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U.S. Department of Energy under Contract DE-AC06-87RL10930

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# RCRA CLOSURE EXPERIENCE WITH RADIOACTIVE MIXED WASTE 183-H SOLAR EVAPORATION BASINS AT THE HANFORD SITE

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Westinghouse Hanford Company

## ABSTRACT

This paper provides an overview of the Resource Conservation and Recovery Act of 1976 (RCRA) closure work of the 183-H Solar Evaporation Basins, at the Hanford Site for the Department of Energy-Richland Operations Office (DOE-RL), Richland, Washington. A detailed description of how the hazardous wastes and radioactive wastes (mixed wastes) were treated (i.e., sludge removal methods, liquid solidification process, and decontamination efforts) is provided.

## INTRODUCTION

The Hanford Site covers 560 square miles of semi-arid land that is owned by the U.S. Government and managed by the Department of Energy, Richland Operations. It is located in the Columbia Basin and northwest of the City of Richland, Washington, which lies approximately 5 miles from the southernmost portion of the Hanford Site boundary and is the nearest population center (Fig. 1). In early 1943, the U.S. Army Corps of Engineers selected the Hanford Site for the production and purification of plutonium.

The 100-H Area, located in the northern part of the Hanford Site along the Columbia River (Fig. 2), was an operational reactor facility from October 1949 to April 1965. The 183-H Basins were originally designated as the 183-H Filter Plant, which operated concurrently with the 105-H Reactor. The filter plant provided water treatment, filtering facilities, and reservoir capacity for the reactor process water system. The filter plant consisted of a head house and chemical building, 16 flocculation and sedimentation basins, a filter building, and clearwell storage with a pump room. Fig. 3 illustrates 183-H Basins at the start of the project, with basin 1 empty and basins 2, 3, and 4 containing liquid and sludge.

Demolition of the 183-H Filter Plant was initiated in 1974 under the Hanford Site Housekeeping and Cleanup Program for the 100-H Area. The 183-H head house, 12 of the 16 flocculation and sedimentation basins in the filter building, and the clearwell pump room were demolished to ground level and the underground portions were backfilled to ground level. The clearwalls alongside the 183-H Basins were left intact for future use as a disposal site for clean debris. The remaining four basins had been designated in 1973 for use as solar evaporation basins for liquid chemical wastes from the 300 Area (N Reactor) fuel fabrication facilities. The treatment process involved temporary storage of the waste in order to accommodate natural evaporation.

