December 30, 2014

Mr. Montague McPherson
Unit Coordinator – Hazardous Sites Response Program
Georgia Department of Natural Resources
205 Butler Street, SE, Suite 1462
Atlanta, Georgia 30334

Re: Conceptual Site Model, Updated Groundwater Model, and Vapor Intrusion Evaluation
North Decatur Road/Burlington Road Site
HSI Site Number 10121
Atlanta, Georgia

Dear Mr. McPherson:

Enclosed is two hard copies and one cd of the conceptual site model, updated groundwater model, and vapor intrusion evaluation for the North Decatur Road/Burlington Road Site (HSI Site Number 10121). We will finalize these upon receipt of your comments for inclusion in the Compliance Status Report.

If you have any questions, please contact me at 678 808-8915.

Sincerely,
URS Corporation

Brent B. Jacobs

Brent Jacobs
Senior Project Manager

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Conceptual Site Model
Emory University
North Decatur Road/Burlington Road Site
HSI No. 10121

A conceptual site model (CSM) has been developed for the Emory University North Decatur Road/Burlington Road Site, HSI No. 10121site located at the intersection of North Decatur Road and Burlington Road in Atlanta, Georgia. See **Figures 1 and 2**.The purpose of the conceptual site model is to:

- Integrate technical data from various sources;
- Support the selection of sample locations;
- Identify data needs; and,
- Evaluate risks to human health and the environment.

Development of the CSM required consideration of the site setting, regulated substances, suspected source, etc. which are described more fully in the following subsections.

1.1 Surface Setting

The surface setting is commercial/university. The property is located in the Druid Hills area of Atlanta, at the intersection of Burlington Road and North Decatur Road. The site consists of a science building and associated parking lot, a multi-level parking garage, and several large landscaped areas. The property immediately south of the site consists of North Decatur Road and a residential neighborhood. The northern adjacent properties consist of a Georgia Power substation (under construction), a multi-level parking garage, and a new hospital facility that is currently under construction. The property immediately to the west consists of the law library and the property immediately east of the site consists of Burlington Road and a dormitory. See **Figure 1**.

1.2 Subsurface Setting

The site is located in the Piedmont physiographic province of the Appalachian Orogenic Belt, and is underlain by the Clarkston Formation. The Clarkston formation is primarily comprised of mica-schist and amphibolite. The soils at the site are characterized as belonging to the Urban Land Series. This classification indicates that the soils at the site have been significantly altered from their original condition due to the construction activities.

The site soils consist of a tan to reddish brown fine sandy silt grading to dense white to black micaceous silty sand. Bedrock was encountered at depth of 42 feet below land surface (bls) in monitoring well MW-2 and 60 feet bls in recovery well RW-2 (**Table 1**). Groundwater is generally encountered from 21 feet bls (monitoring well MW-1) to 37 feet bls (RW-2). The direction of groundwater flow is generally to the southwest **(Figure 3**).

1.3 Regulated Substances

Groundwater remediation and monitoring began at the site in 1995 and is currently ongoing. Based on the groundwater data, the current constituents of concern include PCE and it's degradation products trichloroethene (TCE) and cis-1,2-dichloroethene (cis-1,2 DCE). These COCs were detected in groundwater at the site and are summarized on **Table 2**. The site soils have been certified to meet the Type I Risk Reduction Standards.

1.4 Known or Suspected Source Areas

In 1989 Emory University purchased property at the intersection of North Decatur and Burlington Roads in Atlanta, Georgia. A subsequent site assessment determined the property had likely been impacted by a dry cleaning operation that had previously operated at the property prior to Emory's purchase. An automotive repair garage was also located on the property. The assessment detected PCE in the property soils and groundwater. The dry cleaner building and automotive garage building were subsequently removed during the redevelopment of the property and construction of a six story math building. The former dry cleaners were located in front of the current location of the North Decatur Road math building in the vicinity of recovery well RW-2. The footprint of the former strip mall, including the dry cleaners, is shown on **Figure 2**.

1.5 Contaminant Migration Pathways

An evaluation of the contaminant migration pathways indicates the following potential pathways:

- horizontal and vertical migration through the soil to the groundwater; and
- horizontal and vertical migration within shallow groundwater, with transport driven by hydraulic properties of the local groundwater flow system, and the direction of groundwater flow as influenced by the active pump and treat remediation system.

1.6 Soil and Groundwater Impacts

The extent of groundwater impacts has been complied for this report. The groundwater flow direction is shown on **Figure 3**. The impacts to groundwater are summarized on **Table 2** and shown on **Figure 4** (October 2014 sample results) in plan view and in cross-sectional view on **Figure 6** (August 2014 sample results) and **Figure 7** (October 2014 sample results). The line of section for these maps is provided on **Figure 5** (Cross Section Location Map). The laboratory reports for the 2014 sampling events are included in **Appendix A**.

1.7 Receptor Evaluation

The Site is a highly developed commercial property that is nearly completely covered by buildings, pavement, and landscaped areas **(Figure 2)**. Except for a few landscaped areas, the Site is covered by a 5-story building, 7-story parking garage or pavement. Groundwater from beneath the site flows toward the southwest. There are several large on-site green spaces along North Decatur Road. No surface water bodies are located on the site. The nearest surface water body is an unnamed tributary of Lullwater Creek which is located approximately 1,500 feet due south of the site**.**

A schematic of the CSM is provided in **Figure 6**. As shown in the schematic, bedrock is overlain by an unconsolidated layer of residual soil. Groundwater occurs above bedrock at the property. It is anticipated that the Site will continue to be used as an educational institution in the future. A significant investment has recently been made on property improvements, including a 5-story science building and 7-story parking garage. Recently, Georgia Power installed a high power line on the site and future improvements include the widening of North Decatur Road. Therefore, the CSM assumes the same receptors will continue to be present in the future.

An evaluation of potential receptors was conducted. Potential future human receptors for the Site include current and future on-site workers, students, faculty, visitors, trespassers, utility workers, and future construction workers. Potential receptors may be exposed to on-site soil, but the Site soils meet the Type I Risk Reduction Standards.

A literature review of available information from the U.S. Fish and Wildlife Service (FWS) and Georgia Department of Natural Resources (DNR) was conducted to gather information pertaining to the potential

presence of federally- or state-protected species or their habitats in Dekalb County. None of these species have been identified at the Site. Two endangered and two threatened animal species were reported by the Georgia DNR as potentially occurring in DeKalb County; however these species are all aquatic fishes and invertebrates, and aquatic habitats are not present on the Site. The FWS lists two endangered plant species in DeKalb County, the dwarf sumac and the black-spored quillwort, and one threatened plant species (little amphianthus). None of the species listed have been identified at the Site. Therefore, no endangered and threatened fauna or animal species would be exposed to the constituents of potential concern (COPC).

The nearest surface water body is Lullwater Creek which is located approximately 2,500 feet southwest in the downgradient flow direction. The possibility of future receptors ingesting or contacting surface water that is impacted with the COPCs is considered remote since the concentrations of the COPCs would be reduced to below detection limits by dispersion, advection, and attenuation processes before they reach the Lullwater Creek. The results of the BIOCHLOR groundwater model included in **Appendix C** and the most recent sampling results, indicate that the PCE plume should currently be reduced to below the Maximum Contaminant Level of 5 micrograms per liter (ug/L) at a distance of about 700 feet southwest of the intersection of Burlington Road and North Decatur Road.

The COCs are present in dissolved phase in groundwater and can migrate through the subsurface to reach potential receptors. Groundwater beneath the facility generally flows toward the southwest **(Figure 3)**. Future exposure to Site groundwater will be restricted by covenants barring the installation of wells for any purpose. Therefore, the possibility of future receptors ingesting groundwater from a water-supply well or an irrigation well installed on the Site is considered remote.

Groundwater from the Site or within a one-half mile radius of the site is not currently used as a potable water supply or for irrigation. Future exposure to the Site groundwater will be restricted by covenants barring the installation of wells for any purpose. An updated water well survey was performed by GA EPD in November 2013. GA EPD did not identify any groundwater users within a ½-mile radius of the site. Furthermore, an environmental covenant will be prepared and executed pursuant to the Georgia Uniform Environmental Covenants Act, OCGA § 44-16-1, et seq to limit groundwater use and/or use limitations to protect human health and the environment.

The current and future on-site workers, students, faculty, visitors, trespassers, utility workers, and future construction workers would not be exposed to on-site groundwater. Future exposure to groundwater by on-site workers and customers will be eliminated by the restrictive covenant that will be placed on the property, forbidding the use of groundwater for drinking, irrigation, or other purposes. Where the groundwater plume is covered by enclosed buildings or other structures, current and future on-site workers, students, faculty, visitors, trespassers, utility workers and future construction workers could potentially be exposed to contaminants from the groundwater via the vapor intrusion pathway, although as described in **Appendix B,** vapor intrusion modeling utilizing the Ettinger Vapor Intrusion Model shows there is no exposure.

Utility workers will not have direct contact (dermal or ingestion) with site groundwater as the depth to groundwater (21 to 37 feet) is greater than the depth of utility excavations (approximately 5 feet). However, although no construction plans currently exist, hypothetical future construction workers may have contact with groundwater if the construction activities include deep foundation work and dewatering. Utility workers in trenches may be exposed to COPCs in the vapor phase. It should be noted, however, that utility workers will be on site at any one time for only short durations (typically, a day or days) and will have only sub-chronic exposure to COPCs. It is not appropriate to use chronic toxicity values (reference doses and slope factors) to evaluate sub-chronic exposure for COPCs; instead, short-term exposure and risks to the utility worker will be managed by Occupational Safety and Health Administration (OSHA) requirements.

TABLES

Table 1

Well Construction Details and Water Level Measurements
2012 Corrective Action Effectiveness Report
Emory University North Decatur Road Site
HSI Site No. 10121
Atlanta, Georgia

Well	Top of Casing Elevation (feet)	Well Depth (feet bls)	Screened Interval (feet bls)	6/27/08 Depth To Water (feet)	6/27/08 Groundwater Elevation (feet, msl)	3/11/09 Depth To Water (feet)	3/11/09 Groundwater Elevation (feet, msl)	6/30/09 Depth To Water (feet)	6/30/09 Groundwater Elevation (feet, msl)	1/22/10 Depth To Water (feet)	1/22/10 Groundwater Elevation (feet, msl)	7/8/10 Depth To Water (feet)	7/8/10 Groundwater Elevation (feet, msl)	6/27/11 Depth To Water (feet)	6/27/11 Groundwater Elevation (feet, msl)	01/04/12 Depth To Water (feet)	01/04/12 Groundwater Elevation (feet, msl)	06/26/12 Depth To Water (feet)	06/26/12 Groundwater Elevation (feet, msl)	10/14/2014 Depth to Water (feet)	10/14/14 Groundwater Elevation (feet, msl)
RW-1	968.90	60.0	40-60	55.65	913.25	55.60	913.30	55.65	913.25	54.5	914.40	54.2	914.70	35.60	933.30	NG	-	NG	-	36.46	932.44
RW-2	970.34	60.0	40-60	57.5	912.84	58.4	911.94	57.5	912.84	56.2	914.14	38.9	931.44	40.50	929.84	NG	-	NG	-	37.59	932.75
RW-3	968.35	55.0	35-55	54.3	914.05	54.97	913.38	54.3	914.05	56.75	911.60	56.5	911.85	35.40	932.95	NG	-	NG	-	32.75	935.60
RW-4	968.63	55.0	35-55	42.8	925.83	42.3	926.33	42.8	925.83	40.17	928.46	40.35	928.28	36.43	932.20	38.18	930.45	39.47	929.16	34.86	933.77
RW-5	962.64	60.0	50-60	40.92	921.72	38.9	923.74	40.92	921.72	37.3	925.34	24.74	937.90	35.45	927.19	37.43	925.21	38.22	924.42	35.52	927.12
MW-1	954.59	45.0	35-45	29.69	924.90	27.1	927.49	29.69	924.90	25.6	928.99	23.29	931.30	23.10	931.49	27.54	927.05	27.85	926.74	21.73	932.86
MW-2	968.82	42.0	32-42	38.48	930.34	34.7	934.12	38.48	930.34	33.65	935.17	30.72	938.10	32.10	936.72	35.16	933.66	36.40	932.42	30.43	938.39
MW-4	954.35	48.0	38-48	37.39	916.96	35.6	918.75	37.39	916.96	33.5	920.85	30.8	923.55	32.15	922.20	34.70	919.65	35.68	918.67	35.62	918.73
TP-1	968.86	45.00	35-45	40.92	927.94	43.5	925.36	40.92	927.94	43.25	925.61	44.1	924.76	32.18	936.68	NM		NM		NM	
TP-2	963.36	40.0	30-40	Dry		Dry		Dry		Dry		Dry		NM		NM		NM		NM	
TP-3	958.70	40.0	30-40	Damaged		Damaged		Damaged		Damaged		Damaged		Damaged		NM		NM		NM	
TP-4	966.30	45.0	35-45	Dry		Dry		Dry		Dry		Dry		NM		NM		NM		NM	
TP-5	956.27	58.0	34-58	34.7	921.57	34.70	921.57	34.70	921.57	35.5	920.77	36.25	920.02	28.20	928.07	NM		NM		NM	

NM - Not measured

NG - Not gauged due to pump and wiring obstructing well

Table 2
Summary of Groundwater Analytical Results
Emory University North Decatur/Burlington Road Site
HSI Site No. 10121
Atlanta, Georgia

Well Number	Sample Date	PCE (µg/L)	TCE (µg/L)	1,1-DCE (µg/L)	CIS-1,2-DCE (µg/L)	TRANS-1,2-DCE (µg/L)	VINYL CHLORIDE (µg/L)	1,4-DIOXANE (µg/L)
MW-1	02/05/01	BRL	BRL	BRL	BRL	BRL	BRL	NA
	07/18/01	BRL	BRL	BRL	BRL	BRL	BRL	NA
	11/06/01	BRL	BRL	BRL	BRL	BRL	BRL	NA
	05/02/02	BRL	BRL	BRL	BRL	BRL	BRL	NA
	12/09/02	BRL	BRL	BRL	BRL	BRL	BRL	NA
	01/29/03	BRL	BRL	BRL	BRL	BRL	BRL	NA
	06/19/03	BRL	BRL	BRL	BRL	BRL	BRL	NA
	01/15/04	BRL	BRL	BRL	BRL	BRL	BRL	NA
	06/18/04	BRL	BRL	BRL	BRL	BRL	BRL	NA
	01/28/05	BRL	BRL	BRL	BRL	BRL	BRL	NA
	07/01/05	BRL	BRL	BRL	BRL	BRL	BRL	NA
	02/01/06	BRL	BRL	BRL	BRL	BRL	BRL	NA
	06/20/06	BRL	BRL	BRL	BRL	BRL	BRL	NA
	02/28/07	BRL	BRL	BRL	BRL	BRL	BRL	NA
	06/19/07	BRL	BRL	BRL	BRL	BRL	BRL	NA
	03/01/08	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/08	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	03/11/09	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	06/30/09	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	01/22/10	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	07/09/10	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/11	BRL	BRL	BRL	BRL	BRL	BRL	NA
	01/04/12	BRL	BRL	BRL	BRL	BRL	BRL	NA
	06/26/12	BRL	BRL	BRL	BRL	BRL	BRL	NA
	01/09/13	BRL	BRL	BRL	BRL	BRL	BRL	NA
	06/26/13	BRL	BRL	BRL	BRL	BRL	BRL	NA
	01/21/14	BRL	BRL	BRL	BRL	BRL	BRL	NA
	08/04/14	BRL	BRL	BRL	BRL	BRL	BRL	NA
	10/15/14	BRL	BRL	BRL	BRL	BRL	BRL	NA

Table 2
Summary of Groundwater Analytical Results
Emory University North Decatur/Burlington Road Site
HSI Site No. 10121
Atlanta, Georgia

Well Number	Sample Date	PCE (µg/L)	TCE (µg/L)	1,1-DCE (µg/L)	CIS-1,2-DCE (µg/L)	TRANS-1,2-DCE (µg/L)	VINYL CHLORIDE (µg/L)	1,4-DIOXANE (µg/L)
MW-2	02/05/01	BRL	BRL	BRL	BRL	BRL	BRL	NA
	07/18/01	BRL	BRL	BRL	BRL	BRL	BRL	NA
	11/06/01	BRL	BRL	BRL	BRL	BRL	BRL	NA
	05/02/02	BRL	BRL	BRL	BRL	BRL	BRL	NA
	12/09/02	BRL	BRL	BRL	BRL	BRL	BRL	NA
	01/29/03	BRL	BRL	BRL	BRL	BRL	BRL	NA
	06/19/03	BRL	BRL	BRL	BRL	BRL	BRL	NA
	01/15/04	BRL	BRL	BRL	BRL	BRL	BRL	NA
	06/18/04	BRL	BRL	BRL	BRL	BRL	BRL	NA
	01/28/05	BRL	BRL	BRL	BRL	BRL	BRL	NA
	07/01/05	BRL	BRL	BRL	BRL	BRL	BRL	NA
	02/01/06	BRL	BRL	BRL	BRL	BRL	BRL	NA
	06/20/06	BRL	BRL	BRL	BRL	BRL	BRL	NA
	02/28/07	BRL	BRL	BRL	BRL	BRL	BRL	NA
	06/19/07	BRL	BRL	BRL	BRL	BRL	BRL	NA
	03/01/08	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/08	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	03/11/09	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	06/30/09	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	01/22/10	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	07/09/10	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/11	BRL	BRL	BRL	BRL	BRL	BRL	NA
	01/04/12	BRL	BRL	BRL	BRL	BRL	BRL	NA
	06/26/12	BRL	19	BRL	BRL	BRL	BRL	NA
	01/09/13	BRL	BRL	BRL	BRL	BRL	BRL	NA
	06/26/13	BRL	BRL	BRL	BRL	BRL	BRL	NA
	01/21/14	BRL	BRL	BRL	BRL	BRL	BRL	NA
	08/04/14	BRL	BRL	BRL	BRL	BRL	BRL	NA
	10/15/14	BRL	BRL	BRL	BRL	BRL	BRL	NA

Table 2
Summary of Groundwater Analytical Results
Emory University North Decatur/Burlington Road Site
HSI Site No. 10121
Atlanta, Georgia

Well Number	Sample Date	PCE (µg/L)	TCE (µg/L)	1,1-DCE (µg/L)	CIS-1,2-DCE (µg/L)	TRANS-1,2-DCE (µg/L)	VINYL CHLORIDE (µg/L)	1,4-DIOXANE (µg/L)
MW-3/RW-5*	02/05/01	65	BRL	BRL	BRL	BRL	BRL	NA
	07/18/01	78	BRL	BRL	BRL	BRL	BRL	NA
	11/06/01	89.2	BRL	BRL	BRL	BRL	BRL	NA
	02/14/02	90	BRL	BRL	BRL	BRL	BRL	NA
	07/10/02	66.6	BRL	BRL	BRL	BRL	BRL	NA
	01/29/03	43.1	BRL	BRL	BRL	BRL	BRL	NA
	06/19/03	75	BRL	BRL	BRL	BRL	BRL	NA
	01/15/04	53	BRL	BRL	BRL	BRL	BRL	NA
	06/18/04	56	BRL	BRL	BRL	BRL	BRL	NA
	01/28/05	47	BRL	BRL	BRL	BRL	BRL	NA
	07/01/05	40	BRL	BRL	BRL	BRL	BRL	NA
	02/01/06	57	BRL	BRL	BRL	BRL	BRL	NA
	06/20/06	66	BRL	BRL	BRL	BRL	BRL	NA
	02/28/07	50	BRL	BRL	BRL	BRL	BRL	NA
	06/19/07	14	BRL	BRL	120	BRL	BRL	NA
	03/01/08	39	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/08	44	BRL	BRL	BRL	BRL	BRL	BRL
	03/11/09	40	BRL	BRL	BRL	BRL	BRL	BRL
	06/30/09	66	BRL	BRL	BRL	BRL	BRL	BRL
	01/22/10	71	BRL	BRL	BRL	BRL	BRL	BRL
	07/08/10	73	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/11	160	BRL	BRL	BRL	BRL	BRL	NA
	01/04/12	190	BRL	BRL	BRL	BRL	BRL	NA
	06/27/12	200	BRL	BRL	BRL	BRL	BRL	NA
	01/10/13	230	BRL	BRL	BRL	BRL	BRL	NA
	06/27/13	150	BRL	BRL	BRL	BRL	BRL	NA
	01/21/14	180	BRL	BRL	BRL	BRL	BRL	NA
	08/04/14	190	BRL	BRL	BRL	BRL	BRL	NA
	10/15/14	160	BRL	BRL	BRL	BRL	BRL	NA

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Atlanta, Georgia

Well Number	Sample Date	PCE (µg/L)	TCE (µg/L)	1,1-DCE (µg/L)	CIS-1,2-DCE (µg/L)	TRANS-1,2-DCE (µg/L)	VINYL CHLORIDE (µg/L)	1,4-DIOXANE (µg/L)
MW-4	02/05/01	3.4	BRL	BRL	BRL	BRL	BRL	NA
	07/18/01	4.0	BRL	BRL	BRL	BRL	BRL	NA
	11/06/01	3.8	BRL	BRL	BRL	BRL	BRL	NA
	05/02/02	4.8	BRL	BRL	BRL	BRL	BRL	NA
	12/09/02	3.0	BRL	BRL	BRL	BRL	BRL	NA
	01/29/03	4.1	BRL	BRL	BRL	BRL	BRL	NA
	06/19/03	4.0	BRL	BRL	BRL	BRL	BRL	NA
	01/15/04	3.7	BRL	BRL	BRL	BRL	BRL	NA
	06/18/04	BRL	BRL	BRL	BRL	BRL	BRL	NA
	01/28/05	BRL	BRL	BRL	BRL	BRL	BRL	NA
	07/01/05	BRL	BRL	BRL	BRL	BRL	BRL	NA
	02/01/06	BRL	BRL	BRL	BRL	BRL	BRL	NA
	06/20/06	BRL	BRL	BRL	BRL	BRL	BRL	NA
	02/28/07	BRL	BRL	BRL	BRL	BRL	BRL	NA
	06/19/07	BRL	BRL	BRL	BRL	BRL	BRL	NA
	03/01/08	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/08	5.0	BRL	BRL	BRL	BRL	BRL	BRL
	03/11/09	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	06/30/09	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	01/22/10	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	07/09/10	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/11	8.7	BRL	BRL	BRL	BRL	BRL	NA
	01/04/12	11	BRL	BRL	BRL	BRL	BRL	NA
	06/26/12	14	BRL	BRL	BRL	BRL	BRL	NA
	01/09/13	15	BRL	BRL	BRL	BRL	BRL	NA
	06/26/13	14	BRL	BRL	BRL	BRL	BRL	NA
	01/21/14	20	BRL	BRL	BRL	BRL	BRL	NA
	08/04/14	29	BRL	BRL	BRL	BRL	BRL	NA
	10/15/14	29	BRL	BRL	BRL	BRL	BRL	NA

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Atlanta, Georgia

Well Number	Sample Date	PCE (µg/L)	TCE (µg/L)	1,1-DCE (µg/L)	CIS-1,2-DCE (µg/L)	TRANS-1,2-DCE (µg/L)	VINYL CHLORIDE (µg/L)	1,4-DIOXANE (µg/L)
RW-1	Jun-98	8.4	NA	NA	NA	NA	NA	NA
	Jun-98	NS	NS	NS	NS	NS	NS	NS
	01/08/99	BRL	NA	NA	NA	NA	NA	NA
	07/09/99	12.4	NA	NA	NA	NA	NA	NA
	07/27/99	NS	NS	NS	NS	NS	NS	NS
	01/06/00	20	NA	NA	NA	NA	NA	NA
	07/07/00	56.4	NA	NA	NA	NA	NA	NA
	02/05/01	59.0	BRL	BRL	BRL	BRL	BRL	NA
	07/18/01	NS	NS	NS	NS	NS	NS	NS
	08/06/01	27	BRL	BRL	BRL	BRL	BRL	NA
	11/06/01	NS	NS	NS	NS	NS	NS	NS
	02/14/02	85.4	BRL	BRL	BRL	BRL	BRL	NA
	07/10/02	107	BRL	BRL	BRL	BRL	BRL	NA
	01/29/03	144	BRL	BRL	BRL	BRL	BRL	NA
	06/19/03	170	BRL	BRL	BRL	BRL	BRL	NA
	01/15/04	200	BRL	BRL	BRL	BRL	BRL	NA
	06/18/04	200	BRL	BRL	BRL	BRL	BRL	NA
	01/28/05	190	BRL	BRL	BRL	BRL	BRL	NA
	07/01/05	190	BRL	BRL	BRL	BRL	BRL	NA
	02/01/06	140	BRL	BRL	BRL	BRL	BRL	NA
	06/20/06	160	BRL	BRL	BRL	BRL	BRL	NA
	02/28/07	110	BRL	BRL	BRL	BRL	BRL	NA
	06/19/07	160	BRL	BRL	BRL	BRL	BRL	NA
	03/01/08	90	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/08	130	BRL	BRL	BRL	BRL	BRL	BRL
	03/11/09	99	BRL	BRL	BRL	BRL	BRL	BRL
	06/30/09	120	BRL	BRL	BRL	BRL	BRL	BRL
	01/22/10	170	BRL	BRL	BRL	BRL	BRL	BRL
	07/08/10	200	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/11	180	BRL	BRL	BRL	BRL	BRL	NA
	01/04/12	150	BRL	BRL	BRL	BRL	BRL	NA
	06/27/12	130	BRL	BRL	BRL	BRL	BRL	NA
	01/10/13	120	BRL	BRL	BRL	BRL	BRL	NA
	06/27/13	110	BRL	BRL	BRL	BRL	BRL	NA
	01/21/14	57	BRL	BRL	BRL	BRL	BRL	NA
	08/04/14	160	BRL	BRL	BRL	BRL	BRL	NA
	10/15/14	110	BRL	BRL	BRL	BRL	BRL	NA

Table 2
Summary of Groundwater Analytical Results
Emory University North Decatur/Burlington Road Site
HSI Site No. 10121
Atlanta, Georgia

Well Number	Sample Date	PCE (µg/L)	TCE (µg/L)	1,1-DCE (µg/L)	CIS-1,2-DCE (µg/L)	TRANS-1,2-DCE (µg/L)	VINYL CHLORIDE (µg/L)	1,4-DIOXANE (µg/L)
RW-2	Jun-98	127	NA	NA	NA	NA	NA	NA
	Jun-98	150	NA	NA	NA	NA	NA	NA
	01/08/99	270	NA	NA	NA	NA	NA	NA
	07/09/99	55	NA	NA	NA	NA	NA	NA
	07/27/99	NS	NS	NS	NS	NS	NS	NS
	01/06/00	197	NA	NA	NA	NA	NA	NA
	07/07/00	382	NA	NA	NA	NA	NA	NA
	02/05/01	549	BRL	BRL	BRL	BRL	BRL	NA
	07/18/01	NS	NS	NS	NS	NS	NS	NS
	08/06/01	119	BRL	BRL	BRL	BRL	BRL	NA
	11/06/01	NS	NS	NS	NS	NS	NS	NS
	02/14/02	NS	NS	NS	NS	NS	NS	NS
	07/10/02	710	2.2	NS	NS	NS	NS	NS
	01/29/03	138	2.1	BRL	1.5	BRL	BRL	NA
	06/19/03	630	1.0	BRL	2.0	BRL	BRL	NA
	01/15/04	890	BRL	BRL	BRL	BRL	BRL	NA
	06/18/04	650	BRL	BRL	BRL	BRL	BRL	NA
	01/28/05	490	BRL	BRL	BRL	BRL	BRL	NA
	07/01/05	860	BRL	BRL	BRL	BRL	BRL	NA
	02/01/06	970	BRL	BRL	BRL	BRL	BRL	NA
	06/20/06	1,000	BRL	BRL	BRL	BRL	BRL	NA
	02/28/07	440	BRL	BRL	BRL	BRL	BRL	NA
	06/19/07	780	5.7	BRL	8.1	BRL	BRL	NA
	03/01/08	300	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/08	460	120	BRL	190	BRL	BRL	BRL
	03/11/09	NS	NS	NS	NS	NS	NS	NS
	06/30/09	NS	NS	NS	NS	NS	NS	NS
	01/22/10	NS	NS	NS	NS	NS	NS	NS
	07/08/10	1,200	13	BRL	27	BRL	BRL	BRL
	06/27/11	NS	NS	NS	NS	NS	NS	NS
	01/04/12	790	9.5	BRL	25	BRL	BRL	NA
	06/27/12	570	BRL	BRL	11	BRL	BRL	NA
	01/10/13	37	BRL	BRL	90	BRL	BRL	NA
	06/27/13	490	BRL	BRL	12	BRL	BRL	NA
	01/21/14	700	7.4	BRL	20	BRL	BRL	NA
	08/04/14	670	6.9	BRL	18	BRL	BRL	NA
	10/15/14	550	7.5	BRL	24	BRL	BRL	NA

