Characterization Goals and Objectives

NEWMOA

Back to Basics Part 2: Data Collection & Interpretation: State of the Practice & Lessons Learned

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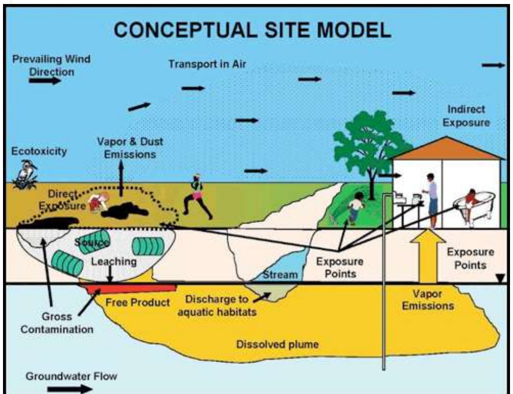
Outline

- Summary of "Part 1: Back to Basics – Developing a Conceptual Site Model (CSM)"
- Identification of Data Gaps
- Setting Characterization Objectives
  - Required resolution
  - Data type
  - Tools
- Incremental Sampling Methodology – quick summary

What is a CSM

What is a Conceptual Site Model (CSM) and how do you use it?

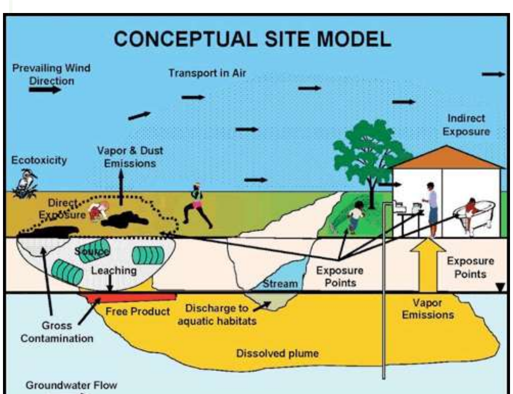


ITRC ISM-1 2012, https://www.itrcweb.org/ism-1/

- CSMs are essential elements of the systematic planning process.
- A CSM serves to conceptualize the relationship between contaminant sources, site geology, and potential exposure pathways.
- It presents the current understanding of the site, **identifies data gaps**, and focuses data collection efforts. The CSM should be maintained and updated as new information is collected throughout the life cycle of the project**, including during remediation.**

What is a CSM

What is a Conceptual Site Model (CSM) and how do you use it?



The CSM is more of a process than a final product. The CSM is essentially never complete.

The CSM should be maintained and updated as new information is collected throughout the life cycle of the project**, including during remediation.**

ITRC ISM-1 2012, https://www.itrcweb.org/ism-1/

What is a CSM

"A conceptual site model is a written and/or illustrative representation of the conditions and the physical, chemical and biological processes that control the transport, migration and potential impacts of contamination (in soil, air, ground water, surface water and/or sediments) to human and/or ecological receptors."

(NJ DEP, 2011 Technical Guidance for Preparation and Submission of a Conceptual Site Model)

What is a CSM

"The goal of a conceptual site model is to provide a description of relevant site features and the surface and subsurface conditions to understand the extent of identified contaminants of concern and the risk they pose to receptors. **The conceptual site model is an iterative tool that should be developed and refined as information is obtained during review of the site history and continues throughout the site and/or remedial investigation.** The level of detail of the conceptual site model should match the complexity of the site and available data."

(NJ DEP, 2011 Technical Guidance for Preparation and Submission of a Conceptual Site Model)

CSM Components

For the purposes of this presentation, we can simplify the CSM into two primary components:

Site Specific Geological Physical CSM

Site Specific Land Use History CSM

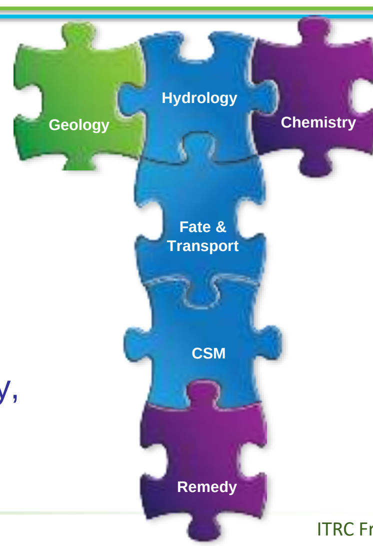
CSM Components

Geological/Physical Site Model

Contains:

