Colorado Department of Public Health and Environment
Radioactive Materials License 1102-01
Renewal Application

Volume 6 of 7

Contents:

Clean Harbors Deer Trail (CHDT). 2004. Permit Renewal Report for Incorporation of a Geosynthetic Clay Liner (GCL) in the Liner Section for Secure Cells 3 Through 7 and in the Cover Section for Secure Cells 1 Through 7 (the Permit Renewal Report – Volume 2).

May 2010

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CLOSURE PLAN

I FACILITY CONDITIONS

A. GENERAL INFORMATION

A.1. Facility Description - Waste Management Units

The currently permitted site occupies approximately 325 acres. The Facility, at the time of closure, will include:

A.1.1. Six closed, capped, graded and vegetated Secure Disposal Cells occupying approximately 90 acres;

A.1.2. One open, active Secure Disposal Cell occupying approximately 10.3 acres of surface area, with approximately 12,500 yd^3 of capacity available (Secure Disposal Cell 7);

A.1.3. Two Contaminated Water Storage Tanks with a capacity of approximately 250,000 gallons each;

A.1.4. One Treatment Building with 15,000 ft^2 of Treatment Area. The Treatment Area includes 4 steel lined treatment mixing basins (each 20 ft wide x 80 ft long x 10 ft deep, 2,400 yd^3 capacity). The Treatment Building is underlain with a clay, synthetic, and concrete lining system that occupies approximately 89,000 ft^2;

A.1.5. One 2,760 ft^2 Off-site Truck Wash building, including a 3,300 gallon wash water recycling system with lined collection sump (17,000 gallon capacity) and lift pump to the Contaminated Water Storage Tanks;

A.1.6. An On-Site Truck Wash bay with a 4,000 gallon underground sump collection tank;

A.1.7. A 4,000 gallon Operations Building/Laboratory/Sampling Station underground collection tank;

A.1.8. Two packed column air scrubber systems with 2,500 gallon liquid capacity each;

A.1.9. Three dust conveyer systems from the Treatment Building baghouses;

A.1.10. One decontamination room attached to the south side of the Containment Building with a 500 gallon capacity sump; and

A.1.11. One Container Management Area located within the Treatment Building, including a Class I and II drum storage area (11,000 gallon capacity), Class III drum storage area (22,000 gallon capacity), drum shredder, and conveyor system.

A.1.12. Two Container Storage Areas totaling 65,400 ft^2 of concrete paving plus curbing.

A.2. Secure Disposal Cell Description

The Secure Disposal Cells within the Facility receive processed waste from drums, treated waste, and direct-bury wastes. The Secure Disposal Cells vary in size from approximately 300 ft by 600 ft by 40 ft deep for Secure Cells 1 and 2 to approximately 500 ft by 900 ft by 60 ft deep for Secure Cells 3 and 7 to approximately 500 ft by 600 ft by 70 ft deep for Secure Cells 4, 5 and 6.

Each Secure Disposal Cell design incorporates a clay and synthetic double composite liner system. A complete description of the Secure Disposal Cell design is provided in Part VI of the Permit.

A.3. Facility Description - Non-waste management Units / Not Part of Closure Plan

The following buildings and facilities are on-site, however they do not and are not anticipated to be used for waste management activities. The closure of these units is not covered by this closure plan, nor are the costs associated with the closure of these units included in the Closure Cost Estimate. If at any time, the Permittee or the Department determines that hazardous wastes have been managed in these units, the Closure Plan and Closure Cost Estimate must be modified. The Department must be notified within 15 days of the determination and the Modification Request must be submitted within 30 days of the determination.

A.3.1. One truck ramp shelter and containment sump (8,900 gallon capacity);

A.3.2. One 2,400 ft^2 truck Sampling Station;

A.3.3. One 250 ft^2 Guard/Scale House and 1,200 ft^2 weigh station;

A.3.4. One 12,000 ft^2 Maintenance Building;

A.3.5. Two 11,050 ft^3 and one 22,100 ft^3 dry treatment reagent silos; two 4200 gallon tanks and one 2600 gallon mixing tank for liquid reagent;

A.3.6. One 7,500 ft^2 Operations Building with office space, employee areas, drivers' lounge, and laboratory ;

A.3.7. Two 10,000 gallon diesel fuel underground tanks and one 3,000 gallon gasoline underground tank;

A.3.8. Approximately 150,000 square feet of gravel base roadways (approximately 3.4 acres);

A.3.9. Approximately 60,000 square feet of segregated stormwater drainage ditches (approximately 1.4 acres);

A.3.10. One Segregated Stormwater Retention Basin (SSRB) occupying approximately 1.5 acres with approximately 3.5 million gallons capacity;

A.3.11. One closed lift station (segregated stormwater) occupying approximately 0.25 acres;

A.3.12. Approximately 784,700 ft^2 of concrete paved access roads and parking areas, including the access road from Highway 36 (approximately 16 acres);

B. PARTIAL CLOSURE REQUIREMENTS

Partial closure activities associated with the Facility will consist of closing individual Secure Disposal Cells and dedicated cell haul roads. Phased development, background sampling and testing, phased closure sampling and testing, and final cover construction activities are described below:

B.1. Phased Development

After Secure Disposal Cells 1 and 2 are excavated, filled and capped in sequence, closure activities for this area will be initiated. Temporary drainage ditches and channels will be restored to permanent drainage

structures. Closure of all Secure Disposal Cells 1 and 2, and access roads will be carried out as described in Sections III and IV of this Closure Plan.

Secure Disposal Cells 3 through 7 will be constructed, filled, and closed in the general sequence shown in the Site Development Drawings.

At the time of final closure of the Facility and assuming that all permitted secure disposal cells have been built, all Secure Disposal Cells except Secure Disposal Cell No. 7 will have been capped, graded, and vegetated. The activities remaining to complete final closure of the Facility consist primarily of decontamination of appropriate structures and equipment, closure of the Treatment Building Surface Impoundment and closure of Secure Disposal Cell No. 7, final grading of the Facility as a whole to provide uniform drainage, and vegetation of graded and previously unvegetated areas to prevent erosion. These activities are described in Sections III and IV of this Closure Plan.

In order to maintain the security of the closed Secure Disposal Cells, the partially closed areas will be inspected as part of the Facility's normal operations in accordance with the Inspection Plan. Maintenance will be performed as required in response to inspections and in accordance with procedures outlined within this Closure Plan.

A background soil sampling and testing program was completed after initial construction of the Facility but prior to waste acceptance at the Facility. Results of this background soil sampling and testing program are maintained as part of the Operating Record.

B.2. Closure Soil Sampling and Testing

At closure of each Secure Disposal Cell and its associated structures, a soil sampling and testing program will be conducted over the area to be closed. Samples will be taken in areas of obvious contamination. Representative soil samples will be taken at a depth of 0 to 6 inches, and analyzed for soil pH and 6 CCR 1007-3, §261, Appendix VIII constituents that the facility disposed in that disposal cell.

For each phase's closure the sampling and testing program will include a minimum of 5 samples taken for every 400 ft of roadway within the area to be closed. If contamination is found, the extent of contamination must be determined in a horizontal and vertical direction. Contaminated soils must be removed until a 6-inch vertical stratum of soil in the contaminated area meets the following decontamination criteria.

Soils will be considered decontaminated when analyses of soil pH and 6 CCR 1007-3, §261, Appendix VIII results indicate that background levels have been met. Test methods and procedures will be those specified in the Waste Analysis Plan. Sampling methods, procedures, record keeping protocol and soil sampling equipment will be those specified in Section III. Contaminated soils will be transferred to an active on-site Secure Disposal Cell or to another permitted hazardous waste disposal facility.

B.3. Special Requirements for Secure Disposal Cell Final Cover Systems

Cover systems for each Secure Disposal Cell will be constructed in increments as soon as weather conditions permit after final waste placement. The construction of each Secure Disposal Cell's final cover system will be in accordance with the Secure Disposal Cell cover plans and specifications included in Attachment 10.1 of this Permit. Vegetative cover will be applied and completed for each Secure Disposal Cell as soon as weather conditions permit according to the specifications in this Closure Plan. Vegetative cover seeding will be completed within a maximum of 6 months after the final cover system construction is completed. If vegetative cover can not be installed in the optimal planting times (May or

October/November), then the covers will be seeded with field crops such as millet, oats, alfalfa, or other appropriate crop. The final vegetative cover will then be drilled at an optimal planting time.

C. NOTIFICATION REQUIREMENTS

The Department will be notified a minimum of 180 days prior to the date the Facility is expected to begin final closure. In addition, the Director will be notified in writing at least 60 days prior to the date on which the facility expects to begin closure of a landfill unit, and the Director will be notified in writing at least 45 days prior to the date on which the facility expects to begin closure of the storage tanks or container storage area. The Director will be notified at least 30 days prior to the date the Permittee expects to begin closure of any piece of equipment.

D. AMENDMENT REQUIREMENTS

This Closure Plan can be amended at any time during the life of the Facility. At a minimum, this plan will be amended whenever changes in the Facility operating plans or design affect the Closure Plan or whenever there is a change in the expected year of closure. Whenever the Permittee requests a permit modification to authorize a change in the Facility operating plans or design, a request to modify the Closure Plan will be submitted at the same time. If a permit modification is not needed to authorize the change in the Facility operating plans or design, the request for modification of the Closure Plan must be made within 60 days after implementing the change in plans or designs. The Director of the Colorado Department of Public Health and Environment (CDPHE) will review and approve any proposed modifications to the plan prior to the amended plan becoming effective.

E. AUXILIARY EQUIPMENT INVENTORY

The following is an example list of equipment that may be used to facilitate the handling of waste and other materials during the closure period:

- bulldozers
- backhoes
- dump trucks
- graders
- water trucks
- pickup trucks
- vacuum trucks
- loaders
- steam cleaning units
- forklifts
- compactors.

F. FINAL CLOSURE SCHEDULE

F.1. Overview:

Final Closure of the Facility is ultimately dependent on consumption of disposal capacity. Final closure activities will be completed in accordance with this plan and within 180 days after receiving the final volume of hazardous waste. Closure of any cell may be delayed pending weather conditions.

F.2. Anticipated Schedule

The schedule of closure for each disposal cell will be dependent on waste receipts. However, the following schedule includes estimated closure milestone dates, which will allow tracking of the progress of closure of each secure cell:

CLOSURE ELEMENT	DAYS ELAPSED
Final receipt of waste	0
Active waste management area surrounding cell, access roads, decontaminated	130
Secure Cell backfilled and compacted	130
Secure Cell cap completed	155
Secure Cell vegetated	175
Secure Cell Closure Certification	180

The following schedule includes estimated closure milestones for final Facility Closure. These milestones will allow tracking of the progress of closure. The initial element of closure will be final receipt of wastes at the Facility:

CLOSURE ELEMENT	DAYS ELAPSED
Final receipt of waste	0
All drums and other containers processed and transferred off-site or treated and disposed of in the active Secure Disposal Cell	36
All waste treated and transferred to the active Secure Disposal Cell	36
Solvent/Oil Storage Tanks contents shipped off-site	36
Container Management Building decontaminated	45
Reagent Silos, Tanks and ancillary components decontaminated	45
Treatment Building, truck unloading, roll-off loading areas decontaminated	50
Treatment Process and Staging Areas within the Treatment Building decontaminated	65
Solvent/Oil Storage Tanks decontaminated	75
Treatment Building removed from site	95
Treatment Building lining system removed	125

CLOSURE ELEMENT	DAYS ELAPSED
Off-site Truck Wash decontaminated	130
Active Waste Management Area (Active Secure Disposal Cell access road and most of process area, including Container Storage Areas)	
Active Secure Disposal Cell backfilled and compacted	130
Treatment Building area backfilled	145
Gravel roads and Site Access Roads (if necessary) decontaminated	145
Active Secure Disposal Cell capped	155
Fuel Tanks emptied and decontaminated	155
On-site Truck Wash decontaminated	155
Operations Building laboratory decontaminated	155
Auxiliary equipment decontaminated	155
Contaminated Water Storage Tanks emptied	165
Contaminated Water Storage Tanks decontaminated	175
Closed Secure Disposal Cell , and Treatment Building liner area, vegetated;	175
Closure certified	180

II TREATMENT AND DISPOSAL OF WASTE INVENTORY

A. MAXIMUM VOLUME OF WASTE ON-SITE AT FINAL CLOSURE

This Closure Plan assumes that the Facility's various waste storage units listed will be filled to capacity when the closure period begins. The actual volume of wastes on-site when the closure period begins will likely be less.

A.1. Liquids - 563,800 gallons as follows:

A.1.1. 11,000 gallons (200 drums) of oils and solvents in the Class I and II Drum Storage Area;

A.1.2. 500,000 gallons of contaminated water in the Contaminated Water Storage Tanks;

A.1.3. 28,800 gallons of contaminated water in the following locations:

- 3,300 gallons in the Off-site Truck Wash recycle tanks
- 17,000 gallons in the Off-site Truck Wash sump
- 4,000 gallons in the Maintenance Building sump collection tank
- 4,000 gallons in the Operations Building/Sampling Station sump collection tank

- 500 gallons in the Treatment Building decontamination room sump

The water in the Contaminated Water Storage Tanks will be treated on-site with the available waste water treatment systems. The treated water will be discharged in accordance with the Facility's CDPS Permit.

A.2. Sludges - 2,509 yd^3 of untreated waste as follows:

A.2.1. 109 yd^3 (22,000 gallons) of untreated containerized waste (assumed to be sludge) in the Class III Drum Storage Area; and

A.2.2. 2,400 yd^3 of untreated waste in the treatment mixing basins.

A.3. Solids - 1,994 yd^3 as follows:

A.3.1. 14 yd^3 of untreated solids in the floor drains, collection tanks, and the Truck Wash recycle unit; and

A.3.2. 1,980 yd^3 of untreated containerized waste in the Container Storage Area

B. OFF-SITE DISPOSAL

B.1. Drum Storage Areas

Approximately 200 drums of oils and solvents or other waste could be stored in the Class I and II Drum Storage Area of the Container Management Area. Therefore, approximately 11,000 gallons may require shipment to an off-site disposal facility. Class III or other containerized waste not excluded for disposal at the Facility will be treated and disposed of in the active Secure Disposal Cell as described in II.C. of this Closure Plan.

B.2. Approved Commercial Treatment, Storage, and Disposal Facilities

Facilities that might be used for disposal of waste inventory during closure will only be those that are properly permitted for the type of waste being shipped off-site.

B.3. Maximum Inventory Requiring Off-Site Disposal

B.3.1. Aqueous Materials - none

B.3.2. Oil/Solvent Materials - 11,000 gallons

C. ON-SITE TREATMENT AND DISPOSAL

Maximum inventory requiring on-site treatment and/or disposal:

C.1. Treatment

1,980 yd^3 in Container Storage Area

109 yd^3 of materials in drums

2,400 yds^3 in treatment mixing basins

14 yd^3 of materials from drains and sumps

4,503 yd^3 TOTAL requiring treatment

C.2. Secure Disposal Cell Placement

4,503 yd^3 of treated material (4,503 x (1+ 0.6)) = 7,205 yd^3 TOTAL

C.3. Wastewater Treatment

500,000 gal Contaminated Water Storage Tanks

28,800 gal in the Facility sumps

528,800 gal TOTAL

III DECONTAMINATING THE FACILITY

A. PROCESS AND OPERATIONS AREA/ROADS

A.1. The process area and site roads that may require decontamination consist of:

A.1.1. The concrete paved entrance road from Highway 36 to the bermed processing area within the Facility (approximately 413,400 ft^2)

A.1.2. The concrete paving within the active waste management area of the Facility including the Secure Disposal Cell 7 haul road (approximately 371,300 ft^2).

A.1.3. The concrete paving within the Container Storage Area (approximately 65,400 ft^2).

A.1.4. The gravel roadways around the Secure Disposal Cell area (approximately 150,000 ft^2).

A.2. All roadways within the Facility are designated for either on-site or off-site vehicle use. Off-site vehicles will travel only on the paved site entrance road and the roadways within the Facility process and operations area or on designated gravel roads for construction support or Facility monitoring. Vehicles leaving the active waste management area are required to be washed in either the On-site or Off-site Truck Washes, therefore contamination of the paved and unpaved roadways outside the active waste management area is not anticipated. All roads (including the access road) will be inspected for areas of obvious contamination and the facility operating record will be consulted to determine locations of past spills or contamination. The active waste management area is expected to consist of the concrete paved process area north of the Maintenance Building and the concrete paved access road to the active Secure Disposal Cell .

A.3. The background sampling and testing, decontamination, and closure procedures for the above listed roadways are described below.

A.3.1. Background Sampling and Testing

A background soil sampling and testing program was conducted in the process and operations areas and access roads after initial construction and prior to acceptance of hazardous wastes at the Facility. Representative samples were taken and analyzed as described in Section I.B.2. of this Closure Plan.

A.3.2. Concrete Paved Areas

As discussed above, this Closure Plan assumes that only the concrete paved areas including the Container Storage Area within the active waste management area will require decontamination

(approximately 436,700 ft^2). Decontamination of the active waste management area will employ the on-site high pressure water cleaning unit. These concrete surfaces will be hydroblasted with an appropriate industrial strength detergent solution. Wash water will drain into adjacent Segregated Stormwater drainage ditches and into the SSRB or temporary storage containers. Representative rinsate samples will be collected from either the ditches, SSRB, or temporary storage containers.

The paved areas will be considered decontaminated on the removal of all visible residues and when a final rinsate volume of 300 gallons or less, at 400 foot intervals, produces a TOC level of less than 50 ppm and pH between 6 and 9. Test methods will be those specified in the Waste Analysis Plan.

Contaminated rinse water will be collected for either on-site treatment in the waste water treatment facility or for disposal at an interim status or permitted hazardous waste disposal facility.

A.3.3. Gravel Roads

This closure plan assumes that there will be no gravel roads requiring decontamination. If decontamination is necessary, the decontamination of all gravel roads that have been used to transport waste material will employ the procedures described below:

A.3.3.1.Sampling:

A sampling program will be initiated to determine the existence and extent of any contamination that may be present on the gravel roadways utilized by equipment going into or out of a disposal cell.

The gravel and soil sampling program will be conducted utilizing a grid system. Samples will be obtained in any areas of obvious contamination and within the grid system. Samples will be taken at a depth of 0 to 6 inches. Composites may be prepared from these samples at a ratio of 5 to 1 and analyzed. The dimensions of the grids will be 400 ft by 50 ft with the long axis of the grids parallel to the center line of the access roads.

Five sampling locations within each grid will be selected randomly. However, within each grid, if an area(s) of potential contamination is noted (i.e., soil discoloration and/or odor), 1 of the sampling locations will be located in that area.

At each sampling location (5 per grid), the sample will be obtained by advancing a bucket or hand auger to a depth of 0 to 6 inches. Each sample will be visually characterized, noted in a field log book and placed in precleaned glassware with Teflon-lined caps. Each sample container will be labeled as to sample location and depth interval, and the chain of custody will be initiated for shipment to an approved analytical laboratory facility. During the sampling activity, the bucket-type hand auger and auxiliary sampling equipment will be cleaned using detergent, distilled water and acetone. The sampling equipment will be rinsed using distilled water to avoid cross contamination.

A minimum of 5 samples will be taken for every 400 ft of gravel roadway within the landfill area.

A.3.3.2.Decontamination:

Samples will be taken in the areas described above and analyzed for soil pH and 6 CCR 1007-3 '261, Appendix VIII constituents that have been disposed in the secure disoposal cell being closed.

If contamination is found, the extent of contamination must be determined in a horizontal and vertical direction. Contaminated soils must be removed until a 6-inch horizontal and vertical

stratum of soil in the contaminated area meets the requirements specified below for decontamination as determined by representative soil samples within the contamination zone.

Soils will be considered decontaminated when analysis of soil pH and 6 CCR 1007-3 '261, Appendix VIII results indicate that background levels have been met. Test methods and procedures will be those specified in the Waste Analysis Plan. Contaminated soils will be transferred to the active Secure Disposal Cell or to an off-site permitted hazardous waste disposal facility.

A.4. Treatment Building - Primary and Secondary Containment

Treatment Building closures will include the Treatment Building primary and secondary liner systems.

A.4.1. Background Sampling and Testing:

Prior to placement of the Treatment Building liner systems, a background soil sampling program was conducted in the area of each impoundment. This pre-operational data was used to establish background parameters and to specify the extent of closure activities.

Ten representative soil samples were taken at a depth of 0 to 6 inches for each unit impoundment and analyzed for soil pH, heavy metals, priority pollutants, and the first 10 major peaks that are quantifiable above 25 percent of the internal standard of 10 ppb, as identified by GC/MS. Background levels for inorganics (except pH) were established at the mean value plus 2 standards deviations; and for organics, background was established at the practical quantification limit. The sampling methods, procedures, record keeping protocol and the soil sampling equipment were those specified in this Closure Plan. Soil samples may have been composited in a ratio of 2:1 (i.e. two samples may have been composited for one analysis). Test methods and procedures were those specified in the Waste Analysis Plan.

A.4.2. Disposal Volumes:

During closure, the concrete floor, HDPE liners, clay liners, and all associated components including the leak detection systems, riser pipes and geotextiles will be removed. These removed materials will be transferred to Secure Disposal Cell 7 or to an appropriately permitted waste disposal facility.

If during the life of the building monitoring of the leak detection system has indicated a failure of the primary containment system, a soil sampling program will be conducted in the excavated area. If required, the soil sampling program will be conducted following removal of the liners.

The following estimated volumes of materials of the Treatment Building's primary and secondary containment systems:

Treatment Building Primary and Secondary Containment Systems

Backfill Between Building and Liner	14,600 yd^3
Clay Liner	17,000 yd^3
Concrete	3,822 yd^3
Steel Plate Liner	150 yd^3
HDPE/Geonet	318 yd^3

Total	35,890 yd^3

A.4.3. Closure Sampling Program:

For purposes of this Closure Plan, it is assumed that the closure sampling program will not be required. If at any time during the active life of the facility a leak is detected in the Leak Detection System of the Treatment Building, the Closure Plan and Closure Cost Estimate must be modified. The Department must be notified within 15 days of the determination and the Modification Request must be submitted within 30 days of the determination.

If required, the sampling program for the excavated area will be conducted utilizing a grid system. Samples will be obtained within the grid system from a depth of 0 to 6 inches. Composites will be prepared from these samples at a ratio of 5:1 (five samples may be composited into one for analysis) and analyzed. The dimensions of the grids will be 100 ft by 100 ft.

Five sampling locations within each grid will be selected randomly. At each sampling location, samples will be obtained by advancing a bucket type hand auger to a depth of 0 to 6 inches. The samples will be visually characterized, noted in a field log book and placed in precleaned glassware with Teflon-lined caps. Each sample container will be labeled as to sample location and depth interval and the chain of custody initiated for shipment to an approved analytical laboratory facility. During the sampling activity, the bucket-type hand auger and auxiliary sampling equipment will be cleaned using detergent, distilled water and acetone. The sampling equipment will be rinsed using distilled water to avoid cross contamination.

A.4.4. Decontamination:

The soil sampling program described above will generate at least 20 representative samples (that may be composited into 4 samples) taken at a depth of 0 to 6 inches. Samples will be taken in areas of obvious contamination. If contamination is found, the extent of contamination must be determined in a horizontal and vertical direction. Contaminated soil must be removed until a 6-inch horizontal and vertical stratum of soil in the contaminated area meets the decontamination criteria specified below, as determined by 5 representative soil samples or a composite of these five samples within the contamination zone.

Soil will be considered decontaminated when analysis of soil pH and 6 CCR 1007-3 '261, Appendix VIII results indicate that background levels have been achieved. Test methods and procedures will be those specified in the Waste Analysis Plan. Sampling methods, procedures, record keeping protocol and the soil sampling equipment will be those specified above. Contaminated soils will be transferred to Secure Disposal Cell 7 or to a permitted hazardous waste disposal facility.

A.4.5. Final Closure:

Following decontamination and testing, if required, of the Container Building Area, the excavation will be backfilled and final cover will be placed over the backfill.

For purposes of this closure plan, the estimated amount of solids generated during closure that may require disposal is 8,973 yds^3. This is based on the assumption that 25% of the Treatment Building containment system will require disposal. If at any time during the active life of the facility a leak is detected in the Leak Detection System of the Treatment Building, the Closure Plan and Closure Cost Estimate must be modified to include the entire containment system. The Department must be notified within 15 days of the determination and the Modification Request must be submitted within 30 days of the determination.

B. EQUIPMENT AND STRUCTURES

B.1. Potentially contaminated equipment and structures will be either decontaminated, disposed of in Secure Disposal Cell 7, or transferred to an interim status or permitted facility for disposal. This Closure Plan assumes decontamination procedures will be used.

B.2. Potentially contaminated equipment and structures will be decontaminated by hydroblasting with an appropriate industrial strength detergent solution or another appropriate 40 CFR 268.45 procedure or transferred to industrial or hazardous waste service. Hydroblasting is assumed for closure cost estimate purposes. The hydroblasting will be done in either the on-site or off-site Truck Wash areas, where practical, or in-situ when necessary. The wash water in the Truck Wash areas will drain to the sump before being transferred for on-site treatment or off-site for disposal. The wash water generated from in-situ cleaning will be collected by a pump or vacuum truck, or similar piece of equipment before being treated or shipped off-site. All contaminated facility equipment, structures and protective clothing that will not be decontaminated will be disposed of in Secure Disposal Cell 7 or shipped to a permitted or interim status hazardous waste disposal facility.

B.3. The volume of wastewater generated during the decontamination of the various equipment and structures at the Facility includes wash water from the decontamination of the associated concrete systems and concrete pads. A summary of these volumes are provided in the Closure Cost Estimate.

B.4. It is estimated that the decontamination activities will generate 250,000 gallons of wastewater with an amount of sediment equal to 5 percent of the wastewater created by mass, and it is estimated that approximately 12,500 gallons (62 yd^3) of sediment will have to be disposed of in Secure Disposal Cell 7 after decontamination.

B.5. The decontamination criteria and specific procedures for the Container Management Building, tanks, sumps, Treatment Building, and heavy equipment are: equipment, tanks, and structures will be considered decontaminated upon the removal of all visible residuals and when a final rinsate volume of 300 gallons or less from 10 % of like equipment produces analytical results that indicate that 6 CCR 1007-3 '261, Appendix VIII constituent concentrations are no greater than maximum contaminant levels for drinking water and the pH is between 6 and 9. Test methods will be those specified in the Waste Analysis Plan. Rinsate that does not meet the above specifications will be collected for treatment on-site or disposal at an interim status or permitted waste disposal facility.

B.6. Container Management Building

Equipment in the Container Management Building (including the drum shredder and drum conveying system) will be disassembled and decontaminated in either the On-site or Off-site Truck Wash areas or disposed of by an approved method. It may also be transferred to another permitted hazardous waste facility to be used in hazardous waste service without decontamination or to an industrial application after removing gross contamination by visual inspection. Decontamination is assumed for closure cost estimate proposes. Representative rinsate samples will be collected at the drain of the Truck Wash area used.

The Container Management Building floor, berms, and any remaining structures will be decontaminated in place. Representative samples will be collected at the Container Management Building sumps.

B.7. Tanks

The Contaminated Water Storage Tanks, and the Off-Site Truck Wash recycling system surge tanks will be emptied during closure. The contents will be treated on-site or transferred to a permitted facility. The empty tanks, foundations, structural supports, piping and containment systems will be decontaminated,

disposed or transferred to other hazardous waste or industrial waste service without being decontaminated as described previously. Representative samples will be collected from each tank's containment area sump. (delay closing CWSTs for leachate collection during post-closure?)

B.8. Collection Sumps

The Maintenance Building underground sump collection tank, the Operations Building/Sampling Station underground sump collection tank, and the in-floor sump of the Off-Site Truck Wash will be emptied during closure. The contents will be treated on-site or transferred to an appropriately permitted facility.

If leaks have not been detected in the leak detection system throughout the life of the tank, the tank and all associated piping will be decontaminated and closed in place.

If leaks have been detected in the leak detection system during the life of the tank, the double-walled fiberglass tank piping, and any other associated structures will be removed. A soil sampling program will be implemented in the excavation pit created by removal of the tank and associated materials.

The soil sampling program will include a minimum of 10 samples taken at a depth of 0 to 6 inches and additional samples will be taken in areas of obvious contamination. (These samples will be collected as follows: 2 samples will be taken from the floor of each excavation pit, 1 sample will be taken from the wall of each excavation pit and 4 samples will be taken from the pipeline excavations). If contamination is found, the extent of contamination will be determined in a horizontal and vertical direction. Contaminated solids will be removed until a 6-inch horizontal and vertical stratum of soil in the excavation pit no longer contains hazardous constituents as determined by 10 representative soil samples within the contamination zone.

Soil will be considered decontaminated when analysis of soil pH and 6 CCR 1007-3 '261, Appendix VIII results indicate values within the mean plus two standard deviations background soil sampling values for inorganics and values below the practical quantification limits for organics, have been achieved. Test methods and procedures will be those specified in the Waste Analysis Plan. Sampling methods, procedures, record keeping protocol and the soil sampling equipment will be those specified herein for the closure of surface impoundments.

Contaminated soils will be disposed of in Secure Disposal Cell 7 or at an interim status or permitted hazardous waste disposal facility. All equipment and associated piping removed from the collection sump area will be decontaminated in either the On-site or Off-site Truck Wash.

Note: This Closure Plan assumes the sumps will require decontamination and in-place closure.

B.9. Treatment Building

Prior to dismantling (removal of walls and roof) the Treatment Building, the walls and roof, process equipment, and treatment mixing basins will be decontaminated. The building will be considered decontaminated upon the removal of all visible residues and when 2 representative rinse water samples (from two different locations along the face) collected from each face of the building meet the decontamination criteria specified in this Closure Plan.

B.10. Heavy Equipment

All equipment and heavy machinery remaining at final closure will be decontaminated in either the On-site or Off-site Truck Wash and meet the sampling standard for unrestricted use, or the transfer to another industrial user standard or transfer to another hazardous waste use standard .

C. CONTAMINATED RAINWATER COLLECTED DURING CLOSURE

The volume of contaminated rainwater collected during the closure period is estimated to be less than 150,000 gallons which is based on the operational experience of Clean Harbors Deer Trail.

All contaminated rainwater collected during the closure period will be transferred to the Contaminated Water Storage Tanks or temporary storage containers before being treated by the Facility's wastewater treatment systems or transferred off-site.

D. SUMMARY OF TOTAL VOLUME OF SOLID WASTE AND WASTEWATER REQUIRING TREATMENT AND/OR DISPOSAL DURING CLOSURE

D.1. Solid Waste Volume to be Disposed of in Secure Disposal Cell 7

On-site Inventory (treated volume)	5,629 yd^3
Treatment Building Liner Systems	8,973 yd^3
Decontamination Activities Sediment	62 yd^3
Total Volume	**14,664 yd^3**

D.2. Wastewater Volume to be Treated and Discharged On-site

On-site Inventory	528,800 gal
Contaminated Rainwater	150,000 gal
Decontamination Activities Wastewater	250,000 gal
Total Volume	**928,800gal**

D.3. Waste Volume to be Shipped Off-site

Oil/Solvent Materials	**11,000 gal**

IV BACKFILL, COVER, AND VEGETATION

A. BACKFILL REQUIREMENTS

A.1. Total Area to be Backfilled:

Treatment Building, approximately	2.1 acres
Secure Disposal Cell 7, approximately	10.3 acres
Total: approximately	12.4 acres

A.2. Total Volume to be Backfilled:

Treatment Building	8,973 yd^3
Secure Disposal Cell 7	
(8973- 8937 yd^3)	37 yd^3

Total	9,010 yd^3

A.3. Backfill Characteristics:

A.3.1. Types of Materials

Soils with varying amounts of silt and clay occur on-site in the very shallow subsurface. These soils typically exhibit permeability between 10^{-4} and 10^{-5} cm/sec. An abundance of this type of soil will be stockpiled from Secure Disposal Cell excavations at the time of closure. This material, along with stockpiled weathered shale from the Secure Disposal Cell excavations, will be the predominant backfill materials.

A.3.2. Total Amount of Backfill Material Required

A.3.2.1. Treatment Building

The volume requirement for backfilling the excavation remaining after closure of the Treatment Building lining system is approximately 8,973 yd^3. It is anticipated that approximately 10,319 yd^3 of backfill will be needed, assuming a 15 percent compaction factor.

A.3.2.2. Secure Disposal Cell 7

The estimated volume requirement for backfilling Secure Disposal Cell 7 after disposal of on-site inventory and decontamination residues/soils is approximately 37 yd^3. It is anticipated that 43 yd^3 of backfill will be needed, assuming a 15 percent compaction factor.

A.3.3. Source of Materials

Based upon backfill requirements, sufficient quantities will exist in on-site stockpiles to accomplish backfilling without excavations, or off-site purchases.

A.3.4. Earthmoving Procedures:

A.3.4.1. It is anticipated all earthmoving activities associated with backfill placement and compaction will be performed by subcontractors.

A.3.4.2. Equipment needed for hauling, spreading, compacting and grading.

(1) Backfill material will be removed from on-site stockpiles and transferred to points of application using loaders and haul trucks or scrapers and bulldozers.

(2) Backfill material will be spread, graded, and compacted using bulldozers, motor graders, and compactors.

B. FINAL COVER

B.1. Total Area to be Covered - Approximately 22.9 acres

- Treatment Building area - approximately 2.1 acres
- Secure Disposal Cell 7 - approximately 10.3 acres
- Other Facility areas - approximately 10.5 acres

B.2. Final Cover Characteristics for Treatment Building and other Facility Areas

B.2.1. Types of material

B.2.1.1. Clay Liner Material

At a depth between approximately 10 and 25 ft, a silty clay soil occurs within the landfill area of the Facility. This material will be utilized in the construction of the compacted clay liners that will cap the closed areas. The clays will be available from on-site stockpiles. Clay cover shall be placed and compacted according to the General Specifications for Liner and Cover Systems.

B.2.1.2. General Fill

This material will be utilized as the 3 ft cover soil layer over the composite liners of closed Secure Disposal Cells and will be the same material as that used for general backfill. Section IV.A.3.a. describes the characteristics for general backfill. The subsoil will be obtained from on-site stockpiles remaining from Secure Disposal Cell excavations. General fill shall be placed and compacted according to the General Specifications for Liner and Cover Systems.

B.2.1.3. Topsoil

Silty soils occur on-site in the very shallow subsurface. These soils will be used as topsoil. They typically exhibit permeability between 10^{-4} and 10^{-5} cm/sec. The topsoil will be obtained from on-site stockpiles remaining from Secure Disposal Cell excavations. Topsoil shall be placed and compacted according to the General Specifications for Liner and Cover Systems.

B.2.2. Depth of Materials

B.2.2.1. Treatment Building Area

Final cover for this unit will consist of a 1 ft thick layer of topsoil to promote vegetation and drainage.

B.2.2.2. Other Facility Areas

Final cover may be necessary in other Facility areas (segregated stormwater ditches, gravel roadways, former stockpile areas, etc.) to promote drainage and vegetation. Final cover for these areas will consist of an 8 inch thick layer of topsoil unless suitable soils for vegetation are present.

B.3. Final Cover for Secure Disposal Cells

The final cover system for all the Secure Disposal Cells is described within the Site Development Drawings and the associated Design and Construction Narrative.

B.4. Total amount of cover materials required

B.4.1. Clay - 57,500 yd3

Placing and compacting a 3 ft layer of clay over the 10.3 acres of Secure Disposal Cell 7 will require approximately 57,500 yd^3 of clay, assuming a 15 percent compaction factor.

B.4.2. General Fill - 57,500 yd3

Placing and compacting a 3 ft layer of General Fill over the 10.3 acres of Secure Disposal Cell 7 will require approximately 57,500 yd^3 of general fill, assuming a 15 percent compaction factor.

B.4.3. Topsoil - 12,800 yd3

To spread an 8 inch thick layer of topsoil to support a vegetative cover over the approximate 10.3 acres of Secure Disposal Cell 7 will require approximately 5,900 yd^3, assuming a compaction factor of 15 percent.

To spread a 1 ft thick layer of topsoil to provide drainage and support a vegetative cover over the 3.2 acres (total) of the Treatment Building and SSRB areas will require approximately 6,000 yd^3, assuming a compaction factor of 15 percent.

To spread an 8 inch thick layer of topsoil to support a vegetative cover over the approximate 11.5 acres of the other facility areas will require approximately 14,200 yd^3, assuming a compaction factor of 15 percent.

B.4.4. HDPE Geomembrane Liner - 450,000 ft2

Placing an 80 mil HDPE liner over approximately 10.3 acres (Secure Disposal Cell 7) will require an estimated 450,000 ft^2 of material.

B.5. Source of materials

Based upon the calculated requirements above, it is anticipated that sufficient quantities of final cover material will exist in on-site stockpiles without excavations or off-site purchases. The geomembrane will be available from off-site purchases.

B.6. Earthmoving Procedures:

B.6.1. It is anticipated all earthmoving activities associated with the application of final cover will be performed by off-site contractors.

B.6.2. Equipment needed for hauling, spreading, compacting, and grading.

Final cover materials will be transported by either haul trucks or scrapers from on-site stockpiles to the points of application.

Final cover materials will be spread, compacted, and graded using bulldozers, motor graders, and compactors, if necessary.

B.6.3. Source of Equipment

All equipment and operators described above will be subcontracted.

C. VEGETATION

C.1. Total Area Requiring Vegetation - approximately 23 acres:

C.1.1. Treatment Building Area - 2.1 acres

C.1.2. Secure Disposal Cell 7 - 10.3 acres

C.1.3. Other Facility areas assumed to require vegetation during closure (gravel roads, former stockpile areas, etc.) - approximately 10.5 acres.

C.2. Vegetation Characteristics

C.2.1. Name or type of vegetation:

Blue gamma, Western Wheatgrass and Buffalo grass will be used at the Permittee as a final cover to prevent erosion.

C.2.2. Climatic, soil and maintenance requirements

Requirements for final cover vegetation are given in the Surface Water Management Plan.

C.3. Soil Preparation Procedures

C.3.1. Type and quantity of fertilizer required per acre

A balanced fertilizer applied at a rate of 80 pounds per acre is adequate. To fertilize 23 acres, 1,840 pounds of fertilizer will be required.

C.3.2. Quantity of seed required per acre.

A satisfactory vegetative cover will be obtained by application of seed at a rate of 12 pounds per acre for 50 percent of the area, 24 pounds per acre for 25 percent of the area and 32 pounds per acre for 25 percent of the area. To vegetate 23 acres, 460 pounds of seed will be required.

C.3.3. Type and quantity of mulch required per acre

A suitable mulch will be applied as straw at a rate of 100 bales per acre; approximately 1,150 bales of straw will be required to vegetate 11.5 acres (50 percent of the total area).

C.3.4. Vegetation Schedule

Although final closure of certain areas will occur at different times, the entire 23 acres requiring vegetation may be done all at 1 time (towards the end of the closure period). Application of seed, fertilizer and mulch will be performed by a contractor.

V GROUNDWATER MONITORING

Groundwater Monitoring during closure shall be conducted in accordance with the applicable sections of the Groundwater Monitoring Plan.

VI COLLECTING, REMOVING, AND TREATING LEACHATE

A. Leachate Collection and Leak Detection Sump Systems

The Secure Cell No. 7 leachate collection system and leak detection systems shall be inspected during closure in accordance with the Facility's Inspection Plan. Removal of liquids from these systems shall be in accordance with the Inspection Plan.

The quantities of leachate generated from the Secure Disposal Cells at the Facility are expected to be minimal. It is anticipated that the maximum amount of leachate removed from all collection systems will be approximately 1,600 gallons semi-annually and decreasing there after.

B. Leachate Treatment Process

Leachate will be treated on-site using the Facility's wastewater treatment systems or shipped off-site for disposal.

C. Leachate Disposal

All leachate removed from each of the Secure Disposal Cell leachate collection systems will be treated on-site or placed in drums or bulk trailers and disposed of at a facility permitted to treat and dispose of the leachate.

D. Equipment Maintenance

Because the major portion of each leak detection and leachate collection system will be located below ground, the amounts and types of repairs and maintenance that can be performed on these systems are limited. Repairs to the exposed portion of the surface access standpipes, associated security devices (e.g., locking caps), and standpipe grouting will be performed as necessary throughout the closure period.

Maintenance activities during the closure period will consist of removal of sand or sediment from the standpipes or sumps and removal or mowing of vegetation in the vicinity of the surface projection of the standpipes. Any sediment or sand removed from leachate collection systems will be transferred to Secure Disposal Cell 7 or off-site for disposal.

VII FENCE MAINTENANCE

The Facility is enclosed by an 8 ft chain link fence topped with barbed wire. During the closure period, this fence will be inspected in accordance with the Facility's Inspection Plan. Any minor damage noted will be repaired by site personnel. Major damage will be repaired by a fencing contractor.

Maintenance activities will consist of:

- Removing or mowing vegetation close to the fence to provide an unobstructed view of the fence and attached warning signs; and
- Filling of channels and gullies caused by erosion or burrowing animals in the soil near the fence.

VII CLOSURE CERTIFICATION

A. Individual Secure Cell Closure

Within 60 days after completion of closure of each Secure Cell, the Permittee shall submit all information required by Part 264.115, 264.116 and 264.119.

B. Final Facility Closure

Within 60 days after completion of final closure of the Facility, the Permittee shall submit all information required by Part 264.115, 264.116 and 264.119.

V. POST CLOSURE RESPONSE PLAN

V.A. Loss of Containment Integrity

If there is just 1 employee or contractor on the premises during the post-closure care period, he/she must have immediate access to a device such as a telephone or a hand-held 2-way radio capable of summoning external emergency assistance.

If during the post-closure care period there is a sudden or non-sudden release of hazardous constituents, the appropriate section or section(s) of the Contingency Plan will be implemented. General responses are summarized below.

V.A.1. Groundwater

Groundwater monitoring for the Facility is detailed in the Groundwater Monitoring Plan. Planned post-closure responses to the results of the groundwater monitoring that indicate the presence of groundwater contamination are described in the Facility's Contingency Plan.

V.A.2. Cover Failure

Final cover failure may result from severe erosion, cracking caused by differential settling or penetration by deep-rooted vegetation or burrowing animals. In the event that final cover failure results in the migration of contamination to surface water, the following response will be initiated immediately upon discovery:

If contaminant migration is still occurring, such migration will be contained as close to the source as possible. Containment will consist of the placement of soil dikes around the source to inhibit the movement of contamination to site drainage systems.

Discharge point(s) for site drainage will be blocked, if necessary, to prevent off-site discharge of potentially contaminated runoff.

The Department will be notified of the discovery of final cover failure verbally within 24 hours and in writing within 7 days.

Following containment of run-off, on-site water contained in site diversion and drainage systems will be sampled sequentially from the source of contamination to determine the extent of contamination. All water found to exhibit hazardous waste characteristics will be removed and transported to an approved off-site facility (injection well, secure landfill with solidification capability, POTW, etc.) for treatment or disposal.

The failing portion of final cover will be repaired by excavation and off-site disposal of all contaminated cover materials at a properly permitted facility. The excavated area will then be repaired by replacement of the compacted clay layer, the drainage layer, and the vegetative layer. The replaced materials will be tied into the remaining cover in such a

manner as to produce a continuous impermeable cover at the location of the repair.

V.B. Storm Erosion

Facilities at the closed site that may experience substantial erosion as a result of severe storms include the final cover and drainage ditches. The following responses will be employed in the event that such erosion is detected:

V.B.1. Final cover

Sand bags will be positioned over the final cover in a manner that diverts the flow of runoff that is responsible for erosion.

V.B.2. Drainage ditches

Sand bags will be positioned at eroding areas to prevent further erosion and to contain runoff within the ditches.

V.C. Drainage Failure

Closed site drainage systems may fail as a result of erosion of drainage ditches, change in slope of final cover caused by differential settling, or accumulation of sediment or debris in drainage ditches.

Responses to drainage failure resulting from erosion have been previously described in Section IV.C. of this Post-Closure Plan.

Responses to drainage failure resulting from differential settling will normally be those described in Section V.C. of this Post-Closure Plan. In an emergency situation, sand bags will be used to contain accumulations of runoff until it can be transferred to functional portions of the drainage system.

Responses to drainage failure resulting from accumulation of sediments or debris will normally be those described in Section V.C. of this Post-Closure Plan. In an emergency situation, sand bags will be used to contain runoff within the boundaries of drainage ditches until accumulated sediment or debris can be removed.

V.D. Drought

In the event of a prolonged period of drought, cover integrity and cover vegetation will be preserved by sprinkling water from a leased spray irrigation system or a truck-mounted sprayer.

VI. POST-CLOSURE TRAINING

VI.A. Applicability

Untrained individuals will not be allowed to work unsupervised at the Facility. The following individuals performing post-closure activities will receive training:

Site Inspectors - (Job description includes performing necessary post-closure site inspections and security. Ensures that maintenance and remedial actions during post-closure are accomplished).

Sampling Personnel - (Job description includes performing all necessary groundwater, soil and surface water sampling. Collects samples, as required, of liquids from the Leachate Collection System(s)/Leak Detection System(s), and Secure Disposal Cell Permanent Sump(s). Knowledgeable in the proper sampling, preserving labeling, and shipping of samples.)

Manual Laborers - (Job description includes operations of vehicles and/or equipment in a safe and responsible manner. Performs physical labor and assigned tasks in a safe and efficient manner.)

VI.B. Trainer Requirements

Training will be under the guidance of the Facility's post-closure care supervisor. This individual must be knowledgeable in hazardous waste management procedures including knowledge of the Facility's Permit and Post-Closure Plan. He/she must oversee the individuals and/or companies performing post-closure maintenance or inspections.

VI.C. Training Program

All individuals performing post-closure activities will receive post-closure classroom and on-the-job-training.

VI.C.1. Classroom Training

Classroom training will be given to all individuals performing post-closure activities. Classroom training will consist of the following:

- A description of the Facility, including the types of wastes disposed of at the site, and site history.
- An explanation of site safety requirements including personnel hazards and the Contingency Plan.

VI.C.2. On-The-Job Training

Post closure inspectors will receive on-the-job-training in the proper inspection procedures, the inspection schedules, and on the types of remedial actions necessary to correct any problem during the post-closure period.

Samplers will receive on-the-job-training on the correct procedure for sampling, preserving, shipping and labeling of samples. The proper use of sampling and monitoring equipment will also be included as part of on-the-job-training.

Manual laborers will receive on-the-job-training in the proper use of equipment and the location of well caps and other physical hazards.

POST CLOSURE COST ESTIMATE

1) OVERVIEW/AMENDMENTS

The Post-Closure Cost Estimate provided herein was developed to coincide with the Post-Closure Plan. This cost estimate will be amended whenever a change in the Post-Closure Plan increases the cost of post-closure care.

2) ASSUMPTIONS

a) Groundwater Monitoring

i) Groundwater monitoring during the post-closure period at the Facility will be conducted in accordance with the Facility's Groundwater Monitoring Plan.

ii) A total of 17 groundwater-monitoring wells and one permanent sump are assumed to produce sufficient water for sampling and analysis during the post-closure monitoring program.

iii) Provided sufficient water is present, the 17 monitoring wells will be sampled and analyzed semi-annually for the parameters specified within the Facility's Groundwater Monitoring Plan.

b) Leachate Collection Systems and Leak Detection Systems

i) The Leachate Collection and Leak Detection Systems at the Facility will be inspected as described in the Post-Closure Plan.

ii) The Leachate Collection Systems will be inspected for fluids on a semi-annual basis. If present, samples will be collected and analyzed on a semi-annual basis for the parameters listed Tables VII-3 and VII-4. Assume each of the 7 collection systems will have fluids present once per year.

iii) The amount of leachate collected in the first year will be 2,590 gallons. The amount of leachate collected per year will decrease at an annual rate of 10 percent. Therefore, approximately 24,800 gallons of leachate will be generated during the post-closure period.

iv) Leachate will be removed from the collection systems using a vacuum truck or by a portable pump.

v) Tank loads of leachate will be transferred to a properly permitted facility.

vi) The seven Leak Detection Systems will be inspected as described in the Post-Closure Plan. Fluids are not expected to be present in these systems throughout the post-closure care period. However, for the purposes of this estimate, assume two samples will be collected and analyzed per year.

c) Maintenance Activities

i) The post-closure maintenance activities at the Facility will be conducted in accordance with the description of activities contained in the Post-Closure Plan.

ii) During the first year of post-closure, the Facility will receive 12 monthly inspections.

iii) During years 2 through 5 of the post-closure period, the Facility will receive regular inspections once every two months.

iv) During years 5 through 10 of the post-closure period, the Facility will receive regular inspections once every three months.

v) During years 11 through 30 of the post-closure period, the Facility will receive regular inspections once every six months.

vi) During years 1 through 30, additional inspection requirements will be conducted on a semi-annual basis.

vii) For the duration of the first two years of the post-closure period, approximately 2.2 acres (10 percent of the last cell closed and 2 percent of previously closed cells) of the area that receives final cover will require maintenance consisting of the application of a layer of silty clay soil averaging 6 inches in-place thickness over the entire area followed by grading and re-vegetation.

viii)For the duration of years 3 through 5 of the post-closure period, an additional 1.4 acres of final cover (2 percent) will require maintenance consisting of application of an average 6 inch in-place layer of silty clay soil, followed by grading and re-vegetation.

ix) For the duration of years 6 through 30 of the post-closure period, an additional 0.7 acres of final cover (1 percent) will require maintenance consisting of application of an average 6 inch in-place layer of silty clay soil, followed by grading and re-vegetation.

x) Cover vegetation will be mowed yearly throughout the post-closure period.

xi) For the duration of the first two years of post-closure, 4.4 acres of final cover will require re-vegetation consisting of seeding, fertilizing, and mulching (2.2 acres for areas receiving additional final cover plus 2.2 acres of areas with poor growth).

xii) For the duration of years 3 through 5 of the post-closure period, an additional 2.8 acres of final cover will require re-vegetation consisting of seeding, fertilizing, and mulching. (1.4 acres for areas receiving additional final cover plus 1.4 acres of areas with poor growth).

xiii) For the duration of years 5 through 30 of the post-closure period, an additional 1.4 acres of final cover will require re-vegetation consisting of seeding, fertilizing, and mulching. (0.7 acres for areas receiving additional final cover plus 0.7 acres of areas with poor growth).

xiv)The grass seed used for re-vegetation will be Blue Grama, Western Wheatgrass and Buffalo grass applied at a maximum rate of 32 pounds per acre.

xv) The fertilizer used for seeding and re-vegetation will consist of a balanced nitrogen/phosphate blend applied at a rate of 80 pounds per acre.

xvi)The mulch used for re-vegetation will be straw applied at a rate of 100 bales per acre.

xvii) Soil required to maintain surface drainage and diversion systems has been included in the quantities required to maintain final cover.

xviii) Clay soil for maintenance of final cover and surface drainage and diversion systems will be obtained from on-site stockpiles at the Facility.

xix)During the post-closure period, two monitoring wells will require replacement.

xx) Costs associated with unscheduled maintenance activities, and with responses to possible occurrences will be funded from the 10 percent contingency included in this post-closure estimate.

xxi) With the exception of site inspections performed by facility personnel, all post-closure maintenance activities will be performed by contractors using crews achieving the levels of production specified below.

xxii) Re-surveying of final cover elevation reference points will be performed by a surveyor and helper.

xxiii) On-site silty soils required for cover maintenance will be excavated, loaded, and transported to the required location by equipment capable of moving 800 yd^3 per 8-hour day.

xxiv) Cover maintenance including placement, compaction, and grading will be performed by equipment capable of spreading, compacting, and grading 800 yd^3 per 8-hour day.

xxv) Seeding of portions of final cover that require re-vegetation will be performed by equipment capable of spreading approximately 2 acres of seed per hour.

xxvi) Mulching of portions of final cover that require re-vegetation will be performed by equipment capable of spreading approximately 4 acres of mulch per 8-hour day.

xxvii) Fertilization of the final cover will be performed by equipment capable of spreading approximately 2 acres of fertilizer per hour.

3) CALCULATIONS

a) Groundwater Monitoring

Item	Amount		Unit Rate	Cost	ref.
Sample Monitoring Wells and Permenant Sump	18	ea	200	$3,600	5
Sample Analysis	17	ea	1725	$29,325	4
Total Estimated Cost per event				$32,925	
Total for 2 events per year, 30 years				**$1,975,500**	

b) Leachate Collection System

Item	Amount		Unit Rate	Cost	ref.
Removal Costs, 7systems per year for 30 years	210	ea	350	$73,500	5
Transportation, 24,800 gallons over 30 years	27800	gal	0.42	$11,676	5
Analytical Costs, 7systems per year for 30 years	210	ea	1725	$362,250	4
Total Estimated Cost per event				**$447,426**	

c) Leak Detection System

Item	Amount		Unit Rate	Cost	ref.
Sample LDS	60	ea	200	$12,000	5
Sample Analysis	60	ea	1725	$103,500	4
Total Estimated Cost				**$115,500**	

d) Maintenance

i) Inspections

Item	Amount		Unit Rate	Cost	ref.
First Year (Monthly)	12	ea	514	$ 6,168.00	5
Years 2-5 (Every 2 months)	24	ea	514	$ 12,336.00	5
Years 6-10 (Every 3 months)	20	ea	514	$ 10,280.00	5
Years 11-30 (Every 6 months)	40	ea	514	$ 20,560.00	5

Semi-Annual Inspections (Years(1-30)	60	ea	514	$ 30,840.00	5
Total Estimated Cost for Inspections				**$ 80,184.00**	

ii) Surveying

Item	Amount		Unit Rate	Cost	ref.
First Year (Two Surveys)	2	ea	1500	$ 3,000.00	12
Years 2-30 (One Survey)	29	ea	1500	$ 43,500.00	12
Total Estimated Cost for Surveys				**$ 46,500.00**	

iii) Soil Replacement

Item	Amount		Unit Rate	Cost	ref.
First Two Years	1774	cy	5.98	$ 10,610.31	5
Years 3-5	1129	cy	5.98	$ 6,752.02	5
Years 6-10 (Every 3 months)	565	cy	5.98	$ 3,375.71	5
Total Estimated Cost for Soil Replacement				**$ 20,738.04**	

e) Re-Vegetation

i) Seeding

Item	Amount		Unit Rate	Cost	ref.
First Two Years	4	acre	592	$ 2,604.80	5
Years 3-5	3	acre	592	$ 1,657.60	5
Years 6-10 (Every 3 months)	1	acre	592	$ 828.80	5
Total Estimated Cost for Seeding				**$ 5,091.20**	

ii) Fertilizing

Item	Amount		Unit Rate	Cost	ref.
First Two Years	4	acre	158	$ 695.20	5
Years 3-5	3	acre	158	$ 442.40	5
Years 6-10 (Every 3 months)	1	acre	158	$ 221.20	5
Total Estimated Cost for Fertilizing				**$ 1,358.80**	

iii) Mulching

Item	Amount		Unit Rate	Cost	ref.
First Two Years	4	acre	706	$ 3,106.40	5
Years 3-5	3	acre	706	$ 1,976.80	5
Years 6-10 (Every 3 months)	1	acre	706	$ 988.40	5
Total Estimated Cost for Mulching				**$ 6,071.60**	

f) Vegetation Maintenance

i) Mowing

Item	Amount		Unit Rate	Cost	ref.
70 acres x 30 years x 2 year	60	ea	4000	$ 240,000.00	1,5
Total Estimated Cost for Mowing				**$ 240,000.00**	

g) Monitor Well Replacement

Item	Amount		Unit Rate	Cost	ref.
Monitor Well Installation	2	ea	6,000	$ 12,000.00	5
Total Estimated Cost for Monitor Well Replacement				**$ 12,000.00**	

h) Drainage Ditch Clean Out

Item	Amount		Unit Rate	Cost	ref.
First Two Years , 2 cleanout per year	4	ea	1800	$ 7,200.00	5
Years 3-30, 1 cleanout per year	28	ea	1800	$ 50,400.00	5
Total Estimated Cost for Ditch Cleanout				**$ 57,600.00**	

4) Total Maintenance Cost

Total Estimated Cost for Inspections	$80,184
Total Estimated Cost for Surveys	$46,500
Total Estimated Cost for Soil Replacement	$20,738
Total Estimated Cost for Seeding	$5,091
Total Estimated Cost for Fertilizing	$1,359
Total Estimated Cost for Mulching	$6,072
Total Estimated Cost for Mowing	$240,000
Total Estimated Cost for Monitor Well Replacement	$12,000
Total Estimated Cost for Ditch Cleanout	$57,600
Total Maintenance Cost	**$469,544**
10% Contingency	**$46,954**
Total Maintenance Cost	**$516,498**

5) Total Post-Closure Costs

Groundwater and Permanent Sump Sampling	$1,975,500
Leachate Collection System	$447,426
Leak Detection System	$115,500
Total Maintenance Cost	$516,498
Total Post Closure Cost Estimate	**$3,054,924**

POST-CLOSURE COST ESTIMATE

REFERENCES

1. Clean Harbors Deer Trail LLC Operational Experiences
2. 2004 Secure Disposal Cell Construction Bids, other Clean Harbors facilities
3. *R.S. Means Environmental Remediation Cost Data, Unit Price 2004*
4. Severn Trent Laboratories (STL), Denver, Colorado
5. Cameron-Cole LLC, Boulder, Colorado
6. Resource Technologies Group; Lakewood, Colorado
7. Poly-Flex, Inc., Grand Prairie, Texas
8. Bulk Materials, Inc., Fort Collins, Colorado
9. Hill Petroleum, Fort Morgan, Colorado
10. Clean Harbors Field Service Center, Denver, Colorado
11. Clean Harbors Environmental Services, Inc. Kimball, Nebraska
12. Hascall Survey

COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT
RCRA PART B
PERMIT ATTACHMENT LF-1.3

SPECIFICATIONS FOR SECURE CELL CONSTRUCTION (CELLS 3 THROUGH 7) AND SURFACE IMPOUNDMENT LINER AND COVER SYSTEM CONSTRUCTION (CELLS 1 THROUGH 7)

CLEAN HARBORS (DEER TRAIL), LLC
HAZARDOUS WASTE
TREATMENT, STORAGE, AND DISPOSAL FACILITY

ADAMS COUNTY, COLORADO

EPA IDENTIFICATION NUMBER COD991300484

FINAL PERMIT

NOTE: This permit attachment is a typical specification for Secure Cell and Surface Impoundment Liner and Cover Construction. Modifications to the plan may be required prior to construction of each secure cell based on final design drawings. The revisions required for each secure cell will be submitted to CDPHE for approval prior to construction.

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SECTION 01010
GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary to construct the secure cell or surface impoundment liner or cover systems at the Clean Harbors (Deer Trail), LLC hazardous waste treatment, storage, and disposal facility (TSDF) in Adams County, Colorado.

B. The work shall include those items identified in the Contract Documents which may include site preparation and earthwork, clay liner construction, geosynthetic clay liner installation, geomembrane liner/cover installation, drainage layer and drainage pipe installation, protective soil layer placement, quality control, surveying, and related work.

1.02 DEFINITIONS

A. The following list of definitions is provided for reference.

1. *Atterberg Limits*: The liquid limit, plastic limit, and shrinkage limit for soils as defined by (ASTM D 4318).

2. *CDPHE*: Colorado Department of Public Health and Environment

3. *CDPHE and RCRA Part B Permit (Part B Permit):* Colorado Department of Public Health and Environment (CDPHE) and Resource Conservation and Recovery Act (RCRA) Part B Permit for the Clean Harbors (Deer Trail), LLC hazardous waste TSDF.

4. *Compaction*: The process of increasing the unit weight of soil by rolling, tamping, vibrating, or other mechanical means. As a result of compaction, the hydraulic conductivity of the soil may be decreased.

5. *Construction Drawings*: Design plans used to construct a facility; the plans must be signed and sealed by a Professional Engineer registered in the State of Colorado.

6. *Construction Quality Assurance (CQA)*: A planned and systematic pattern of all means and actions designed to provide adequate confidence that items or services meet contractual and regulatory requirements (see Permit Attachment LF-10.3).

7. *CQA Engineer*: The individual, firm or corporation, independent from the Owner, Contractor, Supplier, or Manufacturer, that is responsible for observing, testing, and documenting construction activities under the terms of the contract. Provided that the Design Engineer and the Owner are not the same party, the CQA Engineer may be the same as the Design Engineer. The CQA Engineer will provide an experienced personnel for Construction Quality Assurance services. The CQA Engineer is

responsible for certification of cell construction according to the specifications contained herein and will be a Professional Engineer registered in the State of Colorado. The CQA field personnel shall perform his duties under the direct supervision of a registered professional engineer.

8. *CQA Plan*: Site-specific document which addresses the following: (i) CQA personnel responsibilities, authorities, and qualifications; (ii) inspection, monitoring, and testing activities necessary to ensure that the facility is constructed to meet or exceed design criteria, plans, and specifications; and (iii) CQA documentation requirements, (see LF-10).

9. *Contract Documents*: The contract documents for construction of the secure cell or surface impoundment including the General Specifications, the Construction Drawings, the CQA Plan, any supplemental requirements, and the General Agreement.

10. *Contractor*: The individual, firm, or corporation undertaking the execution of the work under the terms of the contract.

11. *Design Engineer*: The individual, firm or corporation having direct responsibility for the design of the secure cell or surface impoundment structure. The Design Engineer must provide a Professional Engineer registered in the State of Colorado. The Design Engineer may be the same as the Owner.

12. *Dewatering:* Process of lowering ground water level(s) or removing storm water to permit construction activities to be made "in the dry" (not drying of fill material).

13. *General Specifications*: Specifications written which apply to the construction of all secure cells and surface impoundments.

14. *Geocomposite:* A planar, polymeric drainage material consisting of a polyethylene geonet core and geotextile filter layers that have been heat-bonded to the top and bottom surfaces of the geonet.

15. *Geomembrane:* A nonporous polymeric membrane liner or barrier used in civil engineering projects.

16. *Geonet*: A net consisting of two sets of transverse polymeric strands which create high in-plane flow capacity; used as a drainage medium in civil engineering projects.

17. *Geosynthetics*: Polymeric materials used to perform various functions in construction projects (i.e., geomembranes, geonets, geocomposites, geotextiles, etc.).

18. *Geosynthetic Clay Liner (GCL)*: A factory manufactured, hydraulic barrier typically consisting of bentonite clay or other very low permeability material, supported by geotextiles and/or geomembranes which are held together by needling, stitching, or chemical adhesives.

19. *Geotextile:* A permeable textile material used with foundation, soil, rock, earth, or any other geotechnical engineering-related material that is an integral part of a man-made project, structure, or system.

20. *Clean Harbors (Deer Trail) LLC:* The owner and operator of the hazardous waste treatment, storage, and disposal facility under construction; referred to as the Owner.

21. *Hydraulic Conductivity*: The rate at which a fluid flows through a porous medium. It is a function of the physical characteristics of both the porous medium and the fluid.

22. *In-situ*: "As is", or as it exists in place naturally.

23. *Laboratory:* The individual, firm, or corporation, independent from the Owner, Manufacturer, Supplier, or Contractor, responsible for conducting tests on construction materials to assure conformance with the General Specifications.

24. *Leachate Collection System*: The drainage layer above the primary composite liner of the secure cell and associated piping, risers, etc. that enable collection and removal of leachate from the secure cell.

25. *Leak Detection System*: The drainage layer sandwiched between the primary and secondary liners of the secure cell or surface impoundment and associated piping, risers, etc., that enable detection, collection, and removal of leachate, if any, that leaks through the primary liner.

26. *Liner System*: The system of natural and synthetic liners and drainage layers beneath the secure cell or surface impoundment, used to contain leachate while allowing its collection and removal.

27. *Manufacturer*: The individual, firm, or corporation responsible for manufacturing a specific component (e.g., a geomembrane liner) used in surface impoundment or secure cell construction.

28. *Moisture Content*: Ratio of quantity of water in the soil (by weight) to the weight of the soil solids (dry soil), expressed in percentage; also referred to as water content.

29. *Optimum Moisture Content (OMC)*: Moisture content corresponding to maximum dry unit weight as determined in the standard Proctor or modified Proctor compaction test (i.e., ASTM D 698 or D 1557).

30. *Owner:* The party known as Clean Harbors (Deer Trail), LLC (CHES), a Colorado Corporation, and the operator of the hazardous waste treatment storage and disposal facility under construction. The Owner shall hire the Contractor(s) to execute the work under the terms of the General Agreement. The activities of the Owner in the General Specifications, any supplemental requirements, and CQA Plan may be performed by the Owner or other party representing the Owner such as, but not limited to, a representative of Highway 36, the Design Engineer, or CQA Engineer.

31. *Particle-Size Distribution*: Distribution of particle sizes within a soil; determined using ASTM D 422.

32. *Permanent Sump*: The drainage layer beneath the sump area of the secondary liner of the secure cell that enables the detection, collection, and removal of leachate if any, that leaks through the secondary liner in that area.

33. *Permeability*: Ability of pore fluid to travel through a soil mass via interconnected voids. "High" permeability indicates relatively rapid flow, and vice versa. Rates of permeability are generally reported in centimeters per second.

34. *Plasticity*: Ability of soil mass to flow or be remolded without raveling or breaking apart. Generally that range of soil water content between the liquid and plastic limit.

35. *Primary Composite Liner*: Top composite liner in a double-liner system consisting of two or more low-permeability components of different materials in contact with each other.

36. *Primary Geomembrane Liner*: Top geomembrane liner in a double-liner system.

37. *Primary Soil Liner*: Top soil liner in a double-liner system.

38. *RCRA*: Resource Conservation and Recovery Act; Federal hazardous waste regulations.

39. *Secondary Composite Liner*: Bottom composite liner in a double-liner system consisting of two or more low-permeability components of different materials in contact with each other.

40. *Secondary Geomembrane Liner*: Bottom geomembrane liner in a double-liner system.

41. *Secondary Soil Liner*: Bottom soil liner in a double-liner system.

42. *Secondary Structure*: The macrostructure of a geologic stratum. Structural features in a soil or rock deposit which can be seen with little or no magnification, to include, but not be limited to, pockets, lenses, layers, seams, or partings of varying soil types, slickensided fissures, laminated structure, bedding planes, and/or mineral concretions or staining.

43. *Secure Cell*: A discrete landfill cell designed and constructed to store industrial and/or hazardous wastes in an environmentally safe manner and in accordance with Federal, State, and local regulations.

44. *Sieve (200 Mesh)*: Refers to the soil particle size that passes (smaller than or equal to) the U.S. Sieve No. 200 (ASTM Specification E-11) which has a 75 micrometer (0.00295 inch) opening.

45. *Specifications*: Detailed descriptions of requirements, dimensions, materials, construction methods, etc., necessary for the construction of a secure cell or surface impoundment.

46. *Subcontractor:* The individual, firm, or corporation that contracts to perform some service or provide some material necessary for the performance of another's contract.

47. *Supplier:* The individual, firm, or corporation responsible for supplying a contractor or a manufacturer with a specific material (e.g., gravel, granular material, resin, etc.) required for construction of a manufactured product or for the construction of the secure cell or surface impoundment.

48. *Surface Impoundment:* A discrete impoundment designed and constructed to hold an accumulation of potentially contaminated rainwater and runoff from processing, hauling, or waste handling operations or designed and operated to contain hazardous waste during treatment of the waste.

49. *TSDF*: treatment, storage, and disposal facility.

50. *Unified Soil Classification System*: Soil classification system in accordance with ASTM D 2487.

51. *Unit Weight*: Weight of soil per unit volume; usually reported in pounds per cubic foot.

52. *"Walking Out"*: Continually rising effect experienced by a sheepsfoot roller during compaction of soil; an indication that the soil is approaching the proper degree of compaction.

PART 2 CONTRACT DOCUMENTS

2.01 INCLUDED DOCUMENTS

A. The Contract Documents for construction of the secure cell or surface impoundment shall include, as applicable: (i) General Specifications, (ii) Supplemental Specifications; (iii) CQA Plan; (iv) Construction Drawings; and (v) General Agreement.

2.02 GENERAL SPECIFICATIONS

A. The secure cell or surface impoundment shall be constructed in accordance with these General Specifications and other applicable Contract Documents.

2.03 SUPPLEMENTAL SPECIFICATION

A. The supplemental specifications provide additional requirements for construction of a specific secure cell liner or cover or surface impoundment that relate to construction contractural considerations, and are not permit-related.

2.04 CQA PLAN

A. The materials, procedures, and test methods and frequencies used in the construction quality assurance of the secure cell or surface impoundment construction shall conform to the requirements of the CQA Plan (Part B Permit Attachment LF-10).

2.05 CONSTRUCTION DRAWINGS

A. The secure cell or surface impoundment shall be constructed not only in accordance with the General Specifications but also in accordance with the Construction Drawings for the specific structure.

2.06 GENERAL AGREEMENT

A. The contractual agreement, and all terms and conditions thereof, between the Owner and the Contractor.

PART 3 PROJECT ORGANIZATION AND CONTROL

3.01 ORGANIZATION CHART

A. The project organization chart for the parties involved in construction of the secure cells and surface impoundments is provided in Figure 01010-1 located in Attachment 10.3 section 3.2.2.

3.02 RESPONSIBILITIES OF PARTIES

A. *Owner:* The Owner is the facility manager, responsible for facility administration, regulatory oversight, health and safety, accounting, purchasing, etc. The Owner has direct authority over the Contractor, CQA Engineer, and Design Engineer and coordinates activities by these parties.

B. *Contractor:* The Contractor is responsible for constructing the secure cell or surface impoundment in accordance with the General Specifications, other applicable contract documents, Construction Drawings and CQA Plan. The Contractor may be responsible for earthwork, geosynthetics, and other components of secure cell or surface impoundment landfill construction. The contracting and administration of contract requirements for secure cell or surface impoundment construction shall be the responsibility of the Owner. Different contractors may be used to construct different components of the secure cell or surface impoundment.

C. *CQA Engineer*: The CQA Engineer is responsible for monitoring construction activities on-site and certifying that the facility is constructed in accordance with the plans and specifications. The CQA Engineer provides information, reports, test results, and observations to the Owner. The CQA Engineer may communicate directly with the Contractor and Design Engineer to coordinate activities and receive information. The CQA Engineer provides an on-site CQA Resident Engineer.

