NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
Dexter R. Matthews, Director | Division of Waste Management | Michael F. Easley, Governor
William G. Ross Jr., Secretary

October 16, 2008

Mr. Haywood Phthisic, Director
Johnston County Public Utilities Department
P O Box 2263
Smithfield, North Carolina

Re: Application for Permit to Construct Phase 4A, Cell 3, and Review of Closure/Post-Closure Plan for the C&D unit, in accordance with .0547
Johnston County MSW and C&D Landfill
Permit No. 51-03
Johnston County, Doc ID 6031

Dear Mr. Phthisic:

An application for a Permit to Construct for Phase 4A, Cell 3 has been submitted to the Division of Waste Management, Solid Waste Section (Section) on your behalf by your consultant RSG Engineers. In accordance with GS 130A-295.8(e), the Section has reviewed your application and found it to be complete within the meaning of the statute. A determination of completion means that the application includes all required components but does not mean that the required components provide all the information that is required for the Section to make a decision on the application. We have performed a technical review of the submitted application and request the following:

1. Please provide a summary description of the history at the landfill in the application, to include the progression of the phases and vertical expansions, with dates and a brief identification of liners and final covers for the different phases.
2. The property line boundary, from Plat Book 59, Page 437, does not appear to match the property line boundary as shown on drawing S1 (in the area of the NCDOT borrow area). Please clarify.
3. The settlement calculations in the Appendix show the calculated settlement at 7 points. Please provide the calculation of the final slope of the liner between each segment to show positive leachate drainage. Please provide confirmation that the post-settlement bottom elevation of the liner system is a minimum of 4 feet above the seasonal high groundwater table.
4. It appears that the flatter portion of Cell 3 was not included in the original approved plans. Please address why this was changed, and address settlement and differential settlement issues for this flatter portion, to ensure adequate positive drainage of leachate.
5. Please provide calculations that demonstrate that the Cell 4A sump is sized to handle the leachate volumes for cells 1, 2, and 3. Please provide a discussion and detail drawing of how the leachate will be moved from the 2 leachate systems to the sump.

6. Why is the surface water collection on top of the final cover designed to channel all of the surface water under the geomembrane of the final cover? This contradicts the purpose of the final cover system to prevent infiltration of surface water. If there is a leak, how will it be found? If by subsidence, the leak will be present for a long time before it is discovered. Please explain why this design was chosen over a design that involves pipes or drainage channels on top of the final cover. Please address how this would be maintained to prevent clogs from grass, leaves, silt, etc. Please address why this design still leaves exposed pipes on the surface of the landfill for all side slope areas which do not have the geomembrane final cover.
7. Drawing FC1 – Please identify the type of final cover that consists on top of Phase 3 for the strip between Phase 4A cell 2 and the C&D Area 2 cell 2. The entire top of Phase 3 should have a final cover with geomembrane.
8. Please provide at least one cross-section that shows the bottom and top of Phase 3 and 4 MSW areas, the C&D Area 1 and 2 areas, and the Phase 4A areas.
9. In the text, please describe how all the liner components will be connected from cell 1 to cell 3.
10. Drawing FC3 – In text or on the drawing, please explain how the leachate seep collection trenches will be used – in the intermediate cover, after final cover is placed, etc. Leachate outbreaks should not occur through the geomembrane after final cover is placed, as it appears to indicate on the drawing.
11. Please provide a detail drawing of the final cover anchor trench.
12. Drawing detail 2/FC2 – Please clarify where the outlet pipe discharges in relation to Cell 3.
13. Please indicate the locations of the white goods, tire, battery, and waste oil collection areas on the existing conditions drawing.
14. Please include a drawing that shows all future phases, as was in the March 2006 drawings.
15. Operating Plan - Section 2.2.1 - Please correct the reference to the NCAC for the definition of acceptable waste.
16. Operating Plan - Section 2.3.1 – Please correct the reference to the NCAC for the definition of hazardous waste.
17. Operating Plan - Section 2.5.3.2 – Please explain how the geosynthetic rain cover is perforated in a new waste area.
18. Operating Plan – Please incorporate the details and operating plan of the Tarpomatic alternate daily cover.
19. Operating Plan – Please describe the operation and application of the approved spray irrigation system for reclaimed wastewater in the text of the plan, similar to the discussion of the yard waste processing area, and reference the operating plan in the appendix.
20. Operating Plan – Please add discussion of the Bulk Reclaimed Water Transfer Station recently approved on the landfill property. Address site security between the station and the landfill and show the location on the site map.
21. Operating Plan - Please provide a brief discussion of the proposed leachate pond equalization basin modifications.
22. Please provide the actual leachate volumes that have been collected in the leak detection system for Phase 4A, historically and currently.
23. The operating plan should address routine leachate collection line cleaning and inspections. All leachate collection lines shall be designed and constructed to permanently allow cleaning and remote camera inspection. All leachate collection lines shall be cleaned at least once a year, except that the Department may allow leachate collection lines to be cleaned once every

two years if the facility has continuous flow monitoring; and the permit holder demonstrates to the Department that the leachate collection lines are clear and functional based on at least three consecutive annual cleanings. Remote camera inspections of the leachate collection lines shall occur upon completion of construction, at least once every five years thereafter, and following the clearing of blockages.

24. Engineering Plan – Section 2.3.1 - Please clarify what the cut will be in the earthwork cut and fill.
25. Please clarify if the stormwater/leachate separation system will involve welding flaps to the liner.
26. Please provide a copy of the facility plan in this report, updated as needed. The plan should describe the increased capacity, and compare the increase to the capacity in the facility plan that was approved in August 2006.
27. Please include with this application a copy of the approved water quality monitoring plan, following Rule .1623 (b)(3).
28. Closure plan – Please provide a schedule for completing all activities necessary to satisfy the closure criteria in Rule .1627 (c).
29. Please address financial assurance submittal and mechanism in the text of the application. Please update the cost estimates in the application to be consistent with the Closure/Post-closure plan for the C&D units submitted in June 2008. Why has the post-closure costs been reduced from the 2007 submittal ($8,340,528)?

Please submit response to comments as replacement pages to the application report. Only one paper copy is necessary, but an electronic copy is also needed, either sent by email, or on a CD.

We have completed a technical review of the Closure and Post-closure plans and cost estimates for the C&D units, in accordance with Rule .0547, and we request that the CQA plan for closure activities and the water monitoring plan be included in the submittal.

For your reference, the Solid Waste Section rules can be found on the Section's website at http://www.wastenotnc.org/swhome/rule.asp; and the North Carolina General Statutes concerning solid waste are located at http://www.ncleg.net/EnactedLegislation/Statutes/HTML/ByArticle/Chapter_130A/Article_9.html.

If you have any questions or comments, please contact me at (919) 508-8510, or by email at donna.wilson@ncmail.net.

Sincerely,

Donna J. Wilson

Donna J. Wilson
Environmental Engineer
Solid Waste Section

cc: Pieter Scheer Smith, RSG&A
Rick Proctor, Johnston County Solid Waste Manager
Dennis Shackelford, Central Regional Supervisor, DWM
Mary Whaley, Waste Management Specialist, DWM

Subject: Johnston County - C&D 547 Comments
From: Pieter Scheer <pieter@rsgengineers.com>
Date: Fri, 09 Jan 2009 12:19:58 -0500
To: Donna Wilson <Donna.Wilson@ncmail.net>

Donna:

Regarding the C&DLF, attached is a copy of the approved Water Quality Monitoring Plan for the C&D. The CQA Manual included with the application for Phase 4A Cell 3 is written to cover all units - including closure of the C&D units. I'll respond with a separate letter and hard copies on this.

Pieter

Pieter K. Scheer, P.E.
Principal, Senior Engineer
Richardson Smith Gardner & Associates, Inc.
14 N. Boylan Ave.
Raleigh, NC 27603
Phone: (919) 828-0577 x123
Fax: (919) 828-3899
www.rsgengineers.com

Donna Wilson wrote:
> either way OK. I would like to get the C&D 547 requirement finalized with this action.
>
> Thanks
>
> Pieter Scheer wrote:
> > Donna:
> >
> > I was assuming you would like these as a separate response?
> >
> > Pieter
> >
> > Pieter K. Scheer, P.E.
> > Principal, Senior Engineer
> > Richardson Smith Gardner & Associates, Inc.
> > 14 N. Boylan Ave.
> > Raleigh, NC 27603
> > Phone: (919) 828-0577 x123
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> >
> > Donna Wilson wrote:
> > > yes.
> > > Also, near the end of my comment letter dated 10-16-08, there are 2 comments for the Closure/post-closure plan and financial assurance for the C&D 547 requirements - request that a CQA plan for closure activities and the water monitoring plan be included in the submittal.
> > > Thanks
> > >
> > > Pieter Scheer wrote:
> > > > Donna:
> > > >
> > > > So Monday, Wed., Thurs. p.m., and Friday are open?
> > > >
> > > > Pieter
> > > >
> > > > Pieter K. Scheer, P.E.
> > > > Principal, Senior Engineer
> > > > Richardson Smith Gardner & Associates, Inc.
> > > > 14 N. Boylan Ave.

Raleigh, NC 27603
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Donna Wilson wrote:

> Pieter - Mary Whaley and I are not available next week on Tuesday all day, and on Thursday morning.

C&D Landfill Water Quality Monitoring Plan - Oct 2005.pdf	**Content-Type:** application/pdf **Content-Encoding:** base64

Johnston County Landfill
Proposed C&D Landfill
Water Quality Monitoring Plan

Prepared For:
Johnston County
Department of Public Utilities
Smithfield, North Carolina

The Water Quality Monitoring Plan for this facility has been prepared by a qualified geologist who is licensed to practice in the State of North Carolina. The plan has been prepared based on knowledge of site conditions and familiarity with North Carolina solid waste rules and industry standard protocol. The Plan described herein should provide for the effective detection of a chronic release of hazardous constituents into ground and surface waters of the State, due to, or caused by past activities at the landfill.

Joan A. Smyth 10/27/05

Joan A. Smyth, P.G.
Project Hydrogeologist

NORTH CAROLINA LICENSED SEAL 1369 GEOLOGIST JOAN A SMYTH

October 2005

G.N. Richardson & Associates
Engineering and Geological Services
14 N. Boylan Avenue
Raleigh, North Carolina 27603

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1.0 Introduction

1.1 Plan Background

Johnston County, North Carolina, owns and has sequentially operated four separate, unlined sanitary landfill units since1973 under Solid Waste Facility Permit #51-01, one lined municipal solid waste landfill (Phase 5) under permit 51-02, and one double-lined MSW landfill (Phase 4A) under permit 51-03. The six distinct municipal solid waste disposal units are located on a single property off State Route 210 in Johnston County.

The lined C&D landfill is proposed as a "piggy-back" landfill being constructed over a portion of the sideslope of the unlined Phase 3 MSW landfill. This lined C&D landfill "piggy-back" design is proposed as a part of the presumptive remedy for the unlined Phase 3 MSW landfill. The liner system of the C&D landfill will prevent rainwater infiltration into the soil covered sideslopes of the unlined Phase 3 MSW landfill. This design, in conjunction with the double-lined Phase 4A MSW landfill will provide significant reduction in leachate generation from the Phase 3 landfill.

The lined C&D landfill is located east of Phase 3 and north of Phases 1 & 2. These three phases of unlined landfills have impacted groundwater in this portion of the site. Therefore, this groundwater monitoring plan is more comprehensive than most for C&D landfills in order to provide for monitorability at the C&D landfill site.

C&D Landfill Monitoring Network

GNRA proposes two groundwater monitoring wells located between unlined MSW landfill Phases 1 & 2, (CDMW-1 and CDMW-2), two wells located adjacent to the diabase dikes located in the C&D area (CDMW-3 and CDMW-4), three downgradient nested pairs (CDMW-5/CDMW-5d, and CDMW-8/CDMW-8d and CDMW-9/CDMW9d), a downgradient shallow well (CDMW-6), a side gradient well (CDMW-7).

Additionally, since this is a lined C&D facility, leachate samples from the leachate collection system will be monitored semi-annually for the same Appendix I constituents that ground water is monitored for.

This Water Quality Monitoring Plan (WQMP) has been prepared to meet the field sampling and laboratory analysis requirements of the site. The WQMP details field and laboratory protocols that must be followed to meet the data objectives for the site.

1.2 Purpose & Scope

This WQMP has been designed to insure that accurate and representative field and laboratory results are obtained for all ground and surface water quality monitoring points. The WQMP addresses the following subjects:

- Ground water sample collection
- Surface water sample collection
- Sample preservation and shipment
- Laboratory analytical procedures
- Sample Chain-of-custody control
- Quality assurance/quality control programs

The methods and procedures described in the following sections are intended to facilitate the collection of true and representative samples and test data. Field procedures are presented in **Sections 3.0 through 7.0** in their general order of implementation. Equipment requirements for each field task are presented within the applicable section. Laboratory procedures, quality assurance methods and record keeping requirements are presented in **Sections 7.0 and 8.0**.

Strict adherence to these procedures stipulated in this plan is required. Any variations from these procedures should be throughly documented in the assessment report.

1.3 Sampling Program Overview

The ground water monitoring well designations, completion type, installation information and analytical requirements are included as **Table 1**. The surface water monitoring station designations, locations, sources and sampling frequency are included as **Table 2**.

2.0 Ground Water Sample Collection

This section presents details of the procedures and equipment required to perform ground water field measurements and sampling from monitoring wells during each monitoring event. A description of proposed ground water monitoring well locations and completion details are presented in **Table 1**. Ground water monitoring well locations for each Phase are shown in **Figure 1**.

2.1 Water Level Measurements

Static water level and total depth to the bottom will be measured in each well prior to any purging or sampling activities. Static water level and well depth measurements are necessary to calculate the volume of stagnant water in the well prior to purging. Additionally these measurements provide a field check on well integrity, degree of siltation, and are used to prepare potentiometric maps, calculate aquifer flow velocities and monitor changes in site hydrogeologic conditions.

Upon opening each well, new latex or nitrile surgical gloves will be donned. New gloves will be worn when taking water level measurements at each well. Appropriate measures will be taken during all measurement activities to prevent soils, decontamination supplies, precipitation, and other potential contaminants from entering the well or contacting clean equipment.

An electronic water level indicator will be used to accurately measure depth to ground water in each well and/or piezometer. Ground water depths will be measured to a vertical accuracy of 0.01 feet relative to established wellhead elevations. Each well will have a permanent, easily identified reference point on the lip of the well riser from which all water level measurements will be taken. The elevation of the reference point will be established by a Registered Land Surveyor.

The electronic water level indicator will be constructed of inert materials such as stainless steel and Teflon. Between well measurements the device will be thoroughly decontaminated by washing with non-phosphate soap and triple rinsing with deionized water to prevent cross contamination from one well to another.

The following measurements will be recorded in a dedicated field book prior to sample collection:

- Well Identification
- Depth to static water level and well bottom (to the nearest 0.01 foot)
- Height of water column in the riser (based upon known depth of well)
- Condition of wellhead protective casing, base pad and riser
- Changes in condition of well and surroundings.

2.2 Monitor Well Evacuation

Water accumulated in each well may be stagnant and unrepresentative of surrounding aquifer conditions, and therefore must be removed to insure that fresh formation water is sampled. Each well will be purged of standing water in the well casing following the measurement of the static water level.

New latex or nitrile surgical gloves will be donned for all well purging and sampling activities and whenever handling decontaminated field equipment. Appropriate measures will be taken during all measurement, purging and sampling activities to prevent surface soils, decontamination supplies, precipitation, and other potential contaminants from entering the well or contacting cleaned equipment.

The volume of standing water in the well riser and screen will be calculated immediately before well evacuation during each monitoring event. A standing water volume will be calculated for each well using measured static water level, well depth and well casing diameter according to the following equation:

$$V = (TD - SWL) \times C$$

Where: V = One well volume

TD = Total depth of the well (in feet)

SWL = Static water level (in feet)

C = Volume constant for given well diameter (gallons/foot)

C = 0.163 gal/ft for two-inch wells.

C = 0.653 gal/ft for four-inch wells.

After the volume of standing water within the casing is established, a minimum of three to five well casing volumes of water will be evacuated from each well that is not outfitted with a MicroPurge ™ system.

New, disposable bailers with either double or bottom check-valves will be used to purge each well if the MicroPurge system is not used. Disposable purge bailers will be constructed of fluorocarbon resin (Teflon) suitable for the well and ground conditions. Each bailer will be certified factory-cleaned according to approved EPA protocol and remain sealed in a plastic sleeve until use. A new Teflon-coated stainless steel, inert mono-filament line or nylon cord will be used for each well to retrieve the bailers.

Wells will be purged at a rate that will not cause recharge water to be excessively agitated or cascade through the screen. Care will also be taken to minimize disturbance to the well sidewalls and bottom which could result in the suspension of silt and fine particulate matter. The volume of water purged from each well and the relative rate of recharge will be documents in sampling field notes. Wells which are of very low recharge rates will be purged once until dry. Damaged, dry or low yielding, and high turbidity wells will noted for reconsideration before the next sampling event.

Purge water will be managed to prevent possible soil and surface water contamination. Well site management options may include temporary containment and disposal as leachate or portable activated carbon filtration.

There are several wells on-site that are outfitted with MicroPurge™ pumps. All MicroPurge™ pumps are constructed of stainless steel and teflon components and are equipped with teflon lined

tubing from the pump to the surface of the well. These pumps have been installed to maximize pump efficiency and data reliability.

Wells that are outfitted with the MicroPurge™ system T1200M pumps will be developed until the field parameters of temperature, pH and Conductivity stabilize to within 10%. The use of the MicroPurge low-flow system allows a sample to be collected from a discreet interval of the well, thus limiting the amount of purging necessary. The pumps operate at a flowrate of approximately 200 ml/min during purging. The stabilization of field parameters indicates that water from the formation is being removed. A "Flow Cell - FC4000" is used to continuously monitor the field parameters of the purge water. This cell evaluates the pH, temperature, and conductivity on a constant basis and provides an ongoing continuous readout of the parameter levels. Once three readings taken 3 to 5 minutes apart have stabilized to within 10% of each other, a sample may be immediately collected from the pump. The pumping rate during sampling shall be 100 ml/min.

Durable, non-dedicated equipment to be lowered into the well (such as water level indicators) will be thoroughly decontaminated before each use. Equipment shall be disassembled to the degree practical, washed with (non-phosphate) soapy potable tap water, and triple rinsed using de-ionized water. Detailed equipment decontamination procedures are detailed in **Section 2.6**.

2.3 Ground Water Sample Collection

After purging activities are complete, ground water samples will be collected for laboratory analysis. Additional care commensurate with the importance of this stage will be taken. All monitoring wells should be sampled in as short a time period as possible, generally within 48 hours.

Sampling will occur within 24 hours of the purging of each well and as soon after well recovery as possible. Wells which fail to recharge or produce an adequate sample volume within 24 hours of purging will be sampled and a notation as to the amount of elapsed time since purging will be placed in the "notes" section of the chain of custody sheet and in the field notes for future evaluation. If particular wells are consistently slow in recharging, a remedy should be proposed for the problem.

Field measurements of temperature, pH, specific conductivity and turbidity will be made immediately prior to sampling each monitoring point. The field test specimens will be collected with the sampling bailer and placed in a clean, non-conductive glass or plastic container for observation. The calibration of the pH, temperature, conductivity and turbidity meters will be completed according to the manufacturers' specifications and consistent with Test Methods for Evaluating Solid Waste -Physical/Chemical Methods (SW-846). A pocket thermometer and litmus paper will be available in case of meter malfunction.

Each well outfitted with a dedicated MicroPurge™ pump will be sampled using the pump immediately upon completion of purging. Field measurements of pH, temperature and conductivity will be collected at the time of sample collection. The flowrate of pumping at the time of sampling shall be 100 ml/min or less.

Each well without a dedicated pump will be sampled using a new, factory-cleaned, disposable Teflon bailer with bottom check-valve and sample discharge mechanism. A new segment of Teflon-coated stainless steel wire, inert mono-filament line or nylon cord will be used to lower and retrieve each bailer. The bailer will be lowered into each well to the point of ground water contact, then allowed to fill as it sinks below the water table. Bottom contact will be avoided in order to avoid suspending sediment in the samples. The bailer will be retrieved and emptied in a manner which minimizes sample agitation.

Samples will be transferred directly from the Teflon bailer into a sample container that has been specifically prepared for the preservation and storage of compatible parameters. A bottom emptying device provided will be used to transfer samples from bailer to sample container. The generation air bubbles and sample agitation will be minimized during bailer discharge.

Ground water samples will be collected and contained in the order of volatilization sensitivity. Initially, only purgeable organics and total metals specimens will be collected for laboratory analysis. Subsequently, other analytical methods may required. When collected, the following order of sampling will be observed:

- Initial measurements of pH, temperature, conductivity and turbidity
- Volatile and Purgeable Organics
- Base Neutral and Acid Extractable Organics
- Total Metals
- Final measurements of pH, temperature, conductivity and turbidity

All samples will be collected and analyzed in an **unfiltered** state during all sampling events.

All reusable sampling equipment including water level probes, pH/conductivity meters, interface probes, and filtering pumps which might contact aquifer water or samples will be thoroughly decontaminated between wells by washing with non-phosphate soapy, de-ionized water and triple rinsing with deionized water. Detailed equipment decontamination procedures are detailed in Section 2.6.

2.4 Field Quality Assurance

Field and trip blanks will be prepared, handled and analyzed as ground water samples to ensure cross-contamination has not occurred. One set of trip blanks, as described later in this document, will be prepared before leaving the laboratory to ensure that the sample containers or handling processes have not affected the quality of the samples. One set of field (equipment) blanks will be created in the field at the time of sampling to ensure that the field conditions, equipment, and handling during sampling collection have not affected the quality of the samples. A duplicate ground water sample may be collected from a single well as a check of laboratory accuracy. Blanks and duplicate containers, preservatives, handling, and transport procedures for surface water samples will be identical to those noted for ground water samples.

2.5 Sample Containers

Sample containers will be provided by the laboratory for each sampling event. Containers must be either new and factory-certified analytically clean by the manufacturer, or cleaned by the laboratory prior to shipment for sampling. Laboratory cleaning methods will be based on the bottle type and analyte of interest.

2.6 Equipment Decontamination

All non-dedicated equipment (such as water level meter) that will come in contact with the well casing and water will be decontaminated. The procedure for decontaminating non-dedicated equipment is as follows:

1. Phosphate-free soap and tap water wash
2. Deionized or distilled water rinse
3. Isopropyl alcohol rinse
4. Deionized or distilled water rinse and air dry
5. Aluminum foil wrap with shiny side out

3.0 Surface Water Sample Collection

This section present details of the procedures and equipment required to perform surface water field measurements and sampling from springs, streams and ponds during each monitoring event. A description of proposed surface water monitoring station locations is presented in **Table 2**. The proposed surface water monitoring station locations are shown in **Figure 2**.

3.1 Surface Water Level Observations

Surface water quality analyses are particularly sensitive to site hydrologic conditions and recent precipitation events. Water levels may fluctuate drastically in comparison the ground water table and may result in either diluting or increasing contaminant loadings. The scheduling of sampling events and the interpretation surface water data must take into account climatic, recent weather and sampling station conditions.

