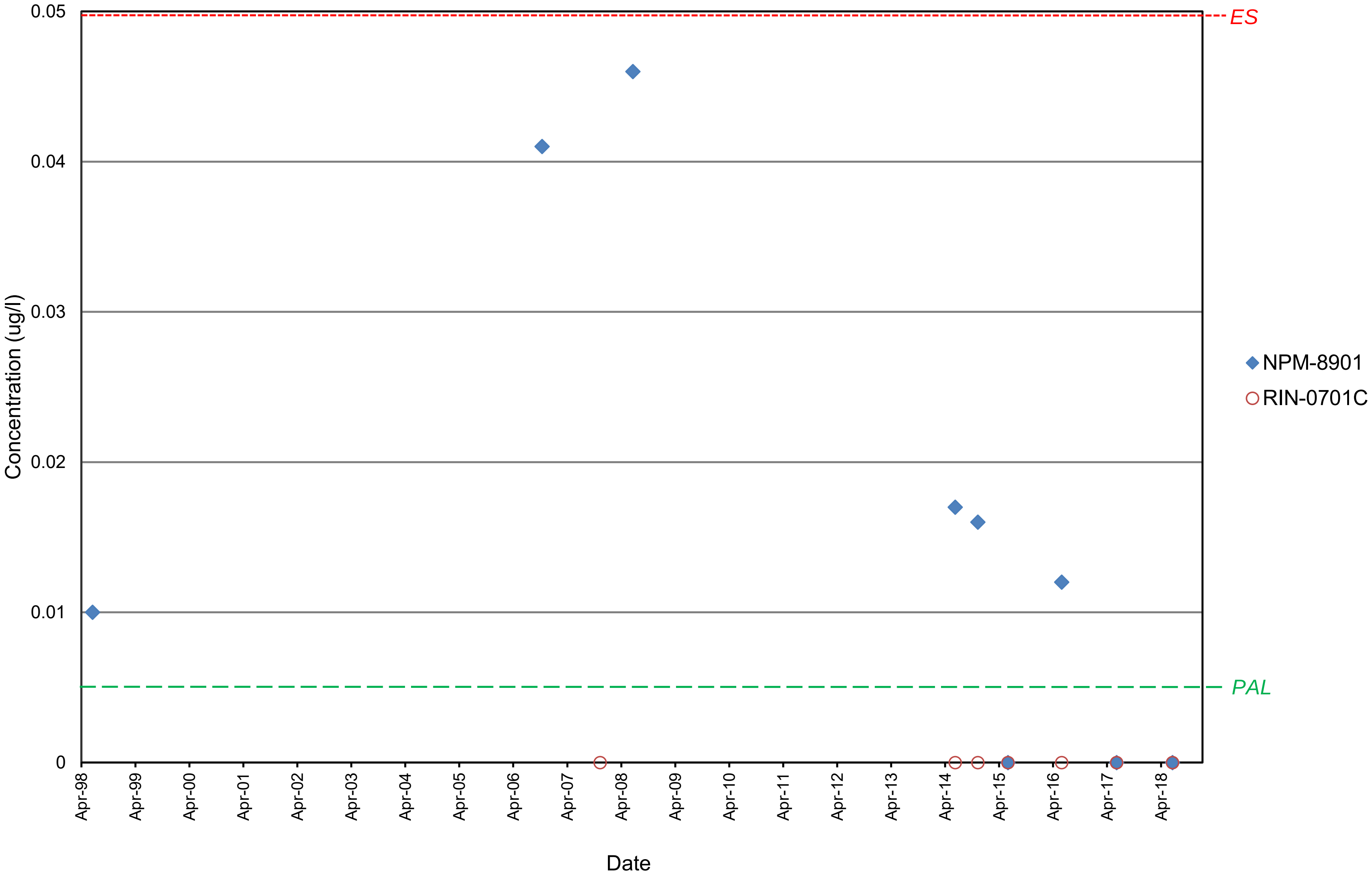
Off-Site Downgradient Wells	Compound	Year Range	Page
SEN-0501A, B, D	DNT	2005 - 2018	8
SEN-0502A, D	DNT	2005 - 2018	9
SEN-0503A, B, D	DNT	2005 - 2018	10

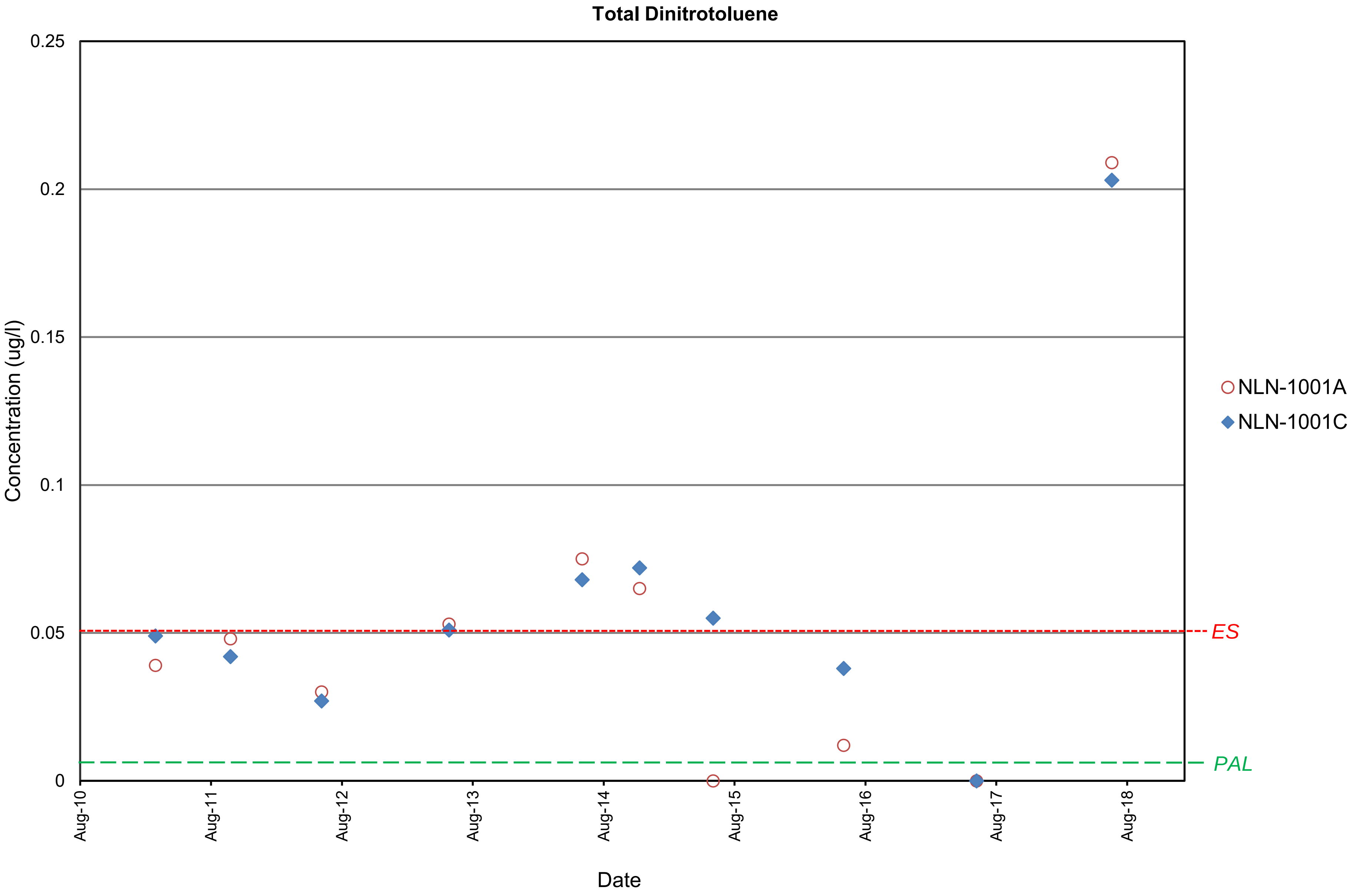
BAAP Groundwater Data | Central Plume | Plume Center



BAAP Groundwater Data Central Plume Plume Center

Total Dinitrotoluene




Total Dinitrotoluene
Concentration (ug/l)
0.25
0.2
0.15
0.1
0.05
0
Aug-10
Aug-11
Aug-12
Aug-13
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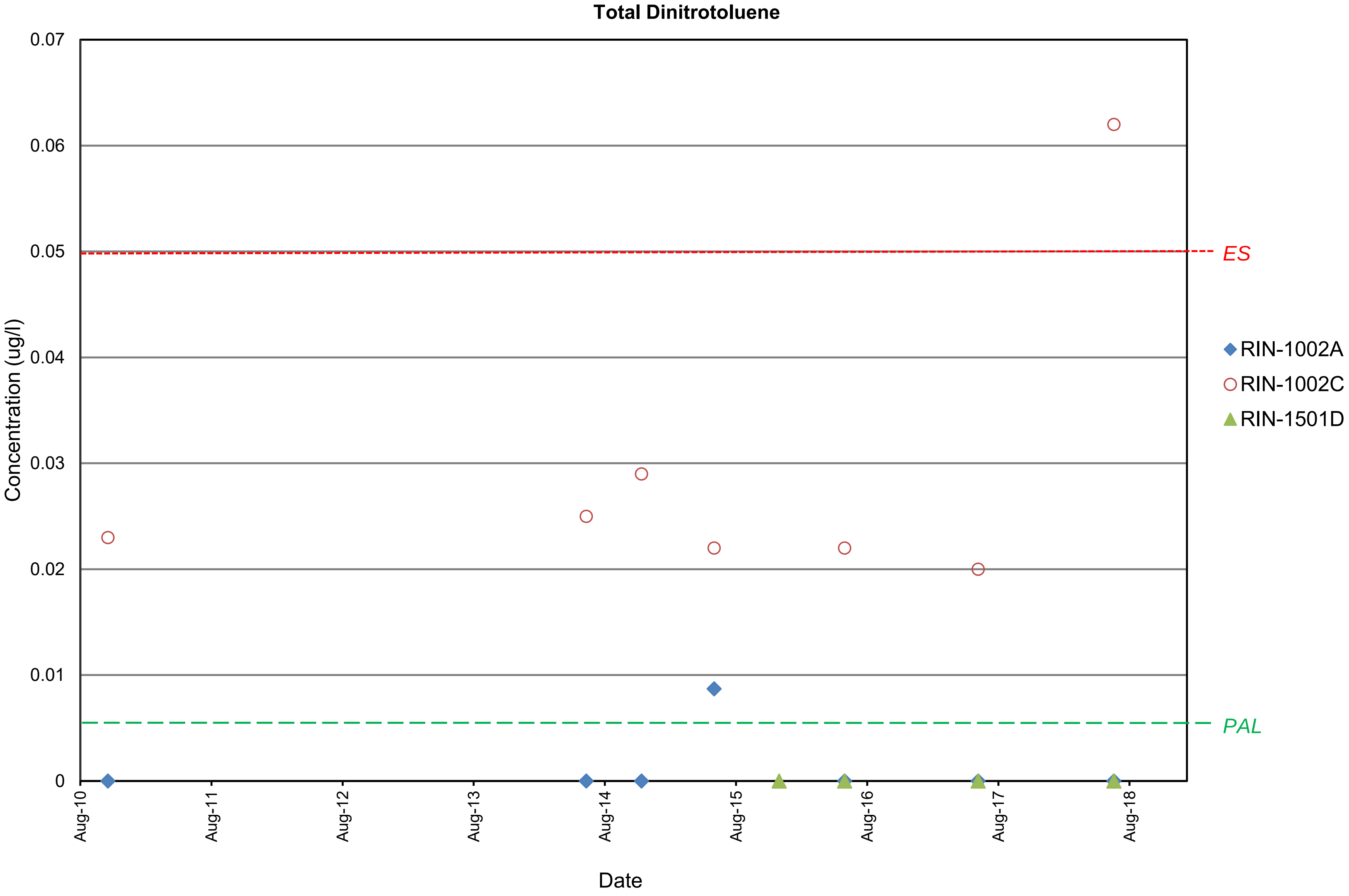
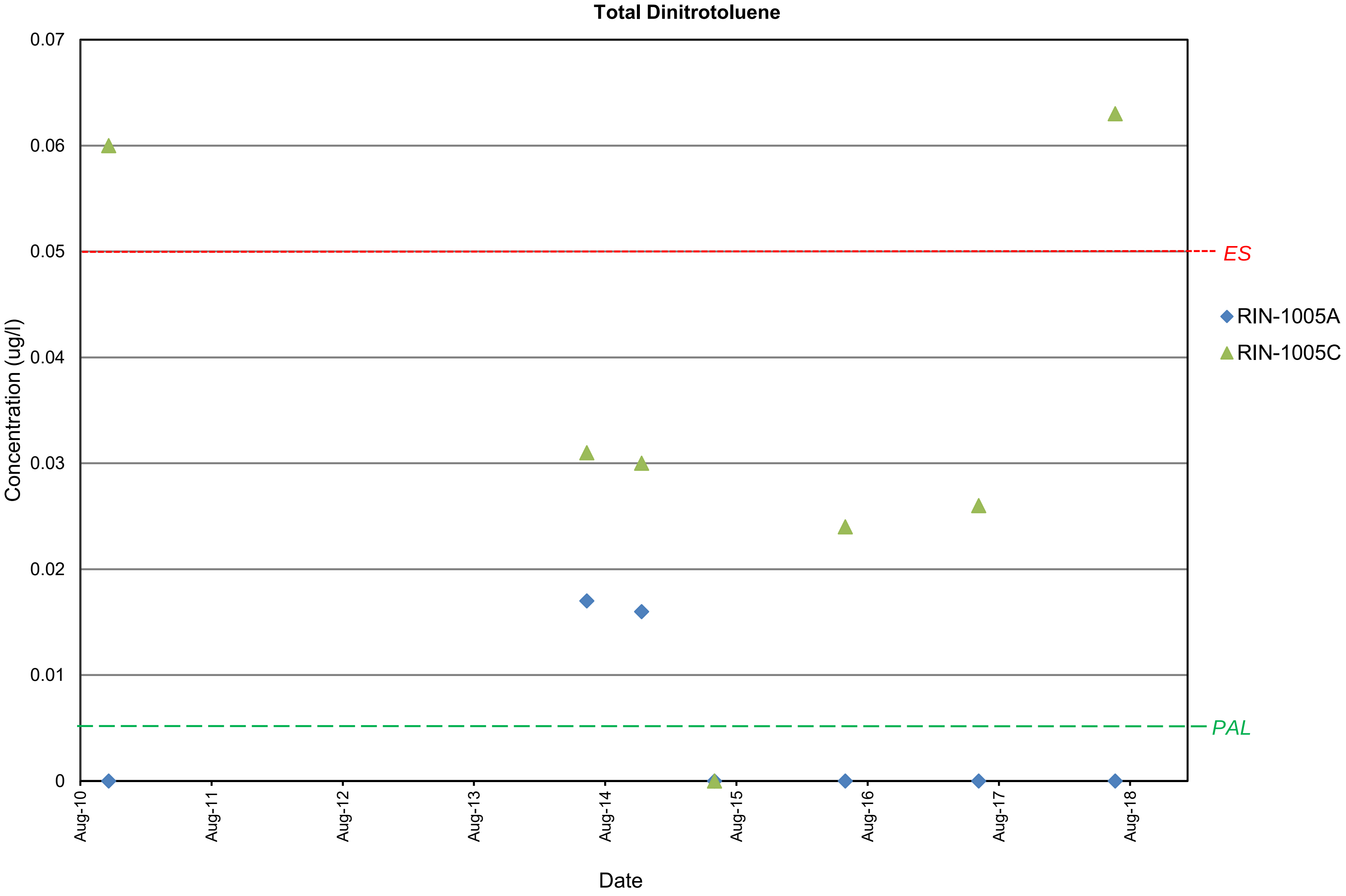
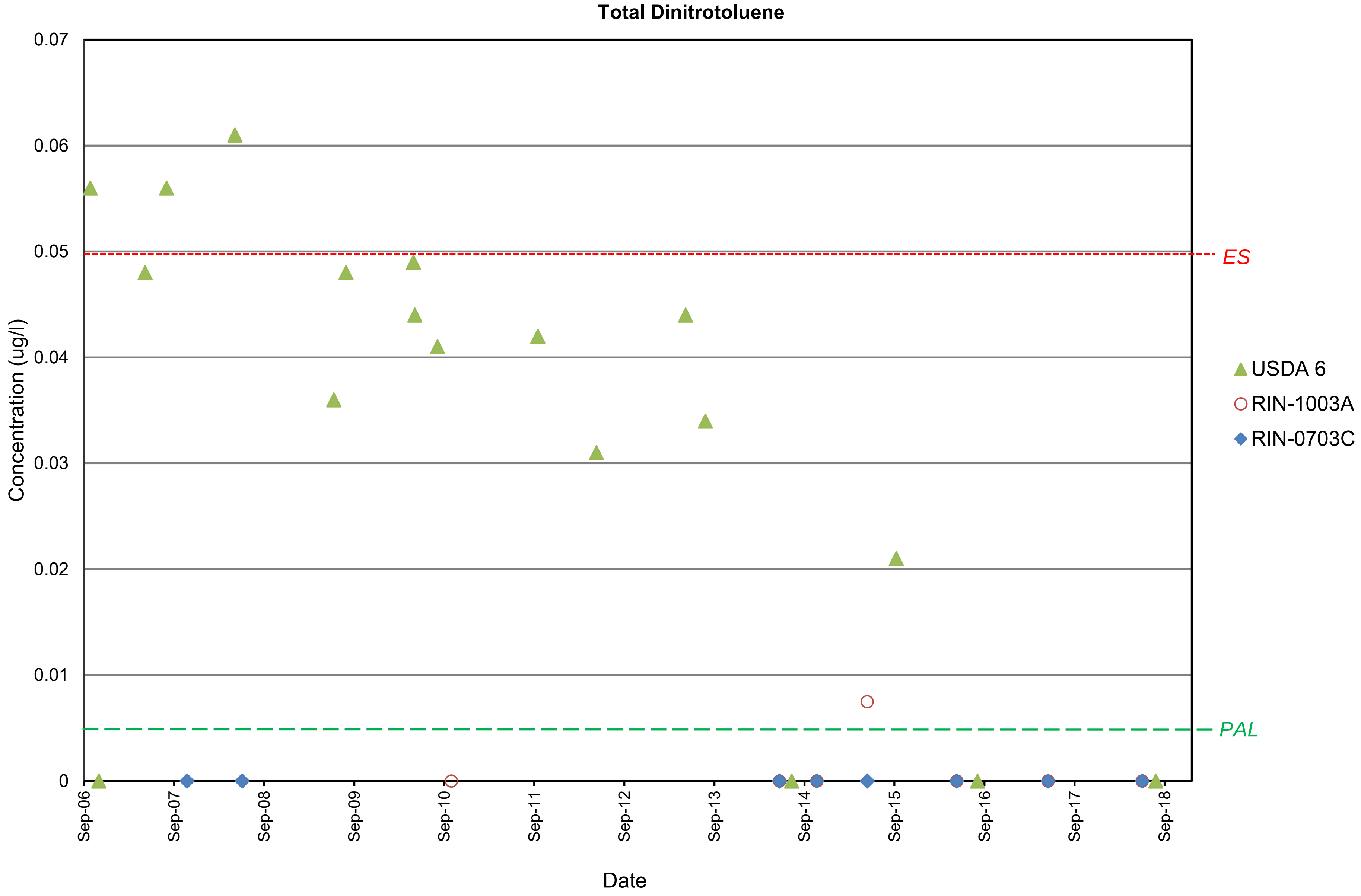
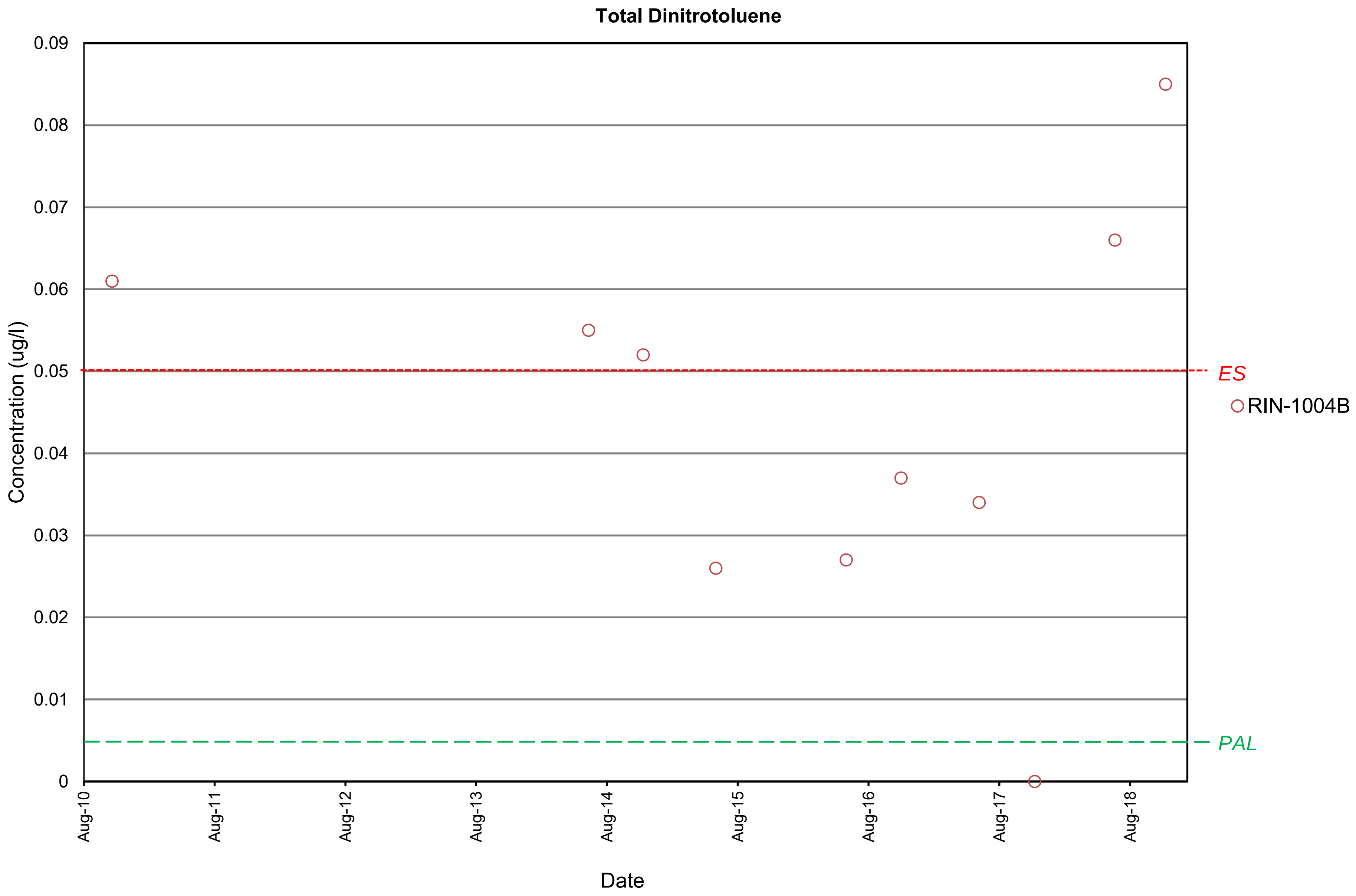
Aug-15
Aug-16
Aug-17
Aug-18
Date
ES
PAL
○ NLN-1001A
◆ NLN-1001C


Total Dinitrotoluene
Concentration (ug/l)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
ES
PAL
RIN-1002A
RIN-1002C
RIN-1501D
Aug-10
Aug-11
Aug-12
Aug-13
Aug-14
Aug-15
Aug-16
Aug-17
Aug-18
Date

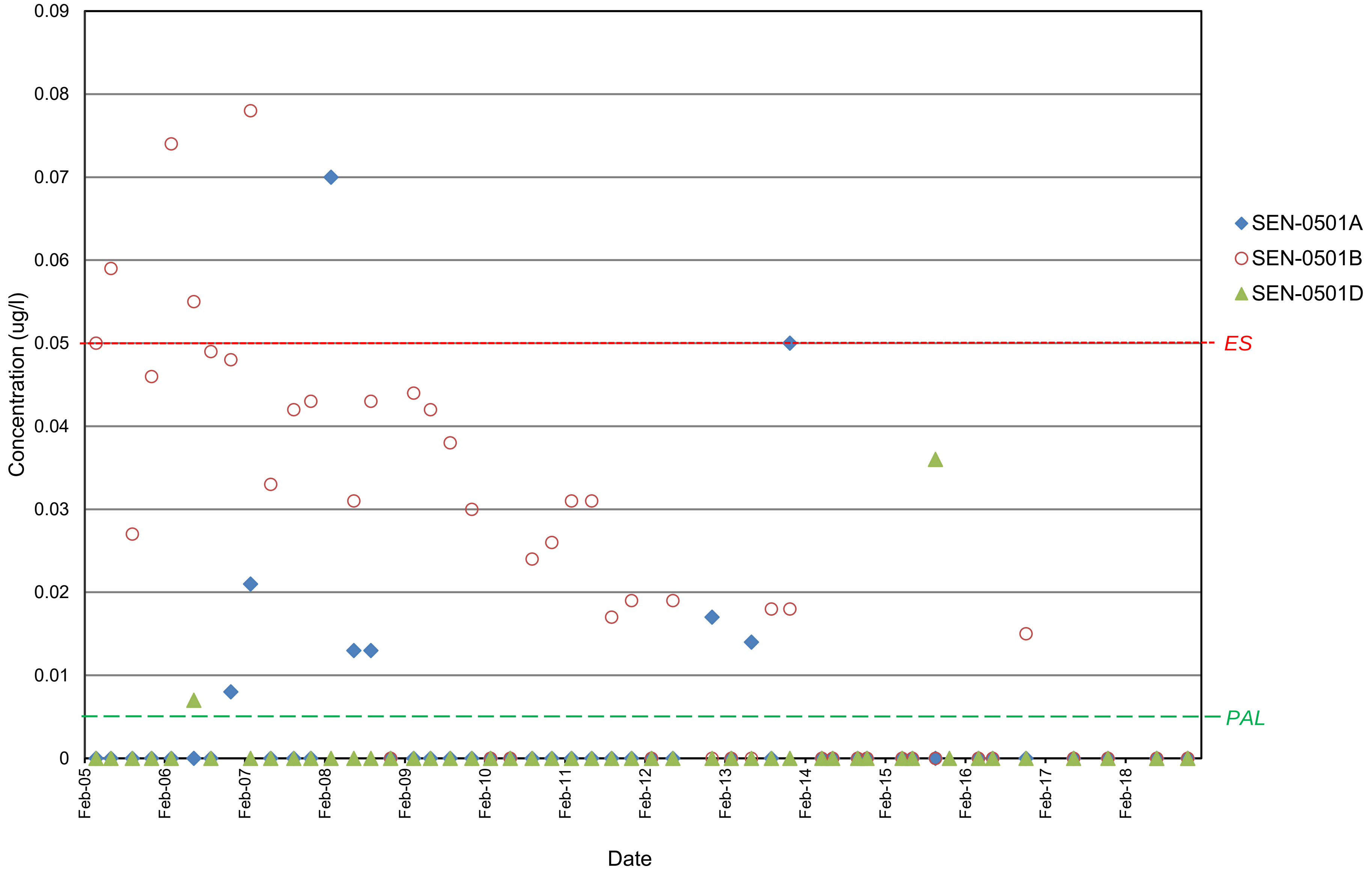

Total Dinitrotoluene
Concentration (ug/l)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
ES
PAL
◆ RIN-1005A
▲ RIN-1005C
Aug-10
Aug-11
Aug-12
Aug-13
Aug-14
Aug-15
Aug-16
Aug-17
Aug-18
Date

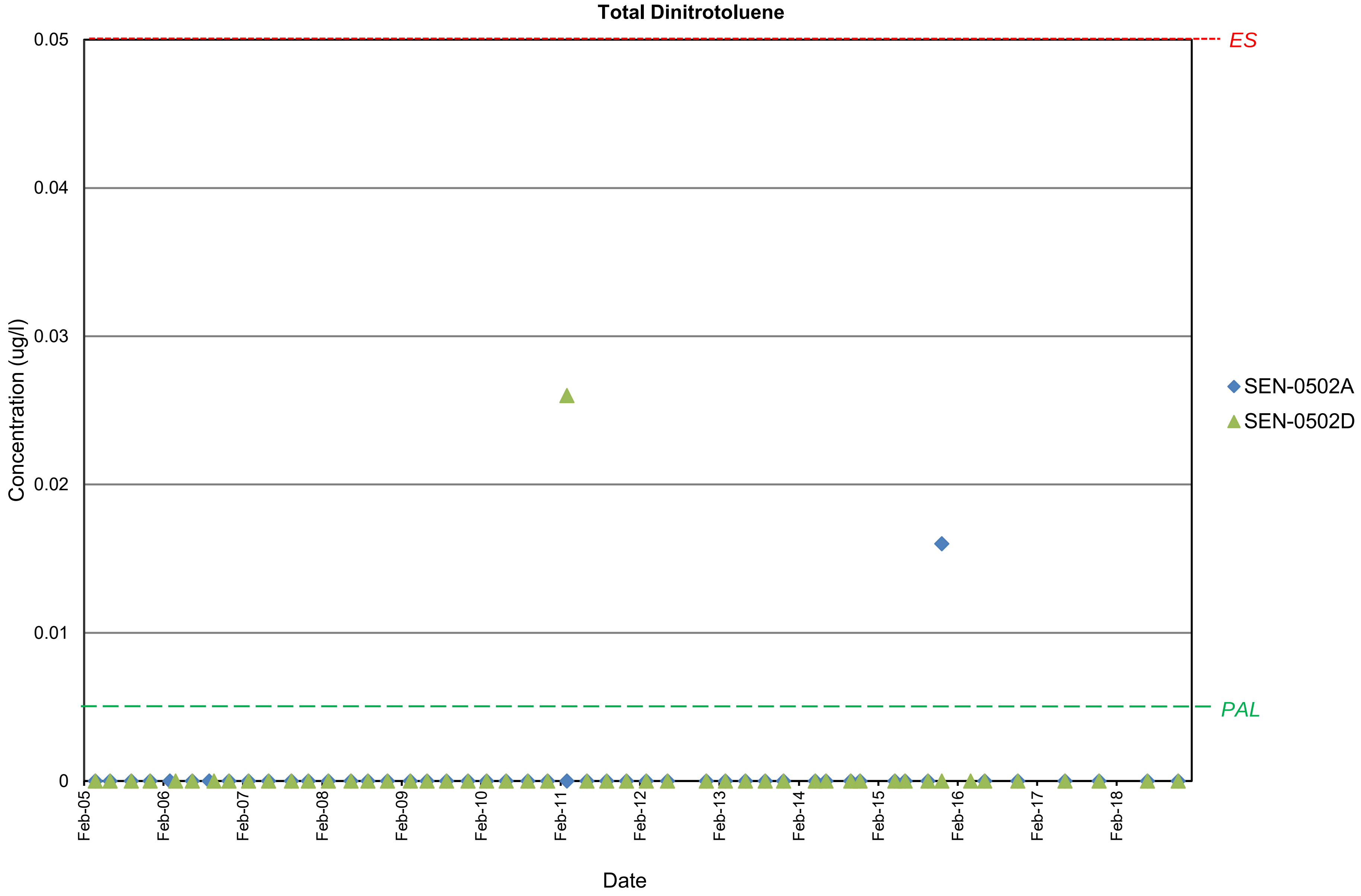

Total Dinitrotoluene
Concentration (ug/l)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
ES
PAL
▲ USDA 6
○ RIN-1003A
◆ RIN-0703C
Sep-06
Sep-07
Sep-08
Sep-09
Sep-10
Sep-11
Sep-12
Sep-13
Sep-14
Sep-15
Sep-16
Sep-17
Sep-18
Date

BAAP Groundwater Data | Central Plume | Plume Center

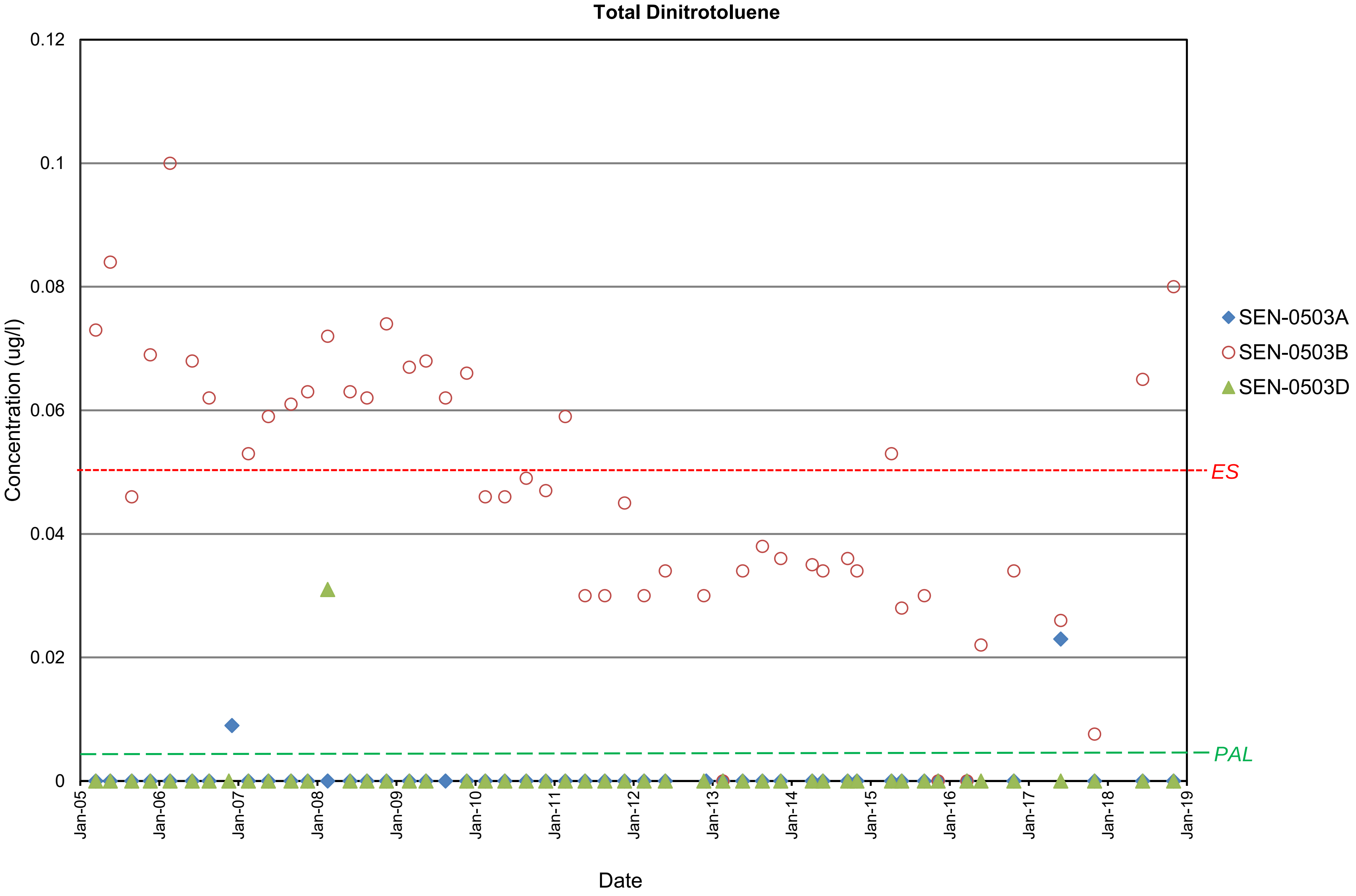


Total Dinitrotoluene




Total Dinitrotoluene
Concentration (ug/l)
0.05
0.04
0.03
0.02
0.01
0
ES
PAL
SEN-0502A
SEN-0502D
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Date

BAAP Groundwater Data Central Plume Plume Leading Edge

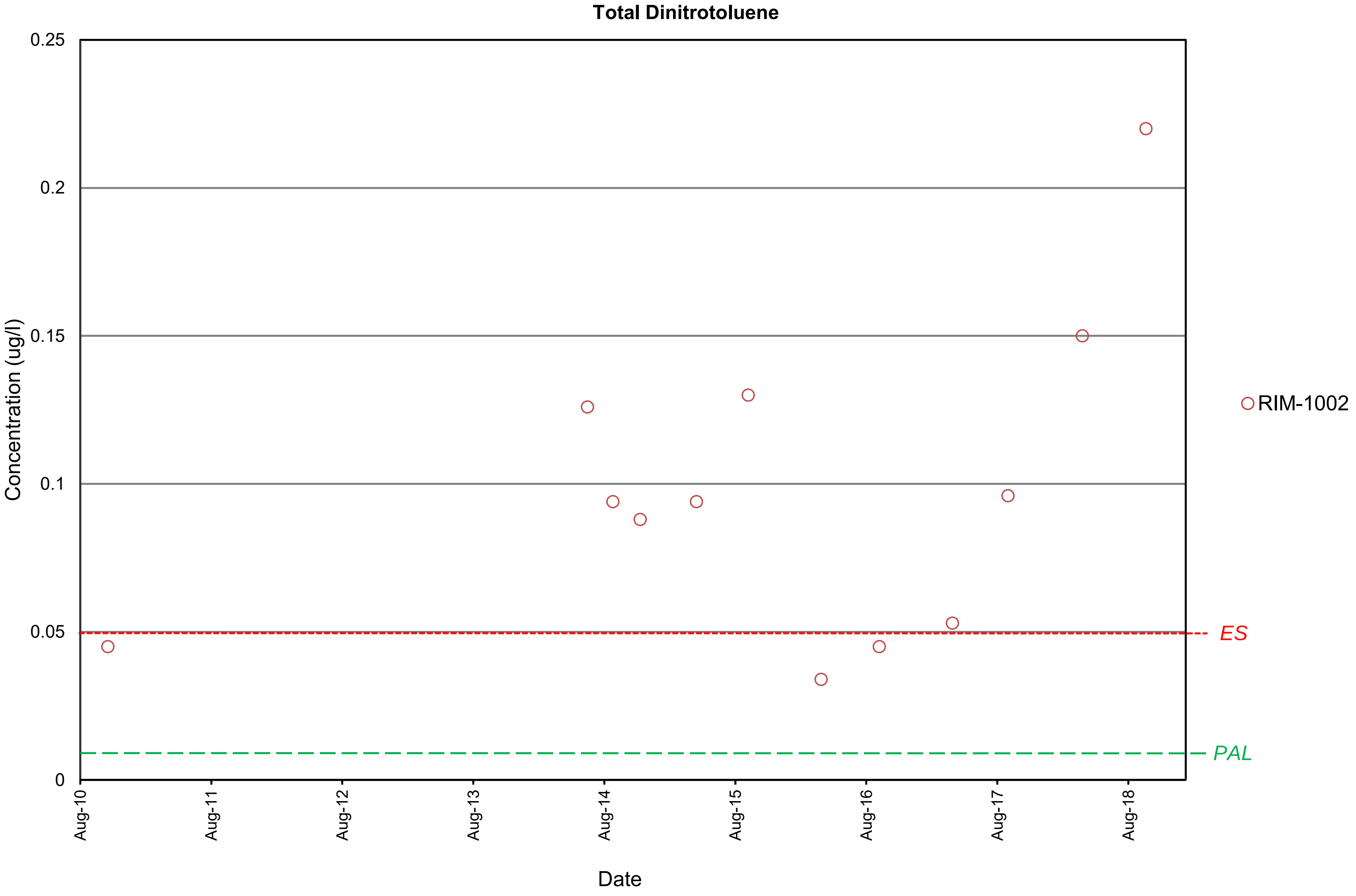


Concentration Graphs
Nitrocellulose Production Area Plume

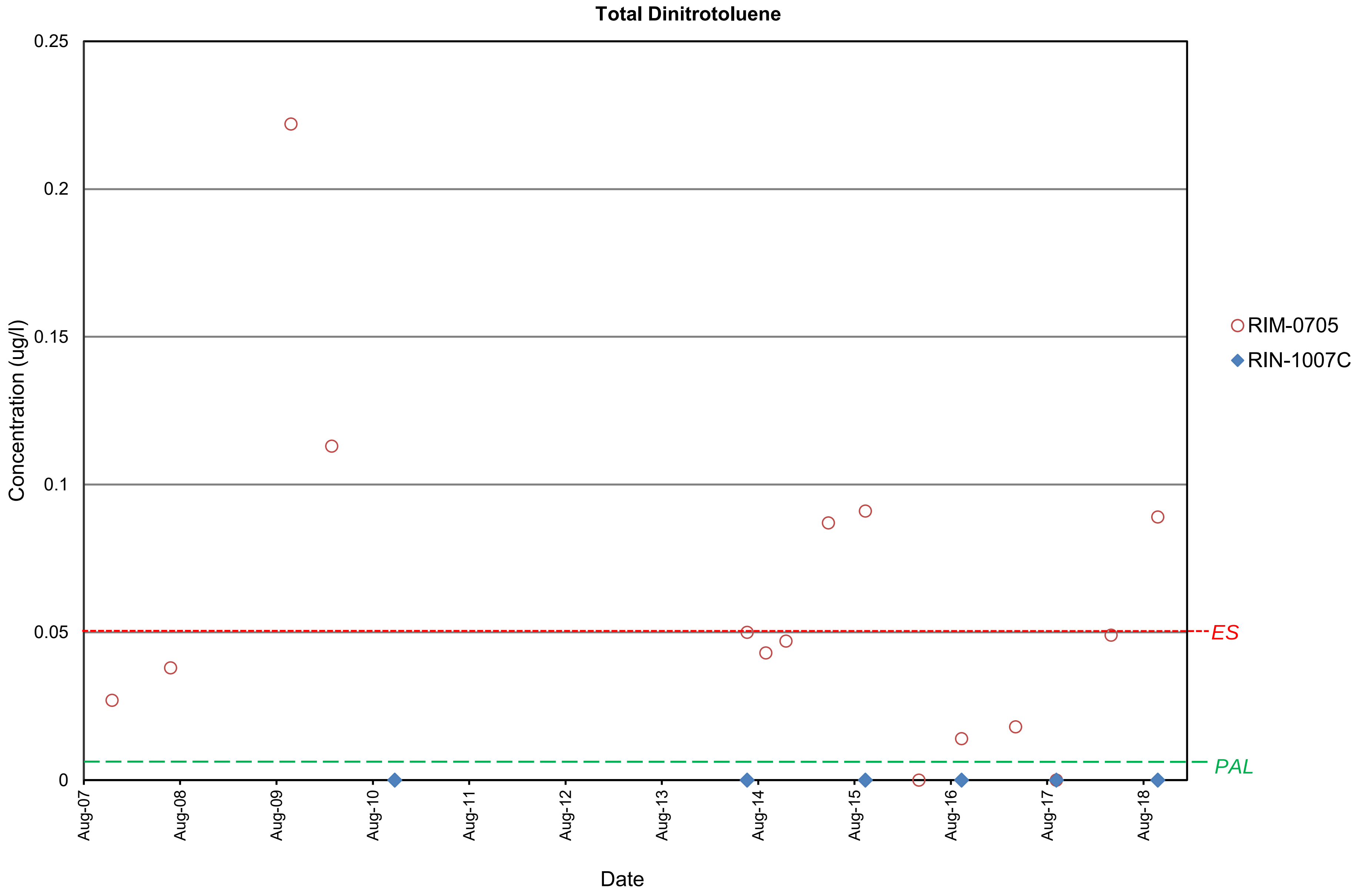
Source Area Wells	Compound	Year Range	Page
RIM-1002	DNT	2010 - 2018	1
RIM-0705, RIN-1007C	DNT	2007 - 2018	2

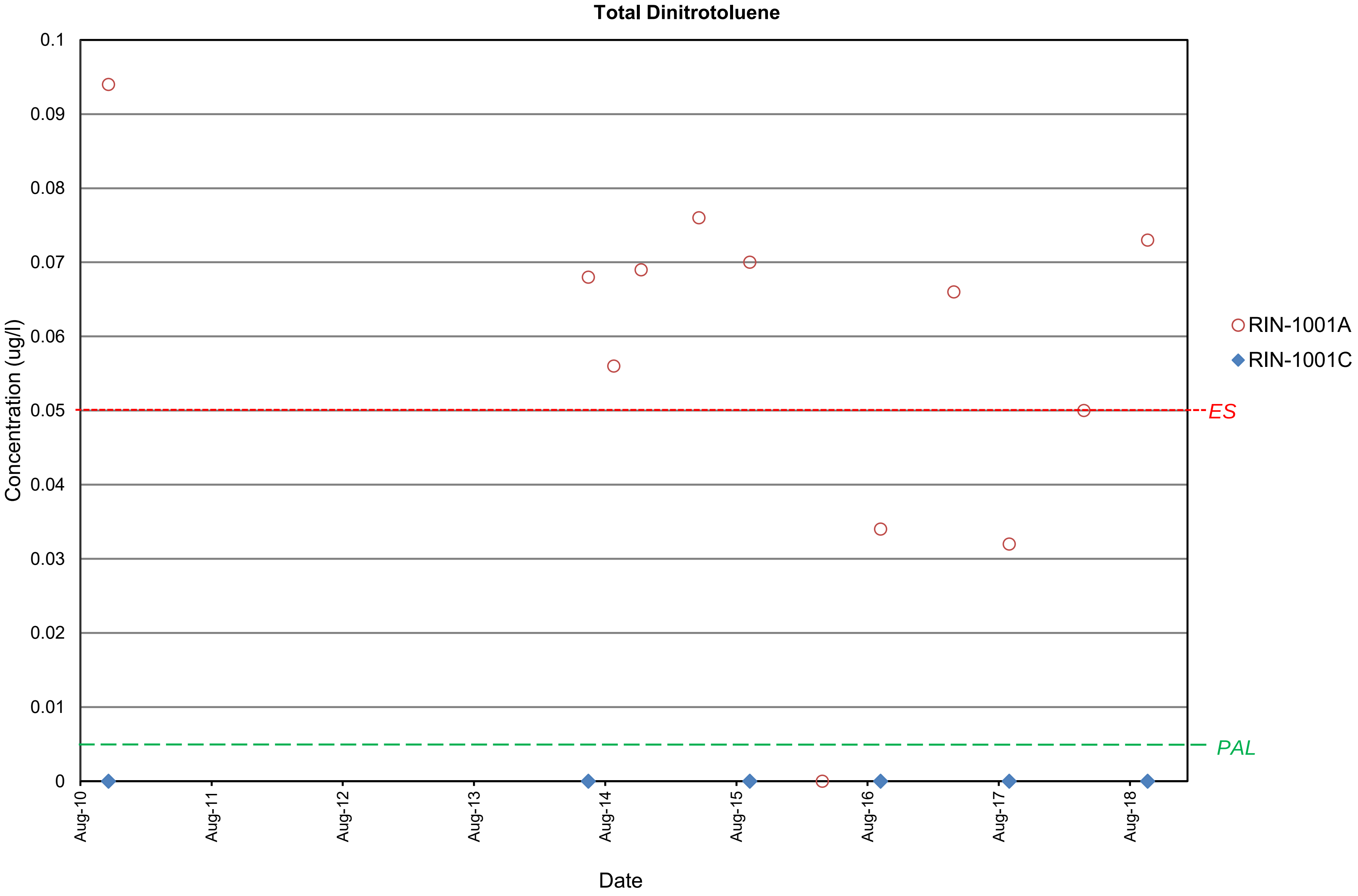
On-Site Downgradient Wells	Compound	Year Range	Page
RIN-1001A, C	DNT	2010 - 2018	3

BAAP Groundwater Data | Nitrocellulose Production Area Plume | Plume Center



BAAP Groundwater Data | Nitrocellulose Production Area Plume | Plume Center




Total Dinitrotoluene
Concentration (ug/l)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Aug-10
Aug-11
Aug-12
Aug-13
Aug-14
Aug-15
Aug-16
Aug-17
Aug-18
Date
○ RIN-1001A
◆ RIN-1001C
ES
PAL

Appendix F

Screening Level Groundwater Risk Evaluation – Exponent

Exponent®

EXTERNAL MEMORANDUM

TO: Joel Janssen, P.G., SpecPro Professional Services, LLC
FROM: Michael Kierski, Ph.D., and Michael Garry, Ph.D.
DATE: December 17, 2018
PROJECT: Badger Army Ammunition Plant, Risk Assessment Consulting Support
SUBJECT: Screening Level Groundwater Risk Evaluation (Draft)

Introduction

SpecPro Professional Services, LLC (SpecPro) requested Exponent evaluate the potential risk associated with exposure to groundwater at the Badger Army Ammunition Plant (BAAP) on behalf of the Department of the Army (Army). Risks associated with groundwater contamination can arise from domestic use of groundwater (e.g., drinking, bathing, and washing) from private residential wells. In addition, exposure to the contamination in groundwater can occur through chemical vapors emanating from groundwater due to transport of chemicals from the water table through soil resulting in release of the vapors into homes, which is referred to as vapor intrusion. We were asked to calculate potential risks associated with domestic use of groundwater from existing residential wells, offsite monitoring wells that are within areas not restricted with respect to the use of the groundwater, as well as hypothetical risks associated with onsite monitoring wells in the event that groundwater onsite is used as source of domestic water in the future.[1] The vapor intrusion exposure pathway will be separately evaluated by SpecPro.

A groundwater risk evaluation was conducted to estimate the cumulative risk associated with both current and hypothetical future exposure to groundwater by residents. Current risks were estimated by evaluating groundwater data collected from both monitoring wells and residential wells located offsite and associated with the three groundwater plumes that have migrated offsite into residential areas. The potential for future groundwater risks was evaluated using groundwater data collected from monitoring wells located onsite and associated with the four onsite groundwater plumes. Groundwater data from 2015, 2016, 2017, and 2018 were used for the initial screening level risk evaluation to best represent current and potential future groundwater quality. We used this data set because these data best represent current groundwater quality at BAAP. Source removal and groundwater remediation activities occurred

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[1] A monitoring well is placed in an area for the specific purpose of monitoring groundwater quality as part of a site investigation, but a monitoring well is not constructed in a way that would allow it to be used to provide drinking water. A residential well, on the other hand, is constructed specifically to provide drinking water.

at BAAP until 2015, so historical groundwater data collected before these activities occurred would not accurately reflect current groundwater quality conditions.

The analyses were focused on areas influenced by the following four groundwater plumes:

- Propellant Burning Ground Plume
- Deterrent Burning Ground Plume
- Central Plume
- Nitrocellulose Production Area Plume.

The assessment used standard U.S. Environmental Protection Agency (EPA) risk assessment methods to evaluate current groundwater risks from consumption. The approach used to estimate groundwater risks for this screening level evaluation was conservative in nature (i.e., more likely to overestimate risk). Maximum concentrations of analytes in offsite or onsite wells associated with each plume were used to estimate risks. Therefore, the risks presented in this screening level groundwater risk evaluation should be viewed as upper bound estimates of the potential groundwater risks within a specific area and do not reflect the risk associated with drinking water from any specific residential or groundwater monitoring well. The remaining sections document the screening risk methods used to estimate the groundwater risks by area and the results of the screening level groundwater risk evaluation by plume.

Screening Level Groundwater Risk Assessment Methods

A screening level groundwater risk evaluation was conducted for each of the four plume areas using EPA human health risk assessment (HHRA) methods (U.S. EPA 1989, 1991). The screening risk evaluation was conducted in two steps. First, site concentrations were compared to health-based screening levels to identify chemicals of potential concern (COPCs). Second, risk estimates were calculated for COPCs that exceeded screening levels.

Methods for Screening of Chemicals of Potential Concern

For this screening evaluation, we relied on the EPA's November 2018 tapwater regional screening levels (RSLs)[2] and Wisconsin Department of Natural Resources' (WDNR's) NR140 groundwater standards (WDNR 2017) to screen the groundwater data. A summary of the groundwater screening levels from these two sources are provided in Table 1. For purposes of the groundwater screening evaluation, we compared the maximum concentration of the chemicals detected in each plume area to the lowest groundwater screening value available for

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[2] The tapwater RSLs table used for the screening process was based on a target cancer risk of one-in-a-million (1E-06) and a noncancer target hazard quotient (THQ) of 0.1.

each chemical.[3] Chemicals with a maximum detected concentration that exceeded the lowest available groundwater screening value for the chemical are considered at the screening level stage to be COPCs.

Groundwater Risk Calculation Methods

Based on EPA risk assessment guidance, COPCs can be further evaluated in the HHRA to provide site-specific risk estimates. The site-specific HHRA is part of the remedial investigation process that serves to document potential risks associated with exposure to chemicals in environmental media at a specific site. This screening level groundwater evaluation is an initial step in the HHRA being completed by SpecPro. The groundwater risk estimates were calculated by plume area using a simple EPA scaling method described in Section 2.6.1 of the online Regional Screening Levels (RSLs) – User's Guide (November 2018), a copy of which is provided as Appendix A of this memorandum.[4] For each COPC, the following calculations were used to estimate potential cancer and noncancer risks, as applicable.

$$\text{Cancer Risk} = (C_{gw} \times \text{TR}) / \text{RSL}_{\text{tapwater (based on cancer effect)}}$$
$$\text{Noncancer HQ} = (C_{gw} \times \text{THQ}) / \text{RSL}_{\text{tapwater (based on noncancer effect)}}$$

where:

Cancer Risk = a unitless probability of an individual developing cancer over a lifetime.
HQ = hazard quotient; a unitless ratio of exposure to chemicals in groundwater to a reference dose at which no health effects are expected to occur.
C_{gw} = Groundwater concentration in units of μg/L or mg/L.
TR = Target cancer risk that the RSL is based on (1E-06).
THQ = Target hazard quotient that the RSL is based on.
$\text{RSL}_{\text{tapwater}}$ = Tapwater RSL (U.S. EPA November 2018) in the same units as C_{gw} for the applicable effect (i.e., cancer or noncancer).

We calculated cancer risks for all COPCs considered potential carcinogens. Cancer risk is expressed as an upper bound probability that an individual will develop cancer as a result of exposure to a chemical in the groundwater over their lifetime. For example, a 1E-06 cancer risk represents a one-in-a-million upper bound risk of an individual contracting cancer during their lifetime from the specific chemical exposure. This cancer risk is in addition to the background level risk of contracting cancer of any kind during one's lifetime unrelated to groundwater

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[3] For the screening assessment, all dinitrotoluene isomers (e.g., 2,4-dinitrotoluene, 3,4-dinitrotoluene, etc.) were summed together to calculate a total dinitrotoluene for each sample. The total dinitrotoluene value was then compared to the lowest screening value available for the dinitrotoluene isomers. This conservative approach was used because some of the dinitrotoluene isomers did not have screening values.

[4] https://www.epa.gov/risk/regional-screening-levels-rsls-users-guide

chemical exposure, which is approximately 40.8% in males (a little less than one in two) and approximately 37.5% in females (a little more than one in three).[5]

We also calculated noncancer risks for each COPC. The chemical-specific noncancer risks are represented by hazard quotient (HQ) values derived by comparing the groundwater chemical concentrations to chemical-specific tapwater RSLs.[6] If the resultant HQ value is less than or equal to 1, then adverse health effects associated with exposure to that chemical in the groundwater are unlikely to occur even among sensitive individuals. An HQ greater than 1 does not necessarily indicate that a health effect will occur but does indicate that there is the potential for a health effect with increasing exposures and that additional analysis is necessary.

EPA's tapwater RSLs are risk-based concentrations developed using specific generic exposure assumptions that represent reasonable maximum exposure (RME) to groundwater. The tapwater RSLs were developed considering potential exposure to chemicals in groundwater associated with domestic use of the groundwater as a drinking water source, as well as other normal domestic water uses, such as bathing, doing laundry, and washing dishes. Exposure to chemicals in groundwater are incorporated into the tapwater RSL for ingestion, dermal contact with the water, and inhalation of the portion of the chemicals in groundwater that are volatilized from the water as it is used (e.g., for bathing). Tapwater RSLs based on noncancer effects are also developed separately for adults and children, and then the lower of the two RSLs is selected for evaluating risks to people. RSLs based on cancer incorporate exposure during both childhood and adulthood. For this reason, the tapwater RSLs are considered a conservative risk-based benchmark on which to calculate risk associated with groundwater chemical exposure.

The potential risk associated with groundwater in each plume area was calculated for each COPC using maximum groundwater concentrations and tapwater RSLs in the equations presented above.[7] The total groundwater risks for an area were estimated by adding the individual cancer risks or noncancer HQs for all COPCs together for a given area. The process of adding these COPC-specific risks together is described in detail in Section 5.15.2 of the online Regional Screening Levels (RSLs) – User's Guide (May 2018). The sum of all cancer risks for the COPC within an area is referred to as the cumulative cancer risk. The sum of all noncancer risks (i.e., HQs) for the COPC within an area is referred to as the hazard index (HI). The groundwater risk evaluation approach used to develop the cumulative cancer risk and

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[5] American Cancer Society PowerPoint presentation titled "cancer-statistics-presentation-2017.pptx" located at https://www.cancer.org/research/cancer-facts-statistics/all-cancer-facts-figures/cancer-facts-figures-2017.html.

[6] The noncancer HQ for each chemical was calculated using the EPA noncancer-based tapwater RSLs based on a THQ of 0.1. Therefore, the noncancer-based risks were estimated using a THQ of 0.1 in the equation presented herein.

[7] For total dinitrotoluene, the risk was calculated two ways (refer to Tables 2b through 8b). First, the risk was estimated using the total dinitrotoluene concentration, and then the risk was calculated by summing the risks for the individual dinitrotoluene isomer(s) that made up the total dinitrotoluene concentration. The second method was used as a check because one of the isomers is more toxic (i.e., 2,6-dinitrotoluene) than the other isomers. Therefore, if the total dinitrotoluene concentration is dominated by 2,6-dinitrotolune, the risk using the total value can slightly underestimate the risk. The maximum total dinitrotoluene risk calculated by the two methods was used as the total risk estimate for an area.

noncancer HI is conservative in nature because it assumes people would be exposed to the maximum concentrations of all COPCs, although not all maximum COPC concentrations within an area occur in the same well. For this reason, the well with the maximum COPC concentration within the area for which the risk was estimated is identified in the risk tables presented in the next section.

Interpretation of Risk Estimates

Although the determination of an acceptable site-specific target cancer risk level is ultimately a decision for risk managers, we provide perspective on the calculated values by comparing them to the range of cancer risk levels cited in EPA's National Contingency Plan (NCP) (U.S. EPA 1990), which EPA describes as the "blueprint for the Superfund law." The NCP (40 CFR 300.430 [e] [2]) states, "For known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual of between 10^{-4} [1E-04] and 10^{-6} [1E-06] using information on the relationship between dose and response." A later EPA memo states that "where the cumulative site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4} [1E-04] and the non-carcinogenic hazard quotient is less than 1,[8] action generally is not warranted unless there are adverse environmental impacts." The memo further states:

> A risk manager may also decide that a baseline [cancer] risk level less than 10^{-4} is unacceptable due to site-specific reasons, and that remedial action is warranted … Other chemical-specific ARARs [Applicable or Relevant and Appropriate Requirements] may also be used to determine whether a site warrants remediation. (U.S. EPA 1991)

To provide perspective on the estimated risks associated with groundwater use, the values are compared to the risk management criteria described above (i.e., cumulative cancer risk range or an HI of 1). Based on the NCP and EPA guidance, cumulative carcinogenic risks below 1E-06 are generally considered to represent a negligible risk, cumulative risks between 1E-06 and 1E-04 are within a range considered acceptable under most conditions, and cumulative cancer risks above 1E-04 indicate unacceptable levels of risk where remedial action or further evaluation needs to be considered. In other words, cumulative cancer risks that fall within the range of 1E-06 and 1E-04 are generally considered acceptable and require no action, but exceptions to this general rule can be made on a site-specific basis as discussed above and presented below. For noncancer effects there is no similar "risk range"; rather, any HI greater than 1 indicates further evaluation is required to determine whether the exposure presents a health concern. In other words, an HI equal to or less than 1 is not considered to pose a potential health concern.

However, as described above, risk managers may elect to consider risks within the risk range of 1E-06 and 1E-04 for remedial action. The Army risk managers have decided that in offsite areas where the Army does not have control over the use of the groundwater as a drinking water

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[8] While the NCP refers to an HQ less than 1 as the risk management criterion, in practice, the cumulative noncancer HI is used as the risk management criterion to determine whether potential noncancer health concerns require further evaluation.

source they will consider cumulative cancer risks above 1E-06 for potential action or additional evaluation. For onsite areas where the Army has control over the use of the groundwater as a drinking water source, they will use a cumulative risk management goal of less than or equal to 1E-04. Using a different remedial cumulative cancer risk goal onsite (1E-04) versus offsite (1E-06) affects the selection of contaminants of concern (COCs) in these two areas (offsite versus onsite), as discussed below.

A summary of the COPCs identified as COCs based on the results of the screening level groundwater risk assessment is presented by plume area in the next sections of this memorandum. COCs are analytes found to significantly contribute to the cumulative risk in a particular area (onsite or offsite) where risk was estimated to be above the risk management criteria selected for that area. For onsite areas, where the Army controls the use of groundwater, the risk management criteria used for defining a chemical as a COC is a cumulative cancer risk >1E-04 or an HI >1. For offsite areas, where the Army does not control the use of the groundwater, the risk management criteria used for defining a chemical as a COC is a cumulative cancer risk >1E-06 or an HI >1. As mentioned above, a cumulative cancer risk greater than 1E-04 is typically considered unacceptable, and an HI greater than 1 indicates a level of exposure that needs to be evaluated further to determine whether a health concern exists. However, in the case of the offsite areas, the Army has decided to take a much more health protective approach and use a lower cumulative cancer risk criterion of greater than 1E-06. For this reason, two different sets of risk management criteria are used in the following sections to put the cumulative risk estimates into perspective in terms of the need for potential action or additional evaluation.

Because of the different risk management criteria applied to onsite and offsite areas, risks by plume area are assessed and described separately for onsite and offsite areas in the following sections. There are currently no residential drinking water wells onsite, so only onsite monitoring well data were used to estimate risks. For offsite portions of each plume, both monitoring well and residential well data were used to estimate risks. Like the onsite area, the monitoring wells in offsite areas are not used as a drinking water source. However, the residential wells in offsite areas are used as a drinking water source. Therefore, risks calculated for a particular offsite plume area may have been based on monitoring well data or residential well data depending on the type of well in which the maximum chemical concentration was detected. For offsite portions of a plume, we specify whether the risk estimate is based on monitoring well or residential well data or a combination of both. The plume-specific risk tables specify the well where the maximum concentration of each chemical was identified.

Screening Risk Evaluation for the Propellant Burning Ground Plume

Risks associated with hypothetical future and current use of groundwater were calculated based on data collected from the Propellant Burning Ground Plume in 2015, 2016, 2017, and 2018. Onsite monitoring well data were used to estimate hypothetical future onsite risks. The Army currently prohibits the use of onsite groundwater as a drinking water source and anticipates continuing this practice in the future. Therefore, it is unlikely that onsite groundwater will be used as a drinking water source in the future. Data from both offsite monitoring wells and residential drinking water wells were used to evaluate current offsite risks.

Future Onsite Risk Evaluation

Table 2a summarizes the results of the onsite COPC screening for the Propellant Burning Ground Plume. Hypothetical future risks were calculated for the COPCs identified in the onsite monitoring well data. Cancer and noncancer risk estimates are summarized in Table 2b for individual COPCs and for cumulative risks. A COPC may be identified as a COC because of its noncancer and/or cancer risks.

For onsite areas *where groundwater use is under the control of the Army* the risk management criteria used to determine which chemicals are COCs were a cumulative cancer risk >1E-04 or an HI >1. The cumulative risk estimates are considered hypothetical in nature, as groundwater onsite would not be expected to be used in these areas in the future because of the restrictions placed on groundwater use by the Army.

Cancer Risk Summary

Cancer risks calculated using the simple scaling method for a hypothetical future onsite residential scenario, along with the maximum observed concentration of each COPC identified in the onsite monitoring wells from the Propellant Burning Ground Plume area, yielded a cumulative cancer risk estimate of 6E-03, which exceeds the upper limit of EPA’s target cancer risk range. The only COC that contributed to that exceedance was dinitrotoluenes.

Noncancer Risk Summary

Based on the same hypothetical future onsite residential scenario, the noncancer HI (which is the sum of all HQs for individual COPCs) for the onsite Propellant Burning Ground Plume was 53, indicating the need for additional analysis. The COCs contributing to the HI >1 were dinitrotoluenes, ethyl ether, and trichloroethene.

Current Offsite Risk Evaluation

Table 3a summarizes the results of the offsite COPC screening for the Propellant Burning Ground Plume. Current risks were calculated for the COPCs identified in the offsite monitoring and residential well data. Cancer and noncancer risk estimates are summarized in Table 3b for individual COPCs and for cumulative risks. For offsite areas *where groundwater use is not under the control of the Army* the risk management criteria used to determine which chemicals are COCs were a cumulative cancer risk >1E-06 or an HI >1.

Cancer Risk Summary

Cancer risks calculated using the simple scaling method for a current offsite residential scenario, along with the maximum observed concentration of each COPC identified in the offsite portion of the Propellant Burning Ground Plume area, yielded a cumulative cancer risk estimate of 1E-04. This is within EPA's target cancer risk range where remedial action or additional evaluation is typically considered unnecessary. However, the risk estimate exceeds the lower cumulative cancer risk goal of 1E-06 selected by the Army. All maximum concentrations of COPCs were from offsite monitoring wells, and none were from a residential well. The COCs that contributed to that exceedance were carbon tetrachloride, chloroform, dinitroluenes, and trichloroethene.

Noncancer Risk Summary

Based on the same current offsite residential scenario, the noncancer HI for the offsite portion of the Propellant Burning Ground Plume was 5, indicating the need for additional analysis. The only COC contributing to the HI >1 was trichloroethene (monitoring well).

Summary of Risks for the Propellant Burning Ground Plume

Based on the maximum risk scenario, both the onsite and offsite areas of the Propellant Burning Ground Plume represent zones where cumulative risk estimates exceed the risk management criteria selected by the Army. The cumulative cancer and noncancer risks (i.e., HI) are summarized separately in the table below. A COPC may be a COC because it exceeds the noncancer HI and/or cumulative cancer risk management criterion. As discussed previously, for offsite areas *where groundwater use is not under the control of the Army* the risk management criteria used to determine which chemicals are COCs are a cumulative cancer risk >1E-06 or an HI >1, whereas the risk management criteria for onsite areas are a cumulative cancer risk >1E-04 or an HI >1.

Summary of Risk Estimates for Propellant Burning Ground Plume

Location	Cumulative Cancer Risk	Noncancer Hazard Index	Contaminants of Concern*
Onsite (Hypothetical Future Risk)	6E-03	53	Ethyl Ether, Dinitrotoluenes, Trichloroethene
Offsite (Current Risk)	1E-04	5	Carbon Tetrachloride, Chloroform, Dinitrotoluenes, Trichloroethene

* A chemical is considered a contaminant of concern (COC) if either the cancer risk or the noncancer hazard quotient (HQ) for that chemical *exceeds* the risk management criteria.

Screening Risk Evaluation for the Deterrent Burning Ground Plume

Risks associated with hypothetical future and current use of groundwater were calculated based on data collected from the Deterrent Burning Ground Plume in 2015, 2016, 2017, and 2018. Onsite monitoring well data were used to estimate hypothetical future onsite risks. The Army currently prohibits the use of onsite groundwater as a drinking water source and anticipates continuing this practice in the future. Therefore, it is unlikely that onsite groundwater will be used as a drinking water source in the future. Data from both offsite monitoring wells and residential drinking water wells were used to evaluate current offsite risks.

Future Onsite Risk Evaluation

Table 4a summarizes the results of the onsite COPC screening for the Deterrent Burning Ground Plume. Hypothetical future risks were calculated for the COPCs identified in the onsite monitoring well data. Cancer and noncancer risk estimates are summarized in Table 4b for individual COPCs and for cumulative risks. A COPC may be identified as a COC because of its noncancer and/or cancer risks.

For onsite areas *where groundwater use is under the control of the Army* the risk management criteria used to determine which chemicals are COCs were a cumulative cancer risk >1E-04 or an HI >1. The cumulative risk estimates are considered hypothetical in nature, as groundwater onsite would not be expected to be used in these areas in the future because of the restrictions placed on groundwater use by the Army.

Cancer Risk Summary

Cancer risks calculated using the simple scaling method for a hypothetical future onsite residential scenario, along with the maximum observed concentration of each COPC identified in the onsite monitoring wells from the Deterrent Burning Ground Plume area, yielded a cumulative cancer risk estimate of 9E-05, which is within EPA's target cancer risk range of 1E-06 to 1E-04 and meets the risk management criterion for the site. Therefore, there are no COCs based on cancer risk.

Noncancer Risk Summary

Based on the same hypothetical future onsite residential scenario, the noncancer HI for the onsite Deterrent Burning Ground Plume was 3, indicating the need for additional analysis. The only COC contributing to the HI >1 was 1,1,2-trichloroethane.

Current Offsite Risk Evaluation

Table 5a summarizes the results of the offsite COPC screening for the Deterrent Burning Ground Plume. Current risks were calculated for the COPCs identified in the offsite monitoring and residential well data. Cancer and noncancer risk estimates are summarized in Table 5b for individual COPCs and for cumulative risks. For offsite areas *where groundwater use is not under the control of the Army* the risk management criteria used to determine which chemicals are COCs were a cumulative cancer risk >1E-06 or an HI >1.

Cancer Risk Summary

Cancer risks calculated using the simple scaling method for a current offsite residential scenario, along with the maximum observed concentration of each COPC identified in the offsite residential or monitoring wells from the Deterrent Burning Ground Plume area, yielded a cumulative cancer risk estimate of 2E-05. This is within EPA's target cancer risk range where remedial action or additional evaluation is typically considered unnecessary. However, the risk estimate exceeds the lower cumulative cancer risk goal of 1E-06 selected by the Army. The COCs that contributed to that exceedance were chloroform (residential well), dinitrotoluenes (monitoring well), and trichloroethene (residential well).

Noncancer Risk Summary

Based on the same current offsite residential scenario, the noncancer HI for the offsite portion of the Deterrent Burning Ground Plume was 2, indicating the need for additional analysis. The only COC contributing to the HI >1 was trichloroethene (residential well).

The HI for the offsite Deterrent Burning Ground Plume area is the result of one residential well with a maximum concentration of trichloroethene (4.7 µg/L) associated with an HQ[9] of 2; HQs for all other chemicals were less than 1. There were no other residential wells within the offsite Deterrent Burning Ground Plume area with chemical concentrations that would be associated with an HQ greater than 1. These results indicate that noncancer risks associated with use of groundwater from residential wells in this plume area would be within the risk management range except for the single residential well located in the Deterrent Burning Ground Plume area. However, this cumulative risk estimate was based on the maximum concentration of trichloroethene detected in the well. Evaluation of long-term trends of trichloroethene indicates that over the last twelve years (2007 through 2018) the concentration of trichloroethene in the Hendershot residential well ranged from a minimum value of 0.4 µg/L to a maximum value of 4.7 µg/L, with arithmetic and geometric mean concentrations of 1.2 and 0.86 µg/L, respectively (Table 5c).

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[9] The term hazard quotient or HQ is used to represent the risk associated with a given chemical in contrast to the term hazard index or HI, which refers to the sum of the multiple chemical-specific HQs. When discussing risk of a given chemical, the term HQ is used. If a given chemical in an area has an HQ greater than 1, then by default, the HI will be greater than 1 too.

Summary of Risks for Deterrent Burning Ground Plume

Based on the maximum risk scenario, both the onsite and offsite areas of the Deterrent Burning Ground Plume represent zones where cumulative risk estimates exceed the risk management criteria selected by the Army. The cumulative cancer and noncancer risks (i.e., HI) are summarized separately in the table below. A COPC may be a COC because it exceeds the noncancer HI and/or cumulative cancer risk management criterion. As discussed previously, for offsite areas *where groundwater use is not under the control of the Army* the risk management criteria used to determine which chemicals are COCs are a cumulative cancer risk >1E-06 or an HI >1, whereas the risk management criteria for onsite areas are cumulative cancer risk >1E-04 or an HI >1.

Summary of Risk Estimates for the Deterrent Burning Ground Plume

Location	Cumulative Cancer Risk	Noncancer Hazard Index	Contaminants of Concern*
Onsite (Hypothetical Future Risk)	9E-05	3	1,1,2-Trichloroethane
Offsite (Current Risk)	2E-05	2	Chloroform, Dinitrotoluenes, Trichloroethene

* A chemical is considered a contaminant of concern (COC) if either the cancer risk or the noncancer hazard quotient (HQ) for that chemical *exceeds* the risk management criteria.

Screening Risk Evaluation for the Central Plume

Risks associated with hypothetical future and current use of groundwater were calculated based on data collected from the Central Plume in 2015, 2016, 2017, and 2018. Onsite monitoring well data were used to estimate hypothetical future onsite risks. The Army currently prohibits the use of onsite groundwater as a drinking water source and anticipates continuing this practice in the future. Therefore, it is unlikely that onsite groundwater will be used as a drinking water source in the future. Data from both offsite monitoring wells and residential drinking water wells were used to evaluate current offsite risks.

Future Onsite Risk Evaluation

Table 6a summarizes the results of the onsite COPC screening for the Central Plume. Hypothetical future risks were calculated for the COPCs identified in the onsite monitoring well data. Cancer and noncancer risk estimates are summarized in Table 6b for individual COPCs and for cumulative risks. A COPC may be identified as a COC because of its noncancer and/or cancer risks.

For onsite areas *where groundwater use is under the control of the Army* the risk management criteria used to determine which chemicals are COCs were a cumulative cancer risk >1E-04 or an HI >1. The cumulative risk estimates are considered hypothetical in nature, as groundwater onsite would not be expected to be used in these areas in the future because of the restrictions placed on groundwater use by the Army.

Cancer Risk Summary

Cancer risks calculated using the simple scaling method for a hypothetical future onsite residential scenario, along with the maximum observed concentration of each COPC identified in the onsite monitoring wells from the Central Plume area, yielded a cumulative cancer risk estimate of 3E-06, which is within EPA's target cancer risk range of 1E-06 to 1E-04 and meets the risk management criterion for the site. Therefore, there are no COCs based on cancer risk.

Noncancer Risk Summary

Based on the same hypothetical future onsite residential scenario, the noncancer HI for the onsite portion of the Central Plume was 0.02, which meets the risk management criterion (HI≤1). Therefore, there are no COCs for the onsite Central Plume area and additional analysis is unnecessary.

Current Offsite Risk Evaluation

Table 7a summarizes the results of the offsite COPC screening for the Central Plume. Current risks were calculated for the COPCs identified in the offsite monitoring and residential well data. Cancer and noncancer risk estimates are summarized in Table 7b for individual COPCs and for cumulative risks. For offsite areas *where groundwater use is not under the control of the Army* the risk management criteria used to determine which chemicals are COCs were a cumulative cancer risk >1E-06 or an HI >1.

Cancer Risk Summary

Cancer risks calculated using the simple scaling method for a current offsite residential scenario, along with the maximum observed concentration of each COPC identified in the offsite portion of the Central Plume area, yielded a cumulative cancer risk estimate of 4E-05. This is within EPA's target cancer risk range where remedial action or additional evaluation is typically considered unnecessary. However, the risk estimate exceeds the lower cumulative cancer risk criteria of 1E-06 selected by the Army. The COCs that contributed to that exceedance were 1,2-dichloroethane (monitoring well), benzene (monitoring well), chloroform (residential well), and dinitrotoluenes (monitoring well).

Noncancer Risk Summary

Based on the same current offsite residential scenario, the noncancer HI for the offsite portion of the Central Plume was 0.4, which meets the risk management criterion (HI≤1). Therefore, there are no COCs for the offsite portion of the Central Plume area and additional analysis is unnecessary.

Summary of Risks for Central Plume

Based on the maximum risk scenario, the offsite area of the Central Plume represents a zone where cumulative risk estimates exceed the risk management criteria selected by the Army. The onsite area of the Central Plume meets the risk management criteria. The cumulative cancer and noncancer risks (i.e., HI) are summarized separately in the table below. A COPC may be a COC because it exceeds the noncancer HI and/or cumulative cancer risk management criterion. As discussed previously, for offsite areas *where groundwater use is not under the control of the Army* the risk management criteria used to determine which chemicals are COCs are a cumulative cancer risk >1E-06 or an HI >1, whereas the risk management criteria for onsite areas are cumulative cancer risk >1E-04 or an HI >1.

Summary of Risk Estimates for the Central Plume

Location	Cumulative Cancer Risk	Noncancer Hazard Index	Contaminants of Concern*
Onsite (Hypothetical Future Risk)	3E-06	0.02	None
Offsite (Current Risk)	4E-05	0.4	1,2-Dichloroethane, Benzene, Chloroform, Dinitrotoluenes

* A chemical is considered a contaminant of concern (COC) if either the cancer risk or the noncancer hazard quotient (HQ) for that chemical *exceeds* the risk management criteria.

Screening Risk Evaluation for the Nitrocellulose Production Area Plume

Risks associated with hypothetical future use of groundwater were calculated based on data collected from the Nitrocellulose Production Area Plume in 2015, 2016, 2017, and 2018. Onsite monitoring well data were used to estimate hypothetical future onsite risks. The Army currently prohibits the use of onsite groundwater as a drinking water source and anticipates continuing this practice in the future. Therefore, it is unlikely that onsite groundwater will be used as a drinking water source in the future. The Nitrocellulose Production Area Plume is contained onsite, so there are no offsite exposures associated with this plume and a current offsite risk evaluation was not conducted.

Future Onsite Risk Evaluation

Table 8a summarizes the results of the onsite COPC screening for the Nitrocellulose Production Area Plume. Hypothetical future risks were calculated for the COPCs identified in the onsite monitoring well data. Cancer and noncancer risk estimates are summarized in Table 8b for individual COPCs and for cumulative risks. A COPC may be identified as a COC because of its noncancer and/or cancer risks.

For onsite areas *where groundwater use is under the control of the Army* the risk management criteria used to determine which chemicals are COCs were a cumulative cancer risk >1E-04 or an HI >1. The cumulative risk estimates are considered hypothetical in nature, as groundwater onsite would not be expected to be used in these areas in the future because of the restrictions placed on groundwater use by the Army.

Cancer Risk Summary

Cancer risks calculated using the simple scaling method for a hypothetical future onsite residential scenario, along with the maximum observed concentration of each COPC identified in the onsite monitoring wells from the Nitrocellulose Production Area Plume area, yielded a cumulative cancer risk estimate of 4E-06, which is within EPA's target cancer risk range of 1E-06 to 1E-04 and meets the risk management criterion for the site. Therefore, there are no COCs based on cancer risk.

Noncancer Risk Summary

Based on the same hypothetical future onsite residential scenario, the noncancer HI for the onsite Nitrocellulose Production Area Plume was 0.04, which meets the risk management criterion (HI≤1). Therefore, there are no COCs for the onsite Nitrocellulose Production Area Plume and additional analysis is unnecessary.

Summary of Risks for the Nitrocellulose Production Area Plume

Based on the maximum risk scenario, the onsite area of the Nitrocellulose Production Area Plume meets the risk management criteria selected by the Army and there are no COCs. This plume is contained onsite and so there is no offsite exposure. The cumulative cancer and noncancer risks (i.e., HI) associated with hypothetical future onsite exposures are summarized separately in the table below.

Summary of Risk Estimates for Nitrocellulose Production Area Plume

Location	Cumulative Cancer Risk	Noncancer Hazard Index	Contaminants of Concern*
Onsite (Hypothetical Future Risk)	4E-06	0.04	None
Offsite (Current Risk)	NA	NA	NA

* A chemical is considered a contaminant of concern (COC) if either the cancer risk or the noncancer hazard quotient (HQ) for that chemical *exceeds* the risk management criteria.

Summary of Hypothetical Future and Current Groundwater Risks

A groundwater risk evaluation was conducted to estimate cumulative risks associated with hypothetical future residential exposure to onsite groundwater and current exposure to offsite groundwater. The hypothetical groundwater risks were evaluated using monitoring well data collected from four plume areas located onsite, where the Army maintains control over the use of the groundwater, and therefore, residential wells are not expected to be constructed in the future. Current risks were estimated by evaluating groundwater data collected for residential wells and offsite monitoring wells sampled downgradient from three plume areas that have migrated offsite. Groundwater data from 2015, 2016, 2017, and 2018 were used for the initial screening level risk evaluation to best represent current and future groundwater quality for each evaluation unless otherwise noted.

Hypothetical Future Onsite Groundwater Risk Evaluation

Based on the results of the future onsite groundwater risk evaluation of the monitoring well data in each plume area, the potential for future risks was evaluated under the hypothetical scenario that residential wells are constructed in each plume area where no residential wells currently exist. For onsite areas where groundwater use is under the control of the Army, the risk management criteria used to determine which chemicals are COCs were a cumulative cancer risk >1E-04 or an HI >1. The cumulative risk estimates are considered hypothetical in nature, as groundwater onsite would not be expected to be used in these areas in the future because of the restrictions placed on groundwater use by the Army.

Based on the maximum risk scenario for each of four onsite plume areas using the monitoring well data, the Propellant Burning Ground Plume and Deterrent Burning Ground Plume areas represent zones that would be associated with cumulative risks that exceed the risk management criteria if onsite groundwater were used as a source of residential drinking water in the future. The onsite portions of the Propellant Burning Ground Plume and Deterrent Burning Ground Plume exceed the noncancer criterion (HI>1), whereas only the Propellant Burning Ground Plume exceeds the cancer criterion (>1E-04).

The following COCs were identified in onsite areas:

- Propellant Burning Ground Plume – ethyl ether, dinitrotoluenes, and trichloroethene
- Deterrent Burning Ground Plume – 1,1,2-trichloroethane.

The cumulative risk estimates meet the risk management criteria in the onsite portions of the Central Plume and Nitrocellulose Production Area Plume, and no COCs were identified.

Current Offsite Groundwater Risk Evaluation

Based on the maximum risk scenario for the offsite portions of the Propellant Burning Ground Plume, Deterrent Burning Ground Plume, and the Central Plume using both monitoring well and private residential well data, all three plume areas are associated with cumulative risks that exceed the risk management criteria. As noted previously, the Army has elected to use a stricter cancer risk management criterion in offsite areas (>1E-06) to provide an extra level of public health protection. All three plumes exceed this lower cancer risk management criterion, whereas only the Propellant Burning Ground Plume and Deterrent Burning Ground Plume exceed the noncancer criterion (HI>1). No risk evaluation of the Nitrocellulose Production Area Plume was necessary offsite, because this plume is contained onsite and so has not affected offsite residential areas.

The following COCs were identified in offsite areas:

- Propellant Burning Ground Plume – carbon tetrachloride, chloroform, dinitrotoluenes, and trichloroethene
- Deterrent Burning Ground Plume – chloroform, dinitrotoluenes, and trichloroethene
- Central Plume – 1,2-dichloroethane, benzene, chloroform, and dinitrotoluenes.

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Tables

Table 1. Summary of Groundwater Screening Levels Used for the Screening Level Groundwater Risk Evaluation
Screening Level Groundwater Risk Evaluation (Draft)
Badger Army Ammunition Plant

CAS	Analyte	Minimum Value	EPA Cancer-based Tapwater RSL	EPA Noncancer-based Tapwater RSL (Based on THQ=0.1)[1]	NR 140 ES	NR 140 PAL	Units
71-55-6	1,1,1-Trichloroethane	40	NA	800	200	40	µg/L
79-00-5	1,1,2-Trichloroethane	0.041	0.28	0.041	5	0.5	µg/L
75-34-3	1,1-Dichloroethane	2.8	2.8	380	850	85	µg/L
75-35-4	1,1-Dichloroethene	0.7	NA	28	7	0.7	µg/L
95-63-6	1,2,4-Trimethylbenzene	5.6	NA	5.6	480	96	µg/L
95-50-1	1,2-Dichlorobenzene	30	NA	30	600	60	µg/L
107-06-2	1,2-Dichloroethane	0.17	0.17	1.3	5	0.5	µg/L
78-87-5	1,2-Dichloropropane	0.5	0.85	0.82	5	0.5	µg/L
108-67-8	1,3,5-Trimethylbenzene	6	NA	6	480	96	µg/L
602-01-7	2,3-Dinitrotoluene	NA	NA	NA	NA	NA	µg/L
121-14-2	2,4-Dinitrotoluene	0.005	0.24	3.8	0.05	0.005	µg/L
619-15-8	2,5-Dinitrotoluene	NA	NA	NA	NA	NA	µg/L
606-20-2	2,6-Dinitrotoluene	0.005	0.049	0.57	0.05	0.005	µg/L
78-93-3	2-Butanone	560	NA	560	4000	800	µg/L
610-39-9	3,4-Dinitrotoluene	NA	NA	NA	NA	NA	µg/L
618-85-9	3,5-Dinitrotoluene	NA	NA	NA	NA	NA	µg/L
67-64-1	Acetone	1400	NA	1400	9000	1800	µg/L
71-43-2	Benzene	0.46	0.46	3.3	5	0.5	µg/L
75-27-4	Bromodichloromethane	0.06	0.13	38	0.6	0.06	µg/L
75-15-0	Carbon disulfide	81	NA	81	1000	200	µg/L
56-23-5	Carbon tetrachloride	0.46	0.46	4.9	5	0.5	µg/L
75-00-3	Chloroethane	80	NA	2100	400	80	µg/L
67-66-3	Chloroform	0.22	0.22	9.7	6	0.6	µg/L
74-87-3	Chloromethane	3	NA	19	30	3	µg/L
156-59-2	cis-1,2-Dichloroethene	3.6	NA	3.6	70	7	µg/L
124-48-1	Dibromochloromethane	0.87	0.87	38	60	6	µg/L
75-71-8	Dichlorodifluoromethane	20	NA	20	1000	200	µg/L
75-43-4	Dichlorofluoromethane	NA	NA	NA	NA	NA	µg/L
60-29-7	Ethyl ether	100	NA	390	1000	100	µg/L
100-41-4	Ethylbenzene	1.5	1.5	81	700	140	µg/L
98-82-8	Isopropylbenzene	45	NA	45	NA	NA	µg/L
179601-23-1	m & p-Xylene	19	NA	19	2000	400	µg/L
91-20-3	Naphthalene	0.17	0.17	0.61	100	10	µg/L
14797-55-8	Nitrate	2	NA	3.2	10	2	mg/L
103-65-1	n-Propylbenzene	66	NA	66	NA	NA	µg/L
95-47-6	o-Xylene	19	NA	19	2000	400	µg/L
100-42-5	Styrene	10	NA	120	100	10	µg/L
14808-79-8	Sulfate	125	NA	NA	250	125	mg/L
98-06-6	tert-Butylbenzene	69	NA	69	NA	NA	µg/L
127-18-4	Tetrachloroethene	0.5	11	4.1	5	0.5	µg/L
109-99-9	Tetrahydrofuran	10	NA	340	50	10	µg/L
108-88-3	Toluene	110	NA	110	800	160	µg/L
25321-14-6	Total Dinitrotoluenes	0.005	0.1	1.1	0.05	0.005	µg/L
156-60-5	trans-1,2-Dichloroethene	20	NA	36	100	20	µg/L
79-01-6	Trichloroethene	0.28	0.49	0.28	5	0.5	µg/L
75-69-4	Trichlorofluoromethane	520	NA	520	3490	698	µg/L

Footnote 1. The U.S. Environmental Protection Agency (EPA) noncancer-based tapwater regional screening levels (RSLs) presented in this table are based on a target hazard quotient (THQ) of 0.1. A THQ of 0.1 is used at the screening step in the risk assessment as a conservative means to select chemicals of potential concern (COPCs).

Table 2a. Summary of Screening Assessment - Propellant Burning Ground Plume - Onsite Monitoring Wells
Screening Level Groundwater Risk Evaluation (Draft)
Badger Army Ammunition Plant

CAS	Analyte	Screening Level	Units	Well Type	Well ID	Well Name	Date Sampled	Result (maximum)
71-55-6	1,1,1-Trichloroethane	40	µg/L	Monitoring	674	PBN-9303C	9/24/18	1.9
75-34-3	1,1-Dichloroethane	2.8	µg/L	Monitoring	793	PBN-1404D	9/28/15	0.53
75-35-4	1,1-Dichloroethene	0.7	µg/L	Monitoring	674	PBN-9303C	9/24/18	0.37
95-63-6	1,2,4-Trimethylbenzene	5.6	µg/L	Monitoring	655	PBN-8912B	9/27/16	0.11
107-06-2	1,2-Dichloroethane	0.17	µg/L	Monitoring	686	PBN-9304C	3/3/16	0.064
108-67-8	1,3,5-Trimethylbenzene	6	µg/L	Monitoring	655	PBN-8912B	9/27/16	0.037
71-43-2	Benzene	0.46	µg/L	Monitoring	655	PBN-8912B	4/12/18	0.3
75-27-4	Bromodichloromethane	0.06	µg/L	Monitoring	669	PBN-9301C	4/23/18	0.16
75-15-0	Carbon disulfide	81	µg/L	Monitoring	794	PBN-1405F	9/26/16	0.39
56-23-5	Carbon tetrachloride	0.46	µg/L	Monitoring	632	PBN-8502A	4/18/18	16
75-00-3	Chloroethane	80	µg/L	Monitoring	775	PBN-1303B	9/12/17	1.4
67-66-3	Chloroform	0.22	µg/L	Monitoring	632	PBN-8502A	9/28/15	4.3
74-87-3	Chloromethane	3	µg/L	Monitoring	633	PBN-8503A	9/25/18	0.14
75-71-8	Dichlorodifluoromethane	20	µg/L	Monitoring	726	SPN-9104D	9/24/15	0.037
60-29-7	Ethyl ether	100	µg/L	Monitoring	687	PBN-9304D	4/14/15	6900
100-41-4	Ethylbenzene	1.5	µg/L	Monitoring	655	PBN-8912B	9/27/16	0.069
179601-23-1	m & p-Xylene	19	µg/L	Monitoring	655	PBN-8912B	9/27/16	0.17
91-20-3	Naphthalene	0.17	µg/L	Monitoring	655	PBN-8912B	9/27/16	0.053
14797-55-8	Nitrate	2	mg/L	Monitoring	368	PBM-0002	9/20/17	4.6
95-47-6	o-Xylene	19	µg/L	Monitoring	655	PBN-8912B	9/27/16	0.075
98-06-6	tert-Butylbenzene	69	µg/L	Monitoring	655	PBN-8912B	9/27/16	0.047
127-18-4	Tetrachloroethene	0.5	µg/L	Monitoring	655	PBN-8912B	4/12/18	0.12
108-88-3	Toluene	110	µg/L	Monitoring	655	PBN-8912B	9/27/16	3.5
25321-14-6	Total Dinitrotoluenes	0.005	µg/L	Monitoring	613	PBN-8202A	5/14/18	420.294
602-01-7	2,3-Dinitrotoluene	NA	µg/L	Monitoring	613	PBN-8202A	5/14/18	78
121-14-2	2,4-Dinitrotoluene	0.005	µg/L	Monitoring	613	PBN-8202A	5/14/18	33
619-15-8	2,5-Dinitrotoluene	NA	µg/L	Monitoring	613	PBN-8202A	5/14/18	0.094
606-20-2	2,6-Dinitrotoluene	0.005	µg/L	Monitoring	613	PBN-8202A	5/14/18	270
610-39-9	3,4-Dinitrotoluene	NA	µg/L	Monitoring	613	PBN-8202A	5/14/18	35
618-85-9	3,5-Dinitrotoluene	NA	µg/L	Monitoring	613	PBN-8202A	5/14/18	4.2
79-01-6	Trichloroethene	0.28	µg/L	Monitoring	686	PBN-9304C	4/5/16	7.3

Notes:

1. Those analytes detected at least once in a well in 2015, 2016, 2017 or 2018 within this specific plume area are presented in this table.
2. Those analytes that have a maximum concentration greater than the screening level are highlighted in yellow and represent chemicals of potential concern (COPCs) for which further evaluation of risk will be conducted.
3. For the screening assessment, all dinitrotoluene isomers (e.g., 2,4-dinitrotoluene, 3,4-dinitrotoluene, etc.) were summed together to calculate a total dinitrotoluenes for each sample. The total dinitrotoluenes value was then compared to the lowest screening value available for the dinitrotoluene isomers. This conservative approach was used because many of the dinitrotoluene isomers did not have screening values. The individual isomers that make up the total dinitrotoluenes concentration for the water sample are provided below the total value in gray highlighting for informational purposes.

NA - A screening value is not available for the analyte.

Table 2b. Summary of Hypothetical Future Risks - Propellant Burning Ground Plume - Onsite Monitoring Wells
Screening Level Groundwater Risk Evaluation (Draft)
Badger Army Ammunition Plant

CAS	Analyte	Screening Level	Units	Well Type	Well ID	Well Name	Date Sampled	Result (maximum)	EPA Cancer-based Tapwater RSL	EPA Noncancer-based Tapwater RSL (Based on THQ=0.1)	Cancer Risk[1]	Noncancer Hazard Quotient (HQ)[1]
75-27-4	Bromodichloromethane	0.06	µg/L	Monitoring	669	PBN-9301C	4/23/18	0.16	0.13	38	1E-06	0.0004
56-23-5	Carbon tetrachloride	0.46	µg/L	Monitoring	632	PBN-8502A	4/18/18	16	0.46	4.9	3E-05	0.3
67-66-3	Chloroform	0.22	µg/L	Monitoring	632	PBN-8502A	9/28/15	4.3	0.22	9.7	2E-05	0.04
60-29-7	Ethyl ether	100	µg/L	Monitoring	687	PBN-9304D	4/14/15	6900	NA	390	NA	2
14797-55-8	Nitrate	2	mg/L	Monitoring	368	PBM-0002	9/20/17	4.6	NA	3.2	NA	0.1
25321-14-6	Total Dinitrotoluenes	0.005	µg/L	Monitoring	613	PBN-8202A	5/14/18	420.294	0.1	1.1	4E-03	38
602-01-7	2,3-Dinitrotoluene	NA	µg/L	Monitoring	613	PBN-8202A	5/14/18	78	NA	NA	NA	NA
121-14-2	2,4-Dinitrotoluene	0.005	µg/L	Monitoring	613	PBN-8202A	5/14/18	33	0.24	3.8	1E-04	0.9
619-15-8	2,5-Dinitrotoluene	NA	µg/L	Monitoring	613	PBN-8202A	5/14/18	0.094	NA	NA	NA	NA
606-20-2	2,6-Dinitrotoluene	0.005	µg/L	Monitoring	613	PBN-8202A	5/14/18	270	0.049	0.57	6E-03	47
610-39-9	3,4-Dinitrotoluene	NA	µg/L	Monitoring	613	PBN-8202A	5/14/18	35	NA	NA	NA	NA
618-85-9	3,5-Dinitrotoluene	NA	µg/L	Monitoring	613	PBN-8202A	5/14/18	4.2	NA	NA	NA	NA
79-01-6	Trichloroethene	0.28	µg/L	Monitoring	686	PBN-9304C	4/5/16	7.3	0.49	0.28	1E-05	3
											6E-03	53
											Cumulative Cancer Risk	Hazard Index (HI)

Notes:

1. For each chemical of potential concern (COPC) identified for the plume area, a cancer risk and noncancer hazard quotient (HQ) were calculated if appropriate U.S. Environmental Protection Agency (EPA) tapwater regional screening levels (RSLs) were available for an analyte.
2. The noncancer HQ for each chemical was calculated using the EPA noncancer-based tapwater RSLs based on a target hazard quotient (THQ) of 0.1.
3. The cumulative cancer risk is calculated by summing the individual cancer risks for each COPC. The total noncancer risk is calculated by summing the analyte-specific HQs to develop a hazard index (HI).
4. The total dinitrotoluenes concentration represents the sum of all isomers of dinitrotoluene detected in the water sample. The individual isomers that make up the total dinitrotoluenes concentration for the water samples are provided below the total value in gray highlighting. The risks associated with dinitrotoluene are based on the total value and the individual isomers. The highest of the two risk estimates (i.e., based on total or the sum of individual isomers) are used in calculating the total risk for the plume area.

NA - A screening value and/or tapwater RSL was not available for the analyte. Where a tapwater RSL was not available, risk was not estimated.

Footnote:

1. All risk values are rounded to one significant figure by convention. In some cases the cumulative cancer risk or hazard index may be different from the sum of the individual cancer risks or HQs as presented because they are summed from the unrounded values.

Table 3a. Summary of Screening Assessment - Propellant Burning Ground Plume - Offsite Wells
Screening Level Groundwater Risk Evaluation (Draft)
Badger Army Ammunition Plant

CAS	Analyte	Screening Level	Units	Well Type	Well ID	Well Name	Date Sampled	Result (maximum)
71-55-6	1,1,1-Trichloroethane	40	µg/L	Monitoring	561	PBN-9101C	10/3/16	0.45
75-34-3	1,1-Dichloroethane	2.8	µg/L	Monitoring	695	PBN-9903D	9/26/16	0.3
75-35-4	1,1-Dichloroethene	0.7	µg/L	Monitoring	561	PBN-9101C	10/3/16	0.084
107-06-2	1,2-Dichloroethane	0.17	µg/L	Monitoring	574	SWN-9103E	10/4/16	0.032
71-43-2	Benzene	0.46	µg/L	Monitoring	574	SWN-9103E	9/14/17	0.22
75-27-4	Bromodichloromethane	0.06	µg/L	Monitoring	561	PBN-9101C	4/9/15	0.079
75-15-0	Carbon disulfide	81	µg/L	Monitoring	561	PBN-9101C	10/3/16	0.072
56-23-5	Carbon tetrachloride	0.46	µg/L	Monitoring	561	PBN-9101C	4/9/15	29
75-00-3	Chloroethane	80	µg/L	Residential	875	Krumenauer	10/2/15	0.075
67-66-3	Chloroform	0.22	µg/L	Monitoring	561	PBN-9101C	9/17/15	3
60-29-7	Ethyl ether	100	µg/L	Monitoring	695	PBN-9903D	4/14/15	3100
108-88-3	Toluene	110	µg/L	Monitoring	574	SWN-9103E	9/14/17	0.79
25321-14-6	Total Dinitrotoluenes	0.005	µg/L	Monitoring	561	PBN-9101C	4/12/18	0.082
606-20-2	2,6-Dinitrotoluene	0.005	µg/L	Monitoring	561	PBN-9101C	4/12/18	0.082
79-01-6	Trichloroethene	0.28	µg/L	Monitoring	561	PBN-9101C	4/9/15	9.6

Notes:

1. Those analytes detected at least once in a well in 2015, 2016, 2017 or 2018 within this specific plume area are presented in this table.
2. Those analytes that have a maximum concentration greater than the screening level are highlighted in yellow and represent chemicals of potential concern (COPCs) for which further evaluation of risk will be conducted.
3. For the screening assessment, all dinitrotoluene isomers (e.g., 2,4-dinitrotoluene, 3,4-dinitrotoluene, etc.) were summed together to calculate a total dinitrotoluenes for each sample. The total dinitrotoluenes value was then compared to the lowest screening value available for the dinitrotoluene isomers. This conservative approach was used because many of the dinitrotoluene isomers did not have screening values. The individual isomers that make up the total dinitrotoluenes concentration for the water sample are provided below the total value in gray highlighting for informational purposes.

NA - A screening value is not available for the analyte.

Table 3b. Summary of Current Risks - Propellant Burning Ground Plume - Offsite Wells
Screening Level Groundwater Risk Evaluation (Draft)
Badger Army Ammunition Plant

CAS	Analyte	Screening Level	Units	Well Type	Well ID	Well Name	Date Sampled	Result (maximum)	EPA Cancer-based Tapwater RSL	EPA Noncancer-based Tapwater RSL (Based on THQ=0.1)	Cancer Risk[1]	Noncancer Hazard Quotient (HQ)[1]
75-27-4	Bromodichloromethane	0.06	µg/L	Monitoring	561	PBN-9101C	4/9/15	0.079	0.13	38	6E-07	0.0002
56-23-5	Carbon tetrachloride	0.46	µg/L	Monitoring	561	PBN-9101C	4/9/15	29	0.46	4.9	6E-05	0.6
67-66-3	Chloroform	0.22	µg/L	Monitoring	561	PBN-9101C	9/17/15	3	0.22	9.7	1E-05	0.03
60-29-7	Ethyl ether	100	µg/L	Monitoring	695	PBN-9903D	4/14/15	3100	NA	390	NA	0.8
25321-14-6	Total Dinitrotoluenes	0.005	µg/L	Monitoring	561	PBN-9101C	4/12/18	0.082	0.1	1.1	8E-07	0.01
606-20-2	2,6-Dinitrotoluene	0.005	µg/L	Monitoring	561	PBN-9101C	4/12/18	0.082	0.049	0.57	2E-06	0.01
79-01-6	Trichloroethene	0.28	µg/L	Monitoring	561	PBN-9101C	4/9/15	9.6	0.49	0.28	2E-05	3
											1E-04	5
											Cumulative Cancer Risk	Hazard Index (HI)

Notes:

1. For each chemical of potential concern (COPC) identified for the plume area, a cancer risk and noncancer hazard quotient (HQ) were calculated if appropriate U.S. Environmental Protection Agency (EPA) tapwater regional screening levels (RSLs) were available for an analyte.
2. The noncancer HQ for each chemical was calculated using the EPA noncancer-based tapwater RSLs based on a target hazard quotient (THQ) of 0.1.
3. The cumulative cancer risk is calculated by summing the individual cancer risks for each COPC. The total noncancer risk is calculated by summing the analyte-specific HQs to develop a hazard index (HI).
4. The total dinitrotoluenes concentration represents the sum of all isomers of dinitrotoluene detected in the water sample. The individual isomers that make up the total dinitrotoluenes concentration for the water samples are provided below the total value in gray highlighting. The risks associated with dinitrotoluene are based on the total value and the individual isomers. The highest of the two risk estimates (i.e., based on total or the sum of individual isomers) are used in calculating the total risk for the plume area.

NA - A screening value and/or tapwater RSL was not available for the analyte. Where a tapwater RSL was not available, risk was not estimated.

Footnote:

1. All risk values are rounded to one significant figure by convention. In some cases the cumulative cancer risk or hazard index may be different from the sum of the individual cancer risks or HQs as presented because they are summed from the unrounded values.

Table 4a. Summary of Screening Assessment - Deterrent Burning Ground Plume - Onsite Monitoring Wells
Screening Level Groundwater Risk Evaluation (Draft)
Badger Army Ammunition Plant

CAS	Analyte	Screening Level	Units	Well Type	Well ID	Well Name	Date Sampled	Result (maximum)
71-55-6	1,1,1-Trichloroethane	40	µg/L	Monitoring	472	DBN-1001B	4/21/16	1.7
79-00-5	1,1,2-Trichloroethane	0.041	µg/L	Monitoring	211	ELN-8203B	4/26/18	0.98
75-34-3	1,1-Dichloroethane	2.8	µg/L	Monitoring	210	ELN-8203A	4/18/16	0.044
75-35-4	1,1-Dichloroethene	0.7	µg/L	Monitoring	216	ELM-8901	4/21/16	0.054
95-50-1	1,2-Dichlorobenzene	30	µg/L	Monitoring	236	S1134R	4/20/15	0.15
107-06-2	1,2-Dichloroethane	0.17	µg/L	Monitoring	234	ELM-9501	4/28/15	0.17
78-87-5	1,2-Dichloropropane	0.5	µg/L	Monitoring	211	ELN-8203B	4/24/17	0.41
67-66-3	Chloroform	0.22	µg/L	Monitoring	301	DBM-8201	4/21/16	0.075
74-87-3	Chloromethane	3	µg/L	Monitoring	220	ELM-8907	4/18/16	0.034
156-59-2	cis-1,2-Dichloroethene	3.6	µg/L	Monitoring	210	ELN-8203A	4/20/15	0.057
75-71-8	Dichlorodifluoromethane	20	µg/L	Monitoring	211	ELN-8203B	4/26/18	0.38
75-43-4	Dichlorofluoromethane	NA	µg/L	Monitoring	210	ELN-8203A	4/18/16	0.029
60-29-7	Ethyl ether	100	µg/L	Monitoring	210	ELN-8203A	4/24/17	0.77
100-42-5	Styrene	10	µg/L	Monitoring	316	DBN-9501C	4/27/15	0.03
14808-79-8	Sulfate	125	mg/L	Monitoring	210	ELN-8203A	4/26/18	1100
127-18-4	Tetrachloroethene	0.5	µg/L	Monitoring	225	ELN-8904A	4/20/15	0.12
109-99-9	Tetrahydrofuran	10	µg/L	Monitoring	211	ELN-8203B	4/18/16	20
25321-14-6	Total Dinitrotoluenes	0.005	µg/L	Monitoring	302	DBM-8202	4/24/17	8.58
602-01-7	2,3-Dinitrotoluene	NA	µg/L	Monitoring	302	DBM-8202	4/24/17	5
606-20-2	2,6-Dinitrotoluene	0.005	µg/L	Monitoring	302	DBM-8202	4/24/17	0.22
610-39-9	3,4-Dinitrotoluene	NA	µg/L	Monitoring	302	DBM-8202	4/24/17	0.26
618-85-9	3,5-Dinitrotoluene	NA	µg/L	Monitoring	302	DBM-8202	4/24/17	3.1
75-69-4	Trichlorofluoromethane	520	µg/L	Monitoring	302	DBM-8202	4/21/15	0.043

Notes:

1. Those analytes detected at least once in a well in 2015, 2016, 2017 or 2018 within this specific plume area are presented in this table.
2. Those analytes that have a maximum concentration greater than the screening level are highlighted in yellow and represent chemicals of potential concern (COPCs) for which further evaluation of risk will be conducted.
3. For the screening assessment, all dinitrotoluene isomers (e.g., 2,4-dinitrotoluene, 3,4-dinitrotoluene, etc.) were summed together to calculate a total dinitrotoluenes for each sample. The total dinitrotoluenes value was then compared to the lowest screening value available for the dinitrotoluene isomers. This conservative approach was used because many of the dinitrotoluene isomers did not have screening values. The individual isomers that make up the total dinitrotoluenes concentration for the water sample are provided below the total value in gray highlighting for informational purposes.

