APPENDIX E

DATA USABILITY ASSESSMENT

Data Usability Assessment: Spectra Energy Partners, Atlantic Bridge, Weymouth Compressor Station, Weymouth, MA	
1: Discuss appropriateness of selected analytical methods to quantitatively support disposal site's *Permanent Solution* Statement. Discuss any impacts to the data used to support the *Permanent Solution* Statement if generated with non-CAM methods. Justify that the data used to support the *Permanent Solution* Statement is adequate in spite of the use of non-CAM methods.	**Appropriateness of Analytical Methods Used** • The following methods were utilized to respond to all contaminants of concern. *Soil: VPH, EPH, PAHs, herbicides, total metals, synthetic precipitation leaching procedure (SPLP) metals, specific conductance, pH *Groundwater: VPH, EPH, total and dissolved metals • Tables DUA-1 and DUA-2 summarize all samples used for the *Permanent Solution* Statement and included in this data usability assessment. • All groundwater sample analyses were performed using the CAM. Select soil sample analyses for VPH, EPH, PAHs, metals, and herbicides were performed using the CAM. Select soil sample analyses were performed using non-CAM methods: pH, specific conductance, and SPLP metals. See Table DUA-1 for the affected samples.
2: Discuss appropriateness of selected analytical methods' Reporting Limits (RL) to quantitatively support the disposal site's *Permanent Solution* Statement.	• Analytical reporting limits, as documented by the laboratory, meet or exceed sensitivity requirements required to assess level of risk and cleanup standards for contaminants of concern previously identified for this response action for all soil samples with the following exceptions. Exception #1: The nondetect results for benzo(a)pyrene and dibenz(a,h)anthracene in samples B105 (14-17'), B-410 (12.5'), and B-415 (11.8'), and acenaphthylene, benzo(a)pyrene, and dibenz(a,h)anthracene in samples B-413 (11') and B-415 (12.2') exhibited reporting limits which were above the MCP S-2/GW-3 standard. Justification for Exception #1: There was no adverse effect to the outcome or conclusion of the *Permanent Solution* Statement due to these sensitivity issues since one or more of the EPH hydrocarbon ranges were above the MCP S-2/GW-3 standard in these samples. In addition, these PAHs are not associated with No. 2 fuel oil releases. • Analytical reporting limits, as documented by the laboratory, meet or exceed sensitivity requirements required to assess level of risk and cleanup standards for contaminants of concern previously identified for this response action for all groundwater samples.
3: Discuss laboratory performance criteria and data quality indicators utilized to assess overall Analytical Accuracy (continuing calibration, laboratory control spikes, etc.) and Analytical Precision (laboratory duplicates, laboratory control spike duplicates, etc.) CAM Data: Review Certification Form and discuss data quality issues noted in narrative. Non-CAM Data: Discuss data quality indicators used to assess data and any data quality issues noted.	( ) *Meets all CAM requirements and performance standards without qualification.* (√) *Does not meet all CAM requirements and performance standards without qualification. If NO, discuss data usability implications* There were no significant issues associated with the groundwater data. Potentially significant issues associated with the soil data are summarized below. Issue #1: Potential uncertainty exists for the C9-C18 aliphatics result in soil sample B-410 (12.5') due to LCS/LCS Duplicate variability. The result for C9-C18 aliphatics in sample B-410 (12.5') is slightly above the MCP S-2/GW-3 standard. The decision-making process may be affected by the variability as the actual result may be lower and below the MCP S-2/GW-3 standard. Justification for Issue #1: Although this result is uncertain, several other sample results exist for C9-C18 aliphatics to adequately quantify the EPC in soil in the risk assessment process. Therefore, the potential uncertainty for C9-C18 aliphatics in this one sample did not significantly affect the outcome or conclusions of this *Permanent Solution* Statement. Data usability was not adversely affected by the remaining data issues listed below as these issues would not cause a significant bias to the reported values whereby the exceedance of a project action level (i.e., Method 1 standard) would change or the presence or absence of a contaminant would change. **Accuracy:** *High Biases (Soil):* • High VPH surrogate recovery affecting C5-C8 and C9-C12 aliphatics: B-317 (13.0) • High recovery of mercury in LCS: TP-1 (5-7') and its field duplicate, TP-1 (7-9'), TP-2 (5-7'), TP-2 (7-9'), TP-3 (5-7'), TP-3 (7-9') • High recoveries of MCPP in LCS and LCS Duplicate: COMP-123 (0-1'), COMP-467 (0-1'), COMP-8910 (0-1') *Low Biases (Soil):* • Low recovery of lead in LCS: COMP-123 (0-1'), COMP-467 (0-1'), COMP-8910 (0-1')

	Low Biases (Groundwater): • Low recovery of C9-C18 aliphatics in LCS Duplicate: MW-201 and field duplicate (November 2016) • Low recovery of naphthalene (EPH) in LCS Duplicate: MW-201 (January 2017), MW-406 and field duplicate (January 2017), MW-407 (January 2017), MW-410 (January 2017), MW-414 (January 2017), MW-402 (January 2017), MW-404 (January 2017), MW-408 (January 2017), MW-412 and field duplicate (January 2017), MW-413 (January 2017), MW-415 (January 2017) **Precision:** *Soil:* • High variability of C9-C18 aliphatics in LCS/LCS Duplicate: B105 (14-17') • High variability of C9-C18 aliphatics, naphthalene (EPH), and dibenz(a,h)anthracene in LCS/LCS Duplicate: B-408 (11'), B-408 (15'), B-409 (11.5'), B-410 (11'), B-410 (14'), B-411 (11.5'), B-411 (16'), B-412 (19'), B-413 (11'), B-413 (23'), B-414 (11'), B-414 (15.5'), B-417 (11') • High variability of naphthalene (EPH) and dibenz(a,h)anthracene in LCS/LCS Duplicate: B-410 (12.5') • High variability of phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, and benzo(ghi)perylene in LCS/LCS Duplicate: B-416 (11'), B-416 (15'), B-417 (15') • High variability of C19-C36 aliphatics in LCS/LCS Duplicate: B-403 (12'), B-404 (11.4'), B-404 (16.5'), B-405 (11.5'), B-406 (21'), field duplicate of B-415 (13.4') • High variability of dinoseb in LCS/LCS Duplicate: B-1 (0-1'), B-2 (0-1'), B-3 (0-1'), B-4 (0-1'), B-5 (0-1'), B-6 (0-1'), B-7 (0-1'), B-8 (0-1'), B-9 (0-1'), B-10 (0-1') • High variability of zinc in laboratory duplicate: B-1 (0-1'), B-2 (0-1'), B-3 (0-1'), B-4 (0-1'), B-5 (0-1'), B-6 (0-1'), B-7 (0-1'), B-8 (0-1'), B-9 (0-1'), B-10 (0-1'), COMP-123 (0-1'), COMP-467 (0-1'), COMP-8910 (0-1'), COMP-123-Fill, COMP-123-Native, COMP-467-Fill, COMP-467-Native, COMP-8910-Native, COMP-910-Fill • ph 24 hour hold time exceeded: TP-2 (5-7'), TP-2 (7-9'), TP-3 (5-7'), TP-3 (7-9'), TP-1 (5-7') field duplicate *Groundwater:* • High variability of C9-C18 aliphatics, C11-C22 aromatics, naphthalene (EPH), 2-methylnaphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenz(a,h)anthracene, and benzo(ghi)perylene in LCS/LCS Duplicate: MW-201 and field duplicate (November 2016) • High variability of dibenz(a,h)anthracene in LCS/LCS Duplicate: MW-202 (November 2016), MW-203 (November 2016), MW-204 (November 2016), MW-205 (November 2016), MW-206 (November 2016) • High variability of C19-C36 aliphatics in LCS/LCS Duplicate: MW-201 and field duplicate (August 2016), MW-202 (August 2016), MW-203 (August 2016), MW-204 (August 2016), MW-205 (August 2016) • High variability of C11-C22 aromatics, naphthalene (EPH), 2-methylnaphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenz(a,h)anthracene, and benzo(ghi)perylene in LCS/LCS Duplicate: MW-201 (January 2017), MW-406 and field duplicate (January 2017), MW-407 (January 2017), MW-410 (January 2017), MW-414 (January 2017), , MW-402 (January 2017), MW-404 (January 2017), MW-408 (January 2017), MW-412 and field duplicate (January 2017), MW-413 (January 2017), MW-415 (January 2017) • High variability of naphthalene (EPH), 2-methylnaphthalene, acenaphthylene, acenaphthene, anthracene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenz(a,h)anthracene, and benzo(ghi)perylene in LCS/LCS Duplicate: MW-206 (March 2017), MW-403 (March 2017), MW-409 (March 2017), MW-411 (March 2017), MW-412 (March 2017), MW-413 (March 2017) • High variability of C19-C36 aliphatics in LCS/LCS Duplicate: MW-201 (June 2017), MW-406 and field duplicate (June 2017), MW-407 (June 2017), MW-410 (June 2017), MW-411 (June 2017), MW-414 (June 2017), MW-416 (June 2017), MW-417 (June 2017)
4: Discuss laboratory performance criteria and data quality indicators utilized to assess overall Field Data Usability (sample preservation compliance, sample subsampling/compositing, field QC samples, etc.)	**Sample Preservation:** Sample preservation procedures were performed as per required methods for all rounds of soil and groundwater sampling. **Field QC:** <u>Accuracy:</u> soil and groundwater data assessed using trip blanks for VPH analyses and cooler temperatures for all coolers; soil data also assessed using MS/MSD and/or MS/duplicate analyses.

	Precision: groundwater data assessed using field duplicates; soil data assessed using field duplicates, MS/MSD and/or MS/duplicate analyses. • Soil Field Duplicates: B/MW 201 (10-12') (EPH, total metals); B-415 (13.4') (EPH), TP-1 (5-7') (PAHs, metals, pH) • Groundwater Field Duplicates: MW-201 (August 2016) (VPH, EPH, total and dissolved metals); MW-201 (November 2016) (VPH, EPH); MW-205 (June 2017) (VPH, EPH); MW-406 (January 2017) (VPH, EPH); MW-406 (March 2017) (VPH, EPH); MW-406 (June 2017) (VPH, EPH); MW-412 (January 2017) (VPH, EPH); MW-417 (March 2017) (VPH, EPH) • Soil MS/MSDs or MS/Duplicates: COMP-123 (0-1') (herbicides); B-2 (0-1') (herbicides, metals); B/MW 202 (5-7') (SPLP mercury); field duplicate of B/MW 201 (10-12') (SPLP metals) Potentially significant issues associated with the soil data are summarized below. Issue #1: Potential uncertainty exists for C9-C18 aliphatics, C19-C36 aliphatics, and C11-C22 aromatics in sample B-415 (13.4') due to field duplicate variability. In this case, results for C9-C18 aliphatics, C19-C36 aliphatics, and C11-C22 aromatics were significantly higher in the original sample. The results for C9-C18 aliphatics, C19-C36 aliphatics, and C11-C22 aromatics in the original sample should be used for decision-making purposes as these results are significantly higher. Justification for Issue #1: Since the higher results were used for decision-making purposes at this location including the calculation of the EPC in the risk characterization, this issue has no adverse effect on the outcome or conclusions of this *Permanent Solution* Statement. Potentially significant issues associated with the groundwater data are summarized below. Issue #1: Potential uncertainty exists for dissolved zinc in groundwater sample MW-201 (August 2016) due to field duplicate variability (>130% RPD). In this case, the result for dissolved zinc was significantly higher in the field duplicate sample. The result for dissolved zinc in the field duplicate sample should be used for decision-making purposes as the result was significantly higher. Justification for Issue #1: Since the higher result was used for decision-making purposes at this location, this issue has no adverse effect on the outcome or conclusions of this *Permanent Solution* Statement. Data usability was not adversely affected by the remaining data issues listed below as these issues would not cause a significant bias to the reported values whereby the exceedance of a project action level (i.e., Method 1 standard) would change or the presence or absence of a contaminant would change. ***Accuracy of Field QC:*** *High Biases (Soil):* • High recoveries of MCPP in MS and MSD: COMP-123 (0-1") *Low Biases (Soil):* • Low recovery of antimony in MS: B-1 (0-1'), B-2 (0-1'), B-3 (0-1'), B-4 (0-1'), B-5 (0-1'), B-6 (0-1'), B-7 (0-1'), B-8 (0-1'), B-9 (0-1'), B-10 (0-1'), COMP-123 (0-1'), COMP-467 (0-1'), COMP-8910 (0-1'), COMP-123-Fill, COMP-123-Native, COMP-467-Fill, COMP-467-Native, COMP-8910-Native, COMP-910-Fill ***Precision of Field QC (Field duplicate criteria: RPD ≤30 for aqueous, ≤50 for solids):*** *Soil:* • Field duplicate variability for phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, and benzo(b)fluoranthene: TP-1 (5-7') • Field duplicate variability for total zinc, barium, and chromium: B/MW 201 (10-12') *Groundwater:* • Field duplicate variability for total zinc: MW-201 (August 2016) *Potential uncertainty:* • Dissolved results higher than total results; high percent difference (>20%) between total and dissolved zinc: MW-203 (August 2016), MW-204 (August 2016), MW-205 (August 2016)
5: Analytical Completeness of Data Used to Support the *Permanent Solution* Statement : Discuss any	• 100% analytical completeness achieved for all site data. • No gross failures of quality control in the analytical procedures.

data rejected pursuant to Appendix II, Rejection Criteria – Analytical Data Usability Assessments	

Table DUA-1
Summary of Soil Samples and Parameters Included in *Permanent Solution* Statement and Data Usability Assessment
Spectra Energy Partners, Atlantic Bridge, Weymouth Compressor Station, Weymouth, MA

Sample Location	VPH	EPH	Herbicides	Total MCP 14 Metals	SPLP MCP 14 Metals	pH	Specific conductance
June 2015							
B-1 (0-1’)			X	X			
B-2 (0-1’)			X	X			
B-3 (0-1’)			X	X			
B-4 (0-1’)			X	X			
B-5 (0-1’)			X	X			
B-6 (0-1’)			X	X			
B-7 (0-1’)			X	X			
B-8 (0-1’)			X	X			
B-9 (0-1’)			X	X			
B-10 (0-1’)			X	X			
COMP-123 (0-1’)			X	X			
COMP-467 (0-1’)			X	X			
COMP-8910 (0-1’)			X	X			
COMP-123-Fill		X		X			
COMP-123-Native				X			X
COMP-467-Fill		X		X			
COMP-467-Native				X			X
COMP-8910-Native				X			X
COMP-910-Fill		X		X			
December 2015							
TP-1 (5-7’)		X[1]		X		X	
TP-1 (7-9’)		X[1]		X		X	
TP-2 (5-7’)		X[1]		X		X	
TP-2 (7-9’)		X[1]		X		X	
TP-3 (5-7’)				X		X	
TP-3 (7-9’)		X[1]		X		X	
April 2016							
B105 (14-17’)	X	X					
May 2016							
B/MW 201 (6-8’)		X		X			
B/MW 201 (10-12’)		X		X	X[2]		
B/MW 202 (5-7’)		X		X	X		

Table DUA-1 Summary of Soil Samples and Parameters Included in *Permanent Solution* Statement and Data Usability Assessment Spectra Energy Partners, Atlantic Bridge, Weymouth Compressor Station, Weymouth, MA							
Sample Location	**VPH**	**EPH**	**Herbicides**	**Total MCP 14 Metals**	**SPLP MCP 14 Metals**	**pH**	**Specific conductance**
B/MW 202 (9-11')		X		X	X		
B/MW 203 (5-7')		X		X	X		
B/MW 203 (9-11')		X		X	X		
B/MW 204 (6-8')		X		X			
B/MW 204 (8-10')		X		X			
B/MW 205 (6-8')		X		X			
B/MW 205 (10-12')		X		X			
October 2016							
B-308 (12.0')	X	X					
B-310 (12.5')	X	X					
B-314 (12.5')	X	X					
B-315 (12.5')	X	X					
B-317 (11.5')	X	X					
B-317 (13.0')	X	X					
December 2016							
B-400 (11.4')		X					
B-400 (12.4')		X					
B-401 (11.5')		X					
B-401 (12.2')		X					
B-402 (11.6')		X					
B-402 (12.2')		X					
B-402 (12.8')		X					
B-403 (10')		X					
B-403 (12')		X					
B-404 (11.4')		X					
B-404 (16.5')		X					
B-405 (11.5')		X					
B-405 (12.5')		X					
B-406 (21')		X					
B-407 (12.8')		X					
B-407 (17.5')		X					
B-408 (11')		X					
B-408 (15')		X					
B-409 (10')		X					

Table DUA-1
Summary of Soil Samples and Parameters Included in *Permanent Solution* Statement and Data Usability Assessment
Spectra Energy Partners, Atlantic Bridge, Weymouth Compressor Station, Weymouth, MA

Sample Location	VPH	EPH	Herbicides	Total MCP 14 Metals	SPLP MCP 14 Metals	pH	Specific conductance
B-409 (11.5’)		X					
B-410 (11’)		X					
B-410 (12.5’)		X					
B-410 (14’)		X					
B-411 (11.5’)		X					
B-411 (16’)		X					
B-412 (19’)		X					
B-413 (11’)		X					
B-413 (23’)		X					
B-414 (11’)		X					
B-414 (15.5’)		X					
B-415 (11.8’)		X					
B-415 (12.2’)		X					
B-415 (13.4’)		X					
B-416 (11’)		X					
B-416 (15’)		X					
B-417 (11’)		X					
B-417 (15’)		X					

[1] Analyzed for polynuclear aromatic hydrocarbons (PAHs) only.

[2] Only the field duplicate sample of this location was analyzed for SPLP metals.

Table DUA-2
Summary of Groundwater Samples and Parameters Included in *Permanent Solution* Statement and Data Usability Assessment
Spectra Energy Partners, Atlantic Bridge, Weymouth Compressor Station, Weymouth, MA

Sample Location	**VPH**	**EPH**	**Total and Dissolved MCP 14 Metals**
MW-201			
August 2016	X	X	X
November 2016	X	X	
January 2017	X	X	
March 2017	X	X	
June 2017	X	X	
MW-202			
August 2016	X	X	X
November 2016	X	X	
January 2017	X	X	
March 2017	X	X	
June 2017	X	X	
MW-203			
August 2016	X	X	X
November 2016	X	X	
January 2017	X	X	
March 2017	X	X	
June 2017	X	X	
MW-204			
August 2016	X	X	X
November 2016	X	X	
January 2017	X	X	
March 2017	X	X	
June 2017	X	X	
MW-205			
August 2016	X	X	X
November 2016	X	X	
January 2017	X	X	
March 2017	X	X	
June 2017	X	X	

Table DUA-2
Summary of Groundwater Samples and Parameters Included in *Permanent Solution* Statement and Data Usability Assessment
Atlantic Bridge, Weymouth Compressor Station, Weymouth, MA

Sample Location	VPH	EPH	Total and Dissolved MCP 14 Metals
MW-206			
November 2016	X	X	
January 2017	X	X	
March 2017	X	X	
June 2017	X	X	
MW-400			
January 2017	X	X	
March 2017	X	X	
June 2017	X	X	
MW-401			
January 2017	X	X	
March 2017	X	X	
June 2017	X	X	
MW-402			
January 2017	X	X	
March 2017	X	X	
June 2017	X	X	
MW-403			
January 2017	X	X	
March 2017	X	X	
June 2017	X	X	
MW-404			
January 2017	X	X	
March 2017	X	X	
June 2017	X	X	
MW-405			
January 2017	X	X	
March 2017	X	X	
June 2017	X	X	
MW-406			
January 2017	X	X	
March 2017	X	X	
June 2017	X	X	

Table DUA-2 Summary of Groundwater Samples and Parameters Included in *Permanent Solution* Statement and Data Usability Assessment Atlantic Bridge, Weymouth Compressor Station, Weymouth, MA			
Sample Location	**VPH**	**EPH**	**Total and Dissolved MCP 14 Metals**
MW-407			
January 2017	X	X	
March 2017	X	X	
June 2017	X	X	
MW-408			
January 2017	X	X	
March 2017	X	X	
June 2017	X	X	
MW-409			
January 2017	X	X	
March 2017	X	X	
June 2017	X	X	
MW-410			
January 2017	X	X	
March 2017	X	X	
June 2017	X	X	
MW-411			
January 2017	X	X	
March 2017	X	X	
June 2017	X	X	
MW-412			
January 2017	X	X	
March 2017	X	X	
June 2017	X	X	
MW-413			
January 2017	X	X	
March 2017	X	X	
June 2017	X	X	
MW-414			
January 2017	X	X	
March 2017	X	X	
June 2017	X	X	

Table DUA-2 **Summary of Groundwater Samples and Parameters Included in *Permanent Solution* Statement and Data Usability Assessment** **Atlantic Bridge, Weymouth Compressor Station, Weymouth, MA**			
Sample Location	**VPH**	**EPH**	**Total and Dissolved MCP 14 Metals**
MW-415			
January 2017	X	X	
March 2017	X	X	
June 2017	X	X	
MW-416			
January 2017	X	X	
March 2017	X	X	
June 2017	X	X	
MW-417			
January 2017	X	X	
March 2017	X	X	
June 2017	X	X	

APPENDIX F

RISK CHARACTERIZATION SUPPORTING DOCUMENTATION

APPENDIX F

RISK CHARACTERIZATION SUPPORTING DOCUMENTATION

APPENDIX F-1

SOIL AND GROUNDWATER SAMPLING DATA

Table 1. Summary of Analytical Results for Soil Samples
Spectra - 6 Bridge Street
Weymouth, Massachusetts

