Fac/Perm/Co ID #	Date	Doc ID#
18-09	10/9/08	5952

CHAS. H. SELLS, INC.
Consulting Engineers, Surveyors & Photogrammetrists

PRINCIPALS
STEVEN W. SMITH, P.E.
SUSAN K. FASNACHT, P.E.
MOSE D. BUONOCORE, P.E.
THOMAS NOVELLINO, C.P., P.P
SENIOR ASSOCIATES
DAN E. BREWER, P.E.
C. ROSS MASSEY, P.E.
DAVID K. BRUBAKER, P.L.S.

Approved

January 25, 2006

John Murray, P.E., Regional Engineer
North Carolina Dept. of Environment & Natural Resources
Solid Waste Division
610 E. Center Ave. Suite 301
Mooresville, NC 28115

NC DEPT. OF ENVIRONMENT
AND NATURAL RESOURCES
RECEIVED
JAN 25 2006
MOORESVILLE REGIONAL OFFICE
DIVISION OF WASTE MANAGEMENT, SWS

Subject: Duke Power Marshall Steam Station, Catawba County
Construction Quality Assurance Program
Revision to Landfill Detail Drawing

Mr. Murray,
As we discussed at our meeting on January 24, 2006, on behalf of Duke Power, Sells is providing three copies of the Construction Quality Assurance Program for the Duke Power Marshall FGD Residue Landfill, dated January 16, 2006.

We are also providing you three copies of the revised drawing, MM6451.00-0007.001, showing the Cell 1 and Cell 2 Details. As you requested, we have revised Detail 1/7 for your comments.

If you have questions on this, please contact me at 704-662-0100.

Sincerely,

William M. Miller

William M. Miller, P.E.

cc Richard Baker, Duke Power
Pat McCabe, Duke Power

CONSTRUCTION QUALITY ASSURANCE PROGRAM

DUKE ENERGY CORP.
MARSHALL STEAM STATION
FGD RESIDUE LANDFILL
CATAWBA COUNTY, NC

Prepared By:

CHAS. H. SELLS, INC.
Consulting Engineers, Surveyors & Photogrammetrists
128 Overhill Drive, Suite 105, Mooresville, NC 28117
Phone: (704) 662-0100
Fax: (704) 662-0101

January 16, 2006

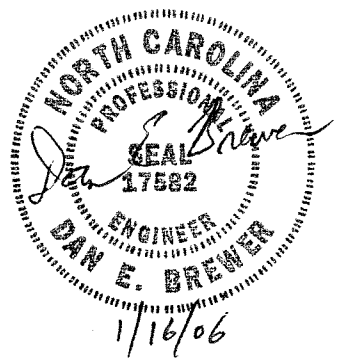


TABLE OF CONTENTS

1.0 PROJECT TEAM AND RESPONSIBILITIES

Construction Quality Assurance (CQA) for the construction of the Marshall FGD Gypsum Landfill will be provided by an engineering and testing firm (ENGINEER) independent of the CONTRACTOR specializing in the inspection and testing of soils and geosynthetics.

The project team providing the CQA services shall consist of the following:

A. Project Engineer - Responsible for defining quality assurance requirements compatible with the project objectives, reviewing and approving shop drawings and manufacturer/installer literature, outlining procedures for the analysis of test data and preparing quality assurance memorandums and quality control reports. The Project Engineer is responsible for design changes (as approved by the State Solid Waste Section), clarifications, and specification addenda. The Project Engineer also has the ultimate responsibility for approving or disapproving any element of the project. The responsibility to stop work is held by the Owner. Construction quality assurance documents will be prepared, signed and sealed by the Project Engineer. The Project Engineer will be a registered Professional Engineer in the State of North Carolina.

B. Construction Quality Assurance Officer - The Construction Quality Assurance Officer (CQAO) will be experienced in quality assurance testing and inspection. The Construction Quality Assurance Officer will report to the Project Engineer. The CQAO serves as the on-site representative of the Owner and is responsible for the field implementation of the approved quality assurance program as follows:

- Monitor the quality assurance activities of the field testing and assure conformance with test procedures and the technical specifications.
- Inform the Project Engineer of non-conformance to the approved CQA program.
- Logging in of geosynthetic samples and establishing laboratory conformance testing lots.
- Insure that sampling is conducted in a manner consistent with ASTM methods.
- Insure that sample handling procedures are in accordance with the appropriate guidelines for the testing to be conducted.

- Approve all field and laboratory test data before the data are reported or entered into the data base for analysis.

- Assign and direct field technicians.

- Maintain an awareness of the entire field testing operation to detect conditions that may jeopardize the quality of testing.

C. Engineering Technicians - Responsible for field observations, testing and inspection. Technicians will be assigned to the project as deemed necessary by the Construction Quality Assurance Officer. Technicians will be responsible to the Construction Quality Assurance Officer.

2.0 STRUCTURAL FILL

2.1 Material

2.1.1 Structural Fill is defined as compacted fill required for area fill, berms, surface water control systems, roadways or other systems not intended to function as a leachate migration barrier.

2.1.2 Structural Fill may consist of on-site or off-site soils that are free of organic material, refuse or debris and can be constructed and compacted as required by the Technical Specifications.

2.2 Construction

2.2.1 Structural Fill will be compacted in lifts not exceeding 10 inches (loose measure). The ENGINEER may reduce maximum allowable lift thickness depending on soil type used, construction equipment and methods employed.

2.2.2 For construction of berms or roadways, in-place density of Structural Fill will be determined by the ENGINEER or his designated representative, at a frequency of at least one test per 300 linear feet of berm or roadway.

2.2.3 For area fills, density tests will be taken at a frequency no less than one test per 20,000 square feet of fill per lift.

2.2.4 All required field density and moisture content tests will be completed before the overlying lift of soil is placed. The surface preparation (e.g. wetting, drying, scarification, etc.) will be completed before the ENGINEER will allow placement of subsequent lifts.

2.2.5 Bulk (100-lb) samples of the Structural Fill will be retained for each 10,000 cubic yards of soil placed. The ENGINEER may reduce the number of bulk samples needed depending on the variability of the soil being used. The following testing will be performed:

- Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock and Soil-Aggregate Mixtures, ASTM D-2216.
- Method for Particle-Size Analysis of Soils, ASTM D-422.

- Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils, ASTM D-4318.

- Moisture-Density Relationship (Standard Proctor), ASTM D-698 or (Modified Proctor) ASTM D-1557.

3.0 COMPACTED SOIL LAYER

3.1 Material

3.1.1 The Compacted Soil Layer is defined as a smooth soil layer for placement of the geomembrane.

3.1.2 Soil layer fill materials are potentially available in on-site and off-site stockpile areas that have been located by the OWNER and ENGINEER. Soil layer fill materials shall be classified according to the Unified Soil Classification System as SC, CL, CH, ML or MH (ASTM D 2487-83). Liquid limit, plasticity index, and percent passing the No. 200 sieve will be considered for proper classification.

3.1.3 Soil layer fill materials shall be reasonably free of gypsum, ferrous, and/or calcareous concretions and nodules or other deleterious substances. Soil layer fill material shall have a maximum size aggregate of 1 inch. The soil layer material shall be raked or sieved by the EARTHWORK CONTRACTOR, if necessary, to remove all aggregate greater than 1 inch in diameter. No more than 5 percent of the soil layer fill material should be retained on the No. 4 sieve.

3.1.4 Continuous and repeated visual inspection of the materials will be performed by the EARTHWORK CONTRACTOR to ensure proper soils are being used. In addition, the ENGINEER will make frequent inspections of the soil layer placement operations and materials, and will consult with the site personnel on suitable fill and locations of such. All soil layer fill proposed shall be inspected by the ENGINEER prior to actual use.

3.2 Construction

3.2.1 The Compacted Soil Layer will be compacted in lifts not exceeding 10 inches (loose measure). The ENGINEER may reduce maximum allowable lift thickness depending on soil type used, construction equipment and methods employed.

