Improving Site Investigation

A guide for property owners, buyers and sellers, attorneys, bankers, insurance representatives, and their environmental consultants.

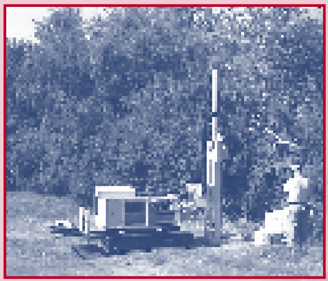
The 4C's of Successful Site Investigations

1 Comprehensive planning *at the beginning of the project.*

2 Collection of sufficient data, *both on and off the property.*

3 Clear reporting *about what was done and why.*

4 Compliance *with state Site Investigation (SI) report requirements.*

A site investigation (SI) determines whether a property has been affected by chemical contamination and whether the contamination is at levels that require cleanup under state regulations. The concepts promoted in this brochure may or may not be ***required*** *by state regulations. However, following the 4C's is more likely to result in a project that moves through the system faster and is more resource-efficient for all involved – responsible parties, consultants, and state regulators.*

1. Comprehensive Planning

Strategic planning at the beginning of a site investigation project helps ensure that the entire process is technically sound, resource-efficient, and operating on a realistic timeline. Upfront planning benefits all phases of the project by fostering trust, open communication, and cooperation among the interested parties.

You and your consultant must have a clear understanding of the state-specific regulations governing the investigation and remediation process, including the actions and reports needed to bring the site to closure. A realistic schedule should build in time for regulatory review and approval, as well as for field work, remediation construction, and the regulatory closure process.

The major milestones in planning for a site investigation project should include:

- Definition of clear project goal(s), such as the elimination of risk and the ability to develop the property for a specific use
- Development of a comprehensive list of regulatory, scientific, and engineering issues that must be addressed to achieve the desired end goal(s)
- Development of a Conceptual Site Model (CSM) or background report for the site
- Review of the CSM to identify areas of uncertainty and additional information needed to achieve the project goal(s)
- Development of a site investigation work plan to collect the required information

Preliminary Research

Every site investigation must begin with a thorough review of available information on the property. In some states, this is formally done prior to the site investigation in a preliminary assessment (PA) phase and a separate report is prepared. Whether during the site investigation, or a prior PA, information needs to be gathered from the following sources:

- Visually inspect the subject site and adjoining properties
- Interview past and present owners and occupants of the property, as well as those of adjoining properties, about the site's history
- Review federal, state, local, and tribal government records, as well as any records the facility has, including to the extent practicable:
  - aerial photographs
  - USGS topological and geological maps
  - Sanborn fire insurance maps
  - MacRae's Industrial Directory
  - site plans and as-built drawings
  - permits for landfills or other disposal units, storage tanks, or hazardous waste management
  - soil boring logs
  - zoning and land use records (e.g., title and deed, chain of title documents, environmental cleanup liens)
  - publicly available registries of engineering controls and institutional controls (land use restrictions)
  - local building and health department records
  - local historical society information
  - state public health department records
  - CERCLIS records
  - Emergency Response Notification System records
  - previous preliminary assessment (PA) and/or site investigation (SI) reports

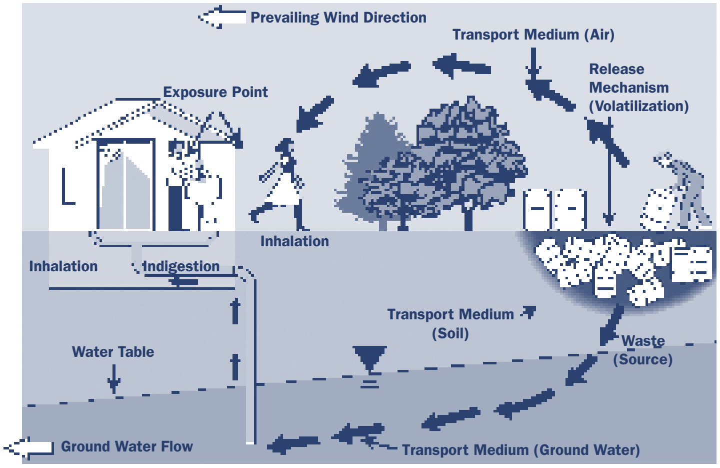
If these resources are not utilized during preliminary research, the consultant should explain why (for example, there were no health department records related to the site).

