CHAPTER 3
PLANNING

Each SI requires a site-specific work plan, sample plan, health and safety plan, and investigation-derived wastes (IDW) plan. These plans help investigators adhere to planned procedures in their field work and identify potential sources of error that could jeopardize the quality of analytical data. Specific plans also facilitate the investigation by defining the activities that will produce information needed to meet SI objectives. This chapter discusses key elements to consider in SI planning and provides background information on sample collection issues to help design the SI and assess the usability of available data. This chapter also provides guidance on SI project management and on site reconnaissance. Special guidance on SI planning for sites containing radioactive substances is provided at the end of the chapter.

3.1 SAMPLE COLLECTION ISSUES

The SI collects selective samples to demonstrate that hazardous substances are present and to determine whether they have migrated from their original locations. The SI differs from traditional approaches to environmental monitoring, for which samples are collected to represent "average" contamination in the environment. For Sl selective and limited sampling, careful planning for data collection is essential to avoid sampling errors.

When sampling is limited, the probability of false negatives in samples increases. "False negative" means a hazardous substance is present but not detected. The potential for false negatives in samples underscores the importance of a well-designed sample plan for the site. Conclusions based on false negative data may result in decisions that do not protect human health and the environment. False positive samples—substance is detected but is not present at the site—are also undesirable; however, they often can be identified by evaluating quality control sample results. The frequency of false positives is normally influenced by sampling and analytical procedures, and not by the sampling approach.

This section provides information on sample types and sample variability that will help the investigator design and implement an effective sample plan.

3.1.1 Sample Types

Normally, SI sampling strategies require biased sampling, also known as non-random or judgmental sampling. Biased sampling uses knowledge of the site and visual observations to propose sample types and locations. Table 3-1 summarizes sample types and their advantages and disadvantages.

SI samples are generally waste source samples or media (environmental) samples. Most SI samples are media samples of ground water, surface water, soil, or air. Analytical data from media samples indicate the presence or absence of hazardous substances released to the environment, exposure of humans to hazardous chemicals, or contamination of the environment. Because concentrations of hazardous substances in media samples may have been diluted by environmental influences, proper sampling procedures are particularly important—even minimal sample contamination or loss could significantly affect analytical results. Source sample results identify hazardous substances present and support attribution of contamination to site operations.

The SI sample plan may specify several types of samples. Grab samples represent chemical conditions at a specific location. They offer the most information regarding hazardous substance variability and are recommended to investigate observed releases

TABLE 3-1: TYPES OF SAMPLES

Sample Type	Advantages	Disadvantages
Biased (non-random, judgmental)	Promotes timeliness Uses knowledge of site Focuses sampling effort	Decreases representativeness Increases chance of false negatives
Unbiased (random, systematic grid)	Increases representativeness Reduces chance of false negatives Allows limited site knowledge	Increases cost Increases time required
Grab	Increases representativeness and variability	Requires more samples Requires careful placement
Composite	Reduces cost Increases area of investigation Reduces chance of false positives	Provides average concentrations only Allows substances to interact
Media	Supports releases Supports target contamination	May require off-site access permits Subject to temporal variation
Waste	Optimizes contaminant identification Supports attribution	May result in elevated concentrations May require sample dilution May require special procedures and equipment
Filtered	Allows comparison with drinking water benchmarks	Comparison with surface water environmental benchmarks not valid May increase sample handling errors
Unfiltered	Allows comparison with surface water environmental benchmarks	Comparison with drinking water benchmarks not valid

and target exposure to contamination. Composite samples consisting of several grab samples represent average concentration values and may be used to identify hazardous substances present in sources.

Aqueous samples may be filtered or unfiltered. Most samples collected during the Sl are unfiltered (see Table 3-2). Because laboratory analysis of unfiltered samples can release metals loosely bound to suspended solids in water, metal concentrations can be overestimated. For this reason, filtered samples are recommended to establish an observed release of metals in a drinking water supply, although either filtered or unfiltered samples are acceptable. Even highly turbid filtered water samples can be compared to health-based drinking water regulatory standards, such as Maximum Contaminant Levels (MCLs).

Monitoring well and surface water environmental target aqueous samples should not be filtered in the field, unless they are to be compared to filtered samples to establish observed releases. Likewise, filtering is not needed when establishing actual contamination of a drinking water supply by organics. Therefore, when the full range of hazardous substances at a site is unknown, collecting both filtered and unfiltered water samples may be warranted. *Hazard Ranking System (HRS) Guidance Manual* and *Guidance for Data Useability in Site Assessment* (both in development) may provide more information on using filtered or unfiltered water samples for HRS scoring.

3.1.2 Sample Variability

The sample plan should minimize the potential for errors related to sampling procedures. Errors resulting from improper sampling are often several times more significant than errors introduced by analytical procedures. To minimize these errors, the investigator should: adhere to standard operating procedures (SOPs); choose appropriate sampling equipment, containers, and preservatives; and plan the sequence of, and schedule for, sample collection.

Samples may reflect variability in collecting and handling samples, or variability of hazardous substances with location, time, or medium.

Sample Collection and Handling Variability

Errors introduced by sample collection and handling variability can change sample concentrations due to incorrect sampling procedures, cross-contamination, and improper sample preservation. Variability caused by error can be reduced through training and by performing all sampling activities in accordance with SOPs. Adhering to SOPs can reduce or eliminate

TABLE 3-2: FILTERED AND UNFILTERED WATER SAMPLES

HRS PATHWAY/ THREAT	METALS ANALYSIS	ORGANIC ANALYSIS	SAMPLES FROM KARST AQUIFERS
Ground Water	Filtered/Unfiltered	Unfiltered	Unfiltered
Surface Water	Filtered/Unfiltered	Unfiltered	Not Applicable
Drinking Water Threat	Filtered when compared with MCLs, MCLGs[1], and Screening Concentrations	Unfiltered	Not Applicable
Environmental Threat	Unfiltered when compared with AWQCs[2] and AALACs[3]	Unfiltered	Not Applicable

[1]MCLG — Maximum Contaminant Level Goals
[2]AWQC — Ambient Water Quality Criteria
[3]AALAC — Ambient Aquatic Life Advisory Concentrations

variability within and between sites for a given sampling method. Collection and handling errors can rarely be corrected without additional sampling and analysis. Before implementing any non-standard procedure, the investigator must assess whether changes may jeopardize data quality.

Potential contamination problems attributable to sampling devices, sample containers, or construction materials include cross-contamination, hazardous substance sorption, and chemical leaching (see Table 3-3). The importance of decontamination increases when investigating barely detectable concentrations. By planning carefully, the investigator can reduce and possibly eliminate contamination. In particular, the SI investigator should remember that polyvinyl chloride (PVC) and other plastics (except Teflon®) tend to absorb organics, and that some halogenated organic compounds and pesticides adsorb to glass surfaces.

Contamination from substances leaching from sampling or monitoring equipment is a particular problem in water samples and may contribute to false negative or false positive results. Contaminants may have analytical interference effects, decreasing or even preventing quantification of the substances of concern. If any samples have been contaminated by equipment, resampling may be needed. Equipment decontamination is particularly important following sampling in areas of suspected high concentrations of hazardous substances. When possible, background and media samples should be collected before waste or source samples.

Confirming the purity of preservatives is important in planning. Contaminated, outdated, or improperly stored preservatives can place analytical results outside the limits of random error.

Holding time—how long a sample can be stored before preparation and analysis without significantly affecting the analytical results—will vary from sample to sample, depending on the substance, preservation technique, and analytical method.

Spatial Variability

Spatial variability—how substances and their concentrations vary from one location to another—depends on the substance and site conditions. As a general rule, variability increases as a source becomes less uniform. In some media, such as soils, spatial variability can be significant. Potential sampling problems due to spatial variation can be significantly

TABLE 3-3: POTENTIAL CONTAMINANTS FROM SAMPLING DEVICES AND WELL CASINGS

MATERIAL	POTENTIAL CONTAMINANTS
Rigid PVC-threaded joints	Chloroform
Rigid PVC-cemented joints	Methyl ethyl ketone, toluene, acetone, benzene, methylene chloride, organic tin compounds, tetrahydrofuran, ethyl acetate, cyclohexanone, vinyl chloride
Flexible or rigid Teflon® tubing	None detectable
Flexible polypropylene tubing	None detectable
Flexible PVC tubing	Phthalate esters, other plasticizers
Soldered pipes	Tin and lead
Stainless steel containers	Chromium, iron, nickel, molybdenum
Glass containers	Boron, silicon
Source: Keith, 1991	

reduced by using previous site information and professional judgment in choosing sample locations. Chapter 4 provides guidance in selecting locations.

For homogeneous sources (e.g., single phase liquid in a tank), spatial variability is reduced, and limited sampling to determine hazardous constituent or wastestream quantity may be appropriate. Representative sampling to determine the HRS hazardous constituent quantity at heterogeneous sources is generally not within the scope of an SI.

Temporal Variability

Hazardous substance concentrations may depend on variables such as the time of day or season of the year. Often the most important temporal variable is weather (i.e., temperature or rainfall). Because weather follows cyclical patterns over a day or year, time-dependent substance levels are expected to follow similar cyclical patterns. The investigator should identify the cyclical nature of the substance concentrations caused by temporal variability and sample when concentrations are expected to be highest. For example, during colder weather a volatile compound may be less readily released than during warmer weather.

For SIs, the duration and frequency of sampling are normally not a consideration, because one-time sampling usually accomplishes the objectives of the investigation. In some instances, however, seasonal variations or weather patterns may require more than one sampling episode.

