



Fluor-BWXT Portsmouth LLC

**Waste Characterization Plan
PIKETON, OHIO**

**U. S. Department of Energy
Portsmouth/Paducah Project Office
and
Fluor-BWXT Portsmouth LLC**

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APPROVALS**Fluor-BWXT Portsmouth LLC
Waste Characterization Plan****DRAFT**

Approval	Ricky Walls (Signature on File)	1/18/2021
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ACRONYMS/DEFINITIONS

AK	Acceptable Knowledge
ASL	Analytical Support Level
ASTM	American Society For Testing And Materials
AWCO	Alternate Waste Package Certifier
CFR	Code Of Federal Regulations
CI	Confidence Interval
DOE	U.S. Department Of Energy
DQO	Data Quality Objective
EPA	Environmental Protection Agency
ER	Environmental Remediation
FBP	Fluor-BWXT Portsmouth LLC
FCN	Field Change Notice
GWMP	Generator's Waste Management Plan
IH	Industrial Hygiene
LLW	Low-Level Waste
MARSSIM	Multi-Agency Radiation Survey And Site Investigation Manual
MDL	Minimum Detectable Limit
MSDS	Material Safety Data Sheet
NCS	Nuclear Criticality Safety
NDA	Non-Destructive Assay
NDAQ	Nondestructive Assay Quality Assurance Program Plan
NMC&A	Nuclear Materials Control And Accountability
NNSS	Nevada National Security Site
PCB	Polychlorinated Biphenyl
PK	Process Knowledge
PORTS	Portsmouth Gaseous Diffusion Plant
ppm	Parts Per Million
QA	Quality Assurance
QC	Quality Control
RCRA	Resource Conservation And Recovery Act
RMDC	Records Management and Document Control
RTR	Real-Time Radiography
SADQ	Sample Analysis Data Quality Assurance Project Plan

SAP	Sampling And Analysis Plan
SMO	Sample Management Office
SNM	Special Nuclear Material
SOW	Statement Of Work
SR	Sampling Request
TCLP	Toxicity Characteristic Leaching Procedure
TMU	Total Measurement Uncertainty
TSDF	Treatment Storage And Disposal Facility
UCL	Upper Confidence Level
UHC	Underlying Hazardous Constituents
UTL	Upper Tolerance Limit
VSL	Validation Support Level
VSP	Visual Sampling Plan
WAC	Waste Acceptance Criteria
WCO	Waste Certification Official
WM	Waste Management

1. PURPOSE

The purpose of the Waste Characterization Plan (hereafter referred to as the characterization plan) is to establish the requirements for the physical, chemical and radiological characterization of wastes produced at the Portsmouth Gaseous Diffusion Plant (PORTS). The characterization plan is a key component of the overall Waste Management (WM) Plan which is designed to ensure compliant and cost effective management of waste from the point of waste generation through to final disposition. The characterization plan is designed to outline the technical approach to waste characterization and align with the FBP-ER-PRO-WD-PL-0006, *Sample Analysis Data Quality Assurance Project Plan (SADQ) at the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio*, U.S. Department of Energy (DOE/PPPO/03-0278).

The characterization plan provides the framework for conducting waste characterization in a consistent, documented manner. The major elements include: determining the Data Quality Objectives (DQOs) based on the sources of waste at PORTS; providing guidance on evaluating the available information (process knowledge and historical data); developing the sampling approach (random or authoritative) and sample coverage guidelines; selecting the analytical approach; and evaluating the sample results.

These guidelines will be used to develop and document the specific requirements for a given waste population at the point of generation. Because of the variety of wastes at the PORTS site, guidelines for specific generating procedures are included to allow appropriate scaling of quality and documentation requirements.

Wastes submitted into the Resource Conservation and Recovery Act (RCRA) Part B Storage area are characterized in accordance with the requirements of Section C of the RCRA Part B Permit.

This document implements applicable regulatory requirements. They are listed in Appendix A, *Regulatory Requirements Flow Down*.

2. SCOPE

The scope of this characterization plan includes all legacy waste currently stored at PORTS and any newly generated waste streams. This includes waste generated from ongoing operations, decommissioning activities, and waste generated from spill cleanup or other upset conditions. It addresses all categories of waste inclusive of sanitary/industrial, universal, radioactive, hazardous, and mixed wastes. Hazardous wastes include those wastes regulated under RCRA and the Toxic Substances Control Act (TSCA). The characterization plan does not address product sampling for ongoing nuclear operations, environmental compliance monitoring, environmental remediation characterization, or health and safety monitoring. While data generated under the characterization plan may be used for nuclear criticality safety (NCS) and nuclear materials control and accountability (NMC&A) purposes, it is not specifically designed to address the requirements of those programs.

3. DEFINING AND DOCUMENTING THE WASTE CHARACTERIZATION APPROACH

All waste characterization will follow the basic requirements specified in Section 3. Not all requirements will apply to all wastes being characterized. In many instances, process knowledge (PK) or acceptable knowledge (AK), historical data, or objective evidence may be suitable to characterize waste with no further intrusive or non-intrusive sampling required, as described in Section 3.4. The waste characterization approach will be dictated in large part by the source of the waste to be characterized. All waste determinations shall be documented within the project files and established shared computer drive, in accordance with

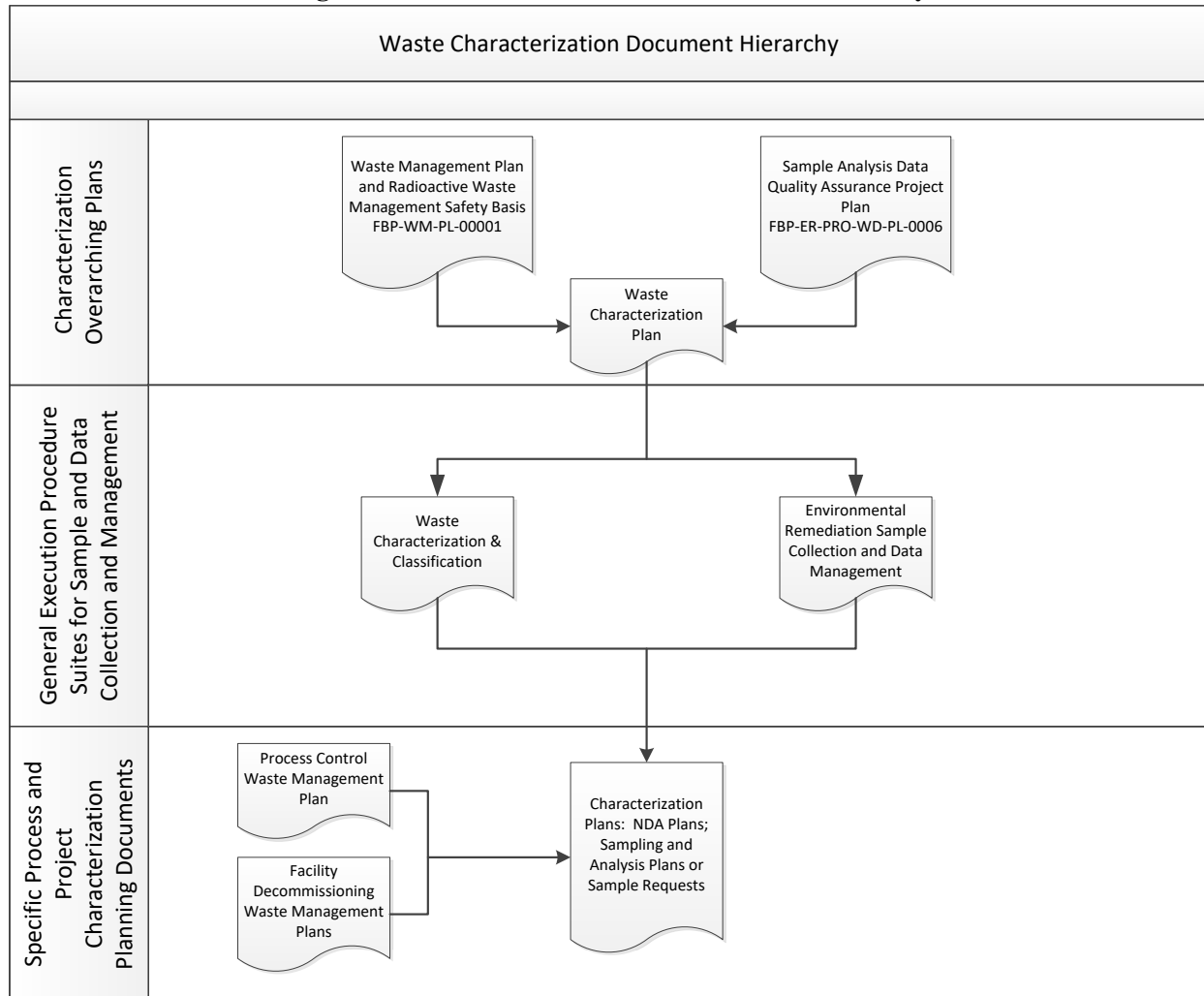
FBP-BS-PL-00001, *Records Management and Document Control Plan for Fluor-BWXT Portsmouth LLC Piketon, Ohio*, and maintained per guidance found in FBP-BS-PRO-00096, *Project Files Management*.

