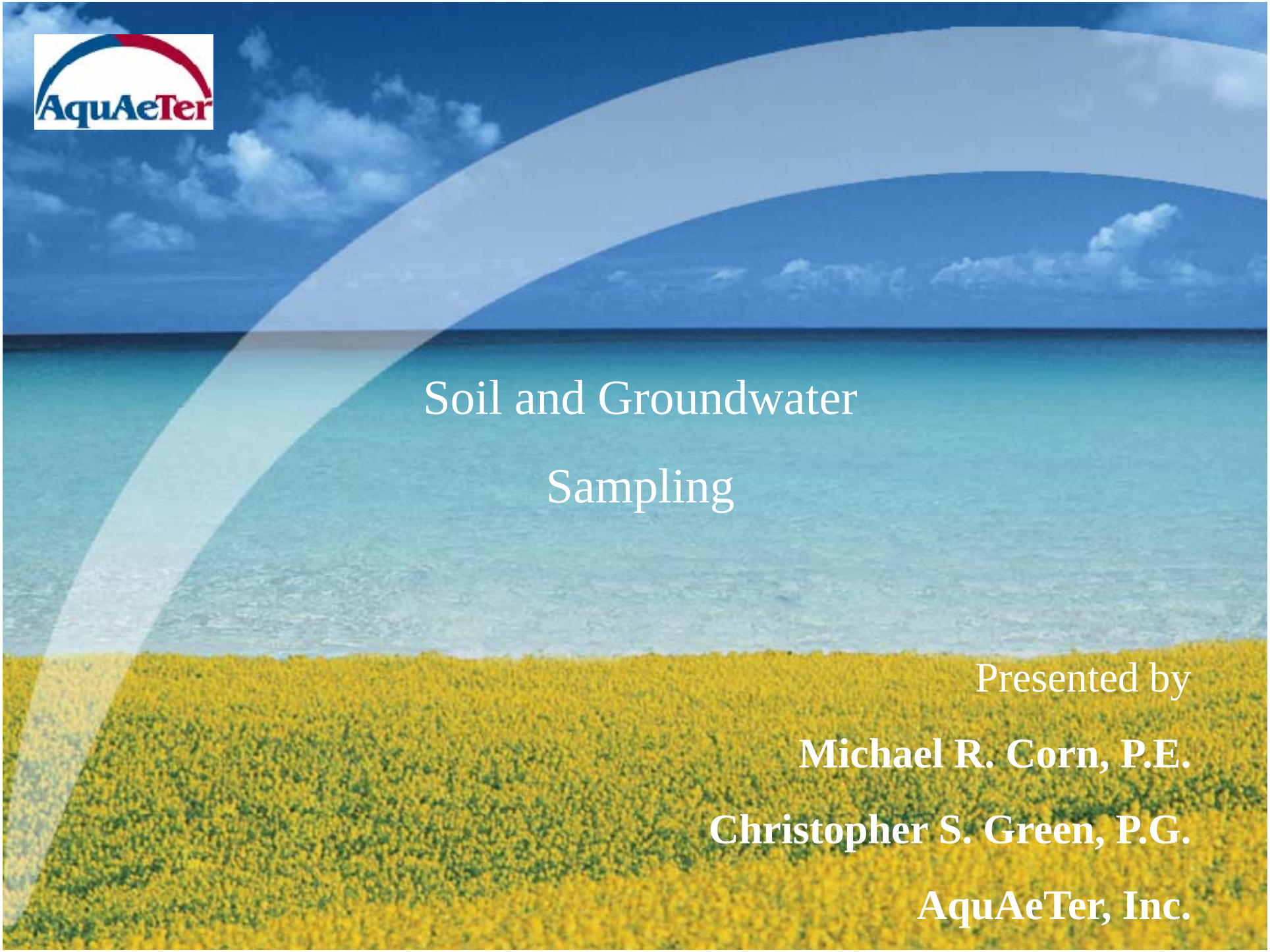

Soil and Groundwater Sampling

Presented by

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WHY DO WE SAMPLE SOIL AND GROUNDWATER

1. **Soil can be impacted by direct contamination through a spill or intentional spreading of contamination, through the air, or through rainfall**
2. **Groundwater can be impacted by leaching of contaminants from the overlying soils, direct injection into the groundwater or interactions with surface waters**
3. **Soil represents a direct exposure through adsorption through the skin or uptake by food and subsequent ingestion by humans of the contaminated food**
4. **Groundwater represents an adsorption risk (e.g., showers) and an ingestion risk**
5. **USEPA has established risk-based screening levels (SLs) for both residential and industrial soils and groundwaters**

RISK-BASED ANALYSES

1. **USEPA and States have established Risk-Based Screening Levels (SLs) that are based on the Precautionary Principle**
2. **Courts rule on Causation which are at levels much higher than precautionary SLs that have "nonproven" safety factors applied to known impacts to rodents**
3. **SLs are established for a $1*10^{-6}$ to $1*10^{-4}$ increase in cancer**
4. **USEPA uses $1*10^{-4}$ SLs to determine if remediation is necessary**
5. **Normal Incidence of cancer in U.S. is 0.5 for men or 1 out every 2 men will have a cancer in their lifetime and 0.33 for women or 1 out of every 3 women will have a cancer in their lifetime**

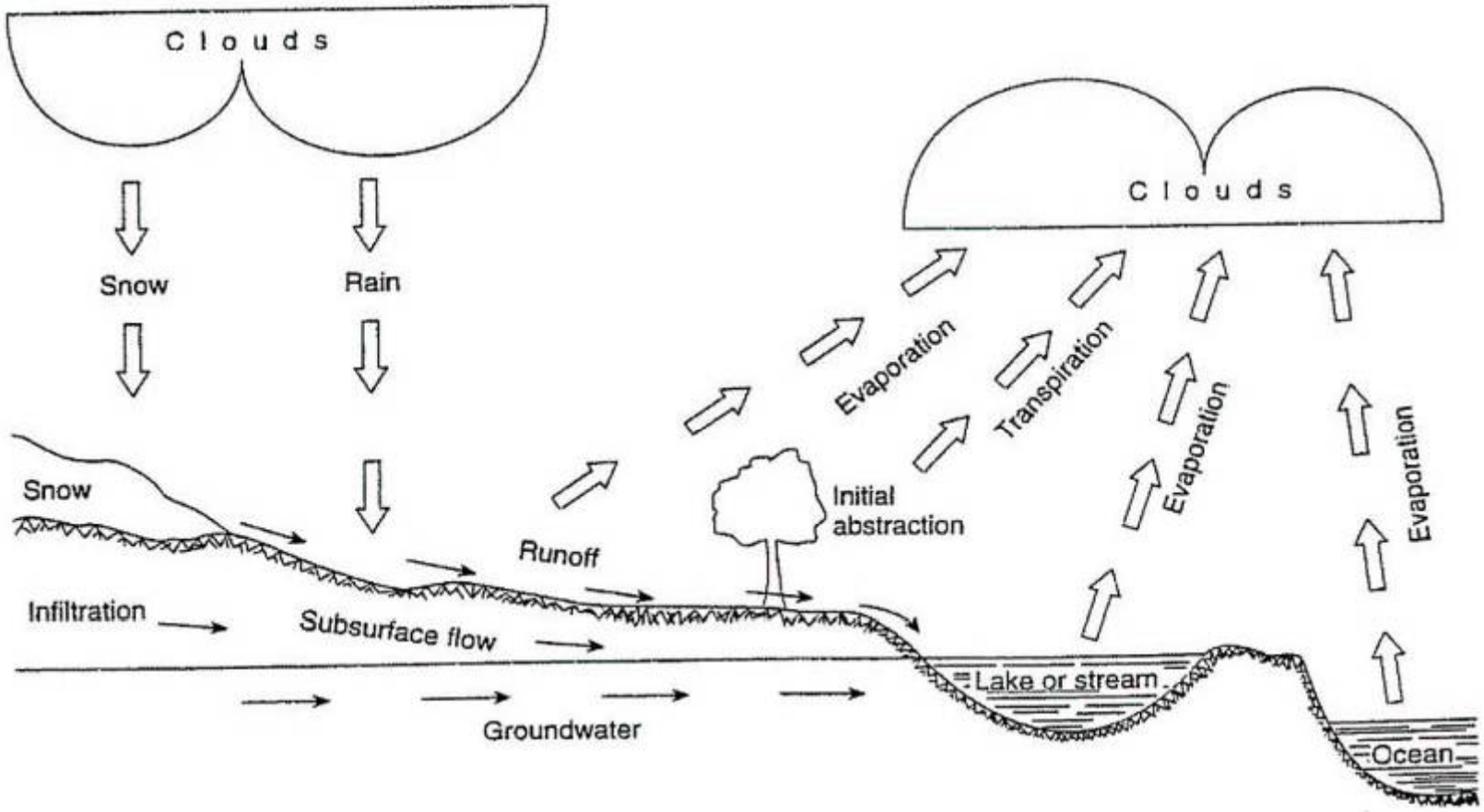
USEPA REGIONAL SLs

master_sl_table_run_12SEP2008

Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; H = HEAST; W = WHO; S = see user guide Section 5; L = see user guide on lead; M = mutagen; V = volatile; c = cancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; n = noncancer; m = Concentration may exceed ceiling limit (See User's Guide); s = Concentration may exceed Csat (See User's Guide); SSL values are based on DAF=1

