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Review of Transuranic Waste Retrieval Plans for Area G, Technical Area 54, Los Alamos National Laboratory

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Prepared by Environmental Programs–Environment and Remediation Support Services

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EXECUTIVE SUMMARY

This report summarizes Los Alamos National Laboratory's (the Laboratory's) plans for retrieving transuranic waste at Area G at Technical Area 54. This information will be used during the preparation of the corrective measure evaluation report for Material Disposal Area (MDA) G.

Currently, the total volume of transuranic (TRU) wastes stored at Area G is approximately 100,000 m^3. Approximately one-third of the waste is stored in belowgrade, earthen-covered configurations that include Pit 9, the corrugated-metal-pipe site, Shafts 302–306, the remote-handled shafts (16 Waste Isolation Pilot Plant canisters, 33 lined shafts, and tritium cylinders in unlined shafts), and Trenches A–D. Radionuclides of concern include americium-241 and various plutonium isotopes in the pits and corrugated metal pipes, plutonium-238 in the trenches, and mostly mixed fission products and some plutonium in the shafts.

In anticipation of TRU waste-retrieval activities at Area G, the Laboratory has started the planning and scheduling necessary for successful execution of those retrieval activities. Future activities, including costs and schedules summarized in this report, are still preliminary and are subject to change. Current activities include further definition and approval of the technical approach to be used for retrieval of both contact-handled and remote-handled transuranic wastes at Area G

Nearly 93.5% of the belowgrade transuranic radionuclide inventory from Area G will be removed during waste-retrieval activities, including the entire TRU radionuclide inventory in Pit 9, Trenches A–D, the corrugated-metal-pipes site, and the shafts. The remaining 6.5% of the TRU inventory was emplaced in Pits 1–5 before 1970 and is considered disposed of rather than in storage.

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1.0 INTRODUCTION

On March 20, 1970, the Atomic Energy Commission (AEC) issued an immediate action directive (IAD) prohibiting the shallow-land burial of transuranic (TRU) waste after April 30, 1970, and requiring TRU waste be placed in retrievable storage until a permanent TRU waste disposal facility became available. This directive serves as the driver for retrieval of TRU wastes and transfer of these wastes to the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico. Until identified as a separate waste category by the AEC in 1970, TRU waste was typically disposed of in shallow burial sites in a similar manner as low-level (radiological) waste (LLW). Solid wastes were disposed of in pits or trenches, and liquid wastes were often put into shafts or underground tanks.

Over the past three decades, Los Alamos National Laboratory (LANL or the Laboratory) has generated contact-handled (CH) and remote-handled (RH) TRU wastes and has placed them belowgrade in retrieval configurations at Technical Area (TA) 54, Area G. The Laboratory's Nuclear Waste Infrastructure Services (NWIS) Division is in the process of planning projects whose objective is to retrieve TRU wastes currently stored belowgrade in the following areas: Pit 9, Trenches A-D, the corrugated-metal-pipes (CMP) site, Shafts 302–306, and the RH shafts. Retrieval projects for these wastes are included in the U.S. Department of Energy (DOE) performance measures for the Laboratory.

Until 1982, TRU waste was defined as waste with greater than 10 nCi/g of plutonium-239 or uranium-233 or greater than 100 nCi/g of plutonium-238. In 1982, the definition of the waste was changed to radioactive waste containing more than 100 nCi (3700 Bq) of alpha-emitting TRU isotopes with half-lives greater than 20 yr per gram of waste.

The belowgrade inventory of TRU waste and retrieval processes for those wastes must be integrated with the corrective measure evaluation for Material Disposal Area (MDA) G, which is being prepared by the Environmental Programs–Environment and Remediation Support Services (ERSS) Division (formerly the Environmental Stewardship Division of the Laboratory).

2.0 BACKGROUND

TA-54 is located on Mesita del Buey, which spans the boundary of the Cañada del Buey and Pajarito Canyon watersheds. The major industrial activity at TA-54 has been waste management. Retrievable TRU waste has been stored within Area G at TA-54 since the AEC directive was implemented in 1970.

Since 1957, Area G has served as the primary radioactive waste management facility for Laboratory-derived wastes (Figure 2.0-1). Currently, the total volume of TRU wastes stored at Area G is approximately 100,000 m^3. Approximately two-thirds of the TRU waste is stored in inspectable storage arrays in 11 aboveground domes. The remaining waste is stored in belowgrade, earthen-covered configurations that include Pit 9, the CMP site, Shafts 302–306, the RH shafts, and Trenches A–D. Radionuclides of concern include americium-241 and various plutonium isotopes in the pits and CMPs, plutonium-238 in the trenches, and mostly mixed fission products and some plutonium in the shafts. Figure 2.0-2 shows an aerial view of Area G.

3.0 DESCRIPTION OF BELOWGRADE TRU WASTE STORED AT AREA G

The following sections describe how TRU waste is currently stored belowgrade in pits, shafts, and trenches at Area G and provide data regarding the TRU inventory of those wastes.

3.1 Pit 9

3.1.1 Background

Pit 9, located at TA-54 in the central portion of Area G, is approximately 400 ft long, 20 ft deep and 30 ft wide (Figure 2.0-2). The south end was excavated to an almost vertical slope, while the north end has a 6 to 1 slope for access to the pit. Figure 3.1-1 shows the excavated pit with waste containers at one end.

Fiberglass-reinforced plywood (FRP) crates and drums were placed in cells and covered with a layer of ¾-in. plywood, then draped with heavy-duty plastic sheeting. A 3-ft-thick dirt barrier was placed between each cell. A plastic pipe was inserted into each cell for monitoring purposes and ventilation. An access shaft fabricated of Uni-strut was placed in one of the cells to allow for visual inspection of the waste drums. Finally, a 3-ft layer of crushed tuff was placed on the surface of the cell (Figures 3.1-2 and 3.1-3).

Pit 9 was used from 1974 to 1979 to retrievably store 30-, 55-, and 85-gal. drums and FRP crates containing TRU waste (>10 nCi/g plutonium-239 or uranium-233 or > 100 nCi/g plutonium-238). The first FRP crate was placed into the pit on November 24, 1974, and the first 55-gal. drum on November 27, 1974. A total of 4083 packages are stored in Pit 9.

3.1.2 Waste Description with Radionuclide Inventory

Of the 4083 waste packages placed in Pit 9, the majority were 55-gal. drums. Other packages included 191 FRP crates. A variety of TRU waste materials are stored in these packages, including TRU-contaminated paper, wood, treatment sludge, process residues, soil, and other combustible and noncombustible materials. Table 3.1-1 provides a summary of container types, general waste descriptions, the quantity of waste containers, their gross weight range, and total surface dose range from neutron and gamma radiation. A total of 1561m^3 of TRU waste is to be retrieved from Pit 9. The TRU activity in Pit 9 is approximately 5923 Ci. Table 3.1-2 provides the total inventories for individual radionuclides in Pit 9.

Pit 9 waste retrieval operations will be affected by the aboveground storage capacity of Area G and associated material-at-risk (MAR) limit. The current MAR total aboveground limit at TA-54, Area G, is 150,000 plutonium equivalent-curies (PE-Ci). Based on historical gamma spectroscopy measurements, the waste in Pit 9 contains a total of 6061 PE-Ci. The Area G MAR inventory will be monitored continuously during retrieval operations to ensure that the aboveground Area G MAR limit is not exceeded.

3.2 Trenches A, B, C, and D

3.2.1 Background

Trenches A–D are located at TA-54 in the south-central portion of Area G (Figure 2.0-2). Trenches A–D were used to retrievably store 30-gal. containers placed inside concrete casks, as shown in Figure 3.2-1. Drums stored in the concrete casks contained heat source plutonium-238 wastes containing >1 g per drum and some legacy uranium-233 wastes. Placement of waste into Trench A occurred between March 1974 and October 1974. Trench B was active between April 1976 and April 1977. Waste placement in Trench C began in April 1977 and ended in September 1981. Trench D was active between September 1981 and December 1985.

Trenches A–D were excavated to different dimensions, based upon the quantity of waste to be stored and the proximity of the trenches to adjacent disposal pits. Trench A contains 120 casks in six arrays (an array

contains 20 numbered casks). Trenches B–D each contain 100 casks in five arrays. Each array was backfilled with crushed tuff up to the rims of the casks. After wastes were placed in the casks, the lids were sealed with asphalt material. When each array was filled, corrugated "Q-decking" was placed above the cask lids to create an air space between the tip of the casks and the overlying 3.25 ft of crushed tuff, which filled the trench. This arrangement is shown in Figures 3.2-1 through 3.2-3. Each array was separated from the next by 5 ft of crushed tuff. A cross-section diagram of trench cask-array and backfill and a diagram of trench dimensions and cask-array layout are shown in Figures 3.2-4 and 3.2-5. Table 3.2-1 describes the trench dimensions, backfill information, and date of waste receipt.

3.2.2 Waste Description and Radionuclide Inventory

Waste records for Trenches A–D indicate that the waste consists of heat source plutonium-238. This waste was placed in casks in the trenches instead of in Pit 9 because of issues relating to nuclear heating, radiolytic gas formation, and radiation emitted from the wastes.

Trenches A–D contain a total of 721 30-gal. drums in 363 concrete casks. The radiation levels from the drums stored in Trenches A–D are up to 250 milliRoentgen per hour (mR/hr) at the container surface. The highest levels are from the uranium-233 drums. At least two of the uranium-233 drums contain small amounts of a liquid waste that were too difficult to solidify. Table 3.2-2 provides a summary of the TRU waste stored in Trenches A–D. Table 3.2-3 summarizes the total TRU radiological quantities for Trenches A–D. The results are based on waste stream samples.

3.3 Corrugated Metal Pipes

3.3.1 General Information

The CMPs are located in the northwest region of Area G (Figure 2.0-2). Waste associated with the CMPs was derived from processing and plutonium-recovery operations at TA-21; therefore, they were originally stored at TA-21. In 1986, the CMPs were moved to TA-54. The storage area is approximately 40 ft wide and 100 ft long. The CMPs are placed two across and stacked two high on top of the far east end of Solid Waste Management Unit 54-015(k) (Pit 29). The CMPs sit on approximately 3 to 4 ft of fill that separates them from the contents of Pit 29. Figure 3.3-1 provides details of the storage configuration at TA-54.

3.3.2 Waste Description and Radionuclide Inventory

A total of 158 CMPs are stored underground at Area G and contain waste fixed in cement paste that originated from the pug mill system located at TA-21. The CMPs are 30 in. in diameter and 20 ft long. Each CMP weighs approximately 5 to 7 tons.

Waste water from Laboratory operations was collected and neutralized, when necessary, in special stainless-steel water-cooled storage tanks at TA-21, Building 257, from May 1968 to 1978. The by-products were then mixed in a pug mill with cement. The wastes fixed in the cement paste through the pug mill system consisted of ferric hydroxide sludge with plutonium-238, plutonium-239, americium-241, uranium-234, uranium-235, and uranium-238, neutralized americium waste with americium-241 and plutonium-239, neutralized strip waste with cesium-137 and strontium-90, potassium hydroxide waste with plutonium-239, and fluorides.

The bottom 12 in. of each CMP was filled with a concrete plug before waste injection. Approximately 2500 L of cement paste was placed into each CMP, each weighing between 5 and 7 tons. The total

volume of the 158 CMPs is approximately 439 m^3. The top 12 in. of each CMP was then capped with a concrete pug. Each CMP was tagged with a brass plate marked with a unique identification number.

Records of pug mill operations indicate that for every gram of feed solution introduced into the pug mill, about 3 g of cement paste was generated. Treatment batches of the cemented waste that met TRU waste parameters were pumped into standing CMPs for interim storage and future retrieval. Table 3.3-1 summarizes the total radiological quantities for the 158 CMPs. The results are based on waste stream samples.

Based on historical database information, the total plutonium-equivalent curies (PE-Ci) content of all CMPs combined is 10,891.07 PE-Ci. To comply with the current MAR limit, CMP retrieval operations will not start until sufficient TRU waste has been shipped to WIPP to allow for storing additional inventory. During CMP retrieval, the Area G MAR inventory will be continuously monitored to ensure that the aboveground Area G MAR limit is not exceeded.

3.4 Shafts 302–306

3.4.1 Background

Shafts 302–306 are located at Area G, northwest of Trenches A–D (Figure 2.0-2). The lined shafts were constructed in 1991 by boring 10-ft diameter vertical shafts, then lining them with 22 ft long and 8 ft diameter CMP. The bottom was filled with gravel, and a ¼-in. steel-plate cover was welded to the top of the metal shaft. This configuration is shown in Figures 3.4-1 and 3.4-2.

Each of the five shafts contains a hot-cell liner that was emplaced in the shafts on December 5, 1991. The waste associated with the shafts originated from examining irradiated fuel components.

3.4.2 Waste Description and Radionuclide Inventory

The waste in Shafts 302–306 consists of hot-cell liners (e.g., alpha-containment boxes). The alpha-containment boxes, decommissioned in 1991, were wrapped in 3–4 mil plastic and then placed in stainless-steel boxes. The alpha-containment boxes measured 10 ft 7 in. by 5 ft 5 in. by 5 ft 5 in. The stainless-steel containers into which the hot-cell liners were placed measured 6 ft by 6 ft by 11 ft. Each vessel was then deposited into its own shaft.

Table 3.4-1 summarizes the initial TRU isotopic distribution and activities at the time the alpha-containment boxes were placed in Shafts 302–306. Table 3.4-2 summarizes the postdecay isotopic distribution and activities for TRU radionuclides in Shafts 302–306.

3.5 RH Shafts

There are two types of RH-TRU wastes. The first is hot-cell liners (discussed in Section 3.4), and the second is hot-cell debris, consisting of metals, inorganic solids, and combustible solids packaged into approximately 1- to 1.5-gal. containers. The debris waste stored in these containers is in three configurations: WIPP canisters, unlined shafts, and lined shafts.

Most of the RH shafts are located in the shaft field south of Dome 226 at Area G of TA-54 (Figure 3.5-1). The following sections describe the waste stored in these shafts.

3.5.1 WIPP Canisters

3.5.1.1 General Information

Between 1983 and 1985, 1- to 1.5-gal. containers were "filled with hot cell debris" (e.g., metals, inorganic solids, and combustible solids). These small containers were placed into 55-gal. drums, and in 1993, three 55-gal. drums were placed into a stainless-steel canister certified to the WIPP Waste Acceptance Criteria (Revision 3) (www.wipp.energy.gov). There are 16 of these canisters, which are approximately 26 in. in diameter, 10 ft long, and 2000 to 3000 lb each, designed to fit into the WIPP 72B cask. Figure 3.5-2 illustrates the WIPP canister configuration.

Between 1993 and 1994, the canisters were placed in lined shafts approximately 16 ft deep. The shafts are spaced approximately 5 ft apart (Figure 3.5-3). Between 1999 and 2000, the shielding lids were temporarily removed so that sample tubing could be connected to the filter vent on the top of the canisters. Headspace gas samples were taken and analyzed for volatile organic compounds (VOCs) and flammable gases.

3.5.1.2 Waste Description and Radionuclide Inventory

Waste stored in the 16 WIPP canisters was generated during projects that examined irradiated fuel pins from reactors; however, the waste does not include the irradiated fuel pins themselves. The contents consist predominantly of debris (rags, plastic, glassware, tools, and equipment) and solidified radioactive solutions (minor components) that were removed and packaged from the hot cells in Wing 9 of the Chemistry and Metallurgy Research (CMR) building. Table 3.5-1 summarizes the initial and postdecay TRU activities for the 16 WIPP canisters. Isotopic distribution was projected to 2009.

3.5.2 Lined Shafts (Shafts 200–232)

3.5.2.1 Waste Description and Radionuclide Inventory

The 33 lined shafts, numbered 200 through 232, were constructed in Shaft Field B, south of Dome 226 (Figure 3.5-1). The shafts were augered into the Bandelier Tuff approximately 3 ft in diameter and 18 ft deep. A 13-ft long by 8.5-in.-diameter ¼-in. thick carbon steel pipe liner was placed into the shaft. The steel pipe liner had a steel plate welded to the bottom and a steel cap attached to the top. Crushed tuff, cobbles, and sand were backfilled into the void between the pipe liner and the initial boring. Waste was emplaced in these shafts from 1979 to 1987. A concrete cap was then placed over the top. Figure 3.5-4 illustrates the configuration of the shaft and emplaced waste.

This waste, generated from 1979 through 1987 by the Laboratory's Chemistry Metallurgy Baker (CMB) Division, and later by the Material Science and Technology (MST) Division, is hot-cell debris waste consisting of metals, inorganic chemicals, and combustible solids. The majority of the waste was placed into 1-gal. packages, which included an inner galvanized-steel can, a middle plastic liner, and an outer carbon-steel container with a welded steel lid. The average weight of these packages is estimated to be approximately 20 to 30 lb. Historical data indicate that Shafts 202, 203, 211, and 212 each contain much larger items, weighing up to 8 tons. Shaft 211 lists five items, each weighing 880 lb. The waste generator descriptions do not always correlate with the weights reported. For example, the waste description may state "Hot cell waste from CMB1-CMB14" with no indication of the physical form of the waste that contributes to a weight of 2.3 tons. This waste may be considered mixed waste because of the historical use of solvents and the presence of lead in the hot cells. The specific radiological characteristics of the waste packages in each lined shaft are listed in Table 3.5-2.

