



GEORGIA
DEPARTMENT OF NATURAL RESOURCES

ENVIRONMENTAL PROTECTION DIVISION

Mock Pre-Meeting: Area-Averaging

May 2023



SITE HISTORY

Five-acre former wood preserving site. Operated from mid 1970 through 1990's.

Soil contamination: Copper, total Chromium, Lead, and Arsenic

1. Groundwater has not been impacted and meets Type 1 RRS.



Surface Soil Concentrations Comparison to Industrial Risk Reduction Standards

Analyte	Maximum Detected Concentration (mg/kg)	Type 3 Risk Reduction Standard* (mg/kg)	Type 4 Risk Reduction Standard** (mg/kg)
Arsenic	342	20	5.94
Copper	889	920	NA
Chromium	2600	1200	--
Chromium, hexavalent	--	--	2.18
Lead	2400	400	270

-- No Value / Incalculable

NA- Not Applicable

* Type 3 RRS calculated in accordance with Rules and Regulations of the State of Georgia, Subject 391-3-19-.07.

** Type 4 RRS calculated in accordance with Rules and Regulations of the State of Georgia, Subject 391-3-19-.07, which incorporates the direct and leaching pathways.



AREA-AVERAGING METHOD

Concentrations in Soil Exceed Industrial RRS

Certify to Type 4 RRS

Determine Decision Units

Non-residential

Site Specific

Based on Exposure Area

Derive Exposure Point Concentrations (EPC)

Removal Management Levels/Hot Spots/Outliers

95% Upper Confidence Limit

Lead: Arithmetic Mean

Demonstrate that soil EPCs are do not exceed Type 4 RRS.

EPCs comparison to Type 4 RRS

Citation: Georgia Environmental Protection Division, Area Averaging Approach to Soil Compliance for Direct Contact Exposure Scenarios, December 15, 2020



Determining Decision Units

Green Dot- Less than Type 1 RRS
Orange Dot- Greater than Type 3 RRS
Red Dot- Exceeds Removal
Management Level (RML)
Blue Outline- Decision Unit
Yellow Line- Property Boundary
Red Cross Hatch- Excavated





DETERMINING EXPOSURE POINT CONCENTRATIONS: RML/HOT SPOTS/OUTLIERS

Sample Location:	Arsenic	Chromium	Lead
SB-01	342	2600	2400
SB-02	38	1289	2210
SB-03	39	1255	2140
SB-04	42	1244	1470
SB-05	39	1356	1265
SB-06	36	65	1212
SB-07	21	78	1245
SB-08	18	98	274
SB-09	16	23	269
SB-10	18	3	287
SB-11	17	11	274
SB-12	11	25	305
SB-13	3	22	314
SB-14	25	24	384
SB-15	29	14	321
SB-16	25	6	289
SB-17	22	21	275
SB-18	12	4	284
SB-19	13	8	211
SB-20	6	12	254

Units: mg/kg

Dark Red: Exceeds RML and/or considered an outlier

Light Red: Excavated due to other constituents' exceedances

* RML for Lead has not been adopted by EPD

Removal Management Level (RML) (mg/kg)	
Arsenic	300
Chromium, hexavalent	633
Lead *	800

Outliers

Arsenic

For 10% significance level, 342 is an outlier.

For 5% significance level, 342 is an outlier.

For 1% significance level, 342 is an outlier.

Chromium

For 10% significance level, 2600 is an outlier.

For 5% significance level, 2600 is an outlier.

For 1% significance level, 2600 is not an outlier.

Lead

For 10% significance level, 2400 is not an outlier.

For 5% significance level, 2400 is not an outlier.

For 1% significance level, 2400 is not an outlier.



Difference in EPCs with Different Data Sets

Constituent	All Data	Replace with Half Detection Limit*	Eliminated Sample Data
Arsenic	65.89	17.87	22.07
Chromium	689.5	39.64	47.62
Lead	784.2	337.1	413.2

All Data

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SB-17	22	21	275
SB-18	12	4	284
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SB-20	6	12	254

Replace Excavated Data with ½ Detection Limit

Sample Location:	Arsenic	Chromium	Lead
SB-01	0.25	0.5	0.25
SB-02	0.25	0.5	0.25
SB-03	0.25	0.5	0.25
SB-04	0.25	0.5	0.25
SB-05	0.25	0.5	0.25
SB-06	36	65	1500
SB-07	21	78	1499
SB-08	18	98	274
SB-09	16	23	269
SB-10	18	3	287
SB-11	17	11	274
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Eliminated Sample Data

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SB-16	25	6	289
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SB-19	13	8	211
SB-20	6	12	254

Citations:

* USEPA. Contract Laboratory Program. Statement of Work for Superfund Analytical Methods, May 2019. Table 5. ICP-AES AND ICP-MS Target Analyte List and Contract Required Quantitation Limits

USEPA. ProUCL: Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations. Version 5.2. <https://www.epa.gov/land-research/proucl-software>, 2022.