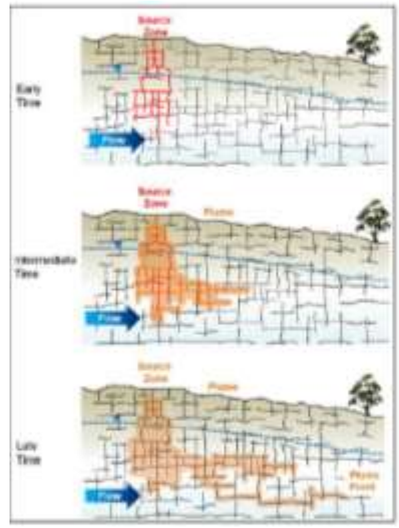
- Geology
- Hydrogeology
- Chemistry
- Fate and Transport

Key to your success: a **team** with expertise in hydrogeology, sedimentology, structural geology, geophysics, geochemistry, and engineering



Summary of Where We're Starting

- Initial CSM is already developed
- Data gaps likely exist that need to be filled
- An iterative approach is recommended for filling these data gaps
- **Recommended process is the ITRC Integrated Site Characterization (ISC) Process**



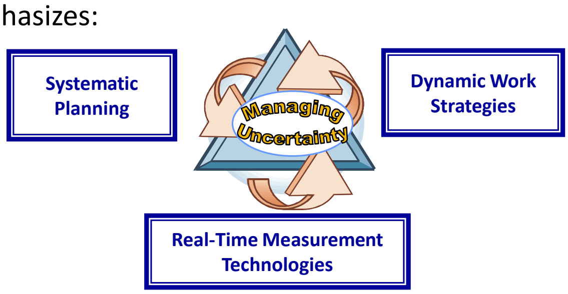
Parker et al. 2012

Integrated Site Characterization

ISC relies on the concept of an *objectives-based site characterization.*

This emphasizes the importance of establishing clear, effective objectives to drive characterization data collection.

It is a systematic, stepwise process that encourages use of a characterization approach which emphasizes:



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Integrated Site Characterization

- Integrated Site Characterization flow chart
  - Planning
  - Tool Selection
  - Implementation
- Planning module
  - Step 1: Define problem and uncertainties
  - Step 2: Identify data gaps & resolution
  - Step 3: Develop data collection objectives
  - Step 4: Design data collection & analysis plan
  - Similar to DQO process

Integrated Site Characterization

- Plan characterization (1-4)
  - Define the problem
  - Identify data needs and resolution
  - Develop data collection objectives
  - Design data collection and analysis plan
- Select tools (5)
- Implement investigation and update CSM (6-8)

Figure 4-1 Integrated Site Characterization

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Data Quality Objectives are "Built in"