D. *Design Engineer:* The Design Engineer is responsible for the design of the secure cell or surface impoundment. The Design Engineer reports to the Owner. The Design Engineer may communicate directly with the Contractor and CQA Engineer.

PART 4 SEQUENCE OF CONSTRUCTION

4.01 OVERALL SEQUENCE

A. The overall sequence of construction for a specific secure cell or surface impoundment shall be as described in the Construction Drawings for the specific structure and in accordance with the Contract Documents.

4.02 SEQUENCE OF LINER AND COVER SYSTEM CONSTRUCTION

A. The sequence of liner systems and cover systems construction shall be as follows, recognizing that not all liner and cover system components may be used in all cases.

Secure Cell Liner Systems:

1. Site Preparation and Earthwork
2. Permanent Sump
3. Secondary Clay Liner
4. Secondary Geomembrane Liner
5. Leak Detection System
6. Primary Clay Liner
7. Primary Geosynthetic Clay Liner
8. Primary Geomembrane Liner
9. Leachate Collection System
10. Protective Soil Layer

Cover Systems:

1. Interim Soil Cover
2. GCL
3. Geomembrane Cover
4. Drainage Layer
5. General Fill Soil
6. Vegetative Cover Soil

B. Several of the above-listed components may be constructed concurrently.

PART 5 REFERENCE STANDARDS

5.01 APPLICABLE ORGANIZATIONS

A. Organizations whose standards are referenced herein are as follows:

1. AASHTO - American Association of State Highway and Transportation Officials

2. ASTM - American Society for Testing and Materials

3. CHS - Colorado Department of Highways (Standard Specifications for Road and Bridge Construction)

4. GRI - Geosynthetics Research Institute

5. OSHA - Occupational Safety and Health Administration

6. USEPA - United States Environmental Protection Agency

5.02 APPLICABLE STANDARDS

A. Any reference to standards of any society, institute, association, or government agency shall be the edition in effect as of the date of the contract, unless stated otherwise.

5.03 SPECIFIC STANDARDS

A. Specific test standards cited in the General Specifications are given in Table 01010-1.

PART 6 GENERAL REQUIREMENTS

A. *Reference Points*: Construction reference monuments and benchmarks have been established by the Owner for use in controlling the construction work. All work shall be constructed based on and in relation to these reference points. The Contractor shall be responsible for re-establishing any reference points disturbed during construction. Disturbed or destroyed points shall be re-established at the Contractor's expense, as directed by the Owner.

B. *Soils Investigation*: Site soil investigations will be performed by the Owner. Soil investigation reports will be available for the Contractor's use. The Contractor shall not assume that information within these reports accurately reflects the soil conditions at all locations within the project area, but that they only depict soil conditions at specific points where samples were taken.

C. *Surveying*: The Contractor shall perform all surveying required to lay out and control the work. Surveying shall be conducted such that all applicable standards required by the State of Colorado are followed. Required Record Drawings shall be as specified in these General Specifications. All surveying shall be performed under the direction of a surveyor licensed to perform such work in the State of Colorado. All Record Drawings shall be signed and sealed by the licensed surveyor who directed the survey work. Record drawings shall be at a scale not smaller than 1 inch = 50 feet. The required surveying of liner system elevations shall be carried out on a grid; approximately 50-foot square on slopes of 25 percent or less and 100-foot square on slopes greater than 25 percent. The survey locations shall be close enough to define the following features in the secure cell or surface impoundment: toe of slope, crest of slope, anchor trench, leachate collection sump, leak detection sump, permanent sump, and perimeter drainage ditch. The thicknesses of the liner system components on the Conceptual Site Development Plan Drawings shall be interpreted as minimums. All surveys shall be referenced to the Owner's site coordinate grid system.

D. *Construction Tolerances:* Unless otherwise stated herein and where practical, construction tolerances shall be " 0.2 feet horizontally, and, provided that minimum thickness requirements are met, " 0.1 feet vertically. All surfaces shall be reasonably free from irregularities with slopes or grades within " 10 percent of their nominal values. All liner and cover surfaces shall be free-draining with no standing water except at low points designated on the Construction Drawings.

E. *Permits*: The Contractor shall not be required to obtain any environmental or general construction permits applying to the general design of the facility. The Contractor shall be required to obtain permits, such as over-size haul permits, related to specific construction equipment or techniques he intends to employ to accomplish the work.

F. *Sedimentation, Erosion Control, and Dewatering*: Contractor shall comply with all requirements of the Owner's Specification 34-0230 for controlling erosion, water pollution, and dust emissions resulting from construction activities; the Contractor shall be responsible for any fines imposed due to noncompliance. Within the disturbed areas in which the Contractor is working, the Contractor shall seal-roll disturbed surfaces when required and maintain temporary grades and ditches to promote water drainage and prevent infiltration. The Contractor shall provide all equipment necessary to dewater excavations within 12 hours after a storm event.

G. *Work Limits*: All clearing, stripping, excavation, backfill and surfacing shall be done to the lines, grades, and dimensions called for on the Construction Drawings and General Specifications unless directed otherwise by the Owner. All work done beyond designated limits without prior approval shall be corrected to the Owner's satisfaction, at no additional cost to the Owner.

H. *Protection of Existing Services and Wells*: The Contractor shall exercise care to avoid disturbing or damaging existing monitor wells, electrical poles and lines, permanent below-ground utilities, permanent drainage structures, temporary utilities and structures, or items which the Owner has marked with red flagging. If the Contractor encounters any unexpected underground utilities during the course of the work, the Contractor shall immediately inform the Owner who will determine whether or not the utility is active. When the work requires the Contractor to be near or cross known utilities, the Contractor shall carefully uncover, support and protect these utilities and shall not cut, damage, or otherwise disturb them without prior authorization from the Owner. All utilities, wells, or other items damaged by the Contractor shall be immediately repaired or replaced by the Contractor to the satisfaction of the Owner at no additional cost to the Owner.

I. *Explosives*: The use of explosives for demolition or excavation is not expected to be required and will not be permitted without prior written approval of the Owner.

J. *Burning*: The use of open fires on site for any reason is prohibited.

K. *Temporary Roads*: The Contractor shall be responsible for constructing and maintaining all temporary roads and laydown areas which the Contractor may require in the execution of his work.

L. *Construction Water*: The quality of construction water used to accomplish construction work is crucial due to the nature of the facilities being constructed. The Owner will provide water for construction and dust control and will specify the source and periodically obtain water quality samples. The Contractor shall not add substances to construction water without the express written consent of the Owner. The Contractor shall utilize measuring devices that allow him to measure and record the volume of water used. Such usage records shall be maintained by the Contractor and provided to the Owner.

M. *Cooperation*: The Contractor shall cooperate with all other parties engaged in project-related activities to the greatest extent possible. Disputes or problems shall be referred to the Owner for resolution.

N. *Familiarization*: The Contractor is responsible for becoming familiar with all aspects of work prior to performing the work.

O. *Safeguards*: The Contractor shall provide and use all personnel safety equipment, barricades, guardrails, signs, lights, flares, and flagmen as required by OSHA, state, or local codes and ordinances. No excavations deeper than 4 feet with side slopes steeper than 2:1 (horizontal:vertical) shall be made without the prior approval of the Owner. When shoring is required, the design and inspection of such shoring shall be the Contractor's responsibility and subject to the review of the Owner prior to use. No personnel shall work within or next to an excavation requiring shoring until such shoring has been installed, inspected, and approved by an Engineer registered in the State of Colorado, provided by the Contractor. The Contractor shall be responsible for any fines imposed due to violation of any laws and regulations relating to the safety of the Contractor's personnel.

P. *Construction Access Plan*: Prior to mobilization to the site, the Contractor shall submit a plan to the Owner showing where he intends to place staging areas, stockpile areas, temporary on-site access roads, temporary erosion control structures, etc. This plan must be approved by the Owner prior to mobilization.

Q. *Clean-up*: The Contractor shall be responsible for general house-keeping during construction. Upon completion of work, the Contractor shall remove all of his equipment, facilities, construction materials, and trash. All disturbed areas shall be revegetated or otherwise put into a condition satisfactory to the Owner. Revegetation shall be carried out in accordance with the requirements in Owner's Specification 34-0229.

R. *Security*: The Contractor is responsible for the safety and condition of all of his tools and equipment. The Owner will not be responsible for lost or stolen materials or equipment.

S. *Acceptance of Work*: Except as otherwise provided within the General Conditions, the Contractor shall retain ownership and responsibility for all work until accepted by Owner. The Owner will accept ownership and responsibility for the liner system: (I) when all work is completed; (ii) after the Contractor has submitted all required documentation, including manufacturing quality control documentation, manufacturing certifications, and Record Drawings signed and sealed by a Professional Land Surveyor licensed in the State of Colorado (if required by Owner); and (iii) after the CQA Engineer has submitted the Final CQA Report

which certifies that the liner has been constructed in accordance with the Construction Drawings and these Specifications and Record Drawings signed and sealed by a Professional Engineer registered in the State of Colorado.

T. *Health and Safety Training*: The Contractor shall provide necessary health and safety training for all of the Contractor's on-site personnel in accordance with the Site Health and Safety Plan. The Owner may require evidence of health and safety training at any time for any of the Contractor's personnel working on site.

U. *Exclusion Areas*: The Contractor's personnel shall not enter any areas on-site identified with signs as exclusion areas without approval of the Owner, and without proper personal protective equipment. The Contractor shall confine activities to the work limits shown on the Construction Drawings.

V. *Hazardous Waste Management Operations*: The Contractor shall not enter areas where active hazardous waste management operations are being performed.

W. *CQA Activities:* The Owner will utilize an independent CQA Engineer to perform CQA activities. The Contractor shall be aware of all CQA activities and shall allow sufficient time in his construction schedule to accommodate CQA activities. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of CQA activities.

X. All quality control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

TABLE 01010-1
TEST METHODS CITED IN GENERAL SPECIFICATIONS AND CQA PLAN

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS		
1.	AASHTO T96	Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine.
2.	AASHTO T104	Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.
AMERICAN SOCIETY OF TESTING AND MATERIALS		
1.	ASTM A 307	Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
2.	ASTM A 726	Standard Specification for Cold-Rolled Carbon Steel Sheet, Magnetic Laminated Quality, Types 1, 2, and 2S.
3.	ASTM D 374C D 1777	Method for Measuring Thickness of Geotextile Materials.
4.	ASTM D 422	Standard Method for Particle-Size Analysis of Soils.
5.	ASTM D 570	Standard Test Method for Water Absorption of Plastics.
6.	ASTM D 638	Standard Test Method for Tensile Properties of Plastics.
7.	ASTM D 698	Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5-lb (2.49-kg) Rammer and 12-in. (305-mm) Drop.
8.	ASTM D 746	Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
9.	ASTM D 751	Standard Methods of Testing Coated Fabrics.
10.	ASTM D 792	Standard Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement.
11.	ASTM D 882	Standard Test Methods for Tensile Properties of Thin Plastic Sheeting.
12.	ASTM D 1004	Standard Test Method of Initial Tear Resistance of Plastic Film and Sheeting.
13.	ASTM D 1204	Standard Plastics Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature.
14.	ASTM D 1238	Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
15.	ASTM D 1248	Standard Specification for Polyethylene Plastic Molding and Extrusion Metals.
16.	ASTM D 1505	Standard Test Methods for Density of Plastics by Density-Gradient Technique.
17.	ASTM D 1556	Standard Test Method for Density of Soil In Place by the Sand-Cone Method.
18.	ASTM D 1593	Standard Specification for Nonrigid Vinyl Chloride Plastic Sheeting.
19.	ASTM D 1603	Standard Test Method for Carbon Black in Olefin Plastics.
20.	ASTM D 2167	Standard Test Method for Density and Unit Weight of Soils in Place by the Rubber Balloon Method.
21.	ASTM D 2216 or D 4643	Standard Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures.
22.	ASTM D 2434	Standard Test Method for Permeability of Granular Soils (Constant Head).
23.	ASTM D 2487	Standard Test Method for Classification of Soils for Engineering Purposes.
24.	ASTM D 2657	Standard Practice for Heat-Joining for Polyolefin Pipe and Fittings.
25.	ASTM D 2663	Carbon-Black Dispersion in Rubber.
26.	ASTM D 2837	Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.
27.	ASTM D 2922	Standard Test Method for Density of Soil and Soil-Aggregate In Place by Nuclear Methods (Shallow Depth).
28.	ASTM D 3015	Recommended Practice for Microscopical Examination of Pigment Dispersion in Plastic Compounds.
29.	ASTM D 3017	Standard Test Method for Moisture Content of Soil and Rock In Place by Nuclear Methods (Shallow Depth).
30.	ASTM D 3083	Standard Specification for Flexible Poly (Vinyl Chloride) Plastic Sheeting for Pond, Canal, and Reservoir Lining.
31.	ASTM D 3350	Standard Specifications for Polyethylene Plastic Pipe and Fittings Materials.
32.	ASTM D 3776	Mass Per Unit Area (Weight) of Woven Fabric.
33.	ASTM D 4253	Standard Test Method for Maximum Index Density of Soils Using a Vibratory Table
34.	ASTM D 4254	Standard Test Method for Minimum Index Density of Soils and Calculations of Relative Density.

TABLE 01010-1 TEST METHODS CITED IN GENERAL SPECIFICATIONS AND CQA PLAN		
35.	ASTM D 4318	Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
36.	ASTM D 4373	Standard Test Method for Calcium Carbonate Content of Soils.
37.	ASTM D 4437	Standard Test Methods for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Geomembranes.
38.	ASTM D 4491	Standard Test Method for Water Permeability of Geotextiles by the Permittivity Method.
39.	ASTM D 4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
40.	ASTM D 4632	Standard Test Method for Breaking Load and Elongation of Geotextiles (Grab Elongation Method and Peel Strength).
41.	ASTM D 4643	Determination of Water (Moisture) Content of Soil by the Microwave Oven Method
42.	ASTM D 4716	Standard Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products.
43.	ASTM D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile.
44.	ASTM D 4716	Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
45.	ASTM D 4833	Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
46.	ASTM D 5261	Measuring mass per unit area of geotextile.
47.	ASTM D 5321	Coefficient of soil and geosynthetics or geosynthetics and geosynthetics friction by direct shear.
48.	ASTM D 5890	Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners
49.	ASTM D 5891	Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners
50.	ASTM E 11	Specification for Wire-Cloth Sieves for Testing Purposes.
51.	ASTM F 714	Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
52.	ASTM C 31	Making and Curing Concrete Test Specimen in the Field.
53.	ASTM C 39	Compressive Strength of Cylindrical Concrete Specimens.
54.	ASTM C 143	Test Method for Slump of Hydraulic Cement Concrete.
55.	ASTM C 173	Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
56.	ASTM C 231	Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY		
1.	USEPA Method 9090	Compatibility Test for Wastes and Membrane Liners.

[END OF SECTION]

SECTION 02010
SUBSURFACE INVESTIGATION

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Prior to the start of construction of each secure cell, the Owner will execute the subsurface investigation described in this Section. The investigation will include test borings, sampling, and analysis in the area selected for the location of the secure cell. The work will be carried out in accordance with this General Specification.

1.02 RELATED SECTIONS

A. Section 02110 - Site Preparation and Earthwork

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.01 TEST BORINGS

A. At a minimum, test borings will be made at each corner and in the center of the secure cell (5 total). Additional test borings may be performed at the discretion of the Owner depending on the variability of the stratigraphy at a given secure cell location. The number of test borings required within the perimeter of the secure cell shall be kept to a minimum. The Contractor should not assume that sufficient subsurface information will be developed to accurately reflect the soil and/or bedrock conditions at all locations within the project area.

B. Test borings will be carried to depths selected by the Owner. The test borings at the perimeter of the secure cell will penetrate a minimum of 10 feet below the lowest planned excavation. Other test borings within the cell perimeter may be advanced to a shallower depth as directed by the Owner.

C. Each test boring will be logged by a qualified geologist or geotechnical engineer supplied by the Owner. Accurate logs of the materials encountered will be maintained. The method of drilling, diameter of the borehole, and other pertinent information will be reported on the boring logs.

D. The type and characteristics of the soil and/or bedrock encountered, as well as strata depths and thicknesses, will be evaluated from the test borings, and noted on the boring logs. The geologist or geotechnical engineer will investigate the macrostructure of the strata. A detailed description of these features will be included on the boring logs.

E. The water level in each test boring will be observed and recorded, if water is encountered during drilling. The initial water level and water level after a 24-hour period (or cave in depth, should that situation occur) will be noted.

F. After drilling, logging, sampling, and water level measurement, each test boring will be decommissioned. Decommissioning will be accomplished by grouting using the tremie method with a grout mix of 7 gallons of water to 1 bag (94 lb) of Type I Portland cement and 2 percent bentonite (by dry weight of cement). Test borings will be grouted to their full depth after the 24-hour water level reading. The amount of grout used at each borehole will be recorded on the boring log.

3.02 SAMPLING AND RECORD KEEPING

A. Soil samples will be taken from the borings and carefully transported to the laboratory to minimize disturbance of the soil and thereby maintain the physical and index properties, and other pertinent in-situ characteristics of the soil.

B. A minimum of two of the five borings (at opposite corners of the secure cell) will be sampled semi-continuously (typically 2-foot intervals) to a minimum depth of 40 feet and sampled at 5-foot intervals thereafter. Depending on the subsurface conditions encountered in the test borings, the remaining test borings may also be sampled semi-continuously or, alternatively, they may be sampled at a predetermined sample interval not to exceed 5 feet. Typically, cohesive soils will be sampled by hydraulically advancing a thin-walled tube sampler, and cohesionless soils will be sampled by driving a 2-inch diameter split-spoon sampler. A pitcher-barrel sampler, dennison sampler, or other sampler maybe used, depending on the actual soil conditions encountered in the borings.

3.03 LABORATORY ANALYSIS

A. Laboratory tests will be performed on selected soil samples recovered from the test borings to characterize the samples in order to develop a description of subsurface conditions at the location of the test borings. Tests will include, but may not be limited to, moisture content, Atterberg limits, permeability (clays), particle size, and standard Proctor compaction. Not all tests will be performed on all samples.

3.04 SURVEYING

A. The locations and elevations of the test borings will be surveyed before the test borings are decommissioned. The surveyor shall be licensed as a Land Surveyor in the State of Colorado.

3.05 GEOTECHNICAL REPORT

A. A geotechnical report will be prepared that provides field and laboratory data, including documentation of the borehole grouting. The report will be prepared by a Professional Engineer registered in the State of Colorado or by a qualified geologist. The report will provide boring logs, laboratory test results, and cross sections of the subsurface soil, bedrock and groundwater conditions encountered in the test borings at the proposed cell locations, and other information that may be pertinent to the cell construction and applicable regulations.

3.06 OTHER SUBSURFACE INVESTIGATION TECHNIQUES

Electrical resistivity, seismic refraction, or other remote sensing techniques, may be utilized in conjunction with the sample borings.

[END OF SECTION]

SECTION 02110
SITE PREPARATION AND EARTHWORK

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary to perform all site preparation, excavation, backfilling, and grading required to construct the secure cell or surface impoundment. The work shall be carried out in accordance with this General Specification, the Supplemental Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02010 - Subsurface Investigation
B. Section 02120 - Permanent Sump
C. Section 02221 - Secondary Clay Liner

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. Work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all testing activities outlined in the CQA Plan and shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. Soil testing (both field and laboratory testing) required by the CQA Plan will be the responsibility of the CQA Engineer. All Quality Control testing required by the General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor. The Contractor shall cooperate with the CQA Engineer during all testing activities. The Contractor shall provide equipment and labor to assist the CQA Engineer in sampling and shall provide access to all areas requiring testing. The Contractor shall repair any damage to finished work caused by the CQA Engineer's sampling or testing activities, except when specifically not required by the General Specifications.

D. The CQA Engineer will coordinate independent surveying required by the CQA Plan. Surveying by the CQA Engineer does not relieve the Contractor of his responsibility to lay out, control, and document the work.

E. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at no cost to the Owner until acceptable test results are obtained.

PART 2 PRODUCTS

2.01 MATERIALS

A. Fill materials shall be obtained from the excavation of the secure cell or surface impoundment, from the excavation of diversion ditches, or from borrow sources identified by the Owner.

B. Soil shall be classified as one of the following: (I) structural or general fill; (ii) clay liner material; (iii) topsoil; (iv) protective soil layer material; or (v) spoil.

1. Soil that is classified according to the Unified Soil Classification System (USCS) as SM, CL, ML, SC or GM or GC (ASTM D 2487) and has a maximum particle size of 4 inches; or other material approved by the Owner, may be used as structural fill or general fill. Structural or general fill shall be placed at the locations shown on the Construction Drawings and in all areas requiring fill that are within 50 feet of the secure cell or surface impoundment liner system. Beyond the 50 foot requirement structural or general fill material characteristics may be modified with the approval of the Owner.

   a. General fill is required in the cover section on top of the geocomposite drainage layer.

2. Soil that meets the requirements of Section 02221 and 02222 of these General Specifications may be used as clay liner material.

3. Soil classified as topsoil may be used for revegetation of disturbed areas or for other purposes shown on the Construction Drawings. All revegetation activities shall be carried out in accordance with this Section and the Owners requirements listed in LF-12.

4. Soil that meets the requirements of Section 02716 of these General Specifications may be used as protective soil layer material.

5. Soil not classified as structural fill or general fill, clay liner material, protective soil layer material, or topsoil shall be classified as spoil material. Spoil may be used for purposes specified in the Construction Drawings or by the Owner, or it may be disposed of on site in a manner approved by the Owner.

PART 3 EXECUTION

3.01 SITE PREPARATION

A. The Contractor shall develop access to the construction area in accordance with the requirements of the Construction Drawings.

B. The Contractor shall install silt fences immediately down-slope of each area to be disturbed prior to the beginning of work in that area. The Contractor shall maintain the silt fences for the

duration of construction. Accumulated sediment behind the silt fences shall be disposed of on-site by the Contractor in a manner approved by the Owner. The area around the top of secure cells and surface impoundments shall be graded to direct surface water away from the structure, wherever possible.

C. All brush, vegetation, rubbish, and other objectionable material shall be removed from the construction area and disposed of in an area designated by the Owner.

D. All topsoil shall be removed from the construction area and stockpiled in areas designated by the Owner for subsequent use on site.

E. A 30-foot wide work area shall be maintained clear of objectionable materials around the edge of the secure cell or surface impoundment construction area.

F. Diversion ditches, either permanent or temporary, shall be constructed in accordance with the Construction Drawings or as approved by the Owner. The Contractor shall be responsible for constructing diversion ditches as required to divert run-on around the construction area. The construction of temporary ditches not shown on the Construction Drawings shall not be undertaken until the Contractor's plan for constructing the ditches is approved by the Owner.

G. Temporary access roads to the construction area shall be constructed in accordance with the Construction Drawings or as approved by the Owner.

3.02 STOCKPILING

A. Prior to the start of excavation and if required by the Owner, the Contractor shall prepare a written excavation plan. The plan shall indicate the areas and sequence of excavation, and the anticipated classification of the excavated material (e.g., structural or general fill, clay liner material). This excavation plan must be reviewed and approved by the Owner. The Contractor shall take into account that the stockpiling portion of the excavation plan may be modified during construction based on the results of any conformance testing of the excavated material required by the CQA Plan.

B. Excavated materials classified as fill shall be stockpiled in designated areas free of incompatible soil, clearing debris, or other objectionable materials. Stockpile areas will be shown on the Construction Drawings or designated by the Owner.

C. Excavated material classified as spoil shall be segregated from fill and stockpiled or disposed of in the manner shown on the Construction Drawings or as specified by the Owner.

D. The CQA Engineer shall assist in the determination of what excavation material is select fill or spoil material.

E. Stockpiles of fill or spoil shall be no steeper than 3:1 (horizontal:vertical) or other slope approved by the Owner, graded to drain, sealed by tracking parallel to the slope with a dozer or other means approved by the Owner, and dressed daily during periods of active placement of fill taken from the stockpile. The Contractor may cover fill stockpiles with plastic sheeting or other material approved by the Owner in order to preserve the moisture content of the fill.

F. Stockpiles that will remain out of active use for a period greater than seven months shall either be covered as described in this section or stabilized by revegetation in accordance with the requirements for revegetation given in Permit Attachment LF-12.

G. The Contractor shall not remove fill material from the project site without the prior written approval of the Owner.

3.03 EXCAVATION

A. Upon completion of site preparation, the secure cell or surface impoundment shall be excavated to the elevations and grades for the subgrade shown on the Construction Drawings. The excavation shall include provisions for any leakage detection system sump or permanent sump shown on the Construction Drawings. All excavation work shall be carried out in compliance with all applicable OSHA regulations.

B. During construction of the secure cell or surface impoundment, the Contractor shall make excavations, as necessary, to ensure the drainage of water to a single area (i.e., a sump) to facilitate water collection and removal. A pump shall be provided for removing water from the sump. The pump shall have a capacity sufficient to meet the requirements of Section 01010 of these General Specifications. Water that accumulates in the sump shall be pumped to the on-site construction water tank or to such other location as designated by the Owner. The Contractor shall maintain the secure cell or surface impoundment excavation in a dry and workable condition. Damaged work or delays caused by water from any source shall be the responsibility of the Contractor.

C. Permeability tests will be conducted on the soil at the base of the excavation in accordance with the CQA Plan. The Contractor shall provide equipment and labor to assist the CQA Engineer in sampling, if necessary.

D. For subgrades on slopes steeper than 5:1 (horizontal:vertical) which will serve as foundations for structural fill, the subgrade shall be terraced or keyed to anchor the fill material and prevent slip failures. Each terrace shall be at least 10 feet wide with a maximum vertical elevation difference between terraces of 10 feet. Terraces shall generally run perpendicular to the fall line of the slope. Terraces shall have grades of not less than 2 percent or more than 5 percent away from the face of the embankment. Surface drainage shall be maintained at all times. This requirement does not apply to structural fills placed within the secure cell or surface impoundment such as ramps or berms.

E. After excavation or stripping to final grade, the CQA Engineer will inspect the subgrade on the side slopes of the secure cell or surface impoundment. The CQA Engineer will identify areas that require additional excavation of weak or excessively weathered subgrade materials on the slopes of the secure cell or surface impoundment excavation. The Owner will direct the Contractor to excavate the soft areas identified by the CQA Engineer. Such excavations shall be backfilled with structural fill or clay liner material. Backfill shall be placed and compacted in accordance with the requirements for structural fill given in this section. If secondary clay liner material is used to backfill these areas, it shall be placed in accordance with Section 02221 of these General Specifications. However, permeability tests will not be required.

F. After excavation to final grade, the CQA Engineer will inspect the subgrade on the base of the secure cell or surface impoundment. The CQA Engineer may identify areas of the subgrade to be proofrolled. If proofrolling is necessary, the Contractor shall use a 20-ton pneumatic-tired roller or other approved equipment. If soft spots or unsuitable materials are found, the Owner may direct the Contractor to excavate the soft material and either fill the excavated area with the same material (assuming the existing material will provide adequate support if recompacted) or structural fill material. Backfill shall be placed and compacted in accordance with the requirements for structural fill given in this section or secondary clay liner material given in Section 02221.

G. The Contractor shall scarify the portion of the subgrade on the base of the secure cell or surface impoundment that is comprised of soil and not treated for soft spots, to a depth of not less than 8 inches and compact it in accordance with the requirements for structural fill as directed by the Owner.

H. The subgrade surface shall be seal-rolled to prevent moisture infiltration unless fill is to be immediately placed on the subgrade.

I. Excavation of the secure cell or surface impoundment shall not be considered complete, and no fill shall be placed on the subgrade, until the CQA Engineer confirms that the minimum elevations and grades shown on the Construction Drawings have been achieved in the field. The Contractor shall be responsible for notifying the CQA Engineer that the excavation (or a significant portion thereof) is complete and the Contractor shall plan for the time required for the CQA Engineer to confirm the elevations and grades of the excavation.

J. Upon completion of excavation of secure cells, a geologist or geotechnical engineer provided by the Owner will map the exposed natural soils on the side slopes and bottom of the excavation. Each distinct soil stratum will be sampled and classified according to ASTM D 2487. Soil maps and grain-size analyses will be included in each secure cell certification report. This requirement only applies to secure cells. The Contractor shall cooperate with the geologist or geotechnical engineer so that the necessary mapping and sampling can be carried out.

K. The Contractor shall remove soils which the CQA Engineer and Owner have determined to have a Unified Soil Classification System (USCS) gradation coarser than SM (silty sand) found at the limits of the secure cell excavation.

L. Soils with a USCS gradation coarser than SM determined in accordance with the CQA Plan shall be removed at the time of cell excavation for a predetermined from the nearest point of the secure cell secondary geomembrane liner. Removed soil shall be replaced with compacted soil of a thickness and permeability that has a travel time equal to or greater than a 100 foot thick clay with a permeability of 1×10^{-7} cm/sec.

M. If directed by the Owner, the Contractor shall excavate additional low-density materials (in-place dry densities of less than 95 pounds per cubic foot) around the edges of the secure cell excavation. Such excavations shall extend no more than 10 feet beyond the subgrade limits shown on the Construction Drawings, and no deeper than 15 feet below the existing ground

surface. Any such overexcavation shall be backfilled as part of, and in accordance with the requirements for, secondary clay liner placement, Section 02221.

3.04 PLACEMENT AND COMPACTION OF STRUCTURAL AND GENERAL FILL

A. Specific requirements for placement and compaction of structural and general fill shall be as specified herein unless other requirements are given on the Construction Drawings.

B. Fill lifts after compaction shall have an average thickness of no more than 6 inches and a maximum thickness of no more than 7 inches. The loose thickness shall be no greater than the length of the pad foot and drum groove of the compaction equipment (7 to 8 inches for a CAT 825 (OR APPROVED EQUAL)).

C. The CQA Engineer must complete field testing of fill placed and compacted to determine compliance with these specifications in accordance with the CQA Plan. The Contractor shall not place a new lift of fill over a preceding lift until approval is given by the CQA Engineer. If the Contractor fails to comply with this requirement, he will be required to remove and replace all unauthorized work at his own expense.

D. Prior to placement of a lift of fill, the previous compacted lift shall be thoroughly scarified to provide good bonding between lifts. Scarification shall be accomplished by raking with a grader, discing, or an alternate method approved by the Owner.

E. The subgrade may be compacted at its natural moisture content.

F. Unless otherwise required by the Construction Drawings, structural fill shall be compacted at a moisture content between 3 percent dry to 3 percent wet of the optimum moisture content and to a minimum dry unit weight of 95 percent of the maximum dry unit weight determined in the standard Proctor compaction test (ASTM D 698). If the moisture content of the structural fill is outside of the acceptable range, the soil shall be wetted or dried back, as appropriate. During wetting or drying, the soil shall be regularly disced or otherwise mixed so that uniform moisture conditions are obtained.

G. Unless otherwise required by the Construction Drawings, general fill shall be compacted at a moisture content near optimum moisture content and to a minimum dry unit weight of 90 percent of the maximum dry unit weight determined in the standard Proctor compaction test (ASTM D 698). If the moisture content of the general fill is outside of the acceptable range, the soil shall be wetted or dried back, as appropriate. During wetting or drying, the soil shall be regularly disced or otherwise mixed so that uniform moisture conditions are obtained. Where general fill is placed over geosynthetic materials, the first lift shall be placed, spread and compacted with a low ground pressure dozer. Extreme care shall be taken during placement and spreading operations to ensure that the earthworks equipment does not damage the underlying geosynthetics.

H. The Contractor may moisture-condition fill in either the stockpile area or work area.

I. Compaction of lifts shall be performed with an appropriately heavy, properly ballasted, penetrating-foot compactor subject to the approval of the CQA Engineer.

J. The Contractor shall not place frozen fill, nor shall he place fill on frozen ground.

K. If fill freezes during construction, the Contractor shall remove the frozen fill, scarify the remaining unfrozen fill, and then place and compact new fill in accordance with these General Specifications. The frozen fill shall not be reused until it has thawed, and been thoroughly blended, and then reworked to an acceptable moisture content.

3.05 SURVEY CONTROL

A. The Surveyor shall survey the location and elevation of the excavation for the secure cell or surface impoundment. He shall also survey the location and elevation of the top of subgrade shown on the Construction Drawings. Surveying shall be performed in general accordance with Section 01010 of these General Specifications.

A. The Surveyor shall provide Record Drawings of the location and elevation of the excavation and the top of subgrade (or top of interim cover for cover systems) for the secure cell or surface impoundment, in accordance with the requirements of Section 01010 of these General Specifications. The Surveyor shall submit this drawing to the Owner prior to the start of secondary clay liner placement or cover GCL placement unless otherwise approved by Owner and CQA Engineer. The Surveyor may submit a partial Record Drawing to obtain approval for a portion of work. The Owner will define the minimum requirements for a partial submittal.

3.06 FIELD QUALITY CONTROL

A. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

3.07 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all materials and all partially-completed and completed work of these General Specifications.

B. In the event of damage, the Owner will identify areas requiring repair, and the Contractor shall make all repairs and replacements necessary to the approval of the Owner at no additional cost to the Owner.

C. At the end of each day, the Contractor shall verify that the entire work area was left in a state that promotes surface drainage off and away from the area and from finished work. If threatening weather conditions are forecast, compacted surfaces shall be seal-rolled or covered with plastic sheeting to protect finished work.

3.08 REVEGETATION

A. At the end of construction, all disturbed areas with exposed soil (including borrow areas, soil stockpiles, material storage areas, Contractor access roads, etc.) shall be graded and revegetated as directed by the Owner or in accordance with the requirements for revegetation in the Owner's Specification.

3.09 SEDIMENTATION AND EROSION CONTROL

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary for the installation of geotextiles for sedimentation and erosion control during construction. The work shall be carried out in accordance with the requirements of Sections 420.06 and 420.07 of the Colorado Department of Highways Standard Specifications for Road and Bridge Construction, pertaining to erosion control and silt fences. Silt fences shall be placed as necessary downslope of all disturbed areas, and shall remain until such areas are successfully revegetated.

3.10 PERFORATIONS

A. Perforations in the subgrade or fill resulting from CQA activities will be filled. Such perforations may include, but are not limited to, the following:

1. Nuclear density test probe locations;

2. Shelby tube sample locations; and

3. Sand-cone, drive cylinder, or rubber balloon test locations.

B. Perforations resulting from nuclear density tests will be filled by the CQA Engineer. All other perforations resulting from construction and/or CQA activities shall be filled by the Contractor. The CQA Engineer will provide the Contractor with the locations of any perforations made as part of CQA activities, except nuclear density tests.

C. Perforations from construction and/or CQA sampling activities (except nuclear density tests) shall be backfilled by the Contractor with structural fill material. The structural fill material shall be placed and compacted in accordance with the requirements of this section. Perforations from nuclear density tests will be backfilled by the CQA Engineer with bentonite (sodium montmorillonite) powder or flakes or a soil-bentonite mixture and compacted by hand tamping.

[END OF SECTION]

SECTION 02119
SAND LAYER CLAY PLUG

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary for the construction of the sand layer clay plug for the secure cell or surface impoundment. The work shall be carried out in accordance with these General Specifications, Supplemental Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02110 - Site Preparation and Earthwork
B. Section 02780 - Geosynthetic Clay Liner

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualifications and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. Work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all testing activities outlined in the CQA Plan and shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. Soil testing (both field and laboratory testing) required by the CQA Plan will be the responsibility of the CQA Engineer. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor. The Contractor shall cooperate with the CQA Engineer during all testing activities. The Contractor shall provide equipment and labor to assist the CQA Engineer in sampling. The Contractor shall provide access to all areas requiring testing. The Contractor shall repair any damage to finished work caused by the CQA Engineer's sampling or testing activities.

D. The CQA Engineer will coordinate independent surveying. Surveying by the CQA Engineer does not relieve the Contractor of his responsibility to lay out, control, and document the work.

E. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at no cost to the Owner until acceptable test results are obtained.

PART 2 PRODUCTS

2.01 MATERIALS

Clay plug material may only be used for construction if it has been shown to be suitable in a test fill program. The test fill program will have been performed prior to construction of the secure cell or surface impoundment, and it is not part of the work included in this General Specification. Depending on the results of future test fills in the secure cell, either the weathered Pierre shale or the on-site silty clay may be used. These General Specifications may be modified per the results of future test fills.

A. Clay plug material shall be obtained from borrow areas or stockpiles identified by the Owner.

B. Clay plug material for secure cell or surface impoundment construction shall:

1. Be classified according to the Unified Soil Classification System (USCS) as CL or CH (ASTM D 2487) and exhibit a minimum liquid limit of 30 and a minimum plasticity index of 11.

2. Have a percentage of gravel (i.e., dry weight retained on a U.S. No. 4 sieve) of less than 15 percent.

3. Have particles no larger than 2 inches (in largest dimension) after processing but prior to placement (4 inches post-processing and 2 inches post-compaction for the weathered Pierre shale).

4. Have a hydraulic conductivity in the range of 1×10^{-7}m/s when compacted in accordance with these General Specifications and tested in the laboratory in accordance with ASTM D 5084 at a confining pressure of 12 psi. Bentonite additives may be admixed with weathered Pierre shale or on-site silty clay to achieve the required hydraulic conductivity of 1×10^{-7}cm/s. Bentonite will be added at percentages defined in the test fill and/or laboratory test programs.

C. The intent of the clay plug is to will provide a barrier of a given thickness and permeability that will result in a travel time equal to a clay 100 feet thick with a permeability 1×10^{-7} cm/sec.

D. The water used to increase the moisture content of the clay plug shall be provided by the Owner. The Contractor shall maintain an accurate record of his water usage.

PART 3 EXECUTION

The requirements of Part 3 may be modified based on the results of future test fills, as a Class 1 modification with prior approval.

3.01 CLAY PLUG COMPACTION CRITERIA

A. The compaction moisture content and the minimum dry unit weight of on-site clay, if used as clay plug material, shall be as follows:

1. The compaction moisture content of the clay plug material used shall be at least optimum moisture content determined in the standard Proctor compaction test (ASTM D 698) and the minimum dry unit weight of the clay plug material shall be at least 99 percent of the maximum dry unit weight obtained from the standard Proctor compaction test (ASTM D 698).

2. If the CAT 825 (OR APPROVED EQUAL) compactor is used, the compaction moisture content of the clay plug material used in the sideslopes of the cell shall be between 1-1/2 and 4 percent above optimum moisture content determined in the standard Proctor compaction test (ASTM D 698) and the minimum dry unit weight of the clay plug material shall be at least 95 percent of the maximum dry unit weight obtained from the standard Proctor compaction test (ASTM D 698). The combination of compacted in-place dry density and moisture content shall result in a minimum degree of saturation of 89 percent.

3. If the REX 3-35 (OR APPROVED EQUAL) compactor is used, the compaction moisture content of the clay plug material used in the sideslopes of the cell shall be between optimum and 3 percent above optimum moisture content determined in the standard Proctor compaction test (ASTM D 698) and the minimum dry unit weight of the clay plug material shall be at least 100 percent of the maximum dry unit weight obtained from the standard Proctor compaction test (ASTM D 698).

B. The compaction moisture content of the weathered Pierre shale, if used as clay plug material, shall be between optimum moisture content and 3 percent wet of the optimum moisture content determined in the standard Proctor compaction test (ASTM D 698) and the minimum dry unit weight of the weathered Pierre shale liner material shall be at least 95 percent of the maximum dry unit weight obtained from the standard Proctor compaction test (ASTM D 698).

A. Compaction and moisture content requirements for either the weathered Pierre shale or on-site clay may vary if bentonite admix is used. The specific placement and compaction criteria will be determined as part of a test fill program.

3.02 CLAY PLUG MATERIAL PLACEMENT

A. The clay plug material shall be placed a minimum of 1 foot above the maximum elevation of the sand seam and a minimum of 1 foot below the minimum elevation of the sand seam.

B. Clay plug placement shall begin only after completion of all, or an approved portion of, excavation and structural fill placement in the secure cell or surface impoundment. Placement shall not begin until the Contractor has verified that sand seam material has been exposed and required portions have been removed.

C. The Contractor shall not place clay plug material on a surface or subgrade that contains debris, branches, vegetation, mud, ice, or frozen material. If frozen subgrade material is encountered, it shall be removed and replaced in accordance with these General Specifications.

D. The Contractor shall construct the clay plug in lifts. Each lift of the clay plug shall meet the minimum requirements of this General Specification.

E. If a CAT 825 (OR APPROVED EQUAL) compactor is used, the average lift thickness after compaction shall be no more than 6 inches, and the maximum lift thickness shall be 7 inches after compaction. If a REX 3-35 (OR APPROVED EQUAL) compactor is used, the average lift thickness after compaction shall be no more than 4 inches and the maximum lift thickness shall be 5 inches after compaction. The loose lift thickness shall be no greater than the length of the compactor pad.

F. Clay plug material shall be placed and compacted in horizontal lifts.

G. Prior to placement of a lift of clay plug material, Contractor shall allow the CQA Engineer to complete field testing in accordance with the CQA Plan. The Contractor shall not place a new lift of clay plug material over a preceding lift until approval is given by the CQA Engineer. If the Contractor fails to comply with this requirement, he will be required by the Owner to remove and replace all unauthorized work at no additional cost to the Owner.

H. Prior to placement of a lift of clay plug material, the previous lift shall be thoroughly scarified to a nominal depth of about 1 to 2 inches to provide good bonding between lifts. Scarification shall be accomplished by discing, raking with a grader penetration by a sheepsfoot compactor or an alternative method approved by the Owner.

I. The excessive trafficking of scarified surfaces by non-placement trucks or other equipment shall not be permitted during the period between scarification and placement of the following lift.

J. If normal handling does not reduce the maximum clod size in clay plug material to an acceptable size, the Contractor shall use a Caterpillar SS250 soil stabilizer, mechanical mixer, or approved equivalent equipment to break up the clods. The clay plug material shall be pulverized until the maximum soil clod size is reduced to 2 inches or less in largest dimension.

K. Moisture conditioning of the clay plug material shall be accomplished in the processing area prior to clay plug construction. The processing area location shall be approved by the Owner. Clay plug material shall be moisture conditioned using a Caterpillar SS250 soil stabilizer or approved equivalent. If the clay plug material is wetter than required, it shall be repeatedly mixed using a Caterpillar SS250 soil stabilizer, harrowing disc, grader, or equivalent to achieve drying.

L. No more than 1.5 percent moisture shall be added to the clay plug material at the time of compaction. Clay plug material requiring more than 1.5 percent moisture shall be removed, returned to the processing area, and conditioned until the proper moisture content is achieved. If the in-place moisture content is too high, the clay may be dozed, windrowed, disced, and/or otherwise mixed to facilitate drying.

M. Clay plug material shall not be placed or compacted during a sustained period of temperature below 32□F that results in frozen clay either in place or in the borrow area. Clay plug material may be placed and compacted during periods of early morning freezing temperatures if above-freezing temperatures are anticipated during the day.

N. The Contractor shall not place frozen clay nor shall the Contractor place clay on frozen ground.

O. If clay plug material freezes after compaction, the Contractor shall either rework the material after it thaws or remove the frozen material. The Contractor shall then place and compact new clay or rework clay in accordance with the General Specifications. Frozen clay shall not be reused until it has thawed and been reworked to an acceptable moisture content. The Contractor shall be responsible for protecting compacted lifts of clay plug material from freezing. If extended freezing conditions are anticipated, the Contractor shall prepare a plan for approval of the Owner which outlines the measures he will take to protect finished work.

P. Clay plug material shall not be placed during periods of unfavorable weather conditions.

Q. If a bentonite admix program is used, the dry bentonite shall be thoroughly mixed prior to moisture conditioning with the dry borrow source material using a soil stabilizer or by discing.

3.03 CLAY PLUG COMPACTION

A. The sequence of compaction of the clay plug for a secure cell or surface impoundment shall be as described in the General Specifications or as shown on the Construction Drawings.

B. Compaction of clay plug on the base of the cell or surface impoundment shall be performed using a Caterpillar 825 compactor. Compaction of material on the sideslopes shall be performed using either a Caterpillar 825 compactor or a REX 3-35 (OR APPROVED EQUAL) compactor.

C. The daily work area shall extend a sufficient distance so as to maintain soil moisture conditions within an acceptable range to allow continuous operations. Desiccation and crusting of the lift surface shall be avoided as much as possible.

D. The CQA Engineer will identify any areas of significant desiccation and crusting of a lift surface. The Contractor shall scarify the surface of such areas to a nominal depth of 1 to 2 inches or to the depth of desiccation identified by the CQA Engineer, and then water condition, disc or mix as necessary, and recompact the area.

E. The transition from an existing full-depth section of clay plug to the beginning of an adjacent section that is to be constructed subsequently shall be accomplished by sloping (cutting back) the end of the full-depth section at 3:1 (horizontal:vertical) or flatter, scarifying the slope of the existing full-depth liner at the transition, and then immediately placing the adjacent lifts of clay plug.

F. If a dual-drum compactor which has the drums laterally separated by the operator's cab and the differential (such as a CAT 825 (OR APPROVED EQUAL)) is used, one trip up and a staggered trip back, to cover the uncompacted area between the drums, shall be considered one pass. The minimum number of compactor passes on each lift of the clay plug shall be as follows:

1. The base of the clay plug shall be compacted with a minimum of 10 passes of the CAT 825 (OR APPROVED EQUAL) if the on-site clay is used. If the weathered Pierre

shale is used, it shall be compacted with a minimum of 6 passes of the CAT 825 (OR APPROVED EQUAL).

2. If the CAT 825 (OR APPROVED EQUAL) is used on the sideslopes of the clay plug, then a minimum of 8 passes are required.

3. If the REX 3-35 (OR APPROVED EQUAL) is used on the sideslopes of the clay plug, then a minimum of 15 passes are required.

It should be noted that more than the minimum number of passes may be necessary to satisfy the other compaction criteria.

G. The number of compactor passes may be modified for bentonite admixed soil based on a test fill.

H. Corners and other areas inaccessible to driven compaction equipment shall be compacted using hand operated equipment (such as a walk-behind roller) approved by the Owner.

3.04 SURVEY CONTROL

A. The Surveyor shall survey the final location and elevations of the top and bottom of the clay plug. Surveying shall be performed in accordance with Section 01010 of these General Specifications. The survey will ensure:

1. The specified thickness of compacted clay plug has been achieved.

B. The Surveyor shall provide a Record Drawing to the Owner of the final location and elevation of the top and bottom of the clay plug, including the location of the sand seam. The Surveyor shall submit this drawing prior to liner construction unless otherwise approved by the Owner and the CQA engineer. The Contractor may submit a partial record to obtain approval for a portion of the work. The Owner will define the minimum requirements for a partial submittal.

3.05 FIELD QUALITY CONTROL

A. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

B. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at his own expense until acceptable test results are obtained.

3.06 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all materials and partially-completed and completed work of these General Specifications.

B. In the event of damage, the CQA Engineer will identify areas requiring repair, and the Contractor shall make repairs and replacements necessary to the approval of the Owner and at no additional cost to the Owner.

C. The Contractor shall minimize, to the maximum extent feasible, desiccation cracking of clay plug material. The Contractor shall sprinkle the clay with water if cracking is observed or if directed by the Owner. The Contractor may seal roll the surface of the clay to reduce drying and desiccation. The Contractor may protect exposed surfaces using light-colored or translucent membranes, such as Visqueen, to inhibit drying of the clay. The CQA Engineer will identify areas of significant cracking of the surface of the clay plug and the Contractor shall repair the identified area to the satisfaction of the Owner and at no additional cost to the Owner.

D. Desiccation cracks larger than 0.2 feet deep or 0.25 inches wide shall be excavated to the full depth of the crack and repaired. Desiccation cracks on the liner surface less than 0.2 feet deep and 0.25 inches wide shall be moistened and compacted with a smooth drum roller until the surfaces meet the requirements of the CQA plan.

3.07 PERFORATIONS

A. Perforations in the clay plug resulting from construction and CQA activities shall be filled. Such perforations may include, but are not limited to, the following:

1. Nuclear density test probe locations;
2. Shelby tube sample locations;
3. Sand-cone or rubber-balloon test locations;
4. Survey stake locations.

B. Perforations in the clay plug resulting from nuclear density tests will be filled by the CQA Engineer. All other perforations in the clay plug resulting from construction and/or CQA sampling activities shall be filled by the Contractor. The CQA Engineer will provide the Contractor with the locations of any tests made as part of CQA activities, except nuclear density tests.

C. Perforations from construction and/or CQA sampling activities (except nuclear density tests) shall be backfilled by the Contractor with clay plug material. The clay plug material shall be placed and compacted (hand tamped) in accordance with the requirements of this section. Perforations in the clay plug from nuclear density tests will be backfilled by the CQA Engineer with bentonite (sodium montmorillonite) powder or flakes or a soil-bentonite mixture and compacted by hand tamping.

[END OF SECTION]

SECTION 02120
PERMANENT SUMP

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary for the construction of the permanent sump below the secure cell liner system. The work shall be carried out in accordance with these General Specifications, Supplemental Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02010 - Subsurface Investigation
B. Section 02110 - Site Preparation and Earthwork
C. Section 02221 - Secondary Clay Liner
D. Section 02225 - Sump and Pipe Bedding Gravel and Road Base Aggregate
E. Section 02714 - Geotextile Filter, Cushion, or Sacrificial Layer
F. Section 02718 - Polyethylene Pipe and Fittings
G. Section 02775 - Geomembrane Liners

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. All work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all testing activities outlined in the CQA Plan and shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. Soil testing (both field and laboratory testing) required by the CQA Plan and geosynthetic conformance testing required by the CQA Plan will be the responsibility of the CQA Engineer. All Quality Control testing required by the General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor. The Contractor shall cooperate with the CQA Engineer during all testing activities. The Contractor shall provide equipment and labor to assist the CQA Engineer in sampling and he shall also provide access to all areas requiring testing. Any geosynthetic rolls that do not meet the requirements of the General Specifications will be rejected. The Contractor shall be required to replace the rejected material with new material that conforms to the specification requirements at his own expense. The Contractor shall repair any damage to finished work caused by the CQA Engineer's sampling or testing activities.

D. The CQA Engineer will coordinate independent surveying required by the CQA Plan. Surveying by the CQA Engineer does not relieve the Contractor of his responsibility to lay out, control and document the work.

E. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at no cost to the Owner until acceptable test results are obtained.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials used to construct the permanent sump shall be those shown on the Construction Drawings. The materials may include geosynthetic clay liners, structural fill, clay liner material, geomembrane liners, sump and pipe bedding gravel, polyethylene pipe and fittings, and geotextile cushion or filter layers.

B. Structural fill materials used to construct the permanent sump shall conform to the requirements of Section 02110 of these General Specifications.

C. Geomembrane liners used to construct the permanent sump shall conform to Section 02775 of these General Specifications.

D. Sump and pipe bedding gravel used to construct the permanent sump shall conform to Section 02225 of these General Specifications.

E. Polyethylene pipe and fittings used to construct the permanent sump shall conform to Section 02718 of these General Specifications.

F. Geotextile filter layers or cushion layers used to construct the permanent sump shall conform of Section 02714 of these General Specifications.

2.02 MANUFACTURING QUALITY CONTROL

A. Manufacturing quality control requirements for the materials used to construct the permanent sump are provided in the appropriate section of these General Specifications for the material required.

B. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

PART 3 EXECUTION

3.01 HANDLING, PLACEMENT, INSTALLATION, AND/OR COMPACTION

A. A permanent sump for the secure cell shall be constructed at the location shown, and in accordance with, the Construction Drawings.

B. The procedures for handling, placement, installation and/or compaction of each material used to construct the permanent sump shall be the same as the procedures given in these General Specifications related to liner system construction for the same corresponding material.

C. The Contractor shall dewater the permanent sump as necessary following any precipitation events. Dewatering shall be performed in a timely manner to minimize softening of the sump area.

3.02 SEAMING, OVERLAPPING, AND REPAIRING

A. The procedures for seaming, overlapping, and repairing each geosynthetic or pipe material used to construct the permanent sump shall be the same as the procedures given in these General Specifications related to liner system construction for the same corresponding material.

3.03 PLACEMENT OF OVERLYING MATERIALS

A. The procedures for placing soil materials over geosynthetics and pipe used to construct the permanent sump shall be the same as the procedures given in these General Specifications related to liner system construction for the same corresponding material.

3.04 SURVEY CONTROL

A. The Surveyor shall survey the location and elevation of the top of subgrade for the permanent sump shown on the Construction Drawings. Surveying shall be performed in accordance with Section 01010 of these General Specifications.

B. The Surveyor shall provide Record Drawings of the location and elevation of the top of subgrade for the permanent sump, in accordance with the requirement of Section 01010 of these General Specifications. The Surveyor shall provide the Record Drawing prior to the placement of the overlying clay liner in the sump unless otherwise approved by Owner and CQA Engineer.

3.05 FIELD QUALITY CONTROL

A. All Quality Control testing required by the General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

3.06 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all materials and all partially-completed and completed work of these General Specifications.

B. In the event of damage, the CQA Engineer will identify areas requiring repair, and the Contractor shall make all repairs and replacements necessary to the approval of the Owner and at no additional cost to the Owner.

[END OF SECTION]

SECTION 02221
SECONDARY CLAY LINER

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary for the construction of the secondary clay liner component of the liner system for the secure cell or surface impoundment. The work shall be carried out in accordance with these General Specifications, Supplemental Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02110 - Site Preparation and Earthwork
B. Section 02120 - Permanent Sump
C. Section 02222 - Primary Clay Liner
D. Section 02775 - Geomembrane Liners
E. Section 02780 - Geosynthetic Clay Liners

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualifications and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. Work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all testing activities outlined in the CQA Plan and shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. Soil testing (both field and laboratory testing) required by the CQA Plan will be the responsibility of the CQA Engineer. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor. The Contractor shall cooperate with the CQA Engineer during all testing activities. The Contractor shall provide equipment and labor to assist the CQA Engineer in sampling. The Contractor shall provide access to all areas requiring testing. The Contractor shall repair any damage to finished work caused by the CQA Engineer's sampling or testing activities.

D. The CQA Engineer will coordinate independent surveying. Surveying by the CQA Engineer does not relieve the Contractor of his responsibility to lay out, control, and document the work.

E. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at no cost to the Owner until acceptable test results are obtained.

PART 2 PRODUCTS

2.01 MATERIALS

Clay liner material may only be used for construction if it has been shown to be suitable in a test fill program. The test fill program will have been performed prior to construction of the secure cell or surface impoundment, and it is not part of the work included in this General Specification. Depending on the results of future test fills, either the weathered Pierre Shale or the on-site silty clay may be used on the base and/or the side slopes of the secure cell. These General Specifications may be modified per the results of future test fills.

A. Clay liner material shall be obtained from borrow areas or stockpiles identified by the Owner.

B. If used, weathered Pierre shale satisfying the requirements of this section shall only be used in areas where the grades are less than 5 percent (base portions of the secure cell liner system). If weathered Pierre shale is used in the base of the cell, it shall be obtained from the existing Pierre shale stockpile. On-site clay material may be used on the base and shall be used on the side slopes of the secure cell liner system.

C. Clay liner material for secure cell or surface impoundment construction shall:

1. Be classified according to the Unified Soil Classification System (USCS) as CL or CH (ASTM D 2487) and exhibit a minimum liquid limit of 30 and a minimum plasticity index of 11.

2. Have a percentage of gravel (i.e., dry weight retained on a U.S. No. 4 sieve) of less than 15 percent.

3. Have particles no larger than 2 inches (in largest dimension) after processing but prior to placement (4 inches post-processing and 2 inches post-compaction for the weathered Pierre shale).

4. Have a hydraulic conductivity of not more than 1×10^{-7} cm/s when compacted in accordance with these General Specifications and tested in the laboratory in accordance with ASTM D 5084 at the conditions given in Permit Attachment LF-8.

A. The water used to increase the moisture content of the clay liner shall be provided by the Owner. The Contractor shall maintain an accurate record of his water usage.

PART 3 EXECUTION

The requirements of Part 3 may be modified based on the results of future test fills, as a Class 1 modification with prior approval.

3.01 SECONDARY CLAY LINER COMPACTION CRITERIA

A. The compaction moisture content and the minimum dry unit weight of on-site clay, if used as secondary clay liner material, shall be as follows:

1. The compaction moisture content of the secondary clay liner material used in the base of the cell shall be at least optimum moisture content determined in the standard Proctor compaction test (ASTM D 698) and the minimum dry unit weight of the clay liner material shall be at least 99 percent of the maximum dry unit weight obtained from the standard Proctor compaction test (ASTM D 698).

2. If the CAT 825 (OR APPROVED EQUAL) compactor is used, the compaction moisture content of the secondary clay liner material used in the sideslopes of the cell shall be between 1-1/2 and 4 percent above optimum moisture content determined in the standard Proctor compaction test (ASTM D 698) and the minimum dry unit weight of the clay liner material shall be at least 95 percent of the maximum dry unit weight obtained from the standard Proctor compaction test (ASTM D 698). The combination of compacted in-place dry density and moisture content shall result in a minimum degree of saturation of 89 percent.

3. If the REX 3-35 (OR APPROVED EQUAL) compactor is used, the compaction moisture content of the secondary clay liner material used in the sideslopes of the cell shall be between optimum and 3 percent above optimum moisture content determined in the standard Proctor compaction test (ASTM D 698) and the minimum dry unit weight of the clay liner material shall be at least 100 percent of the maximum dry unit weight obtained from the standard Proctor compaction test (ASTM D 698).

B. The compaction moisture content of weathered Pierre shale, if used as secondary clay liner material, shall be between optimum moisture content and 3 percent wet of the optimum moisture content determined in the standard Proctor compaction test (ASTM D 698) and the minimum dry unit weight of the weathered Pierre shale shall be at least 95 percent of the maximum dry unit weight obtained from the standard Proctor compaction test (ASTM D 698).

3.02 SECONDARY CLAY LINER PLACEMENT

A. The secondary clay liner shall be constructed to the elevations, grades, and thicknesses shown on the Construction Drawings. The thickness of the clay liner at any location shall be measured perpendicular to the plane of the slope at that location. The compacted secondary clay liner shall be three foot thick across the bottom of the secure cell and 4.5 feet up the side slopes.

B. Secondary clay liner placement shall begin only after completion of all, or an approved portion of, excavation and structural fill placement in the secure cell or surface impoundment. Placement shall not begin until the Contractor has verified that subgrade elevations and grades conform to the Construction Drawings and the CQA Engineer has completed testing and surveying of the subgrade required by the CQA Plan.

C. The Contractor shall not place secondary clay liner material on a surface or subgrade that contains debris, branches, vegetation, mud, ice, or frozen material. If frozen subgrade material is encountered, it shall be removed and replaced in accordance with these General Specifications. Immediately prior to clay liner placement, any wet or soft areas of the subgrade shall be proof-rolled as directed by the Owner. Any excessively wet or soft areas shall be excavated and replaced with properly compacted structural fill.

D. The Contractor shall construct the secondary clay liner in lifts. Each lift of the secondary clay liner shall meet the minimum requirements of this General Specification.

E. If a CAT 825 (or approved equal) compactor is used, the average lift thickness after compaction shall be no more than 6 inches, and the maximum lift thickness shall be 7 inches after compaction. If a REX 3-35 (OR APPROVED EQUAL) compactor is used, the average lift thickness after compaction shall be no more than 4 inches and the maximum lift thickness shall be 5 inches after compaction. The loose lift thickness shall be no greater than the length of the compactor pad.

F. On slopes of 3:1 (horizontal: vertical) or flatter, secondary clay liner material may either be placed and compacted in lifts that are parallel to the slope or in horizontal lifts. For steeper slopes, secondary clay liner material shall be placed and compacted in horizontal lifts.

G. Prior to placement of a lift of secondary clay liner material, Contractor shall allow the CQA Engineer to complete field testing in accordance with the CQA Plan. The Contractor shall not place a new lift of secondary clay liner material over a preceding lift until approval is given by the CQA Engineer. If the Contractor fails to comply with this requirement, he will be required by the Owner to remove and replace all unauthorized work at no additional cost to the Owner.

H. Prior to placement of a lift of secondary clay liner material, the previous lift shall be thoroughly scarified to a nominal depth of about 1 to 2 inches to provide good bonding between lifts. Scarification shall be accomplished by discing, raking with a grader penetration by a sheepsfoot compactor or an alternative method approved by the Owner.

I. The excessive trafficking of scarified surfaces by non-placement trucks or other equipment shall not be permitted during the period between scarification and placement of the following lift.

J. If normal handling does not reduce the maximum clod size in on-site clay to an acceptable size, the Contractor shall use a Caterpillar SS250 soil stabilizer, mechanical mixer, or approved equivalent equipment to break up the clods. The on-site clay material shall be pulverized until the maximum soil clod size is reduced to 2 inches or less in largest dimension. The weathered Pierre shale material shall also be pulverized using a Caterpillar SS250 soil stabilizer (or an approved equivalent piece of equipment) until the maximum soil clod size is reduced to 4 inches or less (in largest dimension). The maximum soil clod size after compaction of the weathered Pierre shale shall be 2 inches or less in largest dimension. The use of a specific stabilizer or mixer shall be approved by the Owner prior to use.

K. Moisture conditioning of the secondary clay liner material shall be accomplished in the processing area prior to clay liner construction. The processing area location shall be approved

by the Owner. Clay liner material shall be moisture conditioned using a Caterpillar SS250 soil stabilizer or approved equivalent. If the clay liner material is wetter than required, it shall be repeatedly mixed using a Caterpillar SS250 soil stabilizer, harrowing disc, grader, or equivalent to achieve drying.

L. No more than 1.5 percent moisture shall be added to the clay liner material at the time of compaction. Clay liner material requiring more than 1.5 percent moisture shall be removed, returned to the processing area, and conditioned until the proper moisture content is achieved. If the in-place moisture content is too high, the clay may be dozed, windrowed, disced, and/or otherwise mixed to facilitate drying.

M. Secondary clay liner material shall not be placed or compacted during a sustained period of temperature below 32□F that results in frozen clay, either in place or in the borrow area. Secondary clay liner material may be placed and compacted during periods of early morning freezing temperatures if above-freezing temperatures are anticipated during the day.

N. The Contractor shall not place frozen clay nor shall the Contractor place clay on frozen ground.

O. If clay liner material freezes after compaction, the Contractor shall remove the frozen material, scarify the remaining unfrozen clay, and then place and compact new clay in accordance with the General Specifications. Frozen clay shall not be reused until it has thawed and been reworked to an acceptable moisture content. The Contractor shall be responsible for protecting compacted lifts of clay liner material from freezing. If extended freezing conditions are anticipated, the Contractor shall prepare a plan for approval of the Owner which outlines the measures he will take to protect finished work.

P. Clay liner material shall not be placed during periods of unfavorable weather conditions.

3.03 SECONDARY CLAY LINER COMPACTION

A. The sequence of compaction of the secondary clay liner for a secure cell or surface impoundment shall be as described in the General Specifications or as shown on the Construction Drawings.

B. Compaction of secondary clay liner on the base of the cell or surface impoundment shall be performed using a Caterpillar 825 (or approved equal) compactor. Compaction of material on the sideslopes shall be performed using either a Caterpillar 825 (or approved equal) compactor or a REX 3-35 (OR APPROVED EQUAL) (or approved equal) compactor.

C. The first lift of secondary clay liner material placed over the permanent sump shall be placed and compacted using a light ground-pressure dozer or a smooth-drum roller operating in the static mode, or other method approved by the Owner, in order to protect the underlying geosynthetics. Wheeled vehicles and footed compactors will not be allowed on this first lift. The compaction and permeability criteria for the first lift will be waived to ensure that the compaction effort and/or testing activities do not result in damage to the underlying geosynthetics.

D. The daily work area shall extend a sufficient distance so as to maintain soil moisture conditions within an acceptable range to allow continuous operations. Desiccation and crusting of the lift surface shall be avoided as much as possible.

E. The CQA Engineer will identify any areas of significant desiccation and crusting of a lift surface. The Contractor shall scarify the surface of such areas to a nominal depth of 1 to 2 inches or to the depth of desiccation identified by the CQA Engineer, and then water condition, disc or mix as necessary, and recompact the area.

F. The transition from an existing full-depth section of clay liner to the beginning of an adjacent section that is to be constructed subsequently shall be accomplished by sloping (cutting back) the end of the full-depth section at 3:1 (horizontal:vertical) or flatter, scarifying the slope of the existing full-depth liner at the transition, and then immediately placing the adjacent lifts of clay liner.

G. If a dual-drum compactor which has the drums laterally separated by the operator's cab and the differential (such as a CAT 825 (or approved equal)) is used, one trip up and a staggered trip back, to cover the uncompacted area between the drums, shall be considered one pass. The minimum number of compactor passes on each lift of the secondary clay liner shall be as follows:

1. The base of the secondary clay liner shall be compacted with a minimum of 10 passes of the CAT 825 (or approved equal) if the on-site clay is used. If the weathered Pierre shale is used, it shall be compacted with a minimum of 6 passes of the CAT 825 (or approved equal).

2. If the CAT 825 (or approved equal) is used on the sideslopes of the secondary clay liner, then a minimum of 8 passes are required.

3. If the REX 3-35 (OR APPROVED EQUAL) is used on the sideslopes of the secondary clay liner, then a minimum of 15 passes are required.

It should be noted that more than the minimum number of passes may be necessary to satisfy the other compaction criteria.

H. Corners and other areas inaccessible to driven compaction equipment shall be compacted using hand operated equipment (such as a walk-behind roller) approved by the Owner.

3.04 SURVEY CONTROL

A. The Surveyor shall survey the final location and elevation of the top of the secondary clay liner. Surveying shall be performed in accordance with Section 01010 of these General Specifications. As part of this work, the Surveyor shall survey the location and elevation of the leak detection system sump. The survey will ensure:

1. The specified thickness of secondary compacted clay liner (3 feet) has been achieved.

2. The top of the secondary clay liner slopes diagonally across the secure cell at about 3 percent grade toward the collection sump; and

3. The top of the secondary clay liner in the collection sump area is at the grades and elevations specified on the contract drawings.

B. The Surveyor shall provide a Record Drawing to the Owner of the final location and elevation of the top of the secondary clay liner, including the location and elevation of the leak detection system sump, in accordance with the requirements of Section 01010 of these General Specifications. The Surveyor shall submit this drawing prior to secondary geomembrane liner construction unless otherwise approved by the Owner and the CQA engineer. The Contractor may submit a partial record to obtain approval for a portion of the work. The Owner will define the minimum requirements for a partial submittal.

3.05 FIELD QUALITY CONTROL

A. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

B. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at his own expense until acceptable test results are obtained.

3.06 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all materials and partially-completed and completed work of these General Specifications.

B. In the event of damage, the CQA Engineer will identify areas requiring repair, and the Contractor shall make repairs and replacements necessary to the approval of the Owner and at no additional cost to the Owner.

C. The Contractor shall minimize, to the maximum extent feasible, desiccation cracking of clay liner material. The Contractor shall sprinkle the clay with water if cracking is observed or if directed by the Owner. The Contractor may seal roll the surface of the clay to reduce drying and desiccation. The Contractor may protect exposed surfaces using light-colored or translucent membranes, such as Visqueen, to inhibit drying of the clay. The CQA Engineer will identify areas of significant cracking of the surface of the secondary clay liner and the Contractor shall repair the identified area to the satisfaction of the Owner and at no additional cost to the Owner.

D. The secondary clay liner surface shall be seal rolled and made smooth and free from ruts or indentations at the end of every working day when precipitation is forecast and/or at the completion of compaction operations in an area.

E. The Contractor shall maintain the clay liner surface in a condition suitable for geomembrane installation as specified in the CQA plan until the surface is covered. Desiccation cracks larger

than 0.2 feet deep or 0.25 inches wide shall be excavated to the full depth of the crack and repaired. Desiccation cracks on the liner surface less than 0.2 feet deep and 0.25 inches wide shall be moistened and compacted with a smooth drum roller until the surfaces meet the requirements of the CQA Plan.

F. The layer of over-built material shall be removed prior to placement of geomembrane liner. The over-built material may be removed in sections to coordinate with geomembrane placement. Where the over-built material is removed, the finished surface shall be protected and maintained as required by the specifications. The surface of the secondary clay liner on the side slope shall be trimmed to meet the requirements of Section 02775 prior to installation of the geomembrane liner.

G. No synthetic sealants or other chemical treatments may be applied to the clay liner material.

H. The CQA Engineer will issue an approval of the installation of the secondary clay liner to the Owner prior to placement of material over the clay liner in accordance with the requirements of the CQA Plan.

3.07 PERFORATIONS

A. Perforations in the secondary clay liner resulting from construction and CQA activities shall be filled. Such perforations may include, but are not limited to, the following:

1. Nuclear density test probe locations;
2. Shelby tube sample locations;
3. Sand-cone or rubber-balloon test locations;
4. Survey stake locations.

B. Perforations in the secondary clay liner resulting from nuclear density tests will be filled by the CQA Engineer. All other perforations in the secondary clay liner resulting from construction and/or CQA sampling activities shall be filled by the Contractor. The CQA Engineer will provide the Contractor with the locations of any tests made as part of CQA activities, except nuclear density tests.

C. Perforations from construction and/or CQA sampling activities (except nuclear density tests) shall be backfilled by the Contractor with clay liner material. The clay liner material shall be placed and compacted (hand tamped) in accordance with the requirements of this section. Perforations in the secondary clay liner from nuclear density tests will be backfilled by the CQA Engineer with bentonite (sodium montmorillonite) powder or flakes or a soil-bentonite mixture and compacted by hand tamping.

[END OF SECTION]

SECTION 02222
PRIMARY CLAY LINER

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary for the construction of the primary clay liner component of the liner system for the secure cell or surface impoundment. The work shall be carried out in accordance with these General Specifications, Supplemental Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02110 - Site Preparation and Earthwork
B. Section 02221 - Secondary Clay Liner
C. Section 02710 - Geocomposite Detection or Collection Layer
D. Section 02712 - Geonet Detection or Collection Layer
E. Section 02775 - Geomembrane Liners
F. Section 02780 - Geosynthetic Clay Liners

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualifications and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. Work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all testing activities outlined in the CQA Plan and shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. Soil testing (both field and laboratory testing) required by the CQA Plan will be the responsibility of the CQA Engineer. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor. The Contractor shall cooperate with the CQA Engineer during all testing activities. The Contractor shall provide equipment and labor to assist the CQA Engineer in sampling. The Contractor shall provide access to all areas requiring testing. The Contractor shall repair any damage to finished work caused by the CQA Engineer's sampling or testing activities.