PORTS has two classes of waste — legacy and decommissioning. The latter class originates from three main sources: processes, projects, and spill cleanup. Wastes will be designated as originating from one of these four sources (defined below).

- Legacy Wastes — The characterization requirements for legacy wastes, defined as waste collected and containerized prior to October 01, 2011, will be specified in either a sampling request form (SR) or a sampling and analysis plan (SAP), based on the criteria included in Section 3.12, if existing data is not sufficient to characterize. If non-destructive assay (NDA) or other non-intrusive measurement methods such as real-time radiography (RTR) are to be employed, they may be included in the SAP to provide a comprehensive document the specific characterization approach.
- Process Wastes — The characterization requirements for all waste generated from ongoing processes (hereafter referred to as process wastes) will be documented in Generator Waste Management Plans (GWMP). Broadly, such plans will specify all mechanisms of characterization, including NDA measurement techniques and intrusive sampling; frequency of measurement collections; analytes of interest and any applicable acceptance criteria. For individual intrusive sampling campaigns of the process waste, either an SR or SAP may be used based on the criteria included in Section 3.12.
- Project Wastes — Project wastes are those wastes that originate from the deactivation, decontamination, and demolition of facilities deemed no longer necessary for the site mission. The waste characterization approaches for all decommissioning wastes are to be outlined in "facility (project) waste management plans." These high level documents are generated as a matrix that lists all known wastes to be generated and outlines the approaches for characterization — survey, NDA, or intrusive sampling. The specific characterization requirements for each waste generated will be specified in either an SR or SAP, based on the criteria included in Section 3.12. If NDA or other non-intrusive measurement methods are to be employed, they may be included in the SAP to provide a comprehensive document or a specific NDA characterization document may be generated. Based on the characterization of the wastes associated with a facility, a specific GWMP will be developed that will specify container types, labeling, regulatory storage requirements, and other specific waste handling protocols, as well estimated waste volumes and target treatment storage and disposal facility (TSDF) specific to the waste stream.
- Spill-Cleanup Wastes — The characterization requirements for wastes collected from upset conditions, primarily spill-cleanup media and associated secondary wastes, will be specified in either an SR or SAP based on the criteria included in Section 3.12. If NDA or other non-intrusive measurement methods are to be employed, they may be included in the SAP to provide a comprehensive document.

The waste characterization document hierarchy is illustrated below:

Figure 1, Waste Characterization Document Hierarchy



3.1 DEVELOPING DATA QUALITY OBJECTIVES

All waste characterization is to be underpinned by defined, documented DQOs as defined in the SADQ. The steps are listed below:

- Step 1. State the problem.
- Step 2. Identify the decision.
- Step 3. Identify inputs to the decision.
- Step 4. Define the study boundaries.
- Step 5. Develop a decision rule.
- Step 6. Specify limits on decision errors.
- Step 7. Optimize the design for obtaining data.

By design, the DQO-development process for a given population considers complexity and cost as part of Step 3. To address this, each of the four groupings of PORTS wastes — legacy, process, project, and spill-cleanup wastes — are evaluated separately.

Under the requirements of FBP-WM-PL-00031, *Nondestructive Assay Quality Assurance Program Plan* (NDAQ), DQOs must be developed for NDA campaigns as well as intrusive sampling campaigns.

All data users should be considered to be part of the DQO process. Each DQO team should consist of the Waste Management Programs Specialist, DQO Coordinator, SAP Coordinator, Field Characterization Manager, Quality Assurance (QA)/Quality Control (QC) Specialist and Project Manager. Other team members may include, but are not limited to, representatives of Environmental Compliance, Transportation, Radiological Control, Industrial Hygiene (IH), and NMC&A.

All of the remaining activities described in Section 3 are required to successfully execute the DQO process.

3.2 DEFINING THE WASTE POPULATION OF CONCERN

The population to be considered for characterization must be defined. Criteria for defining the population may include:

- Common origin — e.g., waste debris from a single facility, spill cleanup from a single event, process waste from a single process, soil excavated from a single location
- Common time of generation — e.g., all media removed during a defined trap change-out, or all personal protective equipment (PPE) generated during a given time period
- Common contaminants — e.g., all trap media with elevated Tc-99, all collected solvents from a given system in the laboratory, all ductwork exposed to polychlorinated biphenyls (PCBs), all equipment suspected of having Beryllium contamination, all painted items potentially containing lead

The population should be specifically defined prior to development of the SR or SAP.

The heterogeneity of the waste must be considered when defining the waste stream. If the population is defined too broadly, the data may not allow for definitive characterization of the population and the population will have to be further split.

Stratification of contamination within or upon a waste or its surfaces (e.g., distinguishable portions or components of the waste that exhibit dissimilar characteristics) must also be considered when defining a waste population. In some instances, contaminants will distribute within the waste or upon waste surfaces disproportionately or segregation of the contaminants within or upon the waste may occur. Examples of this could include process gas converters where the vast majority of the contamination is isolated on the barrier material, or the separation of oil from aqueous liquids within a container. If sampling of all strata is not incorporated into the sampling effort, a misrepresentation of the waste characteristics may occur or entire portions of the waste may be disregarded.

3.3 IDENTIFYING THE DESIRED WASTE DISPOSITION OUTLET AND TRANSPORT MECHANISM

As part of the PORTS mission, all wastes and materials shall eventually be dispositioned at an off-site treatment and/or disposal facility or in the Onsite Waste Disposal Facility (OSWDF). All materials and wastes shall be evaluated to determine if a viable re-use or recycle path exists to minimize the volume of materials ultimately declared as waste. Any material defined as waste must have a defined TSDF identified as the proposed outlet. As the DQO process is iterative by design, it may be determined that the originally proposed TSDF may not be viable based on the characteristics of the wastes as determined through characterization. To initiate the process, however, a designated TSDF must be identified. The requirements of the receiving TSDF licenses, permits, authorization, and waste acceptance criteria (WAC), in conjunction with the expected waste contaminants, will form the basis for the analytes to be characterized. The most current versions of licenses, permits,

authorizations, and acceptance criteria must be obtained and the relevant criteria determined when the TSDF has definitively been identified. For wastes destined for the Nevada National Security Site (NNSS), the waste certification official (WCO) should be consulted for specific guidance in meeting the requirements of the NNSS WAC (DOE/NV-325).

In addition to consideration of the receiving TSDF's requirements, Transportation must be consulted regarding the requirements for packaging and shipping. The requirements for proper transportation classification may not align with the requirements for TSDF waste acceptance. For example, most waste is evaluated for disposal based on the concentration of the contaminant of concern over the entirety of the waste matrix to be disposed. The transportation classification, however, may be based on the potential release of the contaminant in an upset transport condition.

3.4 EVALUATION OF AVAILABLE DATA

Much of the waste currently in storage or scheduled to be generated during the course of the PORTS project is supported by a wealth of available data and PK; the application of this data can provide a major cost savings to the government. It is critical, however, that the data is properly vetted and its use is appropriately documented to provide the basis for waste characterization and subsequent transportation classification. There is a variety of sources of available data described in the following subsections.

3.4.1 Process or Acceptable Knowledge (PK) (AK)

PK and AK are interchangeable terms and will hereafter be referred to as PK throughout the rest of this document. PK can be used as an alternative or supplement to sampling and analysis. It includes information regarding the physical form of the waste, the base materials composing the waste, the nature of the radioactivity present, and the process(es) generating the waste. Examples of PK include but are not limited to:

- Maps of the site with the areas and facilities involved in waste generation and process equipment identified
- Facility mission description as related to radionuclide-bearing materials and their management
- Description of the specific site locations (such as the area or building) and operations relative to the isotopic composition of the uranium-bearing wastes, process components, or process equipment
- Waste identification or categorization schemes used at the facility relevant to the waste material's composition
- Information regarding the waste's physical and chemical composition that could affect the isotopic distribution (e.g., processes used to remove ingrown daughters or alter its expected contribution based solely on radioactive decay kinetics)
- Safeguards and security, materials control and accountability, and other nuclear materials control systems or programs and the data they generated
- Reports of nuclear safety or criticality accidents/excursions involving the use of special nuclear material (SNM) or nuclear material
- Waste packaging procedures; waste disposal, building or nuclear material management area logs or inventory records; and site databases that provide information on material composition, SNM, or nuclear materials
- Test plans, research project reports, or laboratory notebooks that describe the content of materials used in experiments
- Fluor-BWXT Portsmouth LLC (FBP) approved documents of site personnel interviews
- Historical analytical data relevant to the waste stream

The use of PK information concerning the radiological composition of a waste type or process component must be documented and traceable to referenced documents for that waste type/component. The type and quantity of supporting documentation may vary by waste stream.

3.4.1.1 *PROCESS CONTROL INFORMATION*

A subset of PK is process control information. For ongoing processes that generate waste, control of the process is a source of PK that can be used to minimize the amount of sampling. Documentation of the process should dictate the inputs and the operational parameters and with assurance that there have been no upset conditions, the waste may be able to be managed with no or little additional characterization.

