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Preconceptual Design Retrieval Alternatives for the Pit 9 Remediation Project

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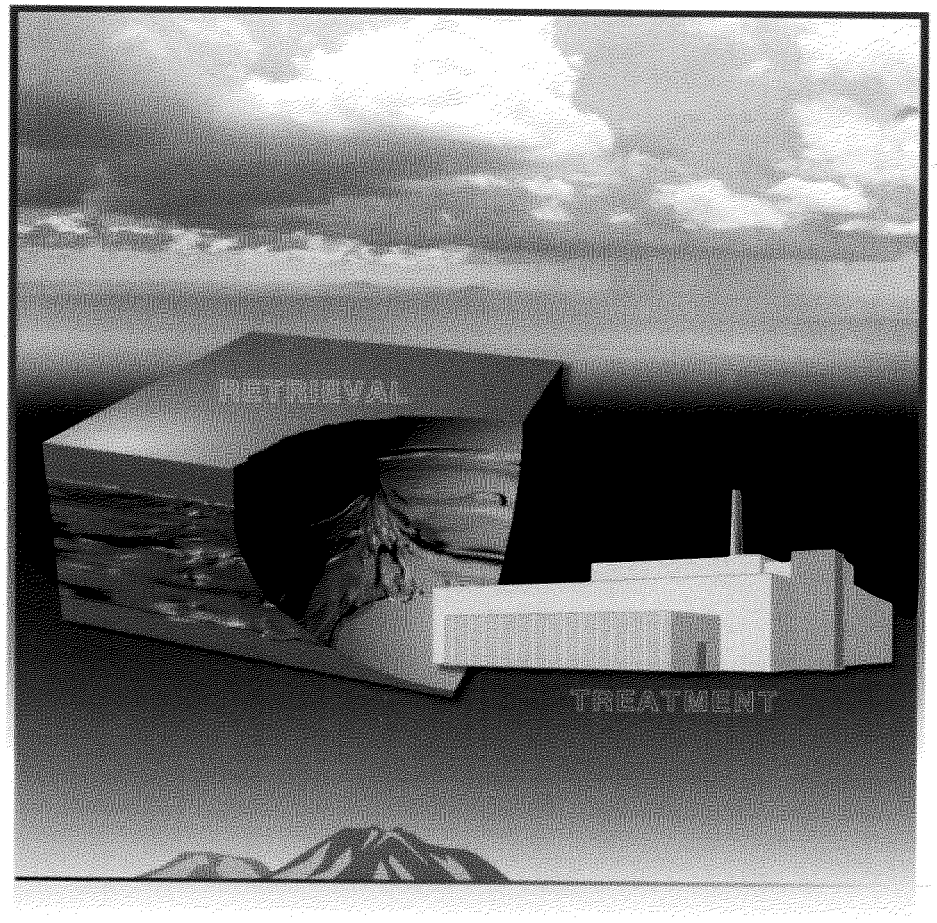

Idaho Completion Project - Bechtel BWXT Idaho, LLC

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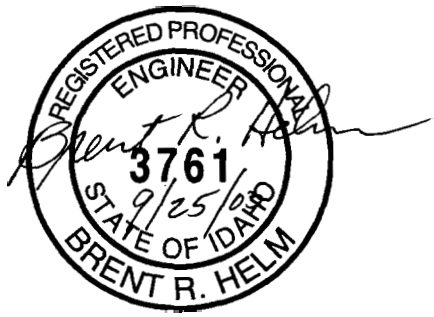
PRECONCEPTUAL DESIGN RETRIEVAL ALTERNATIVES FOR THE PIT 9 REMEDIATION PROJECT

The following report was prepared under the direction of the Professional Engineer as indicated by the seal and signature provided on this page.



