0072883

Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

MAY 15 2007

07-KBC-0041

Mr. Nicholas Ceto, Program Manager
Office of Environmental Cleanup
Hanford Project Office
U.S. Environmental Protection Agency
309 Bradley Blvd., Suite 115
Richland, Washington 99352

Dear Mr. Ceto:

SAMPLING AND ANALYSIS PLAN FOR 105-K EAST BASIN MONOLITHS, KBC-24414, DRAFT REVISION 2-A

The purpose of this letter is to transmit the Sampling and Analysis Plan for 105-K East Basin Monoliths, KBC-24414, Draft Revision 2-A to the U.S. Environmental Protection Agency (EPA) for formal approval. Following EPA approval, the document will be released as Revision 2, and submitted to the Administrative Record for the 100-KR-2 Operable Units.

This Sampling and Analysis Plan is a deliverable per Section 4.2, of the Remedial Design Report and Remedial Action Work Plan for the K Basins Interim Remedial Action, DOE/RL-99-89, Revision 1, requiring U.S. Department of Energy, Richland Operations Office (RL) and EPA approval. Informal comments from RL and EPA have been received and incorporated in the subject document.

The revised plan updates the rationale and strategy for sampling and analysis activities to support removal of the 105-K East Basin and pits. The plan has been changed to reduce the basin and some pits to rubble rather than produce monoliths, the sludge inventory determination has been changed to consist of the sum of residual sludge at a 93 percent/7 percent floor/canister sludge ratio and redeposited sludge concentration, instructions have been added to support management of sand filter backwash after achieving sludge removal criteria, and the management of debris in the basin updated to reflect the results of basin work experience.

If you have any questions, please contact me, or your staff may contact David Brockman, Federal Project Director for K Basin Closure, on (509) 376-1366.

Sincerely,

Keith A. Klein
Manager

KBC:EBD

Attachment

cc w/attach:
G. Bohnee, NPT
L. J. Cusack, Ecology
L. E. Gadbois, EPA
S. Harris, CTUIR
J. Hedges, Ecology
R. Jim, YN
S. L. Leckband, HAB
K. Niles, ODOE
Administrative Record
Environmental Portal

cc w/o attach:
P. M. Knollmeyer, FHI
R. E. Piippo, FHI
J. G. Vance, FFS

KBC-24414
Revision 2-A DRAFT

Sampling and Analysis Plan for the 105-K East Basin Monoliths

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management
Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

FLUOR®
P.O. Box 1000
Richland, Washington

KBC-24414
Revision 2-A DRAFT

Sampling and Analysis Plan for the 105-K East Basin Monoliths

Document Type: RPT Program/Project: KBC

J. L. Westcott
Fluor Hanford, Inc.

Date Published
April 2007

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

FLUOR®
P.O. Box 1000
Richland, Washington

J. D. Aardal 04/27/2007
Release Approval Date

KBC-24414
Revision 2-A DRAFT

Printed in the United States of America

CONTENTS

1.0 INTRODUCTION ... 1-1
1.1 BACKGROUND ... 1-3
1.2 DATA QUALITY OBJECTIVES ... 1-5
1.2.1 Statement of Problem ... 1-5
1.2.2 Identify the Decisions ... 1-7
1.2.3 Identify Inputs to the Decisions ... 1-7
1.2.4 Define the Study Boundaries ... 1-12
1.2.5 Decision Rules ... 1-13
1.2.6 Limits on Decision Error ... 1-15
1.2.7 Optimize the Design for Obtaining Data ... 1-16

2.0 SAMPLING RATIONALE AND DESIGN ... 2-1
2.1 ENCAPSULATING MONOLITHS ... 2-1
2.1.1 Physical Waste Form ... 2-1
2.1.2 Polychlorinated Biphenyl Waste Characterization ... 2-2
2.1.3 Dangerous Waste Constituents ... 2-2
2.1.4 Radionuclide Characterization of Encapsulating Monoliths ... 2-2
2.1.4.1 Radioactive debris Radionuclide Contribution to Monolith ... 2-3
2.1.4.2 Wall and Floor Surface Radionuclide Contribution to Monolith ... 2-4
2.1.4.3 Sludge Radionuclide Contribution to Monolith ... 2-5
2.1.4.4 Radionuclide Concentration Averaging Across the Monolith ... 2-7
2.2 RUBBLIZED BASIN AND PITS ... 2-7
2.2.1 Polychlorinated Biphenyl Waste Characterization ... 2-8
2.2.2 Dangerous Waste Constituents ... 2-8
2.2.3 Radionuclide Characterization of Rubblized Walls and Floors ... 2-8

3.0 SAMPLE and Measurement LOCATION AND FREQUENCY ... 3-1
3.1 SAMPLING ... 3-1
3.1.1 Contamination Sampling ... 3-1
3.1.2 Porous and Nonporous Debris ... 3-1
3.2 MEASUREMENTS ... 3-2
3.2.1 Dose Surveys ... 3-2
3.2.1.1 Below Water Debris Dose Rate Surveys ... 3-2
3.2.1.2 Concrete Surface Dose Surveys ... 3-2
3.2.2 Sludge Quantity Measurements – Basin and Debris ... 3-3
3.2.3 Spoils Inventory ... 3-4
3.2.4 Debris Inventory ... 3-4
3.2.5 Physical Measurements ... 3-5

4.0 SAMPLE HANDLING AND ANALYSIS ... 4-1
4.1 SAMPLE HANDLING AND CUSTODY REQUIREMENTS ... 4-1
4.1.1 Sample Preservation, Containers, and Holding Times ... 4-1

4.1.2 Sample Shipping 4-1
4.2 SAMPLE ANALYSIS 4-1

5.0 QUALITY ASSURANCE PROJECT PLAN 5-1
5.1.1 Project/Task Description 5-1
5.1.2 Project Organization 5-1
5.1.3 Roles and Responsibilities 5-2
5.1.4 Special Training Requirements and Certification 5-5
5.1.5 Quality Assurance Objectives and Criteria for Measurement Data 5-5
5.1.6 Documentation and Records 5-7
5.2 DATA GENERATION AND ACQUISITION 5-7
5.2.1 Quality Control Requirements 5-7
5.2.2 Instrument Testing, Inspection, and Maintenance 5-7
5.2.3 Instrument Calibration and Calibration Frequency 5-7
5.2.4 Inspection/Acceptance Requirements for Supplies 5-8
5.2.5 Non-direct Measurement 5-8
5.2.6 Data Management 5-9
5.3 ASSESSMENT/OVERSIGHT FOR MEASUREMENTS 5-10
5.3.1 Assessments and Response Actions 5-10
5.3.2 Reports to Management 5-10
5.4 DATA REVIEW, VALIDATION, AND USABILITY 5-10
5.4.1 Data Review and Validation Requirements 5-10
5.4.2 Validation Methods 5-11
5.4.3 Reconciliation With User Requirements 5-11

6.0 HEALTH AND SAFETY 6-1

7.0 REFERENCES 7-1

APPENDICES

A EVALUATION OF MONOLITH NRC WASTE CLASSIFICATION ..... A-i

B VISUAL COMPARATOR PLACEMENT ..... B-i

C DATA VALIDATION FORMS ..... C-i

D DISPOSAL OF ENCAPSULATED NON-HAZARDOUS LIQUID AT THE ENVIRONMENTAL RESTORATION DISPOSAL FACILITY ..... D-i

FIGURES

Figure 1-1. K East Basin Sawcut Plan. 1-2

Figure 1-2. K East Basin and Pit Preparation Process Flow Diagram. 1-4

Figure 5-1. Measurement Collection and Waste Management Organization Chart. 5-2

TABLES

Table 1-1. Final List of Contaminants of Concern. 1-5

Table 1-2. Data Quality Objectives and Sampling and Analysis Plan Team Members. 1-6

Table 1-3. Key Decision Makers. 1-6

Table 1-4. Decision Statements for K East Basin Pit Rubble and Monolith Waste Designation. 1-7

Table 1-5. Required Data Assessment 1-8

Table 1-6. Field Instrument Performance Requirements. 1-11

Table 1-7. Decision Rules. (2 sheets) 1-14

Table 2-1. Activated Metal Radionuclide Monolith Inventory. 2-4

Table 5-1. Field Instrument Performance Requirements. 5-5

Table 5-2. Application of Assessment Parameters to Data Collected. 5-10

ACRONYMS

ASME	American Society of Mechanical Engineers
AJHA	Automated Job Hazards Analysis
ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
BHI	Bechtel Hanford, Inc.
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
COC	contaminant of concern
DFSNW	Duratek Federal Services Northwest
DQO	data quality objective
DR	decision rule
DS	decision statement
ERDF	Environmental Restoration Disposal Facility
FH	Fluor Hanford, Inc.
MDL	method detection limit
NLOP	north loadout pit
NRC	U.S. Nuclear Regulatory Commission
PCB	polychlorinated biphenyl
PNNL	Pacific Northwest National Laboratory
QA	quality assurance
SAP	Sampling and Analysis Plan
SNF	spent nuclear fuel

TERMS

Above water concrete surface: Basin and pit structural concrete surfaces that are not or have not been normally submerged under basin water including surfaces interior and exterior (mostly sub-grade) to the basin building.

Below water concrete surface: Basin and pit structural concrete surfaces that are or had been normally submerged under basin water

Final pass: The last pass along a basin or pit floor necessary to remove sludge to attain the endpoint for sludge removal in accordance with the qualified process KBC-24721, *105 K East Qualified Process Demonstrating Endpoint Criteria* .

Monoliths (Encapsulating): Sections of pit concrete floor, or wall and floor that contain grout that encapsulates sludge, debris, and spoils (when present) and provides shielding.

Nonporous radioactive debris: Debris materials where radionuclide contamination is affixed on the surface such as metal, plastic, rubber, and glass.

Porous radioactive debris:. Debris material where radionuclides could penetrate the material surface such as fabric, concrete, wood, and paper with the exception of intact or removed basin floor or wall material.

Redeposited sludge: Sludge that has accumulated on the basin or pit floor after the final sludge removal pass. The sludge includes those quantities measured on the floor and what may be suspended in basin water.

Residual sludge: Sludge that remains on the basin or pit floor with the completion of the final sludge removal pass.

Rubblized basin: Sections of basin concrete walls or floor (i.e., where the below water portion has been hydrolased) that have been size reduced for transportation and disposal and do not contain grout, or residual and redeposited sludge, debris, or spoils (other than small spots).

Rubblized pit: Sections of pit concrete walls or floor (i.e., where the below water portion has not been hydrolased) that have been size reduced for transportation and disposal and do not contain grout, but may contain residual and redeposited sludge and debris.

Spoils: Concrete fines, pieces and aggregate contaminated with radionuclides that is removed from the basin below water wall and floor surfaces by hydrolasing.

Visual comparator: A piece of metal that may be flat and painted or flat with raised steps on the surface mounted on the basin or pit floor used to visually observe material accumulation on the surface from particulate dropping out of the basin water.

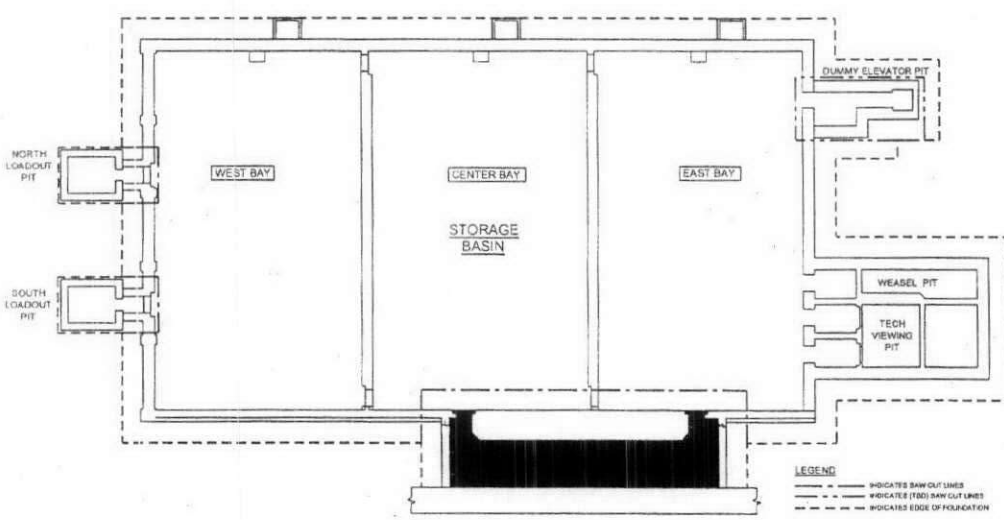
1.0 INTRODUCTION

The K East Basin and pits will be removed as part of the K Basin *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) remedial action (*Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington (also known as the "100 Area Remaining Sites ROD")* [EPA 1999]). The K Basin and pits will be prepared for removal as part of the K East Basin *Interim Action Record of Decision for the 100-KR-2, Operable Unit, Hanford Site, Benton County, Washington* (EPA 1999) and amendment (EPA 2005).

The basin and pit structure disposal plan is a combination of "grout and remove," wherein some basin pits are filled with grout to provide shielding and encapsulate radioactive debris and contamination and "rubblization" wherein the basin and some pit walls and floor are reduced to rubble for transport and disposal. Discrete sections of the grouted concrete pit wall and floor sections (referred to as monoliths) are cut from the basin and removed for disposal. Figure 1-1 shows the conceptual design of the cut lines for the three K East Basin pits that may be removed as monoliths. The basin and the tech view and weasel pits are planned to be and the dummy elevator pit (DEP) may be reduced to rubble for removal. The grouting and rubblizing processes require fuel and sludge removal to ensure compliance with the Environmental Restoration Disposal Facility (ERDF) waste acceptance criteria. Debris may be grouted in monoliths and will be primarily radioactive debris, although some mixed radioactive and dangerous debris may exist. This Sampling and Analysis Plan (SAP) includes descriptions of the processes to achieve end point criteria for sludge removal, encapsulate below water debris, and basin and pit removal as they relate to characterization of the basin pit monoliths and rubblized basin and pits for disposal at ERDF, as described in HNF-20632, *End Point Criteria for the K Basins Interim Remedial Action.*

Figure 1-1. K East Basin Sawcut Plan.

K East Storage Basin Sawcut Plan



Numerous activities are performed to accomplish the removal of the K East Basin and pits. The activities listed below are those activities that may be performed to prepare the basin and pits for removal. The project plans to continue to operate the KE Basin sand filter after achieving the sludge removal end point criteria with the backwash being discharged to the north loadout pit (NLOP) per current practices. The backwash inventory will be monitored to account for the additional radionuclide inventory to the NLOP after achieving the sludge removal end point criteria to prevent a monolith section from exceeding the ERDF WAC. All remaining sludge on the basin floor and that which is in suspension in the basin water will be accumulated in one or more of the basin pits for future grouting along with basin debris.

- Remove the bulk of K East sludge placing it in containers located in the K East Basin
- Transfer sludge from containers in the K East Basin to the K West Basin
- Collect measurements of dose rate on basin and pit walls
- Perform final pass removal of K East sludge from the basin and pits
- Install visual comparators and monitor visual comparators as final pass is accomplished
- Remove debris or place in pits for encapsulation in grout

- Determine the attainment of the sludge removal end point
- Hydrolase basin walls and floors
- Remove the sand filter from service and remove sand from the filter
- Remove basin water from basin and pits
- Grout pits and reduce to rubble the basin and pits that are not grouted

This SAP was developed through use of the data quality objective (DQO) process. The DQO process is a methodical planning approach that provides a systematic process for defining criteria that a data collection design should satisfy. Using the DQO process ensures that the type, quantity, and quality of environmental data used in decision making will be appropriate for the intended application.

1.1 BACKGROUND

The K East Basin is located in the Hanford Site 100 K Area. The fuel basin is a large open-topped concrete pool containing approximately 4.9 million L (1.2 million gal[1]) of demineralized water. The basin, constructed in the early 1950s, was used to store spent nuclear fuel (SNF) from the K East Reactor until the early 1970s, when the reactor was removed from service. In 1975, the K East Basin began storing SNF from N Reactor. The last fuel was received in 1989. Removal of SNF with subsequent drying and shipment to the 200 East Area for storage began in 2000 (*Hanford – A Conversation About Nuclear Waste and Cleanup*, [Gephart 2003]). Except for an 18-in.-wide band of protective concrete sealant (BIO-DUR 560[2] [MSDS 062812, *BIO-DUR 560 Epoxy Base Material Safety Data Sheet*, and MSDS 052505, *BIO-DUR 560 White Curing Agent Material Safety Data Sheet*]) applied near the waterline in 1996, the K East Basin walls and floor are bare concrete (ECN 190564, *Engineering Changes Notice (ECN)-190564: Clean and Seal Concrete Walls and Raise Water Level to Reduce Radiation Dose Levels to Workers Over Foreseeable Life of Facility*). BIO-DUR 560 was also applied to portions of the wall and floor surfaces of the adjacent pits. Over the years that N Reactor SNF was stored in the K East Basin, the fuel condition degraded and sludge accumulated in the basin. Sludge consists of SNF corrosion products (including metallic uranium, uranium hydrides and oxides, plutonium, fission and activation products, and aluminum and zirconium compounds from the cladding), metal oxides from corrosion of basin equipment, ion exchange media from the water treatment system, concrete grit from the basin walls and floor, sand, and dust.