3.4.2 Historical Data

Historical data is measurement data collected for purposes other than waste characterization (e.g., chemical and radiological field screenings) or waste characterization data that was obtained prior to the acceptance of the SADQ by the Ohio Environmental Protection Agency (OEPA) and its subsequent implementation. Historical data must be determined to pertain to the waste under review and be documented to file. In accordance with the SADQ, the following general approach shall be used to validate and assess the usability of historical data:

- Ensure historical data pertains to the waste under review.
- Gather available field sampling protocols, data management protocols, analytical results, including supporting QA/QC analysis results, data packages, supporting field records, Chain of Custody (COC) documentation, and associated audit and surveillance reports.
- Obtain available copies of analytical protocols and performance criteria used to perform analyses, including QA project plans and data validation plans in effect at the time of data generation.
- Compare results for samples and QA/QC analyses to protocol and method performance criteria in effect at the time data were generated or to data validation criteria of the SADQ if no such protocols are readily available.
- Review field records, audit and surveillance reports, and training records for personnel performing sampling and analysis.
- Assign the data set a level of usability that indicates uses for which the data are suitable, based on the level of performance achieved and the quality of the supporting data package.

It is the responsibility of the Waste Management Programs Specialist to ensure that data is assessed in accordance with the SADQ requirements, and the assessment is documented. Data validation support should be obtained from the QA group.

If sufficient supporting QA/QC documentation is not available or if the raw data package is not available, the data set may be assigned or assessed at a more restrictive level of usability than was originally intended or it may be classified as unusable for waste management purposes. Additional confirmatory sampling may also be performed as a basis for accepting data. This usability review and assessment will be documented and retained in the project file.

3.4.3 Known Chemical Composition/Material Safety Data Sheet (MSDS)

If the waste is of a known chemical composition, the use of an MSDS or other similar means of evaluating chemical traits is appropriate for characterizing the waste. If no other contaminants have been introduced into the matrix, this may be the sole source of data required for characterization purposes.

3.4.4 Objective Evidence

Objective evidence (e.g., visual inspection, RTR) is an acceptable means of verifying physical characteristics of a waste and presence/absence of prohibited items. It may be used in conjunction with other monitoring approaches to characterize a population of waste, or as a stand-alone approach if sufficient data is available to fully characterize the waste.

3.5 DETERMINING DATA GAPS

Considering all available PK and historical data, the determination as to whether sufficient usable data exists to meet TSDF requirements (including physical, chemical, and/or radiological considerations) must be made.

Waste collected and containerized prior to October 01, 2011, is considered legacy waste; for such wastes, an additional consideration is whether the waste contains any prohibited items — if it was collected in the absence of a WCO, alternate WCO (AWCO), or a waste package certifier (WPC), it likely will require visual inspection or other objective evidence evaluation (such as RTR) for characterization unless the WM division director grants a dispensation.

3.6 DETERMINING MEASUREMENT METHODOLOGY

When insufficient data exists, a sampling strategy must be developed; all facets of available technologies and sources of data must be considered. The following subsections describe the methods available for non-intrusive and intrusive measurement techniques.

3.6.1 Non-Intrusive Sampling Methods

Non-intrusive sampling involves the collection of the measurement information directly from the waste source and does not destroy the waste matrix. Examples of conditions that would permit the use of non-intrusive sampling are listed below:

- Waste that is known to contain low levels of radioactive contamination from a known source and can be evaluated by means of a direct reading or NDA
- Waste for which scaling factors have been developed, and non-intrusive means (e.g., direct reading or NDA) will be used to measure the primary nuclide
- Non-porous items or other wastes where the contamination is primarily located on the surface that can be evaluated for the contaminant of concern by means of a wipe sample
- The regulatory standard is expressed in concentration per area (e.g., mg/100cm²)
- Non-intrusive IH monitoring results may be used as an indicator of contaminants present and to initiate further sampling

The most common non-intrusive techniques used at PORTS are described in the following subsections.

3.6.1.1 *RADIOLOGICAL SURVEY*

Radiological surveys include either direct readings of equipment or the measurement of smears to evaluate the removable contamination present on accessible, non-porous surfaces. How the survey data is used to characterize the waste stream in total must be documented, controlled, and placed in the project file.

When removable contamination is quantified on a survey, this value must be multiplied by a factor of ten, thus incorporating the standard uncertainty associated with collecting the wipe sample. The adjusted value will be used in evaluating against surface-contaminated object (SCO) limits (refer to 49 Code of Federal Regulations

(CFR) 173.443, *Contamination Control*). Radiological surveys are not acceptable for characterizing items that could have hidden volumes.

In the event removable contamination limits exceed direct readings when the correction factor for collecting the wipe sample is taken into consideration, values derived from direct readings will be utilized in characterizing the waste and measuring activity.

In addition to using radiological surveys for characterization, the waste may be scanned with survey instrumentation to identify hot spots or to aid in selecting sample locations within a sampling unit (to ensure a minimum activity of 2000 cpm alpha, using a calibrated Ludlum 43-93 or equivalent instrument, is obtained prior to sample collection and analysis). Such readings are not required to be documented.

3.6.1.2 *NON-DESTRUCTIVE ASSAY*

NDA evaluates the properties of a material, component or system without intrusion. NDA provides measurements using both gamma-ray and neutron detection instrumentation to locate, characterize and quantify nuclear material. Unlike radiological surveys, NDA can measure radioactivity that is both accessible and inaccessible. NDA is used to measure radioactivity in a variety of wastes at PORTS from all waste groupings — legacy, process, project, and spill-cleanup wastes. It is used on wastes that are either containerized or are measureable components such as a given length of pipe, a motor, or some other piece of operation equipment. NDA measures the entire component; thus, while NDA has no sampling error (which is the largest source of uncertainty in intrusive sampling), there will be total measurement uncertainty (TMU). The NDA provider is responsible for calculating and reporting TMU; Waste Management Programs is responsible for considering the application of uncertainty to ensure compliance with waste packaging, treatment and/or disposal criteria.

All NDA measurements are required to be collected in accordance with the requirements of FBP-WM-PL-00031, *Nondestructive Assay Quality Assurance Program Plan*, or a specific waiver document.

3.6.1.3 *WIPE SAMPLING*

Non-porous surfaces are sometimes subjected to wipe samples to determine the presence and extent of some chemical and/or radiochemical contaminants. Wipe samples are routinely collected to quantify PCBs, beryllium, lead and isotopic-specific radiological surface contamination. Results are reported on an area based concentration. Wipe samples collected at the request of WM will conform to the SADQ. Wipe samples may also be collected at the request of IH. Those samples will be processed in accordance with IH policies and procedures and must be assessed to the requirements of Section 3.4 prior to use.

Wipe samples may be subject to either destructive or non-destructive analytical techniques.

3.6.1.4 *HEALTH AND SAFETY MONITORING*

In addition to wipe samples, IH may collect air monitoring data, and indicator kits are often used to collect data to evaluate health and safety risks. This data may be used to indicate the presence of organic and inorganic compounds, beryllium, and asbestos. This information may be utilized to underpin characterization of the waste; however, prior to use, it must be assessed to the requirements of Section 3.4.

3.6.2 Intrusive Sampling Methods

Intrusive sampling entails the removal of a physical (coupon or volumetric) sample from a waste for measurement. It can be used for either chemical or radiological contaminants of concern, as well as ascertaining physical attributes. Due to the costs involved, health and safety concerns and the sampling error associated with intrusive sampling, non-intrusive sampling will be utilized whenever feasible. Intrusive sampling is the most common method for obtaining chemical data. Refer to Sections 3.7 through 3.11 for intrusive sampling

requirements. Specific quality requirements are detailed in the SADQ and must be considered when collecting and analyzing intrusive samples.

Examples of conditions that would drive the requirement to collect intrusive samples include:

- There is no non-intrusive measurement method for the contaminant of concern
- There are hidden volumes and indications that holdup material may be present. However, NDA may be appropriate for radiological determinations
- There is insufficient historical data or process knowledge to identify contaminants and their concentrations
- For the development of scaling factors, to be used in concert with non-intrusive sampling
- The process or system generating the waste has changed or been breached
- The applicability of historical data associated with the waste is in question

3.7 DETERMINING SAMPLING APPROACH AND MINIMUM REQUIRED NUMBER OF SAMPLES

3.7.1 Authoritative Sampling Approaches

Authoritative sampling is a non-probability sampling technique whereupon samples are selected based upon knowledge of the waste, resulting in a more targeted sample that will produce more predictable results than using a probability (random) sampling technique. Authoritative samples are collected when it is expected that the waste matrix and the contaminant(s) of concern are of a known distribution and any strata boundaries that exist can be identified. An authoritative sample or authoritative sample set is a sample or set of samples collected to be the basis of waste characterization for the specific waste or waste container(s) in question or to determine the upper and lower bounding concentrations for profile development and WAC compliance; it cannot be used to infer information for any other waste.

Authoritative samples can be biased to represent the highest or lowest suspected contamination or the typical concentration for the waste stream in question thus it is not considered random in any manner. Authoritative samples can be directed by indicator information such as sampling the oiliest spot or sampling the area of highest survey readings. Authoritative samples are appropriate only if there is sufficient knowledge of the waste or generating process to conclude the sample selection will achieve the targeted result.

Authoritative sampling is sampling that intends not to estimate average concentrations or typical properties, but to target “worst” or “best” cases (American Society for Testing and Materials [ASTM] D 6051-96) or aid in defining suspected strata. For example, a sample taken at the source of a release could serve as an estimate of the “worst-case” concentration found in the affected media. This information would be useful in identifying the constituent of concern and estimating the maximum level of contamination likely to be encountered. In these instances when contamination is localized, a random sampling scheme may not be suitable to identify an upper bounding limit for characterization purposes.

