

# Case Studies

## Leaching Applications



# Overview of Examples



- **Example 1 – Use of Linear Regression**
- **Example 2 – Use of Empirical Data**
- **Example 3 – Use of Empirical Data & Exposure Duration**



# Example 1 – Use of Linear Regression



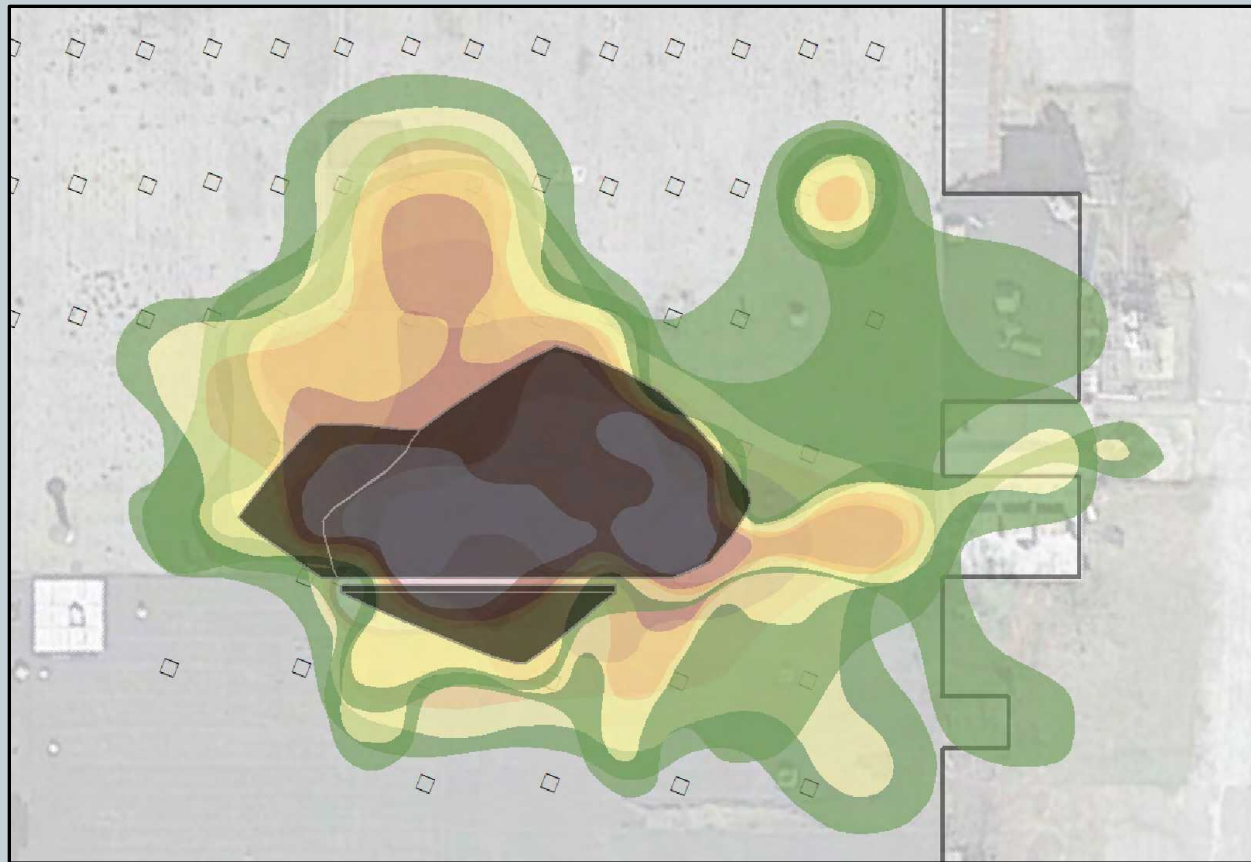
- **More Traditional – More Direct – Age of Release not a factor**
- **Use of SPLP or TCLP to determine leaching threshold**
- **Area of Highest Impacts Known or Unknown?**
- **Totals vs Leaching Test**
- **Leach Highest Totals Concentrations vs. Range of Concentrations (High to Low)**
- **COI do not always behave as hoped...**



# Example 1 – Use of Linear Regression



- Area of Highest Impacts Known (TCE)
- Highest Concentration Failed, Evaluate Range of Concentrations





# Example 1 – Use of Linear Regression

- (1) Plot TCLP results vs. actual respective TCE concentration from which the TCLP analysis was run
- (2) Plot linear line of best fit, show equation
- (3) Solve equation for  $X=5.24$ , which results in TCE concentration that will not leach greater than Type 4 GW RRS. X is the greater of the Type 3 and 4 groundwater RRS, in this case Type 3 groundwater RRS is 5.0, Type 4 is 5.24
- (4) Plug result into column 1a3 (in mg/kg) of Type 4 soil RRS determination worksheet for final Type 4 soil RRS