Media Variability

Sampling concerns vary according to medium (see Table 3-4). Each of the variability concerns discussed above may be affected by the particular medium

TABLE 3-4: SAMPLING ISSUES AFFECTING CONFIDENCE IN ANALYTICAL RESULTS

MAJOR SAMPLING ISSUES	SOIL/ SEDIMENT	GROUND WATER	SURFACE WATER	AIR	AQUATIC ANIMAL TISSUE	SOURCE MATERIAL
Hazardous Substance Migration	✓✓	—	✓	✓	—	✓✓
Temporal Variation	—	✓	✓✓	✓✓	✓	—
Spatial Variation	✓✓	—	✓✓	✓	—	✓✓
Topographic and Geological Features	✓✓	✓✓	—	✓	—	—
Hot Spots	✓✓	—	—	—	—	✓✓
Sample Collection	✓	✓	✓✓	✓✓	✓✓	✓
Sample Preparation and Handling	✓✓	✓✓	✓✓	✓✓	✓✓	✓
Sample Storage	—	✓✓	✓✓	✓✓	✓✓	—
Sample Preservation	—	✓✓	✓✓	—	✓✓	—

Key: ✓✓= Likely source of significant sampling problem
✓ = Potential source of sampling problem
Source: Modified from Keith, 1990

being examined. Sensitivity, precision, and accuracy of the analysis also are potentially affected by the medium.

For heterogeneous media (e.g., soil, surface water), strata should be defined and samples specified by stratum. Media heterogeneity influences both the sampling strategy and data usability.

Surface Water and Ground Water Samples: The heterogeneous nature of water often results in stratification of hazardous substances and requires special sampling and handling procedures. In deeper surface waters, flow may be reduced, resulting in chemical and thermal stratification. Stratification also may occur in lake and ocean samples and in locations where mixing occurs, such as the convergence of two streams or estuarine or near-shore environments. Density and solubility characteristics also can result in stratification. Some liquids, such as halogenated organic compounds, are heavier than water and will sink, while others, such as oils and solids, are lighter than water and tend to float on or near the surface. Surface water collected at the surface should not be compared to samples collected at depth. Samples collected in a tidally influenced area must not be compared to samples collected in fresh water. Aqueous samples must not be compared to sediment samples.

Background and environmental samples must be similar. For the ground water pathway, water samples should be collected from the same aquifer and at approximately the same depth (elevation) in the aquifer. Differences in physical parameters (such as iron content or pH) may indicate that samples have been collected from different aquifers. Since different aquifers can have very different contamination levels and water chemistry, background wells used to establish observed releases must be screened in the same aquifer. Interconnected aquifers are not considered as one aquifer under the HRS, and samples from one aquifer generally should not be compared to samples from an interconnected aquifer to establish an observed release.

Sampling devices should be selected to minimize aeration of the water sample, thereby reducing volatilization or oxidation of hazardous substances. Aeration is a common problem when bailers are used to sample wells. If bailers are used, water field blanks are recommended to detect absorption of air contaminants introduced during sample transfer.

Soil and Sediment Samples: Heterogeneity of media, size, and distribution of particles, and bias introduced by sampling and analysis cause variability in soil and sediment samples. Substantial variability in a single soil Pipe may result from lateral heterogeneity, soil horizons, and grain sizes. Primary soil heterogeneity is due to the parent material, as well as vegetation, slope, climate, and weathering. Vertically composite samples may help overcome the lack of homogeneity in the distribution of chemical species; however, peak values from composite samples may be diluted.

The investigator must document location, depth, and description of the soil to determine the relationship of background to other samples. If the depth and thickness of soil horizons vary with location, the SI investigator must ensure that samples to be compared are from the same horizons and soil types.

Air Samples: Atmospheric conditions are always a concern in air sampling, since some conditions tend to lower detectable concentrations. Conditions that may influence air sample results include:

- Wind speed and direction
- Temperature
- Relative humidity, including precipitation
- Terrain
- Atmospheric stability

Air sample results are unusable if wind direction was not monitored. Wind speed and direction data may be required to establish the migration pattern of emissions from a source. A slight shift in wind direction can substantially alter the amounts of hazardous substances collected in an air sample over a short period of time.

Tissue Samples: Significant variations often occur in sampling human food chain organisms. Differences between species, variations within the species, species mobility, and tissue differentiation present unique challenges. Factors that complicate tissue sampling include:

- Type of organism
- Age of individual

- Population size
- Availability and cost of sampling materials Migratory organisms
- Seasonal, feeding, spawning, or other periodic activities that influence concentration or location of the substances within an organism

Individual organisms should be chosen at random from a well-defined population. Documentation should include the reasoning behind which parts (e.g., filet) of the specimen were analyzed and the accuracy of the measurement.

Containerized Material: Samples from containers (e.g., drums, tanks) can be heterogeneous, especially when different liquids are present, resulting in multiple layers of immiscible liquids. Sampling should be designed to obtain a representative sample of the liquid at all depths. Composite samples from various depths within the container may help overcome the heterogeneity, although hazardous substance concentrations may be underrepresented. If peak concentrations of various hazardous substances are required, several grab samples should be analyzed. Documenting collection procedures will be important to evaluate the use of these data.

3.2 FIELD QA/QC CONSIDERATIONS

Proper field documentation is an important part of the QA/QC program. Field documentation includes accounting for procedures or SOPs to record sample locations, label samples, maintain the chain-of-custody process, and document field observations and measurements. Any deviation from SOPs should be carefully noted. Failure to provide proper documentation can limit the use of analytical data, contribute to uncertainty in the analytical results, and compromise the legal defensibility of the data.

Collection and analysis of QC samples are important aspects of the QA/QC program. Sampling and analysis provide numerous opportunities for errors that contribute to the uncertainty of analytical results. Field QC samples help evaluate analytical results and field methods. Field QC samples must be collected, stored, transported, and analyzed in the same manner as site samples. The laboratory analyzing the samples should not know which are QC samples. These practices ensure that the QC results reflect routine procedure and reliably indicate the quality of field methods, analytical methods, and site sample data.

Table 3-5 summarizes field QC samples appropriate for the SI. Regional guidelines should be consulted to determine the number and type of QC samples, which may be the following:

Co-located or duplicates are usually two samples collected at the same time and location. They are used as measures of either the homogeneity of the medium sampled in a particular location or the precision in sampling.

TABLE 3-5: TYPICAL SI FIELD QC SAMPLES

TYPE OF SAMPLE	PURPOSE
Field Duplicate	To estimate medium homogeneity and sampling precision
Field Blank	To estimate bias caused by contamination introduced during field sampling and laboratory analysis; to compare with laboratory method blank to determine source of contamination
Trip Blank	To estimate bias due to contamination from migration of VOCs into the sample during shipping from the field storage at the laboratory
Field Rinsate	To estimate bias caused by contamination from sampling equipment; to indicate cross-contamination, poor decontamination procedures, and potential contamination due to sampling devices

A comprehensive and well-documented quality assurance/quality control (QA)QC) program is essential to obtain precise and accurate data that represent the site and are scientifically and legally defensible.

Replicates or splits are usually one sample that is divided and sent to the same or separate laboratories for analysis. Replicates are used to check instrument precision and accuracy of a laboratory analysis. Samples may be split for independent analysis.

Field blanks are samples of contaminant-free medium that are either transferred from one container to another in the field or exposed to field conditions. These samples are used as an indicator of sample contamination during the entire process, including sampling, transport, sample preparation, and analysis. They are especially critical as concentrations approach detection limits.

Trip or transport blanks are prepared from contaminant-free media prior to the SI in extra sample containers. They are kept unopened with site samples throughout the field investigation. They are used to measure possible contamination, particularly crosscontamination, introduced during collection, shipping, and storage of samples.

Field rinsates (or equipment blanks) are samples of deionized water (or the decontamination solution) flushed through sampling equipment (e.g., bailer, pump, auger) after decontamination and before resampling to monitor decontamination procedures. Although not routinely collected, field rinsates analyzed via field analytical screening techniques can be extremely valuable in indicating and correcting cross-contamination during sampling.

Field matrix spikes are samples prepared in the field by adding a known amount of contaminants to selected site samples. They are used to identify field, transportation, and matrix effects. Because of the possible sources of error in preparing field spikes, they are not recommended during the SI unless specialized technical support is available. Any results should be compared to laboratory matrix spike results.

3.3 HRS SAMPLING CONSIDERATIONS

Sample planning should reflect the importance of data collection in the HRS process. The investigator needs a good understanding of the HRS to develop an appropriate sample plan and to improve the quality and usefulness of SI information. The following HRS elements require sample data:

Site and Source Characterization: Analytical data are important in characterizing sites and sources, primarily to identify hazardous substances present in site sources. Analytical data also support determining hazardous waste quantity, delineating source dimensions, and investigating the degree of source containment.

Observed Releases and Areas of Observed Contamination: Analytical data may provide direct evidence of an observed release of hazardous substances to affected media, demonstrate significant contamination (observed contamination in the soil exposure pathway), estimate areas of contamination, and show that the contamination is attributable to the site. For an observed release (or observed contamination), significance relates only to the concentration found in a particular pathway or medium, not to the environmental or health effects of that release.

Levels of Contamination at Specific Targets: Analytical data are required to document actual contamination of targets, including wells and surface water intakes supplying drinking water, residential and school properties; and fisheries, wetlands, and other sensitive environments. If data do not demonstrate that targets are exposed to actual contamination, targets are evaluated as potentially exposed. The HRS levels of contamination are:

- **Level I:** Concentrations that meet the criteria for actual contamination (e.g., observed release or observed contamination), and are at or above media-specific benchmark levels (see Table 3-6).