3.2.2 Bulk samples will be taken by the ENGINEER at intervals of 1 sample per 5,000 cubic yards of material to be placed from the excavation areas or stockpile area(s). The samples will be transported to a soils laboratory for compaction testing. The samples will be compacted to at least 95 percent of standard Proctor (ASTM D-698) at moisture contents within 2 percent dry of optimum and 5 percent wet of optimum.

3.2.3 Sampling and testing of the compacted soil layer shall be as follows:

Test	ASTM Method	Frequency
Natural Moisture Content	D-2216	At every density test location and at least once per every 5,000 cubic yards placed.
Field Density	D-2937	Once per every other 100 foot by 100 foot grid per lift.

3.2.4 During compaction of the soil layer material, the soil moisture content and dry density shall be maintained within the limits specified below.

To determine the moisture content and dry density requirements of the compacted soil are being satisfied, field and laboratory tests shall be performed at the frequencies specified.

Moisture content shall be wet of optimum moisture content at the density specified.

The soil layer shall be compacted to a minimum dry density of 95 percent of the maximum dry density determined from the standard Proctor test (ASTM D-698). Where densities less than the specified density are measured, the soil layer shall be recompacted and/or removed and reworked to meet density criteria.

3.2.5 All required field density and moisture content tests will be completed before the overlying lift of soil is placed. The surface preparation (e.g. wetting, drying, scarification, etc.) will be completed before the ENGINEER will allow placement of subsequent lifts.

3.2.6 The surface of the Compacted Soil Layer shall be smooth drum rolled and maintained free of rocks, organics, voids and sharp edges.

4.0 GEOSYNTHETIC CLAY LINER

4.1 Material

4.1.1 The geosynthetic clay liner (GCL) used on the landfill floor shall be equivalent to Claymax 600 CL. The GCL for the side slopes shall be stitched reinforced GCL equivalent to Bentomat DN.

4.1.2 The bentonite shall be high quality sodium bentonite comprised of 90 percent montmorillonite. The bentonite shall be continuously adhered to the underlying and overlying geotextile with a water soluble adhesive.

4.1.3 The GCL shall be shipped rolled with a protective wrap around each roll, labeled with a roll number. Manufacturer's quality control documentation shall be included with each roll.

4.1.4 The GCL shall be stored in a dry, well drained storage area. The GCL shall be stored under plastic sheets or tarpaulins to prevent hydration.

4.2 Geosynthetic Clay Liner Manufacturer and Contractor

4.2.1 The geomembrane installer is the party responsible for installation of the GCL. "Installer" is used interchangeably with "Geosynthetics Contractor". The manufacturer is the party that supplies the geosynthetic products. In some cases the installer and manufacturer may be the same party. The GEOSYNTHETIC CONTRACTOR will submit the following as obtained from the Geosynthetic Clay Liner Manufacturer to the ENGINEER:

- Production Certification
- Testing Program of Compound Ingredients
- Material Certification
- Test Data for Material and encasing geotextiles

All of the above submittals will be reviewed and retained by the ENGINEER.

4.2.2 The GEOSYNTHETIC CONTRACTOR will submit the following to the ENGINEER prior to installation:

- Qualifications and resumes of the GEOSYNTHETIC CONTRACTOR Superintendent and Foreman

- Two sets of proposed GCL field panel layout drawings

4.3 GCL Installation

4.3.1 A liner pre-construction meeting will be held prior to installation. The GEOSYNTHETIC CONTRACTOR, ENGINEER or his representative, and a representative of the OWNER will be in attendance. The technical specifications and quality assurance and quality control procedures will be discussed and agreed upon by all parties.

4.3.2 The geomembrane liner shall be constructed as soon as practical after completion and approval of the Compacted Soil Layer.

4.3.3 The top of the Compacted Soil Layer will be surveyed to ensure specified grades toward the collection sump area have been achieved. The GCL is to cover the bottom of the cell and the side slopes in accordance with the Contract Drawings.

4.3.4 Areas to receive GCL installation should be relatively smooth and even, free of ruts, voids, etc, to the extent required by the ENGINEER. This shall be accomplished by final dressing of the compacted liner with smooth drum rollers. No vehicles are permitted on final dressed surfaces unless authorized by the ENGINEER.

4.3.5 An anchor trench (as illustrated on the Contract Drawings) will be required to secure the GCL. No loose soil will be allowed to underlie the GCL in the anchor trenches. The time schedule for excavation and backfilling of the anchor trenches is to be approved by the ENGINEER so that desiccation of trench soils does not occur prior to backfilling (See Technical Specifications, Section 3.3.10).

4.3.6 The GCL installed into the anchor trench shall be temporarily sandbagged until all layers of geosynthetics are installed. The anchor trench shall be backfilled as soon as possible. A temporary cover over the open trenches may be required to keep the GCL dry prior to backfilling.

4.3.7 Daily installation of GCL shall be limited to the sections of GCL that can be overlain by geomembrane in one day. Panels shall be positioned with the overlap recommended by the manufacturer, but not less than 6 inches for panel sides and 24 inches for panel ends.

4.3.8 Bentomat GCL panels shall be placed so that the white nonwoven geotextile side is placed down onto the soil. Granular bentonite shall be placed along the seams for the entire seam width at an application rate of 0.25 pounds per linear foot.

4.3.9 Claymax GCL panels shall be placed so that the stenciled "Claymax" faces up. Granular bentonite along the seams will be required only in seam areas that do not exhibit continuous seam contact (i.e., minor seam wrinkles).

4.3.10 After panels are initially in place, remove wrinkles as directed by the ENGINEER. Unroll several panels and allow the GCL to relax before beginning adjacent panels. The panels shall be placed on the side slopes first and extend a minimum of 3 feet beyond the toe of slope. No horizontal seams of GCL will be permitted on the side slopes. The panels in the basin floor shall be placed from the upgradient end of the basin and progress downgradient in order to keep stormwater runoff from accumulating under the GCL.

4.3.11 Once the daily panels are placed and smooth, commence placement of the geomembrane in accordance with Section 5.0 GEOMEMBRANE. If exposed GCL cannot be covered by geomembrane before the end of the working day, the panels or sections of panels shall be temporarily covered with plastic and ballasted until geomembrane placement can commence.

4.3.12 If GCL panels become saturated from rainfall and exhibit bentonite swelling prior to geomembrane placement, the saturated sections of GCL shall be removed and replaced.

4.3.13 At the discretion of the ENGINEER, samples will be selected at random and sent to the laboratory for additional conformance testing. The laboratory testing program will be directed by the ENGINEER and include but not be limited to the following properties:

- Bentonite Mass/Area ASTM D 5993
- GCL Grab Strength ASTM D 4632, ASTM D 6768
- GCL Peel Strength ASTM D 4632, ASTM D 6496
- GCL Hydraulic Conductivity ASTM D 5887
- GCL Hydrated Internal Shear Strength, ASTM D 5321, ASTM D 6243

4.3.14 Placement of the GCL will be observed and recorded to assure conformation with the Technical Specifications and GEOSYNTHETIC MANUFACTURER'S recommendations. Any damaged material will be marked for repair and/or replacement.

4.3.15 During seaming of the GCL, the ENGINEER or his representative will observe the seams for the proper overlap and seaming techniques are employed.

5.0 GEOMEMBRANE

5.1 Meetings

5.1.1 A liner pre-construction meeting will be held prior to installation. The GEOSYNTHETIC CONTRACTOR, ENGINEER or his representative, and a representative of the OWNER will be in attendance. The technical specifications and quality assurance and quality control procedures will be discussed and agreed upon by all parties.

5.1.2 At the beginning of each work day the EARTHWORK CONTRACTOR'S Superintendent, the GEOSYNTHETIC CONTRACTOR'S Superintendent, and the CQAO will meet to discuss the upcoming work plan for all parties to ensure cooperation, communication and understanding.

