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ENVIRONMENTAL SOIL AND GROUNDWATER SAMPLING

Procedures for Collecting Representative Data during Site Assessment Field Work

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SOIL SAMPLING

Current Methodology and Key Factors for Success

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CONCEPTUAL SITE MODEL (CSM)

KG0

CSM Development

- Physical Setting, Current Uses at and Surrounding Property
- Current and Historical Records Review
- Radius Search (government databases)
- Local, state or county records regarding environmental cleanups
- Municipal File Review
- Site Reconnaissance
- Interviews
- Conclusions

Objectives

- Research upfront
- Build a CSM first
- Site reconnaissance follows current and historical research (know what to look for)
- Interviews follow site visit (know what to ask)
- Analytical data drives further CSM development (Phase II ESA)

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SOIL SAMPLE COLLECTION

Planning for Assessment

- Site Access
- Spatial and Overhead Concerns
- Utility Concerns
- Damage from Equipment Treads
- Sensitive Receptor Areas
- Property Restoration

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SURFACE SOIL SAMPLING

Methods and Equipment

- Soil Sampling Accessibility
  - Utility Concerns
  - Minimal Site Disturbance
  - Precise Soil Sampling
- Bucket Auger
  - Extensions Available
- Dutch Auger
  - Easy collection of soil in heavily ro
    areas
  - Good for both hard or wet soils
- Hand Trowel

(AMS, 2025)

(Amazon, 2025)

(PALMS Environmental, 2025)

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SUBSURFACE SOIL SAMPLING

Excavators

- Best Visibility Option
- Best Method for Evaluating Fill
- Bladed Bucket versus Toothed Bucket

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SUBSURFACE SOIL SAMPLING

Flush Joint Casing (FJC)
Drill Rig (Drive and Wash)

- "Cased" boring advanced with hammer
- Split Spoon Samplers
- 24" Sampler Hammered into the Ground
- Advanced in 6" Increments
- Most Accurate Vertical Sampling
- Indications of soil compaction
  - Low N-values = softer soils
  - Higher N-values = denser soils
- Considerations
  - Time Factor
  - Poor Recovery
  - Height Constraints
- Allows sampling below water table
- Best for deep samples/wells (50 ft +)

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SUBSURFACE SOIL SAMPLING

Hollow Stem Auger (HSA) Drill Rig

- Utilizes a Rotary Cutting Head
- “Screw” motion clears soil when augers are rotated
- Hollow Stem Augers act as Casing
  - Prevents Cave In
  - Limits Cross Contamination
  - Allows for Enhanced Sand Pack for Groundwater Monitoring Wells
- Faster than Flush Joint Casing
- For medium-depth samples/wells (10-50 ft)
- “Running Sands” issue at depths far below groundwater table

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SUBSURFACE SOIL SAMPLING

Direct-Push Tooling (DPT) Drill Rig

- Minimal ground disturbance (~4” holes)
- Quick and Cost Effective
- Minimal Cuttings Generated, Less Investigation-Derived Waste (IDW)
- Uses Dedicated MacroCore sleeves
- OK for shallow borings (30 ft)
- Beware of Compression Factor
  - Using Static Weight and Force which Results in Soil Compression
  - Soil compressed over 4-5 foot intervals
  - Compression as much as 5X
- “Running Sands” are a problem
  - Tooling completely removed from ground after each sample

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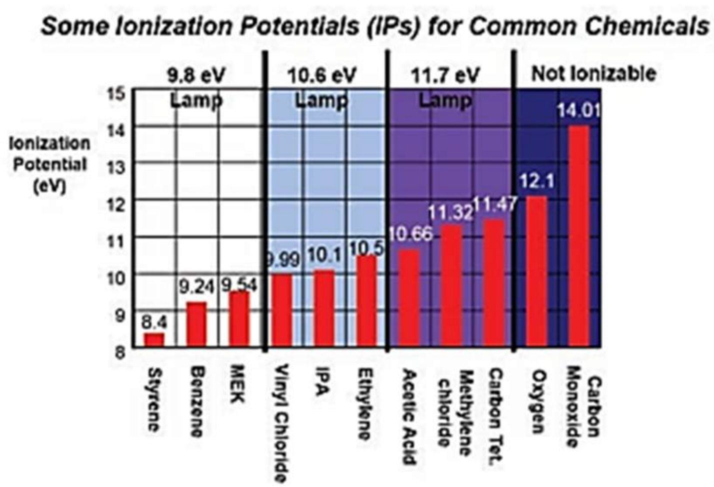
FIELD SCREENING TOOLS

