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Guide for Development of Sample Collection Plans for Radiochemical Analytes in Outdoor Building and Infrastructure Materials Following Homeland Security Incidents

Office of Research and Development

Homeland Security Research Program

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Cincinnati, OH 45268

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Disclaimer

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Foreword

The U.S. Environmental Protection Agency (EPA) is charged by Congress with protecting the Nation's land, air, and water resources. Under a mandate of national environmental laws, the Agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. To meet this mandate, EPA's research program is providing data and technical support for solving environmental problems today and building a science knowledge base necessary to manage our ecological resources wisely, understand how pollutants affect our health, and prevent or reduce environmental risks in the future.

The Center for Environmental Solutions and Emergency Response (CESER) within the Office of Research and Development (ORD) conducts applied, stakeholder-driven research and provides responsive technical support to help solve the Nation’s environmental challenges. The Center’s research focuses on innovative approaches to address environmental challenges associated with the built environment. We develop technologies and decision-support tools to help safeguard public water systems and groundwater, guide sustainable materials management, remediate sites from traditional contamination sources and emerging environmental stressors, and address potential threats from terrorism and natural disasters. CESER collaborates with both public and private sector partners to foster technologies that improve the effectiveness and reduce the cost of compliance, while anticipating emerging problems. We provide technical support to EPA regions and programs, states, tribal nations, and federal partners, and serve as the interagency liaison for EPA in homeland security research and technology. The Center is a leader in providing scientific solutions to protect human health and the environment.

Acronyms and Abbreviations

CFR	Code of Federal Regulations
COC	chain of custody
DCGL	Derived Concentration Guideline Level
DOE	U.S. Department of Energy
DQO	data quality objective
ERLN	Environmental Response Laboratory Network
EPA	U.S. Environmental Protection Agency
FRMAC	Federal Radiological Monitoring and Assessment Center
HASP	Health and Safety Plan
HSRP	Homeland Security Research Program
IATA	International Air Transportation Association
MARLAP	*Multi-Agency Radiological Laboratory Analytical Protocols Manual*
MARSSIM	*Multi-Agency Radiation Survey and Site Investigation Manual*
MQO	measurement quality objective
NIST	National Institute of Standards and Technology
PAG(s)	Protective Action Guide(s)
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
RSP	Radiation Safety Plan
SAM	*Selected Analytical Methods for Environmental Remediation and Recovery (SAM) 2017*
SCP	Sample Collection Plan
SOP	Standard Operating Procedure
SOW	Statement of Work
WMP	Waste Management Plan

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1.0 Introduction

This document provides a framework for developing and implementing an approach to collection of outdoor building and infrastructure material samples during site cleanup after an intentional or unintentional homeland security-related radiological contamination incident. Examples of outdoor building and infrastructure materials include concrete, brick, asphalt, limestone, granite, stucco and wood. This framework is designed to assist incident commanders, project managers, state and local authorities, contractors, and enforcement divisions responsible for the sample collection approach.

The information in this document is intended for use by individuals responsible for collection of samples in support of EPA remediation and recovery efforts following an intentional or accidental homeland security-related contamination incident. The information in this document can be used to develop a systematic and integrated methodology for sample collection that will meet data use needs and site disposition objectives. This document incorporates processes that include quantitative and qualitative assessments at each stage of cleanup decision making: from initial scoping and stakeholder outreach, to evaluation of cleanup options and implementation of the chosen alternative.

It is projected that, following initial site investigation and response under the Federal Radiological Monitoring and Assessment Center (FRMAC), coordination of the remediation of contaminated sites will be turned over by the U.S. Department of Energy (DOE) to the U.S. Environmental Protection Agency (EPA) for cleanup. According to FRMAC (FRMAC 2009), each radiological contamination incident is unique and the DOE FRMAC director and senior EPA representative, in cooperation with coordinating agency and affected state(s), will determine when it is beneficial and appropriate to initiate a transfer of control from DOE to EPA. According to FRMAC guidance, the following five criteria are met for this transfer to occur:

- the immediate emergency condition is stabilized
- offsite releases of radioactive material have ceased, and there is little or no potential for further unintentional off-site releases
- the offsite radiological conditions are evaluated and the immediate consequences are assessed
- an initial long-range monitoring plan has been developed in conjunction with the affected state, tribal and local governments, and appropriate federal agencies
- EPA has received adequate assurances from the other federal agencies that they are committing the required resources, personnel and funds for the duration of the federal response

The elements in this EPA document provide a general guide for preparation of homeland security incident-specific Sample Collection Plans (SCPs). The SCPs are needed for collection of data once a contaminated site has been turned over to EPA and must be in compliance with EPA requirements regarding quality assurance (QA), quality control (QC) and data quality objectives (DQOs). Additional guides may be issued to clarify or amend the traditional cleanup protocols. The elements can be used to develop SCPs for building and/or infrastructure investigation, characterization, cleanup, and final status surveys to release the building and/or infrastructure, or to support decision making for the final disposition of the contaminated structures. It is assumed that the number of SCPs required, and the details contained within each, is dependent on the number, size and complexity of the specific contaminated structures.

This document is not intended for use in developing the following documents, which are required for each project/site in addition to an SCP:

- Quality Assurance Project Plan (QAPP)
- Radiation Safety Plan (RSP) and associated procedures
- Health and Safety Plan (HASP)and associated procedures
- Waste Management Plan (WMP)

The information in this document is intended to apply only to the development of SCPs for cleanup of outdoor building and infrastructure materials contaminated with radioactivity following a homeland security-related incident. EPA's *Selected Analytical Methods for Environmental Remediation and Recovery (SAM) 2017*[1] (EPA 2017b) should be reviewed for analytical methods to be used during laboratory analysis of samples. EPA's *Sample Collection Procedures for Radiochemical Analytes in Outdoor Building and Infrastructure Materials* (EPA 2016) should be reviewed for information regarding specific sample collection procedures and equipment. If additional contamination is present (e.g., unexploded ordnance, chemical warfare agents, biological wastes, hazardous chemical waste, and/or mixed waste), additional direction will be required, and it will be necessary to develop an SCP that includes information on how to handle these materials.

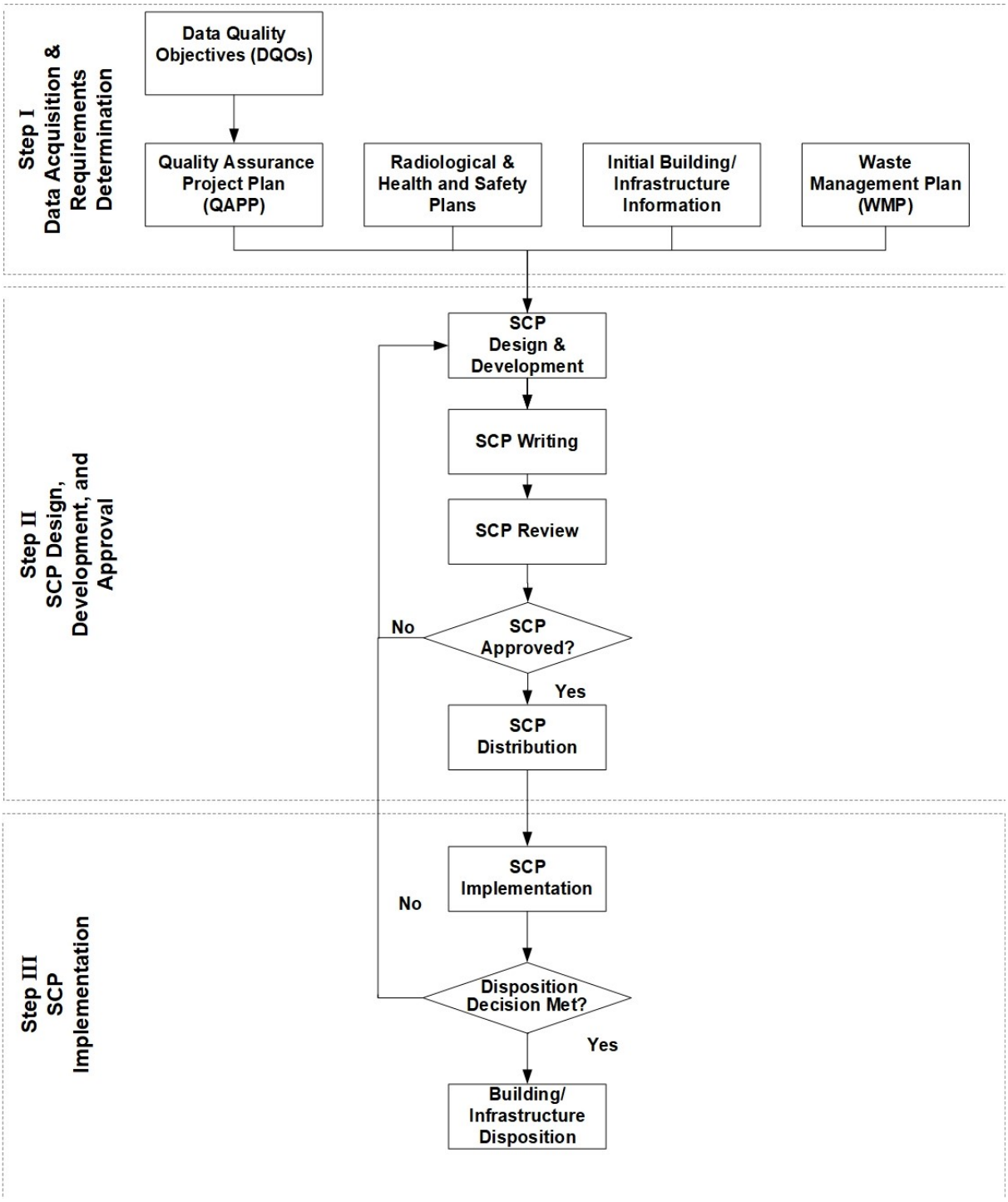
NOTE: The Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM 2000) is cited several times throughout this document, as a resource for additional information and guidance. The manual was developed collaboratively by the EPA, U.S. Department of Defense, U.S. Department of Energy, and Nuclear Regulatory Commission. It provides information on planning, conducting, evaluating and documenting final status radiological surveys. Although the information in MARSSIM is valuable, its introduction acknowledges the site- and incident-specific nature of contamination incidents, stating that the approaches described may not meet the data quality objectives (DQOs) corresponding to a given site. Readers of this guidance document are encouraged to consult MARSSIM (2000) and other resources cited, while considering site- and incident-specific needs and requirements.

2.0 Overview of the SCP Development Process

Figure 2.1 provides a flowchart of major SCP developmental elements and the general processes of project needs' determination through development of sample collection plans and eventual disposition of the contaminated structure(s). The general steps of this process are presented in Figure 2.1. Specific SCP elements are described in this document for each step, and the user is encouraged to review the flowchart for each step. Other elements, as determined in relevant documents listed in Section 6.0, may also be included in the SCP development process.