- **Level II**: Concentrations that either meet the criteria for actual contamination but are less than media-specific benchmarks, or meet the criteria

TABLE 3-6: MEDIA-SPECIFIC BENCHMARKS

HRS PATHWAY/THREAT	BENCHMARKS[1]
Ground Water	Maximum Contaminant Levels Maximum Contaminant Level Goals Screening concentrations[2,3]
Surface Water	
Drinking Water Threat	Maximum Contaminant Levels Maximum Contaminant Level Goals Screening concentrations[2,3]
Human Food Chain Threat	Food and Drug Administration Action Levels Screening concentrations[2,3]
Environmental Threat	Ambient Water Quality Criteria Ambient Aquatic Life Advisory Concentrations
Soil Exposure	Screening concentrations[2,3]
Air	National Ambient Quality Standards National emissions standards for hazardous air pollutants Screening concentrations[2,3]

[1]See Superfund Chemical Data Matrix (SCDM)
[2]Screening concentrations for cancer corresponding to concentrations for the 10^{-6} individual cancer risk for oral exposure (inhalation exposure for the air pathway)
[3]Screening concentration for noncancer toxicological responses corresponding to RfDs for oral exposure (inhalation exposure for the air pathway)

for actual contamination based on direct observation.

- **Potential:** No observed release is required but targets must be within the target distance limit.

Level II contamination is assigned to targets meeting the criteria for actual contamination when none of the eligible substances for a pathway or threat has an established benchmark.

The HRS assigns different relative weights to targets associated with the three levels of contamination. For all pathways and threats, Level I contamination target values are multiplied by 10, Level II contamination target values are multiplied by 1, and potential contamination target values are multiplied by 0.1. The presence of targets exposed to actual contamination may significantly affect the site score. Generally, actual contamination can only be supported with analytical sampling data; therefore, proper selection, collection, and handling of target samples is critical to the success of the SI.

Target Distances: In some instances, analytical data may be used to establish target distance limits. Analytical data also may be used to identify sample locations to make measurements for HRS data requirements (e.g., depth to aquifer, distance to surface water, distances to nearest targets).

3.4 SAMPLE ANALYSIS OPTIONS

The SI investigator must Plan which analytical methods and services to use. Although laboratory analyses are routinely used, field analyses may often

provide the type and quality of data needed to support site assessment decisions, and satisfy data quality objectives (DQOs). To select analytical methods and services, the Sl investigator should consider:

- Available information to identify substances present
- Objectives of the SI (e.g., screening or listing)
- Quality of data needed to support decisions or planning activities
- Availability of services
- Desired turnaround time
- Anticipated number of samples to be analyzed
- Need for special separation or analysis techniques
- Need for lower detection limits
- Need for real-time monitoring
- Comparability and representativeness of data sets

In general, DQOs for analytical data generated during the focused SI may be less demanding than the objectives for data generated during the expanded SI. In addition, lower levels of data quality may be acceptable to screen a site rather than document a site score. The minimum data quality requirements for scoring depend on the specific HRS factor being evaluated. Investigators should be familiar with minimum data quality requirements so they may plan SI sampling and analysis strategies that accomplish the dual goals of meeting DQOs and minimizing sampling and analysis costs.

Sl samples are analyzed by contract laboratory program (CLP) and non-CLP laboratory services. CLP services may be provided through routine analytical services (RAS) and special analytical services (SAS). Non-CLP. services include field analytical support project (FASP) methods. The SI investigator should ensure that non-CLP services meet the DQOs of the SI.

3.4.1 CLP Services

CLP provides analytical services, including sample data management, through a nationwide network of laboratories under contract to EPA. CLP acceptance criteria ensure data of known quality with a high degree of confidence. CLP data satisfy the highest data quality criteria EPA has established for the HRS (i.e., Data Use Category (DUC) I). Therefore, CLP data can typically be used to evaluate all HRS factors requiring analytical data. Sometimes CLP data, like other analytical data, are qualified (e.g., J, R data codes), which may affect their application. However, since CLP codes are nationally consistent, defining how the data can be applied in scoring may be easily determined, as described in *Guidance for Data Useability in Site Assessment*. Non-CLP services may vary in their criteria for qualifying data, so the investigator should determine whether the laboratory's coding criteria are compatible with the DQOs of the investigation.

Under CLP, the majority of analytical needs are met through standardized laboratory services provided by RAS. RAS currently concentrates on analysis of organics and inorganics in water or solid samples. Other types of analysis may be scheduled as SAS. Among the SAS procedures are air and tissue sample analyses and detection of dioxins.

RAS provides broad-spectrum analyses for target analyte list (TAL) and target compound list (TCL) hazardous substances. TAL and TCL are recommended for SIs at CERCLA sites where the composition of wastes are not known. However, full TAL and TCL analyses may not be necessary for all investigations, especially if source hazardous substances are well known and analyses can be narrowed down to measure specific compounds. For example, results from previous investigations can be used to focus CLP analyses for specific substances or classes of substances (e.g., pesticides, volatile organic compounds) to investigate releases, observed contamination, or targets exposed to actual contamination. If partial analyses are scheduled, the investigator should determine whether the resultant data will be representative of the risks at the site and similar to other data sets.

The *Users Guide to the Contract Laboratory Program* (OSWER Directive 9240.0-01D) and the *Samplers Guide to the Contract Laboratory Program* (OERR Directive 9240.0-06) provide information on CLP services. Section 5 of *A Compendium of Superfund Field Operations Methods* (OSWER Dir. 9355.0-14) explains procedures for using CLP laboratories and non-CLP laboratories.

3.4.2 Non-CLP Services

Non-CLP services may provide data of quality similar to CLP. Non-CLP laboratories near the site may be appropriate if fast turnaround is needed. If non-CLP services are used, analytical protocols, data qualifier assignments, and reporting parameters and requirements need to be specified in the packages sent to bidders. For EPA-lead sites, laboratories receiving invitations to bid have usually been approved by the EPA Regional QA representative. For State-lead sites, non-CLP services are usually subcontracts with the prime contractor and are specified when the project is initiated.

Non-CLP data may be CLP quality (DUC I) or lesser quality (DUC II or III). For SI planning purposes, these categories are roughly comparable to the quality of data needed to document a site score, test site hypotheses, or plan sampling. *Guidance for Data Useability in Site Assessment* provides a detailed discussion of sample analysis considerations.

The SI may use FASP to provide onsite screening of samples for suspected hazardous substances. Field screening instruments range from the relatively simple (e.g., hand-held organic vapor detectors) to the more sophisticated (e.g., field gas chromatographs) and typically are calibrated to identify only selected substances. When the investigator is relatively certain of the hazardous substances expected to be found at the site, FASP methods may be appropriate.

As with non-CLP services, FASP and other field screening methods provide data of variable quality that are useful to plan SIs, test hypotheses, and to some extent, evaluate the HRS score. For example, screening data analyzed in the field can be used to establish source boundaries and select sample locations, thereby reducing CLP costs, particularly at larger hazardous waste sites where widespread soil contamination is suspected. FASP data can also facilitate scoring releases and actual contamination. When field screening results are used directly to support scoring, 10 to 20 percent of the screening results should be confirmed by CLP analyses. However, such confirmation may not be necessary for the focused SI, depending on the quality of other analytical data.

FASP analyses (or other field screening analyses) may also help to:

- Design soil sampling grids.
- Select well locations based on soil gas monitoring.
- Select well screen depths.
- Determine the extent of hazardous substance migration.
- Estimate hazardous waste quantities (particularly based on area estimates).

In planning field screening services, the investigator should be aware of several important constraints:

- The hazardous substances must be confirmed by CLP quality data.
- Not all substances are amenable to field methods. Complex sample matrices, high hazard samples, and certain substances (e.g., dioxin) are best analyzed under the more controlled conditions of a fixed laboratory.
- The sample plan for field screening, like the CLP plan, must be reviewed by EPA Regional management.
- A QA plan specific to sampling and analysis should be prepared, including a description or reference to all analytical procedures.

3.5 REVIEW INFORMATION FOR SI PLANNING

Before developing SI plans, the investigator should compile all relevant and available site data. Review of the data should determine what additional work is needed and, for expanded SIs, any remaining nonsampling information needed for HRS documentation. Review of available information also will help avoid duplicating previous efforts and save resources.

Information describing hazardous waste sources, migration pathways, and human and environmental targets is available from many sources. Previous Superfund investigations typically supply the most useful information for SI planning. Other sources of information are site investigations conducted by other parties, investigations of nearby sites listed in CERCLIS, and the CLP Analytical Results Database

(CARD), which compiles information on EPA environmental sampling.

The SI investigator should refine the site hypotheses as new information is gathered and the nature of the problem at the site is better understood. New information also may require updating the preliminary site score, or modifying the scope of the SI. The investigator should assess whether available information:

- Helps characterize site sources.
- Supports testing of site hypotheses.
- Provides information for site scoring.
- Guides further sampling and analysis.
- Indicates the need for emergency response actions.
- Indicates health and safety concerns.

The scope of the SI often depends on the quality of previous analytical data supporting the evaluation of significant pathways of concern. By reviewing available information, the investigator can determine the starting point of the SI and identify further information needed to test or substantiate site hypotheses and satisfy HRS data requirements. Each planned SI sample location should reflect these needs. The investigator may find that substantial data requirements have been satisfied and further sampling is not necessary. For example, when existing analytical data from a critical sample location (e.g., municipal well, fishery) adequately test or support a site hypothesis, resampling in this location may not be necessary.

3.5.1 Review Non-Sampling Information

The review of non-sampling information contributes to understanding the site. This knowledge serves two purposes:

- To help determine the scope of future sampling efforts by verifying the physical characteristics of the site and its surroundings, particularly target locations.
- To determine if existing hypotheses are sound.