Soon after N Reactor SNF storage began at the basin, the basin water quality deteriorated exhibiting increased radionuclide loading. The water treatment loop was upgraded in 1978, by adding filtration and ion exchange removal for Cs-137. Because of continued water loading with Sr-90 and tritium, further water treatment system upgrades were completed in 1986. After these upgrades, the water quality improved markedly, generally showing a reduction in radionuclide concentrations of more than a factor of ten. In general, the K East Basin water did not

---

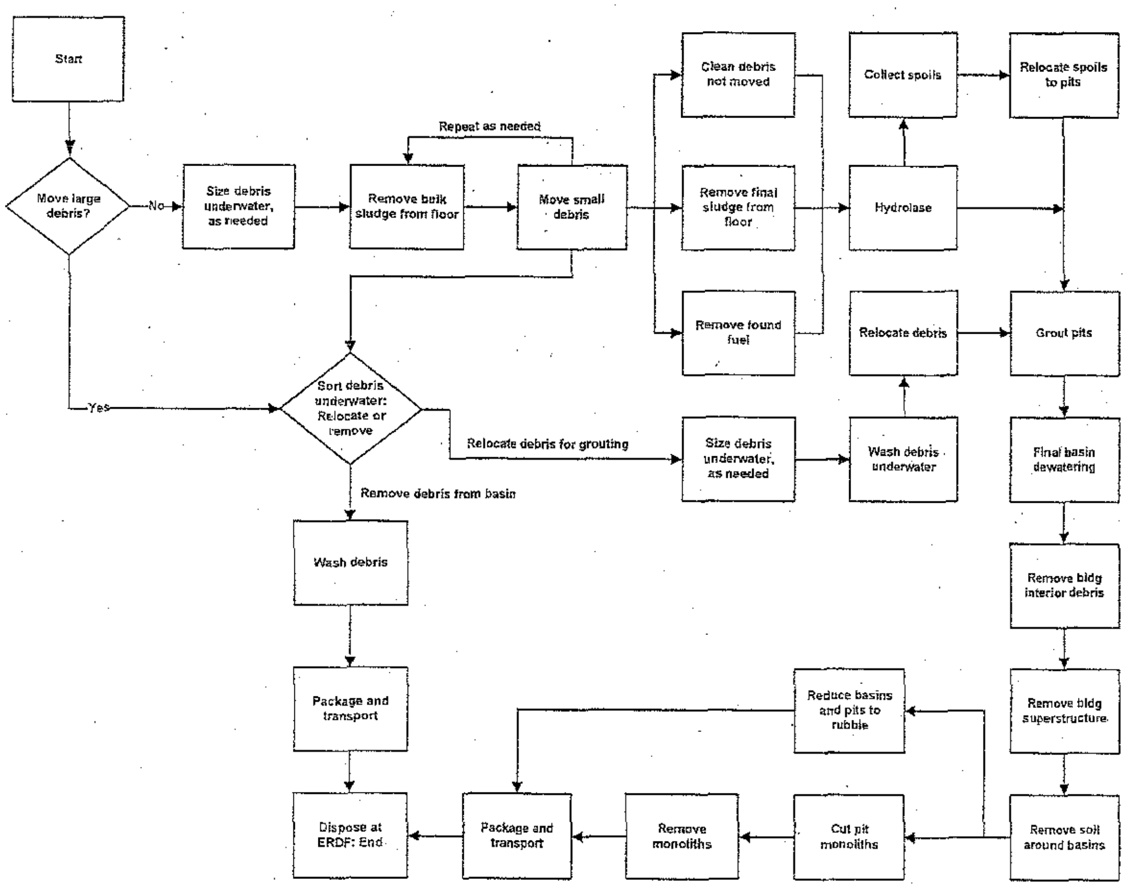
[1] In 2004, grouting of the K East Basin Discharge Chute resulted in the displacement and removal of approximately 108,000 gal of water.

[2] BIO-DUR is a registered trademark of Thin Film Technology, Inc., Houston, Texas.

experience biological growth, however some spot algaecide applications have occurred. Hydrogen peroxide is currently being employed as a spot algaecide.

The remedial design for the K East Basin includes 1) removing fuel and sludge; 2) removing a layer of basin below water concrete surfaces to reduce dose and contamination and meet project applicable or relevant and appropriate requirements (ARAR); 3) segregating below water radioactive debris for in-basin retention or removal; 4) removing certain radioactive debris and equipment from the basin; 5) relocating wall and floor concrete surface removal spoils to the appropriate basin pit; and 6) encapsulating some basin pits, spoils, and radioactive debris with cementacious grout. The selected basin pits that are grouted will be cut into monoliths and transported to ERDF for disposal. The weight of the largest monolith is estimated to be 409,000 kilograms (900,000 pounds). The KE Basin and pits that were not grouted and basin will be size reduced to rubble for transport to ERDF for disposal. A general monolith preparation process flow diagram is provided in Figure 1-2.

Figure 1-2. K East Basin and Pit Preparation Process Flow Diagram.



Note: Flow diagram not intended as a timeline. Certain activities may occur in parallel or very slightly in sequence.

ERDF = Environmental Restoration Disposal Facility

1.2 DATA QUALITY OBJECTIVES

The DQOs applicable to this waste were developed in accordance with EPA QA/G-4, *Guidance for the Data Objectives Process* (EPA 2000). The document KBC-24413, *Data Quality Objectives Summary Report for the 105-K East Basin Monoliths*, provides additional detail to the summary information provided here regarding the DQOs. Three waste streams have been identified which are: (1) K East Basin pit wall and floor with below water radioactive debris encapsulated in grout with no dangerous waste constituents, (2) K East Basin pit wall and floor with below water radioactive debris encapsulated in grout with dangerous waste constituents, and (3) K East Basin and pit wall and floor reduced to rubble for transport to disposal. The list of contaminants of concern (COC) determined by the DQOs process are provided in Table 1-1.

Table 1-1. Final List of Contaminants of Concern.

WS No.	COCs
1	H-3, C-14, Fe-55, Ni-59, Co-60, Ni-63, Se-79, Sr-90, Mo-93, Zr-93, Nb-93m, Nb-94, Tc-99, Pd-107, Cd-113m, Sn-121m, Te-123, Sb-125, Sn-126, I-129, Cs-134, Cs-135, Cs-137, Pm-147, Sm-151, Eu-152, Eu-154, Eu-155, Pa-231,Th-232, U-232, U-233, U-234, U-235, U-236, U-238, Np-237, Pu-238, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Am-242m, Am-243, Cm-242, Cm-243, and Cm-244
	Hg, Se, As, Ba, Cd, Cr, Pb, and Ag
	PCB
2	H-3, C-14, Fe-55, Ni-59, Co-60, Ni-63, Se-79, Sr-90, Mo-93, Zr-93, Nb-93m, Nb-94, Tc-99, Pd-107, Cd-113m, Sn-121m, Te-123, Sb-125, Sn-126, I-129, Cs-134, Cs-135, Cs-137, Pm-147, Sm-151, Eu-152, Eu-154, Eu-155, Pa-231,Th-232, U-232, U-233, U-234, U-235, U-236, U-238, Np-237, Pu-238, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Am-242m, Am-243, Cm-242, Cm-243, and Cm-244
	Hg, Se, As, Ba, Cd, Cr, Pb, Ag, Tl, Ni, Be, and Sb
	PCB
3	H-3, C-14, Fe-55, Ni-59, Co-60, Ni-63, Se-79, Sr-90, Mo-93, Zr-93, Nb-93m, Nb-94, Tc-99, Pd-107, Cd-113m, Sn-121m, Te-123, Sb-125, Sn-126, I-129, Cs-134, Cs-135, Cs-137, Pm-147, Sm-151, Eu-152, Eu-154, Eu-155, Pa-231,Th-232, U-232, U-233, U-234, U-235, U-236, U-238, Np-237, Pu-238, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Am-242m, Am-243, Cm-242, Cm-243, and Cm-244
	Hg, Se, As, Ba, Cd, Cr, Pb, and Ag
	PCB

Notes:
COC = contaminant of concern.
PCB = polychlorinated biphenyl.
WS = waste stream.

1.2.1 Statement of Problem

Determine necessary requirements to properly designate, prepare, and manage waste consisting of K East Basin and pit floor and walls which will include both rubblized basin and pit and grout encapsulated radioactive debris in the form of large pit monoliths for ERDF disposal. The rubblized walls and floors and pit monoliths must conform with the ERDF waste acceptance criteria for disposal.

The project plans to remove as monoliths the north loadout pit (NLOP) and south loadout pit (SLOP) and maybe the DEP. The basin and tech view and weasel pits are planned to be reduced to rubble for removal. If possible the DEP will also be reduced to rubble for removal.

A team was assembled and a workshop held to determine the DQOs and put together this SAP. Table 1-2 identifies the DQO workshop team members. Table 1-3 identifies the key decision makers.

Table 1-2. Data Quality Objectives and Sampling and Analysis Plan Team Members.

Name	Company/Organization	Position or Area of Expertise
Dave Watson	FH/K Basins Closure Project	Regulatory Support
Rob Gentry	FH/K Basins Closure Project	Sludge Project
Gary Hastings	FH/K Basins Closure Project	Radcon
Glen Chronister	FH/K Basins Closure Project	D&D Project
Rich Lipinski	WCH/Waste Management	Waste Management
Jeff Westcott	FH/Waste Management	Task Lead and Waste Management
Tino Romano	DFSNW/Transportation	Transportation Specialist
George Mata	FH/K Basins Closure Project	QA
John Diehl	FH/K Basins Closure Project	QA
Mary Ann Green	FH/K Basins Closure Project	D&D Project
Dan Moder	FH/Waste Services	Waste Management
Dana Farwick	FH/Quality Assurance	QA
Tom Orgill	FH/K Basins Closure Project	D&D Project
Ron Yanochko	FH/K Basins Closure Project	D&D Project
Jim Sloughter	FH/Engineering	Engineering support
Andy Schmidt	PNNL/Engineering	Engineering support

Notes:
WCH = Washington Closure Hanford, LLC.
D&D = decontamination and decommissioning.
DFSNW = Duratek Federal Services Northwest.
FH = Fluor Hanford, Inc.
QA = quality assurance.

Table 1-3. Key Decision Makers.

Name	Organization
Ellen Dagan	U.S. Department of Energy, Richland Operations Office
Larry Gadbois	U.S. Environmental Protection Agency

1.2.2 Identify the Decisions

The decision statements (DS) shown in Table 1-4 are those that were identified in the DQO process that required data collection to support resolution.

The data obtained during the DQO process and as directed by this SAP will be used to complete characterization of the waste for disposal.

Table 1-4. Decision Statements for K East Basin Pit Rubble and Monolith Waste Designation.

DS #1 – Determine if the waste **is** a listed dangerous waste and will be evaluated for treatment and disposal at a candidate facility (e.g., ERDF or other Hanford Site TSD facility), **OR** if the material **is not** a listed dangerous waste and will be evaluated for disposal at a candidate facility (e.g., ERDF or other Hanford Site TSD facility).
DS #2 – Determine if the waste **is** a characteristic dangerous waste and will be evaluated for treatment and disposal at a candidate facility (e.g., ERDF or other Hanford Site TSD facility), **OR** if the material **is not** a characteristic dangerous waste and will be evaluated for disposal at a candidate facility (e.g., ERDF or other Hanford Site TSD facility).
DS #3 – Determine if the waste **is** a toxic dangerous waste and will be evaluated for treatment and disposal at a candidate facility (e.g., ERDF or other Hanford Site TSD facility), **OR** if the material **is not** a toxic dangerous waste and will be evaluated for disposal at ERDF or other Hanford Site TSD facility.
DS #4 – Determine if the waste **is** a persistent dangerous waste and will be evaluated for treatment and disposal at a candidate facility (e.g., ERDF or other Hanford Site TSD facility), **OR** if the material **is not** a persistent dangerous waste and will be evaluated for disposal at a candidate facility (e.g., ERDF or other Hanford Site TSD facility).
DS #5 – Determine if the waste **is** a PCB waste and will be evaluated for disposal at a candidate facility (e.g., ERDF or other Hanford Site TSD facility), **OR** if the material **is not** a PCB waste and will be evaluated for disposal at a candidate facility (e.g., ERDF or other Hanford Site TSD facility).
DS #6 – Determine if the waste complies with the ERDF radiological waste acceptance criteria and can be disposed at ERDF, **OR** if the waste **does not** comply with the ERDF radiological waste acceptance criteria and must be disposed at WIPP if TRU or another Hanford Site TSD facility if not TRU.
DS #7 – Determine if the waste complies with the ERDF waste acceptance criteria physical form requirements and can be disposed at ERDF, **OR** if the waste **does not** comply with the ERDF waste acceptance criteria physical form requirements and must be disposed at another Hanford Site TSD facility.
DS #8 – Determine if the waste **is** land disposal restricted and requires treatment prior to disposal, **OR** if the material **is not** land disposal restricted and may be disposed at ERDF or a Hanford Site TSD facility without treatment.

Notes:

DS = decision statement.
ERDF = Environmental Restoration Disposal Facility.
PCB = polychlorinated biphenyl.
TSD = treatment, storage, and disposal.

1.2.3 Identify Inputs to the Decisions

The data inputs needed to resolve the DSs were identified during the DQO process, along with measurement performance requirements. KBC-24413, Table 3-1, specifies the information and data required to satisfy each DS with a qualitative assessment of whether the data are of sufficient quality to satisfy the corresponding DS. The results of the assessment recorded in KBC-24413 are summarized below and listed in Table 1-5.

Table 1-5. Required Data Assessment

DS No.	Required Data	Survey/Sampling/Data Collection Methods	Additional Information Required? (Y/N)
1	Data to determine if the waste is regulated as a listed dangerous waste, in accordance with WAC 173-303-080, -081, and -082.	Process knowledge	N
2	Data to determine if the waste is regulated as a characteristic dangerous waste, in accordance with 40 CFR 261.24, 40 CFR 268.40, 40 CFR 268.45, WAC 173-303-090[2]-[8], and WAC 173-303-140.	Process knowledge including historical media sampling and analysis	Y Inventory of hazardous radioactive debris to remain in a grouted monolith.
3	Data to determine if the waste meets the definition of a toxic dangerous waste, in accordance with WAC 173-303-100 and WAC 173-303-100[5].	Process knowledge including historical media sampling and analysis	Y Inventory of hazardous radioactive debris to remain in a grouted monolith..
4	Data to determine if the waste meets the definition of a persistent dangerous waste, in accordance with WAC 173-303-100.	Process knowledge including historical media sampling and analysis	Y Inventory of hazardous radioactive debris to remain in a grouted monolith.
5	Data to determine if the waste is regulated, because of PCB concentrations, in accordance with the TSCA or WAC 173-303-9904.	Process knowledge including historical media sampling and analysis	N
6	Data to determine how the waste meets the ERDF radiological waste acceptance criteria.	Process knowledge including historical media sampling and analysis and radiological surveys	Y For monoliths and pits reduced to rubble weight of sludge, dose rate of radioactive debris removed from the basin, and floor and/or wall surface. For rubblized material, dose rate surveys of walls and floors.
7	Data to determine how the waste meets the ERDF waste acceptance criteria physical form requirements.	Process knowledge including historical media sampling and analysis	Y For monoliths, the grout formulation information to meet requirements of structural stability and void space and free liquid.

Table 1-5. Required Data Assessment

DS No.	Required Data	Survey/Sampling/Data Collection Methods	Additional Information Required? (Y/N)
8	Data to determine if the waste is land-disposal restricted, in accordance with 40 CFR 268.	Process knowledge including historical media sampling and analysis	Y Inventory of hazardous radioactive debris to remain in a grouted monolith..

Notes:

40 CFR 268, "Land Disposal Restrictions," *Code of Federal Regulations*, as amended.
Toxic Substances Control Act of 1976, 15 USC 2601, et seq.
WAC 173-303, "Dangerous Waste Regulations," *Washington Administrative Code*, as amended.

DS = decision statement.
ERDF = Environmental Restoration Disposal Facility.
PCB = polychlorinated biphenyl.
TSCA = *Toxic Substances Control Act of 1976.*

Monolith Inputs

The total monolith weight will be determined to support disposal. The radioactive inventory of each pit monolith is calculated as the sum of the activity contributing sources: residual sludge, redeposited sludge, and sludge in or on debris; activity contained in below water concrete surfaces, both intact and as spoil; and contamination on debris. The monolith weight may be calculated from design information and monolith inventory or measured. Monolith total weight measurements will be collected per performance requirements provided on Table 1-6.

Sludge: The existing radionuclide analyses and process knowledge provide adequate information to calculate the radionuclide concentrations in sludge. The weight of sludge located in a monolith is the only information needed to determine the sludge contribution to the monolith radionuclide inventory. The sludge consists of two types, residual sludge and redeposited sludge. A sludge weight determination of each type is necessary to calculate the radionuclide inventory contribution of sludge.

The weight of residual sludge resident in a monolith will be determined by estimating the amount of sludge remaining through visual examination of the floor and radioactive debris and sludge density information. The sludge density used to calculate sludge weight from visual observations shall be as described in the notes of Table A-1 of KBC-24413 Appendix A. The visual examination may be performed by direct observation or use of video and/or still cameras. The basin water visual acuity shall be maintained such that a 0.08 cm (1/32 in.) black line can be seen on an 18% neutral gray card (EPRI 1980) at the time of determination of meeting the sludge removal end point.

Sludge that may be redeposited on the floor after final pass will be measured by placing visual comparators on the floor. The redeposition of sludge in the NLOP from sand filter backwashing may be measured or calculated. The sludge density used to calculate sludge weight from visual observations of comparators shall be as described in the notes of Table B-1 of KBC-24413 Appendix B. Visual comparators will be visually examined by eye-sight aided by use of video and/or still cameras under conditions wherein basin water visual acuity is such that a 0.08 cm (1/32 inch) black line can be seen on an 18% neutral gray card. The redeposition of sludge in the weasel and tech view pits will be determined by visual observation of the visual comparator mounted in the throat of the pit. The quantity of sludge backwashed into the NLOP from the sand filter occurs after sludge has been removed to the extent practicable and the sludge removal end point criteria have been met.

Sludge that may have been collected and placed in a monolith as part of hydrolase spoil will be included in the calculated sludge inventory of a monolith.

Concrete walls and floors: The basin concrete will be characterized using concrete surface radionuclide contaminant information and structural concrete size and composition. The below water concrete basin wall and floor surfaces that have not been hydrolased will have dose rate measurements collected to support radioactivity inventory calculations as described in KBC-25121, *Sampling and Analysis Plan For Waste Containing K East Basin Below Water Concrete Surfaces*.

The below water surface area of wall and floor located in a monolith will be determined and inventoried for each monolith. The below water surface area may be intact or removed wall or floor surface, also called spoil. The inventory will record the surface area, both intact and as spoil, located in each monolith. The determination of area may be calculated based on design information or measured using length measurement devices such as tape measures and rods. The length measurements will be collected per performance requirements provided on Table 1-6.

Debris: The methods to determine the radionuclide inventory contributed by radioactive debris encapsulated in a monolith are established in this document using methods established in HNF-6495, *Sampling and Analysis Plan for K Basins Debris*. A large portion of the porous and nonporous debris will be removed from the basin. The removed debris will be radioactively characterized in accordance with methods specified in HNF-6495. The calculated radioactivity determined for removed porous and nonporous debris shall be used to determine the radioactive content of each debris type with consideration given to the dose rate exhibited by the debris and the surface area of the debris. The dose rate of all debris left in the pits will be collected. The contamination on below water debris will be consistent for both debris types because the debris has been exposed to the same conditions and consists of similar materials. No significant variation in surface contamination is expected.