3.5.3 Tritium Cylinders (Shafts 262–266)

3.5.3.1 Background Information

The tritium cylinders (TRU waste contaminated with tritium) are stored in five shafts located south of Dome 226 in Area G of TA-54, as shown in Figure 2.0-2. This waste was the result of a decommissioning project at TA-55 by the Nuclear Materials Technology Group (NMT-7). These cylinders were emplaced in Shafts 262 through 266 between 1995 and 1997. Each of the five shafts contains a single stainless-steel cylinder. Approximately 7 m^3 of CH-TRU waste, also contaminated with tritium, is contained in the 55-gal. drums.

3.5.3.2 Waste Description and Radionuclide Inventory

Tritium cylinders are stainless-steel waste containers specifically designed as secondary containment for CH-TRU waste also contaminated with tritium. The waste consists primarily of scrap metal (valves, fittings, piping, vessels, pumps, and other equipment) and some other combustibles. The combustibles and noncombustibles were not segregated.

The waste was bagged out of the glove box, or, in the case of the processing tank system, disassembled and bagged. The bags were sealed by the twist-and-tape closure method and placed inside 55-gal. drums painted on the inside with asphalt as a barrier to prevent tritium permeation. Four of the cylinders contain three 55-gal. drums each. The fifth cylinder contains a 20-ft-long tritium tank.

Each drum was identified with a red "T." The bungs were replaced with a carbon composite filter before being loaded into the stainless-steel cylinders. A Linde Type 4A molecular sieve material may have been placed in the annular void spaces between the drums and cylinder walls to absorb tritium dioxide escaping through the carbon filter. The vessel heads were welded in place. A penetration hole was drilled to attach a valve, pressure gauge, pressure-relief valve, and a quick connect at the top of the cylinder to allow future sampling. The cylinder was flushed with helium to leak-test the closure weld.

Specific radiological characteristics of waste in each cylinder are presented in Table 3.5-3.

4.0 TRU WASTE RETRIEVAL PROJECTS AND RADIONUCLIDE INVENTORY

The Laboratory is in the process of developing technical options, budgets, and schedules for retrieving TRU wastes that have been retrievably stored belowgrade. The following sections describe the technical approach for retrieval of these wastes and the quantity of TRU radionuclides expected to be removed from Area G as a result of these retrieval actions.

4.1 Retrieval Method for Pit 9

4.1.1 Soil Sampling

Before overburden removal, soil samples will be collected and analyzed to determine the nature and extent of soil contamination for waste characterization and worker protection. This analysis includes VOCs, gross beta gamma, and gross alpha. If contamination is detected, an appropriate disposition method for the soil will be determined.

4.1.2 Overburden Removal

Overburden soil will be removed using heavy equipment and manual techniques (e.g., shovels). As the overburden is removed, a plastic sheet (tarp) will be used to cover the exposed waste until retrieved. The tarp will be secured to prevent the soil from being blown away in high winds or washed away during inclement weather and will fully cover the exposed waste. The excavated overburden soil will be removed from the retrieval area, placed in a designated area, and covered.

4.1.3 Retrieval Operations

The retrieval process will consider the configuration of drums and FRP crates and standard retrieval methods.

Drums: Drums will be retrieved from Pit 9 and transported to a separate location for washing and venting (Figure 4.1-1). Drum-handling methods will be selected to minimize risk (Figure 4.1-1). In general, drums will be retrieved using a forklift with grapplers that will hug the drum as it is lifted away from the array. After the drum is removed from the array, it will be moved to the drum staging area, where the dust and dirt will be removed using high-efficiency particulate air-filtered (HEPA) vacuuming or manual cleaning.

At the staging area, a radiological survey and drum integrity evaluation will be conducted before each drum is removed from the retrieval site. If removable surface contamination is detected, worker protective measures will be evaluated and contamination-control procedures (i.e., vacuuming, fixation, or plastic wrapping) will be implemented. Additionally, if contamination is found on a drum, the drum grappler will be surveyed for contamination in accordance with standard radiological practices. Before the drum is transported, the removable surface contamination (if present) will be removed or fixed to the drum.

Upon completion of cleaning, surveying, and attaching the correct labels, the drums will be lifted onto a vehicle and transported to the washing and venting area in a separate location (Figure 4.1-1). Drums will be transported over approximately 400 ft of roadway.

There are different handling methods and varying degrees of risk for each drum, depending upon its integrity when it is retrieved. Table 4.1-1 provides four basic flow paths for drums following retrieval, including risk reduction and risk acceptance.

The lowest risk operation will be transferring drums to a separate location for washing and venting before placement in storage before shipment to WIPP. During Transuranic Waste Inspectable Storage Project (TWISP) operations, some drums were vented before washing to reduce the risk associated with handling unvented drums. This approach may be used for the Pit 9 drums because they were also sprayed with a corrosion inhibitor that may prevent a proper seal of the vent annulus area. This approach also may prevent air evacuation from the area and increase the possibility of a drum deflagration. Figure 4.1-1 shows the drum retrieval process.

FRP Crates: FRP crate retrieval will be handled on a case-by-case basis because FRP crate construction was not standardized when the waste was packaged and put into Pit 9. Two possible methods may be used:

1. remove all other containers from around the FRP crate, attach a long section of horizontally suspended I-beam (strongback) with slings (which are spread to prevent crushing the top of the container), and lift the FRP crate with a small crane or a forklift.

2. remove the FRP crate with a large-capacity forklift. If the bottom of the crate is significantly degraded, slide a metal sheet under the FRP crate and use slings to pick it up from this new metal base.

Damaged FRP crates will be handled on a case-by-case basis. Each FRP crate will be repaired, overpacked, or repackaged, as necessary, to remove them from the retrieval area and store them safely in Area G.

The FRP crates will be cleaned to remove excess dirt and surveyed for contamination before they are removed from the retrieval area. Contaminated FRP crates will be decontaminated. Unlike drums, the FRP crates will not be washed and vented before they are placed in aboveground storage. After each FRP crate has been surveyed and is determined to be free from surface contamination, it will be transferred directly to Area G storage where it will await dismantling, repackaging, and characterization to meet the WIPP Waste Acceptance Criteria and subsequent disposal at the WIPP site in Carlsbad, New Mexico. Figure 4.1-2 shows the FRP crate-retrieval process.

4.2 Retrieval Method for Trenches A–D

The cask-handling methods will be selected to minimize risk (Figure 4.2-1). Before field retrievals begin, a demonstration of field operations will be simulated on ten unearthed casks in a controlled environment within a Permacon enclosure inside a dome. This demonstration will involve opening the sampling port or cold drilling the cask lid to determine whether the internal atmosphere contains loose contamination, VOCs, or other hazardous constituents. Once this check has been performed and the internal conditions are deemed acceptable, the lid will be removed using a hoist and manual prying methods. After the lid is removed, each drum will be removed using a grapple attached to an overhead hoist. Each individual drum will be surveyed for contamination and measured for dose. Empty casks will be surveyed and prepared for disposal by applying fixatives, volume reduction, and packaging as appropriate.

Following the demonstration, drums will be removed from the casks in the field and transported to a dome for processing. Casks determined to contain loose internal contamination will be unearthed and transported to a Permacon enclosure for removal of drums and fixing contamination. Unearthed casks will be disposed as LLW in Pit 9 or other approved disposal trenches.

4.3 Retrieval Method for CMPs

CMPs retrieved will be smeared for radiological contamination and cleaned to remove excess soil so that no loose soil remains on them. If a CMP has surface contamination, the soils in the vicinity to the CMPs will be sampled for radioactive constituents. Radioactive (nonhazardous) contaminated soils will be segregated from nonradioactive soils and placed in the LLW disposal pits.

Based on the radiological monitoring information, the CMPs will be staged in the CMP retrieval designated area, contamination will be fixed, and the CMPs will be re-marked. The CMPs will be loaded, secured, and transported to an authorized temporary storage location.

There are different handling methods and varying degrees of risk for each CMP depending upon its integrity when it is retrieved. CMP handling methods will be selected to minimize risk (Figure 4.3-1). In general, CMPs will be retrieved by heavy equipment (i.e., crane, forklift, and/or excavator).

4.4 Retrieval Method for Shafts 302–306

Two alternatives are being considered to dispose of the hot-cell liners currently stored in Shafts 302–306. Hot-cell liners are currently characterized as RH-TRU waste.

Alternative 1 calls for retrieval, characterization, certification, and disposition of the hot-cell liners to WIPP. A crane or other hoist mechanism will be rigged to extract the hot-cell liner. The hot-cell liner will be placed into an "in-process" waste container (either by forklift or other similar equipment) and taken elsewhere at Area G for processing and characterization.

Alternative 2 involves in situ management of hot-cell liners. Depending on waste characterization of the hot-cell liner (either while it is in the shaft/trench or after it has been retrieved), what was initially understood to be RH TRU waste may, after more thorough analysis, be characterized as LLW. To be hazardous characterized as LLW, the waste must be less than 100 nCi/g and determined not to be a hazardous waste under the Resource Conservation and Recovery Act. Some of the hot-cell liners will probably meet these criteria because their activity levels are low and the quantity of plutonium isotopes is low. Hot-cell liners meeting the criteria may be left in place or may be retrieved, characterized, and disposed of in an LLW disposal cell. The disposal cell may be located within Area G, elsewhere at TA-54, within the boundaries of the Laboratory, or off-site at a licensed LLW disposal area.

The baseline plan for the hot-cell liners is **Alternative 2**. Project personnel plan to closely review acceptable knowledge information regarding the hot-cell liners in these shafts. Contents that can be recharacterized as LLW will be recharacterized. The baseline assumes that one of the five hot-cell liners will remain characterized as TRU. This hot-cell liner is expected to be size-reduced and packaged in an RH-72B Road Cask for certification and shipment to WIPP.

4.5 Retrieval Methods for RH Shafts

4.5.1 WIPP Canisters

The objective of the WIPP Canister Retrieval Project is to retrieve the 16 canisters stored in lined shafts at Area G, place the canisters in RH-72B Road Casks, certify the Road Casks for off-site transport, and transport the packages to WIPP in Carlsbad, New Mexico, for permanent disposal. The Central Characterization Project (CCP) in Carlsbad is the 16 WIPP Canister Retrieval Project lead. The Laboratory will provide support, as appropriate, to complete the task.

Before retrieval begins, the retrieval approach will be reviewed and approved by the appropriate authorities. Field activities will include visual inspection of the canisters to ensure they can be lifted safely and to ensure the integrity of the welded seams. Radiological surveys (direct, swipe, and dose) will be performed to determine the extent of the radiological exclusion zone boundary during canister retrieval and packaging operations. The lift plan for removing the canisters from the shafts and loading them into a 72B Road Cask and associated retrieval procedures will be prepared.

Retrieval planning activities will include cold-tests of retrieval procedures using an empty canister in an unused shaft to validate procedures. Positioning the crane to remove the canisters from the shafts will be an important facet of the mock-up because of the low margin for error (boom swing and staging angle) during loading of the RH-72B Road Cask, and the positioning if shielding for canister removal. Once loaded into the RH-72B Road Cask, the canisters will be shipped to WIPP for disposal.

4.5.2 Lined Waste Shafts

There are two possible disposition alternatives of the waste in the 33 lined shafts.

Alternative 1 is retrieval of the RH TRU waste from belowgrade, characterization and certification of the waste, and packaging for shipment to WIPP. Generally, the waste will be retrieved, measured at the point of retrieval to evaluate as low as reasonably achievable (ALARA) and worker-safety requirements, and then packaged for safe interim storage and transport to a processing area. At the processing area, the waste will be characterized and packaged for shipment to WIPP.

The overall approach will concentrate on methods that are highly reliable, most readily implemented, and safe to employ. Retrieval options for each waste configuration are discussed below. A combination of mobile equipment (for retrieval operations), temporary facilities (weather enclosures, storage pads), and existing facilities (such as the existing domes, decontamination and volume reduction system, and CMR Wing 9 hot cells) will be used to support waste processing, packaging, and shipping operations. A number of options for Alternative 1 are being evaluated, as described below.

Telescoping Robotic and/or Crane with Smart-Tool Retrieval: This option incorporates a large, movable glove box (or other enclosure) that contains several remotely operated robotic items designed to perform specific tasks. This equipment includes a telescoping mast and movable platform for deploying a retrieval system over and into the storage shafts, a robotic manipulator or grapple attached to the telescoping mast (capable of using multiple tools for attachment to and retrieval of waste containers or loose objects), and remote camera and sensor systems for visual inspection and environmental feedback during the remote operation.

A crane may also be used to support passive retrieval tools that will remove the waste from the shafts. "Passive" here means not robotic but rather motorized, more dedicated equipment. In this option, the end of a crane cable will be fitted with a mounting platform designed for interchangeable material handling attachments, such as a grapple, a magnet, a suction hose, or a suction cup. A remote camera will also be attached to the platform for visual observation and inspection of retrieval activities. The system will be incorporated into a movable containment structure that is large enough for the crane and all additional support equipment.

Remote Vacuum Retrieval: This method uses a shielded movable chamber, similar to the telescoping option. Soil and canisters would be retrieved using a vacuum-based tool.

Intact Shaft Retrieval: This option involves extracting the shaft and its contents from the subsurface as a single item using any number of technologies. The basic concept is to remove the entire shaft and contents from the subsurface as a single core, then retrieve and process the waste from the coring on the ground surface or other area in a controlled, safe manner. Actual waste handling activities will be conducted at ground level rather than downhole, a more flexible and controllable method. The methods include the following.

Overcoring: As illustrated in Figure 4.5-1, a casing is driven around the shaft. Grout is then injected into the void and the entire assembly is extracted with a crane.

Shaft vitrification: The shaft will be vitrified in place and then extracted as a whole to the ground surface.

Shaft entombment: The shaft will be grouted in situ and then extracted.

This technique can also be adapted to retrieve shafts that undergo in situ vitrification or retrieval through overcoring.

Alternative 2 will evaluate the potential for in situ treatment and stabilization, along with local disposal of the RH TRU waste, through a risk-informed process that is consistent with DOE Order 435.1, "Radioactive Waste Management," and as also recommended by the National Academy of Sciences. This alternative may entail in situ vitrification, entombment (e.g., cementation, grouting), or other methods.

This alternative will be proposed for waste where retrieval is impractical and/or where the retrieval operations will themselves pose a greater risk to workers or the public (either through dose or contamination) than the risk posed by leaving the waste in place or stabilizing it and then possibly extracting it. The RH TRU waste will be entombed in concrete/grout, vitrified under the final cover, and/or left in the shafts under the final cover. In some instances, a vitrified or grout entombed shaft could also be retrieved for further processing.

In Situ Vitrification: In situ vitrification leaves the waste in place in a melted (and thus stable) configuration, as illustrated in Figure 4.5-2. This technique has been applied in treating subsurface structures similar to the Laboratory storage shafts.

Approaches such as the GeoMelt technologies on a radioactively contaminated waste trench located in MDA V and on a mock vertical pipe unit (VPU) at the Horn Rapids Test Site near Hanford, Washington, have been demonstrated to be feasible. The overall objective for both demonstrations was to acquire performance data to evaluate the applicability of the GeoMelt technology on subsurface waste-containing structures throughout the DOE Complex. At MDA V, a trench 25 ft wide, 5 ft deep, and 200 ft long, with nonuniform fill previously used to receive radioactive liquid waste was successfully vitrified. After vitrification, the trench was capped with a 2-ft cover of soil. This procedure provided relevant data for treating other buried waste applications at the Laboratory. The demonstration near Hanford used a mock burial configuration (a VPU) filled with layers of soil, a steel I-beam, wood, and concrete. Cerium oxide was included as a surrogate in the heterogeneous mock waste stream to simulate the presence of radioactive constituents. The 15-ft long VPU was bottomless and was placed on a foundation of concrete blocks. During installation, the VPU was covered with a 5-ft soil layer. The bottom of the VPU was approximately 20 ft belowgrade. The configuration of the VPU was very similar to the Laboratory storage shafts.

In Situ Grouting (ISG): This method encapsulates contaminated waste and surrounding media in place, without retrieval, thus minimizing the potential for contaminants to migrate from the buried waste zone. The resulting waste form is highly resistant to groundwater infiltration, which greatly reduces the potential for release of contaminants and possibly hinders intrusion. Grouts used for stabilization of contaminated media are commonly based on Portland cement or organic polymers (e.g., acrylate, asphalt, or paraffin wax). For in situ stabilization of wastes, grouts are emplaced by either gravity infiltration (permeation grouting) or physical mixing of grout and waste using energy imparted by high-pressure jets (jet grouting). Grouts used for permeation grouting must have a low initial viscosity to allow for adequate infiltration of the waste and surrounding media. Grout may be emplaced in multiple lifts to minimize the risk of failure of the resulting monolith.