Based on this research, the consultant should then document the following information for use in developing the CSM:

- What type(s) of contamination could be expected and where based on past and present site activity
- What type(s) of contamination are known to be present
- Where the contamination originated
- Where the contamination is now located
- How much contamination is present
- How the concentration of contamination might vary within identified areas
- How contaminants are moving and/or changing over time
- Who/what might be exposed to contaminants, both on site and in surrounding areas
- What might be done to reduce exposure

A well-documented CSM helps others understand how and why decisions were made regarding the site. Diagrams, tables, and figures, such as the example shown below, should be included to help convey the information clearly.

Figure Style Conceptual Model



Source	Environmental Exposure Medium	Exposure Point	Exposure Route	Exposed Population
Waste Drum Pit	Groundwater	Residences' Tap Water	Ingestion, Dermal Contact	Neighboring Residents
Waste Drum Pit	Groundwater	Residences' Shower-heads	Inhalation of Volatiles, Dermal Contact	Neighboring Residents
Waste Drum Pit	Air	Ambient Air	Inhalation of Volatiles	Neighboring Residents
Waste Drum Pit	Soil Gas	Indoor Air	Inhalation of Volatiles	Neighboring Residents

The Site Investigation Work Plan

After developing the initial Conceptual Site Model, the project team should develop a site investigation work plan that details how additional information will be obtained. The work plan should clearly outline:

- State-specific requirements regarding data collection and analysis
- Contaminants of concern at the site
- Locations and types of samples (e.g., soil, groundwater, surface water) to be obtained
- Minimum number of samples required to accurately assess site conditions
- Type(s) of field and laboratory analyses to be performed on each sample
- Standard operating procedures (SOPs) for collection and analysis of samples
- At least three sampling locations to be used as permanent groundwater monitoring points

In drafting the work plan, environmental consultants should evaluate the cost of collecting additional samples during initial fieldwork versus the potential costs of making multiple sampling trips and/or delaying completion of the project because of inadequate sampling.

Note that *simply following a site investigation work plan does not guarantee additional investigation will be unnecessary, particularly if the planned activities do not adequately identify the nature and extent of contamination.*

2. Collection of Sufficient Data

Collecting and analyzing samples from locations that accurately reflect site contamination, or "sample representativeness," is a primary factor in data and decision quality. The fewer the samples, the greater the uncertainty about the conclusions drawn.

Innovative on-site techniques can greatly increase the number of samples collected and analyzed—and therefore the overall reliability of the data—without adding significant time to the site investigation project (and usually saving time!). With this real-time data, consultants can focus sample collection on problem areas, eliminate unnecessary sampling, and better target the samples sent for laboratory analysis.

Make sure your consultant has experience using on-site measurement technologies and has considered them for use at your site.

Rapid Sampling Technologies

The rapid sampling techniques most commonly used today are direct-push technologies (for soil, groundwater, and soil gas sampling) and microwells (for permanent groundwater sampling).