NA - A screening value is not available for the analyte.

Table 4b. Summary of Hypothetical Future Risks - Deterrent Burning Ground Plume - Onsite Monitoring Wells
Screening Level Groundwater Risk Evaluation (Draft)
Badger Army Ammunition Plant

CAS	Analyte	Screening Level	Units	Well Type	Well ID	Well Name	Date Sampled	Result (maximum)	EPA Cancer-based Tapwater RSL	EPA Noncancer-based Tapwater RSL (Based on THQ=0.1)	Cancer Risk[1]	Noncancer Hazard Quotient (HQ)[1]
79-00-5	1,1,2-Trichloroethane	0.041	µg/L	Monitoring	211	ELN-8203B	4/26/18	0.98	0.28	0.041	4E-06	2
107-06-2	1,2-Dichloroethane	0.17	µg/L	Monitoring	234	ELM-9501	4/28/15	0.17	0.17	1.3	1E-06	0.01
14808-79-8	Sulfate	125	mg/L	Monitoring	210	ELN-8203A	4/26/18	1100	NA	NA	NA	NA
109-99-9	Tetrahydrofuran	10	µg/L	Monitoring	211	ELN-8203B	4/18/16	20	NA	340	NA	0.01
25321-14-6	Total Dinitrotoluenes	0.005	µg/L	Monitoring	302	DBM-8202	4/24/17	8.58	0.1	1.1	9E-05	0.8
602-01-7	2,3-Dinitrotoluene	NA	µg/L	Monitoring	302	DBM-8202	4/24/17	5	NA	NA	NA	NA
606-20-2	2,6-Dinitrotoluene	0.005	µg/L	Monitoring	302	DBM-8202	4/24/17	0.22	0.049	0.57	4E-06	0.04
610-39-9	3,4-Dinitrotoluene	NA	µg/L	Monitoring	302	DBM-8202	4/24/17	0.26	NA	NA	NA	NA
618-85-9	3,5-Dinitrotoluene	NA	µg/L	Monitoring	302	DBM-8202	4/24/17	3.1	NA	NA	NA	NA
											9E-05	3
											Cumulative Cancer Risk	Hazard Index (HI)

Notes:

1. For each chemical of potential concern (COPC) identified for the plume area, a cancer risk and noncancer hazard quotient (HQ) were calculated if appropriate U.S. Environmental Protection Agency (EPA) tapwater regional screening levels (RSLs) were available for an analyte.
2. The noncancer HQ for each chemical was calculated using the EPA noncancer-based tapwater RSLs based on a target hazard quotient (THQ) of 0.1.
3. The cumulative cancer risk is calculated by summing the individual cancer risks for each COPC. The total noncancer risk is calculated by summing the analyte-specific HQs to develop a hazard index (HI).
4. The total dinitrotoluenes concentration represents the sum of all isomers of dinitrotoluene detected in the water sample. The individual isomers that make up the total dinitrotoluenes concentration for the water sample are provided below the total value in gray highlighting. The risks associated with dinitrotoluene are based on the total value and the individual isomers. The highest of the two risk estimates (i.e., based on total or the sum of individual isomers) are used in calculating the total risk for the plume area.

NA - A screening value and/or tapwater RSL was not available for the analyte. Where a tapwater RSL was not available, risk was not estimated.

Footnote:

1. All risk values are rounded to one significant figure by convention. In some cases the cumulative cancer risk or hazard index may be different from the sum of the individual cancer risks or HQs as presented because they are summed from the unrounded values.

Table 5a. Summary of Screening Assessment - Deterrent Burning Ground Plume - Offsite Wells
Screening Level Groundwater Risk Evaluation (Draft)
Badger Army Ammunition Plant

CAS	Analyte	Screening Level	Units	Well Type	Well ID	Well Name	Date Sampled	Result (maximum)
71-55-6	1,1,1-Trichloroethane	40	µg/L	Residential	163	Purcell-D	4/23/18	0.11
79-00-5	1,1,2-Trichloroethane	0.041	µg/L	Residential	803	Spear	10/5/15	0.25
78-93-3	2-Butanone	560	µg/L	Residential	428	Schumann	10/1/15	1.7
71-43-2	Benzene	0.46	µg/L	Residential	411	Anderson-R	10/1/15	0.012
67-66-3	Chloroform	0.22	µg/L	Residential	426	Cornelius	10/1/15	0.37
74-87-3	Chloromethane	3	µg/L	Residential	426	Cornelius	8/21/18	0.11
75-71-8	Dichlorodifluoromethane	20	µg/L	Residential	412	Curto	8/21/18	0.17
91-20-3	Naphthalene	0.17	µg/L	Residential	428	Schumann	10/1/15	0.072
100-42-5	Styrene	10	µg/L	Residential	428	Schumann	10/1/15	0.054
108-88-3	Toluene	110	µg/L	Residential	428	Schumann	10/1/15	1.8
25321-14-6	Total Dinitrotoluenes	0.005	µg/L	Monitoring	468	ELN-1003B	11/15/18	0.32
602-01-7	2,3-Dinitrotoluene	NA	µg/L	Monitoring	468	ELN-1003B	11/15/18	0.078
606-20-2	2,6-Dinitrotoluene	0.005	µg/L	Monitoring	468	ELN-1003B	11/15/18	0.072
610-39-9	3,4-Dinitrotoluene	NA	µg/L	Monitoring	468	ELN-1003B	11/15/18	0.17
156-60-5	trans-1,2-Dichloroethene	20	µg/L	Residential	428	Schumann	10/1/15	0.37
79-01-6	Trichloroethene	0.28	µg/L	Residential	418	Hendershot	8/29/16	4.7
75-69-4	Trichlorofluoromethane	520	µg/L	Residential	803	Spear	10/5/15	0.043

Notes:

1. Those analytes detected at least once in a well in 2015, 2016, 2017 or 2018 within this specific plume area are presented in this table.
2. Those analytes that have a maximum concentration greater than the screening level are highlighted in yellow and represent chemicals of potential concern (COPCs) for which further evaluation of risk will be conducted.
3. For the screening assessment, all dinitrotoluene isomers (e.g., 2,4-dinitrotoluene, 3,4-dinitrotoluene, etc.) were summed together to calculate a total dinitrotoluenes for each sample. The total dinitrotoluenes value was then compared to the lowest screening value available for the dinitrotoluene isomers. This conservative approach was used because many of the dinitrotoluene isomers did not have screening values. The individual isomers that make up the total dinitrotoluenes concentration for the water sample are provided below the total value in gray highlighting for informational purposes.

NA - A screening value is not available for the analyte.

Table 5b. Summary of Current Risks - Deterrent Burning Ground Plume - Offsite Wells
Screening Level Groundwater Risk Evaluation (Draft)
Badger Army Ammunition Plant

CAS	Analyte	Screening Level	Units	Well Type	Well ID	Well Name	Date Sampled	Result (maximum)	EPA Cancer-based Tapwater RSL	EPA Noncancer-based Tapwater RSL (Based on THQ=0.1)	Cancer Risk[1]	Noncancer Hazard Quotient (HQ)[1]
79-00-5	1,1,2-Trichloroethane	0.041	µg/L	Residential	803	Spear	10/5/15	0.25	0.28	0.041	9E-07	0.6
67-66-3	Chloroform	0.22	µg/L	Residential	426	Roll	10/1/15	0.37	0.22	9.7	2E-06	0.004
25321-14-6	Total Dinitrotoluenes	0.005	µg/L	Monitoring	468	ELN-1003B	11/15/18	0.32	0.1	1.1	3E-06	0.03
602-01-7	2,3-Dinitrotoluene	NA	µg/L	Monitoring	468	ELN-1003B	11/15/18	0.078	NA	NA	NA	NA
606-20-2	2,6-Dinitrotoluene	0.005	µg/L	Monitoring	468	ELN-1003B	11/15/18	0.072	0.049	0.57	1E-06	0.013
610-39-9	3,4-Dinitrotoluene	NA	µg/L	Monitoring	468	ELN-1003B	11/15/18	0.17	NA	NA	NA	NA
79-01-6	Trichloroethene	0.28	µg/L	Residential	418	Hendershot	8/29/16	4.7	0.49	0.28	1E-05	2
											2E-05	2
											Cumulative Cancer Risk	Hazard Index (HI)

Notes:

1. For each chemical of potential concern (COPC) identified for the plume area, a cancer risk and noncancer hazard quotient (HQ) were calculated if appropriate U.S. Environmental Protection Agency (EPA) tapwater regional screening levels (RSLs) were available for an analyte.
2. The noncancer HQ for each chemical was calculated using the EPA noncancer-based tapwater RSLs based on a target hazard quotient (THQ) of 0.1.
3. The cumulative cancer risk is calculated by summing the individual cancer risks for each COPC. The total noncancer risk is calculated by summing the analyte-specific HQs to develop a hazard index (HI).
4. The total dinitrotoluenes concentration represents the sum of all isomers of dinitrotoluene detected in the water sample. The individual isomers that make up the total dinitrotoluenes concentration for the water sample are provided below the total value in gray highlighting. The risks associated with dinitrotoluene are based on the total value and the individual isomers. The highest of the two risk estimates (i.e., based on total or the sum of individual isomers) are used in calculating the total risk for the plume area.

NA - A screening value and/or tapwater RSL was not available for the analyte. Where a tapwater RSL was not available, risk was not estimated.

Footnote:

1. All risk values are rounded to one significant figure by convention. In some cases the cumulative cancer risk or hazard index may be different from the sum of the individual cancer risks or HQs as presented because they are summed from the unrounded values.

Table 5c. Time Trends of Trichloroethene in Hendershot Residential Well: 2007 to 2018
Screening Level Groundwater Risk Evaluation (Draft)
Badger Army Ammunition Plant

CAS	Analyte	Well ID	Well Name	Date Sampled	Result	Units
79-01-6	Trichloroethene	418	Hendershot	8/6/07	0.40	µg/L
79-01-6	Trichloroethene	418	Hendershot	8/24/10	0.60	µg/L
79-01-6	Trichloroethene	418	Hendershot	8/24/11	0.49	µg/L
79-01-6	Trichloroethene	418	Hendershot	8/22/12	0.61	µg/L
79-01-6	Trichloroethene	418	Hendershot	8/20/13	1.28	µg/L
79-01-6	Trichloroethene	418	Hendershot	8/5/14	0.76	µg/L
79-01-6	Trichloroethene	418	Hendershot	10/2/15	0.42	µg/L
79-01-6	Trichloroethene	418	Hendershot	8/29/16	4.70	µg/L
79-01-6	Trichloroethene	418	Hendershot	8/28/17	0.82	µg/L
79-01-6	Trichloroethene	418	Hendershot	8/21/18	2	µg/L
				Arithmetic Mean	1.2	µg/L
				Geometric Mean	0.86	µg/L

Table 6a. Summary of Screening Assessment - Central Plume - Onsite Monitoring Wells
Screening Level Groundwater Risk Evaluation (Draft)
Badger Army Ammunition Plant

CAS	Analyte	Screening Level	Units	Well Type	Well ID	Well Name	Date Sampled	Result (maximum)
56-23-5	Carbon tetrachloride	0.46	µg/L	Monitoring	542	RIN-1502C	12/7/15	0.028
67-66-3	Chloroform	0.22	µg/L	Monitoring	540	RIN-1501D	12/7/15	0.27
25321-14-6	Total Dinitrotoluenes	0.005	µg/L	Monitoring	331	NLN-1001A	6/26/18	0.209
602-01-7	2,3-Dinitrotoluene	NA	µg/L	Monitoring	331	NLN-1001A	6/26/18	0.061
606-20-2	2,6-Dinitrotoluene	0.005	µg/L	Monitoring	331	NLN-1001A	6/26/18	0.058
610-39-9	3,4-Dinitrotoluene	NA	µg/L	Monitoring	331	NLN-1001A	6/26/18	0.09

Notes:

1. Those analytes detected at least once in a well in 2015, 2016, 2017 or 2018 ithin this specific plume area are presented in this table.
2. Those analytes that have a maximum concentration greater than the screening level are highlighted in yellow and represent chemicals of potential concern (COPCs) for which further evaluation of risk will be conducted.
3. For the screening assessment, all dinitrotoluene isomers (e.g., 2,4-dinitrotoluene, 3,4-dinitrotoluene, etc.) were summed together to calculate a total dinitrotoluenes for each sample. The total dinitrotoluenes value was then compared to the lowest screening value available for the dinitrotoluene isomers. This conservative approach was used because many of the dinitrotoluene isomers did not have screening values. The individual isomers that make up the total dinitrotoluenes concentration for the water sample are provided below the total value in gray highlighting for informational purposes.

NA - A screening value is not available for the analyte.

Table 6b. Summary of Hypothetical Future Risks - Central Plume - Onsite Monitoring Wells
Screening Level Groundwater Risk Evaluation (Draft)
Badger Army Ammunition Plant

CAS	Analyte	Screening Level	Units	Well Type	Well ID	Well Name	Date Sampled	Result (maximum)	EPA Cancer-based Tapwater RSL	EPA Noncancer-based Tapwater RSL (Based on THQ=0.1)	Cancer Risk[1]	Noncancer Hazard Quotient (HQ)[1]
67-66-3	Chloroform	0.22	µg/L	Monitoring	540	RIN-1501D	12/7/15	0.27	0.22	9.7	1E-06	0.003
25321-14-6	Total Dinitrotoluenes	0.005	µg/L	Monitoring	331	NLN-1001A	6/26/18	0.209	0.1	1.1	2E-06	0.02
602-01-7	2,3-Dinitrotoluene	NA	µg/L	Monitoring	331	NLN-1001A	6/26/18	0.061	NA	NA	NA	NA
606-20-2	2,6-Dinitrotoluene	0.005	µg/L	Monitoring	331	NLN-1001A	6/26/18	0.058	0.049	0.57	1E-06	0.01
610-39-9	3,4-Dinitrotoluene	NA	µg/L	Monitoring	331	NLN-1001A	6/26/18	0.09	NA	NA	NA	NA
											3E-06	0.02
											Cumulative Cancer Risk	Hazard Index (HI)

Notes:

1. For each chemical of potential concern (COPC) identified for the plume area, a cancer risk and noncancer hazard quotient (HQ) were calculated if appropriate U.S. Environmental Protection Agency (EPA) tapwater regional screening levels (RSLs) were available for an analyte.
2. The noncancer HQ for each chemical was calculated using the EPA noncancer-based tapwater RSLs based on a target hazard quotient (THQ) of 0.1.
3. The cumulative cancer risk is calculated by summing the individual cancer risks for each COPC. The total noncancer risk is calculated by summing the analyte-specific HQs to develop a hazard index (HI).
4. The total dinitrotoluenes concentration represents the sum of all isomers of dinitrotoluene detected in the water sample. The individual isomers that make up the total dinitrotoluenes concentration for the water sample are provided below the total value in gray highlighting. The risks associated with dinitrotoluene are based on the total value and the individual isomers. The highest of the two risk estimates (i.e., based on total or the sum of individual isomers) are used in calculating the total risk for the plume area.

NA - A screening value and/or tapwater RSL was not available for the analyte. Where a tapwater RSL was not available, risk was not estimated.

Footnote:

1. All risk values are rounded to one significant figure by convention. In some cases the cumulative cancer risk or hazard index may be different from the sum of the individual cancer risks or HQs as presented because they are summed from the unrounded values.

Table 7a. Summary of Screening Assessment - Central Plume - Offsite Wells
Screening Level Groundwater Risk Evaluation (Draft)
Badger Army Ammunition Plant

CAS	Analyte	Screening Level	Units	Well Type	Well ID	Well Name	Date Sampled	Result (maximum)
95-63-6	1,2,4-Trimethylbenzene	5.6	µg/L	Monitoring	586	SEN-0503B	6/12/17	0.68
107-06-2	1,2-Dichloroethane	0.17	µg/L	Monitoring	586	SEN-0503B	6/12/17	0.3
108-67-8	1,3,5-Trimethylbenzene	6	µg/L	Monitoring	586	SEN-0503B	6/12/17	0.34
71-43-2	Benzene	0.46	µg/L	Monitoring	586	SEN-0503B	6/12/17	10
75-27-4	Bromodichloromethane	0.06	µg/L	Monitoring	581	SEN-0501B	4/22/15	0.031
75-15-0	Carbon disulfide	81	µg/L	Monitoring	580	SEN-0501A	11/7/16	0.11
56-23-5	Carbon tetrachloride	0.46	µg/L	Monitoring	581	SEN-0501B	6/12/17	0.22
67-66-3	Chloroform	0.22	µg/L	Residential	164	WE-SQ017	10/5/15	2
100-41-4	Ethylbenzene	1.5	µg/L	Monitoring	586	SEN-0503B	6/12/17	1.9
98-82-8	Isopropylbenzene	45	µg/L	Monitoring	586	SEN-0503B	11/7/16	0.03
179601-23-1	m & p-Xylene	19	µg/L	Monitoring	586	SEN-0503B	6/12/17	6.7
103-65-1	n-Propylbenzene	66	µg/L	Monitoring	586	SEN-0503B	6/12/17	0.21
95-47-6	o-Xylene	19	µg/L	Monitoring	586	SEN-0503B	6/12/17	2.6
100-42-5	Styrene	10	µg/L	Monitoring	586	SEN-0503B	6/12/17	0.21
108-88-3	Toluene	110	µg/L	Monitoring	586	SEN-0503B	6/12/17	35
25321-14-6	Total Dinitrotoluenes	0.005	µg/L	Monitoring	586	SEN-0503B	11/15/18	0.08
606-20-2	2,6-Dinitrotoluene	0.005	µg/L	Monitoring	586	SEN-0503B	11/15/18	0.08

Notes:

1. Those analytes detected at least once in a well in 2015, 2016, 2017 or 2018 within this specific plume area are presented in this table.
2. Those analytes that have a maximum concentration greater than the screening level are highlighted in yellow and represent chemicals of potential concern (COPCs) for which further evaluation of risk will be conducted.
3. For the screening assessment, all dinitrotoluene isomers (e.g., 2,4-dinitrotoluene, 3,4-dinitrotoluene, etc.) were summed together to calculate a total dinitrotoluenes for each sample. The total dinitrotoluenes value was then compared to the lowest screening value available for the dinitrotoluene isomers. This conservative approach was used because many of the dinitrotoluene isomers did not have screening values. The individual isomers that make up the total dinitrotoluenes concentration for the water sample are provided below the total value in gray highlighting for informational purposes.

NA - A screening value is not available for the analyte.

Table 7b. Summary of Current Risks - Central Plume - Offsite Wells
Screening Level Groundwater Risk Evaluation (Draft)
Badger Army Ammunition Plant

CAS	Analyte	Screening Level	Units	Well Type	Well ID	Well Name	Date Sampled	Result (maximum)	EPA Cancer-based Tapwater RSL	EPA Noncancer-based Tapwater RSL (Based on THQ=0.1)	Cancer Risk[1]	Noncancer Hazard Quotient (HQ)[1]
107-06-2	1,2-Dichloroethane	0.17	µg/L	Monitoring	586	SEN-0503B	6/12/17	0.3	0.17	1.3	2E-06	0.02
71-43-2	Benzene	0.46	µg/L	Monitoring	586	SEN-0503B	6/12/17	10	0.46	3.3	2E-05	0.3
67-66-3	Chloroform	0.22	µg/L	Residential	164	WE-SQ017	10/5/15	2	0.22	9.7	9E-06	0.02
100-41-4	Ethylbenzene	1.5	µg/L	Monitoring	586	SEN-0503B	6/12/17	1.9	1.5	81	1E-06	0.002
25321-14-6	Total Dinitrotoluenes	0.005	µg/L	Monitoring	586	SEN-0503B	11/15/18	0.08	0.1	1.1	8E-07	0.007
606-20-2	2,6-Dinitrotoluene	0.005	µg/L	Monitoring	586	SEN-0503B	11/15/18	0.08	0.049	0.57	2E-06	0.01
											4E-05	0.4
											Cumulative Cancer Risk	Hazard Index (HI)

Notes:

1. For each chemical of potential concern (COPC) identified for the plume area, a cancer risk and noncancer hazard quotient (HQ) were calculated if appropriate U.S. Environmental Protection Agency (EPA) tapwater regional screening levels (RSLs) were available for an analyte.
2. The noncancer HQ for each chemical was calculated using the EPA noncancer-based tapwater RSLs based on a target hazard quotient (THQ) of 0.1.
3. The cumulative cancer risk is calculated by summing the individual cancer risks for each COPC. The total noncancer risk is calculated by summing the analyte-specific HQs to develop a hazard index (HI).
4. The total dinitrotoluenes concentration represents the sum of all isomers of dinitrotoluene detected in the water sample. The individual isomers that make up the total dinitrotoluenes concentration for the water sample are provided below the total value in gray highlighting. The risks associated with dinitrotoluene are based on the total value and the individual isomers. The highest of the two risk estimates (i.e., based on total or the sum of individual isomers) are used in calculating the total risk for the plume area.

NA - A screening value and/or tapwater RSL was not available for the analyte. Where a tapwater RSL was not available, risk was not estimated.

Footnote:

1. All risk values are rounded to one significant figure by convention. In some cases the cumulative cancer risk or hazard index may be different from the sum of the individual cancer risks or HQs as presented because they are summed from the unrounded values.

Table 8a. Summary of Screening Assessment - Nitrocellulose Production Area Plume - Onsite Monitoring Wells
Screening Level Groundwater Risk Evaluation (Draft)
Badger Army Ammunition Plant

CAS	Analyte	Screening Level	Units	Well Type	Well ID	Well Name	Date Sampled	Result (maximum)
25321-14-6	Total Dinitrotoluenes	0.005	µg/L	Monitoring	478	RIM-1002	9/26/18	0.22
606-20-2	2,6-Dinitrotoluene	0.005	µg/L	Monitoring	478	RIM-1002	9/26/18	0.22

Notes:

1. Those analytes detected at least once in a well in 2015, 2016, 2017 or 2018 within this specific plume area are presented in this table.
2. Those analytes that have a maximum concentration greater than the screening level are highlighted in yellow and represent chemicals of potential concern (COPCs) for which further evaluation of risk will be conducted.
3. For the screening assessment, all dinitrotoluene isomers (e.g., 2,4-dinitrotoluene, 3,4-dinitrotoluene, etc.) were summed together to calculate a total dinitrotoluenes for each sample. The total dinitrotoluenes value was then compared to the lowest screening value available for the dinitrotoluene isomers. This conservative approach was used because many of the dinitrotoluene isomers did not have screening values. The individual isomers that make up the total dinitrotoluenes concentration for the water sample are provided below the total value in gray highlighting for informational purposes.

Table 8b. Summary of Hypothetical Future Risks - Nitrocellulose Production Area Plume - Onsite Monitoring Wells
Screening Level Groundwater Risk Evaluation (Draft)
Badger Army Ammunition Plant

CAS	Analyte	Screening Level	Units	Well Type	Well ID	Well Name	Date Sampled	Result (maximum)	EPA Cancer-based Tapwater RSL	EPA Noncancer-based Tapwater RSL (Based on THQ=0.1)	Cancer Risk[1]	Noncancer Hazard Quotient (HQ)[1]
25321-14-6	Total Dinitrotoluenes	0.005	µg/L	Monitoring	478	RIM-1002	9/26/2018	0.22	0.1	1.1	2E-06	0.02
606-20-2	2,6-Dinitrotoluene	0.005	µg/L	Monitoring	478	RIM-1002	9/26/2018	0.22	0.049	0.57	4E-06	0.04
											4E-06	0.04
											Cumulative Cancer Risk	Hazard Index (HI)

Notes:

1. For each chemical of potential concern (COPC) identified for the plume area, a cancer risk and noncancer hazard quotient (HQ) were calculated if appropriate U.S. Environmental Protection Agency (EPA) tapwater regional screening levels (RSLs) were available for an analyte.
2. The noncancer HQ for each chemical was calculated using the EPA noncancer-based tapwater RSLs based on a target hazard quotient (THQ) of 0.1.
3. The cumulative cancer risk is calculated by summing the individual cancer risks for each COPC. The total noncancer risk is calculated by summing the analyte-specific HQs to develop a hazard index (HI).
4. The total dinitrotoluenes concentration represents the sum of all isomers of dinitrotoluene detected in the water sample. The individual isomers that make up the total dinitrotoluenes concentration for the water sample are provided below the total value in gray highlighting. The risks associated with dinitrotoluene are based on the total value and the individual isomers. The highest of the two risk estimates (i.e., based on total or the sum of individual isomers) are used in calculating the total risk for the plume area.

NA - A screening value and/or tapwater RSL was not available for the analyte. Where a tapwater RSL was not available, risk was not estimated.

Footnote:

1. All risk values are rounded to one significant figure by convention. In some cases the cumulative cancer risk or hazard index may be different from the sum of the individual cancer risks or HQs as presented because they are summed from the unrounded values.

Appendix A

Regional Screening Levels (RSLs) – User's Guide (November 2018)

An official website of the United States government.

We've made some changes to EPA.gov. If the information you are looking for is not here, you may be able to find it on the EPA Web Archive or the January 19, 2017 Web Snapshot.

Close

Regional Screening Levels (RSLs) - User's Guide

November 2018

Regional Screening Levels (RSLs)

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You may need a PDF reader to view some of the files on this page. See EPA’s About PDF page to learn more.

For assistance/questions please use the Regional Screening Levels (RSLs) contact us page.

Disclaimer

This guidance sets forth a recommended, but not mandatory, approach based upon currently available information with respect to risk assessment for response actions at CERCLA sites. This document does not establish binding rules. Alternative approaches for risk assessment may be found to be more appropriate at specific sites (e.g., where site circumstances do not match the underlying assumptions, conditions and models of the guidance). The decision whether to use an alternative approach and a description of any such approach should be documented for such sites.

Accordingly, when comments are received at individual CERCLA sites questioning the use of the approaches recommended in this guidance, the comments should be considered and an explanation provided for the selected approach.

It should also be noted that the screening levels (SLs) in these tables are based upon human health risk and do not address potential ecological risk. Some sites in sensitive ecological settings may also need to be evaluated for potential ecological risk. EPA's guidance "Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessment" contains an eight step process for using benchmarks for ecological effects in the remedy selection process.

On this page:

1. Introduction

The purpose of this website is to provide default screening tables and a calculator to assist Remedial Project Managers (RPMs), On Scene Coordinators (OSC's), risk assessors and others involved in decision-making concerning CERCLA hazardous waste sites and to determine whether levels of contamination found at the site may warrant further investigation or site cleanup, or whether no further investigation or action may be required.

Users within and outside the CERCLA program should use the tables or calculator results at their own discretion and they should take care to understand the assumptions incorporated in these results and to apply the SLs appropriately.

The SLs presented in the Generic Tables are chemical-specific concentrations for individual contaminants in air, drinking water and soil that may warrant further investigation or site cleanup. The SLs generated from the calculator may be site-specific concentrations for individual chemicals in soil, air, water and fish. **It should be emphasized that SLs are not cleanup standards**. We also do not recommend that the RSLs be used as cleanup levels for Superfund Sites until the recommendations in EPA's Supplemental Guidance to Risk Assessment Guidance for Superfund, Volume I, Part A ("Community Involvement in Superfund Risk Assessments (PDF)" (24 pp, 156 K) have been addressed. SLs should not be used as cleanup levels for a CERCLA site until the other remedy selections identified in the relevant portions of the National Contingency Plan (NCP), 40 CFR Part 300, have been evaluated and considered. PRGs (Preliminary Remediation Goals) is a term used to describe a project team's early and evolving identification of possible remedial goals. PRGs may be initially identified early in the Remedial Investigation/ Feasibility Study (RI/FS) process (e.g., at RI scoping) to select appropriate detection limits for RI sampling. Typically, it is necessary for PRGs to be more generic early in the process and to become more refined and site-specific as data collection and assessment progress. The SLs identified on this website are likely to serve as PRGs early in the process--e.g., at RI scoping and at screening of chemicals of potential concern (COPCs) for the baseline risk assessment. However, once the baseline risk assessment has been performed, PRGs can be derived from the calculator using site-specific risks, and the SLs in the Generic Tables are less likely to apply. PRGs developed in the FS will usually be based on site-specific risks and Applicable or Relevant and Appropriate Requirements (ARARs) and not on generic SLs.

2. Understanding the Screening Tables

2.1 General Considerations

Risk-based SLs are derived from equations combining exposure assumptions with chemical-specific toxicity values.

2.2 Exposure Assumptions

Generic SLs are based on default exposure parameters and factors that represent Reasonable Maximum Exposure (RME) conditions for long-term/chronic exposures and are based on the methods outlined in EPA's Risk Assessment Guidance for Superfund, Part B Manual (1991) (PDF) (68 pp, 721 K) and Soil Screening Guidance documents (1996 (PDF) (89 pp, 863 K) and 2002 (PDF) (187 pp, 2.2MB).

Site-specific information may warrant modifying the default parameters in the equations and calculating site-specific SLs, which may differ from the values in these tables. In completing such calculations, the user should answer some fundamental questions about the site. For example, information is needed on the contaminants detected at the site, the land use, impacted media and the likely pathways for human exposure.

Whether these generic SLs or site-specific screening levels are used, it is important to clearly demonstrate the equations and exposure parameters used in deriving SLs at a site. A discussion of the assumptions used in the SL calculations should be included in the documentation for a CERCLA site.

2.3 Toxicity Values

In 2003, EPA's Superfund program revised its hierarchy of human health toxicity values, providing three tiers of toxicity values in a memo (PDF) (4 pp, 225 K). Three tier 3 sources were identified in that guidance, but it was acknowledged that additional tier 3 sources may exist. The 2003 guidance did not attempt to rank or put the identified tier 3 sources into a hierarchy of their own. However, when developing the screening tables and calculator presented on this website, EPA needed to establish a hierarchy among the tier 3 sources. The toxicity values used as “defaults” in these tables and calculator are consistent with the 2003 guidance. Chronic and subchronic toxicity values from the following sources, in the order in which they are presented below, are used as the defaults in these tables and calculator.

1. EPA's Integrated Risk Information System (IRIS).

2. The Provisional Peer Reviewed Toxicity Values (PPRTVs) derived by EPA's Superfund Health Risk Technical Support Center (STSC) for the EPA Superfund program. PPRTVs are archived (removed) when an IRIS profile is released, even if the IRIS profile indicates a toxicity value could not be derived. PPRTVs will retain subchronic values if IRIS releases a profile without subchronic values.

3. EPA's Office of Pesticide Programs (OPP) Human Health Benchmarks for Pesticides (HHBPs). IRIS has archived 51 chemical assessments for pesticides and for these pesticides has instead recommended the use of the toxicity values presented in the HHBP table. These include RfDs (also referred to as chronic PADs) and OSFs (referred to as cancer quantification values). OPP lists 363 pesticides in the HHBP table. Only the 51 archived by IRIS will be used in the RSL calculations.

4. The Agency for Toxic Substances and Disease Registry (ATSDR) minimal risk levels (MRLs). An MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects over a specified duration of exposure. These substance specific estimates, which are intended to serve as screening levels, are used by ATSDR health assessors and other responders to identify contaminants and potential health effects that may be of concern at hazardous waste sites.

5. The California Environmental Protection Agency Office of Environmental Health Hazard Assessment (OEHHA) provides toxicity values for the State of California. The OEHHA Toxicity Criteria Database website should be monitored for any updates to the toxicity values.

6. In the Fall 2009, this new source of toxicity values used was added: screening toxicity values in an appendix to certain PPRTV assessments. While we have less confidence in a screening toxicity value than in a PPRTV, we put these ahead of HEAST toxicity values because these appendix screening toxicity values are more recent and use current EPA methodologies in the derivation, and because the PPRTV appendix screening toxicity values also receive external peer review. To alert users when these values are used, the key presents an "X" (for Appendix) rather than a "P" (for PPRTV). The following is taken from a PPRTV appendix and states the intended usage of appendix screening levels.

   However, information is available for this chemical, which although insufficient to support derivation of a provisional toxicity value, under current guidelines, may be of limited use to risk assessors. In such cases, the Superfund Health Risk Technical Support Center summarizes available information in an appendix and develops a "screening value." Appendices receive the same level of internal and external scientific peer review as the PPRTV documents to ensure their appropriateness within the limitations detailed in the document. Users of screening toxicity values in an appendix to a PPRTV assessment should understand that there is considerably more uncertainty associated with the derivation of an appendix screening toxicity value than for a value presented in the body of the assessment. Questions or concerns about the appropriate use of screening values should be directed to the Superfund Health Risk Technical Support Center.

7. The EPA Superfund program's Health Effects Assessment Summary Table. Values in HEAST are archived (removed) when an IRIS profile or a PPRTV paper is released, even if the PPRTV paper indicates a toxicity value could not be derived.

Users of these screening tables and calculator wishing to consider using other toxicity values, including toxicity values from additional sources, may find the discussions and seven preferences on selecting toxicity values in the attached Environmental Council of States paper useful for this purpose (ECOS website, ECOS paper(DOC)).

When using toxicity values, users are encouraged to carefully review the basis for the value and to document the basis of toxicity values used on a CERCLA site.

Please contact a Superfund risk assessor in your Region for help with chemicals that lack toxicity values in the sources outlined above.

2.3.1 Reference Doses

The current, or recently completed, EPA toxicity assessments used in these screening tables (IRIS and PPRTVs) define a reference dose, or RfD, as an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. It can be derived from a NOAEL, LOAEL, or benchmark dose, or using categorical regression, with uncertainty factors generally applied to reflect limitations of the data used. RfDs are generally the toxicity value used most often in evaluating noncancer health effects at Superfund sites. Various types of RfDs are available depending on the critical effect (developmental or other) and the length of exposure being evaluated (chronic or subchronic). Some of the SLs in these tables also use Agency for Toxic Substances and Disease Registry (ATSDR) chronic oral minimal risk levels (MRLs) as an oral chronic RfD. Screening toxicity values in an appendix to certain

PPRTV assessments were added to the hierarchy in the fall of 2009. The HEAST RfDs used in these SLs were based upon then current EPA toxicity methodologies, but did not use the more recent benchmark dose or categorical regression methodologies. Chronic oral reference doses and ATSDR chronic oral MRLs are expressed in units of (mg/kg-day).

2.3.1.1 Chronic Reference Doses

Chronic oral RfDs are specifically developed to be protective for long-term exposure to a compound. As a guideline for Superfund program risk assessments, chronic oral RfDs generally should be used to evaluate the potential noncarcinogenic effects associated with exposure periods greater than 7 years (approximately 10 percent of a human lifetime). However, this is not a bright line. Note, that ATSDR defines chronic exposure as greater than 1 year for use of their values. The calculator requires the user to select between chronic and subchronic toxicity values.

2.3.1.2 Subchronic Reference Doses

Subchronic oral RfDs are specifically developed to be protective for short-term exposure to a compound. As a guideline for Superfund program risk assessments, subchronic oral RfDs should generally be used to evaluate the potential noncarcinogenic effects of exposure periods between two weeks and seven years. However, this is not a bright line. Note, that ATSDR defines subchronic exposure as less than 1 year for use of their values. The calculator requires the user to select between chronic and subchronic toxicity values.

2.3.2 Reference Concentrations

The current, or recently completed, EPA toxicity assessments used in these screening tables (IRIS and PPRTV assessments) define a reference concentration (RfC) as an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. It can be derived from a NOAEL, LOAEL, or benchmark concentration, or using categorical regression with uncertainty factors generally applied to reflect limitations of the data used. Various types of RfCs are available depending on the critical effect (developmental or other) and the length of exposure being evaluated (chronic or subchronic). These screening tables also use ATSDR chronic inhalation MRLs as a chronic RfC, intermediate inhalation MRLs as a subchronic RfC and California Environmental Protection Agency (chronic) Reference Exposure Levels (RELs) as chronic RfCs. Screening toxicity values in an appendix to certain PPRTV assessments were added to the hierarchy in the fall of 2009. These screening tables may also use some RfCs from EPA's HEAST tables.

2.3.2.1 Chronic Reference Concentrations

The chronic inhalation reference concentration is generally used for continuous or near continuous inhalation exposures that occur for 7 years or more. However, this is not a bright line, and ATSDR chronic MRLs are based on exposures longer than 1 year. EPA chronic inhalation reference concentrations are expressed in units of (mg/m^3). Cal EPA RELs are presented in $\mu g/m^3$ and have been converted to mg/m^3 for use in these screening tables. Some ATSDR inhalation MRLs are derived in parts per million (ppm) and some in mg/m^3. For use in this table all were converted into mg/m^3. The calculator requires the user to select between chronic and subchronic toxicity values.

2.3.2.2 Subchronic reference Concentrations

The subchronic inhalation reference concentration is generally used for exposures that are between 2 weeks and 7 years. However, this is not a bright line, and ATSDR subchronic MRLs are based on exposures less than 1 year. EPA subchronic inhalation reference concentrations are expressed in units of (mg/m^3). Cal EPA RELs are presented in µg/m^3 and have been converted to mg/m^3 for use in these screening tables. Some ATSDR intermediate inhalation MRLs are derived in parts per million (ppm) and some in mg/m^3. For use in this table all were converted into mg/m^3. The calculator requires the user to select between chronic and subchronic toxicity values.

2.3.3 Slope Factors

A slope factor and the accompanying weight-of-evidence determination are the toxicity data most commonly used to evaluate potential human carcinogenic risks. Generally, the slope factor is a plausible upper-bound estimate of the probability of a response per unit intake of a chemical over a lifetime. The slope factor is used in risk assessments to estimate an upper-bound lifetime probability of an individual developing cancer as a result of exposure to a particular level of a potential carcinogen. Slope factors should always be accompanied by the weight-of-evidence classification to indicate the strength of the evidence that the agent is a human carcinogen.

Oral slope factors are toxicity values for evaluating the probability of an individual developing cancer from oral exposure to contaminant levels over a lifetime. Oral slope factors are expressed in units of (mg/kg-day)$^{-1}$. When available, oral slope factors from EPA's IRIS or PPRTV assessments are used. The ATSDR does not derive cancer toxicity values (e.g. slope factors or inhalation unit risks). Some oral slope factors used in these screening tables were derived by the California Environmental Protection Agency, whose methodologies are quite similar to those used by EPA's IRIS and PPRTV assessments. Screening toxicity values in an appendix to certain PPRTV assessments were added to the hierarchy in the fall of 2009. When oral slope factors are not available in IRIS then PPRTVs, Cal EPA assessments, PPRTV appendices or values from HEAST are used.

2.3.4 Inhalation Unit Risk

The IUR is defined as the upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 µg/m^3 in air. Inhalation unit risk toxicity values are expressed in units of (µg/m^3)$^{-1}$.

When available, inhalation unit risk values from EPA's IRIS or PPRTV assessments are used. The ATSDR does not derive cancer toxicity values (e.g. slope factors or inhalation unit risks). Some inhalation unit risk values used in these screening tables were derived by the California Environmental Protection Agency, whose methodologies are quite similar to those used by EPA's IRIS and PPRTV assessments. Screening toxicity values in an appendix to certain PPRTV assessments were added to the hierarchy in the fall of 2009. When inhalation unit risk values are not available in IRIS then PPRTVs, Cal EPA assessments, PPRTV appendices or values from HEAST are used.

2.3.5 Toxicity Equivalence Factors

Some chemicals are members of the same family and exhibit similar toxicological properties; however, they differ in the degree of toxicity. Therefore, a toxicity equivalence factor (TEF) must first be applied to adjust the measured concentrations to a toxicity equivalent concentration.

The following table contains the various dioxin-like toxicity equivalency factors for Dioxins, Furans and dioxin-like PCBs (Van den Berg et al. 2006 (PDF) (19 pp, 290 K)), which are the World Health Organization 2005 values. These TEFs are also presented in the May 2013 fact sheet, " Use of Dioxin TEFs in Calculating Dioxin TEQs at CERCLA and RCRA Sites (PDF)" (8 pp, 105 K) which references the 2010 EPA report, "Recommended Toxicity Equivalence Factors (TEFs) for Human Health Risk Assessments of 2,3,7,8Tetrachlorodibenzo-p-dioxin and Dioxin-Like Compounds (PDF)" (38 pp, 532 K).

Dioxin Toxicity Equivalence Factors

CASRN	**Dioxins and Furans**	**TEF**
	Chlorinated dibenzo-p-dioxins	
1746-01-6	2,3,7,8-TCDD	1
40321-76-4	1,2,3,7,8-PeCDD	1
39227-28-6	1,2,3,4,7,8-HxCDD	0.1
57653-85-7	1,2,3,6,7,8-HxCDD	0.1
57653-85-7	1,2,3,7,8,9-HxCDD	0.1
35822-46-9	1,2,3,4,6,7,8-HpCDD	0.01
3268-87-9	OCDD	0.0003
	Chlorinated dibenzofurans	
51207-31-9	2,3,7,8-TCDF	0.1
57117-41-6	1,2,3,7,8-PeCDF	0.03
57117-31-4	2,3,4,7,8-PeCDF	0.3
70648-26-9	1,2,3,4,7,8-HxCDF	0.1
57117-44-9	1,2,3,6,7,8-HxCDF	0.1

CASRN	**Dioxins and Furans**		**TEF**
72918-21-9	1,2,3,7,8,9-HxCDF		0.1
60851-34-5	2,3,4,6,7,8-HxCDF		0.1
35822-46-9	1,2,3,4,6,7,8-HpCDF		0.01
55673-89-7	1,2,3,4,7,8,9-HpCDF		0.01
39001-02-0	OCDF		0.0003
PCBs			
	IUPAC No.	**Structure**	
Non-*ortho*			
32598-13-3	77	3,3',4,4'-TetraCB	0.0001
70362-50-4	81	3,4,4',5-TetraCB	0.0003
57465-28-8	126	3,3',4,4',5-PeCB	0.1
32774-16-6	169	3,3',4,4',5,5'-HxCB	0.03
Mono-*ortho*			
32598-14-4	105	2,3,3',4,4'-PeCB	0.00003
74472-37-0	114	2,3,4,4',5-PeCB	0.00003
31508-00-6	118	2,3',4,4',5-PeCB	0.00003
65510-44-3	123	2',3,4,4',5-PeCB	0.00003
38380-08-4	156	2,3,3',4,4',5-HxCB	0.00003

CASRN	Dioxins and Furans		TEF
69782-90-7	157	2,3,3',4,4',5'-HxCB	0.00003
52663-72-6	167	2,3',4,4',5,5'-HxCB	0.00003
39635-31-9	189	2,3,3',4,4',5,5'-HpCB	0.00003
Di-_ortho_*			
35065-30-6	170	2,2',3,3',4,4',5-HpCB	0.0001
35065-29-3	180	2,2',3,4,4',5,5'-HpCB	0.00001

* Di-ortho values come from Ahlborg, U.G., et al. (1994), which are the WHO 1994 values from Toxic equivalency factors for dioxin-like PCBs: Report on WHO-ECEH and IPCS consultation, December 1993 Chemosphere, Volume 28, Issue 6, March 1994, Pages 1049-1067 (PDF) (19 pp, 880 K).

2.3.6 Relative Potency Factors (RPFs)

Some chemicals are members of the same family and exhibit similar toxicological properties; however, they differ in the degree of toxicity. Therefore, a relative potency factor (RPF) must first be applied to adjust the oral slope factor or inhalation unit risk based on the realtive potency to the primary compound.

Carcinogenic polycyclic aromatic hydrocarbons

Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons (EPA/600/R-93/089, July 1993), recommends that a RPF be used to convert concentrations of carcinogenic polycyclic aromatic hydrocarbons (cPAHs) to an equivalent concentration of benzo(a)pyrene when assessing the cancer risks posed by these substances from oral exposures. These RPFs are based on the potency of each compound relative to that of benzo(a)pyrene. For the toxicity value database, these RPFs have been applied to the toxicity values. Although this is not in complete agreement with the direction in the aforementioned documents, this approach was used so that toxicity values could be generated for each cPAH. Additionally, it should be noted that computationally it makes little difference whether the RPFs are applied to the concentrations of cPAHs found in environmental samples or to the toxicity values as long as the RPFs are not applied to both. However, if the adjusted toxicity values are used, the user will need to sum the risks from all cPAHs as part of the risk assessment to derive a total risk from all cPAHs. A total risk from all cPAHs is what is derived when the RPFs are applied to the environmental concentrations of cPAHs and not to the toxicity values. These RPFs are not needed, and should not be used, with the Cal EPA toxicity values, **nor should they be used when calculating non-cancer risk**.

The IRIS Profile gives the following instructions for RPF application:

"It (BaP) also serves as an index chemical for deriving relative potency factors to estimate the carcinogenicity of other PAH congeners, such as in EPA's Relative Potency Factor approach for the assessment of the carcinogenicity of PAHs (U.S. EPA, 1993) (PDF) (28 pp, 1.4 MB)."

and

"The inhalation unit risk for benzo[a]pyrene is derived with the intention that it will be paired with EPA's relative potency factors for the assessment of the carcinogenicity of PAH mixtures. In addition, regarding the assessment of early life exposures, because cancer risk values calculated for benzo[a]pyrene were derived from adult animal exposures, and because benzo[a]pyrene carcinogenicity occurs via a mutagenic mode of action, exposures that occur during development should include the application of ADAFs (see Section 2.5)."

The following table presents the RPFs for cPAHs recommended in Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons (PDF) (28 pp, 1.4 MB).

Relative Potency Factors for Carcinogenic Polycyclic Aromatic Hydrocarbons

CASRN	Compound	RPF
50-32-8	Benzo(a)pyrene	1.0
56-55-3	Benz(a)anthracene	0.1
205-99-2	Benzo(b)fluoranthene	0.1
207-08-9	Benzo(k)fluoranthene	0.01
218-01-9	Chrysene	0.001
53-70-3	Dibenz(a,h)anthracene	1.0
193-39-5	Indeno(1,2,3-c,d)pyrene	0.1

2.4 Chemical-specific Parameters

Several chemical specific parameters are needed for development of the SLs.

2.4.1 Sources

Many sources are used to populate the database of chemical-specific parameters. They are briefly described below.

1. The Physical Properties Database (PhysProp EXIT) was developed by Syracuse Research Corporation (SRC). The PhysProp database contains chemical structures, names and physical properties for over 41,000 chemicals. Physical properties collected from a wide variety of sources include experimental, extrapolated and estimated values.

2. The Estimation Programs Interface (EPI Suite^{TM}) was developed by the US Environmental Protection Agency's Office of Pollution Prevention and Toxics and SRC. These programs estimate various chemical-specific properties. The calculations for these SL tables use the experimental values for a property over the estimated values.

3. EPA Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (SSL) and Appendix A-C (39 pp, 681 K), "Chemical Properties and Regulatory/Human Health Benchmarks for SSL Calculations". Table C-1: Chemical-Specific Properties used in SSL Calculations and Table C-4: Metal Kd Values (L/kg) as a Function of pH.

4. WATER9 Version 2.0 is the Windows-based wastewater treatment model containing a database listing many organic compounds and procedures for obtaining reports of constituent fates, including air emissions and treatment effectiveness. This program supersedes WATER8, Chem9, and Chemdat8 WATER9.

5. CHEMFATE Database. CHEMFATE is part of the Environmental Fate Data Bases (EFDB) software developed by SRC under sponsorship of the U.S. Environmental Protection Agency. CHEMFATE contains physical property values, rate constants, and monitoring data for approximately 1700 chemicals.

6. Yaws' Handbook of Thermodynamic and Physical Properties of Chemical Compounds. Knovel, 2003.

7. Baes, C.F. 1984. Oak Ridge National Laboratory. A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture. Values are also found in Superfund Chemical Data Matrix (SCDM).

8. NIOSH Pocket Guide to Chemical Hazards (NPG), NIOSH Publication No. 97-140, February 2004.

9. CRC Handbook of Chemistry and Physics EXIT . (Various Editions)

10. Perry's Chemical Engineers' Handbook (Various Editions).McGraw-Hill. Online version available here EXIT . Green, Don W.; Perry, Robert H. (2008).

11. Lange's Handbook of Chemistry (Various Editions). Online version available here EXIT . Speight, James G. (2005). McGraw-Hill.

12. U.S. EPA 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. OSWER 9285.7-02EP. July 2004. Document (PDF) (186 pp, 4.2 MB) and website.

13. The ARS Pesticide Properties Database: U.S. Department of Agriculture, Agricultural Research Service. 2009. Document (PDF) (393 pp, 775 K) and website.

14. The PubChem website published by the National Center for Biotechnology Information, U.S. National Library of Medicine, 8600 Rockville Pike, Bethesda, MD20894, USA.

15. The Hazardous Substance Data Bank (HSDB) website published by the U.S. National Library of Medicine 8600 Rockville Pike, Bethesda, MD 20894 National Institutes of Health, Health & Human Services.

16. The Agency for Toxic Substances & Disease Registry (ATSDR) Toxicological Profiles. Agency for Toxic Substances and Disease Registry, 4770 Buford Hwy NE, Atlanta, GA 30341.

2.4.2 Hierarchy by Parameter

Generally, the hierarchies below will work for organic and inorganic compounds.

1. Organic Carbon Partition Coefficient (K_{oc}) (L/kg). Not applicable for inorganics. EPI estimated values; SSL, Yaw estimated values; EPI experimental values; Yaw Experimental values. The exception to this hierarchy are the nine ionizable organics identified in table 42 of Part 5 of the Soil Screening Guidance Technical Background Document (PDF) (28 pp, 523 K). Appendix L goes into detail on the derivation of these values. The table is reproduced below:

Compound	**K_{oc} pH=6.8F**
Benzoic acid	0.6
2-chlorophenol	388
2,4-dichlorophenol	147
2,4-dinitrophenol	0.01
pentachlorophenol (PCP)	592
2,3,4,5-tetrachlorophenol	4742
2,3,4,6-tetrachlorophenol	280
2,4,5-trichlorophenol	1597
2,4,6-trichlorophenol	381

2. Dermal Permeability Coefficient (K_p) (cm/hour). EPI estimated values; RAGS Part E.

3. Effective Predictive Domain (EPD). Calculated based on RAGS Part E criteria for MW and log Kow.

4. Fraction Absorbed (FA). RAGS Part E Exhibit B-3; Calculated. Calculated FA values less than zero

are set to zero.

5. Molecular Weight (MW) (g/mole). PHYSPROP; EPI; CRC89; Perry's; Lange's; Yaws.
6. Water Solubility (S) (mg/L at 25 °C, unless otherwise stated in the source). PHYSPROP experimental values; EPI experimental values; CRC; YAWS experimental values; PERRY; LANGE; PHYSPROP estimated values; Yaws estimated values; EPI estimated values (WATERNT v.1.01, WSKOWWIN v1.42 respectively).
7. Unitless Henry's Law Constant (H' at 25 °C, unless otherwise stated in the source.). PHYSPROP experimental values; EPI experimental values; YAWS experimental values; PHYSPROP extrapolated values; PHYSPROP estimated values; EPI group-estimated values; EPI bond-estimated values; PHYSPROP.
8. Henry's Law Constant (atm-m^3/mole at 25 °C, unless otherwise stated in the source). PHYSPROP experimental values; EPI experimental values; YAWS experimental values; PHYSPROP extrapolated values; PHYSPROP estimated values; EPI group-estimated values; EPI bond-estimated values; PHYSPROP.
9. Diffusivity in Air (D_{ia}) (cm^2/s). WATER9 equations.
10. Diffusivity in Water (D_{iw}) (cm^2/s). WATER9 equations.
11. Fish Bioconcentration Factor (BCF) (L/kg). EPI experimental values; EPI estimated values.
12. Soil-Water Partition Coefficient (K_d) (cm^3/g). SSL; BAES.
13. Density (g/cm^3). CRC; Perry's; Lange's; IRIS.
14. Melting Point (MP °C). PHYSPROP; EPI experimental values; CRC; Perry's; Lange's; Yaws freezing point; EPI estimated values.
15. log Octanol-Water Partition Coefficient (logKow). PHYSPROP, EPI experimental values; Yaws experimental values; EPI estimated values; Yaws estimated values.
16. Vapor Pressure (VP). PHYSPROP experimental values, EPI experimental values; PHYSPROP extrapolated values; PHYSPROP estimated values; EPI estimated values.
17. Critical Temperature (T_c °K). CRC; Yaws Experimental; Yaws Estimated.
18. Enthalpy of vaporization at the normal boiling point (cal/mol). CRC, Yaws Extrapolated, Yaws Estimated.

2.5 Maximum Contaminant Levels (MCLs)

The Safe Drinking Water Act (SDWA) was originally passed by Congress in 1974 to protect public health by regulating the nation's public drinking water supply. SDWA authorizes the United States Environmental Protection Agency (US EPA) to set national health based standards for drinking water to protect against both naturally-occurring and man-made contaminants that may be found in drinking water.

US EPA sets national standards for drinking water based on sound science to protect against health risks, considering available technology and costs. These National Primary Drinking Water Regulations set enforceable maximum contaminant levels (MCLs) for contaminants in drinking water or required ways to treat water to remove contaminants. The MCLs are published here (PDF) (6 pp, 924 K).

US EPA sets primary drinking water standards through a three-step process: First, US EPA identifies contaminants that may adversely affect public health and occur in drinking water with a frequency and at levels that pose a threat to public health. Second, US EPA determines a maximum contaminant level goal (MCLG) for contaminants it decides to regulate. This goal is the level of a contaminant in drinking water below which there is no known or expected risk to health. Third, US EPA specifies a MCL, the maximum permissible level of a contaminant in drinking water which is delivered to any user of a public water system. These levels are enforceable standards, and are set as close to the MCLGs as feasible.

MCLs are provided in the RSL tables and the calculator output for users' information. A few things should be understood about the differences between RSLs and MCLs.

- RSLs are generated by and for the Superfund program, and MCLs are generated by the Office of Water although they are both used by other federal and state programs.
- The RSL calculations may result in a lower concentration than the MCL for a contaminant. The most common reason for this is that the RSLs represent risk-based concentrations considering only the relationship between exposure and risk.
- RSLs are calculated considering ingestion, inhalation, and dermal exposure to tap water.
- MCLs are set as close to risk-based goals, or Maximum Contaminant Level Goal (MCLG), as feasible. MCLGs are non-enforceable public health goals. MCLGs consider only public health and not the limits of detection and treatment technology effectiveness. Conversely, MCLs take the best available analytical and treatment technologies and cost into consideration.
- MCLGs for noncancer effects are based on a Reference Dose and consider ingestion of drinking water with a relative source contribution. The relative source contribution is the percentage of total drinking water exposure for the general population, after considering other exposure routes (for example, food, inhalation).
- For chemical contaminants that are carcinogens, EPA sets the MCLG at zero if: 1) there is evidence that a chemical may cause cancer and 2) there is no dose below which the chemical is considered safe. If a chemical is carcinogenic, and a safe dose can be determined, EPA sets the MCLG at a level above zero that is safe.
- If you have questions about the use of MCLs and/or RSLs at a Superfund site, consult your regional risk assessor.

2.6 Understanding Risk Output on the RSL Website

The RSL calculator provides an option to select risk output. In the calculator, select yes if risk output is desired. Selecting risk output requires the calculator to be run in "Site Specific" mode. In site specific mode, the user will be required to enter site concentrations for each media and chemical selected. The "Soil to Groundwater" medium does not have risk output and the risk option will become disabled when selected. The risk and hazard index values presented on this site are chemical-specific values for individual contaminants in air, water, soil, and fish that may warrant further investigation or site cleanup.

This portion of the risk assessment process is generally referred to as "Risk Characterization". This step incorporates the outcome of the exposure and toxicity assessments to calculate the risk resulting from potential exposure to chemicals via the pathways and routes of exposure determined appropriate for the source area.

2.6.1 How Risk is Calculated

The process used to calculate risk (carcinogenic risk and hazard quotient) in this calculator does not follow the traditional method of first calculating a Chronic Daily Intake (CDI). Rather, risk is derived using a simple method that relies on the linear nature of the relationship between concentration and risk. Using the equation below, an RSL, the target risk or target hazard quotient used to calculate the RSL, and a concentration entered by the user are all that is required to calculate risk.

Carcinogenic: TR / RSL = Risk / C

Noncarcinogenic: THQ / RSL = HQ / C

The linear equation above is then rearranged to solve for risk:

Carcinogenic: Risk = (C × TR) / RSL

Noncarcinogenic: HQ = (C × THQ) / RSL

where:

Risk = a unitless probability of an individual developing cancer over a lifetime, determined with the equation above;
HQ = a unitless ratio of exposure concentration to reference concentration where a value greater than unity indicates an individual will likely experience adverse health effects;
C = Concentration entered by the user in site-specific mode [mg/kg ; $\mu g/m^3$; µg/L]
TR = Target Risk provided by the user in site-specific mode
THQ = Target Hazard Quotient provided by the user in site-specific mode
RSL = Regional Screening Level, determined by the values entered by the user in site-specific mode [mg/kg ; $\mu g/m^3$; µg/L]

2.6.2 One-Hit Rule for Carcinogenic Risk

The linear risk equation, listed above, is valid only at low risk levels (below estimated risks of 0.01). For sites where chemical intakes might be high (estimated risks above 0.01, an alternate calculation should be used. The one-hit equation, which is consistent with the linear low-dose model, should be used instead (RAGS, part A, ch. 8). The results presented use this rule. In the following instances, the one-hit rule is used independently in the risk output tables:

- Risk from a single exposure route for a single chemical.
- Summation of single chemical risk (without one-hit rule applied to single chemical results) for multiple exposure routes (right of each row).
- Summation of risk (without one-hit rule applied to single chemical results) from a single exposure route for multiple chemicals (bottom of each column).
- Summation of total risk (without one-hit rule applied to single chemical results or summations listed above) from multiple chemicals across multiple exposure routes (bottom right hand cell).

3. Using the SL Tables

The "Generic Tables" page provides generic concentrations in the absence of site-specific exposure assessments. These concentrations can be used for:

- Prioritizing multiple sites or operable units or areas of concern within a facility or exposure units
- Setting risk-based detection limits for contaminants of potential concern (COPCs)
- Focusing future site investigation and risk assessment efforts (e.g., selecting COPCs for the baseline risk assessment)
- Identifying contamination which may warrant cleanup
- Identifying sites, or portions of sites, which warrant no further action or investigation
- Initial cleanup goals when site-specific data are lacking

Generic SLs are provided for multiple exposure pathways and for chemicals with both carcinogenic and noncarcinogenic effects. A Summary Table is provided that contains SLs corresponding to either a 10^{-6} risk level for carcinogens or a Hazard Quotient (HQ) of 1 for non-carcinogens. The summary table identifies whether the SL is based on cancer or noncancer effects by including a "c" or "n" after the SL. The Supporting Tables provide SLs corresponding to a 10^{-6} risk level for carcinogens and an HQ of 1 for noncarcinogens. Site specific SLs corresponding to an HQ of less than 1 may be appropriate for those sites where multiple chemicals are present that have RfDs or RfCs based on the same toxic endpoint. Site specific SLs based upon a cancer risk greater than 10^{-6} can be calculated and may be appropriate based upon site specific considerations. However, caution is recommended to ensure that cumulative cancer risk for all actual and potential carcinogenic contaminants found at the site does not have a residual (after site cleanup, or when it has been determined that no site cleanup is required) cancer risk exceeding 10^{-4}. Also, changing the target risk or HI may change the balance between the cancer and noncancer endpoints. At some concentrations, the cancer-risk concerns predominate; at other concentrations, noncancer-HI concerns predominate. The user must take care to consider both when adjusting target risks and hazards.

Tables are provided in either MS Excel or in PDF format. The following lists the tables provided and a description of what is contained in each:

- Summary Table - provides a list of contaminants, toxicity values, MCLs and the lesser (more protective) of the cancer and noncancer SLs for resident soil, industrial soil, resident air, industrial air and tapwater.
- Residential Soil Supporting Table - provides a list of contaminants, toxicity values and the cancer and noncancer SLs for resident soil.
- Industrial Soil Supporting Table - provides a list of contaminants, toxicity values and the cancer and noncancer SLs for industrial soil.
- Residential Air Supporting Table - provides a list of contaminants, toxicity values and the cancer and noncancer SLs for resident air.
- Industrial Air Supporting Table - provides a list of contaminants, toxicity values and the cancer and noncancer SLs for industrial air.
- Residential Tapwater Supporting Table - provides a list of contaminants, toxicity values, MCLs and the cancer and noncancer SLs for tapwater.

3.1 Developing a Conceptual Site Model

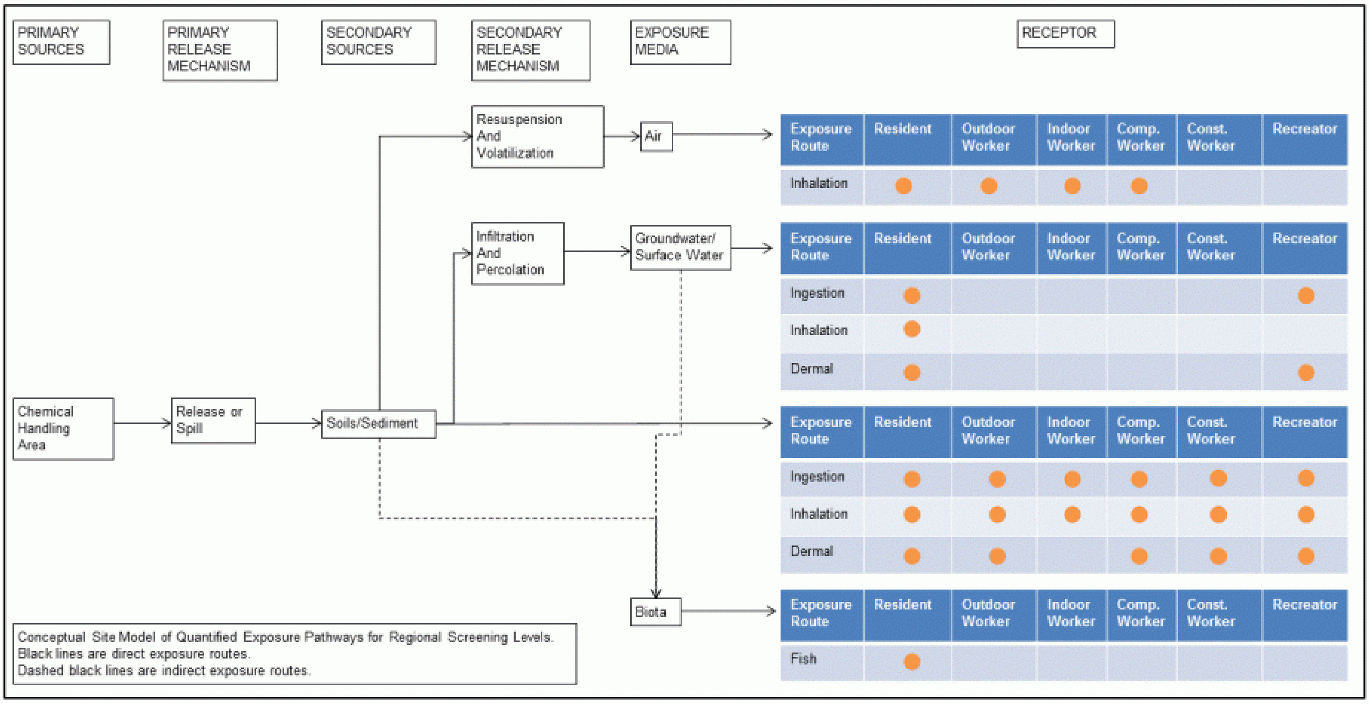
When using generic SLs at a site, the exposure pathways of concern and site conditions should match those used in developing the SLs presented here. (Note, however, that future uses may not match current uses. Future uses are potential site uses that may occur in the future. At Superfund sites, future uses should be considered as well as current uses. RAGS Part A, Chapter 6, provides guidance on selecting future-use receptors.) Thus, it is necessary to develop a conceptual site model (CSM) to identify likely contaminant source areas, exposure pathways, and potential receptors. This information can be used to determine the applicability of SLs at the site and the need for additional information. The final CSM diagram represents linkages among contaminant sources, release mechanisms, exposure pathways, and routes and receptors based on historical information. It summarizes the understanding of the contamination problem. A separate CSM for ecological receptors can be useful. Part 2 and Attachment A of the Soil Screening Guidance for Superfund: Users Guide (EPA 1996) contains the steps for developing a CSM.

As a final check, the CSM should address the following questions:

- Are there potential ecological concerns?
- Is there potential for land use other than those used in the SL calculations (i.e., residential and commercial/industrial)?
- Are there other likely human exposure pathways that were not considered in development of the SLs?
- Are there unusual site conditions (e.g. large areas of contamination, high fugitive dust levels, potential for indoor air contamination)?

The SLs and later PRGs may need to be adjusted to reflect the answers to these questions.

Below is a potential CSM of the quantified pathways addressed in the SL Tables.



Exposure Route	Resident	Outdoor Worker	Indoor Worker	Comp. Worker	Const. Worker	Recreator
Inhalation	●	●	●	●		

Exposure Route	Resident	Outdoor Worker	Indoor Worker	Comp. Worker	Const. Worker	Recreator
Ingestion	●					●
Inhalation	●					
Dermal	●					●

Exposure Route	Resident	Outdoor Worker	Indoor Worker	Comp. Worker	Const. Worker	Recreator
Ingestion	●	●	●	●	●	●
Inhalation	●	●	●	●	●	●
Dermal	●	●		●	●	●

Exposure Route	Resident	Outdoor Worker	Indoor Worker	Comp. Worker	Const. Worker	Recreator
Fish	●					

Conceptual Site Model of Quantified Exposure Pathways for Regional Screening Levels.
Black lines are direct exposure routes.
Dashed black lines are indirect exposure routes.

Conceptual Site Model of Qantified Exposure Pathways for Regional Screening Levels. Click image to view full size image.

3.2 Background

EPA may be concerned with two types of background at sites: naturally occurring and anthropogenic. Natural background is usually limited to metals whereas anthropogenic (i.e. human-made) “background” includes both organic and inorganic contaminants.

Please note that the SL tables, which are purely risk-based, may yield SLs lower than naturally occurring background concentrations of some chemicals in some areas. However, background considerations may be incorporated into the assessment and investigation of sites, as acknowledged in existing EPA guidance. Background levels should be addressed as they are for other contaminants at CERCLA sites. For further information see EPA's guidance Role of Background in the CERCLA Cleanup Program (PDF) (13 pp, 144 K), April 2002, (OSWER 9285.6-07P) and Guidance for Comparing Background and Chemical Concentration in Soil for CERCLA Sites (PDF) (89 pp, 1.2 MB), September 2002, (OSWER 9285.7-41).

Generally EPA does not clean up below natural background. In some cases, the predictive risk-based models generate SL concentrations that lie within or even below typical background concentrations for the same element or compound. Arsenic, aluminum, iron and manganese are common elements in soils that have background levels that may exceed risk-based SLs. This does not mean that these metals cannot be site-related, or that these metals should automatically be attributed to background. Attribution of chemicals to background is a site-specific decision; consult your regional risk assessor.

Where anthropogenic “background” levels exceed SLs and EPA has determined that a response action is necessary and feasible, EPA's goal will be to develop a comprehensive response to the widespread contamination. This will often require coordination with different authorities that have jurisdiction over the sources of contamination in the area.

3.3 Potential Problems

As with any risk based screening table or tool, the potential exists for misapplication. In most cases, this results from not understanding the intended use of the SLs or PRGs. In order to prevent misuse of the SLs, the following should be avoided:

- Applying SLs to a site without adequately developing a conceptual site model that identifies relevant exposure pathways and exposure scenarios.
- Not considering the effects from the presence of multiple contaminants, where appropriate.
- Use of the SLs as cleanup levels without adequate consideration of the other NCP remedy selection criteria on CERCLA sites.
- Use of SL as cleanup levels without verifying numbers with a toxicologist or regional risk assessor.
- Use of outdated SLs when tables have been superseded by more recent values.
- Not considering the effects of additivity when screening multiple chemicals.

- Applying inappropriate target risks or changing a cancer target risk without considering its effect on noncancer, or vice versa.
- Not performing additional screening for pathways not included in these SLs (e.g,. vapor intrusion, fish consumption).
- Adjusting SLs upward by factors of 10 or 100 without consulting a toxicologist or regional risk assessor.

4. Land Use Descriptions, Equations and Technical Documentation

The SLs consider human exposure to individual contaminants in air, drinking water and soil. The equations and technical discussion are aimed at developing risk-based SLs or PRGs. The following text presents the land use equations and their exposure routes. Table 1 presents the definitions of the variables and their default values. Any alternative values or assumptions used in developing SLs on a site should be presented with supporting rationale in the decision document on CERCLA sites.

4.1 Resident

4.1.1 Resident Soil

This receptor spends most, if not all, of the day at home. The activities for this receptor involve typical home making chores (cooking, cleaning and laundering) as well as outdoor activities. The resident is assumed to be exposed to contaminants via the following pathways: incidental ingestion of soil, dermal contact with soil, inhalation of volatiles and fugitive dust. Adults and children exhibit different ingestion rates for soil. For example, the child resident is assumed to ingest 200 mg per day while the adult ingests 100 mg per day. To account for changes in intake as the receptor ages, age adjusted intake equations were developed.

Note that the soil ingestion rates are intended to also represent ingestion of indoor dust. According to U.S. EPA 2011, “The source of the soil in these recommendations could be outdoor soil, indoor containerized soil used to support growth of indoor plants, or a combination of both outdoor soil and containerized indoor soil. The inhalation and subsequent swallowing of soil particles is accounted for in these recommended values, therefore, this pathway does not need to be considered separately.” Further, according to U.S. EPA 1997, “Although the recommendations presented below are derived from studies which were mostly conducted in the summer, exposure during the winter months when the ground is frozen or snow covered should not be considered as zero. Exposure during these months, although lower than in the summer months, would not be zero because some portion of the house dust comes from outdoor soil.”

This land use is for developing residential default screening levels that are presented in the RSL Generic Tables.

4.1.1.1 Noncarcinogenic-child

The residential soil land use equation, presented here, contains the following exposure routes:

- incidental ingestion of soil

$$SL_{\text{res-soil-nc-ing-c}}\left(\text{mg/kg}\right)=\frac{THQ\times AT_{\text{res-c}}\left(\frac{365\text{ days}}{\text{year}}\times ED_{\text{res-c}}\left(6\text{ years}\right)\right)\times BW_{\text{res-c}}\left(15\text{ kg}\right)}{EF_{\text{res-c}}\left(\frac{350\text{ days}}{\text{year}}\right)\times ED_{\text{res-c}}\left(6\text{ years}\right)\times\frac{RBA}{RfD_{o}\left(\frac{\text{mg}}{\text{kg-day}}\right)}\times IRS_{\text{res-c}}\left(\frac{200\text{ mg}}{\text{day}}\right)\times\frac{10^{-6}\text{kg}}{1\text{mg}}}$$

- dermal contact with soil

$$SL_{\text{res-soil-nc-der-c}}\left(\text{mg/kg}\right)=\frac{THQ\times AT_{\text{res-c}}\left(\frac{365\text{ days}}{\text{year}}\times ED_{\text{res-c}}\left(6\text{ years}\right)\right)\times BW_{\text{res-c}}\left(15\text{ kg}\right)}{EF_{\text{res-c}}\left(\frac{350\text{ days}}{\text{year}}\right)\times ED_{\text{res-c}}\left(6\text{ years}\right)\times\frac{1}{\left(RfD_{o}\left(\frac{\text{mg}}{\text{kg-day}}\right)\times GIABS\right)}\times SA_{\text{res-c}}\left(\frac{2373\text{ cm}^{2}}{\text{day}}\right)\times AF_{\text{res-c}}\left(\frac{0.2\text{ mg}}{\text{cm}^{2}}\right)\times ABS_{d}\times\frac{10^{-6}\text{kg}}{1\text{mg}}}$$

- inhalation of volatiles and particulates emitted from soil

$$SL_{\text{res-soil-nc-inh-c}}\left(\text{mg/kg}\right)=\frac{THQ\times AT_{\text{res-c}}\left(\frac{365\text{ days}}{\text{year}}\times ED_{\text{res-c}}\left(6\text{ years}\right)\right)}{EF_{\text{res-c}}\left(\frac{350\text{ days}}{\text{year}}\right)\times ED_{\text{res-c}}\left(6\text{ years}\right)\times ET_{\text{res-c}}\left(\frac{24\text{ hours}}{\text{day}}\right)\times\left(\frac{1\text{ day}}{24\text{ hours}}\right)\times\frac{1}{RfC\left(\text{mg}/\text{m}^{3}\right)}\times\left(\frac{1}{VF_{\text{ulim}}\left(\frac{\text{m}^{3}}{\text{kg}}\right)}+\frac{1}{PEF\left(\frac{\text{m}^{3}}{\text{kg}}\right)}\right)}$$

- Total

$$SL_{\text{res-soil-nc-tot-c}}\left(\text{mg/kg}\right)=\frac{1}{\frac{1}{SL_{\text{res-soil-nc-ing-c}}}+\frac{1}{SL_{\text{res-soil-nc-der-c}}}+\frac{1}{SL_{\text{res-soil-nc-inh-c}}}}$$

4.1.1.2 Noncarcinogenic-adult

The residential soil land use equation, presented here, contains the following exposure routes:

- incidental ingestion of soil

$$SL_{\text{res-soil-nc-ing-a}}\left(\text{mg/kg}\right)=\frac{THQ\times AT_{\text{res-a}}\left(\frac{365\text{ days}}{\text{year}}\times ED_{\text{res}}\left(26\text{ years}\right)\right)\times BW_{\text{res-a}}\left(80\text{ kg}\right)}{EF_{\text{res-a}}\left(\frac{350\text{ days}}{\text{year}}\right)\times ED_{\text{res}}\left(26\text{ years}\right)\times\frac{RBA}{RfD_{o}\left(\frac{\text{mg}}{\text{kg-day}}\right)}\times IRS_{\text{res-a}}\left(\frac{100\text{ mg}}{\text{day}}\right)\times\frac{10^{-6}\text{kg}}{1\text{mg}}}$$

- dermal contact with soil

$$SL_{\text{res-soil-nc-der-a}}\left(\text{mg/kg}\right)=\frac{THQ\times AT_{\text{res-a}}\left(\frac{365\text{ days}}{\text{year}}\times ED_{\text{res}}\left(26\text{ years}\right)\right)\times BW_{\text{res-a}}\left(80\text{ kg}\right)}{EF_{\text{res-a}}\left(\frac{350\text{ days}}{\text{year}}\right)\times ED_{\text{res}}\left(26\text{ years}\right)\times\frac{1}{\left(RfD_{o}\left(\frac{\text{mg}}{\text{kg-day}}\right)\times GIABS\right)}\times SA_{\text{res-a}}\left(\frac{6032\text{ cm}^{2}}{\text{day}}\right)\times AF_{\text{res-a}}\left(\frac{0.07\text{ mg}}{\text{cm}^{2}}\right)\times ABS_{d}\times\frac{10^{-6}\text{kg}}{1\text{mg}}}$$

- inhalation of volatiles and particulates emitted from soil

$$SL_{\text{res-soil-nc-inh-a}}\left(\text{mg/kg}\right)=\frac{THQ\times AT_{\text{res-a}}\left(\frac{365\text{ days}}{\text{year}}\times ED_{\text{res}}\left(26\text{ years}\right)\right)}{EF_{\text{res-a}}\left(\frac{350\text{ days}}{\text{year}}\right)\times ED_{\text{res}}\left(26\text{ years}\right)\times ET_{\text{res-a}}\left(\frac{24\text{ hours}}{\text{day}}\right)\times\left(\frac{1\text{ day}}{24\text{ hours}}\right)\times\frac{1}{RfC\left(\text{mg}/\text{m}^{3}\right)}\times\left(\frac{1}{VF_{\text{ulim}}\left(\frac{\text{m}^{3}}{\text{kg}}\right)}+\frac{1}{PEF\left(\frac{\text{m}^{3}}{\text{kg}}\right)}\right)}$$

- Total

$$\mathrm{SL}_{\text{res-soil-nc-tot-a}}\left(\text{mg/kg}\right)=\frac{1}{\frac{1}{\mathrm{SL}_{\text{res-soil-nc-ing-a}}}+\frac{1}{\mathrm{SL}_{\text{res-soil-nc-der-a}}}+\frac{1}{\mathrm{SL}_{\text{res-soil-nc-inh-a}}}}$$

4.1.1.3 Carcinogenic

The residential soil land use equation, presented here, contains the following exposure routes:

- incidental ingestion of soil

$$\mathrm{SL}_{\text{res-soil-ca-ing}}\left(\text{mg/kg}\right)=\frac{\mathrm{TR}\times\mathrm{AT}_{\text{res}}\left(\frac{365\text{ days}}{\text{year}}\times\mathrm{LT}\left(70\text{ years}\right)\right)}{\mathrm{CSF}_{o}\left(\frac{\text{mg}}{\text{kg-day}}\right)^{-1}\times\mathrm{RBA}\times\mathrm{IFS}_{\text{res-adj}}\left(\frac{36{,}750\text{ mg}}{\text{kg}}\right)\times\left(\frac{10^{-6}\text{kg}}{\text{mg}}\right)}$$

where:

$$\mathrm{IFS}_{\text{res-adj}}\left(\frac{36{,}750\text{ mg}}{\text{kg}}\right)=\left(\begin{array}{l}\frac{\mathrm{EF}_{\text{res-c}}\left(\frac{350\text{ days}}{\text{year}}\right)\times\mathrm{ED}_{\text{res-c}}\left(6\text{ years}\right)\times\mathrm{IRS}_{\text{res-c}}\left(\frac{200\text{ mg}}{\text{day}}\right)}{\mathrm{BW}_{\text{res-c}}\left(15\text{ kg}\right)}+\\\frac{\mathrm{EF}_{\text{res-a}}\left(\frac{350\text{ days}}{\text{year}}\right)\times\left(\mathrm{ED}_{\text{res}}\left(26\text{ years}\right)-\mathrm{ED}_{\text{res-c}}\left(6\text{ years}\right)\right)\times\mathrm{IRS}_{\text{res-a}}\left(\frac{100\text{ mg}}{\text{day}}\right)}{\mathrm{BW}_{\text{res-a}}\left(80\text{ kg}\right)}\end{array}\right)$$

- dermal contact with soil

$$\mathrm{SL}_{\text{res-soil-ca-der}}\left(\text{mg/kg}\right)=\frac{\mathrm{TR}\times\mathrm{AT}_{\text{res}}\left(\frac{365\text{ days}}{\text{year}}\times\mathrm{LT}\left(70\text{ years}\right)\right)}{\left(\frac{\mathrm{CSF}_{o}\left(\frac{\text{mg}}{\text{kg-day}}\right)^{-1}}{\mathrm{GIABS}}\right)\times\mathrm{DFS}_{\text{res-adj}}\left(\frac{103{,}390\text{ mg}}{\text{kg}}\right)\times\mathrm{ABS}_{d}\times\left(\frac{10^{-6}\text{kg}}{\text{mg}}\right)}$$

where:

$$\mathrm{DFS}_{\text{res-adj}}\left(\frac{103{,}390\text{ mg}}{\text{kg}}\right)=\left(\begin{array}{l}\frac{\mathrm{EF}_{\text{res-c}}\left(\frac{350\text{ days}}{\text{year}}\right)\times\mathrm{ED}_{\text{res-c}}\left(6\text{ years}\right)\times\mathrm{SA}_{\text{res-c}}\left(\frac{2373\text{ cm}^{2}}{\text{day}}\right)\times\mathrm{AF}_{\text{res-c}}\left(\frac{0.2\text{ mg}}{\text{cm}^{2}}\right)}{\mathrm{BW}_{\text{res-c}}\left(15\text{ kg}\right)}+\\\frac{\mathrm{EF}_{\text{res-a}}\left(\frac{350\text{ days}}{\text{year}}\right)\times\left(\mathrm{ED}_{\text{res}}\left(26\text{ years}\right)-\mathrm{ED}_{\text{res-c}}\left(6\text{ years}\right)\right)\times\mathrm{SA}_{\text{res-a}}\left(\frac{6032\text{ cm}^{2}}{\text{day}}\right)\times\mathrm{AF}_{\text{res-a}}\left(\frac{0.07\text{ mg}}{\text{cm}^{2}}\right)}{\mathrm{BW}_{\text{res-a}}\left(80\text{ kg}\right)}\end{array}\right)$$

- inhalation of volatiles and particulates emitted from soil

$$\mathrm{SL}_{\text{res-soil-ca-inh}}\left(\text{mg/kg}\right)=\frac{\mathrm{TR}\times\mathrm{AT}_{\text{res}}\left(\frac{365\text{ days}}{\text{year}}\times\mathrm{LT}\left(70\text{ years}\right)\right)}{\mathrm{IUR}\left(\mu\text{g}/\text{m}^{3}\right)^{-1}\times\left(\frac{1000\ \mu\text{g}}{\text{mg}}\right)\times\mathrm{EF}_{\text{res}}\left(\frac{350\text{ days}}{\text{year}}\right)\times\left(\frac{1}{\mathrm{VF}_{\text{ulim}}\left(\frac{\text{m}^{3}}{\text{kg}}\right)}+\frac{1}{\mathrm{PEF}\left(\frac{\text{m}^{3}}{\text{kg}}\right)}\right)\times\mathrm{ED}_{\text{res}}\left(26\text{ years}\right)\times\mathrm{ET}_{\text{res}}\left(\frac{24\text{ hours}}{\text{day}}\right)\times\left(\frac{1\text{ day}}{24\text{ hours}}\right)}$$

- Total

$$SL_{res\text{-}soil\text{-}ca\text{-}tot}\left(mg/kg\right) = \frac{1}{\frac{1}{SL_{res\text{-}soil\text{-}ca\text{-}ing}} + \frac{1}{SL_{res\text{-}soil\text{-}ca\text{-}der}} + \frac{1}{SL_{res\text{-}soil\text{-}ca\text{-}inh}}}$$

4.1.1.4 Mutagenic

The residential soil land use equation, presented here, contains the following exposure routes:

- incidental ingestion of soil

$$SL_{res\text{-}soil\text{-}mu\text{-}ing}\left(mg/kg\right) = \frac{TR \times AT_{res}\left(\frac{365\ days}{year} \times LT\left(70\ years\right)\right)}{CSF_o\left(\frac{mg}{kg\text{-}day}\right)^{-1} \times RBA \times IFSM_{res\text{-}adj}\left(\frac{166{,}833\ mg}{kg}\right) \times \left(\frac{10^{-6}kg}{mg}\right)}$$

where:

$$IFSM_{res\text{-}adj}\left(\frac{166{,}833\ mg}{kg}\right) = \left(\begin{array}{l} \frac{EF_{0\text{-}2}\left(\frac{350\ days}{year}\right) \times ED_{0\text{-}2}\left(2\ years\right) \times IRS_{0\text{-}2}\left(\frac{200\ mg}{day}\right) \times 10}{BW_{0\text{-}2}\left(15\ kg\right)} + \\ \frac{EF_{2\text{-}6}\left(\frac{350\ days}{year}\right) \times ED_{2\text{-}6}\left(4\ years\right) \times IRS_{2\text{-}6}\left(\frac{200\ mg}{day}\right) \times 3}{BW_{2\text{-}6}\left(15\ kg\right)} + \\ \frac{EF_{6\text{-}16}\left(\frac{350\ days}{year}\right) \times ED_{6\text{-}16}\left(10\ years\right) \times IRS_{6\text{-}16}\left(\frac{100\ mg}{day}\right) \times 3}{BW_{6\text{-}16}\left(80\ kg\right)} + \\ \frac{EF_{16\text{-}26}\left(\frac{350\ days}{year}\right) \times ED_{16\text{-}26}\left(10\ years\right) \times IRS_{16\text{-}26}\left(\frac{100\ mg}{day}\right) \times 1}{BW_{16\text{-}26}\left(80\ kg\right)} \end{array}\right)$$

- dermal contact with soil

$$SL_{res\text{-}soil\text{-}mu\text{-}der}\left(mg/kg\right) = \frac{TR \times AT_{res}\left(\frac{365\ days}{year} \times LT\left(70\ years\right)\right)}{\left(\frac{CSF_o\left(\frac{mg}{kg\text{-}day}\right)^{-1}}{GIABS}\right) \times DFSM_{res\text{-}adj}\left(\frac{428{,}260\ mg}{kg}\right) \times ABS_d \times \left(\frac{10^{-6}kg}{mg}\right)}$$

where:

$$DFSM_{res\text{-}adj}\left(\frac{428{,}260\ mg}{kg}\right) = \left(\begin{array}{l} \frac{EF_{0\text{-}2}\left(\frac{350\ days}{year}\right) \times ED_{0\text{-}2}\left(2\ years\right) \times AF_{0\text{-}2}\left(\frac{0.2\ mg}{cm^2}\right) \times SA_{0\text{-}2}\left(\frac{2373\ cm^2}{day}\right) \times 10}{BW_{0\text{-}2}\left(15\ kg\right)} + \\ \frac{EF_{2\text{-}6}\left(\frac{350\ days}{year}\right) \times ED_{2\text{-}6}\left(4\ years\right) \times AF_{2\text{-}6}\left(\frac{0.2\ mg}{cm^2}\right) \times SA_{2\text{-}6}\left(\frac{2373\ cm^2}{day}\right) \times 3}{BW_{2\text{-}6}\left(15\ kg\right)} + \\ \frac{EF_{6\text{-}16}\left(\frac{350\ days}{year}\right) \times ED_{6\text{-}16}\left(10\ years\right) \times AF_{6\text{-}16}\left(\frac{0.07\ mg}{cm^2}\right) \times SA_{6\text{-}16}\left(\frac{6032\ cm^2}{day}\right) \times 3}{BW_{6\text{-}16}\left(80\ kg\right)} + \\ \frac{EF_{16\text{-}26}\left(\frac{350\ days}{year}\right) \times ED_{16\text{-}26}\left(10\ years\right) \times AF_{16\text{-}26}\left(\frac{0.07\ mg}{cm^2}\right) \times SA_{16\text{-}26}\left(\frac{6032\ cm^2}{day}\right) \times 1}{BW_{16\text{-}26}\left(80\ kg\right)} \end{array}\right)$$

- inhalation of volatiles and particulates emitted from soil

$$SL_{res\text{-}soil\text{-}mu\text{-}inh}\left(mg/kg\right) = \frac{TR \times AT_{res}\left(\frac{365\ days}{year} \times LT\left(70\ years\right)\right)}{\begin{array}{c} IUR\left(\mu g/m^3\right)^{-1} \times \left(\frac{1}{VF_{ulim}\left(\frac{m^3}{kg}\right)} + \frac{1}{PEF\left(\frac{m^3}{kg}\right)}\right) \times \left(\frac{1000\ \mu g}{mg}\right) \times \\ \left(\begin{array}{l} \left(ET_{0\text{-}2}\left(\frac{24\ hours}{day}\right) \times \left(\frac{1\ day}{24\ hours}\right) \times EF_{0\text{-}2}\left(\frac{350\ days}{year}\right) \times ED_{0\text{-}2}\left(2\ years\right) \times 10\right) + \\ \left(ET_{2\text{-}6}\left(\frac{24\ hours}{day}\right) \times \left(\frac{1\ day}{24\ hours}\right) \times EF_{2\text{-}6}\left(\frac{350\ days}{year}\right) \times ED_{2\text{-}6}\left(4\ years\right) \times 3\right) + \\ \left(ET_{6\text{-}16}\left(\frac{24\ hours}{day}\right) \times \left(\frac{1\ day}{24\ hours}\right) \times EF_{6\text{-}16}\left(\frac{350\ days}{year}\right) \times ED_{6\text{-}16}\left(10\ years\right) \times 3\right) + \\ \left(ET_{16\text{-}26}\left(\frac{24\ hours}{day}\right) \times \left(\frac{1\ day}{24\ hours}\right) \times EF_{16\text{-}26}\left(\frac{350\ days}{year}\right) \times ED_{16\text{-}26}\left(10\ years\right) \times 1\right) \end{array}\right) \end{array}}$$

- Total

$$SL_{res\text{-}soil\text{-}mu\text{-}tot}\left(mg/kg\right) = \frac{1}{\frac{1}{SL_{res\text{-}soil\text{-}mu\text{-}ing}} + \frac{1}{SL_{res\text{-}soil\text{-}mu\text{-}der}} + \frac{1}{SL_{res\text{-}soil\text{-}mu\text{-}inh}}}$$

4.1.1.5 Vinyl Chloride - Carcinogenic

The residential soil land use equations, presented here, contain the following exposure routes:

- incidental ingestion of soil

$$SL_{res\text{-}soil\text{-}ca\text{-}vc\text{-}ing}\,(mg/kg) = \frac{TR}{\left(\frac{CSF_o\left(\frac{mg}{kg\text{-}day}\right)^{-1}\times RBA\times IFS_{res\text{-}adj}\left(\frac{36{,}750\ mg}{kg}\right)\times\frac{10^{-6}kg}{1\ mg}}{AT_{res}\left(\frac{365\ days}{year}\times LT\,(70\ years)\right)}\right)+\left(\frac{CSF_o\left(\frac{mg}{kg\text{-}day}\right)^{-1}\times RBA\times IRS_{res\text{-}c}\left(\frac{200\ mg}{day}\right)\times\frac{10^{-6}kg}{1\ mg}}{BW_{res\text{-}c}\,(15\ kg)}\right)}$$

where:

$$IFS_{res\text{-}adj}\left(\frac{36{,}750\ mg}{kg}\right) = \left(\frac{EF_{res\text{-}c}\left(\frac{350\ days}{year}\right)\times ED_{res\text{-}c}\,(6\ years)\times IRS_{res\text{-}c}\left(\frac{200\ mg}{day}\right)}{BW_{res\text{-}c}\,(15\ kg)}+\frac{EF_{res\text{-}a}\left(\frac{350\ days}{year}\right)\times\left(ED_{res}\,(26\ years)-ED_{res\text{-}c}\,(6\ years)\right)\times IRS_{res\text{-}a}\left(\frac{100\ mg}{day}\right)}{BW_{res\text{-}a}\,(80\ kg)}\right)$$

- dermal contact with soil

$$SL_{res\text{-}soil\text{-}ca\text{-}vc\text{-}der}\,(mg/kg) = \frac{TR}{\left(\frac{\frac{CSF_o\left(\frac{mg}{kg\text{-}day}\right)^{-1}}{GIABS}\times DFS_{res\text{-}adj}\left(\frac{103{,}390\ mg}{kg}\right)\times ABS_d\times\frac{10^{-6}kg}{1\ mg}}{AT_{res}\left(\frac{365\ days}{year}\times LT\,(70\ years)\right)}\right)+\left(\frac{\frac{CSF_o\left(\frac{mg}{kg\text{-}day}\right)^{-1}}{GIABS}\times SA_{res\text{-}c}\left(\frac{2373\ cm^2}{day}\right)\times AF_{res\text{-}c}\left(\frac{0.2\ mg}{cm^2}\right)\times ABS\times\frac{10^{-6}kg}{1\ mg}}{BW_{res\text{-}c}\,(15\ kg)}\right)}$$

where:

$$DFS_{res\text{-}adj}\left(\frac{103{,}390\ mg}{kg}\right) = \left(\frac{EF_{res\text{-}c}\left(\frac{350\ days}{year}\right)\times ED_{res\text{-}c}\,(6\ years)\times SA_{res\text{-}c}\left(\frac{2373\ cm^2}{day}\right)\times AF_{res\text{-}c}\left(\frac{0.2\ mg}{cm^2}\right)}{BW_{res\text{-}c}\,(15\ kg)}+\frac{EF_{res\text{-}a}\left(\frac{350\ days}{year}\right)\times\left(ED_{res}\,(26\ years)-ED_{res\text{-}c}\,(6\ years)\right)\times SA_{res\text{-}a}\left(\frac{6032\ cm^2}{day}\right)\times AF_{res\text{-}a}\left(\frac{0.07\ mg}{cm^2}\right)}{BW_{res\text{-}a}\,(80\ kg)}\right)$$

- inhalation of volatiles and particulates emitted from soil

$$SL_{res\text{-}soil\text{-}ca\text{-}vc\text{-}inh}\,(mg/kg) = \frac{TR}{\left(\frac{IUR\left(\mu g/m^3\right)^{-1}\times EF_{res}\left(\frac{350\ days}{year}\right)\times ED_{res}\,(26\ years)\times ET_{res}\left(\frac{24\ hours}{day}\right)\times\left(\frac{1\ day}{24\ hours}\right)\times\left(\frac{1000\ \mu g}{mg}\right)}{AT_{res}\left(\frac{365\ days}{year}\times LT\,(70\ years)\right)\times VF_{ulim}\left(\frac{m^3}{kg}\right)}\right)+\left(\frac{IUR\left(\mu g/m^3\right)^{-1}}{VF_{ulim}\left(\frac{m^3}{kg}\right)}\times\left(\frac{1000\ \mu g}{mg}\right)\right)}$$

- Total

$$SL_{res\text{-}soil\text{-}ca\text{-}vc\text{-}tot}\,(mg/kg) = \frac{1}{\frac{1}{SL_{res\text{-}soil\text{-}ca\text{-}vc\text{-}ing}}+\frac{1}{SL_{res\text{-}soil\text{-}ca\text{-}vc\text{-}der}}+\frac{1}{SL_{res\text{-}soil\text{-}ca\text{-}vc\text{-}inh}}}$$

4.1.1.6 Trichloroethylene - Carcinogenic and Mutagenic

The residential soil land use equations, presented here, contain the following exposure routes:

- incidental ingestion of soil

$$SL_{\text{res-soil-tce-ing}}\left(\text{mg/kg}\right) = \frac{TR \times AT_{\text{res}}\left(\frac{365\ \text{days}}{\text{year}} \times LT\left(70\ \text{years}\right)\right)}{CSF_o\left(\frac{\text{mg}}{\text{kg-day}}\right)^{-1} \times RBA \times \left(\frac{10^{-6}\text{kg}}{\text{mg}}\right) \times \left(\begin{array}{l}\left(CAF_o\left(0.804\right) \times IFS_{\text{res-adj}}\left(\frac{37{,}650\ \text{mg}}{\text{kg}}\right)\right) + \\ \left(MAF_o\left(0.202\right) \times IFSM_{\text{res-adj}}\left(\frac{166{,}833\ \text{mg}}{\text{kg}}\right)\right)\end{array}\right)}$$

where:

$$IFS_{\text{res-adj}}\left(\frac{36{,}750\ \text{mg}}{\text{kg}}\right) = \left(\begin{array}{l}\frac{ED_{\text{res-c}}\left(6\ \text{years}\right) \times EF_{\text{res-c}}\left(\frac{350\ \text{days}}{\text{year}}\right) \times IRS_{\text{res-c}}\left(\frac{200\ \text{mg}}{\text{day}}\right)}{BW_{\text{res-c}}\left(15\ \text{kg}\right)} + \\ \frac{\left(ED_{\text{res}}\left(26\ \text{years}\right) - ED_{\text{res-c}}\left(6\ \text{years}\right)\right) \times EF_{\text{res-a}}\left(\frac{350\ \text{days}}{\text{year}}\right) \times IRS_{\text{res-a}}\left(\frac{100\ \text{mg}}{\text{day}}\right)}{BW_{\text{res-a}}\left(80\ \text{kg}\right)}\end{array}\right)$$

where:

$$IFSM_{\text{res-adj}}\left(\frac{166{,}833\ \text{mg}}{\text{kg}}\right) = \left(\begin{array}{l}\frac{ED_{0\text{-}2}\left(2\ \text{years}\right) \times EF_{0\text{-}2}\left(\frac{350\ \text{days}}{\text{year}}\right) \times IRS_{0\text{-}2}\left(\frac{200\ \text{mg}}{\text{day}}\right) \times 10}{BW_{0\text{-}2}\left(15\ \text{kg}\right)} + \\ \frac{ED_{2\text{-}6}\left(4\ \text{years}\right) \times EF_{2\text{-}6}\left(\frac{350\ \text{days}}{\text{year}}\right) \times IRS_{2\text{-}6}\left(\frac{200\ \text{mg}}{\text{day}}\right) \times 3}{BW_{2\text{-}6}\left(15\ \text{kg}\right)} + \\ \frac{ED_{6\text{-}16}\left(10\ \text{years}\right) \times EF_{6\text{-}16}\left(\frac{350\ \text{days}}{\text{year}}\right) \times IRS_{6\text{-}16}\left(\frac{100\ \text{mg}}{\text{day}}\right) \times 3}{BW_{6\text{-}16}\left(80\ \text{kg}\right)} + \\ \frac{ED_{16\text{-}26}\left(10\ \text{years}\right) \times EF_{16\text{-}26}\left(\frac{350\ \text{days}}{\text{year}}\right) \times IRS_{16\text{-}26}\left(\frac{100\ \text{mg}}{\text{day}}\right) \times 1}{BW_{16\text{-}26}\left(80\ \text{kg}\right)}\end{array}\right)$$

- dermal contact with soil

$$\mathrm{SL}_{\text{res-soil-tce-der}}\,(\text{mg/kg}) = \frac{\mathrm{TR}\times\mathrm{AT}_{\text{res}}\left(\frac{365\text{ days}}{\text{year}}\times\mathrm{LT}\,(70\text{ years})\right)}{\left(\frac{\mathrm{CSF}_{o}\left(\frac{\text{mg}}{\text{kg-day}}\right)^{-1}}{\mathrm{GIABS}}\right)\times\left(\frac{10^{-6}\text{kg}}{\text{mg}}\right)\times\left(\left(\mathrm{CAF}_{o}\,(0.804)\times\mathrm{DFS}_{\text{res-adj}}\left(\frac{103{,}390\text{ mg}}{\text{kg}}\right)\times\mathrm{ABS}_{d}\right)+\left(\mathrm{MAF}_{o}\,(0.202)\times\mathrm{DFSM}_{\text{res-adj}}\left(\frac{428{,}260\text{ mg}}{\text{kg}}\right)\times\mathrm{ABS}_{d}\right.\right.}$$

where:

$$\mathrm{DFS}_{\text{res-adj}}\left(\frac{103{,}390\text{ mg}}{\text{kg}}\right) = \left(\begin{array}{c}\frac{\mathrm{ED}_{\text{res-c}}\,(6\text{ years})\times\mathrm{EF}_{\text{res-c}}\left(\frac{350\text{ days}}{\text{year}}\right)\times\mathrm{SA}_{\text{res-c}}\left(\frac{2373\text{ cm}^2}{\text{day}}\right)\times\mathrm{AF}_{\text{res-c}}\left(\frac{0.2\text{ mg}}{\text{cm}^2}\right)}{\mathrm{BW}_{\text{res-c}}\,(15\text{ kg})}+\\ \frac{\left(\mathrm{ED}_{\text{res}}\,(26\text{ years})-\mathrm{ED}_{\text{res-c}}\,(6\text{ years})\right)\times\mathrm{EF}_{\text{res-a}}\left(\frac{350\text{ days}}{\text{year}}\right)\times\mathrm{SA}_{\text{res-a}}\left(\frac{6032\text{ cm}^2}{\text{day}}\right)\times\mathrm{AF}_{\text{res-a}}\left(\frac{0.07\text{ mg}}{\text{cm}^2}\right)}{\mathrm{BW}_{\text{res-a}}\,(80\text{ kg})}\end{array}\right)$$

where:

$$\mathrm{DFSM}_{\text{res-adj}}\left(\frac{428{,}260\text{ mg}}{\text{kg}}\right) = \left(\begin{array}{c}\frac{\mathrm{ED}_{0\text{-}2}\,(2\text{ years})\times\mathrm{EF}_{0\text{-}2}\left(\frac{350\text{ days}}{\text{year}}\right)\times\mathrm{AF}_{0\text{-}2}\left(\frac{0.2\text{ mg}}{\text{cm}^2}\right)\times\mathrm{SA}_{0\text{-}2}\left(\frac{2373\text{ cm}^2}{\text{day}}\right)\times10}{\mathrm{BW}_{0\text{-}2}\,(15\text{ kg})}+\\ \frac{\mathrm{ED}_{2\text{-}6}\,(4\text{ years})\times\mathrm{EF}_{2\text{-}6}\left(\frac{350\text{ days}}{\text{year}}\right)\times\mathrm{AF}_{2\text{-}6}\left(\frac{0.2\text{ mg}}{\text{cm}^2}\right)\times\mathrm{SA}_{2\text{-}6}\left(\frac{2373\text{ cm}^2}{\text{day}}\right)\times3}{\mathrm{BW}_{2\text{-}6}\,(15\text{ kg})}+\\ \frac{\mathrm{ED}_{6\text{-}16}\,(10\text{ years})\times\mathrm{EF}_{6\text{-}16}\left(\frac{350\text{ days}}{\text{year}}\right)\times\mathrm{AF}_{6\text{-}16}\left(\frac{0.07\text{ mg}}{\text{cm}^2}\right)\times\mathrm{SA}_{6\text{-}16}\left(\frac{6032\text{ cm}^2}{\text{day}}\right)\times3}{\mathrm{BW}_{6\text{-}16}\,(80\text{ kg})}+\\ \frac{\mathrm{ED}_{16\text{-}26}\,(10\text{ years})\times\mathrm{EF}_{16\text{-}26}\left(\frac{350\text{ days}}{\text{year}}\right)\times\mathrm{AF}_{16\text{-}26}\left(\frac{0.07\text{ mg}}{\text{cm}^2}\right)\times\mathrm{SA}_{16\text{-}26}\left(\frac{6032\text{ cm}^2}{\text{day}}\right)\times1}{\mathrm{BW}_{16\text{-}26}\,(80\text{ kg})}\end{array}\right)$$

- inhalation of volatiles and particulates emitted from soil

$$\mathrm{SL}_{\text{res-soil-tce-inh}}\,(\text{mg/kg}) = \frac{\mathrm{TR}\times\mathrm{AT}_{\text{res}}\left(\frac{365\text{ days}}{\text{year}}\times\mathrm{LT}\,(70\text{ years})\right)}{\begin{array}{c}\mathrm{IUR}\left({}^{\mu\text{g}}/_{\text{m}^3}\right)^{-1}\times\left(\frac{1}{\mathrm{VF}_{\text{ulim}}\left(\frac{\text{m}^3}{\text{kg}}\right)}+\frac{1}{\mathrm{PEF}\left(\frac{\text{m}^3}{\text{kg}}\right)}\right)\times\left(\frac{1000\,\mu\text{g}}{\text{mg}}\right)\times\left(\frac{1\text{ day}}{24\text{ hours}}\right)\times\\ \left(\left(\begin{array}{l}\mathrm{CAF}_{i}\,(0.756)\times\mathrm{EF}_{\text{res}}\left(\frac{350\text{ days}}{\text{year}}\right)\times\\ \mathrm{ED}_{\text{res}}\,(26\text{ years})\times\mathrm{ET}_{\text{res}}\left(\frac{24\text{ hours}}{\text{day}}\right)\end{array}\right)+\left(\begin{array}{l}\left(\mathrm{ED}_{0\text{-}2}\,(2\text{ years})\times\mathrm{EF}_{0\text{-}2}\left(\frac{350\text{ days}}{\text{year}}\right)\times\mathrm{ET}_{0\text{-}2}\left(\frac{24\text{ hours}}{\text{day}}\right)\times\mathrm{MAF}_{i}\,(0.244)\times10\right)+\\ \left(\mathrm{ED}_{2\text{-}6}\,(4\text{ years})\times\mathrm{EF}_{2\text{-}6}\left(\frac{350\text{ days}}{\text{year}}\right)\times\mathrm{ET}_{2\text{-}6}\left(\frac{24\text{ hours}}{\text{day}}\right)\times\mathrm{MAF}_{i}\,(0.244)\times3\right)+\\ \left(\mathrm{ED}_{6\text{-}16}\,(10\text{ years})\times\mathrm{EF}_{6\text{-}16}\left(\frac{350\text{ days}}{\text{year}}\right)\times\mathrm{ET}_{6\text{-}16}\left(\frac{24\text{ hours}}{\text{day}}\right)\times\mathrm{MAF}_{i}\,(0.244)\times3\right)+\\ \left(\mathrm{ED}_{16\text{-}26}\,(10\text{ years})\times\mathrm{EF}_{16\text{-}26}\left(\frac{350\text{ days}}{\text{year}}\right)\times\mathrm{ET}_{16\text{-}26}\left(\frac{24\text{ hours}}{\text{day}}\right)\times\mathrm{MAF}_{i}\,(0.244)\times1\right)\end{array}\right)\right)\end{array}}$$

- Total.

$$\mathrm{SL}_{\text{res-soil-tce-tot}}\,(\text{mg/kg}) = \frac{1}{\frac{1}{\mathrm{SL}_{\text{res-soil-tce-ing}}}+\frac{1}{\mathrm{SL}_{\text{res-soil-tce-der}}}+\frac{1}{\mathrm{SL}_{\text{res-soil-tce-inh}}}}$$

A number of studies have shown that inadvertent ingestion of soil is common among children 6 years old and younger (Calabrese et al. 1989, Davis et al. 1990, Van Wijnen et al. 1990). Therefore, the dose method uses an age-adjusted soil ingestion factor that takes into account the difference in daily soil ingestion rates, body weights, and exposure duration for children from 1 to 6 years old and others from 7 to 26 years old. The equation is presented below. This health-protective approach is chosen to take into account the higher daily rates of soil ingestion in children as well as the longer duration of exposure that is anticipated for a long-term resident. For more on this method, see RAGS Part B.