Table 2
Summary of Groundwater Analytical Results
Emory University North Decatur/Burlington Road Site
HSI Site No. 10121
Atlanta, Georgia

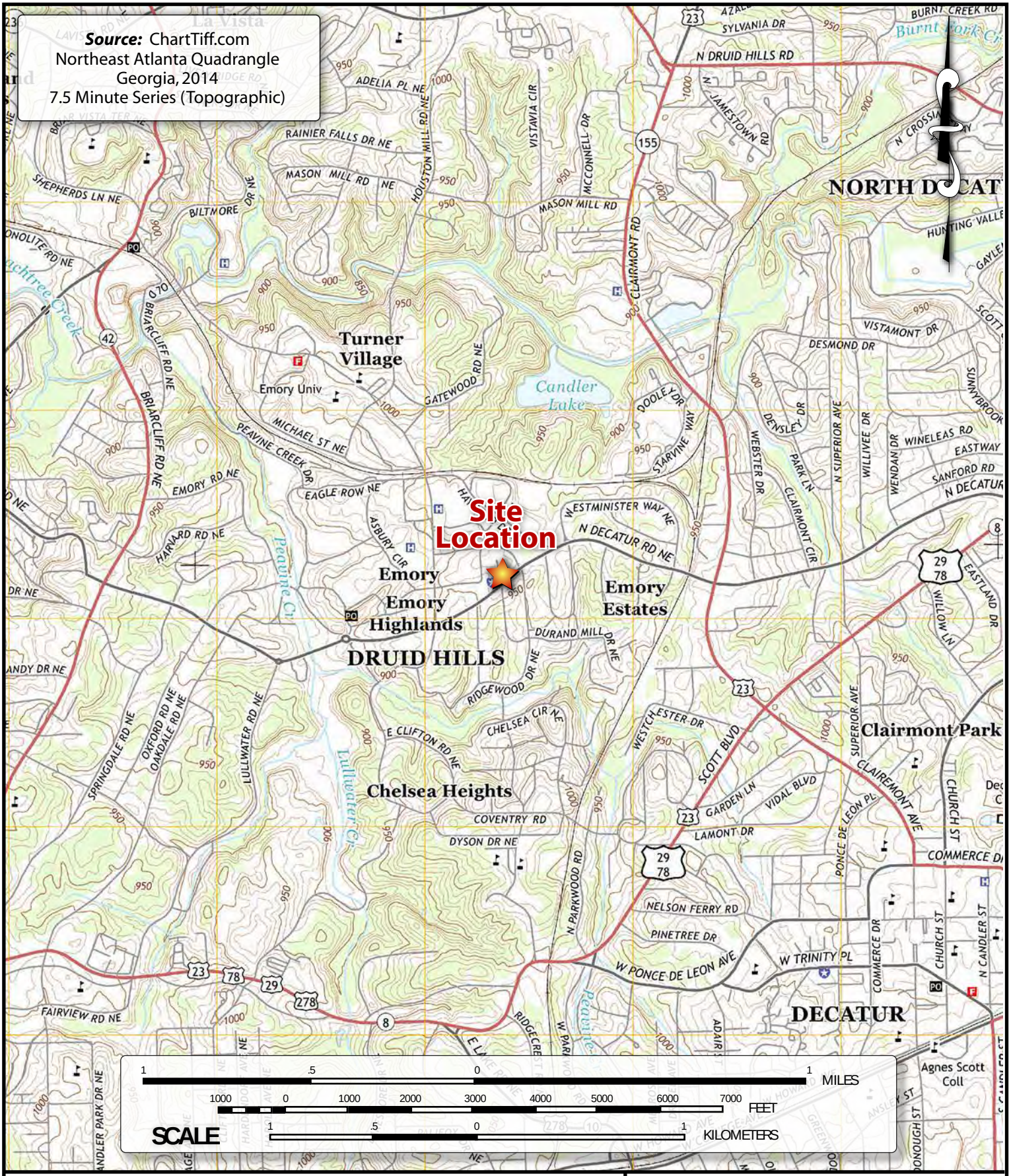
Well Number	Sample Date	PCE (µg/L)	TCE (µg/L)	1,1-DCE (µg/L)	CIS-1,2-DCE (µg/L)	TRANS-1,2-DCE (µg/L)	VINYL CHLORIDE (µg/L)	1,4-DIOXANE (µg/L)
RW-3	Jun-98	6.9	NA	NA	NA	NA	NA	NA
	Jun-98	NS	NS	NS	NS	NS	NS	NS
	01/08/99	6.8	NA	NA	NA	NA	NA	NA
	07/09/99	8.8	NA	NA	NA	NA	NA	NA
	07/27/99	NS	NS	NS	NS	NS	NS	NS
	01/06/00	8.0	NA	NA	NA	NA	NA	NA
	07/07/00	35.9	NA	NA	NA	NA	NA	NA
	02/05/01	39	BRL	BRL	BRL	BRL	BRL	NA
	07/18/01	NS	NS	NS	NS	NS	NS	NS
	08/06/01	27.1	BRL	BRL	BRL	BRL	BRL	NA
	11/06/01	NS	NS	NS	NS	NS	NS	NS
	02/14/02	27.7	BRL	BRL	BRL	BRL	BRL	NA
	07/10/02	31.5	BRL	BRL	BRL	BRL	BRL	NA
	01/29/03	55.4	BRL	BRL	BRL	BRL	BRL	NA
	06/19/03	58	BRL	BRL	BRL	BRL	BRL	NA
	01/15/04	57	BRL	BRL	BRL	BRL	BRL	NA
	06/18/04	71	BRL	BRL	BRL	BRL	BRL	NA
	01/28/05	38	BRL	BRL	BRL	BRL	BRL	NA
	07/01/05	91	BRL	BRL	BRL	BRL	BRL	NA
	02/01/06	53	BRL	BRL	BRL	BRL	BRL	NA
	06/20/06	70	BRL	BRL	BRL	BRL	BRL	NA
	02/28/07	33	BRL	BRL	BRL	BRL	BRL	NA
	06/19/07	71	BRL	BRL	BRL	BRL	BRL	NA
	03/01/08	38	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/08	67	BRL	BRL	BRL	BRL	BRL	BRL
	03/11/09	55	BRL	BRL	BRL	BRL	BRL	BRL
	06/30/09	71	BRL	BRL	BRL	BRL	BRL	BRL
	01/22/10	84	BRL	BRL	BRL	BRL	BRL	BRL
	07/08/10	130	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/11	NS	NS	NS	NS	NS	NS	NS
	01/04/12	NS	NS	NS	NS	NS	NS	NS
	06/27/12	50	BRL	BRL	BRL	BRL	BRL	NA
	01/10/13	54	BRL	BRL	BRL	BRL	BRL	NA
	06/27/13	85	BRL	BRL	BRL	BRL	BRL	NA
	01/21/14	37	BRL	BRL	BRL	BRL	BRL	NA
	08/04/14	62	BRL	BRL	BRL	BRL	BRL	NA
	10/15/14	110	BRL	BRL	BRL	BRL	BRL	NA

Table 2
Summary of Groundwater Analytical Results
Emory University North Decatur/Burlington Road Site
HSI Site No. 10121
Atlanta, Georgia

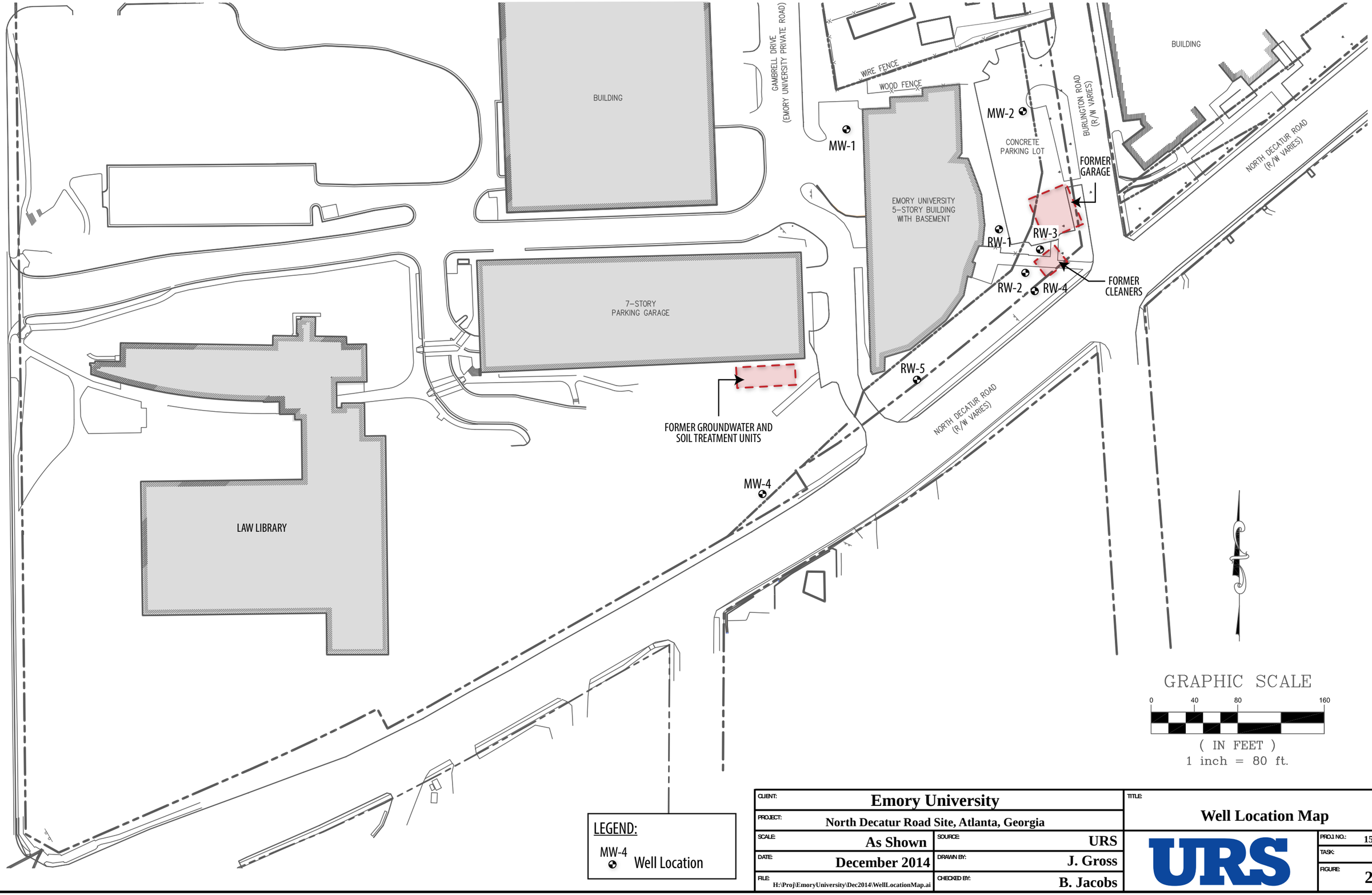
Well Number	Sample Date	PCE (µg/L)	TCE (µg/L)	1,1-DCE (µg/L)	CIS-1,2-DCE (µg/L)	TRANS-1,2-DCE (µg/L)	VINYL CHLORIDE (µg/L)	1,4-DIOXANE (µg/L)
RW-4**	Jun-98	19	NA	NA	NA	NA	NA	NA
	Jun-98	25	NA	NA	NA	NA	NA	NA
	01/08/99	57	NA	NA	NA	NA	NA	NA
	07/09/99	225	NA	NA	NA	NA	NA	NA
	07/27/99	187	NA	NA	NA	NA	NA	NA
	01/06/00	128	NA	NA	NA	NA	NA	NA
	07/07/00	189	NA	NA	NA	NA	NA	NA
	02/05/01	174	BRL	BRL	BRL	BRL	BRL	NA
	07/18/01	NS	NS	NS	NS	NS	NS	NS
	08/06/01	253	BRL	BRL	BRL	BRL	BRL	NA
	11/06/01	NS	NS	NS	NS	NS	NS	NS
	02/14/02	NS	NS	NS	NS	NS	NS	NS
	07/10/02	NS	NS	NS	NS	NS	NS	NS
	01/29/03	NS	NS	NS	NS	NS	NS	NS
	06/19/03	NS	NS	NS	NS	NS	NS	NS
	01/15/04	NS	NS	NS	NS	NS	NS	NS
	06/18/04	NS	NS	NS	NS	NS	NS	NS
	01/28/05	NS	NS	NS	NS	NS	NS	NS
	07/01/05	NS	NS	NS	NS	NS	NS	NS
	02/01/06	NS	NS	NS	NS	NS	NS	NS
	06/20/06	980	BRL	BRL	BRL	BRL	BRL	NA
	02/28/07	540	BRL	BRL	BRL	BRL	BRL	NA
	06/19/07	640	BRL	BRL	BRL	BRL	BRL	NA
	03/01/08	370	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/08	380	BRL	BRL	BRL	BRL	BRL	BRL
	03/11/09	640	BRL	BRL	BRL	BRL	BRL	BRL
	06/30/09	220	BRL	BRL	BRL	BRL	BRL	BRL
	01/22/10	360	BRL	BRL	BRL	BRL	BRL	BRL
	07/09/10	420	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/11	270	BRL	BRL	BRL	BRL	BRL	NA
	01/04/12	150	BRL	BRL	BRL	BRL	BRL	NA
	06/27/12	160	BRL	BRL	BRL	BRL	BRL	NA
	01/10/13	93	BRL	BRL	BRL	BRL	BRL	NA
	06/26/13	68	BRL	BRL	BRL	BRL	BRL	NA
	01/21/14	160	BRL	BRL	BRL	BRL	BRL	NA
	08/04/14	180	BRL	BRL	BRL	BRL	BRL	NA
	10/15/14	250	BRL	BRL	BRL	BRL	BRL	NA

Notes:
µg/L – micrograms per liter or parts p
BRL – Not detected above laboratory method reporting limits
NA – Not analyzed
NS – Not sampled
Monitoring wells MW-1, -2, -3, and -4 were installed between December 2000 and January 2001
* – MW-3 was converted to recovery well RW-5 and became operational on August 6, 2001
** – RW-4 was converted to a monitoring well on June 14, 2006

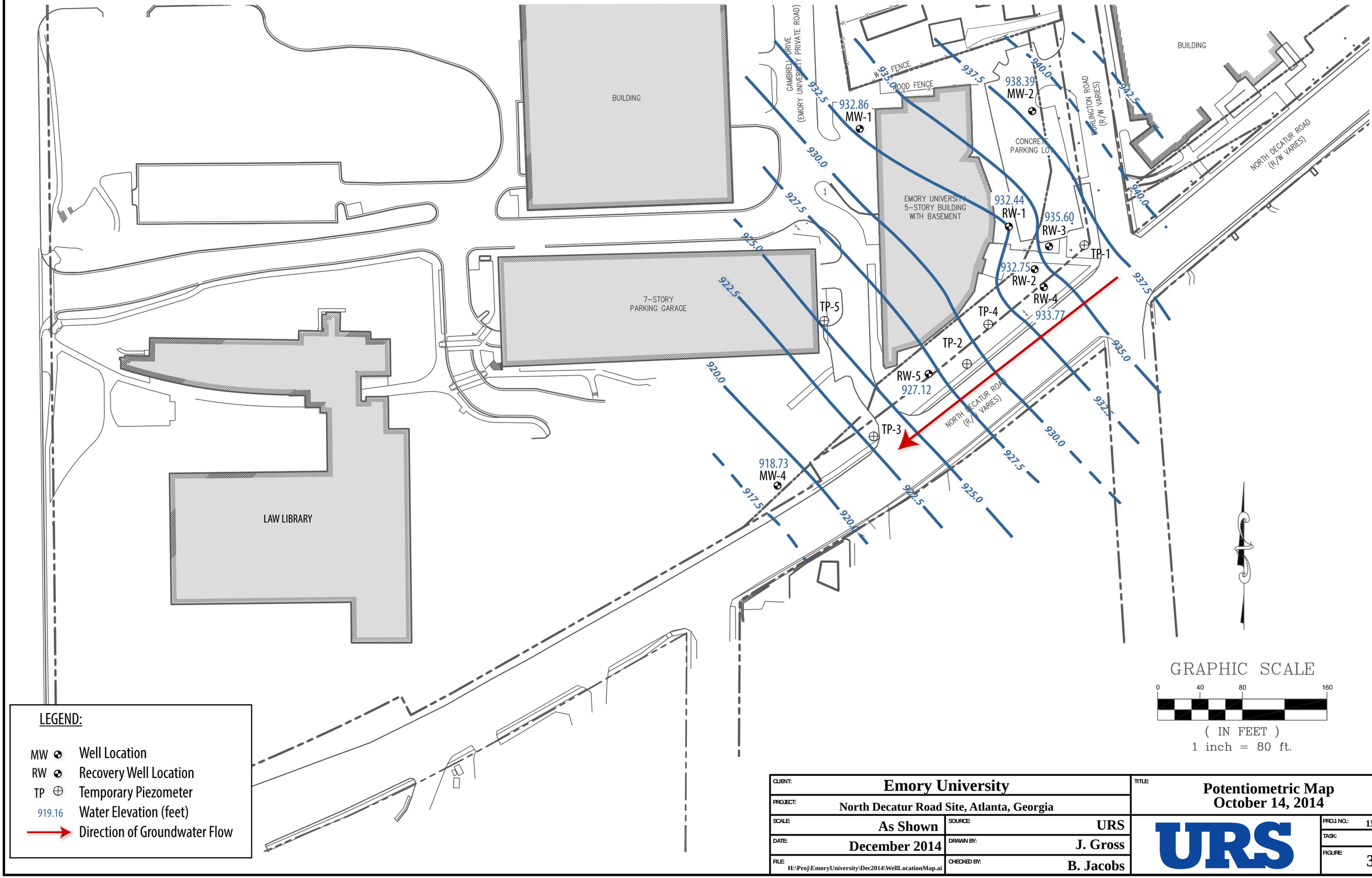
FIGURES



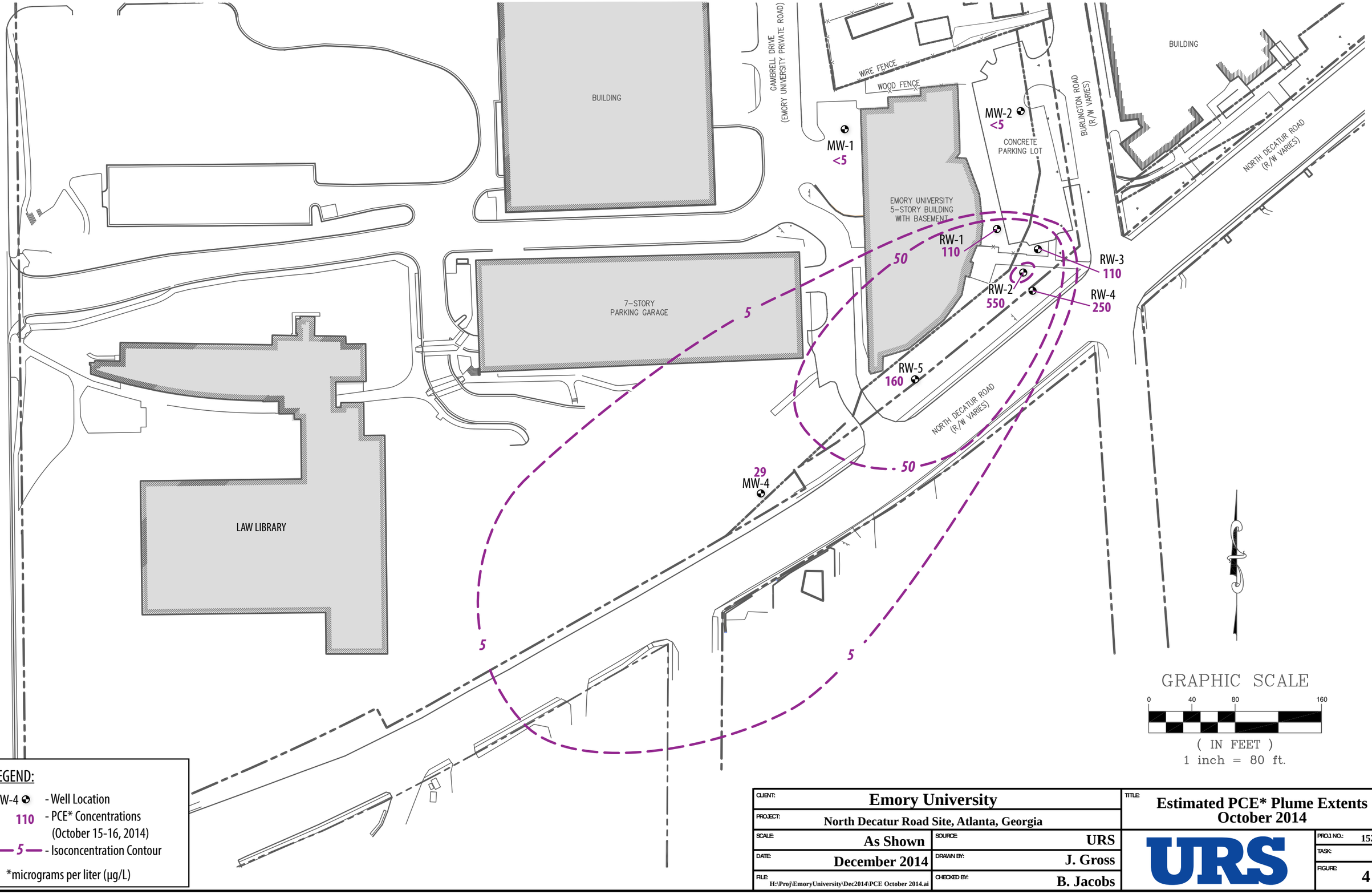
CLIENT:	Emory University	TITLE:	Site Location Map
PROJECT:	North Decatur Road Site, Atlanta, Georgia		
DATE:	December 2014	DESIGNED BY:	
SCALE:	1:24,000	DRAWN BY:	J. Gross
FILE:	H:\proj\EmoryUniversity\December2014\EmoryTopoMap.ai	CHECKED BY:	B. Jacobs
	URS	PROJ NO.:	15263255
		TASK:	01150
		FIGURE:	1



CLIENT:	Emory University		TITLE: Well Location Map
PROJECT:	North Decatur Road Site, Atlanta, Georgia		
SCALE: As Shown	SOURCE: URS		PROJ NO.: 15263255
DATE: December 2014	DRAWN BY: J. Gross		TASK: 01150
FILE: H:\Proj\EmoryUniversity\Dec2014\WellLocationMap.ai	CHECKED BY: B. Jacobs		FIGURE: 2



CLIENT: Emory University		TITLE: Potentiometric Map October 14, 2014	
PROJECT: North Decatur Road Site, Atlanta, Georgia			
SCALE: As Shown	SOURCE: URS	URS	PROJ NO.: 15263255
DATE: December 2014	DRAWN BY: J. Gross		TASK: 01150
FILE: H:\Proj\EmoryUniversity\Dec2014\WellLocationMap.ai	CHECKED BY: B. Jacobs		FIGURE: 3



LEGEND:

MW-4 - Well Location

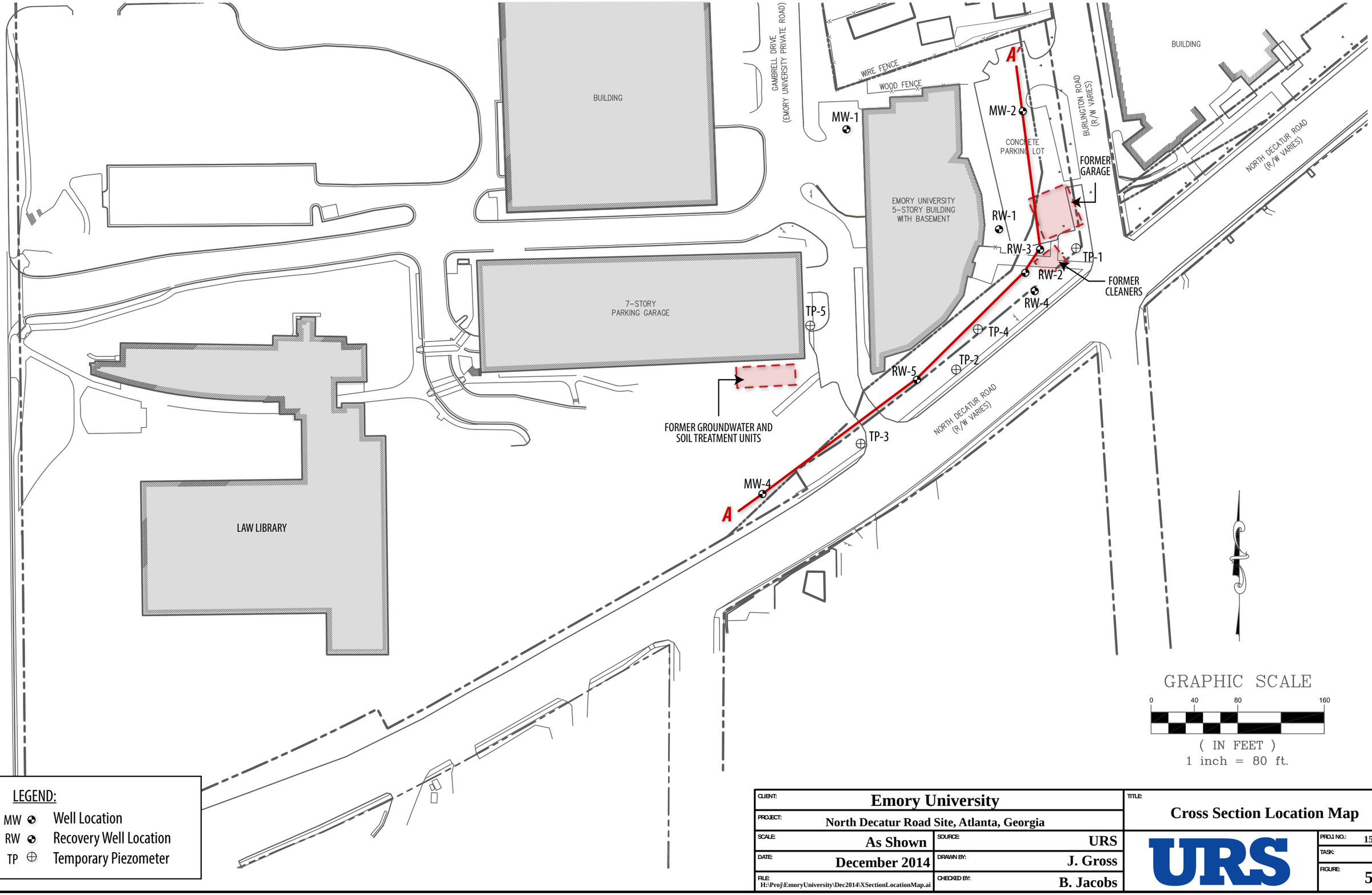
110 - PCE* Concentrations (October 15-16, 2014)

5 - Isoconcentration Contour

*micrograms per liter (µg/L)