Analysis	Analyte		Sample ID:	B-1	B-2	B-3	B-4	B-5	B-6	B-7	B-8	B-9	B-10	B105	B/MW 201			B/MW 202		B/MW 203	
			Sample Depth (ft.):	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	14-17	6-8	10-12	10-12	5-7	9-11	5-7	9-11
			Sample Date:	6/25/2015	6/25/2015	6/25/2015	6/25/2015	6/25/2015	6/25/2015	6/25/2015	6/25/2015	6/25/2015	6/25/2015	4/12/2016	5/12/2016	5/12/2016	5/10/2016	5/11/2016	5/11/2016	5/11/2016	5/12/2016
		S-2/GW-3	UCLs														Field Dup				
VPH																					
(mg/kg)	C9-C10 Aromatics	500	5,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**45**	NA	NA	NA	NA	NA	NA	NA
	C5-C8 Aliphatics	500	5,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	12.5 U	NA	NA	NA	NA	NA	NA	NA
	C9-C12 Aliphatics	3,000	20,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	12.5 U	NA	NA	NA	NA	NA	NA	NA
	Benzene	200	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.502 U	NA	NA	NA	NA	NA	NA	NA
	Toluene	1,000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.502 U	NA	NA	NA	NA	NA	NA	NA
	Ethylbenzene	1,000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.502 U	NA	NA	NA	NA	NA	NA	NA
	p/m-xylene	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.502 U	NA	NA	NA	NA	NA	NA	NA
	o-xylene	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.502 U	NA	NA	NA	NA	NA	NA	NA
	Xylenes (total)	1,000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.502 U	NA	NA	NA	NA	NA	NA	NA
	Methyl tert butyl ether (MTBE)	500	5,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.251 U	NA	NA	NA	NA	NA	NA	NA
	Naphthalene	1,000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.0 U	NA	NA	NA	NA	NA	NA	NA
EPH																					
(mg/kg)	C9-C18 Aliphatics	3,000	20,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**4,570**	**11.4**	**677**	**818**	7.7 U	7.01 U	7.29 U	7.72 U
	C19-C36 Aliphatics	5,000	20,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**9,110**	**73**	**3,260**	**4,310**	**13.3**	7.01 U	**50.1**	**12.3**
	C11-C22 Aromatics	3,000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**9,070**	**32.8**	**2,330**	**3,420**	**25.4**	7.01 U	**27.8**	**18.2**
	Naphthalene	1000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.41 U	0.35 U	0.794 U	1.22 U	0.385 U	0.35 U	0.364 U	0.386 U
	2-Methylnaphthalene	500.0	5,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.41 U	0.35 U	0.794 U	1.22 U	0.385 U	0.35 U	0.364 U	0.386 U
	Acenaphthylene	10	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.41 U	0.35 U	0.794 U	1.22 U	0.385 U	0.35 U	0.364 U	0.386 U
	Acenaphthene	3,000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.41 U	0.35 U	0.794 U	1.22 U	0.385 U	0.35 U	0.364 U	0.386 U
	Fluorene	3,000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.41 U	0.35 U	0.794 U	1.22 U	0.385 U	0.35 U	0.364 U	0.386 U
	Phenanthrene	1000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.41 U	**0.385**	0.794 U	1.22 U	**0.542**	0.35 U	0.364 U	**0.662**
	Anthracene	3,000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.41 U	**0.592**	0.794 U	1.22 U	0.385 U	0.35 U	0.364 U	0.386 U
	Fluoranthene	3,000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.41 U	**1.58**	0.794 U	1.22 U	0.385 U	0.35 U	0.364 U	0.386 U
	Pyrene	3,000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.41 U	**1.29**	0.794 U	1.22 U	0.385 U	0.35 U	0.364 U	**0.431**
	Benzo(a)anthracene	40	3,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.41 U	**0.46**	0.794 U	1.22 U	0.385 U	0.35 U	0.364 U	0.386 U
	Chrysene	400	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.41 U	**0.735**	0.794 U	1.22 U	**0.416**	0.35 U	0.364 U	**0.442**
	Benzo(b)fluoranthene	40	3,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.41 U	**0.358**	0.794 U	1.22 U	0.385 U	0.35 U	0.364 U	0.386 U
	Benzo(k)fluoranthene	400	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.41 U	0.35 U	0.794 U	1.22 U	0.385 U	0.35 U	0.364 U	0.386 U
	Benzo(a)pyrene	7	300	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.41 U	0.35 U	0.794 U	1.22 U	0.385 U	0.35 U	0.364 U	0.386 U
	Indeno(1,2,3-cd)pyrene	40	3,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.41 U	0.35 U	0.794 U	1.22 U	0.385 U	0.35 U	0.364 U	0.386 U
	Dibenz(a,h)anthracene	4.0	300	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.41 U	0.35 U	0.794 U	1.22 U	0.385 U	0.35 U	0.364 U	0.386 U
	Benzo(g,h,i)perylene	3,000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.41 U	0.35 U	0.794 U	1.22 U	0.385 U	0.35 U	0.364 U	0.386 U
Herbicides																					
(mg/kg)	2,4-D	NS	NS	0.028 U	0.028 U	0.03 U	0.029 U	0.028 U	0.031 U	0.029 U	0.028 U	0.029 U	0.029 U	NA	NA	NA	NA	NA	NA	NA	NA
	2,4-DB	NS	NS	0.028 U	0.028 U	0.03 U	0.029 U	0.028 U	0.031 U	0.029 U	0.028 U	0.029 U	0.029 U	NA	NA	NA	NA	NA	NA	NA	NA
	2,4,5-TP (Silvex)	NS	NS	0.0028 U	0.0028 U	0.003 U	0.0029 U	0.0028 U	0.0031 U	0.0029 U	0.0028 U	0.0029 U	0.0029 U	NA	NA	NA	NA	NA	NA	NA	NA
	2,4,5-T	NS	NS	0.0028 U	0.0028 U	0.003 U	0.0029 U	0.0028 U	0.0031 U	0.0029 U	0.0028 U	0.0029 U	0.0029 U	NA	NA	NA	NA	NA	NA	NA	NA
	Dalapon	NS	NS	0.069 U	0.07 U	0.075 U	0.073 U	0.07 U	0.078 U	0.072 U	0.069 U	0.073 U	0.073 U	NA	NA	NA	NA	NA	NA	NA	NA
	Dicamba	NS	NS	0.0028 U	0.0028 U	0.003 U	0.0029 U	0.0028 U	0.0031 U	0.0029 U	0.0028 U	0.0029 U	0.0029 U	NA	NA	NA	NA	NA	NA	NA	NA
	Dichloroprop	NS	NS	0.028 U	0.028 U	0.03 U	0.029 U	0.028 U	0.031 U	0.029 U	0.028 U	0.029 U	0.029 U	NA	NA	NA	NA	NA	NA	NA	NA
	Dinoseb	NS	NS	0.014 U	0.014 U	0.015 U	0.015 U	0.014 U	0.016 U	0.014 U	0.014 U	0.015 U	0.015 U	NA	NA	NA	NA	NA	NA	NA	NA
	MCPA	NS	NS	2.8 U	2.8 U	3.0 U	2.9 U	2.8 U	3.1 U	2.9 U	2.8 U	2.9 U	2.9 U	NA	NA	NA	NA	NA	NA	NA	NA
	MCPP	NS	NS	2.8 U	2.8 U	3.0 U	2.9 U	2.8 U	3.1 U	2.9 U	2.8 U	2.9 U	2.9 U	NA	NA	NA	NA	NA	NA	NA	NA
Metals, total																					
(mg/kg)	Antimony	30	300	**6.9**	**6.6**	**8.0**	**7.5**	**7.3**	**8.3**	**7.1**	**7.4**	**6.8**	**7.8**	NA	2.2 U	2.3 U	2.5 U	2.3 U	2.2 U	2.2 U	2.3 U
	Arsenic	20	500	**17**	**31**	**47**	**48**	**30**	**90**	**34**	**36**	**55**	**48**	NA	**24**	**16**	**20**	**4.4**	**2.5**	**46**	**19**
	Barium	3,000	10,000	**49**	**76**	**99**	**98**	**70**	**110**	**79**	**77**	**120**	**110**	NA	**34**	**11**	**29**	**20**	**6.5**	**39**	**20**
	Beryllium	200	2,000	**1.0**	**2.0**	**2.5**	**2.5**	**1.9**	**3.4**	**2.0**	**1.9**	**2.7**	**2.5**	NA	**0.74**	**0.55**	**0.78**	**0.27**	**0.23**	**0.6**	**1.3**
	Cadmium	100	1,000	**0.73**	**1.2**	**1.7**	**1.7**	**1.1**	**2.9**	**1.3**	**1.3**	**1.8**	**1.7**	NA	0.44 U	0.47 U	0.5 U	0.46 U	0.43 U	0.44 U	0.46 U
	Chromium	200	2,000	**12**	**14**	**17**	**17**	**15**	**20**	**14**	**16**	**17**	**17**	NA	**9.6**	**3.9**	**7.1**	**11**	**6.8**	**12**	**8**
	Lead	600	6,000	**31**	**35**	**37**	**32**	**23**	**29**	**29**	**28**	**27**	**29**	NA	**33**	**9.9**	**14**	**14**	**2.3**	**4.4**	**16**
	Mercury	30	300	**0.061**	**0.17**	**0.17**	**0.13**	**0.084**	**0.14**	**0.11**	**0.081**	**0.10**	**0.10**	NA	**0.191**	0.096 U	0.103 U	0.081 U	0.077 U	**0.252**	0.082 U
	Nickel	1000	10,000	**11**	**20**	**23**	**24**	**20**	**32**	**19**	**20**	**21**	**25**	NA	**11**	**13**	**11**	**9.8**	**8.3**	**16**	**17**
	Selenium	700	7,000	5.5 U	5.6 U	6.0 U	5.8 U	5.6 U	6.3 U	5.8 U	5.5 U	5.8 U	5.8 U	NA	2.2 U	2.3 U	2.5 U	2.3 U	2.2 U	2.2 U	2.3 U
	Silver	200	2,000	0.55 U	0.56 U	0.60 U	0.58 U	0.56 U	0.63 U	0.58 U	0.55 U	0.58 U	0.58 U	NA	0.44 U	0.47 U	0.5 U	0.46 U	0.43 U	0.44 U	0.46 U
	Thallium	60	800	2.8 U	2.8 U	3.0 U	2.9 U	2.8 U	3.1 U	2.9 U	2.8 U	2.9 U	2.9 U	NA	2.2 U	2.3 U	2.5 U	2.3 U	2.2 U	2.2 U	2.3 U
	Vanadium	700	7,000	**48**	**100**	**110**	**120**	**98**	**86**	**89**	**84**	**89**	**99**	NA	**24**	**12**	**16**	**20**	**12**	**24**	**21**
	Zinc	3,000	10,000	**34**	**43**	**54**	**50**	**45**	**35**	**45**	**49**	**47**	**51**	NA	**110**	**6.6**	**15**	**46**	**29**	**13**	**15**

Notes:
mg/kg - milligrams per kilogram (dry weight) or parts per million (ppm).
NA - Sample not analyzed for the listed analyte.
N/A - Not applicable.
NS - No MassDEP standards exist for this analyte.
U - Analyte was not detected at specified quantitation limit.
Values in **Bold** indicate the analyte was detected.
Values shown in Bold and shaded type exceed MassDEP Standards.
EPH - Extractable Petroleum Hydrocarbons.
VPH - Volatile Petroleum Hydrocarbons
UCLs - Upper concentration limits.
Representative of Historic Fill/Beyond Disposal Site Boundary

Table 1. Summary of Analytical Results for Soil Samples
Spectra - 6 Bridge Street
Weymouth, Massachusetts

Analysis	Analyte		Sample ID:	B/MW 204		B/MW 205		B-308	B-310	B-314	B-315	B-317		COMP-123	COMP-467	COMP-8910	COMP-123-Fill
			Sample Depth (ft.):	6-8	8-10	6-8	10-12	12.0	12.5	12.5	12.5	11.5	13.0	0-1	0-1	0-1	N/A
			Sample Date:	5/10/2016	5/10/2016	5/12/2016	5/12/2016	10/12/2016	10/12/2016	10/12/2016	10/12/2016	10/12/2016	10/12/2016	6/10/2015	6/10/2015	6/10/2015	6/26/2015
		S-2/GW-3	UCLs														
VPH																	
(mg/kg)	C9-C10 Aromatics	500	5,000	NA	NA	NA	NA	3.1 U	5.59 U	2.54 U	5.57 U	17 U	**140**	NA	NA	NA	NA
	C5-C8 Aliphatics	500	5,000	NA	NA	NA	NA	3.1 U	5.59 U	2.54 U	5.57 U	17 U	12.4 U	NA	NA	NA	NA
	C9-C12 Aliphatics	3,000	20,000	NA	NA	NA	NA	3.1 U	5.59 U	2.54 U	5.57 U	17 U	**163**	NA	NA	NA	NA
	Benzene	200	10,000	NA	NA	NA	NA	0.124 U	0.224 U	0.102 U	0.223 U	0.679 U	0.498 U	NA	NA	NA	NA
	Toluene	1,000	10,000	NA	NA	NA	NA	0.124 U	0.224 U	0.102 U	0.223 U	0.679 U	0.498 U	NA	NA	NA	NA
	Ethylbenzene	1,000	10,000	NA	NA	NA	NA	0.124 U	0.224 U	0.102 U	0.223 U	0.679 U	0.498 U	NA	NA	NA	NA
	p/m-xylene	NS	NS	NA	NA	NA	NA	0.124 U	0.224 U	0.102 U	0.223 U	0.679 U	0.498 U	NA	NA	NA	NA
	o-xylene	NS	NS	NA	NA	NA	NA	0.124 U	0.224 U	0.102 U	0.223 U	0.679 U	0.498 U	NA	NA	NA	NA
	Xylenes (total)	1,000	10,000	NA	NA	NA	NA	0.124 U	0.224 U	0.102 U	0.223 U	0.679 U	0.498 U	NA	NA	NA	NA
	Methyl tert butyl ether (MTBE)	500	5,000	NA	NA	NA	NA	0.062 U	0.112 U	0.051 U	0.111 U	0.339 U	0.249 U	NA	NA	NA	NA
	Naphthalene	1,000	10,000	NA	NA	NA	NA	0.248 U	0.447 U	0.204 U	0.446 U	1.36 U	0.995 U	NA	NA	NA	NA
EPH																	
(mg/kg)	C9-C18 Aliphatics	3,000	20,000	**7.97**	9.11 U	6.5 U	9.55 U	7.34 U	**11.2**	7.01 U	9.36 U	11 U	**3,740**	NA	NA	NA	**13**
	C19-C36 Aliphatics	5,000	20,000	**51.7**	9.11 U	**8.44**	**10.1**	7.34 U	**132**	7.01 U	9.36 U	11 U	**6,140**	NA	NA	NA	12 U
	C11-C22 Aromatics	3,000	10,000	**33.5**	9.11 U	6.5 U	9.55 U	7.34 U	**97**	7.01 U	9.36 U	11 U	**5,970**	NA	NA	NA	**26**
	Naphthalene	1000	10,000	0.362 U	0.456 U	0.325 U	0.478 U	0.367 U	0.497 U	0.35 U	0.468 U	0.551 U	3.86 U	NA	NA	NA	0.12 U
	2-Methylnaphthalene	500.0	5,000	0.362 U	0.456 U	0.325 U	0.478 U	0.367 U	0.497 U	0.35 U	0.468 U	0.551 U	3.86 U	NA	NA	NA	**0.21**
	Acenaphthylene	10	10,000	0.362 U	0.456 U	0.325 U	0.478 U	0.367 U	0.497 U	0.35 U	0.468 U	0.551 U	3.86 U	NA	NA	NA	0.12 U
	Acenaphthene	3,000	10,000	0.362 U	0.456 U	0.325 U	0.478 U	0.367 U	0.497 U	0.35 U	0.468 U	0.551 U	3.86 U	NA	NA	NA	0.12 U
	Fluorene	3,000	10,000	0.362 U	0.456 U	0.325 U	0.478 U	0.367 U	0.497 U	0.35 U	0.468 U	0.551 U	3.86 U	NA	NA	NA	0.12 U
	Phenanthrene	1000	10,000	**2.03**	0.456 U	0.325 U	0.478 U	0.367 U	0.497 U	0.35 U	0.468 U	0.551 U	3.86 U	NA	NA	NA	**0.61**
	Anthracene	3,000	10,000	0.362 U	0.456 U	0.325 U	0.478 U	0.367 U	0.497 U	0.35 U	0.468 U	0.551 U	3.86 U	NA	NA	NA	0.12 U
	Fluoranthene	3,000	10,000	**2.57**	0.456 U	0.325 U	0.478 U	0.367 U	0.497 U	0.35 U	0.468 U	0.551 U	3.86 U	NA	NA	NA	0.12 U
	Pyrene	3,000	10,000	**2.89**	0.456 U	0.325 U	0.478 U	0.367 U	0.497 U	0.35 U	0.468 U	0.551 U	3.86 U	NA	NA	NA	**0.29**
	Benzo(a)anthracene	40	3,000	**1.34**	0.456 U	0.325 U	0.478 U	0.367 U	0.497 U	0.35 U	0.468 U	0.551 U	3.86 U	NA	NA	NA	**0.13**
	Chrysene	400	10,000	**1.5**	0.456 U	0.325 U	0.478 U	0.367 U	0.497 U	0.35 U	0.468 U	0.551 U	3.86 U	NA	NA	NA	**0.28**
	Benzo(b)fluoranthene	40	3,000	**0.986**	0.456 U	0.325 U	0.478 U	0.367 U	0.497 U	0.35 U	0.468 U	0.551 U	3.86 U	NA	NA	NA	**0.13**
	Benzo(k)fluoranthene	400	10,000	**0.908**	0.456 U	0.325 U	0.478 U	0.367 U	0.497 U	0.35 U	0.468 U	0.551 U	3.86 U	NA	NA	NA	0.12 U
	Benzo(a)pyrene	7	300	**1.02**	0.456 U	0.325 U	0.478 U	0.367 U	0.497 U	0.35 U	0.468 U	0.551 U	3.86 U	NA	NA	NA	0.12 U
	Indeno(1,2,3-cd)pyrene	40	3,000	**0.694**	0.456 U	0.325 U	0.478 U	0.367 U	0.497 U	0.35 U	0.468 U	0.551 U	3.86 U	NA	NA	NA	0.12 U
	Dibenz(a,h)anthracene	4.0	300	0.362 U	0.456 U	0.325 U	0.478 U	0.367 U	0.497 U	0.35 U	0.468 U	0.551 U	3.86 U	NA	NA	NA	0.12 U
	Benzo(g,h,i)perylene	3,000	10,000	**0.71**	0.456 U	0.325 U	0.478 U	0.367 U	0.497 U	0.35 U	0.468 U	0.551 U	3.86 U	NA	NA	NA	0.12 U
Herbicides																	
(mg/kg)	2,4-D	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.026 U	0.027 U	0.027 U	NA
	2,4-DB	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.026 U	0.027 U	0.027 U	NA
	2,4,5-TP (Silvex)	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.0026 U	0.0027 U	0.0027 U	NA
	2,4,5-T	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.0026 U	0.0027 U	0.0027 U	NA
	Dalapon	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.065 U	0.068 U	0.066 U	NA
	Dicamba	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.0026 U	0.0027 U	0.0027 U	NA
	Dichloroprop	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.026 U	0.027 U	0.027 U	NA
	Dinoseb	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.013 U	0.014 U	0.013 U	NA
	MCPA	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.6 U	2.7 U	2.7 U	NA
	MCPP	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.6 U	2.7 U	2.7 U	NA
Metals, total																	
(mg/kg)	Antimony	30	300	2.1 U	**3.8**	2 U	**4.2**	NA	NA	NA	NA	NA	NA	2.6 U	2.7 U	2.6 U	**5.5**
	Arsenic	20	500	**30**	**90**	**3.4**	**130**	NA	NA	NA	NA	NA	NA	29	**44**	**39**	**23**
	Barium	3,000	10,000	**51**	**94**	**4.5**	**81**	NA	NA	NA	NA	NA	NA	**71**	**94**	**85**	**46**
	Beryllium	200	2,000	**0.66**	**2.6**	0.2 U	**4.2**	NA	NA	NA	NA	NA	NA	**1.4**	**1.9**	**1.8**	**1.2**
	Cadmium	100	1,000	0.42 U	0.55 U	0.4 U	0.58 U	NA	NA	NA	NA	NA	NA	**1.0**	**1.5**	**1.3**	**0.89**
	Chromium	200	2,000	**15**	**24**	**2.5**	**19**	NA	NA	NA	NA	NA	NA	**15**	**17**	**18**	**13**
	Lead	600	6,000	**32**	**16**	**2.1**	**10**	NA	NA	NA	NA	NA	NA	**23**	**30**	**27**	**13**
	Mercury	30	300	**0.218**	**0.142**	0.068 U	**0.285**	NA	NA	NA	NA	NA	NA	**0.11**	**0.11**	**0.16**	**0.052**
	Nickel	1000	10,000	**19**	**15**	**1.4**	**17**	NA	NA	NA	NA	NA	NA	**17**	**27**	**25**	**13**
	Selenium	700	7,000	2.1 U	2.7 U	2 U	2.9 U	NA	NA	NA	NA	NA	NA	**5.9**	5.3 U	**5.4**	5.9 U
	Silver	200	2,000	0.42 U	0.55 U	0.4 U	0.58 U	NA	NA	NA	NA	NA	NA	0.52 U	0.53 U	0.52 U	0.59 U
	Thallium	60	800	2.1 U	2.7 U	2 U	2.9 U	NA	NA	NA	NA	NA	NA	**3.6**	**3.6**	**3.3**	2.9 U
	Vanadium	700	7,000	**82**	**71**	**8**	**75**	NA	NA	NA	NA	NA	NA	**90**	**100**	**95**	**33**
	Zinc	3,000	10,000	**62**	**17**	**6.5**	**19**	NA	NA	NA	NA	NA	NA	**46**	**49**	**51**	**17**

Notes:
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N/A - Not applicable.
NS - No MassDEP standards exist for this analyte.
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UCLs - Upper concentration limits.
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Table 1. Summary of Analytical Results for Soil Samples
Spectra - 6 Bridge Street
Weymouth, Massachusetts

Analysis	Analyte		Sample ID:	COMP-123-Native	COMP-467-Fill	COMP-467-Native	COMP-8910-Native	COMP-910-Fill	TP-1			TP-2		TP-3		B-400		B-401	
			Sample Depth (ft.):	N/A	N/A	N/A	N/A	N/A	5-7	5-7	7-9	5-7	7-9	5-7	7-9	11.4	12.4	11.5	12.2
			Sample Date:	6/26/2015	6/26/2015	6/26/2015	6/26/2015	6/26/2015	12/22/2015	12/22/2015	12/22/2015	12/21/2015	12/21/2015	12/21/2015	12/21/2015	12/14/2016	12/14/2016	12/14/2016	12/14/2016
		S-2/GW-3	UCLs							Field Dup									
VPH																			
(mg/kg)	C9-C10 Aromatics	500	5,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	C5-C8 Aliphatics	500	5,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	C9-C12 Aliphatics	3,000	20,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Benzene	200	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Toluene	1,000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Ethylbenzene	1,000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	p/m-xylene	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	o-xylene	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Xylenes (total)	1,000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Methyl tert butyl ether (MTBE)	500	5,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Naphthalene	1,000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EPH																			
(mg/kg)	C9-C18 Aliphatics	3,000	20,000	NA	13 U	NA	NA	14 U	NA	NA	NA	NA	NA	NA	NA	8.1 U	9.26 U	11.1 U	7.76 U
	C19-C36 Aliphatics	5,000	20,000	NA	13 U	NA	NA	14 U	NA	NA	NA	NA	NA	NA	NA	8.1 U	9.26 U	11.1 U	7.76 U
	C11-C22 Aromatics	3,000	10,000	NA	**22**	NA	NA	14 U	NA	NA	NA	NA	NA	NA	NA	**11**	**15**	11.1 U	7.76 U
	Naphthalene	1000	10,000	NA	0.13 U	NA	NA	0.14 U	0.18 U	0.18 U	0.18 U	0.19 U	**0.21**	NA	0.21 U	0.405 U	0.463 U	0.557 U	0.388 U
	2-Methylnaphthalene	500.0	5,000	NA	**0.16**	NA	NA	0.14 U	0.18 U	**0.22**	**0.23**	**0.37**	**0.50**	NA	**0.28**	0.405 U	0.463 U	0.557 U	0.388 U
	Acenaphthylene	10	10,000	NA	0.13 U	NA	NA	0.14 U	0.18 U	0.18 U	0.18 U	0.19 U	0.20 U	NA	0.21 U	0.405 U	0.463 U	0.557 U	0.388 U
	Acenaphthene	3,000	10,000	NA	0.13 U	NA	NA	0.14 U	0.18 U	0.18 U	0.18 U	0.19 U	0.20 U	NA	0.21 U	0.405 U	0.463 U	0.557 U	0.388 U
	Fluorene	3,000	10,000	NA	0.13 U	NA	NA	0.14 U	0.18 U	0.18 U	0.18 U	0.19 U	0.20 U	NA	0.21 U	0.405 U	0.463 U	0.557 U	0.388 U
	Phenanthrene	1000	10,000	NA	**0.34**	NA	NA	**0.18**	**0.47**	**1.2**	**0.91**	**1.0**	**1.3**	NA	**0.69**	0.405 U	0.463 U	0.557 U	0.388 U
	Anthracene	3,000	10,000	NA	0.13 U	NA	NA	0.14 U	0.18 U	0.18 U	0.18 U	0.19 U	0.20 U	NA	0.21 U	0.405 U	0.463 U	0.557 U	0.388 U
	Fluoranthene	3,000	10,000	NA	0.13 U	NA	NA	0.14 U	**0.33**	**0.90**	**0.56**	0.19 U	**0.24**	NA	0.21 U	0.405 U	0.463 U	0.557 U	0.388 U
	Pyrene	3,000	10,000	NA	0.13 U	NA	NA	0.14 U	**0.50**	**1.3**	**0.89**	**0.59**	**0.68**	NA	**0.24**	0.405 U	0.463 U	0.557 U	0.388 U
	Benzo(a)anthracene	40	3,000	NA	0.13 U	NA	NA	0.14 U	**0.25**	**0.65**	**0.46**	**0.27**	**0.31**	NA	0.21 U	0.405 U	0.463 U	0.557 U	0.388 U
	Chrysene	400	10,000	NA	0.13 U	NA	NA	0.14 U	**0.31**	**0.80**	**0.62**	**0.54**	**0.71**	NA	**0.36**	0.405 U	0.463 U	0.557 U	0.388 U
	Benzo(b)fluoranthene	40	3,000	NA	0.13 U	NA	NA	0.14 U	**0.24**	**0.61**	**0.49**	0.19 U	**0.25**	NA	0.21 U	0.405 U	0.463 U	0.557 U	0.388 U
	Benzo(k)fluoranthene	400	10,000	NA	0.13 U	NA	NA	0.14 U	0.18 U	**0.20**	0.18 U	0.19 U	0.20 U	NA	0.21 U	0.405 U	0.463 U	0.557 U	0.388 U
	Benzo(a)pyrene	7	300	NA	0.13 U	NA	NA	0.14 U	**0.20**	**0.46**	**0.37**	0.19 U	0.20 U	NA	0.21 U	0.405 U	0.463 U	0.557 U	0.388 U
	Indeno(1,2,3-cd)pyrene	40	3,000	NA	0.13 U	NA	NA	0.14 U	0.18 U	**0.20**	0.18 U	0.19 U	0.20 U	NA	0.21 U	0.405 U	0.463 U	0.557 U	0.388 U
	Dibenz(a,h)anthracene	4.0	300	NA	0.13 U	NA	NA	0.14 U	0.18 U	0.18 U	0.18 U	0.19 U	0.20 U	NA	0.21 U	0.405 U	0.463 U	0.557 U	0.388 U
	Benzo(g,h,i)perylene	3,000	10,000	NA	0.13 U	NA	NA	0.14 U	0.18 U	0.18 U	**0.19**	0.19 U	0.20 U	NA	0.21 U	0.405 U	0.463 U	0.557 U	0.388 U
Herbicides																			
(mg/kg)	2,4-D	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2,4-DB	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2,4,5-TP (Silvex)	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2,4,5-T	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dalapon	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dicamba	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dichloroprop	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dinoseb	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MCPA	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MCPP	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Metals, total																			
(mg/kg)	Antimony	30	300	**15**	**6.2**	**16**	**16**	**7.1**	2.7 U	2.7 U	2.7 U	2.8 U	3.0 U	2.5 U	3.1 U	NA	NA	NA	NA
	Arsenic	20	500	**13**	**43**	**12**	**13**	**80**	**7.7**	**7.0**	**9.8**	**31**	**54**	**46**	**45**	NA	NA	NA	NA
	Barium	3,000	10,000	**60**	**48**	**77**	**59**	**130**	**23**	**23**	**30**	**41**	**75**	**39**	**31**	NA	NA	NA	NA
	Beryllium	200	2,000	**1.1**	**2.8**	**1.2**	**1.3**	**4.9**	**0.84**	**0.73**	**0.93**	**1.1**	**2.7**	**1.7**	**2.2**	NA	NA	NA	NA
	Cadmium	100	1,000	**0.90**	**1.5**	**0.82**	**0.92**	**2.6**	**0.66**	**0.57**	**0.72**	**1.3**	**1.9**	**1.6**	**1.6**	NA	NA	NA	NA
	Chromium	200	2,000	**34**	**15**	**34**	**35**	**28**	**12**	**11**	**13**	**14**	**9.6**	**8.9**	**32**	NA	NA	NA	NA
	Lead	600	6,000	**34**	**12**	**11**	**17**	**23**	**10**	**9.6**	**15**	**15**	**34**	**13**	**20**	NA	NA	NA	NA
	Mercury	30	300	**0.16**	**0.047**	0.034 U	**0.047**	**0.095**	**0.031**	**0.033**	**0.033**	0.027 U	**0.049**	**0.15**	**0.14**	NA	NA	NA	NA
	Nickel	1000	10,000	**24**	**38**	**24**	**25**	**27**	**12**	**10**	**14**	**14**	**15**	**16**	**21**	NA	NA	NA	NA
	Selenium	700	7,000	6.4 U	6.5 U	6.8 U	6.7 U	6.9 U	5.3 U	5.4 U	5.4 U	5.6 U	6.0 U	5.0 U	6.2 U	NA	NA	NA	NA
	Silver	200	2,000	0.64 U	0.65 U	0.68 U	0.67 U	0.69 U	0.53 U	0.54 U	0.54 U	0.56 U	0.60 U	0.50 U	0.62 U	NA	NA	NA	NA
	Thallium	60	800	3.2 U	3.2 U	3.4 U	3.4 U	3.5 U	2.7 U	2.7 U	2.7 U	2.8 U	3.0 U	2.5 U	3.1 U	NA	NA	NA	NA
	Vanadium	700	7,000	**46**	**40**	**51**	**54**	**86**	**33**	**31**	**39**	**29**	**39**	**24**	**20**	NA	NA	NA	NA
	Zinc	3,000	10,000	**90**	**34**	**63**	**69**	**33**	**36**	**32**	**38**	**30**	**16**	**14**	**20**	NA	NA	NA	NA

Notes:

mg/kg - milligrams per kilogram (dry weight) or parts per million (ppm).