4.1.1.7 Supporting Equations

- Child

$$ED_{res\text{-}c}\left(6\text{ years}\right) = ED_{0\text{-}2}\left(2\text{ years}\right) + ED_{2\text{-}6}\left(4\text{ years}\right)$$

$$BW_{res\text{-}c}\left(15\text{ kg}\right) = \frac{BW_{0\text{-}2}\left(15\text{ kg}\right)\times ED_{0\text{-}2}\left(2\text{ years}\right) + BW_{2\text{-}6}\left(15\text{ kg}\right)\times ED_{2\text{-}6}\left(4\text{ years}\right)}{ED_{0\text{-}2}\left(2\text{ years}\right) + ED_{2\text{-}6}\left(4\text{ years}\right)}$$

$$EF_{res\text{-}c}\left(\frac{350\text{ days}}{\text{year}}\right) = \frac{EF_{0\text{-}2}\left(\frac{350\text{ days}}{\text{year}}\right)\times ED_{0\text{-}2}\left(2\text{ years}\right) + EF_{2\text{-}6}\left(\frac{350\text{ days}}{\text{year}}\right)\times ED_{2\text{-}6}\left(4\text{ years}\right)}{ED_{0\text{-}2}\left(2\text{ years}\right) + ED_{2\text{-}6}\left(4\text{ years}\right)}$$

$$ET_{res\text{-}c}\left(\frac{24\text{ hours}}{\text{day}}\right) = \frac{ET_{0\text{-}2}\left(\frac{24\text{ hours}}{\text{day}}\right)\times ED_{0\text{-}2}\left(2\text{ years}\right) + ET_{2\text{-}6}\left(\frac{24\text{ hours}}{\text{day}}\right)\times ED_{2\text{-}6}\left(4\text{ years}\right)}{ED_{0\text{-}2}\left(2\text{ years}\right) + ED_{2\text{-}6}\left(4\text{ years}\right)}$$

$$AF_{res\text{-}c}\left(\frac{0.2\text{ mg}}{\text{cm}^2}\right) = \frac{AF_{0\text{-}2}\left(\frac{0.2\text{ mg}}{\text{cm}^2}\right)\times ED_{0\text{-}2}\left(2\text{ years}\right) + AF_{2\text{-}6}\left(\frac{0.2\text{ mg}}{\text{cm}^2}\right)\times ED_{2\text{-}6}\left(4\text{ years}\right)}{ED_{0\text{-}2}\left(2\text{ years}\right) + ED_{2\text{-}6}\left(4\text{ years}\right)}$$

$$SA_{res\text{-}c}\left(\frac{2373\text{ cm}^2}{\text{day}}\right) = \frac{SA_{0\text{-}2}\left(\frac{2373\text{ cm}^2}{\text{day}}\right)\times ED_{0\text{-}2}\left(2\text{ years}\right) + SA_{2\text{-}6}\left(\frac{2373\text{ cm}^2}{\text{day}}\right)\times ED_{2\text{-}6}\left(4\text{ years}\right)}{ED_{0\text{-}2}\left(2\text{ years}\right) + ED_{2\text{-}6}\left(4\text{ years}\right)}$$

$$IRS_{res\text{-}c}\left(\frac{200\text{ mg}}{\text{day}}\right) = \frac{IRS_{0\text{-}2}\left(\frac{200\text{ mg}}{\text{day}}\right)\times ED_{0\text{-}2}\left(2\text{ years}\right) + IRS_{2\text{-}6}\left(\frac{200\text{ mg}}{\text{day}}\right)\times ED_{2\text{-}6}\left(4\text{ years}\right)}{ED_{0\text{-}2}\left(2\text{ years}\right) + ED_{2\text{-}6}\left(4\text{ years}\right)}$$

- Adult

$$ED_{res\text{-}a}\left(20\text{ years}\right) = ED_{6\text{-}16}\left(10\text{ years}\right) + ED_{16\text{-}26}\left(10\text{ years}\right)$$

$$BW_{res\text{-}a}\left(80\text{ kg}\right) = \frac{BW_{6\text{-}16}\left(80\text{ kg}\right)\times ED_{6\text{-}16}\left(10\text{ years}\right) + BW_{16\text{-}26}\left(80\text{ kg}\right)\times ED_{16\text{-}26}\left(10\text{ years}\right)}{ED_{6\text{-}16}\left(10\text{ years}\right) + ED_{16\text{-}26}\left(10\text{ years}\right)}$$

$$EF_{res\text{-}a}\left(\frac{350\text{ days}}{\text{year}}\right) = \frac{EF_{6\text{-}16}\left(\frac{350\text{ days}}{\text{year}}\right)\times ED_{6\text{-}16}\left(10\text{ years}\right) + EF_{16\text{-}26}\left(\frac{350\text{ days}}{\text{year}}\right)\times ED_{16\text{-}26}\left(10\text{ years}\right)}{ED_{6\text{-}16}\left(10\text{ years}\right) + ED_{16\text{-}26}\left(10\text{ years}\right)}$$

$$ET_{res\text{-}a}\left(\frac{24\text{ hours}}{\text{day}}\right) = \frac{ET_{6\text{-}16}\left(\frac{24\text{ hours}}{\text{day}}\right)\times ED_{6\text{-}16}\left(2\text{ years}\right) + ET_{16\text{-}26}\left(\frac{24\text{ hours}}{\text{day}}\right)\times ED_{16\text{-}26}\left(4\text{ years}\right)}{ED_{6\text{-}16}\left(2\text{ years}\right) + ED_{16\text{-}26}\left(4\text{ years}\right)}$$

$$AF_{res\text{-}a}\left(\frac{0.07\text{ mg}}{\text{cm}^2}\right) = \frac{AF_{6\text{-}16}\left(\frac{0.07\text{ mg}}{\text{cm}^2}\right)\times ED_{6\text{-}16}\left(10\text{ years}\right) + AF_{16\text{-}26}\left(\frac{0.07\text{ mg}}{\text{cm}^2}\right)\times ED_{16\text{-}26}\left(10\text{ years}\right)}{ED_{6\text{-}16}\left(10\text{ years}\right) + ED_{16\text{-}26}\left(10\text{ years}\right)}$$

$$SA_{res\text{-}a}\left(\frac{6032\text{ cm}^2}{\text{day}}\right) = \frac{SA_{6\text{-}16}\left(\frac{6032\text{ cm}^2}{\text{day}}\right)\times ED_{6\text{-}16}\left(10\text{ years}\right) + SA_{16\text{-}26}\left(\frac{6032\text{ cm}^2}{\text{day}}\right)\times ED_{16\text{-}26}\left(10\text{ years}\right)}{ED_{6\text{-}16}\left(10\text{ years}\right) + ED_{16\text{-}26}\left(10\text{ years}\right)}$$

$$IRS_{res\text{-}a}\left(\frac{100\text{ mg}}{\text{day}}\right) = \frac{IRS_{6\text{-}16}\left(\frac{100\text{ mg}}{\text{day}}\right)\times ED_{6\text{-}16}\left(10\text{ years}\right) + IRS_{16\text{-}26}\left(\frac{100\text{ mg}}{\text{day}}\right)\times ED_{16\text{-}26}\left(10\text{ years}\right)}{ED_{6\text{-}16}\left(10\text{ years}\right) + ED_{16\text{-}26}\left(10\text{ years}\right)}$$

- Age-adjusted

$$ED_{res}\left(26\text{ years}\right) = ED_{0\text{-}2}\left(2\text{ years}\right) + ED_{2\text{-}6}\left(4\text{ years}\right) + ED_{6\text{-}16}\left(10\text{ years}\right) + ED_{16\text{-}26}\left(10\text{ years}\right)$$

$$EF_{res}\left(\frac{350\text{ days}}{\text{year}}\right) = \frac{\begin{array}{c}EF_{0\text{-}2}\left(\frac{350\text{ days}}{\text{year}}\right)\times ED_{0\text{-}2}\left(2\text{ years}\right) + EF_{2\text{-}6}\left(\frac{350\text{ days}}{\text{year}}\right)\times ED_{2\text{-}6}\left(4\text{ years}\right) + \\ EF_{6\text{-}16}\left(\frac{350\text{ days}}{\text{year}}\right)\times ED_{6\text{-}16}\left(10\text{ years}\right) + EF_{16\text{-}26}\left(\frac{350\text{ days}}{\text{year}}\right)\times ED_{16\text{-}26}\left(10\text{ years}\right)\end{array}}{ED_{0\text{-}2}\left(2\text{ years}\right) + ED_{2\text{-}6}\left(4\text{ years}\right) + ED_{6\text{-}16}\left(10\text{ years}\right) + ED_{16\text{-}26}\left(10\text{ years}\right)}$$

$$ET_{res}\left(\frac{24\text{ hours}}{\text{day}}\right) = \frac{\begin{array}{c}ET_{0\text{-}2}\left(\frac{24\text{ hours}}{\text{day}}\right)\times ED_{0\text{-}2}\left(2\text{ years}\right) + ET_{2\text{-}6}\left(\frac{24\text{ hours}}{\text{day}}\right)\times ED_{2\text{-}6}\left(4\text{ years}\right) + \\ ET_{6\text{-}16}\left(\frac{24\text{ hours}}{\text{day}}\right)\times ED_{6\text{-}16}\left(10\text{ years}\right) + ET_{16\text{-}26}\left(\frac{24\text{ hours}}{\text{day}}\right)\times ED_{16\text{-}26}\left(10\text{ years}\right)\end{array}}{ED_{0\text{-}2}\left(2\text{ years}\right) + ED_{2\text{-}6}\left(4\text{ years}\right) + ED_{6\text{-}16}\left(10\text{ years}\right) + ED_{16\text{-}26}\left(10\text{ years}\right)}$$

4.1.2 Resident Tapwater

This receptor is exposed to chemicals in water that are delivered into a residence from sources such as groundwater or surface water. Ingestion of drinking water is an appropriate pathway for all chemicals. The inhalation exposure route is only calculated for volatile compounds. Activities such as showering, laundering, and dish washing contribute to contaminants in the air for inhalation. Dermal contact with tapwater is also considered for analytes determined to be within the effective predictive domain as described in Section 4.9.8.

This land use is for developing residential default screening levels that are presented in the RSL Generic Tables.

4.1.2.1 Noncarcinogenic-child

The tapwater land use equation, presented here, contains the following exposure routes:

- ingestion of water

$$\text{SL}_{\text{res-wat-nc-ing-c}}\left(\mu\text{g/L}\right) = \frac{\text{THQ}\times\text{AT}_{\text{res-c}}\left(\frac{365\ \text{days}}{\text{year}}\times\text{ED}_{\text{res-c}}\left(6\ \text{years}\right)\right)\times\text{BW}_{\text{res-c}}\left(15\ \text{kg}\right)\times\left(\frac{1000\ \mu\text{g}}{\text{mg}}\right)}{\text{EF}_{\text{res-c}}\left(\frac{350\ \text{days}}{\text{year}}\right)\times\text{ED}_{\text{res-c}}\left(6\ \text{years}\right)\times\frac{1}{\text{RfD}_{\text{o}}\left(\frac{\text{mg}}{\text{kg-d}}\right)}\times\text{IRW}_{\text{res-c}}\left(\frac{0.78\ \text{L}}{\text{day}}\right)}$$

- dermal

FOR INORGANICS:

$$\text{SL}_{\text{res-wat-nc-der-c}}\left(\mu\text{g/L}\right) = \frac{\text{DA}_{\text{event}}\left(\frac{\text{ug}}{\text{cm}^2\text{- event}}\right)\times\left(\frac{1000\ \text{cm}^3}{\text{L}}\right)}{\text{K}_{\text{p}}\left(\frac{\text{cm}}{\text{hour}}\right)\times\text{ET}_{\text{event-res-c}}\left(\frac{0.54\ \text{hours}}{\text{event}}\right)}$$

FOR ORGANICS:

$$\text{IF ET}_{\text{event-res-c}}\left(\frac{0.54\ \text{hours}}{\text{event}}\right) \le t^{*}\ (\text{hours})\text{, then SL}_{\text{res-wat-nc-der}}\left(\mu\text{g/L}\right) = \frac{\text{DA}_{\text{event}}\left(\frac{\text{ug}}{\text{cm}^2\text{- event}}\right)\times\left(\frac{1000\ \text{cm}^3}{\text{L}}\right)}{2\times\text{FA}\times\text{K}_{\text{p}}\left(\frac{\text{cm}}{\text{hour}}\right)\sqrt{\frac{6\times\tau_{\text{event}}\left(\frac{\text{hours}}{\text{event}}\right)\times\text{ET}_{\text{event-res-c}}\left(\frac{0.54\ \text{hours}}{\text{event}}\right)}{\pi}}}$$

or,

$$\text{IF ET}_{\text{event-res-c}}\left(\frac{0.54\ \text{hours}}{\text{event}}\right) > t^{*}\ (\text{hours})\text{, then SL}_{\text{res-wat-nc-der}}\left(\mu\text{g/L}\right) = \frac{\text{DA}_{\text{event}}\left(\frac{\text{ug}}{\text{cm}^2\text{- event}}\right)\times\left(\frac{1000\ \text{cm}^3}{\text{L}}\right)}{\text{FA}\times\text{K}_{\text{p}}\left(\frac{\text{cm}}{\text{hour}}\right)\times\left[\frac{\text{ET}_{\text{event-res-c}}\left(\frac{0.54\ \text{hours}}{\text{event}}\right)}{1+\text{B}}+2\times\tau_{\text{event}}\left(\frac{\text{hours}}{\text{event}}\right)\times\left(\frac{1+3\text{B}+3\text{B}^2}{(1+\text{B})^2}\right)\right]}$$

where:

$$\text{DA}_{\text{event}}\left(\frac{\text{ug}}{\text{cm}^2\text{- event}}\right) = \frac{\text{THQ}\times\text{AT}_{\text{res-c}}\left(\frac{365\ \text{days}}{\text{year}}\times\text{ED}_{\text{res-c}}\left(6\ \text{years}\right)\right)\times\left(\frac{1000\ \mu\text{g}}{\text{mg}}\right)\times\text{BW}_{\text{res-c}}\left(15\ \text{kg}\right)}{\left(\frac{1}{\text{RfD}_{\text{o}}\left(\frac{\text{mg}}{\text{kg-day}}\right)\times\text{GIABS}}\right)\times\text{EV}_{\text{res-c}}\left(\frac{1\ \text{events}}{\text{day}}\right)\times\text{ED}_{\text{res-c}}\left(6\ \text{years}\right)\times\text{EF}_{\text{res-c}}\left(\frac{350\ \text{days}}{\text{year}}\right)\times\text{SA}_{\text{res-c}}\left(6365\ \text{cm}^2\right)}$$

- inhalation of volatiles

$$\text{SL}_{\text{res-wat-nc-inh-c}}\left(\mu\text{g/L}\right) = \frac{\text{THQ}\times\text{AT}_{\text{res-c}}\left(\frac{365\ \text{days}}{\text{year}}\times\text{ED}_{\text{res-c}}\left(6\ \text{years}\right)\right)\times\left(\frac{1000\ \mu\text{g}}{\text{mg}}\right)}{\text{EF}_{\text{res-c}}\left(\frac{350\ \text{days}}{\text{year}}\right)\times\text{ED}_{\text{res-c}}\left(6\ \text{years}\right)\times\text{ET}_{\text{res-c}}\left(\frac{24\ \text{hours}}{\text{day}}\right)\times\left(\frac{1\ \text{day}}{24\ \text{hours}}\right)\times\frac{1}{\text{RfC}\left(\text{mg}/\text{m}^3\right)}\times\text{K}\left(\frac{0.5\ \text{L}}{\text{m}^3}\right)}$$

- Total

$$SL_{\text{res-wat-nc-tot-c}}\left(\mu g/L\right) = \frac{1}{\frac{1}{SL_{\text{res-wat-nc-ing-c}}}+\frac{1}{SL_{\text{res-wat-nc-der-c}}}+\frac{1}{SL_{\text{res-wat-nc-inh-c}}}}$$

4.1.2.2 Noncarcinogenic-adult

The tapwater land use equation, presented here, contains the following exposure routes:

- ingestion of water

$$SL_{\text{res-wat-nc-ing-a}}\left(\mu g/L\right) = \frac{THQ\times AT_{\text{res-a}}\left(\frac{365\ \text{days}}{\text{year}}\times ED_{\text{res}}\left(26\ \text{years}\right)\right)\times BW_{\text{res-a}}\left(80\ \text{kg}\right)\times\left(\frac{1000\ \mu g}{mg}\right)}{EF_{\text{res-a}}\left(350\ \frac{\text{days}}{\text{year}}\right)\times ED_{\text{res}}\left(26\ \text{years}\right)\times\frac{1}{RfD_o\left(\frac{mg}{kg\text{-}d}\right)}\times IRW_{\text{res-a}}\left(\frac{2.5\ L}{\text{day}}\right)}$$

- dermal

FOR INORGANICS:

$$SL_{\text{res-wat-nc-der-a}}\left(\mu g/L\right) = \frac{DA_{\text{event}}\left(\frac{ug}{cm^2\text{- event}}\right)\times\left(\frac{1000\ cm^3}{L}\right)}{K_p\left(\frac{cm}{hour}\right)\times ET_{\text{event-res-a}}\left(\frac{0.71\ \text{hours}}{\text{event}}\right)}$$

FOR ORGANICS:

$$\text{IF } ET_{\text{event-res-a}}\left(\frac{0.71\ \text{hours}}{\text{event}}\right)\leq t^*\ (\text{hours}),\text{then } SL_{\text{res-wat-nc-der}}\left(\mu g/L\right) = \frac{DA_{\text{event}}\left(\frac{ug}{cm^2\text{- event}}\right)\times\left(\frac{1000\ cm^3}{L}\right)}{2\times FA\times K_p\left(\frac{cm}{hour}\right)\sqrt{\frac{6\times\tau_{\text{event}}\left(\frac{\text{hours}}{\text{event}}\right)\times ET_{\text{event-res-a}}\left(\frac{0.71\ \text{hours}}{\text{event}}\right)}{\pi}}}$$

or,

$$\text{IF } ET_{\text{event-res-a}}\left(\frac{0.71\ \text{hours}}{\text{event}}\right)>t^*\ (\text{hours}),\text{then } SL_{\text{res-wat-nc-der}}\left(\mu g/L\right) = \frac{DA_{\text{event}}\left(\frac{ug}{cm^2\text{- event}}\right)\times\left(\frac{1000\ cm^3}{L}\right)}{FA\times K_p\left(\frac{cm}{hour}\right)\times\left[\frac{ET_{\text{event-res-a}}\left(\frac{0.71\ \text{hours}}{\text{event}}\right)}{1+B}+2\times\tau_{\text{event}}\left(\frac{\text{hours}}{\text{event}}\right)\times\left(\frac{1+3B+3B^2}{\left(1+B\right)^2}\right)\right]}$$

where:

$$DA_{\text{event}}\left(\frac{ug}{cm^2\text{- event}}\right) = \frac{THQ\times AT_{\text{res-a}}\left(\frac{365\ \text{days}}{\text{year}}\times ED_{\text{res}}\left(26\ \text{years}\right)\right)\times\left(\frac{1000\ \mu g}{mg}\right)\times BW_{\text{res-a}}\left(80\ \text{kg}\right)}{\left(\frac{1}{RfD_o\left(\frac{mg}{kg\text{-day}}\right)\times GIABS}\right)\times EV_{\text{res-a}}\left(\frac{1\ \text{events}}{\text{day}}\right)\times ED_{\text{res}}\left(26\ \text{years}\right)\times EF_{\text{res-a}}\left(\frac{350\ \text{days}}{\text{year}}\right)\times SA_{\text{res-a}}\left(19652\ cm^2\right)}$$

- inhalation of volatiles

$$SL_{\text{res-wat-nc-inh-a}}\left(\mu g/L\right) = \frac{THQ\times AT_{\text{res-a}}\left(\frac{365\ \text{days}}{\text{year}}\times ED_{\text{res}}\left(26\ \text{years}\right)\right)\times\left(\frac{1000\ \mu g}{mg}\right)}{EF_{\text{res-a}}\left(\frac{350\ \text{days}}{\text{year}}\right)\times ED_{\text{res}}\left(26\ \text{years}\right)\times ET_{\text{res-a}}\left(\frac{24\ \text{hours}}{\text{day}}\right)\times\left(\frac{1\ \text{day}}{24\ \text{hours}}\right)\times\frac{1}{RfC\left(mg/m^3\right)}\times K\left(\frac{0.5\ L}{m^3}\right)}$$

- Total

$$SL_{\text{res-wat-nc-tot-a}}\left(\mu g/L\right) = \frac{1}{\frac{1}{SL_{\text{res-wat-nc-ing-a}}}+\frac{1}{SL_{\text{res-wat-nc-der-a}}}+\frac{1}{SL_{\text{res-wat-nc-inh-a}}}}$$

4.1.2.3 Carcinogenic

The tapwater land use equation, presented here, contains the following exposure routes:

- ingestion of water

$$SL_{res\text{-}wat\text{-}ca\text{-}ing}\left(\mu g/L\right) = \frac{TR \times AT_{res}\left(\frac{365\ \text{days}}{\text{year}} \times LT\left(70\ \text{years}\right)\right) \times \left(\frac{1000\ \mu g}{mg}\right)}{CSF_{o}\left(\frac{mg}{kg\text{-}day}\right)^{-1} \times \left(IFW_{res\text{-}adj}\left(\frac{327.95\ L}{kg}\right)\right)}$$

where:

$$IFW_{res\text{-}adj}\left(\frac{327.95\ L}{kg}\right) = \left(\frac{EF_{res\text{-}c}\left(\frac{350\ \text{days}}{\text{year}}\right) \times ED_{res\text{-}c}\left(6\ \text{years}\right) \times IRW_{res\text{-}c}\left(\frac{0.78\ L}{\text{day}}\right)}{BW_{res\text{-}c}\left(15\ kg\right)} + \frac{EF_{res\text{-}a}\left(\frac{350\ \text{days}}{\text{year}}\right) \times \left(ED_{res}\left(26\ \text{years}\right) - ED_{res\text{-}c}\left(6\ \text{years}\right)\right) \times IRW_{res\text{-}a}\left(\frac{2.5\ L}{\text{day}}\right)}{BW_{res\text{-}a}\left(80\ kg\right)}\right)$$

- dermal

FOR INORGANICS:

$$SL_{res\text{-}wat\text{-}ca\text{-}der}\,(\mu g/L) = \frac{DA_{event}\left(\frac{ug}{cm^2\text{- event}}\right) \times \left(\frac{1000\ cm^3}{L}\right)}{K_p\left(\frac{cm}{hour}\right) \times ET_{event\text{-}res\text{-}adj}\left(\frac{0.6708\ hours}{event}\right)}$$

FOR ORGANICS:

$$\text{IF } ET_{event\text{-}res\text{-}adj}\left(\frac{hours}{event}\right) \leq t^*\ (hours)\text{, then } SL_{res\text{-}wat\text{-}ca\text{-}der}\,(\mu g/L) = \frac{DA_{event}\left(\frac{ug}{cm^2\text{- event}}\right) \times \left(\frac{1000\ cm^3}{L}\right)}{2 \times FA \times K_p\left(\frac{cm}{hour}\right)\sqrt{\frac{6 \times \tau_{event}\left(\frac{hours}{event}\right) \times ET_{event\text{-}res\text{-}adj}\left(\frac{0.6708\ hours}{event}\right)}{\pi}}}$$

or,

$$\text{IF } ET_{event\text{-}res\text{-}adj}\left(\frac{hours}{event}\right) > t^*\ (hours)\text{, then } SL_{res\text{-}wat\text{-}ca\text{-}der}\,(\mu g/L) = \frac{DA_{event}\left(\frac{ug}{cm^2\text{- event}}\right) \times \left(\frac{1000\ cm^3}{L}\right)}{FA \times K_p\left(\frac{cm}{hour}\right) \times \left[\frac{ET_{event\text{-}res\text{-}adj}\left(\frac{0.6708\ hours}{event}\right)}{1+B} + 2 \times \tau_{event}\left(\frac{hours}{event}\right) \times \left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right]}$$

where:

$$DA_{event}\left(\frac{ug}{cm^2\text{- event}}\right) = \frac{TR \times AT_{res}\left(\frac{365\ days}{year} \times LT\ (70\ years)\right) \times \left(\frac{1000\ \mu g}{mg}\right)}{\left(\frac{CSF_o\left(\frac{mg}{kg\text{-}day}\right)^{-1}}{GIABS}\right) \times DFW_{res\text{-}adj}\left(\frac{2{,}610{,}650\ events\text{-}cm^2}{kg}\right)}$$

where:

$$DFW_{res\text{-}adj}\left(\frac{2{,}610{,}650\ events\text{-}cm^2}{kg}\right) = \left(\begin{array}{l}\frac{EF_{res\text{-}c}\left(\frac{350\ days}{year}\right) \times EV_{res\text{-}c}\left(\frac{1\ events}{day}\right) \times ED_{res\text{-}c}\ (6\ years) \times SA_{res\text{-}c}\left(6365\ cm^2\right)}{BW_{reswc}\ (15\ kg)} + \\ \frac{EF_{res\text{-}a}\left(\frac{350\ days}{year}\right) \times EV_{res\text{-}a}\left(\frac{1\ events}{day}\right) \times \left(ED_{res}\ (26\ years) - ED_{res\text{-}c}\ (6\ years)\right) \times SA_{res\text{-}a}\left(19652\ cm^2\right)}{BW_{res\text{-}a}\ (80\ kg)}\end{array}\right)$$

and:

$$ET_{event\text{-}res\text{-}adj}\left(\frac{0.6708\ hours}{event}\right) = \left(\frac{\left(ET_{event\text{-}res\text{-}c}\left(\frac{0.54\ hours}{event}\right) \times ED_{res\text{-}c}\ (6\ years) + ET_{event\text{-}res\text{-}a}\left(\frac{0.71\ hours}{event}\right) \times \left(ED_{res}\ (26\ years) - ED_{res\text{-}c}\ (6\ years)\right)\right)}{ED_{res}\ (26\ years)}\right)$$

- inhalation of volatiles

$$SL_{res\text{-}wat\text{-}ca\text{-}inh}\,(\mu g/L) = \frac{TR \times AT_{res}\left(\frac{365\ days}{year} \times LT\ (70\ years)\right)}{EF_{res}\left(\frac{350\ days}{year}\right) \times ED_{res}\ (26\ years) \times ET_{res}\left(\frac{24\ hours}{day}\right) \times \left(\frac{1\ day}{24\ hours}\right) \times IUR\left(\mu g/m^3\right)^{-1} \times K\left(\frac{0.5\ L}{m^3}\right)}$$

- Total

$$SL_{res\text{-}wat\text{-}ca\text{-}tot}\,(\mu g/L) = \frac{1}{\frac{1}{SL_{res\text{-}wat\text{-}ca\text{-}ing}} + \frac{1}{SL_{res\text{-}wat\text{-}ca\text{-}der}} + \frac{1}{SL_{res\text{-}wat\text{-}ca\text{-}inh}}}$$

4.1.2.4 Mutagenic

The tapwater land use equation, presented here, contains the following exposure routes:

- ingestion of water

$$SL_{res\text{-}wat\text{-}mu\text{-}ing}\left(\mu g/L\right) = \frac{TR \times AT_{res}\left(\frac{365\ \text{days}}{\text{year}} \times LT\left(70\ \text{years}\right)\right) \times \left(\frac{1000\ \mu g}{mg}\right)}{CSF_o\left(\frac{mg}{kg\text{-}day}\right)^{-1} \times IFWM_{res\text{-}adj}\left(\frac{1019.9\ L}{kg}\right)}$$

where:

$$IFWM_{res\text{-}adj}\left(\frac{1019.9\ L}{kg}\right) = \left(\begin{array}{l} \frac{EF_{0\text{-}2}\left(\frac{350\ \text{days}}{\text{year}}\right) \times ED_{0\text{-}2}\left(\text{years}\right) \times IRW_{0\text{-}2}\left(\frac{0.78\ L}{\text{day}}\right) \times 10}{BW_{0\text{-}2}\left(15\ kg\right)} + \\ \frac{EF_{2\text{-}6}\left(\frac{350\ \text{days}}{\text{year}}\right) \times ED_{2\text{-}6}\left(\text{years}\right) \times IRW_{2\text{-}6}\left(\frac{0.78\ L}{\text{day}}\right) \times 3}{BW_{2\text{-}6}\left(15\ kg\right)} + \\ \frac{EF_{6\text{-}16}\left(\frac{350\ \text{days}}{\text{year}}\right) \times ED_{6\text{-}16}\left(\text{years}\right) \times IRW_{6\text{-}16}\left(\frac{2.5\ L}{\text{day}}\right) \times 3}{BW_{6\text{-}16}\left(80\ kg\right)} + \\ \frac{EF_{16\text{-}26}\left(\frac{350\ \text{days}}{\text{year}}\right) \times ED_{16\text{-}26}\left(\text{years}\right) \times IRW_{16\text{-}26}\left(\frac{2.5\ L}{\text{day}}\right) \times 1}{BW_{16\text{-}26}\left(80\ kg\right)} \end{array}\right)$$

- dermal

FOR INORGANICS:

$$\text{SL}_{\text{res-wat-mu-der}}\left(\mu\text{g/L}\right) = \frac{\text{DA}_{\text{event}}\left(\frac{\text{ug}}{\text{cm}^2\text{- event}}\right) \times \left(\frac{1000\ \text{cm}^3}{\text{L}}\right)}{\text{K}_\text{p}\left(\frac{\text{cm}}{\text{hour}}\right) \times \text{ET}_{\text{event-res-madj}}\left(\frac{0.6708\ \text{hours}}{\text{event}}\right)}$$

FOR ORGANICS:

$$\text{IF ET}_{\text{event-res-madj}}\left(\frac{0.6708\ \text{hours}}{\text{event}}\right) \le t^*\ (\text{hours}), \text{then SL}_{\text{res-wat-mu-der}}\left(\mu\text{g/L}\right) = \frac{\text{DA}_{\text{event}}\left(\frac{\text{ug}}{\text{cm}^2\text{- event}}\right) \times \left(\frac{1000\ \text{cm}^3}{\text{L}}\right)}{2 \times \text{FA} \times \text{K}_\text{p}\left(\frac{\text{cm}}{\text{hour}}\right)\sqrt{\frac{6 \times \tau_{\text{event}}\left(\frac{\text{hours}}{\text{event}}\right) \times \text{ET}_{\text{event-res-madj}}\left(\frac{\text{hours}}{\text{event}}\right)}{\pi}}}$$

or,

$$\text{IF ET}_{\text{event-res-madj}}\left(\frac{0.6708\ \text{hours}}{\text{event}}\right) > t^*\ (\text{hours}), \text{then SL}_{\text{res-wat-mu-der}}\left(\mu\text{g/L}\right) = \frac{\text{DA}_{\text{event}}\left(\frac{\text{ug}}{\text{cm}^2\text{- event}}\right) \times \left(\frac{1000\ \text{cm}^3}{\text{L}}\right)}{\text{FA} \times \text{K}_\text{p}\left(\frac{\text{cm}}{\text{hour}}\right) \times \left[\frac{\text{ET}_{\text{event-res-madj}}\left(\frac{\text{hours}}{\text{event}}\right)}{1+\text{B}} + 2 \times \tau_{\text{event}}\left(\frac{\text{hours}}{\text{event}}\right) \times \left(\frac{1+3\text{B}+3\text{B}^2}{(1+\text{B})^2}\right)\right]}$$

where:

$$\text{DA}_{\text{event}}\left(\frac{\text{ug}}{\text{cm}^2\text{- event}}\right) = \frac{\text{TR} \times \text{AT}_{\text{res}}\left(\frac{365\ \text{days}}{\text{year}} \times \text{LT}\ (70\ \text{years})\right) \times \left(\frac{1000\ \mu\text{g}}{\text{mg}}\right)}{\left(\frac{\text{CSF}_\text{o}\left(\frac{\text{mg}}{\text{kg-day}}\right)^{-1}}{\text{GIABS}}\right) \times \text{DFWM}_{\text{res-adj}}\left(\frac{8{,}191{,}633\ \text{events - cm}^2}{\text{kg}}\right)}$$

where:

$$\text{DFWM}_{\text{res-adj}}\left(\frac{8{,}191{,}633\ \text{events - cm}^2}{\text{kg}}\right) = \left[\begin{array}{l}
\left(\frac{\text{EV}_{0\text{-}2}\left(\frac{1\ \text{events}}{\text{day}}\right) \times \text{EF}_{0\text{-}2}\left(\frac{350\ \text{days}}{\text{year}}\right) \times \text{ED}_{0\text{-}2}\ (\text{years}) \times \text{SA}_{0\text{-}2}\left(6365\ \text{cm}^2\right) \times 10}{\text{BW}_{0\text{-}2}\ (15\ \text{kg})}\right) + \\
\left(\frac{\text{EV}_{2\text{-}6}\left(\frac{1\ \text{events}}{\text{day}}\right) \times \text{EF}_{2\text{-}6}\left(\frac{350\ \text{days}}{\text{year}}\right) \times \text{ED}_{2\text{-}6}\ (\text{years}) \times \text{SA}_{2\text{-}6}\left(6365\ \text{cm}^2\right) \times 3}{\text{BW}_{2\text{-}6}\ (15\ \text{kg})}\right) + \\
\left(\frac{\text{EV}_{6\text{-}16}\left(\frac{1\ \text{events}}{\text{day}}\right) \times \text{EF}_{6\text{-}16}\left(\frac{350\ \text{days}}{\text{year}}\right) \times \text{ED}_{6\text{-}16}\ (\text{years}) \times \text{SA}_{6\text{-}16}\left(19652\ \text{cm}^2\right) \times 3}{\text{BW}_{6\text{-}16}\ (80\ \text{kg})}\right) + \\
\left(\frac{\text{EV}_{16\text{-}26}\left(\frac{1\ \text{events}}{\text{day}}\right) \times \text{EF}_{16\text{-}26}\left(\frac{350\ \text{days}}{\text{year}}\right) \times \text{ED}_{16\text{-}26}\ (\text{years}) \times \text{SA}_{16\text{-}26}\left(19652\ \text{cm}^2\right) \times 1}{\text{BW}_{16\text{-}26}\ (80\ \text{kg})}\right)
\end{array}\right]$$

and:

$$\text{ET}_{\text{event-res-madj}}\left(\frac{0.6708\ \text{hours}}{\text{event}}\right) = \frac{\left(\begin{array}{l}\text{ET}_{\text{event-res}\,(0\text{-}2)}\left(\frac{0.54\ \text{hours}}{\text{event}}\right) \times \text{ED}_{0\text{-}2}\ (2\ \text{years}) + \text{ET}_{\text{event-res}\,(2\text{-}6)}\left(\frac{0.54\ \text{hours}}{\text{event}}\right) \times \text{ED}_{2\text{-}6}\ (4\ \text{years}) + \\ \text{ET}_{\text{event-res}\,(6\text{-}16)}\left(\frac{0.71\ \text{hours}}{\text{event}}\right) \times \text{ED}_{6\text{-}16}\ (10\ \text{years}) + \text{ET}_{\text{event-res}\,(16\text{-}26)}\left(\frac{0.71\ \text{hours}}{\text{event}}\right) \times \text{ED}_{16\text{-}26}\ (10\ \text{years})\end{array}\right)}{\text{ED}_{0\text{-}2}\ (2\ \text{years}) + \text{ED}_{2\text{-}6}\ (4\ \text{years}) + \text{ED}_{6\text{-}16}\ (10\ \text{years}) + \text{ED}_{16\text{-}26}\ (10\ \text{years})}$$

- inhalation of volatiles

$$SL_{res\text{-}wat\text{-}mu\text{-}inh}\left(\mu g/L\right) = \frac{TR \times AT_{res}\left(\frac{365\ \text{days}}{\text{year}} \times LT\left(70\ \text{years}\right)\right)}{IUR\left(\frac{\mu g}{m^3}\right)^{-1} \times K\left(\frac{0.5\ L}{m^3}\right) \times \left(\begin{gathered}\left(EF_{0\text{-}2}\left(\frac{350\ \text{days}}{\text{year}}\right) \times ET_{0\text{-}2}\left(\frac{24\ \text{hours}}{\text{day}}\right) \times \left(\frac{1\ \text{day}}{24\ \text{hours}}\right) \times ED_{0\text{-}2}\left(2\ \text{years}\right) \times 10\right) + \\ \left(EF_{2\text{-}6}\left(\frac{350\ \text{days}}{\text{year}}\right) \times ET_{2\text{-}6}\left(\frac{24\ \text{hours}}{\text{day}}\right) \times \left(\frac{1\ \text{day}}{24\ \text{hours}}\right) \times ED_{2\text{-}6}\left(4\ \text{years}\right) \times 3\right) + \\ \left(EF_{6\text{-}16}\left(\frac{350\ \text{days}}{\text{year}}\right) \times ET_{6\text{-}16}\left(\frac{24\ \text{hours}}{\text{day}}\right) \times \left(\frac{1\ \text{day}}{24\ \text{hours}}\right) \times ED_{6\text{-}16}\left(10\ \text{years}\right) \times 3\right) + \\ \left(EF_{16\text{-}26}\left(\frac{350\ \text{days}}{\text{year}}\right) \times ET_{16\text{-}26}\left(\frac{24\ \text{hours}}{\text{day}}\right) \times \left(\frac{1\ \text{day}}{24\ \text{hours}}\right) \times ED_{16\text{-}26}\left(10\ \text{years}\right) \times 1\right)\end{gathered}\right)}$$

- Total

$$SL_{res\text{-}wat\text{-}mu\text{-}tot}\left(\mu g/L\right) = \frac{1}{\frac{1}{SL_{res\text{-}wat\text{-}mu\text{-}ing}} + \frac{1}{SL_{res\text{-}wat\text{-}mu\text{-}der}} + \frac{1}{SL_{res\text{-}wat\text{-}mu\text{-}inh}}}$$

4.1.2.5 Vinyl Chloride - Carcinogenic

The tapwater land use equation, presented here, contains the following exposure routes:

- ingestion of water

$$SL_{res\text{-}wat\text{-}ca\text{-}vc\text{-}ing}\left(\mu g/L\right) = \frac{TR}{\left(\frac{CSF_o\left(\frac{mg}{kg\text{-}day}\right)^{-1} \times IFW_{res\text{-}adj}\left(\frac{327.95\ L}{kg}\right) \times \left(\frac{mg}{1000\ \mu g}\right)}{AT_{res}\left(\frac{365\ \text{days}}{\text{year}} \times LT\left(70\ \text{years}\right)\right)}\right) + \left(\frac{CSF_o\left(\frac{mg}{kg\text{-}day}\right)^{-1} \times IRW_{res\text{-}c}\left(\frac{0.78\ L}{day}\right) \times \left(\frac{mg}{1000\ \mu g}\right)}{BW_{res\text{-}c}\left(15\ kg\right)}\right)}$$

where:

$$IFW_{res\text{-}adj}\left(\frac{327.95\ L}{kg}\right) = \left(\begin{gathered}\frac{EF_{res\text{-}c}\left(\frac{350\ \text{days}}{\text{year}}\right) \times ED_{res\text{-}c}\left(6\ \text{years}\right) \times IRW_{res\text{-}c}\left(\frac{0.78\ L}{day}\right)}{BW_{res\text{-}c}\left(15\ kg\right)} + \\ \frac{EF_{res\text{-}a}\left(\frac{350\ \text{days}}{\text{year}}\right) \times \left(ED_{res}\left(26\ \text{years}\right) - ED_{res\text{-}c}\left(6\ \text{years}\right)\right) \times IRW_{res\text{-}a}\left(\frac{2.5\ L}{day}\right)}{BW_{res\text{-}a}\left(80\ kg\right)}\end{gathered}\right)$$

- dermal

$$\text{IF } ET_{\text{event-res-adj}}\left(\frac{0.6708\text{ hours}}{\text{event}}\right) \le t^{*}\ (\text{hours}), \text{then } SL_{\text{res-wat-ca-vc-der}}\left(\mu g/L\right) = \frac{DA_{\text{event}}\left(\frac{\text{ug}}{\text{cm}^2\text{- event}}\right)\times\left(\frac{1000\text{ cm}^3}{L}\right)}{2\times FA\times K_p\left(\frac{\text{cm}}{\text{hour}}\right)\sqrt{\frac{6\times\tau_{\text{event}}\left(\frac{\text{hours}}{\text{event}}\right)\times ET_{\text{event-res-adj}}\left(\frac{0.6708\text{ hours}}{\text{event}}\right)}{\pi}}}$$

or,

$$\text{IF } ET_{\text{event-res-adj}}\left(\frac{0.6708\text{ hours}}{\text{event}}\right) > t^{*}\ (\text{hours}), \text{then } SL_{\text{res-wat-ca-vc-der}}\left(\mu g/L\right) = \frac{DA_{\text{event}}\left(\frac{\text{ug}}{\text{cm}^2\text{- event}}\right)\times\left(\frac{1000\text{ cm}^3}{L}\right)}{FA\times K_p\left(\frac{\text{cm}}{\text{hour}}\right)\times\left[\frac{ET_{\text{event-res-adj}}\left(\frac{0.6708\text{ hours}}{\text{event}}\right)}{1+B}+2\times\tau_{\text{event}}\left(\frac{\text{hours}}{\text{event}}\right)\times\left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right]}$$

where:

$$DA_{\text{event}}\left(\frac{\text{ug}}{\text{cm}^2\text{- event}}\right) = \frac{TR}{\left(\frac{\left(\frac{CSF_o\left(\frac{\text{mg}}{\text{kg-day}}\right)^{-1}}{GIABS}\right)\times DFW_{\text{res-adj}}\left(\frac{2{,}610{,}650\text{ events-cm}^2}{\text{kg}}\right)}{AT_{\text{res}}\left(\frac{365\text{ days}}{\text{year}}\times LT\left(70\text{ years}\right)\right)\times\left(\frac{1000\ \mu g}{\text{mg}}\right)}\right)+\left(\frac{\left(\frac{CSF_o\left(\frac{\text{mg}}{\text{kg-day}}\right)^{-1}}{GIABS}\right)\times EV_{\text{res-c}}\left(\frac{1\text{ events}}{\text{day}}\right)\times SA_{\text{res-c}}\left(6365\text{ cm}^2\right)}{BW_{\text{res-c}}\left(15\text{ kg}\right)\times\left(\frac{1000\ \mu g}{\text{mg}}\right)}\right)}$$

where:

$$DFW_{\text{res-adj}}\left(\frac{2{,}610{,}650\text{ events-cm}^2}{\text{kg}}\right) = \left(\frac{EF_{\text{res-c}}\left(\frac{350\text{ days}}{\text{year}}\right)\times EV_{\text{res-c}}\left(\frac{1\text{ events}}{\text{day}}\right)\times ED_{\text{res-c}}\left(6\text{ years}\right)\times SA_{\text{res-c}}\left(6365\text{ cm}^2\right)}{BW_{\text{res-c}}\left(15\text{ kg}\right)}+\frac{EF_{\text{res-a}}\left(\frac{350\text{ days}}{\text{year}}\right)\times EV_{\text{res-a}}\left(\frac{1\text{ events}}{\text{day}}\right)\times ED_{\text{res-a}}\left(20\text{ years}\right)\times SA_{\text{res-a}}\left(19652\text{ cm}^2\right)}{BW_{\text{res-a}}\left(80\text{ kg}\right)}\right)$$

and:

$$ET_{\text{event-res-adj}}\left(\frac{0.6708\text{ hours}}{\text{event}}\right) = \left(\frac{\left(ET_{\text{event-res-c}}\left(\frac{0.54\text{ hours}}{\text{event}}\right)\times ED_{\text{res-c}}\left(6\text{ years}\right)+ET_{\text{event-res-a}}\left(\frac{0.71\text{ hours}}{\text{event}}\right)\times\left(ED_{\text{res}}\left(26\text{ years}\right)-ED_{\text{res-c}}\left(6\text{ years}\right)\right)\right)}{ED_{\text{res}}\left(26\text{ years}\right)}\right)$$

- inhalation of volatiles

$$SL_{\text{res-wat-ca-vc-inh}}\left(\mu g/L\right) = \frac{TR}{\left(\frac{IUR\left(\mu g/m^3\right)^{-1}\times EF_{\text{res}}\left(\frac{350\text{ days}}{\text{year}}\right)\times ED_{\text{res}}\left(26\text{ years}\right)\times ET_{\text{res}}\left(\frac{24\text{ hours}}{\text{day}}\right)\times\left(\frac{1\text{ day}}{24\text{ hours}}\right)\times K\left(\frac{0.5\text{ L}}{m^3}\right)}{AT_{\text{res}}\left(\frac{365\text{ days}}{\text{year}}\times LT\left(70\text{ years}\right)\right)}\right)+\left(IUR\left(\mu g/m^3\right)^{-1}\times K\left(\frac{0.5\text{ L}}{m^3}\right)\right)}$$

- Total

$$SL_{\text{res-wat-ca-vc-tot}}\left(\mu g/L\right) = \frac{1}{\frac{1}{SL_{\text{res-wat-ca-vc-ing}}}+\frac{1}{SL_{\text{res-wat-ca-vc-der}}}+\frac{1}{SL_{\text{res-wat-ca-vc-inh}}}}$$

4.1.2.6 Trichloroethylene - Carcinogenic and Mutagenic

The tapwater land use equation, presented here, contains the following exposure routes:

- ingestion of water

$$SL_{res\text{-}wat\text{-}tce\text{-}ing}\left(\mu g/L\right) = \frac{TR \times AT_{res}\left(\frac{365\ days}{year} \times LT\left(70\ years\right)\right) \times \left(\frac{1000\ \mu g}{mg}\right)}{CSF_{o}\left(\frac{mg}{kg\text{-}day}\right)^{-1} \times \left(\left(CAF_{o}\left(0.804\right) \times IFW_{res\text{-}adj}\left(\frac{327.95\ L}{kg}\right)\right)\right) + \left(MAF_{o}\left(0.202\right) \times IFWM_{res\text{-}adj}\left(\frac{1019.9\ L}{kg}\right)\right)}$$

where:

$$IFW_{res\text{-}adj}\left(\frac{327.95\ L}{kg}\right) = \left(\begin{array}{c}\frac{ED_{res\text{-}c}\left(6\ years\right) \times EF_{res\text{-}c}\left(\frac{350\ days}{year}\right) \times IRW_{res\text{-}c}\left(\frac{0.78\ L}{day}\right)}{BW_{res\text{-}c}\left(15\ kg\right)} + \\ \frac{\left(ED_{res}\left(26\ years\right) - ED_{res\text{-}c}\left(6\ years\right)\right) \times EF_{res\text{-}a}\left(\frac{350\ days}{year}\right) \times IRW_{res\text{-}a}\left(\frac{2.5\ L}{day}\right)}{BW_{res\text{-}a}\left(80\ kg\right)}\end{array}\right)$$

where:

$$IFWM_{res\text{-}adj}\left(\frac{1019.9\ L}{kg}\right) = \left(\begin{array}{c}\frac{ED_{0\text{-}2}\left(2\ years\right) \times EF_{0\text{-}2}\left(\frac{350\ days}{year}\right) \times IRW_{0\text{-}2}\left(\frac{0.78\ L}{day}\right) \times 10}{BW_{0\text{-}2}\left(15\ kg\right)} + \\ \frac{ED_{2\text{-}6}\left(4\ years\right) \times EF_{2\text{-}6}\left(\frac{350\ days}{year}\right) \times IRW_{2\text{-}6}\left(\frac{0.78\ L}{day}\right) \times 3}{BW_{2\text{-}6}\left(15\ kg\right)} + \\ \frac{ED_{6\text{-}16}\left(10\ years\right) \times EF_{6\text{-}16}\left(\frac{350\ days}{year}\right) \times IRW_{6\text{-}16}\left(\frac{2.5\ L}{day}\right) \times 3}{BW_{6\text{-}16}\left(80\ kg\right)} + \\ \frac{ED_{16\text{-}26}\left(10\ years\right) \times EF_{16\text{-}26}\left(\frac{350\ days}{year}\right) \times IRW_{16\text{-}26}\left(\frac{2.5\ L}{day}\right) \times 1}{BW_{16\text{-}26}\left(80\ kg\right)}\end{array}\right)$$

- dermal

FOR ORGANICS:

$$\text{IF } ET_{\text{event-res-adj}}\left(\frac{\text{hours}}{\text{event}}\right) \le t^{*}\ (\text{hours}), \text{then } SL_{\text{res-wat-tce-der}}\ (\mu g/L) = \frac{DA_{\text{tce-event}}\left(\frac{\text{ug}}{\text{cm}^2\text{- event}}\right)\times\left(\frac{1000\ \text{cm}^3}{\text{L}}\right)}{2\times FA\times K_p\left(\frac{\text{cm}}{\text{hour}}\right)\sqrt{\frac{6\times\tau_{\text{event}}\left(\frac{\text{hours}}{\text{event}}\right)\times ET_{\text{event-res-adj}}\left(\frac{0.6708\ \text{hours}}{\text{event}}\right)}{\pi}}}$$

or,

$$\text{IF } ET_{\text{event-res-adj}}\left(\frac{\text{hours}}{\text{event}}\right) > t^{*}\ (\text{hours}), \text{then } SL_{\text{res-wat-tce-der}}\ (\mu g/L) = \frac{DA_{\text{tce-event}}\left(\frac{\text{ug}}{\text{cm}^2\text{- event}}\right)\times\left(\frac{1000\ \text{cm}^3}{\text{L}}\right)}{FA\times K_p\left(\frac{\text{cm}}{\text{hour}}\right)\times\left[\frac{ET_{\text{event-res-adj}}\left(\frac{0.6708\ \text{hours}}{\text{event}}\right)}{1+B}+2\times\tau_{\text{event}}\left(\frac{\text{hours}}{\text{event}}\right)\times\left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right]}$$

where:

$$DA_{\text{tce-event}}\left(\frac{\text{ug}}{\text{cm}^2\text{- event}}\right) = \frac{TR\times AT_{\text{res}}\left(\frac{365\ \text{days}}{\text{year}}\times LT\ (70\ \text{years})\right)\times\left(\frac{1000\ \mu g}{\text{mg}}\right)}{\frac{CSF_o\left(\frac{\text{mg}}{\text{kg-day}}\right)^{-1}}{GIABS}\times\left(\begin{array}{l}\left(CAF_o\ (0.804)\ \times DFW_{\text{res-adj}}\left(\frac{2{,}610{,}650\ \text{events - cm}^2}{\text{kg}}\right)\right)+\\ \left(MAF_o\ (0.202)\ \times DFWM_{\text{res-adj}}\left(\frac{8{,}191{,}633\ \text{events - cm}^2}{\text{kg}}\right)\right)\end{array}\right)}$$

where:

$$DFW_{\text{res-adj}}\left(\frac{2{,}610{,}650\ \text{events - cm}^2}{\text{kg}}\right) = \left(\begin{array}{c}\frac{EV_{\text{res-c}}\left(\frac{1\ \text{events}}{\text{day}}\right)\times ED_{\text{res-c}}\ (6\ \text{years})\ \times EF_{\text{res-c}}\left(\frac{350\ \text{days}}{\text{year}}\right)\times SA_{\text{res-c}}\left(6365\ \text{cm}^2\right)}{BW_{\text{res-c}}\ (15\ \text{kg})}+\\ \frac{EV_{\text{res-a}}\left(\frac{1\ \text{events}}{\text{day}}\right)\times ED_{\text{res-a}}\ (20\ \text{years})\ \times EF_{\text{resw-a}}\left(\frac{350\ \text{days}}{\text{year}}\right)\times SA_{\text{res-a}}\left(19652\ \text{cm}^2\right)}{BW_{\text{res-a}}\ (80\ \text{kg})}\end{array}\right)$$

where:

$$DFWM_{\text{res-adj}}\left(\frac{8{,}191{,}633\ \text{events - cm}^2}{\text{kg}}\right) = \left[\begin{array}{l}\left(\frac{EV_{0\text{-}2}\left(\frac{1\ \text{events}}{\text{day}}\right)\times ED_{0\text{-}2}\ (2\ \text{years})\ \times EF_{0\text{-}2}\left(\frac{350\ \text{days}}{\text{year}}\right)\times SA_{0\text{-}2}\left(6365\ \text{cm}^2\right)\times 10}{BW_{0\text{-}2}\ (15\ \text{kg})}\right)+\\ \left(\frac{EV_{2\text{-}6}\left(\frac{1\ \text{events}}{\text{day}}\right)\times ED_{2\text{-}6}\ (4\ \text{years})\ \times EF_{2\text{-}6}\left(\frac{350\ \text{days}}{\text{year}}\right)\times SA_{2\text{-}6}\left(6365\ \text{cm}^2\right)\times 3}{BW_{2\text{-}6}\ (15\ \text{kg})}\right)+\\ \left(\frac{EV_{6\text{-}16}\left(\frac{1\ \text{events}}{\text{day}}\right)\times ED_{6\text{-}16}\ (10\ \text{years})\ \times EF_{6\text{-}16}\left(\frac{350\ \text{days}}{\text{year}}\right)\times SA_{6\text{-}16}\left(19652\ \text{cm}^2\right)\times 3}{BW_{6\text{-}16}\ (80\ \text{kg})}\right)+\\ \left(\frac{EV_{16\text{-}26}\left(\frac{1\ \text{events}}{\text{day}}\right)\times ED_{16\text{-}26}\ (10\ \text{years})\ \times EF_{16\text{-}26}\left(\frac{350\ \text{days}}{\text{year}}\right)\times SA_{16\text{-}26}\left(19652\ \text{cm}^2\right)\times 1}{BW_{16\text{-}26}\ (80\ \text{kg})}\right)\end{array}\right]$$

and:

$$ET_{\text{event-res-adj}}\left(\frac{0.6708\ \text{hours}}{\text{event}}\right) = \frac{\left(\begin{array}{l}ET_{\text{event-res}(0\text{-}2)}\left(\frac{0.54\ \text{hours}}{\text{event}}\right)\times ED_{0\text{-}2}\ (2\ \text{years})+ET_{\text{event-res}(2\text{-}6)}\left(\frac{0.54\ \text{hours}}{\text{event}}\right)\times ED_{2\text{-}6}\ (4\ \text{years})+\\ ET_{\text{event-res}(6\text{-}16)}\left(\frac{0.71\ \text{hours}}{\text{event}}\right)\times ED_{6\text{-}16}\ (10\ \text{years})+ET_{\text{event-res}(16\text{-}26)}\left(\frac{0.71\ \text{hours}}{\text{event}}\right)\times ED_{16\text{-}26}\ (10\ \text{years})\end{array}\right)}{ED_{0\text{-}2}\ (2\ \text{years})\ +ED_{2\text{-}6}\ (4\ \text{years})\ +ED_{6\text{-}16}\ (10\ \text{years})\ +ED_{16\text{-}26}\ (10\ \text{years})}$$

- inhalation of volatiles

$$SL_{res\text{-}wat\text{-}tce\text{-}inh}\left(\mu g/L\right) = \frac{TR \times AT_{res}\left(\frac{365\ \text{days}}{\text{year}} \times LT\left(70\ \text{years}\right)\right)}{\begin{array}{l} IUR\left(\mu g/_{m^3}\right)^{-1} \times K\left(\frac{0.5\ L}{m^3}\right) \times \\ \left(\left(EF_{res}\left(\frac{350\ \text{days}}{\text{year}}\right) \times ED_{res}\left(26\ \text{years}\right) \times ET_{res}\left(\frac{24\ \text{hours}}{\text{day}}\right) \times \left(\frac{1\ \text{day}}{24\ \text{hours}}\right) \times CAF_i\left(0.756\right)\right) + \right. \\ \left(\left(\left(ED_{0\text{-}2}\left(2\ \text{years}\right) \times EF_{0\text{-}2}\left(\frac{350\ \text{days}}{\text{year}}\right) \times ET_{0\text{-}2}\left(\frac{24\ \text{hours}}{\text{day}}\right) \times \left(\frac{1\ \text{day}}{24\ \text{hours}}\right) \times MAF_i\left(0.244\right) \times 10\right) + \right.\right. \\ \left(ED_{2\text{-}6}\left(4\ \text{years}\right) \times EF_{2\text{-}6}\left(\frac{350\ \text{days}}{\text{year}}\right) \times ET_{2\text{-}6}\left(\frac{24\ \text{hours}}{\text{day}}\right) \times \left(\frac{1\ \text{day}}{24\ \text{hours}}\right) \times MAF_i\left(0.244\right) \times 3\right) + \\ \left(ED_{6\text{-}16}\left(10\ \text{years}\right) \times EF_{6\text{-}16}\left(\frac{350\ \text{days}}{\text{year}}\right) \times ET_{6\text{-}16}\left(\frac{24\ \text{hours}}{\text{day}}\right) \times \left(\frac{1\ \text{day}}{24\ \text{hours}}\right) \times MAF_i\left(0.244\right) \times 3\right) + \\ \left.\left.\left.\left(ED_{16\text{-}26}\left(10\ \text{years}\right) \times EF_{16\text{-}26}\left(\frac{350\ \text{days}}{\text{year}}\right) \times ET_{16\text{-}26}\left(\frac{24\ \text{hours}}{\text{day}}\right) \times \left(\frac{1\ \text{day}}{24\ \text{hours}}\right) \times MAF_i\left(0.244\right) \times 1\right)\right)\right)\right) \end{array}}$$

- Total

$$SL_{res\text{-}wat\text{-}tce\text{-}tot}\left(\mu g/L\right) = \frac{1}{\frac{1}{SL_{res\text{-}wat\text{-}tce\text{-}ing}} + \frac{1}{SL_{res\text{-}wat\text{-}tce\text{-}der}} + \frac{1}{SL_{res\text{-}wat\text{-}tce\text{-}inh}}}$$

4.1.2.7 Supporting Equations

- Child

$$ED_{res\text{-}c}\left(6\text{ years}\right) = ED_{0\text{-}2}\left(2\text{ years}\right)+ED_{2\text{-}6}\left(4\text{ years}\right)$$

$$BW_{res\text{-}c}\left(15\text{ kg}\right) = \frac{BW_{0\text{-}2}\left(15\text{ kg}\right)\times ED_{0\text{-}2}\left(2\text{ years}\right)+BW_{2\text{-}6}\left(15\text{ kg}\right)\times ED_{2\text{-}6}\left(4\text{ years}\right)}{ED_{0\text{-}2}\left(2\text{ years}\right)+ED_{2\text{-}6}\left(4\text{ years}\right)}$$

$$EV_{res\text{-}c}\left(\frac{1\text{ event}}{\text{day}}\right) = \frac{EV_{0\text{-}2}\left(\frac{1\text{ event}}{\text{day}}\right)\times ED_{0\text{-}2}\left(2\text{ years}\right)+EV_{2\text{-}6}\left(\frac{1\text{ event}}{\text{day}}\right)\times ED_{2\text{-}6}\left(4\text{ years}\right)}{ED_{0\text{-}2}\left(2\text{ years}\right)+ED_{2\text{-}6}\left(4\text{ years}\right)}$$

$$EF_{res\text{-}c}\left(\frac{350\text{ days}}{\text{year}}\right) = \frac{EF_{0\text{-}2}\left(\frac{350\text{ days}}{\text{year}}\right)\times ED_{0\text{-}2}\left(2\text{ years}\right)+EF_{2\text{-}6}\left(\frac{350\text{ days}}{\text{year}}\right)\times ED_{2\text{-}6}\left(4\text{ years}\right)}{ED_{0\text{-}2}\left(2\text{ years}\right)+ED_{2\text{-}6}\left(4\text{ years}\right)}$$

$$ET_{event\text{-}res\text{-}c}\left(\frac{0.54\text{ hours}}{\text{event}}\right) = \frac{ET_{event\,(0\text{-}2)}\left(\frac{0.54\text{ hours}}{\text{event}}\right)\times ED_{0\text{-}2}\left(2\text{ years}\right)+ET_{event\,(2\text{-}4)}\left(\frac{0.54\text{ hours}}{\text{event}}\right)\times ED_{2\text{-}6}\left(4\text{ years}\right)}{ED_{0\text{-}2}\left(2\text{ years}\right)+ED_{2\text{-}6}\left(4\text{ years}\right)}$$

$$ET_{res\text{-}c}\left(\frac{24\text{ hours}}{\text{day}}\right) = \frac{ET_{0\text{-}2}\left(\frac{24\text{ hours}}{\text{day}}\right)\times ED_{0\text{-}2}\left(2\text{ years}\right)+ET_{2\text{-}6}\left(\frac{24\text{ hours}}{\text{day}}\right)\times ED_{2\text{-}6}\left(4\text{ years}\right)}{ED_{0\text{-}2}\left(2\text{ years}\right)+ED_{2\text{-}6}\left(4\text{ years}\right)}$$

$$SA_{res\text{-}c}\left(6365\text{ cm}^2\right) = \frac{SA_{0\text{-}2}\left(6365\text{ cm}^2\right)\times ED_{0\text{-}2}\left(2\text{ years}\right)+SA_{2\text{-}6}\left(6365\text{ cm}^2\right)\times ED_{2\text{-}6}\left(4\text{ years}\right)}{ED_{0\text{-}2}\left(2\text{ years}\right)+ED_{2\text{-}6}\left(4\text{ years}\right)}$$

$$IRW_{res\text{-}c}\left(\frac{0.78\text{ L}}{\text{day}}\right) = \frac{IRW_{0\text{-}2}\left(\frac{0.78\text{ L}}{\text{day}}\right)\times ED_{0\text{-}2}\left(2\text{ years}\right)+IRW_{2\text{-}6}\left(\frac{0.78\text{ L}}{\text{day}}\right)\times ED_{2\text{-}6}\left(4\text{ years}\right)}{ED_{0\text{-}2}\left(2\text{ years}\right)+ED_{2\text{-}6}\left(4\text{ years}\right)}$$

- Adult

$$ED_{res\text{-}a}\left(20\text{ years}\right)=ED_{6\text{-}16}\left(10\text{ years}\right)+ED_{16\text{-}26}\left(10\text{ years}\right)$$

$$BW_{res\text{-}a}\left(80\text{ kg}\right)=\frac{BW_{6\text{-}16}\left(80\text{ kg}\right)\times ED_{6\text{-}16}\left(10\text{ years}\right)+BW_{16\text{-}26}\left(80\text{ kg}\right)\times ED_{16\text{-}26}\left(10\text{ years}\right)}{ED_{6\text{-}16}\left(10\text{ years}\right)+ED_{16\text{-}26}\left(10\text{ years}\right)}$$

$$EV_{res\text{-}a}\left(\frac{1\text{ event}}{\text{day}}\right)=\frac{EV_{6\text{-}16}\left(\frac{1\text{ event}}{\text{day}}\right)\times ED_{6\text{-}16}\left(10\text{ years}\right)+EV_{16\text{-}26}\left(\frac{1\text{ event}}{\text{day}}\right)\times ED_{16\text{-}26}\left(10\text{ years}\right)}{ED_{6\text{-}16}\left(10\text{ years}\right)+ED_{16\text{-}26}\left(10\text{ years}\right)}$$

$$EF_{res\text{-}a}\left(\frac{350\text{ days}}{\text{year}}\right)=\frac{EF_{6\text{-}16}\left(\frac{350\text{ days}}{\text{year}}\right)\times ED_{6\text{-}16}\left(10\text{ years}\right)+EF_{16\text{-}26}\left(\frac{350\text{ days}}{\text{year}}\right)\times ED_{16\text{-}26}\left(10\text{ years}\right)}{ED_{6\text{-}16}\left(10\text{ years}\right)+ED_{16\text{-}26}\left(10\text{ years}\right)}$$

$$ET_{event\text{-}res\text{-}a}\left(\frac{0.71\text{ hours}}{\text{event}}\right)=\frac{ET_{event\,(6\text{-}16)}\left(\frac{0.71\text{ hours}}{\text{event}}\right)\times ED_{6\text{-}16}\left(10\text{ years}\right)+ET_{event\,(16\text{-}26)}\left(\frac{0.71\text{ hours}}{\text{event}}\right)\times ED_{16\text{-}26}\left(10\text{ years}\right)}{ED_{6\text{-}16}\left(10\text{ years}\right)+ED_{16\text{-}26}\left(10\text{ years}\right)}$$

$$ET_{res\text{-}a}\left(\frac{24\text{ hours}}{\text{day}}\right)=\frac{ET_{6\text{-}16}\left(\frac{24\text{ hours}}{\text{day}}\right)\times ED_{6\text{-}16}\left(10\text{ years}\right)+ET_{16\text{-}26}\left(\frac{24\text{ hours}}{\text{day}}\right)\times ED_{16\text{-}26}\left(10\text{ years}\right)}{ED_{6\text{-}16}\left(10\text{ years}\right)+ED_{16\text{-}26}\left(10\text{ years}\right)}$$

$$SA_{res\text{-}a}\left(19652\text{ cm}^2\right)=\frac{SA_{6\text{-}16}\left(19652\text{ cm}^2\right)\times ED_{6\text{-}16}\left(10\text{ years}\right)+SA_{16\text{-}26}\left(19652\text{ cm}^2\right)\times ED_{16\text{-}26}\left(10\text{ years}\right)}{ED_{6\text{-}16}\left(10\text{ years}\right)+ED_{16\text{-}26}\left(10\text{ years}\right)}$$

$$IRW_{res\text{-}a}\left(\frac{2.5\text{ L}}{\text{day}}\right)=\frac{IRW_{6\text{-}16}\left(\frac{2.5\text{ L}}{\text{day}}\right)\times ED_{6\text{-}16}\left(10\text{ years}\right)+IRW_{16\text{-}26}\left(\frac{2.5\text{ L}}{\text{day}}\right)\times ED_{16\text{-}26}\left(10\text{ years}\right)}{ED_{6\text{-}16}\left(10\text{ years}\right)+ED_{16\text{-}26}\left(10\text{ years}\right)}$$

- Age-adjusted

$$ED_{res}\left(26\text{ years}\right)=ED_{0\text{-}2}\left(2\text{ years}\right)+ED_{2\text{-}6}\left(4\text{ years}\right)+ED_{6\text{-}16}\left(10\text{ years}\right)+ED_{16\text{-}26}\left(10\text{ years}\right)$$

$$EF_{res}\left(\frac{350\text{ days}}{\text{year}}\right)=\frac{\begin{gathered}EF_{0\text{-}2}\left(\frac{350\text{ days}}{\text{year}}\right)\times ED_{0\text{-}2}\left(2\text{ years}\right)+EF_{2\text{-}6}\left(\frac{350\text{ days}}{\text{year}}\right)\times ED_{2\text{-}6}\left(4\text{ years}\right)+\\EF_{6\text{-}16}\left(\frac{350\text{ days}}{\text{year}}\right)\times ED_{6\text{-}16}\left(10\text{ years}\right)+EF_{16\text{-}26}\left(\frac{350\text{ days}}{\text{year}}\right)\times ED_{16\text{-}26}\left(10\text{ years}\right)\end{gathered}}{ED_{0\text{-}2}\left(2\text{ years}\right)+ED_{2\text{-}6}\left(4\text{ years}\right)+ED_{6\text{-}16}\left(10\text{ years}\right)+ED_{16\text{-}26}\left(10\text{ years}\right)}$$

$$ET_{res}\left(\frac{24\text{ hours}}{\text{day}}\right)=\frac{\begin{gathered}ET_{0\text{-}2}\left(\frac{24\text{ hours}}{\text{day}}\right)\times ED_{0\text{-}2}\left(2\text{ years}\right)+ET_{2\text{-}6}\left(\frac{24\text{ hours}}{\text{day}}\right)\times ED_{2\text{-}6}\left(4\text{ years}\right)+\\ET_{6\text{-}16}\left(\frac{24\text{ hours}}{\text{day}}\right)\times ED_{6\text{-}16}\left(10\text{ years}\right)+ET_{16\text{-}26}\left(\frac{24\text{ hours}}{\text{day}}\right)\times ED_{16\text{-}26}\left(10\text{ years}\right)\end{gathered}}{ED_{0\text{-}2}\left(2\text{ years}\right)+ED_{2\text{-}6}\left(4\text{ years}\right)+ED_{6\text{-}16}\left(10\text{ years}\right)+ED_{16\text{-}26}\left(10\text{ years}\right)}$$

4.1.3 Resident Air

This receptor spends most, if not all, of the day at home. The activities for this receptor involve typical home making chores (cooking, cleaning and laundering) as well as outdoor activities. The resident is assumed to be exposed to contaminants via the following pathway: inhalation of ambient air. This land use has no assumptions of how contaminants get into the air and the RSLs derived should be compared to air samples.

This land use is for developing residential default screening levels that are presented in the RSL Generic Tables.

4.1.3.1 Noncarcinogenic

The air land use equation, presented here, contains the following exposure routes:

- inhalation

$$SL_{res\text{-}air\text{-}nc}\left(\mu g/m^3\right) = \frac{THQ \times AT_{res\text{-}a}\left(\frac{365\ \text{days}}{\text{year}} \times ED_{res}\left(26\ \text{years}\right)\right) \times \left(\frac{1000\ \mu g}{mg}\right)}{EF_{res}\left(\frac{350\ \text{days}}{\text{year}}\right) \times ED_{res}\left(26\ \text{years}\right) \times ET_{res}\left(\frac{24\ \text{hours}}{\text{day}}\right) \times \left(\frac{1\ \text{day}}{24\ \text{hours}}\right) \times \frac{1}{RfC\left(\frac{mg}{m^3}\right)}}$$

4.1.3.2 Carcinogenic

The air land use equation, presented here, contains the following exposure routes:

- inhalation

$$SL_{res\text{-}air\text{-}ca}\left(\mu g/m^3\right) = \frac{TR \times AT_{res}\left(\frac{365\ \text{days}}{\text{year}} \times LT\left(70\ \text{years}\right)\right)}{EF_{res}\left(\frac{350\ \text{days}}{\text{year}}\right) \times ED_{res}\left(26\ \text{years}\right) \times ET_{res}\left(\frac{24\ \text{hours}}{\text{day}}\right) \times \left(\frac{1\ \text{day}}{24\ \text{hours}}\right) \times IUR\left(\frac{\mu g}{m^3}\right)^{-1}}$$

4.1.3.3 Mutagenic

The air land use equation, presented here, contains the following exposure routes:

- inhalation

$$SL_{res\text{-}air\text{-}mu}\left(\mu g/m^3\right) = \frac{TR \times AT_{res}\left(\frac{365\ \text{days}}{\text{year}} \times LT\left(70\ \text{years}\right)\right)}{IUR\left(\frac{\mu g}{m^3}\right)^{-1} \times \left(\frac{1\ \text{day}}{24\ \text{hours}}\right) \times \left(\begin{array}{l}\left(ED_{0\text{-}2}\left(2\ \text{years}\right) \times EF_{0\text{-}2}\left(\frac{350\ \text{days}}{\text{year}}\right) \times ET_{0\text{-}2}\left(\frac{24\ \text{hours}}{\text{day}}\right) \times 10\right) + \\ \left(ED_{2\text{-}6}\left(4\ \text{years}\right) \times EF_{2\text{-}6}\left(\frac{350\ \text{days}}{\text{year}}\right) \times ET_{2\text{-}6}\left(\frac{24\ \text{hours}}{\text{day}}\right) \times 3\right) + \\ \left(ED_{6\text{-}16}\left(10\ \text{years}\right) \times EF_{6\text{-}16}\left(\frac{350\ \text{days}}{\text{year}}\right) \times ET_{6\text{-}16}\left(\frac{24\ \text{hours}}{\text{day}}\right) \times 3\right) + \\ \left(ED_{16\text{-}26}\left(10\ \text{years}\right) \times EF_{16\text{-}26}\left(\frac{350\ \text{days}}{\text{year}}\right) \times ET_{16\text{-}26}\left(\frac{24\ \text{hours}}{\text{day}}\right) \times 1\right)\end{array}\right)}$$

4.1.3.4 Vinyl Chloride - Carcinogenic

The air land use equation, presented here, contains the following exposure routes:

- inhalation

$$SL_{res\text{-}air\text{-}ca\text{-}vc}\left(\mu g/m^3\right) = \frac{TR}{IUR\left(\frac{\mu g}{m^3}\right)^{-1} + \left(\frac{IUR\left(\frac{\mu g}{m^3}\right)^{-1} \times EF_{res}\left(\frac{350\ \text{days}}{\text{year}}\right) \times ED_{res}\left(26\ \text{years}\right) \times ET_{res}\left(\frac{24\ \text{hours}}{\text{day}}\right) \times \left(\frac{1\ \text{day}}{24\ \text{hours}}\right)}{AT_{res}\left(\frac{365\ \text{days}}{\text{year}} \times LT\left(70\ \text{years}\right)\right)}\right)}$$

4.1.3.5 Trichloroethylene - Carcinogenic and Mutagenic

The air land use equation, presented here, contains the following exposure routes:

- inhalation

$$SL_{res\text{-}air\text{-}tce}\left(\mu g/m^{3}\right)=\frac{TR\times AT_{res}\left(\frac{365\text{ days}}{\text{year}}\times LT\left(70\text{ years}\right)\right)}{\begin{array}{l}IUR\left(\mu g/m^{3}\right)^{-1}\times\left(\frac{1\text{ day}}{24\text{ hours}}\right)\times\\ \left(\begin{array}{l}\left(ED_{res}\left(26\text{ years}\right)\times EF_{res}\left(\frac{350\text{ days}}{\text{year}}\right)\times ET_{res}\left(\frac{24\text{ hours}}{\text{day}}\right)\times CAF_{i}\left(0.756\right)\right)+\\ \left(\begin{array}{l}\left(ED_{0\text{-}2}\left(2\text{ years}\right)\times EF_{0\text{-}2}\left(\frac{350\text{ days}}{\text{year}}\right)\times ET_{0\text{-}2}\left(\frac{24\text{ hours}}{\text{day}}\right)\times MAF_{i}\left(0.244\right)\times 10\right)+\\ \left(ED_{2\text{-}6}\left(4\text{ years}\right)\times EF_{2\text{-}6}\left(\frac{350\text{ days}}{\text{year}}\right)\times ET_{2\text{-}6}\left(\frac{24\text{ hours}}{\text{day}}\right)\times MAF_{i}\left(0.244\right)\times 3\right)+\\ \left(ED_{6\text{-}16}\left(10\text{ years}\right)\times EF_{6\text{-}16}\left(\frac{350\text{ days}}{\text{year}}\right)\times ET_{6\text{-}16}\left(\frac{24\text{ hours}}{\text{day}}\right)\times MAF_{i}\left(0.244\right)\times 3\right)+\\ \left(ED_{16\text{-}26}\left(10\text{ years}\right)\times EF_{16\text{-}26}\left(\frac{350\text{ days}}{\text{year}}\right)\times ET_{16\text{-}26}\left(\frac{24\text{ hours}}{\text{day}}\right)\times MAF_{i}\left(0.244\right)\times 1\right)\end{array}\right)\end{array}\right)\end{array}}$$

4.2 Composite Worker

4.2.1 Composite Worker Soil

This is a long-term receptor exposed during the work day who is a full-time employee working on-site and spends most of the workday conducting maintenance activities outdoors. The activities for this receptor (e.g., moderate digging, landscaping) typically involve on-site exposure to surface soils. The composite worker is expected to have an elevated soil ingestion rate (100 mg per day) and is assumed to be exposed to contaminants via the following pathways: incidental ingestion of soil, dermal contact with soil, inhalation of volatiles and fugitive dust. The composite worker combines the most protective exposure assumptions of the outdoor and indoor workers. The only difference between the outdoor worker and the composite worker is that the composite worker uses the more protective exposure frequency of 250 days/year from the indoor worker scenario.

This land use is for developing industrial default screening levels that are presented in the RSL Generic Tables.

4.2.1.1 Noncarcinogenic

The composite worker soil land use equation, presented here, contains the following exposure routes:

- incidental ingestion of soil

$$SL_{w\text{-soil-nc-ing}}\left(mg/kg\right)=\frac{THQ\times AT_{w\text{-}a}\left(\frac{365\text{ days}}{\text{year}}\times ED_{w}\left(25\text{ years}\right)\right)\times BW_{w}\left(80\text{ kg}\right)}{EF_{w}\left(250\ \frac{\text{days}}{\text{year}}\right)\times ED_{w}\left(25\text{ years}\right)\times\frac{RBA}{RfD_{o}\left(\frac{mg}{kg\text{-}day}\right)}\times IR_{w}\left(100\ \frac{mg}{day}\right)\times\left(\frac{10^{-6}\text{ kg}}{1\text{ mg}}\right)}$$

- dermal exposure

$$SL_{w\text{-soil-nc-der}}\,(\text{mg/kg}) = \frac{THQ \times AT_{w\text{-a}}\left(\frac{365\text{ days}}{\text{year}}\right) \times ED_w\,(25\text{ years}) \times BW_w\,(80\text{ kg})}{EF_w\left(250\,\frac{\text{days}}{\text{year}}\right) \times ED_w\,(25\text{ years}) \times \left(\frac{1}{RfD_o\left(\frac{\text{mg}}{\text{kg-day}}\right) \times GIABS}\right) \times SA_w\left(\frac{3527\text{ cm}^2}{\text{day}}\right) \times AF_w\left(\frac{0.12\text{ mg}}{\text{cm}^2}\right) \times ABS_d \times \left(\frac{10^{-6}\text{ kg}}{1\text{ mg}}\right)}$$

- inhalation of volatiles and particulates emitted from soil

$$SL_{w\text{-soil-nc-inh}}\,(\text{mg/kg}) = \frac{THQ \times AT_{w\text{-a}}\left(\frac{365\text{ days}}{\text{year}}\right) \times ED_w\,(25\text{ years})}{EF_w\left(250\,\frac{\text{days}}{\text{year}}\right) \times ED_w\,(25\text{ years}) \times ET_w\left(\frac{8\text{ hours}}{\text{day}}\right) \times \left(\frac{1\text{ day}}{24\text{ hours}}\right) \times \frac{1}{RfC\left(\text{mg}/\text{m}^3\right)} \times \left(\frac{1}{VF_{ulim}\left(\frac{\text{m}^3}{\text{kg}}\right)} + \frac{1}{PEF\left(\frac{\text{m}^3}{\text{kg}}\right)}\right)}$$

- Total

$$SL_{w\text{-soil-nc-tot}}\,(\text{mg/kg}) = \frac{1}{\frac{1}{SL_{w\text{-soil-nc-ing}}} + \frac{1}{SL_{w\text{-soil-nc-der}}} + \frac{1}{SL_{w\text{-soil-nc-inh}}}}$$

4.2.1.2 Carcinogenic

The composite worker soil land use equation, presented here, contains the following exposure routes:

- incidental ingestion of soil

$$SL_{w\text{-soil-ca-ing}}\,(\text{mg/kg}) = \frac{TR \times AT_w\left(\frac{365\text{ days}}{\text{year}}\right) \times LT\,(70\text{ years}) \times BW_w\,(80\text{ kg})}{EF_w\left(250\,\frac{\text{days}}{\text{year}}\right) \times ED_w\,(25\text{ years}) \times CSF_o\left(\frac{\text{mg}}{\text{kg-day}}\right)^{-1} \times RBA \times IR_w\left(100\,\frac{\text{mg}}{\text{day}}\right) \times \left(\frac{10^{-6}\text{ kg}}{1\text{ mg}}\right)}$$

- dermal exposure

$$SL_{w\text{-soil-ca-der}}\,(\text{mg/kg}) = \frac{TR \times AT_w\left(\frac{365\text{ days}}{\text{year}}\right) \times LT\,(70\text{ years}) \times BW_w\,(80\text{ kg})}{EF_w\left(250\,\frac{\text{days}}{\text{year}}\right) \times ED_w\,(25\text{ years}) \times \left(\frac{CSF_o\left(\frac{\text{mg}}{\text{kg-day}}\right)^{-1}}{GIABS}\right) \times SA_w\left(\frac{3527\text{ cm}^2}{\text{day}}\right) \times AF_w\left(\frac{0.12\text{ mg}}{\text{cm}^2}\right) \times ABS_d \times \left(\frac{10^{-6}\text{ kg}}{1\text{ mg}}\right)}$$

- inhalation of volatiles and particulates emitted from soil

$$SL_{w\text{-soil-ca-inh}}\,(\text{mg/kg}) = \frac{TR \times AT_w\left(\frac{365\text{ days}}{\text{year}}\right) \times LT\,(70\text{ years})}{EF_w\left(250\,\frac{\text{days}}{\text{year}}\right) \times ED_w\,(25\text{ years}) \times ET_w\left(\frac{8\text{ hours}}{\text{day}}\right) \times \left(\frac{1\text{ day}}{24\text{ hours}}\right) \times IUR\left(\mu\text{g}/\text{m}^3\right)^{-1} \times \left(\frac{1000\,\mu\text{g}}{\text{mg}}\right) \times \left(\frac{1}{VF_{ulim}\left(\frac{\text{m}^3}{\text{kg}}\right)} + \frac{1}{PEF\left(\frac{\text{m}^3}{\text{kg}}\right)}\right)}$$

$$SL_{w\text{-soil-ca-tot}}\,(\text{mg/kg}) = \frac{1}{\frac{1}{SL_{w\text{-soil-ca-ing}}} + \frac{1}{SL_{w\text{-soil-ca-der}}} + \frac{1}{SL_{w\text{-soil-ca-inh}}}}$$

- Total

4.2.2 Composite Worker Air

This is a long-term receptor exposed during the work day who is a full-time employee working on-site and spends most of the workday conducting maintenance activities indoors. The composite worker is assumed to be exposed to contaminants via the following pathway: inhalation of ambient air. The composite worker combines the most protective exposure assumptions of the outdoor and indoor workers. The only difference between the outdoor worker and the composite worker is that the composite worker uses the more protective exposure frequency of 250 days/year from the indoor worker scenario. This land use has no assumptions of how contaminants get into the air and the RSLs derived should be compared to air samples.

This land use is for developing industrial default screening levels that are presented in the RSL Generic Tables.

4.2.2.1 Noncarcinogenic

The air land use equation, presented here, contains the following exposure routes:

- Inhalation

$$SL_{w\text{-}air\text{-}nc}\left(\mu g/m^3\right) = \frac{THQ \times AT_w\left(\frac{365\ days}{year} \times ED_w\left(25\ years\right)\right) \times \left(\frac{1000\ \mu g}{mg}\right)}{EF_w\left(\frac{250\ days}{year}\right) \times ED_w\left(25\ years\right) \times ET_w\left(\frac{8\ hours}{day}\right) \times \left(\frac{1\ day}{24\ hours}\right) \times \frac{1}{RfC\left(\frac{mg}{m^3}\right)}}$$

4.2.2.2 Carcinogenic

The air land use equation, presented here, contains the following exposure routes:

- Inhalation

$$SL_{w\text{-}air\text{-}ca}\left(\mu g/m^3\right) = \frac{TR \times AT_w\left(\frac{365\ days}{year} \times LT\left(70\ years\right)\right)}{EF_w\left(\frac{250\ days}{year}\right) \times ED_w\left(25\ years\right) \times ET_w\left(\frac{8\ hours}{day}\right) \times \left(\frac{1\ day}{24\ hours}\right) \times IUR\left(\frac{\mu g}{m^3}\right)^{-1}}$$

4.3 Outdoor Worker

4.3.1 Outdoor Worker Soil

This is a long-term receptor exposed during the work day who is a full-time employee working on-site and spends most of the workday conducting maintenance activities outdoors. The activities for this receptor (e.g., moderate digging, landscaping) typically involve on-site exposure to surface soils. The outdoor worker is expected to have an elevated soil ingestion rate (100 mg per day) and is assumed to be exposed to contaminants via the following pathways: incidental ingestion of soil, dermal contact with soil, inhalation of volatiles and fugitive dust. The outdoor worker receives more exposure than the indoor worker under commercial/industrial conditions.

The outdoor worker soil land use is not provided in the RSL Generic Tables but RSLs can be created by using the Calculator.

4.3.1.1 Noncarcinogenic

The outdoor worker soil land use equation, presented here, contains the following exposure routes:

- incidental ingestion of soil

$$SL_{ow\text{-}soil\text{-}nc\text{-}ing}\left(mg/kg\right) = \frac{THQ \times AT_{ow\text{-}a}\left(\frac{365\ days}{year} \times ED_{ow}\left(25\ years\right)\right) \times BW_{ow}\left(80\ kg\right)}{EF_{ow}\left(225\ \frac{days}{year}\right) \times ED_{ow}\left(25\ years\right) \times \frac{RBA}{RfD_{o}\left(\frac{mg}{kg\text{-}day}\right)} \times IR_{ow}\left(100\ \frac{mg}{day}\right) \times \left(\frac{10^{-6}\ kg}{1\ mg}\right.}$$

- dermal exposure

$$SL_{ow\text{-}soil\text{-}nc\text{-}der}\left(mg/kg\right) = \frac{THQ \times AT_{ow\text{-}a}\left(\frac{365\ days}{year} \times ED_{ow}\left(25\ years\right)\right) \times BW_{ow}\left(80\ kg\right)}{EF_{ow}\left(225\ \frac{days}{year}\right) \times ED_{ow}\left(25\ years\right) \times \left(\frac{1}{RfD_{o}\left(\frac{mg}{kg\text{-}day}\right) \times GIABS}\right) \times SA_{ow}\left(\frac{3527\ cm^{2}}{day}\right) \times AF_{ow}\left(\frac{0.12\ mg}{cm^{2}}\right) \times ABS_{d} \times \left(\frac{10^{-6}\ kg}{1\ mg}\right.}$$

- inhalation of volatiles and particulates emitted from soil

$$SL_{ow\text{-}soil\text{-}nc\text{-}inh}\left(mg/kg\right) = \frac{THQ \times AT_{ow\text{-}a}\left(\frac{365\ days}{year} \times ED_{ow}\left(25\ years\right)\right)}{EF_{ow}\left(225\ \frac{days}{year}\right) \times ED_{ow}\left(25\ years\right) \times ET_{ow}\left(\frac{8\ hours}{day}\right) \times \left(\frac{1\ day}{24\ hours}\right) \times \frac{1}{RfC\left(\frac{mg}{m^{3}}\right)} \times \left(\frac{1}{VF_{ulim}\left(\frac{m^{3}}{kg}\right)} + \frac{1}{PEF\left(\frac{m^{3}}{kg}\right)}\right)}$$

- Total

$$SL_{ow\text{-}soil\text{-}nc\text{-}tot}\left(mg/kg\right) = \frac{1}{\frac{1}{SL_{ow\text{-}soil\text{-}nc\text{-}ing}} + \frac{1}{SL_{ow\text{-}soil\text{-}nc\text{-}der}} + \frac{1}{SL_{ow\text{-}soil\text{-}nc\text{-}inh}}}$$

4.3.1.2 Carcinogenic

The outdoor worker soil land use equation, presented here, contains the following exposure routes:

- incidental ingestion of soil,

$$SL_{ow\text{-}soil\text{-}ca\text{-}ing}\left(mg/kg\right) = \frac{TR \times AT_{ow}\left(\frac{365\ days}{year} \times LT\left(70\ years\right)\right) \times BW_{ow}\left(80\ kg\right)}{EF_{ow}\left(225\ \frac{days}{year}\right) \times ED_{ow}\left(25\ years\right) \times CSF_{o}\left(\frac{mg}{kg\text{-}day}\right)^{-1} \times RBA \times IR_{ow}\left(100\ \frac{mg}{day}\right) \times \left(\frac{10^{-6}\ kg}{1\ mg}\right)}$$

- dermal exposure,

$$SL_{ow\text{-}soil\text{-}ca\text{-}der}\left(mg/kg\right) = \frac{TR \times AT_{ow}\left(\frac{365\ days}{year} \times LT\left(70\ years\right)\right) \times BW_{ow}\left(80\ kg\right)}{EF_{ow}\left(225\ \frac{days}{year}\right) \times ED_{ow}\left(25\ years\right) \times \left(\frac{CSF_{o}\left(\frac{mg}{kg\text{-}day}\right)^{-1}}{GIABS}\right) \times SA_{ow}\left(\frac{3527\ cm^{2}}{day}\right) \times AF_{ow}\left(\frac{0.12\ mg}{cm^{2}}\right) \times ABS_{d} \times \left(\frac{10^{-6}\ kg}{1\ mg}\right)}$$

- inhalation of volatiles and particulates emitted from soil,

$$SL_{ow\text{-}soil\text{-}ca\text{-}inh}\,(mg/kg) = \frac{TR \times AT_{ow}\left(\frac{365\ days}{year} \times LT\,(70\ years)\right)}{EF_{ow}\left(225\ \frac{days}{year}\right) \times ED_{ow}\,(25\ years) \times ET_{ow}\left(\frac{8\ hours}{day}\right) \times \left(\frac{1\ day}{24\ hours}\right) \times IUR\left(\mu g/_{m^3}\right)^{-1} \times \left(\frac{1000\ \mu g}{mg}\right) \times \left(\frac{1}{VF_{ulim}\left(\frac{m^3}{kg}\right)} + \frac{1}{PEF\left(\frac{m^3}{kg}\right)}\right)}$$

- Total.

$$SL_{ow\text{-}soil\text{-}ca\text{-}tot}\,(mg/kg) = \frac{1}{\frac{1}{SL_{ow\text{-}soil\text{-}ca\text{-}ing}} + \frac{1}{SL_{ow\text{-}soil\text{-}ca\text{-}der}} + \frac{1}{SL_{ow\text{-}soil\text{-}ca\text{-}inh}}}$$

4.3.2 Outdoor Worker Air

This is a long-term receptor exposed during the work day who is a full-time employee working on-site and spends most of the workday conducting maintenance activities outdoors. The outdoor worker is assumed to be exposed to contaminants via the following pathway: inhalation of ambient air. This land use has no assumptions of how contaminants get into the air and the RSLs derived should be compared to air samples.

The outdoor worker air land use is not provided in the RSL Generic Tables but RSLs can be created by using the Calculator.

4.3.2.1 Noncarcinogenic

The air land use equation, presented here, contains the following exposure routes:

- Inhalation

$$SL_{ow\text{-}air\text{-}nc}\left(\mu g/m^3\right) = \frac{THQ \times AT_{ow}\left(\frac{365\ days}{year} \times ED_{ow}\,(25\ years)\right) \times \left(\frac{1000\ \mu g}{mg}\right)}{EF_{ow}\left(\frac{225\ days}{year}\right) \times ED_{ow}\,(25\ years) \times ET_{ow}\left(\frac{8\ hours}{day}\right) \times \left(\frac{1\ day}{24\ hours}\right) \times \frac{1}{RfC\left(mg/_{m^3}\right)}}$$

4.3.2.2 Carcinogenic

The air land use equation, presented here, contains the following exposure routes:

- Inhalation

$$SL_{ow\text{-}air\text{-}ca}\left(\mu g/m^3\right) = \frac{TR \times AT_{ow}\left(\frac{365\ days}{year} \times LT\,(70\ years)\right)}{EF_{ow}\left(\frac{225\ days}{year}\right) \times ED_{ow}\,(25\ years) \times ET_{ow}\left(\frac{8\ hours}{day}\right) \times \left(\frac{1\ day}{24\ hours}\right) \times IUR\left(\mu g/_{m^3}\right)^{-1}}$$

4.4 Indoor Worker

4.4.1 Indoor Worker Soil

This receptor spends most, if not all, of the workday indoors. Thus, an indoor worker has no direct dermal contact with outdoor soils. This worker may, however, be exposed to contaminants through ingestion of contaminated soils that have been incorporated into indoor dust and inhalation of volatiles and particulates from outside soils. RSLs calculated for this receptor are expected to be protective of both workers engaged in low intensity activities such as office work and those engaged in more strenuous activity (e.g., factory or warehouse workers).

The indoor worker soil land use is not provided in the Generic Tables but RSLs can be created by using the Calculator.

4.4.1.1 Noncarcinogenic

The indoor worker soil land use equation, presented here, contains the following exposure routes:

- incidental ingestion of soil

$$SL_{\text{iw-soil-nc-ing}}\left(\text{mg/kg}\right)=\frac{THQ\times AT_{\text{iw-a}}\left(\frac{365\ \text{days}}{\text{year}}\times ED_{\text{iw}}\left(25\ \text{years}\right)\right)\times BW_{\text{iw}}\left(80\ \text{kg}\right)}{EF_{\text{iw}}\left(250\ \frac{\text{days}}{\text{year}}\right)\times ED_{\text{iw}}\left(25\ \text{years}\right)\times\frac{RBA}{RfD_{o}\left(\frac{\text{mg}}{\text{kg-day}}\right)}\times IR_{\text{iw}}\left(50\ \frac{\text{mg}}{\text{day}}\right)\times\left(\frac{10^{-6}\ \text{kg}}{1\ \text{mg}}\right)}$$

- inhalation of volatiles and particulates emitted from soil

$$SL_{\text{iw-soil-nc-inh}}\left(\text{mg/kg}\right)=\frac{THQ\times AT_{\text{iw-a}}\left(\frac{365\ \text{days}}{\text{year}}\times ED_{\text{iw}}\left(25\ \text{years}\right)\right)}{EF_{\text{iw}}\left(250\ \frac{\text{days}}{\text{year}}\right)\times ED_{\text{iw}}\left(25\ \text{years}\right)\times ET_{\text{iw}}\left(\frac{8\ \text{hours}}{\text{day}}\right)\times\left(\frac{1\ \text{day}}{24\ \text{hours}}\right)\times\frac{1}{RfC\left(\text{mg}/\text{m}^{3}\right)}\times\left(\frac{1}{VF_{\text{ulim}}\left(\frac{\text{m}^{3}}{\text{kg}}\right)}+\frac{1}{PEF\left(\frac{\text{m}^{3}}{\text{kg}}\right)}\right)}$$

- Total

$$SL_{\text{iw-soil-nc-tot}}\left(\text{mg/kg}\right)=\frac{1}{\frac{1}{SL_{\text{iw-soil-nc-ing}}}+\frac{1}{SL_{\text{iw-soil-nc-inh}}}}$$

4.4.1.2 Carcinogenic

The indoor worker soil land use equation, presented here, contains the following exposure routes:

- incidental ingestion of soil

$$SL_{\text{iw-soil-ca-ing}}\left(\text{mg/kg}\right)=\frac{TR\times AT_{\text{iw}}\left(\frac{365\ \text{days}}{\text{year}}\times LT\left(70\ \text{years}\right)\right)\times BW_{\text{iw}}\left(80\ \text{kg}\right)}{EF_{\text{iw}}\left(250\ \frac{\text{days}}{\text{year}}\right)\times ED_{\text{iw}}\left(25\ \text{years}\right)\times CSF_{o}\left(\frac{\text{mg}}{\text{kg-day}}\right)^{-1}\times RBA\times IR_{\text{iw}}\left(50\ \frac{\text{mg}}{\text{day}}\right)\times\left(\frac{10^{-6}\ \text{kg}}{1\ \text{mg}}\right)}$$

- inhalation of volatiles and particulates emitted from soil

$$SL_{iw\text{-}soil\text{-}ca\text{-}inh}\left(mg/kg\right)=\frac{TR\times AT_{iw}\left(\frac{365\ days}{year}\times LT\left(70\ years\right)\right)}{EF_{iw}\left(250\ \frac{days}{year}\right)\times ED_{iw}\left(25\ years\right)\times ET_{iw}\ \left(\frac{8\ hours}{day}\right)\times\left(\frac{1\ day}{24\ hours}\right)\times IUR\left(\mu g/_{m^3}\right)^{-1}\times\left(\frac{1000\ \mu g}{mg}\right)\times\left(\frac{1}{VF_{ulim}\left(\frac{m^3}{kg}\right)}+\frac{1}{PEF\left(\frac{m^3}{kg}\right)}\right)}$$

- Total

$$SL_{iw\text{-}soil\text{-}ca\text{-}tot}\left(mg/kg\right)=\frac{1}{\frac{1}{SL_{iw\text{-}soil\text{-}ca\text{-}ing}}+\frac{1}{SL_{iw\text{-}soil\text{-}ca\text{-}inh}}}$$

4.4.2 Indoor Worker Air

This is a long-term receptor exposed during the work day who is a full-time employee working on-site and spends most of the workday conducting maintenance activities indoors. The indoor worker is assumed to be exposed to contaminants via the following pathway: inhalation of ambient air. This land use has no assumptions of how contaminants get into the air and the RSLs derived should be compared to air samples.

The indoor worker air land use is not provided in the Generic Tables but RSLs can be created by using the Calculator.

4.4.2.1 Noncarcinogenic

The air land use equation, presented here, contains the following exposure routes:

- Inhalation

$$SL_{iw\text{-}air\text{-}nc}\left(\mu g/m^3\right)=\frac{THQ\times AT_{iw}\left(\frac{365\ days}{year}\times ED_{iw}\left(25\ years\right)\right)\times\left(\frac{1000\ \mu g}{mg}\right)}{EF_{iw}\left(\frac{250\ days}{year}\right)\times ED_{iw}\left(25\ years\right)\times ET_{iw}\left(\frac{8\ hours}{day}\right)\times\left(\frac{1\ day}{24\ hours}\right)\times\frac{1}{RfC\left(mg/_{m^3}\right)}}$$

4.4.2.2 Carcinogenic

The air land use equation, presented here, contains the following exposure routes:

- Inhalation

$$SL_{iw\text{-}air\text{-}ca}\left(\mu g/m^3\right)=\frac{TR\times AT_{iw}\left(\frac{365\ days}{year}\times LT\left(70\ years\right)\right)}{EF_{iw}\left(\frac{250\ days}{year}\right)\times ED_{iw}\left(25\ years\right)\times ET_{iw}\left(\frac{8\ hours}{day}\right)\times\left(\frac{1\ day}{24\ hours}\right)\times IUR\left(\mu g/_{m^3}\right)^{-1}}$$

4.5 Construction Worker

An assessment for the construction worker scenario is described in more detail in the Supplemental Soil Screening Guidance (SSSG, EPA, 2002). Despite the exposure duration of one year, carcinogenic risk is averaged over an assumed lifetime of 70 years, consistent with the assumption that the risk of developing cancer continues even after exposure has stopped. EPA guidance states that the averaging time for noncancer is to be set at the same length as exposure duration, even if the exposure duration is less than one year. For noncancer, the averaging time can be changed to be less than a year by changing the number of weeks worked (EW). Further, the examples given in the SSSG show that the time of traffic (Tt) is equivalent to EF and time of construction (T_c) is the averaging time (length of project).

The particulate emission factor (PEF) and volatilization factor (VF) equations used are unique to this scenario. See Section 4.9 for further information on subchronic VFs and PEFs. The PEFs calculated in these scenarios may predict much higher air concentrations than the standard wind-driven PEFs; however, the inhalation screening level will likely be dominated by the VF in the case of a volatile contaminant. VFs are commonly 5 orders of magnitude more protective than PEFs. Additionally, the ingestion route typically is the driving factor in most RSL calculations. Two types of mechanical soil disturbance are addressed: standard vehicle traffic (unpaved) and other construction activities (wind, grading, dozing, tilling and excavating). In general, the intake and contact rates are all greater than the outdoor worker. Exhibit 5-1 in the supplemental soil screening guidance presents the exposure parameters

The construction worker soil land use is not provided in the Generic Tables but RSLs can be created by using the Calculator.

4.5.1 Construction Worker Soil Exposure to Standard Vehicle Traffic

This is a short-term receptor exposed during the work day working around vehicles suspending dust in the air. The activities for this receptor (e.g., trenching, excavating) typically involve on-site exposure to surface soils. The construction worker is expected to have an elevated soil ingestion rate (330 mg per day) and is assumed to be exposed to contaminants via the following pathways: incidental ingestion of soil, dermal contact with contaminants in soil, inhalation of volatiles and fugitive dust. The only difference between this construction worker and the one described in section 4.5.2 is that this construction worker uses a different PEF. The construction worker soil land use is not provided in the Generic Tables but RSLs can be created by using the Calculator. The construction land use is described in the supplemental soil screening guidance. This land use is limited to an exposure duration of 1 year and is thus, subchronic. Other unique aspects of this scenario are that the PEF is based on mechanical disturbance of the soil. Two types of mechanical soil disturbance are addressed: standard vehicle traffic and other than standard vehicle traffic (e.g. wind, grading, dozing, tilling and excavating). In general, the intakes and contact rates are all greater than the outdoor worker. Exhibit 5-1 in the supplemental soil screening guidance presents the exposure parameters.

4.5.1.1 Noncarcinogenic

The construction worker soil land use equation, presented here, contains the following exposure routes:

- incidental ingestion of soil

$$SL_{cw\text{-}soil\text{-}nc\text{-}ing}\left(\text{mg/kg}\right) = \frac{THQ \times AT_{cw\text{-}a}\left(EW_{cw}\,\frac{50\ \text{weeks}}{\text{year}} \times \frac{7\ \text{days}}{\text{week}} \times ED_{cw}\left(1\ \text{year}\right)\right) \times BW_{cw}\left(80\ \text{kg}\right)}{EF_{cw}\left(EW_{cw}\,\frac{50\ \text{weeks}}{\text{year}} \times DW_{cw}\,\frac{5\ \text{days}}{\text{week}}\right) \times ED_{cw}\left(1\ \text{year}\right) \times \frac{RBA}{RfD_{o}\left(\frac{\text{mg}}{\text{kg-day}}\right)} \times IR_{cw}\left(330\,\frac{\text{mg}}{\text{day}}\right) \times \left(\frac{10^{-6}\ \text{kg}}{1\ \text{mg}}\right)}$$

- dermal exposure

$$SL_{cw\text{-}soil\text{-}nc\text{-}der}\left(mg/kg\right) = \frac{THQ \times AT_{cw\text{-}a}\left(EW_{cw}\frac{50\ weeks}{year} \times \frac{7\ days}{week} \times ED_{cw}\left(1\ year\right)\right) \times BW_{cw}\left(80\ kg\right)}{EF_{cw}\left(EW_{cw}\frac{50\ weeks}{year} \times DW_{cw}\frac{5\ days}{week}\right) \times ED_{cw}\left(1\ year\right) \times \left(\frac{1}{RfD_{o}\left(\frac{mg}{kg\text{-}day}\right) \times GIABS}\right) \times SA_{cw}\left(\frac{3527\ cm^{2}}{day}\right) \times AF_{cw}\left(\frac{0.3\ mg}{cm^{2}}\right) \times ABS_{d} \times \left(\frac{10^{-6}\ kg}{1\ mg}\right)}$$

- inhalation of volatiles and particulates emitted from soil

$$SL_{cw\text{-}soil\text{-}nc\text{-}inh}\left(mg/kg\right) = \frac{THQ \times AT_{cw\text{-}a}\left(EW_{cw}\frac{50\ weeks}{year} \times \frac{7\ days}{week} \times ED_{cw}\left(1\ year\right)\right)}{EF_{cw}\left(EW_{cw}\frac{50\ weeks}{year} \times DW_{cw}\frac{5\ days}{week}\right) \times ED_{cw}\left(1\ year\right) \times ET_{cw}\left(\frac{8\ hours}{day}\right) \times \left(\frac{1\ day}{24\ hours}\right) \times \frac{1}{RfC\left(mg/m^{3}\right)} \times \left(\frac{1}{VF_{ulim\text{-}sc}\left(\frac{m^{3}}{kg}\right)} + \frac{1}{PEF_{sc}\left(\frac{m^{3}}{kg}\right)}\right)}$$

- Total

$$SL_{cw\text{-}soil\text{-}nc\text{-}tot}\left(mg/kg\right) = \frac{1}{\frac{1}{SL_{cw\text{-}soil\text{-}nc\text{-}ing}} + \frac{1}{SL_{cw\text{-}soil\text{-}nc\text{-}der}} + \frac{1}{SL_{cw\text{-}soil\text{-}nc\text{-}inh}}}$$

4.5.1.2 Carcinogenic

The construction worker soil land use equation, presented here, contains the following exposure routes:

- incidental ingestion of soil,

$$SL_{cw\text{-}soil\text{-}ca\text{-}ing}\left(mg/kg\right) = \frac{TR \times AT_{cw}\left(\frac{365\ days}{year} \times LT\left(70\ years\right)\right) \times BW_{cw}\left(80\ kg\right)}{EF_{cw}\left(EW_{cw}\frac{50\ weeks}{year} \times DW_{cw}\frac{5\ days}{week}\right) \times ED_{cw}\left(1\ year\right) \times CSF_{o}\left(\frac{mg}{kg\text{-}day}\right)^{-1} \times RBA \times IR_{cw}\left(330\frac{mg}{day}\right) \times \left(\frac{10^{-6}\ kg}{1\ mg}\right)}$$

- dermal exposure,

$$SL_{cw\text{-}soil\text{-}ca\text{-}der}\left(mg/kg\right) = \frac{TR \times AT_{cw}\left(\frac{365\ days}{year} \times LT\left(70\ years\right)\right) \times BW_{cw}\left(80\ kg\right)}{EF_{cw}\left(EW_{cw}\frac{50\ weeks}{year} \times DW_{cw}\frac{5\ days}{week}\right) \times ED_{cw}\left(1\ year\right) \times \left(\frac{CSF_{o}\left(\frac{mg}{kg\text{-}day}\right)^{-1}}{GIABS}\right) \times SA_{cw}\left(\frac{3527\ cm^{2}}{day}\right) \times AF_{cw}\left(\frac{0.3\ mg}{cm^{2}}\right) \times ABS_{d} \times \left(\frac{10^{-6}\ kg}{1\ mg}\right)}$$

- inhalation of volatiles and particulates emitted from soil,

$$SL_{cw\text{-}soil\text{-}ca\text{-}inh}\left(mg/kg\right) = \frac{TR \times AT_{cw}\left(\frac{365\ days}{year} \times LT\left(70\ years\right)\right)}{EF_{cw}\left(EW_{cw}\frac{50\ weeks}{year} \times DW_{cw}\frac{5\ days}{week}\right) \times ED_{cw}\left(1\ year\right) \times ET_{cw}\left(\frac{8\ hours}{day}\right) \times \left(\frac{1\ day}{24\ hours}\right) \times IUR\left(\mu g/m^{3}\right)^{-1} \times \left(\frac{1000\ \mu g}{mg}\right) \times \left(\frac{1}{VF_{ulim\text{-}sc}\left(\frac{m^{3}}{kg}\right)} + \frac{1}{PEF_{sc}\left(\frac{m^{3}}{kg}\right)}\right)}$$

- Total.

$$SL_{cw\text{-}soil\text{-}ca\text{-}tot}\left(mg/kg\right) = \frac{1}{\frac{1}{SL_{cw\text{-}soil\text{-}ca\text{-}ing}} + \frac{1}{SL_{cw\text{-}soil\text{-}ca\text{-}der}} + \frac{1}{SL_{cw\text{-}soil\text{-}ca\text{-}inh}}}$$

4.5.2 Construction Worker Soil Exposure to Other Construction Activities

This is a short-term receptor exposed during the work day working around heavy vehicles suspending dust in the air. The activities for this receptor (e.g., dozing, grading, tilling, dumping, and excavating) typically involve on-site exposure to surface soils. The construction worker is expected to have an elevated soil ingestion rate (330 mg per day) and is assumed to be exposed to contaminants via the following pathways: incidental ingestion of soil, dermal contact with contaminants in soil, inhalation of volatiles and fugitive dust. The only difference between this construction worker and the one described in section 4.5.1 is that this construction worker uses a different PEF. The construction worker soil land use is not provided in the Generic Tables but RSLs can be created by using the Calculator. The construction land use is described in the supplemental soil screening guidance. This land use is limited to an exposure duration of 1 year and is thus, subchronic. Other unique aspects of this scenario are that the PEF is based on mechanical disturbance of the soil. Two types of mechanical soil disturbance are addressed: standard vehicle traffic and other than standard vehicle traffic (e.g. wind, grading, dozing, tilling and excavating). In general, the intakes and contact rates are all greater than the outdoor worker. Exhibit 5-1 in the supplemental soil screening guidance presents the exposure parameters.