The quantity of radioactive debris in a monolith is determined by maintaining an inventory for each monolith. The inventory will record the radioactive debris item and information pertinent to determine weight and surface area exposed to water, as necessary. The weight and surface area may be calculated from design or other information, measured, or determined by measuring like or similar items. The radioactive debris weight is needed to facilitate the determination of monolith weight. The debris surface area of removed debris versus debris being left in the pits must be monitored in order to adjust the calculated radioactivity as necessary. If weight measurements are collected, the measurements will be accomplished per performance requirements of Table 1-6.

Visual observations will be performed using a camera or human eye to ensure removal of sludge from the radioactive debris. The visual acuity of the basin water shall be maintained such that a 0.08 cm (1/32 in.) black line can be seen on an 18% neutral gray card at the time visual observations of debris are made.

Table 1-6. Field Instrument Performance Requirements.

Measurement	Measurement Method	Action Level/ Detection Limit	Accuracy Requirement	Precision Requirement
Length	Tapes, Rods	Lower 5% of scale range	not applicable	not applicable
Dose Rate	Bicron microrem meter, Geiger-Mueller AMP-100, or ion chamber	Lower 5% of scale range	± 20%	± 20%
Weight	Weigh scale	Lower 5% of scale range	± 2%*	± 2%*

*The stated value or manufacturer's specifications.

PCB and dangerous waste constituent process knowledge: Analysis for polychlorinated biphenyl (PCB) content is not planned as ERDF can accept solid PCB waste. The maximum concentration reported for K East Basin sludge will be assigned to sludge contaminating a monolith.

The existing information is adequate to determine the dangerous waste status of the monolith waste form. No additional testing or analysis is necessary to support designation. The dangerous waste status for radioactive debris and wall and floor surfaces is governed under existing documents HNF-6495 and KBC-25121, respectively. Additionally, an inventory of radioactive debris items will be maintained for each monolith and the radioactive debris items will be evaluated under the dangerous waste regulations. The K East Basin sludge has been designated as a non-dangerous waste per *Washington Administrative Code* (WAC) 173-303, "Dangerous Waste Regulations" (Correspondence No. 0101943, "Contract No. DE-AC06-96RL13200 - Completion of Waste Designation for K Basin Sludge Waste Streams"). The structural concrete and grout used in the grouting process will not cause the waste to be regulated as dangerous waste (EPA 14451, *Regulation of Concrete Residuals as Hazardous Waste*). Basin water that may be encapsulated in small void spaces is a non-dangerous waste and has been determined acceptable to be part of the monolith waste matrix (Appendix D). Fixatives expected to be applied and paints applied to basin concrete and monoliths do not cause the waste to be regulated as dangerous waste.

Rubblized Wall and Floor Inputs

The characterization of basin and pits that have been reduced to rubble will use the same processes as described for monoliths for the material that may be resident in the rubble. Alternately, the radioactive characterization of rubble may be accomplished using a dose rate-to-curie conversion for an ERDF roll-off box or other container and an applicable radionuclide distribution. The basin will have all debris, below water concrete surface, and sludge removed prior to reducing it to rubble, leaving only structural concrete, radioactive contamination, and fixative, if applied, to be crushed into rubble. If below water debris, below water concrete surface, or sludge exists in the basin over and above small spots, then these areas will be added as a contribution to the rubble. The pits being reduced to rubble will be contaminated with radioactive sludge, activity contained in intact below water concrete surfaces, and the tech view and weasel pits will contain debris contaminated with radioactivity in the form of sludge retention tanks.

The basin rubble does not contain sludge except in trace quantities, therefore existing process knowledge can be used to establish that the rubble is not dangerous or PCB remediation waste. Concrete and rebar do not contain PCB and are not dangerous waste (EPA 14451). The radioactive contamination of basin that will be reduced to rubble will be calculated using dose rate measurements. Above water concrete surfaces and below water concrete surfaces that have been hydrolased will be characterized for radionuclide content by using dose rate measurements to calculate radioactive concentrations on the surfaces. The radioactive and chemical content of the rubble will be calculated by averaging the inventory over the rubble produced. The characterization is simple enough that an inventory is not necessary for the basin.

The radioactive and chemical contamination of pits will be characterized using the same methods described for pit monoliths. Unlike pit monoliths, the pit rubble will not contain spoil but will contain sludge on the pit floor and unremoved activity contained in below water concrete surfaces. The radioactive inventory of each pit reduced to rubble is calculated as the sum of the activity contributing sources: sludge that is residual, redeposited and in or on debris; activity contained in intact below water concrete surfaces; and, as applicable, contamination on debris. The radioactive and chemical content of the rubble will be calculated by averaging the inventory over the rubble produced.

The radioactive characterization of basin or pit rubble may be accomplished using an alternate method to those described above. The alternate method will collect dose rate measurements around a filled ERDF roll-off box or other container. A dose rate-to-curie conversion factor and radionuclide distribution are used to calculate the inventory of the container. A radionuclide distribution will be determined using the same inputs described for calculating the radioactive inventory of rubble as described above.

1.2.4 Define the Study Boundaries

The study boundaries identify the spatial and temporal boundaries of the action under investigation, as well as practicable constraints that must be taken into consideration.

The spatial boundaries for this SAP include the grouted and size reduced concrete basin and pit structure waste streams generated by K East Basin removal through the "grout and remove" and "rubblize" processes. Both below water debris and hydrolase surface spoil may be encapsulated in monoliths or removed from the basins for disposal separate from the monoliths. The interim remedial action described in this SAP does not address the removal of the K East Reactor wall or discharge chute. The waste streams are described as follows.

- K East Basin pit wall and floor with below water radioactive debris including activated metal, and basin sludge encapsulated in grout. Fixative may be applied on the exterior surface of the grouted monolith. A small amount of gravel and soil from beneath the

K East Basin may adhere to the base of the monolith when it is removed for transport. Encapsulated radioactive debris material is not regulated as dangerous waste.

- K East Basin pit wall and floor with below water radioactive debris including activated metal, and basin sludge encapsulated in grout. Fixative may be applied on the exterior surface of the grouted monolith. A small amount of gravel and soil from beneath the K East Basin may adhere to the base of the monolith when it is removed for transport. Encapsulated radioactive debris material is regulated as dangerous waste.
- K East Basin and some pit floors and walls and footings that may be cut from the sub-grade basin walls that will be sized reduced for disposal. A small amount of gravel and soil from beneath the K East Basin may be mixed with the rubble when it is removed for transport.

No temporal boundaries were identified to resolve the decisions statements except DS 5 and 6 regarding sludge redeposition and dose rate measurement of below water surface of the basin and pit floors. The measurement of residual sludge, must occur after sludge removal final pass in accordance with the qualified process implemented to meet sludge removal end point criteria. The measurement of sludge redeposition, must start after determination of residual sludge remaining on the floor. The measurement of dose rate on below water surfaces of basin walls and floors that are hydrolased must occur before hydrolasing and after hydrolasing.

Practicable constraints that may impact the data collection effort include physical and environmental barriers within the K East Basin. These barriers include turbid water conditions, equipment and radioactive debris on the basin floor, hydrolasing equipment design limits its use to concrete surfaces located in the basin, and radioactive contamination of rubblized material and on the exterior of monoliths. Tanks have been loaded into the weasel and tech view pits which make it difficult if not impossible to visually observe the floor for sludge removal in compliance with the process parameters identified by the sludge removal demonstration. Instead, sludge will be removed and from the weasel pit videos and/or still photos of the pit after cleaning of sludge but before the placement of tanks will be obtained. Sludge that may have been redeposited in the two pits during sludge removal operations will again be removed from under and around the tanks to the maximum extent practicable, then videos and or still photos will be obtained from under and around the tanks to the extent practicable. These videos and/or still photos will be reviewed after the qualified sludge removal process has been demonstrated to evaluate if adjustment to the amount of sludge left on the floor is necessary. The project plans to reduce to rubble the tech view and weasel pits including the sludge retention tanks mounted in these pits. Sludge shall be removed form inside the tanks and the floor inspected the same way basin and pits floors are. Visual comparators mounted on the floor will have to be placed to avoid interference with obstructions and will be removed when the surface is hydrolased.

1.2.5 Decision Rules

The information developed in the previous steps of the DQO process (KBC-24413) are combined with the parameter of interest and an action level to provide a concise description of what action will be taken based on the results of data collected. Table 1-6 lists the final action level for each measurement; this information has been incorporated into performance requirements presented later in this document. Table 1-7 lists the decision rules that apply to the designation of the K East Basin and pits being removed as a monolith or size reduced pieces of rubble.

Table 1-7. Decision Rules. (2 sheets)

DS No.	DR No.	Decision Rule
1	1	1. If the waste **is** a listed dangerous waste, treat as needed and dispose at the ERDF or other facility approved by EPA and in accordance with the facility's waste acceptance criteria. 2. If the material **is not** a listed dangerous waste, dispose at the ERDF or other facility approved by EPA and in accordance with the facility's waste acceptance criteria.
2	2	1. If the waste **is** a characteristic dangerous waste, treat as needed and dispose at the ERDF or other facility approved by EPA and in accordance with the facility's waste acceptance criteria. 2. If the waste **is not** a characteristic dangerous waste, dispose at the ERDF or other facility approved by EPA and in accordance with the facility's waste acceptance criteria.
3	3	1. If the waste **is** a toxic dangerous waste, treat as needed and dispose at the ERDF or other facility approved by EPA and in accordance with the facility's waste acceptance criteria. 2. If the waste **is not** a toxic dangerous waste, dispose at the ERDF or other facility approved by EPA and in accordance with the facility's waste acceptance criteria.
4	4	1. If the waste **is** a persistent dangerous waste, treat as needed and dispose at the ERDF or other facility approved by EPA and in accordance with the facility's waste acceptance criteria. 2. If the waste **is not** a persistent dangerous waste, dispose at the ERDF or other facility approved by EPA and in accordance with the facility's waste acceptance criteria.
5	5	1. If the waste **is** a PCB waste, treat as needed and dispose at the ERDF or other facility approved by EPA and in accordance with the facility's waste acceptance criteria. 2. If the waste **is not** a PCB waste, dispose at the ERDF or other facility approved by EPA and in accordance with the facility's waste acceptance criteria.
6	6	1. If the waste complies with the radiological waste acceptance criteria or can be treated to comply, dispose at the ERDF or other facility approved by EPA and in accordance with the facility's waste acceptance criteria. 2. If the waste **does not** comply with the radiological waste acceptance criteria, **do not** dispose at ERDF, but if TRU at WIPP or if not TRU then at an EPA approved facility in accordance with the facility's waste acceptance criteria.
7	7	1. If the waste complies with the waste acceptance criteria physical form requirements or can be treated to comply, dispose at the ERDF or other facility approved by EPA and in accordance with the facility's waste acceptance criteria. 2. If the waste **does not** comply with the waste acceptance criteria physical form requirements, **do not** dispose at ERDF, but at an EPA approved facility in accordance with the facility's waste acceptance criteria.

Table 1-7. Decision Rules. (2 sheets)

DS No.	DR No.	Decision Rule
8	8	1. If the waste <u>is</u> land disposal restricted, treat as needed and dispose at the ERDF or other facility approved by EPA and in accordance with the facility's waste acceptance criteria. 2. If the waste <u>**is not**</u> land disposal restricted and <u>**does not**</u> require treatment prior to disposal, dispose to the ERDF or other facility approved by EPA and in accordance with the facility's waste acceptance criteria.

Notes:

DR = decision rule
DS = decision statement.
ERDF = Environmental Restoration Disposal Facility.
PCB = polychlorinated biphenyl.
TSD = treatment, storage, and disposal.

1.2.6 Limits on Decision Error

Sludge: A statistical sample design is not applicable to sludge removal from radioactive debris or the basin floor as a 100% visual observation in accordance with the qualified process will be applied. A judgment sample design has been selected to determine redeposition of sludge on cleaned floor areas. Visual comparators will be placed in each basin bay and pit except the weasel and tech view pits where a comparator will be placed at the throat of the pit. The visual examination results of these visual comparators apply to the basin bay or pit in which it is placed.

Concrete: The sample design for below water concrete surface characterization is not stated in this document but the sample design and methods provided by KBC-25121 are included by reference in this document. A statistical sample design for dose rate measurement of above basin water concrete is not applicable because dose rate surveys will be performed on all exposed concrete surfaces as necessary.

Debris: A judgmental sample design is selected for the characterization of porous and nonporous radioactive debris to be able to answer DS #6. The radioactive contamination of debris removed shall be applied to the debris left in the pits as adjusted for measured dose rate and difference in surface area from removed debris. Containers containing either porous or nonporous material removed from the basin will be characterized per HNF-6495. The contamination on below water debris will be consistent for both debris types because the debris has been exposed to the same conditions and consists of similar materials. No significant variation in surface contamination is expected. At least 5 containers of porous debris constituting more than 50% of the basin porous debris inventory must be characterized in order to provide enough data to calculate radioactivity on the porous debris remaining in pits. At least 10 containers of nonporous debris must be characterized in order to provide enough data to calculate radioactivity on the nonporous debris remaining in pits.

General: The waste management DS# 1 through 4 and 8 are very error tolerant for monoliths by virtue of the robust encapsulation treatment. The encapsulation is a land disposal restriction compliant treatment process that possesses very few restrictions on waste types. Basin and pits reduced to rubble are not tolerant of errors in managing chemically dangerous constituents.

The waste management DS# 7 is error tolerant for monoliths by virtue of the robust encapsulation treatment. Unless large cavities exist or large quantities of water are retained in the monolith the encapsulate will absorb the water over time and grout strength will maintain the cavity preventing subsidence. Rubblized basin and pits are not tolerant of voids and free liquids.

Waste management DS# 6 is not tolerant of sludge inventory error as it drives the determination of whether the waste is classified as greater than Nuclear Regulatory Commission (NRC) class C. The DS# 6 is tolerant of errors in radionuclide inventory contribution from radioactive debris and below water basin concrete surface as their contribution is relatively minor.

1.2.7 Optimize the Design for Obtaining Data

This section generally is used to determine the most resource-effective data collection design for a statistically based sample design. A judgment based approach is being used for all other data collection including weight, volume, area determinations, and inventories are not statistically based. A discussion of the sample rationale and design for obtaining judgment based data is presented in section 2.0

The monolith chemical and radiological characterization will be accomplished by maintaining an inventory and calculating the quantities of component waste materials in the monolith. The component waste materials that must be inventoried include structural concrete, grout, equipment and radioactive debris, below and above basin water floor or wall surface area, and sludge. The quantities of materials such as structural concrete, encapsulating grout, and equipment and radioactive debris may be calculated or weight measurements taken.

The characterization of rubblized basin and pit walls and floors will be accomplished by collecting dose rate measurements on the concrete surface prior to size reduction. No information collection is necessary to support designation of the rubblized waste except identification of fixatives, if applied. An alternate radioactive characterization of rubble using dose rate-to-curie conversion involves the collection of dose rates and knowledge of the radioactive contamination of the rubble. The radionuclide distribution applied will use already established distributions for sludge, debris, and concrete surface.

2.0 SAMPLING RATIONALE AND DESIGN

The K East Basin pit monoliths and rubblized basin and pits activities to characterize monolith or rubble depends on the material that may still be resident in the monolith or rubble. The characterization of basin is the simplest as the rubble will only consist of radioactively contaminated structural concrete and fixative, if applied. The characterization of pits uses the same methods regardless whether the pit is removed as rubble or a monolith. All pits have the same sources of contaminants: structural concrete, radioactivity embedded in below water concrete surfaces, sludge, debris, and fixative, if applied. The only difference is debris may not be in all pits being reduced to rubble and pits removed as monoliths may receive hydrolase spoil whereas pits removed as rubble will not receive spoil. An alternate radioactive characterization of basin or pits reduced to rubble using dose rate-to-curie conversions may be applied as described in section 2.2.3.

The K East Basin and pits may be removed in these three forms: 1) *encapsulating monoliths* without dangerous waste debris, 2) *encapsulating monoliths* that include encapsulated dangerous waste debris, and 3) *Rubblized basin and pit material.* The sampling rationale and design, and sample location and frequency for encapsulated monoliths and rubblized basin and pits are discussed separately in Sections 2.1 and 2.2 respectively.

2.1 ENCAPSULATING MONOLITHS

This section describes the sampling strategy, locations and frequency for the encapsulating monoliths. Encapsulating monoliths are considered to be the sections of pit concrete floor, or wall and floor that include grout that encapsulates sludge contamination, debris, or spoils (when present) and provides shielding. The project plan is to grout encapsulate the NLOP and SLOP and may encapsulate the DEP. The actual pits that are removed as monoliths will be determined in the future when the debris, sludge, and below water concrete surface removal is better understood.

2.1.1 Physical Waste Form

The encapsulating monolith physical waste form attributes important for disposal at the ERDF are: 1) the waste must not exhibit free liquids, 2) it must include minimal void space, and 3) it must not generate harmful gases. The attribute of no free liquid and minimize void space will be met by ensuring that grout will fill the space displacing and/or chemically immobilizing water when the radioactive debris material is grouted in a monolith (See Appendix D). The attribute of no harmful gas generation will be met by removing materials that may generate a harmful gas by ensuring that aluminum radioactive debris surface area ratio to basin floor surface area is less than 33 m^2/m^2 ("Potential for Flammable Atmosphere Above the K-Basin Pool During Grouting," [Epstein 2004]) in the basin at the time grout is added to the basin. The aluminum to floor surface area ratio limit will be complied with by prohibiting the stacking of aluminum canisters on top each other in the basin at the time of grouting.

2.1.2 Polychlorinated Biphenyl Waste Characterization

The encapsulating monoliths that are comprised of pit structural concrete, radioactive debris, and grout include materials that have contacted sludge and will contain sludge residue. Sludge is a PCB contaminated waste. Therefore, the monolith pieces will be designated as PCB remediation waste. The monolith PCB content will be assigned by determining the quantity of sludge contaminating the monolith. An inventory will then be determined using the highest PCB concentration reported for K East Basin sludge multiplied by the quantity of sludge determined to be resident in the monolith.

2.1.3 Dangerous Waste Constituents

The monolith chemical characterization, used to support a WAC 173-303 dangerous waste designation, will be accomplished using a combination of process knowledge and by evaluating the debris inventory of the monoliths. Structural concrete, encapsulating grout, removed and intact wall and floor concrete surface, and sludge do not cause a monolith to be designated as dangerous waste. Removed and intact K East pit wall and floor surface is not dangerous waste as discussed in KBC-25121. Each radioactive debris item, material, or equipment encapsulated in a monolith will be designated to determine its status as dangerous waste. A K Basins radioactive debris inventory list is provided per HNF-SD-SNF-TI-052, *K Basins Debris Inventory*. A list of possible items in the K East Basin not listed on HNF-SD-SNF-TI-052 is provided in Appendix C of KBC-24413. The radioactive debris designation will be based on process knowledge which includes but is not limited to material safety data sheets and article design information. Any fixative that may be applied to the exterior of a monolith will be characterized and designated based on process knowledge.