Photoionization Detector (PID)

- Field/Headspace Screening
- PID Calibration
- Different Bulbs for Different Contaminants
  - Consult your Local Rental Company



(Rae Systems by Honeywell, 04/05/CW)

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FIELD SCREENING TOOLS

Application and Reporting

Tighe&Bond	RIG MAKE/MODEL 7822DT/Geoprobe	ROCK CORE COMPLETED No	CHECKED BY J.Libby
WEATHER Sunny, 80-90°F	DEPTH TO WATER (ft) AND DATE 12.5 7/8/2024	DTW MEASURING LOCATION GS	FIELD TEST TYPE PID (ppm)
DRILLING COMPANY Complete Environmental Services (CES)	SAMPLER TYPE MacroCore	APPROX. GROUND ELEVATION (ft) -	DATUM -
FOREMAN Dave Robeau	SAMPLER ID & OD (in) ID:1.5 OD:2	APPROXIMATE X-LOCATION -	APPROXIMATE Y-LOCATION -
PROJECT NAME	CLIENT		BORING ID **TB-SB-250**
PROJECT LOCATION	START DATE 7/8/2024	END DATE 7/8/2024	PROJECT NUMBER W-1222-043
CITY, STATE	STARTING DEPTH (ft) 0	ENDING DEPTH (ft) 15	TIGHE & BOND REP K.Gagnon/C.Watts

Depth (ft)	Sample Depth (ft)	Rec. (in)	PID (ppm)	Sample Description	Remarks	Lab Sample Depth (ft)	General Stratigraphy	Well Construction
0	0-5	30	3.7	0-0.5': ASPHALT			ASPHALT	No Well Installed
			6.4	0.5-1.8': Brown, fine to coarse SAND and fine to coarse GRAVEL, little Brick			SAND and GRAVEL	
2			23.2	1.8-2.5': Crushed CONCRETE			Crushed CONCRETE	
4								
6	5-10	19.2	18.2					
			137.0	5-7.6': Black, ASH and fine to coarse GRAVEL			ASH and GRAVEL (FILL)	
8								
10	10-15	33.6	51.6	10-10.8': Black, ASH	*Petroleum like impacts observed from 5 to 15 feet*		ASH (FILL)	
			84.6	10.8-12.8': Light Brown, fine to medium SAND, some Silt			SAND	
12			50.1					
				End of Boring at 15 ft BGS				

FIELD SCREENING TOOLS

(DEXSIL, 2025)

DEXSIL Petroflag Kits

- Test for Total Hydrocarbons in Soil (TPH)
- Real Time Results using Extraction Solvent
- Analyzer Includes Response Factors and Detection Limits for TPH
- Calibration Temperatures are Important!
- Results Above the Upper Limit can be Re-Run with Less Sample Mass
- Potential Low Bias from Water Content
  - Poor Extraction
  - Dilution
  - Sample weight bias