1 EPA's *Selected Analytical Methods for Environmental Remediation and Recovery (SAM) 2017* (EPA 2017b) and its methods can be found at https://www.epa.gov/esam/selected-analytical-methods-environmental-remediation-and-recovery-sam

Figure 2.1. Sample Collection Plan (SCP) – Overview



2.1 Step I – Data Acquisition and Requirements Determination

Before preparing an SCP, the project should assemble a core SCP design team. Team members may include, but are not limited to:

- Risk assessors
- Statisticians
- Technical planners
- Health physicists
- Radiochemists
- Civil engineers
- Radiological engineers
- Health and safety specialists
- Construction specialists
- Public and media relations specialists
- Regulatory specialists
- State and local subject matter experts
- Legal specialists
- Incident commanders
- On-scene coordinators

The SCP design team must review the information provided in the Step I section (see Section 3.0), and perform a thorough review of all appropriate documents, including any existing Statements of Work (SOWs), Quality Assurance Project Plans (QAPPs), DQOs, Health and Safety Plans (HASPs), Radiation Safety Plans (RSPs), Waste Management Plans (WMPs), or specifications regarding the impending cleanup effort and disposition decisions. In some cases, the information included in these documents can be prepared along with, and/or incorporated into the SCP.

2.2 Step II – SCP Design and Development

The SCP design team gathers the information obtained in Step I and prepares the SCP prior to any field activities. The SCP will likely be amended or revised several times during cleanup, and these amendments or revisions approved by the incident commander and/or project lead. For each SCP developed, the format and content should be consistent with this document, regardless of the size of the project. Section 4.0 describes the general format and content considerations for an SCP. Appendix A lists the typical elements that should appear in the SCP. Specific elements that should be included will depend on the size and/or complexity of the cleanup project, and the SCP format should be modified as appropriate. A good working knowledge of these elements is necessary to understand the type of information required and to determine if additional sources of information are needed.

2.3 Step III – SCP Implementation

An EPA approved and cleared SCP, from the Step II process, must be in place before data collection activities commence. As noted above, this SCP may be revised or amended throughout site cleanup, as appropriate, to reflect the results of *in-situ* and laboratory data collection throughout site remediation. Depending on the data collected and the need for efficiency, data from earlier phases of site remediation that meet project DQOs also can be used to meet data requirements in subsequent phases. All SCP activities must be performed in compliance with the approved/cleared SCP and should be monitored and verified throughout implementation (See Section 5.0).

While data collection activities are being performed, SCP compliance is monitored by field, desk and laboratory audits. SCP defined QA elements (i.e., field and laboratory QC samples, data assessment procedures) are also monitored to ensure SCP compliance. QA audits of the SCP must conform to requirements set in the QAPP.

When all of the SCP activities are completed, an evaluation is made by the incident commander and/or project lead, to determine if the sampling goals and objectives have been met. If the goals and objectives have not been met, the SCP is reevaluated by returning to Step II.

3.0 Step I - SCP Data Acquisition and Requirements Determination

To prepare an SCP, it is necessary to understand all requirements that are or will be included in the project DQOs[2] and QAPPs, and the site-specific requirements included in the project's HASP, RSP and WMP, as shown in Figure 3.1. SCP developers also must consider all available existing information regarding the specific building(s) and/or infrastructure, and the project, including data collected during the initial response phase of the incident.

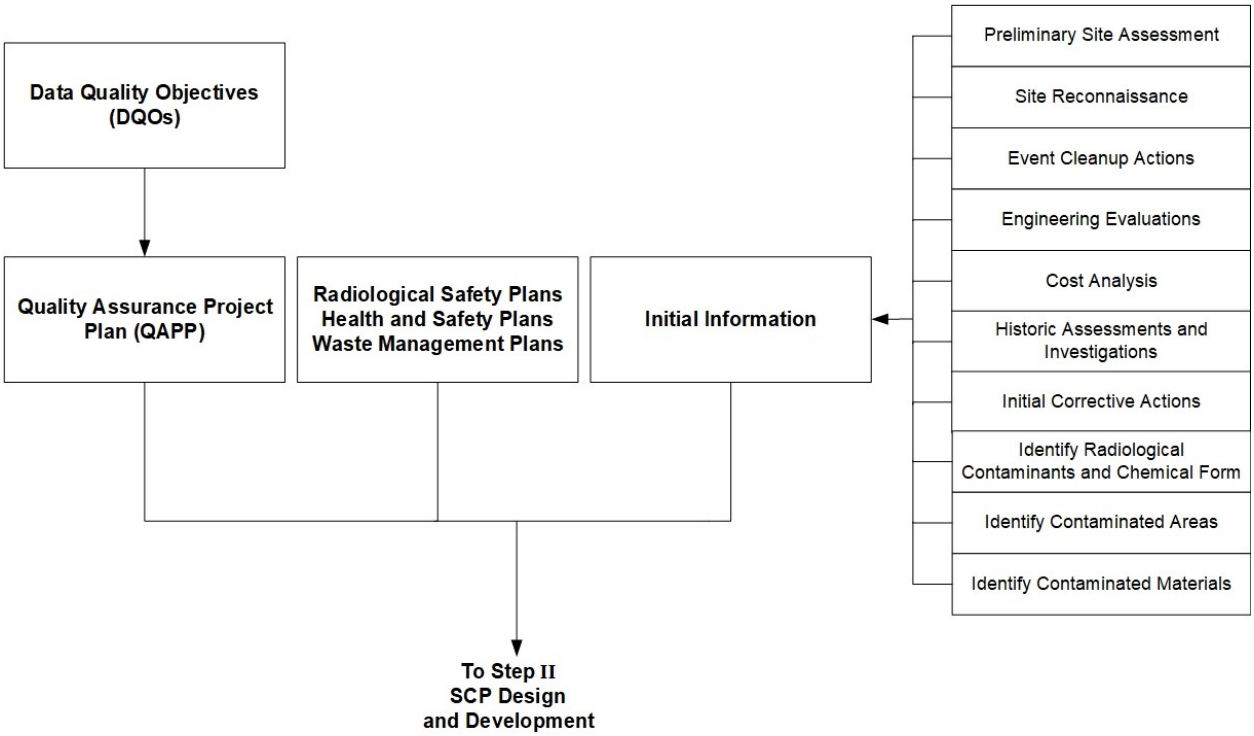
SCP developers should consult with the response team to obtain information collected during the initial phase. As time permits, the team should review data from previous investigations, and/or information regarding site constraints (e.g., site accessibility due to physical or legal limitations, supporting infrastructure availability). Before preparing an SCP, developers should perform a thorough review of information included in all appropriate existing project documents, including any SOWs, QAPPs, DQOs, HASPs, RSPs, WMPs or specifications regarding the project or containing project planning results.

The level of specificity outlined within these project documents may vary from outlining general project goals to specifying sampling and analytical requirements to meet project DQOs. Project documents should identify additional applicable references that might be required for obtaining background information, including (but not limited to):

- Engineering regulations and guidance documents
- Regulatory program and status reports from previous investigations
- Construction data
- Ownership/operational histories
- Site maps, drawings and photographs
- Information on regional meteorological data
- Current and future building/infrastructure use

2 DQOs and Guidance on Systematic Planning Using DQOs are provided in EPA's *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G-4 (EPA 2006), found at: https://www.epa.gov/quality/guidance-systematic-planning-using-data-quality-objectives-process-epa-qag-4

Figure 3.1. Step I - SCP Data Acquisition & Requirements Determination



3.1 Data Quality Objectives (DQOs) and Quality Assurance Project Plan (QAPP)

According to EPA policy, systematic planning must be used to develop acceptance or performance criteria for collection, evaluation or use of environmental data. Systematic planning identifies the expected outcome of the project, technical goals, cost and schedule, and the acceptance criteria for the final result, which must be documented in a QAPP. As defined in the Code of Federal Regulations (CFR) at 40 CFR 300.430 (40 CFR), the QAPP describes policy, organization, and functional activities, as well as the DQOs and measures necessary to achieve adequate data. The QAPP is a plan that provides a process for obtaining data of sufficient quality and quantity to satisfy data needs. In some cases, information contained in the QAPP is also included in the SCP; in these cases, the information must be consistent between the two documents.

The development of a QAPP can either be concurrent and combined with the development of the SCP or separate from the SCP, but it is essential in defining project DQOs and activities needed to ensure that project quality criteria are met. A site-specific QAPP is usually developed in parallel with the development of an SCP. Information pertaining to the preparation of a project-specific QAPP can be found in:

- *Guidance for Quality Assurance Project Plans* (EPA 2002a)
- *EPA Requirements for Quality Assurance Project Plans* (EPA 2001)

Project managers and planners should also review information regarding the DQO process provided in:

- *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA 2006)
- *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM 2000)
- Intergovernmental Data Quality Task Force's *Uniform Federal Policy for Quality Assurance Project Plans* (IDQTF 2005)

Specific QAPP DQO elements related to collection of data for EPA use include:

- Measurement quality objectives (MQOs)[3].
- Cleanup goals, cleanup options, and establishment of remediation levels. [**NOTE:** MARSSIM should be consulted to gain a thorough knowledge of remediation levels, or Derived Concentration Guideline Levels (DCGLs) and how they are interconnected to the SCP and the DQOs of the QAPP.]
- Identification of survey units and boundaries, along with acceptable levels of spatial accuracy (e.g., drift).
- Data assessment, including data quality indicators for precision, bias, completeness, representativeness, reproducibility, comparability, sensitivity and statistical confidence.
- Data verification and validation.
- Data management.

3 Measurement quality objectives (MQOs) are characteristics of a measurement method required to meet the objectives of the survey including required measurement method uncertainty, detection capability, quantification capability, expected concentration range for a radionuclide of concern, specificity, and ruggedness (MARSAME 2009).

3.2 Health and Safety Plans

Safety is a primary consideration in any sampling event and is a critical consideration during development of an SCP. Personnel safety requirements and considerations for a particular building or infrastructure may extend beyond radiological concerns and may include physical hazards or chemicals that are toxic, corrosive, emit harmful or explosive vapors, or are incompatible when mixed. The SCP must be consistent with all radiation and industrial safety requirements and procedures associated with a site. The SCP also must include or reference site-specific personnel safety and protection plans for radiation and industrial health/safety.

Radiation protection requirements included in the site RSP are developed and implemented by the site radiation protection group, which is responsible for:

- Developing and implementing an RSP and radiation work plans for individuals working at the site
- Taking measurements of the radiation levels of all sampling sites and during sampling activities
- Dictating the radiation protection requirements for entering and working in a radioactively contaminated sampling area
- Stopping any activity to protect personnel from overexposure to radiation or from radioactive material contamination associated with the activity

Industrial safety requirements included in the site HASP are developed and instituted by a designated safety individual (e.g., safety and health officer) who is responsible for:

- Developing and implementing a HASP and safety work plans
- Assessing all site activities for potential safety concerns
- Ensuring that personnel are informed as to the potential hazards in a sampling area and dictating the requirements for safely working at the site
- Stopping any job or activity to protect personnel from a dangerous situation

3.3 Waste Management Plan

Ideally, a general WMP will be in place prior to the incident, outlining waste management requirements, procedures, strategies and processes, from the point of generation to final disposition. This general WMP can be used by the incident commander and/or project manager to prepare an incident-specific WMP. This incident-specific plan should address federal (e.g., Resource Conservation and Recovery Act [RCRA]), state and local waste management requirements for the different waste streams; state and/or facility waste disposal agreements; waste characterization and waste acceptance sampling and analysis; identification of waste staging locations; identification of waste management facilities; on-site waste management and minimization strategies and tactics; off-site waste management; waste transportation; and health and safety; as well as tracking and reporting of waste sampling results. Additional details regarding the elements of a WMP are provided in Appendix D of EPA's *Sample Collection Procedures for Radiochemical Analytes in Outdoor Building and Infrastructure Materials* (EPA 2016). Samplers and planners also can refer to EPA's Waste Management Options for Homeland Security Incidents website for information on regulations and guidance to support decision-making regarding waste treatment and disposal.

