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Sample Collection Procedures for Radiochemical Analytes in Environmental Matrices

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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.

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Gregory Sayles, Director
Center for Environmental Solutions and Emergency Response

Acronyms, Abbreviations, Units and Symbols

NOTE: Units of measurement are provided throughout this document, in both metric and U.S. standard formats, as appropriate for use. In addition to the definitions provided below, units are defined with first use in each module.

®	registered trademark
n°	degrees
%	percent
~	approximately
µm	micrometer
AC	alternating current
ALARA	as low as reasonably achievable
ASTM	ASTM International (formerly American Society for Testing and Materials)
atm	atmosphere
Bq	becquerel
CESER	Center for Environmental Solutions and Emergency Response
CFR	Code of Federal Regulations
cm	centimeters
COC	chain of Custody
DC	direct current
DCGL	derived concentration guidance level
DOT	Department of Transportation
dpm	disintegrations per minute
DUP	duplicate
EPA	U.S. Environmental Protection Agency
ERT	Environmental Response Team
ft	feet
g	gram
GPS	Global Positioning System
HASP	Health and Safety Plan
HCl	hydrochloric acid
HDPE	high density polyethylene
HDPP	high density polypropylene
HNO_3	nitric acid
hr	hour
IATA	International Air Transport Association
in.	inches
kg	kilogram
L	liter
lbs	pounds
LLRW	Low Level Radioactive Waste
LSA	low specific activity
m	meter
MDC	Minimum Detectable Concentration
mL	milliliter
mm	millimeter

MQO	measurement quality objective
mR	milliroentgens
mrem	millirem
NAREL	National Analytical Radiation Environmental Laboratory
NIST	National Institute of Standards & Technology
No.	number
NRC	Nuclear Regulatory Commission
oz.	ounces
PPE	personal protective equipment
ppm	parts per million
psi	pounds per square inch
PTFE	polytetrafluoroethylene
PVC	polyvinylchloride
QC	quality control
qt	quart
RSP	Radiation Safety Plan
RWP	Radiation Work Permit
SAM	*Selected Analytical Methods for Environmental Remediation and Recovery*
SCO	surface contaminated object
SCP	Sample Collection Plan
SHO	Safety and Health Officer
SIC	Sample Identification Code
SNM	special nuclear material
SOP	Standard Operating Procedure
TEDA	triethylenediamine
UST	Underground Storage Tank
WMP	Waste Management Plan

Radiometric and General Unit Conversions

To Convert	To	Multiply by	To Convert	To	Multiply by
becquerel (Bq)	picocuries (pCi)	27.0	pCi	Bq	0.037
Bq/square centimeters (cm^2)	(dpm/cm^2)	60	(dpm/cm^2)	(Bq/cm^2)	0.0167
Bq/cubic meters (m^3)	pCi/L	0.027	pCi/L	Bq/m^3	37.0
Bq/kilogram (kg)	pCi/gram (g)	0.027	pCi/g	Bq/kg	37.0
Bq/cubic meter (m^3)	Bq/L	0.001	Bq/L	Bq/m^3	1000
cubic feet (ft^3)	m^3	0.0283	m^3	ft^3	35.3
disintegrations per minute (dpm)	µCi pCi	4.5×10^{-7} 0.45	pCi	dpm	2.22
disintegrations per second (dps)	Bq	1	Bq	dps	1
gallons (gal)	liters (L)	3.78	L	gallon	0.264
inches (in.)	centimeter (cm) millimeter (mm)	2.54 25.4	cm mm	in	0.394 0.0394
kilogram (kg)	pound (lb)	0.456	lb	kg	2.20
microcuries per milliliter (µCi/mL)	pCi/L	10^9	pCi/L	µCi/mL	10^{-9}
millirem (mrem)	millisievert (mSv)	0.01	mSv	mrem	1000
roentgen equivalent: man (rem)	sievert (Sv)	0.01	Sv	rem	1000
square centimeter (cm^2)	square inch (in^2)	0.155	in^2	cm^2	6.45
To Convert	**To**	**Use**	**To Convert**	**To**	**Use**
degree Fahrenheit (°F)	degree Celsius (°C)	(°F-32)/1.8	°C	°F	(°C×1.8)+32

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MODULE I GENERAL INFORMATION

1.0 Introduction

1.1. Scope and Application

The procedures described in this document are intended to provide instructions regarding the collection of environmental samples to be analyzed for radiological contaminants following an intentional or unintentional contamination incident or emergency. This document focuses on the Site Characterization Phase, Remediation Phase, and Final Status Survey Phase (site release) of a contamination incident and ***is not*** intended to address sample collection needs during Initial Response. The procedures are intended for collection of samples in support of the U.S. Environmental Protection Agency (EPA) following a contamination incident.

> NOTE: The procedures in this document were developed to address collection of soil, water, swipe, air and vegetation samples specifically intended for analysis by methods that are included in EPA's *Selected Analytical Methods for Environmental Remediation and Recovery (SAM) 2017* (U.S. EPA 2017). The procedures target the radiochemicals listed in SAM, and complement the information provided in the *Sample Collection Information Document (SCID) for Chemicals, Radiochemicals and Biotoxins –Companion to Selected Analytical Methods for Environmental Remediation and Recovery (SAM) 2017* (Campisano *et al*. 2017).

> NOTE: References for all modules and appendices included in this document are found in Appendix E (References and Supplemental Information).

The procedures describe sample collection only and are intended for use by personnel who have been sufficiently trained in radiological sampling techniques and corresponding radiation safety. It is also assumed that an initial site assessment has been performed prior to implementation of these procedures. Specifically, the document provides information and instructions regarding procedures for sample collection during site characterization, remediation and final status surveys with respect to the following:

- General sampling equipment and materials
- Description of quality control (QC) samples
- Sampling documentation
- Decontamination of sample containers and equipment
- Packaging of samples for transport
- Waste management and waste minimization considerations

The procedures do not include information that is typically included in a site-specific Sample Collection Plan (e.g., sample locations, expected contaminants and concentration levels or methods for determination of the number and type of samples required). The document also does not include tasks or activities that will be performed by site management, radiation protection, site safety and hygiene, and transportation certification personnel. Specifically, this document ***does not*** provide information and instructions that are included in the following documents:

- Sample Collection Plan (SCP)
- Radiological Protection Guidance Plan and associated procedures
- Health and Safety Plan (HASP) and associated procedures
- Analytical methods (e.g., methods listed in SAM)
- Laboratory Standard Operating Procedures (SOPs) (e.g., EPA's National Analytical Radiation Environmental Laboratory [NAREL] SOPs)
- Waste Management Plan (WMP) and associated procedures

1.2. Supplemental Plans and Procedures

1.2.1. Sample Collection Plan (SCP)

An SCP that is specific for the site being evaluated and that outlines the site sampling strategy should be in place prior to initiating the sampling procedures described in this document. Guidance for development of SCPs is provided in EPA's *Guide for Development of Sample Collection Plans for Radiochemical Analytes in Environmental Matrices Following Homeland Security Events* (Hall *et al*. 2009). The SCP should be based on available historical data and recent site assessment information. The SCP will specify: derived concentration guidance levels (DCGLs)[1]; measurement quality objectives (MQOs); matrices, volumes, and number of samples to be collected; sample locations; sample container types and sizes; quality control requirements; specific sample collection equipment to be used; and requirements for field sample filtration and preservation. The information included in the SCP provides detailed site-specific instructions and requirements that are to be used in conjunction with the sample collection procedures that are described in this document.

1.2.2. Safety Plans

Safety is a primary consideration in any sampling event. Safety plans will be specific to a site and incident. Personnel safety requirements and considerations for a particular site can extend beyond radiological concerns and might include physical hazards and also chemicals that are toxic, corrosive, emit harmful or explosive vapors, or are incompatible when mixed. A site-specific Radiological Protection Guidance Plan and HASP should address all radiation and industrial safety requirements and procedures associated with a site.

Radiation protection requirements included in the site RSP are developed and implemented by radiation protection personnel, who are responsible for:

- Developing and implementing an RSP and Radiation Work Permits (RWPs) for individuals working at the site
- Taking measurements of the radiation levels of all sampling sites and associated activities

[1] DCGLs are radionuclide-specific surface or volume residual radioactivity levels that are related to a concentration or dose or risk criterion. Additional information can be found at: https://www.epa.gov/radiation/what-derived-concentration-guideline-level-dcgl

- Dictating the radiation protection requirements for entering and working in a radioactively contaminated sampling area
- Stopping any activity in order to protect personnel from overexposure to radiation or from radioactive material contamination

Industrial safety requirements included in the site HASP are developed and instituted by a designated safety and hygiene professional (e.g., safety and health officer [SHO]), 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 in order to protect personnel from a dangerous situation

1.2.3. Analytical Methods

Analytical methods and laboratory SOPs describe the likely analytical decision paths that would be required by personnel at a radioanalytical laboratory following a radiological or nuclear incident, such as that caused by a terrorist attack. EPA's responsibilities, as outlined in the National Response Plan Nuclear/Radiological Incident Annex (U.S. Department of Homeland Security 2004), include response and recovery actions to detect and identify radioactive substances and to coordinate federal radiological monitoring and assessment activities. EPA's SAM and existing laboratory SOPs are developed to provide guidance to those radioanalytical laboratories that will support EPA's response and recovery actions following a radiological or nuclear incident.

1.2.4. Waste Management Plan

A Waste Management Plan (WMP) that outlines waste management requirements, procedures, strategies and processes, from the point of generation to final deposition, should be in place prior to an incident. Ideally, a general WMP will be in place that can be used to prepare an incident-specific WMP. This plan should address federal, state and local waste management requirements for the different waste streams, waste characterization and also waste acceptance sampling and analysis, identification of waste management facilities, strategies and tactics for on-site waste management and minimization, off-site waste management, waste transportation, and health and safety, as well as tracking and reporting of waste sampling results. It also should include procedures for management and handling waste generated during sample collection activities. (Additional details regarding the elements of a WMP are provided in Appendix D). Sample collectors 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.

1.3. Preparation

1.3.1. Prior to the initiation of sample collection activities and laboratory procurement and as part of efforts to develop the site- and incident-specific SCP, the sample collection planning team should identify and discuss the data needs and purpose for the sample collection being performed, including:

- Types of samples to be collected or measurements to be performed
- Radionuclide(s) of interest
- Potential interfering radionuclides and chemical contaminants
- DCGL for each radionuclide of interest
- MQOs for each radionuclide (e.g., required method uncertainty, required minimum detectable concentration)
- Analytical or screening methods that will be used in the field and laboratory to assay samples (e.g., SAM and/or existing laboratory SOPs)
- Analytical bias and precision (e.g., quantitative or qualitative)
- Number of samples to be collected
- Type and frequency of field quality control (QC) samples to be collected
- Amount of material to be collected for each sample
- Sample collection locations and frequencies
- Sample tracking requirements
- Sample preservation and filtration
- Sample shipping requirements
- Additional SOPs to be followed or developed
- Cost of the methods being used (cost per analysis as well as total cost)
- Specific background for the radionuclide(s) of interest, if applicable (e.g., background levels in clean, non-contaminated material)
- Turnaround time required for sample results
- Analytical measurement documentation requirements
- Anticipated exposure rates, if known

1.3.2. Laboratories should be identified and contacted, and expected requirements corresponding to the sampling event should be reviewed and discussed. To ensure appropriate sample preservation, sample sizes and other analytical issues are considered, radioanalytical specialists should be involved in the development of the SCP and the laboratory performing the analyses should review and be aware of the QC requirements included in the SCP. The SCP and the sample collection procedures should also be reviewed by the laboratory for additional insight into the analysis needed.

1.3.3. Prior to sample collection, sample collectors should review the SCP. The sample collectors' understanding of the requirements will greatly increase the success of the sampling event. A site map should be prepared with details regarding the sample locations (if known) and other geological or topographical information to assist in locating the sample points.

1.3.4. Information regarding issues pertaining to site geology and potential transport of contamination outside the designated sampling area (e.g., into ground water, surface water, soil or air) should be provided to the field sample collection team.

1.3.5. The sample collection team should also evaluate and prepare sampling equipment and personal protective equipment (PPE) needs prior to entry.

1.4. Sampling Phases

WARNING: Samples containing special nuclear material require special consideration. Special nuclear material is defined by the Nuclear Regulatory Commission as (Pu-239, Pu-241, U-233, uranium enriched in the isotope U-233 or U-235). Improper handling or collection of this material may result in instability or criticality (i.e., a sustained series of nuclear reactions). Sample collectors should consult the site-specific Sample Collection Plan and Radiation Safety Plan for further guidance in cases where these materials are known or suspected to be present.

There are three phases in the life span of a contamination incident that require sampling: Site Characterization, Remediation, and Final Status Survey (site release). Waste characterization is an overarching process that also requires sampling but is not addressed in this document.

- Site Characterization Phase sampling takes place after the incident occurrence and prior to initiation of remediation activities. The levels of exposure may be the highest encountered at any time during the process of sampling a site. Personnel should be constantly aware of existing conditions and radiation levels to ensure personnel are not unnecessarily exposed. This phase will be used to determine the extent and magnitude of the problem (i.e., extent of contamination). The samples taken will be used to determine the scope and range of activities needed to remediate the site.
- Remediation Phase sampling takes place during site remediation activities. During this phase, sample collection can occur with deliberate planning and preparation. However, conditions are still considered to be hazardous.
- Final Status Survey Phase sampling takes place after remediation of the affected site. This phase has specific requirements to ensure that the sampling procedures support the expected low concentration levels in the samples collected. Conditions are expected to be non-hazardous and clear of the presence of contamination levels that are in excess of DCGLs.

1.5. Sampling Locations

Sampling locations may be located by the use of an alpha/numeric grid, Global Positioning System (GPS) coordinates, or distances from landmarks, with ±1-meter (m) (3.3 feet [ft]) accuracy. Sample collection during the Site Characterization Phase often uses landmarks, with the actual sample point “fine-tuned” using portable survey instrumentation. The survey team then flags or places another marker (e.g., fluorescent paint) at the sample location. Sample collection points are surveyed, and GPS coordinates recorded, at the time of collection. Maps developed for the site are dependent on the requirements of the SCP.

1.6. Safety Considerations, PPE and First Aid

1.6.1. Safety is a prime consideration in any sampling event. Personnel safety requirements and considerations for a particular site may extend beyond radiological concerns. Additional concerns include physical hazards and chemicals that are toxic, corrosive, emit harmful or explosive vapors, or are incompatible when mixed.

1.6.2. All radiation and industrial safety requirements and procedures associated with the site are to be followed.

a. Radiation protection requirements are developed and instituted by the site radiation protection personnel. These individuals are responsible for:

- Taking measurements of the radiation levels of all sampling sites and associated activities, during and prior to initiating sampling activities
- Monitoring personnel dosimeter readings and responses
- If needed due to levels of radiation, escorting sample collectors in the field
- Dictating the radiation protection requirements for entering and working in a radioactively contaminated sampling area by developing and implementing a Radiation Safety Plan (RSP) and Radiation Work Permit (RWP)
- Stopping any activity in order to protect personnel from overexposure to radiation or from radioactive material contamination

b. Industrial safety requirements are developed and instituted by a designated safety and hygiene professional (e.g., SHO). This person is responsible for:

- 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 in the area
- Stopping any job or activity in order to protect personnel from a dangerous situation
- Developing and implementing a HASP for individuals working in the area to read and follow
- PPE is worn as designated by radiation protection personnel and the designated site and hygiene personnel. PPE should be used during all sample collection and equipment decontamination activities. The results of a site assessment or incident evaluation should be used to determine the type and amount of PPE used. The SCP should include a written HASP and/or hazard evaluation of the area to be sampled. Typical types of PPE are listed in Appendix A6 (Personal Protective Equipment).

> NOTE: As required by the site HASP, all injuries must be reported and, if required, examined by medical personnel. Any open cut, sore, or wound provides a path for contamination to enter the body.

c. The amount of PPE used should be designed and designated to provide the maximum personal protection and mobility for the task being performed. The minimal amount of PPE typically used includes:
   - Protective helmet (i.e., hard hat)
   - Gloves (nitrile or latex over cotton liners)
   - Coveralls
   - Waterproof or water-resistant shoe covers or boots
   - Impact resistant eye protection with side protection (i.e., safety goggles)
   - Dosimeter or milliroentgen (mR) survey meter to measure personnel exposure
   - Lapel air samplers

d. Care should be taken to ensure that PPE is not damaged. If PPE damage is suspected, work must be stopped. Uncontrolled damage can result in contamination of personnel.

e. Care should be taken to ensure that PPE will protect against contamination exposure that can result when working in a wet environment.

f. The level of respiratory PPE needed should be directed by the HASP and/or RSP. Appendix A6 (Personal Protective Equipment) lists the various types of respirators that may be required.

g. First aid kits are to be available at all times. At least one kit should be carried in any vehicle transporting the sampling collection team. At least one kit also should be located at the primary sampling site office.

> NOTE: It is recommended that phone numbers for local Emergency Medical Services be made available to all workers. Contact information and procedures for communicating with emergency responders should be identified and available for use at all times.

2.0 Equipment and Materials

2.1. General Requirements

2.1.1. Only equipment that has been certified (clearly identified) by the site field team leader for use should be used to perform the procedures described in this document. Substitution of materials or equipment must be approved and documented in the SCP (as an amendment or revision) prior to use. All instruments should have current calibrations or inspections clearly identified. Any corresponding certification documentation should be copied and available to the sample collectors, as appropriate.

> NOTE: It is highly recommended that sampling equipment be properly and routinely maintained and organized. This allows sampling teams to enter and exit contaminated areas in the shortest and most effective amount of time. Sample materials should be contained in a controlled area or vehicle with shelving/space sufficient to contain all PPE; sample bottles; materials; supplies; and forms needed to perform sample collection, documentation and packaging.

2.1.2. Staging of Equipment, Supplies and Samples

a. Pre-staging allows for a minimized time in the contamination zone and maximized sample collection and processing efficiency.

b. As practical, all equipment, containers, PPE and documentation for a sampling event should be combined into single sampling kit. The common practice is to place each piece of sampling equipment for an individual sampling event into separate plastic bags. Each of these bags (up to a maximum number that can be physically handled) can be combined in a larger bag or container that holds additional PPE (boots, gloves) and tape or other items needed. Carrying the larger container into the field, an individual can control contamination and sample materials with minimal concern for cross contamination and exposure.

c. Each sample collection team should be aware of the SCP for their designated assignment, including being informed of the location and conditions for the specific sampling point(s) prior to entry. Sampling locations are often marked with fluorescent paint, flags, stakes and/or frames. It is recommended that sample locations be bar-coded in order to facilitate identification of the locations for resurvey.

d. Place markers, such as step-off pads, are used to designate the point for exiting a contaminated area. Personnel are required to perform a given level of personal monitoring and decontamination at these markers to ensure contamination is not spread outside the contaminated area. The markers should be clearly designated, allow for easy egress from the contaminated area, and pre-established prior to site entry by the sample collection team.

e. Once samples are collected, they must be maintained under controlled conditions through shipment to the analytical laboratory(ies). This control is required to mitigate exposure to personnel and to ensure that samples are not compromised prior to analysis. Samples should be stored in a staging area where they can be observed or are under lock and key to prevent tampering. See Module I, Sections 4.0 and 7.0 for additional information regarding on-site sample control and storage.

2.2. Sampling Equipment

Refer to Appendices A1–A6 (tables of sampling equipment and materials) for a more extensive list of equipment necessary for sampling events. The Appendices are supplied for reference. The actual sampling tools, materials and equipment used will be dependent on availability and the actual conditions at the site.

2.2.1. Soil Samples

a. Sampling frames are used to mark areas for collection of soil samples during Final Status Survey Phase sampling, providing specific control of the sample location and size. Frames must be large enough to cover an area larger than the area to be sampled and act to prevent intrusion of surrounding material.
   - Frames must be controlled to prevent movement during sample collection and are properly dispositioned after the sampling event.
   - Frames contain plastic sheeting with an opening to designate the surface area from which a sample is to be collected. The sheeting is labeled to clearly indicate the presence of radioactive material (for example, a large yellow plastic bag labeled as "radioactive material" in magenta lettering).
   - Frames can be approximately 0.5 to 1 m^2 (5 to 11 $feet^2$ [ft]), with an opening for sampling of approximately 100 cm^2 (16 $inches^2$ $[in.]^2$), and constructed of plastic to reduce the weight of material taken into the field.

b. Trowels, spoons, scoops and spatulas are used to collect or remove accessible soils and other solid materials from sub-surfaces.
   - These tools are made of stainless steel or high-density polypropylene (HDPP) or polyethylene (HDPE), with little ornamentation or exposed fasteners to assist in decontamination. Wooden handles may be used but should be covered to minimize contamination.
   - Differences in design between these tools allow for variations in the composition of the material being sampled.
   - Trowels aid in digging into surface soil.
   - Scoops and spoons are used in loose or shifting sandy soil or sediments.
   - Spatulas aid in homogenization and removal of unwanted materials.

c. Bore hole tools (augers, post hole diggers, split spoon, thieves and core samplers) are used to collect or remove soils and other solid materials from sub-surfaces. These tools are used to gain access to and/or collect samples.
   - Caution should be taken when using these tools to avoid mixing sample layers. Augers and drills can scrape the sides of a hole when inserted or removed, causing unwanted upper layer material to fall into the sample location. Each hole should be cleared of all debris prior to sample collection.

- Augers are used to collect soil samples primarily during the Site Characterization Phase. These tools can be manually or machine driven to bite into each section of soil that is being collected, and are typically used to collect samples in parts. Depths are often limited to 1.5 m (5 ft), but can be increased using handle extensions.
- Post hole diggers and drill rigs can be used to excavate to lower levels than can be reached when using an auger. When used with a hollow stem auger, a drill rig can retrieve reasonably undisturbed samples.
- Split spoon samplers are used to collect core samples of undisturbed soils from a wide range of depths, and are often used with a drill rig or other power equipment, or forced into the ground with a sledgehammer.
  - Split spoon samplers consist of two halves of a pipe, each from 15 to 45 cm (6 to 18 in.) long, and threaded at both ends. The halves are held together with a conical ring at one end and a driving bar at the other.
  - A core catcher is positioned in the sampler to prevent loss of sample material upon extraction from the bore hole.
- Thieves are used primarily to collect dry granular or powdered material with particle diameters of less than one-third the width of the thief's slot. Thieves used for collection of soil and sediment samples are different than thieves used for collection of liquid samples (see Module I, Section 2.2.3). Soil and sediment thieves consist of a set of slotted tubes (i.e., an inner and outer tube). The outer tube has a conical pointed tip that permits penetration of the materials being sampled. The inner tube is rotated to open and close the sampler.
- Core samplers are driven into the ground, typically by machine power, and used to collect samples of soils or sediment primarily during site characterization and remediation.
  - Core samplers consist of a hollow tube or pipe that varies in diameter (generally 3.75 to 10 cm or 1.5 to 4 in.).
  - The number and length of core samplers can be varied to obtain samples at different depths.
  - Once the core piping is removed from the ground, it is separated into sectional lengths and sections are opened lengthwise to allow a solid cross-sectional piece of material to be exposed.

2.2.2. Sediment samples are collected using grab samplers, core samplers or dredges.

a. Grab samplers are similar to the open dipping jars used in collecting water samples. Grab samplers, such as the Birge–Ekman sampler, are attached to long poles, and the sampler is dragged across the sediment to collect the sample. Sample collection depth is limited by the length of the pole.

b. Sediment core samplers are hollow rods or tubes that are inserted into the sediment to extract a sample. The type is dependent on the depth and type of water body containing the sediment. Samplers are pushed into the sediment by either gravity or mechanical force, and may or may not have a closure device to prevent sample loss.

c. Dredges are buckets designed to retain soils and sediments collected from the bottom of a pond, lagoon, or other body of water. They are typically constructed of stainless steel with either an open front end or a swivel closure designed such that the majority of liquid collected will drain away from the sample as the dredge is retrieved.

- Some dredges have plastic liners that assist in decontamination and prevent cross contamination of the sampler.
- Dredges are activated by gravity, a tug-line or a messenger, to allow the open jaws to close for sample collection.
- Many dredges are extremely heavy and require the use of a winch to retrieve samples.

2.2.3. Water Samples

a. Bottles and jars are used to collect water samples, and can be attached to extension rods, tethered to a line, or used to collect a sample directly.

- Types and materials are chosen according to their intended use. For example, HDPP, HDPE or glass bottles and jars are used for dipping, drawing surface samples, or sample containment; stainless steel bottles are typically used to collect samples from the bottom of a water body.
- Lid design is based on use, and should not be composed of materials that can absorb water or contaminate samples. Typical designs include: pour lip, screw seal, large or small mouth opening. Polytetrafluoroethylene (PTFE, Teflon®)-lined lids are used for sample collection, storage and transport.
- Dippers are bottles or cups that can be attached to an extension rod and used to collect a sample as they are dipped below the surface of a water body. Maximum depth is determined by the length of the extension rod. These devices are generally constructed of HDPE or HDPP and begin filling upon entry into the water. Extension rods are usually retractable allowing for extended reaches of up to 6 m (20 ft).

b. Mechanically-activated collection vessels include samplers that can be lowered to a specified depth, then closed using a control rod, weighted messenger, tug line or plug to contain the sample.

