CONF-920414--1

DE92 000677

THE MANAGEMENT OF LOW-LEVEL RADIOACTIVE AND MIXED WASTES AT OAK RIDGE NATIONAL LABORATORY

A. P. Malinauskas

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831

"The submitted manuscript has been authored by a contractor of the U.S. Government under contract No. DE-AC05-84OR21400. Accordingly, the U.S. Government retains a nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or allow others to do so, for U.S. Government purposes."

*Research sponsored by the Office of Technology Development, U.S. Department of Energy, under contract DE-AC05-84OR21400 with Martin Marietta Energy Systems, Inc.

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

ABSTRACT

The management of low-level radioactive wastes at Oak Ridge National Laboratory (ORNL) is complicated because of several factors: (1) some of the waste that had been disposed previously does not meet current acceptance criteria; (2) waste is presently being generated both because of on-going operations as well as the remediation of former disposal sites; and (3) low-level radioactive waste streams that also contain chemically toxic species (mixed wastes) are involved. As a consequence, the waste management activities at ORNL range from the application of standard practices to the development of new technologies to address the various waste management problems.

Considerable quantities of low-level radioactive wastes had been disposed in trenches at the ORNL site, and the trenches subsequently covered with landfill. Because the vadose zone is not very extensive in the waste burial area, many of these trenches were located partially or totally within the saturated zone. As a result, considerable amounts of radioactive cesium have been leached from the wastes and have entered the groundwater system. Efforts are currently underway to remediate the problem by excluding groundwater transport through the burial site. This is being accomplished through several approaches: (1) the introduction of polyacrylamide grouts into the voids contained in the burial trenches; (2) compaction of the trench region to collapse the voids; and (3) capping of the burial site to prevent penetration by surface water.

Although a waste minimization program is underway to reduce the amount of low-level radioactive waste that is generated at ORNL, non-trivial quantities of such waste are nonetheless produced. For those cases in which the wastes are otherwise non-toxic, the material is compacted and stored in well-monitored tumuli or underground silos if solid, or are concentrated and stabilized in a solid matrix if liquid.

A number of waste streams have also been generated that not only contain low levels of radioactive species, but chemically noxious species as well. These "mixed wastes" are currently subject to storage and disposal restrictions imposed on both low-level radioactive materials and on substances subject to the Resource Conservation and Recovery Act (RCRA). Examples include radioactivity-contaminated asbestos, low-level radioactive waste streams that also contain polychlorinated biphenyl compounds (PCBs) or degreasing agents, such as trichloroethane (TCA) or trichloroethylene (TCE), and radioactive, organic sludges.

Technologies currently under development at ORNL to treat these mixed wastes are directed toward separating the RCRA components from the radioactive species, either through destruction of the organic component using chemical or biochemical processes, or the application of solvent extraction or precipitation techniques to effect separation into independent waste forms.

I. INTRODUCTION

The Oak Ridge National Laboratory (ORNL) is one of several multi-program facilities within the U.S. Department of Energy (DOE) complex. Although it is primarily a research and development (R&D) institution, the Laboratory has also served as a major supplier of radioisotopes for research, medical, and commercial uses. Moreover, its R&D activities have included investigations of the chemistry and behavior of radioactive materials for purposes of developing radiochemical analysis techniques, of identifying and mitigating consequences of nuclear reactor accidents, and of recovery of materials of value from spent nuclear reactor fuel elements.

These and related activities have resulted in the generation of considerable volumes of radioactive, mixed, and hazardous wastes. In December, 1989, ORNL developed and issued a comprehensive plan for the management of these wastes.[1] This paper summarizes those aspects of the plan that pertain to low-level radioactive and mixed waste streams, and ongoing operations that are directed toward the stabilization of previously disposed material.

II. PAST DISPOSAL SITES

Six sites have been utilized for the disposal of radioactive waste at ORNL. These solid waste storage areas (SWSAs) have been operational for various periods of time, beginning in 1944, and range in size from about 1.5 acres to 68 acres. Documentation concerning the orientation, geometry, and contents of the earlier sites is poor, so that their characterization has become a major remediation action.

