HNF- 4950 REV. 1

DISPOSAL FACILITY DATA

FOR THE

HANFORD IMMOBILIZED LOW-ACTIVITY TANK WASTE

PERFORMANCE ASSESSMENT

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EXECUTIVE SUMMARY

The current Immobilized Low-Activity Waste (ILAW) disposal planning utilizes the existing disposal vaults from the grout program suitably modified to receive ILAW packages and new disposal facilities currently in their early design phase. The existing disposal vaults were originally constructed by the former grout program in the late 1980's and early 1990's. These vaults were designed to contain a liquid low-level waste (LLW) grout mixture during the curing and solidification period, and to serve as a disposal structure for the resulting grouted waste monolith. Five vaults were constructed. One vault was filled before termination of the program leaving four empty vaults available for use.

Each vault is 37.6 m (123.5 ft) long and 15.4 m (50.5 ft) wide, with a roof clearance of 10.4 m (34.0 ft), providing 579 m^2 (6,236 ft^2) of floor space. The vaults are constructed of reinforced concrete, and were designed and constructed in compliance with RCRA requirements for both hazardous waste surface impoundments and land disposal units. Each vault is built above a RCRA-compliant leak detection and collection system. The leak detection system consists of a sealed concrete slab sloped to a collection sump fitted with a riser pipe to the surface. The system is capable of collecting, detecting, sampling, and removing any leachate that might escape from the primary vault structure.

A conceptual design activity has been performed to modify the existing disposal vaults to accept and ultimately serve as a disposal facility for the ILAW from the Hanford waste tanks (Pickett 1998a). The existing asphalt layer and concrete "topping" layer above the precast concrete roof slabs will be removed from the four available vaults. For each vault, side wall and end wall extensions 1.8 m (6.0 ft) high will be added to the original top of the side and end walls, respectively. To support the unloading of ILAW packages from the transportation vehicles, rails for a gantry crane are to be placed on top of the side wall extensions and will run the full length of the vaults.

A conceptual design for the new ILAW disposal facilities (Pickett 1998b) utilizes a long concrete vault concept divided into cells. Each vault will be an underground, open-topped, concrete vault approximately 23 m (76 ft) wide and 207.8 m (686 ft) long. The total vault height was increased to 11.0 m to accommodate the new waste package dimensions. The top of the vault walls will extend 1 m (3.3 ft) above grade. Each vault will be divided into 11 cells, separated by concrete partition walls

Each vault is built above a RCRA-compliant leak detection and collection system. It consists of a cast-in-place reinforced concrete basin approximately 209.5 m (687.3 ft) long, 24.7 m (81 ft) wide with walls 1.07 m (3.5 ft) high. The basin floor is 0.6 m (2 ft) thick and contains steel reinforcing bars within. The catch basin is lined with two flexible membrane liners, and on top of these lie a layer of gravel with perforated collection pipe routed to sumps, one at each end of a vault. Liquids entering the sump can be removed by use of a portable pump lowered down a riser pipe.

Interim closure for each filled cell in the new disposal facility will consist of using inert backfill material followed by a "controlled density fill," unreinforced concrete. A waterproof membrane will be placed above the "controlled density fill." After all cells in the vault have been filled and interim closed, a closure cap consisting of a capillary break followed by a modified RCRA C cap will be placed over the entire vault. A similar closure is assumed for the existing

disposal vaults. Each vault will be interim closed using the process used for the cell closure for the new disposal facility. After all vaults have been filled and interim closed, a similar closure cap will be placed over all four vaults.

The design for the ILAW disposal facilities has not yet been finalized. Facility uncertainty cases have been identified that may impact disposal performance. Alternate concepts for disposal of the ILAW waste are still being considered. Alternate trench concepts are provided to explore the sensitivity of the proposed ILAW disposal performance to different disposal concepts. In December, 1999 the Department of Energy has identified the remote handled trench as the baseline concept for ILAW disposal at Hanford.

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1.0 INTRODUCTION

Based on the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) (Ecology 1996) the U.S. Department of Energy (DOE) and River Protection Project (RPP) team are proceeding with engineering activities to support the eventual disposal of low-activity waste from the Hanford underground storage tanks. The Tank Waste Remediation System (TWRS) Environmental Impact Statement (EIS) (DOE 1996) and the subsequent Record of Decision (ROD) (DOE 1997) stipulate that the low-activity portion of the tank waste shall be vitrified.

The DOE Order 5820.2A (DOE 1988) provided early guidance and requirements for the disposal of radioactive waste on a DOE site. This Order has been superceded by DOE Order 435.1 (DOE 1998a). One requirement in both Orders is the need to develop and maintain a site-specific performance assessment for the proposed disposal facility. This performance assessment must provide reasonable assurance that public health and environmental resources will be protected consistent with local, state, and federal regulations.

The Hanford Immobilized Low-Activity Tank Waste Performance Assessment (DOE 1998b) was issued in 1998 to provide the first formal performance assessment in support of the eventual disposal of low-activity tank waste at Hanford. The analyses within this report used two conceptual facility models (Eiholzer 1995) based on early project planning. Since that time there has been an evolution in the planning for this proposed disposal action. Specifically, the DOE has entered into a contract with BNFL, Inc. that will ultimately lead to the vitrification of approximately 8.6% (6000 packages of 70,000 [Kirkbride 1999]) of the current low-activity waste from the underground tanks. The DOE has proposed that four existing grout vaults be modified and ultimately used for the disposal of the low-activity tank waste (Burbank 1999). Finally, a conceptual design has been developed for new disposal facilities for the low-activity tank waste [Pickett 1998b].

The purpose of this report is to provide a description of the waste package and disposal facilities based on the latest information. This information will be used in the next performance assessment to support the development of models used to assess the overall system performance in meeting established performance objectives (DOE 1998b). This performance assessment is currently scheduled to be issued in 2001. Data on the waste form will be taken from the current BNFL, Inc. planning and contract requirements (BNFL 1998, Taylor 1999). Data on the facility design will be taken from the planned modification to the existing grout vaults (Pickett 1998a) and the conceptual design developed for the new disposal facility (Pickett 1998b). Data on the engineered barriers will be taken from the current draft version of the disposal facility closure plan (Hohl 1998).

2.0 LOW-LEVEL WASTE PACKAGE

The DOE has entered into a contract with BNFL, Inc. to design and ultimately process approximately 9% of the ILAW from the Hanford tanks. (The contract identifies a minimum of 6,000 packages and Kirkbride (1999) estimates approximately 70,000 ILAW packages are needed for all the ILAW). The product description and specifications defined in this section are based on the current DOE contract (DOE 1998b) and the BNFL, Inc. reports submitted to the DOE as part of the contract negotiations. The definition of the product form and specification for the remaining 91% of the Hanford tank waste is not defined at this time. For the purposes of the ILAW Performance Assessment activities, all the ILAW waste products are assumed equivalent to the BNFL, Inc. descriptions and DOE specifications identified in this first contract.

The ILAW product for the first phase to be provided by BNFL, Inc. consists of a silicate glass monolith sealed in a stainless-steel package. The headspace above the silicate glass in the package is filled with silicate sand (BNFL 1998). The stainless steel package has external dimensions of 1.4 m x 1.4 m x 1.4 m, -0 m/+0.05 m (tolerances). The stainless steel wall thickness of the package is 6 mm. The package top is 12 mm plate and the bottom is 8 mm plate. BNFL, Inc. plans to load each ILAW package to within 85% capacity (by volume) and fill the void space with silicate sand such that the remaining free fill space is less than 5% (by volume). (BNFL , Inc. is also considering an alternative inert filling material that may be introduced in liquid form, such as grout.) The top lid will be welded using the tungsten-inert gas (TIG) process. The waste package data are summarized in Table 1. Other canister geometries for the waste package are currently being considered (see section 6.1).

The current contract with BNFL, Inc. (DOE 1998b) also places the following restrictions on the waste packages. The accessible external surface temperatures of the waste package shall not exceed 50º C. The packages shall contain no detectable free liquid. The compressive strength of representative samples shall be equal to or greater than 3.45E6 Pa. At least 75% of the initial compressive strength shall be retained after samples are subjected to thermal degradation, radiation degradation, biodegradation, and immersion degradation. Each fully loaded package shall be able to withstand a compression load of 100,000 kg force.

3.0 DISPOSAL FACILITY DESIGNS

Two disposal facility designs have been developed for the disposal of ILAW product. The first ILAW disposal facilities are currently planned to be the four existing Grout Vaults that will be modified to accept the ILAW waste packages (Pickett 1998a). The Grout Vaults will hereafter be referred to as the existing disposal vaults. The new ILAW disposal facilities are currently designed to consist of rows of concrete cells located below grade. These two facility designs will be used to hold ILAW waste packages generated under the current contract between DOE and BNFL, Inc. (DOE 1998b). Future disposal facility designs may include trench disposal, the reuse of processing canyon facilities, and the reuse of the storage tanks. The analyses of any of these options will be performed in future performance assessments, once plans are developed. A limited examination of trench disposal will be considered as part of the uncertainty cases for the next ILAW Performance Assessment.

In this section, a description of the current facility design concepts for the disposal of ILAW waste packages is provided. For the purposes of the 2001 PA there are the only two design concepts. Therefore, sufficient new disposal facility trenches having the current design (Pickett 1998b) are assumed to be available for the disposal of ILAW from the Hanford waste tanks.

Table 1: Waste Form and Canister Data for the 2001 PA

Silicate Glass Monolith Dimensions: 1.4 m x 1.4 m x 1.2 m (85% waste fill fraction) Minimum Surface Area: 10.6 m^2 (degree of cracking an uncertainty parameter) Glass composition : to be determined Glass corrosion rate: to be determined
Canister Data Material: stainless steel Shape: rectangular prism (1.4 m x 1.4 m x 1.4 m) Wall Thickness: side walls 6mm bottom 8mm top 12mm Number of canisters: 68741*
Canister Fill Data (by free volume) Void space: <5% Glass Monolith: 85% Silicate Sand: 10 - 15% (depends on void space)

*Reference (Kirkbride 1999)

3.1 Existing Disposal Facility

The major components of the existing disposal facility design are the below-grade disposal vaults, the under-vault catch basin, the asphalt diffusion barrier, and the leachate detection, collection, and removal system. The vault and catch basin structures constitute a double-liner composite system. An elastomeric asphalt urethane coating on the vault interior and the concrete vault structure were initially installed to provide the primary composite liner. The secondary composite liner, located below the vault, is the concrete catch basin covered with a high-density polyethylene (HDPE) flexible membrane liner. An asphalt diffusion barrier surrounds each vault. The leachate detection, collection, and removal system allow monitoring of the system’s performance during operations prior to closure.

Construction of the original Grout Vaults was completed in 1995. Specifications for these vaults and their construction are documented in (Koci 1994). A conceptual design study was completed in 1998 that described how the vaults could be modified to accommodate currently planned ILAW waste packages (Pickett 1998a). Materials used in the original construction are specified in Koci 1994.

3.1.1 Location

The existing disposal facility lies east of AP tank farm and Canton Avenue, north of Hanford grid coordinate N40000, west of W45000, and south of N41500 (see Figures 1 and 2). The existing disposal facility is at the western edge of the Tank Waste Vitrification Area.

3.1.2 Design

The dimensional data for the existing disposal facility are summarized in Table 2.

Table 2: Dimension Data Summary for Existing Disposal Facility

Concrete Structures				
	Basin:			
		Bottom footprint (edge):		20.3 m x 41.3 m
		Bottom edge elevation:		185.6 m (609 ft) [maximum]
		Bottom thickness:		0.6 m (minimum)
		Height:		1.7 m (bottom edge to top of basin side wall)
	Vault:			
		Bottom:	outside	39.6 m x 18.6 m
			Inside	15.4 m x 37.7 m
		Bottom edge elevation:		186.5 m (612 ft)
		Thickness:		1.4 m
		Sidewalls:		11.7 m high (measured from bottom of vault)
		Thickness:	N/S walls	0.8 m
			E/W walls	1.4 m bottom
				0.5 m top
	Diffusion Barrier			
		Bottom thickness:		0.9 m
		Sidewall:		
		Height:	3-sides	11.1 m (measured from bottom of vault)
			East side	10.3 m
		Thickness:		1.0 m

3.1.2.1 Concrete Catch Basin

The foundation for the four concrete catch basins consists of an 46 cm (18-in.) asphalt pavement laid on top of an 46 cm (18-in.) base of asphalt-coated gravel. The diffusion barrier material is placed in 15 cm (6-in.) layers over the subgrade. See Koci 1994 for specifications of the lower diffusion barrier materials.

The concrete catch basin is constructed of reinforced concrete. Its major components are concrete, having a compressive strength of 316 kg/ cm^2 (4,500 lb/in^2), Grade 60 reinforcing steel, having an ultimate tensile strength of 4218 kg/ cm^2 (60,000 lb/in^2), and ASTM A36 steel-plate water stops. See Figure 3 for the detailed design of the concrete catch basin.

The concrete catch basin is the foundation for the lower flexible membrane liner (FML). This liner is a 0.15 cm (60-mil) thick HDPE sheet placed directly on the concrete surface of the catch basin. The catch basin is cleaned of dirt and debris prior to liner placement. The basin is formed to provide a 20 cm (8-in.) radius on inside corners and a 5 cm (2-in.) radius on outside corners. The radiused corners keep the basin stress concentrations to a minimum. The basin surface in contact with the flexible membrane liner is given a steel trowel finish. The HDPE liner was fabricated from large pieces of sheeting to proper size and shape, keeping field joints to minimum. Corner pieces were preformed to proper size and shape at the factory. The seam welding technique was qualified for both shop and field work.

The HDPE liner is compatible with the radiation field intensity at the catch basin (DOE-RL 1988). It was installed by qualified personnel experienced in liner installation. Particular care was taken to ensure that liner sections were correctly seamed.

3.1.2.2 Leachate Detection, Collection, and Removal System (LDCRS)

A 10 cm (4-in.) perforated steel leachate collection pipe is laid in the catch basin trough, on top of the HDPE liner. The pipe is covered with a geotextile fabric that will prevent gravel infiltration, but allow liquids to drain from the liner into the perforated pipe and leachate collection system. A layer of small gravel then is placed in the catch basin to a thickness of 0.3 m (1 ft) near the edges of the basin and 1.2 m (4 ft) at the low point of the trough. The gravel is washed and sieved before placement to remove fines and large rocks. Care is taken in handling and placing drainage gravel to prevent contamination that could be caused by blowing sand and debris. Contamination by fine material could cause a reduction in permeability that would slow the leachate movement and lengthen detection time. A geotextile is laid over the gravel to prevent seepage of concrete into the drainage gravel during the vault floor construction. A temporary plastic sheet was placed over each catch basin to protect the catch basin geotextile and gravel prior to vault construction. The perforated collection pipe leads to an embedded pipe and sump. The pipe and sump liner are carbon steel. Sump access is through a 66 cm (26-in.) access riser. See Figures 3 for details.

3.1.2.3 Concrete Vault

The below-grade concrete disposal vaults are of rectangular design and are constructed to the American Concrete Institute (ACI), *Concrete Sanitary Engineering Structures*, ACI 350R-83 (ACI 1983c) requirements.

The vault is built on top of the gravel layer of the LDCRS. The vault is constructed of reinforced concrete having a compressive strength of 316 kg/ cm^2 (4,500 lb/in^2) Grade 60 reinforcing steel, having an ultimate tensile strength of 4218 kg/ cm^2 (60,000 lb/in^2), and ASTM A36 steel plate water stops. The original vault roof was constructed of concrete plates laid on top of the vault. See Figure 4 for details.