- Bailers are tubes used to collect liquids from shallow depths of up to approximately 1 m (3 to 4 ft). These devices are constructed of stainless steel, allowing them to sink and begin filling upon entry into a liquid. They are open at the top, with a check valve or valves in the bottom to prevent or minimize drainage and retain sample volume once removed from the source.
- Bacon collection vessels are used to take composite samples from a liquid (usually a tank, vat, pond, lagoon or lake) at a given depth determined by the length of the line used, up to approximately 60 m (200 ft). These vessels are constructed of stainless steel and begin filling when a sampling line is pulled to open valves at the top and bottom of

the collection vessel. Release of the sampling line will close the valves upon retrieving the collection vessel from the source.

- Coliwasa samplers are used in collecting samples from shallow water or liquids in drums. These samplers are hollow tubes with a stopper at one end that is attached to an internal rod that runs the length of the tube to a locking mechanism at the other end of the tube. Samplers begin filling upon the turning action of a handle at the opposite end of the stopper. The samplers are typically constructed of HDPE or HDPP but may also be constructed of stainless steel or polyvinylchloride (PVC).
- Liquid thieves consist of a single tube, opened at both ends, that is inserted into the liquid matrix and then plugged at the upper end to withdraw a liquid sample. These samplers vary in lengths of up to 2.1 m (7 ft) and in diameters of up to 2.5 cm (1 in.), and are designed to fill once they are placed into a liquid. The top of the thief must be plugged or capped prior to removal from the sample source to prevent sample from escaping out the bottom.
- Kemmerer bottle samplers are messenger-activated water sampling devices that are dropped into deep water bodies or tanks. These samplers are composed primarily of brass, plastic and/or stainless steel, and consist of a lower stopper, an upper stopper with a tip head, a bottle, a messenger, and a cable that runs through the components. The components are separated, lowered to a given sample level, and tripped closed with the messenger to collect the sample.
- Wheaton bottle samplers are messenger-activated water sampling devices used in relatively deep waters for collection of samples at no more than 2 to 3 m (6 to 10 ft) depth. The bottles are lowered to a given depth, then opened and closed with a control rod to collect the sample. The sampler’s reach and control rods are limiting factors in determining the depth of sample collection. Sampler components are primarily composed of plastic and stainless steel.

c. Water pumps and tubing are used when samples are required from depth or are taken over a defined time period. Selection of pumps depends on the intended application, and will involve considerations such as: depth capabilities; pumping action (diaphragm, venturi, peristaltic or piston-type); manual or power-driven operation; flow regulators; stroke counter or volume totalizer to measure flow rate or volume collected; timing mechanisms; and collection basins or bottles that will be used.

> NOTE: Water pumps have depth limitations; therefore, other types of pumps or submersibles may be required for collecting samples from depths greater than 10.7 m (32 ft).

- Pump and tubing materials are dependent on use and mode of operation. Plastics such as polyethylene and PTFE provide the greatest chemical resistance to materials sampled but, in some cases, might not be sufficiently durable for long term sampling.
  - Flow volumes depend on mode of operation and pumping action.

- Low flow pumps (50–200 cm^3/min)
- High flow pumps (500–3000 cm^3/min)

- Pump flow volumes must be monitored and documented. Volume totalizers and timers should be used when possible. Calculation of the volume collected, from flow rate and collection duration, may be used if a volume totalizer is not available.

2.2.4. Air Samples

a. Air samplers consist of a sampler unit, flask or collection vessel, and a filter, cartridge of other collection medium (e.g., bubbler or vacuum flask). The type of air sampler and collection format (media) depend on the air media being sampled (particulate or vapor), as well as the target contaminant and corresponding analytical MQOs.

- Collection filters should be selected to avoid potential interferences (for example, radionuclides that may be present in filter materials, such as potassium-40, and decay products of uranium that are naturally present in glass-fiber air filters). Glass fiber filters or plastic membranes are used to capture particulates.
- Activated charcoal or silver zeolite cartridges are used for adsorbance of iodine and certain noble gases.
- Bubblers or silica gel cartridges are used for collection of atmospheric tritium.

b. Air samplers that capture particulates or vapors are typically battery operated or electrically powered pumps. Ideally, the pump used will provide a consistent flow rate. Personnel lapel samplers are typically battery powered and, in some cases, can result in flow rates that vary can as the battery is drained.

- Use of electric power limits the placement of air samplers to the distance away from a power source.
- DC to AC power converters allow for use of air samplers from a vehicle.
- Use of portable generators is limited to the supply of gasoline.
- Power converters and portable generators have health and safety considerations for handling; sample collectors should consult the site HASP before use.
- Use of battery-operated samplers can be limited by battery capacity and charge.

NOTE: If it is possible that a power source may be depleted during sample collection, the sampler should be equipped with a flow volume totalizer.

c. Air sampling pumps are used to pull air through or into the collection medium, and are based on the sample location and volume of air required to meet analytical MQOs. Air flow rates are typically low for personnel lapel monitors and high for high volume air samplers. Typical flow rates include:

- Lapel samplers: 2 L/min (0.01 ft^3/min)

- General area samplers: 28 to 56 L/min (1 to 2 ft^3/min)
- High volume samplers: 140 to 2800 L/min (5 to 100+ ft^3/min)
- Bubblers – flow rate varies from unit to unit
- Vacuum collection vessels – instantaneous
- Pressurized flasks – 2 to 3 atmospheres (atm) (30 to 45 pounds per square inch [psi])

d. Filter sizes are typically 25 mm (1 in.) for personnel lapel monitors, 47 or 50 mm (1.9 or 2 in.) for general area monitors, and 100 mm (4 in.) for long-term, high volume, general area monitors.

> NOTE: While use of 100 mm (4 in.) filters has increased due to available analytical instrumentation, 200 mm x 250 mm (8 in. x 10 in.) filters are still being used by EPA (e.g., RadNet monitoring system). Use of these larger filters is discouraged in cases where the laboratory uses alpha/beta counters that are capable of analyzing the smaller filters, as the practice of folding or cutting a filter to achieve an appropriate size can impact the accuracy and precision of the associated counting results. Field samplers and laboratories should communicate to determine appropriate filter/swipe sizes.

2.2.5. Surface Area Samples

Filters and swipes are used to collect samples from surface areas. These collection materials are composed of cotton fiber, plastic, glass fiber or paper. Sizes depend on the surface area to be sampled and include:

a. Small (standard) surface area (e.g., desktop) – 100 cm^2 (16 $in.^2$)

b. Large surface area (e.g., portions of wall, floor) – Up to 300 cm^2 (47 $in.^2$)

c. Surfaces greater than 300 cm^2 should be swiped in various, random locations using multiple swipes to cover approximately 1% of the area.

> NOTE: The use of large filters or swipes is discouraged. Some laboratories have instrumentation that is not capable of directly analyzing larger samples and must fold or cut these samples to achieve an appropriate size. This can impact the accuracy and precision of associated counting results. Also see Note regarding air filters in Module I, Section 2.2.4(c), above. Field samplers and laboratories should communicate to determine appropriate filter/swipe sizes.

2.2.6. Vegetation

Cutting tools such as scissors or shears are used to collect samples of vegetation that can then be placed in a plastic bag(s) or a hard, plastic container for primary containment. The tools should be sufficient to collect:

a. Small Bushes – the outer leaves

b. Tall Grasses – the upper tips

c. Trees – the upper or outer leaves or branches, limited to those that are less than 1.5 cm (0.6 in.) in diameter

2.2.7. Containers

a. Plastic bags can be used to contain samples, sample containers, equipment and materials, or waste.
   - Plastic bags in a variety of sizes and types (e.g., zip-locking, open bag with twist ties) are used as needed to accommodate sample collection, double bag storage and equipment storage.
   - Bags containing samples are sealed with tape and double bagged.
   - Bags without zip-locking capabilities can be used for sample shipment or waste containment.
   - If elevated levels of radioactivity are suspected, use of a plastic container is recommended to prevent sample loss and cross-contamination that could occur if a bag becomes damaged.

b. Envelopes made of paper or glassine (transparent paper coated with a glaze), with and without sealing capabilities (either gummed or self-adhesive), are used to contain swipes and documentation.

c. Bottles and jars are used to contain soil, solid and liquid samples.
   - Bottle and jar types and materials are chosen in accordance with intended use. HDPP, HDPE, or glass bottles and jars are used for dipping, drawing surface samples, or sample containment. Stainless steel bottles are typically used to collect samples from the bottom of a body of liquid.
   - Plastic (polypropylene or polyethylene) jars, bottles or bags can be used to collect soil samples, as well as borosilicate glass jars.
   - Lid design is based on use. Typical designs include: pour lip, screw seal, large or small mouth opening. Polytetrafluoroethylene (PTFE, Teflon®)-lined lids are used for sample collection, storage and transport. Container lids should not be composed of materials that can absorb water and should not contain glue or adhesives.
   - Refer to Appendix A3 (Sampling Containers) for typical sizes and dimensions.

2.2.8. Other materials – Based on the nature of the incident and the area affected, other materials or equipment may be needed for sample collection. These materials include items such as tape, solvents, alcohol, paint scrapers, sanders, saws, and vacuum cleaners. The requirements and procedures for these or other items should be reviewed and discussed prior to use. A list of some of the additional equipment that may be needed is included in Appendix A5.

2.3. Closures and Seals

2.3.1. Masking or other adhesive tape is used for sealing containers during sample shipment.

2.3.2. Security seals are attached over the cap of each sample container to provide an indication of sample tampering and to ensure sample integrity. Security seals also can be used for sample shipping or transport containers, to ensure package integrity is not compromised during transport. Typically, one seal is placed on each sample container and multiple seals (e.g., two seals placed on opposite ends) are used on shipping containers.

a. Security seals may be commercially made, or tape seals can be used that contain the signature or initial of the sample collector and the date and time of sample collection.

b. The seal must break or tear if it is removed.

c. Metal seals are usually crimped into place and require cutting or breakage for removal.

2.4. Decontamination Equipment

> NOTE: Procedures for decontamination of personnel and equipment are described in Module I, Section 5.0. Unless determined to be free of contamination, water and other materials that are used for decontamination must be retained and removed from the sampling site for proper disposal. Rinsate water may be required to be collected and analyzed for quality control purposes. Waste generation should be minimized whenever possible, and solid and liquid wastes should be segregated to the greatest extent possible in preparation for waste disposal. The generation of liquid waste should be minimized as much as possible. Information on waste minimization strategies and techniques can be found in the incident WMP (see Appendix D).

2.4.1. Buckets and pails serve as tote containers and portable sinks.

a. Buckets and pails should be constructed of plastic.

b. Lids are needed for containment but are generally not taken into the field.

c. Typically, 5-gallon and 20-gallon buckets are used. The number and size used depend on the degree of cleanliness required. At a minimum, one is used for the initial wash and one is used for the final rinse.

2.4.2. Drums or large cans are used to contain contaminated PPE or accumulated wastes; or clean bags, containers or equipment. Waste segregation and minimization strategies should be included in the incident WMP.

2.4.3. Brushes are used to remove deposits of solids from sampling equipment. Both bottle brushes and flat brushes are used. Brush handles should be sufficient to prevent direct contact with the brush during use.

2.4.4. Cloths are used to remove solids from or dry sampling equipment. Cloths should be certified as clean for use in drying equipment, and may be pretreated to contain a cleaning agent, if approved for the sampling event. Paper towels may be used, but lint-free cloths are preferred.

a. Dry wiping with clean cloths or paper towels is used to remove visible solids.

b. Swiping with cloths or paper towels dampened with deionized water is used to remove additional contamination.

c. Chemically treated swipes (soap swipes, alcohol prep pads, or other approved cleanser) are used to remove heavy grime.

2.4.5. Water is used to wash and rinse contamination from equipment, materials and sample collectors. At least 16 L (~4 gallons) is recommended for every 20 samples collected. Rinse water may be required to be collected as a quality control sample (see Module I, Section 3.2).

> NOTE: Deionized or distilled water should be used for all final rinsing, and the final rinsate submitted as a sample. Depending on the target radiochemical, rinsate samples are to be preserved (see Appendix C).

2.4.6. Soap and other non-ionic detergents are used for decontamination and washing. Soap can be either powder or liquid, and must be non-reactive, anionic, phosphate-free and low-foaming. Stainless steel polishers or cleaners may be used, provided they contain no petroleum distillates and leave no residue.

2.4.7. Step-off pads are used to designate the point for exiting a contaminated area. Personnel are required to perform a given level of personal monitoring and decontamination at the step-off pads to ensure contamination is not spread outside the contaminated area. Step-off pads may be pre-established prior to site entry by the sample collection team. These pads should:

a. Be clearly designated

b. Allow for the easy egress from the area

2.4.8. Sufficient containers should be located at step-off pads to allow for disposal and control of contaminated equipment and clothing. Additional information concerning proper waste containment and disposal can be found in the incident WMP (see Appendix D).

2.4.9. Tote containers should not be used as final rinsate containers, as the materials carried may contaminate the rinsate.

2.4.10. Other materials – Based on the nature of the incident, the area affected, and the extent of contamination, other materials might also be needed in equipment decontamination. Additional materials can include items such as chemical abrasive cloths, sandpaper, grinders, solvents, alcohol and acids. The requirements for and use of these items should be reviewed and discussed prior to use.

2.5. Communications Equipment

2.5.1. Radios or any two-way communication device capable of transmitting the sample collection team's concerns or requests to the standby person or site field team leader shall be employed.

2.5.2. A standby person (individual stationed outside the zone) is required to observe and respond to the sample collection team if problems arise.

3.0 Quality Control

Sample collectors should refer to the SCP to determine the kind and number of QC samples that should be collected or procedures that should be performed. In some cases, additional samples or sample volume will be needed to support laboratory QC sample analysis (e.g., matrix spikes, field replicates). Because QC samples may be shipped to the laboratory as either known QC or blind samples, sample collectors should refer to the SCP to determine how these samples are to be labeled for transport to the laboratory.

3.1. Field Blanks

3.1.1. Field blanks are used to monitor contamination that may be introduced into samples during sample collection, filtration or preservation.

a. If required, the field blank is prepared in the field at the same location, using the same procedures that are used to collect and process the sample. Field blanks are typically prepared prior to sample collection.

b. The field blank is submitted to the laboratory for analysis with the collected samples.

3.1.2. Field blanks are prepared by filling a sample container with blank matrix material (e.g., certified analyte-free water) and preservative (if necessary) using the same collection and processing procedures and equipment that are used to collect the samples.

3.2. Rinsate Blanks

3.2.1. Rinsate blanks are samples collected from rinse water running off decontaminated piece(s) of equipment and are used to determine and document that equipment have been adequately decontaminated.

a. The rinsate blank may or may not be preserved in the field, as described in the SCP.

b. If the rinsate blank is preserved in the field, a field blank should also be prepared.

3.2.2. Depending on the radiochemical of interest, rinsate and rinsate blanks are preserved using hydrochloric or nitric acid (see Appendix C) and submitted to the analytical laboratory to evaluate equipment decontamination.

3.3. Field Replicates

3.3.1. Field replicates are samples collected in the same manner, location, and time as an initial sample. Sample collectors must ensure that sample replicates are as equivalent in proximity, and in mass or volume as possible. Variations can affect representative QC evaluations.

3.3.2. In the case of a solid sample, the location from which a replicate sample is collected should be the space adjacent to the initial sample or the space of the initial sample enlarged to allow for a greater volume of sample to be taken.

3.3.3. A field replicate is used to evaluate sample heterogeneity, sample collection methodology and analytical procedures.

3.3.4. The replicate sample is handled and documented in the same manner as the initial sample.

3.3.5. Field replicates will be sampled and remain in separate packages throughout transport to and storage in the laboratory.

3.4. Background samples

3.4.1. Background samples are collected from a known uncontaminated area to allow for the determination of natural or "background" radionuclide concentrations.

3.4.2. Background samples are collected under the same control requirements as Final Status Survey Phase samples (see Module III).

3.5. Equipment

3.5.1. Equipment that is used to measure or analyze samples in the field requires calibration, operational checks as applicable, routine maintenance, and at least annual standardization/ verification. This equipment is calibrated following procedures included in the manufacturer's product/equipment manual, site SOPs, or performed in the laboratory.

3.5.2. Equipment used to obtain volumetric sample measurements must be certified to appropriate volume specifications.

3.5.3. Instruments that are routinely used in the field and require calibration and standardization/verification or certification to ensure measured sample weights and volumes are accurate.

3.5.4. Linear measuring devices (e.g., tape measures, rulers) are used to measure the length, width and depth of samples. These devices should meet National Institute of Standards and Technology (NIST) requirements (NIST 2014).

3.5.5. Analytical equipment that may be used in the field that require calibration to ensure sample analyses are accurate include:

a. Balances or scales
b. Volumetric pipettes, beakers, graduated cylinders
c. Air sampler flow rate meters and totalizers
d. Lapel air samplers
e. Water pumps
f. pH meters
g. Turbidimeters
h. Dissolved oxygen and/or conductivity meters

3.6. Sample Control

3.6.1. Once samples are collected, they must be maintained under controlled conditions through shipment to an analytical laboratory. This control is required to ensure that samples are not compromised and that analytical data generated are representative of site conditions.

3.6.2. Sample custody requirements

a. Keep samples in an area where they can be observed or are under lock and key to prevent tampering.

b. Maintain samples in the same configuration or condition in which the sample arrived from the sampling site (e.g., cores intact in their casings, containers sealed) until additional procedures are required.

3.6.3. Sample tracking

a. As samples are transferred from collection through processing, packaging, and shipment, record sample progress.

b. The person(s) performing each step is required to record their initials or signature on the label, sample tracking log, chain–of-custody (COC) form, and any other document associated with the sample to qualify the condition of the sample at that point of sample progression. See Module I, Section 4.0 (Documentation) regarding documentation requirements.

3.6.4. All sample collectors are required to perform sample collection, processing, and packaging activities in a manner that does not compromise the integrity of the samples or the requirements associated with the sampling event.

a. Follow documented procedures and adhere to requirements.

b. Notify supervision of problems or concerns.

c. Adhere to all requirements regarding documentation of activities, conditions, observations, and measurements.

3.6.5. Unused sample collection materials, such as air filters and swipes are to be sent to the laboratory with each batch of samples to be analyzed for radioactive analytes. These materials provide the analytical laboratory with a suitable blank or with information that will determine if any activity measured is the result of inherent radioactivity of the filters or swipes used, and the results may be used in assessment of the final field sample results.

4.0 Documentation

> NOTE: ALL documentation produced in collecting and processing samples is considered a legal record and is to be treated as such. Legibility and permanence are to be maintained. If errors are made, either the document error is struck out using a single line and initialed and dated, or it is re-written, checked for accuracy, initialed and dated, and attached to the original for record keeping.

4.1. General Considerations

4.1.1. Pens and markers should be of black indelible ink capable of writing on damp labels and containers. Pens and markers taken inside the contamination zone should be discarded with waste or used disposable PPE.

4.1.2. Logbooks, forms and reports should be assembled and maintained as permanent records.

a. If taken to the sampling area, they should be controlled outside of the contaminated zone to prevent contamination. If needed in the contaminated zone, take only a blank copy of the form or page. Once out of the contaminated area, they are to be rewritten into the original permanent records and verified as transcribed correctly once outside of the zone.

b. Required records include:
   - Sample identification codes (SICs)
   - Field logbook
   - Field report forms
   - COC forms
   - Photographs, when practical
   - Make, model, and accuracy information for any equipment used

c. Written documents are generated and maintained as the primary records of the sampling event. However, information also may be entered into an electronic record during or, as soon as practical, following sample collection.

4.1.3. Control of written and electronic records is detailed in the SCP.

4.2. Sample Labels

4.2.1. Sample labels must be applied to each sample container (including any container that holds a blank or quality control sample), with information that identifies and describes the sample. Sample labels are to include the following information at a minimum:

a. SIC

b. Time and date sample collected

c. Sample volume and matrix (including decontamination rinsate samples)

d. Sample collection location (GPS coordinates or brief description)

e. Signature or initials of the sample collector

4.2.2. If samples are placed in two containers (e.g., double bagged), a duplicate (DUP) label may be placed on the outside of the first bag or container, but inside the second bag or container, for legibility. If a duplicate label is used, it must be identified as a duplicate label or copy. If samples are triple-bagged, the duplicate label should be placed on the outside of the second bag or container, and inside the third.

4.3. Sample Identification Codes (SICs)

4.3.1. SICs are required for all samples collected, including rinsate blanks.

4.3.2. Each sample must have a unique SIC.

a. SICs typically consist of an alpha-numeric sequence code that includes a coded date and location marker.

b. All assigned SICs are used to document the sample location, type of sample, date and time of sample collection, and sample collector.

4.3.3. The SIC is recorded on all field documentation, sample container labels, COC forms, and any other documents pertaining to the sample.

4.4. Field Logbooks

4.4.1. Field personnel, including sample collectors, are responsible for recording data and maintaining field logbooks with adequate information to identify a specific sample and to provide information that may be necessary for interpreting analytical results.

4.4.2. Information that should be recorded in a field logbook entry (see Appendix B1) includes:

a. Number of samples collected, method of sample collection
b. Date and time of collection
c. Any pertinent observations
d. Names of sample collectors and observers
e. Description of sample location
f. GPS coordinates
g. Field screening data, if available

An example field logbook entry is provided in Appendix B1. Electronic data recording devices may also be used as a means of recording information in the field. If electronic recording devices are to be used, however, they should be selected based on durability, accuracy, backup capability, and ease of decontamination.

4.4.3. If photographs are included as part of the sampling documentation, the name of the photographer, SIC, date, time, site location, and site description are to be recorded sequentially in a logbook as each photograph is taken. After the photographs are developed, the associated information included in the logbook entries is to be written on the back of the photograph.

4.5. Field Sample Tracking Form

4.5.1. Field personnel, including sample collectors, are responsible for recording data and maintaining each field sampling tracking form with adequate information to identify a specific sample.

4.5.2. Copies of these forms accompany samples during shipment.

4.5.3. Example field sample tracking forms are provided in Appendices B2 and B4. Information recorded on these forms includes:

a. SIC
b. Sample matrix
c. Chemical decontamination/fixative used on matrix (identification of technology used)
d. Sample description and location
e. Sample dimensions, mass or volume
f. Sample depth (soils)
g. Sample type (including whether wet or dry swipes were used)
h. Number of containers

4.6. Chain of Custody (COC)

4.6.1. Tracking samples from collection to receipt at the laboratory is documented on a COC form. An example COC form is provided in Appendix B3 (Chain-of-Custody Form). EPA policy is to use Scribe wherever practical to generate COC forms.[2]

> **CAUTION:** Documentation of changes in sample custody is important. This is especially true for samples that may be used as evidence of intentional contamination or to establish compliance with a release criterion. In such cases, there should be sufficient evidence to demonstrate that the integrity of the sample is not compromised from the time it is collected to the time it is analyzed. During this time, the sample must either be under the physical custody of a responsible individual who is currently listed on the COC or be secured and protected, under lock and key, from any activity that would change the true value of the results or the nature of the sample. Each individual responsible for sample custody is required to provide signatory documentation each time a sample(s) is received or relinquished.

4.6.2. Information contained on the COC form is to include:

a. Site information – Address of the site, contact person, telephone number, and emergency contact number
b. SIC for each sample
c. Date and time of sample collection
d. Sample volume or mass
e. Sample matrix
f. Contact gamma reading or any additional radiological screening results of the sample, if available, and as provided by radiation protection personnel
g. Analyses requested – general analyses or specific isotopic tests
h. Printed names and signatures of all persons accepting and relinquishing sample custody, and the date and time of transfer
i. The printed name of the certified courier, courier company, and the name and signature of person(s) relinquishing and accepting custody of the samples

4.6.3. If deemed necessary, the following information also should be contained in the COC form:

a. A brief description of the sample(s)
b. Initials of the sample collector(s)
c. Method of shipment (ground, air, or both)
d. Any other pertinent information or comments regarding the sample(s)

[2] Scribe is a software tool developed by EPA's Environmental Response Team (ERT) to assist in managing environmental data. It includes functionality to support sample documentation, including sample labels, COC, and laboratory data reports. For additional information regarding this tool see https://www.epa.gov/ert/environmental-response-team-information-management

4.6.4. At the time of transport, the individual relinquishing the sample(s) must sign and date the COC form. The receiver also must sign and date the form.

4.6.5. The COC is copied and usually has carbonless copies attached to the original that are specified as to use.

a. A copy of the COC is to be retained by the individual or organization relinquishing the samples.

b. A copy of the COC is to be placed into a sealed plastic bag. The sealed bag is placed inside of the sample transport packaging prior to sealing for transport.

c. The original COC is sent to the analytical laboratory in a separate envelope.

4.6.6. The receiving laboratory is required to submit a signed copy of the completed COC to the site field team leader after receipt of the samples, and the original is to be returned with the laboratory's data package. The laboratory should include the following information with or on the completed COC:

a. Time and date received and signature of the person receiving the samples (appears on the COC)

b. Condition of the packaging and the security seal, and condition of security seals, where applicable

c. Condition of and any problems with the individual samples, such as a broken container, missing samples, illegible information

4.7. Verbal Discussions

4.7.1. All verbal discussions pertinent to the sampling event, samples, or transport and receipt of the samples by the analytical laboratory are to be documented in the field logbook.

4.7.2. If sample collectors are contacted by the laboratory, the following information is to be documented:

a. Name of the person who called

b. Name of the person who received the call and answered the questions

c. Content of the conversation, including any specific data or information discussed or provided

d. Time and date of the call

4.8. Transport Documents

4.8.1. Common carrier documents should be included with each shipment and completed as required by the individual carrier.