FIELD SCREENING TOOLS

PetroFLAG®

Hydrocarbon Test Kit - Field Data Sheet

Date: 8/20/24
Operator: Kristi Gagnon
Location: Maple Tree Lane

Calibration Time/Date: 1040 / 8/20/24
Calibration Temperature: 30.9°C

No.	Sample ID	Weight	Time/Date	Reading (ppm)	DF[1]	RF[2]	Actual (ppm)	Comments
1	BL	10g	1050 8/20/24	0				
2	CSD	10g	1050 8/20/24	1000				
3	1-Bottom-West	10g	1103 8/20/24	1175				AN: 1,263
4	3-Bottom-West	10g	1139 8/20/24	159				wet AN: 1,078
5	4-Bottom-West	10g	1200 8/20/24	326				AN: 404 Recheck
6	5-Bottom-West	10g	1225 8/20/24	EEEE, overrange.				AN: Same
7	6-Bottom West	10g	1235 8/20/24	EEEE, overrange.				AN: Same
8	7-SB-7 bottom	10g	1250 8/20/24	EEEE, overrange.				—
9	8-Bottom-west	10g	1325 8/20/24	733				AN: 633
10	9-Sidewall-North	10g	1330 8/20/24	331				AN: 508
11	10-middle-Sw	10g	1344 8/20/24	EEEE, overrange				AN: EEEE
12	11-middle-S	10g	1350 8/20/24	1015				-

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SAMPLING METHODOLOGIES

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Representative Sampling

- Site Specific Data Quality Objectives
  - Discuss with Project Manager

Considerations

- Non-homogeneity of Soil
  - Contaminants tend to reside in finest fraction of soil particles (silt, clay, organic acids)
- Grab versus Composite Samples
  - Grab samples: single volume of soil homogenized and submitted for analysis
  - Composite samples: multiple volumes of soil (aliquots) homogenized and submitted for analysis
  - Volatile Organic Compound Samples **Never Composited!**
- Incremental Sampling
- Cross Contamination Issues
- Decontamination Procedures

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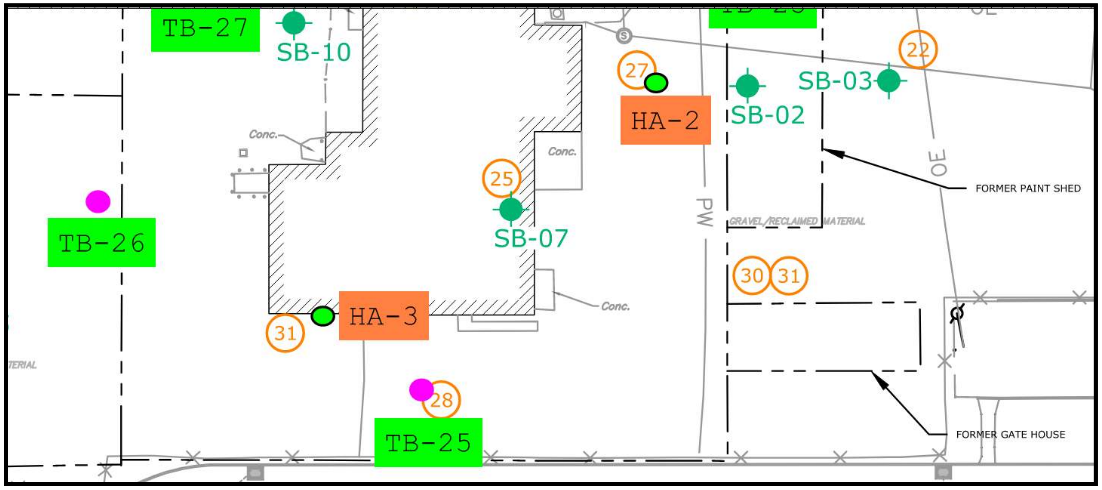
SAMPLING METHODOLOGIES

Judgmental Sampling

- Informed by the nature of the site, contaminant properties, and observations
- Focused sampling from an obvious release or the mostly likely release mechanism
- Known Conditions vs. Uncertainty
  - Has soil been previously disturbed in the past (e.g. construction activities, filled)
  - Is there existing information that suggests where the location of highest contaminant concentrations are likely?
  - Do contaminant physical properties allow observation of impacted media (odors, staining, field screening)