4.5.2.1 Noncarcinogenic

The construction worker soil land use equation, presented here, contains the following exposure routes:

- incidental ingestion of soil

$$SL_{cw\text{-}soil\text{-}nc\text{-}ing}\left(mg/kg\right) = \frac{THQ \times AT_{cw\text{-}a}\left(EW_{cw}\,\frac{50\text{ weeks}}{\text{year}} \times \frac{7\text{ days}}{\text{week}} \times ED_{cw}\,(1\text{ year})\right) \times BW_{cw}\,(80\text{ kg})}{EF_{cw}\left(EW_{cw}\,\frac{50\text{ weeks}}{\text{year}} \times DW_{cw}\,\frac{5\text{ days}}{\text{week}}\right) \times ED_{cw}\,(1\text{ year}) \times \frac{RBA}{RfD_o\left(\frac{mg}{kg\text{-}day}\right)} \times IR_{cw}\left(330\,\frac{mg}{day}\right) \times \left(\frac{10^{-6}\text{ kg}}{1\text{ mg}}\right)}$$

- dermal exposure

$$SL_{cw\text{-}soil\text{-}nc\text{-}der}\left(mg/kg\right) = \frac{THQ \times AT_{cw\text{-}a}\left(EW_{cw}\,\frac{50\text{ weeks}}{\text{year}} \times \frac{7\text{ days}}{\text{week}} \times ED_{cw}\,(1\text{ year})\right) \times BW_{cw}\,(80\text{ kg})}{EF_{cw}\left(EW_{cw}\,\frac{50\text{ weeks}}{\text{year}} \times DW_{cw}\,\frac{5\text{ days}}{\text{week}}\right) \times ED_{cw}\,(1\text{ year}) \times \left(\frac{1}{RfD_o\left(\frac{mg}{kg\text{-}day}\right) \times GIABS}\right) \times SA_{cw}\left(\frac{3527\text{ cm}^2}{day}\right) \times AF_{cw}\left(\frac{0.3\text{ mg}}{cm^2}\right) \times ABS_d \times \left(\frac{10^{-6}\text{ kg}}{1\text{ mg}}\right)}$$

- inhalation of volatiles and particulates emitted from soil

$$SL_{cw\text{-}soil\text{-}nc\text{-}inh}\left(mg/kg\right) = \frac{THQ \times AT_{cw\text{-}a}\left(EW_{cw}\,\frac{50\text{ weeks}}{\text{year}} \times \frac{7\text{ days}}{\text{week}} \times ED_{cw}\,(1\text{ year})\right)}{EF_{cw}\left(EW_{cw}\,\frac{50\text{ weeks}}{\text{year}} \times DW_{cw}\,\frac{5\text{ days}}{\text{week}}\right) \times ED_{cw}\,(1\text{ year}) \times ET_{cw}\left(\frac{8\text{ hours}}{day}\right) \times \left(\frac{1\text{ day}}{24\text{ hours}}\right) \times \frac{1}{RfC\left({}^{mg}\!/_{m^3}\right)} \times \left(\frac{1}{VF_{ulim\text{-}sc}\left(\frac{m^3}{kg}\right)} + \frac{1}{PEF'_{sc}\left(\frac{m^3}{kg}\right)}\right)}$$

- Total

$$SL_{cw\text{-}soil\text{-}nc\text{-}tot}\left(mg/kg\right) = \frac{1}{\frac{1}{SL_{cw\text{-}soil\text{-}nc\text{-}ing}} + \frac{1}{SL_{cw\text{-}soil\text{-}nc\text{-}der}} + \frac{1}{SL_{cw\text{-}soil\text{-}nc\text{-}inh}}}$$

4.5.2.2 Carcinogenic

The construction worker soil land use equation, presented here, contains the following exposure routes:

- incidental ingestion of soil

$$SL_{cw\text{-}soil\text{-}ca\text{-}ing}\left(mg/kg\right)=\frac{TR\times AT_{cw}\left(\frac{365\ days}{year}\times LT\left(70\ years\right)\right)\times BW_{cw}\left(80\ kg\right)}{EF_{cw}\left(EW_{cw}\frac{50\ weeks}{year}\times DW_{cw}\frac{5\ days}{week}\right)\times ED_{cw}\left(1\ year\right)\times CSF_{o}\left(\frac{mg}{kg\text{-}day}\right)^{-1}\times RBA\times IR_{cw}\left(330\frac{mg}{day}\right)\times\left(\frac{10^{-6}\ kg}{1\ mg}\right)}$$

- dermal exposure

$$SL_{cw\text{-}soil\text{-}ca\text{-}der}\left(mg/kg\right)=\frac{TR\times AT_{cw}\left(\frac{365\ days}{year}\times LT\left(70\ years\right)\right)\times BW_{cw}\left(80\ kg\right)}{EF_{cw}\left(EW_{cw}\frac{50\ weeks}{year}\times DW_{cw}\frac{5\ days}{week}\right)\times ED_{cw}\left(1\ year\right)\times\left(\frac{CSF_{o}\left(\frac{mg}{kg\text{-}day}\right)^{-1}}{GIABS}\right)\times SA_{cw}\left(\frac{3527\ cm^{2}}{day}\right)\times AF_{cw}\left(\frac{0.3\ mg}{cm^{2}}\right)\times ABS_{d}\times\left(\frac{10^{-6}\ kg}{1\ mg}\right)}$$

- inhalation of volatiles and particulates emitted from soil

$$SL_{cw\text{-}soil\text{-}ca\text{-}inh}\left(mg/kg\right)=\frac{TR\times AT_{cw}\left(\frac{365\ days}{year}\times LT\left(70\ years\right)\right)}{EF_{cw}\left(EW_{cw}\frac{50\ weeks}{year}\times DW_{cw}\frac{5\ days}{week}\right)\times ED_{cw}\left(1\ year\right)\times ET_{cw}\left(\frac{8\ hours}{day}\right)\times\left(\frac{1\ day}{24\ hours}\right)\times IUR\left(\mu g/m^{3}\right)^{-1}\times\left(\frac{1000\ \mu g}{mg}\right)\times\left(\frac{1}{VF_{ulim\text{-}sc}\left(\frac{m^{3}}{kg}\right)}+\frac{1}{PEF'_{sc}\left(\frac{m^{3}}{kg}\right)}\right)}$$

- Total

$$SL_{cw\text{-}soil\text{-}ca\text{-}tot}\left(mg/kg\right)=\frac{1}{\frac{1}{SL_{cw\text{-}soil\text{-}ca\text{-}ing}}+\frac{1}{SL_{cw\text{-}soil\text{-}ca\text{-}der}}+\frac{1}{SL_{cw\text{-}soil\text{-}ca\text{-}inh}}}$$

4.6 Recreator

4.6.1 Recreator Soil or Sediment

This receptor spends time outside involved in recreational activities. The recreator is assumed to be exposed to contaminants via the following pathways: incidental ingestion of soil, dermal contact with contaminants in soil, and inhalation of volatiles and fugitive dust. There are no default RSLs for this scenario; only site-specific.

The recreator soil land use is not provided in the Generic Tables but RSLs can be created by using the Calculator.

4.6.1.1 Noncarcinogenic - Child

The recreator soil or sediment land use equation, presented here, contains the following exposure routes:

- incidental ingestion of soil or sediment

$$SL_{rec\text{-}soil\text{-}nc\text{-}ing\text{-}c}\left(mg/kg\right)=\frac{THQ\times AT_{rec\text{-}c}\left(\frac{365\ days}{year}\times ED_{rec\text{-}c}\left(years\right)\right)\times BW_{rec\text{-}c}\left(15\ kg\right)}{EF_{rec\text{-}c}\left(\frac{days}{year}\right)\times ED_{rec\text{-}c}\left(years\right)\times\frac{RBA}{RfD_{o}\left(\frac{mg}{kg\text{-}day}\right)}\times IRS_{rec\text{-}c}\left(\frac{200\ mg}{day}\right)\times\frac{10^{-6}kg}{1mg}}$$

- dermal contact with soil or sediment

$$SL_{rec\text{-}soil\text{-}nc\text{-}der\text{-}c}\left(mg/kg\right) = \frac{THQ \times AT_{rec\text{-}c}\left(\frac{365\ days}{year} \times ED_{rec\text{-}c}\left(years\right)\right) \times BW_{rec\text{-}c}\left(15\ kg\right)}{EF_{rec\text{-}c}\left(\frac{days}{year}\right) \times ED_{rec\text{-}c}\left(years\right) \times \frac{1}{\left(RfD_o\left(\frac{mg}{kg\text{-}day}\right) \times GIABS\right)} \times SA_{rec\text{-}c}\left(\frac{2373\ cm^2}{day}\right) \times AF_{rec\text{-}c}\left(\frac{0.2\ mg}{cm^2}\right) \times ABS_d \times \frac{10^{-6} kg}{1 mg}}$$

- inhalation of volatiles and particulates emitted from soil or sediment

$$SL_{rec\text{-}soil\text{-}nc\text{-}inh\text{-}c}\left(mg/kg\right) = \frac{THQ \times AT_{rec\text{-}c}\left(\frac{365\ days}{year} \times ED_{rec\text{-}c}\left(6\ years\right)\right)}{EF_{rec\text{-}c}\left(\frac{days}{year}\right) \times ED_{rec\text{-}c}\left(6\ years\right) \times ET_{rec\text{-}c}\left(\frac{hours}{day}\right) \times \left(\frac{1\ day}{24\ hours}\right) \times \frac{1}{RfC\left(\frac{mg}{m^3}\right)} \times \left(\frac{1}{VF_{ulim}\left(\frac{m^3}{kg}\right)} + \frac{1}{PEF\left(\frac{m^3}{kg}\right)}\right)}$$

- Total

$$SL_{rec\text{-}soil\text{-}nc\text{-}tot\text{-}c}\left(mg/kg\right) = \frac{1}{\frac{1}{SL_{rec\text{-}soil\text{-}nc\text{-}ing}} + \frac{1}{SL_{rec\text{-}soil\text{-}nc\text{-}der}} + \frac{1}{SL_{rec\text{-}soil\text{-}nc\text{-}inh}}}$$

4.6.1.2 Noncarcinogenic - Adult

The recreator soil or sediment land use equation, presented here, contains the following exposure routes:

- incidental ingestion of soil or sediment

$$SL_{rec\text{-}soil\text{-}nc\text{-}ing\text{-}a}\left(mg/kg\right) = \frac{THQ \times AT_{rec\text{-}a}\left(\frac{365\ days}{year} \times ED_{rec\text{-}a}\left(years\right)\right) \times BW_{rec\text{-}a}\left(80\ kg\right)}{EF_{rec\text{-}a}\left(\frac{days}{year}\right) \times ED_{rec\text{-}a}\left(years\right) \times \frac{RBA}{RfD_o\left(\frac{mg}{kg\text{-}day}\right)} \times IRS_{rec\text{-}a}\left(\frac{100\ mg}{day}\right) \times \frac{10^{-6} kg}{1 mg}}$$

- dermal contact with soil or sediment

$$SL_{rec\text{-}soil\text{-}nc\text{-}der\text{-}a}\left(mg/kg\right) = \frac{THQ \times AT_{rec\text{-}a}\left(\frac{365\ days}{year} \times ED_{rec\text{-}a}\left(years\right)\right) \times BW_{rec\text{-}a}\left(80\ kg\right)}{EF_{rec\text{-}a}\left(\frac{days}{year}\right) \times ED_{rec\text{-}a}\left(years\right) \times \frac{1}{\left(RfD_o\left(\frac{mg}{kg\text{-}day}\right) \times GIABS\right)} \times SA_{rec\text{-}a}\left(\frac{6032\ cm^2}{day}\right) \times AF_{rec\text{-}a}\left(\frac{0.07\ mg}{cm^2}\right) \times ABS_d \times \frac{10^{-6} kg}{1 mg}}$$

- inhalation of volatiles and particulates emitted from soil or sediment

$$SL_{rec\text{-}soil\text{-}nc\text{-}inh\text{-}a}\left(mg/kg\right) = \frac{THQ \times AT_{rec\text{-}a}\left(\frac{365\ days}{year} \times ED_{rec\text{-}a}\left(20\ years\right)\right)}{EF_{rec\text{-}a}\left(\frac{days}{year}\right) \times ED_{rec\text{-}a}\left(20\ years\right) \times ET_{rec\text{-}a}\left(\frac{hours}{day}\right) \times \left(\frac{1\ day}{24\ hours}\right) \times \frac{1}{RfC\left(\frac{mg}{m^3}\right)} \times \left(\frac{1}{VF_{ulim}\left(\frac{m^3}{kg}\right)} + \frac{1}{PEF\left(\frac{m^3}{kg}\right)}\right)}$$

- Total

$$SL_{rec\text{-}soil\text{-}nc\text{-}tot\text{-}a}\left(mg/kg\right) = \frac{1}{\frac{1}{SL_{rec\text{-}soil\text{-}nc\text{-}ing\text{-}a}} + \frac{1}{SL_{rec\text{-}soil\text{-}nc\text{-}der\text{-}a}} + \frac{1}{SL_{rec\text{-}soil\text{-}nc\text{-}inh\text{-}a}}}$$

4.6.1.3 Carcinogenic

The recreator soil or sediment land use equation, presented here, contains the following exposure routes:

- incidental ingestion of soil or sediment

$$SL_{\text{rec-soil-ca-ing}}\left(\text{mg/kg}\right) = \frac{TR \times AT_{\text{rec}}\left(\frac{365\ \text{days}}{\text{year}} \times LT\left(70\ \text{years}\right)\right)}{CSF_{o}\left(\frac{\text{mg}}{\text{kg-day}}\right)^{-1} \times RBA \times IFS_{\text{rec-adj}}\left(\frac{\text{mg}}{\text{kg}}\right) \times \left(\frac{10^{-6}\text{kg}}{\text{mg}}\right)}$$

where:

$$IFS_{\text{rec-adj}}\left(\frac{\text{mg}}{\text{kg}}\right) = \left(\frac{ED_{\text{rec-c}}\left(\text{years}\right) \times EF_{\text{rec-c}}\left(\frac{\text{days}}{\text{year}}\right) \times IRS_{\text{rec-c}}\left(\frac{200\ \text{mg}}{\text{day}}\right)}{BW_{\text{rec-c}}\left(15\ \text{kg}\right)} + \frac{ED_{\text{rec-a}}\left(\text{years}\right) \times EF_{\text{rec-a}}\left(\frac{\text{days}}{\text{year}}\right) \times IRS_{\text{rec-a}}\left(\frac{100\ \text{mg}}{\text{day}}\right)}{BW_{\text{rec-a}}\left(80\ \text{kg}\right)}\right)$$

- dermal contact with soil or sediment

$$SL_{\text{rec-soil-ca-der}}\left(\text{mg/kg}\right) = \frac{TR \times AT_{\text{rec}}\left(\frac{365\ \text{days}}{\text{year}} \times LT\left(70\ \text{years}\right)\right)}{\left(\frac{CSF_{o}\left(\frac{\text{mg}}{\text{kg-day}}\right)^{-1}}{GIABS}\right) \times DFS_{\text{rec-adj}}\left(\frac{\text{mg}}{\text{Kg}}\right) \times ABS_{d} \times \left(\frac{10^{-6}\text{kg}}{\text{mg}}\right)}$$

where:

$$DFS_{\text{rec-adj}}\left(\frac{\text{mg}}{\text{kg}}\right) = \left(\frac{ED_{\text{rec-c}}\left(\text{years}\right) \times EF_{\text{rec-c}}\left(\frac{\text{days}}{\text{year}}\right) \times SA_{\text{rec-c}}\left(\frac{2373\ \text{cm}^{2}}{\text{day}}\right) \times AF_{\text{rec-c}}\left(\frac{0.2\text{mg}}{\text{cm}^{2}}\right)}{BW_{\text{rec-c}}\left(15\ \text{kg}\right)} + \frac{ED_{\text{rec-a}}\left(\text{years}\right) \times EF_{\text{rec-a}}\left(\frac{\text{days}}{\text{year}}\right) \times SA_{\text{rec-a}}\left(\frac{6032\ \text{cm}^{2}}{\text{day}}\right) \times AF_{\text{rec-a}}\left(\frac{0.07\ \text{mg}}{\text{cm}^{2}}\right)}{BW_{\text{rec-a}}\left(80\ \text{kg}\right)}\right)$$

- inhalation of volatiles and particulates emitted from soil or sediment

$$SL_{\text{rec-soil-ca-inh}}\left(\text{mg/kg}\right) = \frac{TR \times AT_{\text{rec}}\left(\frac{365\ \text{days}}{\text{year}} \times LT\left(70\ \text{years}\right)\right)}{IUR\left(\mu\text{g}/\text{m}^{3}\right)^{-1} \times \left(\frac{1000\ \mu\text{g}}{\text{mg}}\right) \times EF_{\text{rec}}\left(\frac{\text{days}}{\text{year}}\right) \times \left(\frac{1}{VF_{\text{ulim}}\left(\frac{\text{m}^{3}}{\text{kg}}\right)} + \frac{1}{PEF\left(\frac{\text{m}^{3}}{\text{kg}}\right)}\right) \times ED_{\text{rec}}\left(26\ \text{years}\right) \times ET_{\text{rec}}\left(\frac{\text{hours}}{\text{day}}\right) \times \left(\frac{1\ \text{day}}{24\ \text{hours}}\right)}$$

- Total

$$SL_{\text{rec-soil-ca-tot}}\left(\text{mg/kg}\right) = \frac{1}{\frac{1}{SL_{\text{rec-soil-ca-ing}}} + \frac{1}{SL_{\text{rec-soil-ca-der}}} + \frac{1}{SL_{\text{rec-soil-ca-inh}}}}$$

4.6.1.4 Mutagenic

The recreator soil or sediment land use equation, presented here, contains the following exposure routes:

- incidental ingestion of soil or sediment,

$$\mathrm{SL}_{\text{rec-soil-mu-ing}}\left(\mathrm{mg/kg}\right) = \frac{\mathrm{TR} \times \mathrm{AT}_{\text{rec}}\left(\frac{365\ \text{days}}{\text{year}} \times \mathrm{LT}\ (70\ \text{years})\right)}{\mathrm{CSF}_{o}\left(\frac{\text{mg}}{\text{kg-day}}\right)^{-1} \times \mathrm{RBA} \times \mathrm{IFSM}_{\text{rec-adj}}\left(\frac{\text{mg}}{\text{kg}}\right) \times \left(\frac{10^{-6}\text{kg}}{\text{mg}}\right)}$$

where:

$$\mathrm{IFSM}_{\text{rec-adj}}\left(\frac{\text{mg}}{\text{kg}}\right) = \left(\begin{array}{l} \dfrac{\mathrm{ED}_{0\text{-}2}\ (\text{years}) \times \mathrm{EF}_{0\text{-}2}\left(\frac{\text{days}}{\text{year}}\right) \times \mathrm{IRS}_{0\text{-}2}\left(\frac{200\ \text{mg}}{\text{day}}\right) \times 10}{\mathrm{BW}_{0\text{-}2}\ (15\ \text{kg})} + \\ \dfrac{\mathrm{ED}_{2\text{-}6}\ (\text{years}) \times \mathrm{EF}_{2\text{-}6}\left(\frac{\text{days}}{\text{year}}\right) \times \mathrm{IRS}_{2\text{-}6}\left(\frac{200\ \text{mg}}{\text{day}}\right) \times 3}{\mathrm{BW}_{2\text{-}6}\ (15\ \text{kg})} + \\ \dfrac{\mathrm{ED}_{6\text{-}16}\ (\text{years}) \times \mathrm{EF}_{6\text{-}16}\left(\frac{\text{days}}{\text{year}}\right) \times \mathrm{IRS}_{6\text{-}16}\left(\frac{100\ \text{mg}}{\text{day}}\right) \times 3}{\mathrm{BW}_{6\text{-}16}\ (80\ \text{kg})} + \\ \dfrac{\mathrm{ED}_{16\text{-}26}\ (\text{years}) \times \mathrm{EF}_{16\text{-}26}\left(\frac{\text{days}}{\text{year}}\right) \times \mathrm{IRS}_{16\text{-}26}\left(\frac{100\ \text{mg}}{\text{day}}\right) \times 1}{\mathrm{BW}_{16\text{-}26}\ (80\ \text{kg})} \end{array}\right)$$

- dermal contact with soil or sediment

$$SL_{rec\text{-}soil\text{-}mu\text{-}der}\left(\text{mg/kg}\right)=\frac{TR\times AT_{rec}\left(\frac{365\text{ days}}{\text{year}}\times LT\left(70\text{ years}\right)\right)}{\left(\frac{CSF_o\left(\frac{\text{mg}}{\text{kg-day}}\right)^{-1}}{GIABS}\right)\times DFSM_{rec\text{-}adj}\left(\frac{\text{mg}}{\text{kg}}\right)\times ABS_d\times\left(\frac{10^{-6}\text{kg}}{\text{mg}}\right)}$$

where:

$$DFSM_{rec\text{-}adj}\left(\frac{\text{mg}}{\text{kg}}\right)=\left(\begin{array}{c}\frac{ED_{0\text{-}2}\left(\text{years}\right)\times EF_{0\text{-}2}\left(\frac{\text{days}}{\text{year}}\right)\times AF_{0\text{-}2}\left(\frac{0.2\text{ mg}}{\text{cm}^2}\right)\times SA_{0\text{-}2}\left(\frac{2373\text{ cm}^2}{\text{day}}\right)\times 10}{BW_{0\text{-}2}\left(15\text{ kg}\right)}+\\ \frac{ED_{2\text{-}6}\left(\text{years}\right)\times EF_{2\text{-}6}\left(\frac{\text{days}}{\text{year}}\right)\times AF_{2\text{-}6}\left(\frac{0.2\text{ mg}}{\text{cm}^2}\right)\times SA_{2\text{-}6}\left(\frac{2373\text{ cm}^2}{\text{day}}\right)\times 3}{BW_{2\text{-}6}\left(15\text{ kg}\right)}+\\ \frac{ED_{6\text{-}16}\left(\text{years}\right)\times EF_{6\text{-}16}\left(\frac{\text{days}}{\text{year}}\right)\times AF_{6\text{-}16}\left(\frac{0.07\text{ mg}}{\text{cm}^2}\right)\times SA_{6\text{-}16}\left(\frac{6032\text{ cm}^2}{\text{day}}\right)\times 3}{BW_{6\text{-}16}\left(80\text{ kg}\right)}+\\ \frac{ED_{16\text{-}26}\left(\text{years}\right)\times EF_{16\text{-}26}\left(\frac{\text{days}}{\text{year}}\right)\times AF_{16\text{-}26}\left(\frac{0.07\text{ mg}}{\text{cm}^2}\right)\times SA_{16\text{-}26}\left(\frac{6032\text{ cm}^2}{\text{day}}\right)\times 1}{BW_{16\text{-}26}\left(80\text{ kg}\right)}\end{array}\right)$$

- inhalation of volatiles and particulates emitted from soil or sediment

$$SL_{rec\text{-}soil\text{-}mu\text{-}inh}\left(\text{mg/kg}\right)=\frac{TR\times AT_{rec}\left(\frac{365\text{ days}}{\text{year}}\times LT\left(70\text{ years}\right)\right)}{\begin{array}{c}IUR\left(\mu\text{g}/\text{m}^3\right)^{-1}\times\left(\frac{1}{VF_{ulim}\left(\frac{\text{m}^3}{\text{kg}}\right)}+\frac{1}{PEF\left(\frac{\text{m}^3}{\text{kg}}\right)}\right)\times\left(\frac{1000\ \mu\text{g}}{\text{mg}}\right)\times\\ \left(\begin{array}{l}\left(ED_{0\text{-}2}\left(2\text{ years}\right)\times EF_{0\text{-}2}\left(\frac{\text{days}}{\text{year}}\right)\times ET_{0\text{-}2}\left(\frac{\text{hours}}{\text{day}}\right)\times\left(\frac{1\text{ day}}{24\text{ hours}}\right)\times 10\right)+\\ \left(ED_{2\text{-}6}\left(4\text{ years}\right)\times EF_{2\text{-}6}\left(\frac{\text{days}}{\text{year}}\right)\times ET_{2\text{-}6}\left(\frac{\text{hours}}{\text{day}}\right)\times\left(\frac{1\text{ day}}{24\text{ hours}}\right)\times 3\right)+\\ \left(ED_{6\text{-}16}\left(10\text{ years}\right)\times EF_{6\text{-}16}\left(\frac{\text{days}}{\text{year}}\right)\times ET_{6\text{-}16}\left(\frac{\text{hours}}{\text{day}}\right)\times\left(\frac{1\text{ day}}{24\text{ hours}}\right)\times 3\right)+\\ \left(ED_{16\text{-}26}\left(10\text{ years}\right)\times EF_{16\text{-}26}\left(\frac{\text{days}}{\text{year}}\right)\times ET_{16\text{-}26}\left(\frac{\text{hours}}{\text{day}}\right)\times\left(\frac{1\text{ day}}{24\text{ hours}}\right)\times 1\right)\end{array}\right)\end{array}}$$

- Total

$$SL_{rec\text{-}soil\text{-}mu\text{-}tot}\left(mg/kg\right) = \frac{1}{\frac{1}{SL_{rec\text{-}soil\text{-}mu\text{-}ing}}+\frac{1}{SL_{rec\text{-}soil\text{-}mu\text{-}der}}+\frac{1}{SL_{rec\text{-}soil\text{-}mu\text{-}inh}}}$$

4.6.1.5 Vinyl Chloride - Carcinogenic

The recreator soil or sediment land use equations, presented here, contain the following exposure routes:

- incidental ingestion of soil or sediment

$$SL_{rec\text{-}soil\text{-}ca\text{-}vc\text{-}ing}\left(mg/kg\right) = \frac{TR}{\left(\frac{CSF_o\left(\frac{mg}{kg\text{-}day}\right)^{-1}\times RBA\times IFS_{rec\text{-}adj}\left(\frac{mg}{kg}\right)\times\frac{10^{-6}kg}{1\ mg}}{AT_{rec}\left(\frac{365\ days}{year}\times LT\ \left(70\ years\right)\right)}\right)+\left(\frac{CSF_o\left(\frac{mg}{kg\text{-}day}\right)^{-1}\times RBA\times IRS_{rec\text{-}c}\left(\frac{200\ mg}{day}\right)\times\frac{10^{-6}kg}{1\ mg}}{BW_{rec\text{-}c}\left(15\ kg\right)}\right)}$$

- dermal contact with soil or sediment

$$SL_{rec\text{-}soil\text{-}ca\text{-}vc\text{-}der}\left(mg/kg\right) = \frac{TR}{\left(\frac{\frac{CSF_o\left(\frac{mg}{kg\text{-}day}\right)^{-1}}{GIABS}\times DFS_{rec\text{-}adj}\left(\frac{mg}{kg}\right)\times ABS_d\times\frac{10^{-6}kg}{1\ mg}}{AT_{rec}\left(\frac{365\ days}{year}\times LT\left(70\ years\right)\right)}\right)+\left(\frac{\frac{CSF_o\left(\frac{mg}{kg\text{-}day}\right)^{-1}}{GIABS}\times SA_{rec\text{-}c}\left(\frac{2373\ cm^2}{day}\right)\times AF_{rec\text{-}c}\left(\frac{0.2\ mg}{cm^2}\right)\times ABS\times\frac{10^{-6}kg}{1\ mg}}{BW_{rec\text{-}c}\left(15\ kg\right)}\right)}$$

- inhalation of volatiles and particulates emitted from soil or sediment

$$SL_{rec\text{-}soil\text{-}ca\text{-}vc\text{-}inh}\left(mg/kg\right) = \frac{TR}{\left(\frac{IUR\left(\mu g/_{m^3}\right)^{-1} \times EF_{rec}\left(\frac{days}{year}\right) \times ED_{rec}\left(26\ years\right) \times ET_{rec}\left(\frac{hours}{day}\right) \times \left(\frac{1\ day}{24\ hours}\right) \times \left(\frac{1000\ \mu g}{mg}\right)}{AT_{rec}\left(\frac{365\ days}{year} \times LT\left(70\ years\right)\right) \times VF_{ulim}\left(\frac{m^3}{kg}\right)}\right) + \left(\frac{IUR\left(\mu g/_{m^3}\right)^{-1}}{VF_{ulim}\left(\frac{m^3}{kg}\right)} \times \left(\frac{1000\ \mu g}{mg}\right)\right)}$$

- Total

$$SL_{rec\text{-}soil\text{-}ca\text{-}vc\text{-}tot}\left(mg/kg\right) = \frac{1}{\frac{1}{SL_{rec\text{-}soil\text{-}ca\text{-}vc\text{-}ing}} + \frac{1}{SL_{rec\text{-}soil\text{-}ca\text{-}vc\text{-}der}} + \frac{1}{SL_{rec\text{-}soil\text{-}ca\text{-}vc\text{-}inh}}}$$

4.6.1.6 Trichloroethylene - Carcinogenic and Mutagenic

The recreator soil or sediment land use equations, presented here, contain the following exposure routes:

- incidental ingestion of soil or sediment

$$SL_{rec\text{-}soil\text{-}tce\text{-}ing}\left(mg/kg\right) = \frac{TR \times AT_{rec}\left(\frac{365\ days}{year} \times LT\left(70\ years\right)\right)}{CSF_{o}\left(\frac{mg}{kg\text{-}day}\right)^{-1} \times RBA \times \left(\frac{10^{-6}\ kg}{mg}\right) \times \left(\begin{array}{l}\left(CAF_{o}\left(0.804\right) \times IFS_{rec\text{-}adj}\left(\frac{mg}{kg}\right)\right) + \\ \left(MAF_{o}\left(0.202\right) \times IFSM_{rec\text{-}adj}\left(\frac{mg}{kg}\right)\right)\end{array}\right)}$$

where:

$$IFS_{rec\text{-}adj}\left(\frac{mg}{kg}\right) = \left(\begin{array}{l}\frac{ED_{rec\text{-}c}\left(years\right) \times EF_{rec\text{-}c}\left(\frac{days}{year}\right) \times IRS_{rec\text{-}c}\left(\frac{200\ mg}{day}\right)}{BW_{rec\text{-}c}\left(15\ kg\right)} + \\ \frac{\left(ED_{rec}\left(years\right) - ED_{rec\text{-}c}\left(years\right)\right) \times EF_{rec\text{-}a}\left(\frac{days}{year}\right) \times IRS_{rec\text{-}a}\left(\frac{100\ mg}{day}\right)}{BW_{rec\text{-}a}\left(80\ kg\right)}\end{array}\right)$$

where:

$$IFSM_{rec\text{-}adj\text{-}}\left(\frac{mg}{kg}\right) = \left(\begin{array}{l}\frac{ED_{0\text{-}2}\left(years\right) \times EF_{0\text{-}2}\left(\frac{days}{year}\right) \times IRS_{0\text{-}2}\left(\frac{200\ mg}{day}\right) \times 10}{BW_{0\text{-}2}\left(15\ kg\right)} + \\ \frac{ED_{2\text{-}6}\left(years\right) \times EF_{2\text{-}6}\left(\frac{days}{year}\right) \times IRS_{2\text{-}6}\left(\frac{200\ mg}{day}\right) \times 3}{BW_{2\text{-}6}\left(15\ kg\right)} + \\ \frac{ED_{6\text{-}16}\left(years\right) \times EF_{6\text{-}16}\left(\frac{days}{year}\right) \times IRS_{6\text{-}16}\left(\frac{100\ mg}{day}\right) \times 3}{BW_{6\text{-}16}\left(80\ kg\right)} + \\ \frac{ED_{16\text{-}26}\left(years\right) \times EF_{16\text{-}26}\left(\frac{days}{year}\right) \times IRS_{16\text{-}26}\left(\frac{100\ mg}{day}\right) \times 1}{BW_{16\text{-}26}\left(80\ kg\right)}\end{array}\right)$$

- dermal contact with soil or sediment

$$SL_{rec\text{-}soil\text{-}tce\text{-}der}\,(mg/kg) = \frac{TR\times AT_{rec}\left(\frac{365\ days}{year}\times LT\,(70\ years)\right)}{\left(\frac{CSF_o\left(\frac{mg}{kg\text{-}day}\right)^{-1}}{GIABS}\right)\times\left(\frac{10^{-6}kg}{mg}\right)\times\left(\left(CAF_o\,(0.804)\times DFS_{rec\text{-}adj}\left(\frac{mg}{kg}\right)\times ABS_d\right)+\left(MAF_o\,(0.202)\times DFSM_{rec\text{-}adj}\left(\frac{mg}{kg}\right)\times ABS_d\right)\right)}$$

where:

$$DFS_{rec\text{-}adj}\left(\frac{mg}{kg}\right) = \left(\begin{array}{c}\frac{ED_{rec\text{-}c}\,(years)\times EF_{rec\text{-}c}\left(\frac{days}{year}\right)\times SA_{rec\text{-}c}\left(\frac{2373\ cm^2}{day}\right)\times AF_{rec\text{-}c}\left(\frac{0.2\ mg}{cm^2}\right)}{BW_{rec\text{-}c}\,(15\ kg)}+\\ \frac{\left(ED_{rec}\,(years) - ED_{rec\text{-}c}\,(years)\right)\times EF_{rec\text{-}a}\left(\frac{days}{year}\right)\times SA_{rec\text{-}a}\left(\frac{6032\ cm^2}{day}\right)\times AF_{rec\text{-}a}\left(\frac{0.07\ mg}{cm^2}\right)}{BW_{rec\text{-}a}\,(80\ kg)}\end{array}\right)$$

where:

$$DFSM_{rec\text{-}adj}\left(\frac{mg}{kg}\right) = \left(\begin{array}{c}\frac{ED_{0\text{-}2}\,(years)\times EF_{0\text{-}2}\left(\frac{days}{year}\right)\times AF_{0\text{-}2}\left(\frac{0.2\ mg}{cm^2}\right)\times SA_{0\text{-}2}\left(\frac{2373\ cm^2}{day}\right)\times 10}{BW_{0\text{-}2}\,(15\ kg)}+\\ \frac{ED_{2\text{-}6}\,(years)\times EF_{2\text{-}6}\left(\frac{days}{year}\right)\times AF_{2\text{-}6}\left(\frac{0.2\ mg}{cm^2}\right)\times SA_{2\text{-}6}\left(\frac{2373\ cm^2}{day}\right)\times 3}{BW_{2\text{-}6}\,(15\ kg)}+\\ \frac{ED_{6\text{-}16}\,(years)\times EF_{6\text{-}16}\left(\frac{days}{year}\right)\times AF_{6\text{-}16}\left(\frac{0.07\ mg}{cm^2}\right)\times SA_{6\text{-}16}\left(\frac{6032\ cm^2}{day}\right)\times 3}{BW_{6\text{-}16}\,(80\ kg)}+\\ \frac{ED_{16\text{-}26}\,(years)\times EF_{16\text{-}26}\left(\frac{days}{year}\right)\times AF_{16\text{-}26}\left(\frac{0.07\ mg}{cm^2}\right)\times SA_{16\text{-}26}\left(\frac{6032\ cm^2}{day}\right)\times 1}{BW_{16\text{-}26}\,(80\ kg)}\end{array}\right)$$

- inhalation of volatiles and particulates emitted from soil or sediment

$$SL_{rec\text{-}soil\text{-}tce\text{-}inh}\,(mg/kg) = \frac{TR\times AT_{rec}\left(\frac{365\ days}{year}\times LT\,(70\ years)\right)}{\begin{array}{c}IUR\left(\mu g/m^3\right)^{-1}\times\left(\frac{1}{VF_{ulim}\left(\frac{m^3}{kg}\right)}+\frac{1}{PEF\left(\frac{m^3}{kg}\right)}\right)\times\left(\frac{1000\ \mu g}{mg}\right)\times\left(\frac{1\ day}{24\ hours}\right)\times\\ \left(\left(\begin{array}{c}CAF_i\,(0.756)\times EF_{rec}\left(\frac{days}{year}\right)\times\\ ED_{rec}\,(26\ years)\times ET_{rec}\left(\frac{hours}{day}\right)\end{array}\right)+\left(\begin{array}{c}\left(ED_{0\text{-}2}\,(2\ years)\times EF_{0\text{-}2}\left(\frac{days}{year}\right)\times ET_{0\text{-}2}\left(\frac{hours}{day}\right)\times MAF_i\,(0.244)\times 10\right)+\\ \left(ED_{2\text{-}6}\,(4\ years)\times EF_{2\text{-}6}\left(\frac{days}{year}\right)\times ET_{2\text{-}6}\left(\frac{hours}{day}\right)\times MAF_i\,(0.244)\times 3\right)+\\ \left(ED_{6\text{-}16}\,(10\ years)\times EF_{6\text{-}16}\left(\frac{days}{year}\right)\times ET_{6\text{-}16}\left(\frac{hours}{day}\right)\times MAF_i\,(0.244)\times 3\right)+\\ \left(ED_{16\text{-}26}\,(10\ years)\times EF_{16\text{-}26}\left(\frac{days}{year}\right)\times ET_{16\text{-}26}\left(\frac{hours}{day}\right)\times MAF_i\,(0.244)\times 1\right)\end{array}\right)\right)\end{array}}$$

- Total

$$SL_{rec\text{-}soil\text{-}tce\text{-}tot}\,(mg/kg) = \frac{1}{\frac{1}{SL_{rec\text{-}soil\text{-}tce\text{-}ing}}+\frac{1}{SL_{rec\text{-}soil\text{-}tce\text{-}der}}+\frac{1}{SL_{rec\text{-}soil\text{-}tce\text{-}inh}}}$$

A number of studies have shown that inadvertent ingestion of soil is common among children 6 years old and younger (Calabrese et al. 1989, Davis et al. 1990, Van Wijnen et al. 1990). Therefore, the dose method uses an age-adjusted soil ingestion factor that takes into account the difference in daily soil ingestion rates, body weights, and exposure duration for children from 1 to 6 years old and others from 7 to 26 years old. The equation is presented below. This health-protective approach is chosen to take into account the higher daily rates of soil ingestion in children as well as the longer duration of exposure that is anticipated for a long-term resident. For more on this method, see RAGS Part B (PDF) (68 pp, 721 K).

4.6.1.7 Supporting Equations

- Child

$$ED_{rec\text{-}c}\,(\text{years}) = ED_{0\text{-}2}\,(\text{years}) + ED_{2\text{-}6}\,(\text{years})$$

$$BW_{rec\text{-}c}\,(\text{kg}) = \frac{BW_{0\text{-}2}\,(\text{kg}) \times ED_{0\text{-}2}\,(\text{years}) + BW_{2\text{-}6}\,(\text{kg}) \times ED_{2\text{-}6}\,(\text{years})}{ED_{0\text{-}2}\,(\text{years}) + ED_{2\text{-}6}\,(\text{years})}$$

$$AF_{rec\text{-}c}\left(\frac{\text{events}}{\text{day}}\right) = \frac{AF_{0\text{-}2}\left(\frac{\text{events}}{\text{day}}\right) \times ED_{0\text{-}2}\,(\text{years}) + AF_{2\text{-}6}\left(\frac{\text{events}}{\text{day}}\right) \times ED_{2\text{-}6}\,(\text{years})}{ED_{0\text{-}2}\,(\text{years}) + ED_{2\text{-}6}\,(\text{years})}$$

$$EF_{rec\text{-}c}\left(\frac{\text{days}}{\text{year}}\right) = \frac{EF_{0\text{-}2}\left(\frac{\text{days}}{\text{year}}\right) \times ED_{0\text{-}2}\,(\text{years}) + EF_{2\text{-}6}\left(\frac{\text{days}}{\text{year}}\right) \times ED_{2\text{-}6}\,(\text{years})}{ED_{0\text{-}2}\,(\text{years}) + ED_{2\text{-}6}\,(\text{years})}$$

$$ET_{rec\text{-}c}\left(\frac{\text{hours}}{\text{day}}\right) = \frac{ET_{0\text{-}2}\left(\frac{\text{hours}}{\text{day}}\right) \times ED_{0\text{-}2}\,(\text{years}) + ET_{2\text{-}6}\left(\frac{\text{hours}}{\text{day}}\right) \times ED_{2\text{-}6}\,(\text{years})}{ED_{0\text{-}2}\,(\text{years}) + ED_{2\text{-}6}\,(\text{years})}$$

$$SA_{rec\text{-}c}\left(\frac{\text{cm}^2}{\text{day}}\right) = \frac{SA_{0\text{-}2}\left(\frac{\text{cm}^2}{\text{day}}\right) \times ED_{0\text{-}2}\,(\text{years}) + SA_{2\text{-}6}\left(\frac{\text{cm}^2}{\text{day}}\right) \times ED_{2\text{-}6}\,(\text{years})}{ED_{0\text{-}2}\,(\text{years}) + ED_{2\text{-}6}\,(\text{years})}$$

$$IRS_{rec\text{-}c}\left(\frac{\text{mg}}{\text{day}}\right) = \frac{IRS_{0\text{-}2}\left(\frac{\text{mg}}{\text{day}}\right) \times ED_{0\text{-}2}\,(\text{years}) + IRS_{2\text{-}6}\left(\frac{\text{mg}}{\text{day}}\right) \times ED_{2\text{-}6}\,(\text{years})}{ED_{0\text{-}2}\,(\text{years}) + ED_{2\text{-}6}\,(\text{years})}$$

- Adult

$$\mathrm{ED_{rec\text{-}a}\left(years\right) = ED_{6\text{-}16}\left(years\right) + ED_{16\text{-}26}\left(years\right)}$$

$$\mathrm{BW_{rec\text{-}a}\left(kg\right) = \frac{BW_{6\text{-}16}\left(kg\right) \times ED_{6\text{-}16}\left(years\right) + BW_{16\text{-}26}\left(kg\right) \times ED_{16\text{-}26}\left(years\right)}{ED_{6\text{-}16}\left(years\right) + ED_{16\text{-}26}\left(years\right)}}$$

$$\mathrm{AF_{rec\text{-}a}\left(\frac{events}{day}\right) = \frac{AF_{6\text{-}16}\left(\frac{events}{day}\right) \times ED_{6\text{-}16}\left(years\right) + AF_{16\text{-}26}\left(\frac{events}{day}\right) \times ED_{16\text{-}26}\left(years\right)}{ED_{6\text{-}16}\left(years\right) + ED_{16\text{-}26}\left(years\right)}}$$

$$\mathrm{EF_{rec\text{-}a}\left(\frac{days}{year}\right) = \frac{EF_{6\text{-}16}\left(\frac{days}{year}\right) \times ED_{6\text{-}16}\left(years\right) + EF_{16\text{-}26}\left(\frac{days}{year}\right) \times ED_{16\text{-}26}\left(years\right)}{ED_{6\text{-}16}\left(years\right) + ED_{16\text{-}26}\left(years\right)}}$$

$$\mathrm{ET_{rec\text{-}a}\left(\frac{hours}{day}\right) = \frac{ET_{6\text{-}16}\left(\frac{hours}{day}\right) \times ED_{6\text{-}16}\left(years\right) + ET_{16\text{-}26}\left(\frac{hours}{day}\right) \times ED_{16\text{-}26}\left(years\right)}{ED_{6\text{-}16}\left(years\right) + ED_{16\text{-}26}\left(years\right)}}$$

$$\mathrm{SA_{rec\text{-}a}\left(\frac{cm^2}{day}\right) = \frac{SA_{6\text{-}16}\left(\frac{cm^2}{day}\right) \times ED_{6\text{-}16}\left(years\right) + SA_{16\text{-}26}\left(\frac{cm^2}{day}\right) \times ED_{16\text{-}26}\left(years\right)}{ED_{6\text{-}16}\left(years\right) + ED_{16\text{-}26}\left(years\right)}}$$

$$\mathrm{IRS_{rec\text{-}a}\left(\frac{mg}{day}\right) = \frac{IRS_{6\text{-}16}\left(\frac{mg}{day}\right) \times ED_{6\text{-}16}\left(years\right) + IRS_{16\text{-}26}\left(\frac{mg}{day}\right) \times ED_{16\text{-}26}\left(years\right)}{ED_{6\text{-}16}\left(years\right) + ED_{16\text{-}26}\left(years\right)}}$$

- Age-adjusted

$$\mathrm{ED_{rec}\left(years\right) = ED_{0\text{-}2}\left(years\right) + ED_{2\text{-}6}\left(years\right) + ED_{6\text{-}16}\left(years\right) + ED_{16\text{-}26}\left(years\right)}$$

$$\mathrm{EF_{rec}\left(\frac{days}{year}\right) = \frac{EF_{0\text{-}2}\left(\frac{days}{year}\right) \times ED_{0\text{-}2}\left(years\right) + EF_{2\text{-}6}\left(\frac{days}{year}\right) \times ED_{2\text{-}6}\left(years\right) + EF_{6\text{-}16}\left(\frac{days}{year}\right) \times ED_{6\text{-}16}\left(years\right) + EF_{16\text{-}26}\left(\frac{days}{year}\right) \times ED_{16\text{-}26}\left(years\right)}{ED_{0\text{-}2}\left(years\right) + ED_{2\text{-}6}\left(years\right) + ED_{6\text{-}16}\left(years\right) + ED_{16\text{-}26}\left(years\right)}}$$

$$\mathrm{ET_{rec}\left(\frac{hours}{day}\right) = \frac{ET_{0\text{-}2}\left(\frac{hours}{day}\right) \times ED_{0\text{-}2}\left(years\right) + ET_{2\text{-}6}\left(\frac{hours}{day}\right) \times ED_{2\text{-}6}\left(years\right) + ET_{6\text{-}16}\left(\frac{hours}{day}\right) \times ED_{6\text{-}16}\left(years\right) + ET_{16\text{-}26}\left(\frac{hours}{day}\right) \times ED_{16\text{-}26}\left(years\right)}{ED_{0\text{-}2}\left(years\right) + ED_{2\text{-}6}\left(years\right) + ED_{6\text{-}16}\left(years\right) + ED_{16\text{-}26}\left(years\right)}}$$

4.6.2 Recreator Surface Water

This receptor is exposed to chemicals that are present in surface water. Ingestion of water and dermal contact with water are appropriate pathways. Dermal contact with surface water is also considered for analytes determined to be within the effective predictive domain as described in Section 4.9.8. Inhalation is not considered due to mixing with outdoor air. There are no default RSLs for this scenario; only site-specific.

The recreator surface water land use is not provided in the Generic Tables but RSLs can be created by using the Calculator.

4.6.2.1 Noncarcinogenic - Child

The recreator surface water land use equation, presented here, contains the following exposure routes:

- incidental ingestion of water

$$SL_{\text{rec-wat-nc-ing-c}}\,(\mu g/L) = \frac{THQ \times AT_{\text{rec-c}}\left(\frac{365\text{ days}}{\text{year}} \times ED_{\text{rec-c}}\,(6\text{ years})\right) \times BW_{\text{rec-c}}\,(15\text{ kg}) \times \left(\frac{1000\ \mu g}{mg}\right)}{EF_{\text{rec-c}}\left(\frac{\text{days}}{\text{year}}\right) \times ED_{\text{rec-c}}\,(6\text{ years}) \times \frac{1}{RfD_o\left(\frac{mg}{kg\text{-}d}\right)} \times IRW_{\text{rec-c}}\left(\frac{0.12\text{ L}}{\text{hour}}\right) \times EV_{\text{rec-c}}\left(\frac{\text{events}}{\text{day}}\right) \times ET_{\text{event-rec-c}}\left(\frac{\text{hours}}{\text{event}}\right)}$$

- dermal

FOR INORGANICS:

$$SL_{\text{rec-wat-nc-der-c}}\,(\mu g/L) = \frac{DA_{\text{event}}\left(\frac{ug}{cm^2\text{- event}}\right) \times \left(\frac{1000\text{ cm}^3}{L}\right)}{K_p\left(\frac{cm}{\text{hour}}\right) \times ET_{\text{event-rec-c}}\left(\frac{\text{hours}}{\text{event}}\right)}$$

FOR ORGANICS:

$$\text{IF } ET_{\text{event-rec-c}}\left(\frac{\text{hours}}{\text{event}}\right) \le t^*\ (\text{hour}),\text{then } SL_{\text{rec-wat-nc-der}}\,(\mu g/L) = \frac{DA_{\text{event}}\left(\frac{ug}{cm^2\text{- event}}\right) \times \left(\frac{1000\text{ cm}^3}{L}\right)}{2 \times FA \times K_p\left(\frac{cm}{\text{hour}}\right)\sqrt{\frac{6 \times \tau_{\text{event}}\left(\frac{\text{hours}}{\text{event}}\right) \times ET_{\text{event-rec-c}}\left(\frac{\text{hours}}{\text{event}}\right)}{\pi}}}$$

or,

$$\text{IF } ET_{\text{event-rec-c}}\left(\frac{\text{hours}}{\text{event}}\right) > t^*\ (\text{hour}),\text{then } SL_{\text{rec-wat-nc-der}}\,(\mu g/L) = \frac{DA_{\text{event}}\left(\frac{ug}{cm^2\text{- event}}\right) \times \left(\frac{1000\text{ cm}^3}{L}\right)}{FA \times K_p\left(\frac{cm}{\text{hour}}\right) \times \left[\frac{ET_{\text{event-rec-c}}\left(\frac{\text{hours}}{\text{event}}\right)}{1+B} + 2 \times \tau_{\text{event}}\left(\frac{\text{hours}}{\text{event}}\right) \times \left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right]}$$

where:

$$DA_{\text{event}}\left(\frac{ug}{cm^2\text{- event}}\right) = \frac{THQ \times AT_{\text{rec-c}}\left(\frac{365\text{ days}}{\text{year}} \times ED_{\text{rec-c}}\,(6\text{ years})\right) \times \left(\frac{1000\ \mu g}{mg}\right) \times BW_{\text{rec-c}}\,(15\text{ kg})}{\left(\frac{1}{RfD_o\left(\frac{mg}{kg\text{-}day}\right) \times GIABS}\right) \times EV_{\text{rec-c}}\left(\frac{\text{events}}{\text{day}}\right) \times ED_{\text{rec-c}}\,(6\text{ years}) \times EF_{\text{rec-c}}\left(\frac{\text{days}}{\text{year}}\right) \times SA_{\text{rec-c}}\left(6365\text{ cm}^2\right)}$$

- Total

$$SL_{\text{rec-wat-nc-tot-c}}\,(\mu g/L) = \frac{1}{\frac{1}{SL_{\text{rec-wat-nc-ing-c}}} + \frac{1}{SL_{\text{rec-wat-nc-der-c}}}}$$

4.6.2.2 Noncarcinogenic - Adult

The recreator surface water land use equation, presented here, contains the following exposure routes:

- incidental ingestion of water

$$SL_{\text{rec-wat-nc-ing-a}}\,(\mu g/L) = \frac{THQ \times AT_{\text{rec-a}}\left(\frac{365\text{ days}}{\text{year}} \times ED_{\text{rec-a}}\,(20\text{ years})\right) \times BW_{\text{rec-a}}\,(80\text{ kg}) \times \left(\frac{1000\ \mu g}{mg}\right)}{EF_{\text{rec-a}}\left(\frac{\text{days}}{\text{year}}\right) \times ED_{\text{rec-a}}\,(20\text{ years}) \times \frac{1}{RfD_o\left(\frac{mg}{kg\text{-}d}\right)} \times IRW_{\text{rec-a}}\left(\frac{0.071\text{ L}}{\text{hour}}\right) \times EV_{\text{rec-a}}\left(\frac{\text{events}}{\text{day}}\right) \times ET_{\text{event-rec-a}}\left(\frac{\text{hours}}{\text{event}}\right)}$$

- dermal

FOR INORGANICS:

$$SL_{rec\text{-}wat\text{-}nc\text{-}der\text{-}a}\left(\mu g/L\right) = \frac{DA_{event}\left(\frac{ug}{cm^2\text{- }event}\right)\times\left(\frac{1000\ cm^3}{L}\right)}{K_p\left(\frac{cm}{hour}\right)\times ET_{event\text{-}rec\text{-}c}\left(\frac{hours}{event}\right)}$$

FOR ORGANICS:

$$\text{IF } ET_{event\text{-}rec\text{-}a}\left(\frac{hours}{event}\right) \le t^{*}\left(hour\right)\text{, then } SL_{rec\text{-}wat\text{-}nc\text{-}der}\left(\mu g/L\right) = \frac{DA_{event}\left(\frac{ug}{cm^2\text{- }event}\right)\times\left(\frac{1000\ cm^3}{L}\right)}{2\times FA\times K_p\left(\frac{cm}{hour}\right)\sqrt{\frac{6\times\tau_{event}\left(\frac{hours}{event}\right)\times ET_{event\text{-}rec\text{-}a}\left(\frac{hours}{event}\right)}{\pi}}}$$

or,

$$\text{IF } ET_{event\text{-}rec\text{-}a}\left(\frac{hours}{event}\right) > t^{*}\left(hour\right)\text{, then } SL_{rec\text{-}wat\text{-}nc\text{-}der}\left(\mu g/L\right) = \frac{DA_{event}\left(\frac{ug}{cm^2\text{- }event}\right)\times\left(\frac{1000\ cm^3}{L}\right)}{FA\times K_p\left(\frac{cm}{hour}\right)\times\left[\frac{ET_{event\text{-}rec\text{-}a}\left(\frac{hours}{event}\right)}{1+B}+2\times\tau_{event}\left(\frac{hours}{event}\right)\times\left(\frac{1+3B+3B^2}{\left(1+B\right)^2}\right)\right]}$$

where:

$$DA_{event}\left(\frac{ug}{cm^2\text{- }event}\right) = \frac{THQ\times AT_{rec\text{-}a}\left(\frac{365\ days}{year}\times ED_{rec\text{-}a}\left(20\ years\right)\right)\times\left(\frac{1000\ \mu g}{mg}\right)\times BW_{rec\text{-}a}\left(80\ kg\right)}{\left(\frac{1}{RfD_o\left(\frac{mg}{kg\text{-}day}\right)\times GIABS}\right)\times EV_{rec\text{-}a}\left(\frac{events}{day}\right)\times ED_{rec\text{-}a}\left(20\ years\right)\times EF_{rec\text{-}a}\left(\frac{days}{year}\right)\times SA_{rec\text{-}a}\left(19652\ cm^2\right)}$$

- Total

$$SL_{rec\text{-}wat\text{-}nc\text{-}tot\text{-}a}\left(\mu g/L\right) = \frac{1}{\frac{1}{SL_{rec\text{-}wat\text{-}nc\text{-}ing\text{-}a}}+\frac{1}{SL_{rec\text{-}wat\text{-}nc\text{-}der\text{-}a}}}$$

4.6.2.3 Carcinogenic

The recreator surface water land use equation, presented here, contains the following exposure routes:

- incidental ingestion of water

$$SL_{rec\text{-}wat\text{-}ca\text{-}ing}\left(\mu g/L\right) = \frac{TR\times AT_{rec}\left(\frac{365\ days}{year}\times LT\left(70\ years\right)\right)\times\left(\frac{1000\ \mu g}{mg}\right)}{CSF_o\left(\frac{mg}{kg\text{-}day}\right)^{-1}\times IFW_{rec\text{-}adj}\left(\frac{L}{kg}\right)}$$

where:

$$IFW_{rec\text{-}adj}\left(\frac{L}{kg}\right) = \left(\begin{array}{c}\frac{EV_{rec\text{-}c}\left(\frac{events}{day}\right)\times ED_{rec\text{-}c}\left(6\ years\right)\times EF_{rec\text{-}c}\left(\frac{days}{year}\right)\times ET_{event\text{-}rec\text{-}c}\left(\frac{hours}{event}\right)\times IRW_{rec\text{-}c}\left(\frac{0.12\ L}{hour}\right)}{BW_{rec\text{-}c}\left(15\ kg\right)}+\\ \frac{EV_{rec\text{-}a}\left(\frac{events}{day}\right)\times ED_{rec\text{-}a}\left(20\ years\right)\times EF_{rec\text{-}a}\left(\frac{days}{year}\right)\times ET_{event\text{-}rec\text{-}a}\left(\frac{hours}{event}\right)\times IRW_{rec\text{-}a}\left(\frac{0.071\ L}{hour}\right)}{BW_{rec\text{-}a}\left(80\ kg\right)}\end{array}\right)$$

- dermal

FOR INORGANICS:

$$SL_{\text{rec-wat-ca-der}}\left(\mu g/L\right) = \frac{DA_{\text{event}}\left(\frac{\text{ug}}{\text{cm}^2\text{- event}}\right)\times\left(\frac{1000\ \text{cm}^3}{\text{L}}\right)}{K_p\left(\frac{\text{cm}}{\text{hour}}\right)\times ET_{\text{event-rec-adj}}\left(\frac{\text{hours}}{\text{event}}\right)}$$

FOR ORGANICS:

$$\text{IF } ET_{\text{event-rec-adj}}\left(\frac{\text{hours}}{\text{event}}\right) \le t^{*}\ (\text{hour}),\text{then } SL_{\text{rec-wat-ca-der}}\left(\mu g/L\right) = \frac{DA_{\text{event}}\left(\frac{\text{ug}}{\text{cm}^2\text{- event}}\right)\times\left(\frac{1000\ \text{cm}^3}{\text{L}}\right)}{2\times FA\times K_p\left(\frac{\text{cm}}{\text{hour}}\right)\sqrt{\frac{6\times\tau_{\text{event}}\left(\frac{\text{hours}}{\text{event}}\right)\times ET_{\text{event-rec-adj}}\left(\frac{\text{hours}}{\text{event}}\right)}{\pi}}}$$

or,

$$\text{IF } ET_{\text{event-rec-adj}}\left(\frac{\text{hours}}{\text{event}}\right) > t^{*}\ (\text{hour}),\text{then } SL_{\text{rec-wat-ca-der}}\left(\mu g/L\right) = \frac{DA_{\text{event}}\left(\frac{\text{ug}}{\text{cm}^2\text{- event}}\right)\times\left(\frac{1000\ \text{cm}^3}{\text{L}}\right)}{FA\times K_p\left(\frac{\text{cm}}{\text{hour}}\right)\times\left[\frac{ET_{\text{event-rec-adj}}\left(\frac{\text{hours}}{\text{event}}\right)}{1+B}+2\times\tau_{\text{event}}\left(\frac{\text{hours}}{\text{event}}\right)\times\left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right]}$$

where:

$$DA_{\text{event}}\left(\frac{\text{ug}}{\text{cm}^2\text{- event}}\right) = \frac{TR\times AT_{\text{rec}}\left(\frac{365\ \text{days}}{\text{year}}\times LT\ (70\ \text{years})\right)\times\left(\frac{1000\ \mu g}{\text{mg}}\right)}{\left(\frac{CSF_o\left(\frac{\text{mg}}{\text{kg-day}}\right)^{-1}}{GIABS}\right)\times DFW_{\text{rec-adj}}\left(\frac{\text{events-cm}^2}{\text{kg}}\right)}$$

where:

$$DFW_{\text{rec-adj}}\left(\frac{\text{events-cm}^2}{\text{kg}}\right) = \left(\begin{array}{c}\frac{EV_{\text{rec-c}}\left(\frac{\text{events}}{\text{day}}\right)\times ED_{\text{rec-c}}\ (6\ \text{years})\ \times EF_{\text{rec-c}}\left(\frac{\text{days}}{\text{year}}\right)\times SA_{\text{rec-c}}\left(6365\ \text{cm}^2\right)}{BW_{\text{rec-c}}\ (15\ \text{kg})}+\\ \frac{EV_{\text{rec-a}}\left(\frac{\text{events}}{\text{day}}\right)\times ED_{\text{rec-a}}\ (20\ \text{years})\ \times EF_{\text{rec-a}}\left(\frac{\text{days}}{\text{year}}\right)\times SA_{\text{rec-a}}\left(19652\ \text{cm}^2\right)}{BW_{\text{rec-a}}\ (80\ \text{kg})}\end{array}\right)$$

and:

$$ET_{\text{event-rec-adj}}\left(\frac{\text{hours}}{\text{event}}\right) = \left(\frac{\left(ET_{\text{event-rec-c}}\left(\frac{\text{hours}}{\text{event}}\right)\times ED_{\text{rec-c}}\ (6\ \text{years}) + ET_{\text{event-rec-a}}\left(\frac{\text{hours}}{\text{event}}\right)\times ED_{\text{rec-a}}\ (20\ \text{years})\right)}{ED_{\text{rec-c}}\ (6\ \text{years})\ +\ ED_{\text{rec-a}}\ (20\ \text{years})}\right)$$

- Total

$$SL_{\text{rec-wat-ca-tot}}\left(\mu g/L\right) = \frac{1}{\frac{1}{SL_{\text{rec-wat-ca-ing}}}+\frac{1}{SL_{\text{rec-wat-ca-der}}}}$$

4.6.2.4 Mutagenic

The recreator surface water land use equation, presented here, contains the following exposure routes:

- incidental ingestion of water

$$\mathrm{SL}_{\text{rec-wat-mu-ing}}\left(\mu g/L\right) = \frac{\mathrm{TR}\times\mathrm{AT}_{\text{rec}}\left(\frac{365\ \text{days}}{\text{year}}\times\mathrm{LT}\left(70\ \text{years}\right)\right)\times\left(\frac{1000\ \mu g}{\text{mg}}\right)}{\mathrm{CSF}_{o}\left(\frac{\text{mg}}{\text{kg-day}}\right)^{-1}\times\mathrm{IFWM}_{\text{rec-adj}}\left(\frac{\text{L}}{\text{kg}}\right)}$$

where:

$$\mathrm{IFWM}_{\text{rec-adj}}\left(\frac{\text{L}}{\text{kg}}\right) = \left(\begin{array}{l}\frac{\mathrm{ED}_{0\text{-}2}\left(2\ \text{years}\right)\times\mathrm{EF}_{0\text{-}2}\left(\frac{\text{days}}{\text{year}}\right)\times\mathrm{IRW}_{0\text{-}2}\left(\frac{0.12\ \text{L}}{\text{hour}}\right)\times\mathrm{EV}_{0\text{-}2}\left(\frac{\text{events}}{\text{day}}\right)\times\mathrm{ET}_{0\text{-}2}\left(\frac{\text{hours}}{\text{event}}\right)\times 10}{\mathrm{BW}_{0\text{-}2}\left(15\ \text{kg}\right)}+\\ \frac{\mathrm{ED}_{2\text{-}6}\left(4\ \text{years}\right)\times\mathrm{EF}_{2\text{-}6}\left(\frac{\text{days}}{\text{year}}\right)\times\mathrm{IRW}_{2\text{-}6}\left(\frac{0.12\ \text{L}}{\text{hour}}\right)\times\mathrm{EV}_{2\text{-}6}\left(\frac{\text{events}}{\text{day}}\right)\times\mathrm{ET}_{2\text{-}6}\left(\frac{\text{hours}}{\text{event}}\right)\times 3}{\mathrm{BW}_{2\text{-}6}\left(15\ \text{kg}\right)}+\\ \frac{\mathrm{ED}_{6\text{-}16}\left(10\ \text{years}\right)\times\mathrm{EF}_{6\text{-}16}\left(\frac{\text{days}}{\text{year}}\right)\times\mathrm{IRW}_{6\text{-}16}\left(\frac{0.071\ \text{L}}{\text{hour}}\right)\times\mathrm{EV}_{6\text{-}16}\left(\frac{\text{events}}{\text{day}}\right)\times\mathrm{ET}_{6\text{-}16}\left(\frac{\text{hours}}{\text{event}}\right)\times 3}{\mathrm{BW}_{6\text{-}16}\left(80\ \text{kg}\right)}+\\ \frac{\mathrm{ED}_{16\text{-}26}\left(10\ \text{years}\right)\times\mathrm{EF}_{16\text{-}26}\left(\frac{\text{days}}{\text{year}}\right)\times\mathrm{IRW}_{16\text{-}26}\left(\frac{0.071\ \text{L}}{\text{hour}}\right)\times\mathrm{EV}_{16\text{-}26}\left(\frac{\text{events}}{\text{day}}\right)\times\mathrm{ET}_{16\text{-}26}\left(\frac{\text{hours}}{\text{event}}\right)\times 1}{\mathrm{BW}_{16\text{-}26}\left(80\ \text{kg}\right)}\end{array}\right)$$

- dermal

FOR INORGANICS:

$$SL_{rec\text{-}wat\text{-}mu\text{-}der}\left(\mu g/L\right) = \frac{DA_{event}\left(\frac{ug}{cm^2\text{- event}}\right)\times\left(\frac{1000\ cm^3}{L}\right)}{K_p\left(\frac{cm}{hour}\right)\times ET_{event\text{-}rec\text{-}madj}\left(\frac{hours}{event}\right)}$$

FOR ORGANICS:

$$\text{IF } ET_{event\text{-}rec\text{-}madj}\left(\frac{hours}{event}\right) \le t^*\ (hours)\text{, then } SL_{rec\text{-}wat\text{-}mu\text{-}der}\left(\mu g/L\right) = \frac{DA_{event}\left(\frac{ug}{cm^2\text{- event}}\right)\times\left(\frac{1000\ cm^3}{L}\right)}{2\times FA\times K_p\left(\frac{cm}{hour}\right)\sqrt{\frac{6\times\tau_{event}\left(\frac{hours}{event}\right)\times ET_{event\text{-}rec\text{-}madj}\left(\frac{hours}{event}\right)}{\pi}}}$$

or,

$$\text{IF } ET_{event\text{-}rec\text{-}madj}\left(\frac{hours}{event}\right) > t^*\ (hours)\text{, then } SL_{rec\text{-}wat\text{-}mu\text{-}der}\left(\mu g/L\right) = \frac{DA_{event}\left(\frac{ug}{cm^2\text{- event}}\right)\times\left(\frac{1000\ cm^3}{L}\right)}{FA\times K_p\left(\frac{cm}{hour}\right)\times\left[\frac{ET_{event\text{-}rec\text{-}madj}\left(\frac{hours}{event}\right)}{1+B}+2\times\tau_{event}\left(\frac{hours}{event}\right)\times\left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right]}$$

where:

$$DA_{event}\left(\frac{ug}{cm^2\text{- event}}\right) = \frac{TR\times AT_{rec}\left(\frac{365\ days}{year}\times LT\,(70\ years)\right)\times\left(\frac{1000\ \mu g}{mg}\right)}{\left(\frac{CSF_o\left(\frac{mg}{kg\text{-}day}\right)^{-1}}{GIABS}\right)\times DFWM_{rec\text{-}adj}\left(\frac{events\text{- }cm^2}{kg}\right)}$$

where:

$$DFWM_{rec\text{-}adj}\left(\frac{events\text{ - }cm^2}{kg}\right) = \left[\begin{array}{l}\left(\frac{EV_{0\text{-}2}\left(\frac{events}{day}\right)\times ED_{0\text{-}2}\,(2\ years)\times EF_{0\text{-}2}\left(\frac{days}{year}\right)\times SA_{0\text{-}2}\left(6365\ cm^2\right)\times 10}{BW_{0\text{-}2}\,(15\ kg)}\right)+\\ \left(\frac{EV_{2\text{-}6}\left(\frac{events}{day}\right)\times ED_{2\text{-}6}\,(4\ years)\times EF_{2\text{-}6}\left(\frac{days}{year}\right)\times SA_{2\text{-}6}\left(6365\ cm^2\right)\times 3}{BW_{2\text{-}6}\,(15\ kg)}\right)+\\ \left(\frac{EV_{6\text{-}16}\left(\frac{events}{day}\right)\times ED_{6\text{-}16}\,(10\ years)\times EF_{6\text{-}16}\left(\frac{days}{year}\right)\times SA_{6\text{-}16}\left(19652\ cm^2\right)\times 3}{BW_{6\text{-}16}\,(80\ kg)}\right)+\\ \left(\frac{EV_{16\text{-}26}\left(\frac{events}{day}\right)\times ED_{16\text{-}26}\,(10\ years)\times EF_{16\text{-}26}\left(\frac{days}{year}\right)\times SA_{16\text{-}26}\left(19652\ cm^2\right)\times 1}{BW_{16\text{-}26}\,(80\ kg)}\right)\end{array}\right]$$

and:

$$ET_{event\text{-}rec\text{-}madj}\left(\frac{hours}{event}\right) = \frac{\left(\begin{array}{l}ET_{event\text{-}rec\,(0\text{-}2)}\left(\frac{hours}{event}\right)\times ED_{0\text{-}2}\,(2\ years)+ET_{event\text{-}rec\,(2\text{-}6)}\left(\frac{hours}{event}\right)\times ED_{2\text{-}6}\,(4\ years)+\\ ET_{event\text{-}rec\,(6\text{-}16)}\left(\frac{hours}{event}\right)\times ED_{6\text{-}16}\,(10\ years)+ET_{event\text{-}rec\,(16\text{-}26)}\left(\frac{hours}{event}\right)\times ED_{16\text{-}26}\,(10\ years)\end{array}\right)}{ED_{0\text{-}2}\,(2\ years)+ED_{2\text{-}6}\,(4\ years)+ED_{6\text{-}16}\,(10\ years)+ED_{16\text{-}26}\,(10\ years)}$$

- Total

$$SL_{rec\text{-}wat\text{-}mu\text{-}tot}\left(\mu g/L\right) = \frac{1}{\frac{1}{SL_{rec\text{-}wat\text{-}mu\text{-}ing}}+\frac{1}{SL_{rec\text{-}wat\text{-}mu\text{-}der}}}$$

4.6.2.5 Vinyl Chloride - Carcinogenic

The recreator surface water land use equation, presented here, contains the following exposure routes:

- incidental ingestion of water

$$SL_{\text{rec-wat-ca-vc-ing}}\left(\mu g/L\right)=\frac{TR}{\left(\frac{CSF_o\left(\frac{mg}{\text{kg-day}}\right)^{-1}\times IFW_{\text{rec-adj}}\left(\frac{L}{kg}\right)\times\left(\frac{mg}{1000\ \mu g}\right)}{AT_{rec}\left(\frac{365\ \text{days}}{\text{year}}\times LT\ (70\ \text{years})\right)}\right)+\left(\frac{CSF_o\left(\frac{mg}{\text{kg-day}}\right)^{-1}\times EV_{\text{rec-c}}\left(\frac{\text{events}}{\text{day}}\right)\times ET_{\text{event-rec-c}}\left(\frac{\text{hours}}{\text{event}}\right)\times IRW_{\text{rec-c}}\frac{0.12\ L}{\text{hour}}\times\left(\frac{mg}{1000\ \mu g}\right)}{BW_{\text{rec-c}}\ (15\ kg)}\right)}$$

where:

$$IFW_{\text{rec-adj}}\left(\frac{L}{kg}\right)=\left(\frac{EV_{\text{rec-c}}\left(\frac{\text{events}}{\text{day}}\right)\times ED_{\text{rec-c}}\ (6\ \text{years})\times EF_{\text{rec-c}}\left(\frac{\text{days}}{\text{year}}\right)\times ET_{\text{event-rec-c}}\left(\frac{\text{hours}}{\text{event}}\right)\times IRW_{\text{rec-c}}\left(\frac{0.12\ L}{\text{hour}}\right)}{BW_{\text{recwc}}\ (15\ kg)}+\frac{EV_{\text{rec-a}}\left(\frac{\text{events}}{\text{day}}\right)\times ED_{\text{rec-a}}\ (20\ \text{years})\times EF_{\text{rec-a}}\left(\frac{\text{days}}{\text{year}}\right)\times ET_{\text{event-rec-a}}\left(\frac{\text{hours}}{\text{event}}\right)\times IRW_{\text{rec-a}}\left(\frac{0.071\ L}{\text{hour}}\right)}{BW_{\text{rec-a}}\ (80\ kg)}\right)$$

- dermal

$$\text{IF } ET_{\text{event-rec-adj}}\left(\frac{\text{hours}}{\text{event}}\right)\le t^*\ (\text{hours}),\text{then } SL_{\text{rec-wat-vc-der}}\left(\mu g/L\right)=\frac{DA_{event}\left(\frac{ug}{cm^2\text{- event}}\right)\times\left(\frac{1000\ cm^3}{L}\right)}{2\times FA\times K_p\left(\frac{cm}{\text{hour}}\right)\sqrt{\frac{6\times\tau_{event}\left(\frac{\text{hours}}{\text{event}}\right)\times ET_{\text{event-rec-adj}}\left(\frac{\text{hours}}{\text{event}}\right)}{\pi}}}$$

or,

$$\text{IF } ET_{\text{event-rec-adj}}\left(\frac{\text{hours}}{\text{event}}\right)>t^*\ (\text{hours}),\text{then } SL_{\text{rec-wat-vc-der}}\left(\mu g/L\right)=\frac{DA_{event}\left(\frac{ug}{cm^2\text{- event}}\right)\times\left(\frac{1000\ cm^3}{L}\right)}{FA\times K_p\left(\frac{cm}{\text{hour}}\right)\times\left[\frac{ET_{\text{event-rec-adj}}\left(\frac{\text{hours}}{\text{event}}\right)}{1+B}+2\times\tau_{event}\left(\frac{\text{hours}}{\text{event}}\right)\times\left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right]}$$

where:

$$DA_{event}\left(\frac{ug}{cm^2\text{- event}}\right)=\frac{TR}{\left(\frac{CSF_o\left(\frac{mg}{\text{kg-day}}\right)^{-1}}{GIABS}\right)\times\left(\frac{1000\ \mu g}{mg}\right)\times\left(\left(\frac{DFW_{\text{rec-adj}}\left(\frac{\text{events-cm}^2}{kg}\right)}{AT_{rec}\left(\frac{365\ \text{days}}{\text{year}}\times LT\ (70\ \text{years})\right)}\right)+\left(\frac{EV_{\text{rec-c}}\left(\frac{\text{events}}{\text{day}}\right)\times SA_{\text{rec-c}}\left(6365\ cm^2\right)}{BW_{\text{rec-c}}\ (15\ kg)}\right)\right)}$$

where:

$$DFW_{\text{rec-adj}}\left(\frac{\text{events-cm}^2}{kg}\right)=\left(\frac{EV_{\text{rec-c}}\left(\frac{\text{events}}{\text{day}}\right)\times ED_{\text{rec-c}}\ (6\ \text{years})\times EF_{\text{rec-c}}\left(\frac{\text{days}}{\text{year}}\right)\times SA_{\text{rec-c}}\left(6365\ cm^2\right)}{BW_{\text{rec-c}}\ (15\ kg)}+\frac{EV_{\text{rec-a}}\left(\frac{\text{events}}{\text{day}}\right)\times ED_{\text{rec-a}}\ (20\ \text{years})\times EF_{\text{rec-a}}\left(\frac{\text{days}}{\text{year}}\right)\times SA_{\text{rec-a}}\left(19652\ cm^2\right)}{BW_{\text{rec-a}}\ (80\ kg)}\right)$$

and:

$$ET_{\text{event-rec-adj}}\left(\frac{\text{hours}}{\text{event}}\right)=\left(\frac{\left(ET_{\text{event-rec-c}}\left(\frac{\text{hours}}{\text{event}}\right)\times ED_{\text{rec-c}}\ (6\ \text{years})\right)+\left(ET_{\text{event-rec-a}}\left(\frac{\text{hours}}{\text{event}}\right)\times ED_{\text{rec-a}}\ (20\ \text{years})\right)}{ED_{\text{rec-c}}\ (6\ \text{years})+ED_{\text{rec-a}}\ (20\ \text{years})}\right)$$

- Total

$$SL_{\text{rec-wat-ca-vc-tot}}\left(\mu g/L\right)=\frac{1}{\frac{1}{SL_{\text{rec-wat-ca-vc-ing}}}+\frac{1}{SL_{\text{rec-wat-ca-vc-der}}}}$$

4.6.2.6 Trichloroethylene - Carcinogenic and Mutagenic

The recreator surface water land use equation, presented here, contains the following exposure routes:

- incidental ingestion of water

$$SL_{\text{rec-wat-tce-ing}}(\mu g/L) = \frac{TR \times AT_{\text{rec}}\left(\frac{365\text{ days}}{\text{year}} \times LT\,(70\text{ years})\right) \times \left(\frac{1000\ \mu g}{mg}\right)}{CSF_o\left(\frac{mg}{\text{kg-day}}\right)^{-1} \times RBA \times \left(\left(CAF_o\,(0.804) \times IFW_{\text{rec-adj}}\left(\frac{L}{kg}\right)\right)\right) + \left(MAF_o\,(0.202) \times IFWM_{\text{rec-adj}}\left(\frac{L}{kg}\right)\right)}$$

where:

$$IFW_{\text{rec-adj}}\left(\frac{L}{kg}\right) = \left(\begin{array}{c}\frac{EV_{\text{rec-c}}\left(\frac{\text{events}}{\text{day}}\right) \times ED_{\text{rec-c}}\,(6\text{ years}) \times EF_{\text{rec-c}}\left(\frac{\text{days}}{\text{year}}\right) \times ET_{\text{event-rec-c}}\left(\frac{\text{hours}}{\text{event}}\right) \times IRW_{\text{rec-c}}\left(\frac{0.12\text{ L}}{\text{hour}}\right)}{BW_{\text{rec-c}}\,(15\text{ kg})} + \\ \frac{EV_{\text{rec-a}}\left(\frac{\text{events}}{\text{day}}\right) \times ED_{\text{rec-a}}\,(20\text{ years}) \times EF_{\text{rec-a}}\left(\frac{\text{days}}{\text{year}}\right) \times ET_{\text{event-rec-a}}\left(\frac{\text{hours}}{\text{event}}\right) \times IRW_{\text{rec-a}}\left(\frac{0.071\text{ L}}{\text{hour}}\right)}{BW_{\text{rec-a}}\,(80\text{ kg})}\end{array}\right)$$

where:

$$IFWM_{\text{rec-adj}}\left(\frac{L}{kg}\right) = \left(\begin{array}{c}\frac{ED_{0\text{-}2}\,(2\text{ years}) \times EF_{0\text{-}2}\left(\frac{\text{days}}{\text{year}}\right) \times IRW_{0\text{-}2}\left(\frac{0.12\text{ L}}{\text{hour}}\right) \times EV_{0\text{-}2}\left(\frac{\text{events}}{\text{day}}\right) \times ET_{0\text{-}2}\left(\frac{\text{hours}}{\text{event}}\right) \times 10}{BW_{0\text{-}2}\,(15\text{ kg})} + \\ \frac{ED_{2\text{-}6}\,(4\text{ years}) \times EF_{2\text{-}6}\left(\frac{\text{days}}{\text{year}}\right) \times IRW_{2\text{-}6}\left(\frac{0.12\text{ L}}{\text{hour}}\right) \times EV_{2\text{-}6}\left(\frac{\text{events}}{\text{day}}\right) \times ET_{2\text{-}6}\left(\frac{\text{hours}}{\text{event}}\right) \times 3}{BW_{2\text{-}6}\,(15\text{ kg})} + \\ \frac{ED_{6\text{-}16}\,(10\text{ years}) \times EF_{6\text{-}16}\left(\frac{\text{days}}{\text{year}}\right) \times IRW_{6\text{-}16}\left(\frac{0.071\text{ L}}{\text{hour}}\right) \times EV_{6\text{-}16}\left(\frac{\text{events}}{\text{day}}\right) \times ET_{6\text{-}16}\left(\frac{\text{hours}}{\text{event}}\right) \times 3}{BW_{6\text{-}16}\,(80\text{ kg})} + \\ \frac{ED_{16\text{-}26}\,(10\text{ years}) \times EF_{16\text{-}26}\left(\frac{\text{days}}{\text{year}}\right) \times IRW_{16\text{-}26}\left(\frac{0.071\text{ L}}{\text{hour}}\right) \times EV_{16\text{-}26}\left(\frac{\text{events}}{\text{day}}\right) \times ET_{16\text{-}26}\left(\frac{\text{hours}}{\text{event}}\right) \times 1}{BW_{16\text{-}26}\,(80\text{ kg})}\end{array}\right)$$

- dermal

FOR ORGANICS:

$$\text{IF ET}_{\text{event-rec-madj}}\left(\frac{1\text{ hour}}{\text{event}}\right)\leq t^{*}\,(\text{hours}),\text{then SL}_{\text{rec-wat-tce-der}}\left(\mu g/L\right)=\frac{\text{DA}_{\text{tce-event}}\left(\frac{\text{ug}}{\text{cm}^{2}\text{- event}}\right)\times\left(\frac{1000\text{ cm}^{3}}{\text{L}}\right)}{2\times\text{FA}\times\text{K}_{\text{p}}\left(\frac{\text{cm}}{\text{hour}}\right)\sqrt{\frac{6\times\tau_{\text{event}}\left(\frac{\text{hours}}{\text{event}}\right)\times\text{ET}_{\text{event-rec-madj}}\left(\frac{\text{hours}}{\text{event}}\right)}{\pi}}}$$

or,

$$\text{IF ET}_{\text{event-rec-madj}}\left(\frac{\text{hours}}{\text{event}}\right)>t^{*}\,(\text{hours}),\text{then PRG}_{\text{rec-wat-tce-der}}\left(\mu g/L\right)=\frac{\text{DA}_{\text{tce-event}}\left(\frac{\text{ug}}{\text{cm}^{2}\text{- event}}\right)\times\left(\frac{1000\text{ cm}^{3}}{\text{L}}\right)}{\text{FA}\times\text{K}_{\text{p}}\left(\frac{\text{cm}}{\text{hour}}\right)\times\left[\frac{\text{ET}_{\text{event-rec-madj}}\left(\frac{\text{hours}}{\text{event}}\right)}{1+\text{B}}+2\times\tau_{\text{event}}\left(\frac{\text{hours}}{\text{event}}\right)\times\left(\frac{1+3\text{B}+3\text{B}^{2}}{(1+\text{B})^{2}}\right)\right]}$$

where:

$$\text{DA}_{\text{tce-event}}\left(\frac{\text{ug}}{\text{cm}^{2}\text{- event}}\right)=\frac{\text{TR}\times\text{AT}_{\text{rec}}\left(\frac{365\text{ days}}{\text{year}}\times\text{LT}\,(70\text{ years})\right)\times\left(\frac{1000\ \mu\text{g}}{\text{mg}}\right)}{\frac{\text{CSF}_{\text{o}}\left(\frac{\text{mg}}{\text{kg-day}}\right)^{-1}}{\text{GIABS}}\times\left(\left(\text{AF}_{\text{o}}\,(0.804)\times\text{DFW}_{\text{rec-adj}}\left(\frac{\text{events - cm}^{2}}{\text{kg}}\right)\right)+\left(\text{MAF}_{\text{o}}\,(0.202)\times\text{DFWM}_{\text{rec-adj}}\left(\frac{\text{events - cm}^{2}}{\text{kg}}\right)\right)\right)}$$

where:

$$\text{DFW}_{\text{rec-adj}}\left(\frac{\text{events - cm}^{2}}{\text{kg}}\right)=\left(\begin{array}{c}\frac{\text{EV}_{\text{rec-c}}\left(\frac{\text{events}}{\text{day}}\right)\times\text{ED}_{\text{rec-c}}\,(6\text{ years})\times\text{EF}_{\text{rec-c}}\left(\frac{\text{days}}{\text{year}}\right)\times\text{SA}_{\text{rec-c}}\left(6365\text{ cm}^{2}\right)}{\text{BW}_{\text{rec-c}}\,(15\text{ kg})}+\\ \frac{\text{EV}_{\text{rec-a}}\left(\frac{\text{events}}{\text{day}}\right)\times\text{ED}_{\text{rec-a}}\,(20\text{ years})\times\text{EF}_{\text{rec-a}}\left(\frac{\text{days}}{\text{year}}\right)\times\text{SA}_{\text{rec-a}}\left(19652\text{ cm}^{2}\right)}{\text{BW}_{\text{rec-a}}\,(80\text{ kg})}\end{array}\right)$$

where:

$$\text{DFWM}_{\text{rec-adj}}\left(\frac{\text{events - cm}^{2}}{\text{kg}}\right)=\left[\begin{array}{c}\left(\frac{\text{EV}_{0\text{-}2}\left(\frac{\text{events}}{\text{day}}\right)\times\text{ED}_{0\text{-}2}\,(2\text{ years})\times\text{EF}_{0\text{-}2}\left(\frac{\text{days}}{\text{year}}\right)\times\text{SA}_{0\text{-}2}\left(6365\text{ cm}^{2}\right)\times10}{\text{BW}_{0\text{-}2}\,(15\text{ kg})}\right)+\\ \left(\frac{\text{EV}_{2\text{-}6}\left(\frac{\text{events}}{\text{day}}\right)\times\text{ED}_{2\text{-}6}\,(4\text{ years})\times\text{EF}_{2\text{-}6}\left(\frac{\text{days}}{\text{year}}\right)\times\text{SA}_{2\text{-}6}\left(6365\text{ cm}^{2}\right)\times3}{\text{BW}_{2\text{-}6}\,(15\text{ kg})}\right)+\\ \left(\frac{\text{EV}_{6\text{-}16}\left(\frac{\text{events}}{\text{day}}\right)\times\text{ED}_{6\text{-}16}\,(10\text{ years})\times\text{EF}_{6\text{-}16}\left(\frac{\text{days}}{\text{year}}\right)\times\text{SA}_{6\text{-}16}\left(19652\text{ cm}^{2}\right)\times3}{\text{BW}_{6\text{-}16}\,(80\text{ kg})}\right)+\\ \left(\frac{\text{EV}_{16\text{-}26}\left(\frac{\text{events}}{\text{day}}\right)\times\text{ED}_{16\text{-}26}\,(10\text{ years})\times\text{EF}_{16\text{-}26}\left(\frac{\text{days}}{\text{year}}\right)\times\text{SA}_{16\text{-}26}\left(19652\text{ cm}^{2}\right)\times1}{\text{BW}_{16\text{-}26}\,(80\text{ kg})}\right)\end{array}\right]$$

and:

$$\text{ET}_{\text{event-recw-madj}}\left(\frac{\text{hours}}{\text{event}}\right)=\frac{\left(\begin{array}{l}\text{ET}_{\text{event-rec}\,(0\text{-}2)}\left(\frac{\text{hours}}{\text{event}}\right)\times\text{ED}_{0\text{-}2}\,(2\text{ years})+\text{ET}_{\text{event-rec}\,(2\text{-}6)}\left(\frac{\text{hours}}{\text{event}}\right)\times\text{ED}_{2\text{-}6}\,(4\text{ years})+\\ \text{ET}_{\text{event-rec}\,(6\text{-}16)}\left(\frac{\text{hours}}{\text{event}}\right)\times\text{ED}_{6\text{-}16}\,(10\text{ years})+\text{ET}_{\text{event-rec}\,(16\text{-}26)}\left(\frac{\text{hours}}{\text{event}}\right)\times\text{ED}_{16\text{-}26}\,(10\text{ years})\end{array}\right)}{\text{ED}_{0\text{-}2}\,(2\text{ years})+\text{ED}_{2\text{-}6}\,(4\text{ years})+\text{ED}_{6\text{-}16}\,(10\text{ years})+\text{ED}_{16\text{-}26}\,(10\text{ years})}$$

FOR ORGANICS:

$$\text{IF } ET_{\text{event-rec-madj}}\left(\frac{\text{1 hour}}{\text{event}}\right) \le t^{*}\ (\text{hours}),\text{then } SL_{\text{rec-wat-tce-der}}\left(\mu g/L\right) = \frac{DA_{\text{tce-event}}\left(\frac{\text{ug}}{\text{cm}^{2}\text{- event}}\right)\times\left(\frac{1000\ \text{cm}^{3}}{L}\right)}{2\times FA\times K_{p}\left(\frac{\text{cm}}{\text{hour}}\right)\sqrt{\frac{6\times\tau_{\text{event}}\left(\frac{\text{hours}}{\text{event}}\right)\times ET_{\text{event-rec-madj}}\left(\frac{\text{hours}}{\text{event}}\right)}{\pi}}}$$

or,

$$\text{IF } ET_{\text{event-rec-madj}}\left(\frac{\text{hours}}{\text{event}}\right) > t^{*}\ (\text{hours}),\text{then } PRG_{\text{rec-wat-tce-der}}\left(\mu g/L\right) = \frac{DA_{\text{tce-event}}\left(\frac{\text{ug}}{\text{cm}^{2}\text{- event}}\right)\times\left(\frac{1000\ \text{cm}^{3}}{L}\right)}{FA\times K_{p}\left(\frac{\text{cm}}{\text{hour}}\right)\times\left[\frac{ET_{\text{event-rec-madj}}\left(\frac{\text{hours}}{\text{event}}\right)}{1+B}+2\times\tau_{\text{event}}\left(\frac{\text{hours}}{\text{event}}\right)\times\left(\frac{1+3B+3B^{2}}{(1+B)^{2}}\right)\right]}$$

where:

$$DA_{\text{tce-event}}\left(\frac{\text{ug}}{\text{cm}^{2}\text{- event}}\right) = \frac{TR\times AT_{\text{rec}}\left(\frac{\text{365 days}}{\text{year}}\times LT\,(\text{70 years})\right)\times\left(\frac{1000\ \mu g}{\text{mg}}\right)}{\frac{CSF_{o}\left(\frac{\text{mg}}{\text{kg-day}}\right)^{-1}}{GIABS}\times\left(\left(AF_{o}\,(0.804)\ \times DFW_{\text{rec-adj}}\left(\frac{\text{events - cm}^{2}}{\text{kg}}\right)\right)+\left(MAF_{o}\,(0.202)\ \times DFWM_{\text{rec-adj}}\left(\frac{\text{events - cm}^{2}}{\text{kg}}\right)\right)\right)}$$

where:

$$DFW_{\text{rec-adj}}\left(\frac{\text{events - cm}^{2}}{\text{kg}}\right) = \left(\begin{gathered}\frac{EV_{\text{rec-c}}\left(\frac{\text{events}}{\text{day}}\right)\times ED_{\text{rec-c}}\,(\text{6 years})\ \times EF_{\text{rec-c}}\left(\frac{\text{days}}{\text{year}}\right)\times SA_{\text{rec-c}}\left(6365\ \text{cm}^{2}\right)}{BW_{\text{rec-c}}\,(\text{15 kg})}+\\ \frac{EV_{\text{rec-a}}\left(\frac{\text{events}}{\text{day}}\right)\times ED_{\text{rec-a}}\,(\text{20 years})\ \times EF_{\text{rec-a}}\left(\frac{\text{days}}{\text{year}}\right)\times SA_{\text{rec-a}}\left(19652\ \text{cm}^{2}\right)}{BW_{\text{rec-a}}\,(\text{80 kg})}\end{gathered}\right)$$

where:

$$DFWM_{\text{rec-adj}}\left(\frac{\text{events - cm}^{2}}{\text{kg}}\right) = \left[\begin{gathered}\left(\frac{EV_{0\text{-}2}\left(\frac{\text{events}}{\text{day}}\right)\times ED_{0\text{-}2}\,(\text{2 years})\ \times EF_{0\text{-}2}\left(\frac{\text{days}}{\text{year}}\right)\times SA_{0\text{-}2}\left(6365\ \text{cm}^{2}\right)\times 10}{BW_{0\text{-}2}\,(\text{15 kg})}\right)+\\ \left(\frac{EV_{2\text{-}6}\left(\frac{\text{events}}{\text{day}}\right)\times ED_{2\text{-}6}\,(\text{4 years})\ \times EF_{2\text{-}6}\left(\frac{\text{days}}{\text{year}}\right)\times SA_{2\text{-}6}\left(6365\ \text{cm}^{2}\right)\times 3}{BW_{2\text{-}6}\,(\text{15 kg})}\right)+\\ \left(\frac{EV_{6\text{-}16}\left(\frac{\text{events}}{\text{day}}\right)\times ED_{6\text{-}16}\,(\text{10 years})\ \times EF_{6\text{-}16}\left(\frac{\text{days}}{\text{year}}\right)\times SA_{6\text{-}16}\left(19652\ \text{cm}^{2}\right)\times 3}{BW_{6\text{-}16}\,(\text{80 kg})}\right)+\\ \left(\frac{EV_{16\text{-}26}\left(\frac{\text{events}}{\text{day}}\right)\times ED_{16\text{-}26}\,(\text{10 years})\ \times EF_{16\text{-}26}\left(\frac{\text{days}}{\text{year}}\right)\times SA_{16\text{-}26}\left(19652\ \text{cm}^{2}\right)\times 1}{BW_{16\text{-}26}\,(\text{80 kg})}\right)\end{gathered}\right]$$

and:

$$ET_{\text{event-recw-madj}}\left(\frac{\text{hours}}{\text{event}}\right) = \frac{\left(\begin{gathered}ET_{\text{event-rec}\,(0\text{-}2)}\left(\frac{\text{hours}}{\text{event}}\right)\ \times ED_{0\text{-}2}\,(\text{2 years})+ET_{\text{event-rec}\,(2\text{-}6)}\left(\frac{\text{hours}}{\text{event}}\right)\ \times ED_{2\text{-}6}\,(\text{4 years})+\\ ET_{\text{event-rec}\,(6\text{-}16)}\left(\frac{\text{hours}}{\text{event}}\right)\ \times ED_{6\text{-}16}\,(\text{10 years})+ET_{\text{event-rec}\,(16\text{-}26)}\left(\frac{\text{hours}}{\text{event}}\right)\ \times ED_{16\text{-}26}\,(\text{10 years})\end{gathered}\right)}{ED_{0\text{-}2}\,(\text{2 years})\ +ED_{2\text{-}6}\,(\text{4 years})\ +ED_{6\text{-}16}\,(\text{10 years})\ +ED_{16\text{-}26}\,(\text{10 years})}$$

- Total

$$SL_{\text{rec-wat-tce-tot}}\left(\mu g/L\right) = \frac{1}{\frac{1}{SL_{\text{rec-wat-tce-ing}}}+\frac{1}{SL_{\text{rec-wat-tce-der}}}}$$

4.6.2.7 Supporting Equations

- Child

$$ED_{rec\text{-}c}\left(years\right) = ED_{0\text{-}2}\left(years\right) + ED_{2\text{-}6}\left(years\right)$$

$$BW_{rec\text{-}c}\left(kg\right) = \frac{BW_{0\text{-}2}\left(kg\right) \times ED_{0\text{-}2}\left(years\right) + BW_{2\text{-}6}\left(kg\right) \times ED_{2\text{-}6}\left(years\right)}{ED_{0\text{-}2}\left(years\right) + ED_{2\text{-}6}\left(years\right)}$$

$$EV_{rec\text{-}c}\left(\frac{events}{day}\right) = \frac{EV_{0\text{-}2}\left(\frac{events}{day}\right) \times ED_{0\text{-}2}\left(years\right) + EV_{2\text{-}6}\left(\frac{events}{day}\right) \times ED_{2\text{-}6}\left(years\right)}{ED_{0\text{-}2}\left(years\right) + ED_{2\text{-}6}\left(years\right)}$$

$$EF_{rec\text{-}c}\left(\frac{days}{year}\right) = \frac{EF_{0\text{-}2}\left(\frac{days}{year}\right) \times ED_{0\text{-}2}\left(years\right) + EF_{2\text{-}6}\left(\frac{days}{year}\right) \times ED_{2\text{-}6}\left(years\right)}{ED_{0\text{-}2}\left(years\right) + ED_{2\text{-}6}\left(years\right)}$$

$$ET_{rec\text{-}c}\left(\frac{hours}{event}\right) = \frac{ET_{0\text{-}2}\left(\frac{hours}{event}\right) \times ED_{0\text{-}2}\left(years\right) + ET_{2\text{-}6}\left(\frac{hours}{event}\right) \times ED_{2\text{-}6}\left(years\right)}{ED_{0\text{-}2}\left(years\right) + ED_{2\text{-}6}\left(years\right)}$$

$$SA_{rec\text{-}c}\left(cm^2\right) = \frac{SA_{0\text{-}2}\left(cm^2\right) \times ED_{0\text{-}2}\left(years\right) + SA_{2\text{-}6}\left(cm^2\right) \times ED_{2\text{-}6}\left(years\right)}{ED_{0\text{-}2}\left(years\right) + ED_{2\text{-}6}\left(years\right)}$$

$$IRW_{rec\text{-}c}\left(\frac{L}{hour}\right) = \frac{IRW_{0\text{-}2}\left(\frac{L}{hour}\right) \times ED_{0\text{-}2}\left(years\right) + IRW_{2\text{-}6}\left(\frac{L}{hour}\right) \times ED_{2\text{-}6}\left(years\right)}{ED_{0\text{-}2}\left(years\right) + ED_{2\text{-}6}\left(years\right)}$$

- Adult

$$ED_{rec\text{-}a}\left(\text{years}\right) = ED_{6\text{-}16}\left(\text{years}\right) + ED_{16\text{-}26}\left(\text{years}\right)$$

$$BW_{rec\text{-}a}\left(\text{kg}\right) = \frac{BW_{6\text{-}16}\left(\text{kg}\right) \times ED_{6\text{-}16}\left(\text{years}\right) + BW_{16\text{-}26}\left(\text{kg}\right) \times ED_{16\text{-}26}\left(\text{years}\right)}{ED_{6\text{-}16}\left(\text{years}\right) + ED_{16\text{-}26}\left(\text{years}\right)}$$

$$EV_{rec\text{-}a}\left(\frac{\text{events}}{\text{day}}\right) = \frac{EV_{6\text{-}16}\left(\frac{\text{events}}{\text{day}}\right) \times ED_{6\text{-}16}\left(\text{years}\right) + EV_{16\text{-}26}\left(\frac{\text{events}}{\text{day}}\right) \times ED_{16\text{-}26}\left(\text{years}\right)}{ED_{6\text{-}16}\left(\text{years}\right) + ED_{16\text{-}26}\left(\text{years}\right)}$$

$$EF_{rec\text{-}a}\left(\frac{\text{days}}{\text{year}}\right) = \frac{EF_{6\text{-}16}\left(\frac{\text{days}}{\text{year}}\right) \times ED_{6\text{-}16}\left(\text{years}\right) + EF_{16\text{-}26}\left(\frac{\text{days}}{\text{year}}\right) \times ED_{16\text{-}26}\left(\text{years}\right)}{ED_{6\text{-}16}\left(\text{years}\right) + ED_{16\text{-}26}\left(\text{years}\right)}$$

$$ET_{rec\text{-}a}\left(\frac{\text{hours}}{\text{event}}\right) = \frac{ET_{6\text{-}16}\left(\frac{\text{hours}}{\text{event}}\right) \times ED_{6\text{-}16}\left(\text{years}\right) + ET_{16\text{-}26}\left(\frac{\text{hours}}{\text{event}}\right) \times ED_{16\text{-}26}\left(\text{years}\right)}{ED_{6\text{-}16}\left(\text{years}\right) + ED_{16\text{-}26}\left(\text{years}\right)}$$

$$SA_{rec\text{-}a}\left(\text{cm}^2\right) = \frac{SA_{6\text{-}16}\left(\text{cm}^2\right) \times ED_{6\text{-}16}\left(\text{years}\right) + SA_{16\text{-}26}\left(\text{cm}^2\right) \times ED_{16\text{-}30}\left(\text{years}\right)}{ED_{6\text{-}16}\left(\text{years}\right) + ED_{16\text{-}26}\left(\text{years}\right)}$$

$$IRW_{rec\text{-}a}\left(\frac{\text{L}}{\text{hour}}\right) = \frac{IRW_{6\text{-}16}\left(\frac{\text{L}}{\text{hour}}\right) \times ED_{6\text{-}16}\left(\text{years}\right) + IRW_{16\text{-}26}\left(\frac{\text{L}}{\text{hour}}\right) \times ED_{16\text{-}26}\left(\text{years}\right)}{ED_{6\text{-}16}\left(\text{years}\right) + ED_{16\text{-}26}\left(\text{years}\right)}$$

4.7 Ingestion of Fish

The fish RSL represents the concentration, in the fish, that can be consumed. Note: the consumption rate for fish is not age adjusted for this land use. Also, the SL calculated for fish is not for surface water or soil but is for fish tissue.

The ingestion of fish land use is not provided in the Generic Tables but RSLs can be created by using the Calculator.

4.7.1 Noncarcinogenic

The ingestion of fish equation, presented here, contains the following exposure route:

- consumption of fish.

$$SL_{res\text{-}fsh\text{-}nc\text{-}ing}\left(\text{mg/kg}\right) = \frac{THQ \times AT_{res\text{-}a}\left(\frac{365\ \text{days}}{\text{year}} \times ED_{res}\left(26\ \text{years}\right)\right) \times BW_{res\text{-}a}\left(80\ \text{kg}\right)}{EF_{res\text{-}a}\left(\frac{350\ \text{days}}{\text{year}}\right) \times ED_{res}\left(26\ \text{years}\right) \times \frac{1}{RfD_o\left(\frac{\text{mg}}{\text{kg-day}}\right)} \times IRF_{res\text{-}a}\left(\frac{\text{mg}}{\text{day}}\right) \times \frac{10^{-6}\,\text{kg}}{1\,\text{mg}}}$$

4.7.2 Carcinogenic

The ingestion of fish equation, presented here, contains the following exposure route:

- consumption of fish

$$SL_{res\text{-}fsh\text{-}ca\text{-}ing}\left(mg/kg\right) = \frac{TR \times AT_{res}\left(\frac{365\ days}{year} \times LT\left(70\ years\right)\right) \times BW_{res\text{-}a}\left(80\ kg\right)}{EF_{res}\left(\frac{350\ days}{year}\right) \times ED_{res}\left(26\ years\right) \times CSF_{o}\left(\frac{mg}{kg\text{-}day}\right)^{-1} \times IRF_{res\text{-}a}\left(\frac{mg}{day}\right) \times \frac{10^{-6}kg}{1\ mg}}$$

4.8 Soil to Groundwater

The soil to groundwater scenario was developed to identify concentrations in soil that have the potential to contaminate groundwater above risk based RSLs or MCLs. Migration of contaminants from soil to groundwater can be envisioned as a two-stage process: (1) release of contaminant from soil to soil leachate and (2) transport of the contaminant through the underlying soil and aquifer to a receptor well. The soil to groundwater scenario considers both of these fate and transport mechanisms. First, the acceptable groundwater concentration is multiplied by a dilution factor to obtain a target leachate concentration. For example, if the dilution factor is 10 and the MCL is 0.05 mg/L, the target soil leachate concentration would be 0.5 mg/L. The partition equation (presented in the Soil Screening Guidance documents) is then used to calculate the total soil concentration corresponding to this soil leachate concentration.

These equations are used to calculate screening levels in soil (SSLs) that are protective of groundwater. SSLs are either back-calculated from protective risk-based ground water concentrations or based on MCLs. The SSLs were designed for use during the early stages of a site evaluation when information about subsurface conditions may be limited. Because of this constraint, the equations used are based on conservative, simplifying assumptions about the release and transport of contaminants in the subsurface. Migration of contaminants from soil to groundwater can be envisioned as a two-stage process: (1) release of contaminant in soil leachate and (2) transport of the contaminant through the underlying soil and aquifer to a receptor well. The SSL methodology considers both of these fate and transport mechanisms.

The SSLs protective of groundwater, provided in the generic tables and the calculator, are all risk-based concentrations based on three phases (vapor, soil and water). No substitution for C_{sat} is performed. If the risk-based concentration exceeds C_{sat}, the resulting SSL concentration may be overly protective. This is because the dissolved, absorbed and vapor concentrations cease to rise linearly as soil concentration increases above the C_{sat} level (pure product or nonaqueous phase liquid (NAPL) is present). The SSL model used in the RSL calculator is not a four phase model. If a NAPL is present at your site more sophisticated models may be necessary.

SSLs are provided for metals in the Generic Tables based on Kds from the Soil Screening Guidance Exhibit C-4 . According to Appendix C,

"Exhibit C-4 provides pH-specific soil-water partition coefficients (Kd) for metals. Site-specific soil pH measurements can be used to select appropriate Kd values for these metals. Where site-specific soil pH values are not available, values corresponding to a pH of 6.8 should be used."

If a metal is not listed in Exhibit C-4, Kds were taken from Baes, C. F. 1984 (PDF) (167 pp, 3.0 MB). Kds for organic coumponds are calculated from K_{oc} and the fraction of organic carbon in the soil (f_{oc}). Kds for metals are listed below.