4.8.2. All packages must securely display the following:

a. Sampling contact information, mailing address and phone number

b. Laboratory name(s), mailing address and phone number

c. Quantity and description of contents

d. Date of shipment

e. Appropriate U.S. Department of Transportation (DOT) radioactive/radiation labels, Nuclear Regulatory Commission (NRC) labeling, and/or International Air Transport Association (IATA) labeling (see Module I, Section 7.0)

4.9. Waste Documentation

Documentation needs and requirements pertaining to waste generated during sampling are addressed in the incident WMP (see Appendix D).

5.0 Personnel/Equipment Decontamination

NOTE: The instructions provided in this section are intended to provide general information and guidelines. Requirements set forth by radiation protection personnel also must be consulted and followed for site-specific requirements and procedures.

5.1. Surface Contamination

Personnel or equipment surface contamination can usually be detected by radiation protection personnel, using direct monitoring equipment and methods. In cases where personnel or equipment have been in areas of high background radiation levels, however, surface swipes should be taken (see Module II, Section 7.0) and provided to radiation protection personnel for assessment of contamination prior to exiting the site. Alternatively, suspected contaminated equipment should be controlled in an area of lower background levels for direct reading.

5.2. Personnel and Equipment Decontamination

5.2.1. All personnel, equipment, materials, tools, or other objects exiting a controlled area will be surveyed by radiation protection personnel to determine the presence of contamination and, if necessary, will be decontaminated prior to leaving the controlled area.

5.2.2. Any material or personnel that exceeds the site's release limits, as detailed by radiation protection (e.g., 2x background levels), are to be controlled to prevent the spread of contamination.

5.2.3. Any personnel decontamination is to be handled by radiation protection personnel.

5.2.4. Contaminated sampling materials are to be decontaminated per procedures described in Sections 5.3 and 5.4, and subsequently surveyed by radiation protection personnel for controlled release.

5.2.5. Complex equipment (e.g., has recessed areas or crevices, air flowing through it for cooling, or water pumps) is to be fully surveyed by radiation protection personnel to determine if and how decontamination should be performed.

5.3. Dry, Wet and Chemical Wiping

> NOTE: All wastes produced from wiping off a contaminated surface are to be considered contaminated until proven otherwise. Placing plastic sheeting beneath the equipment to be cleaned facilitates waste collection and disposal. Additional information regarding the management of wastes generated from these activities can be found within the incident WMP (see Appendix D).

5.3.1. Clean surfaces of equipment and sampling containers with single wiping motions starting with equipment handles or outer edges and moving to the most contaminated areas.

a. Dry wiping with clean cloths or paper towels should be used to remove all visible solids contamination.

b. Swiping with cloths or paper towels dampened with deionized water should be used to remove additional contamination.

c. Chemically treated swipes (soap swipes, alcohol prep pads, or other approved cleanser) may be used to remove heavy grime.

5.3.2. If radiation is detected and is not removed by additional wiping, proceed to Section 5.5 for washing and rinsing.

5.4. Decontamination of Pumps and Tubing

5.4.1. Pre-rinse the pump and associated tubing by operating the pump in a deep basin containing approximately 30 to 40 L (8 to 10 gallons) of potable water for approximately 5 minutes.

5.4.2. Wash the pump and tubing by operating the pump in a deep basin containing approximately 30 to 40 L (8 to 10 gallons) of potable water containing a non-phosphate detergent (e.g., Alconox® cleaner [Alconox, Inc., White Plains, NY]) for 5 minutes.

5.4.3. Repeat the wash with a fresh solution of detergent.

5.4.4. Rinse the pump and tubing by operating the pump in a deep basin containing approximately 30 to 40 L (8 to 10 gallons) of potable water for 5 minutes.

5.4.5. If practical, take a sample of the rinse water (1L [0.25 gallons]) and have the sample evaluated by the radiation protection personnel for gross alpha and beta radiation. If gross alpha and beta screening is impractical, disassemble the major pump components and allow to dry. Take a swipe of the internal openings of the pump suction and discharge and the tubing and have the swipes counted for alpha and beta contamination.

5.5. Washing and Rinsing

> NOTE: All wastes produced from wiping off a contaminated surface are to be considered contaminated until proven otherwise. Placing plastic sheeting beneath the equipment to be cleaned facilitates waste collection and disposal. Additional information regarding the management of wastes generated from these activities can be found within the Pre-Incident WMP (see Appendix D).

5.5.1. Place the equipment in a container with sufficient room for washing. Add the minimum amount of water needed for washing.

5.5.2. Using a cloth, wash the piece of equipment.

5.5.3. Rinse the equipment with a minimal amount of water, collecting the rinsate into a wash container. Spray bottles can be used to minimize the amount used.

5.5.4. Wipe off the equipment with a clean paper towel or cloth.

5.5.5. Give the equipment a final rinse with a minimum of rinse water, collecting the rinse water in a separate clean sample container.

5.5.6. Dry off the equipment with a clean paper towel

5.5.7. Take a swipe of the equipment and submit the swipe to radiation protection personnel for analysis to ensure the equipment is properly decontaminated. If radiation is detected and is not removed by additional rinsing (e.g., additional rinsing with rinse water, 1% nitric acid [HNO_3] or hydrochloric acid [HCl]), bag and seal the equipment for delivery to a decontamination station or laboratory.

6.0 Waste Management

Prior to the initiation of sample collection activities, a WMP (see Appendix D) should be in place to address waste management considerations, including waste minimization, segregation, containment and disposal, as well as corresponding regulations. This section provides general summary information regarding waste management. Additional information regarding management and disposal of the low volume of wastes resulting from collection and analysis of environmental samples is provided in EPA's *Selected Analytical Methods for Environmental Remediation and Recovery* (SAM) companion document, *Laboratory Analytical Waste Management and Disposal Information Document* (Hall *et al*. 2019). If interested, sample collectors and planners also can refer to EPA's Waste Management Options for Homeland Security Incidents website and EPA's Incident Waste Decision Support Tool (I-WASTE DST), which provide information regarding regulations and guidance to support decision-making regarding waste treatment and disposal of waste associated with site remediation activities.[3]

6.1. General Information

6.1.1. Some or all waste generated as a result of sample collection activities, including equipment and personnel decontamination waste, will be considered low level radioactive waste (LLRW).

6.1.2. Waste that is generated and compiled for disposal is to be documented. Appendix B5 (Example Waste Control Form) presents a typical format for documenting wastes for disposal.

6.1.3. All waste containers are to be clearly labeled or identifiable as waste. Waste containers may be bottles, drums, plastic bags or garbage cans, depending on the type of waste.

6.1.4. Uncontaminated waste is to be clearly segregated from potentially contaminated or contaminated waste (see Section 6.4).

[3] Pre-registration is needed to access EPA's I-WASTE Tool and Disposal Decision Tool at http://www2.ergweb.com/bdrtool/login.asp

6.1.5. Waste material should not penetrate or be capable of chemically reacting with the container used. To prevent leakage or loss of sample, use waste containers that are durable, can be sealed, and are composed of materials that will not be affected or compromised.

6.1.6. Waste containers should be sealed and, if necessary, taped and wrapped, while implementing as-low-as-reasonably achievable (ALARA) principles.

6.1.7. After each addition, the waste container should be closed. After final insertion of material, the container should be sealed.

6.2. Solids

6.2.1. Dry Wastes

a. Place dry material in a labeled plastic bag or container that is appropriate for containing the waste material.

b. Material should not cut through or penetrate the containment. If necessary, sharp edges should be taped or otherwise wrapped.

c. After each addition, the container should be closed. After final insertion of material, the container should be sealed.

6.2.2. Wet or Damp Wastes

a. Place wet or damp material in a labeled plastic bag or container that is appropriate for containing the waste material.

b. Material that emits fumes or odors should be evaluated by the authorized safety and hygiene personnel regarding the need to control vapors, as some vapors can cause explosions of the container.

6.3. Liquids

6.3.1. Liquids should be segregated based on material (e.g., water with water, oils with oils). Wastes should be evaluated by the authorized safety and hygiene personnel for compatibility to ensure that hazards are not produced from mixing.

6.3.2. Liquid wastes that emit fumes or odors should be examined for possible vapor control problems as some vapors can cause explosions.

6.3.3. Use a liquid containment vessel to collect wet decontamination waste (i.e., decontamination rinsate that is not submitted as a sample).

> NOTE: Wet decontamination can involve the use of a pump to transfer liquid wastes, and drums or other containers with liners for storing liquid wastes. The drums should have secondary containment. Decontamination rinsate containing solvents or acids may need to be analyzed for pH and/or ignitability prior to disposal.

6.4. Segregation

6.4.1. As waste material is produced and collected, segregation must be used to prevent and control additional contamination and radiation exposure levels. If possible, waste should be screened and segregated in the field to minimize the amount.

6.4.2. Radiation and radioactivity levels in the materials used for decontamination will normally be insignificant.

6.4.3. Storing samples in a single location can result in radiation levels that could potentially affect background radiation levels or result in personnel exposure. Care should be taken to monitor radiation levels according to applicable regulatory or radiation protection requirements. If necessary, move or shield the samples. If radiation levels from unshielded samples exceed applicable limits, the samples should be placed in shielded containers. If radiation levels in an area where samples are being stored exceed manageable levels, refer to the appropriate radiation protection guidelines.

a. The potential for decontamination materials to spread contamination is often higher than the potential of contamination from the actual samples taken. Materials used for decontamination should be handled in a manner such that its accumulation and movement will not result in the potential for release.

b. If breached, waste containers can release loose material, vapors, or liquids. Waste containers should be handled in a manner such that they will not be breached.

6.5. Disposal

6.5.1. Procedures or mechanisms for control or disposal should be determined prior to generation of any waste. The field team leader will instruct the sample collection team regarding the actions to take to control or remove the waste generated.

6.5.2. A sample of each waste stream may be required to be packaged and shipped to a laboratory for characterization to inform disposal decisions.

6.5.3. Wastes may be required to be left on site for disposal during remediation.

7.0 Sample Packaging and Transport

WARNING: Samples should be considered contaminated, and the appropriate PPE worn, during the sample packaging and loading process. All samples being shipped for radiochemical analysis are to be properly packaged and labeled before transport off site or within the site, in accordance with U.S. DOT regulations in 49 CFR parts 170–189 or IATA Dangerous Goods Regulations. Specific applicable state requirements also must be considered. Any individual involved in transporting hazardous materials, including packaging hazardous materials for transport, must be trained in and comply with these regulations (DOT 49 CFR 172.700; IATA 1.5). Packages shipped within the U.S. must be verified by a DOT-certified Class 7 shipper. Courses to train individuals regarding these regulations are available in several states. A summary of related requirements is provided in Module I, Sections 7.1 through 7.5 below. The primary concerns are incidents that can occur during sample transport and result in the breakage of the sample containers or that can increase the possibility of spills and leaks (e.g., bumping, jarring, stacking, wetting, and falling). In addition to loss of samples and cross contamination, the possible release of hazardous material poses a threat to the safety of persons handling and transporting the package and laboratory personnel receiving the package.

NOTE: Boxes or ice chests, constructed of metal or hard plastic, make excellent packaging for low-level radioactive environmental samples. Containers (e.g., 30- or 55-gallon drums) meeting Type A packaging requirements (addressed in 49 CFR 173.412, and identified by markings on the drum) are required for samples meeting U.S. DOT placard requirements for Radioactive White I, Radioactive Yellow II or Radioactive Yellow III.

7.1. Regulations and Requirements

7.1.1. Various federal and state agencies have controls over the transport and shipment of radioactive material, including the DOT and the NRC.

7.1.2. All requirements for transport and shipment included in this document reflect the requirements of these agencies.

7.1.3. Definitions of terms pertinent to transportation of materials are stated in the Code of Federal Regulations (CFR) at 49 CFR Parts 171 through 173.

a. Class – The hazard classification of the material for transport purposes. Radioactive material is defined as Class 7.

b. Labels – Indication and signs on a packaging or on material contained in a packaging that designate a hazard or hazardous condition or handling requirements inherent to the packaging or package.

c. Markings – Indication signs pertaining to design or specifications of a package, irrespective of its use.

d. Overpack – An enclosure that is used by a single consignor (the site) to provide protection or convenience in handling of a package or to consolidate two or more packages for shipping purposes.

e. Package – The packaging with its radioactive contents as presented for transport. For example, a package could be a sample cooler used to transport a single sample or multiple samples.

f. Packaging – The assembly of components necessary to enclose completely the radioactive contents. It may consist of one or more sample containers; absorbent materials; spacing structures; radiation shielding; service equipment for filling, emptying, and venting; and pressure relief devices integral to the package. The packaging may be a box, drum or similar receptacle. It may also be a freight container consistent with the required performance standards for transport.

g. Transport index (TI) – The dimensionless number (rounded to the next tenth) placed on the label of the radiation level measured in mSv/hr times 100 or the level in mrem/hr at 1 m (3.3 ft).

7.1.4. The NRC provides regulations governing packaging, preparation, and shipment of licensed and special nuclear materials at 10 CFR Part 71.

a. Samples containing low levels of radioactivity are exempted as set forth in 10 CFR Part 71.10.

b. Low specific activity (LSA) material is defined and discussed in 10 CFR Parts 71.4 and 71.88.

c. Samples classified as LSA need to meet the requirements of the NRC and the requirements of the DOT.

7.1.5. DOT provides regulations governing the transport of hazardous materials at 49 CFR Parts 170 through 189.

a. Requirements for marking and labeling packages and placarding transport vehicles for shipment are detailed in 49 CFR Part 172.

b. Accident reporting is discussed in 49 CFR Part 171.

c. Packaging definitions and requirements are in 49 CFR Part 173.

d. Requirements for training shippers; what is to be included in the shipping papers; and what emergency information is necessary for the shipment are detailed in 49 CFR Part 172.

7.2. Transport Materials

7.2.1. Alert and Hazard Labels

a. Color-coded alert labels can be used to assist in processing a sample by identifying a sample emitting elevated radiation levels and/or by designating sample analysis priority in order to facilitate compliance with sample-segregation requirements specified in the Manual for the Certification of Laboratories Analyzing Drinking Water (U.S. EPA 2005).

- Red denotes radiation levels are equal to or greater than 0.005 mSv/hr (0.5 mrem/hr) and the highest analysis priority.
- Yellow denotes radiation five times above background but below 0.005 mSv/hr (0.5 mrem/hr) secondary analysis priority.
- Blue denotes the lowest analysis priority.
- Labels are typically circular with a diameter of 2.5 cm (1 in.).

b. Hazard labels are required by DOT for shipment and transport purposes. They are specified as to appearance, wording, dimensions, and coloring to be recognizable to handlers during their transport from the site to the analytical laboratory. These labels include:

- Radioactive Material
- Surface Contaminated Object (SCO) – SCO-I and SCO-II
- LSA (Low Specific Activity) – LSA-I, LSA-II, and LSA III
- Radioactive White I, Radioactive Yellow II, and Radioactive Yellow III
- Special nuclear material (SNM)
- Corrosive
- Red or black arrows (“This Way Up”) indicating either direction the package is to be maintained to prevent damage or spillage

c. All shipments of radioactive material, with the exception of those containing excepted quantities (typical in the Final Status Survey Phase of sampling), are to bear two identifying hazard labels affixed to opposite sides of the outer package.

d. A single hazard or alert label, or a combination of these labels, may be required to be placed on a sample container or package based on the hazards identified or considered to be contained in the sample container or package.

e. DOT regulations at 49 CFR Parts 171-173 should be consulted for specific packaging and labeling requirements. Several vendors and government agencies, including DOT, offer specific training on these regulations.

7.2.2. Strong tight containers (packaging) should be used to transport samples.

a. Packages are to meet DOT design requirements: Type IP-I, II or III; Type A; or Type B. Exempted or excepted quantities may be transported in "General design" packages.

b. Packages should survive incidents that can occur during transport, without a release of the contents.

c. Packages should be easy to handle and properly secured.

d. Each lifting attachment, if contained on the packaging, should have a minimum safety factor of triple (3x) strength and provide non-structural damage if failure occurs.

e. The external surface of the container should be smooth, free of unnecessary protrusions, dents, or gouges, and easy to clean.

f. All construction materials should be compatible and able to withstand radiation.

g. Any valve on the container should be protected against leakage or inadvertent opening.

7.2.3. Absorbent Material

a. The transport container should contain triple (3x) the amount of absorbent material required to absorb the entire amount of liquid being shipped.

b. Absorbent material should not degrade when exposed to the liquid being absorbed or from conditions incident to transport.

7.2.4. Cushioning Material

a. The material must be able to absorb impact placed on samples during transport.

b. It must be sufficient to prevent damage from occurring to samples or their containers.

c. Absorbent material may also be used as a cushioning material.

7.2.5. Shielding

a. Shielding materials can include plastic or aluminum sheeting (for alpha or beta radiation), lead sheets or concrete (for gamma radiation), and polyethylene or concrete (for neutron radiation). Shielding also may be accomplished by placing low-level samples (100 µR/h at surface of container) around high-level (100,000 µR/h at container surface) samples.[4] However, combined shipment of samples containing disparate levels of contamination should be avoided, or extra precautions should be taken to prevent cross-contamination.

[4] See EPA's *Guide for Radiological Laboratories for the Control of Radioactive Contamination and Radiation Exposure*, EPA 402-R-12-005.

b. The type and amount of shielding used depends on the type of radiation, radiation levels, packaging type and strength (e.g., cardboard box, plastic cooler), and weight limits of the package.

7.3. Preparing Samples for Transport

7.3.1. Field and Sample Data Compilation

a. Original field logbooks and field sample tracking forms are to be maintained in a secure location by the individual or organization relinquishing the samples. The interagency RadResponder Network is an additional resource that facilitates recording and sharing data.[5]

b. Copies of the appropriate pages of the field logbooks and field sample tracking forms are to be sent to the laboratory with the samples. Appropriate pages include information regarding sample volume or weight, screening results, and potential hazards.

c. Ensure SIC labels are on each sample container.

7.3.2. Wipe each individual sample container with a damp cloth or paper towel to remove any exterior contamination.

a. If directed, or if contamination levels on the sample container cannot be removed to levels specified in the HASP/RSP or SCP, then: (1) place the sample container in a bag, and (2) place the bagged sample container in a second clean bag.

> NOTE: The practice of double bagging is more efficient than wiping containers with absorbent material and is a more effective method for preventing the spread of contamination and the generation of additional waste.

b. If the sample container was not wiped or if removal of contamination could not be achieved, it must be documented in the field logbook and on the COC.

7.3.3. Ensure contamination and radiation levels of the outer container are measured.

> NOTE: Sample radiation and contamination readings are performed by personnel trained in the use of radiation monitoring equipment.

The following information is provided as guidance for steps to be performed prior to sample transport:

a. Perform a surface gamma exposure rate measurement and a surface alpha and beta contamination survey of sample containers. Record the results on the field sample tracking form.

[5] RadResponder is a product of collaboration between the Federal Emergency Management Agency (FEMA), Department of Energy (DOE), National Nuclear Security Administration (NNSA), and the Environmental Protection Agency (EPA), and is provided free of charge to all federal, state, local, tribal, and territorial response organizations. https://www.radresponder.net/

- The final package cannot exceed:
  - 2 mSv/hr (200 mrem/hr) at any point on the outside of the package
  - A TI of 10
  - 0.4 Bq/cm^2 (22 dpm/cm^2) beta – gamma loose surface activity
  - 0.04 Bq/cm^2 (2.2 dpm/cm^2) alpha loose surface activity
- If surface contamination exceeds allowed limits, decontaminate the container and repeat the survey.
- If surface gamma exposure is greater than background levels, record the reading on the sample container and the field sample tracking form.
- Place alert labels on containers that exceed 5x background radiation levels.

b. Based on gamma levels and types of samples, pre-stage samples for loading into the sample transport packaging. Samples with higher radiation levels are to be in the center of the packaging.

> NOTE: When determining loading of packaging (i.e., arrangement, weight and stabilization), allow for the addition of packing materials.

c. Once the samples have been screened and selected for transport, create a list of the samples and SICs that will be placed in the packaging container and record the order of their arrangement in the packaging.

7.4. Packing the Transport Packaging

7.4.1. Avoid cross contamination of samples and sample containers during packing by:

a. Ensuring the sample containers are controlled and sealed to prevent spillage during shipment.

b. Double bagging sample containers prior to packing the samples. Heavy plastic bags, with or without zip-locking seals, can be used.

c. Using heavy plastic lawn bags to contain vegetation samples.

d. Using bags that are large enough to allow the upper ends to be twisted to seal the top closed. Tape is applied to the area of the twist, and the top is folded over and sealed with tape. One continuous piece of tape can be used, tabbing the end to allow for removal.

e. Securing caps on containers holding liquid samples with tape, then placing them into plastic bags containing sufficient liquid absorbing material (i.e., must be able to absorb the entire contents of the inner packagings), and sealing the bags.

7.4.2. Pack the samples in the sample transport packaging.

NOTE: DOT has design specifications for each type of packaging; however, the construction of the packaging, as certified by the manufacturer, limits the total weight of the package and the capability to retain shielding. The shipping transporter will also have limitations as to the maximum weight of any one package that they will transport. These considerations will be determined prior to sample shipment, but the sampling team needs to be aware of any restrictions that apply.

a. Liquid samples should be packaged and shipped separately from other sample types, in packaging that includes liquid absorbing material (e.g., vermiculite) that is sufficient to absorb any spilled liquid. Filters and swipes should be shipped in containers without other types of solids that can crush filters and swipes during shipment.

b. Use the packing list and pre-determined packing order (see Module I, Step 7.3.3.c) as guidance in loading the packaging, noting that changes may be required based upon actual radiation levels and weight considerations.

c. If necessary, add shielding to the outer sides of the inside of the packaging.

d. Place shock absorbing material (bubble wrap, packing peanuts, vermiculite) or liquid absorbing material (e.g., vermiculite) around the samples, as appropriate, including the bottom of the transport packaging and the area above the samples. Samples should be in contact with the shock or absorbent materials and should not be in contact with each other.

e. Ensure that heavier materials are placed on or near the bottom of the packaging.

f. DO NOT jam or overload packaging.

g. DO NOT pack the packaging to an overweight condition.

7.4.3. Assign the package an identification number. Record the package number, samples contained within, and conditions of the contents in the field logbook. Record the sample package number on the package.

7.4.4. Obtain results of a surface contamination and radiation survey of the exterior of the filled transport package from the site radiation protection personnel.

a. If surface contamination exceeds allowed limits, decontaminate the package and repeat the survey. Record the results of the survey in the field logbook.

b. Record the highest and lowest gamma readings on contact, the highest reading at 1 m (3.3 ft), and the location where the reading was noted on the field sample tracking form.

c. If surface contamination or dose rate readings exceed allowable limits, contact the radiation protection and site safety personnel for further instruction.

7.4.5. Complete the COC form with all necessary information, per Section 4.6, and place a copy of the COC form in a zip-locking bag taped to the top of the inside lid of the packaging.

7.4.6. Close and seal the transport package.

a. Apply a security seal in such a manner that it will be torn (broken) if the package if opened. The tape should include the signature of the sender, and the date and time the seal was applied, so that it cannot be removed and replaced.

b. Place a completed custody seal on the package.

c. The container is to be secured with a locking mechanism or a method of securing closure.

- If a White I, Yellow II or Yellow III label is required, the package is to have a locking mechanism and a security seal.
- Industrial Type I packaging, such as a cooler, may be secured with clear packing tape or duct tape.

d. Write the following information on the outside of the package.

- Weight of the package
- Sender's name and address

e. Attach "This Way Up" labels and any other required labels, 180° apart from each other (opposite sides) on the package.

7.5. Transfer of Custody to an Authorized Carrier

7.5.1. Samples, by federal law, may be transported offsite only by authorized carriers.

a. Authorized carriers must be identified prior to sample shipment. Authorized carriers of hazardous materials must be certified by DOT and, as of September 2005, these carriers must also be certified by the U.S. Department of Homeland Security according to DOT's Hazardous Materials Regulation Unit.

b. Transport by an individual or sample collector is not authorized by federal regulations.

c. The U.S. Postal Service will not ship radiological samples.

d. Government-specified carriers may be used. FedEx and United Parcel Service are typical authorized carriers. There are other carriers that specifically transport high-level radioactive materials.

e. Shipment of high-level radioactivity samples should be coordinated in advance to avoid delays that could impact response.

7.5.2. Transfer custody of the samples to the carrier, obtaining a signature from the authorized agent on the COC form.

a. It is the responsibility of both the carrier and the shipper to ensure packages are properly loaded for transport prior to departure from the site.

b. Packages loaded into a vehicle, whether for onsite or offsite transport, are to be secured from movement during transport.

c. Packages of varying contamination levels are segregated. Packages containing samples that are above background (greater than or equal to 5x background) are stored in a shielded area of transport vehicles as far away from transport personnel and personal radiation dosimeters as possible.

d. A loading plan may be required to be determined prior to loading samples into transport vehicles.

e. When appropriate, the vehicle is surveyed prior to transport to ensure that the limits for radiation levels outside the vehicle are met.

- Not to exceed 2 mSv/hr (200 mrem/hr) on the external surface of the vehicle
- Not to exceed 0.1 mSv/hr (10 mrem/hr) at any point 2 m (6.6 ft) from the outer lateral surfaces of the transport vehicle
- Not to exceed 0.02 mSv/hr (2 mrem/hr) in any normally occupied space on the transport vehicle

f. Once samples are transferred to the authorized carrier, the carrier is responsible for the safety and security of the samples during transport.

7.5.3. The original COC form (after custody transfer signature), copies of corresponding field logbook entries and field sample tracking form(s), and a copy of the shipment paperwork should be sealed in a plastic bag and sent overnight to the analytical laboratory.