The baseline plan for waste from the lined shafts is Alternative 1. Cans of RH TRU waste will be removed and prepared for shipment to WIPP. The information available for several shafts indicates the presence of larger, heavier items. The baseline approach for these shafts is removal of the intact shaft liner with the contents still inside. The project expects to perform a feasibility study to identify and evaluate other options for these shafts, but such options are not currently available.

4.5.3 Tritium Cylinders

Tritium cylinders are to be retrieved as part of the Trenches A–D retrieval scope. They are currently stored in Shafts 262 to 266. Though detailed retrieval plans have not yet been developed for the cylinders, the Laboratory has assumed that they can be readily retrieved and stored aboveground until the tritium has decayed sufficiently to meet WIPP waste acceptance criteria. Personnel at NWIS are currently reviewing disposal records to perform the decay calculations. General retrieval activities include removing the concrete plug on each shaft, retrieving and transporting the tritium cylinders to storage inside cargo containers, and replacing the concrete plugs.

4.6 TRU Component Removal

The retrieval methods described above are expected to remove the majority of the TRU radionuclides from Area G. Table 4.6-1 summarizes the TRU radionuclide inventory in each of the storage areas described above and shows the portion of this inventory to be removed during waste retrieval activities.

Table 4.6-1 includes only those alpha-emitting radionuclides with half-lives greater than 20 yr included in the definition of TRU waste from DOE guidance.

As shown in Table 4.6-1, 93.5% of the TRU radionuclide inventory will be removed during waste retrieval activities, including all the TRU radionuclide inventory in Pit 9, Trenches A–D, the CMP site, and the shafts. The remaining 6.5% of the TRU inventory was emplaced in Pits 1–5 before 1970 and is considered nonretrievable.

5.0 RETRIEVAL COSTS AND SCHEDULES

In anticipation of TRU waste retrieval activities in Area G, the Laboratory has begun the planning and scheduling necessary for successful execution of those retrieval activities. The technical approach for retrieval of each of these wastes was described in the previous sections. The following sections present the cost estimates and project schedules that correspond to these technical approaches.

5.1 Cost Estimates

Cost estimates for four parts of the TRU waste retrieval effort were developed in conjunction with the preparation of the Legacy Waste Disposition Project baseline. These four parts are Pit 9, CMPs, Trenches A–D, and the 16 WIPP canisters. Retrieval of the tritium cylinders was included in the cost estimate for Trenches A–D retrieval.

Pre-conceptual cost estimates were developed for incorporation into the report entitled "Legacy Waste Disposition Remote-Handled TRU Waste Retrieval Project Mission Need Statement" (in progress). These estimates include retrieval and disposition of the RH TRU waste in 33 lined shafts in Area G and for Shafts 302–306 containing five hot-cell liners. The total projected cost estimate range for these retrieval projects is $70 million to $135 million, with a point estimate of $95 million. This cost estimate is not broken down in the same manner as those for the previously described four parts, preventing comparison of individual cost elements. The cost estimates do not include the cost of waste characterization and packaging, transportation to WIPP, and disposal at WIPP.

The estimated costs for the retrieval efforts are summarized in Table 5.1-1, along with the cost elements.

5.1.1 Project Management Support

This cost element includes the day-to-day management of the retrieval projects. General functions include

- developing, implementing, and tracking of the project management system, including work breakdown structure (wbs), wbs dictionary, quantity tracking, status and reporting, schedule updates, earned value, and configuration management;
- project team management;
- contractor management;
- ensuring project requirements are met, including safety, safety basis, and quality assurance; and
- coordinating retrieval operations with Area G operations.

5.1.2 Engineering Design

This cost element includes

- conceptual design plan and report;
- final design documents, including drawings, specifications, and plans suitable to be issued for construction;
- facility modifications, such as fencing, traffic, and parking;
- support facilities, including trailers;
- retaining walls;
- surface water management;
- power;
- lightning protection;
- communications (telephone and fax);
- trench development, including shoring (if needed) and access ramps; and
- staging areas.

5.1.3 Safety Basis

This cost element includes

- developing required analytical calculations;
- developing hazards, accident analysis, and associated safety significant and safety class control set;
- identifying safety management program characteristics, including design features and administrative controls; and
- developing technical safety requirements.

5.1.4 Detailed Operating Procedures

This cost element includes development of all operating documents required for the safe execution of the retrieval activity.

5.1.5 Site Characterization

This cost element includes

- visual inspection, as allowed;
- geotechnical investigations to assess the strength of the surrounding soil;
- radiological surveys;
- shallow soil samples to assess contamination in the cover soil;
- air monitoring, as allowed;
- ground-penetrating radar to estimate the depth of cover soil; and
- potholing to confirm the depth of cover soil estimates determined through ground-penetrating radar.

5.1.6 Readiness Assessment

This cost element includes evaluation of

- design documents;
- retrieval procedures;
- site work in preparation for execution;
- field operations;
- qualifications and knowledge verification of execution team;
- transportation protocols for transporting retrieved containers;
- emergency procedures for encountering unusual conditions; and
- project-specific plans.

5.1.7 Preretrieval Activities

This cost element includes

- preparing detailed work plans and schedules, training to project plans and procedures, and participation in the readiness assessment;
- obtaining permits, including excavation, air, and storm water;
- preparation of site and facility for retrieval activities, specifically:
    - installing project support facilities, including power, shelter, communications, and crew clothing
    - setting up lightning protection

- setting up air monitoring
- improving traffic flow
- installing area lighting
- installing storm water, erosion, and sediment control
- equipment mobilization to TA-54.

5.1.8 Retrieval Activities

This cost element includes

- removing cover soil and any other cover materials from above the containers,
- retrieving containers,
- placing containers in inspectable storage,
- washing containers, as necessary,
- installing HEPA-filtered vents on drums, and
- managing contaminated soil.

5.1.9 Project Closeout

This cost element includes

- developing and delivering the final closeout activities report, which will include lifecycle photographs, planned versus actual costs, subcontractor costs, schedule, accomplishments, safety, health, industrial health issues and resolutions, lessons learned, record drawings, and the end state of the retrieval area;
- setting up and conducting tours and visits to the retrieval areas for legislators, regulators, and other DOE site personnel; and
- transitioning retrieval areas to ERSS.

5.2 Schedules

Figure 5.2-1 summarizes the overall project activities and milestones for the Legacy Waste Disposition Project, including the Remote-Handled TRU Waste Retrieval and Disposition Project. The milestones associated with specific retrieval projects are presented in Tables 5.2-1 through 5.2-5.

Key milestones for retrieval of wastes from the 33 lined shafts and the 5 hot-cell liners are presented in Table 5.2-5. The individual activities will be driven by the results of the conceptual design phase in which the scope boundaries and functional level details will be defined in more detail. The conceptual design information available at the time the corrective measures evaluation report is prepared will be reflected in that report. This information is expected to be preliminary and subject to modification as the detailed design is prepared. Details regarding the path forward that are not available at this time will be included in subsequent planning by the TRU waste operations staff.

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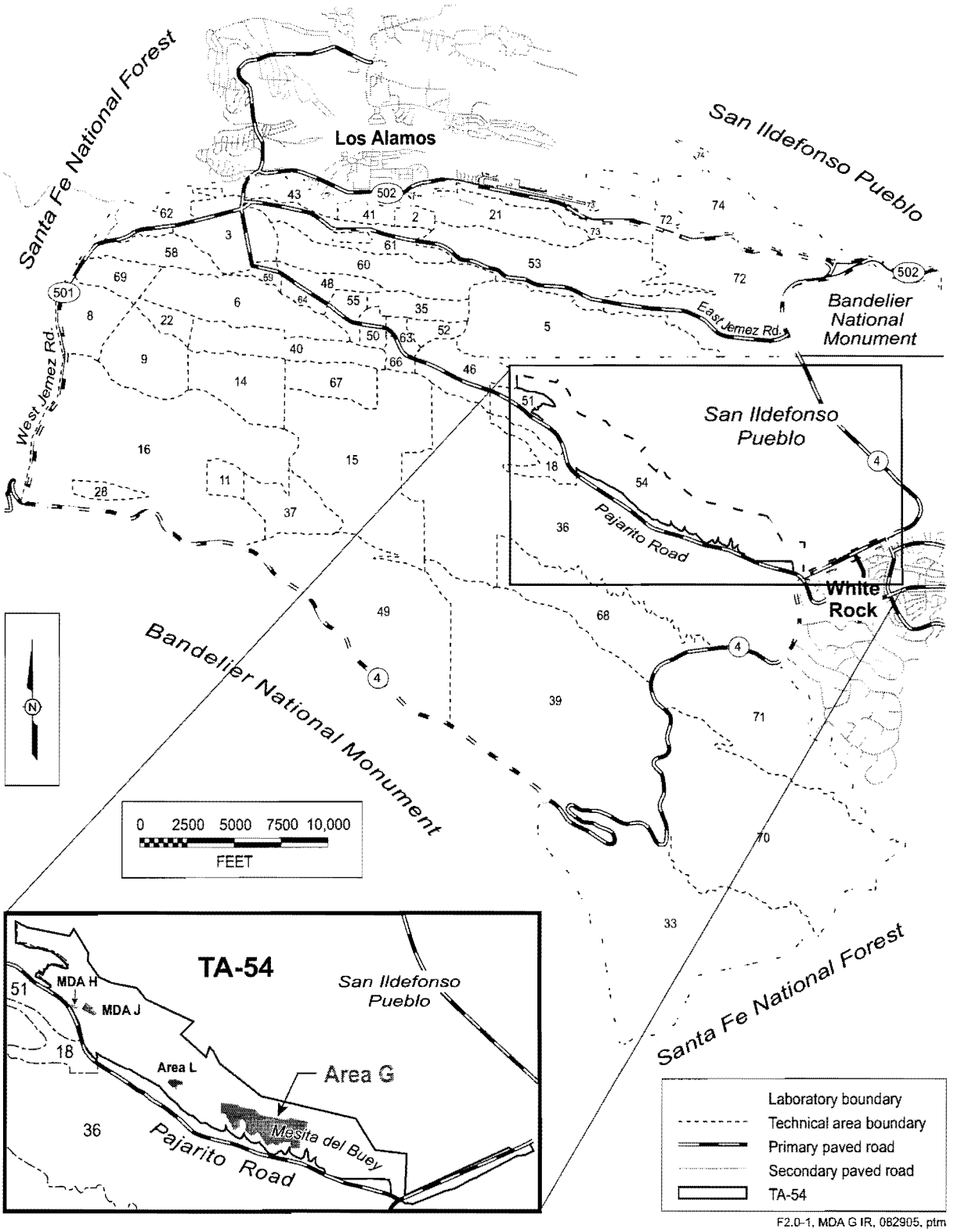

Figure 2.0-1. Location of TA-54, Area G, with respect to Laboratory TAs and surrounding holdings

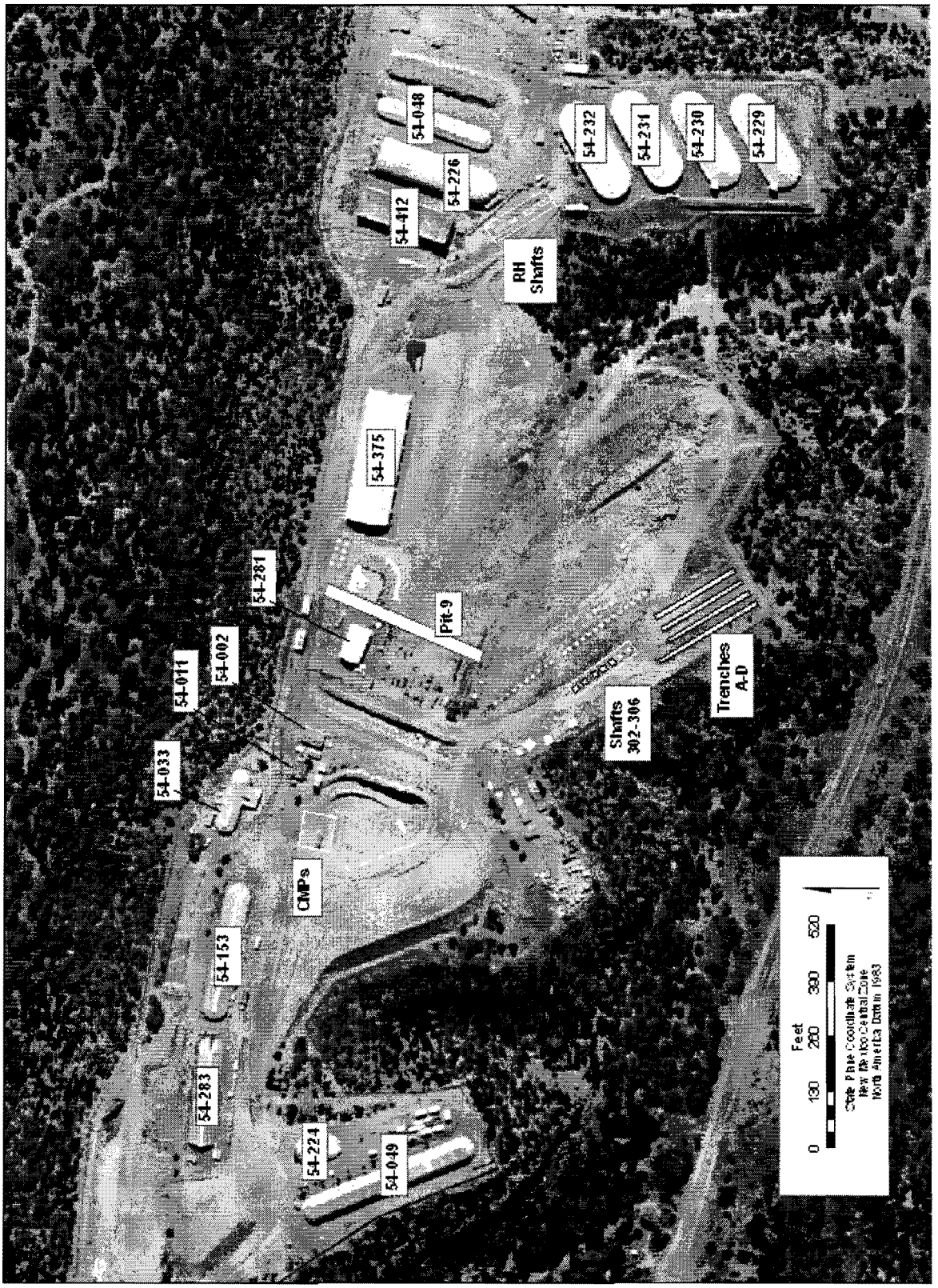

Figure 2.0-2. Aerial view of TA-54, Area G

Figure 3.1-1. Waste containers in TA-54, Area G, Pit 9

Figure 3.1-2. TA-54, Area G, Pit 9 waste containers with plywood covering

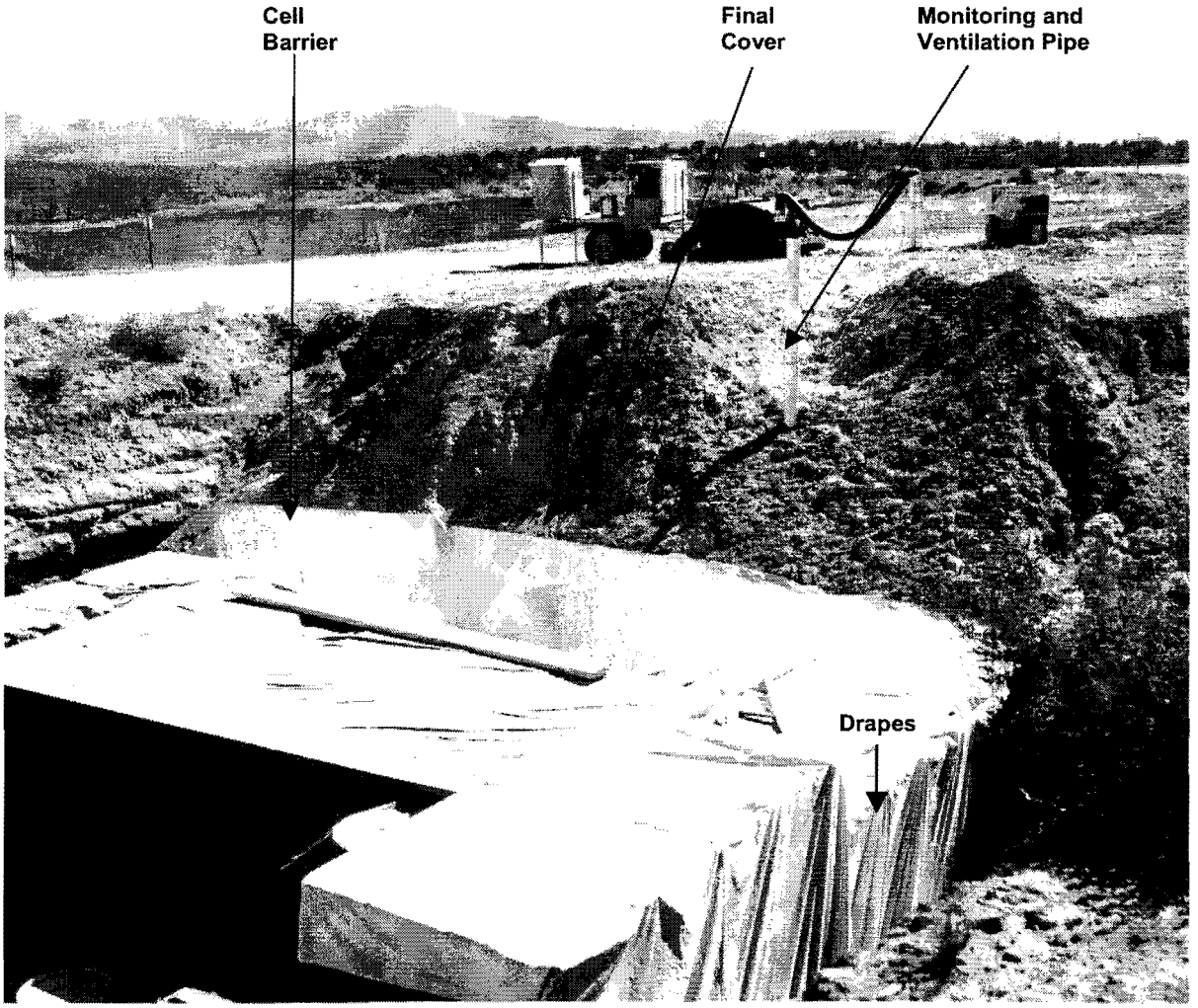

Figure 3.1-3. TA-54, Area G, Pit 9 draped waste containers, ventilation/monitoring pipe, final cover