Contaminant		Toxicity and Chemical-specific Information														Screening Levels																Protection of Groundwater	
		SFO	k e y	IUR	k e y	RfDo	k e y	RfCi	k e y	v o c	muta-gen	RAGS Part E GIABS	RAGS Part E ABS	Csat		Residential Soil	key	Industrial Soil	key	Residential Air	key	Industrial Air	key	Tapwater	key	MCL		Risk-based SSL	MCL-based SSL				
Analyte	CAS No.	(mg/kg-day)$^{-1}$		(ug/m^3)$^{-1}$		(mg/kg-day)		(mg/m^3)						mg/kg		mg/kg		ug/m^3		ug/m^3		ug/L		ug/L		mg/kg	mg/kg				
Nitrosomethylethylamine, N-	10595-95-6	2.2E+01	I									1	0.1			2.2E-02	c	7.8E-02	c					3.1E-03	c			1.1E-06					
Nitrosopyrrolidine, N-	930-55-2	2.1E+00	I	6.1E-04	I							1	0.1			2.3E-01	c	8.2E-01	c	4.0E-03	c	2.0E-02	c	3.2E-02	c			1.7E-05					
Nitrotoluene, m-	99-08-1					2.0E-02	P					1	0.1			1.2E+03	n	1.2E+04	n					7.3E+02	n			8.0E-01					
Nitrotoluene, o-	88-72-2	2.2E-01	P			9.0E-04	P			V		1		1.3E+03		2.9E+00	c*	1.3E+01	c*					3.1E-01	c			2.5E-04					
Nitrotoluene, p-	99-99-0	1.6E-02	P			4.0E-03	P					1	0.1			3.0E+01	c**	1.1E+02	c*					4.2E+00	c*			3.4E-03					
Norflurazon	27314-13-2					4.0E-02	I					1	0.1			2.4E+03	n	2.5E+04	n					1.5E+03	n			1.7E+01					
Nustar	85509-19-9					7.0E-04	I					1	0.1			4.3E+01	n	4.3E+02	n					2.6E+01	n			9.0E+01					
Octabromodiphenyl Ether	32536-52-0					3.0E-03	I					1	0.1			1.8E+02	n	1.8E+03	n					1.1E+02	n			3.1E+01					
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetra (HMX)	2691-41-0					5.0E-02	I					1	0.006			3.8E+03	n	4.9E+04	n					1.8E+03	n			7.1E+00					
Octamethylpyrophosphoramide	152-16-9					2.0E-03	H					1	0.1			1.2E+02	n	1.2E+03	n					7.3E+01	n			1.3E-01					
Oryzalin	19044-88-3					5.0E-02	I					1	0.1			3.1E+03	n	3.1E+04	n					1.8E+03	n			4.8E+00					
Oxadiazon	19666-30-9					5.0E-03	I					1	0.1			3.1E+02	n	3.1E+03	n					1.8E+02	n			1.3E+00					
Oxamyl	23135-22-0					2.5E-02	I					1	0.1			1.5E+03	n	1.5E+04	n					9.1E+02	n	2.0E+02		2.0E-01	4.4E-02				
Paclobutrazol	76738-62-0					1.3E-02	I					1	0.1			7.9E+02	n	8.0E+03	n					4.7E+02	n			1.2E+01					
Paraquat Dichloride	1910-42-5					4.5E-03	I					1	0.1			2.7E+02	n	2.8E+03	n					1.6E+02	n			4.9E-01					
Parathion	56-38-2					6.0E-03	H					1	0.1			3.7E+02	n	3.7E+03	n					2.2E+02	n			8.2E-01					
Pebulate	1114-71-2					5.0E-02	H					1	0.1			3.1E+03	n	3.1E+04	n					1.8E+03	n			2.1E+00					
Pendimethalin	40487-42-1					4.0E-02	I					1	0.1			2.4E+03	n	2.5E+04	n					1.5E+03	n			7.9E+00					
Pentabromodiphenyl Ether	32534-81-9					2.0E-03	I					1	0.1			1.2E+02	n	1.2E+03	n					7.3E+01	n			4.5E+00					
Pentabromodiphenyl ether, 2,2',4,4',5- (BDE-99)	60348-60-9					1.0E-04	I									7.8E+00	n	1.0E+02	n					3.7E+00	n								
Pentachlorobenzene	608-93-5					8.0E-04	I					1	0.1			4.9E+01	n	4.9E+02	n					2.9E+01	n			1.2E-01					
Pentachloroethane	76-01-7	9.0E-02	P									1	0.1			5.4E+00	c	1.9E+01	c					7.5E-01	c			3.9E-04					
Pentachloronitrobenzene	82-68-8	2.6E-01	H			3.0E-03	I					1	0.1			1.9E+00	c*	8.6E+00	c					2.6E-01	c			1.3E-03					
Pentachlorophenol	87-86-5	1.2E-01	I			3.0E-02	I					1	0.25			3.0E+00	c	9.0E+00	c					5.6E-01	c	1.0E+00		3.9E-03	7.0E-03				
Perchlorate and Perchlorate Salts	14797-73-0					7.0E-04	I					1				5.5E+01	n	7.2E+02	n					2.6E+01	n								
Permethrin	52645-53-1					5.0E-02	I					1	0.1			3.1E+03	n	3.1E+04	n					1.8E+03	n			6.5E+02					
Phenmedipham	13684-63-4					2.5E-01	I					1	0.1			1.5E+04	n	1.5E+05	nn					9.1E+03	n			6.8E+00					
Phenol	108-95-2					3.0E-01	I	2.0E-01	C			1	0.1			1.8E+04	n	1.8E+05	nn	2.1E+02	n	8.8E+02	n	1.1E+04	n			8.1E+00					
Phenylenediamine, m-	108-45-2					6.0E-03	I					1	0.1			3.7E+02	n	3.7E+03	n					2.2E+02	n			7.8E-02					
Phenylenediamine, o-	95-54-5	4.7E-02	H									1	0.1			1.0E+01	c	3.7E+01	c					1.4E+00	c			5.0E-04					
Phenylenediamine, p-	106-50-3					1.9E-01	H					1	0.1			1.2E+04	n	1.2E+05	nn					8.9E+03	n			2.4E+00					
Phenylphenol, 2-	90-43-7	1.9E-03	H									1	0.1			2.5E+02	c	8.9E+02	c					3.5E+01	c			7.2E-01					
Phorate	298-02-2					2.0E-04	H					1	0.1			1.2E+01	n	1.2E+02	n					7.3E+00	n			7.9E-03					
Phosgene	75-44-5							3.0E-04	I	V		1		8.7E+04		4.0E-01	n	1.7E+00	n	3.1E-01	n	1.3E+00	n										
Phosmet	732-11-6					2.0E-02	I					1	0.1			1.2E+03	n	1.2E+04	n					7.3E+02	n			2.1E-01					
Phosphine	7803-51-2					3.0E-04	I	3.0E-04	I			1				2.3E+01	n	3.1E+02	n	3.1E-01	n	1.3E+00	n	1.1E+01	n								
Phosphoric Acid	7664-38-2							1.0E-02	I			1				1.4E+07	nn	8.0E+07	nn	1.0E+01	n	4.4E+01	n										
Phosphorus, White	7723-14-0					2.0E-05	I					1				1.6E+00	n	2.0E+01	n					7.3E-01	n			2.7E-03					
Phthalic Acid, P-	100-21-0					1.0E+00	H					1	0.1			6.1E+04	n	8.2E+05	nn					3.7E+04	n			1.3E+01					
Phthalic Anhydride	85-44-9					2.0E+00	I	2.0E-02	C			1	0.1			1.2E+05	nn	1.2E+06	nn	2.1E+01	n	8.8E+01	n	7.3E+04	n			1.8E+01					
Picloram	1918-02-1					7.0E-02	I					1	0.1			4.3E+03	n	4.3E+04	n					2.6E+03	n	5.0E+02		8.0E-01	1.2E-01				
Picramic Acid (2-Amino-4,6-dinitrophenol)	96-91-3					2.0E-03	P					1	0.1			1.2E+02	n	1.2E+03	n					7.3E+01	n			2.9E-02					
Pirimiphos, Methyl	29232-93-7					1.0E-02	I					1	0.1			6.1E+02	n	8.2E+03	n					3.7E+02	n			1.7E-01					
Polybrominated Biphenyls	59536-65-1	3.0E+01	C	8.6E-03	C	7.0E-06	H					1	0.1			1.8E-02	c*	5.7E-02	c*	2.8E-04	c	1.4E-03	c	2.2E-03	c								
Polymeric Methylene Diphenyl Diisocyanate (PMDI)	9016-87-9							6.0E-04	I			1	0.1			8.5E+05	nn	3.6E+06	nn	6.3E-01	n	2.6E+00	n										
Potassium Perchlorate	7778-74-7					7.0E-04	I					1				5.5E+01	n	7.2E+02	n					2.6E+01	n								
Prochloraz	67747-09-5	1.5E-01	I			9.0E-03	I					1	0.1			3.2E+00	c	1.1E+01	c					4.5E-01	c			2.5E-03					
Profluralin	26399-36-0					5.0E-03	H					1	0.1			3.7E+02	n	3.7E+03	n					2.2E+02	n			8.0E+00					
Prometon	1610-18-0					1.5E-02	I					1	0.1			9.2E+02	n	9.2E+03	n					5.5E+02	n			2.8E-01					
Prometryn	7287-19-6					4.0E-03	I					1	0.1			2.4E+02	n	2.5E+03	n					1.5E+02	n			2.3E-01					
Propachlor	1918-16-7					1.3E-02	I					1	0.1			7.9E+02	n	8.0E+03	n					4.7E+02	n			3.7E-01					
Propanil	709-98-8					5.0E-03	I					1	0.1			3.1E+02	n	3.1E+03	n					1.8E+02	n			1.1E-01					
Propargite	2312-35-8					2.0E-02	I					1	0.1			1.2E+03	n	1.2E+04	n					7.3E+02	n			2.0E+02					
Propargyl Alcohol	107-19-7					2.0E-03	I					1	0.1			1.2E+02	n	1.2E+03	n					7.3E+01	n			1.5E-02					
Propazine	139-40-2					2.0E-02	I					1	0.1			1.2E+03	n	1.2E+04	n					7.3E+02	n			8.7E-01					
Propham	122-42-9					2.0E-02	I					1	0.1			1.2E+03	n	1.2E+04	n					7.3E+02	n			3.3E-01					
Propiconazole	60207-90-1					1.3E-02	I					1	0.1			7.9E+02	n	8.0E+03	n					4.7E+02	n			6.4E+00					
Propylene Glycol	57-55-6					2.0E+01	P					1	0.1			1.2E+05	nn	1.2E+07	nn					7.3E+05	n			1.5E+02					
Propylene Glycol Dinitrate	6423-43-4							A 2.7E-04	A	V		1		1.4E+05		6.0E+01	n	2.5E+02	n	2.8E-01	n	1.2E+00	n	5.7E-01	n			1.9E-04					
Propylene Glycol Monoethyl Ether	1569-02-4					7.0E-01	H					1	0.1			4.3E+04	n	4.3E+05	nn					2.6E+04	n			5.2E+00					
Propylene Glycol Monomethyl Ether	107-98-2					7.0E-01	H	2.0E+00	I			1	0.1			4.3E+04	n	4.3E+05	nn	2.1E+03	n	8.8E+03	n	2.6E+04	n			5.2E+00					
Propylene Oxide	75-56-9	2.4E-01	I	3.7E-06	I			3.0E-02	I	V		1		8.8E+04		1.9E+00	c	8.7E+00	c	8.6E-01	c*	3.3E+00	c*	2.3E-01	c			4.7E-05					
Pursuit	81335-77-5					2.5E-01	I					1	0.1			1.5E+04	n	1.5E+05	nn					9.1E+03	n			2.7E+01					

