3 HISTORICAL SITE ASSESSMENT

3.1 Introduction

The Radiation Survey and Site Investigation (RSSI) Process uses a graded approach that starts with the Historical Site Assessment (HSA) and is later followed by other surveys that lead to the final status survey. The HSA is an investigation to collect existing information describing a site's complete history from the start of site activities to the present time. The necessity for detailed information and amount of effort to conduct an HSA depend on the type of site, associated historical events, regulatory framework, and availability of documented information. For example, some facilities—such as Nuclear Regulatory Commission (NRC) licensees that routinely maintain records throughout their operations—already have HSA information in place. Other facilities, such as Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or Resource Conservation and Recovery Act (RCRA) sites, may initiate a comprehensive search to gather HSA information (also see Appendix F for comparison of Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), CERCLA, and RCRA). In the former case, the HSA is essentially complete and a review of the following sections ensures that all information sources are incorporated into the overall investigation. In still other cases, where sealed sources or small amounts of radionuclides are described by the HSA, the site may qualify for a simplified decommissioning procedure (see Appendix B).

The HSA

- identifies potential, likely, or known sources of radioactive material and radioactive contamination based on existing or derived information
- identifies sites that need further action as opposed to those posing no threat to human health
- provides an assessment for the likelihood of contaminant migration
- provides information useful to scoping and characterization surveys
- provides initial classification of the site or survey unit[1] as impacted or non-impacted

The HSA may provide information needed to calculate derived concentration guideline levels (DCGLs, initially described in Section 2.2) and furthermore provide information that reveals the magnitude of a site's DCGLs. This information is used for comparing historical data to potential DCGLs and determining the suitability of the existing data as part of the assessment of the site. The HSA also supports emergency response and removal activities within the context of the

[1] Refer to Section 4.6 for a discussion of survey units.

EPA's Superfund program, fulfills public information needs, and furnishes appropriate information about the site early in the Site Investigation process. For a large number of sites (*e.g.* currently licensed facilities), site identification and reconnaissance may not be needed. For certain response activities, such as reports concerning the possible presence of radioactivity, preliminary investigations may consist more of a reconnaissance and a scoping survey in conjunction with efforts to gather historical information.

The HSA is typically described in three sections: identification of a candidate site (Section 3.3), preliminary investigation of the facility or site (Section 3.4), and site reconnaissance (Section 3.5). The reconnaissance however is not a scoping survey. The HSA is followed by an evaluation of the site based on information collected during the HSA.

3.2 Data Quality Objectives

The Data Quality Objectives (DQO) Process assists in directing the planning of data collection activities performed during the HSA. Information gathered during the HSA supports other DQOs when this process is applied to subsequent surveys.

Three HSA-DQO results are expected:

- identifying an individual or a list of planning team members—including the decision maker (DQO Step 1, Appendix D, Section D.1)

- concisely describing the problem (DQO Step 1, Appendix D, Section D.1)

- initially classifying site and survey unit as impacted or non-impacted (DQO Step 4, Appendix D, Section D.4)

Other results may accompany these three, and this added information may be useful in supporting subsequent applications of the DQO process.

The planning team clarifies and defines the DQOs for a site-specific survey. This multidisciplinary team of technical experts offers the greatest potential for solving problems when identifying every important aspect of a survey. Including a stakeholder group representative is an important consideration when assembling this team. Once formed, the team can also consider the role of public participation for this assessment and the possible surveys to follow. The number of team members is directly related to the scope and complexity of the problem. For a small site or simplified situations, planning may be performed by the site owner. For other specific sites (*e.g.*, CERCLA), a regulatory agency representative may be included.

The representative's role facilitates survey planning—without direct participation in survey plan development—by offering comments and information based on past precedent, current guidance, and potential pitfalls. For a large, complex facility, the team may include technical project managers, site managers, scientists, engineers, community and local government representatives, health physicists, statisticians, and regulatory agency representatives. A reasonable effort should be made to include other individuals—that is, specific decision makers or data users—who may use the study findings sometime in the future.

The planning team is generally led by a member who is referred to as the decision maker. This individual is often the person with the most authority over the study and may be responsible for assigning the roles and responsibilities to planning team members. Overall, the decision-making process arrives at final decisions based on the planning team's recommendations.

The problem or situation description provides background information on the fundamental issue to be addressed by the assessment (see EPA 1994a). The following steps may be helpful during DQO development:

- describe the conditions or circumstances regarding the problem or situation and the reason for undertaking the survey

- describe the problem or situation as it is currently understood by briefly summarizing existing information

- conduct literature searches and interviews, and examine past or ongoing studies to ensure that the problem is correctly defined

- if the problem is complex, consider breaking it into more manageable pieces

Section 3.4 provides guidance on gathering existing site data and determining the usability of this data.

The initial classification of the site involves developing a conceptual model based on the existing information collected during the preliminary investigation. Conceptual models describe a site or facility and its environs and present hypotheses regarding the radionuclides for known and potential residual contamination (EPA 1987b, 1987c). The classification of the site is discussed in Section 3.6, Evaluation of Historical Site Assessment Data.

Several results of the DQO Process may be addressed initially during the HSA. This information or decision may be based on limited or incomplete data. As the site assessment progresses and as decisions become more difficult, the iterative nature of the DQO Process allows for re-evaluation of preliminary decisions. This is especially important for classification of sites and survey units where the final classification is not made until the final status survey is planned.

3.3 Site Identification

A site may already be known for its prior use and presence of radioactive materials. Elsewhere, potential radiation sites may be identified through the following:

- records of authorization to possess or handle radioactive materials (*e.g.*, NRC or NRC Agreement State License, DOE facility records, Naval Radioactive Materials Permit, USAF Master Materials License, Army Radiation Authorization, State Authorization for Naturally Occurring and Accelerator Produced Radioactive Material (NARM))

- notification to government Agencies of possible releases of radioactive substances

- citizens filing a petition under section 105(d) of the Superfund Amendments and Reauthorization Act of 1986 (SARA; EPA 1986)

- ground and aerial radiological surveys

- contacts with knowledge of the site

- review of EPA's Environmental Radiation Ambient Monitoring System (ERAMS) database (Appendix G)

Once identified, the name, location, and current legal owner or custodian (where available) of the site should be recorded.