MODULE II - SAMPLING PROCEDURES – SITE CHARACTERIZATION AND REMEDIATION PHASES

1.0 Collection of Samples

> Sampling efforts requiring the collection of multiple samples, particularly those involving hazardous conditions, could involve a sample collection team consisting of more than a single individual. In these cases, individual team members should be trained to assume specific activities or duties related to the sampling effort. This team approach can reduce the time required for sample collection and adds an additional layer of quality assurance to the overall process. Importantly, sample collection teams also provide an additional level of safety. Each team member must be trained in the collection of samples.

1.1. Overview

1.1.1. This module outlines procedures, equipment, and other considerations specific to the collection of representative environmental samples for the measurement of radiological contaminants during site characterization and remediation.

1.1.2. The intent of any sampling event is to maintain sample integrity by preserving physical form and chemical composition to as great an extent as possible. Sample collectors should rely on training, experience, and supervisory guidance to ensure the sampling event provides the best samples possible to determine the extent and nature of the hazards encountered.

1.1.3. Materials exposed to a release of radioactive contamination can contain four types of contamination:

a. loose surface contamination from the deposition (fallout) of airborne material

b. fixed surface contamination from deposited material that has been absorbed or physically impregnated into a surface

c. contamination that is being transported by a liquid or solvent

d. activated material

The latter is a result of the release of neutron radiation, which transforms the material from non-radioactive radionuclides into radioactive radionuclides. Generally, activated materials will be found only at or near ground zero of a nuclear detonation.

1.1.4. The following issues should be considered by the sample collection team and the field team leader during implementation of the procedures described in this document and the requirements of the Sample Collection Plan (SCP).

> NOTE: Surveys of the ground surface are performed by the radiation protection personnel. The sample collection team is required to review survey results for contamination and radiation prior to taking a sample.

a. The amount of sample collected may be larger but should not be less than the required volume or mass. In general, large volumes or numerous samples are more representative than small volumes.

> NOTE: Large samples may cause problems with shipping, storage, and disposal, as larger volumes can contain higher radiation levels and require shielding or more numerous smaller sample shipments. Large amounts of sample may also cause problems in the laboratory due to increased radiation and difficulties in homogenization of samples to obtain representative aliquots for analysis.

b. During the Remediation Phase, the sample volume may increase, decrease or both. The variations will be dependent on the results found during Site Characterization Phase sampling, specifically the radionuclides and activities/concentrations found.

1.1.5. During the Site Characterization Phase of sample collection, measurement quality objectives (MQOs) corresponding to the specific event are based on unknown contaminants or on-site assessment and screening. The MQOs set during the Remediation Phase will be based on the knowledge obtained from samples taken during the Site Characterization Phase.

1.1.6. The following sample sizes are recommended in EPA's *Sample Collection Information Document for Chemicals, Radiochemicals and Biotoxins* (Campisano *et al*. 2017) to meet MQOs in the site characterization and remediation phases of sampling and should be collected unless otherwise specified by the SCP.[6]

> NOTE: The sample volumes and masses in this document are provided as guidance with respect to typical laboratory requirements for current analytical methods. Sample volumes/masses will be site- or incident-specific, and sample collectors should consult the SCP regarding requirements for the number and volume/mass of samples to collect. These sample volumes/masses should be considered to be minimum sample sizes; additional sample volume/mass may be necessary to satisfy laboratory QC sample requirements.

a. The volume recommended for soil and sediment samples is 0.5 L (0.13 gallons) or approximately 500 g (1.1 lbs).
   - Collect samples that are free of debris, vegetation, rocks, stones, etc., to the greatest extent practical.
   - Collect samples that do not contain a significant amount of liquid.
   - Consult with the SCP regarding area and depth dimensions needed for collection of an appropriate sample amount.

b. The volume for water is 2 to 4 L (0.5–1.1 gallons).
   - Samples are to be relatively free of sediment or debris.

[6] MQOs are based on sample amounts needed to meet the analytical and QC requirements of the methods listed in EPA's *Selected Analytical Methods for Environmental Remediation and Recovery (SAM) 2017* (U.S. EPA 2017).

- Samples are to be free of oil and sludge.

c. Air sample volumes are highly dependent on the sample collection device and site-specific MQOs. Sample collectors should consult the SCP for requirements regarding the air sample collection device to use, collection flow rate, duration, and sample amounts needed.

d. The area required to be covered by swipe samples is dependent on the surface sampled and is to be reported in cm^2.

- Small surfaces (typical surface areas) should be at least 100 cm^2 (16 $in.^2$) per swipe
- Large surfaces should be 300 cm^2 (47 $in.^2$) per swipe
- Surfaces greater than 300 cm^2 should be swiped in various, random locations using multiple swipes to cover approximately 1% of the surface area.

e. The required amount for samples of vegetation is 600 g (1.3 lbs) or approximately 4.0 L (1.1 gallons) of solid packed, low density (0.6 g/mL) vegetation (leafy material such as grass).

f. All other material volumes are dependent on the material sampled and ability to obtain the sample and are to be reported in activity per kilogram or liter.

1.2. Precautions and Limitations

1.2.1. General Precautions and Limitations

a. ALL personal protective equipment (PPE) is to be donned, worn, and properly disposed of during the sampling event.

- Improper use of the PPE can result in contamination of or injury to the individual.
- Improper use of the PPE may result in the spread of contamination beyond the incident sampling site.

b. Avoid contacting equipment and materials with any contaminated or potentially contaminated surface. Use a plastic bag to cover the surface and place materials onto the plastic bag or sheeting. This reduces carryover, contamination and exposure.

c. Note road locations and landmarks in the field logbook. Any information that can be used to clearly ascertain the position of a sample location is important. Global Positioning System (GPS) coordinates are used to specify an exact sampling point.

d. Always refer to the instructions provided in the SCP and by the field team leader prior to taking any samples.

1.2.2. Collection of Soil Samples

a. To collect a representative sample, collect from a relatively open area. If possible, and unless otherwise instructed in the SCP, samples should not be taken from areas located under trees or in areas containing numerous rocks, or large growths of vegetation. These features can prevent surface deposition and can act as absorbers of deposited material.

b. Soil samples require minimal field preparation and are not preserved. Homogenization is of greater importance, except in cases when samples of true surface contamination are requested.

c. Simple field techniques, such as coning and quartering, can be used to homogenize soil or sediment samples. If required, homogenized samples are divided for the creation of replicate samples.

d. If a sample contains significant amounts of residual water (e.g., forms clumps of soil or has standing water), homogenization and separation into sample aliquots must be performed in a laboratory. This will minimize the contamination of personnel and equipment. The sample should be examined to determine the potential volume of liquid and to ensure sufficient soil or sediment sample is collected for all required analyses.

e. The SCP must be reviewed for specific instructions for retaining or shipping excess materials such as rocks, stones and vegetation. If required, these materials are separated and placed into separate bags containing the same Sample Identification Code (SIC) of the sample. This is of particular concern for surface soil samples. Refer to the SCP for the proper management of these materials (i.e., sent to the laboratory, retained on site in storage, or disposed of).

f. During site remediation, rocks, stones and vegetation are typically segregated and left at the sampling site.

1.2.3. Collection of Sediment Samples

a. When sampling sediment, a wide variety of materials may be encountered. The matrix may include fine-grained material, a mixture of course and fine-grained material, and dead vegetative material (leaves, sticks, etc.) or peat moss.

b. Bulk sediment samples can be collected by grab sample, dredge or core sampler. The equipment used to collect discrete samples will depend upon the type of material encountered. Therefore, various sampling tools should be available to ensure the collection of representative samples. Refer to Module I, Section 2.0 (Equipment and Materials) and Appendix A1 (Sampling Equipment).

c. One of the problems encountered when sampling sediments is the amount of water in the sample. A high level of water content will increase the analytical detection limits of the sample, as the concentration calculation is determined on a dry weight basis.

1.2.4. Collection of Water Samples

a. Water samples must be representative of the body of water from which the samples are collected. If the sampling event is conducted in heavy rain, rainwater and sediments might be present in the sample, causing bias.

b. If possible, samples should be collected from a point of lesser turbidity and limited vegetation.

c. During the Site Characterization Phase, sample volumes should be consistent over the sampling events.

d. During the Site Characterization Phase, all material collected during the sampling event should be included in the sample. Unless sample filtration is required and performed in the field (see Appendix C), any sediment present in the sample is required to be shipped with the sample and not separated. If the sample contains significant amounts of residue or sediment, the sample is allowed to sit until the majority of the sediment has settled, and the volume of water is evaluated to ensure that sample volume requirements are met.

e. During the Remediation Phase of sample collection, specific volumes or weights may be requested. The SCP should specify whether a water sample is to be taken based on the sample volume or weight.

f. During remediation, samples containing significant amounts of residue or sediment should be allowed to settle and the liquid decanted. The body of water is resampled to ensure the proper volume is obtained, and the sediment is discarded at the site.

g. Replicate samples are collected by pouring aliquots of a bulk sample into separate containers. Each container should include the required sample volume.

h. Further water sample preparation and handling requirements, including preservation, are to be performed as required by the SCP, and should be performed in a controlled area outside of the sampling zone. Procedures for filtration and preservation of samples in the field are provided in Appendix C as guidance in cases when an SCP requires that these procedures are to be performed in the field. In these cases, samples to be analyzed for dissolved constituents must be filtered prior to preservation.

1.2.5. Collection of Air Particulate, Vapors, and Gas Samples

a. Weather conditions such as heavy snow, rain, dust and wind, can have a major impact on whether an air sample is representative of the actual environmental contamination levels. Air filters can become completely clogged with snow, dust, ice or particulates. If fires are in the area, particulate loading of filters can become as significant problem.

- Based on data collected to determine wind direction and the spread of the plume, air samples should be taken at a location that is downwind of locations at which high depositions are expected. The direction of the prevalent wind also must be used to determine where long term air samplers should be located.
- If the weather is inclement, a covering or housing should be placed either underneath or inside of a covering or housing to minimize debris, rain, or snow from being impinged on the sample filter or cartridge.
- If air samples are taken in the vicinity of an automotive vehicle, the sampler should be positioned upwind of the vehicle's exhaust.

b. Batteries or an electric power supply are required to take particulate and vapor air samples.

- When using a generator, place the generator downwind and far enough away to reduce exhaust capture.

- When using power from a vehicle, such as a power inverter plugged into the cigarette lighter outlet, place the sampler on the hood of the vehicle to reduce exhaust capture.
- Make sure to have fire suppression equipment readily available.

c. Gas samples are often taken using vacuum flasks, collection vessels, or bubblers. Care must be taken to ensure the valves on the vacuum flasks and sample collection vessels are prevented from being inadvertently opened prior to and after sampling.

d. Sampler units (filter and cartridge units) can be assembled outside the plume zone but should be sealed in plastic bags until the sampler is positioned and placed in a plastic bag upon retrieval.

e. Air filter, gas, and cartridge samples are to be taken with care to minimize the collection of liquid, water or water vapor. Air cartridges, particularly those using triethylenediamine (TEDA) impregnated charcoal, have a life expectancy of approximately one week at low volumes in high humidity.

f. When retrieving a filter, it is imperative to collect notes on the condition of the filter, flow rate of the sampler, collection start and stop time, and general environmental conditions.

g. During remediation, air samples are taken as determined by the SCP and, at a minimum, weekly around the site perimeter, daily at job locations, and per task on workers assigned in the field. The actual locations of perimeter samplers and the number of worker lapel samplers should be dictated in the SCP.

1.2.6. Collection of Surface Swipes

a. Swipes are to be collected with care to minimize damage to the swipe material or introduction of airborne contamination during the sampling event.

b. Collection of a swipe sample involves a physical motion that, in areas of high-level surface activity, can cause the material to become airborne. The extent of the airborne problem would be local but could influence the activity found in other areas as the material falls out from the air. Also, an increase in airborne activity might add a respiratory concern to the sample collector.

c. Wet swipes can be used for collection of samples from non-porous surfaces or when the surface contains large amounts of particles that are considered to be part of the sample.

d. Dry swipes are used when the sample surface is porous and moisture could "push" the contamination deeper into the material.

e. An indication of whether wet and/or dry swipes were used should be included in the sample documentation.

2.0 Equipment and Materials

NOTE: The equipment and materials used for sample collection are dependent on the sampling activity. Refer to Module I, Section 2.0 and Appendices A1 through A6.

All personal protective equipment (PPE) and sampling equipment is to be pre-staged and available prior to entering a sampling area. The sample collection team is to set up a step-off pad at the entrance to the survey point, and to don appropriate PPE prior to entering the area. Personnel outside of the area may hand material over to, and retrieve material from, personnel in the area using appropriate contamination control techniques. All steps that will reduce the time in the area, such as pre-writing of labels or sample containers, are to be used to minimize exposure.

3.0 Collection of Soil Samples

In addition to practicing safety precautions, sample collectors must wear appropriate PPE during all sample collection activities. The amount of PPE used should be designed to provide the maximum personal protection and mobility for the task being performed, and documented in the site- and incident-specific HASP and Radiological Protection Guidance Plan.

NOTE: Removal of large stones, rocks, twigs, vegetation and other debris may result in a less than required volume of soil. It is recommended that at least 1.0 L (0.26 gallons) is collected to support analytical method requirements for a 100-g dry sample that is free of debris. These sample sizes are provided for guidance and may vary depending on the specific contamination incident and MQOs.

3.1. Ground Deposition

3.1.1. Record the location, time, date and other pertinent observation information on the field sample tracking form.

3.1.2. Sample the soil as instructed using either Method A (Section 3.1.3, Maintaining a True Surface Sample) or Method B (Section 3.1.4, Shallow Surface Sample).

NOTE: Care should be taken to minimize contact of gloves with portions of the sample. Do not disturb the sample collection area around a sample point. Stake out and put up boundary lines around the sample point as necessary to ensure that the area is not disturbed.

3.1.3. Method A – Maintaining a True Surface Sample

a. Using a trowel, mark the edges around the collection area specified in the SCP.

b. Dig a cut line around the edges of the sampling point as wide as the trowel and to the depth specified in the SCP.

c. Wipe the trowel with a clean paper towel, removing all visible signs of dirt.

d. Slide the trowel or a flat spatula under the sample point to cut away at the 15 cm (~6 in.) deep point. This will likely require a series of cuts.

e. Using the trowel or spatula, pick up the sample.

f. Slowly place the material into a large zip-locking bag. If elevated levels of radioactivity are suspected, use of a plastic container is recommended to prevent cross-contamination that could occur if a bag becomes damaged.

g. Proceed to Module II, Section 3.10 (Soil and Sediment Sample Handling). DO NOT homogenize the sample.

3.1.4. Method B – Collecting a shallow surface sample

a. Using a trowel, mark the edges of the sample collection area specified in the SCP.

b. Cut down to the depth specified in the SCP, picking up the sample, and slowly place the material into a clean stainless-steel bowl large enough to hold more than the required sample volume.

c. Prior to homogenization, remove twigs, roots, leaves, rocks and miscellaneous debris (glass, bricks, etc.) from the sample using a clean stainless-steel spoon or spatula and return the removed material to the sample location. Consult the SCP for specific instructions for retaining or shipping excess materials such as rocks, stones and vegetation. If required, these materials are separated and placed into separate bags containing the same Sample Identification Code (SIC) of the sample.

d. If the volume collected does not meet the sample volume requirements, cut additional material from the outer edges of the hole as needed. Record the amount of additional material in the field logbook and on the field sample tracking form.

e. Wipe the trowel with a clean paper towel to decontaminate it, removing all visible signs of soil.

f. Proceed to Module II, Step 3.10 (Soil Sample Handling).

3.2. Wet Soil

> **WARNING:** Sample collection activities performed in wet soil or standing water are to be reviewed and approved by radiation protection personnel and the designated site safety individual. These conditions can pose a personnel hazard. Individuals may sink into the surface resulting in twisted ankles or knees, or broken limbs. The sampling of severely soaked soils is to be evaluated for personnel safety prior to the sampling event. As necessary, and under the direction of the site safety individual, the soil may be stabilized using a platform, such as ¾-in. plywood or ½-in. plank boards. Additional concern is required for the penetration or wicking of radioactive materials through non-waterproof clothing. In these conditions, radiation protection personnel shall assess the need for upgraded PPE.

3.2.1. Record the location, time, date and other pertinent observation information on the field sample tracking form.

3.2.2. If rain and water saturation make the collection area impossible to dig, attempt to remove the surface layer with a scoop or sample cup on a reach rod.

3.2.3. If snow has fallen or is present, gently remove as much snow as practical prior to collecting the sample. The SCP or the field team leader should be consulted to determine if and how snow samples should be collected as a sample.

3.2.4. Drag a cup, dredge, or scoop through the soil. If possible, the sampler should not exceed a depth of 6 cm (2.4 in.).

3.2.5. Retrieve the sampling device and lower it into a stainless-steel bowl large enough to retain the contents.

3.2.6. Deposit the soil into the bowl.

a. Allow the water to rise and soil to settle.

b. Decant the water carefully into a sample container using a funnel. Consult the SCP or the field team leader regarding whether the decanted water should be disposed of or treated as a sample.

3.2.7. Using a scoop or spoon, remove the soil and place it into the sample container.

3.2.8. Repeat the procedure as necessary to collect the required amount of sample.

3.2.9. Proceed to Module II, Step 3.10.4 (Soil and Sediment Sample Handling).

3.3. Dry and Sandy Soil or Sampling a Mixture of Fines and Gravel

> NOTE: Samples of unconsolidated or sandy soil that is extremely dry and falling apart should be sampled carefully. Material from the area surrounding the sample point should be left as undisturbed as possible. If needed, use a retaining form to prevent side-wall debris from entering the area sampled.

3.3.1. Record the location, time, date and other pertinent observation information on the field sample tracking form.

3.3.2. Using a core sampler, split spoon or thief, make a straight plunge into the soil. The SCP or the field team leader should be consulted regarding the depth the sample.

> NOTE: Sampling of poorly sorted material consisting of large aggregate and fines might not allow a core sampler to be used.

3.3.3. Give the sampling tool a twist to create a coring action.

3.3.4. Remove the sampling tool carefully from the soil.

> NOTE: Separation of coarse and fine-grained material will be inherent to the process and may bias data due to non-representation of all particle sizes present. As a result, data generated from samples of this matrix must be used with caution. As much as possible, samples should be representative of the particle size distribution present in the material being sampled.

3.3.5. Empty the sample into a clean stainless-steel bowl.

a. With a thief, twist the sample handle to open the sampler and lightly shake the sampler.

b. With a corer or split spoon, place the sampling tool over a clean stainless-steel bowl and carefully disassemble the sampler.

3.3.6. Transfer the sample to the sample container. A small funnel can be used to channel the sample into the container, provided the funnel does not restrict the passage of the larger pieces of sample aggregate.

3.3.7. Proceed with Module II, Step 3.10.4.

3.4. Subsurface Soil

> NOTE: Subsurface samples are not normally collected during site characterization. Subsurface samples are generally required if the ground transport mechanisms (water, soil conditions, ground faults) transport the contamination after the contamination incident. The duration of time from incident to cleanup will determine the extent of transport and the need to sample at depth.

3.4.1. Consult the SCP to determine depth of sample collection. If the depth is not noted in the SCP, consult the site field team leader for instruction.

3.4.2. Record the depth, time, date, sample collector and other information in the field logbook and on the field sample tracking form.

3.4.3. For samples less than 2 m (6.6 ft) deep, advance the hole to the desired sampling depth with a hand auger or a hand operated hammer. An extension rod with a split spoon may also be used.

3.4.4. For samples greater than 2 m (6.6 ft) deep, advance the hole to the desired sampling depth with a back-hoe bucket, power auger or other drilling rig.

3.4.5. Cover a designated spot next to the sample location but sufficiently clear to allow work (within 1 m or 3.3 ft) with a plastic sheet large enough to retain the soil excavated.

> NOTE: A 2 x 2 m (6.6 x 6.6 ft) sheet of plastic is typically sufficient for a shallow dig. For a deep dig, the size will be dependent on the depth of the hole and the tool used to excavate the sample point. Plastic sheeting may be placed after the majority of the digging is completed, prior to excavation of the sample volume.

3.4.6. Using the sampling tool, deposit the excavated soil onto the plastic sheet.

3.4.7. Upon reaching the prescribed depth (see Section 3.4.1), collect the sample and move the auger or split spoon to a clean designated area of the plastic sheeting. DO NOT mix the sample with excavated soil.

3.4.8. Obtain the sample directly from the auger or split spoon or place the contents onto the clean designated area of the plastic sheeting and collect the sample from the plastic.

3.4.9. Proceed to Section 3.10 (Soil and Sediment Sample Handling).

3.5. Soil with Vegetation

3.5.1. When it is necessary to collect a sample from an area that is covered with grass, weeds or other organic material, clip the organic material closely to the sample area surface and treat the clippings as a vegetation sample following procedures described in Section 6.0 (Collection of Vegetation Samples).

3.5.2. If the vegetation has stalks greater than 0.6 cm (0.25 in.) in diameter, note the presence of the stalk and take the sample by digging around the stalk. If the stalks are numerous, dig up the stalks and remove the soil from around the roots. DO NOT shake soil free. Hold the stalks over a clean stainless-steel bowl, and lightly tap or scrape the roots with the trowel or scoop.

3.5.3. Bag any vegetation taken separately from the soil. Label the bags with the SIC for the soil samples.

3.5.4. Record the sample location; the type(s) of vegetation encountered and removed; the area (dimensions) of vegetation sampled; time and date of sample collection; name of the sample collector; and other information in the field logbook and on the field sample tracking form.

3.5.5. Collect a soil sample as described in Section 3.1.

3.5.6. Proceed to Section 3.10 (Soil Sample Handling).

3.6. Soil Waste Piles (excavated soil material)

> NOTE: Soil waste piles are best sampled as they are made (i.e., as the material is dumped). Radiation protection personnel can perform a walk-over survey of the pile with a survey instrument to aid in determining the potential activity in the pile and allowing samples to be taken that are representative of pile activity.

3.6.1. Record the location, time, date and other pertinent observation information on the field sample tracking form.

3.6.2. Using a trowel, spoon or scoop, collect a full scoop from each individual dumping and place it into a stainless-steel bowl.

3.6.3. Cut through the sample to remove rocks, stones, foreign material and vegetation. Save this material in a separate sample container for possible evaluation.

3.6.4. After ten samples have been collected, record the location, time, date and other information in the field logbook and on the field sample tracking form.

3.6.5. Proceed to Section 3.10 (Soil and Sediment Sample Handling).

3.7. Sediment

3.7.1. Record the location, time, date and other pertinent observation information on the field sample tracking form.

3.7.2. Drag a cup, dredge or scoop through the sediment at the bottom of the body of water to collect the sample. If possible, the sampler should not exceed a depth of 6 cm (2.4 in.) when removing a sediment sample.

3.7.3. Retrieve the sediment sampling device and lower it into a stainless-steel bowl large enough to retain the contents.

3.7.4. Deposit the sediment into the bowl.

a. Allow the water to rise and sediment to settle.

b. Decant the water carefully into a sample container using a funnel. Consult the SCP or the field team leader regarding whether the decanted water should be disposed of or treated as a sample.

3.7.5. Using a scoop or spoon, remove the sediment and place it into the sample container.

3.7.6. Repeat the procedure as necessary to collect the required amount of sample.

3.7.7. Proceed to Section 3.10 (Soil and Sediment Sample Handling).

3.8. Sediment – Deep Water Body Grab Samples

> NOTE: Grab samplers used to collect sediment from deep water bodies (lakes, reservoir, rivers, marine basin) normally increase in weight based upon the depth and type of water body and the volume of sample they extract. Many grab samplers are gravity activated and use their weight to penetrate the sediment. Mechanical winches may be required for retrieval. The size and weight of the sampler and the need for a winch will dictate the type of boat or barge that is needed.

3.8.1. Record the location, time, date and other pertinent observation information on the field sample tracking form.

3.8.2. Drop a sediment grab sampler down into the body of water until the sampler hits the sediment. Allow or trigger the sampler to scoop a sample.

3.8.3. Retrieve the grab sampler, using a winch, if required.

3.8.4. Inspect the sample retrieved.

a. If the sample does not meet the criteria set in the SCP for filling the grab sampler bucket, drop the sample into a separate container, decontaminate the sampler (if required) or replace the bucket sleeving, and take another sample. Potential reasons for rejection include:

- Sampler jaws not closed and major portion of sample lost
- Sample appears to be washed out of bucket
- Sample leveled at a slope in the bucket (higher at one side than the other)

> NOTE: DO NOT discard any unused sample into water body at this time.

b. If the sample meets the criteria set in the SCP, continue to the next step.

3.8.5. Subsample the sediment as required by the SCP.

3.8.6. Decontaminate or re-sleeve the grab sampler as required.

3.8.7. Place the sediment sample or subsample into a stainless-steel bowl large enough to retain the contents.

a. Allow the sediment to settle.

b. Decant the water carefully into a sample container using a funnel. DO NOT collect more than 4 L (1.1 gallons) of water.

c. Mix the sediment sample or subsample to create a homogenous composite sample.

3.8.8. Using a scoop or spoon, remove the sediment and place it into the sample container.

3.8.9. Upon completion of the sampling event, discard the unused sample material back into the body of water unless instructed otherwise by the SCP.