Brent R. Helm

ABSTRACT

Recommendations for conducting the Pit 9 Remediation Project include conducting the retrieval portion of the project within a confinement structure using the Front-End Loader–Backhoe Method (Alternative 2). The objectives of the retrieval process are to excavate the overburden, contaminated waste (including transuranic), and underburden from the pit; transport the excavated waste to a characterization and treatment facility; and backfill the pit with underburden retrieved during pit excavation, appropriately treated waste, and new overburden. The commonalities and differences in the retrieval alternatives considered to accomplish the objective are based on the type and location of the equipment used to excavate and backfill the pit. A team of experts from varying work disciplines evaluated the preconceptual design alternatives identified during a previous technology evaluation and value engineering study. The team selected the Front-End Loader–Backhoe Method (Alternative 2) as the retrieval alternative for conceptual design, and a large, open primary and secondary structure that covers the entire pit as the confinement structure.

EXECUTIVE SUMMARY

As part of its energy legacy, the Idaho National Engineering and Environmental Laboratory (INEEL) has supported the nuclear energy mission of the United States, both as a research and a waste management facility. Department of Energy (DOE) commitments to the state of Idaho and the United States Environmental Protection Agency drive the need to remediate transuranic (TRU) waste buried in the Pit 9 site at the INEEL. The Pit 9 site was a subsurface disposal facility for containerized radioactive and mixed waste from November 1967 to June 1969. These wastes, which included buried transuranic waste (TRU) from the DOE Rocky Flats Plant, now present a potential risk to the Snake River Plain aquifer due to vapor-phase and subsurface aqueous transport of contaminants. Reducing this risk is the focus of the Pit 9 Remediation Project.

New retrieval facilities and equipment are needed to accomplish Pit 9 remediation. Consequently, a technology evaluation was performed using a structured value engineering process to identify confinement and retrieval alternatives for the Pit 9 Remediation Project and down-select those most promising for hrther evaluation. Alternatives identified as too complex, ineffective, inefficient, or unproven were eliminated from hrther consideration.

An evaluation team chose a large, open primary and secondary structure covering the entire pit as the confinement structure. In addition, three retrieval alternatives were chosen for additional evaluation and were developed hrther to ensure effective comparison and analysis:

- Backhoe–Crane Method (Alternative 1). This alternative uses a remotely controlled backhoe, overhead crane, and automatic guided vehicle (AGV) to excavate the pit. Overburden and underburden are excavated and loaded into hoppers by the above grade backhoe and transferred by the crane and AGV to designated locations. Waste material is loaded into boxes by the above grade backhoe, which are moved to the transfer location by the crane and transported to the characterization and treatment area by an AGV. Characterized and treated waste is packaged in boxes, grouted, and replaced in the pit by the AGV and crane. Underburden and overburden are backfilled by the crane and leveled and compacted by a remotely controlled compactor.

- Front-End Loader–Backhoe Method (Alternative 2). This alternative uses a backhoe to excavate and pile the overburden and underburden, and a front-end loader to excavate the waste seam and transport the backhoe soil piles to designated locations. The front-end loader or an AGV can transport waste to the treatment and characterization facility. The backhoe may also assist the loader during waste excavation as needed. Characterized and treated waste is packaged and grouted in boxes and placed back in the pit with a forklift/loader. Underburden and overburden are placed, leveled, and compacted by the loader.

- Backhoe-Forklift Method (Alternative 3). This alternative uses a backhoe to excavate pit materials into boxes and a forklift/AGV combination to transport the excavated material to designated locations. Characterized and treated waste is packaged and grouted in boxes and replaced in the pit by the forklift/loader. Underburden and overburden are backfilled by the AGV/forklift and leveled and compacted by a remotely controlled compactor.

A team of experts from varying work disciplines selected the Front-End Loader–Backhoe Method (Alternative 2) as the retrieval alternative for conceptual design. Alternative 2 not only received the highest score in the value engineering session, but also the highest ranking in the Pit 9 Retrieval Alternate Selection Meeting. The meeting record is included in Appendix F. The scoring results from the meeting are depicted in Figure E-1. The total score represents the normalized scores of each alternative relative to the scores of all three alternatives. The sum of all three alternatives equals 1.00. As depicted, the major scoring difference favoring Alternative 2 was in the area of technical feasibility.