Surface water level and sampling station conditions will be observed one day prior to, and during each sampling event. Surface water observations will include the flood stage in streams, seasonal base flow conditions, and confirm location and timing for meaningful surface water quality sampling. The following objective observations will be recorded in a dedicated field book prior to sample collection:

- Sample location designation
- Relative stream water level

- Surface water clarity
- Rate of flow and degree of stagnation
- Physical conditions of sampling station
- Changes in surface monitoring station conditions and surroundings.

Modifications to surface sampling station conditions may be required prior to each sampling event. These modifications may include the removal of surface and submerged debris, slightly deepening the station to allow sample container immersion, or channeling/piping to consolidate local discharge. When modifications are required, sufficient time will be allowed for settlement of suspended solids between the disturbance and sample collection. A minimum settling period of four hours prior to sampling will be observed.

3.2 Surface Water Sample Collection

Surface water samples will be obtained from areas of minimal turbulence and aeration. New latex or nitrile surgical gloves will be donned prior to sample collection. The following procedure will be implemented regarding sampling of surface waters:

1. Put on new latex or nitrile surgical gloves.
2. Hold the bottle in the bottom with one hand, and with the other, remove the cap.
3. Push the sample container slowly into the water and tilt up towards the current to fill. A water depth of six inches is generally satisfactory. Care will be taken to avoid breaching the surface or losing sample preservatives while filling the container.
4. If there is little current movement, the container should be moved slowly, in a lateral, side to side direction, with the mouth of the container pointing upstream.

Temperature, pH, specific conductivity and turbidity will be taken at the start of sampling as a measure of field conditions and check on the stability of the water samples over time. Measurements of temperature, pH, specific conductivity and turbidity will be recorded for all surface water samples. The calibration of the pH, temperature, conductivity , and turbidity meters will be completed at the beginning of each sampling event, according to the manufacturers'

specifications and consistent with Test Methods for Evaluating Solid Waste - Physical/Chemical Methods (SW-846).

Surface water samples will be collected and contained in the order of volatilization sensitivity of the parameters as follows:

- Measurements of pH, temperature, conductivity and Turbidity
- Volatile and Purgeable Organics
- Base Neutral and Acid Extractable Organics
- Total Metals

All surface water samples will be collected in an unfiltered state.

All field meters which might contact surface water samples will be thoroughly decontaminated between stations by washing with non-phosphate soapy, de-ionized water and triple rinsing with deionized water.

One surface water samples will be collected at this site (shown on **Figure 2** and listed in **Table 2**). Samples will be collected directly from the station in the container that has been specifically prepared for the preservation and storage of compatible parameters. Samples will be collected in a manner that assures minimum agitation. Additional blanks and duplicate samples will not be taken with the surface water samples.

Sample containers shall be prepared and provided by the laboratory for each surface water sampling event. Each sample containers' preparation and preservatives shall be the same as those utilized for ground water sampling and addressed previously in Section 2.5.

4.0 Field QA/QC Program

Field Quality Assurance/Quality Control (QA/QC) requires the routine collection and analysis of trip blanks to verify that the handling process has not affected the quality of the samples. Any contaminants found in the trip blanks could be attributed to:

1) interaction between the sample and the container,
2) contaminated source water, or
3) a handling procedure that alters the sample.

The laboratory will prepare a trip blank by filling each type of sample bottle with distilled or deionized water. Trip blanks will be placed in bottles of the specific type required for the analyzed parameters and taken from a bottle pack specifically assembled by the laboratory for each ground water sampling event. Trip blanks will be taken prior to the sampling event and transported with the empty bottle packs. The blanks will be analyzed for volatile and purgeable organics only.

The concentration levels of any contaminants found in the trip blank will be reported but will not be used to correct the ground water data. In the event that elevated parameter concentrations are found in a blank, the analysis will be flagged for future evaluation and possible re-sampling.

All field instruments utilized to measure ground water characteristics will be calibrated prior to entering the field, and recalibrated in the field as required, to insure accurate measurement for each sample. The specific conductivity and pH meter shall be recalibrated utilizing two prepared solutions of known concentration in the range of anticipated values (between 4 and 10). A permanent thermometer, calibrated against a National Bureau of Standards Certified thermometer, will be used for temperature meter calibration. The turbidity meter will be calibrated using Lucite standard blocks provided by the manufacturer.

5.0 Sample Preservation and Shipment

Methods of sample preservation, shipment, and chain-of-custody procedures to be observed between sampling and laboratory analysis are presented in the following sections.

5.1 Sample Preservation

Proper storage and transport conditions must be maintained in order to preserve the integrity of samples between collection and analysis. Wet ice will be used to cool and preserve samples, as directed by the analytical laboratory. Samples will be maintained at a temperature of 4° C. Dry ice is not to be used.

Pre-measured chemical preservatives will be provided in the sample containers provided by the analytical laboratory. Hydrochloric acid will be used as a chemical stabilizer and preservative for volatile and purgeable organic specimens. Nitric acid will be used as the preservative for samples for metals analysis.

Upon collection, samples will be placed on ice in high impact polystyrene coolers and cooled to a temperature of 4°C. Samples will be packed and/or wrapped in plastic bubble wrap to inhibit breakage or accidental spills. Chain-of-Custody control documents will be placed in a waterproof pouch and sealed inside the cooler with the samples for shipping. Tape and/or custody seals shall be placed on the outside of the shipping coolers, in a manner to prevent and detect tampering with the samples.

Samples shall be delivered to the analytical laboratory within a 24-hour period in person or using an overnight delivery service to insure holding times are not exceeded. Shipment and receipt of samples will be coordinated with the laboratory.

Chain-of-Custody control will be maintained from sampling through analysis to prevent tampering with analytical specimens. Chain-of-Custody control procedures for all samples will consist of the following:

1. Chain-of-Custody will originate at the laboratory with the shipment of prepared sample bottles and a sealed trip blank. Identical container kits will be shipped by express carrier to the sampler or site or picked up at the laboratory in sealed coolers.

2. Upon receipt of the sample kit, the sampler will inventory the container kit and check its consistency with number and types of containers indicated in the Chain-of-Custody forms and required for the sampling event.

3. Labels for individual sample containers will be completed in the field, indicating the site, time of sampling, date of sampling, sample location/well number, and preservation methods used for the sample.

4. Collected specimens will be placed in the iced coolers and will remain in the continuous possession of the field technician until shipment or transferral as provided by the Chain-of-Custody form has occurred. If continuous possession can not be maintained by the field technician, the coolers will be temporarily sealed and placed in a secured area.

5. Upon delivery to the laboratory, samples will be given laboratory sample numbers and recorded into a logbook indicating client, well number, and date and time of delivery. The laboratory director or his designee will sign the Chain-of-Custody control forms and formally receive the samples. The field technician, project manager and the laboratory director will work together to insure that proper refrigeration of the samples is maintained.

6. Copies of the complete Chain-of-Custody forms will be placed in the laboratory's analytical project file and attached to the laboratory analysis report upon completion.

Chain-of-Custody forms will be used to transfer direct deliveries from the sampler to the laboratory. A coded, express delivery shipping bill shall constitute the Chain-of Custody between the sampler and laboratory for overnight courier deliveries.

6.0 Field Logbook

The field technician will keep an up-to-date logbook documenting important information pertaining to the technician's field activities. The field logbook will document the following:

- Site Name and Location
- Date and Time of Sampling
- Climatic Conditions During Sampling Event
- Sampling Point/Well Identification Number
- Well Static Water Level
- Height of Water Column in Well
- Purged Water Volume and Well Yield (High or Low)
- Presence of Immiscible Layers and Detection Method
- Observations on Purging and Sampling Event
- Time of Sample Collection
- Temperature, pH, Turbidity, and Conductivity Readings
- Signature of Field Technician.

7.0 Laboratory Analysis

The ground and surface water parameters to be analyzed will be those specified in Table 1. These will include field indicators of water quality (pH, conductivity, temperature and turbidity) and selected purgeable organic as listed in Appendix I and Appendix II of 40 CFR.258 and 15 RCRA metals constituents (total metals analysis). All analytical methods are taken from Test Methods For Evaluating Solid Waste - Physical/Chemical Methods (SW-846) or Methods For the Chemical Analysis of Water and Wastes and will be consistent with DSWM's policies regarding analytical methods and PQLs. Analysis will be performed by a laboratory certified by the North Carolina DENR for the analyzed parameters.

Formal environmental laboratory Quality Assurance/Quality Control (QA/QC) procedures are to be utilized at all times. The owner/operator of the landfill is responsible for selecting a laboratory contractor and insuring that the laboratory is utilizing proper QA/QC procedures. The laboratory must have a QA/QC program based upon specific routine procedures outlined in a written laboratory Quality Assurance/Quality Control Manual. The QA/QC procedures listed in the manual shall provide the lab with the necessary assurances and documentation that accuracy and precision goals are achieved in all analytical determinations. Internal quality control checks shall be undertaken regularly by the lab to assess the precision and accuracy of analytical procedures.

During the course of the analyses, quality control data and sample data shall be reviewed by the laboratory manager to identify questionable data and determine if the necessary QA/QC requirements are being followed. If a portion of the lab work is subcontracted, it is the responsibility of the contracted laboratory to verify that all subcontracted work is completed by certified laboratories, using identical QA/QC procedures.

8.0 Data Evaluation

Copies of all laboratory results and water quality reports for the Johnston County Landfill will be kept at the Johnston County Landfill office. Reports summarizing all ground water quality results and data evaluation will be submitted to the DSWM for each sampling event. Upon receipt of each monitoring event's data, the water quality database of analyses will be updated.

Methods to evaluate the data are taken from North Carolina Solid Waste Rules and the EPA RCRA Ground Water Monitoring Technical Guidance Documents. There is existing ground water impact at the site due to unlined MSW Phases 1 & 2 and Phase 3. Therefore, statistical analyses will be performed for this C&D landfill to determine if contaminant levels are increasing due to possible impact from the C&D landfill. As there is existing impact, intra-well statistical analyses will be performed on laboratory data from ground water samples.

The North Carolina Solid Waste Rules provide several methods for statistical analysis of ground water data. These methods are:

1. Parametric Prediction Intervals
2. Non-Parametric Prediction Intervals
3. Tolerance prediction interval
4. Control chart
5. An alternative statistical test method that meets the performance standards of 40 CFR 258.53 (h)

The choice of appropriate methods for data analysis and presentation, including statistical tests, depends on the type of monitoring, the nature of the data, and the proportion of values in the data set that are below detection limits. The statistical analysis will be conducted separately for each detected organic constituent based on the EPA's Statistical Analysis of Ground Water Monitoring Data at RCRA Facilities, Interim Final Guidance Document (1989) and Addendum to the Interim Final Guidance Document (1992). Any statistical analyses will be performed in general accordance methods outlined in the North Carolina State Regulations 15A NCAC 13B.1632.

9.0 Record Keeping and Reporting

9.1 Sampling Reports

Copies of all laboratory analytical data will be forwarded to the DWM within 45 calendar days of the sample collection date. The analytical data submitted will specify the date of sample collection, the sampling point identification and include a map of sampling locations. Should a significant concentration of contaminants be detected in ground and surface water, as defined in North Carolina Solid Waste Rules, Ground Water Quality Standards, or Surface Water Quality Standards, the owner/operator of the landfill shall notify the DWM and will place a notice in the landfill records as to which constituents were detected.

9.2 Well Abandonment/Rehabilitation

Should wells become irreversibly damaged or require rehabilitation, the DWM shall be notified. If monitoring wells and/or piezometers are damaged irreversibly they shall be abandoned under the direction of the DWM. The abandonment procedure in unconsolidated materials will consist of over-drilling and/or pulling the well casing and plugging the well with an impermeable, chemically-inert sealant such as neat cement grout and/or bentonite clay. For bedrock well completions the abandonment will consist of plugging the interior well riser and screen with an impermeable neat cement grout and/or bentonite clay sealant.

9.3 Additional Well Installations

The data will be analyzed to verify the correct placement of wells and determine locations for future monitoring wells, if necessary. Any additional well installations will be carried out in accordance with DWM directives. If the potentiometric maps reveal that the depths, location, or number of wells is insufficient to monitor potential releases of solid waste constituents from the solid waste management area, new well locations and depths will be submitted to the DWM for approval.

All monitoring wells shall be installed under the supervision of a geologist or engineer who is registered in North Carolina and who will certify to the DWM that the installation complies with the North Carolina Regulations. Upon installation of future wells the documentation for the construction of each well will be submitted by the registered geologist or engineer within 30 days

after well construction. Plans to install MicroPurge™ pumps in any additional well installed on-site shall be submitted to DSWM for approval prior to pump installation.

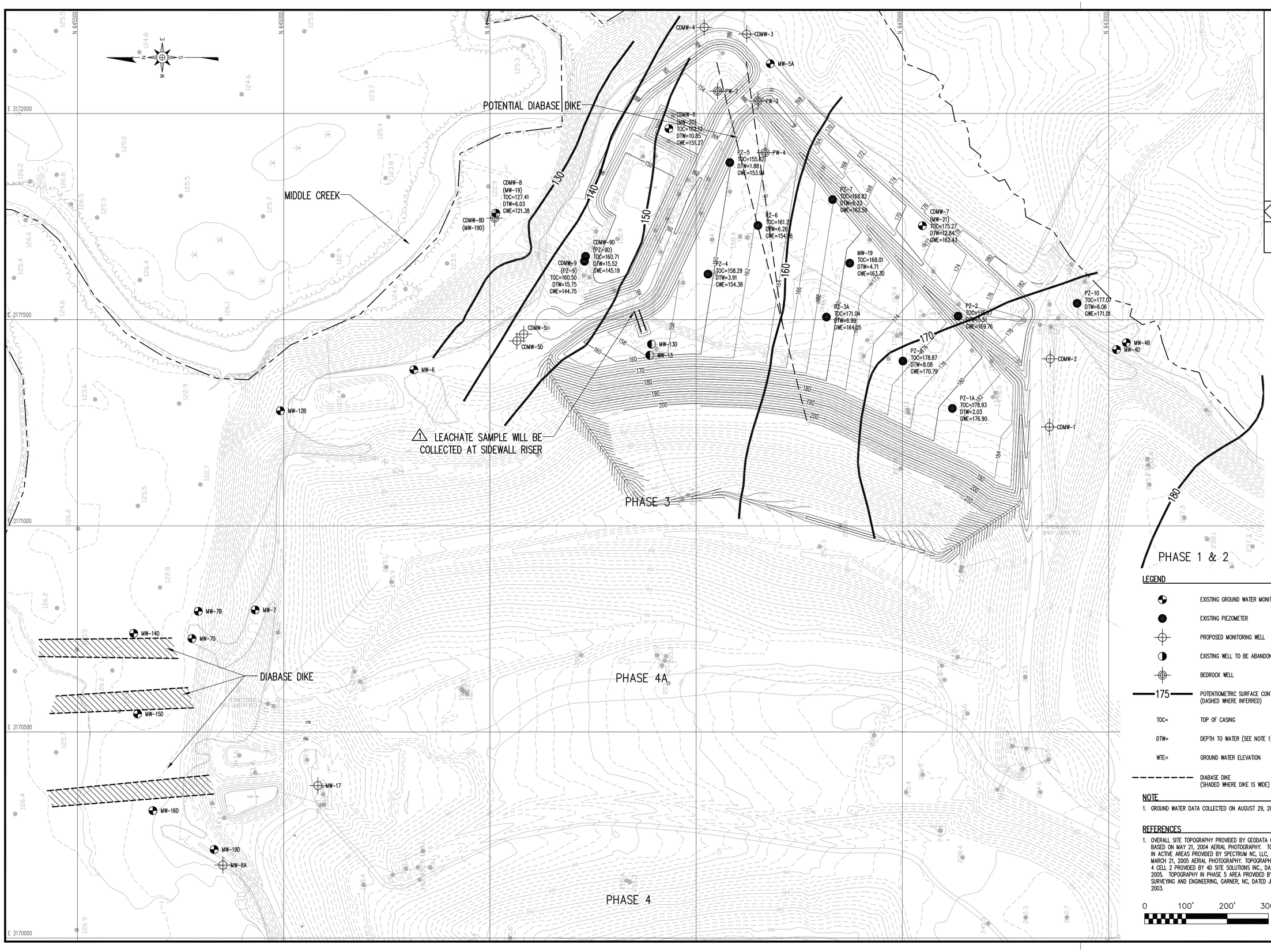
9.4 Implementation Schedule

This program is currently in place and being utilized at the site, with the exception of the addition of MW-8a, MW-14d, MW-15d, MW-16d and MW-17 and the leachate samples. These wells have also been proposed in a letter from GNRA to NCDENR dated July 18, 2001 regarding a recent geophysical evaluation of portions of the site and the proposed installation of additional wells. These well installations will be implemented upon approval from NCDENR.

Table 1
Ground Water Monitoring Well Network
Johnston County Landfill
Johnston County, North Carolina
Proposed C&D Landfill

Monitoring Well	Completion Type	Associated Wells	Screened Interval	Monitoring Program
CDMW-1	Shallow	none	TBD	Appendix I List
CDMW-2	Shallow	none	TBD	Appendix I List
CDMW-3	Shallow	none	TBD	Appendix I List
CDMW-4	Deep	none	TBD	Appendix I List
CDMW-5	Shallow	CDMW-5d	TBD	Appendix I List
CDMW-5d	Shallow	CDMW-5	TBD	Appendix I List
CDMW-6	Shallow	none	TBD	Appendix I List
CDMW-7	Deep	none	TBD	Appendix I List
CDMW-8	Shallow	CDMW-8d	TBD	Appendix I List
CDMW-8d	Deep	CDMW-8	TBD	Appendix I List
CDMW-9	Shallow	CDMW-9d	TBD	Appendix I List
CDMW-9d	Deep	CDMW-9	TBD	Appendix I List

Notes: 1.) Well locations shown on WQMP Figure 1
2.) TBD = To Be Determined



LEGEND

- EXISTING GROUND WATER MONITORING WELL
- EXISTING PIEZOMETER
- PROPOSED MONITORING WELL
- EXISTING WELL TO BE ABANDONED
- BEDROCK WELL
- 175 — POTENTIOMETRIC SURFACE CONTOUR (DASHED WHERE INFERRED)
- TOC= TOP OF CASING
- DTW= DEPTH TO WATER (SEE NOTE 1)
- WTE= GROUND WATER ELEVATION
- DIABASE DIKE (SHADED WHERE DIKE IS WIDE)

NOTE

1. GROUND WATER DATA COLLECTED ON AUGUST 29, 2005.

REFERENCES

1. OVERALL SITE TOPOGRAPHY PROVIDED BY GEODATA CORPORATION, BASED ON MAY 21, 2004 AERIAL PHOTOGRAPHY. TOPOGRAPHY IN ACTIVE AREAS PROVIDED BY SPECTRUM NC, LLC, BASED ON MARCH 21, 2005 AERIAL PHOTOGRAPHY. TOPOGRAPHY OF PHASE 4 CELL 2 PROVIDED BY 4D SITE SOLUTIONS INC., DATED JUNE 2, 2005. TOPOGRAPHY IN PHASE 5 AREA PROVIDED BY SOUTHMND SURVEYING AND ENGINEERING, GARNER, NC, DATED JUNE 16, 2003.

0 100' 200' 300'

NO.	DATE	REVISION
1	2/20/06	ADDED LEACHATE SAMPLE LOCAION CALLOUT

G. N. RICHARDSON & ASSOCIATES, INC.
Engineering and Geological Services
14 N. Boylan Ave. Raleigh, N.C. 27603
ph: 919-828-0577 fax: 919-828-3899
www.gnra.com

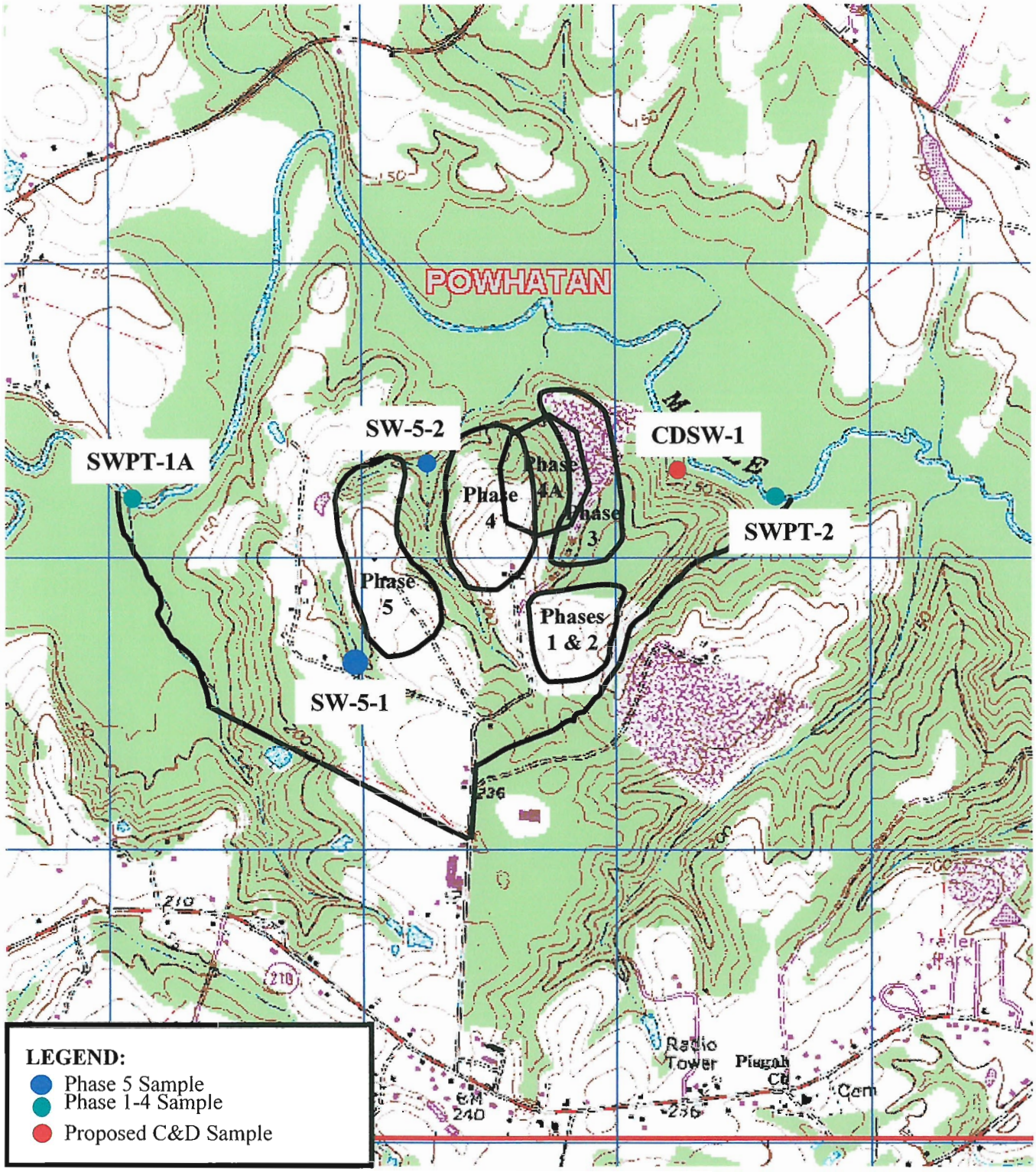
SEAL

SEAL

PROJECT TITLE:
JOHNSTON COUNTY LANDFILL
SMITHFIELD, NORTH CAROLINA

DRAWING TITLE:
POTENTIOMETRIC SURFACE MAP
AUGUST 2005 DATA
WITH PROPOSED
WELL LOCATIONS

DESIGNED BY:	DRAWN BY:
J.A.S.	C.T.J.
CHECKED BY:	PROJECT NO.:
	JOHN-23
SCALE:	DATE:
AS SHOWN	OCT. 2005
FILE NAME	
JOHN-D0385A	
SHEET NO.	DRAWING NO.
	FIG. 1



Surface Water Sampling Locations

Johnston County Landfill

Smithfield, North Carolina

G. N. RICHARDSON & ASSOCIATES, INC.
Engineering and Geological Services
14 N. Boylan Ave.
Raleigh, N.C. 27603
www.gnra.com
ph: 919-828-0577
fax: 919-828-3899

SCALE:	DRAWN BY:	CHECKED BY:	DATE:	PROJECT NO.	FIGURE NO.	FILE NAME
NTS	CJ	JAS	11/3/05	Johnston-23	2	John sw loc.ppt

Subject: Johnston County Landfill (Permit No. 51-01) - Response to Review Comments
From: Pieter Scheer <pieter@rsgengineers.com>
Date: Mon, 12 Jan 2009 09:42:37 -0500
To: "Wilson, Donna" <Donna.Wilson@ncmail.net>

Donna:

Attached are copies of our response on the MSWLF and C&DLF units. If you need anything else let me know. Otherwise I'll send over a hard copy of each later today along with a CD containing a pdf copy of the updated permit application for the Phase 4A - Cell 3 unit for which you already have a hard copy.