This land use is for developing residential default soil screening levels for the protection of groundwater that are presented in the RSL Generic Tables.

Chemical	**CAS**	**Kd**	**Reference**
Aluminum	7429-90-5	1.50E+03	Baes, C.F. 1984
Antimony (metallic)	7440-36-0	4.50E+01	SSG 9355.4-23 July 1996
Arsenic, Inorganic	7440-38-2	2.90E+01	SSG 9355.4-23 July 1996
Barium	7440-39-3	4.10E+01	SSG 9355.4-23 July 1996
Beryllium and compounds	7440-41-7	7.90E+02	SSG 9355.4-23 July 1996
Boron And Borates Only	7440-42-8	3.00E+00	Baes, C.F. 1984
Bromate	15541-45-4	7.50E+00	Baes, C.F. 1984
Cadmium (Diet)	7440-43-9	7.50E+01	SSG 9355.4-23 July 1996
Cadmium (Water)	7440-43-9	7.50E+01	SSG 9355.4-23 July 1996
Chlorine	7782-50-5	2.50E-01	Baes, C.F. 1984
Chromium (III) (Insoluble Salts)	16065-83-1	1.80E+06	SSG 9355.4-23 July 1996
Chromium Salts	0-00-3	8.50E+02	Baes, C.F. 1984

Chemical	CAS	Kd	Reference
Chromium VI (chromic acid mists)	18540-29-9	1.90E+01	SSG 9355.4-23 July 1996
Chromium VI (particulates)	18540-29-9	1.90E+01	SSG 9355.4-23 July 1996
Chromium, Total (1:6 ratio Cr VI : Cr III)	7440-47-3	1.80E+06	SSG 9355.4-23 July 1996
Cobalt	7440-48-4	4.50E+01	Baes, C.F. 1984
Copper	7440-50-8	3.50E+01	Baes, C.F. 1984
Cyanide (CN-)	57-12-5	9.90E+00	SSG 9355.4-23 July 1996
Fluoride	16984-48-8	1.50E+02	Surrogate Value from Fluorine (Soluble Fluoride)
Fluorine (Soluble Fluoride)	7782-41-4	1.50E+02	Baes, C.F. 1984
Hydrogen Cyanide (HCN)	74-90-8	9.90E+00	Surrogate value from Cyanide
Iron	7439-89-6	2.50E+01	Baes, C.F. 1984
Lead and Compounds	7439-92-1	9.00E+02	Baes, C.F. 1984
Lithium	7439-93-2	3.00E+02	Baes, C.F. 1984
Magnesium	7439-95-4	4.50E+00	Baes, C.F. 1984

Chemical	**CAS**	**Kd**	**Reference**
Manganese (Diet)	7439-96-5	6.50E+01	Baes, C.F. 1984
Manganese (Water)	7439-96-5	6.50E+01	Baes, C.F. 1984
Mercury (elemental)	7439-97-6	5.20E+01	SSG 9355.4-23 July 1996
Mercury, Inorganic Salts	0-01-7	5.20E+01	SSG 9355.4-23 July 1996
Molybdenum	7439-98-7	2.00E+01	Baes, C.F. 1984
Nickel Soluble Salts	7440-02-0	6.50E+01	SSG 9355.4-23 July 1996
Phosphorus, White	7723-14-0	3.50E+00	Baes, C.F. 1984
Selenium	7782-49-2	5.00E+00	SSG 9355.4-23 July 1996
Silver	7440-22-4	8.30E+00	SSG 9355.4-23 July 1996
Sodium	7440-23-5	1.00E+02	Baes, C.F. 1984
Sodium Fluoride	7681-49-4	1.50E+02	Surrogate Value from Fluorine (Soluble Fluoride)
Strontium, Stable	7440-24-6	3.50E+01	Baes, C.F. 1984
Thallium (Soluble Salts)	7440-28-0	7.10E+01	SSG 9355.4-23 July 1996

Chemical	CAS	Kd	Reference
Thorium	0-23-2	1.50E+05	Baes, C.F. 1984
Tin	7440-31-5	2.50E+02	Baes, C.F. 1984
Titanium	7440-32-6	1.00E+03	Baes, C.F. 1984
Uranium (Soluble Salts)	0-23-8	4.50E+02	Baes, C.F. 1984
Vanadium and Compounds	0-06-6	1.00E+03	SSG 9355.4-23 July 1996
Vanadium, Metallic	7440-62-2	1.00E+03	SSG 9355.4-23 July 1996
Zinc (Metallic)	7440-66-6	6.20E+01	SSG 9355.4-23 July 1996
Zirconium	7440-67-7	3.00E+03	Baes, C.F. 1984

Because Kds vary greatly by soil type, it is highly recommended that site-specific Kds be determined and used to develop SSLs.

The more protective of the carcinogenic and noncarcinogenic SLs is selected to calculate the SSL.

4.8.1 Noncarcinogenic Tapwater Equations for SSLs

The tapwater equations, presented in Section 4.1.2.1, are used to calculate the noncarcinogenic SSLs for volatiles and nonvolatiles. If the contaminant is a volatile, ingestion, dermal and inhalation exposure routes are considered. If the contaminant is not a volatile, only ingestion and dermal are considered.

4.8.2 Carcinogenic Tapwater Equations for SSLs

The tapwater equations, presented in Section 4.1.2.3, are used to calculate the carcinogenic SSLs for volatiles and nonvolatiles. Sections 4.1.2.4 and 4.1.2.5 present the mutagenic and vinyl chloride equations, respectively. If the contaminant is a volatile, ingestion, dermal and inhalation exposure routes are considered. If the contaminant is not a volatile, only ingestion and dermal are considered.

4.8.3 Method 1 for SSL Determination

Method 1 employs a partitioning equation for migration to groundwater and defaults are provided. This method is used to generate the download default tables. If H' is not available, SSL can still be calculated. H' changes when groundwater temperature changes. Please see section 4.9.9 of this user guide for H' determination at temperature other than 25°C.

- method 1.

$$\text{SSL(mg/kg)} = C_{\text{water}}\left(\frac{\text{mg}}{\text{L}}\right) \times \left[K_d\left(\frac{\text{L}}{\text{kg}}\right) + \left(\frac{\left(\theta_w\left(\frac{L_{\text{water}}}{L_{\text{soil}}}\right) + \theta_a\left(\frac{L_{\text{air}}}{L_{\text{soil}}}\right) \times H'\right)}{\rho_b\left(\frac{1.5\text{ kg}}{\text{L}}\right)}\right)\right]$$

where:

$$C_{\text{water}}\left(\frac{\text{mg}}{\text{L}}\right) = \text{MCL}\left(\frac{\text{ug}}{\text{L}}\right) \times \left(\frac{1\text{ mg}}{1000\text{ ug}}\right) \times \text{DAF}$$

or:

$$C_{\text{water}}\left(\frac{\text{mg}}{\text{L}}\right) = \text{PRG}\left(\frac{\text{ug}}{\text{L}}\right) \times \left(\frac{1\text{ mg}}{1000\text{ ug}}\right) \times \text{DAF}$$

and:

$$\theta_a\left(\frac{L_{\text{air}}}{L_{\text{soil}}}\right) = n\left(\frac{L_{\text{water}}}{L_{\text{soil}}}\right) - \theta_w\left(\frac{0.3\ L_{\text{water}}}{L_{\text{soil}}}\right);$$

$$n\left(\frac{L_{\text{pore}}}{L_{\text{soil}}}\right) = 1 - \left(\frac{\rho_b\left(\frac{1.5\text{ kg}}{\text{L}}\right)}{\rho_s\left(\frac{2.65\text{ kg}}{\text{L}}\right)}\right)$$

$$K_d\left(\frac{\text{L}}{\text{kg}}\right) = K_{oc}\left(\frac{\text{L}}{\text{kg}}\right) \times f_{oc}\left(\frac{0.002\text{ g-carbon}}{\text{g-soil}}\right)\text{, for organic compounds;}$$

K_d values for inorganic compounds are listed in the user guide.

The fraction of organic carbon (f_{oc}) selected for this equation is 0.002. This is the default for subsurface soil identified in U.S. EPA 1996b, Sections 2.5.2 and 2.5.7. According to this source, soil organic carbon decreases rapidly with depth. Note that the default f_{oc} in section “4.9.4 Infinite Source Chronic Volatilization Factor (VF_{ulim})” is 0.006, which is the default for surface soil from the same study.

4.8.4 Method 2 for SSL Determination

Method 2 employs a mass-limit equation for migration to groundwater and site-specific information is required. This method can be used in the calculator portion of this website.

- method 2.

$$\text{SSL}(\text{mg/kg}) = \frac{C_w\left(\frac{\text{mg}}{\text{L}}\right) \times I\left(\frac{0.18\ \text{m}}{\text{year}}\right) \times \text{ED}\left(70\ \text{years}\right)}{\rho_b\left(\frac{1.5\ \text{kg}}{\text{L}}\right) \times d_s\left(\text{m}\right)}$$

where:

$$C_w\left(\frac{\text{mg}}{\text{L}}\right) = \text{MCL}\left(\frac{\text{ug}}{\text{L}}\right) \times \left(\frac{1\ \text{mg}}{1000\ \text{ug}}\right) \times \text{DAF}$$

or:

$$C_w\left(\frac{\text{mg}}{\text{L}}\right) = \text{PRG}\left(\frac{\text{ug}}{\text{L}}\right) \times \left(\frac{1\ \text{mg}}{1000\ \text{ug}}\right) \times \text{DAF}$$

4.8.5 Determination of the Dilution Factor

The SSL values in the download tables are based on a dilution factor of 1. If one wishes to use the calculator to calculate screening levels using the SSL guidance for a source up to 0.5 acres, then a dilution factor of 20 can be used. If all of the parameters needed to calculate a site-specific dilution factor are known, they may be entered.

- Dilution Attenuation Factor.

$$\text{Dilution Attenuation Factor (DAF)} = 1 + \frac{K\left(\frac{\text{m}}{\text{year}}\right) \times i\left(\frac{\text{m}}{\text{m}}\right) \times d\left(\text{m}\right)}{I\left(\frac{0.18\ \text{m}}{\text{year}}\right) \times L\left(\text{m}\right)}$$

where:

$$d\left(\text{m}\right) = \left(0.0112 \times L^2\left(\text{m}\right)\right)^{0.5} + d_a \times \left[1\text{-exp}\left[\frac{-L\left(\text{m}\right) \times I\left(\frac{\text{m}}{\text{year}}\right)}{K\left(\frac{\text{m}}{\text{year}}\right) \times i\left(\frac{\text{m}}{\text{m}}\right) \times d_a\left(\text{m}\right)}\right]\right]$$

4.9 Supporting Equations and Parameter Discussion

There are two parts of the above land use equations that require further explanation. They are the inhalation variables: the particulate emission factor (PEF) and the volatilization factor (VF).

4.9.1 Wind-driven Particulate Emission Factor (PEF)

Inhalation of contaminants adsorbed to respirable particles (PM10) was assessed using a default PEF equal to 1.36×10^9 m^3/kg. This equation relates the contaminant concentration in soil with the concentration of respirable particles in the air due to fugitive dust emissions from contaminated soils. The generic PEF was derived using default values that correspond to a receptor point concentration of approximately 0.76 $\mu\text{g/m}^3$. The relationship is derived by Cowherd (1985) for a rapid assessment procedure applicable to a typical hazardous waste site, where the surface contamination provides a relatively continuous and constant potential for emission over an extended period of time (e.g., years). This represents an annual average emission rate based on wind erosion that should be compared with chronic health criteria; it is not appropriate for evaluating the potential for more acute exposures. Definitions of the input variables are in Table 1.

With the exception of specific heavy metals, the PEF does not appear to significantly affect most soil screening levels. The equation forms the basis for deriving a generic PEF for the inhalation pathway. For more details regarding specific parameters used in the PEF model, refer to Appendix D of the Supplemental Soil Screening Guidance. The use of alternate values on a specific site should be justified and presented in an Administrative Record if considered in CERCLA remedy selection.

$$\text{PEF}\left(\frac{m^3_{air}}{kg_{soil}}\right) = \frac{Q}{C_{wind}}\left(\frac{\left(\frac{g}{m^2\text{-}s}\right)}{\left(\frac{kg}{m^3}\right)}\right) \times \frac{3{,}600\left(\frac{s}{hour}\right)}{0.036\times(1-V)\times\left(\frac{U_m\left(\frac{m}{s}\right)}{U_t\left(\frac{m}{s}\right)}\right)^3\times F(x)}$$

where:

$$\frac{Q}{C_{wind}} = A\times\exp\left[\frac{\left(\ln A_s\,(acre)-B\right)^2}{C}\right]$$

and:

$$\text{if } x < 2,\ F(x) = 1.91207 - 0.0278085\,x + 0.48113\,x^2 - 1.09871\,x^3 + 0.335341\,x^4$$

$$\text{if } x \geq 2,\ F(x) = 0.18\left(8x^3+12x\right)e^{\left(-x^2\right)}$$

where:

$$x = 0.886\times\left(\frac{U_t}{U_m}\right)$$

Note: the generic PEF evaluates wind-borne emissions and does not consider dust emissions from traffic or other forms of mechanical disturbance that could lead to greater emissions than assumed here.

4.9.2 Vehicle traffic-driven Particulate Emission Factor (PEF_{sc})

The equation to calculate the subchronic particulate emission factor (PEF_{sc}) is significantly different from the residential and non-residential PEF equations. The PEF_{sc} focuses exclusively on emissions from truck traffic on unpaved roads, which typically contribute the majority of dust emissions during construction. This equation requires estimates of parameters such as the number of days with at least 0.01 inches of rainfall, the mean vehicle weight, and the sum of fleet vehicle distance traveled during construction.

The number of days with at least 0.01 inches of rainfall can be estimated using Exhibit 5-2 in the supplemental soil screening guidance (PDF) (187 pp, 2.2 MB). Mean vehicle weight (W) can be estimated by assuming the numbers and weights of different types of vehicles. For example, assuming that the daily unpaved road traffic consists of 20 two-ton cars and 10 twenty-ton trucks, the mean vehicle weight would be:

W = [(20 cars x 2 tons/car) + (10 trucks x 20 tons/truck)]/30 vehicles = 8 tons

The sum of the fleet vehicle kilometers traveled during construction (∑ VKT) can be estimated based on the size of the area of surface soil contamination, assuming the configuration of the unpaved road, and the amount of vehicle traffic on the road. For example, if the area of surface soil contamination is 0.5 acres (or 2,024 m^2), and one assumes that this area is configured as a square with the unpaved road segment dividing the square evenly, the road length would be equal to the square root of 2,024 m^2, 45 m (or 0.045 km). Assuming that each vehicle travels the length of the road once per day, 5 days per week for a total of 6 months, the total fleet vehicle kilometers traveled would be:

∑ VKT = 30 vehicles x 0.045 km/day x (52 weeks/year ÷ 2) x 5 days/wk = 175.5 km

$$PEF_{sc}\left(\frac{m^3_{air}}{kg_{soil}}\right) = \frac{Q}{C_{sr}}\left(\frac{\left(\frac{g}{m^2\text{- s}}\right)}{\left(\frac{kg}{m^3}\right)}\right) \times \frac{1}{F_D} \times \left[\frac{T_t(s) \times A_R\left(m^2\right)}{\frac{2.6 \text{ x } \left(\frac{s}{12}\right)^{0.8} \times \left(\frac{W(tons)}{3}\right)^{0.4}}{\left(\frac{M_{dry}}{0.2}\right)^{0.3}} \times \frac{365\left(\frac{days}{year}\right) - p\left(\frac{days}{year}\right)}{365\left(\frac{days}{year}\right)} \times 281.9 \times \Sigma VKT}\right.$$

$$\frac{Q}{C_{sr}}\left(\frac{\left(\frac{g}{m^2\text{- s}}\right)}{\left(\frac{kg}{m^3}\right)}\right) = A \times \exp\left[\frac{\left(\ln A_s\,(acre) - B\right)^2}{C}\right]$$

$$A_R\left(m^2\right) = L_R\,(ft) \times W_R\,(20 \text{ feet}) \times 0.092903\left(\frac{m^2}{feet^2}\right)$$

$$W(tons) = \frac{\left(\text{number of cars} \times \frac{tons}{car} + \text{number of trucks} \times \frac{tons}{truck}\right)}{\text{total vehicles}}$$

$$\Sigma VKT\,(km) = \text{total vehicles} \times \text{distance}\left(\frac{km}{day}\right) \times EW_{cw}\left(\frac{weeks}{year}\right) \times DW_{cw}\left(\frac{days}{week}\right)$$

$$T_t\;(7200000 \text{ s}) = ED_{cw}\,(1 \text{ years}) \times EF_{cw}\left(\frac{250 \text{ days}}{year}\right) \times ET_{cw}\left(\frac{8 \text{ hours}}{day}\right) \times \left(\frac{3600 \text{ s}}{hour}\right)$$

$$F_D\,(0.18584) = 0.1852 + \left(5.3537 / t_c\right) + \left(-9.6318 / t_c^{\;2}\right)$$

$$t_c\,(8400 \text{ hours}) = ED_{cw}\,(1 \text{ years}) \times EW_{cw}\left(\frac{50 \text{ weeks}}{year}\right) \times \left(\frac{7 \text{ days}}{week}\right) \times \left(\frac{24 \text{ hours}}{day}\right)$$

4.9.3 Other than vehicle traffic-driven Particulate Emission Factor (PEF'_{sc})

Other than emissions from unpaved road traffic, the construction worker may also be exposed to particulate matter emissions from wind erosion, excavation soil dumping, dozing, grading, and tilling or similar operations PEF'_{sc}. These operations may occur separately or concurrently and the duration of each operation may be different. For these reasons, the total unit mass emitted from each operation is calculated separately and the sum is normalized over the entire area of contamination and over the entire time during which construction activities take place. Equation E-26 in the supplemental soil screening guidance (PDF) (187 pp, 2.2 MB) was used.

$$PEF'_{sc}\left(\frac{m^3_{air}}{kg_{soil}}\right) = \frac{Q}{C_{sa}}\left(\frac{\left(\frac{g}{m^2\text{-}s}\right)}{\left(\frac{kg}{m^3}\right)}\right) \times \frac{1}{F_D} \times \frac{1}{<J'_T>\left(\frac{g}{m^2 - s}\right)}$$

where:

$$\frac{Q}{C_{sa}}\left(\frac{\left(\frac{g}{m^2\text{-}s}\right)}{\left(\frac{kg}{m^3}\right)}\right) = A \times \exp\left[\frac{\left(\ln A_c\,(acre) - B\right)^2}{C}\right]$$

$$<J'_T>\left(\frac{g}{m^2 - s}\right) = \frac{M^{pc}_{wind}(g) + M_{excav}(g) + M_{doz}(g) + M_{grade}(g) + M_{till}(g)}{A_{surf}\left(m^2\right) \times T_t(s)}$$

$$M^{pc}_{wind}(g) = 0.036 \times (1\text{-}V) \times \left(\frac{U_m\left(\frac{m}{s}\right)}{U_t\left(\frac{m}{s}\right)}\right)^3 \times F(x) \times A_{surf}\left(m^2\right) \times ED\ (years) \times 8760\left(\frac{hours}{year}\right)$$

$$M_{excav}(g) = 0.35 \times 0.0016 \times \frac{\left(\frac{U_m\left(\frac{m}{s}\right)}{2.2}\right)^{1.3}}{\left(\frac{M_{m\text{-}excav}(\%)}{2}\right)^{1.4}} \times \rho_{soil}\left(\frac{Mg}{m^3}\right) \times A_{excav}\left(m^2\right) \times d_{excav}(m) \times N_{A\text{-}dump} \times 1000$$

$$M_{doz}(g) = 0.75 \times \frac{0.45 \times s_{doz}(\%)^{1.5}}{\left(M_{m\text{-}doz}(\%)\right)^{1.4}} \times \frac{\Sigma VKT_{doz}(km)}{S_{doz}\left(\frac{km}{hr}\right)} \times 1000\left(\frac{g}{kg}\right)$$

$$M_{grade}(g) = 0.60 \times 0.0056 \times S_{grade}\left(\frac{km}{hour}\right)^{2.0} \times \Sigma VKT_{grade}(km) \times 1000\left(\frac{g}{kg}\right)$$

and:

$$M_{till}(g) = 1.1 \times s_{till}(\%)^{0.6} \times A_{c\text{-}till}(acres) \times 4047\left(\frac{m^2}{acre}\right) \times 10^{-4}\left(\frac{ha}{m^2}\right) \times 1000\left(\frac{g}{kg}\right) \times N_{A\text{-}till}$$

where:

$$\Sigma VKT_{grade}(km) = A_{c\text{-}grade}(acres) \times 4047\left(\frac{m^2}{acre}\right) \times \frac{1}{B_g(m)} \times \frac{1}{1000\left(\frac{m}{km}\right)} \times N_{A\text{-}grade}$$

where:

$$\Sigma VKT_{doz}(km) = A_{c\text{-}doz}(acres) \times 4047\left(\frac{m^2}{acre}\right) \times \frac{1}{B_g(m)} \times \frac{1}{1000\left(\frac{m}{km}\right)} \times N_{A\text{-}doz}$$

$$T_t\ (7200000\ s) = ED_{cw}(1\ years) \times EF_{cw}\left(\frac{250\ days}{year}\right) \times ET_{cw}\left(\frac{8\ hours}{day}\right) \times \left(\frac{3600\ s}{hour}\right)$$

$$F_D(0.18584) = 0.1852 + \left(5.3537 / t_c\right) + \left(-9.6318 / t_c{}^2\right)$$

$$t_c\left(8400\text{ hours}\right) = ED_{cw}\left(1\text{ years}\right) \times EW_{cw}\left(\frac{50\text{ weeks}}{\text{year}}\right) \times \left(\frac{7\text{ days}}{\text{week}}\right) \times \left(\frac{24\text{ hours}}{\text{day}}\right)$$

and:

$$\text{if } x < 2,\ F\left(x\right) = 1.91207 - 0.0278085\,x + 0.48113\,x^2 - 1.09871\,x^3 + 0.335341\,x^4$$

$$\text{if } x \geq 2,\ F\left(x\right) = 0.18\left(8x^3 + 12x\right)e^{\left(-x^2\right)}$$

where:

$$x = 0.886 \times \left(\frac{U_t}{U_m}\right)$$

4.9.4 Infinite Source Chronic Volatilization Factor (VF_{ulim})

The soil-to-air VF is used to define the relationship between the concentration of the contaminant in soil and the flux of the volatilized contaminant to air. VF is calculated from the equation below using chemical-specific properties and either site-measured or default values for soil moisture, dry bulk density, and fraction of organic carbon in soil. The Soil Screening Guidance: User's Guide (PDF) (89 pp, 863 K) describes how to develop site measured values for these parameters.

VF is only calculated for volatile compounds. Volatiles, for the purpose of this guidance, are chemicals with a Henry's Law constant greater than or equal to 1 x 10^{-5} atm-m^3/mole or a vapor pressure greater than or equal to 1 mm Hg. The volatile status of a chemical is important for some exposure routes. According to RAGS Part E, dermal absorption to soil is not assessed for volatiles. For the purposes of this guidance, dermal exposure to soil is only quantified if RAGS Part E provides a dermal absorption value in Exhibit 3-4 or the website, regardless of volatility status. The rationale for this is that in the considered soil exposure scenarios, volatile organic compounds would tend to be volatilized from the soil on skin and should be accounted for via inhalation routes in the combined exposure pathway analysis. Further, a chemical must be volatile in order to be included in the calculation of tapwater inhalation. H' changes when groundwater temperature changes. Please see section 4.9.9 of this user guide for H' determination at temperature other than 25°C.

unlimited source model for chronic exposure

$$VF_{ulim}\left(\frac{m^3_{air}}{kg_{soil}}\right) = \frac{\frac{Q}{C_{vol}}\left(\frac{\left(\frac{g}{m^2\text{- }s}\right)}{\left(\frac{kg}{m^3}\right)}\right) \times \left(3.14 \times D_A\left(\frac{cm^2}{s}\right) \times T\,(s)\right)^{1/2} \times 10^{-4}\left(\frac{m^2}{cm^2}\right)}{2 \times \rho_b\left(\frac{g}{cm^3}\right) \times D_A\left(\frac{cm^2}{s}\right)}$$

where:

$$\frac{Q}{C_{vol}}\left(\frac{\left(\frac{g}{m^2\text{- }s}\right)}{\left(\frac{kg}{m^3}\right)}\right) = A \times \exp\left[\frac{\left(\ln A_s\,(acre) - B\right)^2}{C}\right]$$

where:

$$D_A\left(\frac{cm^2}{s}\right) = \frac{\left(\theta_a\left(\frac{L_{air}}{L_{soil}}\right)^{10/3} \times D_{ia}\left(\frac{cm^2}{s}\right) \times H' + \theta_w\left(\frac{0.15\ L_{water}}{L_{soil}}\right)^{10/3} \times D_{iw}\left(\frac{cm^2}{s}\right)\right) \Big/ n^2\left(\frac{L_{pore}}{L_{soil}}\right)}{\rho_b\left(\frac{1.5g}{cm^3}\right) \times K_d\left(\frac{cm^3}{g}\right) + \theta_w\left(\frac{0.15\ L_{water}}{L_{soil}}\right) + \theta_a\left(\frac{L_{air}}{L_{soil}}\right) \times H'}$$

where:

$$\theta_a\left(\frac{L_{air}}{L_{soil}}\right) = n\left(\frac{L_{pore}}{L_{soil}}\right) - \theta_w\left(\frac{0.15\ L_{water}}{L_{soil}}\right) \text{and } n\left(\frac{L_{pore}}{L_{soil}}\right) = 1 - \left(\rho_b\left(\frac{1.5g}{cm^3}\right) \Big/ \rho_s\left(\frac{2.65\ g}{cm^3}\right)\right)$$

where:

$$K_d\left(\frac{L}{kg}\right) = K_{oc}\left(\frac{L}{kg}\right) \times f_{oc}\left(\frac{0.006\ g\text{-carbon}}{g\text{-soil}}\right), \text{ for organic compounds;}$$

K_d values for inorganic compounds are listed in the user guide.

The fraction of organic carbon (f_{oc}) selected for this equation is 0.006. This is the default for surface soil identified in U.S. EPA 1996b, Sections 2.4.2 and 2.5.7, and represents the mean value for the top 0.3m of Class B soils. According to this source, soil organic carbon decreases rapidly with depth. Note that the default f_{oc} in section “4.8.3 Method 1 for SSL Determination” is 0.002, which is the default for subsurface soil from the same study.

Diffusivity in Water (cm^2/s)

Diffusivity in water can be calculated from the chemical's molecular weight and density, using the following correlation equation based on WATER9 (U.S. EPA, 2001 (PDF) (38 pp, 185 K)):

$$D_{iw}\left(\frac{cm^2}{s}\right) = 0.0001518 \times \left(\frac{T\,^{o}C+273.16}{298.16}\right) \times \left(\frac{MW\left(\frac{g}{mol}\right)}{\rho\left(\frac{g}{cm^3}\right)}\right)^{-0.6}$$

where:

T typically = 25^{o} C

If density is not available,

$$D_{iw}\left(\frac{cm^2}{s}\right) = 0.000222 \times (MW)^{-\left(\frac{2}{3}\right)}$$

If density is not available, diffusivity in water can be calculated using the correlation equation based on U.S. EPA (1987). The value for diffusivity in water must be greater than zero. No maximum limit is enforced.

Diffusivity in Air (cm^2/s).

Diffusivity in air can be calculated from the chemical's molecular weight and density, using the following correlation equation based on WATER9 (U.S. EPA, 2001 (PDF) (38 pp, 185 K)). If density is not available, an alternate equation is provided.:

$$D_{ia}\left(\frac{cm^2}{s}\right) = \frac{0.00229 \times \left(T^0C+273.16\right)^{1.5} \times \sqrt{0.034+\left(\frac{1}{MW\left(\frac{g}{mol}\right)}\right)} \times MW_{cor}}{\left(\left(\frac{MW\left(\frac{g}{mol}\right)}{2.5\times p\left(\frac{g}{cm^3}\right)}\right)^{0.333} +1.8\right)^2}$$

where:

T typically = 25 ^{0} C

$$MW_{cor} = \left(1\text{-}0.000015\times MW^2\right) \text{ If } MW_{cor} \text{ is less than 0.4, then } MW_{cor} \text{ is set to 0.4.}$$

If density is not available use,

$$D_{ia}\left(\frac{cm^2}{s}\right) = 1.9 \times \left(MW\left(\frac{g}{mol}\right)^{-\left(\frac{2}{3}\right)}\right)$$

For dioxins, furans, and dioxin-like PCBs always use,

$$D_{ia}\left(\frac{cm^2}{s}\right) = \left(\frac{154\left(\frac{g}{mol}\right)}{MW\left(\frac{g}{mol}\right)}\right)^{0.5} \times 0.068\left(\frac{cm^2}{s}\right)$$

For dioxins, furans, and dioxin-like PCBs, diffusivity in air should always be calculated from the molecular weight using the Graham's Law correlation equation based on December 2003 NAS Review Draft Part I: Volume 3 (pg 4-38)(PDF) (148 pp, 1.9 MB). In this equation, the unknown diffusivity is solved by correlation to the known diphenyl diffusivity of 0.068 cm^2/s and MW of 154 g/mol.

4.9.5 Mass-limit Chronic Volatilization Factor (VF$_{mlim}$)

This Equation presents a model for calculating mass-limit SSLs for the outdoor inhalation of volatiles. This model can be used only if the depth and area of contamination are known or can be estimated with confidence. This equation is presented in the Soil Screening Guidance: User's Guide (PDF) (89 pp, 863 KF) and the Supplemental Soil Screening Guidance (PDF) (187 pp, 2.2 MB).

Use of infinite source models to estimate volatilization can violate mass balance considerations, especially for small sources. To address this concern, the Soil Screening Guidance includes a model for calculating a mass-limit SSL that provides a lower limit to the SSL **when the area and depth (i.e., volume) of the source are known or can be estimated reliably.**

A mass-limit SSL represents the level of contaminant in the subsurface that is still protective when the entire volume of contamination volatilizes over the 26-year exposure duration and the level of contaminant at the receptor does not exceed the health-based limit.

To use mass-limit SSLs, determine the area and depth of the source, calculate both standard and mass-limit SSLs, compare them for each chemical of concern and select the higher of the two values.

Note that the equation requires a site-specific determination of the average depth of contamination in the source. Step 3, in the SSG, provides guidance for conducting subsurface sampling to determine source depth. Where the actual average depth of contamination is uncertain, a conservative estimate should be used (e.g., the maximum possible depth in the unsaturated zone). At many sites, the average water table depth may be used unless there is reason to believe that contamination extends below the water table. In this case SSLs do not apply and further investigation of the source in question is needed.

mass limit model for chronic exposure

$$VF_{mlim}\left(\frac{m^3_{air}}{kg_{soil}}\right) = \frac{Q}{C_{vol}}\left(\frac{\left(\frac{g}{m^2\text{- }s}\right)}{\left(\frac{kg}{m^3}\right)}\right) \times \frac{\left[T\,(year) \times \left(3.15 \times 10^7 \left(\frac{s}{year}\right)\right)\right]}{\rho_b\left(\frac{mg}{m^3}\right) \times d_s\,(m) \times 10^6\left(\frac{g}{mg}\right)}$$

where:

$$\frac{Q}{C_{vol}}\left(\frac{\left(\frac{g}{m^2\text{- }s}\right)}{\left(\frac{kg}{m^3}\right)}\right) = A \times \exp\left[\frac{\left(\ln A_s\,(acre) - B\right)^2}{C}\right]$$

4.9.6 Unlimited Source Subchronic Volatilization Factor for Construction Worker ($VF_{ulim\text{-}sc}$)

Equation 5-14 of the supplemental soil screening guidance (PDF) (187 pp, 2.2 MB) is appropriate for calculating the soil-to-air volatilization factor ($VF_{ulim\text{-}sc}$) that relates the concentration of a contaminant in soil to the concentration in air resulting from volatilization. The equation for the subchronic dispersion factor for volatiles, Q/C_{sa}, is presented in Equation 5-15 of the supplemental soil screening guidance (PDF) (187 pp, 2.2 MB). Q/C_{sa} was derived using EPA's SCREEN3 dispersion model for a hypothetical site under a wide range of meteorological conditions. Unlike the Q/C values for the other scenarios, the Q/C_{sa} for the construction scenario's simple site-specific approach can be modified only to reflect different site sizes between 0.5 and 500 acres; it cannot be modified for climatic zone. Site managers conducting a detailed site-specific analysis for the construction scenario can develop a site-specific Q/C value by running the SCREEN3 model. Further details on the derivation of Q/C_{sa} can be found in Appendix E (PDF) (42 pp, 779 K) of the supplemental soil screening guidance (PDF) (187 pp, 2.2 MB). If H' is not available, D_A can still be calculated. H' changes when groundwater temperature changes. Please see section 4.9.9 of this user guide for H' determination at temperature other than 25°C.

unlimited source model for subchronic exposure

$$VF_{ulim\text{-}sc}\left(\frac{m^3_{air}}{kg_{soil}}\right) = \frac{Q}{C_{sa}}\left(\frac{\left(\frac{g}{m^2\text{-}s}\right)}{\left(\frac{kg}{m^3}\right)}\right) \times \frac{1}{F_D} \times \left[\frac{\left(3.14 \times D_A\left(\frac{cm^2}{s}\right) \times T_c\left(s\right)\right)^{1/2}}{2 \times \rho_b\left(\frac{1.5g}{cm^3}\right) \times D_A\left(\frac{cm^2}{s}\right)}\right] \times 10^{-4}\left(\frac{m^2}{cm^2}\right)$$

where:

$$\frac{Q}{C_{sa}}\left(\frac{\left(\frac{g}{m^2\text{-}s}\right)}{\left(\frac{kg}{m^3}\right)}\right) = A \times \exp\left[\frac{\left(\ln A_s\left(acre\right) - B\right)^2}{C}\right]$$

$$T_c\ \left(30240000\ s\right) = ED_{cw}\left(1\ year\right) \times EW_{cw}\left(\frac{50\ weeks}{year}\right) \times \left(\frac{7\ days}{week}\right) \times \left(\frac{24\ hours}{day}\right) \times \left(\frac{3600\ s}{hour}\right)$$

$$F_D\left(0.18584\right) = 0.1852 + \left(5.3537 / t_c\right) + \left(-9.6318 / t_c^{\ 2}\right)$$

$$t_c\left(8400\ hours\right) = ED_{cw}\left(1\ year\right) \times EW_{cw}\left(\frac{50\ weeks}{year}\right) \times \left(\frac{7\ days}{week}\right) \times \left(\frac{24\ hours}{day}\right)$$

$$D_A\left(\frac{cm^2}{s}\right) = \frac{\left(\theta_a\left(\frac{L_{air}}{L_{soil}}\right)^{10/3} \times D_{ia}\left(\frac{cm^2}{s}\right) \times H' + \theta_w\left(\frac{0.15\ L_{water}}{L_{soil}}\right)^{10/3} \times D_{iw}\left(\frac{cm^2}{s}\right)\right) \Big/ n^2\left(\frac{L_{pore}}{L_{soil}}\right)}{\rho_b\left(\frac{1.5g}{cm^3}\right) \times K_d\left(\frac{cm^3}{g}\right) + \theta_w\left(\frac{0.15\ L_{water}}{L_{soil}}\right) + \theta_a\left(\frac{L_{air}}{L_{soil}}\right) \times H'}$$

where:

$$\theta_a\left(\frac{L_{air}}{L_{soil}}\right) = n\left(\frac{L_{pore}}{L_{soil}}\right) - \theta_w\left(\frac{0.15\ L_{water}}{L_{soil}}\right) \text{and } n\left(\frac{L_{pore}}{L_{soil}}\right) = 1 - \left(\rho_b\left(\frac{1.5\ g}{cm^3}\right) \Big/ \rho_s\left(\frac{2.65\ g}{cm^3}\right)\right)$$

and:

$$K_d\left(\frac{L}{kg}\right) = K_{oc}\left(\frac{L}{kg}\right) \times f_{oc}\left(\frac{0.006\ g\text{-}carbon}{g\text{-}soil}\right)$$, for organic compounds;

K_d values for inorganic compounds are listed in the user guide.

4.9.7 Mass-limit Subchronic Volatilization Factor for Construction Worker ($VF_{mlim\text{-}sc}$)

Because the equations developed to calculate SSLs for the inhalation of volatiles outdoors assume an infinite source, they can violate mass-balance considerations, especially for small sources. To address this concern, a mass-limit SSL equation for this pathway may be used (Equation 5-17 of the supplemental soils screening guidance (PDF) (187 pp, 2.2 MB)). This equation can be used only when the volume (i.e., area and depth) of the contaminated soil source is known or can be estimated with confidence. As discussed above, the simple site-specific approach for calculating construction scenario SSLs uses the same emission model for volatiles as that used in the residential and non-residential scenarios. However, the conservative nature of this model (i.e., it assumes all contamination is at the surface) makes it sufficiently protective of construction worker exposures to volatiles.

mass limit model for subchronic exposure

$$VF_{mlim\text{-}sc}\left(\frac{m^3_{air}}{kg_{soil}}\right) = \frac{Q}{C_{sa}}\left(\frac{\left(\frac{g}{m^2\text{-} s}\right)}{\left(\frac{kg}{m^3}\right)}\right) \times \frac{1}{F_D} \times \frac{T_c\,(s)}{\rho_b\left(\frac{1.5\ Mg}{m^3}\right) \times d_s\,(m) \times 10^6\left(\frac{g}{mg}\right)}$$

where:

$$\frac{Q}{C_{sa}}\left(\frac{\left(\frac{g}{m^2\text{-} s}\right)}{\left(\frac{kg}{m^3}\right)}\right) = A \times \exp\left[\frac{\left(\ln A_s\,(acre) - B\right)^2}{C}\right]$$

$$T_c\ (30240000\ s) = ED_{cw}\,(1\ year) \times EW_{cw}\left(\frac{50\ weeks}{year}\right) \times \left(\frac{7\ days}{week}\right) \times \left(\frac{24\ hours}{day}\right) \times \left(\frac{3600\ s}{hour}\right)$$

$$F_D\,(0.18584) = 0.1852 + \left(5.3537\,/\,t_c\right) + \left(-9.6318\,/\,t_c{}^2\right)$$

$$t_c\,(8400\ hours) = ED_{cw}\,(1\ year) \times EW_{cw}\left(\frac{50\ weeks}{year}\right) \times \left(\frac{7\ days}{week}\right) \times \left(\frac{24\ hours}{day}\right)$$

4.9.8 Dermal Contact with Water Supporting Equations

- EPD = Effective Predictive Domain. The EPD is an area on a X/Y plot that symbolizes 95% statistical confidence levels of a regression equation to accurately estimate a dermal permeability constant (K_p). Only if a chemical is within the EPD, will a K_p be estimated and the dermal exposure to water exposure route quantified. The EPD is determined by investigating the predictive power of a regression equation using MW and log Kow values for a compound. If the intersection of the values falls within the designated plotted area, the chemical is determined to be in the EPD and a K_p is estimated. The boundaries of MW and log K_{ow} for the regression equation are presented below. The EPD is depicted in RAGS Part E in Appendix A; Exhibit A-1.

  $-0.06831 \leq 5.103 \times 10^{-4}$ MW + 0.5616 log $K_{ow} \leq 0.5577$ and
  $-0.3010 \leq -5.103 \times 10^{-4}$ MW + 0.05616 log $K_{ow} \leq 0.1758$

- FA = fraction absorbed water. The FA is described in RAGS Part E in Appendix A. The FA term should be applied to account for the loss of chemical due to the desquamation of the outer skin layer and a corresponding reduction in the absorbed dermal dose. To determine FA vales for the RSLs, the following regression analysis was performed. This analysis builds on the RAGS Part E data.

  ```
  logds=(-2.805063-0.0056118*mw) ;
  dsclc=10**logds ;
  dsc = dsclc*&lsc ;
  B = kp*(mw**0.5)/2.6 ;
  tau = &lsc**2/(6*dsc) ;
  logB=log10(B) ;
  ```

```
logtau = log10(tau) ;
if B<=0.1 then FAcalc = 0.9589849087 -.0163393790*logB -.1451565908*logtau
-.0534664095*logB*logtau ;
else if B>0.1 and B<=1 then FAcalc = 1.051232292 + 0.091016187*logB -0.286735467*logtau
-0.180504367*logB*logtau ;
else if B>1 then FAcalc = 0.992336792 + 0.479643809*logB -0.114381522*logtau
-1.263647642*logB*logtau ;
FA = ifn(FAcalc>=1,1,round(FAcalc,0.1));
if FA<0 then FA=0 ;
```

- B = Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (ve)

$$B = \frac{K_p\left(\frac{cm}{hour}\right)}{K_{p,ve}\left(\frac{cm}{hour}\right)} \approx K_p\left(\frac{cm}{hour}\right) \times \frac{\sqrt{MW\left(\frac{g}{mole}\right)}}{2.6} \text{ (as an approximation)}$$

where:

$$K_{p,ve}\left(\frac{cm}{hour}\right) = \frac{K_{ew} \times D_e\left(\frac{cm^2}{hour}\right)}{L_e\,(cm)}$$

where:

$K_{ew} = 1$ (assuming epidermis behaves essentially as water);

$L_e = 10^{-2}\,(cm)$;

$$D_e = \frac{7.1\times10^{-6}\left(\frac{cm^2}{sec}\right)}{\sqrt{MW\left(\frac{g}{mole}\right)}} \text{ (assumes } D_e = 10^{-6}\left(\frac{cm^2}{sec}\right) \text{ when MW = 50)}$$

- t* = Time to reach steady-state (hours) = 2.4 τ_{event}

$$\text{If } B \le 0.6 \text{, then } t^*\,(hours) = 2.4 \times \tau_{event}\left(\frac{hours}{event}\right)$$

or,

$$\text{If } B > 0.6 \text{, then } t^*\,(hours) = 6 \times \tau_{event}\left(\frac{hours}{event}\right) \times \left(b-\sqrt{b^2-c^2}\right)$$

where:

$$b = \frac{2\times\,(1+B)^2}{\pi} - c \quad \text{and} \quad c = \frac{1+3\times B+3\times B^2}{3\times\,(1+B)}$$

- τ_{event} = Lag time per event (hours/event)

$$\tau_{event}\left(\frac{\text{hours}}{\text{event}}\right) = \frac{l_{sc}^{2}\,(\text{cm})}{6 \times D_{sc}\left(\frac{\text{cm}^2}{\text{hour}}\right)}$$

where:

$$\log \frac{D_{sc}\left(\frac{\text{cm}^2}{\text{hour}}\right)}{l_{sc}\,(\text{cm})} = -2.80 - 0.0056 \times \text{MW}\left(\frac{\text{g}}{\text{mole}}\right) \text{ or } \frac{D_{sc}\left(\frac{\text{cm}^2}{\text{hr}}\right)}{l_{sc}\,(\text{cm})} = 10^{\left(-2.80 - 0.0056 \times \text{MW}\left(\frac{\text{g}}{\text{mole}}\right)\right)}$$

thus:

$$l_{sc}\,(\text{cm}) = \frac{10^{\left(-2.80 - 0.0056 \times \text{MW}\left(\frac{\text{g}}{\text{mole}}\right)\right)}}{D_{sc}\left(\frac{\text{cm}^2}{\text{hour}}\right)} \text{ and } D_{sc}\left(\frac{\text{cm}^2}{\text{hour}}\right) = l_{sc}\,(\text{cm}) \times 10^{\left(-2.80 - 0.0056 \times \text{MW}\left(\frac{\text{g}}{\text{mole}}\right)\right)}$$

4.9.9 H' Determination at Temperature Other Than 25°C

In site-specific mode for soil and soil to groundwater land uses, users are given the option to the change groundwater temperature from the default of 25°C to a site-specific value. Since the unitless Henry's Law Constant (H') is derived based on the partial pressure of a gas in equilibrium with a liquid and the equilibrium changes when temperature changes, H' is changed to reflect the equilibrium at the given temperature. The equation below illustrates how H' is derived when groundwater temperature is changed. An EPA Fact Sheet describing the process can be found at https://www.epa.gov/vaporintrusion/fact-sheet-correcting-henrys-law-constant-temperature.

$$H' = \left(\frac{\exp\left[- \frac{\Delta H_{v,w}\left(\frac{cal}{mol}\right)}{R_c\left(1.9872\ cal/mol\text{-}K\right)} \times \left(\frac{1}{T_w\ (K)} - \frac{1}{T_R\ (298.15\ K)} \right) \right] \times HLC\left(atm\text{-}m^3/mol\right)}{R\left(8.205E\text{-}05\ atm\text{-}m^3/mol\text{-}K\right) \times T_w\ (K)} \right)$$

where:

$$T_w\ (K) = T_w\left({}^oC\right) + 273.15$$

and:

$$\Delta H_{v,w}\left(\frac{cal}{mol}\right) = \Delta H_{v,b}\left(\frac{cal}{mol}\right) \times \left[\frac{1 - T_w\ (K)/T_c\ (K)}{1 - T_b\ (K)/T_c\ (K)}\right]^{\eta}$$

where:

$$\text{IF } \left(\frac{T_b}{T_c}\right) < 0.57\text{ , then: } \eta = 0.3;$$

$$\text{IF } \left(\frac{T_b}{T_c}\right) > 0.71\text{ , then: } \eta = 0.41;$$

$$\text{IF } 0.57 < \left(\frac{T_b}{T_c}\right) \leq 0.71\text{ , then: } \eta = \left(0.74 \times \left(\frac{T_b}{T_c}\right) - 0.116\right)$$

5. Special Considerations

Most of the SLs are readily derived by referring to the above equations. However, there are some cases for which the standard equations do not apply and/or external adjustments to the SLs are recommended. These special case chemicals are discussed below.

5.1 Cadmium

IRIS presents an oral "water" RfD for cadmium for use in assessment of risks to water of 0.0005 mg/kg-day. IRIS also presents an oral "food" RfD for cadmium for use in assessment of risks to soil and biota of 0.001 mg/kg-day. The SLs for Cadmium are based on the appropriate oral RfD based on the media. The "water" RfD is slightly more conservative (by a factor of 2) than the RfD for "food" and it could be argued that the more conservative RfD should be used to develop screening levels. RAGS Part E, in Exhibit 4-1, presents a GIABS for soil of 2.5% and for water of 5%.

5.2 Lead

EPA has no consensus RfD or SFO for inorganic lead, so it is not possible to calculate SLs as we have done for other chemicals. EPA considers lead to be a special case because of the difficulty in identifying the classic "threshold" needed to develop an RfD.

EPA therefore evaluates lead exposure by using blood-lead modeling, such as the Integrated Exposure-Uptake Biokinetic Model (IEUBK). The EPA Office of Solid Waste has also released a detailed directive on risk assessment and cleanup of residential soil lead. The directive recommends that soil lead levels less than 400 mg/kg are generally safe for residential use. Above that level, the document suggests collecting data and modeling blood-lead levels with the IEUBK model. For the purposes of screening, therefore, 400 mg/kg is recommended for residential soils. For water, we suggest 15 µg/L (the EPA Action Level in water), and for air, the National Ambient Air Quality Standard of 0.15 $\mu g/m^3$. An updated screening level for soil lead at commercial/industrial (i.e., non-residential) sites of 800 part per million (ppm) is based on a recent analysis of the combined phases of the National Health and Nutrition Examination Survey (NHANES III) that choose a cleanup goal protective for all subpopulations. More information can be found here.

However, caution should be used when both water and soil are being assessed. The IEUBK model shows that if the average soil concentration is 400 mg/kg, an average tap water concentration above 5 µg/L would yield more than 5% of the population above a 10 µg/dL blood-lead level. If the average tap water concentration is 15 µg/L, an average soil concentration greater than 250 mg/kg would yield more than 5% of the population above a 10 µg/dL blood-lead level.

EPA uses a second Adult Lead Model to estimate SLs for an industrial setting. This SL is intended to protect a fetus that may be carried by a pregnant female worker. It is assumed that a cleanup goal that is protective of a fetus will also afford protection for male or female adult workers. The model equations were developed to calculate cleanup goals such that the fetus of a pregnant female worker would not likely have an unsafe concentration of lead in blood.

For lead in soil, the default values for absolute bioavailability (ABA) in the IEUBK Model for Lead in Children are 0.3 for soil and dust and 0.5 for food and water. This corresponds to an RBA for soil of 0.6 (ABA_soil / ABA_water = 0.6). It's important to note that the ABA values in the IEUBK model are central estimates and the oral RBA at any given site may be higher or lower than the default oral RBA for lead. For this reason, and because it provides a more comprehensive characterization of exposure at a site, the TRW recommends using EPA SW846 Method 1340 to estimate site-specific RBA. Guidance related to these topics can be found in the Soil Bioavailability at Superfund Site Guidance. Documents OSWER 9200.3-51 and OSWER 9285.7-77 both contain the value for lead.

For more information on EPA's lead models and other lead-related topics, please go to Addressing Lead at Superfund Sites.

5.3 Manganese

The IRIS RfD (0.14 mg/kg-day) includes manganese from all sources, including diet. The author of the IRIS assessment for manganese recommended that the dietary contribution from the normal U.S. diet (an upper limit of 5 mg/day) be subtracted when evaluating non-food (e.g., drinking water or soil) exposures to manganese, leading to a RfD of 0.071 mg/kg-day for non-food items. The explanatory text in IRIS further recommends using a modifying factor of 3 when calculating risks associated with non-food sources due to a number of uncertainties that are discussed in the IRIS file for manganese, leading to a RfD of 0.024 mg/kg-day. This modified RfD has been used in the derivation of some manganese screening levels for soil and water. For more information regarding the Manganese RfD, users are advised to contact the author of the IRIS assessment on Manganese.

5.4 Vanadium Compounds

The oral RfD toxicity value for Vanadium, used in this website, is derived from the IRIS oral RfD for Vanadium Pentoxide by factoring out the molecular weight (MW) of the oxide ion. Vanadium Pentoxide (V_20_5) has a molecular weight of 181.88. The two atoms of Vanadium contribute 56% of the MW. Vanadium Pentoxide's oral RfD of 9E-03 mg/kg-day multiplied by 56% gives a Vanadium oral RfD of 5.04E-03 mg/kg-day.

5.5 Uranium

The "Uranium Soluble Salts" RSL uses the ATSDR intermediate MRL of 2E-04 mg/kg-day instead of the IRIS oral RfD of 3E-03 mg/kg-day. This is a deviation from the typical RSL toxicity hierarchy. This deviation was justified by the 2003 hierarchy memo (PDF) (4 pp, 25 K) that acknowledges and "recognizes that EPA should use the best science available on which to base risk assessments." In December 2016, the EPA Office of Superfund Remediation and Technology Innovation (OSRTI) announced its determination that the ATSDR intermediate MRL generally reflects a better scientific basis for assessing the chronic health risks of soluble uranium than the RfD currently available in IRIS." The rationale for this determination is summarized in an accompanying memorandum (PDF) (11 pp, 2.5 MB), which recommends use of the ATSDR intermediate MRL for assessing chronic and subchronic human exposures at Superfund sites nationwide.

5.6 Chromium (VI)

It is recommended that valence-specific data for chromium be collected whenever possible when chromium is likely to be an important contaminant at a site, and when hexavalent chromium (Cr (VI)) may exist. For Cr (VI), IRIS shows an air inhalation unit risk (IUR) of 1.2E-2 per (µg/m^3). While the exact ratio of Cr(VI) to Cr(III) in the data used to derive the IRIS IUR value is not known, it is likely that both Cr(VI) and Cr(III) were present. The RSLs, calculated using the IRIS IUR, assume that the Cr(VI) to Cr(III) ratio is 1:6. Because of various sources of uncertainty, this assumption may overestimate or underestimate the risk calculated. Users are invited to review the document "Toxicological Review of Hexavalent Chromium" in support of the summary information on Cr(VI) on IRIS to determine whether they believe this ratio applies to their site and to consider consulting with an EPA regional risk assessor. The uncertainty section of the risk assessment may want to address the potential for overestimating or underestimating the risk and provide quantitative analysis by deriving different IUR values based on different Cr(VI) to Cr(III) ratios from more recent studies.

In the RSL Table, the Cr(VI) specific value (assuming 100% Cr(VI)) is derived by multiplying the IRIS Cr (VI) value by 7. This is considered to be a health-protective assumption, and is also consistent with the State of California's interpretation of the Mancuso study that forms the basis for their estimated cancer potency of Cr(VI).

If you are working on a chromium site, you may want to contact the appropriate regulatory officials in your region to determine what their position is on this issue.

The Maximum Contaminant Level (MCL) of 100 µg/L for "Chromium (total)", from the EPA's MCL listing is applied to the "Chromium, Total" analyte on this website.

The State of California Environmental Protection Agency (CalEPA) determined that Cr(VI) by ingestion is likely to be carcinogenic in humans. CalEPA derived an oral cancer slope factor, based on a dose-related increase of tumors of the small intestine in male mice conducted by the National Toxicology Program (PDF) (162 pp, 1.9 MB). CalEPA determined that Cr(VI) was carcinogenic by mutagenic by mode of action.

EPA's Office of Pesticide Programs (OPP) (PDF) (23 pp, 414 K) made a determination that Cr(VI) has a mutagenic mode of action for carcinogenesis in all cells regardless of type, following administration via drinking water. OPP recommended that Age-Dependent Adjustment Factors (ADAFs) be applied when assessing cancer risks from early-life exposure (< 16 years of age). This determination was reviewed by OPP's Cancer Assessment Review Committee and published in a peer review journal (PDF) (23 pp, 414 K)).

Therefore, the RSL workgroup adopted the Tier III CalEPA value and the OPP recommendation with respect to mutagenicity. More recently, in 2011, external peer reviewers provided input on the EPA's Office of Research and Development Integrated Risk Information System draft Toxicological Review of Hexavalent Chromium. The majority of reviewers questioned the evidence used to support a mutagenic mode of action for carcinogenesis for Cr(VI). Furthermore, in 2011 California Environmental Protection Agency finalized its drinking water Public Health Goal for Cr(VI). CalEPA's Technical Support Document concluded in numerous studies that Cr(VI) is both genotoxic and mutagenic.

Therefore, the RSL workgroup acknowledges that there is uncertainty associated with the assessment of hexavalent chromium. However, no updated consensus IRIS assessment (Tier I) has yet appeared, and chromium is still under review by the IRIS program. With respect to RSLs, the more health-protective approach of applying ADAFs for early life exposure via ingestion, dermal and inhalation was used to calculate screening levels for all exposure pathways. Application of ADAFs for all exposure pathways results in more health-protective screening levels.

As always, consult EPA toxicologists in the Superfund program of the regional office when developing site specific screening levels.

5.7 Aminodinitrotoluenes

The IRIS oral RfD of 2E-03 mg/kg-day for 2,4-Dinitrotoluene is used as a surrogate for 2-Amino-4,6-Dinitrotoluene and 4-Amino-2,6-Dinitrotoluene.

5.8 PCBs

Aroclor 1016 is considered "lowest risk" and assigned appropriate toxicity values. All other Aroclors are assigned the high risk toxicity values.

5.9 Xylenes

The IRIS oral RfD of 2E-01 mg/kg-day for xylene, mixture is used as a surrogate for the 3 xylene congeners. The earlier RfD values for some xylene isomers were withdrawn from our electronic version of HEAST. Also, the IRIS inhalation RfC of 1E-01 mg/m^3 for xylene, mixture is used as a surrogate for the 3 xylene congeners.

5.10 Arsenic

Arsenic screening levels for ingestion of soil are now calculated with the default relative bioavailability factor (RBA) of 0.6. The RBA can be adjusted using the calculator in site-specific/user-provided mode the same way toxicity values can be changed. The RBA for soil ingestion is shown in the calculator output. The 2012 document, Compilation and Review of Data on Relative Bioavailability of Arsenic in Soil (PDF) (58 pp, 474 K) provides supporting information.

In 2017, the EPA has released a standard operating procedure for an in vitro bioaccessibility assay for arsenic in soil. The in vitro method for predicting oral RBA of arsenic in soil (EPA SW846 Method 1340) has been validated, and it is now recommended that the in vitro method be used to estimate site-specific RBA, when site-specific RBA is needed. This method can provide a more comprehensive characterization of RBA variability at the site. The default value represents the 95th percentile of many arsenic soil samples, and it is expected that the site-specific RBA will be less than 0.6 at most sites, which means that the default should be protective for screening. Site-specific RBAs derived with the in vitro method should be verified with your Regional Risk Assessor. Guidance related to these topics can be found in the Soil Bioavailability at Superfund Sites: Guidance.

Absolute bioavailability can be thought of as the absorption fraction (PDF) (20 pp, 133 K). Relative bioavailability accounts for differences in the bioavailability of a contaminant between the medium of exposure (e.g., soil) and the media associated with the toxicity value (e.g., the arsenic RfD and SFO are derived from drinking water studies). The 60% oral RBA for arsenic in soil is empirically-based. It represents an upper-bound estimate from numerous studies where the oral RBA of soil-borne arsenic in samples collected from across the U.S. was experimentally determined against the water-soluble form. This RBA does not apply to dermal exposures to arsenic in soil for which the absorbed dose is calculated using a dermal absorption fraction (ABS_d) of 0.03 (Exhibit 3-4 of USEPA, 2004).

5.11 Total Petroleum Hydrocarbons (TPHs)

The six TPH fractions were assigned representative compounds for determination of toxicity values and chemical-specific parameters to calculate RSLs. The PPRTV (PDF) (60 pp, 678 K) paper was the principal source for the derivation of these values.

The carbon ranges and representative compounds are listed in the table below. An average of the chemical-specific parameters for 2-methylnaphthalene and naphthalene was calculated for the medium aromatic fraction.

TPH Fractions	**Number of Carbons**	**Equivalent Carbon Number Index**	**Representative Compound (RfD/RfC)**
Low aliphatic	C5-C8	EC5-EC8	n-hexane
Medium aliphatic	C9-C18	EC>8-EC16	hydrocarbon streams*
High aliphatic	C19-C32	EC>16-EC35	white mineral oil
Low aromatic	C6-C8	EC6-EC<9	benzene
Medium aromatic	C9-C16	EC9-EC<22	2-methylnaphthalene/naphthalene

TPH Fractions	**Number of Carbons**	**Equivalent Carbon Number Index**	**Representative Compound (RfD/RfC)**
High aromatic	C17-C32	EC>22-EC35	fluoranthene

*Medium aliphatic representative compound was not listed in the PPRTV paper so n-nonane was selected by the RSL work-group to represent the chemical-specific parameters.

5.12 Soil Saturation Limit (C_{sat})

The soil saturation concentration, C_{sat}, corresponds to the contaminant concentration in soil at which the absorptive limits of the soil particles, the solubility limits of the soil pore water, and saturation of soil pore air have been reached. Above this concentration, the soil contaminant may be present in free phase (i.e., nonaqueous phase liquids (NAPLs) for contaminants that are liquid at ambient soil temperatures and pure solid phases for compounds that are solid at ambient soil temperatures). C_{sat} is not calculated for chemicals that are solid at ambient soil temperatures. The following decision criteria was established from SSL guidance, Table C-3: if melting point is less than 20 °C, chemical is a liquid; if melting point is above 20 °C, chemical is solid.

Equation 4-10 is used to calculate C_{sat} for each volatile contaminant. As an update to RAGS HHEM, Part B (USEPA 1991a), this equation takes into account the amount of contaminant that is in the vapor phase in soil in addition to the amount dissolved in the soil's pore water and sorbed to soil particles. If H' is not available, C_{sat} can still be calculated.

Chemical-specific C_{sat} concentrations must be compared with each VF-based inhalation SL because a basic principle of the SL volatilization model is not applicable when free-phase contaminants are present. How these cases are handled depends on whether the contaminant is liquid or solid at ambient temperatures. Liquid contaminants that have a VF-based inhalation SL that exceeds the C_{sa}t concentration are set equal to C_{sat}. For organic compounds that are solids (e.g., PAHs), soil screening decisions are based on the appropriate SLs for other pathways of concern at the site (e.g., ingestion). Note, that the SLs presented for soil inhalation in the RSL tool combine the VF and the PEF components. If the C_{sat} substitution is performed, the whole SL is replaced and not just the VF component.

The RSL tables and the default calculator settings do not substitute C_{sat} for risk-based calculations. If the risk-based concentration exceeds C_{sat}, the resulting SSL concentration may be overly protective. This is because the dissolved, absorbed and vapor concentrations cease to rise linearly as soil concentration increases above the C_{sat} level (pure product or nonaqueous phase liquid (NAPL) is present). The SSL model used in the RSL calculator is not a four phase model. If a NAPL is present at your site more sophisticated models may be necessary. The calculator, if operated in site-specific mode, will give the option to apply the C_{sat} substitution rule. H' changes when groundwater temperature changes. Please see section 4.9.9 of this user guide for H' determination at temperature other than 25°C.

$$C_{sat}\left(\frac{mg}{kg}\right)=\frac{S\left(\frac{mg}{L}\right)}{\rho_b\left(\frac{kg}{L}\right)}\times\left(K_d\left(\frac{L}{kg}\right)\times\rho_b\left(\frac{kg}{L}\right)+\theta_w\left(\frac{L_{water}}{L_{soil}}\right)+H'\times\theta_a\left(\frac{L_{air}}{L_{soil}}\right)\right)$$

where:

$$K_d\left(\frac{L}{kg}\right)=K_{oc}\left(\frac{L}{kg}\right)\times f_{oc}\left(\frac{0.006\ \text{g-carbon}}{\text{g-soil}}\right)\text{, for organic compounds;}$$

K_d values for inorganic compounds are listed in the user guide,

$$\theta_a\left(\frac{L_{air}}{L_{soil}}\right)=n\left(\frac{L_{pore}}{L_{soil}}\right)-\theta_w\left(\frac{L_{water}}{L_{soil}}\right)$$

and:

$$n=1-\left(\frac{\rho_b\left(\frac{kg}{L}\right)}{\rho_s\left(\frac{kg}{L}\right)}\right)$$

5.13 SL Theoretical Ceiling Limit

The ceiling limit of 10^{+5} mg/kg is equivalent to a chemical representing 10% by weight of the soil sample. At this contaminant concentration (and higher), the assumptions for soil contact may be violated (for example, soil adherence and wind-borne dispersion assumptions) due to the presence of the foreign substance itself.

The RSL tables and the default calculator settings do not substitute the theoretical ceiling limit for risk-based calculations but they do indicate if the resulting RSL has exceeded the theoretical ceiling limit in the key. The calculator, if operated in site-specific mode, will give the option to apply the theoretical ceiling limit.

5.14 Target Risk

With the exceptions described previously, SLs are chemical concentrations that correspond to fixed levels of risk (i.e., either a one-in-one million [10^{-6}] for cancer risk or a noncarcinogenic hazard quotient of 1) in soil, air, and water. In noncarcinogenic equations, THQ represents the target hazard quotient and is used for individual substances or exposure routes like: ingestion, dermal, and inhalation. The target hazard index (THI), is the target across multiple substances or exposure routes. In most cases, where a substance causes both cancer and noncancer (systemic) effects, the 10^{-6} cancer risk will result in a more stringent criteria and consequently this value is presented in the printed copy of the Table. SL concentrations that equate to a 10^{-6} cancer risk are indicated by 'ca' in the calculator and 'c' in the generic tables. SL concentrations that equate to a hazard quotient (HQ) of 1 for noncarcinogenic concerns are indicated by 'nc' in the calculator and 'n' in the generic tables.

If the SLs are to be used for site screening, it is recommended that both cancer and noncancer-based SLs be used. Both carcinogenic and noncarcinogenic values may be obtained in the Supporting Tables.

Some users of this SL Table may plan to multiply the cancer SL concentrations by 10 or 100 to set 'action levels' for triggering remediation or to set less stringent cleanup levels for a specific site after considering non-risk-based factors such as ambient levels, detection limits, or technological feasibility. This risk management practice recognizes that there may be a range of values that may be 'acceptable' for carcinogenic risk (EPA's risk management range is one-in-a-million [10^{-6}] to one-in-ten thousand [10^{-4}]). However, this practice could lead one to overlook serious noncancer health threats and it is strongly recommended that the user consult with a toxicologist or regional risk assessor before doing this. Carcinogens are indicated by an asterisk ('*') in the SL Table where the noncancer SLs would be exceeded if the cancer value that is displayed is multiplied by 100. ('**') indicate that the noncancer values would be exceeded if the cancer SL were multiplied by 10. There is no range of 'acceptable' noncarcinogenic 'risk' for CERCLA sites. Therefore, the noncancer SLs should not be multiplied by 10 or 100 when setting final cleanup criteria. In the rare case where noncancer SLs are more stringent than cancer SLs set at one-in-one-million risk, a similar approach has been applied (e.g. 'max').

SL concentrations in the printed Table are risk-based, but for soil there are two important exceptions: (1) for several volatile chemicals, SLs may exceed the soil saturation level ('sat') and (2) SLs may exceed a non-risk based 'ceiling limit' concentration of 10^{+5} mg/kg ('max') for relatively less toxic inorganic and semivolatile contaminants. For more information on the 'sat' value in the SL Table, please see the discussion in Section 5.11. For more information on the 'max' value in the SL Table, please see the discussion in Section 5.13.

With respect to applying a 'ceiling limit' for chemicals other than volatiles, it is recognized that this is not a universally accepted approach. Some within the agency argue that all values should be risk-based to allow for scaling (for example, if the risk-based SL is set at a hazard quotient = 1.0, and the user would like to set the hazard quotient to 0.1 to take into account multiple chemicals, then this is as simple as multiplying the risk-based SL by 1/10th). If scaling is necessary, SL users can do this simply by referring to the Supporting Tables at this website where risk-based soil concentrations are presented for all chemicals.

In spite of the fact that applying a ceiling limit is not a universally accepted approach, this table applies a 'max' soil concentration to the SL Table for the following reasons:

- Risk-based SLs for some chemicals in soil exceed unity (>1,000,000 mg/kg), which is not possible.
- The ceiling limit of 10^{+5} mg/kg is equivalent to a chemical representing 10% by weight of the soil sample. At this contaminant concentration (and higher), the assumptions for soil contact may be violated (for example, soil adherence and wind-borne dispersion assumptions) due to the presence of the foreign substance itself.
- SLs currently do not address short-term exposures (e.g., pica children and construction workers). Although extremely high soil SLs are likely to represent relatively non-toxic chemicals, such high values may not be justified if in fact more toxicological data were available for evaluating short-term and/or acute exposures.

5.15 Screening Sites with Multiple Contaminants

The screening levels in the tables are calculated under the assumption that only one contaminant is present. Users needing to screen sites with multiple contaminants should consult with their regional risk assessors. The following sections describe how target risks can be changed to screen against multiple contaminants and how the ratio of concentration to RSL can be used to estimate total risk.

5.15.1 Adjusting Target Risk and Target Hazard Quotient

When multiple contaminants are present at a site the target hazard quotient (THQ) may be modified. The following options are among the commonly used methods to modify the THQ:

The calculator on this website can be used to generate SLs based on any THQ or target cancer risk (TR) deemed appropriate by the user. The THQ input to the calculator can be modified from the default of 1. How much it should be modified is a user decision, but it could be based upon the number of contaminants being screened together. For example, if one is screening two contaminants together, then the THQ could be modified to 0.5. If ten contaminants are being screened together, then the THQ could be modified to 0.1. The above example weights each chemical equally; it is also possible to weight the chemicals unequally, as long as the total risk meets the desired goal. The decision of how to weight the chemicals is likely to be site-specific, and it is recommended that this decision be made in consultation with the regional risk assessor.

Note that when the TR or THQ is altered, the relationship between cancer-based and noncancer-based SLs may change. At certain risk levels, the cancer-based number may be more conservative; at different risk levels, the noncancer-based number may be more conservative. The data user needs to consider both cancer and noncancer endpoints.

Similar to the above approach of using the calculator to recalculate SLs based on non-default target levels, the values in the screening tables themselves can be addressed directly. Consistent with the above logic, although the EPA Superfund Program has not developed guidance on this, it is not uncommon that Superfund sites are screened at a THQ of 0.1. (The cancer-based SLs are already at a target risk of 1E-6 and are usually not adjusted further in this scenario.) SLs based on a THQ of 0.1 can be derived by dividing a default SL by 10. Again, note that altering the target HQ can change the relationship between cancer-based and noncancer-based screening levels; the data user needs to consider both endpoints. Additional approaches or alternatives may exist. When screening actual or potential Superfund sites, users are encouraged to consult with risk assessors in that EPA Regional Office when evaluating or screening contamination at a site with multiple contaminants to see if they may know of another approach or if they have a preference.

5.15.2 Using RSLs to Sum Risk from Multiple Contaminants

RSLs can be used to estimate the total risk from multiple contaminants at a site as part of a screening procedure used by some regions. This methodology, which does not substitute for a baseline risk assessment, is often called the "sum of the ratios" approach. A step-wise approach follows:

1. Perform an extensive records search and compile existing data.
2. Identify site contaminants in the SL Table. Record the SL concentrations for various media and note whether SL is based on cancer risk (indicated by 'c') or noncancer hazard (indicated by 'n'). Segregate cancer SLs from non-cancer SLs and exclude (but don't eliminate) non-risk based SLs 's' or 'm'.
3. For cancer risk estimates, take the site-specific concentration (maximum or 95th percent of the upper confidence limit on the mean (UCL)) and divide by the SL concentrations that are designated for cancer evaluation 'c'. Multiply this ratio by 10-6 to estimate chemical-specific risk for a reasonable maximum exposure (RME). For multiple pollutants, simply add the risk for each chemical. See

equation below.

$$\text{Total Cancer Risk} = \left[\left(\frac{C_x}{SL_x}\right)+\left(\frac{C_y}{SL_y}\right)+\left(\frac{C_z}{SL_z}\right)\right] \times TR$$

where:

TR = target cancer risk
C = site contaminant concentration

4. For non-cancer hazard estimates, divide the concentration term by its respective non-cancer SL designated as 'n' and sum the ratios for multiple contaminants. The cumulative ratio represents a non-carcinogenic hazard index (HI). A hazard index of 1 or less is generally considered 'safe'. A ratio greater than 1 suggests further evaluation. Note that carcinogens may also have an associated non-cancer SL that is not listed in the SL Table. To obtain these values, the user should view the Supporting Tables. See equation below

$$\text{Total Hazard Index} = \left[\left(\frac{C_x}{SL_x}\right)+\left(\frac{C_y}{SL_y}\right)+\left(\frac{C_z}{SL_z}\right)\right] \times THQ$$

where:

THQ = target hazard quotient
C = site contaminant concentration

5.16 Deriving Soil Gas SLs

The air SLs could apply to indoor air from, e.g., a vapor intrusion scenario. To model indoor air concentrations from other media (e.g., soil gas, groundwater), consult with regional experts in vapor intrusion.

For more information on EPA's current understanding of this emerging exposure pathway, please refer to EPA's recent draft guidance Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance) (USEPA 2002).

5.17 Mutagens

Some of the cancer causing analytes in this tool operate by a mutagenic mode of action for carcinogenesis. There is reason to surmise that some chemicals with a mutagenic mode of action, which would be expected to cause irreversible changes to DNA, would exhibit a greater effect in early-life versus later-life exposure. Cancer risk to children in the context of the U.S. Environmental Protection Agency's cancer guidelines (U.S. EPA, 2005 (PDF) (166 pp, 468 K)) includes both early-life exposures that may result in the occurrence of cancer during childhood and early-life exposures that may contribute to cancers later in life. In keeping with this guidance, separate cancer risk equations are presented for mutagens. The mutagen vinyl chloride has a unique set of equations. Consult Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens, EPA/630/R-03/003F, March 2005 (PDF) (126 pp, 1.78 MB) for further information.

The below table lists the chemicals considered to be carcinogenic by mutagenic mode of action for the purposes of the RSLs. Also provided in the table is a link to the source as to why the chemical is considered to be a mutagen.

Chemical	**CASRN**	**Reference**
	79-06-1	IRIS
Benz[a]anthracene	56-55-3	Benzo[a]pyrene*
Benzidine	92-87-5	Supplemental Guidance
Benzo[a]pyrene	50-32-8	Supplemental Guidance
Benzo[b]fluoranthene	205-99-2	Benzo[a]pyrene*
Benzo[k]fluoranthene	207-08-9	Benzo[a]pyrene*
Chromium(VI)	18540-29-9	CalEPA and OPP
Chrysene	218-01-9	Benzo[a]pyrene*
Coke Oven Emissions	8007-45-2	70 Federal Register 19992
Dibenz[a,h]anthracene	53-70-3	Supplemental Guidance
Dibromo-3-chloropropane, 1,2-	96-12-8	PPRTV
Dimethylbenz(a)anthracene, 7,12-	57-97-6	Supplemental Guidance
Ethylene Oxide	75-21-8	IRIS
Indeno[1,2,3-cd]pyrene	193-39-5	Benzo[a]pyrene*
Methylcholanthrene, 3-	56-49-5	Supplemental Guidance
Methylene Chloride	75-09-2	IRIS
Methylene-bis(2-chloroaniline), 4,4'-	101-14-4	PPRTV
Nitrosodiethylamine, N-	55-18-5	Supplemental Guidance

Nitrosodimethylamine, N-	62-75-9	Supplemental Guidance
Nitroso-N-ethylurea, N-	759-73-9	Supplemental Guidance
Nitroso-N-methylurea, N-	684-93-5	Supplemental Guidance
Safrole	94-59-7	Supplemental Guidance
Trichloroethylene	79-01-6	IRIS
Trichloropropane, 1,2,3-	96-18-4	IRIS
Urethane	51-79-6	Supplemental Guidance
Vinyl Chloride	75-01-4	Supplemental Guidance

* Please see section 2.3.6 of this user guide regarding Relative Potency Factors (RPFs).

5.18 Trichloroethylene (TCE)

It is recommended that a regional risk assessor be consulted when evaluating TCE in any medium especially when less than chronic exposure scenarios are considered. The Superfund program issued a Compilation of Information Relating of Early/Interim Actions at Superfund Sites and the TCE IRIS Assessment (PDF) (3 pp, 929 K) memo in August 2014. Several regions have issued their own guidance as well.

In order to make the calculator display the correct results for TCE, the standard cancer and mutagen equations needed to be combined. Since TCE requires the use of different toxicity values for cancer and mutagen equations, it was decided to make a toxicity value adjustment factor for cancer (CAF) and mutagens (MAF). The adjustments were done for oral (o) and inhalation (i). These adjustment factors are used in the TCE equation images presented in section 4. The equations used are presented below. The adjustment factors are based on the adult-based toxicity values and these are the cancer toxicity values presented in the Generic Tables.

$$CAF_o\,(0.804) = \frac{CSF_o\left(\frac{3.7\times10^{-2}\,mg}{kg-day}\right)^{-1}\text{ NHL+Liver oral slope factor}}{CSF_o\left(\frac{4.6\times10^{-2}\,mg}{kg-day}\right)^{-1}\text{ Adult – based oral slope factor}} \quad MAF_o\,(0.202) = \frac{CSF_o\left(\frac{9.3\times10^{-3}\,mg}{kg-day}\right)^{-1}\text{ Kidney oral slope fact}}{CSF_o\left(\frac{4.6\times10^{-2}\,mg}{kg-day}\right)^{-1}\text{ Adult – based oral slope f}}$$

$$CAF_i\,(0.756) = \frac{IUR\left(3.1\times10^{-6}\,\mu g/m^3\right)^{-1}\text{ NHL+Liver unit risk estimate}}{IUR\left(4.1\times10^{-6}\,\mu g/m^3\right)^{-1}\text{ Adult – based unit risk estimate}} \quad MAF_i(0.244) = \frac{IUR\left(1\times10^{-6}\,\mu g/m^3\right)^{-1}\text{ Kidney unit risk esti}}{IUR\left(4.1\times10^{-6}\,\mu g/m^3\right)^{-1}\text{ Adult – based unit risk e}}$$

5.19 Mercuric Chloride (and other Mercury salts)

The IRIS RfC for "Mercury (elemental)" is used as a surrogate for "Mercuric Chloride (and other Mercury salts)". Note, that the VF for "Mercury (elemental)" is not used as a surrogate for "Mercuric Chloride (and other Mercury salts)". The use of the surrogate RfC would appear to be a violation of the RSL toxicity hierarchy because Cal EPA offers a RfC for Mercuric Chloride. However, the actual form of mercury evaluated for the Cal EPA RfC was elemental mercury. Since IRIS already had a RfC for "Mercury (elemental)", it was decided to use the tier 1 source over a tier 3 source.

5.20 Cyanide (CN-)

The IRIS RfC for "Hydrogen Cyanide" is used as a surrogate for "Cyanide (CN-)".

5.21 Thallic Oxide and Thallium Selenite

The oral RfD for thallic oxide, used in this website, is derived from the PPRTV oral RfD for thallium sulfate by molecular weight (MW) adjustments and stoichiometric calculations. Thallic oxide (Tl_2O_3) has a MW of 456.765 and thallium sulfate (Tl_2SO_4) has a MW of 504.82. To derive the oral RfD of 2E-05 mg/kg-day for thallic oxide, the thallium sulfate RfD of 2E-05 mg/kg-day is multiplied by the MW of thallic oxide (456.765) divided by the MW of thallium sulfate (504.82). The oral RfD for thallium selenite, used in this website, is derived from the PPRTV oral RfD for thallium by molecular weight (MW) adjustments and stoichiometric calculations. Thallium selenite (TlSe) has a MW of 283.34 and thallium (Tl) has a MW of 204.38. To derive the oral RfD of 1E-05 mg/kg-day for thallium selenite, the thallium RfD of 1E-05 mg/kg-day is multiplied by the MW of thallium selenite (283.34) divided by the MW of thallium (204.38).

5.22 Polycyclic Aromatic Hydrocarbons (PAHs)

For PAHs in soil, we have not made any recommendations on a default value, which is to say that the default assumption remains that these are 100% bioavailable. There is also no available in vitro method to estimate the oral RBA of PAHs. A small number of sites have elected to run swine or rat models to assess oral RBA, and the TRW has reviewed them before the RBA was accepted for use at the site. Guidance related to these topics can be found in the Soil Bioavailability at Superfund Sites Guidance.

5.23 Refractory Ceramic Fibers

The ATSDR chronic RfC for refractory ceramic fibers is presented in units of fibers/cm^3. The RfC presented in the tables and calculator is 0.03 fibers/cm^3, which differs from all other chemicals where the RfC unit is mg/m^3. When the chronic RfC is used in the standard RSL air inhalation equations, the resulting units are not in μg/m^3 like all the other chemicals. RSLs are only calculated for air as the medium. The air values in the RSL table are calculated using the equations below to give RSLs in fibers/m^3.

Resident Air Noncancer Equation

$$SL_{\text{res-air-rcf}}\left(\frac{\text{f}}{\text{m}^3}\right)=\frac{THQ\times AT_{\text{res-a}}\left(\frac{365\text{ days}}{\text{year}}\times ED_{\text{res}}\,(26\text{ years})\right)\times\left(\frac{1.0\times10^{6}\text{ cm}^3}{\text{m}^3}\right)}{EF_{\text{res}}\left(\frac{350\text{ days}}{\text{year}}\right)\times ED_{\text{res}}\,(26\text{ years})\times ET_{\text{res}}\left(\frac{24\text{ hours}}{\text{day}}\right)\times\left(\frac{1\text{ day}}{24\text{ hours}}\right)\times\frac{1}{RfC\left(\frac{\text{f}}{\text{cm}^3}\right)}}$$

Composite Worker Air Noncancer Equation

$$SL_{\text{w-air-rcf}}\left(\frac{\text{f}}{\text{m}^3}\right)=\frac{THQ\times AT_{\text{w}}\left(\frac{365\text{ days}}{\text{year}}\times ED_{\text{w}}\,(25\text{ years})\right)\times\left(\frac{1.0\times10^{6}\text{ cm}^3}{\text{m}^3}\right)}{EF_{\text{w}}\left(\frac{250\text{ days}}{\text{year}}\right)\times ED_{\text{w}}\,(25\text{ years})\times ET_{\text{w}}\left(\frac{8\text{ hours}}{\text{day}}\right)\times\left(\frac{1\text{ day}}{24\text{ hours}}\right)\times\frac{1}{RfC\left(\frac{\text{f}}{\text{cm}^3}\right)}}$$

Indoor Worker Air Noncancer Equation

$$SL_{\text{iw-air-rcf}}\left(\frac{\text{f}}{\text{m}^3}\right)=\frac{THQ\times AT_{\text{iw}}\left(\frac{365\text{ days}}{\text{year}}\times ED_{\text{iw}}\,(25\text{ years})\right)\times\left(\frac{1.0\times10^{6}\text{ cm}^3}{\text{m}^3}\right)}{EF_{\text{iw}}\left(\frac{250\text{ days}}{\text{year}}\right)\times ED_{\text{iw}}\,(25\text{ years})\times ET_{\text{iw}}\left(\frac{8\text{ hours}}{\text{day}}\right)\times\left(\frac{1\text{ day}}{24\text{ hours}}\right)\times\frac{1}{RfC\left(\frac{\text{f}}{\text{cm}^3}\right)}}$$

Outdoor Worker Air Noncancer Equation

$$SL_{\text{ow-air-rcf}}\left(\frac{\text{f}}{\text{m}^3}\right)=\frac{THQ\times AT_{\text{ow}}\left(\frac{365\text{ days}}{\text{year}}\times ED_{\text{ow}}\,(25\text{ years})\right)\times\left(\frac{1.0\times10^{6}\text{ cm}^3}{\text{m}^3}\right)}{EF_{\text{ow}}\left(\frac{225\text{ days}}{\text{year}}\right)\times ED_{\text{ow}}\,(25\text{ years})\times ET_{\text{ow}}\left(\frac{8\text{ hours}}{\text{day}}\right)\times\left(\frac{1\text{ day}}{24\text{ hours}}\right)\times\frac{1}{RfC\left(\frac{\text{f}}{\text{cm}^3}\right)}}$$

Refractory Ceramic Fibers Air RSLs (fibers/m^3)

Land Use	**THI = 0.1**	**THI = 1.0**
Resident	3128	31286
Composite Worker	13140	131400
Indoor Worker	13140	131400
Outdoor Worker	14600	146000

5.24 Lanthanum Salts

The oral chronic RfDs for lanthanum salts, used in this website, are derived from the PPRTV oral chronic RfD for lanthanum by molecular weight (MW) adjustments and stoichiometric calculations. Lanthanum chloride, anhydrous ($LaCl_3$) has a MW of 245.27, and lanthanum (La) has a MW of 138.91. To derive the chronic oral RfD of 2.83E-05 mg/kg-day for lanthanum chloride, anhydrous, the lanthanum RfD of 5E-05 mg/kg-day is multiplied by the MW of lanthanum (138.91) divided by the MW of lanthanum chloride, anhydrous (245.27). To derive the chronic oral RfD of 1.87E-05 mg/kg-day for lanthanum chloride heptahydrate, the lanthanum RfD of 5E-05 mg/kg-day is multiplied by the MW of lanthanum (138.91) divided by the MW of lanthanum chloride heptahydrate (371.37). To derive the chronic oral RfD of 1.60E-05 mg/kg-day for lanthanum nitrate hexahydrate, the lanthanum RfD of 5E-05 mg/kg-day is multiplied by the MW of lanthanum (138.91) divided by the MW of lanthanum nitrate hexahydrate (433.01). To derive the chronic oral RfD of 2.08E-05 mg/kg-day for lanthanum acetate hydrate, the lanthanum RfD of 5E-05 mg/kg-day is multiplied by the MW of lanthanum (138.91) divided by the MW of lanthanum acetate hydrate (334.05).

6. Using the Calculator

The Calculator can be used to generate site-specific SLs or PRGs. The calculator requires the user to make some simple selections. To use the calculator Select a land use. Next, select whether you want Default or Site-specific SLs. Selecting default screening levels will reproduce the results in the generic Generic Tables. Selecting Site-Specific will allow you to change exposure parameters. Now pick your analytes. To pick several in a row, depress the left mouse button and drag, then release. Or hold the Ctrl key down and select multiple analytes that are not in a row. Select the output option. Hit the retrieve button. If you selected Site-Specific, the next page allows you to change exposure parameters. Hit the retrieve button. SLs are being calculated. The first table presents the input parameters that were selected. The next table contains the screening levels. This table can be too big to print. The easiest way to manage this table is to move it to a spreadsheet or a database. To copy this table, hold the left mouse key down and drag across the entire table. when done, press Ctrl c to copy. Switch to a spreadsheet and press Ctrl v to paste.

- **Table 1. Standard Default Factors**

Symbol	Definition (units)	Default	Reference
SLs			
Resident SLs			
$SL_{res-sol-nc-ing}$	Resident Soil Noncarcinogenic Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{res-sol-nc-der}$	Resident Soil Noncarcinogenic Dermal (mg/kg)	Contaminant-specific	Determined in this calculator

$SL_{res-sol-nc-inh}$	Resident Soil Noncarcinogenic Inhalation (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{res-sol-nc-tot}$	Resident Soil Noncarcinogenic Total (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{res-sol-ca-ing}$	Resident Soil Carcinogenic Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{res-sol-ca-der}$	Resident Soil Carcinogenic Dermal (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{res-sol-ca-inh}$	Resident Soil Carcinogenic Inhalation (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{res-sol-ca-tot}$	Resident Soil Carcinogenic Total (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{res-sol-mu-ing}$	Resident Soil Mutagenic Ingestion (mg/kg)	Mutagen-specific	Determined in this calculator
$SL_{res-sol-mu-der}$	Resident Soil Mutagenic Dermal (mg/kg)	Mutagen-specific	Determined in this calculator
$SL_{res-sol-mu-inh}$	Resident Soil Mutagenic Inhalation (mg/kg)	Mutagen-specific	Determined in this calculator
$SL_{res-sol-mu-tot}$	Resident Soil Mutagenic Total (mg/kg)	Mutagen-specific	Determined in this calculator
$SL_{res-sol-ca-vc-ing}$	Resident Soil Carcinogenic Vinyl Chloride Ingestion (mg/kg)	Vinyl Chloride -specific	Determined in this calculator

$SL_{res\text{-}sol\text{-}ca\text{-}vc\text{-}der}$	Resident Soil Carcinogenic Vinyl Chloride Dermal (mg/kg)	Vinyl Chloride-specific	Determined in this calculator
$SL_{res\text{-}sol\text{-}ca\text{-}vc\text{-}inh}$	Resident Soil Carcinogenic Vinyl Chloride Inhalation (mg/kg)	Vinyl Chloride-specific	Determined in this calculator
$SL_{res\text{-}sol\text{-}ca\text{-}vc\text{-}tot}$	Resident Soil Carcinogenic Vinyl Chloride Total (mg/kg)	Vinyl Chloride-specific	Determined in this calculator
$SL_{res\text{-}sol\text{-}tce\text{-}ing}$	Resident Soil Trichloroethylene Ingestion (mg/kg)	Trichloroethylene-specific	Determined in this calculator
$SL_{res\text{-}sol\text{-}tce\text{-}der}$	Resident Soil Trichloroethylene Dermal (mg/kg)	Trichloroethylene-specific	Determined in this calculator
$SL_{res\text{-}sol\text{-}tce\text{-}inh}$	Resident Soil Trichloroethylene Inhalation (mg/kg)	Trichloroethylene-specific	Determined in this calculator
$SL_{res\text{-}sol\text{-}tce\text{-}tot}$	Resident Soil Trichloroethylene Total (mg/kg)	Trichloroethylene-specific	Determined in this calculator
$SL_{water\text{-}nc\text{-}ing}$	Resident Tapwater Noncarcinogenic Ingestion (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{water\text{-}nc\text{-}der}$	Resident Tapwater Noncarcinogenic Dermal (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{water\text{-}nc\text{-}inh}$	Resident Tapwater Noncarcinogenic Inhalation (µg/L)	Contaminant-specific	Determined in this calculator

$SL_{water-nc-tot}$	Resident Tapwater Noncarcinogenic Total (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{water-ca-ing}$	Resident Tapwater Carcinogenic Ingestion (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{water-ca-der}$	Resident Tapwater Carcinogenic Dermal (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{water-ca-inh}$	Resident Tapwater Carcinogenic Inhalation (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{water-ca-tot}$	Resident Tapwater Carcinogenic Total (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{water-mu-ing}$	Resident Tapwater Mutagenic Ingestion (µg/L)	Mutagen-specific	Determined in this calculator
$SL_{water-mu-der}$	Resident Tapwater Mutagenic Dermal (µg/L)	Mutagen-specific	Determined in this calculator
$SL_{water-mu-inh}$	Resident Tapwater Mutagenic Inhalation (µg/L)	Mutagen-specific	Determined in this calculator
$SL_{water-mu-tot}$	Resident Tapwater Mutagenic Total (µg/L)	Mutagen-specific	Determined in this calculator
$SL_{res-water-ca-vc-ing}$	Resident Tapwater Carcinogenic Vinyl Chloride Ingestion (µg/L)	Vinyl Chloride-specific	Determined in this calculator
$SL_{res-water-ca-vc-der}$	Resident Tapwater Carcinogenic Vinyl Chloride Dermal (µg/L)	Vinyl Chloride-specific	Determined in this calculator

$SL_{res\text{-}water\text{-}ca\text{-}vc\text{-}inh}$	Resident Tapwater Carcinogenic Vinyl Chloride Inhalation (µg/L)	Vinyl Chloride-specific	Determined in this calculator
$SL_{res\text{-}water\text{-}ca\text{-}vc\text{-}tot}$	Resident Tapwater Carcinogenic Vinyl Chloride Total (µg/L)	Vinyl Chloride-specific	Determined in this calculator
$SL_{water\text{-}tce\text{-}ing}$	Resident Tapwater Trichloroethylene Ingestion (µg/L)	Trichloroethylene-specific	Determined in this calculator
$SL_{water\text{-}tce\text{-}der}$	Resident Tapwater Trichloroethylene Dermal (µg/L)	Trichloroethylene-specific	Determined in this calculator
$SL_{water\text{-}tce\text{-}inh}$	Resident Tapwater Trichloroethylene Inhalation (µg/L)	Trichloroethylene-specific	Determined in this calculator
$SL_{water\text{-}tce\text{-}tot}$	Resident Tapwater Trichloroethylene Total (µg/L)	Trichloroethylene-specific	Determined in this calculator
$SL_{res\text{-}air\text{-}nc}$	Resident Air Noncarcinogenic (µg/m^3)	Contaminant-specific	Determined in this calculator
$SL_{res\text{-}air\text{-}ca}$	Resident Air Carcinogenic (µg/m^3)	Contaminant-specific	Determined in this calculator
$SL_{res\text{-}air\text{-}mu}$	Resident Air Mutagenic (µg/m^3)	Mutagen-specific	Determined in this calculator
$SL_{res\text{-}air\text{-}ca\text{-}vinyl\ chloride}$	Resident Air Carcinogenic Vinyl Chloride (µg/m^3)	Vinyl Chloride-specific	Determined in this calculator
$SL_{res\text{-}air\text{-}tce}$	Resident Air Trichloroethylene (µg/m^3)	Trichloroethylene-specific	Determined in this calculator

Worker SLs			
$SL_{w-sol-nc-ing}$	Composite Worker Soil Noncarcinogenic Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{w-sol-nc-der}$	Composite Worker Soil Noncarcinogenic Dermal (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{w-sol-nc-inh}$	Composite Worker Soil Noncarcinogenic Inhalation (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{w-sol-nc-tot}$	Composite Worker Soil Noncarcinogenic Total (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{w-sol-ca-ing}$	Composite Worker Soil Carcinogenic Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{w-sol-ca-der}$	Composite Worker Soil Carcinogenic Dermal (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{w-sol-ca-inh}$	Composite Worker Soil Carcinogenic Inhalation (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{w-sol-ca-tot}$	Composite Worker Soil Carcinogenic Total (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{w-air-nc}$	Composite Worker Air Noncarcinogenic ($\mu g/m^3$)	Contaminant-specific	Determined in this calculator
$SL_{w-air-ca}$	Composite Worker Air Carcinogenic ($\mu g/m^3$)	Contaminant-specific	Determined in this calculator

$SL_{ow\text{-}sol\text{-}nc\text{-}ing}$	Outdoor Worker Soil Noncarcinogenic Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{ow\text{-}sol\text{-}nc\text{-}der}$	Outdoor Worker Soil Noncarcinogenic Dermal (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{ow\text{-}sol\text{-}nc\text{-}inh}$	Outdoor Worker Soil Noncarcinogenic Inhalation (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{ow\text{-}sol\text{-}nc\text{-}tot}$	Outdoor Worker Soil Noncarcinogenic Total (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{ow\text{-}sol\text{-}ca\text{-}ing}$	Outdoor Worker Soil Carcinogenic Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{ow\text{-}sol\text{-}ca\text{-}der}$	Outdoor Worker Soil Carcinogenic Dermal (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{ow\text{-}sol\text{-}ca\text{-}inh}$	Outdoor Worker Soil Carcinogenic Inhalation (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{ow\text{-}sol\text{-}ca\text{-}tot}$	Outdoor Worker Soil Carcinogenic Total (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{ow\text{-}air\text{-}nc}$	Outdoor Worker Air Noncarcinogenic ($\mu g/m^3$)	Contaminant-specific	Determined in this calculator
$SL_{ow\text{-}air\text{-}ca}$	Outdoor Worker Air Carcinogenic ($\mu g/m^3$)	Contaminant-specific	Determined in this calculator
$SL_{iw\text{-}sol\text{-}nc\text{-}ing}$	Indoor Worker Soil Noncarcinogenic Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator

$SL_{iw-sol-nc-inh}$	Indoor Worker Soil Noncarcinogenic Inhalation (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{iw-sol-nc-tot}$	Indoor Worker Soil Noncarcinogenic Total (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{iw-sol-ca-ing}$	Indoor Worker Soil Carcinogenic Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{iw-sol-ca-inh}$	Indoor Worker Soil Carcinogenic Inhalation (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{iw-sol-ca-tot}$	Indoor Worker Soil Carcinogenic Total (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{iw-air-nc}$	Indoor Worker Air Noncarcinogenic (μg/m^3)	Contaminant-specific	Determined in this calculator
$SL_{iw-air-ca}$	Indoor Worker Air Carcinogenic (μg/m^3)	Contaminant-specific	Determined in this calculator
$SL_{cw-sol-nc-ing}$	Construction Worker Soil Noncarcinogenic Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{cw-sol-nc-der}$	Construction Worker Soil Noncarcinogenic Dermal (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{cw-sol-nc-inh}$	Construction Worker Soil Noncarcinogenic Inhalation (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{cw-sol-nc-tot}$	Construction Worker Soil Noncarcinogenic Total (mg/kg)	Contaminant-specific	Determined in this calculator

$SL_{cw\text{-}sol\text{-}ca\text{-}ing}$	Construction Worker Soil Carcinogenic Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{cw\text{-}sol\text{-}ca\text{-}der}$	Construction Worker Soil Carcinogenic Dermal (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{cw\text{-}sol\text{-}ca\text{-}inh}$	Construction Worker Soil Carcinogenic Inhalation (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{cw\text{-}sol\text{-}ca\text{-}tot}$	Construction Worker Soil Carcinogenic Total (mg/kg)	Contaminant-specific	Determined in this calculator
Recreator SLs			
$SL_{rec\text{-}sol\text{-}nc\text{-}ing}$	Recreator Soil Noncarcinogenic Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{rec\text{-}sol\text{-}nc\text{-}der}$	Recreator Soil Noncarcinogenic Dermal (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{rec\text{-}sol\text{-}nc\text{-}inh}$	Recreator Soil Noncarcinogenic Inhalation (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{rec\text{-}sol\text{-}nc\text{-}tot}$	Recreator Soil Noncarcinogenic Total (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{rec\text{-}sol\text{-}ca\text{-}ing}$	Recreator Soil Carcinogenic Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{rec\text{-}sol\text{-}ca\text{-}der}$	Recreator Soil Carcinogenic Dermal (mg/kg)	Contaminant-specific	Determined in this calculator

$SL_{rec-sol-ca-inh}$	Recreator Soil Carcinogenic Inhalation (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{rec-sol-ca-tot}$	Recreator Soil Carcinogenic Total (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{rec-sol-mu-ing}$	Recreator Soil Mutagenic Ingestion (mg/kg)	Mutagenic-specific	Determined in this calculator
$SL_{rec-sol-mu-der}$	Recreator Soil Mutagenic Dermal (mg/kg)	Mutagenic-specific	Determined in this calculator
$SL_{rec-sol-mu-inh}$	Recreator Soil Mutagenic Inhalation (mg/kg)	Mutagenic-specific	Determined in this calculator
$SL_{rec-sol-mu-tot}$	Recreator Soil Mutagenic Total (mg/kg)	Mutagenic-specific	Determined in this calculator
$SL_{rec-sol-ca-vc-ing}$	Recreator Soil Carcinogenic Vinyl Chloride Ingestion (mg/kg)	Vinyl Chloride-specific	Determined in this calculator
$SL_{rec-sol-ca-vc-der}$	Recreator Soil Carcinogenic Vinyl Chloride Dermal (mg/kg)	Vinyl Chloride-specific	Determined in this calculator
$SL_{rec-sol-ca-vc-inh}$	Recreator Soil Carcinogenic Vinyl Chloride Inhalation (mg/kg)	Vinyl Chloride-specific	Determined in this calculator
$SL_{rec-sol-ca-vc-tot}$	Recreator Soil Carcinogenic Vinyl Chloride Total (mg/kg)	Vinyl Chloride-specific	Determined in this calculator
$SL_{rec-sol-tce-ing}$	Recreator Soil Trichloroethylene Ingestion (mg/kg)	Trichloroethylene-specific	Determined in this calculator

$SL_{rec-sol-tce-der}$	Recreator Soil Trichloroethylene Dermal (mg/kg)	Trichloroethylene-specific	Determined in this calculator
$SL_{rec-sol-tce-inh}$	Recreator Soil Trichloroethylene Inhalation (mg/kg)	Trichloroethylene-specific	Determined in this calculator
$SL_{rec-sol-tce-tot}$	Recreator Soil Trichloroethylene Total (mg/kg)	Trichloroethylene-specific	Determined in this calculator
$SL_{rec-water-nc-ing}$	Recreator Surface Water Non-Carcinogenic Ingestion (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{rec-water-nc-der}$	Recreator Surface Water Non-Carcinogenic Dermal (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{rec-water-nc-tot}$	Recreator Surface Water Non-Carcinogenic Total (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{rec-water-ca-ing}$	Recreator Surface Water Carcinogenic Ingestion (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{rec-water-ca-der}$	Recreator Surface Water Carcinogenic Dermal (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{rec-water-ca-tot}$	Recreator Surface Water Carcinogenic Total (µg/L)	Contaminant-specific	Determined in this calculator
$SL_{rec-water-mu-ing}$	Recreator Surface Water Mutagenic Ingestion (µg/L)	Mutagen-specific	Determined in this calculator
$SL_{rec-water-mu-der}$	Recreator Surface Water Mutagenic Dermal (µg/L)	Mutagen-specific	Determined in this calculator

$SL_{rec\text{-}water\text{-}mu\text{-}tot}$	Recreator Surface Water Mutagenic Total (µg/L)	Mutagen-specific	Determined in this calculator
$SL_{rec\text{-}water\text{-}vc\text{-}ing}$	Recreator Surface Water Carcinogenic Vinyl Chloride Ingestion (µg/L)	Vinyl Chloride-specific	Determined in this calculator
$S_{rec\text{-}water\text{-}vc\text{-}der}$	Recreator Surface Water Carcinogenic Vinyl Chloride Dermal (µg/L)	Vinyl Chloride-specific	Determined in this calculator
$SL_{rec\text{-}water\text{-}vc\text{-}tot}$	Recreator Surface Water Carcinogenic Vinyl Chloride Total (µg/L)	Vinyl Chloride-specific	Determined in this calculator
$SL_{rec\text{-}water\text{-}tce\text{-}ing}$	Recreator Surface Water Trichlroethylene Ingestion (µg/L)	Trichlroethylene-specific	Determined in this calculator
$SL_{rec\text{-}water\text{-}tce\text{-}der}$	Recreator Surface Water Trichlroethylene Dermal (µg/L)	Trichlroethylene-specific	Determined in this calculator
$SL_{rec\text{-}water\text{-}tce\text{-}tot}$	Recreator Surface Water Trichlroethylene Total (µg/L)	Trichlroethylene-specific	Determined in this calculator
Fish SLs			
$SL_{res\text{-}fsh\text{-}nc\text{-}ing}$	Resident Fish Noncarcinogenic Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator
$SL_{res\text{-}fsh\text{-}ca\text{-}ing}$	Resident Fish Carcinogenic Ingestion (mg/kg)	Contaminant-specific	Determined in this calculator
Toxicity Values			
RfD_o or RFDOC	Chronic Oral Reference Dose (mg/kg-day)	Contaminant-specific	EPA Superfund hierarchy

RfC or RFCIC	Chronic Inhalation Reference Concentration (mg/m^3)	Contaminant-specific	EPA Superfund hierarchy
CSF_o or SFO	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Contaminant-specific	EPA Superfund hierarchy
IUR	Inhalation Unit Risk $(\mu g/m^3)^{-1}$	Contaminant-specific	EPA Superfund hierarchy
Miscellaneous Variables			
TR	target risk	1×10^{-6}	Selected by user
THQ	target hazard quotient	0.1	Selected by user
THI	target hazard index	0.1	Selected by user
RBA	relative bioavailability factor	Arsenic = 0.6 All Others = 1	U.S. EPA 2012
K	Andelman Volatilization Factor (L/m^3)	0.5	U.S. EPA 1991b (pg. 20)
K_p	Dermal Permeability Constant (cm/hour)	Contaminant-specific Inorganic default = 0.001	U.S. EPA 2004 Exhibit 3-1 and Section 3.1.2.1
$K_{p,ve}$	Steady-state Permeability Coefficient (cm/hour)	Contaminant-specific	U.S. EPA 2004
K_{ew}	Equillibrium Partition Coefficient between epidermis and water (unitless)	1 - assuming epidermis behaves essentially as water	U.S. EPA 2004

D_e	Effective Diffusivity of absorbing chemical in the epidermis (cm^2/sec)	$(7.1 \times 10^{-6}) / (\sqrt{MW})$	U.S. EPA 2004
L_e	Effective Thickness of the Epidermis (cm)	10^{-2}	U.S. EPA 2004
AT_{res-c}	Averaging time - resident child (days)	365 x ED_{res-c} = 2190	U.S. EPA 1989 (pg. 6-23)
AT_{res-a}	Averaging time - resident adult (days)	365 x ED_{res} = 9490	U.S. EPA 1989 (pg. 6-23)
AT_{res}	Averaging time - resident age adjusted (days)	365 x LT = 25550	U.S. EPA 1989 (pg. 6-23)
AT_{w-a}	Averaging time - composite worker (days)	365 x ED_w = 9125 (non-carcinogenic)	U.S. EPA 1989 (pg. 6-23)
AT_w	Averaging time - composite worker (days)	365 x LT = 25550 (carcinogenic)	U.S. EPA 1989 (pg. 6-23)
AT_{iw-a}	Averaging time - indoor worker (days)	365 x ED_{iw} = 9125 (non-carcinogenic)	U.S. EPA 1989 (pg. 6-23)
AT_{iw}	Averaging time - indoor worker soil (days)	365 x LT = 25550 (carcinogenic)	U.S. EPA 1989 (pg. 6-23)
AT_{ow-a}	Averaging time - outdoor worker (days)	365 x ED_{ow} = 9125 (non-carcinogenic)	U.S. EPA 1989 (pg. 6-23)
AT_{ow}	Averaging time - outdoor worker (days)	365 x LT = 25550 (carcinogenic)	U.S. EPA 1989 (pg. 6-23)
AT_{cw-a}	Averaging time - construction worker (days)	EWcw x 7 (d/wk) x EDcw = 350 (non-carcinogenic)	U.S. EPA 1989 (pg. 6-23)

AT_{cw}	Averaging time - construction worker (days)	365 x LT = 25550 (carcinogenic)	U.S. EPA 1989 (pg. 6-23)
AT_{rec-c}	Averaging time - recreator child (days)	365 x ED_{rec-c}	U.S. EPA 1989 (pg. 6-23)
AT_{rec-a}	Averaging time - recreator adult (days)	365 x ED_{rec-a}	U.S. EPA 1989 (pg. 6-23)
AT_{rec}	Averaging time - recreator (days)	365 x LT	U.S. EPA 1989 (pg. 6-23)
LT	Lifetime (years)	70	U.S. EPA 1989 (pg. 6-22)
$\Delta H_{v,b}$	Enthalpy of vaporization at the normal boiling point (cal/mol)	Contaminant-specific	See Chemical-specific hierarchy
$\Delta H_{v,gw}$	Enthalpy of vaporization at temperature of groundwater (cal/mol)	Contaminant-specific	Determined in this calculator
HLC	Henry's Law Constant at specified groundwater temperature (atm-m^3/mol)	Contaminant-specific	See Chemical-specific hierarchy
T_w	Groundwater Temperatures (Kelvin)	Site-specific	Site-specific
T_C	Critical Temperatures (Kelvin)	Contaminant-specific	See Chemical-specific hierarchy

T_b	Normal Boiling Point (Kelvin)	Contaminant-specific	See Chemical-specific hierarchy

n	If ($T_b/T_C < 0.57$)
	If ($T_b/T_C > 0.71$)
	If ($0.57 < T_b/T_C \leq 0.71$)
		n = 0.3
		n = 0.41
		n = ($0.74 \times T_b/T_C$ - 0.116)
			U.S. EPA Fact Sheet Unitless exponent values used to determine ΔHv,gw

Ingestion and Dermal Contact Rates			
IRW_{res-c}	Resident Drinking Water Ingestion Rate - Child (L/day)	0.78	U.S. EPA 2011, Tables 3-15 and 3-33; weighted average of 90th percentile consumer-only ingestion of drinking water (birth to <6 years)
IRW_{res-a}	Resident Drinking Water Ingestion Rate - Adult (L/day)	2.5	U.S. EPA 2011, Table 3-33; 90th percentile of consumer-only ingestion of drinking water (>= 21 years)
$IFW_{res-adj}$	Resident Drinking Water Ingestion Rate - Age-adjusted (L/kg)	327.95	Calculated using the age adjusted intake factors equation
$IFWM_{res-adj}$	Resident Mutagenic Drinking Water Ingestion Rate - Age-adjusted (L/kg)	1019.9	Calculated using the age adjusted intake factors equation
IRS_{res-c}	Resident Soil Ingestion Rate - Child (mg/day)	200	U.S. EPA 1991a (pg. 15)
IRS_{res-a}	Resident Soil Ingestion Rate - Adult (mg/day)	100	U.S. EPA 1991a (pg. 15)
$IFS_{res-adj}$	Resident Soil Ingestion Rate - Age-adjusted (mg/kg)	36750	Calculated using the age adjusted intake factors equation

$IFSM_{res\text{-}adj}$	Resident Mutagenic Soil Ingestion Rate - Age-adjusted (mg/kg)	166833.33	Calculated using the age adjusted intake factors equation
IR_{iw}	Indoor Worker Soil Ingestion Rate (mg/day)	50	U.S. EPA 1991a (pg. 15)
IR_{ow}	Outdoor Worker Soil Ingestion Rate (mg/day)	100	U.S. EPA 1991a (pg. 15)
IR_{cw}	Construction Worker Soil Ingestion Rate (mg/day)	330	U.S. EPA 2002 Exhibit 5-1
IR_{w}	Composite Worker Soil Ingestion Rate (mg/day)	100	U.S. EPA 1991a (pg. 15)
$IRW_{rec\text{-}c}$	Recreator Surface Water Ingestion Rate - Child (L/hour)	0.12	U.S. EPA 2011, Table 3.5
$IRW_{rec\text{-}a}$	Recreator Surface Water Ingestion Rate - Adult (L/hour)	0.071	U.S. EPA 2011, Table 3.5
$IFW_{rec\text{-}adj}$	Recreator Surface Water Ingestion Rate - Age-adjusted (L/kg)	Site-specific	Calculated using the age adjusted intake factors equation
$IRW_{0\text{-}2}$	Surface Water Ingestion Rate - Age Segment 0-2 (L/hour)	0.12	U.S. EPA 2011, Table 3.5
$IRW_{2\text{-}6}$	Surface Water Ingestion Rate - Age Segment 2-6 (L/hour)	0.12	U.S. EPA 2011, Table 3.5
$IRW_{6\text{-}16}$	Surface Water Ingestion Rate - Age Segment 6-16 (L/hour)	0.071	U.S. EPA 2011, Table 3.5

$IRW_{16\text{-}26}$	Surface Water Ingestion Rate - Age Segment 16-26 (L/hour)	0.071	U.S. EPA 2011, Table 3.5
$IFWM_{rec\text{-}adj}$	Recreator Mutagenic Surface Water Ingestion Rate - Age-adjusted (L/kg)	Site-specific	Calculated using the age adjusted intake factors equation
$IRS_{rec\text{-}c}$	Recreator Soil Ingestion Rate - Child (mg/day)	200	U.S. EPA 1991a (pg. 15)
$IRS_{rec\text{-}a}$	Recreator Soil Ingestion Rate - Adult (mg/day)	100	U.S. EPA 1991a (pg. 15)
$IFS_{rec\text{-}adj}$	Recreator Soil Ingestion Rate - Age-adjusted (mg/kg)	Site-specific	Calculated using the age adjusted intake factors equation
$IRS_{0\text{-}2}$	Soil Ingestion Rate - Age-segment 0-2 (mg/day)	200	U.S. EPA 1991a (pg. 15)
$IRS_{2\text{-}6}$	Soil Ingestion Rate - Age-segment 2-6 (mg/day)	200	U.S. EPA 1991a (pg. 15)
$IRS_{6\text{-}16}$	Soil Ingestion Rate - Age-segment 6-16 (mg/day)	100	U.S. EPA 1991a (pg. 15)
$IRS_{16\text{-}26}$	Soil Ingestion Rate - Age-segment 16-26 (mg/day)	100	U.S. EPA 1991a (pg. 15)
$IFSM_{rec\text{-}adj}$	Recreator Mutagenic Soil Ingestion Rate - Age-adjusted (mg/kg)	Site-specific	Calculated using the age adjusted intake factors equation
$DFS_{res\text{-}adj}$	Resident soil dermal contact factor- age-adjusted (mg/kg)	103390	Calculated using the age adjusted intake factors equation
$DFSM_{res\text{-}adj}$	Resident Mutagenic soil dermal contact factor- age-adjusted (mg/kg)	428260	Calculated using the age adjusted intake factors equation

$DFS_{rec\text{-}adj}$	Recreator soil dermal contact factor- age-adjusted (mg/kg)	Site-specific	Calculated using the age adjusted intake factors equation
$DFSM_{rec\text{-}adj}$	Recreator Mutagenic soil dermal contact factor- age-adjusted (mg/kg)	Site-specific	Calculated using the age adjusted intake factors equation
$DFW_{res\text{-}adj}$	Resident water dermal contact factor- age-adjusted (cm^2 - event/kg)	2610650	Calculated using the age adjusted intake factors equation
$DFWM_{res\text{-}adj}$	Resident Mutagenic water dermal contact factor- age-adjusted (cm^2 - event/kg)	8191633	Calculated using the age adjusted intake factors equation
$DFW_{rec\text{-}adj}$	Recreator water dermal contact factor- age-adjusted (cm^2 - event/kg)	Site-specific	Calculated using the age adjusted intake factors equation
$DFWM_{rec\text{-}adj}$	Recreator Mutagenic water dermal contact factor- age-adjusted (cm^2 - event/kg)	Site-specific	Calculated using the age adjusted intake factors equation
$IRF_{res\text{-}a}$	Fish Ingestion Rate (mg/day)	Site-specific	Recommend using site-specific values
$SA_{res\text{-}c}$	Resident surface area soil - child (cm^2/day)	2373	U.S. EPA 2011a, Tables 7-2 and 7-8; weighted average of mean values for head, hands, forearms, lower legs, and feet (male and female, birth to < 6 years)(forearm and lower leg-specific data used when available, ratios for nearest available age group used elsewhere)

$SA_{res\text{-}a}$	Resident surface area soil - adult (cm^2/day)	6032	U.S. EPA 2011, Tables 7-2 and 7-12; weighted average of mean values for head, hands, forearms, lower legs, and feet (male and female, 21+ years) (forearm and lower leg-specific data used for males and female lower leg; ratio of male forearm to arm applied to female arm data.
$SA_{res\text{-}c}$	Resident surface area water - child (cm^2)	6365	U.S. EPA 2014, weighted average of mean values for children <6 years.
$SA_{res\text{-}a}$	Resident surface area water - adult (cm^2)	19652	U.S. EPA 2014, weighted average of mean values for adults, male and female 21+.
SA_{ow}	Outdoor Worker soil surface area - adult (cm^2/day)	3527	US EPA 2011a, Table 7-2; weighted average of mean values for head, hands, and forearms (male and female, 21+years)
SA_{cw}	Construction Worker soil surface area - adult (cm^2/day)	3527	US EPA 2011a, Table 7-2; weighted average of mean values for head, hands, and forearms (male and female, 21+years)
SA_w	Composite Worker soil surface area - adult (cm^2/day)	3527	US EPA 2011a, Table 7-2; weighted average of mean values for head, hands, and forearms (male and female, 21+years)

$SA_{rec\text{-}c}$	Recreator surface area soil - child (cm^2/day)	2373	U.S. EPA 2011a, Tables 7-2 and 7-8; weighted average of mean values for head, hands, forearms, lower legs, and feet (male and female, birth to < 6 years)(forearm and lower leg-specific data used when available, ratios for nearest available age group used elsewhere)
$SA_{rec\text{-}a}$	Recreator surface area soil - adult (cm^2/day)	6032	U.S. EPA 2011, Tables 7-2 and 7-12; weighted average of mean values for head, hands, forearms, lower legs, and feet (male and female, 21+ years) (forearm and lower leg-specific data used for males and female lower leg; ratio of male forearm to arm applied to female arm data.
$SA_{rec\text{-}c}$	Recreator surface area water - child (cm^2)	6365	U.S. EPA 2014, weighted average of mean values for children <6 years.
$SA_{rec\text{-}a}$	Recreator surface area water - adult (cm^2)	19652	U.S. EPA 2014, weighted average of mean values for adults, male and female 21+.
$SA_{0\text{-}2}$	Resident/Recreator surface area soil - age segment 0-2 (cm^2/day)	2373	U.S. EPA 2011a, Tables 7-2 and 7-8; weighted average of mean values for head, hands, forearms, lower legs, and feet (male and female, birth to < 6 years)(forearm and lower leg-specific data used when available, ratios for nearest available age group used elsewhere)

SA_{2-6}	Resident/Recreator surface area soil - age segment 2-6 (cm^2/day)	2373	U.S. EPA 2011a, Tables 7-2 and 7-8; weighted average of mean values for head, hands, forearms, lower legs, and feet (male and female, birth to < 6 years)(forearm and lower leg-specific data used when available, ratios for nearest available age group used elsewhere)
SA_{6-16}	Resident/Recreator surface area soil - age segment 6-16 (cm^2/day)	6032	U.S. EPA 2011, Tables 7-2 and 7-12; weighted average of mean values for head, hands, forearms, lower legs, and feet (male and female, 21+ years) (forearm and lower leg-specific data used for males and female lower leg; ratio of male forearm to arm applied to female arm data.
SA_{16-26}	Resident/Recreator surface area soil - age segment 16-26 (cm^2/day)	6032	U.S. EPA 2011, Tables 7-2 and 7-12; weighted average of mean values for head, hands, forearms, lower legs, and feet (male and female, 21+ years) (forearm and lower leg-specific data used for males and female lower leg; ratio of male forearm to arm applied to female arm data.
SA_{0-2}	Resident/Recreator surface area water - age segment 0-2 (cm^2)	6365	U.S. EPA 2014, weighted average of mean values for children <6 years.
SA_{2-6}	Resident/Recreator surface area water - age segment 2-6 (cm^2)	6365	U.S. EPA 2014, weighted average of mean values for children <6 years.

