Application for Modification

Z-Area Industrial Solid Waste Landfill
Permit # 025500-1603

Vault 2 Construction
September 2007

Washington Savannah River Company, LLC
Savannah River Site
Aiken, SC 29808

SRS
savannah river site
TM

DHEC
PROMOTE PROTECT PROSPER

Application for Permit to Construct a Solid Waste Management System
Bureau of Land and Waste Management

Submit to: Division of Mining and Solid Waste Permitting, Bureau of Land and Waste Management
SC Department of Health and Environmental Control, 2600 Bull Street, Columbia, SC 29201-1708

(Please Print or Type)

I. Name of project: Z-Area Industrial Solid Waste Landfill, Permit #025500-1603

II. Physical location (Directions to project - use street names, county road numbers, etc.):
Savannah River Site, Intersection of Roads 4 & F County: Aiken

Latitude and longitude (nearest 15 seconds) or UTM coordinates:
UTM Easting 440335, 440377 UTM Northing 3685232, 3685202

III. In accordance with Title 44, Chapter 96 of the Code of Laws of South Carolina, 1976, as amended, I hereby make application, on behalf of the party(ies) whose name(s) appears below, for a permit to construct and operate the following type of solid waste management project (describe):
A Facility located in Z-Area at the U.S. Department of Energy - Savannah River Site used for disposal of Saltstone made from salt solution and dry materials.

IV. Facility name, mailing address: Z-Area Saltstone Disposal Facility, WSRC, Building 704-Z, Aiken, SC 29802, Attention: E. Patten
Telephone number: (803) 208-6206

V. Operator's name, mailing address (if different from name of facility owner): WSRC, Building 704-S, Room 22H Aiken, SC 29802, Attention: K. Liner
Telephone number: (803) 208-6466

VI. Landowner's name, mailing address (if different from name of facility or operator): U.S.DOE, PO Box A, Building 730-B, Room 245, Aiken, SC 29802, Attention A. Gould
Telephone number: (803) 952-9323

VII. I have placed my signature and seal upon the documents submitted with this application signifying that I accept responsibility for the information and/or design contained therein. Additional submittals where required will also bear my signature and seal, signifying that I accept responsibility for the information and/or design contained therein.

Engineer's name (print): William N. Kennedy   Signature: William N Kennedy
Registered Professional Engineer

S.C. Registration No: 20412

VIII. I have read this application and all attached documents. I agree to the requirements and conditions that are contained in it. Also, I agree to the admission of properly authorized persons at all reasonable hours for the purpose of sampling and inspection.

Name of Facility Representative (print): M.A. Lindholm   Signature: [signature]

Facility Representative's title: Manager, Liquid Waste Operations   Date: 9/24/07

Name of Operator Representative (print): E. Patten   Signature: Kevin E. Baker for
(If different from facility representative)

Operator Representative's title: Manager, Saltstone Facility   Date: 09-20-2007

Name of Landowner (print): J.M. Allison, Manager, SR   Signature: William F. Spader for
(if different from facility or operator representative)

Date: 10/5/07

DHEC 1932 (07/1997)

WSP-SSF-2005-00023
Revision 1

Application for Modification

Z-Area Industrial Solid Waste Landfill
Permit # 025500-1603

Engineering Report for Vault 2 Construction

UNCLASSIFIED
DOES NOT CONTAIN UNCLASSIFIED CONTROLLED NUCLEAR INFORMATION

ADC/RO R.M. Hoeppel / RM Hoeppel Date: 9/19/07
DWPF Ops Mgr

DISCLAIMER

LIST OF REVISIONS

Revision Number	Revision Date	Pages effected
0	6/2/2005	All
1	8/20/07	All

APPROVAL PAGE

Prepared By:	**Keith R. Liner** Environmental Engineer, Site Regulatory Integration and Planning	9/18/07 **Date**
Reviewed By:	**Phillip W. Norris** Saltstone Engineering, Waste Solidification Engineering, Liquid Waste Facility Operations	9/20/07 **Date**
Approved By:	Kevin E. Baker for **Elester Patten** Saltstone Facility Manager, Waste Solidification Operations, Liquid Waste Facility Operations	09-20-2007 **Date**

SOUTH CAROLINA REGISTERED PROFESSIONAL ENGINEER
No. 20412
WILLIAM N. KENNEDY

William N. Kennedy
9-25-2007

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1.0 LIST OF ACRONYMS

Acronyms	Definition
ALARA	As Low As Reasonably Achievable
ASTM	American Society for Testing and Materials
CETCO	Colloid Environmental Technologies Company
CBU	Closure Business Unit
CPT	Cone Penetration Test
CROM	The Crom Corporation
cm	Centimeter
DOE	Department of Energy
g	Acceleration of gravity exerted on a body at rest
GCL	Geosynthetic Clay Liner
GSA	General Separations Area
GSE	GSE Lining Technology, Inc.
HDPE	High Density Polyethylene
ISWLF	Industrial Solid Waste Landfill
mil	Unit of length equal to one thousand of an inch
NRC	Nuclear Regulatory Commission
ppm	Parts per million
SCDHEC	South Carolina Department of Health and Environmental Control
SDF	Saltstone Disposal Facility – (Solid Waste Landfill)
sec	Unit of time equal to a second
SFT	Salt Feed Tank

SPF	Saltstone Production Facility – (Industrial Wastewater Treatment Facility)
SRS	US Department of Energy - Savannah River Site
WSRC	Washington Savannah River Company

2.0 INTRODUCTION

This information is being submitted to the South Carolina Department of Health and Environmental Control (SCDHEC) in support of a request for modification of the Savannah River Site (SRS) Z-Area Industrial Solid Waste Landfill (ISWLF) Permit #025500-1603 (formerly SCDHEC Permit # IWP-217) to construct a new vault within Z Area. The new vault, Vault 2, will be constructed and operated according to the design included within this modification package.

The Vault 2 design has been changed based on construction and operation of Saltstone Vaults 1 and 4. The Vault 2 basic design consists of cylindrical tanks, built in pairs, approximately 150 feet in diameter and 22 feet tall. The cylindrical tanks will be constructed of pre-cast Class III sulfate resistant concrete mix panels that will be erected on a poured in place Class III sulfate resistant concrete mix base slab. The major portion of Vault 2 will be encased in a High Density Polyethylene (HDPE) and Geosynthetic Clay Liner (GCL) system. Vault 2 is being designed in accordance with the Class 3 ISWLF requirements found in R.61-107.16, "Solid Waste Management: Industrial Solid Waste Landfills." At this time, it is the intent of SRS that a number of vaults be constructed according to the concept and design contained within this permit modification package to support salt solution waste disposal within Z Area.