Stratification of contaminants within a singular item/container may also justify the use of authoritative sampling. For example, a sample collected from the tube bundle of a process gas converter will contain much higher levels of contamination than the converter shell; and contaminants known to have a higher specific gravity than the waste itself will tend to collect at the bottom of the container. In these instances, specifying the sample location to target these concentrated activities would be required to ensure the upper bounding limit for the specified contaminant is identified for profile and WAC compliance.

Disadvantages of utilizing an authoritative sampling scheme include:

- Difficulty in demonstrating that prejudice was not employed in sampling location selection
- Variances calculated may be poor estimates of the actual population variance

- When applying population statistics, the potential for an over- or underrepresentation of the parameter is greatly increased. This may be appropriate, however, when the intent of the sample selection bias is to determine the worst-case bounding value rather than make statistical inferences about the entire population.

3.7.2 Statistical Sampling Approaches

While many of the waste streams at PORTS are relatively homogeneous for materials of construction, seldom are the contaminants of concern homogeneous in their distribution. Thus, most sampling is based on statistics. Statistical sampling relies on the collection of representative samples to assess the presence or absence of or the distribution of the contaminants of concern, and the number of samples required depends upon the confidence interval and coverage required to meet the needs of the TSDF WAC. For WM and characterization purposes, four standard statistical approaches are identified below. Additional approaches may be utilized at the discretion of a degreed statistician.

- Simple random — The simple random sampling approach considers every possible sampling unit in the target population, with each unit having an equal chance of being selected.
- Stratified random — The stratified random sampling approach first divides the heterogeneous waste into relatively homogeneous strata. At this point, the simple random sampling approach is then employed for each identified strata.
- Systematic — The systematic sampling approach entails collecting samples at a preset interval using a randomly selected location as the starting point, which ensures uniform coverage of the sampling unit. This would be a preferred sampling strategy when locating hot spots is a goal.
- Composite — The composite sampling approach is comprised of collecting individual grab samples from different locations and physically blending them, then extracting a single sample for analysis. This may follow either a random or systematic pattern for sampling location selection. It is a useful tool to estimate the mean of contaminants, and will yield a significant analysis cost reduction.

3.7.3 Minimum Required Number of Samples

All statistical characterization plans for intrusive sampling will be developed and underpinned by one of the following: the "non-parametric statistics table" (see Table 1, *One Sided Non-Parametric Statistics Table*) or statistical software programs, such as visual sampling plan (VSP) or ProUCL. Characterization approaches agreed upon between FBP and State or federal agencies may also be utilized.

The non-parametric statistics table is designed to evaluate the population by assessing the absence of a value at or above the action limit and identifies the minimum number of samples required to meet the selected confidence level and proportion. It is appropriate to use when the waste is of an unknown distribution and will ensure the minimum number of samples will be collected to obtain a statistically defensible data set. If all of the values for the population are below the action limit, the proportion of waste population can be stated as being below the action limit at the defined confidence. If any of the values are above the defined action limit, additional evaluation of the data will be required to determine the concentration value to apply to the waste for characterization. For radiological contamination, which does not have an action limit; it will be used to evaluate presence or absence based upon the method detection limit.

Table 1, One Sided Non-Parametric Statistics Table ¹

		Confidence						
		99%	95%	90%	85%	80%	75%	50%
P r o p o r t i o n	99%	459	299	230	189	161	138	69
	95%	90	59	45	37	32	28	14
	90%	44	29	22	19	16	14	7
	85%	29	19	15	12	10	9	5
	80%	21	14	11	9	8	7	4
	75%	17	11	9	7	6	5	3
	50%	7	5	4	3	3	2	1

¹ Values derived from VSP.

VSP is a statistical software package developed by Battelle Memorial Institute under contract to the DOE and is available as freeware. ProUCL is a statistical software package made available by the U.S. Environmental Protection Agency (USEPA) and is available as freeware. Prior to use of either for waste characterization purposes, it must be installed by FBP Information Technology (IT) and verified in accordance with procedure FBP-BS-PRO-00091, *Information Technology Software Quality Assurance*. In addition, only persons who have completed the VSP training course may design waste characterization sampling approaches using the software. VSP may be utilized for developing sampling approaches with normal or non-normal distributions.

When historical data or PK exists that is deemed applicable to a waste population, additional samples may be collected to underpin this data or a biased sampling approach may be selected. In these instances, a small number of samples that do not meet the conditions above may be collected. Minor contributing radioactive contaminants may require very little if any additional sampling because existing data is adequate to determine a conservative contaminant concentration that will not exceed the TSDF or transportation limits.

Any statistical approach other than those listed above must be developed or approved by a degreed statistician.

3.8 SELECTING SAMPLING LOCATIONS

In selecting sampling locations, sample units will be defined geographically or as a set population of items or containers. Moreover, samples collected will be traceable to a specific geographical location or item/container as identified in the SR or SAP.

3.8.1 Authoritative Sampling Location Selection

The usability of analytical results received from authoritative sampling relies almost entirely upon the accuracy and depth of knowledge of a given waste. Sampling locations will be selected based upon the characteristics that are sought and the end use of the data. If the purpose of the sampling is to obtain an upper or lower bounding limit for a specified contaminant, sample collection will target those sites known to contain the highest and lowest concentrations. If the purpose of the sampling is to obtain a typical contaminant concentration, sample collection will avoid the high and low concentration sites and focus upon areas shown to contain a typical concentration.

3.8.2 Random Sampling Location Selection

Random sampling locations will be selected using either a random number generator, VSP, or other similar statistically defensible method approved by a degreed statistician. When designing a sampling scheme for a structure or equipment, sampling locations will be identified as a geographical location. When designing a sampling scheme for containerized waste, each container within the sample population will have a unique

identifier, and all sampling units will have an equal chance of being selected. In the event a sample unit is duplicated during selection, it will be replaced.

3.9 DEFINING SAMPLING COLLECTION TECHNIQUES

All sampling must conform to the requirements described in Section 6 of the SADQ and all samples must be handled in accordance with Section 7 of the SADQ. The SADQ specifies the documentation to be collected, the numbering protocols, containerization requirements and other quality considerations. While specific protocols for the collection of various materials are addressed in the SADQ, there may be special considerations based on the expected nature of the contamination that will require more detailed collection and handling protocols. Some of the specific areas of concern to be addressed by WM, the samplers, and the laboratory representative are described below.

3.9.1 Sample Size

Sample size considerations are specified in the sampling and analysis plan in consult with the Sample Management Office (SMO). These considerations are only proposed sample sizes, as the sample size is actually determined by the laboratory based on two considerations: 1) the minimum sample size required by the appropriate analytical method or 2) the requirements of the analytical laboratory. For radiological analyses where the purpose is to speciate nuclides as opposed to demonstrate the presence or absence of radiological contamination, a minimum activity of 2000 cpm alpha, using a Ludlum 43-9 or equivalent (notwithstanding weight or size requirements) may also be needed to ensure usable data is acquired.

3.9.2 Sample Depth

Depth considerations shall be determined in accordance with standard sampling practices that would be technically defensible by matrix, material homogeneity and consideration of the waste population to be characterized. When sampling concrete or other porous construction matrices, samples will be limited to the top 15 cm surface to avoid dilution of samples.

3.9.3 Composite versus Discrete Samples

Composite samples are samples that are built from multiple increments composited into a single sample for sub-sampling and analysis. The specific requirements for any given waste or project samples to be composited shall be defined in the sampling and analysis plan and align to the DQOs. In addition to the analytical cost savings, composite sampling increases the representativeness of the material over space and time, thus providing a more accurate representation of the chemical or radiological characteristics of the defined population. Composite sampling should only be used when a single waste population is being evaluated.

3.9.3.1 *COMPOSITE SAMPLES*

When evaluating results, it is important to consider the possible effects of using composite sampling. The possible effects of dilution must be considered for any positive hit obtained from composites of variable sources to ensure there was no improper dilution of a potentially regulated source.

Increment Size — Size of increments shall be dependent upon homogeneity and representative of the media to be sampled. Size of the increment will depend on the intent of the characterization for materials of construction. Size of increments shall be comparable to those obtained for single incremental samples.

Number of Increments — There is no maximum allowable number of increments within a composite sample, as long as each increment is representative of the material and area being sampled. However, to limit the possibility that one or more of the individual increments exceeds a prescribed threshold but remains undetected due to dilution, increments should not exceed a maximum of 10 per composite. The composite sample size should not exceed the size specifications of the laboratory.

Sample Composition — Composite increments shall be weighted to reflect the make-up of the waste to be disposed. For example, if 90% of the waste is wall board and 10% flooring tile, the composite should be at the same ratio.

Specific Instructions — The SAP will contain any specific instructions for the laboratory regarding subsampling to ensure accurate representation of the composite increments.

3.9.3.2 *DISCRETE SAMPLES*

Discrete samples are often referred to as grab samples or coupons and are samples taken from a single location or source. Discrete samples are often used to assess the composition or contaminants in a material of construction. Discrete samples are also used for single containers of waste. A discrete sample may represent many layers of a single container of waste such as that collected with a composite liquid waste sampler (COLIWASA).