5.2 Material

The Geomembrane will be 60 mil High Density Polyethylene (HDPE) as specified in the Technical Specifications.

Smooth geomembrane shall be used on the landfill floor.

Textured geomembrane shall be used for the landfill side slopes. This textured geomembrane shall extend 10 feet past the toe of the slope, onto the landfill floor.

5.3 Geosynthetic Manufacturer and Contractor

5.3.1 The geomembrane installer is the party responsible for installation of the HDPE geomembrane. "Installer" is used interchangeably with "Geosynthetics Contractor". The manufacturer is the party that supplies the geosynthetic products. In some cases the installer and manufacturer may be the same party. The GEOSYNTHETIC CONTRACTOR will submit the following as obtained from the Geosynthetic Manufacturer to the ENGINEER:

- Production Certification
- Testing Program of Compound Ingredients
- Material Certification
- Test Data for Material and Resin

All of the above submittals will be reviewed and retained by the ENGINEER.

5.3.2 The GEOSYNTHETIC CONTRACTOR will submit the following to the ENGINEER prior to installation:

- Qualifications and resumes of the GEOSYNTHETIC CONTRACTOR Superintendent and Foreman
- Two sets of proposed geosynthetic field panel layout drawings.

5.3.3 Geomembrane liner shall be shipped rolled with a protective wrap around each roll, labeled with roll number and manufacturer's batch number. Manufacturers quality control documentation shall be included with each roll.

5.3.4 Pre-shipping Sheet Tests - The GEOSYNTHETIC CONTRACTOR or supplier (manufacturer) will be required to submit his Quality Control program to the ENGINEER prior to initiating field work. At a minimum, the Manufacturer will perform the tests at the frequencies given in Table 2 on the HDPE sheet prior to shipping HDPE material to the site.

5.4 Geomembrane Installation

5.4.1 The ENGINEER or his representative will sample rolls from each shipment of geomembrane delivered to the site. The minimum number of rolls to be sampled from each shipment will be determined by computing the cube root of the total of number of rolls delivered in the shipment and rounding this value upward to the nearest integer. For instance, if 40 rolls of geomembrane are delivered in a shipment, at least 4 rolls will be sampled.

5.4.2 The random samples must be representative of the materials supplied and exclude the outer wrap of geomembrane if evidence of scuffing or other damage is observed. Samples should be full roll width and at least 2 feet long.

5.4.3 The ENGINEER or his representative will measure the geomembrane thickness of each of the random samples at the project site prior to geomembrane installation. Material that does not fall within acceptable thickness criteria will be rejected.

5.4.4 At the discretion of the ENGINEER, samples will be selected at random and sent to the laboratory for additional conformance testing. The laboratory testing program will be directed by the ENGINEER and include but not be limited to the following properties:

- Thickness (ASTM D751)

- Density (ASTM D792)
- Carbon Black Content (ASTM D1603)
- Tensile Properties (ASTM D638)
- Tear Resistance (ASTM D1004)

5.4.5 Seams for the geomembrane shall be double hot wedge fusion or extrusion welds as specified in the Technical Specifications.

5.4.6 During extrusion welding, the ENGINEER or his representative will mark all areas where grinding is considered to be excessive. The location and repair method for the excessive grinding will be recorded in the daily field reports. The method of repair will be determined in the field by the ENGINEER.

5.4.7 Overheating of the geomembrane will be monitored by the ENGINEER or his representative. Coupons will be cut from the end of the extrusion seams and the bottom side of the seam will be observed for visible warping or deformation.

The location and repair method of overheated areas will be recorded in the daily field reports. The method of repair will be determined in the field by the ENGINEER.

5.4.8 During seaming, the ENGINEER or his representative will observe the seams for the proper preparation, grinding technique and overheating.

5.4.9 The ENGINEER or his representative will observe the geomembrane during the coolest part of the day to check for slack. Any areas where "trampolining" occurs will be marked by the ENGINEER for repair by the GEOSYNTHETIC CONTRACTOR.

5.4.10 All repair locations shall be patched and tested in accordance with the Technical Specifications prior to acceptance by the ENGINEER. All patches shall extend a minimum of 6 inches beyond the repair location.

5.5 Test Seams

5.5.1 The GEOSYNTHETIC CONTRACTOR will perform a test seam at least twice daily. These seams will be made on fragment pieces of geomembrane liner to verify that seaming conditions are adequate. Such test seams will be made at the beginning of each seaming period, when changes in storing equipment occur, at the ENGINEER'S discretion, and at least once every four hours during continuous operation of each welding machine.

5.5.2 The ENGINEER shall complete the Test Seam Form immediately after each test.

5.5.3 Requirements for test seams are as found in the Technical Specifications, Section 4.3.5.2.

5.5.4 The welder, date, time and equipment, as well as liner temperature, welding temperature, and seaming parameters will be recorded for each test seam.

5.5.5 A minimum of six specimens from each sample will be tested; three in peel and three in shear. Film Tear Bond (FTB) type failures will be the criterion for qualification of the test seam. Testing will be performed in the field by the GEOSYNTHETIC CONTRACTOR under full-time observation by the ENGINEER or his representative.

5.5.6 Untested portions of the test seam will be retained by the ENGINEER for the project records and future testing as required.

5.5.7 All test seams must pass the field testing before production seaming is performed by the GEOSYNTHETIC CONTRACTOR.

5.6 Non-Destructive Testing

5.6.1 The GEOSYNTHETIC CONTRACTOR is responsible for the completion of non-destructive testing of the entire length of all field seams, verifying that the seam is watertight. The testing will be vacuum, air pressure and spark testing as specified in the Technical Specifications.

5.6.2 Non-destructive testing will be observed by the ENGINEER or his representative on a full-time basis.

5.7 Field Destructive Samples

5.7.1 The GEOSYNTHETIC CONTRACTOR will obtain samples of field seams, suitable for testing, from the beginning and end of each field run exceeding 200 feet in length, as specified in the Technical Specifications, Section 4.3.7. In addition, samples will be removed at a frequency of one sample per 500 linear feet of weld for laboratory destructive testing. The date, time and equipment, seam number, and seaming parameters will be marked on each sample and recorded by the ENGINEER.

5.7.2 Samples retained will be tested in the field by the Geomembrane Installer. A minimum of three specimens from each sample will be tested in peel (ASTM D413). FTB type failures will be the criterion for qualification of the production seam. Testing should be performed from 15 minutes to one hour after completion of the seam by the GEOSYNTHETIC CONTRACTOR.

5.7.3 The ENGINEER or the OWNER may require additional random samples to be taken for testing in areas which visually appear defective and not in accordance with the Technical Specifications.

5.8 Laboratory Destructive Testing

5.8.1 Destructive seam samples will be laboratory tested by the ENGINEER as described in the Technical Specifications. Testing frequency is at least one sample per 500 linear feet of field seam.

Test samples will be at least 18 inches long. A minimum of five peel specimens will be tested for each sample in accordance with ASTM D413. At least five specimens from each sample will be tested for bonded shear strength in accordance with ASTM D3083.

All laboratory specimens will be conditioned for a minimum of one hour prior to testing at a relative humidity of 65±5% and a temperature of 21±2°C (70±4°F).

Peel tests will be performed on both sides of a double-wedge fusion seam.

5.8.2 The load and type of failure will be recorded for each specimen. FTB is the qualified criterion.

The ENGINEER will describe the type of failure for each specimen and record the presence of any disbonding, delamination, foreign material in the bond area, etc.

As a general guideline, the bonded shear strength should equal or exceed the tensile strength (in pounds per unit width) of the parent material. If a shear specimen exhibits a failure within the grinding or preparation area adjacent to the seam that falls below 80 percent of the parent material strength, the ENGINEER may require additional seam repair.