3.8.10. Proceed to Section 3.10 (Soil and Sediment Sample Handling).

3.9. Sediment – Core Samples

> NOTE: Core sediment samplers normally increase in weight based upon the depth and type of water body and the volume of sample they extract. Many core samplers are gravity activated and use their weight to penetrate the sediment. Mechanical winches may be required for retrieval. The size and weight of the corer, the type of penetration device used (hand operated, weights, mechanical vibration or gas piston driven) and the need for a winch will dictate the type of boat or barge that is needed, as well as the number of people required to safely perform the operation.

3.9.1. Record the location, time, date and other pertinent observation information on the field sample tracking form.

3.9.2. Drop a sediment core sampler into the body of water until it reaches the sediment layer.

3.9.3. Push the manual core sampler into the sediment or start the core vibration or mechanical penetration device to push the core sampler into the sediment.

3.9.4. Stop the vibration or mechanical penetration device after the prescribed time frame identified in the SCP.

3.9.5. Retrieve the core sampler, using a winch, if required.

3.9.6. Remove the corer sleeve and open the core sample.

3.9.7. Inspect the sample retrieved.

a. If the sample does not meet the criteria set in the SCP for filling of the grab sampler bucket, drop the sample into a separate container, decontaminate the sampler (if required) or replace the bucket sleeving, and take another sample.

b. Potential reasons for rejection include:

- Core not filled
- Core catcher or water valve failed to close
- Sample leveled at a slope in the core (higher at one side than the other)

> NOTE: DO NOT discard any unused sample into water body at this time.

c. If the sample meets the criteria set in the SCP continue to the next step.

3.9.8. Subsample the sediment as required by the SCP.

3.9.9. Place the sediment sample or subsample into a stainless-steel bowl large enough to retain the contents.

a. Allow the water to rise and sediment to settle.

b. Decant the water carefully into a sample container using a funnel. DO NOT collect more than 4 L (1.1 gallons) of water.

c. Mix the sample or subsample to create a homogenous composite sample.

3.9.10. Using a scoop or spoon, remove the sediment and place it into the sample container.

3.9.11. Upon completion of the sampling event, discard the unused sample material back into the body of water unless instructed otherwise by the SCP.

3.9.12. Proceed to Module II, Section 3.10 (Soil and Sediment Sample Handling).

3.10. Soil and Sediment Sample Handling

NOTE: Homogenization includes a series of mixing and quartering (i.e., dividing into four) steps. It is important that the mixing of soil be as thorough as possible, while taking necessary precautions to avoid exposure of personnel to radioactive materials.

3.10.1. Using the trowel, homogenize or mix the soil.

a. Use a mixing technique dependent on the physical characteristics of the soil (including observed moisture content, particle size and particle size distribution) to achieve a consistent physical appearance over the entire soil sample.

b. Soil should be scraped from the sides, corners and bottom, rolled into the middle of a clean stainless-steel bowl or tray (or *in situ* hole) and mixed.

c. If the sample cannot be quartered, stir the sample in a circular fashion, reversing direction and occasionally turning the sample material over.

d. If the sample can be quartered, quarter the sample into separate sides of the bowl or tray, mix each quarter separately, and roll the mixed quarters into the center of the bowl. Then mix and combine the quarters into an entire sample.

3.10.2. Repeat homogenization steps at least three times to ensure homogenization.

3.10.3. Once a consistent physical appearance over the homogenized sample has been obtained, transfer the sample into an appropriate sample container using a clean stainless-steel spoon or spatula.

NOTE: A 1-L HPDE or HDPP wide mouth bottle is the preferred container for soil samples, as it requires less disturbance of the sample transferred into the bottle and reduces the risk of cross-contamination. A zip-locking bag may be used but requires double bagging to ensure retention of contents during shipment.

3.10.4. Once the sample containers are full, use a clean paper towel to remove any sample particles from the threads or sealing surface of the sample container.

NOTE: The presence of particles can compromise a container’s seal and result in a loss of soil moisture, cross contamination, or sample spillage during transport. Always make sure the container lid is firmly secure.

3.10.5. Place a sample label on the container.

3.10.6. Weigh the sample, or determine the volume based on the container size.

3.10.7. Sample containers should be placed in separate zip-locking bags to protect other containers in case of spillage during transport.

3.10.8. Record the required information in the field logbook, on the field sample tracking form, and on the sample label(s). The following information is to be included at a minimum:

a. SIC
b. Time and date sampled
c. Sample location
d. Depth and area of sample collection
e. Type of sample
f. Sample volume or weight collected
g. Sample collector's initials

3.10.9. Decontaminate the sampling equipment or place it into a bag for decontamination outside of the sampling area per the requirements of Module I, Section 5.0 (Personnel/Equipment Decontamination).

3.10.10. After sample collection, place the container into a transport container in a secure position for transport out of the sampling area.

3.10.11. Recover all wastes, placing them in appropriate waste containers for transport out of the sampling area. Handle wastes per the requirements of Module I, Section 6.0 (Waste Control).

3.10.12. Exit the sampling area using proper techniques to minimize the spread of contamination.

3.10.13. Once outside of the area, prepare the sample(s) for transportation per the requirements of Module I, Section 7.0 (Sample Packaging and Transport).

4.0 Collection of Air Samples

> In addition to practicing safety precautions, sample collectors must wear appropriate PPE during all sample collection activities. The amount of PPE used should be designed to provide the maximum personal protection and mobility for the task being performed, and documented in the site- and incident-specific HASP and Radiological Protection Guidance Plan.

As noted in Module I, Section 2.2.4, an appropriate air sampling assembly is selected based on requirements included in the SCP, the target analytes, laboratory capabilities, and potential interferences with the analytical methods that will be used. In general:

- Glass fiber or plastic membrane filters are used to capture particulates.
- Activated charcoal or silver zeolite cartridges are used for adsorbance of iodine and certain noble gases.
- Bubblers or silica gel cartridges are used for collection of atmospheric tritium.

4.1. Air Sample Pre-Staging Requirements

4.1.1. Sample collection equipment must be assembled outside the contamination zone, prior to sample collection.

4.1.2. If collecting particulates, install the particulate filter (membrane) into the sampler head.

a. Remove the particulate filter retaining ring.

b. Use disposable examination gloves to handle a new filter for each sample collection.

c. Center the filter into the ring.

d. Reinstall the ring and tighten to finger tightness.

4.1.3. If collecting a vapor sample, install a vapor cartridge (silver zeolite or charcoal) into the sampler head. ONLY low-volume samplers are to be used with cartridges, due to the retention factors of gaseous vapors on the charcoal or silver zeolite bed. A new cartridge should be used for collection of each sample.

> NOTE: Tritium exists as a vapor and should no longer be present in the atmosphere at the time of site remediation. If an SCP includes collection of air samples to be measured for tritium, the samples should be collected using either bubblers or silica gel cartridges (see Module II, Section 4.5).

a. Remove the retaining ring.

b. Install cartridge.

c. Note the flow direction of the cartridge and align it with the sampler flow direction.

d. Reinstall the ring and tighten to finger tightness.

4.1.4. If collecting a gas sample with a vacuum flask, ensure the flask or collection vessel is vacuumed and the valves are shut.

4.1.5. Place a sample label on the sampler unit head, flask, or collection vessel.

4.1.6. Place the sampler unit into a clean plastic bag for transport into the contaminated area.

4.2. Collection of Particulate and Vapor Samples

4.2.1. Open the bag to access the sampling pump, and make sure the pump is on the OFF position.

4.2.2. Secure the air sampler to a tripod, table, platform, vehicle hood or tailgate, or another sturdy non-moving surface, and protect the sampler from surface contamination with clean plastic sheeting.

a. Position the sampling unit with the air intake facing the source of the suspected contamination, making sure the face of the sampler is in the breathing zone, approximately 1.25 to 2 m (4 to 6 ft) above the ground surface.

b. Position the sampling unit to avoid interferences from structures, by placing the unit at a distance twice as far as the height of the tallest immediate building.

c. Care should be taken to control exhaust gases that can damage, overwhelm, or block the filter when using a gasoline generator or battery to power air samplers. If air samples are taken in the vicinity of an automotive vehicle, the sampler should be positioned upwind of the vehicle's exhaust.

4.2.3. Attach the appropriate sampling head (i.e., particulate filter).

a. If collecting radioactive iodine, a silver zeolite or charcoal cartridge is installed downstream from the particulate filter and connected to the suction end of the pump with a flow-rate indicator.

b. If collecting tritium, a silica gel cartridge or bubbler is installed downstream from the particulate filter and connected to the suction end of the pump with a flow-rate indicator.

CAUTION: If bubblers are used (see Module II, Section 4.5 and Figure 4.5-1), care must be taken to ensure that the pressure gradient caused by the pump flow rate is sufficient to collect air without pulling water from the bubbler(s). An alternative scenario is to connect the bubbler(s) to the discharge end of the pump, downstream from the particulate filter, as instructed in Section 4.5.

4.2.4. Record the required sample information onto the field logbook, field sample tracking form, and sample label on the sampler unit head. The following information is to be included at a minimum:

a. Sampler unit ID

b. Sampler unit location (GPS coordinates or description)

c. Date and time started

d. Sample collector's initials

4.2.5. Turn on the unit and observe the flow rate, adjusting as necessary to reach the required flow rate per the SCP. Record the flow rate (m^3/min or ft^3/min) into the field logbook and the label on the sampler unit head.

4.2.6. Routinely monitor the sample collectors throughout sample collection as specified by the SCP.

a. Sample collectors are typically checked once every 2 hr during an 8-hr shift.

b. Sample collectors located in work zones may require more frequent monitoring due to the potential for increased particulates resulting from associated work activities.

4.2.7. If any of the following conditions exist, turn off the sampler, and remove the sample head. Record if and why sampling heads were prematurely removed, along with the time or flow volume. Reasons may include:

a. Unit air flow has significantly decreased (greater than 50%)

b. Filter is clogged

c. Filter is wet or covered with snow

d. Filter is torn or otherwise compromised

4.2.8. If the filter unit was turned off prematurely, replace the sampler head unit with a new unit and re-start the sampler.

a. Record the time and date or approximate time the unit was turned off.

b. Record the time and date of the installation of the new unit or head and the restart time and date.

4.2.9. At the end of the sampling period, turn off the unit power. If the sample head is replaced or the sample unit fails, treat the filter and/or cartridge as a sample and proceed with the following steps.

4.2.10. Record the sample information in the field logbook and on the label on the sampler unit head.

a. Flow rate (m^3/min or ft^3/min)

b. Total flow volume (if volume totalizer is attached)

c. Date and time initiated and stopped

d. Sample collector's initials

4.2.11. Don a pair of new gloves and remove the sampler unit head.

4.2.12. Place the sampler unit head into a plastic bag and seal the bag.

CAUTION: Air samplers will be warm, and may be hot, after a sampling event. Used units should be placed into a plastic bag or other containment to control contamination. A hot air sampler must be allowed to cool prior to placing it into a plastic bag, and bags should remain loosely closed around any warm air sampler until cooling is complete.

4.2.13. Recover all wastes and place them in appropriate waste containers for transport out of the sampling area. Handle wastes per the requirements of Module I, Section 6.0 (Waste Control).

4.2.14. Exit the sampling area using proper techniques to minimize the spread of contamination.

4.2.15. After sample collection, immediately place the bag containing the sample head into a sample transport container in a secure position.

4.2.16. Disassemble the sampler head unit in an appropriately controlled area.

a. Open the filter ring.

b. Using forceps or tweezers, remove the filter. If necessary, for large filters (200 x 250 mm or 8 x 10 in.), fold the filter in quarters with collection side inward. DO NOT CUT OR TEAR THE FILTER. See Note in Module I, Section 2.2.8(c), regarding concerns about the use of large air sample collection filters.

c. Place the filter into a Petri dish or directly into a plastic bag and seal the Petri dish or bag.

d. Open the cartridge ring.

e. Remove the cartridge and place the cartridge into a plastic bag.

f. Place the filter and cartridge bags together into a second plastic bag.

4.2.17. Perform an equipment radiation survey or swipe and, if necessary, decontaminate the sampling equipment per the requirements of Module I, Section 5.0 (Decontamination).

4.2.18. Prepare the sample(s) for transportation per the requirements of Module I, Section 7.0 (Sample Packaging and Transport).

4.3. Vacuum Flasks

4.3.1. At the sample point, open the valve of the evacuated flask at the breathing zone.

4.3.2. Shut the valve once the flask reaches atmospheric pressure, as indicated by the absence of the sound of the flow of air into the container.

4.3.3. After sample collection, use packing to immediately secure the flask and protect its valves inside a box or other suitable containment for transfer outside the contaminated area.

4.3.4. Exit the sampling area using techniques to minimize the spread of contamination.

4.3.5. Record the sample information in the field logbook and on the label on the sampler flask or collection vessel.

a. Date and time sampled
b. Location sampled
c. Flask or collection vessel volume
d. Sample collector's initials

4.3.6. Obtain results of an equipment radiation survey or swipe from the site radiation protection personnel. If necessary, decontaminate the sampling equipment per the requirements of Module I, Section 5.0 (Personnel/Equipment Decontamination).

4.3.7. Prepare the sample(s) for transportation per the requirements of Module I, Section 7.0 (Sample Packaging and Transport).

4.4. Lapel Samples

4.4.1. Lapel samplers (personal air sampler) are set up and prepared according to manufacturer's instructions.

a. Flow rates are required to be verified.
b. Sampler heads are assembled per manufacturer's requirements.

4.4.2. Samplers are worn with the sample pump strapped to the waist under PPE and the unit head in the breathing zone.

4.4.3. Upon exit from the contaminated area of concern, record the sample information in the field logbook and on sample label.

a. Flow rate at the start and stop (m^3/min or ft^3/min)
b. Total flow volume (if volume totalizer is attached)
c. Date and time started and stopped
d. Individual wearing the sampler
e. Sample collector's initials

4.4.4. Place the filter and cartridge into a plastic bag. Place a sample label on the bag.

4.4.5. Obtain results of an equipment radiation survey or swipe from the site radiation protection personnel. If necessary, decontaminate the sampling equipment per the requirements of Module I, Section 5.0 (Personnel/Equipment Decontamination).

4.4.6. Prepare the sample(s) for transportation per the requirements of Module I, Section 7.0 (Sample Packaging and Transport).

4.5. Bubbler or Silica Gel Samplers

4.5.1. Bubbler or silica gel samplers can be used to collect air samples for tritium and are set up as described in Section 4.2.3 and Figure 4.5-1 (bubblers) or Figure 4.5-2 (silica gel).

a. As noted in Section 4.2.3, bubblers are installed downstream from the particulate filters, and connected to the suction end of the pump with a flow indicator.

b. Flow rates must be verified. When using bubblers, caution must be taken to ensure the flow rate is sufficient to pull air, without removing bubbler water.

c. Bubblers or cartridges are filled and assembled per manufacturer's requirements.

Figure 4.5-1
Tritium Bubbler

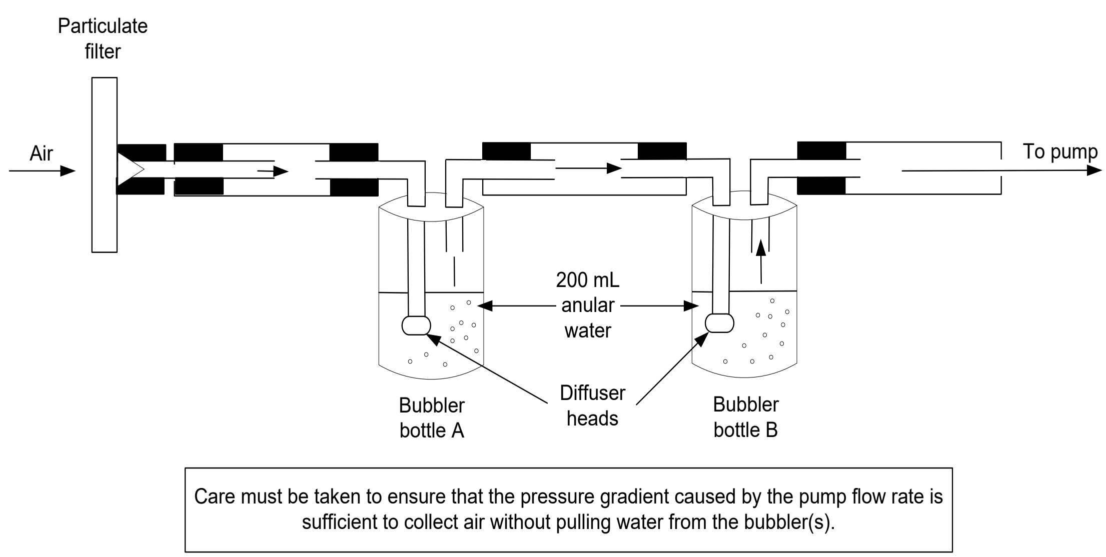
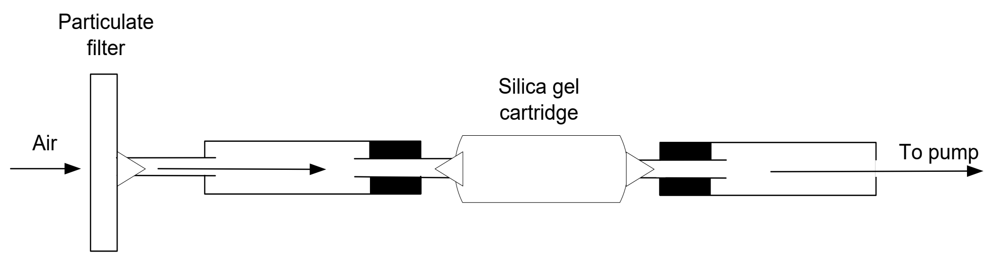


Figure 4.5-2
Tritium Silica Gel Cartridge



4.5.2. Samplers are set at specified locations and operated for the time frame required by the SCP.

4.5.3. Upon exit from the contaminated area of concern, record the sample information in the field logbook and on the sample label.

a. Flow rate at the start and stop (m^3/minute or ft^3/minute)
b. Total flow volume (if volume totalizer is attached)
c. Date and time started and stopped
d. Sample collector's initials

4.5.4. Remove the bubbler or cartridge. Cap the inlet and outlet with parafilm or manufacturer-provided caps and place a sample label on the bubbler or cartridge.

4.5.5. Obtain results of an equipment radiation survey or swipe from site radiation protection personnel. If necessary, decontaminate the sampling equipment per the requirements of Module I, Section 5.0 (Personnel/Equipment Decontamination).

4.5.6. Prepare the sample(s) for transportation per the requirements of Module I, Section 7.0 (Sample Packaging and Transport).

5.0 Collection of Water Samples

In addition to practicing safety precautions, sample collectors must wear appropriate PPE during all sample collection activities. The amount of PPE used should be designed to provide the maximum personal protection and mobility for the task being performed, and documented in the site- and incident-specific HASP and Radiological Protection Guidance Plan.

NOTE: Water samples should generally be discrete (i.e., not composited), and it is recommended that at least 2–4 L are collected to support analytical requirements. These sample sizes are provided for guidance and may vary depending on the specific contamination incident and MQOs.

5.1. Surface Water

Unless otherwise specified in the SCP, surface water samples should be collected directly above sediments, near banks/other depositional areas where water currents are slower and there is greater retention time for the surface water to accumulate contaminants.

> **CAUTION:** Collection of samples from streams and rivers can pose a safety hazard. Sample collectors should not wade into deep water or fast-moving currents or enter water systems where the bottom surface is not clearly visible.

5.1.1. Choose an area that is not sheltered by trees or biased by land runoff.

5.1.2. If possible, take a sample midstream, at least 0.5 to 1 m (20 in. to 3.3 ft) from the shoreline of the body of water, or at a point most representative of the entire water body.

5.1.3. Dip a sampling jar or bottle into the surface of flow and collect the sample.

5.1.4. Avoid stirring up sediment.

5.1.5. Proceed to Module II, Section 5.7 (Water Sample Handling).

5.2. Subsurface Water at Shorelines

5.2.1. Choose an area that is not sheltered by trees or biased by land runoff.

5.2.2. Stand as close as practical to the body of water without causing shoreline material from entering into the water resulting in turbidity.

5.2.3. Lower a sample jar, bottle or dipper between 10 to 25 cm (4 to 10 in.) below the surface and at least 0.5 to 1 m (20 in. to 3.3 ft) from the shoreline.

5.2.4. Raise the bottle above the waterline and return the sample to the shore.

5.2.5. Proceed to Module II, Section 5.7 (Water Sample Handling).

5.3. Stream or River Water

5.3.1. Wearing boots and other protective gear, wade into the water, facing upstream or against the current.

5.3.2. Avoid stirring up sediment. If needed, wait for turbidity to subside prior to sampling.

5.3.3. If possible, take a sample at least 50 cm to 1 m (20 in. to 3.3 ft) from the shoreline, or at a point most representative of the entire water body.

5.3.4. Dip a bottle, jar or manually-activated collection vessel from 10 to 25 cm (4 to 10 in.) below the surface.

5.3.5. Allow the bottle, jar or opened vessel to fill.

5.3.6. Remove the filled bottle, jar or closed vessel from the water body.

5.3.7. Proceed to Module II, Section 5.7 (Water Sample Handling).

5.4. Shallow Well Water or Public Drinking Water

> NOTE: Sampling points from public water supplies should be identified in the SCP and will be based on areas of concern within the distribution system.

5.4.1. Locate the tap nearest to the discharge pump or the tap identified in the SCP.

5.4.2. Turn on the pump and/or open the tap. Allow the water to purge for 1 min (40-foot well) or longer to allow for a representative sample collection. EPA requires a three times (3x) displacement for purging.

5.4.3. Proceed to Module II, Section 5.7 (Water Sample Handling) to take the sample.

5.4.4. Upon completion of taking the sample, close the tap and turn off the pump.

5.5. Storage Tanks, Cisterns, Wells, and Underground Storm Drains or Sewer Lines

> **CAUTION:** There are several safety concerns associated with collection of samples from underground storage tanks (USTs), wells, storm drains, or sewer lines. At least two sample collectors are needed and appropriate procedures for confined space entry must be in place to ensure safe conditions. Hatches or manholes are not to be left open or unmanned when sampling is not in progress unless site safety personnel are in control of the access point. Materials lowered into a tank, cistern or well are to be secured to retrieval lines to prevent loss inside of the tank. NEVER place loose materials around the opening of the tank.

5.5.1. Clearly identify any accessible area around the hatch, manhole or opening with a warning barrier line or tape. These warnings are typically used for side entrances and are not applied to above ground tanks with access points at the top of the tank.

5.5.2. Open the access.

5.5.3. Use the sampling method identified in the SCP to collect the sample.

a. Method A: Dipper with extension rod (not applicable to underground storage tanks [USTs] or wells)
    - Extend a dipper cup to the required depth below the surface.
    - Allow the cup to fill and retrieve the cup when filled.
    - Pour the collected water into an appropriate sample container.
    - Repeat as necessary to fill the sample container with the required volume.
    - Proceed to Module II, Section 5.7 (Water Sample Handling).

b. Method B: Manually-activated collection vessel
    - Ensure the sample collection vessel is open to allow water to enter.
    - Drop the vessel to the described sampling depth.
    - Allow the vessel to settle/flush with water for a few minutes, then follow the manufacturer's instructions to close or stopper the vessel.
    - Retrieve the vessel.

- Proceed to Module II, Section 5.7 (Water Sample Handling).

c. Method C: External and submersible pumps

- A level probe may be required when collecting samples from a well casing to prevent drawdown of the well, which can result in biased sample results. If required, lower a level probe into the sample point and determine the level by stable reading of the probe.
- Lower the pump suction head (external pump) or a submersible pump to the desired depth. If using a submersible pump, ensure the pump is properly assembled with a suction line (tubing) that extends upward at least 30 to 45 cm (12 to 18 in.) from the bottom of the pump.

> NOTE: Submersible pumps are often needed when collecting samples from USTs, cisterns, wells or other bodies of contained water that have a limited depth of 10 m (33 ft).

- Secure the tubing to prevent it from moving during sample collection.
- Sampling pumps may require priming using water brought to the site or taken from the sampling location. Prime the pump per the manufacturer's instructions.
- Limit the flow rate of the pump to prevent aeration or disruption of sediment.
- Throttle down the flow to 50–500 mL/min, as required in the SCP.
- Flush the tubing by pumping approximately 5 to 7 volumes through the line. Depending on the diameter and length of tubing, piping, or hose, the volume capacity of the pumping system will vary.
- Note any problems associated with pumping, such as (but not limited to) sputtering, excessive air bubbles, or bursts of sediment.
- Once the line has been flushed, proceed to Module II, Section 5.7 (Water Sample Handling) to collect the required sample volume into a sample container.
- Upon completion of sample collection, stop the pump. Remove the suction head from the sampling point and secure the sampling site.
- Decontaminate equipment and materials as appropriate, using procedures described in Module I, Section 5.0 (Personnel/Equipment Decontamination).

5.6. Lagoon, Pond and Lake Water

> **CAUTION:** Collection of samples from lagoons, ponds and lakes can constitute a safety hazard. Sample collectors are required to wear a personal floatation device at all times after leaving the shoreline and should not be placed into a situation that requires leaning over the water or outside the safety of the boat or skiff that might result in personnel falling into the water or unbalancing the boat or skiff. Samples collected from locations on top of a water body require at least two individuals.