Hydrologic Cycle



COMPARISON OF UNITS

1 kilogram	=	200	teaspoons
1 gram	=	0.2	teaspoon
1 milligram	=	0.0002	teaspoon
1 microgram	=	0.0000002	teaspoon
1 nanogram	=	0.0000000002	teaspoon
1 picogram	=	0.0000000000002	teaspoon
1 femtogram	=	0.0000000000000002	teaspoon

1 kilogram	=	1,000,000	parts per million (ppm)
1 gram	=	1,000	parts per million (ppm)
1 milligram	=	1	parts per million (ppm)
1 microgram	=	0.001	parts per million (ppm)
1 nanogram	=	0.000001	parts per million (ppm)
1 picogram	=	0.000000001	parts per million (ppm)
1 femtogram	=	0.000000000001	parts per million (ppm)

Per Kilogram for soil

Per Liter for water

Per cubic meter for air

Soil Sampling Methods

- **Surface Soils**
  - Hand Augur
  - Shovel
  - Stainless Steel Spoons
- **Subsurface Soils**
  - Drill Rig
    - Sonic
    - Direct Push
    - Auger
    - Air Rotary

Drilling Equipment

1. Direct Drilling

2. Power Auger Rig

3. Air Rotary

4. Sonic Drilling

Typical Work Station

Groundwater Sampling Methods

- **Grab (Probe) Sampling**
  - Represents in-situ conditions of water column
- **Purge and Sample**
  - Purge 3 well volumes to obtain a representative sample of the aquifer
- **Low Flow**
  - Requires less than one foot of drawdown to obtain a sample that is not influenced by purging methods
    - Metals analysis

Groundwater Sampling Equipment

1. Bailers

2. Peristaltic Pump

3. Submersible Pump

4. Diffusion Bags

Soil Sampling Case Study

Issue

- **A litigation involved residents suing a nearby industry for health effects caused by alleged air, surface water, groundwater and soil contamination in the yards of residents.**

Establish Scope of Work

- **Problem Identification:**
  - Industry accused of contaminating yards and homes of residents at levels above background levels:
    - PAHs
    - Dioxins/Furans
    - Pentachlorophenol
- **Goals of Sampling**
  - Determine if higher than background concentrations exist in yards of residents and if these elevated concentrations are a result of plant operations.

Site Reconnaissance

Industrial Facility

Residential Community

Background Information: Common Sources of Constituents

- **Polycyclic Aromatic Hydrocarbons (PAHs)**
  - Petroleum products
  - Coal
  - Creosote
  - Cigarette Tar
  - Burning of combustible products
  - Car Exhaust
- **Pentachlorophenol**
  - Wood preservative
  - Herbicides
- **Dioxins and Furans**
  - Byproduct in some herbicides
  - Burning of combustible product
  - Byproduct in pentachlorophenol
  - Burning of trash in barrels

Applicable Regulations - Dioxins

- **EPA refers to:**
- **Agency for Toxic Substances and Disease Registry (ATSDR)**
  - 0.05 ppb screening level
  - 1.0 ppm action level
- **State Department Of Environmental Quality Risk Evaluation Procedures For Voluntary Cleanup And Redevelopment Of Brownfield Sites**
  - Individual values for each dioxin

State Tier 1 Risk Based Remediation Goals

DEPARTMENT OF ENVIRONMENTAL QUALITY TIER 1 TRG TABLE													
CHEMICAL	CAS No.	Groundwater			Soil								
					Restricted				Unrestricted				
		ug/l		Notes	mg/kg		Notes		mg/kg		Notes		
DINOSEB	88857	7.00E+00		MCL	2.04E+02	N	Ing		7.82E+01	N	Ing		
DI-N-OCTYLPHTHALATE	117840	2.00E+01		Csol	4.08E+03	N	Ing		1.56E+03	N	Ing		
1,4-DIOXANE	123911	6.09E+00	C		5.20E+02	C	Ing		5.81E+01	C	Ing		
DIOXATHION	78342	5.48E+01	N		3.07E+03	N	Ing		1.17E+02	N	Ing		
DIOXINS & FURANS													
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN (TCDD)	1746016	3.00E-05		MCL	3.82E-05	C	Ing		4.26E-06	C	Ing		
1,2,3,4,6,7,8-HEPTACHLORODIBENZO-P-DIOXIN (HpCDD)	35822469	4.46E-05	C		3.82E-03	C	Ing		4.26E-04	C	Ing		
1,2,3,4,7,8-HEXACHLORODIBENZO-P-DIOXIN (HxCDD)	39227286	4.46E-06	C		3.82E-04	C	Ing		4.26E-05	C	Ing		
1,2,3,6,7,8-HEXACHLORODIBENZO-P-DIOXIN (HxCDD)	57653857	1.08E-05	C		9.23E-04	C	Ing		1.03E-04	C	Ing		
1,2,3,7,8,9-HEXACHLORODIBENZO-P-DIOXIN (HxCDD)	19408743	1.08E-05	C		9.23E-04	C	Ing		1.03E-04	C	Ing		
1,2,3,4,6,7,8,9-OCTACHLORODIBENZO-P-DIOXIN (OCDD)	3268879	4.46E-04	C		3.82E-02	C	Ing		4.26E-03	C	Ing		
1,2,3,7,8-PENTACHLORODIBENZO-P-DIOXIN (PeCDD)	40321764	8.93E-07	C		7.63E-05	C	Ing		8.52E-06	C	Ing		
1,2,3,4,6,7,8-HEPTACHLORODIBENZOFURAN (HpCDF)	67562394	4.46E-05	C		3.82E-03	C	Ing		4.26E-04	C	Ing		
1,2,3,4,7,8,9-HEPTACHLORODIBENZOFURAN (HpCDF)	55673897	4.46E-05	C		3.82E-03	C	Ing		4.26E-04	C	Ing		
1,2,3,4,7,8-HEXACHLORODIBENZOFURAN (HxCDF)	70648269	4.46E-06	C		3.82E-04	C	Ing		4.26E-05	C	Ing		
1,2,3,6,7,8-HEXACHLORODIBENZOFURAN (HxCDF)	57117449	4.46E-06	C		3.82E-04	C	Ing		4.26E-05	C	Ing		
1,2,3,7,8,9-HEXACHLORODIBENZOFURAN (HxCDF)	72918219	4.46E-06	C		3.82E-04	C	Ing		4.26E-05	C	Ing		
2,3,4,6,7,8-HEXACHLORODIBENZOFURAN (HxCDF)	60851345	4.46E-06	C		3.82E-04	C	Ing		4.26E-05	C	Ing		
1,2,3,4,6,7,8,9-OCTACHLORODIBENZOFURAN (OCDF)	39001020	4.46E-04	C		3.82E-02	C	Ing		4.26E-03	C	Ing		
1,2,3,7,8-PENTACHLORODIBENZOFURAN (PeCDF)	57117416	8.93E-06	C		7.63E-04	C	Ing		8.52E-05	C	Ing		
2,3,4,7,8-PENTACHLORODIBENZOFURAN (PeCDF)	57117314	8.93E-07	C		7.63E-05	C	Ing		8.52E-06	C	Ing		
2,3,7,8-TETRACHLORODIBENZOFURAN (TCDF)	51207319	4.46E-06	C		3.82E-04	C	Ing		4.26E-05	C	Ing		