3.4 Initial Site Information

When a site is transferred to the EPA for cleanup, under FRMAC, detailed response-stage investigation data should be available for review and use in planning the cleanup. In general, the information will detail how the investigation was conducted, will identify contamination boundaries, and will detail contamination gradients, as necessary. This information is critical for designing an appropriate and successful SCP that is consistent with the site investigation. The detailed information provided under FRMAC might include:

- Preliminary site assessment information and data, along with indicators regarding the quality of the data
- Identification of contaminated building(s) and/or infrastructure
- Any initial corrective cleanup actions performed to secure and control the effected building(s) and/or infrastructure (e.g., fire hosing)
- Identification of radiological contaminants, and the contaminated outdoor building and/or infrastructure materials
- Contamination deposition profiles comparable to background levels
- Meteorological data

Information and data generated during engineering evaluations and cost analyses can be used to supplement data typically provided by FRMAC for use in designing a SCP.

If detailed response data/information is not available when a site is turned over to the EPA, as might be the case following a homeland security-related incident, the information provided in this document would enable the planning team to develop an SCP for site investigation and characterization, cleanup, final status survey, and disposition. An historical site assessment or operational history, if applicable, could also be performed or obtained to identify areas of concern or to identify liability from historical or current use of radiological substances (see MARSSIM, Chapter 3). Information that tracks these uses should be collected, and includes:

- **Existing Radiation Data Prior to the Contamination Incident** ─ Review of applicable documents and records to determine if any information is available, via public records, regarding potential pre-existing radiological contamination.

- **Interviews/Questionnaires** ─ Interviews or questionnaires with current owner(s), manager(s) or other responsible parties, local government officials, and residents to obtain as much information as possible regarding the building/infrastructure and any operations and activities that occurred that might have included the use of radionuclides. Included in this inquiry would be past and present improvements or alterations, operations, and plans for future use.

- **Site Reconnaissance** ─ A site visit or inspection to observe current uses (and evidence of past uses, when possible), including those likely to involve the use, treatment, storage, disposal or generation of radioactive materials. In some cases, a site access agreement may be needed prior to initiating remediation activities.

- **Evaluation of Data** ─ A written report to document initial investigation findings, observations and recommendations, including suspected or identified areas of radiological concern or liability, and what sampling and analyses activities were conducted to verify the suspected areas of contamination.

3.5 Characterize Real Property Radiological Contaminants

Once potential areas of concern or contamination are identified and evaluated, an SCP strategy is developed so that sufficient data can be obtained to allow a designated individual or group to conclude that the contaminant(s) of concern:

- Is present at levels above the cleanup goals and cleanup is necessary, or
- Is present at levels below the cleanup goals and no further action is required

3.6 Identify Contaminated Areas

Prior to cleanup following initial response, affected and unaffected buildings, as well as infrastructure, will need to be assessed to identify the type, degree and extent of contamination. Sample collection and analysis, as well as *in-situ* measurements, will be required to support this assessment. Buildings and infrastructure in areas that have no reasonable potential for contamination may not need any level of sampling and can be designated as non-impacted.

FRMAC (Sandia 2010) defines this assessment as the evaluation and interpretation of radiological conditions following a radiological emergency, in terms of the Protective Action Guides (PAGs), which are described in FRMAC Assessment Manual Overview and Methods Volume 1 (Sandia 2015). EPA developed PAGs to help responders plan for radiation emergencies (PAG Manual: Protective Action Guides and Planning Guidance for Radiological Incidents (EPA 2017).

Determination of cleanup actions will rely on initial post-incident measurements and model predictions. Initial measurements from first responders and FRMAC teams will be used in SCP development effort to identify the specific areas of contamination. This information includes:

- Outdoor building/infrastructure survey measurements
- Radiological aerial and ground survey data
- Laboratory analyses of various representative samples (e.g., concrete, brick, asphalt matrices, limestone, granite, stucco, wood)
- Meteorological information
- Models (plume dispersion area, deposition rates, and re-suspension probabilities)

It should be noted that the initial assessment models and cleanup goals might be modified after the results of detailed radiological characterization are gathered.

Prior to cleanup actions, information garnered from FRMAC is coupled with data obtained from historic information (local public, corporate, and governmental information). This information is used to identify areas where contamination could have spread or areas that might affect the actions for cleanup of the area. Examples of historic information to examine include:

- Infrastructure support systems data (water, cable, electric, and sewer systems, underground transport or other types of pipe chases or transport facilities)
- Geological and geographical data that could impact cleanup activities (e.g., location of the water table)
- Documentation of locations where radioactive materials were used, stored, or

disposed of prior to the contamination incident (e.g., radioisotopes used by medical professionals, radiological sources used by industries, contaminated backfill material)
- Records, such as news articles or local emergency responder reports that indicate unusual occurrences that could have resulted in the additional spread of contamination

Areas immediately surrounding or adjacent to the affected building(s) and/or infrastructure are included in the identification of contaminated areas because of the potential for inadvertent spread of contamination (e.g., due to airborne re-suspension, rainfall, initial response activities).

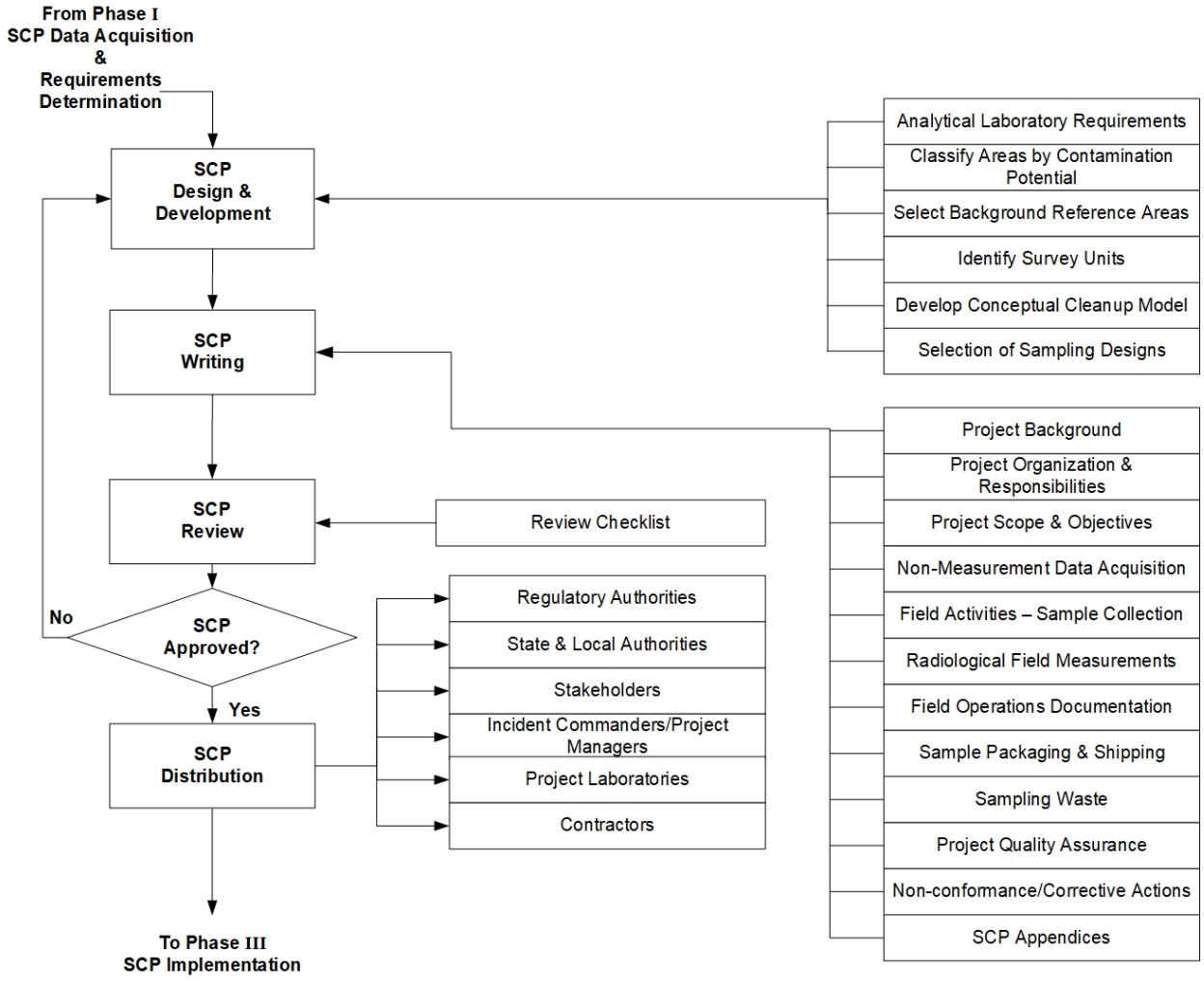
3.7 Identify Contaminated Media

The next step in evaluating the data gathered is to identify potentially contaminated outdoor building and infrastructure media. Direct *in-situ* readings from radiological surveys can identify materials that have the potential to contain residual contamination or materials that do not contain residual contamination. The results of the direct readings can be used for preliminary classification and planning subsequent SCP sampling activities. The evaluation will result in a finding of either “Suspected Contamination” or “No Suspected Contamination,” which may be based on analytical data, professional judgment, or a combination of the two. Results also affect several decisions supporting SCP development, including decisions as to the sampling and analysis techniques that will be used, survey unit determinations, sample sizes, containers, and field equipment.

4.0 Step II - SCP Design and Development

The information and documents gathered and generated during Step I are used to design and develop the project SCP as shown in Figure 4.1. SCPs are designed to lay out and describe project requirements for conducting and completing sampling activities, corresponding data assessment activities, and reporting requirements. Elements that are included in an SCP are listed in Appendix A and described in detail in this section. Specific elements that should be included will depend on the size and/or complexity of the cleanup project, and the SCP format should be modified as appropriate. The SCP is prepared and approved prior to initiation of any sampling activities and is expected to be amended or revised several times during cleanup, as appropriate, to reflect the results of data collection throughout site remediation.

Figure 4.1 Step II - SCP Design and Development



Prior to initiation of SCP design, the decision maker(s) and sample collection planning team should review the information in any existing QAPP and corresponding DQOs, from Step I, to identify the data needs and purpose for sample collection(s), including:

- Location of building(s) and/or infrastructure to be sampled, specific sampling locations, and sampling frequencies
- Types of samples to be collected or measurements to be performed
- Target radionuclide(s)
- Potential interfering radionuclides or chemical contaminants from decontamination activities
- Radiological measurements and instrumentation to support sample collection
- Remediation level for each radionuclide of interest
- MQOs for each radionuclide (e.g., required method uncertainty, required minimum detectable concentration [MDC])
- Analytical or screening methods that will be used in the field and laboratory to assay samples

- Analytical bias and precision (e.g., quantitative or qualitative)
- Number of samples to be collected
- Type and frequency of QC samples to be collected
- Amount of material to be collected for each sample
- Sample tracking requirements (e.g., chain of custody [COC])
- Sample packaging and shipping requirements
- Additional standard operating procedures (SOPs) to be followed or developed
- Cost of the methods being used (cost per analysis as well as total cost)
- The use of gross field measurements
- The use of laboratory surrogate measurements
- Building- or infrastructure-specific background (e.g., from background reference areas) for the radionuclide(s) of interest
- Turnaround time required for sample results to maintain project schedules
- Documentation requirements

For projects that encompass several buildings, infrastructures and types of materials, or that involve a long-term effort, it may be beneficial to generate a comprehensive SCP that includes addendums to cover all aspects of sampling and analytical requirements. These addendums to the SCP must clearly identify the DQOs that are specific to the target building(s)/infrastructure, applicable material matrices, sampling and analysis requirements, and any deviations from the comprehensive SCP. Information in the comprehensive SCP may be referenced in the SCP addendums. When this approach is used, all addendum references to the comprehensive SCP must be verified by the project technical planning team during the document review process. Preparatory inspections (site audits) must ensure that all appropriate plans (comprehensive and addendum SCPs) are available on site, and that sampling personnel are familiar with the procedures included in both.