Because site hypotheses are the basis of the sample plan, they should reflect current conditions and be well-founded. Inaccurate target information may preclude the development of realistic site hypotheses and an effective sample plan. For example, target information based on an outdated PA may not include a new housing development near the site. The investigator should update target information if necessary and determine the significant pathways of concern. Other circumstances that may warrant collecting additional non-sampling information prior to sample planning include flooding of the site, natural disasters, removal of wastes, and altered conditions.

Non-sampling information may come from a variety of sources, including EPA and other Federal agency studies, State and local environmental and health studies, academic studies, and the records of present and former owners and operators of the facility.

3.5.2 Review Analytical Data

The SI investigator should review any available analytical data for information to support the design of the sampling and analysis program, test site hypotheses, and document the site score. While analytical data collected for other purposes may not meet SI objectives, site-specific analytical data generally help to clarify the nature of the problem at the site, regardless of data sources or data quality. The scope of the review depends on the overall quality and quantity of data, the intended use of the data, and whether they are representative of current site conditions and comparable to SI data. Determining whether available data can be applied as SI-generated data requires the professional judgment of an experienced reviewer. Table 3-7 provides some general guidelines for using various types of data.

Both validated and non-validated analytical data may be available. Previous SI data generally will be validated and of CLP-quality. Non-validated data may contain false positives and false negatives, as well as quantitation, transcription, and calculation errors. If data of unknown or questionable quality are critical to make decisions, the investigator should review all available information to assess the level of certainty associated with the data. If these data are used for HRS documentation, they may have to be validated.

TABLE 3-7: TYPES OF ANALYTICAL DATA

TYPE OF DATA	APPLICATION
CLP	No specific limitations; used as necessary for all SI activities
Qualified CLP	Some general limitations depending on types of data qualifiers and bias (e.g., unknown, low, high) associated with the data
Non-CLP	Few limitations if non-CLP data are shown to be equivalent to CLP data (e.g., level of QA/QC documentation, level of laboratory performance, level of data quality, independent data quality review) Limitations if non-CLP data cannot be shown to be comparable to CLP data
Field screening	Augments SI samples, especially to investigate area of contamination
Owner/operator	Few limitations; used as necessary for all SI activities

The investigator may be able to determine the general quality of the data by reviewing QC data. False positives can occur when blanks are contaminated or pike recoveries are very high. False negatives can occur if spike recoveries are very low. If hazardous substances are found in one duplicate but not the other, results may be false positives or negatives.

The investigator should ensure that non-SI analytical data accurately represent conditions at the site when used to test site hypotheses. For example, a release to ground water may be suspected based on site characteristics (e.g., shallow ground water, heavy rainfall, high infiltration, waste disposal below ground) but not supported by non-SI analytical data. The non-SI data may be unreliable due to changed site conditions, or the samples may not have been collected from the appropriate location. These data should not be applied to override reasonable site hypotheses based on strong information on site characteristics unless the investigator is confident that sampling results are reliable, of adequate quality, and truly representative of the site.

Older data may not reflect risks from continuing hazardous substance migration, and partial analyses may not identify all hazardous substances present at the site. If previous samples were not collected from areas where contamination is suspected, false negatives may result. Careful review of both the sampling design and overall data quality helps determine whether non-SI data confidently test site hypotheses. Table 3-8 provides a general approach to review previous analytical data.

Combining data sets from different sampling and analyses events may not be appropriate when non-SI data are used to document the HRS evaluation. Problems in comparing sample results generally are caused by differences in the sample design and time periods—for example, a water sample collected during a period of high precipitation may not be comparable to a water sample collected during the dry season. Comparability also is a problem if analytical methods differ or if detection limits are unknown. The use of routine analytical methods simplifies comparability when combining data sets because all laboratories follow the same standardized procedures and reporting requirements.

The amount of previous analytical data varies substantially. Full data review may be appropriate for smaller amounts of data. For larger data volumes, the investigator may choose to screen for useful sample results before review. Different levels of data review allow the investigator to efficiently assess previous data within the time and resource constraints of the SI. Automated data review systems (e.g., Computer

TABLE 3-8: REVIEW OF PREVIOUS ANALYTICAL DATA

PROCEDURE	CONSIDERATIONS
Determine what data are available	What are the types of previous data: CLP, non-CLP, field screening, full TCL analysis, partial TCL analysis, owner/operator, State?
Evaluate purpose and scope of previous investigations	Why were data collected? What type of investigation: State or Federal Facility investigation, enforcement action, emergency response, RCRA facility inspection, general assessment of ground water quality, environmental property assessment, NPDES permit requirements?
Review sampling locations, dates, depths, and sample descriptions	Was the design of the sampling program similar to the SI sampling strategy? Did it include background samples and field QC samples? Are a sample plan and sample location map available? Is a field notebook available that describes all sampling activities?
Evaluate the sampling results and hazardous substance concentrations	What hazardous substances were detected? What are the range of concentrations, background levels, data qualifiers and codes attached to data, and detection limits?
Review field preparation and collection techniques for previous samples	Were appropriate SOPs used for sample collection and handling?
Review available laboratory documentation	Are QA/QC procedures or data validation procedures available? What are the name of the laboratory, the type of analyses performed, and the performance results?
Assess usability of previous data	What is the overall usability of the data set?

Assisted Data Review and Evaluation (CADRE)) also should be used for large amounts of data.

The data review may focus on:

- The entire site
- Specific sample locations
- Specific hazardous substances
- Elevated substance concentrations
- Ranges of concentrations
- QC assessment
- Background levels
- Attribution considerations

SI DQOs should be flexible to allow use of lesser quality data for screening purposes. Different review levels and quality standards apply depending on the planned end use of data. For the expanded SI, the level of contamination at a target from the site generally requires appropriate background and attribution samples and may require documentation. However, screening a site from further investigation during the focused Sl may not require the same analytical data quality as the expanded SI. To take maximum advantage of previous investigations, all data, including data of lesser quality, should be weighed during SI planning.

EXHIBIT 3-1: CHECKLIST FOR USABILITY OF PREVIOUS ANALYTICAL DATA

1. Have samples been taken at the appropriate location, depth, or stratum to confidently test site hypotheses? ☐ Yes ☐ No

If the answer is "no," additional sampling will likely be needed to fully test hypotheses and provide a basis for the site disposition decision. The data may nevertheless be useful in developing sampling and analysis plans and identifying hazardous substances of concern.

2. Is documentation available to support the analytical procedures used to derive the data (e.g., laboratory QA/QC procedures, type of analyses, detection limits, and data review)? ☐ Yes ☐ No

3. Are representative background levels available for targets exposed to actual contamination and hazardous substances that may demonstrate releases? ☐ Yes ☐ No

4. If background samples are available, are they temporally and spatially comparable to samples indicating releases and exposure of targets to actual contamination? ☐ Yes ☐ No

If the answer to questions 2, 3, or 4 is "no," the data may not support HRS documentation requirements and further review is needed to determine usability. However, the data may support testing of site hypotheses and development of a sampling strategy.

5. Do data provide evidence that attributes the hazardous substances detected in various media and waste samples to the site? ☐ Yes ☐ No

If the answer to question 5 is "no," additional samples will be needed to fully support releases and targets exposed to actual contamination.

If the answers to questions 1 through 5 are all "yes," the previous analytical data may support testing PA hypotheses, identification of hazardous substances of concern, development of a sampling strategy, and HRS documentation requirements, including releases and targets exposed to actual contamination.

3.6 SI PLANS

Site-specific considerations identified during data review are addressed during development of the SI plans. Four plans are developed to help refine the objectives of the investigations and to ensure that SI activities proceed efficiently, safely, and on a nationally consistent basis:

- Work plan
- Sample plan
- Health and safety plan
- Investigation-derived wastes (IDW) plan

SI plans document procedures to be used, resources needed, and the rationale behind the anticipated tasks to ensure that all planning and review steps have been completed prior to starting field activities. The work plan primarily covers administrative activities, while the other three plans cover field activities. The sampling, health and safety, and IDW plans may be sections within the site-specific work plan, or separate documents.

All plans should be prepared with input from all agencies and organizations involved in SI activities. Lead personnel from these organizations should approve and sign all plans.

3.6.1 Work Plan

The work plan specifies administrative and logistical requirements. The purpose of the work plan is to efficiently schedule resources such as personnel, equipment, and laboratory services. Preparing the work plan requires a thorough understanding of the site, its surroundings, and the nature of possible contamination and hazards. Clear and concise work plans are prerequisites for obtaining quality analytical data and making reliable site recommendations.

In general, work plans should include:

- A summary of background information on the site, emphasizing how this information can help identify SI objectives;
- Objectives–for example, "to identify hazardous substances and document a release to surface water,"
- Schedule;
- A description of personnel, special training needs, organization of teams, and equipment requirements; and
- A description of any non-standard equipment and contract services needed.

The work plan must address general considerations and site-specific conditions:

- **Hazards:** What physical or chemical hazards may be encountered? How will they affect time, expense, personnel, or equipment requirements?

- **Location:** Is the site accessible? How far away is the laboratory or home office? Will samples be shipped or hand delivered to the laboratory?

- **Schedule:** Can the site be adequately sampled at this time of year, or will frozen ground or short daylight hours limit sampling? Have recent rains or dry periods affected water levels or created swampy conditions? Does the public frequent the site at certain times?

- **Mobilization/demobilization:** How much time and equipment are needed? Does anything have to be ordered?

3.6.2 Sample Plan

Exhibit 3-2 suggests a general outline for work plan elements combined into the sample plan. Appendix A is an example of such a plan.