3.10 **FIELD QUALITY CONTROL SAMPLES**

Per the requirements of Section 6.7 of the SADQ, field QC samples are to be specified in the SR or SAP. Due to the concentrations of concern regarding waste samples, the trace levels of contaminants captured by blanks are not considered to have a marked impact on the interpretation of the results as opposed to environmental samples. Thus, the only required field QC samples to be considered when collecting waste samples are duplicates. Other field QC samples may be requested at the discretion of the requestor and will be documented in the SR or SAP.

3.11 **DETERMINING REQUIRED ANALYTES AND DEFINING ANALYTICAL TECHNIQUES**

All analytical quality control requirements are specified in the SADQ. The analytical suite will be determined as part of the DQO process.

The SMO will select the most appropriate laboratory based on the determined analyses required detection limits, the requested deliverables, the required turnaround, and comparability of results or other special considerations such as security. Selected laboratory shall be from a DOE Consolidated Audit Program (DOE CAP) audited laboratory, or equivalent. It is the responsibility of Waste Management Programs to notify the SMO if the TSDF has specific laboratory certification requirements or any specific reporting criteria.

3.11.1 **Selection of Analytical Approaches**

Table 2, *Chemical – Analytical Approach*, and Table 3, *Radiochemical – Analytical Approach*, identify analytes of interest for the PORTS site, and will be employed as a basis for documenting analytical minimum reporting requirements in the SR or SAP. Minimum Reporting Requirements specified in Table 2 are minimum detection limits (MDL) that the lab is required to meet; however, actual MDLs should be reported. In the event the lab cannot meet these criteria, WM is to be contacted to make the determination whether the analysis should be performed at the achievable MDLs.

3.11.1.1 *SAMPLING FOR UNDERLYING HAZARDOUS CONSTITUENTS*

In the event a waste exhibits a characteristic of a hazardous waste (ignitability, corrosivity, reactivity or toxicity), underlying hazardous constituents (UHC) must be considered. When planning sampling to determine characteristics, there may be a cost and schedule benefit to consider collection of sufficient sample for UHC analysis to avoid re-sampling. UHCs are often based on totals as opposed to leachates, so ensure that the analytical request is reflective of the regulatory required reporting basis. If PK is sufficient to determine UHC assignment, additional sampling may not be required.

3.11.2 Sample Preparation

3.11.2.1 *LEACHING VERSUS TOTALS*

The toxicity characteristic leaching procedure (TCLP) is a sample preparation extraction method used for determining if waste is hazardous for the characteristic of toxicity under 40 CFR 261.24. TCLP will be utilized if there is data or PK available to suggest the resulting values will be near any identified threshold (regulatory limits, TSDF WAC limits, etc.) or little information is known regarding the existence or concentration of the contaminants of concern within the waste.

If existing data is available that adequately identifies the contaminants in the waste and indicates their concentrations will fall well below any reporting limits, analyzing the sample for totals may be appropriate.

For solids, the reported totals value is to be divided by twenty and then assessed to the applicable limit. For semisolids (such as sludge), the “Rule of 20” may not be applied and the result as reported is to be compared to the regulatory decision limit.

If totals values for solids and semisolids as determined in the paragraph above exceed the regulatory limit, the determination will be made whether additional analysis is warranted or whether the waste shall be declared hazardous. If results exceed the regulatory limit and there is reason to suspect the contaminant may not leach, TCLP analysis is appropriate.

For liquids, oil and grease, the entirety of the waste is considered the extract. If the result is reported in mg/L, it is to be compared to the regulatory decision limit with no application of the “divide by 20” rule. If the result is reported in mass-based units, then density should be reported and the result converted to mg/L, and this value is to be compared to the regulatory decision limit.

3.11.2.2 *SUBSAMPLING OR COMPOSITING IN THE LABORATORY*

On occasion, subsampling or compositing may be required by the laboratory. Typically, this would occur if size reduction or compositing will not be able to be performed in the field due to safety or cost considerations. If subsampling or compositing is required by the lab, specific requirements will be flowed into the SR or SAP and/or statement of work (SOW). This coordination will occur between WM and the SMO.

3.11.3 Units of Measure and Reporting Considerations

3.11.3.1 *LEACHATES*

For TCLP analysis, results are to be reported in mg/L (or other volume-based units such as µg/mL). For non-aqueous liquids, such as oil, results may be reported in mg/kg; however, density should also be reported in these instances in order to convert the result to a volume-based unit.

For radiochemical analysis, results are to be converted from mg/L to an activity based concentration; this will be accomplished by weighing the sample pre and post-leach, then dividing the activity per radionuclide by the mass of the sample that was leached off.

Alternate reporting units may be requested at the discretion of the requestor and will be documented in the SR or SAP.

3.11.3.2 *TOTAL ANALYSIS (RCRA CONSTITUENTS)*

For totals analysis of the waste, results are to be reported as follows:

- Solid samples - mg/kg (or other mass-based units such as µg/g);

- Aqueous liquid samples - mg/L (or other volume-based units such as $\mu\text{g/L}$); and
- Non-aqueous liquid samples – mg/L (or other volume-based units such as $\mu\text{g/L}$); if reported in mass-based units, the density is also to be reported, and results converted to mg/L.

Table 2, Chemical – Analytical Approach

Method	Reported Analyte	CAS Number	Threshold Value	Minimum Reporting Requirement ¹
TCLP metals and Be (For LIQUIDS, OIL, GREASE and SLUDGE – minimum reporting requirement may be expressed in mg/kg)*				
SW-846-6010/6020	Arsenic	7440-38-2	5.0 mg/L	0.5 mg/L
	Barium	7440-39-3	100 mg/L	10 mg/L
	Beryllium	7440-41-7	–	–
	Cadmium	7440-43-9	1.0 mg/L	0.1 mg/L
	Chromium	7440-47-3	5.0 mg/L	0.5 mg/L
	Lead	7439-92-1	5.0 mg/L	0.5 mg/L
	Selenium	7782-49-2	1.0 mg/L	0.1 mg/L
	Silver	7440-22-4	5.0 mg/L	0.5 mg/L
RCRA total metals and Be (Solids) **				
SW-846-6010/6020	Arsenic	7440-38-2	100 mg/kg	10 mg/kg
	Barium	7440-39-3	2000 mg/kg	200 mg/kg
	Beryllium	7440-41-7	–	–
	Cadmium	7440-43-9	20 mg/kg	2 mg/kg
	Chromium	7440-47-3	100 mg/kg	10 mg/kg
	Lead	7439-92-1	100 mg/kg	10 mg/kg
	Selenium	7782-49-2	20 mg/kg	2 mg/kg
	Silver	7440-22-4	100 mg/kg	10 mg/kg
Hexavalent Chromium				
SW-846-7196	Hexavalent Chromium	18540-29-9	–	–
TCLP Mercury (For LIQUIDS, OIL, GREASE and SLUDGE – minimum reporting requirement may be expressed in mg/kg)				
SW-846-7470/7471	Mercury	7439-97-6	0.2 mg/L	0.02 mg/L
Mercury				
SW-846-7470/7471	Mercury	7439-97-6	4.0 mg/kg	0.4 mg/kg
Flash point ²				
SW-846-1010	–	–	–	–
pH ³				
SW-846-9040	–	–	–	–
% Moisture				
ASTM-D2216	–	–	–	–
Asbestos				
EPA/600/R-93/116	Amosite	12172-73-5	–	–
	Anthophyllite	77536-67-5	–	–
	Chrysotile	12001-29-5	–	–
	Crocidolite	12001-28-4	–	–
	Tremolite - Actinolite	77536-68-6; 77536-66-4	–	–

Method	Reported Analyte	CAS Number	Threshold Value	Minimum Reporting Requirement ¹
PCBs (wipe)				
SW-846-8082	Aroclor 1016	12674-11-2	–	1.0 µg/100 cm ²
	Aroclor 1221	11104-28-2	–	1.0 µg/100 cm ²
	Aroclor 1232	11141-16-5	–	1.0 µg/100 cm ²
	Aroclor 1242	53469-21-9	–	1.0 µg/100 cm ²
	Aroclor 1248	12672-29-6	–	1.0 µg/100 cm ²
	Aroclor 1254	11097-69-1	–	1.0 µg/100 cm ²
	Aroclor 1260	11096-82-5	–	1.0 µg/100 cm ²
	Aroclor 1268	11100-14-4	–	1.0 µg/100 cm ²
PCBs (solids, sludge, soil)				
SW-846-8082	Aroclor 1016	12674-11-2	–	1.0 mg/kg
	Aroclor 1221	11104-28-2	–	1.0 mg/kg
	Aroclor 1232	11141-16-5	–	1.0 mg/kg
	Aroclor 1242	53469-21-9	–	1.0 mg/kg
	Aroclor 1248	12672-29-6	–	1.0 mg/kg
	Aroclor 1254	11097-69-1	–	1.0 mg/kg
	Aroclor 1260	11096-82-5	–	1.0 mg/kg
	Aroclor 1268	11100-14-4	–	1.0 mg/kg
PCBs (liquids)				
SW-846-8082	Aroclor 1016	12674-11-2	–	1.0 mg/L
	Aroclor 1221	11104-28-2	–	1.0 mg/L
	Aroclor 1232	11141-16-5	–	1.0 mg/L
	Aroclor 1242	53469-21-9	–	1.0 mg/L
	Aroclor 1248	12672-29-6	–	1.0 mg/L
	Aroclor 1254	11097-69-1	–	1.0 mg/L
	Aroclor 1260	11096-82-5	–	1.0 mg/L
	Aroclor 1268	11100-14-4	–	1.0 mg/L
PCB Oils				
SW-846-8082	Aroclor 1016	12674-11-2	–	25 mg/kg
	Aroclor 1221	11104-28-2	–	25 mg/kg
	Aroclor 1232	11141-16-5	–	25 mg/kg
	Aroclor 1242	53469-21-9	–	25 mg/kg
	Aroclor 1248	12672-29-6	–	25 mg/kg
	Aroclor 1254	11097-69-1	–	25 mg/kg
	Aroclor 1260	11096-82-5	–	25 mg/kg
	Aroclor 1268	11100-14-4	–	25 mg/kg