CLIENT:	Emory University	TITLE:	Estimated PCE* Plume Extents October 2014
PROJECT:	North Decatur Road Site, Atlanta, Georgia		
SCALE:	As Shown	SOURCE: URS	PROJ NO.: 15263255
DATE:	December 2014	DRAWN BY: J. Gross	TASK: 01150
FILE:	H:\Proj\EmoryUniversity\Dec2014\PCE October 2014.ai	CHECKED BY: B. Jacobs	FIGURE: 4

URS

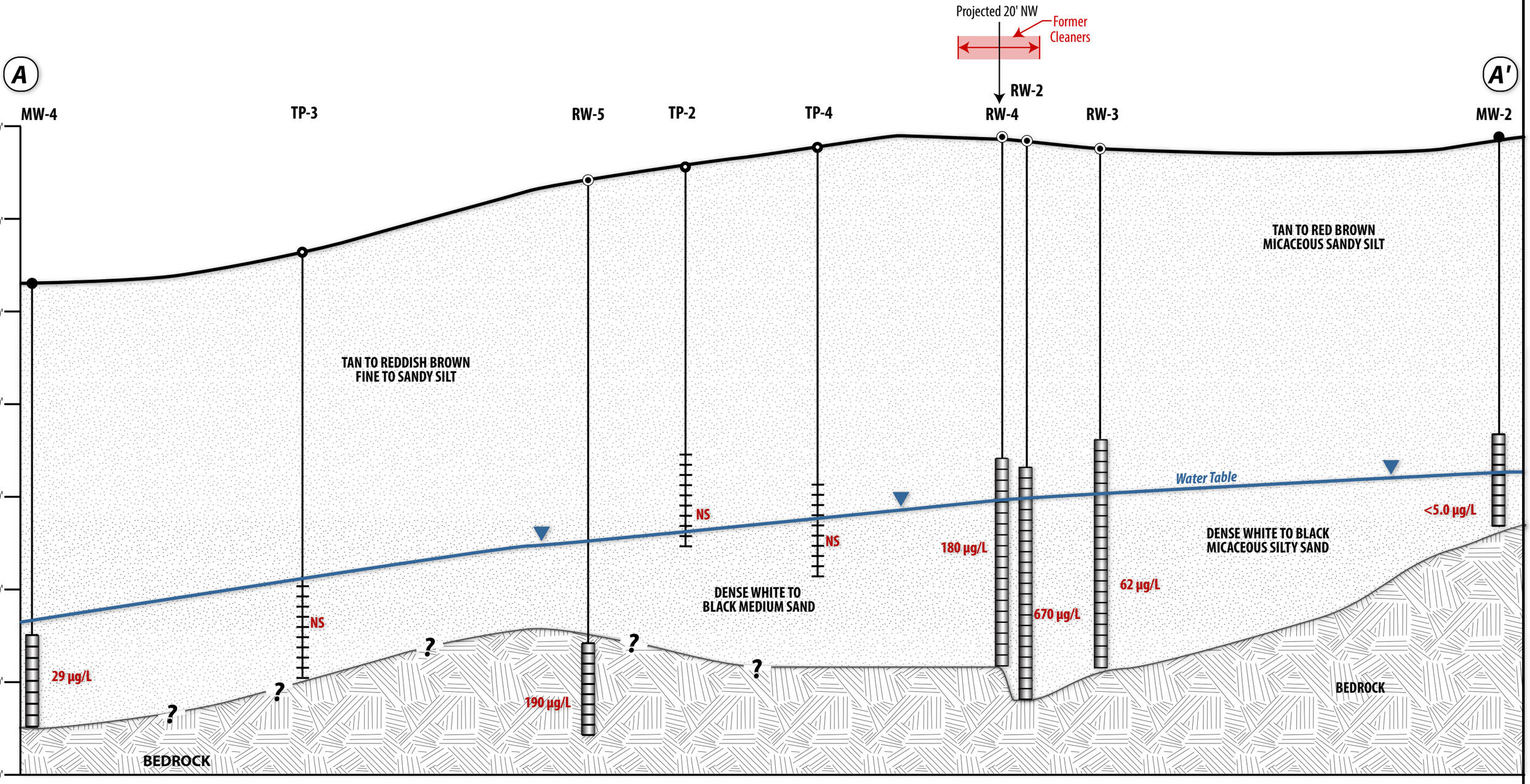


LEGEND:

- MW — Well Location
- RW — Recovery Well Location
- TP — Temporary Piezometer

CLIENT:	Emory University	TITLE:	Cross Section Location Map
PROJECT:	North Decatur Road Site, Atlanta, Georgia		
SCALE:	As Shown	SOURCE: URS	PROJ NO.: 15263255
DATE:	December 2014	DRAWN BY: J. Gross	TASK: 01150
FILE: H:\Proj\EmoryUniversity\Dec2014\XSectionLocationMap.ai		CHECKED BY: B. Jacobs	FIGURE: 5

URS



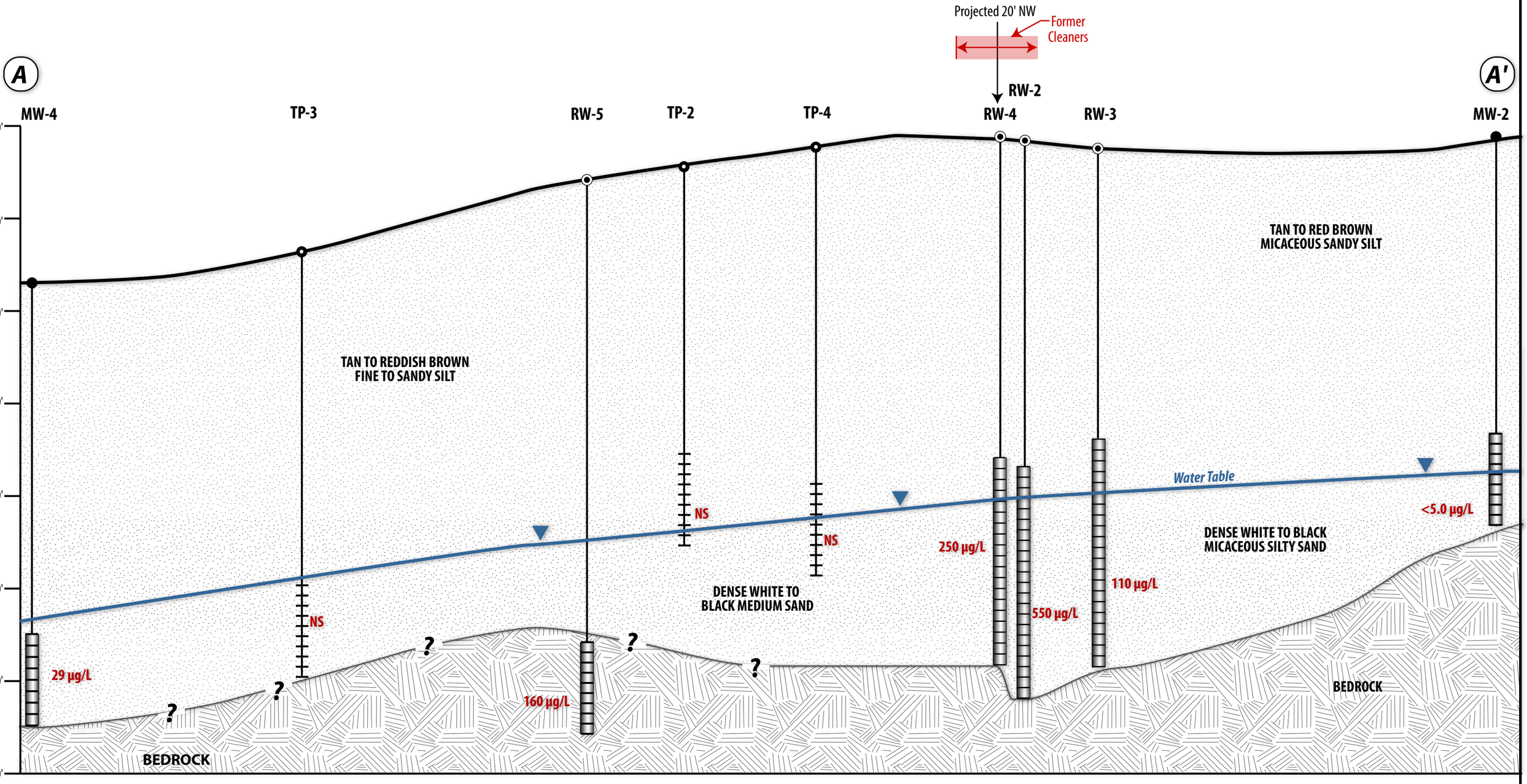
10
5
0
VERTICAL SCALE
IN FEET

0 15 30
HORIZONTAL SCALE
IN FEET

MW - Monitoring Well
TP - Temporary Piezometer
RW - Recovery Well (Except RW-4 which was converted to a Monitoring Well)
NS - Not Sampled

PCE Concentrations from October 2014 Semi-Annual Sampling
Water Table Elevations Measured on October 14, 2014
All units are in micrograms per liter (µg/L)

CLIENT:	Emory University	TITLE:	PCE in Groundwater in Cross Section A-A', August 2014
PROJECT:	North Decatur Road Site, Atlanta, Georgia		
SCALE:	Horizontal: 1" = 30' Vertical: 1" = 10'		
DATE:	December 2014	DRAWN BY:	J. Gross
FILE:	H:\Proj\EmoryUniversity\Dec2014\PCE CrossSect Sug14.ai	CHECKED BY:	B. Jacobs
	URS	PROJ NO.:	15263255
		TASK:	01150
		FIGURE:	6



10
5
0
VERTICAL SCALE
IN FEET

0 15 30
HORIZONTAL SCALE
IN FEET

MW - Monitoring Well
TP - Temporary Piezometer
RW - Recovery Well (Except RW-4 which was converted to a Monitoring Well)
NS - Not Sampled

PCE Concentrations from October 2014 Semi-Annual Sampling
Water Table Elevations Measured on October 14, 2014
All units are in micrograms per liter (µg/L)

CLIENT:	Emory University	TITLE:	PCE in Groundwater in Cross Section A-A', October 2014
PROJECT:	North Decatur Road Site, Atlanta, Georgia		
SCALE:	Horizontal: 1" = 30' Vertical: 1" = 10'		URS
DATE:	December 2014	DRAWN BY: J. Gross	PROJ NO.: 15263255
FILE:	H:\Proj\EmoryUniversity\Dec2014\PCE CrossSect Oct14.ai	CHECKED BY: B. Jacobs	TASK: 01150
			FIGURE: 7

APPENDIX A

AES

ANALYTICAL ENVIRONMENTAL SERVICES, INC.

October 24, 2014

Brent Jacobs
URS
400 Northpark Town Center
Atlanta GA 30328

TEL: (678) 808-8915
FAX: (678) 808-8400

RE: Emory-N. Decatur Rd

Dear Brent Jacobs: Order No: 1410G04

Analytical Environmental Services, Inc. received 10 samples on 10/16/2014 2:17:00 PM for the analyses presented in following report.

No problems were encountered during the analyses. Additionally, all results for the associated Quality Control samples were within EPA and/or AES established limits. Any discrepancies associated with the analyses contained herein will be noted and submitted in the form of a project Case Narrative.
AES' certifications are as follows:
-NELAC/Florida Certification number E87582 for analysis of Environmental Water, soil/hazardous waste, and Drinking Water Microbiology, effective 07/01/14-06/30/15.
-AIHA-LAP, LLC Laboratory ID: 100671 for Industrial Hygiene samples (Organics, Inorganics), Environmental Lead (Paint, Soil, Dust Wipes, Air), and Environmental Microbiology (Fungal) Direct Examination, effective until 09/01/15.

These results relate only to the items tested. This report may only be reproduced in full.

If you have any questions regarding these test results, please feel free to call.

Tara Esbeck

Tara Esbeck
Project Manager

ANALYTICAL ENVIRONMENTAL SERVICES, INC
3080 Presidential Drive, Atlanta GA 30340-3704
AES TEL.: (770) 457-8177 / TOLL-FREE (800) 972-4889 / FAX: (770) 457-8188

CHAIN OF CUSTODY

Work Order: 1410604

Date: 10/14/14 Page 1 of ____

COMPANY:	ADDRESS:
URS Corp	1000 Abernathy Rd NE Suite 900 Atlanta GA 30328
PHONE: 678-808-8975	FAX: 678-808-8400
SAMPLED BY: R. Hilliard / URS	SIGNATURE:

#	SAMPLE ID	SAMPLED DATE	SAMPLED TIME	Grab	Composite	Matrix (See codes)	* BTEX												REMARKS	No # of Containers
							PRESERVATION (See codes)													
1	MW-2	10/14/14	16.33	X		GW	X													2
2	MW-1	10/15/14	0900	X		GW	X													2
3	MW-4	10/15/14	1053	X		GW	X													2
4	RW-1	10/15/14	1353	X		GW	X													2
5	RW-3	10/15/14	1707	X		GW	X													2
6	RW-4	10/15/14	1954	X		GW	X													2
7	RW-5	10/16/14	1052	X		GW	X													2
8	RW-2	10/16/14	1307	X		GW	X													2
9	DUP-1	10/16/14	—	X		GW	X													2
10	Trip Blank	—	—			W	X													2
11																				
12																				
13																				
14																				

Visit our website www.aesatlanta.com to check on the status of your results, place bottle orders, etc.

RELINQUISHED BY	DATE/TIME	RECEIVED BY	DATE/TIME
1:	10/16/14 1417	1: Latoya Reeves	10/16/14 2:17
2:		2:	
3:		3:	

PROJECT INFORMATION
PROJECT NAME: Emory - N. Decatur Rd
PROJECT #: 15263255.01150
SITE ADDRESS: 1724 N. Decatur Rd Decatur GA
SEND REPORT TO: Brent.Jacobs@urs.com
INVOICE TO: (IF DIFFERENT FROM ABOVE)
QUOTE #: PO#:

RECEIPT
Total # of Containers: 20

Turnaround Time Request
- [X] Standard 5 Business Days
- [ ] 2 Business Day Rush
- [ ] Next Business Day Rush
- [ ] Same Day Rush (auth req.)
- [ ] Other

STATE PROGRAM (if any): ____
E-mail? Y / N; Fax? Y / N
DATA PACKAGE: I II III IV

SPECIAL INSTRUCTIONS/COMMENTS:
*Only PCE, TCE, 1,1-DCE, cis-1,2-DCE, Trans-1,2-DCE and Vinyl chloride.

SHIPMENT METHOD
OUT / / VIA:
IN / / VIA:
(CLIENT) FedEx UPS MAIL COURIER
GREYHOUND OTHER____

SAMPLES RECEIVED AFTER 3PM OR ON SATURDAY ARE CONSIDERED RECEIVED THE NEXT BUSINESS DAY. IF TURNAROUND TIME IS NOT INDICATED, AES WILL PROCEED WITH STANDARD TAT OF SAMPLES. SAMPLES ARE DISPOSED 30 DAYS AFTER REPORT COMPLETION UNLESS OTHER ARRANGEMENTS ARE MADE.

MATRIX CODES: A = Air GW = Groundwater SE = Sediment SO = Soil SW = Surface Water W = Water (Blanks) DW = Drinking Water (Blanks) O = Other (specify) WW = Waste Water
PRESERVATIVE CODES: H+I = Hydrochloric acid + ice I = Ice only N = Nitric acid S+I = Sulfuric acid + ice S/M+I = Sodium Bisulfate/Methanol + ice O = Other (specify) NA = None

White Copy - Original; Yellow Copy - Client

Analytical Environmental Services, Inc **Date:** 24-Oct-14

Client:	URS	**Client Sample ID:**	MW-2
Project Name:	Emory-N. Decatur Rd	**Collection Date:**	10/14/2014 4:33:00 PM
Lab ID:	1410G04-001	**Matrix:**	Groundwater

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B				**(SW5030B)**				
1,1-Dichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 12:02	NP
cis-1,2-Dichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 12:02	NP
Tetrachloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 12:02	NP
trans-1,2-Dichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 12:02	NP
Trichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 12:02	NP
Vinyl chloride	BRL	2.0		ug/L	198050	1	10/23/2014 12:02	NP
Surr: 4-Bromofluorobenzene	92.4	66.2-120		%REC	198050	1	10/23/2014 12:02	NP
Surr: Dibromofluoromethane	100	79.5-121		%REC	198050	1	10/23/2014 12:02	NP
Surr: Toluene-d8	97.1	77-117		%REC	198050	1	10/23/2014 12:02	NP

Qualifiers:

*	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 24-Oct-14

Client:	URS	**Client Sample ID:**	MW-1
Project Name:	Emory-N. Decatur Rd	**Collection Date:**	10/15/2014 9:00:00 AM
Lab ID:	1410G04-002	**Matrix:**	Groundwater

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B				**(SW5030B)**				
1,1-Dichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 12:29	NP
cis-1,2-Dichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 12:29	NP
Tetrachloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 12:29	NP
trans-1,2-Dichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 12:29	NP
Trichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 12:29	NP
Vinyl chloride	BRL	2.0		ug/L	198050	1	10/23/2014 12:29	NP
Surr: 4-Bromofluorobenzene	91.9	66.2-120		%REC	198050	1	10/23/2014 12:29	NP
Surr: Dibromofluoromethane	99.8	79.5-121		%REC	198050	1	10/23/2014 12:29	NP
Surr: Toluene-d8	96.5	77-117		%REC	198050	1	10/23/2014 12:29	NP

Qualifiers:

*	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 24-Oct-14

Client:	URS	**Client Sample ID:**	MW-4
Project Name:	Emory-N. Decatur Rd	**Collection Date:**	10/15/2014 10:53:00 AM
Lab ID:	1410G04-003	**Matrix:**	Groundwater

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B				**(SW5030B)**				
1,1-Dichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 12:55	NP
cis-1,2-Dichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 12:55	NP
Tetrachloroethene	29	5.0		ug/L	198050	1	10/23/2014 12:55	NP
trans-1,2-Dichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 12:55	NP
Trichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 12:55	NP
Vinyl chloride	BRL	2.0		ug/L	198050	1	10/23/2014 12:55	NP
Surr: 4-Bromofluorobenzene	94.3	66.2-120		%REC	198050	1	10/23/2014 12:55	NP
Surr: Dibromofluoromethane	101	79.5-121		%REC	198050	1	10/23/2014 12:55	NP
Surr: Toluene-d8	95.6	77-117		%REC	198050	1	10/23/2014 12:55	NP

Qualifiers:

*	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 24-Oct-14

Client:	URS	**Client Sample ID:**	RW-1
Project Name:	Emory-N. Decatur Rd	**Collection Date:**	10/15/2014 1:53:00 PM
Lab ID:	1410G04-004	**Matrix:**	Groundwater

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B				**(SW5030B)**				
1,1-Dichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 13:22	NP
cis-1,2-Dichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 13:22	NP
Tetrachloroethene	110	5.0		ug/L	198050	1	10/23/2014 13:22	NP
trans-1,2-Dichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 13:22	NP
Trichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 13:22	NP
Vinyl chloride	BRL	2.0		ug/L	198050	1	10/23/2014 13:22	NP
Surr: 4-Bromofluorobenzene	93.1	66.2-120		%REC	198050	1	10/23/2014 13:22	NP
Surr: Dibromofluoromethane	99.3	79.5-121		%REC	198050	1	10/23/2014 13:22	NP
Surr: Toluene-d8	97.2	77-117		%REC	198050	1	10/23/2014 13:22	NP

Qualifiers:

*	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 24-Oct-14

Client:	URS	**Client Sample ID:**	RW-3
Project Name:	Emory-N. Decatur Rd	**Collection Date:**	10/15/2014 5:07:00 PM
Lab ID:	1410G04-005	**Matrix:**	Groundwater

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B				**(SW5030B)**				
1,1-Dichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 13:48	NP
cis-1,2-Dichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 13:48	NP
Tetrachloroethene	110	5.0		ug/L	198050	1	10/23/2014 13:48	NP
trans-1,2-Dichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 13:48	NP
Trichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 13:48	NP
Vinyl chloride	BRL	2.0		ug/L	198050	1	10/23/2014 13:48	NP
Surr: 4-Bromofluorobenzene	89	66.2-120		%REC	198050	1	10/23/2014 13:48	NP
Surr: Dibromofluoromethane	97.1	79.5-121		%REC	198050	1	10/23/2014 13:48	NP
Surr: Toluene-d8	95.8	77-117		%REC	198050	1	10/23/2014 13:48	NP

Qualifiers:

*	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 24-Oct-14

Client:	URS	**Client Sample ID:**	RW-4
Project Name:	Emory-N. Decatur Rd	**Collection Date:**	10/15/2014 7:54:00 PM
Lab ID:	1410G04-006	**Matrix:**	Groundwater

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B				**(SW5030B)**				
1,1-Dichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 12:36	NP
cis-1,2-Dichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 12:36	NP
Tetrachloroethene	250	50		ug/L	198050	10	10/23/2014 14:14	NP
trans-1,2-Dichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 12:36	NP
Trichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 12:36	NP
Vinyl chloride	BRL	2.0		ug/L	198050	1	10/23/2014 12:36	NP
Surr: 4-Bromofluorobenzene	93	66.2-120		%REC	198050	1	10/23/2014 12:36	NP
Surr: 4-Bromofluorobenzene	93.8	66.2-120		%REC	198050	10	10/23/2014 14:14	NP
Surr: Dibromofluoromethane	103	79.5-121		%REC	198050	1	10/23/2014 12:36	NP
Surr: Dibromofluoromethane	104	79.5-121		%REC	198050	10	10/23/2014 14:14	NP
Surr: Toluene-d8	101	77-117		%REC	198050	1	10/23/2014 12:36	NP
Surr: Toluene-d8	102	77-117		%REC	198050	10	10/23/2014 14:14	NP

Qualifiers:

*	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 24-Oct-14

Client:	URS	**Client Sample ID:**	RW-5
Project Name:	Emory-N. Decatur Rd	**Collection Date:**	10/16/2014 10:52:00 AM
Lab ID:	1410G04-007	**Matrix:**	Groundwater

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B				**(SW5030B)**				
1,1-Dichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 13:00	NP
cis-1,2-Dichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 13:00	NP
Tetrachloroethene	160	5.0		ug/L	198050	1	10/23/2014 13:00	NP
trans-1,2-Dichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 13:00	NP
Trichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 13:00	NP
Vinyl chloride	BRL	2.0		ug/L	198050	1	10/23/2014 13:00	NP
Surr: 4-Bromofluorobenzene	93.2	66.2-120		%REC	198050	1	10/23/2014 13:00	NP
Surr: Dibromofluoromethane	103	79.5-121		%REC	198050	1	10/23/2014 13:00	NP
Surr: Toluene-d8	101	77-117		%REC	198050	1	10/23/2014 13:00	NP

Qualifiers:

*	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 24-Oct-14

Client:	URS	**Client Sample ID:**	RW-2
Project Name:	Emory-N. Decatur Rd	**Collection Date:**	10/16/2014 1:07:00 PM
Lab ID:	1410G04-008	**Matrix:**	Groundwater

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B				**(SW5030B)**				
1,1-Dichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 13:25	NP
cis-1,2-Dichloroethene	24	5.0		ug/L	198050	1	10/23/2014 13:25	NP
Tetrachloroethene	550	50		ug/L	198050	10	10/23/2014 14:39	NP
trans-1,2-Dichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 13:25	NP
Trichloroethene	7.5	5.0		ug/L	198050	1	10/23/2014 13:25	NP
Vinyl chloride	BRL	2.0		ug/L	198050	1	10/23/2014 13:25	NP
Surr: 4-Bromofluorobenzene	93.6	66.2-120		%REC	198050	1	10/23/2014 13:25	NP
Surr: 4-Bromofluorobenzene	92.7	66.2-120		%REC	198050	10	10/23/2014 14:39	NP
Surr: Dibromofluoromethane	103	79.5-121		%REC	198050	10	10/23/2014 14:39	NP
Surr: Dibromofluoromethane	104	79.5-121		%REC	198050	1	10/23/2014 13:25	NP
Surr: Toluene-d8	102	77-117		%REC	198050	1	10/23/2014 13:25	NP
Surr: Toluene-d8	104	77-117		%REC	198050	10	10/23/2014 14:39	NP

Qualifiers:

*	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 24-Oct-14

Client:	URS	**Client Sample ID:**	DUP-1
Project Name:	Emory-N. Decatur Rd	**Collection Date:**	10/16/2014
Lab ID:	1410G04-009	**Matrix:**	Groundwater

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B				**(SW5030B)**				
1,1-Dichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 13:50	NP
cis-1,2-Dichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 13:50	NP
Tetrachloroethene	160	5.0		ug/L	198050	1	10/23/2014 13:50	NP
trans-1,2-Dichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 13:50	NP
Trichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 13:50	NP
Vinyl chloride	BRL	2.0		ug/L	198050	1	10/23/2014 13:50	NP
Surr: 4-Bromofluorobenzene	92	66.2-120		%REC	198050	1	10/23/2014 13:50	NP
Surr: Dibromofluoromethane	103	79.5-121		%REC	198050	1	10/23/2014 13:50	NP
Surr: Toluene-d8	102	77-117		%REC	198050	1	10/23/2014 13:50	NP

Qualifiers:

*	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 24-Oct-14

Client:	URS	**Client Sample ID:**	TRIP BLANK
Project Name:	Emory-N. Decatur Rd	**Collection Date:**	10/16/2014
Lab ID:	1410G04-010	**Matrix:**	Aqueous

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B				**(SW5030B)**				
1,1-Dichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 11:36	NP
cis-1,2-Dichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 11:36	NP
Tetrachloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 11:36	NP
trans-1,2-Dichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 11:36	NP
Trichloroethene	BRL	5.0		ug/L	198050	1	10/23/2014 11:36	NP
Vinyl chloride	BRL	2.0		ug/L	198050	1	10/23/2014 11:36	NP
Surr: 4-Bromofluorobenzene	92.1	66.2-120		%REC	198050	1	10/23/2014 11:36	NP
Surr: Dibromofluoromethane	98.5	79.5-121		%REC	198050	1	10/23/2014 11:36	NP
Surr: Toluene-d8	92.3	77-117		%REC	198050	1	10/23/2014 11:36	NP

Qualifiers:

*	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc.

Sample/Cooler Receipt Checklist

Client URS Work Order Number 1410604

Checklist completed by [signature] 10/16/14
Signature Date

Carrier name: FedEx __ UPS __ Courier __ Client ✓ US Mail __ Other _____

Shipping container/cooler in good condition? Yes ✓ No __ Not Present __

Custody seals intact on shipping container/cooler? Yes __ No __ Not Present ✓

Custody seals intact on sample bottles? Yes __ No __ Not Present ✓

Container/Temp Blank temperature in compliance? (0°≤6°C)* Yes ✓ No __

Cooler #1 2.1 Cooler #2 _____ Cooler #3 _____ Cooler #4 _____ Cooler#5 _____ Cooler #6 _____

Chain of custody present? Yes ✓ No __

Chain of custody signed when relinquished and received? Yes ✓ No __

Chain of custody agrees with sample labels? Yes ✓ No __

Samples in proper container/bottle? Yes ✓ No __

Sample containers intact? Yes ✓ No __

Sufficient sample volume for indicated test? Yes ✓ No __

All samples received within holding time? Yes ✓ No __

Was TAT marked on the COC? Yes ✓ No __

Proceed with Standard TAT as per project history? Yes __ No __ Not Applicable ✓

Water - VOA vials have zero headspace? No VOA vials submitted __ Yes ✓ No __

Water - pH acceptable upon receipt? Yes ✓ No __ Not Applicable __

Adjusted? _____ Checked by _____

Sample Condition: Good ✓ Other(Explain) _____

(For diffusive samples or AIHA lead) Is a known blank included? Yes __ No ✓

See Case Narrative for resolution of the Non-Conformance.

* Samples do not have to comply with the given range for certain parameters.