The following construction techniques were used to ensure that the vault concrete cracks are minimized:

- Replacing 15% of the cement with pozzolan (fly ash). The reduced cement helps reduce the heat of hydration and the pozzolan densifies the concrete.

- Using ice when necessary to ensure that the plastic concrete has a maximum temperature of 70° F at time of placement .

Using insulated forms or curing blankets to minimize thermal gradients during the curing period.

- Using a low water to cement ratio.

The exterior sides of the vault are covered by the exterior drainage system. This system is formed by a drainage net (HDPE geogrid) and a nominal 0.15 cm (60-mil) HDPE flexible membrane liner. A 5 cm (2-in.) thickness of insulation and geotextile were placed against the exterior drainage system of the catch basin before placing the asphalt paving diffusion barrier. Liquids entering this system from the vault are drained to the LDCRS.

3.1.2.4 Diffusion Barrier

The diffusion barrier was placed under each catch basin and vault as part of the foundation, and around the sides and top of each vault with a minimum thickness of 1 m (40-in.). The diffusion barrier controls the diffusion of moisture into the vault, and the diffusion of radioactive and hazardous contaminants from the vault.

The bottom portion of the diffusion barrier under the first four vaults is made of a 46 cm (18-in.) thick layer of asphalt-coated gravel placed on compacted soil, then an 46 cm (18-in.) thick layer of asphalt pavement.

3.1.2.5 Soil Backfill

Backfill material around the vaults is withdrawn from stockpiled excavated soils and will be compacted to 90% maximum dry density in accordance with ASTM D1557.

3.1.2.6 Modifications to the Exiting Disposal Vaults

The modifications to the existing disposal vaults to support waste package emplacement will include demolition of the roof portions of each original grout vault and modifications to the vault side walls and LDCRS.

To uncover the four existing grout vaults (218-E-16-102 through 218-E-16-105), an approximate area of 107 by 137 m (350 by 450 ft) from the existing grade elevation of 200 m (656 ft) to a 198 m (649.5 ft) elevation will be excavated. A slope of 1-½:1 from the 200 m (656 ft) elevation to new grade will be maintained around this area. In addition to removing compacted backfill around the vaults, the excavation consists of removing and hauling the following materials to the Richland Landfill:

1. The 1.0 m (3-ft 4-in.) deep asphalt and concrete topping (diffusion break) above the vaults, 0.6 m (2-ft) deep by 1.0 m (3-ft 4-in.) wide asphalt covering around three sides of the vaults, and 1.4 m (4-ft 6-in.) deep by 1.0 m (3-ft 4-in.) wide asphalt covering on the east side of each vault will be excavated. The existing concrete vault pits and pump pits located on the top of each vault will be removed. Existing piping and conduits embedded within the asphalt topping and HVAC inlet on each vault will be removed before hauling the asphalt. The HVAC exhauster and ductwork located between Vaults 102 and 103 and above their roofs will also be removed.

2. The precast concrete cover blocks (1.2 m (4-ft) wide by 16.6 m (54-ft 6-in) long by 0.7 m (2-ft 2-in) thick) that make up each vault roof will be removed.

3. Leachate concrete pump pit, located on the east side of each vault, will be removed. Existing 66 cm (26 in.) pipe to leachate collection sump and 21 cm (8 in.) pipe for leak

detection will be cut to the new grade level to maintain the functionality of the leak detection system. Both of these pipes will be provided with new blind flanges.

4. Existing electrical concrete duct banks and manholes with existing cables will be removed.

5. The interior floor and wall surfaces of vaults are coated with an asphaltic coating. Because the coating contributes to the fire loading in the vaults, it must be removed. Removal of the coating will be done by mechanically scraping it from the concrete surfaces or by sandblasting.

The existing walls of each vault will be extended 1.8 m (6 ft) high to provide shielding. Extended concrete walls will taper in thickness from 0.6 m (2 ft) at the base of the existing wall to 0.5 m (1-ft 6-in.) at the top for north and south sides of vaults (Figure 5). The extended concrete walls will remain 0.8 m (2.5 ft) thick for east and west sides of vaults. The vertical rebar of the existing concrete walls will be exposed to splice them mechanically with the new rebar of the wall extension.

Figure 5 shows the waste package loading for package dimensions of 1.2 m x 1.2 m x 1.8 m.

Given the current ILAW waste package dimensions (1.4 m x 1.4 m x 1.4 m), each existing vault will be capable of holding 25 x 10 packages in a given layer and a total of 7 layers in a given vault. Therefore, each existing disposal vault will hold 1750 packages.

Eighty pound (80-lb) American Society of Civil Engineers (ASCE) rated rails will be provided on top of the north and south walls for each vault for a 15-ton gantry crane. These rails will be extended for approximately 14.6 m (48 ft) into the waste package delivery/crane maintenance area. The rails in this area will be supported by W14 steel beams and 46 cm (18-in.) square, concrete columns.

3.2 New ILAW Disposal Facility

The current design for the new ILAW disposal facility consists of a set of disposal vaults located in the south-central part of the 200 East Area (see Figure 1). Each waste disposal vault will be an underground, open-topped, concrete vault approximately 23 m (76 ft) wide, and 207.8 m (686 ft) long. The total vault height was increased to 11.0 m to accommodate the new waste package dimensions. The top of the vault walls will extend 1 m (3.3 ft) above grade. A removable shield wall will extend an additional 1 m (3.3 ft) above the top of the vault walls to support vault loading. Each vault will be divided into 11 cells, separated by concrete partition walls. Underneath the vault will be a concrete catch basin with a leachate detection and collection system.

Each cell being filled will have a moveable, bridge-crane equipped, Gantry Building over it. Two Gantry Buildings are planned for the facility. The Gantry Building will remain in place over a cell after it is filled with ILAW packages to aid in performing partial closure of the cell.

Each vault is built above a RCRA-compliant leak detection and collection system. It consists of a cast-in-place reinforced concrete basin approximately 209.5 m (687.3 ft) long, 24.7 m (81 ft) wide with walls 1.07 m (3.5 ft) high. The basin floor is 0.6 m (2 ft) thick and contains steel reinforcing bars within. The catch basin is lined with two flexible membrane liners, and between these liners lie a layer of gravel with perforated collection pipe routed to sumps, one at each end of a vault.

3.2.1 Location

Approximately 36 hectares (90 acres) of land is allocated for the ILAW Disposal Facility in 200-East Area southwest of PUREX (202-A Building) between 1st and 4th Streets and west of Canton Avenue bounded on the east at coordinate E574653 and on the west at coordinate E574170 (Figures 1 and 6). The land is considered uncontaminated and vacant (Burbank 1997).

The preferred alternative has the storage vaults/trenches oriented with their length in a north–south direction and the Control/Administration Building located at the northwest corner along 4th Street (see Figure 7). In this alternative, the site is divided along its length into three segments. The north segment will be set aside for waste disposal vaults and will include one vault for Phase 1 and the Control/Administration Building. The middle segment will be set aside for a combination of disposal vaults and/or trenches. The south segment will be set aside for waste disposal trenches, although vaults could be constructed. Each segment will be enclosed by chain link security fencing with 3-strand barbed wire. For the 2001 PA base analyses, all vaults are assumed to be concrete vaults as described below.

3.2.2 Design

The dimensional data for the new ILAW disposal facility vaults are summarized in Table 3.

3.2.2.1 Site Work

For Phase 1 construction and operation, portions of the site (approximately 15 hectares [37.5 acres]) will be cleared, grubbed, and leveled to facilitate the construction of one disposal vault, the Control/Administration Building and parking area, perimeter and service roads, and perimeter fence and lighting (Figure 6). Clearing and grubbing will involve complete removal and disposal of all brush, roots, and other deleterious materials. Several hectares of mature sagebrush will be affected by this construction activity.

Table 3: Dimensional Data Summary for the New ILAW Disposal Facility

Concrete Structures			
Basin			
	bottom footprint (edge):		24.7 m x 209.5 m
	bottom edge elevation* :		187.1 m (613.8 ft)
	bottom thickness:		0.6 m (minimum)
	height:		1.7 m (5.5 ft)(bottom edge to top of basin side wall)
Vault			
	Bottom :	outside	207.8 m x 23.0 m
		inside cell	18.3 m x 21.0 m
	Bottom edge elevation*:		188.0 m (616.8 ft)
	Thickness:		1.0 m
	Side walls		11.0 m (high** measured from bottom of vault)
	Outer wall thickness:		1.0 m
	Cell wall thickness:		0.45 m

* Grade elevation assumed to be 198 m
**See Section 5.2 for discussion

3.2.2.2 Concrete Catch Basin

The concrete catch basin is part of the secondary containment for the leachate collection system (Figure 8). The catch basin is cast-in-place reinforced concrete, approximately 209.5 m (687.0 ft) long, 24.7 m (81 ft) wide with walls 1.07 m (3.5 ft) high. The basin floor is 61 cm (24 in.) thick and reinforced with 2.2 cm (.88-in.) steel reinforcing bars at 20 cm (8 in.) on center, top, and bottom both ways. The catch basin floor slopes at 2% towards a trench in the center. The trench slopes toward each end of the basin from the center. The interior dimensions of the concrete catch basin extend a minimum of 25 cm (10 in.) beyond the vault walls. This allows the basin to catch any leachate that may leak through either the vault floor or the walls.

The catch basin is lined with two flexible membrane liners (FML). The upper FML serves as the primary liner; the lower FML, along with the concrete catch basin, serves as the secondary composite liner. The liner material for the FML will be high-density polyethylene (HDPE).

The concrete catch basin serves as the foundation for the FML. The interior concrete surfaces will be formed to provide a 20 cm (8-in.) radius on inside corners and a 5 cm (2-in.) radius on outside corners. Concrete surfaces in contact with the FML will have troweled finishes.

A layer of gravel that serves as a portion of the leachate collection system is placed over the primary liner. The vault is then built on top of these components.

3.2.2.3 Leachate Detection Collection and Removal System (LDCRS)

The leachate collection pit leak detection system can detect liquids that leak into the leachate collection system. The leachate system will be monitored in the control room.

A perforated collection pipe and a layer of gravel placed over the primary liner allows collected liquids to drain to a sump at either end of the vault for sampling and removal. Liquids entering the sump will be detected by instrumentation during the facility operation phase. Samples can be removed by lowering a sample collection device down the leachate riser. Leachate could be removed by use of a portable pump lowered down the riser pipe. Collected liquids will be pumped to a portable tank for disposal. The leachate collection system is shown in Figure 8.

Between the two FML layers is a drainage net that allows any liquid trapped between the liners to drain freely to a sump at either end. This sump is separate from the leachate collection sump, and liquids in the two sumps cannot mix. Liquids entering the sump will be detected by instrumentation and removed by a portable pump lowered down a riser pipe. Collected liquids will be pumped to a portable collection tank for testing and disposal.

3.2.2.4 Concrete Vault

The current underground, reinforced concrete vault design is approximately, 23 m (76 ft) wide, 207.8 m (686 ft) long, and 9.1 m (29.8 ft) deep (outer dimensions, see Figure 9). The elevation of the vault bottom is 186.5 m (612 ft) with respect to sea level. The vault wall will extend 1 m (3.3 ft) above grade to act as a barrier against the tractor/trailer transport vehicle and to keep away any water run-off. The top of the vault extension walls will have slots (320 mm [12.8 in.] wide by 320 mm [12.8 in.] high) in the center. Removable shielding walls will be inserted in these slots before placement of waste packages into the cell. The north–south tractor/trailer drive-through on each side of the vault will be paved with asphalt. Gravel aprons will be provided on the east and west sides of the Gantry Buildings to allow for vehicle traffic past the outside of the building. The exterior walls and the concrete base will be 1 m (3.3 ft) thick. The vault will be divided into 11 cells, separated by 0.45 m (1.5 ft) thick concrete partition walls.

Figure 9 shows that waste package loading assuming the waste package dimensions are 1.2 m x 1.2 m x 1.8 m. Given the currently planned waste package dimensions, each cell will be capable of holding 12 x 14 packages in a given layer. A total of 6 layers are planned for a given cell. This will require extending the total height of the vault by 1.9 m for the ILAW performance assessment calculations. For the ILAW analysis the vault is assumed to extend only 1.0 m above the grade. Therefore, the elevation of the vault bottom is 188.0 m (see Table 4). The grade elevation at the new facility site is assumed to be 198.0 m (649.5 ft). The vault is sized to contain 1008 ILAW packages (1.4 m x 1.4 m x 1.4 m) per cell. The total vault capacity is 11,088 packages.

4.0 ENGINEERED BARRIERS AND SOIL

The closure cap system is an essential part of the overall disposal system. As such, the closure cap system design must be addressed as an integral part of the design for the overall disposal facility system and developed in parallel with the other major parts of the system. The functional objectives, design requirements, and associated performance goals for the closure cap system must be defined accordingly.

The following subsections provide a more detailed description of the regulatory guidance and requirements guiding the closure cap system design.

Current conceptual design work for both the existing and new ILAW disposal facilities indicates the closure cap barrier system will be composed of a layered assemblage of different barriers. Refer back to Figure 10 for a cross-sectional illustration of the concept used for the current conceptual design. The general configurations for both the existing and new disposal facilities are shallow-land burial systems using a vault enclosure for the emplaced waste products. The vault enclosure would be surrounded by a layered system of engineered barriers.

The closure cap will sit on top of the temporary closure cover of the vault. Each layer within the closure cap will be sloped with a two percent grade to allow runoff and minimize erosion. A barrier overhang will be used to control potential water infiltration problems at the edges of the barrier. "Barrier overhang" is the terminology used to describe the projection of the functional barrier surface beyond the perimeter of the waste zone. The barrier overhang will extend 6 m (9.7 ft) beyond the edge of the disposal vault. Beyond the barrier overhang, the barrier layers above the low-permeability layer(s) will extend further but at a steeper slope of 3:1 (horizontal:vertical) until they reach the existing ground elevation. The grading fill layer of the barrier located underneath the low-permeability layer(s) will extend beyond the barrier overhang as well. This layer will support the other 3:1 sloped layers extending beyond the barrier overhang.

The specific choice of barrier materials, barrier thickness, and degree of capping barrier slope are all still subject to change. They will be tailored to the function and performance requirements for these uppermost layers as the design and performance assessment work progresses. Figure 11 provides a cross-sectional elevation view of the closure cap barrier system concept. This or a similar barrier layer system will be built over the vaults following completion of waste emplacement, backfilling, and then temporary and final roofing of the vault. The approximate height of this assemblage of barriers would be at least 1.7 m (5.6 ft) (BHI 1996). Table 4 provides a comprehensive summary of the key functions and characteristics of each of the proposed barrier layers for this particular concept.

Detailed assessments of four surface barrier designs that constitute potential generic remedial alternatives for 200 Area waste sites were assessed in a recent focused feasibility study (BHI 1996). The designs presented in this study were as follows:

> **Hanford Barrier**. Designed to provide 1,000-year isolation of waste sites containing Greater than Class C Low Level Waste (LLW), Greater than Class C mixed waste, and significant inventories of transuranic (TRU) constituents.

Modified RCRA Subtitle C Barrier. Designed to provide 500-year isolation of waste sites with dangerous waste, Category 3 LLW, Category 3 Low Level (LL) mixed waste, and Category 1 LL mixed waste (see Table 5).