5.6.1. Paddle or troll the boat or skiff out to the determined location and use procedures from one of the following methods to collect water samples.

a. Method A – Dipper with extension rod

- Extend a dipper cup to the required depth below the surface.
- Allow the cup to fill and retrieve the cup when filled.
- Pour the collected water into an appropriate sample container.
- Repeat as necessary to fill the sample container with the required volume.
- Proceed to Module II, Section 5.7 (Water Sample Handling).

b. Method B - Kemmerer water sampler on a line

- Open up the Kemmerer sampler and set it for taking a sample.
- Drop the sampler to the desired depth.
- Send the messenger down to the sampler.
- Hold the centerline and retrieve the sampler.
- Grasp the lower stopper and the body of the sampler in one hand.
- Open the top stopper to pour the contents into a sample container following the procedures in Section 5.7.

5.7. Water Sample Handling

5.7.1. Using a funnel, if necessary, add a small amount of sample water to the container and rinse the container.

5.7.2. Discard the rinse water by pouring it into a labeled waste bottle and then wipe the outside of the container dry.

5.7.3. Fill the sample container to within 2 cm (0.75 in.) of the cap and close the container.

5.7.4. Wipe the outside of the sample container with a dry paper towel.

5.7.5. Record the required information in the field logbook, on the field sample tracking form, and on the sample container label(s). The following information is to be included at a minimum:

a. SIC

b. Time and date of sampled

c. Sample location

d. Sample volume collected

e. Sample collector’s initials

5.7.6. Place a sample label on the container.

5.7.7. Obtain results of an equipment radiation survey or swipe from site radiation protection personnel. If necessary, decontaminate the sampling equipment or place it into a bag for decontamination outside of the sampling area per the requirements of Module I, Section 5.0 (Personnel/Equipment Decontamination).

5.7.8. After sample collection, place the sample container into a sample transport container in a secure position for transport out of the sampling area.

5.7.9. Recover all wastes, placing them in appropriate waste containers for transport out of the sampling area. Handle per the requirements of Module I, Section 6.0 (Waste Control).

5.7.10. Exit the sampling area using proper techniques to minimize the spread of contamination.

5.7.11. Once outside the area and back at an appropriate location, prepare the sample(s) for transportation per the requirements of Module I, Section 7.0 (Sample Packaging and Transport).

6.0 Collection of Vegetation Samples

In addition to practicing safety precautions, sample collectors must wear appropriate PPE during all sample collection activities. The amount of PPE used should be designed to provide the maximum personal protection and mobility for the task being performed, and documented in the site- and incident-specific HASP and Radiological Protection Guidance Plan.

NOTE: The required amount for samples of vegetation is 600 g (1.3 lbs) or approximately 4.0 L (1.1 gallons) of solid packed, low density (0.6 g/mL) vegetation (leafy material such as grass). A 1 m^2 area should be staked out from which a sample of vegetation is collected. If a greater area is required to obtain the specified weight or volume of sample, the specific area is to be documented.

6.1. General Considerations

6.1.1. During Site Characterization, samples collected from bushes, small trees, tall grasses, grass or other vegetation should focus on the upper or outer surfaces of exposed vegetation. DO NOT sample plants that are found under large trees or the covering of buildings unless directed to do so.

6.1.2. Using care to minimize physical disturbance of the vegetation, carefully cut the upper exposed surfaces of the vegetation away.

a. Small bushes – the outer leaves

b. Tall grasses – the upper tips

c. Trees – the upper or outer leaves, or branches, limited to those that are less than 1.5 cm (0.6 in.) in diameter

CAUTION: Branches and other woody materials can pierce plastic bags. Bags may require double bagging or placement in a separate harder plastic container.

6.1.3. Gather leaves off a tree or bush if possible. If leaves are collected from the ground, collect leaves that are not covered.

6.1.4. Vegetative material should be cut to approximately 2.5 to 25.5 cm (1 to 10 in.) in length.

6.2. Vegetation Sample Collection

6.2.1. Roll the opening of a plastic bag (sample container) over.

> NOTE: Rolling the top of the bag over will provide a handhold for the bag (by allowing the bag to be grasped from under the rolled area), prevent the possible spread of contamination, and ease cleanup during final sample container closing.

6.2.2. Use cutters (scissors or shears) to cut the material making sample pieces no longer than approximately 25 cm (10 in.).

6.2.3. Avoid disturbance of vegetation as much as possible during sample collection. DO NOT cut by using exertion or "gnawing" away at the stalk.

6.2.4. Place the retrieved sample in the plastic bag, packing it by hand as densely as possible without disrupting the vegetation or compromising the bag's integrity.

6.2.5. Record the required information in the field logbook, on the field sample tracking form, and on the sample container label(s). The following information is to be included at a minimum:

a. SIC
b. Time and date sampled
c. Sample location
d. Area sampled
e. Sample volume collected
f. Sample collector's initials

6.2.6. Affix the sample label(s) to the container(s).

6.2.7. Obtain sample container and sampling equipment survey results from the site radiation protection personnel. If necessary, decontaminate the container. If equipment is contaminated, place it into a bag for decontamination outside of the sampling area per the requirements of Module I, Section 5.0 (Personnel/Equipment Decontamination).

6.2.8. After sample collection, place the sample container into a sample transport container in a secure position for transport out of the sampling area.

6.2.9. Recover all wastes, placing them in appropriate waste containers for transport out of the sampling area. Handle wastes per the requirements of Module I, Section 6.0 (Waste Control).

6.2.10. Exit the sampling area using proper techniques to minimize the spread of contamination.

6.2.11. Once outside of the area and once back at an appropriate location, prepare the sample(s) for transportation per the requirements of Module I, Section 7.0 (Sample Packaging and Transport).

7.0 Collection of Surface Area Samples Using Swipes

In addition to practicing safety precautions, sample collectors must wear appropriate PPE during all sample collection activities. The amount of PPE used should be designed to provide the maximum personal protection and mobility for the task being performed, and documented in the site- and incident-specific HASP and Radiological Protection Guidance Plan.

NOTE: Sample collectors should consult the SCP to determine the appropriate swipe materials and sizes to be used for the collection of surface area samples, along with the number of swipes that should be taken.

7.1. Dry Swipes

7.1.1. Measure or determine by observation the total surface area to be sampled and record the area in the field logbook.

7.1.2. If using a large area swipe (e.g., at most 300 cm^2 [47 $in.^2$]), wipe the entire surface area in parallel strokes. Place the swipe into a glassine envelope or bag, then place a sample label on the envelope or bag.

7.1.3. If using a smaller area swipe (e.g., 100 cm^2 [16 $in.^2$] disc or square), wipe the entire surface in one continuous stroke of approximately 40 cm in length (16 in.) or a 10 x 10 cm (4 x 4 in.) square area, so that an area of approximately 100 cm^2 is sampled. An “S” pattern, or moving from one edge to the other without overlap, is the preferred method. Place the swipe into a glassine envelope or bag, and then place a sample label on the envelope or bag.

7.1.4. Proceed with 7.4 (Swipe Handling).

7.2. Wet Swipes

Appropriate wetting solvents are determined according to the surface being sampled and the target contaminant. Sample collectors should consult the SCP to determine whether wet swipes are to be used, as well as the appropriate wetting solvent.

7.2.1. Measure or determine by observation the total surface area to be sampled and record the area in the field logbook.

7.2.2. Dampen either a large area or small area swipe with the solvent fluid prescribed by the SCP. DO NOT soak the swipe. If necessary, allow the swipe to dry slightly before use.

7.2.3. If a volatile solvent is used (e.g., acetone), proceed with speed to prevent evaporation of the solvent.

7.2.4. Wipe the area per the procedures described in Section 7.1 (Dry Swipes) for either large area or small area swipes.

7.2.5. Proceed with 7.4 (Swipe Handling).

7.3. Tape Swipes

> NOTE: Tape swipes are typically collected for field screening and are not intended for transport to and analysis in the laboratory. When analyzed for radioactivity, the glue side of the tape must face the detector, because the paper backing of the tape will attenuate any alpha particles.

7.3.1. Measure or determine by observation the total surface area to be sampled, and record the area in the field logbook.

7.3.2. Create a tape swipe by laying successive strips of 5 cm (2 in.) duct tape sufficient to collect an area of 100 cm^2 (16 $in.^2$) or less. The edges of the tape should be folded over or covered with tape to prevent them from sticking to the surface of the object. This will create a “picture frame” around the actual sample.

7.3.3. Lay the tape swipe onto the surface to be sampled and press down over the sample area.

7.3.4. Carefully remove the tape and cover the exposed area with a piece of plain paper.

7.3.5. Place the swipe in a plastic bag or envelope. A sample label is to be placed on the bag or envelope.

7.3.6. Proceed with Module II, Section 7.4 (Swipe Handling).

7.4. Swipe Handling

7.4.1. Exit the sampling area using proper techniques to minimize the spread of contamination.

7.4.2. Record the required information in the field logbook, on the field sample tracking form, and on the sample label(s). The following information is to be included at a minimum:

a. SIC
b. Time and date sample collected
c. Sample location
d. Sample area collected
e. Percent of total area (calculated from surface area recorded in the field logbook)
f. Sample collector’s initials

7.4.3. Place a sample label on the container.

7.4.4. Once outside of the area and back at an appropriate location, process the sample for direct reading by radiation protection personnel or, if required in the SCP, for transport per the requirements of Module I, Section 7.0 (Sample Packaging and Transport).

MODULE III - SAMPLING PROCEDURES – FINAL STATUS SURVEY PHASE

1.0 Collection of Samples

1.1. Overview

1.1.1. This module outlines procedures, equipment, and other considerations specific to the collection of representative environmental samples during the Final Status Survey Phase of sample collection following a radiological contamination incident. This Final Status Survey Phase involves collecting samples to support decisions for determining site release.

1.1.2. A final status survey is performed to demonstrate that residual radioactivity in each survey unit satisfies the predetermined criteria for site release. The survey provides data to demonstrate that radiological parameters do not exceed the established derived concentration guidance levels (DCGLs). Samples collected during the Final Status Survey Phase are expected to contain radioactive material below the site's release criteria. There may, however, be random spots of elevated contamination encountered during sampling, therefore, specific precautions are needed during this phase to ensure samples below the release level are not compromised or contaminated.

1.1.3. During the Final Status Survey, methods for collection of soil samples vary slightly from those used during site characterization and remediation. Air, water, and swipe samples are collected using the same procedures described in Module II, Sampling Procedures (Site Characterization and Remediation phases). The measurement quality objectives (MQOs) are modified for all sample matrices.

1.1.4. Site surveys of the sampling units dictate the samples required.

a. A scale drawing of each survey unit is prepared and included in the Sample Collection Plan (SCP), along with the overlying planar reference coordinate system or grid system (normally the global positioning system [GPS] coordinates).

   - Any location within the survey unit is identified by a unique set of coordinates.
   - The maximum length (X) and width (Y) dimensions of each survey unit are determined and included in the SCP.

b. Identifying and documenting a specific location for each field measurement performed and each sample collected is an important part of a Final Status Survey to ensure that measurements can be reproduced if necessary.

   - Part of this identification is the measurement of radiation levels by hand-held survey instruments, which involves a walk-over survey of the area, including surfaces of buildings or other structures.
   - Any vegetation that was deemed contaminated, or for which concern was raised over potential contamination, should have been removed as part of remediation.

1.1.5. The following sample weights, volumes, and requirements have been determined to be necessary to meet the MQOs in the Final Status Survey Phase of sampling and are to be the volumes/masses taken unless otherwise specified in the SCP.

a. Soil and sediment samples are to meet the following requirements:
   - 0.6 L (~1 kg) of soil is to be collected for gamma scans
   - 60 mL (~100 g) of soil is to be collected for radiochemistry methods
   - Discussions with the analytical laboratory will determine if separate additional sample volumes are needed, or if only one sample is required.

b. Soil samples are collected only in the top 15 cm of soil.

c. Subsurface samples are generally not taken unless ground water transport has been an issue.
   - Subsurface samples are taken in areas where excavation has not occurred.
   - (DCGLs and the distribution of contamination will drive the decision to take subsurface samples.

d. Based on known soil density, the area of sample collection will vary and must be noted for each sample location or area in the SCP.

e. Water samples are to meet the following volume requirements.
   - 4 L of water, unless otherwise specified in the SCP
   - Sediments are to be filtered from the sample prior to shipment.

f. Air sample volumes are highly dependent on the sample collection device and site-specific MQOs. Sample collectors should consult the SCP for requirements regarding the air sample collection device to use, collection flow rate, collection duration, and sample amounts needed.

g. The area required to be covered by swipe samples is dependent on the size of the object to be checked for contamination and is to be reported in cm^2.
   - Small (standard) surfaces can be sampled to cover up to 100 cm^2 (16 $in.^2$) per swipe.
   - Large surfaces can be sampled to cover up to 300 cm^2 (47 $in.^2$) per swipe.
   - Surfaces greater than 300 cm^2 should be swiped in various random locations using multiple swipes to cover at least 1% of the total surface area.

h. The required amount for samples of vegetation is 600 g (1.3 lbs) or approximately 4.0 L (1.1 gallons) of solid packed, low density (0.6 g/mL) vegetation (leafy material such as grass).

1.2. Precautions and Limitations

1.2.1. All sample collection activities during Final Status Survey Phase sampling are to be observed for quality control purposes by an independent observer from the start of collection through sample container labeling.

1.2.2. Although Final Status Survey samples could be considered clean and radiation and contamination levels should be at background levels, personnel are to use radiation protection precautions. All equipment and materials, as well as areas where samples are handled, are to be surveyed by radiation protection personnel for contamination and released prior to unrestricted use.

1.2.3. If, during a sampling event, levels of radiation and contamination are measured above levels that are allowed or expected in the SCP, **STOP** the sampling event and notify the field team leader prior to continuing sample collection activities.

1.2.4. Survey points are located within a grid, and should be marked using flags, stakes, or paint markings. These markings must not be disturbed during sample collection.

2.0 Equipment and Materials

NOTE: The equipment and materials used for sample collection are dependent on the sampling activity. Refer to Module I, Section 2.0 and Appendices A1 through A6 for additional information regarding equipment used during sampling. For Final Status Survey Phase sampling, approximately 15% additional materials and equipment including equipment and tools should be prepared for use as needed.

All PPE (personal protective equipment) and sampling equipment are to be pre-staged and available prior to entering a sampling area. The sample collection team is to set up a step-off pad at the entrance to the survey point and to don appropriate PPE prior to entering the area. Personnel outside of the area may hand material over to, and retrieve material from, personnel in the area using appropriate contamination control techniques. All steps that will reduce the time in the area, such as pre-writing of labels or sample containers, are to be used to minimize exposure.

3.0 Collection of Soil Samples

In addition to practicing safety precautions, sample collectors must wear appropriate PPE during all sample collection activities. The amount of PPE used should be designed to provide the maximum personal protection and mobility for the task being performed, and documented in the site- and incident-specific HASP and Radiological Protection Guidance Plan.

3.1. Surface Soil Pre-staging Requirements

3.1.1. Create sample frames for the sampling locations (see Module I, Section 2.2.1).

a. Each sampling event will require one sampling frame for each sample location.

b. Each frame should contain an opening equivalent to the determined sample area as described in the SCP for that area.

3.1.2. Ensure that sample collection equipment is clean or sufficiently decontaminated prior to initiation of sample collection activities.

a. Each sampling event will require one clean stainless-steel bowl and trowel or spoon for each sample for homogenization.

b. Special cutting tools (e.g., bulb cutter) or simple handheld tools, such as a small shovel or trowel, should be used for Final Status Survey Phase soil sample collection. All sampling equipment is to be wrapped in clean aluminum foil with the shiny side of the foil facing the equipment.

c. Extra equipment and materials (approximately 15% more) should be prepared for use as potentially needed.

d. If the SCP includes requirements to sample soil below a paved surface, the pavement should be cored out, extracting the soil below the pavement, rather than excavating the pavement and potentially losing soil in the process.

e. Remove grass, rocks, and foreign debris from soils to the extent possible.

3.1.3. Ensure a copy of the sample collection procedure is provided to the QC observer.

3.2. Surface Soil Collection

> NOTE: Surveys of the ground surface are performed by the radiation protection personnel. However, the sampling team will be required to: (1) locate the sample location by GPS coordinates and posted sample point flags, (2) verify readings of the area prior to taking a sample, and (3) take a radiation reading of the subsurface at the sample point after the sample is taken. If variations are noted from reported survey/sampling points, they are to be noted in the field sample logbook. If there is a significant difference over reported levels and the levels at the time of sampling or if the sampling point appears to be in error (e.g., radiation levels are actually noted at a point adjacent to the sampling point but not at the sampling point), contact the field team leader for instructions.

3.2.1. Note the location of the sample point flag.

3.2.2. Survey, by scanning, the area around the flag using an appropriate survey meter.

> NOTE: While surveying and sampling, do not disturb the sample collection area within a sample point. Stake out and put up boundary lines around the sample point as necessary to ensure that the area is not disturbed.

a. Radiation readings should be taken at 2.5 cm (1 in.) above the ground.

b. The location of the sample point is to be clearly identified by GPS or other coordinate system, and the coordinates recorded in the field logbook and on the field sample tracking form.

3.2.3. Collect the Soil Sample.

a. Place the sampling frame over the sample point.

b. Using a trowel, mark edges into the soil around the sample point per the sampling frame dimensions.

c. Cut to a depth specified in the SCP and pick up the sample. Slowly place the material into a decontaminated stainless-steel bowl large enough to hold more than the required sample volume.

d. Prior to homogenization, remove twigs, roots, leaves, rocks and miscellaneous debris (glass, bricks, etc.) from the sample using a decontaminated stainless-steel spoon or spatula. Return the debris to the sample location.

> NOTE: Removal of large stones, rocks, twigs, vegetation and other debris may result in a less than required volume of soil. It is recommended that at least 1.0 L (0.26 gallons) is collected to support analytical method requirements for a 100-g dry sample that is free of debris.

3.2.4. If the amount of material collected does not appear to meet the amount required, cut additional material from the outer edges of the hole as needed. Record the approximate amount of additional material collected in the field logbook and on the field sample tracking form.

3.2.5. Using a clean trowel, homogenize or mix the soil.

> NOTE: Homogenization of soil includes a series of mixing and quartering steps. It is important that mixing be as thorough as possible.

a. Use a mixing technique dependent on the observed physical characteristics of the soil (including moisture content, particle size distribution) to achieve a consistent physical appearance over the entire soil sample.

b. Soil should be scraped from the sides, corners and bottom, rolled into the middle of a clean stainless-steel bowl and mixed.

c. Quarter (divide into four) the soil and move it to the sides of the bowl/tray/hole.

d. Mix each quarter individually and then roll them to the center of the bowl.

e. Mix the quarters together as an entire sample again.

3.2.6. Repeat the steps of quartering and remixing several times to ensure homogenization.

3.2.7. Once a consistent physical appearance of the homogenized soil has been obtained, transfer the soil into the appropriate sample container using a clean stainless-steel spoon or spatula. A 1-L HPDE or HDPP wide mouth bottle is the preferred container for soil samples, as it requires less disturbance of the sample transferred into the bottle. A zip-locking bag may be used but requires double bagging to ensure retention of contents during shipment.

> NOTE: Once the sample containers are full, use a clean paper towel to remove any particles from the threads or sealing surface of the sample container. The presence of soil particles can compromise the container's seal and may result in loss of soil moisture, cross contamination, or the lid opening in transit. Always make sure the container lid is firmly secure.

3.2.8. Label the sample container.

3.2.9. Weigh the sample(s) or determine the volume based on the container size.

3.2.10. Sample containers should be placed in separate zip-locking bags to protect other containers in case of spillage during transport.

3.2.11. Record the required information in the field logbook, on the field sample tracking form and on the sample label(s). The following information is to be included at a minimum:

a. SIC
b. Time and date sampled
c. Sample location
d. Area sampled
e. Sample volume or weight collected
f. Sample collector's initials

3.2.12. Decontaminate the sampling equipment or place it into a bag for decontamination outside of the sampling area per the requirements of Module I, Section 5.0 (Personnel/Equipment Decontamination).

3.2.13. After sample collection, place the sample container securely into a transport container for transport out of the sampling area.

3.2.14. Recover all wastes, placing them in appropriate waste containers for transport out of the sampling area. Handle wastes per the requirements of Module I, Section 6.0 (Waste Control).

3.2.15. Exit the sampling area using proper techniques to minimize the spread of contamination.

3.2.16. Once outside of the area and back at an appropriate location, prepare the sample(s) for transportation per the requirements of Module I, Section 7.0 (Sample Packaging and Transport).

3.3. Subsurface Soil Pre-staging Requirements

3.3.1. Ensure the coring rig is not located at the edge of an excavated area.

3.3.2. Obtain polyvinylchloride (PVC) tubing at a diameter slightly larger than the diameter of the core interior diameter and cut lengths of tubing of 32 cm (12.8 in.). One length is used for each sample collected.

3.3.3. Obtain end caps for the PVC tubing. One round (or pointed) end and one flat end are needed for each cut tube.

a. The pointed or rounded cap will be placed on the upper or shallow end of the cut.
b. The flat cap will be placed on the lower or deeper end of the cut.

3.3.4. If sample cores are NOT to be opened in the field, designate an area that is free of contamination and preferably out of the elements prior to sampling operations.

3.3.5. Subsurface samples (below 15 cm, or 6 in.) are to be taken by coring equipment only.

a. The core should be retained intact for monitoring and subsequent analysis.

b. Unless otherwise directed, core samples should be taken (separated) in 1-meter (3.3-ft) intervals, as measured from the surface.

c. Gamma logging of boreholes is to be performed immediately after core samples are taken.

d. If ground water is evident in holes remaining after core samples have been secured, ground water samples are to be taken using portable pumps.

3.4. Subsurface Soil Collection

3.4.1. Determine the depth to be sampled as noted in the Sample Collection Plan.

3.4.2. Record the depth, diameter of the core, time, date and other information in the field logbook and on the field sample tracking form.

3.4.3. Take the sample, with core boring equipment, by boring to 50 cm (20 in.) below the desired depth.

3.4.4. Lay down a clean plastic sheet for the retention of the required sample.

> NOTE: A 2 m^2 (21.8 ft^2) sheet is typically sufficient for a shallow dig. For a deep dig, the plastic size will be dependent on the depth of the hole and the tool used to excavate. The clean sheet may be placed after the majority of the digging is done, prior to excavation of the sample volume.

3.4.5. Upon reaching the prescribed depth, move the core to a clean designated area of the plastic sheet.

3.4.6. Obtain results of a gamma logging core hole radiation survey from radiation protection personnel.

a. Note radiation readings at 15-cm (6-in.) intervals and at the point of the sample.

b. Record the results in the field logbook and on the field sample tracking form.

3.4.7. Per requirement of the SCP, either open the core *in situ* or wrap the core in plastic, taping the plastic closed, and transport the core to a designated area.

3.4.8. Upon opening the core, record observations as to the makeup of the core.

a. Measure the core length compared with the depth of the coring. Note any voids in the field logbook.

b. Allow radiation personnel to take radiation readings of the cores.

c. Note the depth of the highest reading and the reading at the point from which the sample will be collected.

3.4.9. Measure the core to the sample point determined by the field sample coordinator. Measure a point 15 cm (6 in.) above the initial sample point and a point 15 cm (6 in.) below the initial sample point for a total sample depth of 30 cm (12 in.). Mark these two locations above and below the target core sample as the points at which the core is to be cut. Cut the core at the locations indicated.

3.4.10. Remove the sample material with minimal disturbance to the core.

3.4.11. Wrap the sample in plastic wrap and tape to seal.

3.4.12. Place the sample in a piece of PVC tubing and cap the ends, sealing the caps with duct tape and a custody seal if required.

3.4.13. Record the required information in the field logbook, on the field sample tracking form, and on the sample label(s). The following information is to be included at a minimum:

a. SIC
b. Time and date sampled
c. Sample location
d. Core area
e. Sample volume or weight collected
f. Sample collector's initials

3.4.14. Place a sample label on the tubing

3.4.15. Decontaminate the sampling equipment or place it into a bag for decontamination outside of the sampling area per the requirements of Module I, Section 5.0 (Personnel/Equipment Decontamination).

3.4.16. After sample collection, place the sample tube into a sample transport container in a secure position for transport out of the sampling area.

3.4.17. Recover all wastes, placing them in appropriate waste containers for transport out of the sampling area. Handle wastes per the requirements of Module I, Section 6.0 (Waste Control).

3.4.18. Exit the sampling area using proper techniques to minimize the spread of contamination.

3.4.19. Once outside of the area and back at an appropriate location, prepare the sample(s) for transportation per the requirements of Module I, Section 7.0 (Sample Packaging and Transport).

3.5. Sediment

3.5.1. Drag a cup, a dredge or a scoop to collect the sample of sediment from the bottom of the body of water.

3.5.2. Retrieve the sediment sampling device and lower it into a clean stainless-steel bowl large enough to retain the contents of the sampling device.

3.5.3. Deposit the sediment into the bowl.

a. Allow the water to rise and sediment to settle.
b. Decant the water carefully into a container using a funnel.

3.5.4. Using a scoop or spoon, remove the sediment and place it into the sample container.

3.5.5. Repeat the procedure as necessary to collect the required sample volume.

3.5.6. Discard the water into the sampled area.

3.5.7. Sample containers should be placed in separate zip-locking bags to protect other containers in case of spillage during transport.

3.5.8. Record the required information in the field logbook, on the field sample tracking form, and on the sample label(s). Include the following information at a minimum:

a. SIC
b. Time and date sampled
c. Sample location
d. Sample volume or weight collected
e. Sample collector's initials

3.5.9. Decontaminate the sampling equipment or place it into a bag for decontamination outside of the sampling area per the requirements of Module I, Section 5.0 (Personnel/Equipment Decontamination).