Note: The final design drawings and dimensions are contained within this Engineering Report and drawings contained in Attachment #11. Some attachments may show different dimensions than that of the final design. These dimensions were used for preliminary work and are bound by the final design parameters found in the Engineering Report and drawings contained in Attachment #11.

3.0 SALTSTONE FACILITY PROCESS SUMMARY

The Saltstone Production Facility (SPF) immobilizes salt solution by blending it with a dry material mixture consisting of cement, slag, and flyash to form a grout. The grout is pumped to the Saltstone Disposal Facility, (SDF) which are large storage and disposal vaults, where it is allowed to harden into a concrete like non-hazardous solid waste form called saltstone. (See Attachment #1)

4.0 PROPOSED MODIFICATION

4.1 Vault Location (SCDHEC R.61-107.16.13, 16.14, 16.15, 16.81, 16.42.g and h)

Vault #2 is to be constructed in Z Area (See Attachment #2) for disposal of salt solution after treatment at the SPF.

Cone Penetration Tests (CPTs), geotechnical boreholes, test pits, and laboratory testing was performed at the footprint of Vault 2 to a depth of over 100 feet below the surface. Subsurface conditions were characterized and soil properties were determined using site-specific data as well as existing data from surrounding areas (References 3,5,7-11). The results of the Geotechnical Investigation Report are contained in Reference 5, a portion of which is included as Attachment #3. Attachment #3 contains the Geotechnical Investigation Report only, see Reference 5, Appendix A-G for field data.

The number of subsurface explorations conducted at the footprint of Vault 2 was based on past experience from subsurface explorations in the General Separations Area (GSA) of SRS, which includes F Area, H Area, J Area, and S Area; as well as Z Area, where Vault 2 will be located. Attachment #3, Section 2.0 contains a detailed description of the number and type of subsurface explorations conducted at the footprint of Vault 2.

The stratigraphy at the Vault 2 project site is similar to the GSA. Attachment #3, Section 3.0 and Table 2 contains a detailed description of the stratigraphy at the Vault 2 site. Using nomenclature developed for the GSA at SRS, the stratigraphy includes an Upland Formation, Tobacco Road Formation, Dry Branch Formation, Santee/Tinker Formation, and Warley Hill Formation. Also included in Attachment #3, Table 2 is the designation of the strata using the Mueser Rutledge Consulting Engineers nomenclature which ranges in classification from Upper S1 to M1. The Vault 2 project site ranges from clayey fine sand to hard clayey silt. (See Attachment #3, Table 2).

Across SRS, the soil from approximately 100 to 250 feet below the ground surface is a marine deposit laid down during the Middle Eocene epoch, which occurred about 35-50 million years ago. These sediments occur within the Lower Dry Branch Formation and the Santee/Tinker Formation at the Vault 2 project site. Often found within these sediments are weak zones interspersed in stronger matrix materials. These weak zones which vary in thickness and lateral extent have been termed "soft zones." See Attachment #3, Section 3.3 for a complete description of soft zones.

As discussed above the soft zones vary in thickness and lateral extent. Soft zones are evaluated using three steps: (1) Using CPT data, identify all soft zones regardless of the thickness. (2) Verify the soft zones identified in Step 1 with boring and laboratory data, (3) if all the soft zones are less than 2 feet thick, soft zone settlement will be insignificant and will not be computed. If any of the soft zones is over 2 feet thick, settlement will be computed. For the Vault 2 project site, some of the soft zones are over 2 feet thick; therefore, the settlement is computed. The settlement was computed based on a 14-foot thick soft zone. Any soft zones less than 14 feet thick; such as 0.4, 0.5, 0.8, 0.9, 1.5, 1.6, and 2.6 feet (Reference 5, Appendix A, Sheet 10, Table 9) will have less settlement and therefore were not computed.

The Vault 2 project site soft zone is conservatively assumed to be a huge rectangular block, 14 feet thick, 150 feet wide and infinitely long. If geo-statistics was used, the resulting shape of the soft zone will be a combination of two circular cones, one above and one upside down immediately below, with tip to tip thickness of 14 feet. The diameter of the cones is interpolated between adjacent CPTs and is several times smaller than 150 feet. Furthermore, based on the results in the surrounding areas including GSA areas J, S, and Z, a soft zone 14 feet thick is the upper bound, among all the 76 known soft zone thicknesses, and is four feet thicker then the second thickest soft zone ever found in the GSA. Based on the above explanation, the assumed soft zone configuration is very conservative.

Differential settlement of Vault 2 is not anticipated to be a problem due to the fact that the overburden is being removed over the compacted soil, which is being replaced with content that is lighter in density. Approximately 10 to 20 feet of soil is being removed from the Vault 2 project site to place the tanks. During construction, the Vault 2 tank structure will produce very small loads on the soil with the tank empty (See Attachment #7, page 9 of QB00485K-007-B-MDM). During operation, the saltstone specific gravity is lighter than the soil removed, so that the load on the soil at the tank foundation is comparable to the soil weight prior to excavation. Therefore, settlement at this point is insignificant with regards to the structure of the tank. The future soil cap will be installed after the Saltstone has solidified. At the time that the tank is full, the solid saltstone will act monolithically, producing very small impact to the structural stresses of the foundation slab and walls due to settlement. The impact to the tank component stresses due to long-term differential settlement is insignificant since the structure imposes uniform loads on the soil and the full tank will behave monolithically.

4.1.1 Fault Areas (SCDHEC R.61-107.16.13)

The Vault 2 project site is not located within a fault area. The Vault 2 project site was evaluated in Attachment #3 and Reference 5 and there are no faults at the project site that have had displacement in Holocene time at SRS.

4.1.2 Seismic Impact Zones (SCDHEC R.61-107.16.14)

The Vault 2 project site is not located in a seismic impact zone. The dynamic settlement and post closure slope stability were evaluated in Attachment #3, Sections 5.3 and 5.4 and the supporting appendices using both the 2,500 year earthquake and the 1886 Charleston earthquake as design earthquakes. The Vault 2 project site is not subject to significant liquefaction and the static and pseudo slope stability analyses show the assumed post-closure condition is stable. The results of the analysis were found to be acceptable.

Note: Reference 5 Appendix G uses a rectangular vault design to calculate slope stability. The slope stability analyses are performed considering sections perpendicular to the slope that passes through the vault. For slope stability in a cylindrical vault, sections passing through different locations of the vault were evaluated. Attachment #10 schematically shows the sections at some of the locations. These sections represent the soil stratum as well as the cross-sections of the vault at specific locations. For each section, the cross-sectional area of the vault is in the shape of a rectangle with the height equal to the height of the vault and the width ranging between 0 and the diameter of the vault.