DETERMINING EXPOSURE POINT CONCENTRATIONS

Arsenic

Nonparametric Distribution Free UCLs			
95% CLT UCL	17.67	95% BCA Bootstrap UCL	17.54
95% Standard Bootstrap UCL	17.64	95% Bootstrap-t UCL	18.06
95% Hall's Bootstrap UCL	17.83	95% Percentile Bootstrap UCL	17.55
90% Chebyshev(Mean, Sd) UCL	20.96	95% Chebyshev(Mean, Sd) UCL	24.27
97.5% Chebyshev(Mean, Sd) UCL	28.86	99% Chebyshev(Mean, Sd) UCL	37.88
Suggested UCL to Use			
95% Student's-t UCL	17.87		

Chromium

Nonparametric Distribution Free UCLs			
95% CLT UCL	30.98	95% BCA Bootstrap UCL	33.7
95% Standard Bootstrap UCL	30.74	95% Bootstrap-t UCL	37.56
95% Hall's Bootstrap UCL	34.11	95% Percentile Bootstrap UCL	31.33
90% Chebyshev(Mean, Sd) UCL	39.34	95% Chebyshev(Mean, Sd) UCL	47.73
97.5% Chebyshev(Mean, Sd) UCL	59.38	99% Chebyshev(Mean, Sd) UCL	82.25
Suggested UCL to Use			
95% Adjusted Gamma UCL	39.64		

Lead

General Statistics			
Total Number of Observations	20	Number of Distinct Observations	15
		Number of Missing Observations	0
Minimum	0.25	Mean	337.1
Maximum	1500	Median	274.5
SD	418.1	Std. Error of Mean	93.48
Coefficient of Variation	1.24	Skewness	2.358



Surface Soil EPC Comparison to Type 4 RRS- Direct Contact Only

Analyte	Exposure Point Concentration (mg/kg)	Type 4 Risk Reduction Standard* (mg/kg)
Arsenic	17.87	30
Chromium	39.64	--
<i>Chromium, hexavalent</i>	--	63
Lead	337.7	1,050**

-- No Value / Incalculable

* Type 4 RRS calculated in accordance with Rules and Regulations of the State of Georgia, Subject 391-3-19-.07. The soil to groundwater pathway was demonstrated as incomplete. RRS based on direct contact only.

** Derived using the Adult Lead Model using standard central tendency industrial exposure parameters



CUMULATIVE RISK

Arsenic and Chromium (VI)

Chemical	Concentration (mg/kg)	Ingestion Risk	Dermal Risk	Inhalation Risk	Carcinogenic Risk	Ingestion HQ	Dermal HQ	Inhalation HQ	Noncarcinogenic HI
Arsenic, Inorganic	1.70E+01	4.66E-06	9.87E-07	4.37E-09	5.66E-06	2.90E-02	6.14E-03	1.90E-04	3.54E-02
Chromium(VI)	3.96E+01	6.06E-06	-	2.00E-07	6.26E-06	1.13E-02	-	6.66E-05	1.14E-02
*Total Risk/HI	-	1.07E-05	9.87E-07	2.04E-07	1.19E-05	4.03E-02	6.14E-03	2.56E-04	4.67E-02

Adult Lead Model

Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009-2014
Soil lead concentration	µg/g or ppm	310
Fetal/maternal PbB ratio	--	0.9
Biokinetic Slope Factor	µg/dL per µg/day	0.4
Geometric standard deviation PbB	--	1.8
Baseline PbB	µg/dL	0.6
Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050
Total ingestion rate of outdoor soil and indoor dust	g/day	--
Weighting factor; fraction of IR _{s+p} ingested as outdoor soil	--	--
Mass fraction of soil in dust	--	--
Absorption fraction (same for soil and dust)	--	0.12
Exposure frequency (same for soil and dust)	days/yr	219
Averaging time (same for soil and dust)	days/yr	365
PbB of adult worker, geometric mean	µg/dL	1.0
95th percentile PbB among fetuses of adult workers	µg/dL	2.5
Target PbB level of concern (e.g., 2-8 µg/dL)	µg/dL	5.0
Probability that fetal PbB exceeds target PbB, assuming lognormal distribution	%	0.2%