Thanks!

Pieter

--
Pieter K. Scheer, P.E.
Principal, Senior Engineer
Richardson Smith Gardner & Associates, Inc.
14 N. Boylan Ave.
Raleigh, NC 27603
Phone: (919) 828-0577 x123
Fax: (919) 828-3899
www.rsgengineers.com

JC DWM Response 011209 MSWLF.pdf	**Content-Type:** application/pdf **Content-Encoding:** base64

JC DWM Response 011209 C&DLF.pdf	**Content-Type:** application/pdf **Content-Encoding:** base64

RICHARDSON SMITH GARDNER & ASSOCIATES
Engineering and Geological Services

January 12, 2009

Ms. Donna J. Wilson
Environmental Engineer II
NC DENR - Division of Waste Management
401 Oberlin Road, Suite 150
Raleigh, NC 27605

Re: Johnston County C&D Landfill (Permit No. 51-03)
Permit Application - Continued Operations
Response to Review Comments

Dear Ms. Wilson:

Richardson Smith Gardner & Associates, Inc. (RSG) appreciates your review of the above referenced plan. We would like to respond to the comments addressed in your letter dated October 16, 2008 (see **attached** - note comments are near end of letter following those for the Phase 4A Cell 3 MSW landfill unit), as follows. The plan review comments are repeated below in *italics* and our response follows in **bold**.

1. *We have completed a technical review of the Closure and Post-Closure plans and cost estimates for the for the C&D units, in accordance with Rule .0547, and we request that the CQA plan for closure activities and the water monitoring plan be included in the submittal.*

   As referenced in our cover letter dated June 20, 2008, construction quality assurance (CQA) information related to the closure of C&D landfill units was provided as part of the permit application for the MSW Phase 4A - Cell 3 landfill unit. Attached is a copy of the CQA Manual from that submittal.

   The Water Quality Monitoring Plan for the C&D landfill units was submitted and approved as part of the permit application for the Area 2 C&D landfill unit. Attached is a copy of the approved plan.

Please contact me at your earliest convenience with any questions or comments which you may have on this submittal or any further questions or comments you may have on the application.

Sincerely,
Richardson Smith Gardner & Associates, Inc.

Pieter K. Scheer, P.E.
Principal, Project Manager
pieter@rsgengineers.com

Attachments: NC DWM Letter - October 16, 2008
CQA Manual
Approved Water Quality Monitoring Plan

cc: Haywood Phthisic, Johnston County
Tim Broome, P.E., Johnston County
Rick Proctor, Johnston County

NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
Dexter R. Matthews, Director | Division of Waste Management | Michael F. Easley, Governor
William G. Ross Jr., Secretary

October 16, 2008

Mr. Haywood Phthisic, Director
Johnston County Public Utilities Department
P O Box 2263
Smithfield, North Carolina

Re: Application for Permit to Construct Phase 4A, Cell 3, and Review of Closure/Post-Closure Plan for the C&D unit, in accordance with .0547
Johnston County MSW and C&D Landfill
Permit No. 51-03
Johnston County, Doc ID 6031

Dear Mr. Phthisic:

An application for a Permit to Construct for Phase 4A, Cell 3 has been submitted to the Division of Waste Management, Solid Waste Section (Section) on your behalf by your consultant RSG Engineers. In accordance with GS 130A-295.8(e), the Section has reviewed your application and found it to be complete within the meaning of the statute. A determination of completion means that the application includes all required components but does not mean that the required components provide all the information that is required for the Section to make a decision on the application. We have performed a technical review of the submitted application and request the following:

1. Please provide a summary description of the history at the landfill in the application, to include the progression of the phases and vertical expansions, with dates and a brief identification of liners and final covers for the different phases.
2. The property line boundary, from Plat Book 59, Page 437, does not appear to match the property line boundary as shown on drawing S1 (in the area of the NCDOT borrow area). Please clarify.
3. The settlement calculations in the Appendix show the calculated settlement at 7 points. Please provide the calculation of the final slope of the liner between each segment to show positive leachate drainage. Please provide confirmation that the post-settlement bottom elevation of the liner system is a minimum of 4 feet above the seasonal high groundwater table.
4. It appears that the flatter portion of Cell 3 was not included in the original approved plans. Please address why this was changed, and address settlement and differential settlement issues for this flatter portion, to ensure adequate positive drainage of leachate.
5. Please provide calculations that demonstrate that the Cell 4A sump is sized to handle the leachate volumes for cells 1, 2, and 3. Please provide a discussion and detail drawing of how the leachate will be moved from the 2 leachate systems to the sump.

6. Why is the surface water collection on top of the final cover designed to channel all of the surface water under the geomembrane of the final cover? This contradicts the purpose of the final cover system to prevent infiltration of surface water. If there is a leak, how will it be found? If by subsidence, the leak will be present for a long time before it is discovered. Please explain why this design was chosen over a design that involves pipes or drainage channels on top of the final cover. Please address how this would be maintained to prevent clogs from grass, leaves, silt, etc. Please address why this design still leaves exposed pipes on the surface of the landfill for all side slope areas which do not have the geomembrane final cover.
7. Drawing FC1 – Please identify the type of final cover that consists on top of Phase 3 for the strip between Phase 4A cell 2 and the C&D Area 2 cell 2. The entire top of Phase 3 should have a final cover with geomembrane.
8. Please provide at least one cross-section that shows the bottom and top of Phase 3 and 4 MSW areas, the C&D Area 1 and 2 areas, and the Phase 4A areas.
9. In the text, please describe how all the liner components will be connected from cell 1 to cell 3.
10. Drawing FC3 – In text or on the drawing, please explain how the leachate seep collection trenches will be used – in the intermediate cover, after final cover is placed, etc. Leachate outbreaks should not occur through the geomembrane after final cover is placed, as it appears to indicate on the drawing.
11. Please provide a detail drawing of the final cover anchor trench.
12. Drawing detail 2/FC2 – Please clarify where the outlet pipe discharges in relation to Cell 3.
13. Please indicate the locations of the white goods, tire, battery, and waste oil collection areas on the existing conditions drawing.
14. Please include a drawing that shows all future phases, as was in the March 2006 drawings.
15. Operating Plan - Section 2.2.1 - Please correct the reference to the NCAC for the definition of acceptable waste.
16. Operating Plan - Section 2.3.1 – Please correct the reference to the NCAC for the definition of hazardous waste.
17. Operating Plan - Section 2.5.3.2 – Please explain how the geosynthetic rain cover is perforated in a new waste area.
18. Operating Plan – Please incorporate the details and operating plan of the Tarpomatic alternate daily cover.
19. Operating Plan – Please describe the operation and application of the approved spray irrigation system for reclaimed wastewater in the text of the plan, similar to the discussion of the yard waste processing area, and reference the operating plan in the appendix.
20. Operating Plan – Please add discussion of the Bulk Reclaimed Water Transfer Station recently approved on the landfill property. Address site security between the station and the landfill and show the location on the site map.
21. Operating Plan - Please provide a brief discussion of the proposed leachate pond equalization basin modifications.
22. Please provide the actual leachate volumes that have been collected in the leak detection system for Phase 4A, historically and currently.
23. The operating plan should address routine leachate collection line cleaning and inspections. All leachate collection lines shall be designed and constructed to permanently allow cleaning and remote camera inspection. All leachate collection lines shall be cleaned at least once a year, except that the Department may allow leachate collection lines to be cleaned once every

two years if the facility has continuous flow monitoring; and the permit holder demonstrates to the Department that the leachate collection lines are clear and functional based on at least three consecutive annual cleanings. Remote camera inspections of the leachate collection lines shall occur upon completion of construction, at least once every five years thereafter, and following the clearing of blockages.

24. Engineering Plan – Section 2.3.1 - Please clarify what the cut will be in the earthwork cut and fill.
25. Please clarify if the stormwater/leachate separation system will involve welding flaps to the liner.
26. Please provide a copy of the facility plan in this report, updated as needed. The plan should describe the increased capacity, and compare the increase to the capacity in the facility plan that was approved in August 2006.
27. Please include with this application a copy of the approved water quality monitoring plan, following Rule .1623 (b)(3).
28. Closure plan – Please provide a schedule for completing all activities necessary to satisfy the closure criteria in Rule .1627 (c).
29. Please address financial assurance submittal and mechanism in the text of the application. Please update the cost estimates in the application to be consistent with the Closure/Post-closure plan for the C&D units submitted in June 2008. Why has the post-closure costs been reduced from the 2007 submittal ($8,340,528)?

Please submit response to comments as replacement pages to the application report. Only one paper copy is necessary, but an electronic copy is also needed, either sent by email, or on a CD.

We have completed a technical review of the Closure and Post-closure plans and cost estimates for the C&D units, in accordance with Rule .0547, and we request that the CQA plan for closure activities and the water monitoring plan be included in the submittal.

For your reference, the Solid Waste Section rules can be found on the Section's website at http://www.wastenotnc.org/swhome/rule.asp; and the North Carolina General Statutes concerning solid waste are located at http://www.ncleg.net/EnactedLegislation/Statutes/HTML/ByArticle/Chapter_130A/Article_9.html.

If you have any questions or comments, please contact me at (919) 508-8510, or by email at donna.wilson@ncmail.net.

Sincerely,

Donna J. Wilson

Donna J. Wilson
Environmental Engineer
Solid Waste Section

cc: Pieter Scheer Smith, RSG&A
Rick Proctor, Johnston County Solid Waste Manager
Dennis Shackelford, Central Regional Supervisor, DWM
Mary Whaley, Waste Management Specialist, DWM

Construction Quality Assurance Manual

Johnston County Landfill
Smithfield, North Carolina

Prepared for:
Johnston County Department of Public Utilities
Smithfield, NC

June 2007

RICHARDSON SMITH GARDNER & ASSOCIATES
Engineering and Geological Services
14 N. Boylan Avenue
Raleigh, North Carolina 27603

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JOHNSTON COUNTY LANDFILL

CONSTRUCTION QUALITY ASSURANCE MANUAL

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SECTION 1.0
GENERAL

1.1 INTRODUCTION

This Construction Quality Assurance (CQA) Manual has been prepared to provide the Owner, (Design) Engineer, and CQA Engineer the means to govern the construction quality and to satisfy landfill certification requirements under current solid waste management regulations.

More specifically, this CQA Manual addresses the soils and geosynthetics components of the liner, leachate management, and the final cover systems (as applicable) for both the MSW and C&D landfill units at the facility.

The CQA Manual is divided into the following sections:

- Section 1.0 General
- Section 2.0 CQA Documentation
- Section 3.0 Earthwork CQA
- Section 4.0 Soil Liner CQA
- Section 5.0 Geomembrane CQA
- Section 6.0 Leachate Management System CQA
- Section 7.0 Geotextile CQA
- Section 8.0 Drainage Geocomposite CQA
- Section 9.0 Geosynthetic Clay Liner CQA
- Section 10.0 Final Cover System CQA

1.2 DEFINITIONS RELATING TO CONSTRUCTION QUALITY

1.2.1 Construction Quality Assurance (CQA)

In the context of this Manual, Construction Quality Assurance is defined as a planned and systematic program employed by the Owner to assure conformity of the liner, leachate management, and final cover systems installation with the project drawings and the project specifications. CQA is provided by the CQA Engineer as a representative of the Owner and is independent from the Contractor and all manufacturers. The CQA program is designed to provide adequate confidence that items or services meet contractual and regulatory requirements and will perform satisfactorily in service.

1.2.2 Construction Quality Control (CQC)

Construction Quality Control refers to actions taken by manufacturers, fabricators, installers, and/or the Contractor to ensure that the materials and the workmanship meet the requirements of the project drawings and the project specifications. The manufacturer's specifications and quality control (QC) requirements are included in this CQA Manual by

reference only. A complete updated version of each geosynthetic component manufacturer's QC Plan shall be incorporated as part of the Contractor's CQC Plan.

1.2.3 CQA Certification Document

At the completion of construction, a certification document will be prepared by the CQA Engineer and submitted to State Solid Waste Regulators. The certification report will include all QC testing performed by the Geosynthetics Manufacturers, all CQC testing performed by the Geosynthetic Installers, and all CQA testing performed by the CQA Engineer.

1.2.4 Discrepancies Between Documents

The Contractor is instructed to bring discrepancies to the attention of the CQA Engineer who shall then notify the Engineer for resolution. The Engineer has the sole authority to determine resolution of discrepancies existing within the Contract Documents (this may also require the approval of State Solid Waste Regulators). Unless otherwise determined by the Engineer, the more stringent requirement shall be the controlling resolution.

1.3 PARTIES TO CONSTRUCTION QUALITY ASSURANCE

1.3.1 Description of the Parties

The parties to Construction Quality Assurance and Quality Control include the Owner, Engineer, Contractor, Geosynthetics Manufacturer, Geosynthetics Installer, CQA Engineer, Geosynthetics CQA Laboratory, and Soils CQA Laboratory.

1.3.1.1 Owner

The Owner is Johnston County, who owns and/or is responsible for the facility.

1.3.1.2 Engineer

The Engineer is responsible for the engineering design, drawings, and project specifications for the liner, leachate management, and final cover systems. The Engineer is an official representative of the Owner. The Engineer serves as communications coordinator for the project, initiating the meetings outlined in **Section 1.7**. The Engineer will also be responsible for proper resolution of all quality issues that arise during construction. The Engineer is Richardson Smith Gardner & Associates, Inc.

1.3.1.3 Contractor

The Contractor is responsible for the construction of the subgrade, earthwork, and for placement of the liner, leachate management, and final cover systems. The

Contractor is responsible for the overall CQC on the project and coordination of submittals to the CQA Engineer. Additional responsibilities of the Contractor are defined by the project specifications.

1.3.1.4 Geosynthetics Manufacturer

The Geosynthetics Manufacturer(s) is (are) responsible for the production of the geosynthetic components used in landfill construction. The Manufacturer(s) is (are) responsible for Quality Control (QC) during manufacture of the geosynthetic components, certification of the properties of the geosynthetic components, and field installation criteria.

1.3.1.5 Geosynthetics Installer

The Geosynthetics Installer(s) is (are) routinely a subcontractor of the Contractor and is (are) responsible for field handling, storing, placing, seaming, protection of (against wind, etc.), and other aspects of the geosynthetics installations. The Installer may also be responsible for transportation of these materials to the site, and for the preparation and completion of anchor trenches.

1.3.1.6 CQA Engineer

The CQA Engineer is a representative of the Owner, is independent from the Contractor, and is responsible for observing, testing, and documenting activities related to the CQA of the earthworks at the site, and the installation of the soil and geosynthetic components of the liner, leachate management, and final cover systems. The CQA Engineer may make field observations and review submittals for the Engineer and is responsible for notifying the Owner and Engineer of all quality issues that arise during construction. The CQA Engineer is also responsible for issuing a facility certification report, sealed by a Professional Engineer registered in The State of North Carolina.

1.3.1.7 Geosynthetics CQA Laboratory

The Geosynthetics CQA Laboratory is a party, independent from the Owner, that is responsible for conducting tests on conformance samples of geosynthetics used in the liner, leachate management, and final cover systems. The Geosynthetics CQA Laboratory service cannot be provided by any party involved with the manufacture, fabrication, or installation of any of the geosynthetic components. The services of the Geosynthetics CQA Laboratory are coordinated by the CQA Engineer and are paid for by the Owner.

1.3.1.8 Soils CQA Laboratory

The Soils CQA Laboratory is a party, independent from the Owner, that is responsible for conducting geotechnical tests on conformance samples of soils and aggregates used in structural fills and the liner, leachate management, and final cover systems. The services of the Soils CQA Laboratory are coordinated by the CQA Engineer and are paid for by the Owner.

1.3.2 Qualifications of the Parties

The following qualifications are required of all parties involved with the manufacture, fabrication, installation, transportation, and CQA of all materials for the liner, leachate management, and final cover systems. Where applicable, these qualifications must be submitted by the Contractor to the Owner and Engineer for review and approval.

1.3.2.1 Contractor

Qualifications of the Contractor are specific to the construction contract and independent of this CQA Manual.

1.3.2.2 Geosynthetics Manufacturers

Each Geosynthetics Manufacturer must satisfy the qualifications presented in the project specifications.

1.3.2.3 Geosynthetic Installer(s)

The Geosynthetic Installer(s) will be trained and qualified to install the geosynthetics components of the liner, leachate management, and final cover systems. Each Geosynthetics Installer must meet the requirements of the project specifications and be approved by the Engineer.

1.3.2.4 CQA Engineer

The CQA Engineer will act as the Owner's Quality Assurance Representative. The CQA Engineer will perform CQA testing to satisfy the requirements of this CQA Manual and will prepare the CQA certification document. The CQA Engineer will have experience in the CQA aspects of the construction and testing of landfill liner, leachate management, and final cover systems, and be familiar with ASTM and other related industry standards. The activities of the CQA Engineer will be performed under the supervision of a Registered Professional Engineer.

1.3.2.5 Geosynthetics CQA Laboratory

The Geosynthetics CQA Laboratory should be certified by the Geosynthetics Accreditation Institute, will have experience in testing geosynthetics, and be familiar with ASTM, GRI, and other applicable test standards. The Geosynthetics CQA Laboratory will be capable of providing test results within 24 hours or a reasonable time after receipt of samples depending on the test(s) to be conducted, as agreed to at the outset of the project by affected parties, and will maintain that standard throughout the installation.

1.3.2.6 Soils CQA Laboratory

The Soils CQA Laboratory will have experience in testing structural fills, soil liners, and aggregates, and be familiar with ASTM and other applicable test standards. The Soils CQA Laboratory will be capable of providing test results within 24 hours or a reasonable time after receipt of samples depending on the test(s) to be conducted, as agreed to at the outset of the project by affected parties, and will maintain that standard throughout the installation.

1.4 SCOPE OF CONSTRUCTION QUALITY ASSURANCE MANUAL

The scope of this CQA Manual includes the CQA of the soils and geosynthetic components of the liner, leachate management, and final cover systems for the subject facility. The CQA for the selection, evaluation, and placement of the soils is included in the scope.

1.5 UNITS

In this CQA Manual, all properties and dimensions are expressed in U.S. units.

1.6 REFERENCES

The CQA Manual includes references to the most recent version of the test procedures of the American Society of Testing and Materials (ASTM) and/or the Geosynthetic Research Institute (GRI). **Appendix A** contains a list of these procedures.

1.7 CQA MEETINGS

To facilitate the specified degree of quality during installation, clear, open channels of communication are essential. To that end, meetings are critical.

1.7.1 Soil Liner CQA Meeting

Prior to the start of the soil liner system construction a CQA Meeting will be held. This meeting will include all parties then involved, including the Engineer, the CQA Engineer, and the Contractor.

The purpose of this meeting is to begin planning for coordination of tasks, anticipate any problems which might cause difficulties and delays in construction, and, above all, review the CQA Manual to all of the parties involved. It is very important that the rules regarding testing, repair, etc., be known and accepted by all.

This meeting should include all of the activities referenced in the project specifications.

The meeting will be documented by the Engineer and minutes will be transmitted to all parties. The Soil Liner CQA Meeting and the Geosynthetics CQA Meeting may be held as one meeting or separate meetings, depending on the direction of the Engineer.

1.7.2 Geosynthetics CQA Meeting

A CQA Meeting will be held at the site prior to placement of the geosynthetics. At a minimum, the meeting will be attended by the Engineer, the CQA Engineer, the Contractor, and the Geosynthetic Installation Superintendent(s).

The purpose of this meeting is to begin planning for coordination of tasks, anticipate any problems which might cause difficulties and delays in construction, and, above all, review the CQA Manual to all of the parties involved. It is very important that the rules regarding testing, repair, etc., be known and accepted by all.

This meeting should include all of the activities referenced in the project specifications.

The meeting will be documented by the Engineer and minutes will be transmitted to all parties. The Soil Liner CQA Meeting and the Geosynthetics CQA Meeting may be held as one meeting or separate meetings, depending on the direction of the Engineer.

1.7.3 CQA Progress Meetings

Progress meetings will be held between the Engineer, the CQA Engineer, the Contractor, the Geosynthetic Installation Superintendent(s), and representatives from any other involved parties at the frequency dictated in the project specifications or, at a minimum, once per month during active construction. These meetings will discuss current progress, planned activities for the next week, and any new business or revisions to the work. The CQA Engineer will log any problems, decisions, or questions arising at this meeting in his daily or periodic reports. Any matter requiring action which is raised in this meeting will be reported to the appropriate parties. These meetings will be documented by the Engineer and minutes will be transmitted to affected parties.

1.7.4 Problem or Work Deficiency Meetings

A special meeting will be held when and if a problem or deficiency is present or likely to occur. At a minimum, the meeting will be attended by the Engineer, the CQA Engineer,

the Contractor, and representatives from any other involved parties. The purpose of the meeting is to define and resolve the problem or work deficiency as follows:

- define and discuss the problem or deficiency;
- review alternative solutions; and
- implement an action plan to resolve the problem or deficiency.

The meeting will be documented by the Engineer and minutes will be transmitted to affected parties.

1.8 CONTROL VERSUS RECORD TESTING

1.8.1 Control Testing

In the context of this CQA Manual, Control Tests are those tests performed on a material prior to its actual use in construction to demonstrate that it can meet the requirements of the project plans and specifications. Control Test data may be used by the Engineer as the basis for approving alternative material sources.

1.8.2 Record Testing

Record Tests are those tests performed during the actual placement of a material to demonstrate that its in-place properties meet or exceed the requirements of the project drawings and specifications.

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SECTION 2.0
CQA DOCUMENTATION

2.1 DOCUMENTATION

An effective CQA plan depends largely on recognition of 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 quality assurance activities. The CQA Engineer will document that quality assurance requirements have been addressed and satisfied.

The CQA Engineer will provide the Owner and Engineer with his daily and weekly progress reports including signed descriptive remarks, data sheets, and logs to verify that required CQA activities have been carried out. These reports will also identify potential quality assurance problems. The CQA Engineer will also maintain at the job site a complete file of project drawings, reports, project specifications, a CQA Manual, checklists, test procedures, daily logs, and other pertinent documents.