- ***Direct-Push Technologies:***
  Direct-push units use the weight of a vehicle, in combination with a hydraulic ram, to "push" sampling devices into the soil. They create a small borehole but do not remove soil, therefore eliminating the time and cost of soil disposal. *For more information, see the Field Analytic Technologies Encyclopedia (FATE) at* **http://fate.clu-in.org/technologies.asp**
- ***Microwells:***
  Microwells are monitoring wells that are vibrated into unconsolidated soils using a small portable rig. Rapid installation is possible to depths of more than 100 feet, and groundwater samples can be obtained immediately. Microwells can be permanent installations. Other advantages of microwells are that there is no soil to dispose of and little purge water is generated. Numerous studies have shown that the quality of samples from microwells is comparable to that of traditional monitoring wells. *For more information, see* **http://fate.clu-in.org/direct_push/dpgroundwater.asp**

On-site Analytical Tools

Samples collected using rapid sampling techniques can then be analyzed with portable instruments operated outside, in the back of a vehicle, or, preferably, in the controlled environment of a mobile field office trailer. An on-site mobile laboratory may be appropriate if a large number of samples are required. Commonly used on-site analytical tools include:

The Triad Approach

Managing decision uncertainty by combining systematic planning, dynamic work strategies, and real-time measurement systems has been termed "the Triad approach." Detailed information on the concepts and practical implementation of the approach, including the Conceptual Site Model (CSM) is available from the Triad Resource Center at **www.triadcentral.org** and the Interstate Technology & Regulatory Council (ITRC) at **www.itrcweb.org/documents/scm-1.pdf**

Rapid Sampling Techniques and On-site Analytics Can Save Time and Money — A Case Study

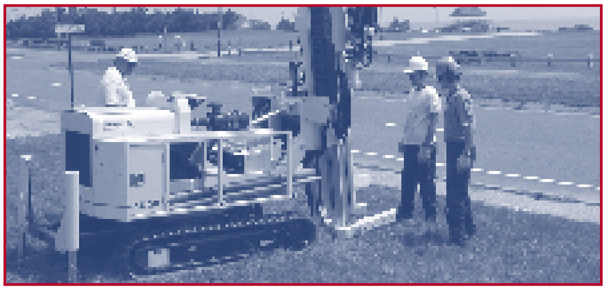
The former Cos Cob Power Plant in Greenwich, Connecticut operated as a coal-fired power plant from 1907 until the mid-1960s. The site covers approximately 9 acres and the contaminants of concern are PAHs (polycyclic aromatic hydrocarbons) and TPH (total petroleum hydrocarbons) associated with the ash that was used as fill across the site, and also PCBs (polychlorinated biphenyls) associated with leaks from electrical transformers.

- ***Project Goal:***
  Define the nature and extent of contamination to determine appropriate reuse options
- ***Characterization:***
  - 70' X 70' sampling grid placed across the site
  - direct-push methods used to collect samples down to four feet below grade
  - based on the on-site analytical results, additional samples collected to define extent of contaminated areas
  - 93 samples analyzed on-site for PAHs and TPH using ultraviolet fluorescence test kits (using micro extraction prior to analysis)
  - 103 samples analyzed on-site for PCBs using a gas chromatograph (GC) with electron capture detector (ECD)
  - based on the on-site analytical results, limited confirmation samples sent to off-site laboratory
- ***Time:***
  All characterization work performed in a single one-week mobilization
- ***Cost Savings:***
  Estimated at 35 percent compared to a "traditional" characterization effort – savings include the costs for increased upfront planning

For more information, see *Expedited Characterization of Petroleum Constituents and Polychlorinated Biphenyls Using Test Kits and Mobile Laboratory Gas Chromatography at Former Cos Cob Power Plant, Greenwich, CT*, last updated September 8, 2004, **www.triadcentral.org/user/includes/dsp_profile.cfm?Project_ID=1**