The sample plan can be incorporated into the work plan or it may be a separate document. During the focused SI, the PA hypotheses and assumptions, along with information from previous investigations, help identify the specific areas that require samples or additional data. Similarly, the focused SI results are used to identify any remaining HRS data requirements at the expanded SI. The sample plan specifies the locations, types, and number of samples and procedures. A typical sample plan describes:

- **Field operations:** Discusses the sequence for conducting field activities. Identifies the functions of each individual worker, specifying who will take samples, supervise chain-of custody procedures, maintain the field log book, and monitor the site for potential hazards.

EXHIBIT 3-2: SI SAMPLE PLAN OUTLINE

INTRODUCTION

- Briefly state the authority and purpose for conducting the SI and the scope of the investigation. Discuss the objectives and goals of the SI.

SITE DESCRIPTION AND REGULATORY AND OPERATIONAL HISTORY

- Describe the site location. Identify the type of facility, whether it is active or inactive, and years of operation. Describe its physical characteristics and setting (e.g., local land use, climate, topography, geology, hydrology, hydrogeology). Include a map showing the location. Include a site plan or sketch showing features on and around the site.

- Describe historical site operations, including all past and current operations and conditions. Identify current and former owners/operators, types of site activities, wastes generated, and waste disposal practices. Identify all sources and source types. Provide the hazardous waste quantity disposed in each source, if possible, and provide volume or area of the sources. Identify hazardous substances associated with or detected in the sources. Describe source containment. Describe any spills that have occurred at the site.

- Specify whether any sources are regulated by RCRA. Describe past regulatory activities, including permits, permit violations, and inspections by local, State, or Federal agencies. If applicable, provide emergency response and waste removal information. Summarize analytical results of earlier investigations. Specify type of data (e.g., CLP, non-CLP, owner/operator).

COLLECTION OF NON-SAMPLING DATA

- Describe additional non-sampling information to be collected (e.g., aquifer boundaries, interconnections, and discontinuities; resources; drainage area; soil group; particulate migration factors) and the rationale for collecting this information. Discuss any field activities needed to obtain this information.

SAMPLING ACTIVITIES

- Discuss objectives of planned field activities. Describe procedures and necessary resources. Discuss the rationale for these tasks.

- Provide explicit instructions for all field activities, including field observations, sampling, environmental monitoring for health and safety purposes, and field QA/QC protocols. Reference appropriate Standard Operating Procedures (SOPs). Discuss purpose of both onsite and offsite reconnaissances and observations (e.g., to verify the selection of sample locations, to evaluate the degree of containment at site sources, to measure source dimensions, to verify distances to nearby targets, and to characterize additional sources of contamination not identified during previous investigations).

- Justify proposed sample locations. Discuss methods to more fully characterize wastes and sources. Identify specific targets to be sampled (e.g., drinking water wells or intakes, fisheries, sensitive environments) to test or substantiate target contamination hypotheses. Describe sampling strategy to test or substantiate observed release hypotheses and presence of media contamination (e.g., soil, ground water, sediment, air, surface water).

EXHIBIT 3-2: SI SAMPLE PLAN OUTLINE (concluded)

- Include a map or site sketch showing previous and proposed sample locations.
- Summarize sample plan in a table, identifying sample types, sample numbers, sample locations, and sample-selection criteria. Describe methods of sample collection and preservation, field measurements, and analytical methods. Refer to Standard Operating Guidelines (SOGs) or provide a table or checklist describing the SOGs.
- Describe investigation-derived wastes (IDW) that may result from field activities. Reference the IDW plan that describes the management approach for non-hazardous and hazardous IDW.

PROJECT MANAGEMENT

- Identify all persons who will be involved in the field activities and discuss their specific responsibilities. Identify all safety and sampling equipment and supplies. Describe any contractual services needed to accomplish field activities. Summarize all transportation and shipping information.
- Describe community relations plans and meetings.
- Provide information on SI costs (e.g., number of technical hours; number of CLP, field screening, or other samples; subcontracting costs). Provide schedule for SI activities and deliverables. Summarize any special requirements that impact the SI (e.g., special safety considerations, special analytical services (SAS), or special equipment).
- Reference the work plan.

ATTACHMENTS

- Sample summary table
- Sample location sketch
- List of references cited in this plan
- Health and safety plan
- Appropriate SOPs and SOGs

- **Sample locations and rationale:** Identifies the location of each sample on a site map, explains the rationale for each location, and specifies the type (e.g., soil, sediment, water), volume, and number of samples.
- **Field quality control samples:** Identifies the number, location, and type of blank and duplicate samples.
- **Sampling equipment decontamination:** Identifies sample decontamination procedures, including decontamination solutions and any special handling.
- **Analytical requirements and sample handling:** Identifies the specific analysis parameters-for example, organics, metals, dioxins-for each sample. Identifies the preservation techniques

and reagents for each sample. Specifies whether samples are to be filtered, and explains why. Identifies the equipment, sampling devices, and type of containers used for each sampling episode. Much of this can be addressed by referencing the appropriate field SOPs. Identifies any procedures not covered by, or that are different from, the SOPs.

- **Sample delivery:** Identifies where samples are to be delivered for shipment or analysis, where splits should be delivered if they are collected, and, if appropriate, specifies special storage or transport requirements.

3.6.3 Health and Safety Plan

The purpose of the health and safety plan is to establish requirements and procedures to protect the health and safety of investigative personnel and the nearby public. The plan must specify levels of protection necessary for each field activity, provide detailed instructions for routine operations and emergency situation responses (see below), list key safety personnel, and describe health and safety monitoring requirements. The health and safety plan is generally prepared after the sample plan and included as an appendix to the work plan. The health and safety plan must be distributed to all team members, discussed at a team meeting prior to site entry, and posted at a conspicuous location at the site before field activities begin.

Routine Operations

Safety practices for routine operations parallel standard industrial hygiene and industrial safety procedures. The health and safety plan at a minimum must:

- Describe hazards and risks associated with the field work to be performed at the site, including all known or suspected physical, biological, radiological, or chemical hazards.

- List key safety personnel and alternates. Also identify other key personnel assigned to various site operations. Indicate where telephone numbers, addresses, and organizations of these people will be posted.

- Designate levels of protection required by location or task, specifying types of respirators and clothing to be worn for each level.

- Designate work areas—exclusion zone, contamination reduction zone, and support zone—on the site map. Include zone boundaries and access control points for each zone. Indicate where the map will be posted.

- List security control procedures to prevent unauthorized access—for example, fences, signs, security patrols, and check-in procedures. Identify procedures to ensure personnel wear the prescribed protective clothing.

- Discuss environmental monitoring protocols at or around the site to indicate chemicals present, and their hazards, possible migration, and associated safety requirements.

- Specify routine and special training required.

- Describe procedures for weather-related problems, such as temperature extremes, high winds, rain, and snow. Identify shelters when necessary. Discuss procedures to minimize heat stress of field team members wearing protective clothing.

Emergencies

Emergencies resulting from fire, chemical exposure, physical injury, or other events require immediate responses to prevent harm to onsite workers, the public, property, or the environment. Contingency plans for managing emergencies should.

- Advise workers of their duties during an emergency—for example, site personnel should be designated as site safety officers, standby rescue personnel, decontamination personnel, and emergency medical technicians. Identify their functions and expertise.

- Identify the location of the nearest telephone.

- Designate emergency communications alternatives—for example, citizen band and hand-held radios.

- Identify names, telephone numbers, and locations of local emergency response official—for example, fire, police, explosives experts, and hazardous materials response units.

- Specify worker evacuation procedures.

- List onsite emergency equipment and all other local medical, rescue, transport, and fire-fighting equipment.

Emergency medical care is an important component of the health and safety plan. To ensure that injured workers are transported to the nearest medical facility and receive appropriate treatment:

- Identify the nearest medical or emergency care facility that handles chemical exposure cases. Record its location, travel time, directions, and telephone number.

- Identify the telephone number of the nearest ambulance service.

- Maintain accurate records on any exposure or potential exposure of site workers during emergencies.

- Specify decontamination procedures for injured workers, transport vehicles, medical facilities, or medical personnel.

3.6.4 IDW Management Plan

Management of Investigation-Derived Wastes During Site Inspections (OERR Directive 9345.3-02) presents a general regulatory background and options to manage IDW generated during SIs. These wastes include soil cuttings, drilling muds, purged ground water, decontamination fluids (water and other fluids), disposable sampling equipment (DE), and disposable personal protective equipment (PPE). The directive addresses typical IDW management scenarios, and describes cost-efficient methods of handling hazardous and non-hazardous IDW to:

- Minimize the quantity of wastes generated.
- Leave a site in same condition or not worse than prior to the investigation.
- Remove wastes that pose an immediate threat to human health or the environment.
- Comply with Federal and State applicable or relevant and appropriate requirements (ARARs) to the extent practicable.

Specific elements of the strategy are to:

- Characterize IDW by available information (e.g., manifests, Material Safety Data Sheets, previous test results, knowledge of the waste generation process, and other relevant records) rather than analyze IDW samples.

- Delineate an Area of Contamination (AOC) unit for leaving RCRA hazardous soil cuttings.

- Dispose of RCRA hazardous ground water, decontamination fluids, and PPE and DE (if generated in excess of 100 kg/month) at RCRA Subtitle C facilities.

- Leave onsite RCRA non-hazardous soil cuttings, ground water, and decontamination fluids, preferably without containerizing and testing.

EPA does not recommend removing wastes from all sites and, in particular, from those sites where IDW do not pose any immediate threat to human health or the environment. Removing wastes from all sites would not benefit human health and the environment and would be unduly expensive, thus impairing EPA's ability to successfully meet the goals of the site assessment program.