2.1.4 Radionuclide Characterization of Encapsulating Monoliths

The encapsulating monolith radionuclide characterization will be accomplished by using the monolith inventory to calculate the total radionuclide content from each source of radioactivity, producing a total inventory by summing each source. The monolith radionuclide contamination sources are K East Basin sludge, radionuclides in the concrete wall and floor surface, and radionuclide contamination on and activation products in radioactive debris. The total radionuclide inventory for a monolith will be compared to the ERDF waste acceptance criteria to ensure it will comply for disposal at the facility.

The quantity of Tc-99 in all the monoliths has been calculated to be less than 3 curies. This maximum possible quantity of Tc-99 is above the ERDF and Hanford Site low-level waste burial grounds thresholds requiring evaluation before acceptance of the waste. The waste will be evaluated to determine if actions such as treatment to reduce Tc-99 mobility or applying limits to the inventory of Tc-99 to acceptable levels are required.

The total weight and volume of a monolith and, if applicable, the waste portion of a monolith that is appropriate for waste classification determinations may be measured or calculated. In the planned monolith configuration all of the grout added is considered in waste classification determination. The conditions where the added grout can be considered in waste classification determinations are discussed in section 2.1.4.4. The calculated weight and volume may be based on design data, on measurements of like or surrogate materials, vendor data, and other information.

2.1.4.1 Radioactive debris Radionuclide Contribution to Monolith

The monolith radionuclide inventory contribution from radioactive debris will be determined for porous and nonporous radioactive debris, activated metal, and used filters. The filters are those used to clarify water overflowing from a pit when it is receiving hydrolase spoil or provide basin water clarity after sludge has been removed from the K East Basin in accordance with the sludge end point criteria described in HNF-20632. K East Basin below water radionuclide distribution information will be used as provided in HNF-6495. It is recognized that a small quantity of radioactive debris left in the basin may not be on an inventory or characterized per requirements of this document. This debris is typified by small and/or irregular items. The small quantity is expected to be limited to <1% of the radioactive debris in a monolith as determined by visual examination.

The radionuclide contamination on radioactive debris remaining in the basin has three components: (1) sludge adhering to or resident in the debris, (2) a surface film of radioactive contaminants on nonporous debris, and (3) for porous radioactive debris only, penetration of radioactive contaminants into the porous debris surface.

- Sludge adhering to debris will be removed by cleaning with water to the extent that sludge is not readily visible. Sludge resident in internal debris void spaces will be removed to the maximum extent practicable. If sludge cannot be removed from radioactive debris the amount will be calculated and added to the residual sludge inventory of a monolith. In order to verify sludge has been removed from radioactive debris using visual means, the water conditions must be controlled to maintain visual acuity at the time these determinations are made.

- Characterization of porous and nonporous radioactive debris being left for encapsulation in a monolith will be determined by removing some of each material from the basin to be characterized as per HNF-6495. An average radionuclide-to-unit area factor can be determined for the contents of containers from these data. The factor can be adjusted to compensate for the debris being left in a monolith dose rate and the difference in surface area between removed and debris being left in a monolith. The total radionuclide inventory of porous and nonporous radioactive debris in a monolith can be determined by multiplying the average radionuclide-to-unit area factor of each debris type by the quantity of debris being left in the monolith as adjusted for debris dose rate and surface area differences.

- Activated metal content of a monolith will not be controlled, but rather a maximum radionuclide inventory stated on Table 2-1 will be apportioned to each monolith such that when summed it will equal the total inventory presented on the table. The stated quantity of radionuclides is the maximum amount from activated metal that may be resident in the K East Basin after fuel and sludge removal as calculated per KBC-23699, *Estimate of Activated Metal in K East Basin Debris*. The project will partition the total inventory of

Table 2-1 to each monolith based on where activated metal is expected to appear in the monoliths.

Table 2-1. Activated Metal Radionuclide Monolith Inventory.

Radionuclide	Maximum Inventory in K East Basin (millicuries)
C-14	1.04E+01
Co-60	3.61E+02
H-3	1.02E+02
Fe-55	1.20E+01
Ni-59	7.13E+00
Ni-63	1.28E+02
Sn-121m	2.27E+01

Radioactive debris left in a monolith may include filters used to clarify water overflowing from a pit when it is receiving hydrolase spoil or provide basin water clarity after sludge has been removed from the K East Basin in accordance with the sludge end point criteria described in HNF-20632. Filters used in any other service may not be left in a monolith or basin and pit rubble. The retention of these filters in a monolith either does not affect the radioactive content as the filter captures material already calculated to reside in the pit or the radioactive content will be estimated and added to the monolith inventory.

The radionuclide inventory contribution from radioactive debris being left in a monolith is the sum of all of the above parts including nonporous radioactive debris, porous radioactive debris, and activated metal.

2.1.4.2 Wall and Floor Surface Radionuclide Contribution to Monolith

The monolith radionuclide inventory contribution from radionuclides in the concrete floor and wall surfaces that are below basin water is determined per KBC-25121. Below water wall and floor surface content in a monolith consists of two possibilities: intact concrete floor and wall surfaces in the monolith, and spoils consisting of floor and wall surface removed via hydrolasing that are placed in the monolith. Both sources are characterized using the same methods as described per KBC-25121. The characterization methods involve the collection of data such as a surface area, location, and dose rate surveys. A discussion of data collection is not provided here but can be found in KBC-25121.

The monolith radionuclide inventory contribution from concrete that is above water, except for sub-grade and cut concrete surfaces[3], will be performed per the methods of above water concrete surfaces as per Section 2.2.2. Sub-grade, cut surfaces, monolith grout surfaces, and below water

[3] Sub-grade and cut concrete surface radioactive contamination will not be considered in determining the radioactive inventory of encapsulating monoliths. The level of contamination necessary to result in a significant radioactive inventory contribution to an encapsulated monolith would produce prohibitive external dose rate on the monolith.

concrete surfaces that have been subjected to surface removal, like hydrolasing, will not be determined as the inventory will be insignificant relative to the other contributions.

2.1.4.3 Sludge Radionuclide Contribution to Monolith

The monolith radionuclide inventory contribution from sludge will be determined by calculating the quantity of K East Basin residual and redeposited sludge contaminating a monolith. K East Basin sludges have been characterized extensively and do not require additional sample analysis. K East Basin sludge exists as two compositions: residual basin sludge consisting of a mixture of 93% floor and 7% canister sludge and redeposited sludge, also called light or fluffy sludge. The composition of residual basin sludge applies to all sludge remaining at the completion of final pass in the K East Basin. The light or redeposited sludge is sludge that settles out from the water after final pass. The K East Basin residual sludge radionuclide concentrations are provided in KBC-24413, Table A-1 in Appendix A. The redeposited sludge radionuclide concentrations are provided in KBC-24413, Table B-1 in Appendix B. The sludge weight is determined for each monolith through determination of sludge depth of each sludge type. For each sludge type, the depth is converted to volume then is multiplied by the concentration for each radionuclide to calculate the sludge contributions to the monolith total radionuclide inventory. The total sludge contribution to the radionuclide inventory of a monolith is the sum of the redeposited sludge plus the residual sludge.

The sludge will be removed to the maximum extent practicable in three steps: (1) gross sludge is removed to reveal radioactive debris; (2) sludge is collected as radioactive debris is removed, moved, and/or cleaned; and (3) a final pass to complete sludge collection is performed. After the final pass, visual examination of the floor will be used to demonstrate compliance with the sludge removal end point criteria, HNF-20632, as implemented by a qualified process KBC-24721 resulting in a determination that the floor is clean. At the point the entire K East basin and pits (or isolated area) are determined to comply with the sludge removal end point criteria visual acuity and inspection of visual comparators is no longer required and the total sludge remaining in the basin and pits is established. However, monitoring of visual comparators in the NLOP may be required after achieving the sludge removal end point criteria if visual comparators are used as the method to measure the quantity of sand filter backwash sludge discharged to the NLOP. The total sludge is the sum of residual sludge and redeposited sludge. The redeposited sludge content will consider the amount of sludge that could settle out from basin water.

The amount of sludge on the basin floor for purposes of calculating a sludge inventory will be the sum of the residual sludge on a floor and the amount of sludge redeposited on the floor after completion of sludge removal. The sludge removal requirement is removal to the maximum extent practicable, however for compliant disposal of the grouted monoliths at the ERDF a total average sludge thickness of 0.508 cm (0.20 in.) across the floor is a calculated maximum allowable sludge depth. The aforementioned calculated maximum allowable sludge thickness is based on expected quantities of spoils and debris being placed in the pits with sludge for grouting. The actual sludge depth remaining will be determined as described herein and will be used with other measurements and calculations to demonstrate the waste is compliant for disposal at the ERDF. The actual maximum amount of sludge that may be resident in a monolith is dependent on measurements of other contributors to the radionuclide inventory like hydrolase spoil and debris

The quantity of residual sludge that may still exist on a floor surface that has been determined to be clean (i.e., after final pass) will be determined by demonstrating the qualified sludge removal process and other activities. If sludge cannot practicably be removed from areas of floor or radioactive debris, the length, width, and depth of the sludge will be determined in order to calculate the total amount of sludge for addition to the monolith sludge inventory. These determinations of extent may be performed visually or based on design data.

Light or redeposited sludge (i.e., fine particulate material that would have been removed by the sand filter during operation) may settle out of the basin water and be redeposited on the floor after it has been cleaned of sludge. Redeposited sludge accumulation will be monitored using visual comparators placed on the basin and pit floors. Visual comparators will be monitored until the end point criteria for sludge removal has been attained for all the K East basin and pits or if isolated from the basin then for that area. The visual comparators will be visually examined to determine if more sludge has redeposited on the floor. The redeposited sludge radionuclide concentrations to be used to calculate the monolith radionuclide inventory are presented in Table B-1 in Appendix B of KBC-24413.

After achieving the sludge removal end point criteria, the sand filter may be backwashed into the NLOP adding backwash sludge (i.e., similar to redeposited sludge) to the NLOP. At the time the sludge end point is attained, an inventory of the sludge resident in the basin and pits will be calculated. The discharge of the sand filter backwash to the NLOP from continued operation of the sand filter after the sludge end point criteria is achieved would merely relocate a small portion of the sludge inventory collected from basin water. Sludge suspended in water that is not accumulated in the sand filter is expected to be redeposited and collected via the hydrolase spoils collection system and distributed to the NLOP and SLOP; or filtered from the basin water during water removal, as necessary. Because the quantity of sludge to be collected in and then backwashed out of the sand filter is expected to be small and that it is not possible to know where in the basin the sludge came from, it is assumed that the sludge inventory will not change in the basin and pits except the NLOP. Sand filter backwash discharged to the NLOP will be added to the NLOP redeposited sludge inventory. The quantity of redeposited sludge added to the NLOP from backwashing the sand filter may be determined by measurement (e.g., using visual comparators to measure it as described in the paragraph immediately above) or calculated based on operating experience, measurements and existing radionuclide inventories

Sludge will be removed to the extent practicable, debris that can be moved with moderate effort will be moved to the extent necessary to support sludge removal. Examples of debris that cannot be moved with moderate effort are tanks that have been located in the tech view and weasel pits. The tech view and weasel pits will be cleaned of sludge before the cleaning process and visual examinations described above are performed to enable sludge retention tanks[4] to be placed in them. Sludge will be removed from these pits to the extent practicable prior to placement of tanks. Video of the cleaned weasel pit floor will be produced prior to placement of the tank to document the floor condition. After sludge removal from the tanks an inspection and sludge removal process will be undertaken in these pits. It is unlikely that the three step qualified

[4] Sludge retention tanks will be used to temporarily store sludge prior to transfer from K East. After use and cleaning the tanks will be left in place to be reduced to rubble.

sludge removal process can be used due to tanks obstructing access. Instead, sludge will be removed from inside, under, and around the tanks to the extent practicable and video and/or still photos will be recorded to the extent practicable. An evaluation of the pit video and still photo data will be conducted to determine whether to adjust the characterization sludge thickness layer, to be applied to these pit floors.

2.1.4.4 Radionuclide Concentration Averaging Across the Monolith

Guidance given in the Nuclear Regulatory Commission (NRC) *Issuance of Final Branch Technical Position on Concentration Averaging and Encapsulation, Revision in Part to Waste Classification Technical Position* (BTP)(NRC 1995) and *Technical Position on Waste Form (Revision 1)* (NRC 1991) documents describe situations where both encapsulants such as grout and waste weight and volume together may be used in waste class determinations. The monolith waste form was evaluated against the NRC guidance papers, the evaluation is provided in Appendix A.

The K East Basin grouting process is necessary to reduce dose rate on the exterior of the monoliths as low as reasonably achievable (ALARA) and meet the ERDF waste acceptance criteria, meet requirements for free liquid and void space, macroencapsulate hazardous waste to comply with treatment standards, fix radioactive debris and contamination for burial and transportation, and fulfill transportation requirements to ship waste (e.g., isotopes, activity, dose). Grouting the pit provides dose rate reduction by placing shielding (i.e., grout) between the radioactivity and the exterior of the monolith where the pit connects with the basin and at the open top of the pit.

K East Basin monoliths are similar to the situation described in Section 3.7 "Encapsulation of Solid Material" of the branch technical position (NRC 1995) because the finished monoliths will encapsulate radioactive debris, as well as provide shielding for contaminants on the concrete basin substrate. In order to comply with the NRC guidance, the grout will be formulated to bear the expected overburden and the radionuclide loading limited to ensure less than 0.2 µSv/hr (0.02 mrem/hr) external monolith surface dose rate after a 500-year decay period.

2.2 RUBBLIZED BASIN AND PITS

This section describes the sampling strategy and measurement collection, locations and frequency for the K East Basin and pits that will be reduced to rubble for disposal. The project plan is to reduce to rubble the entire K East Basin and tech view and weasel pits. The DEP may also be reduced to rubble depending upon the basin and pit conditions. The basin will have all debris removed and all below water concrete surfaces removed by hydrolasing. Hydrolasing removes a layer of concrete surface thereby removing both sludge and radionuclides embedded in concrete surfaces. The pits will not be hydrolased but will have debris removed except the sludge retention tanks located in the tech view and weasel pits and concrete and debris surfaces will be rinsed with water removing contamination from surfaces. The determinations described herein will be evaluated over the entire basin rubble, the tech view and weasel pit rubble, and, if necessary, the DEP rubble.

2.2.1 Polychlorinated Biphenyl Waste Characterization

The rubblized basin are comprised of wall and floor concrete where all below water surfaces have been removed by hydrolasing thereby also removing all sludge. Therefore, basin rubble waste will not be considered a PCB containing waste.

The rubblized pits are comprised of floor and wall below water concrete surfaces that are not hydrolased. Therefore, pit rubble will contain sludge contamination. Sludge is a PCB contaminated waste. Therefore, the pit rubble will be designated as PCB remediation waste. The rubble PCB content will be assigned by determining the quantity of sludge contaminating the rubble of the tech view and weasel pits and, if necessary, DEP. An inventory will then be determined using the highest PCB concentration reported for K East Basin sludge multiplied by the quantity of sludge determined to be resident in the rubble of the tech view and weasel pits and, if necessary, DEP.

2.2.2 Dangerous Waste Constituents

The K East Basin rubble consists only of structural concrete and radioactive fixative if applied. Structural concrete is not a dangerous waste. Fixative is not expected to cause the rubble to be dangerous waste, however the rubble will be designated when the fixative is known to confirm this determination.

The pit rubble consists of structural concrete, sludge contamination, radioactive fixative if applied, and sludge retention tanks in the tech view and weasel pits. Structural concrete and sludge do not cause a monolith to be designated as dangerous waste. The sludge retention tanks are constructed of metal which do not designate as dangerous waste. Any fixative that may be applied to the pit rubble will be characterized and designated based on process knowledge. Fixative is not expected to cause the rubble to be dangerous waste, however the rubble will be designated when the fixative is known to confirm this determination.

2.2.3 Radionuclide Characterization of Rubblized Walls and Floors

The rubblized basin and pits will be characterized for surface contamination in two components: 1) the area below basin water and 2) the area above basin water. The rubble radionuclide inventory will be the sum of the two components. The concentration is determined by dividing the inventory by the applicable basin rubble or pit rubble weight or volume. The tech view and weasel pits will be evaluated as one unit. The DEP, if reduced to rubble, will be evaluated as a separate unit. An alternate method that may be used is provided at the end of this section.

Above Water Concrete Surface Contribution

The basin and pit concrete above water surfaces will be characterized by collecting surface dose rates then applying a dose rate-to-curie conversion factor to determine the Cs-137 inventory of the surface. The dose rate-to-curie conversion factor that may be used is documented per *Dose-to Curie Method for Estimating K-East Basin Residual Contamination* (Mantooth 2004) or another conversion factor may be developed. For calculation purposes the average dose rate will be used unless all or most of the dose rate measurements are less than instrument detection limits. If most but not all measurements are less than detection limits then the average of the measured values (i.e., greater than detection limit) will be used. If all measurements are less than detection limits then the detection limit will be used. The above water portions of the basin and pit concrete surfaces will use the radionuclide ratios of above water radioactive debris provided in Table 2-2 of HNF-6495 to calculate the total inventory of a surface. The above water concrete surface area and radioactivity will be calculated that contributes to the basin and each pit.

Basin Rubble Below Water Contribution

The below water concrete basin walls and floors will be characterized after hydrolasing by collecting dose rates, determine the Cs-137 inventory by applying a dose rate-to-curie conversion factor, and then the radionuclide inventory by applying the radionuclide distribution determined by KBC-25121. The dose rate-to-curie conversion factor that may be used is documented per *Dose-to Curie Method for Estimating K-East Basin Residual Contamination* (Mantooth 2004) or another conversion factor may be developed. For calculation purposes the average dose rate will be used unless all or most of the dose rate measurements are less than instrument detection limits. If most but not all measurements are less than detection limits then the average of the measured values (i.e., greater than detection limit) will be used. If all measurements are less than detection limits then the detection limit will be used.