A separate SCP can be developed for the final status survey. Final status surveys are performed after cleanup is complete to demonstrate that residual levels of radioactive materials satisfy criteria for building/infrastructure disposition. These surveys provide data to demonstrate that radiological parameters do not exceed the established remediation levels and that DQOs have been met. Final status survey SCPs are designed based on these objectives and the known or anticipated radiological conditions at the site. The SCP must include an appropriate number and location of measurement and sampling points to demonstrate compliance with the site release criteria. Planning for a final status survey SCP should include early discussions with the appropriate agencies concerning logistics for confirmatory surveys and sampling. Confirmatory activities are usually limited in scope to include checking conditions at selected locations, comparing findings with those of the final status survey, and performing independent statistical evaluations of the data developed from the final status survey. An independent verification survey may be performed to provide data to substantiate results of the final status survey. Independent evaluations of final building or infrastructure conditions are more extensive than the confirmatory activity listed above and involve validation of the cleanup final status survey procedures, results, and documentation. The independent verification survey is not a replacement or supplement to the final status survey, but it serves to validate the final status survey prior to releasing the effected buildings/infrastructure for use.

4.1 Review of Successful Sampling Plans

When preparing an SCP, the design should match the needs of a given project with the resources available, including personnel, time, cost and equipment. Project needs generally consist of the cleanup objectives and tolerable limits of uncertainty. The goal of the SCP should be to acquire and use all of the information available so that the data collected meet the needs of the data user (i.e., decision maker).

The following is a list of some site-specific sampling plans. These sampling plans range from complex site characterization plans to smaller sub-site project plans. All web addresses in the following list were last accessed June 5, 2020:

- Reconnaissance Level Characterization Plan for D&D Facilities, Revision 1 Reconnaissance Level Characterization Plan (RLCP) For the Rocky Flats Environmental Technology Site (RFETS), Appendix D. D&D (Decontamination and Decommissioning) Characterization Protocol, MAN-077-DDCP, July 2002 (RFETS 2002)

- Pre-Demolition Survey Report (PDSR), Building 551 Closure Project, Rocky Flats Environmental Technology Site, Revision 1, December 31, 2002 (RFETS 2002a)

- Rocky Flats Environmental Technology Site, Type 1 Reconnaissance Level Characterization Report (RLCR) Area 5 Group 6a Closure Projects Trailers T130C, T130D, T130E, T130F, T130G & T130H, Revision 0, April 15, 2003 (RFETS 2003)

- Battelle. Radiological Characterization and Final Status Plan for Battelle Columbus Laboratories Decommissioning Project, West Jefferson Site," Revision 0, March 2000 (Battelle 2000)

- Battelle Memorial Institute Columbus Operations Decommissioning Plan, DD-93-19, Revision 3, August 2000 (Battelle 2000a).

- Site Characterization Plan for Decontamination and Decommissioning of Buildings 3506 and 3515 at Oak Ridge National Laboratory, ORNL/ER/Sub/87-99053/69, Oak Ridge, Tennessee, September 1993 (ORNL 1993)

4.2 Defining Radioanalytical Laboratory Requirements for SCP Sample Analysis

Early consideration of analytical capability is essential to the success of the SCP. SCPs for large projects may indicate that more than one analytical laboratory is necessary to meet the SCP objectives. Prior to defining radioanalytical laboratory requirements, SCP designers should review the *Multi-Agency Radiological Laboratory Analytical Protocols Manual* (MARLAP 2004), Volume 1, Chapters 5 and 7, for a detailed discussion on obtaining laboratory services. The methods listed in SAM should be reviewed to aid in discussions with the laboratory. The radioanalytical laboratory(s) that will perform the analyses should be selected early in the planning process, so that they may be consulted regarding the analytical methods to be used and to ensure sampling activities will address the analytical needs. Designers and planners should focus on choosing a laboratory that is a member of EPA's Environmental Response Laboratory Network (ERLN), a national network of laboratories that can be ramped up as needed to support large scale environmental responses. Designers must select the methods that will be

used to analyze samples, and design the SCP to meet the analytical needs of those methods.

SCP designers should also consider the use of mobile laboratories to provide on-site analytical capability and minimize off-site sample transportation, if feasible. The SCP must identify:

- Laboratories
- Communications protocols between project management, field personnel and laboratory personnel
- COC requirements
- Number and type(s) of samples each laboratory is expected to receive
- Packaging and shipping requirements, including those specified by laboratory(ies)
- Project requirements for analytical result turnaround times
- SAM-approved analytical methods that will be used
- Corrective action procedures for handling suspect analytical data
- Requirements for documentation, reporting and project deliverables

Procurement of laboratory services usually requires a statement of work (SOW) describing the analytical services needed. Careful preparation of the SOW is essential to ensuring laboratories perform the required services in a technically competent and timely manner (consult MARLAP, Volume 1, Chapters 5 and 7, for expanded details). SOWs must be reviewed by personnel familiar with radioanalytical laboratory operations. For complicated sampling events requiring a large number of analyses, it is recommended that a portion of laboratory evaluations take the form of an audit. For smaller sites or facilities, the decision maker(s) may decide that a review of the laboratory's qualifications is sufficient. There are eight criteria that should be evaluated during this review:

1. The laboratory should possess appropriate well-documented procedures, instrumentation, and trained personnel to perform the analyses required to address the DQOs (e.g., radionuclide(s) of interest and target detection limits).
2. The laboratory should be experienced in performing the same or similar analyses.
3. The laboratory should have satisfactory performance evaluation results from formal monitoring or accreditation programs and should be able to provide a summary of QA audits and proof of participation in inter-laboratory cross-check programs. Equipment calibrations should be performed using National Institute of Standards and Technology (NIST) traceable reference radionuclide standards whenever possible.
4. The laboratory should have adequate capacity to perform all analyses within the desired timeframe to meet project required turnaround times.
5. The laboratory possesses a radioactive material handling license or permit for the samples to be analyzed.
6. The laboratory should provide an internal QC review plan for all generated data, and the QC reviewers must be independent of the data generators.
7. The laboratory should have an active and fully documented QA program in place, and the QA program should comply with the project DQOs.
8. The laboratory should have adequate protocols for method performance documentation and sample security.

4.3 Classify Areas by Contamination Potential

After a radiological contamination incident, affected areas of buildings and/or infrastructure will have differing potential for contamination and, accordingly, will not need the same level of sampling to demonstrate compliance with established cleanup goals. The sampling process will be more efficient if the SCP is designed so that areas with higher potential for contamination (based in part on results of the Step I assessment) or that have a greater prioritization for reuse (e.g., residential or business use) receive a higher degree of sampling.

Site classification is a critical step in designing the SCP. The working hypothesis of MARSSIM is that all impacted areas that are being evaluated for release have a reasonable potential for radioactive contamination above the DCGL. This initial assumption means that all structures in these areas are initially considered to have the highest potential for contamination (Class 1 areas)[4] unless some basis is provided for reclassification as either an impacted area with low potential for a dose above the release criteria (Class 2), an impacted area with little to no potential for a dose above the release criteria (Class 3) or a non-impacted area. Buildings and infrastructure that have been designated as non-impacted are typically used as sources of reference materials.

4.4 Select Background Reference Materials

If a reference material is necessary, the SCP should clearly identify background reference materials. These are located in non-impacted areas and should have characteristics that are similar to the outdoor infrastructure or building material(s) being sampled and evaluated for contamination. A reference material cannot contain contamination that was introduced by the incident that is the reason for the response, and should not be located in areas that are a part of the survey unit being evaluated. (See MARSSIM, Chapter 4.)

If the suspected contaminant is normally present in the infrastructure or outdoor building material (or if the measurement system used is not specific for a suspected radionuclide), background measurements are compared to the survey unit measurements to determine the level of residual radioactivity.

4.5 Identify Survey Units

Each survey unit is a physical area consisting of either an entire building or infrastructure, or a portion of a building or infrastructure comprising a specified size and shape for which a separate decision will be made as to whether or not that area exceeds the release criterion. This decision is made as a result of the final status survey, and the survey unit is the primary entity for demonstrating compliance with the release criterion. The SCP must clearly define each survey unit from which samples will be collected. (See MARSSIM, Chapter 4.)

To facilitate sample collection design and ensure that the number of sampling points are relatively uniformly distributed among structures of similar contamination potential, the site is divided into survey units that share a common history or other characteristics, or are naturally distinguishable from other portions of the site. A survey unit should not include materials that have different contamination classifications; however, in some cases, it might be advantageous to combine dissimilar materials into a single unit to

4 As defined by MARSSIM

obtain a survey unit that is more representative of a building or infrastructure and minimize sampling densities. (See NRC 1998, Chapter 12)

An example of combining dissimilar materials into a single survey unit could be an overpass. The bridge material (e.g. reinforced concrete and/or metal) might be different than the road surface. In that case, combining the materials into a single survey unit would be more representative of the entire overpass.

4.6 Develop a Conceptual Cleanup Model of the Site for SCP Planning

A model serves as the basis for defining sample collection needs during development of the SCP to support cleanup goals. Project planners should gather and analyze available information to develop a conceptual model that shows locations of known contamination, areas of suspected contamination, types and concentrations of radionuclides on impacted buildings and infrastructure, potentially contaminated materials, and locations of potential reference (background) areas. The diagram should include the general layout of the affected area including all buildings and their uses, infrastructure, water treatment facilities, drainage and sewer systems, roads, power lines and utilities, and any other supporting infrastructure systems.

4.7 Selection of Sampling Designs

The main goal in the development of the SCP is to collect samples that are representative of site conditions. Using the conceptual cleanup model, crucial infrastructure and buildings requiring assessment are identified for possible sampling. Sampling strategies can be grouped into either statistical or non-statistical methods. To ensure that samples are as representative as possible, statistics are often used to design an appropriate sampling strategy and to provide a sound basis for supporting decisions. In selecting the sampling design, use of a statistician is recommended to ensure the design provides the data needed to support project decisions.