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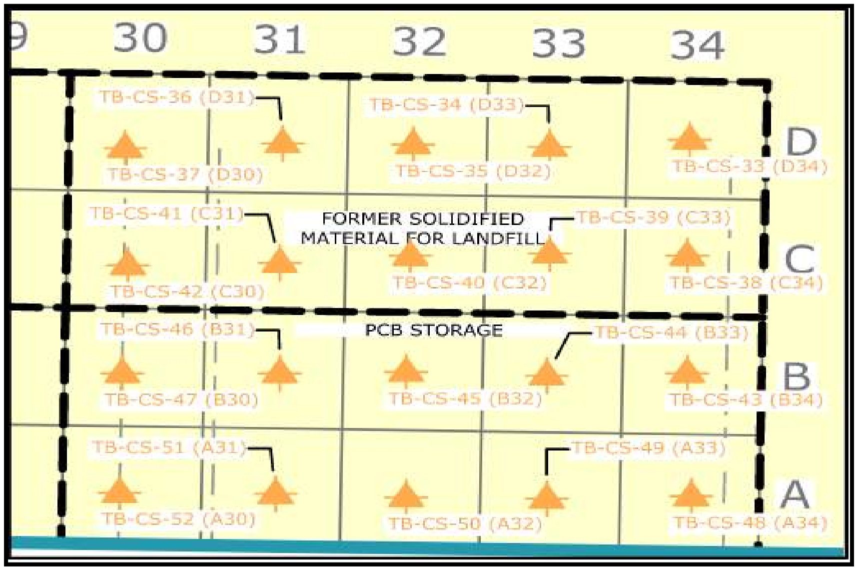
SAMPLING METHODOLOGIES

Systematic Sampling

- Used when Contaminant Distribution is Unknown (PCBs, metals, PFAS)
  - No odors, staining, point source
- Set up Grid Cells (Letter, Number)
  - Helpful to reduce uncertainty about nature, extent, and distribution of contamination at a site
  - Number of samples depends on variability of initial data (standard deviation)
    - Source Unknown
    - Soil has been Disturbed
    - Lower potential for “missed” areas with high contaminant concentrations
- Can include composite sampling or grab sampling, or a combination of both



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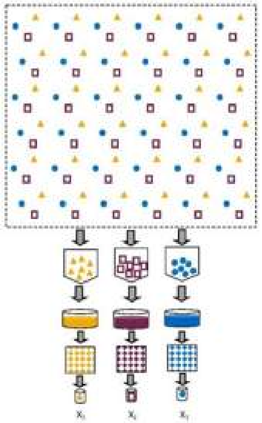
SAMPLING METHODOLOGIES



Incremental Sampling Methodology (ISM)

- Type of Systematic Sampling
- Structured Composite Sampling Process
- Samples representative of soil throughout a prescribed area/depth called a Decision Unit
- Can have multiple samples (Sampling Units) within a Decision Unit
- Soil non-Homogeneity addressed through “Sub-Sampling” (samples of composite sample)
- Compared to traditional systematic sampling approaches
- ISM yields an accurate estimate of the true mean soil concentration for a given area
- ISM manages micro-scale soil heterogeneity and minimizes potential bias errors

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SAMPLING METHODOLOGIES

Incremental Sampling Methodology (ISM)

- Site is segregated into areas, each called a decision unit (DU)
- Increments (aliquots) collected evenly throughout DU (30 to 100 increments)
  - Can include Sample Units (SU) for varying depths within a DU
- Increments are composited into single composite sample (1 per DU/SU)
- Composite sample is then Sub-Sampled (samples of composite sample)
  - Initial sample is sieved, “slab cake” prepared from finest portions of sample
  - Slab cake is re-sampled as “meta” composite sample
- Final “meta” composite sample is analyzed for contaminants
- Laboratory typically performs ISM processing and analysis
  - Bulk sample volume is a drawback (5-gallon bucket)
  - Can reduce sample bulk by Sub-Sampling in field and discarding initial composite sample

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SAMPLING METHODOLOGIES

Incremental Sampling Methodology (ISM)

Two-Dimensional Slab Cake

- Targets finest soil fraction for analysis
- Sieved composite sample spread in even thickness
- Divided into increments and “sub-sampled”
- Sub-samples are re-composited into “meta” composite sample
- “Meta” composite sample analyzed