D. The CQA Engineer will coordinate independent surveying. Surveying by the CQA Engineer does not relieve the Contractor of his responsibility to lay out, control, and document the work.

E. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming

area shall be reworked by the Contractor at no cost to the Owner until acceptable test results are obtained.

PART 2 PRODUCTS

2.01 MATERIALS

Clay liner material may only be used for construction if it has been shown to be suitable in a test fill program. The test fill program will have been performed prior to construction of the secure cell or surface impoundment, and it is not part of the work included in this General Specification. Depending on the results of future test fills, either the Weathered Pierre Shale or the on-site silty clay may be used on the base and/or the side slopes of the secure cell. These general specifications may be modified per the results of future test fills.

A. Clay liner material shall be obtained from on-site borrow areas or stockpiles identified by the Owner.

B. If used, weathered Pierre shale satisfying the requirements of this section shall only be used in areas where the grades are less than 5 percent (base portions of the secure cell liner system). If weathered Pierre shale is used in the base of the cell, it shall be obtained from the existing Pierre shale stockpile. On-site clay material may be used on the base and shall be used on the side slopes of the secure cell liner system.

C. Clay liner material for secure cell or surface impoundment construction shall:

1. Be classified according to the Unified Soil Classification System (USCS) as CL or CH (ASTM D 2487) and exhibit a minimum liquid limit of 30 and a minimum plasticity index of 11.

2. Have a percentage of gravel (i.e., dry weight retained on a U.S. No. 4 sieve) of less than 15 percent.

3. Have particles no larger than 2 inches (in largest dimension) after processing and prior to placement (4 inches post-processing and 2 inches post-compaction for the weathered Pierre shale).

4. Have a hydraulic conductivity of not more than 1×10^{-7} cm/s when compacted in accordance with this General Specification and tested in the laboratory in accordance with ASTM D 5084 at the conditions given in Permit Attachment LF-8.

D. The water used to increase the moisture content of the clay liner shall be provided by the Owner. The Contractor shall maintain an accurate record of his water usage.

PART 3 EXECUTION

The requirements of Part 3 may be modified based on the results of future test fills as a Class 1 modification with prior approval.

3.01 PRIMARY CLAY LINER COMPACTION CRITERIA

A. The compaction moisture content and the minimum dry unit weight of on-site clay, if used as primary clay liner material, shall be as follows:

1. The compaction moisture content of the clay liner material used in the base of the cell shall be at least optimum moisture content determined in the standard Proctor compaction test (ASTM D 698) and the minimum dry unit weight of the clay liner material shall be at least 99 percent of the maximum dry unit weight obtained from the standard Proctor compaction test (ASTM D 698).

2. If the CAT 825 (or approved equal) compactor is used, the compaction moisture content of the clay liner material used in the sideslopes of the cell shall be between 1-1/2 and 5 percent above optimum moisture content determined in the standard Proctor compaction test (ASTM D 698) and the minimum dry unit weight of the clay liner material shall be at least 95 percent of the maximum dry unit weight obtained from the standard Proctor compaction test (ASTM D 698). The combination of compacted in-place dry density and moisture content shall result in a minimum degree of saturation of 89 percent.

B. The compaction moisture content of the weathered Pierre shale, if used as primary clay liner material, shall be between optimum moisture content and 3 percent wet of the optimum moisture content determined in the standard Proctor compaction test (ASTM D 698) and the minimum dry unit weight of the weathered Pierre shale liner material shall be at least 95 percent of the maximum dry unit weight obtained from the standard Proctor compaction test (ASTM D 698).

3.02 PRIMARY CLAY LINER PLACEMENT

A. Upon completion of the leak detection system, the primary liner will be constructed. The primary clay liner shall be constructed to the elevations, grades, and thicknesses shown on the Construction Drawings. The thickness of the clay liner at any location shall be measured perpendicular to the plane of the slope at that location. The compacted primary clay liner shall be a minimum of three feet thick across the bottom of the secure cell. A compacted primary clay liner shall not be placed on the side slope of the secure cell except at the toe of slope.

B. Primary clay liner placement shall begin only after completion of all, or an approved portion of, the leak detection layer, the leak detection system sump, and associated piping. Placement shall not begin until the sampling and testing activities of the CQA Engineer are complete for work to be covered by the primary clay liner.

C. The Contractor shall not place primary clay liner material on the surface of the leak detection layer unless it is free of debris, branches, vegetation, mud, ice, or other deleterious material. Excessive wrinkles in the geosynthetic components of the leak detection layer shall have been worked out or repaired by the Contractor to the satisfaction of the CQA Engineer.

D. The Contractor shall construct the primary clay liner in lifts. Each lift of the primary clay liner shall meet the minimum requirements of this General Specification.

E. If a CAT 825 (or approved equal) compactor is used, the average lift thickness after compaction shall be no more than 6 inches, and the maximum lift thickness shall be 7 inches after compaction. If a REX 3-35 (OR APPROVED EQUAL) compactor is used, the average lift thickness after compaction shall be no more than 4 inches and the maximum lift thickness shall be 5 inches after compaction. The loose lift thickness shall be no greater than the length of the compactor pad.

F. At the 3:1 (horizontal:vertical) toe of slope area, primary clay liner material shall be placed and compacted by hand in horizontal lifts.

G. The first lift of primary clay liner material above the leak detection layer shall be constructed using a 9-inch thick loose lift. The lift shall be placed and spread using a low-ground pressure dozer (e.g., Caterpillar D6H LGP or other equipment approved by the Owner). Extreme care shall be taken during placement and spreading operations to ensure that the earthwork equipment does not damage the underlying geosynthetics.

H. When primary clay liner material is placed on secure cell side slopes in horizontal lifts, extreme care shall be taken not to damage the underlying geosynthetics. Mechanized clay placement and compaction equipment (except the REX 3-35 (OR APPROVED EQUAL)) shall not operate within a three-foot (one-foot for the REX 3-35 (OR APPROVED EQUAL)) wide zone (measured horizontally) from the surface of the leak detection layer. The Contractor shall spread fill in this zone by orienting the dozer blade toward the slope face and with laborers using hand tools.

I. Prior to placement of a lift of primary clay liner material, the Contractor shall allow the CQA Engineer to complete field testing to determine compliance with these specifications. The Contractor shall not place a new lift of primary clay liner material over a preceding lift until approval is given by the CQA Engineer in accordance with the CQA Plan. If the Contractor fails to comply with this requirement, he will be required by the Owner to remove and replace all unauthorized work at no additional cost to the Owner.

J. Prior to placement of a lift of primary clay liner material over an existing lift, the previous lift shall be thoroughly scarified to a nominal depth of 1 to 2 inches to provide good bonding between lifts. Scarification shall be accomplished by discing, raking with a grader, penetration by a sheepsfoot compactor, or an alternate method approved by Owner.

K. The excessive trafficking of scarified surfaces by non-placement trucks or other equipment shall not be permitted during the period between scarification and placement of the following lift.

L. If normal handling does not reduce the maximum clod size in on-site clay to an acceptable size, the Contractor shall use a Caterpillar SS250 soil stabilizer, mechanical mixer, or approved equivalent equipment to break up the clods. The on-site clay material shall be pulverized until the maximum soil clod size is reduced to 2 inches or less in largest dimension. The weathered Pierre shale material shall be pulverized using a Caterpillar minimum of four passes of the SS250 soil stabilizer (or an approved equivalent piece of equipment) until the maximum soil clod size is reduced to 4 inches or less (in largest dimension). The maximum soil clod size

after compaction of the weathered Pierre shale shall be 2 inches or less in largest dimension. The use of a specific stabilizer or mixer shall be approved by the Owner prior to use.

M. Moisture conditioning of the primary clay liner material shall be accomplished in the processing area using a Caterpillar SS250 soil stabilizer or approved equivalent prior to clay liner construction. The processing area location shall be approved by the Owner. Moisture shall be uniformly distributed throughout the clay liner material. If the clay liner material is wetter than required, then it shall be repeatedly mixed using a Caterpillar SS250 soil stabilizer, harrowing disc, grader, or equivalent to facilitate drying.

N. No more than 1.5 percent moisture shall be added to the clay liner material at the time of compaction. Clay liner material requiring more than 1.5 percent moisture shall be removed, returned to the processing area, and conditioned until the proper moisture content is achieved. If the in-place moisture content is too high, the clay may be dozed, windrowed, disced, and/or mixed to facilitate drying.

O. Primary clay liner material shall not be placed or compacted during a sustained period of temperature below 32□F that results in frozen clay, either in place or in the borrow area. Primary clay liner material may be placed and compacted during periods of early morning freezing temperatures if above-freezing temperatures are anticipated during the day.

P. The Contractor shall not place frozen clay nor shall the Contractor place clay on frozen ground.

Q. If clay liner material freezes after compaction, the Contractor shall remove the frozen material, scarify the remaining unfrozen clay, and then place and compact new clay in accordance with the General Specifications. Frozen clay shall not be reused until it has thawed and been reworked to an acceptable moisture content. The Contractor shall be responsible for protecting compacted lifts of clay liner material from freezing. If extended freezing conditions are anticipated, the Contractor shall prepare a plan for the Owner's approval which outlines the measures he will take to protect finished work.

R. Clay liner material shall not be placed during periods of unfavorable weather conditions.

3.03 PRIMARY CLAY LINER COMPACTION

A. The sequence of compaction of the primary clay liner for a secure cell or surface impoundment shall be as described in the General Specifications or as shown on the Construction Drawings.

B. Except as noted in this Section, compaction of lifts on the base of the cell shall be performed using a Caterpillar 825 compactor.

C. The first lift of primary clay liner material on the base of the secure cell shall be placed and compacted using a light ground-pressure dozer and a smooth-drum roller operating in the static mode, or other method approved by the Owner, in order to protect the underlying geosynthetics. Wheeled vehicles and footed compactors will not be allowed on this first lift. The compaction and permeability criteria for the first lift will be waived to ensure that the compaction effort and/or testing activities do not result in damage to the underlying geosynthetics.

D. On side slopes in the toe of slope area, compaction of the three-foot (one-foot if the REX 3-35 (OR APPROVED EQUAL) is used) wide zone (measured horizontally) of primary clay liner material immediately adjacent to the leak detection layer shall be achieved using hand-operated equipment (such as a walk-behind roller, or other equipment) approved by the Owner. At the Owner's discretion CQA testing may be performed in this zone. Hand-operated equipment shall not be used within 3 inches (measured horizontally) of the side slope and the CQA Engineer will not perform field testing within this zone.

E. The daily work area shall extend a sufficient distance so as to maintain soil moisture conditions within an acceptable range to allow continuous operations. Desiccation and crusting of the lift surface shall be avoided as much as possible.

F. The CQA Engineer will identify any areas of significant desiccation and crusting of a lift surface. The Contractor shall scarify the surface of such areas to a nominal depth of 1 to 2 inches or to the depth of desiccation identified by the CQA Engineer, and then water condition, disc or mix as necessary, and recompact the area.

G. The transition from an existing full-depth section of clay liner to the beginning of an adjacent section that is to be constructed subsequently shall be accomplished by sloping (cutting back) the end of the full-depth section at 3:1 (horizontal:vertical) or flatter, scarifying the slope of the existing full-depth liner at the transition, and then immediately placing the adjacent lifts of clay liner.

H. If a dual-drum compactor which has the drums laterally separated by the operator's cab and the differential (such as a CAT 825 (or approved equal)) is used, one trip up and a staggered trip back to cover the uncompacted area between the drums will be considered one pass. The minimum number of compactor passes on each lift of the primary clay liner shall be as follows:

1. The base of the primary clay liner shall be compacted with a minimum of 10 passes of the CAT 825 (or approved equal) if the on-site clay is used. If the weathered Pierre shale is used it shall be compacted with a minimum of 6 passes of the CAT 825 (or approved equal).

2. More than the minimum number of passes may be necessary to satisfy the other compaction criteria.

I. Corners and other areas inaccessible to driven compaction equipment shall be compacted using hand operated equipment (such as a walk-behind roller) approved by the Owner.

3.04 SURVEY CONTROL

A. The Surveyor shall survey the final location and elevation of the top of the primary clay liner. Surveying shall be performed in accordance with Section 01010 of these General Specifications. As part of this work, the Surveyor shall survey the location and elevation of the leachate collection system sump. The survey will ensure:

1. The specified thickness of primary compacted clay liner (3 feet on the bottom) has been achieved;

2. The top of the primary clay liner slopes diagonally across the secure cell at about 3% grade toward the collection sump; and

3. The top of the primary clay liner in the collection sump area is at the grades and elevations specified in the contract drawings.

B. The Surveyor shall provide a Record Drawing to the Owner of the final location and elevation o f the top of the primary clay liner, including the location and elevation of the leachate collection system sump, in accordance with the requirements of this Section 01010 of these General Specifications. The Surveyor shall submit this drawing prior to primary geomembrane liner construction unless otherwise approved by Owner and CQA Engineer. The Contractor may submit a partial record to obtain approval for a portion of the work. The Owner will define the minimum requirements for a partial submittal.

3.05 FIELD QUALITY CONTROL

A. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

B. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at his own expense until acceptable test results are obtained.

3.06 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all materials and partially-completed and completed work of these General Specifications.

B. In the event of damage, the CQA Engineer will identify areas requiring repair, and the Contractor shall make repairs and replacements necessary to the approval of the Owner and at no additional cost to the Owner.

C. The Contractor shall minimize, to the maximum extent feasible, desiccation cracking of clay liner material. He shall sprinkle the clay with water if cracking is observed or if directed by the Owner. The Contractor may seal roll the surface of the clay to reduce drying and desiccation. The Contractor may also protect exposed surfaces using light-colored or translucent membranes, such as Visqueen, to inhibit drying of the clay. The CQA Engineer will identify areas of significant cracking of the surface of the primary clay liner; and the Contractor shall repair the identified area to the satisfaction of the Owner and at no additional cost to the Owner.

D. The primary clay liner surface shall be seal rolled and made smooth and free from ruts or indentations at the end of every working day when precipitation is forecast and/or at the completion of placement and compaction operations in an area.

E. The Contractor shall maintain the clay liner surface in a condition suitable for geosynthetic clay liner installation as specified in the CQA plan until the surface is covered. Desiccation cracks larger than 0.2 feet deep or 0.25 inches wide shall be excavated to the full depth of the crack and repaired. Desiccation cracks on the liner surface less than 0.2 feet deep and 0.25 inches wide shall be moistened and compacted with a smooth drum roller until the surface of the clay liner meets the requirements of the CQA Plan.

F. The over-built layer of soil shall be removed prior to placement of geomembrane liner. The over-built soil layer may be removed in sections to coordinate with geomembrane placement. Where the over-built soil layer is removed, the finished surface shall be protected and maintained as required by these General Specifications. The surface of the primary clay liner shall be trimmed to meet all requirements of Section 02775 and Section 02780 of these General Specifications prior to installation of the geosynthetic clay liner.

G. No synthetic sealants or other chemical treatments may be applied to the clay liner material.

H. The CQA Engineer will issue an approval of the installation of the primary clay liner to the Owner in accordance with the CQA Plan prior to placement of material over the clay liner.

3.07 PERFORATIONS

A. Perforations in the primary clay liner resulting from construction and CQA activities shall be filled. Such perforations may include, but are not limited to, the following:

1. Nuclear density test probe locations;
2. Shelby tube sampling locations;
3. Sand-cone or rubber-balloon test locations;
4. Survey stake locations.

B. Perforations in the primary clay liner resulting from nuclear density tests will be filled by the CQA Engineer. All other perforations in the primary clay liner resulting from construction and/or CQA sampling activities shall be filled by the Contractor if necessary. The CQA Engineer will provide the Contractor with the locations of any tests made as part of CQA activities, except nuclear density tests.

C. Perforations from construction and/or CQA sampling activities (except nuclear density tests) shall be backfilled by the Contractor with clay liner material. The clay liner material shall be placed and compacted (hand tamped) in accordance with the requirements of this section. Perforations in the primary clay liner from nuclear density tests will be backfilled by the CQA Engineer with bentonite (sodium montmorillonite) powder or flakes or a soil-bentonite mixture and compacted by hand tamping.

[END OF SECTION]

SECTION 02224
GRANULAR LEACHATE COLLECTION LAYER

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary for the placement of the granular component of the leachate collection system in the secure cell. The work shall be carried out in accordance with these General Specifications, Supplemental Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02225 - Sump and Pipe Bedding Gravel and Road Base Aggregate
B. Section 02712 - Geonet Collection or Detection Layer
C. Section 02714 - Geotextile Filter, Cushion, or Sacrificial Layer
D. Section 02718 - Polyethylene Pipe and Fittings
E. Section 02775 - Geomembrane Liners

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. Work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all activities outlined in the CQA Plan and the Contractor shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. Testing specified in the CQA Plan for the granular leachate collection system materials (which does not include quality control testing at the source) will be the responsibility of the CQA Engineer. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor. The Contractor shall cooperate with the CQA Engineer during all sampling and testing activities. The Contractor shall provide equipment and labor to assist the CQA Engineer in sampling. The Contractor shall provide access to all areas requiring testing. The Contractor shall repair any damage to finished work caused by the CQA Engineer's sampling or testing activities.

D. Quality control testing (in accordance with Part 2.02 of this section) of the granular material at the source shall be the responsibility of the Contractor.

E. The CQA Engineer will coordinate independent surveying. Surveying by the CQA Engineer does not relieve the Contractor of his responsibility to lay out, control, and document the work.

F. If the CQA Engineer's test indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at no cost to the Owner until acceptable test results are obtained.

PART 2 PRODUCTS

2.01 MATERIAL FOR GRANULAR LEACHATE COLLECTION LAYER

A. Granular material for this work shall consist of clean, hard, durable, non-carbonate particles which are free of metals, roots, trees, stumps, concrete, construction debris, organic matter, and deleterious materials and coatings.

B. Granular material shall classify as SW (well-graded sand) or SP (poorly-graded sand) according to the Unified Soil Classification System (ASTM D 2487). The granular material shall have 100 percent passing the No. 4 U.S. standard sieve and not more than 3 percent passing the No. 200 U.S. standard sieve after placement, when tested in accordance with ASTM D 422.

C. Granular material shall have a hydraulic conductivity of at least 1×10^{-2} cm/s when compacted in the laboratory to at least 70 percent relative density obtained from the relative density test (ASTM D 4253 and 4254) and then tested in accordance with ASTM D 2434.

D. Granular material shall meet the requirements of AASHTO T104 for soundness.

E. Granular material shall have less than 5 percent loss of weight, when tested for calcium carbonate content in accordance with ASTM D 4373. This requirement may be waived by Owner if it can be demonstrated that material does not contain a significant carbonate content.

2.02 GRANULAR MATERIAL SUPPLIER QUALITY CONTROL

A. The Contractor shall require that the granular material Supplier sample and test the material in accordance with the methods specified in Part 2.01 of this section to demonstrate that it conforms to the requirements of Part 2.01. The Contractor shall require the granular material Supplier provide to the Owner written certification along with tests results, that the specified tests have been performed on representative samples of the granular material that will be delivered to the Owner's site and that material meets the requirements of Part 2.01 of this section.

B. If a granular material sample fails to meet the quality control requirements of this General Specification, the Contractor shall require the granular material Supplier to perform sufficient sampling and testing to identify the extent of the nonconforming material to the satisfaction of the CQA Engineer. The Contractor shall not use nonconforming material.

C. The Contractor shall require that the granular material Supplier comply with the certification and submittal requirements of the CQA Plan.

2.03 TRANSPORTATION

A. Transportation of granular material shall be the responsibility of the Contractor.

2.04 HANDLING AND STORAGE

A. Handling, stockpiling, and protection of the granular material prior to and following incorporation in the work is the responsibility of the Contractor. The Contractor shall be liable for any mixing of the material with other materials incurred prior to final acceptance.

B. The Contractor shall be responsible for storage of the granular material at the site. The Contractor shall store the material at a location approved by the Owner and in such a manner that it is not adversely affected by dust, dirt, mud, or vegetation. During stockpiling, the Contractor may elect to place the granular material on a protective sheet and/or to cover it to prevent mixing with other materials. The CQA Engineer will identify contaminated material which will be rejected by the Owner.

PART 3 EXECUTION

3.01 GRANULAR MATERIAL COMPACTION CRITERIA

A. The granular leachate collection system shall be placed in a single lift and compacted as described in Part 3.02 of this section.

3.02 PLACEMENT AND COMPACTION

A. Granular material shall be placed in the leachate collection system at the locations and to the thicknesses shown on the Construction Drawings.

B. Prior to placing the granular material, the Contractor shall verify by visual inspection that the underlying geosynthetic components are free of holes, tears, excessive wrinkles, or foreign objects. The Contractor, accompanied by the CQA Engineer, will visually inspect the geosynthetics and identify excessive wrinkles prior to placement of granular material. The Contractor shall "work out" or repair wrinkles to the satisfaction of the CQA Engineer prior to placement of the granular material. Wrinkles shall not be of a size that they could, in the opinion of the CQA Engineer, fold back on themselves.

C. To minimize the impact on the underlying geomembrane, spreading of granular material shall be conducted prior to 12:00 Noon, unless otherwise approved by the Owner.

D. Granular material shall be spread in a single lift using a low ground-pressure dozer (Caterpillar D6H-LGP or other equivalent equipment approved by the Owner), low-ground pressure tracked front-end loader, or belt conveyor. The tracked equipment shall operate only over previously-placed granular material. The granular material shall be compacted with a minimum

of three passes of the dozer. The Contractor shall not operate equipment directly on geomembranes, geotextiles, geonets, or geocomposites.

E. Unless otherwise specified by the Owner, the equipment used to haul and spread granular leachate collection material shall not exert ground pressures exceeding the following:

Allowable Equipment Ground Pressure (psi)	Thickness of Granular Material Above Uppermost Geosynthetic (inches)
<5	12
<10	18
<20	24
>20	36

The maximum allowable equipment ground pressure shall be 65 psi. The acceptability of equipment operating at ground pressures greater than 65 psi will be evaluated by the Owner at the Contractor's expense.

F. When placing granular material with any mechanized equipment, the maximum acceptable drop height is 3 feet.

G. The Contractor shall operate equipment in a manner that is protective of underlying geosynthetics. If it is suspected that damage to the underlying geosynthetics may have occurred during granular material placement, the Contractor shall uncover the suspect area to expose the potentially-damaged geosynthetics. The Contractor shall repair any observed damage of the underlying geosynthetics, at no additional cost to the Owner, in accordance with the repair requirements of the applicable section of these General Specifications.

H. Within 1 foot of the toe of a slope, granular material shall be spread by hand. Extreme care shall be taken when placing granular material to protect the installed components of the liner system.

I. Geotextile filter layers shall be placed as shown on the Construction Drawings. Geotextile filter layer placement shall be in accordance with Section 02714 of these General Specifications.

3.03 SURVEY CONTROL

A. The Surveyor shall survey the final location and elevation of the top of the granular leachate collection layer. Surveying shall be performed in accordance with Section 01010 of these General Specifications.

B. The Surveyor shall provide a Record Drawing to the Owner of the final location and elevation of the top of the granular leachate collection layer, in accordance with the requirements of Section 01010 of these General Specifications. The Record Drawing shall be provided prior to the placement of the protective soil layer unless otherwise approved by the Owner and CQA Engineer. The Surveyor may submit a partial drawing to obtain approval for a portion of the work. The Owner will define the minimum requirements for a partial submittal.

3.04 FIELD QUALITY CONTROL

A. All Quality Control testing required by the General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

B. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor, at his own expense, until acceptable test results are obtained.

3.05 PROTECTION OF WORK

A. After the granular material has been placed, the Contractor shall maintain it free of ruts, depressions, and damage resulting from the hauling and handling of any material, equipment, tools, etc.

B. The Contractor shall use all means necessary to protect all materials and partially-completed and completed work of these General Specifications.

C. In the event of damage, the CQA Engineer will identify any areas requiring repair, and the Contractor shall make all repairs and replacements necessary to the approval of the Owner and at no additional cost to the Owner.

[END OF SECTION]

SECTION 02225
SUMP AND PIPE BEDDING GRAVEL AND ROAD BASE AGGREGATE

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary for the placement of gravel associated with the leachate collection system and leak detection system sumps, collector pipes, and riser pipes. The work shall be carried out in accordance with these General Specifications, Supplemental Specifications, the CQA Plan, and the Construction Drawings.

B. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, testing, and installation services necessary for the installation of road base aggregate where shown on the Construction Drawings. The work shall be carried out in accordance with the Construction Drawings and the requirements of Section 304 of the State of Colorado Highway Department Standard Specifications for Road and Bridge Construction, except that the aggregate shall satisfy the gradation requirements for AASHTO No. 57 coarse aggregate rather than the gradation requirements of Subsection 703.03.

1.02 RELATED SECTIONS

A. Section 02224 - Granular Leachate Collection Layer
B. Section 02710 - Geocomposite Detection or Collection Layer
C. Section 02712 - Geonet Detection or Collection Layer
D. Section 02714 - Geotextile Filter or Cushion Layer
E. Section 02718 - Polyethylene Pipe and Fittings
F. Section 02775 - Geomembrane Liners

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. Work will be monitored and tested in accordance with the requirements of the CQA Plan.
B. The Contractor shall be aware of all activities outlined in the CQA Plan, and the Contractor shall account for these activities in the construction schedule.

C. On-site testing as specified in the CQA Plan for the sump and pipe bedding gravel (which does not include quality control testing at the source) will be the responsibility of the CQA Engineer. The Contractor shall cooperate with the CQA Engineer during all sampling and testing activities. The Contractor shall provide equipment and labor to assist the CQA Engineer in sampling. The Contractor shall provide access to all areas requiring testing. The Contractor will repair any damage to finished work caused by the CQA Engineer's sampling and testing activities.

D. Quality control testing (in accordance with Part 2.02 of this section) of the sump and pipe bedding gravel at the source shall be the responsibility of the Contractor.

PART 2 PRODUCTS

2.01 MATERIAL FOR SUMP AND PIPE BEDDING GRAVEL AND ROAD BASE AGGREGATE

A. Gravel for the work shall consist of clean, hard, durable, non-carbonate, rounded, sub-rounded to sub-angular particles which are free of metals, roots, trees, stumps, concrete, construction debris, other organic matter, and deleterious materials and coatings.

B. The gravel shall be screened and washed to have a gradation (when tested in accordance with ASTM D 422) after placement equivalent to AASHTO No. 57 coarse aggregate. This requirement may be waived by the Owner for gravel to be used as road base aggregate (see Section 3.01.I).

C. Gravel shall have a hydraulic conductivity of at least 1 cm/s when compacted in the laboratory to at least 70 percent relative density obtained from the relative density test (ASTM D 4253 and 4254) and tested in accordance with ASTM D 2434. This requirement does not apply to road base aggregate.

D. Gravel shall meet the requirements of AASHTO T96 for abrasion and AASHTO T104 for soundness. This requirement does not apply to road base aggregate.

E. Gravel shall have less than 5 percent loss of weight, when tested for calcium carbonate content in accordance with ASTM D 4373. This requirement may be waived by the owner if it can be otherwise demonstrated that the material contains no significant carbonate content.

2.02 GRAVEL SUPPLIER QUALITY CONTROL

A. The Contractor shall require that the gravel Supplier sample and test the gravel to demonstrate that the material conforms to the requirements of Part 2.01 of this section. The Contractor shall require the gravel Supplier provide to the Owner written certification along with test results, that tests have been performed on representative samples of the gravel material that will be delivered to the Owner's site. The analysis shall demonstrate that tests (i.e., ASTM D 422, ASTM D 2434, ASTM D 4373, AASHTO T96, and AASHTO T104) have been performed and that acceptable results were obtained.

B. If a gravel sample fails to meet the quality control requirements of this General Specification, the Contractor shall require the gravel Supplier to perform sufficient sampling and testing to identify the extent of the nonconforming material to the satisfaction of the CQA Engineer. The Contractor shall not use nonconforming material.

C. The Contractor shall require that the gravel Supplier comply with the certification and submittal requirements of the CQA Plan.

D. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

2.03 TRANSPORTATION

A. Transportation of gravel shall be the responsibility of the Contractor.

2.04 HANDLING AND STORAGE

A. Handling, stockpiling, and protection of the gravel prior to and following incorporation into the work is the responsibility of the Contractor. The Contractor shall be liable for contamination of the material incurred prior to final acceptance.

B. The Contractor shall be responsible for storage of the gravel at the site. The Contractor shall store the gravel at a location approved by the Owner and in such a manner so that it is not contaminated by dirt, mud, vegetation, or excessive dust. During stockpiling, the Contractor may elect to place the gravel on a protective sheet and/or to cover it to prevent contamination. The CQA Engineer will identify contaminated material which will be rejected by the Owner.

PART 3 EXECUTION

3.01 GRAVEL COMPACTION CRITERIA

A. Gravel used for construction of sumps and pipe bedding and access ramp road base aggregate shall be placed in maximum 12 inch thick loose lifts. Gravel shall be compacted using two passes of a hand operated vibrating compactor such as a hand tamper or walk-behind vibrating compactor or other method approved by the Owner.

3.02 PLACEMENT AND COMPACTION

A. Gravel shall be placed at the locations and to the thicknesses shown on the Construction Drawings. These locations may include the leachate collection system sump, leak detection system sump, and bedding for collection laterals, mains, and/or riser pipes for the leachate collection system and leak detection system. Gravel shall also be placed as road base aggregate, as shown on the Construction Drawings.

B. Gravel shall not be placed directly on the primary or secondary geomembrane liner. Gravel may be placed on top of a geotextile cushion layer, geonet, geocomposite drainage layer, or geomembrane rub sheet, as shown on the Construction Drawings. Gravel may be placed using a backhoe, front-end loader, belt conveyor, spreader box, or other method approved by the Owner, as long as the ground-pressure requirements of this Section are not exceeded. The maximum acceptable gravel drop height is 3 feet.

C. Final spreading of the gravel may be performed using a low ground-pressure dozer (Caterpillar D6H-LGP or other similar equipment approved by the CQA Engineer), low-ground pressure front-end loader, or by hand. The tracked equipment shall operate only over previously-placed gravel or other soil. The Contractor shall not operate equipment directly on geosynthetics.

D. Unless otherwise specified by the Owner, the equipment used to spread gravel shall not exert ground pressures exceeding the following:

Allowable Equipment Ground Pressure (psi)	Thickness of Gravel Above Geosynthetic (inches)
<5	12
<10	18
<20	24
>20	36

The maximum allowable equipment ground pressure shall be 65 psi. The acceptability of equipment operating at ground pressures greater than 65 psi will be evaluated by the Owner at the Contractor's expense.

E. The Contractor shall operate equipment in a manner that is protective of polyethylene pipes and underlying geosynthetics. If it is suspected that damage to polyethylene pipes or underlying geosynthetics may have occurred, the Owner will instruct the Contractor to remove the overlying material to expose the potentially-damaged materials. The Contractor shall repair, at his own expense, any observed damage, in accordance with the requirements of these General Specifications.

F. Within 1 foot of the toe of a slope, gravel shall be spread by hand. Extreme care shall be taken when placing gravel to protect the installed components of the liner system.

G. Geotextile filter or cushion layers shall be placed as shown on the Construction Drawings. Geotextile filter and cushion layer placement shall be in accordance with Section 02714 of these General Specifications.

H. Gravel for road base aggregate shall be placed and compacted in accordance with Section 304.04 of the State of Colorado Highway Department Standard Specifications for Road and Bridge Construction.

3.03 FIELD QUALITY CONTROL

A. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

B. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at his own expense until acceptable test results are obtained.

3.04 PROTECTION OF WORK

A. After the gravel has been incorporated into the work, the Contractor shall maintain it free of ruts, depressions, and damage resulting from the hauling and handling of any material, equipment, tools, etc.

B. The Contractor shall use all means necessary to protect all prior work, materials and completed and partially completed work of other Sections of these General Specifications.

C. In the event of damage, the CQA Engineer will identify areas requiring repair, and the Contractor shall make repairs and replacements necessary, to the approval of the Owner at no additional cost to the Owner.

3.05 SURVEY CONTROL

A. The Surveyor shall survey the final location and elevation of the top of the road base. Surveying shall be performed in accordance with of Section 01010 of these General Specifications.

B. The Surveyor shall provide a Record Drawing to the Owner of the final location and elevation of the final surface of the road base, in accordance with the requirements of Section 01010 of these General Specifications.

[END OF SECTION]

SECTION 02710
GEOCOMPOSITE DETECTION OR COLLECTION LAYER

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary for the installation of the geocomposite leak detection or leachate collection layer of the secure cell or surface impoundment. The work shall be carried out in accordance with these General Specifications, Supplemental Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02222 - Primary Clay Liner
B. Section 02225 Sump and Pipe Bedding Gravel and Road Base Aggregate
C. Section 02712 - Geonet Detection or Collection Layer
D. Section 02714 - Geotextile Filter or Cushion Layer
E. Section 02716 - Protective Soil Layer
F. Section 02775 - Geomembrane Liners
G. Section 02780 - Geosynthetic Clay Liners

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. Work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all activities outlined in the CQA Plan, and the Contractor shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. If testing is not completed prior to delivery to the site, the Contractor shall deliver geocomposite to the site at least 14 calendar days prior to installation to allow sufficient time for testing required by the CQA Plan.

D. Any geocomposite rolls that do not meet the requirements of these General Specifications will be rejected. The Contractor shall replace the rejected material with new material that conforms to the specification requirements, at no additional cost to the Owner.

E. If the CQA Engineer's test indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at no cost to the Owner until acceptable test results are obtained.

PART 2 PRODUCTS

2.01 GEOCOMPOSITE PROPERTIES

A. The Contractor shall require that the geocomposite Manufacturer furnish material with minimum average roll values, as defined by the Federal Highway Administration (FHWA), meeting or exceeding the criteria specified in Table 02710-1. The Contractor shall require that the Manufacturer provide results for tests performed using the procedures listed in Table 02710-1, as well as a certification that the material delivered to the site meets or exceeds the specified values.

B. In addition to the property values listed in Table 02710-1, the geocomposite shall:

1. Retain its structure during handling, placement, and long-term service.

2. Be capable of withstanding outdoor (i.e., ultra-violet light) exposure for a minimum of 30 days with no measurable degradation in the specified physical properties.

3. Meet any additional requirements of the Construction Drawings.

4. Be manufactured with a geonet that does not contain any reclaimed polymer, nor any foaming or blowing agents.

2.02 MANUFACTURING QUALITY CONTROL

A. The Contractor shall require that the geocomposite Manufacturer sample and test the geocomposite to demonstrate that the material conforms to the requirements of these General Specifications. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor. Test results shall be provided to the Owner. Sampling shall, in general, be performed on sacrificial portions of the geocomposite material such that repair is not required. The Contractor shall require that the geocomposite Manufacturer sample and test the geocomposite, at a minimum, as specified below and perform the following manufacturing quality control tests:

	Test	Procedure
Geonet Component 1/50,000 ft^2	Specific gravity	ASTM D 1505
	Thickness	ASTM D 374C or D1777
	Carbon black	ASTM D 1603
	Test	**Procedure**
Geotextile Component 1/100,000 ft^2	Mass per unit area	ASTM D 5261
	Apparent opening size	ASTM D 4751
	Permitivity	ASTM D 4491
	Grab strength	ASTM D 4632
	Tear strength	ASTM D 4533
	Puncture strength	ASTM D 4833
Geocomposite Component	Peel strength	ASTM F 904

B. Any geocomposite sample that does not comply with these General Specifications shall result in rejection of the roll from which the sample was obtained. The Contractor shall replace any rejected rolls at no additional cost to the Owner.

C. If a geocomposite sample fails to meet the quality control requirements of this General Specification the Contractor shall require that the geocomposite Manufacturer sample and test each roll manufactured in the same lot, or at the same time, as the failing roll. Sampling and testing of rolls shall continue until a pattern of acceptable test results as determined by the CQA Engineer is established.

D. Additional sample testing may be performed, at the geocomposite Manufacturer's discretion and expense, to more closely identify any non-complying rolls and/or to qualify individual rolls.

E. If required by the Owner the Contractor shall require the geocomposite Manufacturer to retain a coupon of geocomposite (10 feet by 2 feet) provided for the project for every 20,000 ft^2 of geocomposite produced for the project until the work is accepted by the Owner.

F. The Contractor shall require that the geocomposite Manufacturer comply with the certification and submittal requirements of the CQA Plan.

2.03 LABELING

A. Geocomposite rolls shall be labeled with the following information.

1. Name of Manufacturer;
2. Product identification;
3. Lot number;
4. Roll number; and
5. Roll dimensions.

B. If any special handling is required, it shall be so marked on the geocomposite itself, e.g., "This Side Up" or "This Side Against Soil To Be Retained".

2.04 TRANSPORTATION

A. Transportation of the geocomposite shall be the responsibility of the Contractor. The Contractor shall be liable for damage to the geocomposite incurred prior to and during transportation to the site. The Contractor shall replace damaged rolls at no additional cost to the Owner.

2.05 HANDLING AND STORAGE

A. Geocomposite shall be shipped and stored in watertight and opaque protective covers.

B. Handling, storage, and care of the geocomposite prior to and following incorporation into the work is the responsibility of the Contractor. The Contractor shall be liable for damage to the

material incurred prior to final acceptance by the Owner. The Contractor shall repair damage in accordance with Part 3.03 of this section and at no additional cost the Owner.

C. The Contractor shall be responsible for storage of the geocomposite at the site. The geocomposite shall be stored off the ground and out of direct sunlight and shall be protected from puncture, cutting, and excessive heat, cold, moisture, mud, dirt, dust or any other damaging or deleterious condition. The geocomposite shall be stored in accordance with any additional requirements of the geocomposite Manufacturer.

PART 3 EXECUTION

3.01 HANDLING AND PLACEMENT

A. Geocomposite shall be installed at all locations shown on the Construction Drawings.

B. The Contractor shall handle the geocomposite in such a manner as to ensure the geocomposite is not damaged in any way.

C. When placing geocomposite on geomembrane, the geomembrane liner that will underlie the geocomposite shall be clean and free of excessive dust and dirt, stones, rocks, or other obstructions that could potentially damage the geomembrane. The geomembrane shall be swept clean prior to geocomposite placement. At the direction of the Owner, the Contractor shall clean the geomembrane with water.

D. The Contractor shall take all necessary precautions to prevent damage to underlying layers during placement of the geocomposite.

E. In the presence of excessive wind, the Contractor shall weight the geocomposite with sandbags or equivalent weight approved by the Owner.

F. On side slopes, the geocomposite shall be secured, by the Contractor, at the top of the slope and then rolled down the slope.

G. If necessary, the Contractor shall position the geocomposite by hand after it is unrolled to minimize wrinkles.

H. Geocomposite shall be clean when installed. During installation, care shall be taken by the Contractor not to entrap stones, excessive dirt, or moisture that could damage the underlying geomembrane, clog drains or filters, or hamper subsequent seaming.

I. Geocomposite shall not be welded to the geomembrane liners. Geocomposite shall only be cut using a cutter approved by the geocomposite Manufacturer and the Owner.

J. Tools shall not be left on or in the geocomposite.

K. After placing the geocomposite, the geocomposite shall not be left exposed for a period in excess of 30 days unless a longer exposure period is approved by the Owner based on a formal

demonstration from the Contractor (e.g., a certification from the geocomposite Manufacturer) that the geotextile component of the geocomposite is stabilized against ultra-violet (UV) light degradation for a period in excess of 30 days.

L. If white colored geotextile is used in the geocomposite, precautions shall be taken against "snow blindness" of personnel.

3.02 SEAMS AND OVERLAPS

A. The components of the geocomposite (e.g., geotextile-geonet-geotextile) are not bonded together at the ends and edges of the rolls. Each component shall be secured or seamed to the like component at overlaps.

B. No horizontal seams shall be allowed on slopes steeper than 5:1 (horizontal:vertical), unless approved by the Owner.

C. Geonet Components:

1. The geonet components shall be overlapped by at least 4 inches. These overlaps shall be secured by tying.

2. Tying shall be achieved by nylon strings, plastic fasteners, or polymer braid. Metallic devices shall not be used. Tying devices shall be provided in a color different than the geonet to allow easy inspection.

3. For slopes steeper than 5:1 (horizontal:vertical), tying shall be every 5 feet along the slope, every 2 feet across the slope, and every 6 inches in the anchor trench. For slopes flatter than 5:1 (horizontal:vertical), tying shall be every 10 feet in both directions and every 6 inches in the anchor trench.

4. In all cases, at least 2 ties per panel dimension shall be installed.

5. When more than one layer of geocomposite is installed, joints shall be staggered at least 1 foot.

6. The joints on adjacent geocomposite panels shall be staggered at least 1 foot.

D. Geotextile Components:

1. The bottom layers of the geotextile shall be overlapped.

2. The top layers of geotextiles shall be continuously sewn (i.e., spot sewing is not allowed). Geotextiles shall be overlapped a minimum of 3 inches prior to sewing.

3. Polymeric thread shall be used for all sewing. The seam type shall be Federal Standard (No. 751.a) Type SSa. The seams shall be sewn using Stitch Type 401.

3.03 REPAIR

A. Any holes or tears in the geocomposite shall be repaired by placing a patch extending 1 foot beyond the edges of the hole or tear. The patch shall be secured over the hole or tear by tying fasteners through the geocomposite patch, and through the top geotextile and geonet beneath the patch. The patch shall be secured every 6 inches with approved tying devices. A larger geotextile patch shall be placed over the geocomposite patch and shall be heat sealed to the top geotextile of the geocomposite needing repair. If the hole or tear width across the roll is more than 50 percent of the width of the roll, the damaged area shall be cut out and the two portions of the geocomposite shall be joined in accordance with Part 3.02 of this section.

3.04 PLACEMENT OF OVERLYING MATERIALS

A. The primary clay liner (secure cell floor), geosynthetic clay liner, geomembrane liner, or protective soil layer as required by the Construction Drawings, shall be placed as soon as possible after placement and approval of the geocomposite leakage detection layer or leachate collection layer. Placement of each overlying material shall be in accordance with the appropriate sections of these General Specifications.

B. The Contractor shall place overlying soil materials in such a manner as to ensure that:

1. The geocomposite and underlying geosynthetic materials are not damaged;

2. Minimal slippage occurs between the geocomposite and underlying layers; and

3. Excessive stresses are not produced in the geocomposite.

C. Unless otherwise specified by the Owner, the equipment operating on soil material overlying a geocomposite shall comply with the following:

Maximum Allowable Equipment Ground Pressure (psi)	Thickness of Soil Above Geocomposite (inches)
<5	12
<10	18
<20	24
>20	36

The maximum allowable equipment ground pressure shall be 65 psi. The acceptability of equipment operating at ground pressures greater than 65 psi will be evaluated by the Owner at the Contractor's expense.

The requirements do not apply to equipment used to construct the secondary or primary clay liners; however, the Owner can restrict the use of equipment that, in the Owner's opinion, may be potentially damaging to the geocomposite.

D. The CQA Engineer will provide monitoring of the spreading of soils over the geocomposite in accordance with the CQA Plan.

3.05 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all materials and partially completed and completed work of these General Specifications.

B. The CQA Engineer will identify any areas requiring repair. The Contractor shall immediately make repairs and replacements necessary, to the approval of the Owner and at no additional cost to Owner.

C. The CQA Engineer will issue an approval of the geocomposite detection or collection layer installation to the Owner prior to placement of material over the geocomposite in accordance with the CQA Plan.

TABLE 02710-1
REQUIRED GEOCOMPOSITE PROPERTIES

Properties	Units	Specified Values[4]	Test Method
Geonet Component:			
Polymer composition	%	95 polyethylene by weight	
Polymer specific gravity		0.92	ASTM D 1505
Polymer melt index	g/10 min.	0.1 - 0.5	ASTM D 1238
Carbon black content	%	2 - 3	ASTM D 1603
Nominal thickness	mm	5	ASTM D 5199
Geotextile Component:			
Polymer composition	%	95 polyester polypropylene, or polyethylene by weight	
Mass per unit area	oz/yd^2	5.7	ASTM D 5261
Apparent opening size	mm	O_{95} 0.212mm	ASTM D 4751
Permitivity	sec^{-1}	0.1	ASTM D 4491
Grab strength	lb	150	ASTM D 4632[1]
Tear strength	lb	50	ASTM D 4533[2]
Puncture strength	lb	80	ASTM D 4833[3]
Geocomposite:			
Transmissivity	m^2/s	5×10^{-4}	ASTM D 4716[5]

NOTES:

(1) Minimum of values measured in machine and cross machine directions with 1 inch clamp on constant rate of extension (CRE) machine.

(2) Minimum value measured in machine and cross machine direction.

(3) Tension testing machine with a 1.75-inch diameter ring clamp, the steel ball being replaced with a 0.31-inch diameter solid steel cylinder with flat tip centered within the ring clamp.

(4) Values represent minimum average roll values (i.e., any roll in a lot should meet or exceed the values in this table). Where ranges of values are specified, the average roll value must be within the specified range. The apparent opening size specified is a maximum average roll value.

(5)	The design transmissivity is the hydraulic transmissivity of the geocomposite measured using water at 68/F " 3/F with a hydraulic gradient of not less than 0.1, nor more than 0.5, under a compressive stress of not less than 10,000 psf. For the test, the geocomposite shall be sandwiched between a layer of clay material representative of the clay that will be used at the Highway 36 site and an 80-mil thick HDPE geomembrane. The minimum test duration shall be 24 hours and the report of results shall include measurements at intervals over the entire test duration.

[END OF SECTION]

SECTION 02712
GEONET DETECTION OR COLLECTION LAYER

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary for the installation of the geonet leak detection layer or geonet leachate collection layer of the secure cell or surface impoundment. The work shall be carried out in accordance with this General Specification, Supplemental Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02221 - Secondary Clay Liner
B. Section 02222 - Primary Clay Liner
C. Section 02224 - Granular Leachate Collection Layer
D. Section 02225 - Sump and Pipe Bedding Gravel and Road Base Aggregate
E. Section 02710 - Geocomposite Detection or Collection Layer
F. Section 02714 - Geotextile Filter or Cushion Layer
G. Section 02775 - Geomembrane Liners

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. All work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all activities outlined in the CQA Plan, and the Contractor shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. If CQA testing is not completed prior to delivery at the site, the Contractor shall deliver geonet to the site at least 14 calendar days prior to installation to allow sufficient time for testing required by the CQA Plan.

D. Any geonet rolls that do not meet the requirements of these General Specifications will be rejected. The Contractor shall replace the rejected material with new material that conforms to the specification requirements, at no additional cost to the Owner.

E. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at no cost to the Owner until acceptable test results are obtained.

PART 2 PRODUCTS

2.01 GEONET PROPERTIES

A. The Contractor shall require that the geonet Manufacturer furnish material with minimum average roll values, as defined by the Federal Highway Administration (FHWA), meeting or exceeding the criteria specified in Table 02712-1. The Contractor shall require that the geonet Manufacturer provide results for tests performed using the procedures listed in Table 02712-1, as well as a certification that the material properties for the material delivered to the site will meet or exceed the specified values.

B. In addition to the property values listed in Table 02712-1, the geonet shall:

1. Retain its structure during handling, placement, and long-term service.

2. Meet any additional requirements of the Construction Drawings.

3. Not be manufactured from any reclaimed polymer, nor any foaming or blowing agents.

2.02 MANUFACTURING QUALITY CONTROL

A. The Contractor shall require that the geonet Manufacturer sample and test the geonet to demonstrate that the material conforms to the requirements of these General Specifications. All Quality Control testing required by the General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor. Test results shall be provided to the Owner. Sampling shall, in general, be performed on sacrificial portions of the geonet material such that repair is not required. The Contractor shall require that the geonet Manufacturer sample and test the geonet, at a minimum, once every 50,000 ft^2 and perform the following manufacturing quality control tests:

Test	Procedure
Specific gravity	ASTM D 1505
Thickness	ASTM D 5199
Carbon black	ASTM D 1603

B. Any geonet sample that does not comply with these General Specifications shall result in rejection of the roll from which the sample was obtained. The Contractor shall replace any rejected rolls at no additional cost to the Owner.

C. If a geonet sample fails to meet the quality control requirements of these General Specifications, the Contractor shall require that the geonet Manufacturer sample and test each roll manufactured, in the same lot, or at the same time, as the failing roll. Sampling and testing of rolls shall continue until a pattern of acceptable test results is established as specified within the CQA Plan.

D. Additional sample testing may be performed, at the geonet Manufacturer's discretion and expense, to more closely identify any non-complying rolls and/or to qualify individual rolls.

E. If requested by Owner, the Contractor shall require the geonet Manufacturer to retain a coupon of geonet (10 feet by 2 feet) provided for the project for every 20,000 ft^2 of geonet produced for the project until the work is accepted by the Owner.

F. The Contractor shall require that the geonet Manufacturer comply with the certification and submittal requirements of the CQA Plan.

2.03 LABELING

A. Geonet rolls shall be labeled with the following information.

1. Name of Manufacturer;
2. Product identification;
3. Lot number;
4. Roll number; and
5. Roll dimensions.

2.04 TRANSPORTATION

A. Transportation of geonet shall be the responsibility of the Contractor. The Contractor shall be liable for damage to the geonet incurred prior to and during transportation to the site. The Contractor shall repair or replace damaged rolls at no additional cost to the Owner.

2.05 HANDLING AND STORAGE

A. Geonet shall be protected from damage during shipping and storage.

B. Handling, storage, and care of the geonet prior to and following incorporation into the work is the responsibility of the Contractor. The Contractor shall be liable for damage to the material incurred prior to final acceptance by the Owner. The Contractor shall repair damage in accordance with Part 3.03 of this Section and at no additional cost to the Owner.

C. The Contractor shall be responsible for storage of the geonet at the site. The geonet shall be stored off the ground and shall be protected from excessive heat or cold, moisture mud, dirt, dust, or any other damaging or deleterious condition. The geonet shall be stored in accordance with any additional requirements of the geonet Manufacturer.

PART 3 EXECUTION

3.01 HANDLING AND PLACEMENT

A. Geonet shall be installed at all locations shown on the Construction Drawings.

B. The Contractor shall handle the geonet in such a manner as to ensure the geonet is not damaged in any way.

C. Just prior to geonet placement, the geomembrane liner that will underlie the geonet shall be clean and free of dust, dirt, stones, rocks, or other obstructions that could potentially damage

the geomembrane. The geomembrane shall be swept clean prior to geonet placement. At the direction of the Owner, the Contractor shall clean the geomembrane with water.

D. The Contractor shall take all necessary precautions to prevent damage to underlying layers during placement of the geonet.

E. In the presence of excessive wind, the geonet shall be weighted by the Contractor with sandbags or equivalent weight approved by the Owner.

F. On side slopes, the geonet shall be secured by the Contractor at the top of slope and then rolled down the slope.

G. If necessary, the Contractor shall position the geonet by hand after it is unrolled to minimize wrinkles.

H. Geonet shall be clean when installed. During installation, care shall be taken by the Contractor not to entrap stones and excessive dirt or moisture that could damage the underlying geomembrane or clog drains or filters.

I. Geonet shall not be welded to geomembrane liners. Geonet shall only be cut using a cutter approved by the geonet Manufacturer and the Owner.

J. Tools shall not be left on or in the geonet.

K. Geonet shall not be placed in direct contact with textured geomembrane liner unless specifically called for on the Construction Drawings.

3.02 STACKING AND JOINING

A. When two or more layers of geonets are stacked, care shall be taken to prevent the strands of one layer of geonet from penetrating the channels of an overlying or underlying layer.

B. A layer of geonet shall not be installed in a direction perpendicular to an underlying layer of geonet unless approved by the Owner.

C. In the corners of the side slopes, where overlaps between perpendicular geonet strips are required, an extra layer of geonet shall be provided on top of the previously installed geonets, from top to bottom of the slope, as shown on the Construction Drawings.

D. Adjacent rolls of geonet shall be overlapped by at least 4 inches. The overlaps shall be secured by tying.

E. Tying shall be achieved by nylon strings, plastic fasteners, or polymer braid. Metallic devices shall not be used. Tying devices shall be provided in a color different than the geonet to allow for easy inspection.

F. For slopes steeper than 5:1 (horizontal:vertical), tying shall be every 5 feet along the slope, every 2 feet across the slope, and every 6 inches in the anchor trench. For slopes flatter than 5:1 (horizontal:vertical), tying shall be every 10 feet in both directions, and every 6 inches in the anchor trench.

G. In all cases, at least 2 ties per panel dimension shall be installed.

H. When more than one layer of geonet is installed, joints shall be staggered at least 1 foot.

I. The joints on adjacent geonet panels shall be staggered at least 1 foot.

J. No horizontal seams shall be allowed on slopes steeper than 5:1 (horizontal:vertical), unless approved by the Owner.

3.03 REPAIR

A. Any holes or tears in the geonet shall be repaired by placing a patch over the hole or tear extending 1 foot beyond the edges of the hole or tear. The patch shall be secured to the original geonet by tying every 6 inches with approved tying devices. If the hole or tear width across the roll is more than 50 percent of the width of the roll, the damaged area shall be cut out and the two portions of the geonet shall be joined in accordance with Part 3.02 of this section.

3.04 PLACEMENT OF OVERLYING MATERIALS

A. An installed layer of geonet shall be covered with an overlying layer (geotextile or geomembrane), as required by the Construction Drawings, as soon as possible after installation and approval to minimize the accumulation of dirt or dust in the geonet and the potential for damage to the geonet or the underlying geomembrane. If dust or dirt accumulates in the geonet layer prior to placement of the overlying layer, the Contractor shall clean the geonet by sweeping or washing with water. Placement of each overlying material shall be in accordance with these General Specifications.

B. Soil shall not be placed in direct contact with geonets. Geonets shall be separated from soil materials by a geotextile filter or other material, as indicated on the Construction Drawings. The only exception to this shall be at those locations shown on the Construction Drawings where sump or pipe bedding gravel directly overlies one or more layers of geonet.

C. The Contractor shall place soil above geonet layers (e.g., above a geotextile filter which overlies the geonet) in such a manner as to ensure that:

1. The geonet and underlying geomembrane are not damaged;

2. Minimal slippage occurs between the geonet and the underlying geomembrane; and

3. Excessive stresses are not produced in the geonet.

D. Unless otherwise specified by the Owner, all equipment operating on soil material overlying a geonet shall comply with the following:

Maximum Allowable Equipment Ground Pressure (psi)	Thickness of Soil Above Geonet (inches)
<5	12
<10	18
<20	24
>20	36

The maximum allowable equipment ground pressure shall be 65 psi. The acceptability of equipment operating at ground pressures greater than 65 psi will be evaluated by the Owner at the Contractor's expense.

The equipment pressure requirements do not apply to equipment used to construct the secondary or primary clay liners; however, the Owner may restrict the use of equipment that, in the Owner's opinion, may be potentially damaging to the geonet.

E. The CQA Engineer will provide monitoring of the placement of soil materials over the geonet or overlying layer in accordance with the CQA Plan.

3.05 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all materials and partially completed and completed work of these General Specifications.

B. The CQA Engineer will identify any areas requiring repair. The Contractor shall make repairs and replacements as necessary, to the approval of the Owner and at no additional cost to the Owner.

A. The CQA Engineer will issue an approval of the geonet detection or collection layer installation to the Owner prior to placement of material over the geonet in accordance with the CQA Plan.

TABLE 02712-1
REQUIRED GEONET PROPERTIES

PROPERTIES	UNITS	SPECIFIED VALUES(2)	TEST METHOD
Polymer composition	%	95 polyethylene by weight	
Polymer specific gravity		0.92	ASTM D 1505(1)
Polymer melt index	g/10 min.	0.1 - 0.5	ASTM D 1238
Carbon black content	%	2-3	ASTM D 1603
Nominal thickness	mm	5	ASTM D 5199
Transmissivity	m^2/s	5×10^{-4}	ASTM D 4716(3)

NOTES:
(1) The specific gravity of the geonet polymer shall not exceed that of the geomembrane.
(2) Values represent minimum average roll values (i.e., any roll in a lot should meet or exceed the values in this table). Where ranges of values are specified, the average roll values must be within the specified range.

(3) The design transmissivity is the hydraulic transmissivity of the geonet measured using water at 68□F with a hydraulic gradient of not less than 0.1, nor more than 0.5, under a compressive stress of not less than 10,000 psf. For the test, the geonet shall be sandwiched between an 80-mil thick HDPE geomembrane on bottom, and on top, either: (I) a 60-mil or 80-mil thick HDPE geomembrane (if the Construction Drawings show the geonet sandwiched between two geomembranes); or (ii) a geotextile filter layer and a layer of soil representative of the protective soil layer that will be used at the Highway 36 site (if the Construction Drawings show the geonet overlain by a geotextile filter layer and protective soil layer). The minimum test duration shall be 24 hours and the report for the test results shall include measurements at intervals over the entire test duration.

[END OF SECTION]

SECTION 02714
GEOTEXTILE FILTER, OR CUSHION LAYER

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary for the installation of the geotextile filter layer, cushion layer (also called a separation layer), or sacrificial layer in the secure cell or surface impoundment. The work shall be carried out in accordance with these General Specifications, Supplemental Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02120 - Permanent Sump
B. Section 02222 - Primary Clay Liner
C. Section 02224 - Granular Leachate Collection Layer
D. Section 02225 - Sump and Pipe Bedding Gravel and Road Base Aggregate
E. Section 02712 - Geonet Detection or Collection Layer
F. Section 02716 - Protective Soil Layer
G. Section 02775 - Geomembrane Liners

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. Work will be monitored and tested in accordance with requirements of the CQA Plan.

B. The Contractor shall be aware of all activities outlined in the CQA Plan, and the Contractor shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. If CQA testing is not completed prior to delivery, the Contractor shall deliver geotextile to the site at least 14 calendar days prior to installation to allow sufficient time for testing required by the CQA Plan.

D. Any geotextile rolls that do not meet the requirements of these General Specifications will be rejected. The Contractor shall replace the rejected material with new material that conforms to the specification requirements, at no additional cost to the Owner.

E. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at no cost to the Owner until acceptable test results are obtained.

PART 2 PRODUCTS

2.01 GEOTEXTILE PROPERTIES

A. The Contractor shall require that the geotextile Manufacturer furnish geotextile with minimum average roll values, as defined by the Federal Highway Administration (FHWA), meeting or exceeding the criteria specified in Tables 02714-1 (for filter layers), or Table 02174-2 (for cushion layers). The Contractor shall require that the geotextile Manufacturer provide results for tests performed using the procedures in Table 02714-1, or 02714-2, as well as a certification that the material delivered to the site meets or exceeds the specified values.

B. Geotextile products shall be needle-punched, non-woven materials manufactured from continuous filaments or stapled fibers.

C. In addition to the property values listed in Table 02714-1 or 02714-2, the geotextile filter or cushion layer shall:

1. Retain its structure during handling, placement, and long-term service.

2. Be capable of withstanding outdoor (i.e., ultra-violet) light for a minimum of 30 days with no measurable degradation in the specified physical properties.

3. Meet any additional requirements of the Construction Drawings.

2.02 MANUFACTURING QUALITY CONTROL

A. The Contractor shall require that the geotextile Manufacturer sample and test the geotextile to demonstrate that the material conforms to the requirements of this General Specification. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor. Test results shall be provided to the Owner. Sampling shall, in general, be performed on sacrificial portions of the geotextile material such that repair is not required. The Contractor shall require that the geotextile Manufacturer sample and test the geotextile, at a minimum, once every 100,000 ft^2 and perform the following manufacturing quality control tests:

	Test Procedure
Mass per unit area	ASTM D 5261
Apparent opening size (if the geotextile is being used as a filter)	ASTM D 4751
Permitivity (if the geotextile is being used as a filter)	ASTM D 4491
Grab strength	ASTM D 4632

Tear strength	ASTM D 4533
Puncture strength	ASTM D 4833

B. Any geotextile sample that does not comply with this General Specification shall result in rejection of the roll from which the sample was obtained. The Contractor shall replace any rejected roll at no additional cost to the Owner.

C. If a geotextile sample fails to meet the quality control requirements of this General Specification, the Contractor shall require that geotextile Manufacturer sample and test each roll manufactured in the same lot, or at the same time, as the failing roll. Sampling and testing of rolls shall continue until a pattern of acceptable test results is established in accordance with the CQA Plan.

D. Additional sample testing may be performed, at the geotextile Manufacturer's discretion and expense, to more closely identify any non-complying rolls and/or to qualify individual rolls.

E. If requested by the Owner, the Contractor shall require the geotextile Manufacturer to retain a coupon of geotextile (10 feet by 2 feet) provided for the project for every 20,000 ft^2 of geotextile produced for the project until the work is accepted by the Owner.

F. The Contractor shall require that the geotextile Manufacturer comply with the certification and submittal requirements of the CQA Plan.

2.03 LABELING

A. Geotextile rolls shall be marked or tagged with the following information:

1. Name of Manufacturer;
2. Product identification;
3. Lot number;
4. Roll number; and,
5. Roll dimensions.

B. If any special handling is required, it shall be so marked on the geotextile itself, e.g., "This Side Up" or "This Side Against Soil to be Retained".

2.04 TRANSPORTATION

A. Transportation of the geotextile is the responsibility of the Contractor. The Contractor shall be liable for damage to the geotextile incurred prior to and during transportation to the site. The Contractor shall repair or replace damaged rolls at no additional cost to the Owner.

2.05 HANDLING AND STORAGE

A. Geotextile shall be shipped and stored in watertight and opaque protective covers.

B. Handling, storage, and care of the geotextile prior to and following incorporation into the work is the responsibility of the Contractor. The Contractor shall be liable for damage to the geotextile incurred prior to final acceptance by the Owner. The Contractor shall repair damage in accordance with Part 3.03 of this section and at no additional cost to the Owner.

C. The Contractor shall be responsible for storage of the geotextile at the site. The geotextile shall be stored off the ground and out of direct sunlight and precipitation, and shall be protected from puncture, cutting, excessive heat , cold, moisture, mud, dirt, dust, or any other damaging or deleterious condition. The geotextile shall be stored in accordance with any additional requirements of the geotextile Manufacturer.

PART 3 EXECUTION

3.01 HANDLING AND PLACEMENT

A. Geotextile shall be installed at the locations shown on the Construction Drawings.

B. The Contractor shall handle the geotextile in such a manner as to ensure the geotextile is not damaged in any way.

C. The Contractor shall take all necessary precautions to prevent damage to underlying layers during placement of the geotextile.

D. After placing the geotextile, the geotextile shall not be left exposed for a period in excess of 30 days unless a longer exposure period is approved by the Owner, based on a demonstration from the Manufacturer (e.g., a certification from the geotextile Manufacturer) that the geotextile is stabilized against ultra-violet light (UV) degradation for a period in excess of 30 days. This requirement does not apply to material used as sacrificial geotextile.

E. If white colored geotextile is used, precautions shall be taken against "snow blindness" of personnel.

F. Just prior to geotextile placement, the layer that will underlie the geotextile, if it is a geosynthetic, shall be clean and free of dust, dirt, stones, rocks, or other obstructions that could potentially damage the liner system. At the direction of the Owner, the Contractor shall clean the underlying layer with water.

G. In the presence of excessive wind, the geotextile shall be weighted with sandbags or equivalent weight approved by the Owner.

H. On side slopes, the geotextile shall be secured at the top of the slope and then rolled down the slope.

I. If necessary, the Contractor shall position the geotextile by hand after it is unrolled to minimize wrinkles.

J. Geotextile shall be clean when installed. During installation, care shall be taken not to entrap stones, and excessive dirt or moisture that could damage the underlying layers, clog drains or filters, or hamper subsequent seaming.

K. Tools shall not be left in or on the geotextile.

L. The Contractor shall examine the entire geotextile surface after installation to ensure that no potentially harmful foreign objects (including broken sewing needles) are present. The Contractor shall remove any such foreign objects and shall replace any damaged geotextile Broken sewing needles may need to be located using a metal detector or other method approved by the Owner.

M. Geotextile shall only be cut using a cutter approved by the geotextile Manufacturer and the Owner.

3.02 SEAMS AND OVERLAPS

A. All geotextile overlaps shall be continuously sewn (i.e., spot sewing and thermal bonding are not allowed). Geotextiles shall be overlapped a minimum 3 inches prior to sewing. No horizontal seams shall be allowed on slopes steeper than 5:1 (horizontal:vertical) (i.e., seams shall be along, not across, the slopes), except as part of a patch, unless approved by the Owner.

B. Polymeric thread shall be used for all sewing. The seam type shall be Federal Standard Type (No. 751.a) SSa. The seams shall be sewn using Stitch Type 401.

3.03 REPAIR

A. Any holes or tears in the geotextile shall be repaired as follows:

1. On slopes steeper than 5:1 (horizontal:vertical), a patch made from the same geotextile shall be overlapped a minimum three inches and double seamed into place (with each seam approximately 0.5 inches apart and no closer than 1 inch from any edge). Should a tear exceed 10 percent of the width of the roll, that roll shall be removed from the work and replaced with new material, at no additional cost to the Owner.

2. On slopes equal to or flatter than 5:1 (horizontal:vertical), a patch made from the same geotextile shall be overlapped a minimum of 3 inches and stitched into place.

B. Care shall be taken to remove soil or other material which may have penetrated the torn geotextile.

3.04 PLACEMENT OF OVERLYING MATERIALS

A. The Contractor shall place all overlying soil materials in such manner as to ensure that:

1. The geotextile and underlying geosynthetic materials are not damaged;

2. Minimum slippage occurs between the geotextile and underlying layers; and,

3. Excessive stresses are not produced in the geotextile.

B. The CQA Engineer will monitoring the spreading of soil materials over the geotextile in accordance with the CQA Plan.

C. Unless otherwise specified by the Owner, all equipment operating on soil material overlying the geotextile shall comply with the following (Note: a greater thickness shall be required as per Sections 02710, 02712, and 02775 if the geotextile is directly underlain by a geocomposite, geonet, or geomembrane):

Maximum Allowable Equipment Ground Pressure (psi)	Thickness of Soil Above Geotextile (inches)
<5	6
<10	12
<20	18
>20	24

The maximum allowable equipment ground pressure shall be 65 psi. The acceptability of equipment operating at ground pressures greater than 65 psi will be evaluated by the Owner at the Contractor's expense.

The equipment ground pressure requirements do not apply to separator geotextiles used below aggregate road base nor to equipment used to construct the secondary and primary clay liners; however, the Owner may restrict the use of equipment that, in the Owner's opinion, may potentially damage the underlying geotextiles.

3.05 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all prior work, materials and partially-completed and completed work of these General Specifications.

B. The CQA Engineer will identify any areas requiring repair. The Contractor shall make repairs and replacements as necessary, to the approval of the Owner, and at no additional cost to Owner.

C. The CQA Engineer will issue an approval of geotextile filter, cushion, separator, or sacrificial layer installation in accordance with the CQA Plan prior to placement of material over the geotextile.

TABLE 02714-1
REQUIRED GEOTEXTILE PROPERTIES

Properties	Units	Specified Values [4]	Test Method
Polymer composition	%	95 [polypropylene, polyester, or polyethylene by weight]	
Mass per unit area	oz/yd^2	8	ASTM D 5261
Apparent opening size	mm	O_{95}, 0.212mm	ASTM D 4751
Permitivity	sec^{-1}	0.1	ASTM D 4491
Grab strength	lb	200	ASTM D 4632[1]
Tear strength	lb	85	ASTM D 4533[2]
Puncture strength	lb	100	ASTM D 4833 [3]

NOTES:

1. Minimum values for both machine and cross machine direction with 1 inch clamp on constant rate of extension (CRE) machine.
2. Minimum value measured in machine and cross machine direction.
3. Tension testing machine with a 1.75-inch diameter ring clamp, the steel ball being replaced with a 0.31-inch diameter solid steel cylinder with flat tip centered within the ring clamp.
4. Values represent minimum average roll values (i.e., any roll in a lot should meet or exceed the values in this table). The specified apparent opening size is a maximum average roll value.

TABLE 02714-2
REQUIRED GEOTEXTILE PROPERTIES
CUSHION GEOTEXTILES

Properties	Qualifier	Units	Specified Values [4]	Test Method
Polymer composition	minimum	%	95 [polypropylene, polyester, or polyethylene by weight]	
Mass per unit area	minimum	oz/yd^2	12	ASTM D 5261
Grab strength	minimum	lb	300	ASTM D 4632[1]
Tear strength	minimum	lb	110	ASTM D 4533[2]
Puncture strength	minimum	lb	135	ASTM D 4833 [3]

NOTES:

1. Minimum values for both machine and cross machine direction with 1 inch clamp on constant rate of extension (CRE) machine.
2. Minimum value measured in machine and cross machine direction.
3. Tension testing machine with a 1.75-inch diameter ring clamp, the steel ball being replaced with a 0.31-inch diameter solid steel cylinder with flat tip centered within the ring clamp.
4. All values represent minimum average roll values (i.e., any roll in a lot should meet or exceed the values in this table).

[END OF SECTION]

SECTION 02716
PROTECTIVE SOIL LAYER

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary for the construction of the protective soil layer component of the secure cell. The work shall be carried out in accordance with these General Specifications, Supplemental Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02223 - Granular Leachate Collection Layer
B. Section 02225 - Sump and Pipe Bedding Gravel and Road Base Aggregate
C. Section 02710 - Geocomposite Detection or Collection Layer
D. Section 02712 - Geonet Detection or Collection Layer
E. Section 02714 - Geotextile Filter, Cushion, or Sacrificial Layer
F. Section 02775 - Geomembrane Liners

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. Work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all testing activities outlined in the CQA Plan, and the Contractor shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. Soil testing (both field and laboratory testing) required by the CQA Plan will be the responsibility of the CQA Engineer. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor. The Contractor shall cooperate with the CQA Engineer during all testing activities. The Contractor shall provide equipment and labor to assist the CQA Engineer in sampling. The Contractor shall provide access to all areas requiring testing. The Contractor shall repair any damage to finished work caused by the CQA Engineer sampling or testing activities.

D. The CQA Engineer will coordinate independent surveying required by the CQA Plan. Surveying by the CQA Engineer does not relieve the Contractor of his responsibility to lay out, control, and document the work.

E. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at no cost to the Owner until acceptable test results are obtained.

PART 2 PRODUCTS

2.01 MATERIALS

A. Protective soil layer material shall be obtained from secure cell or surface impoundment excavation or from on-site borrow sources identified by the Owner.