3.4 Preliminary HSA Investigation

This limited-scope investigation serves to collect readily available information concerning the facility or site and its surroundings. The investigation is designed to obtain sufficient information to provide initial classification of the site or survey unit as impacted or non-impacted. Information on the potential distribution of radioactive contamination may be used for classifying each site or survey unit as Class 2 or Class 1 and is useful for planning scoping and characterization surveys.

Table 3.1 provides a set of questions that can be used to assist in the preliminary HSA investigation. Apart from obvious cases (*e.g.*, NRC licensees), this table focuses on characteristics that identify a previously unrecognized or known but undeclared source of potential contamination. Furthermore, these questions may identify confounding factors for selecting reference sites.

Table 3.1 Questions Useful for the Preliminary HSA Investigation

1.	Was the site ever licensed for the manufacture, use, or distribution of radioactive materials under Agreement State Regulations, NRC licenses, or Armed Services permits, or for the use of 91B material?	Indicates a higher probability that the area is impacted.
2.	Did the site ever have permits to dispose of, or incinerate, radioactive material onsite? Is there evidence of such activities?	Evidence of radioactive material disposal indicates a higher probability that the area is impacted.
3.	Has the site ever had deep wells for injection or permits for such?	Indicates a higher probability that the area is impacted.
4.	Did the site ever have permits to perform research with radiation generating devices or radioactive materials except medical or dental x-ray machines?	Research that may have resulted in the release of radioactive materials indicates a higher probability that the area is impacted.
5.	As a part of the site's radioactive materials license were there ever any Soil Moisture Density Gauges (Americium-Beryllium or Plutonium-Beryllium sources), or Radioactive Thickness Monitoring Gauges stored or disposed of onsite?	Leak test records of sealed sources may indicate whether or not a storage area is impacted. Evidence of radioactive material disposal indicates a higher probability that the area is impacted.
6.	Was the site used to create radioactive material(s) by activation?	Indicates a higher probability that the area is impacted.
7.	Were radioactive sources stored at the site?	Leak test records of sealed sources may indicate whether or not a storage area is impacted.
8.	Is there evidence that the site was involved in the Manhattan Project or any Manhattan Engineering District (MED) activities (1942-1946)?	Indicates a higher probability that the area is impacted.
9.	Was the site ever involved in the support of nuclear weapons testing (1945-1962)?	Indicates a higher probability that the area is impacted.
10.	Were any facilities on the site used as a weapons storage area? Was weapons maintenance ever performed at the site?	Indicates a higher probability that the area is impacted.
11.	Was there ever any decontamination, maintenance, or storage of radioactively contaminated ships, vehicles, or planes performed onsite?	Indicates a higher probability that the area is impacted.

Table 3.1 Questions Useful for the Preliminary HSA Investigation (continued)

12.	Is there a record of any aircraft accident at or near the site (*e.g.*, depleted uranium counterbalances, thorium alloys, radium dials)?	May include other considerations such as evidence of radioactive materials that were not recovered.
13.	Was there ever any radiopharmaceutical manufacturing, storage, transfer, or disposal onsite?	Indicates a higher probability that the area is impacted.
14.	Was animal research ever performed at the site?	Evidence that radioactive materials were used for animal research indicates a higher probability that the area is impacted.
15.	Were uranium, thorium, or radium compounds (NORM) used in manufacturing, research, or testing at the site, or were these compounds stored at the site?	Indicates a higher probability that the area is impacted or results in a potential increase in background variability.
16.	Has the site ever been involved in the processing or production of Naturally Occurring Radioactive Material (*e.g.*, radium, fertilizers, phosphorus compounds, vanadium compounds, refractory materials, or precious metals) or mining, milling, processing, or production of uranium?	Indicates a higher probability that the area is impacted or results in a potential increase in background variability.
17.	Were coal or coal products used onsite? If yes, did combustion of these substances leave ash or ash residues onsite? If yes, are runoff or production ponds onsite?	May indicate other considerations such as a potential increase in background variability.
18.	Was there ever any onsite disposal of material known to be high in naturally occurring radioactive materials (*e.g.*, monazite sands used in sandblasting)?	May indicate other considerations such as a potential increase in background variability.
19.	Did the site process pipe from the oil and gas industries?	Indicates a higher probability that the area is impacted or results in a potential increase in background variability.
20.	Is there any reason to expect that the site may be contaminated with radioactive material (other than previously listed)?	See Section 3.6.3.

Appendix G of this document provides a general listing and cross-reference of information sources—each with a brief description of the information contained in each source. The *Site Assessment Information Directory* (EPA 1991e) contains a detailed compilation of data sources, including names, addresses, and telephone numbers of agencies that can provide HSA information.

3.4.1 Existing Radiation Data

Site files, monitoring data, former site evaluation data, Federal, State, or local investigations, or emergency actions may be sources of useful site information. Existing site data may provide specific details about the identity, concentration, and areal distribution of contamination. However, these data should be examined carefully because:

- Previous survey and sampling efforts may not be compatible with HSA objectives or may not be extensive enough to characterize the facility or site fully.

- Measurement protocols and standards may not be known or compatible with HSA objectives (*e.g.*, Quality Assurance/Quality Control (QA/QC) procedures, limited analysis rather than full-spectrum analysis) or may not be extensive enough to characterize the facility or site fully.

- Conditions may have changed since the site was last sampled (*i.e.*, substances may have been released, migration may have spread the contamination, additional waste disposal may have occurred, or decontamination may have been performed).

Existing data can be evaluated using the Data Quality Assessment (DQA) process described in Appendix E. (Also see DOE 1987 and EPA 1980c, 1992a, 1992b, 1996a for additional guidance on evaluating data.)

3.4.1.1 Licenses, Site Permits, and Authorizations

The facility or site radioactive materials license and supporting or associated documents are potential sources of information for licensed facilities. If a license does not exist, there may be a permit or other document that authorized site operations involving radioactivity. These documents may specify the quantities of radioactive material authorized for use at the site, the chemical and physical form of the materials, operations for which the materials are (or were) used, locations of these operations at the facility or site, and total quantities of material used at the site during its operating lifetime.

EPA and State agencies maintain files on a variety of environmental programs. These files may contain permit applications and monitoring results with information on specific waste types and quantities, sources, type of site operations, and operating status of the facility or site. Some of these information sources are listed in Appendix G (*e.g.*, Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS), Resource Conservation and Recovery Information System (RCRIS), Ocean Data Evaluation System (ODES)).