For example, consider the cylindrical vault in Attachment #10 is 22 feet high and 150 feet in diameter. Section A passes through the center of the vault which cuts 22-feet-high by 150-feet-wide cross-section of the vault. Section Z passes through the edge of the vault which cuts 22-feet-high by 0-feet-wide cross-section of the vault. Sections between Section A and Section Z cut 22 feet high by 0 to 150-feet-wide cross-sections of the vault.

As indicated in Reference 5, Appendix G, the concrete vault and the saltstone are much stronger than the surrounding soils. Therefore, if the vault is located at the failure surface, the factor of safety for the soil stability will be increased. The more area that is occupied by the vault, the higher the factor of safety of the slope. Consequently, Section A has the high factor of safety while Section Z has the lowest factor of safety. Note that for the vault located away from the failure surface, the factor of safety will not be affected.

Reference 5, Appendix G; Sheet 7A, Table 2, Case 10; Sheet 28E, Figure 23; and Sheet 28F, Figure 24 show that for the case of Section Z, where the width of the vault is zero, or the vault does not exist, the factor of safety is 1.3. Since this is the lowest factor of safety for all the sections, slope contains cylindrical vault provides a sufficient factor of safety.

4.1.3 Unstable Areas (SCDHEC R.61-107.16.15)

The Vault 2 project site is not located in an unstable area. Static settlement was estimated for the times immediately after operation is completed, immediately after the closure cap is completed, and 30 years after closure cap is completed. Settlement 30 years after the closure is estimated to be an average of 9 inches and a maximum of 18 inches. (Reference 5, Appendix E, Sheet 13). Subsequent additional settlement more than 30 years after the closure will be insignificant. Dynamic settlement includes settlement due to liquefaction and partial liquefaction, as well as settlement due to compression of soft zones. The estimated maximum dynamic settlement and estimated maximum differential dynamic settlement is ½ inch. The estimated static and dynamic settlements were found to be acceptable.

4.2 Vault Seismic Stability Analysis (SCDHEC R.61-107.16.42.g and h)

Vault 2 is designed for seismic loads in combination with concurrent service and environmental loads with the following factors S_s- 0.6g and S_1 - 0.2g. Vault 2 is designed to prevent damage to the structure from a seismic event during filling with grout. Seismic restraint cables are installed in accordance with Attachment #11, Document Number 06059, sheet 12 of 13 in order to carry seismic loads. The inertia loads acting in the lateral direction on Vault 2 are not a factor during filling or once full due to the fact that it is designed in accordance with the above specifications and it is buried in the ground.

The vendor calculation (Summary included in Attachment #7) used the design parameters of the Vault 2 project site's existing soil and seismic loads as input for the seismic calculations. Page 2 and 3 of the Crom Corporation's (CROM) submittal QB00485K-007-B-MDM (See Attachment #7) show the seismic loads used and the soil allowable bearing pressure. Page 9 of the same calculation (See Attachment #7) shows the results for various load combinations that were compared to the allowables for soil, concrete and reinforcement. The final results show foundation checks for sliding, overturning and bearing. The calculations show that the required Safety Factors were met.

4.3 Water Table (SCDHEC R.61-107.16.42.j)

The historically high water table in the area of Vault 2 construction is 238.2 to 241.5 feet above mean sea level (Reference 4). The vault floor will be at an elevation of approximately 268 feet above mean sea level.

At worst case the base of the vault is 26.5 feet above the historically high water table. Therefore, the requirement that the vault floor be separated by a minimum of two (2) feet from the historically high water table, as required by SCDHEC R.61-107.16.42.j, is satisfied.

See Attachment #11 Sketch A for a cross-sectional summary of the groundwater elevations in relation to the Vault 2 elevation and Attachment #11, *WSRC-TR-2005 00131, Figure 2- Configuration of the Long Term Average Water table Near the SDF* for a contour map showing the historical water table levels.

4.4 Vault ISWLF Classification (SCDHEC R.61-107.16.4. and 16.5)

Based on past sampling of the salt solution to be disposed of in Vault 2 (Reference 2), a Class 3 ISWLF, as defined by SCDHEC regulation R.61-107.16.5, is required. As such, the vault shall be operated and constructed in accordance with the Class 3 ISWLF design criteria found in SCDHEC regulation R.61-107.16. Specifics of the vault design are described within this section.

4.5 Vault Basic Construction (SCDHEC R.61-107.16.42)

The basic construction of Vault 2 consists of a reinforced Class III sulfate resistant concrete mix floor and prestressed Class III sulfate resistant concrete mix walls manufactured by CROM. The main components of the prestressed walls consist of pre-cast Class III sulfate resistant concrete mix, a steel shell diaphragm, reinforcing bars, prestressing wires and shotcrete. A steel shell diaphragm is being erected around the pre-cast Class III sulfate resistant concrete mix panels which will continuously extend the height of the tank. The steel diaphragm has no horizontal joints. The vertical joints, which connect the steel panels of the diaphragm, are sealed watertight by polysulfite material injection. Vertical reinforcing bars are installed to resist bending moments, shrinkage, and temperature stresses. High strength prestressing wires are installed around the vault, which are tightened to design specifications. Vault wall pre-stressing is designed to carry the vault's hydraulic load and to help facilitate the vault walls being in compression. Shotcrete is used during various stages of the vault construction to protect the reinforcing bars and prestressing wires. The reinforcing steel, prestressing wire, and steel shell diaphragm are all of carbon steel construction. Carbon steel construction is acceptable due to the fact that the waste to be disposed of in Vault 2 will not come into contact with the carbon steel components due to the Class III sulfate resistant concrete mix design.

4.6 Vault Concrete Specification (SCDHEC R.61-107.16.42)

The waste stream to be disposed of in Vault 2 is high in sulfates, which can attack hardened concrete. Due to the high sulfate nature of the waste stream that will be disposed of in Vault 2, its floor, walls, and roof are being constructed with a Class III sulfate resistant concrete mix. The sulfate resistance concrete will meet the specification found in American Concrete Institute Standard 201, Section 2.2. Sulfate resistant Class III concrete mix is designed to retard the ingress and movement of water. Pozzolans and slag are added to the cement to reduce the water to cementitious materials ratio. These additives attract the water molecules before they reach the vault exterior. In addition, the vault walls are constructed with wire prestressing and the exterior is backfilled, which allows the walls to be under compression, which further minimizes water penetration into the walls. Testing is currently in progress to demonstrate an expansion of less than or equal to 0.1% in accordance with ASTM 1012 which is used to demonstrate the sulfate resistance of concrete.

4.7 Vault Floor (SCDHEC R.61-107.16.42.a, b and l)

The existing grade will be excavated for the vault floor. The vault floor will consist of the components as shown in Attachment #11, Document Number 06059, sheet 13 of 13.

A circular mud mat approximately 4 inches thick will be constructed on the compacted grade.