Standard RCRA Subtitle C Barrier. Designed to provide 30-year isolation of dangerous waste sites.

Modified RCRA Subtitle D Barrier. Designed to provide 100-year isolation of waste sites with Category 1 LLW and nonhazardous/nonradioactive solid waste.

The Modified RCRA Subtitle C Barrier is assumed to be the appropriate surface barrier design for the ILAW disposal facilities. This assumption is based on the following information:

The ILAW disposal facilities will not contain significant quantities of TRU constituents nor LLW with greater-than-Class C activity.

The proposed disposal facilities may contain waste regulated as dangerous waste, but this may not apply if the waste is delisted. However, the ILAW disposal facilities will contain LLW with Category 3 activity.

4.1 Partial Closure Activities

Partial closure activities for the new ILAW disposal vaults will consist of constructing a temporary closure cover over an individual disposal cell within a vault after the cell is filled with ILAW packages. This will be done for each disposal cell within a vault. The Gantry Building will remain over the cell until the temporary closure cover is installed. The purpose of this temporary barrier will be to prevent infiltration of water from the time that the cell is filled to when the final closure cap is added. A final closure cap will be constructed once all of the cells within a vault are filled and the Gantry Buildings are moved from the vault.

The following activities will occur for each cell once it is filled with ILAW packages:

Concrete shield covers (1.4 m x 1.4 m x 0.3 m) are placed above waste packages

Empty spaces between the rows of waste packages will be filled with a filler material (assumed to be sand).

The top surface of the concrete shield covers will be covered with 0.1 m (4 in) (minimum) of a filler material (assumed to be sand).

The filler material layer will be covered by 0.5 m (1.6 ft) of controlled density fill.

The temporary shielding walls above the extension walls of the cell will be relocated to the next cell. The slots of the cell wall where the temporary shielding walls were located will be filled with controlled density fill.

A temporary geomembrane liner will be laid over the cell after controlled density fill has been placed to prevent rain water intrusion. Once the liner is placed, the Gantry Building can be moved from the cell.

This partial closure activity is assumed to also apply to the existing disposal vaults.

Table 4: Summary of Modified RCRA Subtitle C Barrier Layers

Layer No.[1]	Thickness cm (in.)	Layer Description	Specifications	Function
1	50 (20)	Silt loam topsoil with pea gravel admix	McGee Ranch silt loam containing 15 wt. % pea gravel, 2.36 to 9.5 mm in diameter, conforming to ASTM D448 No. 8 aggregate; to be placed at a bulk density of approximately 1.46 g/cc.	The topsoil material was identified for optimal water retention properties and should provide a good rooting medium for cover vegetation. The pea gravel is designed to minimize wind erosion of the silt loam without significantly affecting its moisture retention capabilities.
2	50 (20)	Compacted topsoil	McGee Ranch silt loam without pea gravel, compacted to 90% of optimum dry density as determined by standard Proctor test; in-place bulk density will be approximately 1.76 g/cc.	Same as Layer 1. Layer 2 provides a supplemental soil moisture storage capacity. Compaction of this layer is intended to retard the rate of infiltration of soil moisture. The extended residence time of moisture in Layer 2 will increase the amount of moisture removed by evapotranspiration.
3	15 (6)	Sand filter	Clean, screened sand meeting the following particle sizes: D_{15} = 0.15 to 0.50 mm, D_{50} = 0.375 to 1.2 mm, and D_{85} = 0.70 to 2.5 mm.	This layer is part of a two-layer graded filter designed to prevent the migration of topsoil particles into Layer 5.
4	15 (6)	Gravel filter	Clean, screened aggregate meeting the following particle sizes: D_{15} = 1.5 to 2.0 mm, D_{50} =15 to 20 mm, and D_{85} <37.5 mm.	Same as Layer 3.
5	15 (6)	Lateral drainage aggregate	Naturally occurring aggregate, minus 32-mm (1 1/4-in.) material, conforming to the grading identified in WDOT M41-10, 9-03.9(3) for base course, with D_{10} >1 mm and k >1 cm/s.	The lateral drainage layer will intercept and divert moisture along a 2% slope to the margin of the cover for collection and/or discharge.

Layer No.[1]	Thickness cm (in.)	Layer Description	Specifications	Function
6	15 (6)	Asphaltic concrete with spray-applied asphalt coating	Asphaltic concrete, consisting of asphalt conforming to WDOT M41-10, 9-02.1(4) - Grade AR-4000W, and aggregate with particle size gradation conforming to ASTM C 136. Asphalt will make up 7.5 wt. % of total mixture. A spray-applied, styrene-butadiene asphalt material will be sprayed onto the asphaltic concrete surface in two layers, each 100 mils thick minimum.	This layer will function as a hydrologic barrier and as a biointrusion barrier.
7	10 (4)	Asphalt base course	Crushed aggregate, minus 16-mm (5/8-in.) diameter material, conforming to WDOT M41-10, 9-03.9(3) for top course surfacing material.	The function of the material in this layer is to provide a stable base for placing and supporting the asphalt layer.
8	Variable	Grading fill	Clean, bank run sand and gravel conforming to WDOT M41-10, 9-03.18.	This layer will provide a smooth, level subgrade for construction of the overlying layers.

[1] Barrier layers are listed in sequence from top to bottom (BHI 1996)

4.2 Closure Cover Installation

This section provides a general description of the techniques used for the installation of the closure cap. The closure cover for the existing vaults will be continuous over all four units while individual covers will be used for the new ILAW vaults. The closure cover for the existing vaults will use the shielding berm for the high point of the cover and one direction over all four vaults. Individual covers over each new disposal vault are planned because separate excavations are planned for construction of each vault, which requires that they be separated a greater distance to allow for clearance of the 1-1/2 to 1 excavation slopes. A continuous cover over these vaults would result in consumption of excessive quantities of material. The closure cover installation process will consist of the following tasks.

Gravel will be added to obtain a two percent slope. The height of this gravel layer will be such that the total cap thickness at the edge of the vault is 5 m (as per NRC requirements [10CFR61]).This layer will be smoothed to establish a smooth, planar-base surface for accurate and controlled placement of the overlying layers. A 10 cm (4 in.) thick asphalt base course will be placed over the gravel. This base course layer will provide a stable base for placement of the overlying low-permeability asphalt layer. Grade stakes are used to ensure that thicknesses and overall slopes are maintained.

The next task will be the installation of a water infiltration barrier. The asphaltic concrete mixture will be specially formulated to produce a minimum hydraulic conductivity and will be applied 15 cm (6 in.) thick. A spray-applied asphalt will then be applied over the layer to seal any voids or defects in the surface. This layer will function as a low-permeability barrier as well as an intrusion barrier. A slope of two percent will carry infiltration to the layer edges where it will enter the surrounding soil. The asphalt will prevent burrowing animals from reaching the waste and will act as a barrier against inadvertent intrusion by man.

Next, a 15 cm (6 in.) thick layer of drainage gravel will be laid down. The function of this layer will be to allow moisture that reaches this layer to laterally migrate to the barrier edge.

The next task will be the installation of a two-layer graded filter layer. The first of these two layers installed will be a 15 cm (6 in.) thick gravel filter layer. The gravel in this layer will be sized to be compatible with the lateral drainage gravel layer below and the forthcoming sand filter layer above. Once the gravel filter layer is installed, a 15 cm (6 in.) thick sand filter layer will be installed. The purpose of these two layers is to prevent topsoil particles from moving downward and clogging the lateral drainage layer.

After the filter layers are installed, a 50 cm (20 in.) thick layer of compacted topsoil will be installed. This layer will supplement the moisture storage capacity of the layer to be installed above it. The material used for the topsoil will be McGee Ranch silt loam without pea gravel. The topsoil will be compacted to 90 percent of optimum dry density as determined by standard Proctor test. The in-place bulk density of the topsoil will be approximately 1.76 g/cm^3.

Another 50 cm (20 in.) thick layer of topsoil will be installed next. This layer also contains McGee Ranch silt loam in it, but it will also contain 15 wt.% pea gravel, 2.36 to 9.5 mm in diameter, mixed uniformly. The topsoil mixture will be placed at a bulk density of approximately 1.46 g/cm^3. The pea gravel is designed to minimize wind erosion of the silt loam without significantly affecting its moisture retention capabilities. Construction quality assurance will be conducted throughout installation of each layer to ensure that the appropriate slopes are maintained and that the desired compaction is attained.

Next, the ground will be prepared for planting and fertilized. Once this is complete, the ground will be seeded with mixed perennial grasses and planted with shrubs.

5.0 ILAW DISPOSAL FACILITY CONCEPTUAL MODELS

The existing and new ILAW disposal facility designs will form the basis for the performance assessment calculations scheduled for the 2001 PA. To facilitate these calculations, conceptual models have been developed for the base analysis case. These conceptual models incorporate the important design features impacting contaminant transport from the waste product to the far field vadose zone. From these conceptual models, numerical models will be developed to conduct the transport calculations for important waste products from the waste form to the far field vadose zone. Other numerical models will be used to calculate the transport of these released waste products through the vadose zone and the groundwater to potential receptors identified in the scenarios for the ILAW PA (Mann 1999).

The disposal facility conceptual models identify the vault geometry and layout, the planned materials of construction, and selected information on the waste packages. Additional information on the materials of construction and the near field material properties pertinent to waste product transport are provided in the near-field data packages (Meyer 1999 and Kaplan 1999). Additional information on the waste form can be found in the waste form data package (McGrail et al.1999).

For the 2001 ILAW PA, all waste packages are assumed to have the design given in Table 1 of this report. The minimum surface area for the glass monolith within each package is assumed to be 10.6 m^2 (geometric surface area of the rectangular prism 1.4 m x 1.4 m x 1.2m). Cracking that occurs within the monolith during cooling is assumed to increase the surface area available for dissolution. The initial surface area estimate is provided by McGrail 1999. The nominal void space is assumed to be 1% (by free volume). The filler material is assumed to be 14% silicate sand (by free volume).

5.1 Existing Disposal Facility Conceptual Model

Section 3.1 of this report describes the current status of the existing disposal facility design. To facilitate the numerical calculations, the vault layout and geometrical dimensions have been simplified. The layout of the existing disposal vaults is shown in Figure 12. The figure provides a top view of the vault layout and the distance between the vaults. In the conceptual model, the ancillary modifications made to the site to support the loading of the disposal vaults have been removed. Specifically, the support structure for the Gantry Building, the rail extensions and their supporting structures for the bridge crane, and the paved and graveled areas supporting the loading of the vaults have been removed so that only backfill soil is in the immediate vicinity of the existing disposal vaults.

Figure 13 provides a simplified geometry for the existing disposal vaults. In this simplified conceptual model, the leachate tank and sampling port are assumed to be effectively closed so that they do not provide any preferential path for moisture influx or contaminant transport. The catch basin is simplified to be a rectangular pad, that is 0.6 m (2 ft) thick everywhere. The HDPE layer is ignored in the model since its function as a moisture barrier is assumed to degrade in less than 100 years. The drainage pipe to the leachate tank is also not included in the model. The vault is assumed to sit on a gravel layer that is uniformly 0.3 m (1 ft) thick. The dimensions of the conceptual model vault are the same as given in Figures 4 and 5 and as provided in Table 2.

Also shown in Figure 13 is the diffusion barrier that surrounds most of each vault. This diffusion barrier is 1 m (3.3 ft) thick on the vault side walls and 0.9 m (3.0 ft) on the bottom of the disposal vault. Between the diffusion barrier and the concrete vault a layer, composed of 5.0 cm (2 in) thermal board, geotextile and HDPE mesh, has been applied to provide a path to the LDCRS for any moisture leaving the concrete vault. This layer will be exposed during the modifications planned for these vaults. This layer is assumed to be sealed during the closure process.

The inside dimensions for each vault are 15.4 m (50.5 ft) wide by 37.6 m (123.5 ft) long by 12.2 m (40 ft) in height. One layer of waste packages corresponds to 10 x 25 = 250 waste packages. Each vault will hold 7 waste package layers. Assuming the waste package geometry is a 1.4 m cube, the spacing between each waste package (including the walls) is 9.3 cm (3.7 in) along the width dimension and 10.2 cm (4.0 in) along the length dimension. This volume is assumed to be filled with silicate sand.

The interim closure for the existing disposal vaults is assumed to be as described in Section 4 of this report (see Figure 9 for general layer description). The waste packages will be stacked 7 layers high to a height of 9.8 m (32 ft). A 10 cm (4 in) filler material layer (assumed to silicate sand) is also placed between each layer of waste packages. The concrete shield covers are assumed to be 1.4 m x 1.4 m x 0.3 m and are placed just above the top layer of waste packages. The filler material is assumed to have a depth of 1.0 m (3.3 ft) above the concrete shield covers. A "controlled density fill" consisting of a mixture of portland cement, fly ash, aggregate, water, and admixtures is then placed on top of the inert filler material layer. The depth of the "controlled density fill" is 0.45 m (1.5 ft). A waterproof membrane layer (assumed to be 60 mil HPDE is placed over the interim closed vault.

The orientation and design for the final closure cap for the existing disposal vaults is described in Section 4. The cap orientation is shown in Figure 10 and extends 6 m beyond the layout of all four existing vaults. Note that the cap is placed with its western edge on an existing shield berm and slopes downward from west to east over all four vaults. The slope of the closure mound outside the area of the cap is in a 3:1 slope to the existing ground elevation.

5.2 New ILAW Disposal Facility Conceptual Model

Section 3.2 of this report describes the current status of the new ILAW disposal facility design. To facilitate numerical calculations the vault layout and geometrical dimensions have been simplified. The layout of the new disposal vaults is shown in Figure 14. The figure provides a top view of the vault layout and the distance between the vaults. In the conceptual model, the ancillary modifications made to the site to support the loading of the disposal vaults have been removed. Specifically, the support structure for the Gantry Building, the rail extension and their supporting structure for the bridge crane, and the paved and gravel areas supporting the loading of the vaults have been removed so that only backfill soil is in the immediate vicinity of the disposal vaults. Based on the Kirkbride (1999) estimate of approximately 70,000 packages needed for disposal of all planned ILAW waste, only 6 new disposal vaults would be required to complete the disposal of all ILAW (assuming the existing disposal vaults are fully utilized).

Figure 15 provides a simplified geometry for the new disposal vaults. In this simplified conceptual model, the leachate tanks and sampling ports are assumed to be effectively sealed during closure so that they do not provide any preferential path for moisture influx or contaminant transport. The catch basin is simplified to be a rectangular pad, that is 0.6 m (2 ft) thick everywhere. The HDPE layers are ignored in the model since their function as a moisture barrier is assumed to degrade in less than 100 years. The drainage pipes to the leachate tanks are also not included in the model. The vault is assumed to sit on a gravel layer that is uniformly 0.3 m (1 ft) thick. The dimensions of the conceptual model vault are the same as given in Figures 8 and 9 and as provided in Table 3.

Each new vault is divided into 11 equivalent cells (see Figure 9). The inside dimensions for each cell are 18.3 m (60 ft) long by 21 m (68.9 ft) wide by 8.1 m (26.6 ft) in height. The vault height was assumed to be increased to 10.0 m so that the vault could accommodate 6 layers of waste packages. One layer of waste packages corresponds to 12 x 14 = 168 waste packages. Each vault will hold 6 waste package layers. Assuming the waste package geometry is a 1.4 m cube, the spacing between each waste package (including the walls) is 9.3 cm (3.7 in) along the width dimension and 11.5 cm (4.5 in) along the length dimension. This free space is assumed to be filled with silicate sand.