Pit Rubble Below Water Contribution

The radionuclide inventory contribution from below water pit material is the sum of radionuclides contained in intact concrete surfaces, sludge contamination, and, for the tech view and weasel pit, contamination on the sludge retention vessel. The pit surfaces and sludge retention vessel will be rinsed with water removing contamination from the surfaces. The quantity of sludge on the pit floors, radionuclides contained in the intact concrete floors and walls, and radionuclides contaminating the retention vessels will be determined as described for monoliths in section 2.1.4 of this SAP. An inventory of debris, sludge, and below water concrete surface will be maintained for the tech view and weasel pit unit and DEP unit.

Alternate Method

Instead of summing all the contributors to obtain a total radioactive inventory, the radioactivity may be calculated based on a dose rate measurement on the exterior of an ERDF roll-off box or other container in which rubble is loaded. The inventory requirement applied to pits described per the other method still applies as it is necessary information to determine the proper radioactive distribution to be applied. The process to calculate the radionuclide inventory and concentration in rubble loaded into an ERDF roll-off box or other container is.

1. Identify the radionuclide distribution that is applicable to the rubble. A distribution can be determined by assigning a bounding distribution (i.e., bounding actinide to Cs-137 ratios) or calculating a distribution by summing all of the radioactive contributions including porous and nonporous debris, concrete surface, and residual and redeposited sludges.
2. Collect dose rate measurements around the filled ERDF roll-off box or other container.

3. Use a dose rate-to-curie conversion to calculate the Cs-137 content of the ERDF roll-off box or other container.
4. Use the radionuclide distribution and Cs-137 content to calculate the total radionuclide inventory of the ERDF roll-off box or other container.
5. Determine the mass and volume of rubble in the ERDF roll-off box or other container.
6. Calculate the radionuclide concentration by dividing the inventory by the mass or volume of rubble in the container.

Dose rate-to-curie relationships will be or have been established for ERDF roll-off box or other container configurations. The relationship will establish the number and locations of dose rate measurements to be collected. An ERDF roll-off box dose rate-to-curie relationship is documented in HNF-26419, *ERDF Roll-off Container Dose-Rate-To-Curie Method for Hard Debris Waste*.

The identification of the applicable radionuclide distribution is discussed in detail in section 5.2.5.

Radionuclide Concentration Averaging Across the Rubble

The KE Basin rubble is contaminated materials on which radioactivity resides near the surface of components or metals as described in section 3.4 of the NRC BTP (NRC 1995). The rubble is size reduced structural concrete and metal sludge collection tanks that are contaminated on the surface with radioactivity. The NRC BTP states that "the volume or weight of the contaminated item should be the total weight or displaced volume of the item (i.e., major void volumes subtracted from envelope volume)." The act of reducing the material to rubble will eliminate major voids. The NRC BTP continues when discussing mixtures containing multiple radionuclides contaminating material, like KE Basin rubble, that the concentration may be determined using averaging methods (NRC 1995).

The NRC via the BTP recognizes concentration averaging as appropriate for determining the waste radionuclide concentrations in material including KE Basin rubble, however practically there are three distinct areas where rubble will be created by the KE Basin removal. The three areas are: the basin, the tech view and weasel pits, and DEP. The basin contamination is different than the pits as it will not contain meaningful quantities of sludge or below water concrete surface which the pits will, therefore the basin will be considered separately from the pits. The tech view and weasel pits are adjacent to each other and both will contain sludge collection tanks when reduced to rubble so these two pits will be considered as one separate unit for concentration averaging. The DEP, if reduced to rubble, is not close to the other pits and does not contain tanks, so the pit will be considered a separate unit for concentration averaging.

3.0 SAMPLE AND MEASUREMENT LOCATION AND FREQUENCY

This SAP includes sampling for surface contamination, dose rate surveys, and the collection of measurements and information of materials in monoliths or tech view and weasel pits. Sampling and measurement activities required are discussed separately in this section.

3.1 SAMPLING

The exterior surfaces of monoliths, debris being left in pits, and concrete surfaces of walls and floors that are reduced to rubble will be surveyed for radioactive contamination. The location and frequency of sample collection is established in this section. The application of SW-846, *Test Methods for Evaluating Solid, Waste Physical/Chemical Methods* (EPA 1997), sample collection requirements were considered in the preparation of this SAP. However, SW-846 is designed to collect samples for physical and chemical testing not testing for smearable radioactive contamination. Therefore, sample collection is performed in accordance with work documents prepared pursuant to 10 CFR 835, "Occupational Radiation Protection," and the Fluor Hanford, Inc. (FH) radiation protection plan requirements instead of SW-846 requirements.

Debris waste being removed from below water will be characterized for radioactivity to establish the radionuclide inventory of debris being left in the pits. The design is judgment based and thus the statistical methods described in chapter 9 of SW-846 are not applicable.

3.1.1 Contamination Sampling

Samples of smearable radioactive contamination are collected from exterior surfaces of monoliths and concrete surfaces before they are reduced to rubble for the purpose of radioactive contamination control and demonstrate compliance with ERDF supplemental requirements (0000X-DC-W0001). The number of samples and location of samples to be collected on each surface shall be selected in the field and recorded on survey reports.

Each radioactive smear sample will be collected by swiping with a dry filter or soft absorbent paper, applying moderate pressure, on the exterior surface over an area of approximately 100 cm^2.

3.1.2 Porous and Nonporous Debris

Characterization of porous and nonporous radioactive debris being left in pits will be determined by removing some of the material from the basin to be characterized as per HNF-6495. A radionuclide-to-unit area factor can be determined for the contents of each container from these data. An average radionuclide-to-unit area factor that is adequate to represent the waste will be determined. At least 5 containers of porous debris constituting more than 50% of the basin porous debris inventory must be characterized in order to provide enough data to calculate the radioactivity on the porous debris remaining in pits. At least 10 containers of nonporous debris must be characterized in order to provide enough data to calculate the radioactivity on the nonporous debris remaining in pits.

3.2 MEASUREMENTS

Measurements and baseline data concerning contaminants of concern are required to develop estimates of components that make up the radionuclide inventory in the monoliths and rubblized basin and pits and develop the final characterization. This section describes the measurements required and processes to obtain the information.

3.2.1 Dose Surveys

Surface dose rate measurements of concrete surface and below water debris will be collected. Dose rate measurements will be obtained using an ion chamber, Geiger-Mueller AMP-100, or bicron microrem meter which shall be operated in accordance with internal work requirements and processes established in compliance with 10 CFR 835. The dose rate detection limit will be dictated by the background. Background measurements shall not be more than 20% of the surface dose rate measurement unless less than 10 mRem/hr. Survey reports documenting the surface dose rate measurements shall, at a minimum, include the following information:

- Date of measurement
- Identify material and location material was obtained and sample number if applicable
- Uncorrected dose rate
- Location where measurement was taken
- Background dose rate measurement, where applicable
- Person taking the measurements
- Instrument number.

The survey reports will be provided to Waste Services for data validation. The survey reports will be maintained as a record per Section 5.1.6 of this SAP.

3.2.1.1 Below Water Debris Dose Rate Surveys

Below water debris will be surveyed to measure dose rate as necessary to characterize debris in accordance with HNF-6495 that is removed from the basin. Below water debris that is being left in the basin will be surveyed as necessary to demonstrate a radioactivity relationship between debris removed from the basin and debris that remains in the pits. Porous and nonporous debris are considered separately when establishing a relationship between debris removed and being left. The locations and frequency of measurements are dictated by the methods used in accordance with HNF-6495.

3.2.1.2 Concrete Surface Dose Surveys

The radionuclide inventory contribution from nuclides in intact concrete floor and wall surfaces that are below basin water is determined per KBC-25121. Dose rate surveys of below basin water concrete surfaces that have been subjected to surface removal, like hydrolasing, may be collected as described for above water surfaces provided below.

K East Basin concrete surfaces that are above water will be characterized when necessary by measuring the dose rate of the concrete surface to determine the inventory of Cs-137 which is then related to ratios of other radionuclides as described in Section 2.2.3. The location and frequency of dose surveys on above water concrete will be over all surfaces as necessary to comply with the requirements for transportation and radiation control program.

3.2.2 Sludge Quantity Measurements – Basin and Debris

Two measurements of sludge are collected, the amount of residual sludge remaining and the amount of sludge redeposited after completion of final pass. Sludge is removed from the floor to the maximum extent practicable using a qualified process that limits the possible quantity of sludge contamination on the floor at the completion of final pass sludge removal. This sludge residual layer thickness, if any, is determined by visual observation of the basin and pit floors. After completion of final pass visual comparators will be placed on the floor to measure the amount of sludge that may have redeposited on the floor area. The residual sludge radionuclide concentrations are provided in Table A-1 of KBC-24413 columns labeled, "Estimated Sludge Concentration". The redeposited sludge radionuclide concentrations are provided in Table B-1 of KBC-24413 in the column labeled "sludge concentration." The total sludge radionuclide contribution is the sum of the radionuclide inventory of residual and redeposited sludges.

Visual observation of floor, radioactive debris, and visual comparator will be performed in accordance with quality processes and work instructions that satisfy the fundamentals of the FH quality assurance program. When visual observations are made the water visual acuity shall be maintained such that a 0.08 cm (1/32 in.) black line can be seen on an 18% neutral gray card. Visual observations will be performed using the human eye, still camera, or video camera. In the event that spent nuclear fuel is found it will be removed. Fourteen visual comparators shall be placed in the basin and pits after the floor has been cleaned of sludge as specified in Appendix B. Additional comparators may be placed as necessary, for example to measure sand filter backwash material in the NLOP. The visual comparators will be used to determine the quantity of sludge that has redeposited on the floor. The visual comparators may consist of either or both step disks or painted plates. The location of visual comparators and a description of the both types is provided in Appendix B. The sludge redeposition determination may be made for each basin bay or pit individually.

Visual inspections of the floor, radioactive debris and visual comparator shall be recorded on still camera or video at a rate of 100% in accordance with the qualified process at the time sludge removal end point determinations are made less the places where interferences prohibit floor examination. The recordings shall include the check of the visual acuity. The redeposition of sludge in the weasel and tech view pits will be determined by visual observation to the extent possible given the obstructions that exist. The visual inspection recordings shall, at a minimum, include the following information:

- Date of measurement
- Location where observation was taken

- Person taking the measurements
- Instrument.

The visual recordings are record material and will be maintained per Section 5.1.6 of this SAP.

3.2.3 Spoils Inventory

Hydrolase spoils inventory information is required to calculate the quantity of radionuclide inventory in a monolith. The following minimum information shall be collected for spoils that shall remain for grouting:

- Estimated weight
- Estimated volume
- Location placed (monolith)
- Date record was produced
- Person recording inventory information

The spoils inventories will be maintained per Section 5.1.6 of this SAP.

3.2.4 Debris Inventory

Debris inventory information is required to calculate the quantity of radionuclide contaminants and designate waste. Inventory information is required for nonporous debris and porous debris each separately. Information necessary to monitor the surface area will be included in the inventory. Debris inventory information may be collected on an individual debris basis or on an aggregated unit basis, such as a basket provided consistent methods are employed. Debris inventory information may be collected either during sorting and aggregation or at a later date. Debris inventories shall be performed in accordance with quality processes and work instructions that satisfy the fundamentals of the FH quality assurance program.

The following minimum information shall be collected for debris that shall remain for encapsulation or rubblizing:

- Identification of material (e.g., carbon steel, plastic, wood)
- General debris description (material if known)
- Estimated weight, if necessary
- Surface area information (aluminum only)
- Location placed (monolith)
- Date record was produced
- Person recording inventory information

The debris inventories will be maintained per Section 5.1.6 of this SAP.

3.2.5 Physical Measurements

Physical measurements of length and weight are obtained on an as needed basis. The measurements may include measuring radioactive debris, concrete to be rubblized, or monolith weight and lengths obtained to support area or volume determinations. Basin surface area, quantity of concrete that is reduced to rubble, and radioactive debris surface area and weight may be calculated from design or other information rather than measured.

Unless otherwise specified, physical measurements of length will be obtained using tapes and rods and weight obtained using weigh scales. These physical measurements will be performed as specified in Table 5-1 operated in accordance with quality processes and work instructions that satisfy the fundamentals of the FH quality assurance program.

Records of physical measurements shall at a minimum include the following information:

- Date of measurement
- Identify material and location material was obtained if applicable
- Location where measurement was taken
- Person taking the measurements
- Instrument, if applicable.

Copies of records shall be provided to Waste Services for data validation and K Basin Engineering in order to support maintenance of a monolith inventory. Weight and length measurement records will be maintained per Section 5.1.6 of this SAP.

4.0 SAMPLE HANDLING AND ANALYSIS

The application of SW-846 (EPA 1997) sample handling and analysis requirements were considered in the preparation of this SAP. However, SW-846 is designed to manage and test samples for physical and chemical parameters not testing for smearable radioactive contamination. Therefore, management and testing is performed in accordance with work documents prepared pursuant to 10 CFR 835 and the FH radiation protection plan requirements instead of SW-846 requirements. This section does not apply to direct measurements, such as radiation dose rates taken on objects in the field or visual observations, as the waste itself is subjected to measurements rather than a sample of waste collected for testing. The requirements for these measurements are provided in sections 3.2 and 5.2 of this SAP.

4.1 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

The only samples being collected and tested are smearable radioactivity samples collected and tested in the field. Chain-of-custody and analysis request documents are not prepared and maintained for these samples because the samples are tested at the field location by the sample collector soon after collection.

4.1.1 Sample Preservation, Containers, and Holding Times

Sample preservation and holding time requirements do not apply to these samples as they are tested soon after collection. The sample media will be placed in trays, bags, or other containers that are free of radiological contamination in order to move the sample into an area where they may be tested.

4.1.2 Sample Shipping

The activity is not applicable because no sample shipping is required.

4.2 SAMPLE ANALYSIS

The testing of samples of smearable radioactivity shall be performed in the field close to the place where the sample was collected. The location where testing is performed will be configured to minimize the background radiation dose rate. The sample will be tested using hand-held field instruments as described in Table 5-1 to measure dose rate. The test results will be recorded on a survey report.

5.0 QUALITY ASSURANCE PROJECT PLAN

This document is written in accordance with the applicable requirements of EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans*. The document SW-846, *Test Methods for Evaluating Solid, Waste Physical/Chemical Methods* (EPA 1997) does not apply to activities conducted in accordance with this SAP except statistical data evaluation per chapter 9 as discussed previously.

This section identifies the individuals or organizations participating in the project and discusses their specific roles and responsibilities. Quality objectives for measurement data; special training requirements for staff performing the work; and the management of documents and records are also discussed.

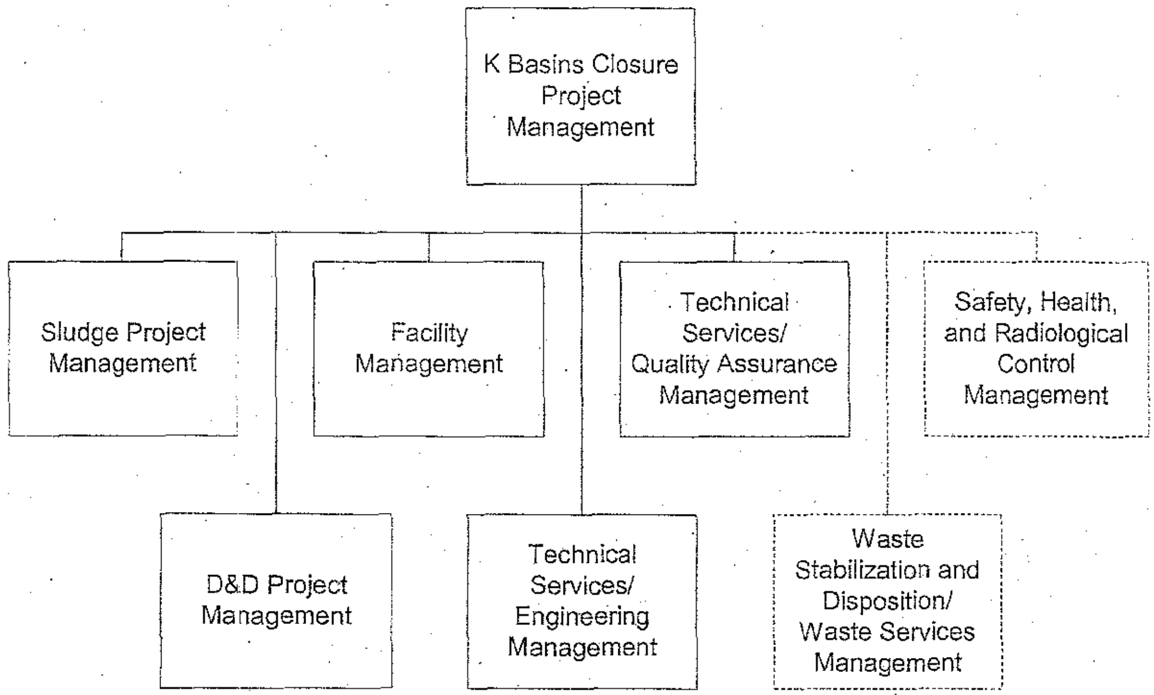
5.1.1 Project/Task Description

The K East Basin and pits will be removed and disposed as waste in the ERDF. Fuel and sludge will be removed from the basin to comply with endpoints identified in HNF-20632. A layer of floor and wall surface will be removed from the basin bays using a process called hydrolasing to reduce dose rate and contamination produced by the basin that are size reduced to rubble. Radioactive debris and hydrolase spoil will be placed in pits to be encapsulated with grout. Shielding may be placed around the material for encapsulation if necessary. Grout will be added to fill some pits to the top encapsulating debris, spoil, and sludge into a monolith waste form. The grouted pits will be cut from the basin for transport to ERDF for disposal. Basin and some pit walls and floors will then be sized reduced to rubble for transport for disposal at the ERDF. Prior to reducing walls and floors to rubble, basin below water surfaces will be hydrolased and pit below water surfaces rinsed with water. Fixatives may be applied to the exterior of grouted pit monoliths and/or concrete that is reduced to rubble to control the spread of contamination.

5.1.2 Project Organization

Figure 5-1 presents the organization chart for measurement collection and waste management interfaces to the ERDF.

Figure 5-1. Measurement Collection and Waste Management Organization Chart.



D&D = decontamination and decommissioning.

5.1.3 Roles and Responsibilities

This section identifies the responsibilities of the organizations supporting K East Basin removal and disposal activities that collect, analyze, survey, or assess results of data for waste disposal.

K Basin Closure Project

The K Basin Closure Project has the following responsibilities:

- Integrate activities of the project to accomplish removal and disposal of K East Basin and pits
- Manage corrective actions associated with work performed by organization
- Maintain qualifications of personnel performing work in accordance with this document.