\\Aes_server\I\Sample Receipt\My Documents\COCs and pH Adjustment Sheet\Sample_Cooler_Recipt_Checklist_Rev1.rtf

Client: URS
Project Name: Emory-N. Decatur Rd
Workorder: 1410G04

ANALYTICAL QC SUMMARY REPORT

BatchID: 198050

Sample ID: **MB-198050** Client ID: Units: **ug/L** Prep Date: **10/21/2014** Run No: **278317**
SampleType: **MBLK** TestCode: **TCL VOLATILE ORGANICS SW8260B** BatchID: **198050** Analysis Date: **10/21/2014** Seq No: **5882161**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
1,1-Dichloroethene	BRL	5.0									
cis-1,2-Dichloroethene	BRL	5.0									
Tetrachloroethene	BRL	5.0									
trans-1,2-Dichloroethene	BRL	5.0									
Trichloroethene	BRL	5.0									
Vinyl chloride	BRL	2.0									
Surr: 4-Bromofluorobenzene	48.18	0	50.00		96.4	66.2	120				
Surr: Dibromofluoromethane	59.60	0	50.00		119	79.5	121				
Surr: Toluene-d8	48.49	0	50.00		97.0	77	117				

Sample ID: **LCS-198050** Client ID: Units: **ug/L** Prep Date: **10/21/2014** Run No: **278317**
SampleType: **LCS** TestCode: **TCL VOLATILE ORGANICS SW8260B** BatchID: **198050** Analysis Date: **10/21/2014** Seq No: **5882160**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
1,1-Dichloroethene	57.92	5.0	50.00		116	63.1	140				
Trichloroethene	54.10	5.0	50.00		108	71.2	135				
Surr: 4-Bromofluorobenzene	47.98	0	50.00		96.0	66.2	120				
Surr: Dibromofluoromethane	58.09	0	50.00		116	79.5	121				
Surr: Toluene-d8	47.42	0	50.00		94.8	77	117				

Sample ID: **1410E71-043AMS** Client ID: Units: **ug/L** Prep Date: **10/21/2014** Run No: **278393**
SampleType: **MS** TestCode: **TCL VOLATILE ORGANICS SW8260B** BatchID: **198050** Analysis Date: **10/22/2014** Seq No: **5883799**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
1,1-Dichloroethene	57.93	5.0	50.00		116	60.2	159				
Trichloroethene	55.33	5.0	50.00		111	70.1	144				
Surr: 4-Bromofluorobenzene	47.08	0	50.00		94.2	66.2	120				
Surr: Dibromofluoromethane	46.67	0	50.00		93.3	79.5	121				

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: URS
Project Name: Emory-N. Decatur Rd
Workorder: 1410G04

ANALYTICAL QC SUMMARY REPORT

BatchID: 198050

Sample ID: **1410E71-043AMS** Client ID: Units: **ug/L** Prep Date: **10/21/2014** Run No: **278393**
SampleType: **MS** TestCode: **TCL VOLATILE ORGANICS SW8260B** BatchID: **198050** Analysis Date: **10/22/2014** Seq No: **5883799**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Surr: Toluene-d8	47.92	0	50.00		95.8	77	117				

Sample ID: **1410E71-043AMSD** Client ID: Units: **ug/L** Prep Date: **10/21/2014** Run No: **278393**
SampleType: **MSD** TestCode: **TCL VOLATILE ORGANICS SW8260B** BatchID: **198050** Analysis Date: **10/22/2014** Seq No: **5883800**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
1,1-Dichloroethene	56.90	5.0	50.00		114	60.2	159	57.93	1.79	19.2	
Trichloroethene	54.58	5.0	50.00		109	70.1	144	55.33	1.36	20	
Surr: 4-Bromofluorobenzene	47.14	0	50.00		94.3	66.2	120	47.08	0	0	
Surr: Dibromofluoromethane	47.72	0	50.00		95.4	79.5	121	46.67	0	0	
Surr: Toluene-d8	47.50	0	50.00		95.0	77	117	47.92	0	0	

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

APPENDIX B

EMORY UNIVERSITY
NORTH DECATUR ROAD/BURLINGTON ROAD
HSI No. 10121
ATLANTA, GEORGIA

Introduction

An evaluation for potential vapor intrusion from groundwater and soil pathways was conducted for the site. The evaluation utilized a weight of evidence approach consistent with ITRC's *Vapor Intrusion Pathway: A Practical Guideline* (ITRC, 2007) and follows the principles in *EPA's Superfund Vapor Intrusion FAQs* (EPA, 2012) available on-line at http:// http://www.epa.gov/oswer/vaporintrusion/, and *EPA's draft Final Guidance for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Sources to Indoor Air* (EPA, 2013). Lines of evidence used in the data evaluation will initially include building-specific factors (such as size and air exchange rate) and analytical data (groundwater) collected during the investigation. The findings from this evaluation are presented in this Section.

Approach

A tiered evaluation was performed to assess whether the vapor intrusion exposure pathway is complete. The evaluation consists of the following three steps, summarized below and detailed in the following sub-sections.

- Tier 1 Screen– Identification of constituents of potential concern (COPCs) for vapor intrusion.
- Tier 2 Screen– Comparison of groundwater data to risk-based screening concentrations.
- Tier 3 Screen (Site-specific Assessment) – Comparison of groundwater concentrations to screening concentrations derived using the Johnson & Ettinger (J&E) Model.

Tier 1 Screening Summary

Groundwater samples have been collected at and adjacent to the site as part of various investigations. Four shallow monitoring wells and four recovery wells, which are in the vicinity of the groundwater and soil former treatment units (Figure 1), were selected as part of this evaluation. Results from these wells indicate various volatile organic compounds (VOCs) listed in EPA's *Vapor Intrusion Screening Level (VISL) Calculator* (May 2014 edition - EPA, 2014) available on-line at http://www.epa.gov/oswer/vaporintrusion/ are present in the site's shallow groundwater (**Table 1**). Historical groundwater monitoring data have been collected from these locations since 1998. However for this evaluation, only the more recent data collected from monitoring events conducted in 2013 and 2014 were evaluated to reflect current conditions.

EPA's *Superfund Vapor Intrusion FAQs* (EPA, 2012) does not recommend the use of soil concentrations for assessing whether or not the vapor intrusion pathway is complete because of the large uncertainties associated with using them. However, soil concentrations provide useful information in identifying potential source areas. The source of VOCs in the subsurface soils has been identified and remediated and certified to meet the Georgia Environmental Protection Division (GAEPD) Georgia Hazardous Site Response Act (HSRA) Type 1 Risk reduction Standards (RRS).

Tier 2 Screening Summary

The site is currently used for non-residential land use. However, volatile constituents detected in shallow groundwater were compared to both commercial/industrial and residential screening levels generated using EPA's Vapor Intrusion Screening Level (VISL) calculator (EPA, 2014) to identify COPCs for indoor air. The VISLs were based on EPA's SLs for industrial air and residential air, respectively, with an applied generic attenuation factor (EPA, 2014).

Table 2 presents the screening levels and the comparison to the on-site groundwater data. The following observations were noted.

- Tetrachloroethylene (PCE) was detected above commercial/industrial VISLs and residential VISLs in each of the recovery well locations (RW-1 through RW-4) and two monitoring well locations (MW-3 and MW-4).
- The maximum detected PCE concentration was observed in recovery well location RW-2.
- Trichloroethene (TCE) was detected above residential VISLs but less than commercial/industrial VISLs. The exceedance was limited to one location (RW-2).
- No other constituents were detected above VISLs.

Tier 3: Site-Specific Assessment

The EPA spreadsheets that incorporate the J&E Model were used to further evaluate the vapor intrusion pathway from PCE and TCE identified in shallow groundwater. The J&E Model is a one-dimensional analytical solution to convective and diffusive vapor transport into indoor spaces and provides an estimated attenuation coefficient that relates the vapor concentration in the indoor space to the vapor concentration at the source of contamination. The model is constructed as both a steady-state solution to vapor transport (infinite or non-diminishing source) and as a quasi-steady-state solution (finite or diminishing source). Inputs to the model include chemical properties of the contaminant, saturated and unsaturated zone soil properties, and structural properties of the building. Model results (both screening and advanced) are provided as either a risk-based groundwater concentration, or as an estimate of the incremental risks associated with a user-defined initial groundwater concentration (EPA, 2003). The J&E model is considered a conservative screening level tool. For instance, the model assumes that all vapors originating from below the building will enter the building unless the floors and walls are perfect vapor barriers. In addition, the model does not account for dispersion or transformation processes (e.g., biodegradation, hydrolysis).

The following site-specific inputs were incorporated into the groundwater model:

- Depth below grade to bottom of enclosed space floor – 200 cm (default value for basement)
- Depth below grade to water table – 1154 cm (site-specific average, 38 feet)
- Soil Conservation Service (SCS) soil type directly above water table – Sandy Loam (site-specific).
- Average groundwater temperature (degrees (°) Celsius) – 18 ° (regional-specific)
- Default vadose zone soil type parameters for sandy loam.

- Default building-related information and air exchange rate
- The model was run to calculate a screening concentration based on residential or non-residential endpoints. Exposure scenarios were evaluated: using USEPA default exposure assumptions (i.e., worker – 250 days/year for 25 years).
- Most recent inhalation toxicity factors as listed in EPA's Regional Screening Level Table (May 2014) were used.
- The current version of the EPA spreadsheets that incorporate the J&E model does not have an input for the number of hours per day; however, 24 hr/day is implicit in the model. Therefore, to derive a screening level consistent with a non-residential endpoint the model output was multiplied by 3 to adjust the exposure rate for a commercial/industrial worker from the assumed value of 24 hr/day to an 8 hr/day exposure. Commercial/industrial screening levels presented in **Table 2** include the adjustment factor.

Table 2 summarizes the results of the J&E Model. J&E Model outputs are provided in **Appendix A**. As presented in the table, maximum detected concentrations of TCE were less than the site-specific screening levels for residential or commercial/industrial land use.

Maximum detected concentrations of PCE were less than site-specific screening levels for commercial/industrial land use. Concentrations of PCE were detected above site-specific screening levels for residential land use in one location RW-2. However, exceedances were not observed in cross-gradient location RW-4 and downgradient location MW-3. The PCE concentration (44 ug/L) detected in off-site sample collected during a December 2013 Phase II Environmental Site Assessment at 1743, 1767, 1775, and 1785 North Decatur Road (University Inn) was also less than the site-specific screening level.

Summary

The results of this site-specific evaluation indicate that vapor intrusion from groundwater to indoor air is not expected to be a concern at this time. Constituents detected in groundwater were less than risk-based screening levels derived using site-specific assumptions.

References

Interstate Technical and Regulatory Guidance (ITRC), 2007. *Vapor Intrusion Pathway: A Practical Guideline*. January.

EPA, 2003. *User Guide for Evaluating Subsurface Vapor Intrusion into Buildings, June 2003. Prepared by: Environmental Quality Management, Inc*.

EPA, 2012. *EPA's Superfund Vapor Intrusion FAQs*. February. Available on-line at http://www.epa.gov/oswer/vaporintrusion/.

EPA, 2013. OSWER Final Guidance for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Sources to Indoor Air. External Review Draft. April 2013.

EPA, 2014. *Vapor Intrusion Screening Level Calculator*. May 2014 edition. Available on-line at http://www.epa.gov/oswer/vaporintrusion/.

FIGURE

BUILDING

GAMBRELL DRIVE
(EMORY UNIVERSITY PRIVATE ROAD)

WIRE FENCE

WOOD FENCE

MW-1

MW-2

CONCRETE
PARKING LOT

BURLINGTON ROAD
(R/W VARIES)

BUILDING

NORTH DECATUR ROAD
(R/W VARIES)

EMORY UNIVERSITY
5-STORY BUILDING
WITH BASEMENT

RW-1

RW-3

RW-2

RW-4

7-STORY
PARKING GARAGE

RW-5

NORTH DECATUR ROAD
(R/W VARIES)

MW-4

LEGEND:

MW-4 WELL LOCATIONS

GRAPHIC SCALE

0 30 60 120

(IN FEET)

1 inch = 60 ft.

BURLINGTON RD 115kV SUBSTATION
EMORY UNIVERSITY

WELL LOCATION MAP

FIGURE: 1

URS
400 Northpark Town Center
1000 Abernathy Road, N.E., Suite 900
Atlanta, Georgia 30328
Tel: (678) 808-8800 Fax: (678) 808-8400

PROJECT NO. 15263255

SCALE: 1" = 60'

DATE: 03/28/2014

TABLES

Table 1
Summary of Groundwater Analytical Results
Emory University North Decatur/Burlington Road Site
HSI Site No. 10121
Atlanta, Georgia

Well Number	Sample Date	PCE (µg/L)	TCE (µg/L)	1,1-DCE (µg/L)	CIS-1,2-DCE (µg/L)	TRANS-1,2-DCE (µg/L)	VINYL CHLORIDE (µg/L)	1,4-DIOXANE (µg/L)
MW-1	02/05/01	BRL	BRL	BRL	BRL	BRL	BRL	NA
	07/18/01	BRL	BRL	BRL	BRL	BRL	BRL	NA
	11/06/01	BRL	BRL	BRL	BRL	BRL	BRL	NA
	05/02/02	BRL	BRL	BRL	BRL	BRL	BRL	NA
	12/09/02	BRL	BRL	BRL	BRL	BRL	BRL	NA
	01/29/03	BRL	BRL	BRL	BRL	BRL	BRL	NA
	06/19/03	BRL	BRL	BRL	BRL	BRL	BRL	NA
	01/15/04	BRL	BRL	BRL	BRL	BRL	BRL	NA
	06/18/04	BRL	BRL	BRL	BRL	BRL	BRL	NA
	01/28/05	BRL	BRL	BRL	BRL	BRL	BRL	NA
	07/01/05	BRL	BRL	BRL	BRL	BRL	BRL	NA
	02/01/06	BRL	BRL	BRL	BRL	BRL	BRL	NA
	06/20/06	BRL	BRL	BRL	BRL	BRL	BRL	NA
	02/28/07	BRL	BRL	BRL	BRL	BRL	BRL	NA
	06/19/07	BRL	BRL	BRL	BRL	BRL	BRL	NA
	03/01/08	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/08	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	03/11/09	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	06/30/09	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	01/22/10	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	07/09/10	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/11	BRL	BRL	BRL	BRL	BRL	BRL	NA
	01/04/12	BRL	BRL	BRL	BRL	BRL	BRL	NA
	06/26/12	BRL	BRL	BRL	BRL	BRL	BRL	NA
	01/09/13	BRL	BRL	BRL	BRL	BRL	BRL	NA
	06/26/13	BRL	BRL	BRL	BRL	BRL	BRL	NA
	01/21/14	BRL	BRL	BRL	BRL	BRL	BRL	NA
	08/04/14	BRL	BRL	BRL	BRL	BRL	BRL	NA
	10/15/14	BRL	BRL	BRL	BRL	BRL	BRL	NA

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MW-2	02/05/01	BRL	BRL	BRL	BRL	BRL	BRL	NA
	07/18/01	BRL	BRL	BRL	BRL	BRL	BRL	NA
	11/06/01	BRL	BRL	BRL	BRL	BRL	BRL	NA
	05/02/02	BRL	BRL	BRL	BRL	BRL	BRL	NA
	12/09/02	BRL	BRL	BRL	BRL	BRL	BRL	NA
	01/29/03	BRL	BRL	BRL	BRL	BRL	BRL	NA
	06/19/03	BRL	BRL	BRL	BRL	BRL	BRL	NA
	01/15/04	BRL	BRL	BRL	BRL	BRL	BRL	NA
	06/18/04	BRL	BRL	BRL	BRL	BRL	BRL	NA
	01/28/05	BRL	BRL	BRL	BRL	BRL	BRL	NA
	07/01/05	BRL	BRL	BRL	BRL	BRL	BRL	NA
	02/01/06	BRL	BRL	BRL	BRL	BRL	BRL	NA
	06/20/06	BRL	BRL	BRL	BRL	BRL	BRL	NA
	02/28/07	BRL	BRL	BRL	BRL	BRL	BRL	NA
	06/19/07	BRL	BRL	BRL	BRL	BRL	BRL	NA
	03/01/08	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/08	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	03/11/09	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	06/30/09	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	01/22/10	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	07/09/10	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/11	BRL	BRL	BRL	BRL	BRL	BRL	NA
	01/04/12	BRL	BRL	BRL	BRL	BRL	BRL	NA
	06/26/12	BRL	19	BRL	BRL	BRL	BRL	NA
	01/09/13	BRL	BRL	BRL	BRL	BRL	BRL	NA
	06/26/13	BRL	BRL	BRL	BRL	BRL	BRL	NA
	01/21/14	BRL	BRL	BRL	BRL	BRL	BRL	NA
	08/04/14	BRL	BRL	BRL	BRL	BRL	BRL	NA
	10/15/14	BRL	BRL	BRL	BRL	BRL	BRL	NA

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MW-3/RW-5*	02/05/01	65	BRL	BRL	BRL	BRL	BRL	NA
	07/18/01	78	BRL	BRL	BRL	BRL	BRL	NA
	11/06/01	89.2	BRL	BRL	BRL	BRL	BRL	NA
	02/14/02	90	BRL	BRL	BRL	BRL	BRL	NA
	07/10/02	66.6	BRL	BRL	BRL	BRL	BRL	NA
	01/29/03	43.1	BRL	BRL	BRL	BRL	BRL	NA
	06/19/03	75	BRL	BRL	BRL	BRL	BRL	NA
	01/15/04	53	BRL	BRL	BRL	BRL	BRL	NA
	06/18/04	56	BRL	BRL	BRL	BRL	BRL	NA
	01/28/05	47	BRL	BRL	BRL	BRL	BRL	NA
	07/01/05	40	BRL	BRL	BRL	BRL	BRL	NA
	02/01/06	57	BRL	BRL	BRL	BRL	BRL	NA
	06/20/06	66	BRL	BRL	BRL	BRL	BRL	NA
	02/28/07	50	BRL	BRL	BRL	BRL	BRL	NA
	06/19/07	14	BRL	BRL	120	BRL	BRL	NA
	03/01/08	39	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/08	44	BRL	BRL	BRL	BRL	BRL	BRL
	03/11/09	40	BRL	BRL	BRL	BRL	BRL	BRL
	06/30/09	66	BRL	BRL	BRL	BRL	BRL	BRL
	01/22/10	71	BRL	BRL	BRL	BRL	BRL	BRL
	07/08/10	73	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/11	160	BRL	BRL	BRL	BRL	BRL	NA
	01/04/12	190	BRL	BRL	BRL	BRL	BRL	NA
	06/27/12	200	BRL	BRL	BRL	BRL	BRL	NA
	01/10/13	230	BRL	BRL	BRL	BRL	BRL	NA
	06/27/13	150	BRL	BRL	BRL	BRL	BRL	NA
	01/21/14	180	BRL	BRL	BRL	BRL	BRL	NA
	08/04/14	190	BRL	BRL	BRL	BRL	BRL	NA
	10/15/14	160	BRL	BRL	BRL	BRL	BRL	NA

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MW-4	02/05/01	3.4	BRL	BRL	BRL	BRL	BRL	NA
	07/18/01	4.0	BRL	BRL	BRL	BRL	BRL	NA
	11/06/01	3.8	BRL	BRL	BRL	BRL	BRL	NA
	05/02/02	4.8	BRL	BRL	BRL	BRL	BRL	NA
	12/09/02	3.0	BRL	BRL	BRL	BRL	BRL	NA
	01/29/03	4.1	BRL	BRL	BRL	BRL	BRL	NA
	06/19/03	4.0	BRL	BRL	BRL	BRL	BRL	NA
	01/15/04	3.7	BRL	BRL	BRL	BRL	BRL	NA
	06/18/04	BRL	BRL	BRL	BRL	BRL	BRL	NA
	01/28/05	BRL	BRL	BRL	BRL	BRL	BRL	NA
	07/01/05	BRL	BRL	BRL	BRL	BRL	BRL	NA
	02/01/06	BRL	BRL	BRL	BRL	BRL	BRL	NA
	06/20/06	BRL	BRL	BRL	BRL	BRL	BRL	NA
	02/28/07	BRL	BRL	BRL	BRL	BRL	BRL	NA
	06/19/07	BRL	BRL	BRL	BRL	BRL	BRL	NA
	03/01/08	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/08	5.0	BRL	BRL	BRL	BRL	BRL	BRL
	03/11/09	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	06/30/09	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	01/22/10	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	07/09/10	BRL	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/11	8.7	BRL	BRL	BRL	BRL	BRL	NA
	01/04/12	11	BRL	BRL	BRL	BRL	BRL	NA
	06/26/12	14	BRL	BRL	BRL	BRL	BRL	NA
	01/09/13	15	BRL	BRL	BRL	BRL	BRL	NA
	06/26/13	14	BRL	BRL	BRL	BRL	BRL	NA
	01/21/14	20	BRL	BRL	BRL	BRL	BRL	NA
	08/04/14	29	BRL	BRL	BRL	BRL	BRL	NA
	10/15/14	29	BRL	BRL	BRL	BRL	BRL	NA

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RW-1	Jun-98	8.4	NA	NA	NA	NA	NA	NA
	Jun-98	NS	NS	NS	NS	NS	NS	NS
	01/08/99	BRL	NA	NA	NA	NA	NA	NA
	07/09/99	12.4	NA	NA	NA	NA	NA	NA
	07/27/99	NS	NS	NS	NS	NS	NS	NS
	01/06/00	20	NA	NA	NA	NA	NA	NA
	07/07/00	56.4	NA	NA	NA	NA	NA	NA
	02/05/01	59.0	BRL	BRL	BRL	BRL	BRL	NA
	07/18/01	NS	NS	NS	NS	NS	NS	NS
	08/06/01	27	BRL	BRL	BRL	BRL	BRL	NA
	11/06/01	NS	NS	NS	NS	NS	NS	NS
	02/14/02	85.4	BRL	BRL	BRL	BRL	BRL	NA
	07/10/02	107	BRL	BRL	BRL	BRL	BRL	NA
	01/29/03	144	BRL	BRL	BRL	BRL	BRL	NA
	06/19/03	170	BRL	BRL	BRL	BRL	BRL	NA
	01/15/04	200	BRL	BRL	BRL	BRL	BRL	NA
	06/18/04	200	BRL	BRL	BRL	BRL	BRL	NA
	01/28/05	190	BRL	BRL	BRL	BRL	BRL	NA
	07/01/05	190	BRL	BRL	BRL	BRL	BRL	NA
	02/01/06	140	BRL	BRL	BRL	BRL	BRL	NA
	06/20/06	160	BRL	BRL	BRL	BRL	BRL	NA
	02/28/07	110	BRL	BRL	BRL	BRL	BRL	NA
	06/19/07	160	BRL	BRL	BRL	BRL	BRL	NA
	03/01/08	90	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/08	130	BRL	BRL	BRL	BRL	BRL	BRL
	03/11/09	99	BRL	BRL	BRL	BRL	BRL	BRL
	06/30/09	120	BRL	BRL	BRL	BRL	BRL	BRL
	01/22/10	170	BRL	BRL	BRL	BRL	BRL	BRL
	07/08/10	200	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/11	180	BRL	BRL	BRL	BRL	BRL	NA
	01/04/12	150	BRL	BRL	BRL	BRL	BRL	NA
	06/27/12	130	BRL	BRL	BRL	BRL	BRL	NA
	01/10/13	120	BRL	BRL	BRL	BRL	BRL	NA
	06/27/13	110	BRL	BRL	BRL	BRL	BRL	NA
	01/21/14	57	BRL	BRL	BRL	BRL	BRL	NA
	08/04/14	160	BRL	BRL	BRL	BRL	BRL	NA
	10/15/14	110	BRL	BRL	BRL	BRL	BRL	NA

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RW-2	Jun-98	127	NA	NA	NA	NA	NA	NA
	Jun-98	150	NA	NA	NA	NA	NA	NA
	01/08/99	270	NA	NA	NA	NA	NA	NA
	07/09/99	55	NA	NA	NA	NA	NA	NA
	07/27/99	NS	NS	NS	NS	NS	NS	NS
	01/06/00	197	NA	NA	NA	NA	NA	NA
	07/07/00	382	NA	NA	NA	NA	NA	NA
	02/05/01	549	BRL	BRL	BRL	BRL	BRL	NA
	07/18/01	NS	NS	NS	NS	NS	NS	NS
	08/06/01	119	BRL	BRL	BRL	BRL	BRL	NA
	11/06/01	NS	NS	NS	NS	NS	NS	NS
	02/14/02	NS	NS	NS	NS	NS	NS	NS
	07/10/02	710	2.2	NS	NS	NS	NS	NS
	01/29/03	138	2.1	BRL	1.5	BRL	BRL	NA
	06/19/03	630	1.0	BRL	2.0	BRL	BRL	NA
	01/15/04	890	BRL	BRL	BRL	BRL	BRL	NA
	06/18/04	650	BRL	BRL	BRL	BRL	BRL	NA
	01/28/05	490	BRL	BRL	BRL	BRL	BRL	NA
	07/01/05	860	BRL	BRL	BRL	BRL	BRL	NA
	02/01/06	970	BRL	BRL	BRL	BRL	BRL	NA
	06/20/06	1,000	BRL	BRL	BRL	BRL	BRL	NA
	02/28/07	440	BRL	BRL	BRL	BRL	BRL	NA
	06/19/07	780	5.7	BRL	8.1	BRL	BRL	NA
	03/01/08	300	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/08	460	120	BRL	190	BRL	BRL	BRL
	03/11/09	NS	NS	NS	NS	NS	NS	NS
	06/30/09	NS	NS	NS	NS	NS	NS	NS
	01/22/10	NS	NS	NS	NS	NS	NS	NS
	07/08/10	1,200	13	BRL	27	BRL	BRL	BRL
	06/27/11	NS	NS	NS	NS	NS	NS	NS
	01/04/12	790	9.5	BRL	25	BRL	BRL	NA
	06/27/12	570	BRL	BRL	11	BRL	BRL	NA
	01/10/13	37	BRL	BRL	90	BRL	BRL	NA
	06/27/13	490	BRL	BRL	12	BRL	BRL	NA
	01/21/14	700	7.4	BRL	20	BRL	BRL	NA
	08/04/14	670	6.9	BRL	18	BRL	BRL	NA
	10/15/14	550	7.5	BRL	24	BRL	BRL	NA

Table 1
Summary of Groundwater Analytical Results
Emory University North Decatur/Burlington Road Site
HSI Site No. 10121
Atlanta, Georgia

Well Number	Sample Date	PCE (µg/L)	TCE (µg/L)	1,1-DCE (µg/L)	CIS-1,2-DCE (µg/L)	TRANS-1,2-DCE (µg/L)	VINYL CHLORIDE (µg/L)	1,4-DIOXANE (µg/L)
RW-3	Jun-98	6.9	NA	NA	NA	NA	NA	NA
	Jun-98	NS	NS	NS	NS	NS	NS	NS
	01/08/99	6.8	NA	NA	NA	NA	NA	NA
	07/09/99	8.8	NA	NA	NA	NA	NA	NA
	07/27/99	NS	NS	NS	NS	NS	NS	NS
	01/06/00	8.0	NA	NA	NA	NA	NA	NA
	07/07/00	35.9	NA	NA	NA	NA	NA	NA
	02/05/01	39	BRL	BRL	BRL	BRL	BRL	NA
	07/18/01	NS	NS	NS	NS	NS	NS	NS
	08/06/01	27.1	BRL	BRL	BRL	BRL	BRL	NA
	11/06/01	NS	NS	NS	NS	NS	NS	NS
	02/14/02	27.7	BRL	BRL	BRL	BRL	BRL	NA
	07/10/02	31.5	BRL	BRL	BRL	BRL	BRL	NA
	01/29/03	55.4	BRL	BRL	BRL	BRL	BRL	NA
	06/19/03	58	BRL	BRL	BRL	BRL	BRL	NA
	01/15/04	57	BRL	BRL	BRL	BRL	BRL	NA
	06/18/04	71	BRL	BRL	BRL	BRL	BRL	NA
	01/28/05	38	BRL	BRL	BRL	BRL	BRL	NA
	07/01/05	91	BRL	BRL	BRL	BRL	BRL	NA
	02/01/06	53	BRL	BRL	BRL	BRL	BRL	NA
	06/20/06	70	BRL	BRL	BRL	BRL	BRL	NA
	02/28/07	33	BRL	BRL	BRL	BRL	BRL	NA
	06/19/07	71	BRL	BRL	BRL	BRL	BRL	NA
	03/01/08	38	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/08	67	BRL	BRL	BRL	BRL	BRL	BRL
	03/11/09	55	BRL	BRL	BRL	BRL	BRL	BRL
	06/30/09	71	BRL	BRL	BRL	BRL	BRL	BRL
	01/22/10	84	BRL	BRL	BRL	BRL	BRL	BRL
	07/08/10	130	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/11	NS	NS	NS	NS	NS	NS	NS
	01/04/12	NS	NS	NS	NS	NS	NS	NS
	06/27/12	50	BRL	BRL	BRL	BRL	BRL	NA
	01/10/13	54	BRL	BRL	BRL	BRL	BRL	NA
	06/27/13	85	BRL	BRL	BRL	BRL	BRL	NA
	01/21/14	37	BRL	BRL	BRL	BRL	BRL	NA
	08/04/14	62	BRL	BRL	BRL	BRL	BRL	NA
	10/15/14	110	BRL	BRL	BRL	BRL	BRL	NA