A GCL will be laid out over the lower mud mat. The GCL consists of "bentonite sandwiched between two geotextiles." Bentonite, the hydraulically functional portion of a GCL, is the general term given to a swelling type montmorillonite clay which formed as the stable alteration product of volcanic ash. Bentonite is expected to remain mineralogically and chemically stable.

A 100-mil HDPE liner with hermetically sealed joints will be spread out on top of the GCL. The HDPE liner will be installed in direct and uniform contact with the GCL. The HDPE liner has been selected to be chemically and physically resistant to the salt solution waste stream. The 100-mil HDPE liner exceeds the 60-mil HDPE liner required by the Class 3 ISWLF requirements. The HDPE/GCL installation details are discussed in Section 4.10 and are included in Attachment #5.

A second circular mud mat approximately 4 inches thick will be poured on top of the GCL/HDPE in order to protect the GCL/HDPE during construction.

A circular Class III sulfate resistant concrete mix concrete tank base will be poured in place with a minimum thickness of 8 inches. The saturated hydraulic conductivity of the concrete will generally range from $1.0x10^{-08}$ to $1.0x10^{-13}$ cm/sec, it is anticipated that the Class III sulfate resistant concrete mix utilized for the base slab will have a saturated hydraulic conductivity of at least $1.0x10^{-10}$ cm/sec, which exceeds the saturated hydraulic conductivity of $1.0x10^{-07}$ cm/sec required by the Class 3 ISLWF regulations.

The GCL/HDPE base liners will be hermetically sealed to the same system that will be installed on the vault walls as shown in Attachment #11, Document Number 06059, sheet 13 of 13. Lean Class III sulfate resistant concrete mix will be used to fill the voids and relieve stresses from the liner system around critical areas.

As shown, the vault floor described meets and exceeds that required by SCDHEC R.61-107.16.42.a, b and l.

4.8 Vault Walls (SCDHEC R.61-107.16.42. a, b and l)

The vault walls will be constructed of pre-cast Class III sulfate resistant concrete mix panels approximately 8 inches thick. (See Attachment #11, Document Number 06059, sheet 6 of 13) The Class III sulfate resistant concrete mix wall joints will be sealed using grout up to the thickness of the panel. (See Attachment #11, Document Number 06059, sheet 8 of 13)

The saturated hydraulic conductivity of the concrete will generally range from $1.0x10^{-08}$ to $1.0x10^{-13}$ cm/sec, it is anticipated that the Class III sulfate resistant concrete mix utilized for the vault wall panels will have a saturated hydraulic conductivity of at least $1.0x10^{-10}$ cm/sec, which exceeds the saturated hydraulic conductivity of $1.0x10^{-07}$ cm/sec required by the Class 3 ISLW regulations.

A continuous steel shell diaphragm will be installed surrounding the pre-cast Class III sulfate resistant concrete mix panels. The steel shell wall joints will be sealed watertight by injecting with a polysulfite material from the bottom to the top. (See Attachment #11, Document Number 06059, sheet 8 of 13)

Vertical reinforcing bars will be installed outside of the steel shell, which will be covered by shotcrete.

Prestressing wires will be installed around the circumference of the vault wall. The wires will be tensioned in accordance with the prestressing schedule. (See Attachment #11, Document Number 06059, sheet 7 of 13). The prestressing wires will be covered for protection.

The vault will have a number of inside columns which are used to support the roof. Typical column spacing and construction is shown on Attachment #11, Document Number 06059, sheet 2 of 13, sheet 3 of 13, and sheet 6 of 13.

The HDPE/GCL liner system that is beneath the tank base will be hermetically sealed to an identical liner system that will surround the vault walls. The HDPE liner will extend the entire height of the tank. The GCL liner will be discontinued approximately 2-4 feet above the base of the tank. GCL installation will be resumed on the vault roof as described below.

The vault will be approximately 22-feet high and 150-feet in diameter. Backfill as described in Section 4.17 will be added around the vault walls.

As shown, the vault wall described meets and exceeds that required by SCDHEC R.61-107.16.42.a, b and l.

4.9 Vault Roof (SCDHEC R.61-107.16.42. a, b and l)

A roof will be formed and poured in place with a minimum thickness of 8 inches. The roof will be constructed with a minimum slope of 2% to allow adequate stormwater runoff.

The saturated hydraulic conductivity of the concrete will generally range from $1.0x10^{-08}$ to $1.0x10^{-13}$ cm/sec, it is anticipated that the Class III sulfate resistant concrete mix utilized for the vault roof will have a saturated hydraulic conductivity of at least $1.0x10^{-10}$ cm/sec, which exceeds the saturated hydraulic conductivity of $1.0x10^{-07}$ cm/sec required by the Class 3 ISLW regulations.

Roof penetrations will be available for ventilation, thermocouple trees, closed circuit television, and closure capping, (see Attachment #11, Document Number 06059, sheet 4 of 13, sheet 5 of 13, sheet 9 of 13, sheet 10 of 13, and sheet 11 of 13).

The roof penetrations will be sealed in a manner to prevent rain infiltration using neoprene gasket material. After the vault is filled the roof mounted items will be removed and the penetrations will be filled in a manner that makes them equivalent to the rest of the Class III sulfate resistant concrete mix.

The HDPE/CGL liner system will be extended over the vault roof prior to installation of the closure cap over all the Z-Area vaults.

As shown, the vault roof described meets and exceeds that required by SCDHEC R.61-107.16.42.a, b and l.

4.10 Liner Installation Details (SCDHEC R.61-107.16.42. a, b and l, 16.90)

The Vault 2 liner will consist of a HDPE and GCL system. The GCL consists of "bentonite sandwiched between two geotextiles." Bentonite, the hydraulically functional portion of a GCL, is the general term given to a swelling type montmorillonite clay which formed as the stable alteration product of volcanic ash. Bentonite is expected to remain mineralogically and chemically stable.

A 100-mil HDPE liner with hermetically sealed joints will be spread out on top of the GCL. The HDPE liner will be installed in direct and uniform contact with the GCL. The HDPE liner has been selected to be chemically and physically resistant to the salt solution waste stream. The 100-mil HDPE liner exceeds the 60-mil HDPE liner required by the Class 3 ISWLF requirements.

