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Technical Work Plan for Surface Impoundments Operable Unit Engineering Support Studies

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Energy Systems Environmental Restoration Program

Technical Work Plan for Surface Impoundments Operable Unit Engineering Support Studies

Date Issued—November 1995

Prepared by
Parsons Engineering Science, Inc.
Atlanta, Georgia

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PREFACE

This *Technical Work Plan for Surface Impoundments Operable Unit Engineering Support Studies,* ORNL/ER-324, has been produced to support remediation of the Surface Impoundments Operable Unit at Oak Ridge National Laboratory, Oak Ridge, Tennessee. The intent of this work plan is to provide a comprehensive guide which, when used as a data collection guide for field activities, will provide the necessary information required to complete a report on geotechnical properties of the sediments at Surface Impoundments Operable Unit. Information gained from this work will be used in the preliminary engineering activities by providing geotechnical properties essential to the remediation design process.

EXECUTIVE SUMMARY

This document provides a comprehensive work plan which, when utilized as a data collection guide for field activities, will provide the necessary information required to complete a report on geotechnical properties of the sediments contained in the Surface Impoundments Operable Unit at Oak Ridge National Laboratory in Oak Ridge, Tennessee. Detailed guidance is provided for the following activities:

- Collection of samples from the impoundments.
- Compressive strength testing of the raw sediments.
- Compressive strength testing of the structurally modified (lime and cement additives) sediments.
- Testing for sediment physical properties and settling rates.
- Testing for sediment dewatering characteristics.
- Testing for radiation activity during the field work.
- Testing for polymer additions that may enhance settling.

The work plan additionally provides guidance and examples for the preparation of documents necessary to establish readiness for safe and satisfactory performance of the field activities. An outline for the format requested for a report of these data is also provided.

1. INTRODUCTION

For Information Only

This document is a technical work plan for performing engineering support studies for the design and implementation of four selected remedial alternatives for the Surface Impoundments Operable Unit (SIOU), Waste Area Grouping (WAG) 1, located at the Oak Ridge National Laboratory (ORNL) in Oak Ridge, Tennessee. This operable unit consists of four inactive surface impoundments that contain low-level radioactive sediments that are also contaminated with several heavy metals and organics. Currently, the remedial investigation and feasibility study (RI/FS) report is being completed for the impoundments. This work plan describes the engineering studies and methodologies to support the design and implementation of the selected remedial alternatives (sediments only) identified through the FS.

1.1 OBJECTIVES

The primary objectives of this project are to identify, design, and describe the engineering studies for collecting the necessary data on the SIOU sediments for the detailed design and implementation of the retained remedial alternatives currently being evaluated. The following are specific objectives identified for this project:

- Identify and develop specific engineering support studies for better evaluation of remedial technologies.
- Compile data to support detailed analysis and design of the selected remedial alternatives.
- Reduce performance uncertainties of technologies for remediation of the SIOU, thus facilitating remedy selection, detailed evaluation, and design.

1.2 PROJECT BACKGROUND

ORNL is located within the U.S. Department of Energy's (DOE's) Oak Ridge Reservation (ORR) in Oak Ridge, Tennessee. ORNL is listed on the U.S. Environmental Protection Agency's (EPA's) National Priority List (NPL), and remediation of the SIOU is being conducted under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Currently, DOE is conducting the RI/FS activities at the SIOU as a pilot project under Streamlined Approach for Environmental Restoration (SAFER). The draft RI/FS report (January 1995)[1] identified several remediation alternatives of varying costs and effectiveness. Four of these alternatives were selected as likely candidates for further evaluation. These alternatives require further evaluation using engineering support studies to gather data needed for the design and implementation of the selected alternatives.

The SAFER program aims to optimize the management of inherent uncertainty in environmental restoration activities while making judicious progress toward site remediation. The EPA guidance on the RI/FS process under CERCLA recommends conducting treatability studies

in order to better evaluate technology performances and to reduce performance uncertainties to facilitate selection and implementation of a remedial alternative. Since a treatability study was not needed to determine which alternatives to select, engineering support studies are needed to collect sufficient data to support remedial design and implementation of the selected alternative. The data from the engineering studies will also reduce to acceptable levels the uncertainties associated with the selected remediation alternative.

The following subsections present the history and background information leading up to the engineering support studies. Information in these subsections was summarized from the draft RI/FS report.[1]

1.2.1 Site History

The SIOU is located in the south-central portion of WAG 1, which is centrally located within the DOE ORR. The site is owned by DOE and operated by Lockheed Martin Energy Systems, Inc. (Energy Systems). The SIOU consists of four surface impoundments:

- Impoundment 3513: Waste Holding Basin.
- Impoundment 3524: Equalization Basin.
- Impoundment 3539: Process Waste Basin.
- Impoundment 3540: Process Waste Basin.

Impoundments 3513 and 3524 were constructed in 1944 and 1943, respectively, whereas Impoundments 3539 and 3540 were constructed in 1964. These impoundments were used to manage low-level liquid radioactive wastes. Currently, the impoundments are inactive and are undergoing the RI/FS process under CERCLA. The impoundments contain sediments that are low-level radioactive. The sediments also contain other contaminants such as Resource Conservation and Recovery Act (RCRA) metals and polychlorinated biphenyls (PCBs). Impoundments 3513 and 3524 are estimated to contain 2-ft of sediments, whereas Impoundments 3539 and 3540 contain sediments a few inches thick. The sediments are currently maintained under a water shield for worker health protection purposes. A detailed account of the impoundment construction, past operations, and environmental history is presented in the draft RI/FS report.[1]

Impoundment 3513 was taken out of service in 1976, and Impoundment 3524, in 1989. Impoundments 3539 and 3540 were removed from service in 1990. A Federal Facility Agreement (FFA) to respond to the placement of ORR on the NPL was negotiated in 1992. In accordance with the agreement, DOE initiated remedial investigation at the SIOU in 1994.

1.2.2 Previous Investigations and Results

Several studies were conducted in the 1980s to investigate and characterize the sediments that were accumulated in the impoundments and the areas surrounding the impoundments. In 1986 and 1987, groundwater in the surface impoundments area was investigated. These investigations focused primarily on the radioactivity associated with the sediments and waste residues. The results of these investigations have been published in several documents, which are referenced in the draft RI/FS report[1] for the SIOU.

Upon the deactivation of the impoundments, investigations have been conducted at the SIOU to characterize contamination and environmental risk. A remedial investigation was conducted in

1994 that included sampling and analysis of sediment accumulated in the impoundments. The sediment analyses included primarily chemical and radiochemical analyses. The sediment samples were also analyzed for limited geotechnical parameters. The data from the RI activities are described in detail in the draft RI/FS report.[1] A brief summary of the sediment characterization data is presented below.

1.2.3 Sediment Characterization and Inventory

This section summarizes the RI findings of the physical, chemical, and radioactive properties of the sediments in the impoundments. Impoundments 3513 and 3524 are estimated to contain an average of 2-ft-thick sediment layer, whereas the accumulated sediment in Impoundments 3539 and 3540 is estimated to be approximately 2–3 in. thick. Using the impoundment dimensions presented in the draft RI/FS report, the above sediment layer thicknesses result in an approximate total in situ sediment volume of 4800 yd^3 for all four impoundments combined.

Sediments in the impoundments were found to contain elevated levels of radioactivity and heavy metals and low levels of organics. A water shield is maintained over the sediment blanket accumulated in the impoundments to reduce the exposure to the radioactivity from the sediment to acceptable levels. Sediments were also found to contain heavy metals such as chromium, lead, and mercury. The sediments contained low concentrations of organics such as PCBs and some volatile organics. A complete summary of the analytical data and the RI findings is presented in the SIOU draft RI/FS report.[1] Radiochemical data from the 1994 sampling of sediments from the impoundments are presented in Appendix E of this work plan.

1.3 DOCUMENT ORGANIZATION

This work plan consists of six sections, including this introductory section. Chapter 2 presents the technical approach for the remediation of the impoundments together with a brief description of each of the four alternatives currently being considered and the data needs for detailed design and implementation of these alternatives. Chapter 3 details the engineering study methodologies to satisfy the data needs identified in Chap. 2. The engineering study data collection, evaluation, and interpretation procedures and guidelines are described in Chap. 4. A tentative schedule for conducting the engineering studies associated with each of the alternatives is presented in Chap. 5, and references are provided in Chap. 6.

A total of five appendices present supporting data and plans and other information pertinent to the work plan. The following is a list of these appendices:

- Appendix A: Sediment Sampling Plan (SSP) to describe the field activities associated with sediment sampling for characterization and engineering support studies.

- Appendix B: Standard operating procedures and American Society for Testing and Materials (ASTM)/EPA standard methods for conducting the engineering support studies.

- Appendix C: Health and safety issues that need to be addressed during the implementation of the engineering support studies.

- Appendix D: Quality Assurance/Quality Control (QA/QC) Plan identifies the data quality objectives and presents the level of QA/QC required for the engineering support studies.

- Appendix E: Radiochemical data from sediment sampling at impoundments in 1994.

2. TECHNICAL APPROACH

For Information Only

2.1 PROJECT OVERVIEW

This project involves preparation of an engineering work plan to be implemented by a contractor to be selected by Energy Systems. The work plan presents the design and description of engineering studies necessary to support detailed design and implementation of the selected alternatives for remediation of four surface impoundments at the ORNL SIOU. The project work consists of the following specific tasks:

- Review the retained remedial alternatives evaluated in the draft SIOU RI/FS report[1] and identify data needs to support detailed design and implementation of each alternative.
- Identify appropriate engineering support studies to provide the data needs identified in the above task.
- Develop the engineering studies methodologies and describe associated testing and data collection activities.
- Describe procedures to analyze and evaluate the data gathered from the engineering studies.
- Prepare a work plan documenting the above tasks.

2.2 TECHNICAL ASSUMPTIONS

Several assumptions were made in the development of technical information presented in this document. These assumptions were required because the RI/FS has not been completed. However, the assumptions, to the extent possible, were based on current practice and best engineering judgment. These assumptions are listed for each remedial alternative being evaluated for the site. A list of general assumptions applicable to all alternatives is also presented below. The general assumptions also include those related to the general execution of the project.

2.2.1 General

- The engineering support studies described in this work plan do not necessarily address the overall effectiveness or the ability to implement the selected remedial alternatives.
- Only sediment that has accumulated in the impoundments requires treatment. All contaminated soils do not require treatment prior to placement in the cells.
- Geotechnical testing to evaluate berm structural integrity/stability will be performed by others as part of the detailed design of the selected remedial alternative.

- The engineering studies will be conducted on sediment samples from Impoundments 3513 and 3524 since the sediment volume from the other two smaller impoundments (3539 and 3540) is relatively negligible.

- Treatment of the existing groundwater is not part of the scope of this work plan.

- All waste management activities will take place within the designated area of contamination (AOC), and hence land disposal restrictions (LDRs, 40 CFR Part 268) will not be triggered.

2.2.2 Alternative 1: No Action

- The "No Action" alternative involves no construction or monitoring activities. Therefore, this alternative requires no engineering studies.

2.2.3 Alternative 2: Multilayered Cap and Institutional Controls

- The RI/FS report indicates the presence of the water table above the sediment layers in the impoundments. For developing the engineering studies under this alternative, the site groundwater conditions are assumed not to influence the design or implementation of the remedial alternatives.

2.2.4 Alternative 3: Consolidation Cell and Simple Dewatering

- Any engineering studies necessary for the design and construction activities of the proposed consolidation cell are not part of the scope of this work plan..

- All sediment and contaminated soils generated during this alternative can be accommodated in the consolidation cell.

- Moisture control and shielding necessary for the in situ solidification of the sediment in the consolidation cell can be accomplished.

2.2.5 Alternative 4: Consolidation Cell and Ex Situ Treatment

- Any engineering studies necessary for the design and construction activities of the proposed consolidation cell are not part of the scope of this work plan.

- All treated sediments and contaminated soils generated during this alternative can be accommodated in the consolidation cell.

2.3 DESCRIPTION OF ALTERNATIVES

The engineering support studies will be conducted to obtain the data to support the design and implementation of the alternatives for remediation of the impoundments. The following subsections will provide a brief overview of each of the four alternatives identified for remediation of the impoundments, including a listing of the data needs developed for each alternative.

2.3.1 Alternative 1: No Action

This alternative assumes the persistence of existing conditions at the site and involves no further remedial action at the impoundment sites. No construction or monitoring activities will be involved under this alternative. This alternative is being included in the list of selected remedial alternatives for the impoundments as required by the CERCLA feasibility study guidance document[2] and provides a baseline for comparison to other alternatives.

There are no data needs for the implementation of the no action alternative, and therefore no engineering studies are presented under this alternative.

2.3.2 Alternative 2: Multilayered Cap and Institutional Controls

This alternative is a waste containment and monitoring alternative. Alternative 2 is being evaluated in the RI/FS report for the SIOU, which is currently in preparation. A conceptual process flow diagram for this alternative is shown in Fig. 2.1. Under this alternative, the wastes in the impoundments will be left in place. Any water shield in the impoundments will be gradually replaced by placing a backfill consisting of shot rocks. The backfill will be placed over a geofilter composite consisting of a geotextile and a geogrid. Water in excess of the shielding requirement will be removed by pumping it to the on-site wastewater treatment plant. Any contaminated soils removed at the site will be relocated to the impoundments. This backfill will be overlain with a multilayered cap consisting of a geotextile layer and a layer of topsoil with a vegetative cover. After the construction of the cap, the impoundments will be managed under institutional controls such as deed restrictions, site access and use restrictions, security, and periodic monitoring of groundwater and the cap.

2.3.2.1 Engineering data needs

The data needs for the design and implementation of Alternative 2 arise from compaction and settlement of sediment that may occur during and after the placement of backfill and construction of the cap. The data to determine the shielding requirements during the construction under this alternative will be required for health and safety purposes. Further, physical characterization of sediment in the impoundments will be necessary to design and implement engineering support studies to evaluate the dewatering and consolidation characteristics of the sediment. The following are the specific data needs identified for Alternative 2:

- Sediment physical characterization.
- Shielding requirements during sampling and engineering studies.
- Sediment settling characteristics during shot rock placement.
- Sediment dewatering characteristics under surcharge due to the placement of backfill/cap.
- Consolidation characteristics of sediment after the placement of surcharge.

The appropriate engineering studies to meet the data needs identified for this alternative are described in Sect. 2.4.2.

2.3.3 Alternative 3: Consolidation Cell and Simple Dewatering

Similar to Alternative 2, this alternative is a waste containment and monitoring alternative. However, Alternative 3 involves the construction of a secure waste containment cell for

consolidating sediment and soils from all four impoundments. The alternative was developed in the site draft RI/FS report. A conceptual process flow diagram for this alternative is shown in Fig. 2.2.

Impoundment 3524 is the proposed location for construction of the consolidation cell. Initially, sediment and any contaminated subimpoundment soils at the Impoundment 3524 area will be placed in Impoundment 3513. A consolidation cell consisting of a multilayered liner including a leachate detection, collection, and removal system will be constructed. Sediment from Impoundments 3513, 3539, and 3540 will be placed in the consolidation cell and may be treated using in situ treatment methods.

The two in situ treatment methods identified are sediment dewatering under surcharge and physical solidification using solidification reagents. Surcharge will consist of shot rocks and contaminated soil as described under Alternative 2 and a temporary cap. Under this alternative, sediment will be actively dewatered using the leachate collection and removal system installed in the consolidation cell. Sediment solidification will involve mixing the sediment with a solidification reagent at a predetermined mix ratio to improve the physical characteristics of the sediment to support the surcharge and cap. This in situ treatment method may produce a solidified sediment capable of supporting the consolidation cell closure construction.

The consolidation cell will be initially closed by constructing a temporary cap. All contaminated soils generated during the site closure will be placed in the consolidation cell beneath a multilayered cap. Once it is determined that substantial subsidence is complete, the multilayered cap will be redressed.

2.3.3.1 Engineering data needs

Under this alternative, the data needs for the design and implementation of Alternative 3 will include sediment characterization, shielding requirements, sediment dewatering characteristics, sediment compaction and settlement characteristics, sediment solidification characteristics, and pumpability of sediments. Physical characterization of sediment in the impoundments will be necessary to evaluate dewatering, consolidation, and solidification characteristics of the sediment. The sediment may consolidate during and after the placement of backfill and construction of the cap; hence, measurement and evaluation of the anticipated consolidation characteristics of the sediment will be necessary. Further, engineering support study data will be required to evaluate the characteristics of the solidified sediment. The following are the specific data needs identified for Alternative 3:

- Sediment physical characterization.
- Shielding requirements during sampling and engineering studies.
- Consolidation cell capacity requirements.
- Sediment settling characteristics during sediment transfer.
- Sediment dewatering characteristics under the surcharge due to the placement of backfill materials.
- Consolidation characteristics of sediment after the placement of surcharge.
- Reagents and dosage for in situ physical solidification of sediment.
- Consolidation characteristics of solidified sediment under surcharge.
- Head losses through piping during transport of sediment slurry.

The appropriate engineering studies to meet the data needs identified for this alternative are described in Sect. 2.4.3.

2.3.4 Alternative 4: Consolidation Cell and Ex Situ Treatment

Alternative 4 is also a waste containment and monitoring alternative, which was developed in the RI/FS report. A conceptual process flow diagram for this alternative is shown in Fig. 2.3. Similar to Alternative 3, this alternative involves the construction of a secure waste containment cell for consolidating sediment from all four impoundments. However, this alternative differs from alternative 3 in that sediment from Impoundments 3513, 3524, 3539, and 3540 will be treated ex situ using solidification with or without mechanical dewatering prior to placement in the consolidation cell.

The ex situ solidification process under this alternative will consist of mixing the sediment with appropriate solidification reagents and allowing the mixture to set in forms. The primary objective of the ex situ solidification is to yield a solidified monolith block. The sediment will be gravity drained to a suitable moisture content for ex situ solidification. However, if gravity draining were found to be ineffective in removing excessive moisture, mechanical dewatering techniques such as belt press, filter press, or centrifuge may be used prior to solidification.

All contaminated soils generated during the site closure will be placed over the solidified sediment in the consolidation cell. A multilayered cap, described under Alternative 3 (Sect. 2.3.3), will be constructed as part of the final closure construction.

2.3.4.1 Engineering data needs

Under Alternative 4, the data needs for design and implementation of the alternative will include sediment characterization, shielding requirements, sediment dewatering characteristics, sediment solidification characteristics, and pumpability of sediments. Physical characterization of sediment in the impoundments will be necessary for use in the design and implementation of engineering support studies to evaluate sediment dewatering and solidification. Further, engineering study data will be required to evaluate the solidification characteristics of the sediment. The following are the specific data needs identified for Alternative 4:

- Sediment physical characterization.
- Shielding requirements during sampling and engineering studies.
- Consolidation cell capacity requirements.
- Sediment settling characteristics during sediment transfer.
- Sediment dewatering characteristics using gravity thickening.
- Sediment dewatering characteristics using mechanical dewatering techniques.
- Reagents and dosage for ex situ solidification of sediment.
- Strength and bearing capacity of solidified sediment.
- Head losses through piping during transport of sediment slurry.

The appropriate engineering studies to meet the data needs identified for this alternative are described in Sect. 2.4.4.

2.4 PROCESS CONCEPTUALIZATION

On the basis of the data needs identified for each alternative in Sect. 2.3, objectives for engineering support studies were developed, and appropriate analytical tests and experiments necessary to meet these objectives were formulated. The following subsections describe the conceptual design of engineering studies. These studies are described in detail in Chap. 3.

2.4.1 Alternative 1: No Action

As described in Sect. 2.3.1, this alternative involves no construction or monitoring activities, and no data needs for the implementation of this alternative are anticipated. Therefore, no engineering studies are determined necessary for the implementation of the no action alternative.

2.4.2 Alternative 2: Multilayered Cap and Institutional Controls

This alternative involves backfilling the impoundments and constructing a multilayered cap. Sediment in the impoundments may settle during and after the backfill and cap are in place. On the basis of the data needs identified under this alternative (Sect. 2.3.2), engineering support studies to evaluate the dewatering and consolidation characteristics of the sediment were determined necessary. The following are the specific objectives for the engineering studies:

- obtain sediment characteristics influencing the sediment dewatering and consolidation properties,
- determine sediment settling properties,
- determine sediment dewatering characteristics under gravity and surcharge, and
- determine sediment consolidation characteristics under surcharge.

To achieve the above objectives, the following engineering study tasks were designed:

- Sediment sampling and compositing.
- Sediment characterization for geotechnical properties.
- Sediment settling properties using gravity settling tests.
- Sediment dewatering characteristics using the Paint Filter Test and Modified Liquid Release Test.
- Sediment consolidation characteristics using the Harvard Miniature Compaction Test and One-Dimensional Consolidation Test.

A detailed methodology for conducting these engineering studies is described in Chap. 3. The data management and interpretation procedures are presented in Chap. 4.

2.4.3 Alternative 3: Consolidation Cell and Simple Dewatering

Alternative 3 involves consolidation of all sediment in a consolidation cell to be constructed at the existing Impoundment 3524 location and in situ treatment of the sediment. Sediment will be transferred from Impoundment 3524 to Impoundment 3513 during consolidation cell construction and from Impoundments 3513, 3539, and 3540 for final placement in the consolidation cell. These sediment transfer activities will require evaluation of sediment settling and pumping characteristics to support the design of the alternative. The sediment will be processed using dewatering techniques such as gravity thickening and dewatering by surcharge.

The sediment may also be treated using in situ physical solidification technology. Further, sediment in the consolidation cell may settle during and after cell closure. On the basis of the data needs identified under this alternative (Sect. 2.3.3), engineering support studies to evaluate the sediment settling, pumping, dewatering, solidification, and consolidation characteristics were determined necessary. The following are the specific objectives for the engineering studies:

- To obtain sediment characteristics influencing the sediment settling, pumping, dewatering, solidification, and consolidation properties.
- To determine sediment settling properties.
- To determine sediment dewatering characteristics under gravity and surcharge.
- To determine sediment physical solidification characteristics.
- To determine sediment consolidation characteristics.
- To determine consolidation characteristics of solidified sediment.
- To determine head losses through piping during transport of sediment slurry.

To achieve the above objectives, the following engineering support study tasks were devised:

- Sediment sampling and compositing.
- Sediment characterization for geotechnical properties.
- Sediment settling properties using gravity settling tests with or without polymers.
- Sediment dewatering characteristics using the Paint Filter Test and Modified Liquid Release Test.
- Sediment physical solidification tests using different solidification reagents at different mix ratios.
- Sediment consolidation characteristics using the Harvard Miniature Compaction Test and One-Dimensional Consolidation Test.
- Pump loop test on sediment to determine pipe head losses.

A detailed methodology for conducting these engineering studies is described in Chap. 3. The data management and interpretation procedures are presented in Chap. 4.

2.4.4 Alternative 4: Consolidation Cell and Ex Situ Treatment

This alternative is similar to Alternative 3 except that the dewatered sediment will be solidified ex situ prior to placement in the consolidation cell. As in Alternative 3, the sediment transfer activities will require evaluation of sediment settling characteristics. The sediment may require dewatering using techniques such as gravity thickening with or without mechanical dewatering. On the basis of the data needs identified under this alternative (Sect. 2.3.4), engineering support studies to evaluate the sediment settling, dewatering, and solidification characteristics were determined necessary. The following are the specific objectives for the engineering studies:

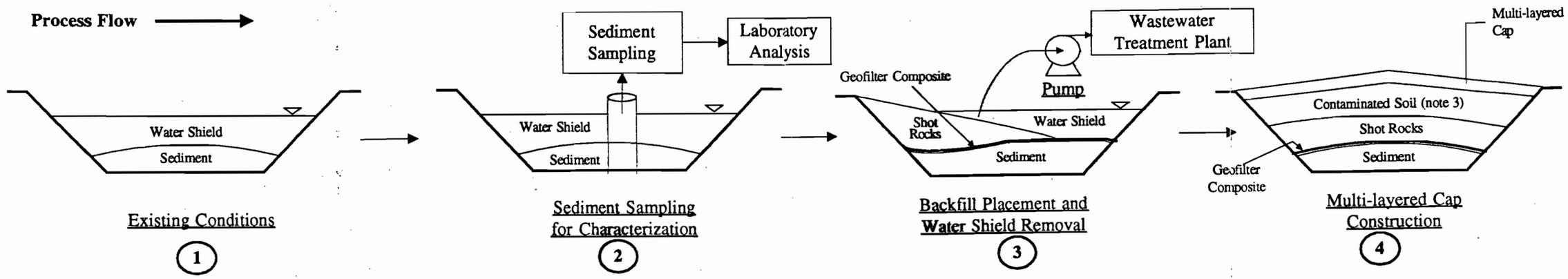
- Obtain sediment characteristics influencing the sediment settling, dewatering, and solidification properties.
- Determine sediment settling properties.
- Determine sediment dewatering characteristics under gravity and mechanical dewatering.
- Determine sediment physical solidification characteristics.
- Determine head losses through piping during transport of sediment slurry.

To achieve the above objectives, the following engineering support study tasks were devised:

- Sediment sampling and compositing.
- Sediment characterization for geotechnical properties.
- Sediment settling properties using gravity settling tests with or without flocculants.
- Sediment dewatering characteristics using the Paint Filter Test and bench- and/or pilot-scale mechanical dewatering tests such as belt press, filter press, and centrifuge.
- Sediment physical solidification tests using different solidification reagents and different mix ratios.
- Pump loop test on sediment to determine pipe head losses.

A detailed methodology for conducting these engineering studies is described in Chap. 3. The data management and interpretation procedures are presented in Chap. 4.

Fig. 2.1. Conceptual process flow diagram for Alternative 2: Multilayered Cap and Institutional Controls.



Remedial Alternative Tasks:

Sediment sampling and characterization
Shot rock placement and removal of water shield
Multilayer cap construction

Remedial Alternative Data Needs:

Sediment physical characterization (Appendix A)
Shielding requirements (H&S Plan)
Sediment dewatering characteristics under surcharge
Sediment consolidation characteristics

Engineering Study Tasks:

Sediment sampling and characterization
Sediment settling characteristics
Sediment dewatering characteristics
Sediment consolidation characteristics

Specific Tests During Engineering Study:

Sediment Characterization:
- Particle size distribution
- Specific gravity (sediment solids)
- Sediment bulk density
- Moisture content

Sediment Settling Characteristics
- Gravity settling tests

Sediment Dewatering Characteristics:
- Paint filter test
- Modified liquid release test

Sediment Consolidation Characteristics:
- Harvard Miniature Compaction test
- One-dimensional consolidation test

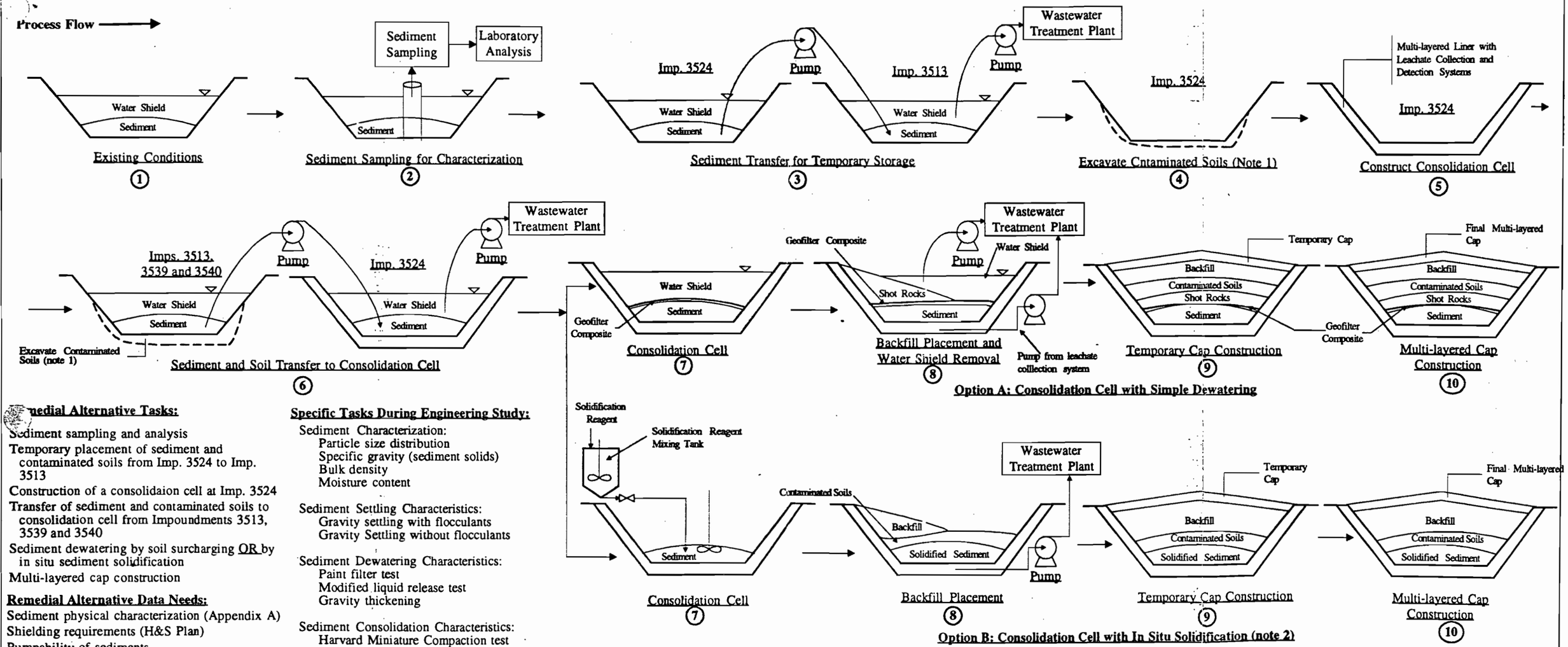
Notes:

Note 1: (4) indicates the remedial step sequence number .

Note 2: Remedial steps (2) and (3) shown are applicable to each of the two largest impoundments. The remaining steps are applicable to all four impoundments.

Note 3: Contaminated soils removed at the site as part of the remedial alternative will be placed in the impoundments and capped.

Fig. 2.2. Conceptual process flow diagram for Alternative 3: Consolidation Cell and Simple Dewatering.



Remedial Alternative Tasks:

Sediment sampling and analysis
Temporary placement of sediment and contaminated soils from Imp. 3524 to Imp. 3513
Construction of a consolidaion cell at Imp. 3524
Transfer of sediment and contaminated soils to consolidation cell from Impoundments 3513, 3539 and 3540
Sediment dewatering by soil surcharging OR by in situ sediment solidification
Multi-layered cap construction

Remedial Alternative Data Needs:

Sediment physical characterization (Appendix A)
Shielding requirements (H&S Plan)
Pumpability of sediments
Consolidation cell capacity requirements
Sediment dewatering characteristics
Consolidation characteristics of sediment
In situ solidification reagents and process

Engineering Study Tasks:

Sediment sampling
Sediment characterization
Pump-loop test
Sediment settling characteristics
Sediment dewatering characteristics
Sediment consolidation characteristics
Sediment in-situ physical solidification

Specific Tasks During Engineering Study:

Sediment Characterization:
- Particle size distribution
- Specific gravity (sediment solids)
- Bulk density
- Moisture content

Sediment Settling Characteristics:
- Gravity settling with flocculants
- Gravity Settling without flocculants

Sediment Dewatering Characteristics:
- Paint filter test
- Modified liquid release test
- Gravity thickening

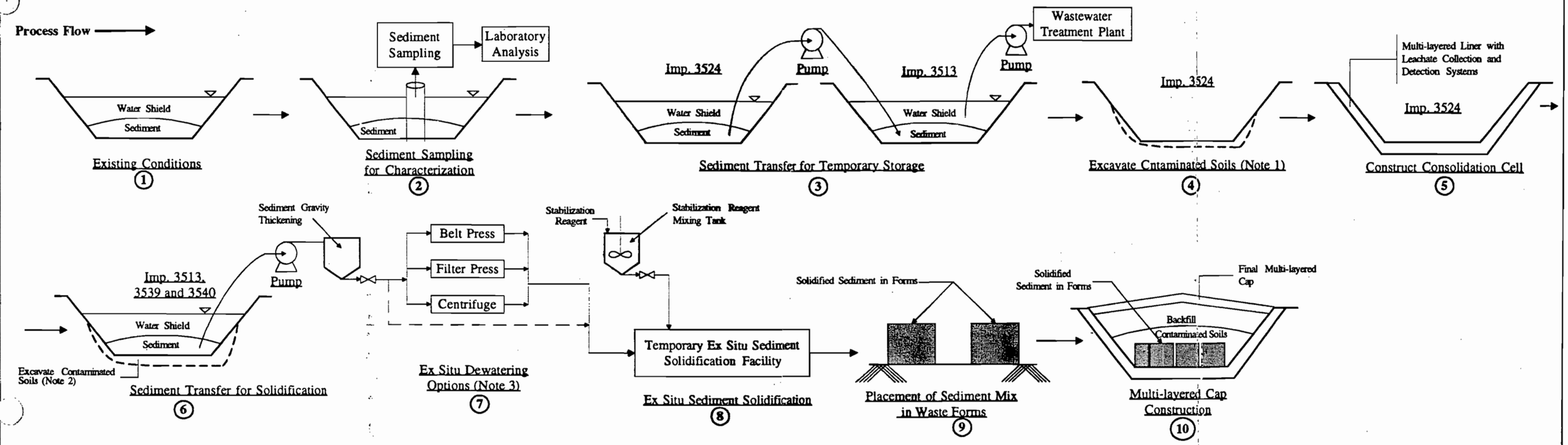
Sediment Consolidation Characteristics:
- Harvard Miniature Compaction test
- One-dimensional consolidation test

Sediment In Situ Physical Solidification:
- Reagent mix ratios
- Initial and final water content
- Volume change
- Unconfined compressive strength

Notes:

Note 1: Contaminated soils from all four impoundments will be stockpiled for backfilling the consolidation cell.
Note 2: Sediment in-situ solidification process is assumed not to require shielding.
Note 3: (4) indicates the remedial step sequence number .
Note 4: Imp. = Impoundment

Fig. 2.3. Conceptual process flow diagram for Alternative 4: Consolidation Cell and Ex Situ Treatment.



Remedial Alternative Tasks:

- Sediment sampling and analysis
- Temporary placement of sediment and contaminated soils from Imp. 3524 to Imp. 3513
- Construction of a consolidation cell at Imp. 3524
- Ex situ dewatering of sediment from Imp. 3513, 3539 and 3540 (if necessary)
- Ex situ solidification of (dewatered) sediments
- Transfer of sediment and solidification reagent mix into waste forms
- Transfer of solidified sediment in waste forms to consolidation cell
- Multi-layered cap construction

Remedial Alternative Data Needs:

- Sediment physical characterization (appendix A)
- Shielding requirements (H&S Plan)
- Pumpability of sediments
- Consolidation cell capacity requirements
- Sediment dewatering characteristics
- Ex situ solidification reagents and process

Engineering Study Tasks:

- Sediment sampling
- Sediment characterization
- Pump loop test
- Sediment settling characteristics
- Sediment mechnical dewatering characteristics
- Sediment ex situ solidification

Specific Tasks During Engineering Study:

Sediment Characterization:
- Particle size distribution
- Specific gravity (sediment solids)
- Bulk density
- moisture content

Sediment Settling Characteristics:
- Gravity settling with flocculants
- Gravity Settling without flocculants

Sediment Dewatering Characteristics:
- Paint filter test
- Modified liquid release test
- Gravity thickening test

Specific Tasks During Engineering Study: Contd.....

Sediment Mechanical Dewatering
- Belt press
- Filter press
- Centrifuge

Sediment Ex Situ Solidification:
- Reagent mix ratios
- Initial and final water content
- Volume change
- Unconfined compressive strength

Notes:

Note 1: Contaminated soils from Impoundment 3524 may be stockpiled for backfilling the consolidation cell.

Note 2: Contaminated soils from Impoundments 3513, 3539 and 3540 will be stockpiled for backfilling the consolidation cell.

Note 3: The final sediment dewatering option may consist of gravity thickening with or without one of the mechanical dewatering techniques (belt press, filter press or centrifuge).

Note 4: (4) indicates the remedial step sequence number.

Note 5: Imp. = Impoundment

3. ENGINEERING SUPPORT STUDY EXPERIMENTAL PLAN

This chapter presents the methodology for performing the various engineering support studies identified under the Technical Approach (Chap. 2) for the design and implementation of the alternatives. These engineering support studies are described by each selected alternative in the following subsections. The description of the engineering studies task for each alternative is presented as a stand-alone subsection independent of other alternatives. Describing each alternative independent of the others provides for flexibility in implementing the work plan, irrespective of the selected alternative. Tests that are repeated within an alternative are only described once and referenced where subsequently repeated.

ALTERNATIVE 1
NO ACTION

3.1 ALTERNATIVE 1: NO ACTION

For Information Only

As described in Chap. 2, the no action alternative involves no construction or monitoring activities. Therefore, no engineering studies are determined necessary for the implementation of the no action alternative.

ALTERNATIVE 2
MULTILAYER CAP AND INSTITUTIONAL CONTROLS

3.2 ALTERNATIVE 2: MULTILAYER CAP AND INSTITUTIONAL CONTROLS

For Information Only

This alternative is a waste containment and monitoring alternative and involves backfilling the impoundments and constructing a multilayered cap at each impoundment (or over the SIOU site). Specific engineering support study tasks were developed based on the data needs identified in Chap. 2. These studies would provide information required to support the design and implementation of this alternative. These tasks, illustrated in Fig. 3.1 and listed below, will be performed on sediments from each of the two impoundments:

- Task 1: Perform Sediment Sampling (Impoundments 3513 and 3524).
- Task 2: Prepare Composite Sediment Sample.
- Task 3.1: Characterize Composite Sediment Sample.
- Task 3.2: Perform Paint Filter Test.
- Task 3.3: Gravity Drain Composite Sample for Further Testing.
  - Perform Harvard Miniature Compaction Tests.
  - Perform One-Dimensional Consolidation Tests.
  - Perform Modified Liquid Release Tests.
- Task 3.4: Perform gravity settling tests.

All tasks above will be performed independently for Impoundments 3513 and 3524. For each task described, an objective for performing the test is provided, and relevant Standard Operating Procedures (SOPs) and ASTM/EPA standard methods are referenced and/or presented in Appendix B. All geotechnical analyses will be performed in accordance with the referenced standard methods listed in the *1994 Annual Book of ASTM Standards*, Vol. 04.08.[2] Moisture content is calculated for several of the tests and is calculated using data from the ASTM Method for Water Content. All data management and interpretations are based on moisture content. The EPA standard test protocol for the Paint Filter Test is also referenced and presented in Appendix B. Any modifications to the standard test methods are included in the description of the relevant task.

A description of each task listed above is presented in the following sections. All tasks will be performed in conformance with requirements of the project Health and Safety (H&S) Plan to be prepared prior to the field activities. Data will be collected and interpreted in accordance with the procedures presented in Chap. 4 (Data Management and Interpretation).

3.2.1 Task 1: Collect Sediment Samples

The first task in performing the engineering support studies for Alternative 2 is to collect representative sediment samples. The objective of this task is to obtain representative sediment samples for characterization and to perform all subsequent tests described under this remedial alternative.

Five discrete sediment samples will be collected from each of Impoundments 3513 and 3524 (total of ten samples). Five samples were selected because the geotechnical properties of the sediment within each impoundment are not expected to exhibit a wide variability. Sediment sampling for Alternative 2 is limited to Impoundments 3513 and 3524 and will not include

Impoundments 3539 and 3540. This is based on the sludge volume data presented in the RI/FS draft report.[1] Impoundments 3539 and 3540 each contain a 2-in.-thick sludge layer and hence are not expected to influence the design or implementation of the alternative.