- ***Field-portable Gas Chromatograph (GC):***
  GC, combined with a detection technology such as mass spectrometry (MS), is used to provide definitive compound identification and quantification. GC/MS can detect and quantify individual compounds in sample containing a wide array of unknown compounds. This technology has been adapted for on-site use to analyze volatile organic compounds (VOCs) in water, soil, soil gas, and ambient air. *For more information, see* **www.newmoa.org/cleanup/advisory/gc.htm** *and* **http://fate.clu-in.org/gc.asp**
- ***Immunoassay:***
  Immunoassay testing uses antibodies that are highly specific to the target compound or group of compounds. This technique can be used to analyze many types of environmental matrices, including water, soil, surfaces (wipes), sediments, sludge, compost, and concrete. Test kits are available for a wide variety of organic contaminants, including the gasoline constituents benzene, toluene, ethylbenzene, and xylene (BTEX); various individual and classes of pesticides; and explosives and propellants. Immunoassay analysis can provide qualitative (the contaminant is or is not present), semi-quantitative (the contaminant is above, below, or between two specified levels), or quantitative (with low detection limits) results. *For more information, see* **www.newmoa.org/cleanup/advisory/immunoassay web.htm** *and* **http://fate.clu-in.org/immunoassay.asp**
- ***X-ray Fluorescence (XRF):***
  XRF is used primarily to determine the metal composition of soils. Some of the elements of environmental concern that XRF can identify are arsenic, barium, cadmium, chromium, copper, lead, mercury, selenium, silver, and zinc. Field XRF analyzers are generally hand-held, battery-operated instruments that provide semi-quantitative or quantitative data for 50–100 samples per day. The instrument can also be placed directly on the ground to provide qualitative data, often within 30 seconds. *For more information, see* **www.newmoa.org/cleanup/advisory/xrfweb.htm** *and* **http://fate.clu-in.org/xrf.asp**

When using on-site analytical technologies, a representative number of samples should always be sent to an off-site laboratory as a quality control measure to confirm the field results. Where possible, your consultant should discuss and coordinate use of these technologies with state regulators.



Geoprobe for soil and groundwater sampling

Common Misconceptions about Sample Analysis

1. Off-site laboratory analyses are always correct.

Many site investigators assume that sending samples to a laboratory and specifying the use of an "EPA-approved method" takes care of data quality. But good analytical techniques do not necessarily ensure good data. For example:

- Samples collected from a small number of locations may not be truly representative of site conditions. Soil conditions and contaminant concentrations can vary tremendously over just a few feet.
- Improper handling of samples during collection and transport can lead to incorrect analytical results. Chemicals can volatize into the air, or contamination can be inadvertently introduced. Improper preservation of samples can also alter chemical characteristics.
- Consultants do not always fully understand the quality assurance/quality control (QA/QC) data from the laboratory, which can significantly change the interpretation of results. For instance, the lowest concentration the laboratory can detect for a particular analysis might be higher than the regulatory action level for the contaminant. As a result, concentrations reported as undetectable might still be of serious concern.

A large number of samples analyzed with real-time measurement can provide a more accurate picture of site conditions than a smaller number of samples sent to an off-site laboratory.

2. On-site data analyses are not legally defensible.

Analytical data generated in the field should be legally defensible as long as:

- The logic behind the use of a particular method is sound
- The decision-making use of the data is appropriate given the method's capabilities
- Proper quality assurance/quality control procedures are used
- Qualified staff operate the equipment

For more information, see Barton P. Simmons, Using Field Method Experience and Lessons: Defensibility of Field Data, available at **www.clu-in.org/download/char/legalpap.pdf**

Using Previously Generated Data

If using data collected more than a year before the current investigation, the consultant must be able to explain why the information was considered reliable. To help ensure this reliability, the consultant should:

- If possible, interview the person who generated the data about was done and what quality assurance methods were used
- Take samples in key areas to test the CSM predicted by the historical data – over time, contaminants can move and/or degrade in the environment. If the current data confirms these predictions, you can place more confidence in the older data
- Look for historical trends in contaminant concentrations, such as seasonal variations

3. Clear Reporting

The environmental consultant must prepare a report summarizing the site investigation (SI) activities and their results in detail. The SI report should delineate the nature and extent of contamination and provide recommendations for future corrective actions at the site (e.g., additional investigation or remediation), including information to justify the recommendations.