The manufacture, shipment, and installation of the HDPE/GCL liner shall be in accordance with an approved and authorized dealer and installer of GSE Lining Technology, Inc. (GSE) products. Attachment #5 contains the plans and specifications for the GCL/HDPE installation. Specific items included in Attachment #5 are:

Document Number	Document Title
QB00485K-022A-MDM	Certification that authorized dealer and installer is certified by GSE products
QB00485K-023A-MDM	GSE Lining Technology, Inc. - Recommended Handling and Storage Procedures
QB00485K-024A-MDM	GSE Geomembranes – Manufacturing Quality Assurance Manual
QB00485K-025A-MDM	GSE Geomembranes – Installation Quality Assurance Manual
QB00485K-026A-MDM	Field Test Log Sheets
QB00485K-027A-MDM	HDPE/GCL Layout Details
QB00485K-030A-MDM	GCL Certification Example
QB00485K-031A-MDM	Colloid Environmental Technologies Company (CETCO) GCL Construction Quality Assurance Manual
QB00485K-032A-MDM	CETCO GCL Manufacturing Quality Assurance and Quality Control Manual
QB00485K-033A-MDM	Bentomat Claymax Installation Guidelines

4.11 Vault 2 Interior Coating

Vault 2 may be coated with an interior waterproof coating or barrier that is being applied to minimize the primary degradation mechanism of the Vault 2 concrete, which is sulfate attack from the saltstone grout. The sulfates are inherent in the salt solution waste stream that is mixed with dry materials to form grout by the SPF. The interior waterproof coating design will be an industrial coating/barrier system that provides greater than just short-term protection to the concrete. It is important to note that the interior coating is not required per the SCDHEC ISWLF regulations.

4.12 Vault HELP Modeling (SCDHEC R.61-107.16.42)

Preliminary groundwater modeling was performed based on conceptual design requirements of the Vault 2 design consisting of a 4 inch mud mat, 8 inch base, 8 inch wall, and 8 inch roof, all of which is surrounded by a HPDE/GCL diffusion barrier. The groundwater modeling report and input documents are included as Attachment #4. The report summarizes the results that show with proper selection of materials and vault dimensions the Vault 2 nitrate concentrations to the groundwater are expected to remain below the Maximum Contaminate Level of 10 parts per million (ppm) for a 10,000 year period.

4.13 Vault Leachate (Drain Water) Collection (SCDHEC R.61-107.16.42.c-f, h(3) and p)

A leachate collection system is required in typical landfill construction to carry away rainwater from storm events. As discussed above, the roof and roof penetrations will be designed to be water tight. The roof will be sloped to allow stormwater runoff. The design and construction of Vault 2 is such that rainwater infiltration is not expected. For these reasons a typical leachate collection system is not required for the Vault 2 design, however, excess water can be introduced into Vault 2 from bleed and process water. In order to manage the bleed and process water inventories in Vault 2, a drain water collection system will be installed, similar to that shown in Attachment #9. The materials for the drain water collection system will be similar to those used for the drain water collection system in Vault 4. The bleed and process water collected by the drain water collection system will be pumped from Vault 2, back to the Salt Feed Tank (SFT), located in the SPF. In accordance with the approval for installation of the Vault 4 sheet drain system (Letter Gill (SCDHEC) to Liner (WSRC) dated 5/14/2003) SCDHEC will be notified if any changes are made from the basic Vault 4 design materials or the installation shown in Attachment #9.

It should be noted that Vault 2 is designed to carry the hydrostatic load inside and outside of the tank as well as any overburden loads after filling. As such, the sheet drain system installed in Vault 4, for structural concerns and prevention of cracks, is not required in Vault 2. The drain water collection system is being installed in Vault 2 to manage the bleed and process water introduced into Vault 2.

Although the Vault 2 drain water collection system is not subject to the design criteria for a typical leachate collection system, the design complies with the requirements found in R.61-107.16.42 for a leachate collection system (i.e. no more than one (1) foot of hydraulic head on the liner system resulting from a 25-year, 24 hour storm event) for the following reasons:

(1) Vault 2 will be constructed with a concrete roof sloped at 2% (minimum) that will shed the rainfall from a 25-year, 24-hour storm event during the active life of the facility. Upon closure, the facility will be capped with a liner system consisting of HDPE and soil that will shed any stormwater.
(2) As described in this section, Vault 2 will have a drain water collection system which will remove the free liquid inventory from inside of the Vault 2 cells.
(3) Vault 2 is a watertight enclosure and as such, any free liquid inventory will be contained within the Vault 2 cells and will not escape to accumulate on the liner system.
(4) The bleed and process water collected by the drain water collection system will be returned to the SFT in the SPF for processing.
(5) Extensive pilot testing of the drain water collection system prior to installation in Vault 4 showed that it removes excess water without clogging. (Reference 12)

4.14 Vault Leak Detection System (SCDHEC R.61-107.16.42)

A leak detection system will not be installed in Vault 2. Vault 2 is certified to be watertight for a period of ten years. The Class III sulfate resistant concrete mix specification and design is resistant to the ingress of water due to the formulation. The Class III sulfate resistant concrete mix is designed to retard the ingress and movement of water. Pozzolans and slag are added to the cement to reduce the water to cementitious materials ratio. These additives attract the water molecules before they reach the vault exterior. In addition, the vault walls are constructed with wire prestressing and the exterior is backfilled, this allows the walls to be under compression, which further minimizes water penetration into the walls. In addition, the time that any liquid is present in the vault is minimal. For these reasons a leak detection system will not be installed in Vault 2. A liner system will be installed as described above to minimize any impact of contaminants to the environment. If contaminants should escape to the environment a series of monitoring wells are installed downstream of Vault 2 for detection.

4.15 Operating Protocol

Currently there are no plans to fill the Vault 2 cells simultaneously, but future plans could change this protocol. The differential settlement discussed in Attachment #3, Section 5.2.4 that may occur when one of the Vault 2 cells is being filled and the other remains empty is very small. Each Vault 2 cell is constructed on its own foundation, which allows each to independently settle. The only physical tie between the Vault 2 cells is the grout transfer line and the drain water collection line (See Attachment #11, drawings P-PA-Z-00017, C-CH-Z-00012). Any differential settlement that occurs due to the filling of one Vault 2 cell at a time is minimal and will not affect the empty Vault 2 cell due to the above design considerations.

4.16 Settlement Monitoring (SCDHEC R.61-107.16.42.i)

Four settlement monitoring markers per the Vault 2 cells will be installed, monitored and recorded per the SRS Site Guidelines, which includes periodic monitoring during construction and operation. The installation of the settlement markers will be on top of mudmats during the initial phase of Vault 2 construction. During the final phase of Vault 2 construction new markers will be installed on the Vault 2 cell roofs prior to backfill. The settlement markers on the Vault 2 cell roofs will continue settlement monitoring during operation and thereafter, with the results being evaluated periodically.

In addition, benchmark monuments are located at the Vault 2 project site as show in Attachment #11, Drawing C-CG-Z-00026 for horizontal and vertical elevation control.