As a general guideline, the peel adhesion should exceed 62 percent of the geomembrane yield strength of the parent material. The test report should note if a peel specimen fails in the grinding preparation area. Both sides of the double-wedge fusion seam must pass the testing requirements to constitute a passing test.

5.9 Documentation

Forms to be completed by the GEOSYNTHETIC CONTRACTOR:

- Subgrade Certification (signed daily by the GEOSYNTHETIC CONTRACTOR'S Superintendent and submitted to the CQAO)

- Seam Test Weld Form (completed after each seam test by the Welding Technician for approval by the CQAO.)

- Pre-construction shop drawings and post construction as built record drawings.

Forms to be completed by the CQAO:

- CQAO Daily Report
- Field Inventory Control
- Seam Inspection Report
- Geomembrane Deployment
- Laboratory Destructive Testing
- Geomembrane Repair Record

Table 5-1

REQUIRED PRE-SHIPPING SHEET TESTING
OF
MEMBRANE LINER (HDPE)

Property	Test Method	Frequency
Thickness	ASTM D-1593 Par. 8.1.3	Each Roll
Sheet Density	ASTM D-792 Method A	Each Roll
Tensile Properties	ASTM D638, Type IV (As modified in NSF54)	Each Roll
Tear Resistance	ASTM D1004 Die C	Every Fifth Roll
Puncture Resitence	FTMS 101B Method 2065	Every Fifth Roll
Carbon Black Content	ASTM D1603	Every Fifth Roll
Carbon Black Dispersion	ASTM D-3015 (As modified in NSF54)	Every Fifth Roll
Dimensional Stability	ASTM D1204 (1 Hour @ 100°C)	Every Tenth Roll
Low Temperature Impact	ASTM D746	Every Tenth Roll
Melt Flow Index	ASTM D1238 Condition 190/2.16 (At two normal loads)	Every 180,000 lb. of Resin*
Environmental Stress Crack	ASTM D-1693 Appendix A (As modified in NSF54)	Every 180,000 lb. of Resin*

* Or at least once per railcar for railcars containing less than 180,000 lb.

6.0 LEACHATE COLLECTION AND REMOVAL SYSTEM (LCRS)

6.1 Geotextile, Geonet, and Geocomposite

6.1.1 On the landfill floor, the leachate collection system will consist of a geonet overlain by a nonwoven needle-punched geotextile. On the landfill side slopes, the leachate collection system will comprise of a geocomposite (geotextile/geonet/geotextile). A one foot thick operational cover soil will overlie the LCRS on the landfill floor. The cover soil thickness varies from one foot to greater than one foot on the side slopes. Within the operational cover on the landfill floor will be a series of leachate collection piping wrapped with gravel and geotextile.

6.1.2 Upon delivery to the site, the geotextile will be inspected by the ENGINEER. All applicable product information will be recorded. The following is a summary of the documentation that will be submitted by the GEOSYNTHETIC CONTRACTOR prior to material approval:

- mill certificates/delivery tickets
- grab strength (ASTM D4632)
- grab/tensile elongation (ASTM D4632/D4595)
- wide width tensile strength, M.D., C.D. (ASTM D4595)
- puncture strength (ASTM D4833)
- fabric weight (ASTM D3776)
- apparent opening size, AOS (ASTM D4751)

6.1.3 Upon delivery to the site, the geonet will be inspected by the ENGINEER. All applicable product information will be recorded. The following is a summary of the documentation that will be submitted by the Contractor prior to material approval:

- mill certificates/delivery tickets
- hydraulic transmissivity test data (ASTM D4716)
- density (ASTM D1505)
- wide width tensile strength and elongation (M.D. and C.D.) (ASTM D4595)

6.1.4 Roll tags or packing lists will be retained for all rolls of geonet, geotextile, and geocomposite delivered to the site.

6.1.5 Storage and handling conditions for the geonet, geotextile, and geocomposite will be observed by the ENGINEER or his representative. The material should be kept as dry and as free of dirt and debris as possible.

6.1.6 Geonet, geotextile, and geocomposite should be kept in protective wrapping until installation. Any rolls delivered to the site without UV and moisture protective wrapping may be rejected by the ENGINEER or his representative.

6.1.7 The geonet will be conformance tested by the GEOSYNTHETIC MANUFACTURER to determine its ability to transmit water in-place (ASTM D4716) under the conditions outlined below:

- Normal Compressive stress equal to the maximum vertical stress for the completed landfill.
- Hydraulic gradients ranging from 0.25 to 1.0.
- Seating Period of at least 48 hours
- Compacted operational cover soil placed over the Geonet/Geotextile and a 60 mil HDPE geomembrane beneath the Geonet.

6.1.8 The transmissivity test must confirm that the Geonet exhibits a hydraulic transmissivity of at least $1x10^{-4}$ m^2/sec.

6.1.9 Any test not meeting the technical specifications criteria will result in possible retesting, at the direction of the ENGINEER, or rejection of the geotextile.

6.1.10 Placement of the geonet, geotextile, and geocomposite will be observed and recorded to assure conformation with the Technical Specifications and GEOSYNTHETIC MANUFACTURER'S recommendations. Any damaged material (including underlying geomembrane) will be marked for repair and/or replacement.

6.2 Leachate Collection Pipe and Sump

6.2.1 Manufacturer's technical data shall be provided to the ENGINEER by the supplier.

6.2.2 A minimum 1-foot long specimen of each solid and perforated pipe of each pipe size may be retained by the ENGINEER.

6.2.3 The butt fusion weld of the drainage pipe will be observed by the ENGINEER or his representative for any holes or burrs in the weld that may potentially damage the geomembrane.

6.2.4 The prefabricated sumps will be observed by the ENGINEER or his representative prior to placement to assure that they are smooth and free of burrs or sharp edges which may potentially damage the geomembrane.

6.2.5 The ENGINEER or his representative will verify the proper geomembrane protection has been provided before the sumps are placed.

6.2.6 Pressure testing of the HDPE discharge lines will be observed by the ENGINEER or his representative. The pressure and time at the beginning and end of the test will be recorded for each section of pipe tested.

6.2.7 The base of the trench of the leachate discharge piping (outside of landfill cell) will be observed by the ENGINEER or his representative prior to placement of the piping. Any sharp stones, soft material or other potentially damaging material should be removed. One bulk sample of the trench backfill material will be collected during placement or compaction. A standard Proctor maximum dry density (ASTM D-698) test will be performed on the pipe backfill material for field density testing.

6.3 Operational Cover

6.3.1 Operational cover will consist of on-site sandy/silty soils. One sample per 3,000 cubic yards of the proposed operational cover soils shall be obtained by the ENGINEER for classification and gradation testing. Material must meet the gradation requirements described in the Technical Specifications, Section 6.2.1. Placement of the operational cover will be placed in minimum 12 inch thick lifts in a method to be approved by the ENGINEER.

6.3.2 The ENGINEER will monitor operational cover placement on a full-time basis.

6.3.3 Wrinkles in the geomembrane resulting from operational cover placement will be "walked out" prior to additional operational cover placement. Any excessive wrinkles will be observed by the ENGINEER for possible repair by the GEOSYNTHETIC CONTRACTOR.

6.3.4 The final surface of the operational cover will be rolled with a non-vibratory smooth drum roller.

7.0 FINAL COVER SYSTEM

7.1 Compacted Soil Layer

7.1.1 The compacted soil layer will consist of on-site or off-site soil meeting the criteria for the compacted soil layer.

7.1.2 The compacted soil layer will be at least 18 inches thick and shall be compacted in nine inch lifts in accordance with the Technical Specifications.

7.1.3 The thickness of the compacted lift will be measured at random locations after spreading, leveling and compacting is completed prior to placement to the Geomembrane Cap.

7.1.4 Density testing will be performed on the compacted soil layer at a frequency of at least one test per 100 foot by 100 foot grid for every other lift. The location of each test will be randomly determined by the ENGINEER or his representative. Densities less than the specified compaction as outlined in the Technical Specifications shall be recompacted and/or removed and reworked to meet density objectives.