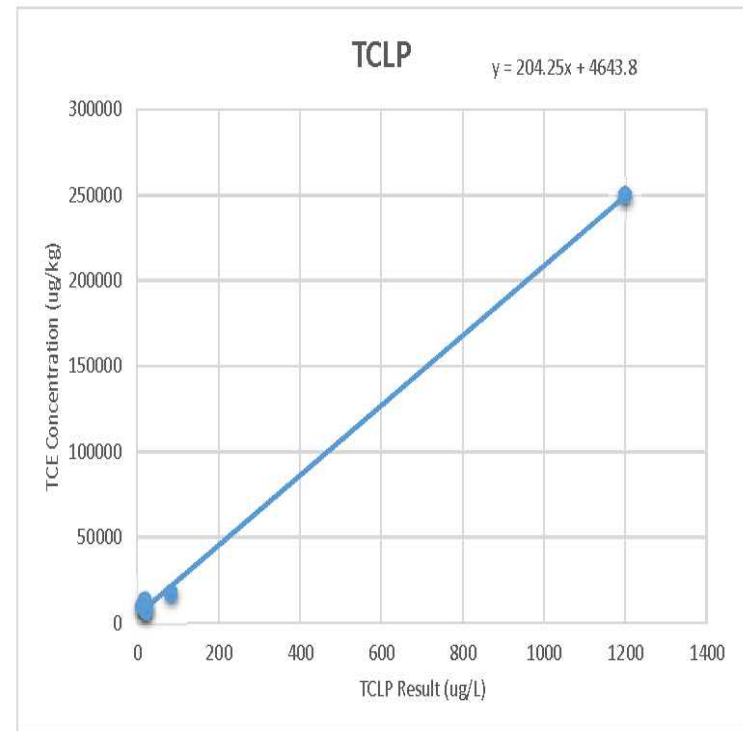
	TCLP Result (ug/L)	TCE Concentration (ug/kg)
UCSB-52 (0-2)	13	9900
UCSB-53 (6-8)	20	13000
UCSB-49 (0-2)	<b>23</b>	<b>7000</b>
UCSB-8 (6-8)	23	8950
UCSB-34 (6-8)	84	17400
UCSB-48 (6-8)	<b>1200</b>	<b>250000</b>

Solve equation for 5.24 ug/L ( $x=5.24$ ), which is the Type 4 GW RRS

5.24

5714

Thus, soils less than or equal to 5714 ug/kg are not predicted to leach in excess of the Type 4 GW RRS



Note: Seven samples were collected for TCLP analysis. One sample had a non-detect result. It was determined to use only results with numerical detections in the derivation to improve accuracy in lieu of including an estimate value. Laboratory results for all totals and TCLP analysis have been attached to this derivation package.

# Example 1 – Use of Linear Regression



## TYPE 4 SOIL RISK REDUCTION STANDARD CALCULATIONS-DETERMINATION

CONSTITUENT	Select Least Concentration					if 2i, 2ii, and 1a3 are NA, Select Highest of 1a1, BG, DL			Type 4 RRS <2 ft	Type 4 RRS >2 ft
	2i (Eq6)	2ii (Eq7)	1a3	IEUBK	GALM	1a1	BG	DL		
VOCs										
Trichloroethene	2.39E+01	7.08E+00	5.71E+00	NA	NA	NA	NA	NA	5.71E+00	5.71E+00

### NOTES:

1a1 is Type 1 Soil Criteria

1a3 is Groundwater Protection Eq. 4-10, or soil concentration that will not generate leachate concentrations that exceed the higher of the Type 3 and 4 groundwater RRS as determined from laboratory testing

IEUBK is Integrated Exposure Uptake Biokinetic Model for Lead in Children, V1.1

GALM is Georgia Adult Lead Model per Georgia Administrative Code, Appendix (391-3-19) IV. GEORGIA ADULT LEAD MODEL