B. Protective soil layer material shall classify as CL, ML, SC, GC, SM, or GM according to the Unified Soil Classification System (ASTM D 2487) and shall have a maximum particle size not exceeding 3 inches.

PART 3 EXECUTION

3.01 PROTECTIVE SOIL LAYER COMPACTION CRITERIA

A. The Contractor shall place and compact the soil as described in of this Section.

3.02 PLACEMENT AND COMPACTION

A. Protective soil layer material shall be placed above the leachate collection system (including the geotextile filter layer above the leachate collection system) at the locations and to the thicknesses shown on the Construction Drawings.

B. The Contractor shall not place the protective soil layer until the CQA Engineer confirms that the constructed grades and elevations of the granular leachate collection system meet the requirements of the Construction Drawings, all field testing is complete, and the geotextile filter layer above the leachate collection system has been installed, tested, and approved in accordance with the requirements of the CQA Plan.

C. Prior to placing the protective soil layer, the CQA Engineer will verify that the underlying geosynthetic components are free of holes, tears, excessive wrinkles, or foreign objects. As instructed by the Owner, the Contractor shall "work out" or repair all excessive wrinkles to the satisfaction of the CQA Engineer prior to placement of the protective soil layer. In all cases, wrinkles in the primary geomembrane liner on the secure cell side slopes shall not be of a size that they could fold back on themselves.

D. The final in-place thickness of the protective soil layer shall be not less than 24 inches on floor areas and 18 inches on slope areas.

E. The protective soil material shall be spread in one lift using a low ground-pressure dozer (Caterpillar D6H-LGP, or other equipment approved by the Owner), low-ground pressure tracked front-end loader, or belt conveyor. Equipment shall operate only over previously-placed protective soil layer material. The Contractor shall not operate equipment directly on geomembranes, geotextiles, geonets, or geocomposites.

F. Unless otherwise specified by the Owner, the equipment used to haul and spread the protective soil layer shall not exert ground pressures exceeding the following:

Allowable Equipment Ground Pressure (psi)	Minimum Thickness of Protective Soil Layer Above the Primary Geomembrane Liner (inches)
<5	12
<10	18
<20	24
>20	36

The maximum allowable equipment ground pressure shall be 65 psi. The acceptability of equipment operating at ground pressures greater than 65 psi will be evaluated by the Owner at the Contractor's expense.

G. Protective soil layer material shall be compacted by two passes of tracked equipment such as a Caterpillar D6H-LGP or other equipment approved by the Owner.

H. In areas of heavy traffic, the thickness of the protective soil layer shall be increased at the direction of the Owner to satisfy the requirements of this Section. Heavy traffic areas shall be compacted with a smooth drum roller or other equipment approved by the Owner.

I. The Contractor shall operate equipment in a manner that is protective of underlying geosynthetics. If it is suspected that any damage to the underlying geosynthetics may have occurred, the Owner will instruct the Contractor to remove overlying protective soil layer material to expose the geosynthetics. The Contractor shall repair, at his own expense, any damage of the underlying geosynthetics in accordance with these General Specifications.

J. The Contractor shall minimize to the extent possible the generation of dust during placement of the protective soil layer. Water may be used for dust control if approved by the Owner. Chemical dust suppressants shall not be used.

K. No protective soil layer material shall be placed or compacted during a sustained period of temperature below 32°F that results in frozen material, either in-place or in the borrow area. With the approval of the Owner, protective soil layer material may be placed and compacted during periods of early morning freezing temperatures if above-freezing temperatures are anticipated during the day.

L. The Contractor shall not place frozen protective soil layer material nor shall he place protective soil layer material on frozen ground.

M. Protective soil layer material shall not be placed during periods of precipitation or unfavorable weather conditions.

3.03 SURVEY CONTROL

A. The Surveyor shall survey the final location and elevation of the top of the protective soil layer installed by the Contractor. Surveying shall be performed in accordance with Section 01010 of these General Specifications.

B. The Surveyor shall provide a Record Drawing of the location and elevation of the top of the protective soil layer to the Owner in accordance with the requirements of Section 01010 of these General Specifications.

3.04 FIELD QUALITY CONTROL

A. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

B. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at his own expense until acceptable test results are obtained.

3.05 PROTECTION OF WORK

A. After the protective soil layer has been placed, the Contractor shall maintain it free of ruts, depressions, and damage resulting from the hauling and handling of any material, equipment, tools, etc.

B. The Contractor shall use all means necessary to protect all materials and partially-completed and completed work of these General Specifications.

C. In the event of damage, the CQA Engineer will identify any areas requiring repair, and the Contractor shall make repairs and replacements necessary, to the approval of the Owner and at no additional cost to the Owner.

[END OF SECTION]

SECTION 02718
POLYETHYLENE PIPE AND FITTINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary for the installation of all high density polyethylene (HDPE) pipes, pipe fittings, and appurtenances required for secure cell or surface impoundment construction. The work shall be carried out in accordance with these General Specifications, Supplemental Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02222 - Primary Clay Liner
B. Section 02224 - Granular Leachate Collection Layer
C. Section 02225 - Sump and Pipe Bedding Gravel and Road Base Aggregate
D. Section 02710 - Geocomposite Detection or Collection Layer
E. Section 02712 - Geonet Detection or Collection Layer
F. Section 02714 - Geotextile Filter or Cushion Layer
G. Section 02775 - Geomembrane Liners

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. All work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all activities outlined in the CQA Plan, and the Contractor shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. The CQA Engineer will coordinate independent surveying as required by the CQA Plan. Surveying by the CQA Engineer does not relieve the Contractor of his responsibility to lay out, control, and document the work.

D. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at no cost to the Owner until acceptable test results are obtained.

PART 2 PRODUCTS

2.01 HIGH DENSITY POLYETHYLENE (HDPE) RESIN PROPERTIES

A. The HDPE pipe and fittings shall be manufactured from new, high molecular weight, high density polyethylene (HDPE) resin conforming to ASTM D 1248 (Type III, Class C Category 5, Grade P 34), ASTM D 3350 (Cell Classification PE 345464C), and having a Plastic Pipe Institute (PPI) Rating of PE 3408. The resin shall be pre-compounded. In plant blending of non-compounded resins shall not be permitted. Pipe and fittings shall be manufactured form the same resin and by the same manufacturer.

B. The polyethylene compound shall contain a minimum of 2 percent carbon black to withstand outdoor exposure without loss of properties.

C. The polyethylene compound shall have minimum resistance of 5,000 hours when tested for environmental stress crack in accordance with requirements of GRI-GM5.

2.02 HIGH DENSITY POLYETHYLENE PIPE AND FITTINGS PROPERTIES

A. The Contractor shall provide pipe having the nominal diameters shown on the Construction Drawings.

B. All HDPE pipe and fittings shall have a minimum Standard Diameter Ratio (SDR) of 11 unless otherwise indicated on the Construction Drawings.

C. All HDPE pipe and fittings shall have a minimum hydrostatic design basis (HDB) of 1,600 pounds per square inch when determined in accordance with ASTM D 2837 unless otherwise indicated on the Construction Drawings.

D. All HDPE pipe and fittings shall comply with ASTM F 714.

E. HDPE pipe shall be supplied in standard laying lengths not exceeding 50 feet.

F. HDPE pipe shall be furnished non-perforated or perforated to meet the requirements of the Construction Drawings. Perforations, if required, shall be drilled into the pipe after manufacture.

G. HDPE pipes and fittings shall be homogeneous throughout and free of visible cracks, holes (other than intentional manufactured perforations), foreign inclusions, or other deleterious effects, and shall be uniform in color, density, melt index, and other physical properties.

H. Fittings at the ends of pipes shall be HDPE end caps unless otherwise indicated on the Construction Drawings.

I. Geomembrane boots shall be either field or shop-fabricated to the dimensions shown on the Construction Drawings. Pipe boots shall be fabricated from the same resin as the polyethylene geomembrane to which they are welded. Pipe boots shall be installed as indicated on the Construction Drawings.

2.03 MANUFACTURING QUALITY CONTROL

A. The Contractor shall submit to the Owner for approval within 14 days prior to the start of pipe work a complete list of materials to be furnished and the name of the pipe Manufacturer.

B. The Contractor shall submit to the Owner the pipe Manufacturer's certification of compliance with the product requirements of Part 2 of this section, including certification that stress regression testing has been performed in accordance with ASTM D 2837 on the pipe products representative of that delivered to the site. The Manufacturer's Certification must be based on a QC testing frequency of one sample per lot.

C. The Contractor shall submit to the Owner in writing the following documentation from the pipe Manufacturer on the raw materials used to manufacture the pipe and fittings:

1. Certificate identifying the specific resin used, its source, and the information required by ASTM D 1248.

2. Certificate stating that no recycled resin was used in manufacturing the pipe except for a small percentage (15 percent or less) of resin generated in the pipe Manufacturer's own plant form production using the same resin as the recycled material.

D. If requested by the Owner, the Contractor shall require the pipe manufacturer to retain one section of pipe (at least 5 feet in length) provided for the project for every 1,500 lineal feet of pipe produced for the project until the work is accepted by the Owner.

E. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

2.04 LABELING

A. The following shall be continuously indent-printed on the polyethylene pipe, or spaced at intervals not exceeding 10 feet:

1. Name and/or trademark of the pipe Manufacturer.
2. Nominal pipe size.
3. Standard dimension ratio (SDR).
4. The letters PE followed by the polyethylene grade per ASTM D 1248, followed by the hydrostatic design stress in 100's of psi (i.e., PE 3408).
5. Manufacturing Standard Reference (e.g., ASTM F 714-1).
6. A production code from which the date and place of manufacture can be determined.

2.05 TRANSPORTATION

A. Transportation of polyethylene pipe and fittings shall be the responsibility of the Contractor. The Contractor shall be liable for all damage to the polyethylene pipe and fittings incurred prior to and during transportation to the site.

2.06 HANDLING AND STORAGE

A. Handling, storage, and care of the polyethylene pipe and fittings, prior to and following installation at the site, is the responsibility of the Contractor. The Contractor shall be liable for all damage to the material incurred prior to final acceptance by the Owner.

B. The Contractor shall be responsible for storage of polyethylene pipe and fittings at the site. Pipe and fittings shall be stored on clean level ground, preferably turf or sand, free of sharp objects which could damage the pipe. Stacking shall be limited to a height that will not cause excessive deformation of the bottom layers of pipe under anticipated temperature conditions. Where necessary due to ground conditions, the pipe shall be stored on wooden sleepers that are spaced suitably and of such width as not to allow deformation of the pipe. The pipe shall be stored to minimize bowing.

2.07 PIPE BEDDING MATERIAL

A. Pipe bedding material shall meet the requirements of Section 02224 of this General Specification as well as any other requirements of the Construction Drawings.

2.08 HDPE FLAT STOCK

A. HDPE flat stock installed below polyethylene pipe shall consist of layers of high density polyethylene (HDPE) furnished at the dimensions shown on the Construction Drawings.

2.09 PORTLAND CEMENT CONCRETE

A. Portland cement concrete used in the pads around the riser pipes shall be Class B, as specified in Section 601.02 of the Colorado Highway Specifications.

PART 3 EXECUTION

3.01 HANDLING AND PLACEMENT

A. Pipe, fittings, and HDPE flat stock shall be installed as indicated on the Construction Drawings. These locations include sumps, collection laterals, mains, and/or riser pipe for the permanent sump, leachate collection system and leak detection system.

B. The Contractor shall exercise care when transporting, handling and placing pipe and fittings, such that they will not be cut, kinked, twisted, or otherwise damaged.

C. The Contractor shall comply with the pipe Manufacturer's recommendations for handling, storage, and installation of all polyethylene pipe fittings.

D. Ropes, fabric, or rubber-protected slings and straps shall be used when handling pipe. Slings, straps, etc. shall not be positioned at butt-fused joints. Chains, cables or hooks shall not be inserted into the pipe ends as a means of handling pipe.

E. Pipe or fittings shall not be dropped onto rocky or unprepared ground. The pipe and fittings shall not be dropped into trenches or dragged over sharp objects.

F. The maximum allowable depth of cuts, gouges, or scratches on the exterior surface of pipe or fittings is 10 percent of the wall thickness. The interior of the pipe and fittings shall be free of cuts, gouges and scratches. The CQA Engineer will inspect the pipes in accordance with the CQA Plan. Sections of pipe with excessive cuts, gouges, or scratches will be rejected and the Contractor will be required to remove and replace the rejected pipe, at no additional cost to the Owner.

G. Whenever pipe laying is not actively in progress, the open end of pipe that has been placed shall be closed using a watertight plug.

H. Where pipes penetrate through geomembranes, an effective seal shall be established in accordance with these General Specifications as well as the details shown on the Construction Drawings.

3.02 INSTALLATION

A. All pipe and fittings shall be installed in accordance with these General Specifications and the pipe Manufacturer's instructions.

B. The Contractor shall carefully examine all pipe and fittings for cracks, damage or defect before installation. Defective materials shall be removed from the site and replaced with non-defective material at no additional cost to the Owner.

C. The interior of all pipe and fittings shall be inspected, and any foreign material shall be completely removed from the pipe interior before it is moved into final position.

D. Field cutting of pipe shall be carefully made, without damage to pipe or lining system components, so as to leave a smooth end at right angles to the axis of pipe. The method and device used to cut the pipes shall be approved of by the Owner. Sharp edges of cut ends shall be filed off smooth. Flame cutting will not be allowed.

E. All pipe and fittings shall be laid or placed to the grades and elevations shown on the Construction Drawings with bedding and backfill as shown on the Construction Drawings.

F. Placement of overlying pipe bedding gravel shall be carried out in accordance with Section 02224 of these General Specifications.

G. No pipe shall be laid until the CQA Engineer has observed the condition of the pipe.

H. Blocking under piping shall not be permitting unless specifically accepted by the Owner.

I. The Contractor shall provide all necessary adapters and/or connection pieces required when connecting different types and sizes of pipe or when connecting pipe made by different manufacturers.

J. Concrete installed in the pads around the riser pipes shall be installed in accordance with the applicable requirements of Sections 601.05 through 601.14 of the Colorado Highway Specifications, and as shown on the construction Drawings. The Contractor shall be responsible for testing of the concrete, and shall provide the results to the Owner as soon as possible. As a minimum one slump test shall be performed, in accordance with ASTM C 143, for the concrete crest pad. One air entrainment test for the concrete crest pad shall be performed, in accordance with either ASTM C 173 or C 231. Three concrete cylinders shall be obtained, in accordance with ASTM C 31, from the concrete crest pad. The cylinders shall be tested after 28 days in accordance with ASTM C 39 and shall meet the requirements of these General Specifications or the Construction Drawings. Exposed surfaces of concrete shall be broom-finished.

3.03 JOINTS AND CONNECTIONS

A. HDPE pipe shall be joined with thermal butt-fusion joints. All joints shall be made in accordance with ASTM D 2657 and the pipe Manufacturer's recommendations, and shall be made by trained personnel authorized by the pipe Manufacturer.

B. Mechanical connections of HDPE pipe to auxiliary equipment such as valves, flow meters, pumps and tanks shall consists of the following unless indicated otherwise on the Construction Drawings:

1. An HDPE flange connection, called a stub end, shall be butt-fused to the HDPE pipe. Outside diameter and drilling shall comply with the requirements indicated on the Construction Drawings.

2. A Type 316 stainless steel back-up flange. Outside diameter and drillings shall comply with the requirements indicated on the Construction Drawings.

3. Other mechanical couplings, such as 360 degree full circle clamps, shall only be used if approved by the Owner.

4. The stub ends shall be connected with corrosion-resistant bolts and nuts of Type 316 stainless steel, as specified in ASTM A 726 and ASTM A 307.

C. Polyethylene stub ends and flanges shall be at the ambient temperature of the surrounding soil at the time they are bolted tight to prevent relaxation of the flange bolts and loosening of the joint due to thermal contraction or expansion of the polyethylene pipe. Bolts shall be drawn up evenly and in line.

D. Pipe adjacent to joints and joints themselves shall be rigidly supported for a distance of at least one pipe diameter beyond the backup flanges.

E. Pipe boot connections shall be made in the field using viton rings and stainless steel clamps, as shown on the Construction Drawings. The viton ring material shall have a thickness of 3/16 inch and shall have an inner diameter equal to the outer diameter of the pipe on which the viton ring is to be placed. The stainless steel clamps shall be made of 3/16 inch thick, 2 inch wide,

Type 316 stainless steel. The clamps shall be joined around the pipe boot using a Type 316 stainless steel clasp, not thicker than 3/8 inch. These materials shall be chosen by the Contractor and approved by the Owner.

3.04 SURVEY CONTROL

A. The Surveyor shall survey the location and final elevation of the invert of all polyethylene leachate collection pipes (excluding laterals). The pipe shall be surveyed at its ends and at approximate 50-foot intervals between the ends. In addition, all joints, etc. shall be located horizontally and vertically and overall length measured. Surveying shall be performed in accordance with Section 01010 of these General Specifications.

B. The Surveyor shall provide a Record Drawing of the location and final elevation of all leachate collection pipes.

3.05 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all materials and all partially-complete and completed work of these General Specifications.

B. In the event of damage, the Contractor shall make all repairs and replacements necessary, to the approval of the Owner and at no additional cost to the Owner.

C. The CQA Engineer will issue an approval of pipe installation and inspection to the Owner prior to completely covering the pipe in accordance with the CQA Plan.

[END OF SECTION]

SECTION 02775
GEOMEMBRANE LINERS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment supervision, transportation, and installation services necessary for the installation of the primary and secondary geomembrane liners of the secure cell or surface impoundment. The work shall be carried out in accordance with these General Specifications, Supplemental Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02221 - Secondary Clay Liner
B. Section 02222 - Primary Clay Liner
C. Section 02224 - Granular Leachate Collection Layer
D. Section 02225 - Sump and Pipe Bedding Gravel and Road Base Aggregate
E. Section 02710 - Geocomposite Detection or Collection Layer
F. Section 02712 - Geonet Detection or Collection Layer
G. Section 02714 - Geotextile Filter, or Cushion, Layer
H. Section 02716 - Protective Soil Layer
I. Section 02718 - Polyethylene Pipe and Fittings
J. Section 02780 - Geosynthetic Clay Liners

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan. The Contractor shall require the geomembrane manufacturer to comply with the submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. All work will be constructed, monitored, and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all activities outlined in the CQA Plan, and the Contractor shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. The Contractor shall deliver geomembrane to the site at least 14 calendar days prior to installation to allow sufficient time for testing required by the CQA Plan.

D. Geomembrane rolls that do not meet the requirements of this General Specification will be rejected. The Contractor shall replace rejected material with new material that conforms to the specification requirements, at no additional cost to the Owner.

E. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at no cost to the Owner until acceptable test results are obtained.

PART 2 PRODUCTS

2.01 RESIN

A. Reclaimed polymer shall not be added to the resin; however, the use of polymer recycled during the manufacturing process will be permitted if the recycled polymer does not exceed 2 percent by weight of the total polymer weight. The product shall be manufactured specifically for use in geomembranes, using new, first-quality polyethylene resin.

B. The resin shall comply with the following properties for high density polyethylene (HDPE):

1. Specific Gravity: Greater than 0.932 g/mil (ASTM D 1505)

2. Melt Index:Less than 1.08/10 min (ASTM D 1238 Condition E 190/C, 2.16 kg)

3. Water absorption:0.1% max (ASTM D 570)

2.02 GEOMEMBRANE PROPERTIES

A. The geomembrane Manufacturer shall be either Gundle Lining Systems, Inc., Houston, Texas, Polyflex Construction, Grand Marshall, Texas, or other Manufacturer making geomembrane meeting the requirements of this section. The Owner (based on concurrence with regulatory authorities) may approve an alternate material if sufficient evidence is submitted to verify that the alternate material has been tested (EPA Method 9090) by exposure to leachates with characteristics similar to those expected to be produced by the Owner and the tests verify that the alternate material's performance is satisfactory. The Owner will furnish test leachate, if available, upon request.

B. Smooth or textured HDPE geomembrane shall be used based on the requirements of the Construction Drawings.

C. The Contractor shall require that the geomembranes Manufacture furnish geomembrane with minimum average roll values, as defined by the Federal Highway Administration (FHWA), meeting or exceeding the criteria specified in Table 02775-1 and that meet the manufacturing quality control requirements of this section. The Contractor shall require the geomembrane Manufacturer to certify in writing as well as provide test results that demonstrate that the geomembrane delivered to the site complies with the properties listed in Table 02775-1.

D. In addition to the property values listed in Table 02775-1, the geomembrane material shall:

1. Contain a maximum of 1 percent by weight of additives, fillers, or extenders (not including carbon black).

2. Not have striations, roughness (except in the case of textured HDPE geomembranes where a roughened surface is characteristic), pinholes, or bubbles on the surface.

3. Be produced so as to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter.

4. Be manufactured in a single layer or coextruded.

2.03 MANUFACTURING QUALITY CONTROL

A. Resin:

1. The Contractor shall require the geomembrane Manufacturer to certify in writing that the resin used to manufacture the geomembrane delivered to the project site complies with the product specifications of this section. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor Any geomembrane manufactured from non-complying resin will be rejected.

2. The Contractor shall require the Manufacturer to supply quality control certificates from the resin Supplier that includes the origin (resin production plant), identification (brand name, number) the production date of the resin used in the manufacturer of the geomembrane shipped to the site, and the results of test conducted to verify that the resin used to manufacturer the geomembrane rolls assigned to the project meets the specifications of Part 2.01 of this section.

B. Rolls:

1. The Contractor shall require that the geomembrane Manufacturer continuously monitor the geomembrane during the manufacturing process for inclusions, bubbles, or other defects. Geomembrane that exhibits defects will not be accepted.

2. The Contractor shall require that the geomembrane Manufacturer monitor the geomembrane thickness during the manufacturing process. Geomembrane that fails to meet the specified minimum thickness will not be accepted.

3. The Contractor shall require that the geomembrane Manufacturer sample and test the geomembrane, at a minimum, frequency specified in the GRI-GM-13 and perform the following tests to demonstrate that the geomembrane properties conform to the values specified in this section. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor. Samples shall be taken across the entire width of the roll and shall not include the first wrapping or outer layer of the roll (about 3.3 feet).

Test Procedure	
Specific gravity	ASTM D 1505
Thickness (Smooth)	ASTM D 5994
Thickness (Textured)	ASTM D 5994
Yield strength	ASTM D 6693
Yield elongation	ASTM D 6693
Tensile strength	ASTM D 6693
Tensile elongation	ASTM D 6693
Carbon black content	ASTM D 1603

4. Geomembrane rolls that do not have acceptable manufacturing quality control test results shall be rejected by the Owner.

5. In the case of the rejection of a roll of geomembrane, the Contractor shall require that the geomembrane Manufacturer sample and test each roll manufactured in the same lot, or at the same time, as the failing roll. Sampling and testing of rolls shall continue until a pattern of acceptable test results is established in accordance with the CQA Plan.

6. Additional testing may be performed at the geomembrane Manufacturer's discretion and expense, to more closely identify the non-complying rolls and/or to qualify individual rolls.

7. If requested by Owner, one coupon of geomembrane (at least 10 feet by 2 feet) for every 100,000 ft^2 of membrane produced shall be retained intact by the geomembrane Manufacturer until construction of landfill or surface impoundment components, for which the geomembrane is used, is complete and the Owner has accepted the completed work.

C. Manufacturing Plant Visit:

1. The Manufacturer shall permit the Owner or Owner's representative(s) to visit the manufacturing plant. Visits may be during the manufacturing of the geomembrane rolls for the specific project.

2. During the visit, the Owner or Owner's representative(s) may:

   a. Review the manufacturing process, quality control procedures, laboratory facilities, and testing procedures;

   b. Verify that properties guaranteed by the Manufacturer comply with the specifications;

   c. Verify that the measurements of properties by the Manufacturer are properly documented and the test methods used are acceptable;

d. Inspect select geomembrane rolls for evidence of holes, blisters, or any sign of contamination by foreign matter;

e. Review packaging and transportation procedures;

f. Verify that roll packages are labeled in compliance with this Section; and

g. Take conformance samples from geomembrane rolls that are assigned to the project.

2.04 LABELING

A. The geomembrane shall be labeled with the following information:

1. Thickness of the material;
2. Length and width of the roll or factory panel;
3. Name of Manufacturer;
4. Product identification;
5. Lot number; and,
6. Roll or factory panel number.

2.05 TRANSPORTATION

A. Transportation of the geomembrane is the responsibility of the Contractor. The Contractor shall be liable for all damage to materials prior to and during transportation to the site. The Contractor shall replace any damaged rolls at no additional cost to the Owner.

2.06 HANDLING AND STORAGE

A. Handling, storage, and care of the geomembrane prior to and following incorporation in the work is the responsibility of the Contractor. The Contractor shall be liable for all damage to the material incurred prior to final acceptance of the installation by the Owner. The Contractor shall repair any damage in accordance with this Section and at no additional cost to the Owner.

B. The Contractor shall be responsible for storage of the geomembrane at the site. The geomembrane shall be protected from dirt, excessive heat or cold, puncture, cutting, or other damaging or deleterious conditions. The geomembrane shall also be stored in accordance with any additional requirements of the geomembrane Manufacturer.

PART 3 EXECUTION

3.01 EARTHWORK

A. Surface Preparation

1. Geomembrane liner shall be installed at all locations shown on the Construction Drawings.

2. For secure cells (or significant portions thereof), the primary and secondary geomembrane liners and the cover geomembrane shall be installed as soon as practical after construction and CQA testing of the secondary clay liners and the clay cover. In areas where geosynthetic clay liner is used to cover the primary clay, primary geomembrane liner shall be installed as required by Section 2780. For surface impoundments (or significant portions thereof), the primary and secondary geomembrane liners shall be installed as soon as practical after the completion and CQA testing of the secondary clay liner and leak detection layer. Prior to geomembrane liner installation, the Contractor shall verify, by surveying, that the elevations, thicknesses, and grades of the clay liners conform to the requirements of the Construction Drawings. Installation of the geomembranes shall not begin until the CQA Engineer completes conformance testing and surveying of the appropriate portions of the clay liners in accordance with the CQA Plan.

3. Areas to receive geomembrane liner shall be smooth and even, and free of ruts, voids, and protrusions or wrinkles in the clay or in the geosynthetic clay liner. Any surface features, as determined by the CQA Engineer or Owner, which could damage the geomembrane shall be removed by the Contractor. For slopes of 3:1 (horizontal:vertical) or flatter, the final surface of the clay liner prior to receiving geomembrane shall be rolled smooth using a smooth drum roller. For slopes steeper than 3H:1V, dressing of the slopes shall be accomplished by back-dragging the surface with a dozer blade or by other methods approved by the Owner (such as raking the surface by hand) until the Owner is satisfied that the surface is smooth and even, and free of ruts, voids, obstructions, etc.. No vehicles shall be allowed on the final dressed surface without the approval of the Owner.

4. The Contractor shall provide written certification that the surface on which the geomembrane will be installed is acceptable. The certificate of acceptance for each area under consideration shall be given to the Owner as part of geomembrane installation in that area.

5. Special care shall be taken to maintain the prepared surface of the clay liner.

6. No geomembrane shall be placed in an area which has been softened by precipitation or which has excessively cracked due to desiccation.

7. Any damage to the surface of the clay liner or geosynthetic clay liner caused by weather, installation activities, or other activities shall be repaired by the Contractor at no expense to the Owner.

B. Anchor Trenches:

1. The anchor trench shall be excavated prior to geomembrane placement to the elevations, grades, and width shown on the Construction Drawings.

2. No loose soil shall be allowed beneath the geomembrane in the anchor trench.

3. The anchor trench shall be backfilled as shown on the construction drawings after the secondary geomembrane and geocomposite drainage layers and the primary geomembrane and geocomposite drainage layer, have been installed. If necessary, a small amount of backfill (about 6 inches) may be placed in the trench immediately after geomembrane installation. Care shall be taken when backfilling the anchor trench to prevent any damage to the geomembrane or other geosynthetics.

4. Clay fill shall be placed in the anchor trench to the limits shown on the Construction Drawings. The clay fill shall be compacted using suitable hand-operated compaction equipment. Clay shall be compacted to the requirements in the Construction Drawings. In the absence of additional requirements, the moisture content of the clay fill in the anchor trenches shall be not less than the optimum moisture content, nor more than four percent wet of the optimum moisture content. The optimum moisture content will be obtained from the standard Proctor compaction test (ASTM D 698). The minimum allowable dry unit weight of clay fill in the anchor trench shall be 90 percent of the maximum dry unit weight obtained from the standard Proctor compaction test (ASTM D698).

5. Slightly rounded corners shall be provided at the top in-board side of the anchor trench to avoid sharp bends in the geomembrane.

3.02 GEOMEMBRANE DEPLOYMENT

A. Layout Drawings:

1. The Contractor shall provide at least 2 sets of geomembrane panel layout drawings to the Owner at least 14 days prior to geomembrane deployment. Drawings shall indicate the geomembrane panel configuration, dimensions, details, seam locations, etc. Field seams shall be differentiated from factory seams (if any). The layout drawings must be approved by the Owner prior to the installation of any geomembranes. These drawings shall not be modified without the prior approval of the Owner.

B. Field Panel Identification:

1. A geomembrane field panel is defined as a roll or a portion of a roll cut in the field.

2. Each field panel must be given an identification code (number or letter-number) consistent with the layout plan. This identification code shall be agreed upon by the Owner, and Contractor. The field panel identification code shall be related, through a table or chart, to the original resin, and the constituent rolls and factory panels.

C. Field Panel Placement:

1. Field panels shall be installed at the location and positions indicated in the layout drawings.

2. Field panels shall be placed one at a time, and each field panel shall be seamed shortly after its placement.

3. Geomembrane shall not be placed when the ambient temperature is below 40□ F unless the Contractor has previously submitted a geomembrane cold-weather placement and seaming plan and such plan has been approved by the Owner.

4. Geomembranes shall not be placed during a precipitation event, in the presence of excessive moisture (e.g., fog, dew), in an area of ponded water, or in the presence of excessive winds.

5. The Contractor shall employ placement methods which ensure that:

   a. No vehicular traffic shall be allowed on the geomembrane.

   b. Equipment used shall not damage the geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons, or other means.

   c. Personnel working on the geomembrane shall not smoke, consume food or beverages (except for body fluid replenishment), wear damaging shoes, have cans, glass containers, or tools not required for liner placement on the geomembrane, or engage in other activities which could damage the geomembrane.

   d. The method used to unroll the panels shall not scratch or crimp the geomembrane and shall not damage the supporting soil.

   e. The method used to place the panels shall minimize wrinkles (especially differential wrinkles between adjacent panels).

   f. Temporary loads and/or anchors (e.g., sand bags), not likely to damage the geomembrane, shall be placed on the geomembrane to prevent uplift by wind.

6. On slopes, geomembranes shall be installed from the top of the slope to the bottom. The geomembrane shall be temporarily anchored at the top of the slope prior to deployment. Unrestrained release of the geomembrane from the top of the slope is not acceptable.

7. Any field panel or portion thereof which becomes seriously damaged (torn, twisted, or crimped) shall be replaced with new material at no expense to the Owner. Less serious damage may be repaired with the approval of the Owner. Damaged panels or portions of damaged panels which have been rejected shall be removed from the work area at no expense to the Owner.

8. Adjacent geomembrane panels shall be overlapped as described in this Section. Larger overlaps shall be used if thermal contraction of the geomembrane is anticipated prior to seaming. Adjacent panels shall be placed under similar temperature conditions, preferably early in the day when temperatures are cooler, to minimize the potential for differential contraction.

9. If a textured geomembrane is placed over the GCL, a slip sheet (such as 20-mil smooth HDPE) shall first be placed over the GCL in order to allow the geomembrane to slide into its proper position. Once the overlying geomembrane is properly positioned, the slip-sheet shall be carefully removed paying close attention to avoiding any movement to the geomembrane.

3.03 FIELD SEAMING

A. Seam Layout:

1. In general, seams shall be oriented parallel to the line of maximum slope, i.e., oriented down, not across, the slope. In corners and at odd-shaped geometric locations, the number of field seams shall be minimized. No horizontal seam shall be permitted less than 10 feet from the toe of the slope, except where approved by the Owner. No panels shall be seamed in the field without the Owner's approval.

B. Personnel:

1. All personnel performing seaming operations shall be qualified as required by the CQA Plan. At least one seamer shall have a minimum of 1,000,000 ft^2 of HDPE geomembrane experience. Seamers who don't have a minimum of 1 million ft^2 HDPE geomembrane experience will be considered unexperienced. Qualifications of the seamers shall be provided to the CQA Engineer prior to the start of construction. All personnel performing field seaming shall be qualified by experience or by passing seaming tests. The seaming tests shall require all inexperienced seamers to make 5 trial seams on-site prior to any actual field seams. The trial seams shall be tested according to this section and shall be performed under the supervision of an experienced seamer. The CQA Engineer, or a designated representative, will observe and record the results of the tests. No seaming shall be performed unless a "master seamer" is present.

C. Weather Conditions for Seaming:

1. Seaming shall not be attempted at ambient temperatures below 40°F. At ambient temperatures between 40°F and 50°F, seaming will be allowed if the geomembrane is preheated either by the sun or a hot air device, and if there is no excessive cooling from wind. At ambient temperatures above 50□ F, no preheating will be required. In all cases, the geomembrane shall be dry and protected from excessive wind.

2. If the Contractor wishes to perform seaming at ambient temperatures below 40°F, he shall demonstrate that the seam so produced is equivalent to those produced under normally-approved conditions, and that the overall quality of the geomembrane is not adversely affected. The Contractor shall submit to the Owner for approval a geomembrane cold-weather placement and seaming plan that details all aspects of the cold-weather seaming operation.

3. To minimize geomembrane contraction stresses, seaming should ideally be carried out in the morning and late evening when the geomembrane is relatively contracted, and

during the middle of the day if overcast conditions prevail. If the geomembrane is to be seamed in the middle of a sunny day, the Contractor shall ensure that there is sufficient slack in the geomembrane to prevent excessive stresses or trampolining when the geomembrane contracts as cooler temperatures prevail. The required amount of slack shall be determined by the Contractor and it should not be so much so as to cause excessive wrinkling of the geomembrane. If excessive trampolining or wrinkling of the geomembrane is observed, the Contractor will be required to make repairs to eliminate the problem at no additional cost to the Owner.

4. Ambient temperatures shall be measured near the crest of the secure cell or surface impoundment.

D. Overlapping and Temporary Bonding:

1. Geomembrane panels shall be overlapped a minimum of 3 inches for extrusion welding and 4 inches for fusion welding or a greater amount if recommended by the geomembrane Manufacturer, but in any event, sufficient overlap shall be provided to allow peel tests to be performed on the seam.

2. The procedure used to temporarily bond adjacent panels together shall not damage the geomembrane. The temperature of the air at the nozzle of a spot welding apparatus shall be controlled such that the geomembrane is not damaged.

3. No solvent or adhesive shall be used for cleaning or bonding of the geomembrane liner material.

E. Seam Preparation:

1. Prior to seaming, the seam area shall be cleaned so that it is free of moisture, dust, dirt, debris of any kind, and foreign material.

2. If seam overlap grinding is required, the process shall be completed according to the geomembrane Manufacturer's instructions and in a manner that does not damage the geomembrane.

3. Seams shall be aligned with the fewest possible number of wrinkles and "fishmouths".

F. General Seaming Requirements:

1. All geomembrane overlaps shall be continuously seamed using approved procedures.

2. Seaming shall extend to the outside edge of panels to be placed in the anchor trench.

3. If required, a firm substrate shall be provided by using a flat board, a conveyor belt, or similar hard surface, directly under the seam overlap to achieve proper support.

4. If seaming operations are carried out at night, adequate illumination shall be provided.

5. Fishmouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle to achieve a flat overlap. The cut fishmouths or wrinkles shall be seamed and any portion where the overlap is inadequate shall be patched with an oval or round patch of the same geomembrane that extends a minimum of 6 inches beyond the cut in all directions.

6. At the end of each day or installation segment, all exposed geomembrane edges shall be anchored by sandbags or other approved means. Sandbags securing the geomembrane on side slopes should be connected by a rope fastened at the top of the slope by a temporary anchor. If high winds are expected, boards with weighted sand bags on top may be used to keep wind from getting under the exposed edge of the geomembrane.

G. Seaming Process:

1. Approved processes for field seaming are extrusion welding and fusion welding using equipment that the Owner has approved by make and model. Alternate processes shall not be used unless a plan for their use has been submitted by the Contractor and approved by the Owner. Seaming equipment shall not damage the geomembrane.

2. Extrusion Equipment and Procedures:

   a. The Contractor shall maintain at least one spare operable seaming apparatus on site.

   b. The extrusion welding apparatus shall be equipped with gauges indicating the temperature in the apparatus and at the nozzle.

   c. Prior to beginning a seam, the extruder shall be purged until all heat-degraded extrudate has been removed from the barrel. Whenever the extruder is stopped, the barrel shall be purged of all heat-degraded extrudate.

   d. The Contractor shall provide documentation regarding the extrudate to the Owner and shall certify that the extrudate is compatible with the specifications, and consists of the same resin as the geomembrane.

   e. The electric generator for the extrusion welders shall be placed either outside the area to be lined or on a smooth base or other such manner that no damage occurs to the geomembrane.

3. Fusion Equipment and Procedures:

   a. The Contractor shall maintain at least one spare operable seaming apparatus on site.

   b. The fusion-welding apparatus shall be an automated vehicular-mounted device equipped with gauges indicating the applicable temperatures and pressures

c. The edges of cross seams shall be abraded to a smooth incline (top and bottom) prior to welding.

d. A movable protective layer shall be used directly below each geomembrane overlap to be seamed if deemed necessary by the Owner.

e. The electric generator for the fusion welders shall be placed either outside the area to be lined or on a smooth base or other such manner that no damage occurs to the geomembrane.

f. All fusion-welded seam intersections shall be patched in accordance with this Section.

H. Trial Seams:

1. Trial seams shall be made on fragment pieces of geomembrane to verify that seaming conditions are adequate. Such trial seams shall be made at the beginning of each seaming period (morning and afternoon). Each seamer shall make at least one trial seam each day. Trials seams shall also be made in the event that the ambient temperature varies more than 20°F since the last passing trial seam. Trial seams shall be made under the same conditions as actual seams. The trial seam sample shall be at least 5 feet long by 1 foot wide (after seaming) with the seam centered lengthwise for fusion trial seams and at least 3 feet long by 1 foot wide for extrusion trial seams. Seam overlap shall be as indicated in Part 3.03.D. of this Section.

2. Five specimens, each 1 inch wide, shall be cut from the trial seam sample by the Contractor. Two specimens shall be tested for shear strength and three specimens shall be tested for peel strength using a field tensiometer. Both tracks of double fusion welds will be tested for peel strength on each of the three specimens unless otherwise approved by the Owner. The test specimens shall not fail in the seam and shall meet or exceed the strength requirements in Table 02775-2. If a specimen fails, the entire operation shall be repeated. If the second trial seam fails, the seaming apparatus or seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful trial seams are achieved. Trial seam failure is defined as failure of any one of the five specimens.

3. The CQA Engineer will observe trial seam testing procedures. Successful trial seam samples will be assigned a number and marked accordingly by the CQA Engineer, who will also log the date, hour, ambient temperature, number of seaming unit, name of seamer, and pass or fail description. The sample itself will be retained only until the construction of the liner is complete, and the liner has been accepted by the Owner.

I. Nondestructive Seam Continuity Testing:

1. Except as noted below the Contractor shall nondestructively test for continuity all field seams over their full length, using the vacuum test (primarily for extrusion seams),or air pressure test (for double fusion seams only) methods. All other test methods must be approved by the Owner. These tests shall be carried out as the seaming work

progresses, not at the completion of all field seaming. The Contractor shall complete any required repairs in accordance with this Section at no additional cost to the Owner.

2. If the seam cannot be nondestructively tested after final installation, the following procedures shall apply:

   a. Prior to seaming, the seamer shall make a new trial seam.

   b. The seam shall be capped with the same type of geomembrane if the seams of the cap can be nondestructively tested.

   c. If the seam is accessible to nondestructive testing prior to final installation but not after final installation, the seam shall be nondestructively tested prior to final installation.

   d. At the discretion of the Owner, vacuum testing of fusion welded seams may be allowed in lieu of capping fusion welded seams which cannot be air pressure tested.

   e. If none of the above techniques are practical the CQA Engineer will closely observe and document the seaming process.

3. Vacuum Testing

   a. The equipment for vacuum box testing shall comprise the following:

      i. A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, and a vacuum gauge.

      ii. A steel vacuum tank and pump assembly equipped with a pressure controller and pipe connections.

      iii. A rubber pressure/vacuum hose with fittings and connections.

      iv. A bucket and applicator.

      v. A soapy solution.

   b. The following procedures shall be followed:

      i. Energize the vacuum pump and reduce the tank pressure to approximately 5 psi gauge.

      ii. Wet a strip of geomembrane seam approximately 4 inches by one and one half times the length (minimum) of the vacuum box with the soapy solution.

iii. Place the box over the wetted area.

iv. Close the bleed valve and open the vacuum valve.

v. Ensure that a leak tight seal is created as evidenced by a negative box pressure of a minimum 5 psi gauge.

vi. Examine the geomembrane through the viewing window for the presence of soap bubbles for not less than 10 seconds.

vii. If no bubbles appear after 10 seconds, close the vacuum valve and open the bleed valve, move the box to the next adjoining area with a minimum 3 inches overlap, and repeat the process.

viii. All areas where soap bubbles appear shall be marked with a marker that will not damage the geomembrane and repaired in accordance with Part 3.03.K. of this Section with no additional cost to the Owner.

4. Air Pressure Testing (For Double-Fusion Seams Only):

a. The following procedures are applicable to those processes which produce a double seam with an enclosed space.

b. The equipment shall comprise the following:

i. An air pump (manual or motor driven), equipped with a pressure gauge, capable of generating and sustaining a pressure between 25 and 30 psi, and mounted on a cushion to protect the geomembrane.

ii. A rubber hose with fittings and connections.

iii. A sharp hollow needle, or other approved pressure feed device.

c. The following procedures shall be followed:

i. Seal both ends of the seam to be tested.

ii. Insert needle, or other approved pressure feed device, into the tunnel created by the fusion weld.

iii. Insert a protective cushion between the air pump and the geomembrane.

iv. Energize the air pump to a gauge pressure between 25 and 30 psi, close valve, and sustain the pressure for not less than 5 minutes.

v. If the loss of pressure exceeds 2 psi, or does not stabilize, locate faulty area and repair in accordance with Part 3.03.K. of this Section.

vi. At the end of the test, cut the air channel at the end of the seam opposite the needle and verify air flow to ensure that the entire seam length was tested.

vii. Remove the needle, or other approved pressure feed device, and repair all test penetrations in accordance with Part 3.03.K. of this Section.

J. Destructive Testing:

1. Destructive seam tests shall be performed on samples collected from selected locations to evaluate seam strength and integrity. Destructive testing shall be carried out as the seaming work progresses, not at the completion of all field seaming.

2. Sampling:

a. Destructive test samples shall be collected at a minimum average frequency of one test location per 500 feet of productoinseam length. Production seaming does not include welding associated with patches. Test locations shall be determined during seaming, and may be prompted by suspicion of excess crystallinity, contamination, offset seams, or any other potential cause of imperfect seaming. The CQA Engineer will be responsible for choosing the locations of destructive seam samples. The Contractor shall not be informed in advance of the locations where the seam samples will be taken. The CQA Engineer may increase the sampling frequency.

b. Samples shall be cut by the Contractor at the locations designated by the CQA Engineer as the seaming progresses in order to obtain laboratory test results before the geomembrane is covered by another material. Each sample shall be numbered and the sample number and location identified on the panel layout drawing. All holes in the geomembrane resulting from the destructive seam sampling shall be immediately covered to prevent desiccation of the underlying clay. The holes shall be repaired in accordance with Part 3.03.K. of this Section. The continuity of the new seams in the repaired areas shall be tested according to this Section.

c. Two test specimens, each 1 inch wide and 6 to 12 inches long with the seam centered parallel to the width, shall be taken. The test specimens shall be spaced a clear distance of approximately 42 inches apart. These specimens shall be tested in the field in accordance with Part 3.03.J.3 of this Section. If these samples pass the field test, a laboratory sample shall be taken. The removed destructive sample shall be at least 12 inches wide by 42 inches long with the seam centered lengthwise. The sample shall be cut into three parts and distributed as follows:

i. One 12-inch long portion to the Contractor.

ii. One 18-inch long portion to the CQA Engineer for laboratory testing.

iii. One 12-inch long portion to the CQA Engineer for archive storage.

3. Field Testing:

a. The two 1 inch wide test specimens shall be tested in the field, using a tensiometer, for peel adhesion. Field testing shall be the responsibility of the Contractor and shall be observed by the CQA Engineer. The test specimens shall not fail in the weld more than 10 percent and shall meet the peel strength requirements of Table 02775-2. Both tracks of double-fusion welded seams shall be tested in peel on each test specimen unless otherwise approved by the Owner. If any field test sample fails to pass, then the procedures outlined in Part 3.03.K. of this Section shall be followed.

4. Laboratory Testing:

a. Laboratory testing by the CQA Engineer, in accordance with the CQA Plan, shall include seam shear strength and shear strain at yield (ASTM D 3083) and peel adhesion (ASTM D 413). The minimum acceptable values to be obtained in these tests are those indicated in Table 02775-2. At least 5 specimens shall be tested for each test method. Specimens shall be selected alternately by test from the samples (i.e., peel, shear, peel, shear...). A sample passes the laboratory tests when at least 4 out of 5 of the test specimens meet or exceed all of the test criteria. Both tracks of double-fusion welded seams shall be tested in peel.

5. Destructive Test Failure:

a. The following procedures shall apply whenever a sample fails a destructive test, whether the test is conducted by the CQA Engineer's laboratory, the Contractor's laboratory, (if used) or by a field tensiometer. The Contractor shall have two options:

i. The Contractor can reconstruct the seam(s) (e.g., remove the old seam(s) and reseam, or cap the seam(s)) between any two passed test locations.

ii. The Contractor can trace the welding path to an intermediate location, a minimum of 10 feet from the location of the failed test (in each direction) and take test specimens for an additional field destructive tests at each location. If these field destructive tests pass, then full laboratory samples shall be taken. If these laboratory samples pass the tests, then the seam(s) shall be reconstructed between these locations. If either sample fails, then the process shall be repeated to establish the zone in which the seam shall be reconstructed. This will be done by following the chronological order in which the seaming apparatus welded the seam(s) prior to and after it welded the failing test location.

In any case, all acceptable seams must be bounded by two locations from which samples passing laboratory destructive tests have been obtained. In cases exceeding 150 feet of reconstructed seam(s), a sample taken from within the reconstructed zone must pass destructive testing. Whenever a sample fails, the CQA Engineer may require additional tests for seams that were formed by the same seamer and/or seaming apparatus or seamed during the same time shift at no additional cost to the Owner.

iii. Should three consecutive failing destructives be performed on a single welding apparatus, the apparatus shall not be permitted to weld until the machine has been repaired and successfully passed three consecutive trial seams.

K. Defects and Repairs:

1. The geomembrane will be inspected before and after seaming for evidence of defects, holes, blisters, undispersed raw materials and any sign of contamination by foreign matter. The surface of the geomembrane shall be clean at the time of inspection. The geomembrane surface shall be swept or washed by the Contractor if surface contamination inhibits inspection.

2. Each suspect location, both in seam and non-seam areas shall, at the discretion of the CQA Engineer, be either repaired or nondestructively tested using the methods described Part 3.03.I. of this section, as appropriate. Each location which fails nondestructive testing shall be marked by the CQA Engineer and repaired by the Contractor.

3. When geomembrane seaming is completed (or when seaming of a significant area of a geomembrane is completed) and prior to placing overlying materials, the CQA Engineer shall identify all excessive geomembrane wrinkles. The Contractor shall cut and reseam all wrinkles so identified. The seams thus produced shall be tested like any other seams.

4. Repair Procedures:

a. Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, shall be repaired by the Contractor. Repairs to the geomembrane shall be completed to the base of the anchor trench but are not required across the base of the anchor trench. Several repair procedures exist. The final decision as to the appropriate repair procedure shall be agreed upon between the CQA Engineer and the Contractor. The procedures available include:

i. patching, used to repair holes, tears, intersections of fusion-welded seams, and undispersed raw materials;

ii. abrading and spot extrusion welding, used to repair small sections of extruded seams and air pressure test needle holes;

iii. spot seaming, used to repair areas where the geomembrane has been scratched, the geomembrane thickness has been reduced, or other minor, localized flaws exists;

iv. capping, used to repair failed seams; and,

vi. removing failing seams and replacing them with strips of new material seamed into place (used with long lengths of fusion seams).

b. In addition, the following shall be satisfied:

I. surfaces of the geomembrane which are to be repaired shall be abraded prior to the repair;

ii. all surfaces must be clean and dry at the time of repair;

iii. all seaming equipment used in repair procedures must be approved by the Owner;

iv. the repair procedures, materials, and techniques shall be approved in advance, for the specific repair, by the CQA Engineer;

v. patches or caps shall extend at least 6 inches beyond the edge of the defect, and all corners of patches shall be rounded with a radius of at least 3 inches; and,

vi. the geomembrane below large caps shall be appropriately cut to avoid water or gas collection between the two sheets.

5. Repair Verification:

a. Each repair shall be located, logged, and nondestructively tested using the methods described in Part 3.03.I. of this Section, as appropriate. Repairs which pass the nondestructive test shall be taken as an indication of an adequate repair. Failed tests will require the repair to be redone and retested until a passing test results. At the discretion of the CQA Engineer, destructive testing may be required on large repairs.

3.04 MATERIALS IN CONTACT WITH THE LINER

A. The Contractor shall not leave any tools or equipment on the geomembrane.

B. The Contractor shall take all necessary precautions to ensure that the geomembrane is not damaged during its installation or during the installation of other components of the liner

system or by other construction activities. Installation on rough surfaces shall be performed carefully. If approved by the Owner, additional loosely placed geotextile sections may be used by the Contractor to protect the geomembrane.

C. The CQA Engineer will provide monitoring of the placement and spreading of soil materials over the geomembrane as required by the CQA Plan.

D. Placement of granular leachate collection material on top of a geomembrane liner shall be carried out in accordance with Section 02224 of these General Specifications.

E. Equipment shall not be driven directly on the geomembrane. Unless otherwise specified by the Owner, all equipment operating on materials overlying the geomembrane shall comply with the following:

Maximum Allowable Equipment Ground Pressure (psi)	Thickness of Soil Above Geomembrane (inches)
<5	12
<10	18
<20	24
>20	36

The maximum allowable equipment ground pressure shall be 65 psi. The acceptability of equipment operating at ground pressures greater than 65 psi will be evaluated by the Owner at the Contractor's expense.

These equipment ground pressure requirements do not apply to any equipment used to construct the secondary or primary clay liners. The Owner may restrict the use of equipment that may potentially damage the geomembrane.

F. Appurtenances:

1. Installation of the geomembrane in sump areas, and connection of the geomembrane to appurtenances shall be made according to the specifications. Extreme care shall be taken while seaming around sumps and appurtenances since neither nondestructive nor destructive testing may be feasible in these areas.

2. All clamps, slips, bolts, nuts, or other fasteners used to secure the geomembrane to each appurtenance shall be at least as durable as the geomembrane.

3. Geomembrane boots for pipe penetrations shall be factory fabricated and tested where practical. Geomembrane boots shall be installed as shown on the Construction Drawings and in accordance with any geomembrane Manufacturer recommendations.

3.05 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all materials and partially completed and completed work.

B. In the event of damage, the Contractor shall make repairs and replacements necessary to the approval of the Owner and at no additional cost to the Owner.

C. The CQA Engineer will issue an approval of the geomembrane liner installation to the Owner in accordance with the CQA Plan prior to placement of any material over the geomembrane.

3.06 RECORD DRAWINGS

A. Within 7 days of the completion of installation of any layer of geomembrane liner and unless otherwise approved by the Owner, the Contractor shall provide 2 copies of a complete "as-built" record drawing to the Owner. This record drawing shall be prepared by the Contractor and shall be at a scale of no less than 1 inch = 30 feet.

B. Record drawings shall include the following:

1. The surveyed locations, dimensions, and elevations of anchor trenches.

2. The identification, size, and surveyed location of all deployed field panels of geomembrane liner (with date of deployment).

3. The identification, length, and surveyed location of all seams (both factory and field seams).

4. The location, and type of all repairs to seams and field panels.

5. The destructive test sample locations and pass/fail results.

C. The Owner will review the record drawing and either approve it or return it to the Contractor for revision. If the drawing is returned to the Contractor, he shall revise the drawing as requested by the Owner. No additional construction that would cover the installed geomembrane may be performed until the record drawing is approved by the Owner. The Contractor may submit a partial record to obtain approval for a portion of work.

TABLE 02775-1
REQUIRED GEOMEMBRANE

Property	Test Method	80 mil HDPE[1]	40 mil HDPE
Thickness	ASTM D5994	80 mil	40 mil
	ASTM D5994 (Textured)	72 mil (min.)	36 mil (min.)
Specific Gravity	ASTM D1505	0.940	0.940
Elongation @ Yield	ASTM D6693	13%	13%
Elongation @ Break	ASTM D6693 Speed C	500% Smooth 100% Textured	500% Smooth 100% Textured
Tensile Strength @ Yield	ASTM D6693 Test Specimen Type IV	160 lb/in	80 lb/in
Tensile Strength @ Break	ASTM D6693	270 lb/in Smooth 100 lb/in Textured	135 lb/in Smooth 46 lb/in Textured
Carbon Black Content	ASTM D1603	2% to 3%	2% to 3%
Stress Creek Resistance	ASTM D5397	300 hrs	300 hrs
Puncture Resistance	ASTM D4833	96 lb Smooth 95 lb Textured	48 lb Smooth 45 lb Textured

Note: [1] Values represent minimum average roll values (i.e., any roll in a lot should meet or exceed the values in this table). Where ranges of values are given, the average roll values must be within the specified range. The specified dimensional stability is a maximum average roll value.

TABLE 02775-2
REQUIRED GEOMEMBRANE SEAM PROPERTIES

PROPERTY	TEST METHOD	80 MIL HDPE[1]	40 MIL HDPE
1.Shear strength at yield	ASTM D6392	FTB, 90% of Parent Mat'l	FTB, 90% of Parent Mat'l
2.Shear Strain at Yield	ASTM D6392	10%	10%
3.Peel Strength	ASTM D6392	FTB, 60% of Parent Mat'l	FTB, 60% of Parent Mat'l

NOTE: [1]Specified properties are minimums.

[END OF SECTION]

SECTION 02780
GEOSYNTHETIC CLAY LINERS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment supervision, transportation, and installation services necessary for the installation of the primary geosynthetic clay liner (GCL) of the secure cell or surface impoundment. The work shall be carried out in accordance with these General Specifications, Supplemental Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02221 - Secondary Clay Liner
B. Section 02222 - Primary Clay Liner
C. Section 02224 - Granular Leachate Collection Layer
D. Section 02225- Sump and Pipe Bedding Gravel and Road Base Aggregate
E. Section 02710 - Geocomposite Detection or Collection Layer

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan. The Contractor shall require the GCL manufacturer to comply with the submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. All work will be constructed, monitored, and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all activities outlined in the CQA Plan, and the Contractor shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. The Contractor shall deliver GCL to the site at least 14 calendar days prior to installation to allow sufficient time for testing required by the CQA Plan.

D. GCL rolls that do not meet the requirements of this General Specification will be rejected. The Contractor shall replace rejected material with new material that conforms to the specification requirements, at no additional cost to the Owner.

E. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at no cost to the Owner until acceptable test results are obtained.

PART 2 PRODUCTS

2.01 GCL PROPERTIES

The GCL material shall be in accordance with the test methods, test frequencies and material physical properties as listed in Table 02780-1.

A. In addition to the property values listed in Table 02780-1, the GCL material shall:

1. The GCL shall be manufactured by mechanically bonding the geotextiles using a needle punching process to create frictional and shear strength characteristics.

2. In order to maintain these characteristics, no glues, adhesives or other non-mechanical bonding processes shall be used in lieu of the needle punch process. Their use to enhance the physical properties of the GCL is permitted.

3. Acceptable GCLs for this project include any needle punched GCLs which meet the requirements of this specifications.

4. The GCL supplied in accordance with this project shall be manufactured by needle punching as described below.

   i. To demonstrate the uniformity of the manufacturing process, no delamination of the geotextile components from the bentonite core shall occur when the GCL is exposed to 70 degree tap water for one hour.

5. Interface Shear Testing of Proposed Equal Materials

   Interface shear tests (ASTM D 5321) shall be performed by the Geosynthetic Laboratory under the direction of the Design Engineer for any GCL material proposed as an equal for Bentofix GCL. Interface shear testing will be performed on fully hydrated GCL samples using a 12 inch by 12 inch shear box under test conditions described in LF13, Appendix B. One conformance test shall be performed per 500,000 ft^2 of material installed. However, interface sheer testing is not required for cover GCL due to a very high factor of safety against sliding. A proposed equal material must demonstrate a strength envelop which is equivalent to the materials previously tested (see Figure LF13, Appendix B). All costs related to testing and evaluation of proposed equal materials are the responsibility of the Contractor.

6. Interface Shear Testing for QA Conformance Samples

   Interface shear tests (ASTM D 5321) shall be performed by the Geosynthetic Laboratory under the direction of the CQA Engineer using the same test procedures described in LF13, Appendix B. Tests will be performed at a frequency of one test per 100,000 ft^2 of material. All costs related to testing and evaluation of conformance samples is the responsibility of the CQA Engineer.

2.02 MANUFACTURING QUALITY CONTROL

A. The Contractor shall require that the GCL Manufacturer sample and test the GCL, at the frequencies outlined in Table 02780-1 the tests shall demonstrate that the GCL properties conform to the values specified in Table 02780-1. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor. GCL rolls that do not have acceptable manufacturing quality control test results shall be rejected by the Owner.

B. Quality Control certificates shall be issued by the GCL manufacturer to the project engineer, CQA inspector or other designated party for each delivery of material. The certifications shall be signed by the quality control manager of the GCL manufacturer or other responsible party and shall include the following information:

1. Shipment Packing List - A list indicating the rolls shipped on a particular truckload.

2. Bill of Lading - A list indicating the rolls shipped on a particular truckload.

3. Letter of Certification - The letter indicating the material is in conformance with the physical properties specified.

4. Physical Properties Sheet - The material specification for the GCL supplied in accordance with this specification.

C. Quality Control submittals shall be issued by the GCL manufacturer to the project engineer, CQA inspector or other designated party for each lot of material if necessary. The submittals shall include the following information:

1. Bentonite Manufacturer Certification - Bentonite manufacturer quality documentation for the particular lot of clay used in the production of the rolls delivered.

2. Geotextile Manufacturer Certification - Geotextile manufacturer quality control documentation for the particular lots of geotextiles used in the production of the rolls delivered.

3. GCL Manufacturer Tracking List - Cross referencing list delineating the corresponding geotextile and bentonite lots for the materials used in the production of the rolls delivered.

4. Manufacturing Quality Control Data - The manufacturing quality control test data indicating the actual test values obtained when tested at the appropriate frequencies for the properties specified in Table 02780-1.

D. Manufacturing Plant Visit:

1. The Manufacturer shall permit the Owner or Owner's representative(s) to visit the manufacturing plant. Visits may be during the manufacturing of the GCL rolls for the specific project.

2. During the visit, the Owner or Owner's representative(s) may:

   a. Review the manufacturing process, quality control procedures, laboratory facilities, and testing procedures;

   b. Verify that properties guaranteed by the Manufacturer comply with the specifications;

   c. Verify that the measurements of properties by the Manufacturer are properly documented and the test methods used are acceptable;

   d. Inspect select GCL rolls for evidence of holes, delamination, or any sign of contamination by foreign matter;

   e. Review packaging and transportation procedures;

   f. Verify that roll packages are labeled in compliance with this Section; and,

   g. Take conformance samples from GCL rolls that are assigned to the project.

E. Any accessory bentonite used for sealing seams, penetrations, or repairs, shall be the same granular bentonite as used in the production of the GCL itself.

2.03 LABELING

A. The geomembrane shall be labeled with the following information:

1. Length and width of the roll or factory panel;
2. Name of Manufacturer;
3. Product identification;
4. Lot number; and,
5. Roll or factory panel number.

2.04 TRANSPORTATION

A. Transportation of the GCL is the responsibility of the Contractor. The Contractor shall be liable for all damage to materials prior to and during transportation to the site. The Contractor shall replace any damaged rolls at no additional cost to the Owner.

2.05 HANDLING AND STORAGE

A. Handling, storage, and care of the GCL prior to and following incorporation in the work is the responsibility of the Contractor. The Contractor shall be liable for all damage to the material incurred prior to final acceptance of the installation by the Owner. The Contractor shall repair any damage in accordance with this Section and at no additional cost to the Owner.

B. The Contractor shall be responsible for storage of the GCL at the site. The GCL shall be protected from water, dirt, puncture, cutting, or other damaging or deleterious conditions. The GCL shall also be stored in accordance with any additional requirements of the GCL Manufacturer, Owner, or CQA Engineer.

1. GCL should be stored no higher than three to four rolls high or limited to the height at which the handling apparatus may be safely handled by installation personnel. Stacks or tiers of rolls should be situated in a manner that prevents sliding or rolling by Achocking@ the bottom layer of rolls.

2. Rolls shall not be stacked on uneven or discontinuous surfaces as this may cause bending or deformation of the rolls and in turn damage the GCL or cause difficulty inserting the core pipe.

3. An additional tarpaulin or plastic sheet shall be used over the stacked rolls to provide extra protection for GCL material stored outdoors.

4. Bagged bentonite material shall be stored and tarped next to GCL rolls unless other more protective measures are available. Bags shall be stored on pallets or other suitably dry surface which will prevent undue prehydration.

C. GCL must be supported during handling to ensure worker safety and prevent damage to the liner. Under no circumstances should the rolls be dragged, lifted from one end, lifted with only the forks of a lift truck or pushed to the ground from the delivery vehicle.

The CQA inspector shall verify that suitable handling equipment exists which does not pose any danger to installation personnel or risk of damage or deformation to the GCL material itself. Typical handling equipment is described below:

1. Spreader Bar Assembly - A spreader bar assembly shall include both a core pipe or bar and a spreader bar beam. The core pipe shall be used to uniformly support the roll when inserted through the GCL core while the spreader bar beam will prevent chains or straps from chafing the roll edges.

2. Stinger - A stinger is a rigid pipe or rod with one end directly connected to a forklift or other handling equipment. If a stinger is used, it should be fully inserted to it=s full length into the roll to prevent excessive bending of the roll when lifted.

3. Roller Cradles - Roller cradles consist of two larger diameter rollers spaced approximately 3 inches apart which both support the GCL roll and allow it to be freely

unrolled. The use of roller cradles shall be permitted if the rollers support the entire width of the GCL roll.

4. Straps - Straps may be used to support the ends of the spreader bars *but are not recommended as the primary support mechanism.* As straps may damage the GCL where around the roll and generally do not provide sufficient uniform support to prevent roll bending or deformation, great care must be exercised when this option is used.

PART 3 EXECUTION

3.01 EARTHWORK

Earthen Subgrade - The surface upon which the GCL material will be installed shall be inspected by the CQA inspector and certified by the Earthwork Contractor to be in accordance with the requirements of this specification.

A. Site specific compaction requirements should be followed in accordance with the project drawings and specifications. At a minimum, the level of compaction should be such that no rutting is caused by installation equipment or other construction vehicles which traffic the area of deployment.

B. The surfaces to be lined shall be smooth and free of any debris, vegetation, roots, sticks, sharp rocks, or other deleterious materials larger than two inches as well as free of any voids, large cracks or standing water or ice.

C. Directly prior to deployment of the GCL, the subgrade shall be final graded to fill remaining voids or desiccation cracks, and smooth drum rolled to eliminate sharp irregularities or abrupt elevation changes. The surfaces to be lined shall be maintained in this smooth condition.

3.02 GEOSYNTHETIC SUBGRADE

Prior to GCL deployment on another geosynthetic surface shall be inspected and approved by the third party CQA inspector in accordance with the requirements of the project specification documents.

3.03 ANCHOR TRENCH

An anchor trench shall be excavated by the earthwork contractor or liner installer to the lines and grades shown on the project drawings.

A. The anchor trench shall be constructed free of sharp edges or corners and maintained in a dry condition. No loose soil shall be permitted beneath the GCL within the trench.

B. The anchor trench shall be inspected as well as approved by the CQA inspector prior to the GCL placement, back-filling and compaction of the anchor key material.

3.04 SUBGRADE INSPECTION

The earthen or geosynthetic subgrade shall be continuously inspected, approved and certified by the CQA inspector prior to GCL placement.

Upon approval by the CQA inspector, it shall be the installer's responsibility to indicate to the Engineer any change in the condition of the subgrade that could cause it to be out of compliance with any of the requirements of this section or the project specific specification.

3.05 GCL DEPLOYMENT

A. GCL Orientation - In the absence of specific guidelines, GCL panels should be placed with the non-woven side up on slopes to maximize the shear strength characteristics.

B. GCL Panel Position - Where possible, all slope panels should be installed parallel to the maximum slope while panels installed in flat areas require no particular orientation. No horizontal GCL panel seams shall be allowed on slopes steeper than 5%.

C. Panel Deployment - GCL materials shall be installed in general accordance with the procedures set forth in this section, subject to site specific conditions which would necessitate modifications.

Reinforced GCL shall be used on both slopes as well as the flat areas to ensue the GCL withstands the rigors of the installation and subsequent low load hydration.

1. Deployment should proceed from the highest elevation to the lowest to facilitate drainage in the event of precipitation.

2. The GCL may be deployed on slopes by pulling the material from a suspended roll, or securing a roll end into an anchor trench and unrolling each panel as the handling equipment slowly moves backwards.

3. Deployment on flat areas shall be conducted in the same manner as that for the slopes, however, care should be taken to minimize Adragging@ the GCL. Slip-sheet may be used to facilitate positioning of the liner while ensuring the GCL is not damaged from underlying sources.

4. Overlaps shall be a minimum of 6 inches and be free of wrinkles, folds or Afishmouths@.

5. The Contractor shall only install as much GCL that can be covered at the end of the day. No GCL shall be left exposed overnight. The exposed edge of the GCL shall be covered by a temporary tarpaulin or other such water resistant sheeting until the next working day.

D. Anchoring - All GCL material installed on slopes greater than 7H:1V shall be anchored to prevent potential GCL panel movement.

1. Standard Anchor - The GCL shall be placed into and across the base of the excavated trench, stopping at the back wall of the excavation as shown on the drawing.

E. Seaming - A 6-inch lap line and a 9-inch match line shall be imprinted on both edges of the upper geotextile component of the GCL to assist in installation overlap quality control. Lines shall be printed as continuous dashes in easily observable non-toxic ink.

1. Overlap seams shall be a minimum of six inches on panel edges and one foot on panel ends.

2. Loose granular bentonite should be placed between panels at a rate of 1/4 pound per linear foot of seam.

F. Detailing - Detail work, defined as the sealing of the liner to pipe penetrations, foundation walls, drainage structures, spillways, and other appurtenances, shall be performed as recommended by the Design Engineer and the GCL Manufacturer.

G. Damage Repair - Prior to geomembrane material placement, damage to the GCL shall be identified and repaired by the installer. Damage is defined as any rips or tears in the geotextiles, delamination of geotextiles or a displaced panel.

1. Rip and Tear Repair (Flat Surfaces) - Rips or tears may be repaired by completely exposing the affected area, removing all foreign objects or soil and by then placing a patch cut from unused GCL over the damage (damaged material may be left in place), with a minimum of overlap of 12 inches on all edges.

2. Rip and Tear Repair (Slopes) - Damaged GCL material on slopes shall be repaired by the same procedures above. The minimum overlap of 12 inches on all edges may be increased as recommended by the CQA Engineer.

3. Displaced Panels - Displaced panels shall be adjusted to the correct position an orientation. The adjusted panel shall then be inspected for any geotextile damage or bentonite loss. Damage shall be repaired by the above procedure.

4. Premature Hydration - If the GCL is subjected to premature hydration, the GCL installer shall notify the QA/QC technician and project engineer for a site specific determination as to whether the material is acceptable or if alternative measures must be taken to ensure the quality of the design-dependent upon the degree of damage.

3.06 MATERIALS IN CONTACT WITH THE GCL

A. The Contractor shall not leave any tools or equipment on the GCL.

B. The Contractor shall take all necessary precautions to ensure that the GCL is not damaged during its installation or during the installation of other components of the liner system or by other construction activities. Installation on rough surfaces shall be performed carefully.

C. The CQA Engineer will provide monitoring of the placement and spreading of soil materials over the GCL. Equipment shall not be driven directly on the GCL. Unless otherwise specified by the Owner, all equipment operating on materials overlying the GCL shall comply with the following:

Maximum Allowable Equipment Ground Pressure (psi)	Thickness of Soil Above Geomembrane (inches)
<5	12
<10	18
<20	24
>20	36

The maximum allowable equipment ground pressure shall be 65 psi. The acceptability of equipment operating at ground pressures greater than 65 psi will be evaluated by the Owner at the Contractor's expense.

D. Installation of the overlying geosynthetic component can be accomplished through the use of *lightweight*, rubber-tired equipment such as a 4-wheel all-terrain vehicle (ATV). This vehicle can be driven directly on the GCL, provided the ATV makes no sudden stops, starts, or turns.

E. Smooth HDPE may be dragged across the GCL surface with equipment or by hand labor during positioning. Similarly, the HDPE may be unrolled with the use of low ground pressure equipment.

F. If a textured geomembrane is placed over the GCL, a slip sheet (such as 20-mil smooth HDPE) shall first be placed over the GCL in order to allow the geomembrane to slide into its proper position. Once the overlying geomembrane is properly positioned, the slip-sheet shall be carefully removed paying close attention to avoiding any movement to the geomembrane.

3.07 PROTECTION OF THE WORK

A. The Contractor shall use all means necessary to protect all materials and partially completed and completed work.

B. In the event of damage; the Contractor shall make repairs and replacements necessary to the approval of the Owner and at no additional cost to the Owner.

C. The CQA Engineer will issue an approval of the GCL liner installation to the Owner in accordance with the CQA Plan prior to placement of any material over the GCL.