The sampling procedures and sample management protocols are described in the Sediment Sampling Plan (SSP, Appendix A). Radiation levels will be monitored to determine shielding requirements during sample collection (see ESP-307-7, Operation of Radiation Survey Instruments, in Appendix A). The SSP is based on similar procedures used during the sediment sampling conducted in the summer of 1994 as part of the RI/FS. The individual sediment samples will be stored in 20-gal containers and composited as described in Task 2 below.

The total volume of sediment samples required for the tests in this alternative is estimated to be ~200 gal (100 gal each from Impoundments 3513 and 3524). This volume is based on the sample volume required for the type and number of tests planned and the sediment solids characterization data presented in the draft RI/FS report. In order that adequate sediment volume be collected for all testing, a factor of 1.5 was used to estimate the total sediment volume for the tests. This safety factor will provide a contingency if the sediment solids concentration during sampling is lower than that presented in the draft RI/FS report.

3.2.2 Task 2: Prepare Composite Samples

This task involves preparation of two independent composite sediment samples, one for each impoundment, from the samples collected from Impoundments 3513 and 3524. These composite samples will be used in all subsequent testing for sediment geotechnical properties, dewatering, and consolidation characteristics.

The samples will be composited in 120-gal storage containers with tight-fitting covers. Storage containers will be selected to maintain adequate shielding requirements during sample storage. Results from radiation monitoring and the existing radiochemical data in the draft RI/FS report will be used to determine shielding requirements (if necessary) during sediment storage. These samples will be composited using equal volumes from discrete sediment samples collected from each impoundment in Task 1.1. Twenty gallons each of the five discrete sediment samples from the impoundments will be transferred to the 120-gal container. The discreet samples should be mixed to ensure homogeneity prior to transfer. The contents of the 5-gal containers will be mixed using a plastic rod.

The composite sample containers will be appropriately labeled, including the information such as date, time, sample identification, samplers, etc. The composite sample containers will be stored at an appropriate location until further use. Two potential locations for setting up a trailer for use in conducting the engineering studies are shown in the site plan (Fig. A.3 in Appendix A). These locations will also be used for storing sediment samples. Sample information will be logged in a field log book, and a chain of custody form shall be completed as specified in Chap. 4 (Data Management and Interpretation). This log book will be given to Energy Systems for record keeping at the completion of the studies.

3.2.3 Task 3.1: Characterize Composite Sediment Samples

Under this task, the two composite sediment samples prepared in Task 2 will be characterized for certain sediment geotechnical properties. This task may be performed by an on-site or off-site

geotechnical laboratory. The objective of this task is to determine the geotechnical data that may influence the sediment dewatering and consolidation characteristics. Both composite samples will be characterized for each of the following parameters:

- particle size analysis,
- moisture content,
- bulk density,
- specific gravity of sediment solids, and
- pH.

A summary of the analytical methods for the analyses to be conducted under this task is listed in Table 3.1.

3.2.4 Task 3.2: Perform Paint Filter Test (EPA Method: SW846-9095)

The Paint Filter Test is used to determine the presence of "free liquids" in a representative sample of bulk material. This test provides a measure of gravity-drainable liquid in the sediment samples. This liquid volume is expected to be released upon placing the surcharge over the sediment volume in the impoundments during remediation. The measurement of the gravity-drainable liquid volume provides data to estimate the volume of water that will require removal from the impoundments during the placement of shot rocks (surcharge) during the impoundment closures. Further, this measurement will also provide data to determine initial consolidation of sediment that will occur because of removal of free liquid.

The test consists of placing 100 milliliters (mL) or 100 g of sample in a paint filter, which rests in a funnel attached to a ring stand. Any liquid that drains through the filter paper will be collected in a graduated cylinder. A detailed test procedure is presented as EPA Method 9095 in Appendix B.

The Paint Filter Test is generally used for defining the presence of free liquids under hazardous waste regulations (40 CFR Parts 261, 264, 265, and 268). However, the following modifications to the standard methods are deemed necessary to meet the data needs to define the sediment dewaterability under gravity:

- A moisture content analysis (SOP 8, Appendix B) will be performed on the initial sediment sample.

- The test will be conducted for the duration until no more free liquid accumulation in the graduated cylinder occurs in a 2-min interval. This test duration replaces the 5-min time defined in the standard method.

- The test results reported shall include initial sample volume (or weight), initial moisture content, and total volume of free liquids collected. This reporting will replace the 'yes/no' reporting of the presence of free liquid required in the standard method.

- A moisture content analysis (SOP 8, Appendix B) will be performed on the final sediment sample at the conclusion of the Paint Filter Test.

The Paint Filter Test and moisture content analysis listed above are on-site analyses. During the Paint Filter Test, care must be taken to ensure that significant moisture loss does not occur.

3.2.5 Task 3.3: Gravity Drain Composite Samples

This task involves gravity drainage of the two composite sediment samples to prepare the samples for the following tests:

1. Modified Liquid Release Test,
2. Harvard Miniature Compaction Test, and
3. One-Dimensional Consolidation Test.

Gravity drainage of the samples may be accomplished using a 5-gal perforated (at bottom) bucket. A fine filtering mesh should be placed in the bucket to prevent loss of fine sediment material. The end of this task is the cessation of free liquid from the sample. No data reporting is required under this task.

The tests listed above will be conducted on the gravity-drained samples. The following sections describe these test methods.

3.2.5.1 Modified Liquid Release Test

A liquid release test (LRT) was proposed by EPA in the *Federal Register* on December 24, 1986, to test the presence of free liquids in waste samples under a specified pressure, simulating landfill conditions. This test was adopted with some modifications to obtain the data to determine the volume of liquids that may be released from the sediment under surcharge during the closure of impoundments. The test involves application of specified pressures to a sediment sample and measuring the amount of liquids released. This test will be conducted on the composite sediment samples after gravity draining.

An estimate of the overburden pressure from the shot rock, soil, and cap will be obtained to select the minimum pressure at which the Modified Liquid Release Test will be conducted. A detailed description of the Modified Liquid Release Test is presented in SOP 1 in Appendix B. The following modifications to the test method are deemed necessary to meet the data needs required to define the sediment dewaterability under surcharge:

- A moisture content analysis (SOP 8, Appendix B) will be performed on the initial gravity-drained composite sample.

- The sediment samples will be subjected to pressures of 0, 5, 10, 20, 30, 40, and 50 pounds per square inch (psi). Each application of pressure will be held constant until the release of liquid has stopped. The test pressures may be modified after estimating the potential overburden pressure from the shot rock, soil, and cap.

- The release of liquids will be considered complete at each applied pressure when no more liquid is released in a 2-min interval.

- All released liquids will be collected in a graduated container, and the cumulative volumes of liquid released at each pressure increment will be noted.

- The data reporting will consist of readings of the pressure applied to the sample and the corresponding cumulative volume of liquids released.

- A moisture content analysis (SOP 8, Appendix B) will be performed on the final sediment sample at the conclusion of the LRT.

3.2.5.2 Harvard Miniature Compaction Test

The Harvard Miniature Compaction Test determines the relationship between the moisture content and dry density of soil-like materials. The test determines an optimum moisture content that allows maximum compaction to occur so as to achieve maximum dry density. The objective of this test is to collect data that aid in determining the moisture content and density at an anticipated level of compaction of sediments.

The test will be performed using several aliquots taken from each composite sample. The moisture content of these aliquots will be adjusted to provide a good distribution over the range of anticipated optimum moisture content. Therefore, the test requires that sediment samples have low moisture content (~10–15%) so that the test moisture content could be adequately controlled. The gravity-drained samples obtained in Task 3.3 may be further air dried or dried in an oven at 140°C prior to conducting the test. The test will be conducted in accordance with the description developed for the Harvard Miniature Compaction Test and presented in SOP 15 in Appendix B.

3.2.5.3 One-Dimensional Consolidation Test (ASTM D2435)

This test estimates the vertical consolidation of the sediment that may occur during the implementation of Alternative 2. The vertical consolidation expected is due to removal of free liquids and application of surcharge in the form of shot rocks, contaminated soils, and multilayered cap. The test results will provide an estimate of consolidation rate and amount of pore fluid lost. The final cap design and construction should account for the anticipated sediment consolidation to ensure that the integrity of the cap is not disrupted because of excessive sediment consolidation with time.

The One-Dimensional Consolidation Test (ASTM D2435) will be performed using the gravity-drained composite sediment samples.

3.2.6 Task 3.4: Perform Gravity Settling Tests

As part of the remedial activities under this alternative, shot rocks will be placed in the impoundments. This operation will result in resuspension of the sediments, thereby increasing the potential for exposure to radiation. To minimize radiation exposure, the shot rock placement operations will have to be suspended to allow the sediment solids to settle. Because of the potential for a wide range in particle size distribution of the sediment solids, the settling characteristics of the sediment solids will depend on the particle size distribution of a representative composite sample from each impoundment. The objective of this task, therefore, is to perform settling tests on a composite sediment sample representative of sediment samples collected from Impoundments 3513 and 3524. The tests will be performed on the composite samples prepared in Task 2. These tests will be used to evaluate the variability in settling characteristics of the samples at varying initial solids concentration.

Since the volume of the surface water shielding in the impoundments will result in a more diluted sediment slurry after resuspension of the sediments, the settling tests will be performed on sediment samples diluted appropriately. To simulate the sediment solids concentration in the impoundment during resuspension, a solids content ranging from 0.1 to 2% (1,000 to 20,000 mg/L) will be evaluated during the settling tests. Specific steps for this task are described below.

3.2.6.1 Perform percent solids on sediment and prepare 0.1–2% solids samples

A percent solids analysis on each sediment sample will be performed on-site prior to performance of the settling tests. The solids analysis will be performed in accordance with SOP 2. A 1-L glass beaker will be used to prepare the diluted, sediment samples. Based on the result of the solids analysis, for each sample diluted, sediment samples will be prepared at the following solids concentration; 1,000, 4,000, 8,000, 12,000, 16,000, and 20,000 mg/L. The volume of initial sediment sample to be diluted to 1 L will be calculated as follows:

$$V = (Y/I) ,$$

where V is the volume of initial sediment sample for dilution (L), Y is the target percent solids (%), and I is the initial percent solids in the sediment sample (%).

Note: 1% solids = 10,000 mg/L, 2% = 20,000 mg/L, and so on ...

Example:

I = 10% = 100,000 mg/L
Y = 1% = 1,000 mg/L
V = (1/10) = 0.1 L = 100 mL

Therefore, dilute 100 mL of initial sediment sample in 1000 mL of solution. The initial sediment sample should be stirred with a magnetic stir bar to completely resuspend sediment solids prior to measuring the respective sample volume required for dilution. Tap water should be used as dilution water.

3.2.6.2 Gravity settling tests

To measure the settleability of the sediment solids, gravity settling tests will be performed on the sediment slurries prepared as described above. The gravity settling test is a common test used to evaluate the settleability of activated sludge in biological wastewater treatment plants. This test consists of observing the settling of the sediment liquid interface with time. The SOP for performing the gravity settling tests is presented as SOP 3 in Appendix B.

At the completion of each test, the supernatant total suspended solids (TSS) and settled sludge volume will be measured and recorded on-site. Determination of TSS will be performed using SOP 4 in Appendix B. A total of 10 (2 samples × 5 dosages) gravity settling tests will be performed on two composite sediment samples, one each from Impoundments 3513 and 3524. For each test, radiation levels should be recorded above the water surface during settling, after settling, and above the settled sediment layer after decanting the supernatant.

ALTERNATIVE 3
CONSOLIDATION CELL AND SIMPLE DEWATERING

3.3 ALTERNATIVE 3: CONSOLIDATION CELL AND SIMPLE DEWATERING

On the basis of engineering data needs identified for this alternative and described in Chap. 2, an implementation flow diagram of the engineering study tasks required for this alternative was developed. The engineering study tasks developed for this alternative are illustrated in Fig. 3.2 and listed below:

- Task 1.1: Collect Multiple Sediment Samples from Impoundments 3513 and 3524
- Task 2.1: Perform Gravity Settling Tests
- Task 2.2: Perform Jar Tests with Polymers
- Task 2.3: Prepare Two Composite Samples Using Sediments from Impoundments 3513 and 3524 (four total)
- Task 3.1: Characterize Four Composite Samples
- Task 3.2: Prepare a Composite Sample from Four Samples for Further Testing
- Task 4.1: Perform Paint Filter Test
- Task 4.2: Gravity Drain Composite Samples
  - Perform Modified Liquid Release Tests
  - Perform Harvard Miniature Compaction Tests
  - Perform One-Dimensional Consolidation Tests
- Task 4.3: Perform Gravity Thickening Tests
- Task 5.1: Perform Solidification Tests
  - Perform Harvard Miniature Compaction Test
  - Perform One-Dimensional Consolidation Tests
  - Perform Unconfined Compressive Strength (UCS) Tests

Performance of the tasks listed above will include sampling of sediments, on-site testing and analyses, and geotechnical analyses. A description of each task listed above is presented below. For each task described, an objective for performing the test is provided, and relevant SOPs and ASTM/EPA standard methods are referenced and/or presented in Appendix B. All geotechnical analyses will be performed in accordance with the referenced standard methods listed in the *1994 Annual Book of ASTM Standards*, Vol. 04.08.[3] Moisture content is calculated for several of the tests and is calculated using data from the ASTM Method for Water Content. All data management and interpretations are based on moisture content. The EPA standard test protocol for the Paint Filter Test is also referenced and presented in Appendix B. Any modifications to the standard test methods are included in the description of the relevant task.

A description of each task listed above is presented below. All tasks will be performed in conformance with requirements of the project H&S Plan to be prepared prior to the field activities. Data will be collected and interpreted in accordance with the procedures presented in Chap. 4 (Data Management and Interpretation).

3.3.1 Task 1.1: Collect Multiple Sediment Samples

The first engineering study task under Alternative 3 is to collect representative sediment samples from Impoundments 3513 and 3524. The objective of this task is to obtain representative sediment samples for characterization and to perform all subsequent tests described under this remedial alternative.

Five discrete sediment samples will be collected each from Impoundments 3513 and 3524. Five samples per impoundment were selected in order to evaluate variability of sediment geotechnical properties. Sediment sampling for this alternative is limited to Impoundments 3513 and 3524 and will not include Impoundments 3539 and 3540. This is based on the sludge volume data presented in the RI/FS draft report. Impoundments 3539 and 3540 each contain a 2-in.-thick sludge layer and hence are not expected to influence the design or implementation of the alternative. Further, sediments in Impoundments 3539 and 3540 are expected to have geotechnical properties similar to those of sediments in Impoundments 3513 and 3524.

The sampling procedures and sample management protocols are described in the SSP, Appendix A. Radiation levels will be monitored to determine shielding requirements during sample collection (see ESP-307-7, Operation of Radiation Survey Instruments, in Appendix A). The SSP is based on similar procedures used during the sediment sampling conducted in the summer of 1994 as part of the RI/FS.

The total volume of sediment samples required for the tests in this alternative is estimated to be ~400 gal (200 gal each from Impoundments 3513 and 3524). This volume is based on the sample volume required for the type and number of tests planned and the sediment solids characterization data presented in the draft RI/FS report. In order that adequate sediment volume be collected for all testing, a factor of 1.5 was used to estimate the total sediment volume for the tests. This safety factor will provide a contingency if the sediment solids concentration during sampling is lower than presented in the draft RI/FS report. Details of the volume estimates are presented in Fig. A.1 in the SPP in Appendix A.

The samples will be stored in labeled 5-gal storage containers with tight-fitting covers. Storage containers will be selected to maintain adequate shielding requirements during sample storage. A total of 10 storage containers will be used for storage of the five individual sediment samples from each impoundment. Results from radiation monitoring and existing radiochemical data in the draft RI/FS report will be used to determine shielding requirements (if necessary) during sediment storage. The samples will be stored at appropriate locations until further use. Two potential locations for setting up a trailer for use in conducting the engineering studies are shown in the site plan (Fig. A.3 in Appendix A). These locations will also be used for storing sediment samples.

3.3.2 Task. 2.1: Perform Gravity Settling Tests

As part of the activities for this remedial alternative, sediments will be pumped as a slurry initially from Impoundment 3524 to Impoundment 3513 and from Impoundments 3513, 3539, and 3540 into Impoundment 3524 after installation of the liner and leachate collection/detection system. Because of the potential for a wide range in particle size distribution of the sediment solids, the settling characteristics of the sediment slurry will depend on the settling characteristics of the sediment solids from each impoundment. The objective of this task, therefore, is to perform settling tests on the 10 individual sediment samples collected from Impoundments 3513 and 3524 to determine variability in settling characteristics.

Since the volume of the surface water shielding in Impoundment 3524 will result in a more diluted sediment slurry, the settling tests will be performed on sediment samples diluted appropriately. In order to simulate the sediment solids concentration in the impoundment during transfer operations, a solids content ranging from 0.1 to 2% (1,000 to 20,000 mg/L) will be evaluated during the settling tests. Specific steps for this task are described below.

3.3.2.1 Perform percent solids on sediment and prepare 0.1–2% solids samples

A percent solids analysis on each sediment sample will be performed on-site prior to performance of the settling tests. The solids analysis will be performed using SOP 2 (Appendix B). A 1-L glass beaker will be used to prepare the diluted sediment samples. On the basis of the result of the solids analysis for each sample, diluted sediment samples will be prepared at the following solids concentrations; 1,000, 4,000, 8,000, 12,000, 16,000, and 20,000 mg/L. The volume of initial sediment sample to be diluted to 1 L of specific test solids concentration will be calculated as follows:

$$V = (Y/I) ,$$

where V is the volume of initial sediment sample for dilution (L), Y is the target percent solids (%), and I is the initial percent solids in sediment sample (%).

Note: 1% solids = 10,000 mg/L, 2% solids = 20,000 mg/L, and so on ...

Example:

I = 10% = 100,000 mg/L
Y = 1% = 1,000 mg/L
V = (1/10) = 0.1 L = 100 mL

Therefore, dilute 100 mL of initial sediment sample in 1000 mL of solution. The initial sediment sample should be stirred with a magnetic stir bar to completely resuspend sediment solids prior to measuring the respective sample volume required for dilution. Tap water should be used as dilution water.

3.3.2.2 Gravity settling tests

To measure the settleability of the sediment solids, gravity settling tests will be performed on the sediment slurries prepared as described above. The gravity settling test is a common test used to evaluate the settleability of activated sludge in biological wastewater treatment plants. This test consists of observing the settling of the sludge (sediment)–liquid interface with time. The SOP for performing the gravity settling tests is presented as SOP 3 in Appendix B.

At the completion of each test, the supernatant TSS and settled sludge volume will be measured and recorded on-site. Determination of TSS will be performed using SOP 4 (Appendix B). A total of 50 (10 samples × 5 dosages) gravity settling tests will be performed on sediment samples from Impoundments 3513 and 3524. For each test, radiation levels should be recorded above the water surface during settling and after settling and above the settled sediment layer after decanting the supernatant.

3.3.3 Task. 2.2: Perform Jar Tests with Polymers

During the transfer of sediments from Impoundment 3513 to Impoundment 3524, there is a potential for increase in radiation levels because of slowly settling sediment solids which will result in long downtimes during remedial construction activities. The objective of this task is to evaluate the use of polymers to increase the settling velocity of the sediment solids in order to

reduce radiation exposure and therefore reduce the operation downtime during sediment transfer. The increase in settling velocity is caused by the increase in particle size from flocculation of smaller particles after addition of the polymer.

To evaluate the use of polymers to enhance settling rates, jar tests will be performed using a Phipps and Bird™ Gang Stirrer. A minimum of three polymers from three selected polymer vendors (total of nine polymers) will be tested. The jar tests will be performed on the sediment slurry with the worst settling characteristics as determined from Task 2.1. These tests will be used to select the best polymer and optimum dosage. During each set of jar tests a control without any polymer will be used for comparison. Parameters to be measured and/or monitored during testing include settling time, settled sediment volume, and supernatant TSS.

The Phipps and Bird™ Gang Stirrer contains six stirrers, which allows evaluation of five polymer dosages and a control. Prior to performing the jar tests, polymer solutions corresponding to the various dosages to be tested will be prepared. Detailed instructions for preparing the polymer solutions and performing the jar tests are presented in SOP 5 (Appendix B).

3.3.4 Task 2.3: Prepare Composite Samples

This task involves preparation of two separate composite sediment samples each for Impoundments 3513 and 3524. The two composite samples will be prepared by combining equal volumes of sediments from the five samples into two separate containers. The five samples from each impoundment will be composited into two 100-gal storage containers. A total of four composite samples (two each for Impoundments 3513 and 3524) will be prepared. Based on the estimated sediment volume required, specific steps for preparing these samples are presented in SOP 6 in Appendix B.

3.3.5 Task 3.1: Characterize Composite Samples

This task involves submittal of the four composite samples prepared in Task 2.3 for geotechnical characterization. The objective of this task is to provide geotechnical data required for other engineering studies. Each of the four samples will be characterized for the following parameters:

1. particle size analysis (sieve and hydrometer),
2. moisture content,
3. specific gravity of sediment solids, and
4. bulk density.

A summary of the analytical methods and sample sizes is presented in Table 3.1.

3.3.6 Task 3.2: Prepare Composite Sample

This task involves preparation of one separate composite sediment sample from the four composite samples from Impoundments 3513 and 3524 prepared as described in Task 2.3. The composite sample will represent the combined sediments from Impoundments 3513 and 3524 that will be pumped backed into Impoundment 3524 after construction of the consolidation cell. The sediments will be composited based on the approximate percentage each impoundment will have after transfer of all sediments. On the basis of sediment volumes presented in the draft RI/FS

report, Impoundment 3513 contributes ~60% and Impoundment 3524 contributes ~40% of the anticipated total sediment volume to the consolidation cell.

Therefore, for every 5 gal of composite sample prepared, 3 gal of Impoundment 3513 sediment and 2 gal of Impoundment 3524 sediment will be added. The composite sample prepared during this task will be used for all subsequent testing. Based on the estimated sediment volume required, specific steps for preparing this sample are presented in SOP 7 (Appendix B). The composite sample will be composited into storage container(s). Because of the need to limit the maximum size of the storage containers, the composite sample may be prepared in two 200-gal containers. The composite sample will be referred to as COMP 1 in all subsequent tasks.

3.3.7 Task 4.1: Perform Paint Filter Test (EPA Method: SW846-9095)

The Paint Filter Test is used to determine the presence of "free liquids" in a representative sample of bulk material. This test provides a measure of gravity-drainable liquid in the sediment samples. This liquid volume is expected to be released upon transferring the sediments into the consolidation cell during remediation. The measurement of the gravity-drainable liquid volume provides data to estimate the volume of water that will require removal through the leachate collection system. Further, this measurement will also provide data to determine initial consolidation of sediment that will occur because of removal of free liquid.

The test consists of placing 100 mL or 100 g of sample in a paint filter, which rests in a funnel attached to a ring stand. Any liquid that drains through the filter will be collected in a graduated cylinder. A detailed test procedure is presented as EPA Method 9095 in Appendix B.

The Paint Filter Test is generally used for defining the presence of free liquids under hazardous waste regulations (40 CFR Parts 261, 264, 265, and 268). However, the following modifications to the standard methods are deemed necessary to meet the data needs to define the sediment dewaterability under gravity:

- A moisture content analysis (SOP 8, Appendix B) will be performed on the initial sediment sample.

- The test will be conducted for the duration until no more free liquid accumulation in the graduated cylinder occurs in a 2-min interval. This test duration replaces the 5-min time defined in the standard method.

- The test results reported shall include initial sample volume (or weight), initial moisture content, and total volume of free liquids collected. This reporting will replace the 'yes/no' reporting of the presence of free liquid required in the standard method.

- A moisture content analysis (SOP 8, Appendix B) will be performed on the final sediment sample at the conclusion of the Paint Filter Test.

The Paint Filter Test will be performed on the COMP 1 sediment sample to simulate gravity drainage of the sediments through the leachate collection system installed in the consolidation cell (Impoundment 3524). The Paint Filter Test and moisture content analysis listed above are on-site analyses. During the Paint Filter Test, care must be taken to ensure that significant moisture loss does not occur.

3.3.8 Task 4.2: Gravity Drain Composite Samples

This task involves gravity drainage of sediment sample COMP 1 to provide sufficient drained samples for the following tests:

1. Modified Liquid Release Test,
2. Harvard Miniature Compaction Tests, and
3. One-Dimensional Consolidation Tests.

Gravity drainage of the samples may be accomplished using a 5-gal perforated (at bottom) bucket. A fine filtering mesh should be placed in the bucket to prevent loss of fine material. The end of this task is the cessation of free liquid from the sample. No data reporting is required under this task. The following sections describe these test methods.

3.3.8.1 Modified Liquid Release Test

An LRT was proposed by EPA in the *Federal Register* on December 24, 1986, to test the presence of free liquids in waste samples under a specified pressure, simulating landfill conditions. This test was adopted with some modifications to obtain the data to determine the volume of liquids that may be released from the sediment under surcharge during the closure of impoundments. The test involves application of specified pressures to a sediment sample and measuring the amount of liquids released. This test will be conducted on the gravity-drained composite sediment sample (COMP 1).

Application of this test to the COMP 1 sample will simulate the compressive forces from shot rock, contaminated soil, and cap on the drained sediments in the consolidation cell. The modified LRT will simulate the drainage of released liquids due to overburden pressure through the leachate collection system installed in the consolidation cell (Impoundment 3524). An estimate of the overburden pressure from the shot rock, soil, and cap will be obtained to select the minimum pressure at which the modified LRT will be conducted.

A detailed description of the modified LRT is presented in SOP 1 (Appendix B). The following modifications to the test method are deemed necessary to meet the data needs required to define the sediment dewaterability under surcharge:

- A moisture content analysis (SOP 8, Appendix B) will be performed on the initial gravity-drained sediment sample.

- The sediment sample will be subjected to pressures of 0, 5, 10, 20, 30, 40 and 50 psi. Each application of pressure will be held constant until the release of liquid has stopped. The test pressures may be modified after estimating the potential overburden pressure from shot rock, soil, and cap.

- The release of liquids will be considered complete at each applied pressure when no more liquid is released in a 2-min interval.

- All released liquids will be collected in a graduated container, and the cumulative volumes of liquid released at each pressure increment will be noted.

- The data reporting will consist of readings of the pressure applied to the sample and the corresponding cumulative volume of liquids released.

- A moisture content analysis (SOP 8, Appendix B) will be performed on the final sediment sample at the conclusion of the LRT.

3.3.8.2 Harvard Miniature Compaction Test

The Harvard Miniature Compaction Test determines the relationship between the moisture content and dry density of soil-like materials. The test determines an optimum moisture content that allows maximum compaction to occur so as to achieve maximum dry density. The objective of this test is to collect data that aid in determining the moisture content and density at an anticipated level of compaction of sediments.

The test will be performed using several aliquots taken from each composite sample. The moisture content of these aliquots will be adjusted to provide a good distribution over the range of anticipated optimum moisture content. Therefore, the test requires that sediment samples have low moisture content (~10–15%) so that the test moisture content could be adequately controlled. The gravity-drained samples obtained in Task 4.2 may be further air dried or dried in an oven at 140°C prior to conducting the test. The test will be conducted in accordance with the description developed for the Harvard Miniature Compaction Test and presented in SOP 15 in Appendix B.

3.3.8.3 One-Dimensional Consolidation Tests (ASTM D2435)

Implementation of Alternative 3 will result in the consolidation of the sediment during in situ dewatering by gravity drainage and under surcharge or in consolidation of the solidified sediment. To predict the consolidation behavior of the dewatered sediment or solidified sediment under an applied overburden stress, One-Dimensional Consolidation Tests will be performed on the drained sediment sample (COMP 1) and solidified sediment samples. The consolidation tests will provide an estimate of consolidation rate and amount of pore fluid released during the consolidation.

Information obtained from consolidation tests will be used to estimate how much consolidation or settlement may take place in the consolidation cell under proposed overburden conditions and how long it may take for an amount of consolidation to take place.

3.3.9 Task 4.3: Perform Gravity Thickening Tests

Gravity thickening (if necessary) will be performed to evaluate additional dewatering of the sediments prior to solidification tests. The sediment sample (COMP 1) in the storage container will be allowed to thicken, and any supernatant above the sediment will be decanted prior to subsequent tests. The time allowed for thickening and the volume of supernatant decanted will be recorded. Percent solids analysis (SOP 2, Appendix B) will be performed on the sediment sample before and after gravity thickening.

3.3.10 Task 5.1: Solidification Tests

The solidification tests involve blending of sediment and solidification reagents in predetermined ratios under controlled moisture conditions. The solidification reagents may absorb moisture, chemically react, and bind sediment solids to result in improved sediment physical

conditions such as consistency and structural strength. The solidification of sediments may also reduce chemical leachability of waste constituents, especially heavy metals.

The objective of the solidification tests is to collect data to determine the specific requirements, such as appropriate solidification reagent, mix ratio(s), and moisture content, to implement the in situ solidification technology. In addition, some geotechnical tests will also be conducted on the solidified sediment to characterize the solidified mix and to estimate the behavior of the solidified sediments during the closure of the consolidation cell.

The primary objective of employing the in situ solidification option under this alternative is to improve the physical characteristics of sediment for better compatibility with the closure actions. As such, solidification reagents that require high moisture for hydration and result in significant increases in structural strength were selected for the study. These reagents consist of Portland cement, cement kiln dust, and fly ash. Lime kiln dust may be used in place of cement kiln dust.

The solidification test methodology is described in SOP 13 (Appendix B). The tests will use gravity-drained composite sample obtained from Tasks 3.2 and 4.3. The solidification testing will also include several preliminary tests to evaluate the effectiveness of the reagent and mix ratios. These tests will consist of initial and final moisture content, volume changes, bulk density, and UCS. The data from these tests will be used to identify the best suited solidification reagent and mix ratio. Further testing will be performed to estimate the behavior of the solidified sediments under the closure surcharge. These tests will consist of the Harvard Miniature Compaction Test and the One-Dimensional Consolidation Test.

These two tests will be performed using the sediment and reagent mix determined best suited during the solidification test evaluation. However, the Harvard Miniature Compaction Test or both tests may not be required if the solidified sediment samples develop significantly high UCS.

3.3.10.1 Harvard Miniature Compaction Test

The objective of this test is to collect data that aid in determining the optimum moisture content that allows maximum compaction to occur so as to achieve maximum dry density of solidified sediments. The data obtained from this can also be used to determine the density of solidified sediments at an anticipated level of compaction. The test methodology is the same as that described in Sect. 3.3.9.2.

3.3.10.2 One-Dimensional Consolidation Tests (ASTM D2435)

This test will measure the vertical consolidation of the solidified sediment that may occur during the placement of backfill materials such as shot rocks and contaminated soils and the construction of a multilayered cap. The test results will provide data for estimating the consolidation rate and amount if pore fluid is released during the consolidation. The final cap design and construction should account for the anticipated consolidation to ensure that the integrity of the cap is not disrupted because of excessive sediment consolidation with time.

The One-Dimensional Consolidation Test (ASTM D2435) is the same as that described in Task 4.2.

ALTERNATIVE 4
CONSOLIDATION CELL AND EX SITU TREATMENT

3.4 ALTERNATIVE 4: CONSOLIDATION CELL AND EX SITU TREATMENT

For Information Only

Alternative 4 is a waste treatment, containment, and monitoring alternative. The sediment will be treated ex situ using the solidification technology prior to placement in the consolidation cell. Specific engineering study tasks were developed based on the engineering support studies identified in Chap. 2. These studies will provide data required to support the design and implementation activities for this alternative. These tasks are illustrated in Fig. 3.3 and are listed below:

- Task 1.1: Collect Multiple Sediment Samples from Impoundments 3513 and 3524
- Task 1.2: Perform Pump Loop Test
- Task 2.1: Perform Gravity Settling Tests
- Task 2.2: Perform Jar Tests with Polymers
- Task 2.3: Prepare Composite Sample Each for Impoundments 3513 and 3524 (four samples total)
- Task 3.1: Characterize Four Composite Samples
- Task 3.2: Prepare Two Composite Samples from Four Samples for Further Testing
- Task 4.1: Perform Buchner Funnel Tests
- Task 4.2: Perform Gravity Thickening Tests
- Task 5.1: Perform Mechanical Dewatering Tests (Optional)
- Task 5.2: Perform Solidification Tests

Performance of the tasks listed above will include sampling of sediments, on-site testing and analyses, and geotechnical analyses. A description of each task listed above is presented below. For each task described, the objective for performing the test is provided, and specific SOPs and ASTM/EPA standard methods are referenced/or presented in Appendix B. All geotechnical analyses will be performed in accordance with the referenced standard methods listed in the *1994 Annual Book of ASTM Standards*, Vol. 04.08.[3] Moisture content is calculated for several of the tests and is calculated using data from the ASTM Method for Water Content. All data management and interpretations are based on moisture content. The EPA standard test protocol for the Paint Filter Test is also referenced and presented in Appendix B. Any modifications to the standard test methods are included in the description of the relevant task.

A description of each task listed above is presented in the following sections. All tasks will be performed in conformance with requirements of the project H&S Plan to be prepared prior to the field activities. Data will be collected and interpreted in accordance with the procedures presented in Chap. 4 (Data Management and Interpretation).

3.4.1 Task 1.1: Collect Multiple Sediment Samples

The first engineering study task under Alternative 4 is to collect representative sediment samples from Impoundments 3513 and 3524. The objective of this task is to obtain representative sediment samples for characterization and to perform all subsequent tests described under this remedial alternative.

Five discrete sediment samples will be collected each from Impoundments 3513 and 3524. Five samples per impoundment were selected in order to evaluate variability of sediment geotechnical properties. Sediment sampling for this alternative is limited to Impoundments 3513 and 3524 and will not include Impoundments 3539 and 3540. This is based on the sludge volume data presented in the RI/FS draft report. Impoundments 3539 and 3540 each contained only a 2-in.-thick sludge layer and hence are not expected to influence the design or implementation of the alternative. Further, sediments in Impoundments 3539 and 3540 are expected to have geotechnical properties similar to those of sediments in Impoundments 3513 and 3524.

The sampling procedures and sample management protocols are described in the SSP, Appendix A. Radiation levels will be monitored to determine shielding requirements during sample collection (see ESP-307-7, Operation of Radiation Survey Instruments, in Appendix A). The SSP is based on similar procedures used during the sediment sampling conducted in the summer of 1994 as part of the RI/FS.

The total volume of sediment samples required for the tests in this alternative is estimated to be ~550 gal, 275 gal each from Impoundments 3513 and 3524. This volume is based on the sample volume required for the type and number of tests planned and the sediment solids characterization data presented in the draft RI/FS report. In order that adequate sediment volume be collected for all testing, a factor of 1.5 was used to estimate the total sediment volume for the tests. This safety factor will provide a contingency if the sediment solids concentration during sampling is lower than that presented in the draft RI/FS report.

The samples will be stored in labeled 50-gal storage containers with tight-fitting covers. Storage containers will be selected to maintain adequate shielding requirements during sample storage. A total of 10 storage containers will be used for storage of the five individual sediment samples from each impoundment. Results from radiation monitoring and existing radiochemical data in the draft RI/FS report will be used to determine shielding requirements (if necessary) during sediment storage. Two potential locations for setting up a trailer for use in conducting the engineering studies are shown in the site plan (Fig. A.3 in Appendix A). These locations will also be used for storing sediment samples.

3.4.2 Task 1.2: Perform Pump Loop Test

Implementation of this alternative involves pumping of sediment slurry between Impoundments 3513 and 3524. Based on existing characterization data, the solids concentration in the sediments ranges from 10 to 30%. To select the appropriate pump for pumping sediment slurry at a high solids concentration, a pump loop test will be performed to determine pipe head losses. The pump loop test will be performed using procedures outlined in SOP 14 (Appendix B).

3.4.3 Task. 2.1: Perform Gravity Settling Tests

As part of the activities for this remedial alternative, sediments will be pumped as a slurry initially from Impoundments 3524 to 3513 and from Impoundments 3513, 3539, and 3540 into Impoundment 3524 after installation of the liner and leachate collection/detection system. Because of the potential for a wide range in particle size distribution of the sediment solids, the settling characteristics of the sediment slurry will depend on the settling characteristics of the sediment solids from each impoundment. The objective of this task, therefore, is to perform settling tests

on the 10 individual sediment samples collected from Impoundments 3513 and 3524 to determine variability in settling characteristics.

Since the volume of the surface water shielding in Impoundment 3524 will result in a more diluted sediment slurry, the settling tests will be performed on sediment samples diluted appropriately. To simulate the sediment solids concentration in the impoundment during transfer operations, a solids content ranging from 0.1 to 2% (1,000 to 20,000 mg/L) will be evaluated during the settling tests. Specific steps for this task are described below.

3.4.3.1 Perform percent solids on sediment and prepare 0.1–2% solids samples

A percent solids analysis on each sediment sample will be performed on-site prior to performance of the settling tests. The solids analysis will be performed using SOP 2 (Appendix B). A 1-L glass beaker will be used to prepare the diluted sediment samples. On the basis of the result of the solids analysis, diluted sediment samples will be prepared for the following solids concentration for each sample: 1,000, 4,000, 8,000, 10,000, 15,000, and 20,000 mg/L. The volume of initial sediment sample to be diluted to 1 L of test sample at a specific solids concentration will be calculated as follows:

$$V = (Y/I) ,$$

where V is the volume of initial sediment sample for dilution (L), Y is the target percent solids (%), and I is the initial percent solids in the sediment sample (%).

Note: 1% solids = 10,000 mg/L, 2% = 20,000 mg/L, and so on ...

Example:

I = 10% = 100,000 mg/L
Y = 1% = 1,000 mg/L
V = (1/10) = 0.1 L = 100 mL

Therefore, dilute 100 mL of initial sediment sample in 1000 mL of solution. The initial sediment sample should be stirred with a magnetic stir bar to completely resuspend sediment solids prior to measuring the respective sample volume required for dilution. Tap water should be used as dilution water.

3.4.3.2 Gravity settling tests

To measure the settleability of the sediment solids, gravity settling tests will be performed on the sediment slurries prepared as described above. The gravity settling test is a common test used to evaluate the settleability of activated sludge in biological wastewater treatment plants. This test consists of observing the settling of the sludge (sediment)–liquid interface with time. The SOP for performing the gravity settling tests is presented as SOP 3 in Appendix B.

At the completion of each test, the supernatant TSS and settled sludge volume will be measured and recorded on-site. Determination of TSS will be performed using SOP 4 (Appendix B). A total of 50 (10 samples × 5 dosages) gravity settling tests will be performed on sediment samples from Impoundments 3513 and 3524. For each test, radiation levels should be

recorded above the water surface during settling, after settling, and above the settled sediment layer after decanting the supernatant.

3.4.4 Task. 2.2: Perform Jar Tests with Polymers

During the transfer of sediments from Impoundment 3513 to Impoundment 3524, there is a potential for increase in radiation levels due to slowly settling sediment solids. The objective of this task is to evaluate the use of polymers to increase the settling velocity of the sediment solids in order to reduce radiation exposure and therefore to reduce operation downtime during the sediment transfer. The increase in settling velocity is caused by the increase in particle size from flocculation of smaller particles after addition of the polymer.