2i is Eq. 6 of the RAGS Part B

2ii is Eq 7 of the RAGS Part B

BG is background concentration

DL is laboratory detection limit

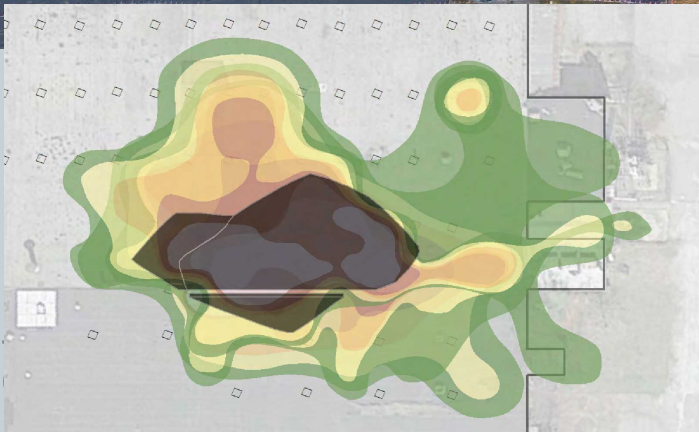
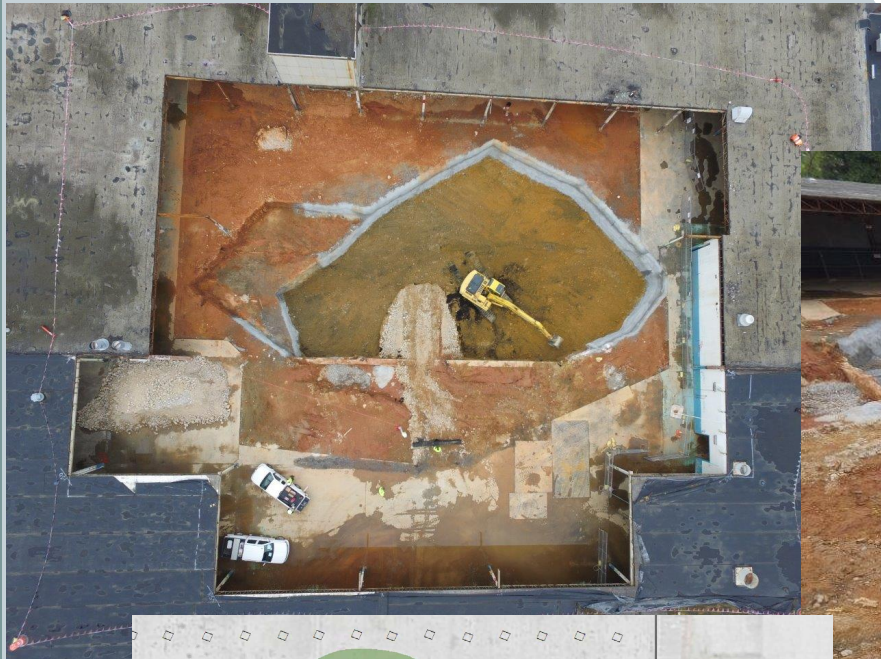
NA indicates value not available or not applicable

All results are in milligrams per kilogram (mg/Kg)

**Type 3 = 0.5 mg/kg**  
**Type 4 = 5.714 mg/kg**



# Example 1 – Use of Linear Regression





# Example 2 – Use of Empirical Data



- Use of Empirical Data to Eliminate the Leachate Pathway
- Important Factors:
  - Age of the Release : 70 – 100 years
    - ✓ Knowledge of Site History – Photos, Etc.
  - Good Groundwater Data
    - ✓ 10 monitoring wells
    - ✓ Right position relative to impacted material
    - ✓ More than 1 sampling event could be required
- 873 page submittal with empirical data – Old and New