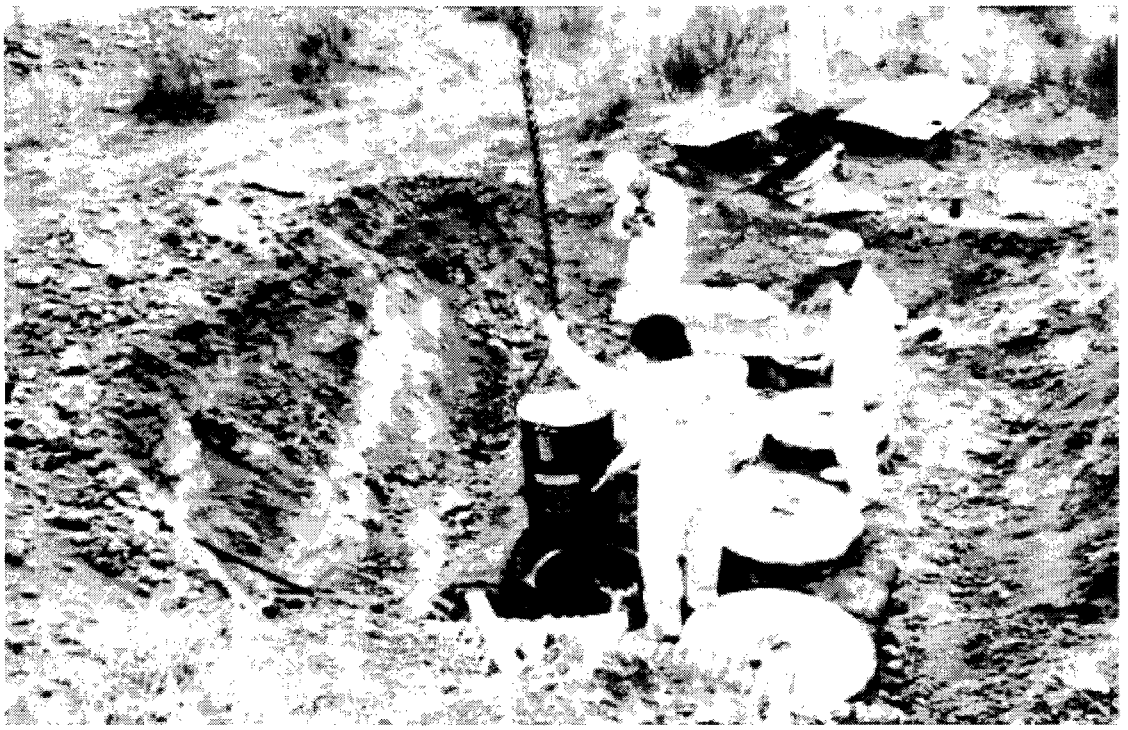

Figure 3.2-1. Placement of 30-gal. drum into a trench cask, 1985

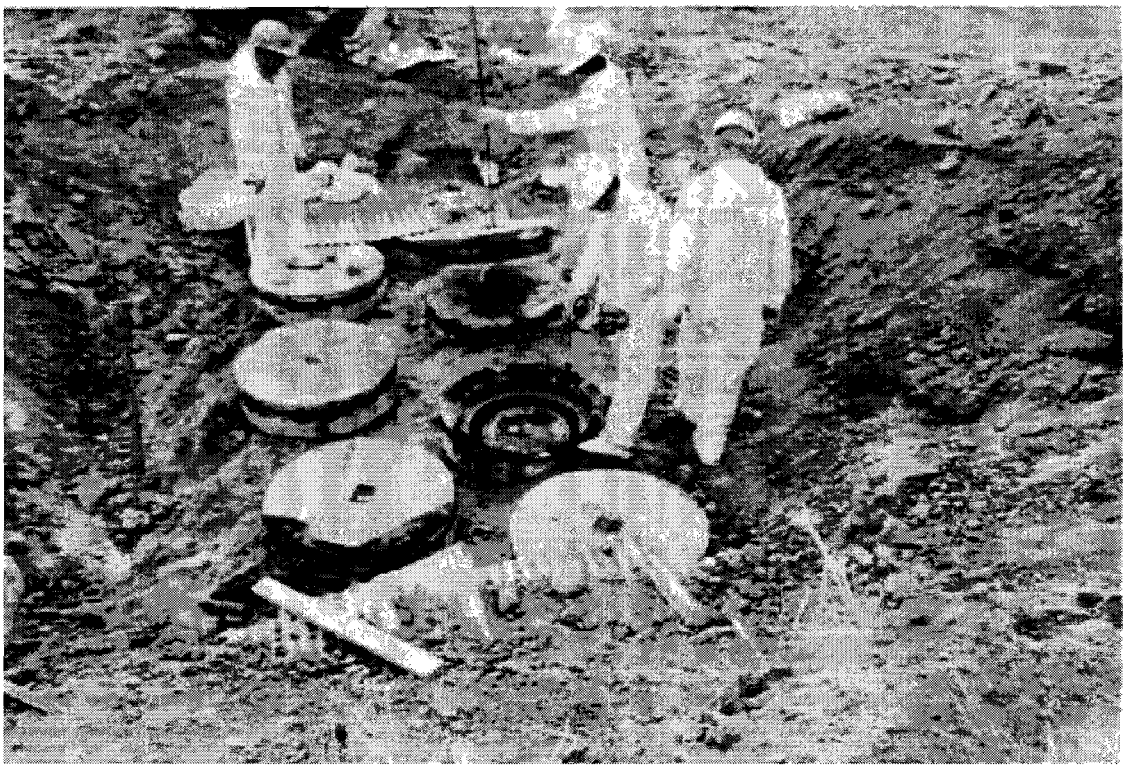

Figure 3.2-2. Cask array, 1985

Figure 3.2-3. Photograph showing full casks before being sealed, 1985

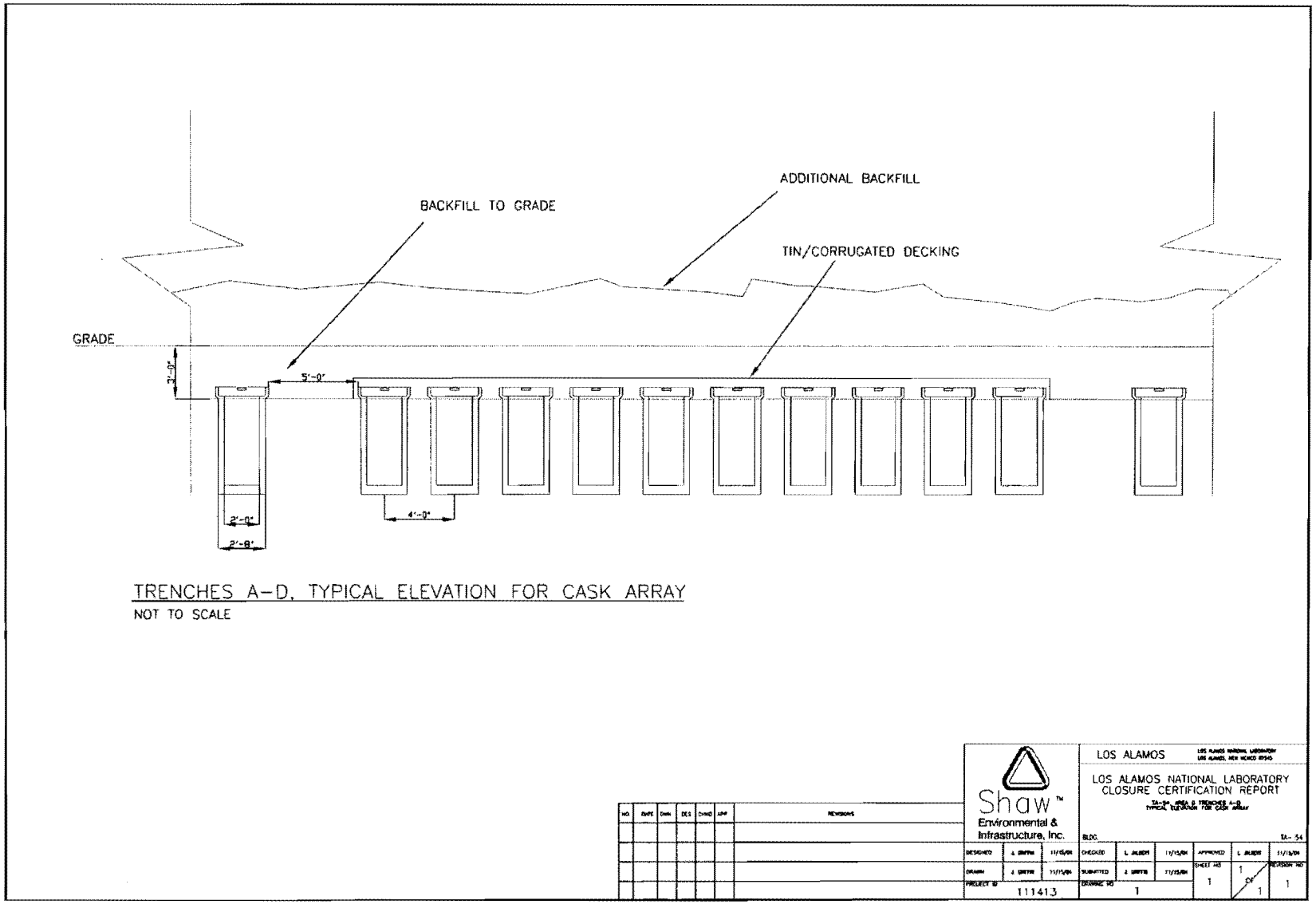

Figure 3.2-4. Cross-section of trench cask array and backfill

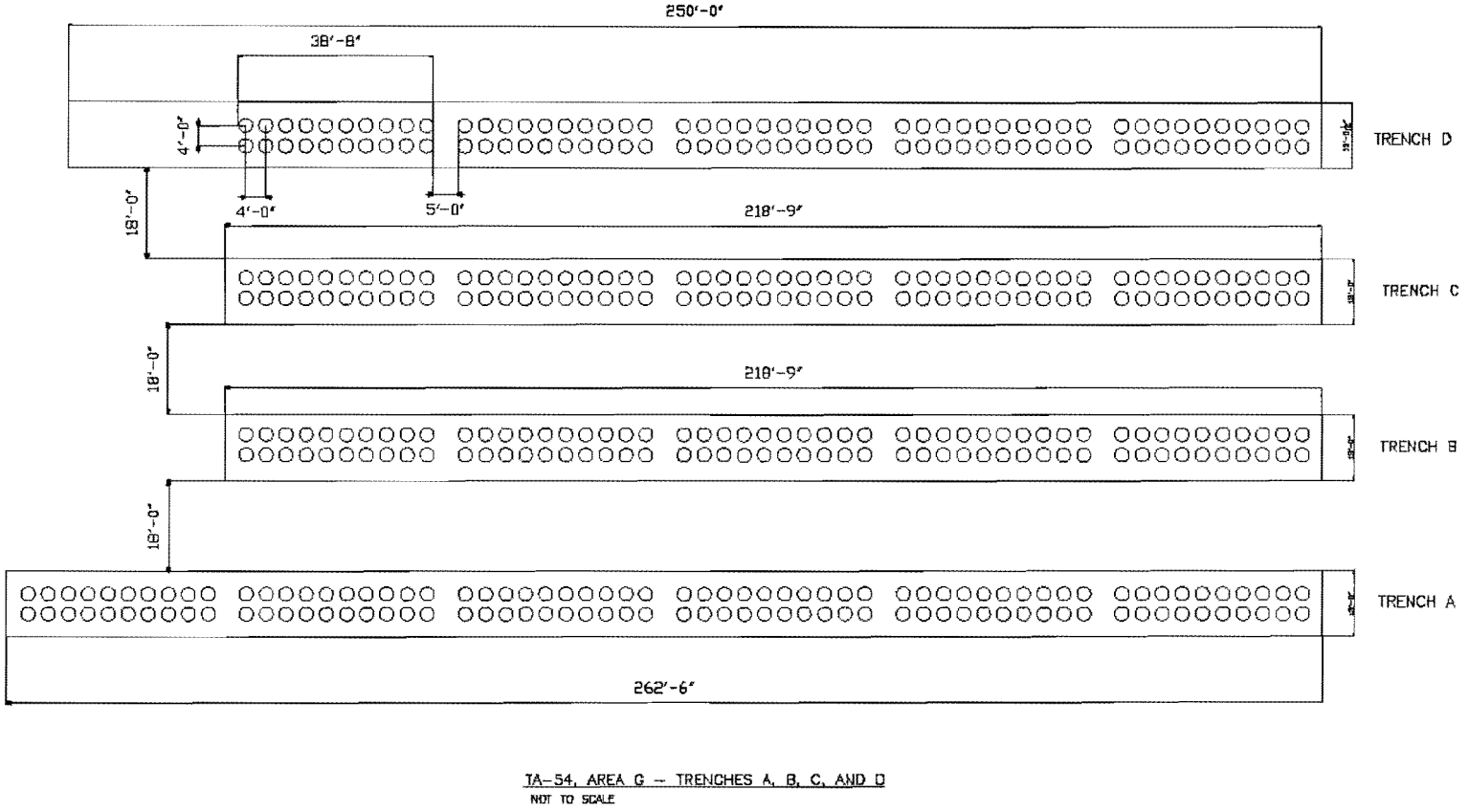

Figure 3.2-5. Dimensions and cask array layout for Trenches A–D at Area G

Figure 3.3-1. TA-54, Area G, CMPs prepared for temporary storage

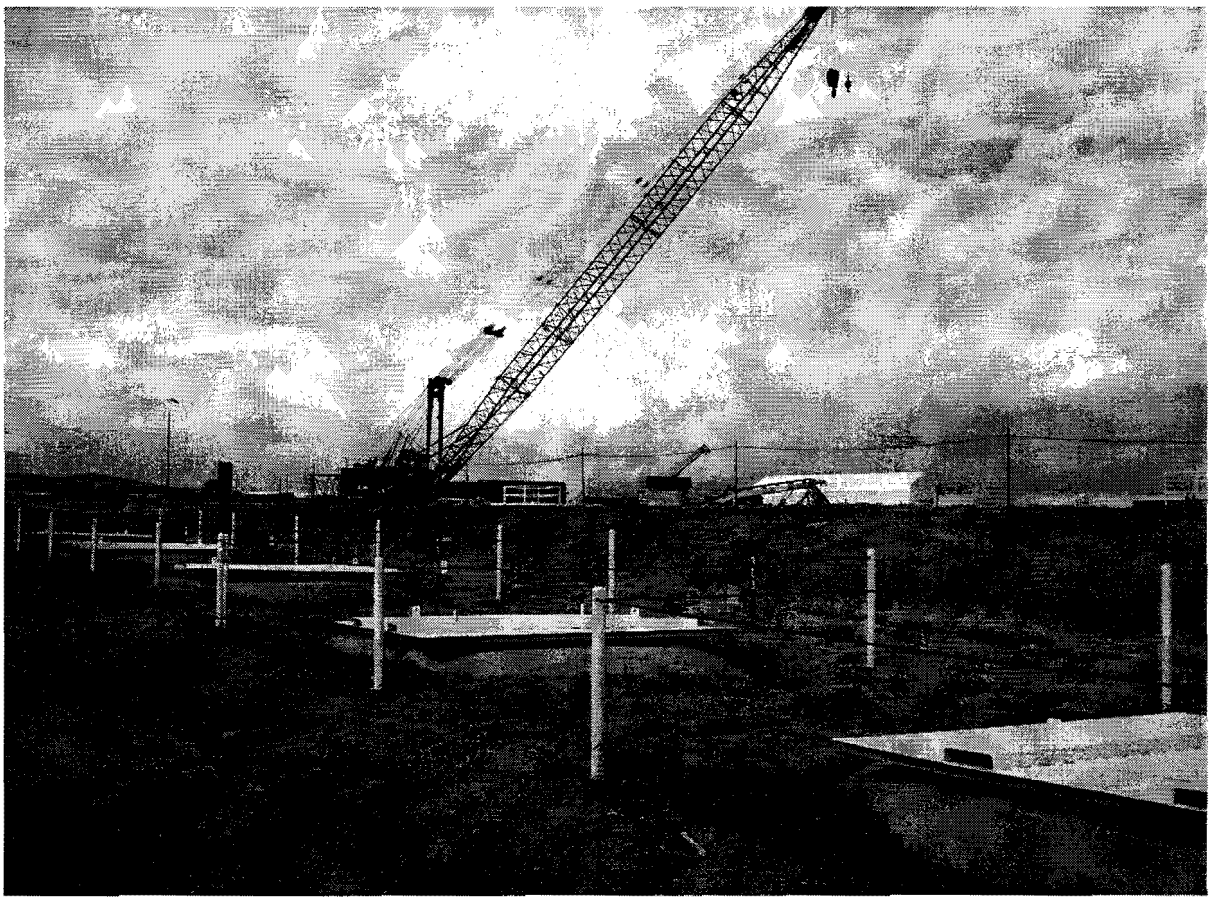

Figure 3.4-1. Site photograph showing the location of Shafts 302–306

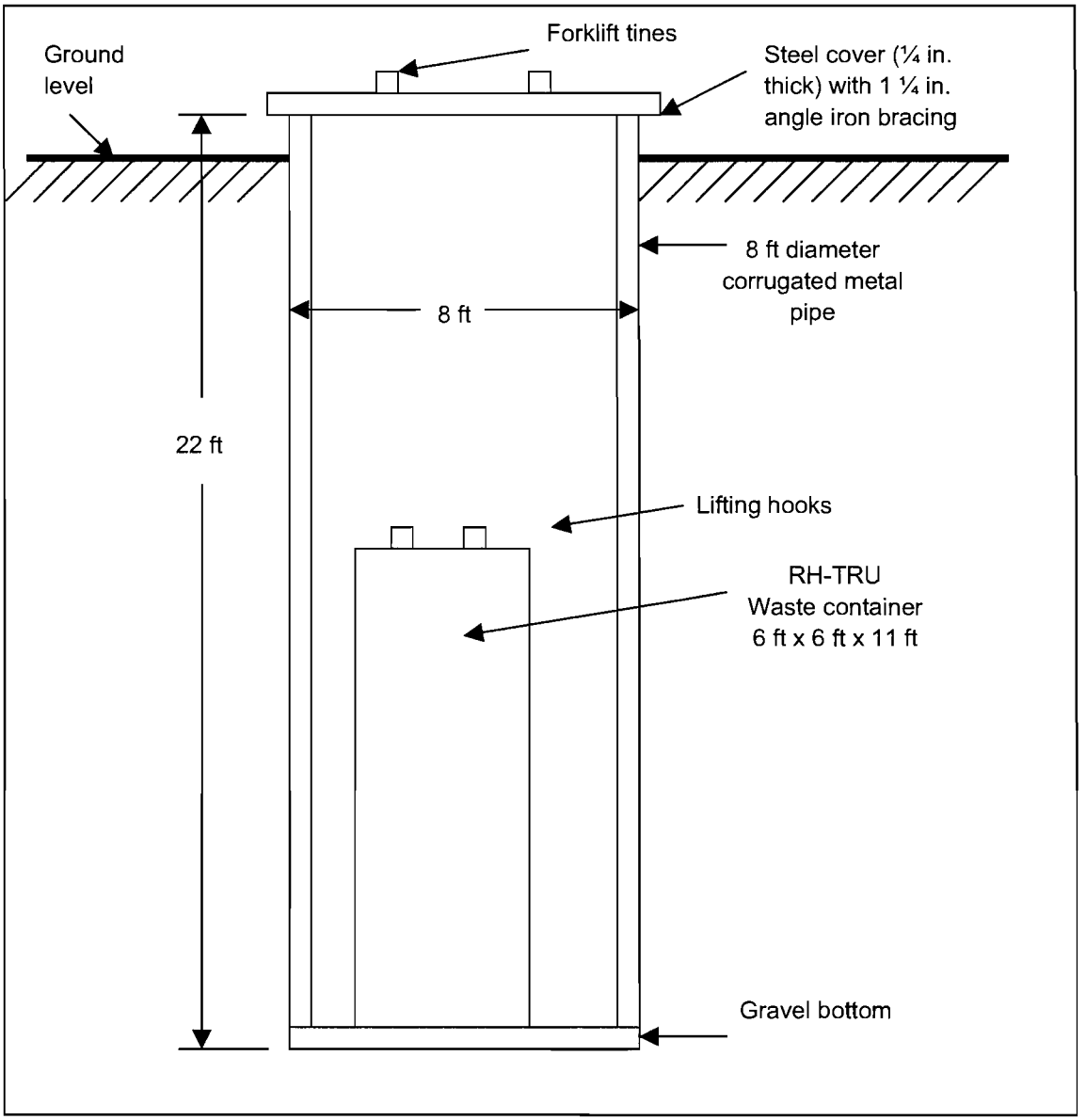

Figure 3.4-2. RH-TRU shaft design at TA-54, Area G

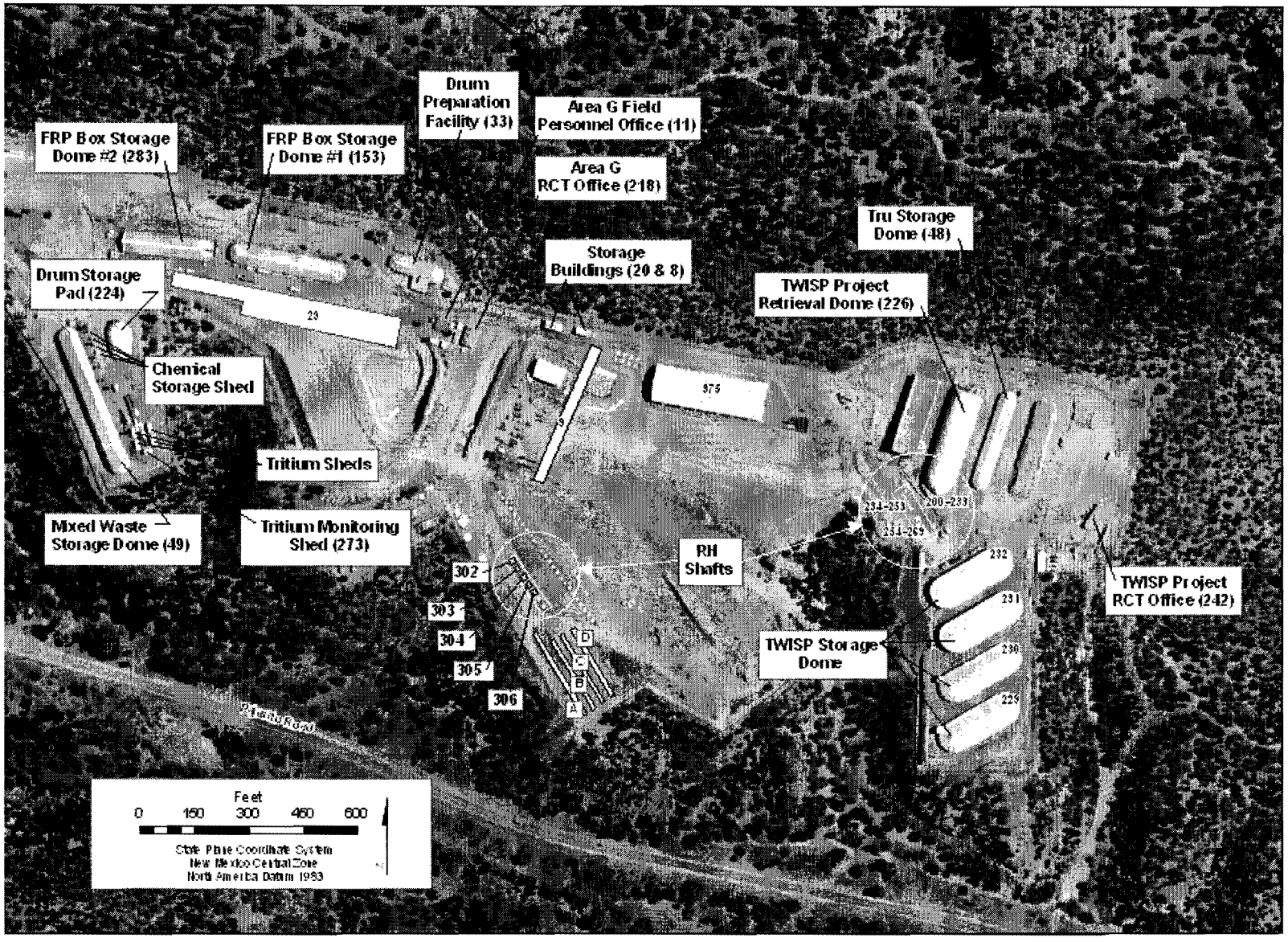

Figure 3.5-1. Aerial photograph showing RH shafts in TA-54, Area G

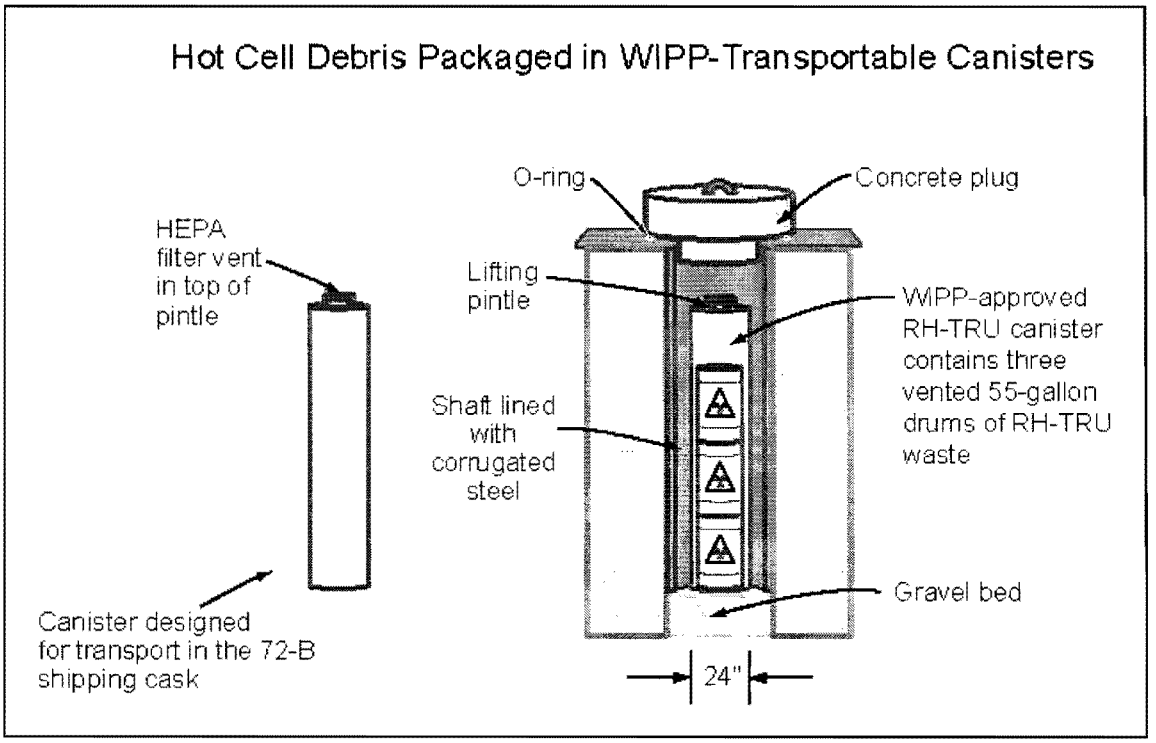

Figure 3.5-2. WIPP canister configuration

Figure 3.5-3. Photograph of the layout of 16 WIPP canisters at TA-54, Area G

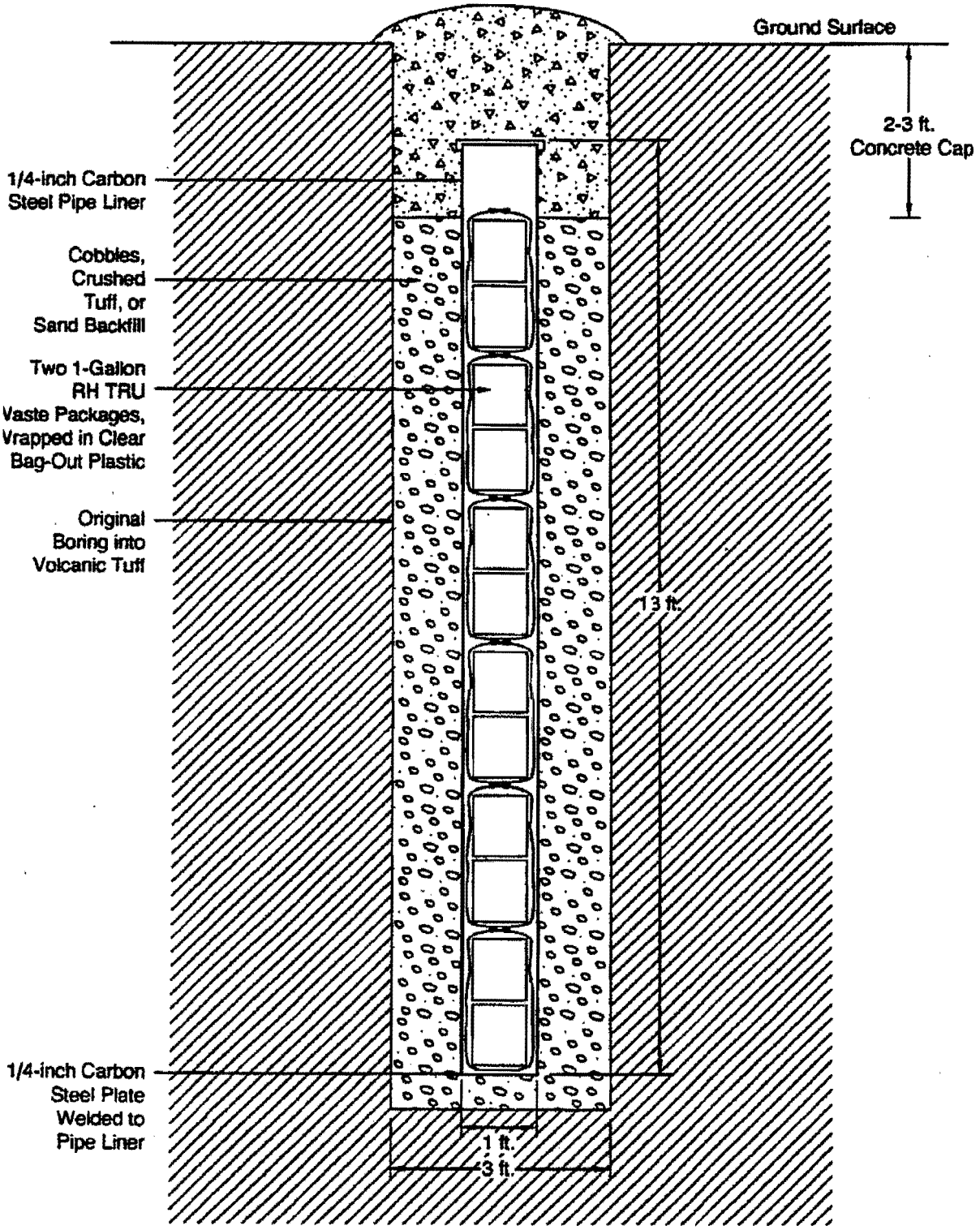

Figure 3.5-4. RH-lined shaft configuration

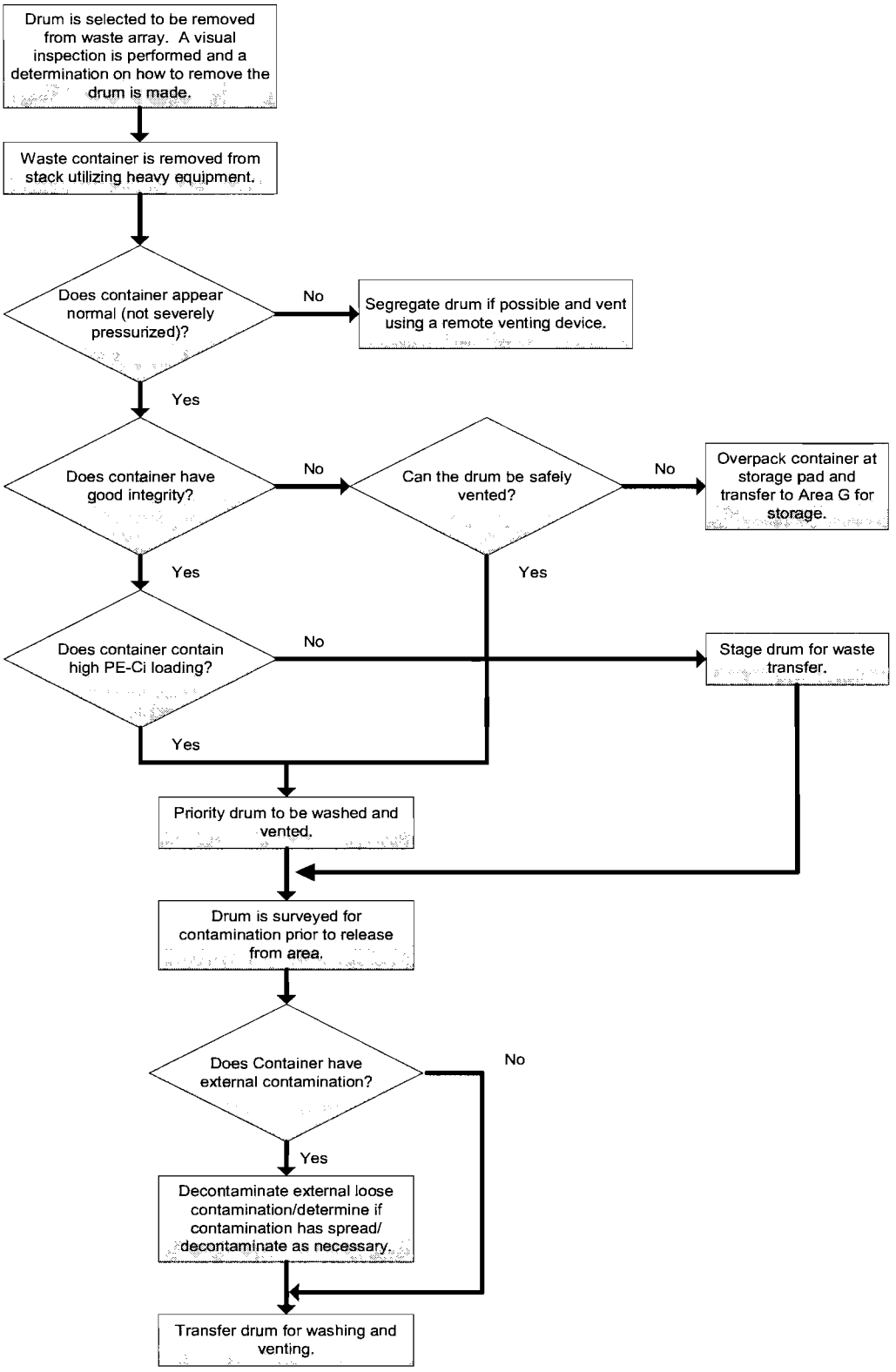

Figure 4.1-1. Typical drum-handling method

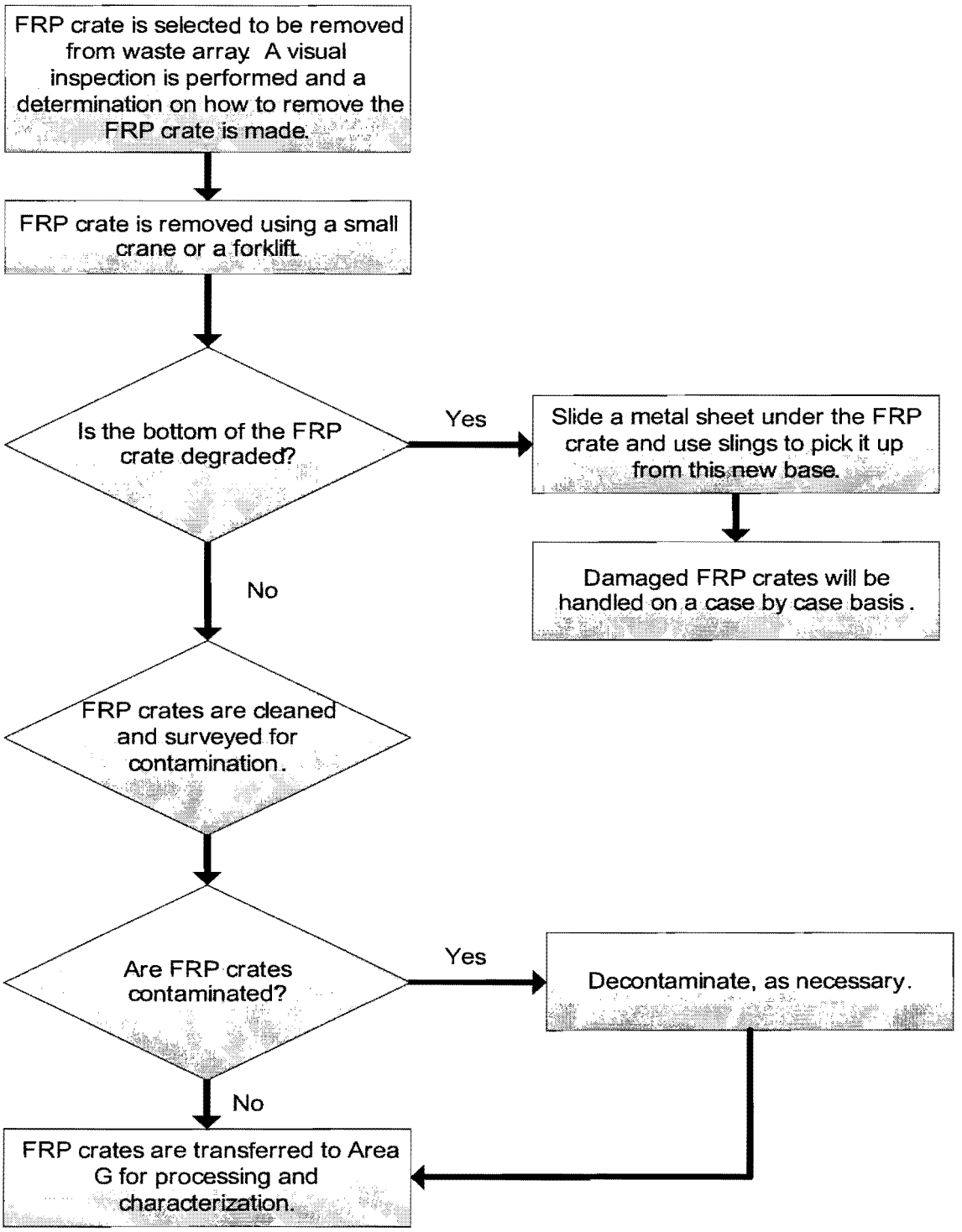

Figure 4.1-2. FRP crate-removal operations

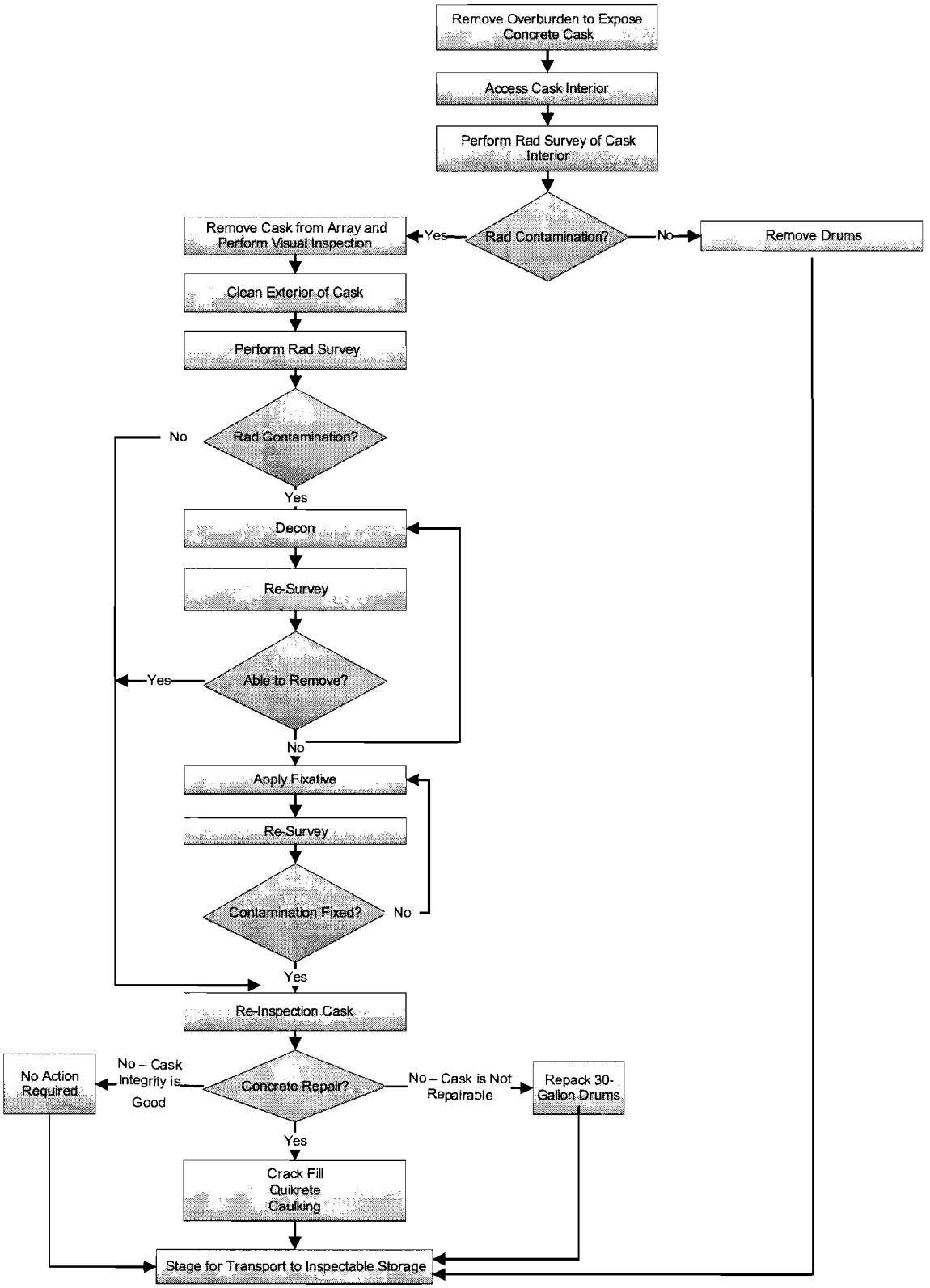

Figure 4.2-1. Cask-retrieval operations

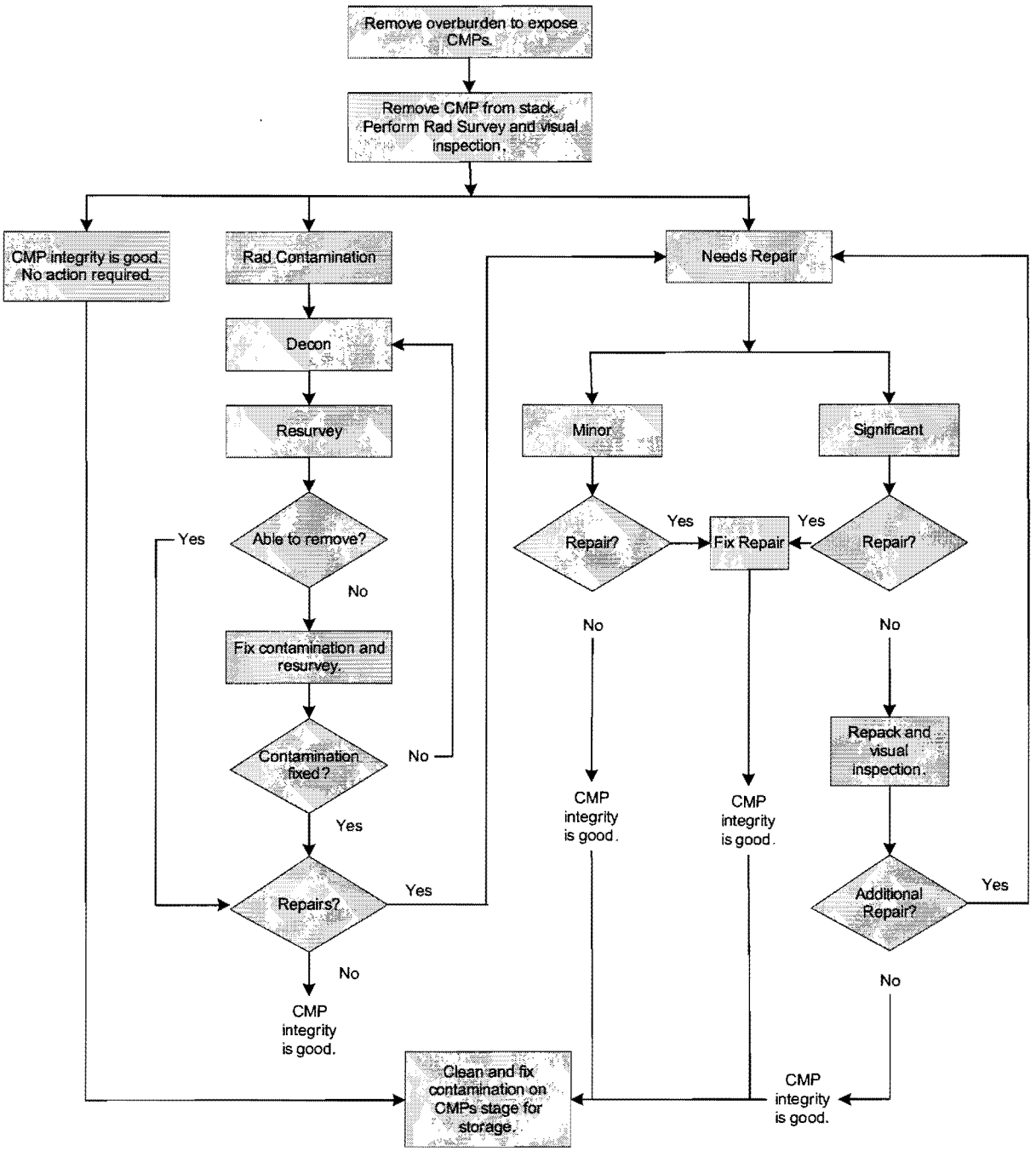

Figure 4.3-1. CMP-retrieval operations

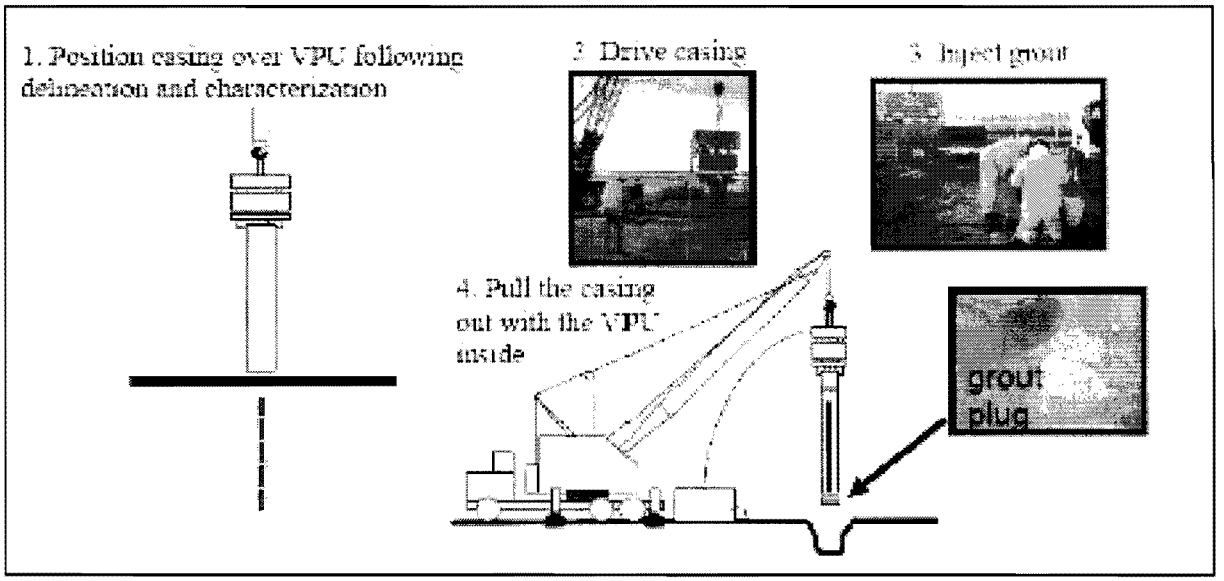

Figure 4.5-1. Intact shaft retrieval using grouting

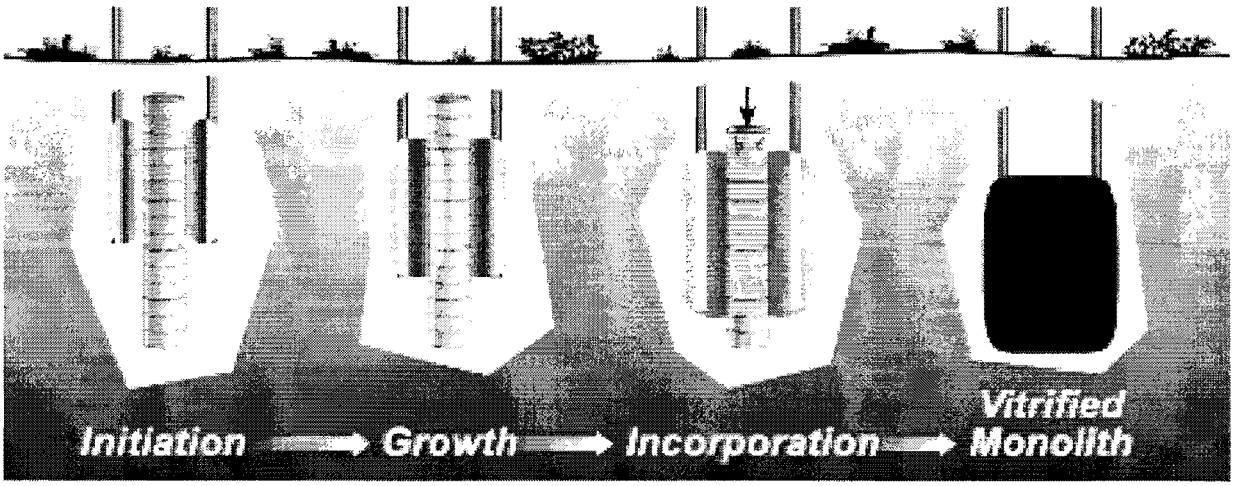

Figure 4.5-2. In situ vitrification schematic (per GeoMelt technologies)

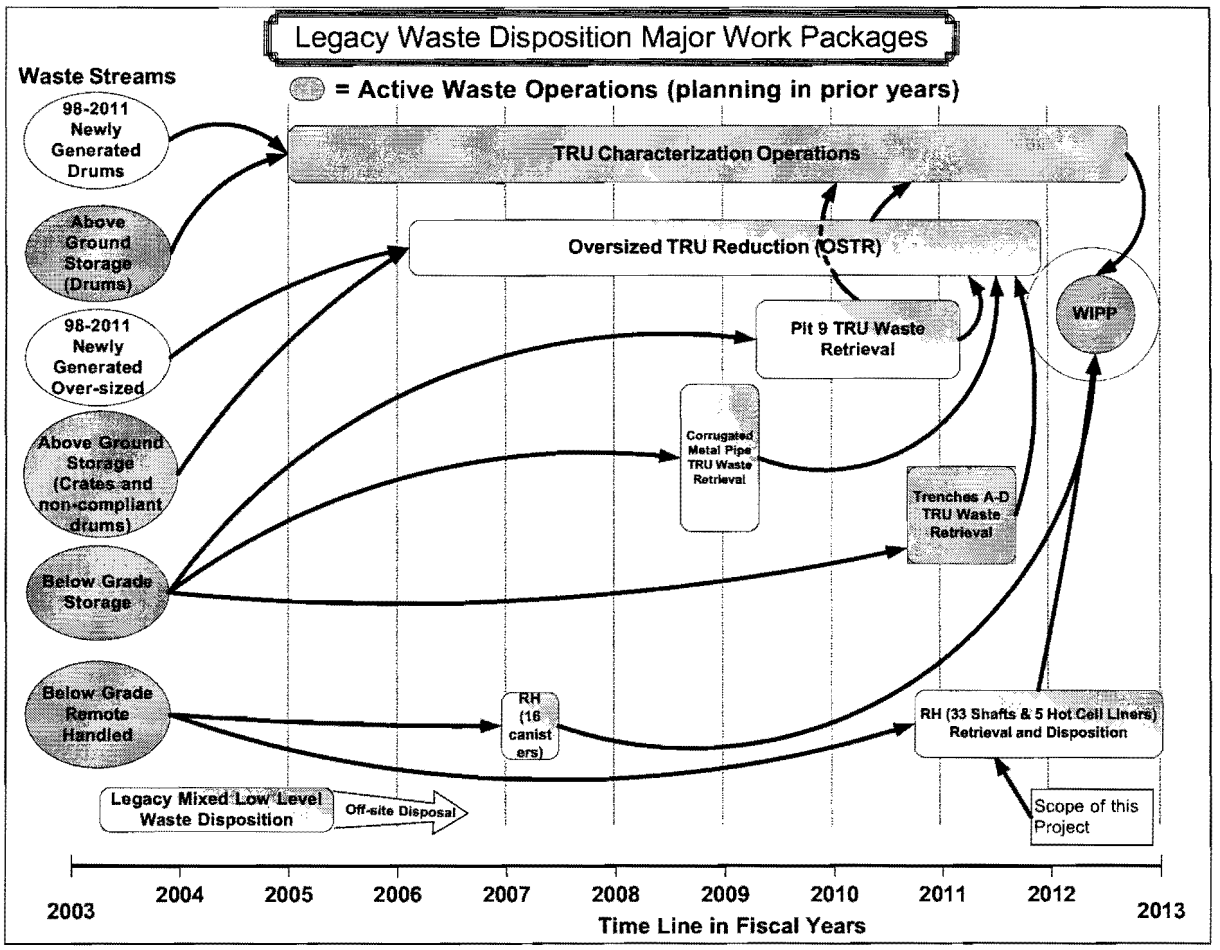

Figure 5.2-1. Overview of legacy waste disposition at TA-54, Area G

Table 3.1-1
Summary of Waste Contents in Pit 9

Container Type	General Waste Description	Quantity of Containers	Gross Weight Range (lb/container)	Total Dose Range (mrem/hr)
55-gal. steel drum	Cellulosics (paper, wood, etc.)	219	49–171	1–18
	Cement paste	133	350–706	0–5
	Chemical treatment sludge	300	206–898	0–12
	Chemical waste	4	113–154	1–2
	Combined combustible/noncombustible trash	68	75–185	0–50