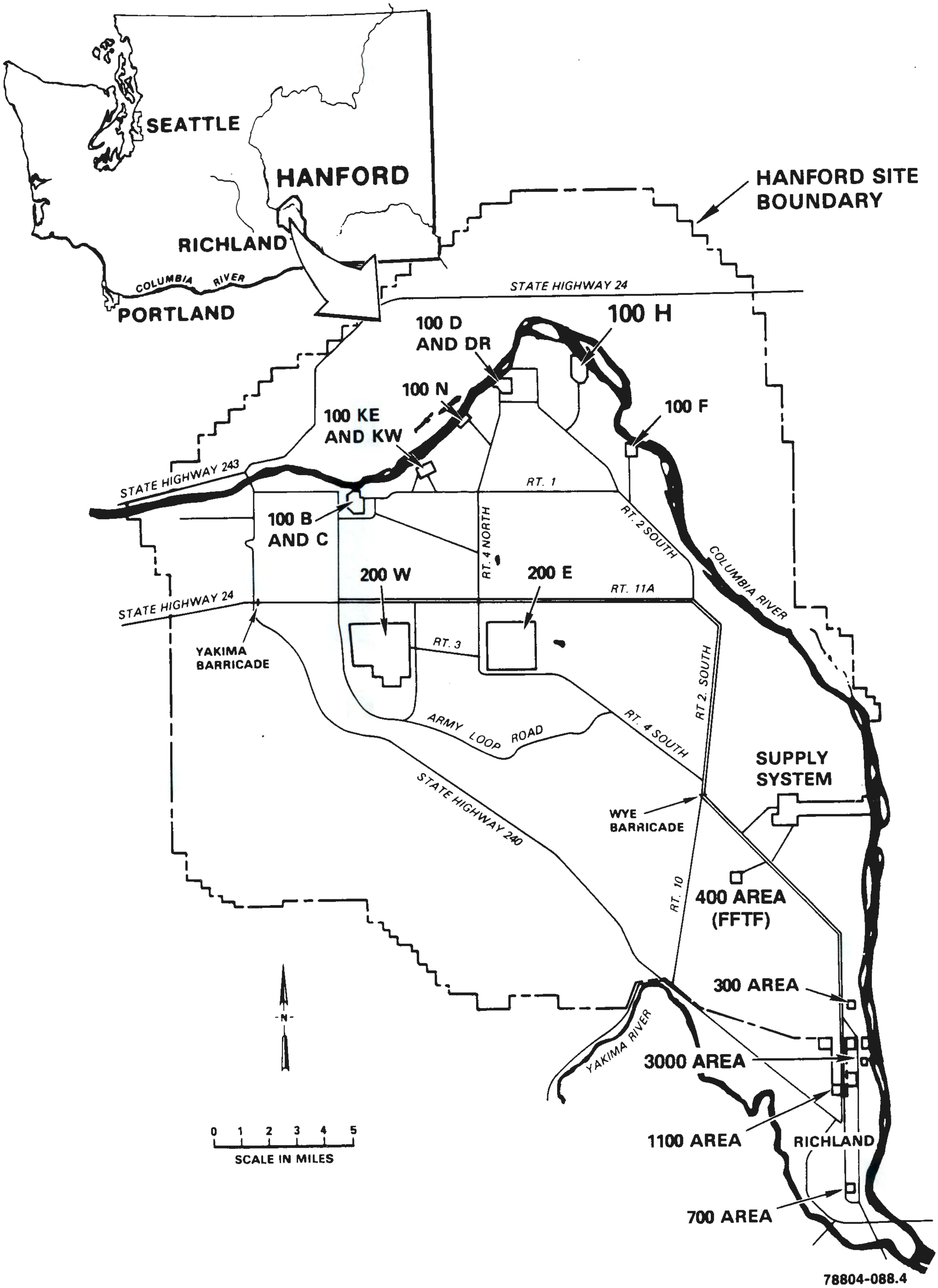


Fig. 1. Hanford Site Map.