TABLE 02780-1
REQUIRED GCL PROPERTIES[4]

Geotextile Properties	Test Method	Manufacturer's QC Minimum Test Frequency	Value -English-	Value -SI-
Nonwoven Mass/Unit Area	ASTM D 5261	1/200,000 sq. ft (1/200,000 sq.m)	7.4 oz./yd^2 Typical 6.0 oz./yd^2 MARV	250 g/m^2 Typical 200 g/m^2 MARV
Woven	ASTM D 5261	1/200,000 sq. ft (1/20,000 sq. M)	3.4 oz./yd^2 Typical 3.1 oz./yd^2 MARV	115 g/m^2 Typical 105 g/m^2 MARV
BENTONITE				
Swell Index	ASTM D 5890	1/100,000 lbs. (50,000 kg)	24 ml/2g min.	24 ml/2g min.
Fluid Loss	ASTM D 5891	1/100,000 lbs. (50,000 kg)	18 ml max.	18 ml max.
FINISHED GCL [4]				
Bentonite Mass Per Unit Area[1]	ASTM D 5993	1/50,000 sq. ft	0.75 lb./sq. Ft MARV	4.39 kg/m^2 MARV
Grab Strength[2]	ASTM D 4362	1/200,000 sq. ft	95 lbs MARV	422 N MARV
Grab Elongation[2]	ASTM D 4632	1/200,000 sq. ft	75% Typical	75% Typical
Peel Strength	ASTM D 4632	1/50,000 sq. ft	15 lbs. min.	66 N min.
Permeability[3]	ASTM D 5084	weekly during production	5 x 10^{-9} cm/sec max	5 x 10^{-9} cm/sec max

Notes:

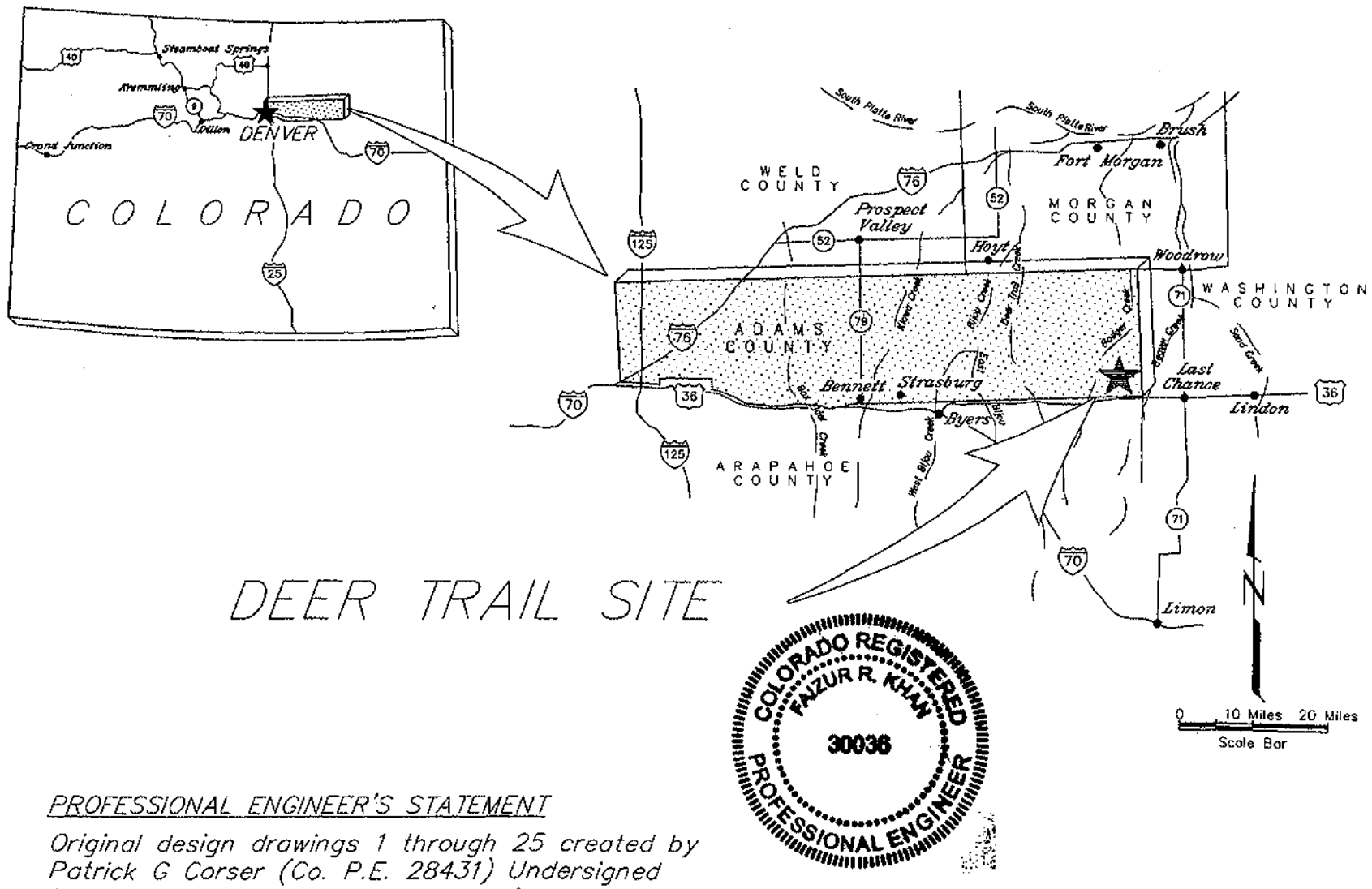
1. Oven-dried measurement reflecting a moisture content of zero.
2. Measured at maximum peak, in the weakest principal direction.
3. De-Aired Tap Water @ 5 psi maximum effective confining stress and 2 psi head.
4. Internal shear strength testing (ASTM D 5321) of QA conformance samples or proposed equal material will be performed by the CQA Engineer as described in this specification.

[END OF SECTION]

PERMIT ATTACHMENT LF-4
CONCEPTUAL SITE DEVELOPEMENT PLANS
CLEAN HARBORS DEER TRAIL, LLC
HAZARDOUS WASTE TREATMENT, STORAGE AND DISPOSAL FACILITY
ADAMS COUNTY, COLORADO

SEPTEMBER 2004

REVISION - 1



DEER TRAIL SITE

COLORADO REGISTERED
FAIZUR R. KHAN
30036
PROFESSIONAL ENGINEER

LIST OF DRAWINGS

DRAWING NO.	DRAWING TITLE
1	COVER SHEET
2	COMPLIANCE BOUNDARY GENERAL LOCATION MAP
3	1994 EXISTING CONDITIONS
4-10	CELL DEVELOPMENT SEQUENCE
11	EXCAVATION PLAN FOR NEW SITE LAYOUT
12	STOCKPILE LOCATION MAP
13	NORTH - SOUTH CROSS-SECTION
14	EAST - WEST CROSS-SECTION
15	TYPICAL - EXCAVATION PLAN
16	TYPICAL - FILLING PLAN AND DETAILS (3 SHEETS)
17	TYPICAL - CELL CROSS-SECTION
18	TYPICAL LINER SYSTEM DETAILS
19	TYPICAL LINER SYSTEM DETAILS
20	TYPICAL - SUMP DETAILS AND CROSS-SECTIONS (4 SHEETS)
21	TYPICAL ACCESS RAMP DETAILS
22	TYPICAL - SURFACE WATER DETAILS (2 SHEETS)
23	TYPICAL LEACHATE PUMPING SYSTEM LAYOUT
24	TYPICAL LEACHATE PUMPING SYSTEM DETAILS
25	TYPICAL COVER CROSS-SECTIONS AND DETAILS

PROFESSIONAL ENGINEER'S STATEMENT

Original design drawings 1 through 25 created by Patrick G Corser (Co. P.E. 28431) Undersigned is the responsible design engineer for revisions discussed in the notes section dated September 2004.

9-27-04 Faizur R. Khan
Date *Faizur R. Khan, CO P.E. 30036*

NOTE: ORIGINAL DESIGN DRAWINGS PREPARED BY TERRAMATRIX ON 11/94

CleanHarbors®
DEER TRAIL, LLC.

DWG.: Deertrail-1.DWG

DRAWING No.:	REV.
1	1

T.3 S.

S 00°28'07"W (5260.42')

S 00°16'39" W (5268.91')

SET NE CORNER SECTION 25, T3S, R57W 6TH P.M. 30" No.6 REBAR WITH 2" ALUMINUM CAP LS 23500.

FOUND No.4 REBAR AND CAP 16823 AS PER RECORD. REPLACED WITH 30" No.6 REBAR AND 2" ALUMINUM CAP LS 23500 NE CORNER SECTION 36, T3S, R57W 6TH P.M.

BENCHMARK A1

FOUND 1916 BRASS CAP 3-3/8" DIA. 2.9' BELOW ASPHALT. SE CORNER SECTION 36, T3S, R57W, 6TH P.M.

COLORADO STATE HIGHWAY 36

N 89°59'17"E (4934.72')

BASIS OF BEARING N 89°59'19" (4934.57')

R. 57 W.

SECTION 25 (597.736 ACRES)

SECTION 36 (595.477 ACRES)

S 89°19'54" (4968.76')

S 89°17'37" (4954.73')

L5-10A

L3-26

L4-

L3-2

L4-32

L5-8

WASTE WATER TREATMENT PLANT

POTENTIALLY CONTAMINATED RAINWATER BASIN

CONTAMINATED WATER AND CARBON TREATMENT

OIL / SOLVENT HOLDING TANKS

SOLIDIFICATION BUILDING

MAINTENANCE BUILDING

FUEL ISLAND

POWER SUBSTATION

PUMP HOUSE

WATER TANKS

SEWAGE EFFLUENT POND

TRUCK WASH

TRUCK STAGING AREA

OPERATIONS BUILDING

GUARD HOUSE

SET NW CORNER SECTION 36, T3S, R57W 6TH P.M. 30" No.6 REBAR WITH 2" ALUMINUM CAP LS 23500.

N 01°08'11" E (5330.72')

FOUND AXLE ON E-W FENCELINE. NORTH CORNER SECTION 25, T3S, R57W 6TH P.M. DOES NOT AGREE WITH PREVIOUSLY RECORDED CORNER SET AND RECORDED LS 16823.

S 00°44'33" E (5345.51')

FOUND No.4 REBAR AND CAP LS 16823 AS PER RECORD TIES. UPON TRYING TO UPGRADE TO STATE STANDARDS A PIECE OF ANGLE IRON WAS FOUND WITH A 10" SPIKE DRIVEN DOWN AT THE INSIDE CORNER OF S36, T3S, R57W 6TH P.M. FITS EXISTING ROW INFORMATION BETTER THAN THE No.4 REBAR, THEREFORE UPGRADED THE SPIKE AND ANGLE IRON LOCATION AND RECORDED AS THE SECTION CORNER.

N 30,000 N 29,000 N 28,000 N 27,000 N 26,000 N 25,000 N 24,000 N 23,000 N 22,000 N 21,000 N 20,000

E 20,000 E 19,000 E 18,000 E 17,000 E 16,000 E 15,000

T.3 S.

LEGEND

- SURFACE WATER DRAINAGE
- ROAD
- FENCE
- SECTION LINE BOUNDARY
- COMPLIANCE BOUNDARY
- ⊙L3-2 BENCH MARK

NOTES:

1.) TOPOGRAPHIC MAPPING PERFORMED BY MERRICK & COMPANY, AURORA, COLORADO, IN JULY 1991, ORIGINAL MAP SCALE 1 INCH = 50', CONTOUR INTERVAL 2 FEET. GRID COORDINATES CORRESPOND TO LOCAL COORDINATE SYSTEM ESTABLISHED FOR THE H36LDC TSDF SITE (TIED TO BENCH MARK A1, HIGHWAY 36 RIGHT OF WAY MONUMENT AT N. 20,000, E. 20,000).

2.) SECTION CORNER INFORMATION OBTAINED FROM SURVEY DATA COLLECTED BY HASCALL SURVEYS INC. LONGMONT, COLORADO, IN AUGUST 1994.

3.) BENCH MARK INFORMATION OBTAINED FROM TOPOGRAPHIC MAPPING PERFORMED BY MERRICK & COMPANY, AURORA, COLORADO, IN JULY 1991.

4.) ORIGINAL DESIGN DRAWINGS PREPARED BY TERRAMATRIX ON 11/94

SCALE

400' 0 400' 800'

CONTOUR INTERVAL NONE

SURVEY BENCH MARKS

SURVEY BENCH MARKS

NO.	NORTHING	EASTING	ELEVATION
A1	20,000.00	20,000.00	4779.95
L3-2	23,659.32	17,060.48	4891.27
L3-26	25,775.50	17,800.24	4892.34
L4-28	25,649.14	15,471.23	4880.85
L4-32	26,402.38	16,088.23	4874.14
L5-8	23,659.13	15,919.36	4869.82
L5-10A	26,389.30	17,817.65	4893.67

Rev. No	NOTES	DATE	BY	CHKD
1	REVISED TO SHOW NEW OWNERSHIP	9/04	WDS	FK
0	ISSUED FOR PERMIT MOD. REPORT	11/94	JGN	PGC

SCALE: SEE BAR SCALE

DESIGN BY: TEL (TERRAMATRIX)

DRAWN BY: JGN (TERRAMATRIX)

CHECK BY: PGC (TERRAMATRIX)

PROJECT No. 603

FILE NAME: DEERTRAIL-2.DWG

CleanHarbors DEER TRAIL, LLC

PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN

DRAWING TITLE: COMPLIANCE BOUNDARY GENERAL LOCATION MAP

SHEET: 1 OF 1

DRAWING No.: 2

REV. 1

LEGEND

- UC-2 — SURFACE WATER DRAINAGE
- FENCE
- 4820 — ELEVATION OF EXISTING GRADE (FEET)
- COMPLIANCE BOUNDARY
- L3-2 BENCH MARK (SEE DRAWING 2)
- CULVERT

NOTES:

1.) TOPOGRAPHIC MAPPING PERFORMED BY MERRICK & COMPANY, AURORA, COLORADO, IN JULY 1991, ORIGINAL MAP SCALE 1 INCH = 50', CONTOUR INTERVAL 2 FEET. GRID COORDINATES CORRESPOND TO LOCAL COORDINATE SYSTEM ESTABLISHED FOR THE H36LDC TSDF SITE (TIED TO BENCH MARK A1, HIGHWAY 36 RIGHT OF WAY MONUMENT AT N. 20,000, E. 20,000).

2.) CELL 1 AND CELL 2 TOPOGRAPHIC ELEVATION ASSUMES ELEVATIONS SHOWN ARE AT TOP OF LINER SYSTEM.

3.) CURRENT CONDITIONS – CELL 1 IS CLOSED, CELL 2 IS ACTIVE

4.) ORIGINAL DESIGN DRAWINGS PREPARED BY TERRAMATRIX ON 11/94

SCALE

250' 0 250' 500'

CONTOUR INTERVAL 2' AND 10'

Rev. No	NOTES	DATE	BY	CHKD
1	ADDITION OF NOTE 3; NEW OWNERSHIP	9/04	WDS	FK
0	ISSUED FOR PERMIT MOD. REPORT	11/94	JGN	PGC

SCALE: SEE BAR SCALE

DESIGN BY: TEL (TERRAMATRIX)

DRAWN BY: JGN (TERRAMATRIX)

CHECK BY: PGC (TERRAMATRIX)

PROJECT No. 603

FILE NAME: DEERTRAIL-3.DWG

CleanHarbors DEER TRAIL, LLC

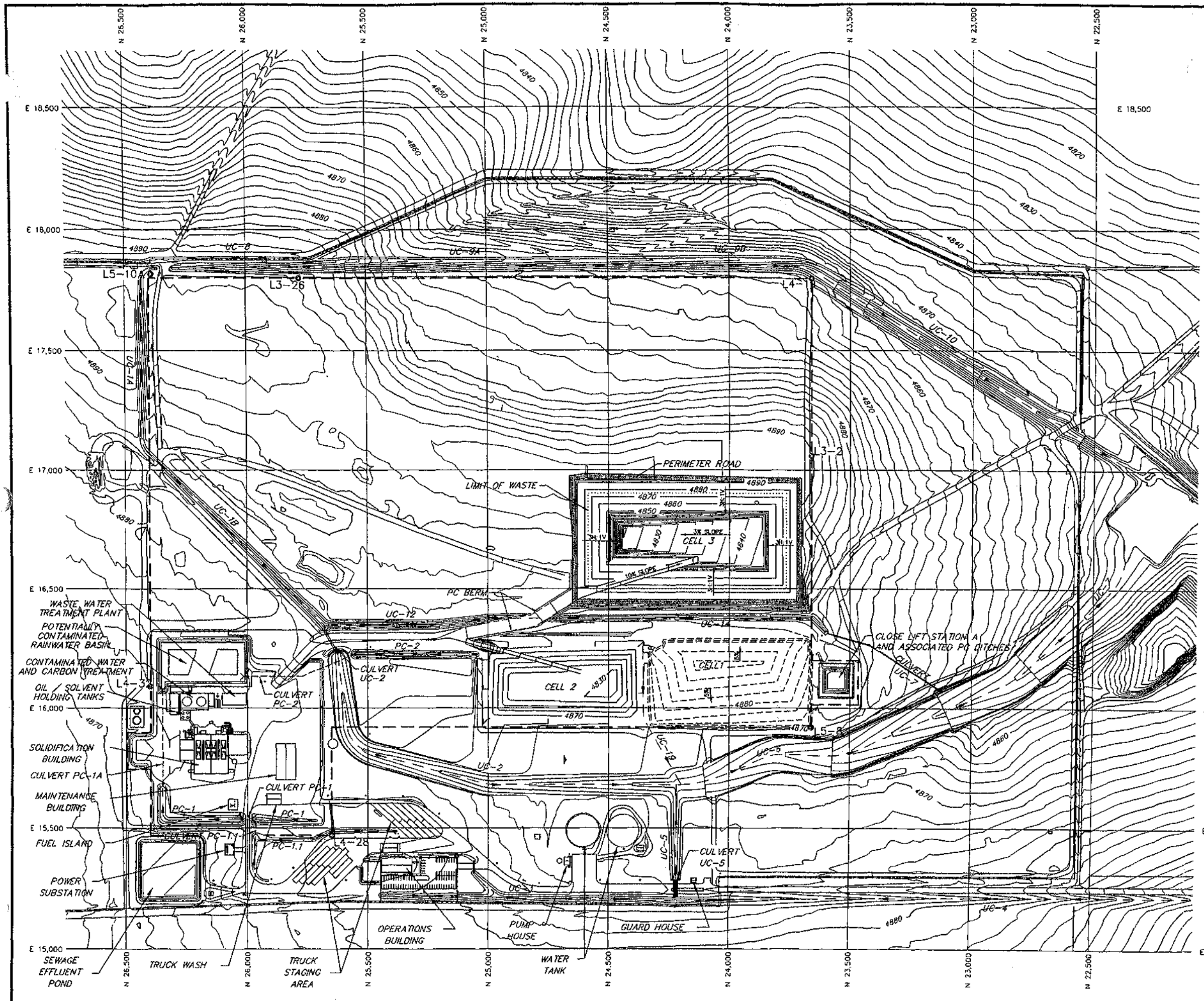
PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN

DRAWING TITLE: 1994 EXISTING CONDITIONS

SHEET: 1 OF 1

DRAWING No.: 3

REV.: 1



LEGEND

- UC-2 — SURFACE WATER DRAINAGE
- FENCE
- 4820 — ELEVATION OF EXISTING GRADE (FEET) (BASED ON 1991 TOPOGRAPHY)
- COMPLIANCE BOUNDARY
- L3-2 BENCH MARK (SEE DRAWING 2)
- 4830 — ELEVATION OF CELL GRADE (FEET)
- 4870 — ELEVATION OF COVER GRADE (FEET)
- WASTE LIMIT
- PC BERM (POTENTIALLY CONTAMINATED)
- CULVERT

APPROXIMATE DESIGN VOLUME:	
CELL 1	173,385 cu.yd.
CELL 2	220,600 cu.yd.
CELL 3	414,300 cu.yd.
TOTAL	808,285 cu.yd.
PC AREA (POTENTIALLY CONTAMINATED):	
TOTAL PC AREA	19.8 acres

NOTE:

1.) ALL DIMENSIONS, GRADES AND LOCATIONS SHOWN ARE TYPICAL.

2.) FINAL DESIGN DIMENSIONS, GRADES AND LOCATIONS TO BE COMPILED IN CONSTRUCTION DRAWINGS AND SUBMITTED TO CDPHE PRIOR TO CONSTRUCTION.

3.) CURRENT CONDITIONS – CELL 1 IS CLOSED; CELL 2 IS ACTIVE; CELL 3 IS NOT CONSTRUCTED (FUTURE)

4.) ORIGINAL DESIGN DRAWINGS PREPARED BY TERRAMATRIX ON 11/94

SCALE

200' 0 200' 400'

CONTOUR INTERVAL 2' AND 10'

Rev. No.	NOTES	DATE	BY	CHKD
1	REV. CELL 2 DESIGN VOL.; NEW OWNERSHIP; NOTE 3	9/04	WDS	FK
0	ISSUED FOR PERMIT MOD. REPORT	11/94	JGN	PGC

SCALE: SEE BAR SCALE
DESIGN BY: TEL (TERRAMATRIX)
DRAWN BY: JGN (TERRAMATRIX)
CHECK BY: PGC (TERRAMATRIX)
PROJECT No. 603
FILE NAME: DEERTRAIL-4.DWG

Clean Harbors
DEER TRAIL, LLC.

PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN

DRAWING TITLE: CELL DEVELOOPMENT SEQUENCE FILL CELL 2 – CONSTRUCT CELL 3

SHEET: 1 OF 1
DRAWING No.: 4
REV.: 1

LEGEND

- UC-2 — SURFACE WATER DRAINAGE
- FENCE
- 4820 — ELEVATION OF EXISTING GRADE (FEET) (BASED ON 1991 TOPOGRAPHY)
- COMPLIANCE BOUNDARY
- ⊗L3-2 BENCH MARK (SEE DRAWING 2)
- 4830 — ELEVATION OF CELL GRADE (FEET)
- 4870 — ELEVATION OF COVER GRADE (FEET)
- WASTE LIMIT
- PC BERM (POTENTIALLY CONTAMINATED)
- CULVERT

APPROXIMATE DESIGN VOLUME:	
CELL 1	173,385 cu.yd.
CELL 2	220,600 cu.yd.
CELL 3	414,300 cu.yd.
CELL 4	424,200 cu.yd.
TOTAL	1,232,485 cu.yd.
PC AREA (POTENTIALLY CONTAMINATED):	
TOTAL PC AREA	21.1 acres

NOTE:

1.) ALL DIMENSIONS, GRADES AND LOCATIONS SHOWN ARE TYPICAL.

2.) FINAL DESIGN DIMENSIONS, GRADES AND LOCATIONS TO BE COMPILED IN CONSTRUCTION DRAWINGS AND SUBMITTED TO CDPHE PRIOR TO CONSTRUCTION.

3.) CURRENT CONDITIONS – CELL 1 IS CLOSED; CELL 2 IS ACTIVE; CELL 3 AND 4 ARE NOT CONSTRUCTED (FUTURE)

A 6|6 — DETAIL/SECTION NUMBER; DRAWING No. WHERE DETAIL/SECTION IS REFERENCED; DRAWING No. WHERE DETAIL/SECTION IS SHOWN

SCALE

200' 0 200' 400'

CONTOUR INTERVAL 2' AND 10'

Rev. No.	NOTES	DATE	BY	CHKD
1	REV. CELL 2 VOL/CONT; NEW OWNERSHIP; NOTE 3	9/04	WDS	FK
0	ISSUED FOR PERMIT MOD. REPORT	11/94	JGN	PGC

SCALE:	SEE BAR SCALE
DESIGN BY:	TEL (TERRAMATRIX)
DRAWN BY:	JGN (TERRAMATRIX)
CHECK BY:	PGC (TERRAMATRIX)
PROJECT No.	603
FILE NAME:	DEERTRAIL-5.DWG

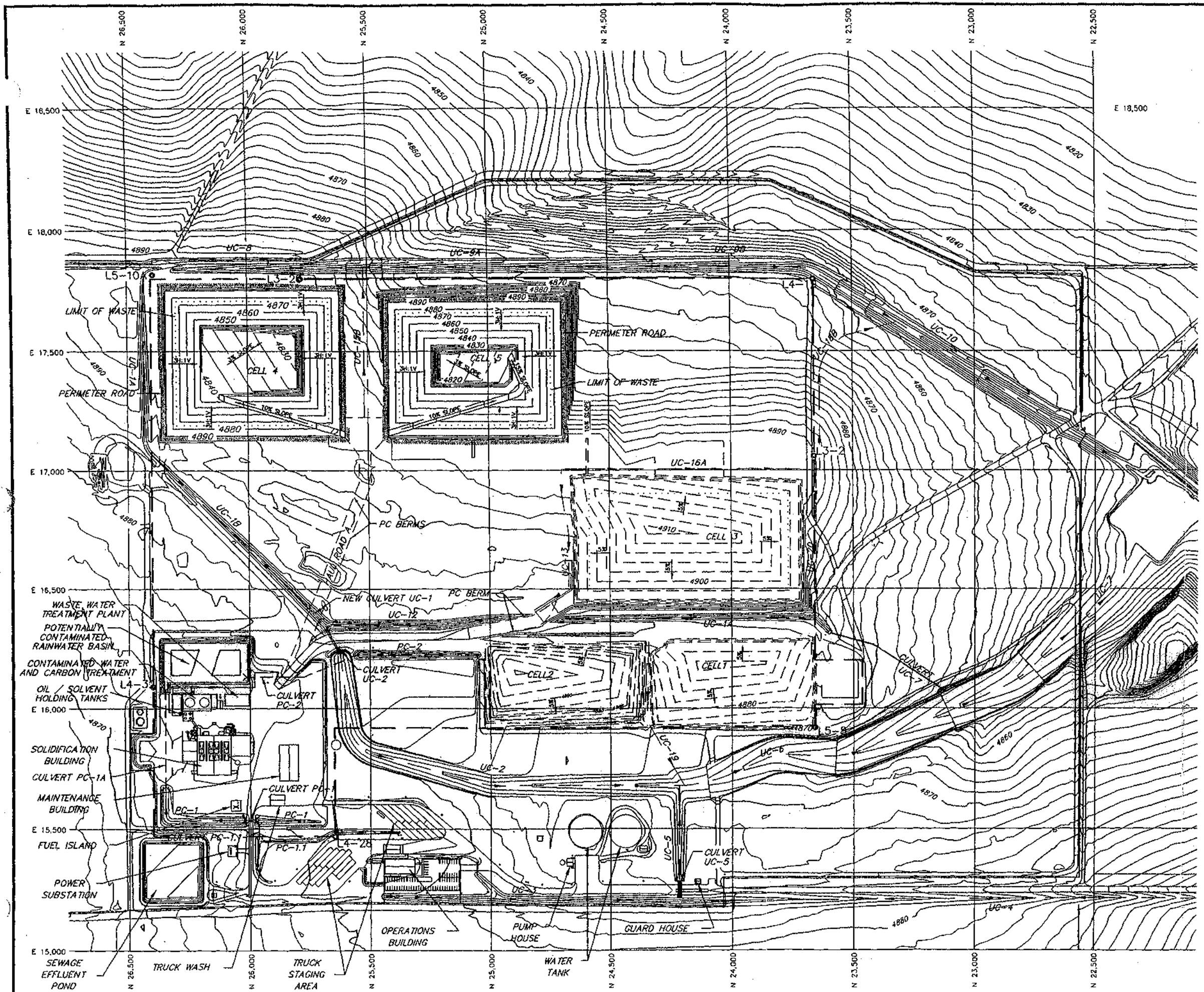
Clean Harbors
DEER TRAIL, LLC.

PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN

DRAWING TITLE: CELL DEVELOPMENT SEQUENCE FILL CELL 3 – CONSTRUCT CELL 4

SHEET: 1 OF 1

DRAWING No.: 5 REV.: 1



LEGEND

- UC-2 — SURFACE WATER DRAINAGE
- FENCE
- 4820 — ELEVATION OF EXISTING GRADE (FEET) (BASED ON 1991 TOPOGRAPHY)
- COMPLIANCE BOUNDARY
- L3-2 BENCH MARK (SEE DRAWING 2)
- 4830 — ELEVATION OF CELL GRADE (FEET)
- 4870 — ELEVATION OF COVER GRADE (FEET)
- WASTE LIMIT
- PC BERM (POTENTIALLY CONTAMINATED)
- CULVERT

APPROXIMATE DESIGN VOLUME:	
CELL 1	173,385 cu.yd.
CELL 2	220,600 cu.yd.
CELL 3	414,300 cu.yd.
CELL 4	424,200 cu.yd.
CELL 5	406,700 cu.yd.
TOTAL	1,639,185 cu.yd.
PC AREA (POTENTIALLY CONTAMINATED):	
TOTAL PC AREA	21.1 acres

NOTE:

1.) ALL DIMENSIONS, GRADES AND LOCATIONS SHOWN ARE TYPICAL.

2.) FINAL DESIGN DIMENSIONS, GRADES AND LOCATIONS TO BE COMPILED IN CONSTRUCTION DRAWINGS AND SUBMITTED TO CDPHE PRIOR TO CONSTRUCTION.

3.) CURRENT CONDITIONS – CELL 1 IS CLOSED; CELL 2 IS ACTIVE; CELL 3 THRU 5 ARE NOT CONSTRUCTED (FUTURE)

SCALE

200' 0 200' 400'

CONTOUR INTERVAL 2' AND 10'

Rev. No.	NOTES	DATE	BY	CHKD
1	REV CELL 2 VOL/CONT; NEW OWNERSHIP; NOTE 3	9/04	WDS	FK
0	ISSUED FOR PERMIT MOD. REPORT	11/94	JGN	PGC

SCALE: SEE BAR SCALE

DESIGN BY: TEL (TERRAMATRIX)

DRAWN BY: JGN (TERRAMATRIX)

CHECK BY: PGC (TERRAMATRIX)

PROJECT No. 603

FILE NAME: DEERTRAIL-6.DWG

Clean Harbors

DEER TRAIL, LLC.

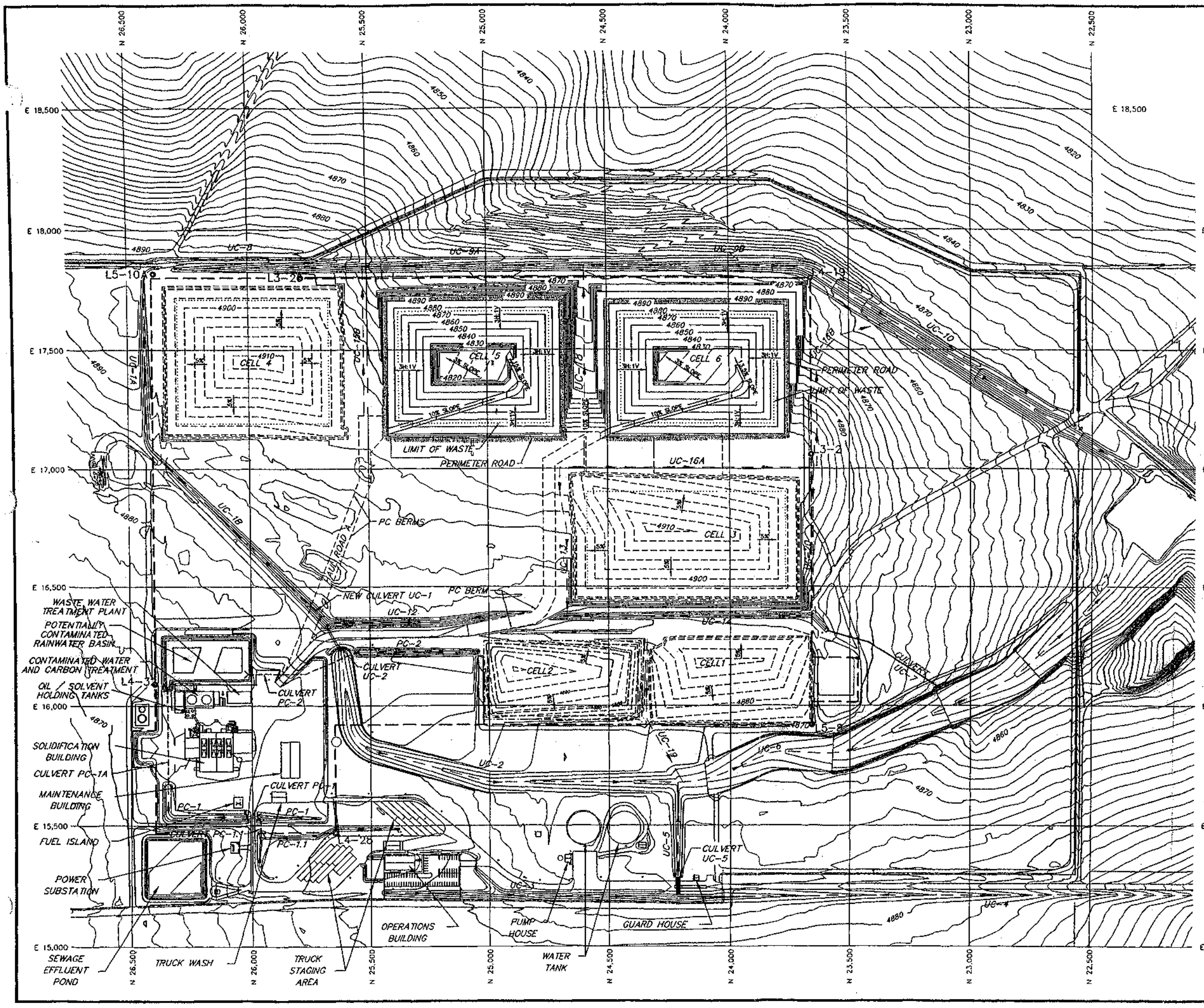
PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN

DRAWING TITLE: CELL DEVELOPMENT SEQUENCE FILL CELL 4 – CONSTRUCT CELL 5

SHEET: 1 OF 1

DRAWING No.: 6

REV. 1



LEGEND

- UC-2 — SURFACE WATER DRAINAGE
- FENCE
- 4820 — ELEVATION OF EXISTING GRADE (FEET) (BASED ON 1991 TOPOGRAPHY)
- COMPLIANCE BOUNDARY
- L3-2 BENCH MARK (SEE DRAWING 2)
- 4830 — ELEVATION OF CELL GRADE (FEET)
- 4870 — ELEVATION OF COVER GRADE (FEET)
- WASTE LIMIT
- PC BERM (POTENTIALLY CONTAMINATED)
- CULVERT

APPROXIMATE DESIGN VOLUME:	
CELL 1	173,385 cu.yd.
CELL 2	220,600 cu.yd.
CELL 3	414,300 cu.yd.
CELL 4	424,200 cu.yd.
CELL 5	406,700 cu.yd.
CELL 6	373,700 cu.yd
TOTAL	2,012,885 cu.yd.
PC AREA (POTENTIALLY CONTAMINATED):	
TOTAL PC AREA	21.8 acres

NOTE:

1.) ALL DIMENSIONS, GRADES AND LOCATIONS SHOWN ARE TYPICAL.

2.) FINAL DESIGN DIMENSIONS, GRADES AND LOCATIONS TO BE COMPILED IN CONSTRUCTION DRAWINGS AND SUBMITTED TO CDPHE PRIOR TO CONSTRUCTION.

3.) CURRENT CONDITIONS – CELL 1 IS CLOSED; CELL 2 IS ACTIVE; CELL 3 THRU 6 ARE NOT CONSTRUCTED (FUTURE)

N

SCALE
200' 0 200' 400'
CONTOUR INTERVAL 2' AND 10'

Rev. No.	NOTES	DATE	BY	CHKD
4				
3				
2				
1	REV CELL 2 VOL/CONT; NEW OWNERSHIP; NOTE 3	9/04	WDS	FK
0	ISSUED FOR PERMIT MOD. REPORT	11/04	JGN	PGC

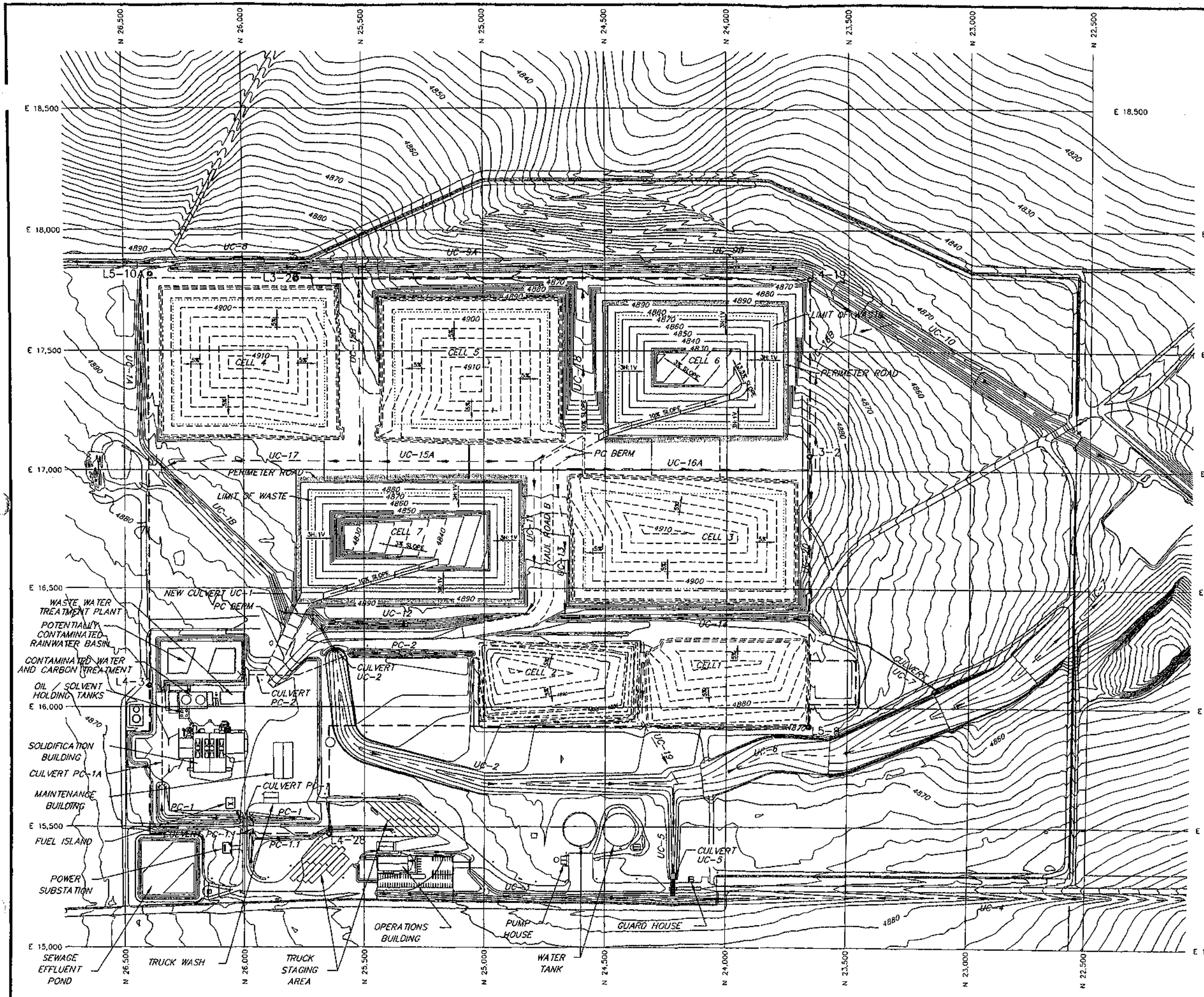
SCALE:	SEE BAR SCALE
DESIGN BY:	TEL (TERRAMATRIX)
DRAWN BY:	JGN (TERRAMATRIX)
CHECK BY:	PGC (TERRAMATRIX)
PROJECT No.	603
FILE NAME:	DEERTRAIL-7.DWG

Clean Harbors
DEER TRAIL, LLC.

PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN

DRAWING TITLE: CELL DEVELOPMENT SEQUENCE
FILL CELL 5 – CONSTRUCT CELL 6

SHEET: 1 OF 1
DRAWING No.: 7
REV. 1



LEGEND

- UC-2 — SURFACE WATER DRAINAGE
- FENCE
- 4820 — ELEVATION OF EXISTING GRADE (FEET) (BASED ON 1991 TOPOGRAPHY)
- COMPLIANCE BOUNDARY
- L3-2 BENCH MARK (SEE DRAWING 2)
- 4830 — ELEVATION OF CELL GRADE (FEET)
- 4870 — ELEVATION OF COVER GRADE (FEET)
- WASTE LIMIT
- PC BERM (POTENTIALLY CONTAMINATED)
- CULVERT

APPROXIMATE DESIGN VOLUME:	
CELL 1	173,385 cu.yd.
CELL 2	220,600 cu.yd.
CELL 3	414,300 cu.yd.
CELL 4	424,200 cu.yd.
CELL 5	406,700 cu.yd.
CELL 6	373,700 cu.yd.
CELL 7	401,760 cu.yd.
TOTAL	2,334,645 cu.yd.
PC AREA (POTENTIALLY CONTAMINATED):	
TOTAL PC AREA	20.4 acres

NOTE:

1.) ALL DIMENSIONS, GRADES AND LOCATIONS SHOWN ARE TYPICAL.

2.) FINAL DESIGN DIMENSIONS, GRADES AND LOCATIONS TO BE COMPILED IN CONSTRUCTION DRAWINGS AND SUBMITTED TO CDPHE PRIOR TO CONSTRUCTION.

3.) CURRENT CONDITIONS – CELL 1 IS CLOSED; CELL 2 IS ACTIVE; CELL 3 THRU 7 ARE NOT CONSTRUCTED (FUTURE)

SCALE

200' 0 200' 400'

CONTOUR INTERVAL 2' AND 10'

Rev. No.	NOTES	DATE	BY	CHKD
1	REV CELL 2 VOL/CONT; NEW OWNERSHIP; NOTE 3	9/04	WDS	FK
0	ISSUED FOR PERMIT MOD. REPORT	11/94	JGN	PGC

SCALE: SEE BAR SCALE
DESIGN BY: TEL (TERRAMATRIX)
DRAWN BY: JGN (TERRAMATRIX)
CHECK BY: PGC (TERRAMATRIX)
PROJECT No. 603
FILE NAME: DEERTRAIL-8.DWG

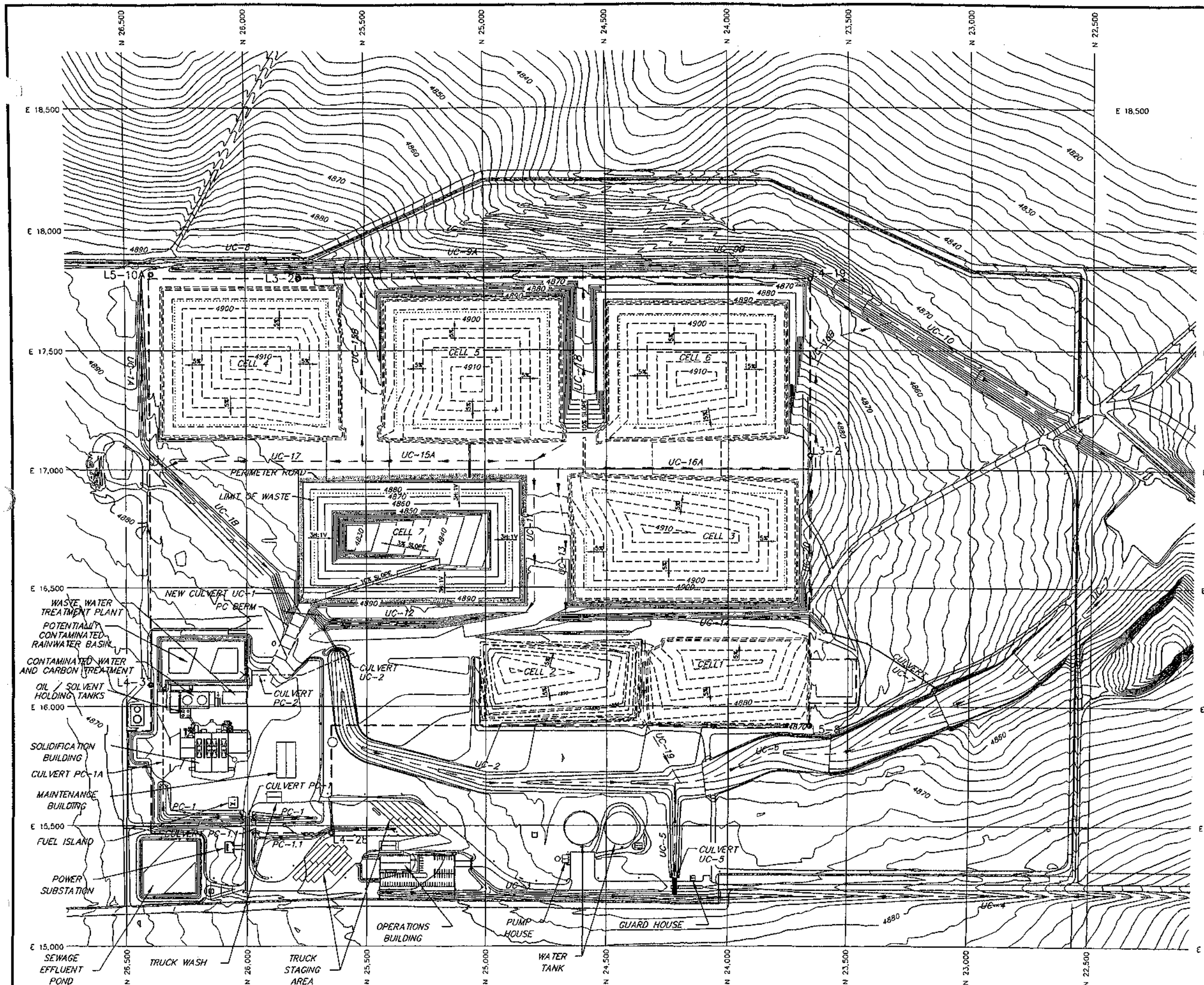
Clean Harbors
DEER TRAIL, LLC.

PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN

DRAWING TITLE: CELL DEVELOPMENT SEQUENCE FILL CELL 6 – CONSTRUCT CELL 7

SHEET: 1 OF 1

DRAWING No.: 8 REV.: 1



LEGEND

- UC-2 — SURFACE WATER DRAINAGE
- FENCE
- 4820 — ELEVATION OF EXISTING GRADE (FEET) (BASED ON 1991 TOPOGRAPHY)
- COMPLIANCE BOUNDARY
- L3-2 BENCH MARK (SEE DRAWING 2)
- 4830 — ELEVATION OF CELL GRADE (FEET)
- 4870 — ELEVATION OF COVER GRADE (FEET)
- WASTE LIMIT
- PC BERM (POTENTIALLY CONTAMINATED)
- CULVERT

APPROXIMATE DESIGN VOLUME:	
CELL 1	173,385 cu.yd.
CELL 2	220,600 cu.yd.
CELL 3	414,300 cu.yd.
CELL 4	424,200 cu.yd.
CELL 5	406,700 cu.yd.
CELL 6	373,700 cu.yd.
CELL 7	401,760 cu.yd.
TOTAL	2,414,645 cu.yd.
PC AREA (POTENTIALLY CONTAMINATED):	
TOTAL PC AREA	18.2 acres

NOTE:

1.) ALL DIMENSIONS, GRADES AND LOCATIONS SHOWN ARE TYPICAL.

2.) FINAL DESIGN DIMENSIONS, GRADES AND LOCATIONS TO BE COMPILED IN CONSTRUCTION DRAWINGS AND SUBMITTED TO CDPHE PRIOR TO CONSTRUCTION.

3.) CURRENT CONDITIONS – CELL 1 IS CLOSED; CELL 2 IS ACTIVE; CELL 3 THRU 7 ARE NOT CONSTRUCTED (FUTURE)

N

SCALE
200' 0 200' 400'
CONTOUR INTERVAL 2' AND 10'

Rev. No.	NOTES	DATE	BY	CHKD
1	REV CELL 2 VOL/CONT; NEW OWNERSHIP; NOTE 3	9/04	WDS	FK
0	ISSUED FOR PERMIT MOD. REPORT	11/94	JGN	PGC

SCALE: SEE BAR SCALE
DESIGN BY: TEL (TERRAMATRIX)
DRAWN BY: JGN (TERRAMATRIX)
CHECK BY: PGC (TERRAMATRIX)
PROJECT No. 603
FILE NAME: DEERTRAIL-9.DWG

Clean Harbors
DEER TRAIL, LLC.

PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN

DRAWING TITLE: CELL DEVELOPMENT SEQUENCE FILL CELL 7

SHEET: 1 OF 1
DRAWING No.: 9
REV. 1

LEGEND

- UC-2 — SURFACE WATER DRAINAGE
- FENCE
- 4820 — ELEVATION OF EXISTING GRADE (FEET) (BASED ON 1991 TOPOGRAPHY)
- COMPLIANCE BOUNDARY
- ⊕L3-2 BENCH MARK (SEE DRAWING 2)
- 4830 — ELEVATION OF CELL GRADE (FEET)
- 4870 — ELEVATION OF COVER GRADE (FEET)
- WASTE LIMIT
- PC BERM (POTENTIALLY CONTAMINATED)
- CULVERT
- DROP STRUCTURE

NOTE:

1.) ALL DIMENSIONS, GRADES AND LOCATIONS SHOWN ARE TYPICAL.

2.) FINAL DESIGN DIMENSIONS, GRADES AND LOCATIONS TO BE COMPILED IN CONSTRUCTION DRAWINGS AND SUBMITTED TO CDPHE PRIOR TO CONSTRUCTION.

3.) CURRENT CONDITIONS – CELL 1 IS CLOSED; CELL 2 IS ACTIVE; CELL 3 THRU 7 ARE NOT CONSTRUCTED (FUTURE)

A/6|6 — DETAIL/SECTION NUMBER; DRAWING No. WHERE DETAIL/SECTION IS REFERENCED; DRAWING No. WHERE DETAIL/SECTION IS SHOWN

SCALE

200' 0 200' 400'

CONTOUR INTERVAL 2' AND 10'

Rev. No	NOTES	DATE	BY	CHKD
4				
3				
2				
1	REV CELL 2 VOL/CONT; NEW OWNERSHIP; NOTE 3	9/04	WDS	FK
0	ISSUED FOR PERMIT MOD. REPORT	11/94	JGN	PGC

SCALE: SEE BAR SCALE
DESIGN BY: TEL (TERRAMATRIX)
DRAWN BY: JGN (TERRAMATRIX)
CHECK BY: PGC (TERRAMATRIX)
PROJECT No. 603
FILE NAME: DEERTRAIL-10.DWG

CleanHarbors
DEER TRAIL, LLC.

PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN

DRAWING TITLE: FINAL CLOSURE CELL DEVELOPMENT SEQUENCE FINAL COVER CELL 7

SHEET: 1 OF 1
DRAWING No.: 10
REV.: 1

LEGEND

- UC-2 — SURFACE WATER DRAINAGE
- FENCE
- 4820 — ELEVATION OF EXISTING GRADE (FEET) (BASED ON 1991 TOPOGRAPHY)
- — — COMPLIANCE BOUNDARY
- ⊗L3-2 BENCH MARK (SEE DRAWING 2)

NOTE:
FOR CELL DETAILS SEE DRAWINGS 4 THRU 10 (CELL DEVELOPMENT SEQUENCE), AND DRAWING 15 (TYPICAL – EXCAVATION PLAN).

DETAIL/SECTION NUMBER

A / 6 | 6

DRAWING No. WHERE DETAIL/SECTION IS REFERENCED

DRAWING No. WHERE DETAIL/SECTION IS SHOWN

N

SCALE

200' 0 200' 400'

CONTOUR INTERVAL 2' AND 10'

Rev. No	NOTES	DATE	BY	CHKD
4				
3				
2				
1	REVISED TO SHOW NEW OWNERSHIP	9/04	WDS	FK
0	ISSUED FOR PERMIT MOD. REPORT	11/94	JGN	PGC

SCALE: SEE BAR SCALE
DESIGN BY: TEL (TERRAMATRIX)
DRAWN BY: JGN (TERRAMATRIX)
CHECK BY: PGC (TERRAMATRIX)
PROJECT No. 603
FILE NAME: DEERTRAIL-11.DWG

CleanHarbors
DEER TRAIL, LLC.

PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN

DRAWING TITLE: EXCAVATION PLAN FOR NEW SITE LAYOUT

SHEET: 1 OF 1
DRAWING No.: 11
REV.: 1

LEGEND

- SURFACE WATER DRAINAGE
- FENCE
- 4850 ELEVATION OF EXISTING GRADE (FEET) (BASED ON 1991 TOPOGRAPHY)
- COMPLIANCE BOUNDARY
- ⊙L3-2 BENCH MARK
- 4830 ELEVATION OF CELL GRADE (FEET)
- LIMIT OF FILL
- 4820 ELEVATION OF STOCKPILE GRADE (FEET)

NOTE:

1.) ALL DIMENSIONS, GRADES AND LOCATIONS SHOWN ARE TYPICAL.

2.) FINAL DESIGN DIMENSIONS, GRADES AND LOCATIONS TO BE COMPILED IN CONSTRUCTION DRAWINGS AND SUBMITTED TO CDPHE PRIOR TO CONSTRUCTION.

2.) STOCKPILE CAPACITY TABLE WAS PREPARED ON NOV. 1994 AND MAY NOT ACCURATELY REFLECT PRESENT CAPACITY

STOCKPILE CAPACITY TABLE	
AREA	VOLUME
A	957,700 cy
B	256,900 cy

STOCKPILE A

STOCKPILE B

CELL 1

CELL 2

CELL 3

CELL 4

CELL 5

CELL 6

CELL 7

NOTE:
FOR CELL DETAIL SEE DRAWINGS 4 THRU 10 (CELL DEVELOPMENT SEQUENCE), AND DRAWING 15 (TYPICAL - / EXCAVATION PLAN).

POTENTIALLY CONTAMINATED RAINWATER BASIN

SOLIDIFICATION BUILDING

MAINTENANCE BUILDING

FUEL ISLAND

POWER SUBSTATION

SEWAGE EFFLUENT POND

TRUCK WASH

TRUCK STAGING AREA

OPERATIONS BUILDING

PUMP HOUSE

WATER TANK

GUARD HOUSE

SCALE

250' 0 250' 500'

CONTOUR INTERVAL 2'

Rev. No	NOTES	DATE	BY	CHKD
4				
3				
2				
1	REVISED TO SHOW NEW OWNERSHIP	9/04	WDS	FK
0	ISSUED FOR PERMIT MOD. REPORT	11/94	JGN	PGC

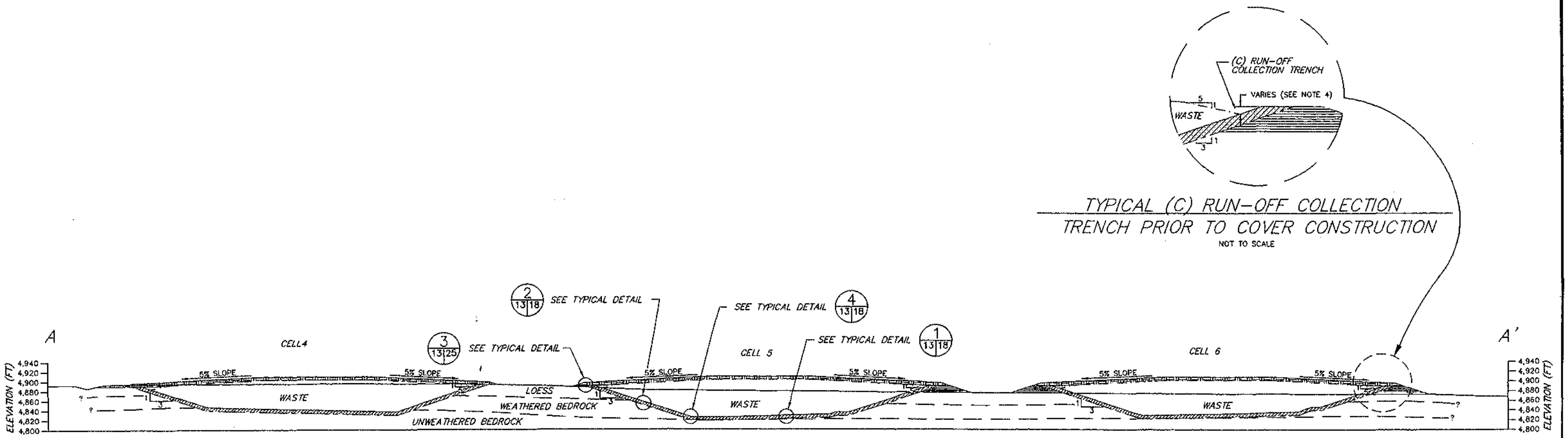
SCALE: SEE BAR SCALE
DESIGN BY: TEL (TERRAMATRIX)
DRAWN BY: JGN (TERRAMATRIX)
CHECK BY: PGC (TERRAMATRIX)
PROJECT No. 603
FILE NAME: DEERTRAIL-12.DWG

CleanHarbors
DEER TRAIL, LLC.

PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN

DRAWING TITLE: TYPICAL STOCKPILE LOCATION MAP

SHEET: 1 OF 1
DRAWING No.: 12
REV. 1



NORTH -- SOUTH CROSS-SECTION (A 0,1|13)

HORIZONTAL SCALE
0 100' 200'

VERTICAL SCALE
0 100' 200'

LEGEND

- EXISTING GRADE
- TOP OF WASTE
- SUBGRADE
- LINER LAYER
- COVER LAYER
- FILL
- CUT

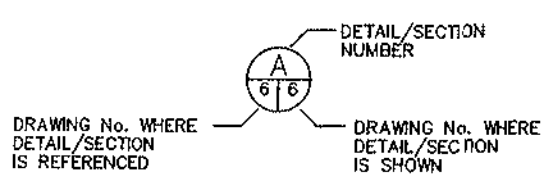
NOTES:

1.) CONTACT BETWEEN LOESS / WEATHERED BEDROCK AND WEATHERED BEDROCK / UNWEATHERED BEDROCK IS BASED ON ISOPACH MAPS PRODUCED FROM REVIEW OF ALL BORINGS COMPLETED AT THE SITE. ACTUAL LIMITS MAY VARY FROM THOSE SHOWN.

2.) ALL DIMENSIONS, GRADES AND LOCATIONS SHOWN ARE TYPICAL

3.) FINAL DESIGN DIMENSIONS, GRADES AND LOCATIONS TO BE COMPILED IN DESIGN CONSTRUCTION DRAWINGS AND SUBMITTED TO CDPHE PRIOR TO CONSTRUCTION.

4.) DIMENSION VARIES TO MAINTAIN STORAGE CAPACITY OF RUN-OFF FROM 24 HOUR 8.2 INCH RAIN FALL WITH 1-INCH OF FREEBOARD AS REQUIRED BY SECTION I (D)(9)(a) OF PART B PERMIT. CONTAMINATED WATER STORAGE DITCH MAY BE FILLED WITH WASTE AS COVER IS CONSTRUCTED AND DRAINAGE AREA REDUCED.

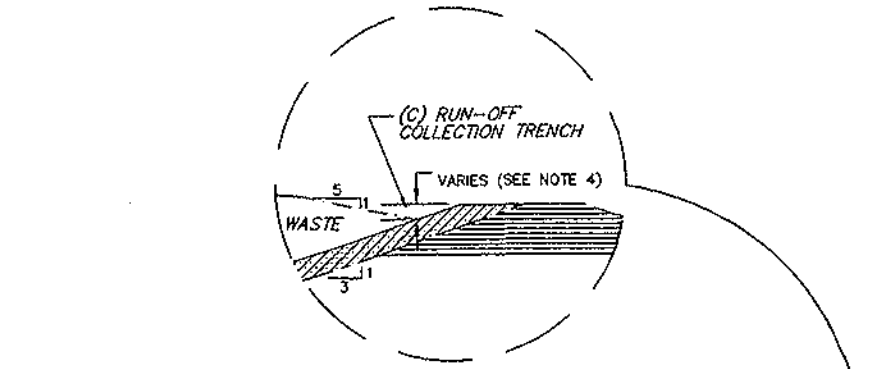


Rev. No	NOTES	DATE	BY	CHKD
4				
3				
2				
1	REVISED TO SHOW NEW OWNERSHIP	9/04	WDS	FK
0	ISSUED FOR PERMIT MOD. REPORT	11/94	JGN	PGC

SCALE: SEE BAR SCALE	Clean Harbors DEER TRAIL, LLC.
DESIGN BY: TEL (TERRAMATRIX)	
DRAWN BY: JGN (TERRAMATRIX)	
CHECK BY: PGC (TERRAMATRIX)	PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN
PROJECT No. 603	DRAWING TITLE: NORTH-SOUTH CROSS-SECTION
FILE NAME: DEERTRAIL-13.DWG	

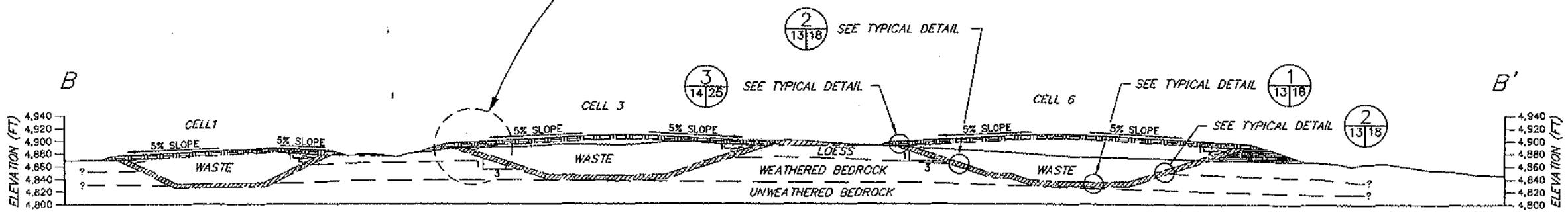
SHEET: 1 OF 1

DRAWING No.: 13 | REV.: 1



TYPICAL (C) RUN-OFF COLLECTION TRENCH PRIOR TO COVER CONSTRUCTION

NOT TO SCALE



EAST - WEST CROSS-SECTION (B / 10,1 / 14)

HORIZONTAL SCALE
0 100' 200'

VERTICAL SCALE
0 100' 200'

LEGEND

- EXISTING GRADE
- TOP OF WASTE
- SUBGRADE
- LINER LAYER
- COVER LAYER
- FILL
- CUT

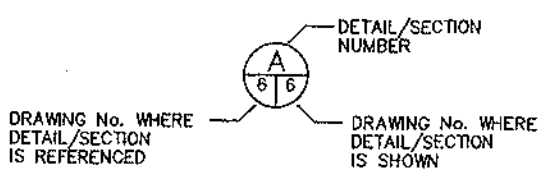
NOTES:

1.) CONTACT BETWEEN LOESS / WEATHERED BEDROCK AND WEATHERED BEDROCK / UNWEATHERED BEDROCK IS BASED ON ISOPACH MAPS PRODUCED FROM REVIEW OF ALL BORINGS COMPLETED AT THE SITE. ACTUAL LIMITS MAY VARY FROM THOSE SHOWN.

2.) ALL DIMENSIONS, GRADES AND LOCATIONS SHOWN ARE TYPICAL

3.) FINAL DESIGN DIMENSIONS, GRADES AND LOCATIONS TO BE COMPILED IN DESIGN CONSTRUCTION DRAWINGS AND SUBMITTED TO CDPHE PRIOR TO CONSTRUCTION.

4.) DIMENSION VARIES TO MAINTAIN STORAGE CAPACITY OF RUN-OFF FROM 24 HOUR 8.2 INCH RAIN FALL WITH 1-INCH OF FREEBOARD AS REQUIRED BY SECTION I (D)(9)(a) OF PART B PERMIT. CONTAMINATED WATER STORAGE DITCH MAY BE FILLED WITH WASTE AS COVER IS CONSTRUCTED AND DRAINAGE AREA REDUCED.

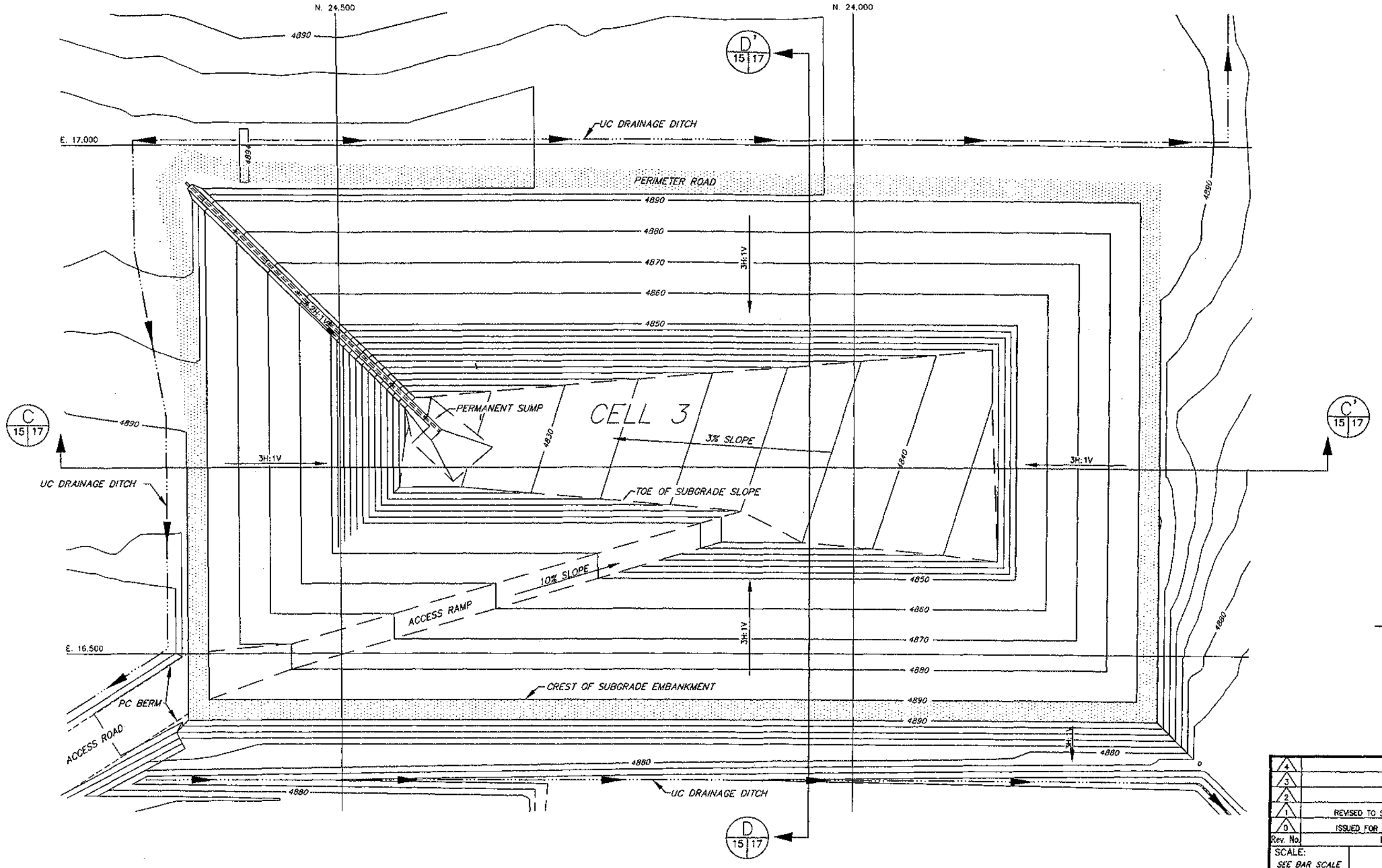


Rev. No	NOTES	DATE	BY	CHKD
4				
3				
2				
1	REVISED TO SHOW NEW OWNERSHIP	9/04	WDS	FK
0	ISSUED FOR PERMIT MOD. REPORT	11/94	JGN	PGC

SCALE: SEE BAR SCALE	Clean Harbors DEER TRAIL, LLC.
DESIGN BY: TEL (TERRAMATRIX)	
DRAWN BY: JGN (TERRAMATRIX)	
CHECK BY: PGC (TERRAMATRIX)	PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN
PROJECT No. 603	DRAWING TITLE: EAST-WEST CROSS-SECTION
FILE NAME: DEERTRAIL-14.DWG	

SHEET: 1 OF 1

DRAWING No.: 14 REV. 1



LEGEND

- 4890 — ELEVATION OF CELL GRADE (FEET)
- 4880 — ELEVATION OF EXISTING GRADE (FEET)
- PC BERM (POTENTIALLY CONTAMINATED)
- UC DRAINAGE DITCH (UNCONTAMINATED)
- LIMITS OF CONSTRUCTION
- GRADE BREAK

NOTES:

1.) GRADING PLANS INDICATE 90 DEGREE CORNERS. FINAL DESIGN MAY INCORPORATE UNIFORM RADIUS CORNERS.

2.) ALL DIMENSIONS, GRADES AND LOCATIONS SHOWN ARE TYPICAL

3.) FINAL DESIGN DIMENSIONS, GRADES AND LOCATIONS TO BE COMPILED IN DESIGN CONSTRUCTION DRAWINGS AND SUBMITTED TO CDPHE PRIOR TO CONSTRUCTION.

A / 6 6 — DETAIL/SECTION NUMBER; DRAWING No. WHERE DETAIL/SECTION IS REFERENCED; DRAWING No. WHERE DETAIL/SECTION IS SHOWN

N

SCALE
50' 0 50' 100'
CONTOUR INTERVAL 2'

Rev. No.	NOTES	DATE	BY	CHKD
4				
3				
2				
1	REVISED TO SHOW NEW OWNERSHIP	9/04	WOS	FK
0	ISSUED FOR PERMIT MOD. REPORT	11/94	JGN	PGC

SCALE: SEE BAR SCALE
DESIGN BY: TEL (TERRAMATRIX)
DRAWN BY: JGN (TERRAMATRIX)
CHECK BY: PGC (TERRAMATRIX)
PROJECT No. 603
FILE NAME: DEERTRAIL-15.DWG

Clean Harbors
DEER TRAIL, LLC.

PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN
DRAWING TITLE: TYPICAL EXCAVATION PLAN

SHEET: 1 OF 1
DRAWING No.: 15
REV. 1

N. 24,500

N. 24,000

TYPICAL RISER AND CLEANOUT PIPES SEE DETAIL 12 (16|20)

4895

D' (16|17)

TYPICAL CLEANOUT PIPE SEE DETAIL 10 (16|19)

E. 17,000

UC DRAINAGE DITCH

EXTEND TRENCH TO PRIMARY GEOCOMPOSITE DRAINAGE LAYER

WASTE LIMITS

5%

TYPICAL GAS VENT SEE DETAIL 5 (16|25)

4910

C (16|17)

4890

CELL 3

5%

5%

UC DRAINAGE DITCH

C' (16|17)

UC DRAINAGE DITCH

TYPICAL GAS VENT TRENCH SEE DETAIL 24 (16|25)

APPROXIMATELY 200.0'

5%

TYPICAL CLEANOUT PIPE SEE DETAIL 10 (16|19)

4900

E. 16,500

PC BERMS

3H:1V

4890

3H:1V

4880

UC DRAINAGE DITCH

TYPICAL CLEANOUT PIPE SEE DETAIL 10 (16|19)

D (16|17)

LEGEND

- 4890 — ELEVATION OF CELL GRADE (FEET)
- 4870 — ELEVATION OF COVER GRADE (FEET)
- WASTE LIMIT
- PC BERM (POTENTIALLY CONTAMINATED)
- UC DRAINAGE DITCH (UNCONTAMINATED)
- 4880 — ELEVATION OF EXISTING GRADE (FEET)
- GRADE BREAK LINE
- GAS VENT TRENCH (APPROX. LOCATION)
- GAS VENT (APPROX. LOCATION)

NOTES:

1.) GRADING PLANS INDICATE 90 DEGREE CORNERS. FINAL DESIGN MAY INCORPORATE UNIFORM RADIUS CORNERS.

2.) ALL DIMENSIONS, GRADES AND LOCATIONS SHOWN ARE TYPICAL

3.) FINAL DESIGN DIMENSIONS, GRADES AND LOCATIONS TO BE COMPILED IN DESIGN CONSTRUCTION DRAWINGS AND SUBMITTED TO CDPHE PRIOR TO CONSTRUCTION.

A (6|6) — DETAIL/SECTION NUMBER; DRAWING No. WHERE DETAIL/SECTION IS REFERENCED; DRAWING No. WHERE DETAIL/SECTION IS SHOWN

N

SCALE

50' 0 50' 100'

CONTOUR INTERVAL 2'

Rev. No	NOTES	DATE	BY	CHKD
4				
3				
2				
1	REVISED TO SHOW NEW OWNERSHIP	9/04	WDS	FK
0	ISSUED FOR PERMIT MOD. REPORT	11/94	JGN	PGC

SCALE: SEE BAR SCALE

DESIGN BY: TEL (TERRAMATRIX)

DRAWN BY: JGN (TERRAMATRIX)

CHECK BY: PGC (TERRAMATRIX)

PROJECT No. 603

FILE NAME: DEERTRAIL-16A.DWG

CleanHarbors DEER TRAIL, LLC.

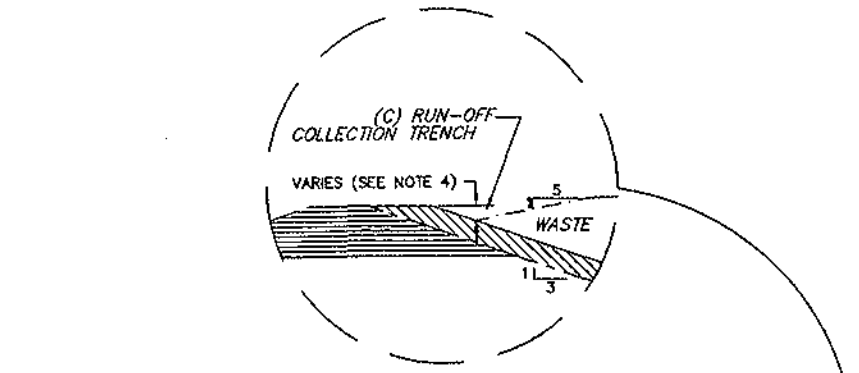
PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN

DRAWING TITLE: TYPICAL – FILLING PLAN AND DETAILS

SHEET: 1 OF 3

DRAWING No.: 16

REV. 1



TYPICAL (C) RUN-OFF COLLECTION TRENCH PRIOR TO COVER CONSTRUCTION

NOT TO SCALE

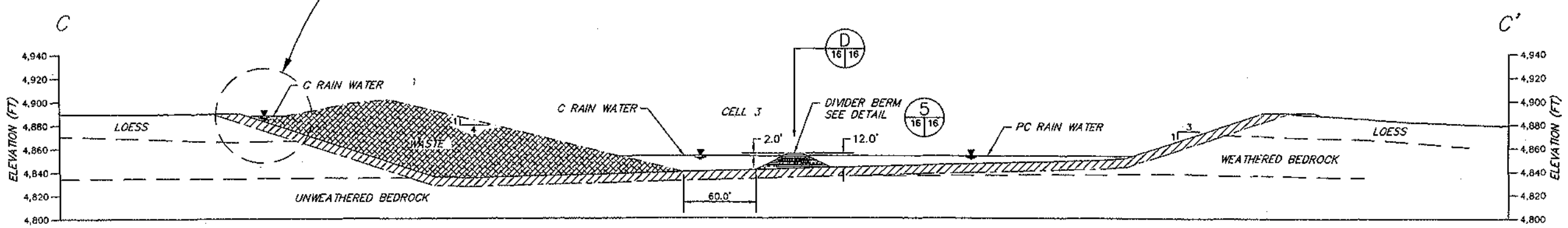
NOTES:

(1) TYPICAL DIVIDER BERM IS SHOWN TO SEGREGATE PC AND C WATER WITHIN ACTIVE CELLS. THE LOCATION OF THE BERM CAN BE VARIED TO MEET OPERATIONAL REQUIREMENTS PROVIDED ADEQUATE STORAGE CAPACITY IS AVAILABLE.

(2) A FILLING PLAN FOR EACH SECURE CELL WILL BE DEVELOPED AS PART OF THE CONSTRUCTION DRAWING PREPARATION. THIS FILLING PLAN WILL INCORPORATE OPERATIONAL REQUIREMENTS, STABILITY CONSTRAINTS AND SURFACE WATER CONTROL FEATURES.

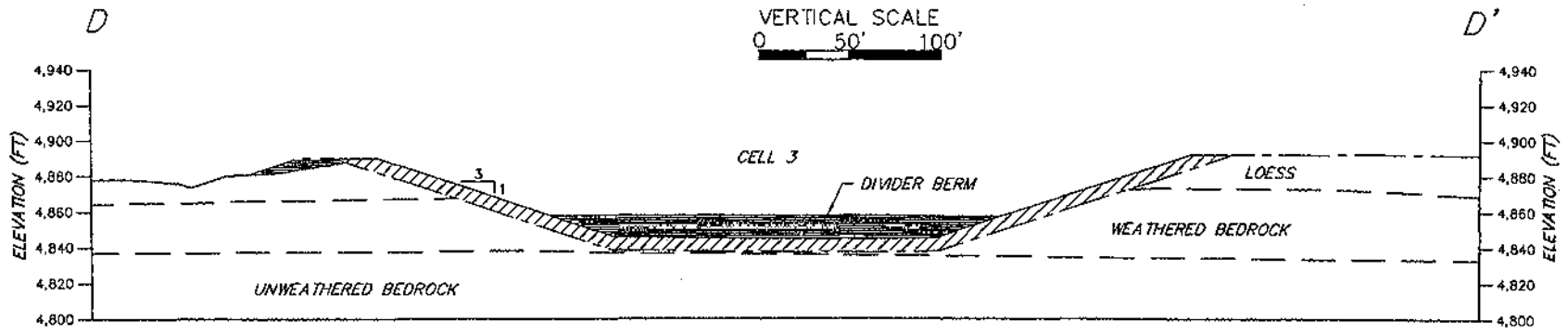
(3) CONTACT BETWEEN LOESS/WEATHERED BEDROCK AND WEATHERED BEDROCK/ UNWEATHERED BEDROCK IS BASED ON ISOPACH MAPS PRODUCED FROM REVIEW OF ALL BORINGS COMPLETED AT THE SITE, ACTUAL LIMITS MAY VARY FROM THOSE SHOWN.

4.) DIMENSION VARIES TO MAINTAIN STORAGE CAPACITY OF RUN-OFF FROM 24 HOUR 8.2 INCH RAIN FALL WITH 1-INCH OF FREEBOARD AS REQUIRED BY SECTION I (D)(9)(a) OF PART B PERMIT. CONTAMINATED WATER STORAGE DITCH MAY BE FILLED WITH WASTE AS COVER IS CONSTRUCTED AND DRAINAGE AREA REDUCED.



TYPICAL INTERMEDIATE FILLING PLAN CROSS-SECTION WITH DIVIDER BERM C 16|16

HORIZONTAL SCALE
0 50' 100'
VERTICAL SCALE
0 50' 100'



TYPICAL INTERMEDIATE FILLING PLAN CROSS-SECTION WITH DIVIDER BERM D 16|16

HORIZONTAL SCALE
0 50' 100'
VERTICAL SCALE
0 50' 100'

LEGEND

- EXISTING GRADE
- TOP OF WASTE
- SUBGRADE
- LINER LAYER
- WASTE
- FILL

A 6|6 — DETAIL/SECTION NUMBER; DRAWING No. WHERE DETAIL/SECTION IS REFERENCED; DRAWING No. WHERE DETAIL/SECTION IS SHOWN

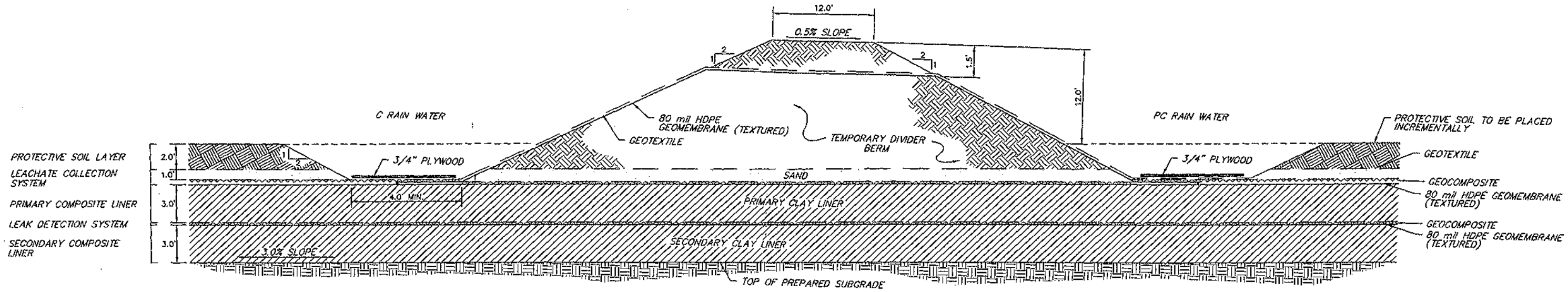
Rev. No.	NOTES	DATE	BY	CHKD
4				
3				
2				
1	REVISED TO SHOW NEW OWNERSHIP	9/04	WDS	FK
0	ISSUED FOR PERMIT MOD. REPORT	11/94	JGN	PGC

SCALE: SEE BAR SCALE
DESIGN BY: TEL (TERRAMATRIX)
DRAWN BY: JGN (TERRAMATRIX)
CHECK BY: PGC (TERRAMATRIX)
PROJECT No. 603
FILE NAME: DEERTRAIL-16B.DWG

Clean Harbors
DEER TRAIL, LLC.

PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN
DRAWING TITLE: TYPICAL - FILLING PLAN AND DETAILS

SHEET: 2 OF 3
DRAWING No.: 16
REV. 1



TEMPORARY DIVIDER BERM DETAIL

NOT TO SCALE

5 / 16 | 16

NOTE:

1.) HEIGHT OF TEMPORARY DIVIDER BERM MAY VARY DEPENDING ON LOCATION IN CELL.

2.) BERM AND TEMPORARY LINER SYSTEM WILL BE REMOVED PRIOR TO FILLING.

3.) SEE ADDITIONAL NOTES ON DRAWING 16, SHEET 2 OF 3

A / 6 | 6 — DETAIL/SECTION NUMBER; DRAWING No. WHERE DETAIL/SECTION IS REFERENCED; DRAWING No. WHERE DETAIL/SECTION IS SHOWN

Rev. No.	NOTES	DATE	BY	CHKD
4				
3				
2				
1	REVISED TO SHOW NEW OWNERSHIP	9/04	WDS	PK
0	ISSUED FOR PERMIT MOD. REPORT	11/94	JGN	PGC

SCALE: SEE BAR SCALE

DESIGN BY: TEL (TERRAMATRIX)

DRAWN BY: JGN (TERRAMATRIX)

CHECK BY: PGC (TERRAMATRIX)

PROJECT No. 603

FILE NAME: DEERTRAIL-16C.DWG

CleanHarbors
DEER TRAIL, LLC.

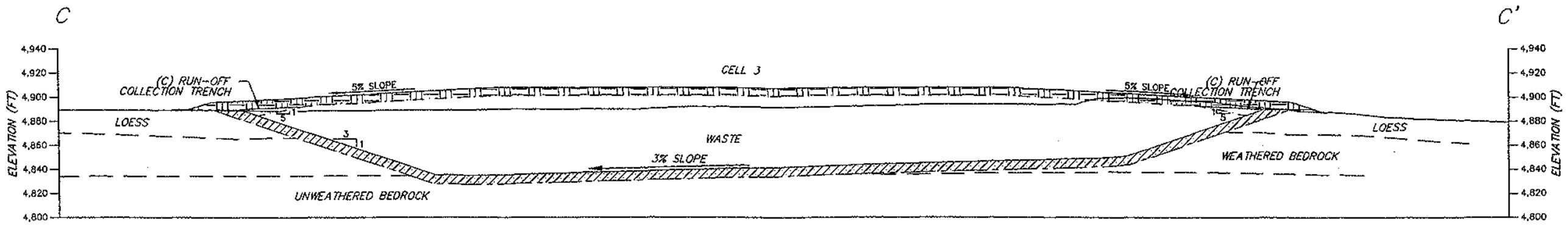
PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN

DRAWING TITLE: TYPICAL – FILLING PLAN AND DETAILS

SHEET: 3 OF 3

DRAWING No.: 16

REV.: 1

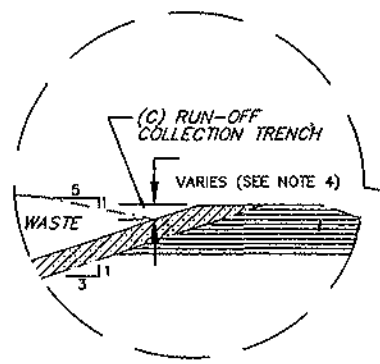


TYPICAL CROSS-SECTION C

10,11,15,1617

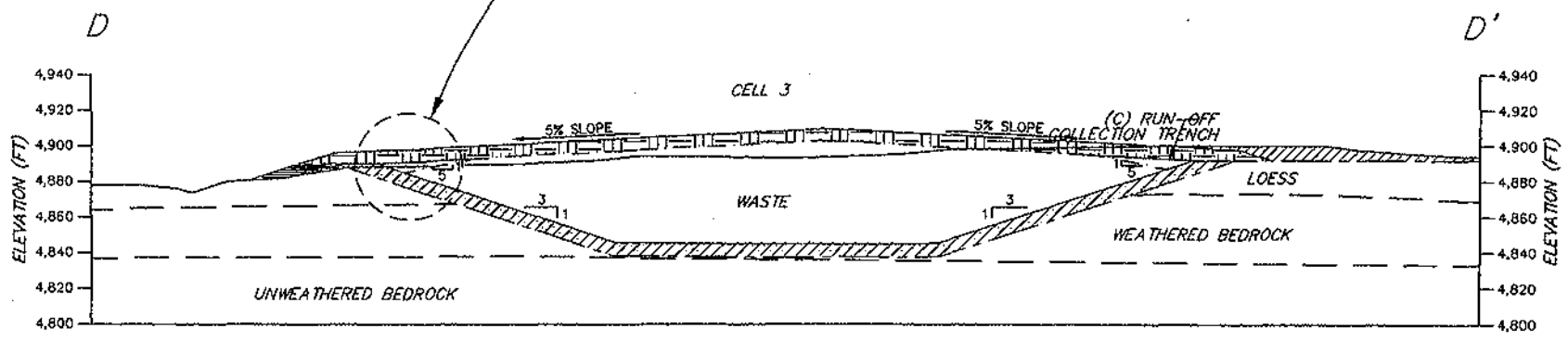
HORIZONTAL SCALE
0 50' 100'

VERTICAL SCALE
0 50' 100'



TYPICAL (C) RUN-OFF COLLECTION TRENCH PRIOR TO COVER CONSTRUCTION

NOT TO SCALE



TYPICAL CROSS-SECTION D

10,11,15,1617

HORIZONTAL SCALE
0 50' 100'

VERTICAL SCALE
0 50' 100'

LEGEND

- EXISTING GRADE
- TOP OF WASTE
- SUBGRADE
- LINER LAYER
- COVER LAYER
- FILL
- CUT

NOTES:

1.) CONTACT BETWEEN LOESS / WEATHERED BEDROCK AND WEATHERED BEDROCK / UNWEATHERED BEDROCK IS BASED ON ISOPACH MAPS PRODUCED FROM REVIEW OF ALL BORINGS COMPLETED AT THE SITE. ACTUAL LIMITS MAY VARY FROM THOSE SHOWN.

2.) ALL DIMENSIONS, GRADES AND LOCATIONS SHOWN ARE TYPICAL.

3.) FINAL DESIGN DIMENSIONS, GRADES AND LOCATIONS TO BE COMPILED IN DESIGN CONSTRUCTION DRAWINGS AND SUBMITTED TO CDPHE PRIOR TO CONSTRUCTION.

4.) DIMENSION VARIES TO MAINTAIN STORAGE CAPACITY OF RUN-OFF FROM 24 HOUR 8.2 INCH RAIN FALL WITH 1-INCH OF FREEBOARD AS REQUIRED BY SECTION I (D)(9)(a) OF PART B PERMIT. CONTAMINATED WATER STORAGE DITCH MAY BE FILLED WITH WASTE AS COVER IS CONSTRUCTED AND DRAINAGE AREA REDUCED.

DETAIL/SECTION NUMBER

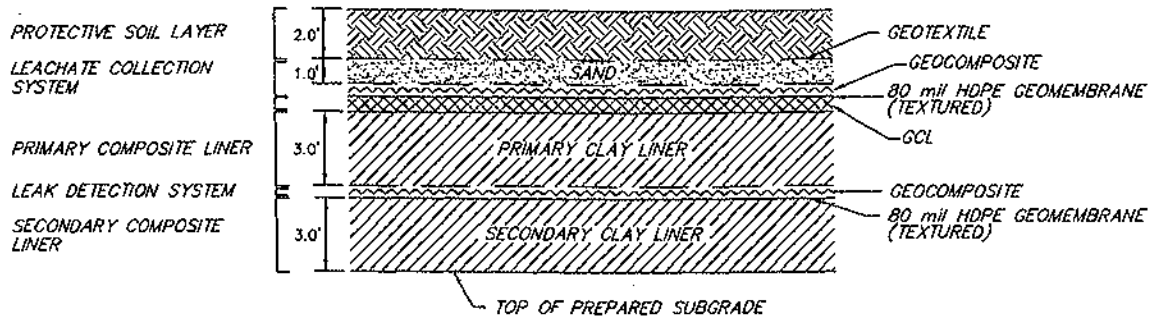
A
6 | 6

DRAWING No. WHERE DETAIL/SECTION IS REFERENCED

DRAWING No. WHERE DETAIL/SECTION IS SHOWN

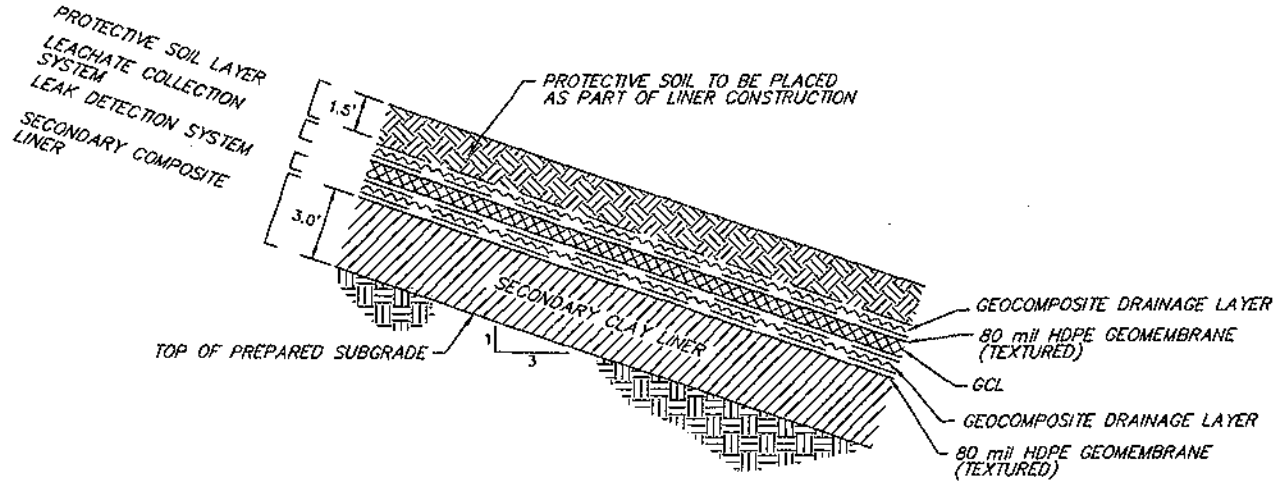
Rev. No.	NOTES	DATE	BY	CHKD
4				
3				
2				
1	REVISED TO SHOW NEW OWNERSHIP	9/04	WDS	FK
0	ISSUED FOR PERMIT MOD. REPORT	11/94	JGN	PGC

SCALE: SEE BAR SCALE	Clean Harbors DEER TRAIL, LLC.
DESIGN BY: TEL (TERRAMATRIX)	
DRAWN BY: JGN (TERRAMATRIX)	
CHECK BY: PGC (TERRAMATRIX)	PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN
PROJECT No. 603	DRAWING TITLE: TYPICAL CELL CROSS-SECTION
FILE NAME: DEERTRAIL-17.DWG	SHEET: 1 OF 1
	DRAWING No.: 17 REV.: 1



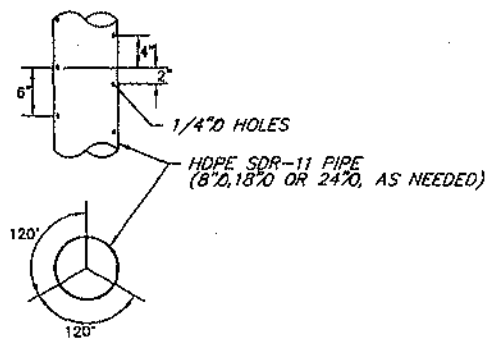
TYPICAL BASE LINING SYSTEM DETAIL (1 / 13 | 18)

SCALE IN FEET: 0 — 4'



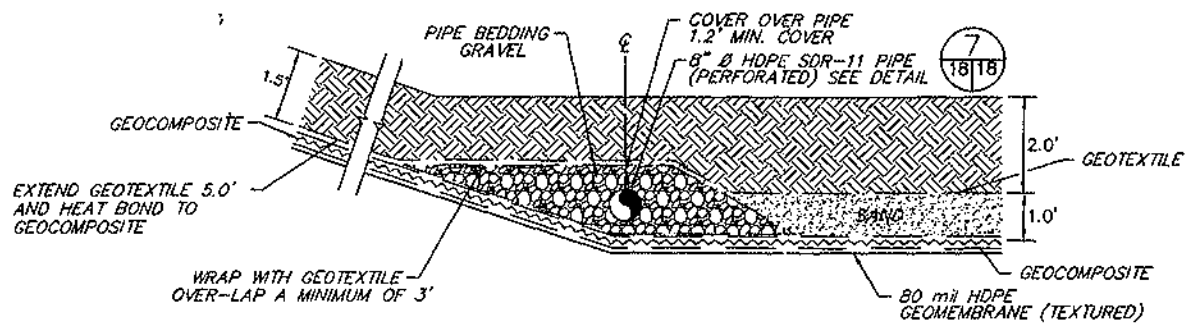
TYPICAL SIDESLOPE LINING SYSTEM DETAIL (2 / 13 | 18)

SCALE IN FEET: 0 — 4'



TYPICAL PIPE PERFORATION DETAIL (7 / 18 | 18)

NOT TO SCALE
(SEE NOTE 4)



TYPICAL LEACHATE COLLECTION SYSTEM PIPE OR GEONET FLUSH PIPE AND BEDDING GRAVEL (6 / 18 | 18)

SCALE IN FEET: 0 — 2'

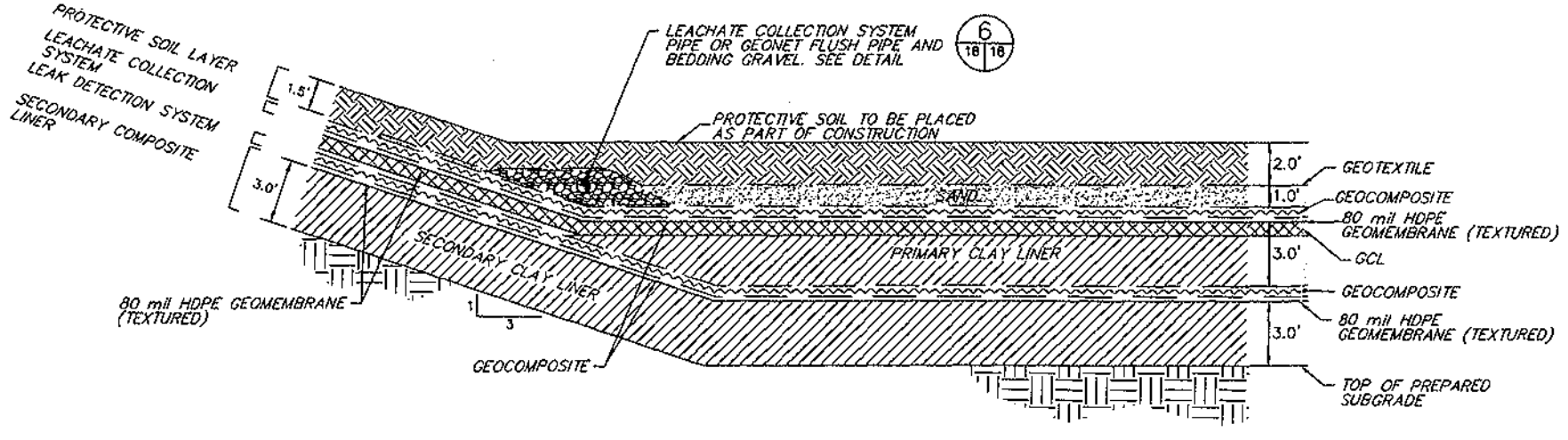
NOTES:

1.) DETAILS ARE SHOWN TO THE SCALE NOTED EXCEPT FOR THE GEOSYNTHETICS; THESE ARE SHOWN AT AN EXAGGERATED SCALE FOR CLARITY.

2.) MATERIAL SPECIFICATIONS ARE PROVIDED IN THE GENERAL SPECIFICATIONS AND THE SUPPLEMENTAL SPECIFICATIONS.

3.) PERFORATIONS SHALL CONSIST OF THREE ROWS OF HOLES 1/4" IN DIAMETER AT 6" CENTERS WITH ALLOWABLE TOLERANCE OF 1/16" ON THE DIAMETER AND 1/4" ON THE SPACING. THE ROWS SHALL BE PARALLEL TO THE AXIS OF THE PIPE AND SET 120 DEGREES PLUS OR MINUS 5 DEGREES APART. THE HOLES OF EACH ROW SHALL BE OFFSET FROM THE HOLES OF THE OTHER ROWS BY 2".

4.) ALL DIMENSIONS ARE TYPICAL (EXCEPT SOIL LINER THICKNESS) AND COULD VARY IN FINAL DESIGN CONSTRUCTION DRAWINGS.



TYPICAL TOE OF SLOPE DETAIL (4 / 13 | 18)

SCALE IN FEET: 0 — 4'
(SEE NOTE 1,2 AND 3)

DETAIL/SECTION NUMBER: A (6 / 6)
DRAWING No. WHERE DETAIL/SECTION IS REFERENCED
DRAWING No. WHERE DETAIL/SECTION IS SHOWN

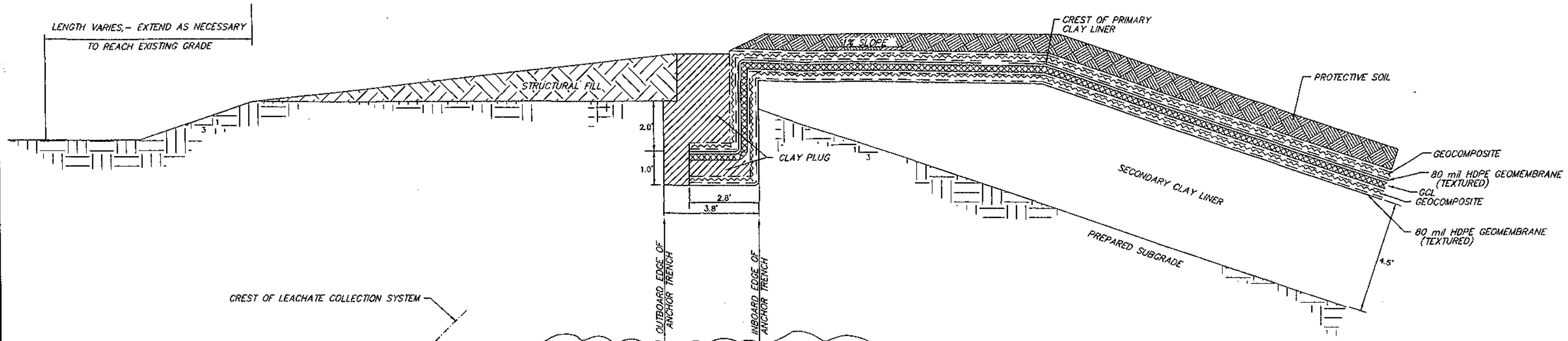
Rev. No.	NOTES	DATE	BY	CHKD
4				
3				
2				
1	REVISED TO SHOW NEW OWNERSHIP	9/04	WDS	FK
0	ISSUED FOR PERMIT MOD. REPORT	11/94	JGN	PGC

SCALE: SEE BAR SCALE
DESIGN BY: TEL (TERRAMATRIX)
DRAWN BY: JGN (TERRAMATRIX)
CHECK BY: PGC (TERRAMATRIX)
PROJECT No. 603
FILE NAME: DEERTRAIL-18.DWG

CleanHarbors
DEER TRAIL, LLC.

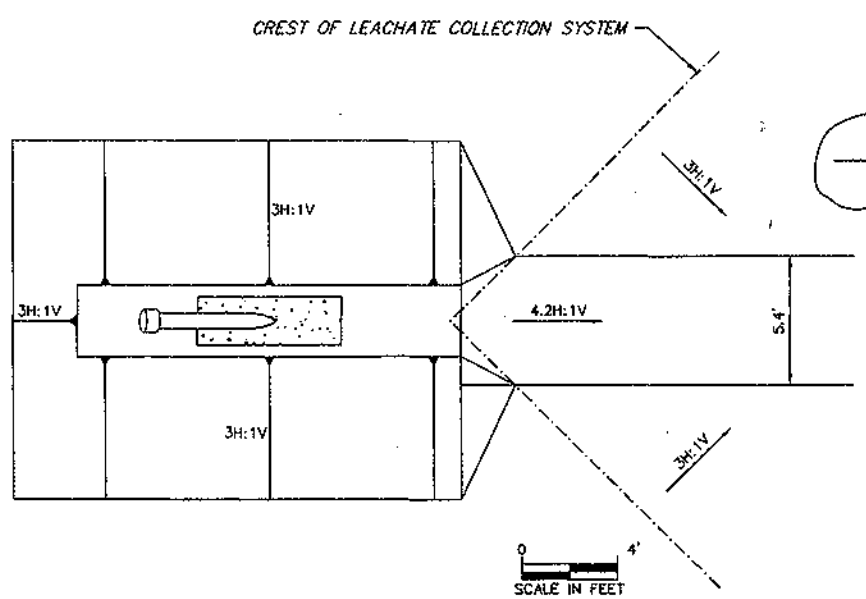
PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN
DRAWING TITLE: TYPICAL LINER SYSTEM DETAILS

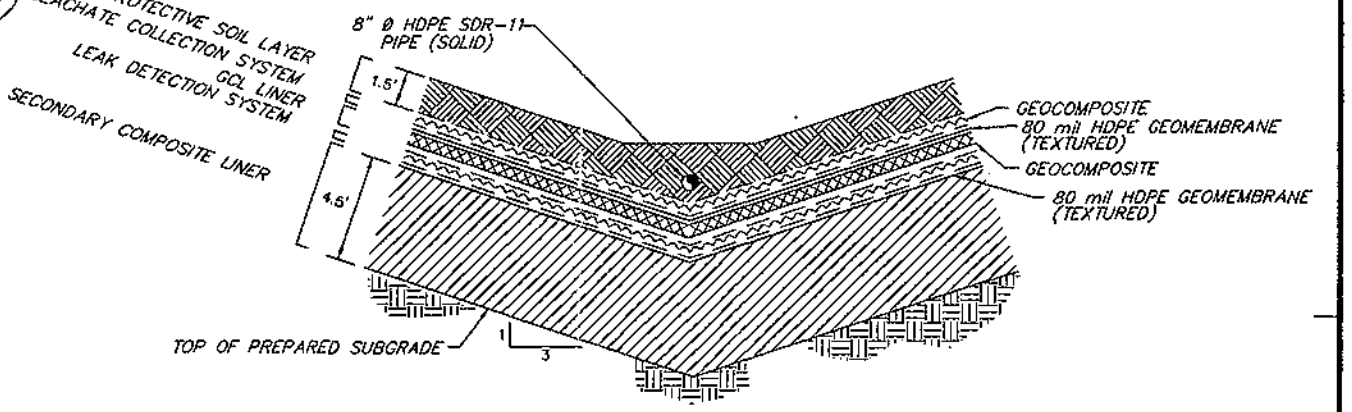
SHEET: 1 OF 1
DRAWING No.: 18
REV.: 1



TYPICAL ANCHOR TRENCH DETAIL (8/19)

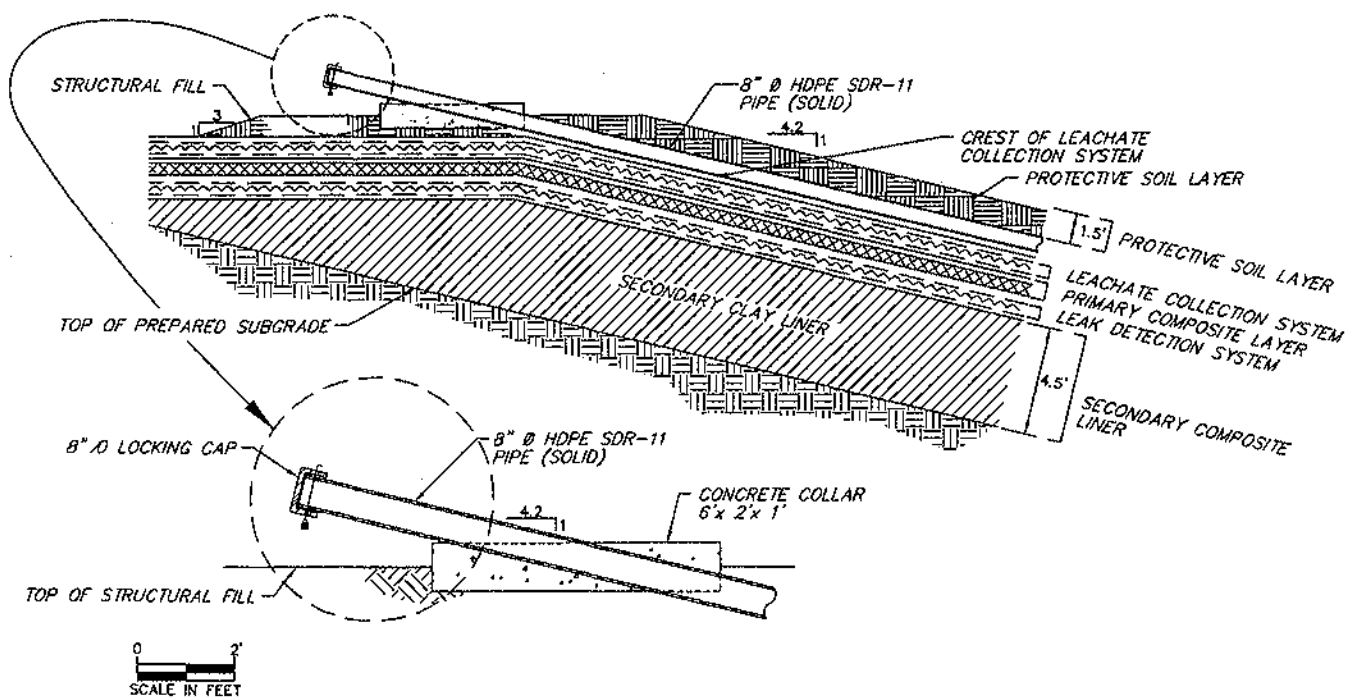
SCALE IN FEET (SEE NOTE 1 AND 2)





TYPICAL CLEANOUT PIPE DETAIL (9/19)

0 4'
SCALE IN FEET
(SEE NOTE 1 AND 2)



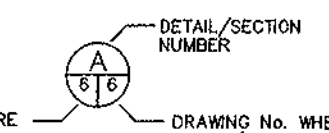
TYPICAL CLEANOUT PIPE SUPPORT PLAN, PROFILE, AND DETAIL (10/19)

NOTES:

1.) DETAILS ARE SHOWN TO THE SCALE NOTED EXCEPT FOR THE GEOSYNTHETICS; THESE ARE SHOWN AT AN EXAGGERATED SCALE FOR CLARITY.

2.) MATERIAL SPECIFICATIONS ARE PROVIDED IN THE GENERAL SPECIFICATIONS AND THE SUPPLEMENTAL SPECIFICATIONS.

3.) ALL DIMENSIONS ARE TYPICAL (EXCEPT SOIL LINER THICKNESS) AND COULD VARY IN FINAL DESIGN CONSTRUCTION DRAWINGS.



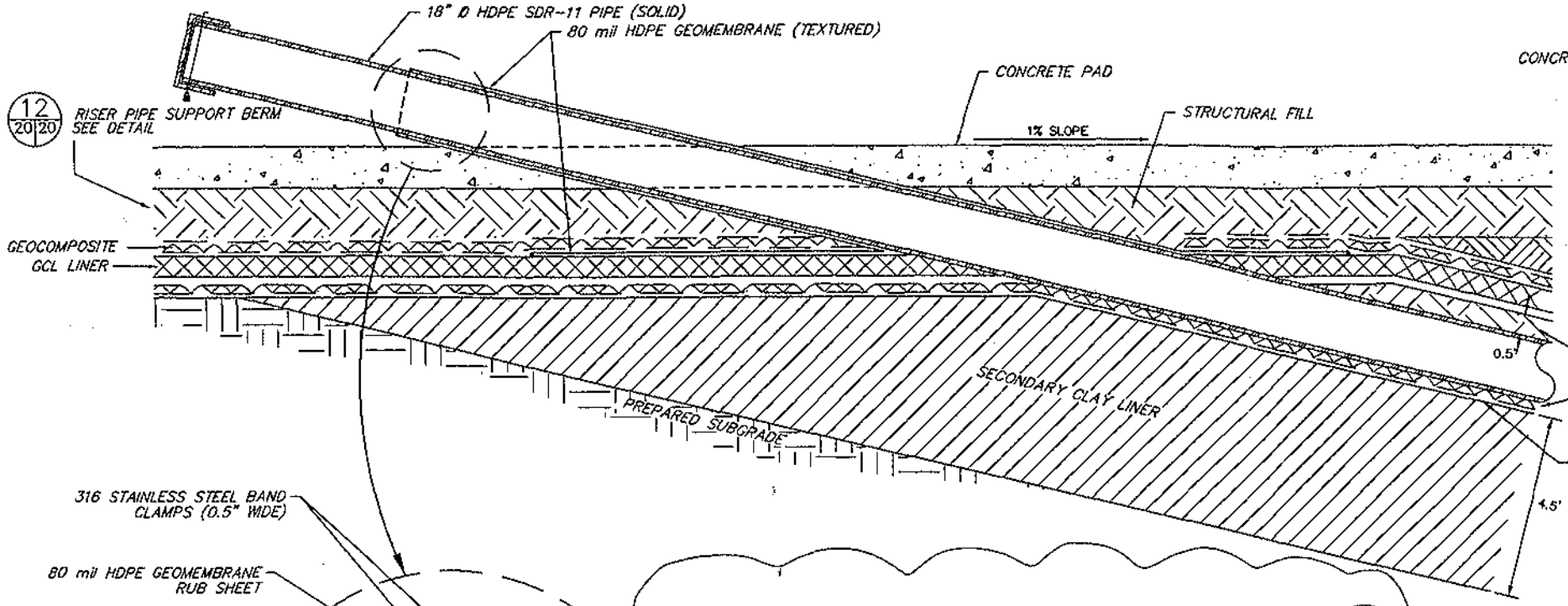
Rev. No.	NOTES	DATE	BY	CHKD
4				
3				
2	REVISED TO SHOW NEW OWNERSHIP	9/04	WDS	FK
1	ADD GCL & ELIMINATE PRIM. CLAY ON SIDE SLOPES	11/96	KLC	JPP
0	ISSUED FOR PERMIT MOD. REPORT	11/94	JGN	PGC

SCALE: SEE BAR SCALE
DESIGN BY: TEL (TERRAMATRIX)
DRAWN BY: JGN (TERRAMATRIX)
CHECK BY: PGC (TERRAMATRIX)
PROJECT No. 603
FILE NAME: DEERTRAIL-19.DWG

Clean Harbors
DEER TRAIL, LLC.

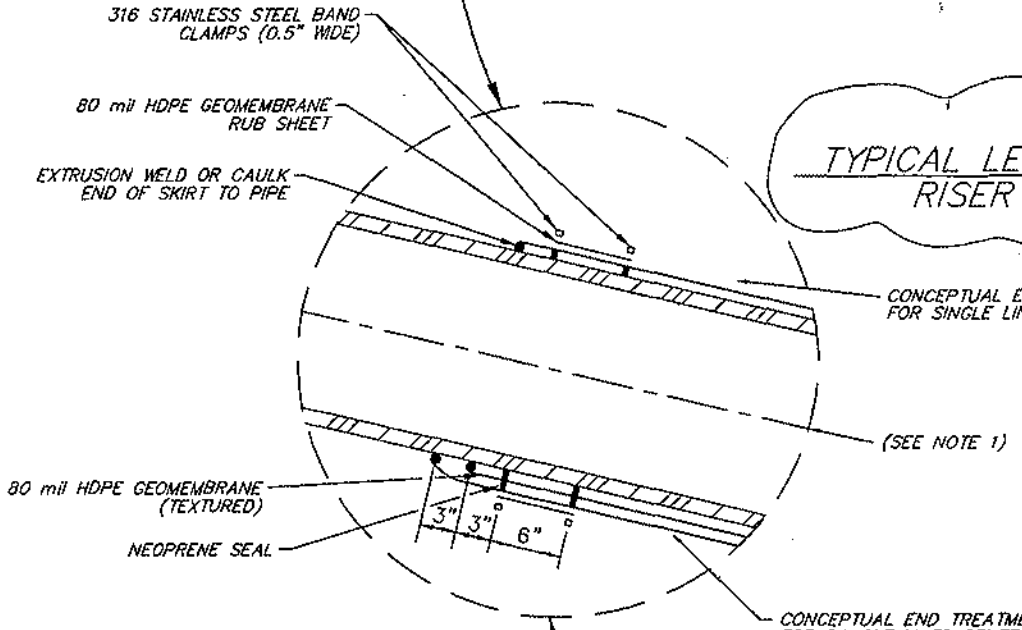
PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN
DRAWING TITLE: TYPICAL LINER SYSTEM DETAILS

SHEET: 1 OF 1
DRAWING No.: 19
REV.: 2



TYPICAL LEAK DETECTION SYSTEM SUMP RISER PIPE LINER PENETRATION

11 20 20



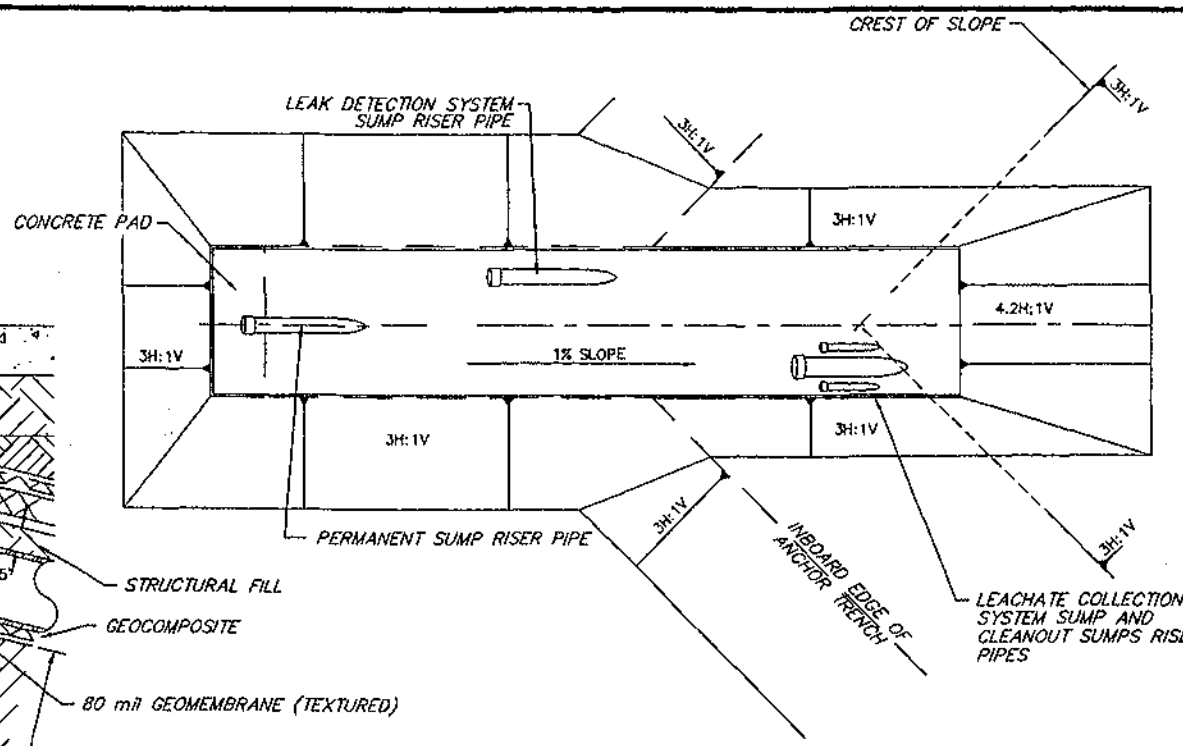
0 2' SCALE IN FEET

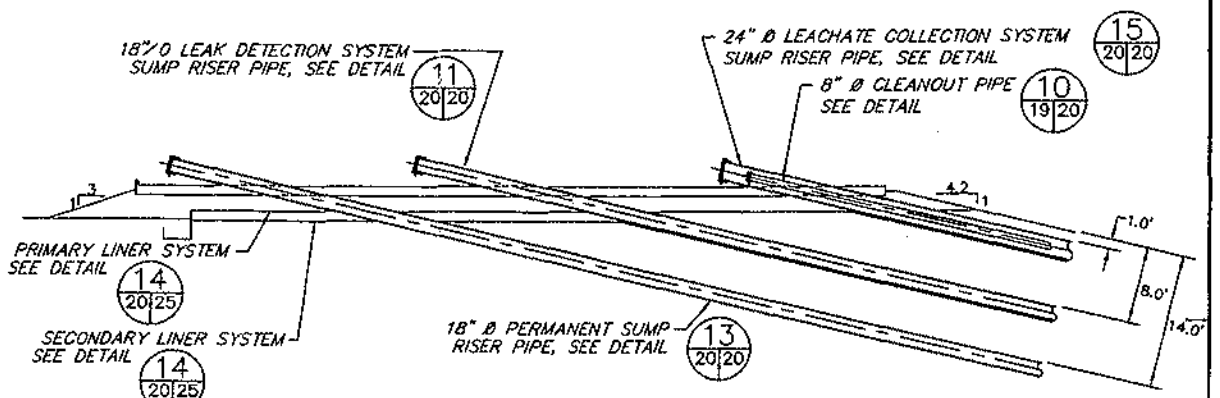
NOTES:

1.) ACTUAL LINER END TREATMENT DETAILS SHALL BE DESIGNED BY GEOMEMBRANE INSTALLER AND SUBMITTED ON SHOP DRAWINGS.

2.) DETAILS ARE SHOWN TO THE SCALE NOTED EXCEPT FOR THE GEOSYNTHETICS: THESE ARE SHOWN AT AN EXAGGERATED SCALE FOR CLARITY.

3.) ALL DIMENSIONS ARE TYPICAL (EXCEPT SOIL LINER THICKNESS) AND COULD VARY IN FINAL DESIGN CONSTRUCTION DRAWINGS.



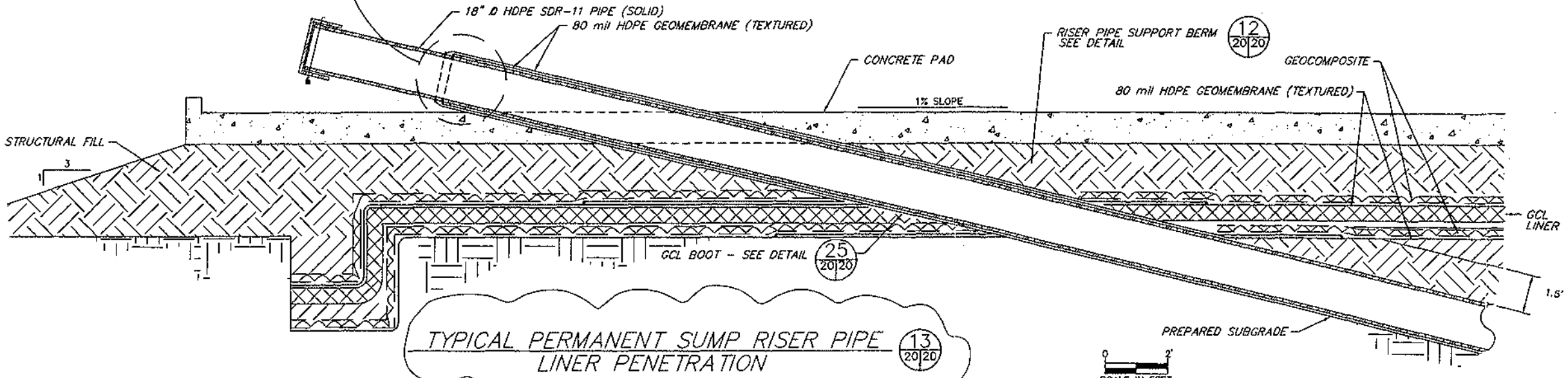


TYPICAL PLAN AND PROFILE RISER AND CLEANOUT PIPE SUPPORT BERM

12 16 20

0 10' SCALE IN FEET

A 6 6 — DETAIL/SECTION NUMBER; DRAWING No. WHERE DETAIL/SECTION IS REFERENCED; DRAWING No. WHERE DETAIL/SECTION IS SHOWN



TYPICAL PERMANENT SUMP RISER PIPE LINER PENETRATION

13 20 20

0 2' SCALE IN FEET

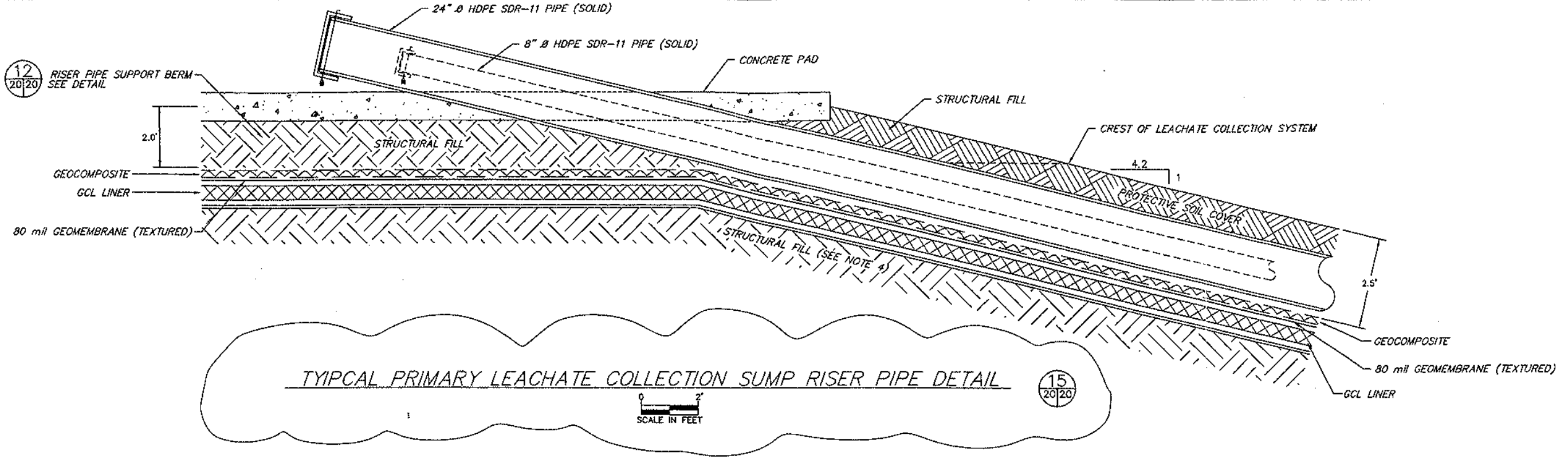
Rev. No.	NOTES	DATE	BY	CHKD
4				
3				
2				
1	REVISED TO SHOW NEW OWNERSHIP	9/04	WDS	FK
0	ISSUED FOR PERMIT MOD. REPORT	11/94	JGN	PGC

SCALE: SEE BAR SCALE
DESIGN BY: TEL (TERRAMATRIX)
DRAWN BY: JGN (TERRAMATRIX)
CHECK BY: PGC (TERRAMATRIX)
PROJECT No. 603
FILE NAME: DEERTRAIL-20A.DWG

CleanHarbors
DEER TRAIL, LLC.

PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN
DRAWING TITLE: TYPICAL - SUMP DETAILS AND CROSS-SECTIONS

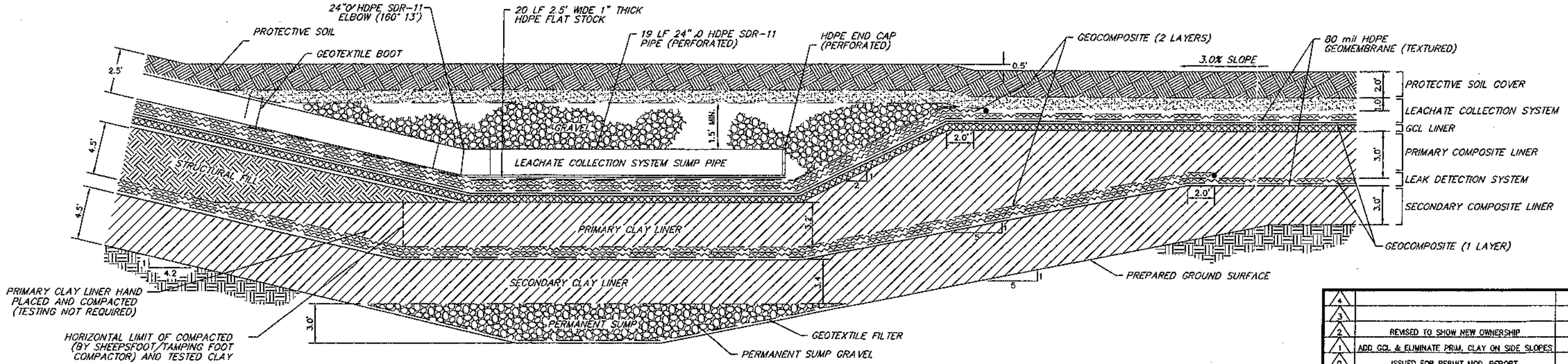
SHEET: 1 OF 4
DRAWING No.: 20
REV.: 1



TYIPCAL PRIMARY LEACHATE COLLECTION SUMP RISER PIPE DETAIL

15/20/20

SCALE IN FEET 0 2'



TYPICAL LEACHATE COLLECTION SUMP SECTION

E/20/20

SCALE IN FEET 0 4'

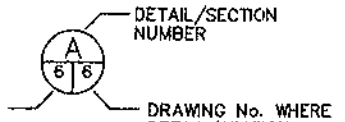
NOTES:

1.) DETAILS ARE SHOWN TO THE SCALE NOTED EXCEPT FOR THE GEOSYNTHETICS; THESE ARE SHOWN AT AN EXAGGERATED SCALE FOR CLARITY.

2.) LOWER LINER COMPONENTS NOT SHOWN.

3.) ALL DIMENSIONS ARE TYPICAL (EXCEPT SOIL LINER THICKNESS) AND COULD VARY IN FINAL DESIGN CONSTRUCTION DRAWINGS.

4.) SECTIONS CUT ALONG SIDE SLOPE RISER PIPE TRENCH, THEREFORE, STRUCTURAL FILL BACKFILL FOR PIPES IS SHOWN BELOW PRIMARY AND SECONDARY CLAY LINERS.



Rev. No.	NOTES	DATE	BY	CHKD
4				
3				
2	REVISED TO SHOW NEW OWNERSHIP	9/04	WDS	FK
1	ADD GCL & ELIMINATE PRIM. CLAY ON SIDE SLOPES	11/96	KLC	JPP
0	ISSUED FOR PERMIT MOD. REPORT	11/94	JGN	PGC

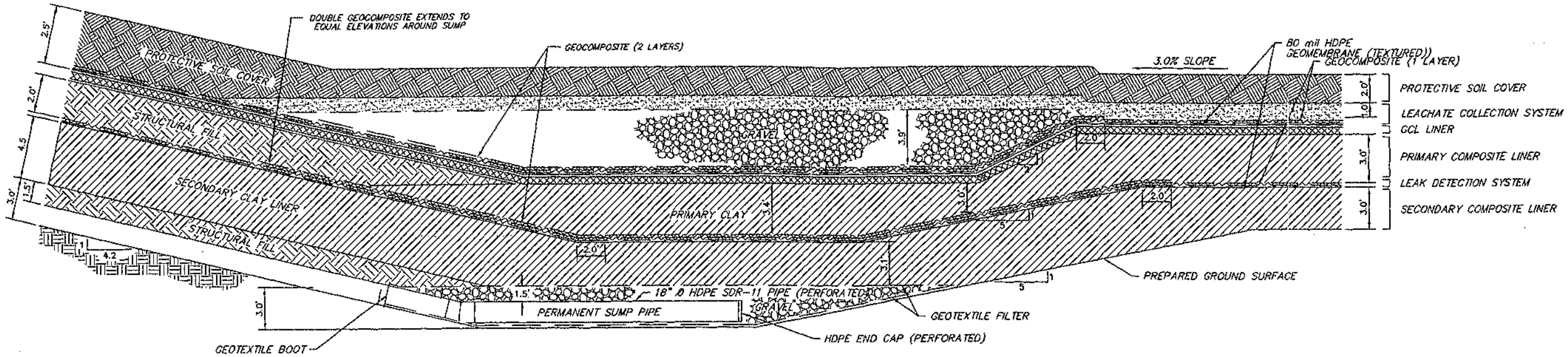
SCALE: SEE BAR SCALE
DESIGN BY: TEL (TERRAMATRIX)
DRAWN BY: JGN (TERRAMATRIX)
CHECK BY: PGC (TERRAMATRIX)
PROJECT No. 603
FILE NAME: DEERTRAIL-208.DWG

Clean Harbors
DEER TRAIL, LLC.

PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN

DRAWING TITLE: TYPICAL – SUMP DETAILS AND CROSS-SECTIONS

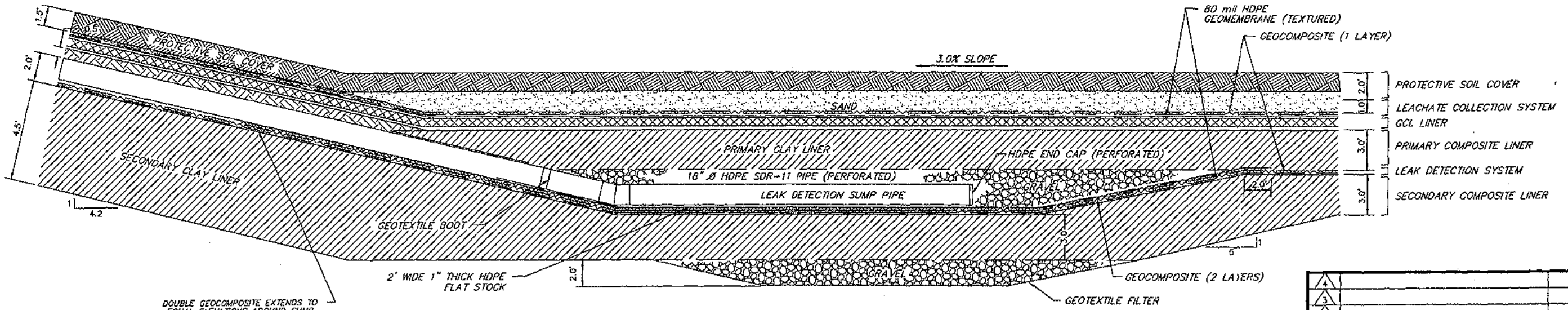
SHEET: 2 OF 4
DRAWING No.: 20
REV.: 2



TYPICAL PERMANENT SUMP SECTION

F-20

NOT TO SCALE



TYPICAL LEAK DETECTION SUMP SECTION

G-20

NOT TO SCALE

NOTES:

1.) DETAILS ARE SHOWN TO THE SCALE NOTED EXCEPT FOR THE GEOSYNTHETICS; THESE ARE SHOWN AT AN EXAGGERATED SCALE FOR CLARITY.

2.) ALL DIMENSIONS ARE TYPICAL (EXCEPT SOIL LINER THICKNESS) AND COULD VARY IN FINAL DESIGN CONSTRUCTION DRAWINGS.

A / 6 / 6 — DETAIL/SECTION NUMBER; DRAWING No. WHERE DETAIL/SECTION IS REFERENCED; DRAWING No. WHERE DETAIL/SECTION IS SHOWN

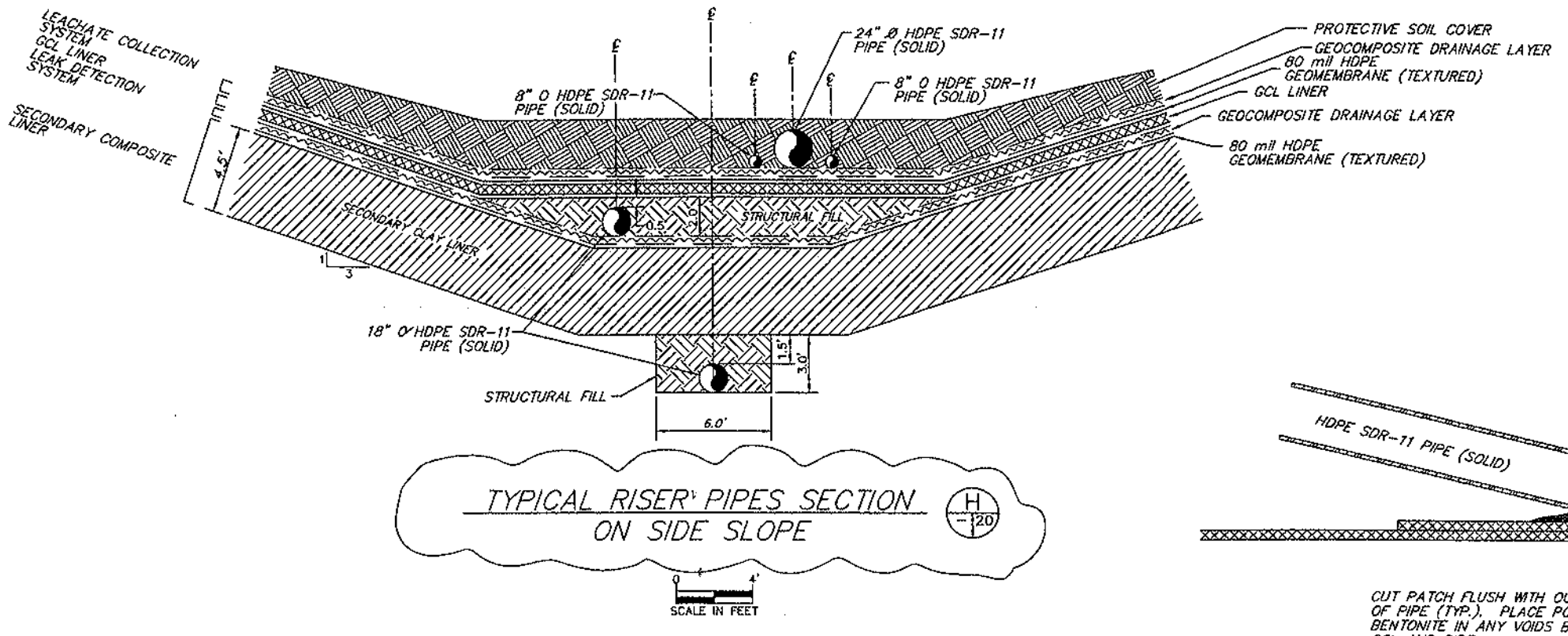
Rev. No.	NOTES	DATE	BY	CHKD
4				
3				
2	REVISED TO SHOW NEW OWNERSHIP	9/04	WDS	PK
1	ADD GCL & ELIMINATE PRIM. CLAY ON SIDE SLOPES	11/96	KLC	JPP
0	ISSUED FOR PERMIT MOD. REPORT	11/94	JGN	PGC

SCALE: SEE BAR SCALE
DESIGN BY: TEL (TERRAMATRIX)
DRAWN BY: JGN (TERRAMATRIX)
CHECK BY: PGC (TERRAMATRIX)
PROJECT No. 603
FILE NAME: DEERTRAIL-20C.DWG

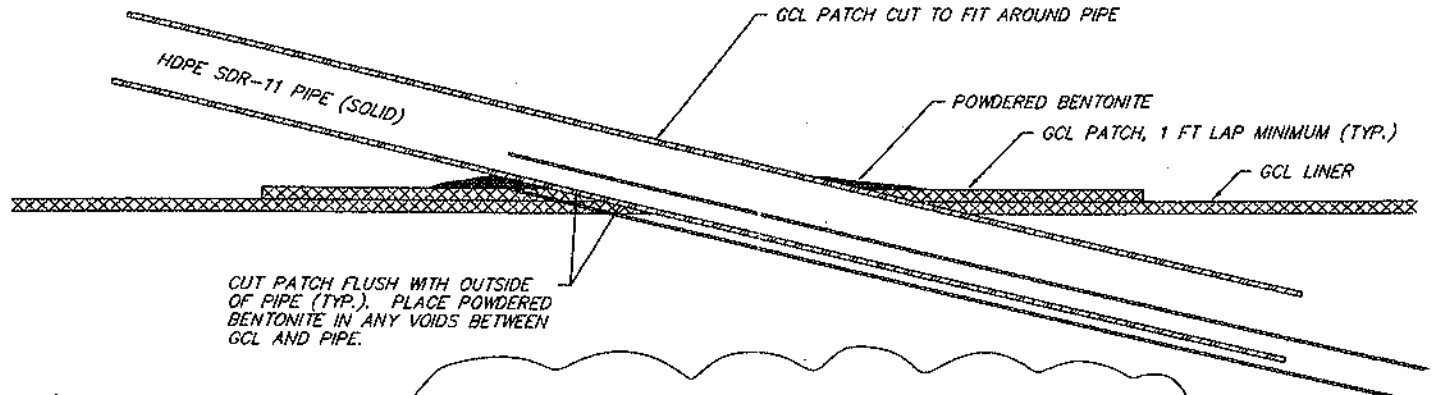
Clean Harbors
DEER TRAIL, LLC.

PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN
DRAWING TITLE: TYPICAL - SUMP DETAILS AND CROSS-SECTIONS

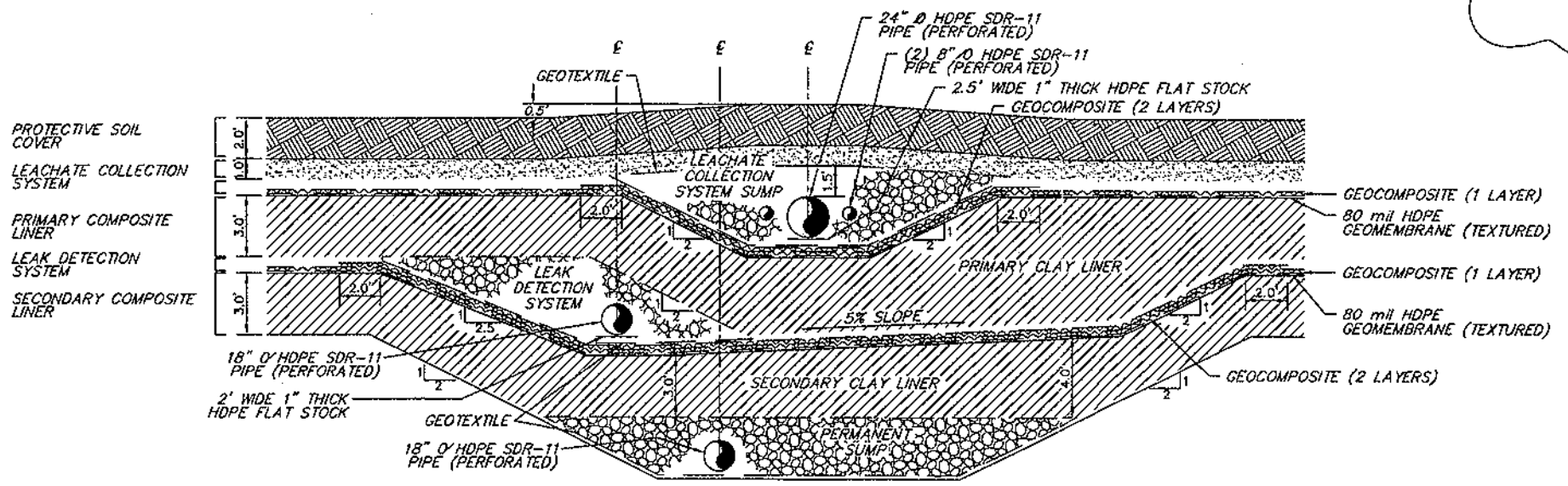
SHEET: 3 OF 4
DRAWING No.: 20
REV.: 2



TYPICAL RISER PIPES SECTION ON SIDE SLOPE (H-20)

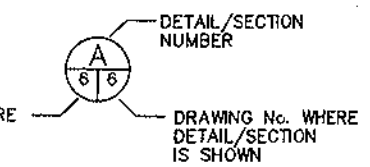


GCL BOOT DETAIL (25/20/20) N.T.S.