(Mark Bruce, Eurofins, 2019) ITRC

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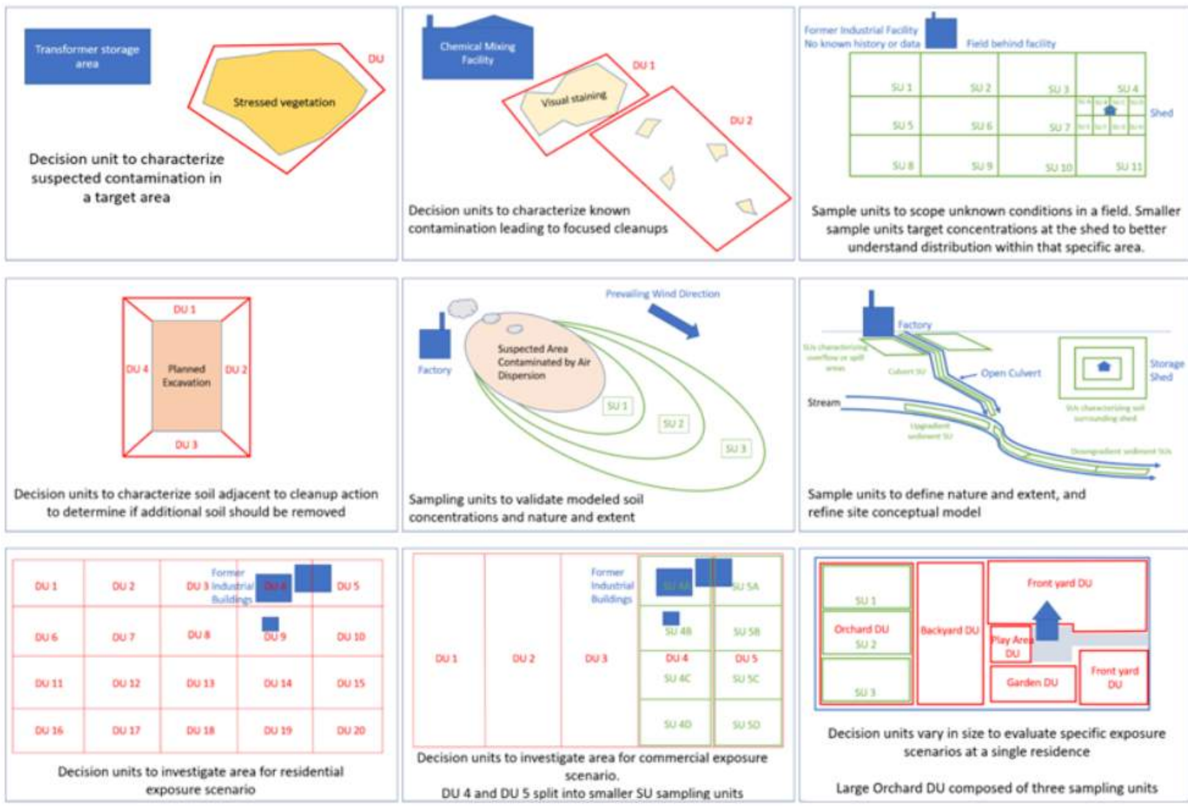
SAMPLING METHODOLOGIES

Incremental Sampling Methodology (ISM)



(ITRC, 2025)

LESSONS LEARNED

Non-Homogeneity of Soil is a Challenge

- Hoosac River Assessment
  - Mercury above the industrial hygiene level, reanalysis (from the same jar) showed much lower levels
- Emergency Response Situation in CT
  - Leachable lead concentration issues when analyzed via SPLP and reanalyzed showed different concentrations (some hazardous waste levels, some not)
- Field Screening Should Reflect Analytical Results
  - Sample loses “freshness” during screening
  - Should collect Duplicate Samples for field screening vs. lab analysis
  - Collect one for screening
  - One for lab analysis

Understand CSM, DQOs, Project Objectives before Sample Collection

- Soil sampling can be iterative
- Incorporate data quality issues, access issues, non-homogeneity into subsequent boring/sampling rounds

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QUESTIONS?

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