Table 1
Summary of Groundwater Analytical Results
Emory University North Decatur/Burlington Road Site
HSI Site No. 10121
Atlanta, Georgia

Well Number	Sample Date	PCE (µg/L)	TCE (µg/L)	1,1-DCE (µg/L)	CIS-1,2-DCE (µg/L)	TRANS-1,2-DCE (µg/L)	VINYL CHLORIDE (µg/L)	1,4-DIOXANE (µg/L)
RW-4**	Jun-98	19	NA	NA	NA	NA	NA	NA
	Jun-98	25	NA	NA	NA	NA	NA	NA
	01/08/99	57	NA	NA	NA	NA	NA	NA
	07/09/99	225	NA	NA	NA	NA	NA	NA
	07/27/99	187	NA	NA	NA	NA	NA	NA
	01/06/00	128	NA	NA	NA	NA	NA	NA
	07/07/00	189	NA	NA	NA	NA	NA	NA
	02/05/01	174	BRL	BRL	BRL	BRL	BRL	NA
	07/18/01	NS	NS	NS	NS	NS	NS	NS
	08/06/01	253	BRL	BRL	BRL	BRL	BRL	NA
	11/06/01	NS	NS	NS	NS	NS	NS	NS
	02/14/02	NS	NS	NS	NS	NS	NS	NS
	07/10/02	NS	NS	NS	NS	NS	NS	NS
	01/29/03	NS	NS	NS	NS	NS	NS	NS
	06/19/03	NS	NS	NS	NS	NS	NS	NS
	01/15/04	NS	NS	NS	NS	NS	NS	NS
	06/18/04	NS	NS	NS	NS	NS	NS	NS
	01/28/05	NS	NS	NS	NS	NS	NS	NS
	07/01/05	NS	NS	NS	NS	NS	NS	NS
	02/01/06	NS	NS	NS	NS	NS	NS	NS
	06/20/06	980	BRL	BRL	BRL	BRL	BRL	NA
	02/28/07	540	BRL	BRL	BRL	BRL	BRL	NA
	06/19/07	640	BRL	BRL	BRL	BRL	BRL	NA
	03/01/08	370	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/08	380	BRL	BRL	BRL	BRL	BRL	BRL
	03/11/09	640	BRL	BRL	BRL	BRL	BRL	BRL
	06/30/09	220	BRL	BRL	BRL	BRL	BRL	BRL
	01/22/10	360	BRL	BRL	BRL	BRL	BRL	BRL
	07/09/10	420	BRL	BRL	BRL	BRL	BRL	BRL
	06/27/11	270	BRL	BRL	BRL	BRL	BRL	NA
	01/04/12	150	BRL	BRL	BRL	BRL	BRL	NA
	06/27/12	160	BRL	BRL	BRL	BRL	BRL	NA
	01/10/13	93	BRL	BRL	BRL	BRL	BRL	NA
	06/26/13	68	BRL	BRL	BRL	BRL	BRL	NA
	01/21/14	160	BRL	BRL	BRL	BRL	BRL	NA
	08/04/14	180	BRL	BRL	BRL	BRL	BRL	NA
	10/15/14	250	BRL	BRL	BRL	BRL	BRL	NA

Notes:
µg/L – micrograms per liter or parts p
BRL – Not detected above laboratory method reporting limits
NA – Not analyzed
NS – Not sampled
Monitoring wells MW-1, -2, -3, and -4 were installed between December 2000 and January 2001
* – MW-3 was converted to recovery well RW-5 and became operational on August 6, 2001
** – RW-4 was converted to a monitoring well on June 14, 2006

Table 2
Comparison of Constituents Detected in Groundwater to Vapor Intrusion Screening Levels

Analyte[1]	Units	Minimum Detect	Maximum Detect	Location of Max Detect	EPA VISL GW-to-Indoor Air - Com/Ind[2]	J&E Modeled GW SL Com/Ind[3]	EPA VISL GW-to-Indoor Air - Res[2]	J&E Modeled GW SL - Res[3]
1,1-Dichloroethene	ug/L	<5.0	<5.0	-	820	-	200	-
cis-1,2-Dichloroethene	ug/L	12	90	RW-2	NV	-	NV	-
trans-1,2-Dichloroethene	ug/L	<5.0	<5.0	-	NV	-	NV	-
Tetrachloroethene	ug/L	14	700	RW-2	65	1275	15	292
Trichloroethene	ug/L	<5.0	7.5	RW-2	7.5	131	1.2	22
Vinyl Chloride	ug/L	<2.0	<2.0	-	2.5	-	0.15	-

Notes:
1 - Analytes reported during most recent 2013 and 2014 sampling events
2 - EPA Vapor Intrusion Screening Level (VISL) for Groundwater (May 2014 version)
3 - Johnson and Ettinger Site-Specific Groundwater Screening Level (SL)
Model Assumptions:
GW Screen version 3.1
Slab-on-grade
Site-specific soil type: sandy silt (sandy loam used in the model per instructions)
Site-specific depth to water: 38 feet (most shallow depth in RW locations)
Region-specific groundwater temperature: 18 deg C (65 deg F)
Toxicity factors updated consistent with those consistent with EPA's VISL Calculator
Model output multiplied by a factor of 3 to account for an 8-hour exposure for a worker
For TCE , the resident model results are applied by a factor of 0.72 to account for mutagenic mechanisms.

APPENDIX A

DATA ENTRY SHEET

GW-SCREEN
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES: X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES:

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
127184		Tetrachloroethylene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (^oC)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
200	1154.44	SL	18.3	

MORE ↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vandose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)
SL			SL	1.62	0.387	0.103

MORE ↓

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-06	1	70	25	25	250

Used to calculate risk-based groundwater concentration.

CHEMICAL PROPERTIES SHEET

ABC

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
7.20E-02	8.20E-06	1.84E-02	25	8,288	394.40	620.20	1.55E+02	2.00E+02	2.6E-07	4.0E-02

END

INTERMEDIATE CALCULATIONS SHEET

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^V (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
954.44	0.284	0.184	6.02E-09	0.901	5.42E-09	25.00	0.387	0.067	0.320	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Vadose zone effective diffusion coefficient, D^{eff}_V (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)
2.54E+04	1.80E+06	2.22E-04	200	9,469	1.27E-02	5.31E-01	1.78E-04	7.27E-03	6.24E-05	1.81E-03

Diffusion path length, L_d (cm)	Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
954.44	200	5.31E+02	0.10	3.69E+00	7.27E-03	4.00E+02	3.27E+05	6.97E-05	3.70E-02	2.6E-07	4.0E-02

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
4.25E+02	1.58E+03	4.25E+02	2.00E+05	4.25E+02

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

END

]

DATA ENTRY SHEET

GW-SCREEN
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES: X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES:

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
127184		Tetrachloroethylene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
200	1154.44	SL	18.3	

MORE ↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vandose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)
SL			SL	1.62	0.387	0.103

MORE ↓

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-06	1	70	26	26	350

Used to calculate risk-based groundwater concentration.

CHEMICAL PROPERTIES SHEET

ABC

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
7.20E-02	8.20E-06	1.84E-02	25	8,288	394.40	620.20	1.55E+02	2.00E+02	2.6E-07	4.0E-02

END

INTERMEDIATE CALCULATIONS SHEET

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^V (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
954.44	0.284	0.184	6.02E-09	0.901	5.42E-09	25.00	0.387	0.067	0.320	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Vadose zone effective diffusion coefficient, D^{eff}_V (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)
2.54E+04	1.80E+06	2.22E-04	200	9,469	1.27E-02	5.31E-01	1.78E-04	7.27E-03	6.24E-05	1.81E-03

Diffusion path length, L_d (cm)	Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
954.44	200	5.31E+02	0.10	3.69E+00	7.27E-03	4.00E+02	3.27E+05	6.97E-05	3.70E-02	2.6E-07	4.0E-02

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
2.92E+02	1.13E+03	2.92E+02	2.00E+05	2.92E+02

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

END

]

DATA ENTRY SHEET

GW-SCREEN
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES: X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES:

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
79016		Trichloroethylene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (^oC)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
200	1154.44	SL	18.3	

MORE ↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vandose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)
SL			SL	1.62	0.387	0.103

MORE ↓

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-06	1	70	25	25	250

Used to calculate risk-based groundwater concentration.

CHEMICAL PROPERTIES SHEET

ABC

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	4.1E-06	2.0E-03

END

INTERMEDIATE CALCULATIONS SHEET

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^V (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
954.44	0.284	0.184	6.02E-09	0.901	5.42E-09	25.00	0.387	0.067	0.320	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Vadose zone effective diffusion coefficient, D^{eff}_V (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)
2.54E+04	1.80E+06	2.22E-04	200	8,454	7.40E-03	3.09E-01	1.78E-04	7.98E-03	7.03E-05	2.02E-03

Diffusion path length, L_d (cm)	Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
954.44	200	3.09E+02	0.10	3.69E+00	7.98E-03	4.00E+02	1.06E+05	7.38E-05	2.28E-02	4.1E-06	2.0E-03

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
4.37E+01	1.28E+02	4.37E+01	1.47E+06	4.37E+01

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

END

]

DATA ENTRY SHEET

GW-SCREEN
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES: X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES:

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
79016		Trichloroethylene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (^oC)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
200	1154.44	SL	18.3	

MORE ↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vandose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)
SL			SL	1.62	0.387	0.103

MORE ↓

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-06	1	70	26	26	350

Used to calculate risk-based groundwater concentration.

CHEMICAL PROPERTIES SHEET

ABC

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	4.1E-06	2.0E-03

END

INTERMEDIATE CALCULATIONS SHEET

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^V (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
954.44	0.284	0.184	6.02E-09	0.901	5.42E-09	25.00	0.387	0.067	0.320	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Vadose zone effective diffusion coefficient, D^{eff}_V (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)
2.54E+04	1.80E+06	2.22E-04	200	8,454	7.40E-03	3.09E-01	1.78E-04	7.98E-03	7.03E-05	2.02E-03

Diffusion path length, L_d (cm)	Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
954.44	200	3.09E+02	0.10	3.69E+00	7.98E-03	4.00E+02	1.06E+05	7.38E-05	2.28E-02	4.1E-06	2.0E-03

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
3.00E+01	9.13E+01	3.00E+01	1.47E+06	3.00E+01

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

END

]

APPENDIX C

Groundwater Model
Emory University
North Decatur Road/Burlington Road Site
HSI No. 10121

This report summarizes the results of the groundwater model (BIOCHLOR) runs that were recently performed using the October 2014 and historic groundwater monitoring results obtained from wells associated with the North Decatur Road/Burlington Road Remediation System ("Site") located at Emory University. The modeling runs were performed as a scientific and cost-effective means to estimate future dissolved-phase chlorinated solvent concentrations in site groundwater.

MODEL DESCRIPTION

BIOCHLOR v. 2.2 (March 2002) is a fate and transport model that is publicly available at the USEPA Center for Subsurface Modeling Support (CSMoS). Originally developed for the Air Force Center for Environmental Excellence (AFCEE) Technology Transfer Division, BIOCHLOR simulates remediation by natural attenuation of dissolved solvents at chlorinated solvent release sites using three different model types:

- Solute transport without decay
- Solute transport with biotransformation modeled as a sequential first-order decay process
- Solute transport with biotransformation modeled as a sequential first-order decay process with two different reaction zones (i.e., each zone has a different set of rate coefficient values)

Based on the Domenico analytical solution, the Microsoft Excel spreadsheet software can simulate 1-D advection, 3-D dispersion, linear adsorption, and biotransformation of chlorinated solvents by reductive dechlorination.

As a screening model BIOCHLOR provides insight on how far a dissolved chlorinated solvent plume will extend, and what groundwater concentrations are likely to be encountered, if no engineered controls or source area reduction measures are implemented at a contaminant site. This model was deemed appropriate for use at this site, since it is a screening tool for chlorinated solvents (the groundwater contaminants at the site), no free product is present, and the groundwater flow field at the site is not complicated. Now that the extraction system at the site has been removed, there are no pumping wells to impact the direction of flow within the shallow groundwater flow field and the dissolved contaminants (chlorinated solvents) are limited in extent to the groundwater within the unconsolidated overburden and a few feet of underlying fractured bedrock.

MODEL INPUTS

Source

One key (source) input parameter required by BIOCHLOR is knowledge of the time of the release (spill, leak, etc.); as well as, size (or volume and duration) of the release. Unfortunately, at the Emory site, there is no clear indication of the actual time of the release, the amount, or for that matter, when and where the actual release occurred. The initial Corrective Action Plan for the Site prepared by Willmer Engineering in 1993 (CAP_1993) potentially related the measured groundwater impacts by perchloroethylene (aka tetrachloroethylene, or PCE) to a former dry cleaning establishment that had ceased operations 8-10 years earlier. The CAP_1993 also noted the presence of a former automotive repair facility located adjacent to the dry cleaning establishment as another potential source of the PCE contamination, since both facilities would have been expected to have used PCE in their daily routine operations (i.e., cleaning parts and/or cleaning clothes).

The locations of the former garage and cleaners are provided on **Figure 1** (attached). For modeling purposes, the source area for the original PCE release was estimated to be 20 feet wide at the surface (the approximate width of the former cleaners), was assumed to be located in the immediate vicinity of the former recovery well RW-3 (for subsequent distance measurements), and it was assumed that the release (model start date) occurred on/or about 1983. (*As noted in previous letters to the Agency, during the subsequent calibration of the model the start date for the time of the release was later changed to 1988*). Based upon the various cross-sections that have been developed for the site (see Figures 5 and 6, PCE in Groundwater-August and October 2014, in the accompanying Conceptual Site Model section) and the typical measured depth to the static water table at the site, the (maximum) saturated thickness (unconsolidated overburden plus fractured rock upper-surface) of this PCE source area for model input was estimated to be 40 feet.

Hydrogeologic Data

In order to calculate advection, dispersion, adsorption, and biotransformation parameters required for the model, BIOCHLOR also requires that the hydrogeologic parameters (hydraulic conductivity, gradient, and effective porosity) for the spill site be entered as model input. The hydraulic conductivity used in the model was a value (4.0E-04 centimeters per second) provided in the CAP_1993, which was originally determined (calculated average) based upon the results of a number of falling head and recharge permeability tests conducted at the Site in 1993. This value is also quite typical for Piedmont soils. The effective porosity of the sediments in the subsurface was input as 15 percent; a value that was also provided earlier in the original 1993 Corrective Action Plan. The BIOCHLOR User's Manual (January 2000) indicates that soils similar to the Piedmont soils at the Site (sandy silts and silty sands) typically exhibit effective porosities ranging from 1 to 30 percent, although experience with Piedmont soils indicates effective porosities more in the range of 15 to 25 percent. As a conservative measure 15% was selected, since groundwater plumes move a greater distance downgradient in

soils with a lower effective porosity. The hydraulic gradient used in the model (0.04376 foot per foot, or 4.4 percent) was calculated from the water level measurements and contours developed from the most recent groundwater sampling event conducted in October 2014 (**Figure 2**, attached). The gradient selected followed a path parallel to the direction of groundwater flow in the central portion of the site beginning at an upgradient position along the estimated position of the 940-feet elevation water level contour, passing almost directly over former recovery well RW-1, and terminating downgradient at the estimated position of the 920-feet elevation contour; a change in elevation of 20 feet over a measured distance of approximately 457 feet. This calculated gradient under non-pumping conditions compares favorably with the estimated (overall) gradient provided in the 1993 CAP (4 percent) before any of the remedial activities took place at the site. Now that remedial groundwater extraction at the site has ceased, the similarity in gradients suggests that there has been little change in the many factors (rainfall, infiltration characteristics, topographic position, soil porosity, etc.) that could affect the position of the water table during the past 20-year period. As a result, today's calculated groundwater seepage velocity should mimic the groundwater seepage velocity in the past. With an estimated hydraulic conductivity of 4.0E-04 cm/sec, an effective porosity of 0.15, and gradient of 0.04376, the calculated seepage velocity for the site is 120.7 feet per year, or about 0.33 feet per day.

Dispersivity

The dispersion characteristics of the plume were calculated by the model based upon an initial estimate of the current (2014) plume length (1000 feet) using the results from the most-recent (October) sampling event. Based upon the October 2014 sampling results, it was assumed that the groundwater PCE concentrations would be at the current drinking water standard (maximum contaminant level, or MCL) of 5 micrograms per liter (ug/L) at a distance no greater than 1000 feet downgradient of the original source area (vicinity of RW-3). The longitudinal dispersivity for the plume was then calculated (23.798 feet) using the plume-length estimate formula developed by Xu and Eckstein (1995) within BIOCHLOR (Option 3). The transverse and vertical dispersivities were set to the default values programmed in BIOCHLOR (0.1 and 1.0E-99, respectively).

Retardation Factor

Dissolved PCE in site groundwater can be reduced by adsorption to the subsurface soils. The ratio of the groundwater seepage velocity to the rate of PCE (or any contaminant) movement in groundwater is the retardation factor (R). The retardation factor for PCE and its breakdown products in site groundwater was calculated by BIOCHLOR using an estimate of the aquifer's soil bulk density (rho) and fraction of the soil matrix comprised of natural organic carbon (f_{oc}) in soil derived from uncontaminated areas. Because no laboratory analysis was available, the rho value selected, 1.7 kilograms per liter, is the suggested default value in BIOCHLOR. The f_{oc} value selected for calculation of the retardation factor (0.001, or 0.1%) is the default value in BIOCHLOR. Initially, a f_{oc} of 0.3% (GA EPD default value) was selected for input but BIOCHLOR would

not accept the value. BIOCHLOR Version 2.2 incorporates an automatic approximation calibration feature that indicated, based upon the previous input parameters (effective porosity, hydraulic conductivity, etc.) and sampling results, the f_{oc} estimate had to be less than 0.195 percent for model calibration. The 0.1% f_{oc} value used in the model is considered conservative. As the fraction of organic carbon increases, the calculated retardation value also increases (drastically); resulting in much shortened groundwater plumes. With a rho of 1.7 kg/L and an estimated f_{oc} of 0.001, BIOCHLOR calculated a common retardation factor of 2.47 for the dissolved chlorinated solvent constituents in site groundwater.

Biotransformation Data

First order decay kinetics are assumed to be present at that site based on the change in PCE contaminant concentrations over time and, more recently, with the monitored presence of PCE daughter products (TCE and 1,2-DCE). The first-order decay rate (λ, or lambda) represents the degradation of the contaminant as it moves through the aquifer with time (transport decay). Lambda is equal to 0.693 divided by the half-life of the contaminant in groundwater. Usually, this parameter influences the downgradient change in contaminant concentrations more than any other input parameter in BIOCHLOR. Initially, the λ values were selected from the mean of the typical ranges of values presented in BIOCHLOR manual for PCE and its daughter products. For the first order transformation of PCE to TCE the typical λ values range from 0.07 to 1.20 year $^{-1}$, with a mean of 0.635 year $^{-1}$. The mean λ input value for the PCE transformation was subsequently changed (slightly) to 1.15 year $^{-1}$ during the calibration process; near the high end of λ values but still within the range of typical values. All of the other mean λ values selected for the transformation of the PCE daughter products (e.g., TCE to cis1,2-DCE, etc.) were kept constant (no change) during the subsequent modeling process and can be seen on the model input attached.

Contaminant Concentrations

With respect to the chlorinated solvent of concern (PCE) and its breakdown products by biotransformation [Trichloroethylene (TCE), Dichloroethylene (DCE), and Vinyl Chloride (VC)], there is no historic information in the file regarding the groundwater conditions at the time of the initial spill (prior to calibration, assumed to have occurred in 1983). For modeling purposes it was assumed that the groundwater PCE concentration at the time of the release would have been equivalent to the maximum solubility of PCE in groundwater. According to information provided in the BIOCHLOR manual, the aqueous phase solubility of PCE in groundwater at 20 degrees Centigrade is 150 milligrams per liter (mg/L). This value was input as the source groundwater concentration used in all subsequent calculations by the model for the movement of the dissolved PCE plume. The source concentrations for the PCE daughter products were estimated based upon the historic monitoring well sampling results during the model calibration procedures.

The 1993 CAP included laboratory results for groundwater samples obtained at monitoring well locations GWC-1 and GWC-2, both located approximately 85 feet downgradient of the assumed source location (RW-3), with reported groundwater PCE concentrations of 2,480 micrograms per liter (ug/L) and 16,530 ug/L, respectively. Significantly, GWC-1 was screened at the top of rock; whereas, GWC-2 was screened at the water table. As described in previous correspondence with the GA EPD, the 16,530 ug/L (16.53 mg/L) value was used in the model during the initial attempts at calibration, assuming that the release had occurred on, or about, 1983. Based upon the previous model runs, the estimated release date was subsequently changed to 1988.

Although there is a rather lengthy record of historic sampling results prior to 2014 (see Table 2, Conceptual Site Model) most of these results cannot be used in in the model, since BIOCHLOR was not intended to predict the effect of remedial applications. An active remedy (including soil vapor extraction and groundwater extraction and treatment) occurred almost continuously at the site during the period 1995-2011. By 2012, the groundwater extraction had declined to the point that the impact of the extraction system on the groundwater flow field was hardly evident in the shape of the groundwater contours. By 2013, extraction at the site had ceased. Currently, groundwater conditions at the site are presumed to be at equilibrium, given the rather lengthy period of declining groundwater extraction at the site and the complete dismantling of the extraction system during the past year.

During the most recent sampling event conducted at the site in October 2014, the laboratory results at select monitoring wells were as follows:

RW-2 (TCE-550 ug/L, TCE-7.5 ug/L, cis 1,2 DCE-24 ug/L, VC-BRL); located 25 feet downgradient of source.

RW-5/MW-3 (TCE-160 ug/L, TCE-BRL, DCE-BRL, VC-BRL); located 165 feet downgradient of source.

MW-4 (TCE-29 ug/L, TCE-BRL, DCE-BRL, VC-BRL); located 340 feet downgradient of source.

[*As previously noted, the source area (for modeling purposes) is presumed to be in the immediate vicinity of former recovery well RW-3].*

MODEL SIMULATIONS

Calibration

Although multiple BIOCHLOR simulations were previously run until the model output matched the measured groundwater concentrations in the site wells (as described in earlier correspondence to the GA EPD), little effort (or change) was required to simulate the results of the most-recent sampling event conducted in October 2014 using the input parameters described in the previous correspondence. The recent groundwater concentration values were used to refine the model input parameters so that the calibrated model could be used to predict future contaminant concentrations at the site, assuming that natural attenuation would be the only remedy that would continue at the site. Very slight changes in earlier estimates of the site hydrogeologic parameters were sufficient to simulate both recent and historic results with adequate accuracy. A compilation of the various input parameters that were used to calibrate BIOCHLOR are provided on **Table 1** (attached).

The predicted model output for 2014, with the input parameters previously described, 26 years after the assumed date of the release (1988), is provided in the appendix to this report as Plates 1A and 1B (attached). Plate 1A provides a summation of the input values used in the 2014 model run and Plates 1B, 1C, 1D, and 1E provide the final numeric and visual model output of the PCE, TCE, cis-1,2-DCE, and VC concentrations, respectively. As indicated on Plate 1B, the decreasing trend of the 2014 Site field PCE concentrations (October 2014 sampling results) with distance conforms very well to the modeled output PCE concentrations generated with the predicted first-order biotransformation. The October 2014 sampling results at RW-2 (25-feet downgradient), RW-5 (about 165-feet downgradient), and MW-4 (340 feet downgradient) conform favorably to the model output indicating biotransformation of the original PCE release. The presence of PCE, TCE, and cis-1,2-DCE in the October 2014 sampling results obtained from recovery well RW-2 clearly indicates that biotransformation of PCE in the Site groundwater is occurring. Historically, the PCE daughter products (TCE, cis-1,2-DCE, VC, etc.) were not present in the samples obtained from the various site monitoring wells. Their absence in the historic sampling results is thought to be due to the masking effect of the near-constant remedial actions (soil vapor extraction and groundwater extraction and removal) that were being actively conducted at the site during the period from 1995 to 2011. A figure presenting the estimated configuration of the current PCE plume in site groundwater, based upon the October 2014 sampling results and BIOCHLOR output, is provided as **Figure 3**.

To recheck the validity of the model input parameters, the model was run for only 5 years to see if BIOCHLOR would simulate the PCE concentrations reported present in the site monitoring wells in the 1993 CAP. The predicted model output for 1995, using the identical input parameters that were used previously in the 2014 model, five (5) years after the (assumed) release in 1988, is provided in the appendix as Plates 2A/2B (attached). As indicated on Plate 2B, the modeled PCE concentrations generated using first-order biotransformation conform very well to the reported presence of PCE (16,530 ug/L) in 1993 at monitoring well GWC-2, located about 85 feet downgradient of the source area. No daughter products were reported present in the 1993 data.

Based upon the excellent simulation of both the 1993 and 2014 PCE sampling results, the input values appeared validated and the model was deemed calibrated. The calibrated model was then run in 5-year increments into the future (2019, 2024,…) to predict the chlorinated solvent concentrations that could be expected downgradient of the source area; as well as, the anticipated length of the downgradient chlorinated solvent plume.

Predicted Concentrations

Because of the sparse current record of PCE daughter products in the sample results, the model predictions in this report focus on the future PCE concentrations to be expected at the site, although the model predictions for

the daughter products can be easily generated using the same input parameters utilized for the PCE concentration predictions. The current mandated Primary Drinking Water Standard, or maximum contaminant level (MCL), for the presence of PCE in drinking water is 5 ug/L (0.005 mg/L). In the model predictions to follow, the point at which the plume center line PCE concentrations decreased to the MCL was used to distinguish the furthest extent, or end, of the downgradient plume(s).

The model output illustrating the predicted PCE concentrations in 2019, 31 years after the assumed time of the release, is provided in the appendix as Plates 3A/3B (attached). Plate 3A provides a summation of the (previously calibrated) input values used in the 2019 model run and Plate 3B provides the final numeric and visual model output. The only change to the input parameters (Plate 3A) was in the section for the calculation of the dispersion coefficients. Based on an initial trial model run, the estimated maximum length of the plume was decreased to 800 feet, which resulted in the calculation of slightly smaller dispersion coefficients than those calculated for the 2014 model. No other changes in the initial input parameters were made. As presented on Plate 3B, the model predicts that the maximum PCE concentration in site groundwater in the source area will be 304 ug/L; PCE concentrations will have declined to 50 ug/L about 125-feet downgradient of the source area, and will have diminished to the current MCL approximately 480-feet downgradient. A figure presenting the predicted extents of the PCE groundwater plume at the site in 2019 is provided as **Figure 4**.