$SA_{6\text{-}16}$	Resident/Recreator surface area water - age segment 6-16 (cm^2)	19652	U.S. EPA 2014, weighted average of mean values for adults, male and female 21+.
$SA_{16\text{-}26}$	Resident/Recreator surface area water - age segment 16-26 (cm^2)	19652	U.S. EPA 2014, weighted average of mean values for adults, male and female 21+.
$AF_{res\text{-}c}$	Resident soil adherence factor - child (mg/cm^2)	0.2	U.S. EPA 2002 (Exhibit 1-2)
$AF_{res\text{-}a}$	Resident soil adherence factor - adult (mg/cm^2)	0.07	U.S. EPA 2002 (Exhibit 1-2)
AF_{ow}	Outdoor Worker soil adherence factor (mg/cm^2)	0.12	U.S. EPA 2011, Table 7-20 and Section 7.2.2; arithmetic mean of weighted average of body part- specific (hands, forearms, and face) mean adherence factors for adult commercial/industrial activities
AF_{w}	Composite Worker soil adherence factor (mg/cm^2)	0.12	U.S. EPA 2011, Table 7-20 and Section 7.2.2; arithmetic mean of weighted average of body part- specific (hands, forearms, and face) mean adherence factors for adult commercial/industrial activities
AF_{cw}	Construction Worker soil adherence factor (mg/cm^2)	0.3	U.S. EPA 2002 (Exhibit 5-1)
$AF_{rec\text{-}c}$	Recreator soil adherence factor - child (mg/cm^2)	0.2	U.S. EPA 2002 (Exhibit 1-2)

$AF_{rec\text{-}a}$	Recreator soil adherence factor - adult (mg/cm^2)	0.07	U.S. EPA 2002 (Exhibit 1-2)
$AF_{0\text{-}2}$	Resident/Recreator soil adherence factor - age segment 0-2 (mg/cm^2)	0.2	U.S. EPA 2002 (Exhibit 1-2)
$AF_{2\text{-}6}$	Resident/Recreator soil adherence factor - age segment 2-6 (mg/cm^2)	0.2	U.S. EPA 2002 (Exhibit 1-2)
$AF_{6\text{-}16}$	Resident/Recreator soil adherence factor - age segment 6-16 (mg/cm^2)	0.07	U.S. EPA 2002 (Exhibit 1-2)
$AF_{16\text{-}26}$	Resident/Recreator soil adherence factor - age segment 16-26 (mg/cm^2)	0.07	U.S. EPA 2002 (Exhibit 1-2)
$BW_{res\text{-}c}$	Resident Body Weight - child (kg)	15	U.S. EPA 1991a (pg. 15)
$BW_{res\text{-}a}$	Resident Body Weight - adult (kg)	80	U.S. EPA 2011, Table 8-3; weighted mean values for adults 21 - 78
$BW_{rec\text{-}c}$	Recreator Body Weight - child (kg)	15	U.S. EPA 1991a (pg. 15)
$BW_{rec\text{-}a}$	Recreator Body Weight - adult (kg)	80	U.S. EPA 2011, Table 8-3; weighted mean values for adults 21 - 78
$BW_{0\text{-}2}$	Resident/Recreator Body Weight - age segment 0-2 (kg)	15	U.S. EPA 1991a (pg. 15)
$BW_{2\text{-}6}$	Resident/Recreator Body Weight - age segment 2-6 (kg)	15	U.S. EPA 1991a (pg. 15)

BW_{6-16}	Resident/Recreator Body Weight - age segment 6-16 (kg)	80	U.S. EPA 2011, Table 8-3; weighted mean values for adults 21 - 78
BW_{16-26}	Resident/Recreator Body Weight - age segment 16-26 (kg)	80	U.S. EPA 2011, Table 8-3; weighted mean values for adults 21 - 78
BW_{ow}	Outdoor Worker Body Weight (kg)	80	U.S. EPA 1991a (pg. 15)
BW_{cw}	Construction Worker Body Weight (kg)	80	U.S. EPA 2011, Table 8-3; weighted mean values for adults 21 - 78
BW_{iw}	Indoor Worker Body Weight (kg)	80	U.S. EPA 2011, Table 8-3; weighted mean values for adults 21 - 78
BW_{w}	Composite Worker Body Weight (kg)	80	U.S. EPA 2011, Table 8-3; weighted mean values for adults 21 - 78
ABS_{d}	Fraction of contaminant absorbed dermally from soil (unitless)	Contaminant-specific Inorganic default = none VOC default = none SVOC default = 0.1	U.S. EPA 2004 (Exhibit 3-4 and section 3.2.2.4)
GIABS	Fraction of contaminant absorbed in gastrointestinal tract (unitless) Note: if the GIABS is >50% then it is set to 100% for the calculation of dermal toxicity values.	Contaminant-specific Inorganic default = 1.0 VOC default = 1.0 SVOC default = 1.0	U.S. EPA 2004 (Exhibit 4-1 and section 4.2)
DA_{event}	Absorbed dose per event ($\mu g/cm^2$ - event)	Contaminant-specific	U.S. EPA 2004 (Equation 3.2 and 3.3)

Exposure Frequency, Exposure Duration, and Exposure Time Variables			
EF_{res}	Resident Exposure Frequency (days/year)	350	U.S. EPA 1991a (pg. 15)
EF_{res-a}	Resident Exposure Frequency - adult (days/year)	350	U.S. EPA 1991a (pg. 15)
EF_{res-c}	Resident Exposure Frequency - child (days/year)	350	U.S. EPA 1991a (pg. 15)
EF_{w}	Composite Worker Exposure Frequency (days/year)	250	U.S. EPA 1991a (pg. 15)
EF_{iw}	Indoor Worker Exposure Frequency (days/year)	250	U.S. EPA 1991a (pg. 15)
EF_{ow}	Outdoor Worker Exposure Frequency (days/year)	225	U.S. EPA 2002 (Exhibit 1-2)
EF_{cw}	Construction Worker Exposure Frequency (days/year)	250	U.S. EPA 2002 Exhibit 5-1
EF_{rec}	Recreator Exposure Frequency (days/year)	Site-specific	Site-specific
EF_{rec-c}	Recreator Exposure Frequency - child (days/year)	Site-specific	Site-specific
EF_{rec-a}	Recreator Exposure Frequency - adult (days/year)	Site-specific	Site-specific
EF_{0-2}	Resident/Recreator Exposure Frequency - age segment 0-2 (days/year)	Resident - 350 Recreator - Site-specific	Resident - U.S. EPA 1991a (pg. 15) Recreator - Site-specific

EF_{2-6}	Resident/Recreator Exposure Frequency - age segment 2-6 (days/year)	Resident - 350 Recreator - Site-specific	Resident - U.S. EPA 1991a (pg. 15) Recreator - Site-specific
EF_{6-16}	Resident/Recreator Exposure Frequency - age segment 6-16 (days/year)	Resident - 350 Recreator - Site-specific	Resident - U.S. EPA 1991a (pg. 15) Recreator - Site-specific
EF_{16-26}	Resident/Recreator Exposure Frequency - age segment 16-26 (days/year)	Resident - 350 Recreator - Site-specific	Resident - U.S. EPA 1991a (pg. 15) Recreator - Site-specific
ED_{res}	Resident Exposure Duration (years)	26	EPA 2011, Table 16-108; 90th percentile for current residence time.
ED_{res-c}	Resident Exposure Duration - child (years)	6	U.S. EPA 1991a (pg. 15)
ED_{res-a}	Resident Exposure Duration - adult (years)	20	ED_{res} (26 years) - ED_{res-c} (6 years)
ED_{w}	Composite Worker Exposure Duration - (years)	25	U.S. EPA 1991a (pg. 15)
ED_{iw}	Indoor Worker Exposure Duration - (years)	25	U.S. EPA 1991a (pg. 15)
ED_{ow}	Outdoor Worker Exposure Duration (years)	25	U.S. EPA 1991a (pg. 15)
ED_{cw}	Construction Worker Exposure Duration (years)	1	U.S. EPA 2002 Exhibit 5-1
ED_{rec}	Recreator Exposure Duration (years)	26	EPA 2011, Table 16-108; 90th percentile for current residence time.

ED_{rec-c}	Recreator Exposure Duration - child (years)	6	U.S. EPA 1991a (pg. 15)
ED_{rec-a}	Recreator Exposure Duration - adult (years)	20	ED_{rec} (26 years) - ED_{rec-c} (6 years)
ED_{0-2}	Resident/Recreator Exposure Duration - age segment 0-2 (years)	2	U.S. EPA 2005 (pg. 37)
ED_{2-6}	Resident/Recreator Exposure Duration - age segment 2-6 (years)	4	U.S. EPA 2005 (pg. 37)
ED_{6-16}	Resident/Recreator Exposure Duration - age segment 6-16 (years)	10	U.S. EPA 2005 (pg. 37)
ED_{16-26}	Resident/Recreator Exposure Duration - age segment 16-26 (years)	10	U.S. EPA 2005 (pg. 37)
ET_{res-a}	Resident Exposure Time (hours/day)	24	The whole day
ET_{res-c}	Resident Exposure Time (hours/day)	24	The whole day
ET_{res}	Resident Exposure Time (hours/day)	24	The whole day
ET_{w}	Composite Worker Exposure Time (hours/day)	8	The work day
ET_{iw}	Indoor Worker Exposure Time (hours/day)	8	The work day
ET_{ow}	Outdoor Worker Exposure Time (hours/day)	8	The work day

ET_{cw}	Construction Worker Exposure Time (hours/day)	8	The work day
ET_{rec}	Recreator Exposure Time (hours/day)	Site-specific	Site-specific
$ET_{rec\text{-}c}$	Recreator Exposure Time - child (hours/day)	Site-specific	Site-specific
$ET_{rec\text{-}a}$	Recreator Exposure Time - adult (hours/day)	Site-specific	Site-specific
$ET_{event\text{-}res\text{-}c}$	Resident Water Exposure Time - child (hours/event)	0.54	U.S. EPA 2011, Table 16-28; weighted average of 90th percentile time spent bathing (birth to <6 years)
$ET_{event\text{-}res\text{-}a}$	Resident Water Exposure Time - adult (hours/event)	0.71	U.S. EPA 2011, Tables 16-30 and 16-31; weighted average of adult (21 to 78) 90th percentile of time spent bathing/ showering in a day, divided by mean number of baths/showers taken in a day.
$ET_{event\text{-}res\text{-}adj}$	Resident Water Exposure Time - age-adjusted (hours/event)	0.6708	Calculated using the age adjusted intake factors equation
$ET_{event\text{-}res\text{-}madj}$	Resident Exposure Time - age-adjusted (hours/event)	0.6708	Calculated using the age adjusted intake factors equation
$ET_{event\text{-}rec\text{-}c}$	Recreator Surface Water Exposure Time - child (hours/event)	Site-specific	Site-specific
$ET_{event\text{-}rec\text{-}a}$	Recreator Surface Water Exposure Time - adult (hours/event)	Site-specific	Site-specific

ET_{0-2}	Resident/Recreator Exposure Time - age segment 0-2 (hours/day)	Resident - 24 Recreator - Site-specific	Resident - The whole day Recreator - Site-specific
ET_{2-6}	Resident/Recreator Exposure Time - age segment 2-6 (hours/day)	Resident - 24 Recreator - Site-specific	Resident - The whole day Recreator - Site-specific
ET_{6-16}	Resident/Recreator Exposure Time - age segment 6-16 (hours/day)	Resident - 24 Recreator - Site-specific	Resident - The whole day Recreator - Site-specific
ET_{16-26}	Resident/Recreator Exposure Time - age segment 16-26 (hours/day)	Resident - 24 Recreator - Site-specific	Resident - The whole day Recreator - Site-specific
$ET_{event\text{-}rec\text{-}adj}$	Recreator Exposure Time - age-adjusted (hours/event)	Site-specific	Calculated using the age adjusted intake factors equation
$ET_{event\text{-}rec\,(0-2)}$	Recreator Exposure Time - age segment 0-2 (hours/event)	Site-specific	Site-specific
$ET_{event\text{-}rec\,(2-6)}$	Recreator Exposure Time - age segment 2-6 (hours/event)	Site-specific	Site-specific
$ET_{event\text{-}rec\,(6-16)}$	Recreator Exposure Time - age segment 6-16 (hours/event)	Site-specific	Site-specific
$ET_{event\text{-}rec\,(16-26)}$	Recreator Exposure Time - age segment 16-26 (hours/event)	Site-specific	Site-specific
$ET_{event\text{-}res\,(0-2)}$	Resident Exposure Time - age segment 0-2 (hours/event)	0.54	Calculated based on the ET given for ETevent-res-c

$ET_{event\text{-}res\ (2\text{-}6)}$	Resident Exposure Time - age segment 2-6 (hours/event)	0.54	Calculated based on the ET given for ETevent-res-c
$ET_{event\text{-}res\ (6\text{-}16)}$	Resident Exposure Time - age segment 6-16 (hours/event)	0.71	Calculated based on the ET given for ETevent-res-a
$ET_{event\text{-}res\ (16\text{-}26)}$	Resident Exposure Time - age segment 16-26 (hours/event)	0.71	Calculated based on the ET given for ETevent-res-a
$ET_{event\text{-}rec\text{-}madj}$	Recreator Exposure Time - age-adjusted (hours/event)	Site-specific	Calculated using the age adjusted intake factors equation
$EV_{rec\text{-}c}$	Recreator Events - child (events/day)	Site-specific	Site-specific
$EV_{rec\text{-}a}$	Recreator Events - adult (events/day)	Site-specific	Site-specific
$EV_{res\text{-}c}$	Resident Events - child (events/day)	1	U.S. EPA 2004; Exhibit 3-2
$EV_{res\text{-}a}$	Resident Events - adult (events/day)	1	U.S. EPA 2004; Exhibit 3-2
$EV_{0\text{-}2}$	Resident/Recreator Events - age segment 0-2 (events/day)	Resident - 1 Recreator - Site-specific	U.S. EPA 2004; Exhibit 3-2
$EV_{2\text{-}6}$	Resident/Recreator Events - age segment 2-6 (events/day)	Resident - 1 Recreator - Site-specific	U.S. EPA 2004; Exhibit 3-2
$EV_{6\text{-}16}$	Resident/Recreator Events - age segment 6-16 (events/day)	Resident - 1 Recreator - Site-specific	U.S. EPA 2004; Exhibit 3-2

$EV_{16\text{-}26}$	Resident/Recreator Events - age segment 16-26 (events/day)	Resident - 1 Recreator - Site-specific	U.S. EPA 2004; Exhibit 3-2
Soil to Groundwater SSL Factor Variables			
C_w	Target soil leachate concentration (mg/L)	nonzero MCL or RSL × DAF	U.S. EPA. 2002 Equation 4-14
DAF	Dilution attenuation factor (unitless)	1 (or site-specific)	U.S. EPA. 2002 Equation 4-11
ED	Exposure duration	70	U.S. EPA. 2002 Equation 4-14
I	Infiltration Rate (m/year)	0.18	U.S. EPA. 2002 Equation 4-11
L	source length parallel to ground water flow (m)	site-specific	U.S. EPA. 2002 Equation 4-11
i	hydraulic gradient (m/m)	site-specific	U.S. EPA. 2002 Equation 4-11
K	aquifer hydraulic conductivity (m/year)	site-specific	U.S. EPA. 2002 Equation 4-11
θ_w	water-filled soil porosity (L_{water}/L_{soil})	0.3	U.S. EPA. 2002 Equation 4-10
θ_a	air-filled soil porosity (L_{air}/L_{soil})	$= n-\theta_w$	U.S. EPA. 2002 Equation 4-10
n	total soil porosity (L_{pore}/L_{soil})	$= 1-(\rho_b/\rho_s)$	U.S. EPA. 2002 Equation 4-10
ρ_s	soil particle density (Kg/L)	2.65	U.S. EPA. 2002 Equation 4-10
ρ_b	dry soil bulk density (kg/L)	1.5	U.S. EPA. 2002 Equation 4-10

H'	Dimensionless Henry Law Constant (unitless)	Contaminant-specific	See Chemical-specific hierarchy
K_d	soil-water partition coefficient (L/kg)	= K_{oc}*f_{oc} for organics	U.S. EPA. 2002 Equation 4-10
K_{oc}	soil organic carbon/water partition coefficient (L/kg)	Contaminant-specific	See Chemical-specific hierarchy
f_{oc}	fraction organic carbon in soil (g/g)	0.002	U.S. EPA. 2002 Equation 4-10
d_a	aquifer thickness (m)	site-specific	U.S. EPA. 2002 Equation 4-10
d_s	depth of source (m)	site-specific	U.S. EPA. 2002 Equation 4-10
d	mixing zone depth (m)	site-specific	U.S. EPA. 2002 Equation 4-12
Wind Particulate Emission Factor Variables			
PEF	Particulate Emission Factor - Minneapolis (m^3/kg)	1.36 x 10^9(region-specific)	U.S. EPA 2002 Exhibit D-2
Q/C_{wind}	Inverse of the Mean Concentration at the Center of a 0.5-Acre-Square Source (g/m^2-s per kg/m^3)	93.77 (region-specific)	U.S. EPA 2002 Exhibit D-2
V	Fraction of Vegetative Cover (unitless)	0.5	U.S. EPA. 2002 Equation 4-5
U_m	Mean Annual Wind Speed (m/s)	4.69	U.S. EPA. 2002 Equation 4-5

U_t	Equivalent Threshold Value of Wind Speed at 7m (m/s)	11.32	U.S. EPA. 2002 Equation 4-5
F(x)	Function Dependent on U_m /U_t (unitless)	0.194	U.S. EPA. 2002 Equation 4-5
A	Dispersion constant unitless	PEF and region-specific	U.S. EPA 2002 Exhibit D-2
A_s	Areal extent of the site or contamination (acres)	0.5 (range 0.5 to 500)	U.S. EPA 2002 Exhibit D-2
B	Dispersion constant unitless	PEF and region-specific	U.S. EPA 2002 Exhibit D-2
C	Dispersion constant unitless	PEF and region-specific	U.S. EPA 2002 Exhibit D-2
Mechanical Particulate Emission Factor Variables from Vehicle Traffic			
PEF_{sc}	Particulate Emission Factor - subchronic (m^3/kg)	(site-specific)	U.S. EPA 2002 Equation 5-5
Q/C_{sr}	Inverse of the ratio of the 1-h geometric mean concentration to the emission flux along a straight road segment bisecting a square site (g/m^2-s per kg/m^3)	23.02 (for 0.5 acre site)	U.S. EPA 2002 Equation 5-5
F_D	Dispersion correction factor (unitless)	0.185	U.S. EPA 2002 Equation E-16
T	Total time over which construction occurs (s)	site-specific	U.S. EPA 2002 Equation 5-5
A_R	Surface area of contaminated road segment (m^2)	($A_R = L_R * W_R * 0.092903m^2/ft^2$)	U.S. EPA 2002 Equation 5-5

L_R	Length of road segment (ft)	Site-specific	U.S. EPA 2002 Equation 5-5
W_R	Width of road segment (ft)	20	U.S. EPA 2002 Equation E-18
W	Mean vehicle weight (tons)	(number of cars x tons/car + number of trucks x tons/truck) / total vehicles)	U.S. EPA 2002 Equation 5-5
p	Number of days with at least 0.01 inches of precipitation (days/year)	Site-specific	U.S. EPA 2002 Exhibit 5-2
∑VKT	Sum of fleet vehicle kilometers traveled during the exposure duration (km)	∑VKT = total vehicles x distance (km/day) x frequency (weeks/year) x (days/year)	U.S. EPA 2002 Equation 5-5
A	Dispersion constant unitless	12.9351	U.S. EPA 2002 Equation 5-6
A_s	Areal extent of site surface soil contamination (acres)	0.5 (range 0.5 to 500)	U.S. EPA 2002 Equation 5-6
B	Dispersion constant unitless	5.7383	U.S. EPA 2002 Equation 5-6
C	Dispersion constant unitless	71.7711	U.S. EPA 2002 Equation 5-6
Mechanical Particulate Emission Factor Variables from other than Vehicle Traffic			
PEF'_{sc}	Particulate Emission Factor - subchronic (m^3/kg)	(site-specific)	U.S. EPA 2002 Equation E-26

Q/C_{sa}	Inverse of the ratio of the 1-h. geometric mean air concentration and the emission flux at the center of the square emission source (g/m^2-s per kg/m^3)	Site-specific	U.S. EPA 2002 Equation E-15
F_D	Dispersion correction factor (unitless)	Site-specific	U.S. EPA 2002 Equation E-16
A	Dispersion constant unitless	2.4538	U.S. EPA 2002 Equation E-15
B	Dispersion constant unitless	17.5660	U.S. EPA 2002 Equation E-15
C	Dispersion constant unitless	189.0426	U.S. EPA 2002 Equation E-15
A_s	Areal extent of site surface soil contamination (acres)	(range 0.5 to 500)	U.S. EPA 2002 Equation E-15
J'_T	Total time-averaged PM_{10} unit emission flux for construction activities other than traffic on unpaved roads (g/m^2-s)	Site-specific	U.S. EPA 2002 Equation E-25
M^{PC}_{wind}	Unit mass emitted from wind erosion (g)	site-specific	U.S. EPA 2002 Equation E-20
V	Fraction of Vegetative Cover (unitless)	0	U.S. EPA 2002 Equation E-20
U_m	Mean Annual Wind Speed (m/s)	4.69	U.S. EPA 2002 Equation E-20
U_t	Equivalent Threshold Value of Wind Speed at 7m (m/s)	11.32	U.S. EPA 2002 Equation E-20

F(x)	Function Dependent on U_m /U_t (unitless)	0.194	U.S. EPA 2002 Equation E-20
A_{surf}	Areal extent of site surface soil contamination (m^2)	(range 0.5 to 500)	U.S. EPA 2002 Equation E-20
ED	Exposure duration (years)	Site-specific	U.S. EPA 2002 Equation E-20
M_{excav}	Unit mass emitted from excavation soil dumping (g)	site-specific	U.S. EPA 2002 Equation E-21
0.35	PM_{10} particle size multiplier (unitless)	0.35	U.S. EPA 2002 Equation E-21
U_m	Mean annual wind speed during construction (m/s)	4.69	U.S. EPA 2002 Equation E-21
$M_{m\text{-}excav}$	Gravimetric soil moisture content (%)	12 (mean value for municipal landfill cover)	U.S. EPA 2002 Equation E-21
ρ_{soil}	In situ soil density (includes water) (mg/m^3)	1.68	U.S. EPA 2002 Equation E-21
A_{excav}	Areal extent of excavation (m^2)	(range 0.5 to 500)	U.S. EPA 2002 Equation E-21
d_{excav}	Average depth of excavation (m)	Site-specific	U.S. EPA 2002 Equation E-21
$N_{A\text{-}dump}$	Number of times soil is dumped (unitless)	2	U.S. EPA 2002 Equation E-21
M_{doz}	Unit mass emitted from dozing operations (g)	site-specific	U.S. EPA 2002 Equation E-22
0.75	PM_{10} scaling factor (unitless)	0.75	U.S. EPA 2002 Equation E-22

s_{doz}	Soil silt content (%)	6.9	U.S. EPA 2002 Equation E-22
$M_{m\text{-}doz}$	Gravimetric soil moisture content (%)	7.9 (mean value for overburden)	U.S. EPA 2002 Equation E-22
$\sum VKT_{doz}$	Sum of dozing kilometers traveled (km)	Site-specific	U.S. EPA 2002 Equation E-22
S_{doz}	Average dozing speed (kph)	11.4 (mean value for graders)	U.S. EPA 2002 Equation E-22
$N_{A\text{-}doz}$	Number of times site is dozed (unitless)	Site-specific	U.S. EPA 2002 Equation E-22
B_d	Dozer blade length (m)	Site-specific	U.S. EPA 2002 Page E-28
M_{grade}	Unit mass emitted from grading operations (g)	site-specific	U.S. EPA 2002 Equation E-23
0.60	PM10 scaling factor (unitless)	0.60	U.S. EPA 2002 Equation E-23
$\sum VKT_{grade}$	Sum of grading kilometers traveled (km)		U.S. EPA 2002 Equation E-23
S_{grade}	Average grading speed (kph)	11.4 (mean value for graders)	U.S. EPA 2002 Equation E-23
$N_{A\text{-}grade}$	Number of times site is graded (unitless)	Site-specific	U.S. EPA 2002 Equation E-23
B_g	Grader blade length (m)	Site-specific	U.S. EPA 2002 Page E-28
M_{till}	Unit mass emitted from tilling operations (g)	site-specific	U.S. EPA 2002 Equation E-24
s_{till}	Soil silt content (%)	18	U.S. EPA 2002 Equation E-24

$A_{c\text{-}till}$	Areal extent of tilling (acres)	Site-specific	U.S. EPA 2002 Equation E-24
$A_{c\text{-}grade}$	Areal extent of grading (acres)	Site-specific	Necessary to solve $\sum VKT_{grade}$ in U.S. EPA 2002 Equation E-23
$A_{c\text{-}doz}$	Areal extent of dozinging (acres)	Site-specific	Necessary to solve $\sum VKT_{grade}$ in U.S. EPA 2002 Equation E-22
$N_{A\text{-}till}$	Number of times soil is tilled (unitless)	2	U.S. EPA 2002 Equation E-24
Chronic Volatilization Factor and Soil Saturation Limit Variables			
VF_{ulim}	Volatilization Factor - Los Angeles (m^3/kg)	Contaminant-specific	U.S. EPA. 2002 Equation 4-8
C_{sat}	Soil saturation concentration (mg/kg)	Contaminant-specific	U.S. EPA. 2002 Equation 4-9
Q/C_{vol}	Inverse of the Mean Concentration at the Center of a 0.5-Acre-Square Source (g/m^2-s per kg/m^3)	68.18	U.S. EPA. 2002 Equation 4-8
A	Dispersion constant unitless	11.9110 (region-specific)	U.S. EPA 2002 Exhibit D-3
A_s	Areal extent of the site contamination (acres)	0.5 (range 0.5 to 500)	U.S. EPA 2002 Equation 4-8
B	Dispersion constant unitless	18.4385 (region-specific)	U.S. EPA 2002 Exhibit D-3
C	Dispersion constant unitless	209.7845 (region-specific)	U.S. EPA 2002 Exhibit D-3

D_A	Apparent Diffusivity (cm^2/s)	Contaminant-specific	U.S. EPA. 2002 Equation 4-8
T	Exposure interval (s)	8.2×108 (used for unlimited source model)	U.S. EPA. 2002 Equation 4-8
T	Exposure interval (years)	26 (used for mass-limit model)	U.S. EPA. 2002 Equation 4-13
ρ_b	Dry soil bulk density (g/cm^3)	1.5	U.S. EPA. 2002 Equation 4-8
θ_a	Air-filled soil porosity (L_{air}/L_{soil}) (n-θ_w)	0.28	U.S. EPA. 2002 Equation 4-8
n	Total soil porosity (L_{pore}/L_{soi}l) (1-(ρ_b/ρ_s)	0.43	U.S. EPA. 2002 Equation 4-8
θ_w	Water-filled soil porosity (L_{water}/L_{soil})	0.15	U.S. EPA. 2002 Equation 4-8
ρ_s	Soil particle density (g/cm^3)	2.65	U.S. EPA. 2002 Equation 4-8
S	Water Solubility Limit (mg/L)	Contaminant-specific	See Chemical-specific hierarchy
R	Universal Gas Constant (L-atm/mole-K)	0.082057	U.S. EPAFact Sheet
R_c	Universal Gas Constant (cal/mole-K)	1.9872	U.S. EPA Fact Sheet
D_{ia}	Diffusivity in air (cm^2/s)	Contaminant-specific	U.S. EPA. 2001
H'	Dimensionless Henry's Law Constant	Contaminant-specific	See Chemical-specific hierarchy

D_{iw}	Diffusivity in water (cm^2/s)	Contaminant-specific	U.S. EPA. 2001
K_d	Soil-water partition coefficient (L/Kg) ($K_{oc} \times f_{oc}$)	Contaminant-specific	U.S. EPA. 2002 Equation 4-8
K_{oc}	Soil organic carbon-water partition coefficient (L/Kg)	= K_{oc}*f_{oc} for organics	See Chemical-specific hierarchy
f_{oc}	Organic carbon content of soil (g/g)	0.006	U.S. EPA. 2002 Equation 4-8
ds	Average source depth (m)	Site-specific	U.S. EPA 2002 Equation 4-13
Subchronic Volatilization Factor for Unlimited Source and Mass-limit Equations			
$VF_{ulim\text{-}sc}$	Subchronic Volatilization Factor (m^3/kg)	Contaminant-specific	U.S. EPA 2002 Equation 5-14
Q/C_{sa}	Inverse of the ratio of the 1-h geometric mean air concentration to the volatilization flux at the center of a square source (g/m^2-s per kg/m^3)	14.31 (for 0.5 acre site)	U.S. EPA 2002 Equation 5-14
A	Dispersion constant unitless	2.4538	U.S. EPA 2002 Equation 5-15
A_c	Areal extent of the site soil contamination (acres)	0.5 (range 0.5 to 500)	U.S. EPA 2002 Equation 5-15
B	Dispersion constant unitless	17.5660	U.S. EPA 2002 Equation 5-15
C	Dispersion constant unitless	189.0426	U.S. EPA 2002 Equation 5-15

D_A	Apparent Diffusivity (cm^2/s)	Contaminant-specific	U.S. EPA 2002 Equation 5-14
T	Total time over which construction occurs (s)	site-specific	U.S. EPA 2002 Equation 5-14
ρ_b	Dry soil bulk density (g/cm^3)	1.5	U.S. EPA 2002 Equation 5-14
F_D	Dispersion correction factor (unitless)	0.185	U.S. EPA 2002 Equation 5-14
θ_a	Air-filled soil porosity (L_{air}/L_{soil}) ($n-\theta_w$)	0.28	U.S. EPA 2002 Equation 5-14
n	Total soil porosity (L_{pore}/L_{soil}) ($1-(\rho_b/\rho_s$)	0.43	U.S. EPA 2002 Equation 5-14
θ_w	Water-filled soil porosity (L_{water}/L_{soil})	0.15	U.S. EPA 2002 Equation 5-14
ρ_s	Soil particle density (g/cm^3)	2.65	U.S. EPA 2002 Equation 5-14
D_{ia}	Diffusivity in air (cm^2/s)	Contaminant-specific	U.S. EPA 2001
H'	Dimensionless Henry's Law Constant	Contaminant-specific	See Chemical-specific hierarchy
D_{iw}	Diffusivity in water (cm^2/s)	Contaminant-specific	U.S. EPA 2001
K_d	Soil-water partition coefficient (L/Kg) ($K_{oc}\times f_{oc}$)	$= K_{oc}*f_{oc}$ for organics	See Chemical-specific hierarchy
K_{oc}	Soil organic carbon-water partition coefficient (L/Kg)	Contaminant-specific	See Chemical-specific hierarchy

f_{oc}	Organic carbon content of soil (g/g)	0.006 (0.6%)	U.S. EPA 2002 Equation 5-14
T	Total time over which construction occurs (year)	site-specific (T=ED)	U.S. EPA 2002 Equation 5-17
d_s	Average source depth (m)	Site-specific	U.S. EPA 2002 Equation 5-17

7. References

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U.S. EPA 2005. Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens. March 2005. Document (PDF) (166 pp, 468 K)

U.S. EPA 2009. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment) Final. OSWER 9285.7-82. January 2009. Document (PDF) (68 pp, 724 K), memo (PDF) (3 pp, 487 K) and website.

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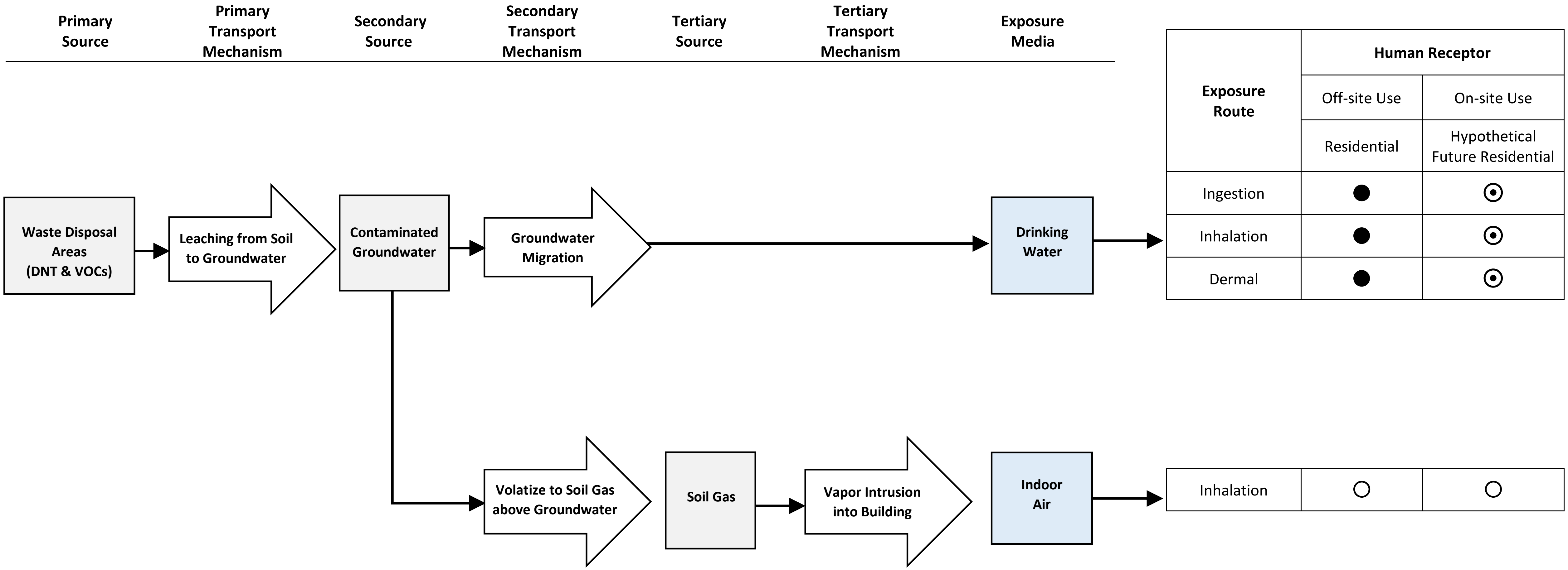
For assistance/questions please use the Regional Screening Levels (RSLs) contact us page. For general risk assessment questions, separate from the RSLs, please use the link below.

LAST UPDATED ON NOVEMBER 19, 2018

Appendix G

Groundwater Conceptual Site Models – Exposure Routes

Groundwater Conceptual Site Model – PBG Plume
Badger Army Ammunition Plant



Exposure Route	Human Receptor	
	Off-site Use	On-site Use
	Residential	Hypothetical Future Residential
Ingestion	●	⊙
Inhalation	●	⊙
Dermal	●	⊙
Inhalation	○	○

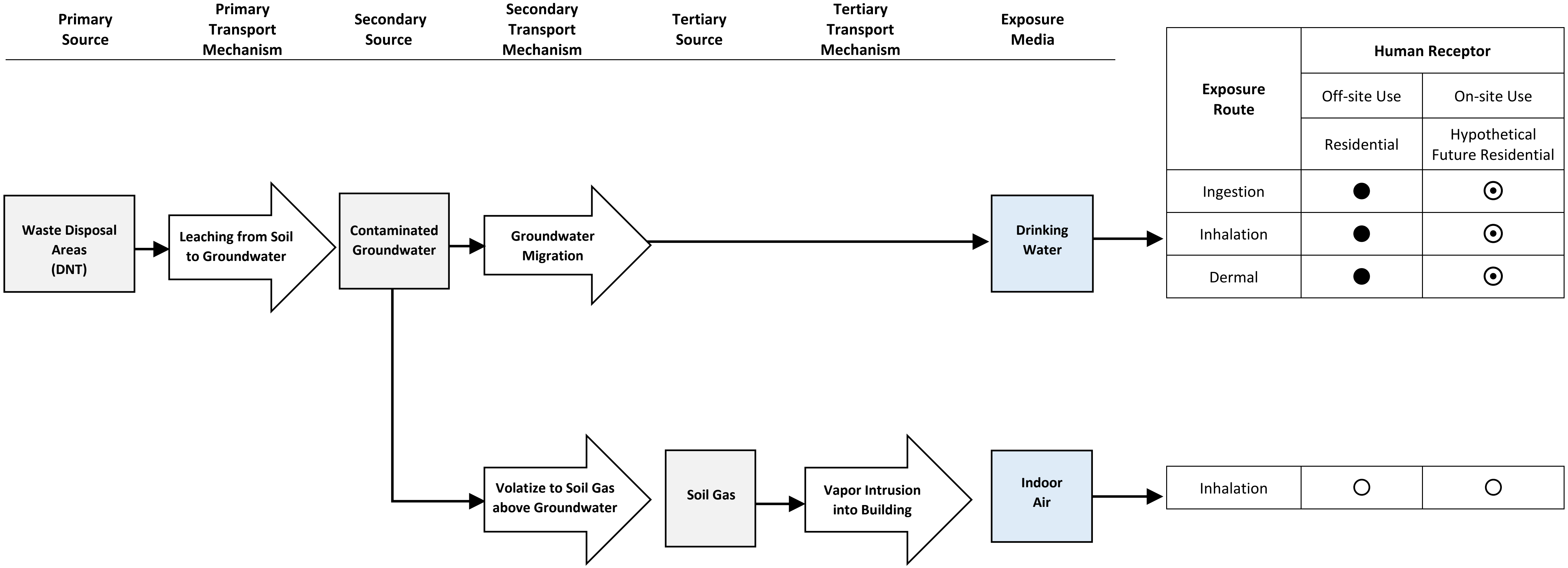
LEGEND:

● Pathway potentially complete under current land use conditions and warrants further evaluation.

⊙ Pathway incomplete or considered insignificant under current land use conditions but potentially complete under hypothetical future onsite groundwater usage.

○ Pathway incomplete or considered insignificant; no further evaluation is warranted.

Groundwater Conceptual Site Model – DBG Plume
Badger Army Ammunition Plant



Exposure Route	Human Receptor	
	Off-site Use	On-site Use
	Residential	Hypothetical Future Residential
Ingestion	●	⊙
Inhalation	●	⊙
Dermal	●	⊙
Inhalation	○	○

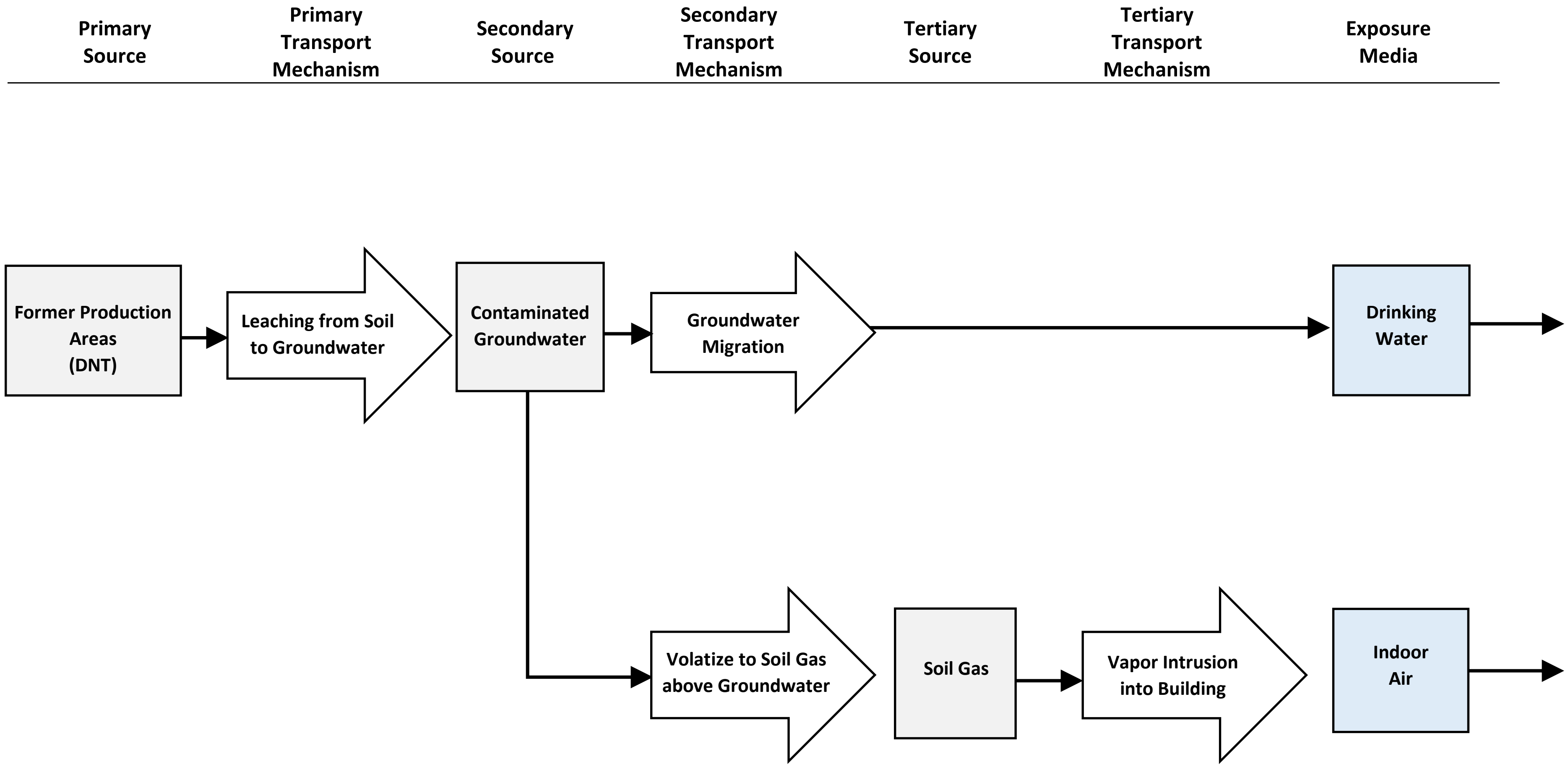
LEGEND:

● Pathway potentially complete under current land use conditions and warrants further evaluation.

⊙ Pathway incomplete or considered insignificant under current land use conditions but potentially complete under hypothetical future onsite groundwater usage.

○ Pathway incomplete or considered insignificant; no further evaluation is warranted.

Groundwater Conceptual Site Model – Central Plume
Badger Army Ammunition Plant



Exposure Route	Human Receptor	
	Off-site Use	On-site Use
	Residential	Hypothetical Future Residential
Ingestion	●	⊙
Inhalation	●	⊙
Dermal	●	⊙
Inhalation	○	○

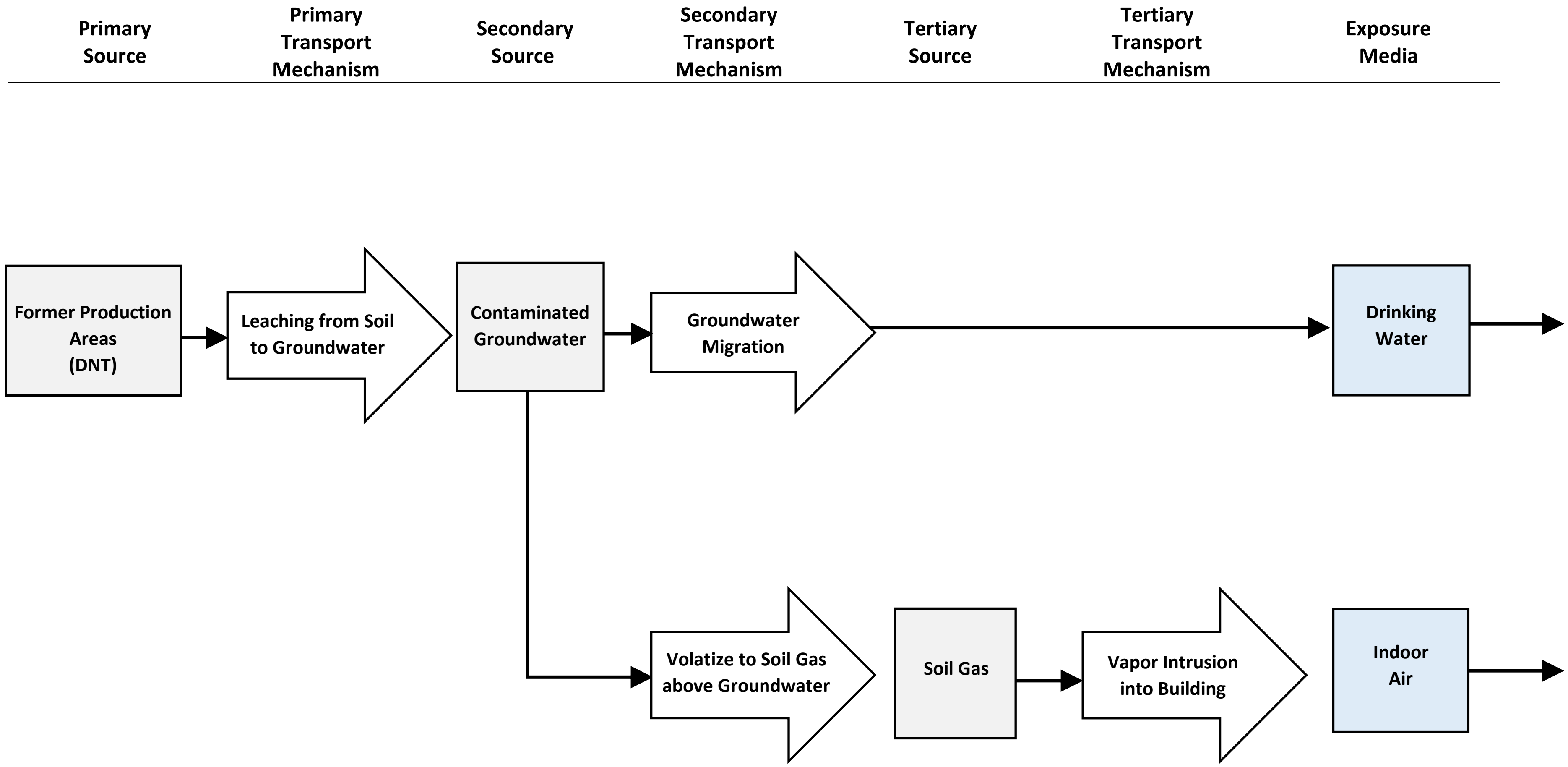
LEGEND:

● Pathway potentially complete under current land use conditions and warrants further evaluation.

⊙ Pathway incomplete or considered insignificant under current land use conditions but potentially complete under hypothetical future onsite groundwater usage.

○ Pathway incomplete or considered insignificant; no further evaluation is warranted.

Groundwater Conceptual Site Model – NC Area Plume
Badger Army Ammunition Plant



Exposure Route	Human Receptor	
	Off-site Use	On-site Use
	Residential	Hypothetical Future Residential
Ingestion	○	⊙
Inhalation	○	⊙
Dermal	○	⊙
Inhalation	○	○

LEGEND:

● Pathway potentially complete under current land use conditions and warrants further evaluation.

⊙ Pathway incomplete or considered insignificant under current land use conditions but potentially complete under hypothetical future onsite groundwater usage.

○ Pathway incomplete or considered insignificant; no further evaluation is warranted.

Appendix H

Vapor Intrusion Investigation Reports (2012)

DEPARTMENT OF THE ARMY
BADGER ARMY AMMUNITION PLANT
2 BADGER ROAD
BARABOO, WISCONSIN 53913-5000

August 15, 2012

SUBJECT: Vapor Intrusion Pathway Analysis Reports
Badger Army Ammunition Plant

Mr. Will Myers
Hydrogeologist Program Coordinator
Wisconsin Department of Natural Resources
South Central Region
3911 Fish Hatchery Road
Fitchburg, WI 53711-5397

Dear Mr. Myers:

The Wisconsin Department of Natural Resources (WDNR) issued a letter dated September 9, 2011 reminding responsible parties that a vapor intrusion investigation should be conducted at all sites where volatile organic compounds (VOC) are present in the soil and groundwater. The Propellant Burning Ground (PBG) Plume contains the following VOCs: carbon tetrachloride, chloroform, and trichloroethylene. The Deterrent Burning Ground and Central Plumes contain primarily dinitrotoluene, which does not pose a vapor pathway risk.

Based on the WDNR letter and the Alternative Feasibility Study – Groundwater Remedial Strategy, Badger Technical Services, LLC (BTS) conducted a vapor intrusion pathway analysis for the PBG Plume.

In February 2012, BTS personnel conducted ten vapor intrusion pathway borings in accordance with WDNR vapor intrusion guidance, *Addressing Vapor Intrusion at Remediation & Redevelopment Sites in Wisconsin*, PUB-RR-800, December 2010 using the post-run tubing vapor sampling technique. Due to inconclusive results for half the samples, due to ineffectively sealed fittings, BTS recommended conducting further investigation of this pathway at five locations.

On April 19, 2012, BTS submitted the *Vapor Intrusion Pathway Analysis Report* to the Department of the Army (Enclosure 1). A complete evaluation of the vapor pathway was not possible based on the initial information because several of the soil gas samples reported elevated levels of the leak detection tracer gas. Therefore, BTS conducted a supplemental investigation in June and July 2012, as reported in the BTS July 16, 2012, *Supplemental Vapor Intrusion Pathway Analysis Report* (Enclosure 2), at locations where the soil gas analytical data were deemed invalid be re-sampled using helium as the leak-detection tracer gas using an alternate leak detection methodology.

Based on the results of the activities presented within these reports, the data indicate the PBG Plume does not present a significant risk to human health via vapor intrusion off-site. Analytical results of soil gas samples collected off-site do not exceed the WDNR Vapor Risk Screening Levels for Deep Soil Gas.

Please do not hesitate to contact me at 608-643-3361 if you have any questions.

Sincerely,

Joan M. Kenney

Joan M. Kenney
Commander's Representative

Attachments
Enclosures
Copy furn: Hank Kuehling, WDNR SCR R&R Program LTE Hydrogeologist
Michelle Mullin, U.S. Environmental Protection Agency
Ryan Wozniak, Wisconsin Department of Health and Family Services
Ralph Jesse, U.S. Department of Agriculture
Badger Technical Services, LLC

Attachments

Soil Boring Log Information

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ ________________

Page 1 of 1

Facility/Project Name Badger Army Ammunition Plant / Vapor Intrusion Pathway Analysis	License/Permit/Monitoring Number	Boring Number VIP-1

Boring Drilled by: Name of crew chief (first, last) and Firm First Name: Dave Last Name: Paulson Firm: Soil Essentials LTD	Date Drilling Started 2/27/12	Date Drilling Completed 2/27/12	Drilling Method Direct-Push

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water ____ Feet MSL	Surface Elevation ____ Feet MSL	Borehole Diameter 2.125 inches

Local Grid Origin (estimated:) or Boring Location
State Plane 540043 N, 319020 E
NE of SW of Section 14 T 10 N R 6 E

Local Grid Location
______ Feet N S ______ Feet E W

Facility ID **157053930**	County **Sauk**	County Code **57**	Civil Town/City/ or Village **Town of Sumpter**

Sample		Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties					RQD/Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			0-45’	No soil samples were collected. Boring drilled to install HDPE tubing for soil vapor collection.										
				B.T. @ 45’ bgs.										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Jeff Larkin

Firm: Badger Technical Services, LLC.

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completion of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ ________________

Page 1 of 1

Facility/Project Name Badger Army Ammunition Plant / Vapor Intrusion Pathway Analysis	License/Permit/Monitoring Number	Boring Number VIP-2

Boring Drilled by: Name of crew chief (first, last) and Firm First Name: Dave Last Name: Paulson Firm: Soil Essentials LTD	Date Drilling Started 2/27/12	Date Drilling Completed 2/27/12	Drilling Method Direct-Push
WI Unique Well No DNR Well ID No. Well Name	Final Static Water ____ Feet MSL	Surface Elevation ____ Feet MSL	Borehole Diameter 2.125 inches
Local Grid Origin (estimated:) or Boring Location State Plane 540372 N, 317498 E SW of NE of Section 14 T 10 N R 6 E	Local Grid Location ______ Feet N S ______ Feet E W		

Facility ID **157053930**	County **Sauk**	County Code **57**	Civil Town/City/ or Village **Town of Sumpter**

Sample		Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties					RQD/Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			0-25'	No soil samples were collected. Boring drilled to install HDPE tubing for soil vapor collection.										
				B.T. @ 25' bgs.										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Jeff Larkin Firm: Badger Technical Services, LLC.

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ ________________

Page 1 of 1

Facility/Project Name Badger Army Ammunition Plant / Vapor Intrusion Pathway Analysis	License/Permit/Monitoring Number	Boring Number VIP-3

Boring Drilled by: Name of crew chief (first, last) and Firm
First Name: Dave Last Name: Paulson
Firm: Soil Essentials LTD

Date Drilling Started: 2/27/12
Date Drilling Completed: 2/27/12
Drilling Method: Direct-Push

WI Unique Well No DNR Well ID No. Well Name

Final Static Water ____ Feet MSL
Surface Elevation ____ Feet MSL
Borehole Diameter 2.125 inches

Local Grid Origin (estimated:) or Boring Location
State Plane 540322 N, 315818 E
SE of NW of Section 26 T 10 N R 6 E

Local Grid Location
______ Feet N S ______ Feet E W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	**Sauk**	**57**	**Town of Prairie du Sac**

Sample		Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties					RQD/Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			0-45'	No soil samples were collected. Boring drilled to install HDPE tubing for soil vapor collection. B.T. @ 45' bgs.										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Jeff Larkin
Firm: Badger Technical Services, LLC.

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completion of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ ________________

Page 1 of 1

Facility/Project Name Badger Army Ammunition Plant / Vapor Intrusion Pathway Analysis	License/Permit/Monitoring Number	Boring Number VIP-4

Boring Drilled by: Name of crew chief (first, last) and Firm First Name: Dave Last Name: Paulson Firm: Soil Essentials LTD	Date Drilling Started 2/27/12	Date Drilling Completed 2/27/12	Drilling Method Direct-Push

WI Unique Well No DNR Well ID No. Well Name	Final Static Water ____ Feet MSL	Surface Elevation ____ Feet MSL	Borehole Diameter 2.125 inches

Local Grid Origin (estimated:) or Boring Location State Plane 540766 N, 315809 E SW of NE of Section 26 T 10 N R 6 E	Local Grid Location ______ Feet N S ______ Feet E W

Facility ID **157053930**	County **Sauk**	County Code **57**	Civil Town/City/ or Village **Town of Prairie du Sac**

Sample		Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties					RQD/Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			0-45'	No soil samples were collected. Boring drilled to install HDPE tubing for soil vapor collection. B.T. @ 45' bgs.										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Jeff Larkin	Firm: Badger Technical Services, LLC.

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completion of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ ________________

Page 1 of 1

Facility/Project Name Badger Army Ammunition Plant / Vapor Intrusion Pathway Analysis	License/Permit/Monitoring Number	Boring Number VIP-5

Boring Drilled by: Name of crew chief (first, last) and Firm First Name: Dave Last Name: Paulson Firm: Soil Essentials LTD	Date Drilling Started 2/27/12	Date Drilling Completed 2/27/12	Drilling Method Direct-Push
WI Unique Well No DNR Well ID No. Well Name	Final Static Water ____ Feet MSL	Surface Elevation ____ Feet MSL	Borehole Diameter 2.125 inches

Local Grid Origin (estimated:) or Boring Location State Plane 541097 N, 315811 E SW of NE of Section 26 T 10 N R 6 E	Local Grid Location ______ Feet N S ______ Feet E W

Facility ID **157053930**	County **Sauk**	County Code **57**	Civil Town/City/ or Village **Town of Prairie du Sac**

Sample		Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties					RQD/Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			0-45’	No soil samples were collected. Boring drilled to install HDPE tubing for soil vapor collection. B.T. @ 45’ bgs.										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Jeff Larkin Firm: Badger Technical Services, LLC.

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completion of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ ________________

Page 1 of 1

Facility/Project Name Badger Army Ammunition Plant / Vapor Intrusion Pathway Analysis	License/Permit/Monitoring Number	Boring Number VIP-6

Boring Drilled by: Name of crew chief (first, last) and Firm First Name: Dave Last Name: Paulson Firm: Soil Essentials LTD	Date Drilling Started 2/27/12	Date Drilling Completed 2/27/12	Drilling Method Direct-Push

WI Unique Well No	DNR Well ID No.	Well Name	Final Static Water ____ Feet MSL	Surface Elevation ____ Feet MSL
				Borehole Diameter 2.125 inches

Local Grid Origin (estimated:) or Boring Location
State Plane 541455 N, 315689 E
NW of SW of Section 25 T 10 N R 6 E

Local Grid Location
______ Feet N S ______ Feet E W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	**Sauk**	**57**	**Town of Prairie du Sac**

Sample									Soil Properties					
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/Comments
			0-45’	No soil samples were collected. Boring drilled to install HDPE tubing for soil vapor collection. B.T. @ 45’ bgs.										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Jeff Larkin

Firm: Badger Technical Services, LLC.

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completion of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ ________________

Page 1 of 1

Facility/Project Name Badger Army Ammunition Plant / Vapor Intrusion Pathway Analysis	License/Permit/Monitoring Number	Boring Number VIP-7

Boring Drilled by: Name of crew chief (first, last) and Firm First Name: Dave Last Name: Paulson Firm: Soil Essentials LTD	Date Drilling Started 2/28/12	Date Drilling Completed 2/28/12	Drilling Method Direct-Push

WI Unique Well No DNR Well ID No. Well Name	Final Static Water ____ Feet MSL	Surface Elevation ____ Feet MSL	Borehole Diameter 2.125 inches

Local Grid Origin (estimated:) or Boring Location State Plane 541541 N, 314767 E NW of NW of Section 36 T 10 N R 6 E	Local Grid Location ______ Feet N S ______ Feet E W

Facility ID **157053930**	County **Sauk**	County Code **57**	Civil Town/City/ or Village **Town of Prairie du Sac**

Sample		Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties					RQD/Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			0-45’	No soil samples were collected. Boring drilled to install HDPE tubing for soil vapor collection. B.T. @ 45’ bgs.										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Jeff Larkin Firm: Badger Technical Services, LLC.

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ ________________

Page 1 of 1

Facility/Project Name Badger Army Ammunition Plant / Vapor Intrusion Pathway Analysis		License/Permit/Monitoring Number	Boring Number VIP-8	
Boring Drilled by: Name of crew chief (first, last) and Firm First Name: Dave Last Name: Paulson Firm: Soil Essentials LTD		Date Drilling Started 2/28/12	Date Drilling Completed 2/28/12	Drilling Method Direct-Push
WI Unique Well No DNR Well ID No. Well Name		Final Static Water ____ Feet MSL	Surface Elevation ____ Feet MSL	Borehole Diameter 2.125 inches
Local Grid Origin (estimated:) or Boring Location State Plane 541463 N, 315099 E SW of SW of Section 25 T 10 N R 6 E		Local Grid Location ______ Feet N S	______ Feet E W	
Facility ID **157053930**	County **Sauk**	County Code **57**	Civil Town/City/ or Village **Town of Prairie du Sac**	

Sample		Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties					RQD/Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			0-45’	No soil samples were collected. Boring drilled to install HDPE tubing for soil vapor collection. B.T. @ 45’ bgs.										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Jeff Larkin
Firm: Badger Technical Services, LLC.

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ ________________

Page 1 of 1

Facility/Project Name Badger Army Ammunition Plant / Vapor Intrusion Pathway Analysis	License/Permit/Monitoring Number	Boring Number VIP-9	
Boring Drilled by: Name of crew chief (first, last) and Firm First Name: Dave Last Name: Paulson Firm: Soil Essentials LTD	Date Drilling Started 2/28/12	Date Drilling Completed 2/28/12	Drilling Method Direct-Push
WI Unique Well No DNR Well ID No. Well Name	Final Static Water ____ Feet MSL	Surface Elevation ____ Feet MSL	Borehole Diameter 2.125 inches
Local Grid Origin (estimated:) or Boring Location State Plane 541465 N, 315363 E SW of SW of Section 25 T 10 N R 6 E	Local Grid Location ______ Feet N S	______ Feet E W	
Facility ID **157053930**	County **Sauk**	County Code **57**	Civil Town/City/ or Village **Town of Prairie du Sac**

Sample		Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties					RQD/Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			0-45’	No soil samples were collected. Boring drilled to install HDPE tubing for soil vapor collection. B.T. @ 45’ bgs.										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Jeff Larkin

Firm: Badger Technical Services, LLC.

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ ________________

Page 1 of 1

Facility/Project Name Badger Army Ammunition Plant / Vapor Intrusion Pathway Analysis		License/Permit/Monitoring Number		Boring Number VIP-10	
Boring Drilled by: Name of crew chief (first, last) and Firm First Name: Dave Last Name: Paulson Firm: Soil Essentials LTD		Date Drilling Started 2/28/12	Date Drilling Completed 2/28/12	Drilling Method Direct-Push	
WI Unique Well No DNR Well ID No. Well Name		Final Static Water ____ Feet MSL	Surface Elevation ____ Feet MSL	Borehole Diameter 2.125 inches	
Local Grid Origin (estimated:) or Boring Location State Plane 541565 N, 316021 E SW of NW of Section 26 T 10 N R 6 E		Local Grid Location ______ Feet N S ______ Feet E W			
Facility ID **157053930**	County **Sauk**	County Code **57**	Civil Town/City/ or Village **Town of Prairie du Sac**		

Sample: Number and Type	Sample: Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Soil Properties: Moisture Content	Soil Properties: Liquid Limit	Soil Properties: Plasticity Index	Soil Properties: P 200	RQD/Comments
			0-45’	No soil samples were collected. Boring drilled to install HDPE tubing for soil vapor collection.										
				B.T. @ 45’ bgs.										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Jeff Larkin Firm: Badger Technical Services, LLC.

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ ________________

Page 1 of 1

Facility/Project Name: Badger Army Ammunition Plant / Vapor Intrusion Pathway Analysis

License/Permit/Monitoring Number:

Boring Number: VIP-1A

Boring Drilled by: Name of crew chief (first, last) and Firm
First Name: Dave Last Name: Paulson
Firm: Soil Essentials LTD

Date Drilling Started: 7/3/12

Date Drilling Completed: 7/3/12

Drilling Method: Direct-Push

WI Unique Well No DNR Well ID No. Well Name

Final Static Water ____ Feet MSL

Surface Elevation ____ Feet MSL

Borehole Diameter 2.125 inches

Local Grid Origin (estimated:) or Boring Location
State Plane 540043 N, 319020 E
NE of SW of Section 14 T 10 N R 6 E

Local Grid Location
______ Feet N S ______ Feet E W

Facility ID: **157053930**

County: **Sauk**

County Code: **57**

Civil Town/City/ or Village: **Town of Sumpter**

Sample		Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties					RQD/Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			0-45’	No soil samples were collected. Boring drilled to install HDPE tubing for soil vapor collection.										
				B.T. @ 45’ bgs.										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Brenda Boyce

Firm: Badger Technical Services, LLC.

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ ________________

Page 1 of 1

Facility/Project Name Badger Army Ammunition Plant / Vapor Intrusion Pathway Analysis	License/Permit/Monitoring Number	Boring Number VIP-4A

Boring Drilled by: Name of crew chief (first, last) and Firm First Name: Dan Last Name: Bendorf Firm: Probe Technologies, Inc.	Date Drilling Started 6/27/12	Date Drilling Completed 6/27/12	Drilling Method Direct-Push

WI Unique Well No DNR Well ID No. Well Name	Final Static Water ____ Feet MSL	Surface Elevation ____ Feet MSL	Borehole Diameter 2.125 inches

Local Grid Origin (estimated:) or Boring Location State Plane 540766 N, 315809 E SW of NE of Section 26 T 10 N R 6 E	Local Grid Location ______ Feet N S ______ Feet E W

Facility ID **157053930**	County **Sauk**	County Code **57**	Civil Town/City/ or Village **Town of Prairie du Sac**

Sample									Soil Properties						
Number and Type	Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/Comments
			0-37’	No soil samples were collected. Boring drilled to install HDPE tubing for soil vapor collection. B.T. @ 37’ bgs.										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Brenda Boyce	Firm: Badger Technical Services, LLC.

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Remediation/Redevelopment ☒ Waste Management ☐ Other ☐ ________________

Page 1 of 1

Facility/Project Name: Badger Army Ammunition Plant / Vapor Intrusion Pathway Analysis
License/Permit/Monitoring Number:
Boring Number: VIP-5A

Boring Drilled by: Name of crew chief (first, last) and Firm
First Name: Dan Last Name: Bendorf
Firm: Probe Technologies, Inc.
Date Drilling Started: 6/27/12
Date Drilling Completed: 6/27/12
Drilling Method: Direct-Push

WI Unique Well No DNR Well ID No. Well Name
Final Static Water ____ Feet MSL
Surface Elevation ____ Feet MSL
Borehole Diameter 2.125 inches

Local Grid Origin (estimated:) or Boring Location
State Plane 541097 N, 315811 E
SW of NE of Section 26 T 10 N R 6 E
Local Grid Location ______ Feet N S ______ Feet E W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	**Sauk**	**57**	**Town of Prairie du Sac**

Sample		Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties					RQD/Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			0-40’	No soil samples were collected. Boring drilled to install HDPE tubing for soil vapor collection. B.T. @ 40’ bgs.										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature: Brenda Boyce
Firm: Badger Technical Services, LLC.

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ ________________

Page 1 of 1

Facility/Project Name: Badger Army Ammunition Plant / Vapor Intrusion Pathway Analysis
License/Permit/Monitoring Number:
Boring Number: VIP-7A

Boring Drilled by: Name of crew chief (first, last) and Firm
First Name: Dan Last Name: Bendorf
Firm: Probe Technologies, Inc.
Date Drilling Started: 6/27/12
Date Drilling Completed: 6/27/12
Drilling Method: Direct-Push

WI Unique Well No DNR Well ID No. Well Name
Final Static Water ____ Feet MSL
Surface Elevation ____ Feet MSL
Borehole Diameter 2.125 inches

Local Grid Origin (estimated:) or Boring Location
State Plane 541541 N, 314767 E
NW of NW of Section 36 T 10 N R 6 E
Local Grid Location ______ Feet N S ______ Feet E W

Facility ID	County	County Code	Civil Town/City/ or Village
157053930	**Sauk**	**57**	**Town of Prairie du Sac**

Sample		Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties					RQD/Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			0-37’	No soil samples were collected. Boring drilled to install HDPE tubing for soil vapor collection. B.T. @ 37’ bgs.										

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Signature: Brenda Boyce
Firm: Badger Technical Services, LLC.

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ ________________

Page 1 of 1

Facility/Project Name Badger Army Ammunition Plant / Vapor Intrusion Pathway Analysis	License/Permit/Monitoring Number	Boring Number VIP-9A

Boring Drilled by: Name of crew chief (first, last) and Firm First Name: Dan Last Name: Bendorf Firm: Probe Technologies	Date Drilling Started 6/27/12	Date Drilling Completed 6/27/12	Drilling Method Direct-Push

WI Unique Well No DNR Well ID No. Well Name	Final Static Water ____ Feet MSL	Surface Elevation ____ Feet MSL	Borehole Diameter 2.125 inches

Local Grid Origin (estimated:) or Boring Location State Plane 541465 N, 315363 E SW of SW of Section 25 T 10 N R 6 E	Local Grid Location ______ Feet N S ______ Feet E W

Facility ID **157053930**	County **Sauk**	County Code **57**	Civil Town/City/ or Village **Town of Prairie du Sac**

Sample		Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties					RQD/Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			0-39’	No soil samples were collected. Boring drilled to install HDPE tubing for soil vapor collection. B.T. @ 39’ bgs.										

I hereby certify that the information on this form is true and correct to the best of my knowledge.

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Firm: Badger Technical Services, LLC.

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State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION
Form 4400-122

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☒ Other ☐ ________________

Page 1 of 1

Facility/Project Name Badger Army Ammunition Plant / Vapor Intrusion Pathway Analysis	License/Permit/Monitoring Number	Boring Number VIP-10A	
Boring Drilled by: Name of crew chief (first, last) and Firm First Name: Dave Last Name: Paulson Firm: Soil Essentials LTD	Date Drilling Started 7/3/12	Date Drilling Completed 7/3/12	Drilling Method Direct-Push
WI Unique Well No DNR Well ID No. Well Name	Final Static Water ____ Feet MSL	Surface Elevation ____ Feet MSL	Borehole Diameter 2.125 inches
Local Grid Origin (estimated:) or Boring Location State Plane 541565 N, 316021 E SW of NW of Section 26 T 10 N R 6 E	Local Grid Location ______ Feet N S	______ Feet E W	
Facility ID **157053930**	County **Sauk**	County Code **57**	Civil Town/City/ or Village **Town of Prairie du Sac**

Sample		Blow Counts	Depth in Feet (Below ground surface)	SOIL ROCK DESCRIPTION	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties					RQD/Comments
Number and Type	Length Att. & Recovered (in)								Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	
			0-45’	No soil samples were collected. Boring drilled to install HDPE tubing for soil vapor collection. B.T. @ 45’ bgs.										

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Well / Drillhole / Borehole Abandonment Forms

State of Wisconsin
Department of Natural Resources
PO Box 7921, Madison WI 53707-7921
dnr.wi.gov

Well / Drillhole / Borehole Abandonment

Form 3300-005 (R 12/04) Page 1 of 2

Notice: Completion of this report is required by chs. 160, 281, 283, 289, 291-293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291-293, 295, and 299, Wis. Stats., failure to file this form may result in a forfeiture of between $10-25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. Return form to the appropriate DNR office and bureau. See instructions on reverse for more information.

Route to:
☐ Drinking Water ☐ Watershed/Wastewater ☐ Waste Management ☑ Remediation/Redevelopment ☐ Other:

1. General Information

WI Unique Well No.: ___ ___ ___ ___ ___
DNR Well ID No.:
County: Sauk
Common Well Name: VIP-1
Gov't Lot # (if applicable):
¼ / ¼: NE / SW
¼:
Section: 14
Township: 10 N
Range: 6 ☑ E ☐ W
Well Location ☐ ft. / ☐ M (Local Grid ☐)
540043 [✓ N] / S 319020 [✓ E] / W Datum: NAD 83
WTM–☑ UTM–☐ Latitude/Longitude–☐ State Plane–☑ Zone: [✓ S] C N
Local Grid Origin ☐ ft. / ☐ M
N, E / W Datum
WTM–☐ UTM–☐ Latitude/Longitude–☐ State Plane–☐ Zone: S C N
Reason For Abandonment: Temporary Soil Boring
WI Unique Well No. of Replacement Well: ___ ___ ___ ___ ___

2. Facility / Owner Information

Facility Name: Badger Army Ammunition Plant
Facility ID: 157053930
License/Permit/Monitoring No.:
Street Address of Well: 2 Badger Road
City, Village or Town: Baraboo
Present Well Owner: U.S. Army
Original Well Owner:
Street Address or Route of Present Owner: 2 Badger Road
City: Baraboo
State: WI
ZIP Code: 53913

3. Well / Drillhole / Borehole Information

☐ Monitoring Well
☐ Water Well
☑ Borehole / Drillhole

Original Construction Date: 2/27/12
If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug
☑ Other (specify): Geoprobe

Formation Type:
☑ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Groundsurface (ft.): 45
Casing Diameter (in.):
Lower Drillhole Diameter (in.): 2.125
Casing Depth (ft.):
Was well annular space grouted? ☐ Yes ☑ No ☐ Unknown
If yes, to what depth (feet)?
Depth to Water (feet)

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed? ☐ Yes ☐ No ☑ N/A
Liner(s) removed? ☐ Yes ☐ No ☑ N/A
Screen removed? ☐ Yes ☐ No ☑ N/A
Casing left in place? ☐ Yes ☐ No ☑ N/A
Was casing cut off below surface? ☐ Yes ☐ No ☑ N/A
Did sealing material rise to surface? ☑ Yes ☐ No ☐ N/A
Did material settle after 24 hours? ☐ Yes ☑ No ☐ N/A
If yes, was hole retopped? ☐ Yes ☐ No ☑ N/A
If bentonite chips were used, were they hydrated with water from a known safe source? ☐ Yes ☐ No ☑ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Screened & Poured (Bentonite Chips) ☑ Other (Explain): Poured / chipped bentonite

Sealing Materials
☐ Neat Cement Grout ☐ Clay-Sand Slurry (11 lb./gal. wt.)
☐ Sand-Cement (Concrete) Grout ☐ Bentonite-Sand Slurry " "
☐ Concrete ☑ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout
☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used To Fill Well / Drillhole

5. Material Used To Fill Well / Drillhole	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Chipped Bentonite	Surface	45	40 lbs	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Sealing Work: Dave Paulson
Date of Abandonment: 2/27/12
Street or Route: W6306 State Road 39
Telephone Number: (608) 527-2355
City: New Glarus
State: WI
ZIP Code: 53574
Signature of Person Doing Work:
Date Signed: 4/19/12

DNR Use Only
Date Received:
Noted By:
Comments:

State of Wisconsin
Department of Natural Resources
PO Box 7921, Madison WI 53707-7921
dnr.wi.gov

Well / Drillhole / Borehole Abandonment

Form 3300-005 (R 12/04) Page 1 of 2

Notice: Completion of this report is required by chs. 160, 281, 283, 289, 291-293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291-293, 295, and 299, Wis. Stats., failure to file this form may result in a forfeiture of between $10-25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. Return form to the appropriate DNR office and bureau. See instructions on reverse for more information.

Route to:

☐ Drinking Water ☐ Watershed/Wastewater ☐ Waste Management ☑ Remediation/Redevelopment ☐ Other: ____

1. General Information

WI Unique Well No.: ___ ___ ___ ___ ___
DNR Well ID No.:
County: Sauk
Common Well Name: VIP-2
Gov't Lot # (if applicable):
¼ / ¼: SW / NE
¼:
Section: 14
Township: 10 N
Range: 6 ☑ E ☐ W
Well Location ☐ ft. / ☐ M (Local Grid ☐)
540372 [✓ N] / ☐ S 317498 [✓ E] / ☐ W
Datum: NAD 83
WTM– ☑ UTM– ☐ Latitude/Longitude– ☐ State Plane– ☑ Zone [✓ S] ☐ C ☐ N
Local Grid Origin ☐ ft. / ☐ M
____ N, ____ ☐ E / ☐ W
Datum:
WTM– ☐ UTM– ☐ Latitude/Longitude– ☐ State Plane– ☐ Zone ☐ S ☐ C ☐ N
Reason For Abandonment: Temp. Borehole-Vapor Collection
WI Unique Well No. of Replacement Well: ___ ___ ___ ___ ___

2. Facility / Owner Information

Facility Name: Badger Army Ammunition Plant
Facility ID: 157053930
License/Permit/Monitoring No.:
Street Address of Well: 2 Badger Road
City, Village or Town: Baraboo
Present Well Owner: U.S. Army
Original Well Owner:
Street Address or Route of Present Owner: 2 Badger Road
City: Baraboo
State: WI
ZIP Code: 53913

3. Well / Drillhole / Borehole Information

☐ Monitoring Well
☐ Water Well
☑ Borehole / Drillhole

Original Construction Date: 2/27/12
If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug
☑ Other (specify): Geoprobe

Formation Type:
☑ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Groundsurface (ft.): 25
Casing Diameter (in.):
Lower Drillhole Diameter (in.): 2.125
Casing Depth (ft.):
Was well annular space grouted? ☐ Yes ☑ No ☐ Unknown
If yes, to what depth (feet)?
Depth to Water (feet):

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☑ N/A
Liner(s) removed?	☐ Yes	☐ No	☑ N/A
Screen removed?	☐ Yes	☐ No	☑ N/A
Casing left in place?	☐ Yes	☐ No	☑ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☑ N/A
Did sealing material rise to surface?	☑ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☑ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☑ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☑ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Screened & Poured (Bentonite Chips) ☑ Other (Explain): Poured / chipped bentonite

Sealing Materials
☐ Neat Cement Grout ☐ Clay-Sand Slurry (11 lb./gal. wt.)
☐ Sand-Cement (Concrete) Grout ☐ Bentonite-Sand Slurry " "
☐ Concrete ☑ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout
☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used To Fill Well / Drillhole

5. Material Used To Fill Well / Drillhole	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Chipped Bentonite	Surface	25	25 lbs	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Sealing Work: Dave Paulson
Date of Abandonment: 2/27/12
Street or Route: W6306 State Road 39
Telephone Number: (608) 527-2355
City: New Glarus
State: WI
ZIP Code: 53574
Signature of Person Doing Work:
Date Signed: 4/19/12

DNR Use Only
Date Received:
Noted By:
Comments:

State of Wisconsin
Department of Natural Resources
PO Box 7921, Madison WI 53707-7921
dnr.wi.gov

Well / Drillhole / Borehole Abandonment

Form 3300-005 (R 12/04) Page 1 of 2

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Route to:

☐ Drinking Water ☐ Watershed/Wastewater ☐ Waste Management ☑ Remediation/Redevelopment ☐ Other: ______

1. General Information

WI Unique Well No.: ___ ___ ___ ___ ___
DNR Well ID No.:
County: Sauk
Common Well Name: VIP-3
Gov't Lot # (if applicable):
¼ / ¼: SE / NW
¼:
Section: 26
Township: 10 N
Range: 6 ☑ E ☐ W
Well Location ☐ ft. / ☐ M (Local Grid ☐)
540322 [✓ N] / S 315818 [✓ E] / W Datum: NAD 83
WTM– ☑ UTM– ☐ Latitude/Longitude– ☐ State Plane– ☑ Zone: [✓ S] C N
Local Grid Origin ☐ ft. / ☐ M
______ N, ______ E / W Datum: ______
WTM– ☐ UTM– ☐ Latitude/Longitude– ☐ State Plane– ☐ Zone: S C N
Reason For Abandonment: Temp. Borehole-Vapor Collection
WI Unique Well No. of Replacement Well: ___ ___ ___ ___ ___

2. Facility / Owner Information

Facility Name: Badger Army Ammunition Plant
Facility ID: 157053930
License/Permit/Monitoring No.:
Street Address of Well: 2 Badger Road
City, Village or Town: Baraboo
Present Well Owner: U.S. Army
Original Well Owner:
Street Address or Route of Present Owner: 2 Badger Road
City: Baraboo
State: WI
ZIP Code: 53913

3. Well / Drillhole / Borehole Information

☐ Monitoring Well
☐ Water Well
☑ Borehole / Drillhole

Original Construction Date: 2/27/12

If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug
☑ Other (specify): Geoprobe

Formation Type:
☑ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Groundsurface (ft.): 25
Casing Diameter (in.):
Lower Drillhole Diameter (in.): 2.125
Casing Depth (ft.):
Was well annular space grouted? ☐ Yes ☑ No ☐ Unknown
If yes, to what depth (feet)?
Depth to Water (feet):

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☑ N/A
Liner(s) removed?	☐ Yes	☐ No	☑ N/A
Screen removed?	☐ Yes	☐ No	☑ N/A
Casing left in place?	☐ Yes	☐ No	☑ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☑ N/A
Did sealing material rise to surface?	☑ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☑ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☑ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☑ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Screened & Poured (Bentonite Chips) ☑ Other (Explain): Poured / chipped bentonite

Sealing Materials
☐ Neat Cement Grout ☐ Clay-Sand Slurry (11 lb./gal. wt.)
☐ Sand-Cement (Concrete) Grout ☐ Bentonite-Sand Slurry " "
☐ Concrete ☑ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout
☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used To Fill Well / Drillhole

5. Material Used To Fill Well / Drillhole	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Chipped Bentonite	Surface	25	25 lbs	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Sealing Work: Dave Paulson
Date of Abandonment: 2/27/12
Street or Route: W6306 State Road 39
Telephone Number: (608) 527-2355
City: New Glarus
State: WI
ZIP Code: 53574
Signature of Person Doing Work:
Date Signed: 4/19/12

DNR Use Only

Date Received:
Noted By:
Comments:

State of Wisconsin
Department of Natural Resources
PO Box 7921, Madison WI 53707-7921
dnr.wi.gov

Well / Drillhole / Borehole Abandonment

Form 3300-005 (R 12/04) Page 1 of 2

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Route to:

☐ Drinking Water ☐ Watershed/Wastewater ☐ Waste Management ☑ Remediation/Redevelopment ☐ Other:

1. General Information

WI Unique Well No.: ___ ___ ___ ___ ___
DNR Well ID No.:
County: Sauk
Common Well Name: VIP-4
Gov't Lot # (if applicable):
¼ / ¼: SW / NE
¼:
Section: 26
Township: 10 N
Range: 6 ☑ E ☐ W
Well Location ☐ ft. / ☐ M (Local Grid ☐) Datum
540766 [✓ N] / S 315809 [✓ E] / W NAD 83
WTM– ☑ UTM– ☐ Latitude/Longitude– ☐ State Plane– ☑ Zone [✓ S] ☐ C ☐ N
Local Grid Origin ☐ ft. / ☐ M Datum
N, ☐ E / ☐ W
WTM– ☐ UTM– ☐ Latitude/Longitude– ☐ State Plane– ☐ Zone ☐ S ☐ C ☐ N
Reason For Abandonment: Temp. Borehole-Vapor Collection
WI Unique Well No. of Replacement Well: ___ ___ ___ ___ ___

2. Facility / Owner Information

Facility Name: Badger Army Ammunition Plant
Facility ID: 157053930
License/Permit/Monitoring No.:
Street Address of Well: 2 Badger Road
City, Village or Town: Baraboo
Present Well Owner: U.S. Army
Original Well Owner:
Street Address or Route of Present Owner: 2 Badger Road
City: Baraboo
State: WI
ZIP Code: 53913

3. Well / Drillhole / Borehole Information

☐ Monitoring Well
☐ Water Well
☑ Borehole / Drillhole

Original Construction Date: 2/27/12

If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug
☑ Other (specify): Geoprobe

Formation Type:
☑ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Groundsurface (ft.): 25
Casing Diameter (in.):
Lower Drillhole Diameter (in.): 2.125
Casing Depth (ft.):
Was well annular space grouted? ☐ Yes ☑ No ☐ Unknown
If yes, to what depth (feet)?
Depth to Water (feet)

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☑ N/A
Liner(s) removed?	☐ Yes	☐ No	☑ N/A
Screen removed?	☐ Yes	☐ No	☑ N/A
Casing left in place?	☐ Yes	☐ No	☑ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☑ N/A
Did sealing material rise to surface?	☑ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☑ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☑ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☑ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Screened & Poured (Bentonite Chips) ☑ Other (Explain): Poured / chipped bentonite

Sealing Materials
☐ Neat Cement Grout ☐ Clay-Sand Slurry (11 lb./gal. wt.)
☐ Sand-Cement (Concrete) Grout ☐ Bentonite-Sand Slurry " "
☐ Concrete ☑ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout
☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used To Fill Well / Drillhole	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Chipped Bentonite	Surface	25	25 lbs	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Sealing Work: Dave Paulson
Date of Abandonment: 2/27/12
Street or Route: W6306 State Road 39
Telephone Number: (608) 527-2355
City: New Glarus
State: WI
ZIP Code: 53574
Signature of Person Doing Work:
Date Signed: 4/19/12

DNR Use Only
Date Received:
Noted By:
Comments:

State of Wisconsin
Department of Natural Resources
PO Box 7921, Madison WI 53707-7921
dnr.wi.gov

Well / Drillhole / Borehole Abandonment

Form 3300-005 (R 12/04) Page 1 of 2

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Route to:

☐ Drinking Water ☐ Watershed/Wastewater ☐ Waste Management ☑ Remediation/Redevelopment ☐ Other:

1. General Information

WI Unique Well No.: ___ ___ ___ ___ ___
DNR Well ID No.:
County: Sauk
Common Well Name: VIP-5
Gov't Lot # (if applicable):
¼ / ¼: SE / NE
¼:
Section: 26
Township: 10 N
Range: 6 ☑ E ☐ W

Well Location ☐ ft. / ☐ M (Local Grid ☐)
541097 [✓ N] / S 315811 [✓ E] / W Datum: NAD 83
WTM– ☑ UTM– ☐ Latitude/Longitude– ☐ State Plane– ☑ Zone: [✓ S] C N

Local Grid Origin ☐ ft. / ☐ M
N, E / W Datum:
WTM– ☐ UTM– ☐ Latitude/Longitude– ☐ State Plane– ☐ Zone: S C N

Reason For Abandonment: Temp. Borehole-Vapor Collection
WI Unique Well No. of Replacement Well: ___ ___ ___ ___ ___

2. Facility / Owner Information

Facility Name: Badger Army Ammunition Plant
Facility ID: 157053930
License/Permit/Monitoring No.:
Street Address of Well: 2 Badger Road
City, Village or Town: Baraboo
Present Well Owner: U.S. Army
Original Well Owner:
Street Address or Route of Present Owner: 2 Badger Road
City: Baraboo
State: WI
ZIP Code: 53913

3. Well / Drillhole / Borehole Information

☐ Monitoring Well
☐ Water Well
☑ Borehole / Drillhole

Original Construction Date: 2/27/12

If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug
☑ Other (specify): Geoprobe

Formation Type:
☑ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Groundsurface (ft.): 25
Casing Diameter (in.):
Lower Drillhole Diameter (in.): 2.125
Casing Depth (ft.):
Was well annular space grouted? ☐ Yes ☑ No ☐ Unknown
If yes, to what depth (feet)?
Depth to Water (feet):

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☑ N/A
Liner(s) removed?	☐ Yes	☐ No	☑ N/A
Screen removed?	☐ Yes	☐ No	☑ N/A
Casing left in place?	☐ Yes	☐ No	☑ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☑ N/A
Did sealing material rise to surface?	☑ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☑ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☑ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☑ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Screened & Poured (Bentonite Chips) ☑ Other (Explain): Poured / chipped bentonite

Sealing Materials
☐ Neat Cement Grout ☐ Clay-Sand Slurry (11 lb./gal. wt.)
☐ Sand-Cement (Concrete) Grout ☐ Bentonite-Sand Slurry " "
☐ Concrete ☑ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout
☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used To Fill Well / Drillhole

5. Material Used To Fill Well / Drillhole	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Chipped Bentonite	Surface	25	25 lbs	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Sealing Work: Dave Paulson
Date of Abandonment: 2/27/12
Street or Route: W6306 State Road 39
Telephone Number: (608) 527-2355
City: New Glarus
State: WI
ZIP Code: 53574
Signature of Person Doing Work:
Date Signed: 4/19/12

DNR Use Only
Date Received:
Noted By:
Comments:

State of Wisconsin
Department of Natural Resources
PO Box 7921, Madison WI 53707-7921
dnr.wi.gov

Well / Drillhole / Borehole Abandonment

Form 3300-005 (R 12/04) Page 1 of 2

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Route to:
☐ Drinking Water ☐ Watershed/Wastewater ☐ Waste Management ☑ Remediation/Redevelopment ☐ Other: ____

1. General Information

WI Unique Well No.: ___ ___ ___ ___ ___
DNR Well ID No.:
County: Sauk
Common Well Name: VIP-6
Gov't Lot # (if applicable):
¼ / ¼: NW / SW
¼:
Section: 25
Township: 10 N
Range: 6 ☑ E ☐ W
Well Location ft. / M (Local Grid ☐)
541455 [✓ N] / S 315689 [✓ E] / W Datum NAD 83
WTM– ☑ UTM– ☐ Latitude/Longitude– ☐ State Plane– ☑ Zone [✓ S] C N
Local Grid Origin ft. / M Datum
________ N, ________ E / W
WTM– ☐ UTM– ☐ Latitude/Longitude– ☐ State Plane– ☐ Zone S C N
Reason For Abandonment: Temp. Borehole-Vapor Collection
WI Unique Well No. of Replacement Well: ___ ___ ___ ___ ___

2. Facility / Owner Information

Facility Name: Badger Army Ammunition Plant
Facility ID: 157053930
License/Permit/Monitoring No.:
Street Address of Well: 2 Badger Road
City, Village or Town: Baraboo
Present Well Owner: U.S. Army
Original Well Owner:
Street Address or Route of Present Owner: 2 Badger Road
City: Baraboo
State: WI
ZIP Code: 53913

3. Well / Drillhole / Borehole Information

☐ Monitoring Well
☐ Water Well
☑ Borehole / Drillhole

Original Construction Date: 2/27/12
If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug
☑ Other (specify): Geoprobe

Formation Type:
☑ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Groundsurface (ft.): 45
Casing Diameter (in.):
Lower Drillhole Diameter (in.): 2.125
Casing Depth (ft.):
Was well annular space grouted? ☐ Yes ☑ No ☐ Unknown
If yes, to what depth (feet)?
Depth to Water (feet):

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☑ N/A
Liner(s) removed?	☐ Yes	☐ No	☑ N/A
Screen removed?	☐ Yes	☐ No	☑ N/A
Casing left in place?	☐ Yes	☐ No	☑ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☑ N/A
Did sealing material rise to surface?	☑ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☑ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☑ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☑ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Screened & Poured (Bentonite Chips) ☑ Other (Explain): Poured / chipped bentonite

Sealing Materials
☐ Neat Cement Grout ☐ Clay-Sand Slurry (11 lb./gal. wt.)
☐ Sand-Cement (Concrete) Grout ☐ Bentonite-Sand Slurry " "
☐ Concrete ☑ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout
☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used To Fill Well / Drillhole

5. Material Used To Fill Well / Drillhole	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Chipped Bentonite	Surface	45	40 lbs	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Sealing Work: Dave Paulson
Date of Abandonment: 2/27/12
Street or Route: W6306 State Road 39
Telephone Number: (608) 527-2355
City: New Glarus
State: WI
ZIP Code: 53574
Signature of Person Doing Work:
Date Signed: 4/19/12

DNR Use Only
Date Received:
Noted By:
Comments:

State of Wisconsin
Department of Natural Resources
PO Box 7921, Madison WI 53707-7921
dnr.wi.gov

Well / Drillhole / Borehole Abandonment

Form 3300-005 (R 12/04)

Page 1 of 2

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Route to:
☐ Drinking Water ☐ Watershed/Wastewater ☐ Waste Management ☑ Remediation/Redevelopment ☐ Other:

1. General Information

WI Unique Well No.: ___ ___ ___ ___ ___
DNR Well ID No.:
County: Sauk
Common Well Name: VIP-7
Gov't Lot # (if applicable):
¼ / ¼: NW / NW
¼:
Section: 36
Township: 10 N
Range: 6 ☑ E ☐ W
Well Location ft. / M (Local Grid ☐) Datum
541541 [✓ N] / S 314767 [✓ E] / W NAD 83
WTM– ☑ UTM– ☐ Latitude/Longitude– ☐ State Plane– ☑ Zone [✓ S] C N
Local Grid Origin ft. / M Datum
N, E / W
WTM– ☐ UTM– ☐ Latitude/Longitude– ☐ State Plane– ☐ Zone S C N
Reason For Abandonment: Temp. Borehole-Vapor Collection
WI Unique Well No. of Replacement Well: ___ ___ ___ ___ ___

2. Facility / Owner Information

Facility Name: Badger Army Ammunition Plant
Facility ID: 157053930
License/Permit/Monitoring No.:
Street Address of Well: 2 Badger Road
City, Village or Town: Baraboo
Present Well Owner: U.S. Army
Original Well Owner:
Street Address or Route of Present Owner: 2 Badger Road
City: Baraboo
State: WI
ZIP Code: 53913

3. Well / Drillhole / Borehole Information

☐ Monitoring Well
☐ Water Well
☑ Borehole / Drillhole

Original Construction Date: 2/28/12
If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug
☑ Other (specify): Geoprobe

Formation Type:
☑ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Groundsurface (ft.): 45
Casing Diameter (in.):
Lower Drillhole Diameter (in.): 2.125
Casing Depth (ft.):
Was well annular space grouted? ☐ Yes ☑ No ☐ Unknown
If yes, to what depth (feet)?
Depth to Water (feet):

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☑ N/A
Liner(s) removed?	☐ Yes	☐ No	☑ N/A
Screen removed?	☐ Yes	☐ No	☑ N/A
Casing left in place?	☐ Yes	☐ No	☑ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☑ N/A
Did sealing material rise to surface?	☑ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☑ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☑ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☑ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Screened & Poured (Bentonite Chips) ☑ Other (Explain): Poured / chipped bentonite

Sealing Materials
☐ Neat Cement Grout ☐ Clay-Sand Slurry (11 lb./gal. wt.)
☐ Sand-Cement (Concrete) Grout ☐ Bentonite-Sand Slurry " "
☐ Concrete ☑ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout
☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used To Fill Well / Drillhole

5. Material Used To Fill Well / Drillhole	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Chipped Bentonite	Surface	45	40 lbs	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Sealing Work: Dave Paulson
Date of Abandonment: 2/28/12
Street or Route: W6306 State Road 39
Telephone Number: (608) 527-2355
City: New Glarus
State: WI
ZIP Code: 53574
Signature of Person Doing Work:
Date Signed: 4/19/12

DNR Use Only
Date Received:
Noted By:
Comments:

State of Wisconsin
Department of Natural Resources
PO Box 7921, Madison WI 53707-7921
dnr.wi.gov

Well / Drillhole / Borehole Abandonment

Form 3300-005 (R 12/04)

Page 1 of 2

Notice: Completion of this report is required by chs. 160, 281, 283, 289, 291-293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291-293, 295, and 299, Wis. Stats., failure to file this form may result in a forfeiture of between $10-25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. Return form to the appropriate DNR office and bureau. See instructions on reverse for more information.

Route to:

☐ Drinking Water ☐ Watershed/Wastewater ☐ Waste Management ☑ Remediation/Redevelopment ☐ Other: ______

1. General Information

WI Unique Well No.: ___ ___ ___ ___ ___
DNR Well ID No.:
County: Sauk
Common Well Name: VIP-8
Gov't Lot # (if applicable):
¼ / ¼: SW / SW
¼:
Section: 25
Township: 10 N
Range: 6 ☑ E ☐ W
Well Location ft. / M (Local Grid ☐)
541463 [✓ N] / S 315099 [✓ E] / W Datum: NAD 83
WTM– ☑ UTM– ☐ Latitude/Longitude– ☐ State Plane– ☑ Zone: [✓ S] C N
Local Grid Origin ft. / M
______ N, ______ E / W Datum:
WTM– ☐ UTM– ☐ Latitude/Longitude– ☐ State Plane– ☐ Zone: S C N
Reason For Abandonment: Temp. Borehole-Vapor Collection
WI Unique Well No. of Replacement Well: ___ ___ ___ ___ ___

2. Facility / Owner Information

Facility Name: Badger Army Ammunition Plant
Facility ID: 157053930
License/Permit/Monitoring No.:
Street Address of Well: 2 Badger Road
City, Village or Town: Baraboo
Present Well Owner: U.S. Army
Original Well Owner:
Street Address or Route of Present Owner: 2 Badger Road
City: Baraboo
State: WI
ZIP Code: 53913

3. Well / Drillhole / Borehole Information

☐ Monitoring Well
☐ Water Well
☑ Borehole / Drillhole

Original Construction Date: 2/28/12
If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug
☑ Other (specify): Geoprobe

Formation Type:
☑ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Groundsurface (ft.): 45
Casing Diameter (in.):
Lower Drillhole Diameter (in.): 2.125
Casing Depth (ft.):
Was well annular space grouted? ☐ Yes ☑ No ☐ Unknown
If yes, to what depth (feet)?
Depth to Water (feet):

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☑ N/A
Liner(s) removed?	☐ Yes	☐ No	☑ N/A
Screen removed?	☐ Yes	☐ No	☑ N/A
Casing left in place?	☐ Yes	☐ No	☑ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☑ N/A
Did sealing material rise to surface?	☑ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☑ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☑ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☑ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Screened & Poured (Bentonite Chips) ☑ Other (Explain): Poured / chipped bentonite

Sealing Materials
☐ Neat Cement Grout ☐ Clay-Sand Slurry (11 lb./gal. wt.)
☐ Sand-Cement (Concrete) Grout ☐ Bentonite-Sand Slurry " "
☐ Concrete ☑ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout
☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used To Fill Well / Drillhole

5. Material Used To Fill Well / Drillhole	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Chipped Bentonite	Surface	45	40 lbs	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Sealing Work: Dave Paulson
Date of Abandonment: 2/28/12
Street or Route: W6306 State Road 39
Telephone Number: (608) 527-2355
City: New Glarus
State: WI
ZIP Code: 53574
Signature of Person Doing Work:
Date Signed: 4/19/12

DNR Use Only
Date Received:
Noted By:
Comments:

State of Wisconsin
Department of Natural Resources
PO Box 7921, Madison WI 53707-7921
dnr.wi.gov

Well / Drillhole / Borehole Abandonment

Form 3300-005 (R 12/04) Page 1 of 2

Notice: Completion of this report is required by chs. 160, 281, 283, 289, 291-293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291-293, 295, and 299, Wis. Stats., failure to file this form may result in a forfeiture of between $10-25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. Return form to the appropriate DNR office and bureau. See instructions on reverse for more information.