Method	Reported Analyte	CAS Number	Threshold Value	Minimum Reporting Requirement ¹
TCLP VOCs (For LIQUIDS, OIL, GREASE and SLUDGE – minimum reporting requirement may be expressed in mg/kg)				
SW-846-8260	Benzene	71-43-2	0.5 mg/L	0.05 mg/L
	Carbon Tetrachloride	56-23-5	0.5 mg/L	0.05 mg/L
	Chlorobenzene	108-90-7	100 mg/L	10 mg/L
	Chloroform	67-66-3	6.0 mg/L	0.6 mg/L
	1,4-Dichlorobenzene	106-46-7	7.5 mg/L	0.75 mg/L
	1,2-Dichloroethane	107-06-2	0.5 mg/L	0.05 mg/L
	1,1-Dichloroethylene	75-35-4	0.7 mg/L	0.07 mg/L
	Methyl Ethyl Ketone (MEK) (2-Butanone)	78-93-3	200 mg/L	20 mg/L
	Tetrachloroethylene	127-18-4	0.7 mg/L	0.07 mg/L
	Trichloroethylene	79-01-6	0.5 mg/L	0.05 mg/L
	Vinyl Chloride	75-01-4	0.2 mg/L	0.02 mg/L
VOCs				
SW-846-8260	Benzene	71-43-2	10 mg/kg	1.0 mg/kg
	Carbon Tetrachloride	56-23-5	10 mg/kg	1.0 mg/kg
	Chlorobenzene	108-90-7	2000 mg/kg	200 mg/kg
	Chloroform	67-66-3	120 mg/kg	12 mg/kg
	1,4-Dichlorobenzene	106-46-7	150 mg/kg	15 mg/kg
	1,2-Dichloroethane	107-06-2	10 mg/kg	1.0 mg/kg
	1,1-Dichloroethylene	75-35-4	14 mg/kg	1.4 mg/kg
	Methyl Ethyl Ketone (MEK) (2-Butanone)	78-93-3	4000 mg/kg	400 mg/kg
	Tetrachloroethylene	127-18-4	14 mg/kg	1.4 mg/kg
	Trichloroethylene	79-01-6	10 mg/kg	1.0 mg/kg
	Vinyl Chloride	75-01-4	4.0 mg/kg	0.4 mg/kg
TCLP SVOCs (For LIQUIDS, OIL, GREASE and SLUDGE – minimum reporting requirement may be expressed in mg/kg)				
SW-846-8270	o-Cresol (2-Methylphenol)	95-48-7	200 mg/L	20 mg/L
	m-Cresol ⁴ (3-Methylphenol)	108-39-4	200 mg/L	20 mg/L
	p-Cresol ⁴ (4-Methylphenol)	106-44-5	200 mg/L	20 mg/L
	Cresol	–	200 mg/L	20 mg/L
	2,4-Dinitrotoluene	121-14-2	0.13 mg/L ⁵	0.13 mg/L ⁵
	Hexachlorobenzene	118-74-1	0.13 mg/L ⁵	0.13 mg/L ⁵
	Hexachlorobutadiene	87-68-3	0.5 mg/L	0.05 mg/L
	Hexachloroethane	67-72-1	3.0 mg/L	0.3 mg/L
	Nitrobenzene	98-95-3	2.0 mg/L	0.2 mg/L
	Pentachlorophenol	87-86-5	1000 mg/L	100 mg/L
	Pyridine	110-86-1	5.0 mg/L	0.5 mg/L
	2,4,5-Trichlorophenol	95-95-4	400 mg/L	40 mg/L
	2,4,6-Trichlorophenol	88-06-2	2.0 mg/L	0.2 mg/L

Method	Reported Analyte	CAS Number	Threshold Value	Minimum Reporting Requirement ¹
SVOCs				
SW-846-8270	o-Cresol (2-Methylphenol)	95-48-7	4000 mg/kg	400 mg/kg
	m-Cresol ⁴ (3-Methylphenol)	108-39-4	4000 mg/kg	400 mg/kg
	p-Cresol ⁴ (4-Methylphenol)	106-44-5	4000 mg/kg	400 mg/kg
	Cresol	—	4000 mg/kg	400 mg/kg
	2,4-Dinitrotoluene	121-14-2	2.6 mg/kg ⁵	2.6 mg/kg ⁵
	Hexachlorobenzene	118-74-1	2.6 mg/kg ⁵	2.6 mg/kg ⁵
	Hexachlorobutadiene	87-68-3	10 mg/kg	1.0 mg/kg
	Hexachloroethane	67-72-1	60 mg/kg	6.0 mg/kg
	Nitrobenzene	98-95-3	40 mg/kg	4 mg/kg
	Pentachlorophenol	87-86-5	2000 mg/kg	200 mg/kg
	Pyridine	110-86-1	100 mg/kg	10 mg/kg
	2,4,5-Trichlorophenol	95-95-4	8000 mg/kg	800 mg/kg
	2,4,6-Trichlorophenol	88-06-2	40 mg/kg	4 mg/kg
TCLP Pesticides (For LIQUIDS, OIL, GREASE and SLUDGE – minimum reporting requirement may be expressed in mg/kg)				
SW-846-8081	Chlordane	57-74-9	0.03 mg/L	0.003 mg/L
	Endrin	72-20-8	0.02 mg/L	0.002 mg/L
	Heptachlor	76-44-8	0.008 mg/L	0.0008 mg/L
	Heptachlor Epoxide	1024-57-3	0.008 mg/L	0.0008 mg/L
	Lindane	58-89-9	0.4 mg/L	0.04 mg/L
	Methoxychlor	72-43-5	10 mg/L	1.0 mg/L
	Toxaphene	8001-35-2	0.5 mg/L	0.05 mg/L
Pesticides				
SW-846-8081	Chlordane	57-74-9	0.6 mg/kg	0.06 mg/kg
	Endrin	72-20-8	0.4 mg/kg	0.04 mg/kg
	Heptachlor	76-44-8	0.16 mg/kg	0.016 mg/kg
	Heptachlor Epoxide	1024-57-3	0.16 mg/kg	0.016 mg/kg
	Lindane	58-89-9	8.0 mg/kg	0.8 mg/kg
	Methoxychlor	72-43-5	200 mg/kg	20 mg/kg
	Toxaphene	8001-35-2	10 mg/kg	1.0 mg/kg
TCLP Herbicides (For LIQUIDS, OIL, GREASE and SLUDGE – minimum reporting requirement may be expressed in mg/kg)				
SW-846-8150	2,4-D	94-75-7	0.13 mg/L ⁵	0.13 mg/L ⁵
	2,4,5-TP (Silvex)	93-72-1	1.0 mg/L	0.1 mg/L
Herbicides				
SW-846-8150	2,4-D	94-75-7	2.6 mg/kg ⁵	2.6 mg/kg ⁵
	2,4,5-TP (Silvex)	93-72-1	20 mg/kg	2 mg/kg

Method	Reported Analyte	CAS Number	Threshold Value	Minimum Reporting Requirement ¹
Polychlorinated Dibenzo-p-Dioxins (PCDD) and Polychlorinated Dibenzofurans (PCDF)				
SW-846-8280/8290	2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	1746-01-6	0.001 mg/kg	0.0005 mg/kg
	1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	40321-76-4	0.001 mg/kg	0.0005 mg/kg
	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	39227-28-6	0.001 mg/kg	0.0005 mg/kg
	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	57653-85-7	0.001 mg/kg	0.0005 mg/kg
	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	19408-74-3	0.001 mg/kg	0.0005 mg/kg
	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	35822-46-9	0.0025 mg/kg	0.00125 mg/kg
	1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD)	3268-87-9	0.005 mg/kg	0.0025 mg/kg
	2,3,7,8-Tetrachlorodibenzofuran (TCDF)	51207-31-9	0.001 mg/kg	0.0005 mg/kg
	1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	57117-41-6	0.001 mg/kg	0.0005 mg/kg
	2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	57117-31-4	0.001 mg/kg	0.0005 mg/kg
	1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	70648-26-9	0.001 mg/kg	0.0005 mg/kg
	1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	57117-44-9	0.001 mg/kg	0.0005 mg/kg
	1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	72918-21-9	0.001 mg/kg	0.0005 mg/kg
	2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	60851-34-5	0.001 mg/kg	0.0005 mg/kg
	1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	67562-39-4	0.0025 mg/kg	0.00125 mg/kg
	1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	55673-89-7	0.0025 mg/kg	0.00125 mg/kg
	1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF)	39001-02-0	0.005 mg/kg	0.0025 mg/kg

¹ If the laboratory cannot meet this reporting limit, approval for an adjusted reporting limit must be obtained from the waste management programs specialist.