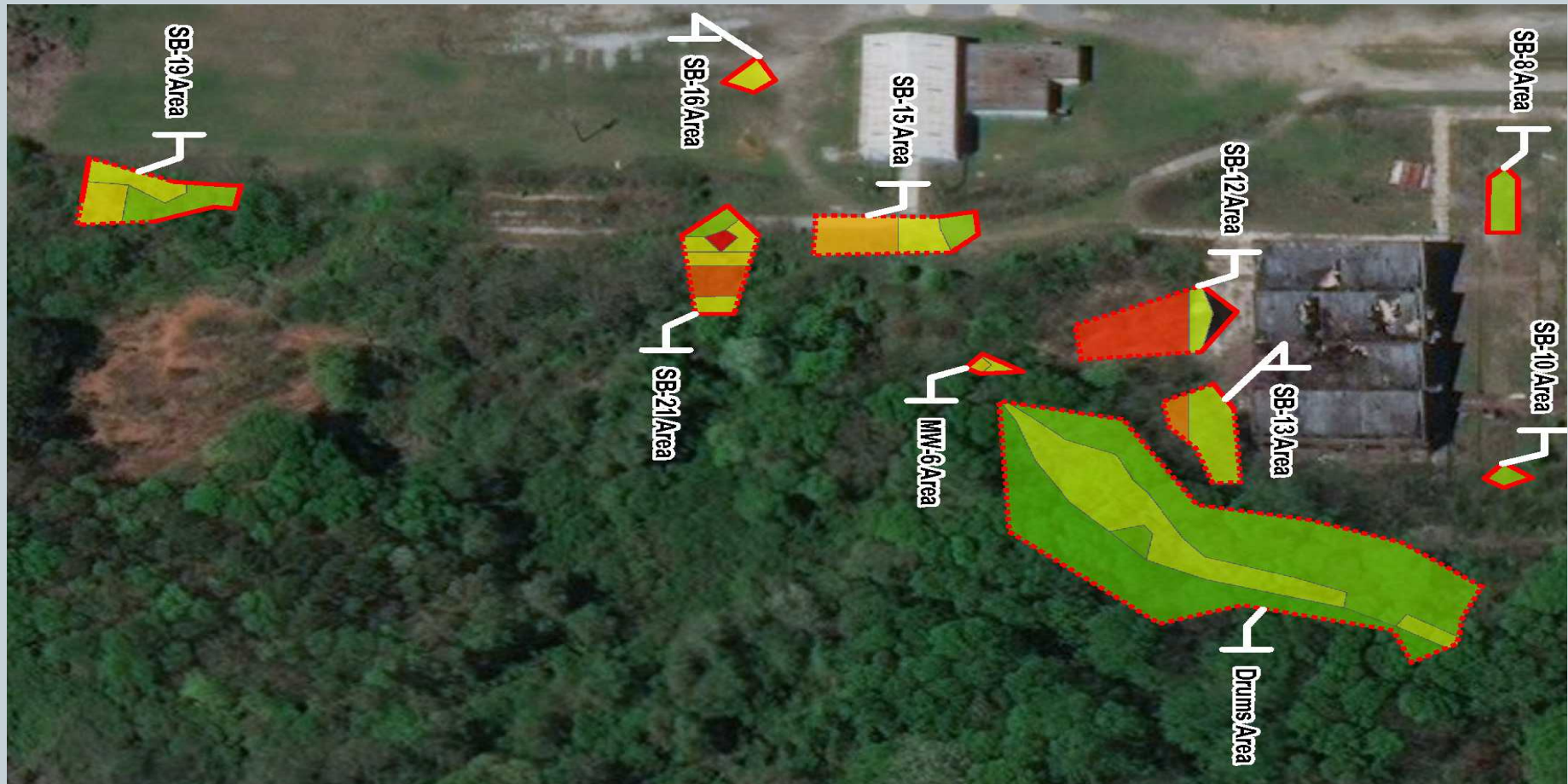




# Example 2 – Use of Empirical Data

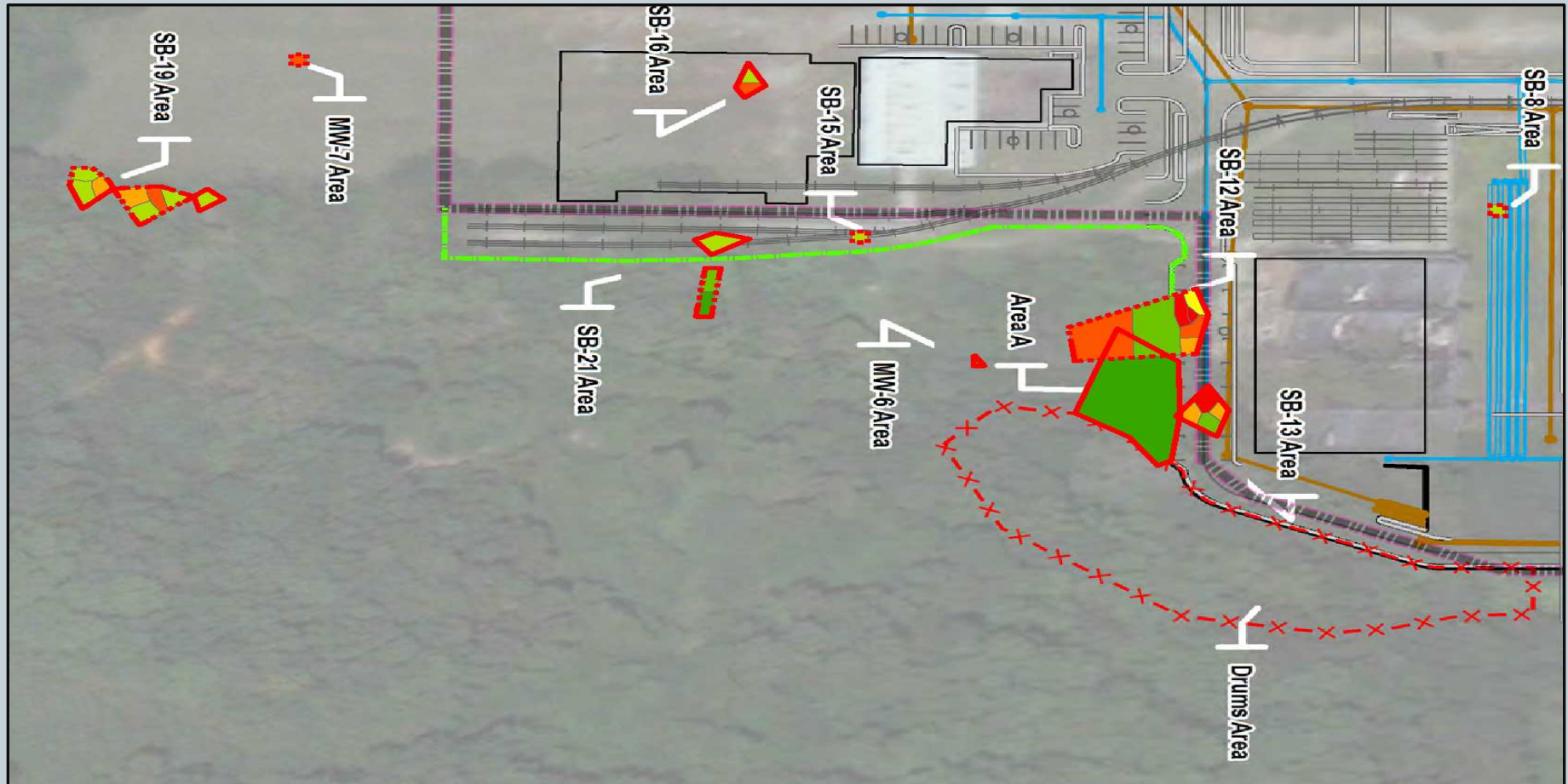


Lead driver – Original RRS = 270 and 400 mg/kg



# Example 2 – Use of Empirical Data

Lead driver – New RRS = 1050 and 1278 mg/kg



# Example 2 – Use of Empirical Data



## TYPE 2 SOIL RISK REDUCTION STANDARD CALCULATIONS-DETERMINATION

Type 2 RRS-Select Lowest Concentration								
		Carcinogenic	Non-carcinogenic		Groundwater Protection Via:			
			Adult	Child	SPLP	Leaching Model	IEUBK	TYPE 2 RRS
		(mg/kg)	(mg/kg)	(mg/kg)		(mg/kg)	(mg/kg)	(mg/kg)
<b>METALS</b>								
Barium	7440-39-3	NA	1.35E+05	1.53E+04	NA	3.11E+03	NA	3.11E+03
Chromium (III)	16065-83-1	NA	1.25E+06	1.17E+05	NA	8.09E+08	NA	1.17E+05
Chromium (VI)	18540-29-9	3.01E+00	2.46E+03	2.34E+02	NA	NA	NA	3.01E+00
Lead	7439-92-1	NA	NA	NA	NA	NA	418	4.18E+02
<b>SVOCs</b>								
Benzo(a)pyrene	50-32-8	1.15E+00	1.53E+02	1.78E+01	NA	5.89E+00	NA	1.15E+00
Benzo(b)fluoranthene	205-99-2	1.15E+01	NA	NA	NA	6.01E+01	NA	1.15E+01
Chrysene	218-01-9	1.15E+03	NA	NA	NA	1.81E+03	NA	1.15E+03

### NOTES:

IEUBK is Integrated Exposure Uptake Biokinetic Model for Lead in Children, V1.1

For those substances for which none of the concentrations can be calculated, the highest of concentrations in Table 2 of Appendix III, background concentrations, or detection limit concentrations.