K Basin Sludge Project

The K Basin Sludge Project has the following responsibilities:

- Remove sludge, perform sludge quantity measurements and certify sludge removal meets endpoint criteria

- Perform radioactive debris removal, inventory and relocation activities
- Procure equipment necessary to perform K East Basin sludge and radioactive debris removal operations
- Manage corrective actions associated with work performed by organization
- Maintain qualifications of personnel performing work in accordance with this document.

K Basin Decontamination and Decommissioning Project

The K Basin Decontamination and Decommissioning Project has the following responsibilities:

- Manage and integrate K East Basin removal activities
- Procure equipment necessary to perform K East Basin removal operations
- Grout the pits and cut apart from the basin
- Size reduce basin and pits into rubble for removal
- Excavate around the basin to gain access to the monoliths and rubble and load each for transport to ERDF
- Obtain and maintain services to operate hydrolasing equipment for removal of basin concrete surface
- Manage corrective actions associated with work performed by organization
- Maintain qualifications of personnel performing work in accordance with this document.

K Basin Facility Management

K Basin Facility Management has the following responsibilities:

- Execute K East Basin sludge, radioactive debris, and waste removal operations
- Collect information necessary to maintain a radioactive debris and concrete surface, both removed and intact, inventory for each pit
- Support hydrolasing of basin concrete surfaces
- Manage corrective actions associated with work performed by organization
- Maintain qualifications of personnel performing work in accordance with this document.

K Basin Technical Services/Engineering

The K Basin Technical Services/Engineering organization has the following responsibilities:

- Manage corrective actions associated with work performed by organization
- Maintain qualifications of personnel performing work in accordance with this document.

Safety, Health, and Radiological Control

The K Basin Safety, Health, and Radiological Control organization has the following responsibilities:

- Support the K East Basin removal activities and transportation of waste to ERDF
- Collect dose rate measurements to support radioactive debris and basin surface characterization
- Evaluate data and perform statistical calculations
- Manage corrective actions associated with work performed by organization
- Maintain qualifications of personnel performing work in accordance with this document.

Waste Stabilization and Disposal/Waste Services

The Waste Stabilization and Disposal/Waste Services organization has the following responsibilities:

- Perform data review and validation, then prepare a report of measurements performed
- Perform waste designation and radioactive waste classification determinations
- Prepare ERDF waste profile and shipping papers
- Maintain an inventory of the radioactive debris, sludge, and concrete surface, both removed and intact, for each pit
- Prepare and maintain calculations of surface area that radioactive debris exhibits and weights and volumes of radioactive debris
- Manage corrective actions associated with work performed by organization
- Maintain qualifications of personnel performing work in accordance with this document.

K Basin Technical Services/Quality Assurance

The K Basin Technical Services/Quality Assurance Organization has the following responsibilities:

- Conduct surveillance to verify compliance with the implementation of this SAP
- Manage corrective actions associated with work performed by organization
- Maintain qualifications of personnel performing work in accordance with this document.

5.1.4 Special Training Requirements and Certification

Activities performed in accordance with this document do not require specific or special training except QA personnel who will perform visual inspections. The QA personnel performing visual inspections shall be certified as Level II inspectors. The activities performed as directed by this document are normal and routine. Personnel training is performed and maintained in accordance with quality processes and work instructions that satisfy the fundamentals of the FH quality assurance program.

5.1.5 Quality Assurance Objectives and Criteria for Measurement Data

The quality assurance (QA) objective of this plan is to develop implementation guidance that will provide data of known and appropriate quality. Data quality typically is assessed by representativeness, comparability, accuracy, precision, and completeness. These parameters are described in the following paragraphs. The applicable quality control guidelines, quantitative target limits, and levels of effort for assessing data quality are dictated by the intended use of the data and the nature of the measurement method. A summary of COCs is provided in Table 1-1. The measurement methods and method performance requirements are presented in Table 5-1. The nomenclature used to describe quality parameters is contained in the discussion following Table 5-1.

Table 5-1. Field Instrument Performance Requirements.

Measurement	Measurement method	Accuracy requirement	Precision requirement
Weight	Weigh scale	± 2%*	± 2%*
Length	Tapes, rods	not applicable	not applicable
Dose Rate	Bicron microrem meter, Geiger-Mueller AMP-100, or ion chamber	± 20%	± 20%
Visual Observation	Video or still camera	*	*

Note:
*The value if stated or per manufacturer's specifications.

Representativeness. Representativeness is a measure of how closely measurement results reflect the actual quantity in the waste matrix. Sampling plan design, sampling techniques, and sample-handling protocols (e.g., storage, preservation, and transportation) have been developed and are discussed in other sections of this document. Test plan design, techniques, and management protocols have been developed to ensure field measurements taken represent the waste. The field measurement and sample collection documentation will establish that protocols have been followed and sample and measurement identification and integrity are ensured. The representativeness attribute is not applicable to pit inventory and/or field visual observation and other field measurements if the measurement was made on the waste rather than a sample of the waste.

Comparability. Comparability expresses the confidence with which one data set can be compared to another. Data comparability will be maintained by using standard documented work processes and instructions, consistent methods, and consistent units. Test plan design, techniques, and management protocols have been developed to ensure consistent field measurements are collected. The attribute is not applicable to pit inventory.

Accuracy. Accuracy is an assessment of the closeness of the measured value to the true value. Accuracy of laboratory results is assessed by measuring known instrument standards. Field measurement accuracy targets for weight, length, and dose rate are listed in Table 5-1. The visual observation is performed under conditions where basin visual acuity requirement of the camera system is maintained. Field measurement instrument accuracy is assured by calibrating the instrument and maintaining it properly calibrated. The attribute is not applicable to pit inventory.

Precision. Precision is a measure of the data spread when more than one measurement has been taken on the same sample or standard. The visual observation is performed under conditions where basin visual acuity is maintained. Field measurement precision targets for weight, length, and dose rate are listed in Table 5-1. Field measurement instrument precision is assured by calibrating the instrument and maintaining it properly calibrated. The attribute is not applicable to pit inventory.

Completeness. Completeness is a comparison of the amount of valid data obtained to the valid data required from the measurement process. The attribute does not apply to field measurements of weight and length as these measurements are performed on an as needed basis. The attribute is accomplished for visual examination of floor, visual comparator, and radioactive debris at a rate of 100% less those areas where interferences prohibit examination. The completeness requirement for each pit is an accurate inventory of sludge; radioactive debris, including surface area and weight of radioactive debris (deminimus levels of <1% of surface area or pit weight); below water basin surface, both as intact and hydrolase spoil; grout; fixative applied; and structural concrete. The completeness requirement for the basin shall be the collection of contamination and surface dose rates necessary to determine the concentration of radioactivity and compliance with ERDF requirements.

5.1.6 Documentation and Records

Field measurement documentation will be kept in accordance with quality processes and work instructions that satisfy the fundamentals of the FH quality assurance program. Field measurements include weight, length, radioactive surface contamination, and dose rate measurements and visual observations using cameras or eyesight. Visual observation performed to determine sludge has been removed from debris and in compliance with the sludge endpoint criteria shall be 100% video or still photos less the area where interferences prohibit examination in accordance with the qualified process.

5.2 DATA GENERATION AND ACQUISITION

This section describes quality control requirements; instrument testing, inspection and maintenance requirements; calibration, and acceptance inspection requirements. Sample and measurement rationale, design and implementation are described in Sections 2 and 3 of this SAP.

5.2.1 Quality Control Requirements

When visual observations are made the water visual acuity shall be maintained such that a 0.08 cm (1/32 in.) black line can be seen on an 18% neutral gray card.

Quality control applied to instruments used to obtain dose rate measurements are those identified per the radiation control program conducted in accordance with processes and work instructions that satisfy the requirements in 10 CFR 835 and FH radiation control program.

No applicable quality control requirements apply to other field instruments.

5.2.2 Instrument Testing, Inspection, and Maintenance

Field instruments including cameras, weigh scale, tapes, and rods will be tested, inspected and maintained in accordance with quality processes and work instructions that satisfy the fundamentals of the FH quality assurance program. Field dose rate measurement instruments will be tested, inspected and maintained in accordance with processes and work instructions that satisfy the requirements in 10 CFR 835 and FH radiation control program.

Correction of nonconformances shall be in accordance with quality processes and work instructions that satisfy the fundamentals of the FH quality assurance program.

5.2.3 Instrument Calibration and Calibration Frequency

Field instruments including cameras, weigh scale, tapes, and rods will be calibrated in accordance with quality processes and work instructions that satisfy the fundamentals of the FH quality assurance program. Calibration does not apply to tapes and rods used for length measurement. Field dose rate measurement instruments will be calibrated in accordance with processes and work instructions that satisfy the requirements in 10 CFR 835 and FH radiation control program.

Correction of nonconformances shall be in accordance with quality processes and work instructions that satisfy the fundamentals of the FH quality assurance program.

5.2.4 Inspection/Acceptance Requirements for Supplies

Supplies obtained to support field instruments including cameras will be obtained in accordance with quality processes and work instructions that satisfy the fundamentals of the FH quality assurance program. Inspection and acceptance of supplies does not apply to weigh scale, tapes, and rods equipment. Field dose rate measurement instruments supplies will be inspected and accepted in accordance with processes and work instructions that satisfy the requirements in 10 CFR 835 and FH radiation control program.

Correction of nonconformances shall be in accordance with quality processes and work instructions that satisfy the fundamentals of the FH quality assurance program.

5.2.5 Non-direct Measurement

Direct and non-direct measurements of radionuclides are utilized to determine the radionuclide inventory of rubble and monoliths. The radionuclide concentrations shall be calculated over a monolith or for rubble over the DEP, tech view and weasel pits, and the basin. Direct measurements governed by this document consist of dose rates of above water basin concrete surface, debris being left in pits, and below water concrete surfaces that have been subjected to hydrolasing. Other documents govern the collection of direct and non-direct measurements performed to support below water basin concrete surface (KBC-25121) and radioactive debris (HNF-6495) radionuclide inventory determinations.

The quantity of sludge contaminating the basin and radioactive debris is calculated using measurements of residual sludge on debris and floor and redeposited sludge on the floor. The amount of redeposited sludge added to the NLOP from backwashing the sand filter into it may be calculated based on operating experience and process knowledge or it may be measured. The quantity of sludge is calculated by determining the volume of sludge (depth times width times length) and converting to weight, as necessary, using the appropriate sludge density. The radionuclide inventory contribution to a monolith or rubble is calculated by multiplying the quantity of each sludge type by the radionuclide concentrations. The residual basin sludge radionuclide concentrations are provided in Table A-1 of KBC-24413 columns labeled, "Estimated Sludge Concentration". The redeposited sludge radionuclide concentrations are provided in Table B-1 of KBC-24413 column labeled "sludge concentration." Some of the radionuclide concentrations in sludge were calculated by ratioing to a key radionuclide that was directly measured in sludge. The total sludge radionuclide contribution is the sum of the radionuclide inventory of residual and redeposited sludges.

The radionuclide inventory characterization of radioactive debris, above water basin concrete surfaces, and below water concrete surfaces that have been subjected to hydrolasing directly measures dose rate to determine an inventory of Cs-137. Other radionuclides are not directly measured but are scaled to Cs-137 using radionuclide distributions documented in HNF-6495, Table 2-2 for K East Basin porous and nonporous radioactive debris and K East Basin above water concrete surface material. Porous radioactive debris shall use the radionuclide distribution in the column for K East Basin below water unwashed radioactive debris. Nonporous radioactive debris shall use the radionuclide distribution in the column for K East Basin below water washed metal radioactive debris. The K East Basin above water concrete surface shall use the radionuclide distribution in the column for K East Basin above water radioactive debris. Below water concrete surfaces that have been hydrolased shall use the radionuclide distribution in Table D-1 of KBC-25121.

Basin and pit surface area and radioactive debris surface area and weight may be calculated from design or other information rather than measured. Also, material vendor information and material safety data sheets may be used to consider chemical constituents of radioactive debris and radioactive contamination fixatives.

An alternative radioactive characterization of rubble method measures dose rate to determine an inventory of Cs-137 then use a radionuclide distribution to calculate an inventory in an ERDF roll-off box or other container. A radionuclide distribution will be determined that is applicable to the rubble. The distribution may be a bounding distribution or a calculated distribution for the basin or pit rubble. For a bounding distribution it must be shown that the distribution bounds the rubble radioactivity for the actinide content because the actinide content drives the waste management requirements. For a calculated distribution the radioactive inventory of the basin or pit rubble is calculated as described above for rubble (sum of all contributors of radioactivity such as sludge, debris, and concrete) then each nuclide is ratioed to the Cs-137 activity. Measurements of dose rate will be collected that are used with a dose rate-to-curie conversion for a container to calculate the Cs-137 content of a container. The total radionuclide content of a container is calculated by multiplying the Cs-137 content by the distribution ratio to Cs-137 for each radionuclide.

5.2.6 Data Management

Sampling and measurements generated during this project will be managed according to the processes described in Section 5.1.6, Documents and Records. Data will be generated during sample collection, field dose surveys, inventories of debris and spoils, and in developing information concerning monolith size and weights and concentration of radioactivity in rubble. Specific records and a summary of their content are identified in Sections 3 and 4 of this SAP.

The organization responsible for generating the measurement data shall be responsible for ensuring that the data is managed per Section 5.1.6.

5.3 ASSESSMENT/OVERSIGHT FOR MEASUREMENTS

5.3.1 Assessments and Response Actions

The Fluor Hanford, Inc., QA organization may conduct random surveillances and assessments in accordance with quality processes and work instructions that satisfy the fundamentals of the FH quality assurance program. Assessments and surveillances are performed to verify compliance with requirements outlined in this SAP, procedures, and regulatory requirements.

Correction of nonconformances shall be in accomplished in accordance with quality processes and work instructions that satisfy the fundamentals of the FH quality assurance program.

5.3.2 Reports to Management

The project status is maintained and presented to Fluor Hanford management via a summary report written for monoliths and rubble that are evaluated for ERDF acceptance. A summary report will be published on an as-needed basis but before a monolith or rubble is sent to ERDF for disposal and before encapsulating monoliths are grouted.

Project QA personnel will report the results of its surveillance activities to project management. Quality control activities will be performed before a monolith is prepared for disposal. Nonconformances and corrective action status are reported to Fluor Hanford management in accordance with quality processes and work instructions that satisfy the fundamentals of the FH quality assurance program.

5.4 DATA REVIEW, VALIDATION, AND USABILITY

Requirements for review and evaluation of data usability are described in the following sections.

5.4.1 Data Review and Validation Requirements

The data collected will be validated against the criteria in Section 5.1.5. Data validation will include review of quality assurance objectives (QAO) (e.g., representativeness, comparability, and completeness), and preparation of a summary report. The application of data validation QAO to the field measurements and other data collection is described in Table 5-2..

Table 5-2. Application of Assessment Parameters to Data Collected.

	Field Dose Rate Measurement	Field Weight Measurement	Field Length Measurement	Field Visual Observation	Monolith Inventory
Representa-tiveness	Qual	Qual	Qual	Qual	N/A
Comparability	Qual	Qual	Qual	Qual	N/A
Accuracy	Qual	Qual	Qual	Quant (3.2.2)	N/A

Table 5-2. Application of Assessment Parameters to Data Collected.

	Field Dose Rate Measurement	Field Weight Measurement	Field Length Measurement	Field Visual Observation	Monolith Inventory
Precision	Qual	Qual	Qual	Quant (3.2.2)	N/A
Completeness	Quant (3.2.1)	N/A	N/A	Qual	Qual
MDL	Quant (3.2.1)	Quant (3.2.5)	Quant (3.2.5)	N/A	N/A

Notes:

Qual- qualitative, attained by compliance with procedures, this document, manufacturers instructions, etc.

Quant- quantitative, attained by compliance with numerical requirement and qualitative requirements as applicable.

N/A- not applicable- assessment parameter does not apply to data.

5.4.2 Validation Methods

Data validation is the comparison of reported data and data quality measures to data QAO in accordance with requirements specified in Section 5.4.1 of this document. Each data collection supporting monolith and rubblized basin and pit characterization will be evaluated with the results of the evaluation being recorded on a form provided in Appendix C or equivalent. Records shall be maintained per Section 5.1.6 of this SAP.

The data collected will not undergo a third-party validation.

5.4.3 Reconciliation With User Requirements

The calculated concentrations of radionuclides and chemical constituents, as applicable, of a monolith with weight and volume will be compared by the project to the applicable BHI-00139, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*, for acceptance at the ERDF. All calculations performed demonstrating conformance to the waste acceptance criteria shall be performed in a manner satisfying the quality criteria expressed in FH quality assurance program and be checked. A monolith is acceptable to the ERDF regarding free liquid and minimization of void when materials listed on the inventory are evaluated and determined to conform to information presented in Appendix D.

A summary report evaluating the overall adequacy of the total measurement system with regard to the DQO of the data generated and comparison to the ERDF acceptance criteria will be sent to Waste Services and K Basin Closure Project management. The report will be published on an as-needed basis but prior to shipment of rubble to the ERDF and before encapsulating monoliths are grouted.

6.0 HEALTH AND SAFETY

All field operations at Fluor Hanford-operated facilities required by this SAP will be conducted in accordance with the principals of an integrated environmental, safety, and health management program. This includes a health and safety plan prepared in accordance with Title 29, *Code of Federal Regulations*, Part 1910, "Occupational Safety and Health Standards" (29 CFR 1910).

The integrated environmental, safety, and health management program identifies processes and procedures where the primary hazards associated with waste management activities are managed. Some of these hazards are direct radiation exposure, potential personnel contamination, potential inhalation of airborne concentrations of radioactive materials, and exposures to hazardous substances. Rather than list the requirements to mitigate and control radiological and hazardous chemical exposures, the management plan references documents that provide the necessary direction to mitigate and control these hazards. The program incorporates the requirements of 29 CFR 1910 Sub-part 120(6)(1)(v), the management plan shall be made available to Fluor Hanford employees and any contractor or sub-contractor involved with hazardous waste operations.

Fluor Hanford has a robust and mature radiation protection program fully implementing Title 10, *Code of Federal Regulations*, Part 835, "Occupational Radiation Protection" (10 CFR 835), as amended. Implementation of radiological work and radiation protection activities is achieved through the Integrated Safety Management System process. The radiation protection program addresses roles and responsibilities, qualifications, training, implementation of the as low as reasonably achievable philosophy, external and internal dosimetry, monitoring and surveillance, work control mechanisms (e.g., radiation work permits, and access and entry requirements), self-assessments, and use of specific radiation monitoring devices and meters.