NA - Sample not analyzed for the listed analyte.

N/A - Not applicable.

NS - No MassDEP standards exist for this analyte.

U - Analyte was not detected at specified quantitation limit.

Values in **Bold** indicate the analyte was detected.

Values shown in Bold and shaded type exceed MassDEP Standards.

EPH - Extractable Petroleum Hydrocarbons.

VPH - Volatile Petroleum Hydrocarbons

UCLs - Upper concentration limits.

Representative of Historic Fill/Beyond Disposal Site Boundary

Table 1. Summary of Analytical Results for Soil Samples
Spectra - 6 Bridge Street
Weymouth, Massachusetts

Analysis	Analyte		Sample ID:	B-402			B-403		B-404		B-405		B-406	B-407		B-408		B-409		B-410		
			Sample Depth (ft.):	11.6	12.2	12.8	10	12	11.4	16.5	11.5	12.5	21	12.8	17.5	11	15	10	11.5	11	12.5	14
			Sample Date:	12/14/2016	12/14/2016	12/14/2016	12/14/2016	12/14/2016	12/14/2016	12/14/2016	12/14/2016	12/14/2016	12/14/2016	12/15/2016	12/15/2016	12/13/2016	12/13/2016	12/12/2016	12/12/2016	12/12/2016	12/12/2016	12/12/2016
		S-2/GW-3	UCLs																			
VPH																						
(mg/kg)	C9-C10 Aromatics	500	5,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	C5-C8 Aliphatics	500	5,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	C9-C12 Aliphatics	3,000	20,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Benzene	200	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Toluene	1,000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Ethylbenzene	1,000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	p/m-xylene	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	o-xylene	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Xylenes (total)	1,000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Methyl tert butyl ether (MTBE)	500	5,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Naphthalene	1,000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EPH																						
(mg/kg)	C9-C18 Aliphatics	3,000	20,000	7.18 U	**353**	8.49 U	6.92 U	7.29 U	**165**	7.55 U	12.7 U	7.65 U	7.14 U	**3,300**	7.36 U	8.16 U	6.81 U	8.13 U	9.05 U	**697**	**3,690**	**21.5**
	C19-C36 Aliphatics	5,000	20,000	7.18 U	**693**	8.49 U	6.92 U	7.29 U	**278**	7.55 U	12.7 U	7.65 U	7.14 U	**5,650**	7.36 U	**8.22**	6.81 U	8.13 U	9.05 U	**2,740**	**5,810**	**32**
	C11-C22 Aromatics	3,000	10,000	7.18 U	**776**	**9.61**	6.92 U	7.29 U	**704**	**9.87**	**49.7**	7.65 U	7.14 U	**6,670**	7.36 U	**30.1**	6.81 U	**37.4**	**10.3**	**7,670**	**7,170**	**18.5**
	Naphthalene	1000	10,000	0.359 U	0.708 U	0.424 U	0.346 U	0.364 U	0.404 U	0.377 U	0.636 U	0.383 U	0.357 U	**11.8**	0.368 U	0.408 U	0.341 U	0.406 U	0.452 U	3.99 U	8.16 U	0.413 U
	2-Methylnaphthalene	500.0	5,000	0.359 U	0.708 U	0.424 U	0.346 U	0.364 U	0.404 U	0.377 U	**0.675**	0.383 U	0.357 U	**45.2**	0.368 U	0.408 U	0.341 U	0.406 U	0.452 U	3.99 U	8.16 U	0.413 U
	Acenaphthylene	10	10,000	0.359 U	0.708 U	0.424 U	0.346 U	0.364 U	0.404 U	0.377 U	0.636 U	0.383 U	0.357 U	3.63 U	0.368 U	0.408 U	0.341 U	0.406 U	0.452 U	3.99 U	8.16 U	0.413 U
	Acenaphthene	3,000	10,000	0.359 U	0.708 U	0.424 U	0.346 U	0.364 U	0.404 U	0.377 U	0.636 U	0.383 U	0.357 U	3.63 U	0.368 U	**0.692**	0.341 U	0.406 U	0.452 U	3.99 U	8.16 U	0.413 U
	Fluorene	3,000	10,000	0.359 U	0.708 U	0.424 U	0.346 U	0.364 U	0.404 U	0.377 U	0.636 U	0.383 U	0.357 U	3.63 U	0.368 U	0.408 U	0.341 U	0.406 U	0.452 U	3.99 U	8.16 U	0.413 U
	Phenanthrene	1000	10,000	0.359 U	0.708 U	0.424 U	0.346 U	0.364 U	**1.61**	0.377 U	**1.99**	0.383 U	0.357 U	**8.97**	0.368 U	**0.438**	0.341 U	0.406 U	0.452 U	3.99 U	8.16 U	0.413 U
	Anthracene	3,000	10,000	0.359 U	0.708 U	0.424 U	0.346 U	0.364 U	0.404 U	0.377 U	0.636 U	0.383 U	0.357 U	3.63 U	0.368 U	0.408 U	0.341 U	0.406 U	0.452 U	3.99 U	8.16 U	0.413 U
	Fluoranthene	3,000	10,000	0.359 U	0.708 U	0.424 U	0.346 U	0.364 U	0.404 U	0.377 U	**1.13**	0.383 U	0.357 U	3.63 U	0.368 U	0.408 U	0.341 U	0.406 U	0.452 U	3.99 U	8.16 U	0.413 U
	Pyrene	3,000	10,000	0.359 U	0.708 U	0.424 U	0.346 U	0.364 U	**1.08**	0.377 U	**1.67**	0.383 U	0.357 U	3.63 U	0.368 U	0.408 U	0.341 U	0.406 U	0.452 U	3.99 U	8.16 U	0.413 U
	Benzo(a)anthracene	40	3,000	0.359 U	0.708 U	0.424 U	0.346 U	0.364 U	0.404 U	0.377 U	**0.943**	0.383 U	0.357 U	3.63 U	0.368 U	0.408 U	0.341 U	0.406 U	0.452 U	3.99 U	8.16 U	0.413 U
	Chrysene	400	10,000	0.359 U	0.708 U	0.424 U	0.346 U	0.364 U	**1.19**	0.377 U	**1.42**	0.383 U	0.357 U	3.63 U	0.368 U	0.408 U	0.341 U	0.406 U	0.452 U	3.99 U	8.16 U	0.413 U
	Benzo(b)fluoranthene	40	3,000	0.359 U	0.708 U	0.424 U	0.346 U	0.364 U	0.404 U	0.377 U	**0.655**	0.383 U	0.357 U	3.63 U	0.368 U	0.408 U	0.341 U	0.406 U	0.452 U	3.99 U	8.16 U	0.413 U
	Benzo(k)fluoranthene	400	10,000	0.359 U	0.708 U	0.424 U	0.346 U	0.364 U	0.404 U	0.377 U	0.636 U	0.383 U	0.357 U	3.63 U	0.368 U	0.408 U	0.341 U	0.406 U	0.452 U	3.99 U	8.16 U	0.413 U
	Benzo(a)pyrene	7	300	0.359 U	0.708 U	0.424 U	0.346 U	0.364 U	0.404 U	0.377 U	**0.799**	0.383 U	0.357 U	3.63 U	0.368 U	0.408 U	0.341 U	0.406 U	0.452 U	3.99 U	8.16 U	0.413 U
	Indeno(1,2,3-cd)pyrene	40	3,000	0.359 U	0.708 U	0.424 U	0.346 U	0.364 U	0.404 U	0.377 U	0.636 U	0.383 U	0.357 U	3.63 U	0.368 U	0.408 U	0.341 U	0.406 U	0.452 U	3.99 U	8.16 U	0.413 U
	Dibenz(a,h)anthracene	4.0	300	0.359 U	0.708 U	0.424 U	0.346 U	0.364 U	0.404 U	0.377 U	0.636 U	0.383 U	0.357 U	3.63 U	0.368 U	**0.742**	0.341 U	0.406 U	0.452 U	3.99 U	8.16 U	0.413 U
	Benzo(g,h,i)perylene	3,000	10,000	0.359 U	0.708 U	0.424 U	0.346 U	0.364 U	0.404 U	0.377 U	0.636 U	0.383 U	0.357 U	3.63 U	0.368 U	0.408 U	0.341 U	0.406 U	0.452 U	3.99 U	8.16 U	0.413 U
Herbicides																						
(mg/kg)	2,4-D	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2,4-DB	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2,4,5-TP (Silvex)	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2,4,5-T	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dalapon	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dicamba	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dichloroprop	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dinoseb	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MCPA	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MCPP	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Metals, total																						
(mg/kg)	Antimony	30	300	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Arsenic	20	500	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Barium	3,000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Beryllium	200	2,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Cadmium	100	1,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Chromium	200	2,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Lead	600	6,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Mercury	30	300	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nickel	1000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Selenium	700	7,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Silver	200	2,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Thallium	60	800	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Vanadium	700	7,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Zinc	3,000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

mg/kg - milligrams per kilogram (dry weight) or parts per million (ppm).

NA - Sample not analyzed for the listed analyte.

N/A - Not applicable.

NS - No MassDEP standards exist for this analyte.

U - Analyte was not detected at specified quantitation limit.

Values in **Bold** indicate the analyte was detected.

Values shown in Bold and shaded type exceed MassDEP Standards.

EPH - Extractable Petroleum Hydrocarbons.

VPH - Volatile Petroleum Hydrocarbons

UCLs - Upper concentration limits.

Representative of Historic Fill/Beyond Disposal Site Boundary

Table 1. Summary of Analytical Results for Soil Samples
Spectra - 6 Bridge Street
Weymouth, Massachusetts

Analysis	Analyte		Sample ID:	B-411		B-412	B-413		B-414		B-415				B-416		B-417	
			Sample Depth (ft.):	11.5	16	19	11	23	11	15.5	11.8	12.2	13.4	13.4	11	15	11	15
			Sample Date:	12/12/2016	12/12/2016	12/12/2016	12/12/2016	12/12/2016	12/13/2016	12/13/2016	12/14/2016	12/14/2016	12/14/2016	12/14/2016	12/13/2016	12/13/2016	12/13/2016	12/13/2016
		S-2/GW-3	UCLs											Field Dup				
VPH																		
(mg/kg)	C9-C10 Aromatics	500	5,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	C5-C8 Aliphatics	500	5,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	C9-C12 Aliphatics	3,000	20,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Benzene	200	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Toluene	1,000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Ethylbenzene	1,000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	p/m-xylene	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	o-xylene	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Xylenes (total)	1,000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Methyl tert butyl ether (MTBE)	500	5,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Naphthalene	1,000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EPH																		
(mg/kg)	C9-C18 Aliphatics	3,000	20,000	**12.6**	9.43 U	8.27 U	**1,780**	8.22 U	**52.7**	**108**	**3,250**	**2,680**	**1,060**	**510**	6.96 U	8.14 U	**6.94**	7.31 U
	C19-C36 Aliphatics	5,000	20,000	**98.4**	9.43 U	**21.4**	**4,590**	**13.6**	**256**	**175**	**6,670**	**5,500**	**1,740**	**712**	**95.4**	8.14 U	**53.8**	7.31 U
	C11-C22 Aromatics	3,000	10,000	**246**	9.43 U	**36.5**	**6,610**	**21**	**192**	**256**	**8,790**	**5,710**	**1,890**	**866**	**114**	8.14 U	**90.9**	7.31 U
	Naphthalene	1000	10,000	0.35 U	0.472 U	0.414 U	12.2 U	0.411 U	0.367 U	0.379 U	8.08 U	13.1 U	2.3 U	0.434 U	0.348 U	0.407 U	0.344 U	0.365 U
	2-Methylnaphthalene	500.0	5,000	0.35 U	0.472 U	0.414 U	12.2 U	0.411 U	0.367 U	0.379 U	8.08 U	13.1 U	2.3 U	**0.675**	0.348 U	0.407 U	0.344 U	0.365 U
	Acenaphthylene	10	10,000	0.35 U	0.472 U	0.414 U	12.2 U	0.411 U	0.367 U	0.379 U	8.08 U	13.1 U	2.3 U	0.434 U	0.348 U	0.407 U	0.344 U	0.365 U
	Acenaphthene	3,000	10,000	0.35 U	0.472 U	0.414 U	12.2 U	0.411 U	0.367 U	0.379 U	8.08 U	13.1 U	2.3 U	0.434 U	0.348 U	0.407 U	0.344 U	0.365 U
	Fluorene	3,000	10,000	0.35 U	0.472 U	0.414 U	12.2 U	0.411 U	0.367 U	0.379 U	8.08 U	13.1 U	2.3 U	0.434 U	0.348 U	0.407 U	0.344 U	0.365 U
	Phenanthrene	1000	10,000	0.35 U	0.472 U	0.414 U	12.2 U	0.411 U	0.367 U	0.379 U	8.08 U	13.1 U	2.3 U	0.434 U	**0.4**	0.407 U	**0.654**	0.365 U
	Anthracene	3,000	10,000	0.35 U	0.472 U	0.414 U	12.2 U	0.411 U	0.367 U	0.379 U	8.08 U	13.1 U	2.3 U	0.434 U	0.348 U	0.407 U	0.344 U	0.365 U
	Fluoranthene	3,000	10,000	0.35 U	0.472 U	0.414 U	12.2 U	0.411 U	0.367 U	0.379 U	8.08 U	13.1 U	2.3 U	0.434 U	**0.454**	0.407 U	**0.674**	0.365 U
	Pyrene	3,000	10,000	0.35 U	0.472 U	0.414 U	12.2 U	0.411 U	0.367 U	0.379 U	8.08 U	13.1 U	2.3 U	0.434 U	**0.486**	0.407 U	**0.763**	0.365 U
	Benzo(a)anthracene	40	3,000	0.35 U	0.472 U	0.414 U	12.2 U	0.411 U	0.367 U	0.379 U	8.08 U	13.1 U	2.3 U	**0.67**	0.348 U	0.407 U	**0.458**	0.365 U
	Chrysene	400	10,000	0.35 U	0.472 U	0.414 U	12.2 U	0.411 U	0.367 U	0.379 U	8.08 U	13.1 U	2.3 U	**0.781**	**0.409**	0.407 U	**0.627**	0.365 U
	Benzo(b)fluoranthene	40	3,000	0.35 U	0.472 U	0.414 U	12.2 U	0.411 U	0.367 U	0.379 U	8.08 U	13.1 U	2.3 U	0.434 U	0.348 U	0.407 U	**0.385**	0.365 U
	Benzo(k)fluoranthene	400	10,000	0.35 U	0.472 U	0.414 U	12.2 U	0.411 U	0.367 U	0.379 U	8.08 U	13.1 U	2.3 U	0.434 U	0.348 U	0.407 U	0.344 U	0.365 U
	Benzo(a)pyrene	7	300	0.35 U	0.472 U	0.414 U	12.2 U	0.411 U	0.367 U	0.379 U	8.08 U	13.1 U	2.3 U	0.434 U	0.348 U	0.407 U	**0.39**	0.365 U
	Indeno(1,2,3-cd)pyrene	40	3,000	0.35 U	0.472 U	0.414 U	12.2 U	0.411 U	0.367 U	0.379 U	8.08 U	13.1 U	2.3 U	0.434 U	0.348 U	0.407 U	0.344 U	0.365 U
	Dibenz(a,h)anthracene	4.0	300	0.35 U	0.472 U	0.414 U	12.2 U	0.411 U	0.367 U	0.379 U	8.08 U	13.1 U	2.3 U	0.434 U	0.348 U	0.407 U	0.344 U	0.365 U
	Benzo(g,h,i)perylene	3,000	10,000	0.35 U	0.472 U	0.414 U	12.2 U	0.411 U	0.367 U	0.379 U	8.08 U	13.1 U	2.3 U	0.434 U	0.348 U	0.407 U	**0.396**	0.365 U
Herbicides																		
(mg/kg)	2,4-D	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2,4-DB	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2,4,5-TP (Silvex)	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2,4,5-T	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dalapon	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dicamba	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dichloroprop	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dinoseb	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MCPA	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	MCPP	NS	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Metals, total																		
(mg/kg)	Antimony	30	300	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Arsenic	20	500	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Barium	3,000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Beryllium	200	2,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Cadmium	100	1,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Chromium	200	2,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Lead	600	6,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Mercury	30	300	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nickel	1000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Selenium	700	7,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Silver	200	2,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Thallium	60	800	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Vanadium	700	7,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Zinc	3,000	10,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

mg/kg - milligrams per kilogram (dry weight) or parts per million (ppm).
NA - Sample not analyzed for the listed analyte.
N/A - Not applicable.
NS - No MassDEP standards exist for this analyte.
U - Analyte was not detected at specified quantitation limit.
Values in **Bold** indicate the analyte was detected.
Values shown in Bold and shaded type exceed MassDEP Standards.
EPH - Extractable Petroleum Hydrocarbons.
VPH - Volatile Petroleum Hydrocarbons
UCLs - Upper concentration limits.
Representative of Historic Fill/Beyond Disposal Site Boundary

Table 2. Summary of Analytical Results for Soil Samples -- >3 Foot Depth Interval
Spectra - 6 Bridge Street
Weymouth, Massachusetts

Analysis	Analyte			Sample ID:	B105	B/MW 201	B-317	B-402	B-404	B-407	B-410			B-411	B-413	B-414	B-415			B-416	B-417
				Sample Depth (ft.):	14-17	10-12	13.0	12.2	11.4	12.8	11	12.5	14	11.5	11	11	11.8	12.2	13.4	11	11
				Sample Date:	4/12/2016	5/12/2016	10/12/2016	12/14/2016	12/14/2016	12/15/2016	12/12/2016	12/12/2016	12/12/2016	12/12/2016	12/12/2016	12/13/2016	12/14/2016	12/14/2016	12/14/2016	12/13/2016	12/13/2016
		S-1/GW-2	S-1/GW-3	UCLs		combo													combo		
VPH																					
(mg/kg)	C9-C10 Aromatics	100	100	5,000	**45**	NA	**140**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	C9-C12 Aliphatics	1,000	1,000	20,000	12.5 U	NA	**163**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EPH																					
(mg/kg)	C9-C18 Aliphatics	1,000	1,000	20,000	**4,570**	**747.5**	**3,740**	**353**	**165**	**3,300**	**697**	**3,690**	**21.5**	**12.6**	**1,780**	**52.7**	**3,250**	**2,680**	**1,060**	6.96 U	**6.94**
	C19-C36 Aliphatics	3,000	3,000	20,000	**9,110**	**3,785**	**6,140**	**693**	**278**	**5,650**	**2,740**	**5,810**	**32**	**98.4**	**4,590**	**256**	**6,670**	**5,500**	**1,740**	**95.4**	**53.8**
	C11-C22 Aromatics	1,000	1,000	10,000	**9,070**	**2,875**	**5,970**	**776**	**704**	**6,670**	**7,670**	**7,170**	**18.5**	**246**	**6,610**	**192**	**8,790**	**5,710**	**1,890**	**114**	**90.9**
	Naphthalene	20	500	10,000	1.0 U	1.007 U	0.995 U	0.708 U	0.404 U	**11.8**	3.99 U	8.16 U	0.413 U	0.35 U	12.2 U	0.367 U	8.08 U	13.1 U	1.367 U	0.348 U	0.344 U
	2-Methylnaphthalene	80	300	5,000	7.41 U	1.007 U	3.86 U	0.708 U	0.404 U	**45.2**	3.99 U	8.16 U	0.413 U	0.35 U	12.2 U	0.367 U	8.08 U	13.1 U	**0.9125 J**	0.348 U	0.344 U
	Phenanthrene	500	500	10,000	7.41 U	1.007 U	3.86 U	0.708 U	**1.61**	**8.97**	3.99 U	8.16 U	0.413 U	0.35 U	12.2 U	0.367 U	8.08 U	13.1 U	1.367 U	**0.4**	**0.654**
	Fluoranthene	1000	1000	10,000	7.41 U	1.007 U	3.86 U	0.708 U	0.404 U	3.63 U	3.99 U	8.16 U	0.413 U	0.35 U	12.2 U	0.367 U	8.08 U	13.1 U	1.367 U	**0.454**	**0.674**
	Pyrene	1,000	1,000	10,000	7.41 U	1.007 U	3.86 U	0.708 U	**1.08**	3.63 U	3.99 U	8.16 U	0.413 U	0.35 U	12.2 U	0.367 U	8.08 U	13.1 U	1.367 U	**0.486**	**0.763**
	Benzo(a)anthracene	7	7	3,000	7.41 U	1.007 U	3.86 U	0.708 U	0.404 U	3.63 U	3.99 U	8.16 U	0.413 U	0.35 U	12.2 U	0.367 U	8.08 U	13.1 U	**0.91 J**	0.348 U	**0.458**
	Chrysene	70	70	10,000	7.41 U	1.007 U	3.86 U	0.708 U	**1.19**	3.63 U	3.99 U	8.16 U	0.413 U	0.35 U	12.2 U	0.367 U	8.08 U	13.1 U	**0.9655 J**	**0.409**	**0.627**
	Benzo(b)fluoranthene	7	7	3,000	7.41 U	1.007 U	3.86 U	0.708 U	0.404 U	3.63 U	3.99 U	8.16 U	0.413 U	0.35 U	12.2 U	0.367 U	8.08 U	13.1 U	1.367 U	0.348 U	**0.385**
	Benzo(a)pyrene	2	2	300	7.41 U	1.007 U	3.86 U	0.708 U	0.404 U	3.63 U	3.99 U	8.16 U	0.413 U	0.35 U	12.2 U	0.367 U	8.08 U	13.1 U	1.367 U	0.348 U	**0.39**
	Benzo(g,h,i)perylene	1,000	1,000	10,000	7.41 U	1.007 U	3.86 U	0.708 U	0.404 U	3.63 U	3.99 U	8.16 U	0.413 U	0.35 U	12.2 U	0.367 U	8.08 U	13.1 U	1.367 U	0.348 U	**0.396**

Notes:

mg/kg - milligrams per kilogram (dry weight) or parts per million (ppm).

NA - Sample not analyzed for the listed analyte.

N/A - Not applicable.

NS - No MassDEP standards exist for this analyte.

U - Analyte was not detected at specified quantitation limit.

Values in **Bold** indicate the analyte was detected.

Values shown in Bold and shaded type exceed MassDEP S-1 standards.

EPH - Extractable Petroleum Hydrocarbons.

VPH - Volatile Petroleum Hydrocarbons

UCLs - Upper concentration limits.

Table 3. Summary of Analytical Results for Disposal Site Groundwater Samples
Spectra - 6 Bridge Street
Weymouth, Massachusetts

Analysis	Analyte		Sample Location:	MW-404			MW-406			MW-407			MW-410			MW-412			MW-414		
			Sample ID:	MW-404	MW-404	MW-404	MW-406	MW-406	MW-406	MW-407	MW-407	MW-407	MW-410	MW-410	MW-410	MW-412	MW-412	MW-412	MW-414	MW-414	MW-414
			Sample Date:	1/5/2017	3/23/2017	6/6/2017	1/5/2017	3/21/2017	6/7/2017	1/5/2017	3/21/2017	6/7/2017	1/6/2017	3/21/2017	6/7/2017	1/5/2017	3/22/2017	6/6/2017	1/6/2017	3/21/2017	6/7/2017
		GW-2	GW-3				combo	combo	combo							combo					
VPH																					
(ug/L)	C9-C10 Aromatics	4,000	50,000	100 U	50 U	50 U	250 U	50 U	50 U	250 U	50 U	**68.3**	250 U	50 U	50 U	250 U	50 U	50 U	250 U	50 U	50 U
	C9-C12 Aliphatics	5,000	50,000	100 U	50 U	50 U	250 U	50 U	50 U	250 U	50 U	50 U	250 U	50 U	50 U	250 U	50 U	50 U	250 U	50 U	**58.3**
	Ethylbenzene	20,000	5,000	4.0 U	2.0 U	2.0 U	10 U	**3.22**	2.0 U	10 U	2.0 U	2.0 U	10 U	2.0 U	2.0 U	10 U	2.0 U	2.0 U	10 U	2.0 U	2.0 U
	Naphthalene	700	20,000	8.0 U	4.0 U	4.0 U	10 U	**6.72**	4.0 U	10 U	4.0 U	**7.57**	10 U	4.0 U	4.0 U	10 U	4.0 U	4.0 U	10 U	4.0 U	4.0 U
EPH																					
(ug/L)	C19-C36 Aliphatics	NS	50,000	100 U	**223**	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U
	C11-C22 Aromatics	50,000	5,000	100 U	100 U	100 U	100 U	**102**	100 U	100 U	100 U	**178**	100 U	**125**	100 U	**102**	100 U	100 U	**188**	**105**	**131**

Notes:
ug/L - micrograms per liter.
NS - No MassDEP standards exist for this analyte.
U - Analyte was not detected at specified quantitation limit.
Values in **bold** indicate the analyte was detected.
VPH - Volatile Petroleum Hydrocarbons.
EPH - Extractable Petroleum Hydrocarbons.