Scope of Work for Sampling

- **Sample soil in front and back yards of residents separately for constituents of concern:**
  - Determine if there is a difference in concentrations that could be attributed to the plant.
  - Time spent in each location is different, therefore risk levels are different.
- **Sample other residences in the area to determine background levels.**
- **Perform a detailed site reconnaissance to pinpoint alternative sources of COCs in the yards.**
- **Work Plan has to allow for deviations and/or adjustments to sampling methodology due to field conditions.**

Scope of Work for Sampling, cont.

- **Take 5 surface samples (0-6 inches) each in front and back yard.**
- **Take 4 samples from random sampling locations.**
- **Take 1 sample from an area of high traffic.**
- **Composite front and backyard samples in the lab to determine the average exposure in each area, but hold individual samples in case these need to be run.**

SAMPLING METHODOLOGY

1. **Systematic sampling – such as, equal spacing between sample points.**
2. **Random sampling – grid the sample area and randomly select sample points.**
3. **Bias sampling – e.g., Select hot spots.**
4. **Modified Sampling – combining one or more sampling methods.**

Identify Laboratory

- **Detection Limits**
  - MDL –Method Detection Limit
  - PQL – Practical Quantitation Limit
- **Preservatives / Hold Times / Shipping**
- **Results Turnaround**
  - Data Package – Lab Documentation
- **Laboratory Qualifications**

Laboratory Communication

- **Communicated specific requirements to lab through a memorandum sent prior to sampling event.**

MEMORANDUM

TO: [redacted]
FROM: Chrisie Brown, P.E., and Christopher Green, P.G., **AquAeTer**
DATE: April 14, 2005
JOB NO.: [redacted]
RE: **SOIL SAMPLING FOR DIOXINS AND FURANS**

AquAeTer will be sending soil samples to [redacted] for dioxin and furan analysis by SW846 EPA Method 8290. This memo details specific requests for sampling and data handling. If you have questions or comments, please address them to Christopher Green or Chrisie Brown at 615-373-8532.

Sample Schedule

Samples will be shipped to the lab overnight beginning [redacted] (for delivery on [redacted]). **AquAeTer** will fax the chain of custody the day the samples are shipped.

Sample Handling and Labeling

The shipment will contain some samples labeled and packaged in groups of five (5). These groups should be composited into one sample for analysis. The individual samples in these groups should be maintained so that they can be analyzed independently if required. A few individual samples may also be present in the shipment. **AquAeTer** requests that these samples also be held by Eno until a written request is received for analysis.

Each set of samples for the compositing will have a 12-character unique identifier followed by the numbers 1 through 5. **AquAeTer** requests that Eno label the composite sample from each group with the same 12-character identifier followed by "COMP." For example, a set of numbers might look like:

AAT-007CC-SS-FY-1
AAT-007CC-SS-FY-2
AAT-007CC-SS-FY-3 } lab composite = AAT-007CC-SS-FY-COMP
AAT-007CC-SS-FY-4
AAT-007CC-SS-FY-5

Duplicate samples will also be sent that will require compositing. Duplicates 1 through 3 will be labeled as follows:

Identify Required SOPs

- **United States Environmental Protection Agency (USEPA), Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM) (November 2001)**
  - Decon
  - Sampling/Quartering Method
  - Equipment Blanks

Work Plan

DRAFT

SAMPLING AND ANALYSIS PLAN
SURFACE SOIL SAMPLING FOR DIOXINS, FURANS, POLYCYCLIC AROMATIC HYDROCARONS, AND PENTACHLOROPHENOL
[redacted]

INTRODUCTION

AquAeTer, Inc. (AquAeTer) will conduct soil sampling in the yards of several [redacted] citizens near the [redacted] facility located near [redacted]. The scope of work for this project is to collect representative soil samples from the yards of [redacted] citizens. Surface soils will be collected at twelve residences and three background locations around [redacted].

ANALYTICAL METHODS AND DATA QUALITY

Methods specified in the United States Environmental Protection Agency (USEPA), Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM) (November 2001) will be implemented to obtain the soil samples and prepare the samples for analysis. The following analytical methods will be used to determine the concentrations constituents of concern in the soil samples:

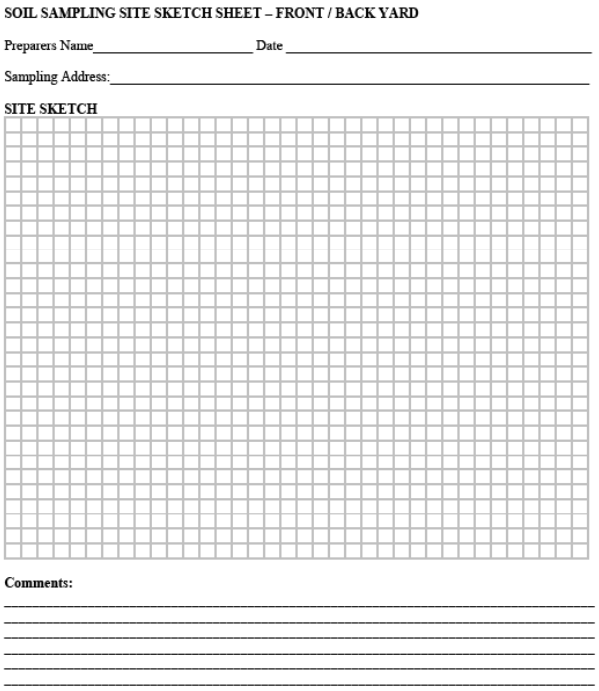
ANALYSIS	EPA SW-846 METHOD	HOLDING TIME
Soil Moisture	160.3	None
Polycyclic Aromatic Hydrocarbons (PAH) and Pentachlorophenol	8270C	14 day
Dioxins and Furans	8290	30 day

The analytical methods chosen will provide reporting limits (RL) equal to the practical quantitation limits (PQL), which are less than USEPA Region 9 Preliminary Remediation Goals (PRGs). USEPA Region 4, including Mississippi, recommends the use of Region 9 PRGs for guidance.

To provide quality assurance and quality control (QA/QC) of laboratory sampling procedures a matrix spike and matrix spike duplicate (MS/MSD) sample will be collected. Reanalysis may be necessary in certain situations. To ensure that the laboratory has sufficient volume for MS/MSD analysis, triple the sample volume must be collected.

Field Preparation

- Design Data Collection Format
- Brief Sampling Team Members
- Perform Dry Run of Equipment and Procedures
- Sampling Logistics
- Adjust Work Plan as Necessary



SOIL SAMPLING SITE SKETCH SHEET – FRONT / BACK YARD

Preparers Name_____ Date _____

Sampling Address:_____

SITE SKETCH

Comments:

Pre-Sampling Equipment Blank

Site Reconnaissance – Measuring Yards

Site Reconnaissance
Sampling Location Determination

GPS Sampling Locations

Place Sample Kits at Location

Collect Samples

Prepare Samples

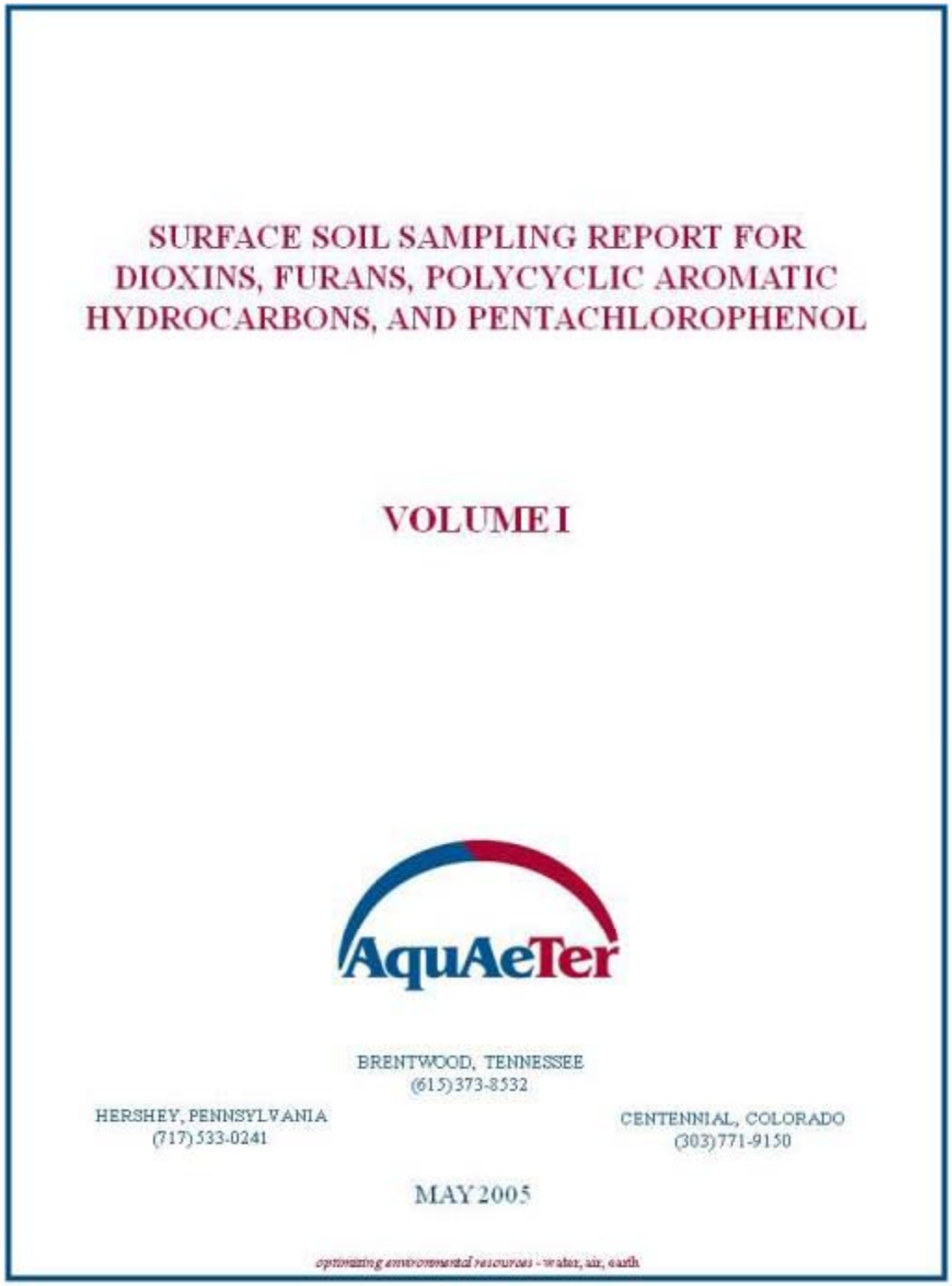
Sampling Equipment Decon
Using EPA Approved Methods

Documenting potential alternate sources

Yard Trash

Burn Barrels

Reporting Results



SURFACE SOIL SAMPLING REPORT FOR
DIOXINS, FURANS, POLYCYCLIC AROMATIC
HYDROCARBONS, AND PENTACHLOROPHENOL

VOLUME I

AquAeTer

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(717)533-0241

CENTENNIAL, COLORADO
(303)771-9150

MAY 2005

optimizing environmental resources - water, air, earth

Comparison of Dioxins and Furans in Soils with ATSDR Consideration of Action Levels

CONSTITUENT	ATSDR SCREENING LEVEL (ug/kg)	ATSDR CONSIDERATION OF ACTION (ug/kg)	MEASURED BACKYARD (ug/kg)	MEASURED FRONT YARD (ug/kg)	MEASURED FY DUPLICATE (ug/kg)
Dioxins/Furans					
TCDD TEQ	0.050		0.016	0.079	0.056
TCDD TEQ		1.000	0.016	0.079	0.056

SOIL TCDD TEQ VALUES FOR BOTH THE BACKYARD AND FRONT YARD ARE LESS THAN EITHER THE SCREENING LEVEL (BACKYARD) OR THE ACTION LEVEL SUGGESTED BY ATSDR AND USED BY THE USEPA

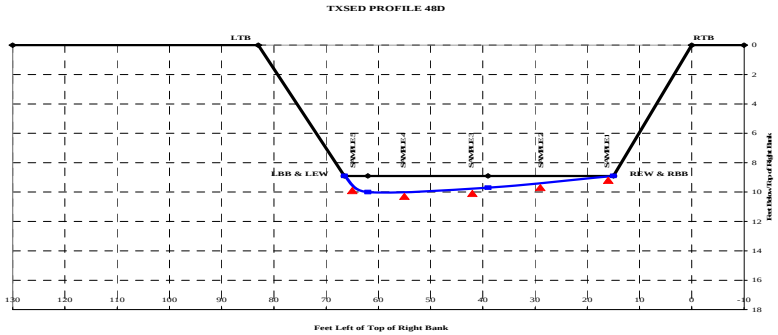
NO ACTION REQUIRED

Sediment Sampling Case Study

Field Sampling Conditions

Example of Data Collected

Transect: TXSED / **48D**					
Transect Description:	Right bank slopes steeply from the top of bank to edge of water. No sandbars present in creek. Left bank has slight break in slope, steeper slope closer to the water, then gentler slope to top of bank. The distance from the top of right bank to the top of left bank is 83 feet. Transect is in a straight section of the creek. Tree-line extends along both tops of banks, with trees overhanging on both sides of creek. Dead logs have been deposited along right bank. Two tires were noted in the creek.				
Sample Number	1	2	3	4	5
Date / Time	November 30, 2005	November 30, 2005	November 30, 2005	November 30, 2005	November 30, 2005
Sample Equipment	Stainless Steel Shovel and Stainless Steel Bowl	Stainless Steel Shovel and Stainless Steel Bowl	Stainless Steel Shovel and Stainless Steel Bowl	Stainless Steel Shovel and Stainless Steel Bowl	Stainless Steel Shovel and Stainless Steel Bowl
Distance from RTB	16 feet, 1 foot from right edge of water	29 feet	42 feet	55 feet	65 feet
Transect Off-Set		15 feet upstream of transect	10 feet upstream		
Water Depth	<1 foot	1 foot	1 foot	< 1 foot	0.5 feet
Sample Depth	0 – 0.5 feet	0 – 0.5 feet	0 – 0.5 feet	0 – 0.5 feet	0 – 0.5 feet
Sample Description	Black, silt, organic material. Strong odor. Duplicate sample 48DD collected	Dark brown to black, gravel, sandy, angular and rounded gravel, coarse grained sands. No odor (field record does not indicate a sample odor) Duplicate sample 48DD collected.	Brown, sand, angular and rounded pebbles, coarse grained sands. No odor (field record does not indicate a sample odor) Duplicate sample 48DD collected	Brown, sand, gravelly, angular and rounded pebbles, coarse grained sand. No odor (field record does not indicate a sample odor) Duplicate sample 48DD collected	Black, silt, sandy, vegetation leaves and roots. Slight odor. Duplicate sample 48DD collected
Materials Excluded	Vegetation excluded.	Large pebbles and cobbles excluded.	Large pebbles and cobbles excluded.	Large pebbles excluded.	Top 2 inches of detritus (leaf matter) removed prior to sample collection. Vegetation excluded.



View looking upstream at 48D

Example Results

CONSTITUENT	METHOD	UNITS	TCEQ PCL	05 AAT 48 D	05 AAT 48 DD	05 AAT 46 D	05 AAT 44 D	05 AAT 42 D
PHYSICAL/CHEMICAL								
Moisture content	160.3	%	no PCL	22.1	23.4	16.5	17.6	14.4
Total Organic Carbon (TOC)	5310B	mg/kg	no PCL	4,260	1,190	291 J	3,330	2,040
PAHs								
Total PAHs	--	ug/kg	no PCL	131,945	222,390	1,722	3,619	43,113
Total cPAHs	--	ug/kg	no PCL	12,775	18,450	663	1,911	6,823
1-Methylnaphthalene	8270C SIM	ug/kg	8,700,000	4,400	7,200	9	15	720
2-Methylnaphthalene	8270C SIM	ug/kg	490,000	7,400	12,000	12	22	460
Acenaphthene	8270C SIM	ug/kg	7,400,000	12,000	20,000	39	110	2,900
Acenaphthylene	8270C SIM	ug/kg	7,400,000	230	270	35	95	200
Anthracene	8270C SIM	ug/kg	3,700,000	5,100	7,900	80	140	1,900
Benzo(a)anthracene	8270C SIM	ug/kg	16,000	3,800	6,100	94	240	1,900
Benzo(a)pyrene	8270C SIM	ug/kg	1,600	1,500	***2,000***	110	330	880
Benzo(b)fluoranthene	8270C SIM	ug/kg	16,000	2,400	3,100	180	530	1,500
Benzo(g,h,i)perylene	8270C SIM	ug/kg	3,700,000	640	570	72	210	310
Benzo(k)fluoranthene	8270C SIM	ug/kg	160,000	1,100	1,400	74	180	700
Chrysene	8270C SIM	ug/kg	1,600,000	3,700	5,000	110	340	1,700
Dibenz(a,h)anthracene	8270C SIM	ug/kg	1,600	210	220	22	71	110
Fluoranthene	8270C SIM	ug/kg	4,900,000	18,000	35,000	300	440	7,300
Fluorene	8270C SIM	ug/kg	4,900,000	11,000	21,000	65	130	3,800
Indeno(1,2,3-cd)pyrene	8270C SIM	ug/kg	16,000	65	630	73	220	33
Naphthalene	8270C SIM	ug/kg	2,500,000	9,400	19,000	27	56	300
Phenanthrene	8270C SIM	ug/kg	3,700,000	38,000	60,000	180	140	13,000
Pyrene	8270C SIM	ug/kg	3,700,000	13,000	21,000	240	350	5,400
PCP								
Pentachlorophenol	8270C	ug/kg	56,000	NA	NA	NA	NA	NA
METALS								
Arsenic	6020	mg/kg	110	1.60 J	2.59 J	9.8	2.30 J	1.83 J