The Fluor Hanford Chemical Management Program in conjunction with implementation of the integrated environmental, safety, and health management program, will be relied upon to protect the workers, the general public, and the environment from specific chemical substances and their associated hazards. The Chemical Management Program provides direction for the acquisition, storage, transportation, use, final disposition, record keeping, and management review of program performance for chemicals at the Hanford Site.

7.0 REFERENCES

0101943, 2001, "Contract No. DE-AC06-96RL13200 - Completion of Waste Designation for K Basin Sludge Waste Streams," (Letter from P. G. Loscoe to D. R. Sherwood, U.S. Environmental Protection Agency, and M. A. Wilson, Washington State Department of Ecology, March 27, 2001), U.S. Department of Energy, Richland Operations Office, Richland, Washington.

10 CFR 830, "Nuclear Safety Management," Subpart A *Quality Assurance Requirements*, *Code of Federal Regulations*, as amended.

10 CFR 835, "Occupational Radiation Protection," *Code of Federal Regulations*, as amended.

29 CFR 1910, "Occupational Safety and Health Standards," *Code of Federal Regulations*, as amended.

40 CFR 268, "Land Disposal Restrictions," *Code of Federal Regulations*, as amended.

49 CFR, "Transportation" Parts 100-185, *Code of Federal Regulations*, as amended.

0000X-DC-W0001, *Supplemental Waste Acceptance Criteria for Bulk Shipments to ERDF*, Rev. 1, Bechtel Hanford, Inc., Richland, Washington.

BHI-00139, 2002, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*, Bechtel Hanford, Inc., Richland, Washington.

Comprehensive Environmental Response, Compensation and Liability Act of 1980, 42 USC 9601 et seq.

ECN 190564, 1995, *Engineering Change Notice (ECN)-190564: Clean and Seal Concrete Walls and Raise Water Level to Reduce Radiation Dose Levels to Workers Over Foreseeable Life of Facility*, Westinghouse Hanford Company, dated February 2, 1992, Richland, Washington.

EPA, 1997, *Test Methods for Evaluating Solid, Waste Physical/Chemical Methods*, SW-846, 3rd Edition, as amended, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1999, *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington (also known as the "100 Area Remaining Sites ROD")*, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1999, *Interim Action Record of Decision for the 100-KR-2, Operable Unit, Hanford Site, Benton County, Washington (also known as the "K Basins Interim ROD")*, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 2005, *Interim Action Amended Record of Decision for the 100-KR-2, Operable Unit, Hanford Site, Benton County, Washington (also known as the "K Basins Interim ROD Amendment")*, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 2000, *Guidance for the Data Quality Objectives Process*, EPA QA/G-4, U.S. Environmental Protection Agency, Washington, D.C.

EPA 14451, 2000, *Regulation of Concrete Residuals as Hazardous Waste*, RCRA Online document #14451, U.S. Environmental Protection Agency, Washington, D.C.

EPA/240/B-01/003, 2001, *EPA Requirements for Quality Assurance Project Plans*, U.S. Environmental Protection Agency, Washington, D.C.

EPRI, 1980, Training Module 101 1G "Code Requirements for Visual Examination" and Training Module 101 2G "Code Requirements for Visual Examination (ASME XI)", Electric Power Research Institute, Palo Alto, California.

Epstein, M. and Plys, M., 2004, "Potential for Flammable Atmosphere Above the K-Basin Pool During Grouting," Fauske & Associates, LLC letter report (September 30, 2004).

Gephart, R.E., 2003, *Hanford – A Conversation About Nuclear Waste and Cleanup*, Batelle Press, Richland, Washington.

HNF-6495, 2005, *Sampling and Analysis Plan for K Basins Debris*, Rev. 3, Fluor Hanford, Richland, Washington.

HNF-20632, 2005, *End Point Criteria for the K Basins Interim Remedial Action*, Rev. 0, Fluor Hanford, Richland, Washington.

HNF-26419, 2005, *ERDF Roll-off Container Dose-Rate-To-Curie Method for Hard Debris Waste*, Rev. 0, Fluor Hanford, Richland, Washington.

KBC-24413, 2007, *Data Quality Objectives Summary Report for the 105-K East Basin Monoliths*, Rev. 1, Fluor Hanford, Inc., Richland, Washington.

KBC-23699, 2005, *Estimate of Activated Metal in K East Basin Debris*, Rev. 0, Fluor Hanford, Inc. Richland, Washington.

KBC-24721, 2005, *105 K East Qualified Process Demonstrating Endpoint Criteria*, Rev. 0-A, Fluor Hanford, Inc. Richland, Washington.

KBC-25121, 2005, *Sampling and Analysis Plan For Waste Containing K East Basin Below Water Concrete Surfaces*, Rev. 0, Fluor Hanford, Richland, Washington.

MSDS 052505 1996, *BIO-DUR 560 White Curing Agent Material Safety Data Sheet*, Thin Film Technology, Inc., Houston, Texas.

MSDS 062812, 1995, *BIO-DUR 560 Epoxy Base Material Safety Data Sheet*, Thin Film Technology, Inc., Houston, Texas.

Nalco, 2004, *Optimer 7194 Plus Flocculent Material Safety Data Sheet*, Rev. 2.2, Nalco Energy Services, L.P., Sugar Land, Texas.

NRC, 1991, *Branch Technical Position on Waste Form (Revision 1)*, U.S. Nuclear Regulatory Commission, Washington, D.C.

NRC, 1995, *Issuance of Final Branch Technical Position on Concentration Averaging and Encapsulation, Revision in Part to Waste Classification Technical Position*, U.S. Nuclear Regulatory Commission, Washington, D.C.

Toxic Substances Control Act of 1976, 15 USC 2601, et seq.

WAC 173-303, "Dangerous Waste Regulations," *Washington Administrative Code*, as amended.

APPENDIX A

EVALUATION OF MONOLITH NRC WASTE CLASSIFICATION

APPENDIX A

Evaluation of Monolith NRC Waste Classification

Waste Description: K East Basin monoliths are discrete sections of the grouted debris/concrete pit. Debris encapsulated in the grouted monoliths is primarily non-mixed debris, although some mixed debris (i.e. elemental lead and batteries) exists. The monoliths will be disposed at the Environmental Restoration Disposal Facility (ERDF). The grouting process requires the removal of sludge to ensure compliance with the ERDF waste acceptance criteria, encapsulating remaining equipment and debris with grout, and cutting the pits into large blocks.

Monoliths will be prepared to conform with the ERDF waste acceptance criteria (WAC) and managed as special handled waste per the supplemental criteria. A Waste Shipping and Receiving Plan will address the special handling requirements. The monolithing process is necessary to:

- Reduce external dose of the finished monoliths to as low as is reasonably achievable (ALARA) levels and meet the ERDF WAC;
- Fix debris and contamination for burial and transportation;
- Eliminate void space to the extent practicable (at least 90% full); and
- Fulfill Department of Transportation requirements to ship waste (isotopes, activity, dose, etc.).

The referenced Branch Technical Position (BTP) describes situations where both encapsulants such as grout and waste masses together may be used in waste class determinations. K East Basin monoliths are similar to the BTP situation described in Section 3.7 (*Encapsulation of Solid Material*) as the monoliths will encapsulate both mixed and non-mixed debris and hydrolase spoil, as well as provide shielding for contaminants on the concrete basin substrate. Radionuclide concentrations may be averaged over the waste and encapsulant if:

1. The volume and attributes of the encapsulated waste comply with the constraints established in Appendix C of the BTP;
2. The solidified mass meets the waste form structural criteria of 10 CFR 61.56 for Class B and Class C waste; and
3. The disposal unit containing the encapsulated mass is segregated from disposal units containing Class A wastes, that do not meet the structural stability requirements of 10 CFR 61.56(b).

Monolith transportation and disposal will comply with the three stated requirements above. BTP Appendix C requirements are listed with compliance methods on Table A-1. Grout will meet the waste form structural integrity requirements specified in 10 CFR 61.56(b)1, 2, and 3. Segregation of monoliths from Class A waste is not an ERDF requirement.

In conclusion, K East Basin monoliths prepared for disposal will comply with the ERDF WAC and will be managed as special handled waste per the supplemental criteria. Since each monolith will encapsulate multiple sources distributed throughout the three dimensions of the grouted debris/concrete monoliths, radionuclide concentration averaging in accordance with BTP, Section 3.7 may be used.

Table A-1. Branch Technical Position Appendix C

Requirements and Requirement Compliance

Requirements	Method of Compliance
A minimum solidified volume or mass for encapsulation should be that which can reasonable be expected to increase the difficulty of an inadvertent intruder moving the waste by hand without the assistance of mechanical equipment.	K East Basin monolith volumes will be greater than 100 m^3 each. Finished monolith sizes will preclude movement by hand.
A maximum solidified volume or mass for encapsulation of a single discrete source (from which concentrations are determined) should be 0.2 m^3 or 500 kg (typical 55 gallon drum). Larger volumes and masses may be used for encapsulation of single sources but, in general, unless a specific rationale is provided, no credit beyond the volume or mass indicated should be considered when determining waste concentrations. Encapsulation of multiple sources (e.g. filters) in larger volumes may be considered acceptable under the Alternative provisions paragraph.	K East Basin monoliths are a special handled waste form acceptable under the Alternatives provisions paragraph (Section 3.9) since they include the encapsulation of multiple sources and are large, heavy, and awkward. The monoliths are also acceptable under the Alternative provisions paragraph, because the intent of grouting is not to dilute isotopic concentrations, but rather to prepare a cost effective, 10 CFR Part 61, Subpart C compliant waste form which encapsulates multiple sources distributed throughout the three dimensions of the grouted debris/concrete monoliths. Preparing the basin for disposal in this manner also reduces the exposure to workers during remediation of the K East Basin. The monoliths will be prepared to maintain radiation exposures ALARA and will not present large radioactive "point source" concerns in the disposal site. The Alternate provisions paragraph requires compliance with performance objectives in 10 CFR Part 61, Subpart C. Compliance is assured via compliance with the ERDF WAC. In part, the ERDF WAC

Table A-1. Branch Technical Position Appendix C

Requirements and Requirement Compliance

Requirements	Method of Compliance
	presents requirements necessary to ensure compliance based on a performance assessment written to 10 CFR Part 61, Subpart C objectives.
A maximum amount of gamma-emitting radioactivity (e.g., Cs-137/Ba-137m, Nb-94) or radioactive material generally acceptable for encapsulation is that which, if credit is taken for a 500-year decay period, would result in a dose rate of less than 0.2 uSv/hr (0.02 mrem/hr) on the surface of the encapsulating media. The calculation to determine compliance with this criterion may consider the minimum attenuation factor provided by the encapsulating media but, in general, this factor should not exceed an attenuation factor that would be provided by 15 inches of concrete encapsulating material. Furthermore, the maximum Cs-137/Ba-137m gamma-emitting generally acceptable for encapsulation in a single disposal container is 1.1 TBq (30 Ci).	Assigned inventory limits will be procedurally enforced based on dose modeling calculations. Sludge mass, wall/floor surface area, and debris loading limits will be established to ensure compliance with transportation and disposal requirements. Credit taken for a 500-year decay period will result in a dose rate of less than 0.2 uSv/hr (0.02 mrem/hr) on the surface of the encapsulating media. The large volume of monoliths is equivalent to greater than 500 times the size of one 55 gallon drum on which the 30 curies of Cs-137 loading is based on. The Cs-137 content of each monolith is much less than equivalent limit of 15,000 curies (500 times the 30 curie limit).
A maximum amount of any radionuclide that should be encapsulated in a single disposal container intended for disposal at a commercial low-level waste disposal facility is that which, when averaged over the waste and the encapsulating media, does not exceed the maximum concentration limits for Class C waste, as	The K East Basin monoliths will be prepared so that isotopic loading will not exceed limits. The radionuclide inventory will be calculated before monolith preparation to control the inventory to ensure compliance.

Table A-1. Branch Technical Position Appendix C

Requirements and Requirement Compliance

Requirements	Method of Compliance
defined in Tables 1 and 2 of 10 CFR 61.55.	
In all cases when a discrete source of radioactive solid waste is encapsulated, written procedures should be established to ensure that the radiation source(s) is reasonably centered within the encapsulating medium.	K East Basin monolith preparation will ensure placement of debris inside the grouted structures. Procedures will be employed governing the encapsulation process.

Reference

NRC, *Issuance of Final Branch Technical Position on Concentration Averaging and Encapsulation, Revision in Part to Waste Classification Technical Position*, dated January 17, 1995.

APPENDIX B

VISUAL COMPARATOR PLACEMENT

APPENDIX B

VISUAL COMPARATOR PLACEMENT

Two types of comparators may be used: step disks or painted plate. Both are mounted on the floor then visually observed to determine the thickness of sludge that has been redeposited on the floor. Both types may be cleaned to reset the unit to identify the redeposition of sludge on it.

The step disks consist of a flat disk milled in a flat circle with steps of increasing thickness from outside edge to the center. The step disk is used by observing the step edge to determine if the edge is still visible. If the edge is visible then the redeposited sludge layer is less than the step. This method is able to identify sludge thickness of 30 mils or more.

The painted plate is a small painted plate. The plates are visually observed from directly above to monitor sludge redeposition on it. Pictures with known quantities of sludge on the plates have been taken that provide a standard to quantify the sludge thickness layer (SNF-19537). This method is able to identify sludge thickness layers of less than 10 mils.

The number of visual comparators judged to be adequate to monitor conditions is set to be a total of 14, one for each pit and three for each of the three basin bays. This small number reflects the measurement and measurement conditions. The redepositing of sludge on each pit and basin bay floor will be consistent throughout because basin water mixes within and between basin bays and pits spreading the suspended sludge throughout and the slow redeposition of suspended sludge provides a large quantity of time for mixing to occur.

The locations of visual comparators within the basin bays were randomly selected as noted in the list below. The existing Cubicle Storage Location numerical grid was used (from drawing number H-1-34711) to specify locations for the random samples. Each grid number was assigned a random number and sorted from highest to lowest. The grid numbers with the lowest specified random numbers were chosen. The grid numbers chosen are:

4732
6738
5443

2623
4335
2815

2211
0941

2272

One visual comparator is to be located in each pit. The locations of visual comparators in all the pits except the weasel and tech view pits is at the area center of the pit. The location of visual comparators for the weasel and tech view pits is at the throat of each pit.

All visual comparators are to be located as close a possible to the location specified. If the visual comparator can not be located as specified, locate the comparator as close as possible to the specified location and the actual location will be recorded.

References

SNF-19537, 2004, *Development of Detection Limit and Visual Aid for Additional Canister Particulate in MCO Baskets*, Rev. 0, Flour Hanford, Inc, Richland, Washington.

APPENDIX C

DATA VALIDATION FORMS

APPENDIX C

DATA VALIDATION FORMS

Dose Rate Data Validation Checklist		
Identification:		
Data Quality Attribute	**Attribute Criteria**	**Decision**
The measurements are representative of the waste.	Surveys were collected using methods and locations specified in SAP. The number and quantity of surveys were collected per the SAP.	☐yes ☐no
The waste measurements are comparable.	The measurements were performed per methods as specified in the SAP. The measurement results with QA data is reported as specified in the SAP.	☐yes ☐no
The measurement accuracy is within acceptable limits.	The results comply with the QA requirements as specified in the SAP (calibration requirements met)	☐yes ☐no
The measurement precision is within acceptable limits	The results comply with the QA requirements as specified in the SAP (calibration requirements are met)	☐yes ☐no
The measurement data is complete.	The results reported comply with the requirements as listed above, that is the data is valid, and meets the SAP specified rate of for data being valid for decision making.	☐yes ☐no
The measurement detection limit is acceptable	The reported method detection limits for the analyses comply with the SAP specifications.	☐yes ☐no
Data for Monolith meet quality requirements and are valid for use in decision making.		☐yes ☐no
Assessor Comments and Notes:		
Assessor Certification Print Name, sign, and date:		

Weight Data Validation Checklist

Identification:

Data Quality Attribute	**Attribute Criteria**	**Decision**
The measurements are representative of the waste.	The material being measured is clearly identified.	☐yes ☐no
The waste measurements are comparable.	The measurements are collected in compliance with procedures, work plans, or within skill of the craft.	☐yes ☐no
The measurement accuracy is within acceptable limits.	Instrument is calibrated at the time measurement is obtained.	☐yes ☐no
The measurement precision is within acceptable limits	Instrument is calibrated at the time measurement is obtained.	☐yes ☐no
The measurement data is complete.	Not applicable	☐yes ☐no
The measurement detection limit is acceptable	Measurement result is equal to or more than 5% of the instrument scale.	☐yes ☐no
Data for Monolith meet quality requirements and are valid for use in decision making.		☐yes ☐no

Assessor Comments and Notes:

Assessor Certification

Print Name, sign, and date:

Length Data Validation Checklist		
Identification:		
Data Quality Attribute	**Attribute Criteria**	**Decision**
The measurements are representative of the waste.	The material being measured is clearly identified.	☐ yes ☐ no
The waste measurements are comparable.	The measurements are collected in compliance with procedures, work plans, or within skill of the craft.	☐ yes ☐ no
The measurement accuracy is within acceptable limits.	Instrument is calibrated at the time measurement is obtained.	☐ yes ☐ no
The measurement precision is within acceptable limits	Instrument is calibrated at the time measurement is obtained.	☐ yes ☐ no
The measurement data is complete.	Not applicable	☐ yes ☐ no
The measurement detection limit is acceptable	Measurement result is equal to or more than 5% of the instrument scale.	☐ yes ☐ no
Data for Monolith meet quality requirements and are valid for use in decision making.		☐ yes ☐ no
Assessor Comments and Notes:		
Assessor Certification Print Name, sign, and date:		

Visual Observation Data Validation Checklist		
Identification:		
Data Quality Attribute	**Attribute Criteria**	**Decision**
The measurements are representative of the waste.	The floor area and/or debris of the video and/or still photos is clearly identified.	☐ yes ☐ no
The waste measurements are comparable.	The video and/or still photos are collected in compliance with procedures or work plans.	☐ yes ☐ no
The measurement accuracy is within acceptable limits.	The videos and/or still photos collected when basin water visual acuity complies with requirement unless prevented by obstructions such as tanks in the weasel and tech view pits.	☐ yes ☐ no
The measurement precision is within acceptable limits	The videos and/or still photos collected when basin water visual acuity complies with requirement unless prevented by obstructions such as tanks in the weasel and tech view pits.	☐ yes ☐ no
The measurement data is complete.	The video and/or still photos are collected on all the basin and pit floors and debris unless obstructionos prevent their collection.	☐ yes ☐ no
The measurement detection limit is acceptable	Not applicable	☐ yes ☐ no
Data for Monolith meet quality requirements and are valid for use in decision making.		☐ yes ☐ no
Assessor Comments and Notes:		
Assessor Certification Print Name, sign, and date:		

Monolith Inventory Data Validation Checklist		
Identification:		
Data Quality Attribute	**Attribute Criteria**	**Decision**
The measurements are representative of the waste.	Not Applicable	☐ yes ☐ no
The waste measurements are comparable.	Not Applicable	☐ yes ☐ no
The measurement accuracy is within acceptable limits.	Not Applicable	☐ yes ☐ no
The measurement precision is within acceptable limits .	Not Applicable	☐ yes ☐ no
The measurement data is complete.	Each monolith has an inventory. Each inventory shall account for: debris type and surface area, under basin water wall surface, sludge content, total weight, total volume, fixative applied, and above water wall surface.	☐ yes ☐ no
The measurement detection limit is acceptable	Not Applicable	☐ yes ☐ no
Data for Monolith meet quality requirements and are valid for use in decision making.		☐ yes ☐ no

Assessor Comments and Notes:

Assessor Certification
Print Name, sign, and date:

APPENDIX D

DISPOSAL OF ENCAPSULATED NON-HAZARDOUS LIQUID AT THE ENVIRONMENTAL RESTORATION DISPOSAL FACILITY

APPENDIX D

DISPOSAL OF ENCAPSULATED NON-HAZARDOUS LIQUID AT THE ENVIRONMENTAL RESTORATION DISPOSAL FACILITY

D1.0 SUMMARY

Some debris that will be grouted in the 105-K East (KE) Basin pits may have void spaces that currently contain non-hazardous basin water. In some instances grout is not anticipated to displace all water in these void spaces. Similarly, concrete scabbling spoils that will be grouted in the basin have a liquid component. 40 CFR 264.314(f) (and WAC 173-303-140(4)(b)(v)) allows disposal of non-hazardous liquid waste in a landfill provided a demonstration can be made that two criteria are met: First, the only reasonable alternative is placement in the Environmental Restoration Disposal Facility (ERDF) landfill. Second, such placement will not present further risk to the underground source of drinking water. The KE Basin monolith disposal proposal meets both these criteria, as demonstrated herein.