APPENDIX F-2

PROUCL DOCUMENTATION FOR 95% UPPER CONFIDENCE LIMITS

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/15/2017 4:18:35 PM
From File	ProUCL_Import.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

C9-C18 Aliphatics

General Statistics

Total Number of Observations	17	Number of Distinct Observations	17
Number of Detects	16	Number of Non-Detects	1
Number of Distinct Detects	16	Number of Distinct Non-Detects	1
Minimum Detect	6.94	Minimum Non-Detect	6.96
Maximum Detect	4570	Maximum Non-Detect	6.96
Variance Detects	2663605	Percent Non-Detects	5.882%
Mean Detects	1633	SD Detects	1632
Median Detects	903.8	CV Detects	0.999
Skewness Detects	0.522	Kurtosis Detects	-1.413
Mean of Logged Detects	6.19	SD of Logged Detects	2.212

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.853	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.887	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.206	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.213	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1537	KM Standard Error of Mean	395.8
KM SD	1580	95% KM (BCA) UCL	2143
95% KM (t) UCL	2228	95% KM (Percentile Bootstrap) UCL	2170
95% KM (z) UCL	2188	95% KM Bootstrap t UCL	2343
90% KM Chebyshev UCL	2725	95% KM Chebyshev UCL	3262
97.5% KM Chebyshev UCL	4009	99% KM Chebyshev UCL	5475

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.589	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.794	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.174	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.227	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.522	k star (bias corrected MLE)	0.466

	A–E	F	G–K	L
48	Theta hat (MLE)	3127	Theta star (bias corrected MLE)	3504
49	nu hat (MLE)	16.71	nu star (bias corrected)	14.91
50	Mean (detects)	1633		
51				
52	**Gamma ROS Statistics using Imputed Non-Detects**			
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs			
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)			
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs			
56	This is especially true when the sample size is small.			
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates			
58	Minimum	6.94	Mean	1553
59	Maximum	4570	Median	747.5
60	SD	1614	CV	1.039
61	k hat (MLE)	0.529	k star (bias corrected MLE)	0.475
62	Theta hat (MLE)	2937	Theta star (bias corrected MLE)	3272
63	nu hat (MLE)	17.98	nu star (bias corrected)	16.14
64	Adjusted Level of Significance (β)	0.0346		
65	Approximate Chi Square Value (16.14, α)	8.062	Adjusted Chi Square Value (16.14, β)	7.469
66	95% Gamma Approximate UCL (use when n>=50)	3110	95% Gamma Adjusted UCL (use when n<50)	3357
67				
68	**Estimates of Gamma Parameters using KM Estimates**			
69	Mean (KM)	1537	SD (KM)	1580
70	Variance (KM)	2496604	SE of Mean (KM)	395.8
71	k hat (KM)	0.947	k star (KM)	0.819
72	nu hat (KM)	32.18	nu star (KM)	27.84
73	theta hat (KM)	1624	theta star (KM)	1878
74	80% gamma percentile (KM)	2509	90% gamma percentile (KM)	3717
75	95% gamma percentile (KM)	4945	99% gamma percentile (KM)	7841
76				
77	**Gamma Kaplan-Meier (KM) Statistics**			
78	Approximate Chi Square Value (27.84, α)	16.8	Adjusted Chi Square Value (27.84, β)	15.91
79	95% Gamma Approximate KM-UCL (use when n>=50)	2547	95% Gamma Adjusted KM-UCL (use when n<50)	2690
80				
81	**Lognormal GOF Test on Detected Observations Only**			
82	Shapiro Wilk Test Statistic	0.861	**Shapiro Wilk GOF Test**	
83	5% Shapiro Wilk Critical Value	0.887	Detected Data Not Lognormal at 5% Significance Level	
84	Lilliefors Test Statistic	0.189	**Lilliefors GOF Test**	
85	5% Lilliefors Critical Value	0.213	Detected Data appear Lognormal at 5% Significance Level	
86	**Detected Data appear Approximate Lognormal at 5% Significance Level**			
87				
88	**Lognormal ROS Statistics Using Imputed Non-Detects**			
89	Mean in Original Scale	1537	Mean in Log Scale	5.951
90	SD in Original Scale	1629	SD in Log Scale	2.358
91	95% t UCL (assumes normality of ROS data)	2227	95% Percentile Bootstrap UCL	2183
92	95% BCA Bootstrap UCL	2250	95% Bootstrap t UCL	2293
93	95% H-UCL (Log ROS)	122003		
94				

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution			
KM Mean (logged)	5.94	KM Geo Mean	379.9
KM SD (logged)	2.307	95% Critical H Value (KM-Log)	4.96
KM Standard Error of Mean (logged)	0.578	95% H-UCL (KM -Log)	94839
KM SD (logged)	2.307	95% Critical H Value (KM-Log)	4.96
KM Standard Error of Mean (logged)	0.578		
DL/2 Statistics			
DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1537	Mean in Log Scale	5.899
SD in Original Scale	1629	SD in Log Scale	2.455
95% t UCL (Assumes normality)	2227	95% H-Stat UCL	185150
DL/2 is not a recommended method, provided for comparisons and historical reasons			
Nonparametric Distribution Free UCL Statistics			
Detected Data appear Approximate Normal Distributed at 5% Significance Level			
Suggested UCL to Use			
95% KM (t) UCL	2228		
When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test			
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL			
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
Recommendations are based upon data size, data distribution, and skewness.			
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
C19-C36 Aliphatics			
General Statistics			
Total Number of Observations	17	Number of Distinct Observations	17
		Number of Missing Observations	0
Minimum	32	Mean	3132
Maximum	9110	Median	2740
SD	2968	Std. Error of Mean	719.8
Coefficient of Variation	0.948	Skewness	0.428
Normal GOF Test			
Shapiro Wilk Test Statistic	0.875	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.892	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.206	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.207	Data appear Normal at 5% Significance Level	
Data appear Approximate Normal at 5% Significance Level			
Assuming Normal Distribution			

	A	B	C	D	E	F	G	H	I	J	K	L
142	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
143				95% Student's-t UCL		4389				95% Adjusted-CLT UCL (Chen-1995)		4396
144										95% Modified-t UCL (Johnson-1978)		4401
145												
146	**Gamma GOF Test**											
147				A-D Test Statistic		0.89	**Anderson-Darling Gamma GOF Test**					
148				5% A-D Critical Value		0.79	Data Not Gamma Distributed at 5% Significance Level					
149				K-S Test Statistic		0.191	**Kolmogorov-Smirnov Gamma GOF Test**					
150				5% K-S Critical Value		0.22	Detected data appear Gamma Distributed at 5% Significance Level					
151	**Detected data follow Appr. Gamma Distribution at 5% Significance Level**											
152												
153	**Gamma Statistics**											
154				k hat (MLE)		0.588				k star (bias corrected MLE)		0.523
155				Theta hat (MLE)		5326				Theta star (bias corrected MLE)		5983
156				nu hat (MLE)		19.99				nu star (bias corrected)		17.8
157				MLE Mean (bias corrected)		3132				MLE Sd (bias corrected)		4329
158										Approximate Chi Square Value (0.05)		9.246
159				Adjusted Level of Significance		0.0346				Adjusted Chi Square Value		8.605
160												
161	**Assuming Gamma Distribution**											
162				95% Approximate Gamma UCL (use when n>=50))		6029				95% Adjusted Gamma UCL (use when n<50)		6478
163												
164	**Lognormal GOF Test**											
165				Shapiro Wilk Test Statistic		0.855	**Shapiro Wilk Lognormal GOF Test**					
166				5% Shapiro Wilk Critical Value		0.892	Data Not Lognormal at 5% Significance Level					
167				Lilliefors Test Statistic		0.211	**Lilliefors Lognormal GOF Test**					
168				5% Lilliefors Critical Value		0.207	Data Not Lognormal at 5% Significance Level					
169	**Data Not Lognormal at 5% Significance Level**											
170												
171	**Lognormal Statistics**											
172				Minimum of Logged Data		3.466				Mean of logged Data		6.996
173				Maximum of Logged Data		9.117				SD of logged Data		1.952
174												
175	**Assuming Lognormal Distribution**											
176				95% H-UCL		59810				90% Chebyshev (MVUE) UCL		15232
177				95% Chebyshev (MVUE) UCL		19562				97.5% Chebyshev (MVUE) UCL		25573
178				99% Chebyshev (MVUE) UCL		37380						
179												
180	**Nonparametric Distribution Free UCL Statistics**											
181	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
182												
183	**Nonparametric Distribution Free UCLs**											
184				95% CLT UCL		4316				95% Jackknife UCL		4389
185				95% Standard Bootstrap UCL		4285				95% Bootstrap-t UCL		4435
186				95% Hall's Bootstrap UCL		4331				95% Percentile Bootstrap UCL		4328
187				95% BCA Bootstrap UCL		4392						
188				90% Chebyshev(Mean, Sd) UCL		5291				95% Chebyshev(Mean, Sd) UCL		6270

97.5% Chebyshev(Mean, Sd) UCL	7627	99% Chebyshev(Mean, Sd) UCL	10294

Suggested UCL to Use

95% Student's-t UCL	4389		

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test

When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

C11-C22 Aromatics

General Statistics

Total Number of Observations	17	Number of Distinct Observations	17
		Number of Missing Observations	0
Minimum	18.5	Mean	3798
Maximum	9070	Median	2875
SD	3482	Std. Error of Mean	844.6
Coefficient of Variation	0.917	Skewness	0.199

Normal GOF Test

Shapiro Wilk Test Statistic	0.844	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.892	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.219	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.207	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	5273	95% Adjusted-CLT UCL (Chen-1995)	5231
		95% Modified-t UCL (Johnson-1978)	5279

Gamma GOF Test

A-D Test Statistic	0.915	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.789	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.247	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.219	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.6	k star (bias corrected MLE)	0.533
Theta hat (MLE)	6331	Theta star (bias corrected MLE)	7122
nu hat (MLE)	20.4	nu star (bias corrected)	18.13

MLE Mean (bias corrected)	3798	MLE Sd (bias corrected)	5201
		Approximate Chi Square Value (0.05)	9.486
Adjusted Level of Significance	0.0346	Adjusted Chi Square Value	8.835
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	7260	95% Adjusted Gamma UCL (use when n<50)	7794
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.857	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.892	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.238	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.207	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	2.918	Mean of logged Data	7.212
Maximum of Logged Data	9.113	SD of logged Data	1.972
Assuming Lognormal Distribution			
95% H-UCL	80326	90% Chebyshev (MVUE) UCL	19640
95% Chebyshev (MVUE) UCL	25245	97.5% Chebyshev (MVUE) UCL	33025
99% Chebyshev (MVUE) UCL	48307		
Nonparametric Distribution Free UCL Statistics			
Data do not follow a Discernible Distribution (0.05)			
Nonparametric Distribution Free UCLs			
95% CLT UCL	5187	95% Jackknife UCL	5273
95% Standard Bootstrap UCL	5184	95% Bootstrap-t UCL	5319
95% Hall's Bootstrap UCL	5088	95% Percentile Bootstrap UCL	5145
95% BCA Bootstrap UCL	5130		
90% Chebyshev(Mean, Sd) UCL	6332	95% Chebyshev(Mean, Sd) UCL	7479
97.5% Chebyshev(Mean, Sd) UCL	9072	99% Chebyshev(Mean, Sd) UCL	12202
Suggested UCL to Use			
99% Chebyshev (Mean, Sd) UCL	12202		
Recommended UCL exceeds the maximum observation			
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
Recommendations are based upon data size, data distribution, and skewness.			
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			

APPENDIX F-3

TRENCH AIR MODELING

TABLE 1
SOIL TO OUTDOOR AIR
Spectra - 6 Bridge Street, Weymouth, Massachusetts

	Soil EPC	Soil Temp.	Soil Temp.	Henry's Law Constant at ref. temp.	Henry's Law Reference Temp.	Normal Boiling Point	Enthalpy of vaporization at T_S	Critical Temp.	constant	Enthalpy of vaporization at T_S	Gas Constant	Henry's Law Constant at T_S	Gas Constant	Henry's Law Constant
	C_R	T_S	T'_S	H_R	T_R	T_B	$\Delta H_{v,B}$	T_C	n	$\Delta H_{v,TS}$	R_c	H_{TS}	R	H'_{TS}
Units:	µg/kg	^oC	K	atm-m^3/mol	K	K	cal/mol	K	unitless	cal/mol	cal/mol-K	atm-m^3/mol	m^3-atm/mol-K	unitless
Formula:	**Input**	(10 for screening)	(T_S + 273.15)	lookup	(lookup+273.15)	lookup	lookup	lookup	(Note 7)	(Note 8)		(Note 9)		H_{TS} / (R * T'_S)
Analyte														
On-Property Soil (0-15' bgs)														
C9-C10 Aromatics	**1.40E+05**	1.00E+01	2.83E+02	7.92E-03	2.98E+02	NA	NA	NA	NA	NA	1.99E+00	7.92E-03	8.21E-05	3.41E-01
C9-C12 Aliphatics	**1.63E+05**	1.00E+01	2.83E+02	1.56E+00	2.98E+02	NA	NA	NA	NA	NA	1.99E+00	1.56E+00	8.21E-05	6.71E+01
C9-C18 Aliphatics	**4.57E+06**	1.00E+01	2.83E+02	1.66E+00	2.98E+02	NA	NA	NA	NA	NA	1.99E+00	1.66E+00	8.21E-05	7.13E+01
C11-C22 Aromatics	**9.07E+06**	1.00E+01	2.83E+02	7.20E-04	2.98E+02	NA	NA	NA	NA	NA	1.99E+00	7.20E-04	8.21E-05	3.10E-02
Naphthalene	**1.18E+04**	1.00E+01	2.83E+02	4.83E-04	2.98E+02	4.91E+02	1.04E+04	7.48E+02	3.70E-01	1.29E+04	1.99E+00	1.52E-04	8.21E-05	6.55E-03
2-Methylnaphthalene	**4.52E+04**	1.00E+01	2.83E+02	4.99E-04	2.98E+02	5.14E+02	1.08E+04	7.61E+02	3.84E-01	1.40E+04	1.99E+00	1.43E-04	8.21E-05	6.17E-03
Phenanthrene	**8.97E+03**	1.00E+01	2.83E+02	3.93E-05	2.98E+02	6.13E+02	1.31E+04	8.69E+02	4.06E-01	1.84E+04	1.99E+00	7.58E-06	8.21E-05	3.26E-04

TABLE 1 (continued)
SOIL TO OUTDOOR AIR
Spectra - 6 Bridge Street, Weymouth, Massachusetts

	Conversion Factor µg/kg to g/g	SCS soil type in vadose zone	Vadose zone soil dry bulk density	Vadose zone soil water-filled porosity	Organic carbon partition coefficient	Vadose zone organic carbon fraction	Soil-water partition coefficient	Vadose zone soil total porosity	Vadose zone soil air-filled porosity	Conversion Factor g/cm^3 to $\mu g/m^3$	Source Vapor Conc.
	Conv01	ST_v	ρ_b	$\theta_{w,v}$	K_{oc}	$f_{oc,v}$	K_d	n_v	$\theta_{a,v}$	Conv03	C_{source}
Units:	µg/kg / g/g	unitless	g/cm^3	cm^3/cm^3	cm^3/g	unitless	cm^3/g	cm^3/cm^3	cm^3/cm^3	g/cm^3 / $\mu g/m^3$	$\mu g/m^3$
Formula:		(Note 11)	lookup	lookup	lookup	(0.002 for screening)	$K_{oc} * f_{oc}$	lookup	$n_v - \theta_{w,v}$		(Note 21)
On-Property Soil (0-15' bgs)											
C9-C10 Aromatics	1.00E-09	SCL	1.63E+00	1.46E-01	1.78E+03	2.00E-03	3.56E+00	3.84E-01	2.38E-01	1.00E+12	1.29E+07
C9-C12 Aliphatics	1.00E-09	SCL	1.63E+00	1.46E-01	1.50E+05	2.00E-03	3.00E+02	3.84E-01	2.38E-01	1.00E+12	3.53E+07
C9-C18 Aliphatics	1.00E-09	SCL	1.63E+00	1.46E-01	6.80E+05	2.00E-03	1.36E+03	3.84E-01	2.38E-01	1.00E+12	2.38E+08
C11-C22 Aromatics	1.00E-09	SCL	1.63E+00	1.46E-01	5.01E+03	2.00E-03	1.00E+01	3.84E-01	2.38E-01	1.00E+12	2.78E+07
Naphthalene	1.00E-09	SCL	1.63E+00	1.46E-01	1.19E+03	2.00E-03	2.38E+00	3.84E-01	2.38E-01	1.00E+12	3.13E+04
2-Methylnaphthalene	1.00E-09	SCL	1.63E+00	1.46E-01	2.50E+03	2.00E-03	5.00E+00	3.84E-01	2.38E-01	1.00E+12	5.48E+04
Phenanthrene	1.00E-09	SCL	1.63E+00	1.46E-01	1.40E+04	2.00E-03	2.80E+01	3.84E-01	2.38E-01	1.00E+12	1.04E+02

TABLE 1 (continued)
SOIL TO OUTDOOR AIR
Spectra - 6 Bridge Street, Weymouth, Massachusetts

	Depth below grade to bottom of trench	Depth below grade to contamination	Source Trench Separation	Diffusivity in air	Diffusivity in water	Vadose zone Effective Diffusion Coeff.	Total Overall Effective Diffusion Coeff.	Area of Trench Below Grade	Trench Ventilation Rate	Pressure Diff. between soil & enclosed space	Vadose zone soil saturated hydraulic conductivity	Conversion Factor hr to s
	L_F	L_t	L_T	D_a	D_w	D_v^{eff}	D_T^{eff}	A_B	Q_{trench}	ΔP	$K_{s,v}$	Conv02
Units:	cm	cm	cm	cm^2/s	cm^2/s	cm^2/s	cm^2/s	cm^2	cm^3/s	$g/cm\text{-}s^2$	cm/hr	s/hr
Formula:	(120 (4') for screening)	(400 for screening)	$L_t - L_F$	lookup	lookup	(Note 13)	(Note 4)	(Note 2)	(Note 22)	(40 for screening)	lookup	
On-Property Soil (0-15' bgs)												
C9-C10 Aromatics	1.20E+02	4.00E+02	2.80E+02	7.00E-02	5.00E-06	3.99E-03	3.99E-03	3.29E+05	1.70E+05	4.00E+01	5.50E-01	3.60E+03
C9-C12 Aliphatics	1.20E+02	4.00E+02	2.80E+02	7.00E-02	5.00E-06	3.99E-03	3.99E-03	3.29E+05	1.70E+05	4.00E+01	5.50E-01	3.60E+03
C9-C18 Aliphatics	1.20E+02	4.00E+02	2.80E+02	7.00E-02	5.00E-06	3.99E-03	3.99E-03	3.29E+05	1.70E+05	4.00E+01	5.50E-01	3.60E+03
C11-C22 Aromatics	1.20E+02	4.00E+02	2.80E+02	6.00E-02	5.00E-06	3.42E-03	3.42E-03	3.29E+05	1.70E+05	4.00E+01	5.50E-01	3.60E+03
Naphthalene	1.20E+02	4.00E+02	2.80E+02	5.90E-02	7.50E-06	3.37E-03	3.37E-03	3.29E+05	1.70E+05	4.00E+01	5.50E-01	3.60E+03
2-Methylnaphthalene	1.20E+02	4.00E+02	2.80E+02	6.29E-02	7.20E-06	3.59E-03	3.59E-03	3.29E+05	1.70E+05	4.00E+01	5.50E-01	3.60E+03
Phenanthrene	1.20E+02	4.00E+02	2.80E+02	3.33E-02	7.47E-06	2.15E-03	2.15E-03	3.29E+05	1.70E+05	4.00E+01	5.50E-01	3.60E+03

TABLE 1 (continued)
SOIL TO OUTDOOR AIR
Spectra - 6 Bridge Street, Weymouth, Massachusetts

	Viscosity of water at 10^oC	Viscosity of water at system temp.	Density of water	Acceleration due to gravity	Vadose zone soil intrinsic permeability	Vadose zone residual soil water content	Vadose zone effective total fluid saturation	Vadose zone van Genuchten shape parameter	Vadose zone soil relative air permeability	Vadose zone soil effective vapor permeability	Thickness of soil between soilgas & trench
	μ_{w-10}	μ_w	ρ_w	g	$k_{i,v}$	$\theta_{r,v}$	S_{te}	M_v	k_{rg}	k_v	L_{soil}
Units:	g/cm-s	g/cm-s	g/cm^3	cm/s^2	cm^2	cm^3/cm^3	unitless	unitless	unitless	cm^2	cm
Formula:		(Note 16)	(0.999 for screening)		(Note 17)	lookup	(Note 18)	lookup	(Note 19)	(Note 20)	(1 for screening)
On-Property Soil (0-15' bgs)											
C9-C10 Aromatics	1.31E-02	1.31E-02	9.99E-01	9.81E+02	2.04E-09	6.30E-02	2.59E-01	2.48E-01	8.59E-01	1.75E-09	1.00E+00
C9-C12 Aliphatics	1.31E-02	1.31E-02	9.99E-01	9.81E+02	2.04E-09	6.30E-02	2.59E-01	2.48E-01	8.59E-01	1.75E-09	1.00E+00
C9-C18 Aliphatics	1.31E-02	1.31E-02	9.99E-01	9.81E+02	2.04E-09	6.30E-02	2.59E-01	2.48E-01	8.59E-01	1.75E-09	1.00E+00
C11-C22 Aromatics	1.31E-02	1.31E-02	9.99E-01	9.81E+02	2.04E-09	6.30E-02	2.59E-01	2.48E-01	8.59E-01	1.75E-09	1.00E+00
Naphthalene	1.31E-02	1.31E-02	9.99E-01	9.81E+02	2.04E-09	6.30E-02	2.59E-01	2.48E-01	8.59E-01	1.75E-09	1.00E+00
2-Methylnaphthalene	1.31E-02	1.31E-02	9.99E-01	9.81E+02	2.04E-09	6.30E-02	2.59E-01	2.48E-01	8.59E-01	1.75E-09	1.00E+00
Phenanthrene	1.31E-02	1.31E-02	9.99E-01	9.81E+02	2.04E-09	6.30E-02	2.59E-01	2.48E-01	8.59E-01	1.75E-09	1.00E+00

TABLE 1 (continued)
SOIL TO OUTDOOR AIR
Spectra - 6 Bridge Street, Weymouth, Massachusetts

	Vapor viscosity at avg. soil temp.	Avg. Vapor Flow Rate Into trench	Infinite Source Attenuation Coeff.	Infinite Source Trench Conc.
	μ_{TS}	Q_{soil}	α	C_{trench}
Units:	g/cm-s	cm^3/s	unitless	$\mu g/m^3$
Formula:	$0.00018*(T'_S/298.15)$^0.5	(Note 5)	(Note 6)	$C_{source} * \alpha$
On-Property Soil (0-15' bgs)				
C9-C10 Aromatics	1.75E-04	3.99E-04	2.35E-09	3.04E-02
C9-C12 Aliphatics	1.75E-04	3.99E-04	2.35E-09	8.30E-02
C9-C18 Aliphatics	1.75E-04	3.99E-04	2.35E-09	5.59E-01
C11-C22 Aromatics	1.75E-04	3.99E-04	2.35E-09	6.53E-02
Naphthalene	1.75E-04	3.99E-04	2.35E-09	7.36E-05
2-Methylnaphthalene	1.75E-04	3.99E-04	2.35E-09	1.29E-04
Phenanthrene	1.75E-04	3.99E-04	2.35E-09	2.45E-07

TABLE 1 (continued)
SOIL TO OUTDOOR AIR
Spectra - 6 Bridge Street, Weymouth, Massachusetts

Notes:

Reference: *User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings* , USEPA, June 19, 2003.

(1) Purposely left blank

(2) For screening, assume a trench 4 ft deep, 3 ft wide, and 30 ft long.

(3) Purposely left blank

(4) $D_T^{eff} = L_T / (L_T / D_v^{eff})$

(5) $Q_{soil} = \Delta P{*}k_v{*}L_{soil}) / \mu_{TS}$; not from above reference

(6) $\alpha = [D_T^{eff}{*}A_B/(Q_{trench}{*}L_T)]/[(D_T^{eff}{*}A_B/(Q_{soil}{*}L_T))+1]$; assumes no resistance (Peclet number is infinite)

(7) A function of the ratio T_B/T_C:

T_B/T_C	n
<0.57	0.30
0.57-0.71	$0.74(T_B/T_C)-0.116$
>0.71	0.41

If values are not available for calculation, result is NA.