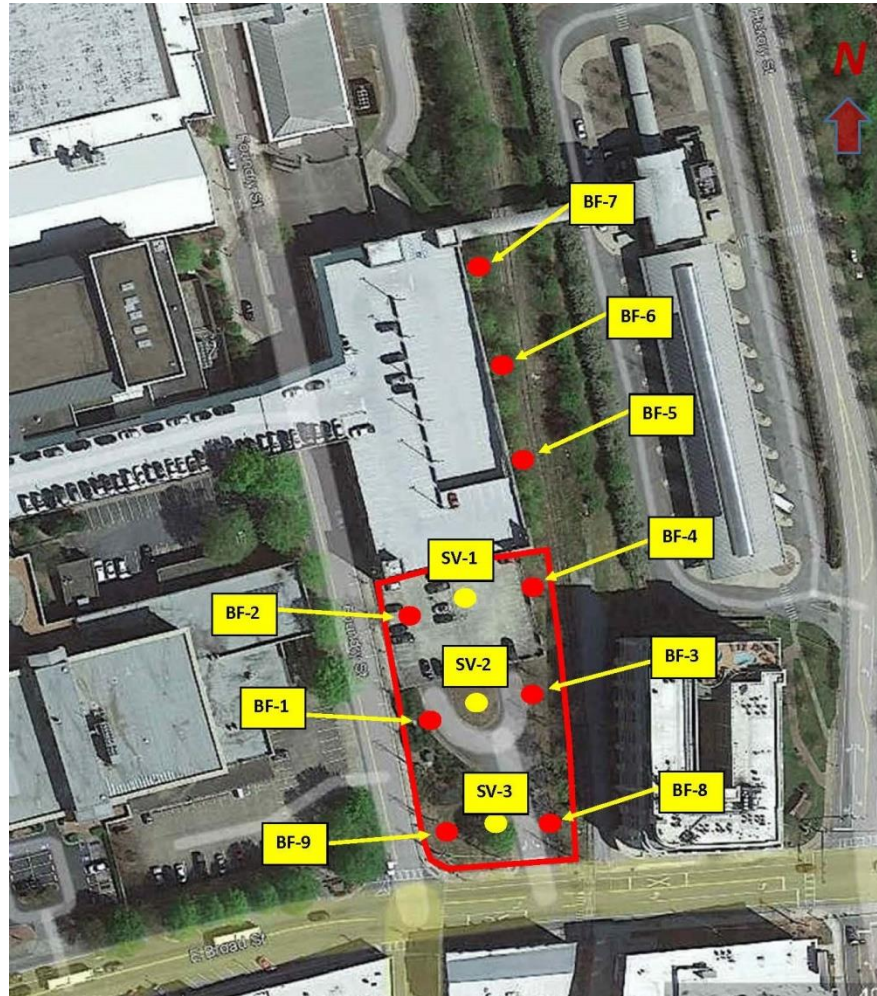
Citations:

USEPA, Regional Screening Levels Calculator: https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search