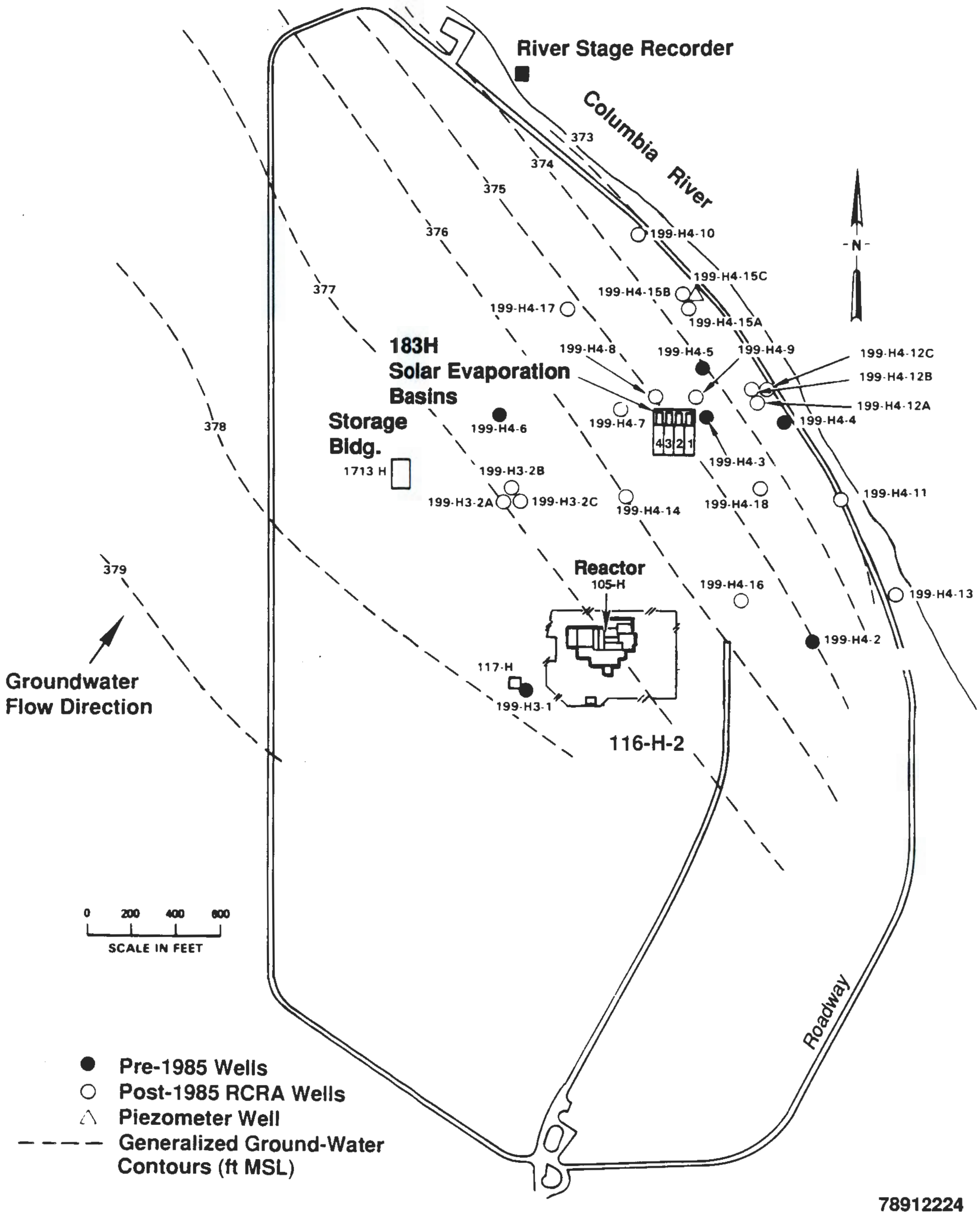


Fig. 2. 100-H Area Map.

Fig. 3. 183-H Basins.

The U.S. Department of Energy is closing the 183-H Basins in accordance with the Resource Conservation and Recovery Act of 1976 (1) (RCRA), as administered by the Washington State Department of Ecology through the Washington Administrative Code (WAC) Dangerous Waste Regulations (2). The 183-H Basins are also being closed in accordance with the Hanford Federal Facility Agreement and Consent Order (3), also known as the Tri-Party Agreement.

In November 1985, a 183-H Basins Part A Permit Application (4) was filed which initiated the "interim status" closure process. The "183-H Solar Evaporation Basins, Interim Status Closure/Post-Closure Plan," (5) together with the Final Status Post-Closure Permit Application for the 183-H Solar Evaporation Basins (6) will complete the permit application as required by WAC 173-303. For purposes of RCRA and WAC 173-303, the DOE is the operator and the Westinghouse Hanford Company is the co-operator of certain hazardous waste management units on the Hanford Site.

This RCRA closure site is located within a Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) (7) past practices site. Soil sampling, groundwater monitoring, waste removal, and landfill cover design must not interfere with future CERCLA remedial actions.

Physical Description

The 183-H Basins are concrete structures, each comprised of a deep sedimentation basin and a shallow flocculation basin. The flocculation basin is 45 ft 6 in. wide, 33 ft long, and 9 ft 6 in. deep. The sedimentation basin is 53 ft 6 in. wide, 95 ft long, 16 ft 6 in. deep at the north end, and 15 ft 6 in. deep at the south end. The basins are constructed above ground and have earthen berms on three sides. The northside berm was added to provide an asphalt covered ramp up to the basin deck level to permit a tank truck to unload chemical waste by gravity flow.