2.2 DAILY CQA REPORT

The CQA Engineer's reporting procedures will include preparation of a daily report which, at a minimum, will include the following information, where applicable:

- a unique identifying sheet number for cross referencing and document control;
- date, project name, location, and other identification;
- data on weather conditions;
- a reduced-scale Site Plan showing all proposed work areas and test locations;
- descriptions and locations of ongoing construction;
- descriptions and specific locations of areas, or units, of work being tested and/or observed and documented;
- locations where tests and samples were taken;
- a summary of test results;
- calibrations or recalibrations of test equipment, and actions taken as a result of recalibration;
- off-site materials received, including quality verification documentation;

- decisions made regarding acceptance of units of work, and/or corrective actions to be taken in instances of substandard quality;

- summaries of pertinent discussions with the Contractor and/or Geosynthetic Installers; and

- the CQA Engineer's signature.

The daily report must be completed at the end of each CQA Engineer's shift, prior to leaving the site. This information will be submitted weekly to and reviewed by the Owner and Engineer.

2.3 CQA PROGRESS REPORTS

The CQA Engineer will prepare a summary progress report each week, or at time intervals established at the pre-construction meeting. As a minimum, this report will include the following information, where applicable:

- a unique identifying sheet number for cross-referencing and document control;

- the date, project name, location, and other information;

- a summary of work activities during the progress reporting period;

- a summary of construction situations, deficiencies, and/or defects occurring during the progress reporting period;

- summary of all test results, failures and retests, and

- signature of the CQA Engineer.

The CQA Engineer's progress reports must summarize the major events that occurred during that week. Critical problems that occur shall be communicated verbally to the Engineer immediately as well as being included in the weekly reports. The CQA Engineer's weekly report must be submitted to the Owner and Engineer no later than the Monday following the week reported.

2.4 CQA PHOTOGRAPHIC REPORTING

Photographs will be taken by the CQA Engineer at regular intervals during the construction process and in all areas deemed critical by the CQA Engineer.

These photographs will serve as a pictorial record of work progress, problems, and mitigation activities. These records will be presented to the Engineer upon completion of the project.

In lieu of photographic documentation, videotaping may be used to record work progress,

problems, and mitigation activities. The Engineer may require that a portion of the documentation be recorded by photographic means in conjunction with videotaping.

2.5 DEFICIENCIES

The Owner and Engineer will be made aware of any significant recurring nonconformance with the project specifications. The Engineer will then determine the cause of the non-conformance and recommend appropriate changes in procedures or specification. When this type of evaluation is made, the results will be documented, and any revision to procedures or project specifications will be approved by the Owner and Engineer.

2.6 DESIGN AND/OR PROJECT TECHNICAL SPECIFICATION CHANGES

Design and/or project specification changes may be required during construction. In such cases, the CQA Engineer will notify the Engineer. The Engineer will then notify the appropriate agency, if necessary.

Design and/or project specification changes will be made only with the written agreement of the Engineer, and will take the form of an addendum to the project specifications. All design changes will include a detail (if necessary) and state which detail it replaces in the plans.

2.7 FINAL CQA REPORT

At the completion of each major construction activity at the landfill unit, the CQA Engineer will certify all required forms, observation logs, field and laboratory testing data sheets including sample location plans, etc. The CQA Engineer will also provide a final report which will certify that the work has been performed in compliance with the plans and project technical specifications, and that the supporting documents provide the necessary information.

The CQA Engineer will also provide summaries of all the data listed above with the report. The Record Drawings will include scale drawings depicting the location of the construction and details pertaining to the extent of construction (e.g., depths, plan dimensions, elevations, soil component thicknesses, etc.). All surveying and base maps required for development of the Record Drawings will be done by the Contractor's Construction Surveyor. These documents will be certified by the Contractor and delivered to the CQA Engineer and included as part of the final CQA (Certification) report.

It may be necessary to prepare interim certifications, as allowed by the regulatory agency to expedite completion and review.

At a minimum, the items shown in **Table 2.1** will be included in the Final CQA Report. Note that some items may not be applicable to all projects.

2.8 STORAGE OF RECORDS

All handwritten data sheet originals, especially those containing signatures, will be stored by the CQA Engineer in a safe repository on site. Other reports may be stored by any standard method which will allow for easy access. All written documents will become property of the Owner.

TABLE 2.1A: FINAL CQA REPORT GENERAL OUTLINE (LINER SYSTEM)

1.0 Introduction
2.0 Project Description
3.0 CQA Program
    3.1 Scope of Services
    3.2 Personnel
4.0 Earthwork CQA
5.0 Soil Liner CQA
6.0 GCL CQA
7.0 Geomembrane CQA
8.0 Leachate Management System CQA
9.0 Geotextile CQA
10.0 Drainage Geocomposite CQA
11.0 Summary and Conclusions
12.0 Project Certification

Appendices

Appendix A Design Clarifications and Modifications
Appendix B Piezometer Abandonment (if applicable)
Appendix C Geophysical Investigation (if applicable)
Appendix D Photographic Documentation
Appendix E CQA Reporting
    E1. CQA Reports
    E2. CQA Meeting Minutes
Appendix F Earthwork CQA Data
    F1. CQA Test Results - Control Tests
    F2. CQA Test Results - Record Tests
Appendix G Soil Liner CQA Data
    G1. CQA Test Results - Control Tests
    G2. CQA Test Results - Record Tests
Appendix H Interface Shear Strength Test Data
Appendix I GCL CQA Data
    I1. Manufacturer's Product Data Submittals and Quality Control Certificates
    I2. Geosynthetics Inventory - GCL
    I3. CQA Test Results - Material Control Tests
    I4. GCL Installation Certification

TABLE 2.1A (CONTINUED):

Appendix J	Geomembrane CQA Data
	J1. Manufacturer's Product Data Submittals and Quality Control Certificates
	J2. Geosynthetics Inventory - Geomembrane(s)
	J3. CQA Test Results - Material Control Tests
	J4. Subgrade Acceptance Certificates
	J5. Trial Seam Logs
	J6. Panel Placement Logs
	J7. Panel Seaming Logs
	J8. CQC Test Results - Nondestructive Seam Testing Report Forms
	J9. CQC Test Results - Destructive Seam Testing Report Forms (Field)
	J10. CQA Test Results - Destructive Seam Testing Report Forms (Laboratory)
	J11. Repair Logs
	J12. Geomembrane Installation Certification
Appendix K	Leachate Management System CQA Data
	K1. Manufacturer's Product Data Submittals and Quality Control Certificates
	K2. CQA Test Results - Drainage Aggregate
	K3. CQA Test Results - Protective Cover
	K4. CQC Test Results - Pressure Testing of HDPE Transmission Piping
	K5. Documentation of Pump Start Up
Appendix L	Geotextile CQA Data
	L1. Manufacturer's Product Data Submittals and Quality Control Certificates
	L2. Geosynthetics Inventory - Geotextiles
	L3. CQA Test Results - Material Control Tests
Appendix M	Drainage Geocomposite CQA Data
	M1. Manufacturer's Product Data Submittals and Quality Control Certificates
	M2. Geosynthetics Inventory - Drainage Geocomposite
	M3. CQA Test Results - Material Control Tests
Appendix N	Record Drawings
	N1. Subgrade As-Built
	N2. Soil Liner As-Built
	N3. Geomembrane As-Built(s)
	N4. Leachate Collection Media As-Built
	N5. HDPE Pipe As-Built
	N6. Protective Cover As-Built

TABLE 2.1B: FINAL CQA REPORT GENERAL OUTLINE (FINAL COVER SYSTEM)

1.0 Introduction
2.0 Project Description
3.0 CQA Program
  3.1 Scope of Services
  3.2 Personnel
4.0 Earthwork CQA
5.0 Final Cover System CQA
6.0 Geomembrane CQA
7.0 Geotextile CQA
8.0 Drainage Geocomposite CQA
9.0 Summary and Conclusions
10.0 Project Certification

Appendices

Appendix A Design Clarifications/Modifications
Appendix B Photographic Documentation
Appendix C CQA Reporting
  C1. CQA Reports
  C2. CQA Meeting Minutes
Appendix D Earthwork CQA Data
  D1. CQA Test Results - Control Tests
  D2. CQA Test Results - Record Tests
Appendix E Final Cover System CQA Data
  E1. Manufacturer's Product Data Submittals and Quality Control Certificates
  E2. CQA Test Results - Drainage Aggregate
  E3. CQA Test Results - Vegetative Soil Layer
  E4. CQC Test Results - Pressure Testing of HDPE Piping
Appendix F Interface Shear Strength Test Data
Appendix G Geomembrane CQA Data
  G1. Manufacturer's Product Data Submittals and Quality Control Certificates
  G2. Geosynthetics Inventory - Geomembrane
  G3. CQA Test Results - Material Control Tests
  G4. Subgrade Acceptance Certificates
  G5. Trial Seam Logs
  G6. Panel Placement Logs
  G7. Panel Seaming Logs
  G8. CQC Test Results - Nondestructive Seam Testing Report Forms
  G9. CQC Test Results - Destructive Seam Testing Report Forms (Field)
  G10. CQA Test Results - Destructive Seam Testing Report Forms (Laboratory)
  G11. Repair Logs
  G12. Geomembrane Installation Certification

TABLE 2.1B (CONTINUED):

Appendix H	Geotextile CQA Data
	H1. Manufacturer's Product Data Submittals and Quality Control Certificates
	H2. Geosynthetics Inventory - Geotextiles
	H3. CQA Test Results - Material Control Tests
Appendix I	Drainage Geocomposite CQA Data
	I1. Manufacturer's Product Data Submittals and Quality Control Certificates
	I2. Geosynthetics Inventory - Drainage Geocomposite
	I3. CQA Test Results - Material Control Tests
Appendix J	Record Drawings
	J1 Subgrade As-Built
	J2 Geomembrane As-Built
	J3 HDPE Pipe As-Built
	J4 Vegetative Soil Layer As-Built

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SECTION 3.0
EARTHWORK CQA

3.1 INTRODUCTION

This section of the CQA Manual addresses earthwork (excavation and embankment) and outlines the soils CQA program to be implemented with regard to material approval, subgrade approval, field control and record tests, and resolution of problems.

3.2 EMBANKMENT MATERIAL APPROVAL

All material to be used as compacted embankment shall be approved in advance by the CQA Engineer. Approval is based upon successful completion of CQA control testing outlined below. Such testing can be performed either during excavation and stockpiling or from existing stockpiles prior to use.

3.2.1 Control Tests

The procedure for CQA testing during excavation and stockpiling (including existing stockpiles) is outlined below.

Each load of soil will be examined either at the borrow source or the stockpile area. Any unsuitable material will be rejected or routed to separate stockpiles consistent with its end use. Appropriate entries will be made in the daily log.

During stockpiling operations, control tests, as shown on **Table 3.1**, will be performed by the CQA Engineer prior to placement of any compacted embankment.

3.3 SUBGRADE APPROVAL

The CQA Engineer will verify that the compacted embankment subgrade is constructed in accordance with the project specifications.

3.4 EARTHWORK CONSTRUCTION

3.4.1 Construction Monitoring

A. Earthwork shall be performed as described in the project specifications.

B. Only soil previously approved by the CQA Engineer (see **Section 3.2**) shall be used in construction of the compacted embankment. Unsuitable material will be removed prior to acceptance by the CQA Engineer.

C. All required field density and moisture content tests shall be completed before the overlying lift of soil is placed. The surface preparation (e.g. wetting, drying,

scarification, etc.) shall be completed before the CQA Engineer will allow placement of subsequent lifts.

D. The CQA Engineer will monitor protection of the earthwork during and after construction.

3.4.2 Control Tests

The control tests, as shown on **Table 3.2**, will be performed by the CQA Engineer prior to placement of compacted embankment.

3.4.3 Record Tests

The record tests, as shown on **Table 3.2**, will be performed by the CQA Engineer during placement of compacted embankment.

3.4.3.1 Record Test Failure

Recompaction of the failed area shall be performed and retested until the area meets or exceeds requirements outlined in the specifications.

3.4.4 Judgmental Testing

During construction, the frequency of control and/or record testing may be increased at the discretion of the CQA Engineer when visual observations of construction performance indicate a potential problem. Additional testing for suspected areas will be considered when:

- the rollers slip during rolling operation;
- the lift thickness is greater than specified;
- the fill material is at an improper moisture content;
- fewer than the specified number of roller passes are made;
- dirt-clogged rollers are used to compact the material;
- the rollers may not have used optimum ballast;
- the fill materials differ substantially from those specified; or
- the degree of compaction is doubtful.

3.5 DEFICIENCIES

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies will be documented by the CQA Engineer. The Contractor shall correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer will observe all retests on repaired defects.

TABLE 3.1: CQA TESTING PROGRAM FOR EMBANKMENT MATERIAL APPROVAL

PROPERTY	TEST METHOD	MINIMUM TEST FREQUENCY
CONTROL TESTS:		
Visual Classification	ASTM D 2488	Each Soil
Moisture-Density Relationship	ASTM D 698	5,000 CY per Each Soil

TABLE 3.2: CQA TESTING PROGRAM FOR COMPACTED EMBANKMENT

PROPERTY	TEST METHOD	MINIMUM TEST FREQUENCY
CONTROL TESTS: (See **Table 3.1**)		
RECORD TESTS:		
Lift Thickness	-----	Each Lift
In-Place Density	ASTM D 6938[1]	20,000 ft^2 per lift & 1 per 500 LF/lift of Berms (< 200 ft. base width)
Moisture Content	ASTM D 6938[2]	20,000 ft^2 per lift & 1 per 500 LF/lift of Berms (< 200 ft. base width)

Notes:

1. Optionally use ASTM D 1556, ASTM D 2167, or ASTM D 2937. For every 10 nuclear density tests perform at least 1 density test by ASTM D 1556, ASTM D 2167, or ASTM D 2937 as a verification of the accuracy of the nuclear testing device.
2. Optionally use ASTM D 2216, ASTM D 4643, or ASTM D 4959. For every 10 nuclear moisture tests perform at least 1 moisture test by ASTM D 2216, ASTM D 4643, or ASTM D 4959 as a verification of the accuracy of the nuclear testing device.

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SECTION 4.0
SOIL LINER CQA

4.1 INTRODUCTION

This section of the CQA Manual addresses the soil liner component of the liner system and outlines the soils CQA program to be implemented with regard to material approval, subgrade approval, test fill construction, field and laboratory control and record tests, and resolution of problems.

4.2 SOIL LINER MATERIAL APPROVAL

All material to be used as soil liner shall be approved in advance by the CQA Engineer. Approval is based upon successful completion of CQA control testing outlined below. Such testing can be performed either during excavation and stockpiling or from existing stockpiles prior to use.

4.2.1 Control Tests

The procedure for CQA testing during excavation and stockpiling (including existing stockpiles) is outlined below.

Each load of soil will be examined either at the borrow source or the stockpile area. Any unsuitable material will be rejected or routed to separate stockpiles consistent with its end use. Appropriate entries will be made in the daily log.

During stockpiling operations, control tests, as shown on **Table 4.1**, will be performed by the CQA Engineer prior to placement of any soil liner material.

4.3 SUBGRADE APPROVAL

The CQA Engineer will verify that the soil liner subgrade is constructed in accordance with the project specifications.

4.4 TEST FILL CONSTRUCTION

A test fill meeting the requirements of the project specifications will be constructed using the same construction methods, equipment, and material to be used for the soil liner component. The test fill construction will be conducted prior to or coincide with the beginning of construction of the soil liner component.

Construction equipment and methods will be reviewed by the CQA Engineer prior to test fill placement.

4.4.1 Control Tests

The control tests, as shown on **Table 4.2**, will be performed by the CQA Engineer prior to placement of soil liner material in the test fill.

4.4.2 Record Tests

The record tests, as shown on **Table 4.2**, will be performed by the CQA Engineer during placement of soil liner material in the test fill.

4.4.3 Test Fill Completion

The test fill program is completed when the Contractor has shown that the soil liner constructed using the same construction methods, equipment, and material to be used in construction of the soil liner will satisfy project specifications. No soil liner can be placed until the test fill program is completed.

4.5 SOIL LINER CONSTRUCTION

4.5.1 Construction Monitoring

A. Soil liner shall be placed as described in the applicable section(s) of the project specifications using the construction methods, equipment, and material demonstrated in the test fill construction.

B. Only soil previously approved by the CQA Engineer (see **Section 4.2**) shall be used in construction of the soil liner. Unsuitable material will be removed prior to acceptance by the CQA Engineer.

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

D. The CQA Engineer will monitor protection of the soil liner during and after construction.

E. The liner surface shall be sprinkled with water as needed to prevent desiccation. Should desiccation occur, the last lift shall be reconstructed in accordance with the project specifications. Standing water should not be present on the soil liner.

F. Frost heave or other damage due to freezing shall require lift reconstruction in accordance with the project specifications.

G. The CQA Engineer will inspect the soil liner and certify that it is in accordance with

the project specifications and approved plans prior to the Contractor beginning installation of overlying geosynthetics.

H. The finished soil liner shall be free of all rock protrusions. All cracks and voids shall be filled and the surface made uniform. This shall be accomplished by final dressing of the soil liner with smooth-drum rollers and hand raking. No rubber tired vehicles are permitted on the final dressed surface unless authorized by the CQA Engineer.

I. The surface on which the overlying geosynthetics are to be placed shall be maintained in a firm, clean, and smooth condition and shall be within the acceptable moisture range before and during the geosynthetics installation.

4.5.2 Control Tests

The control tests, as shown on **Table 4.3**, will be performed by the CQA Engineer prior to placement of soil liner material.

4.5.3 Record Tests

The record tests, as shown on **Table 4.3** and as described below, will be performed by the CQA Engineer during placement of soil liner material.

A. Each lift will be checked visually for soil clods, rocks, debris, plant materials and other foreign material. Any such material which does not meet specified requirements shall be identified and removed prior to and during the compaction process.

B. The thickness of the loose lift will be measured at random locations after spreading and leveling is completed. Loose lift thickness should not exceed the depth of penetration of the compaction feet.

C. Moisture content will be monitored by the CQA Engineer prior to compaction. If the soil is drier than the specified minimum moisture content, water will be added and the lift will be disced to distribute the moisture evenly.

Results of testing will be certified within 7 days of soil liner placement.

4.5.3.1 Record Test Failure

The following procedures shall be used in the event of density or hydraulic conductivity test failure:

A. Failed Density Test: Recompaction of the failed area shall be performed and retested until the area meets or exceeds requirements outlined in the

specifications.

B. Failed Hydraulic Conductivity Test: The area of failure shall be localized and reconstructed in accordance with the project specifications. This area will be retested as outlined within the plan by the CQA Engineer. Optionally, at least five replicate samples shall be obtained and tested by the Contractor in the immediate vicinity of the failed test. If all five samples pass, then the initial failing test will be discounted. However, should the replicate samples confirm the failure of the soil liner to meet specifications, the area of failure shall be localized, reconstructed, and retested as described above.

4.5.4 Judgmental Testing

During construction, the frequency of control and/or record testing may be increased at the discretion of the CQA Engineer when visual observations of construction performance indicate a potential problem. Additional testing for suspected areas will be considered when:

- the rollers slip during rolling operation;
- the lift thickness is greater than specified;
- the fill material is at an improper moisture content;
- fewer than the specified number of roller passes are made;
- dirt-clogged rollers are used to compact the material;
- the rollers may not have used optimum ballast;
- the fill materials differ substantially from those specified; or
- the degree of compaction is doubtful.

4.5.5 Perforations In Soil Liner

All holes shall be patched with compacted soil liner (if allowed by the project specifications) or sodium bentonite compacted and hydrated in the holes.

4.6 DEFICIENCIES

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies will be documented by the CQA Engineer. The Contractor shall correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer will observe all retests on repaired defects.

TABLE 4.1: CQA TESTING PROGRAM FOR SOIL LINER MATERIAL APPROVAL

PROPERTY	TEST METHOD	MINIMUM TEST FREQUENCY
CONTROL TESTS:		
Visual Classification	ASTM D 2488	Each Soil
Moisture Content	ASTM D 2216	2,000 CY per Each Soil
Grain Size Analysis	ASTM D 422	2,000 CY per Each Soil
Atterberg Limits	ASTM D 4318	2,000 CY per Each Soil
Moisture-Density Relationship	ASTM D 698	5,000 CY per Each Soil
Hydraulic Conductivity - Lab Remolded	ASTM D 5084[3]	10,000 CY per Each Soil

TABLE 4.2: CQA TESTING PROGRAM FOR SOIL LINER TEST FILL

PROPERTY	TEST METHOD	MINIMUM TEST FREQUENCY
CONTROL TESTS: (See **Table 4.1**)		
Moisture-Density Relationship	ASTM D 698[4]	1 per lift
Hydraulic Conductivity - Lab Remolded	ASTM D 5084[3,4]	1 per lift
RECORD TESTS:		
Lift Thickness	-----	Each Lift
Atterberg Limits	ASTM D 4318	1 per lift
Grain Size Analysis	ASTM D 422	1 per lift
In-Place Density	ASTM D 2922[1]	3 per lift
Moisture Content	ASTM D 6938[2]	3 per lift
Hydraulic Conductivity - Undisturbed (Shelby Tube)	ASTM D 6938[3]	1 per lift

TABLE 4.3: CQA TESTING PROGRAM FOR SOIL LINER

PROPERTY	TEST METHOD	MINIMUM TEST FREQUENCY
CONTROL TESTS: (See **Table 4.1**)		
RECORD TESTS:		
Lift Thickness	-----	Each Lift
In-Place Density	ASTM D 6938[1]	10,000 ft^2 per lift
Moisture Content	ASTM D 6938[2]	10,000 ft^2 per lift
Hydraulic Conductivity - Undisturbed (Shelby Tube)	ASTM D 5084[3]	80,000 ft^2 per lift

Notes:

1. Optionally use ASTM D 1556, ASTM D 2167, or ASTM D 2937. For every 10 nuclear density tests perform at least 1 density test by ASTM D 1556, ASTM D 2167, or ASTM D 2937 as a verification of the accuracy of the nuclear testing device.
2. Optionally use ASTM D 2216, ASTM D 4643, or ASTM D 4959. For every 10 nuclear moisture tests perform at least 1 moisture test by ASTM D 2216, ASTM D 4643, or ASTM D 4959 as a verification of the accuracy of the nuclear testing device.
3. Maximum effective confining pressure and hydraulic gradient as required by the project specifications. Backpressure as recommended by ASTM D 5084.
4. These tests performed on the test fill may count toward the minimum frequencies established in **Table 4.1**.

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SECTION 5.0
GEOMEMBRANE CQA

5.1 INTRODUCTION

This section of the CQA Manual addresses the geomembrane components of the liner and final cover systems and outlines the CQA program to be implemented with regard to manufacturer and installer approval, material approval, subgrade approval, field and laboratory control and record tests, repairs, and resolution of problems.

5.2 GEOMEMBRANE MANUFACTURER AND INSTALLER APPROVAL

The Contractor shall submit the qualifications of the Geomembrane Manufacturer and the Geomembrane Installer, as described in the specifications, to the CQA Engineer for approval.

5.3 GEOMEMBRANE MATERIAL APPROVAL

5.3.1 Geomembrane Product Data

The CQA Engineer will review the Contractor's submittals for conformance with the project specifications.

5.3.2 Shipment And Storage

During shipment and storage, all geomembrane will be protected as required by the project specifications. The CQA Engineer will observe rolls upon delivery at the site.