3.4.1.2 Operating Records

Records and other information sources useful for site evaluations include those describing onsite activities; current and past contamination control procedures; and past operations involving demolition, effluent releases, discharge to sewers or onsite septic systems, production of residues, land filling, waste and material storage, pipe and tank leaks, spills and accidental releases, release of facilities or equipment from radiological controls, and onsite or offsite radioactive and hazardous waste disposal. Some records may be or may have been classified for National Security purposes and means should be established to review all pertinent records. Past operations should be summarized in chronological order along with information indicating the type of permits and approvals that authorized these operations. Estimates of the total activity disposed of or released at the site and the physical and chemical form of the radioactive material should also be included. Records on waste disposal, environmental monitoring, site inspection reports, license applications, operational permits, waste disposal material balance and inventory sheets, and purchase orders for radioactive materials are useful—for estimating total activity. Information on accidents, such as fires, flooding, spills, unintentional releases, or leakage, should be collected as potential sources of contamination. Possible areas of localized contamination should be identified.

Site plats or plots, blueprints, drawings, and sketches of structures are especially useful to illustrate the location and layout of buildings on the site. Site photographs, aerial surveys, and maps can help verify the accuracy of these drawings or indicate changes following the time when the drawings were prepared. Processing locations—plus waste streams to and from the site as well as the presence of stockpiles of raw materials and finished product—should be noted on these photographs and maps. Buildings or outdoor processing areas may have been modified or reconfigured such that former processing areas were converted to other uses or configurations. The locations of sewers, pipelines, electric lines, water lines, *etc.*, should also be identified. This information facilitates planning the Site Reconnaissance and subsequent surveys, developing a site conceptual model, and increasing the efficiency of the survey program.

Corporate contract files may also provide useful information during subsequent stages of the Radiation Survey and Site Investigation Process. Older facilities may not have complete operational records, especially for obsolete or discontinued processes. Financial records may also provide information on purchasing and shipping that in turn help to reconstruct a site's operational history.

While operating records can be useful tools during the HSA, the investigator should be careful not to place too much emphasis on this type of data. These records are often incomplete and lack information on substances previously not considered hazardous. Out-of-date blueprints and drawings may not show modifications made during the lifetime of a facility.

3.4.2 Contacts and Interviews

Interviews with current or previous employees are performed to collect first-hand information about the site or facility and to verify or clarify information gathered from existing records. Interviews to collect first-hand information concerning the site or facility are generally conducted early in the data-gathering process. Interviews cover general topics, such as radioactive waste handling procedures. Results of early interviews are used to guide subsequent data collection activities.

Interviews scheduled late in the data gathering process may be especially useful. This activity allows questions to be directed to specific areas of the investigation that need additional information or clarification. Photographs and sketches can be used to assist the interviewer and allow the interviewees to recall information of interest. Conducting interviews onsite where the employees performed their tasks often stimulates memories and facilitates information gathering. In addition to interviewing managers, engineers, and facility workers, interviews may be conducted with laborers and truck drivers to obtain information from their perspective. The investigator should be cautious in the use of interview information. Whenever possible, anecdotal evidence should be assessed for accuracy and results of interviews should be backed up with supporting data. Steps that ensure specific information is properly recorded may include hiring trained investigators and taking affidavits.

3.5 Site Reconnaissance

The objective of the Site Reconnaissance or Site Visit is to gather sufficient information to support a decision regarding further action. Reconnaissance activity is not a risk assessment, a scoping survey, or a study of the full extent of contamination at a facility or site. The reconnaissance offers an opportunity to record information concerning hazardous site conditions as they apply to conducting future survey work. In this regard, information describing physical hazards, structural integrity of buildings, or other conditions, defines potential problems that may impede future work. This section is most applicable to sites with less available information and may not be necessary at other sites having greater amounts of data, such as Nuclear Regulatory Commission (NRC) licensed facilities.

To prepare for the Site Reconnaissance, begin by reviewing what is known about the facility or site and identify data gaps. Given the site-specific conditions, consider whether or not a Site Reconnaissance is necessary and practical. This type of effort may be deemed necessary if a site is abandoned, not easily observed from areas of public access, or discloses little information during file searches. These same circumstances may also make a Site Reconnaissance risky for health and safety reasons—in view of the many unknowns—and may make entry difficult. This investigative step may be practical, but less critical, for active facilities whose operators grant access and provide requested information. Remember to arrange for proper site access and prepare an appropriate health and safety plan, if required, before initiating the Site Reconnaissance.

Investigators should acquire signed consent forms from the site or equipment owner to gain access to the property to conduct the reconnaissance. Investigators are to determine if State and Federal officials, and local individuals, should be notified of the reconnaissance schedule. If needed, local officials should arrange for public notification. Guidance on obtaining access to sites can be found in *Entry and Continued Access Under CERCLA* (EPA 1987d).

A study plan should be prepared before the Site Reconnaissance to anticipate every reconnaissance activity and identify specific information to be gathered. This plan should incorporate a survey of the site's surroundings and provide details for activities that verify or identify the location of: nearby residents, worker populations, drinking water or irrigation wells, foods, and other site environs information.

Preparing for the Site Reconnaissance includes initially gathering necessary materials and equipment. This includes a camera to document site conditions, health and safety monitoring instruments including a radiation detection meter for use during the site visit, and extra copies of topographic maps to mark target locations, water distribution areas, and other important site features. A logbook is critical to keeping a record of field activities and observations as they occur. For documentation purposes MARSSIM recommends that the logbook be completed in waterproof ink, preferably by one individual. Furthermore, each page of the logbook should be signed and dated, including the time of day, after the last entry on the page. Corrections should be documented and approved.

3.6 Evaluation of Historical Site Assessment Data

The main purpose of the Historical Site Assessment (HSA) is to determine the current status of the site or facility, but the data collected may also be used to differentiate sites that need further action from those that pose little or no threat to human health and the environment. This screening process can serve to provide a site disposition recommendation or to recommend additional surveys. Because much of the data collected during HSA activities is qualitative or is analytical data of unknown quality, many decisions regarding a site are the result of professional judgment.

There are three possible recommendations that follow the HSA:

- An emergency action to reduce the risk to human health and the environment—this alternative is applicable to Superfund removal actions, which are discussed in detail by EPA (EPA 1988c).