The NCP requires that IDW generated during SIs be managed in compliance with all ARARs to the extent practicable. In addition, other legal and practical considerations may affect the handling of IDW. Investigators should be familiar with OERR's IDW directive as well as the requirements of the NCP for identifying ARARs.

IDW from SIs may contain hazardous substances as defined by CERCLA Section 101 (14) and listed at 40 CFR Part 302.4. Some CERCLA hazardous substances are RCRA Subtitle C hazardous wastes, while other substances may be regulated by other Federal laws such as the Safe Drinking Water Act, Clean Air Act, Toxic Substances Control Act, and Clean Water Act. EPA estimates that to date RCRA hazardous IDW have been generated at fewer than 15 percent of CERCLA sites. However, RCRA

regulations, and in particular the RCRA Land Disposal Restrictions, are very important as potential ARARs since they regulate treatment, storage, and disposal of many of the most hazardous materials.

3.7 SITE RECONNAISSANCE

Site reconnaissance may occur prior to completing the SI sample plan, since the primary objective of site reconnaissance is to verify planned sample locations by examining the site and its surroundings. Before site reconnaissance field activities begin, the investigator should arrange for site access and prepare a specific health and safety plan, even if a reconnaissance was performed during a previous investigation. The investigator also should consider informing interested parties (e.g., community representatives, and local, State, or Federal officials) of upcoming field activities. Early contact should facilitate the reconnaissance and subsequent field sampling and alleviate possible negative impacts caused by site activities.

The site reconnaissance team should perform the following activities to verify the planned sample locations.

- Locate all sources.
- Determine the physical state of wastes deposited at the source.
- Identify each source type.
- Examine each source for evidence of hazardous substance migration.
- Evaluate the degree of source containment.
- Identify overland flow paths.
- Determine the distances from sources to onsite and nearby targets.
- Refine the site sketch depicting important features (e.g., source locations, nearby targets).

Investigators should allocate sufficient time to verify or, if necessary, modify sample locations based on site reconnaissance information. Preferably, a small crew should conduct the site reconnaissance prior to sampling. If an onsite reconnaissance was conducted recently, the site reconnaissance for SI sampling may be conducted on the first day of field activities.

Site reconnaissance also is important when evaluating the need for emergency response action at the site. Emergency response could include the stabilization or removal of wastes, fencing the site or specific sources, evacuation of nearby populations, and other activities that eliminate, control, or otherwise mitigate an imminent threat to human health and the environment. If monitoring equipment indicates radioactivity, field team members should immediately leave the site and notify the EPA Regional radiation program office.

3.7.1 Emergency Response

At any time during the Superfund process, an emergency response action (or removal) may be taken at the site. Removals typically are relatively short-term actions designed to respond to situations that require immediate action to eliminate a present threat or avoid a more serious future problem. Some conditions that may result in a removal action include the threat of-

- Fire or explosion
- Direct contact with hazardous substances
- Continuing release of hazardous substances
- Drinking water contamination

Removal actions can include, but are not limited to:

- Fencing the site;
- Providing 24-hour security to restrict public access;
- Stabilizing waste sources, such as leaking drums or overflowing surface impoundments;
- Removing hazardous substances from the site;
- Capping areas of contamination;
- Evacuating local populations; and
- Providing alternative drinking water supplies.

While not every SI will be of interest to the Regional emergency response program, there will be a number of sites where it is important to consult with them. The Regional EPA site assessment contact, in conjunction with removal program personnel, will determine if a removal site evaluation is necessary. The SI investigator should review the PA to determine if the conclusions are still accurate. If there was a referral to the emergency response program at that time, the emergency response action memorandum and any follow up action should be included in the SI background material. If no referral was made, the SI investigator should assess site conditions to determine if an emergency response

action is warranted. If this is the case, the SI investigator should involve emergency response personnel in planning SI field activities to determine if a removal action is appropriate. The emergency response representative should identify sampling information that should be collected dining the SI that will assist future response activities. Likewise, if an immediate response is necessary, emergency response personnel may be able to collect valuable information to assist SI field activities.

3.7.2 Effects of Removal Actions

Removal actions may affect SI activities, including sample planning and site scoring. The effects of removal actions may be considered when evaluating the HRS score (*The Revised Hazard Ranking System: Evaluating Sites After Waste Removals*, OSWER Directive 9345.1-03FS). Three requirements that must be met for a removal to affect the site evaluation are:

- The removal action must physically remove waste from the site.
- The removal action must have occurred before approval of the SI work plan for non-Federal facilities, and 18 months after a Federal facility has been placed on the Federal Facilities Docket.
- The removed wastes must be disposed or destroyed at a facility permitted under RCRA, Toxic Substance Control Act (TSCA), or the Nuclear Regulatory Commission (NRC), as appropriate.

While removal actions may affect the way specific HRS factors are evaluated, the removal itself generally will not alter significantly the SI sampling strategy, which determines:

- Whether a hazardous substance has impacted a target;
- The types of substances at the site; and
- Whether a release has occurred.

If analytical data indicate that a release of hazardous substances has occurred before or after a removal, the removal does not negate this information. If a removal has eliminated the entire source, but professional judgment concludes that a release has occurred, samples should be collected. The resulting analytical data can be used to evaluate specific HRSfactors, regardless of the status of the removal. The investigator is not responsible or required to document that the source and the threat of a release from the source has been completely eliminated.

If a removal has eliminated a portion of site sources, sample planning should focus on the remaining portion. Unless the potentially responsible party (e.g., site owner or operator) can document otherwise, the SI investigator can reasonably assume that the remaining portion contains the same hazardous substances as the removed portion. Note that the substance-specific waste characteristics factors (e.g., toxicity, mobility, persistence) cannot be based on a hazardous substance that was completely removed from a site through a removal; however, the investigator is not required to obtain substance specific information.

3.7.3 Site Access

Legal access to the site must be obtained from the site owner before conducting a site reconnaissance. In some Regions, EPA personnel are responsible for obtaining access. In other Regions, State or contractor personnel may make access arrangements. While the owners, operators, or persons in charge of a site cannot prevent EPA's entering the property, they can require a court order. Four types of access agreements can be used for the SI:

- Voluntary entry (consenting)
- Conditional entry
- Entry with warrant (nonconsenting)
- Entry without warrant

The Regional SAM should consult with State counsel to ensure that all appropriate State requirements are met before initiating the SI. State laws for collecting evidence may be more restrictive than Federal laws, and noncompliance could result in suppression of evidence in a legal proceeding. Finalizing site access arrangements can take considerable time; hence these activities should be initiated early in the SI planning process.

Voluntary Entry

In general, the investigator should pursue voluntary entry first, followed by conditional entry, and if necessary, entry with a warrant. An entry is

considered voluntary as long as the owner agrees. The field team must not exhibit any form or semblance of coercion to gain entry. Entry gained via verbal or physical threat may later be determined invalid, and any information obtained during inspection could become inadmissible in legal proceedings.

The investigator should confirm consent to entry by notifying the owner in writing of the activities to be conducted (e.g., sample collection, picture taking, visual observations). CERCLA requirements governing split samples and receipts take precedence over a State law when the State program is operating with Federal funds.

Upon arrival at the site, field team members should present their credentials and inform the owner/ operator or designee of the nature of the work and their authority for conducting the SI. If the owner withdraws consent at any time, which is equivalent to refused entry, a warrant is required to complete the SI. Any information gathered before consent is withdrawn, including samples and photographs, can be used in a legal proceeding, as can any information obtained in an area open to the public.

Conditional Entry

The owner may consent to entry but impose conditions—for example, limiting areas of the site reconnaissance, limiting employees to be interviewed, or requiring confidentiality agreements. If avoiding conditional entry is not possible, accept only conditions that do not significantly interfere with the SI and note them in the logbook. State employees should consult with their own counsel or the EPA Office of Regional Counsel to determine if such agreements are acceptable or should be treated as a refusal of entry. The field team should be informed about such conditions prior to arriving at the site.

Entry With Warrant

If consent cannot be obtained or is withdrawn, the investigator should seek an entry warrant. The SI must be conducted strictly in accordance with the warrant, which might, for example, restrict access to certain areas or records. Failure to do so could jeopardize the admissibility of the information obtained.

When refused entry, the investigator should note in the logbook the person refusing entry, the date and time of refusal, the reasons given for refusal, and other pertinent details. The investigator should then leave the premises and immediately seek a warrant.

Entry Without Warrant

Entry without a warrant is normally reserved for emergencies and instances where evidence might be lost if site entry is delayed. When ownership of an abandoned site cannot be determined, the investigator should discuss the need for a warrant with the EPA Office of Regional Counsel.

Some courts have ruled that inspections under the Federal Insecticide, Fungicide, and Rodenticide Act and the Toxic Substances Control Act involving industries that are highly regulated are not subject to warrant requirements. Investigators should consult with the EPA Office of Regional Counsel before entering a site without consent and without a warrant. Investigators should consider requesting assistance or backup from local police for this type of entry.

3.7.4 Community and Neighborhood Contacts

Local representatives should be contacted in advance. Community relations coordinators can help identify appropriate representatives. Only designated team members should participate in discussions with local residents, remaining as factual as possible and avoiding expressing opinions or raising expectations for future action. Team representatives should always refer questions to the Regional SAM, who may:

- Explain the purpose of SI activities.
- Identify the site location.
- Explain the tasks to be Performed.
- Identify a contact for further information.
- Determine whether meetings should be held and to whom the SI results and other information should be provided.