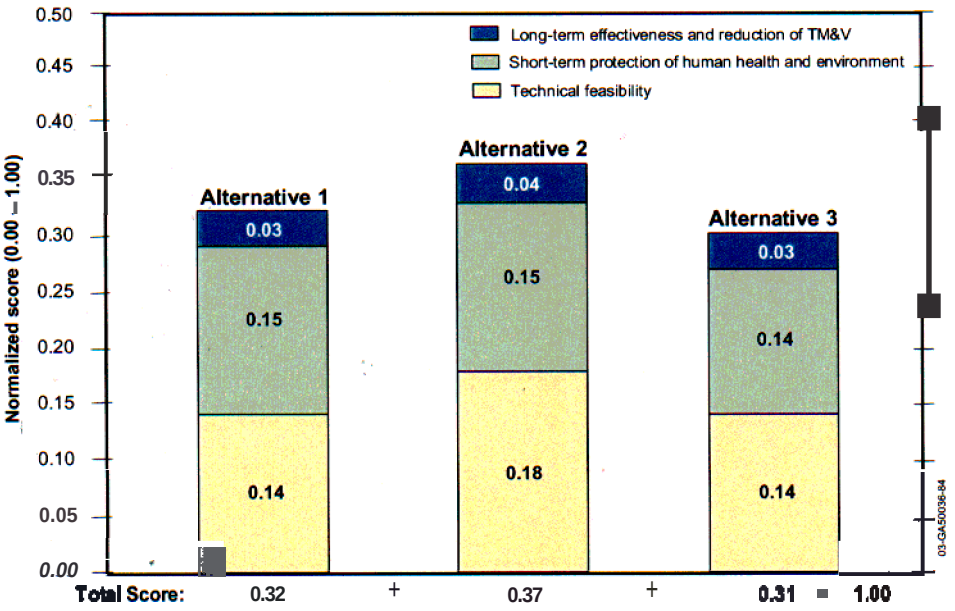


Figure E-1. Scoring of retrieval alternatives.

The advantages to Alternative 2 over the other alternatives are as follows:

- Lowest estimated capital and life-cycle cost. The estimated capital costs were approximately $3 million lower than Alternative 3 and $24 million lower than Alternative 1. The estimated life-cycle cost was $1 million lower than Alternative 3 and $48 million lower than Alternative 1.

a Simpler, more easily decontaminable confinement structure. The confinement structure for Alternative 2 is lower in height (4 ft).

- Transport containers are not required to move waste from the retrieval area.
- Larger objects can be moved without breaking them up.
- Larger quantities of waste material can be delivered to the characterization location with fewer disturbances.
- The generation of dust and spread of contamination caused by dumping into transport boxes is eliminated.
- Waste removal will take less operating time.
- The mobile equipment can be used for other retrieval projects.

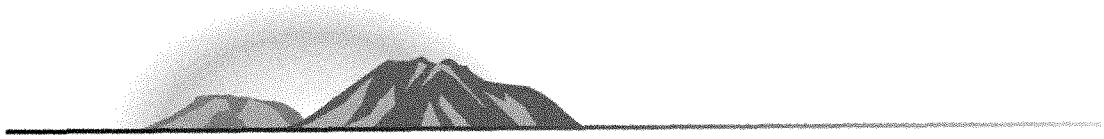
Alternative 2 does have a higher level of unmitigated technical and safety risks than Alternative 1, but the differences are slight and mitigation of the risks is included in the present design concept. Most of the differences in the preliminary risk assessment between the alternatives were in the area of safety risks that can be mitigated through design features.

The recommended alternative established through this preconceptual design study will be hrther developed and documented in a conceptual design report scheduled for completion in September 2004.

CONTENTS

FIGURES

TABLES



ACRONYMS

AGV	automatic guided vehicle
CAS	criticality alarm system
DD&D	deactivation, decontamination, and decommissioning
DOE	Department of Energy
DOE-ID	Department of Energy Idaho Operations Office
EDF	Engineering Design File
EPA	Environmental Protection Agency
GEM	Glovebox Excavator Method
HEPA	high-efficiency particulate air (filter)
HVAC	heating, ventilating, and air conditioning
IBC	International Building Code
INEEL	Idaho National Engineering and Environmental Laboratory
LHD	load-haul-dump
LMAES	Lockheed Martin Advanced Environmental Systems
NFPA	National Fire Protection Association
OU	Operable Unit
ROD	Record of Decision
RWMC	Radioactive Waste Management Complex
SAR	Safety Analysis Report
SDA	Subsurface Disposal Area
SOW	scope of work
SSC	systems, structures, and components
TRU	transuranic
VC	value engineering
VOC	volatile organic compound