3.5.10. After sample collection, place the container to a sample transport container in a secure position for transport out of the sampling area.

3.5.11. Recover all wastes, placing them in appropriate waste containers for transport out of the sampling area. Handle wastes per the requirements of Module I, Section 6.0 (Waste Control).

3.5.12. Exit the sampling area using proper techniques to minimize the spread of contamination.

3.5.13. Once outside of the area and back at an appropriate location, prepare the sample(s) for transportation per the requirements of Module I, Section 7.0 (Sample Packaging and Transport).

4.0 Collection of Water Samples

In addition to practicing safety precautions, sample collectors must wear appropriate PPE during all sample collection activities. The amount of PPE used should be designed to provide the maximum personal protection and mobility for the task being performed, and documented in the site- and incident-specific HASP and Radiological Protection Guidance Plan.

4.1. Water Sampling Pre-staging Requirements

Ensure that sample collection equipment is clean or sufficiently decontaminated prior to initiation of sample collection activities.

4.1.1. Each sampling event will require one funnel for each sample collected.

4.1.2. Extra sampling equipment and materials (approximately 15% additional materials) should be prepared for use as potentially needed.

4.2. Water Sample Collection Procedures

4.2.1. Water sampling procedures to be used will depend on the body of water to be sampled. Perform the sampling steps per the requirements of Module II, Section 5.0 (Collection of Water Samples) for the body of water to be sampled.

NOTE: Instructions regarding filtration and preservation of samples in the field are included in Appendix C.

4.2.2. Water that is not included in the sample volume is to be returned to the sampled body of water unless otherwise stipulated in the SCP.

5.0 Collection of Swipe Samples

Swipe sample collection is performed per the requirements of Module II, Section 7.0 (Collection of Surface Area Samples Using Swipes).

6.0 Collection of Air Samples

Air sample collection is performed per the requirements of Module II, Section 4.0 (Collection of Air Samples).

7.0 Collection of Vegetation Samples

Vegetation sample collection is performed per the requirements of Module II, Section 6.0 (Collection of Vegetation Samples).

Appendix A
List of Sampling Equipment and Materials

APPENDIX – A1 **Sampling Equipment**

Sample Matrix	Sampling Tools	
Soil	Frames Trowel/shovel Scoop/spoon/sample cup Spatula Dredge Auger	Back-hoe bucket Split spoon sampler Thief Core sampler Bulb cutter
Sediment	Grab samplers (scoop/cup/jar) Extension rods Core sampler	Dredge Funnel
Air	Vacuum with pump Collection vessel Filters (glass fiber, plastic) Cartridges (charcoal, zeolite, silica gel) Bubbler Vacuum flask	
Water	Grab samplers (Bottles/Jars) Dippers with extension rod Pump (manual or powered) Tubing	
Surfaces	Wipes (cotton fiber, glass fiber, plastic, paper, tape)	
Vegetation	Cutting tool (e.g., scissors, shears)	

APPENDIX – A2 Sampling Equipment Application Advantages and Disadvantages

Table A.1 ***Soil and Sediment Sampling Equipment***

Tool	Type	Matrix	Advantages	Disadvantages	References*
Auger	Screw Type	Soil	• Cohesive soils • Near surface sampling to depths up to 15 feet with extensions	• Will not retain dry, loose or granular material • Hand manipulated • Soil profiling is difficult • Not applicable for consolidated formations	• ASTM D1452-09 • ASTM D4700-91 • Manufacturer's Instructions
Auger	Dutch	Soil	• Wet clayey, fibrous or rooted soils (marshes) • Near surface sampling to depths up to 15 feet with extensions	• Hand manipulated • Soil profiling is difficult • Not applicable for consolidated formations	Manufacturer's Instructions
Auger	Eijkelcamp, Glesbeck, Netherlands	Soil	• Stony soil or asphalt • Near surface sampling to depths up to 15 feet with extensions	• Hand manipulated • Soil profiling is difficult • Not applicable for consolidated formations	Manufacturer's Instructions
Auger	Planar	Soil	• Cleans out and flattens bottom of pre-drilled holes • Near surface sampling to depths up to 15 feet with extensions	• Hand manipulated • Soil profiling is difficult • Not applicable for consolidated formations	Manufacturer's Instructions
Auger	Spiral	Soil	• Removal of rock • Near surface sampling to depths up to 15 feet with extensions	• Hand manipulated • Soil profiling is difficult • Not applicable for consolidated formations	Manufacturer's Instructions
Auger	Tip Type – Mud Tip	Soil	• Heavy, wet soil and clay • Bit tips are farther apart than typical soil augers	–	Manufacturer's Instructions
Auger	Tip Type – Sand Head	Soil	• Extremely dry or sandy soils • Bit tips are closer together to retain loose or sandy samples	–	Manufacturer's Instructions
Iwan (Post Hole Digger)		Soil	• Cohesive, soft or hard soils • Near surface sampling to depths up to 15 feet with extensions	• Will not retain dry, loose or granular material • Hand manipulated • Soil profiling is difficult • Not applicable for consolidated formations	Manufacturer's Instructions
Core Borer		Soil	• Rotating core allows for penetration of heavy consolidated soils • Maximum depth depends on number of sections	• Expensive	• ASTM D6169-98 (2005) • Manufacturer's Instructions

Tool	Type	Matrix	Advantages	Disadvantages	References*
Scoops and Spoons		Soil	• Handheld • Easily manipulated • Low cost • Near surface sampling to depths up to 25 cm (10 inches)	• Limited to surface sampling • Hand manipulated • Limited durability, easily broken or bent in cohesive or hard packed soils	• ASTM D5633-04 (2008) • ASTM 4700-91 (2006) • Manufacturer's Instructions
Split Spoon		Soil	• Cohesive soils • Solid barrels for use in sands, silts and clays • Can be power driven by weight to penetrate harder soil compositions • Provides core type sample • Can be used up to a maximum of 25 feet	• Not for use on consolidated formations • Less effective in non-cohesive sands • Questionable recovery if used to extract material below water table	• ASTM D1586-11 • ASTM D3550-01 (2007) • ASTM D4700-91 (2006) • ASTM D6169-98 (2005) • Manufacturer's Instructions
Shovels		Soil	• Handheld • Easily manipulated • Low cost • Near surface sampling to depths up to 2 m (7 feet)	• Limited to surface sampling • Hand manipulated	• ASTM D5633-94 (2008) • ASTM 4700-91 (2006) • Manufacturer's Instructions
Trowel		Soil	• Surface soils • Can be used up to 25 cm (10 inches)	• Not for use on consolidated formations • Painted surface trowels should be avoided	Manufacturer's Instructions
Thief		Soil	• Dry granular material with small particle diameters • Pointed tips facilitate penetration of soil material	–	Manufacturer's Instructions
Grab sampler	Birge-Ekman Sampler	Sediment	• Soft sediments, silts and sand from shallow water • Handles easily • Allows subsampling • Sample depth up to 30 cm with volumes up to 12 L	• Restricted to low currents due to its light weight • Top flaps may not close completely resulting in sample loss	Manufacturer's Instructions
Grab sampler	Dredge - Petersen	Sediment	• Deep lakes, rivers and estuaries • Most sediments • Sample depth up to 30 cm with volumes up to 9.5 L	• May not close completely, resulting in sample loss • Descent shock wave can disturb upper sediment layer • Low current conditions • Metal frame may contaminate sample • Can exceed target depth	Manufacturer's Instructions

Tool	Type	Matrix	Advantages	Disadvantages	References*
Grab sampler	Dredge - Shipek®	Sediment	• Basins, large inland lakes, and reservoirs • Allows subsampling • Retains fine grain sediments effectively • Sample depth up to 10 cm with volumes up to 3 L	• Not useful on compacted soils, silts or clay • May not close completely, resulting in sample loss • Descent shock wave can disturb upper sediment layer • Low current conditions • Metal frame may contaminate sample • Can exceed target depth	Manufacturer's Instructions
Grab sampler	Dredge - Van Veen	Sediment	• Sandy, silted or clay sediment from deep lakes, rivers and estuaries • Adequate on most non-compacted substrates • Stainless steel; can be lined • Large sample maintained intact for subsampling • Screened covering prevents "wave" effects • Sample depth up to 30 cm; volumes up to 75 L	• May not close completely, resulting in sample loss • May close prematurely in rough water • May require winch • Relatively expensive	Manufacturer's Instructions
Corer	Tube, hand operated	Sediment	• Shallow, wadable or easily accessible water • Stainless steel or plastic, with plastic or glass liners • Preserves layering • Minimal contamination risk • Sample depth up to 10 cm with volumes up to 0.5 L	• Small sample size • Requires careful handling to prevent spillage • If liners are used, requires removal of liners prior to collection of next sample • Glass liners may break	Manufacturer's Instructions
Corer	Tube, gravity: Benthos	Sediment	• Soft grained sediments • Valve in liner retains complete sample in tube • Fins permit vertical penetration of substrate • Sample depth up to 3 m with volumes up to 10 L	• Requires weights for penetration, resulting in need for winch with 1000 kg lifting capacity • Compacts sediments	Manufacturer's Instructions
Corer	Tube, gravity: Kajak – Brinkhurst	Sediment	• Deep lakes and rivers • Collects greater volume than other samplers • Sample depth up to 70 cm with volumes up to 1.25 L	• Requires careful handling to avoid loss of sample • Requires removal of liners prior to collection of next sample	Manufacturer's Instructions

Tool	Type	Matrix	Advantages	Disadvantages	References*
Corer	Tube, gravity: Alpine	Sediment	• Soft fine grain semi-consolidated sediments • Interchangeable steel barrel allows different penetration depths • Sample depth up to 2 m with volumes up to 2 L	• Lacks stabilizing fins for vertical penetration • May penetrate non-vertically and incompletely • Requires lifting of 200 kg • Disturbs sediment strata • Compacts sediment	Manufacturer's Instructions
Corer	Tube, gravity: Phlenger cover	Sediment	• Deep lakes and rivers • Semi-consolidated substrates • Sample depth up to 50 cm with volumes up to 0.5 L	• Requires careful handling to avoid loss of sample • Requires removal of liners prior to collection of next sample • Small sample volume	Manufacturer's Instructions
Corer	Box, gravity	Sediment	• Shallow wadable water • Large, undisturbed sample • Optimal for collecting intact subsamples • Sample depth up to 70 cm with volumes up to 30 L	• Difficult to handle • Depth of sediment must be approximately 1 m • Relatively heavy, requiring a winch	Manufacturer's Instructions
Corer	Tube, piston	Sediment	• Large deep lakes • Typically recovers an undisturbed sample of most sediments • Sample depth up to 20 m with volumes up to 40 L	• Requires lifting of 200 kg • Piston and piston positioning at penetration may fail • Disturbs surface layer (0 to 0.5 m)	Manufacturer's Instructions

* Full reference citations are provided in Appendix E.

Abbreviations:

cm = centimeters
kg = kilograms
L = liters
m = meters

Table A.2 ***Water Sampling Equipment***

Tool	Type	Matrix	Advantages	Disadvantages	References*
Grab samplers	Cup, bottle or jar swing sampler	Water	• Easy to use • Adaptable to various sizes • Samples up to 6 feet depth	• Cannot collect samples at discrete depths • Easy to spill sample	–
	Dippers with extension rod	Water	• Sample depth determined by length of extension rod • Generally HDPE or HDPP construction	• Difficulty in retaining entire sample volume increases with depth	–
Manually-activated collection vessel	Bailer	Water	• Shallow water depths of up to 1 meter (3-4 feet) • Check valves, balls or mechanically-operated valves open/close tube • Lowered prior to opening to collect at-depth sample • Inexpensive	• Sample media can coat exterior • Difficult to decontaminate	Manufacturer’s Instructions
Manually-activated collection vessel	Bacon “bomb”	Water	• Tug line to close valves • Can be lowered prior to opening to collect an at-depth sample • Maximum depth 200 feet • Sample volume ranges from 0.12 to 1 liter (L)	• Sampler remains open until at depth • Can be difficult to decontaminate • Tends to aerate sample	Manufacturer’s Instructions
Manually-activated collection vessel	Coliwasa	Water	• Rod opens and closes the sampler	• Sample media can coat exterior • Can be difficult to decontaminate • Limited to 1.5 m (5 ft) depth • Suspended solids can prevent sealing and result in sample loss	• ASTM D5495-03 (2016) • Manufacturer’s Instructions
Manually-activated collection vessel	Kemmerer	Water	• Use a line to trigger the sampler to collect the sample at depth • Good up to maximum depth 70 meters (200 feet)	• Sample media can coat exterior • Difficult to decontaminate • Difficult to ensure proper operation at depth • Suspended solids can prevent sealing and result in sample loss	Manufacturer’s Instructions
Manually-activated collection vessel	Thieves	Water	• Shallow water • Length and diameter vary • Open at both ends; plugged at the upper end once submerged to withdraw a sample	• Improper plugging or capping can result in sample loss	Manufacturer’s Instructions

Tool	Type	Matrix	Advantages	Disadvantages	References*
Manually-activated collection vessel	Wheaton	Water	• Opened and closed with control rod • Depths up to 3 meters (10 feet) • Primary composition is steel and plastic	• Suspended solids can prevent sealing and result in sample loss	Manufacturer's Instructions
Pumps	Bladder	Ground-water	• Single-well sampling • Samples containing trace inorganics • Maximum depth of 100 feet • Up to 3 gallons/minute	• Needs compressed gas; large gas volumes and longer cycles needed with increased depth • Affected by high levels of suspended solids • Difficult to decontaminate	• ASTM D4448-01 (2007) • Manufacturer's Instructions
Pumps	Gear	Water	• Gear set drives fluid resulting in positive displacement • Maximum depth 100 feet • Up to 1.5 gallons/minute	• Requires electricity • Flow rates cannot be controlled • Suspended solids will clog gears • May stall at low flow rates	Manufacturer's Instructions
Pumps	Helical	Water	• Helical (worm gears) drive fluid resulting in positive displacement • Maximum depth 100 feet • Up to 1.5 gallons/minute	• Requires electricity • Flow rates cannot be controlled • Suspended solids will clog gears • Pumping may alter chemistry due to sample turbulence	Manufacturer's Instructions
Pumps	Piston	Water	• Drives fluid resulting in positive displacement with pulsing flow • Maximum depth 100 feet • Up to 1.5 gallons/minute	• Requires electricity • Requires filtration to prevent damage to piston and valve • Expensive	• ASTM D4448-01 (2007) • Manufacturer's Instructions
Pumps	Peristaltic	Water	• Shallow water sampling • Lift action creates a suction resulting in a positive displacement • Maximum depth 25 feet • Up to 8 gallons/minute	• Requires electricity • Small diameter lines	Manufacturer's Instructions
Pumps	Centrifugal	Water	• Shallow water • Requires constant water volume to avoid cavitation • Maximum depth 25 feet • Up to 60 gallons/minute • Submersible available	• Requires electricity • Small diameter • Loss of flow can occur when air enters sampling line • Difficulty handling viscous water	Manufacturer's Instructions

* Full reference citations are provided in Appendix E.

Abbreviations:
HDPE = high density polyethylene
HDPP = high density polypropylene

Table A.3 ***Air Sampling Equipment***

Tool	Matrix	Advantages	Disadvantages	References
Air pump, battery operated	Air	• Portable • Small units can be used to take breathing zone air samples	• Low velocity • Power and speed decline with use; failure possible due to unknown battery life • Low pump head limits length of air line	Manufacturer's Instructions
Air pump, electric	Air	• Continuous pre-set air flow • Large volume air samples • Can have longer lines attached to filter or sampler • Flow rates variable to low flow and high flow	• Requires power source • Can overheat if air drawn through filter or canister compromises air flow • Pumps tend to be noisy	Manufacturer's Instructions
Cartridge, Charcoal	Air, Vapor	• Majority of radionuclides • Good for iodine • Retains noble gases	–	Manufacturer's Instructions
Cartridge, Zeolite	Air, Vapor	• Majority of radionuclides • Retains noble gases (though fewer than charcoal cartridges)	• Relatively expensive compared with charcoal	Manufacturer's Instructions
Cartridge, Silica Gel	Air, Vapor	• Used to collect tritium • Entrains tritium-containing moisture	• Can dry out if not maintained properly • Relative humidity is a limiting factor in sampling duration	Manufacturer's Instructions
Bubbler	Air, Vapor	• Used to collect tritium • Entrains gas in water or other liquid	• Limited by solubility of gases • Can dry out if not maintained properly; caution needed to ensure flow rate is sufficient to pull air without displacing bubbler liquid	Manufacturer's Instructions
Filters (glass fiber, plastic)	Air, Particulates	• Capture particulates down to 0.1 micrometer (µm)	• Easily clogged; excessive loading can attenuate results • No method of determining time frame of deposition • Glass fiber filters may have inherent radioactivity	Manufacturer's Instructions
Filter, chart spool type	Air, Particulates	• Capture particulates down to 0.1 µm • Allows method of determining time frame of deposition	• Easily clogged; excessive loading can attenuate results • Material chosen may have inherent radioactivity from naturally occurring isotopes	Manufacturer's Instructions
Vacuum flask	Air	• Grabs a volume of ambient air for analysis • Provides a reasonably large sample volume (up to 4 liters [L])	• Vacuum can easily be lost • Loss of vacuum results in contaminated sample • No clear indication of state of vacuum or bulb valves	Manufacturer's Instructions

Table A.4 ***Surface Area Sampling Equipment***

Tool	Matrix	Advantages	Disadvantages	References
Dry Swipe • Whatman #41 filter paper • Glass-fiber filter	Surfaces	• Ease of use • Simple collection procedure • Minimal equipment needed	• May not work well with dry material or material stuck on surface	Manufacturer's Instructions
Wet Swipe • Whatman #41 filter paper • Glass-fiber filter	Surfaces	• Appropriate for collecting dry material and sampling porous surfaces	• Requires solvent (methanol, demineralized water) • Contaminant can be absorbed into swipe material or covered by residual moisture, leading to potential underestimation of alpha emitters	Manufacturer's Instructions
Tape Swipe (Duct tape)	Surfaces	• Best for collecting material stuck on surface • Minimal equipment needed	• Appropriate for screening only	Manufacturer's Instructions
Cotton Swipe	Surfaces	• Best for rough surfaces • Wet or dry - finished wood, tile, linoleum, stainless steel or painted metal • Wet - concrete and asphalt • One of few swipe media effective on concrete	• Not effective on unfinished wood or unpainted metal • Requires the use of wetting solvents for many surfaces	Manufacturer's Instructions
Glass Fiber Swipe	Surfaces	• Best for smooth surfaces • Used dry • Finished wood, tile, linoleum, asphalt, stainless or painted metal	• Not effective on concrete, unfinished wood or unpainted metal	Manufacturer's Instructions
Paper Swipe	Surfaces	• Wet or dry - tile, linoleum, asphalt, stainless or painted metal • Dry - finished wood	• Not effective on concrete, unfinished wood or unpainted metal	Manufacturer's Instructions

Table A.5 ***Vegetation Sampling Equipment***

Tool	Matrix	Advantages	Disadvantages	References
Scissors	Vegetation	• Small easy to carry • Ease of use • Easily cuts grass or small branches	• Not efficient for collection of 1 kilogram (kg) of vegetation • Difficult to cut thick branches	Manufacturer's Instructions
Shears (Cutters)	Vegetation	• Best for collection of thick branches • Best for collection of a large amount of sample	• Heavy • Not efficient for collection of grass	Manufacturer's Instructions

APPENDIX – A3 Sampling Containers

Sample Matrix	Containers	Capacities
Water, Liquids	Bottles (HDPE or glass)* – wide and small mouth	1 liter (L) 4 L (1 gallon) Cubitainers®
Soils and Sediment	Plastic (polypropylene or polyethylene) jars or bottles – wide mouth with PTFE lids	500 milliliter (mL) 1 L
	Borosilicate glass jars – wide mouth with PTFE lids	500 mL 1 L
	Plastic Bags (zip-locking - Sealable)**	1 quart 2 quarts
Air Samples	Envelopes – Paper	2.5 inches x 5 inches 3 inches x 5 inches 9 inches x 12 inches
	Plastic Bags (zip-locking - Sealable)	1 quart
Surface Wipes	Plastic Bags (zip-locking - Sealable)	1 quart
Vegetation	Plastic Bags (zip-locking - Sealable)	1 quart 2 quarts
	Plastic Bags (Non-sealable)**	15 gallons 30 gallons 55 gallons
	Plastic Jars – wide mouth with PTFE lids	500 mL 1 L

Abbreviations:
HDPE = high density polyethylene
PTFE = polytetrafluoroethylene (Teflon®)

* If water samples collected for tritium are to be stored for a long period of time (e.g., greater than 6 months), the samples should be collected in glass bottles. Alternatively, samples could be collected in plastic and transferred to glass bottles in the laboratory.

** Durability must be considered to prevent punctures from solid materials – normally used to contain sample bottles or jars.

APPENDIX – A4 <u>**Shipping Materials and Packaging**</u>

Type	Potential Materials
Cushioning and Packing	Styrofoam™ peanuts and pieces Bubble wrap Vermiculite
Absorbents	Vermiculite Chemsorb® (Chemsorb, Wood Dale, IL)
Industrial Package Type 1	Fiberboard box or drum Plywood or natural wood box or drum Plastic drum or jerrican Plastic cooler
Industrial package Type 2	Steel box or drum Aluminum box or drum Industrial package Type 2, Type A, or Type B container
Type A	Steel box or drum
Type B (U) or (M)	Specific steel container

APPENDIX – A5 **Additional Equipment to Consider for Sampling Operations**

Item	***Item Description***
AC Generator	Gasoline powered – 1500 watts
Bottle	16-ounce squeeze bottle with nozzle
Bowls	Stainless steel mixing – approximately 18-inch diameter, 6-inch depth (approximately 2 gallons)
Bucket	Plastic with handle – 5 gallons. For carrying tools and materials; can be used for carrying samples or for equipment decontamination
Chisel	————
Drill	3/8 inch
Drum Hand Truck	Transport 30- and 55-gallon drums
First Aid Kit	————
Filter Paper	Quantitative-grade paper with greater than 8 µm particle retention; e.g., Whatman 40® 12.5 centimeters (5 inches) and 18.5 centimeters (7.4 inches), or equivalent
Flashlight	————
Forceps	6 inches
Funnels	240 milliliters (mL); 960 mL; plastic
Gas cartridges for air samplers	Silver zeolite; activated carbon; others as needed based on site conditions and target radionuclides
Gasoline containers	5 gallon, with spark arrest and safety cap closure
GPS unit	Handheld; preferably able to tie into the radiation detection equipment for logging sample radiation readings at location
Hammer	12 ounce, 20 ounce, and small sledge
Labels	Labels and markings for required shipping and samples
Ladder	6 feet and 10 feet
Mixing paddle	Attachable to drill with extension 2–3 feet
Pens and markers	Indelible, waterproof, black and red
Petri dishes	30 millimeter (mm) and 50 mm
Plastic bags	(Non-sealable) 15, 30 and 55 gallon, for general wastes
	(Non-sealable) 15, 30 and 55 gallon, for contaminated wastes
Plastic sheeting	Preferably in a large roll (20 feet x 33.3 feet)
Rope – nylon	White – 3/8 inch and 1/2 inch; nylon or weatherproof cotton
Rope – nylon	Yellow and magenta; 3/8 inch
Salvage and over pack drums	————
Saw	Electric circular, manual hand, and hack saws
Screw drivers	Flat and Philips head; Small and large
Shielding material	Sheet steel, plywood, lead blankets and bricks

Item	***Item Description***
Sieves	Stainless steel No. 4 (100 mm mesh)
Signs	Yellow and magenta for radiation work
Signs	Red, white, and black for safety concerns
Sign	Blue and white for entry and other instruction
Soap and cleansers	————
Spill kit	————
Stakes	Wooden construction
Stakes with flag	Wire with flag for marking
Step-off pads	Yellow and magenta for radiation work
Tape	Yellow and magenta for radiation work
Tape	Duct tape; packing tape; 2 inches and 3 inches wide
Tape measure	50–200 feet preferably with metric scale as well
Tripod	For mounting air samplers
Tripod	For retrieving material from pits or excavations
Utility carts	————
Weigh scale	Hanging pull type; kg with gram divisions capable of weighing up to 5 kilograms

APPENDIX – A6 <u>Personal Protective Equipment</u>

Item	***Description***
Boot / shoe covers	Plastic
Boots	Rubber
Coveralls	Paper - Tyvek® (Dupont, Wilmington, DE)
Coveralls - cotton	————
Coveralls – water-resistant/proof	————
Ear protection	————
Eyewear	May require sunshades for outdoor work in bright conditions
Face shields	————
Gloves – exam	Latex or nitrile; powder free
Gloves – work	Heavy cotton
Hard hats	————
Respirators	Full face air purifying
	Full face powered air
	Airline full face
	Self-contained air supplied
Monitoring devices	Radiation dosimeter
	Lapel sampler
Personal floatation device	————

Appendix B
Forms

APPENDIX – B1 Example Field Logbook Entry

This logbook entry format is provided to demonstrate the minimum information to be recorded in a bound logbook. Illustrations or pictures of the site also should be included with annotations and should accompany or be referenced in the entry. Pagination (Page X of Y) should correspond to each sample event. The logbook should also contain pagination to demonstrate logbook maintenance.