	Combustible trash (paper, plastic, rubber, etc.)	132	85–187	0–120
	Filter media	6	399	0
	Filter media residue	3	90–112	0
	Glass	11	77–185	0–2
	Graphite solid	1	155	1
	Hydrocarbon oil (liquid)	8	265–450	0–1
	"Items needing special tracking"	5	97–122	0–1
	Leached process residue	216	33–448	0–100
	Metal crucibles, scrap, dies	133	0–283	0–9
	Non-property number equipment	1	172	0
	Other combustibles	863	55–386	0–150
	Other noncombustibles	987	51–416	0–250
	Plastics	19	80–156	0–150
	Property number equipment	182	39–415	0–10
	Radioactively contaminated soil	46	150–450	0
	Scrap metal	23	110–298	1–2
	Silicon-based oil (liquid)	3	501	0–5
	Total 55-Gal. Steel Drums	**3363**		
30-gal. drum	Cellulosics (paper, wood, etc.)	127	23–135	0–4
	Chemical waste	2	105–114	1
	Combined combustible/noncombustible trash	38	49–119	0–5
	Combustible decon. waste	1	78	0
	Combustible trash (paper, plastic, rubber, etc.)	10	44–143	0–10
	Filter media	1	47	0
	Glass	3	50–117	0–1
	"Items needing special tracking"	2	85–86	0–1
	Leached process residue	232	31–612	0–45
	Metal crucibles, scrap, dies	45	42–248	0–5
	Other combustibles	2	70–74	0
	Other noncombustibles	33	52–124	0–100
	Plastics	8	60–108	0–1

Table 3.1-1 (continued)

Container Type	General Waste Description	Quantity of Containers	Gross Weight Range (lb/container)	Total Dose Range (mrem/hr)
	Property number equipment	10	67–264	0–2
	Scrap metal	1	54	0
	Silicon-base oil (liquid)	1	273	1
	Skull and oxide	1	106	0
	Total 30-Gal. Drums	**517**		
85-gal. drum	Leached process residue	1	123	1
	Other combustibles	2	86–162	0–7
	Total 85-Gal. Drums	**3**		
Other	Noncombustible building debris	1	4001	0
	Non-property number equipment	2	2000	0
	Property number equipment	3	2000	0
	Total Other Containers	**6**		
Crates	Combined combustible/noncombustible trash	4	403–600	0
	Filter media	25	673–684	0
	"Items needing special tracking"	1	732	0
	Noncombustible building debris	1	1985	0
	Non-property number equipment	112	500–5401	0–5
	Property number equipment	42	88–4001	0–70
	Radioactively contaminated soil	6	2000–4001	0
	Total Crates	**191**		
Low-level waste	Trash cans	1	n/a*	n/a
	Unknown item	1	n/a	n/a
	Two-section glove box	1	n/a	n/a