D2.0 INTRODUCTION

The KE Basin pits, including contaminated debris (piping, metal racks, equipment, etc) remaining in the basin pits and spoils from the basin concrete scabbling will be grouted with a cement type grout. Based on radiological contaminant levels in the basin and pits, grout will be added while water is still in the basin. Grout is added to pits displacing water until the pit is filled with grout. Thereafter the pits filled with grout will be cut from the basin into large sections for disposal at ERDF.

Some debris that will be grouted in the basin pits exhibit void spaces that currently contain basin water. In some instances grout is not anticipated to displace all water in these void spaces. Similarly, the concrete scabbling spoils have entrained water. Spoils remaining in the basins will be configured in open strainers (or similar) where flowable grout can contact the spoils and displace free liquids. Residual water in the spoils or in void spaces in debris will be encapsulated in the grout.

D2.1 WASTE CONFIGURATION

Debris and spoils containing residual basin water will be solidified / stabilized in the grouted waste form using an ASTM C-150 Type I/II low alkali Portland cement before disposal at the ERDF. Debris and spoils grouted in the basin will have the following characteristics:

- Debris with void spaces are primarily small (<2" diameter) carbon steel pipes, although other debris types exist;
- Concrete scabbling spoils will contact the grout that encapsulate it thereby providing an interface for continued uptake of moisture by the grout during curing;

- Debris and spoils to be grouted within the basin will be positioned such that it will be a minimum of approximately 2 feet from the surface of any side of the solidified waste form after cutting;
- The compressive strength of the cement grout has been shown to be approximately 250 PSI at 28 days and 2,500 PSI at 90 days;

The *total ungrouted void space* of debris rack pipes is estimated to total 70 ft^3 (i.e., approximately 525 gallons), while that of the remaining debris is estimated to be less than 5.3 ft^3 (i.e., approximately 40 gallons). While a definitive minimum value is not readily predicted, the maximum volume of water encapsulated in debris is estimated to be less than 565 gallons.

Similarly, the spoils generated during the underwater scabbling of the basin and pit concrete surfaces have entrained water as a consequence of being generated underwater. Concrete scabbling spoils are estimated to have entrained water of up to 470 gallons at the time of grouting.

If void spaces in debris were not filled at all by grout, and the curing of the concrete had no uptake of residual water in spoils or in debris, a maximum total amount of basin water is estimated to be 1035 gallons in the basin monolith. This estimated liquid volume constitutes <0.1% of the volume of the monolith that will be disposed. It is anticipated that only a portion of the liquid volume estimated will not be displaced with grout.

D3.0 DISCUSSION

The ERDF Waste Acceptance Criteria (WAC) Section 4.3.5, *General Restrictions* prohibits bulk disposal of waste containing free liquids, unless the free liquids are eliminated by stabilization (adding materials to chemically immobilize the free liquids in the waste) before disposal at the ERDF. 40 CFR 264.314(f)[5] [and WAC 173-303-140(4)(b)(v)] allows disposal of non-hazardous liquid waste in a landfill if the owner or operator of such landfill demonstrates to the EPA that:

(1) The only reasonably available alternative is the placement in the landfill; and

(2) Placement in the landfill will not present a risk of contamination of any underground source of drinking water.[6]

The basin water encapsulated in the monoliths is non-hazardous liquid. Basin water is deionized water contaminated with low levels of radionuclides (See Table D-1). The basin water radionuclide concentrations are all significantly below the radionuclide concentrations in the

[5] See Attachment A for complete language.

[6] Although not included in the language of the ERDF WAC, Section 4.3.5, the Resource Conservation and Recovery Act (RCRA), as amended - Title 42 USC 6901 and the Washington state Dangerous Waste Regulations - WAC 173-303 are primary ARARs for this facility as identified in the ERDF Record of Decision, 20 January 1995 and therefore are applicable to this situation.

ERDF WAC. The basin water pH will elevate as it contacts grout but is expected to remain nonhazardous with a pH of less than 12.5. Water in contact with grout or concrete is known to not exhibit the characteristic of corrosivity with the onset of grout or concrete cure (Lea, F. M.,1970). "Based on current chemical characterization data, the water is not regulated as a dangerous waste or as a PCB remediation waste" (EPA, 1999a).

The KE Basin proposal meets both of the demonstration criteria as discussed below:

D3.1 ALTERNATIVES TO DISPOSAL AT ERDF

A major component to the Hanford Site cleanup affecting the Columbia River corridor is eliminating the significant radiological source at the 100 K area. In 2003 alternative approaches to accelerate the deactivation of the basins were evaluated and the Grout & Remove Alternative was selected. The Grout & Remove Alternative prepares and grouts debris in the basin under the *Record of Decision (ROD) for the K Basins Interim Remedial Action* (EPA, 1999a), for subsequent removal of the basin under the *Interim Action ROD for the 100 Area Remaining Sites, 100 Area Reactor Waste, and 200-CW-3 Waste* Sites (EPA, 1999b). Both RODs identify ERDF as the selected disposal location for debris and demolition waste that meets the ERDF WAC. If ERDF cannot be used, the alternatives Hanford could include the Central Waste Complex (CWC), Low Level Burial Grounds (LLBG), T Plant, and Waste Receiving and Processing facility. Disposal off of the Hanford site is not feasible as the monolith transportation configuration is not compliant for transport on public roads. Primary features of these storage, treatment and disposal units, as identified in the *Hanford Site Solid Waste Acceptance Criteria* (HNF-EP-0063, Revision 11), include the following:

> *CWC* – The CWC is a storage unit for low-level mixed, TRU, TRU mixed, TSCA PCB waste, and other waste types requiring treatment before disposal. Although the CWC can accept CERCLA waste, the facility was not designed to accommodate storage of large monoliths such as the K Basins monoliths and is not a disposal facility. The CWC has similar free liquid criteria to that of ERDF.
>
> *LLBG* - *CERCLA* waste shipped directly from the generator is prohibited, unless the EPA has specifically approved management of the waste at the LLBG. The LLBG has similar free liquid criteria to that of ERDF. Certain types of waste can be disposed in bulk rather than packaging in containers. This includes building rubble and other homogeneous waste similar to the monolith waste form however acceptance is limited to waste of relatively low concentrations of radionuclides.
>
> *T-Plant* - T Plant Complex is a treatment and storage unit having a number of functions, including equipment decontamination, waste treatment, storage, sampling, NDE, repackaging. *CERCLA* waste shipped directly from the generator is prohibited, unless the EPA has specifically approved management of the waste at T-Plant. T-Plant can not accommodate large monoliths such as the K Basins monoliths and is not a disposal facility.
>
> *WRAP* – The WRAP is a treatment and storage unit. The WRAP receives waste containers for verification, sampling, NDA, NDE, treatment, and repackaging. *CERCLA* waste shipped directly from the generator is prohibited, unless the EPA has specifically

approved management of the waste at WRAP. WRAP can not accommodate large monoliths such as the K Basins monoliths and is not a disposal facility.

Based on foregoing, the grouted KE Basin waste can reasonably only go to ERDF for disposal.

D3.2 RISK OF CONTAMINATION OF ANY UNDERGROUND SOURCE OF DRINKING WATER

Although quantitative analyses were not performed, basin water (i.e., free liquids) potentially existing within the grouted basin monoliths would not present any further risk of contamination to underlying groundwater, if indeed any such liquid would migrate from the monoliths.

The basin water encapsulated in a monolith is unlikely to be released as it is distributed in the interior of the monolith and constitutes <0.1% portion of the monolith volume. Cement encapsulating debris and spoils is be anticipated to continue assimilating available moisture over time. Hydration continues for a long period of time, up to decades in duration (Kosmatka et al. 2002).

If basin water were to migrate from the monoliths it would not contaminate underlying groundwater. The rationale for this is described below:

1. Basin water is deionized water contaminated with low levels of radionuclides (See Table D-1). The basin water radionuclide concentrations are all significantly below the radionuclide concentrations in the ERDF WAC. "Based on current chemical characterization data, the water is not regulated as a dangerous waste or as a PCB remediation waste" (EPA, 1999a). There are no corrosive characteristics of the basin water that would threaten the integrity of the leachate liner.

2. If basin water was released from a monolith at ERDF it would be collected by a double liner that complies with requirements of RCRA. It includes a leachate collection system between the liners to collect any liquids. As of 1999, ERDF has collected approximately 7,571,000 L (2 million gal) of leachate from two disposal cells (EPA, 1999b). The basin water discussed herein represents only 0.037% of that volume. The potential release of basin water does not represent a significant addition to ERDF leachate volume.

   Leachate collected in the ERDF is authorized for use as dust suppression at the ERDF (EPA, 1996). "The leachate must be sampled prior to use to ensure compliance with Land Disposal Restrictions (LDRs), ERDF waste acceptance criteria, and other health-based limits (whichever is more restrictive)."

3. The Hanford site receives approximately 7 inches of precipitation per year (EPA, 1995). The amount of rain water that would percolate around the monoliths to be collected in the ERDF as leachate would be approximately 71,900 gallons each year. This estimated rain water intrusion does not represent the entire ERDF area but only the area where the monoliths are disposed and would occur each year until a cap is installed covering the waste. The potential release of basin water does not represent a significant volume as compared to natural rainwater intrusion.

4. ERDF receives primarily low level waste. Less than 1% of waste received is considered to be a hazardous mixed waste (DOE. 1999). Therefore, if any liquid were to migrate from the monoliths the threat of mobilizing RCRA constituents from surrounding wastes is proportionally small.

5. The primary RCRA constituent of concern is elemental lead which will be macroencapsulated within the grout matrix. "Dangerous Waste Regulations regulated debris which cannot be treated using macroencapsulation to meet 40 CFR 268, Land Disposal Restrictions, Sections 40 and 45, standards will be removed from the basin (FH, 2005). Therefore, if any liquid were to migrate from the monolith the threat of mobilizing RCRA constituents from the grouted waste matrix is small.

6. The maximum estimated volume of free liquids is <0.1% of the total monolith waste volume. This is less than the amount permitted for radioactive waste disposal (10 CFR 61.56(a)(3)). "Solid waste containing liquid shall contain as little free standing and noncorrosive liquid as is reasonably achievable, but in no case shall the liquid exceed 1% of the volume."

7. As described in the 1995 ERDF Record of Decision (EPA, 1995), "at its nearest point, the Columbia River is located approximately 11.2 km (7.1 mi) from the ERDF location. Other surface water bodies located near the ERDF location include West Lake, approximately 6.4 km (4 mi) north, and Rattlesnake Springs, approximately 6.4 km (4 mi) southwest. The 200 Area is not within the 100-year floodplain of the Columbia River. Groundwater travel times from this area to the Columbia River are greater than 90 years. The water table elevation generally ranges from 123 m (405 ft) along the east side of the selected site to 139 m (455 ft) along the west side of the site."

8. "The selected remedy (i.e., 1995 ERDF ROD) protects human health and the environment through isolation of waste away from the groundwater and the Columbia River. Modeling indicates that, at this location, the ERDF design, a double-lined trench with a modified RCRA-compliant cap, will minimize risk to less than 10E-5 for up to 10,000 years under current climate conditions assuming that the cover remains intact." Although quantitative analyses were not performed, the estimated maximum amount of residual basin water (~1035 gallons) should not impact assumptions used in the model.

D4.0 DEFINITIONS

Free liquids means liquids which readily separate from the solid portion of a waste under ambient temperature and pressure.

Ground water means water below the land surface in a zone of saturation.

Stabilization (40 CFR 268.42) means "[a process that] involves the use of the following reagents (or waste reagents): (1) Portland cement; or (2) lime/pozzolans (e.g., fly ash and cement kiln dust)" (EPA-542-R-00-010).

D5.0 REFERENCES

BHI, 2002, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*, BHI-00139, Rev. 4, Bechtel Hanford, Inc., Richland, Washington.

DOE, 1999, DOE/EM-0387, *Profiles of Environmental Restoration CERCLA Disposal Facilities*, U.S. Department of Energy Office of Environmental Restoration, July 1999

EPA-542-R-00-010, *Solidification / Stabilization us at Superfund Sites*, September 2000

EPA, 1995, EPA/ROD/R10-95/100, *Hanford 200-Area (USDOE), OU 14*, U.S. Environmental Protection Agency, Richland, Washington.

EPA, Ecology, and DOE, 1996, *U.S. Department of Energy Environmental Restoration Disposal Facility - Hanford Site Benton Country), Washington - Explanation of Significant Difference*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington.

EPA, 1999a, EPA/ROD/R10-99/059, *Record of Decision for the K Basins Interim Remedial Action*, U.S. Environmental Protection Agency, Richland, Washington.

FH, 2007, KBC-24413, Data *Quality Objectives for the KE Basins Monoliths*, Rev. 1 Fluor Hanford, Richland, Washington.

EPA, 1999b, EPA/ROD/R10-99/039, *Interim Remedial Action Record of Decision for the 100 Area Remaining Sites, 100 Area Reactor Waste, and 200-CW-3 Waste Sites*, U.S. Environmental Protection Agency, Richland, Washington.

Kosmatka, S. H., B. Kerkhoff, W.C. Panarese, *Design and Control of Concrete Mixtures*, Portland Cement Association, 2002.

Lea, F. M., 1970, *The Chemistry of Cement and Concrete*, 3rd Ed., Chemical Publishing Co., New York, New York.

Tables

Table D-1. KE Basin Water Radionuclide Constituents (Sample No. W040002543, 12/07/04) – 2 pages.

Constituent	ERDF Limit (Ci/m^3)	KE Basin Water (Ci/m3)
Actinium-227	7.50E+04	
Americium-241	5.00E-02	4.40E-12
Americium-243	5.70E-02	
Carbon-14	5.10E+00	
cesium-134	Unlimited	4.46E-14
cesium-135	8.80E+00	
cesium-137	3.20E+01	2.56E-09
Chlorine-36	3.50E-02	
Cobalt-60	Unlimited	1.37E-18
curium-242	2.00E+04	
curium-243	8.50E+01	
Curium-244	4.00E+01	
Curium-245	5.50E-02	
Curium-246	1.1E-01	
curium-247	3.00E-02	
curium-248	2.80E-02	
Europium-150	1.70E+02	
Europium- 152	2.10E+07	2.92E-12
Europium-154	Unlimited	8.12E-13
Hydrogen-3	Unlimited	
Iodine-129	8.00E-02	
Lead-210	5.30E+05	
Molybdenum-93	5.00E+01	
Neptunium-237	1.50E-03	
Nickel-59	2.10E+02	
Nickel-63	7.00E+02	
Niobium-94	1.20E-02	3.45E-14
Palladium-107	8.30E+02	
Plutonium-238	1.50E+00	1.20E-12
Plutonium-239	2.90E-02	7.60E-12
plutonium-240	2.90E-02	
plutonium-241	6.20E+00	
plutonium-242	1.1E-01	
plutoniun-244	3.30E-02	

Table D-1. KE Basin Water Radionuclide Constituents
(Sample No. W040002543, 12/07/04) – 2 pages.

Constituent	ERDF Limit (Ci/m^3)	KE Basin Water (Ci/m3)
Potassium-40	9.50E-02	
Radium-226 + daughters	1.40E-04	
Radium-228	2.20E-04	
Samarium-147	9.30E-01	
Samarium- 151	5.30E+04	
Selenium-79	2.80E+01	
Strontium-90	7.00E+03	1.10E-09
Technetium-99	1.30E+00	
Thorium-228 + daughters	1.20E-04	
Tin-126	8.50E-03	
Uranium-233/234	7.40E-02	4.80E-13
Uranium-235	2.70E-03	1.30E-13
Uranium-238 + daughters	1.20E-02	2.40E-13
Zirconium-93	1.40E+02	

Attachment A

40 CFR 264.314(f)

(f) Effective November 8, 1985, the placement of any liquid which is not a hazardous waste in a landfill is prohibited unless the owner or operator of such landfill demonstrates to the Regional Administrator, or the Regional Administrator determines, that:

(1) The only reasonably available alternative to the placement in such landfill is placement in a landfill or unlined surface impoundment, whether or not permitted or operating under interim status, which contains, or may reasonably be anticipated to contain, hazardous waste; and

(2) Placement in such owner or operator's landfill will not present a risk of contamination of any underground source of drinking water (as that term is defined in Sec. 144.3 of this chapter.)