5.3.3 Quality Control Certificates

Upon delivery, the CQA Engineer will:

- verify that the Manufacturer's quality control certificates have been provided at the specified frequency and that each certificate identified the rolls or sheets related to it; and

- review the Manufacturer's quality control certificates and verify that the certified properties meet the project technical specifications.

5.3.4 Material Control Tests

Samples for material control tests, as shown on **Table 5.1**, will be obtained by the CQA Engineer at the indicated frequencies upon delivery of the geomembrane. Alternatively, samples may be randomly obtained at the manufacturing site by the CQA Engineer or representatives of the Geosynthetics CQA Laboratory.

Unless otherwise specified, samples will be 3 feet long by the roll or sheet width. The CQA Engineer will mark the machine direction on the samples with an arrow.

All material control tests will be performed by the Geosynthetics CQA Laboratory.

All control test results must be available at the site prior to the deployment of all geomembrane. The CQA Engineer will examine all results from laboratory conformance testing.

5.3.4.1 Material Control Test Failure

The following procedure will apply whenever a sample fails a material control test:

A. The Geomembrane Installer will replace the roll or sheet of geomembrane that is in nonconformance with the project specifications with a roll or sheet that meets project specifications.

B. The Geomembrane Installer will remove conformance samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll or sheet on both sides of the failed roll or sheet. These two samples must both conform to project specifications. If either of these samples fail, then the next numerical roll or sheet will be tested until a passing roll or sheet is found. This additional conformance testing will be at the expense of the Geomembrane Installer. If either of the two closest rolls or sheets fail, the Engineer will dictate the frequency of additional testing.

The CQA Engineer will document actions taken in conjunction with material control test failures.

5.4 GEOMEMBRANE INSTALLATION

5.4.1 Handling

The Geosynthetic Installer will handle all geomembrane in such a manner as required by the project specifications.

5.4.2 Earthwork

5.4.2.1 Surface Preparation

The Geomembrane Installer will certify in writing that the surface on which the geomembrane will be installed meets line and grade, and the surface preparation requirements of the project specifications. The certificate of acceptance will be given to the CQA Engineer prior to commencement of geomembrane installation in the area under consideration. The CQA Engineer will give a copy of this certificate

to the Engineer.

To ensure a timely covering of the subgrade (or soil liner) surface, the Engineer may allow subgrade acceptance in areas as small as one acre. After the supporting soil has been accepted by the Geomembrane Installer, it will be the Geomembrane Installer's responsibility to indicate to the Engineer and CQA Engineer any change in the supporting soil condition that may require repair work. If the CQA Engineer concurs with the Geomembrane Installer, then the Engineer will ensure that the supporting soil is repaired.

5.4.2.2 Anchorage System

The CQA Engineer will verify that anchor trenches have been constructed and backfilled according to project specifications and design drawings.

5.4.3 Geomembrane Placement

5.4.3.1 Field Panel Identification

The CQA Engineer will document that the Geomembrane Installer labels each field panel with an "identification code" (number or letter-number consistent with the layout plan) agreed upon by the Geomembrane Installer and CQA Engineer at the Geosynthetics CQA Meeting (see **Section 1.7.2**).

The Geomembrane Installer will establish a table or chart showing correspondence between roll or sheet numbers and field panel identification codes. This documentation shall be submitted to the CQA Engineer weekly for review and verification. The field panel identification code will be used for all quality control and quality assurance records.

5.4.3.2 Field Panel Placement

5.4.3.2.1 Location: The CQA Engineer will verify that field panels are installed at the location indicated in the Geomembrane Installer's layout plan, as approved or modified in **Section 5.4.3.1**.

5.4.3.2.2 Installation Schedule: The CQA Engineer will evaluate every change in the schedule proposed by the Geomembrane Installer and advise the Engineer on the acceptability of that change.

The CQA Engineer will record the identification code, location, and date of installation of each field panel.

5.4.3.2.3 Placement of Geomembrane: The CQA Engineer will verify that project specification related restrictions on placement of geomembrane are fulfilled. Additionally, the CQA Engineer will verify that the supporting soil has not been damaged by weather conditions.

5.4.3.2.4 Damage: The CQA Engineer will visually observe each panel, after placement and prior to seaming, for damage. The CQA Engineer will advise the Engineer which panels, or portion of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels which have been rejected will be marked and their removal from the work area recorded by the CQA Engineer. Repairs will be made according to procedures described in this section.

As a minimum, the CQA Engineer will document that:

- the panel is placed in such a manner that it is unlikely to be damaged; and
- any tears, punctures, holes, thin spots, etc. are either marked by the Geomembrane Installer for repair or the panel is rejected.

5.4.4 Field Seaming

5.4.4.1 Seam Layout

The Geomembrane Installer will provide the CQA Engineer with a seam layout drawing, i.e., a drawing of the area to be lined showing all expected seams. The CQA Engineer and Engineer will review the seam layout drawing and verify that it is consistent with the accepted state of practice and this CQA Manual.

A seam numbering system compatible with the panel numbering system will be agreed upon at the Geosynthetics CQA Meeting (see **Section 1.7.2**). An on-going written record of the seams and repair areas shall be maintained by the Geomembrane Installer with weekly review by the CQA Engineer.

5.4.4.2 Requirements of Personnel

The Geomembrane Installer will provide the CQA Engineer with a list of proposed seaming personnel and their experience records. This document will be reviewed by the CQA Engineer for compliance with project specifications.

5.4.4.3 Seaming Equipment and Products

Field seaming processes must comply with project specifications. Proposed alternate processes will be documented and submitted to the Engineer and CQA Engineer for their approval. Only seaming apparatus which have been specifically approved by make and model will be used. The CQA Engineer will submit all documentation to the Engineer for his concurrence.

5.4.5 Field Seam Control Tests

5.4.5.1 Trial Seams

A. Prior to production seaming, after four (4) hours of continuous seaming, and/or when significant changes in geomembrane or ambient temperature occurs, the Geomembrane Installer shall perform trial seams to verify that seaming conditions and procedures are adequate. Trial seams shall be performed by each operator of extrusion welders and by the primary operator of each wedge welder using seaming equipment to be used in production seaming.

B. Trial seams shall be made on appropriate sized pieces of identical or equivalent geomembrane material.

C. Hot wedge trial seams shall be approximately 72" x 12" with the seam centered lengthwise. Extrusion fillet trial seams shall be approximately 36" x 12" with the seam centered lengthwise. A minimum of four coupons shall be tested in peel and shear (two each) (ASTM D 6392) by the Geomembrane Installer using a field tensiometer. All coupons shall meet the minimum seam strength requirements as shown in the project specifications.

D. Each trial seam shall be assigned a number and the test results recorded in the appropriate log by the Geomembrane Installer. The CQA Engineer will observe all trial seams and compile all trial seam logs.

5.4.6 Field Seam Record Tests

5.4.6.1 Nondestructive Seam Continuity Testing

The Geomembrane Installer shall test and document all seams continuously over their full length using one of the following nondestructive seam tests. This testing shall be performed simultaneously with geomembrane deployment as the work progresses and not at the completion of all field seaming.

A. Vacuum Testing shall conform to ASTM D 5641 requirements.

B. Air Pressure Testing (for double seam with an enclosed space) shall conform to ASTM D 5820 requirements and the requirements listed in **Table 5.2**.

The CQA Engineer will observe the nondestructive testing on a full time basis to ensure conformance with this CQA Manual and the project specifications.

5.4.6.2 Field Destructive Seam Testing

A. The Geomembrane Installer shall obtain 12" x 30" (or longer as needed) samples of field seams with the seam centered lengthwise, suitable for testing, at an average frequency of one sample per 500 linear feet of seam. The sample shall be cut into two equal-length pieces, one for field destructive seam testing by the Geosynthetics Installer and one given to the CQA Engineer as an archive sample. The date, time, equipment, seam number, and seaming parameters will be marked on each sample and recorded by the CQA Engineer.

B. The Geomembrane Installer shall perform and document field destructive seam testing using a field tensiometer. A minimum of five coupons each will be tested in peel and shear (ASTM D 6392). Coupons shall meet the minimum seam strength requirements as shown in the project specifications.

C. The CQA Engineer or the Owner may require additional random samples to be taken for testing in areas which visually appear defective and not in accordance with the project requirements.

D. All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired in accordance with repair procedures described in this manual.

5.4.6.3 Geosynthetics CQA Laboratory Destructive Testing

A. The Geomembrane Installer shall obtain 12" x 30" (or longer as needed) samples of field seams with the seam centered lengthwise, suitable for testing, at an average frequency of one sample per day to confirm field destructive seam tests. The sample shall be cut into two equal-length pieces, both to be given to the CQA Engineer for laboratory destructive seam testing and as an archive sample. The date, time, equipment, seam number, and seaming parameters will be marked on each sample and recorded by the CQA Engineer.

B. Laboratory destructive test samples will be packaged and shipped to the Geosynthetics CQA Laboratory by the CQA Engineer in a manner that

will not damage the test sample.

C. A minimum of five coupons each will be tested in peel and shear (ASTM D 6392) by the Geosynthetics CQA Laboratory. Coupons shall meet the minimum seam strength requirements as shown in the project specifications.

D. All geomembrane destructive test samples that fail to meet project specifications will be saved and sent to the CQA Engineer for observation.

E. The CQA Engineer will review laboratory test results as soon as they become available.

5.4.6.4 Field Seam Record Test Failure

For noncomplying tests, the CQA Engineer will:

- observe continuity testing of the repaired areas performed by the Geomembrane Installer;
- confirm the record location, date, test unit number, name of tester, and compile the record of testing provided by the Geomembrane Installer;
- provide a walk-through inspection of all impacted seam areas and verify that the areas have been tested in accordance with the CQA Manual and project specifications; and
- verify that the Geomembrane Installer has marked repair areas with the appropriate color-coded marking pencil.

5.4.6.5 Defining Extent of Field Seam Record Test Failure

All defective seam test failures must be bounded by acceptable destructive tests. The CQA Engineer will document repair actions taken in conjunction with all seam test failures.

5.4.7 Repairs & Verification

5.4.7.1 Repair Procedures

A. All repair procedures shall be in accordance with the project specifications. The CQA Engineer will observe all repair procedures.

B. All surfaces shall be clean and dry at the time of the repair.

C. After an extrusion seam is made, no more than ¼ inch of abrasion shall be visible beyond the weld.

5.4.7.2 Repair Verification

A. Each repair shall be numbered and logged by the Geomembrane Installer.

B. Each repair shall be non-destructively tested by the Geomembrane Installer using the methods described above. Repairs which pass non-destructive testing shall be taken as an indication of an adequate repair.

C. Repairs more than 150 feet long may be of sufficient length to require destructive test sampling, at the discretion of the CQA Engineer. A failed test indicates that the repair shall be redone and retested until passing test results are achieved.

5.5 LINER SYSTEM ACCEPTANCE

The geomembrane component of the liner system will be accepted by the Owner when:

- the installation is finished;
- verification of the adequacy of all seams and repairs, including associated testing, is complete;
- CQA Engineer provides the Engineer with a final copy of the nondestructive test documentation, repair information, and as-built drawings, as submitted by the Geomembrane Installer;
- CQA Engineer provides the Engineer with a certification, submitted by the Geomembrane Installer that the geomembrane was installed in accordance with the Geomembrane Manufacturer's recommendations as well as the project drawings and project specifications; and
- all documentation of the installation is completed including the CQA Engineer's final report.

5.6 MATERIALS IN CONTACT WITH GEOMEMBRANES

The quality assurance procedures indicated in this subsection are only intended to assure that the installation of these materials does not damage the geomembrane. All reasonable measures to protect the geomembrane and provide additional quality assurance procedures are necessary to assure that systems built with these materials will be constructed to ensure proper performance.

5.6.1 Soils

Prior to placement, the CQA Engineer will visually confirm that all soil materials to be placed against the geomembrane comply with project specifications. The Geomembrane Installer will provide the CQA Engineer a written surface acceptance certificate in accordance with **Section 5.4.2**. All soil materials shall be placed and compacted in accordance with project specifications.

5.6.2 Sumps and Appurtenances

The CQA Engineer will verify that:

- installation of the geomembrane in appurtenance areas, and connection of the geomembrane to appurtenances have been made according to the project specifications;
- extreme care is taken while seaming around appurtenances since neither nondestructive nor destructive testing may be feasible in these areas; and
- the geomembrane or appurtenances have not been visibly damaged while making connections to appurtenances.

5.7 DEFICIENCIES

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies will be documented by the CQA Engineer. The Contractor shall correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer will observe all retests on repaired defects.

TABLE 5.1: CQA TESTING PROGRAM FOR GEOMEMBRANE MATERIAL APPROVAL

PROPERTY	TEST METHOD	TEST FREQUENCY
Thickness	ASTM D 5199/D 5994	100,000 ft^2 or 1 per Lot[1]
Density	ASTM D 1505/D 792	100,000 ft^2 or 1 per Lot[1]
Carbon Black Content	ASTM D 1603	100,000 ft^2 or 1 per Lot[1]
Carbon Black Dispersion	ASTM D 5596	100,000 ft^2 or 1 per Lot[1]
Tensile Properties:	ASTM D 6693 (Type IV)	
Tensile Strength at Yield		100,000 ft^2 or 1 per Lot[1]
Tensile Strength at Break		100,000 ft^2 or 1 per Lot[1]
Elongation at Yield		100,000 ft^2 or 1 per Lot[1]
Elongation at Break		100,000 ft^2 or 1 per Lot[1]
Tear Resistance	ASTM D 1004	100,000 ft^2 or 1 per Lot[1]

Notes:

1. Whichever provides the larger number of tests.

TABLE 5.2 AIR PRESSURE TEST REQUIREMENTS

MATERIAL	MIN. PRESSURE (PSI)	MAX. PRESSURE DROP (PSI) AFTER 5 MINUTES
30 Mil LLDPE	15	3
$\geq$ 60 Mil HDPE	25	3

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SECTION 6.0
LEACHATE MANAGEMENT SYSTEM CQA

6.1 INTRODUCTION

This section of the CQA Manual addresses the components of the leachate management system including components of the leachate collection system (LCS) (drainage aggregate, collection pipe, protective cover, and geosynthetic rain cover), leak detection system (LDS) (Phase 4A only), and the leachate transmission and storage system (sumps, transmission piping, manholes, valves, etc.). By reference to **Sections 7.0 and 8.0** of this CQA Manual, this section also addresses the geotextiles and drainage geocomposite that are components of the LCS. This section outlines the CQA program to be implemented with regard to material approval, construction monitoring, and resolution of problems.

6.2 LEACHATE MANAGEMENT SYSTEM MATERIAL APPROVAL

The CQA Engineer will verify that the following are provided and installed in accordance with the project drawings, specifications, and this CQA Manual.

6.2.1 Coarse Aggregate (Drainage Aggregate)

A. Receipt of Contractor's submittals on coarse aggregate.

B. Review of submittals for coarse aggregate for conformity to the project specifications.

C. Verify that coarse aggregate in stockpiles or at borrow sources conforms to the project specifications.

D. Conduct material control tests in accordance with **Table 6.1**.

6.2.2 Leachate Collection Media (Drainage Aggregate)

A. Receipt of Contractor's submittals on leachate collection media.

B. Review of submittals for leachate collection media for conformity to the project specifications.

C. Verify that collection media in stockpiles or at borrow sources conforms to the project specifications.

D. Conduct material control tests in accordance with **Table 6.1**.

6.2.3 High Density Polyethylene (HDPE) Pipe

A. Receipt of Contractor's submittals on HDPE pipe.

B. Review of submittals for HDPE pipe for conformity to the project specifications.

6.2.4 Geotextiles (Verify for each type of Geotextile)

The CQA program for geotextiles is presented in **Section 7.0** of this CQA Manual.

6.2.5 Drainage Geocomposite

The CQA program for drainage geocomposite is presented in **Section 8.0** of this CQA Manual.

6.2.6 Protective Cover

A. Review the proposed source of protective cover for conformance with the project specifications.

B. Conduct material control tests in accordance with **Table 6.1**.

6.2.7 Geosynthetic Rain Cover

A. Receipt of Contractor's submittals on Geosynthetic Rain Cover.

B. Review of submittals for Geosynthetic Rain Cover for conformity to the project specifications.

6.2.8 Sumps/Manholes/Leachate Storage

A. Receipt of Contractor's submittals on sumps/manholes/leachate storage.

B. Review of submittals for sumps/manholes/leachate storage for conformity to the project specifications.

6.2.9 Valves

A. Receipt of Contractor's submittals on valves.

B. Review of submittals for valves for conformity to the project specifications.

6.3 LEACHATE MANAGEMENT SYSTEM INSTALLATION

6.3.1 Leachate Collection System (LCS)

The CQA Engineer will allow installation of the LCS to proceed only after he has been provided certification of the installed HDPE geomembrane.

The CQA Engineer will monitor and document the construction of all LCS components for compliance with the project specifications. Monitoring the construction work includes the following:

- monitoring the minimum vertical buffer maintained between field equipment and the geomembrane;
- monitoring that the placement of the LCS components does not fold or damage the geomembrane or other underlying layers; and
- witness and verify the installation of collection piping and gravel columns.

6.3.2 Leachate Transmission and Storage System

The CQA Engineer will monitor and document the construction of all leachate transmission and storage system components for compliance with the project specifications. Monitoring the construction work includes the following:

- witness and verify the installation of transmission piping;
- witness and verify the leak testing of transmission piping; and
- witness and verify the leak testing of manholes, etc. (where applicable).

6.4 DEFICIENCIES

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies will be documented by the CQA Engineer. The Contractor shall correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer will observe all retests on repaired defects.

TABLE 6.1: CQA TESTING PROGRAM FOR LEACHATE MANAGEMENT SYSTEM

COMPONENT	PROPERTY	TEST METHOD	MINIMUM TEST FREQUENCY
CONTROL TESTS:			
Coarse Aggregate:	Gradation	ASTM C 136	5,000 CY
	Carbonate Content	ASTM D 3042	1 per source
Leachate Collection Media:	Gradation	ASTM C 136	5,000 CY
	Permeability[1]	ASTM D 2434	10,000 CY
	Carbonate Content	ASTM D 3042	1 per source
Protective Cover: (Soil Only - See Note 2)	Visual Classification	ASTM D 2488	Each Load
	Grain Size Analysis	ASTM D 422	5,000 CY per Each Soil

Notes:

1. Option for Failed Permeability Test:
   In the case of a failed permeability test value within 20% of the specified value, an additional three tests may be run on the proposed material. If all three tests pass, then the results from the first test can be discounted. Otherwise a different material or material from a different source shall be submitted. The cost for additional testing shall be borne solely by the Contractor.
2. If protective cover consists of additional leachate collection media, perform control tests in accordance with the requirements for leachate collection media.

SECTION 7.0
GEOTEXTILE CQA

7.1 INTRODUCTION

This section of the CQA Manual addresses geotextiles and outlines the CQA program to be implemented with regard to material approval, material control tests, repairs, and resolution of problems.

7.2 GEOTEXTILE MATERIAL APPROVAL

7.2.1 Geotextile Product Data

For each type of geotextile to be used, the CQA Engineer will review the Contractor's submittals for conformance with the project specifications.

7.2.2 Shipment And Storage

During shipment and storage, all geotextiles will be protected as required by the project specifications. The CQA Engineer will observe rolls upon delivery at the site.

7.2.3 Quality Control Certificates

Upon delivery, the CQA Engineer will:

- verify that the Manufacturer's quality control certificates have been provided at the specified frequency and that each certificate identified the rolls related to it; and

- review the Manufacturer's quality control certificates and verify that the certified properties meet the project technical specifications.

7.2.4 Geotextile Material Control Tests

Samples for material control tests, as shown on **Table 7.1**, will be obtained by the CQA Engineer at the indicated frequencies upon delivery of the geotextiles. Alternatively, samples may be randomly obtained at the manufacturing site by the CQA Engineer or representatives of the Geosynthetics CQA Laboratory.

Unless otherwise specified, samples will be 3 feet long by the roll width. The CQA Engineer will mark the machine direction on the samples with an arrow.

All material control tests will be performed by the Geosynthetics CQA Laboratory.

All test results must be available at the site prior to the deployment of all geotextiles. The

CQA Engineer will examine all results from laboratory testing.

7.2.4.1 Material Control Test Failure

The following procedure will apply whenever a sample fails a material control test:

A. The Geosynthetic Installer will replace the roll of geotextile that is in nonconformance with the project specifications with a roll that meets project specifications.

B. The Geosynthetic Installer will remove samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must both conform to project specifications. If either of these samples fail, then the next numerical roll will be tested until a passing roll is found. This additional testing will be at the expense of the Geosynthetic Installer. If either of the two closest rolls fail, the Engineer will dictate the frequency of additional testing.

The CQA Engineer will document actions taken in conjunction with material control test failures.

7.3 GEOTEXTILE INSTALLATION

7.3.1 Handling And Placement

The Geosynthetic Installer will handle and place all geotextiles in such a manner as required by the project specifications.

7.3.2 Seams And Overlaps

All geotextiles will be seamed or overlapped in accordance with project specifications or as approved by the CQA Engineer and Engineer.

7.3.3 Repairs

Any holes or tears in the geotextile will be repaired in accordance with the project specifications. The CQA Engineer will observe any repair.

7.3.4 Placement Of Overlying Materials

All soil materials located on top of a geotextile shall be placed in accordance with the project specifications.

7.4 DEFICIENCIES

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies will be documented by the CQA Engineer. The Contractor shall correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer will observe all retests on repaired defects.

TABLE 7.1: CQA TESTING PROGRAM FOR GEOTEXTILE MATERIAL APPROVAL

PROPERTY	TEST METHOD	TEST FREQUENCY
CONTROL TESTS:		
Tensile Properties	ASTM D 4632	100,000 ft^2 or 1 per Lot[1]
Puncture Resistance	ASTM D 4833	100,000 ft^2 or 1 per Lot[1]
Trapezoidal Tear Strength	ASTM D 4533	100,000 ft^2 or 1 per Lot[1]
Apparent Opening Size (AOS) (Type GT-S Geotextile Only)	ASTM D 4751	100,000 ft^2 or 1 per Lot[1]

Notes:

1. Whichever provides the larger number of tests.
2. CQA testing is not required for geotextiles placed outside of the containment area.

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SECTION 8.0
DRAINAGE GEOCOMPOSITE CQA

8.1 INTRODUCTION

This section of the CQA Manual addresses drainage geocomposite (DGC) and outlines the CQA program to be implemented with regard to material approval, material control tests, repairs, and resolution of problems.

8.2 DGC MATERIAL APPROVAL

8.2.1 DGC Product Data

The CQA Engineer will review the Contractor's submittals for conformance with the project specifications.

8.2.2 Shipment And Storage

During shipment and storage, all DGC will be protected as required by the project specifications. The CQA Engineer will observe rolls upon delivery at the site.

8.2.3 Quality Control Certificates

Upon delivery, the CQA Engineer will:

- verify that the Manufacturer's quality control certificates have been provided at the specified frequency and that each certificate identified the rolls related to it; and

- review the Manufacturer's quality control certificates and verify that the certified properties meet the project technical specifications.

8.2.4 DGC Material Control Tests

Samples for material control tests, as shown on **Table 8.1**, will be obtained by the CQA Engineer at the indicated frequencies upon delivery of the DGC. Alternatively, samples may be randomly obtained at the manufacturing site by the CQA Engineer or representatives of the Geosynthetics CQA Laboratory.