(8) $\Delta H_{v,TS} = \Delta H_{v,B}{*}[(1-T_S/T_C)/(1-T_B/T_C)]^n$; if values are not available for calculation, result is NA.

(9) $H_{TS} = EXP[-\Delta H_{v,TS}/R_c{*}(1/T_S-1/T_R)]{*}H_R$; if values are not available for calculation, result assumed to be H_R

(10) Purposely left blank

(11) Refer to 12 SCS soil types - if no site-specific information is available, use SCL for screening.

(12) Purposely left blank

(13) $D_v^{eff} = D_a{*}(\theta_{a,v}^{3.33}/n_v^2)+(D_w/H'_{TS})(\theta_{w,v}^{3.33}/n_v^2)$

(14) Purposely left blank

(15) Purposely left blank

(16) $\mu_w = \mu_{w-10} * (T'_S / 283.15)^{0.5}$

(17) $k_{i,v} = K_{s,v} * 1/Conv02 * \mu_w / (\rho_w * g)$

(18) $S_{te} = (\theta_{w,v} - \theta_{r,v}) / (n_v - \theta_{r,v})$

(19) $k_{rg} = (1 - S_{te})^{0.5} * (1-S_{te}^{1/Mv})^{2Mv}$

(20) $k_v = k_{i,v} * k_{rg}$; note that the model is very sensitive to this parameter and if site-specific values are available, they should be used.

(21) $C_{source} = H'_{TS} * C_R * Conv01 * \rho_b / (\theta_{w,v} + K_d * \rho_b + H'_{TS} * \theta_{a,v}) * Conv02$

(22) For screening, assume a trench 4 ft deep, 3 ft wide, 30 ft long and an air exchange rate of 60/hr. The air exchange rate is based on the assumption that the wind speed in the trench is a small fraction of the ground wind speed and that it could take up to 1 minute for a contaminant to be cleared from the trench air space.

Table 2 Exposure-point concentrations (inhalation) for construction/utility workers in a trench: Groundwater less than 15 feet deep Spectra - 6 Bridge Street Weymouth, Massachusetts	CAS No.	Molecular Weight MWi g/mol	Henry's Law Constant Hi atm-m3/mol	Gas-Phase Mass Transfer Coefficient KiG cm/s	Liquid-Phase Mass Transfer Coefficient KiL cm/s	Overall Mass Transfer Coefficient Ki cm/s	Concentration of Contaminant in Groundwater Cgw ug/L	Volatilization Factor VF L/m3	Concentration of Contaminant in Trench Ctrench ug/m3	Concentration of Contaminant in Trench Ctrench mg/m3
Ethylbenzene	100-41-4	106.17	7.88E-03	4.38E-01	1.05E-03	1.04E-03	3.22E+00	4.26E-02	1.37E-02	1.37E-05
Naphthalene	91-20-3	128.17	4.83E-04	4.11E-01	9.52E-04	8.57E-04	7.57E+00	3.51E-02	2.66E-01	2.66E-04
C9-C12 Aliphatics		149	1.56	3.91E-01	8.83E-04	8.83E-04	5.83E+01	3.62E-02	2.11E-01	2.11E-04
C9-C10 Aromatics		120	0.00792	4.20E-01	9.84E-04	9.78E-04	6.83E+01	4.01E-02	2.74E-01	2.74E-04
C11-C22 Aromatics		150	0.00072	3.90E-01	8.80E-04	8.20E-04	1.88E+02	3.36E-02	6.33E-01	6.33E-04

For Mass-Transfer Coefficients

Kg,H2O	0.833	cm/s
MWH2O	18	
Kg,O2	0.002	cm/s
MWO2	32	
T	**51.6**	F
T	284	K
R	8.20E-05	atm-m3/mol-K

For Emission Flux and Concentration in Trench

CF1	1.00E-03	L/cm3
CF2	1.00E+04	cm2/m2
CF3	3600	s/hr
F	**1**	
ACH	360	hr-1

Trench dimensions

Length	**31.5**	ft
	9.60	m
Width	**31.5**	ft
	9.60	m
Depth	**8**	ft
	2.44	m
Width/Depth	3.94	

APPENDIX F-4

RISK AND HAZARD CALCULATIONS FOR SOIL

Table 1
Adult Commercial Worker - >3' Interval
Incidential Ingestion of Soil
Spectra - 6 Bridge Street
Weymouth, Massachusetts

		EPC	Exposure Estimates				Toxicity Values		Risk Estimates	
	Constituent	Soil Concentration (mg/kg)	RAF Ingestion Cancer (--)	LADD Cancer (mg/kg-d)	RAF Ingestion Noncancer (--)	ADD Noncancer (mg/kg-d)	Cancer Slope Factor (Oral) (mg/kg-d)-1	Chronic Noncancer Reference Dose (Oral) (mg/kg-d)	Cancer Risk (- -)	Hazard Quotient (- -)
VPH										
C9-C10	C9-C10 Aromatics	1.4E+02	NC	NA	1	4.7E-05	NA	3.0E-02	NA	1.6E-03
C9-C12	C9-C12 Aliphatics	1.6E+02	NC	NA	1	5.5E-05	NA	1.0E-01	NA	5.5E-04
EPH										
C9-C18	C9-C18 Aliphatics	2.2E+03	NC	NA	1	7.5E-04	NA	1.0E-01	NA	7.5E-03
C19-C36	C19-C36 Aliphatics	4.4E+03	NC	NA	1	1.5E-03	NA	2.0E+00	NA	7.4E-04
C11-C22	C11-C22 Aromatics	9.1E+03	NC	NA	0.3	9.2E-04	NA	3.0E-02	NA	3.1E-02
91-20-3	Naphthalene	2.2E+00	NC	NA	0.3	2.3E-07	NA	2.0E-02	NA	1.1E-05
91-57-6	2-Methylnaphthalene	4.5E+00	NC	NA	0.3	4.5E-07	NA	4.0E-03	NA	1.1E-04
85-01-8	Phenznthrene	2.5E+00	NC	NA	0.3	2.5E-07	NA	3.0E-02	NA	8.3E-06

	Cancer Risk	Hazard Index
TOTAL:	0E+00	4E-02

NA = Not Applicable
NC = Not carcinogenic

Where:

Bold = Cancer Risk >1.0E-05 or Hazard Quotient > 1.0E+00

LADDcancer = [Soil Concentration x UC x RAF x IR x EF x ED x EP] / [BW x APcancer]
ADDnon-cancer = [Soil Concentration x UC x RAF x IR x EF x ED x EP] / [BW x APnon-cancer]
Cancer Risk = LADDcancer x Slope Factor
Hazard Quotient = ADDnon-cancer / Reference Dose

Unit Conversion (CF) =	1.0E-06	kg/mg
Relative Absorption Factor (RAF) =	CS	(unitless) [1]
Ingestion Rate (IR) =	50	mg/d [1]
Exposure Duration (ED) =	1	day/event [1]
Exposure Frequency (EF) =	0.411	events/days (5 days per week for 30 weeks) [2]
Exposure Period (EP) =	27	year [1]
Body Weight (BW) =	61.1	kg [1]
Averaging Period Cancer (AP_{cancer}) =	70	years [1]
Averaging Period Noncancer ($AP_{noncancer}$) =	27	years [1]

[1] MassDEP, 2014
[2] Best professional judgement

Table 2
Adult Commercial Worker - >3' Interval
Dermal Contact with Soil
Spectra - 6 Bridge Street
Weymouth, Massachusetts

	Constituent	EPC Soil Concentration (mg/kg)	Exposure Estimates RAF Dermal Cancer (--)	LADD Cancer (mg/kg-d)	RAF Dermal Noncancer (--)	ADD Noncancer (mg/kg-d)	Toxicity Values Cancer Slope Factor (Oral) (mg/kg-d)-1	Chronic Noncancer Reference Dose (Oral) (mg/kg-d)	Risk Estimates Cancer Risk (--)	Hazard Quotient (--)
VPH										
C9-C10	C9-C10 Aromatics	1.4E+02	NA	NA	0.2	2.0E-05	NA	3.0E-02	NA	6.5E-04
C9-C12	C9-C12 Aliphatics	1.6E+02	NA	NA	0.2	2.3E-05	NA	1.0E-01	NA	2.3E-04
C9-C18	C9-C18 Aliphatics	2.2E+03	NA	NA	0.2	3.1E-04	NA	1.0E-01	NA	3.1E-03
C19-C36	C19-C36 Aliphatics	4.4E+03	NA	NA	0.2	6.2E-04	NA	2.0E+00	NA	3.1E-04
C11-C22	C11-C22 Aromatics	9.1E+03	NA	NA	0.1	6.4E-04	NA	3.0E-02	NA	2.1E-02
91-20-3	Naphthalene	2.2E+00	NA	NA	0.1	1.6E-07	NA	2.0E-02	NA	7.9E-06
91-57-6	2-Methylnaphthalene	4.5E+00	NA	NA	0.1	3.2E-07	NA	4.0E-03	NA	7.9E-05
85-01-8	Phenznthrene	2.5E+00	NA	NA	0.1	1.7E-07	NA	3.0E-02	NA	5.8E-06

	Cancer Risk	Hazard Index
TOTAL:	0E+00	3E-02

Bold = Cancer Risk >1.0E-05 or Hazard Quotient > 1.0E+00

NA = Not Applicable
NC = Not carcinogenic
Where:
LADDcancer = Soil Concentration x UC x SA x SAF x RAF x EF x ED x EP / (BW x APcancer)
ADDnon-cancer = Soil Concentration x UC x SA x SAF x RAF x EF x ED x EP / (BW x APnon-cancer)
Cancer Risk = LADDcancer x Slope Factor
Hazard Quotient = ADDnon-cancer / Reference Dose

Unit Conversion (UC1) =	1E-06	kg/mg
Skin Surface Area (SA) =	3473	cm^2/d [1]
Soil Adherence Factor (SAF) =	0.03	mg/cm2 [1]
Relative Absorption Factor (RAF) =	CS	(unitless) [1]
Exposure Duration (ED) =	1	day/event [1]
Exposure Frequency (EF) =	0.411	events/days (5 days per week for 30 weeks) [2]
Exposure Period (EP) =	27	yrs [1]
Body Weight (BW) =	61.1	kg [1]
Averaging Period Cancer (AP_{cancer}) =	70	years [1]
Averaging Period Noncancer ($AP_{noncancer}$) =	27	yrs [1]

[1] MassDEP, 2014
[2] Best professional judgement

Table 3
Adult Commercial Worker - >3' Interval
Inhalation of Fugitive Dusts - Exposure Via the Lungs
Spectra - 6 Bridge Street
Weymouth, Massachusetts

			Exposure Estimates		Toxicity Values		Risk Estimates	
	Constituent	Soil Concentration (mg/kg)	$LADE_{Inh}$ Cancer (ug/m^3)	ADE_{Inh} Noncancer (ug/m^3)	Unit Risk Factor (Inh) $(ug/m^3)^{-1}$	Chronic Noncancer Reference Conc. (Inh) (ug/m^3)	Cancer Risk (- -)	Hazard Quotient (- -)
VPH								
C9-C10	C9-C10 Aromatics	1.4E+02	1.6E-04	4.1E-04	NA	5.0E+01	NA	8.1E-06
C9-C12	C9-C12 Aliphatics	1.6E+02	1.8E-04	4.7E-04	NA	2.0E+02	NA	2.4E-06
EPH								
C9-C18	C9-C18 Aliphatics	2.2E+03	2.5E-03	6.5E-03	NA	2.0E+02	NA	3.2E-05
C19-C36	C19-C36 Aliphatics	4.4E+03	4.9E-03	1.3E-02	NA	NA	NA	NA
C11-C22	C11-C22 Aromatics	9.1E+03	1.0E-02	2.6E-02	NA	5.0E+01	NA	5.3E-04
91-20-3	Naphthalene	2.2E+00	2.5E-06	6.5E-06	NA	3.0E+00	NA	2.2E-06
91-57-6	2-Methylnaphthalene	4.5E+00	5.0E-06	1.3E-05	NA	5.0E+01	NA	2.6E-07
85-01-8	Phenznthrene	2.5E+00	2.8E-06	7.2E-06	NA	5.0E+01	NA	1.4E-07

NC = Not carcinogenic
NA = Not Applicable

	Cancer Risk	Hazard Index
TOTAL:	0E+00	6E-04

Bold = Cancer Risk >1.0E-05 or Hazard Quotient > 1.0E+00

Where:

LADEcancer = (OHM x 0.5 X PM10 x IR x RAF x EF x ED x EP x UC1 / (APcancer x BW)) x (BW assumed/IR assumed)
ADEnon-cancer = (OHM x 0.5 X PM10 x IR x RAF x EF x ED x EP x UC1 / APnon-cancer x BW) x (BW assumed/IR assumed)
Cancer Risk = LADEcancer x Cancer Slope Factor
Hazard Quotient = ADEnon-cancer / Reference Dose

Respirable Dust (PM_{10}) =	60	ug/m3 [1]
Relative Absorption Factor (RAF) =	1	unitless
Inhalation Rate (IR) =	60	l/min [1]
Exposure Frequency (EF) =	0.411	events/days (5 days per week for 30 weeks) [2]
Exposure Duration (ED) =	4	hours/event [2]
Exposure Period (EP) =	9855	days [1]
Body Weight (BW) =	61.1	kg [1]
Averaging Period Cancer (AP_{cancer}) =	25550	days [1]
Averaging Period Noncancer ($AP_{noncancer}$) =	9855	days [1]
Inhalation Rate assumed (IR assumed) =	20	m3/day [1]
Unit Conversion (UC) =	6.00E-11	(60 min/hour; 1x 10-9 kg/ug; 0.001 m3/l)

[1] MassDEP, 2014
[2] Best professional judgement

Table 4
Adult Commercial Worker - >3' Interval
Inhalation of Fugitive Dusts - Exposure Via the GI Tract
Spectra - 6 Bridge Street
Weymouth, Massachusetts

	Constituent	Soil Concentration (mg/kg)	RAF Cancer Ing (--)	Exposure Estimates: $LADD_{GI-Inh}$ Cancer (mg/kg-day)	Exposure Estimates: RAF Noncancer Ing (--)	Exposure Estimates: ADD_{GI-Inh} Noncancer (mg/kg-day)	Toxicity Values: Cancer Slope Factor (Oral) $(mg/kg\text{-}day)^{-1}$	Toxicity Values: Chronic Noncancer Reference Dose (Oral) (mg/kg-day)	Risk Estimates: Cancer Risk (- -)	Risk Estimates: Hazard Quotient (- -)
VPH										
C9-C10	C9-C10 Aromatics	1.4E+02	NC	NA	1.00E+00	1.22E-06	NA	3.0E-02	NA	4.1E-05
C9-C12	C9-C12 Aliphatics	1.6E+02	NC	NA	1.00E+00	1.42E-06	NA	1.0E-01	NA	1.4E-05
EPH										
C9-C18	C9-C18 Aliphatics	2.2E+03	NC	NA	1.00E+00	1.94E-05	NA	1.0E-01	NA	1.9E-04
C19-C36	C19-C36 Aliphatics	4.4E+03	NC	NA	1.00E+00	3.83E-05	NA	2.0E+00	NA	1.9E-05
C11-C22	C11-C22 Aromatics	9.1E+03	NC	NA	3.00E-01	2.37E-05	NA	3.0E-02	NA	7.9E-04
91-20-3	Naphthalene	2.2E+00	NC	NA	3.00E-01	5.88E-09	NA	2.0E-02	NA	2.9E-07
91-57-6	2-Methylnaphthalene	4.5E+00	NC	NA	3.00E-01	1.18E-08	NA	4.0E-03	NA	2.9E-06
85-01-8	Phenznthrene	2.5E+00	NC	NA	3.00E-01	6.48E-09	NA	3.0E-02	NA	2.2E-07

NC = Not carcinogenic
NA = Not Applicable

	Cancer Risk	Hazard Index
TOTAL:	0E+00	1E-03

Bold = Cancer Risk >1.0E-05 or Hazard Quotient > 1.0E+00

Where:

LADDcancer = (OHM x 1.5 X PM10 x IR x RAF x EF x ED x EP x UC1 / (APcancer x BW))
ADDEnon-cancer = (OHM x 1.5 X PM10 x IR x RAF x EF x ED x EP x UC1 / APnon-cancer x BW)
Cancer Risk = LADEcancer x Cancer Slope Factor
Hazard Quotient = ADEnon-cancer / Reference Dose

Respirable Dust (PM_{10}) =	60	ug/m3 [1]
Inhalation Rate (IR) =	60	l/min [1]
Exposure Frequency (EF) =	0.411	events/days (5 days per week for 30 weeks) [2]
Exposure Duration (ED) =	4	hours/event [2]
Exposure Period (EP) =	9855	days [1]
Body Weight (BW) =	61.1	kg [1]
Averaging Period Cancer (AP_{cancer}) =	25550	days [1]
Averaging Period Noncancer ($AP_{noncancer}$) =	9855	days [1]
Unit Conversion (UC1)=	6.00E-11	(60 min/hour; 1x 10-9 kg/ug; 0.001 m3/l)

[1] MassDEP, 2014
[2] Best professional judgement

Construction Worker - Soil: Table CW-1 (10-17' bgs)
Exposure Point Concentration (EPC) and Risk
Based on Construction Worker 18-25 years of age

ShortForm Version 10-12

Vlookup Version v0315

ELCR (all chemicals) =

HI (all chemicals) = 9.4E-02

****Do not insert or delete any rows****

Click on empty cell below and select OHM using arrow.

Oil or Hazardous Material (OHM)		EPC (mg/kg)	ELCR ingestion	ELCR dermal	ELCR inhalation GI	ELCR inhalation pulmonary	$ELCR_{total}$	Subchronic HQ_{ing}	Subchronic HQ_{derm}	Subchronic HQ_{inh-GI}	Subchronic HQ_{inh}	HQ_{total}
AROMATICS	C9 to C10	1.4E+02						5.7E-04	1.2E-03	1.5E-05	1.0E-05	1.8E-03
ALIPHATICS	C9 to C12	1.6E+02						2.0E-04	4.0E-04	5.2E-06	1.0E-05	6.2E-04
ALIPHATICS	C9 to C18	4.6E+03						5.6E-03	1.1E-02	1.5E-04	2.8E-04	1.7E-02
ALIPHATICS	C19 to C36	9.1E+03						1.9E-03	3.8E-03	4.8E-05		5.7E-03
AROMATICS	C11 to C22	9.1E+03						1.1E-02	3.8E-02	2.9E-04	6.8E-04	5.0E-02
NAPHTHALENE		1.2E+01						2.2E-05	7.3E-05	5.7E-07	1.5E-04	2.4E-04
METHYLNAPHTHALENE, 2-		4.5E+01						4.2E-03	1.4E-02	1.1E-04	3.4E-06	1.8E-02
PHENANTHRENE		9.0E+00						1.1E-05	3.7E-05	2.9E-07	6.7E-07	4.9E-05

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Construction Worker - Soil: Table CW-2

Equations to Calculate Cancer Risk for Construction Worker

Cancer Risk from Ingestion

$$ELCR_{ing} = LADD_{ing} * CSF_{oral}$$

$$LADD_{ing} = \frac{EPC * IR * RAF_{c\text{-}ing} * EF * ED_{ing} * EP * C1}{BW * AP_{lifetime}}$$

Cancer Risk from Dermal Absorption

$$ELCR_{derm} = LADD_{derm} * CSF_{oral}$$

$$LADD_{derm} = \frac{EPC * SA * AF * RAF_{c\text{-}derm} * EF * ED_{derm} * EP * C1}{BW * AP_{lifetime}}$$

Cancer Risk from Particulate Inhalation - Gastrointestinal Absorption

$$ELCR_{inh\text{-}GI} = LADD_{inh\text{-}GI} * CSF_{oral}$$

$$LADD_{inh\text{-}GI} = \frac{EPC * RCAF_{inh\text{-}gi} * PM_{10} * VR_{work} * RAF_{c\text{-}ing} * EF * ED_{inh} * EP * C2 * C3 * C4}{BW * AP_{lifetime}}$$

Cancer Risk from Particulate Inhalation - Pulmonary Absorption

$$ELCR_{inh} = LADD_{inh} * CSF_{inhalation}$$

$$LADD = \frac{EPC * RCAF_{inh} * PM_{10} * VR_{work} * RAF_{c\text{-}inh} * EF * ED_{inh} * EP * C2 * C3 * C4}{BW * AP_{lifetime}}$$

Parameter	Value	Units
CSF	OHM-specific	$(mg/kg\text{-}day)^{-1}$
LADD	age/OHM-specific	mg/kg-day
EPC	OHM-specific	mg/kg
IR	100	mg/day
$RAF_{c\text{-}ing}$	OHM-specific	dimensionless
$RAF_{c\text{-}derm}$	OHM-specific	dimensionless
$RAF_{c\text{-}inh}$	OHM-specific	dimensionless
EF	0.714	event/day
$ED_{ing\ \&\ derm}$	1	day/event
ED_{inh}	0.333	day/event
EP	182	days
C1	1.0E-06	kg/mg
C2	1.0E-09	kg/µg
C3	1440	min/days
C4	1.0E-03	m^3/L
BW	58.0	kg
$AP_{(lifetime)}$	25,550	days
VR_{work}	60	L/min
AF	0.29	mg/cm^2
SA	3473	cm^2/day
$RCAF_{inh\text{-}gi}$	1.5	dimensionless
$RCAF_{inh}$	0.5	dimensionless
PM_{10}	60	$\mu g/m^3$

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Construction Worker - Soil: Table CW-3

Equations to Calculate Noncancer Risk for Construction Worker

Vlookup Version v0315

Noncancer Risk from Ingestion

$$HQ_{ing} = \frac{ADD_{ing}}{RfD_{oral\text{-}subchronic}}$$

$$ADD_{ing} = \frac{EPC * IR * RAF_{nc\text{-}ing} * EF * ED_{ing} * EP * C1}{BW * AP_{noncancer}}$$

Noncancer Risk from Dermal Absorption

$$HQ_{derm} = \frac{ADD_{derm}}{RfD_{oral\text{-}subchronic}}$$

$$ADD_{dermal} = \frac{EPC * SA * AF * RAF_{nc\text{-}derm} * EF * ED_{dermal} * EP * C1}{BW * AP_{noncancer}}$$

Noncancer Risk from Particulate Inhalation - Gastrointestinal Absorption

$$HQ_{inh\text{-}GI} = \frac{ADD_{inh\text{-}GI}}{RfD_{oral\text{-}subchronic}}$$

$$ADD_{inh\text{-}GI} = \frac{EPC * RCAF_{inh\text{-}gi} * PM_{10} * VR_{work} * RAF_{nc\text{-}ing} * EF * ED_{inh} * EP * C2 * C3 * C4}{BW * AP_{noncancer}}$$

Noncancer Risk from Particulate Inhalation - Pulmonary Absorption

$$HQ_{inh} = \frac{ADD}{RfD_{inhalation\text{-}subchronic}}$$

$$ADD_{inh} = \frac{EPC_{soil} * RCAF_{inh} * PM_{10} * VR_{work} * RAF_{nc\text{-}inh} * EF * ED_{inh} * EP * C2 * C3 * C4}{BW * AP_{noncancer}}$$

Parameter	Value	Units
RfD	OHM-specific	mg/kg-day
ADD	OHM-specific	mg/kg-day
EPC	OHM-specific	mg/kg
IR	100	mg/day
$RAF_{nc\text{-}ing}$	OHM-specific	dimensionless
$RAF_{nc\text{-}derm}$	OHM-specific	dimensionless
$RAF_{nc\text{-}inh}$	OHM-specific	dimensionless
EF	0.714	event/day
$ED_{ing\ \&\ derm}$	1	day/event
ED_{inh}	0.333	day/event
EP	182	days
C1	1.0E-06	kg/mg
C2	1.0E-09	kg/µg
C3	1440	min/days
C4	1.0E-03	m^3/L
BW	58.0	kg
$AP_{noncancer}$	182	days
VR_{work}	60	L/min
AF	0.29	mg/cm^2
SA	3473	cm^2/day
$RCAF_{inh\text{-}gi}$	1.5	dimensionless
$RCAF_{inh}$	0.5	dimensionless
PM10	60	µg/m^3

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Construction Worker - Soil: Table CW-4
Definitions and Exposure Factors