7.2 Geomembrane Cap

The geomembrane cap shall consist of a 40 mil textured LLDPE. The CQA procedures established for the landfill bottom geomembrane (Section 5.0 GEOMEMBRANE) will be modified and submitted to the Division of Waste Management for approval prior to closure.

7.3 Final Cover Soil

The final cover and topsoil will be at least two feet thick and compacted in accordance with the Closure/Post-Closure Plan

The thickness of the cap will be randomly tested by the ENGINEER to verify adequate coverage.

7.4 Drainage System

The drainage system will consist of a geocomposite, underdrains and surface water ditches. The ENGINEER shall review shop drawings and manufacturer's literature for the geosynthetics. The materials must be approved by the ENGINEER prior to installation. The ENGINEER shall monitor installation of the drainage system to verify conformance with the Closure Plan.

7.5 Gas Venting System

The gas venting system trenching and piping shall be installed as soon as possible following installation of the compacted soil layer. The gas vents should be installed prior to the geomembrane cap installation.

8.0 AS-BUILT CONDITIONS

The finished lines and grades of the surface of the excavated and/or constructed cell and operational cover will be presented to the ENGINEER by the CONTRACTOR. Final topographic surveys for the top of liner and operational cover should be performed in a minimum 100 foot by 100 foot grid.

An As-built drawing showing the location and identifying number of the geomembrane panels, seams and destructive samples will be maintained and updated by the ENGINEER. This does not replace the required Panel Layout As-Built to be submitted by the GEOSYNTHETIC CONTRACTOR.

As-built location and detail for construction of the Leachate Collection System will be submitted to the ENGINEER by the CONTRACTOR.

The contractor shall be responsible for submitting to the ENGINEER the following:

- Survey drawings verifying that finished lines and grades of the excavated and/or constructed cell, operational cover and final cover (by others following closure activities) have been obtained.

- All material certifications and warranty information for the installed material and equipment.

- As-Built utility line locations.

9.0 CQA SUBMITTAL

The Construction Quality Assurance document will contain the results of all tests performed on the following items for each completed phase:

1. General Structural Fill for cell floor, berms, roadways and surface water control structures
2. Geosynthetic Clay Liner
3. Geomembrane Liner
4. Leachate Collection and Removal System
5. Operational Cover
6. Final Cover System (ie: compacted soil layer, geomembrane cap, and final soil cover after closure)*

Portions of the above items may be submitted to the Division as individual certification reports during construction. Following construction, the individual certification reports shall be compiled into one CQA document for an Application for Permit to Operate.

"As-Built" drawings will be included with the CQA document. A comprehensive narrative of the construction process and CQA activities including daily reports from the CQA Officer and documentation of progress meetings. Color photographs of key elements for landfill construction shall also be included in the CQA document.

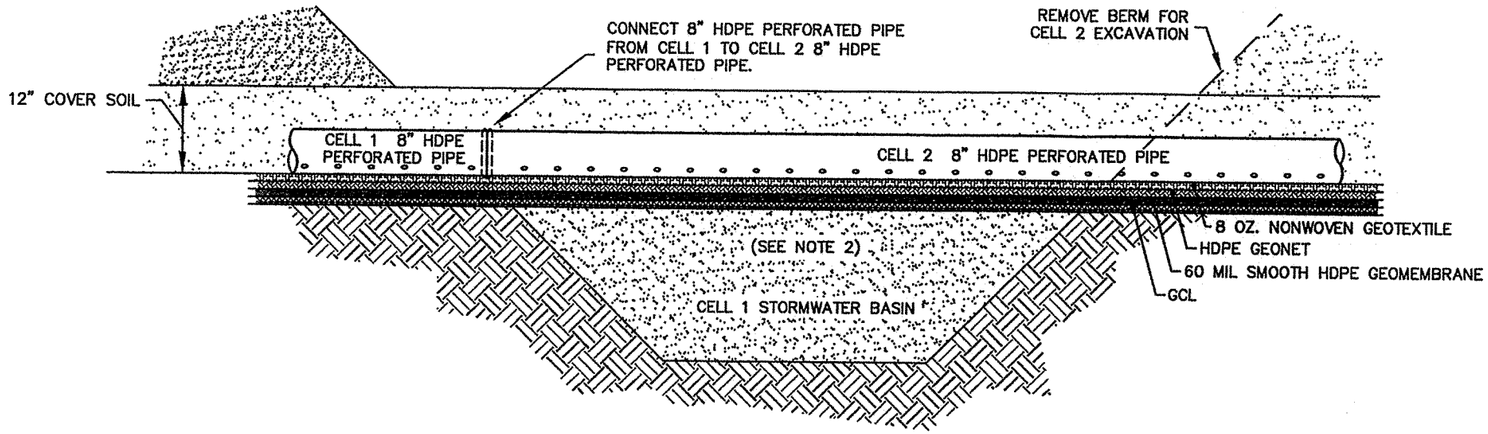
The CQA document will be submitted to NCDENR, Solid Waste Section, within 60 days following completion of construction of each phase.

Testing will be performed during closure of the phase. Test results will be provided as part of the closure certification.

10.0 REFERENCED LIST OF STANDARDS

ASTM C-31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C-33	Standard Specification for Concrete Aggregates
ASTM C-39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C136	Standard Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D422	Standard Method for Particle - Size Analysis of Soils
ASTM D448	Standard Classification for Sizes of Aggregate for Road and Bridge Construction
ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D698	Standard Test Method Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 4.4 lb. (2.49 kg) Rammer and 12-inch (305-mm) Drop
ASTM D751	Standard Methods of Testing Coated Fabrics
ASTM D792	Standard Test Methods for Specific Gravity and Density of Plastics by Displacement
ASTM D1004	Test Method for Initial Tear Resistance of Plastic Film and Sheeting
ASTM D1238	Test Method for Flow Rates of Thermoplastic by Extrusion Plastometer
ASTM D1556	Standard Test Method for Density of Soil in-Place by the Sand-Cone Method
ASTM D1557	Standard Test Methods for Moisture-Density Relations of Soils and Soil - Aggregate Mixtures Using 10-lb. (4.54-kg) Hammer and 18-in. (457-mm) Drop
ASTM D1603	Test Method for Carbon Black in Olefin Plastics

ASTM D2172	Standard Test Methods for Extraction of Bitumen from Bituminous Paving Materials
ASTM D2216	Standard Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, Soil - Aggregate Mixtures
ASTM D2922	Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D2937	Standard Test Methods for Density of Soil in Place by the Drive-Cylinder Method
ASTM D3776	Test Method for Weight (mass) per Unit Area of Woven Fabric
ASTM D3786	Standard Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics - Diaphragm Bursting Strength Test Method
ASTM D4318	Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4595	Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
ASTM D4632	Standard Test Method for Breaking Load and Elongation of Geotextiles (Grab Method)
ASTM D4716	Standard Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile related Products
ASTM D4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile
ASTM D4833	Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D5084	Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
EPA/530/SW-89/069	The Fabrication of Polyethylene FML Field Seams



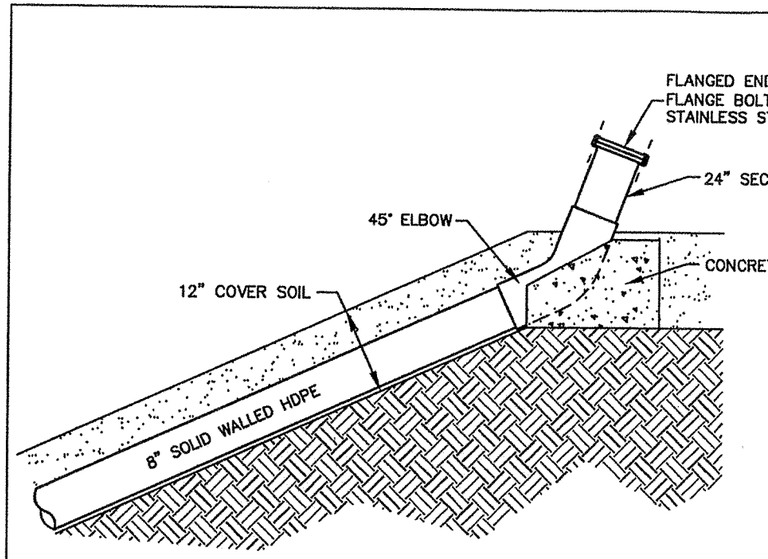
1) AFTER COMPLETION OF CELL 2 EXCAVATION AND INSTALLATION OF THE CELL 2 STORMWATER COLLECTION BASIN, THE CELL 1 STORMWATER BASIN WILL BE ABANDONED.