NOTES:

DD & HD - Duplicate Sample

J - Estimated value, result is < or = to method detection limit (MDL), but > or equal to limit of quantification (LOQ)

U - Constituent was not detected, value given is MDL

NA - Not analyzed

1830 - Concentration falls between 10^{-4} and 10^{-5} risk levels

Groundwater Case Study

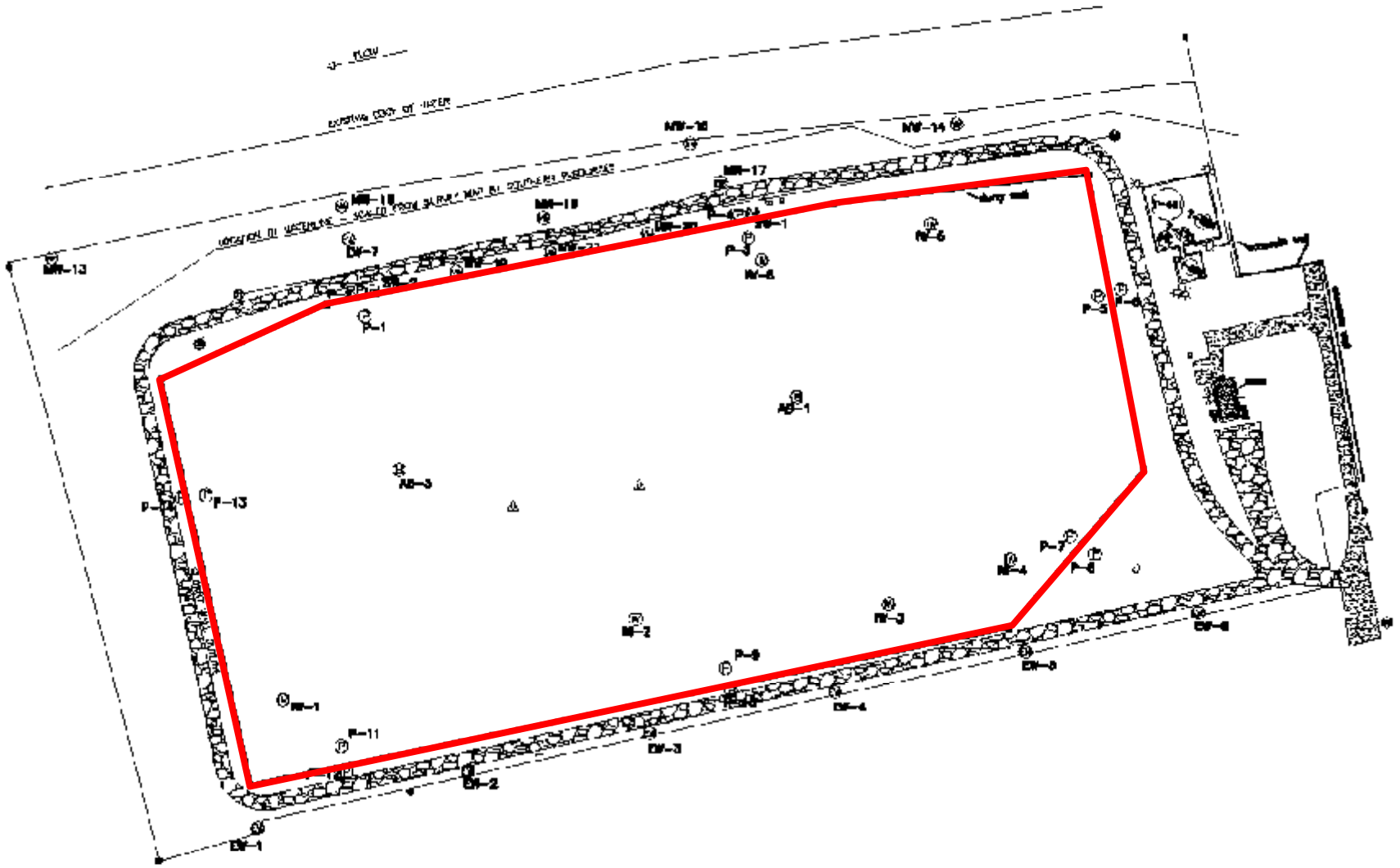
Issue

- **At a former manufacturing site, acidic groundwater appears to be moving from within a slurry wall towards an adjacent river.**

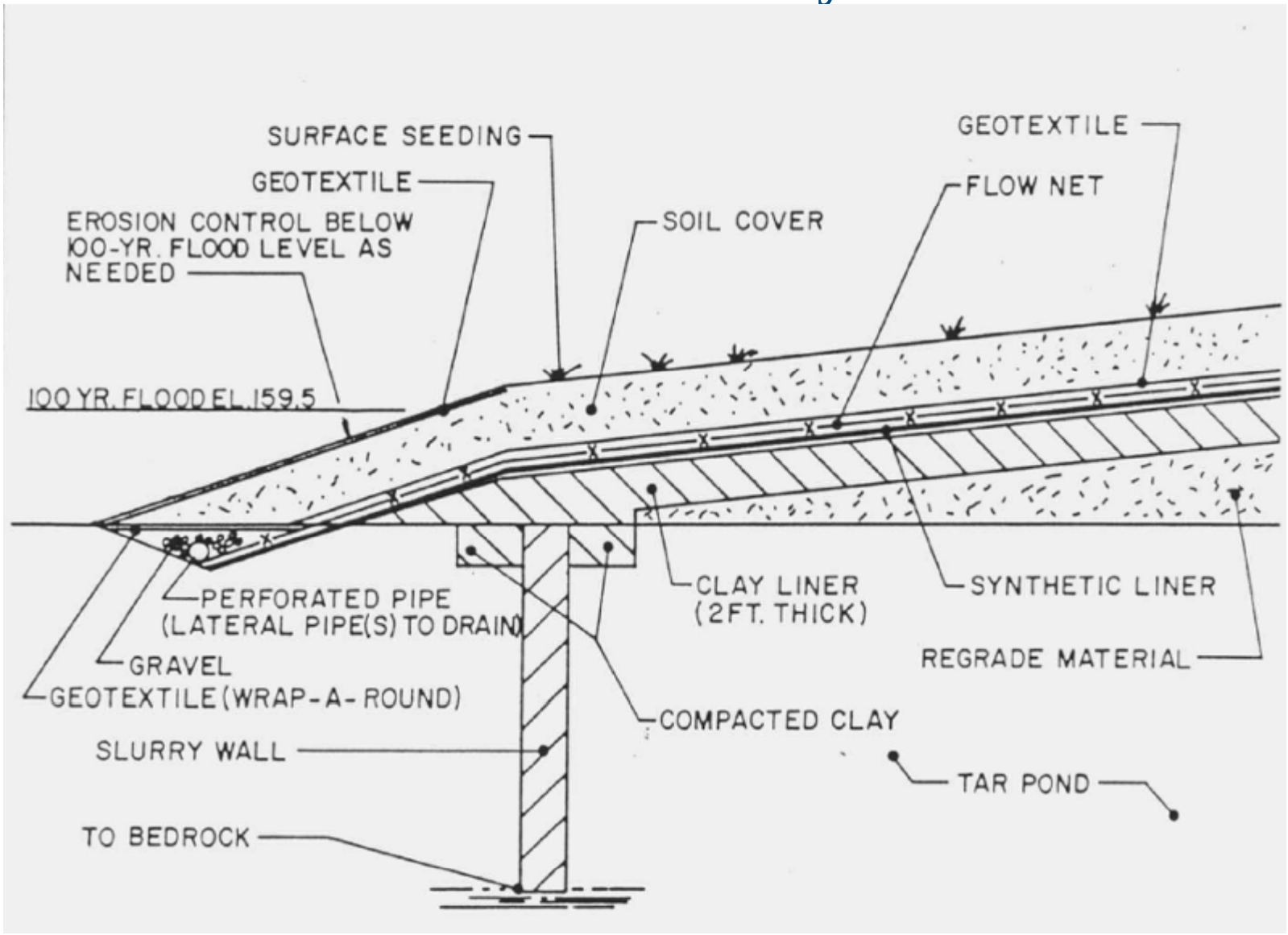
Background Information

- **Tall oil, cresylic acid, and 2,4-dichlorophenoxyacetic acid (2,4-D) have been manufactured.**
- **Tar ponds, present prior to 2,4-D manufacturing operation, were consolidated in a natural ravine.**
- **The third pond was closed in 1987 and underwent a RCRA closure.**
- **Closure included:**
  - Stabilization of the contents
  - Installation of a bentonite slurry wall to bedrock
  - Capping with a low permeability membrane