Vlookup Version v0315

Parameter	Value	Units	Notes
ELCR - Excess Lifetime Cancer Risk	chemical specific	dimensionless	Pathway specific (ing =ingestion, derm=dermal, inh=inhalation)
HI - Hazard Index	chemical specific	dimensionless	Pathway specific (ing =ingestion, derm=dermal, inh=inhalation)
CSF - Cancer Slope Factor	chemical specific	$(mg/kg\text{-}day)^{-1}$	see Table CW-5.
RfD - Reference Dose	chemical specific	mg/kg-day	see Table CW-5.
LADD - Lifetime Average Daily Dose	chemical specific	mg/kg-day	Pathway specific. See Table CW-2.
ADD - Average Daily Dose	chemical specific	mg/kg-day	Pathway specific. See Table CW-3.
EPC - Exposure Point Concentration	chemical specific	mg/kg	see Table CW-1.
IR - Soil Ingestion Rate	100	mg/day	MADEP. 2002. Technical Update: Calculation of an Enhanced Soil Ingestion Rate. (http://www.mass.gov/dep/ors/orspubs.htm).
RAF_c - Relative Absorption Factor for Cancer Effects	chemical specific	dimensionless	Pathway specific - see Table CW-5.
RAF_{nc} - Relative Absorption Factor for Noncancer Effects	chemical specific	dimensionless	Pathway specific - see Table CW-5.
EF - Exposure Frequency	0.714	event/day	5 events (days) / 7 events (days) in a week; MADEP 1995 Guidance for Disposal Site Risk Characterization pg B-38.
$ED_{ing,derm}$ - Exposure Duration for ingestion or dermal exposure	1	day/event	
ED_{inh} - Exposure Duration for inhalation exposure	0.333	day/event	Represents 8 hours / event.
EP - Exposure Period	182	days	6 months; MADEP 1995 Guidance for Disposal Site Risk Characterization.
BW - Body Weight	58.0	kg	U.S. EPA. 1997. Exposure Factors Handbook. Table 7-7, Females, ages 18 - 25.
$AP_{(lifetime)}$ - Averaging Period for lifetime	25,550	days	Represents 70 years
$AP_{(noncancer)}$ - Averaging Period for noncancer	182	days	6 months; MADEP 1995 Guidance for Disposal Site Risk Characterization.
AF - Adherence Factor	0.29	mg/cm^2	MA DEP. 2002 Technical Update: Weighted Skin-Soil Adherence Factors. (http://www.mass.gov/dep/ors/orspubs.htm)
VR_{work} - Ventilation Rate during work (heavy exertion)	60	L/min	Table B-4 MADEP 1995 Guidance for Disposal Site Risk Characterization.
SA - Surface Area	3473	cm^2/day	MADEP. 1995. Guidance for Disposal Site Risk Characterization. 50th percentile for females. Appendix Table B-2.
$IFAF_{inh\text{-}gi}$ - Ingestion Fraction Adjustment Factor, gastrointestinal	1.5	dimensionless	MADEP 2007. Characterization of Risks Due to Inhalation of Particulates by Construction Workers
$IFAF_{inh}$ - Inhalation Fraction Adjustment Factor, inhalation	0.5	dimensionless	MADEP 2002. Characterization of Risks Due to Inhalation of Particulates by Construction Workers
PM10 - Concentration of PM_{10}	60	$\mu g/m^3$	MADEP 1995 Guidance for Disposal Site Risk Characterization pg B-11

MassDEP ORS
Contact: Lydia Thompson
Lydia.Thompson@state.ma.us
617-556-1165

Construction Worker - Soil: Table CW-5 Chemical-Specific Data

Vlookup Version v0315

Oil or Hazardous Material	Oral CSF $(mg/kg\text{-}day)^{-1}$	$RAF_{c\text{-}ing}$	$RAF_{c\text{-}derm}$	$RAF_{c\text{-}inh}$	Inhalation CSF $(mg/kg\text{-}day)^{-1}$	Subchronic Oral RfD mg/kg-day	Subchronic $RAF_{nc\text{-}ing}$	Subchronic $RAF_{nc\text{-}derm}$	Subchronic $RAF_{nc\text{-}inh}$	Subchronic Inhalation RfD
AROMATICS C9 to C10						3.0E-01	1	0.2	1	1.4E-01
ALIPHATICS C9 to C12						1.0E+00	1	0.2	1	1.7E-01
ALIPHATICS C9 to C18						1.0E+00	1	0.2	1	1.7E-01
ALIPHATICS C19 to C36						6.0E+00	1	0.2		
AROMATICS C11 to C22						3.0E-01	0.3	0.1	1	1.4E-01
NAPHTHALENE						2.0E-01	0.3	0.1	1	8.6E-04
METHYLNAPHTHALENE, 2-						4.0E-03	0.3	0.1	1	1.4E-01
PHENANTHRENE						3.0E-01	0.3	0.1	1	1.4E-01

Construction Worker - Soil: Table CW-6
Cyanide Calculations

The soil cyanide concentration limit set to protect a construction worker against an acute, potentially lethal one-time dose of cyanide from incidental ingestion of contaminated soil is 12,000 mg/kg_{soil}. This is the concentration of available cyanide in soil below which acute human health effects would not be expected following a one-time exposure. This soil concentration is calculated using the equation below with a one-time soil ingestion estimate of 50 mg_{soil} and an available cyanide dose limit of 0.01 $mg/kg_{body\ weight}$.

MassDEP's guidance on evaluating the risk from a one-time cyanide dose considers cyanide's potentially lethal effects as well as information on cyanide metabolism:

> Cyanides are detoxified rapidly by the body, and a large acute dose which overwhelms the detoxification mechanism is potentially more toxic than the same dose distributed over a period of hours. (MassDEP *Background Documentation for the Development of an Available Cyanide Benchmark Concentration,* originally dated October 1992, Modified August 1998)

Assessment of a potential one-time dose requires an estimate of the maximum soil concentration the trespasser could contact at any one time. The average soil concentration within a typical exposure area will underestimate the potential one-time dose. Therefore, to assess the acute risk of a one-time potentially lethal dose, the EPC for cyanide should be a conservative estimate of the maximum concentration.

The construction worker soil concentration limit to protect against adverse effects from an acute (one-time) exposure to cyanide is 12,000 mg/kg.

Acute Concentration Calculation for Cyanide

$$\text{Concentration} = \frac{\text{HQ x Acute Dose Limit x BW}}{\text{IR x RAF x Conversion Factor}}$$

Parameter	Value	Units
HQ (Hazard Quotient)	1	(unitless)
Acute Dose Limit	0.01	mg avail. CN/ kg BW
BW (Body Weight) $_{11\text{-}12}$	58	kg
IR $_{\text{(1-time reasonable max)}}$	50	mg
Conversion Factor	1.0E-06	kg soil / mg soil
RAF	1	(unitless)

The toxicological basis for estimating an allowable one-time dose is documented in MassDEP's 1992 *Background Documentation for the Development of an "Available Cyanide" Benchmark Concentration,* which is published at: http://www.mass.gov/eea/docs/dep/toxics/stypes/dscyanide.pdf

APPENDIX F-5

RISK AND HAZARD CALCULATIONS FOR GROUNDWATER

Table 1
Construction Worker
Dermal Contact with Groundwater
Spectra - 6 Bridge Street
Weymouth, Massachusetts

	Constituent	Ground Water Concentration (mg/l)	Kp cm/hr	RAF Dermal Cancer (--)	LADD Cancer (mg/kg-d)	RAF Dermal Noncancer (--)	ADD Noncancer (mg/kg-d)	Toxicity Values: Cancer Slope Factor (mg/kg-d)-1	Toxicity Values: Subchronic Non-Cancer Reference Dose (mg/kg-d)	Risk Estimates: Cancer Risk (--)	Risk Estimates: Non-Cancer Hazard Quotient (--)
VPH											
C9-C10	C9-C10 Aromatics	6.8E-02	1.3E-01	NC	NA	1.00	1.5E-03	NA	3.0E-01	NA	5.2E-03
C9-C12	C9-C12 Aliphatics	5.8E-02	1.0E+00	NC	NA	1.00	1.0E-02	NA	1.0E+00	NA	1.0E-02
100-41-4	Ethylbenzene	3.2E-03	4.8E-02	NC	NA	1.00	2.7E-05	NA	5.0E-02	NA	5.3E-04
91-20-3	Naphthalene	7.6E-03	4.6E-02	NC	NA	1.00	5.9E-05	NA	2.0E-01	NA	3.0E-04
EPH											
C19-C36	C19-C36 Aliphatics	2.2E-01	NA	NC	NA	1.00	NA	NA	6.0E+00	NA	NA
C11-C22	C11-C22 Aromatics	1.9E-01	5.2E-01	NC	NA	1.00	1.7E-02	NA	3.0E-01	NA	5.6E-02

	Cancer Risk	Hazard Index
TOTAL:	0E+00	7E-02

NA = Not Applicable
NC = No Criteria

LADD = Lifetime Average Daily Dose
RAF = Relative Absorption Coefficient
ADD = Average Daily Dose

Bold = Cancer Risk >1.0E-05 or Hazard Quotient > 1.0E+00

Where:
LADD = (EPC x SA x Kp x RAF x ED x EF x EP x UC)/(BW x APcancer)
ADD = (EPC x SA x Kp x RAF x ED x EF x EP x UC)/(BW x APnoncancer)

Constituent Specific (CS)		
Exposure Point Concentration (EPC):	CS	mg/l
Skin surface area (SA):	3477	cm2 [1]
Permeability constant (Kp):	CS	cm/h
Exposure Duration (ED):	8	hours/event [2]
Exposure Frequency (EF):	0.36	events/d [2]
Exposure Period (EP):	182	days [1]
Units Conversion (UC):	0.001	l/cm3
Body Weight (BW):	58	kg [1]
Averaging Period (APcancer):	25550	days [1]
Averaging Period (APnoncancer):	182	days [1]

[1] MassDEP, 2014
[2] Best Professional Judgement

APPENDIX F-6

RISK AND HAZARD CALCULATIONS FOR TRENCH AIR

Table 1
Construction Worker - Soil
Inhalation of Trench Air Exposure Pathway
Spectra - 6 Bridge Street
Weymouth, Massachusetts

		EPC	Estimated Dose		Toxicity Values		Risk Estimates	
	Constituent	Trench Air Concentration	ADEcancer (Cancer)	ADEnon-cancer (Non-cancer)	Unit Risk	Subchronic Noncancer Reference Concentration	Cancer Risk	Hazard Quotient
		μg/m3	μg/m3	μg/m3	μg/m3	μg/m3	(--)	(--)
VPH								
C9-C10	C9-C10 Aromatics	3.0E-02	2.6E-05	3.6E-03	NA	5.0E+02	NA	7.E-06
C9-C12	C9-C12 Aliphatics	8.3E-02	7.1E-05	1.0E-02	NA	6.0E+02	NA	2.E-05
EPH								
C9-C18	C9-C18 Aliphatics	5.6E-01	4.8E-04	6.7E-02	NA	6.0E+02	NA	1.E-04
C11-C22	C11-C22 Aromatics	6.5E-02	5.6E-05	7.8E-03	NA	5.0E+02	NA	2.E-05
91-20-3	Naphthalene	7.4E-05	6.3E-08	8.8E-06	NA	3.0E+00	NA	3.E-06
91-57-6	2-Methylnaphthalene	1.29E-04	1.1E-07	1.5E-05	NA	5.0E+02	NA	3.E-08
85-01-8	Phenanthrene	2.5E-07	2.1E-10	2.9E-08	NA	5.0E+02	NA	6.E-11

	Cancer Risk	Hazard Index
TOTAL:	0E+00	2E-04

Bold = Cancer Risk >1.0E-05 or Hazard Quotient > 1.0E+00

Where:

LADEcancer = IAC x EFx ED x EP/APcancer
ADEnon-cancer = IAC x EF x ED x EP / APnon-cancer
Cancer Risk = LADEcancer x UR
Hazard Quotient = ADEnon-cancer / Inhalation Reference Concentration

LADE = Life Time Average Daily Exposure
ADE = Average Daily Exposure
EPC = Exposure Point Concentration
$\mu g/m^3$ = micrograms per cubic meter

And where:

Exposure Frequency (EF) =	130	days/year (5 days a week for 26 weeks of exposure)
Exposure Duration (ED) =	8	hrs/day [1]
Exposure Period (EP) =	0.5	yr [1]
Unit Conversion (UC) =	0.042	days/hr
Averaging Period (APcancer) =	25550	days [1]
Averaging Period (APnon-cancer) =	182	days [1]

[1] MassDEP, 2014

Table 2
Construction Worker - Groundwater
Inhalation of Trench Air Exposure Pathway
Spectra - 6 Bridge Street
Weymouth, Massachusetts

		EPC	Estimated Dose		Toxicity Values		Risk Estimates	
		Trench Air Concentration	ADEcancer (Cancer)	ADEnon-cancer (Non-cancer)	Unit Risk	Subchronic Noncancer Reference Concentration	Cancer Risk	Hazard Quotient
	Constituent	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	(--)	(--)
VPH								
C9-C10	C9-C10 Aromatics	2.7E-01	2.3E-04	3.3E-02	NA	5.0E+02	NA	7.E-05
C9-C12	C9-C12 Aromatics	2.1E-01	1.8E-04	2.5E-02	NA	6.0E+02	NA	4.E-05
100-41-4	Ethylbenzene	1.4E-02	1.2E-05	1.6E-03	NA	9.0E+03	NA	2.E-07
91-20-3	Naphthalene	2.7E-01	2.3E-04	3.2E-02	NA	3.0E+00	NA	1.E-02
EPH								
C11-C22	C11-C22 Aromatics	6.3E-01	5.4E-04	7.6E-02	NA	5.0E+02	NA	2.E-04

	Cancer Risk	Hazard Index
TOTAL:	0E+00	1E-02

Bold = Cancer Risk >1.0E-05 or Hazard Quotient > 1.0E+00

Where:

LADEcancer = IAC x EFx ED x EP/APcancer
ADEnon-cancer = IAC x EF x ED x EP / APnon-cancer
Cancer Risk = LADEcancer x UR
Hazard Quotient = ADEnon-cancer / Inhalation Reference Concentration

LADE = Life Time Average Daily Exposure
ADE = Average Daily Exposure
EPC = Exposure Point Concentration
$\mu g/m^3$ = micrograms per cubic meter

And where:

Exposure Frequency (EF) =	130	days/year (5 days a week for 26 weeks of exposure)
Exposure Duration (ED) =	8	hrs/day [1]
Exposure Period (EP) =	0.5	yr [1]
Unit Conversion (UC) =	0.042	days/hr
Averaging Period (APcancer) =	25550	days [1]
Averaging Period (APnon-cancer) =	182	days [1]

[1] MassDEP, 2014

APPENDIX G

FEASIBILITY EVALUATION CALCULATIONS

Table G-1
LNAPL Containing Soil Volume and LNAPL Mass Volume Estimates
Algonquin
Atlantic Bridge Project
Weymouth Compressor Station
6 and 50 Bridge Street
Weymouth, Massachusetts

Estimate of LNAPL Containing Soil and LNAPL Mass			Source of Data
Disposal Site Area	31,823	ft^2	Figure 2
	0.73	acres	
Average Vertical LNAPL Thickness	3.4	ft	Table 1
Volume of LNAPL Containing Soil	108,199	ft^3	-
Average NAPL in Soil	0.101	fraction	Table 3
NAPL Volume	10,928	ft^3	-
	81,742	gal	

Table G-2
Soil Excavation and Dewatering Estimates
Algonquin
Atlantic Bridge Project
Weymouth Compressor Station
6 and 50 Bridge Street
Weymouth, Massachusetts

Soil Excavation Estimates: Overburden and LNAPL Containing Soil			Source of Data:
Disposal Site Area	31,823	ft^2	Figure 2
	0.73	acres	
Average Vertical LNAPL Thickness	3.4	ft	Table 1
LNAPL Containing Soil	4,007	yds	Table E-1
	6011	tons	-
Overburden Volume(1)(2)	11,786	yds	Assume 10 ft average thickness
	17,680	tons	
Dewatering Volume(3)	598,400	gallons	Assume 25% specific yield of one pore volume required for dewatering.

Notes:
1) Assumes no side slopes in excavation.
2) Assumes excavation will be surrounded by sheet pile.
3) Assumes insignificant leakage through sheet pile joints and underlying fine sand, silt, clay materials.

Table G-3
Cost Estimate: Soil Excavation and Off-Site Recycling - 4,000 tons
Atlantic Bridge Project
Weymouth Compressor Station
6 and 50 Bridge Street
Weymouth, Massachusetts

Description	Quantity	Units	Unit Cost	Cost	Data source
TRC Consulting & Field Work					
Soil & GW precharacterization for disposal (TRC)	0	Day	$2,000	$0	Assume existing data adequate
RGP Application / SWPPP NOI & NOT	1	LS	$15,000	$15,000	JPS Estimate
Well abandonment oversight	3	Day	$2,000	$6,000	JPS Estimate; increased.
Remediation Plans & Specifications / Bid Support	1	LS	$50,000	$50,000	JPS Estimate
Project and Construction Management/Meetings	1	LS	$200,000	$200,000	JPS Estimate
Excavation Oversight (labor/PID/1 dust meter)	51	Days	$2,000	$102,000	JPS Estimate, reduced to 36%
IRACS/RAM Plan & RAM Completion Reports	0	LS	$25,000	$0	JPS Estimate, assume not relevant
PSS with AUL (assumes survey needed)	0	LS	$30,000	$0	JPS Estimate
CWA compliance (ConCom/ACE/MassDEP)	1	LS	$40,000	$40,000	Placeholder guess
			Subtotal Consulting Work	**$413,000**	
TRC Subcontractors					
Soil precharacterization for disposal (lab)	0	ea	$1,000	$0	Assume existing data adequate
Soil precharacterization for disposal (driller)	0	day	$2,000	$0	Assume existing data adequate
Well abandonment (13 wells)(driller)	0	LS	$3,000	$0	Assume existing data adequate
RGP Compliance Sampling (lab)	1	LS	$17,000	$17,000	JPS Estimate
Post-Excavation Soil Testing (lab)	1	LS	$10,000	$10,000	JPS Estimate
			Subtotal TRC Subcontractors Work	**$27,000**	
Contractor Site Prep, Earthwork, Dewatering					
Mobilization and Contractor Work Plans	1	LS	$25,000	$25,000	JPS Estimate
Mow grass	1	LS	$1,500	$1,500	Placeholder guess
Temporary fence adjacent to pavement	400	LF	$7	$2,800	Approximation from past projects
Erosion controls (installed)	1000	LF	$15	$15,000	Scaled from Figure 2.
Excavator/operator/1 laborer (prevailing wage)	44	Day	$3,000	$132,000	NRC (formerly Enpro); reduced by 15%
2nd laborer (prevailing wage)	44	Day	$1,000	$44,000	NRC (formerly Enpro); reduced by 15%
Front Loader and Operator (prevailing wage)	43	Day	$2,200	$94,600	NRC (formerly Enpro); reduced by 15%
Roller and Operator (prevailing wage)	43	Day	$2,200	$94,600	JPS Estimate, reduced by 15%.
Dozer and Operator (prevailing wage)	43	Day	$2,200	$94,600	JPS Estimate, reduced by 15%.
Dump truck and driver (prevailing wage)	76	Day	$1,600	$121,600	NRC (formerly Enpro)
Contaminated soil removal (Trans & disposal)	4000	Ton	$100	$400,000	Table E-2 estimate
Backfill material (cert clean natural crushed gravel)	4000	Ton	$20	$80,000	Table E-2 estimate
Geotextile fabric	40000	Sq ft	$1	$40,000	Includes 25% overlap
Polysheeting	50	Rolls	$200	$10,000	JPS Estimate
Temporarily remove and replace fence	1	LS	$10,000	$10,000	Placeholder guess
Odor control allowance (mob/demob/1 month)	1	LS	$18,000	$18,000	Approximation from past projects
Shoring along road (install and removal)	25,000	Sq ft	$50	$1,250,000	1000 LF x 25 ft deep
Seismic monitoring during sheet piling	10	Day	$1,000	$10,000	Approximation from past projects
Water treatment system (mob/demob/disposal)	1	LS	$15,000	$15,000	JPS Estimate
Water treatment system operation (Grade 2I)	750,000	Gal	$1	$750,000	Table E-2 plus 25% for leakage, runoff.
Fractionation tank rental (2) (mob/demob/1 month)	1	LS	$6,000	$6,000	JPS Estimate
Frac tank cleaning (2) (prevailing wage)	1	LS	$8,000	$8,000	NRC (formerly Enpro)
Frac tank residuals disposal (non-haz)	40	Drum	$250	$10,000	CDR-increased based on Table E-2
Oil absorbents and disposal of spent in drums	1	LS	$10,000	$10,000	Placeholder guess
Police Details	16	Day	$450	$7,200	JPS Estimate
			Subtotal Contractor Work	**$3,249,900**	
Contingency	15	Percent	**Subtotal**	**$553,485**	
Total				**$4,243,385**	

Table G-4
Cost Estimate: In-Situ Bioremediation
Atlantic Bridge Project
Weymouth Compressor Station
6 and 50 Bridge Street
Weymouth, Massachusetts

Description	Quantity	Units	Unit Cost	Cost	Data source
TRC Consulting & Field Work					
Soil Bioremediation Pilot & Full Scale Management	1	LS	$300,000	$300,000	CDR Estimate
RGP Application / SWPPP NOI & NOT	1	LS	$15,000	$15,000	JPS Estimate
Well abandonment oversight	0	Day	$2,000	$0	JPS Estimate; increased.
Remediation Plans & Specifications / Bid Support	1	LS	$50,000	$50,000	JPS Estimate
Project and Construction Management/Meetings	1	LS	$100,000	$100,000	CDR Estimate
Excavation Oversight (labor/PID/1 dust meter)	0	Days	$2,000	$0	JPS Estimate, reduced to 36%
IRACS/RAM Plan & RAM Completion Reports	0	LS	$25,000	$0	JPS Estimate, assume not relevant
PSS with AUL (assumes survey needed)	0	LS	$30,000	$0	JPS Estimate
CWA compliance (ConCom/ACE/MassDEP)	1	LS	$40,000	$40,000	Placeholder guess
Subtotal Consulting Work				**$505,000**	
TRC Subcontractors					
Soil precharacterization for bioremediation (lab)	1	ea	$20,000	$20,000	CDR Estimate
Soil Pilot Study (excavator)	5	day	$3,000	$15,000	Assume 5 days
Soil Sampling- Pre- & Post Pilot and Full Scale (lab)	40	ea	$300	$12,000	Assume existing data adequate
Soil Tilling	10	LS	$3,000	$30,000	Assume 1 day/event
RGP Compliance Sampling (lab)	1	LS	$17,000	$17,000	JPS Estimate
Subtotal TRC Subcontractors Work				**$94,000**	
Contractor Site Prep, Earthwork, Dewatering					
Mobilization and Contractor Work Plans	1	LS	$25,000	$25,000	JPS Estimate
Mow grass	1	LS	$1,500	$1,500	Placeholder guess
Temporary fence adjacent to pavement	400	LF	$7	$2,800	Approximation from past projects
Erosion controls (installed)	1000	LF	$15	$15,000	Scaled from Figure 2.
Excavator/operator/1 laborer (prevailing wage)	44	Day	$3,000	$132,000	NRC (formerly Enpro); reduced by 15%
2nd laborer (prevailing wage)	44	Day	$1,000	$44,000	NRC (formerly Enpro); reduced by 15%
Front Loader and Operator (prevailing wage)	43	Day	$2,200	$94,600	NRC (formerly Enpro); reduced by 15%
Roller and Operator (prevailing wage)	43	Day	$2,200	$94,600	JPS Estimate, reduced by 15%.
Dozer and Operator (prevailing wage)	43	Day	$2,200	$94,600	JPS Estimate, reduced by 15%.
Dump truck and driver (prevailing wage)	76	Day	$1,600	$121,600	NRC (formerly Enpro)
Contaminated soil removal (Trans & disposal)	1000	Ton	$100	$100,000	Assume 1000 cy soil cannot be used as backfill.
Backfill material (cert clean natural crushed gravel)	3000	Ton	$20	$60,000	Assume 1000 cy soil cannot be used as backfill.
Geotextile fabric	40000	Sq ft	$1	$40,000	Includes 25% overlap
Polysheeting	50	Rolls	$200	$10,000	JPS Estimate
Temporarily remove and replace fence	1	LS	$10,000	$10,000	Placeholder guess
Odor control allowance (mob/demob/1 month)	1	LS	$18,000	$18,000	Approximation from past projects
Shoring along road (install and removal)	25,000	Sq ft	$50	$1,250,000	1000 LF x 25 ft deep
Seismic monitoring during sheet piling	10	Day	$1,000	$10,000	Approximation from past projects
Water treatment system (mob/demob/disposal)	1	LS	$15,000	$15,000	JPS Estimate
Water treatment system operation (Grade 2I)	750,000	Gal	$1	$750,000	Table E-2 plus 25% for leakage, runoff.
Fractionation tank rental (2) (mob/demob/1 month)	1	LS	$6,000	$6,000	JPS Estimate
Frac tank cleaning (2) (prevailing wage)	1	LS	$8,000	$8,000	NRC (formerly Enpro)
Frac tank residuals disposal (non-haz)	40	Drum	$250	$10,000	CDR-increased based on Table E-2
Oil absorbents and disposal of spent in drums	1	LS	$10,000	$10,000	Placeholder guess
Police Details	16	Day	$450	$7,200	JPS Estimate
Subtotal Contractor Work				**$2,929,900**	
Contingency	15	Percent	**Subtotal**	**$529,335**	
Total				**$4,058,235**	

APPENDIX H

ACTIVITY AND USE LIMITATION

Form 1075

Note: Pursuant to 310 CMR 40.1074(5), upon transfer of any interest in or a right to use the property or a portion thereof that is subject to this Notice of Activity and Use Limitation, the Notice of Activity and Use Limitation shall be incorporated either in full or by reference into all future deeds, easements, mortgages, leases, licenses, occupancy agreements or any other instrument of transfer. Within 30 days of so incorporating the Notice of Activity and Use Limitation in a deed that is recorded or registered, a copy of such deed shall be submitted to the Department of Environmental Protection.