Preconceptual Design Retrieval Alternatives for the Pit 9 Remediation Project

1. INTRODUCTION

This preconceptual design report presents the waste retrieval alternative down-selection process and supporting designs for the retrieval portion of the Pit 9 Remediation Project at the Idaho National Engineering and Environmental Laboratory (INEEL).

1.1 Background

The INEEL is a U.S. Department of Energy (DOE) facility located 52 km (32 mi) west of Idaho Falls, Idaho. It occupies 2,305 km^2 (890 mi^2) of the northeastern portion of the Eastern Idaho Snake River Plain. The Radioactive Waste Management Complex (RWMC) is located in the southwestern portion of the INEEL (see Figure 1). The Subsurface Disposal Area (SDA) is a 39-ha (97-acre) area located within the RWMC, which is part of Waste Area Group 7—the designation for the RWMC used in the *Federal Facility Agreement and Consent Order for the Idaho National Engineering Laboratory* (DOE-ID 1991). The *Federal Facility Agreement and Consent Order* integrates the response obligations imposed by the *Comprehensive Environmental Response, Compensation and Liability Act* (CERCLA; 42 USC § 9601 et seq.) and corrective action obligations imposed by the *Resource Conservation and Recovery Act* (RCRA; 42 USC § 6901 et seq.) and *Hazardous Waste Management Act* (Idaho Code § 39-4401 et seq.) at the INEEL that relate to the release(s) of hazardous substances.

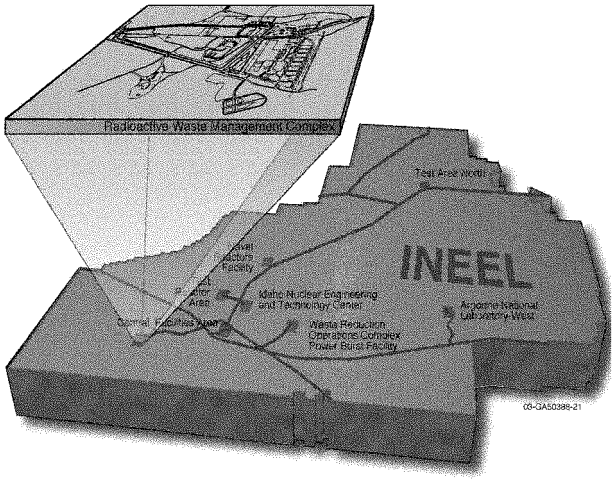


Figure 1. The Radioactive Waste Management Complex (RWMC) is located in the southwestern portion of the INEEL.

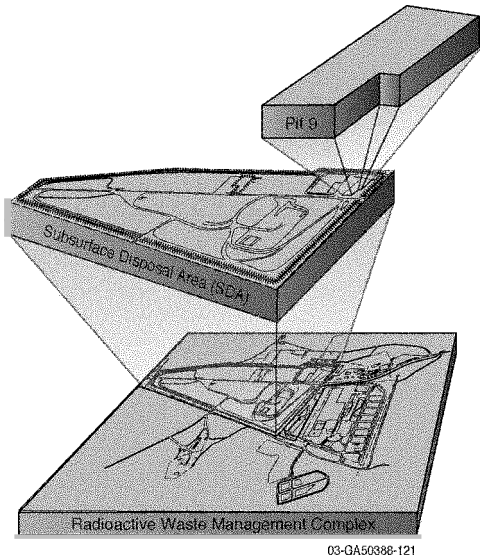


Figure 2. Graphic representation of the RWMC showing an expanded view of the Pit 9 Remediation Project area.

Waste Area Group 7 is subdivided into 13 Operable Units (OUs). OU 7-10, referred to in this report as Pit 9, is located in the northeast corner

of the SDA (see Figure 2). From 1967 through 1969, chemicals, radioactive materials, and sludge from DOE weapons plants were buried in Pit 9. These materials contain characteristic-hazardous, listed-hazardous, low-level radioactive, and TRU waste.