- The site or area is impacted and further investigation is needed before a decision regarding final disposition can be made. The area may be Class 1, Class 2, or Class 3, and a scoping survey or a characterization survey should be performed. Information collected during the HSA can be very useful in planning these subsequent survey activities.

- The site or area is non-impacted. There is no possibility or an extremely low probability of residual radioactive materials being present at the site. The site or area can be released.

Historical analytical data indicating the presence of contamination in environmental media (surface soil, subsurface soil, surface water, ground water, air, or buildings) can be used to support the hypothesis that radioactive material was released at the facility or site. A decision that the site is contaminated can be made regardless of the quality of the data, its attribution to site operations, or its relationship to background levels. In such cases, analytical indications are sufficient to support the hypothesis—it is not necessary to definitively demonstrate that a problem exists. Conversely, historical analytical data can also be used to support the hypothesis that no release has occurred. However, these data should not be the sole basis for this hypothesis. Using historical analytical data as the principal reason for ruling out the occurrence of contamination forces the data to demonstrate that a problem does not exist.

In most cases it is assumed there will be some level of process knowledge available in addition to historical analytical data. If process knowledge suggests that no residual contamination should be present and the historical analytical data also suggests that no residual contamination is present, the process knowledge provides an additional level of confidence and supports classifying the area as non-impacted. However, if process knowledge suggests no residual contamination should be present but the historical analytical data indicate the presence of residual contamination, the area will probably be considered impacted.

The following sections describe the information recommended for assessing the status of a site. This information is needed to accurately and completely support a site disposition recommendation. If some of the information is not available, it should be identified as a data need for future surveys. Data needs are collected during Step 3 of the Data Quality Objective (DQO) process (Identify Inputs to the Decision) as described in Appendix D, Section D.3. Section 3.6.5 provides information on professional judgment and how it may be applied to the decision making process.

3.6.1 Identify Potential Contaminants

An efficient HSA gathers information sufficient to identify the radionuclides used at the site—including their chemical and physical form. The first step in evaluating HSA data is to estimate the potential for residual contamination by these radionuclides.

Site operations greatly influence the potential for residual contamination (NRC 1992a). An operation that only handled encapsulated sources is expected to have a low potential for contamination—assuming that the integrity of the sources was not compromised. A review of leak-test records for such sources may be adequate to demonstrate the low probability of residual contamination. A chemical manufacturing process facility would likely have contaminated piping, ductwork, and process areas, with a potential for soil contamination where spills, discharges, or leaks occurred. Sites using large quantities of radioactive ores—especially those with outside waste collection and treatment systems—are likely to have contaminated grounds. If loose dispersible materials were stored outside or process ventilation systems were poorly controlled, then windblown surface contamination may be possible.

Consider how long the site was operational. If enough time elapsed since the site discontinued operations, radionuclides with short half-lives may no longer be present in significant quantities. In this case, calculations demonstrating that residual activity could not exceed the DCGL may be sufficient to evaluate the potential residual contaminants at the site. A similar consideration can be made based on knowledge of a contaminant’s chemical and physical form. Such a determination relies on records of radionuclide inventories, chemical and physical forms, total amounts of activity in waste shipments, and purchasing records to document and support this decision. However, a number of radionuclides experience significant decay product ingrowth, which should be included when evaluating existing site information.

3.6.2 Identify Potentially Contaminated Areas

Information gathered during the HSA should be used to provide an initial classification of the site areas as impacted or non-impacted.

Impacted areas have a reasonable potential for radioactive contamination (based on historical data) or contain known radioactive contamination (based on past or preliminary radiological surveillance). This includes areas where 1) radioactive materials were used and stored; 2) records indicate spills, discharges, or other unusual occurrences that could result in the spread of contamination; and 3) radioactive materials were buried or disposed. Areas immediately surrounding or adjacent to these locations are included in this classification because of the potential for inadvertent spread of contamination.

Non-impacted areas—identified through knowledge of site history or previous survey information—are those areas where there is no reasonable possibility for residual radioactive contamination. The criteria used for this segregation need not be as strict as those used to demonstrate final compliance with the regulations. However, the reasoning for classifying an area as non-impacted should be maintained as a written record. Note that—based on accumulated survey data—an impacted area’s classification may change as the RSSI Process progresses.

All potential sources of radioactivity in impacted areas should be identified and their dimensions recorded (in 2 or 3 dimensions—to the extent they can be measured or estimated). Sources can be delineated and characterized through visual inspection during the site reconnaissance, interviews with knowledgeable personnel, and historical information concerning disposal records, waste manifests, and waste sampling data. The HSA should address potential contamination from the site whether it is physically within or outside of site boundaries. This approach describes the site in a larger context, but as noted in Chapter 1, MARSSIM's scope concerns releasing a site and not areas outside a site's boundaries.

3.6.3 Identify Potentially Contaminated Media

The next step in evaluating the data gathered during the HSA is to identify potentially contaminated media at the site. To identify media that may and media that do not contain residual contamination supports both preliminary area classification (Section 4.4) and planning subsequent survey activities.

This section provides guidance on evaluating the likelihood for release of radioactivity into the following environmental media: surface soil, subsurface soil, sediment, surface water, ground water, air, and buildings. While MARSSIM's scope is focused on surface soils and building surfaces, this section makes note of still other media to provide a starting place to identify and address all possible media. The evaluation will result in either a finding of "Suspected Contamination" or "No Suspected Contamination," which may be based on analytical data, professional judgment, or a combination of the two.

Subsequent sections describe the environmental media and pose questions pertinent to each type. Each question is accompanied by a commentary. Carefully consider the questions within the context of the site and the available data. Avoid spending excessive amounts of time answering each question because answers to every question are unlikely to be available at each site. Questions that cannot be answered based on existing data can be used to direct future surveys of the site. Also, keep in mind the numerous differences in site-specific circumstances and that the questions do not identify every characteristic that might apply to a specific site. Additional questions or characteristics identified during a specific site assessment should be included in the HSA report (Section 3.8; EPA 1991f).