NOTICE OF ACTIVITY AND USE LIMITATION
M.G.L. c. 21E, § 6 and 310 CMR 40.0000

Disposal Site Name: Calpine Fore River – 6 & 50 Bridge Street, Weymouth, Massachusetts
DEP Release Tracking No.(s): 4-26230, 4-26243

This Notice of Activity and Use Limitation ("Notice") is made as of this __day of ________, 2018, by Algonquin Gas Transmission, LLC, 890 Winter Street, Suite 300, Waltham, Massachusetts 02451, together with his/her/its/their successors and assigns (collectively "Owner").

W I T N E S S E T H:

WHEREAS, Algonquin Gas Transmission, LLC is the owner(s) in fee simple of that certain parcel(s) of land located in Weymouth, Norfolk County, Massachusetts, with the buildings and improvements thereon, pursuant to a deed recorded with the Norfolk Registry of Deeds in Book 34726, Page 482;

WHEREAS, said parcel(s) of land, which is more particularly bounded and described in Exhibit A, attached hereto and made a part hereof ("Property") is subject to this Notice of Activity and Use Limitation. The Property is shown on a plan recorded with the Norfolk Registry of Deeds in Book [to be determined], Page [to be determined];

WHEREAS, a portion of the Property ("Portion of the Property") is subject to this Notice of Activity and Use Limitation. The Portion of the Property is more particularly bounded and described in Exhibit A-1, attached hereto and made a part hereof. The Portion of the Property is shown on a plan recorded with the Norfolk Registry of Deeds in Plan Book [to be determined], Page [to be determined];

WHEREAS, the Portion of the Property comprises all of a Disposal Site as the result of a release of oil and/or hazardous material. Exhibit B is a sketch plan showing the relationship of the Portion of the Property subject to this Notice of Activity and Use Limitation to the boundaries of said disposal site existing within the limits of the Property and to the extent such boundaries have been established. Exhibit B is attached hereto and made a part hereof; and

WHEREAS, one or more response actions have been selected for the Disposal Site in accordance with M.G.L. c. 21E ("Chapter 21E") and the Massachusetts Contingency Plan, 310 CMR 40.0000 ("MCP"). Said response actions are based upon (a) the restriction of human access to and contact with oil and/or hazardous material in soil and/or (b) the restriction of certain activities occurring in, on, though, over or under the Portion of the Property. A description of the basis for such restrictions, and the oil and/or hazardous material release event(s) or site history that resulted in the contaminated media subject to the Notice of Activity and Use

Limitation is attached hereto as Exhibit C and made a part hereof;

Form 1075: continued

NOW, THEREFORE, notice is hereby given that the activity and use limitations set forth in this Notice of Activity and Use Limitation are as follows:

1. Activities and Uses Consistent with Maintaining No Significant Risk Conditions. The following Activities and Uses are consistent with maintaining a Permanent Solution and a condition of No Significant Risk and, as such, may occur on the Portion of the Property pursuant to 310 CMR 40.0000:

(i) Use for commercial and/or industrial uses, including but not limited to: banking and retail; business, professional, or governmental offices; manufacturing, automotive, or industrial uses; restaurants; municipal government facilities; public utilities facilities; and pedestrian and/or vehicle traffic and vehicle parking;;

(ii) Construction of occupied buildings, if such are completed in accordance with the Obligations and Conditions set forth in Paragraph 3 of this Notice of Activity and Use Limitation;

(iii) Gardening of agricultural crops for human consumption only using raised beds with imported clean soil;

(iv) Activities associated with emergency utility repair of existing utilities;

(v) Activities associated with construction/excavation, if such activities are conducted in accordance with the Obligations and Conditions set forth in Paragraph 3 of this Notice of Activity and Use Limitation;

(vi) Such other activities or uses which, in the Opinion of a Licensed Site Professional, shall present no greater risk of harm to health, safety, public welfare or the environment than the activities and uses set forth in this Paragraph; and

(vii) Such other activities and uses not identified in Paragraph 2 as being Activities and Uses Inconsistent with maintaining No Significant Risk Conditions.

2. Activities and Uses Inconsistent with Maintaining No Significant Risk Conditions. The following Activities and Uses are inconsistent with maintaining a Permanent Solution and a condition of No Significant Risk pursuant to 310 CMR 40.0000, and, as such, may not occur on the Portion of the Property:

(i) Residential use;

(ii) Uses where children may be present with high frequency and/or may engage in activities associated with high intensity soil exposure including, but not limited to, recreational (park, playground, athletic field), school, and daycare; and

(iii) Any activity including, but not limited to, excavation, which is likely to disturb light non-aqueous phase liquid (LNAPL) in the smear zone greater than 10 feet below existing grade, unless such activities are conducted in accordance with the Obligations and Conditions in Paragraph 3 of this Notice of Activity and Use Limitation.

3. <u>Obligations and Conditions</u>. The following obligations and/or conditions are necessary and shall be undertaken and/or maintained at the Portion of the Property to maintain a Permanent Solution and a condition of No Significant Risk:

(i) A minimum depth of ten (10) feet to LNAPL beneath the Portion of the Property must be maintained;

(ii) Prior to construction of occupied buildings, the potential for vapor intrusion associated with LNAPL must be evaluated by a Licensed Site Professional and/or mitigated (as appropriate) through the use of engineering controls;

(iii) New utilities installed within the Portion of the Property where LNAPL is present should be placed in vapor-tight utility vaults for the protection of emergency utility workers;

(iv) A Soil/LNAPL Management Plan must be prepared by a Licensed Site Professional and implemented prior to the commencement of any planned (non-emergency) intrusive construction activity within the Portion of the Property for the potential to encounter LNAPL. The Soil/LNAPL Management Plan shall describe soil excavation, handling, storage, transport, and disposal procedures and include a description of the engineering controls and air monitoring procedures to be implemented so that workers and receptors in the vicinity are not impacted by fugitive vapors. The Soil/LNAPL Management Plan must identify provisions to contain, collect, recover, store, and remove LNAPL if it is encountered. On-site workers must be informed of the requirements of the Soil/LNAPL Management Plan, and it must be available on-site throughout the course of the construction project;

(v) A Health and Safety Plan must be prepared by a Certified Industrial Hygienist or other qualified individual and implemented prior to the commencement of any planned (non-emergency) intrusive construction activity within the Portion of the Property. The Health and Safety Plan shall specify the type of personal protective equipment, engineering controls, and environmental monitoring necessary to prevent worker exposures to LNAPL through dermal contact, ingestion, and/or inhalation. Workers must be informed of the requirements of the Health and Safety Plan, and it must be available on-site throughout the course of the construction project; and

(vi) Soils within the Portion of the Property may not be relocated or removed from the Portion of the Property, unless such activity is first evaluated by a Licensed Site Professional who renders an Opinion that states that such relocation is consistent with maintaining a condition of No Significant Risk.

4. Proposed Changes in Activities and Uses. Any proposed changes in activities and uses at the Portion of the Property which may result in higher levels of exposure to oil and/or hazardous material than currently exist shall be evaluated by a Licensed Site Professional who shall render an Opinion, in accordance with 310 CMR 40.1080, as to whether the proposed changes are inconsistent with maintaining a Permanent Solution and a condition of No Significant Risk. Any and all requirements set forth in the Opinion to meet the objective of this Notice shall be satisfied before any such activity or use is commenced.

5. Violation of a Permanent or Temporary Solution. The activities, uses and/or exposures upon which this Notice is based shall not change at any time to cause a significant risk of harm to health, safety, public welfare, or the environment or to create substantial hazards due to exposure to oil and/or hazardous material without the prior evaluation by a Licensed Site Professional in accordance with 310 CMR 40.1080, and without additional response actions, if necessary, to maintain a condition of No Significant Risk.

If the activities, uses, and/or exposures upon which this Notice is based change without the prior evaluation and additional response actions determined to be necessary by a Licensed Site Professional in accordance with 310 CMR 40.1080, the owner or operator of the Portion of the Property subject to this Notice at the time that the activities, uses and/or exposures change, shall comply with the requirements set forth in 310 CMR 40.0020.

6. Incorporation Into Deeds, Mortgages, Leases, and Instruments of Transfer. This Notice shall be incorporated either in full or by reference into all future deeds, easements, mortgages, leases, licenses, occupancy agreements or any other instrument of transfer, whereby an interest in and/or a right to use the Property or a portion thereof is conveyed in accordance with 310 CMR 40.1074(5).

Owner hereby authorizes and consents to the filing and recordation and/or registration of this Notice, said Notice to become effective when executed under seal by the undersigned Licensed Site Professional, and recorded and/or registered with the appropriate Registry(ies) of Deeds and/or Land Registration Office(s).

WITNESS the execution hereof under seal this _____________ day of _____________, 2018.

ALGONQUIN GAS TRANSMISSION, LLC
By Its Operator

SPECTRA ALGONQUIN MANAGEMENT, LLC,

By: ____________________________________

Name:

Title:

COMMONWEALTH OF MASSACHUSETTS

______________, ss ____________, 2018

On this ____ day of ___________, 2018, before me, the undersigned notary public, personally appeared ________________________ (name of document signer), proved to me through satisfactory evidence of identification, which were _______________________, to be the person whose name is signed on the preceding or attached document, and acknowledged to me that (he) (she) signed it voluntarily for its stated purpose.

(as partner for ____________, a partnership)
(as ____________ for ______________, a corporation)
(as attorney in fact for ________________, the principal)
(as ___________ for _______________, (a) (the) _________________)

_________________ (official signature and seal of notary)

The undersigned Licensed Site Professional hereby certifies that in her Opinion this

Notice of Activity and Use Limitation is consistent with a Permanent Solution and maintaining a condition of No Significant Risk

Date: _________________

____
Kelley Race, PG, LSP
Licensed Site Professional SEAL

COMMONWEALTH OF MASSACHUSETTS

_______________, ss _____________, 2018

On this ____ day of ___________, 2018, before me, the undersigned notary public, personally appeared Kelley Race, proved to me through satisfactory evidence of identification, which were _______________________, to be the person whose name is signed on the preceding or attached document, and acknowledged to me that she signed it voluntarily for its stated purpose.

as Licensed Site Professional for Algonquin Gas Transmission LLC,

_________________ (official signature and seal of notary)

Upon recording, return to:

Algonquin Gas Transmission, LLC
890 Winter Street, Suite 300
Waltham, Massachusetts 02451

EXHIBIT A

LEGAL DESCRIPTION

A CERTAIN PARCEL OF LAND SITUATED IN THE CITY OF WEYMOUTH, IN THE COUNTY OF NORFOLK AND THE COMMONWEALTH OF MASSACHUSETTS BOUNDED AND DESCRIBED AS FOLLOWS:

COMENCING AT A POINT BEING AT STA:7+22.05 ON THE MASS DOT BASELINE FOR ROUTE 3A, LAYOUT 8237 OF 2012; THENCE N 23°56'48" E A DISTANCE OF FIFTY SIX AND NINETY ONE HENDREDTHS FEET (56.91’) TO THE POINT OF BEGINNING; THENCE

N 68°41'20" W A DISTANCE OF ONE HUNDRED SIXTY AND TWENTY SIX HUNDREDTHS FEET (160.26') TO A POINT; THENCE

N 70°58'50" W A DISTANCE OF TWO HUNDRED AND ZERO HUNDREDTHS FEET (200.00') TO A POINT; THENCE

N 74°29'20" W A DISTANCE OF TWO HUNDRED THIRTY SEVEN AND NINETY FOUR HUNDREDTHS FEET (237.94') TO A POINT; THENCE

N 15°30'40" E A DISTANCE OF EIGHTEEN AND FORTY HUNDREDTHS FEET (18.40') TO A POINT; THENCE

N 74°29'20" W A DISTANCE OF SIXTY SEVEN AND ZERO HUNDREDTHS FEET (67.00') TO A POINT; THENCE

ALONG THE EXTREME LOW WATER AS SHOWN ON LAND COURT PLAN 7785C APPROXIMATELY ONE THOUSAND FOUR HUNDRED AND SIXTY SEVEN FEET (1,467’) TO A POINT; THENCE

S 20°34'21" E A DISTANCE OF SEVENTY EIGHT AND EIGHTY FOUR HUNDREDTHS FEET (78.84') TO A POINT; THENCE

S 66°42'19" E A DISTANCE OF FIFTY ONE AND SIXTY HUNDREDTHS FEET (51.60') TO A POINT; THENCE

N 55°48'02" E A DISTANCE OF TWENTY FOUR AND EIGHTY FOUR HUNDREDTHS FEET (24.84') TO A POINT; THENCE

N 81°57'10" E A DISTANCE OF FORTY EIGHT AND EIGHTY FOUR HUNDREDTHS FEET (48.84') TO A POINT; THENCE

S 06°06'06" W A DISTANCE OF FIVE HUNDRED FORTY TWO AND TWO HUNDREDTHS FEET (542.02') TO A POINT; THENCE

S 76°07'04" W A DISTANCE OF SEVENTY FIVE AND SEVENTY TWO HUNDREDTHS FEET (75.72') TO A POINT; THENCE

SOUTHERLY AND CURVING TO THE RIGHT ALONG THE ARC OF A NON TANGENT CURVE HAVING A RADIUS OF ONE HUNDRED FIFTEEN AND FOURTEEN HUNDREDTHS FEET (115.14'), A LENGTH OF ONE HUNDRED FIFTY EIGHT AND FORTY SEVEN HUNDREDTHS FEET (158.47') AND A CHORD LENGTH OF ONE HUNDRED FORTY SIX AND TWENTY SIX

HUNDREDTHS FEET (146.26') WITH A CHORD BEARING OF S 09°32'02" E TO A POINT; THENCE

S 60°02'12" E A DISTANCE OF ELEVEN AND FORTY NINE HUNDREDTHS FEET (11.49') TO A POINT; THENCE

S 15°49'16" E A DISTANCE OF THIRTY SEVEN AND SIXTY TWO HUNDREDTHS FEET (37.62') TO A POINT; THENCE

S 29°32'46" W A DISTANCE OF TEN AND THIRTY EIGHT HUNDREDTHS FEET (10.38') TO A POINT; THENCE

N 60°30'49" W A DISTANCE OF NINETY THREE AND SIXTY HUNDREDTHS FEET (93.60') TO A POINT; THENCE

N 29°29'10" E A DISTANCE OF FIVE AND ZERO HUNDREDTHS FEET (5.00') TO A POINT; THENCE

N 60°30'50" W A DISTANCE OF FOUR HUNDRED FIFTY THREE AND FIVE HUNDREDTHS FEET (453.05') TO THE POINT OF BEGINNING. SAID PARCEL CONTAINING 658,363SQUARE FEET OR 15.114 ACRES MORE OR LESS AS SHOWN ON A PLAN TITLED “SUBDIVISION PLAN OF LAND IN WEYMOUTH MASSACHUSETTS” PREPARED BY VHB, INC. DATED FEBRUARY 1, 2017.

EXHIBIT A-1

LEGAL DESCRIPTION

A CERTAIN PARCEL OF LAND SITUATED IN THE CITY OF WEYMOUTH, IN THE COUNTY OF NORFOLK AND THE COMMONWEALTH OF MASSACHUSETTS BOUNDED AND DESCRIBED AS FOLLOWS:

COMENCING AT A POINT BEING AT STA:7+22.05 ON THE MASS DOT BASELINE FOR ROUTE 3A, LAYOUT 8237 OF 2012; THENCE N 23°56'48" E A DISTANCE OF FIFTY SIX AND NINETY ONE HENDREDTHS FEET (56.91’); THENCE N 6°54'26" E A DISTANCE OF SIXTY TWO AND NO HUNDRETHS (62.00 TO THE POINT OF BEGINNING; THENCE

N 08°39'23" E A DISTANCE OF SEVENTY TWO AND FIVE HUNDREDTHS FEET (72.05') TO A POINT; THENCE

N 24°50'01" E A DISTANCE OF SIXTEEN AND NINE HUNDREDTHS FEET (16.09') TO A POINT; THENCE

N 55°22'31" E A DISTANCE OF EIGHTY TWO AND FORTY SIX HUNDREDTHS FEET (82.46') TO A POINT; THENCE

N 57°19'11" E A DISTANCE OF FORTY NINE AND FORTY TWO HUNDREDTHS FEET (49.42') TO A POINT; THENCE

S 80°33'39" E A DISTANCE OF ONE HUNDRED NINETEEN AND THIRTY SEVEN HUNDREDTHS FEET (119.37') TO A POINT; THENCE

S 05°30'42" W A DISTANCE OF ONE HUNDRED SIXTY EIGHT AND NINETY THREE HUNDREDTHS FEET (168.93') TO A POINT; THENCE

S 07°53'51" W A DISTANCE OF SEVENTY TWO AND ELEVEN HUNDREDTHS FEET (72.11') TO A POINT; THENCE

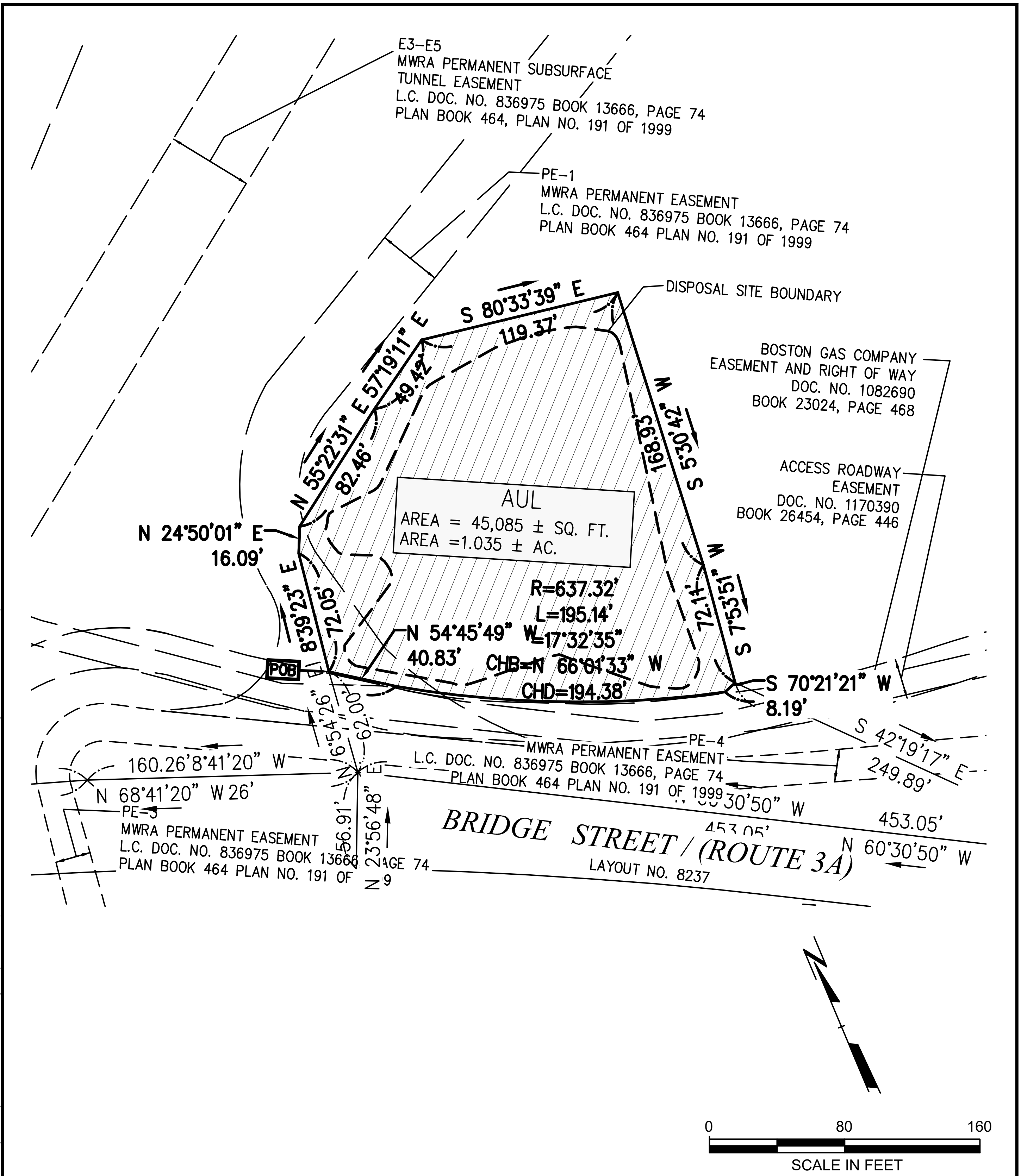
S 70°21'21" W A DISTANCE OF EIGHT AND NINETEEN HUNDREDTHS FEET (8.19') TO A POINT; THENCE

NORTHWESTERLY AND CURVING TO THE RIGHT ALONG THE ARC OF A CURVE HAVING A RADIUS OF SIX HUNDRED THIRTY SEVEN AND THIRTY TWO HUNDREDTHS FEET (637.32'), A LENGTH OF ONE HUNDRED NINETY FIVE AND FOURTEEN HUNDREDTHS FEET (195.14') AND A CHORD LENGTH OF 194.38 FEET (194.38') WITH A CHORD BEARING OF N 66°01'33" W TO A POINT; THENCE

N 54°45'49" W A DISTANCE OF FORTY AND EIGHTY THREE HUNDREDTHS FEET (40.83') TO THE POINT OF BEGINNING.

SAID PARCEL CONTAINING 45084.75 SQUARE FEET OR 1.035 ACRES MORE OR LESS AS SHOWN ON A PLAN TITLED “ACTIVITY USE LIMITATION PLAN OF LAND IN WEYMOUTH MASSACHUSETTS” PREPARED BY VHB, INC. DATED SEPTEMBER 27, 2017.

EXHIBIT B



TRC

2 Liberty Sq
6th Floor
Boston, MA 02113
(617)350-3444

PROJECT:

WEYMOUTH, MASSACHUSETTS
RTNs 4-26230 and 4-26243

TITLE:

EXHIBIT B - SKETCH PLAN

DRAWN BY:	JMM
CHECKED BY:	RN
APPROVED BY:	RN
DATE:	02/15/2018
PROJ. NO.:	140143
FILE:	AUL Sketch Plan.dwg

EXHIBIT B

EXHIBIT C

Activity and Use Limitation Opinion
6 & 50 Bridge Street
Algonquin Gas Transmission, LLC
Weymouth, Massachusetts

Introduction

In accordance with the requirements of 310 CMR 40.1074, this Activity and Use Limitation (AUL) Opinion has been prepared to maintain a condition of No Significant Risk for the Massachusetts Department of Environmental Protection (MassDEP) Disposal Site that is tracked under Release Tracking Numbers (RTNs) 4-26230 and 4-26243. The Disposal Site is identified as an approximate one-acre portion within the four-acre North Parcel of the approximately 12.3-acre Atlantic Bridge Project Weymouth Compressor Station (ABPWCS) Property (the Property), a triangular peninsula lying northeast of Route 3A (Bridge Street), at 6 & 50 Bridge Street, Norfolk County, Weymouth, Massachusetts.

The area subject to this AUL is shown on Exhibit B and is roughly coincident with the boundaries of the Disposal Site for RTNs 4-26230 and 4-26243. The Property is currently owned by Algonquin Gas Transmission, LLC (Algonquin) and is a combination of vegetated land, asphalt paved and unpaved access roads, storage areas, and an existing Algonquin metering and regulating station on the southwest portion. A Massachusetts Water Resources Authority (MWRA) pumping station abuts the Property on the northeast. There is an existing public walkway located directly east of the Property along King's Cove.

On July 29, 2016, RTN 4-26230 was issued in response to Reportable Concentrations (RCs) of petroleum-related compounds detected in soil above applicable RCs for category S-1 soil (RCS-1). The same day RTN 4-26243 was issued in response to a 72-hour reporting condition pursuant to 310 CMR 40.0314 that was triggered when greater than 0.5 inch of oil (referred to as light non-aqueous phase liquid or LNAPL) was observed in a monitoring well (MW-201) on the Property.

The AUL area and the larger 6 & 50 Bridge Street Property are shown on "Activity and Use Limitation Plan of Land in Weymouth, MA, Prepared for Spectra Energy Partners, LLC, Prepared by Vanasse Hangen Brustlin, Inc., Dated September 27, 2017", which is included by reference in the Notice of AUL for which this opinion has been prepared.

Reason for Activity and Use Limitation (310 CMR 40.1074(2)(e)

Based on the persistent presence of LNAPL in the subsurface at depths greater than 10 feet below existing grade, an AUL is required for the Disposal Site to prevent direct contact with LNAPL. In addition, the AUL requires restriction on future use of the Disposal Site and further investigation of the potential vapor intrusion pathway and/or engineering controls installed to mitigate the vapor intrusion pathway if building construction occurs within the Disposal Site boundary where LNAPL is present.

Site History, Summary of Release and Response Actions Taken to Address the Release (310 CMR 40.1074(2)(f)

Review of available historical maps indicate that the Property within which the Disposal Site is situated historically consisted of significantly less upland area and was undeveloped. Following tideland filling activities in approximately the late 1910s/early 1920s, the areal footprint of the Property as depicted in the historic record remains largely unchanged. The source(s) of the material used to fill the Property is unknown; however, an off-site and off-property source(s) of material would have been required given that much of the current footprint of the Property was tidal until at least 1917. Ancillary filling during operation of Boston Edison's Edgar Station south of the Property would also have originated off-property. Consistent with the timeframe for development of the Edgar Station, the Sanborn® Fire Insurance Map from 1927 indicates significant filling has occurred between the Weymouth Fore River and King's Cove and the Illuminating Company of Boston is depicted as occupying and staging coal at the Property. Although the eastern portion of the Property remains undeveloped, the Illuminating Company of Boston remains present through at least 1962 and coal storage occurs until at least 1969 within the western portion of the Property.