In 1993, the *OU 7-10 Interim Action Record of Decision* (ROD) (DOE-ID 1993) was signed. The associated *Remedial Design/Remedial Action Scope of Work and Remedial Design Work Plan: Operable Unit 7-10 (Pit 9 Project Interim Action)* (EG&G 1993) documented the schedule and approach for the implementation of the *OU 7-10 Interim Action ROD*. The DOE management and operating contractor subcontracted with Lockheed Martin Advanced Environmental Systems (LMAES) to perform the *OU 7-10 Scope of Work* **(SOW;** EG&G 1993).

The INEEL revised the OU 7-10 **SOW** in 1995 (LMITCO 1995) to address details for design, construction, and operation approaches. This resulted in significant changes in the cost estimates for the *OU 7-10 Interim Action ROD,* which in turn required the issuance of the *Explanation of Significant Differences for the Pit 9 Interim Action Record of Decision at the Radioactive Waste Management Complex at the Idaho National Engineering Laboratory* (DOE-ID 1995).

DOE prepared a contingency plan to accommodate the possibility that LMAES might not fulfill the terms of the 1993 OU 7-10 **SOW** (EG&G 1993). This contingency plan developed into the staged interim action approach formalized in the revised OU 7-10 **SOW,** *Remedial Design/Remedial Action Scope of Work and Remedial Design Work Plan: Operable Unit 7-10 (Pit 9 Project Interim Action)* (LMITCO 1997) issued in 1997. The revised OU 7-10 **SOW** (LMITCO 1997) identified performance objectives, deadlines, and deliverables in the event that the LMAES contract was not completed. The LMAES contract was subsequently terminated and the INEEL began work on the Staged Interim Action Project.

The *1998 Explanation of Significant Differences (ESD) to the OU 7-10 Interim Action ROD* (DOE-ID 1998), which launched the Staged Interim Action Project, also formalized the alternative of the three-stage (Stages I, II, and 111) approach for satisfying the requirements of the *OU 7-10 Interim Action ROD,* its two associated ESDs (DOE-ID 1995, 1998), and the *Remedial Design/Remedial Action SOW* (LMITCO 1997). The three stages of the Staged Interim Action Project are as follows:

- Stage I – Subsurface exploration of Pit 9 to support citing of Stage II
- Stage II (also referred to as the Glovebox Excavator Method [GEM]) – Limited waste retrieval demonstration of a select area of Pit 9 including excavation and retrieval of waste-zone material and overburden soils, as well as characterization, packaging, and storing retrieved waste-zone material. Stage II also includes design, procurement, construction, and subsequent removal of project facilities and equipment from the pit surface as well as underburden sampling and analysis.
- Stage III (Pit 9 Remediation Project) – Overall remediation of Pit 9 using information from Stage II.

1.2 Scope

This report (a) establishes and documents the technical baseline for the retrieval portion of the project, (b) provides descriptions of alternatives evaluated, (c) provides the basis for down-selection to a single preferred retrieval alternative, (d) provides a basis for conceptual design planning, (e) establishes budgetary cost estimate information, (f) provides a basis for preliminary safety analysis.

1.3 Objectives and Assumptions

The Pit 9 Remediation Project objectives are to retrieve approximately 500,000 ft^3 of waste and interstitial soil material from Pit 9, transport it to a characterization and treatment facility, return material with ≤100 nCi/g[1] TRU content to the excavation site, and provide preliminary closure of the pit.

The retrieval system will include remotely-operated excavation equipment performing multiple-passes of top-down retrieval of pit contents controlled within a large, open, primary-confinement building. Selected pieces of remotely operated equipment will remove overburden, waste, and underburden; transfer the required material to a characterization facility; return acceptable materials to the pit for final disposition; and backfill the pit.

The basis for design, used in developing these preconceptual design retrieval alternatives is documented in the *Mission Analysis and Definition for the Operable Unit 7-10 Stage III Project* (INEEL 2002) and the "Waste Retrieval Process Technology Search for the OU 7-10 Stage III Project" (EDF-4025 2003). See the accompanying CD for an electronic version of EDF-4025.