If Equation 4-10/Leaching Model not excluded due to empirical data, Type 2 RRS = 270 mg/kg



# Example 2 – Use of Empirical Data



## TYPE 4 SOIL RISK REDUCTION STANDARD CALCULATIONS-DETERMINATION

	Groundwater Protection Via Greater of:		Commercial/Industrial Worker		Excavation Worker		ALM (Surface Soils)	ALM (Subsurface Soils)	Surface Soils TYPE 4 RRS	Subsurface Soils TYPE 4 RRS
	Greater of Type 3 or 4 Groundwater Criteria	Laboratory Method	Carcinogenic	Non-carcinogenic	Carcinogenic	Non-carcinogenic				
	(mg/kg)	(mg/kg)	(mg/kg)		(mg/kg)					
RCRA METALS (mg/kg)										
Chromium (VI)	NA	NA	6.33E+01	3.48E+03	9.43E+02	1.70E+03	NA	NA	6.33E+01	9.43E+02
Lead	NA	NA	NA	NA	NA	NA	1050	1278	1.05E+03	1.28E+03
SVOCs (mg/kg)										
Benzo[a]pyrene	7.69E+01	NA	2.11E+01	2.22E+02	3.36E+02	7.14E+01	NA	NA	2.11E+01	7.14E+01
NOTES:										
ALM is EPA Adult Lead Model										
For those substances for which none of the concentrations can be calculated, the highest of concentrations in Table 2 of Appendix III, background concentrations, or detection limit concentrations.										
Groundwater Protection applies to entire soil column.										
Surface Soils are defined as soils within 1 foot of ground surface. Surface Soils Type 4 RRS determined as the lower of the groundwater protection value and the commercial/industrial worker values.										
Subsurface Soils are defined as soils greater than 1 ft in depth. Subsurface Soils Type 4 RRS determined as the lower of the groundwater protection value and the excavation worker values.										

If Leaching Model not excluded due to empirical data, Type 4 RRS = 400 mg/kg



# Example 3 – Use of Empirical Data & Exposure Duration



- Use of Empirical Data to Eliminate the Leachate Pathway
- Important Factors:
  - Age of the Release : >45 years
    - ✓ Knowledge of Site History – Historical Topo
  - Good Groundwater Data
    - ✓ Right position relative to impacted material
    - ✓ More than 1 sampling event could be required
- Reduction in Exposure Duration 90day to 30day
- Submittal with empirical data – Old and New