Two above ground storage tanks (ASTs), a No. 2 Fuel Oil tank with a capacity of 11,256,000 gallons and a Fuel Additive tank with a 6,000-gallon capacity, were present on the Property. The larger Fuel Oil AST was installed in the late 1970s and the historic photographic record indicates that the Fuel Oil AST was removed sometime between January 2004 and April 2005. The smaller Fuel Additive AST was installed in 1990 and removed from the property in 1997.

Summarized below are the previous investigations conducted at the Property and Disposal Site that are regarded to be representative of current Site conditions or have triggered RTNs in the past.

Investigations on the Property lead to ABB Environmental Services (ABB) completing a partial Response Action Outcome (RAO) Statement for RTN 4-3002387 (previously identified as RTN 3-2387 before the Town of Weymouth was moved from MassDEP Region 3 to Region 4). In the July 1997 Class B-1 RAO, ABB identified contaminant concentrations in soil that exceeded applicable cleanup criteria (e.g., arsenic concentrations of up to 228 mg/kg). However, ABB attributed those concentrations to the presence of coal ash, which was observed during boring advancement and test pitting. ABB inferred contaminant concentrations identified were not reportable to MassDEP due to a Massachusetts Contingency Plan (MCP, 310 CMR 40.0000) reporting exemption for coal/coal ash.

TRC observed geotechnical soil investigations completed by others in June 2015, December 2015, and April 2016. Geotechnical investigations included the completion of soil borings (June 2015 and April 2016) and test pits (December 2015) and identified the presence of anthropogenic materials in soil beneath the Property up to 22 feet below grade. TRC collected soil samples for laboratory analysis during geotechnical investigation activities.

Soil analytical results indicated the presence of metals (particularly arsenic) at concentrations consistent with those identified by ABB. During installation of geotechnical soil boring B-105 in April 2016, TRC observed soils containing viscous petroleum from approximately 14 to 17 feet below grade. Laboratory analysis for volatile and extractable petroleum hydrocarbons of soil collected at B-105 between 14 -17' identified extractable petroleum hydrocarbons in excess of MCP RCS-1 Standards. This reporting condition resulted in MassDEP assigning RTN 4-26230.

In May 2016, TRC oversaw the installation of five soil borings and monitoring wells (B/MW-201 through 205) to evaluate the extent of the petroleum identified at boring B-105. Petroleum staining consistent with that observed at B-105 was identified at B/MW-201 from approximately 12 to 18 feet below grade. No visual or olfactory indicators of petroleum contamination were observed at borings B/MW-202 through B/MW-205.

On July 29, 2016, during gauging of monitoring wells on the Disposal Site, TRC identified greater than 0.5 inch of LNAPL in monitoring well MW-201, triggering a 72-hour reporting condition, pursuant to 310 CMR 40.0313(1). This reporting condition resulted in MassDEP assignment of RTN 4-26243.

TRC conducted Immediate Response Actions (IRA) from August 2016 to November 2017 (date of IRA Status Report #3) to address RTN 4-26243. Measures taken under the IRA included:

- Gauging of monitoring wells to evaluate the thickness of LNAPL present, at frequencies up to weekly;
- Characterization of the LNAPL via petroleum fingerprint analysis;
- Installation of 37additional soil borings to evaluate the extent of LNAPL;
- Collection of soil samples from soil borings to evaluate soil contaminant concentrations;
- Installation of 18 additional groundwater monitoring wells;
- Completion of 4 seasonal rounds of groundwater sample collection from all wells on the Property for laboratory analysis of volatile and/or extractable petroleum hydrocarbons;
- Deployment/removal/disposal of oil-absorbent socks on a weekly or biweekly basis in wells with persistent LNAPL;
- Completion of a skim test to evaluate LNAPL recoverability; and,
- Collection of soil cores for specialty laboratory analysis to evaluate LNAPL saturation levels in soils, fluid properties of the LNAPL, and fluid transport properties of the soil.

Based on the actions completed under the IRA, TRC concluded the following:

- The LNAPL was identified as weathered No. 2 Fuel Oil;
- LNAPL was observed in several of the borings and in monitoring wells proximate to the footprint of the former 11,256,000-gallon No. 2 Fuel Oil AST;
- The depth to product ranges from approximately 10 feet below existing grade to 12.6 feet below grade.
- Volatile and extractable petroleum hydrocarbon concentrations in groundwater did not exceed MCP Method 1 GW-2 and GW-3 criteria in any of the sampling events (August 2016, November 2016, January 2017, March 2017, and June 2017), which indicates a

lack of a significant dissolved phase plume. The lack of elevated soil jar headspace readings supports the lack of a significant soil vapor plume in the vadose zone. A limited potential may exist for volatile components of the LNAPL to partition into soil and soil vapor and impact air in future buildings and underground utilities

- LNAPL occurs mostly in Historic Fill at a depth ranging between approximately 10 and 18 feet below existing grade. Petroleum-containing soil ranged from 0.2 to 6 feet in thickness, averaging 3.3 feet. LNAPL and petroleum-containing soil decreases abruptly in all direction supporting that capillary forces have stabilized the release. LNAPL is not observed in the outer perimeter of monitoring wells. Thus, gauging data supports it is not migrating.
- LNAPL thickness was gauged weekly or biweekly in Disposal Site monitoring wells between August 29, 2016 and June 19, 2017. The LNAPL is observed to be a black, viscous, sticky liquid that tends to make LNAPL thickness measurements difficult and biased high. The LNAPL transmissivity (Tn) ranged from 0.537 ft^2/d to 0.0027 ft^2/day, which are below the ASTM 2856 criterion of 0.8 ft^2/day, and supports it is infeasible to initiate LNAPL removal operations.
- Chemical analysis of the LNAPL indicates it consists primarily of long chain C11-C22 aromatic and C9-C36 aliphatic petroleum hydrocarbon compounds. The dynamic viscosity of the LNAPL was determined to be 43,641 cP at 50^oF (similar to groundwater temperature), and is 4 orders of magnitude higher than a cutoff point of 2-3 cSt for significant migration[1]. A comparison of Disposal Site conditions to those in MassDEP's Policy #WSC-16-450 indicates "hydraulic/vacuum recovery technologies are deemed to be infeasible."
- An Imminent Hazard (IH) is not presented by the impacts that have come to be located at this Disposal Site. This determination is based on a review of criteria for conditions "deemed to pose" an IH under 310 CMR 40.0321(1) and the criteria for conditions that "could pose" an IH under 310 CMR 40.0321(2).
- The extent of LNAPL is bounded by wells located on the Disposal Site and Property at greater distances from the former Fuel Oil AST boundary, including wells MW-416 and MW-417 located beyond the fence line.

Additional information on the response actions that have been conducted at the Disposal Site is summarized in the following reports, as well as the forthcoming PSCS:

- IRA Plan, dated September 15, 2016
- IRA Status Report #1, dated November 22, 2016
- IRA Status Report #2, dated May 11, 2017
- Phase I Initial Site Investigation Report and Tier Classification, dated July 28, 2017
- IRA Status Report #3, dated November 16, 2017

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[1] *Assessment and Remediation of Petroleum Contaminated Sites*. G. Mattney Cole, CRC Press, Inc. 1994.

- IRA Completion Report, dated [Insert date]

Agreement to Reference Notice of AUL

In accordance with 310 CMR 40.1074(2)(h), Algonquin Gas Transmission LLC and its successors and assigns agree to reference the AUL in all deeds, easements, mortgages, leases, licenses, occupancy agreements, or any other agreements which convey an interest in and/or a right to use the portion of the Property subject to the AUL.

Procedures for Changing Permitted Site Activities and Uses

In accordance with 310 CMR 40.1074(2)(i), a description of the procedures to be followed to ensure that changes in permitted activities and/or uses meet the objectives of the AUL is provided below:

Any proposed changes in activities and/or uses within the AUL boundaries which may result in higher levels of exposure to oil and/or hazardous material than currently exist will be evaluated by an LSP. The LSP will render an Opinion, consistent with 310 CMR 40.1080, as to whether the proposed changes will result in a significant risk of harm to human health, safety, public welfare, or the environment. Any and all requirements set forth above to meet the objective of the AUL will be satisfied before any proposed changes in activity and/or use are initiated.

Prepared for:
Algonquin Gas Transmission LLC
890 Winter Street, Suite 300,
Waltham, Massachusetts 02451

Prepared by:
TRC Environmental Corporation
650 Suffolk Street
Lowell, Massachusetts 01854

Kelley Race, PG, LSP
Licensed Site Professional No. 3180

LSP Seal:

Date:

EXHIBIT D

EXHIBIT D

DOCUMENTATION OF SIGNATORY AUTHORITY

I, __________________, do hereby certify that I am the ___________________________, having a principal office at ______________________________, and that pursuant to a vote of the ___________________________on ______________, _____, I am duly authorized to execute the forgoing document on behalf of the ___________________________.

In Witness Whereof, I have hereunto set my hand on this ___day of______________, 2018.

____

Name,

as ______________________________

THE COMMONWEALTH OF MASSACHUSETTS

_______________________,ss

On this ___ day of _____________ 2018, before me, the undersigned notary public, personally appeared _______________________, proved to me though satisfactory evidence of identification, which was photographic identification with a signature issued by a federal or state governmental agency, oath or affirmation of a credible witness, personal knowledge of the undersigned, to be the person whose name is signed on the preceding or attached documents in my presence.

(*Official seal*)

____

_________, Notary Public

My Commission Expires:

APPENDIX I

PUBLIC INVOLVEMENT NOTICES

2 Liberty Square
6th Floor
Boston, MA 02109

617.350.3444 PHONE
617.350.3443 FAX

www.trcsolutions.com

XXXX __, 2018

Daniel McCormack, R.S., C.H.O.
Director Weymouth Health Department
75 Middle Street
Weymouth, MA 02189

Re: Atlantic Bridge Project Weymouth Compressor Station
6 & 50 Bridge Street, Weymouth, Massachusetts
RTNs 4-26243 and 4-26230

To Whom It May Concern:

TRC Environmental Corporation (TRC) is providing this notification letter on behalf of Algonquin Gas Transmission, LLC (Algonquin) to inform you of the availability of a Immediate Response Action Report and Permanent Solution with Conditions Statement including an Activity and Use Limitation for the above-referenced release in Weymouth, Massachusetts. A notice of Activity and Use Limitation statement will be published in the Boston Globe, Weymouth News, and Patriot Ledger newspapers the week of ________, 2018. A copy of that notice and the Activity and Use Limitation is attached to this letter.

The Permanent Solution with Conditions Statement including the Activity and Use Limitation has been provided to your office as part of the information repository established under the Public Involvement Plan site designation. In addition, the documents can viewed on the Massachusetts Department of Environmental Protection (MassDEP release lookup website (http://public.dep.state.ma/SearchableSites/Search.aspx) or at the MassDEP Southeast Regional Office, location at 20 Riverside Drive, Lakeville, MA 02347. The public may request an appointment by calling (508) 946-2700.

If you have any questions concerning this notification, please contact us at (617) 385-6033.

Sincerely,
TRC ENVIRONMENTAL CORPORATION

DRAFT DRAFT

Kelley C. Race, P.G., LSP
Program Manager

Ryan Niles, P.G.
Project Manager

cc Gary Davis, Gus Lachlan- Algonquin

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XXXX __, 2018

Town of Weymouth
Mayor's Office
75 Middle Street
Weymouth, Massachusetts 02189

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The Permanent Solution with Conditions Statement including the Activity and Use Limitation has been provided to the Health Department as part of the information repository established under the Public Involvement Plan site designation. A copy of the Activity and Use Limitation is attached for your files. In addition, the documents can viewed on the Massachusetts Department of Environmental Protection (MassDEP release lookup website (http://public.dep.state.ma/SearchableSites/Search.aspx) or at the MassDEP Southeast Regional Office, location at 20 Riverside Drive, Lakeville, MA 02347. The public may request an appointment by calling (508) 946-2700.

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APPENDIX J

BEST MANAGEMENT PRACTICES FOR NON-COMMERCIAL GARDENING AT DISPOSAL SITES

Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

One Winter Street Boston, MA 02108 • 617-292-5500

DEVAL L. PATRICK
Governor

MAEVE VALLELY BARTLETT
Secretary

DAVID W. CASH
Commissioner

BEST MANAGEMENT PRACTICES ("BMPS") FOR NON-COMMERCIAL GARDENING AT DISPOSAL SITES

WSC # 14-910

This document provides guidance on the use of Best Management Practices or "BMPs" for gardening at locations within the boundary of a disposal site cleaned up pursuant to the Massachusetts Contingency Plan (MCP), 310 CMR 40.0000.

This document is intended solely as guidance. It is not a regulation, rule or requirement, and should not be construed as mandatory. It does not create any substantive or procedural rights, and is not enforceable by any party in any administrative proceeding with the Commonwealth. This document provides guidance on approaches the Massachusetts Department of Environmental Protection (MassDEP) considers acceptable for meeting requirements set forth in the MCP. Parties using this guidance should be aware that other acceptable alternatives may be available for achieving and documenting compliance with the applicable regulatory requirements and performance standards of the MCP.

Benjamin J. Ericson
Assistant Commissioner

12/31/14

1.0 Introduction: Why Should Gardening Best Management Practices Be Used?

It is not uncommon for properties in Massachusetts to have measurable levels – usually low levels – of contaminants such as lead or petroleum hydrocarbons in soil. These contaminants may be present from natural sources or as a result of human activities on or around the property. Some contamination may require cleanup based on the standards published by the Massachusetts Department of Environmental Protection (MassDEP) in 310 CMR 40.0000, the Massachusetts Contingency Plan (MCP), although even properties that have been cleaned up under the MCP will likely have measurable residual levels of some contaminants remaining in the soil. Such residual levels are safe and protective when they meet the cleanup requirements.

MassDEP recognizes that in a residential setting, yards and gardens are areas where people are most likely to have increased direct and indirect contact with soils, and that many gardeners may wish to further reduce their exposure to even residual contaminants in soil. Therefore MassDEP has developed recommendations for practical techniques, or Best Management Practices ("BMPs"), for non-commercial gardening in areas that may still contain residual levels of contaminants. These BMPs are consistent with national guidance on urban gardening and reflect a consensus among gardening experts on measures that effectively reduce exposure to common contaminants that may occur through non-commercial gardening. They work by isolating the garden from any contamination remaining in the soil below through the use of impermeable barriers and/or raised garden beds, and other relatively simple, common sense measures.

In all cases, the *use* of the recommended BMPs is optional. The *inclusion* of BMPs and a recommendation for their use in an MCP Permanent Solution Statement that documents the disposal site assessment and cleanup is required in specific circumstances, however, to inform current and future occupants of a property of practical methods to further reduce exposure to residual soil contaminants during gardening.

2.0 Purpose

The purpose of this guidance is to support Potentially Responsible Parties and Licensed Site Professionals in preparing those Permanent Solution Statements that, pursuant to 310 CMR 1056(2)(j)1 and based on a Method 3 risk characterization, require inclusion of "the recommendation and description of Best Management Practices for Non-commercial Gardening in a residential setting to minimize and control potential risk qualitatively evaluated pursuant to 310 CMR 40.0923(3)(c)." More generally, beyond the required recommendation for BMPs under the MCP, MassDEP encourages the optional use these gardening BMPs or similar measures by gardeners in residential settings who wish to reduce their potential exposure to soil contaminants.

3.0 Scope and Applicability

The following provisions are relevant to including the recommendation of gardening BMPs in a Permanent Solution Statement as part of a Permanent Solution with Conditions:

- 310 CMR 40.0006(12) (definition of Best Management Practices for Non-commercial Gardening)
- 310 CMR 40.1056(2)(j)1 (Content of Permanent Solution Statements);
- 310 CMR 40.1041(2)(c)2 (Categories of Permanent Solutions);
- 310 CMR 40.40.1013 (Limitations, Assumptions and Conditions on Site Activities and Uses That Do Not Require an AUL); and
- 310 CMR 40.0923(3)(c) (Identification of Site Activity and Uses).

The MCP defines gardening BMPs as follows:

> Best Management Practices for Non-commercial Gardening means current practices generally accepted by practitioners of safe gardening methods that limit potential human exposure to OHM during gardening activities and as the result of consumption of fruits and vegetables grown in a non-commercial garden. Such practices include, but are not limited to: locating garden beds outside of areas affected by releases of OHM; gardening in raised beds above a barrier layer; use of soil and soil amendments unaffected by releases of OHM in garden beds; and covering adjacent areas to limit the transfer of OHM from windborne material into garden beds.

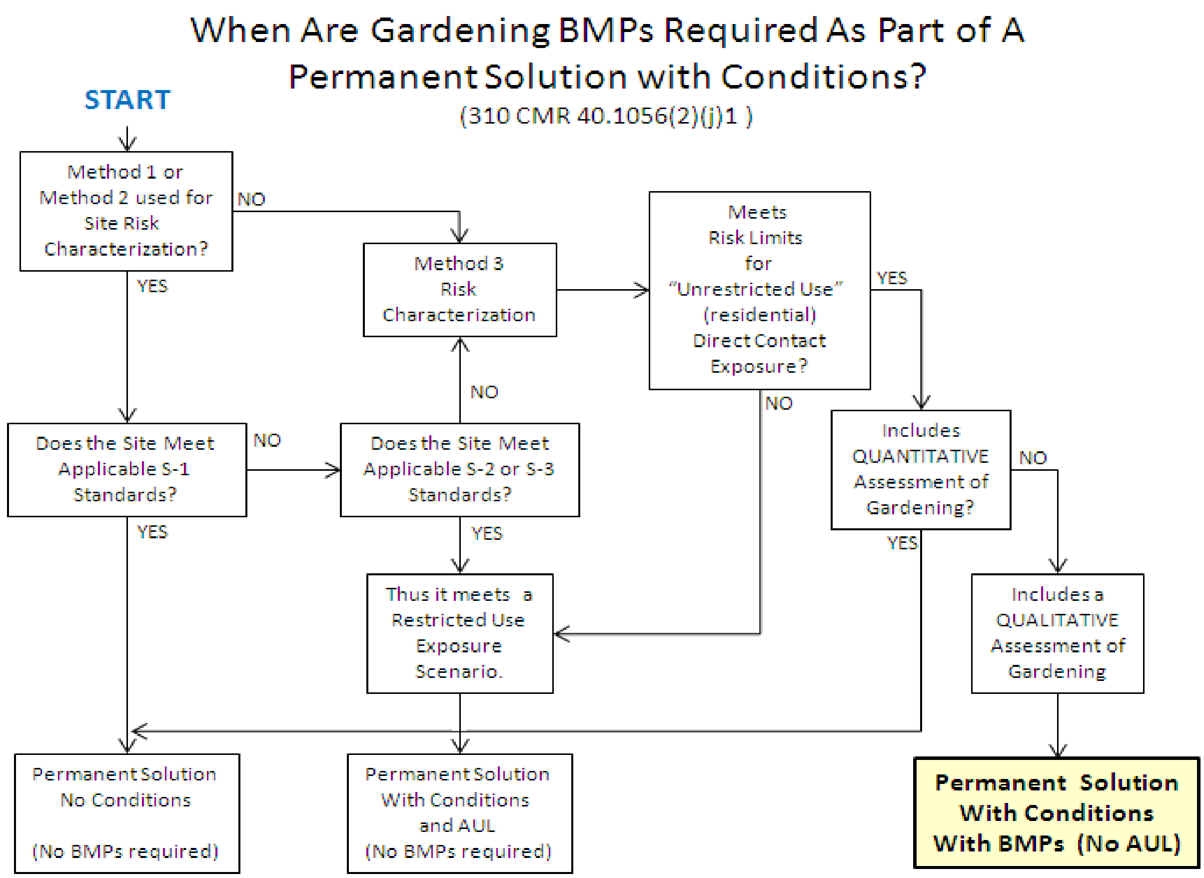
As required at 310 CMR 40.1056(2)(j)1, where applicable to disposal sites evaluated using a Method 3 Risk Characterization, “the recommendation and description of Best Management Practices for Non-commercial Gardening in a residential setting to minimize and control potential risk qualitatively evaluated pursuant to 310 CMR 40.0923(3)(c)” must be included in the disposal site Permanent Solution Statement. The gardening BMPs requirement applies to disposal sites that are demonstrated to pose No Significant Risk of Harm to Health using a Method 3 Risk Characterization that includes:

(a) the assumption of unrestricted use (including residential use) of the property;
(b) a quantitative assessment of direct contact exposures (ingestion, dermal contact and inhalation) to soil; and

(c) a *qualitative* assessment of incremental exposures associated with gardening activities.

In those cases where a *quantitative* assessment of exposures associated with gardening is conducted and the disposal site is shown to meet risk limits for gardening, then inclusion of gardening BMPs descriptions and a recommendation for their use in the Permanent Solution Statement is *not* required. Figure 1 below illustrates when inclusion of gardening BMPs descriptions and a recommendation for their use is required as part of a Permanent Solution with Conditions.

Figure 1



4.0 Best Management Practices for Non-Commercial Gardening

The attachment below, “Best Management Practices for Non-commercial Gardening at Disposal Sites,” is appropriate for use to meet the requirement at 310 CMR 40.1056(2)(j)1 to include in the Permanent Solution Statement a “recommendation and description of Best Management Practices for Non-commercial Gardening in a residential setting to minimize and control potential risk qualitatively evaluated pursuant to 310 CMR 40.0923(3)(c).”

To highlight and assist readers in locating this information in the Permanent Solution Statement, these BMPs should appear under a distinct heading in the Permanent Solution Statement and be identified as a distinct item in the Table of Contents of the Permanent Solution Statement. The narrative of the Permanent Solution Statement should provide some context for the BMPs, including a reference to recommended use of the BMPs as a condition of the Permanent Solution with Conditions.

Attachment
Best Management Practices for Non-commercial Gardening at Disposal Sites

Best Management Practices for Non-commercial Gardening at Disposal Sites

This property is part of a disposal site that has been assessed and determined to meet the requirements of a Permanent Solution with Conditions under the Massachusetts Contingency Plan (MCP), 310 CMR 40.0000, where the Conditions include the recommendation of Best Management Practices ("BMPs") for gardening to reduce the potential risks from exposure to contaminated soil that remains on the site.

While the property has been determined to be safe for unrestricted use, including residential use, there are residual levels of contaminants remaining in the soil. Gardeners should consider implementing BMPs to further reduce potential exposure to material in the soil, regardless of the contaminant levels remaining. Implementing BMPs such as those suggested below will allow safer gardening in a wider range of site conditions. Not every BMP is necessary for every single site, but a combination of BMPs appropriate for your particular site will help reduce the potential for additional exposure.

Construct Physical Controls and Improve Soil Conditions

Actions to minimize contact (covering the soil) and reduce contaminant levels (such as amending the soil) will further reduce potential risks. Many good gardening practices, like adding compost and soil amendments, improve the soil while reducing the amount of contaminants and exposure to them. Recommendations include:

- Build your garden away from areas known or suspected to be contaminated. In addition to areas where residual contamination may be present, as identified by the disposal site assessment, other sources of contamination can include painted structures (particularly older buildings that may have been painted with lead paint), roads and rail lines.
- Build a hedge or fence to reduce windblown contamination from mobile sources and busy streets.
- Cover existing soil and walkways with mulch, landscape fabric, stones, or bricks.
- Use mulch in your garden beds to reduce dust and soil splash back, reduce weed establishment, regulate soil temperature and moisture, and add organic matter.
- Use soil amendments (such as lime and compost) to maintain neutral pH and add organic matter to improve soil structure.
    - Not all amendments are the same; be sure to choose the right amendments for your soil - amendments that improve conditions at one garden may not work well in others.
    - Keep in mind that each amendment type will have different application amounts and techniques (e.g., rototilling), and may need to be maintained and reapplied (e.g., annually).

  - Be sure to work with your local or state regulatory agency, and ask if your municipality provides free compost or mulch. Obtain compost only from a reputable source that can provide information regarding the quality and type of feedstock used to generate the compost.
- Add topsoil or clean fill from a reputable source that can provide information regarding the quality of the topsoil or fill to ensure the soil is safe for handling by children or gardeners of all ages and for food production.
- Build raised beds or container gardens.
  - Raised beds can be made by simply mounding soil into windrows or by building containers.
  - Raised beds help improve water drainage in heavy clay soils or low-lying areas. They also create accessible gardening locations for many users and allow for more precise soil management.
  - Foot traffic should not be necessary in the bed, so the soil does not become compacted and soil preparation in the coming years is minimized.
  - Place a water permeable fabric cover or geotextile as the bottom layer of your raised bed to further reduce exposure to soils of concern.
  - Sided beds can be made from wood, synthetic wood, stone, concrete block, brick or naturally rot-resistant woods such as cedar and redwood. Avoid using chemical-treated lumber for the raised bed because chemicals used in the treated wood could make their way into the soils and plants.

Minimize Ongoing Contact with or Ingestion of Soil

Actions to further reduce contact with soil during and after gardening activities can also minimize potential risks from any contaminants remaining in the soil.

- Do not use plants grown in contaminated soil for compost.
- Work in the garden when soil is moist or damp to minimize creation of dust.
- Avoid “double-digging” to decrease likelihood of moving deep soils to the surface.
- Wear gloves, long sleeves and pants while gardening to prevent skin exposure;
- Remove gardening shoes and garments before entering the home, and wash gardening clothes separately from other clothing.
- Wash hands after gardening.
- Wash all vegetables thoroughly.

For More Information

These recommended BMPs are consistent with federal, state and local guidance on urban gardening in general. MassDEP has additional information available online at: http://www.Mass.Gov/eea/agencies/massdep/cleanup/regulations/gardening-best-management-practices-at-disposal-sites.html