² Or equivalent ASTM method.

³ Or equivalent method based upon sample matrix.

⁴ m-Cresol and p-Cresol will be reported together.

⁵ If minimum detectable limit (MDL) is greater than the regulatory value, the MDL becomes the regulatory value.

Table 3, Radiochemical – Analytical Approach

Analyte	Method	Reported Analytes
Transuranics	Alpha spectroscopy	Am-241 Np-237 Pu-238 Pu-239/240
Isotopic U	Inductively coupled plasma mass spectroscopy (ICP-MS) <i>[process type material – higher levels of contamination]</i> Alpha spectroscopy <i>[environmental levels of contamination]</i>	U-234 U-235 U-236 U-238
Other radionuclides	Alpha spectroscopy	Th-228 Th-230 Th-232
	Liquid scintillation counting	Pu-241
Technetium-99	ICP-MS <i>[process type material – higher levels of contamination]</i>	Tc-99
	Liquid scintillation counting <i>[environmental levels of contamination]</i>	

3.11.3.3 *SMEARS OR WIPES*

PCB surface sampling results are to be reported as µg PCBs per 100 cm² per 40 CFR 761.274.

Radiochemical surface sampling results are to be reported as follows:

- Smears taken by Radiological Control personnel and measured by an alpha/beta counting system will be reported as dpm/100 cm²; and
- Wipe samples collected and submitted for destructive analysis will be reported as pCi/sample unless specified differently in the SR or SAP. In addition, the following shall be reported:
 - The surface area covered by a single wipe sample if different than 100 cm²; or
 - The number of wipe samples collected in order to meet a minimum activity of 2000 cpm alpha.

3.11.3.4 *DRY WEIGHT VERSUS WET WEIGHT*

Whether analyses are reported on a dry weight or wet weight basis can have a marked impact on the results and may change the regulatory status. The reporting basis of the analyses must be documented in the SR or SAP. It is recommended that if waste is to be reported on a wet weight or as received basis that a moisture determination be requested from the laboratory.

3.11.3.5 *REPORTING PCBs*

EPA has codified specific criteria regarding the analysis and reporting of PCBs. Non-liquid PCBs must be reported on a dry weight basis as µg PCBs per gram of sample (ppm by weight) per 40 CFR 761.274. Dry weight is defined at 40 CFR 761.3 as the weight of the sample, excluding the weight of the water in the sample. Analytical procedures which calculate the dry weight concentration by adjusting for moisture content may be used.

Liquid PCBs must be reported on a wet weight basis as µg PCBs per gram of sample (ppm by weight) per 40 CFR 761.274. Wet weight means reporting chemical analysis results by including either the weight, or the volume and density, of all liquids as defined at 40 CFR 761.3.

PCBs existing in multiple phases must have each phase analyzed independently and, unless the phases are separated for shipment, the highest resulting concentration is to be applied to the matrix. For multiphasic PCBs consisting of oil and an aqueous-phase, however, only results of the oil need be considered because PCBs are naturally repelled from water.

3.12 DOCUMENTING THE SAMPLING APPROACH

3.12.1 Sampling Request Form versus Sampling and Analysis Plan (SAP)

After the determination has been made that existing data are insufficient to appropriately characterize the waste stream and sampling will be required, the next step in decision-making will be to ascertain which tool shall be used — the SR or the SAP — to document the sampling approach.

3.12.1.1 *SAMPLING REQUEST FORM*

An SR will be completed by the Waste Management Programs Specialist and reviewed and approved by the WM Programs Sr. Manager or designee, and submitted to the Field Characterization group for review. An SR will be utilized, including but not limited to, the following conditions:

- To verify waste attributes, where sufficient knowledge of the waste exists through PK or historical data
- To characterize a waste stream that consists of a single container/item
- To characterize a waste stream when the entire waste population will be sampled

3.12.1.2 *SAMPLING AND ANALYSIS PLAN*

An SAP will be written by a team identified through the DQO process, and will be reviewed and approved by the WM Programs Manager or designee; minimally, it will include the following information:

- The data users and their data needs
- A description of the waste
- A defined waste population
- A list of the sample items or locations
- The contaminants of concern
- The analytical methods to be employed
- The DQOs

An SAP will be utilized, including but not limited to, the following conditions:

- To document a statistically-based sampling approach
- To document complex sampling strategies
- To document sampling requirements for on-going waste generation activities

3.12.1.3 *FIELD CHANGE NOTICES AND REVISIONS*

In the event changes to the SAP are required after final approvals have been obtained, the Field Change Notice (FCN) process will be implemented per the SADQ. Per the SADQ, an FCN is required when an activity changes the scope of the project, provides clarification, incorporates additional information, corrects errors in the original SAP, documents re-sampling activities, documents sample location changes, etc.

A revision to the SAP, in lieu of an FCN, will be necessitated if the DQOs need to be modified.

In the event changes to the SR are required after final approvals have been obtained, the SR will be revised and resubmitted for signatures and approval.

3.13 EVALUATION OF DATA

3.13.1 Data Verification

Data verification is the responsibility of the analytical laboratory, which shall verify that all data has been produced in accordance with the SADQ as required under the analytical SOW issued by the SMO.

Analytical support level (ASL) D packages as defined in Section 4.1.1 of the SADQ are required for all routine waste analyses. Specially developed protocols may be required for wastes with particularly complex matrices and in those cases, ASL E may be specified.

3.13.2 Data Validation

Data validation is an independent assessment of data against established criteria to determine technical reliability of the reported analytical results. Data validation will be conducted by QA as part of the analytical data review process. Data packages designated to be validated will be validated per FBP data validation procedures, and, if necessary, qualifiers will be assigned. These data qualifiers are entered into PEMS. Laboratory data shall be validated at a frequency specified in the DQO/SR/SAP. Appendix C of the SADQ provides requirements for field and data validation. Data cannot be validated at a validation support level (VSL) more restrictive than the ASL at which it was analyzed.

Data validation for NDA results obtained under the requirements of QSNDA will be aligned to the Data Quality Objectives specific for those measurements. Data validation will be performed by NDA personnel as specified under QSNDA or by an independent, third party with knowledge of quality control requirements and NDA measurement techniques. Waste Management personnel will review and verify required signatures on the NDA Measurement Data Reports and NDA validation reports when available.

All waste characterization data used to support off-site transport to a TSDF will be validated per the given frequency:

- Less than 20 samples within a single sample delivery group — 100% validation of all results
- Greater than 20 samples with multiple sample delivery groups — a minimum of 10% validation of all results, ensuring that a sample delivery group from each laboratory, for each analytical group (e.g., metals, volatiles, semi-volatiles, radiochemical analysis), is validated.
- Legacy data which does not meet the requirements of this section will be evaluated to ascertain usability on a case by case basis.

3.13.3 Data Assessment

Data assessment is the overall assessment of the data collected relative to the available PK and the goals of the SR or SAP. Prior to considering the data for classification, a data usability review must be performed. This assessment will include, but not be limited to the following:

- An evaluation of matrix spike and matrix spike duplicate for non-concentrated wastes for chemical contaminants. If the laboratory has flagged the matrix spike and matrix spike duplicate for being outside of the QC recovery limit, it will be documented as to whether the waste characterization and/or classification will be modified based upon the matrix data. Waste matrices can greatly impact the amount of contaminant available for measurement.

- An evaluation of non-detects for chemical and radiological wastes. The presence of non-detects can impact the waste classification and derived analyte concentration of a waste. The use of non-detects in a data set are further described in 3.13.4.2. It will be documented as to whether the waste characterization and/or classification will be modified based upon how non-detects are managed in the data set.
- An evaluation of lab qualifiers. Section 15 of the SADQ provides specific guidance on assessing the laboratory quality assurance data to evaluate precision, accuracy and completeness. These are generally assessed during validation and the data will be received with the appropriate lab qualifiers (flags). The flags are to be evaluated and determination made as to whether they could impact the waste characterization and/or classification decisions.

Upon receipt of sample data, the data will first be assessed to determine whether it aligns with the expected PK. Laboratory reports of unexpected nuclides or chemicals can often be due to inappropriate libraries, interferences or misidentifications. If such results are encountered, the SMO should be contacted who will in turn contact the laboratory. If the laboratory confirms the result, the Sr. Manager of Waste Programs must be contacted to make a determination as to whether or not to include the suspect value. Any deletion of results from the data set used to classify the waste will be documented on the data usability review and approval signature of the Sr. Manager of Waste Programs or their designee obtained.

3.13.4 Data Interpretation and Population Assessment

Data interpretation is the use of the accepted data to determine whether the data collected for the population of waste under investigation meets the DQOs and, moreover, supports the classification of the waste. Data interpretation is the responsibility of the Waste Management Programs Specialist, with the assistance of a statistician if needed.

3.13.4.1 *STATISTICAL EVALUATION*

The DQOs will establish the statistical criteria to be used to assess and classify the waste when population statistics are used. It is recommended that data be statistically evaluated using statistical software, such as VSP or ProUCL. Such software will evaluate the normality of the results and can transform the data using a variety of statistical tools and can be used to determine the mean, upper confidence level (UCL), and upper tolerance limit (UTL) for the data set and provide additional statistical information. Output from these software programs can be saved in the project files as the basis for the waste classification.