USEPA, Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil, January 2003



HOW TO HANDLE TOO MANY NON-DETECTS



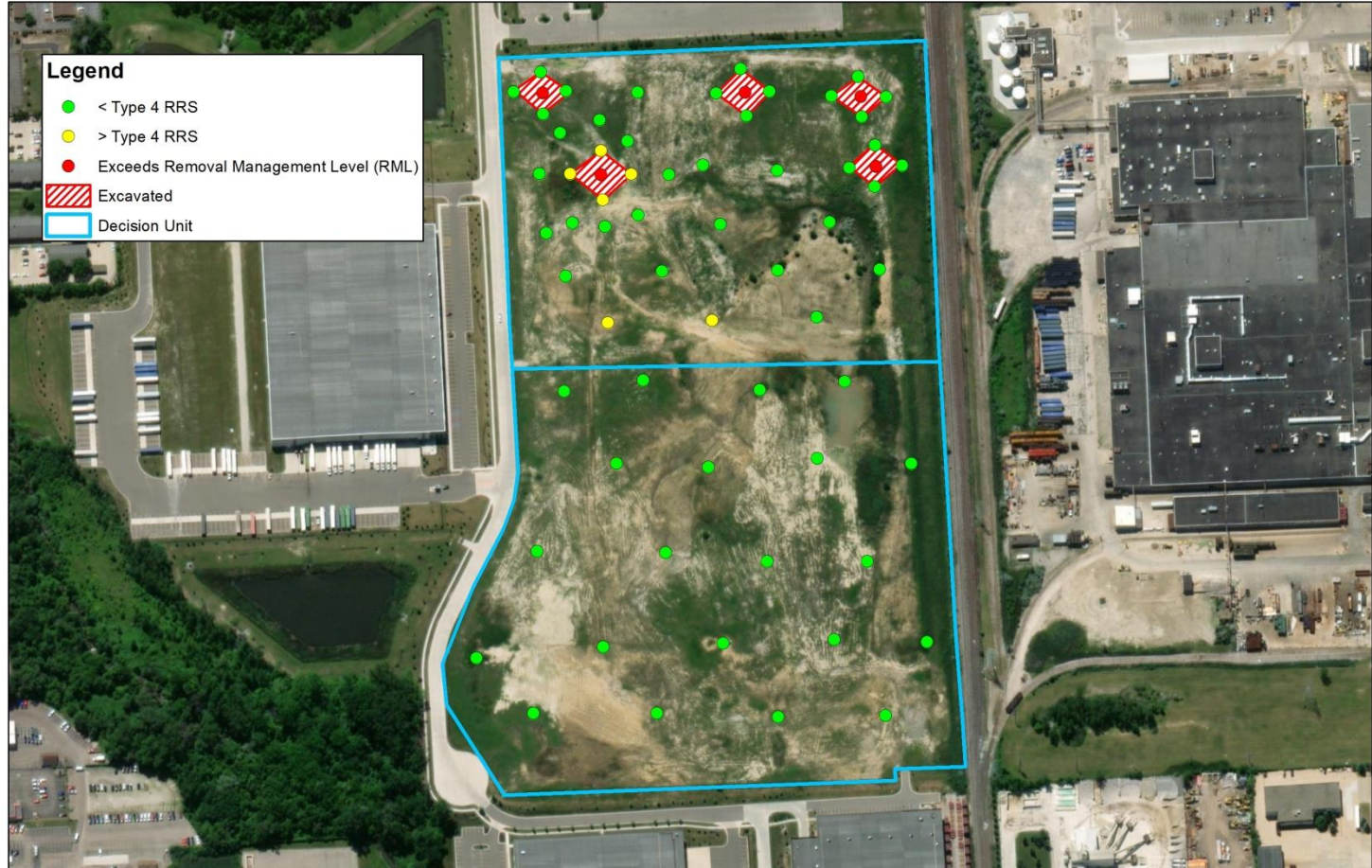


DECISION UNITS





DECISION UNITS





TECHNICAL GUIDANCE DOCUMENT

Frequently Asked Questions Evaluating the Soil-to-Groundwater Migration Pathway

<https://epd.georgia.gov/about-us/land-protection-branch/land-protection-branch-technical-guidance>



COMMON MISTAKES/ISSUES

- **Comparing area averaging EPCs to Type 1 and/or 3 RRS**
- **Not having a sufficient data set**
- **Not determining whether there are more than one statistical population in the data set**
- **Not checking for outliers or hot spots**
- **After determining that the site area average EPC is below Type 2 or 4 RRS, not determining whether the site meets a cumulative cancer risk of $1E-05$ or an HI or 1**
- **Including all samples in the data sets**
- **When duplicate samples are taken, using the lower of the concentrations for that data point**
- **Removing hot spots from the data set, but not stating what will happen with those areas in the document.**



HELPFUL GUIDELINES

- **Calculate Type 2 or 4 RRS for your site**
- **Compare site-wide concentrations to the Type 2 or 4 RRS.**
 - ⑩ Are concentrations below Type 2 or 4 RRS?
 - ⑩ How many exceed? Are they just over or significant over the RRS?
- **Input entire data set into ProUCL**
 - ⑩ Determine the number of populations in the data set – each population should be evaluated separately
 - ⑩ Determine if there are outliers in the data set
 - ⑩ Determine if any concentrations in the data set exceed constituent-specific concentrations set at a cancer risk of $1E-04$ or an HQ of 3.



Questions