To evaluate the use of polymers to enhance settling rates, jar tests will be performed using a Phipps and Bird™ Gang Stirrer. A minimum of three polymers from three selected polymer vendors (total of nine polymers) will be tested. The jar tests will be performed on the sediment slurry with the worst settling characteristics as determined from Task 2.1. These tests will be used to select the best polymer and optimum dosage. During each set of jar tests a control without any polymer will be used for comparison. Parameters to be measured and/or monitored during testing include settling time, settled sediment volume, and supernatant TSS. The following equipment is needed for performing the gravity settling tests:

1. jar test apparatus (Phipps and Bird™ Six Gang Stirrer),
2. commercially available liquid polymers (Betz, Nalco, and Allied Colloids),
3. stopwatch, and
4. 1-L glass beakers.

The Phipps and Bird™ Gang Stirrer contains six stirrers, which allows evaluation of five polymer dosages and a control. Prior to performing the jar tests, polymer solutions corresponding to the various dosages to be tested will be prepared. Detailed instructions for preparing the polymer solutions and performing the jar tests are presented in SOP 5 (Appendix B).

3.4.5 Task 2.3: Prepare Composite Samples

This task involves preparation of two separate composite sediment samples each for Impoundments 3513 and 3524. The composite samples will be prepared by combining equal volumes of sediments from the five samples into two separate containers. The five samples from each impoundment will be composited into 150-gal storage containers. A total of four composite samples (two each for Impoundments 3513 and 3524) will be prepared. Based on the estimated sediment volume required, specific steps for preparing these samples are presented in SOP 6 in Appendix B.

3.4.6 Task 3.1: Characterize Composite Samples

This task involves submittal of the four composite samples prepared in Task 2.3 for geotechnical characterization. The objective of this task is to provide geotechnical data required for other engineering studies. Each of the four samples will be characterized for the following parameters:

1. particle size analysis (sieve and hydrometer),
2. moisture content,
3. specific gravity of sediment solids, and
4. bulk density.

A summary of the analytical methods and sample sizes is presented in Table 3.1.

3.4.7 Task 3.2: Prepare Composite Sample

This task involves preparation of one composite sediment sample from the four composite samples from Impoundments 3513 and 3524. The composite sample will represent the combined sediments from Impoundments 3513 and 3524 that will be pumped backed into Impoundment 3524 after construction of the consolidation cell. The sediments will be composited based on the approximate percentage each impoundment will have after transfer of all sediments. On the basis of sediment volumes presented in the draft RI/FS report, Impoundment 3513 contributes ~60% and Impoundment 3524 contributes ~40% of the anticipated total sediment volume to the consolidation cell.

Therefore, for every 5 gal of composite sample prepared, 3 gal of Impoundment 3513 sediment and 2 gal of Impoundment 3524 sediment will be added. The composite sample prepared during this task will be used for all subsequent testing. On the basis of the estimated sediment volume required, specific steps for preparing the sample are presented in SOP 7 (Appendix B). The composite sample will be composited into storage container(s). Because of the need to limit the maximum size of storage containers, the composite sample will be prepared in two 300-gal containers. The composite sample will be referred to as COMP 1 in all subsequent tasks.

3.4.8 Task 4.1: Perform Buchner Funnel Tests

Buchner funnel tests will be used to evaluate conditioning agents for use in mechanical dewatering of the sediment solids. An evaluation should be made on the dewaterability of the gravity-drained sediment (COMP 1) since mechanical dewatering (using a belt press, filter press, or centrifuge) is one of the unit processes being considered for this alternative. This evaluation involves the testing of various polymers to select a polymer and to optimize the dosage. Evaluation of polymers for use in dewatering operations will be performed in the laboratory by filtering the sediment through a filter paper using a Buchner funnel and measuring either the time required to collect a given volume of sample or the time required for the sediment cake to begin to crack.

Evaluation of polymers for use in dewatering the gravity-drained sediments (COMP 1) will be evaluated using the Buchner funnel. The procedures for performing the Buchner funnel test are presented in SOP 9 in Appendix B. The Buchner funnel apparatus is shown in Fig. B.1 in SOP 9 (Appendix B).

3.4.9 Task 4.2: Perform Gravity Thickening Tests

Gravity thickening (if necessary) will be performed to evaluate additional dewatering of the sediments prior to mechanical dewatering and solidification tests. The sediment sample (COMP 1) in the storage container will be allowed to thicken, and any supernatant above the sediment will be decanted prior to subsequent tests. The time allowed for thickening and the volume of

supernatant decanted will be recorded. Percent solids analysis (SOP 2, Appendix B) will be performed on the sediment sample before and after gravity thickening.

3.4.10 Task 5.1: Perform Bench-Scale Mechanical Dewatering Tests (Optional)

Mechanical dewatering using a belt press, filter press, or centrifuge is being evaluated for this alternative. The results from the Buchner funnel tests will be used to select a polymer and dosage for use in the mechanical dewatering tests. Pilot-scale dewatering tests will be performed to evaluate the use of mechanical dewatering equipment. Two vendors each of belt press, filter press, and centrifuges were contacted to determine the availability of laboratory-, bench-, and/or pilot-scale equipment and also a laboratory testing facility.

All vendors contacted have laboratory-, bench- and pilot-scale equipment and also laboratory testing facilities. Because of the potential for high levels of radiation from the sediments, the pilot-scale dewatering tests will have to be performed on-site. The pilot-scale equipment is available for rental or purchase. An estimate of between 20 and 50 gal of the gravity-drained composite sediment sample (COMP 1) will be required to perform the dewatering tests using the dewatering equipment. On-site pilot-scale testing will provide data for use in sizing the dewatering equipment during the detailed design. Performance data from the pilot-scale tests will include cake solids concentration, filtrate TSS, operating pressures, polymer usage, and solids capture.

Since the operating procedure for the different pilot equipment may differ among vendors, vendor-specific SOPs should be followed to perform the pilot-scale dewatering tests.

3.4.11 Task 5.2: Solidification Tests

The solidification tests involve blending of sediment and solidification reagents in predetermined ratios under controlled moisture conditions. The solidification reagents may absorb moisture, chemically react, and bind sediment solids to result in improved sediment physical conditions such as consistency and structural strength. The solidification of sediments may also reduce chemical leachability of waste constituents, especially heavy metals.

The objective of the solidification tests is to collect data to determine the specific requirements, such as appropriate solidification reagent, mix ratio(s), and moisture content, to implement the ex situ solidification technology. The primary objective of employing the ex situ solidification option under this alternative is to obtain monoliths of solidified sediment forms to facilitate transportation and disposal activities. The UCS tests will be conducted on the solidified sediment to determine if the solidified mass can develop sufficient strength for handling as a monolith. As such, solidification reagents that would result in significant increases in structural strength were selected for the study. These reagents consist of Portland cement, cement kiln dust, and fly ash. Lime kiln dust may also be used.

The solidification test methodology is described in SOP 13 (Appendix B). The tests will use gravity-drained composite sample obtained from Tasks 3.2 and 4.2. The solidification testing will also include several tests to evaluate the effectiveness of the reagent and mix ratios. These tests will consist of initial and final moisture content, volume changes, bulk density, and UCS. The solidification testing protocol under Alternative 4 will not include testing compaction and consolidation properties of the solidified sediment. Therefore, Steps 21 and 22 listed in SOP 13 are not relevant to this alternative. Accordingly, the number of solidification mix molds should

be reduced from ten to five in Step 20 of the SOP. The data from this task will be used to identify the best suited solidification reagent and mix ratio.

3.5 ENGINEERING STUDY REPORT

An integral part of executing the engineering support studies for any and each of the alternatives, except Alternative 1 (No Action), is the preparation of a report describing the work conducted and presenting the study results. The report will be prepared by the engineering support study contractor and submitted to Energy Systems. The report should be structured for an effective and clear presentation of the information collected from the engineering support studies. The report, at a minimum, should contain the following information:

- background information,
- description of remedial alternative,
- description of engineering support studies, including any deviations from the work plan,
- engineering support study methodology,
- engineering support study results,
- data evaluation,
- mass balances,
- summary and conclusions, and
- appendices presenting pertinent engineering support study information such as data reports, data validation procedures, QA/QC report, etc.

3.6 RESIDUALS MANAGEMENT

The proposed engineering studies described in this work plan for Alternatives 2, 3, and 4 will result in residuals that will require management, including handling, transportation, treatment, and/or disposal. Residuals are expected to be generated from the following activities and conditions:

- debris from sediment sampling effort,
- excess or unusable sediment samples, and
- residuals from various sediment testing.

All engineering study residuals, including excess or unusable sediment sample, are exempt from the hazardous waste regulations as per treatability study samples exclusion (40 CFR Part 260.4). This exemption allows 1000 kg of nonacute hazardous wastes for use in treatability studies, which will not be subjected to regulations under 40 CFR Parts 261 to 263 or to the notification requirements of Chap. 3010 of RCRA. However, all samples must be managed in accordance with the health and safety requirements for the sediment material. Further, all shipping and transport of residuals must be in compliance with the applicable Department of Transportation (DOT) regulations.

The debris from the sampling effort will be contained on-site and will be managed as solid wastes, low-level radioactive wastes, or mixed wastes. These wastes will be managed in compliance with all applicable rules and regulations and may be managed in the same manner as that for similar wastes routinely generated at ORNL. All residuals consisting of excess unusable

sediment sample and study residues will be transported to the site and placed in the impoundments for further management during the impoundment remediation.

Table 3.1. Summary of analytical methods for engineering support studies[a]

	Field analysis		Laboratory analysis		
Task description	# of samples	Analytical method	# of samples	Analytical method	Comments
For Information Only					
ALTERNATIVE 2:					
Task 3.1					
Particle size distribution			2	ASTM D422-63	Composite sediment samples, one each from Impoundments 3513 and 3524
Moisture content			2	ASTM D2216-80	
Bulk density			2	ASTM D2937	
Specific gravity of sediment solids			2	ASTM D854-92	
pH	2	SW846-9045			
Task 3.2					
Paint Filter Test			2	SW846-9095	Composite sediment samples, one each from Impoundments 3513 and 3524
Moisture content of drained sample			2	ASTM D2216-80	
Task 3.3					
Harvard Miniature Compaction Test			2	ASTM D2345	Composite sediment samples, one each from Impoundments 3513 and 3524
One-Dimensional Consolidation Test			2		
Modified Liquid Release Test			2	SW846-1311 (modified)	
Task 3.4					
Gravity settling tests	(2 × 5)[b]	SOP 3			Composite sediment samples, one each from Impoundments 3513 and 3524
Applies					
ALTERNATIVE 3:					
Task 2.1					
Gravity settling tests	(10 × 5)[b]	SOP 3			Five discrete sediment samples each from Impoundments 3513 and 3524
Task 2.2					
Jar tests with polymers	(10 × 5)[b]	SOP 5			Five discrete sediment samples each from Impoundments 3513 and 3524

Table 3.1 (continued)

	Field analysis		Laboratory analysis		
Task description	# of samples	Analytical method	# of samples	Analytical method	Comments
Task 3.1					
Particle size distribution			4	ASTM D422-63	Composite sediment samples, one each from Impoundments 3513 and 3524
Moisture content			4	ASTM D2216-80	
Bulk density			4	ASTM D2937	
Specific gravity of sediment solids			4	ASTM D854-92	
pH	4	SW846-9045			
Task 4.1					
Paint Filter Test			1	SW846-9095	One composite sediment sample from Impoundments 3513 and 3524
Moisture content of drained sample			1	ASTM D2216-80	
Task 4.2					
Harvard Miniature Compaction Test		SOP 15	1	ASTM D2345	
One-Dimensional Consolidation Test			1		
Modified Liquid Release Test			1	SW846-1311 (modified)	
Task 4.3					One composite sediment sample from Impoundments 3513 and 3524
Gravity thickening test	1				
Task 5.1: Solidification Test					
Initial moisture content	4	ASTM D2216			One composite sediment sample from Impoundments 3513 and 3524
Volume change	$(1 \times 3 \times 4)^c$				
Pocket penetrometer	$(1 \times 3 \times 4)^c$				
Initial moisture content	$(1 \times 3 \times 4)^c$	ASTM D2216			
Unconfined compressive strength			$(1 \times 2 \times 2)$	ASTM D1633	
Harvard Miniature Compaction Test		SOP 15	1		
One-Dimensional Consolidation Test			1	ASTM D2345	

Table 3.1 (continued)

Task description	Field analysis		Laboratory analysis		Comments
	# of samples	Analytical method	# of samples	Analytical method	
Omit					
ALTERNATIVE 4:					
Task 2.1					
Gravity settling tests	(10 × 5)[b]	SOP 3			Five discrete sediment samples each from Impoundments 3513 and 3524
Task 2.2					
Jar tests with polymers	(10 × 5)[b]	SOP 5			Five discrete sediment samples each from Impoundments 3513 and 3524
Task 3.1					
Particle size distribution			4	ASTM D422-63	Two composite sediment samples each from Impoundments 3513 and 3524
Moisture content			4	ASTM D2216-80	
Bulk density			4	ASTM D2937	
Specific gravity of sediment solids			4	ASTM D854-92	
pH	4	SW846-9045			
Task 4.1					
Buchner funnel test	1	SOP 9			One composite sediment sample from Impoundments 3513 and 3524
Task 4.2					
Gravity thickening test	1				One composite sediment sample from Impoundments 3513 and 3524
Optional Task 5.1					
Mechanical dewatering tests	1				One composite sediment sample from Impoundments 3513 and 3524. Tests will include belt press, filter press, and centrifuge. May include bench-scale test with or without pilot-scale tests.

Table 3.1 (continued)

	Field analysis		Laboratory analysis		
Task description	# of samples	Analytical method	# of samples	Analytical method	Comments
Task 5.2: Solidification Test					One composite sediment sample from Impoundments 3513 and 3524
Initial moisture content	2	ASTM D2216			
Volume change	(1 × 3 × 4)[c]				
Pocket penetrometer	(1 × 3 × 4)[c]				
Initial moisture content	(1 × 3 × 4)[c]	ASTM D2216			
Unconfined compressive strength			(1 × 2 × 2)	ASTM D2166-91	

[a]References: American Society for Testing and Materials, Vol. 04-08, Soil and Rock, 1994. SW-846, *Test Methods for Evaluation of Solid Wastes, Physical/Chemical Methods*, EPA, 1988.

[b]Based on five samples each from Impoundment 3513 and 3524 and testing at five solids concentrations.

[c]Based on one composite sediment sample and three solidification reagents at four mix ratios.

4. DATA MANAGEMENT AND INTERPRETATION

This chapter presents the procedures to document, track, and interpret the data that will be generated during the engineering support studies. The results of the engineering support studies described in Chap. 3 will be used to better evaluate the remedial technology performance and to support design and implementation of the selected remediation alternatives. The data management and interpretation procedures associated with the studies will include the following tasks:

- data recording and reporting,
- data transfer and reduction, and
- data interpretation.

These three tasks will be performed for each engineering study or task described in Chap. 3. For ease and clarity of presentation, the data management and interpretation procedures are described by each engineering study task. The following is the list of engineering studies or tasks developed for the selected remediation alternatives in Chap. 3:

- sediment sampling;
- sediment analysis (geotechnical analysis);
- pump loop tests;
- sediment gravity dewatering (Paint Filter Tests);
- sediment gravity settling (column tests);
- sediment gravity settling with polymers (jar tests);
- sediment mechanical dewatering (Buchner funnel tests, filter press, belt press, and centrifuge);
- sediment consolidation (Modified Liquid Release Tests, Harvard Miniature Compaction Tests, and consolidation tests);
- sediment solidification (volume increase, penetrometer tests, and unconfined compressive strength).

The engineering support studies for the remediation alternatives include one or more of the studies listed above. Table 4.1 presents a list of engineering support studies required for each of the four alternatives evaluated in this project. As explained earlier, the No Action alternative does not require any engineering support studies. The following is a detailed description of data management and interpretation requirements for the engineering support studies listed above.

4.1 SEDIMENT SAMPLING

Sediment samples will be collected for characterization and engineering support studies. The sampling requirements vary by the remediation alternatives as described in Chap. 3. All sampling activities will be conducted in accordance with the SSP (Appendix A). The quality assurance and quality control issues, including sample handling and document control, are described in the project QA/QC plan (Appendix D).

4.1.1 Data Recording and Reporting

Bound field log books will be maintained by the field team leader and other team members to maintain a daily record of all sediment sampling activities and any other significant events,

observations, and measurements during the field activities. All entries must be identified by date and time of entry and the name of the person performing data entry. All information pertinent to sediment sampling will be recorded in bound log books, which are preferably at least 4 in. by 7 in. in size with consecutively numbered pages. Waterproof ink will be used in making all entries. Entries in the log book must include at least the following:

- Name and title of author, date and time of entry, and weather/environmental conditions during field activity.
- Location of sampling activity.
- Name and title of field crew.
- Name and title of any site visitors (including their corporate, government, or other affiliation, their job function, and reason for being on-site).
- Sample media (e.g., sediment).
- Sample collection method.
- Number and volume of sample(s) taken.
- Date and time of collection.
- Sample identification number(s).
- Sample distribution (e.g., on-site or off-site laboratory).
- Field observations (i.e., weather conditions, local site activities, etc.).
- Any field measurements made, such as pH, health and safety monitoring, and associated calibration.
- Dates and method of sample shipments (if any).
- Sample handling (e.g., shielding for off-site transportation).
- Any deviations from the work plan.

Any error discovered in the field entries should be corrected by the person who made the entry. All corrections should be done simply by crossing a single line through the error, initialing, recording the date of correction, and entering the correct information. The erroneous information should not be obliterated.

4.1.2 Data Transfer and Reduction

Data transfer activities may occur in the laboratory (on-site or off-site) for sample documentation and during the preparation of an engineering study report. The accuracy of sampling data transfer at the laboratory will be ensured through the use of sample chain-of-custody forms and data validation procedures, which are described in the QA/QC plan. All data transfers during the preparation of a report should be reconciled with the original entries in the field log books. No data reduction activities are anticipated for the sediment sampling task.

4.1.3 Data Interpretation

No formal data interpretation activities are anticipated for the sediment sampling task. However, the sampling data may be examined with the data from other engineering support studies to identify the locations of sediment variability and sediment inventory uncertainties.

4.2 SEDIMENT SAMPLE ANALYSIS

This study step will involve analysis of sediment samples for physical and geotechnical properties. The objective of the sample analysis is to define sediment characteristics that influence or determine the performance of remedial technologies or processes that would be employed under the selected alternatives. The types of analyses vary from one remediation alternative to another based on the data needs (Chap. 3).

Data generated from sample analysis may consist of data from field analyses such as pH, water content, etc., and laboratory analyses such as bulk density, particle size analysis, specific gravity, etc. All sample analyses will be conducted in accordance with the standard methods or the SOPs (Appendix B). The QA/QC requirements for the analyses will be defined by the data quality objectives (DQOs) described in the project QA/QC plan (Appendix D).

4.2.1 Data Recording and Reporting

The data recording and reporting will include documenting the information pertinent to performing the analyses and the analytical results. These activities are described below under field and laboratory analyses.

4.2.1.1 Field analyses

Field analyses may include pH, TSS, moisture content, density, paint filter test, etc. The range of analyses that could be performed in the field depends on the capabilities of the field setup during the engineering studies. Any special data recording and reporting procedures for field analyses that were not previously anticipated should be performed in accordance with the standard methods or standard operating procedures for those analyses.

The data recording and reporting activities for field analyses will contain the following items:

- project identification,
- date, time, and name of the individual(s) performing the analysis,
- field sample identification (location, matrix, and description),
- analytical method identification and reference citation,
- instrument calibration,
- analytical results (including units), and
- any special conditions.

All field analysis data will be recorded in a bound field log book similar to that described under sediment sampling (Sect. 4.1.1). Any hard copies of instrument data outputs should also be filed with the log book entries. All corrections to the field data will be performed in accordance with that described under sediment sampling (Sect. 4.1.1).

4.2.1.2 Laboratory analyses

The laboratory data recording will begin with the logging of samples received for laboratory analyses. The sample logging data should be reconciled with the data recorded on the chain-of-custody accompanying the samples. The laboratory will record all data generated during the sample analysis, including the instrument calibration and QC sample analyses.

Laboratory reporting of analytical results for this project will include environmental and QC sample analysis data in hard copy format. Hard copy reports of analytical results will contain the following items:

- laboratory name,
- client name,
- date of report issue,
- project identification,
- field sample number,
- laboratory sample number,
- sample matrix description,
- sampling date,
- analytical method description and reference citation,
- individual parameter results,
- date of analysis,
- detection limits achieved,
- concentration units,
- any special conditions, and
- corresponding QC report.

All analytical data will be verified prior to being released by the laboratory. Laboratory data verification will consist of reviewing the data for both editorial and technical validity.

4.2.2 Data Transfer and Reduction

Data transfer and reduction activities will be performed for both the field analyses and laboratory analyses. All data reduction activities will be performed in accordance with the standard methods or SOPs. Further, any data reduction steps specific to the engineering studies are described under data reduction procedures for the corresponding study in this chapter.

4.2.2.1 Field analyses

During processing of field data, validation checks will be performed by individuals designated by the project manager to ensure that data reduction and transfer results are correct and accurate. The data from the field analyses will be processed in accordance with the QA/QC requirements described in Appendix D.

4.2.2.2 Laboratory analyses

All steps involving data reduction of laboratory analytical results will be performed by the laboratory in accordance with the requirements established in standard methods, SOPs (Appendix B), QA/QC plan, and the laboratory internal QA/QC procedures. All data reduction steps will be sufficiently documented by the laboratory to allow any future review and check of the work.

The laboratory analytical data will be transferred in the hard copy form with or without the electronic form. The hard copy data set will be reviewed to ensure compliance with all applicable quality checks. The electronic form will be checked to assure that the data are identical to those in the hard copy.

4.2.3 Data Interpretation

The field and laboratory data obtained under this engineering study step will be used for physical and geotechnical characterization of the sediment. These sediment characteristics will be used in the design of engineering support studies and in interpreting the results of these studies. The analytical data types for sediment characterization and their application in the engineering studies are listed in Table 4.2.

4.3 SEDIMENT GRAVITY DEWATERING

The sediment gravity dewatering test provides an estimate of liquid volume that is drainable from the sediment under gravity. This measurement provides the data to estimate the volume of water that may be expected to be removed initially from the impoundments and to determine initial consolidation of sediment that will occur because of the removal of free liquid.

The sediment gravity dewatering test consists primarily of the Paint Filter Test (EPA Method SW846-9095) and moisture content test (ASTM D2216). As detailed in Chap. 3, this study involves determination of initial moisture content of the sediment; determination of volume of free liquids in the sample; and determination of final moisture content of the drained sample. The data recording and interpretation procedures will be modified, where necessary, from those of the standard test methods to suit the data needs of this engineering study. Sections 4.3.1 to 4.3.3 present the data management activities associated with the tests.

4.3.1 Data Recording and Reporting

The sediment gravity dewatering study may be conducted in the field or in an off-site laboratory. All data generated in the field during this study will be documented in a bound field log book with adequate detail and clarity. At a minimum, the following data types will be recorded during the field testing.

- Initial moisture content: Initial and final sample weights; test temperature; test date, time, and duration; and personnel conducting the test and data recording.

- Paint Filter Test: Initial weight of sample; volume of free liquid collected; test date, time, and duration; and personnel conducting the test and data recording.

- Final moisture content: Initial and final sample weights; test temperature; test date, time, and duration; and personnel conducting the test and data recording.

All laboratory data recording and reporting will be in accordance with the standard methods. The laboratory will also record the duration of the Paint Filter Test and the volume of free liquids released from the sediment sample during the test. All laboratory data will be reported in hard copy format after internal check and data quality reviews.

4.3.2 Data Transfer and Reduction

The data collected during the gravity dewatering study will be reduced to provide results for initial and final moisture contents of the sediment samples and the volume of free liquid released

from the samples. The moisture content data will be reduced using the procedure described in SOP 8 (Appendix B) to calculate the moisture content. The volume of free liquids released during the Paint Filter Test will be reported without further data reduction.

The data from the study will be evaluated to determine the amount of free liquids that may be released under gravity. The following is a description of the data reduction procedure:

$$\text{Free liquid weight, } W_w = (MC_i - MC_f) \times W ,$$

where MC_i is the initial moisture content, MC_f is the final moisture content, and W is the weight of the Paint Filter Test sample.

The free liquid weight calculated above should be the same or nearly the same as the weight of the liquids released in the Paint Filter Test. However, small differences may exist because of the presence of dissolved material and evaporation losses during the Paint Filter Test.

4.3.3 Data Interpretation

The amount of drainable liquids in a given sediment sample is dependent on the initial moisture content and moisture–solids relationship. The volume of the free liquids that would be released from the sediment under gravity can be calculated by

$$\text{Free liquid weight, } W_w = (MC_i - MC_f) \times W ,$$

where MC_i is the initial moisture content, MC_f is the final moisture content, W is the weight of sediment in the impoundment, and W_w is the volume of sediment × bulk density of sediments.

The free liquid weight calculated above (W_w) can be approximated to volume (V_w) by using a specific gravity of 1 for the drained liquids.

Further, removal of drainable free liquids will result in vertical settlement of the sediment blanket. The aggregate sediment settlement is dependent on sediment solids characteristics and the solid–liquid relationship within the sediment mass. However, for approximation, sediment volume reduction due to settlement may be assumed to be equal to the volume of free liquids removed during gravity draining. The sediment volume reduction and the volume of free liquids removed are nearly equal, if the degree of saturation is 100% (all voids are filled with liquids) at final moisture content, MC_f (Sect. 4.3.2). The sediment settlement due to gravity drainage of liquids is calculated as follows:

V_w = Volume of liquid released $\simeq$ sediment volume reduction due to settlement,

Average settlement height = V_w / A_s,

where, A_s is the area of sediment in the impoundment.

4.4 SEDIMENT GRAVITY SETTLING

Sediment gravity settling test data will be used to predict the settling characteristics of the sediments' solids when resuspended during the remediation activities. Sediment solids resuspension would increase the potential for radiation exposure. The gravity settling test description is presented in SOP 3 (Appendix B). The data management activities associated with the sediment settling tests are described below.

4.4.1 Data Recording and Reporting

All data collected during this test will be recorded in a bound field log book similar to that described under sediment sampling (Sect. 4.1.1). Entries in the log book must include at least the following:

- date of test,
- name of technician performing the test, and
- task number of test.

A sample table of how data should be recorded during this test is presented at the end of SOP 3 in Appendix B.

4.4.2 Data Transfer and Reduction

No data transfer or reduction is required for this test.

4.4.3 Data Interpretation

The results of the gravity settling tests will be correlated to determine settling velocities at the various suspended solids concentrations. The following steps should be used to interpret the data from the settling tests:

1. Arrange the settling data at the various suspended solids concentrations as shown in the example in Table 4.3.

2. Correlate these data by plotting the sediment–liquid interface with time as shown in the example in Fig. 4.1.

3. Calculate the zone settling velocity (ZSV) as the slope of the straight-line portion of the curve. This slope will be in milliliters per minute and should be corrected to feet per hour by using the appropriate conversion factor for the specific cylinder. For ease of conversion, an inch scale can be taped to the cylinder (SOP 3, Appendix B) so that conversion factors are unnecessary.

4. Correlate the ZSV to the respective suspended solids concentration on the plot as shown in Fig. 4.2.

5. Use velocity at specific suspended solids concentration from plot similar to Fig. 4.2 to extrapolate settling times in the impoundments as shown below:

Settling time (h) = total water depth (ft)/settling velocity (ft/h) .

A method often used in wastewater treatment plant operations to determine the settling characteristics of sludge is called the sludge (sediment) volume index (SVI). This empirical index is defined as the volume in milliliters occupied by one gram of dry solids after settling for 30 min in a 1000-mL graduated cylinder. In using this empirical index, the lower the SVI, the better the sludge (sediment) settling characteristics. SVI should be obtained from the settling tests data by selecting the value of the sludge–liquid interface corresponding to 30 min. The SVI numbers should be compared for sediments collected from different impoundments to determine any differences in settling characteristics.

4.5 SEDIMENT GRAVITY SETTLING WITH POLYMERS

Data obtained from sediment gravity settling tests with polymers will be used to evaluate increasing the settling velocity of the sediment solids during transfer between ponds. Sediment solids resuspension during transfer of sediments would increase the potential for radiation exposure. Gravity settling tests with polymers is described in SOP 5 (Appendix B). The data management activities associated with these tests are described below.

4.5.1 Data Recording and Reporting

All data collected during this test will be recorded in a bound field log book similar to that described under sediment sampling (Sect. 4.1.1). Entries in the log book must include at least the following:

- date of test,
- name of technician performing the test, and
- task number of test.

A sample table of how data should be recorded during this test is presented at the end of SOP 5 in Appendix B.

4.5.2 Data Transfer and Reduction

No data transfer or reduction is required for this test.

4.5.3 Data Interpretation

The results of the jar tests with polymers will be correlated to determine an optimum dosage and type of polymer to enhance the settling rates of the sediment solids. The following steps should be used to interpret the data from the jar tests:

1. For each polymer tested, use data recorded in Table SOP 5 (Appendix B) to plot polymer dosage vs supernatant TSS and turbidity. An example of this plot is shown in Fig. 4.3.

2. Compare settling times among the control (no polymer addition) and samples with polymer to confirm that polymer addition produced a faster settling sediment slurry.

3. For each polymer tested, select the optimum polymer dosage corresponding to the lowest supernatant TSS.

4. Select three polymers as alternatives for polymer addition during remediation based on lowest dosages of polymers selected in step 3 above.

5. Obtain cost information from polymer vendors to evaluate cost-effectiveness of selected polymers.

4.6 SEDIMENT MECHANICAL DEWATERING

For Information Only

Mechanical dewatering using a belt press, filter press, or centrifuge is one of the unit processes being considered for this alternative. Prior to performing the mechanical dewatering tests, Buchner funnel tests will be used to select a polymer and optimum dosage for conditioning of the sediments. The data management and interpretation procedures associated with the Buchner funnel and dewatering tests are described below.

4.6.1 Data Recording and Reporting

All data collected during performance of Buchner funnel and other dewatering tests will be recorded in a bound field log book similar to that described under sediment sampling (Sect. 4.1.1). Entries in the log book must include at least the following:

- date of test,
- name of technician performing the test, and
- task number of test.

A sample table illustrating how data should be recorded during these tests is presented at the end of SOP 9 in Appendix B.

4.6.2 Data Transfer and Reduction

The data collected during the Buchner funnel tests will be reduced (calculate t/V) as shown in Table SOP 9 (Appendix B). Other data reduction for the mechanical dewatering tests is described under the interpretation section for each test.

4.6.3 Data Interpretation

Data interpretation procedures for the following tests are presented below:

- Buchner funnel tests,
- pilot-scale filter press tests,
- pilot-scale belt press tests, and
- pilot-scale centrifuge tests.

4.6.3.1 Buchner funnel tests

The following steps describe using an example of the data from Buchner funnel tests to select a polymer for conditioning the sediments before mechanical dewatering. A description of the equations used to analyze the data is presented in SOP 9.

1. For each Buchner funnel run, data will be collected as presented in the example in Table 4.4. The third column is the elapsed time divided by the volume.

2. The data are correlated by plotting t/V vs V as shown in the example in Fig. 4.4.

3. The slope of the line is equal to "b" (Eq. 3 in SOP 9):

   $b = 0.004\ s/cm^6$.

4. The specific conditions of the test were:

   Filter paper area = 104.6 cm^2

   Vacuum, P = 15 in. of Hg

   = 526 g/cm^2

   Initial sludge concentration, C_i = 4.4 g/100 mL = 4.4%

   Final sludge concentration, C_f = 20 g/100 mL = 20%

   Filtrate viscosity, = 0.00895 poises

5. Calculate the solids deposited per unit volume of filtrate (Eq. 7 in SOP 9)

$$c = \frac{1}{[(100 - C_i)/C_i] - [(100 - C_f)/C_f]}$$

$$c = 0.056\ g/mL, \text{ or } 5.6\% .$$

6. Calculate the specific resistance, r (Eq. 4 in SOP 9).

   $r = 2\ PA^2b/c,$

   $r = 2(526)(104.6)^2(0.004)/(0.00895*0.056),$

   $r = 0.92 \times 10^6\ s^2/g.$

7. By computing the specific resistance at varying polymer dosages, the optimum value is found by determining the minimum specific resistance as shown in Fig. 4.5. Therefore, as seen from Fig. 4.5, the optimum conditioner concentration for dewatering is 6 lb of polymer/ton of dry

solids. The variation of specific resistance with polymer dosage as shown in Fig. 4.5 would represent the best conditioner curve of all those tested.

4.6.3.2 Pilot-scale filter press tests

At the completion of the pilot-scale filter press runs, the following key design data will be obtained:

- filter cake solids concentration (%),
- operating pressure for filter press (psi),
- filtration cycle time (h),
- filtrate quality (TSS) and volume,
- polymer dosage (lb/lb dry solids), and
- solids capture (%).

Mass balances for solids and liquids should be prepared for each run using data from the pilot-scale runs. The mass balances and other data from the pilot-scale runs will be used during detailed design to size a filter press for dewatering the sediments.

4.6.3.3 Pilot-scale belt press tests

At the completion of the pilot-scale belt press runs, the following key design data will be obtained:

- filter cake solids concentration (%),
- belt press loading rate (lb of dry solids/ft · h),
- filtrate quality (TSS) and volume,
- polymer dosage (lb/lb dry solids), and
- solids capture (%).

Mass balances for solids and liquids should be prepared for each run using data from the pilot-scale runs. The mass balances and other data from the pilot-scale runs will be used during detailed design to size a belt press for dewatering the sediments.

4.6.3.4 Pilot-scale centrifuge tests

At the completion of the pilot-scale centrifuge runs, the following key design data will be obtained:

- filter cake solids concentration (%),
- centrate quality (TSS) and volume,
- polymer dosage (lb/lb dry solids), and
- solids recovery (%).

Mass balances for solids and liquids should be prepared for each run using data from the pilot-scale runs. The mass balances and other data from the pilot-scale runs will be used during detailed design to size a centrifuge for dewatering the sediments.

4.7 SEDIMENT CONSOLIDATION

Vertical consolidation of the sediment blanket is expected to occur because of removal of liquids from the sediment under gravity drainage and because of the application of surcharge pressure. The sediment gravity dewatering tests and resultant settlement due to liquids removal are described in Sect. 4.3. Consolidation potential of the sediment under surcharge pressure will be estimated using three geotechnical tests: Modified Liquid Release Test (modified EPA SW846-1311), Harvard Miniature Compaction Test (SOP 15), and One-Dimensional Consolidation Test (ASTM D2435-90). Sections 4.7.1 to 4.7.3 contain a description of the data management and interpretation procedures for the sediment consolidation engineering studies.

4.7.1 Data Recording and Reporting

All laboratory data will be reported in hard copy format after an internal check and data quality reviews. The data from the Harvard Miniature Compaction and One-Dimensional Consolidation tests will be recorded in accordance with the procedures described in the corresponding standard methods. Data recording for the modified liquid release test will be performed using Table SOP 1 (Appendix B). As a minimum, the following data will be recorded for the test:

- Initial moisture content: Initial and final sample weights; test temperature; test date, time, and duration; and personnel conducting the test and data recording.

- Modified Liquid Release Test: Initial weight of sample; pressure increments at 0, 5, 10, 20, 30, 40, and 50 psi and corresponding volume of liquids released; test date, time, and duration; and personnel conducting the test and data recording.

- Final moisture content: Initial and final sample weights; test temperature; test date, time, and duration; and personnel conducting the test and data recording.

4.7.2 Data Transfer and Reduction

The data collected during the sediment consolidation study will be reduced to provide results for the volumes of liquid released under pressure, moisture–dry density relationship, and vertical consolidation under drained conditions. All moisture content data involved in these tests will be reduced using the procedure described in SOP 8. The following describes the data reduction steps for each test proposed for the sediment consolidation study.

4.7.2.1 Modified Liquid Release Test

The data from the study will be evaluated to determine the unit volume of free liquids released per initial weight of the sediment under surcharge pressure. The data will be used to produce a plot of unit volume of liquids released vs the pressure applied to the sample. The data tabulation and plot are shown in Table 4.5.

The total volume of liquids released should be the same or nearly the same as that calculated using the initial and the final moisture contents of the sample. However, a small difference may exist because of the evaporation losses during the test.

4.7.2.2 Harvard Miniature Compaction Test

The data from the study will be evaluated to determine the moisture–dry density relationship for the sediment sample. The data will include a plot of moisture content vs the sediment dry density (SOP 15, Appendix B). From the plot, maximum dry density and optimum moisture content, which is the moisture content corresponding to the maximum dry density, will be determined.

4.7.2.3 One-Dimensional Consolidation Test

The data from the study will be evaluated to determine the coefficient of consolidation for the sediment sample. The data will also include the following plots (ASTM D2435-90):

- plot of strain (consolidation) vs vertical effective stress and
- plot of void ratio vs vertical effective stress.

These plots and the coefficient of consolidation value will be used to estimate the consolidation potential of the sediment as described in Sect. 4.7.3.

4.7.3 Data Interpretation

The amount and rate of settlement that may occur in the sediment blanket are dependent on several factors, including moisture–solids relationship, initial stress conditions, increase in stress, pore fluid drainage conditions, and initial thickness of the sediment layer. The data generated from the sediment consolidation tests will be interpreted to estimate long-term settlement, volume of liquids squeezed out, and resultant compaction level. The data interpretation procedure is described below for each test.

4.7.3.1 Modified Liquid Release Test

Using the data plot shown in Table 4.5, determine the unit volume of liquids released (V_u) due to anticipated loading during the impoundment remediation (P, psi). The total volume of liquids released will be calculated as:

$$V = V_u \times W ,$$

where W is the total weight of the sediment in the impoundment.

The calculated volume will be used to determine the hydraulic impact on the existing wastewater treatment plant or requirements for a packaged treatment plant.

4.7.3.2 Harvard Miniature Compaction Test

The maximum dry density value will be used to estimate the anticipated compaction of sediment given by

$$\text{Compaction} = (\text{dry density achieved})/(\text{maximum dry density}) .$$

In addition, the optimum moisture content value indicates the moisture content at or near which the maximum compaction may be achieved. The higher the compaction, the lower will be the compressibility and future settlement of the sediments.

4.7.3.3 One-Dimensional Consolidation Test

Data from the One-Dimensional Consolidation Test will be used to estimate the anticipated settlement in the sediment layer. The settlement is given by

$$\text{Settlement} = [D * (e_o - e)] / e_o ,$$

where D is the depth of the sediment layer, e_o is the initial void ratio, and e is the void ratio at the estimated stress level during the impoundment remediation.

The laboratory results from the One-Dimensional Consolidation Tests will include additional data for use by detailed design engineers. These data will be used to calculate the coefficient of consolidation (C_v) and the compression index (C_c). These two coefficients are used for predicting the time and amount of consolidation from overburden pressure.

4.8 SEDIMENT SOLIDIFICATION

A sediment solidification study will be conducted to improve the consistency of the sediment and/or to result in monolith blocks for handling and transportation during the impoundment remediation. Different solidification agents will be tested at varying concentrations to determine the best suited reagent and mix ratio. Several field and laboratory tests were designed to aid in achieving the solidification study objectives. These tests include

- Field Testing
  - — Moisture Content Test (ASTM D2216)
  - — Volume Change
  - — Pocket Penetrometer
- Laboratory Testing
  - — Unconfined Compressive Strength (ASTM D 2166-91)
  - — Harvard Miniature Compaction Test (SOP 15, Appendix B)
  - — One-Dimensional Consolidation Test (ASTM D 2345)

Sections 4.8.1 to 4.8.3 describe the data management and interpretation procedures for the sediment consolidation engineering studies.