4.17 Exterior Wall Backfill (SCDHEC R.61-107.16.42.m)

Backfill will be added around the vault walls to an elevation of approximately 290 feet above mean sea level (See Attachment #11 Sketch A) using the native soil excavated as part of vault construction and spoil piles from previous vault construction prior to the first receipt of saltstone grout into the Vault 2 cells. The final grade of the slope will be 0.5%

to ensure proper stormwater runoff. (See Attachment #6 and 11, Drawings C-CG-Z-00030) The backfilled area will be seeded and planted as necessary to minimize erosion from stormwater runoff. Stormwater will be collected and discharged in accordance with the Z-Area general stormwater discharge permit. It should be noted that the soil used for backfill is native soil only and is not intended to be structural fill.

4.18 Vault Grout Transfer Lines

A grout line will be installed from the Saltstone Production Facility to Vault 2. Appropriate pipe supports will be installed along the grout line run. The grout line will be equipped with a three-way valve that will allow the grout to be pumped to Cell 2A or 2B upon reaching the Vault 2 site. The grout line may be shielded for radioactivity using pre-cast interlocking concrete blocks and lead pipe wrap. The grout line shielding requirements may be revised if waste lower in radioactivity is sent to Vault 2 in the future. (See Attachment #11, drawings P-PA-Z-00017, C-CH-Z-00012).

4.19 Vault Thermocouple and Camera Installation

Thermocouples will be installed in Vault 2 for grout temperature monitoring. Two sets of 2 thermocouple trees, total of 4, will be installed in Vault 2. The sets of thermocouples will be located at the center of Vault 2 180 degrees apart.

Video cameras will also be installed in Vault 2 to monitor grout pouring. Video camera output will be available in the Z-Area central control room (See Attachment #11, Document Number 06059, sheet 4 of 13, sheet 5 of 13, and J-J5-Z-00007).

4.20 Vault 2 Portable Ventilation

As previously described and approved for use in Vault 4 (SCDHEC approval letter Litton to Liner, 2/15/07) a portable ventilation system may be used to exhaust the Vault 2 tanks of any flammable vapors at predetermined grout heights. The portable ventilation system is only expected to be used to exhaust the vault tanks during grout non-pouring periods. Ventilation will only be required if flammable gases are found to be at or above their Lower Flammability Limits. Actual levels of flammable gas concentrations will be measured at Vault 4 during initial Modular Caustic Side Solvent Extraction Unit startup runs which will be completed before Vault 2 operations. The portable skid is expected to consist of a fan, moisture separator assemblies, a heater/HEPA assembly, and instrumentation/controls that allow monitoring of flow rate and differential pressure across the heater/HEPAs. Vault air exhausted by the portable ventilation system will be humid due to natural environmental conditions within the vault. Moisture separator assemblies will be used to remove excess water vapor from the vent stream. It is important to note that the water vapor is being condensed and removed from the ventilation exhaust air only as a means to protect the HEPA filters. The same water vapor naturally condensed in the vault during previous grout pouring operations. A portion of the condensate will be removed by a moisture separator installed on the portable ventilation connection on the roof of the vault tanks. This condensate will drop by gravity into the vault tank. The condensate will either be hydrated into the curing grout or will be collected by the vault drain water return (leachate) system, where it will be returned to the SFT in the SPF for processing. The ventilation system design may include additional features required to handle any excess water vapor condensing in the ductwork downstream of the moisture separator. Any collected condensate will be returned to the SFT in the SPF for processing.

4.21 Vault Utilities

The vault will be supplied power via overhead power lines. Power will be used for lighting and instrumentation loads. Vault 2 will require no additional utilities such as water and sewage.

4.22 Vault Stormwater Details (SCDHEC R.61-107.16.26, 16.42.m, 16.88)

The Vault 2 construction site covers approximately 14 acres. The 14 acre Vault 2 construction site comprises only 25 % of the 55 acre local drainage area. Stormwater management measures will be installed to maintain post-development rates essentially the same as pre-development discharge rates. Stormwater measures will be implemented in two phases. During phase one measures will be installed to control erosion and sediment during the construction phase. At the completion of construction, phase two measures will be implemented which will grade the site to its final elevation which will direct surface runoff into existing perimeter vegetated drainage ditches. The Stormwater Pollution Prevention Plan for the Z-Area Disposal Site Vault 2 is included as Attachment #6. This document will be revised, as necessary, during Vault 2 construction.

4.23 Vault Closure Plan (SCDHEC R.61-107.16.60, 16.94)

Vault 2 will be closed in accordance with the closure concept contained in the Closure Plan Engineering Report previously submitted. (Reference 13) A final closure plan will be submitted at a later date.

4.24 Groundwater Monitoring Plan (SCDHEC R.61-107.16.53, Subpart E)

The Groundwater Monitoring Plan was previously submitted. The plan has been prepared in accordance with SCDHEC regulations and past guidance. The Groundwater Monitoring Plan has been found acceptable by a South Carolina registered Professional Geologist knowledgeable of groundwater regulatory requirements. The Groundwater Monitoring Plan has been duly stamped and signed. (See Attachment #8)

4.25 Vault Design and Structural Summary

The soil properties from the SRS Geotechnical Report (Reference 5) were evaluated for determining the best location for construction of Saltstone Vault 2. Soil parameters from the geotechnical report (Reference 5) were used by the designer (CROM) together with the loading requirements for natural phenomena at SRS for the analysis and design of Vault 2, per AWWA D110. The enclosed calculations show that the two Vault 2 tanks will meet all the structural and soil requirements with the allowable safety factors. Design and SRS drawings incorporate the results from the geotechnical report (Reference 5) and the design calculations to provide a design package that meets the SRS requirements for structurally sound saltstone storage and disposal vaults with the required leak tight properties.

The overall design has been found acceptable by a South Carolina registered Professional Engineer. The modification package has been duly stamped and signed.

5.0 REFERENCES

1. *Groundwater Monitoring Plan for the Z-Area Saltstone Disposal Facility*, WSRC-TR-2005-00257, Revision 4, September 2006 (Attachment #8)

2. *Low Curie Salt Grout Sample Results*, ESH-EPG-2005-00087, K. Liner (WSRC) to J. Gilbo (SCDHEC), 3/14/05

3. Mueser Rutledge Consulting Engineers, Saltstone Disposal Z-Area, October 14, 1986

4. *Saltstone Disposal Facility: Determination of the probable maximum water table Elevation*, WSRC-TR-2005-00131, Rev. 0

5. *Saltstone Vault No. 2 Geotechnical Investigation Report*, K-ESR-Z-00001, Rev. 0, April 2006

6. *Stormwater Pollution Plan, Z-Area Saltstone Disposal Site Vault No. 2*, C-ESR-Z-00004, 6/28/07 (Attachment #6)