USEPA Data Quality Objectives

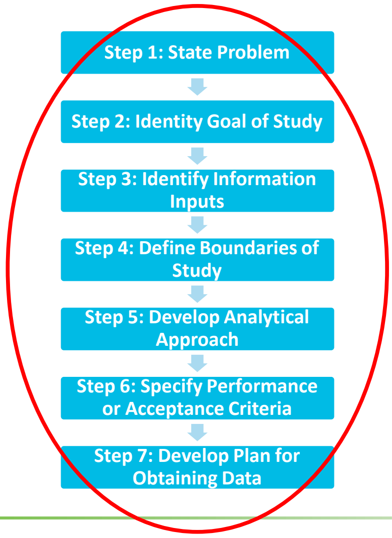


Figure 4-1 Integrated Site Characterization

Step 1: Define Problem and Assess CSM Uncertainties

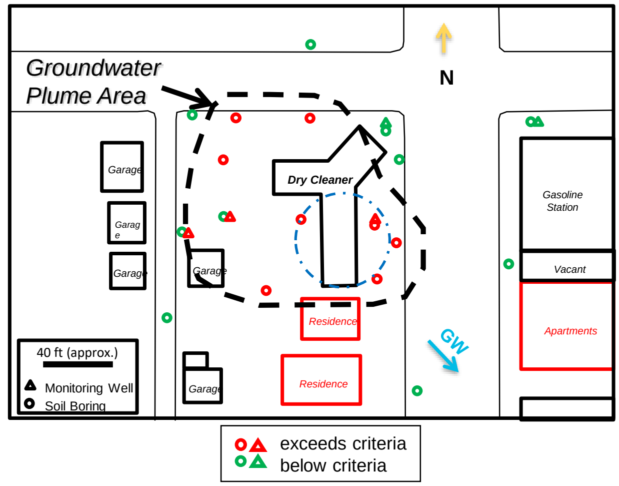
- Assess existing CSM
- Define problem
- Define uncertainties

Figure 4-1 Integrated Site Characterization

Case Example – Dry Cleaner Site

Case Example

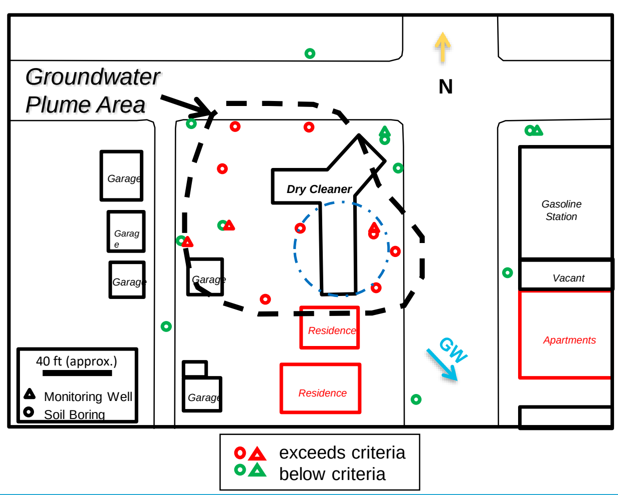
1. Commercial & residential location
2. Shallow groundwater (<20’ bgs)
3. Five MWs; 10-ft screens
4. 18 soil borings; 5-ft samples
5. No soil-gas evaluation
6. In situ chemical oxidation (ISCO) & enhanced in situ bioremediation (EISB) injections in source area & plume



Step 1: Define Problem and Assess Uncertainties

Case Example

1. Uncertain plume delineation; no down-gradient control
2. Source area inferred, not confirmed
3. No remedy evaluation
4. No soil gas or VI assessment



Step 2: Identify Data Needs & Spatial Resolution

- Translate uncertainties into data needs
- Determine resolution needed to assess controlling heterogeneities