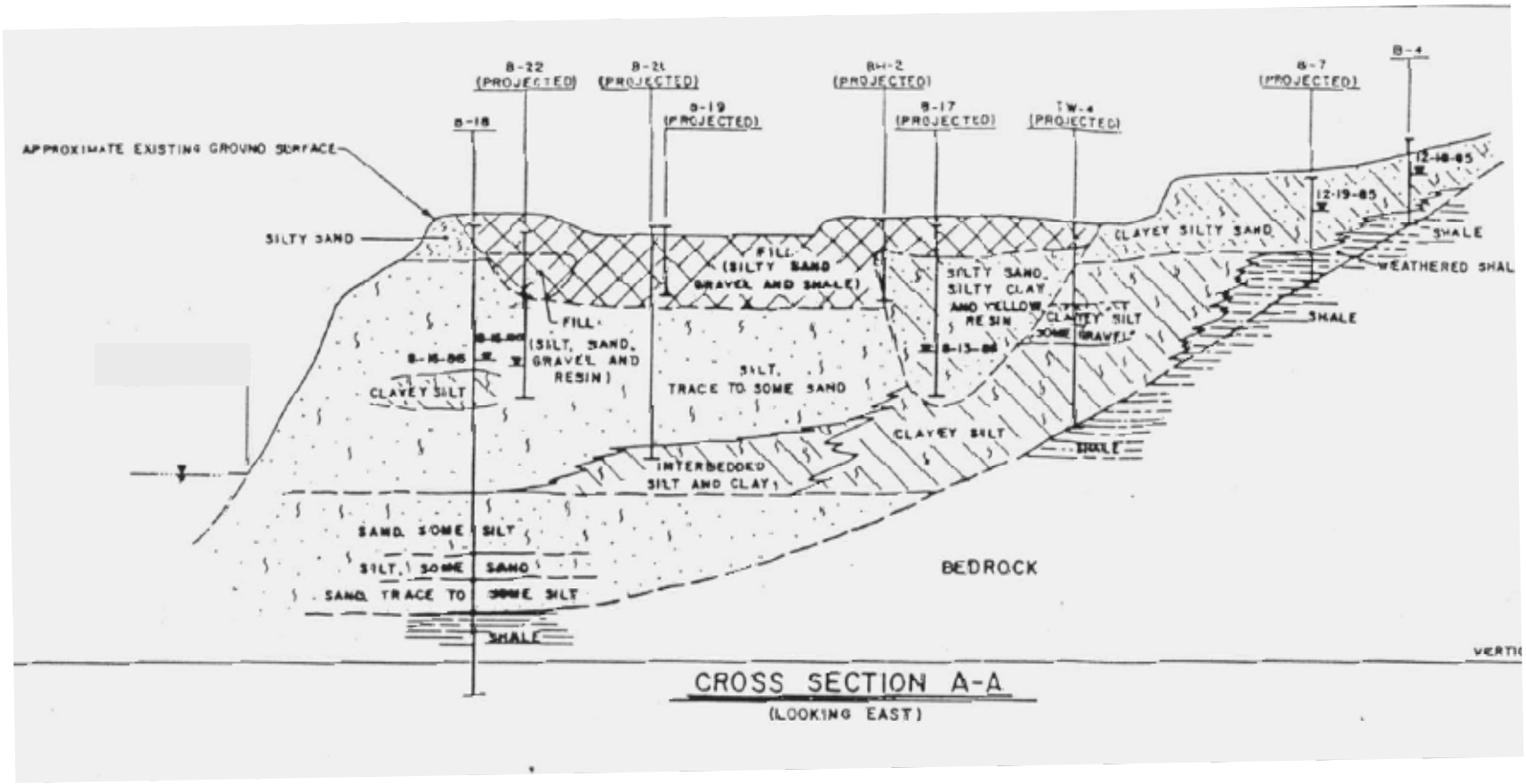
Site Reconnaissance



Profile of the Slurry Wall

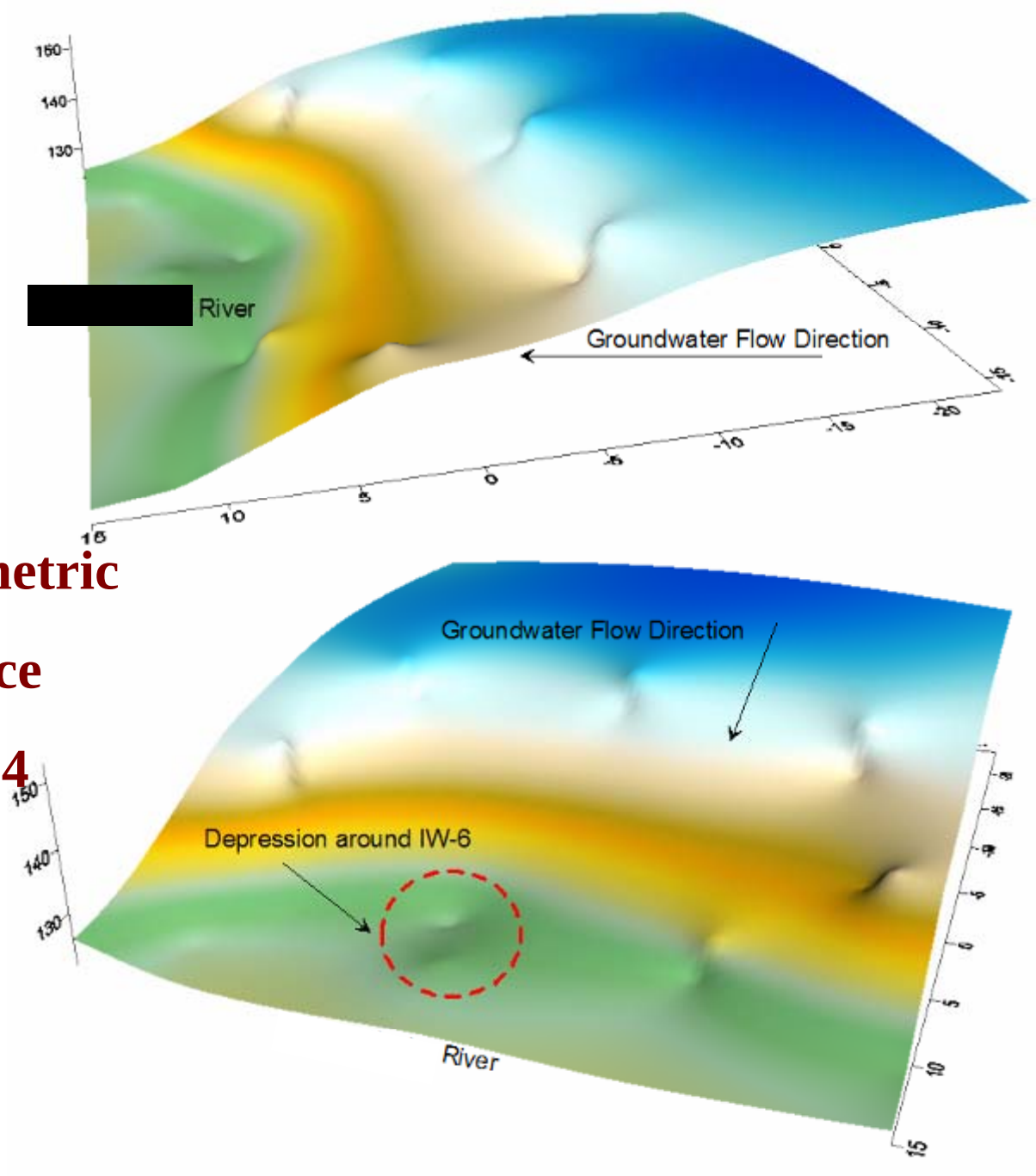


Geologic Cross Section

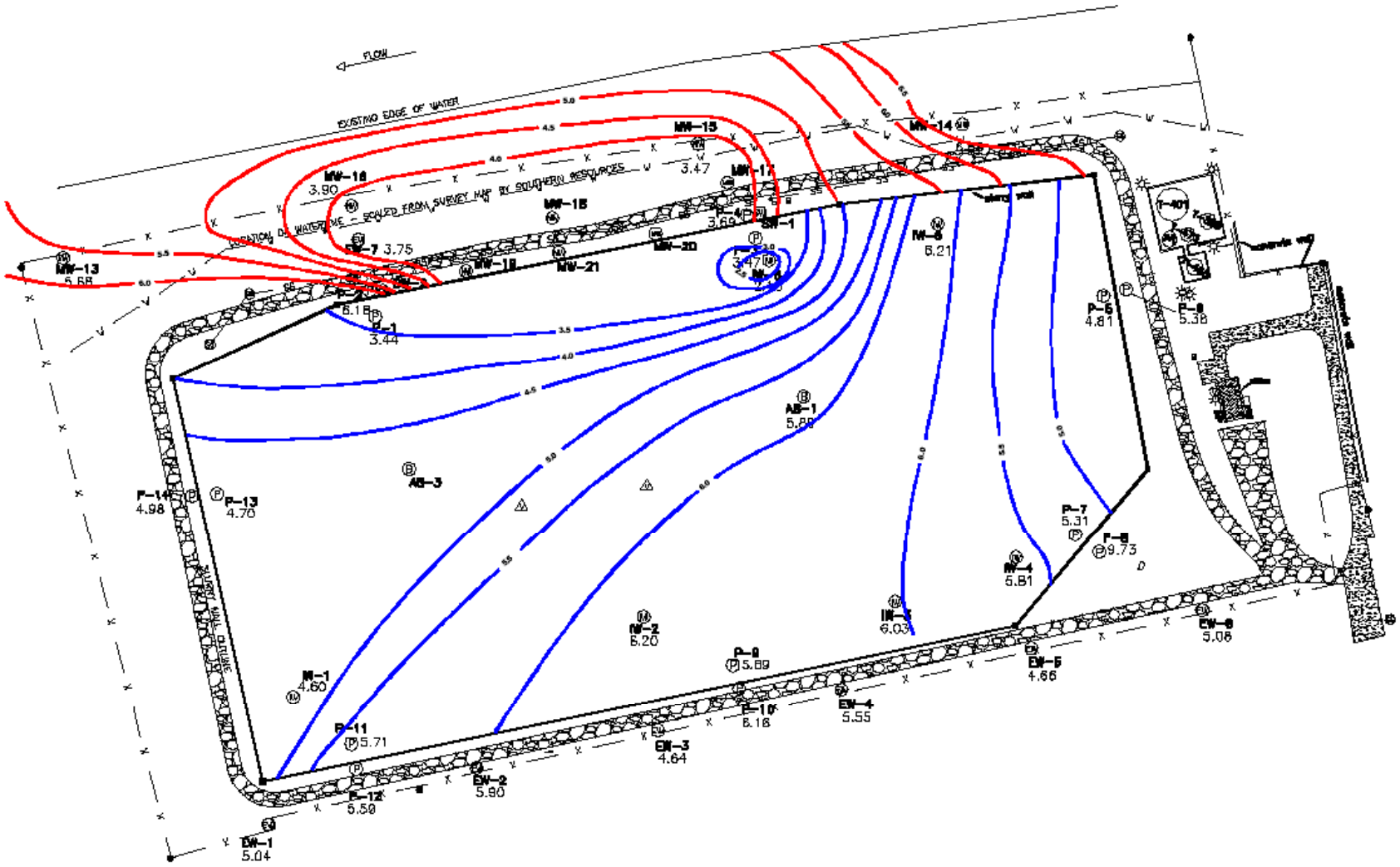


Water Level Measurements

Potentiometric Surface 9/29/04



pH Contours


FLOW
EXISTING EDGE OF WATER
LOCATION OF WATERLINE - SCALED FROM SURVEY MAP BY SOUTHERN RESOURCES
MW-13
5.68
MW-18
3.90
MW-15
3.47
MW-14
MW-17
MW-16
3.75
MW-21
MW-20
3.66
MW-1
6.18
3.44
MW-6
6.21
P-5
4.81
P-6
5.38
AS-1
5.88
AS-3
P-14
4.98
P-13
4.76
P-7
5.31
P-8
9.73
MW-4
5.81
MW-2
5.20
MW-3
6.03
P-9
5.89
EW-6
5.08
EW-5
4.66
MW-1
4.60
P-11
5.71
P-10
6.16
EW-4
5.55
EW-3
4.64
P-12
5.58
EW-2
5.90
EW-1
5.04

Key Analytical Data at Northern Slurry Wall

P-4

pH: 4.0

Acidity: 9,700

Sulfate: 7,500

Iron: 1,500

P-1