Unless otherwise specified, samples will be 3 feet long by the roll width. The CQA Engineer will mark the machine direction on the samples with an arrow.

All material control tests will be performed by the Geosynthetics CQA Laboratory.

All test results must be available at the site prior to the deployment of all DGC. The CQA

Engineer will examine all results from laboratory testing.

8.2.4.1 Material Control Test Failure

The following procedure will apply whenever a sample fails a material control test:

A. The Geosynthetic Installer will replace the roll of DGC that is in nonconformance with the project specifications with a roll that meets project specifications.

B. The Geosynthetic Installer will remove samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must both conform to project specifications. If either of these samples fail, then the next numerical roll will be tested until a passing roll is found. This additional testing will be at the expense of the Geosynthetic Installer. If either of the two closest rolls fail, the Engineer will dictate the frequency of additional testing.

The CQA Engineer will document actions taken in conjunction with material control test failures.

8.3 DGC INSTALLATION

8.3.1 Handling And Placement

The Geosynthetic Installer will handle and place all DGC in such a manner as required by the project specifications.

8.3.2 Stacking And Joining

When several layers of DGC are stacked, care should be taken to ensure that stacked DGC are placed in the same direction. Stacked DGC will never be laid in perpendicular directions to the underlying DGC (unless otherwise specified by the Engineer). The CQA Engineer will observe the stacking of DGC.

Adjacent rolls of DGC will be joined according to construction drawings and project specifications.

8.3.3 Repairs

Any holes or tears in the DGC will be repaired in accordance with the project specifications. The CQA Engineer will observe any repair.

8.3.4 Placement Of Overlying Materials

All soil materials located on top of DGC shall be placed in accordance with the project specifications.

8.4 DEFICIENCIES

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies will be documented by the CQA Engineer. The Contractor shall correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer will observe all retests on repaired defects.

TABLE 8.1: CQA TESTING PROGRAM FOR DGC MATERIAL APPROVAL

PROPERTY	TEST METHOD	TEST FREQUENCY
CONTROL TESTS:		
Thickness (geonet only)	ASTM D 5199	100,000 ft^2 or 1 per Lot[1]
Density (geonet only)	ASTM D 1505	100,000 ft^2 or 1 per Lot[1]
Ply Adhesion	ASTM D 413/ GRI GC7	100,000 ft^2 or 1 per Lot[1]
Transmissivity	ASTM D 4716[2]	1 per Resin Lot

Notes:

1. Whichever provides the larger number of tests.
2. Conduct tests for transmissivity in accordance with the conditions given in the project specifications.

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SECTION 9.0
GEOSYNTHETIC CLAY LINER (GCL) CQA

9.1 INTRODUCTION

This section of the CQA Manual addresses geosynthetic clay liner (GCL) and outlines the CQA program to be implemented with regard to material approval, material control tests, repairs, and resolution of problems.

9.2 GCL MANUFACTURER AND INSTALLER APPROVAL

The Contractor shall submit the qualifications of the GCL Manufacturer and the GCL Installer, as described in the specifications, to the CQA Engineer for approval.

9.3 GCL MATERIAL APPROVAL

9.3.1 GCL Product Data

The CQA Engineer will review the Contractor's submittals for conformance with the project specifications.

9.3.2 Shipment And Storage

During shipment and storage, GCL will be protected as required by the project specifications. The CQA Engineer will observe rolls upon delivery at the site.

9.3.3 Quality Control Certificates

Upon delivery, the CQA Engineer will:

- verify that the Manufacturer's quality control certificates have been provided at the specified frequency and that each certificate identified the rolls related to it; and
- review the Manufacturer's quality control certificates and verify that the certified properties meet the project technical specifications.

9.3.4 GCL Material Control Tests

Samples for material control tests, as shown on **Table 9.1**, will be obtained by the CQA Engineer at the indicated frequencies upon delivery of the GCL. Alternatively, samples may be randomly obtained at the manufacturing site by the CQA Engineer or representatives of the Geosynthetics CQA Laboratory.

Unless otherwise specified, samples will be 3 feet long by the roll width. The CQA

Engineer will mark the machine direction on the samples with an arrow.

All material control tests will be performed by the Geosynthetics CQA Laboratory.

All test results must be available at the site prior to the deployment of all GCL. The CQA Engineer will examine all results from laboratory testing.

9.3.4.1 Material Control Test Failure

The following procedure will apply whenever a sample fails a material control test:

A. The Geosynthetic Installer will replace the roll of GCL that is in nonconformance with the project specifications with a roll that meets project specifications.

B. The Geosynthetic Installer will remove samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must both conform to project specifications. If either of these samples fail, then the next numerical roll will be tested until a passing roll is found. This additional testing will be at the expense of the Geosynthetic Installer. If either of the two closest rolls fail, the Engineer will dictate the frequency of additional testing.

The CQA Engineer will document actions taken in conjunction with material control test failures.

9.4 GCL INSTALLATION

9.4.1 Handling And Placement

The Geosynthetic Installer will handle and place all GCL in such a manner as required by the project specifications.

9.4.2 Seams And Overlaps

All GCL will be seamed or overlapped in accordance with project specifications or as approved by the CQA Engineer and Engineer.

9.4.3 Repairs

Any holes or tears in the GCL will be repaired in accordance with the project specifications. The CQA Engineer will observe any repair.

9.4.4 Placement Of Overlying Materials

All soil materials located on top of the GCL shall be placed in accordance with the project specifications.

9.5 DEFICIENCIES

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies will be documented by the CQA Engineer. The Contractor shall correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer will observe all retests on repaired defects.

TABLE 9.1: CQA TESTING PROGRAM FOR GCL MATERIAL APPROVAL

PROPERTY	TEST METHOD	TEST FREQUENCY
CONTROL TESTS:		
Hydraulic Conductivity	ASTM D 5084/D 5887	100,000 ft^2 or 1 per Lot[1]
Bentonite Content	ASTM D 5993 (@ 0% moisture)	100,000 ft^2 or 1 per Lot[1]
Peel Strength	ASTM D 6496	100,000 ft^2 or 1 per Lot[1]

Notes:

1. Whichever provides the larger number of tests.

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SECTION 10.0
FINAL COVER SYSTEM CQA

10.1 INTRODUCTION

This section of the CQA Manual addresses the landfill gas (LFG) system, drainage aggregate and piping, and the vegetative soil layer of the final cover system. By reference to **Sections 5.0, 7.0, and 8.0** of this CQA Manual, this section also addresses the geomembrane, geotextiles, and drainage geocomposite that are included in the final cover system. This section outlines the CQA program to be implemented with regard to material approval, construction monitoring, and resolution of problems.

10.2 FINAL COVER SYSTEM MATERIAL APPROVAL

The CQA Engineer shall verify that the following are provided and installed in accordance with the project drawings, specifications, and this CQA Manual.

10.2.1 High Density Polyethylene (HDPE) Pipe

A. Receipt of Contractor's submittals on HDPE pipe.

B. Review of submittals for HDPE pipe for conformity to the project specifications.

10.2.2 Polyvinyl Chloride (PVC) Pipe

A. Receipt of Contractor's submittals on PVC pipe.

B. Review of submittals for PVC pipe for conformity to the project specifications.

10.2.3 Corrugated Polyethylene (CPE) Pipe

A. Receipt of Contractor's submittals on CPE pipe.

B. Review of submittals for CPE pipe for conformity to the project specifications.

10.2.4 LFG System Components

A. Receipt of Contractor's submittals on LFG system components.

B. Review of submittals for LFG system components for conformity to the project specifications.

10.2.5 Aggregates (Verify for each type of aggregate)

A. Receipt of Contractor's submittals on aggregates.

B. Review of submittals for aggregates for conformity to the project specifications.

C. Verify that aggregates in stockpiles or at borrow sources conform to the project specifications.

D. Conduct material control tests in accordance with **Table 10.1**.

10.2.6 Geomembrane

The CQA program for geomembranes is presented in **Section 5.0** of this CQA Manual.

10.2.7 Geotextiles

The CQA program for geotextiles is presented in **Section 7.0** of this CQA Manual.

10.2.8 Drainage Geocomposite

The CQA program for drainage geocomposite is presented in **Section 8.0** of this CQA Manual.

10.2.9 Vegetative Soil Layer

A. Review the proposed source of vegetative soil layer for conformance with the project specifications.

B. Conduct material control tests in accordance with **Table 10.1**.

10.3 FINAL COVER SYSTEM INSTALLATION

The CQA Engineer will monitor and document the construction of all final cover system components for compliance with the project specifications. Monitoring the construction work for the components of the final cover system includes the following:

- verify location and depth of LFG wells;
- verify location of all piping;
- monitoring the minimum vertical buffer maintained between field equipment and geosynthetics/piping; and
- monitoring that the placement of the final cover system components does not fold or damage the geosynthetics or other underlying layers.

10.4 DEFICIENCIES

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies will be documented by the CQA Engineer. The Contractor shall correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer will observe all retests on repaired defects.

TABLE 10.1: CQA TESTING PROGRAM FOR FINAL COVER SYSTEM

COMPONENT	PROPERTY	TEST METHOD	MINIMUM TEST FREQUENCY
CONTROL TESTS:			
Coarse Aggregate:	Gradation	ASTM C 136	5,000 CY
Vegetative Soil Layer:	Visual Classification	ASTM D 2488	Each Load
	Grain Size Analysis	ASTM D 422	5,000 CY
	Atterberg Limits	ASTM D 4318	5,000 CY

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Appendix A

Reference List of Test Methods

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JOHNSTON COUNTY LANDFILL

CQA MANUAL
APPENDIX A: REFERENCE LIST OF TEST METHODS

American Society American Society of Testing and Materials (ASTM):

ASTM C 136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
ASTM D 413	Standard Test Methods for Rubber Property - Adhesion to Flexible Substrate.
ASTM D 422	Standard Test Method for Particle Size Analysis of Soils.
ASTM D 698	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3).
ASTM D 792	Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
ASTM D 1004	Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
ASTM D 1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique.
ASTM D 1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
ASTM D 1603	Standard Test Method for Carbon Black in Olefin Plastics.
ASTM D 2167	Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
ASTM D 2216	Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
ASTM D 2434	Standard Test Method for Permeability of Granular Soils (Constant Head).
ASTM D 2488	Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

ASTM D 2937	Standard Test Method for Density of Soil in Place by the Drive Cylinder Method.
ASTM D 3042	Standard Test Method for Insoluble Residue in Carbonate Aggregates.
ASTM D 4318	Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
ASTM D 4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
ASTM D 4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
ASTM D 4643	Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method.
ASTM D 4716	Standard Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products.
ASTM D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile.
ASTM D 4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
ASTM D 4959	Standard Test Method for Determination of Water (Moisture) Content of Soil by Direct Heating Method.
ASTM D 5084	Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
ASTM D 5199	Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
ASTM D 5596	Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.
ASTM D 5641	Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.
ASTM D 5820	Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes.

ASTM D 5887	Standard Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter.
ASTM D 5993	Standard Test Method for Measuring Mass per Unit of Geosynthetic Clay Liners.
ASTM D 5994	Standard Test Method for Measuring Core Thickness of Textured Geomembrane.
ASTM D 6392	Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.
ASTM D 6496	Standard Test Method for Determining Average Bonding Peel Strength Between the Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners.
ASTM D 6693	Standard Test Method for Determining Tensile Properties of Nonreinforced Flexible Polyethylene and Nonreinforced Polypropylene Geomembranes.
ASTM D 6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

Geosynthetic Research Institute (GRI):

GRI GC7	Determination of Adhesion and Bond Strength of Geocomposites.

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Johnston County Landfill
Proposed C&D Landfill
Water Quality Monitoring Plan

Prepared For:
Johnston County
Department of Public Utilities
Smithfield, North Carolina

The Water Quality Monitoring Plan for this facility has been prepared by a qualified geologist who is licensed to practice in the State of North Carolina. The plan has been prepared based on knowledge of site conditions and familiarity with North Carolina solid waste rules and industry standard protocol. The Plan described herein should provide for the effective detection of a chronic release of hazardous constituents into ground and surface waters of the State, due to, or caused by past activities at the landfill.

Joan A. Smyth 10/27/05

Joan A. Smyth, P.G.
Project Hydrogeologist

NORTH CAROLINA LICENSED SEAL 1369 GEOLOGIST JOAN A SMYTH

October 2005

G.N. Richardson & Associates
Engineering and Geological Services
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Raleigh, North Carolina 27603

TABLE OF CONTENTS

1.0 Introduction

1.1 Plan Background

Johnston County, North Carolina, owns and has sequentially operated four separate, unlined sanitary landfill units since1973 under Solid Waste Facility Permit #51-01, one lined municipal solid waste landfill (Phase 5) under permit 51-02, and one double-lined MSW landfill (Phase 4A) under permit 51-03. The six distinct municipal solid waste disposal units are located on a single property off State Route 210 in Johnston County.

The lined C&D landfill is proposed as a "piggy-back" landfill being constructed over a portion of the sideslope of the unlined Phase 3 MSW landfill. This lined C&D landfill "piggy-back" design is proposed as a part of the presumptive remedy for the unlined Phase 3 MSW landfill. The liner system of the C&D landfill will prevent rainwater infiltration into the soil covered sideslopes of the unlined Phase 3 MSW landfill. This design, in conjunction with the double-lined Phase 4A MSW landfill will provide significant reduction in leachate generation from the Phase 3 landfill.

The lined C&D landfill is located east of Phase 3 and north of Phases 1 & 2. These three phases of unlined landfills have impacted groundwater in this portion of the site. Therefore, this groundwater monitoring plan is more comprehensive than most for C&D landfills in order to provide for monitorability at the C&D landfill site.

C&D Landfill Monitoring Network

GNRA proposes two groundwater monitoring wells located between unlined MSW landfill Phases 1 & 2, (CDMW-1 and CDMW-2), two wells located adjacent to the diabase dikes located in the C&D area (CDMW-3 and CDMW-4), three downgradient nested pairs (CDMW-5/CDMW-5d, and CDMW-8/CDMW-8d and CDMW-9/CDMW9d), a downgradient shallow well (CDMW-6), a side gradient well (CDMW-7).

Additionally, since this is a lined C&D facility, leachate samples from the leachate collection system will be monitored semi-annually for the same Appendix I constituents that ground water is monitored for.

This Water Quality Monitoring Plan (WQMP) has been prepared to meet the field sampling and laboratory analysis requirements of the site. The WQMP details field and laboratory protocols that must be followed to meet the data objectives for the site.

1.2 Purpose & Scope

This WQMP has been designed to insure that accurate and representative field and laboratory results are obtained for all ground and surface water quality monitoring points. The WQMP addresses the following subjects:

- Ground water sample collection
- Surface water sample collection
- Sample preservation and shipment
- Laboratory analytical procedures
- Sample Chain-of-custody control
- Quality assurance/quality control programs

The methods and procedures described in the following sections are intended to facilitate the collection of true and representative samples and test data. Field procedures are presented in **Sections 3.0 through 7.0** in their general order of implementation. Equipment requirements for each field task are presented within the applicable section. Laboratory procedures, quality assurance methods and record keeping requirements are presented in **Sections 7.0 and 8.0**.

Strict adherence to these procedures stipulated in this plan is required. Any variations from these procedures should be throughly documented in the assessment report.

1.3 Sampling Program Overview

The ground water monitoring well designations, completion type, installation information and analytical requirements are included as **Table 1**. The surface water monitoring station designations, locations, sources and sampling frequency are included as **Table 2**.

2.0 Ground Water Sample Collection

This section presents details of the procedures and equipment required to perform ground water field measurements and sampling from monitoring wells during each monitoring event. A description of proposed ground water monitoring well locations and completion details are presented in **Table 1**. Ground water monitoring well locations for each Phase are shown in **Figure 1**.

2.1 Water Level Measurements

Static water level and total depth to the bottom will be measured in each well prior to any purging or sampling activities. Static water level and well depth measurements are necessary to calculate the volume of stagnant water in the well prior to purging. Additionally these measurements provide a field check on well integrity, degree of siltation, and are used to prepare potentiometric maps, calculate aquifer flow velocities and monitor changes in site hydrogeologic conditions.

Upon opening each well, new latex or nitrile surgical gloves will be donned. New gloves will be worn when taking water level measurements at each well. Appropriate measures will be taken during all measurement activities to prevent soils, decontamination supplies, precipitation, and other potential contaminants from entering the well or contacting clean equipment.

An electronic water level indicator will be used to accurately measure depth to ground water in each well and/or piezometer. Ground water depths will be measured to a vertical accuracy of 0.01 feet relative to established wellhead elevations. Each well will have a permanent, easily identified reference point on the lip of the well riser from which all water level measurements will be taken. The elevation of the reference point will be established by a Registered Land Surveyor.

The electronic water level indicator will be constructed of inert materials such as stainless steel and Teflon. Between well measurements the device will be thoroughly decontaminated by washing with non-phosphate soap and triple rinsing with deionized water to prevent cross contamination from one well to another.

The following measurements will be recorded in a dedicated field book prior to sample collection:

- Well Identification
- Depth to static water level and well bottom (to the nearest 0.01 foot)
- Height of water column in the riser (based upon known depth of well)
- Condition of wellhead protective casing, base pad and riser
- Changes in condition of well and surroundings.

2.2 Monitor Well Evacuation

Water accumulated in each well may be stagnant and unrepresentative of surrounding aquifer conditions, and therefore must be removed to insure that fresh formation water is sampled. Each well will be purged of standing water in the well casing following the measurement of the static water level.

New latex or nitrile surgical gloves will be donned for all well purging and sampling activities and whenever handling decontaminated field equipment. Appropriate measures will be taken during all measurement, purging and sampling activities to prevent surface soils, decontamination supplies, precipitation, and other potential contaminants from entering the well or contacting cleaned equipment.

The volume of standing water in the well riser and screen will be calculated immediately before well evacuation during each monitoring event. A standing water volume will be calculated for each well using measured static water level, well depth and well casing diameter according to the following equation:

$$V = (TD - SWL) \times C$$

Where: V = One well volume

TD = Total depth of the well (in feet)

SWL = Static water level (in feet)

C = Volume constant for given well diameter (gallons/foot)

C = 0.163 gal/ft for two-inch wells.

C = 0.653 gal/ft for four-inch wells.

After the volume of standing water within the casing is established, a minimum of three to five well casing volumes of water will be evacuated from each well that is not outfitted with a MicroPurge ™ system.

New, disposable bailers with either double or bottom check-valves will be used to purge each well if the MicroPurge system is not used. Disposable purge bailers will be constructed of fluorocarbon resin (Teflon) suitable for the well and ground conditions. Each bailer will be certified factory-cleaned according to approved EPA protocol and remain sealed in a plastic sleeve until use. A new Teflon-coated stainless steel, inert mono-filament line or nylon cord will be used for each well to retrieve the bailers.

Wells will be purged at a rate that will not cause recharge water to be excessively agitated or cascade through the screen. Care will also be taken to minimize disturbance to the well sidewalls and bottom which could result in the suspension of silt and fine particulate matter. The volume of water purged from each well and the relative rate of recharge will be documents in sampling field notes. Wells which are of very low recharge rates will be purged once until dry. Damaged, dry or low yielding, and high turbidity wells will noted for reconsideration before the next sampling event.

Purge water will be managed to prevent possible soil and surface water contamination. Well site management options may include temporary containment and disposal as leachate or portable activated carbon filtration.

There are several wells on-site that are outfitted with MicroPurge™ pumps. All MicroPurge™ pumps are constructed of stainless steel and teflon components and are equipped with teflon lined

tubing from the pump to the surface of the well. These pumps have been installed to maximize pump efficiency and data reliability.

Wells that are outfitted with the MicroPurge™ system T1200M pumps will be developed until the field parameters of temperature, pH and Conductivity stabilize to within 10%. The use of the MicroPurge low-flow system allows a sample to be collected from a discreet interval of the well, thus limiting the amount of purging necessary. The pumps operate at a flowrate of approximately 200 ml/min during purging. The stabilization of field parameters indicates that water from the formation is being removed. A "Flow Cell - FC4000" is used to continuously monitor the field parameters of the purge water. This cell evaluates the pH, temperature, and conductivity on a constant basis and provides an ongoing continuous readout of the parameter levels. Once three readings taken 3 to 5 minutes apart have stabilized to within 10% of each other, a sample may be immediately collected from the pump. The pumping rate during sampling shall be 100 ml/min.

Durable, non-dedicated equipment to be lowered into the well (such as water level indicators) will be thoroughly decontaminated before each use. Equipment shall be disassembled to the degree practical, washed with (non-phosphate) soapy potable tap water, and triple rinsed using de-ionized water. Detailed equipment decontamination procedures are detailed in **Section 2.6**.

2.3 Ground Water Sample Collection

After purging activities are complete, ground water samples will be collected for laboratory analysis. Additional care commensurate with the importance of this stage will be taken. All monitoring wells should be sampled in as short a time period as possible, generally within 48 hours.

Sampling will occur within 24 hours of the purging of each well and as soon after well recovery as possible. Wells which fail to recharge or produce an adequate sample volume within 24 hours of purging will be sampled and a notation as to the amount of elapsed time since purging will be placed in the "notes" section of the chain of custody sheet and in the field notes for future evaluation. If particular wells are consistently slow in recharging, a remedy should be proposed for the problem.

Field measurements of temperature, pH, specific conductivity and turbidity will be made immediately prior to sampling each monitoring point. The field test specimens will be collected with the sampling bailer and placed in a clean, non-conductive glass or plastic container for observation. The calibration of the pH, temperature, conductivity and turbidity meters will be completed according to the manufacturers' specifications and consistent with Test Methods for Evaluating Solid Waste -Physical/Chemical Methods (SW-846). A pocket thermometer and litmus paper will be available in case of meter malfunction.

Each well outfitted with a dedicated MicroPurge™ pump will be sampled using the pump immediately upon completion of purging. Field measurements of pH, temperature and conductivity will be collected at the time of sample collection. The flowrate of pumping at the time of sampling shall be 100 ml/min or less.

Each well without a dedicated pump will be sampled using a new, factory-cleaned, disposable Teflon bailer with bottom check-valve and sample discharge mechanism. A new segment of Teflon-coated stainless steel wire, inert mono-filament line or nylon cord will be used to lower and retrieve each bailer. The bailer will be lowered into each well to the point of ground water contact, then allowed to fill as it sinks below the water table. Bottom contact will be avoided in order to avoid suspending sediment in the samples. The bailer will be retrieved and emptied in a manner which minimizes sample agitation.

Samples will be transferred directly from the Teflon bailer into a sample container that has been specifically prepared for the preservation and storage of compatible parameters. A bottom emptying device provided will be used to transfer samples from bailer to sample container. The generation air bubbles and sample agitation will be minimized during bailer discharge.

Ground water samples will be collected and contained in the order of volatilization sensitivity. Initially, only purgeable organics and total metals specimens will be collected for laboratory analysis. Subsequently, other analytical methods may required. When collected, the following order of sampling will be observed:

- Initial measurements of pH, temperature, conductivity and turbidity
- Volatile and Purgeable Organics
- Base Neutral and Acid Extractable Organics
- Total Metals
- Final measurements of pH, temperature, conductivity and turbidity

All samples will be collected and analyzed in an **unfiltered** state during all sampling events.

All reusable sampling equipment including water level probes, pH/conductivity meters, interface probes, and filtering pumps which might contact aquifer water or samples will be thoroughly decontaminated between wells by washing with non-phosphate soapy, de-ionized water and triple rinsing with deionized water. Detailed equipment decontamination procedures are detailed in Section 2.6.