3.6.3.1 Surface Soil

Surface soil is the top layer of soil on a site that is available for direct exposure, growing plants, resuspension of particles for inhalation, and mixing from human disturbances. Surface soil may also be defined as the thickness of soil that can be measured using direct measurement or scanning techniques. Typically, this layer is represented as the top 15 cm (6 in.) of soil (40 CFR 192). Surface sources may include gravel fill, waste piles, concrete, or asphalt paving. For many sites where radioactive materials were used, one first assumes that surface contamination exists and the evaluation is used to identify areas of high and low probability of contamination (Class 1, Class 2 or Class 3 areas).

- Were all radiation sources used at the site encapsulated sources?

A site where only encapsulated sources were used would be expected to have a low potential for contamination. A review of the leak-test records and documentation of encapsulated source location may be adequate for a finding of "No Suspected Contamination."

- Were radiation sources used only in specific areas of the site?

Evidence that radioactive materials were confined to certain areas of the site may be helpful in determining which areas are impacted and which are non-impacted.

- Was surface soil regraded or moved elsewhere for fill or construction purposes?

This helps to identify additional potential radiation sites.

3.6.3.2 Subsurface Soil and Media

Subsurface soil and media are defined as any solid materials not considered to be surface soil. The purpose of these investigations is to locate and define the vertical extent of the potential contamination. Subsurface measurements can be expensive, especially for beta- or alpha-emitting radionuclides. Removing areas from consideration for subsurface measurements or defining areas as non-impacted for subsurface sampling conserves limited resources and focuses the site assessment on areas of concern.

- Are there areas of known or suspected surface soil contamination?

Surface soil contamination can migrate deeper into the soil. Surface soil sources should be evaluated based on radionuclide mobility, soil permeability, and infiltration rate to determine the potential for subsurface contamination. Computer modeling may be helpful for evaluating these types of situations.

- Is there a ground-water plume without an identifiable source?

Contaminated ground water indicates that a source of contamination is present. If no source is identified during the HSA, subsurface contamination is a probable source.

- Is there potential for enhanced mobility of radionuclides in soils?

Radionuclide mobility can be enhanced by the presence of solvents or other volatile chemicals that affect the ion-exchange capacity of soil.

- Is there evidence that the surface has been disturbed?

Recent or previous excavation activities are obvious sources of surface disturbance. Areas with developed plant life (forested or old growth areas) may indicate that the area remained undisturbed during the operating life of the facility. Areas where vegetation is removed during previous excavation activity may be distinct from mature plant growth in adjacent areas. If a site is not purposely replanted, vegetation may appear in a sequence starting with grasses that are later replaced by shrubs and trees. Typically, grasslands recover within a few years, sagebrush or low ground cover appears over decades, while mature forests may take centuries to develop.

- Is there evidence of subsurface disturbance?

Non-intrusive, non-radiological measurement techniques may provide evidence of subsurface disturbance. Magnetometer surveys can identify buried metallic objects, and ground-penetrating radar can identify subsurface anomalies such as trenches or dump sites. Techniques involving special equipment are discussed in Section 6.10.

- Are surface structures present?

Structures constructed at a site—during the operational history of that site—may cover below-ground contamination. Some consideration for contaminants that may exist beneath parking lots, buildings, or other onsite structures may be warranted as part of the investigation. There may be underground piping, drains, sewers, or tanks that caused contamination.

3.6.3.3 Surface Water

Surface waters include streams and rivers, lakes, coastal tidal waters, and oceans. Note that certain ditches and intermittently flowing streams qualify as surface water. The evaluation determines whether radionuclides are likely to migrate to surface waters or their sediments. Where a previous release is not suspected, the potential for future release depends on the distance to surface water and the flood potential at the site. With regard to the two preceding sections, one can also consider an interaction between soil and water in relation to seasonal factors including soil cracking due to freezing, thawing, and dessication that influence the dispersal or infiltration of radionuclides.

- Is surface water nearby?

The proximity of a contaminant to local surface water is essentially determined by runoff and radionuclide migration through the soil. The definition for *nearby* depends on site-specific conditions. If the terrain is flat, precipitation is low, and soils are sandy, nearby may be within several meters. If annual precipitation is high or occasional rainfall events are high, within 1,200 meters (3/4 mile) might be considered nearby. In general, sites need not include the surface water pathway where the overland flow distance to the nearest surface water is more than 3,200 meters (2 miles).

- Is the waste quantity particularly large?

Depending on the physical and chemical form of the waste and its location, *large* is a relative term. A *small* quantity of liquid waste may be of more importance—*i.e.*, a greater risk or hazard—than a *large* quantity of solid waste stored in water tight containers.

- Is the drainage area large?

The drainage area includes the area of the site itself plus the upgradient area that produces runoff flowing over the site. Larger drainage areas generally produce more runoff and increase the potential for surface water contamination.

- Is rainfall heavy?

If the site and surrounding area are flat, a combination of heavy precipitation and low infiltration rate may cause rainwater to pool on the site. Otherwise, these characteristics may contribute to high runoff rates that carry radionuclides overland to surface water. Total annual rainfall exceeding one meter (40 inches), or a once in two-year-24-hour precipitation exceeding five cm (two inches) might be considered "heavy."

Rainfall varies for locations across the continental United States from high (*e.g.*, 89 in./y, Mt. Washington, NH) to low values (*e.g.*, 4.2 in./y, Las Vegas, NV). Precipitation rates will vary during the year at each location due to seasonal and geographic factors. A median value for rainfall within the United States, as found in van der Leeden *et al*. 1990, is about 26 in./y as is observed for Minneapolis, MN.

- Is the infiltration rate low?

Infiltration rates range from very high in gravelly and sandy soils to very low in fine silt and clay soils. Paved sites prevent infiltration and generate runoff.

- Are sources of contamination poorly contained or prone to runoff?

Proper containment which prevents radioactive material from migrating to surface water generally uses engineered structures such as dikes, berms, run-on and runoff control systems, and spill collection and removal systems. Sources prone to releases via runoff include leaks, spills, exposed storage piles, or intentional disposal on the ground surface. Sources not prone to runoff include underground tanks, above-ground tanks, and containers stored in a building.

- Is a runoff route well defined?

A well defined runoff route—along a gully, trench, berm, wall, *etc.*—will more likely contribute to migration to surface water than a poorly defined route. However, a poorly defined route may contribute to dispersion of contamination to a larger area of surface soil.

- Has deposition of waste into surface water been observed?

Indications of this type of activity will appear in records from past practice at a site or from information gathered during personal interviews.

- Is ground water discharge to surface water probable?