4.8.1 Data Recording and Reporting

The sediment solidification testing will be conducted both in an on-site field laboratory and an off-site laboratory. All data generated in the field during this study will be documented in a bound field log book with adequate detail and clarity. At a minimum, the following data types will be recorded during the field testing.

- Moisture content: Sample identification (ID); initial and final sample weights; test temperature; test date, time, and duration; and personnel conducting the test and data recording.

- Volume change: Sample ID; initial and final sample mold heights; test date, time, and duration; and personnel conducting the test and data recording.
- Pocket penetrometer: Sample ID; penetrometer reading in pounds per square inch; test date, time, and duration; and personnel conducting the test and data recording.

The data from the UCS, Harvard Miniature Compaction, and One-Dimensional Consolidation tests will be recorded in accordance with the procedures described in the corresponding standard methods and/or SOPs (Appendix B). All laboratory data will be reported in hard copy format after an internal check and data quality reviews.

4.8.2 Data Transfer and Reduction

The data collected during the field testing of the sediment solidification testing will be reduced to identify the initial selection of solidification reagents and mix ratios. On the basis of the field test results, laboratory testing will be conducted (SOP 13). The laboratory data will be used to select the final solidification reagent and mix ratio. The Harvard Miniature Compaction and One-Dimensional Consolidation tests will be used to characterize the settling properties of the solidified sediments. However, based on the strength characteristics achieved through sediment solidification, Harvard Miniature Compaction and One-Dimensional Consolidation tests may not be required, as explained in SOP 13. The data reduction procedures for the Harvard Miniature Compaction and One-Dimensional Consolidation tests are described in Sect. 4.7.2.

All moisture content data will be reduced using the procedure described in SOP 8 to calculate the moisture content. The data for the remaining tests will be reduced as described below.

4.8.2.1 Volume change

Data from the volume test will be used to estimate the anticipated increase (or decrease) in the solidified sediment volume during the setting period. The volume change is given by

$$V_{change} = (H - H_o) \times A$$

where H is the final height of the solidified sample mold, H_o is the initial height of the solidified sample mold, and A is the cross-sectional area of the solidified sample mold.

4.8.2.2 Pocket penetrometer

Data from the pocket penetrometer test will be used to estimate the bearing strength developed by the solidified sediment mold prior to testing using the UCS test. The measured value of the pocket penetrometer will be used directly in the evaluation, and no further data reduction will be performed.

4.8.2.3 Unconfined compressive strength

Data from the UCS test will be reported as tons per square inch (tons/in.^{2}) or as pounds per square inch (psi). These data will be used as a direct indicator of the bearing strength of the solidified sediment mold, and no further data reduction will be performed.

4.8.3 Data Interpretation

The primary objective of the sediment solidification study is to improve the physical consistency of the sediment, including the strength properties. The proposed solidification reagents (Chap. 3), when mixed with the sediment at a specific ratio(s), are expected to result in changes to the sediment physical characteristics, thereby achieving the study objectives. These changes are measured using several tests such as moisture content test, volume change, pocket penetrometer, UCS, Harvard Miniature Compaction Test, and One-Dimensional Consolidation Test. The data interpretation steps for the Harvard Miniature Compaction and One-Dimensional Consolidation tests are described in Sect. 4.7.3. The data interpretation procedures for the remaining tests are described below.

4.8.3.1 Moisture content

The sediment moisture may require modification to achieve optimum mix consistency during the solidification in the field. The moisture content data provide this important process control measurement. Moisture content requirements during solidification mix preparation will identify the need to add or remove water from the sediments.

4.8.3.2 Volume change

During the solidification process, the volume of the solidified sediment mix may change. The measurement of volume change is important to determine the impoundment's capacity to contain the solidified wastes. Solidification reagents and mix ratios that result in substantially high volume increases may prove to be unfavorable from an implementation point of view.

4.8.3.3 Pocket penetrometer

This is a quick and inexpensive method to estimate the bearing strength developed by the solidified sediment before a more expensive and time-consuming UCS test could be performed. Solidified sediment molds exhibiting relatively higher pocket penetrometer strength should be chosen for further strength testing using the UCS test.

4.8.3.4 Unconfined compressive strength

This test indicates the bearing strength developed by the solidified sediment. On the basis of the anticipated backfill material and depths and construction equipment, ~50 psi of pressure may be exerted on the solidified sediments. Solidification mixes developing UCS in excess of 50 psi may not require consolidation tests because the bearing strength of the solidified sediment is adequate to support the anticipated load and may not undergo significant settlement over time. On the other hand, sediment solidification mixes developing UCS significantly less than 50 psi may require consolidation tests (Sect. 4.7) to study the sediment settlement under the anticipated load.

Table 4.1. List of engineering support studies by each remedial alternative

Engineering support study	Alternative 1, No Action[a]	Alternative 2, Multilayered Cap and Institutional Controls	Alternative 3, Consolidation Cell and Simple Dewatering	Alternative 4, Consolidation Cell and Ex Situ Treatment
Sediment sampling	No	Yes	Yes	Yes
Sediment analysis	No	Yes	Yes	Yes
Pump loop test	No	No	Yes	Yes
Sediment gravity dewatering	No	Yes	Yes	Yes
Sediment gravity settling	No	Yes	Yes	Yes
Sediment gravity settling with polymers	No	No	Yes	Yes
Sediment mechanical dewatering	No	No	No	Yes
Sediment consolidation	No	Yes	Yes	No
Sediment solidification	No	No	Yes	Yes

[a]No Action alternative involves no remedial actions, and hence no engineering studies are deemed necessary.

Table 4.2. Summary of sediment characterization analyses[a]

Analysis	Analytical method	Data types	Data use/interpretation
Particle size distribution	ASTM D422-63	Percent distribution of sediment solids size	Data used to estimate a wide range of characteristics, including soil classification, soil-water behavior, solidification, and soil compressibility.
Moisture content	ASTM D2216-80	Ratio of weight of water to the total sediment sample weight	Data used to determine the amount of water in the sample.
Bulk density	ASTM D2937	Bulk density of sediment sample	Used in determination of weight and volume relationship for sediment samples.
Specific gravity	ASTM D854	Specific gravity of sediment samples	Used in the calculation of unit weights of sediment at different moisture contents.
pH	SW846-9045	pH of the sediment samples	To determine the compatibility for flocculation and solidification studies.
Paint Filter Test	SW846-9095	Drainable free liquids under gravity	Volume of gravity drainable free liquids and initial sediment settlement due to such liquid removal.
Harvard Miniature Compaction Test	SOP 15	Moisture and dry density relationship for a given compactive effort	Estimate the achievable compaction at various sediment moisture contents.
One-Dimensional Consolidation Test	ASTM D2345	Consolidation index, consolidation rate at various stress conditions	Data used to estimate the total settlement and the rate of settlement during and after impoundment closure construction.
Modified liquid release test	SW846-1311 (Mod) and SOP 1	Amount of dewatered liquids at various pressures	Estimate the amount of liquids released under surcharge pressure.
Gravity settling tests	SOP 3	Settling rates for sediment solids under gravity	Data will be used to determine the settling rates of sediment solids suspended because of remedial construction activities in the impoundments.
Jar settling tests with polymers	SOP 5	Settling rates for sediment solids treated with flocculants	Same as gravity settling data, except that polymers will be used to evaluate/enhance sediment solids settling
Buchner funnel tests	SOP 9	Polymer dosages for conditioning sediments	Data used to determine optimum polymer dosage for mechanical dewatering of sediments.
Solidification	SOP 13	Solidification reagent and mix ratio	Data used to identify the best suited reagent and the mix ratio for sediment physical solidification.
Unconfined compressive strength	ASTM D2166	Compressive strength	Data used in the evaluation of compressive strength of solidified sediment.
Pump loop tests	SOP 14	Pipe head losses during sediment transfer	Determine pipe head losses for sizing pumps to be used to transfer sediments between impoundments.

[a]References: American Society for Testing and Materials, Vol. 04-08, Soil and Rock, 1994. SW-846, *Test Methods for Evaluation of Solid Wastes, Physical/Chemical Methods*, EPA, 1988.

Table 4.3. Gravity settling tests

Time (min)	Suspended solids concentration (mg/L)					
	1,000	4,000	8,000	12,000	16,000	20,000
0	1,000	1,000	1,000	1,000	1,000	1,000
1	840	940	985	990	998	999
2	675	880	965	985	995	998
3	570	820	945	980	990	997
4	490	765	920	970	985	995
5	425	720	900	960	983	994
6	380	680	880	950	980	993
7	360	640	860	940	978	993
8	335	600	840	935	977	992
9	310	560	815	925	975	991
10	295	535	795	915	970	990
15	210	425	695	880	950	985
20	155	355	625	840	940	980
25	115	305				
30	85	275	525	770	915	975
40	60	240	480	740	900	960
50	55	230	455	725	885	960
Total settled volume (mL)	6,360	9,970	12,685	14,505	15,421	15,802

Table 4.4. Buchner funnel test

Date of Test: NOW

Technician: TECH 1

Alternative #: Example

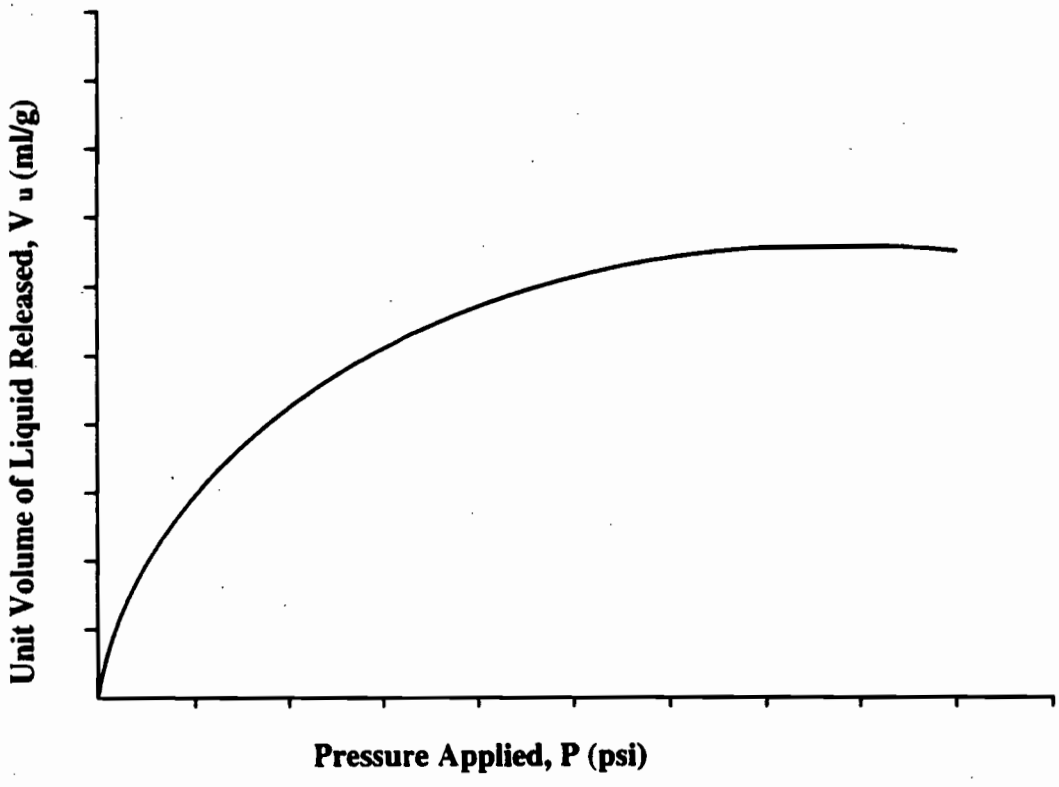
Task #: 1

Time (s)	Volume, V (mL)	t/V (s/mL)
14.5	66	0.22
29.5	92	0.31
45	112	0.4
59	129	0.46
70	134	0.52
89	156	0.57
105	167	0.63
120	174	0.69

Table 4.5. Example data reduction for modified liquid release test

Pressure, P (psi)	Volume of liquids released, V (mL)	Cumulative volume of liquids released, V_{cum} (mL)	Unit liquid volume released, $V_u = V_{cum}/W$ (mL/g)	Comments
0	V_1	V_1		
5	V_2	$V_1 + V_2$		
10	V_3	$V_1 + V_2 + V_3$		
20	V_4			
30	V_5			
40	V_6			
50	V_7			

Weight of the initial sample used in the test = W (g).
The above data will be plotted as shown below.



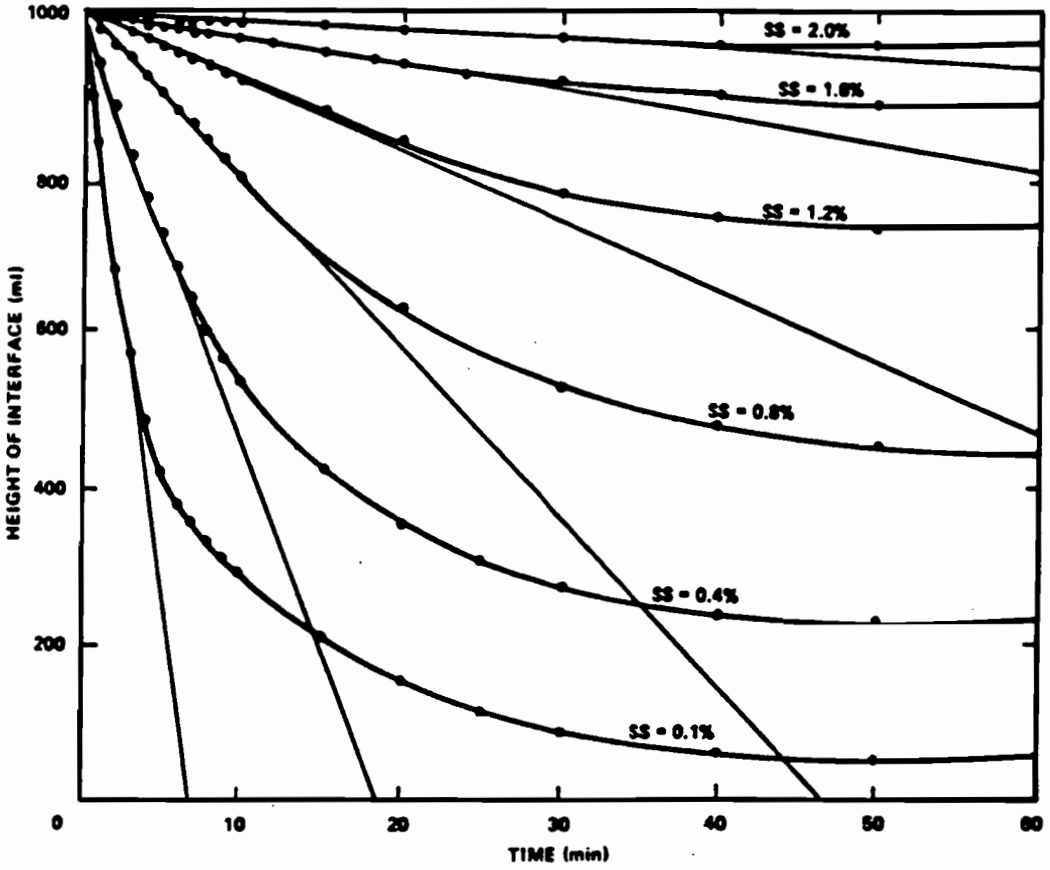


Fig. 4.1. Settling curves at various suspended solids concentrations.

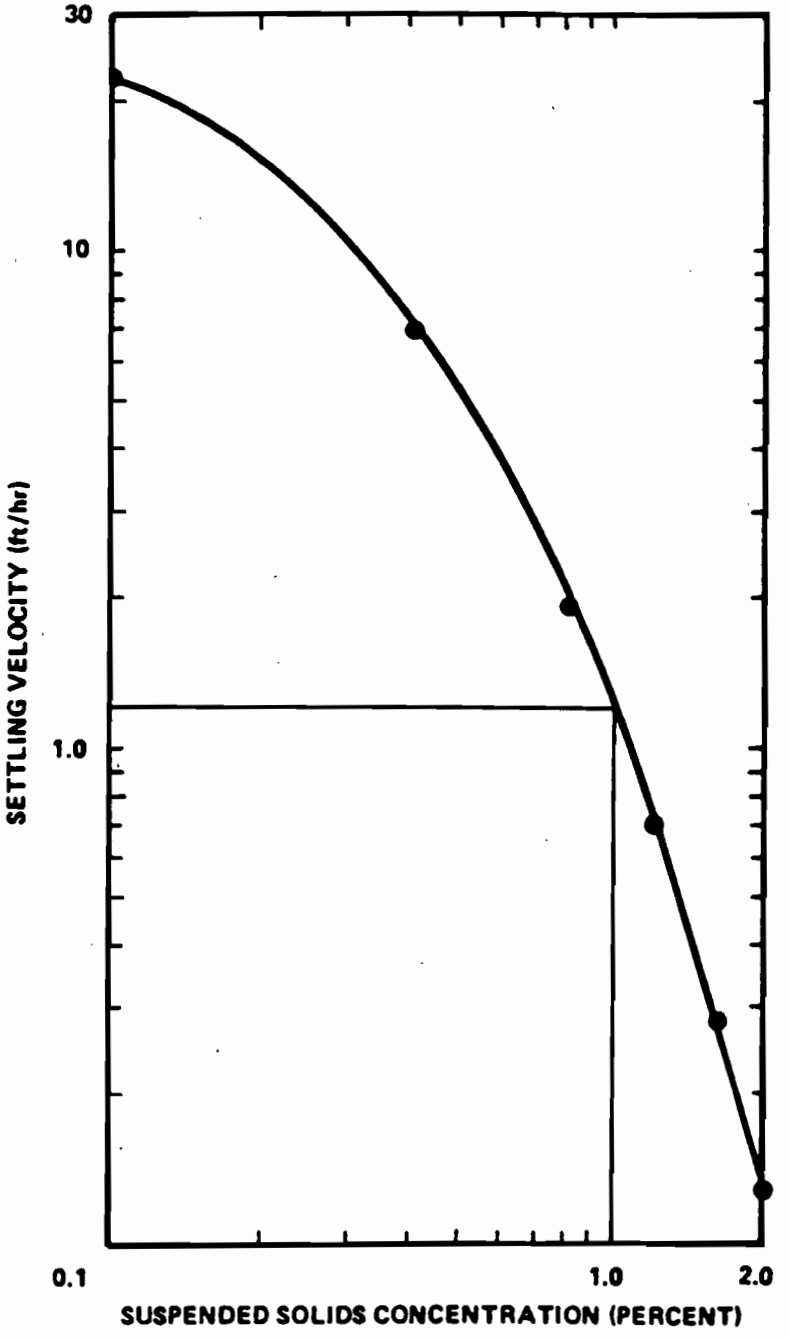


Fig. 4.2. Relationship of settling velocity and suspended solids concentration.

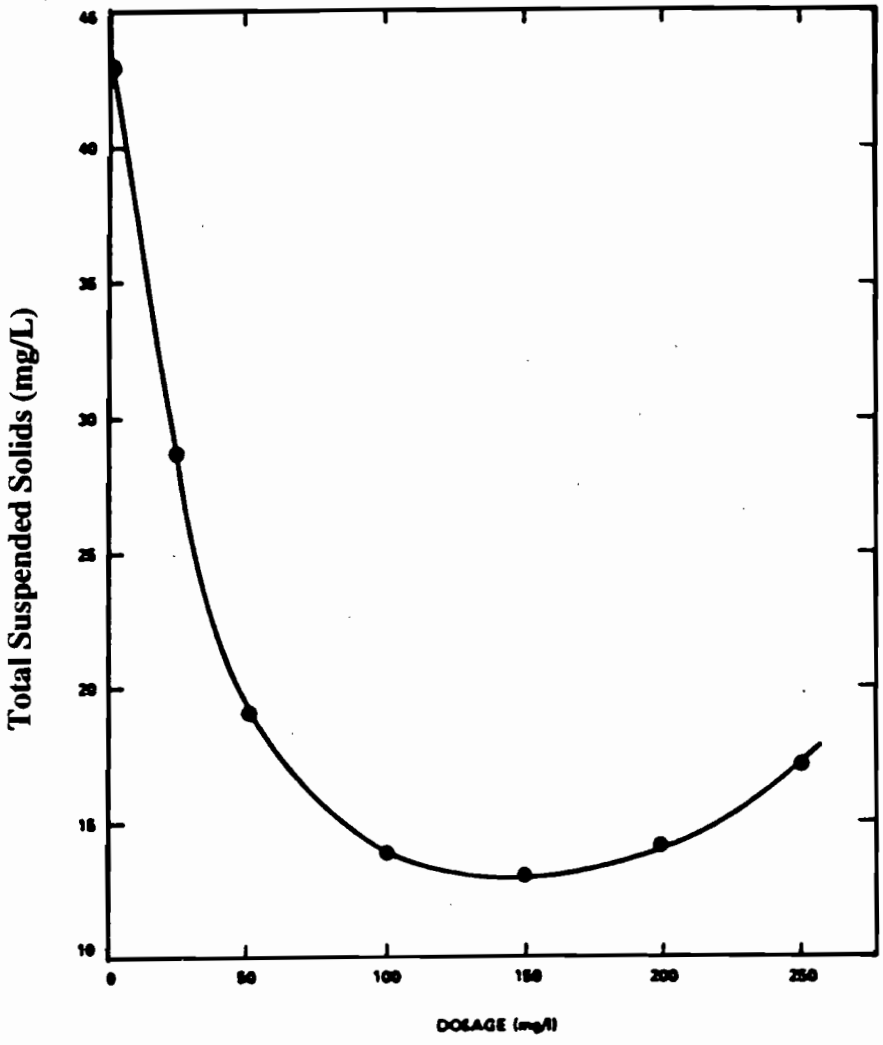


Fig. 4.3. Optimum polymer dosage determination.

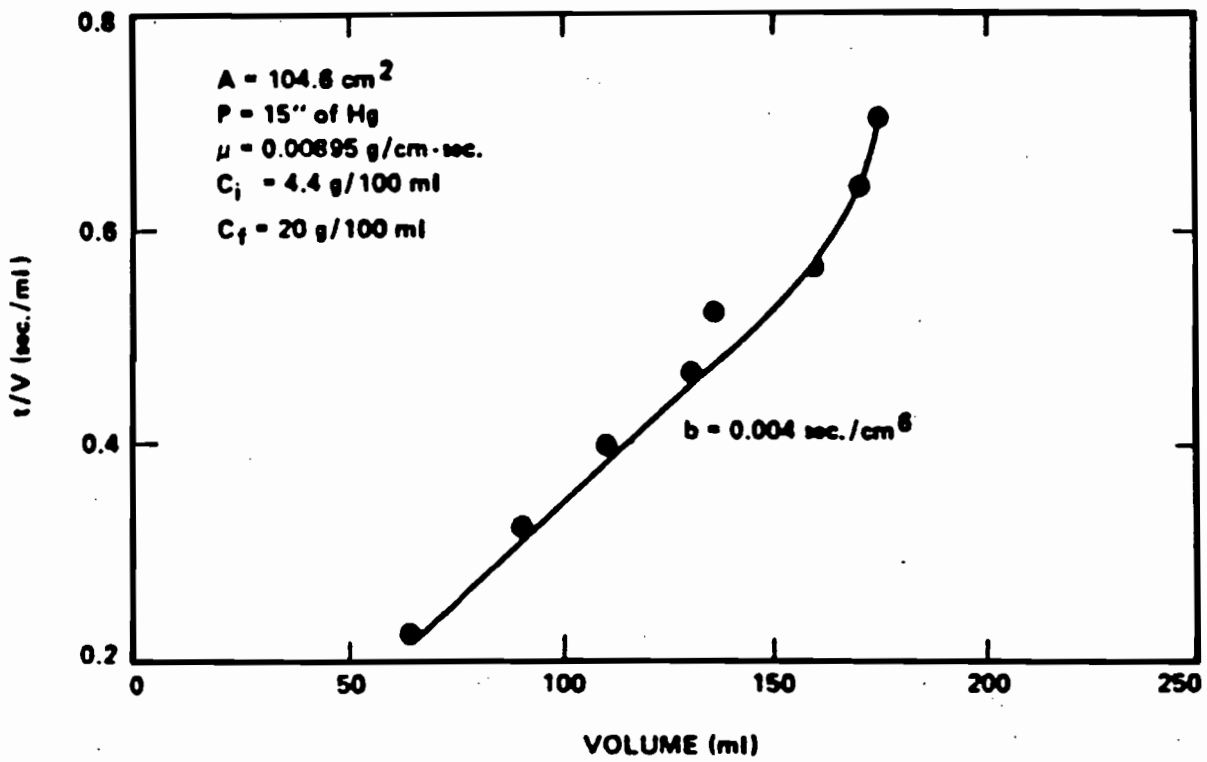


Fig. 4.4. Correlation of Buchner funnel results.

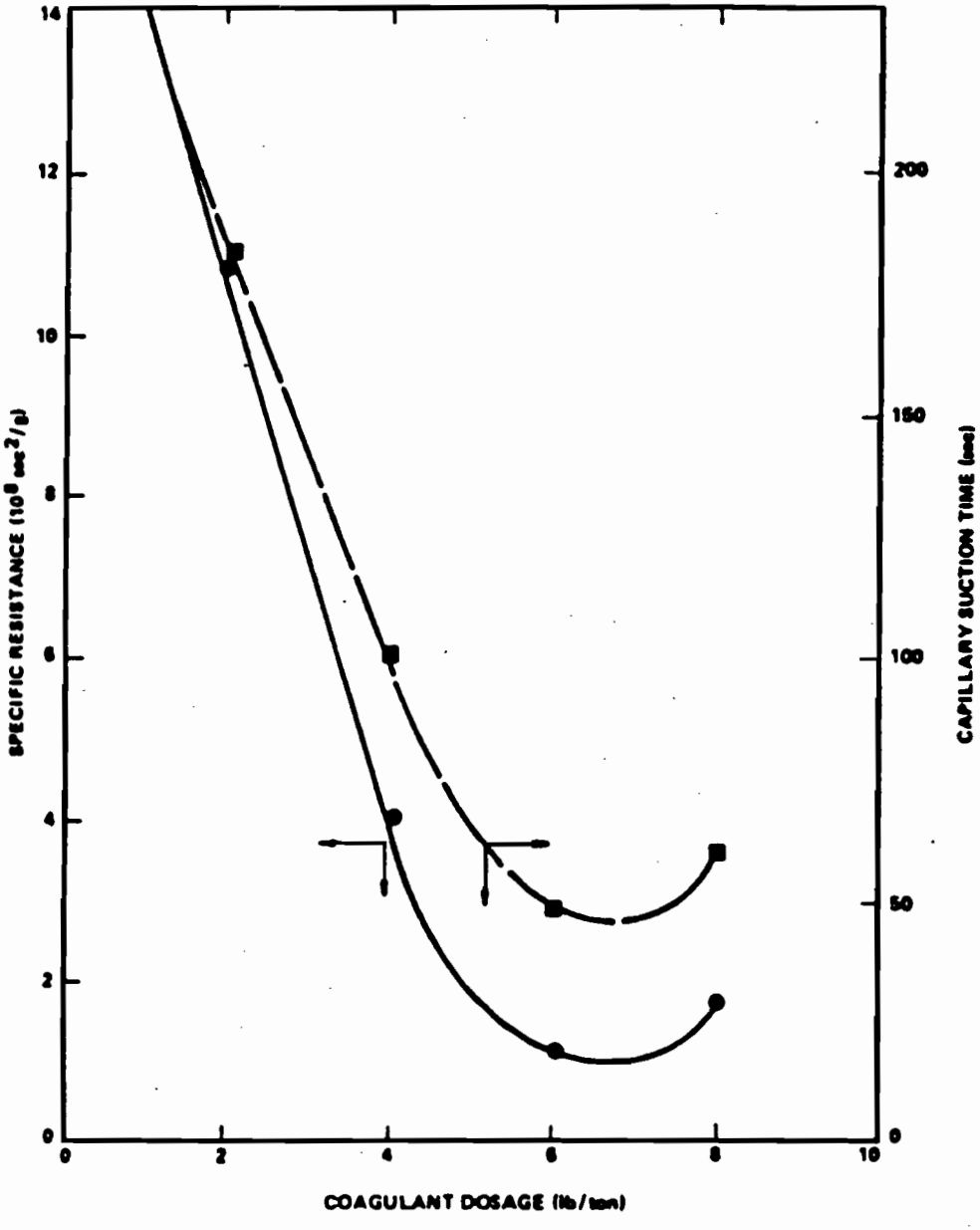


Fig. 4.5. Effect of coagulant dosage on sludge specific resistance and capillary suction time.

5. SCHEDULE

The estimated schedules for performing the engineering studies for Alternatives 2, 3, and 4 are shown in Figs. 5.1, 5.2, and 5.3 respectively.

Task	Weeks																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Mobilization																				
Task 1 Collect Sediment Samples																				
Task 2 Prepare Composite Samples																				
Task 3.1 Characterize Composite Sediment Samples (including laboratory turnaround time)																				
Task 3.2 Perform Paint Filter Tests																				
Task 3.3 Gravity Drain Composite Samples (including laboratory turnaround time)																				
Task 3.4 Perform Gravity Settling Tests																				
Demobilization																				
Prepare Engineering Study Report																				

Fig. 5.1. Alternative 2 schedule: Multilayer Cap and Institutional Controls.

For Information Only

Task	Weeks																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Mobilization																								
Task 1.1 Collect Multiple Sediment Samples																								
Task 2.1 Perform Gravity Settling Tests																								
Task 2.2 Perform Jar Tests with Polymers																								
Task 2.3 Prepare Composite Samples																								
Task 3.1 Characterize Composite Samples (including laboratory turnaround time)																								
Task 3.2 Prepare Duplicate Composite Samples																								
Task 4.1 Perform Paint Filter Tests																								
Task 4.2 Gravity Drain Composite Samples																								
Task 4.3 Perform Buchner Funnel Tests																								
Task 4.4 Perform Gravity Thickening Tests																								
Task 5.1 Perform Solidification Tests																								
Demobilization																								
Prepare Engineering Study Report																								

Fig. 5.2. Alternative 3 schedule: Consolidation Cell and Simple Dewatering.

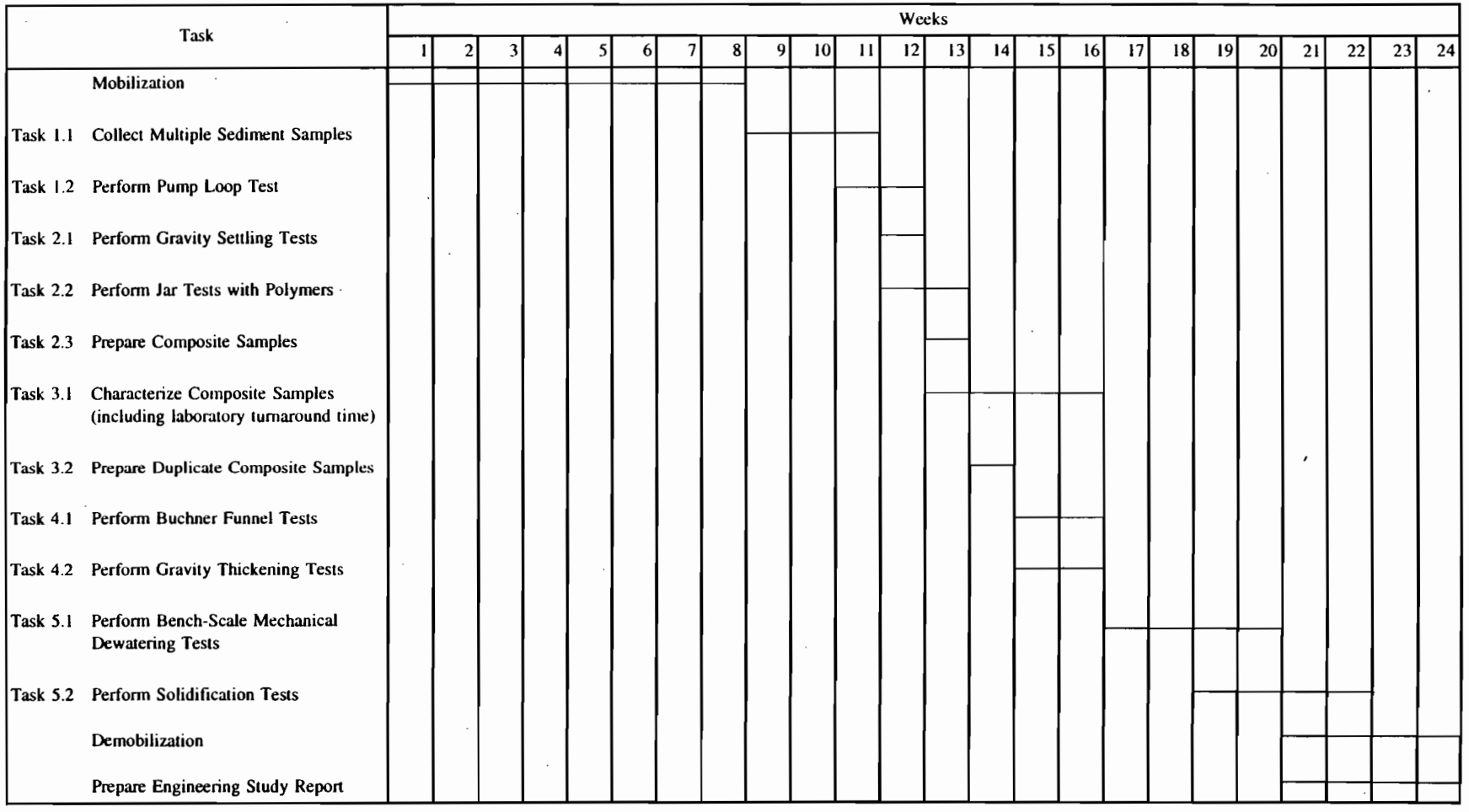


Fig. 5.3. Alternative 4 schedule: Consolidation Cell and Ex Situ Treatment.

For Information Only

6. REFERENCES

1. *Draft RI/FS Report for Surface Impoundments Operable Unit for Waste Area Grouping 1*, Oak Ridge Natl. Lab., January 1995.

2. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, PB89-184626, U.S. Environmental Protection Agency, October 1988.

3. *1994 Annual Book of ASTM Standards*, Vol. 04:08, *Soil and Rock; Dimension Stone; Geosynthetics*.

Appendix A

SEDIMENT SAMPLING PLAN
FOR
ENGINEERING SUPPORT STUDIES

Appendix A

SEDIMENT SAMPLING PLAN FOR ENGINEERING SUPPORT STUDIES

A.1 OBJECTIVES

The objectives of the sampling plan described below are to collect sediment samples required to perform engineering support studies relating to closure of WAG 1 impoundments.

A.2 MEDIA TO BE SAMPLED

Sediment from Impoundments 3513 and 3524.

A.3 DATA USERS

Engineering Studies Contractor to perform testing to support the selected remedial alternative detailed design.

A.4 AREA

The two impoundments to be sampled are located on the southwest side of ORNL within WAG 1. The two impoundments are 3513, Waste Holding Settling Basin, and 3524, Equalization Basin.

A.5 COMMENTS (DEPTH OF WATER, SEDIMENT LAYER, ETC.)

The water depths in the two impoundments have been estimated a ~3 ft deep. Sediment samples will be collected to the top of the clay layer underlying the impoundments.

A.6 HISTORIC INFORMATION AVAILABLE

An investigation of the Concentration, Distribution, and Inventory of Radionuclides in the Sediment of Process Waste System Basin 3524, ORNL/TM-8682.

Preliminary Inventory of Pu-239, -240, Sr-90, and Cs-137 in Waste Pond No. 2 (3513), ORNL/TM-5802.

Additional information is available in ORNL/TM-9936 of June 1986 and ORNL/TM-9969 of September 1986.

A.7 CONSTRAINTS

Constraints on this project are the radioactivity level of the sediment samples during sampling and performance of the engineering studies. The radioactivity levels will influence the sampling and engineering studies task because of exposure concerns. In addition, the radioactivity levels will influence the shipment of samples to contracted geotechnical laboratories.

The Nuclear Criticality Safety (NCS) Section at ORNL does not have any concerns regarding nuclear criticality safety but notes that ORNL NCS Procedure 1.0 requires notification of the ORNL NCS Section prior to the transfer of fissionable material (e.g., samples) in excess of 25 g ^{235}U fissionable equivalent mass.

A.8 SAMPLING METHODS

Random

A.9 ANALYTICAL PARAMETERS

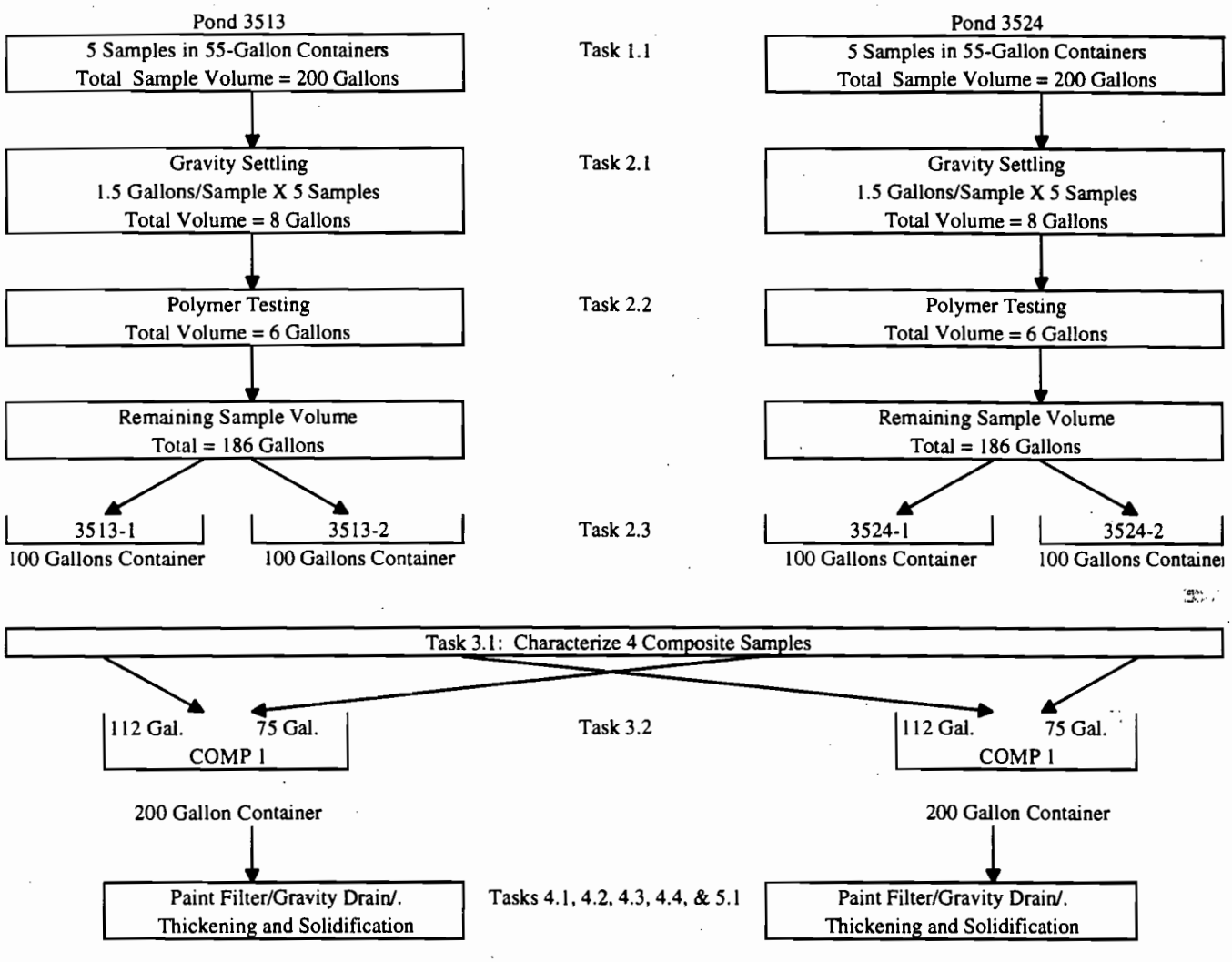
Sediment samples collected from the impoundments will be analyzed only for geotechnical parameters as described in the Technical Work Plan for each alternative.