<table>
<tr><td colspan="4">Site Name</td><td colspan="2">Page X of Y.</td></tr>
<tr><td colspan="2">Sample Collection:</td><td>Number Taken</td><td>Matrix</td><td>Date</td><td>Time:</td></tr>
<tr><td>Sample Collectors (Print Names)</td><td colspan="3"></td><td>Observed by Initials</td><td></td></tr>
<tr><td colspan="6">Location of Sample Collection:</td></tr>
<tr><td colspan="6">Landmark Description
Compass Point</td></tr>
</table>

Sample Identification Code (SIC)	GPS Coordinates	Contact Gamma mR/hr	Remarks
1 -			
2 -			
3 -			
4 -			
5 -			
6 -			
7 -			
8 -			
9 -			
10 -			
11 -			
12 -			
13 -			
14 -			
15 -			
16 -			
17 -			
18 -			
19 -			
20 -			

Comments: Note sample number and describe problem or information. Add pictures or illustrations on separate page.

APPENDIX – B2 Example Field Sample Tracking Form

Field Sample Tracking Form								
Site Name				Date			Page X of Y	
No.	Sample Identification Code	Matrix[1]	Sample Location / Description[2]	Volume (mL) / Mass (g)	Area Sampled (cm^2)	Depth (m/ft)	Sample Type[3]	Number of Containers
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								

Remarks:

Notes: 1 – Matrix codes: SO – Soil; GW – Water; AF – Air Filter; GV – Gas/Vapor: B – Bubbler (Tritium); SG – Silica Gel (Tritium); SD – Solid; SW – Swipe; VEG – Vegetation 2 – Describe the sample location by compass point relative to landmark or GPS coordinates. 3 – Sample Type Code – REG – Regular; DUP – Duplicate; RIN – Sample Rinsate; BLK – Field Blank; BKG - Background	Reviewed by Initials	Date

APPENDIX – B3 Example Chain of Custody Form

EPA	USEPA Radionuclide Analysis Traffic Report & Chain of Custody Record	Case No.: DAS No.: SDG No.: Page of

Date Shipped	Chain of Custody Record:	Sample Collector Signature:	For Lab Use Only
Carrier Name	Relinquished By: (Date/Time)	Received By: (Date / Time)	Lab Contract No.:
Air bill:	1)		Unit Price:
Shipped To:	2)		Transfer To:
	3)		Lab Contract No.:
	4)		Unit Price:

	Sample Identification Code	Sample Collector	Matrix / Type	Volume / Mass	Analysis Required	Sampling Location / Sample Depth	Date / Time	Laboratory Sample No.	FOR LAB USE ONLY Sample Condition on Receipt
1									
2									
3									
4									
5									
6									

Additional Sample Collector Signature(s):		Sample(s) to be used for laboratory QC?	Cooler temperature Upon Receipt:	Chain of Custody Seal Number:
			Shipment Iced? (Yes/No)	Custody Seal Intact? (Yes/No)

Analysis Key:	Type: Comp, Core, Grab	Analysis Required: Gross Alpha, Gross Beta, Alpha Scan, Gamma Scan, Specific Isotopes or Radionuclides, Other

Matrix: AF- Air Filter; GV – Gas or Vapor; DW – Drinking Water; GW – Groundwater; SD – Sediment; SO – Soil; S – Solid; SW – Swipe; B – Bubbler (Tritium); SG – Silica Gel (Tritium); VEG – Vegetation

DAS – Delivery as Analytical Services; SDG – Sample Delivery Group

APPENDIX – B4 Example Air Sample Tracking Form

Site Name				**Sample Date**			**Page _____ of ______**			
Location Sampled		**Sample Type**	**Cartridge/Sampler Type**	**Air Sampler Identification Number**	**Air Sampler Flow Rate (mL/min)**	**Time Started**	**Tech Initials**	**Time Stopped**	**Tech Initials**	**Total Volume (mL)**
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										

Key Sample Type: BZ – breathing zone, G - grab, WA – work area, VAC - vacuum, Other (**must be described in Comments)**
Cartridge Type: PT – particulate, CC – charcoal, SZ – Silver Zeolite cartridge (**NOTE: If combination is used add both codes**)
Tritium Sampler Type: B – Bubbler, SG – Silica Gel

Comments:

	Reviewed by Initials	Date

APPENDIX – B5 Example Waste Control Form

All material sent for disposal will need to be manifested with approved FULL analytical documentation. A full listing of all contaminants is required for Disposal Approval Codes.

Waste Control Form

Site Name:		
Waste ID Number:		
Date Opened:		Signature:

Instructions: Cross out unused items with "X". If the term "Other" is used, indicate by name in blank space an item description appropriate for shipping information. Mixed wastes (i.e., radioactive material and chemical wastes), explosives, and gases are NOT allowed, unless specific permission is granted in writing. All material shall be made as inert as practical (e.g., liquids solidified, acids or bases neutralized) for shipment.

Waste Container:		
Industrial Package 1	Industrial Package 2	Industrial Package 3
Type A	Type B (U)	Type B (M)
Markings found on approved containers:		UN Code:
Volume: ft^3 / gallon / L	Container to have less than 5% void space after filling.	

Waste Type			
UN ID No.	Soil	Aqueous Liquid	Flammable
	Solids	Non-Aqueous Liquid	Other (identify below)
	PPE	Hazardous Material	

Hazard Level (state known internal levels or assumptions/calculated values)			
Chemical	% or ppm	Radioactive Material	dpm / 100cm^2
Chemical	% or ppm	LSA-1 / LS-II / LSA-III	A_1 / A_2

External Radiation and Contamination Levels			
Surface	dpm / 100cm^2	Attach Copy of Survey Map	
Radiation on Contact	mR / hr	At 1 meter (3.3 ft)	mR / hr

Container Labels Required: (Package Orientation is mandatory for any package capable of being hand carried or trucked)			
Toxic Substance	Gas – Flammable	Radioactive LSA-I	Radioactive I
Corrosive	Gas – Non-Flammable	Radioactive LSA-II	Radioactive II
Solid – Flammable	Gas –Toxic	Radioactive LSA-II	Radioactive III
Liquid – Flammable	SCO-I	SCO-II	Fissile

Date Closed:	Signature:
Disposal Approval Code:	Overpacking Required/Completed
Transportation Company: *Name, Contact Name and information*	
Disposal Company: *Name, Contact Name and information*	
Date Disposed:	Date Disposal Certificate Received:

Appendix C
Filtration and Preservation of Aqueous Samples

APPENDIX – C Filtration and Preservation of Aqueous Samples

1.0 General

1.1. It is recommended that aqueous samples containing larger amounts of sediment, or that will be analyzed for dissolved constituents, be filtered in the laboratory. If field filtration is required, the samples must be filtered in a controlled area. If these samples require preservation, the samples must be filtered prior to the addition of preservative.

1.2. Samples requiring filtration and/or preservation are identified in the Sample Collection Plan.

1.2.1. Section 2 of this Appendix describes procedures for sample filtration. Filtration of samples to be analyzed for dissolved constituents requires that the sample is passed through a 0.45 µm filter. In some cases (e.g., for samples with high percent solids content), additional filters and/or larger pore size filters might be needed. The filter(s), filtrate, and the filtered sample are sent to the laboratory for analysis.

1.2.2. Section 3 of this Appendix describes procedures for sample preservation. Samples are preserved by the addition of acid to reduce the sample pH to less than or equal to 2.0.

> NOTE: According to *EPA's Manual for the Certification of Laboratories Analyzing Drinking Water* (U.S. EPA 2005), drinking water samples are measured for total activity, which represents the maximum potential exposure. For this reason, drinking water samples collected for measurement of radionuclides are not filtered.

2.0 Sample Filtration

2.1. Samples containing a large amount of settleable materials should be allowed to settle, and the water decanted from the settled materials prior to filtration. If, after decanting, the sample appears to contain suspended materials, it may require filtration to remove the suspended materials.

2.2. Only samples that are to be analyzed for dissolved constituents should be filtered through a 0.45 µm filter.

2.3. To prevent filter clogging and potential loss of target contaminants, allow all samples requiring filtration to settle as much as possible prior to filtration.

> NOTE: In cases when a sufficient volume of sample cannot be obtained using gravity filtration alone, it may be necessary to use vacuum filtration. If this is necessary, precautions should be taken to ensure that sample does not overflow into the vacuum system during filtration.

2.4. Set up a filtration funnel or filtration apparatus (see Figure C1).

2.5. Rinse the filter using a squeeze bottle containing demineralized water (ASTM grade Type I or II) and discard the rinse water.

2.6. Slowly filter the sample until a sufficient amount of sample volume (e.g., 2–4 liters) has been collected into a flask or other collection vessel.

2.7. If the filter becomes clogged, carefully pour any sample remaining in the filter funnel back into the original sample bottle and allow the sample to settle further. Collect the filter as described in Section 2.18. Install and rinse a new filter and continue filtration.

> **CAUTION:** The volume of sample in the filter assembly should not reach more than three quarters of the filter assembly capacity.

2.8. When the remaining sample volume is near the level of any settled sediment in the sample bottle, stop and allow the filter to drain.

2.9. If practical, decant water from the sample, without clogging the filter with sediment.

2.10. Cap the original sample container containing the remaining sediment and refer to the Sample Collection Plan to determine whether it will be sent to the laboratory.

2.11. Remove the collection vessel from the filtration assembly and transfer the filtrate to a temporary container (e.g., disposable plastic beaker).

2.12. Reattach the collection vessel to the filtration assembly.

2.13. Rinse the filter with half of the volume of the filtered sample in the temporary container. Collect the rinsate (i.e., re-filtered sample) into the collection vessel.

2.14. Allow the filter to drain and then add the remaining portion of filtered sample, in the temporary container, to rinse the filter.

2.15. Allow the filter to drain.

2.16. Disconnect the collection vessel from the filter assembly and transfer the filtrate to a clean sample bottle.

2.17. Place a sample label on the filtered sample bottle and ensure the label has the following. information:

- Sample Identification Number
- Date and Time of Sampling
- Sample Location
- Initials of Sample Collector
- Date and Time of Filtration
- Preservation Status of the sample at time of filtration (Preserved Yes/No)
- Initials of technician performing filtration

2.18. Using tweezers, carefully remove the filter from the filter rig. Place the filter on a drying plate in a covered area and allow the filter to air dry. Place the dried filter in a Petri dish or other suitable container and seal with tape to prevent opening. Place a sample label on the Petri dish and ensure the label has the following information:

- Sample Identification Number
- Date and Time of Sampling
- Sample Location
- Initials of Sample Collector
- Date and Time of Filtration

- Initials of technician performing filtration

3.0 Sample Preservation

3.1. If a sample requires preservation, perform these steps in a controlled designated area.

> NOTE: According to EPA's *Manual for the Certification of Laboratories Analyzing Drinking Water* (U.S. EPA 2005), sample preservatives should be screened for radioactive content by lot number prior to their use, and the results documented. Drinking water samples preserved in the field, with reagents that are not provided by the laboratory, are to be accompanied by a radioactive free field blank sample that is preserved in the same manner as the submitted sample.

> **CAUTION:** Refer to the Sample Collection Plan to determine the type of acid that should be used for sample preservation. There are several limitations to the type of acid used based upon the isotope of interest. Table C.1 lists acids that should be used for preservation of isotopes that are included in EPA's *Selected Analytical Methods for Environmental Remediation and Recovery (SAM) 2017* (U.S. EPA 2017).

> **WARNING**: Concentrated and dilute acid solutions must be handled with caution. Nitric acid should not be allowed to dry on paper towels or absorbent materials at full strength. A fire may result. Ensure that any spills are properly cleaned up and that any spill on absorbent materials is properly processed prior to disposal. Refer to site safety personnel for proper disposal requirements.

3.1.1. Ensure the area is set up for the addition of acid by performing the following:

a. Clear the work area.

b. Place a sufficient amount of absorbent material to cover the area and secure it with duct tape.

c. Ensure another person knows you are working with acid.

3.1.2. Open the sample container and the acid bottle.

3.1.3. Using a pipette or dropper, transfer approximately 4 mL of concentrated HCl or 2 mL of concentrated HNO_3 per liter of sample. (Adjust the amount added, as needed, for sample volumes other than one liter.)

3.1.4. Place the pipette or dropper in a secure location to prevent dripping, and close the acid and sample bottles.

3.1.5. Carefully agitate the sample, remove the lid, and check the pH with pH paper (recommended for contamination control) or a pH probe. Add additional acid as necessary to reach a sample pH of less than or equal to 2.

a. DO NOT add more than 5 additional mL of concentrated acid.

b. If the sample pH cannot be lowered sufficiently after the addition of an extra 5 mL of acid, close the sample container and record the information in the field sample logbook and on the sample label.

Table C.1: Acids for Preservation of Samples Collected for Measurement of Radioisotopes included in EPA's *Selected Analytical Methods for Environmental Remediation and Recovery (SAM) 2017* (U.S. EPA 2017).

Analyte	Preservative
Note: Preservation requirements taken from EPA's *Manual for the Certification of Laboratories Analyzing Drinking Water* (U.S. EPA 2005).	
Gross Alpha	HNO_3 to pH <2
Gross Beta	HNO_3 to pH <2
Cesium-137	Conc. HCl to pH <2
Iodine-131	Do not acidify
Radium-226	Conc. HCl or HNO_3 to pH <2
Strontium-89	Conc. HCl or HNO_3 to pH <2
Strontium-90	Conc. HCl or HNO_3 to pH <2
Tritium (Hydrogen-3)	Do not acidify
Uranium-238	Conc. HCl or HNO_3 to pH <2
Note**:** The following analytes are not included in EPA's *Manual for Certification of Laboratories Analyzing Drinking Water* (U.S. EPA 2005). Preservation recommendations for these analytes are based on best professional judgment.	
Gamma	Conc. HCl or HNO_3 to pH <2
Americium-241	Conc. HCl or HNO_3 to pH <2
Californium-252	Conc. HCl or HNO_3 to pH <2
Cobalt-60	Conc. HCl or HNO_3 to pH <2
Curium-244	Conc. HCl or HNO_3 to pH <2
Europium-154	Conc. HCl or HNO_3 to pH <2
Indium-111	Conc. HNO_3 to pH <2
Iodine-125	Do not acidify
Iridium-192	Conc. HCl or HNO_3 to pH <2
Molybdenum-99	Conc. HCl or HNO_3 to pH <2
Neptunium-237	Conc. HNO_3 to pH <2
Neptunium-239	Conc. HNO_3 to pH <2
Phosphorus-32	Conc. HCl or HNO_3 to pH <2
Plutonium-238	Conc. HCl or HNO_3 to pH <2
Plutonium-239	Conc. HCl or HNO_3 to pH <2
Polonium-210	Conc. HCl or HNO_3 to pH <2
Radium-223	Conc. HNO_3 to pH <2
Rhenium-188	Conc. HNO_3 to pH <2
Rubidium-82	Conc. HNO_3 to pH <2
Ruthenium-103	Conc. HCl or HNO_3 to pH <2
Ruthenium-106	Conc. HCl or HNO_3 to pH <2
Selenium-75	Conc. HCl or HNO_3 to pH <2
Technetium-99	Do not acidify
Technetium-99m	Do not acidify
Thorium-227	Conc. HNO_3 to pH <2
Thorium-228	Conc. HNO_3 to pH <2
Thorium-230	Conc. HNO_3 to pH <2
Thorium-232	Conc. HNO_3 to pH <2

Analyte	Preservative
Total Activity Screening	Do not acidify
Uranium-234	Conc. HCl or HNO_3 to pH <2
Uranium-235	Conc. HCl or HNO_3 to pH <2

3.1.6. Once the sample pH is less than or equal to 2.0, close the sample container and note the following in the field sample logbook and on the sample label.

- Acid added – Type, concentration, and volume
- pH of the sample
- Date and time of preservation
- Initials of the person who added the acid

3.1.7. Package the sample per the requirements of Module I, Section 7.0.

3.1.8. Clean the area of materials, ensuring any drips or spills of acid are contained and processed per the requirements of Site Safety.

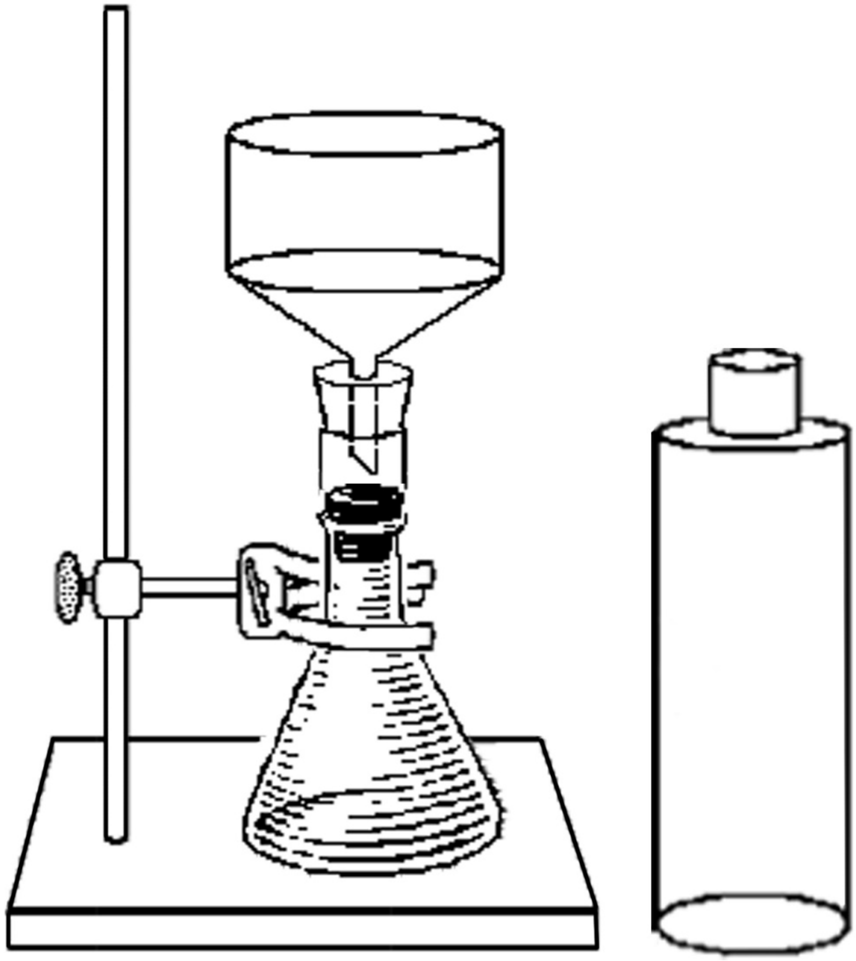


Figure C1: Example Filtration Apparatus

Appendix D
Framework for Waste Management Plan Development for Waste Generated During Radiological Sampling of Environmental Samples

APPENDIX D – Framework for Waste Management Plan Development for Waste Generated During Collection of Radiological Environmental Samples

The purpose of this appendix is to provide a framework to assist incident commanders, project managers, state and local authorities, contractors, and enforcement divisions in developing and implementing an approach for the management of waste generated during environmental sampling activities after a contamination event; management of waste that is generated from remediation or other activities not resulting from sample collection are outside its scope. Approaches to management of sampling wastes should be included in an incident-specific Waste Management Plan (WMP), along with a systematic and integrated methodology for the management of waste generated from as part of the overall radiological response. This appendix presents the key waste management considerations associated with sampling activities that should be addressed, prior to an incident if possible, and documented within a WMP.

1.0 Background

During a radiological/nuclear incident, the waste generator is responsible for characterizing on-site waste, including waste that has been treated on-site. Most of the waste generated during the sample collection process, depending on the activity level of the radiological release, would likely be characterized as low-level radioactive waste, and a smaller subset of the generated sampling process waste would be characterized as hazardous, non-hazardous or mixed waste. The characterization of sampling activity waste is often driven by state requirements, both in the state of the incident as well as the state(s) where the waste management facilities exist. It should be noted that states may have more restrictive requirements than the federal government for some of the waste streams, which is why it is so important to identify these within a WMP.

Coordinating the characterization of sampling activity waste with the overall response sampling activities for environmental samples will save time, effort and analytical costs; and reduces the burden on the radioanalytical laboratories. Laboratory capacity is expected to be exceeded in a wide-area release scenario, and laboratories are likely to prioritize analysis of samples for use in determining the extent of contamination and re-occupancy decisions over analysis of samples to characterize sampling activity waste. Coordinating sampling activity waste characterization with other sampling needs in the overall radiological response sampling and analysis plan (SAP) will help to address capacity issues.

At the time of publication of this document, there are only four commercial facilities in the United States that accept Low Level Radioactive Waste (LLRW), complicating the waste management decision making process. While there are some additional Resource Conservation Recovery Act (RCRA) Subtitle C (Hazardous Waste Facilities) that can handle mixed waste and potentially could handle some LLRW, it would require state, facility, and public acceptance as well as permit modifications to do so. Liquid LLRW is especially difficult and expensive to manage and therefore may require some solidification/ evaporation treatment prior to acceptance by a LLRW disposal facility. Finally, because of the limited waste management facilities for LLRW, and extensive transportation requirements associated with LLRW, transportation costs can become quite high and multiple methods of transportation may need to be considered (e.g., trucks, railways).

2.0 Waste Management Plans

Waste generation and management begin as soon as the response to a radiological or nuclear contamination incident is initiated. Since this waste is considered a potential source of contamination, proper sampling of waste generated during the sampling process, to characterize the waste for management and disposal, is essential. Personal protective equipment (PPE) and clothing, materials from sampling activities, and liquids from personnel and equipment decontamination activities associated with sampling collection activities could potentially be generated by first responders, crime scene investigators, and environmental sampling personnel. Generation of these waste streams will continue throughout response and recovery. Planning for waste management is critical to an effective response and can help eliminate double-handling of sampling activity waste and facilitate a smooth, timely, safe and efficient response. A WMP for waste generated due to environmental sampling should be developed, either prior to or early in an event, that outlines the waste management requirements, procedures, strategies, and processes from the point of generating sampling waste to final deposition.

> NOTE: Experience has shown that the development of a pre-incident WMP can improve waste management activities during an incident by addressing many of waste management decisions outside of the time-sensitive activities and decisions that have to be made during the incident. An incident-specific WMP can be developed using the pre-incident WMP to tailor the elements of that plan with the site and incident specific considerations as well as to integrate it with the other overall radiological response plans.

The WMP should address:

Waste Management Strategies: Information regarding waste management strategies should focus on:

- Relevant federal, state and local waste management regulations
- Identification of waste management facilities to support disposal of waste generated from sampling activities
- Projections of the magnitude and types of potential wastes expected to be generated from sampling activities during the different phases of the incident
- Potential types of waste
  - *Inorganic* (solids: used PPE, sampling equipment, supplies)
  - *Organic* (sampling supplies that are petroleum based)
  - *Liquids* (decontamination water, wastewaters from sampling activities)
  - *Low Level Radioactive Waste (LLRW)* (any radioactive waste that does not belong in one of the following categories: [1] high-level waste, [2] spent nuclear fuel, [3] uranium and thorium mill tailings, and [4] transuranics)
  - *Hazardous Materials* (PCBs, or other toxic industrial chemicals that may be combined with sampled environmental materials)
  - *Mixed Waste* (hazardous waste combined with LLRW that is generated during sampling activities)

Waste Management oversight: Activities including health and safety, radiological exposure reduction, contamination control, and quality control/assurance should be discussed in general terms as they relate to the generation of sampling activity waste handling. On-site waste management discussions should focus on:

- Waste segregation (e.g., liquids, solids, clean, contaminated, mixed) and optimization strategies
- Minimization of sampling activity waste
- Waste characterization to meet the waste acceptance criteria associated with disposal of sampling activity waste at disposal facilities identified to support the overall response
- Physical and/or chemical assessment of the waste generated during sampling activities to determine whether the waste was successfully solidified or requires further treatment to facilitate packaging decisions, to identify handling and processing requirements, and to provide additional information related to the particular waste generated
- Reducing potential hazards that could be encountered during waste management activities, such as waste treatment, characterization, packaging and labeling

Off-Site Waste Management: Discussions of the disposal of potential sampling activity waste generated at off-site facilities that could be used to treat solid, liquid, or mixed radiological waste and disposal of laboratory sample waste after analysis.

Waste Transportation: Discussion of logistics related to moving waste generated from sampling activities from the contaminated site to an interim location or final facility for treatment and/or disposal. Since transportation of radiological waste is tightly regulated, the WMP should address:

- Coordination with state radiation protection and waste management officials involving the states in which the waste is generated, the states which the waste will be transported through, and the states in which the facilities reside that will be accepting this waste
- Coordination with multiple federal agencies
- Coordination with the facilities that will be accepting the sampling activity waste

Tracking, Reporting, and Data/Records Management for Waste Management: Discussion of process to ensure proper and complete tracking of all sampling activity waste including:

- Sampling logs
- Chain of custody forms
- Disposal packages (including accumulation data, waste composition, volumes, weight, DOT or IATA hauler information)
- Worker training
- Audits and reviews of waste disposal activities
- WMP and associated procedures

Additional Resources: EPA's *Selected Analytical Methods for Environmental Remediation and Recovery* (SAM) Companion *Laboratory Analytical Waste Management and Disposal Information Document* (Hall *et al*. 2019) provides additional information regarding management and disposal of waste resulting from sample collection and analysis. This document includes information regarding:

- Waste minimization, categorization and segregation
- Waste containment, storage and treatment
- Waste management and disposal regulations

EPA provides additional information regarding management of waste generated during site remediation in EPA's Waste Management Options for Homeland Security Incidents website and EPA's Incident Waste Decision Support Tool (I-WASTE DST).

Appendix E
References and Supplemental Information

APPENDIX – E References and Supplemental Information

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