2.4 Field Quality Assurance

Field and trip blanks will be prepared, handled and analyzed as ground water samples to ensure cross-contamination has not occurred. One set of trip blanks, as described later in this document, will be prepared before leaving the laboratory to ensure that the sample containers or handling processes have not affected the quality of the samples. One set of field (equipment) blanks will be created in the field at the time of sampling to ensure that the field conditions, equipment, and handling during sampling collection have not affected the quality of the samples. A duplicate ground water sample may be collected from a single well as a check of laboratory accuracy. Blanks and duplicate containers, preservatives, handling, and transport procedures for surface water samples will be identical to those noted for ground water samples.

2.5 Sample Containers

Sample containers will be provided by the laboratory for each sampling event. Containers must be either new and factory-certified analytically clean by the manufacturer, or cleaned by the laboratory prior to shipment for sampling. Laboratory cleaning methods will be based on the bottle type and analyte of interest.

2.6 Equipment Decontamination

All non-dedicated equipment (such as water level meter) that will come in contact with the well casing and water will be decontaminated. The procedure for decontaminating non-dedicated equipment is as follows:

1. Phosphate-free soap and tap water wash
2. Deionized or distilled water rinse
3. Isopropyl alcohol rinse
4. Deionized or distilled water rinse and air dry
5. Aluminum foil wrap with shiny side out

3.0 Surface Water Sample Collection

This section present details of the procedures and equipment required to perform surface water field measurements and sampling from springs, streams and ponds during each monitoring event. A description of proposed surface water monitoring station locations is presented in **Table 2**. The proposed surface water monitoring station locations are shown in **Figure 2**.

3.1 Surface Water Level Observations

Surface water quality analyses are particularly sensitive to site hydrologic conditions and recent precipitation events. Water levels may fluctuate drastically in comparison the ground water table and may result in either diluting or increasing contaminant loadings. The scheduling of sampling events and the interpretation surface water data must take into account climatic, recent weather and sampling station conditions.

Surface water level and sampling station conditions will be observed one day prior to, and during each sampling event. Surface water observations will include the flood stage in streams, seasonal base flow conditions, and confirm location and timing for meaningful surface water quality sampling. The following objective observations will be recorded in a dedicated field book prior to sample collection:

- Sample location designation
- Relative stream water level

- Surface water clarity
- Rate of flow and degree of stagnation
- Physical conditions of sampling station
- Changes in surface monitoring station conditions and surroundings.

Modifications to surface sampling station conditions may be required prior to each sampling event. These modifications may include the removal of surface and submerged debris, slightly deepening the station to allow sample container immersion, or channeling/piping to consolidate local discharge. When modifications are required, sufficient time will be allowed for settlement of suspended solids between the disturbance and sample collection. A minimum settling period of four hours prior to sampling will be observed.

3.2 Surface Water Sample Collection

Surface water samples will be obtained from areas of minimal turbulence and aeration. New latex or nitrile surgical gloves will be donned prior to sample collection. The following procedure will be implemented regarding sampling of surface waters:

1. Put on new latex or nitrile surgical gloves.
2. Hold the bottle in the bottom with one hand, and with the other, remove the cap.
3. Push the sample container slowly into the water and tilt up towards the current to fill. A water depth of six inches is generally satisfactory. Care will be taken to avoid breaching the surface or losing sample preservatives while filling the container.
4. If there is little current movement, the container should be moved slowly, in a lateral, side to side direction, with the mouth of the container pointing upstream.

Temperature, pH, specific conductivity and turbidity will be taken at the start of sampling as a measure of field conditions and check on the stability of the water samples over time. Measurements of temperature, pH, specific conductivity and turbidity will be recorded for all surface water samples. The calibration of the pH, temperature, conductivity , and turbidity meters will be completed at the beginning of each sampling event, according to the manufacturers'

specifications and consistent with Test Methods for Evaluating Solid Waste - Physical/Chemical Methods (SW-846).

Surface water samples will be collected and contained in the order of volatilization sensitivity of the parameters as follows:

- Measurements of pH, temperature, conductivity and Turbidity
- Volatile and Purgeable Organics
- Base Neutral and Acid Extractable Organics
- Total Metals

All surface water samples will be collected in an unfiltered state.

All field meters which might contact surface water samples will be thoroughly decontaminated between stations by washing with non-phosphate soapy, de-ionized water and triple rinsing with deionized water.

One surface water samples will be collected at this site (shown on **Figure 2** and listed in **Table 2**). Samples will be collected directly from the station in the container that has been specifically prepared for the preservation and storage of compatible parameters. Samples will be collected in a manner that assures minimum agitation. Additional blanks and duplicate samples will not be taken with the surface water samples.

Sample containers shall be prepared and provided by the laboratory for each surface water sampling event. Each sample containers' preparation and preservatives shall be the same as those utilized for ground water sampling and addressed previously in Section 2.5.

4.0 Field QA/QC Program

Field Quality Assurance/Quality Control (QA/QC) requires the routine collection and analysis of trip blanks to verify that the handling process has not affected the quality of the samples. Any contaminants found in the trip blanks could be attributed to:

1) interaction between the sample and the container,
2) contaminated source water, or
3) a handling procedure that alters the sample.

The laboratory will prepare a trip blank by filling each type of sample bottle with distilled or deionized water. Trip blanks will be placed in bottles of the specific type required for the analyzed parameters and taken from a bottle pack specifically assembled by the laboratory for each ground water sampling event. Trip blanks will be taken prior to the sampling event and transported with the empty bottle packs. The blanks will be analyzed for volatile and purgeable organics only.

The concentration levels of any contaminants found in the trip blank will be reported but will not be used to correct the ground water data. In the event that elevated parameter concentrations are found in a blank, the analysis will be flagged for future evaluation and possible re-sampling.

All field instruments utilized to measure ground water characteristics will be calibrated prior to entering the field, and recalibrated in the field as required, to insure accurate measurement for each sample. The specific conductivity and pH meter shall be recalibrated utilizing two prepared solutions of known concentration in the range of anticipated values (between 4 and 10). A permanent thermometer, calibrated against a National Bureau of Standards Certified thermometer, will be used for temperature meter calibration. The turbidity meter will be calibrated using Lucite standard blocks provided by the manufacturer.

5.0 Sample Preservation and Shipment

Methods of sample preservation, shipment, and chain-of-custody procedures to be observed between sampling and laboratory analysis are presented in the following sections.

5.1 Sample Preservation

Proper storage and transport conditions must be maintained in order to preserve the integrity of samples between collection and analysis. Wet ice will be used to cool and preserve samples, as directed by the analytical laboratory. Samples will be maintained at a temperature of 4° C. Dry ice is not to be used.

Pre-measured chemical preservatives will be provided in the sample containers provided by the analytical laboratory. Hydrochloric acid will be used as a chemical stabilizer and preservative for volatile and purgeable organic specimens. Nitric acid will be used as the preservative for samples for metals analysis.

Upon collection, samples will be placed on ice in high impact polystyrene coolers and cooled to a temperature of 4°C. Samples will be packed and/or wrapped in plastic bubble wrap to inhibit breakage or accidental spills. Chain-of-Custody control documents will be placed in a waterproof pouch and sealed inside the cooler with the samples for shipping. Tape and/or custody seals shall be placed on the outside of the shipping coolers, in a manner to prevent and detect tampering with the samples.

Samples shall be delivered to the analytical laboratory within a 24-hour period in person or using an overnight delivery service to insure holding times are not exceeded. Shipment and receipt of samples will be coordinated with the laboratory.

Chain-of-Custody control will be maintained from sampling through analysis to prevent tampering with analytical specimens. Chain-of-Custody control procedures for all samples will consist of the following:

1. Chain-of-Custody will originate at the laboratory with the shipment of prepared sample bottles and a sealed trip blank. Identical container kits will be shipped by express carrier to the sampler or site or picked up at the laboratory in sealed coolers.

2. Upon receipt of the sample kit, the sampler will inventory the container kit and check its consistency with number and types of containers indicated in the Chain-of-Custody forms and required for the sampling event.

3. Labels for individual sample containers will be completed in the field, indicating the site, time of sampling, date of sampling, sample location/well number, and preservation methods used for the sample.

4. Collected specimens will be placed in the iced coolers and will remain in the continuous possession of the field technician until shipment or transferral as provided by the Chain-of-Custody form has occurred. If continuous possession can not be maintained by the field technician, the coolers will be temporarily sealed and placed in a secured area.

5. Upon delivery to the laboratory, samples will be given laboratory sample numbers and recorded into a logbook indicating client, well number, and date and time of delivery. The laboratory director or his designee will sign the Chain-of-Custody control forms and formally receive the samples. The field technician, project manager and the laboratory director will work together to insure that proper refrigeration of the samples is maintained.

6. Copies of the complete Chain-of-Custody forms will be placed in the laboratory's analytical project file and attached to the laboratory analysis report upon completion.

Chain-of-Custody forms will be used to transfer direct deliveries from the sampler to the laboratory. A coded, express delivery shipping bill shall constitute the Chain-of Custody between the sampler and laboratory for overnight courier deliveries.

6.0 Field Logbook

The field technician will keep an up-to-date logbook documenting important information pertaining to the technician's field activities. The field logbook will document the following:

- Site Name and Location
- Date and Time of Sampling
- Climatic Conditions During Sampling Event
- Sampling Point/Well Identification Number
- Well Static Water Level
- Height of Water Column in Well
- Purged Water Volume and Well Yield (High or Low)
- Presence of Immiscible Layers and Detection Method
- Observations on Purging and Sampling Event
- Time of Sample Collection
- Temperature, pH, Turbidity, and Conductivity Readings
- Signature of Field Technician.

7.0 Laboratory Analysis

The ground and surface water parameters to be analyzed will be those specified in Table 1. These will include field indicators of water quality (pH, conductivity, temperature and turbidity) and selected purgeable organic as listed in Appendix I and Appendix II of 40 CFR.258 and 15 RCRA metals constituents (total metals analysis). All analytical methods are taken from Test Methods For Evaluating Solid Waste - Physical/Chemical Methods (SW-846) or Methods For the Chemical Analysis of Water and Wastes and will be consistent with DSWM's policies regarding analytical methods and PQLs. Analysis will be performed by a laboratory certified by the North Carolina DENR for the analyzed parameters.

Formal environmental laboratory Quality Assurance/Quality Control (QA/QC) procedures are to be utilized at all times. The owner/operator of the landfill is responsible for selecting a laboratory contractor and insuring that the laboratory is utilizing proper QA/QC procedures. The laboratory must have a QA/QC program based upon specific routine procedures outlined in a written laboratory Quality Assurance/Quality Control Manual. The QA/QC procedures listed in the manual shall provide the lab with the necessary assurances and documentation that accuracy and precision goals are achieved in all analytical determinations. Internal quality control checks shall be undertaken regularly by the lab to assess the precision and accuracy of analytical procedures.

During the course of the analyses, quality control data and sample data shall be reviewed by the laboratory manager to identify questionable data and determine if the necessary QA/QC requirements are being followed. If a portion of the lab work is subcontracted, it is the responsibility of the contracted laboratory to verify that all subcontracted work is completed by certified laboratories, using identical QA/QC procedures.

8.0 Data Evaluation

Copies of all laboratory results and water quality reports for the Johnston County Landfill will be kept at the Johnston County Landfill office. Reports summarizing all ground water quality results and data evaluation will be submitted to the DSWM for each sampling event. Upon receipt of each monitoring event's data, the water quality database of analyses will be updated.

Methods to evaluate the data are taken from North Carolina Solid Waste Rules and the EPA RCRA Ground Water Monitoring Technical Guidance Documents. There is existing ground water impact at the site due to unlined MSW Phases 1 & 2 and Phase 3. Therefore, statistical analyses will be performed for this C&D landfill to determine if contaminant levels are increasing due to possible impact from the C&D landfill. As there is existing impact, intra-well statistical analyses will be performed on laboratory data from ground water samples.

The North Carolina Solid Waste Rules provide several methods for statistical analysis of ground water data. These methods are:

1. Parametric Prediction Intervals
2. Non-Parametric Prediction Intervals
3. Tolerance prediction interval
4. Control chart
5. An alternative statistical test method that meets the performance standards of 40 CFR 258.53 (h)

The choice of appropriate methods for data analysis and presentation, including statistical tests, depends on the type of monitoring, the nature of the data, and the proportion of values in the data set that are below detection limits. The statistical analysis will be conducted separately for each detected organic constituent based on the EPA's Statistical Analysis of Ground Water Monitoring Data at RCRA Facilities, Interim Final Guidance Document (1989) and Addendum to the Interim Final Guidance Document (1992). Any statistical analyses will be performed in general accordance methods outlined in the North Carolina State Regulations 15A NCAC 13B.1632.

9.0 Record Keeping and Reporting

9.1 Sampling Reports

Copies of all laboratory analytical data will be forwarded to the DWM within 45 calendar days of the sample collection date. The analytical data submitted will specify the date of sample collection, the sampling point identification and include a map of sampling locations. Should a significant concentration of contaminants be detected in ground and surface water, as defined in North Carolina Solid Waste Rules, Ground Water Quality Standards, or Surface Water Quality Standards, the owner/operator of the landfill shall notify the DWM and will place a notice in the landfill records as to which constituents were detected.

9.2 Well Abandonment/Rehabilitation

Should wells become irreversibly damaged or require rehabilitation, the DWM shall be notified. If monitoring wells and/or piezometers are damaged irreversibly they shall be abandoned under the direction of the DWM. The abandonment procedure in unconsolidated materials will consist of over-drilling and/or pulling the well casing and plugging the well with an impermeable, chemically-inert sealant such as neat cement grout and/or bentonite clay. For bedrock well completions the abandonment will consist of plugging the interior well riser and screen with an impermeable neat cement grout and/or bentonite clay sealant.

9.3 Additional Well Installations

The data will be analyzed to verify the correct placement of wells and determine locations for future monitoring wells, if necessary. Any additional well installations will be carried out in accordance with DWM directives. If the potentiometric maps reveal that the depths, location, or number of wells is insufficient to monitor potential releases of solid waste constituents from the solid waste management area, new well locations and depths will be submitted to the DWM for approval.

All monitoring wells shall be installed under the supervision of a geologist or engineer who is registered in North Carolina and who will certify to the DWM that the installation complies with the North Carolina Regulations. Upon installation of future wells the documentation for the construction of each well will be submitted by the registered geologist or engineer within 30 days

after well construction. Plans to install MicroPurge™ pumps in any additional well installed on-site shall be submitted to DSWM for approval prior to pump installation.

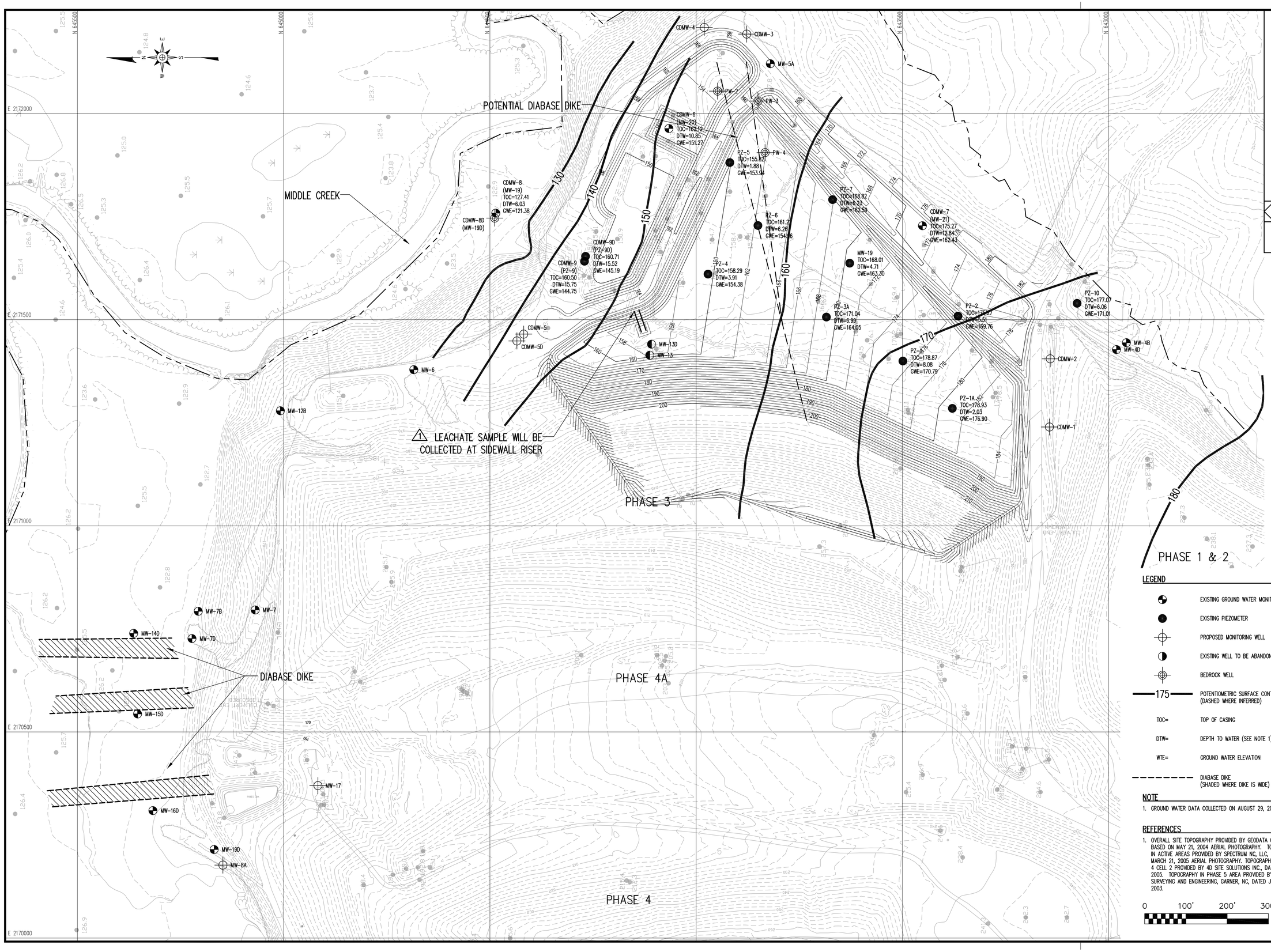
9.4 Implementation Schedule

This program is currently in place and being utilized at the site, with the exception of the addition of MW-8a, MW-14d, MW-15d, MW-16d and MW-17 and the leachate samples. These wells have also been proposed in a letter from GNRA to NCDENR dated July 18, 2001 regarding a recent geophysical evaluation of portions of the site and the proposed installation of additional wells. These well installations will be implemented upon approval from NCDENR.

Table 1
Ground Water Monitoring Well Network
Johnston County Landfill
Johnston County, North Carolina
Proposed C&D Landfill

Monitoring Well	Completion Type	Associated Wells	Screened Interval	Monitoring Program
CDMW-1	Shallow	none	TBD	Appendix I List
CDMW-2	Shallow	none	TBD	Appendix I List
CDMW-3	Shallow	none	TBD	Appendix I List
CDMW-4	Deep	none	TBD	Appendix I List
CDMW-5	Shallow	CDMW-5d	TBD	Appendix I List
CDMW-5d	Shallow	CDMW-5	TBD	Appendix I List
CDMW-6	Shallow	none	TBD	Appendix I List
CDMW-7	Deep	none	TBD	Appendix I List
CDMW-8	Shallow	CDMW-8d	TBD	Appendix I List
CDMW-8d	Deep	CDMW-8	TBD	Appendix I List
CDMW-9	Shallow	CDMW-9d	TBD	Appendix I List
CDMW-9d	Deep	CDMW-9	TBD	Appendix I List

Notes: 1.) Well locations shown on WQMP Figure 1
2.) TBD = To Be Determined



LEGEND

- EXISTING GROUND WATER MONITORING WELL
- EXISTING PIEZOMETER
- PROPOSED MONITORING WELL
- EXISTING WELL TO BE ABANDONED
- BEDROCK WELL
- 175 — POTENTIOMETRIC SURFACE CONTOUR (DASHED WHERE INFERRED)
- TOC= TOP OF CASING
- DTW= DEPTH TO WATER (SEE NOTE 1)
- WTE= GROUND WATER ELEVATION
- DIABASE DIKE (SHADED WHERE DIKE IS WIDE)

NOTE

1. GROUND WATER DATA COLLECTED ON AUGUST 29, 2005.

REFERENCES

1. OVERALL SITE TOPOGRAPHY PROVIDED BY GEODATA CORPORATION, BASED ON MAY 21, 2004 AERIAL PHOTOGRAPHY. TOPOGRAPHY IN ACTIVE AREAS PROVIDED BY SPECTRUM NC, LLC, BASED ON MARCH 21, 2005 AERIAL PHOTOGRAPHY. TOPOGRAPHY OF PHASE 4 CELL 2 PROVIDED BY 4D SITE SOLUTIONS INC., DATED JUNE 2, 2005. TOPOGRAPHY IN PHASE 5 AREA PROVIDED BY SOUTHMND SURVEYING AND ENGINEERING, GARNER, NC, DATED JUNE 16, 2003.