The interim closure for the new disposal vaults is assumed to be as described in Section 4 of this report (see Figure 9 for general layer description). The waste packages will be stacked 6 layers high. A 10 cm (4 in) filler material layer (assumed to silicate sand) is also placed between each layer of waste packages. The concrete shield covers are assumed to be 1.4 m x 1.4 m x 0.3 m and are placed on the top layer of waste packages. The filler material layer is assumed to have a depth of 0.3 m (1.0 ft) above the concrete shield covers. A "controlled density fill" consisting of a mixture of portland cement, fly ash, aggregate, water, and admixtures is then placed on top of the filler material layer. The depth of the "controlled density fill" is 0.45 m (1.5 ft). A waterproof membrane layer (assumed to be 60 mil HPDE is placed over the interim closed vault.

The orientation and design for the final closure cap for the new disposal vaults is described in Section 4. The cap orientation is shown in Figure 10 and extends 6 m beyond the layout of each new vault. Note that the cap is shaped like an inverted "v" and placed with its apex along the length dimension (north-south) and centered over each vault. The slope of the closure mound outside the area of the cap is in a 3:1 slope to the existing ground elevation.

6.0 FACILITY UNCERTAINTY CASES

A number of assumptions are currently associated with our understanding of the disposal facilities to be used in the disposal of ILAW waste. Planning has identified concepts to be used and locations for the disposal of initial waste to be provided by BNFL, Inc. under contract to the DOE. These designs are not finalized. Also, the closure system to be used for the disposal facilities has not been finalized. Sections 3 and 4 of this report provide the facility parameters to be used in the best estimate calculations for the performance assessment. Section 5 contains the disposal facility conceptual models for the ILAW base analysis case. In this section of the report we define sensitivity cases that may be used to assess the sensitivity of the performance assessment to uncertainties in the facility design.

6.1 Waste Form Geometry

The facility conceptual design has been based on a waste package geometry of 1.2 x 1.2 m x 1.8 m. Recent BNFL, Inc. planning has been considering different dimensions and geometries for the waste package. For example Kirkbride (1999) analysis of Phase I processing has used a waste package having dimensions of 1.4 m x 1.4 m x 1.4 m. Kirkbride (1999) also refers to a cylindrical geometry having a similar volume (Taylor 1999); however the dimensions for this cylindrical form have not been finalized.

Also, the projected waste loading into the 1.4 m x 1.4 m x 1.4 m was assumed to be 2.3 m^3 of waste product. The remaining volume was assumed to be filled with a filler material. The final free volume void space in the waste package was assumed to be 1%.

The uncertainty in the waste form geometry and waste loading into the packages impacts the total inventory in a given vault. A reasonable upper bound for waste loading in the disposal vaults assumes the package geometry is 1.2 m x 1.2 m x 1.8 m and each package has 95% of the available volume filled with waste glass (BNFL 1998). This optimizes the number of packages in the disposal vaults and maximizes the waste loading in each package.

6.2 Vault Layout

The layout for the existing facilities has been established; however, the new ILAW facilities are currently in the design phase. The current design layout was based upon the results from the ILAW PA analyses (Mann 1998). However, the design layout may change. The current layout for the new ILAW facility has each trench with its longest length perpendicular to the projected groundwater flow path. An alternate orientation could have each trench with its longest length parallel to the projected groundwater flow path.

6.3 Facility Closure

The current design for the closure cap for both the existing and the new ILAW disposal facilities is described in Section 4. Alternate closure cap designs exist. For example the Hanford barrier (Myers 1994) was assumed for the last performance assessment. Another case that could be considered is when there is no closure cap installed on the disposal facility. Another closure cap case (modified RCRA C with capillary break) that should be considered is the inclusion of a capillary break beneath the asphalt layer in the modified RCRA C base design. Although such a capillary break has not been designed, the dimensions for the capillary break above the asphalt barrier are assumed. Specifically, a sand layer, 1 m (3.3 ft) thick would be immediately below the asphalt layer and the gravel layer below this sand layer would be at least 0.3 m (1 ft) thick.

Failure of the closure cap before its design life also needs to be considered. For example seismic activity or subsidence of the disposal facility could lead to a break in the closure cap.

6.4 Side Hydraulic Diverter

The earlier disposal facility conceptual design (Eiholzer 1995) included a side hydraulic diverter to channel moisture away from the facility. While the current design does not contain such a diverter, its potential incorporation into future designs cannot be dismissed. An earlier study (Mann 1995) showed the impact of such a diverter on the earlier ILAW disposal facility concepts. The side wall diverter is assumed to be a 1 m (3.3 ft) thick layer next to the concrete vault walls that extends to the bottom of the vault.

6.5 Alternate Concepts

Several alternate concepts for disposal of the ILAW have been considered by the River Protection Project. These disposal options include: reuse of the process canyon facilities, reuse of the storage tanks, and other trench disposal concepts.

Several trench concepts may be envisioned to reflect the uncertainty in the new disposal facility design. For example the current, new disposal vault geometry and vault layout could be assumed with either a concrete bottom pad or backfill soil and the side walls made of backfill soil. This vault would be installed above a leachate collection system similar to the one described later in this section. The closure cover is assumed to be equivalent to the closure cap described in Section 4.

One trench concept that is receiving additional consideration is the Remote Handled (RH) trench concept. Under the ILAW disposal alternative described below the disposal facility is a Resource Conservation and Recovery Act (RCRA) compliant landfill (i.e., double lined trench with leachate collection system). Many operational aspects and ancillary activities of the landfill (e.g., leachate collection and disposition, storm water control, installation of surface barrier at closure, etc.) would be similar to that incorporated into the Radioactive Mixed Waste Burial Trench, which was designed and constructed under the Solid Waste Program. However, operational activities related to ILAW package receipt and emplacement in the trench would be modified to accommodate the potentially higher radiation dose rate from remote-handled ILAW.

In December, 1999 the Department of Energy identified the Remote Handled trench as the baseline concept for ILAW disposal at Hanford. The RH trench complex would be constructed in the same location as the new ILAW disposal facility. The RH trench concepdtual model is depicted in Figure 16. The RH trench internal dimensions 260 m long by 80 m wide by 10 m deep. The trench sides have a 3:1 slope. Trench construction requires excavation of 1.9 x 10^5 m^3. The trench liner surface area is about 2.9 x 10^4 m^2.

The trench is provided with a primary and secondary liner as depicted in Figure 17. Beneath both the primary and secondary liner is an admix layer (bentonite clay/soil mixture) 0.5 m and 1 m thick, respectively. The operations layer is comprised of crushed concrete and soil. The thickness of this layer is assumed to be 0.9 m (3.0ft).

The specific design shown in Figure 17 was taken from the remote maintained Radioactive Mixed Waste (RMW) Land Disposal Facility (drawing H-2-131579 Rev. 3). The primary and secondary drainage gravel are for the two drainage collection systems associated with RCRA compliant disposal facilities. Both the primary and secondary drainage layers are comprised of a geocomposite drainage layer on top of HDPE. The geocomposite cage consists of geonet bonded to geotextile. Geotextile is placed above each gravel layer. The specifications for these materials as used in the RMW Land Disposal Facility Trenches are given in WHC Project W-025 specifications (WHC1994).

Because the trench walls have a fairly shallow slope (3 m run for every 1 m rise) each successive layer can be increased in both length and width. Whereas the first layer could be 14 packages wide by 132 packages long (14 by 132 matrix), the second layer could be a 22 by 140 matrix (assuming 1.5 m center to center packing of the ILAW packages). The upper-most (4th) layer could be a 42 by 160 matrix. The net result is that while a baseline new ILAW disposal facility trench capacity is 11,088 ILAW packages, the RH trench capacity could theoretically be 16,448.

Packing the ILAW packages in such large, contiguous matrix (42 by 160 packages for the 4th lift [a single layer of ILAW packages and cover soil]) would, however, create operational impediments. About 100 ecology blocks would be required to create a shielding array between the leading face and operations area of the 4th lift. When it became necessary to advance the ecology blocks, movement of such a large number would be a significant undertaking, potentially requiring several shifts to complete. During this period the trench would be unavailable for ILAW package receipt.

To facilitate continuous receipt operations the matrix size is limited to a smaller size than that which would contiguously cover the entire layer. These smaller sized matrices, termed burial cells, provide the following benefits.

- Corridors are created within the disposal matrix to facilitate access for operational activities such as the emplacement of cover soil
- The size of the exposed leading face is minimized
- The number of ecology blocks required to establish an effective radiation shield is reduced to a number that can easily be moved in a single shift
- A larger portion of the trench can be covered with a rain curtain, thereby reducing the quantity of collected leachate that must be dispositioned.

A conceptual layout of a trench with these burial cells is depicted in Figure 16. Specific details of the trench packing is presented in Table 5. Given this packing density, approximately 6 trenches are needed to accommodate the entire Phase 1 and Phase 2 ILAW production.

Table 5: Trench Packing Characteristics.

Layer	Cells per layer	Matrix size per cell	Packages per layer
1	2	6 x 132	1,584
2	3	6 x 140	2,520
3	4	7 x 150	4,200
4	6	6 x 160	5,760
Total packages per trench			14,064

The details for the closure cover shown in Figure 16 have not been designed. For this report the closure cap is assumed to have the same relative thickness, materials and slope as the modified RCRA subtitle C closure cap defined in Section 4.

Figure 18 depicts the conceptual model layout dimensions. The layout assumes a 5 m spacing between caps for each vault. Each vault layout is depicted with the inner rectangle representing the bottom of the vault (200 m x 20 m), the middle rectangle representing the top of the vault (260 m x 80 m), and the outer rectangle includes the trench wall dimensions (272 m x 92 m).

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8.0 PEER REVIEW

Practice 134 290 1112
Publication Date 01Mar99
Attachment 02 - Sheet 1 of 1

FLUOR DANIEL NORTHWEST

TECHNICAL PEER REVIEWS

CHECKLIST FOR TECHNICAL PEER REVIEW

Document Reviewed: HNF-4950, Rev.1
Title: Disposal Facility Data for the Hanford Immobilized Low-Activity Tank Waste
Author: Raymond J. Puigh
Date: October 20, 1999
Scope of Review: Full Document

Yes	No*	NA	
[ ]	[ ]	[X]**	Previous reviews complete and cover analysis, up to scope of this review, with no gaps.
[X]	[ ]	[ ]	Problem completely defined.
[ ]	[ ]	[X]	Accident scenarios developed in a clear and logical manner.
[X]	[ ]	[ ]	Necessary assumptions explicitly stated and supported.
[ ]	[ ]	[X]	Computer codes and data files documented.
[X]	[ ]	[ ]	Data used in calculations explicitly stated in document.
[X]	[ ]	[ ]	Data checked for consistency with original source information as applicable.
[ ]	[ ]	[X]	Mathematical derivations checked including dimensional consistency of results.
[ ]	[ ]	[X]	Models appropriate and used within range of validity or use outside range of established validity justified.
[X]	[ ]	[ ]	Hand calculations checked for errors. Spreadsheet results should be treated exactly the same as hand calculations.
[ ]	[ ]	[X]	Software input correct and consistent with document reviewed.
[ ]	[ ]	[X]	Software output consistent with input and with results reported in document reviewed.
[ ]	[ ]	[X]	Limits/criteria/guidelines applied to analysis results are appropriate and referenced. Limits/criteria/guidelines checked against references.
[ ]	[ ]	[X]	Safety margins consistent with good engineering practices.
[ ]	[ ]	[X]	Conclusions consistent with analytical results and applicable limits.
[X]	[ ]	[ ]	Results and conclusions address all points required in the problem statement.
[ ]		[X]**	Review calculations, comments, and/or notes are attached.
[X]	[ ]	[ ]	Traceability
[X]	[ ]	[ ]	Document approved (i.e., the reviewer affirms the technical accuracy of the document).

D. W. Wootan *D W Wootan*   *10/20/99*
Reviewer: (Printed and Signed)   Date

* All "NO" responses must be explained below or on an additional page.

** Any calculations, comments, or notes generated as part of this review should be signed, dated and attached to this checklist. Such material should be labeled and recorded in such a manner as to be intelligible to a technically qualified third party.