	Total Low-Level Waste	**3**		
Total Containers		**4083**		

* n/a = Not applicable.

Table 3.1-2
Summary of TRU Radionuclide Inventory in Pit 9

Radionuclide	Total Inventory (Ci)
Am-241	279
Cf-249	0.001
Np-237	0.004
Pu-238	3004
Pu-239	1949
Pu-240	691
Pu-242	0.37
Pu-244	5.27E-08
Total	**5923**

Table 3.2-1
Dimensions of Trenches, Approximate Depth of Crushed Tuff Backfill, Soil Volume, and Period of Waste Receipt

Trench	Dimensions (ft)			Approximate Depth of Backfill (ft)	Total Soil Volume (ft^3)	Total Soil Volume (m^3)	Period of Waste Receipt
A	262.5	13	8*	6	20475.0	579.9	1974
B	218.75	13	8*	6	17062.5	483.2	1974–1977
C	218.75	13	8*	8	22750.0	644.3	1977–1981
D	250	13	10	5	16250.0	460.2	1981–1985

*The 8-ft depth includes the augering of 2-ft-deep holes in the 6-ft-deep floors of Trenches A and B.

Table 3.2-2
Summary of Waste in Trenches A–D

Trench	Total # of Packages	Total Volume (m^3)	General Waste Description	Total TRU (Ci)
A	120	132.38	Mixed cellulosics; plastic materials; rubber materials; mixed paper, plastic, rubber; mixed combustible/noncombustible trash; leached process residue; property number (PN) equipment; non-PN equipment; metal crucibles, scrap, dies; other scrap materials; filter media; other combustibles; other noncombustibles; glass	3.68E+04
B	99	93.58	Mixed cellulosics; plastic materials; mixed paper, plastic, rubber; mixed combustible/noncombustible trash; PN equipment; metal crucibles, scraps, dies; other scrap materials; other noncombustibles	3.17E+04
C	100	80.00	Mixed cellulosics; plastic materials; rubber materials; mixed paper, plastic, rubber; mixed combustible/noncombustible trash; leached process residue; PN equipment; non-PN equipment; precious metals; other scrap metals; other combustibles; other noncombustibles	3.03E+04
D	44	29.20	Plastic materials; rubber materials; mixed paper, plastic, rubber, etc.; mixed combustible/noncombustible trash; leached process residues; hydroxide cake; PN equipment; other scrap metals; other combustibles; other noncombustibles; glass	5.42E+03
Total				**10.41E+04**

Table 3.2-3
Summary of Radionuclide Inventories for Trenches A–D

Trench	Radionuclide	Total Inventory (Ci)