Figure 4-1 Integrated Site Characterization

2. Identify Data Needs / Gaps and Resolution

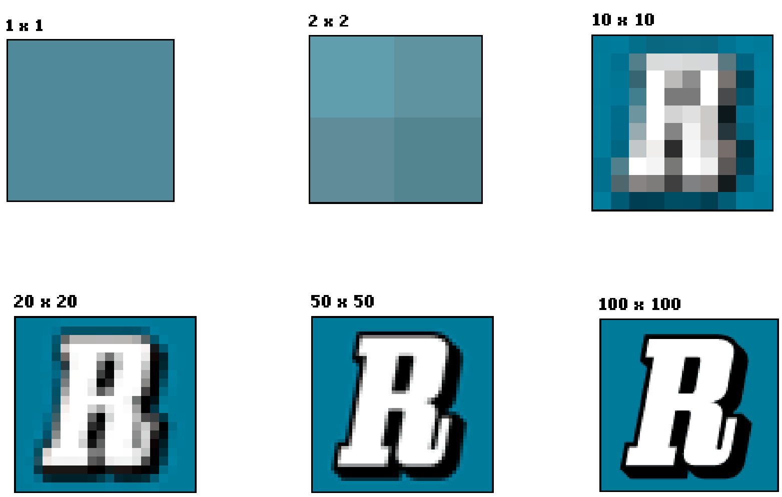
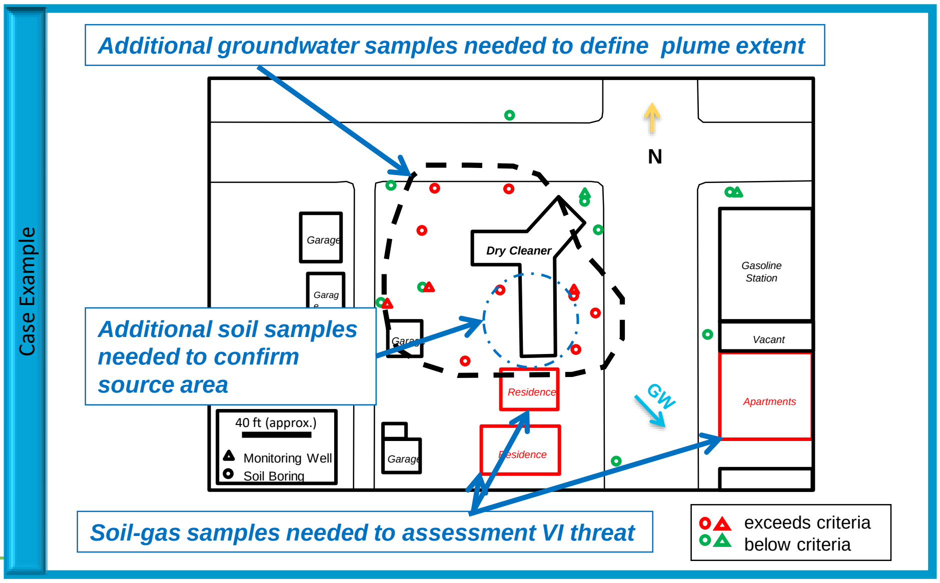


Figure courtesy of Seth Pitkin

Step 2: Identify Data Needs & Spatial Resolution



Identify Significant Data Gaps

- Missing information limits the formulation of a scientifically defensible interpretation of environmental conditions and/or potential risks in a bedrock hydrogeologic system. A data gaps exists when:
  - it is not possible to conclude with confidence whether or not a release has occurred
  - evaluation of all data, in proper context, does not/cannot support the CSM
  - if more than one interpretation of existing data set

- **Fractured rock CSMs will unavoidably have data gaps throughout the process**
  - the lateral and vertical extent of contamination
  - the direction the contamination is moving
  - identification of imperiled receptors
  - the rate at which the contamination is moving
  - what areas should be targeted for sampling.

Each data gap can be transformed into one or more specific characterization objectives

Step 3: Establish Data Collection Objectives

- Specific, Clear, Actionable
- Consider data types, quality, density, and resolution

Figure 4-1 Integrated Site Characterization

Formulate-Revise Characterization and Data Collection Objectives

- Data collection objectives (DQOs)- determine specific data needs and to select tools to be used in the investigation
- DQOs should be clear, focused, specific, & consider:
  - fracture orientation,
  - spacing and aperture,
  - hydraulic head,
  - and flow velocity

- **Characterization Objective:** Determine the lateral and vertical extent of dissolved phase VOCs.
- **Data Gap:** The vertical and lateral extent is unknown.
- **Data Collection Objective**: Gather data on: fracture location, orientation, connectivity and VOC concentration in the source, plume and towards receptors.