~~NUCLEAR ENGINEERING~~

Figure 1. Location of Existing Vaults and New ILAW Disposal Facility

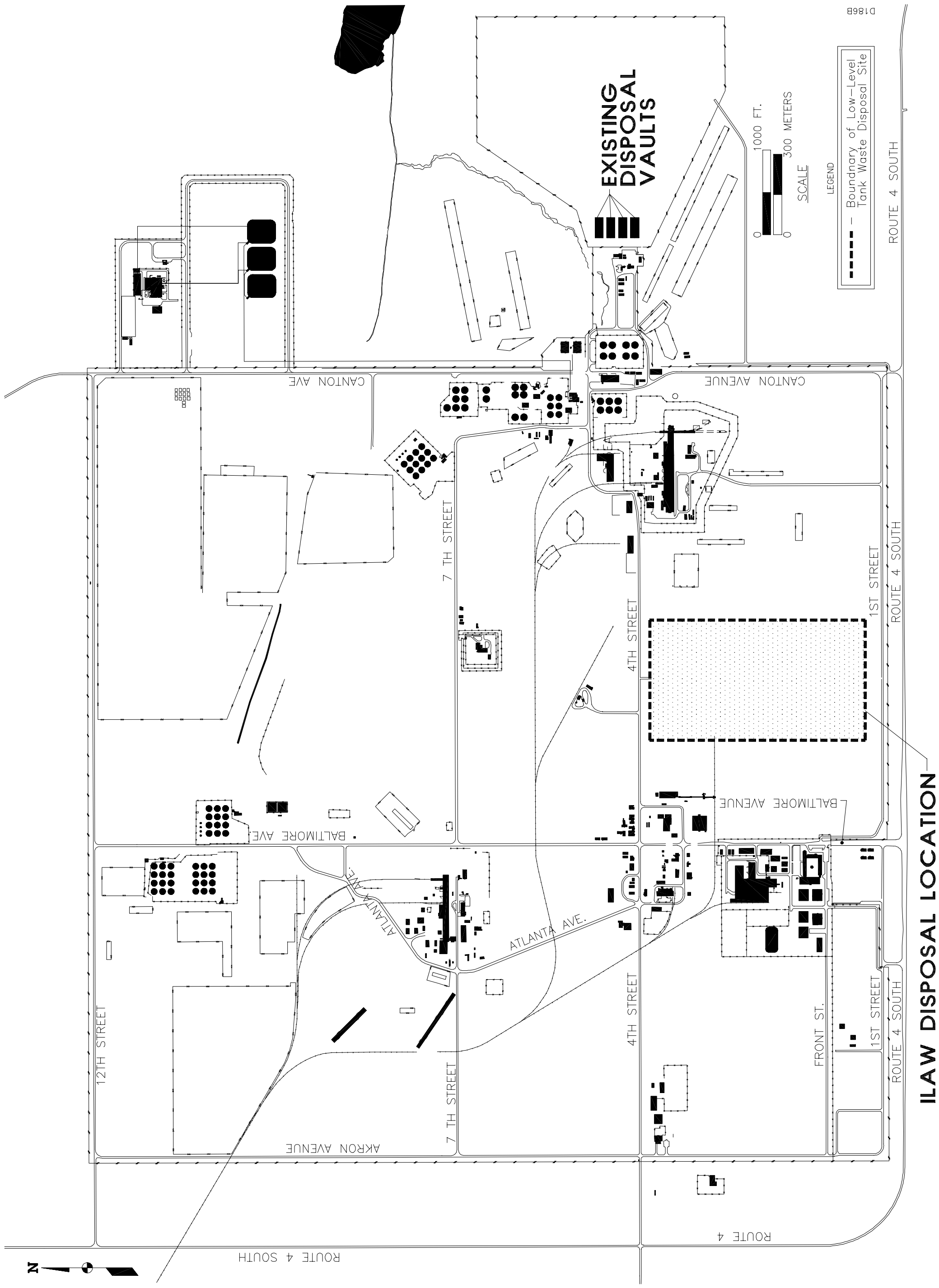


Figure 2. Existing Disposal Facility Site Plan

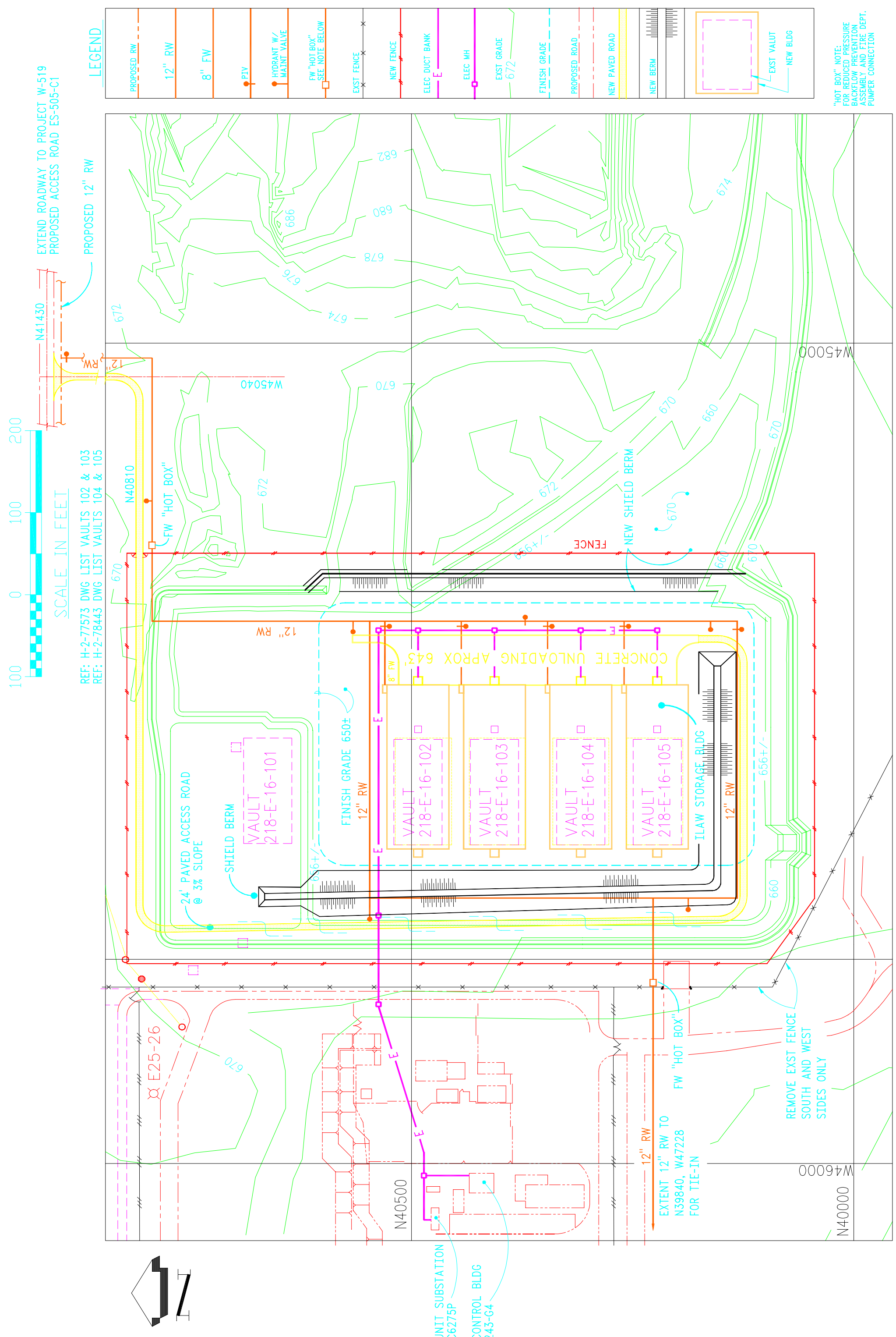


Figure 3. Existing Disposal Facility Catch Basin

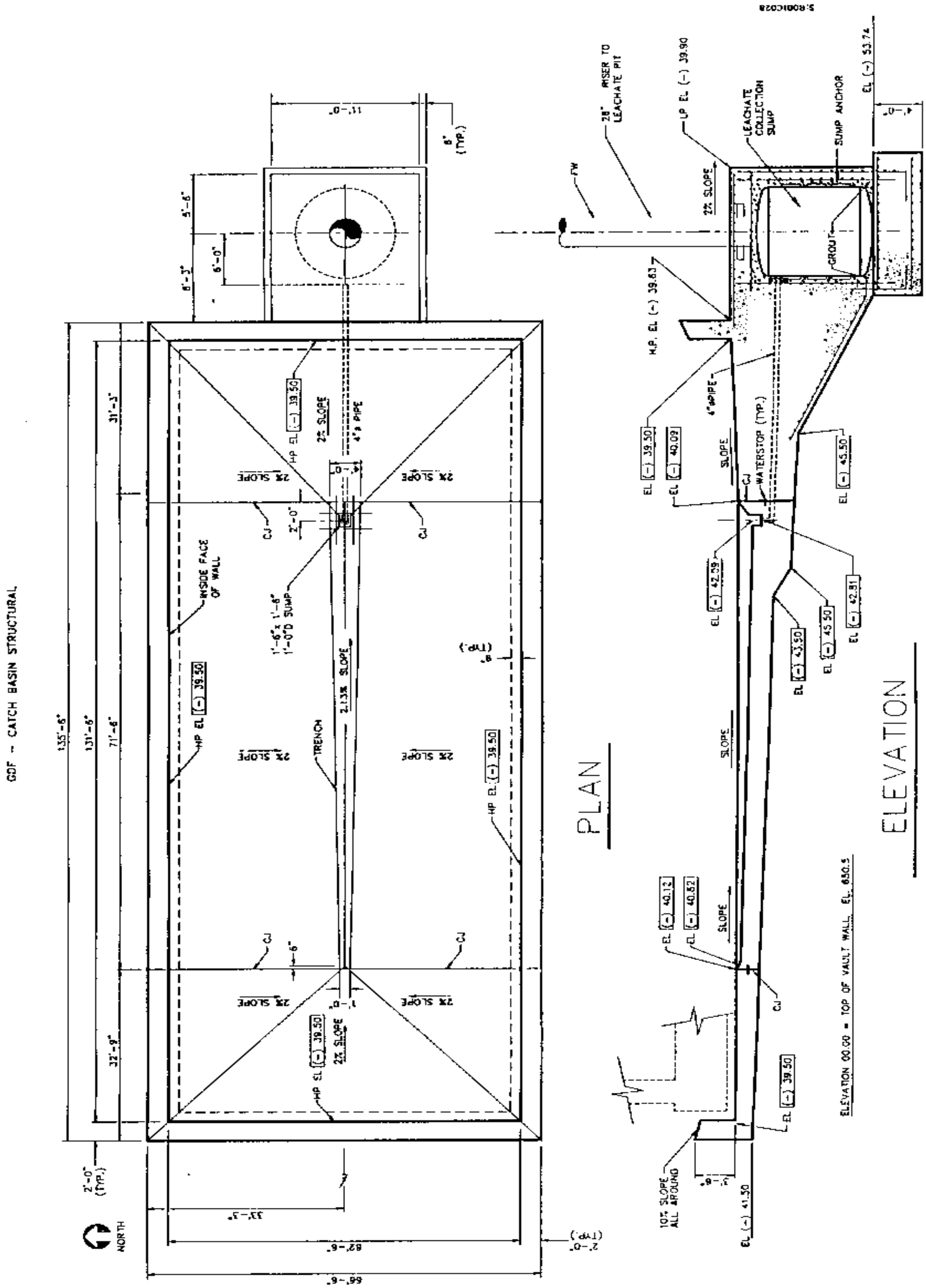


Figure 4. Existing Disposal Facility Vault

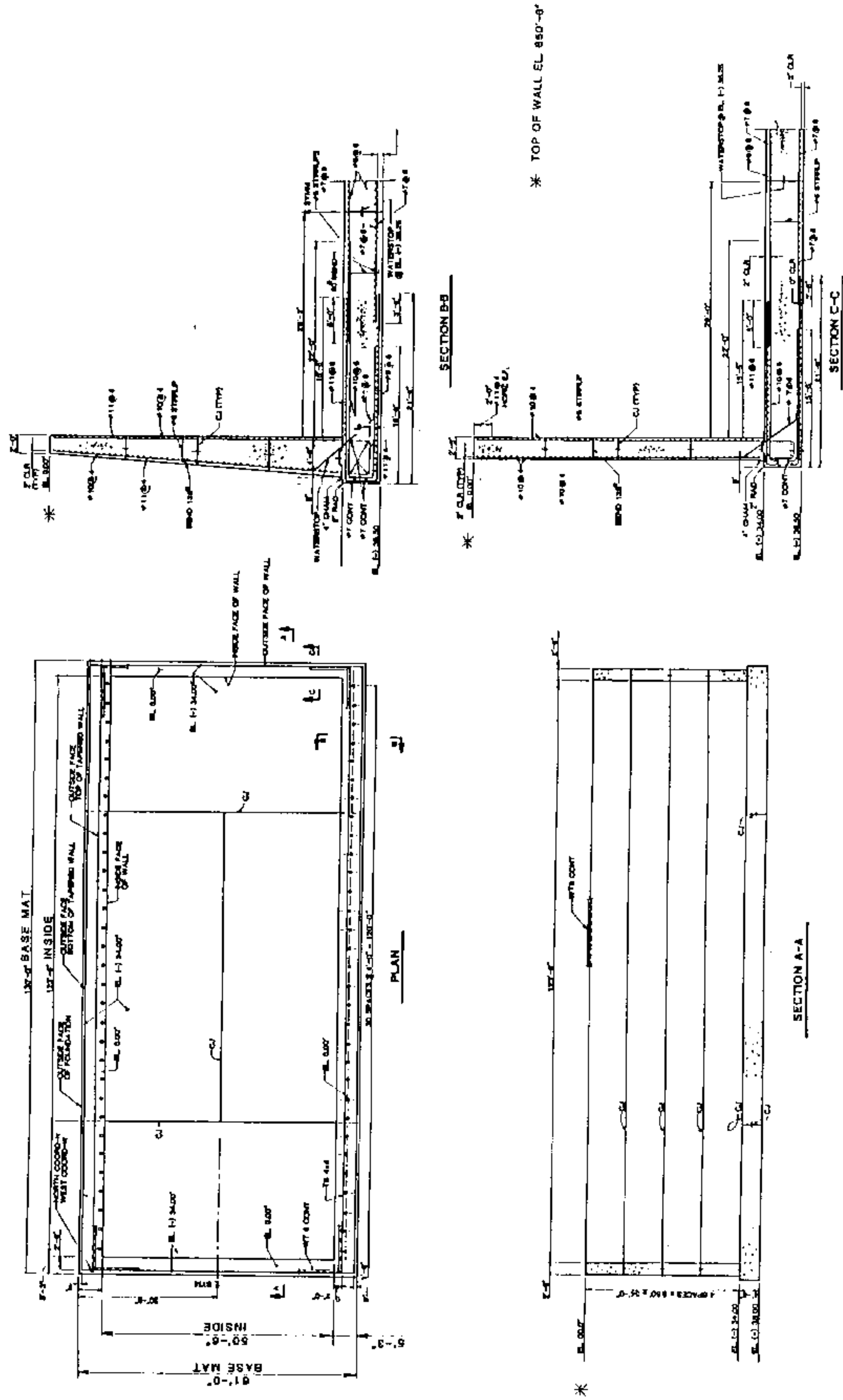


Figure 5. Existing Disposal Vault Side Wall Extension

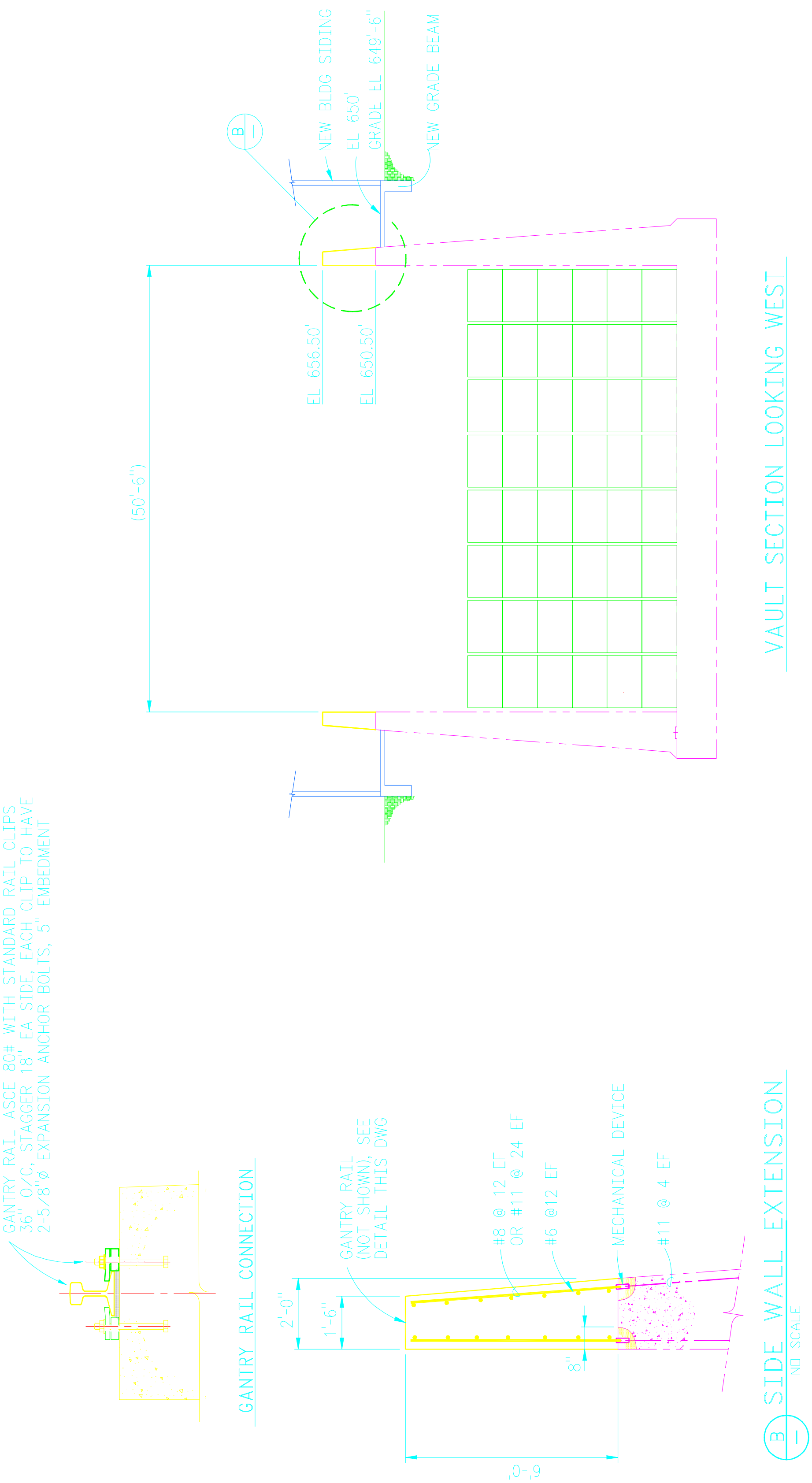