# Example 3 – Use of Empirical Data & Exposure Duration



1957 Topographic Map

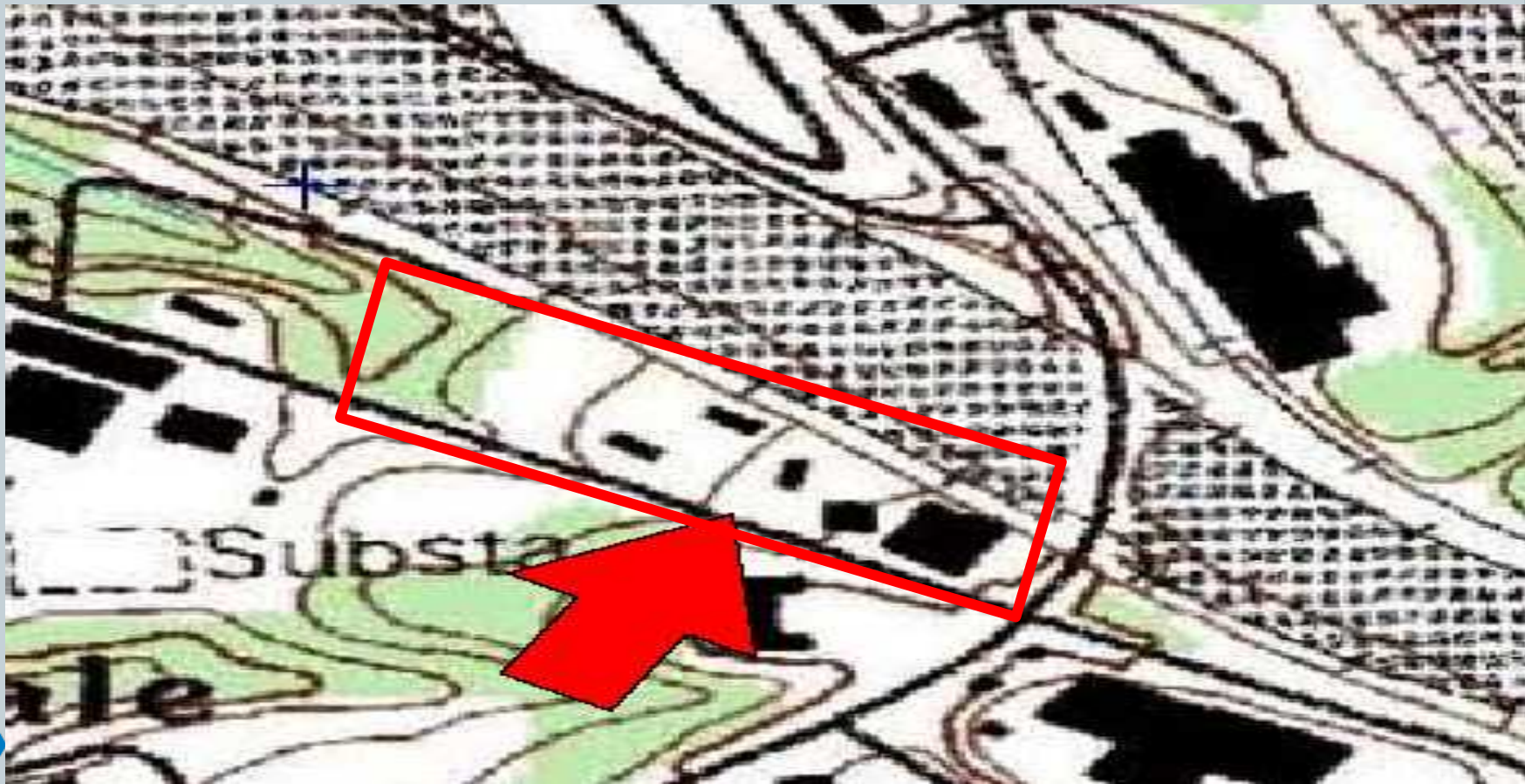




# Example 3 – Use of Empirical Data & Exposure Duration

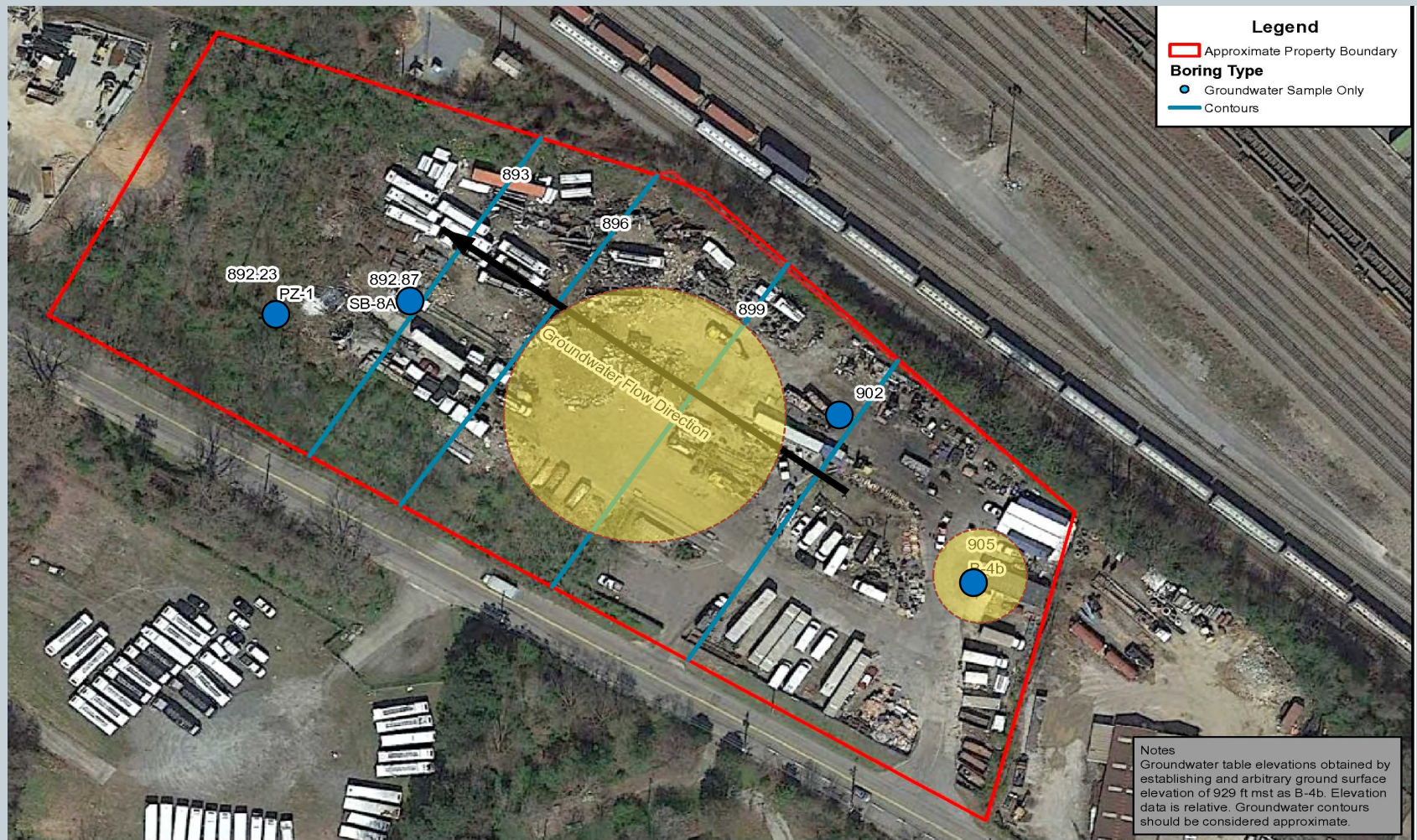


## 1995 Topographic Map





# Example 3 – Use of Empirical Data & Exposure Duration





# Example 3 – Exposure Duration



## Adult Lead Model (ALM) for Commercial/Industrial Worker (Surface Soils)

Parameters	PbB	PbB <sub>fetal,0.95</sub>	R <sub>fetal/maternal</sub>	BKSF	GSD <sub>i</sub>	PbB <sub>o</sub>	IRs	AF <sub>s,D</sub>	EF <sub>s,D</sub>	AT <sub>s,D</sub>	Cs
Units	µg/dL	µg/dL	unitless	(µg/dL) / (µg/day)	unitless	µg/dL	g/day	unitless	days/yr	days/yr	mg/kg
Value	2.11	5	0.9	0.4	1.8	0.6	0.05	0.12	219	365	1050
<p>NOTES:</p> $PbB = \frac{PbB_{fetal,0.95}}{R_{fetal/maternal} \cdot GSD_i^{1.645}}$ $C_s = \frac{[(PbB - PbB_o) * (IR_s * AF_{s,D})^{-1}]}{BKSF * (EF_{s,D} / AT_{s,D})}$											

## Site-Specific Adult Lead Model (ALM) for Excavation Worker (Subsurface Soils)

Parameters	PbB	PbB <sub>fetal,0.95</sub>	R <sub>fetal/maternal</sub>	BKSF	GSD <sub>i</sub>	PbB <sub>o</sub>	IRs	AF <sub>s,D</sub>	EF <sub>s,D</sub>	AT <sub>s,D</sub>	Cs
Units	µg/dL	µg/dL	unitless	(µg/dL) / (µg/day)	unitless	µg/dL	g/day	unitless	days/yr	days/yr	mg/kg
Value	2.11	5	0.9	0.4	1.8	0.6	0.10	0.12	30	365	3834
<p>NOTES:</p> $PbB = \frac{PbB_{fetal,0.95}}{R_{fetal/maternal} \cdot GSD_i^{1.645}}$ $C_s = \frac{[(PbB - PbB_o) * (IR_s * AF_{s,D})^{-1}]}{BKSF * (EF_{s,D} / AT_{s,D})}$											