The model output illustrating the predicted PCE concentrations in 2024, 36 years after the assumed time of the release, is provided in the appendix as Plates 4A/4B (attached). Plate 4A provides a summation of the (previously calibrated) input values used in the 2024 model run and Plate 4B provides the final numeric and visual model output. Again, based on an initial trial model run, in this model the estimated maximum length of the plume was decreased to 600 feet, which resulted in the calculation of slightly smaller dispersion coefficients than those calculated for the 2014 model. No other changes in the initial input parameters were made. As presented on Plate 4B, the model predicts that the maximum PCE concentration in site groundwater in the source area will be 112 ug/L; concentrations will have declined to 50 ug/L approximately 45-feet downgradient, and will have diminished to the current MCL 320-feet downgradient. A figure presenting the predicted extents of the PCE groundwater plume at the site in 2024 is provided as **Figure 5**.

The model output illustrating the predicted PCE concentrations in 2029, 41 years after the assumed time of the release, is provided in the appendix as Plates 5A/5B (attached). Plate 5A provides a summation of the (previously calibrated) input values used in the 2029 model run and Plate 5B provides the final numeric and visual model output. Based on an initial trial model run, the estimated maximum length of the plume was decreased to 500 feet, which again resulted in the calculation of slightly smaller dispersion coefficients. No other changes in the initial input parameters were made. As presented on Plate 5B, the model predicts that the

maximum PCE concentration in site groundwater in the source area will be about 41 ug/L, and PCE concentrations will have declined to the MCL approximately 180-feet downgradient of the source area. A figure presenting the predicted extents of the PCE groundwater plume at the site in 2029 is provided as **Figure 6**.

The model output illustrating the predicted PCE concentrations in 2034, 46 years after the assumed time of the release, is provided in the appendix as Plates 6A/6B (attached). Plate 6A provides a summation of the (previously calibrated) input values used in the 2034 model run and Plate 6B provides the final numeric and visual model output. Based on an initial trial model run, the estimated maximum length of the plume was decreased to 300 feet; again resulting in the calculation of slightly smaller dispersion coefficients. No other changes in the initial input parameters were made. As presented on Plate 6B, the model predicts that the maximum PCE concentration in site groundwater in the former source area will be about 15 ug/L, and PCE concentrations will have declined to the MCL within 80-feet of the former source area. A figure presenting the predicted extents of the PCE groundwater plume at the site in 2034 is provided as **Figure 7** (attached).

The model output illustrating the predicted PCE concentrations in 2039, 51 years after the assumed time of the release, is provided in the appendix as Plates 7A/7B (attached). Plate 7A provides a summation of the (previously calibrated) input values used in the 2039 model run and Plate 7B provides the final numeric and visual model output. In this model run the estimated maximum length of the plume was decreased to 200 feet, which again resulted in the calculation of slightly smaller dispersion coefficients. No other changes in the initial input parameters were made. As presented on Plate 7B, the model predicts that PCE in site groundwater due to the 1988 release should no longer be an issue, with predicted maximum PCE concentrations in groundwater of about 5 to 6 ug/L at the point of the original release in the former source area.

SENSITIVITY ANALYSIS

Methodology

A sensitivity analysis was performed to evaluate the influence or relative importance of key input variables, particularly those variables where literature values were used for input. The parameters evaluated in the sensitivity analysis herein include the biotransformation decay coefficients, the retardation factor, hydraulic conductivity, and the effective porosity. The analysis was run for model year 2019 at two distances: 165 feet (the distance downgradient from the source to RW-5) and 320 feet (the distance to the furthest downgradient well MW-4). For each parameter being considered, the predicted concentrations at both of these points of reference were determined for: 1) baseline conditions (the calibrated value presented earlier), 2) a value two times greater than baseline, and 3) a value one-half of the baseline condition. The predicted values resulting from this sensitivity analysis are provided on **Table 2**.

Analysis of the information presented on the table suggests that (for the Emory BIOCHLOR model) changes in the hydraulic conductivity and porosity (which affects the seepage velocity) had almost an equal impact on the final predicted downgradient PCE plume concentrations. However, the most sensitive parameter was shown to be the 1st order decay coefficient (λ).

With respect to the advection terms of the Emory BIOCHLOR model, the sensitivity analysis indicates that if the hydraulic conductivities of the subsurface materials are less permeable than the baseline estimate, the current PCE plume will reach an acceptable concentration (MCLs) at the points of reference sooner than anticipated. Whereas, if the hydraulic conductivities of the subsurface materials are more permeable than the baseline estimate, the current PCE plume will reach an acceptable concentration at the points of reference later than currently anticipated. Conversely, if the effective porosity of the subsurface materials is significantly less than the baseline estimate, the current PCE plume will take longer to reach an acceptable concentration at the points of reference; whereas, if the effective porosity of the subsurface materials is significantly greater than the baseline estimate, the current PCE plume will reach an acceptable concentration sooner than currently anticipated at the points of reference.

With respect to the calculated retardation factor in the Emory BIOCHLOR model, decreasing the retardation factor did not have an appreciable difference in the predicted PCE concentrations. However, increasing the retardation factor did increase the predicted concentrations downgradient of the source area.

As expected, changes in the 1st order decay coefficient (λ) had an appreciable effect on the modeled predictions. Doubling lambda significantly reduced the predicted PCE plume concentrations downgradient at the points of interest; whereas, reducing lambda (by one-half) significantly increased the predicted PCE plume concentrations downgradient at the points of interest. Since lambda is equal to 0.693 divided by the half-life of the contaminant, the latter point is significant. Greater lambda values are the result of shorter half-lives and smaller lambda values are the result of longer half-lives. As the calibrated model utilized a lambda near the upper range of the typical values indicated by EPA (2000) (a short half-life), any change in future model conditions would be much more likely to require a lessening of the lambda value (i.e., if this were the model parameter requiring change, it can't go much higher); thereby, more likely to result in an increase in the predicted downgradient PCE plume concentrations.

Attachments: Tables 1, 2
Figures 1-7
Appendix- BIOCHLOR output (Plates 1A-7B)

TABLES

TABLE 1

Input Parameters for the Emory BIOCHLOR Model

Mechanism	Parameter	Value	Units	Basis
Advection	Hydraulic Conductivity	4.00E-04	cm/sec	Average conductivity presented in the 1993 CAP
	Hydraulic Gradient	0.04376	ft/ft	Measured gradient under non-pumping conditions, October 2014
	Effective Porosity	0.15	unitless	Typical value for Piedmont Soil, presented in 1993 CAP
Dispersion	Alpha X	23.798	feet	XU and Eckstein (1995) calculation based on estimated 1000 ft. plume length
	Alpha Y/Alpha X	0.1	unitless	EPA model default value
	Alpha Z/Alpha X	1.00E-99	unitless	EPA model default value
Adsorption	Soil Bulk Density	1.7	kg/L	EPA model default value
	Fraction Organic Carbon	1.00E-03	unitless	Conservative estimate within the range of typical values (EPA, 2000)
	Organic Carbon Partitioning Coefficients			
	PCE	426	L/kg	EPA model default value
	TCE	130	L/kg	EPA model default value
	DCE	125	L/kg	EPA model default value
	VC	30	L/kg	EPA model default value
	Ethenes	302	L/kg	EPA model default value
	Retardation Factor	2.47		Calculated value based on input values above
Biotransformation	1st Order Decay Coefficients (λ)			
	PCE->TCE	1.150	1/yr	Within range of typical values (EPA, 2000) after model calibration
	TCE->DCE	0.475	1/yr	Mean of typical values in guidance (EPA, 2000)
	DCE->VC	1.740	1/yr	Mean of typical values in guidance (EPA, 2000)
	VC->Ethene	1.420	1/yr	Mean of typical values in guidance (EPA, 2000)
General	Simulation Time	varies	year	Assumes the release began in 1988
	Model Area Width	250	feet	Assumption based on monitoring well sampling results
	Model Area Length	1000	feet	Assumption based on monitoring well sampling results
	Zone Length	1000	feet	Assumes one zone
Source Data	Type	continuous		Assumes continuous source concentrations throughout time
	Source Thickness in Saturated Zone	40	feet	Based on analysis of site cross-section
	Source Width	20	feet	Approximate width of former cleaning establishment
	Source Concentrations			
	PCE	150.0	mg/L	Aqueous phase solubility of PCE (EPA, 2000)
	TCE	0.5	mg/L	Based on model calibration
	DCE	4.0	mg/L	Based on model calibration
	VC	0.1	mg/L	Based on model calibration
	Ethenes	0	mg/L	Based on model calibration

EPA, 2000: BIOCHLOR Natural Attenuation Decision Support System. User's Manual Version 1.0 USEPA. January 2000

EPA, 2001: BIOCHLOR Natural Attenuation Decision Support System. User's Manual Addendum Version 2.0 USEPA. March 2001

TABLE 2

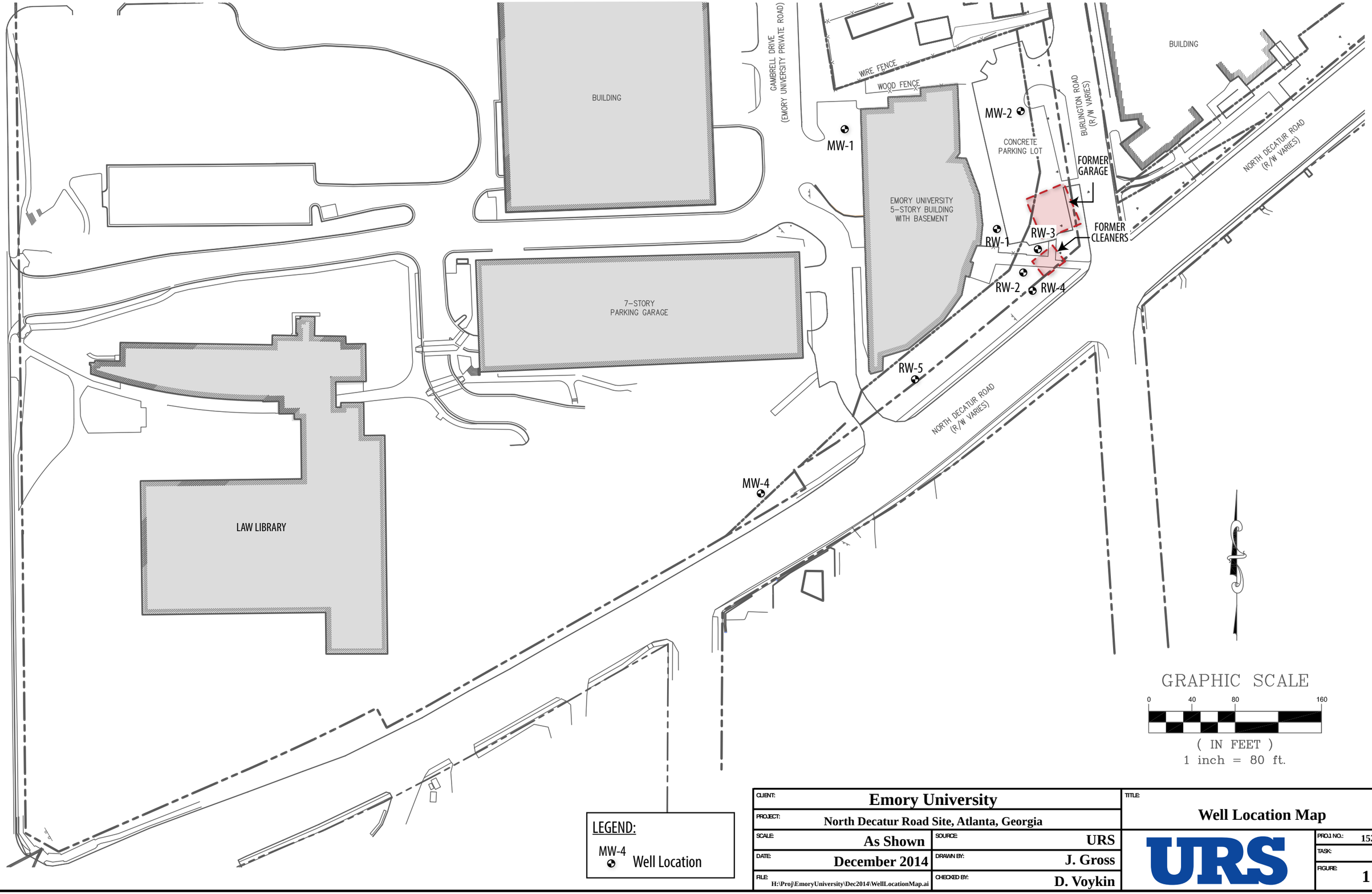
Sensitivity Analysis for the Emory BIOCHLOR Model (Year 2019)

Hydraulic Conductivity (cm/second)						
	Concentrations (mg/L) at 165 feet			Concentrations (mg/L) at 340 feet		
Constituent	2.00E-04	K=4.0E-04 (Baseline)	8.00E-04	2.00E-04	K=4.0E-04 (Baseline)	8.00E-04
PCE	0.020	0.039	0.057	0.003	0.012	0.026
TCE	0.098	0.069	0.043	0.091	0.072	0.051
DCE	0.022	0.012	0.006	0.024	0.016	0.009
VC	0.018	0.007	0.002	0.024	0.013	0.005
Porosity						
	Concentrations (mg/L) at 165 feet			Concentrations (mg/L) at 340 feet		
Constituent	n_e=0.075	n_e=0.15 (Baseline)	n_e=0.30	n_e=0.075	n_e=0.15 (Baseline)	n_e=0.30
PCE	0.069	0.039	0.015	0.037	0.012	0.002
TCE	0.055	0.069	0.064	0.081	0.072	0.040
DCE	0.007	0.012	0.014	0.014	0.016	0.010
VC	0.003	0.007	0.011	0.008	0.013	0.011
Retardation Factor						
	Concentrations (mg/L) at 165 feet			Concentrations (mg/L) at 340 feet		
Constituent	R=1.235	R=2.47 (Baseline)	R=4.940	R=1.235	R=2.47 (Baseline)	R=4.94
PCE	0.030	0.039	0.070	0.007	0.012	0.039
TCE	0.047	0.069	0.163	0.036	0.072	0.344
DCE	0.008	0.012	0.031	0.008	0.016	0.083
VC	0.004	0.007	0.020	0.006	0.013	0.073
1st Order Decay Coefficient - λ (1/year)						
	Concentrations (mg/L) at 165 feet			Concentrations (mg/L) at 340 feet		
Constituent	0.575	1.150 (Baseline)	2.3*	0.575	1.150 (Baseline)	2.3*
PCE	0.078	0.039	0.012	0.049	0.012	0.001
	0.288	0.475 (Baseline)	0.950	0.288	0.475 (Baseline)	0.950
TCE	0.083	0.069	0.046	0.107	0.072	0.032
	0.870	1.740 (Baseline)	3.480	0.870	1.740 (Baseline)	3.480
DCE	0.019	0.012	0.007	0.032	0.016	0.008
	0.710	1.420 (Baseline)	2.840	0.710	1.420 (Baseline)	2.840
VC	0.01	0.007	0.004	0.024	0.013	0.007

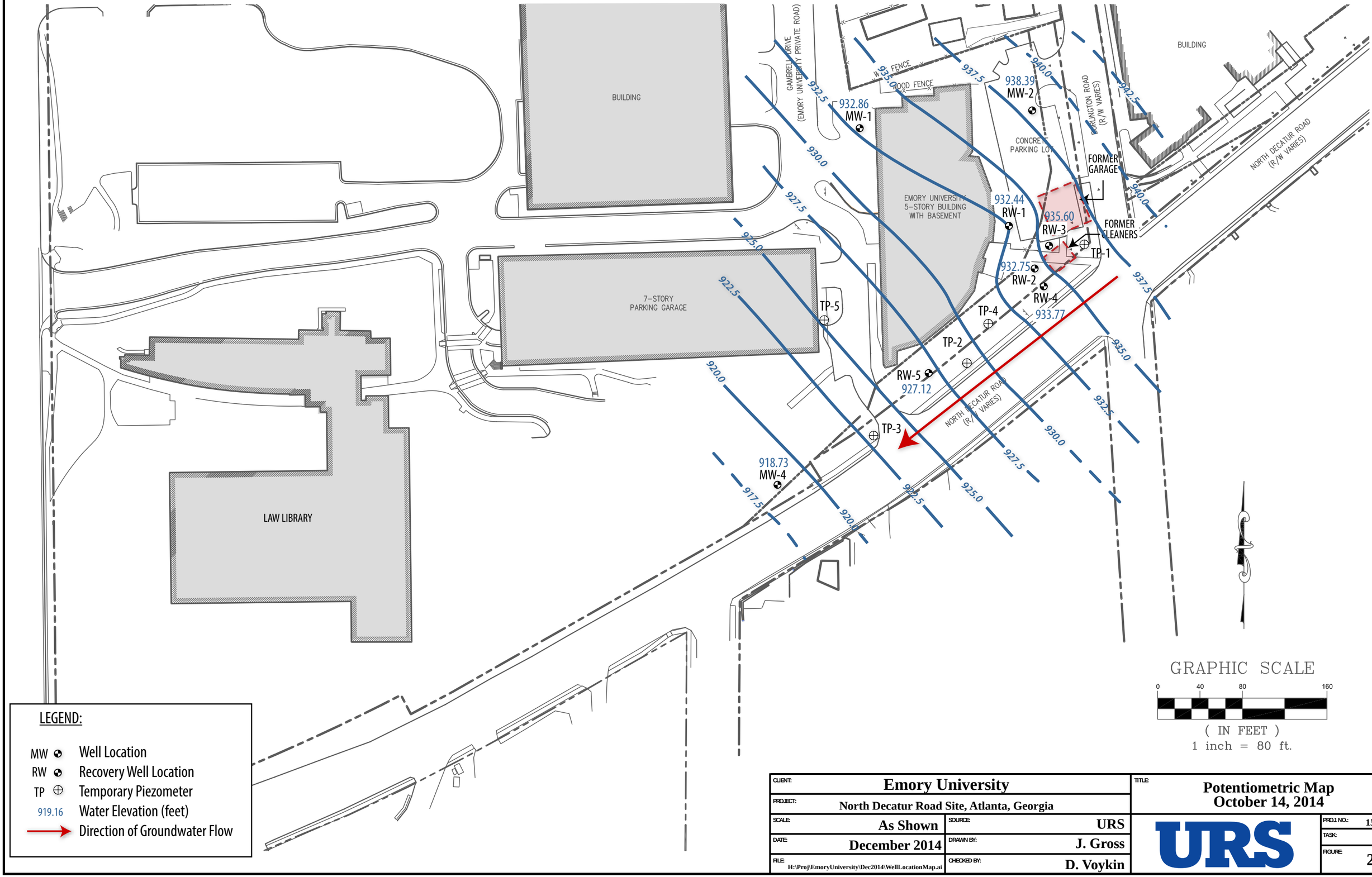
basis for sensitivity analysis: 0.5 times and 2.0 times the baseline value

* value for λ outside of typical range for PCE (0.07 to 1.20 yr^{-1})

FIGURES



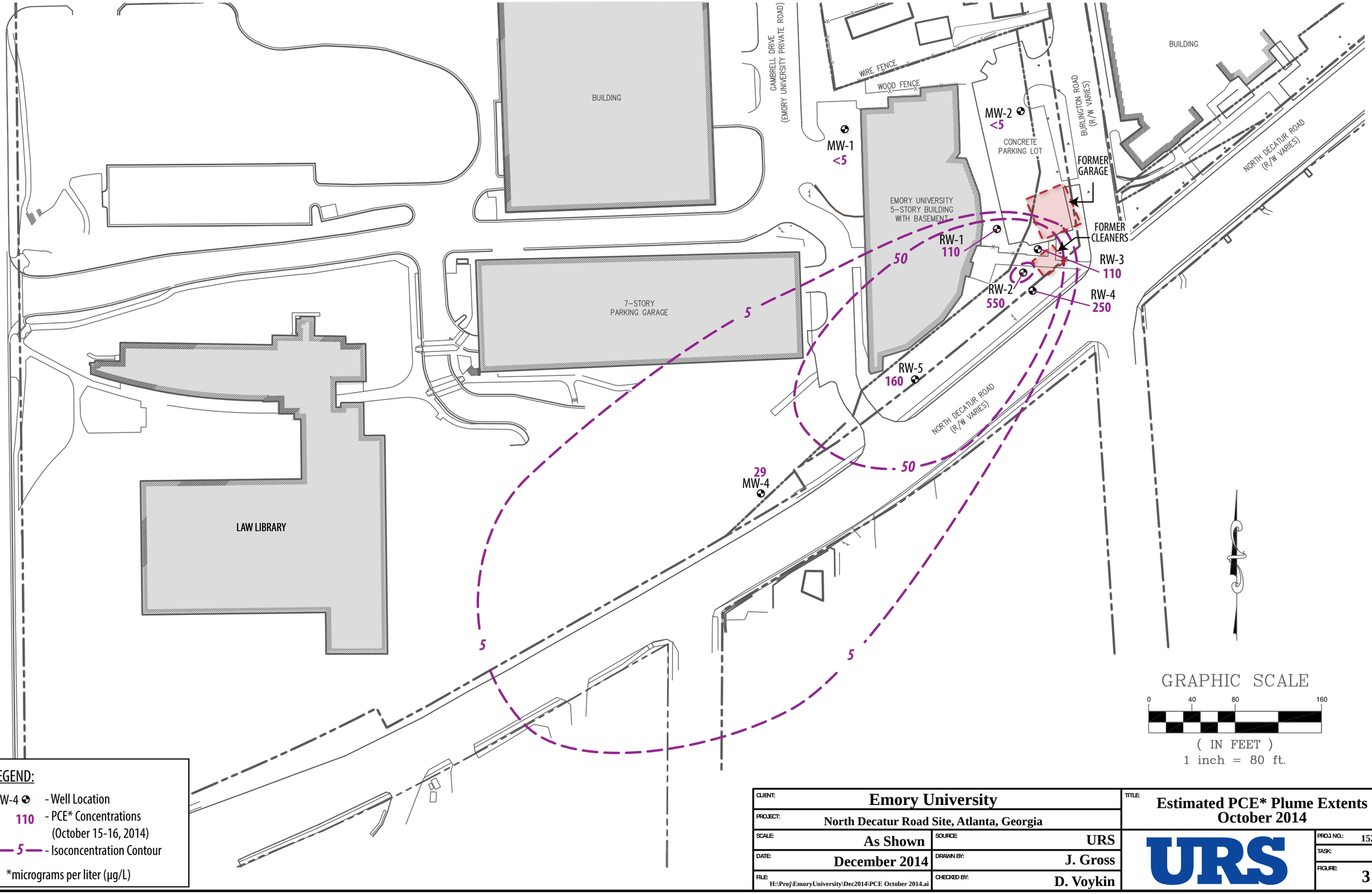
CLIENT:	Emory University		TITLE: Well Location Map
PROJECT:	North Decatur Road Site, Atlanta, Georgia		
SCALE: As Shown	SOURCE: URS		PROJ NO.: 15263255
DATE: December 2014	DRAWN BY: J. Gross		TASK: 01150
FILE: H:\Proj\EmoryUniversity\Dec2014\WellLocationMap.ai	CHECKED BY: D. Voykin		FIGURE: 1



LEGEND:

- MW — Well Location
- RW — Recovery Well Location
- TP — Temporary Piezometer
- 919.16 — Water Elevation (feet)
- Direction of Groundwater Flow

CLIENT: Emory University		TITLE: Potentiometric Map October 14, 2014	
PROJECT: North Decatur Road Site, Atlanta, Georgia			
SCALE: As Shown	SOURCE: URS	URS	PROJ NO.: 15263255
DATE: December 2014	DRAWN BY: J. Gross		TASK: 01150
FILE: H:\Proj\EmoryUniversity\Dec2014\WellLocationMap.ai	CHECKED BY: D. Voykin		FIGURE: 2



LEGEND:

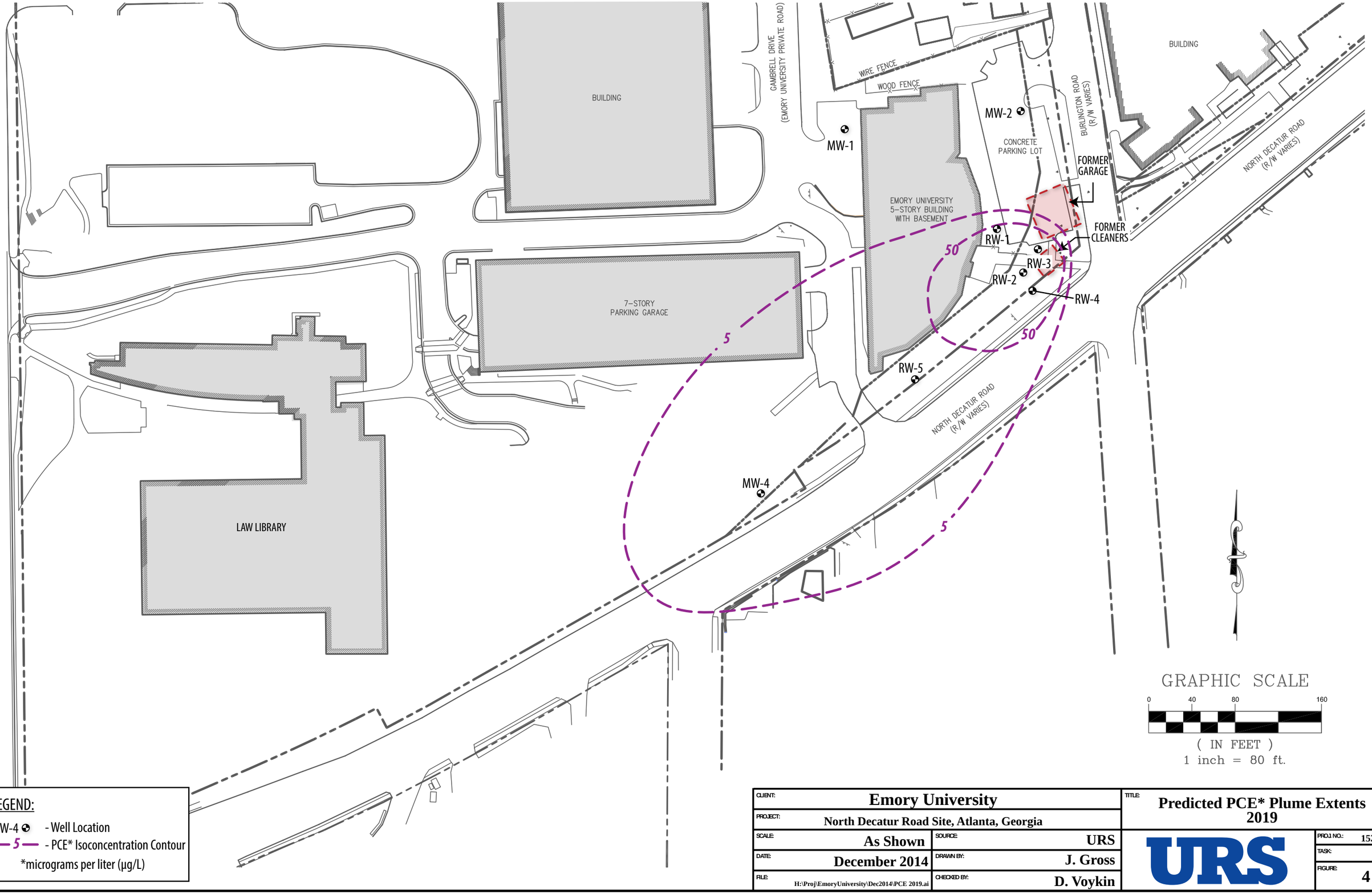
MW-4 - Well Location

110 - PCE* Concentrations (October 15-16, 2014)

5 - Isoconcentration Contour

*micrograms per liter (µg/L)

CLIENT:	Emory University	TITLE:	Estimated PCE* Plume Extents October 2014
PROJECT:	North Decatur Road Site, Atlanta, Georgia		
SCALE:	As Shown	SOURCE: URS	PROJ NO.: 15263255
DATE:	December 2014	DRAWN BY: J. Gross	TASK: 01150
FILE:	H:\Proj\EmoryUniversity\Dec2014\PCE October 2014.ai	CHECKED BY: D. Voykin	FIGURE: 3