7. Woodward-Clyde Consultants, *Investigation of Slope Stability*, Savannah River Plant, July 9, 1985

8. WSRC Report No. C-ESR-Z-00001, *Z-Area Vault No. 2 Geotechnical Investigation Report.*

9. WSRC Calculation No. K-CLC-Z-00002, *Slope Stability for the Saltstone Disposal Facility*, April 3, 2003

10. WSRC Calculation No. K-CLC-Z-00003, *Subsurface Stratigraphy for Saltstone No. 4*, August 21, 2002

11. WSRC Calculation No. K-CLC-Z-00004, *Liquefaction Settlement for Saltstone Disposal Vault No. 4 due to PC3 and PC4 Earthquakes*, May 31, 2003

12. *Z-Area Industrial Solid Waste Landfill Vault Cracking*, ESH-WPG-2006-00132, Revision 0, October 19, 2006

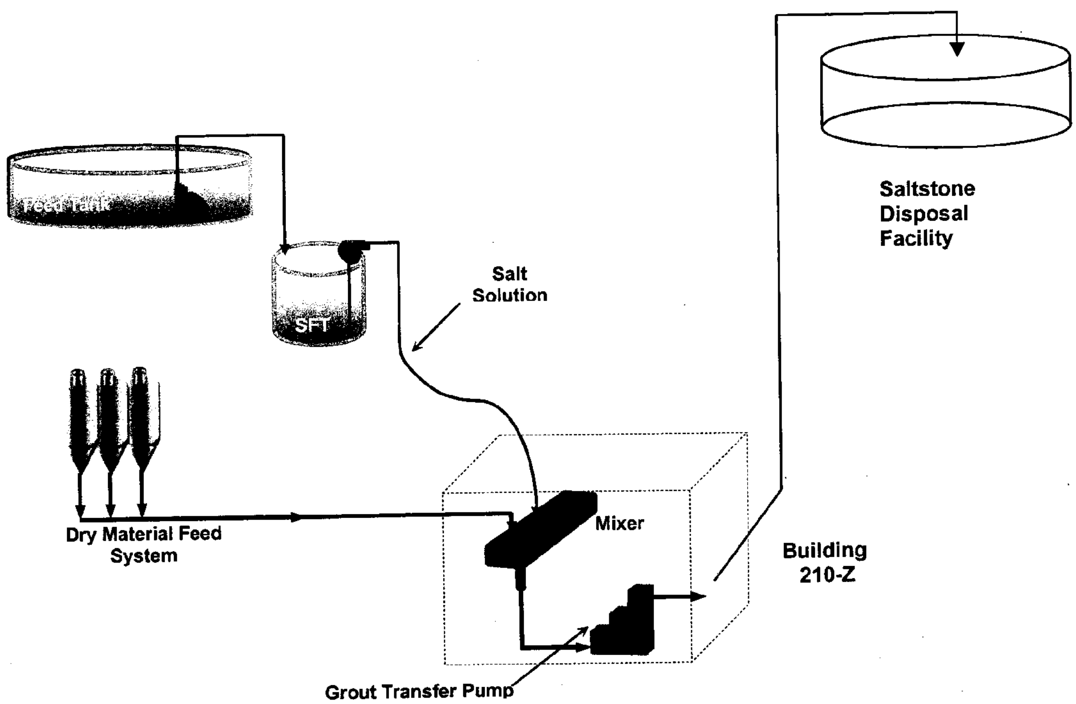
13. Z-Area Industrial Solid Waste Landfill Permit #025500-1603, *Closure Plan Engineering Report*, WSP-SSF-2005-00022, 5/11/05

6.0 ATTACHMENTS

Attachment 1:	Saltstone Production Facility Process Flow Diagram
Attachment 2:	Vault Location
Attachment 3:	Geotechnical Investigation Report
Attachment 4:	Estimating Groundwater Nitrate Concentrations for Saltstone Vault 2 Industrial Solid Waste Landfill Permit
Attachment 5:	HDPE/GCL Installation Details
Attachment 6:	Stormwater Pollution Prevention Plan
Attachment 7:	Vault 2 Seismic Calculations
Attachment 8:	Groundwater Monitoring Plan
Attachment 9:	Vault 2 Drain Water Collection System
Attachment 10:	Slope Stability Cylindrical Vault
Attachment 11:	Vault 2 Drawings

Attachment #1

Saltstone Production Facility Process Flow Diagram



Attachment #2

Vault Location

Reference:

Document Number	Document Title
Attachment A, G-CDL-Z-00005	Saltstone Vault No 2 Site Plan

Attachment #3

Geotechnical Investigation Report

Reference:

Document Number	Document Title
K-ESR-Z-0001	Saltstone Vault No 2 Geotechnical Investigation Report

Attachment #4

Estimating Groundwater Nitrate Concentrations for Saltstone Vault 2 Industrial Solid Waste Landfill Permit

Reference:

Document Number	Document Title
WSRC-TR-2006-00098	Estimating Groundwater Nitrate Concentrations for Saltstone Vault 2 Industrial Solid Waste Landfill Permit
T-CLC-Z-00017	Saltstone Vault No. 2 - Structural Performance Assessment
WSRC-TR-2003-00523	Saltstone Disposal Facility Mechanically Stabilized Earth Vault Closure Cap Degradation Base Case: Institutional Control to Pine Forest Scenario
WSRC-TR-2005-00101	Scoping Study; High Density Polyethylene in Saltstone Service

Attachment #5

HDPE/GCL Installation Details

Reference:

Document Number	Document Title
QB00485K-022A-MDM	Certification that authorized dealer and installer is certified by GSE products
QB00485K-023A-MDM	GSE Lining Technology, Inc. - Recommended Handling and Storage Procedures
QB00485K-024A-MDM	GSE Geomembranes – Manufacturing Quality Assurance Manual
QB00485K-025A-MDM	GSE Geomembranes – Installation Quality Assurance Manual
QB00485K-026A-MDM	Field Test Log Sheets
QB00485K-027A-MDM	HDPE/GCL Layout Details
QB00485K-030A-MDM	GCL Certification Example
QB00485K-031A-MDM	CETCO GCL Construction Quality Assurance Manual
QB00485K-032A-MDM	CETCO GCL Manufacturing Quality Assurance and Quality Control Manual
QB00485K-033A-MDM	Bentomat Claymax Installation Guidelines

Attachment #6

Stormwater Pollution Prevention Plan

Reference:

Document Number	Document Title
C-ESR-Z-00004	Z-Area Stormwater Pollution Prevention Plan
C-CLC-Z-00021	Z-Area Saltstone Disposal Site Vault No. 2 Stormwater Hydrology Calculations

Attachment #7

Vault 2 Seismic Calculations

Reference:

Document Number	Document Title
C-SOW-Z-00001, Pages 8-10	Storage Tanks, Statement of Work, Task #1
QB00485K-007-B-MDM	CROM Seismic Calculation
QB00485K-008-B-MDM	CROM Seismic Calculation
QB00485K-009-B-MDM	CROM Seismic Calculation

Executive Summary
The seismic calculations that follow in this attachment use MathCAD, EXCEL, and company developed software (by CROM) that are based on ACI 318 and the requirements of AWWA D110. The design input used was given on the Specification C-SOW-Z-0001, Task #1 (included in this Attachment). The calculation results show acceptable safety factors per ACI 318 and AWWA D110.