TYPICAL SUMPS SECTION ON BASE OF CELL (1-20)

NOTES:
1.) DETAILS ARE SHOWN TO THE SCALE NOTED EXCEPT FOR THE GEOSYNTHETICS; THESE ARE SHOWN AT AN EXAGGERATED SCALE FOR CLARITY.
2.) ALL DIMENSIONS ARE TYPICAL (EXCEPT SOIL LINER THICKNESS) AND COULD VARY IN FINAL DESIGN CONSTRUCTION DRAWINGS.



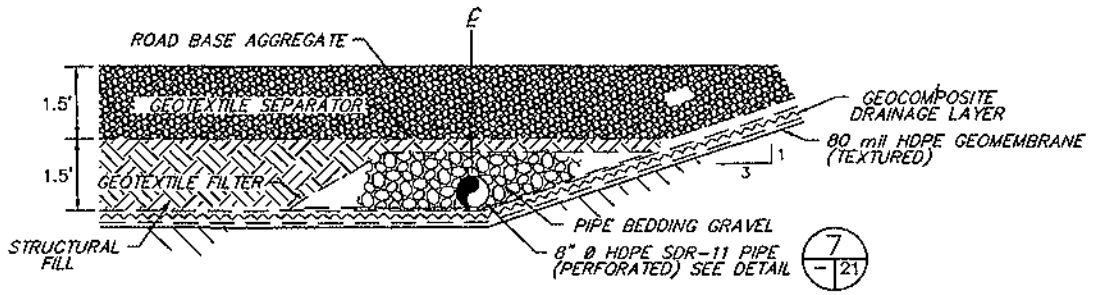
Rev. No	NOTES	DATE	BY	CHKD
4				
3				
2	REVISED TO SHOW NEW OWNERSHIP	9/04	WDS	FK
1	ADD GCL TO LINER SYSTEM	11/96	TWS	PGC
0	ISSUED FOR PERMIT MOD. REPORT	11/94	JGN	PGC

SCALE: SEE BAR SCALE
DESIGN BY: TEL (TERRAMATRIX)
DRAWN BY: JGN (TERRAMATRIX)
CHECK BY: PGC (TERRAMATRIX)
PROJECT No. 603
FILE NAME: DEERTRAIL-200.DWG

Clean Harbors
DEER TRAIL, LLC.

PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN
DRAWING TITLE: TYPICAL - SUMP DETAILS AND CROSS-SECTIONS

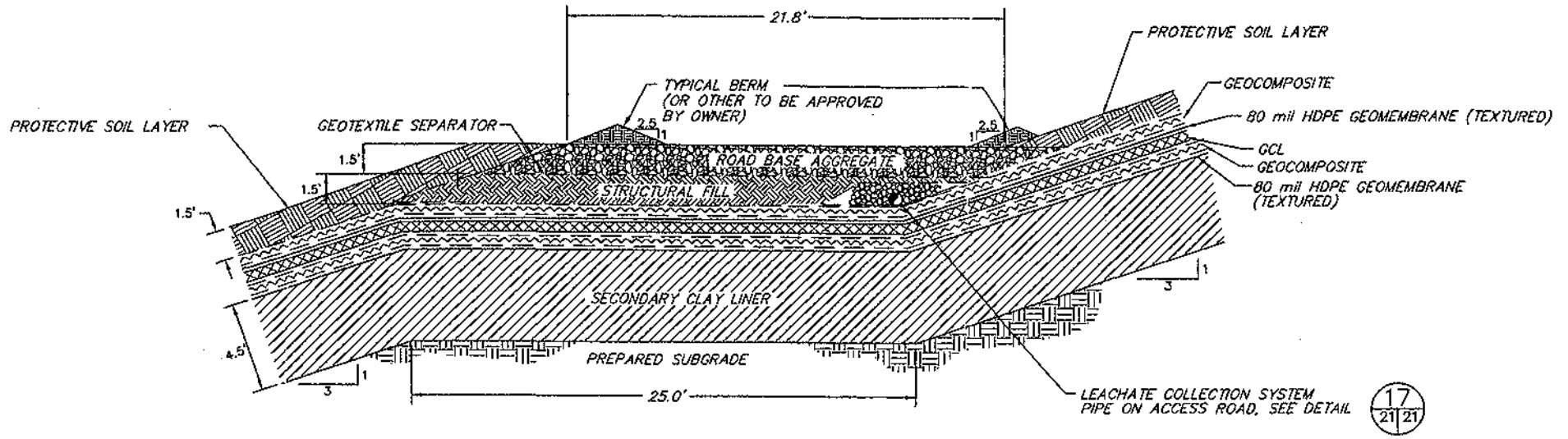
SHEET: 4 OF 4
DRAWING No.: 20
REV.: 2



TYPICAL LEACHATE COLLECTION SYSTEM PIPE ON ACCESS ROAD DETAIL

17 / 21 | 21

SCALE IN FEET



TYPICAL ACCESS RAMP DETAIL

16 / 21

SCALE IN FEET

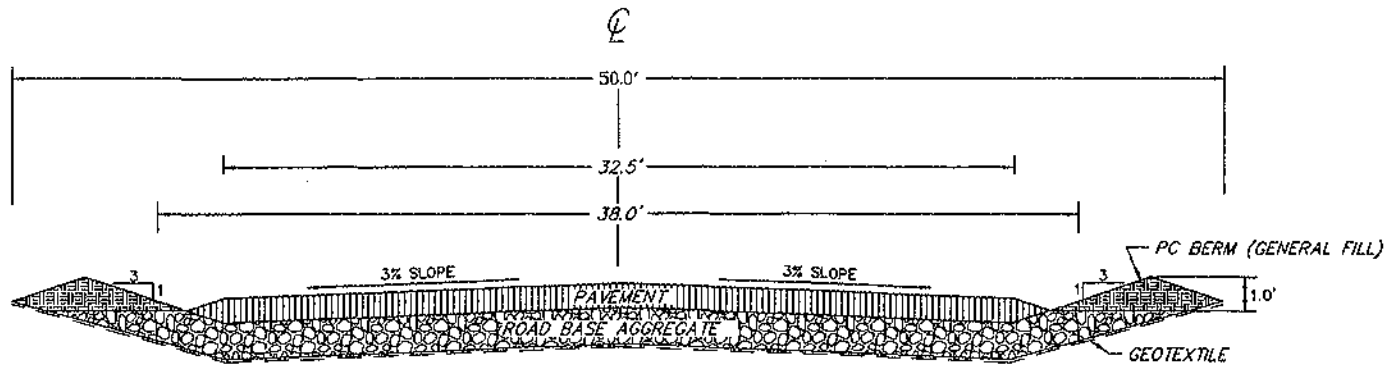
(SEE NOTE 1, 2, AND 3)

NOTES:

1.) DETAILS ARE SHOWN TO THE SCALE NOTED EXCEPT FOR THE GEOSYNTHETICS; THESE ARE SHOWN AT AN EXAGGERATED SCALE FOR CLARITY.

2.) MATERIAL SPECIFICATIONS ARE PROVIDED IN THE GENERAL SPECIFICATIONS AND THE SUPPLEMENTAL SPECIFICATIONS.

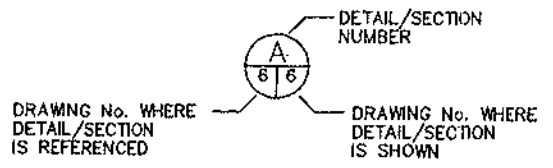
3.) ALL DIMENSIONS ARE TYPICAL (EXCEPT SOIL LINER THICKNESS) AND COULD VARY IN FINAL DESIGN CONSTRUCTION DRAWINGS.



TYPICAL HAUL ROAD CROSS SECTION

J / 21 | 21

NOT TO SCALE



Rev. No.	NOTES	DATE	BY	CHKD
4				
3				
2	REVISED TO SHOW NEW OWNERSHIP	9/04	WDS	FK
1	ADD GCL & ELIMINATE PRIM. CLAY ON SIDE SLOPES	11/96	KLC	JPP
0	ISSUED FOR PERMIT MOD. REPORT	11/94	JGN	PGC

SCALE: SEE BAR SCALE

DESIGN BY: TEL (TERRAMATRIX)

DRAWN BY: JGN (TERRAMATRIX)

CHECK BY: PGC (TERRAMATRIX)

PROJECT No. 603

FILE NAME: DEERTRAIL-21.DWG

CleanHarbors

DEER TRAIL, LLC.

PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN

DRAWING TITLE: TYPICAL ACCESS RAMP DETAILS

SHEET: 1 OF 1

DRAWING No.: 21

REV.: 2

PERMANENT UC STORMWATER CHANNEL DESIGN ANALYSIS

CHANNEL	TRIBUTARY AREA (acres)	TRIBUTARY CHANNEL	TOTAL TRIBUTARY AREA (acres)	8.2" EVENT DESIGN FLOW (cfs)	BOTTOM SLOPE (%)	SHAPE	BOTTOM WIDTH B (ft.)	SIDE SLOPE H:V	FLOW VELOCITY n=0.035 (fps)	FLOW DEPTH n=0.06 (ft.)	ACTUAL DESIGN CHANNEL DEPTH (ft.)	FREEBOARD n=0.06 (ft.)	FROUDE NUMBER n=0.035
UC-1A *	3.5	---	3.5	28	1.10	VEE	---	4:1	3.5	1.7	4.1	2.4	.73 (Subcritical)
UC-1B *	6.4	UC-1,17	16.0	95	0.50	VEE	---	4:1	3.5	3.2	4.1	0.9	.54 (Subcritical)
UC-2 *	18.2	UC-1B,12	45.3	247	0.50	VEE	---	4:1	4.5	4.6	4.7	0.9	.58 (Subcritical)
UC-3 *	13.9	---	13.9	72	0.75	VEE	---	4:1	3.8	2.7	3.7	1.0	.64 (Subcritical)
UC-4 *	34.5	---	34.5	155	0.75	VEE	---	4:1	4.6	3.6	4.6	1.0	.68 (Subcritical)
UC-5 *	2.1	UC-3,4	50.5	220	0.80	VEE	---	5:1	4.9	3.7	4.7	1.0	.64 (Subcritical)
UC-6 *	24.0	UC-2,5,19	123.0	401	1.00	VEE	---	16:1	4.7	2.8	4.3	1.5	.77 (Subcritical)
UC-7 *	38.8	UC-6,20,14	175.8	621	0.76	VEE	---	16:1	4.7	3.5	4.8	1.3	.69 (Subcritical)
UC-8 *	4.7	---	4.7	37	1.20	VEE	---	4:1	3.9	1.9	3.3	1.7	.65 (Subcritical)
UC-9A *	5.2	UC-8,15B	21.8	121	0.70	VEE	---	4:1	4.2	3.3	4.6	1.3	.77 (Subcritical)
UC-9B *	5.6	UC-9A,18	34.8	156	0.70	VEE	---	4:1	4.5	3.6	4.8	1.2	.64 (Subcritical)
UC-10 *	15.0	UC-9B,16B	62.3	204	0.50	TRAPEZOID	12	4:1	4.1	3.1	3.4	0.3	.57 (Subcritical)
UC-11	5.1	---	5.1	35	2.20	VEE	---	7.5	4.1	1.3	1.6	0.3	.98 (Subcritical)
UC-12 *	6.0	UC-11	11.1	64	0.40	VEE	---	4:1	2.9	2.9	3.1	0.3	.48 (Subcritical)
UC-13	2.5	---	2.5	20	2.20	VEE	---	4:1	4.1	1.4	1.7	0.2	.58 (Subcritical)
UC-14 *	9.3	UC-13	11.8	80	0.60	VEE	---	4:1	3.6	2.9	3.4	0.5	.48 (Subcritical)
UC-15A	4.5	---	4.5	35	0.70	VEE	---	4:1	3.1	2.1	2.4	0.3	.99 (Subcritical)
UC-15B	7.4	UC-15A	11.9	84	2.00	VEE	---	9:1	4.7	1.7	2.0	0.3	.60 (Subcritical)
UC-16A	9.6	---	9.6	68	0.50	VEE	---	4:1	3.2	2.8	3.1	0.3	.53 (Subcritical)
UC-16B	2.9	UC-16A	12.5	81	1.80	VEE	---	6:1	4.9	2.0	2.3	0.3	.96 (Subcritical)
UC-17	6.1	---	6.1	46	1.40	VEE	---	4:1	4.3	2.0	2.3	0.3	.84 (Subcritical)
UC-18	7.4	---	7.4	57	2.00	VEE	---	6:1	4.7	1.7	2.0	0.3	.58 (Subcritical)
UC-19	3.2	---	3.2	25	0.70	VEE	---	4:1	2.9	1.8	2.1	0.3	.58 (Subcritical)
UC-20	2.2	---	2.2	18	2.10	VEE	---	4:1	4.0	1.3	1.6	0.3	.96 (Subcritical)

TEMPORARY PC STORMWATER CHANNEL DESIGN ANALYSIS

CHANNEL	TRIBUTARY AREA (acres)	TRIBUTARY CHANNEL	TOTAL TRIBUTARY AREA (acres)	8.2" EVENT DESIGN FLOW (cfs)	BOTTOM SLOPE (%)	SHAPE	BOTTOM WIDTH B (ft)	SIDE SLOPE H:V	FLOW VELOCITY n=0.035 (fps)	FLOW DEPTH n=0.06 (ft)	ACTUAL DESIGN CHANNEL DEPTH (ft)	FREEBOARD n=0.06 (ft.)	FROUDE NUMBER n=0.035
PC-1 *	5.6	PC 1.1	9.5	68	0.20	TRAP.	12	3:1	2.3	2.3	3.5	1.2	.35 (Subcritical)
PC-1.1 *	3.9	---	3.9	33	0.50	VEE	---	3:1	2.9	2.4	3.0	0.6	.51 (Subcritical)
PC-2 *	1.3	HAUL RD B	2.4	18	0.50	VEE	---	3:1	2.5	1.9	2.3	0.4	.49 (Subcritical)
PC-3 *	1.6	---	1.6	15	0.4	VEE	---	3:1	2.2	1.9	2.3	0.4	.44 (Subcritical)
PC-4 *	0.3	PC-3	1.8	17	1.80	VEE	---	3:1	3.9	1.5	1.9	0.4	.89 (Subcritical)
HAUL ROAD A	1.3	---	1.3	10	1.1	VEE	---	3:1 / 33.3:1	3.0 **	0.5 **	1.0	0.5	.86 (Subcritical)
HAUL ROAD B	1.3	---	1.1	9	1.0	VEE	---	3:1 / 33/3:1	3.0 **	0.5 **	1.0	0.5	.82 (Subcritical)

NOTE:
* EXISTING STRUCTURE
** Mannings N = 0.025

TYPICAL CHANNEL SECTION
NOT TO SCALE

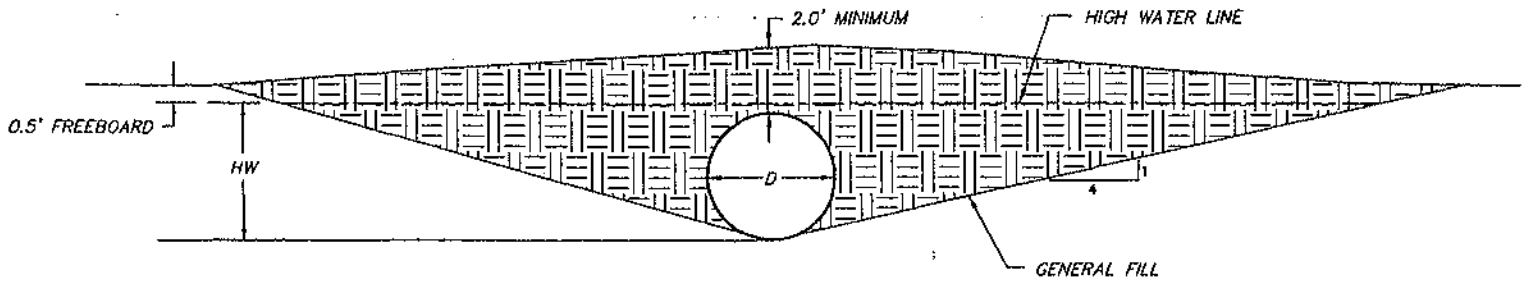
Rev. No	NOTES	DATE	BY	CHKD
4				
3				
2	REVISED TO SHOW NEW OWNERSHIP	9/04	WDS	FK
1	REVISED DITCH 16B	7/95	JGN	TEL
0	ISSUED FOR PERMIT MOD. REPORT	11/94	JGN	PGC

SCALE: SEE BAR SCALE
DESIGN BY: TEL (TERRAMATRIX)
DRAWN BY: JGN (TERRAMATRIX)
CHECK BY: PGC (TERRAMATRIX)
PROJECT No. 603
FILE NAME: DEERTRAIL-22A.DWG

Clean Harbors
DEER TRAIL, LLC.

PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN
DRAWING TITLE: TYPICAL - SURFACE WATER DETAILS

SHEET: 1 OF 2
DRAWING No.: 22
REV.: 2



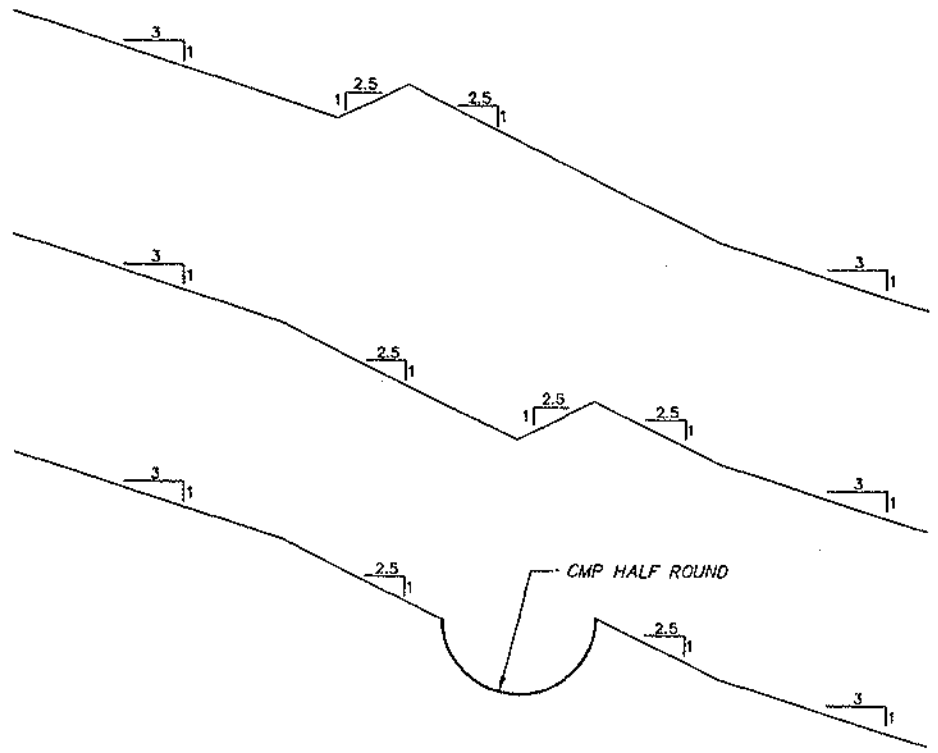
STORMWATER CULVERT DESIGN ANALYSIS

Culvert	Tributary Channel	8.2" Event Design Flow (cfs)	Inlet Condition	Slope (%)	Length (Feet)	# /Design Size (Inches)	HW/D	Actual #/Size (Inches)	Outlet Rip Rap Protection (Feet)
UC-1	UC-1B	95	Rip Rap Headwall	0.5	125	2/36	1.5		10
UC-2 (*)	UC-1B,12	160	Concrete Headwall	0.9	190	1/72	0.9	1/72	20
UC-5 (*)	UC-3,4	224	Concrete Headwall	0.8	70	3/48	1.1	3/48	20
UC-7 (*)	UC-14,20	93	Concrete Drop Inlet	3.7	660	1/48	1.3	1/48	50
Temporary (*) Road Crossing	UC-9B, 16-B	156	Projecting	0.5	40	2/48	1.1	2/48	10
PC-1 (*)	PC-1	49	Concrete Headwall	0.2	70	1/48	0.8	2/48	10
PC-1.1 (*)	PC-1.1	33	Concrete Headwall	3.4	70	1/36	1.0	2/36	10
PC-2 (*)	PC-2	18	Concrete Drop Inlet	0.1	469	1/24	1.4	1/24	---
PC-3 (*)	PC-3	7	RipRap	0.5	100	1/24	0.7	1/24	10
PC-1A (*)	PC-1	68	Concrete Drop Inlet	0.5	400	1/65x40	1.0	2/65x40	---

NOTE: (*) EXISTING CULVERT

TYPICAL CULVERT CROSS-SECTION AND DESIGN ANALYSIS

NOT TO SCALE



TYPICAL CONTOUR DITCH ALTERNATIVES SECTION AND DETAIL (23/25|22)

SCALE
0 1' 2'

DETAIL/SECTION NUMBER (A / 6|6)
DRAWING No. WHERE DETAIL/SECTION IS REFERENCED
DRAWING No. WHERE DETAIL/SECTION IS SHOWN

Rev. No	NOTES	DATE	BY	CHKD
4				
3				
2	REVISED TO SHOW NEW OWNERSHIP	9/04	WDS	FK
1	DRAFT 1	11/94	JGN	PGC
0	DRAFT	10/94	TWS	PGC

SCALE: SEE BAR SCALE
DESIGN BY: TEL (TERRAMATRIX)
DRAWN BY: JGN (TERRAMATRIX)
CHECK BY: PGC (TERRAMATRIX)
PROJECT No. 603
FILE NAME: DEERTRAIL-22B.DWG

CleanHarbors
DEER TRAIL, LLC.

PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN
DRAWING TITLE: TYPICAL - SURFACE WATER DETAILS

SHEET: 2 OF 2
DRAWING No.: 22
REV.: 2

LEGEND

- SURFACE WATER DRAINAGE
- 4820 — ELEVATION OF EXISTING GRADE (FEET) BASED ON 1991 TOPOGRAPHY)
- COMPLIANCE BOUNDARY
- LEACHATE DISCHARGE LINE (DOUBLE WALL)
- LEACHATE VALVE VAULT
- LEACHATE METER AND ACCESS VAULT

N 26,500 N 26,000 N 25,500 N 25,000 N 24,500 N 24,000 N 23,500 N 23,000 N 22,500

E 18,500 E 18,000 E 17,500 E 17,000 E 16,500 E 16,000 E 15,500 E 15,000

4840 4850 4860 4870 4880 4890

CELL 4
CELL 5
CELL 6
CELL 7
CELL 3
CELL 2
CELL 1

TYPICAL LEACHATE COLLECTION SUMP AND RISER PUMP DETAIL – SEE 18 (23|24)

TYPICAL CELL LEACHATE DISCHARGE LINE

LEACHATE VALVE VAULT A – SEE 19 (23|24)

COMBINED LEACHATE LINE

LEACHATE VALVE VAULT B – SEE 19 (23|24)

CONNECT COMBINED LEACHATE LINE TO EXISTING VALVE BOX No.5.

LEACHATE METER AND ACCESS VAULT SEE 21 (23|24)

WASTE WATER TREATMENT PLANT

POTENTIALLY CONTAMINATED RAINWATER BASIN

CONTAMINATED WATER AND CARBON TREATMENT

OIL / SOLVENT HOLDING TANKS

SOLIDIFICATION BUILDING

MAINTENANCE BUILDING

FUEL ISLAND

POWER SUBSTATION

SEWAGE EFFLUENT POND

TRUCK WASH

TRUCK STAGING AREA

OPERATIONS BUILDING

PUMP HOUSE

WATER TANK

GUARD HOUSE

NOTE:

1.) ALL DIMENSIONS, GRADES AND LOCATIONS SHOWN ARE TYPICAL.

2.) FINAL DESIGN DIMENSIONS, GRADES AND LOCATIONS TO BE COMPILED IN CONSTRUCTION DRAWINGS AND SUBMITTED TO CDPHE PRIOR TO CONSTRUCTION.

DETAIL/SECTION NUMBER — A (6|6)

DRAWING No. WHERE DETAIL/SECTION IS REFERENCED

DRAWING No. WHERE DETAIL/SECTION IS SHOWN

SCALE

200' 0 200' 400'

CONTOUR INTERVAL 2' AND 10'

Rev. No.	NOTES	DATE	BY	CHKD
4				
3				
2				
1	REVISED TO SHOW NEW OWNERSHIP	9/04	WDS	FK
0	ISSUED FOR PERMIT MOD. REPORT	11/94	JGN	PGC

SCALE: SEE BAR SCALE
DESIGN BY: TEL (TERRAMATRIX)
DRAWN BY: JGN (TERRAMATRIX)
CHECK BY: PGC (TERRAMATRIX)
PROJECT No. 603
FILE NAME: DEERTRAIL-23.DWG

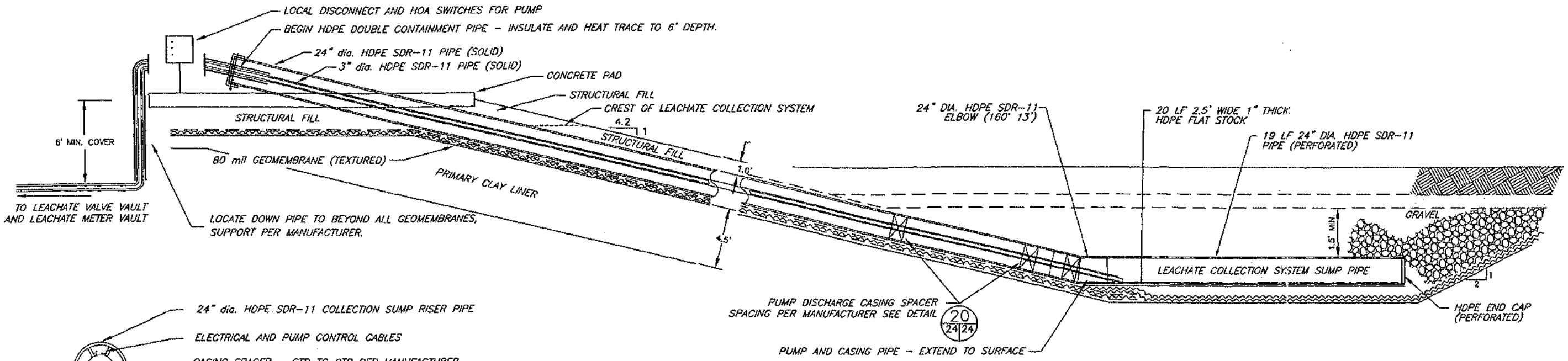
CleanHarbors
DEER TRAIL, LLC.

PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN

DRAWING TITLE: TYPICAL LEACHATE PUMPING SYSTEM LAYOUT

Civil Design Consultants, Inc.
ENGINEERS AND PLANNERS
P.O. BOX 775167 STEAMBOAT SPRINGS, CO 80477 303-879-3022

SHEET: 1 OF 1
DRAWING No.: 23
REV. 1

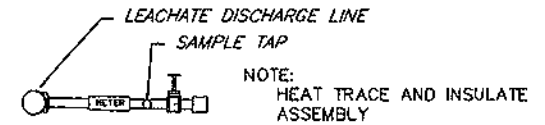


TYPICAL LEACHATE COLLECTION SUMP AND RISER PIPE PUMP DETAIL (18 / 23 / 24)

NOT TO SCALE

TYPICAL PUMP DISCHARGE CASING SPACER DETAIL (20 / 24 / 24)

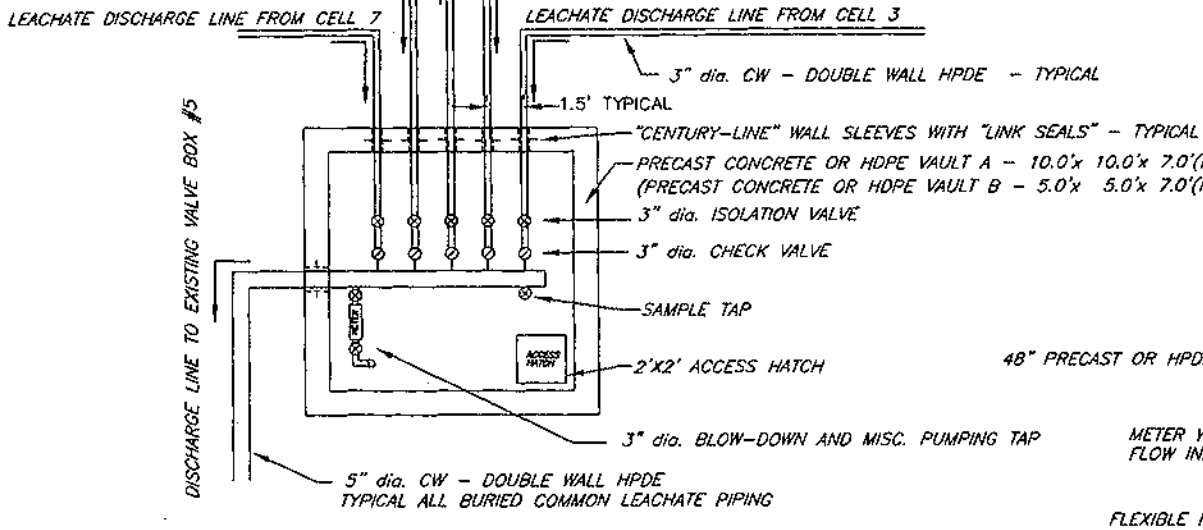
NOT TO SCALE

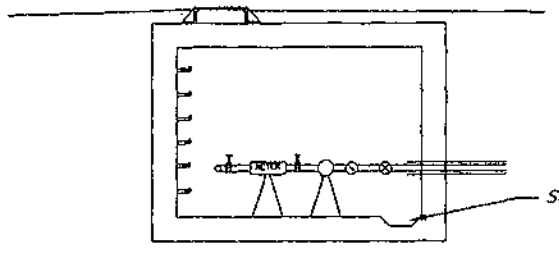


NOTE:
HEAT TRACE AND INSULATE ASSEMBLY

TYPICAL PUMPING TAP WITH QUICK COUPLER DETAIL (22 / 24 / 24)

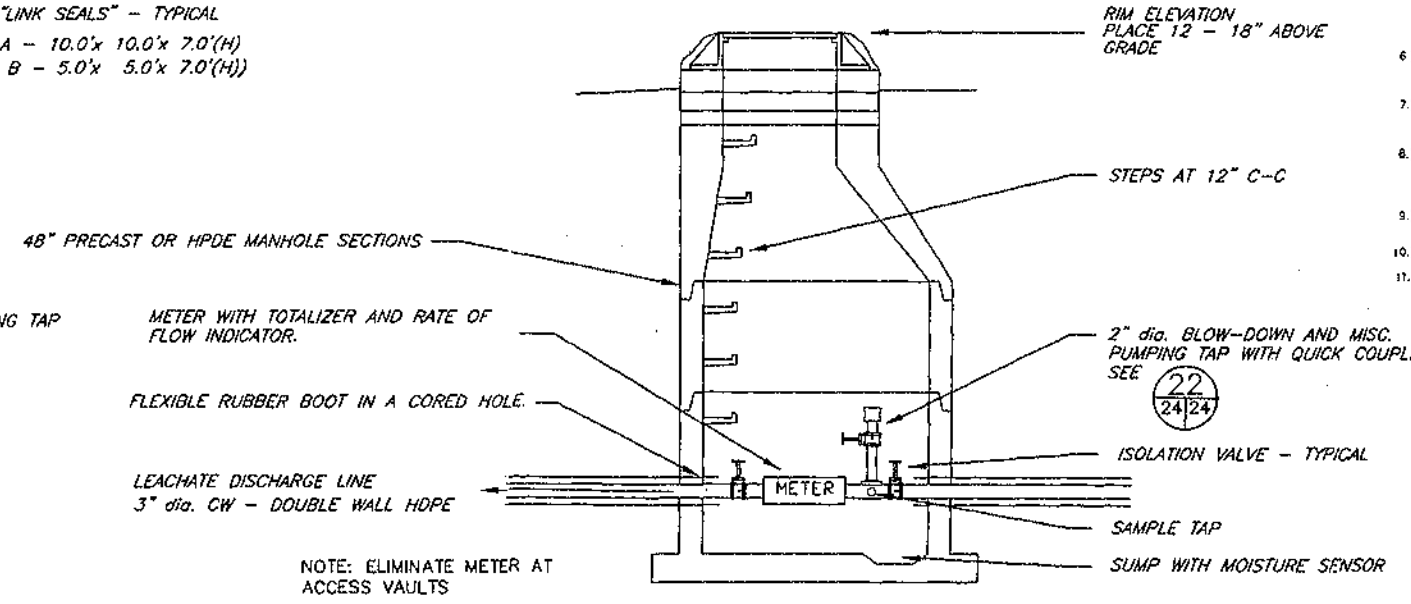
NOT TO SCALE





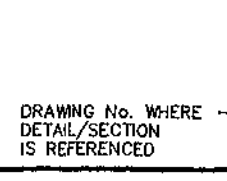
TYPICAL LEACHATE VALVE VAULT DETAIL AND SECTION (19 / 23 / 24)

NOT TO SCALE



TYPICAL LEACHATE METER AND ACCESS VAULT SECTION (21 / 23 / 24)

NOT TO SCALE



NOTES:

1) ALL BURIED LEACHATE DISCHARGE PIPING / FITTINGS SHALL BE SCHEDULE 9, DOUBLE CONTAINMENT HDPE MEETING ASTM D3350; INSTALL PER MANUFACTURERS WRITTEN SPECIFICATIONS; "GUARDIAN" DOUBLE CONTAINMENT SYSTEMS OR APPROVED EQUAL.

2.) PLACE #12 DETECTION WIRE ON TOP OF ALL BURIED CW AND PCW DISCHARGE PIPES; EXPOSE WIRE AT EACH VAULT. SPLICES ARE TO BE MADE WITH BRASS WIRE NUTS AND SECURELY TAPED. TEST TO PROVE CONTINUITY AFTER INSTALLATION.

3.) ALL INSTALLATIONS SHALL BE IN ACCORDANCE WITH COPHE REGULATIONS.

4.) INSULATE AND HEAT TRACE ALL EXPOSED DISCHARGE PIPING TO A DEPTH OF 6' BELOW FINISH GRADE AVOID FREEZING

5.) PRIMARY LEACHATE COLLECTION PUMP TO BE "GRUNDFOS" STAINLESS STEEL SUBMERSIBLE PUMP; MODEL 13SS100-6, OR APPROVED EQUAL. PROVIDE LEACHATE LEVEL DETECTION PROBES TO ENERGIZE PUMP; B/W/ CONTROL TYPE LH W/3 SS ELECTRODES, OR EQUAL. OUTFIT PUMP WITH 6" HDPE CASING AND 3" HDPE DISCHARGE PIPING EXTENDED TO THE SURFACE. SUPPORT PUMP, CASING AND DISCHARGE LINE INSIDE RISER PIPE WITH CASING SPACERS BY "CASCADE", "PSI", "APS" OR APPROVED EQUAL. PROVIDE FOR DRAIN-BACK OF PUMP RISER PIPE DURING PERIODS OF NON-USE TO MINIMIZE FREEZING POTENTIAL.

6.) LEACHATE VALVE VAULTS TO BE PRECAST CONCRETE OR HDPE SUITABLE FOR LIQUID CONTAINMENT ALL PENETRATIONS SHALL BE WITH CIP "CENTURY-LINE" WALL SLEEVES AND "LINK-SEALS" OR EQUAL.

7.) PROVIDE SIMILAR LEACHATE RISER PIPE PUMPING SYSTEM FOR LEAK DETECTION SYSTEM AND PERMANENT SUMP SYSTEMS. PUMPS SHALL BE "GRUNDFOS" MODEL 25S07-05 OR APPROVED EQUAL. ACTIVATION OF PUMPS SHALL BE BY "HAND".

8.) PROVIDE "BLOW-DOWN AND CONNECTION TAP" ON HORIZONTAL RUN OF EACH LEACHATE COLLECTION DISCHARGE LINE – SEE DETAIL. "TAP" IS TO ALLOW CONNECTION OF THE DISCHARGE LINE FROM PERMANENT SUMP AND LEAK DETECTION SUMPS AND TO PROVIDE A POINT TO "BLOW-DOWN" THE LINES TO REMOVE LEACHATE. HEAT TRACE AND INSULATE TO AVOID FREEZING.

9.) AT FINAL DESIGN CONFIRM REQUIRED PUMP MODEL AND HORSEPOWER AND CONSIDER REDUCING DIAMETER OF RISER PIPE FROM 24" TO 8", 10" OR 12" DIAMETER.

10.) ALL DIMENSIONS, GRADES AND LOCATIONS SHOWN ARE TYPICAL.

11.) FINAL DESIGN DIMENSIONS, GRADES AND LOCATIONS TO BE COMPILED IN DESIGN CONSTRUCTION DRAWINGS AND SUBMITTED TO COPHE PRIOR TO CONSTRUCTION.

Rev. No.	NOTES	DATE	BY	CHKD
4				
3				
2				
1	REVISED TO SHOW NEW OWNERSHIP	9/04	WDS	FK
0	ISSUED FOR PERMIT MOD. REPORT	11/94	JGN	PGC

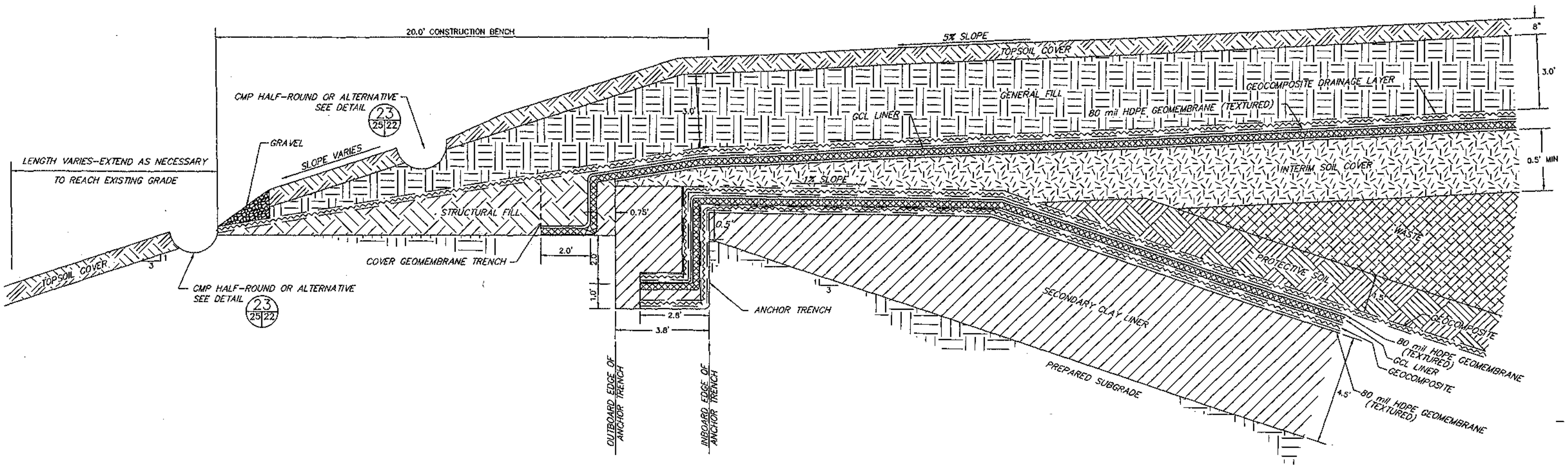
SCALE: SEE BAR SCALE
DESIGN BY: TEL (TERRAMATRIX)
DRAWN BY: JGN (TERRAMATRIX)
CHECK BY: PGC (TERRAMATRIX)
PROJECT No. 603
FILE NAME: DEERTRAIL-24.DWG

Clean Harbors
DEER TRAIL, LLC.

PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN
DRAWING TITLE: TYPICAL LEACHATE PUMPING SYSTEM DETAILS

Civil Design Consultants, Inc.
ENGINEERS AND PLANNERS
P.O. BOX 775167 STEAMBOAT SPRINGS, CO 80477 303-879-3022

SHEET: 1 OF 1
DRAWING No.: 24
REV. 1



TYPICAL COVER LINER DETAIL (3/13/25)

NOT TO SCALE

NOTES:
1.) DETAILS ARE SHOWN TO THE SCALE NOTED EXCEPT FOR THE GEOSYNTHETICS; THESE ARE SHOWN AT AN EXAGGERATED SCALE FOR CLARITY.
2.) ALL DIMENSIONS ARE TYPICAL (EXCEPT SOIL LINER THICKNESS) AND COULD VARY IN FINAL DESIGN CONSTRUCTION DRAWINGS.

A/6/6 — DETAIL/SECTION NUMBER
DRAWING No. WHERE DETAIL/SECTION IS REFERENCED
DRAWING No. WHERE DETAIL/SECTION IS SHOWN

Rev. No.	NOTES	DATE	BY	CHKD
4				
3				
2	REVISED TO SHOW NEW OWNERSHIP	9/04	WDS	FK
1	ACC GCL & ELIMINATE FRUM. CLAY ON SIDE SLOPES	11/96	KLC	JPP
0	ISSUED FOR PERMIT MOD. REPORT	11/94	JGN	PGC

SCALE: SEE BAR SCALE
DESIGN BY: TEL (TERRAMATRIX)
DRAWN BY: JGN (TERRAMATRIX)
CHECK BY: PGC (TERRAMATRIX)
PROJECT No. 603
FILE NAME: DEERTRAIL-25.DWG

Clean Harbors
DEER TRAIL, LLC.

PROJECT: CONCEPTUAL SITE DEVELOPMENT PLAN
DRAWING TITLE: TYPICAL COVER CROSS-SECTIONS AND DETAILS
SHEET: 1 OF 1
DRAWING No.: 25
REV.: 2

COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT
RCRA PART B
PERMIT ATTACHMENT LF-10.3

CONSTRUCTION QUALITY ASSURANCE (CQA) PLAN FOR SECURE CELL CONSTRUCTION (CELLS 3 THROUGH 7) AND SURFACE IMPOUNDMENT LINER AND COVER SYSTEM CONSTRUCTION (CELLS 1 THROUGH 7)

Clean Harbors (Deer Trail), LLC
Treatment, Storage, and Disposal Facility

ADAMS COUNTY, COLORADO

EPA IDENTIFICATION NUMBER COD991300484

PERMIT RENEWAL
September 2004

NOTE: This permit attachment is a typical construction quality assurance plan. Modifications to the plan may be required prior to construction of each secure cell based on the final design drawings and specifications. The revisions required for each secure cell will be submitted to CDPHE for approval prior to construction.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

SECTION I - GENERAL

1.0 INTRODUCTION

This Construction Quality Assurance (CQA) Plan for the Clean Harbors (Deer Trail) hazardous waste treatment, storage, and disposal facility (CHDT), Adams County, Colorado, has been prepared to fulfill the requirements of Permit Conditions Module I, paragraph G.1., Module IV, paragraph A.6., and Module V, paragraph A.4. of the United States Environmental Protection Agency (USEPA) Resource Conservation and Recovery Act (RCRA) Hazardous Solid Waste Amendments (HSWA) Permit, Identification Number COD991300484. The CQA Plan was also prepared to meet the requirements of Part II.E.1.b.i. Colorado Department of Public Health and Environment (CDPHE) RCRA Part B Permit Number 086_001_002/S001, S002, T49, T21, and D81. The CQA Plan is Attachment LF_10.3 to the Part B Permit for the CHDT.

The CQA Plan (Part B Permit Attachment LF_10.3) addresses the construction quality assurance of the soils, geosynthetics, and related liner system components for secure cells and surface impoundments at the CHDT. The CQA Plan is divided into the following sections:

- Section I: General;
- Section II: Soils CQA;
- Section III: Geosynthetic Clay Liner CQA;
- Section IV: Geomembrane CQA;
- Section V: Geotextile CQA;
- Section VI: Geonet CQA;
- Section VII: Geocomposite CQA;
- Section VIII: Polyethylene Pipe and Fittings CQA; and,
- Section IX: CQA Documentation.

2.0 DEFINITIONS RELATING TO CONSTRUCTION QUALITY ASSURANCE

2.1 Construction Quality Assurance and Construction Quality Control

The CQA Plan is a site_specific document which addresses the following: (i) CQA personnel responsibilities, authorities, and qualifications; (ii) inspection, monitoring, and testing activities necessary to ensure that the facility is constructed to meet or exceed design criteria, plans, and specifications; and (iii) CQA documentation requirements.

Construction Quality Assurance (CQA) _ A planned and systematic pattern of the means and actions designed to provide adequate confidence that items or services meet contractual and regulatory requirements, and will perform satisfactorily in service.

Construction Quality Control (CQC) _ Those actions which provide a means to measure and control the characteristics of an item or service to meet contractual and regulatory requirements.

2.2 Use of the Terms in This Plan

In the context of this document:

- Construction Quality Assurance (CQA) refers to means and actions employed by the CQA Engineer to assure conformity of liner system preparation, production, and installation with this CQA Plan, the General Specifications (Part B Permit Attachment LF_1), and the Construction Drawings. CQA is provided by a party independent from the product Manufacturer and Contractor.

- Construction Quality Control (CQC) refers to those actions taken by Manufacturers, Suppliers, Contractors, or Owners, including their designated representatives, to ensure that the materials and the workmanship meet the requirements of the General Specifications, and the Construction Drawings. In the case of soils, and within this CQA Plan, CQC is typically made a part of the CQA requirements and is provided by the CQA Engineer. In the case of geosynthetic and other non_soil components, CQC is provided by the Manufacturers and installers of the various geosynthetics.

3.0 PARTIES TO CONSTRUCTION QUALITY ASSURANCE

3.1 Organization Chart

A typical project organization chart for construction of secure cells and surface impoundments is provided in Figure I_1.

3.2 Description of the Parties

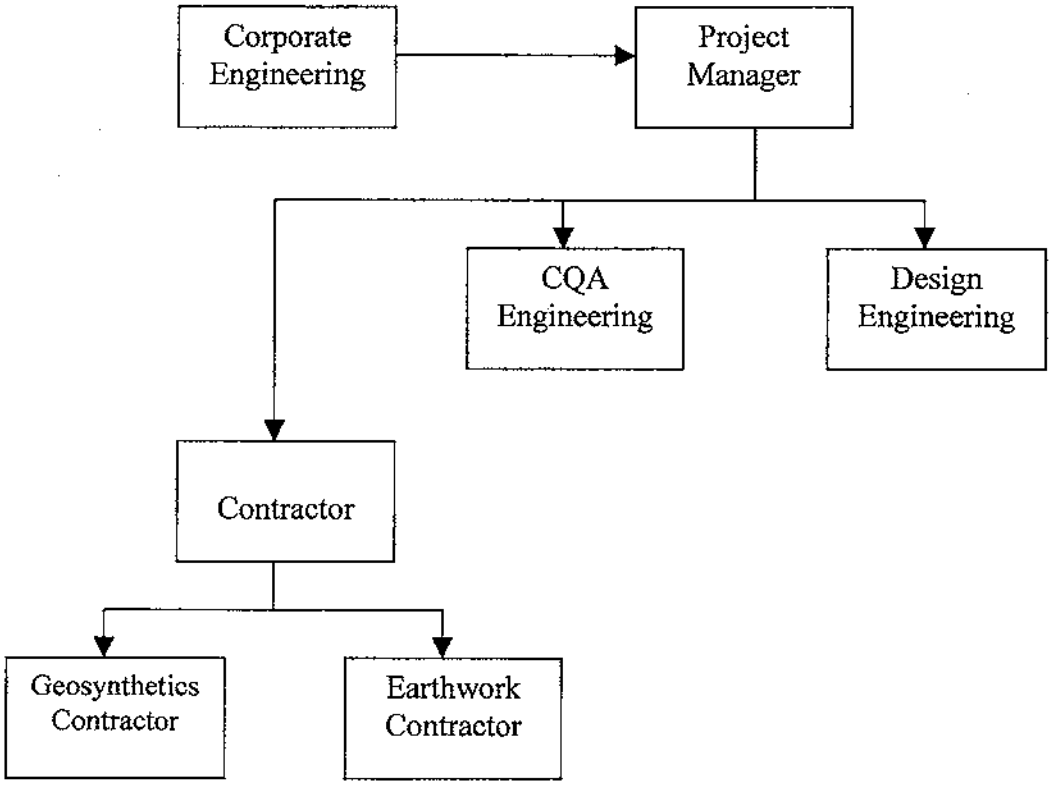
3.2.1 Design Engineer

The Design Engineer is the individual, firm or corporation having direct responsibility for the design of the secure cell or surface impoundment structure. During construction, the Design Engineer must approve any significant deviation from the design requirements of the Contract Documents. The Design Engineer may be an employee of the Owner. An individual representing the Design Engineer directly responsible for the project must be registered as a Professional Engineer in the State of Colorado.

3.2.2 Contractor

The individual, firm, or corporation undertaking the execution of the work under the terms of the Contract Documents. The Contractor may be responsible for constructing the entire liner system (earthwork and geosynthetics), or only selected components of the liner system. The reference to Contractor refers to the General Contractor and all subcontractors which the General Contractor may employ in meeting the requirements of the Contract Documents.

Figure 01010-1
Clean Harbors Deer Trail
Secure Cell and Surface Impoundment
Project Organizational Chart



3.2.3 Gravel Supplier

The Gravel Supplier excavates (or manufactures) and delivers gravel for the sump and pipe bedding layers to the Contractor at the Highway 36 TSDF.

3.2.4 Granular Material Supplier

The Granular Material Supplier excavates (or manufactures) and delivers granular material for the granular leachate collection layer to the Contractor at the Highway 36 TSDF.

3.2.5 Resin Supplier

The Resin Supplier produces and delivers resin to the Manufacturer of geosynthetic materials or polymer based products such as pipe.

3.2.6 Manufacturer

The Manufacturer manufactures a specific component (e.g., geomembrane, geosynthetic clay liner, geotextile, geocomposite, geonet, or pipe) of the proposed liner system and delivers the component to the Contractor at the site. In the General Specifications, the term Manufacturer may refer to the geomembrane Manufacturer, geotextile Manufacturer, geocomposite Manufacturer, geonet Manufacturer, or pipe Manufacturer.

3.2.7 Construction Quality Assurance (CQA) Engineer

The CQA Engineer is an individual, firm, or corporation, independent from the Owner, Contractor, and Manufacturer, that observes, tests, and documents activities related to the CQA of the earthworks at the site, and observes, tests, and documents activities related to the CQA of the installation of the geosynthetic components of the liner system. The CQA Engineer (or his designated experienced field personnel) observes, tests, and documents activities related to the CQA of pipes and other liner system components. The CQA Engineer must provide an experienced field personnel which directly manages the CQA activities under the direct supervision of a Professional Engineer registered in the State of Colorado. The CQA Engineer may be the same as the Design Engineer, but must be independent from the Owner.

3.2.8 Soils Construction Quality Assurance (CQA) Laboratory

The Soils CQA Laboratory is independent from the Owner, Gravel Supplier, Granular Material Supplier, and Contractor. The Soils CQA Laboratory conducts tests in the laboratory (which may be on site or off site) on samples of soil taken from the borrow pits, stockpiles, or the liner system.

3.2.9 Geosynthetics Construction Quality Assurance (CQA) Laboratory

The Geosynthetics CQA Laboratory is independent from the Owner, Resin Supplier, Manufacturer, and Contractor. The Geosynthetics CQA Laboratory conducts tests on samples of geosynthetics taken from the site. The Geosynthetics CQA Laboratory may also conduct tests on pipes or other liner system components. The Geosynthetics CQA

Laboratory service cannot be provided by any party involved with the manufacture or installation of any of the geosynthetic components.

3.2.10 Owner

The Owner owns and operates the secure cell or surface impoundment. In this CQA Plan, the term "Owner" refers specifically to the CHDT.

3.3 Qualifications of the Parties

3.3.1 Design Engineer

The representative of the Design Engineer who is directly responsible for the project will be a qualified Professional Engineer registered in the State of Colorado. The Design Engineer will have a history which demonstrates familiarity with all liner system components, including detailed design methods and procedures.

3.3.2 Geomembrane Installer

The Geomembrane Installer (who may be either the Contractor or a subcontractor to the Contractor) will be trained and qualified to install geosynthetics, as well as other liner system components such as pipe, if necessary.

All personnel performing seaming operations will be qualified by experience (i.e., each seamer will have installed no less than 100,000 square feet of geomembrane using the same methods of seaming that will be used on this project). At least one seamer will have experience seaming a minimum of 1,000,000 square feet of geomembrane using the same method of seaming that will be used on this project. The most experienced seamer, the "master seamer", will provide direct supervision, as required, over less experienced seamers. Field seaming may not take place without an approved master seamer being present.

The Contractor will provide the Owner and CQA Engineer with a list of proposed seaming personnel and their professional records. Any proposed seaming personnel deemed insufficiently experienced will not be accepted by the Owner or will be required to pass a seaming test prior to working on the Project.

3.3.3 Construction Quality Assurance (CQA) Engineer Personnel

Personnel representing the CQA Engineer shall be properly trained and qualified to test and inspect soils, including high_ and low_permeability soils, geosynthetics, including geomembranes, geotextiles, geocomposites and geonets, and pipe. The CQA Engineer will predominately be represented by an experienced field personnel who has direct responsibility for management of the CQA activities. The CQA field personnel will be experienced in construction, CQA of soils; CQA of geosynthetics and pipe; and preparation of CQA documentation including CQA forms, reports, and plans.

The CQA field personnel shall perform his duties under the direct supervision of a registered professional engineer.

3.3.4 Soils Construction Quality Assurance (CQA) Laboratory

The Soils CQA Laboratory will have experience with the physical testing of soils, meet all applicable regulatory requirements, and be familiar with ASTM and other required test standards. The Soils CQA Laboratory will be capable of providing test results in accordance with the specifications.

3.3.5 Geosynthetics Construction Quality Assurance (CQA) Laboratory

The Geosynthetics CQA Laboratory will have experience in testing geosynthetics and other relevant liner system components and be familiar with ASTM and other applicable test standards.

3.4 Duties of Construction Quality Assurance Engineer

The overall responsibility of the CQA Engineer is to perform those activities specified in the CQA Plan (e.g., inspection, sampling, testing and documentation final certification). At a minimum, the CQA Engineer will be represented by a CQA Engineer and the necessary supporting CQA inspection personnel. Specific responsibilities of the CQA Engineer may include:

- Reviewing design criteria, plans, and specifications for clarity and completeness so that the CQA Plan can be implemented.
- Educating CQA inspection personnel on CQA requirements and procedures.
- Scheduling and coordinating CQA inspection activities.
- Directing and supporting the CQA inspection personnel in performing observations and tests by:
    - confirming that regular calibration of testing equipment is properly conducted and recorded;
    - confirming that the testing equipment, personnel, and procedures do not change adversely over time and verifying that changes do not adversely impact the inspection process;
    - confirming that the test data are accurately recorded and maintained; and,
    - verifying that the raw data are properly recorded, validated, reduced, summarized, and interpreted.
- Providing to the Owner reports on the inspection results including:
    - review and interpretation of data sheets and reports;

- identification of work that the CQA Engineer believes should be accepted, rejected, or uncovered for observation, or that may require special testing, inspection, or approval; and,

- rejection of defective work and verification that corrective measures are implemented.

- Verifying that the Contractor's construction quality control plan, if required, is in accordance with the site_specific CQA Plan.

- At the Owner's request, reporting to the Contractor results of observations and tests as the work progresses and interacting with the Contractor to provide assistance in modifying the materials and work to comply with the specified design.

- Providing the final report and certifications required by the CQA Plan.

For the supporting CQA inspection personnel, specific responsibilities may include:

- Performing independent on-site inspection of the work in progress to verify conformance with the facility design criteria, plans, and specifications;

- Verifying that the equipment used in testing meets the test requirements and that the tests are conducted according to the standardized procedures defined by the CQA plan; and,

- Reporting to the CQA Engineer results of all inspections including work that is not of acceptable quality or that fails to meet the specified design.

4.0 SCOPE OF CONSTRUCTION QUALITY ASSURANCE

The scope of this CQA Plan includes the CQA of the subgrade, and soil, pipe, and geosynthetic components of the liner and cover system. The CQA Plan also includes the CQA of manufacturing, shipping, handling, and installing of all geosynthetics and pipe.

This CQA Plan does not address design guidelines, installation specifications, or selection of soils, geosynthetics, pipe or other liner system components, which are all described in the General Specifications.

The CQA Plan does not provide for Construction Quality Control which the Contractor may independently undertake to facilitate the Contractor's achieving his requirements under the General Specifications.

5.0 UNITS

In this CQA Plan, all properties and dimensions are expressed in customary U.S. units.

6.0 REFERENCES

6.1 Applicable Organizations

Organizations whose standards are referenced in the CQA Plan and the General Specifications are as follows:

- ASHTO - American Association of State Highway and Transportation Officials;
- CHS - Colorado Department of Highways (Standard Specifications for Road and Bridge Construction);
-
- ASTM - American Society for Testing and Materials;
- GRI - Geosynthetic Research Institute;
- OSHA - Occupational Safety and Health Administration; and,
- USEPA - United States Environmental Protection Agency.

6.2 Applicable Standards

Any reference to standards of any society, institute, association, or governmental agency will pertain to the edition in effect as of the date of this CQA Plan, unless stated otherwise.

6.3 Specific Standards

Specific test standards which may be cited in the CQA Plan and the General Specifications are given in Table I-1. These standards may be modified due to technological advances since compilation of Table I-1. All such modifications are to be approved by the Owner.

TABLE I_1
TEST METHODS CITED IN GENERAL SPECIFICATIONS AND CQA PLAN

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS		
1.	AASHTO T96	Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine.
2.	AASHTO T104	Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.
AMERICAN SOCIETY OF TESTING AND MATERIALS		
1.	ASTM A 307	Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
2.	ASTM A 726	Standard Specification for Cold-Rolled Carbon Steel sheet, Magnetic Laminated Quality, types 1, 2, and 2S
3.	ASTM D 374C or D D 1777	Method for Measuring Thickness of Geotextile Materials.
4.	ASTM D 413	Standard Test Method for Rubber Property Adhesion to Flexible Substrate.
5.	ASTM D 422	Standard Method for Particle-Size Analysis of Soils.
6.	ASTM D 570	Standard Test Method for Water Absorption of Plastics.
7.	ASTM D 638	Standard Test Method for Tensile Properties of Plastics.
8.	ASTM D 698	Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5-lb (2.49-kg) Rammer and 12-in. (305-mm) Drop.

TABLE I_1
TEST METHODS CITED IN GENERAL SPECIFICATIONS AND CQA PLAN

9.	ASTM D 746	Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
10.	ASTM D 751	Standard Methods of Testing Coated Fabrics.
11.	ASTM D 792	Standard Test Methods for Specific Gravity (Relative density) and Density of Plastics by Displacement.
12.	ASTM D 882	Standard Test Methods for Tensile Properties of Thin Plastic Sheeting.
13.	ASTM D 1004	Standard Test Method of Initial Tear Resistance of Plastic film and Sheeting.
14.	ASTM D 1204	Standard Plastics Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature.
15.	ASTM D 1238	Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
16.	ASTM D 1248	Standard Specification for Polyethylene Plastic Molding and extrusion Metals.
17.	ASTM D 1505	Standard Test Methods for Density of Plastics by Density-Gradient Technique.
18.	ASTM D 1556	Standard Test Method for Density of Soil In Place by the Sand-Cone Method.
19.	ASTM D 1593	Standard Specification for Nonrigid Vinyl Chloride Plastic Sheeting.
20.	ASTM D 1603	Standard Test Method for Carbon Black in Olefin Plastics.
21.	ASTM D 2167	Standard Test Method for Density and Unit Weight of Soils in Place by Rubber Balloon Method.
22.	ASTM D 2216 or D 4643	Standard Method for Laboratory Determination of water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures.
23.	ASTM D 2434	Standard Test Method for Permeability of Granular Soils (Constant Head).
24.	ASTM D 2487	Standard Test Method for Classification of Soils for Engineering Purposes.
25.	ASTM D 2657	Standard Practice for Heat-Joining for Polyolefin Pipe and Fittings.
26.	ASTM D 2663	Carbon-Black Dispersion in Rubber.
27.	ASTM D 2837	Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.
28.	ASTM D 2922	Standard Test Method for Density of Soil and Soil-Aggregate In Place by Nuclear Methods (Shallow Depth).
29.	ASTM D 3015	Recommended Practice for Microscopical Examination of Pigment Dispersion in Plastic Compounds.
30.	ASTM D 3017	Standard Test Method for Moisture Content of Soil and Rock In Place by Nuclear Methods (Shallow Depth).
31.	ASTM D 3083	Standard Specification for Flexible Poly (Vinyl Chloride) Plastic Sheeting for Pond, Canal, and Reservoir Lining.
32.	ASTM D 3350	Standard Specifications for Polyethylene Plastic Pipe and Fittings Materials.
33.	ASTM D 3776	Mass Per Unit Area (Weight) of Woven Fabric.
34.	ASTM D 4253	Standard Test Method for Maximum Index Testing of Soils Using a Vibratory Table.
35.	ASTM D 4254	Standard test Method for Minimum Index Density of Soils and Calculations of Relative Density.
36.	ASTM D 4318	Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
37.	ASTM D 4373	Standard Test Method for Calcium Carbonate Content of Soils.
38.	ASTM D 4437	Standard Test Methods for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Geomembranes.

TABLE I_1
TEST METHODS CITED IN GENERAL SPECIFICATIONS AND CQA PLAN

39.	ASTM D 4491	Standard Test Method for Water Permeability of Geotextiles by the Permittivity Method.
40.	ASTM D 4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
41.	ASTM D 4632	Standard Test Method for Breaking Load and Elongation of Geotextiles (Grab Elongation Method and Peel Strength).
42.	ASTM D 4643	Determination of Water (Moisture) Content of Soil by the Microwave Oven Method.
43	ASTM D 4716	Standard Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products.
44.	ASTM D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile
45.	ASTM D 4833	Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
46.	ASTM D 5084	Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
47.	ASTM D 5261	Measuring Mass Per Unit Area of Geotextile
48.	ASTM D 5321	Coefficient of Soil and Geosynthetics or Geosynthetics and Geosynthetics Friction by Direct Shear.
50.	ASTM D 5890	Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners.
51.	ASTM 5891	Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners.
52.	ASTM E 11	Specification for Wire-Cloth Sieves for Testing Purposes.
53.	ASTM F 714	Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
54.	ASTM F 904	Standard Test Method for Comparison of Bond Strength or Ply Adhesion of Similar Laminates Made from Flexible Materials.
	GEOSYNTHETIC RESEARCH INSTITUTE	
1.	GRI-GMI	Standard Test Method for Ductile/Brittle Transition Time for Notched Polyethylene Specimen under Constant Stress.
	UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	
1.	USEPA Method 9090 Compatibility Test for Wastes and Membrane Liners.	

SECTION II - SOILS CONSTRUCTION QUALITY ASSURANCE

1.0 INTRODUCTION

This section of the CQA Plan addresses the soils components of the liner and cover systems and specifies the soils CQA program to be implemented with regard to materials selection and evaluation, laboratory test requirements, field test requirements, and treatment of problems.

This section of the CQA Plan also addresses for construction of the foundation subgrade, clay liners, clay covers granular drainage layers, sump and pipe bedding gravel, the protective soil layer, and general fill cover soil.

2.0 FOUNDATION SUBGRADE

2.1 Verification of Subgrade Continuity

When the excavation of the secure cell or surface impoundment is completed, the CQA Engineer will:

- Obtain thin walled tube or other appropriate undisturbed sampling technique (Shelby tube samples) of the subgrade material and perform permeability testing (secure cells only), at the frequency specified in Table II_1, samples taken from unweathered Pierre shale may require extra care to retrieve; the Shelby tubes will be pushed perpendicular to the soil using available onsite equipment provided by the Contractor;

- Inspect the subgrade on the side slopes and base of the secure cell or surface impoundment and note areas of weak or excessively weathered subgrade materials and areas with soils with a Unified Soil Classification System (USCS) gradation coarser than SM; and,

- Observe the proof rolling of the base of the secure cell or surface impoundment and note areas that exhibit excessive rutting, heaving, or softening.

In accordance with CHDT's Part B Permit, the Contractor will be required to remove soils with a USCS gradation coarser than SM. The backfill material in the excavation will be structural fill or clay liner material that will be placed and compacted so as to exhibit an equal or lower hydraulic conductivity than the adjacent undisturbed soil. The scope of the testing program implemented to demonstrate lower hydraulic conductivity will be established by the CQA Engineer and Owner after the nature and extent of the excavated material is known. The testing program will be submitted to CDPHE prior to backfilling over_excavated areas. The CQA Engineer will observe any excavation and backfilling operations.

The scope of the testing program implemented to demonstrate lower hydraulic conductivity will be established by the CQA Engineer and Owner after the nature and extent of the excavated material is known. The testing program will be submitted to CDPHE prior to backfilling over-excavated areas. The CQA Engineer will observe any excavation and backfilling operations.

After the areas identified above are repaired, the CQA Engineer will verify and document scarification and compaction of selected portions of the subgrade designated by the Owner on the base of the secure cell or surface impoundment. Scarification will generally be to a depth of

not less than 8 inches. The CQA Engineer will verify and document that the compaction of the scarified surface is performed in accordance with the requirements for structural fill, provided in the General Specifications.

The CQA Engineer will report any problems or deviations from the above requirements to the Owner.

2.2 Fill Placement and Compaction

The General Specifications will be followed for the placement and compaction of fill. The CQA Engineer will monitor the fill placement and compaction to verify and document the following:

- The soil being placed meets the General Specification requirements for fill as determined by the test methods and frequencies specified within this CQA Plan;
- The compacted lift thickness is in accordance with the requirements of the General Specifications;
- The previous lift is scarified as specified in the General Specifications before placing the next lift;
- Fill is moisture conditioned, as required in the General Specifications; and,
- The compacted moisture content and dry unit weight of the fill meets specifications as determined by the test methods and frequencies described below.

2.3 Construction Quality Assurance Evaluation

The minimum frequency of soils testing for CQA purposes will conform to the minimum frequencies presented in Table II_2.

Nuclear density meter test methods will be used for the field testing of the in-situ dry unit weight and moisture content of the in-place, compacted fill. Sand cone tests, drive cylinder and/or rubber balloon tests and oven moisture content tests will be conducted to calibrate the results of the nuclear density meter and in cases of uncertainty with the nuclear density meter test results. Any conflict over the test results will be resolved by the CQA Engineer and the Owner. All perforations in the fill will be backfilled in accordance with the General Specifications.

If an in-place density test results fails to meet specifications, a confirmatory test will be performed immediately adjacent to the failed test. If the confirmatory test meets or exceeds specifications then a second confirmatory test will be performed at a second location immediately next to the failed test. If the second confirmatory test also meets or exceeds specifications then the area will be declared as meeting project specifications and the confirmatory tests will be reported. In the event that either confirmatory test fails to meet specifications, then additional testing will be performed to identify the limits of the area that does not meet project specifications.

If a defective area is discovered in the fill, the CQA Engineer will determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Engineer

will determine the extent of the defective area by additional tests, observations, a review of records, or other means that the CQA Engineer deems appropriate. If the defect is related to adverse site conditions, such as excessively wet soils or surface desiccation, the CQA Engineer will define the limits and nature of the defect by testing or observation. After the extent and nature of a defect is determined, the CQA Engineer will notify the Owner, and verify that the deficiency is corrected by the Contractor before any additional work is performed in the area of the deficiency.

2.4 Surveying

A Professional Land Surveyor registered in the State of Colorado will perform the CQA survey. The CQA Surveyor will independently survey the excavation and to confirm that the grades and elevations in the field agree with those shown on the Construction Drawings. CQA Surveys will be conducted in accordance with the requirements described in Part 8 of Section II.

The results of the survey conducted by the CQA Surveyor will be compiled in a report signed by the CQA Surveyor and the CQA Engineer. The CQA Engineer and the Owner will review and approve the survey results before the next phase of the lining system is constructed.

3.0 PERMANENT SUMP

3.1 Placement, Installation, and Compaction

The Contractor will be required to construct a permanent sump below the secure cell liner system. The CQA Engineer will monitor the excavation of the permanent sump and verify and document that the procedures for handling, placement, installation, and compaction of each material used to construct the permanent sump are the same as the procedures given in the General Specifications for liner system construction for that respective material.

3.2 Construction Quality Assurance Evaluation

Field quality assurance procedures for each material used to construct the sump will be the same as the procedures given in the CQA Plan for liner system construction for that respective material.

3.3 Surveying

A Professional Land Surveyor registered in the State of Colorado will perform the CQA Survey. The CQA surveyor will independently survey the elevations and grades of the excavation of the permanent sump, the top of subgrade of the permanent sump and the top of the gravel collection layer shown on the Construction Drawings.