Step 3: Example Data Collection Objectives

Delineate extent of dissolved-phase plume; determine stability and attenuation rate

- Grab groundwater samples at X and Y depths
- Soil borings every X feet to capture subsurface variability
- Delineate to drinking water standards
- Install three to five wells; monitor along axis of flow
  - Quarterly for two years
  - Evaluate C vs T and C vs. distance trends
  - Specify COCs and geochemical parameters

Step 3: Drycleaner Site Data Collection Objectives

Case Example

- Objectives
  - Define plume extent exceeding standards
  - Assess remedy progress – soil and GW samples
  - Assess shallow soil vapor & VI threat
  - Streamline assessment – days not weeks
- Data types & resolution
  - Continuous cores; samples at lithologic boundaries
  - Groundwater samples every 4’
  - Soil gas at 5 and 10 feet

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Step 4: Data Collection & Analysis Plan

- Write work plan
  - Recognize data limitations
  - Select data management tool
  - Develop data analysis process
- Consider real-time analysis

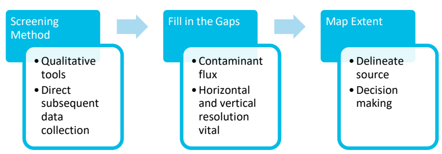


Figure 4-1 Integrated Site Characterization

4. Design Data Collection and Analysis Process

- There are generally three types of data collected:
  - Quantitative:
    - A tool that provides compound-specific values in units of concentration based on traceable standards (e.g., µg/L, ppm, and µg/m^3)
  - Semi-quantitative:
    - A tool that provides compound-specific quantitative measurements based on traceable standards but in units other than concentrations (e.g., ng or ug) or provides measurements within a range.
  - Qualitative
    - A tool that provides an indirect measurement (e.g. LIF and PID measurements provide a relative measure of absence or presence, but are not suitable as stand-alone tools for making remedy decisions.

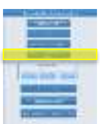
4. Design Data Collection and Analysis Process

Accuracy:

- How “close” a result comes to the true value?
- Requires careful calibration of analytical methods with standards

Precision:

- The reproducibility of multiple measurements
- Described by a standard deviation, standard error, or confidence interval.



4. Design Data Collection and Analysis Process

Develop Site Investigation Work Plan

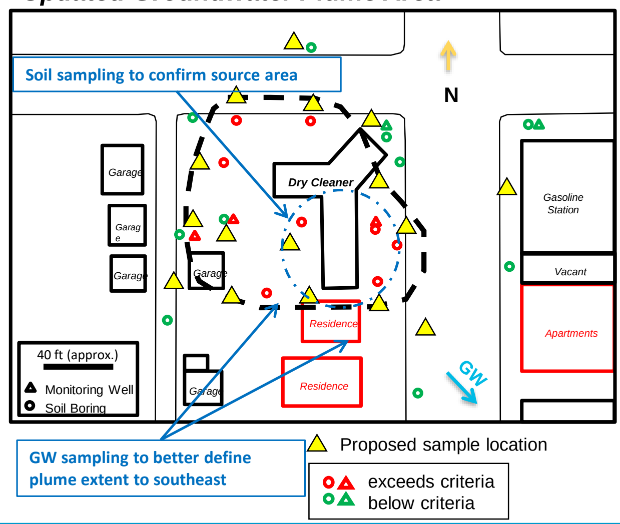
- The plan should be Dynamic-Flexible-Adaptable
  - This concept works for large and small sites
- Consider use of field laboratory
- Incorporate real time data collection and analysis to continuously up date CSM
- Continuously adjust work plan to incorporate evolving CSM and to address data gaps as they are understood

Step 4: Data Collection & Analysis Plan

Case Example

- 16 borings
- 80 soil samples (~5 per boring)
- 48 grab groundwater samples (~3 per boring)