Figure 6. New ILAW Disposal Facility Site Plan

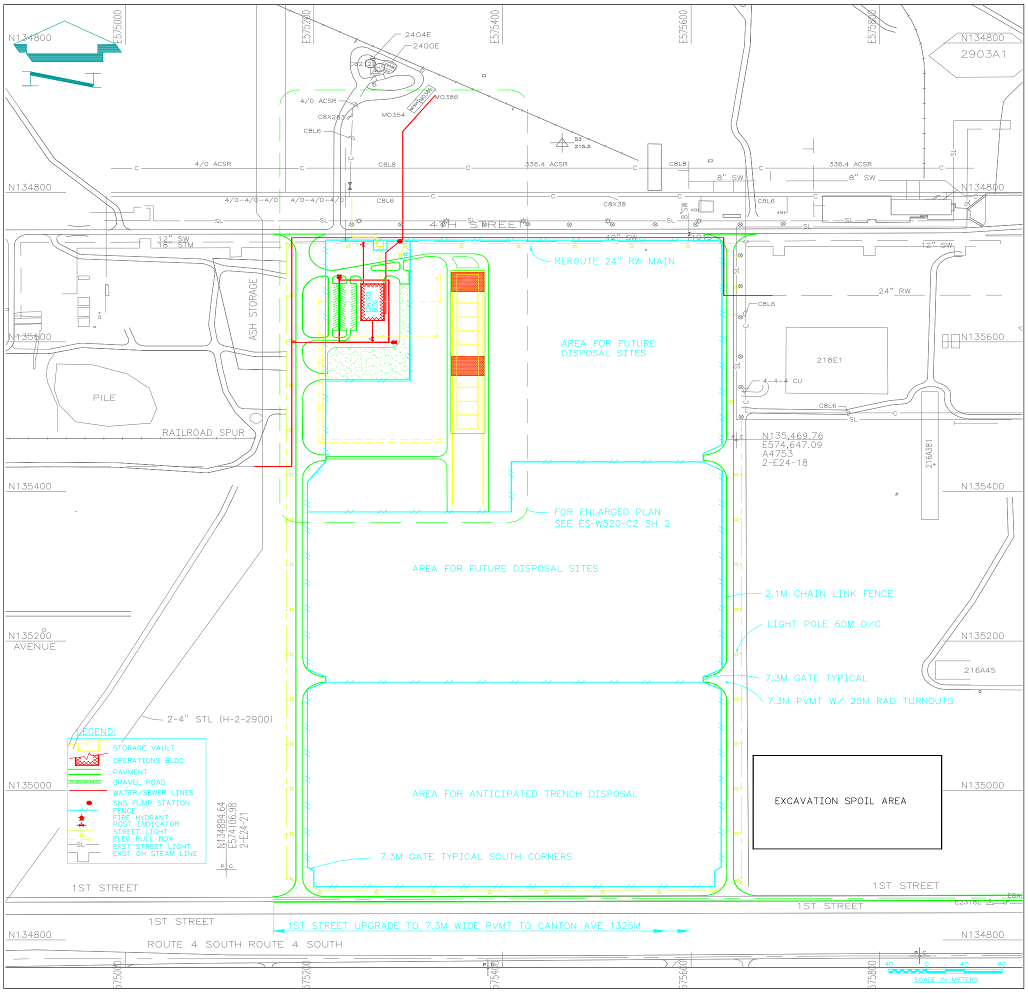


Figure 7. New Disposal Facility Vault Layout

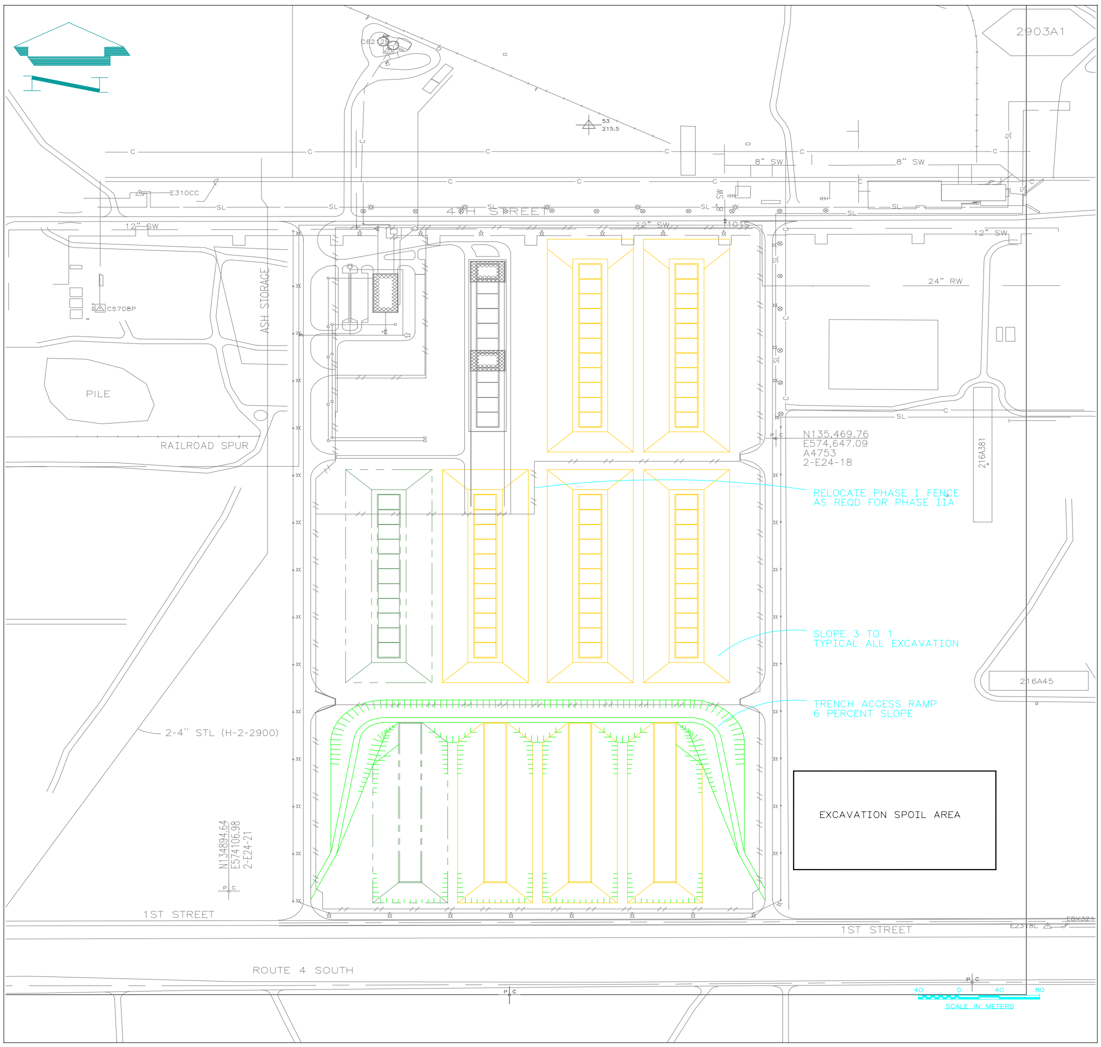


Figure 8. New Disposal Facility Catch Basin and Leachate Collection System

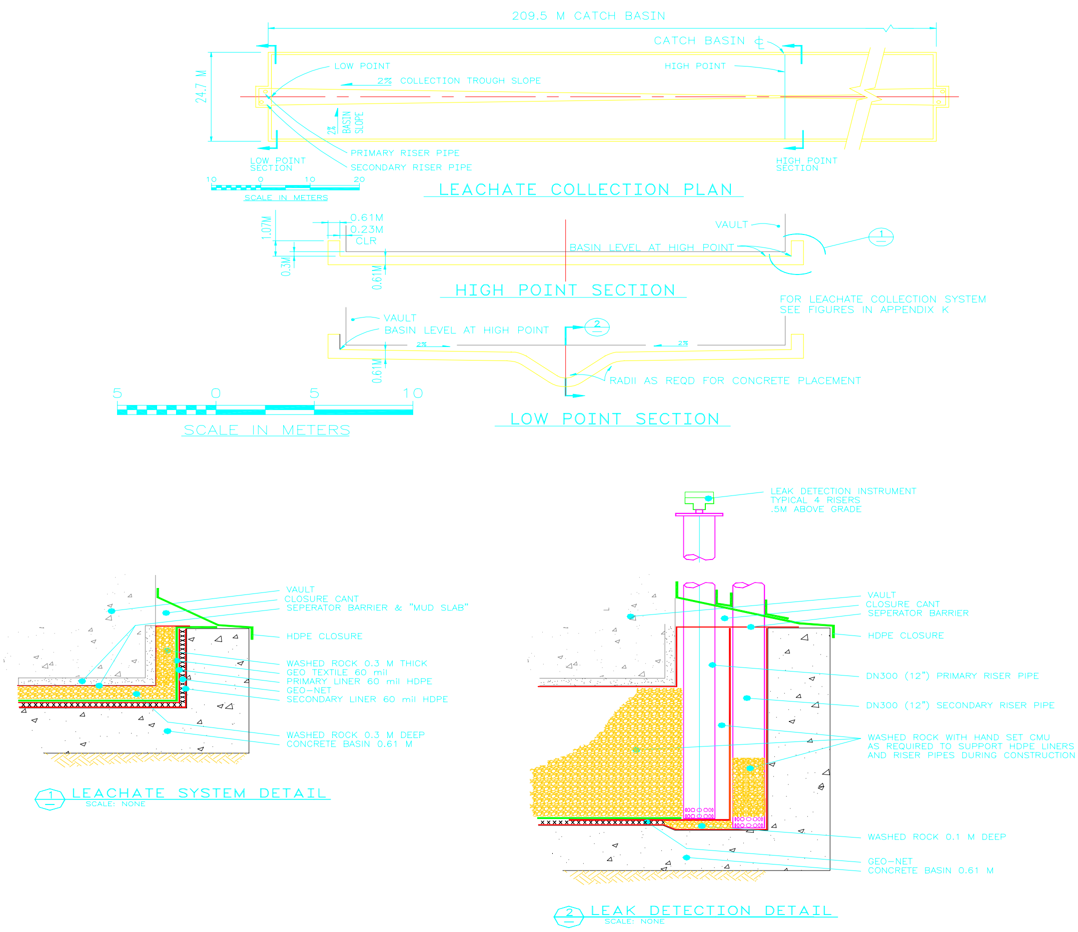


Figure 9. New Disposal Facility Vault Layout

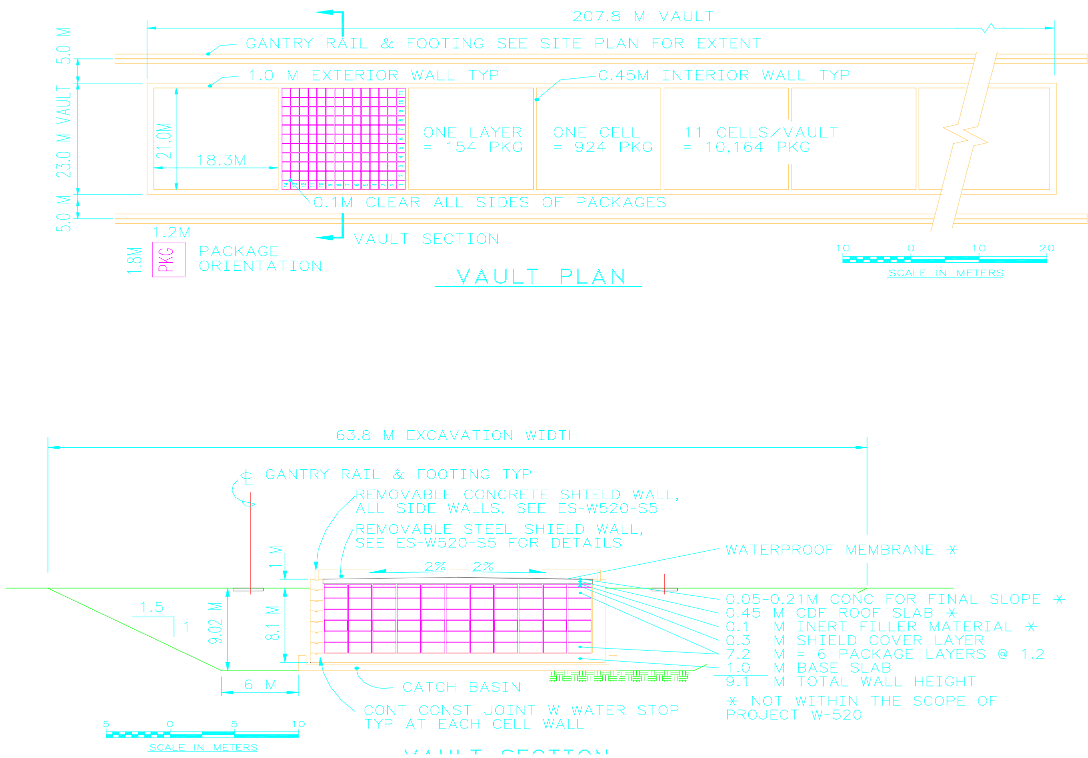


Figure 10. Cross-Sectional Elevation View of Proposed ILAW Product Disposal Facilities