Before being used for waste collection, the 183-H Basins were modified. Openings were sealed and a surface-mounted pipe manifold was installed for filling purposes. The distribution flume and gates were above the proposed liquid level and were not used to confine the wastes. The steel flume gates in basin 1 were removed leaving the gate openings. The gate openings in basins 2, 3, and 4 were sealed by filling with concrete to increase their capacity. The walls of basins 2 and 3 were sealed by spray coating with a black polyurethane material. This material experienced some degradation from sunlight, resulting in the use of a white Butyl and Hypalon coating for basin 4.

Geotextile liners installed in basins 2 and 3 during the cleanup effort are 36-mil Hypalon-membrane reinforced with a polyester scrim. The liner in basin 2 was installed in 1986, and the liner in basin 3 was installed in 1987.

## Wastes Discharged to Basins

During the operational life of the 183-H Basins, approximately 2,500,000 gal of routine and nonroutine wastes were discharged into this facility. The routine waste stream consisted of spent acid etch solutions (primarily nitric, sulfuric, hydrofluoric, and chromic acids) generated by the nuclear fuel fabrication process. Typically these acidic solutions were reacted (neutralized) with excess sodium hydroxide before being transported to the 183-H Basins. Metal constituents in the waste included copper, silicon, zirconium, aluminum, chromium, manganese, nickel, and uranium. Following reaction with sodium hydroxide, these metals were present primarily in the form of precipitates. The resultant slurry of liquid and metal precipitates was transported and discharged into the 183-H Basins.

On several occasions, nonroutine wastes (both listed and nonlisted) were discharged to the basins. Nonroutine wastes consisted of unused chemicals and spent solutions from miscellaneous processes, development tests, and laboratories. Some nonlisted wastes were added directly into the basins, and some were mixed into the routine waste stream before being transported to the basins.

Chemical analyses of the wastes showed the major constituents of the solids phase to be sodium, copper, water of hydration, fluoride, nitrate, and sulphate ions. These constituents comprised approximately 90 percent of the total solid material. The liquid phase consisted primarily of water plus 40 percent sodium nitrate, and sulphate ions.

Routine wastes consisted of uranium and technetium-99. The waste material was categorized as a low-level, nontransuranic radioactive waste. A review of the discharge records of any nonroutine wastes to the basins indicated that six different listed wastes were also discharged into the facility. The quantities of these listed waste discharges were small: 4.5 lb of solid material and 2 to 3 gal of liquid solution. The listed chemicals with their associated dangerous waste numbers are listed as follows:

Listed Wastes

| Chemical | Dangerous waste number | Quantity |
|---|---|---|
| Formic acid | U123 | 2 lb |
| Unused cyanide solutions | P030 | 2 gal |
| Unused cuprous cyanide | P029 | 1 lb |
| Unused sodium cyanide | P106 | 1 lb |
| Unused potassium cyanide | P098 | 0.5 lb |
| Unused saturated vanadium (pentoxide $V_2O_5$ aqueous solution) | P120 | 0.1 gal |

The waste designations at the start of the project and after all the liquids had been consolidated into basin 2 are listed as follows:

Basin 1 Sludge

U123, P029, P030, P098, P106, P120 - Discarded chemical products

WT01 - Toxicity [Extremely Hazardous Waste (EHW)]

Basin 2 Sludge

U123, P029, P030, P098, P106, P120 - Discarded chemical products

WT02 - Toxicity [Dangerous Waste (DW)]

D007 - EP Toxicity (Chromium)

Basin 2 Liquid

U123, P029, P030, P098, P106, P120 - Discarded chemical products

WT01 - Toxicity (EHW)

D007 - EP Toxicity (Chromium)

Basins 3 and 4 (Sludge and Crystalline Strata)

U123, P029, P030, P098, P106, P120 - Discarded chemical products

WT01 - Toxicity (EHW)

The WT01 and WT02 toxicity was due primarily to copper, nitrates, and fluorides.