> Decisions regarding the number and location of samples to be collected will be based on several site- and incident-specific considerations, including the expected pre-existing background levels and location of the target contaminant, the anticipated variability of measurements, and the project DQOs. Some guidance for selecting a sampling design and the number of field and quality control (QC) samples that should be collected is provided in several resources, including:
>
> - Chapters 3, 4 and 5 of the Multi-Agency Radiation Survey and Site Investigation Manual
> - EPA's *Guidance on Choosing a Sampling Design for Environmental Data Collection for Use in Developing a Quality Assurance Project Plan*, QA/G-5S (EPA 2002b)

EPA's *Guidance on Choosing a Sampling Design for Environmental Data Collection for Use in Developing a Quality Assurance Project Plan*, QA/G-5S (EPA 2002a) is a tool-box of statistical designs for sample collection that can be consulted during development of the SCP. An SCP may contain some or all of the designs. However, it is important that the design(s) selected meet the objectives of the QAPP, and can support the DQOs and remediation levels of the project. Sample collection designs can be based on, but not limited to:

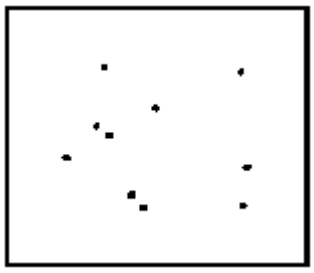
Judgmental Sampling - In judgmental or “bias” sampling, selection of sampling units (i.e., the amount and location and/or timing of sample collection) is based on the feature or condition under investigation and on professional judgment. This type of sampling differs from statistical scientific theory probability-based sampling. Therefore, conclusions are limited and depend entirely on the validity and accuracy of professional judgment. Expert judgment may also be used in conjunction with other sampling designs to produce effective sampling for defensible decisions.

Simple Random Sampling - In simple random sampling, particular sampling units (e.g., locations and/or times) are selected using random numbers, and all possible selections of a given number of units are equally likely. For example, a simple random sample of a contaminated brick facade can be taken by numbering all the bricks and randomly selecting numbers or by sampling an area using pairs of random coordinates. This method is easy to understand, and the equations for determining sample population size are relatively straightforward. Simple random sampling is most useful when the population of interest is homogeneous (e.g., similar contaminated materials, and no expected major patterns of contamination or hot spots). Advantages of this design include:

- Provides statistically unbiased estimates of the mean, proportions and variability
- Relatively easy to understand and implement
- Sample size calculations and data analysis are straightforward

An example is shown in Figure 4.2, with dots representing determined locations for collection of individual samples.

Figure 4.2 Simple Random Sampling
(*from EPA QA/G-5S, EPA/240/R-02/005*)



Stratified Sampling - In stratified sampling, the target population is separated into non-overlapping strata, or into subpopulations that are known or thought to be more homogeneous (relative to the building/infrastructure material or to the contaminant), so that there tends to be less variation among sampling units. Strata may be chosen on the basis of spatial or temporal proximity, or on the basis of preexisting information or professional judgment. This design is useful when the target population is heterogeneous and the area can be subdivided based on expected contamination levels. Advantages of this sampling design are that it has potential for achieving greater precision in estimates of the mean and variance, and that it allows computation of reliable estimates for population subgroups of special interest. Greater precision can be obtained if the measurement of interest is strongly correlated with the variable used to make the strata. Examples are provided in Figure 4.3a (asphalt surface) and Figure 4.3b (building façade).

Figure 4.3a Stratified Sampling – Asphalt Surface
(*adapted from EPA QA/G-5S, EPA/240/R-02/005*)

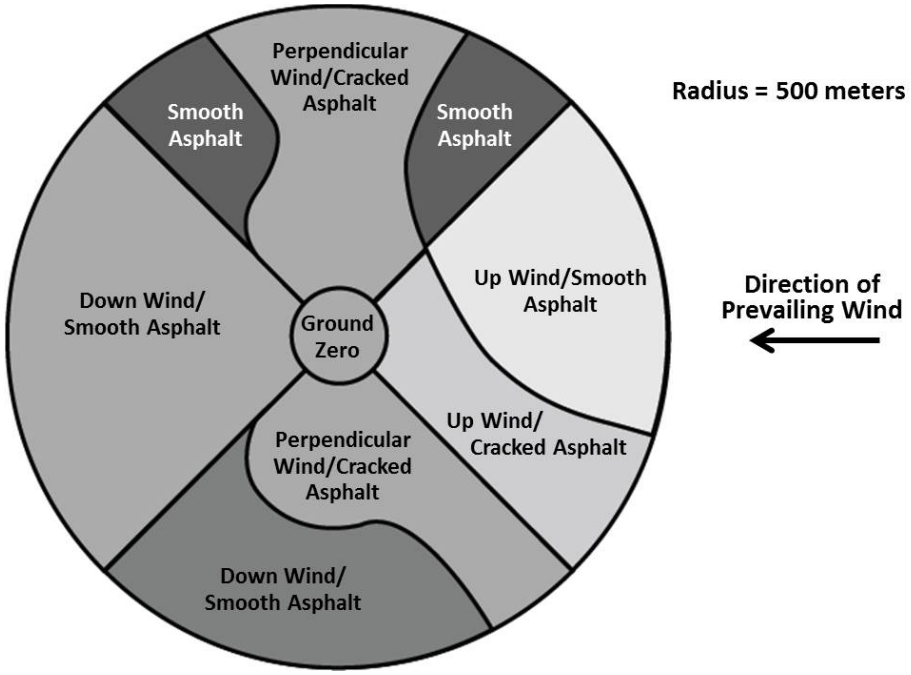
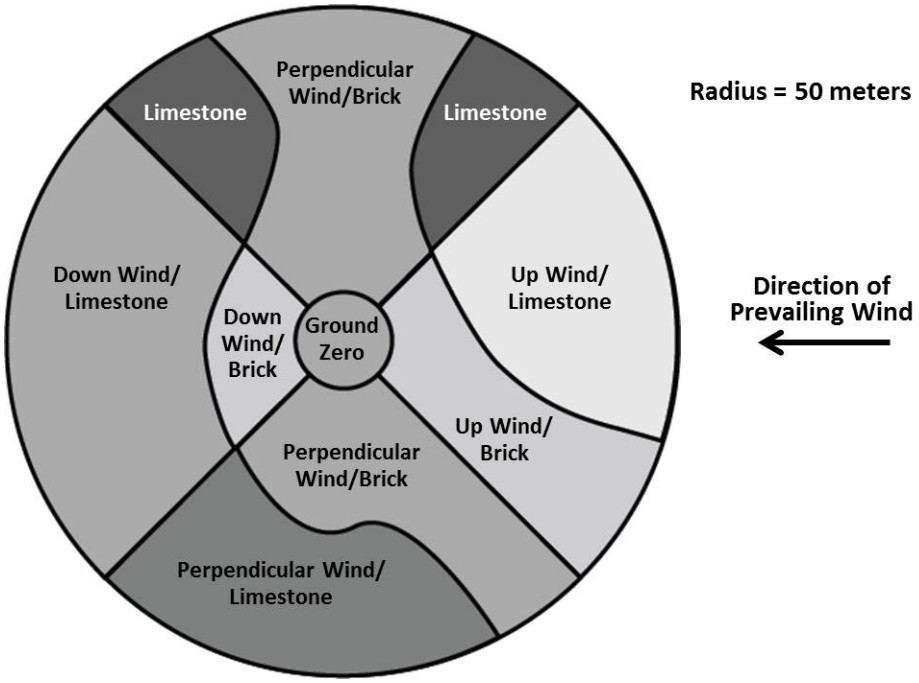
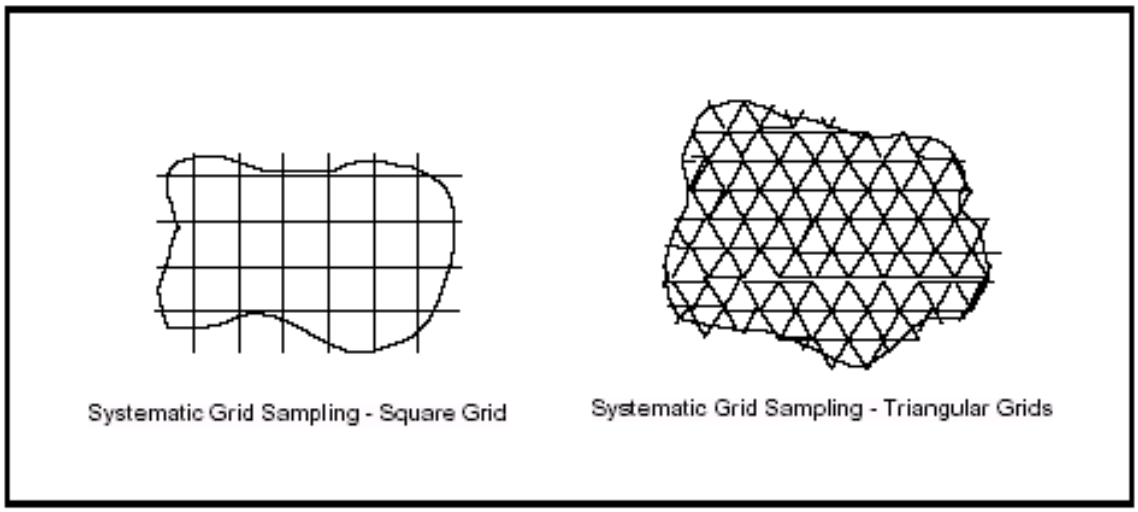


Figure 4.4b Stratified Sampling – Building Façade
(*adapted from EPA QA/G-5S, EPA/240/R-02/005*)



Systematic and Grid Sampling - In systematic and grid sampling, samples are taken at regularly spaced intervals over space or time. An initial location and/or time is chosen at random. The remaining sampling locations are defined so that all locations are at regular intervals over an area (grid) or time (systematic). Examples of systematic grids include square, rectangular, triangular or radial. In random systematic sampling, an initial sampling location (or time) is chosen at random and the remaining sampling sites are specified so that they are located according to a regular pattern (e.g., at the points identified by the intersection of each line in one of the grids). Systematic and grid sampling is used to search for hot spots and to infer means, percentiles or other parameters. It is also useful for estimating spatial patterns or trends over time. This design provides a practical and easy method for designating sample locations and ensures uniform coverage of a site, unit or process. An example is shown in Figure 4.4.