This preconceptual design effort made the following key programmatic assumptions in developing the three alternatives identified in this report for hrther study and selecting the final alternative for conceptual design:

- Material contaminated with ≤100 nCi/g of TRU and/or contaminated with VOCs below a predetermined action level will be returned to the pit.
- The *OU 7-10 Interim Action ROD* assumed that one-half the retrieved material would be contaminated with TRU isotopes at levels greater than 10 nCi/g. For lack of data on the extent of migration of TRU or other contamination, it is still assumed that one-half of the material retrieved from the pit will be contaminated with TRU isotopes but now at levels >100 nCi/g. This was hrther interpreted to mean that 50% of the soil and 50% of the waste will be contaminated with TRU isotopes at levels >100 nCi/g.
- Material returned to the pit must be stabilized to meet structural requirements to minimize subsidence of a future cap.
- Objects located in the pit and that are too large for a container or treatment are stabilized in place or moved to a dedicated pit location and stabilized.
- High radiation objects will be stabilized in place or moved to a new pit location and stabilized.
- Waste outside the defined pit boundaries will not be retrieved.
- All Lockheed Martin Advanced Environmental Systems (LMAES) structures and equipment, except for the sheet piles and concrete, will be removed by others before construction begins.

1. Subject to agreement between the Idaho Department of Environmental Quality, EPA Region X, and DOE.

In addition, the following key design assumptions will be validated during conceptual design or a later phase of the design process:

- The retrieval facility will be classified as Hazard Class II because, to date, all facilities located at the RWMC are classified to this level, a sufficient quantity of releasable radionuclides exists inside the pit, and the potential for a criticality occurrence exists.
- The retrieval building will have a secondary confinement. This assumption is based on engineering judgment, since the Preliminary Documented Safety Analysis (PDSA) has not been completed.
- The overburden located between the upper 2 to 3 ft and within 1 ft of the waste seam will be potentially contaminated.
- Excavation will be accomplished by remotely controlled equipment, rather than manned equipment.
- Clean overburden can be transported and staged on the SDA, without packaging.
- Potentially contaminated overburden can be staged inside the Pit 9 confinement without packaging.

Secondary assumptions are identified in the body of this report.

1.4 Retrieval Alternatives Selection Methodology

At the outset, a number of potential equipment and methods were considered feasible for retrieving waste from Pit 9. This preconceptual design analysis evaluates the technology alternatives for retrieving waste from the pit, and recommends a final solution for conducting a conceptual design. This report documents the results of Steps 3 and 4 of the following 4-step process:

1. Perform a technology search to review the potential alternatives available for waste retrieval equipment and facility design
2. Conduct a technology evaluation of retrieval options to down-select three to six alternatives for hrther design and evaluation
3. Develop a more detailed design and evaluation of the selected alternatives
4. Select a final alternative to recommend for conceptual design.

Step 1 has been accomplished. Engineers experienced in the technical areas of confinement, excavation, transport, material handling, and contamination control evaluated potential technologies. Their evaluation is documented in "Waste Retrieval Process Technology Search for the OU 7-10 Stage III Project" (EDF-4025 2003).

Step 2 has been accomplished. A technology evaluation of retrieval options for the Pit 9 Remediation Project was performed and documented in the *Technology Evaluation of Retrieval Options for the Pit 9 Remediation Project* report (INEEL 2003b) to identify retrieval alternatives for the Pit 9 Remediation Project and down-select alternatives for hrther evaluation. (An electronic copy of INEEL

2003b can be found on the accompanying CD.) A value engineering (VE) process was used to accomplish this objective. The following three alternatives were selected for hrther evaluation:

- Backhoe–Crane Method (Alternative 1)
- Front-End Loader–Backhoe Method (Alternative 2)
- Backhoe–Forklift Method (Alternative 3)

Section 2 describes the three retrieval process alternatives selected as described in the previous paragraph and completes Step 3.

Section 7 describes the evaluation process and subsequent recommendation for the conceptual design and completes Step 4.