pH: 3.4

Acidity: 54,000

Sulfate: 24,000

Iron: 2,000

P-3

pH: 3.5

Acidity: 90,000

Sulfate: 33,000

Iron: 3,300

IW-6

pH: 2.2

Acidity: 27,000

Sulfate: 12,000

Iron: 1,500

Example Problem

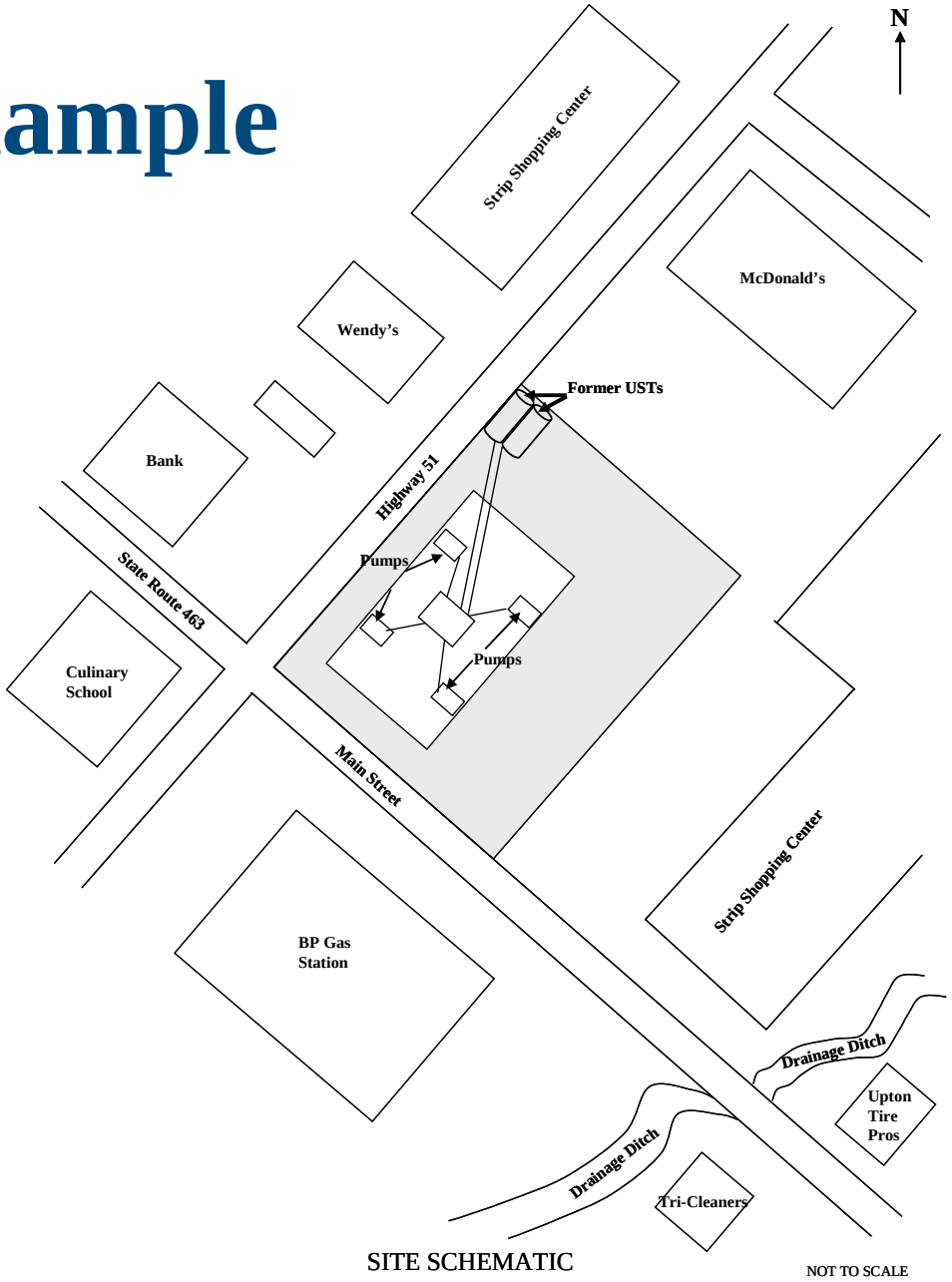
During the removal of two Underground Storage Tanks (USTs) from an abandoned factory, it was noted that acetone and toluene were leaking from one of the USTs. It has been noted over the past couple of months that some odd smells have been coming from the drainage ditch south of the property.

Bedrock approximately = 30 feet bgs

Groundwater approximately = 20 feet bgs

Construct a work plan to determine the potential impacts (if any) on the soils and groundwater within the area. Provide any assumptions.

Site Example



SITE SCHEMATIC

NOT TO SCALE