A	Pu-238	3.7023E+04
	Pu-239	3.5462E-01
	Pu-242	9.9580E-05
	Pu-240	1.3898E-01
B	Pu-238	3.1878E+04
	Pu-239	5.5098E+00
	Pu-242	2.4061E-04
	Pu-240	3.3581E-01
C	Pu-238	3.021E+04
	Pu-239	2.8200E+01
	Pu-242	4.4317E-03
	Pu-240	8.9937E+00
D	Pu-238	5.4182E+03
	Pu-239	2.7173E+04
	Pu-242	7.6305E-04
	Pu-240	1.0650E+00

Table 3.3-1
Total Quantities of TRU Radionuclide Waste for All CMPs

Isotope	Total Curies	Total Grams	Fissile Grams
Am-241	10453.54	3074.57	57.49
Pu-238	31.72	1.87	0.2108
Pu-239	59.66	962.20	962.20
Total	**10,544.92**	**4038.64**	**1019.90**

Table 3.4-1
Initial Isotopic Distribution and Activity

TRU Isotope	Shaft 302	Shaft 303	Shaft 304	Shaft 305	Shaft 306
Am-241	1.09E-02	3.12E-02	2.19E-02	4.68E-02	2.44E-02
Pu-238	3.63E-03	1.04 E-02	7.27E-03	1.56E-02	8.10E-03
Pu-239	1.85E-02	5.28 E-02	3.69E-02	7.91E-02	4.12E-02
Pu-240	1.19E-02	3.39 E-02	2.37E-02	5.08E-02	2.64E-02
Pu-242	4.22E-06	1.21E-05	8.45E-06	1.81E-05	9.41E-06
Np-247	na*	na	na	na	na
Total TRU	**4.49E-02**	**1.28E-01**	**8.98E-02**	**1.92E-01**	**1.00E-01**

*na = Not available.

Table 3.4-2
Decayed Isotopic Distribution and Activity

TRU Isotope	Shaft 302	Shaft 303	Shaft 304	Shaft 305	Shaft 306
Am-241	1.78E-02	5.07E-02	3.55E-02	7.61E-02	3.96E-02
Pu-238	3.15E-03	9.00E-03	6.30E-03	1.35E-02	7.02E-03
Pu-239	1.85E-02	5.27E-02	3.69E-02	7.91E-02	4.11E-02
Pu-240	1.18E-02	3.38 E-02	2.37E-02	5.07E-02	2.64E-02
Pu-242	4.22E-06	1.21E-05	8.45E-06	1.81E-05	9.41E-06
Np-247	8.68E-08	2.48-E07	1.74E-07	3.72E07	1.93E-07
Total TRU	**5.13E-02**	**1.46E-01**	**1.02E-01**	**2.19E-01**	**1.14E-01**

Table 3.5-1
Initial and Decayed Activity of TRU in WIPP Canisters

Shaft	Initial Activity (Ci)	Initial Date	Decayed Activity* (Ci)
236	1.81E+00	1994	1.81E+00
237	9.90E+00	1993	9.89E+00
238	1.48E+01	1993	1.48E+01
239	1.54E+01	1993	1.54E+01
240	1.45E+01	1993	1.45E+01
241	1.69E+01	1993	1.69E+01
242	4.20E-02	1993	4.20E-02
243	4.70E-01	1993	4.70E-01
246	7.29E-01	1994	7.28E-01
247	1.39E+00	1994	1.39E+00
248	1.33E+01	1993	1.33E+01
249	1.48E+01	1993	1.48E+01
250	1.66E+01	1993	1.66E+01
251	1.68E+01	1993	1.68E+01
252	1.50E-01	1993	1.50E-01
253	2.31E-02	1993	2.31E-02
Total	**1.38E+02**		**1.38E+02**

*Decayed to 2009.