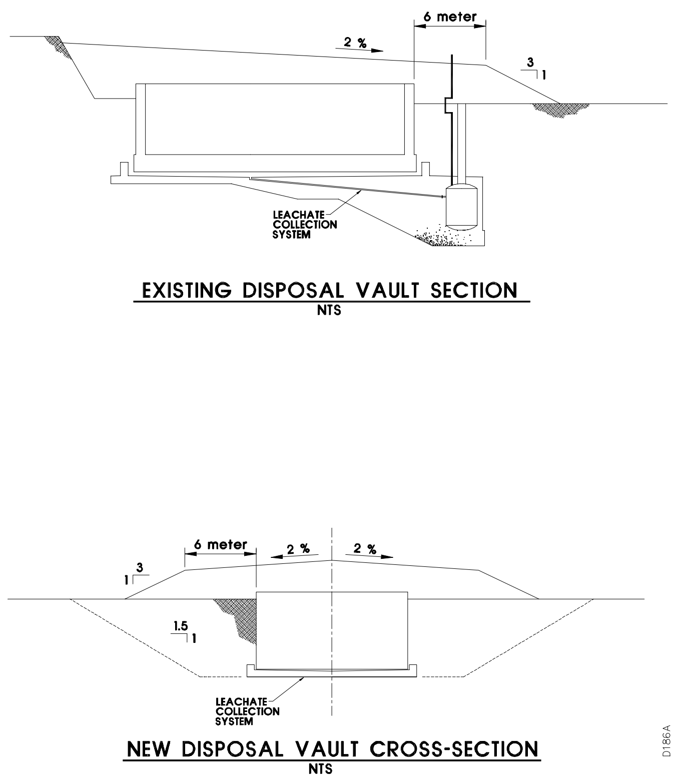
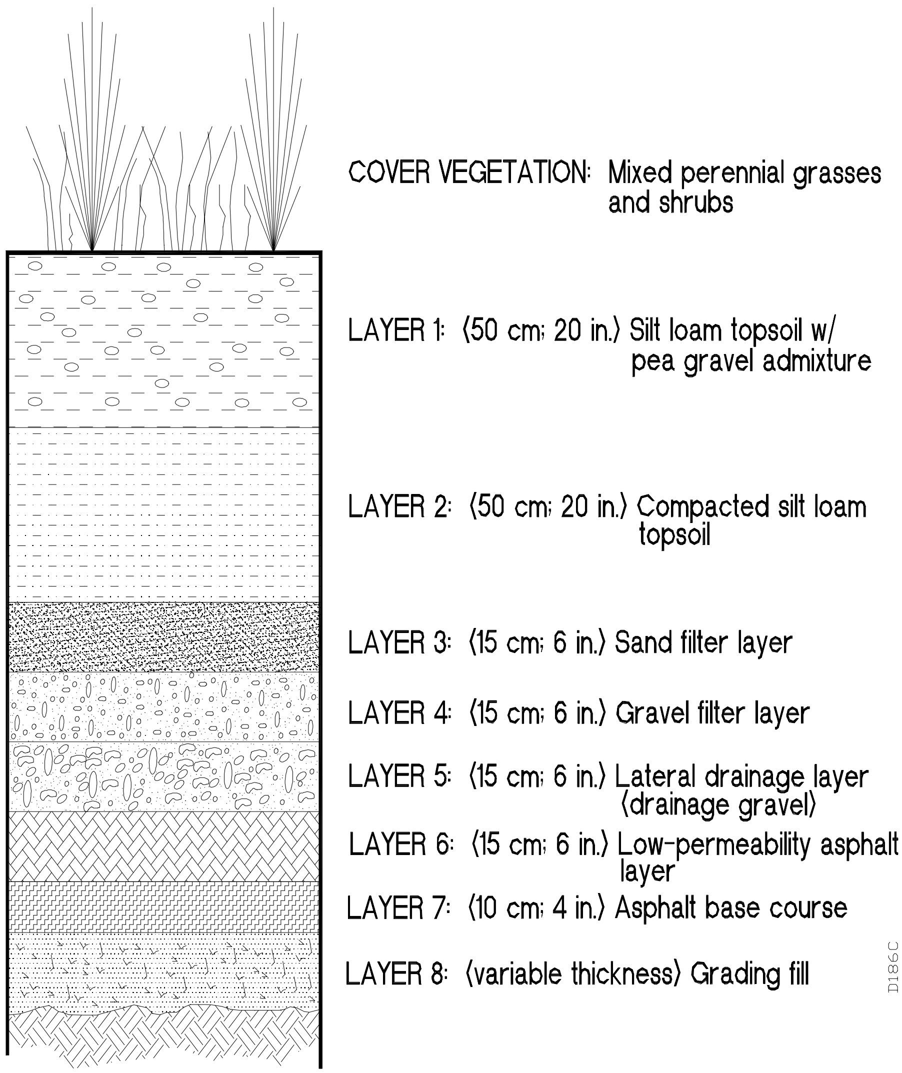


Figure 11. Modified RCRA Subtitle C Barrier, Cross-Sectional Elevation View.



EXISTING DISPOSAL FACILITY LAOUT (Outer Top of Vault)

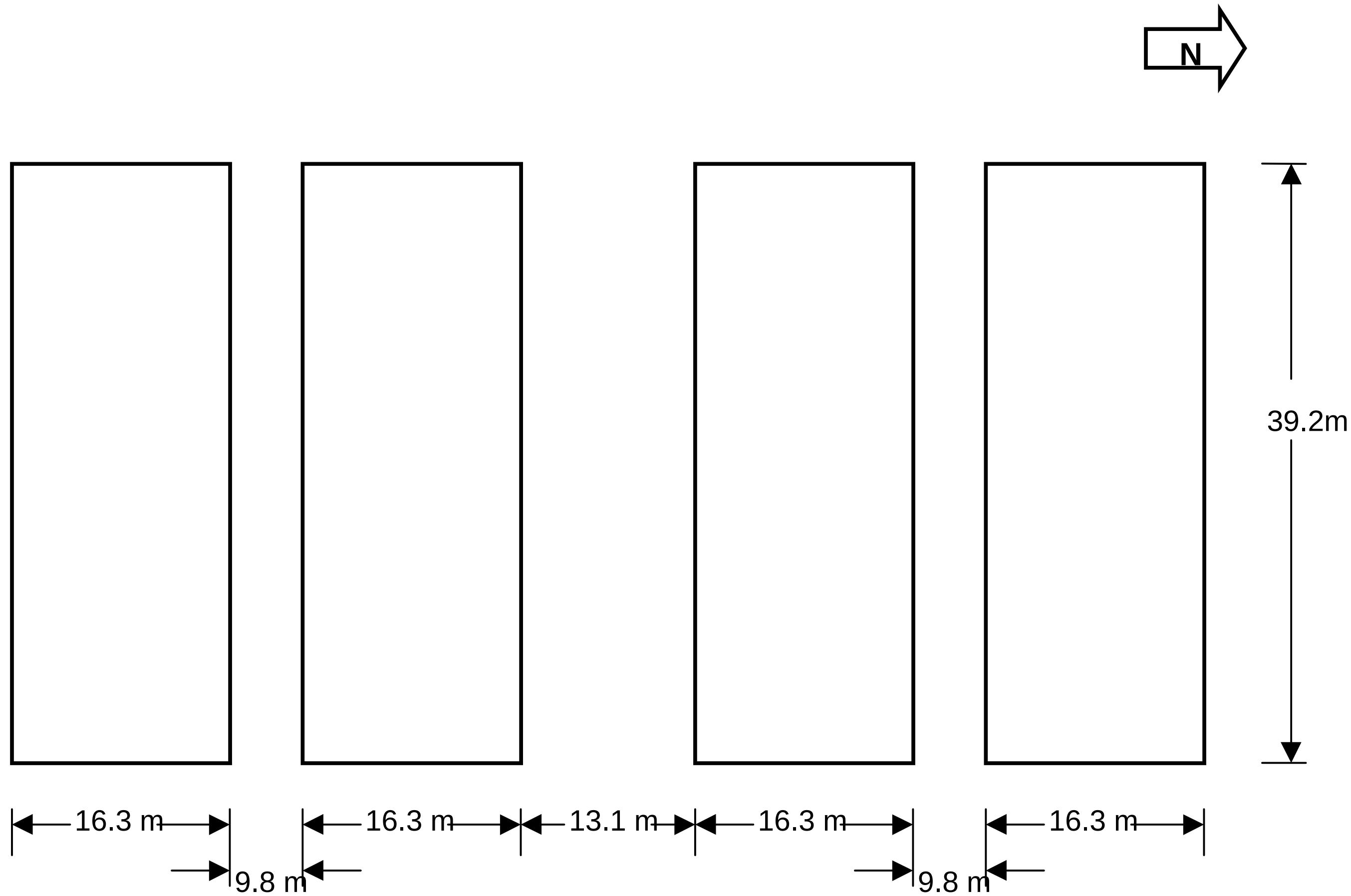


Figure 12. Existing Disposal Facility Conceptual Model Layout

EXISTING DISPOSAL VAULT CONCEPTUAL

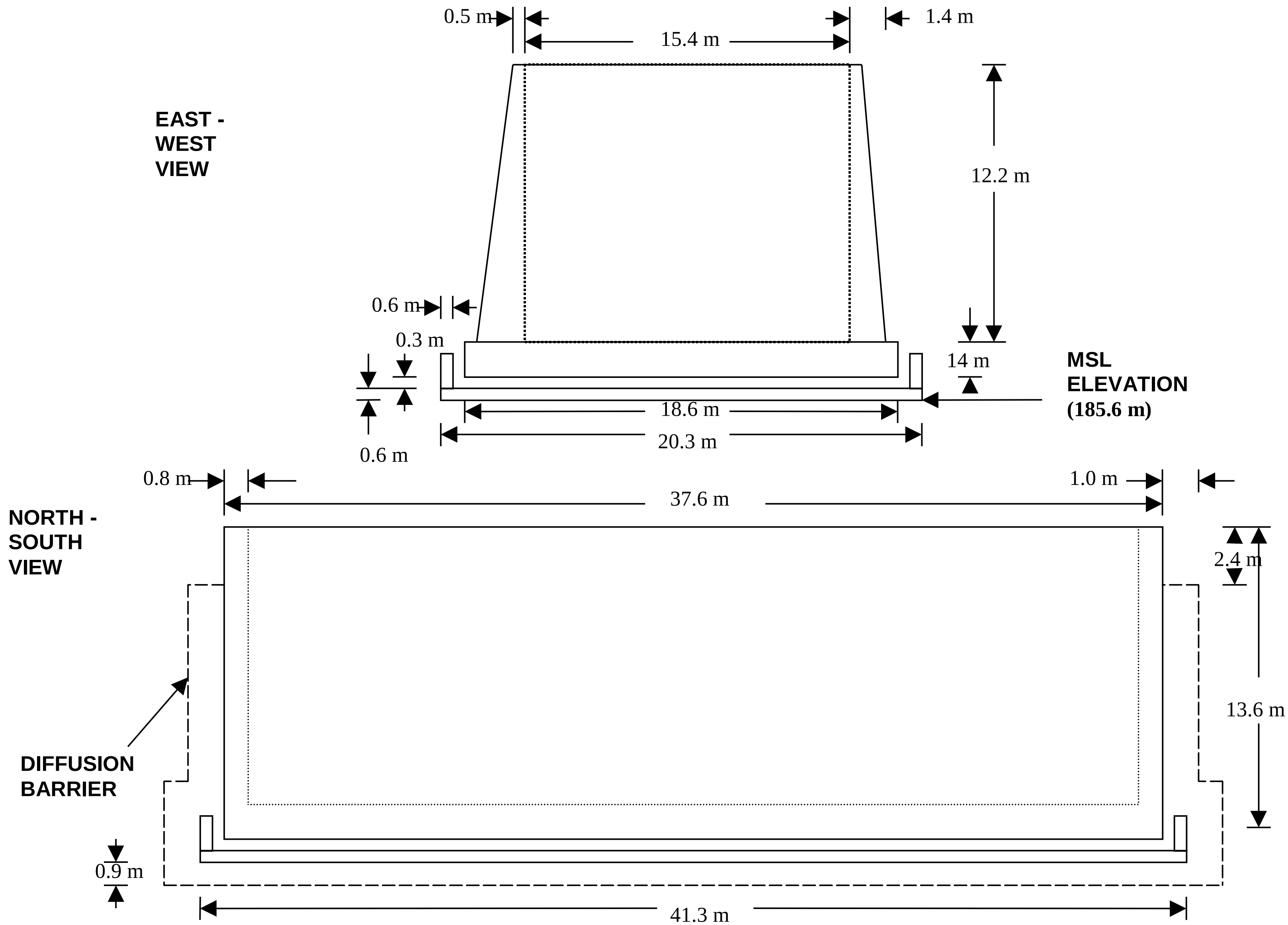


Figure 13. Existing Disposal Vault Conceptual Model

NEW DISPOSAL FACILITY LAYOUT (Top of Vaults)