The hydrogeology and geographical information of the area around and inside the site may be sufficiently documented to indicate discharge locations.

- Does analytical or circumstantial evidence suggest surface water contamination?

Any condition considered suspicious—and that indicates a potential contamination problem—can be considered circumstantial evidence.

- Is the site prone to flooding?

The Federal Emergency Management Agency (FEMA) publishes flood insurance rate maps that delineate 100-year and 500-year flood plains. Ten-year floodplain maps may also be available. Generally, a site on a 500-year floodplain is not considered prone to flooding.

3.6.3.4 Ground Water

Proper evaluation of ground water includes a general understanding of the local geology and subsurface conditions. Of particular interest is descriptive information relating to subsurface stratigraphy, aquifers, and ground water use.

- Are sources poorly contained?

Proper containment which prevents radioactive material from migrating to ground water generally uses engineered structures such as liners, layers of low permeability soil (*e.g.*, clay), and leachate collection systems.

- Is the source likely to contaminate ground water?

Underground tanks, landfills,[2] surface impoundments and lagoons are examples of sources that are likely to release contaminants that migrate to ground water. Above ground tanks, drummed solid wastes, or sources inside buildings are less likely to contribute to ground-water contamination.

- Is waste quantity particularly large?

Depending on the physical and chemical form of the waste and its location, *large* is a relative term. A *small* quantity of liquid waste may be of more importance—*i.e.*, greater risk or hazard—than a *large* quantity of solid waste stored in water tight containers.

- Is precipitation heavy?

If the site and surrounding area are flat, a combination of heavy precipitation and low infiltration rate may cause rainwater to pool on the site. Otherwise, these characteristics may contribute to high runoff rates that carry radionuclides overland to surface water. Total annual rainfall exceeding one meter (40 in.), or a once in two-year-24-hour precipitation exceeding five cm (two in.) might be considered “heavy.”

Rainfall varies for locations across the continental United States from high (*e.g.*, 89 in./y, Mt. Washington, NH) to low values (*e.g.*, 4.2 in./y, Las Vegas, NV). Precipitation rates will vary during the year at each location due to seasonal and geographic factors. A median value for rainfall within the United States, as found in van der Leeden *et al*. 1990, is about 26 in./y as is observed for Minneapolis, MN.

- Is the infiltration rate high?

Infiltration rates range from very high in gravelly and sandy soils to very low in fine silt and clay soils. Unobstructed surface areas are potential candidates for further examination to determine infiltration rates.

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[2] Landfills can affect the geology and hydrogeology of a site and produce heterogeneous conditions. It may be necessary to consult an expert on landfills and the conditions they generate.

- Is the site located in an area of karst terrain?

In karst terrain, ground water moves rapidly through channels caused by dissolution of the rock material (usually limestone) that facilitates migration of contaminants.

- Is the subsurface highly permeable?

Highly permeable soils favor downward movement of water that may transport radioactive materials. Well logs, local geologic literature, or interviews with knowledgeable individuals may help answer this question.

- What is the distance from the surface to an aquifer?

The shallower the source of ground water, the higher the threat of contamination. It is difficult to determine whether an aquifer may be a potential source of drinking water in the future (*e.g.*, next 1,000 years). This generally applies to the shallowest aquifer below the site.

- Are suspected contaminants highly mobile in ground water?

Mobility in ground water can be estimated based on the distribution coefficient (K_d) of the radionuclide. Elements with a high K_d, like thorium (*e.g.*, K_d = 3,200 cm^3/g), are not mobile while elements with a low K_d, like hydrogen (*e.g.*, K_d = 0 cm^3/g), are very mobile. The NRC (NRC 1992b) and Department of Energy (DOE) (Yu, *et al.*, 1993) provide a compilation of K_d values. These values can be influenced by site-specific considerations such that site-specific K_d values need to be evaluated or determined. Also, the mobility of a radionuclide can be enhanced by the presence of a solvent or volatile chemical.

- Does analytical or circumstantial evidence suggest ground water contamination?

Evidence for contamination may appear in current site data; historical, hydrogeological, and geographical information systems records; or as a result of personal interviews.

3.6.3.5 Air

Evaluation of air is different than evaluation of other potentially contaminated media. Air is rarely the source of contamination. Air is evaluated as a pathway for resuspending and dispersing radioactive contamination as well as a contaminated media.

- Were there observations of contaminant releases into the air?

Direct observation of a release to the air might occur where radioactive materials are suspected to be present in particulate form (*e.g.*, mine tailings, waste pile) or adsorbed to particulates (*e.g.*, contaminated soil), and where site conditions favor air transport (*e.g.*, dry, dusty, windy).

- Does analytical or circumstantial evidence suggest a release to the air?

Other evidence for releases to the air might include areas of surface soil contamination that do not appear to be caused by direct deposition or overland migration of radioactive material.

- For radon exposure only, are there elevated amounts of radium (^{226}Ra) in the soil or water that could act as a source of radon in the air?

The source, ^{226}Ra, decays to ^{222}Rn, which is radon gas. Once radon is produced, the gas needs a pathway to escape from its point of origin into the air. Radon is not particularly soluble in water, so this gas is readily released from water sources which are open to air. Soil, however, can retain radon gas until it has decayed (see Section 6.9). The rate that radon is emitted by a solid, *i.e.* radon flux, can be measured directly to evaluate potential sources of radon.

- Is there a prevailing wind and a propensity for windblown transport of contamination?

Information pertaining to geography, ground cover (*e.g.*, amount and types of local vegetation), meteorology (*e.g.*, windspeed at 7 meters above ground level) for and around the site, plus site-specific parameters related to surface soil characteristics enter into calculations used to describe particulate transport. Mean annual windspeed can be obtained from the National Weather Service surface station nearest to the site.

3.6.3.6 Structures

Structures used for storage, maintenance, or processing of radioactive materials are potentially contaminated by these materials. The questions presented in Table 3.1 help to determine if a building might be potentially contaminated. The questions listed in this section are for identifying potentially contaminated structures, or portions of structures, that might not be identified using Table 3.1. Section 4.8.3.1 also presents useful information on identifying structural contamination.

- Were adjacent structures used for storage, maintenance, or processing of radioactive materials?

Adjacent is a relative term for this question. A processing facility with a potential for venting radioactive material to the air could contaminate buildings downwind. A facility with little potential for release outside of the structures handling the material would be less likely to contaminate nearby structures.