2) SOIL USED TO FILL CELL 1 STORMWATER BASIN TO BE PLACED IN ACCORDANCE WITH TECHNICAL SPECIFICATIONS, SECTION 2.3, CONSTRUCTION PLAN APPLICATION MM6451.01-0000.001.

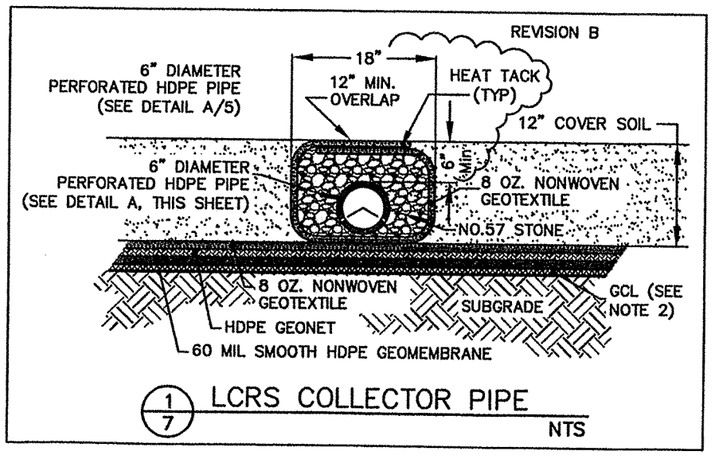
3) INSTALL LINER SYSTEM AS SHOWN.

4) REMOVE LEACHATE SUMP AND CONNECT 8" HDPE PERFORATED PIPE FROM CELL 1 TO CELL 2 8" HDPE PERFORATED PIPE.

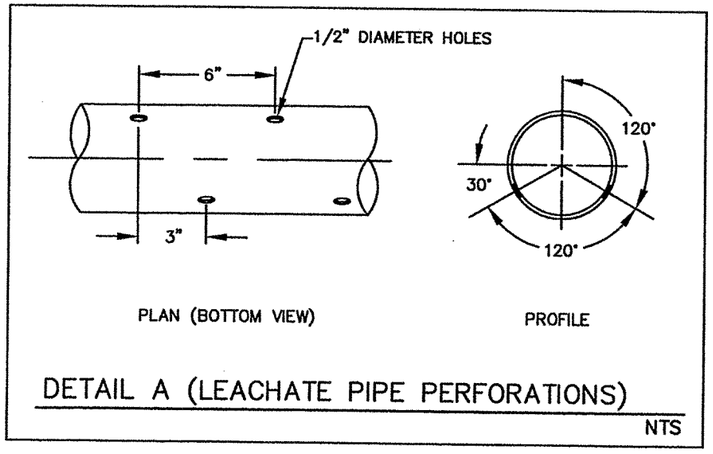
7/7 CELL 1 STORMWATER BASIN ABANDONMENT
NTS



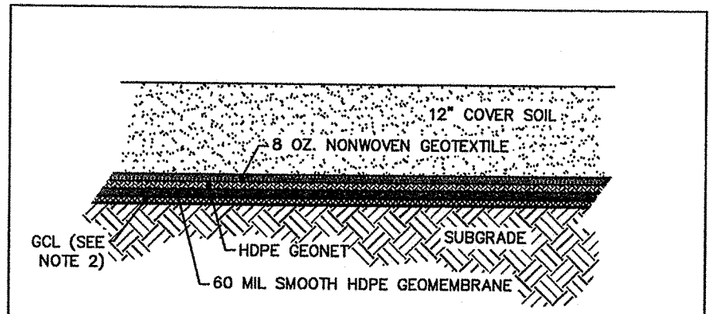
2/7 LEACHATE HEADER PIPE CLEANOUT



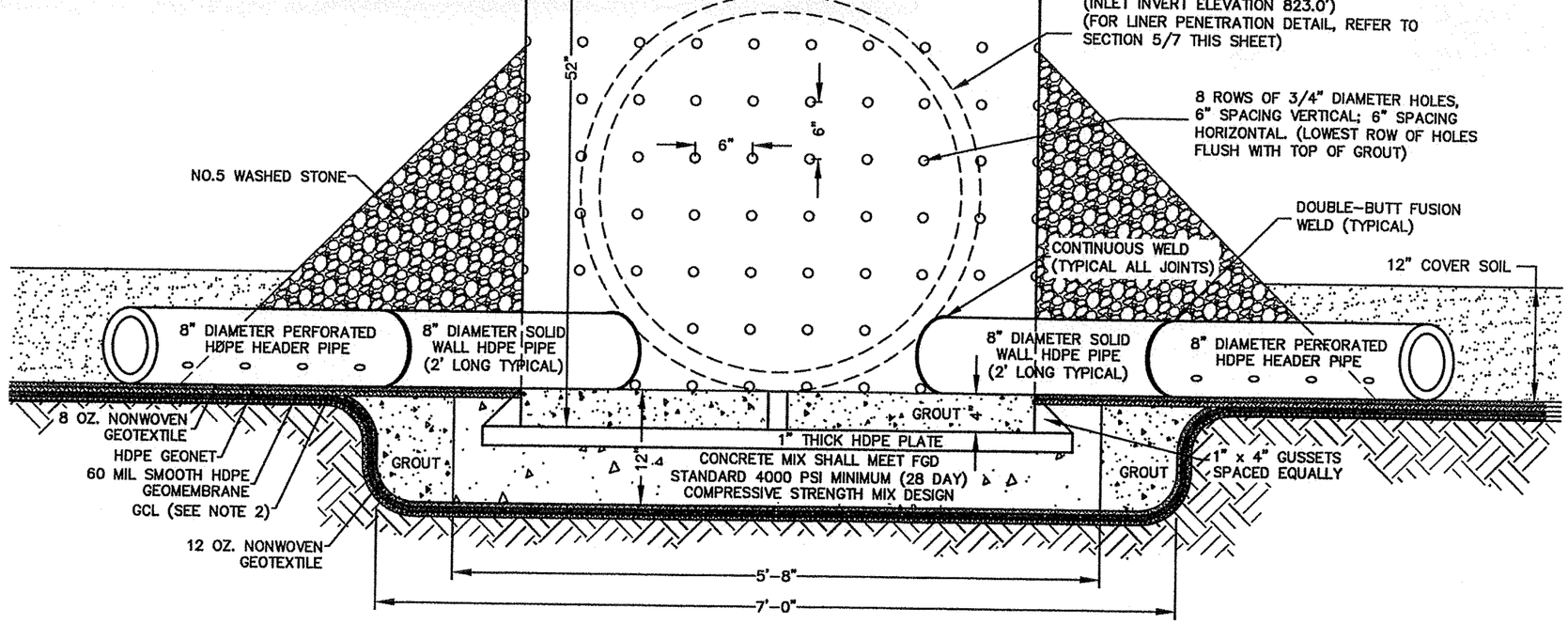
1/7 LCRS COLLECTOR PIPE
NTS



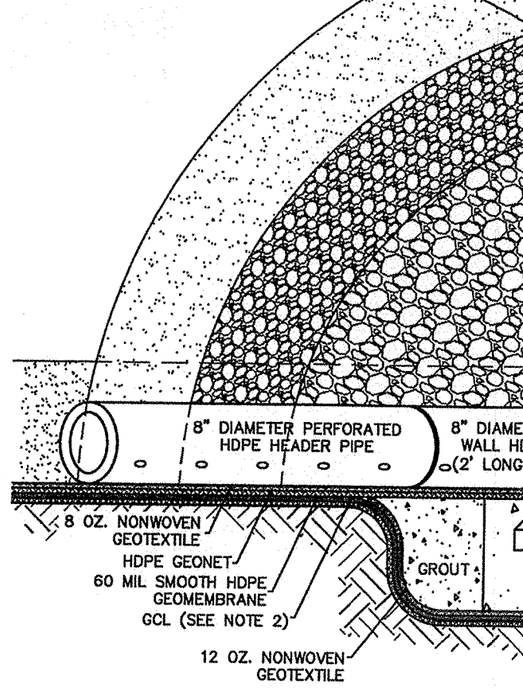
DETAIL A (LEACHATE PIPE PERFORATIONS)
NTS