Some of the trenches which were used for disposal of the wastes in the solid waste storage areas have experienced intrusion by groundwater, and have therefore become sources for groundwater contamination. Corrective measures have included the construction of underground dams of concrete or bentonite-shale to divert lateral groundwater transport, utilization of polyvinyl chloride (PVC) membranes or bentonite-shale caps to minimize infiltration of precipitation, and surface contouring to control drainage.

Advanced methods are also being developed to stabilize the buried waste; those include dynamic compaction,[2] injection of polyacrylamide grout,[2,3] and in-situ vitrification.[2]. The purpose of dynamic compaction is to reduce the void volume of the burial trenches primarily to minimize subsidence, which occurs over prolonged periods of time, and which can cause failure of impermeable membranes or other covers that are designed to prevent intrusion by rainwater. Tests using a 3.6 Mg weight that was repeatedly dropped from a height of 7m under actual field conditions achieved a 77% reduction in trench void volume on average.[2]

In-situ grouting with polyacrylamide also seeks to reduce the void volume of the trench, but by filling the voids with a biologically and chemically stable polymeric species rather than by compression of the volume containing the voids.[3,4] Field tests of the polyacrylamide grouting technique yielded reductions in hydraulic conductivity of two orders of magnitude.[3]

In-situ vitrification utilizes electrical resistance to heat the waste and the host medium to temperatures of about 1400 C, thereby destroying organic contaminants and retaining radioactive and other toxic components in a glass matrix that is highly resistant to leaching processes.[2,5-7] Experiments conducted to date at ORNL using simulated waste and buried sludge containing small quantities of radioactive species indicate that, although the process is relatively expensive, amounting to a cost of about $400 per cubic meter of buried waste, virtually permanent encapsulation can be realized even in saturated soils.[3,8]

Of the six solid waste storage areas, only SWSA6 remains operational. The others have been closed and are subject to corrective activities ranging from annual grounds maintenance to the employment of measures to stabilize the contaminants to a greater degree.

III. PRESENT DISPOSAL ACTIVITIES

Waste currently emplaced in SWSA6 is contained in a variety of enclosures, depending upon waste type. Contact-handled low level radioactive waste (CH-LLW) and remote-handled low level radioactive waste (RH-LLW) having a surface dose rate of less than 1 rem/hr is emplaced in underground concrete silos which are illustrated schematically in Fig. 1. The silos are constructed by pouring concrete into the annulus formed between two concentric cylinders formed from corrugated steel pipe, one 8-ft in diameter and the second 9-ft in diameter. The cylinders, which range from 14-ft to 20-ft in length, are mounted on a wire reinforced, 12-in. thick concrete pad. The silo is capped with a 12-in thick, steel-reinforced concrete cap.

The silos are constructed such that the base is located at least 2-ft above the maximum water table elevation. In addition, monitoring wells which are fabricated from 3-in PVC pipe are located inside and outside the silos to monitor their continued hydrological isolation.

Some CH-LLW is presently being emplaced in an above-grade tumulus as that depicted schematically in Fig. 2. The LLW, which is containerized, is placed in rectangular concrete casks which are stacked on a concrete pad that is subsequently capped upon closure of the tumulus. The initial tumulus pad is about 65-ft wide by 105-ft long, and varies in thickness from 8-in at the center to 16-in along the curbed perimeter of the pad. Surface drainage channels have been constructed to divert surface water runoff.

The LLW is placed in standardized 6-ft long, 4-ft wide, and 4-ft high containers which are subsequently placed in the concrete casks. The 4-in annular space between the container and the cask is then filled with concrete and a pre-cast concrete lid is placed on the cask and sealed with bitumen. The original pad could accommodate 290 casks, or about 28,000 ft^3 of solid waste.

Remote-handled low level waste (RH-LLW) having a surface dose rate exceeding 1 rem/hr is emplaced in a modified version of the concrete silos for CH-LLW. As is shown in Fig. 3, the silo itself is constructed in the same manner as for the CH-LLW, but is fitted with seven to eleven 20-in diameter cast iron pipes. Moreover, the space between the pipes is filled with concrete, and each of the pipes contains a 12-in to 18-in concrete floor. The pipes are filled with waste in serial fashion.

When a pipe is filled to within 3 feet of its full length, the pipe is capped with poured concrete. No limits are imposed on the amount of radioactive material that can be placed in the individual pipes, except that the dose rate over the top of the well may not exceed 200 mrem/hr.