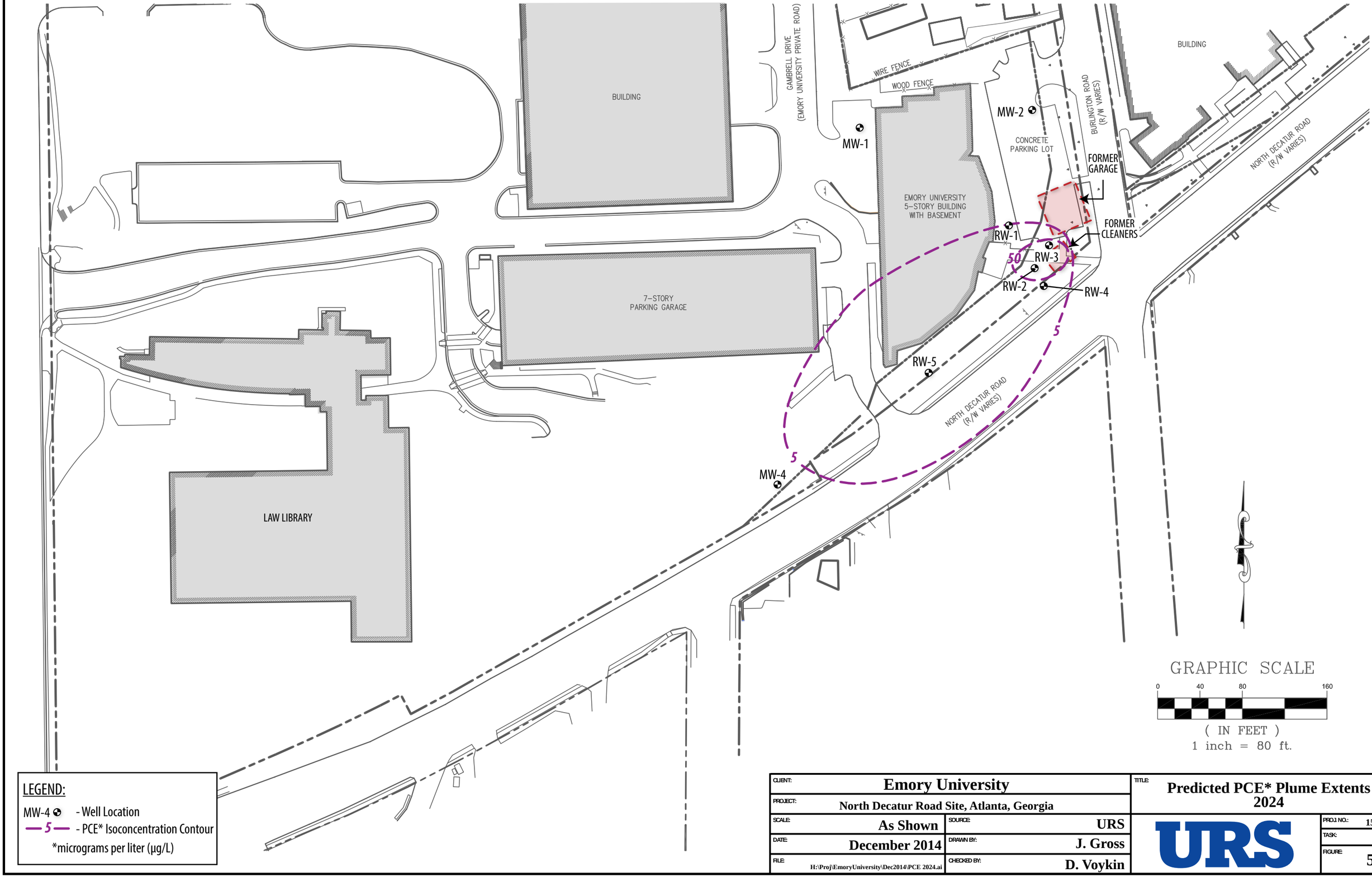
LEGEND:

MW-4 - Well Location

5 - PCE* Isoconcentration Contour

*micrograms per liter (µg/L)

CLIENT: Emory University		TITLE: Predicted PCE* Plume Extents 2019	
PROJECT: North Decatur Road Site, Atlanta, Georgia			
SCALE: As Shown	SOURCE: URS	URS	PROJ NO.: 15263255
DATE: December 2014	DRAWN BY: J. Gross		TASK: 01150
FILE: H:\Proj\EmoryUniversity\Dec2014\PCE 2019.ai	CHECKED BY: D. Voykin		FIGURE: 4



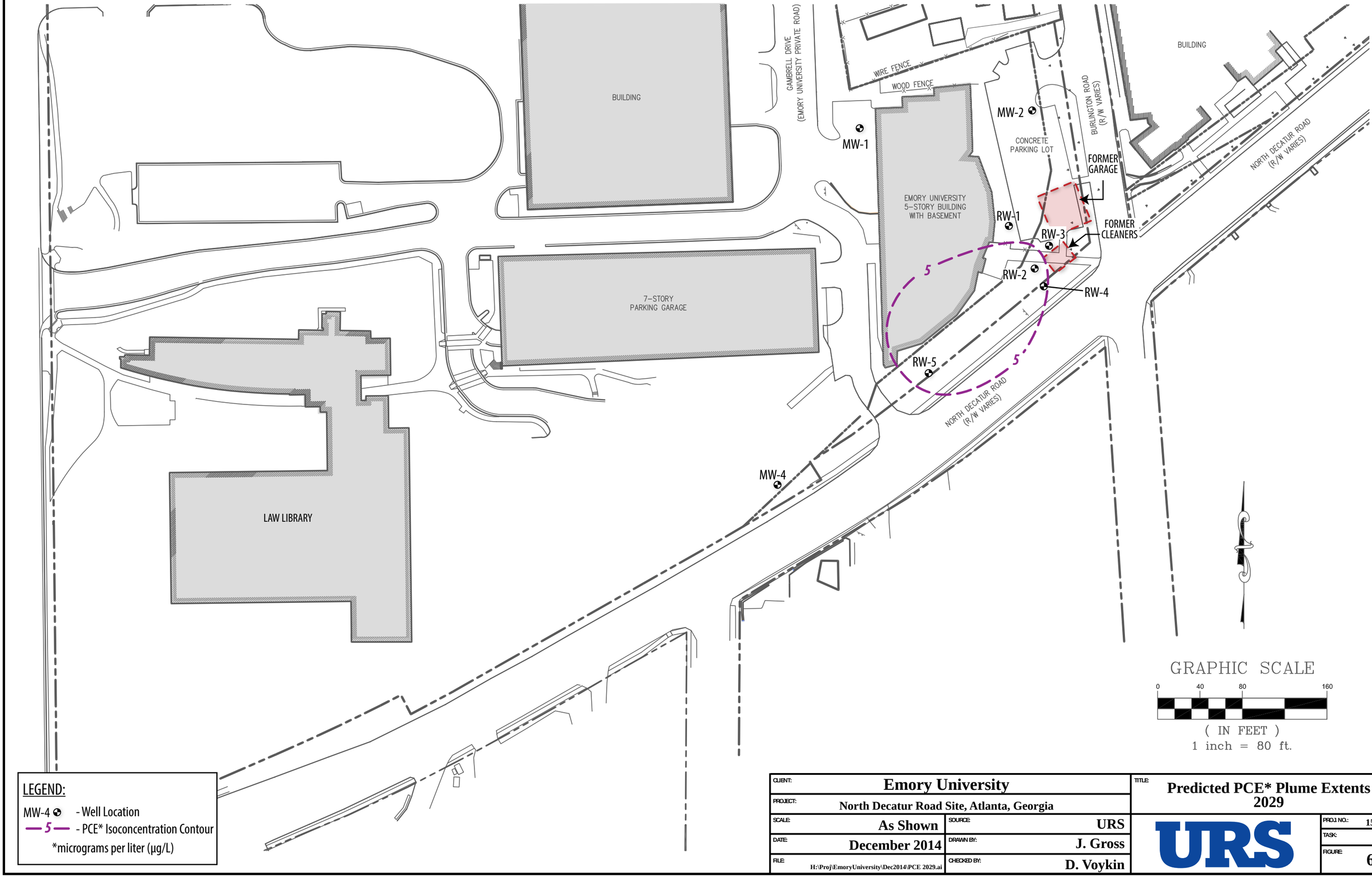
LEGEND:

MW-4 - Well Location

5 - PCE* Isoconcentration Contour

*micrograms per liter (µg/L)

CLIENT:	Emory University	TITLE:	Predicted PCE* Plume Extents 2024
PROJECT:	North Decatur Road Site, Atlanta, Georgia		
SCALE:	As Shown	SOURCE: URS	PROJ NO.: 15263255
DATE:	December 2014	DRAWN BY: J. Gross	TASK: 01150
FILE:	H:\Proj\EmoryUniversity\Dec2014\PCE 2024.ai	CHECKED BY: D. Voykin	FIGURE: 5



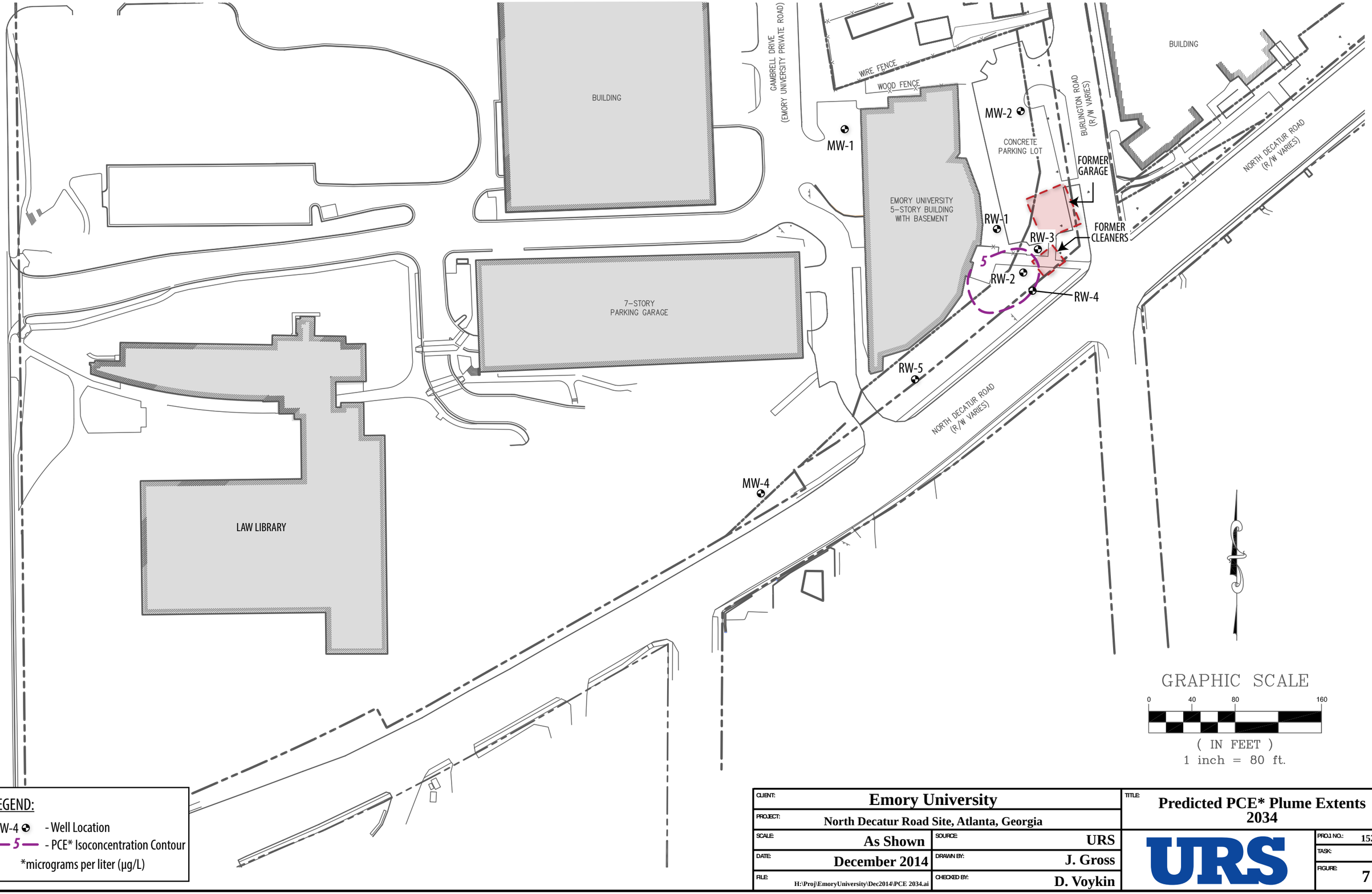
LEGEND:

MW-4 - Well Location

5 - PCE* Isoconcentration Contour

*micrograms per liter (µg/L)

CLIENT:	Emory University	TITLE:	Predicted PCE* Plume Extents 2029
PROJECT:	North Decatur Road Site, Atlanta, Georgia		
SCALE:	As Shown	SOURCE: URS	PROJ NO.: 15263255
DATE:	December 2014	DRAWN BY: J. Gross	TASK: 01150
FILE:	H:\Proj\EmoryUniversity\Dec2014\PCE 2029.ai	CHECKED BY: D. Voykin	FIGURE: 6



LEGEND:

MW-4 - Well Location

5 - PCE* Isoconcentration Contour

*micrograms per liter (µg/L)

CLIENT:	Emory University	TITLE:	Predicted PCE* Plume Extents 2034
PROJECT:	North Decatur Road Site, Atlanta, Georgia		
SCALE:	As Shown	SOURCE: URS	PROJ NO.: 15263255
DATE:	December 2014	DRAWN BY: J. Gross	TASK: 01150
FILE:	H:\Proj\EmoryUniversity\Dec2014\PCE 2034.ai	CHECKED BY: D. Voykin	FIGURE: 7

APPENDIX

BIOCHLOR Model Output

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Emory University
N. Decatur Road
Run Name

Data Input Instructions:
115 → 1. Enter value directly....or
↑ or
0.02 → 2. Calculate by filling in gray cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	120.7	(ft/yr)
or			
Hydraulic Conductivity	K	4.0E-04	(cm/sec)
Hydraulic Gradient	i	0.04376	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	23.798	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R
or

	Koc		R	
Soil Bulk Density, rho	1.7	(kg/L)		
FractionOrganicCarbon, foc	1.0E-3	(-)		
Partition Coefficient				
PCE	426	(L/kg)	5.83	(-)
TCE	130	(L/kg)	2.47	(-)
DCE	125	(L/kg)	2.42	(-)
VC	30	(L/kg)	1.34	(-)
ETH	302	(L/kg)	4.42	(-)
Common R (used in model)* =			**2.47**	

4. BIOTRANSFORMATION -1st Order Decay Coefficient*

	Zone 1 λ (1/yr)	half-life (yrs)	Yield	Zone 2 λ (1/yr)	half-life (yrs)
PCE → TCE	1.150		0.79	0.000	
TCE → DCE	0.475		0.74	0.000	
DCE → VC	1.740		0.64	0.000	
VC → ETH	1.420		0.45	0.000	

λ HELP

5. GENERAL

Simulation Time*	26	(yr)
Modeled Area Width*	250	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA TYPE: Decaying Single Planar

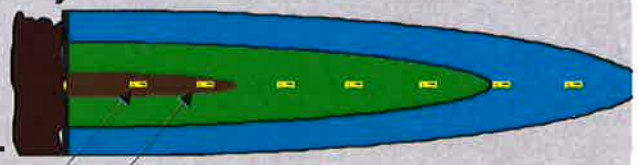
Source Options

Source Thickness in Sat. Zone* 40 (ft)

Width* (ft) Y1: 20

Conc. (mg/L)*	C1	K_s* (1/yr)
PCE	150.0	0.2
TCE	.5	0.2
DCE	4.0	0.2
VC	0.1	0.2
ETH	0.0	0.2

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)	.55	.16	.029								
TCE Conc. (mg/L)	.008										
DCE Conc. (mg/L)	.024										
VC Conc. (mg/L)											
ETH Conc. (mg/L)											
Distance from Source (ft)	25	165	340								
Date Data Collected	2014										

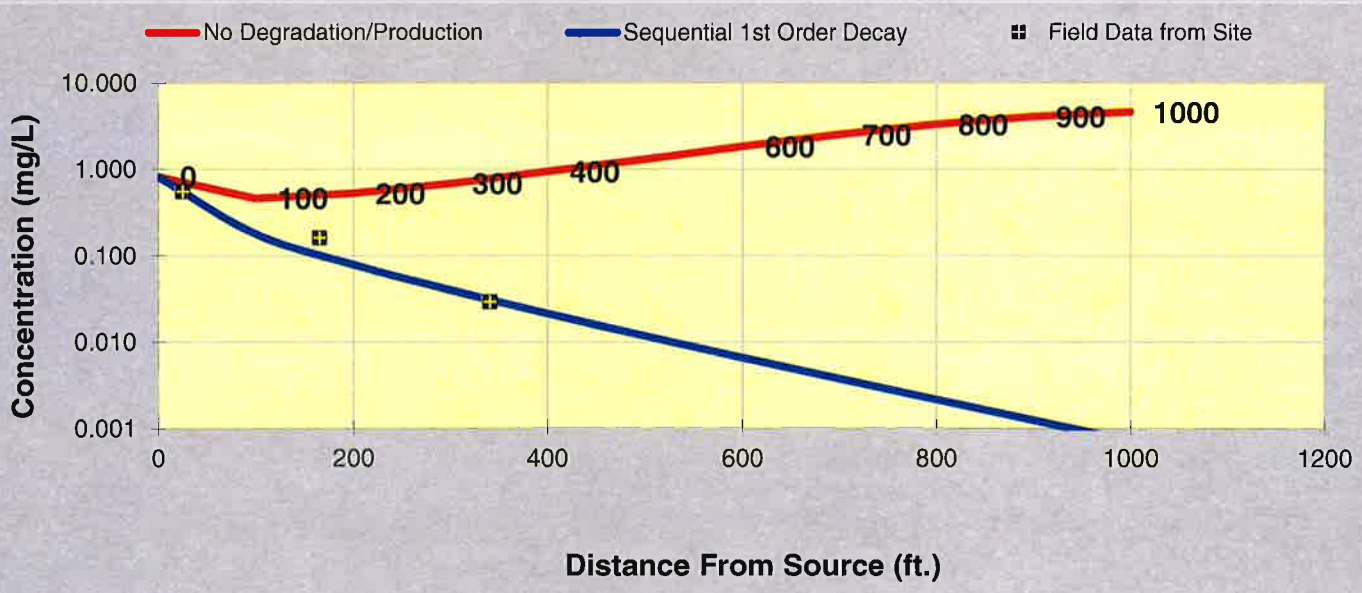
8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore | RESE | SEE | Paste

Plate 1A

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

PCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	0.827	0.463	0.528	0.686	0.941	1.310	1.834	2.514	3.304	4.072	4.613
Biotransformation	0.8275	0.180	0.079	0.040	0.021	0.012	0.007	0.004	0.002	0.001	0.001
	Monitoring Well Locations (ft)										
	25	165	340								
Field Data from Site	0.550	0.160	0.029								



See PCE | See TCE | See DCE | See VC | See ETH

Time: 26.0 Years

Log ⟷ Linear

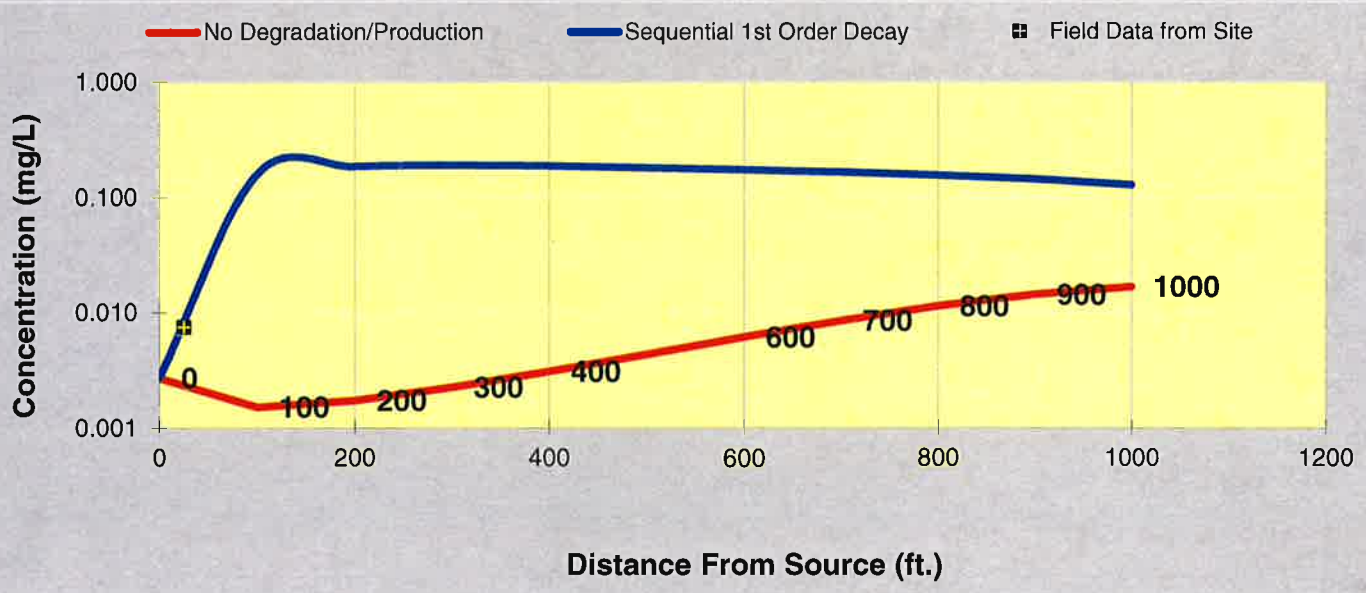
Prepare Animation | Return to Input | To All | To Array

Plate 1B

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	0.003	0.002	0.002	0.002	0.003	0.004	0.006	0.009	0.012	0.015	0.017
Biotransformation	0.0028	0.160	0.187	0.192	0.188	0.182	0.175	0.167	0.157	0.145	0.129

	Monitoring Well Locations (ft)										
	25	165	340								
Field Data from Site	0.008										



See PCE | See TCE | See DCE | See VC | See ETH

Prepare Animation

Time: 26.0 Years

Log ⟺ Linear

Return to Input | To All | To Array

Plate 1C

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

DCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	0.022	0.012	0.014	0.018	0.025	0.035	0.050	0.069	0.093	0.117	0.136
Biotransformation	0.0221	0.024	0.035	0.042	0.045	0.046	0.046	0.045	0.043	0.040	0.035
	Monitoring Well Locations (ft)										
	25	165	340								
Field Data from Site	0.024										

See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

26.0 Years

Log ⟺ Linear

Return to Input

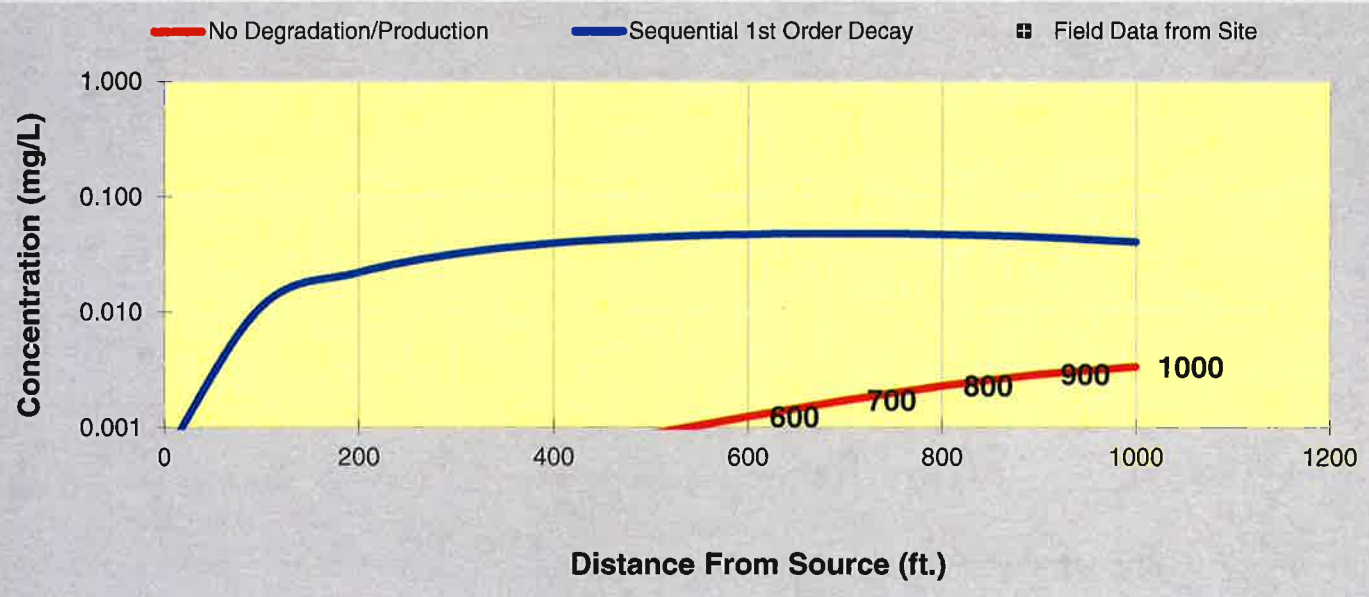
To All

To Array

Plate 1D

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

VC	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	0.001	0.000	0.000	0.000	0.001	0.001	0.001	0.002	0.002	0.003	0.003
Biotransformation	0.0006	0.011	0.022	0.032	0.040	0.045	0.047	0.048	0.047	0.045	0.041
	Monitoring Well Locations (ft)										
	25	165	340								
Field Data from Site											



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

26.0 Years

Log ⟷ Linear

Return to Input

To All

To Array

Plate 1E

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Emory University
N. Decatur Road
Run Name

Data Input Instructions:
115 → 1. Enter value directly....or
↑ or
0.02 → 2. Calculate by filling in gray cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	120.7	(ft/yr)
or			
Hydraulic Conductivity	K	4.0E-04	(cm/sec)
Hydraulic Gradient	i	0.004376	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	19.011	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc.