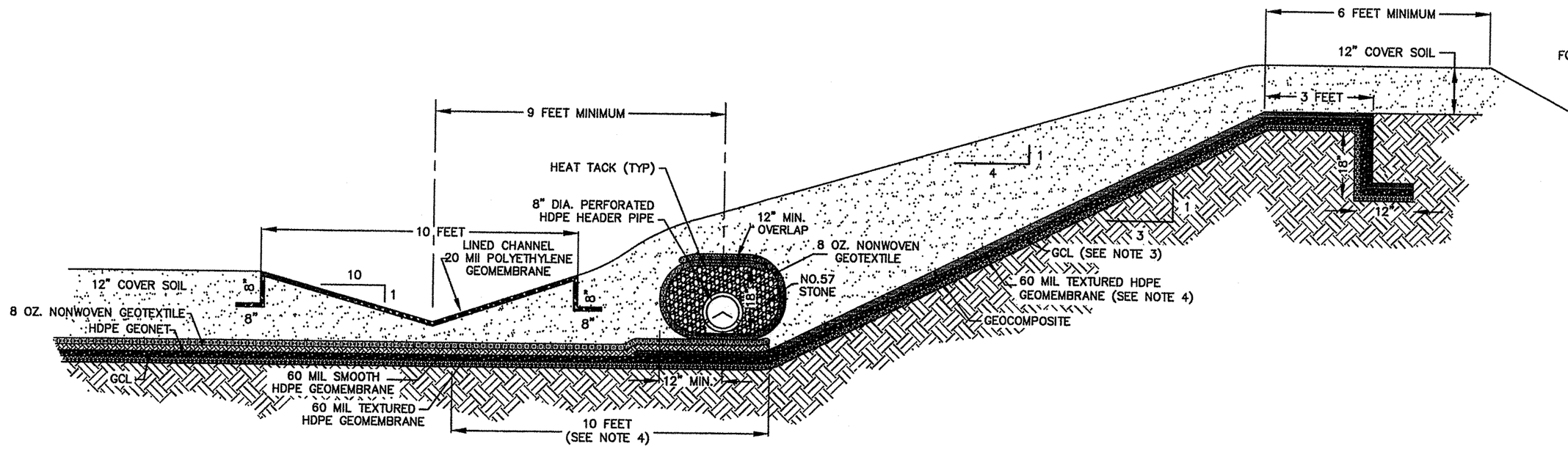


4/7 BOTTOM LINER SYSTEM
NTS

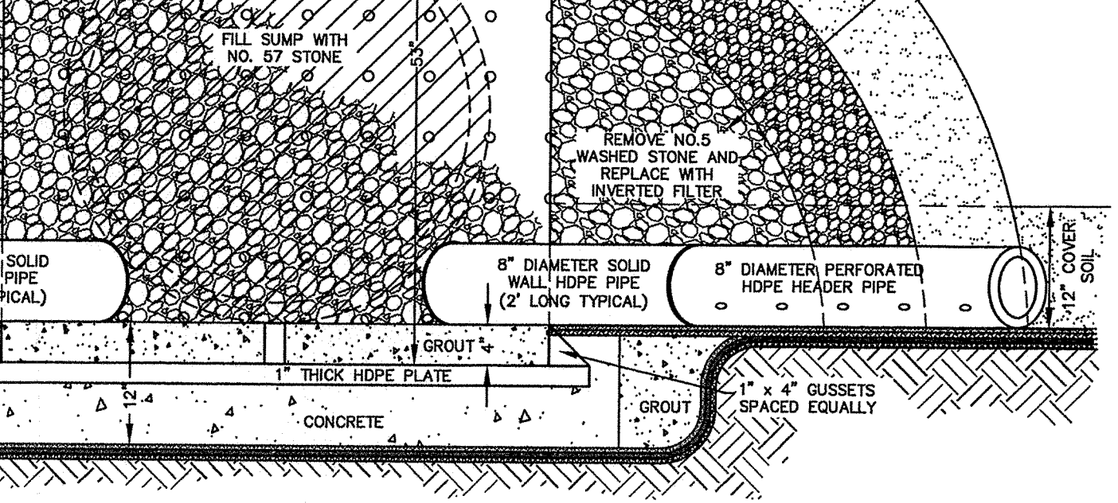


8/7 CELL 2 STORMWATER RISER
(SEE DETAIL B THIS SHEET FOR INACTIVE SUMP) NTS





3/7 LCRS HEADER PIPE
NTS



DETAIL B – INACTIVE LEACHATE SUMP
(PRIOR TO LANDFILLING OVER) NTS

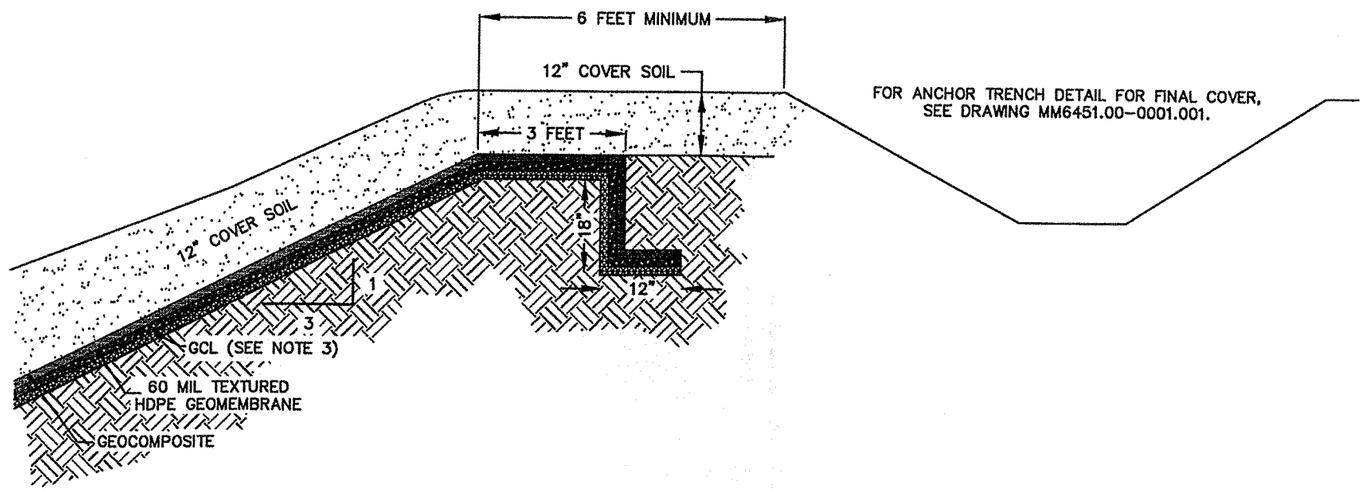
REQUIREMENTS.