It is assumed that the tank full of water is the critical loading for the tank design. The drain water collection system will remove any free liquid from the tank, which will prevent the tank from being full of water and will prevent the tank from being subjected to the specific gravity of the bleed and process water and the saltstone slurry, which has a specific gravity of approximately 1.2. The solid Saltstone, which has a specific gravity of approximately 1.7 and a density of approximately 110 pounds per cubic feet, exerts its force on the tank foundation slab on grade, and therefore, is not a critical load for the tank. The seismic analysis found in this attachment (by comparison) shows that the weight of 25 feet high solidified Saltstone is less than the soil density of 125 pounds per cubic feet load that was removed during excavation, which is also less than the soil allowable bearing of 3,500 pounds per cubic feet.

Attachment #8

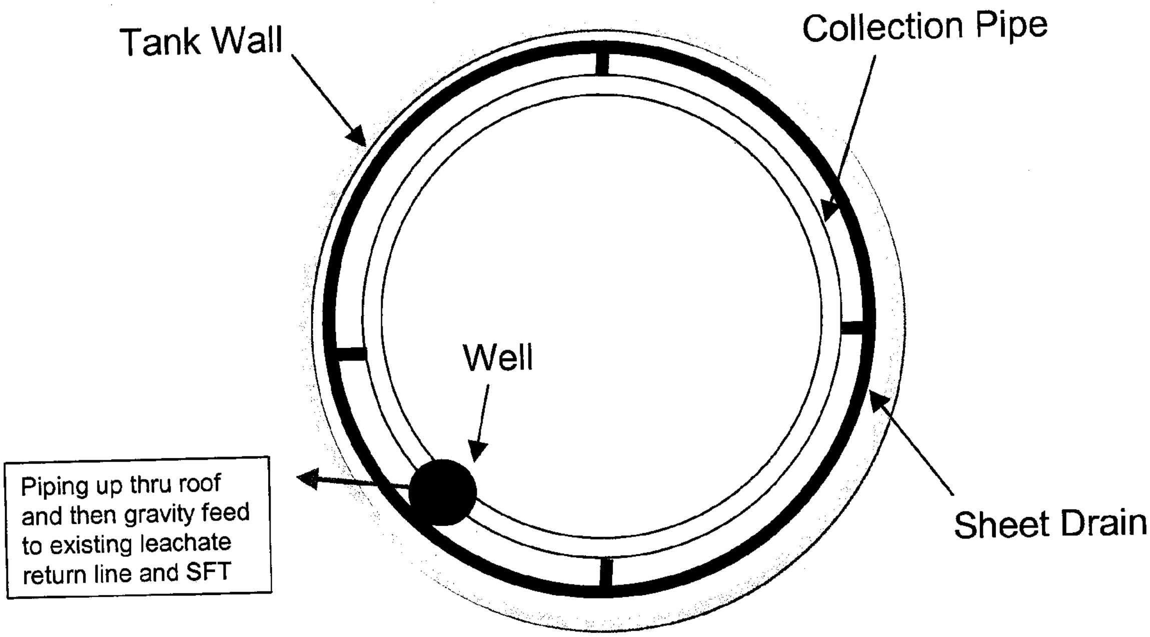
Ground Water Monitoring Plan

Reference:

Document Number	Document Title
WSRC-TR-2005-00257, Revision 4	Groundwater Monitoring Plan for the Z Area Saltstone Disposal Facility

Attachment #9

Vault 2 Drain Water Collection System



Attachment #10

Slope Stability Cylindrical Vault

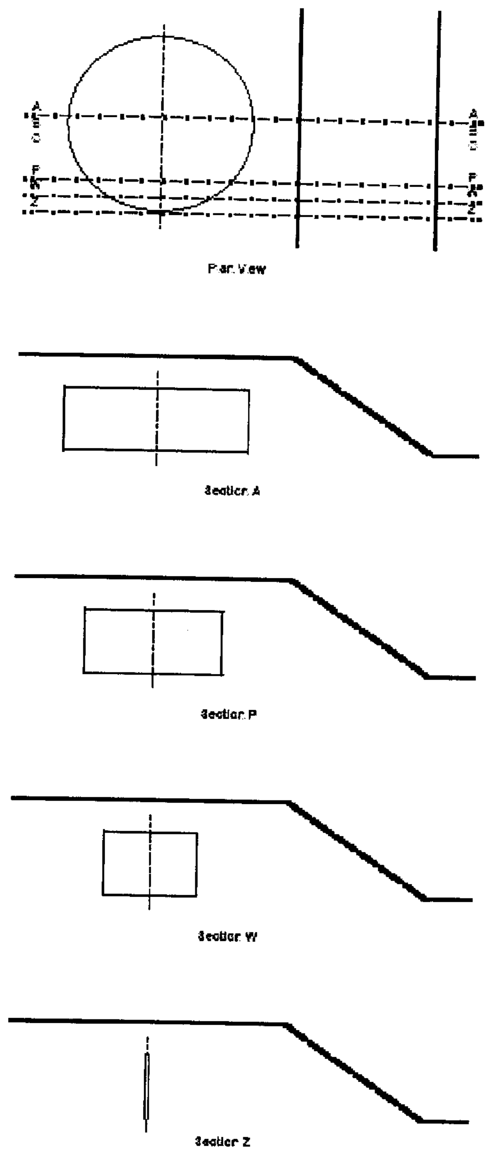


Figure 1 Cylindrical Vault

Attachment #11

Vault 2 Drawings

Reference:

Document Number	Document Title
WSRC-TR-2005 00131	Figure 2 - Configuration of the Long Term Average Water table Near the SDF
Sketch A	Saltstone Vault No.2 Section Looking West
J-J5-Z-00007	Vault 2 Thermocouple Arrangement
C-CH-Z-00012	Closure Business Unit (CBU)-Saltstone Storage Vault #2, Grout Fill Line Pipe Supports and Shielding Plan, Sections and Details
P-PA-Z-00017	CBU-Saltstone Storage Vault #2, 3"Grout Fill Line
C-CG-Z-00026	Z-Area Saltstone Disposal Site Vault #2 – Overall Site Plan
C-CG-Z-00030	Z-Area Saltstone Disposal Site Vault #2 – Finish Grading Plan
Document Number 06059 Drawings QB00485K-010-B-MDM through QB00485K-019-B-MDM	2.9-mg Saltstone Storage Tanks 2A & 2B Sheets 1 through 13