A.10 SAMPLING QUANTITY

Depending on the alternative selected, the number of individual samples collected from each impoundment range from 5 to 10. Figure A.1 summarizes the total volume of sediment samples required for Alternatives 3.

A.11 SEDIMENT SAMPLING PROCEDURES

The sediment samples will be collected following similar procedures to that used during the summer 1994 sampling effort and described in ESP-304-1 (Sediment Sampling Procedures: Streambeds). For sampling the sediment, a modified pontoon boat will be placed in the impoundment and utilized as a platform. The boat will be moved manually and held in place by aluminum rods. After positioning the boat at a sample location, an 8-ft-long steel casing will be driven into the clay bottom of the impoundment. Because of the large volume of sample required for performing all characterization and engineering studies, a large-diameter casing will be used. Depending on the final alternative selected, the casing diameter will be 16, 24, or 19 in. for Alternatives 2, 3, and 4 respectively.



NOTES: COMP 1 contains 60 % and 40 % of sediments from Imp. 3523 and 3524 respectively.

Summary of Storage and Composite Containers

1.	55 gallons	10 (Initial storage containers for 10 sediment samples from impoundments)
2.	100 gallons	4 (Empty containers for preparing composite samples)
3.	200 gallons	2 (Empty containers for preparing composite samples)

NOTE: 1. The sediment volumes estimated above are based on a 10 % sediment solids concentration from the impoundments. Based on a sediment depth of 24", the diameter of steel casing required for sample collection at each location is 19".
2. Two 200 gallons containers were selected for making the composite sample (COMP 1) based on limitation on volume of container. As an alternate, a single 400 gallon container may be used to prepare COMP 1.

Fig. A.1. Alternative 3: Consolidation and Simple Dewatering Estimation and Preparation of Sample Volumes.

After positioning the casing, the surface water will be pumped out using a centrifugal or air diaphragm pump. After removing the surface water, the sediment will then be pumped into the appropriate storage containers. An Impoundment Lifting Plan used during the 1994 sampling is also attached at the end of this plan. The following procedures should be implemented during sampling.

Environmental Surveillance

1. ESP-102: Field QC
2. ESP-105: Field Waste—Control of Field Work—Contaminated Media
3. ESP-304-1: Sediment Sampling: Streambeds
4. ESP-307-6: Organic Vapor Detection
5. ESP-307-7: Operation of Radiation Survey Instruments
6. ESP-308-1: Composite Procedures
7. ESP-308-3: Container Sampling: Drum and Tank
8. ESP-501: Chain of Custody
9. ESP-503: Field Log Book and Data Forms
10. ESP-802: Equipment Decontamination

These ESPs will be provided as an attachment to this work plan by Energy Systems.

A.12 SAMPLING LOCATIONS

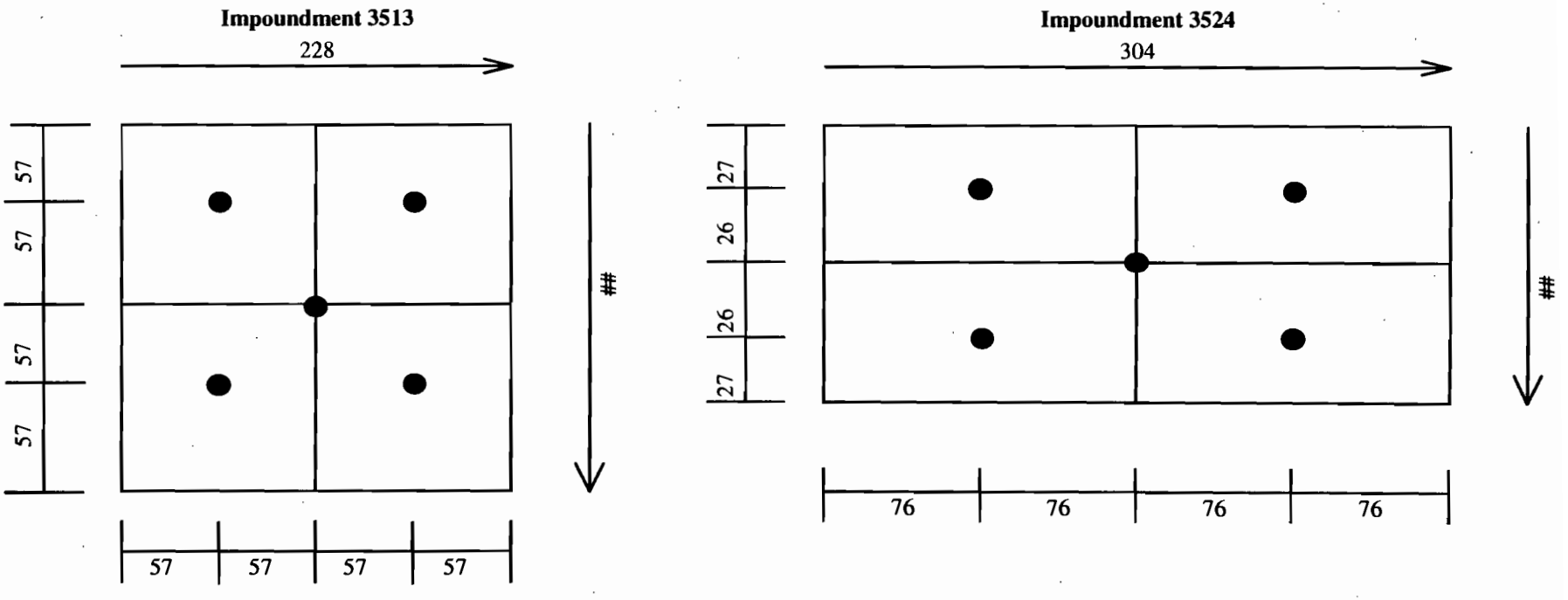
The sampling locations will be based on the alternative being evaluated. For Alternative 2 (Multilayered Cap and Institutional Controls), the sample locations are based on collecting samples that are representative of the sediments from Impoundments 3513 and 3524. These samples will be subsequently composited into a single sample for use in performing specific studies. For Alternatives 3 and 4, the sample locations are based on obtaining samples that may indicate variability in the characteristics of the sediment solids from Impoundments 3513 and 3524. These samples will also be composited later for performing specific engineering studies. The sample locations selected for each alternative are described below.

Alternative 2: Multilayered Cap with Institutional Controls

The sampling effort for this alternative involves collection of five discrete samples each from Impoundments 3513 and 3524. The five sample locations for Impoundments 3513 and 3524 are identified in Fig. A.2. These samples will subsequently be composited for other engineering studies as described in the Work Plan.

Alternative 3: Consolidation Cell and Simple Dewatering

The sampling effort for this alternative involves collection of five discrete samples each from Impoundments 3513 and 3524. The five sample locations for Impoundments 3513 and 3524 are identified in Fig. A.3. These samples will subsequently be composited for other engineering studies as described in the Work Plan.



NOTES:
1. All dimensions in feet relative to top of impoundments
2. Drawing not to scale
3 ● = Sampling Locations

I:\401280\9412J51\FIG-A4.XLS

Fig. A.2. Sediment Sampling Locations: Alternative 2, 3, and 4.

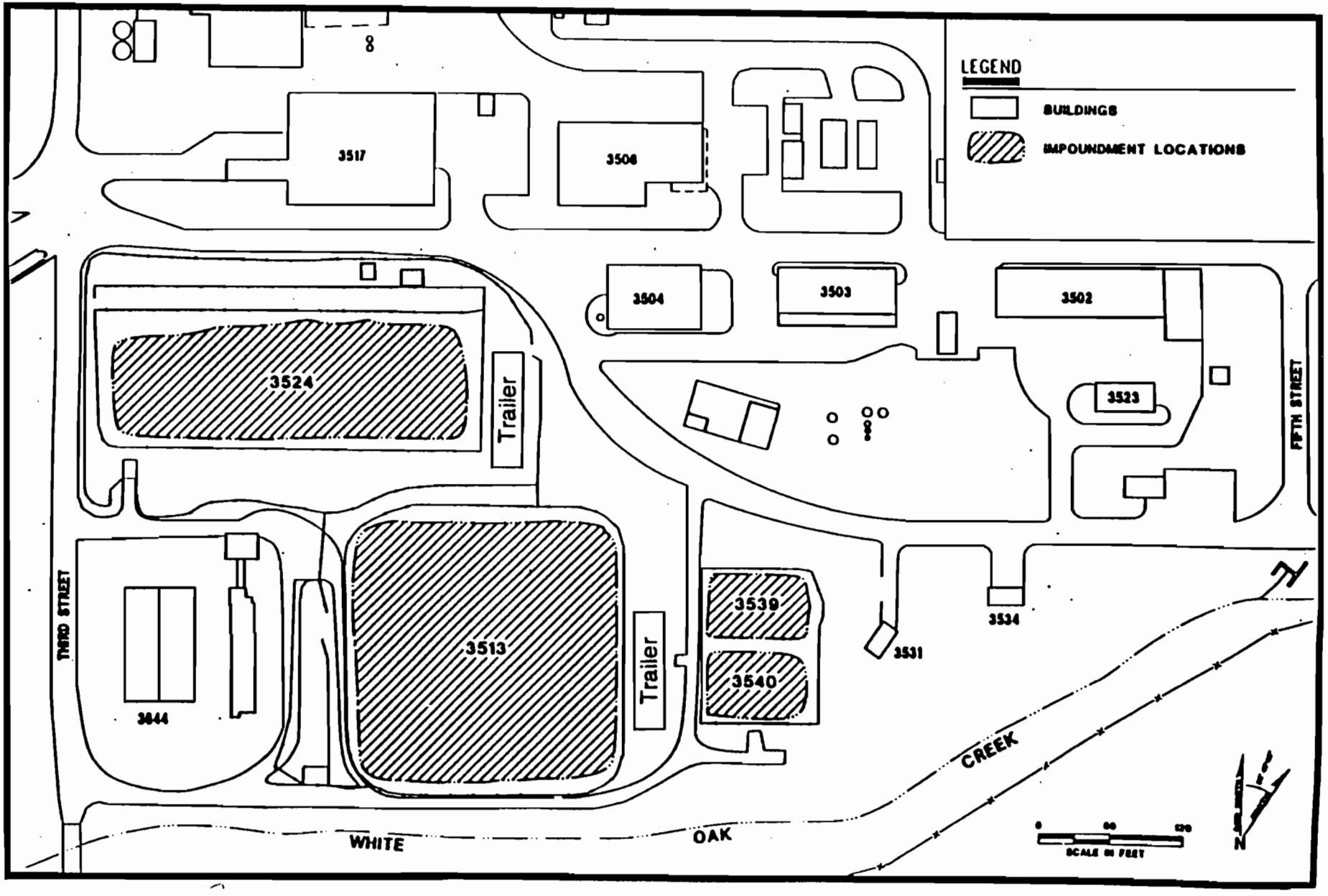


Fig. A.3. Location of the Surface Impoundments within ORNL.

Alternative 4: Consolidated Cell and Ex Situ Treatment

Same as Alternative 3.

A.13 SAMPLE HANDLING

This subsection provides the procedures for sample packaging, shipping, and chain-of-custody procedures.

A.13.1 Sample Label

Samples obtained at the site will be placed in an appropriate sample container (with appropriate shielding requirements) for shipment to the geotechnical laboratory. Sample containers will be identified with a separate identification label. Labeling will be done with indelible/waterproof ink. Errors will be crossed out with a single line, dated, and initialed. Each securely affixed label will include the following information:

- project identification,
- sample identification,
- sampler's name or initials,
- date of collection,
- time of collection, and
- required analytical method numbers.

A.13.2 Sample Custody

Proper sample custody procedures will be used to ensure that samples have been obtained from the locations stated and that they have reached the laboratory without alteration. Sample containers will be maintained in the storage area prior to use. Evidence of the sample traceability from collection to shipment, laboratory receipt, and laboratory custody will be documented. A sample is considered to be in a person's custody if the sample is:

- in a person's actual possession,
- in view after being in a person's possession,
- locked so that no one can tamper with it after having been in physical custody, or
- in a secured area, restricted to authorized personnel.

The sample team leader (STL) is responsible for overseeing and supervising the implementation of proper sample custody procedures in the field. The STL is also designated as the field sample custodian and is responsible for ensuring sample custody until the samples have been transferred to the laboratory (either directly or via a courier). After the samples are received by the laboratory, a designated person will be responsible for maintaining a file of all the original documents (e.g., chain-of-custody forms, traffic reports, special analytical services request form, etc.) pertinent to sample custody and sample analysis protocol.

A.13.3 Chain-of-Custody Records

Samples will be accompanied by a Chain-of-Custody Record, an example of which is shown in Fig. A.4. A Chain-of-Custody Record will accompany the sample during shipment to the laboratory and through the laboratory. When transferring samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. The laboratory maintains a file copy, and the completed original will be returned to the project manager as a part of the final analytical report. This record will be used to document sample custody transfer from the sampler to a laboratory.

Shipments will be sent by overnight express carrier, and airbills will be kept as receipt of shipment. Airbills will be retained as part of the permanent documentation. Sample shipments will be in accordance with U.S. DOT regulations (49 CFR 171 to 177).

A.13.4 Sample Handling

After the samples are placed in the sample containers, they will be packaged and prepared for shipment to the laboratory in the following manner:

- Clean the outer surface of the filled container with paper towels (dye free), using deionized water, as necessary.
- Attach completed sample label to the container and cover the label with clear tape. (This may be done prior to sample collection.)
- Seal the container by wrapping tape around the lid of the container.
- Seal chain-of-custody form in a zip-lock-type plastic bag and tape the bag to the container.
- Securely seal shipping container with packing tape.
- Attach airbill and ship to analytical laboratory via overnight courier.

A.14 EQUIPMENT DECONTAMINATION

Since the samples to be collected from the impoundments will not require any chemical or radiochemical analysis (only geotechnical analysis), no decontamination of equipment will be required between sampling locations. By eliminating decontamination of the steel casing and sampling pump(s), the time required for implementing the sampling plan will be significantly reduced. Although Energy Systems has indicated that solidified samples may be analyzed for TCLP (Metals) in the future, the samples for solidification tests are composite samples, not individual samples. Therefore, using the equipment at each location without decontamination will not have a significant effect on any future TCLP results on solidified samples.

ES JOB NUMBER	PROJECT NAME\LOCATION	PRESERVATIVE REQUIRED / ANALYSES REQUIRED	SHIP TO:
SAMPLER(S): (Signature)			

Date	Time	Sample Description	Number of Containers	Sample Type	Matrix	Remarks
				G C		
				G C		
				G C		
				G C		
				G C		
				G C		
				G C		
				G C		
				G C		
				G C		
				G C		
				G C		
				G C		
				G C		
				G C		
				G C		
				G C		
				G C		
				G C		

Relinquished by: (Signature)	Date/Time	Received for Laboratory by:	Date/Time	Remarks:
				Airbill#:

Distribution: Original, yellow and pink sheets sent to lab. Gold retained by field personnel.
Lab retains original and sends yellow and pink copies with analytical report.

G - Grab

Fig. A.4. Engineering-Science Chain of Custody Record.

IMPOUNDMENT SAMPLING LIFTING PLAN
(1994)

May 17, 1994

Impoundment Sampling Lifting Plan

I. Description of Work

The lifting work takes place in and around ponds 3513, 3524, 3539, 3540 and will be performed by Martin Marietta Energy System (MMES) P & L personnel. The work will involve placing scaffolding to span ponds 3539 and 3540 to allow access for sampling of the pond contents by MAD personnel. Additionally, a rectangular, flat work platform (modified pontoon boat) weighing less than 880 lbs. and about 16 x 8 ft. in dimensions will be lifted off a trailer and placed in 3524 pond. MAD personnel will perform sampling and the work platform will be returned to the trailer. This process will be repeated at pond 3513. The order of work may vary from this description but the work description remains the same.

II. Procedures

A. Oak Ridge Nation Laboratory (ORNL) Plant and Equipment Division Procedures

1. M-3.14, Training, Testing, Certification and Retaining of Power Equipment Operators.

2. M-3.20, General Rigging Requirements

B. Martin Marietta Energy System (MMES) IS 115, Hoisting and Rigging

C. Department of Energy (DOE) Order 5480.4

III. Work Responsibilities

A. A pre-operational inspection of the job site and job requirements shall be performed.

B. A pre-job conference with the necessary personnel involved with the lift shall be performed to verify the weight of the load, value of the load and any hidden hazards.

C. The load chart shall be checked for the weights to be lifted by the mobile crane.

D. The radius of operation of the selected crane shall be determined and verified as correct.

E. The safest way to hook up the load shall be determined to be utilized.

Appendix B

STANDARD OPERATING PROCEDURES

Appendix B

STANDARD OPERATING PROCEDURES

SOP 1: Modified Liquid Release Test

SOP 2: Percent Solids Analysis

SOP 3: Gravity Settling Test

SOP 4: Total Suspended Solids (TSS)

SOP 5: Jar Testing With Polymers

SOP 6: Preparation of Two Composite Samples

SOP 7: Preparation of COMP 1

SOP 8: Moisture Content

SOP 9: Buchner Funnel Test Procedure

SOP 13: Bench-Scale Solidification

SOP 14: Pump Loop Test

SOP 15: Harvard Miniature Compaction Test

SOP-1
MODIFIED LIQUID RELEASE TEST

SOP - 1
MODIFIED LIQUID RELEASE TEST

The modified LRT was designed to collect data for the determining the volume of liquids that may be released from the sediments under surcharge pressure. The test involves application of gradually increasing pressures to a sediment sample and measuring the amount of liquids released at each application of specified pressure. This test will be conducted in duplicate setups, and will be performed using gravity-drained samples. All activities listed in this SOP shall be conducted in accordance with the project Health and Safety Plan. The following is a step-by step procedure for performing the test.

1. Obtain a gravity-drained sediment sample for testing (COMP 1 and COMP2).
2. Perform water content test (ASTM D 2216) for two separate samples drawn from the gravity-drained sediment sample. The average (arithmetic mean) of the two water content results will be recorded as the initial water content of the sediment sample.
3. Weigh 100 grams of the sample used in Step 2, and place it in a Zero Headspace Extractor (ZHE) used for extraction in the TCLP testing (SW846-1311).
4. Prepare the ZHE with the sample as described in the Standard method (SW846.1311).
5. Place a graduated container capable of measuring to the nearest 0.1 milliliter (ml) at the end of liquid extrusion from the ZHE.
6. The sediment samples will be subjected to gradual application of pressures of 0, 5, 10, 20, 30, 40 and 50 pounds per square inch (psi). Each application of pressure will be accomplished in about 30 seconds. Once a specified pressure is reached, it will held constant until the release of liquids is considered complete as described in Step 7.
7. The release of liquids will be considered complete at each applied pressure, when no more visually observable release of liquid from the ZHE occurs in a two-minute interval.
8. At each applied pressure, after the completion of Step 7, note down the cumulative volume of liquid released to the nearest 0.1 ml.
9. Release the pressure after the completion of steps 6, 7 and 8 under applied pressure 50 psi.
10. Remove as much of the sample as possible from the ZHE at the conclusion of the test. Perform water content test (ASTM D 2216) using this sample.

11. The data reporting will consist of readings of the pressure applied to the sa- e and the corresponding cumulative volumes of liquid released.

Table SOP-1
Modified Liquid Release Test (LRT)

Date of Test: _____

Technician: _____

Alternative #: _____

Task #: _____

Initial Moisture Content on Gravity Drained Sample	_____ (%)
Final Moisture Content After LRT	_____ (%)

Pressure (psi)	Cumulative Volume of Liquid (mL)
0	
5	
10	
20	
30	
40	
50	

SOP 2
PERCENT SOLIDS ANALYSIS

SOP-2
PERCENT SOLIDS ANALYSIS

The specific test procedures for calculating percent solids is outlined below:

1. Use ASTM D 2216-92 to calculate water content as:

$$W = \left[\left(M_{cws} - M_{cds}\right) / \left(M_{cds} - M_c\right)\right] \times 100 = \frac{M_w}{M_s} \times 100$$

Where:

W	=	Water content, %
M_{cws}	=	Mass of container, and wet sample, g
M_{cds}	=	Mass of container, and oven dried sample, g
M_c	=	Mass of container, g
M_w	=	Mass of water ($M_w = M_{cws} - M_{cds}$), g, and
M_s	=	Mass of solid particles ($M_s = M_{cds} - M_c$), g.

Calculate percent solids as:

Percent Solids (%) = 100 - (% Moisture)

$$\text{Where (\% Moisture)} = \left(\frac{W}{W + 1}\right) \times 100$$

and W = Water content in decimal (e.g., 40% = 0.40)

SOP 3
GRAVITY SETTLING TEST

SOP-3
GRAVITY SETTLING TEST

The specific test procedure for gravity settling test is outlined below:

1. Add one-liter of sediment slurry to a graduated cylinder (the approximate depth is about 13 to 14 inches depending on the cylinder diameter).
2. With the stirring rod, gently mix the sediment so that all solids are suspended.
3. Remove stirring rod and observe the sludge-liquid interface as the sediment mass subsides in the cylinder. Record the sediment interface at equally-spaced time intervals until the rate of settling begins to decrease. Frequently, it is difficult to observe a distinct interface, and the interface level must be approximated with regard to other dispersed flocs.
4. Repeat Steps 1 through 3 for all sediment samples at different solids concentrations.

The following equipment are needed for performing the gravity settling tests:

1. **Graduated Cylinder:** The cylinder should be at least 2 inches in diameter and 14 inches deep to the 1,000 ml level The cylinder can be graduated in millimeters or inches. If a one-liter graduated cylinder is used, the millimeters should be calibrated into inches. Each cylinder should be calibrated separately since the diameter and, thus, the ml/inch, vary among cylinders.
2. **Stirring Rod:** A stirring rod extending throughout the length of the graduated cylinder for mixing the sediment slurry prior to settling.
3. **Stopwatch:** A stopwatch to record the sediment-liquid interface with time.

Table SOP-3
Gravity Settling Tests

Date of Test: _____

Technician: _____

Alternative #: _____

Task #: _____

Time (Mins)	Suspended Solids Concentration (mg/L)					
	1,000	4,000	8,000	12,000	16,000	20,000
0						
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
15						
20						
25						
30						
40						
50						
60						
Total Settled Volume (mL)						

Note: Initial total suspended solids concentration before dilutions ____ mg/L.

SOP 4
TOTAL SUSPENDED SOLIDS (TSS)

SOP-4
TOTAL SUSPENDED SOLIDS (TSS)

The specific test procedure for TSS analysis is described in Standard Methods for the *Examination of Water and Wastewater Method 209C, 16th Edition, 1995*, copy attached.

tions to the same dish after evaporation. Dry for at least 1 h in an oven at 180 ± 2°C, cool in a desiccator to balance temperature, and weigh. Repeat drying cycle of drying, cooling, desiccating, and weighing until a constant weight is obtained or until weight loss is less than 4% of previous weight or 0.5 mg, whichever is less.

4. Calculation

$$\text{mg total dissolved solids/L} = \frac{(A - B) \times 1000}{\text{sample volume, mL}}$$

where:

A = weight of dried residue + dish, mg, and
B = weight of dish, mg.

5. Precision and Accuracy

Single-laboratory analyses of 77 samples of a known of 293 mg/L prepared as Solution B (Section 104B) were made with a standard deviation of differences of 21.20 mg/L.

209 C. Total Suspended Solids Dried at 103-105°C

1. General Discussion

a. Principle: A well-mixed sample is filtered through a weighed standard glass-fiber filter and the residue retained on the filter is dried to a constant weight at 103 to 105°C. The increase in weight of the filter represents the total suspended solids. If the suspended material clogs the filter and prolongs filtration, the difference between the total solids and the total dissolved solids may provide an estimate of the total suspended solids.

b. Interferences: Exclude large floating particles or submerged agglomerates of nonhomogeneous materials from the sample if it is determined that their inclusion is not desired in the final result. Because excessive residue on the filter may form a water-entrapping crust, limit the sample size to that yielding no more than 200 mg residue. For samples high in dissolved solids thoroughly wash the filter to ensure removal of the dissolved material. Prolonged filtration times resulting from filter clogging may produce high results owing to excessive solids capture on the clogged filter.

2. Apparatus

Apparatus listed in Sections 209A.2 and 209B.2 is required, except for evaporating dishes, steam bath, and 180°C drying oven. In addition:

*Planchet,** aluminum or stainless steel, 65-mm diam.

3. Procedure

a. Preparation of glass-fiber filter disk: Insert disk with wrinkled side up in filtration apparatus. Apply vacuum and wash disk with three successive 20-mL portions of distilled water. Continue suction to remove all traces of water, and discard washings. Remove filter from filtration apparatus and transfer to an aluminum or stainless steel planchet as a support. Alternatively remove crucible and filter combination if a Gooch crucible is used. Dry in an oven at 103 to 105°C for 1 h. If volatile solids are to be measured, ignite at 550 ± 50°C for 15 min in a muffle furnace. Cool in desiccator to balance temperature and

*Available from New England Nuclear, Boston, Mass., or equivalent.

weigh. Repeat cycle of dryin
cooling, desiccating, and wei
constant weight is obtained o
loss is less than 0.5 mg betwe
weighings. Store in desiccator
Weigh immediately before us

b. Selection of filter and sar
Section 209B.3c. For non
samples such as raw wastewat
filter to permit filtering a
sample.

c. Sample analysis: Assemb
paratus and filter and begin
filter with a small volume of
to seat it. Filter a measured v
mixed sample through the gl
Wash with three successive 1
of distilled water, allowing c
age between washings and co
for about 3 min after filtratic
Carefully remove filter from
paratus and transfer to an
stainless steel planchet as a
ternatively, remove the cru
combination from the crucit
Gooch crucible is used. Dr
h at 103 to 105°C in an o
desiccator to balance tem
weigh. Repeat the cycle of c
desiccating, and weighing u

209 D. Fixe

1. General Discussion

a. Principle: The residu
A, B, or C is ignited to cor
550 ± 50°C. The remainin
sent the fixed total, dissolve
solids while the weight lo
the volatile solids. The d
useful in control of waste
plant operation because it

= weight of dried residue + dish, mg, and
= weight of dish, mg.

:ision and Accuracy

e-laboratory analyses of 77 samples
own of 293 mg/L prepared as So-
3 (Section 104B) were made with a
'd deviation of differences of 21.20

Dried at 103-105°C

aratus

ratus listed in Sections 209A.2 and
is required, except for evaporating
iteam bath, and 180°C drying oven.
:ion:
*het,** aluminum or stainless steel,
diam.

edure

eparation of glass-fiber filter disk:
isk with wrinkled side up in filtra-
aratus. Apply vacuum and wash
h three successive 20-mL portions
'ed water. Continue suction to re-
. traces of water, and discard wash-
Remove filter from filtration
is and transfer to an aluminum or
steel planchet as a support. Al-
:ly remove crucible and filter com-
if a Gooch crucible is used. Dry
:n at 103 to 105°C for 1 h. If volatile
e to be measured, ignite at 550 ±
15 min in a muffle furnace. Cool
:ator to balance temperature and

from New England Nuclear, Boston, Mass.,
nt

weigh. Repeat cycle of drying or igniting, cooling, desiccating, and weighing until a constant weight is obtained or until weight loss is less than 0.5 mg between successive weighings. Store in desiccator until needed. Weigh immediately before use.

b. Selection of filter and sample sizes: See Section 209B.3*c*. For nonhomogeneous samples such as raw wastewater, use a large filter to permit filtering a representative sample.

c. Sample analysis: Assemble filtering apparatus and filter and begin suction. Wet filter with a small volume of distilled water to seat it. Filter a measured volume of well-mixed sample through the glass fiber filter. Wash with three successive 10-mL volumes of distilled water, allowing complete drainage between washings and continue suction for about 3 min after filtration is complete. Carefully remove filter from filtration apparatus and transfer to an aluminum or stainless steel planchet as a support. Alternatively, remove the crucible and filter combination from the crucible adapter if a Gooch crucible is used. Dry for at least 1 h at 103 to 105°C in an oven, cool in a desiccator to balance temperature, and weigh. Repeat the cycle of drying, cooling, desiccating, and weighing until a constant weight is obtained or until the weight loss is less than 4% of the previous weight or 0.5 mg, whichever is less.

4. Calculation

$$\text{mg total suspended solids/L} = \frac{(A - B) \times 1000}{\text{sample volume, mL}}$$

where:

A = weight of filter + dried residue, mg, and
B = weight of filter, mg.

5. Precision and Accuracy

The standard deviation was 5.2 mg/L (coefficient of variation 33%) at 15 mg/L, 24 mg/L (10%) at 242 mg/L, and 1. mg/L (0.76%) at 1707 mg/L in studies by two analysts of four sets of 10 determinations each.

Single-laboratory duplicate analyses of 50 samples of water and wastewater were made with a standard deviation of differences of 2.8 mg/L.

209 D. Fixed and Volatile Solids Ignited at 550°C

1. General Discussion

a. Principle: The residue from Method A, B, or C is ignited to constant weight at 550 ± 50°C. The remaining solids represent the fixed total, dissolved, spended solids while the weight lost nition is the volatile solids. The de ation is useful ntrol of wastew eatment pla ation because it a rough approximation of the amount of organic matter present in the solid fraction of wastewater, activated sludge, and industrial wastes.

b. Interferences: Negative errors in the volatile solids may be produced by loss of volatile matter during drying. Determination of low concentrations of volatile solids in the presence of high fixed solids con-

SOP 5
JAR TESTING WITH POLYMERS

SOP-5
JAR TESTING WITH POLYMERS

The purpose of the "jar test" is to determine the most effective dosage of chemical addition polymers for improving the performance of sediment settling rates.

The following supplies are required for this test:

Supplies

1. Phipp & Bird™ Six Gang Stirrer
2. 500 mL or 1000 mL beakers (6)
3. Pipettes or syringes - 1 mL to 10 mL
4. Polymers mixed to required strength
5. Jar test data form
6. Sediment sample to be tested

Data

1. pH and temperature of sediment slurry
2. TSS of sediment slurry

Polymer Solution Preparation

Liquid polymers are usually diluted to a 1% solution (vol/vol). This is done by adding one part (by volume) of polymer to 100 parts (by volume) of water. The following polymer dosages will be evaluated during the jar tests; 20, 50, 100, 150, and 200 mg/L. Measure out the desired quantity of neat polymer into separate syringes. All polymer solutions are to be prepared simultaneously so that polymer can be added to each desired sample at approximately the same time. If polymer additions to the samples are spaced apart, then settling rates will differ accordingly and comparison may be difficult. Leave one beaker of sample free of polymer for comparative purposes. The amount of polymer, mixed at 1% to add to a one liter sample to achieve different dosages may be determined by referring to Table B1.

Amount of Chemicals to Add to One Liter Sample Volume

In the event that Table A1 is not available the following formulas can be used to calculate dosages if polymer concentrations are known.

a. One Liter Sample

mg/l dosage = (10)*(% polymer solution)*(mls polymer solution used)

b. 500 Milliliter Sample

mg/l dosage = (20)*(% polymer solution)*(mls polymer solution used)

Table B1
Amount of Chemicals to Add to One Liter Sample Volume

(mg/L) Desired	Mls of Concentrated Solution to Add	Mls of 1% Solution to Add	Mls of 0.1% Solution to Add
0.1	0.0001	0.01	0.1
0.5	0.0005	0.05	0.5
1.0	0.0001	0.1	1.0
2.0	0.002	0.2	2.0
3.0	0.003	0.3	3.0
4.0	0.004	0.4	4.0
5.0	0.005	0.5	5.0
6.0	0.006	0.6	6.0
7.0	0.007	0.7	7.0
8.0	0.008	0.8	8.0
9.0	0.009	0.9	9.0
10.0	0.01	1.0	10.0
15.0	0.015	1.5	15.0
20.0	0.02	2.0	20.0
25.0	0.025	2.5	25.0
30.0	0.05	3.0	50.0
75.0	0.075	7.5	75.0
100.0	0.1	10.0	100.0
200.0	0.2	20.0	200.0
500.0	0.5	50.0	500.0
1000.0	1.0	100.0	1000.0

One liter of the sediment slurry should be measured into each of the beakers to be used in the test. Each sample must contain a representative portion of the whole sample. Mix the container holding the sediment slurry thoroughly before filling each beaker. Then place the beakers on the gang stirrer in a position that allows the paddles to rotate freely.

Jar Tests Procedure for Determining Optimum Polymer Dosage

1. Transfer 1 liter of 1% sediment slurry to six beakers.
2. Transfer the samples to the gang stirrer.
3. Add polymer solution to beakers and then set the gang stirrer on 100 RPM (rapid mix) for 2 minutes.

4. After the rapid mix period of 2 minutes, stop the gang stirrer and allow the samples to settle. Immediately begin to observe all characteristics of each sample and record on the jar test data form. Observations that are important include:

   - Rate at which coagulation occurs.
   - Particle size characteristics
   - Settling characteristics.
   - Turbidity of water above sludge.
   - Suspended solids in supernatant.
   - Volume of sludge after 30 minutes settling.
   - pH of supernatant.

5. After 30 minutes of settling a small portion of the clear water in the sample should be carefully withdrawn and analyzed for turbidity, total suspended solids and pH.

6. Determine the optimum dosage of polymer by correlating the polymer dosage versus settling rate and settled sludge volume.

7. Repeat steps 1 to 6 with other polymers and select the lowest dosage for each polymer tested.

The following equipment are needed for performing the gravity settling tests:

1. Jar Test apparatus (Phipps and Bird™ Six Gang Stirrer).
2. Commercially available liquid polymers (Betz, Nalco and Allied Colloids).
3. Stopwatch
4. One liter glass beakers

Table SOP-5
Jar Test Data Form

Date of Test: _____
Technician: _____
Alternative #: _____
Task #: _____

Jar No.	Chemical Dosage			Final Sediment Volume (ml)	Settling Time (min)	Comments
	Polymer A	Polymer B	Polymer C			
1						
2						
3						
4						
5						
6						

Parameter	Sediment Slurry	Polymer Name	Test Conditions
pH (units)		A.	Flash Mix RPM:
Supernatant Turbidity (NTU)		B.	Time:
Supernatant TSS (ppm)		C.	

NOTE: Settling time is the minimum time required to produce a settled sediment layer.

SOP 6
PREPARATION OF TWO COMPOSITE SAMPLES

SOP - 6
PREPARATION OF COMPOSITE SAMPLE

Alternative 3: Consolidation and Simple Dewatering

1. Use two 100-gallon containers for preparing composite samples.
2. Thoroughly mix the containers storing five individual sediment samples to resuspend all solids.
3. Transfer five gallons of sediment from each of 5 samples into 100-gallon containers. Start from Sample 1 to Sample 5.
4. Repeat Step 3 for second 100-gallon container.
5. Label the two 100-gallon composite samples as (3513-1, and 3513-2) for impoundment 3513 and (3524-1, and 3524-2) for Impoundment 3524.
6. Repeat Steps 1 through 5 for Impoundments 3513 and 3524.

   (See Figure A2 in Appendix A)

Alternative 4: Consolidation and Ex-Situ Treatment

1. Use two 150-gallon containers for preparing composite samples.
2. Thoroughly mix the containers storing five individual sediment samples to resuspend all solids.
3. Transfer five gallons of sediment from each of five samples into 150-gallon containers. Start from Sample 1 to Sample 5.
4. Repeat Step 3 for second 150-gallon container.
5. Label the two 150-gallon composite samples as (3513-1, and 3513-2) for impoundment 3513 and (3524-1, and 3524-2) for Impoundment 3524.
6. Repeat Steps 1 through 5 for Impoundments 3513 and 3524.

   (See Figure A3 in Appendix A)

SOP 7
PREPARATION OF COMP 1

SOP - 7
PREPARATION OF COMP 1 SAMPLE

Alternative 3: Consolidation and Simple Dewatering

1. Use two 200-gallon containers for preparing the composite sample. Label as COMP 1.
2. Thoroughly mix the four containers storing composite sediment samples from Impoundments 3513 and 3524.
3. Transfer three gallons of sediments from Impoundment 3513 and two gallons of sediments from Impoundment 3524 into one of the two 200-gallon containers.
4. Repeat Step 3 until both containers (COMP 1) are filled up.

(See Figure A2 in Appendix A)

Alternative 4: Consolidation and Ex-Situ Treatment

1. Use two 300-gallon containers for preparing the composite sample. Label as COMP 1.
2. Thoroughly mix the four containers storing composite sediment samples from Impoundments 3513 and 3524.
3. Transfer three gallons of sediments from Impoundment 3513 and two gallons of sediments from Impoundment 3524 into one of the two 200-gallon containers.
4. Repeat Step 3 until both containers (COMP 1) are filled up.

(See Figure A3 in Appendix A)

SOP 8
MOISTURE CONTENT

SOP-8
MOISTURE CONTENT

The specific test procedures for calculating moisture content is outlined below:

1. Use ASTM D 2216-92 to calculate water content as:

$$W = \left[\left(M_{cws} - M_{cds}\right) / \left(M_{cds} - M_c\right)\right] \times 100 = \frac{M_w}{M_s} \times 100$$

Where:

W	=	Water content, %
M_{cws}	=	Mass of container, and wet sample, g
M_{cds}	=	Mass of container, and oven dried sample, g
M_c	=	Mass of container, g
M_w	=	Mass of water ($M_w = M_{cws} - M_{cds}$), g, and
M_s	=	Mass of solid particles ($M_s = M_{cds} - M_c$), g.

$$\text{Moisture Content } (\%) = \left(\frac{W}{1 + W}\right) \times 100\ \%$$

Where:

W	=	Water content in decimals, (e.g. 40% = 0.40)

SOP 9
BUCHNER FUNNEL TEST PROCEDURE

SOP-9
BUCHNER FUNNEL TEST PROCEDURES

The following tests will be conducted to evaluate the dewatering characteristics of the drained sediment. Initially, Buchner-funnel test will be performed on site. The results from the Buchner-funnel test will be used in bench- and pilot-scale mechanical dewatering tests.

The stepwise experimental procedure for conducting the Buchner funnel test is provided below:

1. The initial solids content (TSS) of the sediment will be measured using SOP-4.
2. The Buchner funnel will be prepared using a screen and filter paper (see Figure B.1). The filter paper will be wetted with water and a vacuum will be applied to obtain a seal.
3. The valve will be closed and vacuum adjusted to 15 to 20 inches of mercury.
4. 200 mL of the sludge sample will be placed in a one liter beaker and the appropriate polymer will then be added.
5. Drained sediment (COMP 1), will be added to the Buchner funnel and sufficient time will be allowed for a cake to form (usually about 10 seconds).
6. The pinch-clamp will be released.
7. The filtrate volume will be recorded every 15 to 30 seconds until vacuum breaks or the rate of filtrate collection drops to about 1 mL per minute.
8. The above mentioned steps will be repeated using varying concentrations of the same polymer or using different polymers.
9. Specific resistance will be determined for each test and then the optimum polymer dosage will be defined based on the minimum specific resistance.