Ground Water Monitoring

Groundwater well monitoring has been established around the facility and will continue under Operable Unit HR-1 Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) requirements during the Post Closure period. There are 24 groundwater monitoring wells around the 183-H basins. (Fig. 2). Ten of these wells are sampled on a quarterly basis, three wells are sampled monthly to monitor work activities, and the remainder are sampled annually.

Project Plan

The project began in November 1985 with the submittal of the Interim Status/Post-Closure Plan to the Washington State Department of Ecology. Many cleanup options were considered and discounted, such as accelerated evaporation, solidification, and removal by tank trucks and/or railroad tank cars. On February 5, 1986, the EPA and Ecology jointly initiated legal proceedings against the DOE-RL for noncompliance with RCRA regulations. A penalty of $49,000 was imposed for illegally operating an evaporation facility. This penalty was subsequently appealed. The immediate objective for this project was to efficiently and safely bring the existing facility into compliance with the regulations and to initiate the RCRA closure of the basins.

No option had been fully developed at that time, and in order to proceed with the closure activities it was decided to go into an assured containment mode. This consisted of pumping the liquid in basin 2 to basins 3 and 4. The sludge in basin 2 was then removed, and a 36-mil Hypalon liner was installed. The liner was field seamed with 100 percent vacuum testing to ensure a quality leak-tight installation.

All the liquid in the 183-H Basins was then consolidated by pumping it into the now lined basin 2. The liquid was pumped through a 75 micron multiwedge strainer specifically designed to remove all particulate matter. The addition of the Hypalon liner into basin 2 now provided double containment or "assured containment".

Obtaining this "assured containment" mode signified to Ecology a start in the cleanup of the basins. This was a determining factor in having the noncompliance penalty rescinded. Various options such as liquid removal, accelerated evaporation and solidification in place were considered and rejected.

The project plan specified that all the sludge material would be removed from one basin at a time, packaged and then transported to the newly permitted hazardous waste interim storage facility at the Central Waste Complex in the 200 West Area on the Hanford Site. During this period, Ecology was informed that the closure efforts were enhanced by passive evaporation during the summer months, although this method was not considered usable for the total disposal of the liquids. Passive evaporation was effective since the Hanford Site receives a yearly average rainfall of only 6.25 in. and has an average evaporation rate of approximately 50 in.

During the sludge removal efforts, methods to solidify the remaining liquid waste were investigated. Following sludge removal, the liquid will be solidified and removed. The facility will then be cleaned or decontaminated from both radioactive and hazardous wastes, demolished, and removed as clean material or left in place under a RCRA landfill cover. The closure plan resulted in the following major activities:

- Sludge removal
- Liquid solidification and removal
- Decontamination
- Landfill cover installation

Sludge Removal

Sludge removal was initiated in 1985 with the removal of 7,646 $ft^3$ from basin 1, followed by the removal of 8,955 $ft^3$ from basin 2 in 1986; 13,000 $ft^3$ of sludge from basin 3 in 1987; and 6,259 $ft^3$ of sludge from basin 4 in 1988.