3. ADSORPTION

			R	
Retardation Factor*				
or				
Soil Bulk Density, rho	1.7	(kg/L)		
FractionOrganicCarbon, foc	1.0E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.83	(-)
TCE	130	(L/kg)	2.47	(-)
DCE	125	(L/kg)	2.42	(-)
VC	30	(L/kg)	1.34	(-)
ETH	302	(L/kg)	4.42	(-)

Common R (used in model)* = 2.47

4. BIOTRANSFORMATION -1st Order Decay Coefficient*

	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	1.150		0.79
TCE → DCE	0.475		0.74
DCE → VC	1.740		0.64
VC → ETH	1.420		0.45
Zone 2	λ (1/yr)	half-life (yrs)	
PCE → TCE	0.000		
TCE → DCE	0.000		
DCE → VC	0.000		
VC → ETH	0.000		

λ HELP

5. GENERAL

Simulation Time*	5	(yr)
Modeled Area Width*	250	(ft)
Modeled Area Length*	600	(ft)
Zone 1 Length*	600	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA TYPE: Decaying Single Planar

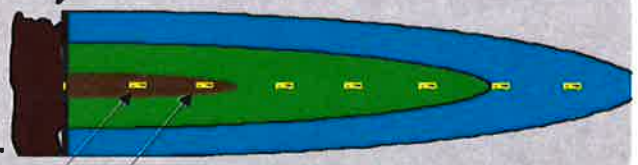
Source Options

Source Thickness in Sat. Zone* 40 (ft)

Width* (ft) Y1: 20

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE	150.0	0.2
TCE	.5	0.2
DCE	4.0	0.2
VC	0.1	0.2
ETH	0.0	0.2

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)	16.53											
TCE Conc. (mg/L)												
DCE Conc. (mg/L)												
VC Conc. (mg/L)												
ETH Conc. (mg/L)												
Distance from Source (ft)	85											
Date Data Collected	1993											

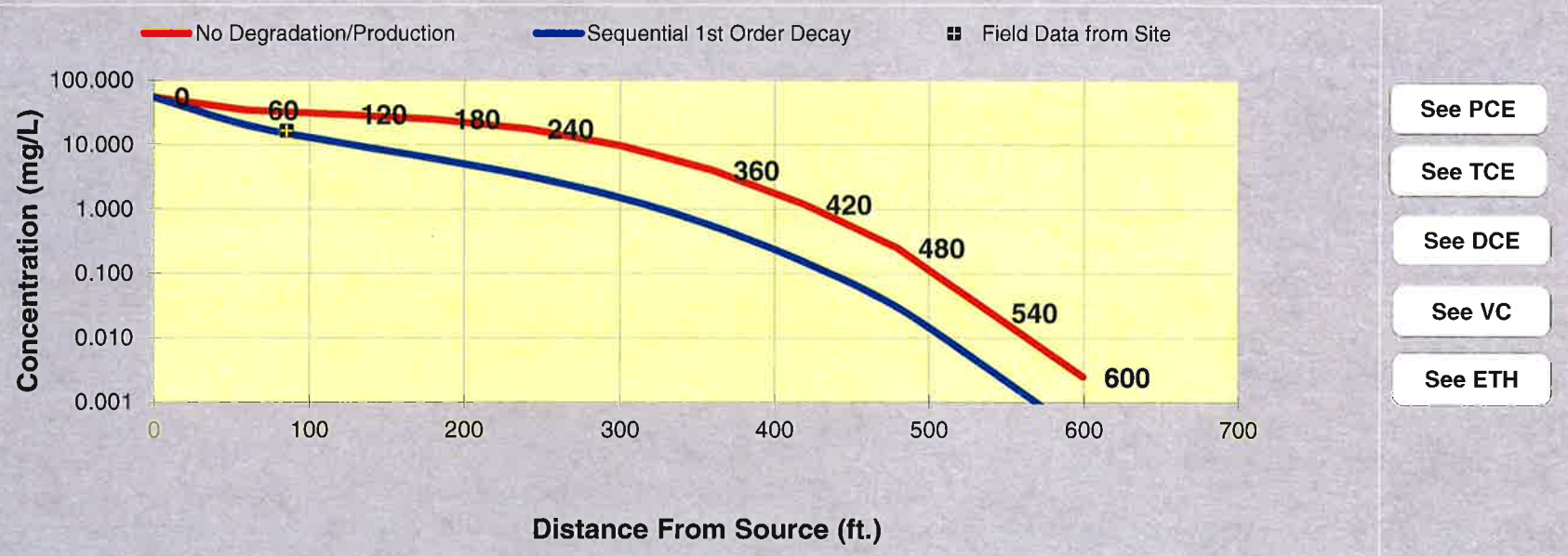
8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore | RESE | SEE | Paste

Plate 2A

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

PCE	Distance from Source (ft)										
	0	60	120	180	240	300	360	420	480	540	600
No Degradation	55.182	34.621	29.974	25.194	17.851	9.853	4.039	1.195	0.250	0.025	0.002
Biotransformation	55.1819	20.113	10.746	6.152	3.308	1.515	0.549	0.150	0.030	0.003	0.000
	Monitoring Well Locations (ft)										
	85										
Field Data from Site	16.530										



See PCE | See TCE | See DCE | See VC | See ETH

Time: 5.0 Years

Log ⟺ Linear

Prepare Animation | Return to Input | To All | To Array

Plate 2B

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Emory University
N. Decatur Road
Run Name

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	120.7	(ft/yr)
or			
Hydraulic Conductivity	K	4.0E-04	(cm/sec)
Hydraulic Gradient	i	0.04376	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	22.595	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R

or

	Koc		R	
Soil Bulk Density, rho		1.7		(kg/L)
FractionOrganicCarbon, foc		1.0E-3		(-)
Partition Coefficient				
PCE	426	(L/kg)	5.83	(-)
TCE	130	(L/kg)	2.47	(-)
DCE	125	(L/kg)	2.42	(-)
VC	30	(L/kg)	1.34	(-)
ETH	302	(L/kg)	4.42	(-)

Common R (used in model)* = 2.47

4. BIOTRANSFORMATION -1st Order Decay Coefficient*

	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	1.150		0.79
TCE → DCE	0.475		0.74
DCE → VC	1.740		0.64
VC → ETH	1.420		0.45
Zone 2	λ (1/yr)	half-life (yrs)	
PCE → TCE	0.000		
TCE → DCE	0.000		
DCE → VC	0.000		
VC → ETH	0.000		

λ HELP

5. GENERAL

Simulation Time*	31	(yr)
Modeled Area Width*	250	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA TYPE: Decaying Single Planar

Source Options

Source Thickness in Sat. Zone* 40 (ft)

Width* (ft) Y1: 20

Conc. (mg/L)*	C1	K_s* (1/yr)
PCE	150.0	0.2
TCE	.5	0.2
DCE	4.0	0.2
VC	0.1	0.2
ETH	0.0	0.2

7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)											
TCE Conc. (mg/L)											
DCE Conc. (mg/L)											
VC Conc. (mg/L)											
ETH Conc. (mg/L)											
Distance from Source (ft)	25	165	340								
Date Data Collected	2019										

8. CHOOSE TYPE OF OUTPUT TO SEE:

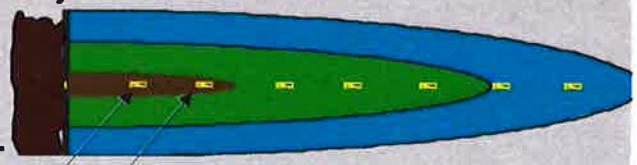
RUN CENTERLINE | RUN ARRAY | Help | Restore | RESE | SEE | Paste

Data Input Instructions:

115 → 1. Enter value directly....or
↑ or
0.02 → 2. Calculate by filling in gray cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



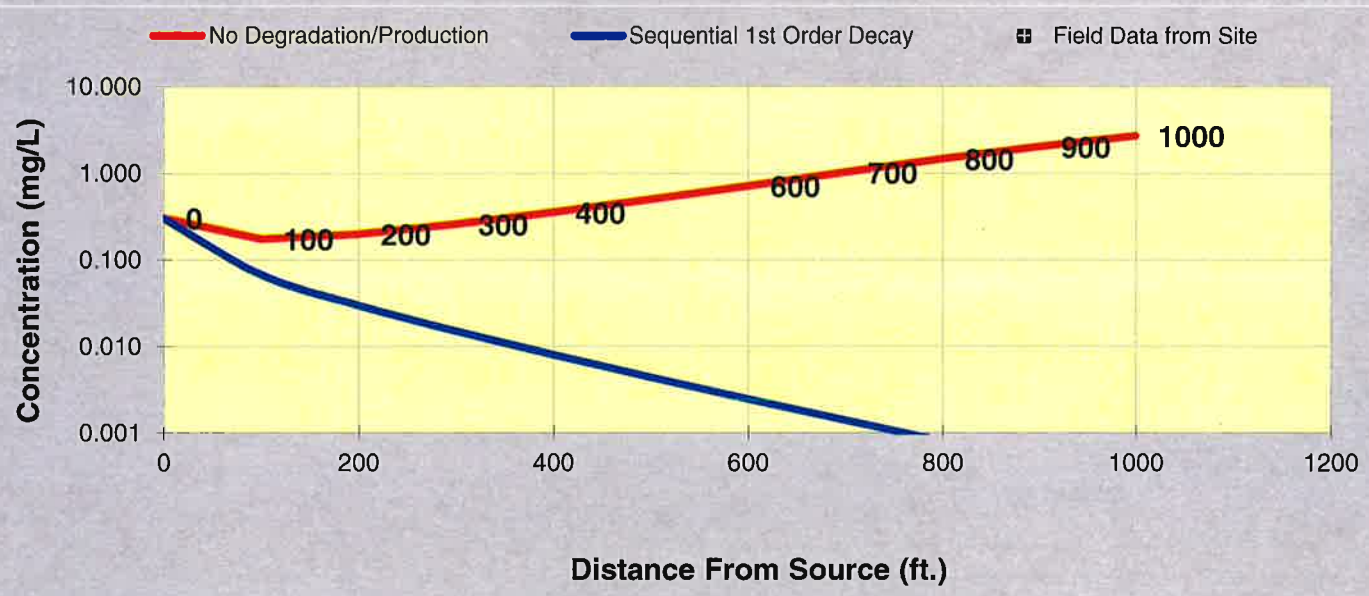
View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

Plate 3A

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

PCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	0.304	0.174	0.198	0.257	0.352	0.496	0.711	1.023	1.457	2.027	2.703
Biotransformation	0.3044	0.068	0.030	0.015	0.008	0.004	0.002	0.001	0.001	0.000	0.000
	Monitoring Well Locations (ft)										
	25	165	340								
Field Data from Site											



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

31.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

Plate 3B

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Emory University
N. Decatur Road
Run Name

Data Input Instructions:
115 → 1. Enter value directly....or
↑ or 2. Calculate by filling in gray
0.02 cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	120.7	(ft/yr)
or			
Hydraulic Conductivity	K	4.0E-04	(cm/sec)
Hydraulic Gradient	i	0.04376	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	19.811	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc.

3. ADSORPTION

Retardation Factor*			R	
or				
Soil Bulk Density, rho		1.7	(kg/L)	
FractionOrganicCarbon, foc		1.0E-3	(-)	
Partition Coefficient	Koc			
PCE		426	(L/kg)	5.83 (-)
TCE		130	(L/kg)	2.47 (-)
DCE		125	(L/kg)	2.42 (-)
VC		30	(L/kg)	1.34 (-)
ETH		302	(L/kg)	4.42 (-)

Common R (used in model)* = 2.47

4. BIOTRANSFORMATION -1st Order Decay Coefficient*

	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	1.150		0.79
TCE → DCE	0.475		0.74
DCE → VC	1.740		0.64
VC → ETH	1.420		0.45
Zone 2	λ (1/yr)	half-life (yrs)	
PCE → TCE	0.000		
TCE → DCE	0.000		
DCE → VC	0.000		
VC → ETH	0.000		

λ HELP

5. GENERAL

Simulation Time*	36	(yr)
Modeled Area Width*	250	(ft)
Modeled Area Length*	800	(ft)
Zone 1 Length*	800	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA TYPE: Decaying Single Planar

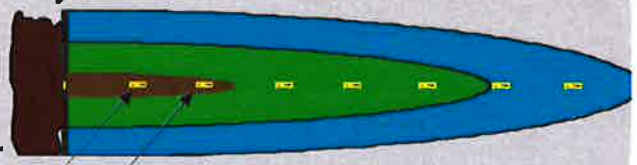
Source Options

Source Thickness in Sat. Zone* 40 (ft)

Width* (ft) Y1: 20

Conc. (mg/L)*	C1	K_s* (1/yr)
PCE	150.0	0.2
TCE	.5	0.2
DCE	4.0	0.2
VC	0.1	0.2
ETH	0.0	0.2

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)											
TCE Conc. (mg/L)											
DCE Conc. (mg/L)											
VC Conc. (mg/L)											
ETH Conc. (mg/L)											
Distance from Source (ft)	25	165	340								
Date Data Collected	2024										

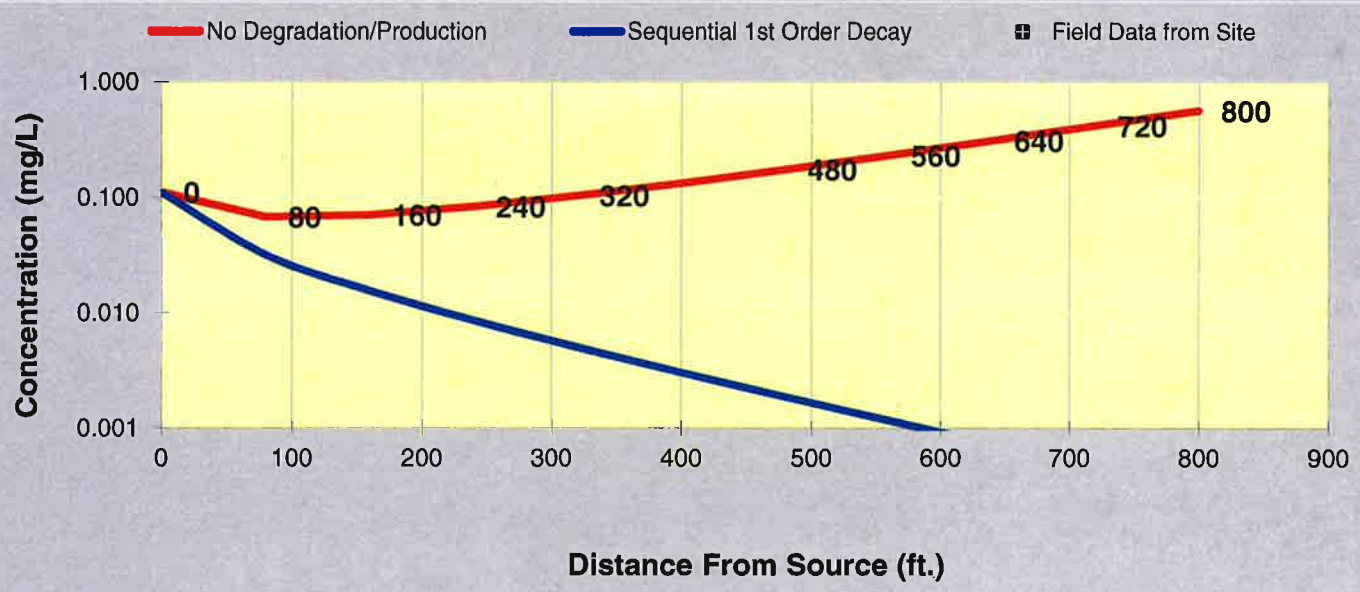
8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore | RESE | SEE | Paste

Plate 4A

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

PCE	Distance from Source (ft)										
	0	80	160	240	320	400	480	560	640	720	800
No Degradation	0.112	0.068	0.071	0.084	0.104	0.134	0.176	0.234	0.313	0.423	0.573
Biotransformation	0.1120	0.032	0.016	0.009	0.005	0.003	0.002	0.001	0.001	0.000	0.000
	Monitoring Well Locations (ft)										
	25	165	340								
Field Data from Site											



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

36.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

Plate 4B

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

PCE	Distance from Source (ft)										
	0	60	120	180	240	300	360	420	480	540	600
No Degradation	0.041	0.027	0.026	0.028	0.032	0.037	0.045	0.054	0.066	0.082	0.101
Biotransformation	0.0412	0.015	0.008	0.005	0.003	0.002	0.001	0.001	0.001	0.001	0.000
	Monitoring Well Locations (ft)										
	25	165	340								
Field Data from Site											

See PCE | See TCE | See DCE | See VC | See ETH

Time: 41.0 Years

Log ⟺ Linear

Prepare Animation | Return to Input | To All | To Array

Plate 5B

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Emory University
N. Decatur Road
Run Name

Data Input Instructions:
115 → 1. Enter value directly....or
↑ or
0.02 → 2. Calculate by filling in gray cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	120.7	(ft/yr)
or			
Hydraulic Conductivity	K	4.0E-04	(cm/sec)
Hydraulic Gradient	i	0.04878	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	18.158	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R
or

Soil Bulk Density, rho	1.7	(kg/L)	
FractionOrganicCarbon, foc	1.0E-3	(-)	
Partition Coefficient	Koc		
PCE	426	(L/kg)	5.83 (-)
TCE	130	(L/kg)	2.47 (-)
DCE	125	(L/kg)	2.42 (-)
VC	30	(L/kg)	1.34 (-)
ETH	302	(L/kg)	4.42 (-)

Common R (used in model)* = 2.47

4. BIOTRANSFORMATION -1st Order Decay Coefficient*

	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	1.150		0.79
TCE → DCE	0.475		0.74
DCE → VC	1.740		0.64
VC → ETH	1.420		0.45
Zone 2	λ (1/yr)	half-life (yrs)	
PCE → TCE	0.000		
TCE → DCE	0.000		
DCE → VC	0.000		
VC → ETH	0.000		

λ HELP

5. GENERAL

Simulation Time*	41	(yr)
Modeled Area Width*	250	(ft)
Modeled Area Length*	600	(ft)
Zone 1 Length*	600	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA TYPE: Decaying Single Planar

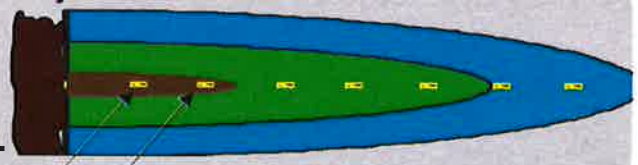
Source Options

Source Thickness in Sat. Zone* 40 (ft)

Width* (ft) Y1: 20

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE	150.0	0.2
TCE	.5	0.2
DCE	4.0	0.2
VC	0.1	0.2
ETH	0.0	0.2

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)											
TCE Conc. (mg/L)											
DCE Conc. (mg/L)											
VC Conc. (mg/L)											
ETH Conc. (mg/L)											
Distance from Source (ft)	25	165	340								
Date Data Collected	2029										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore | RESE | SEE | Paste

Plate 5A

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Emory University
N. Decatur Road
Run Name

Data Input Instructions:
115 → 1. Enter value directly....or
↑ or
0.02 → 2. Calculate by filling in gray cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	120.7	(ft/yr)
or			
Hydraulic Conductivity	K	4.0E-04	(cm/sec)
Hydraulic Gradient	i	0.04376	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	13.971	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R
or

			R
Soil Bulk Density, rho	1.7	(kg/L)	
FractionOrganicCarbon, foc	1.0E-3	(-)	
Partition Coefficient	Koc		
PCE	426	(L/kg)	5.83 (-)
TCE	180	(L/kg)	2.47 (-)
DCE	125	(L/kg)	2.42 (-)
VC	30	(L/kg)	1.34 (-)
ETH	302	(L/kg)	4.42 (-)

Common R (used in model)* = 2.47

4. BIOTRANSFORMATION -1st Order Decay Coefficient*

	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	1.150		0.79
TCE → DCE	0.475		0.74
DCE → VC	1.740		0.64
VC → ETH	1.420		0.45
Zone 2	λ (1/yr)	half-life (yrs)	
PCE → TCE	0.000		
TCE → DCE	0.000		
DCE → VC	0.000		
VC → ETH	0.000		

λ HELP

5. GENERAL

Simulation Time*	46	(yr)
Modeled Area Width*	250	(ft)
Modeled Area Length*	400	(ft)
Zone 1 Length*	400	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA TYPE: Decaying Single Planar

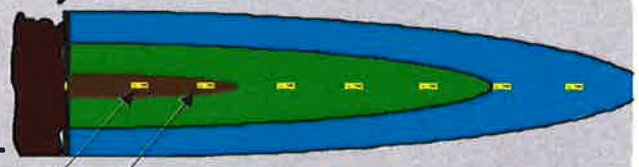
Source Options

Source Thickness in Sat. Zone* 40 (ft)

Width* (ft) Y1: 20

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE	150.0	0.2
TCE	.5	0.2
DCE	4.0	0.2
VC	0.1	0.2
ETH	0.0	0.2

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)												
TCE Conc. (mg/L)												
DCE Conc. (mg/L)												
VC Conc. (mg/L)												
ETH Conc. (mg/L)												
Distance from Source (ft)	25	165	340									
Date Data Collected	2004											

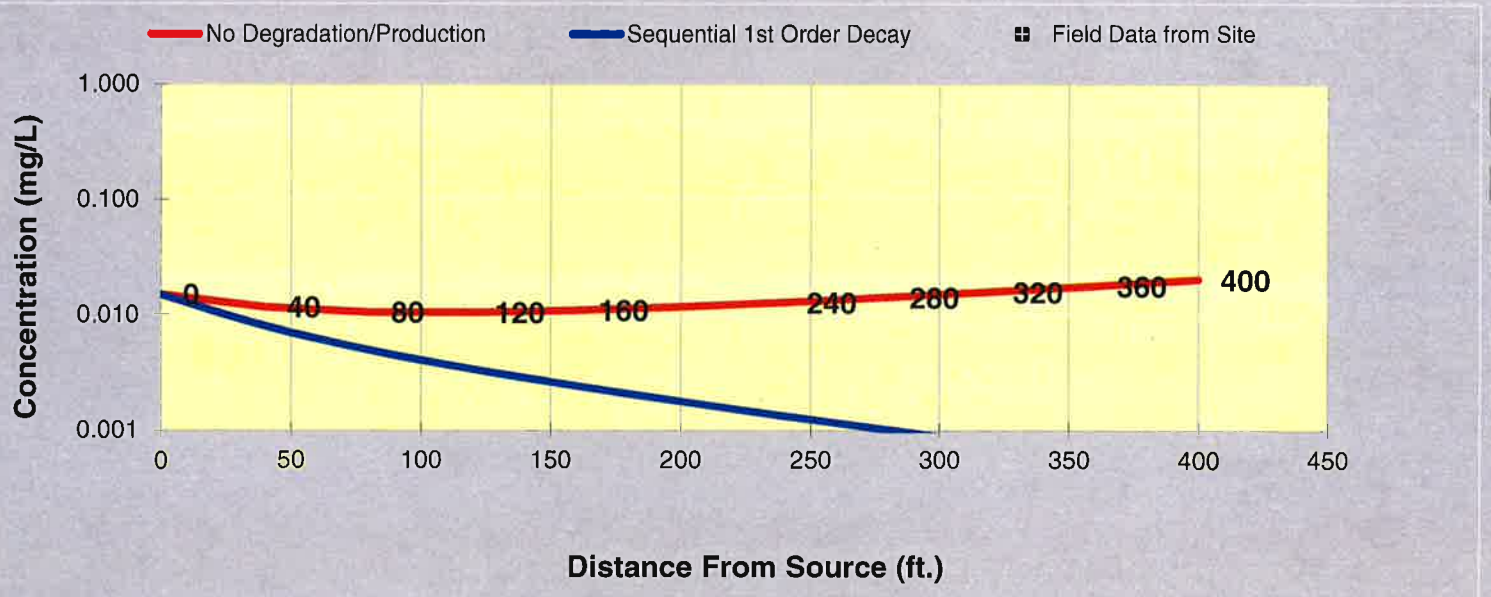
8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore | RESE | SEE | Paste

Plate 6A

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

PCE	Distance from Source (ft)										
	0	40	80	120	160	200	240	280	320	360	400
No Degradation	0.015	0.012	0.011	0.011	0.011	0.012	0.013	0.014	0.016	0.018	0.020
Biotransformation	0.0152	0.008	0.005	0.003	0.002	0.002	0.001	0.001	0.001	0.001	0.000
	Monitoring Well Locations (ft)										
	25	165	340								
Field Data from Site											



See PCE | See TCE | See DCE | See VC | See ETH

Prepare Animation

Time: 46.0 Years

Log ⟺ Linear

Return to Input | To All | To Array

Plate 6B

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Emory University
N. Decatur Road
Run Name

Data Input Instructions:
115 → 1. Enter value directly....or
or
0.02 → 2. Calculate by filling in gray cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	120.7	(ft/yr)
or			
Hydraulic Conductivity	K	4.0E-04	(cm/sec)
Hydraulic Gradient	i	0.04876	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	11.099	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R
or

Soil Bulk Density, rho	1.7	(kg/L)		
FractionOrganicCarbon, foc	1.0E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.83	(-)
TCE	130	(L/kg)	2.47	(-)
DCE	125	(L/kg)	2.42	(-)
VC	30	(L/kg)	1.34	(-)
ETH	302	(L/kg)	4.42	(-)

Common R (used in model)* = 2.47

4. BIOTRANSFORMATION -1st Order Decay Coefficient*

	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	1.150		0.79
TCE → DCE	0.475		0.74
DCE → VC	1.740		0.64
VC → ETH	1.420		0.45
Zone 2	λ (1/yr)	half-life (yrs)	
PCE → TCE	0.000		
TCE → DCE	0.000		
DCE → VC	0.000		
VC → ETH	0.000		

λ HELP

5. GENERAL

Simulation Time*	51	(yr)
Modeled Area Width*	250	(ft)
Modeled Area Length*	300	(ft)
Zone 1 Length*	300	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA TYPE: Decaying Single Planar

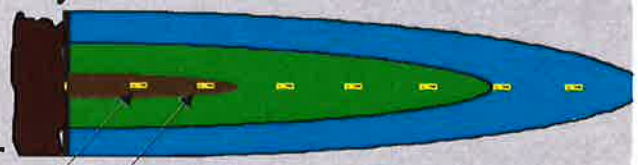
Source Options

Source Thickness in Sat. Zone* 40 (ft)

Width* (ft) Y1: 20

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE	150.0	0.2
TCE	.5	0.2
DCE	4.0	0.2
VC	0.1	0.2
ETH	0.0	0.2

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)											
TCE Conc. (mg/L)											
DCE Conc. (mg/L)											
VC Conc. (mg/L)											
ETH Conc. (mg/L)											
Distance from Source (ft)	25	165	340								
Date Data Collected	2039										

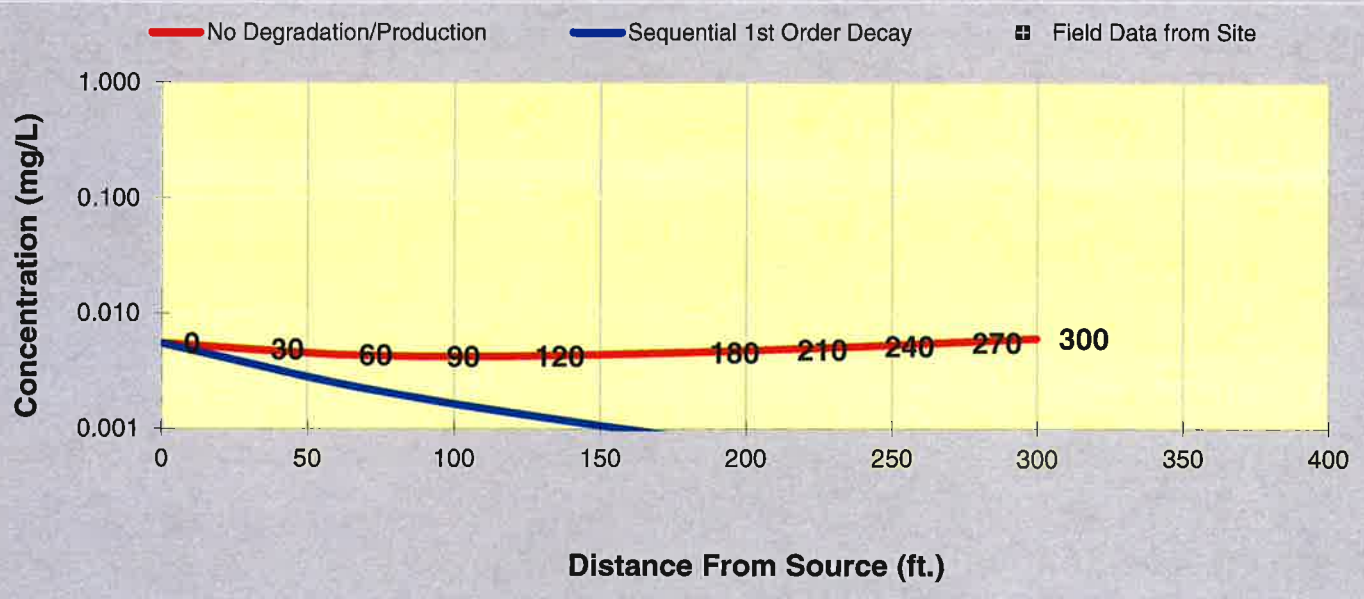
8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore | RESE | SEE | Paste

Plate 7A

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

PCE	Distance from Source (ft)										
	0	30	60	90	120	150	180	210	240	270	300
No Degradation	0.006	0.005	0.004	0.004	0.004	0.004	0.005	0.005	0.005	0.006	0.006
Biotransformation	0.0056	0.004	0.003	0.002	0.001	0.001	0.001	0.001	0.001	0.000	0.000
	Monitoring Well Locations (ft)										
	25	165	340								
Field Data from Site											



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

51.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

Plate 7B