In addition to presenting the data, the site investigation report must clearly explain what was done at the site and why each decision was made. The report should contain text and graphics (preferably 3D maps) to explain the refined Conceptual Site Model that has resulted from the characterization effort.

An incomplete or unclear report can result in lengthy regulatory review, causing significant delays and cost increases. In order to lessen delays during the regulatory review or problems during a post-project audit, your consultant's SI should:

- Include a stated purpose or goal
- Document adequate research of the site's history
- Clearly present data
- Demonstrate that the analytical methods used were appropriate
- Discuss all data, including each outlier, and not oversimplify complex data
- Clearly define the extent of contamination and potential risks, particularly to off-site areas
- Identify each area of concern and which contaminant(s) at each are above and which are below the applicable state or federal standard

- Demonstrate that the data support the conclusions reached and decisions made
- Document the assumptions made and models used to determine potential risk
- Propose next steps

Supporting Materials

The site investigation report must address all applicable state-specific requirements for maps, tables and other information. In addition to the information discussed in the previous sections, the following items should be included, whether or not they are specifically required:

- Refined CSM including supporting text and graphics
- Site figure, drawn to scale and generally larger than 8 1/2 by 11, showing:
  - north arrow
  - an accurate and descriptive key
  - property lines and surrounding land usage
  - utilities, underground storage tanks (USTs), underground injection controls (UICs), floor drains, etc.
  - areas of potential concern (such as chemical storage areas or public water supplies)
  - all sampling locations (past and present) and analytical results, highlighting any that exceed standards (this may require more than one figure, color coding, etc.)
  - if the property is being redeveloped, an overlaid schematic of the conceptual plan
- Groundwater contour map, including flow direction, classification, and depth to groundwater
- Groundwater and soil contamination contour maps for each contaminant detected, including sampling locations
- Table of all samples taken, including sample depths, analytical analysis performed, analytical results, applicable standards, etc.
- Graphs depicting data trends if data over time are available
- Copies of all analytical reports from laboratories, including QA/QC documents
- Color digital photographs of primary areas of concern and other relevant information that could be photo-documented to compliment the text of the report – a picture is worth a thousand words

Including this information can greatly improve report clarity, thereby decreasing the chance that state regulators will need to request additional information.

4. Compliance with State Requirements

Details on state-specific regulations and reporting requirements can be found at:

Connecticut Department of Environmental Protection
Bureau of Waste Management
(860) 424-3021
www.dep.state.ct.us/wtr/remediation
www.dep.state.ct.us/wtr/regs/remediationregs.htm

Maine Department of Environmental Protection
Bureau of Remediation and Waste Management
(207) 287-2651
www.maine.gov/dep/rwm
www.maine.gov/dep/rwm/rem/statute.htm

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup, Division of Response and Remediation
(617) 292-5500
www.mass.gov/dep/cleanup
www.state.ma.us/cleanup/laws/regulati.htm

Note: In Massachusetts, site investigation is known as a Phase II investigation.

New Hampshire Department of Environmental Services
Waste Management Division
(603) 271-2900
www.des.state.nh.us/orcb_hwrb.htm
www.des.state.nh.us/orcb/doclist/wm1403.pdf

New Jersey Department of Environmental Protection
Site Remediation and Waste Management
(609) 292-1250
www.nj.gov/dep/srp
www.nj.gov/dep/srp/regs/techrule

New York Department of Environmental Conservation
Division of Environmental Remediation
(518) 402-9706
www.dec.state.ny.us/website/der
www.dec.state.ny.us/website/der/guidance

Rhode Island Department of Environmental Management
Office of Waste Management
(401) 222-2797
www.dem.ri.gov/programs/benviron/waste
www.dem.ri.gov/pubs/regs/regs/waste/remreg04.pdf

Vermont Department of Environmental Conservation
Waste Management Division
(802) 241-3888
www.anr.state.vt.us/dec/wastediv/sms/sites_management_section.htm
www.anr.state.vt.us/dec/wastediv/sms/SI_Procedures.pdf

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