Route to:

☐ Drinking Water ☐ Watershed/Wastewater ☐ Waste Management ☑ Remediation/Redevelopment ☐ Other: ____

1. General Information

WI Unique Well No.: ___ ___ ___ ___ ___
DNR Well ID No.:
County: Sauk
Common Well Name: VIP-9
Gov't Lot # (if applicable):
¼ / ¼: SW / SW
¼:
Section: 25
Township: 10 N
Range: 6 ☑ E ☐ W

Well Location ft. / M (Local Grid ☐) Datum
541465 [✓ N] / S 315363 [✓ E] / W NAD 83
WTM– ☑ UTM– ☐ Latitude/Longitude– ☐ State Plane– ☑ Zone [✓ S] C N

Local Grid Origin ft. / M Datum
________ N, ________ E / W ________
WTM– ☐ UTM– ☐ Latitude/Longitude– ☐ State Plane– ☐ Zone S C N

Reason For Abandonment: Temp. Borehole-Vapor Collection
WI Unique Well No. of Replacement Well: ___ ___ ___ ___ ___

2. Facility / Owner Information

Facility Name: Badger Army Ammunition Plant
Facility ID: 157053930
License/Permit/Monitoring No.:
Street Address of Well: 2 Badger Road
City, Village or Town: Baraboo
Present Well Owner: U.S. Army
Original Well Owner:
Street Address or Route of Present Owner: 2 Badger Road
City: Baraboo
State: WI
ZIP Code: 53913

3. Well / Drillhole / Borehole Information

☐ Monitoring Well
☐ Water Well
☑ Borehole / Drillhole

Original Construction Date: 2/28/12

If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug
☑ Other (specify): Geoprobe

Formation Type:
☑ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Groundsurface (ft.): 45
Casing Diameter (in.):
Lower Drillhole Diameter (in.): 2.125
Casing Depth (ft.):

Was well annular space grouted? ☐ Yes ☑ No ☐ Unknown
If yes, to what depth (feet)?
Depth to Water (feet):

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☑ N/A
Liner(s) removed?	☐ Yes	☐ No	☑ N/A
Screen removed?	☐ Yes	☐ No	☑ N/A
Casing left in place?	☐ Yes	☐ No	☑ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☑ N/A
Did sealing material rise to surface?	☑ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☑ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☑ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☑ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Screened & Poured (Bentonite Chips) ☑ Other (Explain): Poured / chipped bentonite

Sealing Materials
☐ Neat Cement Grout ☐ Clay-Sand Slurry (11 lb./gal. wt.)
☐ Sand-Cement (Concrete) Grout ☐ Bentonite-Sand Slurry " "
☐ Concrete ☑ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout
☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used To Fill Well / Drillhole

5. Material Used To Fill Well / Drillhole	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Chipped Bentonite	Surface	45	45 lbs	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Sealing Work: Dave Paulson
Date of Abandonment: 2/28/12
Street or Route: W6306 State Road 39
Telephone Number: (608) 527-2355
City: New Glarus
State: WI
ZIP Code: 53574
Signature of Person Doing Work:
Date Signed: 4/19/12

DNR Use Only

Date Received:
Noted By:
Comments:

State of Wisconsin
Department of Natural Resources
PO Box 7921, Madison WI 53707-7921
dnr.wi.gov

Well / Drillhole / Borehole Abandonment

Form 3300-005 (R 12/04)

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Route to:

☐ Drinking Water ☐ Watershed/Wastewater ☐ Waste Management ☑ Remediation/Redevelopment ☐ Other: ____

1. General Information

WI Unique Well No.: ___ ___ ___ ___ ___
DNR Well ID No.:
County: Sauk
Common Well Name: VIP-10
Gov't Lot # (if applicable):
¼ / ¼: SW / NW
¼:
Section: 26
Township: 10 N
Range: 6 ☑ E ☐ W
Well Location ☐ ft. / ☐ M (Local Grid ☐)
541565 [✓ N] / S 316021 [✓ E] / W Datum: NAD 83
WTM– ☑ UTM– ☐ Latitude/Longitude– ☐ State Plane– ☑ Zone: [✓ S] C N
Local Grid Origin ☐ ft. / ☐ M
______ N, ______ E / W Datum: ______
WTM– ☐ UTM– ☐ Latitude/Longitude– ☐ State Plane– ☐ Zone: S C N
Reason For Abandonment: Temp. Borehole-Vapor Collection
WI Unique Well No. of Replacement Well: ___ ___ ___ ___ ___

2. Facility / Owner Information

Facility Name: Badger Army Ammunition Plant
Facility ID: 157053930
License/Permit/Monitoring No.:
Street Address of Well: 2 Badger Road
City, Village or Town: Baraboo
Present Well Owner: U.S. Army
Original Well Owner:
Street Address or Route of Present Owner: 2 Badger Road
City: Baraboo
State: WI
ZIP Code: 53913

3. Well / Drillhole / Borehole Information

☐ Monitoring Well
☐ Water Well
☑ Borehole / Drillhole

Original Construction Date: 2/28/12

If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug
☑ Other (specify): Geoprobe

Formation Type:
☑ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Groundsurface (ft.): 45
Casing Diameter (in.):
Lower Drillhole Diameter (in.): 2.125
Casing Depth (ft.):
Was well annular space grouted? ☐ Yes ☑ No ☐ Unknown
If yes, to what depth (feet)?
Depth to Water (feet):

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☑ N/A
Liner(s) removed?	☐ Yes	☐ No	☑ N/A
Screen removed?	☐ Yes	☐ No	☑ N/A
Casing left in place?	☐ Yes	☐ No	☑ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☑ N/A
Did sealing material rise to surface?	☑ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☑ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☑ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☑ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Screened & Poured (Bentonite Chips) ☑ Other (Explain): Poured / chipped bentonite

Sealing Materials
☐ Neat Cement Grout ☐ Clay-Sand Slurry (11 lb./gal. wt.)
☐ Sand-Cement (Concrete) Grout ☐ Bentonite-Sand Slurry " "
☐ Concrete ☑ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout
☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used To Fill Well / Drillhole	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Chipped Bentonite	Surface	45	40 lbs	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Sealing Work: Dave Paulson
Date of Abandonment: 2/28/12
Street or Route: W6306 State Road 39
Telephone Number: (608) 527-2355
City: New Glarus
State: WI
ZIP Code: 53574
Signature of Person Doing Work:
Date Signed: 4/19/12

DNR Use Only
Date Received:
Noted By:
Comments:

State of Wisconsin
Department of Natural Resources
PO Box 7921, Madison WI 53707-7921
dnr.wi.gov

Well / Drillhole / Borehole Abandonment

Form 3300-005 (R 12/04)

Notice: Completion of this report is required by chs. 160, 281, 283, 289, 291-293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291-293, 295, and 299, Wis. Stats., failure to file this form may result in a forfeiture of between $10-25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. Return form to the appropriate DNR office and bureau. See instructions on reverse for more information.

Route to:
☐ Drinking Water ☐ Watershed/Wastewater ☐ Waste Management ☑ Remediation/Redevelopment ☐ Other: ____

1. General Information

WI Unique Well No.: ___ ___ ___ ___ ___
DNR Well ID No.:
County: Sauk
Common Well Name: VIP-1A
Gov't Lot # (if applicable):
¼ / ¼: NE / SW
¼:
Section: 14
Township: 10 N
Range: 6 ☑ E ☐ W
Well Location ft. / M (Local Grid ☐) Datum
540043 [✓ N] / S 319020 [✓ E] / W NAD 83
Zone
WTM– ☑ UTM– ☐ Latitude/Longitude– ☐ State Plane– ☑ [✓ S] C N
Local Grid Origin ft. / M Datum
________ N, ________ E / W ________
Zone
WTM– ☐ UTM– ☐ Latitude/Longitude– ☐ State Plane– ☐ S C N
Reason For Abandonment: Temporary Soil Boring
WI Unique Well No. of Replacement Well: ___ ___ ___ ___ ___

2. Facility / Owner Information

Facility Name: Badger Army Ammunition Plant
Facility ID: 157053930
License/Permit/Monitoring No.:
Street Address of Well: 2 Badger Road
City, Village or Town: Baraboo
Present Well Owner: U.S. Army
Original Well Owner:
Street Address or Route of Present Owner: 2 Badger Road
City: Baraboo
State: WI
ZIP Code: 53913

3. Well / Drillhole / Borehole Information

☐ Monitoring Well
☐ Water Well
☑ Borehole / Drillhole

Original Construction Date: 7/3/12
If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug
☑ Other (specify): Geoprobe

Formation Type:
☑ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Groundsurface (ft.): 45
Casing Diameter (in.):
Lower Drillhole Diameter (in.): 2.125
Casing Depth (ft.):
Was well annular space grouted? ☐ Yes ☑ No ☐ Unknown
If yes, to what depth (feet)?
Depth to Water (feet):

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☑ N/A
Liner(s) removed?	☐ Yes	☐ No	☑ N/A
Screen removed?	☐ Yes	☐ No	☑ N/A
Casing left in place?	☐ Yes	☐ No	☑ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☑ N/A
Did sealing material rise to surface?	☑ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☑ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☑ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☑ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Screened & Poured (Bentonite Chips) ☑ Other (Explain): Poured / chipped bentonite

Sealing Materials
☐ Neat Cement Grout ☐ Clay-Sand Slurry (11 lb./gal. wt.)
☐ Sand-Cement (Concrete) Grout ☐ Bentonite-Sand Slurry " "
☐ Concrete ☑ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout
☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used To Fill Well / Drillhole

5. Material Used To Fill Well / Drillhole	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Chipped Bentonite	Surface	45	40 lbs	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Sealing Work: Dave Paulson
Date of Abandonment: 7/3/12
Street or Route: W6306 State Road 39
Telephone Number: (608) 527-2355
City: New Glarus
State: WI
ZIP Code: 53574
Signature of Person Doing Work:
Date Signed: 7/12/12

DNR Use Only
Date Received:
Noted By:
Comments:

State of Wisconsin
Department of Natural Resources
PO Box 7921, Madison WI 53707-7921
dnr.wi.gov

Well / Drillhole / Borehole Abandonment

Form 3300-005 (R 12/04) Page 1 of 2

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Route to:

☐ Drinking Water ☐ Watershed/Wastewater ☐ Waste Management ☑ Remediation/Redevelopment ☐ Other:

1. General Information

WI Unique Well No.: ___ ___ ___ ___ ___
DNR Well ID No.:
County: Sauk
Common Well Name: VIP-4A
Gov't Lot # (if applicable):
¼ / ¼: SW / NE
¼:
Section: 26
Township: 10 N
Range: 6 ☑ E ☐ W
Well Location ☐ ft. / ☐ M (Local Grid ☐)
540766 [✓ N] / S 315809 [✓ E] / W Datum: NAD 83
WTM–☑ UTM–☐ Latitude/Longitude–☐ State Plane–☑ Zone: [✓ S] C N
Local Grid Origin ☐ ft. / ☐ M
N, E / W Datum
WTM–☐ UTM–☐ Latitude/Longitude–☐ State Plane–☐ Zone: S C N
Reason For Abandonment: Temp. Borehole-Vapor Collection
WI Unique Well No. of Replacement Well: ___ ___ ___ ___ ___

2. Facility / Owner Information

Facility Name: Badger Army Ammunition Plant
Facility ID: 157053930
License/Permit/Monitoring No.:
Street Address of Well: 2 Badger Road
City, Village or Town: Baraboo
Present Well Owner: U.S. Army
Original Well Owner:
Street Address or Route of Present Owner: 2 Badger Road
City: Baraboo
State: WI
ZIP Code: 53913

3. Well / Drillhole / Borehole Information

☐ Monitoring Well
☐ Water Well
☑ Borehole / Drillhole

Original Construction Date: 6/27/12

If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug
☑ Other (specify): Geoprobe

Formation Type:
☑ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Groundsurface (ft.): 37
Casing Diameter (in.):
Lower Drillhole Diameter (in.): 2.125
Casing Depth (ft.):
Was well annular space grouted? ☐ Yes ☑ No ☐ Unknown
If yes, to what depth (feet)?
Depth to Water (feet):

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☑ N/A
Liner(s) removed?	☐ Yes	☐ No	☑ N/A
Screen removed?	☐ Yes	☐ No	☑ N/A
Casing left in place?	☐ Yes	☐ No	☑ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☑ N/A
Did sealing material rise to surface?	☑ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☑ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☑ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☑ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Screened & Poured (Bentonite Chips) ☑ Other (Explain): Poured / chipped bentonite

Sealing Materials
☐ Neat Cement Grout ☐ Clay-Sand Slurry (11 lb./gal. wt.)
☐ Sand-Cement (Concrete) Grout ☐ Bentonite-Sand Slurry " "
☐ Concrete ☑ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout
☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used To Fill Well / Drillhole

5. Material Used To Fill Well / Drillhole	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Chipped Bentonite	Surface	37	30 lbs	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Sealing Work: Dan Bendorf
Date of Abandonment: 6/27/12
Street or Route: W1225 South Shore Drive
Telephone Number: (262) 470-4768
City: Palmyra
State: WI
ZIP Code: 53156
Signature of Person Doing Work:
Date Signed: 7/12/12

DNR Use Only

Date Received:
Noted By:
Comments:

State of Wisconsin
Department of Natural Resources
PO Box 7921, Madison WI 53707-7921
dnr.wi.gov

Well / Drillhole / Borehole Abandonment

Form 3300-005 (R 12/04) Page 1 of 2

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Route to:

☐ Drinking Water ☐ Watershed/Wastewater ☐ Waste Management ☑ Remediation/Redevelopment ☐ Other: ______

1. General Information

WI Unique Well No.: ___ ___ ___ ___ ___
DNR Well ID No.:
County: Sauk
Common Well Name: VIP-5A
Gov't Lot # (if applicable):
¼ / ¼: SE / NE
¼:
Section: 26
Township: 10 N
Range: 6 ☑ E ☐ W
Well Location ☐ ft. / ☐ M (Local Grid ☐)
541097 [✓ N] / S 315811 [✓ E] / W
Datum: NAD 83
WTM– ☑ UTM– ☐ Latitude/Longitude– ☐ State Plane– ☑ Zone [✓ S] C N
Local Grid Origin ☐ ft. / ☐ M
______ N, ______ E / W
Datum:
WTM– ☐ UTM– ☐ Latitude/Longitude– ☐ State Plane– ☐ Zone S C N
Reason For Abandonment: Temp. Borehole-Vapor Collection
WI Unique Well No. of Replacement Well: ___ ___ ___ ___ ___

2. Facility / Owner Information

Facility Name: Badger Army Ammunition Plant
Facility ID: 157053930
License/Permit/Monitoring No.:
Street Address of Well: 2 Badger Road
City, Village or Town: Baraboo
Present Well Owner: U.S. Army
Original Well Owner:
Street Address or Route of Present Owner: 2 Badger Road
City: Baraboo
State: WI
ZIP Code: 53913

3. Well / Drillhole / Borehole Information

☐ Monitoring Well
☐ Water Well
☑ Borehole / Drillhole

Original Construction Date: 6/27/12

If a Well Construction Report is available, please attach.

Construction Type:

☐ Drilled ☐ Driven (Sandpoint) ☐ Dug
☑ Other (specify): Geoprobe

Formation Type:

☑ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Groundsurface (ft.): 40
Casing Diameter (in.):
Lower Drillhole Diameter (in.): 2.125
Casing Depth (ft.):
Was well annular space grouted? ☐ Yes ☑ No ☐ Unknown
If yes, to what depth (feet)?
Depth to Water (feet):

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☑ N/A
Liner(s) removed?	☐ Yes	☐ No	☑ N/A
Screen removed?	☐ Yes	☐ No	☑ N/A
Casing left in place?	☐ Yes	☐ No	☑ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☑ N/A
Did sealing material rise to surface?	☑ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☑ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☑ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☑ N/A

Required Method of Placing Sealing Material

☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Screened & Poured (Bentonite Chips) ☑ Other (Explain): Poured / chipped bentonite

Sealing Materials

☐ Neat Cement Grout ☐ Clay-Sand Slurry (11 lb./gal. wt.)
☐ Sand-Cement (Concrete) Grout ☐ Bentonite-Sand Slurry " "
☐ Concrete ☑ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:

☐ Bentonite Chips ☐ Bentonite - Cement Grout
☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used To Fill Well / Drillhole

5. Material Used To Fill Well / Drillhole	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Chipped Bentonite	Surface	40	35 lbs	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Sealing Work: Dan Bendorf
Date of Abandonment: 6/27/12
Street or Route: W1225 South Shore Drive
Telephone Number: (262) 470-4768
City: Palmyra
State: WI
ZIP Code: 53156
Signature of Person Doing Work:
Date Signed: 7/12/12

DNR Use Only

Date Received:
Noted By:
Comments:

State of Wisconsin
Department of Natural Resources
PO Box 7921, Madison WI 53707-7921
dnr.wi.gov

Well / Drillhole / Borehole Abandonment

Form 3300-005 (R 12/04) Page 1 of 2

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Route to:

☐ Drinking Water ☐ Watershed/Wastewater ☐ Waste Management ☑ Remediation/Redevelopment ☐ Other: ______

1. General Information

WI Unique Well No.: ___ ___ ___ ___ ___
DNR Well ID No.:
County: Sauk
Common Well Name: VIP-7A
Gov't Lot # (if applicable):
¼ / ¼: NW / NW
¼:
Section: 36
Township: 10 N
Range: 6 ☑ E ☐ W
Well Location ☐ ft. / ☐ M (Local Grid ☐)
541541 [✓ N] / S 314767 [✓ E] / W Datum: NAD 83
WTM– ☑ UTM– ☐ Latitude/Longitude– ☐ State Plane– ☑ Zone: [✓ S] C N
Local Grid Origin ☐ ft. / ☐ M
______ N, ______ E / W Datum: ______
WTM– ☐ UTM– ☐ Latitude/Longitude– ☐ State Plane– ☐ Zone: S C N
Reason For Abandonment: Temp. Borehole-Vapor Collection
WI Unique Well No. of Replacement Well: ___ ___ ___ ___ ___

2. Facility / Owner Information

Facility Name: Badger Army Ammunition Plant
Facility ID: 157053930
License/Permit/Monitoring No.:
Street Address of Well: 2 Badger Road
City, Village or Town: Baraboo
Present Well Owner: U.S. Army
Original Well Owner:
Street Address or Route of Present Owner: 2 Badger Road
City: Baraboo
State: WI
ZIP Code: 53913

3. Well / Drillhole / Borehole Information

☐ Monitoring Well
☐ Water Well
☑ Borehole / Drillhole

Original Construction Date: 6/27/12
If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug
☑ Other (specify): Geoprobe

Formation Type:
☑ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Groundsurface (ft.): 37
Casing Diameter (in.):
Lower Drillhole Diameter (in.): 2.125
Casing Depth (ft.):
Was well annular space grouted? ☐ Yes ☑ No ☐ Unknown
If yes, to what depth (feet)?
Depth to Water (feet):

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☑ N/A
Liner(s) removed?	☐ Yes	☐ No	☑ N/A
Screen removed?	☐ Yes	☐ No	☑ N/A
Casing left in place?	☐ Yes	☐ No	☑ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☑ N/A
Did sealing material rise to surface?	☑ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☑ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☑ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☑ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Screened & Poured (Bentonite Chips) ☑ Other (Explain): Poured / chipped bentonite

Sealing Materials
☐ Neat Cement Grout ☐ Clay-Sand Slurry (11 lb./gal. wt.)
☐ Sand-Cement (Concrete) Grout ☐ Bentonite-Sand Slurry " "
☐ Concrete ☑ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout
☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used To Fill Well / Drillhole

5. Material Used To Fill Well / Drillhole	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Chipped Bentonite	Surface	37	30 lbs	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Sealing Work: Dan Bendorf
Date of Abandonment: 6/27/12
Street or Route: W1225 South Shore Drive
Telephone Number: (262) 470-4768
City: Palmyra
State: WI
ZIP Code: 53156
Signature of Person Doing Work:
Date Signed: 7/12/12

DNR Use Only
Date Received:
Noted By:
Comments:

State of Wisconsin
Department of Natural Resources
PO Box 7921, Madison WI 53707-7921
dnr.wi.gov

Well / Drillhole / Borehole Abandonment

Form 3300-005 (R 12/04)
Page 1 of 2

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Route to:
☐ Drinking Water ☐ Watershed/Wastewater ☐ Waste Management ☑ Remediation/Redevelopment ☐ Other: ______

1. General Information

WI Unique Well No. ___ ___ ___ ___ ___
DNR Well ID No.
County: Sauk
Common Well Name: VIP-9A
Gov't Lot # (if applicable)
¼ / ¼: SW / SW
¼
Section: 25
Township: 10 N
Range: 6 ☑ E ☐ W
Well Location ft. / M (Local Grid ☐) Datum
541465 [✓ N] / S 315363 [✓ E] / W NAD 83
WTM– ☑ UTM– ☐ Latitude/Longitude– ☐ State Plane– ☑ Zone [✓ S] C N
Local Grid Origin ft. / M Datum
______ N, ______ E / W ______
WTM– ☐ UTM– ☐ Latitude/Longitude– ☐ State Plane– ☐ Zone S C N
Reason For Abandonment: Temp. Borehole-Vapor Collection
WI Unique Well No. of Replacement Well ___ ___ ___ ___ ___

2. Facility / Owner Information

Facility Name: Badger Army Ammunition Plant
Facility ID: 157053930
License/Permit/Monitoring No.
Street Address of Well: 2 Badger Road
City, Village or Town: Baraboo
Present Well Owner: U.S. Army
Original Well Owner
Street Address or Route of Present Owner: 2 Badger Road
City: Baraboo
State: WI
ZIP Code: 53913

3. Well / Drillhole / Borehole Information

☐ Monitoring Well
☐ Water Well
☑ Borehole / Drillhole

Original Construction Date: 6/27/12
If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug
☑ Other (specify): Geoprobe

Formation Type:
☑ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Groundsurface (ft.): 39
Casing Diameter (in.)
Lower Drillhole Diameter (in.): 2.125
Casing Depth (ft.)
Was well annular space grouted? ☐ Yes ☑ No ☐ Unknown
If yes, to what depth (feet)?
Depth to Water (feet)

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed? ☐ Yes ☐ No ☑ N/A
Liner(s) removed? ☐ Yes ☐ No ☑ N/A
Screen removed? ☐ Yes ☐ No ☑ N/A
Casing left in place? ☐ Yes ☐ No ☑ N/A
Was casing cut off below surface? ☐ Yes ☐ No ☑ N/A
Did sealing material rise to surface? ☑ Yes ☐ No ☐ N/A
Did material settle after 24 hours? ☐ Yes ☑ No ☐ N/A
If yes, was hole retopped? ☐ Yes ☐ No ☑ N/A
If bentonite chips were used, were they hydrated with water from a known safe source? ☐ Yes ☐ No ☑ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Screened & Poured (Bentonite Chips) ☑ Other (Explain): Poured / chipped bentonite

Sealing Materials
☐ Neat Cement Grout ☐ Clay-Sand Slurry (11 lb./gal. wt.)
☐ Sand-Cement (Concrete) Grout ☐ Bentonite-Sand Slurry " "
☐ Concrete ☑ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout
☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used To Fill Well / Drillhole

5. Material Used To Fill Well / Drillhole	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Chipped Bentonite	Surface	39	35 lbs	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Sealing Work: Dan Bendorf
Date of Abandonment: 6/27/12
Street or Route: W1225 South Shore Drive
Telephone Number: (262) 470-4768
City: Palmyra
State: WI
ZIP Code: 53156
Signature of Person Doing Work
Date Signed: 7/12/12

DNR Use Only
Date Received
Noted By
Comments

State of Wisconsin
Department of Natural Resources
PO Box 7921, Madison WI 53707-7921
dnr.wi.gov

Well / Drillhole / Borehole Abandonment

Form 3300-005 (R 12/04)

Page 1 of 2

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Route to:

☐ Drinking Water ☐ Watershed/Wastewater ☐ Waste Management ☑ Remediation/Redevelopment ☐ Other: ______

1. General Information

WI Unique Well No.: ___ ___ ___ ___ ___
DNR Well ID No.:
County: Sauk
Common Well Name: VIP-10A
Gov't Lot # (if applicable):
¼ / ¼: SW / NW
¼:
Section: 26
Township: 10 N
Range: 6 ☑ E ☐ W
Well Location ft. / M (Local Grid ☐)
541565 [✓ N] / S 316021 [✓ E] / W Datum: NAD 83
WTM–☑ UTM–☐ Latitude/Longitude–☐ State Plane–☑ Zone: [✓ S] C N
Local Grid Origin ft. / M
______ N, ______ E / W Datum: ______
WTM–☐ UTM–☐ Latitude/Longitude–☐ State Plane–☐ Zone: S C N
Reason For Abandonment: Temp. Borehole-Vapor Collection
WI Unique Well No. of Replacement Well: ___ ___ ___ ___ ___

2. Facility / Owner Information

Facility Name: Badger Army Ammunition Plant
Facility ID: 157053930
License/Permit/Monitoring No.:
Street Address of Well: 2 Badger Road
City, Village or Town: Baraboo
Present Well Owner: U.S. Army
Original Well Owner:
Street Address or Route of Present Owner: 2 Badger Road
City: Baraboo
State: WI
ZIP Code: 53913

3. Well / Drillhole / Borehole Information

☐ Monitoring Well
☐ Water Well
☑ Borehole / Drillhole

Original Construction Date: 7/3/12

If a Well Construction Report is available, please attach.

Construction Type:
☐ Drilled ☐ Driven (Sandpoint) ☐ Dug
☑ Other (specify): Geoprobe

Formation Type:
☑ Unconsolidated Formation ☐ Bedrock

Total Well Depth From Groundsurface (ft.): 45
Casing Diameter (in.):
Lower Drillhole Diameter (in.): 2.125
Casing Depth (ft.):
Was well annular space grouted? ☐ Yes ☑ No ☐ Unknown
If yes, to what depth (feet)?
Depth to Water (feet):

4. Pump, Liner, Screen, Casing & Sealing Material

Pump and piping removed?	☐ Yes	☐ No	☑ N/A
Liner(s) removed?	☐ Yes	☐ No	☑ N/A
Screen removed?	☐ Yes	☐ No	☑ N/A
Casing left in place?	☐ Yes	☐ No	☑ N/A
Was casing cut off below surface?	☐ Yes	☐ No	☑ N/A
Did sealing material rise to surface?	☑ Yes	☐ No	☐ N/A
Did material settle after 24 hours?	☐ Yes	☑ No	☐ N/A
If yes, was hole retopped?	☐ Yes	☐ No	☑ N/A
If bentonite chips were used, were they hydrated with water from a known safe source?	☐ Yes	☐ No	☑ N/A

Required Method of Placing Sealing Material
☐ Conductor Pipe-Gravity ☐ Conductor Pipe-Pumped
☐ Screened & Poured (Bentonite Chips) ☑ Other (Explain): Poured / chipped bentonite

Sealing Materials
☐ Neat Cement Grout ☐ Clay-Sand Slurry (11 lb./gal. wt.)
☐ Sand-Cement (Concrete) Grout ☐ Bentonite-Sand Slurry " "
☐ Concrete ☑ Bentonite Chips

For Monitoring Wells and Monitoring Well Boreholes Only:
☐ Bentonite Chips ☐ Bentonite - Cement Grout
☐ Granular Bentonite ☐ Bentonite - Sand Slurry

5. Material Used To Fill Well / Drillhole

5. Material Used To Fill Well / Drillhole	From (ft.)	To (ft.)	No. Yards, Sacks Sealant or Volume (circle one)	Mix Ratio or Mud Weight
Chipped Bentonite	Surface	45	40 lbs	

6. Comments

7. Supervision of Work

Name of Person or Firm Doing Sealing Work: Dave Paulson
Date of Abandonment: 7/3/12
Street or Route: W6306 State Road 39
Telephone Number: (608) 527-2355
City: New Glarus
State: WI
ZIP Code: 53574
Signature of Person Doing Work:
Date Signed: 7/12/12

DNR Use Only

Date Received:
Noted By:
Comments:

BADGER TECHNICAL SERVICES

19 April 2012

Contracting Officer's Representative
Badger Army Ammunition Plant
2 Badger Road
Baraboo, WI 53913-5000

Subject: Vapor Intrusion Pathway Analysis Report

Dear Sir:

The Wisconsin Department of Natural Resources (WDNR) issued a letter dated September 9, 2011 reminding responsible parties that a vapor intrusion investigation should be conducted at all sites where volatile organic compounds (VOC) are present in the soil and groundwater. The Propellant Burning Ground (PBG) Plume contains the following VOCs: carbon tetrachloride, chloroform and trichloroethylene (TCE). The Deterrent Burning Ground and Central Plumes contain primarily dinitrotoluene (DNT), which does not pose a vapor pathway risk.

The *Alternative Feasibility Study – Groundwater Remedial Strategy* (Alt FS) document states that a vapor intrusion pathway analysis would be conducted along the PBG Plume to determine the level of risk to down-gradient receptors. Based on the WDNR letter and the Alt FS, Badger Technical Services, LLC (BTS) conducted a vapor intrusion pathway analysis for the PBG Plume. BTS performed this work under Performance Work Statement (PWS) #0050.

The PBG Plume extends along the southwest portion of Badger Army Ammunition Plant (BAAAP) and off-site toward the Wisconsin River in the direction of groundwater flow. Figure 1 shows the PBG Plume area in relation to BAAAP. On February 27 and 28, 2012, BTS personnel conducted ten vapor intrusion pathway (VIP) Geoprobe® borings to a depth of 25 or 45 feet approximately half-way to the groundwater table (per WDNR vapor intrusion guidance, *Addressing Vapor Intrusion at Remediation & Redevelopment Sites in Wisconsin*, PUB-RR-800, December 2010) using post-run tubing vapor sampling technique. VIP borings were placed at well nest locations to compare groundwater contaminant concentrations to the soil vapor results. VIP boring locations are depicted on Figure 2.

After drilling the VIP boring to the desired depth, new high-density polyethylene 3/8-inch or 1/4-inch OD tubing was placed down to the bottom of the borehole. The tubing was connected to a flow controller/sampler attached to a 6-liter summa canister. Under negative pressure, the canister was allowed to draw vapor from the bottom of the borehole until filled, approximately 30 to 50 minutes. To ensure sample integrity, quality control leak detection tracer techniques were used during sample collection at borings VIP-1 through VIP-9. Isopropyl alcohol wetted rags were placed around fitting connections to determine whether any leaking or short-circuiting of air through the fittings had occurred. Boring VIP-10 was inadvertently omitted from the leak detection methodology. Soil borings were abandoned following sample collection.

Soil vapor samples were submitted to the Wisconsin State Laboratory of Hygiene (certification #113133790) for chloroform, carbon tetrachloride and TCE Method TO-15 laboratory analysis. Chloroform was detected within sample VIP-10 at a concentration of 22.3 parts per billion vapor (ppbV) exceeding the WDNR Vapor Risk Screening Level (RSL) for Deep Soil Gas (see *Addressing Vapor Intrusion at Remediation & Redevelopment Sites in Wisconsin*, PUB-RR-800, December 2010). However, because this sample was collected beyond the extent of the PBG Plume, and based on its proximity to the Windings subdivision, the chloroform is likely the result of well chlorination activities. Analytical results also detected chloroform, carbon tetrachloride and/or TCE at concentrations below WDNR Vapor RSLs at borings VIP-1, VIP-5, VIP-8, and VIP-9. A summary of the analytical results is presented on Table 1. Laboratory reports and chain of custody records are attached.

Please note that due to the presence of isopropanol, analytical results for samples VIP-1, VIP-4, VIP-5, VIP-7, and VIP-9 are considered questionable. The presence of the isopropanol is due to the short-circuiting of air through the hardware/fitting connections. Sample results for VIP-6 and VIP-8 were also flagged due to isopropanol related issues. However, according to Wisconsin State Laboratory of Hygiene personnel, the flag is the result of a failed quality control check and had no bearing on the results for the targeted compounds.

Other than the carbon tetrachloride concentrations identified in monitoring well PBN-9101C and borings VIP-8 and VIP-9, there does not appear to be a definitive groundwater to soil vapor contaminant correlation. Due to the short-circuiting of soil vapor in the five above-referenced borings, it is difficult to provide a reasonable correlative assessment between the soil vapor and most recent groundwater monitoring results shown in Table 2.

Based on the investigation results, which were inconclusive for half the samples due to ineffectively sealed fittings, BTS recommends that the Army conduct further investigation of this pathway at five locations. BTS suggests that soil gas samples be collected again, utilizing a refined sample collection procedure, at VIP-1, VIP-4, VIP-5, VIP-7 and VIP-9. VIP-10 will be added to confirm the level of chloroform at that location. Helium will be used as a leak detection tracer due to the ability of the laboratory to quantify this element. Additional steps will be taken to ensure that fittings are adequately sealed.

Please contact Clair Ruenger or myself if you have any questions.

Respectfully,

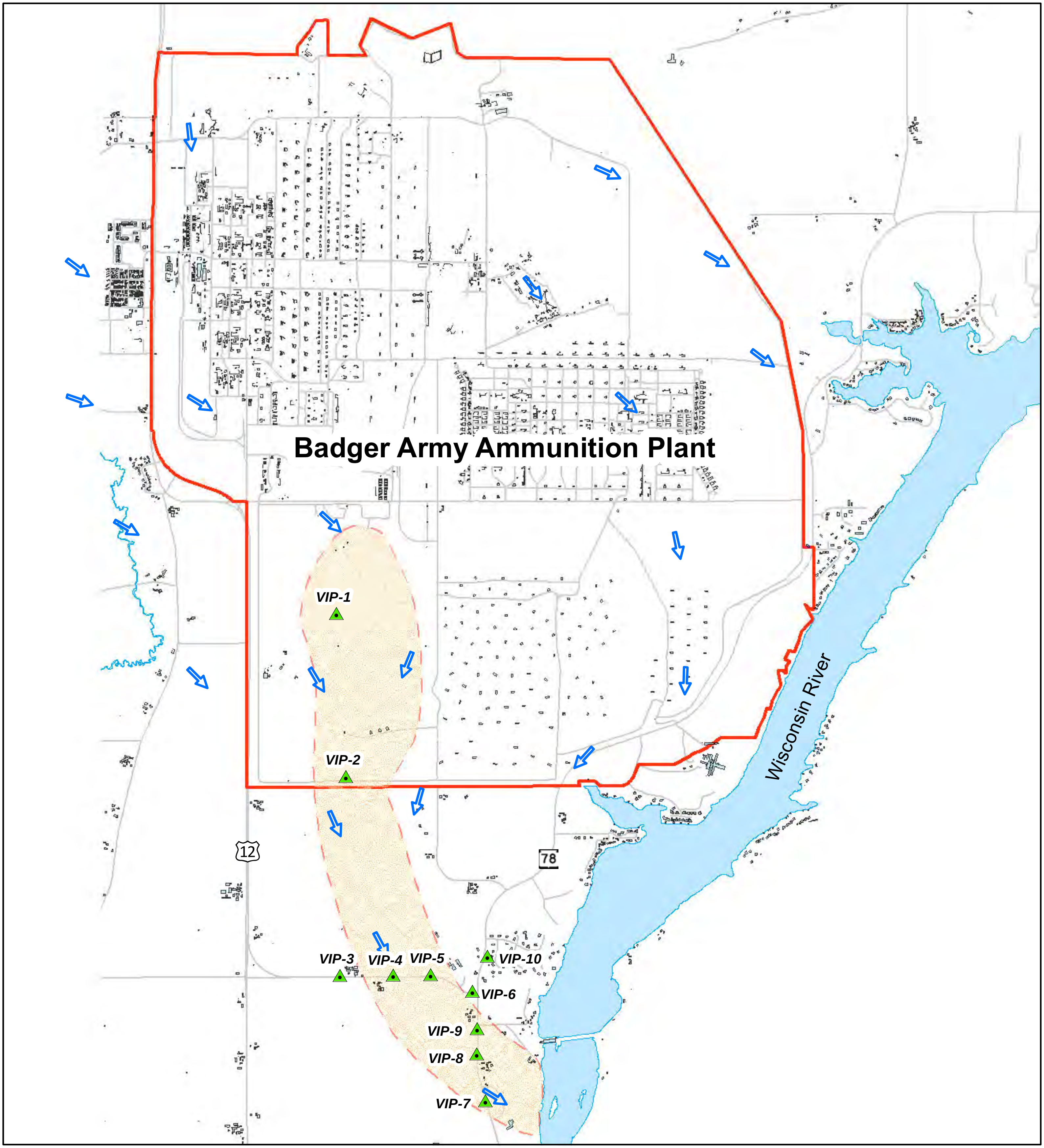
F. A. Anstett

F. A. Anstett
Sr. Program Manager

BHB:dkf
Att. a/s

let_sitton_041912_Vapor Intrusion Investigation Report

Figures



Legend

- 🟥 Badger Army Ammunition Plant Boundary
- ▲ Vapor Intrusion Pathway Boring
- ↘ Groundwater Flow
- ▨ Groundwater Plume
- ▬ Paved Road
- ▭ Existing Building
- ⌐ ¬ Former Building Footprint

Figure 1

Site Location Map
Vapor Intrusion Pathway Analysis Report
Badger Army Ammunition Plant

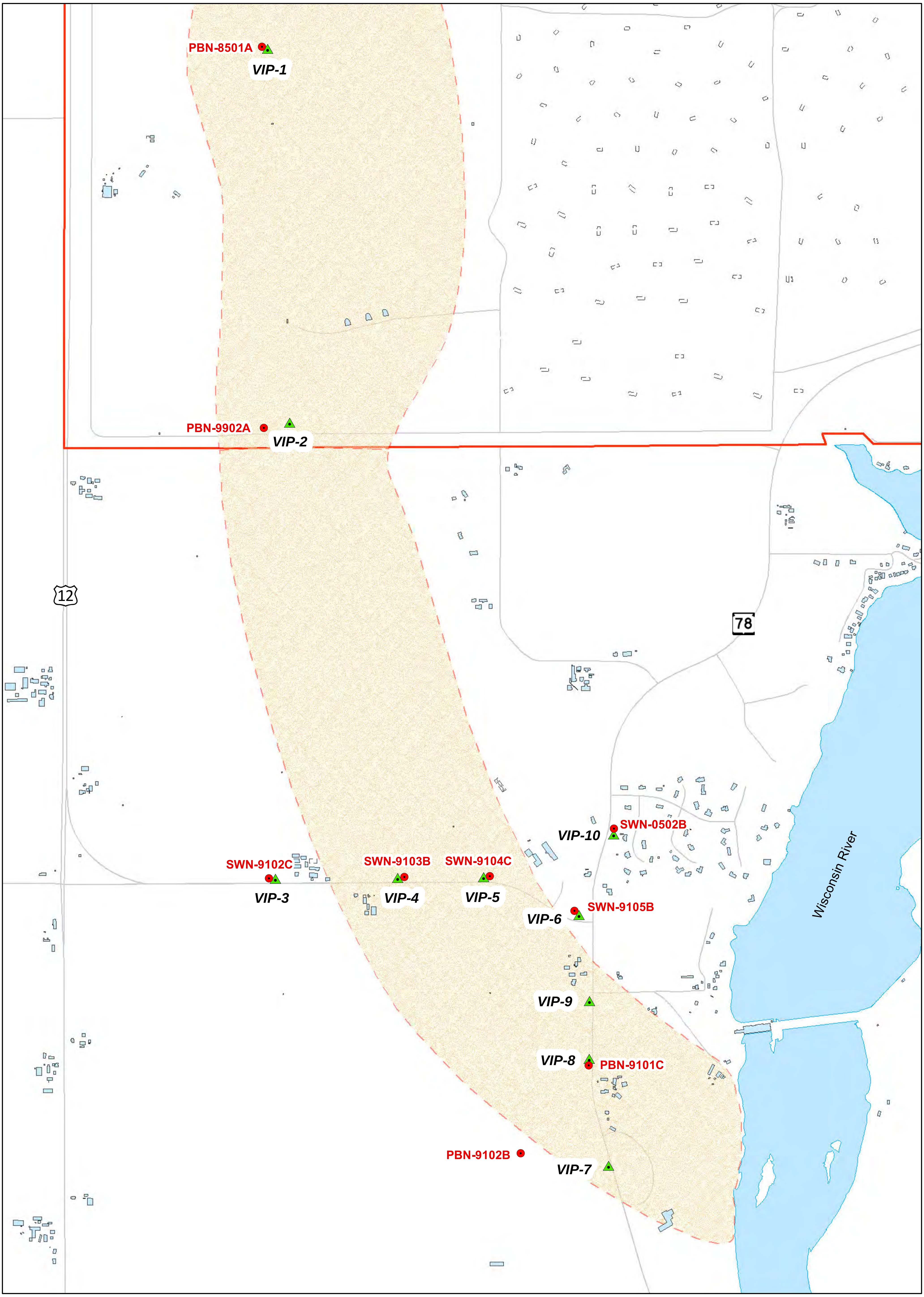
1 inch = 3,500 feet

0 5,000 10,000 Feet

BTS
BADGER TECHNICAL SERVICES

N

D:\GIS_Projects\BTS Projects\
Vapor Instrusion\MXDs\Fig_1_Site Loc



Legend

- Badger Army Ammunition Plant Boundary
- ▲ Vapor Intrusion Pathway Boring
- ● Monitoring Well
- ▨ Groundwater Plume
- Paved Road
- ▭ Existing Building
- ⌐ ┘ Former Building Footprint

Figure 2

Boring Location Map
Vapor Intrusion Pathway Analysis Report
Badger Army Ammunition Plant

1 inch = 1,042 feet

0 1,400 2,800 Feet

D:\GIS_Projects\BTS Projects\
Vapor Instrusion\MXDs\Fig_1_Vapor_Inv

Tables

Table 1

Soil Vapor Sample Analytical Results

Vapor Intrusion Pathway Analysis Report

Badger Army Ammunition Plant

Boring/Soil Vapor Sample ID	Location Description	Date Sampled	Sample Depth (feet bgs)	Chloroform	Carbon Tetrachloride	Trichloroethylene
VIP-1	Badger Army Ammuniton Plant	2/27/12	45.0	<0.085* (IS)	0.296* (IS)	<0.085* (IS)
VIP-2	Badger Army Ammuniton Plant	2/27/12	25.0	<0.085 (IS)	<0.085 (IS)	<0.085 (IS)
VIP-3	County Road Z Right of Way	2/27/12	45.0	<0.085 (IS)	<0.085 (IS)	<0.085 (IS)
VIP-4	County Road Z Right of Way	2/27/12	45.0	<0.085* (IS)	<0.085* (IS)	<0.085* (IS)
VIP-5	County Road Z Right of Way	2/27/12	45.0	0.441*^	<0.085*^	<0.085*^
VIP-6	State Highway 78 Right-of-Way	2/27/12	45.0	<0.085^	<0.085^	<0.085^
VIP-7	State Highway 78 Right-of-Way	2/28/12	45.0	<0.085*^	<0.085*^	<0.085*^
VIP-8	State Highway 78 Right-of-Way	2/28/12	45.0	0.159^ (J)	29.2^ (U)	0.316^
VIP-9	State Highway 78 Right-of-Way	2/28/12	45.0	<0.085*^	0.814*^	<0.085*^
VIP-10	State Highway 78 Right-of-Way	2/28/12	45.0	**22.3^ (U)**	<0.085^	<0.085^
Wisconsin Department of Natural Resources - Vapor Risk Screening Levels for Deep Soil Gas				22	64	38

Results expressed in parts per billion vapor (ppbV)

Bold text identifies a vapor risk screening level exceedance.

bgs - Below ground surface

* Due to the high amount of isopropanol in this sample (there was a leak in the probe setup), the results are questionable.

^ Because of residual isopropanol (IPA) in the instrumentation, the 4-bromofluorobenzene (BFB) tune check did not pass, so the results are approximate.

IS - The internal standard QC limit is exceeded.

J - Analytical result is between limit of detection (LOD) and limit of quantitation (LOQ).

U - Results are approximate, above upper calibration range.

Table 2

Groundwater Analytical Results

Vapor Intrusion Pathway Analysis Report

Badger Army Ammunition Plant

Boring/Soil Vapor Sample ID	Monitoring Well ID (nearest soil vapor sample)	Groundwater Depth (feet bgs)	Groundwater Monitoring Well Screen Interval (feet bgs)	Chloroform	Carbon Tetrachloride	Trichloroethylene
VIP-1	PBN-8501A	98.0	112.9-121.9	0.42 J	3.91	1.02
VIP-2	PBN-9902A	43.5	45.0-60.0	<0.10	<0.10	<0.10
VIP-3	SWN-9102C	76.7	142.5-152.5	<0.10	<0.10	<0.10
VIP-4	SWN-9103B	79.1	103.4-113.4	1.58	14	1.13
VIP-5	SWN-9104C	79.3	154.0-164.0	0.47 J	1.28	<0.10
VIP-6	SWN-9105B	80.7	102.5-112.5	0.51	<0.10	<0.10
VIP-7	PBN-9102B	76.7	105.0-115.0	0.12 J	<0.10	<0.10
VIP-8	PBN-9101C	85.0	142.5-152.5	6.32	44.6	14.5
VIP-9	PBN-9101C	85.0	142.5-152.5	6.32	44.6	14.5
VIP-10	SWN-0502B	103.5	145.8-155.8	1.11	0.15 J	<0.10

Results expressed in micrograms per liter (ug/l)

bgs - Below ground surface

J - Analytical result is between limit of detection (LOD) and limit of quantitation (LOQ).

Note - Groundwater monitoring activities were not conducted during the Vapor Intrusion Pathway Analysis project. The groundwater results presented in this table are associated with September and December 2011 quarterly groundwater monitoring at the Badger Army Ammunition Plant.

Laboratory Reports and Chain of Custody Records

WSLH

Wisconsin State Laboratory of Hygiene
2601 Agriculture Drive, PO Box 7996
Madison, WI 53707-7996
(800)442-4618 • FAX (608)224-6213
http://www.slh.wisc.edu

Laboratory Report

D.F. Kurtycz, M.D., Medical Director • Charles D. Brokopp, Dr.P.H., Director

Environmental Health Division Organic Chemistry

WDNR LAB ID: 113133790 NELAP LAB ID: E37658 EPA LAB WI00007 WI DATCP ID: 105-415

WSLH Sample: OW003671

BADGER TECHNICAL SERVICES

1 BADGER ROAD

BARABOO, WI 53913

Bill To
Billing ID: 7305879
Customer ID: 320225
TRACKING 4920
2601 AGRICULTURAL DRIVE
MADISON WI 53718

ID#:
Waterbody/Outfall ID:
Point/Well:
Account #: LH034
Project No:
Date Received: 03/02/2012 09:20:00
Date Reported: 03/20/2012
Sample Reason:

Field #:
Collection Start: 02/27/2012 09:11:00
Collection End:
Collected By: JML-BADGER TECHNICAL
County:
Sample Source: AIR
Sample Depth:
Sample Information:
Sample Location: VIP-1 @ BADGER ARMY AMMUNITION PLANT
Sample Description: 6 L CANISTER / PASSIVE CANISTER SAMPLER (CS1200E)
Analyses and Results:

Analysis Date	Lab Comment
03/07/2012	SEE OW003671.MM1

Analysis Method	Result	Units	LOD	LOQ	Report Limit
CHLOROFORM	*IS ND	PPB V	0.085	0.280	
CARBON TETRACHLORIDE	*IS 0.296	PPB V	0.085	0.280	
TRICHLOROETHYLENE	*IS ND	PPB V	0.085	0.280	

OW003671.MM1:

WISCONSIN STATE LABORATORY OF HYGIENE SAMPLE OW003671 CONTAINS THE FOLLOWING FLAGS.

THE INTERNAL STANDARD QC LIMIT IS EXCEEDED - *IS.

DUE TO THE HIGH AMOUNT OF ISOPROPANOL IN THIS SAMPLE, THERE WAS A LEAK IN THE PROBE SETUP, THEREFORE THE RESULTS ARE QUESTIONABLE.

IF YOU HAVE ANY QUESTIONS, CONTACT STEVE GEIS AT (608) 224-6269.

Environmental Health Division Organic Chemistry

WDNR LAB ID: 113133790 NELAP LAB ID: E37658 EPA LAB WI00007 WI DATCP ID: 105-415

WSLH Sample: OW003671

Analysis Date	Lab Comment
03/07/2012	

Analysis Method	Result	Units	LOD	LOQ	Report Limit
TOXIC ORGANIC COMPOUNDS IN AMBIENT AIR T015 - PREP	COMPLETE				1

Test results for NELAP accredited tests are certified to meet the requirements of the NELAC standards. For a list of accredited analytes see http://www.slh.wisc.edu/nelap/

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD

Responsible Party: Steve Geis Steve Geis, Chemist Supervisor

If there are questions about this report, please contact Steve Geis at 608-224-6269.

The results in this report apply only to the sample specifically listed above. This report is not to be reproduced except in full.

Report #: 9500944

Wisconsin State Laboratory of Hygiene
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Madison, WI 53707-7996
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http://www.slh.wisc.edu

Laboratory Report

D.F. Kurtycz, M.D., Medical Director • Charles D. Brokopp, Dr.P.H., Director

Environmental Health Division Organic Chemistry

WDNR LAB ID: 113133790 NELAP LAB ID: E37658 EPA LAB WI00007 WI DATCP ID: 105-415

WSLH Sample: OW003672

BADGER TECHNICAL SERVICES

1 BADGER ROAD

BARABOO, WI 53913

Bill To
Billing ID: 7305879
Customer ID: 320225
TRACKING 4920
2601 AGRICULTURAL DRIVE
MADISON WI 53718

ID#:
Waterbody/Outfall ID:
Point/Well:
Account #: LH034
Project No:
Date Received: 03/02/2012 09:20:00
Date Reported: 03/20/2012
Sample Reason:

Field #:
Collection Start: 02/27/2012 10:25:00
Collection End:
Collected By: JML-BADGER TECHNICAL
County:
Sample Source: AIR
Sample Depth:
Sample Information:
Sample Location: VIP-2 @ BADGER ARMY AMMUNITION PLANT
Sample Description: 6 L CANISTER / PASSIVE CANISTER SAMPLER (CS1200E)
Analyses and Results:

Analysis Date: 03/07/2012
Lab Comment: THE INTERNAL STANDARD QC LIMIT IS EXCEEDED - *IS.

Analysis Method	Result	Units	LOD	LOQ	Report Limit
CHLOROFORM	*IS ND	PPB V	0.085	0.280	
CARBON TETRACHLORIDE	*IS ND	PPB V	0.085	0.280	
TRICHLOROETHYLENE	*IS ND	PPB V	0.085	0.280	

Analysis Date: 03/07/2012
Lab Comment:

Analysis Method	Result	Units	LOD	LOQ	Report Limit
TOXIC ORGANIC COMPOUNDS IN AMBIENT AIR T015 - PREP	COMPLETE				1

Environmental Health Division Organic Chemistry

WDNR LAB ID: 113133790 NELAP LAB ID: E37658 EPA LAB WI00007 WI DATCP ID: 105-415

WSLH Sample: OW003672

Test results for NELAP accredited tests are certified to meet the requirements of the NELAC standards. For a list of accredited analytes see http://www.slh.wisc.edu/nelap/

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD

Responsible Party: Steve Geis Steve Geis, Chemist Supervisor

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director • Charles D. Brokopp, Dr.P.H., Director

Environmental Health Division Organic Chemistry

WDNR LAB ID: 113133790 NELAP LAB ID: E37658 EPA LAB WI00007 WI DATCP ID: 105-415

WSLH Sample: OW003673

BADGER TECHNICAL SERVICES

1 BADGER ROAD

BARABOO, WI 53913

Bill To
Billing ID: 7305879
Customer ID: 320225
TRACKING 4920
2601 AGRICULTURAL DRIVE
MADISON WI 53718

ID#:
Waterbody/Outfall ID:
Point/Well:
Account #: LH034
Project No:
Date Received: 03/02/2012 09:20:00
Date Reported: 03/20/2012
Sample Reason:

Field #:
Collection Start: 02/27/2012 12:02:00
Collection End:
Collected By: JML-BADGER TECHNICAL
County:
Sample Source: AIR
Sample Depth:
Sample Information:
Sample Location: VIP-3-CTY Z ROW
Sample Description: 6 L CANISTER / PASSIVE CANISTER SAMPLER (CS1200E)
Analyses and Results:

Analysis Date	Lab Comment
03/07/2012	THE INTERNAL STANDARD QC LIMIT IS EXCEEDED - *IS.

Analysis Method	Result	Units	LOD	LOQ	Report Limit
CHLOROFORM	*IS ND	PPB V	0.085	0.280	
CARBON TETRACHLORIDE	*IS ND	PPB V	0.085	0.280	
TRICHLOROETHYLENE	*IS ND	PPB V	0.085	0.280	

Analysis Date	Lab Comment
03/07/2012	

Analysis Method	Result	Units	LOD	LOQ	Report Limit
TOXIC ORGANIC COMPOUNDS IN AMBIENT AIR T015 - PREP	COMPLETE				1

Environmental Health Division Organic Chemistry

WDNR LAB ID: 113133790 NELAP LAB ID: E37658 EPA LAB WI00007 WI DATCP ID: 105-415

WSLH Sample: OW003673

Test results for NELAP accredited tests are certified to meet the requirements of the NELAC standards. For a list of accredited analytes see http://www.slh.wisc.edu/nelap/

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD

Responsible Party: Steve Geis Steve Geis, Chemist Supervisor

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director • Charles D. Brokopp, Dr.P.H., Director

Environmental Health Division   Organic Chemistry

WDNR LAB ID: 113133790   NELAP LAB ID: E37658   EPA LAB WI00007   WI DATCP ID: 105-415

WSLH Sample: OW003674

BADGER TECHNICAL SERVICES

1 BADGER ROAD

BARABOO, WI 53913

Bill To
Billing ID: 7305879
Customer ID: 320225
TRACKING 4920
2601 AGRICULTURAL DRIVE
MADISON WI 53718

ID#:
Waterbody/Outfall ID:
Point/Well:
Account #: LH034
Project No:
Date Received: 03/02/2012 09:20:00
Date Reported: 03/20/2012
Sample Reason:

Field #:
Collection Start: 02/27/2012 13:59:00
Collection End:
Collected By: JML-BADGER TECHNICAL
County:
Sample Source: AIR
Sample Depth:
Sample Information:
Sample Location: VIP-4-CTY Z ROW
Sample Description: 6 L CANISTER / PASSIVE CANISTER SAMPLER (CS1200E)
Analyses and Results:

Analysis Date	Lab Comment
03/07/2012	SEE OW003674.MM1

Analysis Method	Result	Units	LOD	LOQ	Report Limit
CHLOROFORM	*IS ND	PPB V	0.085	0.280	
CARBON TETRACHLORIDE	*IS ND	PPB V	0.085	0.280	
TRICHLOROETHYLENE	*IS ND	PPB V	0.085	0.280	

OW003674.MM1:

WISCONSIN STATE LABORATORY OF HYGIENE SAMPLE OW003674 CONTAINS THE
FOLLOWING FLAGS.

THE INTERNAL STANDARD QC LIMIT IS EXCEEDED - *IS.

DUE TO THE HIGH AMOUNT OF ISOPROPANOL IN THIS SAMPLE, THERE
WAS A LEAK IN THE PROBE SETUP, THEREFORE THE RESULTS ARE
QUESTIONABLE.

IF YOU HAVE ANY QUESTIONS, CONTACT STEVE GEIS AT (608) 224-6269.

Environmental Health Division Organic Chemistry

WDNR LAB ID: 113133790 NELAP LAB ID: E37658 EPA LAB WI00007 WI DATCP ID: 105-415

WSLH Sample: OW003674

Analysis Date	Lab Comment
03/07/2012	

Analysis Method	Result	Units	LOD	LOQ	Report Limit
TOXIC ORGANIC COMPOUNDS IN AMBIENT AIR T015 - PREP	COMPLETE				1

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List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD

Responsible Party: Steve Geis, Chemist Supervisor

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director • Charles D. Brokopp, Dr.P.H., Director

Environmental Health Division   Organic Chemistry

WDNR LAB ID: 113133790   NELAP LAB ID: E37658   EPA LAB WI00007   WI DATCP ID: 105-415

WSLH Sample: OW003675

BADGER TECHNICAL SERVICES

1 BADGER ROAD

BARABOO, WI 53913

Bill To
Billing ID: 7305879
Customer ID: 320225
TRACKING 4920
2601 AGRICULTURAL DRIVE
MADISON WI 53718

ID#:
Waterbody/Outfall ID:
Point/Well:
Account #: LH034
Project No:
Date Received: 03/02/2012 09:20:00
Date Reported: 03/20/2012
Sample Reason:

Field #:
Collection Start: 02/27/2012 15:10:00
Collection End:
Collected By: JML-BADGER TECHNICAL
County:
Sample Source: AIR
Sample Depth:
Sample Information:
Sample Location: VIP-5-CTY Z ROW
Sample Description: 6 L CANISTER / PASSIVE CANISTER SAMPLER (CS1200E)
Analyses and Results:

Analysis Date	Lab Comment
03/14/2012	SEE OW003675.MM1

Analysis Method	Result	Units	LOD	LOQ	Report Limit
CHLOROFORM	0.441	PPB V	0.085	0.280	
CARBON TETRACHLORIDE	ND	PPB V	0.085	0.280	
TRICHLOROETHYLENE	ND	PPB V	0.085	0.280	

OW003675.MM1:

WISCONSIN STATE LABORATORY OF HYGIENE SAMPLE OW003675 CONTAINS THE FOLLOWING FLAGS.

DUE TO THE HIGH AMOUNT OF ISOPROPANOL IN THIS SAMPLE, THERE WAS A LEAK IN THE PROBE SETUP, THEREFORE THE RESULTS ARE QUESTIONABLE.

BECAUSE OF THE IPA LEAK, THE BFB TUNE CHECK DID NOT PASS SO THE RESULTS ARE APPROXIMATE.

IF YOU HAVE ANY QUESTIONS, CONTACT STEVE GEIS AT (608) 224-6269.

Environmental Health Division Organic Chemistry

WDNR LAB ID: 113133790 NELAP LAB ID: E37658 EPA LAB WI00007 WI DATCP ID: 105-415

WSLH Sample: OW003675

Analysis Date	Lab Comment
03/14/2012	

Analysis Method	Result	Units	LOD	LOQ	Report Limit
TOXIC ORGANIC COMPOUNDS IN AMBIENT AIR T015 - PREP	COMPLETE				1

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List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD

Responsible Party: Steve Geis, Chemist Supervisor

If there are questions about this report, please contact Steve Geis at 608-224-6269.

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http://www.slh.wisc.edu

Laboratory Report

D.F. Kurtycz, M.D., Medical Director • Charles D. Brokopp, Dr.P.H., Director

Environmental Health Division Organic Chemistry

WDNR LAB ID: 113133790 NELAP LAB ID: E37658 EPA LAB WI00007 WI DATCP ID: 105-415

WSLH Sample: OW003676

BADGER TECHNICAL SERVICES

1 BADGER ROAD

BARABOO, WI 53913

Bill To
Billing ID: 7305879
Customer ID: 320225
TRACKING 4920
2601 AGRICULTURAL DRIVE
MADISON WI 53718

ID#:
Waterbody/Outfall ID:
Point/Well:
Account #: LH034
Project No:
Date Received: 03/02/2012 09:20:00
Date Reported: 03/20/2012
Sample Reason:

Field #:
Collection Start: 02/27/2012 16:25:00
Collection End:
Collected By: JML-BADGER TECHNICAL
County:
Sample Source: AIR
Sample Depth:
Sample Information:
Sample Location: VIP-6-HWY 78 ROW
Sample Description: 6 L CANISTER / PASSIVE CANISTER SAMPLER (CS1200E)
Analyses and Results:

Analysis Date	Lab Comment
03/14/2012	SEE OW003676.MM1

Analysis Method	Result	Units	LOD	LOQ	Report Limit
CHLOROFORM	ND	PPB V	0.085	0.280	
CARBON TETRACHLORIDE	ND	PPB V	0.085	0.280	
TRICHLOROETHYLENE	ND	PPB V	0.085	0.280	

```
OW003676.MM1:

WISCONSIN STATE LABORATORY OF HYGIENE SAMPLE OW003676 CONTAINS THE
FOLLOWING FLAGS.

BECAUSE OF THE IPA LEAK, THE BFB TUNE CHECK DID NOT PASS
SO THE RESULTS ARE APPROXIMATE.

IF YOU HAVE ANY QUESTIONS, CONTACT STEVE GEIS AT (608) 224-6269.
```

Environmental Health Division   Organic Chemistry

WDNR LAB ID: 113133790   NELAP LAB ID: E37658   EPA LAB WI00007   WI DATCP ID: 105-415

WSLH Sample: OW003676

Analysis Date	Lab Comment
03/14/2012	

Analysis Method	Result	Units	LOD	LOQ	Report Limit
TOXIC ORGANIC COMPOUNDS IN AMBIENT AIR T015 - PREP	COMPLETE				1

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List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD

Responsible Party: Steve Geis, Chemist Supervisor

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Laboratory Report

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Environmental Health Division Organic Chemistry

WDNR LAB ID: 113133790 NELAP LAB ID: E37658 EPA LAB WI00007 WI DATCP ID: 105-415

WSLH Sample: OW003677

BADGER TECHNICAL SERVICES

1 BADGER ROAD

BARABOO, WI 53913

Bill To
Billing ID: 7305879
Customer ID: 320225
TRACKING 4920
2601 AGRICULTURAL DRIVE
MADISON WI 53718

ID#:
Field #:
Waterbody/Outfall ID:
Collection Start: 02/28/2012 08:20:00
Point/Well:
Collection End:
Account #: LH034
Collected By: JML-BADGER TECHNICAL
Project No:
County:
Date Received: 03/02/2012 09:20:00
Sample Source: AIR
Date Reported: 03/20/2012
Sample Depth:
Sample Reason:
Sample Information:
Sample Location: VIP-7-HWY 78 ROW
Sample Description: 6 L CANISTER / PASSIVE CANISTER SAMPLER (CS1200E)
Analyses and Results:

Analysis Date	Lab Comment
03/14/2012	SEE OW003677.MM1

Analysis Method	Result	Units	LOD	LOQ	Report Limit
CHLOROFORM	ND	PPB V	0.085	0.280	
CARBON TETRACHLORIDE	ND	PPB V	0.085	0.280	
TRICHLOROETHYLENE	ND	PPB V	0.085	0.280	

OW003677.MM1:

WISCONSIN STATE LABORATORY OF HYGIENE SAMPLE OW003677 CONTAINS THE FOLLOWING FLAGS.

DUE TO THE HIGH AMOUNT OF ISOPROPANOL IN THIS SAMPLE, THERE WAS A LEAK IN THE PROBE SETUP, THEREFORE THE RESULTS ARE QUESTIONABLE.

BECAUSE OF THE IPA LEAK, THE BFB TUNE CHECK DID NOT PASS SO THE RESULTS ARE APPROXIMATE.

IF YOU HAVE ANY QUESTIONS, CONTACT STEVE GEIS AT (608) 224-6269.

Environmental Health Division Organic Chemistry

WDNR LAB ID: 113133790 NELAP LAB ID: E37658 EPA LAB WI00007 WI DATCP ID: 105-415

WSLH Sample: OW003677

Analysis Date	Lab Comment
03/14/2012	

Analysis Method	Result	Units	LOD	LOQ	Report Limit
TOXIC ORGANIC COMPOUNDS IN AMBIENT AIR T015 - PREP	COMPLETE				1

Test results for NELAP accredited tests are certified to meet the requirements of the NELAC standards. For a list of accredited analytes see http://www.slh.wisc.edu/nelap/

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD

Responsible Party: Steve Geis Steve Geis, Chemist Supervisor

If there are questions about this report, please contact Steve Geis at 608-224-6269.

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director • Charles D. Brokopp, Dr.P.H., Director

Environmental Health Division Organic Chemistry

WDNR LAB ID: 113133790 NELAP LAB ID: E37658 EPA LAB WI00007 WI DATCP ID: 105-415

WSLH Sample: OW003678

BADGER TECHNICAL SERVICES

1 BADGER ROAD

BARABOO, WI 53913

Bill To
Billing ID: 7305879
Customer ID: 320225
TRACKING 4920
2601 AGRICULTURAL DRIVE
MADISON WI 53718

ID#:
Waterbody/Outfall ID:
Point/Well:
Account #: LH034
Project No:
Date Received: 03/02/2012 09:20:00
Date Reported: 03/20/2012
Sample Reason:

Field #:
Collection Start: 02/28/2012 10:00:00
Collection End:
Collected By: JML-BADGER TECHNICAL
County:
Sample Source: AIR
Sample Depth:
Sample Information:
Sample Location: VIP-8 HWY 78 RPW
Sample Description: 6 L CANISTER / PASSIVE CANISTER SAMPLER (CS1200E)
Analyses and Results:

Analysis Date	Lab Comment
03/14/2012	SEE OW003678.MM1

Analysis Method	Result	Units	LOD	LOQ	Report Limit
CHLOROFORM	0.159	PPB V	0.085	0.280	
Note: The reported value above is equal to or greater than the LOD and less than the LOQ.					
CARBON TETRACHLORIDE	*U 29.2	PPB V	0.085	0.280	
TRICHLOROETHYLENE	0.316	PPB V	0.085	0.280	

Environmental Health Division Organic Chemistry

WDNR LAB ID: 113133790 NELAP LAB ID: E37658 EPA LAB WI00007 WI DATCP ID: 105-415

WSLH Sample: OW003678

OW003678.MM1:

WISCONSIN STATE LABORATORY OF HYGIENE SAMPLE OW003678 CONTAINS THE FOLLOWING FLAGS.

RESULTS ARE APPROXIMATE, ABOVE UPPER CALIBRATION RANGE - *U.

BECAUSE OF THE IPA LEAK, THE BFB TUNE CHECK DID NOT PASS SO THE RESULTS ARE APPROXIMATE.

IF YOU HAVE ANY QUESTIONS, CONTACT STEVE GEIS AT (608) 224-6269.

Analysis Date	Lab Comment
03/14/2012	

Analysis Method	Result	Units	LOD	LOQ	Report Limit
TOXIC ORGANIC COMPOUNDS IN AMBIENT AIR T015 - PREP	COMPLETE				1

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List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD

Responsible Party: Steve Geis Steve Geis, Chemist Supervisor

If there are questions about this report, please contact Steve Geis at 608-224-6269.

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http://www.slh.wisc.edu

Laboratory Report

D.F. Kurtycz, M.D., Medical Director • Charles D. Brokopp, Dr.P.H., Director

Environmental Health Division　　Organic Chemistry

WDNR LAB ID: 113133790　NELAP LAB ID: E37658　EPA LAB　WI00007　WI DATCP ID: 105-415

WSLH Sample: OW003679

BADGER TECHNICAL SERVICES

1 BADGER ROAD

BARABOO, WI 53913

Bill To
Billing ID: 7305879
Customer ID: 320225
TRACKING 4920
2601 AGRICULTURAL DRIVE
MADISON WI 53718

ID#:
Waterbody/Outfall ID:
Point/Well:
Account #: LH034
Project No:
Date Received: 03/02/2012 09:20:00
Date Reported: 03/20/2012
Sample Reason:

Field #:
Collection Start: 02/28/2012 11:32:00
Collection End:
Collected By: JML-BADGER TECHNICAL
County:
Sample Source: AIR
Sample Depth:
Sample Information:
Sample Location: VIP-9-HWY 78 ROW
Sample Description: 6 L CANISTER / PASSIVE CANISTER SAMPLER (CS1200E)
Analyses and Results:

Analysis Date	Lab Comment
03/14/2012	SEE OW003679.MM1

Analysis Method	Result	Units	LOD	LOQ	Report Limit
CHLOROFORM	ND	PPB V	0.085	0.280	
CARBON TETRACHLORIDE	0.814	PPB V	0.085	0.280	
TRICHLOROETHYLENE	ND	PPB V	0.085	0.280	

Environmental Health Division Organic Chemistry

WDNR LAB ID: 113133790 NELAP LAB ID: E37658 EPA LAB WI00007 WI DATCP ID: 105-415

WSLH Sample: OW003679

OW003679.MM1:

WISCONSIN STATE LABORATORY OF HYGIENE SAMPLE OW003679 CONTAINS THE FOLLOWING FLAGS.

DUE TO THE HIGH AMOUNT OF ISOPROPANOL IN THIS SAMPLE, THERE WAS A LEAK IN THE PROBE SETUP, THEREFORE THE RESULTS ARE QUESTIONABLE.

BECAUSE OF THE IPA LEAK, THE BFB TUNE CHECK DID NOT PASS SO THE RESULTS ARE APPROXIMATE.

IF YOU HAVE ANY QUESTIONS, CONTACT STEVE GEIS AT (608) 224-6269.

Analysis Date	Lab Comment
03/14/2012	

Analysis Method	Result	Units	LOD	LOQ	Report Limit
TOXIC ORGANIC COMPOUNDS IN AMBIENT AIR T015 - PREP	COMPLETE				1

Test results for NELAP accredited tests are certified to meet the requirements of the NELAC standards. For a list of accredited analytes see http://www.slh.wisc.edu/nelap/

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD

Responsible Party: Steve Geis, Chemist Supervisor

If there are questions about this report, please contact Steve Geis at 608-224-6269.

The results in this report apply only to the sample specifically listed above. This report is not to be reproduced except in full.

Report #: 9500952

WSLH

Wisconsin State Laboratory of Hygiene
2601 Agriculture Drive, PO Box 7996
Madison, WI 53707-7996
(800)442-4618 • FAX (608)224-6213
http://www.slh.wisc.edu

Laboratory Report

D.F. Kurtycz, M.D., Medical Director • Charles D. Brokopp, Dr.P.H., Director

Environmental Health Division Organic Chemistry

WDNR LAB ID: 113133790 NELAP LAB ID: E37658 EPA LAB WI00007 WI DATCP ID: 105-415

WSLH Sample: OW003680

BADGER TECHNICAL SERVICES

1 BADGER ROAD

BARABOO, WI 53913

Bill To
Billing ID: 7305879
Customer ID: 320225
TRACKING 4920
2601 AGRICULTURAL DRIVE
MADISON WI 53718

ID#:
Waterbody/Outfall ID:
Point/Well:
Account #: LH034
Project No:
Date Received: 03/02/2012 09:20:00
Date Reported: 03/20/2012
Sample Reason:

Field #:
Collection Start: 02/28/2012 13:27:00
Collection End:
Collected By: JML-BADGER TECHNICAL
County:
Sample Source: AIR
Sample Depth:
Sample Information:
Sample Location: VIP-10-HWY 78 ROW
Sample Description: 6 L CANISTER / PASSIVE CANISTER SAMPLER (CS1200E)
Analyses and Results:

Analysis Date: 03/14/2012
Lab Comment: SEE OW003680.MM1

Analysis Method	Result	Units	LOD	LOQ	Report Limit
CHLOROFORM	*U 22.3	PPB V	0.085	0.280	
CARBON TETRACHLORIDE	ND	PPB V	0.085	0.280	
TRICHLOROETHYLENE	ND	PPB V	0.085	0.280	

```
OW003680.MM1:

WISCONSIN STATE LABORATORY OF HYGIENE SAMPLE OW003680 CONTAINS THE
FOLLOWING FLAGS.

RESULTS ARE APPROXIMATE, ABOVE UPPER CALIBRATION RANGE - *U.

BECAUSE OF THE IPA LEAK, THE BFB TUNE CHECK DID NOT PASS
SO THE RESULTS ARE APPROXIMATE.

IF YOU HAVE ANY QUESTIONS, CONTACT STEVE GEIS AT (608) 224-6269.
```

Environmental Health Division Organic Chemistry

WDNR LAB ID: 113133790 NELAP LAB ID: E37658 EPA LAB WI00007 WI DATCP ID: 105-415

WSLH Sample: OW003680

Analysis Date	Lab Comment
03/14/2012	

Analysis Method	Result	Units	LOD	LOQ	Report Limit
TOXIC ORGANIC COMPOUNDS IN AMBIENT AIR T015 - PREP	COMPLETE				1

Test results for NELAP accredited tests are certified to meet the requirements of the NELAC standards. For a list of accredited analytes see http://www.slh.wisc.edu/nelap/

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD

Responsible Party: Steve Geis, Chemist Supervisor

If there are questions about this report, please contact Steve Geis at 608-224-6269.

The results in this report apply only to the sample specifically listed above. This report is not to be reproduced except in full.

Page 1 of 2

State of Wisconsin
Department of Natural Resources

PO # BTS0001344

Chain of Custody Record

Form 4100-145 (R 3/09)

Sample Collector(s) Name: JEFF LARKIN

Return Report As: (select one) ☒ Email ☐ Hard Copy

Email or Postal Address: jeffrey.larkin@specpro-inc.com

Phone Number (include area code): 608-434-5571

Property Owner: Department of the Army

Property Address: Badger Army Ammunition Plant
Baraboo, WI 53913-5000

Phone Number (include area code):

Split Samples: Offered? ☐ Yes ☐ No
Accepted? ☐ Yes ☐ No Accepted By (Signature):

Field ID No.	Date	Time	No. of Containers	Station Location Sample Description	Lab ID Number	Lab Use Only: Cracked / Broken	Improperly Sealed	Good Condition	Other Comments
VIP-1	2/27/12	0911-0942	1	Badger Army Ammunition Plant For: carbon tetrachloride, chloroform + TCE Analysis TO-15					
VIP-2	2/27/12	1025-1056	1	Badger Army Ammunition Plant For: carbon tetrachloride, chloroform + TCE analyses (TO-15)					
VIP-3	2/27/12	1202-1232	1	Cty Z ROW For: carbon tetrachloride, chloroform + TCE analyses (TO-15)					
VIP-4	2/27/12	1359-1429	1	Cty Z ROW For: carbon tetrachloride, chloroform + TCE analyses (TO-15)					
VIP-5	2/27/12	1510-1540	1	Cty Z ROW For: carbon tetrachloride, chloroform + TCE analyses (TO-15)					
VIP-6	2/27/12	1625-1706	1	Hwy 78 ROW For: carbon tetrachloride, chloroform + TCE analyses (TO-15)					

Was the sample shipping container sealed on receipt? ☐ Yes ☐ No

Method of Shipment:
- ☐ Staff
- ☐ U.S. Postal Service
- ☐ UPS
- ☒ FedEx
- ☐ Other–specify:

Reason for Sample Collection:
- ☐ Anhydrous Ammonia Spill
- ☐ Animal Waste
- ☐ Open Burning
- ☐ Dairy Product Spill
- ☐ Construction/Storm Water Runoff
- ☐ Pesticide Spill * – Specify Pesticide:
- ☐ Hazardous Waste Release *
- ☐ Petroleum Product Release * – Specify Product:
- ☐ Industrial Spill/Runoff * – Specify Industry Type:
- ☐ Other – Specify:

* Contact the laboratory with product information and for consultation. Also, include sample of suspected spilled product.

I hereby certify that I received and properly handled these samples as noted below:

Relinquished By (Signature)	Date / Time	Received By (Signature)	Date / Time
3/1/12 1125	~~2/29/12~~		3-1-12
Relinquished By (Signature)	Date / Time	Received By (Signature)	Date / Time
Relinquished By (Signature)	Date / Time	Received for Laboratory By (Signature)	Date / Time

Disposition of Unused Portion Sample:
- ☐ Dispose
- ☐ Return
- ☐ Retain until further notice
- ☐ Other

If you need additional room for notes, use the back of this form.

Page 2 of 2

State of Wisconsin
Department of Natural Resources

PO# BTS0001344

Chain of Custody Record

Form 4100-145 (R 3/09)

Sample Collector(s) Name JEFF LARKIN

Return Report As: (select one) ☒ Email ☐ Hard Copy

Email or Postal Address jeffrey.larkin@specpro-inc.com

Phone Number (include area code) 608-434-5571

Property Owner Department of the Army

Property Address Badger Army Ammunition Plant
Baraboo, WI 53913-5000

Phone Number (include area code)

Split Samples: Offered? ☐ Yes ☐ No

Accepted? ☐ Yes ☐ No Accepted By (Signature):

						Lab Use Only			
Field ID No.	Date	Time	No. of Containers	Station Location Sample Description	Lab ID Number	Cracked / Broken	Improperly Sealed	Good Condition	Other Comments
VIP-7	2/28/12	0820- 0915	1	Hwy 78 ROW For: carbon tetrachloride, chloroform + TCE analyses (TO-15)					
VIP-8	2/28/12	1000- 1032	1	Hwy 78 ROW For: carbon tetrachloride, chloroform + TCE analyses (TO-15)					
VIP-9	2/28/12	1132- 1206	1	Hwy 78 ROW For: carbon tetrachloride chloroform + TCE analyses (TO-15)					
VIP-10	2/28/12	1327- 1359	1	Hwy 78 ROW For: carbon tetrachloride, chloroform + TCE analyses (TO-15)					

Was the sample shipping container sealed on receipt? ☐ Yes ☐ No

Method of Shipment:
- ☐ Staff
- ☐ U.S. Postal Service
- ☐ UPS
- ☒ FedEx
- ☐ Other–specify:

Reason for Sample Collection:
- ☐ Anhydrous Ammonia Spill
- ☐ Animal Waste
- ☐ Open Burning
- ☐ Dairy Product Spill
- ☐ Construction/Storm Water Runoff
- ☐ Pesticide Spill * – Specify Pesticide:
- ☐ Hazardous Waste Release *
- ☐ Petroleum Product Release * – Specify Product:
- ☐ Industrial Spill/Runoff * – Specify Industry Type:
- ☐ Other – Specify:

* Contact the laboratory with product information and for consultation. Also, include sample of suspected spilled product.

I hereby certify that I received and properly handled these samples as noted below:

Relinquished By (Signature)	Date / Time 3/1/12 1250 ~~2/29/12~~	Received By (Signature)	Date / Time
Relinquished By (Signature)	Date / Time	Received By (Signature)	Date / Time
Relinquished By (Signature)	Date / Time	Received for Laboratory By (Signature)	Date / Time

Disposition of Unused Portion Sample:
- ☐ Dispose
- ☐ Return
- ☐ Retain until further notice
- ☐ Other

If you need additional room for notes, use the back of this form.

BADGER TECHNICAL SERVICES

16 July 2012

Contracting Officer’s Representative
Badger Army Ammunition Plant
2 Badger Road
Baraboo, WI 53913-5000

Subject: Supplemental Vapor Intrusion Pathway Analysis Report

Dear Sir:

On April 19, 2012, Badger Technical Services, LLC (BTS) submitted the *Vapor Intrusion Pathway Analysis Report* to the Department of the Army. The investigation included conducting ten Geoprobe® borings to a depth half way to the water table depth and collecting a soil gas sample at that depth. The purpose of the investigation was to determine the risk to human receptors should vapors from the Propellant Burning Ground (PBG) Plume partition from the groundwater to the soil. The PBG plume is the one of three plumes migrating from the Badger Army Ammunition Plant and is the only one plume associated with contaminants (volatile organic compounds) with the potential for vapor pathway concerns.

A complete evaluation of the vapor pathway was not possible based on the initial information because several of the soil gas samples reported elevated levels of the leak detection tracer gas. Therefore, BTS proposed the locations where the soil gas analytical data were deemed invalid be re-sampled using helium as the leak-detection tracer gas using an alternate leak detection methodology. BTS performed this work under Performance Work Statement (PWS) #0067.

The previous vapor intrusion pathway analysis resulted in five soil gas sample locations (VIP-1, VIP-4, VIP-5, VIP-7, and VIP-9) considered to have questionable analytical results due to the presence of isopropyl alcohol, the leak detection tracer gas, in the samples. In addition, vapor intrusion probe boring VIP-10 was inadvertently omitted from the leak detection methodology and the sample also reported an elevated level of chloroform. These six locations were selected to be re-sampled to either obtain reliable analytical data and/or to confirm the previous analytical result. Figure 1 shows the PBG Plume in relation to the Badger Army Ammunition Plant (BAAAP) and the locations of the initial ten probe borings with corresponding well locations.

On June 27, 2012, Probe Technologies of Palmyra, Wisconsin advanced four Geoprobe® borings to a depth of approximately 40 feet below grade (bg). These probe boring locations were VIP-4A, VIP-5A, VIP-7A, and VIP-9A. The Geoprobe® encountered refusal at approximately 15 to 20 feet bg preventing the advancement and sample collection of VIP-1A and VIP-10A. Several attempts were made in the general area to penetrate a denser layer, but were not successful. On July 3, 2012, Soil Essentials of New Glarus, Wisconsin advanced the probe borings VIP-1A and VIP-10A to 45 feet bg with a more powerful Geoprobe®.

After drilling the probe boring to the desired depth, new high-density polyethylene 3/8-inch or 1/4-inch OD tubing was placed down to the bottom of the borehole (post-run tubing vapor sampling technique) and threaded onto the tip of the hollow steel drill rods. The down-hole tubing connects to a laboratory-supplied flow controller/sampler attached to a laboratory-supplied 6-liter summa canister. To ensure sample integrity, the following quality control leak detection tracer technique was used prior to sample collection. The flow controller/sampler with vinyl tubing connected to each end was placed inside an airtight container. Helium gas was injected into the airtight container. A helium gas detector (RadioDetection MGD-2002) was inserted into the tubing connected to the flow controller/sampler and the other end of the tubing was left open to the ambient air. BTS personnel monitored the helium detector to see whether any leaking or short-circuiting of air through the fittings was occurring. None of the tracer tests indicated leaks in the fittings. The flow controller/sampler was then connected to the summa canister, and the tubing was connected to the down-hole tubing with hose clamps. The valve on the summa canister was opened and under negative pressure, the canister was allowed to draw vapor from the bottom of the borehole until filled, approximately 30 minutes. The valve was then closed on the summa canister and the flow controller removed. Soil borings were abandoned with bentonite chips following sample collection.

Soil vapor samples were submitted to the Wisconsin State Laboratory of Hygiene (certification #113133790) for chloroform, carbon tetrachloride, and trichloroethylene (TCE) Method TO-15 laboratory analysis. Carbon tetrachloride was detected within sample VIP-1A at a concentration of 68.3 parts per billion vapor (ppbV) exceeding the WDNR Vapor Risk Screening Level (RSL) for Deep Soil Gas of 64 ppbV (see *Addressing Vapor Intrusion at Remediation & Redevelopment Sites in Wisconsin*, PUB-RR-800, December 2010). Analytical results also reported concentrations below WDNR Vapor RSLs at VIP-9A and VIP-10A. Carbon tetrachloride was reported at 0.563 ppbV at VIP-9A, and at VIP-10A, carbon tetrachloride and TCE were reported at concentrations of 25.5 ppbV and 1.08 ppbV, respectively. Chloroform was not detected at VIP-10A. It should be noted that the property closest to this data point has an in-ground swimming pool which, along with potential of private well chlorination impacts could be source(s) of the chloroform previously detected. Table 1 provides a summary of the analytical results. Laboratory reports and chain of custody records are attached.

There does not appear to be a strong correlation between groundwater concentrations and soil gas for the selected volatile organic compounds. Table 2 provides the groundwater analytical data for the three contaminants of concern and groundwater depth information for the shallow monitoring wells nearest to the probe boring locations. The well location with the highest groundwater contamination is PBN-9101C with carbon tetrachloride at 44.6 micrograms per liter (µg/l), which is in proximity to VIP-8 and VIP-9A. Carbon tetrachloride in soil gas was reported at 29.2 ppbV at VIP-8 and only 0.563 ppbV at VIP-9A. The soil gas sample with the highest reported concentration of carbon tetrachloride was VIP-1A with 68.3 ppbV; however, the carbon tetrachloride groundwater concentration at that location (PBN-8501A) is only 3.91 µg/l. VIP-10A is located outside the PBG Plume; however, carbon tetrachloride was reported at 25.5 ppbV at that location.

There seems to be more of a correlation between density of lithology and soil gas concentrations. Probe borings that encountered difficulty in penetrating at shallow depth (15 to 20 feet bg) were the locations where the soil gas concentrations were highest. As stated previously, VIP-1A and VIP-10A required a more powerful Geoprobe® to penetrate to total depth. The more dense lithologic layer could be acting as a confining layer, concentrating the low-level vapors below the dense layer and preventing the soil gas from diffusing to the surface. It should be noted, valid concentrations reported off-site are still below any WDNR Vapor RSLs.

The supplemental vapor intrusion pathway analysis filled the data gaps and provided reliable data to adequately evaluate the vapor pathway from the PBG Plume. Based on the findings of this analysis and the previous investigation, the data indicate that the PBG Plume does not present a significant risk to human health via vapor intrusion off-site. Analytical results of soil gas samples collected off-site do not exceed the WDNR Vapor RSLs for Deep Soil Gas.

Please contact Clair Ruenger or myself if you have any questions.

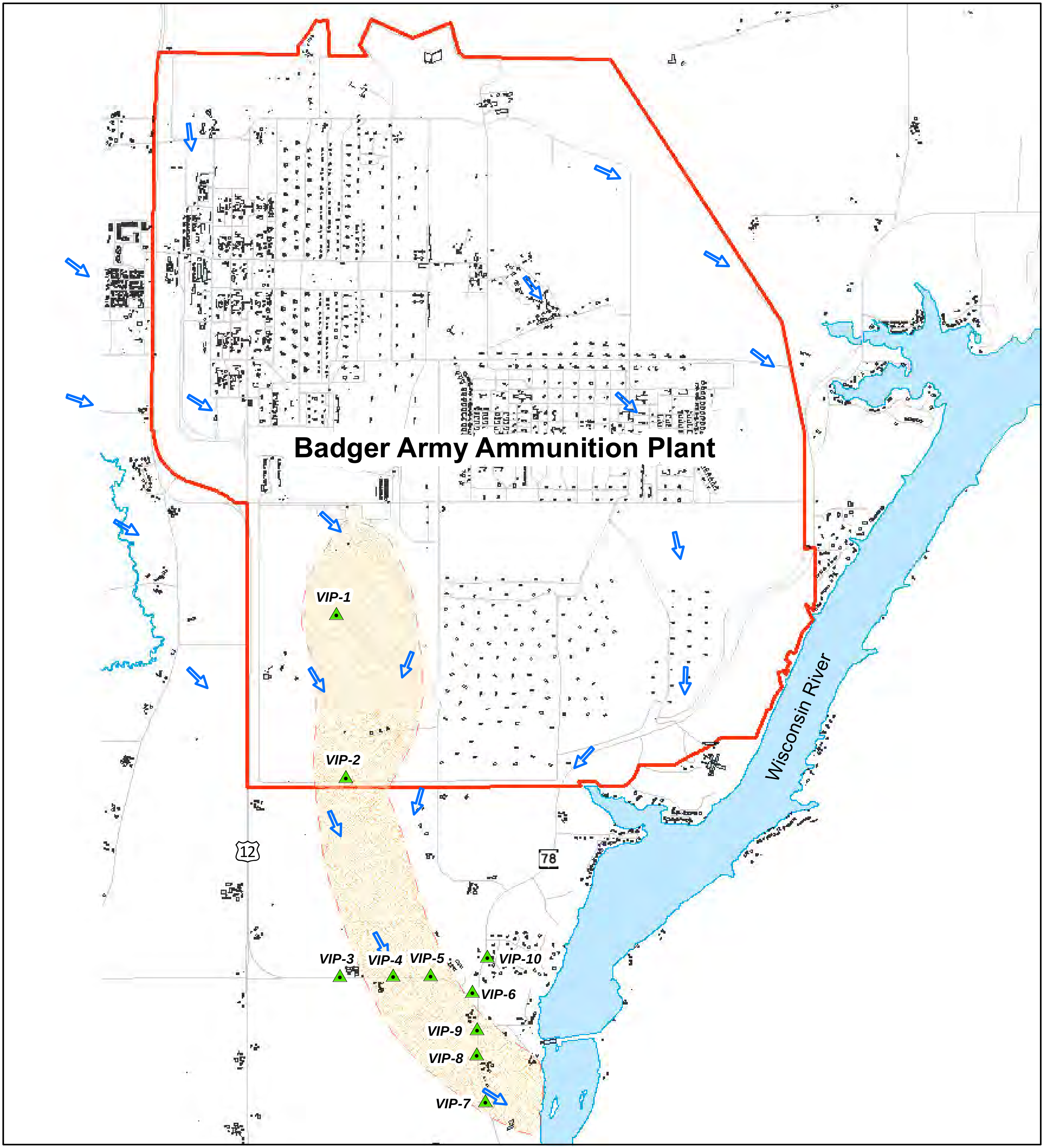
Respectfully,

F. A. Anstett
Sr. Program Manager

BHB:dkf
Att. a/s

let_sitton_071612_Supplemental VIPA Report.doc

Figures



Legend

- ▬ Badger Army Ammunition Plant Boundary
- ▲ Vapor Intrusion Pathway Boring
- ➘ Groundwater Flow
- ▨ Groundwater Plume
- ▬ Paved Road
- ▭ Existing Building
- ⌐ ¬ Former Building Footprint

Figure 1

Site Location Map
Supplemental Vapor Intrusion Pathway Analysis Report
Badger Army Ammunition Plant

1 inch = 3,500 feet

0 5,000 10,000 Feet

N

D:\GIS_Projects\BTS Projects\
Vapor Instrusion\Supplemental VIPA\Fig_1_Site Loc

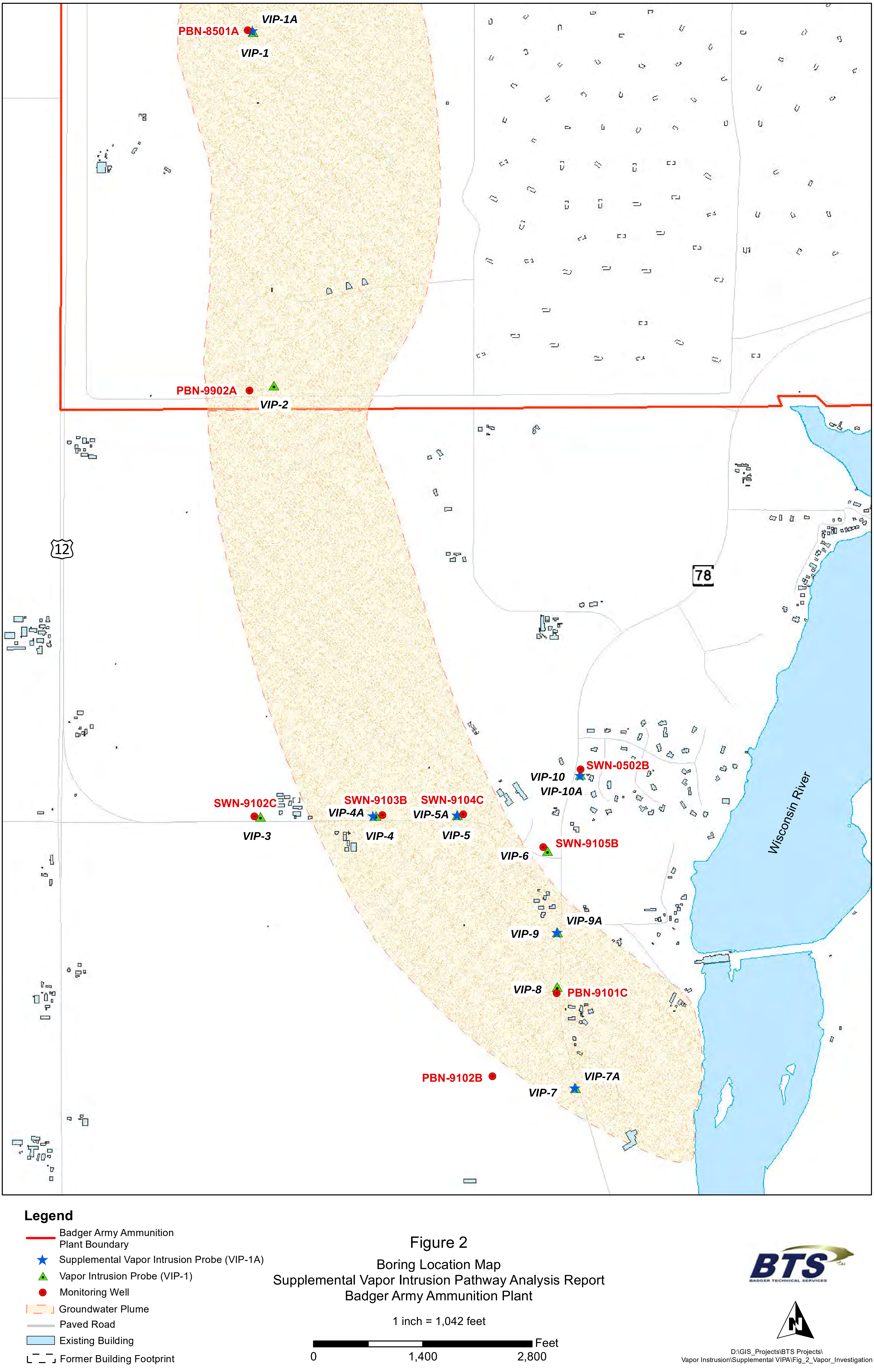


Figure 2

Boring Location Map
Supplemental Vapor Intrusion Pathway Analysis Report
Badger Army Ammunition Plant

1 inch = 1,042 feet

D:\GIS_Projects\BTS Projects\
Vapor Instrusion\Supplemental VIPA\Fig_2_Vapor_Investigation

Tables

Table 1

Soil Vapor Sample Analytical Results

Supplemental Vapor Intrusion Pathway Analysis Report

Badger Army Ammunition Plant

Boring/Soil Vapor Sample ID	Location Description	Date Sampled	Sample Depth (feet bgs)	Chloroform	Carbon Tetrachloride	Trichloroethylene
VIP-1	_Badger Army Ammuniton Plant_	_2/27/12_	_45.0_	_<0.085* (IS)_	_0.296* (IS)_	_<0.085* (IS)_
VIP-1A	Badger Army Ammuniton Plant	7/3/12	45.0	<0.085	**68.3**	<0.694 (I)
VIP-2	_Badger Army Ammuniton Plant_	_2/27/12_	_25.0_	_<0.085 (IS)_	_<0.085 (IS)_	_<0.085 (IS)_
VIP-3	_County Road Z Right-of-Way_	_2/27/12_	_45.0_	_<0.085 (IS)_	_<0.085 (IS)_	_<0.085 (IS)_
VIP-4	_County Road Z Right-of-Way_	_2/27/12_	_45.0_	_<0.085* (IS)_	_<0.085* (IS)_	_<0.085* (IS)_
VIP-4A	County Road Z Right-of-Way	6/27/12	37.0	<0.085	<0.085	<0.085
VIP-5	_County Road Z Right-of-Way_	_2/27/12_	_45.0_	_0.441*^_	_<0.085*^_	_<0.085*^_
VIP-5A	County Road Z Right-of-Way	6/27/12	40.0	<0.085	<0.085	<0.085
VIP-6	_State Highway 78 Right-of-Way_	_2/27/12_	_45.0_	_<0.085^_	_<0.085^_	_<0.085^_
VIP-7	_State Highway 78 Right-of-Way_	_2/28/12_	_45.0_	_<0.085*^_	_<0.085*^_	_<0.085*^_
VIP-7A	State Highway 78 Right-of-Way	6/27/12	37.0	<0.085	<0.085	<0.085
VIP-8	_State Highway 78 Right-of-Way_	_2/28/12_	_45.0_	_0.159^ (J)_	_29.2^ (U)_	_0.316^_
VIP-9	_State Highway 78 Right-of-Way_	_2/28/12_	_45.0_	_<0.085*^_	_0.814*^_	_<0.085*^_
VIP-9A	State Highway 78 Right-of-Way	6/27/12	39.0	<0.085	0.563	<0.085
VIP-10	_State Highway 78 Right-of-Way_	_2/28/12_	_45.0_	_**22.3^ (U)**_	_<0.085^_	_<0.085^_
VIP-10A	State Highway 78 Right-of-Way	7/3/12	45.0	<0.085	25.5	1.08
Wisconsin Department of Natural Resources - Vapor Risk Screening Levels for Deep Soil Gas				22	64	38

Results expressed in parts per billion vapor (ppbV)

Bold text identifies a vapor risk screening level exceedance.

bgs - Below ground surface

* Due to the high amount of isopropanol in this sample (there was a leak in the probe setup), the results are questionable.

^ Because of residual isopropanol (IPA) in the instrumentation, the 4-bromofluorobenzene (BFB) tune check did not pass, so the results are approximate.

IS - The internal standard QC limit is exceeded.

J - Analytical result is between limit of detection (LOD) and limit of quantitation (LOQ).

U - Results are approximate, above upper calibration range.

Italics indicate previously reported data.

I - elevated detection limit due to matrix interference

Table 2

Groundwater Analytical Results

Supplemental Vapor Intrusion Pathway Analysis Report

Badger Army Ammunition Plant

Boring/Soil Vapor Sample ID	Monitoring Well ID (nearest soil vapor sample)	Groundwater Depth (feet bgs)	Groundwater Monitoring Well Screen Interval (feet bgs)	Chloroform	Carbon Tetrachloride	Trichloroethylene
VIP-1, VIP-1A	PBN-8501A	98.0	112.9-121.9	0.42 J	3.91	1.02
VIP-2	PBN-9902A	43.5	45.0-60.0	<0.10	<0.10	<0.10
VIP-3	SWN-9102C	76.7	142.5-152.5	<0.10	<0.10	<0.10
VIP-4, VIP-4A	SWN-9103B	79.1	103.4-113.4	1.58	14	1.13
VIP-5, VIP-5A	SWN-9104C	79.3	154.0-164.0	0.47 J	1.28	<0.10
VIP-6	SWN-9105B	80.7	102.5-112.5	0.51	<0.10	<0.10
VIP-7, VIP-7A	PBN-9102B	76.7	105.0-115.0	0.12 J	<0.10	<0.10
VIP-8	PBN-9101C	85.0	142.5-152.5	6.32	44.6	14.5
VIP-9, VIP-9A	PBN-9101C	85.0	142.5-152.5	6.32	44.6	14.5
VIP-10, VIP-10A	SWN-0502B	103.5	145.8-155.8	1.11	0.15 J	<0.10

Results expressed in micrograms per liter (ug/l)

bgs - Below ground surface

J - Analytical result is between limit of detection (LOD) and limit of quantitation (LOQ).

Note - Groundwater monitoring activities were not conducted during the Vapor Intrusion Pathway Analysis project. The groundwater results presented in this table are associated with September and December 2011 quarterly groundwater monitoring at the Badger Army Ammunition Plant.

Laboratory Reports and Chain of Custody Records

Wisconsin State Laboratory of Hygiene
2601 Agriculture Drive, PO Box 7996
Madison, WI 53707-7996
(800)442-4618 • FAX (608)224-6213
http://www.slh.wisc.edu

Laboratory Report

D.F. Kurtycz, M.D., Medical Director • Charles D. Brokopp, Dr.P.H., Director

Environmental Health Division Organic Chemistry

WDNR LAB ID: 113133790 NELAP LAB ID: E37658 EPA LAB WI00007 WI DATCP ID: 105-415

WSLH Sample: OX000053

BADGER TECHNICAL SERVICES

1 BADGER RD.

BARABOO WI 53913

Bill To
Billing ID: 7305879
Customer ID: 320225
TRACKING 4920
2601 AGRICULTURAL DRIVE
MADISON WI 53718

Field #:
Collection Start: 07/03/2012 08:26:00
Collection End: 07/03/2012 08:56:00
Collected By: BHB-BADGER TECH. SVC
County:
Sample Source: AIR
Sample Depth: 45'
Sample Information: SAMPLER 5473
Sample Location: VIP-1A BADGER ARMY AMMUNITION PLANT
Sample Description: 6L CANISTER/PASSIVE SAMPLER

ID#:
Waterbody/Outfall ID:
Point/Well:
Account #: LH034
Project No:
Date Received: 07/05/2012
Date Reported: 07/10/2012
Sample Reason:

Analyses and Results:

Analysis Date
07/09/2012 10:48:45

Lab Comment
INTERFERENCE INDICATED BY *I.

Analysis Method	Result	Units	LOD	LOQ	Report Limit
CHLOROFORM	ND	PPB V	0.085	0.280	
CARBON TETRACHLORIDE	68.3	PPB V	0.085	0.280	
TRICHLOROETHYLENE	*I< 0.694	PPB V	0.085	0.280	

Environmental Health Division Organic Chemistry

WDNR LAB ID: 113133790 NELAP LAB ID: E37658 EPA LAB WI00007 WI DATCP ID: 105-415

WSLH Sample: OX000053

Test results for NELAP accredited tests are certified to meet the requirements of the NELAC standards. For a list of accredited analytes see http://www.slh.wisc.edu/nelap/

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD

Responsible Party: Steve Geis, Chemist Supervisor

If there are questions about this report, please contact Steve Geis at 608-224-6269.

The results in this report apply only to the sample specifically listed above. This report is not to be reproduced except in full.

Wisconsin State Laboratory of Hygiene
2601 Agriculture Drive, PO Box 7996
Madison, WI 53707-7996
(800)442-4618 • FAX (608)224-6213
http://www.slh.wisc.edu

Laboratory Report

D.F. Kurtycz, M.D., Medical Director • Charles D. Brokopp, Dr.P.H., Director

Environmental Health Division Organic Chemistry

WDNR LAB ID: 113133790 NELAP LAB ID: E37658 EPA LAB WI00007 WI DATCP ID: 105-415

WSLH Sample: OW004797

BADGER TECHNICAL SERVICES

1 BADGER RD

BARABOO, WI 53913

Bill To
Billing ID: 7305879
Customer ID: 320225
TRACKING 4920
2601 AGRICULTURAL DRIVE
MADISON WI 53718

ID#:
Waterbody/Outfall ID:
Point/Well:
Account #: LH034
Project No:
Date Received: 06/29/2012 11:12:00
Date Reported: 07/09/2012
Sample Reason:

Field #:
Collection Start: 06/27/2012 08:20:00
Collection End: 06/27/2012 08:45:00
Collected By: BHB
County:
Sample Source: AIR
Sample Depth:
Sample Information:
Sample Location: VIP-4A BADGER ARMY AMMUNITION PLANT
Sample Description: 6 L CANISTER / PASSIVE SAMPLER
Analyses and Results:

Analysis Date	Lab Comment
07/06/2012	

Analysis Method	Result	Units	LOD	LOQ	Report Limit
CHLOROFORM	ND	PPB V	0.085	0.280	
CARBON TETRACHLORIDE	ND	PPB V	0.085	0.280	
TRICHLOROETHYLENE	ND	PPB V	0.085	0.280	

Environmental Health Division Organic Chemistry

WDNR LAB ID: 113133790 NELAP LAB ID: E37658 EPA LAB WI00007 WI DATCP ID: 105-415

WSLH Sample: OW004797

Test results for NELAP accredited tests are certified to meet the requirements of the NELAC standards. For a list of accredited analytes see http://www.slh.wisc.edu/nelap/

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD

Responsible Party: Steve Geis Steve Geis, Chemist Supervisor

If there are questions about this report, please contact Steve Geis at 608-224-6269.

The results in this report apply only to the sample specifically listed above. This report is not to be reproduced except in full.