For guidance on community relations during SIs, see *Community Relations in Superfund: A Handbook,* Section 4.1 (OSWER Directive 9230.0-03C, January 1992).

3.7.5 Government Contacts

EPA Regional management should contact appropriate municipal, county, State, and Federal officials before starting field work. These groups frequently have information on the site's waste practices, history, and compliance records, and may be aware of other investigations or enforcement activities at or near the site. Activities by other agencies do not provide sufficient reason to cancel or postpone the SI, but the work schedule can be adjusted if it does not compromise the health and safety of the public or the environment.

3.8 SITES CONTAINING RADIOACTIVE SUBSTANCES

SIs for sites containing radioactive substances require many of the same considerations for site-specific planning discussed in previous sections of this chapter. Investigators performing SIs at radiation sites also collect a limited number of selective samples, rather than an extensive number of "average" samples, to investigate sources and migration pathways and establish contamination levels at targets. Sample collection issum including types, variability, and QA/QC requirements, are generally similar for sites with radioactive substances.

The SI approach for radiation sites differs from nonradioactive sites based on HRS data needs, field instrumentation and procedures, sample collection and handling, laboratory support, and analytical methods.

This section provides a supplemental discussion of SI planning considerations for sites containing radioactive substances. Guidance is provided on radiation survey instruments and techniques, special sampling and analysis issues, and HRS requirements. This section also provides information on components of a radiation health and safety plan, an IDW plan, and supporting documentation.

For additional information on radiation concepts and terminology, background levels of radionuclides in the environment, and data usability considerations for radioactive substances, the SI investigator should refer to *Guidance for Data Useability in Site Assessment.*

3.8.1 Key Radiation Site Personnel

When planning SIs at sites containing radioactive waste, the SI investigator should consult with a health physicist and a radiochemist during all phases of sample planning and implementation. A health physicist can assist the investigator by:

- Reviewing the site history and records to identify radionuclides and radioactive sources and waste streams;
- Planning samples and analysis, including the selection of field instruments;
- Implementing the SI sample plan and interpreting measurement data;
- Preparing and implementing a radiation health and safety plan, including training and monitoring SI personnel;
- Preparing and implementing IDW plans; and
- Determining data adequacy and usability.

The health physicist may facilitate planning field activities. For example, the health physicist may identify techniques, such as walkover and grid surveys, to locate radioactive contamination. A health physicist may know where maximum concentrations (hot spots) are likely to be found. Often, certain locations between, or at the fringe of, grid patterns should be investigated, such as near the foundations of structures or along a facility's sanitary sewer lines. Establishing actual contamination may hinge on this data. During field work, the health physicist may interpret measurements so that technical decisions can be made in the field.

A radiochemist can assist the investigator by:

- Specifying sample size, collection, handling, and holding time considerations;
- Establishing desired analytical sensitivities, turnaround times, and QA/QC requirements to meet data needs;
- Recommending radionuclide- and media-specific radioanalytical procedures;
- Selecting radiochemical laboratories;
- Interpreting radioanalytical data;
- Resolving data discrepancies and data gaps; and
- Determining data adequacy and usability.

For health physics and radioanalytical support, the SI investigator should contact EPA Regional, laboratory, or Headquarters Office of Radiation Programs (ORP) staff.

3.8.2 Radiation Survey Instruments

In addition to laboratory analysis of collected samples, mdionuclides can be investigated by a variety of field survey instruments and techniques. These instruments and techniques provide immediate information on the location and distribution of sources and releases of radionuclides, allowing rapid field screening of potential radiation sites.

The SI investigator should consider the capabilities and limitations of the various types of radiation survey instruments when planning field work. Instrument selection depends on several factors, including the type (alpha, beta, gamma, and x-ray) and energy of radiation emitted by each radionuclide of concern, expected concentrations (activity per unit mass) above background levels, shielding and self-absorption by the contaminated material, and desired measurement sensitivity.

Gamma Detectors

Five types of field survey detectors are commonly used for measuring gamma radiation exposure rates: ion chambers, pressurized ion chambers (PICs), Geiger-Mueller (GM) counters, sodium iodide (Nal) scintillation detectors, and organic scintillation detectors (see Table 3-9). Nal and organic

TABLE 3-9: GAMMA RADIATION SURVEY INSTRUMENTS

INSTRUMENT	SPECIFICATIONS	ADVANTAGES	DISADVANTAGES
Ion Chamber	Moderate to high exposure rate range: 1 to 2,000 mR/hour Accuracy: ±5% at the high end of the scale	Reading is directly proportional to radiation field Suitable for high radiation fields Very portable	Poor sensitivity Inadequate for near-background radiation rates
Pressurized Ion Chamber (PIC)	Low range: 1 to 500µR/hour Accuracy: ±5% full scale	Reading is directly proportional to radiation field Suitable for near-background radiation rates	Not as portable as ion chamber Allows fewer measurements per day
Geiger-Mueller (GM) Tube	Moderate to high range: 1 to 5,000 mR/hour Accuracy: ±10% full scale	Also detects beta radiation Very portable	Poor sensitivity Reading is not directly proportional to radiation field; response varies with photon energy
NaI Scintillation Detector	Low range 1 to 5,000 µR/hour Accuracy: ±10% at high end to ±30% at low end of scale	Suitable for background radiation rates Very portable	Reading is not directly proportional to radiation field; response varies with photon energy
Organic Scintillation Detector	Low range: 1 to 25 µR/hour Accuracy: ±10% full scale	Suitable for background radiation rates Very portable	Response is generally linear with energy

scintillation detectors are used most often because of their portability and ability to measure exposure rates at and above natural background' levels. These detectors usually record exposure rates in microroentgens per hour (µR/hr), microrem per hour (prem/hr), or counts per minute (cpm), which are converted to µR/hr or µrem/hr by an instrument-specific calibration factor. The SI investigator should cross-check exposure rate measurements made with these detectors against a limited number of PIC measurements because the response characteristics of NaI and organic scintillations detectors are energy dependent. Although less portable than hand-held survey detectors, PICs provide a flatter response over a wider range of gamma energies.

Two other portable detectors may be useful in field surveys: high-resolution gamma spectroscopy systems (HRGS) and field instruments for detecting low energy radiation (FIDLER). HRGS typically use a germanium-lithium detector coupled to a multichannel analyzer to identify gamma-emitting radionuclides by determining the energies and relative detection frequencies of incident gamma and X-ray photons. The energy spectrum acquired from the analyzer is compared against reference spectra for known or suspected radionuclides. FIDLERs are specialized NaI detector systems that measure low-energy photon radiation from radionuclides such as plutonium or americium.

Prior to the field survey, all survey instruments should be calibrated for the range of gamma radiation energies expected. At a minimum, EPA requires a two-point energy calibration at 25 and 75 percent of full scale, performed annually by a certified laboratory using gamma standards traceable to the National Institute of Standards and Technology (NIST). A current calibration certificate must be provided for each survey instrument. Moreover, during the field survey, the proper operating response of each instrument should be confirmed daily using a gamma radiation check source in a reproducible geometry. The results of instrument checks should be recorded in the field notebook.

TABLE 3-10: ALPHA AND BETA RADIATION SURVEY INSTRUMENTS

INSTRUMENT	RADIATION DETECTED	ADVANTAGES	DISADVANTAGES
Alpha scintillation probe[1]	Alpha	High detection efficiency Very portable	Very fragile Measures only alpha particles
Air proportional detector	Alpha	Large surface area High detection efficiency	Very fragile Measures only alpha particles Affected by moisture
Geiger-Mueller (GM) pancake type probe[1]	Alpha, beta, and gamma	Large surface area Detects all types of radiation	Decreases ability to discriminate among radiation types Not recommended for measuring alpha particles
Side-shielded GM probe[1]	Beta and gamma	Discriminates between beta and gamma radiation Useful in high gamma radiation fields	Gamma reading is not directly proportional to radiation field; response varies with energy
[1]All probes are attached to an appropriate rate meter or scaler (pulse counter)			

Alpha and Beta Detectors

Survey instruments for measuring alpha and beta radiation include alpha scintillation probes, air proportional detectors, GM pancake type probes, and side-shielded GM probes (see Table 3-10). Measurements made with alpha and beta detectors are usually recorded as counts per minute (cpm) per unit area for the active detection area of the probe. These measurements are then converted to activity units of disintegrations per minute (dpm) per unit area by an instrument-specific efficiency factor. Alpha and beta detectors should also be properly calibrated using appropriate NIST standards and their responses checked daily in the field.

Operation, maintenance, and calibration standards for radiation monitoring instruments may be found in the American National Standards Institute's Radiation Protection Instrumentation and Calibration (1978).

3.8.3 Survey Techniques

In planning SI sampling and field screening, the investigator should be aware that background levels of radioactivity and radiation exposure rates can vary significantly in the environment, both spatially and temporally. The accuracy of background level evaluations can be increased by using a combination of surveying methods and sampling, especially for soil and air releases at radiation sites. The SI investigator should research natural radiation exposure rates and background concentrations for all radionuclides suspected to be at the site.

In general, four types of radiation survey techniques may be used during focused and expanded SIs (see Table 3-11): walkover surveys, grid surveys, downhole gamma logging, and special purpose surveys. A walkover survey may assist planning focused Sl samples by detecting hot spots and releases of radionuclides and aiding sample location selection. This survey is conducted by walking the site and offsite areas with a hand-held radiation detector. At sites with gamma-emitting radionuclides, gamma exposure rates are measured with a NaI or organic scintillation detector held one meter above the ground surface. Measurements may also be made closer to the ground to pinpoint gamma sources. At sites with radionuclides that do not emit gamma radiation, alpha and beta survey meters may be used to scan surface areas for elevated count rates. During the field survey, all areas with elevated exposure rates or count rates should be marked with survey stakes and measurement results recorded on the site map.