In addition to the modified silos, RH-LLW with a surface dose rate exceeding 1 rem/hr and contained in 55-gal drums are also emplaced in double-walled pipe wells. These wells are constructed of two concentric corrugated steel drainage pipes, one 30-in diameter that is placed in another that is 36-in diameter and positioned in an auger hole. Similar to the silos, a wire reinforced, 12-inch-thick concrete floor is poured into the bottom of the well, and the annulus between the pipes is likewise filled with concrete. When the well is filled with material contained in 55-gal drums, it is capped with a 12-in thick concrete plug. As with the modified silos, no limit is placed on the radioactivity content of the well, provided the surface dose rate over the top of the open well does not exceed 200 mrem/hr and that over a capped well is less than 2.5 mrem/hr.

Suspect waste material, which gives no indication of external radiation but which cannot be certified as free from contamination, is emplaced in a specific section of SWSA6 that is reserved for this class of waste. This disposal area is an open landfill type and covers about one acre of the SWSA6 site.

IV. FUTURE ACTIVITIES

Current LLW disposal practices at SWSA6 are to be phased out by May 1992, and a new strategy will be implemented.[1] This new strategy involves the separation of disposal technologies into five separate categories:[1]

1. Below Regulatory Concern Waste - LLW that is suitable for disposal in a sanitary/industrial landfill and will not expose any member of the public to an effective dose equivalent (EDE) of more than 4 mrem/yr at the time of disposal.

2. Class I Waste - LLW that is also suitable for disposal in a sanitary/industrial landfill and will not expose any member of the public to an EDE of more than 10 mrem/year at the time of disposal.

3. Class II Waste - LLW containing primarily radionuclides with half-lives of 30 years or less and is suitable for disposal in engineered facilities which are designed to isolate the waste from the environment for a period of time sufficient to allow the radionuclides to decay to a level such that no member of the public will be exposed to an EDE of more than 10 mrem/yr.

4. Class III Waste - LLW consisting of radionuclides with half-lives exceeding 30 years and which will be disposed of in facilities having intruder protection.

5. Class IV Waste - LLW not suitable for disposal on the Oak Ridge Reservation and which would require either treatment to reduce the contamination to a level consistent with one of the other four categories or shipment to an off-site disposal facility.

Future operations at SWSA6 will incorporate the new strategy and utilize above-grade tumuli for disposal of the majority of LLW. In the late 1990s, Class I and Class II Waste Disposal Facilities are to be made operational.

ORNL has been segregating and storing solid alpha-contaminated waste since 1970, and has developed procedures for non-destructive assay and examination of packages containing contact handled transuranic waste (CH-TRU). This waste is scheduled for storage in a specially designed facility. Significant amounts of sludges containing transuranic nuclides are also stored at ORNL; these wastes, which require remote handling, will be processed to yield a waste form that is also acceptable for storage in the specially designed disposal facility.

Finally, a number waste streams have been generated that contained chemically noxious contaminants as well as low levels of radionuclides. Methods are currently under development to separate these mixed wastes either by destruction or chemical modification of the chemically toxic constituents, or by separation of the waste into a LLW component and a hazardous waste component.

REFERENCES

1. J. S. Baldwin, J. D. Sease, and D. L. Jones, Oak Ridge National Laboratory Report ORNL/TM-11433 (December, 1989).

2. B. P. Spalding, G. K. Jacobs, and E. C. Davis, Oak Ridge National Laboratory Report ORNL/TM-11286 (September, 1989).

3. B. P. Spalding and T. A. Fontaine, *Field Demonstration of In-Situ Grouting of Radioactive Solid Waste Burial Trenches with Polyacrylamide*, ASTM Symposium on Stabilization/Solidification of Hazardous, Radioactive, and Mixed Waste, Williamsburg, VA, May 28-June 1, 1990.

4. B. P. Spalding, S. Y. Lee, C. D. Farmer, L. K. Hyder, and P. Supaokit, *In-Situ Grouting of Buried Transuranic Waste with Polyacrylamide*, pp. 39-76 in Oak Ridge Model Conference Proceedings, CONF-871075, Vol. I, Part 3 (1987).