# Example 3 – Use of Empirical Data & Exposure Duration



Lead driver – RRS = 1050(219 days) and 3,830 (30 days) mg/kg  
Requires documentation of exposure

## TYPE 4 SOIL RISK REDUCTION STANDARD CALCULATIONS-DETERMINATION

	Groundwater Protection Via Greater of:		Commercial/Industrial Worker		Excavation Worker		ALM (Surface Soils)	ALM (Subsurface Soils)	Surface Soils TYPE 4 RRS	Subsurface Soils TYPE 4 RRS
	Greater of Type 3 or 4 Groundwater Criteria	Laboratory Method	Carcinogenic	Non-carcinogenic	Carcinogenic	Non-carcinogenic				
	(mg/kg)	(mg/kg)	(mg/kg)		(mg/kg)					
RCRA METALS (mg/kg)										
Lead	NA	NA	NA	NA	NA	NA	1050	3834	1.05E+03	3.83E+03
VOCs (mg/kg)										
Benzene	2.06E-01	NA	5.08E+01	4.23E+02	3.98E+02	1.76E+02	NA	NA	2.06E-01	2.06E-01
SVOCs (mg/kg)										
Benzo[a]pyrene	7.69E+01	NA	2.11E+01	2.22E+02	3.36E+02	7.14E+01	NA	NA	2.11E+01	7.14E+01

### NOTES:

ALM is EPA Adult Lead Model

For those substances for which none of the concentrations can be calculated, the highest of concentrations in Table 2 of Appendix III, background concentrations, or detection limit concentrations.

Groundwater Protection applies to entire soil column.

Surface Soils are defined as soils within 1 foot of ground surface. Surface Soils Type 4 RRS determined as the lower of the groundwater protection value and the commercial/industrial worker values.

Subsurface Soils are defined as soils greater than 1 ft in depth. Subsurface Soils Type 4 RRS determined as the lower of the groundwater protection value and the excavation worker values.

# Contact Information



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