Wisconsin State Laboratory of Hygiene
2601 Agriculture Drive, PO Box 7996
Madison, WI 53707-7996
(800)442-4618 • FAX (608)224-6213
http://www.slh.wisc.edu

Laboratory Report

D.F. Kurtycz, M.D., Medical Director • Charles D. Brokopp, Dr.P.H., Director

Environmental Health Division Organic Chemistry

WDNR LAB ID: 113133790 NELAP LAB ID: E37658 EPA LAB WI00007 WI DATCP ID: 105-415

WSLH Sample: OW004800

BADGER TECHNICAL SERVICES

1 BADGER RD

BARABOO, WI 53913

Bill To
Billing ID: 7305879
Customer ID: 320225
TRACKING 4920
2601 AGRICULTURAL DRIVE
MADISON WI 53718

ID#:
Waterbody/Outfall ID:
Point/Well:
Account #: LH034
Project No:
Date Received: 06/29/2012 11:12:00
Date Reported: 07/09/2012
Sample Reason:

Field #:
Collection Start: 06/27/2012 09:50:00
Collection End: 06/27/2012 10:17:00
Collected By: BHB
County:
Sample Source: AIR
Sample Depth:
Sample Information:
Sample Location: VIP-5A BADGER ARMY AMMUNITION PLANT
Sample Description: 6 L CANISTER / PASSIVE SAMPLER

Analyses and Results:

Analysis Date	Lab Comment
07/06/2012	

Analysis Method	Result	Units	LOD	LOQ	Report Limit
CHLOROFORM	ND	PPB V	0.085	0.280	
CARBON TETRACHLORIDE	ND	PPB V	0.085	0.280	
TRICHLOROETHYLENE	ND	PPB V	0.085	0.280	

Environmental Health Division Organic Chemistry

WDNR LAB ID: 113133790 NELAP LAB ID: E37658 EPA LAB WI00007 WI DATCP ID: 105-415

WSLH Sample: OW004800

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List of Abbreviations:

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LOQ = Level of quantification
ND = None detected. Results are less than the LOD

Responsible Party: Steve Geis Steve Geis, Chemist Supervisor

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director • Charles D. Brokopp, Dr.P.H., Director

Environmental Health Division Organic Chemistry

WDNR LAB ID: 113133790 NELAP LAB ID: E37658 EPA LAB WI00007 WI DATCP ID: 105-415

WSLH Sample: OW004799

BADGER TECHNICAL SERVICES

1 BADGER RD

BARABOO, WI 53913

Bill To
Billing ID: 7305879
Customer ID: 320225
TRACKING 4920
2601 AGRICULTURAL DRIVE
MADISON WI 53718

ID#:
Waterbody/Outfall ID:
Point/Well:
Account #: LH034
Project No:
Date Received: 06/29/2012 11:12:00
Date Reported: 07/09/2012
Sample Reason:

Field #:
Collection Start: 06/27/2012 14:40:00
Collection End: 06/27/2012 15:10:00
Collected By: BHB
County:
Sample Source: AIR
Sample Depth:
Sample Information:
Sample Location: VIP-7A BADGER ARMY AMMUNITION PLANT
Sample Description: 6 L CANISTER / PASSIVE SAMPLER
Analyses and Results:

Analysis Date
07/06/2012

Lab Comment

Analysis Method	Result	Units	LOD	LOQ	Report Limit
CHLOROFORM	ND	PPB V	0.085	0.280	
CARBON TETRACHLORIDE	ND	PPB V	0.085	0.280	
TRICHLOROETHYLENE	ND	PPB V	0.085	0.280	

WSLH Sample: OW004799

Test results for NELAP accredited tests are certified to meet the requirements of the NELAC standards. For a list of accredited analytes see http://www.slh.wisc.edu/nelap/

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD

Responsible Party: Steve Geis Steve Geis, Chemist Supervisor

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director • Charles D. Brokopp, Dr.P.H., Director

Environmental Health Division Organic Chemistry

WDNR LAB ID: 113133790 NELAP LAB ID: E37658 EPA LAB WI00007 WI DATCP ID: 105-415

WSLH Sample: OW004798

BADGER TECHNICAL SERVICES

1 BADGER RD

BARABOO, WI 53913

Bill To
Billing ID: 7305879
Customer ID: 320225
TRACKING 4920
2601 AGRICULTURAL DRIVE
MADISON WI 53718

ID#:
Waterbody/Outfall ID:
Point/Well:
Account #: LH034
Project No:
Date Received: 06/29/2012 11:12:00
Date Reported: 07/09/2012
Sample Reason:

Field #:
Collection Start: 06/27/2012 13:30:00
Collection End: 06/27/2012 13:57:00
Collected By: BHB
County:
Sample Source: AIR
Sample Depth:
Sample Information:
Sample Location: VIP-9A BADGER ARMY AMMUNITION PLANT
Sample Description: 6 L CANISTER / PASSIVE SAMPLER
Analyses and Results:

Analysis Date Lab Comment
07/06/2012

Analysis Method	Result	Units	LOD	LOQ	Report Limit
CHLOROFORM	ND	PPB V	0.085	0.280	
CARBON TETRACHLORIDE	0.563	PPB V	0.085	0.280	
TRICHLOROETHYLENE	ND	PPB V	0.085	0.280	

Environmental Health Division Organic Chemistry

WDNR LAB ID: 113133790 NELAP LAB ID: E37658 EPA LAB WI00007 WI DATCP ID: 105-415

WSLH Sample: OW004798

Test results for NELAP accredited tests are certified to meet the requirements of the NELAC standards. For a list of accredited analytes see http://www.slh.wisc.edu/nelap/

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD

Responsible Party: Steve Geis, Chemist Supervisor

If there are questions about this report, please contact Steve Geis at 608-224-6269.

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Laboratory Report

D.F. Kurtycz, M.D., Medical Director • Charles D. Brokopp, Dr.P.H., Director

Environmental Health Division Organic Chemistry

WDNR LAB ID: 113133790 NELAP LAB ID: E37658 EPA LAB WI00007 WI DATCP ID: 105-415

WSLH Sample: OX000054

BADGER TECHNICAL SERVICES

1 BADGER RD.

BARABOO WI 53913

Bill To
Billing ID: 7305879
Customer ID: 320225
TRACKING 4920
2601 AGRICULTURAL DRIVE
MADISON WI 53718

Field #:
Collection Start: 07/03/2012 09:58:00
Collection End: 07/03/2012 10:28:00
Collected By: BHB-BADGER TECH. SVC
County:
Sample Source: AIR
Sample Depth: 45'
Sample Information: SAMPLER 2432
Sample Location: VIP-10A BADGER ARMY AMMUNITION PLANT
Sample Description: 6L CANISTER/PASSIVE SAMPLER

ID#:
Waterbody/Outfall ID:
Point/Well:
Account #: LH034
Project No:
Date Received: 07/05/2012
Date Reported: 07/10/2012
Sample Reason:

Analyses and Results:

Analysis Date 07/09/2012 12:35:21
Lab Comment

Analysis Method	Result	Units	LOD	LOQ	Report Limit
CHLOROFORM	ND	PPB V	0.085	0.280	
CARBON TETRACHLORIDE	25.5	PPB V	0.085	0.280	
TRICHLOROETHYLENE	1.08	PPB V	0.085	0.280	

Environmental Health Division Organic Chemistry

WDNR LAB ID: 113133790 NELAP LAB ID: E37658 EPA LAB WI00007 WI DATCP ID: 105-415

WSLH Sample: OX000054

Test results for NELAP accredited tests are certified to meet the requirements of the NELAC standards. For a list of accredited analytes see http://www.slh.wisc.edu/nelap/

List of Abbreviations:

LOD = Level of detection
LOQ = Level of quantification
ND = None detected. Results are less than the LOD

Responsible Party: Steve Geis, Chemist Supervisor

If there are questions about this report, please contact Steve Geis at 608-224-6269.

The results in this report apply only to the sample specifically listed above. This report is not to be reproduced except in full.

State of Wisconsin
Department of Natural Resources

PO # BTS 0001832

Chain of Custody Record

Form 4100-145 (R 3/09)

Sample Collector(s) Name	Return Report As: (select one)	Email or Postal Address	Phone Number (include area code)
Brenda Boyce	☑ Email ☐ Hard Copy	brenda.boyce@specpro-inc.com	608-434-5722

Property Owner	Property Address	Phone Number (include area code)
Department of the Army	Badger Army Ammunition Plant	

Split Samples: Offered? ☐ Yes ☐ No
Accepted? ☐ Yes ☐ No Accepted By (Signature): ______

06/29/12
11:12
OW004797
OW004800
OW004799
OW004798

Field ID No.	Date	Time	No. of Containers	Station Location Sample Description	Lab Use Only: Cracked / Broken	Improperly Sealed	Good Condition	Other Comments
VIP-4A	6-27-12	8:20 8:45	1	Vapor sample for chloroform, TCE and carbon tetrachloride				
VIP-5A	6-27-12	9:50 10:17	1					
VIP-7A	6-27-12	2:40 3:10	1					
VIP-9A	6-27-12	1:30 1:57	1					

Was the sample shipping container sealed on receipt? ☐ Yes ☐ No

Method of Shipment:

☐ Staff
☐ U.S. Postal Service
☐ UPS
☐ FedEx
☐ Other–specify: ______

Reason for Sample Collection:

☐ Anhydrous Ammonia Spill
☐ Animal Waste
☐ Open Burning
☐ Dairy Product Spill
☐ Construction/Storm Water Runoff
☐ Pesticide Spill * – Specify Pesticide: ______
☐ Hazardous Waste Release *
☐ Petroleum Product Release * – Specify Product: ______
☐ Industrial Spill/Runoff * – Specify Industry Type: ______
☐ Other – Specify: ______

*** Contact the laboratory with product information and for consultation. Also, include sample of suspected spilled product.**

I hereby certify that I received and properly handled these samples as noted below:

Relinquished By (Signature)	Date / Time	Received By (Signature)	Date / Time
Brenda Boyce	6-28-12/1441		
Relinquished By (Signature)	Date / Time	Received By (Signature)	Date / Time
Relinquished By (Signature)	Date / Time	Received for Laboratory By (Signature)	Date / Time

Disposition of Unused Portion Sample:

☐ Dispose
☐ Return
☐ Retain until further notice
☐ Other ______

If you need additional room for notes, use the back of this form.

State of Wisconsin
Department of Natural Resources

PO# BTS0001832

Chain of Custody Record

Form 4100-145 (R 3/09)

Sample Collector(s) Name	Return Report As: (select one)	Email or Postal Address	Phone Number (include area code)
Brenda Boyce	☑ Email ☐ Hard Copy	brenda.boyce@specpro-inc.com	608-434-5722

Property Owner	Property Address	Phone Number (include area code)
Dept. of Army	Badger Army Ammunition Plant	

Split Samples: Offered? ☐ Yes ☐ No

Accepted? ☐ Yes ☐ No Accepted By (Signature): ____________

Field ID No.	Date	Time	No. of Containers	Station Location Sample Description	Lab ID Number	Cracked / Broken	Improperly Sealed	Good Condition	Other Comments
VIP-1A	7-3-12	8:26 8:56	1	Vapor sample for chloroform, TCE and carbon tetrachloride	0X000053			✓	
VIP-10A	7-3-12	9:58 10:28	1	analysis ↓	0X000054			✓	

Lab Use Only

Was the sample shipping container sealed on receipt? ☒ Yes ☐ No

Method of Shipment:

- ☐ Staff
- ☐ U.S. Postal Service
- ☐ UPS
- ☑ FedEx
- ☐ Other–specify: ____________

Reason for Sample Collection:

- ☐ Anhydrous Ammonia Spill
- ☐ Animal Waste
- ☐ Open Burning
- ☐ Dairy Product Spill
- ☐ Construction/Storm Water Runoff
- ☐ Pesticide Spill * – Specify Pesticide: ____________
- ☐ Hazardous Waste Release *
- ☐ Petroleum Product Release * – Specify Product: ____________
- ☐ Industrial Spill/Runoff * – Specify Industry Type: ____________
- ☐ Other – Specify: ____________

*** Contact the laboratory with product information and for consultation. Also, include sample of suspected spilled product.**

I hereby certify that I received and properly handled these samples as noted below:

Relinquished By (Signature)	Date / Time	Received By (Signature)	Date / Time
Brenda Boyce	7-3-12/1345		

Relinquished By (Signature)	Date / Time	Received By (Signature)	Date / Time

Relinquished By (Signature)	Date / Time	Received for Laboratory By (Signature)	Date / Time
			7/5/12 9:52

Disposition of Unused Portion Sample:

- ☐ Dispose
- ☐ Return
- ☐ Retain until further notice
- ☐ Other ____________

If you need additional room for notes, use the back of this form.

Indoor Air Vapor Action Levels for Various VOCs
Quick Look-Up Table[1]
Based on **November 2011** Regional Screening Level Summary Table

Chemical	**Non-Residential (1-in-100,000 risk for carcinogens)**		**Residential (1-in-100,000 risk for carcinogens)**		**Molecular Weight (MW)**	**Basis of RSL[2]**
	ppbV[*]	**µg/m^3**	**ppbV[*]**	**µg/m^3**	**g/mole**	
Benzene	4.9	16.0	0.95	3.1	78.11	c
Carbon Tetrachloride	3.1	20	0.64	4.1	153.82	c
Chloroform	1.1	5.3	0.22	1.1	119.38	c
Chloromethane	190	390	45	94	50.49	n
Dichlorodifluoromethane	88	440	20	100	120.91	n
1,1 – Dichloroethane (1,1-DCA)	19	77	3.6	15	98.96	c
1,2-Dichloroethane (1,2-DCA)	1.1	4.7	0.23	0.94	98.96	c
1,1 -Dichloroethylene (1,1-DCE)	220	880	52	210	96.94	n
1,2-Dichloroethene (cis and mixed)	NA	NA	NA	NA	96.94	n
1,2-Dichloroethene (trans)	65	260	16	63	96.94	n
Ethylbenzene	11	49	2.2	9.7	106.17	c
Methyl-tert-Butyl Ether (MTBE)	130	470	26	94	88.15	c
Methylene Chloride	74	260	15	52	84.93	c
Naphthalene	0.68	3.6	0.14	0.72	128.18	c
Tetrachloroethylene	3.0	21	0.60	4.1	165.83	c
Toluene	5700	22,000	1400	5200	92.14	n
1,1,1 - Trichloroethane	4000	22,000	940	5200	133.41	n
Trichloroethylene	**1.6**	**8.8**	**0.38**	**2.1**	**131.39**	**n**
Trichlorofluromethane	540	3100	130	730	137.37	n
Trimethylbenzene (1,2,4)	6.2	31	1.5	7.3	120.2	n
Trimethylbenzene (1,3,5)	NA	NA	NA	NA	120.2	n
Vinyl Chloride	11	28	0.62	1.6	62.5	c
Xylene (mix)	100	440	23	100	106.17	n
Xylene (n,m,o separately)	100	440	23	100	106.17	n

[1] Regional Screening Tables: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm

[2] Basis for Regional Screening Level – n = non-carcinogen; c = carcinogen. Non-carcinogen RSL table values are based on a HI = 1; therefore, no multiple should be applied to the table values. Carcinogen RSL (cRSL) table values are listed as 1-in-1,000,000; in Wisconsin indoor air, 1-in-100,000 excess lifetime cancer risk is acceptable. This table of Vapor Action Levels was developed by multiplying the cRSL values by 10. Screening levels in this table are rounded to 2 significant digits.

[*] Conversions from µg/m^3 to ppbV in this table based on T = 20ºC or 68 ºF; P = 1 atm or 101.325 kPA (see next page)

Update: December 6, 2011

Convert µg/m^3 to ppbV

On-line calculator: Indoor Air Unit Conversion
http://www.epa.gov/athens/learn2model/part-two/onsite/ia_unit_conversion.html
At 20ºC and 1 atm:

$$ppbV = \frac{\mu g / m^3}{MW} \times 8.3144 \left[\frac{L \cdot kPa}{mol \cdot {}^\circ K}\right] \times \left[T_{^\circ C} + 273.15\right] {}^\circ K \times \frac{1}{101.325\,kPa}$$

OR ppbV = (µg/m^3 x **24.05**)/molecular weight

Using indoor vapor action levels (VAL) to determine vapor risk screening levels (VRSL)

Vapor risk screening levels are used to estimate indoor air concentrations from sub-slab vapor, soil gas or groundwater concentrations. Standard attenuation factors are applied to each media. This table lists the attenuation factor (AF = C_{IA}/C_{source}) and the dilution factor (inverse of the AF). The VAL is divided by the AF or multiplied by the dilution factor to calculate the vapor risk screening level.

Media Screened	**Residential / Small Commercial Buildings**		**Large Commercial / Industrial Buildings**	
	Attenuation Factor	*Dilution Factor*	*Attenuation Factor*	*Dilution Factor*
Sub-slab vapor	0.1	10	0.01	100
Deep soil gas	0.01	100	0.001	1000
Groundwater	0.001	1000	0.0001	10,000

Determining the Vapor Risk Screening Level for Groundwater
(at what concentration would groundwater potentially cause an indoor air exceedance)

$$C_{gw} = \frac{C_{IA}}{\left(H \times AF_{gw} \times 1000 \, {}^{L}\!/_{m^3}\right)}$$

Where: C_{gw} = groundwater concentration (**µg/L**)
C_{IA} = indoor air concentration (from Quick look-up table, **µg/m^3**)
H = Henry's Law constant (dimensionless) from Chemical Specific Parameter Table:
http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm
AF_{gw} = attenuation factor between groundwater and indoor air

Note: The default attenuation factor for groundwater to indoor air is 0.001. However, if the contaminated groundwater is located at the building foundation, the attenuation factor should be increased to 0.1 (i.e., treated as a sub-slab concentration). If contaminated groundwater is located close to the foundation (but not in contact with the foundation), the default attenuation factor of 0.001 may not be predictive of indoor air concentration. In that case, sub-slab sampling should be conducted.

Update: December 6, 2011

Appendix I

Remedial Alternative Cost Summaries

PBG Plume Alternative 2 Cost Summary
Remedial Investigation/Feasibility Study
Badger Army Ammunition Plant

Alternative	Item Description	Comments	Sub Totals	Total Costs
Monitored Natural Attenuation and Alternate Water Supply	**Direct Capital Cost**	No design cost to implement alternative	$ -	$0
	Indirect Capital Cost	Engineering Design (10% of Direct Capital Cost)	$ -	$0
		Legal/License/Permit (5% of Direct Capital Cost)	$ -	
		Start-up & Shake-down (10% of Direct Capital Cost)	$ -	
		Contingency (20% of Direct Capital Cost)	$ -	
	Annual O&M	30 years of groundwater monitoring at current groundwater sampling program	$ 4,511,746	$4,913,113
		Provision of bottled water - 20 gallons/month for 3 months, once every 3 years for 30 years	$ 1,367	
		Residential well replacement - 1 well every 3 years for 30 years	$ 400,000	
				$4,913,113

Notes:
Costs are based on current monitoring plans and engineering estimates.
O&M - Operations and Maintenance
Residential well replacement will be offered when a NR 140 ES is exceeded in consecutive sampling rounds.
See Section 8.8 for an explanation of why the O&M term is limited to 30 years.

PBG Plume Alternative 3 Cost Summary
Remedial Investigation/Feasibility Study
Badger Army Ammunition Plant

Alternative	Item Description	Comments	Sub Totals	Total Costs
Active Groundwater Remediation - Pump & Treat	**Direct Capital Cost**	Four groundwater extraction wells	$ 520,573	$3,633,573
		Four mobile treatment units	$ 2,460,000	
		Treatment area preparation, piping, utilities, SCADA System, buoy system, restoration	$ 653,000	
	Indirect Capital Cost	Engineering Design (10% of Direct Capital Cost)	$ 363,357	$1,635,108
		Legal/License/Permit (5% of Direct Capital Cost)	$ 181,679	
		Start-up & Shake-down (10% of Direct Capital Cost)	$ 363,357	
		Contingency (20% of Direct Capital Cost)	$ 726,715	
	Annual O&M	30 years of groundwater monitoring at current groundwater sampling program	$ 4,511,746	$7,433,131
		Provision of bottled water - 20 gallons/month for 3 months, once every 3 years for 30 years	$ 1,367	
		Residential well replacement - 1 well every 3 years for 30 years	$ 400,000	
		Mobile treatment units - 8 years of O&M (2 for 8 years, 1 for 6 years, 1 for 2 years)	$ 2,520,018	
				$12,701,812

Notes:
Costs are based on current monitoring plans and engineering estimates.
O&M - Operations and Maintenance
Residential well replacement will be offered when a NR 140 ES is exceeded in consecutive sampling rounds.
See Section 8.8 for an explanation of why the O&M term is limited to 30 years.

PBG Plume Alternative 4 Cost Summary
Remedial Investigation/Feasibility Study
Badger Army Ammunition Plant

Alternative	Item Description	Comments	Sub Totals	Total Costs
Active Groundwater Remediation - Anaerobic Bioremediation	**Direct Capital Cost**	Biochemical product (59 tankers)	$ 2,754,328	$3,254,729
		Drilling, well installation & development, direct push, injection, abandonment & decontamination (9 wells, 150 DPTs)	$ 500,402	
	Indirect Capital Cost	Engineering Design (10% of Direct Capital Cost)	$ 325,473	$1,464,628
		Legal/License/Permit (5% of Direct Capital Cost)	$ 162,736	
		Start-up & Shake-down (10% of Direct Capital Cost)	$ 325,473	
		Contingency (20% of Direct Capital Cost)	$ 650,946	
	Annual O&M	30 years of groundwater monitoring at current groundwater sampling program	$ 4,511,746	$4,913,113
		Provision of bottled water - 20 gallons/month for 3 months, once every 3 years for 30 years	$ 1,367	
		Residential well replacement - 1 well every 3 years for 30 years	$ 400,000	
				$9,632,470

Notes:
Costs are based on current monitoring plans and engineering estimates.
O&M - Operations and Maintenance
Residential well replacement will be offered when a NR 140 ES is exceeded in consecutive sampling rounds.
See Section 8.8 for an explanation of why the O&M term is limited to 30 years.

PBG Plume Alternative 5 Cost Summary
Remedial Investigation/Feasibility Study
Badger Army Ammunition Plant

Alternative	Item Description	Comments	Sub Totals	Total Costs
Well Replacement - Plume Area	**Direct Capital Cost**	Replacement of 47 residential wells	$ 2,350,000	$2,350,000
	Indirect Capital Cost	Engineering Design (10% of Direct Capital Cost)	$ 235,000	$1,057,500
		Legal/License/Permit (5% of Direct Capital Cost)	$ 117,500	
		Start-up & Shake-down (10% of Direct Capital Cost)	$ 235,000	
		Contingency (20% of Direct Capital Cost)	$ 470,000	
	Annual O&M	30 years of groundwater monitoring at current groundwater sampling program	$ 4,511,746	$4,511,746
				$7,919,246

Notes:

Costs are based on current monitoring plans and engineering estimates.

O&M - Operations and Maintenance

See Section 8.8 for an explanation of why the O&M term is limited to 30 years.

PBG Plume Alternative 6 Cost Summary
Remedial Investigation/Feasibility Study
Badger Army Ammunition Plant

Alternative	Item Description	Comments	Sub Totals	Total Costs
Source Area Treatment	**Direct Capital Cost**	Biochemical product (2 tankers)	$ 83,150	$201,433
		Drilling, well installation & development, injection & decontamination (9 locations)	$ 118,283	
	Indirect Capital Cost	Engineering Design (10% of Direct Capital Cost)	$ 20,143	$90,645
		Legal/License/Permit (5% of Direct Capital Cost)	$ 10,072	
		Start-up & Shake-down (10% of Direct Capital Cost)	$ 20,143	
		Contingency (20% of Direct Capital Cost)	$ 40,287	
	Annual O&M	30 years of groundwater monitoring at current groundwater sampling program	$ 4,511,746	$4,913,113
		Provision of bottled water - 20 gallons/month for 3 months, once every 3 years for 30 years	$ 1,367	
		Residential well replacement - 1 well every 3 years for 30 years	$ 400,000	
				$5,205,190

Notes:
Costs are based on current monitoring plans and engineering estimates.
O&M - Operations and Maintenance
Residential well replacement will be offered when a NR 140 ES is exceeded in consecutive sampling rounds.
See Section 8.8 for an explanation of why the O&M term is limited to 30 years.

DBG Plume Alternative 2 Cost Summary
Remedial Investigation/Feasibility Study
Badger Army Ammunition Plant

Alternative	Item Description	Comments	Sub Totals	Total Costs
Monitored Natural Attenuation and Alternate Water Supply	**Direct Capital Cost**	No design cost to implement alternative	$ -	$0
	Indirect Capital Cost	Engineering Design (10% of Direct Capital Cost)	$ -	$0
		Legal/License/Permit (5% of Direct Capital Cost)	$ -	
		Start-up & Shake-down (10% of Direct Capital Cost)	$ -	
		Contingency (20% of Direct Capital Cost)	$ -	
	Annual O&M	30 years of groundwater monitoring at current groundwater sampling program	$ 3,839,123	$4,240,490
		Provision of bottled water - 20 gallons/month for 3 months, once every 3 years for 30 years	$ 1,367	
		Residential well replacement - 1 well every 3 years for 30 years	$ 400,000	
				$4,240,490

Notes:
Costs are based on current monitoring plans and engineering estimates.
O&M - Operations and Maintenance
Residential well replacement will be offered when a NR 140 ES is exceeded in consecutive sampling rounds.
See Section 8.8 for an explanation of why the O&M term is limited to 30 years.

DBG Plume Alternative 3 Cost Summary
Remedial Investigation/Feasibility Study
Badger Army Ammunition Plant

Alternative	Item Description	Comments	Sub Totals	Total Costs
Active Groundwater Remediation - Pump & Treat	**Direct Capital Cost**	Three groundwater extraction wells	$ 390,430	$2,776,030
		Three mobile treatment units	$ 1,845,000	
		Treatment area preparation, piping, utilities, SCADA System, buoy system, restoration	$ 540,600	
	Indirect Capital Cost	Engineering Design (10% of Direct Capital Cost)	$ 277,603	$1,249,214
		Legal/License/Permit (5% of Direct Capital Cost)	$ 138,802	
		Start-up & Shake-down (10% of Direct Capital Cost)	$ 277,603	
		Contingency (20% of Direct Capital Cost)	$ 555,206	
	Annual O&M	24 years of groundwater monitoring at current groundwater sampling program	$ 3,199,269	$8,522,395
		Provision of bottled water - 20 gallons/month for 3 months, once every 3 years for 24 years	$ 1,184	
		Residential well replacement - 1 well every 3 years for 24 years	$ 333,333	
		Mobile treatment units - 22 years of O&M (2 for 22 years, 1 for 10 years)	$ 4,988,608	
				$12,547,639

Notes:
Costs are based on current monitoring plans and engineering estimates.
O&M - Operations and Maintenance
Residential well replacement will be offered when a NR 140 ES is exceeded in consecutive sampling rounds.

DBG Plume Alternative 4 Cost Summary
Remedial Investigation/Feasibility Study
Badger Army Ammunition Plant

Alternative	Item Description	Comments	Sub Totals	Total Costs
Active Groundwater Remediation - Anaerobic Bioremediation	**Direct Capital Cost**	Biochemical product (149 tankers)	$ 7,033,063	$8,107,868
		Direct push, injection, hole abandonment & decontamination (406 locations)	$ 1,074,805	
	Indirect Capital Cost	Engineering Design (10% of Direct Capital Cost)	$ 810,787	$3,648,540
		Legal/License/Permit (5% of Direct Capital Cost)	$ 405,393	
		Start-up & Shake-down (10% of Direct Capital Cost)	$ 810,787	
		Contingency (20% of Direct Capital Cost)	$ 1,621,574	
	Annual O&M	4 years of groundwater monitoring at current groundwater sampling program	$ 639,854	$706,748
		Provision of bottled water - 20 gallons/month for 3 months, once every 3 years for 4 years	$ 228	
		Residential well replacement - 1 well every 3 years for 4 years	$ 66,667	
				$12,463,156

Notes:
Costs are based on current monitoring plans and engineering estimates.
O&M - Operations and Maintenance
Residential well replacement will be offered when a NR 140 ES is exceeded in consecutive sampling rounds.

DBG Plume Alternative 5 Cost Summary
Remedial Investigation/Feasibility Study
Badger Army Ammunition Plant

Alternative	Item Description	Comments	Sub Totals	Total Costs
Well Replacement - Plume Area	**Direct Capital Cost**	Replacement of 57 residential wells	$ 2,280,000	$2,280,000
	Indirect Capital Cost	Engineering Design (10% of Direct Capital Cost)	$ 228,000	$1,026,000
		Legal/License/Permit (5% of Direct Capital Cost)	$ 114,000	
		Start-up & Shake-down (10% of Direct Capital Cost)	$ 228,000	
		Contingency (20% of Direct Capital Cost)	$ 456,000	
	Annual O&M	30 years of groundwater monitoring at current groundwater sampling program	$ 3,839,123	$3,839,123
				$7,145,123

Notes:
Costs are based on current monitoring plans and engineering estimates.
O&M - Operations and Maintenance
See Section 8.8 for an explanation of why the O&M term is limited to 30 years.

DBG Plume Alternative 6 Cost Summary
Remedial Investigation/Feasibility Study
Badger Army Ammunition Plant

Alternative	Item Description	Comments	Sub Totals	Total Costs
Source Area Treatment	**Direct Capital Cost**	Biochemical product (11 tankers)	$ 517,375	$645,631
		Direct push, injection, hole abandonment & decontamination (56 locations)	$ 128,256	
	Indirect Capital Cost	Engineering Design (10% of Direct Capital Cost)	$ 64,563	$290,534
		Legal/License/Permit (5% of Direct Capital Cost)	$ 32,282	
		Start-up & Shake-down (10% of Direct Capital Cost)	$ 64,563	
		Contingency (20% of Direct Capital Cost)	$ 129,126	
	Annual O&M	30 years of groundwater monitoring at current groundwater sampling program	$ 3,839,123	$4,240,490
		Provision of bottled water - 20 gallons/month for 3 months, once every 3 years for 30 years	$ 1,367	
		Residential well replacement - 1 well every 3 years for 30 years	$ 400,000	
				$5,176,654

Notes:
Costs are based on current monitoring plans and engineering estimates.
O&M - Operations and Maintenance
Residential well replacement will be offered when a NR 140 ES is exceeded in consecutive sampling rounds.
See Section 8.8 for an explanation of why the O&M term is limited to 30 years.

Central Plume Alternative 2 Cost Summary
Remedial Investigation/Feasibility Study
Badger Army Ammunition Plant

Alternative	Item Description	Comments	Sub Totals	Total Costs
Monitored Natural Attenuation and Alternate Water Supply	**Direct Capital Cost**	No design cost to implement alternative	$ -	$0
	Indirect Capital Cost	Engineering Design (10% of Direct Capital Cost)	$ -	$0
		Legal/License/Permit (5% of Direct Capital Cost)	$ -	
		Start-up & Shake-down (10% of Direct Capital Cost)	$ -	
		Contingency (20% of Direct Capital Cost)	$ -	
	Annual O&M	30 years of groundwater monitoring at current groundwater sampling program	$ 1,997,172	$2,398,538
		Provision of bottled water - 20 gallons/month for 3 months, once every 3 years for 30 years	$ 1,367	
		Residential well replacement - 1 well every 3 years for 30 years	$ 400,000	
				$2,398,538

Notes:

Costs are based on current monitoring plans and engineering estimates.

O&M - Operations and Maintenance

Residential well replacement will be offered when a NR 140 ES is exceeded in consecutive sampling rounds.

See Section 8.8 for an explanation of why the O&M term is limited to 30 years.

Central Plume Alternative 3 Cost Summary
Remedial Investigation/Feasibility Study
Badger Army Ammunition Plant

Alternative	Item Description	Comments	Sub Totals	Total Costs
Active Groundwater Remediation - Pump & Treat	**Direct Capital Cost**	Eight groundwater extraction wells	$ 1,041,147	$6,939,247
		Eight mobile treatment units	$ 4,920,000	
		Treatment area preparation, piping, utilities, SCADA System, buoy system, restoration	$ 978,100	
	Indirect Capital Cost	Engineering Design (10% of Direct Capital Cost)	$ 693,925	$3,122,661
		Legal/License/Permit (5% of Direct Capital Cost)	$ 346,962	
		Start-up & Shake-down (10% of Direct Capital Cost)	$ 693,925	
		Contingency (20% of Direct Capital Cost)	$ 1,387,849	
	Annual O&M	12 years of groundwater monitoring at current groundwater sampling program	$ 865,441	$7,953,709
		Provision of bottled water - 20 gallons/month for 3 months, once every 3 years for 12 years	$ 592	
		Residential well replacement - 1 well every 3 years for 12 years	$ 173,333	
		Mobile treatment units - 10 years of O&M	$ 6,914,343	
				$18,015,617

Notes:
Costs are based on current monitoring plans and engineering estimates.
O&M - Operations and Maintenance
Residential well replacement will be offered when a NR 140 ES is exceeded in consecutive sampling rounds.

Central Plume Alternative 4 Cost Summary
Remedial Investigation/Feasibility Study
Badger Army Ammunition Plant

Alternative	Item Description	Comments	Sub Totals	Total Costs
Active Groundwater Remediation - Anaerobic Bioremediation	**Direct Capital Cost**	Biochemical product (291 tankers)	$ 13,627,063	$16,082,742
		Direct push, injection, hole abandonment & decontamination (988 locations)	$ 2,455,680	
	Indirect Capital Cost	Engineering Design (10% of Direct Capital Cost)	$ 1,608,274	$7,237,234
		Legal/License/Permit (5% of Direct Capital Cost)	$ 804,137	
		Start-up & Shake-down (10% of Direct Capital Cost)	$ 1,608,274	
		Contingency (20% of Direct Capital Cost)	$ 3,216,548	
	Annual O&M	4 years of groundwater monitoring at current sampling program	$ 332,862	$399,756
		Provision of bottled water - 20 gallons/month for 3 months, once every 3 years for 4 years	$ 228	
		Residential well replacement - 1 well every 3 years for 4 years	$ 66,667	
				$23,719,733

Notes:
Costs are based on current monitoring plans and engineering estimates.
O&M - Operations and Maintenance
Residential well replacement will be offered when a NR 140 ES is exceeded in consecutive sampling rounds.

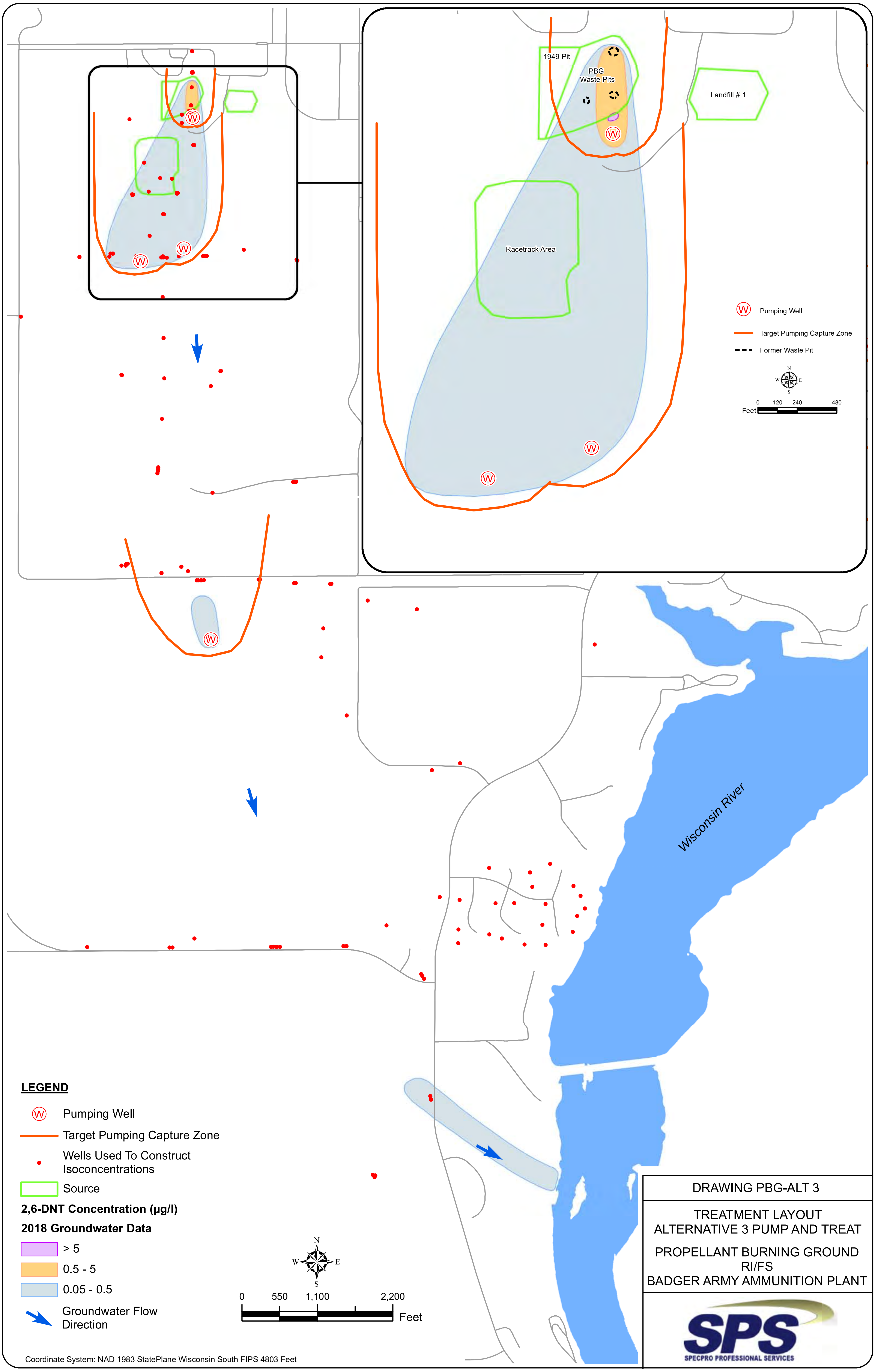
Central Plume Alternative 5 Cost Summary
Remedial Investigation/Feasibility Study
Badger Army Ammunition Plant

Alternative	Item Description	Comments	Sub Totals	Total Costs
Well Replacement - Plume Area	**Direct Capital Cost**	Replacement of 23 residential wells	$ 920,000	$920,000
	Indirect Capital Cost	Engineering Design (10% of Direct Capital Cost)	$ 92,000	$414,000
		Legal/License/Permit (5% of Direct Capital Cost)	$ 46,000	
		Start-up & Shake-down (10% of Direct Capital Cost)	$ 92,000	
		Contingency (20% of Direct Capital Cost)	$ 184,000	
	Annual O&M	30 years of groundwater monitoring at current groundwater sampling program	$ 1,997,172	$1,997,172
				$3,331,172

Notes:
Costs are based on current monitoring plans and engineering estimates.
O&M - Operations and Maintenance
See Section 8.8 for an explanation of why the O&M term is limited to 30 years.

Appendix J

Remedial Alternative Treatment Area Drawings



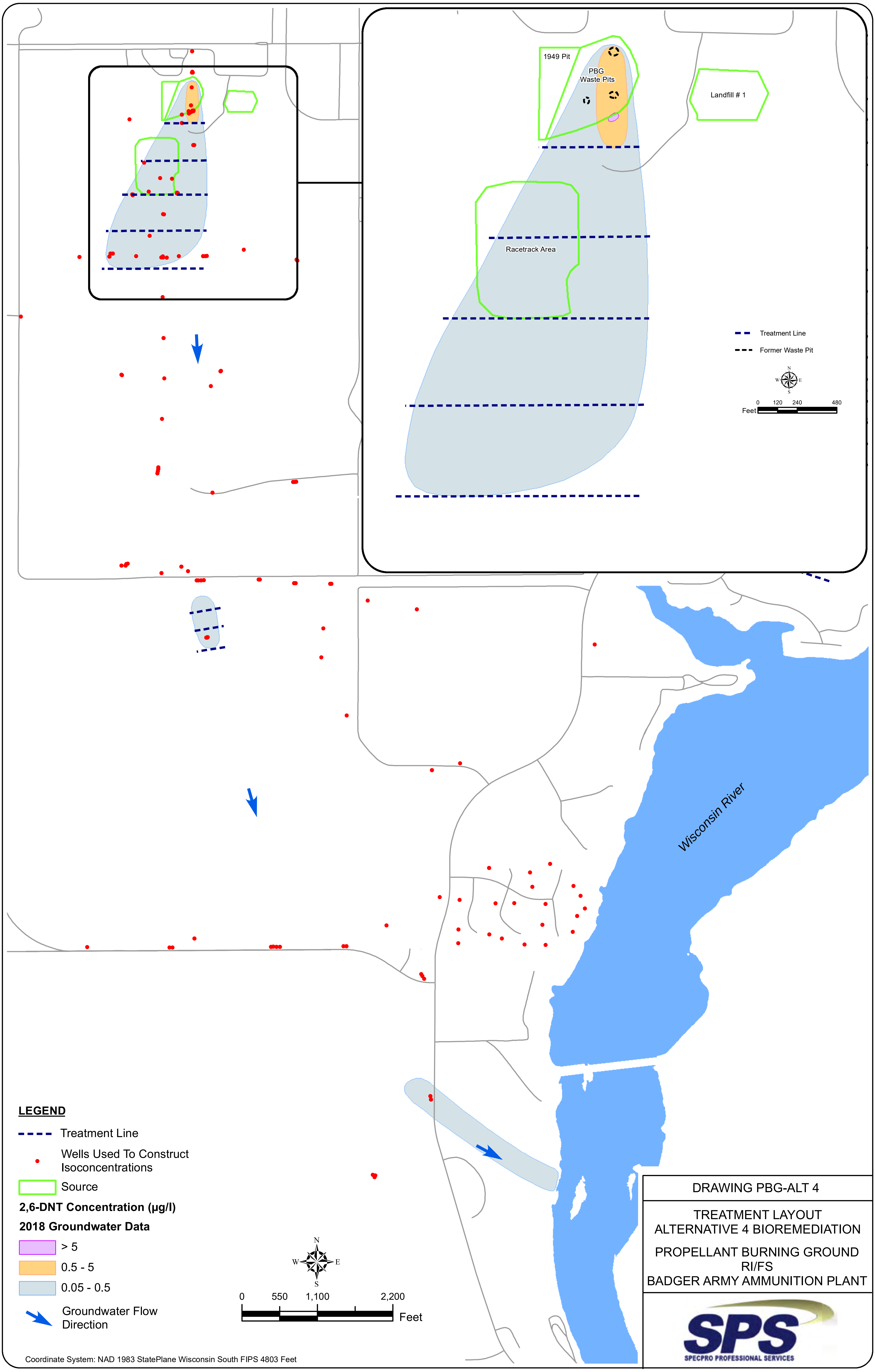
Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet

DRAWING PBG-ALT 3

TREATMENT LAYOUT
ALTERNATIVE 3 PUMP AND TREAT

PROPELLANT BURNING GROUND
RI/FS
BADGER ARMY AMMUNITION PLANT

SPS
SPECPRO PROFESSIONAL SERVICES

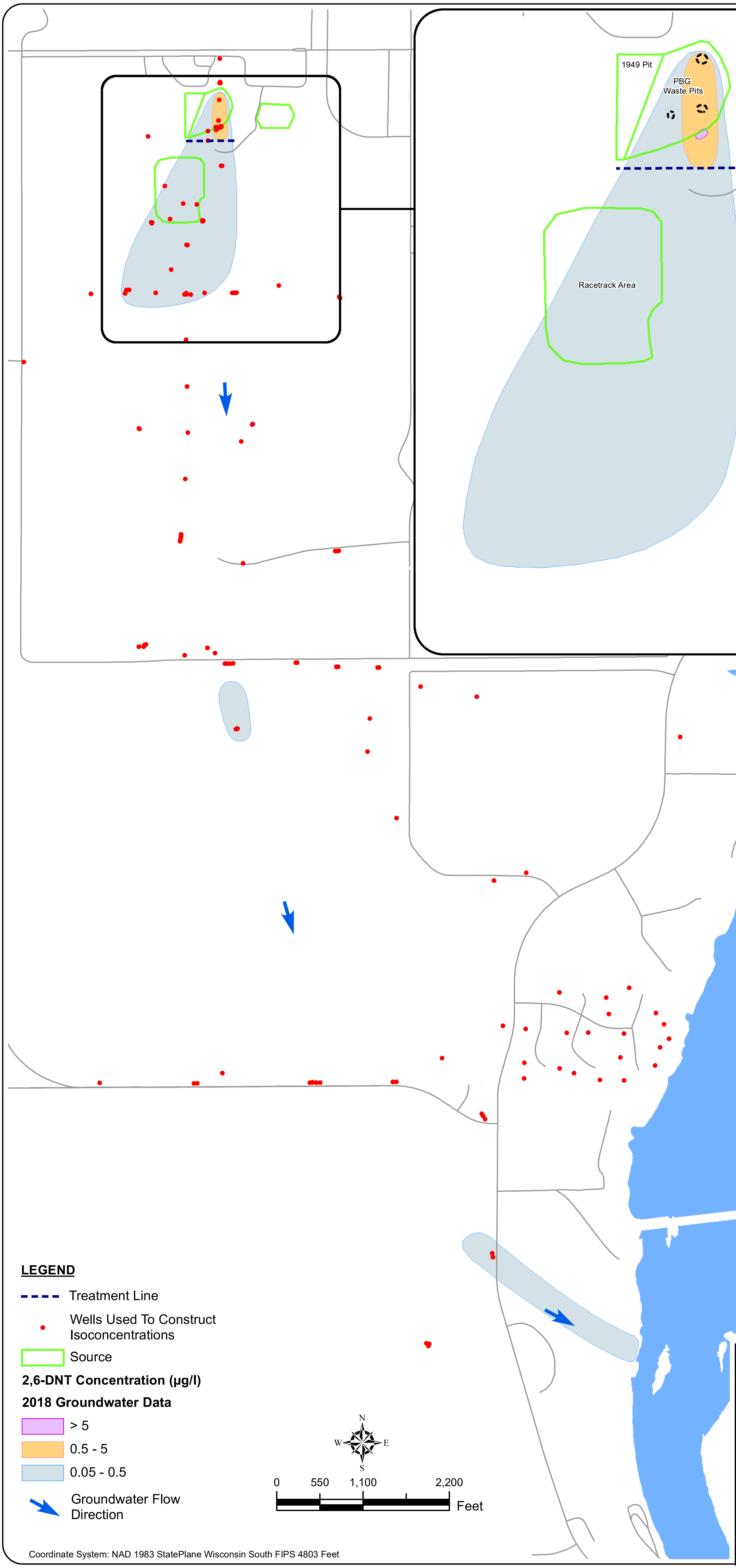


DRAWING PBG-ALT 4

TREATMENT LAYOUT
ALTERNATIVE 4 BIOREMEDIATION

PROPELLANT BURNING GROUND
RI/FS
BADGER ARMY AMMUNITION PLANT

SPS
SPECPRO PROFESSIONAL SERVICES

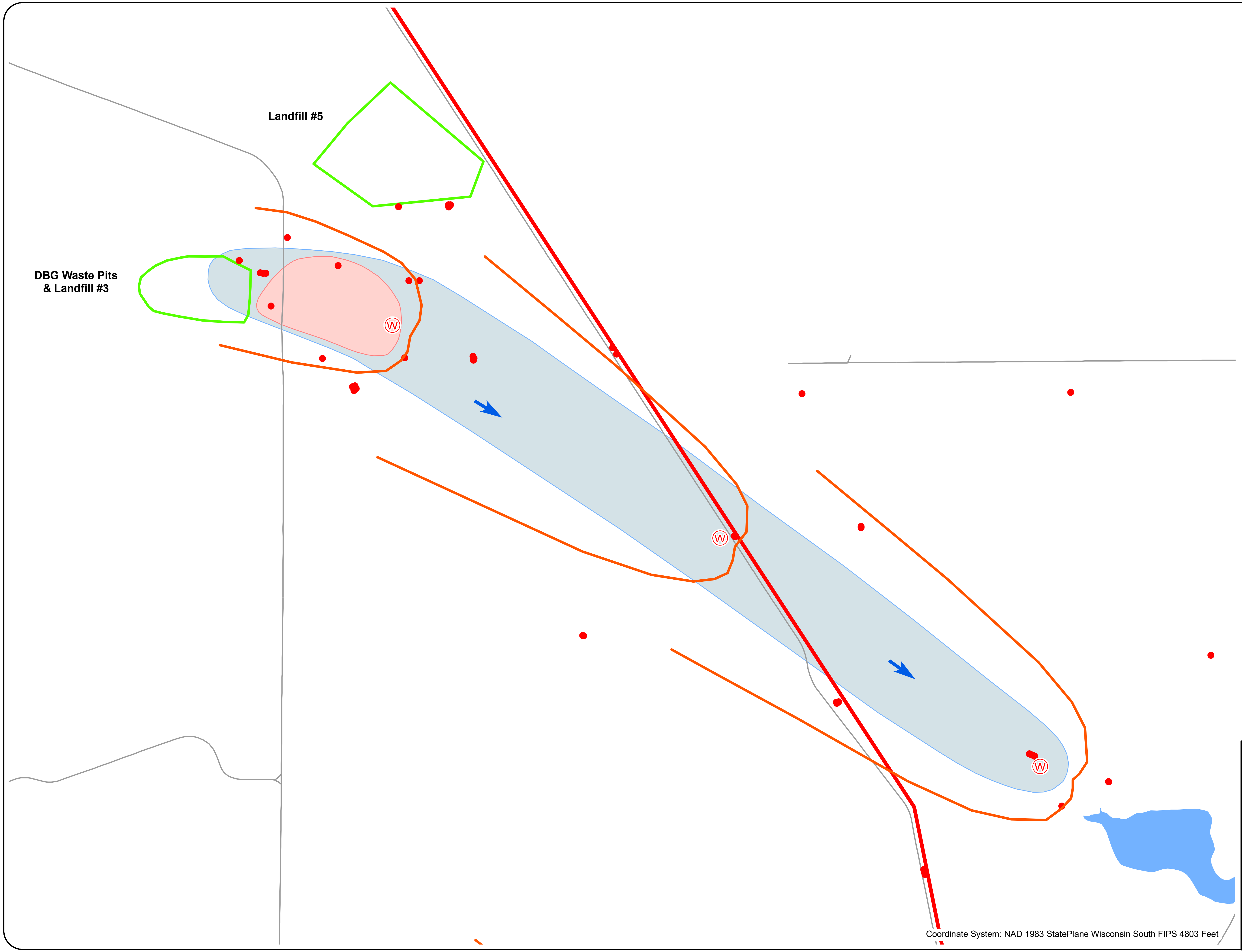


DRAWING PBG-ALT 6

TREATMENT LAYOUT
ALTERNATIVE 6 SOURCE AREA

PROPELLANT BURNING GROUND
RI/FS
BADGER ARMY AMMUNITION PLANT

SPS
SPECPRO PROFESSIONAL SERVICES



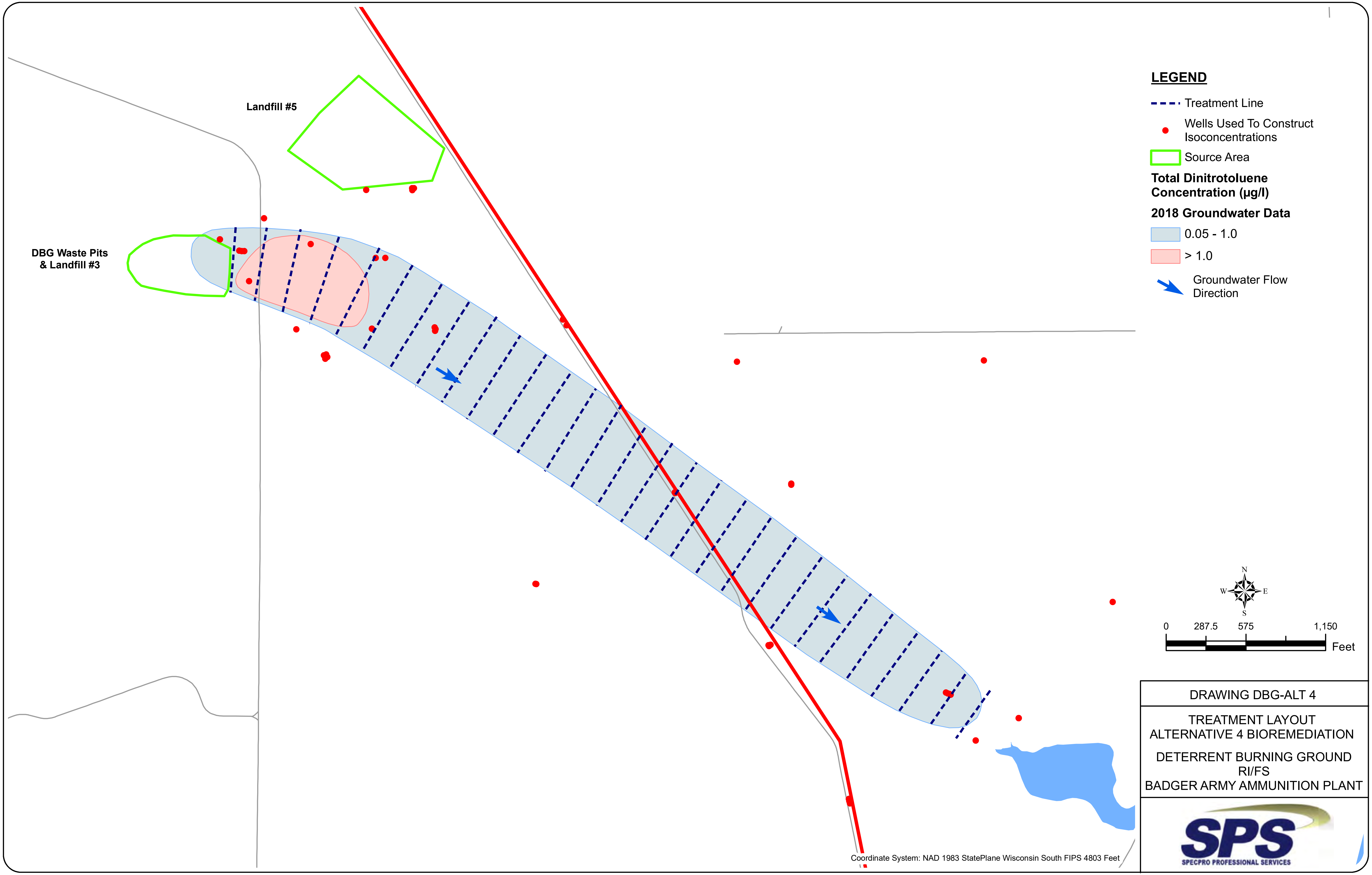
Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet

DRAWING DBG-ALT 3

TREATMENT LAYOUT
ALTERNATIVE 3 PUMP AND TREAT

DETERRENT BURNING GROUND
RI/FS
BADGER ARMY AMMUNITION PLANT

SPS
SPECPRO PROFESSIONAL SERVICES



LEGEND

- - - - Treatment Line

● Wells Used To Construct Isoconcentrations

🟩 Source Area

Total Dinitrotoluene Concentration (µg/l)

2018 Groundwater Data

▨	0.05 - 1.0
🟥	> 1.0

➘ Groundwater Flow Direction

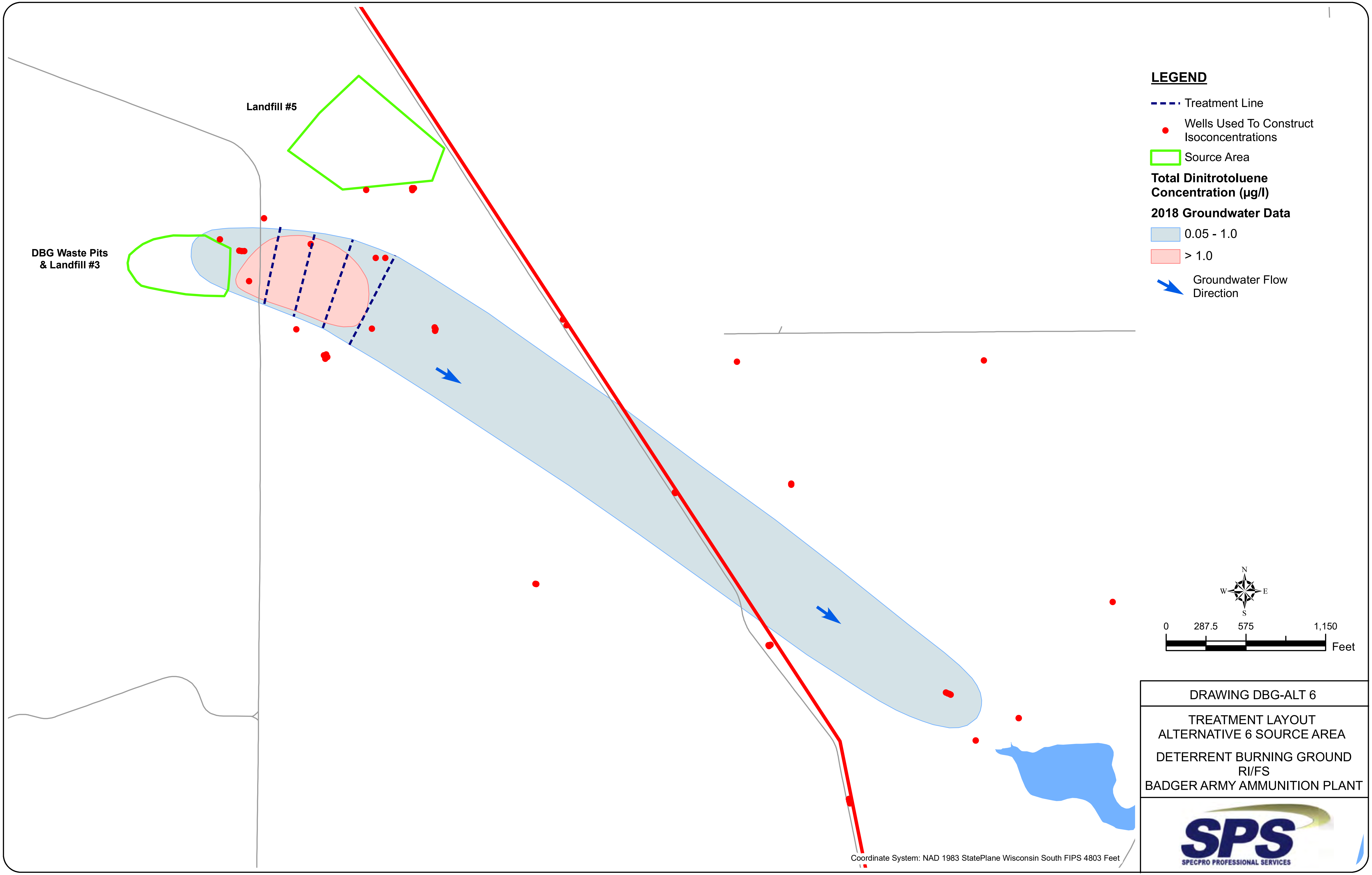
Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet

DRAWING DBG-ALT 4

TREATMENT LAYOUT
ALTERNATIVE 4 BIOREMEDIATION

DETERRENT BURNING GROUND
RI/FS
BADGER ARMY AMMUNITION PLANT

SPS
SPECPRO PROFESSIONAL SERVICES

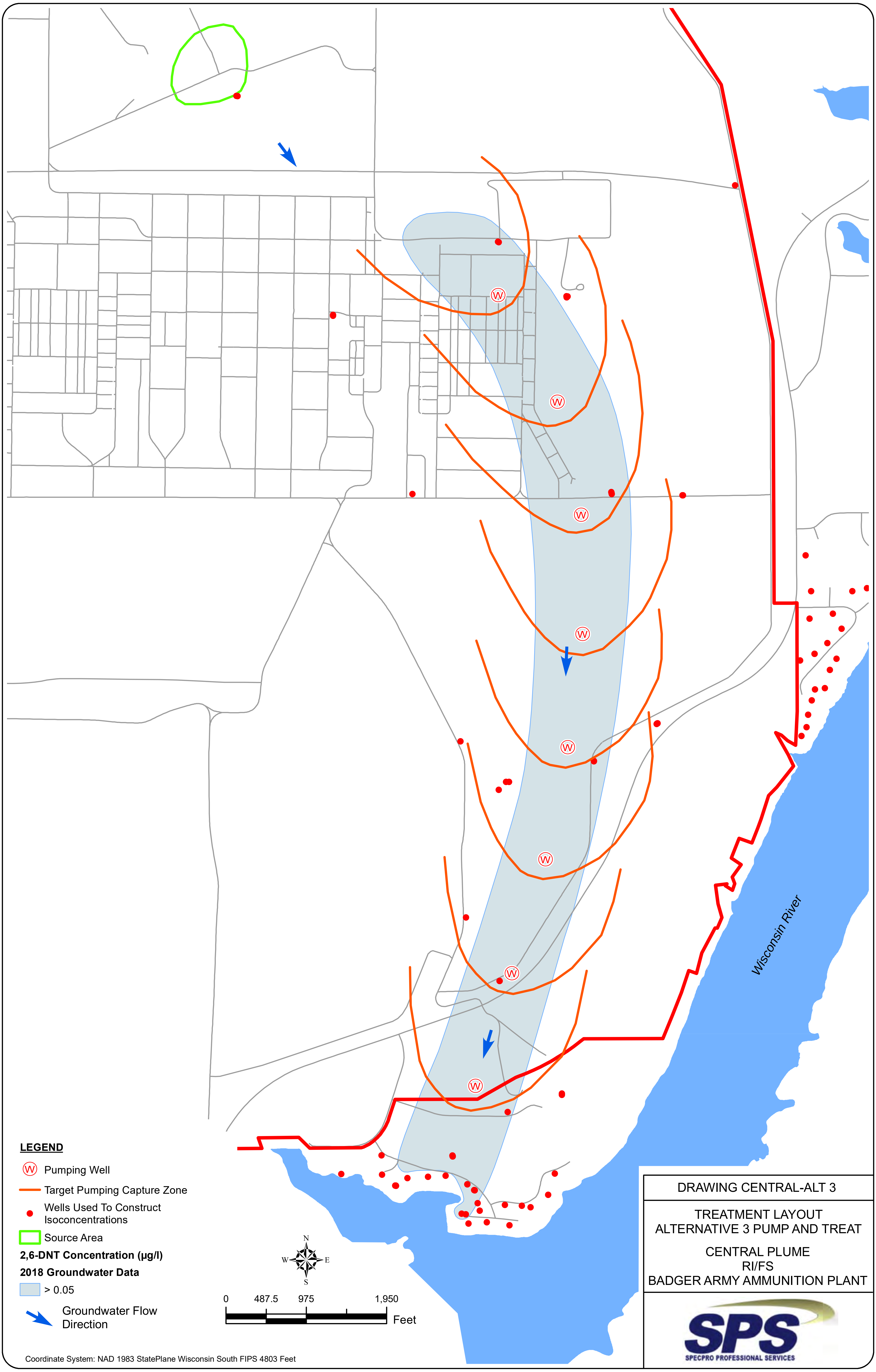


Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet

DRAWING DBG-ALT 6

TREATMENT LAYOUT
ALTERNATIVE 6 SOURCE AREA

DETERRENT BURNING GROUND
RI/FS
BADGER ARMY AMMUNITION PLANT

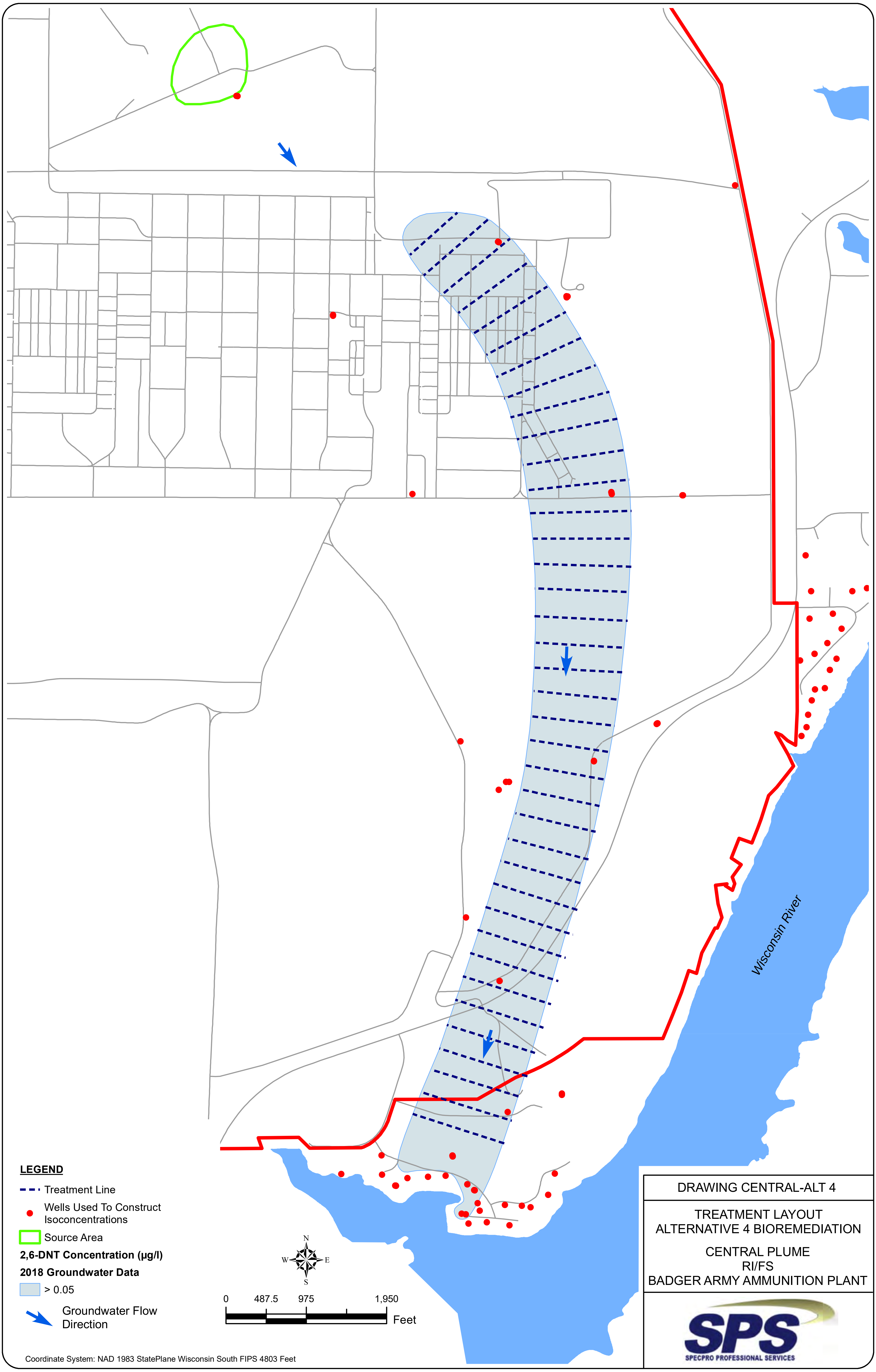


DRAWING CENTRAL-ALT 3

TREATMENT LAYOUT
ALTERNATIVE 3 PUMP AND TREAT

CENTRAL PLUME
RI/FS
BADGER ARMY AMMUNITION PLANT

Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet



DRAWING CENTRAL-ALT 4

TREATMENT LAYOUT
ALTERNATIVE 4 BIOREMEDIATION

CENTRAL PLUME
RI/FS
BADGER ARMY AMMUNITION PLANT

SPS
SPECPRO PROFESSIONAL SERVICES

Appendix K

Army Response to Comments on RI/FS

Army Response to Comments on Groundwater RI/FS

Comments from WDNR

Item	Comment	Response	Action	Army Acceptance (A/NA/P/R) $^{(1)}$
1.	Overall, the RI/FS is well written. It presents a good summary of site conditions. The data tables consolidate information from many years of investigation and monitoring and the figures clearly depict known site hydrogeologic conditions and contaminant plume locations.	Acknowledge comment	No action needed.	NA
2.	The Groundwater Human Health Risk Assessment indicates that the Army conducted vapor intrusion pathway analyses for all of the groundwater contaminant plumes in 2012 using the Department's vapor intrusion guidance (PUB-RR-800, dated December 2010). Based on significant advances in the science of vapor intrusion, substantial revisions were made to this guidance and an updated version was published in January 2018. We request that the Army review its assessment of potential vapor intrusion using the updated guidance.	The Army has reviewed the WDNR's January 2018 Vapor Intrusion Guidance (PUB-RR-800) and determined that vapor intrusion still does not pose a risk to area residents. The WDNR's January 2018 guidance references the Wisconsin Vapor Quick Look-up Table for Vapor Action Levels (VAL) and Vapor Risk Screening Levels (VRSL) related to commonly encountered contaminants at cleanup sites. These levels are based on USEPA Regional Screening Levels dated November 2017. Using the updated guidance, the Army determined the VAL and calculated the November 2017 VRSL for deep soil gas related to carbon tetrachloride, chloroform, and trichloroethene. The calculated November 2017 VRSL values were higher than the VRSL values used in the 2012 Vapor Intrusion Pathway Analysis Report. Based on this information, the Army believes that additional investigation of the vapor pathway is not warranted.	The Army has reviewed its assessment of potential vapor intrustion using the 2018 WDNR Vapor Intrustion Guidance and sees no risk to area residents through vapor intrusion.	A
3.	Based on the Human Health Risk Assessment (HHRA), no constituents of concern (COCs) were identified for the Nitrocellulose Production Area Plume because no existing, nearby receptors were identified for this plume. Based on the lack of COCs, this plume was subsequently not addressed in the Remedial Alternatives Analysis (RAA) despite the presence of chemical constituents in the plume above Wis. Admin. Code NR 140 (NR 140) enforcement standards (ESs). The contamination in this plume must be addressed. State law (Wis, State Statute 292.11(3)) requires "A person who possesses or controls a hazardous substance which is discharged or who causes the discharge of a hazardous substance shall take the actions necessary to restore the environment to the extent practicable and minimize the harmful effects from the discharge to the air, lands or waters of this state." This response must be done in accordance with applicable regulations (Wis. Admin. Code NR 700 series as authorized in Wis, State Statute 292.31(2). Therefore, we request that the Army include this plume in the RAA and evaluate remedial options consistent with the other contaminant plumes at the site.	The human health risk assessment did not identify risk above the risk management criteria for the NC Area Plume. Therefore, groundwater remedial alternatives were not considered by the Army for the NC Area Plume. For environmental cleanup decision-making, the Army must follow both CERCLA guidance and the Department of Defense (DoD) Manual 4715.20 (March 9, 2012). The DoD Manual outlines the policies and procedures the Army must follow when conducting environmental restoration under the Defense Environmental Restoration Program (DERP). DERP guidance (b.(5)a.3.h.) states, "If prior to the FS, the DoD Component determines that the site is protective of human health and the environment, the DoD Component is not required to complete an FS or a response action, and will not evaluate ARARs pursuant to subsection 9621(d)(2)(A) of CERCLA." The Army is committed to monitoring the groundwater contamination associated with the NC Area Plume.	The document requires no changes. The Army will continue to review and revise the groundwater monitoring program to ensure it remains protective of human health. The Army will discuss future groundwater monitoring of the NC Area Plume with the WDNR.	R
4.	Consideration should be given to including analysis of major ions (e.g,, calcium, sodium, magnesium, iron, chloride, sulfate, bicarbonate, and nitrate) for groundwater samples collected from select monitoring wells along the longitudinal axis of the plume and from select private wells in areas near the plume boundaries. This may allow better identification of the plume extent and migration in advance of COCs being detected. These indicator parameters may also be helpful in identifying local sources of COCs (particularly VOCs) and differentiating those originating the plumes emanating from the site.	These are not site related contaminants of concern. Depending on the selected remedy monitoring for the major ions may be included in post-ROD remedial activities.	The document requires no changes. The Army will continue to review and revise the groundwater monitoring program to ensure it remains protective of human health.The Army will discuss future groundwater monitoring of the plumes with the WDNR.	A
5.	The characterization of the downgradient extent of the Central Plume is inadequate. The fact that this plume is impinging upon a residential area accentuates the need for additional study. The hydrogeologic flow patterns (particularly at depth) near Grubers Grove Bay and beyond are poorly defined. The likely ultimate fate of this plume, if it were to continue to propagate, needs to be better defined.	For the past 15 years, the Army has been closely monitoring the groundwater in the downgradient portion of the Central Plume. Throughout this time, the Army has also made a commitment to monitor the homeowner's drinking water and replace impacted wells. During 2018 and 2019, the Army sampled the residential wells located south of Gruber's Grove Bay and potentially downgradient of the Central Plume. Dinitrotoluene (six isomers) was not detected in these residential wells, indicating there was no likely migration of the Central Plume beneath Gruber's Grove Bay. The Army will consider these recommendations and discuss them with the WDNR.	The document requires no changes.	P
6.	Detections of COCs in monitoring wells near the downgradient edges of the Deterrent Burning Ground Plume and Central Plume suggest plume expansion in those areas. An enhanced monitoring network for those areas should be developed and installed. Long term use of residential wells as the primary means of plume delineation is unacceptable.	The Army has been working with the USGS to evaluate the current groundwater monitoring network. The Army will use the USGS' recommendations to enhance the monitoring well network in the downgradient portion of the Deterrent Burning Ground and Central Plumes.	The document requires no changes. The Army will continue to review and revise the groundwater monitoring program to ensure it remains protective of human health.The Army will discuss the USGS' recommendations with the WDNR.	A
7.	Remedial Alternative 4 (injection of emulsified vegetable oil to promote anerobic biodegradation of CVOCS and DNTs) is conceptually attractive. However, the technical basis regarding injection point locations, spacing and depth are not well defined. The proposed depths of the injections were not indicated and the spacing was based upon groundwater rather than contaminant velocity. Some additional detail should be provided as the density of the injection network can have a large effect on the cost estimate.	The depths of the injection points will encompass the vertical extent of the DNT contaminant plumes. Specific details regarding the horizontal and vertical spacing of the injection points will be determined after a remedy is selected during the remedial design phase. If necessary, the Army will conduct a field-scale pilot test to evaluate the performance and capabilities of using emulsified vegetable oil to treat contaminated groundwater at BAAP.	If Alternative 4 is selected, the Army would further define specifications for implementation in the remedial design phase.	A
8.	Active remediation (as opposed to relying solely on monitored natural attenuation) may be necessary in the PBG source area and the downgradient portion of the DBG plume due to the rising contaminant concentrations.	Active remediation in the PBG source area was proposed in Alternatives 3, 4 & 6. Active remediation in the downgradient portion of the DBG Plume was proposed in Alternatives 3 & 4. The Army will select the most appropriate groundwater remedy.	No change to document.	A

Comments from WDNR

Item	Comment	Response	Action	Army Acceptance (A/NA/P/R) (1)
9.	Continued evaluation of contaminant concentrations and groundwater elevations is necessary in the PBG source area to determine whether rising DNT concentrations are the result of increased groundwater elevations or cap integrity issues.	The Army has increased testing the monitoring wells near the PBG source area (PBG Waste Pits) to better understand the increase of dinitrotoluene in the shallow groundwater. The Army plans to also increase monitoring the groundwater elevations/depth near the PBG source area. In September 2020, the Army sampled an additional 107 monitoring wells both near the PBG source area and downgradient. In conjunction with the regularly scheduled September 2020 sampling of 79 monitoring wells, the Army sampled all monitoring wells associated with the PBG Plume. The Army will continue work with the USGS to re- evaluate the groundwater monitoring program for the PBG Plume. The PBG final cover system was constructed in two phases (1998 & 2008) and consists of compacted clay, 60-mil geomembrane, drainage layer sand, geotextile filter barrier, general fill and topsoil. The final cover construction activities have received WDNR approval. Cap and cover areas are inspected annually for erosion, settlement, undesirable vegetation, and other deficiencies and maintained as necessary. Annual cap and cover maintenance reports are submitted to the WDNR and USEPA.	The Army conducted a comprehensive sampling of the PBG Plume and will continue to discuss future groundwater monitoring of the PBG Plume with the WDNR.	A

Notes:
(1) Acceptance: A – Accepted, NA - Not Applicable, P - Partially Accepted, R – Rejected

Comments from RAB

Item	Comment	Response	Action	Army Acceptance (A/NA/P/R) (1)
1.	Remedial goals and calculations of risk should fully comply with state and federal environmental regulations, standards, guidance and health advisories (Duplicated in TAPP Questions, item 6, May 7, 2020).	The Army follows the risk based CERCLA process. If there is risk, the Army will comply with state regulations that have been properly identified as ARARs. EPA has put out guidance and procedures on how federal organizations will comply with CERCLA. The Army follows the EPA guidelines. These guidelines can be found online at: *https://www.epa.gov/enforcement/comprehensive-environmental- response-compensation-and-liability-act-cercla-and-federal*	The document requires no change. The Army will follow all federal regulations and state ARARs.	A
2.	Remedial goals and calculations of risk should be the same both on-site and off-site as consistent with Wisconsin's environmental regulations, standards, guidance and health advisories (Duplicated in TAPP Questions, item 23, May 7, 2020).	Groundwater access restrictions for the BAAP property (on-site) are already in place and restricts property owners from accessing groundwater as part of the property transfer agreement. Specifically, the groundwater restrictions state, "The Grantee, its successors and assigns, shall not access or use groundwater underlying the Property for any purpose without the prior written approval of the Army and the WDNR." In off-site areas, where the Army does not have control over the use of the groundwater as a drinking water source, the Army taskes a more conservative and protective stance, a cumulative cancer risk greater than 1x10-6 is cause for potential action or additional evaluation. For areas on-site, where the Army has control over the use of groundwater as a drinking source, a cumulative cancer risk greater than 1x10-4 is cause for potential action or additional evaluation.	The document requires no change.	R
3.	The WDNR, the State legislature, the State Attorney General's Office and the Governor should assure that remedial goals and calculations of risk to public health and environmental are fully compliant with all state environmental regulations, standards, guidance and health advisories (Duplicated in TAPP Questions, item 25, May 7, 2020).	The Army follows the CERCLA process. CERCLA is a risk-based process. If there is risk, the Army will comply with state regulations that have been properly identified as ARARs. EPA has put out guidance and procedures on how federal organizations will comply with CERCLA. The Army follows the EPA guidelines.	The document requires no change. The Army has forwarded this comment to the WDNR for response	A
4.	The Wisconsin Groundwater Enforcements Standard for DNT is based on Total DNT, i.e. the summed total concentration of 6 forms of DNT. The Army's evaluation of risk should be consistent with this and other state standards (Duplicated in TAPP Questions, item 22, April 14, 2020).	The State of Wisconsin has three different NR 140 Enforcement Standards (ES) for DNT: 2,4 DNT, 2,6 DNT and Total DNT. All three have the same NR 140 ES equal to 0.05 micrograms per liter. The Army will comply to the extent those standards have been identified as ARARs.	The document requires no change. The Army will comply with all federal regulations and state ARARs.	A
5.	A final decision on the selected remedy for groundwater should be deferred until the RAB, the public, regulators and the Army have had an opportunity to review and comment the pending U.S. Geological Survey studies (Duplicated in TAPP Questions, items 1 and 2, April 14, 2020).	Concurrent with the RI/FS report preparation, yet independent of this effort, the United Stated Geological Survey (USGS) is performing a comprehensive review of the BAAP groundwater monitoring program. The intention of the review is to evaluate the existing program and determine if modifications can be made to strengthen the value of the data generated from the monitoring effort. No modifications are being proposed, at this time, to the previously approved monitoring program; however, results of the USGS evaluation may result in suggested modifications to enhance the program. The remedy will not be chosen until after the RI/FS Report is finalized, and the Proposed Plan and subject comment period is completed. After consideration of public comments, the selected remedy will be documented in a record of decision (ROD) that will be published in the Administrative Record.	The document requires no change. The Army will consider all USGS recommendations and use all available USGS reports in implementation of its groundwater monitoring program. Every alternative in the RI/FS includes continuation of a groundwater monitoring program. Any changes to the Groundwater Monitoring Plan will be reviewed by WDNR before implementation. The proposed changes will also be briefed to the RAB and available for public review once submitted to WDNR. The Army will continuously update its groundwater monitoring program as more data becomes available.	P
6.	We support the USGS recommendation for continuous real-time groundwater-level monitor to be located near the waste pits and other source areas (Duplicated in TAPP Questions, item 8, April 14, 2020).	The Army has installed real-time groundwater level monitoring equipment and continues to work with the WDNR on monitoring strategies.	The document requires no changes.	A
7.	The discussion and effectiveness of using vegetable oil (EVO) as a bioremediation tool at BAAP seems to be overstated. There appears to be an assumption that using EVO would be effective in remediating the COC's at BAAP although there is no reference to previous studies or in situ use of EVO for the BAAP COC's showing that it would be effective. It is referenced that a pilot study would be used before overall implementation. If there are studies showing the effectiveness of EVO with these COC's, it should be referenced. If not, any selection of this alternative should be supplemented with a secondary alternative in case the pilot effort does not result in effective bioremediation of the COC's. In addition, there are differences in the plumes based on chemistry and geology, thus a pilot study in the nitrocellulose production plume may indicate effective reduction, but that might not be the case in another plume such as the Central Plume. Pilot studies for EVO use should be conducted in several plume locations. Data collection is needed to determine if the right conditions are present for effective degradation (proper microbes, porosity, redox, and so forth).	Emulsified vegetable oil (EVO) is a proven technology to effectively treat chlorinated solvents and energetics. If necessary, the Army will conduct a field-scale pilot test to evaluate the performance and capabilities of using EVO to treat contaminated groundwater at BAAP. The Army has had success remediating many sites using EVO. In situ bioremediation of groundwater is a widely used technology for contaminated site treatment because of its relatively low cost, adaptability to site- specific conditions, and effectiveness. The CERCLA process will be followed throughout and it provides a mechanism for revisions to the selected remedy if not proven effective. Modifications to the remedial design based on site specific constraints as it relates to each plume will be considered to the degree necessary to increase effectiveness.	The document requires no change. IAW CERCLA and EPA guidance, the cleanup approaches are re-evaluated throughout cleanup as remedy effectiveness is evaluated and site conditions change. If appropriate, remedies may change.	A
8.	It appears that the cost estimates for annual O&M in Alternatives 2 and 5 for all of the contaminant plumes (PBB, DBG and central) may be significantly underestimated in Sections 9, 10 and 11 for the reasons below. Therefore, the cost estimates associated with Alternatives 2 and 5 should be adjusted accordingly to consider the long-term monitoring and testing costs which could be significantly higher than stated in the current document. The timeframes in the Alternatives need to reflect reality at BAAP and not simply be adjusted to what appears to be an arbitrary 30-year timeline. Otherwise, this skews the cost analysis and misrepresents the economics of final cleanup which will be a significant factor in the decision process.	For environmental cleanup decision-making, the Army must follow both CERCLA guidance and the Department of Defense (DoD) Manual 4715.2 (March 9, 2012). This relates primarily to budgeting purposes for the Army. The DoD Manual outlines the procedures the Army must follow when conducting environmental restoration under the Defense Environmental Restoration Program (DERP). DERP guidance (13.(a)(6)) states, "For long- term maintenance phases that are expected to continue indefinitely, cost-to-complete estimates should include a finite period of 30 years."	Text was added to the FS to clarify 30 years.	P

Comments from RAB

Item	Comment	Response	Action	Army Acceptance (A/NA/P/R) (1)
8. a.b.c.	In using the groundwater flow calculations contained in Section 4.4.4 of the subject document, a single flushing of distance from the source area to the release point at the Wisconsin River/Lake would be approximately 44 yrs. for the PBG, 69 yrs. for DBG and 56 yrs. for the central plume. All of the flow times significantly exceed the 30 yr timeframe assumed in the draft final RI/FS. It is well known that a single flushing of groundwater does not totally eliminate contaminants in groundwater environments due to many variables (e.g. pH, temperature, adhesion, ion state, mineralization, etc). It is assumed that the objective is to get the concentration of the COC's below the PAL or ES. However, there is no scientific basis for assuming that this would be accomplished in 30 years or within a single flushing period. It would be helpful to have a scientific estimate of the effectiveness of the flushing effect of the contaminants of concern that is specific to the known geology at BAAP.	Groundwater flow calculations will continue to be refined as necessary during the remedial design.	The document requires no change. The Army has contracted with USGS to provide accurate groundwater flow data/mapping and will use actual BAAP groundwater flow data when calculations are made in the remedial design. 30 years was used in the comparison of FS alternatives, as directed by DERP guidance.	P
9.	There is considerable apprehension on the part of homeowners who are in the path of or directly adjacent to any of the contaminant plumes (See insert B of Fig. 20). These homeowners are being affected irrespective of whether their water exceeds either the PAL or ES limits since the value and salability of their property is negatively affected. Given that the Army has backed away from its previous proposal to construct a rural water supply system, the following would be a proactive and reasonable approach that would be a positive step for the community: (Comment duplicated in comment from Chris Hanson)	The current groundwater sampling program including monitoring wells and residential wells is being conducted according to sampling plans agreed upon by the Army and WDNR. Sampling plans are routinely modified based on requests from the WDNR.	The document requires no change. The Army will continue to review and revise the groundwater monitoring program to ensure it remains protective of human health.	A
9. a.	Develop and maintain a residential well testing program for all residential wells that are directly in the path or immediately adjacent to any of the plumes.(Comment duplicated in comment from Chris Hanson)	The Army's sampling program is designed to identify and be protective of the residential wells that could be potentially impacted. A total of 54 residential wells are sampled at varying frequencies each year. The current groundwater sampling program of residential wells is being conducted according to sampling plans agreed upon by the Army and WDNR. The sampling plan is routinely modified based on requests from the WDNR.	The document requires no change. The Army has contracted with the USGS to collect additional data related to groundwater at BAAP. Where it is relevant, that data will be incorporated into the process.	A
9. b.	Expand Alternative 5 (Well Replacement) for all plumes to include well replacement for any residential well that is directly in the path of a plume, exceeds the PAL for any contaminant, and groundwater modeling shows that it has a high likelihood of being contaminated in the future. (Per conversation with Mike Kelly on 12/5/19, this approach would be within the Army's authority). (Comment duplicated in comment from Chris Hanson)	Related to Alternative 5, well replacement criteria are as follows, "If sampling results indicate an increasing trend for a plume's COC in three consecutive rounds and the data shows that the plume is migrating toward a residential well, the Army will evaluate if well replacement is necessary." Army headquarters may authorize replacement of a well in advance of contamination if data shows contamination is very likely in the future.	When contamination of a residential well is estimated to be imminent, circumstances may allow well replacement in advance. Army headquarters would review data and may authorize well replacement in advance on a case-by-case basis.	A
10.	Why has the Army not asked for authority to build the water system? It seems that a price tag almost 3 times higher for Army's preferred solution(s) would be justification enough.	A public water system does not treat the groundwater contamination. The purpose of the RI/FS is to determine remedial actions based on risk.	The document requires no change.	R
11.	Are the source-area caps intended to be permanent? Do any remediation alternatives apply directly to the contamination underneath the caps? We support the USGS recommendation for “Source Area Treatment”. However, we do not support remedial actions that will actively push more contamination to groundwater and placing nearby drinking water wells and surface water at greater risk. (in response to USGS TAPP Questions, items 12 and 14, April 14, 2020).	Yes, source area caps and/or covers are permanent. Maintenance and monitoring of the conditions of each cap and cover are conducted annually. None of the groundwater remedial actions address soil contamination under the caps. The caps were the final remedial action agreed upon with the WDNR to close the sites. This RI/FS only pertains to groundwater contamination. Active remediation in the PBG source area was proposed in Alternatives 3, 4 & 6. Active remediation in the DBG source area was proposed in Alternatives 3, 4 & 6.	The document requires no change.	A
12.	The U.S. Army Corps of Engineers conducted five-year reviews of the PBG and DBG in 2013 and 2019. According to the RI/FS, the 2019 reports were not yet available. When will the 2019 reports be available?	The status of the five-year review is pending final approval and will be available to the public thereafter.	The Army will provide the five-year review to the RAB once it has been finalized.	NA
13.	More information is needed regarding sewer lines and drainage ditches. Have all historic sewer lines been remediated? Has contaminated soil from all the open drainage ditches been disposed of?	This RI/FS only pertains to groundwater contamination. The historic sewer lines and drainage ditches throughout the former BAAP production areas have been remediated under previous actions. All contaminated soil and sewer piping related to these cleanup actions were disposed of in the on-site licensed Landfills 3118 and 3646.	The document requires no change.	R
14.	Rising groundwater is a potential threat to capped contaminant source areas in the PBG and DBG source areas. Continuous, real-time groundwater level monitoring stations at selected wells near the source areas are recommended as part of a potential treatment and monitoring plan. These stations would help monitor recharge from precipitation events, effects of pump and treat on groundwater levels, and provide early warning about rising groundwater levels that might come in contact with contaminated soils. Collection of groundwater samples downgradient of the source areas could be coordinated with rises in groundwater levels.	The design phase is when the Army will consider the use of real- time groundwater monitoring and its value to the remediation effort. Additionally, the Army has increased testing the monitoring wells near the PBG source area (PBG Waste Pits) to better understand the increase of dinitrotoluene in the shallow groundwater. The Army plans to also increase monitoring the groundwater elevations/depth near the PBG source area.	The document requires no change. During September 2020, the Army sampled an additional 107 monitoring wells both near the PBG source area and downgradient. In conjunction with the regularly scheduled September 2020 sampling of 79 monitoring wells, the Army sampled all monitoring wells associated with the PBG Plume. The Army will work with the USGS to re-evaluate the groundwater monitoring program for the PBG Plume.	A

Comments from RAB

Item	Comment	Response	Action	Army Acceptance (A/NA/P/R) (1)
15.	The U.S. Army should further pursue identification of the source of the Central Plume (Duplicated in TAPP Questions, item 13, April 14, 2020).	Based on the groundwater flow direction and the groundwater contaminant detections, the source of contaminated groundwater related to the Central Plume was believed to be in the north- central portion of BAAP where nitroglycerin, rocket paste, and rocket propellant were produced. However, several investigations/excavations to date have not determined a specific source of DNT contamination (e.g., landfill or disposal area). It is believed that the broad production area may have caused the groundwater impacts. Based on historical document reviews, the investigation of the source of DNT contamination focused on the Rocket Paste production area. The WDNR was provided with multiple reports on the investigation and remedial soil activities. The WDNR provided the Army with multiple case closure letters. The Army is not performing any additional soil investigations at BAAP.	The document requires no change.	R
16.	Could contamination have moved under or across the River? To help alleviate this concern, it is recommended that sampling under, or across the River be included as part of the monitoring program.	Regarding groundwater contamination in the PBG Plume, Woody Myers from the WDNR conducted a presentation on groundwater flow near the Wisconsin River during a RAB meeting in March 2015. Mr. Myers did not recommend sampling groundwater on the other side of the Wisconsin River. Mr. Myers referenced a preliminary groundwater model from the Wisconsin Geological and Natural History Survey (WGNHS) showing that groundwater on the east/south side of the Wisconsin River, at all depths, flows west towards the River. Regarding groundwater contamination in the Central Plume, during 2018 and 2019, the Army sampled the residential wells located south of Gruber's Grove Bay/Wisconsin River and potentially downgradient of the Central Plume. Dinitrotoluene was not detected in these residential wells, indicating there was no likely migration of the Central Plume beneath Gruber's Grove Bay. Regarding groundwater contamination in the DBG Plume, the Army has been working with the USGS to evaluate the current groundwater monitoring network.	The document requires no change. The Army will use USGS recommendations to enhance the monitoring well network in the downgradient portion of the DBG Plume and evaluate if contamination has migrated into the Weigand's Bay/Wisconsin River. The Army has continued to work with the USGS regarding sampling groundwater on the eastern side of the Wisconsin River. The Army will conduct this effort in calendar year 2021.	R
17.	The U.S. Army should regularly test all drinking water wells located within or very near known groundwater contaminant plumes, including but not limited to the Ron Lins home.	The Army's sampling program is designed to identify and be protective of the residential wells that could be potentially impacted. A total of 54 residential wells are sampled at varying frequencies each year. The current groundwater sampling program of residential wells is being conducted according to sampling plans agreed upon by the Army and WDNR. The sampling plan is routinely modified based on requests from the WDNR.	The document requires no change. The Army has contracted with the USGS to collect additional data related to groundwater at BAAP. Where it is relevant, that data will be incorporated into the process.	P
18.	Soil samples collected in 2019 from the settling ponds and spoil disposal areas in the vicinity of the deterrent burning ground area show a relatively high concentration of total mercury. This is an area that contributed runoff to Grubers Grove Bay, which also contains high concentrations of mercury in bed sediment. It is recommended that groundwater sampling be performed for mercury in nearby monitor and residential wells.	The purpose of the RI/FS is to address contaminants of concern in groundwater as they pertain to risk to human health. The USGS study for mercury was based on sediment cleanup standards and conducted to help refine the source of mercury in Gruber's Grove Bay. There is no evidence that mercury in the soil at the Settling Ponds has migrated into the groundwater. The Army has no plans to sample the groundwater for mercury at BAAP.	The document requires no change.	R

Notes:
(1) Acceptance: A – Accepted, NA - Not Applicable, P - Partially Accepted, R – Rejected

Comments from CSWAB

Item	Comment	Response	Action	Army Acceptance (A/NA/P/R) (1)
1.	**Private Well Testing at and near the Propellant Burning Ground Plume** The groundwater pump-and-treat system at the southern boundary of Badger was installed and operated to prevent the migration of contaminants beyond the property boundary. Now that the system has been shut down, this protective barrier is gone and contaminant movement is no longer inhibited. Further, we disagree with the Army's reliance on sampling conducted prior the cessation of active groundwater remediation, particularly in light of the significant increases in groundwater contaminant levels at the Propellant Burning Grounds and exceedances at the southern plant boundary including ethyl ether. We ask that the Army be required to regularly test down-gradient drinking water wells located in or near estimated plume margins which – despite the tidy maps in the RI/FS – are not static.	The current groundwater sampling program including monitoring wells and residential wells is being conducted according to sampling plans agreed upon by the Army and WDNR. Sampling plans are routinely modified based on requests from the WDNR.	The document requires no changes. The Army will continue to review and revise the groundwater monitoring program to ensure it remains protective of human health.	P
2.	**PFAS Investigations & Testing** The Army has indicated that the pending Preliminary Assessment/Site Investigation (PA/SI) for PFAS at Badger may be limited to only PFOA and PFOS. a) We strongly support the Wisconsin Department of Natural Resources (WDNR) request that the PA/SI evaluate all 36 PFAS compounds for which the Department has requested drinking water standards. We recognize that the 2018 sampling effort by the Army did not include all of these but did include 18 compounds. b) We also ask that the RI/FS not be finalized until the PA/SI has been submitted to and formally reviewed by the WDNR for completeness and consistency with non-military site investigations in Wisconsin. c) In September 2018, area residents collectively asked that the U.S. Army prioritize public and private well testing in its planned investigation for PFAS – a group of highly toxic compounds that has not been included in any of the Army's previous environmental studies. More than 100 people, including members of the community's Restoration Advisory Board, signed a resolution asking that the Army test all public drinking water systems within a four-mile radius of Badger for PFAS. The resolution also asked that the Army include PFAS analysis in its upcoming testing of approximately 300 residential wells near the former military base. This testing should be completed before any remedy selection begins. d) In addition to firefighting foam, PFAS have been found in solid waste, landfills and surrounding environmental media (soil, groundwater), leachates, landfill gas, wastewater effluents, and biosolids. A scientific study of U.S. municipal landfill leachate detected PFAS in over 50% of the landfills tested. As the majority of land disposal sites at Badger are unlined and without leachate collection systems, any PFAS present will inevitably migrate off-site with the potential to contaminate groundwater. PFAS are highly soluble and do not degrade in the environment. The RI/FS for groundwater should be amended to include PFAS testing at all 10 landfills and other pertinent land disposal sites at Badger.	2a) There are currently no methods available to test for all 36 compounds, as far as we are aware. There is currently only enough data to determine risk for three (PFOS, PFOA, PFBS). 2b) The PA/SI is a separate document to determine if further action is necessary to address potential risks related to PFAS. The Amy will address all risks related to previous activities at BAAP. 2c) Based on information collected in the PFAS PA/SI, the Army does not see itself as a source of PFAS contamination. The Army is unable to legally test private wells for contaminants not related to its activities. Because PFAS compounds are so prevalent in nature, it would not be reasonable to test private wells and directly attribute PFAS contamination to government activities at BAAP. 2d) Based on information collected in the PFAS PA/SI, the Army does not have a record of PFAS containing materials being placed in any of the BAAP landfills. This includes soils, packaging and processing materials which would have been used during operation of the installation. Therefore there would be no reason to assume these materials would have made their way into the landfills or wastewater effluents.	The document requires no changes. The PA/SI is a separate document.	NA
3.	**Aesthetic water quality** The Army has and proposes to replace impacted residential well replacement with deeper wells which invariably have very poor aesthetic quality. Water from these wells is often heavy in iron concentrations requiring household treatment for the life of the well, long after active remediation is complete. The RI/FS should indicate how residents will be compensated in this regard.	The Army will work with homeowners to replace any impacted residential well. If water quality requires a household treatment system, the Army will provide one, but the Army can not compensate residents for long-term operation of their well system under the Defense Environmental Restoration Program.	The document requires no change.	R
4. a.	**Contaminants of Concern** The Wisconsin River acts as a discharge point for groundwater east and south of Badger. Based on historical groundwater sampling data, groundwater is contaminated by chlorinated solvents and explosives from the Propellant Burning Grounds. The RI/FS states: "While other contaminants of concern were detected, it is unlikely these contaminants are site related." The RI/FS should be amended to list ALL detected contaminants of concern in groundwater at Badger and the range of concentrations (minimum and maximum) for each. This request includes (but is not limited to) vanadium, tetrahydrofuran, nitrates, pesticides/herbicides, PFAS, PCBs, dioxins and asbestos.	The RI/FS does contain tables listing all the detected contaminants of concern in groundwater during 2018. All groundwater data collected from Badger is provided to the WDNR and available at the WDNR's GEMS website: *https://dnr.wi.gov/wastemgmt/gotw/webpages/UserAgreement.aspx.* The Army does sample monitoring wells for tetrahydrofuran when volatile organic compounds (VOCs) are analyzed and nitrates on select wells in the PBG Plume. Based on the currently WDNR approved groundwater monitoring sampling plan, the Army does not sample groundwater for vanadium, pesticides/herbicides, PFAS, PCBs, dioxins or asbestos. These compounds have not been identified as contaminants of concern due to Army legacy operations.	The Executive Summary in the RI/FS report has been revised to provide clarity regarding contaminants of concern.	P
4. b.	EPA estimates that 90% of 1,4-dioxane produced was for use as a stabilizer for chlorinated solvents including 1,1,1-TCA and carbon tetrachloride. The RI/FS should address the potential for solvent stabilizers to be present at Badger.	During April 2017, the Army sampled three monitoring wells for 1,4- dioxane. A well was sampled downgradient from the DBG (ELM-8901), Landfill #5 (ELN-8203A) and the PBG (PBN-8205A). 1,4-Dioxane has not been detected above 0.24 micrograms per liter (µg/l). Because the concentrations of chlorinated stabilizers is low at BAAP, the potential for solvent stabilizers is also low. The Army will continue to sample monitoring wells for both 1,1,1-TCA and carbon tetrachloride when volatile organic compounds (VOCs) are analyzed. Monitoring wells downgradient of the DBG, Landfill #5, and the PBG are analyzed for VOCs.	The document requires no change.	P

Comments from CSWAB

Item	Comment	Response	Action	Army Acceptance (A/NA/P/R) (1)
5.	**DNT – A Mixture of 6 Isomers** According to the RI/FS (page 5), remedy Alternative 3 (Pump and Treat), Alternative 4 (Anaerobic Bioremediation) and Alternative 6 (Source Area Treatment) for the Propellant Burning Ground groundwater contaminant plume will target elevated levels of only one form of DNT (2,6-DNT). However, all six forms of DNT (2,4-, 2,6-, 2,3-, 2,5-, 3,4- and 3,5-DNT) have been detected in groundwater at Badger. Similarly, the calculation of cumulative cancer and non-cancer risk is limited to only 2,6-DNT at the Propellant Burning Ground (off-site and on-site) and the Central Plume (off-site) – which are both impacting neighboring residential areas. This is a signification omission as degradation of identified contaminants of concern is a significant consideration in the majority of proposed alternative remedies and the minor forms of DNT do NOT biologically or chemically degrade. In fact, the Army evaluated the groundwater capture of the MIRM (groundwater pump-and-treat system) by tracking 2,3-DNT because it was "more persistent and could be used as an indicator within the entire PBG plume whereas the 2,4- and 2,6- were only being detected in the source area." Moreover, consideration of all six isomers is necessary to be consistent with Wisconsin's Groundwater Enforcement Standard of 0.05 ug/l for the summed total concentration of all six DNT isomers. Therefore we ask that all six isomers of DNT are included as Contaminants of Concern in groundwater both inside and outside the facility.	The risk-based COCs identified in the **PBG Plume** were chloroform, CTET, ethyl ether, TCE, and 2,6-DNT. The Screening Level Groundwater Risk Evaluation (Appendix G) identified that both 2,6-DNT and total DNT had an on-site cancer risk and noncancer risk above the risk management criteria; with 2,6-DNT having higher risk values. The Army reports only 2,6-DNT in the RI/FS as it is the most conservative and cleanup of 2,6-DNT will also affect total DNT levels. The risk-based COCs identified in the **Central Plume** were benzene, chloroform, 1,2-dichloroethane, and 2,6-DNT. The Screening Level Groundwater Risk Evaluation (Appendix G) identified that only 2,6-DNT had an off-site cancer risk above the risk management criteria. Total DNT had an off-site cancer risk that was below the risk management criteria. The risk-based COCs identified in the DBG Plume were chloroform, 1,1,2-TCA, TCE, and total DNT. Total DNT was identified as having an off-site cancer risk above the risk management criteria. The HHRA did not identify any human health risk related COCs for the **NC Area Plume**. The Army's groundwater remediation efforts at BAAP will be inclusive of all six DNT isomers (total DNT). The Army does follow Wisconsin's NR 140 Groundwater Enforcement Standard of 0.05 ug/l for total DNT as it relates to monitoring the groundwater plumes.	The relevant portions of the RI/FS report were updated to reflect the following statement: The Army's groundwater remediation efforts at BAAP will be inclusive of all six DNT isomers (total DNT).	A
6.	**Total Mass of DNT in Source Areas** The Army's calculation of the remaining total mass of residual DNT contamination in the plume source areas is based on soil data for only two of the six isomers present at Badger. As a result, the remaining mass of total DNT is significantly underestimated. Moreover, actual field data is necessary to accurately quantify and substantiate the estimated risk to human health and the environment. The WDNR previously ordered and then deferred soil testing for all forms of DNT pending action by EPA nearly 10 years ago and is no longer relevant. WDNR should now reinstate its order to the Army to test (fully characterize) contaminated soils in plume source areas for all six forms of DNT.	The Army's calculation of the remaining total mass of DNT is based on the best available information to date. Depending upon the chosen remediation alternative, additional DNT mass calculations may be necessary in the remedial design phase.	The document requires no changes. The Army will address total mass of DNT as necessary in the remedial design phase.	P
7.	**Vapor Intrusion** The Army's evaluation of vapor intrusion as a potential route of exposure should be amended to include degradation products of DNTs. Scientific studies indicate that o-nitrotoluene (2-nitrotoluene; CAS 88722), for example, is sufficiently toxic and volatile to be considered a vapor intrusion threat.	EPA's Office of Solid Waste and Emergency Response (OSWER) Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air [OSWER Publication 9200.2-154, June 2015], specifies the following regarding a chemical's volatility. A chemical generally is "volatile" if: 1) Vapor pressure is greater than 1 millimeter of mercury (mm Hg) or 2) Henry's law constant (ratio of a chemical's vapor pressure in air to its solubility in water) is greater than 10-5 atmosphere-meter cubed per mole (atm m3 mol-1). The Army evaluated the vapor pressure and Henry's law constant for 15 possible degradation products of DNT. All 15 compounds have a vapor pressure below 1 mm Hg. Only 2- nitrotoluene had a Henry's law constant above 10-5 atm m3 mol-1; it was 1.25 10-5 atm m3 mol-1. If the Henry's law constant is above 10-5 atm m3 mol-1 then that compound could volatilize from water into soil and pose a potential vapor intrusion risk. The Army did conduct DNT degradation groundwater sampling, including 2-nitrotoluene, near the PBG waste pits from 2008 to 2014. 2-Nitrotoluene concentrations were not sufficient to pose a vapor intrusion threat.	The document requires no changes.	R
8.	**Surface water, natural springs and wetlands** The Clean Water Act, 33 U.S.C. ss 1251 et seq., was enacted by Congress to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." Id. ss 1251(a). Wisconsin has an EPA-approved NPDES permitting program, and the WDNR is the agency that issues NPDES permits to point-source dischargers within the State. For this reason, Wisconsin issued WPDES permits containing effluent limitations for the discharge of treated groundwater from the IRM/MIRM to Lake Wisconsin. In comments on the previous RI/FS for groundwater, the WDNR noted that one possible concern about contaminated groundwater seeping into Lake Wisconsin/Wisconsin River might be for carbon tetrachloride, particularly at the groundwater/surface water interface. Enforceable limitations will also help assure that the discharge of contaminated groundwater to spring-fed wetlands at Weigand's Bay does not negatively impact this aquatic ecosystem and fisheries. The same recommendation applies to groundwater discharge to the Lower Wisconsin Riverway through "seeps" in the river bank. Given the State has not enforcement groundwater standards outside the Badger property literally for decades, the public cannot rely on this mechanism alone to protect aquatic ecosystems. Therefore, we ask that the State apply the SAME effluent limitations required for the IRM/MIRM discharge to the discharge of contaminated groundwater to all surface water, natural springs and wetlands near Badger.	The Army under the CERCLA process is not required to obtain state permits, including NPDES. However, we will comply with those properly identified substantial provisions as ARARs.	Since this comment requests action by the state, it has been forwarded to the WDNR.	NA

Comments from CSWAB				
Item	**Comment**	**Response**	**Action**	**Army Acceptance (A/NA/P/R) (1)**
9.	**Soils as a Source of Groundwater Contamination** The presented alternative remedies are limited to groundwater primarily because the Army maintains that contaminated soils in source areas have been addressed "to the maximum extent possible" and that the WDNR has issued site closure for soil cleanup. However, these regulatory approvals are contingent on the ability of the remedy to protect human health and the environment by achieving compliance with state and federal standards and all specific conditions outlined in closure documents. Therefore, we ask that the WDNR formally review current site conditions and make a determination as to whether or not compliance with source area closure conditions (for soil) at Badger are currently and fully achieved. If not compliant, we ask that the WDNR require the Army to complete an RI/FS (or equivalent) examining technologies and methods that could improve the control of source areas.	All soil source areas were closed in accordance with Wisconsin law and have appropriate closure documents. This RI/FS only pertains to groundwater contamination.	Since this comment requests action by the state, it has been forwarded to the WDNR.	R

Notes:
(1) Acceptance: A – Accepted, NA - Not Applicable, P - Partially Accepted, R – Rejected