The following polymer dosages (based on 200 mL samples), will be evaluated; 0, 0.1, 0.2, 0.4, 0.8, 1.0, 1.5, and 2.0 for each polymer; where polymer dosage is expressed as percentage of sediment solids. These dosages correspond to a range of 0 to 40 lb of polymer per ton of dry solids. Three polymers from three different vendors (Betz, Nalco, and Allied Colloid) will be evaluated. The mass of neat polymer required is calculated as:

Mass of polymer = [(% Dosage) * Volume of Sediment * Density of Sediment]/100

Where: % Dosage = 0, 0.1, 0.2, 0.4, 0.8, 1.0, 1.5, and 2.0
Volume of sediment = 200 mL

The volume of neat polymer should be calculated using specific gravity information provided by each vendor.

The following equipment are required for performing the Buchner Funnel Tests:

1. 250 ml volumetric cylinder ground-glass with standard taper joint neck.
2. Glass adapter with side arm
3. Rubber stopper for volumetric cylinder with hole for Buchner Funnel
4. No. 2 Buchner Funnel
5. Whatman No. 42 paper
6. Wire screen support for filter paper
7. Pinch clamp
8. 1/4 hp vacuum pump with vacuum gauge, tubing and valves
9. Stop watch

Derivation of Equations Used With Buchner Funnel Tests

The basic filtration equation derived from Poiseilles and D'Arcy's law is:

$$dV / dt = \frac{PA^2}{\mu(rcV + R_m A)} \tag{1}$$

where:

V	=	volume of filtrate, cm^3
t	=	time, sec
P	=	applied vacuum, g/cm^2
A	=	filter area, cm^2
c	=	solids per unit volume of filtrate, g/cm^3
r	=	specified resistance, sec^2/g
R_m	=	initial resistance of the filter media, sec^2/g
μ	=	filtrate viscosity, poises, g/cm.sec

Integration and rearrangement of this equation permits the calculation of specific resistance, r, which is a measure of the filterability of the sludge and is numerically equal to the pressure difference required to produce a unit rate of filtrate flow of unit viscosity through a unit weight of cake. Integration of Equation 1 yields:

$$\frac{t}{V} = \left[\frac{\mu rc}{2PA^2} \cdot V + \frac{\mu R_m}{PA}\right] \tag{2}$$

An arithmetic plot of t/V versus V will generate a linear relationship with a slope equal to $\mu rc/2PA^2$ and an intercept of $\mu R_m/PA$. Thus, if the slope of the line is defined as "b," then:

$$b = \frac{\mu rc}{2PA^2} \tag{3}$$

The specific resistance is therefore:

$$r = \frac{2PA^2 b}{\mu c} \tag{4}$$

Specific resistance is primarily useful to compare the filtration characteristics of different sludges and to determine the optimum polymer requirements of a specific sludge. The Buchner funnel apparatus is used to generate the data needed to determine the t/V versus V relationship and, subsequently, specific resistance. The solids deposited per volume of filter, c, are determined by:

$$c = \frac{1}{\left[(100 - C_i)/C_i\right] - \left[(100 - C_f)/C_f\right]} \tag{5}$$

where:

C_i = initial solids content of influent sludge, %, or g/100mL

C_f = final solids content of cake sludge, % or g/100 mL

Table SOP-9
Buchner Funnel Test

Date of Test: _____

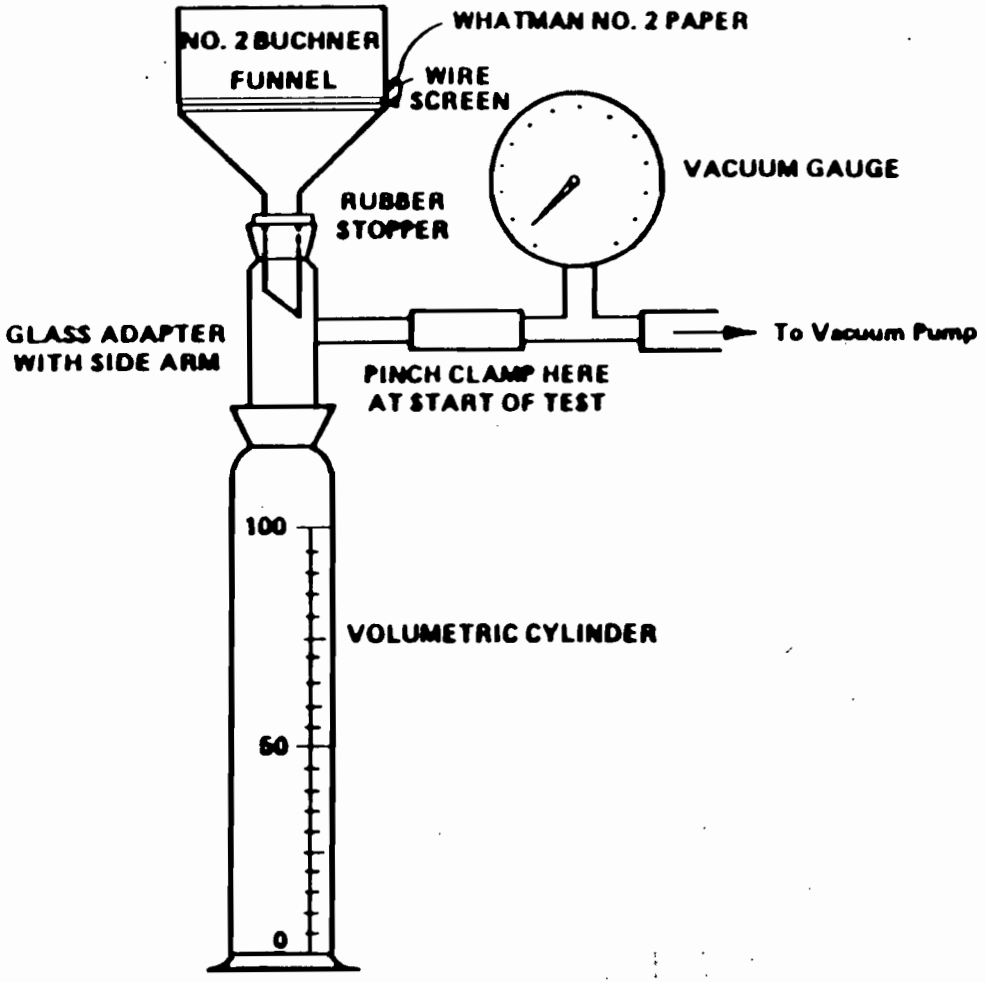
Technician: _____

Alternative #: _____

Task #: _____

Time (Sec)	Volume(V) (mL)	t/V (Sec/mL)

Figure B1
Schematic Representation of Buchner Funnel Test



SOP 13
BENCH-SCALE SOLIDIFICATION

SOP - 13
BENCH-SCALE SOLIDIFICATION

The solidification tests will involve blending of sediment and solidification reagents such as portland cement, cement kiln dust (or lime kiln dust), and fly ash in predetermined ratios under controlled moisture conditions. The tests will use thickened composite sediment sample (COMP 1 after further thickening). Any references to solidification reagents applies to all reagents that may be finally selected for actual testing. All activities listed in this SOP shall be conducted in accordance with the project Health and Safety Plan.

The solidification testing activities can be grouped into three phases. The initial phase will consist of essentially field screening testing to determine the reagents and mix ratios that are better suited to achieving the test objectives. The second of phase of the solidification testing will consist of laboratory tests for unconfined compressive strength to identify the most suited reagent and mix ratio to achieve the largest improvement in structural strength of the solidified sediment The final phase of the solidification testing will include chemical and geotechnical characterization of solidified sediments for the solidification reagent and mix ratio determined in Phase 2. The following is a step-by step procedure for performing the test.

Phase 1: Initial Screening Tests

1. Obtain thickened sediment sample for solidification testing. The estimated volume of the sample required is approximately 10 gallons.
2. Perform moisture content test (ASTM D 2216) for two separate samples drawn from the thickened sediment sample. The average (arithmetic mean) of the two moisture content will be recorded as the initial water content of the sediment sample.
3. For each solidification reagent, calculate the amount of reagent required to result in 10, 25, 40 and 50 percent mix on a dry weight basis. This is given by:

   Weight of reagent required, $K = [X-(X*W/100)] * (Y/100)$ grams, where,

   X = Wet weight of thickened sediment,

   W = Average moisture content expressed as percent value, and

   Y = Solidification mix ratio expressed as a percent value of dried sediment solids.
4. Weigh 'X' grams of thickened wet sediment sample and 'K' grams of dry solidification reagent, or a multiple thereof, into a mixing bowl.
5. Homogenize the mixture, and add water if necessary based on mix consistency and ease of mixing. Note down the amount of water added to the mixture.

6. Monitor the mixture during mixing for any organic emissions using an organic vapor analyzer (OVA), and record temperature and pH of mixture at the conclusion of mixing.

7. Transfer the homogenized mixture into clear-plastic, graduated, 8-ounce molds. Fill the molds approximately 3/4 full, and label the molds. Mark on the outside of the mold the level of solidification mixture in the mold using a marker pen. Seal the molds with a cap and allow it to cure away from direct sunlight.

8. Prepare two sets of two molds each (one duplicate) for each reagent type and mix ratio. One set of the samples will be tested for strength development after one and three days of curing. The strength tests will be performed using a pocket penetrometer. Other analyses to be performed on one- and three-day cured samples include moisture content and volume increase. The testing procedures are as described below and should be conducted in the order listed:

   8.1. Volume Change: Visually inspect the mold to see of the level of the solidification mass has changed from the mark made in Step 7 above. If a change has occurred, mark the new level and note down the difference in volume between the original marking (Step 7) and the new marking using the graduated volume scale on the mold cup. All volume increases will be noted as positive volume changes, and all volume decreases will be noted as negative changes.

   8.2. Pocket Penetrometer: Place the flat end of the shaft of a pocket penetrometer on the solidified sediment mass such that full contact occurs between the end of the shaft and the solidified mass surface. Ensure that the marker ring is set to zero. Hold the penetrometer truly vertical, and gradually push to apply load until the shaft has penetrated the solidified mass up to the groove on the shaft. Remove the penetrometer, and note down the pressure applied from the position of the marker ring. Repeat the penetrometer testing on the duplicate mold for the same mix ratio. The average of these two penetrometer readings should noted as the bearing strength of the solidified sediment for the given reagent and mix ratio.

   8.3. Moisture Content: Moisture content testing should be performed in accordance with SOP 8 presented in Appendix B. Moisture content testing for each solidification mixture will be set up in duplicate using the duplicate mold. The average of the two moisture content readings will be reported as the moisture content of the solidified sediment for the given reagent and mix ratio.

9. On the basis of the results obtained in Steps 1 through 8, determine two solidification reagents and mix ratios for further evaluation using unconfined compressive strength (UCS) in Phase 2 of the solidification testing.

Phase 2: Confirmation Tests

10. Obtain thickened sediment sample for Phase 2 solidification testing. The estimated volume of the required sample size is approximately 43 gallons.

11. Perform Steps 2 through 6, described under Phase 1, using the thickened sediment sample and solidification reagents at mix ratios determined for Phase 2 testing in Step 9.

12. Place the solidification mixture (Step 11) in 8-ounce plastic molds as described in Step 7. Also, fill a plastic mold measuring approximately 3 inches in diameter and 7 inches in height. This mold should be filled at least 6 inches for subsequent UCS testing. Label all molds, and seal the molds with a cap and allow it to cure away from direct sunlight.

13. Prepare two sets of two 8-ounce molds each (one duplicate) for each reagent type and mix ratio. Test one set of these samples for strength development (pocket penetrometer), moisture content, and volume increase (Step 8). Prepare two larger molds for each reagent type and mix ratio, which will be used in UCS testing after curing for 3 and 7 days.

14. Perform activities described in Step 8 (Phase 1) using the 8-ounce molds after a curing period of days 1, 3, 5 and 7.

15. In addition to step 13, after a curing period of 3 and 7 days, the larger molds will be tested for UCS. If the UCS testing is performed at an off-site laboratory, the molds must be transported to the laboratory in time so that the testing could be performed immediately after the completion of specified curing times.

16. On the basis of the results obtained in Steps 10 through 15, determine the solidification reagent and the mix ratio that would result in most suitable improvements in structural strength of sediments.

Phase 3: Characterization Tests

17. Obtain thickened sediment sample for Phase 3 solidification testing. The estimated volume of the required sample size is approximately 18 gallons.

18. Perform Steps 2 through 6, described under Phase 1, using the solidification reagent at the mix ratio determined from Phase 2 testing (Step 16).

19. Place the solidification mixture in plastic molds measuring approximately 3 inches in diameter and 7 inches in height. This mold should be filled at least 6 inches. Label all molds, and seal the molds with a cap and allow it to cure away from direct sunlight.

20. Prepare at least 10 molds. These molds will be tested for geotechnical and chemical characterization in accordance with the following criteria.

21. If the solidification reagent at the mix ratio selected for Phase 3 testing resulted in a solidified mass during Phase 2 that developed some compressive strength (>5 psi), then no Harvard Miniature Compaction Test (SOP 15) will be performed in Phase 3. Otherwise, perform Harvard Miniature Compaction Test using four molds after 3 days of curing.

22. If the solidification reagent at the mix ratio selected for Phase 3 testing resulted in a solidified mass during Phase 2 that developed significant compressive strength (>50 psi), then no One Dimensional Consolidation Test will be

performed in Phase 3. Otherwise, perform One Dimensional Consolidation Test (ASTM D 2435) using one mold after 3 days of curing.

23. If the solidification mix ratio selected for Phase 3 testing is different from those tested during Phase 2, perform UCS test on sample molds after three and seven day curing.

SOP 14
PUMP LOOP TEST

SOP - 14
PUMP LOOP TEST

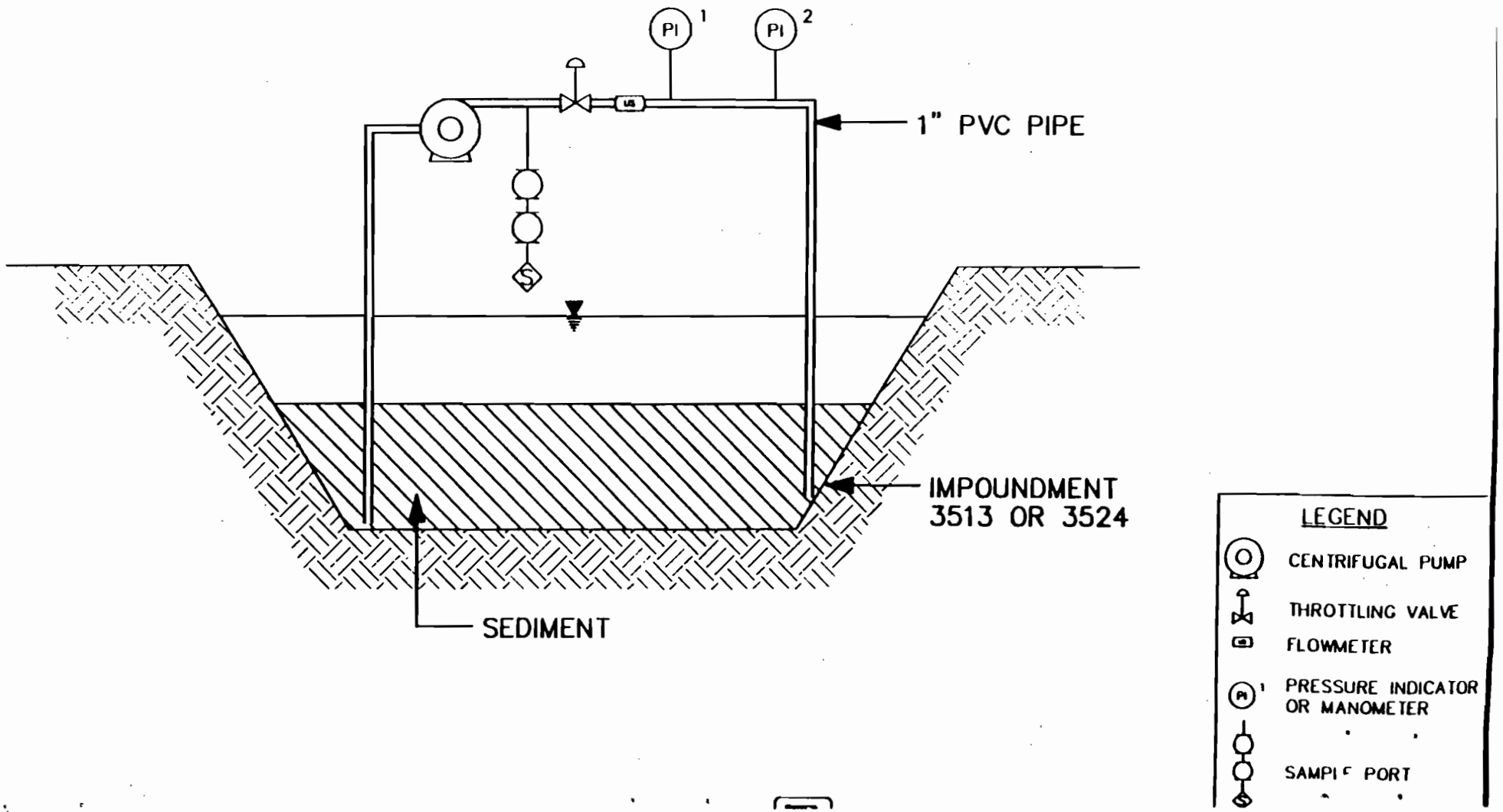
EQUIPMENT REQUIRED

1. Centrifugal Pump; (10 gpm maximum capacity)
2. 1" PVC pipe (100' to 150' long)
3. Pressure gauges or manometers (2)
4. Flowmeter
5. Throttling valve

PROCEDURE

1. Install pipe along side of impoundment. Use pipe support to anchor pipe.
2. Install two pressure gauges or manometers at points of pipe approximately 50 feet apart. Install sample tap on pipe before first pressure gauge. Install flow meter before first pressure gauge. Install throttling valve before first pressure gauge.
3. Position suction line at bottom of impoundment and turn pump on. Discharge line should return to the same impoundment.
4. Run pump until flow rate reading shows constant value (+/- 10 %)..
5. Record pressures at P_1 and P_2.
6. Increase headloss through throttling valve to change flow rate.
7. Repeat Steps 4 through 6 and record pressure readings.

FIGURE B-5
SCHEMATIC OF PUMP LOOP TEST



SOP 15
HARVARD MINIATURE COMPACTION TEST

ELE International

ELE International, Inc.
P.O. Box 8004, 86 Albrecht Drive
Lake Bluff, Illinois, USA 60044-800

Worldwide: (708) 295-9400
USA Toll Free: (800) 323-1242
Facsimile: (708) 295-9414
Telex: 687-1537 SOILT

Technical Data

MODEL **CN-435 Harvard Miniature Compactor Apparatus**

SOILTEST Products Division

Table of Contents

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Unpacking 1
Assembly 1
Operation 1, 2
Calculations 2
Moisture-Density Relationship 2
Accessories 2

CN-435 Harvard Miniature Compaction Apparatu

1. General

The test using the Harvard Miniature Compaction Apparatus determines the relationship between the moisture content of soils and resulting densities (oven-dry weight per cubic foot) when the soil is compacted in the laboratory with this apparatus. The Harvard Miniature Compaction apparatus more closely approximates the action of the sheepsfoot roller. Selection of the most appropriate number of layers, number of tamps per layer and tamping force depends on the type of material and the intended use to which the compacted material will be put. In general, at least five layers and ten tamps per layer are required to produce homogeneous test specimens.

2. Unpacking

In shipment, all of the parts are packed carefully to prevent damage. It is suggested that all packing material be carefully checked to ascertain that no parts are overlooked. The apparatus consists of the following:

CN-427	Specimen ejector, to facilitate removal of the soil sample from the mold.
CN-428	Mold Holder, a clamping device to hold the mold and collar in place during compaction, with solid base plate.
CN-428B	Compaction Mold and Collar, 1/454 cu. ft. capacity with detachable collar.
CN-429	Collar Remover, a device for holding the compacted soil in place while the extension collar is being removed.
CN-430	Compaction Tamper, provided with springs which can be preset for both 20 and 40 pound loadings.

3. Assembly

Very little assembly is required since the collar remover and specimen ejector are shipped completely assembled.

To assemble the mold, place the collar in place on top of the mold. Place the solid base plate in the recess at the base of the mold holder. Turn the two lock clamps on the mold holder to the open position and place the mold into the slight recess in the mold holder. Turn the lock clamps on two pins on the mold collar. Fit into position on the uprights of the mold holder. Then tighten the knurled set screws in position to hold the mold collar in place.

The CN-430 Tamper is supplied with the 20 pound compaction spring assembled in place. To change the springs, remove the two locknuts on top of the tamper and unscrew the cap. The spring is now free for removal.

4. Operation

4.1 Sample Preparation

Air dry to a slightly damp condition a 2 to 3 lb. sample c soil taken from a portion of the material passing the no. (4.75mm) sieve. Mix thoroughly to break up lumps and sure a homogeneous mixture. Then divide into six to eig portions, such that each portion contains slightly more than enough material for one test. To each portion add approximately the required amount of water to obtain th desired range of moisture contents. After thorough mixing, place each portion in a small glass jar with tight-. ting cover and store overnight or until ready for testing.

For soils that mix readily with water and have low dry strength, it is satisfactory to add water and mix the specimen immediately prior to testing. It is important th a compacted specimen not be remixed and used over again.

4.2 Test Procedures

4.2.1 With the mold and collar clamped to the base, place the desired amount of loose soil in the mold. five layers, two slightly heaping teaspoonsful will b required for each layer. Level the surface by press lightly with a wood plunger.

4.2.2 Insert the tamper in the mold until it is in contact with the surface of the soil, and press down firmly t one feels that the spring is starting to compress. Re the force and shift the tamp to a new position. Eac the first four tamps should be applied in separate quadrants and adjacent to the mold. The fifth tamp should be in the center, making one complete cover This cycle is then repeated until the desired numbe tamps has been applied. The tamps should be app the approximate rate of 10 tamps per 15 sec.

4.2.3 Add the next layer and repeat the procedure until the required number of compacted layers has been placed. The top layer should extend at least 1/2 in. the extension collar.

4.2.4 Transfer the mold assembly to the collar remover and release the clamps. Then press down firmly on piston and at the same time pull up on the handle. p the collar loose from the compacted oil.

4.2.5 Remove the mold from the base and carefully trim away the excess soil from the top of the mold and fr the bottom, if any.

4.2.6 Weigh the mold containing the compacted soil to the nearest 0.1 g. It is convenient to use a tare weight equal to the weight of the empty mold, as then the resulting net weight in grams is numerically equal to the wet unit weight of the compacted soil, in pounds per cubic foot.

4.2.7 Remove the specimen from the mold with the sample ejector and place in a suitable container for drying and determination of moisture content. If the specimen is used for compression test, it is either dried after the test or the moisture content may be determined from the excess material removed from the collar.

4.2.8 Compact additional specimens until points have been established on both sides of the optimum moisture content.

5. Calculations

Calculate the moisture content and the dry unit weight of the soil as compacted for each trial, as follows:

$w = (A - B)/(B - C) \times 100$ and $W = W1 \times 100/(w + 100)$

where:

w = percentage of moisture in the specimen

A = weight of container and wet soil

B = weight of container and dried soil

C = weight of container

W = dry unit weight, in pounds per cubic foot (kilograms per cubic meter) of compacted soil, and

W 1 = wet unit weight, in pounds per cubic foot (kilograms per cubic meter) of compacted soil.

6. Moisture Density Relationship

6.1 The calculations in Section 5 shall be made to determine the moisture content and corresponding oven-dry weight (density) for each of the compacted soil samples. The oven-dry unit weights (densities) of the soil shall be plotted as ordinates and corresponding moisture contents as abscissas.

6.2 Optimum Moisture Content - When the densities and corresponding moisture contents for the soil have been determined and plotted as indicated above, it will be found that by connecting the plotted points with a smooth line, a curve is produced. The moisture content corresponding to the peak of the curve shall be termed the " optimum moisture content" of the soil under the above compaction.

6.3 Maximum Density - The oven-dry weight of the soil at "optimum moisture content" shall be termed "maximum density" under the above compaction.

7. Accessories

L-415	Balance, 2610 gram capacity, 0.1 gram sensitivity
L-5B	Oven 17 x 11-1/2 x 16" inside dimensions, 115 v 50/60 cycle, AC
MC-320A	Speedy Moisture Tester

ASTM
STANDARD METHODS
ASTM D 422

Particle Size Analysis: ASTM D 422-63

Moisture Content: ASTM D 2216-92

Bulk Density: ASTM D 2937-83

Specific Gravity: ASTM D 854-92

One Dimensional Consolidation Test: ASTM D 2435

Unconfined Compressive Strength: ASTM D 2166-91

EPA TEST METHODS
EPA METHOD 9095: PAINT FILTER TEST

PAINT FILTER LIQUIDS TEST

1.0 SCOPE AND APPLICATION

1.1 This method is used to determine the presence of free liquids in a representative sample of waste.

1.2 The method is used to determine compliance with 40 CFR 264.314 and 265.314.

2.0 SUMMARY OF METHOD

2.1 A predetermined amount of material is placed in a paint filter. If any portion of the material passes through and drops from the filter within the 5-min test period, the material is deemed to contain free liquids.

3.0 INTERFERENCES

3.1 Filter media were observed to separate from the filter cone on exposure to alkaline materials. This development causes no problem if the sample is not disturbed.

4.0 APPARATUS AND MATERIALS

4.1 Conical paint filter: Mesh number 60 (fine meshed size). Available at local paint stores such as Sherwin-Williams and Glidden for an approximate cost of $0.07 each.

4.2 Glass funnel: If the paint filter, with the waste, cannot sustain its weight on the ring stand, then a fluted glass funnel or glass funnel with a mouth large enough to allow at least 1 in. of the filter mesh to protrude should be used to support the filter. The funnel is to be fluted or have a large open mouth in order to support the paint filter yet not interfere with the movement, to the graduated cylinder, of the liquid that passes through the filter mesh.

4.3 Ring stand and ring, or tripod.

4.4 Graduated cylinder or beaker: 100-mL.

5.0 REAGENTS

5.1 None.

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 All samples must be collected according to the directions in Chapter Nine of this manual.

6.2 A 100-mL or 100-g representative sample is required for the test. If it is not possible to obtain a sample of 100 mL or 100 g that is sufficiently representative of the waste, the analyst may use larger size samples in multiples of 100 mL or 100 g, i.e., 200, 300, 400 mL or g. However, when larger samples are used, analysts shall divide the sample into 100-mL or 100-g portions and test each portion separately. If any portion contains free liquids, the entire sample is considered to have free liquids.

7.0 PROCEDURE

7.1 Assemble test apparatus as shown in Figure 1.

7.2 Place sample in the filter. A funnel may be used to provide support for the paint filter.

7.3 Allow sample to drain for 5 min into the graduated cylinder.

7.4 If any portion of the test material collects in the graduated cylinder in the 5-min period, then the material is deemed to contain free liquids for purposes of 40 CFR 264.314 and 265.314.

8.0 QUALITY CONTROL

8.1 Duplicate samples should be analyzed on a routine basis.

9.0 METHOD PERFORMANCE

9.1 No data provided.

10.0 REFERENCES

10.1 None required.

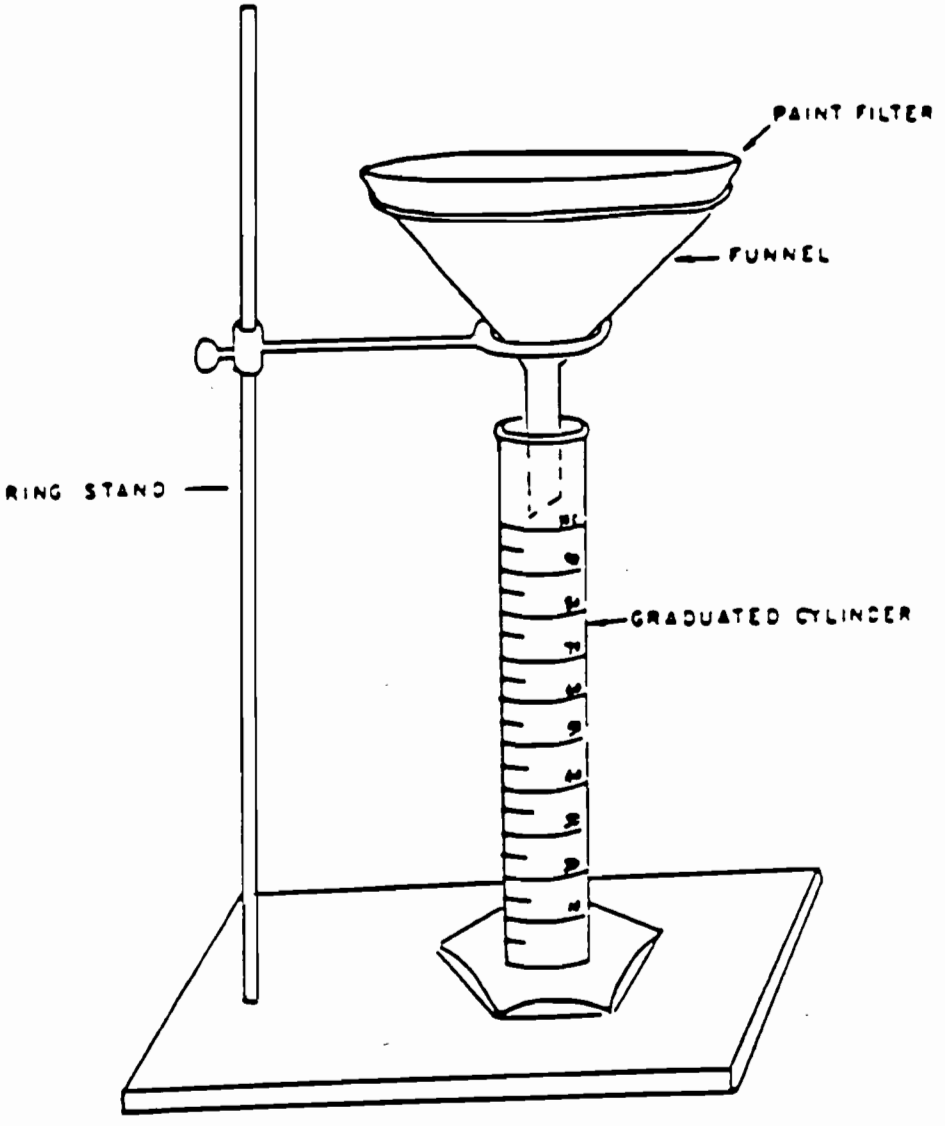
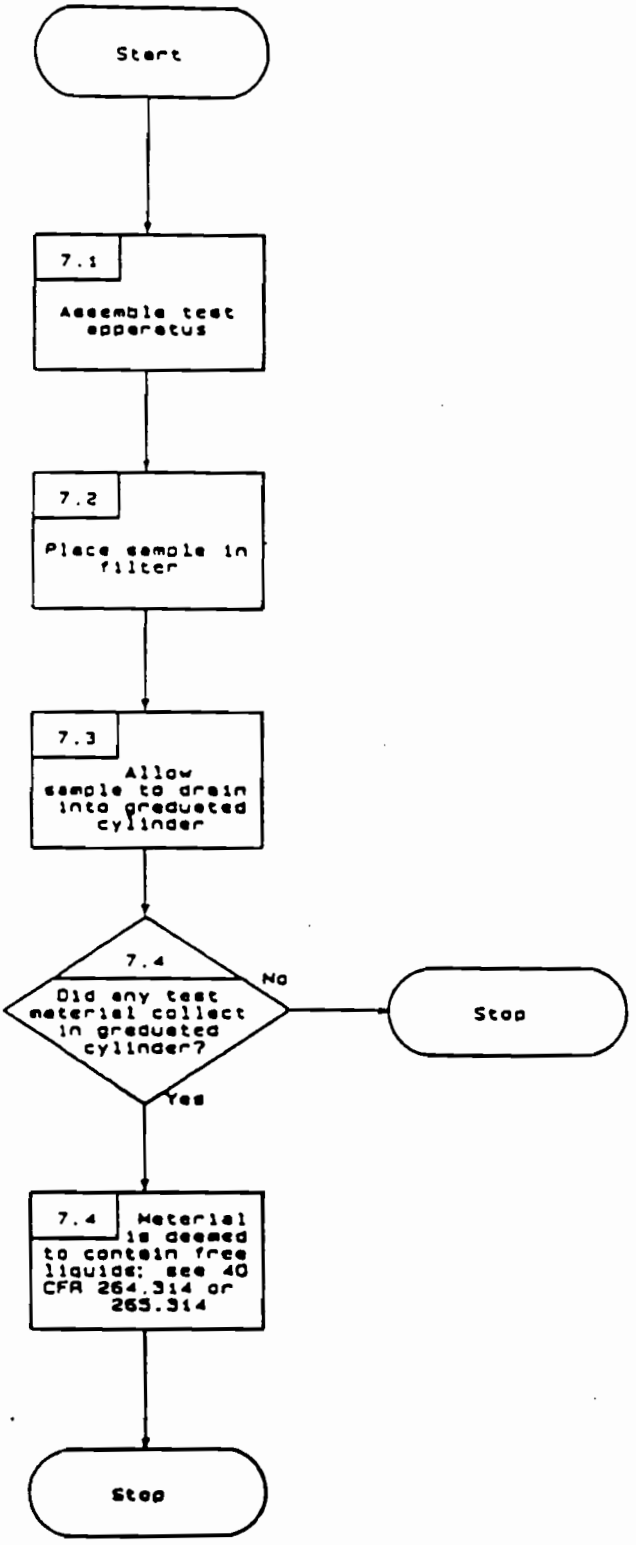


Figure 1. Paint filter test apparatus.


Start
7.1
Assemble test apparatus
7.2
Place sample in filter
7.3
Allow sample to drain into graduated cylinder
7.4
Did any test material collect in graduated cylinder?
No
Stop
Yes
7.4
Material is deemed to contain free liquids; see 40 CFR 264.314 or 265.314
Stop

Appendix C

HEALTH AND SAFETY ISSUES FOR IMPLEMENTING ENGINEERING SUPPORT STUDIES

APPENDIX C
HEALTH AND SAFETY ISSUES FOR IMPLEMENTING ENGINEERING SUPPORT STUDIES

Health and Safety Requirements

- Water safety and Rescue Procedures
- Heat/Cold Stress
- Radiation Protection Requirements
  - Airborne Contamination Monitoring
  - Ingestion Monitoring
  - Denmal Contact
- Comply with ORNL Safety Requirements for Standard Industrial Hazards
  - Electrical, Ladders, Safety Glasses, etc.
- Eye Wash Station and Decontamination Station in the Field
- Spill containment
- Waste Handling and Disposal
- Telephone Access
- Temporary Power Safety Requirements and Code Compliance
- Readiness Review Requirements
- No Smoking, Eating, Drinking
- Training Requirements
  - HAZWOPER, OSHA, HAZCOM, RAD Worker

Emergency Response

- Martin Marietta Interface Definition for Emergency Response
- Notification Requirements

Operational Requirements

- Temporary Power
- Trailer Set-up and Stabilization
- Air Sampling at the Pond to Establish the Background
- Reference to Site Monitoring Program for Air Monitoring
- Access to Clean Water and a Phone System

1.0 INTRODUCTION

The introduction section will contain an introductory statement which will discuss the Health and Safety Plan (HASP) applicability to the project, the purpose and regulatory basis, the site history, and the Scope of Work.

1.1 Purpose and Regulatory Basis

This section will identify the purpose of the HASP and the regulation (federal, state and site specific) that the HASP addresses.

1.2 Background

The site history will be summarized in this section along with some construction features of the facility.

1.3 Scope of Work

An overview of the scope of work for the project will be presented in this section.

2.0 ORGANIZATIONAL RESPONSIBILITIES AND STRUCTURE

This section will include project subcontractors responsibilities and their coordination. The key personnel organization will also be presented as will SRS emergency, and other key telephone numbers.

2.1 Coordination and Responsibilities

This section will present the title and responsibilities of key personnel in the safety plan. The chain of command will also be established among key personnel.

2.2 Personnel Organization Structure

This section will identify and provide phone number and job title of personnel engaged in the organization.

2.3 SRS Emergency Telephone Numbers

This section will identify SRS personnel (and title) to contact in the event of an emergency.

2.4 Additional Telephone Numbers

This section will provide other useful phone numbers at the site such as information, weather, etc.

3.0 REMEDIATION SITE CHARACTERIZATION

This section will identify the various hazards (such as radiological, chemical, biological, etc.) that are present in the project area. The exposure routes for each hazard will be identified as will any other potential job site hazards.

3.1 Radiological Hazards

This section will identify any radiological hazard areas at the facility and the status of the areas.

3.2 Chemical Hazards

This section will identify any chemical hazard areas at the facility and the status of the areas.

3.3 Exposure Routes

This section will present a summary of the exposure assessment for each hazard, including media, hazard, pathway, and potential.

3.4 Physical Stresses

This section will present stress hazards, such as noise, heat, cold, etc., that are present at the jobsite. The managing group, and/or regulations that define action to take to minimize risks of stress are identified.

4.0 HEALTH AND SAFETY TRAINING

This section will identify worker, and visitor, required training and applicable documentation to ensure proper training has been given.

4.1 General Training

This section will identify general site training requirements for all employees working on activities identified in the scope of work.

4.2 Activity Specific Task Training

This section will provide the specific training requirements for each employee performing tasks on activities that fall under regulatory (or other) requirements for specialized training such as asbestos abatements, lead abatements, etc.

4.3 Training Documentation

This section will identify the training qualification and certification records required for activities as well as document verification responsibility.

4.4 Visitor Training

This section will provide a definition of visitor training responsibilities and regulations that involve visitors.

5.0 REMEDIATION ENGINEERING CONTROLS

5.1 Initial Site Entry PPE

This section will identify the required personal protective equipment for all activities except that which is required by specific activity tasks.

5.2 Activity Specific Task PPE and Engineering Controls

Controlling procedures and the activity impacted by the procedures will be identified as will the PPE requirements associated with a particular activity.

5.3 Activity Specific Task PPE Special Instruction

Special Instructions pertaining to the use of PPE for project activity tasks will be provided.

6.0 MEDICAL SURVEILLANCE

Various medical surveillance programs applicable to this project will be identified in this section.

6.1 SRS Medical Surveillance Program

This section will include general and activity specific task medical surveillance requirements and compliance determination.

7.0 REMEDIATION AIR MONITORING

This section will present guidelines and procedures governing surveys of the jobsite (facility). A discussion of the methods to be used for activity specific task air monitoring will be included.

8.0 REMEDIATION SITE CONTROLS

Site control will be introduced in this section as will the zoning of the site, such as exclusion zone, contamination reduction zone, etc. Communication and teamwork inside each zone will be discussed as well.

9.0 SUPPORTING DOCUMENTATION

This section will provide discussions on various permits required to perform D & D activities as well as regulatory information and enforcement responsibilities of permits.

10.0 DECONTAMINATION

This section will include a discussion of the procedures for decontamination of personnel and equipment.