If the statistical evaluation is performed in spreadsheets, the spreadsheets must be peer reviewed and managed in accordance with FBP-BS-PRO-00091, *Information Technology Software Quality Assurance*.

3.13.4.2 *USE OF NON-DETECTS IN DATA SET*

When the population data set includes non-detects, there are several ways to manage this information. Consideration of the total number of samples collected and proximity of the detected results to the regulatory decision level and/or detection limit will need to be taken into account. If the data set consists of all non-detects, the detection limit is below any regulatory threshold for the contaminant of concern and the data set is sufficient to characterize the waste population, it will be assumed the contaminant is not present. If the data set consists of detects and non-detects, utilizing statistical software, such as VSP or ProUCL, to evaluate the data may be appropriate.

An alternate approach for managing a large number of non-detects in a data set would be to calculate the concentration for the contaminant of concern using only those results above the detection limit, disregarding results below the detection limit, provided the detection limit is below the regulatory limit. This would bias the results high, but could be appropriate for contaminants known, through historical data or PK, to be present at very low levels where there is no risk of exceeding a WAC or transportation limit. Caution should be taken if the concern is determining the presence or absence of a contaminant as opposed to a concentration. Any

detected values must be reviewed and the rationale for their omission from the data set must be documented and approved by the Sr. Manager of Waste Programs or designee.

When the detected results are near the detection limit or regulatory decision level, assigning the detection limit for non-detects, irrespective of the percentage of non-detects present, may be appropriate.

If data suggests the waste may qualify as radiologically clean, the data is to be forwarded to Radiological Control personnel as the basis for submitting a UE-5 form (FBP-RP-PRO-00004-F01, *UE-5 Request for Release of Equipment/Material From DOE Control*).

3.13.4.3 *EVALUATION OF DATA OUTLIERS*

If upon analyzing the data outliers are identified, it may be an indicator of several things, including the following:

- Distinct sub-populations within the defined waste population
- The data is not normally distributed
- The anomaly occurred as a result of human or measurement error (e.g., equipment malfunction, human transcription mistake)

If it can be determined that the anomaly occurred as a result of human or measurement mistake, the value will be discarded when assessing the data set. If the accuracy of the sample results can be established, and the data is determined to be normally distributed, it may also be appropriate to discard the outlier. Employing statistical software or consulting a degreed statistician to assess the data set to determine the proper approach is suggested.

3.13.4.4 *CONSIDERATION AND APPLICATION OF UNCERTAINTY*

3.13.4.4.1 Authoritative Sampling

If materials or wastes to be shipped are based on authoritative values obtained from intrusive sampling and analysis — i.e., one laboratory result per item or package with no relationship between the items or packages of concern — the nominal value plus the uncertainty is to be used to determine the upper bound of the package or item unless the DQOs specify other requirements.

Materials or wastes to be classified and shipped on the basis of NDA will be evaluated relative to nominal value reported plus the uncertainty to assess compliance relative to regulatory limits, Department of Transportation (DOT) packaging limits and the TSDF WAC. Likewise, radionuclide values scaled by NDA will be evaluated based on the NDA nominal value plus NDA measurement uncertainty. The scaling factor development will be on nominal values and will not include uncertainty to avoid an additional positive bias.

The application of measurement uncertainties may vary based upon the material/item or measurement method (i.e., NDA versus intrusive sampling) and the level of uncertainty applied should be from approved Technical Basis Documents or other documented site sources unless a more conservative approach is used.

3.13.4.4.2 Population Statistics

Materials or wastes to be shipped based on population statistics developed from intrusive data may be classified for shipment based on several different evaluations. The most common include calculating the 95% UCL of the mean or the 95% UTL, using nominal values for a discrete population. This assessment will be an evaluation of the overall uncertainty, sampling and counting.

3.13.5 Application of Statistical Parameters

Statistical software such as VSP will be utilized in determining statistical parameters, or a degreed statistician will be consulted as needed.

The statistical parameter selected for a contaminant of concern for a given waste population will be dependent upon the requirements of the TSDF WAC, transport and disposal regulations, and the sampling scheme selected. Prior to the application of a parameter, the data will be assessed utilizing statistical software to determine the appropriate parameter (e.g., UCL, UTL) based on the distribution.

3.13.6 Determination of Radiologically Clean (UE-5) Wastes

The Radiological Control department has sole responsibility for determining and documenting waste as radiologically clean. This will be documented on a UE-5 form, and provided to WM and Transportation personnel for inclusion in the project and shipment files. Waste not specifically identified on a UE-5 form shall be considered low-level waste (LLW).

Data obtained by Waste Management that could impact radiological determinations must be forwarded to Radiological Control for consideration in ascertaining whether the waste is radiologically clean.

For facilities, the Radiological Control department may implement surveys consistent with concepts and terminology within the *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) and *Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual* (MARSAME). The DQO process and a graded approach are integrated within these processes to assure defensible data with cost effectiveness. Compliance with FBP procedures, which establish absolute limits, obviates the non-parametric statistical analyses.

4. WASTE CHARACTERIZATION DATA AND WASTE CLASSIFICATION FILES

All data must be retained in accordance with the requirements specified in Section 13 of the SADQ.

4.1 SAMPLE DESIGN DOCUMENTATION

4.1.1 Sampling Requests

SRs shall be assigned a document number and the signed, finalized version maintained by Environmental Remediation (ER). Signed electronic copies will be forwarded to WM and maintained in a WM shared computer-drive folder.

4.1.2 Sampling and Analysis Plans

SAPs shall be assigned a document number, and Records Management and Document Control (RMDC) will maintain the signed original. WM will maintain an electronic copy in a WM shared computer-drive folder.

Revisions and field change notices (FCNs) shall also receive a document number and be maintained as above, tied to the original document. Revisions and FCNs shall be forwarded to affected personnel (e.g., ER Sampling, Maintenance).

4.1.2.1 SAMPLE DESIGN OUTPUT FILES

VSP, ProUCL, or other statistical software program output files shall be maintained in electronic format in a WM shared computer-drive folder. The SAP shall include the basis for input data and resulting sampling requirements.

4.1.2.2 *STATISTICAL GUIDANCE*

Statistical guidance received from a degreed statistician shall be documented and maintained in electronic format in a WM shared computer-drive folder.

4.2 **PROJECT FILES**

Project files will be compiled for each WM supported project, and shall be maintained by the WM organization. Project files shall contain at a minimum the applicable documentation described in the following subsections.

4.2.1 **Process Knowledge Statements**

A characterization approach that consists of or is entirely based upon PK is to be documented and maintained on file; it shall include references to any documents, plans, or procedures employed, and identify information received from subject matter expert (SME) interviews, emails, and/or written statements. The original documents and attachments will be maintained in the project file and an electronic copy in a WM shared computer-drive folder.

4.2.2 **Analytical Laboratory Reports**

All analytical reports are submitted by the laboratories to the SMO. The requestor of the data will receive an electronic copy of the analytical data report. This electronic copy of the analytical report will be maintained in a WM shared computer-drive folder.

4.2.3 **Surveys and NDA Results**

Surveys used as the basis of characterization shall be maintained in the project file. Spreadsheets demonstrating how the survey data has been converted to activity are also to be maintained as part of the project file.

NDA reports will be managed in the same manner as analytical data.

4.2.4 **Data Evaluation Output Files**

Statistical parameters that have been defined through evaluation of data by either VSP or other software reviewed and managed in accordance with FBP-BS-PRO-00091, *Information Technology Software Quality Assurance*, or a degreed statistician shall be maintained in electronic format a WM shared computer-drive folder.

4.2.5 **Other**

Projects may collect visual documentation (video, photographic) and digital imaging documentation to supplement the PK. This supplemental data shall be maintained in the project files to support the final characterization and disposal of material from the site.

5. REFERENCES

- FBP-BS-PL-00001, *Records Management and Document Control Plan for Fluor-B&W Portsmouth LLC Piketon, Ohio*
- FBP-BS-PRO-00091, *Information Technology Software Quality Assurance*
- FBP-ER-PRO-WD-PL-0006, *Sample Analysis Data Quality Assurance Project Plan (SADQ) At the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio, U.S. Department of Energy DOE/PPPO/03-0278*
- FBP-WM-PL-00031, *Nondestructive Assay Quality Assurance Program Plan (NDAQ)*

Appendix A

REGULATORY REQUIREMENTS FLOW DOWN

1. 49 Code of Federal Regulations (CFR) 173.443, *Contamination Control*
2. EPA 402-R-97-016, NUREG-1575, U.S. Environmental Protection Agency, Washington, D.C.
3. EPA. 1997. *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM)
4. EPA. 2000a. *Guidance for the Data Quality Objectives Process - QA/G-4*. EPA/600/R-96/055, Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C.
5. EPA. 2000b. *Guidance for Data Quality Assessment - Practical Methods for Data Analysis - QA/G-9, QA00 Update*. EPA/600/R/96/084, Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C.
6. EPA. 2002. *Guidance for Choosing a Sampling Design for Environmental Data Collection, QA/G-5S, Peer Review Draft*. Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C.