- Is a building or its addition or a new structure located on a former radioactive waste burial site or contaminated land?

Comparing past and present photographs or site maps and retrieving building permits or other structural drawings and records in relation to historical operations information will reveal site locations where structures may have been built over buried waste or contaminated land.

- Was the building constructed using contaminated material?

Building materials such as concrete, brick, or cinder block may have been formed using contaminated material.

- Does the potentially non-impacted portion of the building share a drainage system or ventilation system with a potentially contaminated area?

Technical and architectural drawings for site structures along with visual inspections are required to determine if this is a concern in terms of current or past operations.

- Is there evidence that previously identified areas of contamination were remediated by painting or similar methods of immobilizing contaminants?

Removable sources of contamination immobilized by painting may be more difficult to locate, and may need special consideration when planning subsequent surveys.

3.6.4 Develop a Conceptual Model of the Site

Starting with project planning activities, one gathers and analyzes available information to develop a conceptual site model. The model is essentially a site diagram showing locations of known contamination, areas of suspected contamination, types and concentrations of radionuclides in impacted areas, potentially contaminated media, and locations of potential reference (background) areas. The diagram should include the general layout of the site including buildings and property boundaries. When possible, produce three dimensional diagrams. The conceptual site model will be upgraded and modified as information becomes available throughout the RSSI Process. The process of developing this model is also briefly described in Attachment A of EPA 1996b.

The model is used to assess the nature and the extent of contamination, to identify potential contaminant sources, release mechanisms, exposure pathways, human and/or environmental receptors, and to develop exposure scenarios. Further, this model helps to identify data gaps, determine media to be sampled, and assists staff in developing strategies for data collection. Site history and preliminary survey data generally are extremely useful sources of information for developing this model. The conceptual site model should include known and suspected sources of contamination and the types of contaminants and affected media. Such a model can also illustrate known and potential routes of migration and known or potential human and environmental receptors.

The site should be classified or initially divided into similar areas. Classification may be based on the operational history of the site or observations made during the Site Reconnaissance (see Section 3.5.2). After the site is classified using current and past site characteristics, further divide the site or facility based on anticipated future use. This classification can help to a) assign limited resources to areas that are anticipated to be released without restrictions, and b) identify areas with little or no possibility of unrestricted release. Figure 3.1 shows an example of how a site might be classified in this manner. Further classification of a site may be possible based on site disposition recommendations (unrestricted vs. release with passive controls).

3.6.5 Professional Judgment

In some cases, traditional sources of information, data, models, or scientific principles are unavailable, unreliable, conflicting, or too costly or time consuming to obtain. In these instances professional judgment may be the only practical tool available to the investigator. Professional judgment is the expression of opinion, that is documented in written form and based on technical knowledge and professional experience, assumptions, algorithms, and definitions, as stated by an expert in response to technical problems (NRC 1990). For general applications, this type of judgment is a routine part of scientific investigation where knowledge is incomplete. Professional judgment can be used as an independent review of historical data to support decision making during the HSA. Professional judgment should only be used in situations where data are not reasonably obtainable by collection or experimentation.

The process of recruiting professionals should be documented and as unbiased as possible. The credentials of the selected individual or individuals enhance the credibility of the elicitation, and the ability to communicate their reasoning is a primary determinant of the quality of the results. Qualified professionals can be identified by different sources, including the planning team, professional organizations, government agencies, universities, consulting firms, and public interest groups. The selection criteria for the professionals should include potential conflict of interest (economic or personal), evidence of expertise in a required topic, objectiveness, and availability.