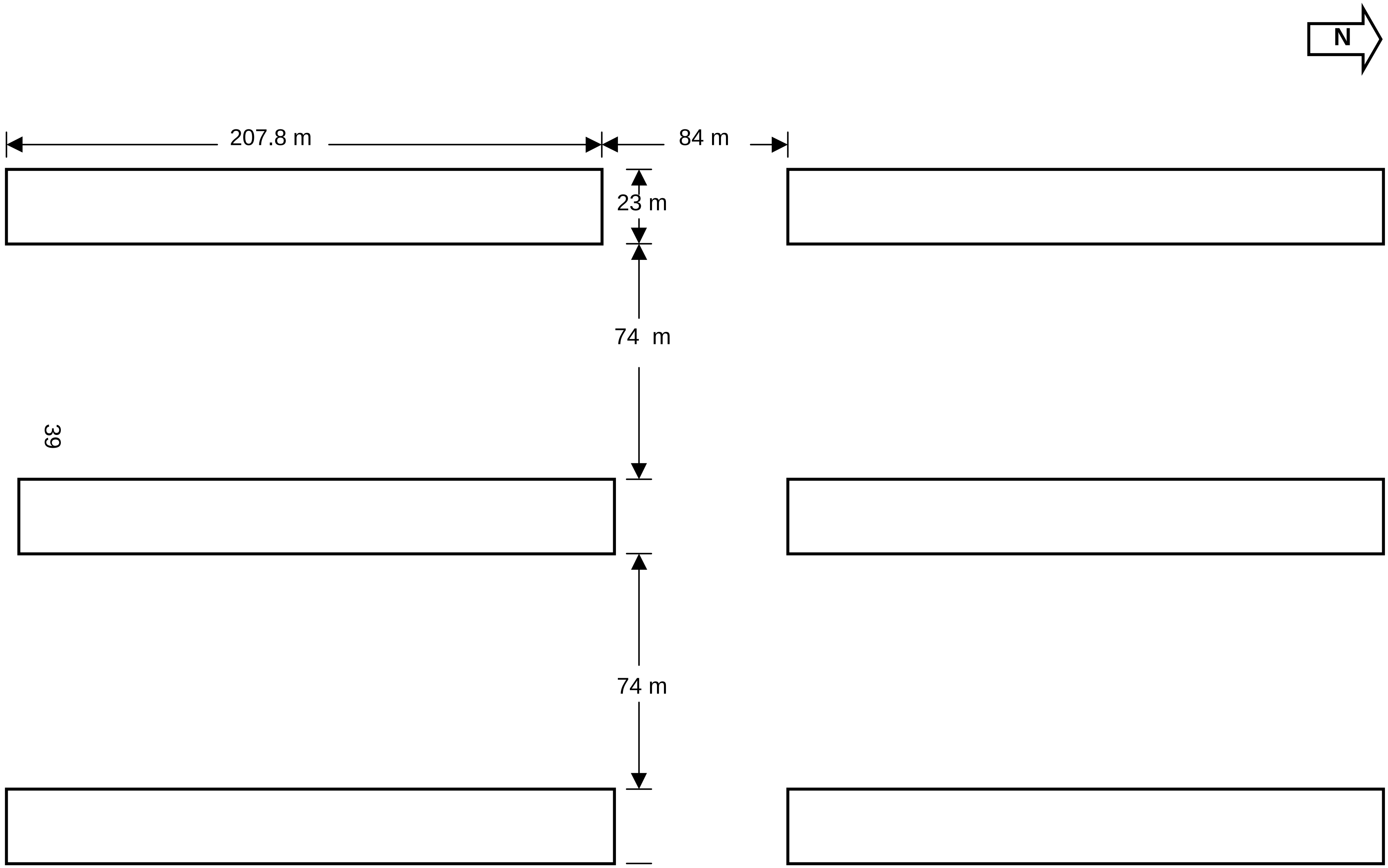


Figure 15. New Disposal Vault Conceptual Model

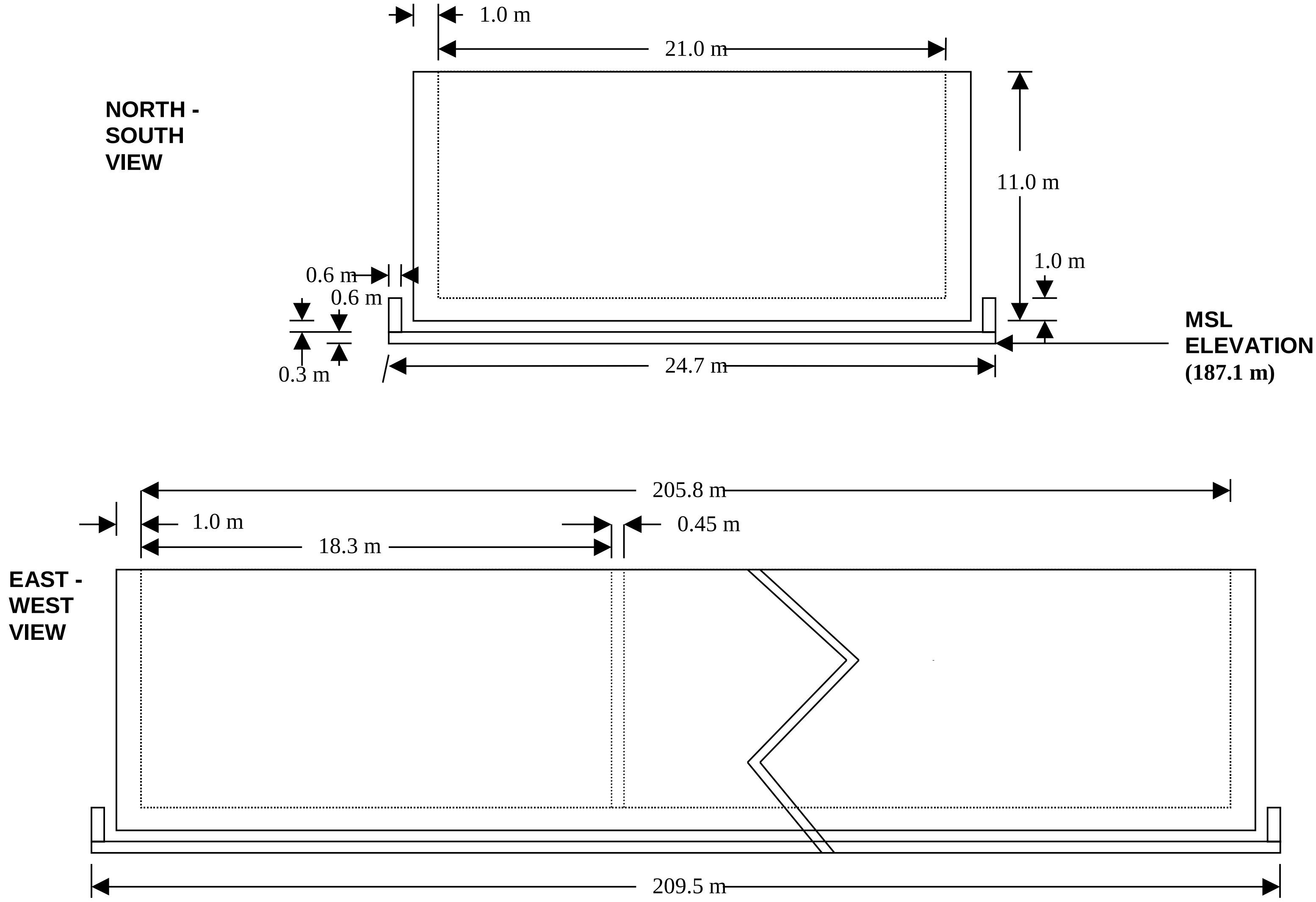


Figure 15. New Disposal Vault Conceptual Model

RH TRENCH CONCEPTUAL MODEL

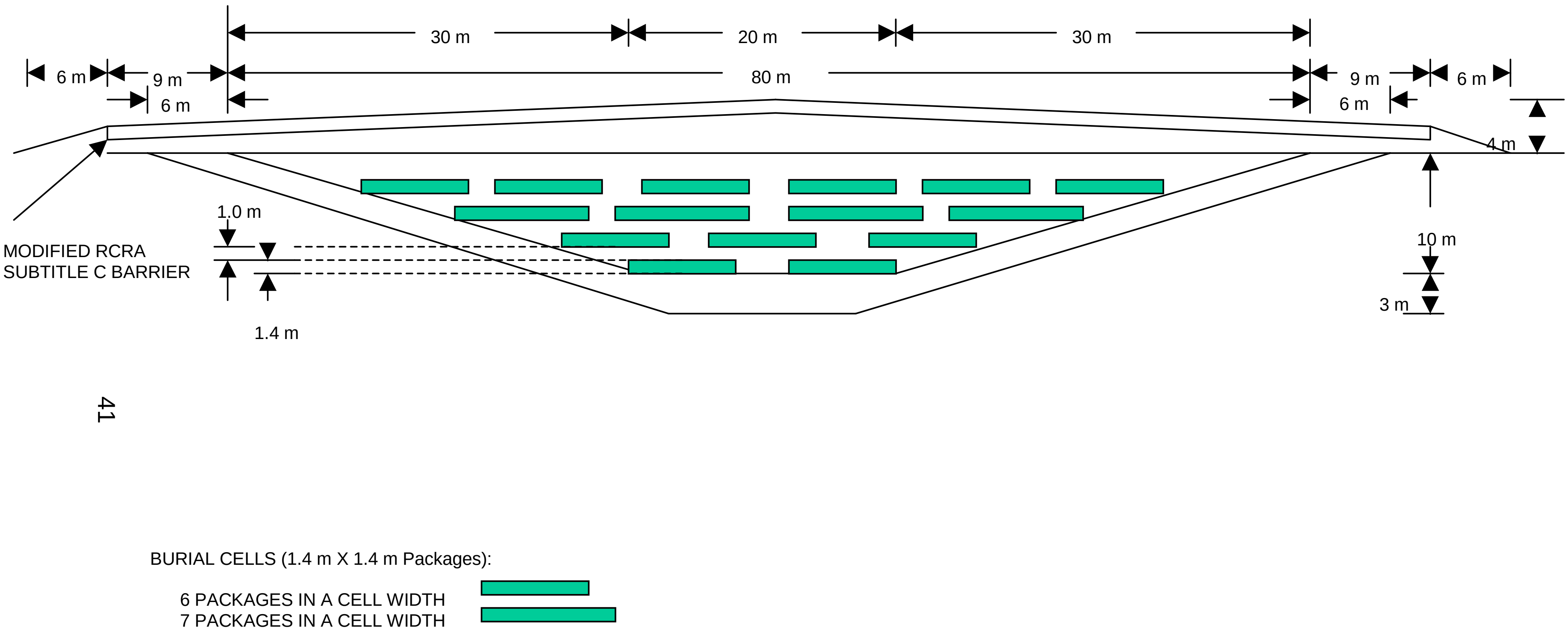


Figure 16. RH Trench Conceptual Model

RH TRENCH LINER SYSTEM DETAIL

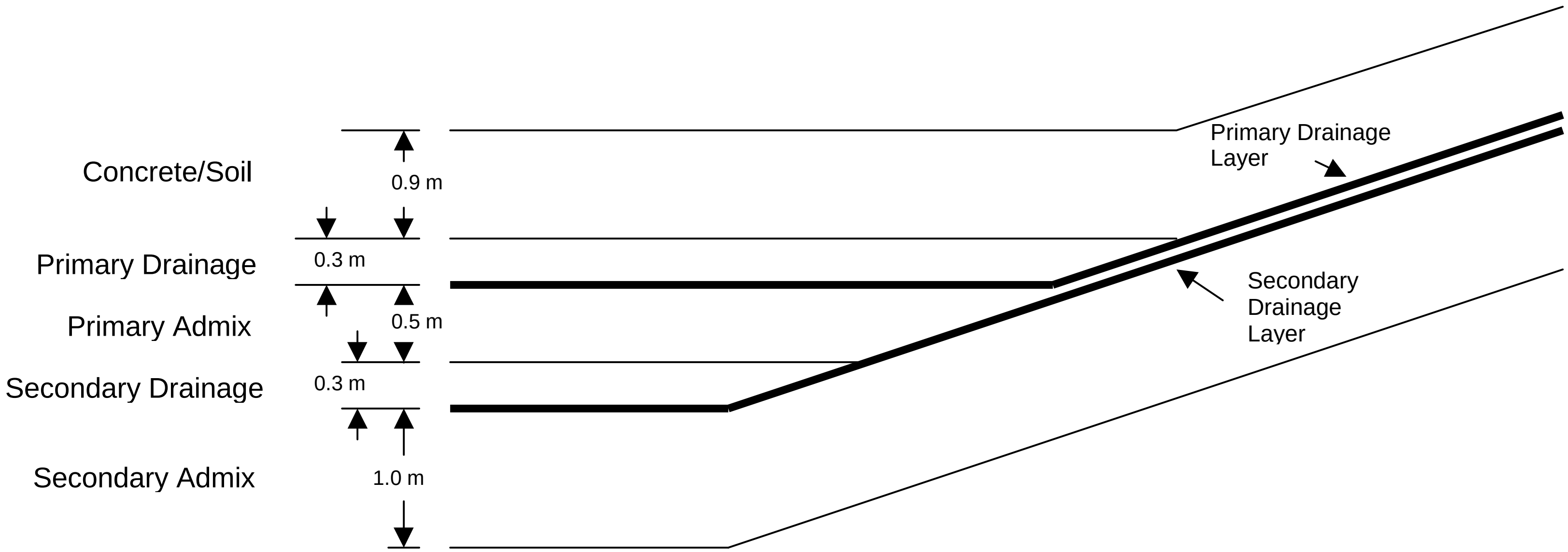


Figure 17. RH Trench Liner System Detail

RH TRENCH CONCEPTUAL MODEL LAYOUT

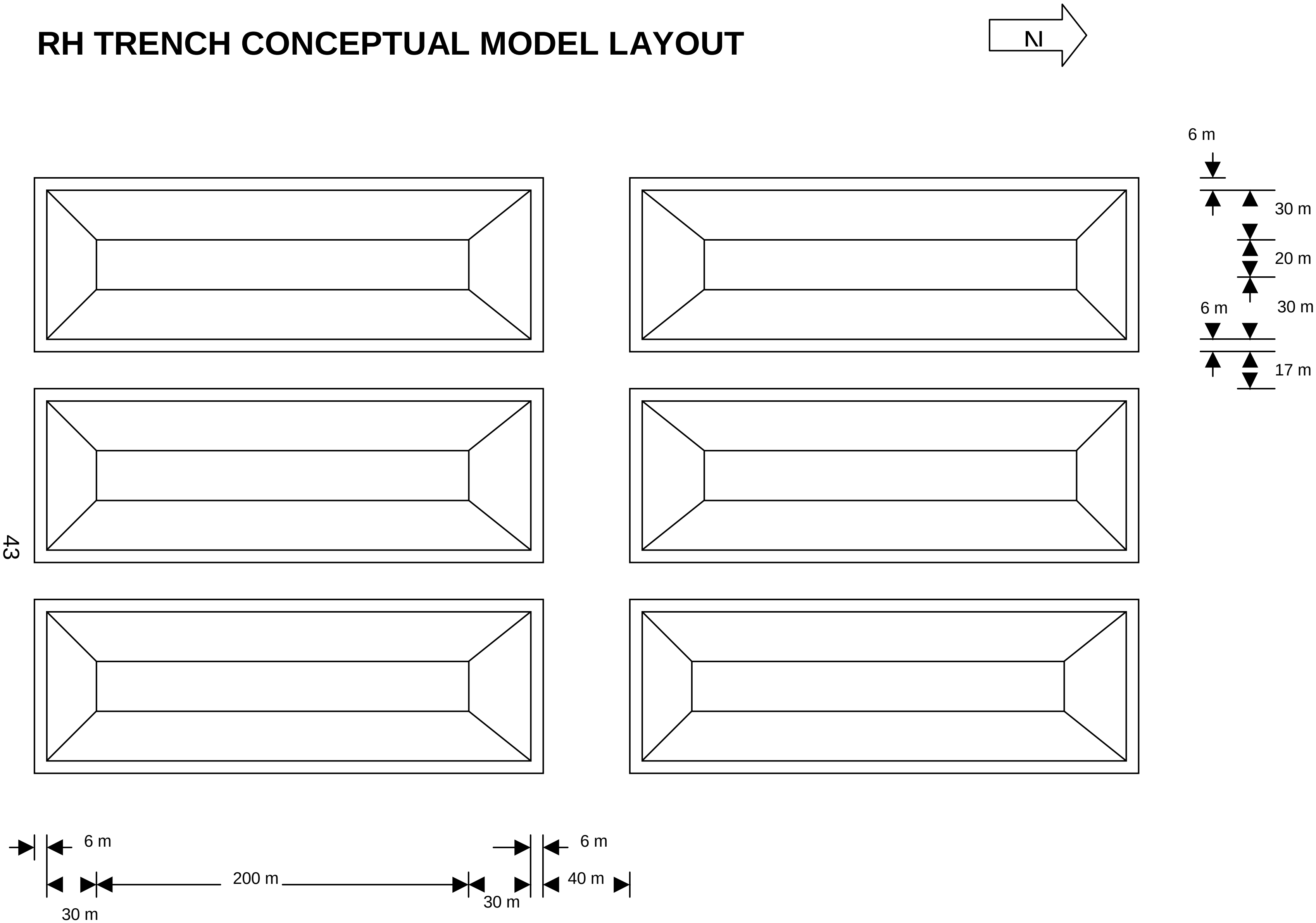


Figure 18. RH Trench Conceptual Model Layout

QUALITY ASSURANCE

Quality assurance for this report is provided through the following peer review process. A peer review plan was established that identified two technical reviews to be performed on the Facility Data Package for the Immobilized Low-Activity Tank Waste Performance Assessment. Fluor Federal Services (FFS) was responsible for an internal review of the document. The Numatec Hanford Company (NHC), Pacific Northwest National Laboratory (PNNL), and Bechtel Hanford Company (BHI) were responsible for the Hanford technical review of this document. NHC has subject mater experts on the facility design and the engineering studies that have been performed for the disposal facilities. PNNL has responsibility for the incorporation of the facility design into the modeling calculations for contaminant transport. BHI manages the Vadose Zone/Groundwater Integration Project and is responsible for assuring that appropriate data and models are used for Hanford risk assessments.

The Hanford reviewers, upon completion of their reviews, provided the author (R. Puigh) with written documentation of their comments. Acceptance of the comment resolutions was indicated by reviewers' signature on the Engineering Data Transmittal (EDT).

The peer review members were selected based on their experience and knowledge of specific subject areas. The internal peer review was provided by Raziuddin Khaleel. Dewey Burbank was chosen from NHC to provide the technical review. He was chosen based on his knowledge of the disposal facility design activities. Dr. B. McGrail and Philip Meyer from PNNL were chosen to appoint technical reviewers for the facility data report to assure the report contains all relevant information needed for the contaminant transport model calculations. Dr. Graham represents the point of contact for the review of the data package by the Hanford Site Vadose Zone/Groundwater Integration Project. Dr. Graham is responsible for appointing other Hanford technical experts as deemed necessary to review this data package.

Design data for the existing disposal vaults were developed under Westinghouse Hanford Company QA/QC procedures associated with design. The conceptual design data for the existing facility modifications and the new disposal facilities were developed under QA/QC practices for FDNW, Inc.