Table 3.5-2
Initial and Decayed Activity of TRU Waste in 33 Lined Shafts

Shaft Number	Package ID*	Base Year	Initial Isotopic Distribution Activity (Ci)	Target Year	Decayed Isotopic Distribution Activity (Ci)
200	Total	1981	3.21E+00	2009	3.21E+00
201	Total	1979	13.5081	2009	13.487
202	S803548	1979	4.05E+00	2009	4.05E+00
203	S803547	1979	2.33E+00	2009	2.32E+00
204	Total	1979	3.69E+00	2009	3.68E+00
205	Total	1980	7.26E+00	2009	7.25E+00
206	Total	1981	1.80E+01	2009	1.80E+01
207	Total	1981	8.80E-02	2009	8.80E-02
208	Total	1981	1.81E+00	2009	1.81E+00
209	Total	1981	3.10E-02	2009	3.10E-02
210	Total	1981	2.48E-02	2009	2.48E-02
211	Total	1981	4.32E-01	2009	4.31E-01
212	S803758	1980	1.24E+01	2009	1.24E+01
213	Total	1981	3.10E+00	2009	3.09E+00
214	Total	1982	3.72E-02	2009	3.72E-02
215	Total	1982	9.67E-01	2009	9.66E-01
216	Total	1982	9.30E-02	2009	9.30E-02
217	Total	1982	1.82E+00	2009	1.82E+00
218	Total	1982	2.77E+00	2009	2.77E+00
219	Total	1983	2.84E+00	2009	2.84E+00
220	Total	1983	3.78E-02	2009	3.78E-02
221	Total	1983	3.72E-02	2009	3.72E-02
222	Total	1983	3.37E-01	2009	3.62E-01
223	Total	1983	4.05E-02	2009	4.42E-02
224	Total	1985	6.82E-01	2009	6.81E-01
225	Total	1984	4.96E-02	2009	4.96E-02
226	Total	1984	4.96E-02	2009	4.96E-02
227	Total	1984	1.11E+00	2009	1.11E+00
228	Total	1987	4.96E-02	2009	4.96E-02
229	Total	1984	2.23E-01	2009	2.23E-01
230	Total	1984	5.99E+00	2009	5.99E+00
231	Total	1985	3.72E-02	2009	3.72E-02
232	Total	1987	7.43E+00	2009	8.96E+00
Total			**9.45E+01**		**9.60E+01**

*"Total" indicates more than one container in the shaft. Otherwise, the container number is shown.

Table 3.5-3
Initial and Decayed Activity of TRU Isotopes in Tritium Cylinders

Shaft	Package ID	Gross Weight (lb)	TRU Activity (Ci)		
			Initial Year	Initial	Decayed (to 2009)
262	55618	2130	1996	8.47E-01	5.59E-01
263	55432	2590	1995	3.98E-01	2.58E-01
264	55449	2670	1995	4.92E-01	3.18E-01
265	55516	2340	1996	8.76E+00	5.79E+00
266	56197	2480	1997	1.24E+00	8.58E-01
Total				**1.17E+01**	**7.78E+00**

Table 4.1-1
Drum-Handling Method

Drum Condition	Risk Reduction	Risk Acceptance
Integrity of the drum is acceptable for transportation, washing, and venting.	Drum is vented in an American Society of Mechanical Engineers pressure vessel. Drum can be washed, thus allowing a better seal of the vent annulus area during venting.	Drum is washed before venting, which represents additional movement before venting. However, this movement is minimal since washing and venting occur in the same building and movement is by manual techniques once delivered to the dome.
Integrity of the drum is acceptable to load and transfer for drum washing and venting but needs to be overpacked after venting due to visible corrosion.	Drum is vented before placement in an overpack for storage and/or subsequent movements for characterization/disposal.	A drum having minor corrosion is moved, washed, and vented before overpacking.
Integrity of the drum is not acceptable for transportation, washing, and venting; drum is overpacked at the retrieval site.	Drum integrity is questionable; therefore, it is overpacked into an acceptable container.	Drum is not vented before placement in an overpack for storage and/or subsequent movements for characterization/disposal. Overpack is vented.
Drum is severely overpressurized and requires remote venting.	Drum is able to be vented. Venting process uses an inert gas to minimize the likelihood of a deflagration. Venting is performed with operators at a remote area away from the drum.	Drum is vented outdoors without a pressure vessel to contain any deflagration. The drum venting system cannot vent bulging drums due to the physical size changes.

Table 4.6-1
Summary of TRU Waste To Be Removed

	TRU Activity (Ci)	TRU Activity To Be Removed (Ci)	Total TRU and Non-TRU Activity (Ci)	TRU Activity Removed as Percentage of Total TRU Activity
Pit 9	5923	5923	26,700	4.6%
CMPs	10,545	10,545	10,700	8.2%
Trenches A-D	104,121	104,121	105,100	80.6%
Hot-Cell Liners (Shafts 302-306)	0.63	0.63	10.90	0.0%
33 Lined Shafts (Shafts 200-232)	96	96	173	0.0%
16 WIPP Canisters (Shafts 236-243, 246-253)	138	138	7820	0.1%
Tritium Cylinders (Shafts 262-266)	7.8	7.8	1930	0.0%
Total (Retrievable)	**120,831.4**	**120,831.4**	**152,433.9**	**93.5%**
Pits 1–5 (Nonretrievable)	8327	0	—*	—
Total	**129,158**	**120,831**		
Area G	—	—	1,384,614	—

* — = Not applicable.

Table 5.1-1
Estimated Costs for Four TRU Waste Retrieval Projects ($ Million)

	Project Management Support	Engineering Design	Safety Basis	Detailed Operating Procedures	Site Characterization	Readiness Assessment	Preretrieval Activities[a]	Retrieval Activities	Project Closeout	Total
Pit 9	8.01	0.69	0.00[b]	0.86	0.23	0.00[b]	0.94	8.35	0.20	19.28
Trenches A–D/ Tritium Cylinders	4.55	0.69	0.00[b]	0.45	0.17	1.22	2.89	3.74	0.20	13.91
CMPs	4.16	0.54	0.76	0.57	0.15	1.72	0.09	2.09	0.20	10.28
16 WIPP Canisters	1.42	0.70	—[c]	—	—	—	6.36[d]	0.83[e]	—	7.19
33 Lined Shafts	—	—	—	—	—	—	—	—	—	70–135[f]
Hot Cell Liners	—	—	—	—	—	—	—	—	—	
Total	**18.14**	**2.62**	**0.76**	**1.88**	**0.55**	**2.94**	**10.28**	**15.01**	**0.6**	**52.78**

Note: Does not contain the cost for 33 lined shafts or hot-cell liners.

[a] Includes a management reserve allotment.

[b] One safety basis development and readiness assessment will be performed for Pit 9, CMPs, and Trenches A–D. Costs are included in the CMP totals.

[c] — = Cost included under other activities.

[d] Includes safety basis and readiness assessment.

[e] CCP costs.

[f] Source: Legacy Waste Disposition Project.

Table 5.2-1
Pit 9 Retrieval Project Schedule

Description	Early Start Date	Early Finish Date
Pit 9 retrieval basis for interim operation complete		19-Sep-07
Pit 9 final engineering design complete		08-May-07
Pit 9 Retrieval detailed operating procedures complete		02-May-08
Pit 9 site characterization complete		04-Feb-08
Pit 9 permits in place		13-Aug-08
Pit 9 Pre-retrieval activities complete		06-Jan-09
Pit 9 readiness assessment complete		27-Jun-09
Pit 9 retrieval operations	13-Jan-10	23-Mar-11
Pit 9 Retrieval of waste complete		20-Apr-11
Pit 9 project closeout activities complete		30-Jun-11

Source: LWD Baseline Schedule, 4-11-06.

Table 5.2-2
Trenches A–D and Tritium Cylinders Retrieval Project Schedule

Description	Early Start Date	Early Finish Date
Trenches A–D Retrieval basis for interim operation complete		18-Sep-07
Trenches A–D final engineering design complete		14-May-07
Trenches A–D retrieval detailed operating procedures complete		31-Jul-08
Trenches A–D site characterization complete		17-Jul-09
Trenches A–D permits in place		27-Aug-09
Trenches A–D preretrieval activities complete		23-Mar-10
Trenches A–D readiness assessment complete		01-Nov-10
Trenches A–D retrieval operations complete	17-Nov-10	23-Sep-11
Tritium cylinders retrieval operations complete		16-Sep-11
Trenches A–D/tritium cylinders waste retrieval complete		24-Oct-11
Trenches A–D/tritium cylinders project closeout complete		24-Oct-11

Source: LWD Baseline Schedule, 4-11-06.

Table 5.2-3
CMP Retrieval Project Schedule

Description	Early Start Date	Early Finish Date
CMP retrieval basis for interim operation complete		19-Sep-07
CMP final engineering design complete		21-May-07
CMP retrieval detailed operating procedures complete		25-Sep-08
CMP site characterization complete		18-Oct-07
CMP permits in place		22-Aug-08
CMP preretrieval activities complete		03-Dec-08
CMP readiness assessment complete		27-Jul-09
CMP retrieval operations	18-Aug-09	18-Feb-10
Retrieval of waste from CMP complete		18-Mar-10
CMP closeout activities complete		18-Mar-10

Source: LWD Baseline Schedule, 4-11-06.

Table 5.2-4
16 WIPP Canisters Retrieval Project Schedule

Description	Early Start Date	Early Finish Date
WIPP canister retrieval documented safety analysis addendum complete		23-Aug-06
WIPP canister preliminary planning/design complete		11-Jan-06
WIPP canister retrieval DOPs complete		04-May-06
WIPP canister site characterization complete		30-May-06
WIPP canister manifest in place		18-May-07
WIPP canister preretrieval activities complete		28-Sep-06
WIPP canister readiness assessment complete		05-Feb-07
WIPP canister retrieval operations	12-Feb-07	29-Jun-07
Ship canisters to WIPP		29-Jun-07

Source: LWD Baseline Schedule, 4-11-06.

Table 5.2-5
33 Lined Shafts and 5 Hot-Cell Liners Schedule

Description	Date
Complete preconceptual planning	December 2005
CD-0, begin conceptual design	March 2006
Input to corrective measure evaluations report due	June 2007
State approval of corrective measure evaluations/decision on TA-54 closure remedy	December 2007
CD-1, complete conceptual phase, authorization to begin detailed design/planning phase	March 2008
Complete design, deliver CD-2/3 package (set performance baseline, authorize execution)	January 2009
Field operations (setup, retrieval, disposition)	Second quarter fiscal year 2009 through fourth quarter fiscal year 2012
CD-4, complete project, turn over site to closure project	First quarter fiscal year 2013
Project closeout	Third quarter fiscal year 2013

Source: Legacy Waste Disposition Project Office, 1-17-06.

Appendix A

Acronyms and Glossary

ACRONYMS

AEC	Atomic Energy Commission
ALARA	as low as reasonably achievable
CCP	Central Characterization Project
CH	contact handled
CMB	Chemistry Metallurgy Baker (Division)
CMP	corrugated metal pipe
CMR	Chemistry and Metallurgy Research
DOE	Department of Energy
FRP	fiberglass reinforced plywood
HEPA	high-efficiency particulate air (filter)
IAD	immediate action directive
ISG	in situ grouting
LLW	low level (transuranic) waste
MAR	material at risk
MDA	material disposal area
MST	Material Science and Technology (Division)
NMT	Nuclear Materials Technology Group
NWIS	Nuclear Waste Infrastructure Services
RCRA	Resource Conservation and Recovery Act
RH	remote handled
TA	technical area
TRU	transuranic waste
TWISP	Transuranic Waste Inspectable Storage Project
VOC	volatile organic compound
VPU	vertical pipe unit
WBS	work breakdown structure
WIPP	Waste Isolation Pilot Plant

GLOSSARY

analysis—A critical evaluation, usually made by breaking a subject (either material or intellectual) down into its constituent parts, then describing the parts and their relationship to the whole. Analyses may include physical analysis, chemical analysis, toxicological analysis, and knowledge-of-process determinations.

as low as reasonably achievable (ALARA)—(1) An approach to radiation protection for controlling or managing exposure (both individual and collective) to the workforce and the general public. (2) An approach for controlling or managing releases of radioactive material to the environment at levels as low as social, technical, economic, practical, and public-policy considerations permit. ALARA is not a dose limit.

assessment—(1) The act of reviewing, inspecting, testing, checking, conducting surveillance, auditing, or otherwise determining and documenting whether items, processes, or services meet specified requirements. (2) An evaluation process used to measure the performance or effectiveness of a system and its elements. In this glossary, assessment is an all-inclusive term used to denote any one of the following: audit, performance evaluation, management system review, peer review, inspection, or surveillance.

cap—A modern engineered landfill cover that is designed and constructed to minimize or eliminate the release of constituents into the environment.

Code of Federal Regulations (CFR)—A document that codifies all rules of the executive departments and agencies of the federal government. The code is divided into 50 volumes, known as titles. Title 40 of the CFR (referenced as 40 CFR) covers environmental regulations.

Compliance Order on Consent (Consent Order)—For the Environmental Remediation and Surveillance Program, an enforcement document signed by the New Mexico Environment Department, the U.S. Department of Energy, and the Regents of the University of California on March 1, 2005, which prescribes the requirements for corrective action at Los Alamos National Laboratory. The purposes of the Consent Order are (1) to define the nature and extent of releases of contaminants at, or from, the facility; (2) to identify and evaluate, where needed, alternatives for corrective measures to clean up contaminants in the environment and prevent or mitigate the migration of contaminants at, or from, the facility; and (3) to implement such corrective measures. The Consent Order supersedes the corrective action requirements previously specified in Module VIII of the Laboratory's Hazardous Waste Facility Permit.

Consent Order—See Compliance Order on Consent.

corrective action—(1) In the Resource Conservation and Recovery Act, an action taken to rectify conditions potentially adverse to human health or the environment. (2) In the quality assurance field, the process of rectifying and preventing nonconformances.

corrective measure evaluation—An evaluation of potential remedial alternatives undertaken to identify a preferred remedy that will be protective of human health and the environment and that will attain appropriate cleanup goals.

Curie—A unit of radioactivity defined as the quantity of any radioactive nuclide that has an activity of 3.7×10^{10} disintegrations per second (dps).

disposal—The discharge, deposit, injection, dumping, spilling, leaking, or placing of any solid waste or hazardous waste into, or on, any land or water so that such solid waste or hazardous waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including groundwaters.

gamma radiation—A form of electromagnetic, high-energy ionizing radiation emitted from a nucleus. Gamma rays are essentially the same as x-rays (though at higher energy) and require heavy shielding, such as concrete or steel, to be blocked.

material disposal area (MDA)—A subset of the solid waste management units at Los Alamos National Laboratory (the Laboratory) that include disposal units such as trenches, pits, and shafts. Historically, various disposal areas (but not all) were designated by the Laboratory as MDAs.

mixed waste—Waste containing both hazardous and source, special nuclear, or byproduct materials subject to the Atomic Energy Act of 1954.

Module VIII—Module VIII of the Los Alamos National Laboratory (the Laboratory) Hazardous Waste Facility Permit. This permit allows the Laboratory to operate as a hazardous-waste treatment, storage, and disposal facility. From 1990 to 2005, Module VIII included requirements from the Hazardous and Solid Waste Amendments. These requirements have been superceded by the March 1, 2005, Compliance Order on Consent (Consent Order).

percent recovery (%R)—The amount of material detected in a sample (less any amount already in the sample) divided by the amount added to the sample, expressed as a percentage.

radionuclide—Radioactive particle (human-made or natural) with a distinct atomic weight number.

screening action level (SAL)—A radionuclide's medium-specific concentration level; it is calculated by using conservative criteria below which it is generally assumed that no potential exists for a dose that is unacceptable to human health. The derivation of a SAL is based on conservative exposure and on land-use assumptions. However, if an applicable regulatory standard exists that is less than the value derived, it is used in place of the SAL.

site characterization—Defining the pathways and methods of migration of hazardous waste or constituents, including the media affected; the extent, direction and speed of the contaminants; complicating factors influencing movement; or concentration profiles.

site-specific health and safety plan (SSHASP)—A health and safety plan that has been tailored to a site or to an Environmental Remediation and Surveillance (ERS) Program field activity and that has been approved by an ERS health and safety representative. A SSHASP contains information specific to the project, including the scope of work, relevant history, descriptions of hazards from activity associated with the project site(s), and techniques for exposure mitigation (e.g., personal protective equipment and hazard mitigation).

solid waste—Any garbage, refuse, or sludge from a waste treatment plant, water supply treatment plant, or air-pollution control facility, and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations and from community activities. Solid waste does not include solid or dissolved materials in domestic sewage; solid or dissolved materials in irrigation return flows; industrial discharges that are point sources subject to permits under section 402 of the Federal Water Pollution Control Act, as amended; or source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954, as amended.

technical area (TA)—At Los Alamos National Laboratory, an administrative unit of operational organization (e.g., TA-21).

transport (transportation)—(1) The movement of a hazardous waste by air, rail, highway, or water. (2) The movement of a contaminant from a source through a medium to a receptor.

treatment—Any method, technique, or process, including elementary neutralization, designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to neutralize such waste, recover energy or material resources from the waste, or to render such waste nonhazardous or less hazardous; safer to transport, store, or dispose of; or amenable for recovery or storage; or reduced in volume.

treatment, storage, and disposal facility—An interim-status or permitted facility in which hazardous waste is treated, stored, or disposed.

tuff—Consolidated volcanic ash, composed largely of fragments produced by volcanic eruptions.

U.S. Environmental Protection Agency (EPA)—The federal agency responsible for enforcing environmental laws. Although state regulatory agencies may be authorized to administer some of this responsibility, EPA retains oversight authority to ensure the protection of human health and the environment.

work plan—A document that specifies the activities to be performed when implementing an investigation or remedy. At a minimum, the work plan should identify the scope of the work to be performed, specify the procedures to be used to perform the work, and present a schedule for performing the work. The work plan may also present the technical basis for performing the work.