Updated Groundwater Plume Area

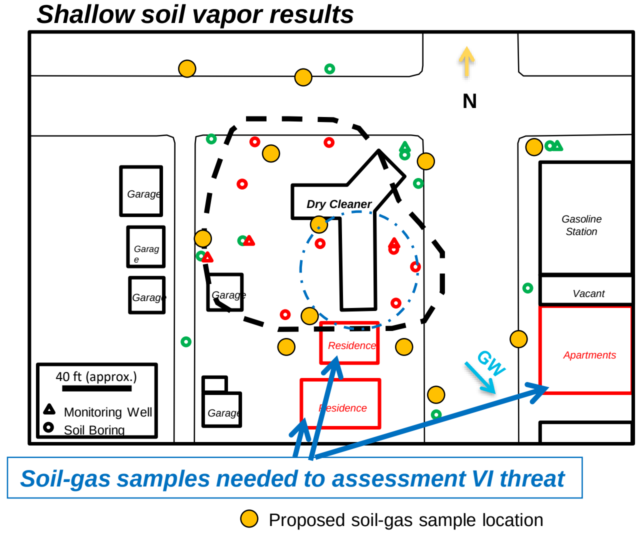


Step 4: Data Collection & Analysis Plan

Case Example

- Soil gas
  - 12 points
  - 24 samples

Shallow soil vapor results



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What is Incremental Sampling Methodology (ISM)?

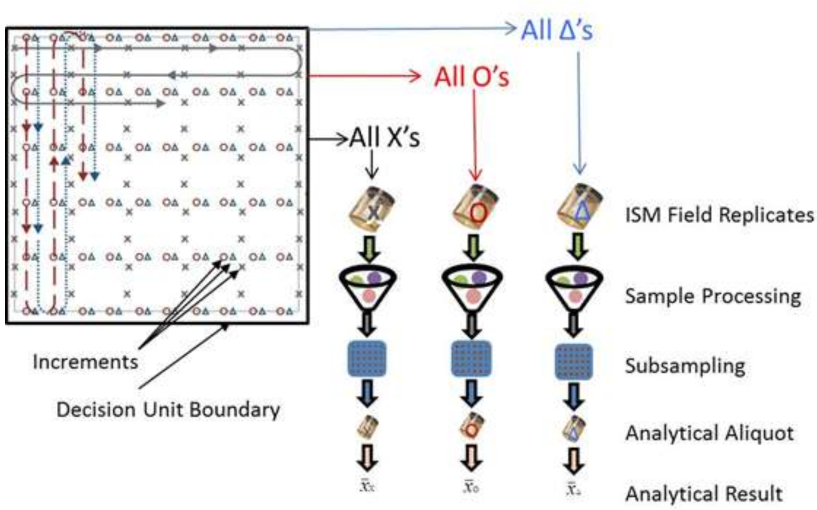
ISM Objective: To obtain a single sample for analysis that has the mean analyte concentration representative of the decision unit

- Structured composite sampling and processing protocol
- Reduces data variability
- Provides a reasonably unbiased estimate of mean contaminant concentrations in a volume of soil targeted for sampling

Decision Unit (DU): the smallest volume of soil (or other media) for which a decision will be made based upon ISM sampling

ITRC ISM-1 2012, https://www.itrcweb.org/ism-1/

What is Incremental Sampling Methodology (ISM)?



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Advantages and Limitations of ISM

Advantages of ISM	Effect
Improved spatial coverage (increments x replicates)	• Sample includes high and low concentrations in proper proportions
Higher Sample Mass	• Reduces errors associated with sample processing and analysis
Optimized processing	• Representative subsamples for analysis
Fewer non-detects	• Simplifies statistical analysis
More consistent data	• More confident decision

Limitations of ISM	Effect
Small number of replicates	• Limits Upper Confidence Limit calculation methods
No spatial resolution within Decision Unit	• Limits remediation options within Decision Unit • Limits multivariate comparisons
Assessing Acute Toxicity	• Decision Unit has to be very small

ITRC ISM-1 2012, https://www.itrcweb.org/ism-1/

Incremental Sampling Methodology (ISM)

- Archived ITRC training: https://clu-in.org/live/archive/default.cfm?display=all&group=itrc
- Scroll to "January 2017" for archived Parts 1 and 2
- ISM document: https://www.itrcweb.org/ism-1/

Conducting Investigation – Details Later Today!

- Step 6: Implement investigation
- Step 7: Perform data evaluation and interpretation
- Step 8: Update CSM

Figure 4-1 Integrated Site Characterization

Summary

- Assess current CSM and identify data gaps
- Characterization activities should be driven by specific objectives
- Characterization plan should facilitate dynamic decision making

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