Total sludge removed equals 162,000 $ft^3$. The method used for removal consisted of manually shoveling and/or scooping the sludge with a 5-gal bucket. The sludge was placed into a 90-mil polyethylene 55-gal drum liner inside a U.S. Department of Transportation Specification 17-H 55-gal drum. Exterior protection of the drum and liner consisted of encasing the drum in a 10-mil polyethylene bag and taping the top of the bag to the drum. The 10-mil polyethylene bag inside the liner was then folded down around the top of the drum and taped. This completely covered all exterior surfaces of the drum. Approximately 1 $ft^3$ of diatomaceous earth absorbent was then placed in the bottom of the liner. Each prepared drum was next moved into the basin for loading. After 4.5 $ft^3$ of sludge material had been placed in the lined drum, the sludge was covered with 1.5 $ft^3$ of mixed diatomaceous earth adsorbents to ensure absorption of all free liquid. The inner 10-mil polyethylene bag was then closed, taped, and tucked inside over the absorbent and a 90-mil liner cover installed over the liner and bolted tight. Using a hoist, the filled drum was then raised to the top of the basin where a radiation protection technologist carefully peeled the outer 10-mil polyethylene bag from the drum. These outer bags were placed in a separate waste drum. All exterior drum surfaces were then surveyed to ensure radioactive contaminated material was not present. Next a group of four drums were placed on a pallet and securely banded together with 0.75-in steel bands. The drums' covers were then installed and bolted securely. All palletized drums were ultimately set aside onto a paper-covered, roped-off asphalt parking area for temporary storage while awaiting transport to the Central Waste Complex, Retrievable Waste Storage Facility. These conservative packaging requirements were predicated upon the contained waste being dispositioned for burial and/or long-term storage.

A simpler packaging method meeting appropriate U.S. Department of Transportation specifications was later used. This consisted of a 17-H painted steel 55-gal drum lined with two 10-mil polyethylene bags.

Liquid Solidification and Removal

The liquid waste was solidified into a solid, freestanding monolithic form inside polyethylene-lined U.S. Department of Transportation Specification 17-H steel drums. The drums were then transported to the 200 West Area Central Waste Complex, Retrievable Waste Storage Facility.

The solidification agent selected for the liquids removal was Sorbond LPC-II*. Selection of this material was the result of an 11-month test and evaluation effort in which 13 different solidification agents were investigated. Samples of each material were obtained and tested in the laboratory using a 40 percent sodium nitrate saturated solution. Various ratios of material to liquid were determined, and a full-scale field test of three candidate materials was conducted within the confines of basin 3.

The use of Sorbond LPC-II material provided a high-packaging efficiency with less than a 30 percent volumetric increase. The initial Sorbond test resulted in solidifying 36 gal of liquid waste in a 55-gal drum by adding

*Sorbond LPC-II is a trademark of American Colloid Company.

261.4 lb of Sorbond LPC-II. This mixing proportion resulted in a liquid volume increase of approximately 6 in. in depth within the drum, leaving 6-3/4 in of freeboard.

Actual liquid solidification procedures increased the liquid content per drum to 40 gal, with a corresponding increase of solidifying agent to 290.4 lb. This proportion resulted in approximately 2 to 3 in. of freeboard in each drum. Once mixed into the solution, the initial gel occurred quickly (less than 1 hour after the mixing action was terminated). Continued mixing extended the setup time, with full cure requiring 3 days. After full cure, the freespace in each drum was filled with an absorbent material to absorb any condensation that might have accumulated after bolting the lid in place.

To expedite the liquid solidification process, equipment was procured for mixing quantities of 320 gal of liquid in each batch (eight drums per batch). All equipment used for the liquid solidification process was installed within the confines of the 183-H Basins (Fig. 4).