Figure 4.5 Systematic/Grid Sampling
(*from EPA QA/G-5S, EPA/240/R-02/005*)



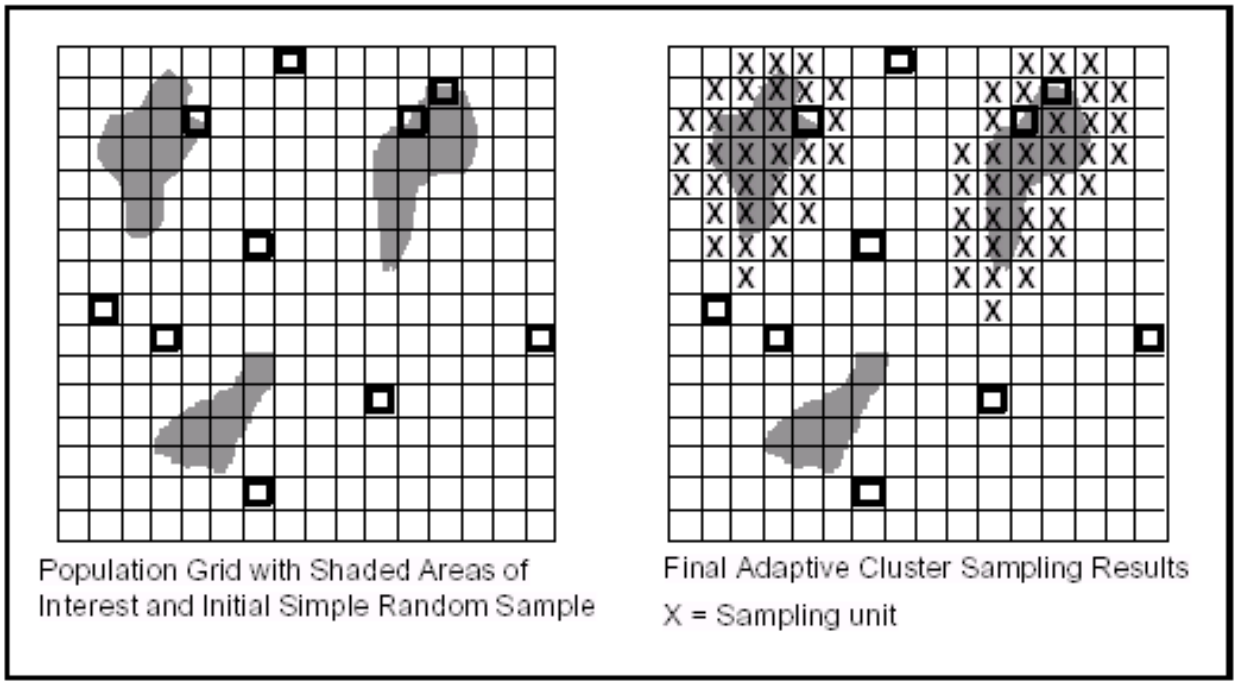
Ranked Set Sampling - In ranked set sampling, *m* sets (each of size *r*) of areas to be sampled are identified using simple random selection. The locations are ranked independently within each set using professional judgment or inexpensive, fast or surrogate measurements. One sampling unit from each set is selected (based on the observed ranks) for subsequent measurement using a more accurate and reliable (hence, more expensive) method for the contaminant of interest. Relative to simple random sampling, this design results in more representative samples and so leads to more precise estimates of the population parameters.

Ranked set sampling is useful when the cost of locating and ranking locations on buildings and/or infrastructure is low compared to laboratory measurements. It is also appropriate when an inexpensive auxiliary variable (based on expert knowledge or measurement) is available to rank population units with respect to the variable of interest. To use this design effectively, it is important that the ranking method and choice of analytical method(s) are strongly correlated.

Adaptive Cluster Sampling - In adaptive cluster sampling, initial measurements are made of randomly selected primary sampling units using simple random sampling. Whenever a sampling unit is found to show a characteristic of interest, additional

sampling units adjacent to the original unit are selected and measurements are made. Several additional rounds of sampling and analysis may be needed. Adaptive cluster sampling also tracks selection probabilities for later phases of sampling so that an unbiased estimate of the population mean can be calculated. An example application of adaptive cluster sampling is delineating the borders of a plume of contamination. It is useful for estimating or searching for rare characteristics in a population, and is appropriate for inexpensive, rapid measurements. It enables delineating the boundaries of hot spots, while also using all data collected with appropriate weighting to give unbiased estimates of the population mean. An example is shown in Figure 4.5.

Figure 4.6 Adaptive Cluster Sampling
(*from EPA QA/G-5S, EPA/240/R-02/005*)



Composite Sampling - In composite sampling, volumes of similar material from several selected sampling locations on a building or infrastructure are physically combined and mixed to form a single homogeneous sample. Compositing can be very cost effective because it reduces the number of radiochemical analyses needed. It is most cost effective when analytical costs are large relative to sampling costs; it demands, however, that there are no safety hazards or potential biases (e.g., increased radiological dose rates or radioanalyte cross contamination) associated with the compositing process. Compositing is often used in conjunction with other sampling designs when the goal is to estimate the population mean and when information on spatial or temporal variability is not needed. It can also be used to estimate the prevalence of a rare trait. An example is shown in Figure 4.6.

Figure 4.7 Composite Sampling
(*from EPA QA/G-5S, EPA/240/R-02/005*)

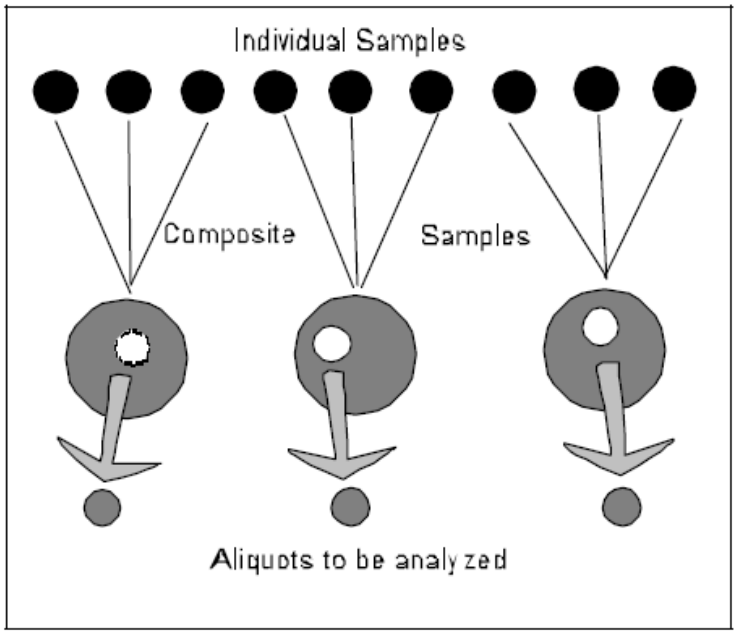


Table 4-1 provides a comparison of advantages and disadvantages for each of the sampling designs listed above.

Table 4-1 Comparison of Sampling Designs

Sampling Design*	Statistical or Non-Statistical	Application	Advantage	Disadvantage
Judgmental Sampling	Non-Statistical	Best professional judgment is used to select sampling locations that appear to be representative of average conditions.	Good for homogeneous, well-defined sites	Not usually recommended for sole use. Conclusions are limited and depend entirely on the validity and accuracy of professional judgment.
Simple Random Sampling	Statistical	Representative sampling locations are chosen using the theory of random chance probabilities.	Good when background information is not available and no visible signs of contamination are present.	May not be cost-effective for samples located too close together. Does not take into account spatial variability of contaminated material.
Stratified Sampling	Statistical	Site is divided into several sampling areas (strata) based on background or site survey information; each stratum is evaluated using a separate random sampling strategy.	Good for large sites, or sites containing a variety of materials to be sampled, surface area features, or past/present uses.	Often more cost-effective than random sampling. More difficult to implement in the field and to analyze results. Does not take into account spatial variability of contaminated material.

Sampling Design*	Statistical or Non-Statistical	Application	Advantage	Disadvantage
Systematic and Grid Sampling	Statistical	Most common statistical strategy; involves collecting samples at predetermined, regular intervals within a grid pattern.	Best strategy for minimizing bias and providing complete site coverage. Can be used effectively at sites where no background information exists. Ensures that samples will not be taken too close together.	Does not take into account spatial variability of contaminated material.
Ranked Set Sampling	Statistical	Sets of sampling locations are identified using simple random sampling and ranked independently within each set using professional judgment or inexpensive, fast, or surrogate measurements.	More efficient than simple random sampling. Useful when the cost of locating and ranking locations is low compared to laboratory measurements.	Does not take into account spatial variability of contaminated material.
Adaptive Cluster Sampling	Statistical	Sampling designs in which the procedure for selecting sites or units for the sample population may depend on values of the variable of interest observed.	Takes advantage of sample population characteristics so as to obtain more precise estimates of population values for a given sample size.	Coefficients of variation may be rather large compared to other designs. Areas of contamination could be missed.
Composite Sampling	Statistical	Multiple discrete samples are collected from a similar material and combined into a single sample with the intention that this single sample represents the components of that of material.	Analytical cost savings.	Limitations include aspects of false negatives or positives, and loss of information regarding any relationships between radionuclides in individual samples.

* Although biased sampling is typically used for characterization, sampling designs and strategies will depend on the specific contamination incident and site

Listed below are several available software tools that can be used to aid designers in the development of SCPs.

NOTE: Mention of company names, trade names, or commercial products in this document does not constitute endorsement or recommendation for use.

- **Dose Risk Calculation (DCAL)** software performs biokinetic and dosimetric calculations for the case of acute intake of a radionuclide by inhalation, ingestion, or injection into blood at a user-specified age at intake. The user may compute either equivalent or absorbed dose rates as a function of time following intake of the radionuclide. The equivalent dose option enables the generation of a table of age-specific dose coefficients, i.e., committed equivalent doses to organs and committed effective doses per unit intake. DCAL software is accessible at https://www.epa.gov/radiation/dcal-software-and-resources

- **Cumulative Probability Plot** can be used to plot empirical data on cumulative probability distribution graphs. The software computes parametric statistics and a "test statistic" based on "sampling by variables." It is useful for visual presentation of characterization and final status surveys. Cumulative Probability Plot is available for download at http://www.radprocalculator.com/Probability.aspx

- **GENII-NESHAPS** provides a set of software for calculating radiation dose and risk from radionuclides released to the environment. The GENII-NESHAPS Edition is specifically designed to help site managers plan and improve compliance with 40 CFR 61, subparts H and I. GENII-NESHAPS Version 2 is available for download at https://cfpub.epa.gov/si/si_public_record_Report.cfm?Lab=ORIA&dirEntryID=73944

- **MARSSIMPower2000** implements the final status survey designs described in MARSSIM. MARSSIMPower2000 is available for download at http://cvg.homestead.com/marssimpower2000.html

- **RESRAD-BUILD** is a computer code designed for analyzing radiation exposures resulting from occupying a building contaminated with radioactive materials or housing contaminated equipment or furniture, as well as from remediating the contamination. Developed by Argonne National Laboratory, RESRAD codes are available for download at http://resrad.evs.anl.gov/codes/resrad-build/

  RESRAD RDD is a computer code developed to derive operational guidelines for use in emergency planning and response associated with a radiological dispersal device (RDD) incident. The operational guidelines are expressed in terms of ground surface radioactivity concentration levels (for comparison with measurement data) or stay times (with known radioactivity concentrations) in the contaminated area and correspond to the Protection Action Guides (PAGs) in terms of radiation doses established by EPA (EPA 400-R-92-001). RESRAD RDD can be downloaded at https://resrad.evs.anl.gov/codes/resrad-rdd/

- **Spatial Analysis and Decision Assistance** (SADA) was developed by the University of Tennessee and incorporates tools from environmental assessment fields. These tools include integrated modules for visualization, geospatial analysis, statistical analysis, human health risk assessment, ecological risk assessment, cost/ benefit analysis, sampling design, and decision analysis. SADA 5.0.78 is available for download at https://www.sadaproject.net/download.html

- **Visual Sample Plan** (VSP) provides statistical solutions to sampling design (how many samples to take and where to take them) and provides mathematical and statistical algorithms. Visual Sample Plan is available for download at https://vsp.pnnl.gov/

- **Turbo FRMAC** software performs a series of automated calculations that allow users to determine best courses of action during a radiological emergency. Actionable decisions such as residential evacuations or crop destruction can be made based on values generated from instrument outputs of field samples or from atmosphere dispersion models. The values are generated from formulas created by EPA, FDA and other federal agencies, and can be used to determine risk level exceedances. Developed by Sandia National Laboratories, Turbo FRMAC is available for download at https://nirp.sandia.gov/Software/TurboFRMAC/TurboFRMAC.aspx - Downloads

- **ProUCL** software provides a variety of statistical tools that can be used to address sampling and statistical issues regarding a specific Superfund site. The software's primary functions include calculating upper statistical limits, but also provide a variety of graphical and statistical analysis tools for groundwater monitoring. Users input datasets and statistical tests are then applied, generating outputs that include recommendations, cautions and cited references. ProUCL version 5.1.00 can be downloaded at https://www.epa.gov/land-research/proucl-software

- **Surface Preliminary Remediation Goals (SPRG)** and **Building Preliminary Remediation Goals (BPRG) Calculators** use slope factors that are dependent on inhalation, ingestion, or dermal exposure pathways to calculate outdoor (the SPRG) and indoor (the BPRG) radiation cleanup levels. The calculators can be used to determine initial cleanup goals and radiation exposures in outdoor, residential and commercial environments. The BPRG calculator can be accessed at https://epa-bprg.ornl.gov/cgi-bin/bprg_search. The SPRG calculator may be accessed in the future at https://www.epa.gov/region8/calculating-preliminary-remediation-goals-prgs. Additional information on SPRGs can be found at https://cfpub.epa.gov/si/si_public_record_Report.cfm?Lab=OSRTI&dirEntryID=151643

4.8 Writing the SCP - Content of Major Elements

When all of the appropriate site information is gathered, the SCP designers take the information and assemble the SCP. Appendix A provides a checklist of elements that can be used as a template for writing a site-specific SCP. The specific elements that would be appropriate to include depend on site conditions (e.g., the extent and type of the contamination, site size, number of impacted buildings or infrastructures, types of impacted materials, project needs and DQOs).