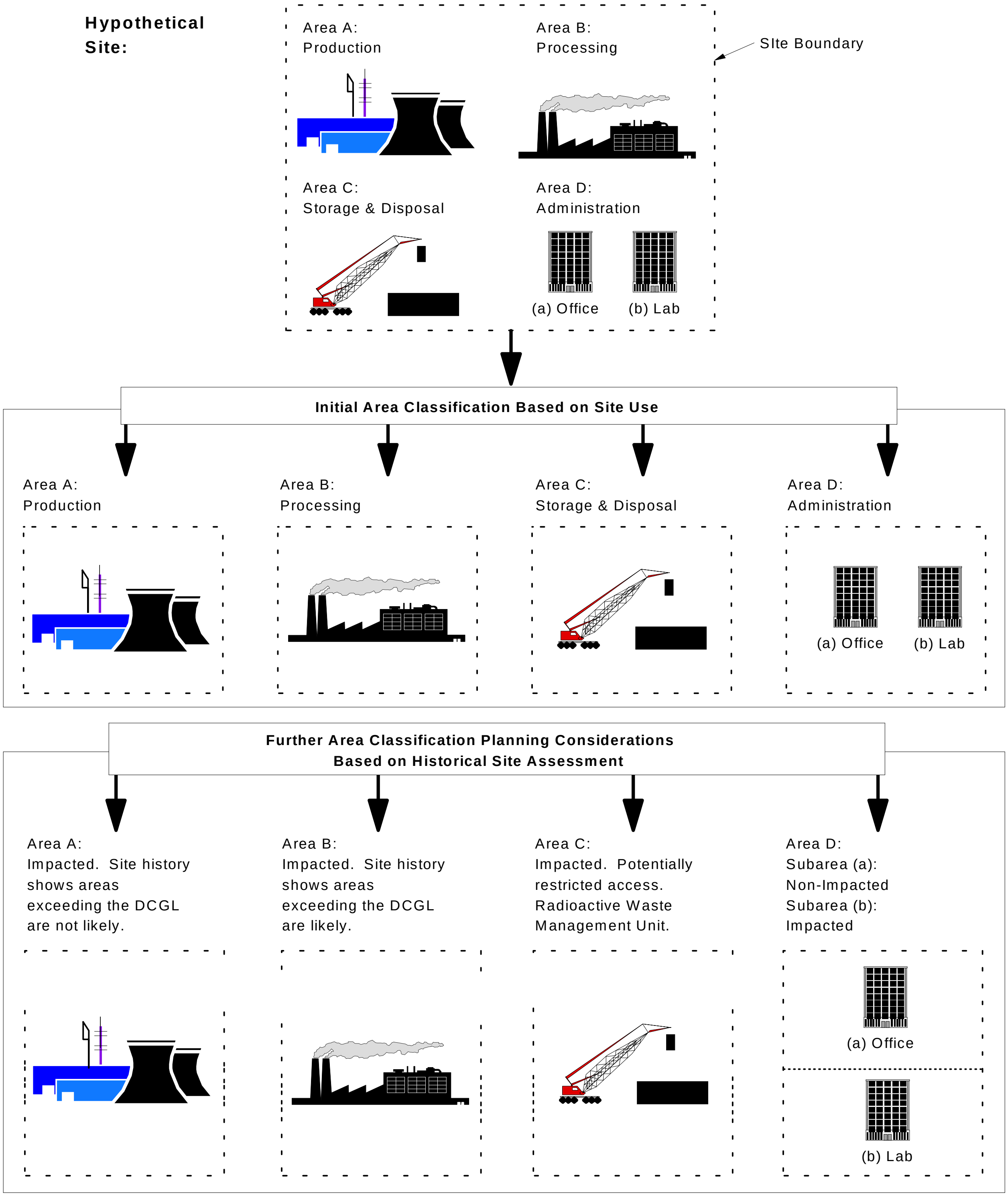

Figure 3.1 Example Showing how a Site Might be Classified Prior to Cleanup Based on the Historical Site Assessment

3.7 Determining the Next Step in the Site Investigation Process

As stated in Section 1.1, the purpose of this manual is to describe a process-oriented approach for demonstrating compliance with the release criterion for residual radioactivity. The highest probability of demonstrating compliance can be obtained by sequentially following each step in the RSSI Process. In some cases, however, performing each step in the process is not practical or necessary. This section provides guidance on how the results of the HSA can be used to determine the next step in the process.

The best method for determining the next step is to review the purpose for each type of survey described in Chapter 5. For example, a scoping survey is performed to provide sufficient information for determining 1) whether present contamination warrants further evaluation and 2) initial estimates of the level of effort for decontamination and preparing a plan for a more detailed survey. If the HSA demonstrates that this information is already available, do not perform a scoping survey. On the other hand, if the information obtained during the HSA is limited, a scoping survey may be necessary to narrow the scope of the characterization survey.

The exception to conducting additional surveys before a final status survey is the use of HSA results to release a site. Generally, the analytical data collected during the HSA are not adequate to statistically demonstrate compliance for impacted areas as described in Chapter 8. This means that the decision to release the site will be based on professional judgment. This determination will ultimately be decided by the responsible regulatory agency.

3.8 Historical Site Assessment Report

A narrative report is generally a useful product for an HSA. Use this report to summarize what is known about the site, what is assumed or inferred, activities conducted during the HSA, and all researched information. Cite a supporting reference for each factual statement given in the report. Attach copies of references (*i.e.*, those not generally available to the public) to the report. The narrative portion of the report should be written in plain English and avoid the use of technical terminology.

To encourage consistency in the content of HSA narratives, both the structure and content of each report should follow the outline shown in Figure 3.2. Additional information not identified in the outline may be requested by the regulatory agency at its discretion. The level of effort to produce the report should reflect the amount of information gathered during the HSA.

3.9 Review of the HSA

The planning team should ensure that someone (a first reviewer) conducts a detailed review of the HSA report for internal consistency and as a quality-control mechanism. A second reviewer with considerable site assessment experience should then examine the entire information package to assure consistency and to provide an independent evaluation of the HSA conclusions. The second reviewer also evaluates the package to determine if special circumstances exist where radioactivity may be present but not identified in the HSA. Both the first reviewer and a second independent reviewer should examine the HSA written products to ensure internal consistency in the report's information, summarized data, and conclusions. The site review ensures that the HSA's recommendations are appropriate.

An important quality assurance objective is to find and correct errors. A significant inconsistency indicating either an error or a flawed conclusion, if undetected, could contribute to an inappropriate recommendation. Identifying such a discrepancy directs the HSA investigator and site reviewers to reexamine and resolve the apparent conflict.

Under some circumstances, experienced investigators may have differing interpretations of site conditions and draw differing conclusions or hypotheses regarding the likelihood of contamination. Any such differences should be resolved during the review. If a reviewer's interpretations contradict those of the HSA investigator, the two should discuss the situation and reach a consensus. This aspect of the review identifies significant points about the site evaluation that may need detailed explanation in the HSA narrative report to fully support the conclusions. Throughout the review, the HSA investigator and site reviewers should keep in mind the need for conservative judgments in the absence of definitive proof to avoid underestimating the presence of contamination, which could lead to an inappropriate HSA recommendation.

1. Glossary of Terms, Acronyms and Abbreviations

2. Executive Summary

3. Purpose of the Historical Site Assessment

4. Property Identification
    - 4.1 Physical Characteristics
        - 4.1.1 Name - CERCLIS ID# (if applicable), owner/operator name, address
        - 4.1.2 Location - street address, city, county, state, geographic coordinates
        - 4.1.3 Topography - USGS 7.5 minute quadrangle or equivalent
        - 4.1.4 Stratigraphy
    - 4.2 Environmental Setting
        - 4.2.1 geology
        - 4.2.2 hydrogeology
        - 4.2.3 hydrology
        - 4.2.4 meteorology

5. Historical Site Assessment Methodology
    - 5.1 Approach and Rationale
    - 5.2 Boundaries of Site
    - 5.3 Documents Reviewed
    - 5.4 Property Inspections
    - 5.5 Personal Interviews

6. History and Current Usage
    - 6.1 History - years of operation, type of facility, description of operations, regulatory involvement; permits & licenses, waste handling procedures
    - 6.2 Current Usage - type of facility, description of operations, probable source types and sizes, description of spills or releases, waste manifests, radionuclide inventories, emergency or removal actions
    - 6.3 Adjacent Land Usage - sensitive areas such as wetlands or preschools

7. Findings
    - 7.1 Potential Contaminants
    - 7.2 Potential Contaminated Areas
        - 7.2.1 Impacted Areas—known and potential
        - 7.2.2 Non-Impacted Areas
    - 7.3 Potential Contaminated Media
    - 7.4 Related Environmental Concerns

8. Conclusions

9. References

10. Appendices
    - A. Conceptual Model and Site Diagram showing Classifications
    - B. List of Documents
    - C. Photo documentation Log
      Original photographs of the site and pertinent site features

Figure 3.2 Example of a Historical Site Assessment Report Format