2) GCL ON BOTTOM SURFACE OF LANDFILL SHALL BE CLAYMAX 600 CL OR EQUIVALENT.

3) GCL ON SLOPES SHALL REINFORCED GCL EQUIVALENT TO BE BENTOMAT DN. REINFORCED GCL SHALL EXTEND 10 FEET PAST THE TOE OF SLOPE, ONTO THE LANDFILL FLOOR.

4) TEXTURED 60MIL HDPE GEOMEMBRANE SHALL BE USED ON THE SIDE SLOPES. THE TEXTURED GEOMEMBRANE SHALL EXTEND 10 FEET PAST THE TOE OF THE SLOPE, ONTO THE LANDFILL FLOOR.

AL COVER,
001.



6/7 LINER SYSTEM ANCHOR TRENCH
(TYPICAL) NTS

MARSHALL STEAM
FGD RESIDUE LA
CATAWBA COUNTY, NORTH CA

REVISIONS

B	01/24/06	Revised For DENR Comments
A	12/15/05	ISSUED FOR CPA

PROJECT #: 046003.001 DATE: 12/15/05

DRAWN BY: DC CHECKED BY: DB

TITLE
Cell 1 And Cell 2 -
DETAILS

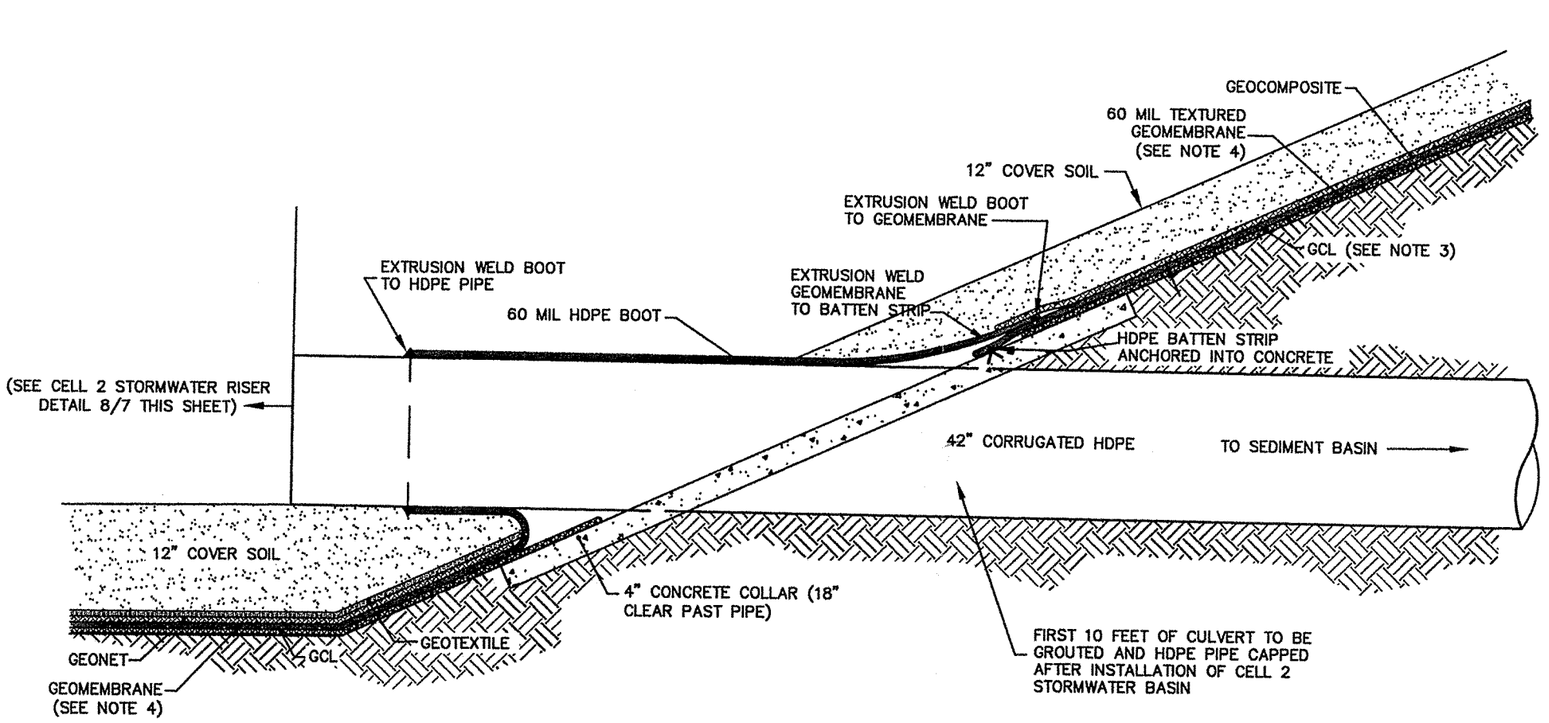
DOCUMENT NO:
MM6451.00-0007.001

ITH 1/2" HDPE BLIND
WITH (4) 1/2"
BOLTS.

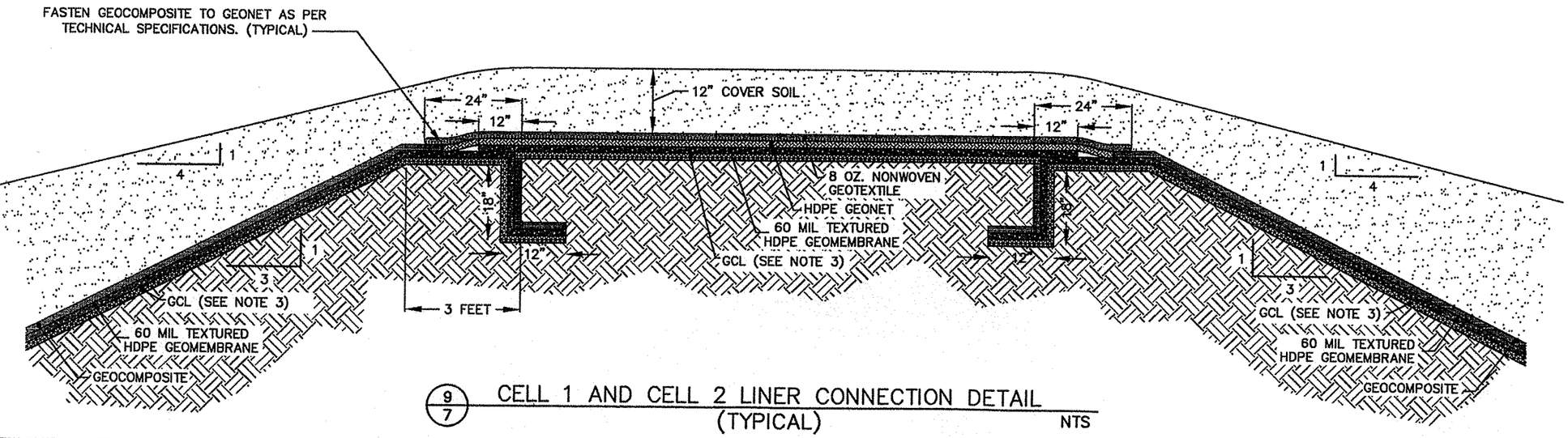
N OF PIPE

CRADLE BALLAST

NTS



5/7 STORM WATER COLLECTION AND REMOVAL (SWCR) CULVERT PENETRATION.
NTS



9/7 CELL 1 AND CELL 2 LINER CONNECTION DETAIL (TYPICAL)
NTS

CHAS. H. SELLS, INC.
Consulting Engineers, Surveyors & Photogrammetrists
128 Overhill Drive
Suite 1
Mooresville, NC 28117
Tel: 704-662-01
Fax: 704-662-0
www.chashells.com

NORTH CAROLINA PROFESSIONAL SEAL 17582 ENGINEER DAN E. BREWER
1/24/06

TION
L