4.8.1 Project Background

With the information gathered during Step I, including response information turned over by FRMAC, the SCP should provide both a site history (including descriptions of the use of the site, permits, and the previous use of radioisotopes or the use of chemical decontamination agents during the response) and information regarding the radiological contamination incident. The historical and response data from any investigation and sampling efforts should be identified and summarized. An assessment of the quality of the data should be included, as well as a discussion of any problems encountered during initial site assessment and incident response. The SCP should include a description and a map of the location (physical address, GPS coordinates, cross streets, compass bearing), size, and important physical features of the affected area, such as schools, public parks, business centers, transportation infrastructure, water treatment facilities, lakes, streams, drainage and sewer systems, buildings, and roads. Maps should include both scales and legends.

This section of the SCP should also include an Executive Summary describing the results of the initial investigation of the contaminant and the project's planned approach toward resolution.

4.8.2 Project Organization and Responsibilities

This element of the SCP identifies key field personnel or organizations responsible for each sampling activity during cleanup and remediation. A chart showing project organization and lines of authority should be included. The chart should identify QC management organizations and identify their appropriate independent reporting chain outside project management. This section of the SCP should describe the responsibilities of all project field personnel, including subcontractor roles and their key points of contact, sampling personnel, and liaison personnel between field, laboratory and QC managers.

This section of the SCP should also identify any special training requirements and/or personnel certifications necessary to perform the work, as well as all organizations responsible for:

- Project planning
- Project coordination
- Sample collection
- Disposal of sampling waste
- Sample custody

4.8.3 Project Scope and Objectives

The SCP must describe specific project objectives of the sampling effort. It should identify the planned project activities, QA procedures to be implemented to support project activities, relevant regulatory standards, and the project schedule. The intended use of data should be stated and should satisfy the intended uses of the data for meeting any identified regulatory requirements and project-specific clean up criteria. An outline of the project schedule should be provided and should include project plan review periods, sampling activities, sample analysis, data management and validation, and project report writing.

4.8.4 Non-Measurement Data Acquisition

The SCP should describe data needed from non-measurement sources, such as databases, literature, handbooks and local authorities. Information of this type may be needed to support assessment of:

- Data supporting modeling activities
- Public transportation infrastructure
- Building and infrastructure uses (e.g., residential, commercial, recreational)
- Infrastructure support systems
- Meteorological data

4.8.5 Field Activities – Project Sample Collection Procedures

The SCP should provide detailed site-specific instructions and requirements that are to be used in conjunction with the sample collection procedures described in EPA's *Sample Collection Procedures for Radiochemical Analytes in Outdoor Building and Infrastructure Materials* (EPA 2016). The design team should refer to these sample collection procedures for detailed information on how the samples required under the SCP are to be collected. The SCP must provide details to describe the field activities to be performed, including but not limited to, information regarding:

- Sampling and field data-gathering procedures to be used
- Specific sample collection equipment to be used
- Data acquisition equipment and procedures to be used
- Sample sizes required for each material matrix, to meet DQOs and MQOs
- Sampling locations (corresponding GPS coordinates, if applicable)
- The number of samples to be collected from each sampling location
- Type of sample preservation, if applicable
- Sample container types and sizes
- QC requirements (e.g., field QC samples)
- *In situ* field measurements (if any) and equipment

4.8.6 Radiological Field Measurements and Equipment

Many cleanup projects will include on-site screening for detection and/or measurement of contamination. This screening can assist with project planning and reduce the burden of sample collection and analyses. Site RSP requirements for the sampling efforts to be performed should be identified, along with the support function interface between the radiation protection group and the sample collection personnel. A listing of building- and/or infrastructure-specific matrices, the expected radionuclides present in the matrices, and the appropriate instrumentation and measurement techniques to be used for each matrix should be detailed.

4.8.7 Sampling Operations Documentation

The SCP should identify requirements regarding the records that will be used to document sampling operations and should also identify the records and schedule for those that require periodic submittal. The SCP also should include proposed documentation forms. Documentation of error correction procedures must be defined in the SCP and must be equivalent to the requirements of the QAPP. Sampling operations documents may include but are not limited to:

- Daily QC reports, including background checks
- Field logbooks
- Field work forms
- Photographic records
- Field analytical records

This section should also address the sample documentation records, such as:

- Sample numbering system
- Sample labels and tags
- Field sampling logs/log books
- COC forms and custody seals
- Laboratory notification documentation forms
- Electronic file naming system, if applicable

Sample custody requirements should be defined for:

- Outdoor building/infrastructure and field QC samples
- Sample transfer to the laboratory(s)
- Laboratory custody control

The SCP should also define project record custody requirements for original field documents and laboratory reports. It should define record management practices for, but not limited to:

- SOPs
- SOP review documentation, versions tracking, and record retention requirements
- Corrective action reports
- Shipment manifesting and bills of lading
- Waste profile and waste shipment vehicle survey forms

4.8.8 Sample Packaging and Shipping Requirements

The SCP should include a discussion of sample packaging and shipping requirements in accordance with appropriate federal and state regulations (e.g., Department of Transportation regulations found at 49 CFR 171–178 (49 CFR); International Air Transportation Association [IATA] regulations). It should identify:

- Appropriate laboratory(s)
- Laboratory(s) addresses and points of contact
- Sample submittal schedule
- Mode of sample transportation (e.g., overnight courier)
- COC forms and seals
- Manifesting requirements for the shipment

It is recommended that the receiving laboratories also document the condition of building/infrastructure samples upon receipt at the laboratory. This enables verification of correct sample volumes, COC completeness and accuracy, and overall packaging techniques.

Sample packaging and shipping procedures described in Module I, Section 7.0, of EPA's *Sample Collection Procedures for Radiochemical Analytes in Outdoor Building and Infrastructure Materials* (EPA 2016) and in EPA's SAM companion *Sample Collection Information Document for Chemicals, Radiochemicals and Biotoxins* (EPA 2017a) should also be reviewed before completing this section of the SCP.

4.8.9 Sampling Waste

The SCP should describe procedures that will be used for collecting, labeling, storing, and disposing of the sampling waste. The SCP should detail procedures for assessing corresponding sample results or sampling the waste to determine whether it is hazardous. The SCP should address how the sample results will be evaluated to determine disposal options for the sampling waste. Disposal actions must be conducted with the concurrence of appropriate project technical personnel and management. Module I, Section 6.0 and Appendix D, of EPA's *Sample Collection Procedures for Radiochemical Analytes in Outdoor Building and Infrastructure Materials* (EPA 2016) should be reviewed before completing this section of the SCP.

4.8.10 Project Quality Assurance (QA)

The SCP must include QA/QC elements that are consistent with the QAPP and are applied throughout the project to ensure proper execution of the SCP and appropriate data generation. The project assessment activities should be discussed as they pertain to the QA objectives identified in the QAPP. In general, the SCP should provide specifications for QA activities by defining in detail:

- Project schedules
- Proper technical review/approval of project documents
- Radiochemical DQOs and MQOs identified in the QAPP, and their respective data quality indicators
- QA/QC protocols necessary to achieve the DQOs and MQOs
- Analytical methods and measurements
- Evaluation of laboratories
- QC samples and sample handling procedures/verification
- QC sample analysis
- Use of single- and double-blind performance evaluation samples
- Equipment calibration and maintenance documentation
- SCP QA implementation protocols
- Establishing experience and training requirements for key field personnel
- Level of decision making empowered to key field personnel
- Communication protocols between the field and project stakeholders
- Data assessment procedures for the evaluation and the identification of any data limitations, including data review, validation, and reporting
- Generation of required quality reports
- Sampling requirements to support the final status survey

EPA or EPA contract audit personnel should conduct a variety of audits (field, laboratory, office) to identify procedures that could cause problems with sampling and analytical results. The audits should be scheduled as early as possible, and should cover project activities from initial investigation to post closure monitoring to include but not be limited to:

- Sample collection from all building and infrastructure media (i.e., concrete, brick, granite, asphalt, etc. and sample generated waste)
- Use of sampling devices
- Decontamination of equipment or activities that could cause cross-contamination
- Post sample collection activities (packaging/shipping)
- Laboratory activities
- Data reporting, including electronic media
- COC procedures and documentation
- Field logs

4.8.11 Non-Conformance/Corrective Actions

The SCP must address notification procedures and corrective actions that should be followed by field and laboratory personnel if there are deviations from the SCP or problems with samples upon receipt at the laboratory. Typical problems or deviations include, but are not limited to:

- Improper COC documentation
- Broken sample containers or questionable sample integrity (e.g., broken custody seals)
- Sample location changes
- Insufficient sample amount

Corrective action procedures must address:

- Corrective actions required if field and/or analytical procedures are found to deviate from the requirements in the SCP
- Re-sampling with additional analysis of new samples
- Reanalysis of existing field or QC samples
- Proper data qualification
- Notification processes
- Contingencies

The SCP must state that significant changes to or deviations from the approved SCP will not be made without the written approval of the incident commander and/or project lead.

4.8.12 SCP Appendices

The SCP appendices should include, but not limited to, the following items:

- References
- List of abbreviations and acronyms
- Standard project forms to be used
  - COC forms
  - Sample labels
  - Shipping manifest
  - Audit forms
  - Non-conformance reporting forms
  - QA report forms
- Summary tables
  - Data quality objectives summary
  - Building and infrastructure cleanup objectives
  - Sample container requirements
  - Names and addresses of owners of property on the site
  - Sample container types and quantities
  - Summary of building/infrastructure sample matrices and locations
  - Summary of number of samples and analyses
  - Listing of approved analytical laboratories and contact information
- List of figures
  - Project organization
  - Sampling schedule
  - Proposed on-site and off-site sampling locations

4.9 SCP Review and Approval

The SCP should be reviewed to determine whether it will provide data that satisfy data use needs and project/site DQOs, and whether it is compatible with all site constraints. As a guide, reviewers should use a checklist that contains general information that

typically should be included in an SCP. Review checklists can be prepared by reviewing Appendix A and identifying project specific variations.