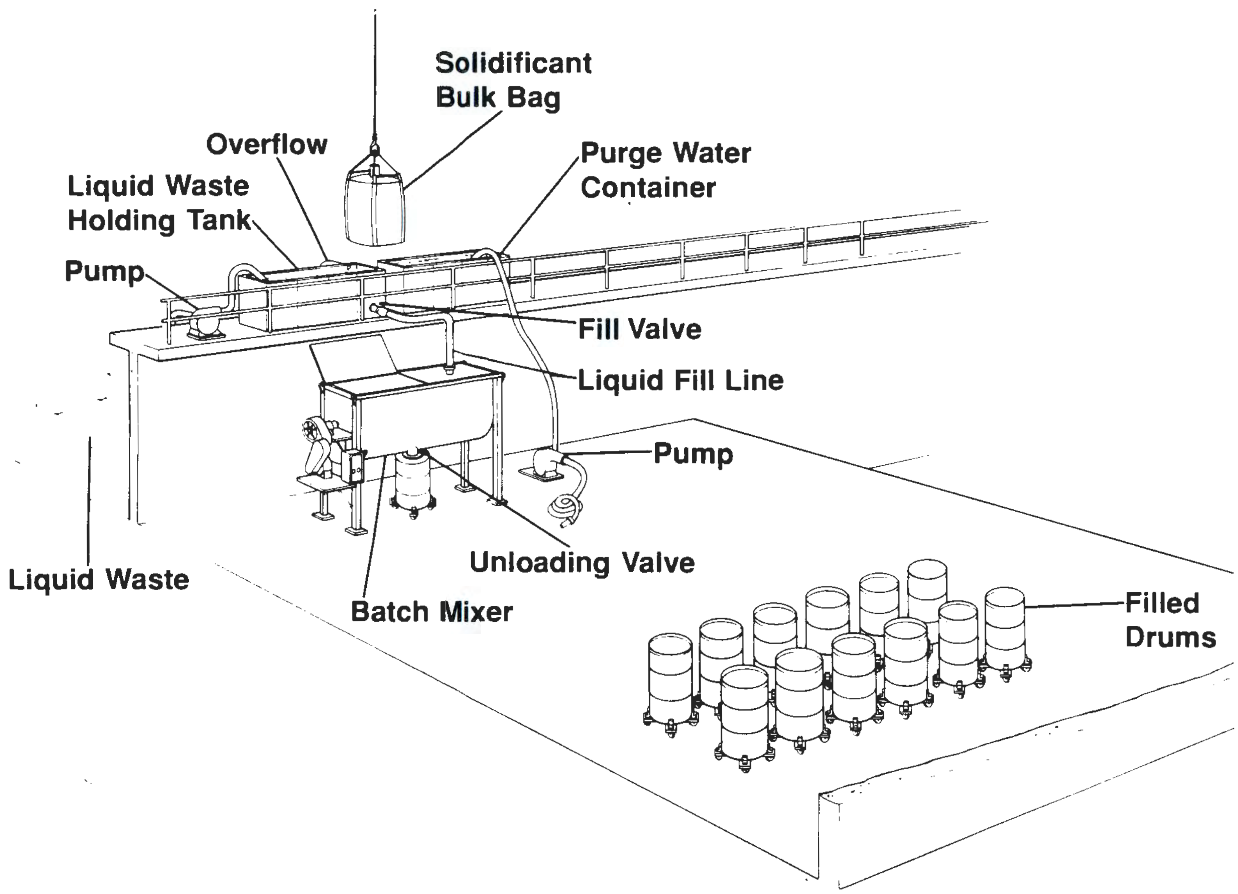


Fig. 4. Solidification Equipment Installation.

The mixing equipment consisted of a paddle-type batch mixer with a maximum capacity of 62.5 $ft^3$ (467 gal). A holding tank fitted with an overflow device to premeasure each batch of 320 gal was located above the batch mixer to permit gravity-feeding into the mixer for each batch. The Sorbond LPC-II material quantity of 2,323 lb was obtained in bulk bags, each containing approximately 2,300 lb; the exact weight was stenciled on each bag. Each batch was charged with the contents of one bulk bag and topped off to produce exactly 2,323 lb. The makeup quantity was less than 50 lb for each batch. The exact weight of each bulk bag and the makeup quantity was recorded for each batch to control the mixing proportions. After mixing each batch (320 gal of liquid and 2,323 lb of Sorbond LPC-II), the mixed solution was drained from the mixer through a bottom discharge valve into polyethylene-lined 55-gal drums. Each drum was filled within 2 in. of the top then moved aside on individual dollies to permit continued filling of drums. One mixer batch filled eight drums, which were then stored on the opposite side of the basin until fully cured.