The results of the survey conducted by the CQA Surveyor will be compiled in a report signed by the CQA Surveyor and the CQA Engineer. The CQA Engineer and Owner will approve the survey results before the next phase of the lining system construction.

Surveying will be conducted in accordance with requirements described in Part 8 of Section II.

4.0 CLAY LINERS AND COVERS

4.1 Secondary Clay Liner Placement and Compaction

The CQA Engineer will verify and document that the secondary clay liner is constructed to the elevations, grades, and thicknesses shown on the Construction Drawings, with material meeting the requirements of the General Specifications as determined by the test methods and frequencies specified within this CQA Plan.

Prior to the placement of the secondary clay liner, the CQA Engineer will verify and document that:

- All or an approved portion of the excavation, subgrade foundation and permanent sump (for secure cells only) are complete, and that a survey has been conducted to verify that the subgrade grades and elevations conform to the Construction Drawings;
- The subgrade meets specifications as determined by the test requirements of this CQA Plan;
- The surface of the subgrade is free of debris, wet and soft areas, ponded water, vegetation, mud, ice or frozen material; and,
- If frozen subgrade material is encountered, it is removed and replaced in accordance with the General Specifications.

During placement and compaction of the secondary clay liner, the CQA Engineer (or his designated representative) will verify and document that:

- In accordance with the CHDT Part B Permit, continuous close inspection of the placement and compaction of clay liner material with earthmoving equipment is performed by the CQA Engineer;
- The clay liner material meets the requirements of the General Specifications as determined by the CQA testing methods and frequency in Table II-3;
- The secondary clay liner is placed in accordance with the conditions and minimum requirements of the General Specifications;
- Each lift is compacted to the required thickness and minimum dry unit weight within the range of moisture contents established by the General Specifications as determined by the CQA testing methods and frequency in Table II-3;
- The Contractor uses the compaction equipment and the number of passes specified in the General Specifications;
- Thin-walled (i.e., Shelby tube) samples of secondary clay liner material are collected and laboratory permeability testing is performed at the frequency specified in Table II-3; and,

- Perforations in the clay liner at testing and sampling locations are backfilled in accordance with the General Specifications.

The CQA Engineer will document the properties of the clay soil as determined by the test methods and frequency prescribed by this CQA Plan and will report any nonconformance with the General Specifications to the Owner.

4.2 Primary Clay Liner Placement and Compaction

The CQA Engineer will verify and document that the primary clay liner is constructed to the elevations, grades, and thicknesses shown on the Construction Drawings, with material meeting the requirements of the General Specifications as determined by the test methods and frequencies specified within this CQA Plan.

Prior to the placement of the primary clay liner, the CQA Engineer will verify and document that:

- All, or an approved portion, of the leak detection layer, the leak detection system sump, and any associated piping are complete, and that all conformance sampling, testing, and documenting has been conducted to verify that the Contractor's work is in conformance with the Contract Documents; and,

- The leak detection layer is free of debris, ponded water, rocks, mud, ice, or other deleterious material, and that excessive wrinkles in the geosynthetic components of the leak detection layer have been "worked out".

All of the CQA activities identified for the secondary clay liner in Section 4.1 above are also required during placement and compaction of the primary clay liner. In addition, the CQA Engineer will verify and document that the first lift of primary clay liner material above the leak detection system is placed with extreme care using low ground pressure equipment as described in the General Specifications (compaction requirements will be waived to assure that no damage to the underlying geosynthetics occurs):

- For the remaining lifts, the lift thicknesses correspond to the requirements of the General Specifications; and,

- On the side slopes, mechanized equipment does not operate within the minimum distance specified in the General Specifications and that field quality control tests are not performed within a 1 foot zone of the slope face.

The CQA Engineer will document the properties of the clay soil in the primary liner as determined by the test methods and frequencies prescribed within this CQA Plan and will report any nonconformance with the General Specifications to the Owner.

4.3 Construction Quality Assurance Evaluation

Extensive construction quality assurance testing is required of the clay liners, and the Contractor must take quality assurance testing into account when planning his construction schedule. Nuclear density meter test methods will be used for testing the in_situ compacted dry unit weight and moisture content of the clay materials. Sand cone, drive cylinder and/or Rubber Balloon tests and oven moisture content tests will be used to calibrate the reading of the nuclear density meter and in cases of uncertainty with the nuclear density meter readings. Any

discrepancies between test results will be resolved by the CQA Engineer and the Owner. Thin walled (i.e., Shelby) tube samples will be collected for hydraulic conductivity testing. At the request of the CQA Engineer, onsite construction equipment operated by the Contractor will be used to slowly push the sample tube through the clay layer. The CQA Engineer will conduct moisture, density, and hydraulic conductivity tests as specified in Table II_3.

The testing frequency during clay liner construction may be increased or modified at the discretion of the CQA Engineer when visual observations of construction performance indicate potential problems.

During construction, the frequency of testing may be increased by the CQA Engineer during adverse weather conditions, if equipment breaks down, at the start and finish of grading, if the material fails to meet the requirements of the General Specifications, or the extent of the work area is reduced.

All perforations in the clay liner at nuclear density test probe locations will be backfilled by the CQA Engineer with bentonite (sodium montmorillonite) powder or flakes or a soil_bentonite mixture and compacted by hand tamping. All perforations at sand cone or rubber balloon test locations, Shelby tube sample locations, and test pit locations will be backfilled by the Contractor with clay liner material and compacted in accordance with the specifications for clay liner.
If an in_place density test results fail to meet specifications, a confirmatory test will be performed immediately adjacent to the failed test. If the confirmatory test meets or exceeds specifications then a second confirmatory test will be performed at a second location immediately next to the failed test. If the second confirmatory test also meets or exceeds specifications then the area will be declared as meeting project specifications and the confirmatory tests will be reported. In the event that either confirmatory test fails to meet specifications, then additional testing will be performed to identify the limits of the area that does not meet project specifications.

If a defective area is discovered in the clay liner, the CQA Engineer will determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Engineer will determine the extent of the defective area by additional tests, observations, a review of records, or other means that the CQA Engineer deems appropriate. If the defect is related to adverse site conditions, such as excessively wet soils or surface desiccation, the CQA Engineer will define the limits and nature of the defect by testing or observation. After the extent and nature of a defect is determined and has been remedied by the Contractor, the CQA Engineer will verify that the deficiency is corrected by retesting repaired areas before any additional work is performed by the Contractor in the area of the deficiency.

Based on the requirements of the General Specifications, the Contractor will be required to use all means necessary to protect all prior work, as well as all materials and completed work of other Sections. In the event of damage, the Contractor will be required to immediately make all repairs and replacements necessary. The CQA Engineer will verify and document that all damages are repaired.

4.4 Surveying

A Professional Land Surveyor registered in the State of Colorado will perform the CQA surveys. The CQA Surveyor will independently survey the elevations and grades of the secondary and primary clay liner surfaces, and to confirm that the lines and elevations in the field agree with

those shown on the Construction Drawings. CQA surveys will be conducted in accordance with the requirements described in Part 8 of Section II.

The results of the survey conducted by the CQA Surveyor will be compiled in a report signed by the CQA Surveyor and the CQA Engineer, and will be reviewed by the Owner. The Owner and the CQA Engineer will approve the survey results before the next phase of the liner system (geomembrane installation) is constructed.

5.0 GRANULAR LEACHATE COLLECTION LAYER

5.1 Supplier

The Contractor will require that the granular material Supplier provide the CQA Engineer with quality control test results and a written certification signed by a responsible party of the Supplier that the tests required by the General Specifications have been performed on the material to be delivered to the site.

The CQA Engineer will examine the tests results and report any deviations to the Owner. If the gravel supplier cannot provide test results required by the general specifications, then the CQA Engineer may perform or arrange to perform the tests.

5.2 Conformance Evaluation

The test methods and frequency for CQA conformance testing of the granular leachate collection material are specified in Table II_4.
If the granular material fails to meet the requirements of the General Specifications, the CQA Engineer will perform sufficient sampling and testing to identify the extent of the nonconforming material at the expense of the Contractor. Nonconforming material will be removed from the site.

5.3 Placement and Compaction

Prior to the placement of the granular leachate collection layer, the CQA Engineer will verify and document that:

- The underlying geomembrane liner or geosynthetic layer is free of holes, tears, excessive wrinkles, or foreign objects; and,
- All work on underlying layers is complete and accepted by the Owner.

During placement and compaction of the granular leachate collection layer, the CQA Engineer will verify and document that:

- Granular material satisfies the requirements of the General Specifications as determined by the testing prescribed within the CQA Plan;
- The equipment wheel ground pressure versus the material thickness requirements given in the General Specifications are complied with;

- The granular material is placed in a manner so that the maximum material drop height is in accordance with the General Specifications;

- In accordance with Part II.E.1.b.ii. of the CHDT Part B Permit, continuous close inspection of the placement and compaction of granular leachate collection layer material with earth moving equipment is performed; and,

- The granular material is compacted utilizing the equipment and number of passes specified in the General Specifications.

5.4 Construction Quality Assurance Evaluation

No density tests will be conducted on the granular leachate collection layer. If the CQA Engineer suspects damage to pipes or underlying geosynthetic, the contractor will be required to expose the potentially damaged materials and repair any observed damage.

5.5 Surveying

A Professional Land Surveyor registered in the State of Colorado will perform CQA surveys. The CQA surveyor will independently survey the elevations and grades of the top of the granular leachate collection layer, and to confirm that the grades and elevations in the field agree with those shown on the Construction Drawings. The CQA surveys will be performed in accordance with the requirements described in Part 8 of Section II.

The results of the survey conducted by the CQA Surveyor will be compiled in a report signed by the CQA Surveyor and the CQA Engineer, and will be reviewed by the Owner. The Owner and CQA Engineer will approve the survey results before the next phase of the lining system is constructed.

6.0 SUMP AND PIPE BEDDING GRAVEL AND ROAD BASE AGGREGATE GRAVEL

6.1 Supplier

The Contractor will provide the CQA Engineer with quality control test results and a written certification signed by a responsible party of the Gravel Supplier that the tests required by the General Specifications have been performed on material representative of that which is to be delivered to the site.

The CQA Engineer will examine the tests results and report any deviations from the General Specifications to the Owner. If the Gravel Supplier cannot provide test results required by the General Specifications, then the CQA Engineer may perform or arrange to perform the tests.

6.2 Conformance Evaluation

The test methods and frequency for CQA testing of the gravel is specified in Table II_5.

If the gravel fails to meet the requirements of the General Specifications, the CQA Engineer will perform sufficient sampling and testing to identify the extent of the nonconforming material with the cost of such tests borne by the Contractor. Nonconforming material will be removed from the site.

6.3 Placement

Prior to the placement of the gravel, the CQA Engineer will verify and document that:

- The underlying geotextile is free of holes, tears, excessive wrinkles, or foreign objects; and,
- All work on underlying layers is complete and accepted by the Owner.

During placement of the gravel, the CQA Engineer will verify and document that:

- In accordance with the CHDT Part B Permit, continuous close inspection of the placement of gravel with earth-moving equipment is performed;
- The gravel is suitable and meets the requirements of the General Specifications as determined by the test methods and frequency prescribed within this CQA Plan; and,
- The gravel is placed in accordance with the General Specifications.

6.4 Construction Quality Assurance Evaluation

No density tests will be conducted on the sump and pipe bedding gravel, or road base gravel. If the CQA Engineer suspects damage to pipes or underlying geosynthetics, the Contractor will be required to expose the potentially damaged materials and repair any observed damage.

7.0 PROTECTIVE SOIL LAYER

7.1 Placement and Compaction

Prior to the placement of the protective soil layer, the CQA Engineer will verify and document that:

- The underlying geocomposite is free of holes, tears, excessive wrinkles, or foreign objects; and,
- All work on underlying layers is complete and accepted by the Owner.

During placement of the protective soil layer, the CQA Engineer will verify and document that:

- The soil is suitable and satisfies the requirements of the General Specifications as determined by the test methods and frequencies prescribed within this CQA Plan;
- The protective soil is placed in accordance with the General Specifications;
- The lift thicknesses and total thickness of the protective soil layer agree with the requirements of the General Specifications;

- If excessive wrinkles begin to develop in the underlying geosynthetics during material placement or spreading, the wrinkles are worked out prior to continued placement operations;

- The protective soil layer is lightly compacted as described in the General Specifications;

- The protective soil is placed on the side slopes to the limits shown on the construction drawings; and,

- No protective soil layer material is placed or compacted during periods of unfavorable weather conditions.

7.2 Conformance Evaluation

There are no CQA testing requirements for the protective soil layer, other than thickness requirements.

If damage to underlying geosynthetics is expected, the CQA Engineer will require that the overlying protective soil layer material be removed to expose the geosynthetics.

The Contractor will be required to use all means necessary to protect all prior work, as well as all materials and completed work of other Sections. In the event of damage, the Contractor will be required to immediately make all repairs and replacements necessary. The CQA Engineer will verify and document that all damages are repaired.

7.3 Surveying

A Professional Land Surveyor registered in the State of Colorado will perform the CQA surveys. The CQA surveyor will independently survey the elevations and grades of the top of the protective soil layer on the base and side-slopes of the secure cell, and to confirm that the grades and elevations in the field agree with those shown on the Construction Drawings. The CQA surveys will be performed in accordance with the requirements described in Part 8 of Section II.

The results of the survey conducted by the CQA Surveyor will be compiled in a report signed by the CQA Surveyor and the CQA Engineer, and will be reviewed by the Owner.

8.0 SURVEYING

The Surveyor will be required to survey each soil layer of the liner system and cover system (except the vegetative soil cover) for the secure cell or surface impoundment in accordance with the requirements of the General Specifications. If required by the Owner, a Record Drawing will be submitted by the Surveyor before the placement of the next liner system layer. The surveys will be conducted at a 100 foot grid for slopes greater than 25 percent and at 50 foot grid for slopes less than 25 percent. All pipes for leachate detection, collection and/or removal will be surveyed at start and end points and at 50 foot intervals in between. The CQA survey will include enough information to confirm that the following features of the secure cell or surface impoundment are constructed in accordance with the Construction Drawings:

- Toe of slope;
- Crest of slope;
- Grade breaks;
- Anchor trench;
- Leachate collection sump;
- Leak detection sump;
- Permanent sump (secure cells only); and,
- Perimeter drainage ditches.

The CQA results will be submitted to the Owner for final approval to proceed on the liner system construction.

TABLE II-1
MINIMUM FREQUENCY OF TESTING FOR CQA EVALUATION OF FOUNDATION SUBGRADE

Test	Frequency	Standard Test Method
Permeability		
Shelby Tube or other appropriate undisturbed samples	3 from base of excavation	ASTM D 5084

TABLE II_2
MINIMUM FREQUENCY OF TESTING FOR CQA EVALUATION OF STRUCTURAL AND GENERAL FILL

Test	Frequency	Standard Test Method
Material Properties		
Standard Proctor	1 per 5,000 cy placed (minimum 1 per source)	ASTM D 698
Sieve Analysis	1 per 5,000 cy placed (minimum 1 per source)	ASTM D 422
Atterberg Limits	1 per 5,000 cy placed (minimum 1 per source)	ASTM D 4318
In Place		
Nuclear Density Meter (50 ft. grid)		
In-Situ Moisture Content	1 per 2,500 ft^2 per lift	ASTM D 3017
In-Situ Dry Unit Weight	1 per 2,500 ft^2 per lift	ASTM D 2922
Calibration and Check		
Sand Cone (In-Situ Density)	1 per day of fill placement	ASTM D 1556
Oven Moisture Contents (In-Situ Moisture Content)	1 per day of fill placement	ASTM D 2216

TABLE II_3:
MINIMUM FREQUENCY OF TESTING FOR CQA EVALUATION OF CLAY LINER MATERIAL AND COMPACTION

Test	Frequency	Standard Test Method
Material Properties		
Standard Proctor	1 per 3,000 cy placed (minimum 1 per source)	ASTM D 698
Sieve Analysis	1 per 3,000 cy placed (minimum 1 per source)	ASTM D 422
Atterberg Limits	1 per 3,000 cy placed (minimum 1 per source)	ASTM D 4318
In Place		
Lift Thickness Before Compaction	1 per 2,500 ft^2 per lift	Field Measurement
Nuclear Density Meter[1] (50 ft. grid)		
In-Situ Moisture Content	1 per 2,500 ft2 per lift	ASTM D 3017
In-Situ Dry Unit Weight	1 per 2,500 ft^2 per lift	ASTM D 2922
Calibration and Check		
Sand Cone, Rubber Balloon (In-Situ Density), Drive Cylinder	1 per day of fill placement	ASTM D 1556/D 2167/ASTM D 2937

Oven Moisture Contents (In-situ Moisture Content)	1 per day of fill placement	ASTM D 2216
Permeability[1]		
Shelby tube Samples	1 for every 1,000 cu. yd. placed	ASTM D 5084
[1]The Shelby tube sampling and nuclear density testing frequency does not include clay placed as overbuild material on the cell side-slopes.		

TABLE II-4:
MINIMUM FREQUENCY OF TESTING FOR CQA EVALUATION OF GRANULAR LEACHATE COLLECTION LAYER

Test	Frequency	Standard Test Method
Material Properties		
Sieve Analysis	1 per 500 cy placed (minimum 1 per source)	ASTM D 422
Permeability	1 per source	ASTM D 2434

TABLE II-5
MINIMUM FREQUENCY OF TESTING FOR CQA EVALUATION OF SUMP AND PIPE BEDDING GRAVEL AND ROAD BASE GRAVEL

Test	Frequency	Standard Test Method
Material Properties		
Sieve Analysis	1 per 100 cy placed (minimum 1 per source)	ASTM D 422

SECTION III - GEOSYNTHETIC CLAY LINER CONSTRUCTION QUALITY ASSURANCE

1.0 GEOSYNTHETIC CLAY LINER MANUFACTURE AND DELIVERY

1.1 Manufacture and Quality Control

Prior to the installation of the Geosynthetic Clay Liner (GCL), the Contractor will be required to provide the CQA Engineer with the following information from the GCL Manufacturer:

- The certification required by the General Specifications signed by a responsible party employed by the GCL Manufacturer based on sampling interval of 1/ 40,000 ft^2; and,

- The manufacturing quality control certificates for each shift's production of GCL, signed by a responsible party employed by the GCL Manufacturer (such as the production manager). The quality control certificates will include:

  - Roll numbers and identification; and,

  - Sampling procedures and results of quality control tests specified by the General Specifications including descriptions of the test methods used for GCL rolls assigned to the Highway 36 project.

The CQA Engineer will verify and document that:

- The property values certified by the GCL Manufacturer meet all of the specified values listed in the General Specifications;

- The measurements of properties by the GCL Manufacturer are properly documented and the test methods used are in accordance with the General Specifications; and,

- The quality control certificates have been provided at the specified frequency for GCL rolls, and each certificate identifies the rolls or batch number related to that certificate.

The CQA Engineer will report deviations from the above requirements to the Owner prior to installation of the GCL.

1.2 Labeling

The CQA Engineer will verify and document that the GCL Manufacturer has labeled each roll of GCL as specified in the General Specifications.

The CQA Engineer will examine GCL rolls upon delivery and deviation from the above requirements will be reported to the Owner prior to installation of the GCL.

1.3 Transportation and Handling

The CQA engineer will observe and document the type of GCL handling equipment used by the installer is consistent with handling equipment identified in the general specifications.

Upon delivery at the site, the CQA Engineer will conduct a visual inspection of all rolls for defects and for damage. This examination will be conducted without unrolling rolls unless visible defects or damages are found. The CQA Engineer will indicate to the Owner:

- Any rolls that should be unrolled to allow for their inspection;
- Any rolls, or portions thereof, which should be rejected and removed from the site because they have severe flaws; and,
- Any rolls which include minor repairable flaws.

1.4 Storage

The CQA Engineer will verify and document that storage of the GCL is in accordance with the General Specifications.

1.5 Quality Assurance Conformance Testing

Either at the Manufacture's plant or upon delivery of the rolls of GCL, the CQA Engineer will ensure that samples are removed at the specified frequency and forwarded to the Geosynthetics CQA Laboratory for testing to verify and document conformance with the General Specifications.

Unless otherwise specified, samples will be taken at a rate of one per lot or one per 100,000 ft^2 whichever is greater. These samples will be tested for:

- Bentonite Moisture Content ASTM D 4643
- GCL Grab Strength, Elongation, Per Strength ASTM D 4632
- GCL Permeability ASTM D-5887
- GCL Interface Shear Strength ASTM D 5321

Conformance samples will be taken across the entire width of the roll and will not include the first 3 feet along the length of the roll. Unless otherwise specified, samples will be 1.5 feet (minimum) long by the roll width. The CQA Engineer will Mark the machine direction on the samples with an arrow.

The CQA Engineer will examine all results from laboratory conformance testing and will compare the results to the specifications presented in Table 02780-1 of the Specifications. In addition, the CQA Engineer will report any nonconformance to the Owner as soon practical after the test results become available.

The following procedure will apply whenever a sample fails a conformance test that is conducted by the Geosynthetics CQA Laboratory:

- The Contractor will be required to replace the roll (or rolls) of geotextile that is not in conformance with the specifications with a roll that meets the requiremnts of the General Specificaitons.

- The CQA Engineer will ensure that conformance samples are removed for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the roll from which the failing sample was obtained. These two samples must pass the above conformance tests. If either of these samples fail to meet the requirements, samples will be collected from the five numerically closest untested rollls on both sides of the failed samples and tested by the Geosynthetics CQA Labatory. These ten samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of geotextile on site and a sample from every roll that is subsequently delivered from the same Manufacturer must be conformance tested by the Geosynthetics CQA Laboratory. The cost of all such tests are to be borne by the Contractor.

The CQA Engineer will document actions taken in conjunction with conformance test failures and report all actions to the Owner.

2.0 GEOSYNTHETIC CLAY LINER INSTALLATION

2.1 Earthworks

2.1.1 Surface Preparation

The Contractor or subcontractor responsible for GCL installation will be required to certify in writing that the surface on which the GCL will be installed is acceptable. The certificate of acceptance will be required to be given by the Contractor to the CQA Engineer, who will then verify to the Owner that the subgrade and/or geocomposite installation is accepted immediately prior to commencement of GCL installation in the area under consideration.

After the surface on which the GCL is to be installed has been accepted by the Contractor responsible for GCL installation, it will be the CQA Engineer's responsibility to indicate to the Owner any change in the underlying layer that may, in accordance with the General Specifications, require repair work. If the Owner requires repair work, then it will be the responsibility of the Contractor to repair the underlying layer.

2.1.2 Anchor Trenches

The CQA Engineer will verify and document that the anchor trench backfill meets the requirements of the General Specifications and that the backfill is placed in accordance with the General Specifications.

2.2 Geosynthetic Clay Liner Deployment

2.2.1 Field Panel Identification

A field panel is the unit area of GCL which is to be placed in the field, i.e., a field panel is a roll or a portion of roll cut in the field.

The CQA Engineer will verify that each field panel is given an identification code (number or letter_number) consistent with the layout plan. This identification code will be agreed upon by the Owner, and the Contractor. This field panel identification code should be as simple and logical as possible. (Note: manufacturing plant roll numbers are usually cumbersome and are not related to location in the field.) It will be the responsibility of the Contractor to ensure that each field panel placed is marked with the manufacturing plant roll number. The roll number will be marked in the center of the panel in a color to allow for easy inspection.

The CQA Engineer will establish a table or chart showing correspondence between manufacturing plant roll numbers and field panel identification codes. The field panel identification code will be used for all CQA records.

2.2.2 Field Panel Placement

2.2.2.1 Installation Schedule

The CQA Engineer will evaluate significant changes in the schedule proposed by the Contractor and advise the Owner on the acceptability of that change. The CQA Engineer will verify and document that the condition of the underlying layer has not changed detrimentally during installation. Any damage to the surface of the underlying layer will be repaired by the Contractor in accordance with the General Specifications.

The CQA Engineer will record the identification code, location, and date of installation of each field panel.

2.2.2.2 Weather Conditions

The CQA Engineer will verify and document that GCL is not placed during inclement weather conditions as specified within the General Specifications.

Additionally, the CQA Engineer will verify and document that the underlying layer has not been damaged by weather conditions.

2.2.2.3 Damage

The CQA Engineer will visually observe each panel, after placement, for damage. The CQA Engineer will advise the Owner which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels which have been rejected by the Owner will be marked, and their removal from the work area will be documented by the CQA Engineer.

2.2.2.4 Seam Overlap and Bentonite Seal

The CQA engineer will observe and document that the seam overlaps and bentonite material placed between panels along the seams meet specification guidelines. The CQA engineer will verify overlap width and will observe bentonite seal placement.

2.3 Defects and Repairs

2.3.1 Identification

All seams and non_seam areas of the GCL will be inspected by the CQA Engineer for evidence of defects, holes, decontamination of geotextiles, displaced panels, premature hydration, and any sign of contamination by foreign matter. The CQA Engineer will observe and document repair procedures described below.

2.3.2 Repair Procedures

Prior to cover material placement, damage to the GCL shall be identified and repaired by the installer.

2.3.2.1 Rip and Tear Repair (Flat Surfaces)

Rips or tears may be repaired by completely exposing the affected area, removing all foreign objects or soil, and by then placing a patch cut from unused GCL over the damage (damaged material may be left in place), with a minimum overlap of 12 inches on all edges.

Accessory bentonite should be placed between the patch edges and the repaired material at a rate of a quarter pound per lineal foot of edge spread in a continuous six inch fillet.

2.3.2.2 Rip and Tear Repair (Slopes)

Damaged GCL material on slopes shall be repaired by the same procedures above, however, the overlapped edges of the patch should be wide enough to ensure the patch will keep its position during backfill or cover operations.

2.3.2.3 Displaced Panels

Displaced panels shall be adjusted to the correct position and orientation. The adjusted panel shall then be inspected for any geotextile damage or bentonite loss. Damage shall be repaired by the above procedure.

2.3.2.4 Premature Hydration

If the GCL is subjected to premature hydration, the GCL installer shall notify the QA/QC technician and project engineer for a site specific determination as to whether the material is acceptable or if alternative measures must be taken to ensure the quality of the design - dependent upon the degree of damage.

SECTION IV - GEOMEMBRANE CONSTRUCTION QUALITY ASSURANCE

1.0 GEOMEMBRANE MANUFACTURE AND DELIVERY

1.1 Resin

Prior to the installation of the HDPE geomembrane material, the Contractor will be required to provide the CQA Engineer with the following information from the geomembrane Manufacturer:

- A copy of the quality control certificates issued by the resin Supplier that includes the origin (resin Supplier's name and resin production plant), identification (brand name, number) the production date of the resin used in the manufacture of the geomembrane shipped to the site, and the results of tests conducted to verify that the quality of the resin used to manufacture the geomembrane rolls assigned to the project meets the General Specifications; and

- Certification from the geomembrane Manufacturer that no reclaimed polymer is added to the resin during the manufacture of the geomembrane to be used in this project; the use of polymer recycled during the manufacturing process is permitted if the recycled polymer does not exceed 2 percent by weight of the total polymer weight.

The CQA Engineer will review these documents and report any discrepancies with the above requirements to the Owner.

1.2 Geomembrane Manufacturing Quality Control

Prior to the installation of the HDPE geomembrane, the Contractor will be required to provide the CQA Engineer with the following information from the geomembrane Manufacturer:

- The certification required by the General Specifications signed by a responsible party employed by the geomembrane Manufacturer based on sampling interval specified in GR1-GM13; and,

- The manufacturing quality control certificates for each shift's production of geomembrane, signed by a responsible party employed by the geomembrane Manufacturer (such as the production manager). The quality control certificates will include:

  - Roll numbers and identification; and,

  - Sampling procedures and results of quality control tests specified by the General Specifications including descriptions of the test methods used for geomembrane rolls assigned to the Highway 36 project.

The CQA Engineer will verify and document that:

- The property values certified by the geomembrane Manufacturer meet all of the specified values listed in the General Specifications;
- The measurements of properties by the geomembrane Manufacturer are properly documented and the test methods used are in accordance with the General Specifications; and,
- The quality control certificates have been provided at the specified frequency for geomembrane rolls, and each certificate identifies the rolls or batch number related to that certificate.

The CQA Engineer will report deviations from the above requirements to the Owner prior to installation of the geomembrane.

1.3 Labeling

The CQA Engineer will verify and document that the geomembrane Manufacturer has labeled each roll of geomembrane as specified in the General Specifications.

The CQA Engineer will examine geomembrane rolls upon delivery and deviation from the above requirements will be reported to the Owner prior to installation of the geomembrane.

1.4 Transportation and Handling

Upon delivery at the site, the CQA Engineer will conduct a visual inspection of all rolls for defects and for damage. This examination will be conducted without unrolling rolls unless visible defects or damages are found. The CQA Engineer will indicate to the Owner:

- Any rolls that should be unrolled to allow for their inspection;
- Any rolls, or portions thereof, which should be rejected and removed from the site because they have severe flaws; and,
- Any rolls which include minor repairable flaws.

1.5 Storage

The CQA Engineer will verify and document that storage of the geomembrane is in accordance with the General Specifications.

1.6 Quality Assurance Conformance Testing

Either at the Manufacture's plant or upon delivery of the rolls of geomembrane, the CQA Engineer will ensure that samples are removed at the specified frequency and forwarded to the Geosynthetics CQA Laboratory for testing to verify and document conformance with the General Specifications.

Conformance samples will be taken by the CQA Engineer across the entire width of the roll and will not include the first 3 feet. Unless otherwise specified, samples will be 1.5 feet (minimum)

long by the roll width. The CQA Engineer will mark the direction of the machine used to cut the samples with an arrow.
Unless otherwise specified, samples will be taken at a rate of one per lot or one per 100,000 ft^2 whichever is greater. These samples will be tested for:

- Specific gravity (ASTM D 1505);
- Thickness (ASTM D 5994
- Yield strength and yield elongation (ASTM D 6693);
- Tensile strength and tensile elongation at break (ASTM D 6693);
- Carbon black content (ASTM D 1603); and,

The CQA Engineer will examine all results from laboratory conformance testing and will report any nonconformance to the Owner as soon practical after the test results become available.

The following procedure will apply whenever a sample fails a conformance test that is conducted by the CQA Engineer:

- The Contractor will be required to replace the roll (or rolls) of geomembrane that is in nonconformance with the General Specifications with a roll that meets the General Specifications.
- The CQA Engineer will ensure that conformance samples are removed for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must pass the above conformance tests. If either of these samples fail, samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics CQA Laboratory. These ten samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of geomembrane on site and every roll subsequently delivered from the same Manufacturer must be conformance tested by the Geosynthetics CQA Laboratory; the cost of all such additional tests are to be borne by the Contractor.

The CQA Engineer will document actions taken in conjunction with conformance test failures and report all actions to the Owner.

2.0 GEOMEMBRANE INSTALLATION

2.1 Earthwork

2.1.1 Surface Preparation

The Contractor or subcontractor responsible for geomembrane installation will be required to certify in writing that the surface on which the geomembrane will be installed is acceptable. The certificate of acceptance will be required to be given by the Contractor to the CQA Engineer, who will then verify to the Owner that the subgrade is accepted immediately prior to commencement of geomembrane installation in the area under consideration.

After the surface on which the geomembrane is to be installed has been accepted by the Contractor responsible for geomembrane installation, it will be the CQA Engineer's responsibility to indicate to the Owner any change in the underlying layer that may, in accordance with the General Specifications, require repair work. If the Owner requires repair work, then it will be the responsibility of the Contractor to repair the underlying layer.

2.1.2 Anchor Trenches

The CQA Engineer will verify and document that the anchor trench backfill meets the requirements of the General Specifications and that the backfill is placed in accordance with the General Specifications.

2.2 Geomembrane Deployment

2.2.1 Layout Drawing

The Contractor will be required to produce layout drawings which show the geomembrane panel configuration, dimensions, details, seam locations, etc. The layout drawings must be approved by the Owner prior to the installation of the geomembrane. The layout drawings, as modified and/or approved by the Owner will be part of the specifications, and a copy will be furnished to the CQA Engineer. The CQA Engineer will become familiar with the layout drawings.

2.2.2 Field Panel Identification

A field panel is the unit area of geomembrane which is to be seamed in the field, i.e., a field panel is a roll or a portion of roll cut in the field.

The CQA Engineer will verify that each field panel is given an identification code (number or letter_number) consistent with the layout plan. This identification code will be agreed upon by the Owner, and the Contractor. This field panel identification code should be as simple and logical as possible. (Note: manufacturing plant roll numbers are usually cumbersome and are not related to location in the field.) It will be the responsibility of the Contractor to ensure that each field panel placed is marked with the manufacturing plant roll number. The roll number will be marked in the center of the panel in a color to allow for easy inspection.

The CQA Engineer will establish a table or chart showing correspondence between manufacturing plant roll numbers and field panel identification codes. The field panel identification code will be used for all CQA records.

2.2.3 Field Panel Placement

2.2.3.1 Location

The CQA Engineer will verify and document that field panels are installed at the locations and positions indicated in the Contractor's layout plan, as approved or modified by the Owner.

2.2.3.2 Installation Schedule

The CQA Engineer will evaluate significant changes in the schedule proposed by the Contractor and advise the Owner on the acceptability of that change. The CQA Engineer will verify and document that the condition of the underlying layer has not changed detrimentally during installation. Any damage to the surface of the underlying layer will be repaired by the Contractor in accordance with the General Specifications.

The CQA Engineer will record the identification code, location, and date of installation of each field panel.

2.2.3.3 Weather Conditions

The CQA Engineer will verify and document that geomembrane is not placed during inclement weather conditions as specified within the General Specifications.

Additionally, the CQA Engineer will verify and document that the underlying layer has not been damaged by weather conditions.

2.2.3.4 Damage

The CQA Engineer will visually observe each panel, after placement and prior to seaming, for damage (e.g., holes, blisters, creases). The CQA Engineer will advise the Owner which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels which have been rejected by the Owner will be marked, and their removal from the work area will be documented by the CQA Engineer.

2.3 Field Seaming

2.3.1 Seam Layout

The CQA Engineer will verify and document that the seam layout shown on the Panel Layout Drawing (Part 2.2.1) is consistent with the General Specifications. No panels may be seamed in the field without the Owner's approval. In addition, seams not specifically shown on the seam layout drawing may not be made without the Owner's prior approval.

A seam numbering system compatible with the panel numbering system will be agreed upon by the Contractor, the Owner, and CQA Engineer.

2.3.2 Seaming Equipment and Products

Processes approved by the General Specifications for field seaming are: (i) extrusion seaming; and (ii) fusion seaming. Proposed alternate processes will be required to be documented and submitted to the Owner for approval. Only seaming apparatus which the Owner has specifically

approved by make and model will be used. The Contractor will be required to use a pyrometer to ensure that accurate temperatures of the extrudate and seamer nozzle are being achieved.

The extrusion_seaming apparatus will be equipped with gauges indicating the temperatures of the extrudate and nozzle. The Contractor will be required to provide to the CQA Engineer the Manufacturer's certification that the extrudate is compatible with the General Specifications and is comprised of the same resin as the geomembrane.

The CQA Engineer will log ambient temperatures, seaming apparatus temperatures, and extrudate temperatures or fusion_seaming apparatus speeds. Ambient temperatures will be measured as specified in the General Specifications.

2.3.3 Seam Preparation

The CQA Engineer will verify and document that:

- Prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris, and foreign material; and,
- Preparation of seams is in accordance with the General Specifications.

2.3.4 Weather Conditions for Seaming

The CQA Engineer will verify and document that weather conditions for seaming are within the limits specified in the General Conditions.

2.3.5 Trial Seams

The Contractor will be required to make trial seams on fragment pieces of geomembrane liner to verify that seaming conditions are adequate. The Contractor will be required to make and test trial seams at the frequency and in accordance with the methods specified in the General Specifications.

The CQA Engineer will observe all trial seam procedures. The successful trial seam sample will be assigned a number and marked accordingly by the CQA Engineer, who will log the date, hour, ambient temperature, number of seaming unit, name of seamer, and pass or fail description. The sample itself will be retained only until the construction of the liner is complete and the liner has been accepted by the Owner.

2.3.6 Nondestructive Seam Continuity Testing

2.3.6.1 Introduction

Except as otherwise noted in the General Specifications, the Contractor will nondestructively test all field seams over their full length in accordance with the General Specifications. The purpose of nondestructive tests is to check the continuity of seams. Continuity testing will be carried out as the seaming work progresses, not at the completion of all field seaming. Nondestructive testing will not be permitted before sunrise or after sunset unless the Contractor demonstrates to the Owner that the Contractor has the capabilities to perform continuity testing under reduced light conditions.

The CQA Engineer will:

- Observe the continuity testing;
- Record location, date, test unit number, name of tester, and outcome of all testing; and,
- Document and inform the Contractor of any required repairs.

The Contractor will be required to complete any required repairs in accordance with the General Specifications.

The CQA Engineer will:

- Observe the repair and re_testing of the repair;
- Mark on the geomembrane that the repair has been made; and,
- Document the results.

The CQA Engineer will verify and document the procedures specified in the General Specifications where seams cannot be nondestructively tested.

The location, date of visual observation, name of tester, and outcome of the test or observation will be recorded by the CQA Engineer and reported to the Owner.

2.3.7 Destructive Seam Testing

2.3.7.1 Concept

Destructive seam tests will be performed at selected locations. The purpose of these tests is to evaluate seam strength and integrity. Seam strength testing will be done as the seaming work progresses, not at the completion of all field seaming.

2.3.7.2 Location and Frequency

The CQA Engineer will select locations where seam samples will be cut out for laboratory testing. The test frequency and locations will be established as follows:

- Samples will be collected at a minimum frequency of one test location per 500 ft of seam length (this minimum frequency is to be determined as an average taken throughout the entire secure cell or surface impoundment project); and,

- Test locations will be determined during seaming at the CQA Engineer's discretion; selection of such locations may be prompted by suspicion of excess crystallinity, contamination, offset seams, or any other potential cause of imperfect seaming.

The Contractor will not be informed in advance of the locations where the seam samples will be taken.

2.3.7.3 Sampling Procedure

The Contractor will be required to cut samples as directed by the CQA Engineer as the seaming progresses in order to have laboratory test results before the geomembrane is covered by another material. The CQA Engineer will:

- Observe sample cutting;

- Assign a number to each sample and mark it accordingly;

- Record the sample number and location on the panel layout drawing; and,

- Record the reason for taking the sample at this location (e.g., routine testing, suspicious feature of the geomembrane, etc.).

All holes in the geomembrane resulting from destructive seam sampling will be covered by the Contractor immediately after sampling and repaired in accordance with the repair procedures described in the General Specifications. The continuity of the new seams in the repaired area will be nondestructively tested according to the General Specifications.

2.3.7.4 Size of Samples

At a given sampling location, two types of samples will be required to be taken by the Contractor.

First, two specimens for field testing will be taken. Each of these specimens will be 1 inch wide by 6 to 12 inches long, with the seam centered parallel to the width. The distance between these two specimens will be approximately 42 inches. If both specimens pass the field test described in the General Specifications, a sample for laboratory testing will be taken.

The sample for laboratory testing will be required to be taken between the two specimens for field testing. The destructive sample will be 12 inches wide by 42 inches long with the seam centered lengthwise. The sample will be cut into three parts and distributed as follows:

- One portion to the Contractor, 12 inches long;
- One portion to the CQA Engineer for archive storage, 12 inches long; and,
- One portion to the CQA Engineer for CQA Laboratory testing, 18 inches long.

Final determination of the sample sizes will be made at the preconstruction meeting.

2.3.7.5 Field Testing

The two 1_inch wide specimens specified above will be required to be tested in the field, by the Contractor, by tensiometer for peel and should not fail in the seam. If any field test sample fails to pass, then the procedures outlined in the General Specifications will be required to be followed.

The CQA Engineer will observe field tests and mark all samples and portions with their number, date, and time.

2.3.7.6 Geosynthetic Construction Quality Assurance Laboratory Testing

Laboratory destructive test samples will be packaged and shipped to the CQA Laboratory by the CQA Engineer in a manner which will not damage the test sample. The CQA Engineer will store the archive samples until the completion of the project. Laboratory destructive test samples will be tested by the Geosynthetics CQA Laboratory.

Testing will include "Shear Strength", "Peel Strength", and "Shear Strain at Yield" (ASTM D 6392 with 1_inch wide strip, tested at 2 inches per minute). The minimum acceptable values to be obtained in these tests are those indicated in Table 02775_2 of Section 02775 of the General Specifications. At least 5 specimens will be tested for each test method. Specimens will be selected alternately by test from the samples (i.e., peel, shear, peel, shear...). At least 4 out of 5 of the specimens must pass.

The Geosynthetics CQA Laboratory will provide test results verbally to the CQA Engineer in a timely manner after they receive the samples. The CQA Engineer will review laboratory test results as soon as they become available, and inform the Owner of the test results.

2.3.7.7 Procedures for Destructive Test Failure

The procedures specified within the General Specifications will be required whenever a sample fails a destructive test, whether that test is conducted by the Geosynthetics CQA Laboratory, the Contractor's laboratory (if required), or by field tensiometer. The CQA Engineer will verify and document that one of the options specified within the General Specifications is followed.

The CQA Engineer will document all actions taken in conjunction with destructive test failures.

2.4 Defects and Repairs

2.4.1 Identification

All seams and non_seam areas of the geomembrane will be inspected by the CQA Engineer for evidence of defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane will be required to be clean at the time of examination. The geomembrane surface will be required to be broomed or washed by the Contractor if the amount of dust or mud inhibits examination.

2.4.2 Evaluation

Each suspect location both in seam and non_seam areas will be required to be either non_destructively tested using the methods described in the General Specifications, or repaired as appropriate as determined by the CQA Engineer. Each location which fails the non_destructive testing will be marked by the CQA Engineer and will be required to be repaired by the Contractor. Materials should not be placed over geomembrane locations that have been repaired until the CQA Engineer has approved the repair.

2.4.3 Large Wrinkles

When seaming of the geomembrane is completed (or when seaming of a large area of the geomembrane is completed) and prior to placing overlying materials, the CQA Engineer will visually inspect the geomembrane for wrinkles. The CQA Engineer will indicate to the Contractor which wrinkles, if any, should be cut and reseamed. The seam thus produced will be tested like any other seam.

2.4.4 Repair Procedures

Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test will be repaired by the Contractor in accordance with the applicable method specified within the General Conditions.

2.4.5 Testing of Repairs

Each repair will be located and logged by the CQA Engineer. Each repair will be non_destructively tested using the methods described in the General Specifications as appropriate. Repairs which pass the non_destructive test will be considered as an adequate repair. Large caps may be of sufficient extent to require destructive testing, at the discretion of the CQA Engineer. Failed tests will require the repair to be redone and retested until passing test results are obtained. The CQA Engineer will observe the non_destructive testing of repairs and will document the date of the repair and test outcome.

2.5. Appurtenances

The CQA Engineer will verify and document that:

- Installation of the geomembrane around, and connection of geomembrane to appurtenances have been made according to the General Specifications;

- Extreme care is taken while seaming around appurtenances since neither non_destructive nor destructive testing may be feasible in these areas; and,

- The geomembrane has not been visibly damaged while being connected to appurtenances.

The CQA Engineer will inform the Owner if the above conditions are not fulfilled.

3.0 SURVEYING

The CQA Engineer, in conjunction with the Surveyor, will be required to prepare an "as_built" Record Drawing for geomembrane installations. It will include the surveyed location of field panels, seams (factory and field), repairs, and test locations.

The CQA results (Record Drawing and certification of Contractor's work) will be submitted to the Owner for final review and approval prior to proceeding with construction of any subsequent liner system components.

SECTION V - GEOTEXTILE CONSTRUCTION QUALITY ASSURANCE

1.0 GEOTEXTILES

1.1 Manufacturing

The Geosynthetics Contractor will be required to provide the CQA Engineer with the following information from the geotextile Manufacturer:

- Certification required by the General Specifications signed by a responsible party employed by the geotextile Manufacturer; and,
- The manufacturing quality control certificates for each shift's production of geotextile rolls, which include geotextile roll numbers and identification, sampling procedures, and descriptions and results of the quality control tests specified in the General Specifications signed by a responsible party employed by the geotextile Manufacturer.

The CQA Engineer will examine all geotextile Manufacturer's certifications to verify and document that the property values listed on the certifications meet or exceed those specified within the General Specifications and that proper and complete documentation has been provided by the geotextile Manufacturer for all geotextile used at the site. The CQA Engineer will report any deviations from the above requirements to the Owner prior to installation of the geotextile.

1.2 Labeling

The CQA Engineer will verify and document that the geotextile Manufacturer has labeled all rolls of geotextile with the information specified in the General Specifications.

The CQA Engineer will examine rolls upon delivery and any deviation from the above requirements will be reported to the Owner prior to installation of the geotextile.

1.3 Shipment and Storage

The CQA Engineer will observe rolls of geotextile upon delivery at the site and any deviation from the requirements specified within the General Specifications will be reported to the Owner. Any damaged rolls will be rejected by the CQA Engineer and required to be repaired or replaced by the Contractor.

1.4 Conformance Testing

Either at the Manufacturer's factory or upon delivery of the geotextile rolls, the CQA Engineer will ensure that samples are removed and forwarded to the Geosynthetics CQA Laboratory for testing to verify and document conformance with the requirements of the General Specifications.

Conformance samples will be taken across the entire width of the roll and will not include the first 3 feet along the length of the roll. Unless otherwise specified, samples will be 1.5 feet

(minimum) long by the roll width. The CQA Engineer will mark the machine direction on the samples with an arrow.

Samples will be taken at a rate of one per lot or one per 100,000 ft^2, whichever is greater. These samples will be tested for:

- Mass per unit area (ASTM D 5261);
- Grab strength (ASTM D 4632);
- Tear strength (ASTM D 4533);
- Puncture strength (ASTM D 4833); and,
- Permittivity (ASTM D 4491).

If the geotextile is being used as a filter, cushion or separator, the samples will also be tested for apparent opening size (ASTM D 4751).

The CQA Engineer will examine all results of laboratory conformance testing and report any nonconformance to the Owner as soon as results become available.

The following procedure will apply whenever a sample fails a conformance test that is conducted by the Geosynthetics CQA Laboratory:

- The Contractor will be required to replace the roll (or rolls) of geotextile that is not in conformance with the specifications with a roll that meets the requirements of the General Specifications.

- The CQA Engineer will ensure that conformance samples are removed for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the roll from which the failing sample was obtained. These two samples must pass the above conformance tests. If either of these samples fail to meet the requirements, samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics CQA Laboratory. These ten samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of geotextile on site and a sample from every roll that is subsequently delivered from the same Manufacturer must be conformance tested by the Geosynthetics CQA Laboratory. The cost of all such tests are to be borne by the Contractor.

The CQA Engineer will document actions taken in conjunction with conformance test failures and report all actions taken to the Owner.

1.5 Handling and Placement

The Geosynthetics Contractor will be required to handle all geotextile in such a manner as to ensure the geotextile is not damaged in any way. The CQA Engineer will verify and document compliance with the following:

- Just prior to geotextile placement, the layer that underlies the geotextile, if it is a geosynthetic, is clean and free of excessive amounts of dust, dirt, stones, rocks, or other obstructions that could potentially damage the liner system.

- In the presence of excessive wind, the geotextile is weighted with sandbags (or equivalent weight approved by the CQA Engineer).

- Geotextile is kept under tension to minimize the presence of wrinkles in the geotextile. If necessary, the geotextile is positioned by hand after being unrolled to minimize wrinkles.

- Geotextiles are cut using a geotextile cutter approved by the geotextile Manufacturer and the CQA Engineer. If in place, special care is taken to protect other materials (such as underlying geosynthetics) from damage which could be caused by the cutting of the geotextiles.

- The Contractor takes any necessary precautions to prevent damage to the underlying layers during placement of the geotextile.

- During placement of geotextiles, care is taken not to entrap in the geotextile stones, excessive dust, or moisture that could damage the underlying layers, generate clogging of drains or filters, or hamper subsequent seaming.

- Geotextile is not left exposed for a period in excess of 30 days after placement unless a longer exposure period is approved by the CQA Engineer and Owner.

The CQA Engineer will document any noncompliance with the above requirements and report them to the Owner.

1.6 Seams and Overlaps

The CQA Engineer will verify and document that all geotextile seams are oriented, overlapped and sewn in accordance with the General Specifications.

The Contractor will be required to pay close attention at seams to ensure that no protective soil layer material could be inadvertently placed beneath the geotextile.

Sewing will be required to be performed as required in the General Specifications.

1.7 Repair

The CQA Engineer will verify and document that any holes or tears in the geotextile are repaired in accordance with the requirements of the General Specifications.

The CQA Engineer will document any noncompliance with the above requirements and report it to the Owner.

SECTION VI - GEONET CONSTRUCTION QUALITY ASSURANCE

1.0 GEONET

1.1 Manufacturing

The Geosynthetics Contractor will be required to provide the CQA Engineer with the following information from the geonet Manufacturer:

- Certifications required by the General Specifications signed by a responsible party employed by the geonet Manufacturer;
- The certification from the geonet Manufacturer that no reclaimed polymer was added to the resin during the manufacture of the geonet rolls assigned to this project; and,
- The manufacturing quality control certificates for each shift's production of geonet rolls, which include geonet roll numbers and identification, sampling procedures, and descriptions and results of quality control tests for polymer specified in the General Specifications signed by a responsible party employed by the geonet Manufacturer.

The CQA Engineer will examine all geonet Manufacturer's certifications to verify and document that the property values listed on the certifications meet or exceed those specified within the General Specifications and that proper and complete documentation has been provided by the geonet Manufacturer for all geonet used at the site. The CQA Engineer will report any deviations from the above requirements to the Owner.

1.2 Labeling

The CQA Engineer will verify and document that the geonet Manufacturer has labeled all rolls of geonet as specified within the General Specifications.

The CQA Engineer will examine rolls upon delivery and any deviation from the above requirements will be reported to the Owner prior to installation of the geonet.

1.3 Shipment and Storage

The CQA Engineer will observe the rolls of geonet upon delivery at the site and any deviations from the requirements specified within the General Specifications will be reported to the Owner. Any damaged rolls will be rejected by the CQA Engineer and will be required to be repaired or replaced by the Contractor.

1.4 Conformance Testing

Either at the Manufacturer's plant or upon delivery of the geonet rolls, the CQA Engineer will ensure that samples are removed and forwarded to the Geosynthetic CQA Laboratory for testing, to verify and document conformance with the requirements of the General Specifications.

Conformance samples will be taken across the entire width of the roll and will not include the first 3 feet. Unless otherwise specified, samples will be 1.5 feet long (minimum) by the roll width. The CQA Engineer will mark the machine direction on the samples with an arrow.

Samples will be taken at a rate of one per lot or one per 100,000 ft^2, whichever is greater. These samples will be tested for:

- Polymer specific gravity (ASTM D 1505);
- Carbon black (ASTM D 1603);
- Thickness (ASTM D 5199); and,
- Transmissivity (ASTM D 4716).

The CQA Engineer will examine all results from laboratory conformance testing and will report any nonconformance to the Owner as soon as the results become available.

The following procedure will apply whenever a sample fails a conformance test that is conducted by the Geosynthetics CQA Laboratory:

- The Contractor will be required to replace the roll (or rolls) of geonet that is not in conformance with the specifications with a roll that meets the requirements of the General Specifications.

- The CQA Engineer will ensure that conformance samples are removed for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must pass the above conformance tests. If either of these samples fail, samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics CQA Laboratory. These ten samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of geonet on site and a sample from every roll that is subsequently delivered from the same Manufacturer must be conformance tested by the Geosynthetics CQA Laboratory. The cost of such tests is to be borne by the Contractor.

The CQA Engineer will document actions taken in conjunction with conformance test failures and report all actions taken to the Owner.

1.5 Handling and Placement

The Contractor will handle all geonet in such a manner as to ensure the geonet is not damaged. The CQA Engineer will verify and document compliance with the following:

- The geonet is free of dirt or excessive dust just before installation.

- Just prior to geonet placement, the geomembrane liner that will underlie the geonet is clean and free of excessive amounts of dust, dirt, stones, rocks, or other obstructions that could potentially damage the geomembrane or clog the drainage system.

- On side slopes, the geonet is secured at the top of the slope then rolled down the slope in such a manner as to keep the geonet sheet in tension. If necessary, the geonet is positioned by hand after being unrolled to minimize wrinkles. Geonet can be place in the horizontal direction (i.e., across the slope) in some special locations (e.g., at the toe of a slope). If an extra layer of geonet is required, this extra layer of geonet can be placed in the horizontal direction. Such locations will be identified on the Construction Drawings.

- In the presence of excessive wind, the geonet is weighted with sandbags or the equivalent.

- Unless otherwise specified, geonet is not welded to geomembrane.

- Geonet will only be cut using a cutter approved by the geonet Manufacturer and the CQA Engineer. If in place, special care is taken to protect underlying geosynthetics from damage that could be caused by cutting of the geonet.

- The Geosynthetics Contractor takes any necessary precautions to prevent damage to underlying layers during placement of the geonet.

- During placement of geonets, care is taken not to entrap in the geonet dirt or excessive dust that could cause clogging of the drainage system, and/or stones that could damage the adjacent geomembrane. If dirt or excessive dust is entrapped in the geonet, it is hosed clean prior to placement of the next material on top of it. In this regard, care should be taken with the handling or sandbags, to prevent rupture or damage of the sandbag.

- Geonet is not placed in direct contact with textured geomembrane liner unless specifically called for in the Construction Drawings.

The CQA Engineer will document any noncompliance with the above requirements and report it to the Owner.

1.6 Stacking and Joining

Geonet will be stacked and joined in accordance with the Construction Drawings and the General Specifications. As a minimum, the CQA Engineer will verify and document that staking, joining and overlapping is in accordance with the General Specifications.

The CQA Engineer will document any noncompliance with the above requirements and report it to the Owner.

1.7 Repair

The CQA Engineer will verify and document that any holes or tears in the geonet are repaired in accordance with the General Specifications.

The CQA Engineer will observe any repair, note any noncompliance with the above requirements and report them to the Owner.

SECTION VII - GEOCOMPOSITE CONSTRUCTION QUALITY ASSURANCE

1.0 GEOCOMPOSITES

1.1 Manufacturing

The Geosynthetics Contractor will be required to provide the CQA Engineer with the following information from the geocomposite Manufacturer:

- Certification required by the General Specifications signed by a responsible party employed by the geocomposite Manufacturer;
- The certification from the geocomposite Manufacturer that no reclaimed polymer was added to the resin during the manufacture of the geonet component of the geocomposite rolls assigned this project; and,
- The manufacturing quality control certificates for each shift's production of geocomposite rolls which include geocomposite roll numbers and identification, sampling procedures, and descriptions and results of quality control tests for the geonet specified in the General Specifications signed by a responsible party employed by the geocomposite Manufacturer.

The CQA Engineer will examine all of the geocomposite Manufacturer certifications to verify and document that the property values listed on the certifications meet or exceed those specified within the General Specifications and that proper and complete documentation has been provided by the geocomposite Manufacturer for all geocomposite used at the site. The CQA Engineer will report any deviations from the above requirements to the Owner prior to installation of the geocomposite.

1.2 Labeling

The CQA Engineer will verify and document that the geocomposite Manufacturer has labeled all rolls of geocomposite as specified within the General Specifications.

The CQA Engineer will examine rolls upon delivery and any deviation from the above requirements will be reported to the Owner prior to installation of the geocomposite.

1.3 Shipment and Storage

The CQA Engineer will observe rolls of geocomposite upon delivery at the site and any deviation from the requirements of the General Specifications will be reported to the Owner. Any damaged rolls will be rejected by the CQA Engineer and required to be repaired or replaced by the Contractor.

1.4 Conformance Testing

Either at the Manufacturer's plant or upon delivery of the geocomposite rolls, the CQA Engineer will ensure that samples are removed and forwarded to the Geosynthetics CQA Laboratory for testing to verify and document conformance with the requirements of the General Specifications.

Conformance samples will be taken across the entire width of the roll and will not include the first 3 feet. Unless otherwise specified, samples will be 1.5 feet long (minimum) by the roll width. The CQA Engineer will mark the machine direction on the samples with an arrow.

Samples will be taken at a rate of one per lot or one per 100,000 ft^2, whichever is greater. These samples will be tested for: peel strength (ASTM F 904); and hydraulic transmissivity (ASTM D 4716).

The CQA Engineer will examine all results from laboratory conformance testing and will report any nonconformance to the Owner as soon as the results are become available.

The following procedure will apply whenever a sample fails a conformance test that is conducted by the Geosynthetics CQA Laboratory:

- The Contractor will be required to replace the roll (or rolls) of geocomposite that is not in conformance with the specifications with a roll that meets the requirements of the General Specifications.

- The CQA Engineer will ensure that conformance samples are removed for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must pass the above conformance tests. If either of these samples fail, samples will be collected from the 5 numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics CQA Laboratory. These ten samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of geocomposite on site and a sample from every roll that is subsequently delivered from the same Manufacturer must be conformance tested by the Geosynthetics CQA Laboratory. The cost of such tests is to be borne by the Contractor.

The CQA Engineer will document actions taken in conjunction with conformance test failures and report all actions to the Owner.

1.5 Handling and Placement

The Contractor will be required to handle all geocomposite in such a manner as to ensure it is not damaged. The CQA Engineer will verify and document compliance with the following:

- Just prior to geocomposite placement, the layer that will underlie the geocomposite is clean and free of excessive amounts of dust, dirt, stones, rocks, or other obstructions that could potentially damage the underlying layers or clog the drainage system.

- In the presence of excessive wind, the geocomposite is weighted with sandbags (or equivalent weight approved by the CQA Engineer).
- Geocomposite is kept under tension to minimize the presence of wrinkles in the geocomposite. If necessary, the geocomposite is positioned by hand after being unrolled to minimize wrinkles.

- Geocomposites are cut using a geocomposite cutter approved by the geocomposite Manufacturer and the CQA Engineer. If in place, special care is taken to protect other materials from damage which could be caused by the cutting of the geocomposites.

- The Geosynthetics Contractor takes all necessary precautions to prevent damage to the underlying layers during placement of the geocomposite.

- Geocomposite is not welded to geomembranes.

- During placement of clean geocomposite, care is taken not to entrap stones, excessive dust, or moisture that could damage the underlying geomembrane, generate clogging of drains or filters, or hamper subsequent seaming.

- A visual examination of the geocomposite is carried out over the entire surface, after installation, to ensure that no potentially harmful foreign objects, such as needles, are present.

- Geocomposite is not left exposed for a period in excess of 30 days after placement unless a longer exposure period is approved by the CQA Engineer and the Owner.

The CQA Engineer will document any noncompliance with the above requirements and report it to the Owner.

1.6 Seams and Overlaps

The components of the geocomposite (e.g., geotextile_geonet_geotextile) are not bonded together at the ends and edges of the rolls. The CQA Engineer will document that the geocomposite is overlapped and secured or seamed in accordance with the General Specifications.

1.7 Repair

The CQA Engineer will verify that any holes or tears in the geocomposite are repaired in accordance with the General Specifications.

The CQA Engineer will observe any repair, document any noncompliance with the above requirements, and report the noncompliance to the Owner.

SECTION VIII - POLYETHYLENE PIPE AND FITTINGS CONSTRUCTION QUALITY ASSURANCE

1.0 POLYETHYLENE PIPE MANUFACTURE AND DELIVERY

1.1 Manufacturing

Prior to incorporating the polyethylene pipe and fittings into the work the Contractor will be required to provide the CQA Engineer with the certifications required by the General Specifications signed by a responsible party employed by the pipe Manufacturer.

The CQA Engineer will verify and document that the property values certified by the pipe Manufacturer meet the requirements of the General Specifications based on a sampling interval of one sample per lot. The CQA Engineer will report any deviations from the above requirements to the Owner.

1.2 Labeling

The CQA Engineer will verify that the pipe is labeled with the information specified in the General Specification. Any deviations from the labeling requirements will be reported to the Owner prior to pipe installation.

1.3 Shipment and Storage

The CQA Engineer will verify and document that the pipe and fittings are stored in accordance with the General Specifications.

The CQA Engineer will visual inspect the pipe upon delivery at the site and any deviations from the requirements of the General Specifications will be reported to the Owner.

1.4 Conformance Testing

No conformance testing will be conducted on the materials delivered to the site.

2.0 PIPE INSTALLATION

2.1 Handling and Laying

The CQA Engineer will verify and document that the pipe is installed at the specified locations and grades and that placement of backfill around and over the pipe is conducted in accordance with the requirements of the General Specifications, and in a manner intended to prevent damage to the pipe.

The pipe and fittings will be carefully examined before installation by the CQA Engineer. The CQA Engineer will verify and document that cracks, damage or defects are not present in the pipe and fittings in excess of that allowed by the General Specifications.

The CQA Engineer will also note the condition of the interior of pipes and fittings. Foreign material shall be removed from the pipe interior before it is moved into final position. No pipe will be permitted to be placed until the CQA Engineer has observed the condition of the pipe.

The CQA Engineer will document any deviation from the above requirements and report it to the Owner.

2.2 Joints and Connections

Lengths of pipe will be required to be assembled into suitable installation lengths by the butt-fusion process. Butt-fusion refers to the butt-joining of the pipe by softening the aligned faces of the pipe ends in a suitable apparatus and pressing them together under controlled pressure.

The CQA Engineer will spot-monitor butt fusion welding operations to ensure that the Contractor follows the General Specifications.

The CQA Engineer will document any noncompliance with the above requirements and report it to the Owner.

2.3 Surveying

A Professional Land Surveyor registered in the State of Colorado will provide the CQA Surveys. The CQA Surveyor will independently survey the final elevation of the invert of all polyethylene leachate collection pipe (excluding laterals).

The results of the survey will be compiled in a report signed by the CQA Surveyor and the CQA Engineer and will be reviewed by the Owner. The Owner and the CQA Engineer will approve the results contained in the report before any subsequent construction that completely covers the pipe occurs.

SECTION IX - CONSTRUCTION QUALITY ASSURANCE DOCUMENTATION

1.0 DOCUMENTATION

1.1 Introduction

An effective CQA plan depends largely on recognition of all construction activities that should be monitored, and on assigning responsibilities for the monitoring of each activity. This is most effectively accomplished and verified by the documentation of construction quality assurance activities. The CQA Engineer will document that all quality assurance requirements have been addressed and satisfied.

The CQA Engineer will provide the Owner with signed descriptive remarks, data sheets, and logs to verify and document that all monitoring activities have been carried out. The Owner will maintain at the site a complete file of Construction Drawings, the CQA plan (Part B Permit Attachment LF-10), the General Specifications (Part B Permit Attachment LF-1), test procedures, daily reports, testing logs, and other pertinent forms and documents. The forms to be used for CQA documentation should include, at a minimum, those presented in this CQA Plan. The forms presented in this CQA Plan may be revised as necessary by the CQA Engineer.

1.2 Daily Record Keeping

1.2.1 Overview

Daily records will be completed in the field documenting CQA project administration, soils CQA, geosynthetics CQA, and other required CQA activities. The forms to be completed that pertain to each of these categories of records are discussed below.

1.2.2 Project Administration Records

Most project administration records are completed daily by the CQA Engineer and submitted weekly to the Owner. Examples of these forms are included in Appendices A, B, and C and are briefly described below.

Daily Field Report

The Daily Field Report will be prepared by the CQA Engineer and submitted weekly to the Owner. At a minimum, the Daily Field Report will include the following information:

- The date, project name, location, and other identification;
- A narrative of the events and activities, including meetings and observations which occurred during a given day;
- The weather conditions;
- Source and amount of water used to construct the clay liner, if any;

- The name of parties to any discussions;
- The relevant subject matter or issues;
- The activities planned and performed;
- The schedule; and,
- The signature of the CQA Engineer.

Daily Temperature Log

Ambient temperatures and liner temperatures will be recorded on the Daily Temperature Log by the CQA Engineer at various times during the day. This log will be available for review at the site and will be issued as part of the Final Report.

Personnel Daily Log

The Personnel Daily Log will be prepared at the beginning of the project and updated each day by the CQA Engineer. This log will list the Contractor's and CQA Engineer's personnel involved with the project and is a record of attendance for each day of the project. This log will be available for review at the site and will be issued as part of the Final Report.

Contractor Personnel Log

The Contractor Personnel Log will be prepared at the beginning of the project and updated as required by the CQA Engineer. This log will provide a summary of the Contractor's and CQA Engineer's personnel involved in the project (on site and off site), describes their position, and lists the time periods of involvement with site work. This log will be available for review at the site and will be issued as part of the Final Report.

Weekly Field Report

On a weekly basis, the CQA Engineer will summarize in a Weekly Field Report the activities recorded on the Daily Field Reports. This report will be submitted each week to the Owner along with the Daily Field Reports, and will include, at a minimum, the following information:

- The date, project name, location, and other information;
- A summary of work activities during reporting period;
- A summary of construction situations, deficiencies, and/or defects occurring during the reporting period;
- A summary of actions taken to remedy such situations, deficiencies and/or defects;
- A summary of test results, failures and retests; and,

- The signature of the CQA Resident Engineer.

1.2.3 Soils CQA Records

Records kept for soils related activities will be completed by the CQA Engineer. The information will be recorded as testing is done in the field or as results are received from the laboratory. The records will be available for review on site, and copies will be issued as part of the Final Report. Examples of the relevant forms are included in Appendix B and are briefly described below.

Field Laboratory Compaction Test Log (ASTM D 698 Method A, B, C, D and ASTM D 1557 Method A, B, C).

The results of field compaction tests will be recorded on the Field Laboratory Compaction Test Log. Separate forms are available for each test method used.

Field Sand Cone and Rubber Balloon Density Test Log

The results of the sand cone and rubber balloon in_situ density test on soils will be recorded on the Field Sand Cone or rubber balloon Density Test Log. The results will be used for comparison or calibration with nuclear density test results.

Summary of Sieve Analysis Test Data

This form will provide a summary of sieve analysis test results for soils.

Summary of Field Density Test

This form will provide a summary of field nuclear density test results and sand cone test results for soils.

Summary of Index Laboratory Test Data

This form will provide a summary of index test results performed as required for soils.

Summary of Permeability Laboratory Data

This form will provide a summary of laboratory permeability test data required for clay liners.

1.2.4 Geosynthetics CQA Records

Records for the installation of geosynthetics will be completed by the CQA Engineer. The information will be recorded as the work progresses. The records will be available for review on site and copies will be issued as part of the final CQA report. Examples of the CQA forms to be completed for geosynthetics are included in Appendix C and briefly described below.

Material Inventory

The identifying roll number and pertinent information of each roll of geosynthetic received at the site will be recorded on this form as the materials arrive at the site. This information will be used to track manufacturer's quality control information, conformance test samples, and other CQA documentation.

Nondestructive Test Log

This form will be used to record the time, date, equipment operator, and results of vacuum box or air pressure testing of production geomembrane seaming operations.

Panel Placement Monitoring Log

This form will be used to record geomembrane panel numbers as they are placed in the field and to cross_reference the assigned panel numbers with roll numbers. The weather conditions, time, and temperature at placement will be recorded on the log. Measured dimensions used to calculate the area of the geomembrane will be recorded on the log.

Repair Summary Log

Information on repairs to geomembrane panels and seams will be recorded on this form. The information recorded will include a code to describe the type of repair, the name of the operator making the repair, the location (i.e., seam or panel location) of the repair, nondestructive testing results of the repair, and initials of the CQA Engineer observing the repair.

Seam and Panel Repair Location Log

The relative location of repairs to geomembrane panels and seams described in the Repair Summary Log will be recorded on this form. The results of destructive tests and nondestructive can be indicated in this log, as well as, locations and results of thickness measurements taken for each panel.

Destructive Test Log

This form will be used to record the results from testing performed on geomembrane seams at the Geosynthetics CQA Laboratory (an independent testing laboratory). The results for both peel and shear will be recorded. The form will be completed as data becomes available.

Trial Seam and Seaming Log

This form will be used to record results of trial geomembrane seam testing and to track production seaming activities. The time, temperature, type of seaming equipment used, name of seamer, and length of seam will be recorded.

Certificate of Acceptance Subgrade Surface

The Certificate of Acceptance is required to be signed by the Contractor prior to the installation of the geomembrane. The area being accepted must be described on the certificate.

1.2.5 Survey Records

Record Drawings resulting from surveying performed by the CQA Surveyor and will be reviewed by the CQA Engineer and the Owner. The Record Drawings will be available for review on-site, and copies will be issued as part of the final CQA Report issued by the CQA Engineer. At a minimum, these Record Drawings will include as-built survey data for the following liner system components:

- Excavated subgrade;
- Structural fill;
- Secondary clay liner;
- Primary clay liner;
- Polyethylene pipe and fittings;
- Geomembrane liners;
- Granular leachate collection layer; and,
- Protective soil layer.

1.3 Photographic Documentation

Photographic documentation will serve as a pictorial record of work progress, problems, and mitigation activities. The basic file will contain color prints; negatives will also be stored in a separate file in chronological order. These photographs will be available for review by the Owner, the CQA Engineer, and other interested parties. Selected photographs will be reproduced as part of the Final Report. The remaining photographs will be transmitted to the Owner and archived by the Owner as part of the operating records.

1.4 Design and/or Specifications Changes

Design and/or specification changes may be required during construction. In such cases, the CQA Engineer will notify the Owner. The Owner will notify CDPHE, and when necessary, the Design Engineer.

Major design and/or specifications changes will be made only with the written agreement of the Design Engineer and the Owner and will take the form of an addendum to the General Specifications.

1.5 Signatures and Final Report

At the completion of the work, the CQA Engineer will submit a final CQA report to the Owner. At a minimum, this report will include: (a) summaries of all construction activities; (b) sources and amounts of water used to construct the clay liners; (c) results of chemical quality analyses of construction water from each source; (d) observation logs and testing data sheets including sample location plans; (e) a discussion of any changes from design and material specifications; (f) CQA Record Drawings; and, (g) a summary statement sealed and signed by a Professional Engineer registered in the State of Colorado that construction quality assurance was conducted as provided in the CQA Plan and, based on visual observations and data generated in accordance with the CQA Plan, the secure cell or surface impoundment was constructed in accordance with the Construction Drawings, the CQA Plan, and the General Specifications, except as properly authorized and documented in the CQA final report. The CQA Record Drawings will include the following: primary and secondary geomembrane panel layout

drawings; all drawings (including cross_sections) depicting any deviations from the Construction Drawings; and all survey conformance data.