NOTE: Due to the complexity that each site-specific SCP might require, a detailed checklist is beyond the scope of this document.

Once an SCP has been approved, appropriate personnel sign the signature page. Personnel signing the SCP are determined on a project-specific basis. It is recommended that the incident commander/project manager sign the title page of the SCP, and that the technical manager sign the title page of the associated QAPP. Deviations from the approved SCP must receive written approval from the incident commander and/or project lead. In addition, there may be significant changes in the project that necessitate appending or modifying the SCP. Similar procedures for review and approval of those modified sections are necessary prior to execution of the modifications.

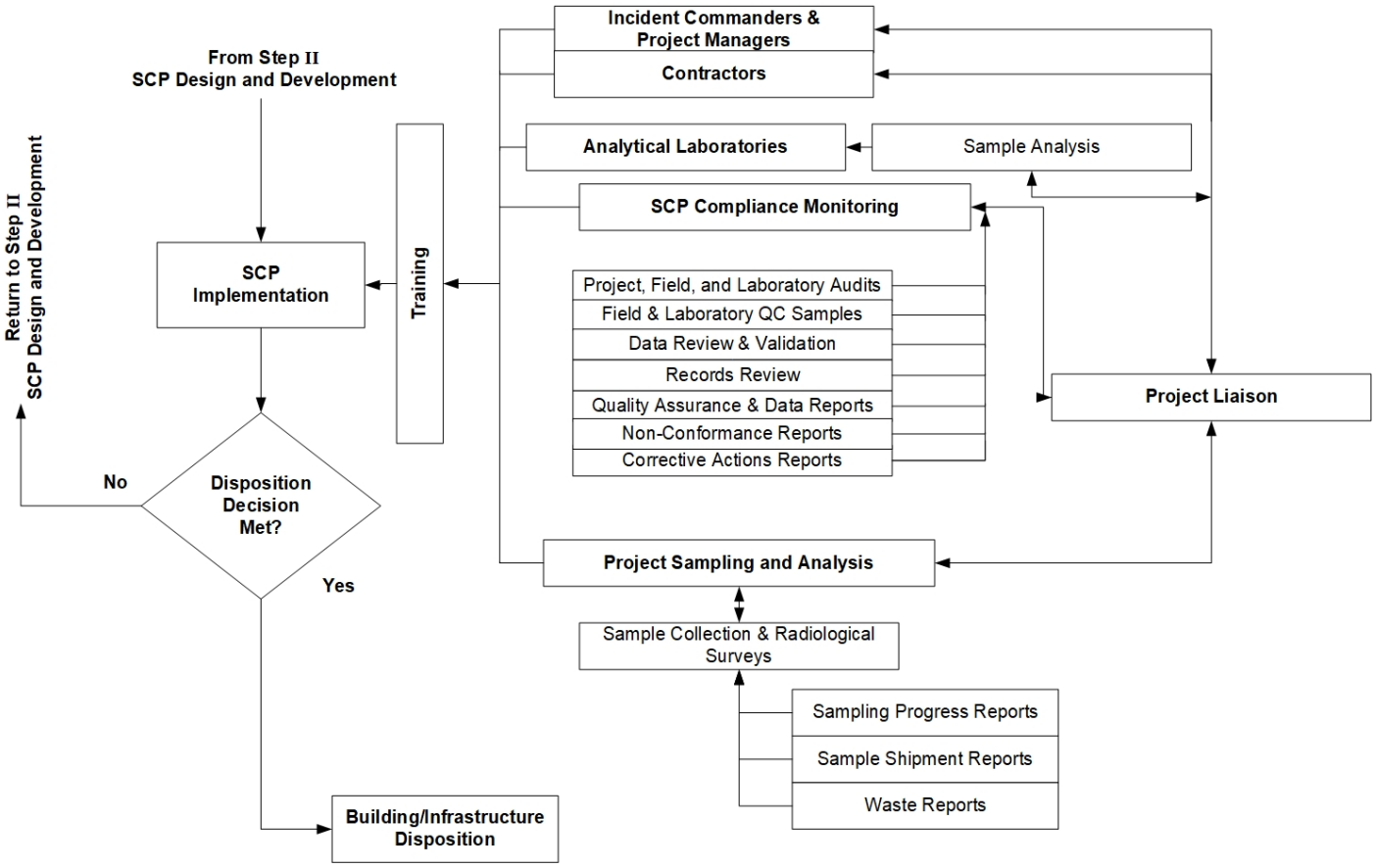
4.10 SCP Distribution

Once approved, the final SCP and/or its approved modifications must be distributed to all appropriate parties, including project and technical managers, primary and QA laboratory(s), appropriate regulatory authorities, stake holders, and subcontractors (i.e., sampling firms, data validation firms).

5.0 Step III - SCP Implementation

An approved SCP must be in place before implementing the SCP activities. Figure 5.1 outlines the elements of a SCP, highlighting the importance of personnel being trained in these elements prior to their implementation.

Figure 5.1 Step III - SCP Implementation



5.1 Personnel Training

Prior to implementation of the SCP, project personnel must be adequately trained for their specific duties and possess a full understanding of all aspects of the SCP. Training must include safety and health requirements and practices as defined in the HASP and RSP.

5.2 Field Sample Collection

Prior to performing sample collection, sampling personnel should ensure that proper field equipment is available, in good condition, and meets QA requirements. Personnel also should ensure that sample collection and handling procedures are performed in accordance with the SCP and following specifications provided in EPA's *Sample Collection Procedures for Radiochemical Analytes in Outdoor Building and Infrastructure Materials* (EPA 2016).

5.3 Project Liaison

A liaison between project management, field, and laboratory personnel should be identified to ensure smooth transition of all samples from the field to the laboratory or laboratories. Liaison duties also may include implementation of proper sample documentation, packaging, and shipping procedures.

5.4 SCP Compliance Monitoring

Before data collection activities begin, an approved SCP must be in place and subsequent collection activities must be performed in compliance with the approved SCP. There are several QA elements that may be applied to the project to ensure proper SCP compliance. These include, but are not limited to:

- Field and laboratory audits
- Field and laboratory quality control samples
- Equipment calibration and maintenance documentation
- QA sample handling verification
- QA sample analysis using single- and double-blind performance evaluation samples
- Data review and/or data validation
- Electronic media audits
- Generation of QA reports and data quality assessment reports

5.4.1 Project, Field, and Laboratory Audits

During implementation of the SCP, field activity audits should be performed for all phases of field work, from initial investigation and data collection, to post closure monitoring. Field audits should be scheduled as early in the activity as possible to identify procedures that could cause problems with the sampling and analytical results. This oversight is necessary to ensure that approved procedures, as specified in the SCP, are used. Field audits include monitoring critical activities such as decontamination of equipment or activities that could cause cross-contamination, sample collection from all outdoor building and infrastructure media (i.e., concrete, brick, granite, asphalt), and post sample collection activities (packaging/ shipping). Laboratory audits must also be performed to ensure that procedures for proper communication, proper documentation, and awareness of project DQOs are in place and that these procedures are in compliance with the analytical SOW.

5.4.2 Project Activity Reports

While data collection activities are being performed, the sampling team should communicate daily with appropriate project personnel regarding project status by submitting at least, but not limited to, the following:

- Field sampling progress reports in relationship to project schedules including field work forms, photographic records, field analytical records
- Sample shipment reports
- Waste accumulation reports
- Other project required field reports

Project quality assurance monitoring of data collection activities must include all of the applicable QA/QC requirements identified in the SCP and the QA group should communicate daily with appropriate project personnel regarding project status by submitting at least, but not limited to, the following:

- QA and data quality assessment reports
- QC samples and sample handling procedures/verification reports
- QC sample analysis reports
- Field instrumentation QC reports
- Non-conformance reports
- Corrective action reports

5.5 Site Disposition

For most sites, following review of data results generated during one or more surveys, a disposition decision is based on a demonstration of compliance with site cleanup goals. When survey results are used to support a decision, the decision maker(s) needs to ensure that the data will support that decision with satisfactory confidence. Actions must be taken to manage the uncertainty in the survey results, so that sound, defensible decisions may be made. These actions include design and implementation of proper survey and sampling plans to control known causes of uncertainty, proper application of QC procedures to detect and control significant sources of error, and careful analysis of uncertainty before the data are used to support decision making.

> **NOTE**: If the decision maker(s) determine that the cleanup goals have not been met to satisfy the site QAPP ─ due to a sample collection issue ─ then the SCP will be re-optimized through reevaluation and then redesigned. Additional sampling and analysis may be required to satisfy compliance demonstration and site disposition.

6.0 References and Additional Resources

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6.10 EPA 2017. *PAG Manual: Protective Action Guides and Planning Guidance for Radiological Incidents*, EPA-400/R-17/001, January 2017. Washington DC: U.S. Environmental Protection Agency. https://www.epa.gov/radiation/pag-manuals-and-resources

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6.24 SANDIA 2015. *FRMAC Assessment Manual Overview and Methods* Volume 1 [Protective Action Guides (PAGs)] SAND2015-2884R, April 2015. Livermore, California: Sandia National Laboratories.

Other References *(All web addresses were last accessed June 8, 2020*)

In addition to the information provided in this document, the following documents are recommended as resources for generating an SCP that clearly identifies project goals, associated data needs, and application of QA elements based upon the QAPP project goals designed to reach site release:

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Appendix A

Sample Collection Plan
Design Elements and Development Checklist

1.0 Project Background
- 1.1 Site History and Contaminants
- 1.2 Contaminants and Contaminated Materials
- 1.3 Summary of Site Data Prior to Contamination Incident
- 1.4 Site-Specific Definition of Problems (*including a description of the contamination incident*)
- 1.5 FRMAC Incident Response Data

2.0 Project Organization and Responsibilities

3.0 Project Scope and Objectives
- 3.1 Task Description
- 3.2 Applicable Regulations/Standards/Risk Based Cleanup Goals
- 3.3 Project Schedule

4.0 Nonmeasurement Data Acquisition

5.0 Sample Collection Field Activities

- 5.1 General Considerations

- 5.1 Surface Area Sample Collection

  - *5.1.1 Rationale/Design*
    - 5.1.1.1 General Considerations
    - 5.1.1.2 Sample Collection Overview
    - 5.1.1.3 Number and Location of Samples
    - 5.1.1.4 Sample Containers
    - 5.1.1.5 QA/QC Samples and Frequency
    - 5.1.1.6 Field and Laboratory Analysis

  - *5.1.2 Sample Collection Procedures*
    - 5.1.2.1 Sampling using Dry Swipes
    - 5.1.2.2 Sampling using Wet Swipes (Tritium sampling)
    - 5.1.2.3 Sampling using Tape Swipe
    - 5.1.2.4 Swipe Handling, Sample Containers and Cross Contamination Prevention

  - *5.1.3 Field Quality Control Procedures*
  - *5.1.4 Decontamination Procedures*

- 5.2 Building/Infrastructure Materials Sample Collection

  - *5.2.1 Rationale/Design*
    - 5.2.1.1 General Considerations
    - 5.2.1.2 Sample Collection Overview