A grid survey during the expanded SI can refine gamma exposure rate measurements and help

TABLE 3-11: RADIATION SURVEYING METHODS

SURVEY TYPE	MEDIUM	DATA PROVIDED
High Resolution Gamma Spectroscopy	All	identify specific gamma-emitting radionuclides
Down hole Gamma Logging	Soil	Identify distribution of gamma-emitting radionuclides relative to soil depth
Beta/Gamma Measurements	Soil	Identify distribution of radionuclides relative to spoil depth
Gross Alpha or Gross Beta/ Gamma Measurements	All	Screen for radioactivity levels prior to laboratory analysis
Surface Area		
Walkover Survey (Focused SI)	Soil	Identify hot spots for future investigation
Grid Survey (Expanded SI)	Soil	Establish areas of observed contamination

delineate areas of surface contamination. In this type of survey, a grid system should be planned for the area of radioactivity determined during the focused SI. Additional survey measurements with other instruments may be planned at grid point locations to contribute to the evaluation of contaminated soil volume and hazardous waste quantity.

Downhole gamma logging may determine the distribution and depth of gamma-emitting radionuclides in soil. In this type of survey, a gamma radiation probe is lowered down a hole drilled in the soil, and exposure or count rate measurements are rc,;orded at selected depths (typically every six inches). Downhole measurements Liken at selected locations where gamma radiation has been detected are compared with similar measurements taken at background locations.

The SI investigator may plan special purpose surveying to support other Sl activities related to quality assurance and the health and safety of field personnel. Examples of special surveying procedures may include GM and alpha scintillation detector surveys of surveying and sampling equipment, potentially radioactive structures, investigation-derived wastes, and decontamination process materials. The SI investigator should consult a health physicist during SI planning for guidance on: selecting, calibrating, and operating radiation survey meters; conducting survey techniques; and interpreting survey results. Additional guidance on survey instruments and techniques can be found in the references listed in Table 3-12.

3.8.4 Special Sampling and Analysis Issues

In planning radionuclide sampling and analysis, the SI investigator should be aware that radionuclide analyses are not currently conducted as part of CLP RAS. Instead, these analyses are conducted under SAS or a separate CLP-equivalent program. For information to evaluate and select laboratories with radioanalytical services, the investigator should contact EPA's National Air and Radiation Environmental Laboratory (NAREL) in Montgomery, Alabama, or the Nuclear Radiation Assessment Division of the Environmental Monitoring Systems Laboratory in Las Vegas, Nevada.

The Nuclear Radiation Assessment Division also provides quality assurance oversight for participating radiation measurement laboratories, including radionuclide analytical services through the Environmental Radioactivity Intercomparison Program. Quality assurance plans for all analytical procedures involving radioactive samples may be derived from several sources, including the U.S. *Nuclear Regulatory Commission's Quality Assurance for Radiological Monitoring Programs (Normal Operations)-Effluent Streams and the Environment,* Regulatory Guide No. 4.15, Revision 1 (1979) or American National Standards Institute's *Quality Assurance Program Requirements for Nuclear Facilities*, Report No. ANSI/ASME NQA-1 (1986).

TABLE 3-12: RADIOACTIVITY MEASUREMENT PROCEDURES - REFERENCES

Conference of Radiation Control Program Directors, Inc., 1979. Ionizing Radiation Measurement Criteria for Regulatory Purposes. Prepared for U.S. Department of Commerce, National Bureau of Standards. NBS GCR 79-173.

National Council on Radiation Protection and Measurements, 1985. A Handbook of Radioactivity Measurements Procedures. NCRP Report No. 58.

National Council on Radiation Protection and Measurements, 1978. instrumentation and Monitoring Methods for Radiation Protection. NCRP Report No. 57.

Schleien, B., and Terpilak, M.S., Editors, 1994. *The Health Physics and Radiological Health Handbook, Nucleon Associates,* Inc.

3.8.5 HRS Requirements for Radiation Sites

Section 7 of the FIRS addresses sites containing radioactive substances, alone or in combination with other hazardous substances. Major HRS factors and special analytical data requirements are summarized below.

Human toxicity factors: Radionuclides are evaluated on the basis of carcinogenicity and are designated as weight-of-evidence category A carcinogens. Toxicity is determined for each radionuclide individually based on its slope factor values, expressed in terms of lifetime excess total cancer risk per unit of radioactivity ingested or inhaled. SCDM Part B (OSWER Directive 9345.1-13) provides toxicity values for a limited number of radionuclides.

In general, sites containing mixed radioactive and other hazardous substances are evaluated in greater detail than sites with only one of these types of hazardous substances. Human toxicity factor values are evaluated for radioactive and nonradioactive components separately; the substance posing the greatest hazard is selected based on toxicity, mobility, persistence, and/or bioaccumulation potential. Source hazardous waste quantity factors for mixed radioactive and other hazardous substances also are evaluated separately for radioactive and nonradioactive substances, and the combined quantities of both components are summed to derive the pathway hazardous waste quantity factor value.

Source Characterization: The quantity of radioactive substances in a source is based on the net activity content (after subtracting background levels) of all radionuclides present, rather than on their mass. To characterize sources, radioanalytical data are required to:

- Identify all radioactive substances and decay products present in the source.
- Determine the concentration of each radionuclide in the source.
- Determine the natural background concentration of each radionuclide.
- Delineate source dimensions (area, depth, volume).
- Investigate source containment.

Obs.rved Releases and Areas of Observed Contamination: Observed release criteria for naturally occurring and ubiquitous man-made radionuclides in the environment require radioanalytical data to:

- Identify all such radionuclides and decay products present in each migration pathway.
- Determine the concentration of each radionuclide in these media.
- Determine the mean site-specific natural background concentrations of each radionuclide in each medium.
- Determine the minimum detectable activity (MDA) concentration for each radionuclide in each medium.

Observed release criteria for non-ubiquitous, manmade radionuclides in the environment require radioanalytical data to:

- Identify all such radionuclides and decay products present in each migration pathway.
- Determine the concentration of each radionuclide in these media.
- Determine the lower limit of detection (LLD) for each radionuclide in each medium.

In addition, observed contamination criteria for the soil exposure pathway require radioanalytical data to:

- Determine gamma radiation exposure rates at one meter above the surface of contaminated surficial. materials (or one meter away from above ground sources).
- Establish natural radiation exposure rates at uncontaminated background locations.

Levels of Contamination at Specific Targets: Media specific benchmarks for radionuclides used to establish Level I and Level II contamination, in activity units rather than mass units, include:

- Maximum Contaminant Levels (MCLs) for the ground water pathway and the drinking water threat in the surface water pathway; Uranium Mill Tailings Radiation Control Act (UMTRCA) standards for the soil exposure pathway;
- Uranimum Mill Tailings Radiation Control Act (UMTRCA) standards for the soil exposure pathway; and

- Screening concentrations for radionuclides corresponding to a 10^{-6} lifetime cancer risk following lifetime exposure via inhalation (air pathway) or ingestion (ground water pathway, drinking water or human food chain threats, and soil exposure pathway).

Persistence: Persistence criteria for the surface water pathway require radioanalytical. data to determine the effective radioactive and volatilization half-life for each radionuclide evaluated.

3.8.6 Radiation Health and Safety Plan

The basic techniques for protecting the health and safety of the field investigative team assessing a radiation site overlap those involving other hazardous substances. Important differences relate to the gamma radiation exposure pathway, monitoring procedures for radionuclide exposures, and regulatory requirements. Radionuclides emitting gamma radiation, even if contained in buried sources, may expose personnel. Exposure also may result from the inhalation and ingestion of contaminated air, water, and soil, from dermal contact or through open cuts. A health physicist should be onsite at all times during the SI to monitor the work of field personnel. All field personnel should meet minimum qualification criteria for radiation protection, as defined in the American National Standards Institute's S*election, Qualification and Training of Personnel for Nuclear Power Plants*, Report No. ANSI/ANS-3.1 (1987).

Exposure conditions and limits are regulated under Federal statutes. Federal regulations require that records of personnel exposures must be maintained. These should include records of external and internal exposure, records of unusual exposure, records of exposure from previous employment, and records of special investigations.

The radiation health and safety plan should provide accurate monitoring and reporting of personnel exposures. The most common personnel radiation monitors are film badges or thermolurninescent dosimeters worn by individuals.

Several approaches may be used alone or combined to assess internal exposure. Air sample analysis may provide a quantitative assessment of radionuclides in breathing air. For gamma emitting radionuclides, calibrated whole body counters are commonly used to quantify the body burden of radionuclides. Since radionuclides once ingested or inhaled also may be excreted from the body, bioassays involving urine, blood, or feces can be used to assess body burdens for radionuclides.

In addition, adequate records should be maintained to document personnel qualifications (training, respirator fit test, medical exams, etc.), personnel access to controlled locations onsite, and analytical services for personnel dosimeters, bioassays, work area monitoring samples, and respirators.

EPA is developing an Agency-wide radiation health and safety program. SI investigators should contact ORP, the Safety, Health, and Environmental Management Division (SHEM), or Regional health managers for information on this program.

3.8.7 IDW Plan

Radioactive wastes generated during the SI must be packaged and removed according to Federal guidelines. Contract services are available for removal of radioactive wastes. The IDW plan should discuss all aspects of radioactive waste removal. The IDW plan also should include a plan for the storage and removal of rinsates that qualify as radioactive liquid waste. The investigator should consult with a health physicist to keep current with developing lowlevel radioactive waste (LLRW) regulations. Some States operate LLRW repositories.