11.0 EMERGENCY RESPONSE PLAN

The site emergency plan, and other emergency plans, such as spill prevention measures, clean-up, and reporting will be discussed in this section. Reference to sponsoring regulation and responsibility to enforce plan will also be provided.

12.0 CONFINED SPACE ENTRY

No confined spaces have been identified within the confines of this project. Therefore, a discussion of confined space entry requirements is not applicable.

13.0 RECORD KEEPING

This section will provide worker's responsibilities for maintaining logbooks, Section 9 documentation and any other documents introduced in this HASP. Record copies and designated recipients of copies will be identified insofar as such information is made available.

14.0 APPROVAL AND COMPLIANCE STATEMENT

This section will establish the provisions, amendment process, and acknowledgement criteria of this HASP.

14.1 Provisions

This section will provide HASP purpose and establish application to this project. Responsibilities of worker's to conform to the HASP will be indicated as well.

14.2 Amendments to Plan

This section will provide the method for correctly making amendments to the HASP and reference made to the process for making changes to the HASP.

14.3 HASP Acknowledgement

This section will provide a copy of the acknowledgement form used to document all worker's compliance to HASP guidelines.

Appendices

As appropriate.

Suggested Readings and Reference Materials

Safety and Health References

1. Occupational Safety and Health Act (OSH Act), 1970.

2. Executive Order 21296, Occupational Safety and Health Programs for Federal Employees

3. DOE Order 5480.4, Environmental Protection, Safety, and Health Protection Standards

4. 29 CFR 1910.120(e)(3)(i), OSHA training requirements.

5. 29 CFR 1910.96(i)(2), Radiological worker requirements.

6. OSHA 1910.134, Respirator requirements.

7. 29 CFR 1926.1101(k)(8), Asbestos worker requirements/training.

8. LITCO, Radiological Control Manual.

9. U.S. Department of Energy, Decommissioning Handbook. March 1994.

10. LITCO, D&D Project Manager's Handbook, Revision 1, November 1994.

Suggested Readings

1. Arbuckle, J., Environmental Law Handbook, Twelfth Edition, Government Institutes, Rockville, MD, 1993.

2. Wentz, C., Hazardous Waste Management, McGraw-Hill, Inc., 1989.

3. Freeman, H., Standard Handbook of Hazardous Waste Treatment and Disposal, McGraw-Hill, Inc., 1989.

Health and Safety

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Lockheed Idaho Technologies Company
Idaho Falls, ID 83415-2414
208/526-9711 Fax: 208/526-2714

29.a

Notes

Learning Objectives

- Safety and Regulatory Requirements
- Training
- Safety Values and Total Safety Culture
- Worker Protection
- Radiological Controls
- Safety Documentation
- Environmental Protection

29.b

Notes

Statutory and Regulatory Requirements

OSHA EMPLOYEE RIGHTS

- Work Under Safe and Healthful Conditions, Free of Recognized Hazards
- Have Basic and Specific Health and Safety Training
- Wear and Use Personal Protective Clothing and Equipment
- Report Hazardous Working Conditions Without Penalty

30.a

Notes

Employee Responsibility

- Comply with OSHA Health and Safety Standards and Regulations
- Be able to Perform Assigned Work Duties
- Use Personal Protective Clothing and Equipment Provided
- Observe all Rules, Signs, and Instructions Relating to Personal Safety
- Have a Baseline Medical Examination that Includes Confirmation of Fitness for Duty
- Report Unsafe and Unhealthful Working Conditions
- Report Accidents, Injuries, and Property Damage

30.b

Notes

DOE Order 5480.4

- Emergency Preparedness
- Environmental Protection
- Fire Protection
- Health Protection
- Occupational Safety
- Nuclear Safety
- Transportation Safety

31.a

Notes

Safety Values and Total Safety Culture

Worker Protection

31.b

Notes

31

Health and Safety Elements

- Hoisting and Rigging
- Material Handling
- Process Safety
- Flame Cutting
- Compressed Gases
- Structural Effects During Decommissioning

(continued)

32.a

Notes

Health and Safety Elements

(continued)

- Thermal Stress on Workers
- Noise and Vibration
- Heavy Equipment Operation
- Potential Material Toxicity
- Hazard Communication
- Hazard Control Methods

32.b

Notes

Safety Improvements

- Lockout/Tagout Practices
- Ground Fault Circuit Interrupter (GFCI) Use
- Provide Ventilation
- Fix Contamination
- Decontamination Procedures
- Provide Shielding, Lighting, Signs and Barricades, Shoring
- Ensure Proper Housekeeping
- Rigging and Certification
- Use of Heavy Equipment to Minimize Employee's Exposure to Hazards

33.a

Notes

Common Forms of Personal Protective Equipment (PPE)

- Respiratory/Inhalation
- Absorption/Irritation Protection
- Trauma
- Heat and Cold

33.b

Notes

Radiation Control (RadCon) Manual

Safety Documentation

34.a

Notes

Health and Safety Plan Elements

- Provision for Qualified Safety and Health Professionals and Technicians
- Availability of Medical Services and First Aid
- Medical Surveillance
- Arrangements for Off-Site Emergency Response
- Training Requirements
- Pre-Job Briefing

(continued)

34.b

Notes

Health and Safety Plan Elements

(continued)

- Safety Review of Work Plans and Procedures
- Personnel Exposure Monitoring
- Work Area Assessment and Monitoring Inspections
- Accident and Injury Reporting
- Reviews of Safety Performance

35.a

Notes

Conclusion

Health and Safety is DOE's #1 Priority

- Implementation of Health and Safety Requirements
- Comply with DOE Orders
- Promote Training
- Provide Proper Worker Protection
- Proper Worker Respect and Attitude of Safety Programs

35.b

Notes

HAZWOPER WORK PLAN SITE HEALTH AND SAFETY PLAN (1994 SAMPLING)

HAZWOPER WORK PLAN
SITE "EALTH AND SAFETY PLAN
FOR

WAG 1, Impoundment Sampling, Inpoundments: 3513, 3524, 3539, & 3540

Prepared by: This plan is prepared by members from the Oak Ridge National Laboratory (ORNL) Measurement Applications and Development Group of the Health Science Research Division for the ORNL Environmental Restoration Program. The Oak Ridge National Laboratory is currently managed by Martin Marietta Energy Systems for the Department of Energy.

Purpose: The objectives of this sampling project is:

1) to collect data for risk assessment purposes to determine the risk (if any) associated with suspected chemicals, metals and organics to remediate the impoundments.

2) to determine through sampling, if there is a risk of radionuclides being transported through the groundwater.

3) to use this additional data, to make recommendations for future remediations activities.

Reviewed/Approved by:

Office of Radiation Protection
Representative: _____

Industrial Hygiene Section
Representative: _____

Industrial Safety Representative: _____

HAZWOPER Program Coordinator: _____

Laboratory Protection Representative: _____

Facility Manager: _____

Site Safety and Health Officer: _____

Environmental Restoration Program _____
ES and H Manager (only applicable for ER project)

DOE Representative: _____

This plan will be kept at the project site. The anticipated duration of the project is 2 weeks. (circle one).

HAZWOPER Work Plan
Site Health and Safety Plan for
WAG 1 Impoundment Sampling

INTRODUCTION

This Work Plan/Site Health and Safety Plan (HASP) are for the performance of the WAG 1 impoundment sampling effort. The work will be conducted by the Oak Ridge National Laboratory (ORNL) by the Measurement Applications and Development Group, Plant and Equipment and associated ORNL environmental, safety, and health support groups. This activity will fall under the scope of 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response (HAZWOPER). The purpose of this document is to establish site specific health and safety guidelines to be followed by all personnel involved in conducting work for this project. Work will be conducted in accordance with requirements as stipulated in the ORNL HAZWOPER Program Manual, and applicable ORNL, MMES, and DOE policies and procedures. This site specific Health and Safety Plan (HASP) serves as an extension of the ORNL HAZWOPER Program Manual and combined they fulfill the requirements of 29 CFR 1910.120.

The levels of protection and the procedures specified in this plan are based on the best information available from historical data and preliminary evaluations of the area. Therefore, these recommendations represent the minimum health and safety requirements to be observed by all personnel engaged in this project. Unforeseeable site conditions, changes in scope of work, or hazardous conditions not previously considered will warrant a reassessment of protection levels and controls stated. Minor changes, such as downgrade of personal protective equipment or change in the model of a site instrument may be justified and documented in the site log book by the Site Safety and Health Officer. Significant changes will require revision of the Health and Safety Plan and must have approval by the appropriate safety and health discipline and the HAZWOPER Program Coordinator prior to restart of site operations.

1.0 PROJECT AND SITE DESCRIPTION

Project description

Note: In this section list objectives of the project/ tasks to be performed (ex. drilling, sampling, etc)--also any equipment to be used (drill rigs, etc.)

Sediment sampling from the bottom of each impoundment pond will be completed to meet the objectives of the project. These samples will be collected from either a pontoon boat, with extension poles (ponds 3524 and 3513) or a suspension bridge will be placed over for the smaller ponds; 3539,3540. A sampling device, like a 5' split spoon, or alternate sampling device will be physically driven or forced into the sediment and into the clay bottom, just

enough to form a seal, and the contents extracted. The sample will be removed and surveyed for beta/gamma radioactive contamination. If radiation levels permit, the entire sample will be containerized and shipped to an analytical laboratory for analysis. If radiation levels are in excess of those permitted by the analytical laboratory, either an aliquot of the sample will be retained for analysis or an alternate sample location will be selected. Excess sample will be discarded back into the pond.

Site Description

The WAG 1 impoundment ponds are located South of White Oak Avenue within the Oak Ridge National Laboratory proper. The terrain is relatively flat, with a slight drop toward the South. The purpose of this activity is to collect data to provide information for Risk Assessment. There are overhead communication lines around the perimeter of the pond area, to the North, South and West ends of the larger ponds. A cleared access area (from overhead lines) for any lifting or placements of watercraft is toward the East sides of the ponds and would not involve any interference with these lines. A large tree is between pond 3513 and 3539 and 3540, but should not interfere with the operation. The closest buildings to the 4 ponds are buildings 3517 to the North and building 3544 to the West. There are 4 ponds that make up this area. Three radiological contaminants are of concern, they are; cesium, strontium and plutonium.. From past sampling data, the ranges are; for cesium >44.6 uCi- <89.3 uCi, strontium, , >4.5 uCi- <13.4 uCi and for plutonium, >10 uCi/kg- <10 uCi/kg. The first, and closest to White Oak Ave. is pond 3524. It is the second largest of the 4 ponds with a total holding capacity of 1,000,000 gallons. This pond was constructed in 1945 and received high activity radiological process waste water and functioned as a back-up receptacle for the gunite tanks W-5 and W-6. An earthen dike separates pond 3524 from pond 3513, which lies to the South of pond 3524. Pond 3513 is the largest of the ponds and has a holding capacity of 1,880,000 gallons. This pond received process waste water of lower activity than pond 3524, and also received supernatant from the gunite tanks. 3513 also received water from 3524 when the depth of that pond was reaching capacity, water was pumped from 3524 into 3513. Ponds 3539 and 3940 are located to the East of 3513 and were constructed in 1964. Both ponds have a holding capacity of 150,000 gallons each. The estimated depths of ponds 3524 and 3513 are approximately 3 feet. Both ponds received process waste from the 4500 building complex. As one pond filled the other pond was being emptied into the process waste system.

Note: in this section provide a description of the site/area. Also any historical data you may have or any reference documents with site characterization/historical data.

2.0 SITE ORGANIZATION AND COORDINATION

The work will be performed by Plant and Equipment Division of ORNL. ORNL Industrial Hygiene, Industrial Safety, and Radiation Protection will provide appropriate health and safety services including monitoring and oversight.

The following section details the organizational structure for this project. Key personnel and their project responsibilities are listed. **A qualified representative from the MAD group** will serve as the Site Safety and Health Officer (SSHO) (Glen Cofer). **An qualified representative from the MAD group will also serve as** is the alternate SSHO (Dennis Rice).

2.1 Site Safety and Health Officer

Primary on-site contact for safety and health during field activities. Oversees the on-site execution of all field activities regarding safety and health procedures. Has the authority to stop all work if conditions are judged to be hazardous to on-site personnel or to the public. The SSHO will remain at the project site at all times while workers are performing site activities. Other specific responsibilities are as follows:

1. Ensures that all on-site project personnel meet the required level of training, medical requirements including respirator fit test (as required), attend a pre-entry briefing on project and potential site hazards, and review the Work Plan and HASP. Maintains copies of documentation of the above at the project site and ensures documentation is available for on-site review. Note: the OSHA Special Access Training Badge may be used as verification of training.

2. Require personnel to obtain immediate medical attention in the case of a work-related injury or illness.

3. Deny access to all or any portion of the work area as warranted.

4. Order work to cease, evacuation of the work area by all personnel, and reestablish safe working conditions, as needed.

5. Control access to the site by visitors and unauthorized personnel. Advise visitors and unauthorized personnel of their responsibilities, and ensure they meet access requirements, before entry into the Contamination Reduction Zone or Exclusion Zone is allowed.

6. Ensure the correct field execution of the Work Plan and HASP.

7. Ensure this Work Plan and HASP are revised and approved if there are changes in site conditions or tasks.

8. Advise emergency response personnel in an emergency.

9. Coordinate with Industrial Hygiene (IH), Industrial Safety (IS), and Radiation Protection (RP) to establish site work zones, and contribute for establishment of the level of required personnel protection, monitoring, and other controls.

10. Coordinate and minimize the number of personnel and amount of equipment in the work zones.

11. Coordinate accident prevention by oversight of field activities and being aware of all site operations.

12. Ensure that needed work permits are obtained and made available on site.

13. Ensure that HAZWOPER Program Coordinator (HPC), IH, IS, and RP are contacted prior to commencement of site work to 1) notify of intent to begin work, and 2) schedule monitoring support, as needed.

14. Conduct daily inspection of the work site.

15. Provide the HPC a list of personnel participating in site activities for inclusion in the hazardous waste worker medical surveillance program.

16. Ensures that appropriate fall protection measures are in place, as warranted.

17. Ensures that an approved hoisting and rigging plan is available, as warranted.

18. Ensure that appropriate measure have been taken to prevent spills.

2.2 Field Personnel

1. Taking all reasonable precautions to prevent injury to themselves and to their fellow employees; being alert to potentially harmful situations.

2. Performing only those tasks that they believe they can do safely and immediately reporting any accidents and/or unsafe conditions to the SSHO.

3. Notifying the SSHO of any special medical conditions (i.e., allergies, diabetes, etc.).

4. Preventing spillage to the extent possible. In the event spillage occurs, contain the spillage, notify the SSHO, and clean up immediately using safe clean up measures as directed by the SSHO. Note: Do not engage in spill containment or clean-up if conditions are not safe and if the clean-up cannot be accomplished with supplies available at the site. Evacuate the area. All spills must be reported to the ORNL Environmental Interface (4-8770).

5. Avoid splashing materials to the extent possible.

6. Practice good housekeeping by keeping the work area neat, clean, and orderly to the extent possible.

7. Reporting all injuries, no matter how minor.

8. Comply with the work plan and HASP, as well as posting and rules at the project site.

2.3 Radiation Protection

ORNL Radiation Protection will be responsible for oversight and approval of personnel protection requirements related to radiation protection. A representative from the Office of Radiation Protection will review and approve the Work Plan and HASP prior to commencement of field activities. ORNL Radiation Protection will be consulted prior to entry into any posted Radiological Area and will instruct field participants on requirements for that area, including the need for a Radiation Work Permit, appropriate monitoring, dosimetry, and personal protective equipment. The Radiation Protection representative will be contacted for all radiological concerns at the site.

2.4 Industrial Hygiene

The ORNL Industrial Hygiene Section and the HPC will be responsible for the oversight and approval of personnel protection related to industrial hygiene and the requirements of 29 CFR 1910.120 (HAZWOPER). The IH Divisional Representative and the HPC will review and approve the Work Plan and HASP prior to commencement of field activities. The Industrial Hygiene representative and the HPC will provide guidance regarding personal protective equipment, and industrial hygiene monitoring and sampling requirements. The Industrial Hygiene section will provide and IH technician as warranted to provide site monitoring/sampling. The IH section will be contacted for all IH and HAZWOPER concerns at the site.

2.5 Industrial Safety

The ORNL Industrial Safety Section will be responsible for oversight and approval of personnel protection related to safety. A representative from Industrial Safety will review and approve the Work Plan and HASP prior to commencement of field activities. Industrial Safety will provide guidance regarding potential safety hazards, personal protective equipment and safety requirements. The Industrial Safety Section representative will be contacted for all safety concerns at the site.

A complete organizational structure and description of responsibilities may be found in Section 3 of the ORNL HAZWOPER Program Manual.

3.0 PROJECT HAZARD EVALUATION

Place an X in each ☐ to indicate existing conditions or those that may be a result of site operations.

Note: if there are several tasks, duplicate and complete this page for each task.

Task: **Pond sediment sampling**

3.1 Physical Hazards

X	Heat Stress(potential)	☐	Cold Stress	X	Noise
☐	Confined Space	☐	Enclosed Space	X	Manual Lifting
X	Tripping/Falling	X	Ergonomic	☐	High Pressure
☐	Oxygen Deficient	☐	Explosive/Flammable	X	Vibration

3.2 Safety/Construction Hazards

☐	Trenching	☐	Excavating	X	Heavy Equipment Op.
☐	Demolition	☐	Elevated Work	☐	Welding/Cutting
X	Hoisting/rigging	☐	Underground hazards	X	Overhead hazards

3.3 Chemical Hazards

X	Volatile Organic	☐	Inorganics		Carcinogen
☐	Corrosive	☐	Reproductive toxicant	X	Metals
☐	Mutagen	☐	Asbestos		
☐	OSHA Specific				

EPA requests that VOA and metal samples be taken to satisfy a Risk Assessment gap for data. Due to historical information and process knowledge no hazard should be encountered from these items.

3.4 Ionizing Radiological Hazards

X	Internal Exposure	X	External Exposure

3.5 Non-Ionizing Radiological Hazards

☐	UV	☐	RF	☐	Microwave
☐	Laser		High Voltage		

3.6 Biological/Vector Hazards

☐	Wildlife	☐	Plants	☐	Medical Waste
☐	Bacterial	☐	Parasites		

Note: for the items checked IN 3.1--3.6--provide additional information below.

3.7 Description of hazards and controls

3.7.1 Physical hazards

Temperature Extremes

Tasks Sampling effort. This activity will be conducted in the spring of the year and temperatures are not expected to pose excessive strain. However, the SSHO will follow the precautions listed below.

Temperature extremes (Hot/Cold)? ☐ Yes X No
Average daily high temperature (during work shift) 70°F/°C
Average daily low temperature (during work shift) 40 °F/°C
_____ Temperature WBGT °C (obtain from IH prior to daily activities, as necessary)

Work load:
☐ Light
X Moderate
☐ Heavy

Precautions *(specify)*: If Tyvek over garment is needed to be worn, a work/rest regiment will be followed allowing for periodic breaks when temperature and/or humidity is a concern. Work/rest cycles will comply with ACGIH recommendations and will be given as weather and work intensity are evaluated. The up-take of liquids (water) will be emphasized

Cooling/heating equipment needed:

Noise

Tasks Excessive noise could be generated if there is a need to drive the split spoon into the pond's bottom. This would result in metal (sledge hammer) on metal (split spoon) or post driver on metal, also the possible use of a gas powered generator. Hearing protection will be worn when driving the sampling device into the sediment. Noise levels have already been collected for the hot water washer and hearing protection is required when working around 6 feet of the engine.

Noise extremes? ? Yes ☐ No

Sound level _____dB(A)

Noise source(s): 1) Hammering (metal on metal)
2) Possibly the gas powered generator

1) Hearing protection will be worn when driving the split spoon into the sediment.

Noise above 85 dB(A) (hearing protection required): X Yes ☐ No

Precautions *(specify)*: Due to past noise level sampling for the hot water washer s reach which exceed 85 dB(A) hearing protection will be worn within a radius of 6 feet of the engine.. Either ear plugs or ear muffs.

Confined/Enclosed Spaces

Tasks N/A

Type of space (pit, vault, excavation, etc.) _____

Is the area posted as a confined/enclosed space? (yes) _____ (no) _____

Confined Space Entry Permit required? (yes) _____ (no) _____

Lock-out/Tag-out required? (yes) _____ (no) _____

Identify equipment that is needed:

two-way radios	(yes) ____	(no) ____
safety harness	(yes) ____	(no) ____
hoist	(yes) ____	(no) ____
safety line	(yes) ____	(no) ____

other: _____

Note: ORNL Industrial Hygiene must be contacted prior to entry into a confined space. Training requirements should be listed/verified in Section 9.

Ergonomic hazards

Tasks: Lifting,

Heavy lifting (yes) X (no) _____

1) lifting of sample laden split spoons

Controls:

1) at pre-entry briefing, instruct workers on the proper way to lift, using legs and reiterate at the daily safety meetings

2) when at all possible utilize any mechanical means of lifting sampling spoons.

Vibrating equipment (yes)_X_____ (no) _____

1) vibrations from holding the upright spoons while the spoon is being driven through the sediment.

2) vibrations from the impact of the sledge hammer or post driver.

Controls:

1) wearing leather gloves, or having some kind of shock absorption pads on drivers handles
2) if hammer or post driver is used, gloves to absorbs vibrations

Tripping/falling (yes) _X_____ (no) _____

1) Not expecting any water on the decking due to placement of plastic and distance to the water's surface. The manufacturer equipped the boat with a non-skid surface.

Controls:

Coast Guard approved floatation devises **will be worn** while activities are being conducted on the water. Rescue devices, (life ring with rope and/or rescue extension poles will be on board the boat.

Controls/protective equipment:

The watercraft is equipped with manufacturers safety rails to prevent the possibility of slipping/ falling off the boat
Additional safety equipment that will be carried on the boat will be safety life ring with rope and/or an extension pole in case someone falls overboard.

Fire/Explosion

Tasks decon machine and the portable generator .

Are flammable liquids present? X Yes ☐ No

Description: Gasoline

Location: in a designated approved safety can maintained in a shaded area within the support zone

Quantity: 5 gallons

Containment/Storage method: an approved gasoline storage receptacle

Describe flammable/explosive atmosphere (accessing fuel tank, etc.)

Describe controls such as atmospheric testing, etc.

For welding, cutting, or brazing, is Hot Work Permit required? ☐ Yes X No

Oxygen Deficient/Enriched Atmosphere

Describe operations which may create oxygen deficient/enriched (circle one) atmosphere

Controls: atmospheric testing by Industrial Hygiene

3.7.2 Safety/Construction hazards

Excavation

Approximate dimensions of area to be excavated: _____**N/A**

Identify type of equipment to be used:

Shoring required? (yes)_____ (no) _____

List known or suspected underground hazards: (or attach a copy of the excavation/penetration permit)

List operations to be conducted in the excavated area:

List any hazardous materials to be used in the excavated area (gases, etc.)

Controls:

(List additional controls)

Heavy Equipment Operation/Hoisting and Rigging

List heavy equipment to be used at the site:

A crane will have to be utilized to lift the watercraft from the trailer into the ponds

Does each piece of equipment have an
Annual Inspection Certificate: (yes)__X__ (no)____

Has each piece of equipment been inspected
for both mechanical and safety
concern prior to use (yes)__X__ (no)____

Have approved rigging, straps, cables, etc.
been inspected (yes) __X__ (no) ____

These implements will have to be inspected when transported to the site and prior to use at the site.

Daily visual inspections of the crane will be performed by the SSHO to determine any leaking of fluids or gross abnormalities.

Additional Controls:

Extreme care will be taken when working around any piece of heavy equipment. When moving around the crane ensure the operator has made visual contact will you before you move and you use hand signals to indicate your actions. At all time follow the directions of the "spotter" when movement around the crane is necessary. Do not interfere or move around the crane unless absolutely necessary.

Electrical hazards

Tasks___NA_____

Electrical shock hazard? ☐ Yes ☐ No

_____ Voltage
_____ Current

Location of hazard:_____

Controls:

_____

_____

Overhead hazards

There are over head lines around three sides of the ponds. These have been determined to be communication lines and will not pose a specific health and safety concern. There are power lines to the South of the ponds. We have an avenue towards the East sides of ponds 3513 and 3525 that a boat can be lifted and placed into the ponds from that location without any interference from overhead lines. Ponds 3539 and 3540 can be accessed from the same place from the West side of these respective ponds.

Amount of voltage within electrical lines: _____

Height from equipment to hazard: _____

Requireddistance: _____

Grounding required: (yes) _____ (no) _____

Lock-out required: (yes) _____ (no) _____

Additional controls:

_____

_____

_____

Note: Industrial Safety should be notified prior to commencement of activities.

Hoisting/rigging

P&E will be notified prior to requiring their services

An approved Hoisting and Rigging Plan will be in place for any overhead activity requiring hoisting and rigging.

Elevated work

A "spotter" will be on-site and will monitor the crane with respect to overhead lines. The area that the crane will be operating to place the boat in to each pond is free of overhead obstructions. If another area has to be utilized, communication lines are approximately 20 feet from the surface, and power line are approximately 35-40 feet high. If this is a possibility the following requirements will be followed:

Normal Voltage	Minimum required Clearance
to 50 kV	10 ft
over 50 to 200 kV	15 ft
over 200 to 350 kV	20 ft
over 350 to 500 kV	25 ft
over 500 to 750 kV	35 ft
over 750 to 1000 kV	45 ft

Department of Energy, Hoisting and Rigging Manual

Demolition

3.7.3 Chemical Hazards

For chemicals identified in Section 3.3 provide the following information. Available historical and site characterization data should be used to complete this section. An Industrial Hygiene representative may be contacted to assist in completion of this section.

Substance: _____Gasoline_____

Use: (for materials brought on site) decon machine and generator

Location: (for substances identified at the site) will be stored in an approved container kept within the support zone

TLV 300 ppm PEL _____ IDLH _____ STEL _____

Route of exposure: skin contact, inhalation

Target organs: nervous system, skin

LEL _____ UEL _____ FP _____

Signs and Symptoms of exposure: irrigation to contacted area

Health Effects

_____

Additional comments and controls

wear protective gloves(vinyl or rubber) when pouring gasoline and flush with water if any irrigation occurs.

Substance: Isopropyl Alcohol

Use: (for materials brought on site) decontamination of sampling equipment

Location: (for substances identified at the site) CRZ at decon machine

TLV 400 ppm PEL _____ IDLH 12,000 ppm STEL _____

Route of exposure: skin contact and inhalation

Target organs: skin, eyes upper respiratory tract

LEL 2.0% UEL 12.7 % (200)) FP _____

Signs and Symptoms of exposure: irritation dry cracking skin at contact area

Health Effects

Additional comments and controls

PPE, rubber gloves will be worn during the process where this chemical will be required. If there is an large skin exposure the area will be flushed with water.

See section 5 for Industrial Hygiene monitoring/sampling requirements.

3.7.4 Ionizing Radiation

For ionizing radiological hazards identified in Section 3.4, provide the following information. Available historical and site characterization data should be used to complete this section. An Office of Radiation Protection representative may be contacted to assist in completion of this section.

Any known contamination present (from prior scanning or history)	(yes) _X__ (no) ___
Primary contaminating isotope(s)	^{137}CS, ^{90}SR, ^{239}PU, ^{3}H
Radiation type	Alpha, Beta & ,Gamma

Location on site: In sediment, water and the surrounding banks of the ponds

Radiation work permit required?	X Yes No

Dose rate	(maximum)	_____ mR/h @ ___ meter(s)
	(average)	_____ mR/h

Unknown due to material being shielded by the water

Worker dose limit	60 mR/day not to exceed 200 mR/week or 1250 mR/ 3 months as monitored by visual dosimeters

These levels have been agreed upon by Jerry Grey and Ralph Jeffers of the Office of Radiation Protection.

Contamination level	(fixed) > 1000	dpm/100 cm^2 (possible)
	(removable) > 200	dpm/100 cm^2 (possible)

Airborne contamination concentration _____ μCi/mi

unknown at this time. Collection will be performed for preliminary data, then routine collection in work area ,EZ, while work is being conducted. These samples will be collected prior to any sampling activity to determine "background".

Water contamination potential? X Yes ☐ No

Unrestricted airborne contamination release potential? ☐ Yes XNo
samples will be contained while wet to prevent airborne release.

Health Physics coverage Conditional
continuous while workers are in the C-zone and on or around the water.

A representative from the Office of Radiation Protection will be on-site through all activities associated with this project. Any articles that are transported out of the Contamination Area (EZ) will be scanned and possibly smeared by the on-site HP. Samples that need to be transported to the analytical laboratory will also be scanned and "green tagged" by the HP. "Green tagging" will be preformed by the ORP representative.

High volume sampling to be conducted? (yes) _____ (no) _X_____
Low volume sampling to be conducted? (yes) ___X___ (no) _____

Low volume area air sampling will take place prior to sampling activities. These results will help in determining "background" for PPE and NESHAPS concerns.

Personal monitoring/sampling? (yes) _____ (no) ___X____

Additional controls/requirements:

The MAD group will provide HP technicians during all intrusive sampling activities.

Instruments to be utilized and monitoring requirements are identified in Section 5

3.7.5 Nonionizing Radiation

Tasks N/A

High-Voltage (> 100Kv) electrical transmission lines nearby? ☐ Yes ☐ No
Location, distance and voltage:

Radiofrequency radiation sources (AM and/or FM broadcast: towers, r-f sealers) nearby? ☐ Yes ☐ No
Location and distance:

Microwave sources in use on site? ☐ Yes ☐ No

Location and distance: _____

Lasers in use nearby? ☐ Yes ☐ No
Location and laser class: _____

Are ultrasound sources in use on site? ☐ Yes ☐ No
Location: _____

3.7.6 Sanitation

Tasks Sampling

Potable water required? drinking purposes

Non-potable water used? equipment decon

Eating, drinking, chewing, use of tobacco permitted?
Location: support zone

Toilet facilities required?
Location and number: Bldg. 3544 or 3503

Washing facilities required?
Location: Bldg. 3503

Change rooms required?
Specify: 7503

3.7.7 Illumination

Tasks Impoundment sampling

Additional illumination needed? ☐ Yes X No ☐ NA

4.0 TASK BREAKDOWN

(Provide detailed description, controls, and requirements for each task to be performed, i.e., drilling, sampling, etc.). This section should be duplicated and completed for individual tasks (if hazards and controls are different).

4.1 **Task Description: Pond sediment sampling**

Type of Work: Intrusive X Non-intrusive ☐

Engineering Controls: Samples will be contained in at least one layer of plastic or glass jar upon collection

Administrative Controls: (required permits, training, etc.) Radiation work permit, Hoisting and Rigging plan

Initial Level of Personal Protective Equipment:

Level of Protection: ( ) A (X) C (X) Modified
( ) B (X) D

1) "C" level PPE will be required if the donning of respirators is warranted, this would primarily be from a Radiological concern
2) "D" modified, would be the normal sampling attire

Respirator: ( ) SCBA (X) Fullface (X) 1/2 Face Resp.
( ) PAPR ( ) Other
Cartridge: ____Hepa combination filter

- if airborne contamination is detected in preliminary air samples, and when sampling ponds 3539 and 3540, respirators will be used. Samples from ponds 3524 and 3513 will be wet sludge samples and no chance of airborne radiological contamination is expected. Respirators will not be worn for these ponds.

Protective Clothing: ( ) Encapsulating Suit (X) Tyvek
( ) Saranex (X) Splash suit
( ) C-zone (X) Company Clothing (khakis)
( ) Other

1) Tyvek suits will be worn as conditions warrant. If the sampling effort is quite wet and a lot of water is generated, we will up-grade to tyvek or other more appropriate PPE.
2) Tyvek, with a splash suit or apron, (at the SSHOs proffessional judgement) will be worn during decon activities, when using the hot water washer due to the potential for mist.

Head/eye/ear: (X) Hard Hat (X) Safety Glasses (X) Goggles
(X) Splash Shield (X) Ear Plugs ( ) Ear Muffs
( ) Other

- Hard hat will be worn if any overhead winching operations are involved

-Splash shields or goggles will be worn during driving operations, and decon activities with the hot water washer, either with or in place or safety glasses

- Hearing protection will be worn if sound levels meet or exceed 85 dBA

Gloves: (X) Nitrile ( ) Neoprene ( ) PVC
( ) Latex (X) Vinyl (X) Leather
( ) Other

Nitrile or vinyl for sampling and protection from possible contact of contamination and for protection during decon.
leather could be worn under vinyl or nitrile gloves as necessary to protect personnel for impact injury (driving and steadying split spoons)

Footwear: (X) Steel-toed Leather ( ) Chemical Overboots
( ) Steel-toed Rubber (X) Other: Rubber overboots or booties

Describe the donning/doffing steps:

Donning:

Donning of the prescribed PPE will take place in the support zone. Tyvek suits will be donned first, followed by rubber overboots or plastic booties. The pant legs of the tyvek suit will be pulled over the outside of the inner boots or booties and taped using 2" tape. Vinyl or Nitrile gloves will be donned and taped to the sleeves of the suit. If needed, don the appropriate respirator and perform the qualitative checks to determine integrity. Once all PPE is in place the Contamination Area /CRZ/EZ and be entered. Outer booties will be removed prior to stepping onto the pontoon boat or suspension bridge. A fresh outer pair of booties will be donned prior to stepping off the boat or bridge. This will protect the boat from any contamination that might be transferred from the soil. Sampling has not be conducted along the bank to determine the presents or absences of contamination. Extra booties are an added precaution to protect the watercraft from an extensive decontamination process. A support person will be used to transport supplies and samples between the work area and the support zone.

Doffing:

At the Contamination Area/CRZ interface, each individual will remove the outer gloves, then the outer booties (one at a time) and step out of the Contamination Area and into the CRZ. Used outer gloves and booties will be placed in a magenta marked "radioactive" SLLW trash bag located at the Contamination Area/CRZ interface. A clear plastic trash bag will also be provided for the collection of each individual workers inner gloves, booties and tyvek suit. The necessary number of trash bags will be pre-rolled open (by the support personnel) and placed flat on the ground within the CRZ. Upon exiting from the Contamination Area to the CRZ, each worker will proceed to, and step onto one of the rolled bags. The inner booties and inner gloves will then be untaped from the tyvek suit and the tape dropped into the bag. The tyvek suit will be rolled inside out and down over each ankle and booties. The inner booties will then be removed one at a time, as the worker steps backward out of the plastic bag and toward the Support Zone. At this point, remove the respirator,(if one was donned) by grasping the cartridges and pulling the respirator, outward and up, pulling it away from your face. The inner gloves will be removed by carefully grabbing the inside of the cuff and pulling the glove inside out, then dropping them into the plastic bag. Each worker will then carefully contain(by rolling) their own plastic trash bag of PPE,and will carry it(by the surfaces previously protected by rolling) to the CRZ/Support Zone interface. Support personnel will frisk each bag of waste, and where no activity was detected, consolidate all bags into one additional bag for placement into the VLA B-25 box. The exiting worker will perform a whole body alpha frisk at the Support Zone/CRZ boundary. If no alpha contamination is detected, the worker will proceed to the reduced background area within the Support Zone and will perform a beta-gamma frisk. A B_25 box will be located within the Support Zone to provide reduced background shielding for personnel beta-gamma frisking and collection of VLA 'suspect" waste. If beta-gamma contamination was detected on a worker's PPE by support personnel and background was > 50 cpm in the reduced background area, the worker should move to an area < 50 cpm beta-gamma and re-frisk to insure no contamination is present on skin or khaki clothing. If background is greater than 100 cpm beta-gamma in the reduced background area, workers and used PPE should be relocated to an area <50 cpm beta-gamma and refrisked. Any contaminated PPE must be disposed as SLLW. All generated waste will be disposed of following the Health Science Research Divisions, Waste Management Plan. This has the approval of Waste Management and Remedial Action.

Modifications allowed: All upgrades of PPE must be approved by the Site Safety and Health Officer and for upgrades to respiratory protection (level "C") or higher must gain approval from the appropriate safety and health representative. Downgrades in PPE will be justified and documented in the site log book by the Site Safety and Health Officer and the radiation protection technician.

Additional Personal Protective Equipment information may be found in Section 11 of the ORNL HAZWOPER Program Manual.

5.0 MONITORING REQUIREMENTS

Note: the IH or HPC rep. and the HP rep. should be consulted to assist in preparing this section

Due to past sampling data and historical information, the contaminants of concern are radiological in nature. Due to the scope of this effort and the contaminants of concern, radiological and sound level instrumentation will be the only monitoring devices that will be employed for these activities.

5.1 Direct Reading Instruments	Task(s)	Monitoring Frequency	Action Guidelines
LEL Meter			
O_2 Meter			
Colorimetric Indicator Tubes			
Photoionization Detector (PID)			
Flame Ionization Detector (FID)			
Alpha Meter	X	during egress from the EZ >300 dpm /100cm²	Stop Work
Beta/Gamma Meter	X	continuously while sampling and upon egress from the EZ >1000 dpm/100 cm²	Stop Work
Area Radiation Monitors			
Noise Meter			
Other (Specify)	X		

1) **Ionization Chamber**

The ionization chamber will be utilized to determine how contaminated the sediment is before a sample is brought to the surface. After the water has been pumped from the PVC tube, the ionization chamber will be lower to the sediment and a reading taken.

during sampling

200 mR/h beta/gamma

If at any time a sampling tube is extracted from the pond and scanning results are ≥200 mR/h Beta/gamma that sample will be rejected and disposited back into the pond.

Monitoring will be performed continuously by members of the MAD group while work is being conducted within the radiation contamination area and the EZ. This will consist of dose rate and personnel visual dosimeter (gamma & X-ray pocket dosimeter) monitoring. We will attempt to keep doses below 20 mRem/day and 100 per week. We will also monitor ourselves

for alpha and beta contamination upon egress as described in the PPE section. PPE will be adjusted according to conditions encountered. If air samples reveal activity, we will stop work and re-evaluate the effort and don respirators and contact the HP department .

5.2 Personal Monitoring

Whole-body Dosimetry	X	continuous	Dosimetry required for entering a radiation area
Extremity Dosimetry			
Whole-body Count	X	annual	When working inside a posted dressed area
Urinalysis/Bioassay	X	annual	When working inside a posted dressed out area
Chemical Air Sampling			
Area Radiation Air Sampling	X	2 consecutive day prior to start of sampling	> 10% DAC
Personal Sampling Pumps			

Instruments used by IH representative will be calibrated and maintained in accordance with IH Standard Operating Procedures. Instruments used by the Office of Radiation Protection are calibrated and source checked in accordance with established Health Physics procedures.

Site monitoring requirements may change based on site conditions. All changes must be documented in the site log book.

6.0 SITE CONTROL

Site work zones are required to reduce the accidental spread of hazardous substances from contaminated areas to clean areas. In accordance with the ORNL HAZWOPER Program Manual, three zones will be established: 1) exclusion zone, 2) contamination reduction zone, and 3) support zone. The identification of the zones will provide for control of operations and flow of personnel. The HPC will provide signs to be posted at the site for HAZWOPER requirements. The HP will determine radiological posting. Should additional barriers (rope, tape) or signs be required, HP, IH, and IS will be consulted. The HPC may modify the zones for short term, transient type projects. The modification would include use of the HAZWOPER barrier tape and A-frame sign only. Additional information regarding site control may be found in Section 7 of the ORNL HAZWOPER Program Manual.

Personnel accessing the zones must meet access requirements as stated in this plan and at entrance of the zones. Entrance and exit points for the zones will be clearly marked. Perimeter monitoring of the zones will be conducted periodically to ensure correct placement of the zones. The SSHO is responsible for ensuring all workers and visitors meet site access requirements. Section 9 is a record of site access requirements and personnel qualifications.