5. J. L. Buelt, C. C. Chapman, S. M. Barnes, and R. D. Dierks, *A Review of Continuous Ceramic-Lined Melters and Associated Experience at PNL*, pp. 107-113 in Ceramics and Nuclear Waste Management, CONF-790420 (1979).

6. J. G. Carter, S. O. Bates, and G. D. Maupin, Pacific Northwest Laboratory Report PNL-6174 (1987).

7. J. G. Carter, S. S. Koegler, and S. O. Bates, Pacific Northwest Laboratory Report PNL-6530 (1988).

8. B. P. Spalding, ORNL Lab Notes (June 1991).

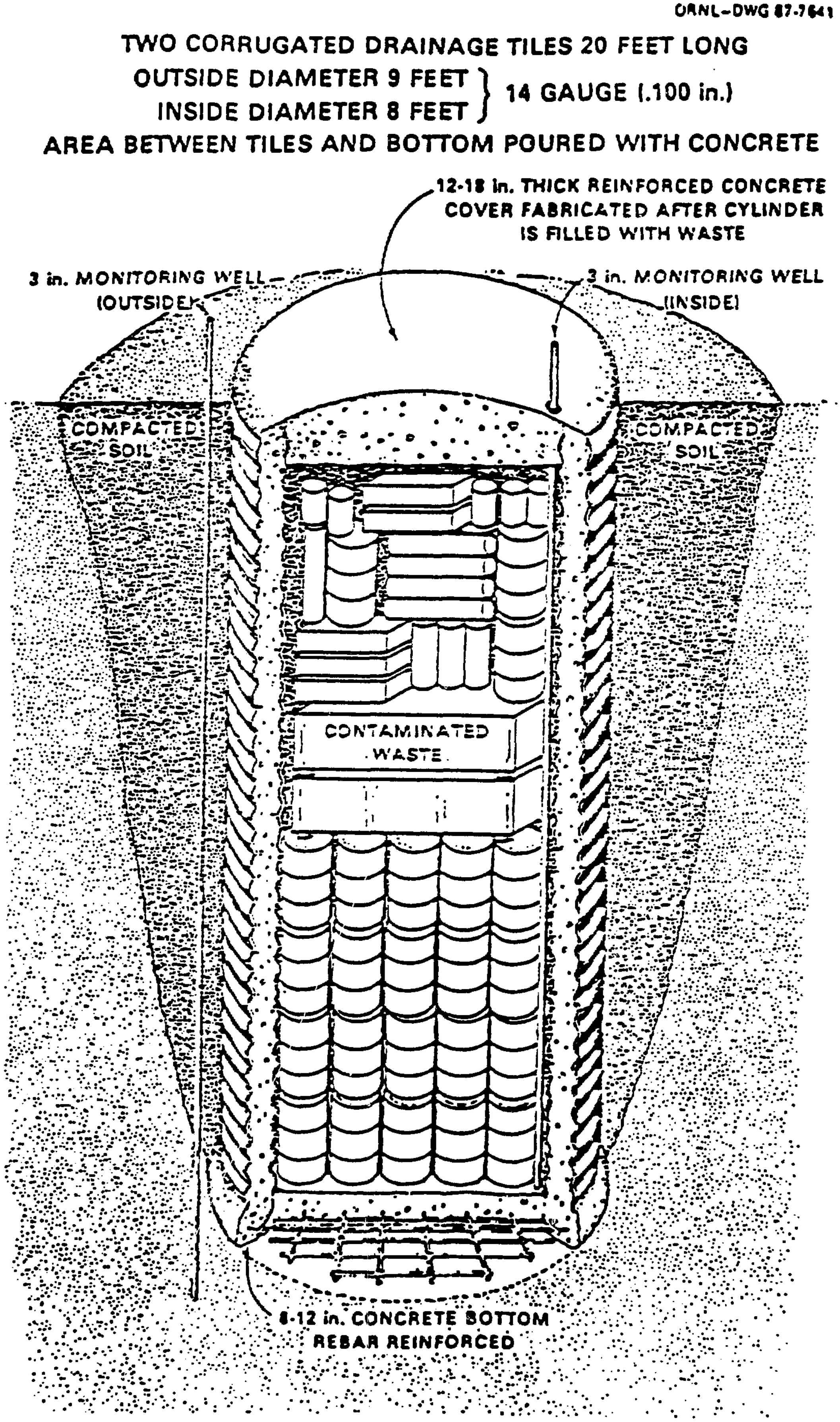
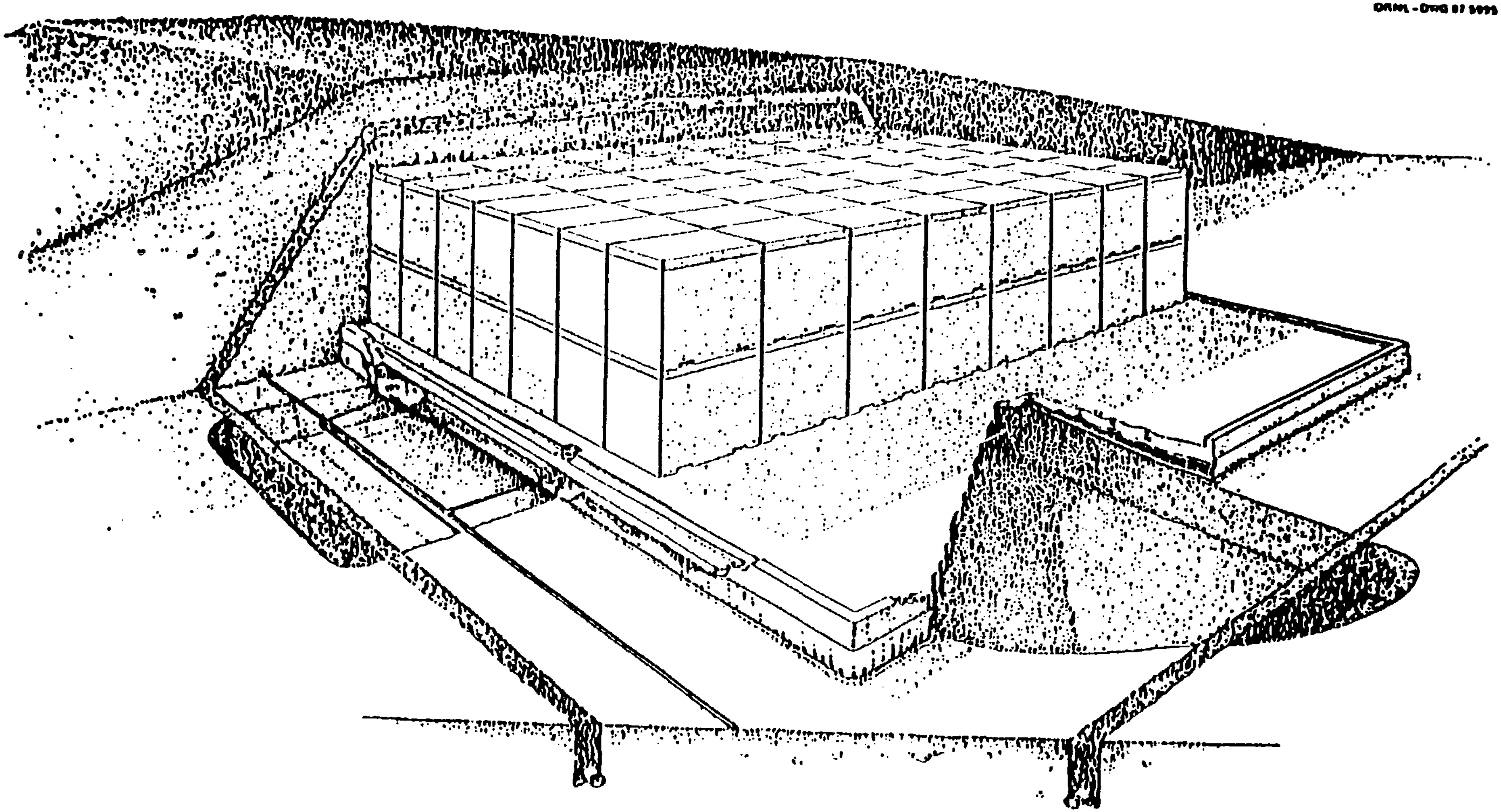


Fig. 1. Schematic representation of an underground concrete silo in SWSA6.