After a three-day cure period, each drum was hoisted out of the basin onto a laydown area immediately north of the basin on the other side of the chain link fence. The drums were radiologically surveyed to ensure they were clean and then relocated to a temporary storage area on the east side of the 183-H Basins to await transportation to the Central Waste Complex, Retrievable Waste Storage Facility at the 200 West Area.

The drummed waste from the 183-H Basins was removed from the temporary storage area within 90 days in order to comply with applicable regulations. The waste drums were shipped within the Hanford Site to the 200 West Area Central Waste Complex, Retrievable Waste Storage Facility, a distance of 17 miles.

Decontamination

Initial plans were to decontaminate the 183-H Basins structure so that the demolition rubble could be disposed of into a clean landfill. This proved to be impractical, and a wet spray sandblasting technique was selected instead. The concrete surfaces within basins 1 and 4 were cleaned using this technique. Subsequent sampling and analysis of the cleaned concrete has indicated that a minimum of 1/2 in. of concrete would have to be removed in order to clean the structure. This resultant volume of removed concrete and spent grit would produce a large quantity of new hazardous waste that would require packaging and disposal at the Central Waste Complex.

Based on the current cost for disposal, a clean closure would be cost prohibitive. In addition, clean closure may be ruled out because of the underlying contaminated soils and groundwater. A landfill closure with an engineered cover and post-closure is to be installed instead. While cost considerations were a reasonable factor in selecting a method of closure, effective environmental protection remained the primary objective.

Landfill Cover

The 183-H Basins will be closed as a landfill and some contaminants will be left within the soil column and capped with an earthen cover to restrict contaminant migration.

The cover configuration will be developed and evaluated using EPA guidance and design manuals and other technical references. The primary objective of the cover will be to confine waste for a minimum of 30 years and the primary functions of the cover are to enhance moisture storage and lateral drainage while minimizing erosion, water infiltration, differential settling and sedimentation, and long-term maintenance requirements. Secondary functions that support the primary functions are to preserve slope stability and minimize deterioration due to thermal extremes. All of these cover functions have been met with the proposed preliminary cover design. Fig. 5 illustrates the proposed cover design.

The total project cost to date is $9 million, and the estimated total cost at the time of closure is $28.6 million. The post-closure for 30 years of care is estimated to cost $.5 million per year, based on 1992 constant dollars.

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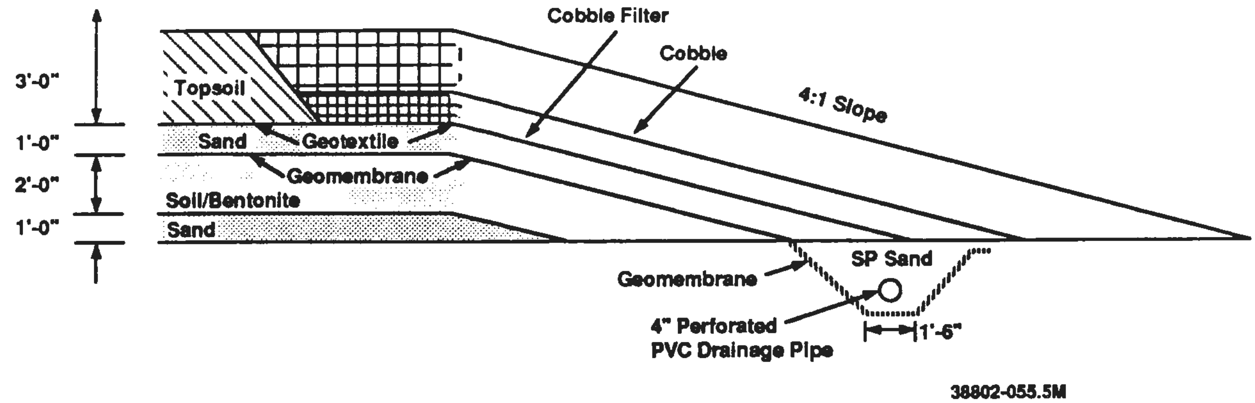


Fig. 5. Proposed Cover Details.

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