Use of the buddy system is required for this project. All workers will have a partner to work with. To ensure worker safety, personnel will maintain (1) internal communication, (2) line of sight with other workers, and (3) work party monitoring. A two-way radio will be maintained in the clean, support zone to ensure communication with the Laboratory Shift Superintendent and emergency, safety, and health support personnel.

(Note: Provide a site map marked with the location of the zones and the emergency evacuation route).

7.0 DECONTAMINATION

The purpose of decontamination is to prevent contaminants that may be present on protective clothing and equipment from coming into contact with personnel as they un-suit. Also, decontamination protects workers from hazardous substances that may contaminate and eventually permeate the PPE used onsite; it protects personnel by minimizing the transfer of harmful materials into clean areas. Combining decontamination with the correct sequential method of removing personal protective equipment will prevent exposure to personnel leaving the work areas as well as off-site migration of contaminants. Generally, decontamination is accomplished by starting with the most heavily contaminated item and progressing to the least contaminated item.

Personnel will remove any disposable PPE and dispose of it in provided containers before leaving the contamination reduction zone in the order listed below. Provide a description of the decontamination steps/stations for this project.

Refer to the PPE Section on "Doffing" for a more detailed explanation. ,IF any contamination is detected on any article of clothing, an attempt will be made to decontaminate the clothing by removing the particles with tape, else disposal of that article of clothing will be disposed. If any contamination is detected on any part of the skin, an attempt will be made to remove the contamination by washing with soap and water. The LSS will be notified along will the ORNL Office of Radiation Protection and they will follow their procedures for decontamination of personnel . An Occurrence Report following DOE order 5000. 3B will be generated..

If contamination is detected on equipment, describe how the equipment will be cleaned.

Due to sampling requirements, all sampling implements will be decontaminated between usage. Decontamination will take place in the CRZ, or on board the watercraft in an attempt to limit the spread of contamination. Either a hot water washer or garden sprayer may be employed to conduct this activity. Each piece of contaminated equipment will be placed in plastic bags or wrapped in plastic for transporting. The article will be placed in a suitable container and washed with water and phosphate- free soap. The article will be scrapped off with a putty knife or coarse bristled brush as necessary to remove the gross debris (mud, dirt). Spoils and water from the decontamination process will be returned to the point of origin. Waste will be disposed of according to the waste management plan. A thin coat of isopropyl alcohol is sprayed on the sampling implement. It is then washed thoroughly with deionized water and allowed to air dry. Dried implements will be smeared for radioactivity. If no transferable contamination is observed, the implements will be reused at the next sampling location or moved to a low background area and scanned for fixed Alpha, Beta and Gamma contamination when sampling operations are completed. Radioactive contaminants will require additional decontamination or disposal of the particular tool. Waste Management issues will be handled under the Health Science Research Divisions Waste Management Plan. This issue has been discussed and approved by Waste Management and Remedial Action.

Materials possibly utilized in decontamination in this project include:

- hot water washer (if applicable)
- 409 or appropriate cleanser
- disposable cloth wipes

Items that might need decontaminating:

- sampling tools:
  - possible split spoons
  - sediment sampler
  - stainless steel pans
  - stainless steel trowels
  - sample plunger

-possible: (anything that possibly gets dirty is possibly contaminated)
  - sledge hammer
  - post driver

-the designated watercraft:

the watercraft will be lifted and placed on adequate elevated supports (as determined by IS) and allowed to air dry. The pontoons and/or bottom of the craft will be scanned and swiped for the detection of any radiological contamination. If any contamination is detected on the craft or any article related to the craft, (extension poles, tripods, or troughs, etc.) the craft and/or article will be decontaminated by MAD Technicians on site.

-ropes or cables:

The ropes or cables that will be used for the purpose of positioning and securing the craft at the various sampling locations will be removed and spread on plastic and allowed to air dry. Once dry, the ropes or cables will be disposed of, according to the Waste Management Plan.

8.0 EMERGENCY PREPAREDNESS

The responsibility of day-to-day implementation of this information primarily lies with the SSHO. During an actual emergency response situation, the SSHO will serve as the Emergency Coordinator until the Laboratory Shift Superintendent or emergency response team arrives.

Medical assistance will be provided by the Health Division, which is located at Building 4500-North. The LSS will provide emergency response personnel and coordinate emergency assistance. The radio number for the LSS is Station 103. The telephone number for the LSS is 574-6606. The nearest fire alarm box is located at **BUILDING 3544**. In the event that the LSS is not available, emergency services may be reached at the telephone numbers shown below.

The SSHO will perform the following pre-emergency tasks before starting field activities and will coordinate emergency response with the LSS:

1. Locate nearest telephone and alarm station.
2. Confirm and post emergency telephone numbers.
3. Post site map of work areas marked with evacuation routes.
4. Inventory and check out on-site emergency equipment and supplies, as warranted.

In the event of an emergency that requires evacuation of the site, a verbal instruction will be given by the SSHO to evacuate the area. Personnel will exit to a pre-designated support area. At this point, the SSHO will account for all personnel, ascertain information about the emergency, and advise further instructions to the on-site personnel. In all situations that require evacuation, personnel shall not reenter the work area until the conditions causing the emergency have been corrected, the hazard reassessed, the Work Plan and HASP revised, approved, and reviewed with on-site personnel, and instructions given for re-entry.

Emergency Personnel	Phone	Radio #
ORNL Emergency Response	911	
Laboratory Shift Superintendent	574-6606	403
Fire Department	574-5678	
Medical Center	574-7431	
Security	574-7196	401
Industrial Hygiene	576-5064/ 576-6445	69
Industrial Safety	576-5974	
Radiation Protection	574-6701	334
Environmental Compliance	574-8770	650 or 216
Facility Manager (Lou Holder)	574-8312	
ER ES&H (Charles Clark)	576-8268	
HAZWOPER (Ann Saulsbury)	576-5064	
Project Manager (Elizabeth Krispin)	571-3924	

The SSHO will brief workers on emergency response procedures and the evacuation route in the pre-entry briefing.

9.0 TRAINING/MEDICAL REQUIREMENTS

List applicable training/medical requirements for this project. All site personnel and visitors requiring access to the work zones (contamination reduction zone and exclusion zone) will be required to meet these access requirements. A least one individual generally the SSHO will have the 8 Hr. HAZWOPER Supervision Training. This individual will need to be on-site at all times, as long as work is being conducted within the CRZ or beyond.

Training

_____ 24/40 hour HAZWOPER (SARA/OSHA) training
___X_____ 40 hour HAZWOPER (SARA/OSHA) training
___X_____ Current HAZWOPER 8-hour Annual Refresher (as applicable)
___X_____ 8-hour HAZWOPER Supervisor training (SSHO)
___X_____ Radiation Worker Training
___X_____ Respirator fit test/training
_____ Confined space entrant
_____ Confined space attendant
___X_____ Other (list)

Site-specific Training

Medical Surveillance

___X_____ ORNL Hazardous Waste Worker Medical Surveillance Program (only for individual meeting criteria as specified in Section 9 of the ORNL HAZWOPER Program Manual.

_____ Other, please list.

Note: If site conditions change, or other hazards are detected, the training and access requirements will be revised accordingly.

*** The MAD groups personnel will supply and maintain on site copies of all required training certificates and medical examination records to verify compliance.

Site Personnel Qualifications:

9.1 Name: _____ Badge number: _____

Assigned tasks: _____

_____

	YES	NO	DATE
40 hr. training:	☐	☐	_____
24 hr. training:	☐	☐	_____
Annual Refresher Training:	☐	☐	_____
Supervisor training:	☐	☐	_____
Confined space entry training:	☐	☐	_____
Radiation worker:	☐	☐	_____

Respirator fit tested/trained:	☐	☐	_____
Medical Surveillance Program:	☐	☐	_____

Other training: _____

_____

_____

9.2 Name: _____ Badge number: _____

Assigned tasks: _____

_____

	YES	NO	DATE
40 hr. training:	☐	☐	_____
24 hr. training:	☐	☐	_____
Annual Refresher Training:	☐	☐	_____
Supervisor training:	☐	☐	_____
Confined space entry training:	☐	☐	_____
Radiation worker:	☐	☐	_____
Respirator fit tested/trained:	☐	☐	_____
Medical Surveillance Program:	☐	☐	_____

Other training: _____

_____

_____

9.3 Name: _____ Badge number: _____

Assigned tasks: _____

_____

	YES	NO	DATE
40 hr. training:	☐	☐	_____
24 hr. training:	☐	☐	_____
Annual Refresher Training:	☐	☐	_____
Supervisor training:	☐	☐	_____
Confined space entry training:	☐	☐	_____
Radiation worker:	☐	☐	_____
Respirator fit tested/trained:	☐	☐	_____
Medical Surveillance Program:	☐	☐	_____

Other training: _____

_____

_____

9.4 Name: _____ Badge number: _____

Assigned tasks: _____

_____

	YES	NO	DATE
40 hr. training:	☐	☐	_____

24 hr. training:	☐	☐	_____
Annual Refresher Training:	☐	☐	_____
Supervisor training:	☐	☐	_____
Confined space entry training:	☐	☐	_____
Radiation worker:	☐	☐	_____
Respirator fit tested/trained:	☐	☐	_____
Medical Surveillance Program:	☐	☐	_____

Other training: _____

_____

_____

9.5 Name: _____ Badge number: _____

Assigned tasks: _____

_____

	YES	NO	DATE
40 hr. training:	☐	☐	_____
24 hr. training:	☐	☐	_____
Annual Refresher Training:	☐	☐	_____
Supervisor training:	☐	☐	_____
Confined space entry training:	☐	☐	_____
Radiation worker:	☐	☐	_____
Respirator fit tested/trained:	☐	☐	_____
Medical Surveillance Program:	☐	☐	_____

Other training: _____

_____

_____

9.6 Name: _____ Badge number: _____

Assigned tasks: _____

_____

	YES	NO	DATE
40 hr. training:	☐	☐	_____
24 hr. training:	☐	☐	_____
Annual Refresher Training:	☐	☐	_____
Supervisor training:	☐	☐	_____
Confined space entry training:	☐	☐	_____
Radiation worker:	☐	☐	_____
Respirator fit tested/trained:	☐	☐	_____
Medical Surveillance Program:	☐	☐	_____

Other training: _____

_____

_____

9.7 Name: _____ Badge number: _____

Assigned tasks: _____

	YES	NO	DATE
40 hr. training:	☐	☐	_____
24 hr. training:	☐	☐	_____
Annual Refresher Training:	☐	☐	_____
Supervisor training:	☐	☐	_____
Confined space entry training:	☐	☐	_____
Radiation worker:	☐	☐	_____
Respirator fit tested/trained:	☐	☐	_____
Medical Surveillance Program:	☐	☐	_____

Other training: _____

9.8 Name: _____ Badge number: _____

Assigned tasks: _____

	YES	NO	DATE
40 hr. training:	☐	☐	_____
24 hr. training:	☐	☐	_____
Annual Refresher Training:	☐	☐	_____
Supervisor training:	☐	☐	_____
Confined space entry training:	☐	☐	_____
Radiation worker:	☐	☐	_____
Respirator fit tested/trained:	☐	☐	_____
Medical Surveillance Program:	☐	☐	_____

Other training: _____

9.9 Name: _____ Badge number: _____

Assigned tasks: _____

	YES	NO	DATE
40 hr. training:	☐	☐	_____
24 hr. training:	☐	☐	_____
Annual Refresher Training:	☐	☐	_____
Supervisor training:	☐	☐	_____
Confined space entry training:	☐	☐	_____
Radiation worker:	☐	☐	_____
Respirator fit tested/trained:	☐	☐	_____

Medical Surveillance Program: ☐ ☐ _____

Other training: _____

_____

_____

Appendix D

QUALITY ASSURANCE/QUALITY CONTROL PLAN

APPENDIX D
QUALITY ASSURANCE/QUALITY CONTROL PLAN

This plan presents quality assurance and quality control (QA/QC) procedures for conducting the engineering support studies described in the work plan. The quality control procedures for collection of sediment samples from the site are described in the sediment sampling plan (Appendix A) of the work plan. The QA elements addressed in the work plan and this appendix are presented in Table D.1.

At present, the engineering studies identified for the selected remedial alternatives include only physical and geophysical testing. However, in future, MMES may choose to include Toxicity Characteristic Leaching Procedure (TCLP) to evaluate the performance of the proposed sediment solidification study. This QA/QC plan includes the data quality control procedures for the engineering studies described in the work plan and the TCLP tests.

D.1 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT

The quality assurance objective for the engineering support studies is to generate data of adequate quality for their end use(s). The primary objective of the studies were to obtain data to support the design and implementation of the selected alternatives. This subsection presents the data quality objectives (DQOs) for the engineering support studies and the objectives for precision, accuracy, representation, comparability, and completeness (PARCC). Data Quality Objectives (DQOs) are qualitative and quantitative statements concerning data needs and quality of data. The required quality of data depends on its use. Parts of the EPA publication entitled Test Methods for Evaluating Solid Waste (SW-846), 3rd Edition, Final Update I, July 1992; and 1994 Annual Book of ASTM Standards (ASTM), Volume 04:08 are incorporated by reference.

D.1.1 Data Quality Objectives

The DQOs for the engineering support studies are defined by the intended use(s) of the data. The principal data objective for the engineering support study is stated above (Section D.1). The analytical data quality level for SW-846 methods will be Level III. EPA recommends the use of Level III for data used to characterize sites, evaluate alternatives, or conduct engineering studies. The targeted method detection limits (MDLs), estimated quantitation limits (EQLs), and QC acceptance criteria for the TCLP metal analyses will be as described in SW-846.

Because of the variability involved with individual geotechnical properties and their inter-relationships, no specific data quality parameters such as precision and accuracy

have been established. However, where available, the DQOs for the geotechnical tests will be as described in the ASTM standards, and for the remaining study methods the DQOs will be as defined in the corresponding SOPs. To the extent practicable, precision for the geotechnical data will be established through the use of duplicate samples and/or analyses.

D.1.2 Precision and Accuracy

The precision of a measurement is an expression of mutual agreement of multiple measurement values of the same property conducted under prescribed similar conditions. Precision is evaluated most directly by recording and comparing multiple measurements of the same parameter on the same exact sample under the same conditions. It is usually expressed in terms of the standard deviation. The objectives for precision in the analyses on this project were determined based on inter-laboratory comparison study results expressed in the EPA analytical methods to be used on this project and a consideration of the expected parameter concentrations. The precision objectives for analytical methods selected for the engineering support studies are summarized in SW846.

The degree of accuracy of a measurement is based on a comparison of the measured value with the actual true value. Accuracy of an analytical procedure is best determined based on analysis of a known or "spiked" sample quantity.

The degree of accuracy and the recovery of analyte to be expected for the analysis of QA samples and spiked samples is dependent upon the matrix, method of analysis, and compound being analyzed. The concentration of the analyte relative to the detection limit is also a major factor in determining the accuracy of the measurement. The analytical range for most analyses is generally accepted to be five times the detection limit at the lower end.

Accuracy for measurements of parameters in a soil matrix is usually lower than for liquid matrices. Objectives for accuracy for the methods that will be utilized in this investigation are summarized in SW-846.

D.1.3 Representation

Samples taken must be representative of the population. In addition, sampling will be scheduled so as to be representative of any temporal changes such as those expected during the solidification study. Sampling devices will be cleaned between sampling events to ensure cross-contamination does not occur. Sample selection and handling procedures will also incorporate consideration of obtaining the most representative sample possible.

D.1.4 Completeness

The completeness of the data is the amount of valid data obtained from the measurement system versus the amount of data expected from the program. At the end of each sampling event, an assessment of the completeness of data will be performed. The

specific objective for completeness of this project shall be greater than or equal to 80 percent.

D.1.5 Comparability

Consistency in the acquisition, handling, and analysis of samples is necessary to ensure comparability of results. The implementation of SW-846 methods, ASTM standards, and SOPs for analysis of samples will ensure comparability.

D.2 SAMPLE CUSTODY

A sample is under custody if:

- It is in sample team leader's (STL's) actual possession, or
- It is in STL's view, after being in physical possession of STL; or
- It was in STL's physical possession and then STL locked it up to prevent tampering; or
- It is in a designated and identified secure area.

The following procedures will be used in transferring and shipping samples:

- Samples will be accompanied by a Chain-of-Custody Record at all times. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the Record. This Record documents transfer of custody of samples from the STL to another person, or to the laboratory.
- Samples will be properly packaged for shipment and dispatched to the appropriate laboratory for analysis with a separate signed Chain-of-Custody Record enclosed in each sample box or cooler. Shipping containers will be custody-sealed for shipment to the laboratory by overnight express.
- All packages will be accompanied by the Chain-of-Custody Record showing identification of the contents. The original Record will accompany the shipment, and a copy will be retained by engineering support studies personnel.
- If sent by common carrier, a bill of lading will be used. Receipts of Bill of Lading will be retained as part of the permanent documentation.

D.3 CALIBRATION PROCEDURES

Calibration of laboratory instruments and equipment will be performed at approved intervals as specified by the method and manufacturer or more frequently as conditions dictate. Calibration standards used as reference standards will be traceable to the National Bureau of Standards, when existent.

Records of calibration, repair, or replacement will be filed and maintained by the designated laboratory personnel performing quality control activities. Calibration records

of assigned laboratories will be filed and maintained at the laboratory location where the work is performed and subject to QA audit. Field instruments will also be calibrated prior to measurement and calibration results recorded.

D.4 ANALYTICAL PROCEDURES

The analytical procedures selected for the engineering support studies are described in SW-846, ASTM, or in SOP. The holding times specified in these documents will be met for samples collected and analyzed during the engineering support studies. Immediately after sample collection and until the completion of analyses, all samples will be preserved in accordance with the requirements of the intended analytical methods.

D.5 DATA REDUCTION, VALIDATION, AND REPORTING

The procedures used for calculations and data reduction are specified in each analytical method referenced previously. Raw data are entered in laboratory benchsheets and/or notebooks. A separate benchsheet will be maintained for each analytical procedure. Calculations will include factors such as sample dilution ratios, corrections for blank readings, and conversion to dry-weight basis for solid samples, if required by the method. Further, data reduction and reporting procedures specific to the engineering studies are described in Section 4.

Data are generally reported as micrograms per kilograms for solid or non-aqueous liquid (sediment) samples. Concentration units are always listed on reports and any special conditions, such as dry weight conversions, are noted. In all cases the actual units reported will be consistent with the units specified in the appropriate method. The data reporting form also includes the unique sample number given each sample, details of sample receipt and report preparation. The data generated by each analytical method will be validated by comparing its QC report with the QC acceptance criteria specified for that method.

D.5.1 Field Analyses

During processing of field data, validation checks will be performed by individuals designated by the project manager. The purpose of these checks is to identify "outliers"; that is, data which does not conform to the pattern established by other observations. Because of the limited number of observations, detailed statistical analysis of the data to be obtained during engineering support studies may not be feasible and the principal method of validation will be routine checks to assure that data is correctly transcribed and that reported identification codes and sampling information match the corresponding information in the field records. In addition, data will be compared against that obtained in previous investigations (where available) and against applicable standards and guidelines.

Although outliers may be the result of transcription errors or instrumental breakdowns, they may also be manifestations of a greater degree of spatial or temporal variability than expected. Therefore, after an outlier has been identified, a decision must

be made concerning its further use. Obvious mistakes in data will be corrected when possible, and the correct value will be inserted. If the correct value cannot be obtained, the data may be excluded. An attempt will be made to explain the existence of the outlier. If no plausible explanation can be found for the outlier, it may be excluded, but a note to that effect will be included in the report. Also, an attempt will be made to determine the effect of the outlier when both included and excluded in the data set and the results will be discussed in the report.

All field analytical data and validation will be assembled in hard-copy format for subsequent comparisons, evaluation and reporting. All such records will become part of the project file.

D.5.2 Laboratory Analyses

Laboratory QC data are recorded on the QC report forms for the appropriate tests and correlated to the analysis results by the laboratory lot control numbers. The QC results are used to prepare control charts for each test and matrix type. At a minimum, QC reports will contain the following items:

- Narrative describing any non-compliant samples
- Initial and continuing calibration results
- Method blank
- Surrogate results, and
- Matrix spike/matrix spike duplicate results.

All analytical data and QC reports will be assembled in hard-copy and/or electronic formats for subsequent comparisons, evaluation and reporting. All such records will become part of the project file.

D.6 INTERNAL QUALITY CONTROL CHECKS

The internal quality control checks for the analytical laboratory will be based on the guidance provided in SW-846 and the ASTM documents.

D.7 FIELD QUALITY CONTROL

Quality control checks for all samples taken during the engineering support study will be provided by field QC sampling. Duplicate samples will be collected at a frequency of 10 percent of the study samples for all analyses.

D.8 SYSTEM AND PERFORMANCE AUDITS

D.8.1 System Audits

System audits, performed by the Laboratory Quality Assurance Manager or his designee, will encompass evaluation of QA components to ascertain their appropriate

selection and application. In addition, laboratory QC procedures and associated documentation will be audited. If conditions adverse to quality are detected, the engineering study Project Manager may request the Project Quality Assurance Manager to perform unscheduled audits.

D.8.2 Performance Audits

The laboratory routinely analyzes performance evaluation samples as required by state certification. Blind QC samples may be submitted along with project samples by the Project Manager during the engineering support studies.

D.9 PREVENTATIVE MAINTENANCE OF LABORATORY INSTRUMENTS

Analytical instruments will be serviced at intervals recommended by the manufacturer. Service contracts for regular maintenance and emergency service will be maintained for major instruments. An instrument repair maintenance log book will be maintained for each instrument. Entries will include the date of service, type of problem encountered, corrective action taken, and initials and affiliation of the person providing the service.

The instrument use log book will be monitored by the analysts to detect any degradation of instrument performance. Changes in response factors or sensitivity will be used as indication of potential problems. Where available, back-up instrumentation and an inventory of critical spare parts will be maintained to minimize delays in completion of analyses.

D.10 DATA ASSESSMENT PROCEDURES

D.10.1 Accuracy

The percent recovery (PR) is calculated as below:

$$PR = \frac{S_s - S_o}{S_A} \times 100$$

S_o = The background value, value obtained by analyzing the sample, (= Ø for surrogate spikes).

S_A = Concentration of the spike added to the sample.

S_s = Value obtained by analyzing the sample with the spike added.

PR = Percent Recovery

D.10.2 Precision

The relative percent difference (RPD) is calculated as below:

$$RPD = \frac{|V_1 - V_2|}{(V_1 + V_2)/2} \times 100$$

$V_1, V_2 =$ The 2 values obtained by analyzing the duplicate samples

D.10.3 Completeness

The percent complete (PC) is calculated as follows:

$$PC = \frac{N_A}{N_I} \times 100$$

$N_A =$ Actual number of valid analytical results obtained

$N_I =$ Theoretical number of results obtainable under ideal conditions.

The validity of the analytical results will be judged by determining the suitability for their intended use or uses.

D.11 DOCUMENT CONTROL

The project files will include background documents, project plans, photographs, field and laboratory analytical data (including all raw and summary data), laboratory documents, and all interim/final reports.

D.11.1 Contractor Initiated Documents

The engineering support studies contractor will be the originator of a variety of documents. These documents may include the following:

- Documentation Related to Work Performance
- Correspondence
- Accident and Safety Reports
- Project Schedules
- Photographs
- Analytical Reports

Analytical reports will be transmitted from the laboratory to the Project QA Officer. Upon receipt, the analytical data will be stamped "Received" followed by the date of receipt. The data will be maintained in the project file.

D.11.2 Record Status

To prevent the inadvertent use of obsolete or superseded project-related procedures, all personnel of the laboratory and project staffs will be responsible for reporting changes in protocol to the Project Manager and/or the Laboratory Manager. The Project Manager

and/or Laboratory Manager will then inform the project and laboratory staffs and the Project QA Officer of these changes.

D.11.3 Record Storage

All project related information will be maintained by the Project Manager. Designated personnel will assure that incoming records are legible and are in suitable condition for storage.

Record storage will be performed in two stages:

- Storage during and immediately following the project
- Permanent storage of records directly related to the project

Both stages will use storage facilities that provide a suitable environment to minimize deterioration or damage and that prevent loss. The facilities will, where possible, have controlled access and will provide protection from excess moisture and temperature extremes. Records will be secured in steel file cabinets labeled with the appropriate project identification.

D.12 CORRECTIVE ACTIONS

The following procedures have been established to assure that conditions adverse to quality, such as malfunctions, deficiencies, deviations, and errors, are promptly investigated, evaluated, and corrected.

When a significant condition adverse to quality is noted at the laboratory, the cause of the condition will be determined and corrective action taken to preclude repetition. Condition identification, cause, reference documents, and corrective action planned to be taken will be documented and reported to the project manager. Implementation of corrective action will be verified by follow-up action. All project personnel have the responsibility, as part of the normal work duties, to promptly identify, correct, and report conditions adverse to quality.

Corrective actions may be initiated as a minimum:

- When predetermined acceptance standards are not attained (objectives for precision, accuracy and completeness)
- When procedures or data compiled are determined to be faulty
- When equipment or instrumentation is found faulty
- When samples and test results are questionably traceable
- As a result of system and performance audits

Table D.1. Quality Assurance Project Plan Elements Engineering Support Studies

	Element	Section
1.	Project Objectives	1.1
2.	Project Description	1.2
3.	QA Objectives for Measurement	D.1
4.	Sediment Sampling Procedures	Appendix A
5.	Sample Custody	D.2
6.	Calibration Procedures	D.3
7.	Analytical Procedures	D.4
8.	Data Reduction, Validation and Reporting	D.5
9.	Internal Quality Control	D.6
10.	Performance and System Audits	D.8
11.	Preventative Maintenance	D.9
12.	Data Assessment Procedures	D.10
13.	Corrective Actions	D.12
14.	Quality Assurance Reports	D.13

D.13 QUALITY ASSURANCE REPORTS

The engineering support studies report (Section 3.5) should present a summary of QA/QC activities implemented during the study.

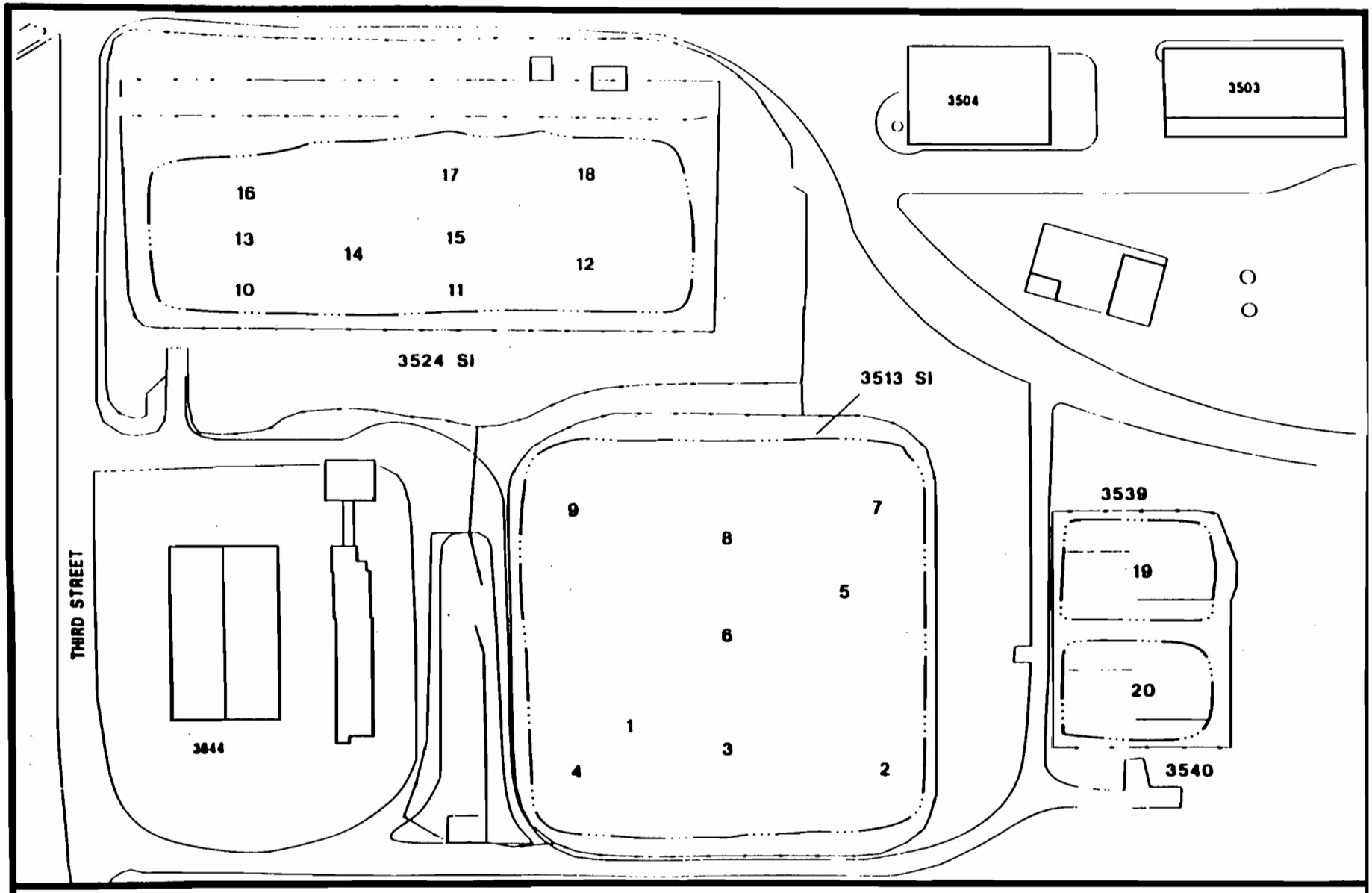
TABLE D.1

Quality Assurance Project Plan Elements
Engineering Support Studies

	Element	Section
1.	Project Objectives	1.1
2.	Project Description	1.2
3.	QA Objectives for Measurement	D.1
4.	Sediment Sampling Procedures	Appendix A
5.	Sample Custody	D.2
6.	Calibration Procedures	D.3
7.	Analytical Procedures	D.4
8.	Data Reduction, Validation and Reporting	D.5
9.	Internal Quality Control	D.6
10.	Performance and System Audits	D.8
11.	Preventative Maintenance	D.9
12.	Data Assessment Procedures	D.10
13.	Corrective Actions	D.12
14.	Quality Assurance Reports	D.13

Appendix E

RADIOCHEMICAL DATA FROM 1994 SEDIMENT SAMPLING AT IMPOUNDMENTS



Sediment sampling points for the Surface Impoundments OU Remedial investigation

CDM FEDERAL PROGRAMS CORPORATION

Oak Ridge National Laboratory

Fig. B4.1

Table B4.1. Radionuclide activities in sediment samples from Impoundment 3524

Analyte	Units	ID 24-10	ID 24-11	ID 24-12	ID 24-13	ID 24-14	ID 24-15	ID 24-16	ID 24-17	ID 24-18	ID 24-19
Plutonium-238	Bq/g	3.85	51.35	23.86	17.87	110.54	16.80	5.70	131.99	13.95	15.87
Plutonium-239,240	Bq/g	13.24	725.86	266.3	166.85	1763.23	302.92	13.32	2660.38	81.80	145.69
Thorium-228	Bq/g	0.88	0.09	8.36	14.33	15.27	9.04	3.66	36.66	5.36	6.05
Thorium-230	Bq/g	0.07	0.92	0.77	0.26	1.26	2.22	0.50	3.05	0.95	1.35
Thorium-232	Bq/g	0.09	4.65	2.34	0.40	8.25	6.58	1.17	23.64	1.51	3.36
Uranium	μg/g	24.00	388.00	176.00	86.00	744.00	259.00	64.00	1585.00	108.00	125.00
Uranium-234	Bq/g	0.33	5.36	2.44	1.19	10.32	5.40	0.89	21.98	3.00	2.60
Uranium-235	Bq/g	0.01	0.22	0.09	0.03	0.39	0.14	0.03	0.87	0.06	0.07
Uranium-238	Bq/g	0.30	4.77	2.18	1.06	9.17	3.20	0.79	19.57	1.33	1.54

Source: Remedial Investigaiton, 1994.

Table B4.4. Radionuclide activities in sediment samples from Impoundment 3513

Radionuclide	Units	ID 13-01	ID 13-02	ID 13-03	ID 13-04	Dup 13-04	ID 13-05	ID 13-06	ID 13-07	ID 13-08	ID 13-09
Plutonium-238	Bq/g	18.3	< 1.26	< 0.85	1.22	26.67	< 1.70	22.12	2.15	< 1.26	5.96
Plutonium-239,240	Bq/g	239.99	194.82	84.57	207.25	56.79	153.68	334.67	135.48	186.20	236.96
Thorium-228	Bq/g	11.10	12.31	2.5	10.78	73.33	6.92	8.92	7.60	5.48	7.11
Thorium-230	Bq/g	1.68	2.22	0.43	1.10	3.59	1.22	1.35	1.16	1.05	1.26
Thorium-232	Bq/g	8.97	9.74	2.17	5.86	20.53	5.17	11.62	6.33	5.77	9.06
Uranium	μg/g	363.00	525.00	2,675.00	271.00	960.00	2,778.00	964.00	242.00	2,016.00	1,252.00
Uranium-234	Bq/g	5.03	6.07	30.93	3.77	13.54	32.11	8.92	3.36	29.97	17.35
Uranium-235	Bq/g	0.20	0.30	1.52	0.15	0.54	1.58	0.54	0.14	1.14	0.71
Uranium-238	Bq/g	4.48	6.47	33.04	3.35	12.02	34.30	11.91	2.99	24.90	15.46

Source: Remedial Investigation data, 1994.

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Table B4.7. Radionuclide activities in interstitial waters from core samples from Impoundment 3524

Analyte	Units	ID 24-10	ID 24-11	ID 24-12	ID 24-13	ID 24-14	ID 24-15	ID 24-16	ID 24-17	ID 24-18	Dup 24-18
Gross alpha	Bq/L	26.6	52.0	23.4	61.1	18.5	24.0	25.0	31.1	22.4	19.3
Gross beta	Bq/L	1417.1	2763.1	848.5	696.0	528.2	1430.0	721.8	323.1	1092.7	111.73
Cerium-144	Bq/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cesium-134	Bq/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.1
Cesium-137	Bq/L	1.11	321.9	68.4	39.6	13.0	144.6	160.2	41.1	88.4	102.8
Chromium-51	Bq/L	28.0	ND	1.6	1.3	0.9	ND	0.7	ND	1.6	0.5
Cobalt-57	Bq/L	0.5	0.3	0.03	0.4	0.4	0.2	0.4	0.7	3.2	1.9
Cobalt-58	Bq/L	0.4	0.3	ND	ND	0.1	0.3	ND	0.4	ND	ND
Cobalt-60	Bq/L	11.1	8.0	4.7	2.4	2.0	6.2	3.1	27.8	4.1	3.7
Iron-59	Bq/L	ND	ND	ND	ND	ND	ND	ND	ND	1.9	0.6
Manganese-54	Bq/L	0.3	0.1	0.1	ND	0.1	0.1	ND	0.1	ND	0.6
Niobium-95	Bq/L	ND	ND	ND	ND	ND	ND	ND	ND	2.5	0.2
Potassium-40	Bq/L	4.6	ND	1.6	ND	ND	0.1	1.3	ND	0.8	ND
Ruthenium-106	Bq/L	0.7	ND	0.5	ND	1.9	ND	0.1	0.6	0.1	ND
Sodium-22	Bq/L	0.1	ND	0.3	0.3	0.2	ND	ND	0.5	ND	0.6
Strontium	Bq/L	850.9	1035.9	321.9	362.6	192.4	355.2	3700.0	111.0	444.0	628.9
Strontium-89	Bq/L	148.0	554.9	125.8	74.0	136.9	55.5	ND	18.5	196.1	55.5
Antimony-125	Bq/L	ND	ND	ND	3.8	ND	0.5	3.8	ND	0.5	ND
Thallium-208	Bq/L	ND	ND	ND	ND	ND	1.5	ND	ND	1.5	0.9
Zinc-65	Bq/L	1.0	ND	0.2	ND	ND	ND	ND	ND	ND	2.0
Zirconium-95	Bq/L	ND	ND	ND	ND	ND	7.3	ND	ND	7.3	0.4
Bismuth-212	Bq/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lead-212	Bq/L	ND	ND	0.9	ND	0.2	0.2	ND	0.2	0.9	0.5
Uranium-235	Bq/L	ND	ND	ND	ND	ND	ND	ND	ND	148.0	0.7

Source: Remedial Investigation data, 1994.

ND = Not Detected

Table B4.8. Radionuclide activities in interstitial waters from core samples from Impoundment 3513

Analyte	Units	ID 13-01	ID 13-02	ID 13-03	ID 13-04	Dup 13-04	ID 13-05	ID 13-06	ID 13-07	ID 13-08	Dup 13-09
Gross alpha	Bq/L	38.5	23.0	18.4	11.0	29.9	12.48	22.0	33.3	13.76	13.04
Gross beta	Bq/L	1024	1370	668	579	1040	596	959	838	822	876
Cesium-137	Bq/L	340	266	57.7	61.4	55.5	459	181	477	255	265
Chromium-51	Bq/L	ND	ND	0.459	ND	ND	0.651	1.87	2.35	ND	ND
Cobalt-57	Bq/L	0.150	0.540	0.077	0.237	0.177	0.910	0.149	0.141	0.426	.0907
Cobalt-58	Bq/L	0.0907	ND	0.013	ND	ND	ND	ND	0.291	ND	0.168
Cobalt-60	Bq/L	1.38	1.07	0.303	0.611	0.555	4.51	1.10	1.81	1.31	3.06
Lead-212	Bq/L	ND	ND	ND	0.266	0.095	ND	.0714	ND	ND	0.178
Manganese-54	Bq/L	ND	0.529	.016	ND	0.128	ND	.0052	ND	ND	ND
Potassium-40	Bq/L	0.168	1.92	ND	ND	ND	2.42	3.10	0.773	ND	3.37
Ruthenium-106	Bq/L	0.607	ND	1.04	0.448	.625	4.88	.088	5.59	300	3.38
Sodium-22	Bq/L	0.0503	0.047	.0925	0.128	ND	0.765	ND	0.262	59.2	0.129
Strontium	Bq/L	444	407	277	233	322	74	292	344	ND	407
Strontium-89	Bq/L	70.3	77.7	51.8	48.1	30.0	88.8	159	48.1	ND	77.7
Thallium-208	Bq/L	ND	ND	ND	ND	0.251	ND	0.37	ND	ND	ND
Zinc-65	Bq/L	.0648	ND	0.133	ND	0.243	ND	ND	ND	ND	ND

Source: Remedial Investigation data, 1994.

ND = Not Detected

Table B4.9. Radionuclide activities in sediment samples from Impoundments 3539 and 3540

Radionuclide	Activity (Bq/g)	Impoundment 3539	Impoundment 3540
Plutonium-238	Bq/q	ND	20.0
Plutonium-239,240	Bq/q	162.0	25.0
Thorium-228	Bq/q	70.0	73.9
Thorium-230	Bq/q	11.1	9.3
Thorium-232	Bq/q	85.7	86.1
Uranium	μg/g	168.0	153.0
Uranium-234	Bq/q	199.0	105.0
Uranium-235	Bq/q	4.2	3.9
Uranium-238	Bq/q	55.8	50.8

Source: Remedial Investigation data, 1994.

ND = Not Detected

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