ORNL-DWG 87 5995

Fig. 2. Above-Grade Tumulus for LLW Disposal.

ORNL-DWG 86-13795

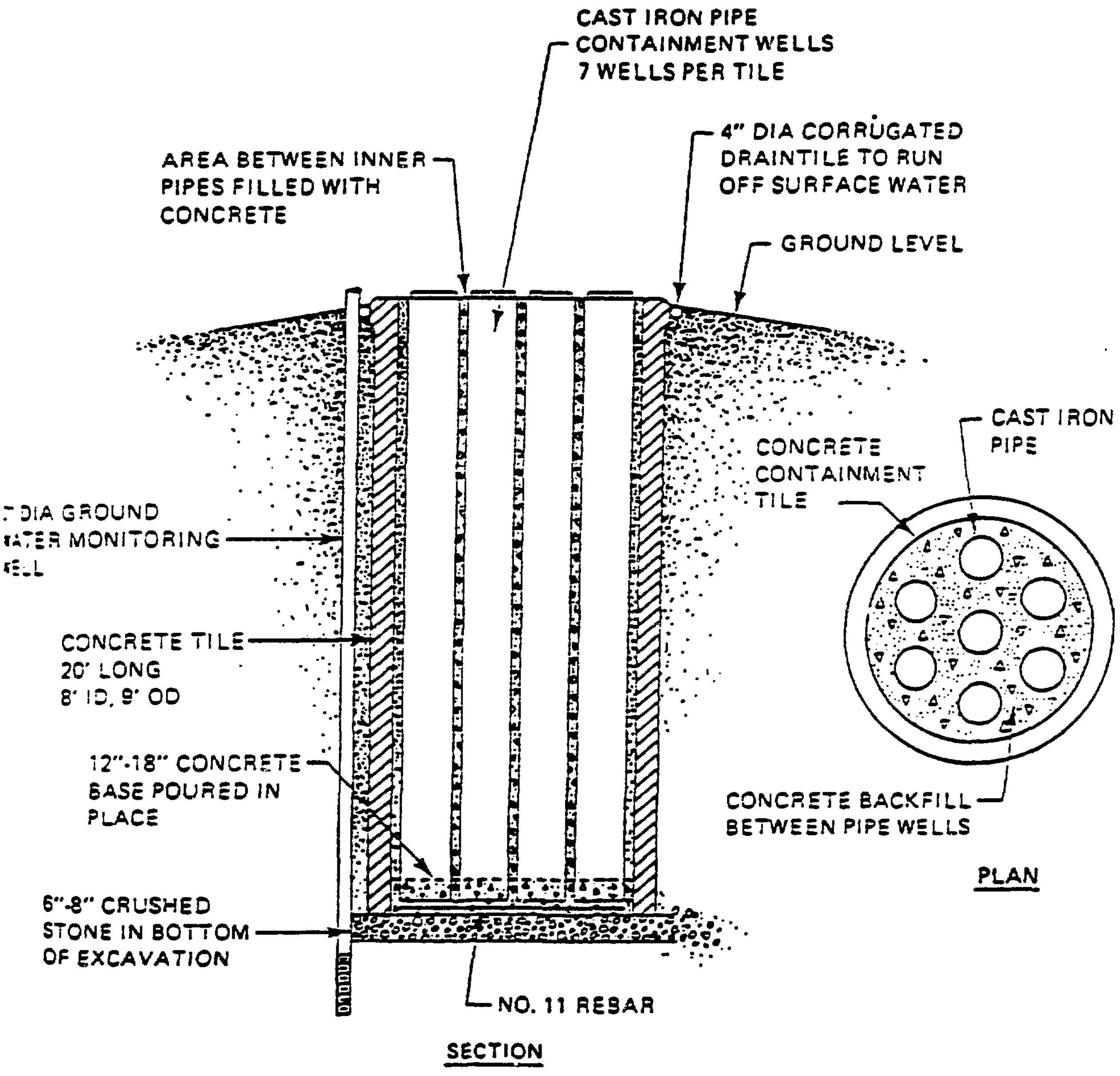


Fig. 3. Cross-section of concrete silos with containment wells.