0 100' 200' 300'

NO.	DATE	REVISION
1	2/20/06	ADDED LEACHATE SAMPLE LOCAION CALLOUT

G. N. RICHARDSON & ASSOCIATES, INC.
Engineering and Geological Services
14 N. Boylan Ave. Raleigh, N.C. 27603
ph: 919-828-0577 fax: 919-828-3899
www.gnra.com

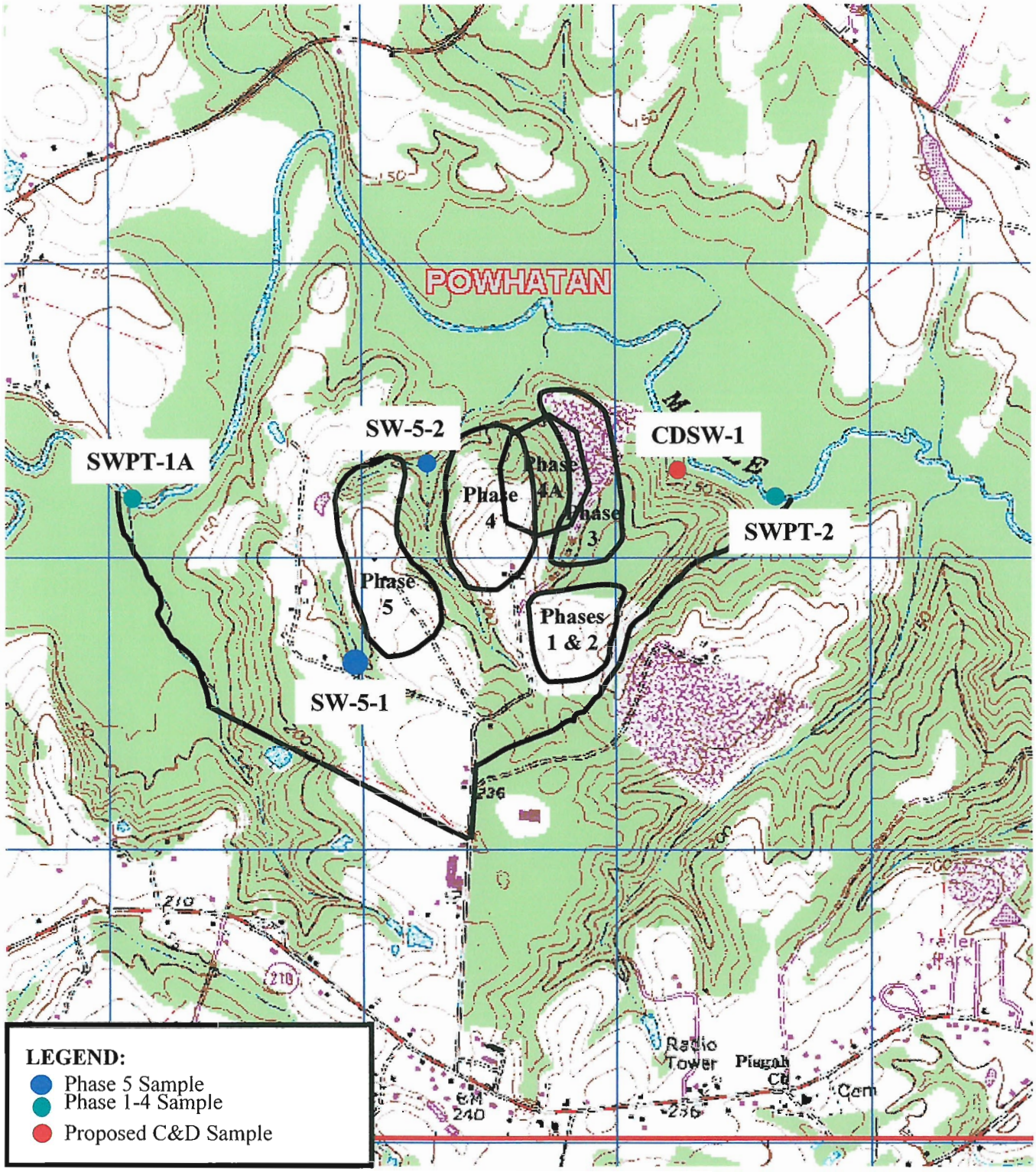
SEAL

SEAL

PROJECT TITLE:
JOHNSTON COUNTY LANDFILL
SMITHFIELD, NORTH CAROLINA

DRAWING TITLE:
POTENTIOMETRIC SURFACE MAP
AUGUST 2005 DATA
WITH PROPOSED
WELL LOCATIONS

DESIGNED BY:	DRAWN BY:
J.A.S.	C.T.J.
CHECKED BY:	PROJECT NO.:
	JOHN-23
SCALE:	DATE:
AS SHOWN	OCT. 2005
FILE NAME	
JOHN-D0385A	
SHEET NO.	DRAWING NO.
	FIG. 1



Surface Water Sampling Locations

Johnston County Landfill

Smithfield, North Carolina

G. N. RICHARDSON & ASSOCIATES, INC.
Engineering and Geological Services
14 N. Boylan Ave.
Raleigh, N.C. 27603
www.gnra.com
ph: 919-828-0577
fax: 919-828-3899

SCALE:	DRAWN BY:	CHECKED BY:	DATE:	PROJECT NO.	FIGURE NO.	FILE NAME
NTS	CJ	JAS	11/3/05	Johnston-23	2	John sw loc.ppt

Subject: Johnston County application
From: Donna Wilson <Donna.Wilson@ncmail.net>
Date: Tue, 13 Jan 2009 14:47:03 -0500
To: Pieter Scheer <pieter@rsgengineers.com>

Pieter - As we discussed, I have a few more comments on the Johnston County application:

1. The change in volume should be compared to the 19,900,000 cubic yard capacity quoted in the 2006 fact sheet, which is for both the MSW and C&D capacity (18,367,420 cy MSW + 1,487,003 cy C&D = 19,854,423). This was rounded to 19,900,000 in the public notice and fact sheets.
2. Please clarify in the report that the gross capacity numbers include bottom of waste to top of final cover.
3. The application for continued operations of the C&D landfill (.0547 requirements) should state when C&D Area 1 stopped receiving waste, when closure activities began, and when closure activities will be completed.

Thanks, Donna

--
Donna J. Wilson
Environmental Engineer
Solid Waste Section/Division of Waste Management
NC DENR
1646 Mail Service Center
Raleigh NC 27699-1646
Phone 919-508-8510
Section webpage - http://wastenotnc.org/swhome

Subject: Re: Johnston County application
From: Pieter Scheer <pieter@rsgengineers.com>
Date: Tue, 13 Jan 2009 19:30:58 -0500
To: Donna Wilson <Donna.Wilson@ncmail.net>

Donna:

Attached is a copy of revised Section 2.0 from the Facility and Engineering Plan. Section 2.3.1 has been revised per your Comments No. 1 & 2 (refer to first 2 paragraphs on Page 2.0-4).

Regarding Comment No. 3, as we discussed earlier, the final waste was disposed of in the Area 1 C&D unit prior to July 1, 2008. I have asked the County for final confirmation of the actual date. Also per our earlier discussion, the closure and post-closure plan, revised as part of the Phase 4A - Cell 3 response to comments (see attached copy) did include information in Section 1.6 (refer to first paragraph on Page 1.0-4) related to the closure schedule for Area 1 unit. The construction of the Phase 4A - Cell 3 MSW landfill unit will be the first phase of closure of the Area 1 C&D landfill unit.

Please let me know if you have any questions or comments on this information.

Pieter

Pieter K. Scheer, P.E.
Principal, Senior Engineer
Richardson Smith Gardner & Associates, Inc.
14 N. Boylan Ave.
Raleigh, NC 27603
Phone: (919) 828-0577 x123
Fax: (919) 828-3899
www.rsgengineers.com

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>
> Thanks, Donna

F&EP Plan Section 2.0 Rev. 011309.pdf	**Content-Type:** application/pdf **Content-Encoding:** base64

JC Attachment E (Closure & Post Closure Plan).pdf	**Content-Type:** application/pdf **Content-Encoding:** base64

Closure And Post-Closure Plan

Johnston County Landfill
Smithfield, North Carolina

Prepared for:

Johnston County Department of Public Utilities
Smithfield, NC

June 2008
Revised: December 2008

RICHARDSON SMITH GARDNER & ASSOCIATES
Engineering and Geological Services
14 N. Boylan Avenue
Raleigh, North Carolina 27603

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JOHNSTON COUNTY LANDFILL

CLOSURE AND POST-CLOSURE PLAN

TABLE OF CONTENTS

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SECTION 1.0
CLOSURE PLAN

1.1 OVERVIEW

This plan is intended to serve as a guide for the proposed closure. A formalized Closure Plan for each landfill unit (or incremental portion thereof) will be submitted to the Solid Waste Section of the North Carolina Department of Environment and Natural Resources Division of Waste Management (DWM) for approval prior to beginning closure construction.

1.2 MAXIMUM CLOSURE AREA AND WASTE CAPACITY

The following are the estimated areas and capacity for each landfill unit to be closed under this plan.

Landfill Unit	Closure Area (Acres)	Gross Capacity (CY)[1]	Net (Waste) Capacity (CY/Tons)[1]
MSW Landfill Units			
Phase 4A (Through Cell 3 - Fill Sequence 1)	29.4	2,531,948	2,152,156 CY 1,383,316 Tons
Phase 5	19.2	1,087,199	884,625 CY 514,181 Tons
Total (MSW):	48.6	3,619,147	3,036,781 CY 1,897,497 Tons
C&D Units			
Area 1	12.9 (See Note 2)	614,472	515,563 CY 304,780 Tons
Area 2 (Cell 1)	11.9	410,675	353,056 CY 212,920 Tons
Total (C&D):	24.8	1,027,345	868,619 CY 517,700 Tons

Notes:

1. The volume and tonnage figures assumed for each landfill unit are based on the site's Facility Plan. Refer to Section 2.0 (Facility Report) of the Facility and Engineering Plan (**Attachment A**).

2. The Area 1 C&D landfill unit has a total area of 16.2 acres but has a reduced closure area due to the overlying Phase 4A - Cell 3 MSW landfill unit.

1.3 FINAL COVER SYSTEM

The final cover system will consist of the following components (top-down):

- a 24-inch thick vegetative soil layer (including 6 inches of topsoil);
- a drainage geocomposite (with drainage breaks)
- a 30-mil textured LLDPE geomembrane; and
- a 12-inch thick intermediate cover layer.

The final cover system will be placed on prepared intermediate cover at a maximum slope of 4H:1V. Surface water control devices will also be incorporated into the final cover of each landfill unit and some units will have a landfill gas (LFG) control system. The final cover surface will be vegetated upon completion of the final cover installation according to the project seeding specifications.

Placement of the vegetative soil layer over the cover geosynthetics must be done with care to avoid damage to these materials. This soil layer should be placed from the bottom up using a small dozer equipped with low ground contact pressure (6 psi or less) tracks. A minimum of 12 inches of soil should be maintained between the dozer tracks and the underlying geosynthetics. The soil buffer should receive no compaction other than that provided by the dozer tracks. Pans or other heavy equipment should not operate on the vegetative soil layer.

Refer to the appropriate permit application for a detailed discussion and details related to the design of the final cover system for each landfill unit.

1.4 LANDFILL GAS SYSTEM

For the MSW landfill units and C&D landfill units overlying MSW units, a landfill gas system is provided in the final cover design. This system includes a system of collection wells placed within the waste to capture the gas and either passively vent or flare the gas via utility flares or, as required, actively collect and flare the gas via header piping and a blower/flare system. The collection wells should be placed before any geosynthetics are placed.

Refer to the appropriate permit application for a detailed discussion and details related to the design of the landfill gas system for each landfill unit.

1.5 SURFACE WATER SYSTEMS

Precipitation falling on the cover will infiltrate into the cover or run off the cover. Short-term the run-off runs down the surface of the intermediate cover. Long-term the run-off is collected in a series of drainage breaks built into the areas covered by final cover. These drainage breaks are provided along side slopes (rain gutters and diversion berms). Water captured by rain gutters or diversion berms is routed toward one of the down pipes. Flow in the down pipes is routed to the base of the landfill and to one of the site sediment basins.

Refer to the appropriate permit application for a detailed discussion and details related to the design of surface water systems for each landfill unit.

1.5.1 Incremental Operation

During much of the life of the landfill, surface run-off will be handled by the intermediate cover system. Operations must strive to provide operational grading that encourages run-off from the intermediate cover to drain to the perimeter channels along the perimeter berms or to areas covered by final cover. Corrugated polyethylene (CPE) piping and temporary soil berms must be installed if required to accomplish this run-off routing.

1.5.2 Required Maintenance

The surface water systems must be inspected annually and immediately after every major storm. Sediment build-up in the drainage features/devices must be cleaned out on a regular basis to promote run-off. Sediments removed can be used as daily or intermediate cover.

1.6 CLOSURE SCHEDULE

In general , closure activities will occur on the following schedule:

MSW Landfill Units (15A NCAC 13B.1627(c)(5)):

- No later that 30 days after the date on which the MSWLF unit receives the known final receipt of wastes; or
- If the MSWLF unit has remaining capacity and there is a reasonable likelihood that the MSWLF unit will receive additional wastes, no later than one year after the most recent receipt of wastes.

C&D Landfill Units (15A NCAC 13B.0543(c)(5)):

- No later that 30 days after the date on which the C&DLF unit receives the known final receipt of wastes;
- No later than 30 days after the date that a 10 acre or greater area of waste, is within in 15 feet of final design grades; or
- No later than one year after the most recent receipt of wastes, if the C&DLF unit has remaining capacity.

All closure activities shall be completed within 180 days. Exemptions and extensions may be approved by the DWM.

For the Area 1 C&D landfill unit, closure will occur in two stages. The first stage will be the construction of the Phase 4A Cell 3 landfill unit in early to mid 2009 which will close the eastern half of Area 1. After construction of Phase 4A Cell 3, the remainder of Area 1 will be closed beginning in fall 2009. Closure of Area 1 is scheduled to be complete by the end of FY 2009-10.

1.7 CLOSURE VERIFICATION

The following procedures will be implemented following closure:

- A Construction Quality Assurance (CQA) report will be submitted to the DWM. This report will describe the observations and tests used before, during, and upon completion of construction to ensure that the construction materials meet the final cover design specifications and the construction and certification requirements. The CQA report will contain as-built drawings.

- A signed certification from a registered Professional Engineer verifying that closure has been completed in accordance with the closure plan will be submitted to the DWM.

- At least one sign notifying all persons of the closing of the landfill (or incremental portions thereof) and that wastes are no longer accepted will be posted. Suitable barriers will be installed as necessary at former access points to prevent new waste from being deposited.

- Within 90 days, a survey plat, prepared by a registered Professional Land Surveyor, indicating the location and dimensions of landfill disposal areas, will be prepared.

- A notation will be recorded on the deed notifying any potential purchaser of the property that the land has been used as a landfill facility and that future use is restricted under the approved closure plan. A copy of the deed notation as recorded will be filed with the operating record.

SECTION 2.0
POST-CLOSURE PLAN

2.1 OVERVIEW

This Post-Closure Plan has been developed to outline steps to be taken to ensure the integrity of the landfill during its post-closure care period. The post-closure care period will last at least 30 years after final closure and, at a minimum, will consist of the following:

- Maintaining the integrity and effectiveness of final cover system;
- Performing groundwater and surface water monitoring;
- Maintaining and operating a gas monitoring system; and
- Maintaining run-on/run-off controls.

No wastes will remain exposed after closure of the landfill. Access to the closed site by the public will not pose a health hazard.

2.2 POST-CLOSURE CONTACT

All correspondence and questions concerning the post-closure care of the unit should be directed to:

Johnston County Department of Public Utilities
Attn: Director
309 E. Market Street
Smithfield, NC 27577
Phone: (919) 209-8333
Fax: (919) 934-7174.

2.3 POST-CLOSURE USE

After filling operations cease at the landfill and the landfill is officially closed in accordance with the Closure Plan, each landfill unit will be maintained as a grassy hill. Johnston County will maintain control of the property and prevent public access to it during the post-closure period.

There may be (an) access road(s) on the final cover to allow proper maintenance during post-closure. Precise location of the access road(s) will be determined as a part of operations. Low ground pressure and rubber tire vehicles will be used for maintenance.

2.4 MAINTENANCE

2.4.1 Repair of Security Control Devices

All security control devices will be inspected and maintained as necessary to ensure access to the site is controlled. Locks, vehicular gates, and fencing will be replaced if functioning improperly. Warning signs will be kept legible at all times and will be replaced if damaged by inclement weather or vandalism.

2.4.2 Erosion Damage Repair

If erosion of the final cover occurs during post-closure, the affected area will be repaired and reseeded as necessary. If necessary, rolled erosion control products (RECPs) will be used to expedite rapid revegetation of slopes and to secure topsoil in place.

2.4.3 Correction of Settlement, Subsidence, and Displacement

Minimum slopes of 5 percent will be maintained after settlement in order to prevent ponding and allow for proper drainage without infiltration. If vertical or horizontal displacement occurs due to differential settlement, cracks will be filled with appropriate material and final cover will be reestablished. Excessive vertical displacement is not anticipated.

2.4.4 Leachate Management System (Lined Units)

In order to maintain the free flow in leachate collection piping, they will be cleared of debris using the manholes or cleanout locations for access. If pipes should crush or buckle within the landfill, leachate will flow through the gravel columns. The leachate collection system (LCS) includes a continuous blanket drain on the base of the landfill which will allow drainage of leachate even in the very unlikely event of total failure of the leachate collection pipes.

2.4.5 Closure of Leachate Storage Lagoon

After closure of the lined landfill units has been achieved, the generation of leachate will eventually curtail. The flow rate immediately after closure should decrease to approximately 100 gallons/acre/day. Toward the end of the 30-year post-closure period, the flow should approach zero, at which time the storage lagoon will not be required. The following procedures will be followed to properly close the leachate storage lagoon:

- Completely drain and remove all liquids, sludges, sediments, etc. from the storage lagoon.
- Disassemble the lagoon, piping, and appurtenances and dispose of the contents in a manner approved by the DWM.

- Sample and analyze the underlying soil for appropriate constituents inherent to leachate. Assess the results for evidence of contaminant migration.

- If contamination of underlying soils is exhibited, perform an assessment as to the degree of contamination and develop remedial actions.

- Obtain approval of the DWM for the assessment and associated remedial measures.

- Perform the remedial actions as necessary to limit any threats to public health and the environment.

- Restore the area to closely match pre-existing conditions in the vicinity of the containment areas. Activities may include: filling, grading, topsoiling, and seeding.

2.4.6 Repair of Run-On/Run-Off Control Structures

All drainage swales, ditches, and perimeter channels will be repaired, cleaned, or realigned in order to maintain their original condition. Any culverts that are damaged will be repaired or replaced.

2.4.7 Landfill Gas System

The landfill gas system will be maintained by the County and operated in accordance with any site air quality permits. Proper operation of the system is verified through testing at the landfill gas monitoring wells.

If gas wells/vents do not function as a result of irregular settlement, accumulation of liquids (condensate, leachate, water), binding or corrosion, additional and/or replacement wells/vents can be installed if necessary in accordance with the current Landfill Gas Management Plan.

2.4.8 Groundwater Monitoring Wells

Procedures outlined in the current Water Quality Monitoring Plan or subsequent revision will take precedence; however, a brief description follows. All groundwater monitoring wells have been installed with concrete pads and protective casings to prevent accidental damage by vehicles and equipment. The wells are also equipped with a locking cap to discourage vandalism. Groundwater wells will be inspected regularly (at the time of sampling) to ensure integrity. Persons inspecting a well should look at the overall condition of the well, for signs of well tampering, and cracking or degradation of the concrete pad. Should a well require replacement, the defective well should be abandoned in accordance with specifications provided in the SAP and a new well installed at a

location that is approved by the DWM.

2.5 MONITORING PLAN

The closed unit will be monitored for a minimum of 30 years. A series of inspections will be scheduled to ensure the integrity and effectiveness of the final cover system, surface water systems, groundwater monitoring system, landfill gas system, and to protect human health and the environment.

2.5.1 Inspection Frequencies

Inspections to be conducted during the post-closure care period will occur regularly as shown in **Table 2.1**.

2.5.2 Quarterly Inspections

Quarterly inspections of the closed site will be conducted by the County. These inspections will include examination of the security control devices for signs of deterioration or vandalism to ensure access to the site is limited to authorized persons. Each disposal area will be checked to ensure the integrity of the final cover system is maintained, erosion damage is repaired, vegetative cover persists, and that cover settlement, subsidence, and displacement are minimal. Drainage swales and channels will be cleared of litter and debris and benchmark integrity will be noted and maintained.

2.5.3 Semi-Annual Inspections

Semi-annual inspections of the site during the post-closure period will be conducted by the County with attention paid to integrity and drainage of the final cover system and condition of the groundwater and gas monitoring systems.

A report of findings will be made to the responsible party, including recommendations for actions deemed necessary to ensure the site continues to meet the closure performance standard.

2.6 ENGINEERING CERTIFICATION

Based on the County's monitoring reports, annual certifications by a registered engineer will be placed in the operating record. They will certify that the closure plan has been followed, noting discrepancies along with the corrective actions undertaken. At the end of the post closure period, the individual certifications will be compiled into a final document and forwarded to the DWM.

TABLE 2.1: POST-CLOSURE INSPECTION FREQUENCIES

INSPECTION ACTIVITY	YEAR 1	YEARS 2-30
Security Control Devices	Quarterly	Quarterly
Vegetative Cover Condition	Quarterly[1]	Quarterly
Surface Water Systems	Quarterly[1]	Quarterly
Erosion Damage	Quarterly[1]	Quarterly
Cover Drainage System	Quarterly[1]	Semi-Annually
Cover Settlement, Subsidence, and Displacement	Quarterly[1]	Semi-Annually
Leachate Management System	Quarterly	Semi-Annually
Landfill Gas System	Quarterly[3]	Semi-Annually[3]
Groundwater Monitoring System	Semi-Annually	Semi-Annually[2]
Benchmark Integrity	Annually	Annually
Leachate Collection Pipe Cleanout	Annually	Annually

Notes:

1. These items will be inspected after each large storm event (i.e. $\geq$ 1 inch in any 24 hours).
2. Or in accordance with groundwater monitoring schedule described in the current Water Quality Monitoring Plan.
3. Or in accordance with the current Landfill Gas Management Plan or air quality permit(s).

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SECTION 3.0
CLOSURE/POST-CLOSURE COST ANALYSIS

3.1 OVERVIEW

The purpose of this section is to provide a written estimate in current dollars of costs associated with all activities specified in the written closure and post-closure plans which have been developed for the MSW and C&D landfill units of the Johnston County Landfill.

3.2 ESTIMATED CLOSURE COSTS

Tables 3.1A, 3.1B, 3.1C, and 3.1D summarize the estimated costs for complete closure of the MSW Phase 4A (Cells 1-3), MSW Phase 5, C&D Area 1, and C&D Area 2 (Cell 1) landfill units, respectively (the maximum area to be closed). The cost estimate for each unit is based on a third party providing the necessary services and includes labor in the unit prices given. The estimated closure costs will be reviewed and updated as required to reflect adjustments for inflation, increased costs in construction or materials, or any other adjustments to the Closure Plan.

3.3 ESTIMATED POST-CLOSURE COSTS

Tables 3.2A and 3.2B summarize the estimated costs for the post-closure care maintenance activities for MSW Phases 1-4A and C&D Areas 1-2[1] and the MSW Phase 5 landfill unit. The cost estimate for each is based on a third party providing the necessary services and includes labor in the unit prices given. The estimated post-closure costs will be reviewed and updated as required to reflect adjustments for inflation, rising costs of anticipated post-closure care, or any other adjustments to the Post-Closure Plan.

3.4 FINANCIAL ASSURANCE MECHANISM

Johnston County intends to continue to use the Local Government Financial Test (15A NCAC 13B.1628(e)(1)(f)) to demonstrate financial assurance for this facility.

[1]The MSW Phases 1-4 units (previously closed), the MSW Phase 4A unit, and the C&D Areas 1 and 2 units are combined in that these units are in the same portion of the site.

TABLE 3.1A: MSW - PHASE 4A - CLOSURE COST ESTIMATE[1]

ITEM	QUANTITY	UNITS	UNIT COST	ITEM COST (2008 $)
Surface Preparation	29.4	Acre	$10,000	$294,000
Landfill Gas System	29.4	Acre	$15,000	$441,000
30 mil Textured LLDPE Geomembrane	1,281,000	SF	$0.45	$576,450
Drainage Geocomposite	1,281,000	SF	$0.55	$704,550
Vegetative Soil Layer (24")	95,000	CY	$5.00	$475,000
Erosion Control (Rain Gutters, Diversion Berms, Down Pipes, Drainage Channels, Etc.)	29.4	Acre	$15,000	$441,000
Revegetation	29.4	Acre	$1,500	$44,100
Surveying	29.4	Acre	$2,000	$58,800
			Subtotal:	$3,034,900
Bonds, Mobilization, & Insurance			(4% of Subtotal):	$121,396
			Subtotal:	$3,156,296
			Contingency (10%):	$315,630
			Construction Subtotal:	**$3,471,926**
Engineering	29.4	Acre	$2,000	$58,800
CQA	29.4	Acre	$6,000	$176,400
			TOTAL:	**$3,707,126**

Notes:

1. Assumes closure of 29.4 acres (Phase 4A).

TABLE 3.1B: MSW - PHASE 5 - CLOSURE COST ESTIMATE[1]

ITEM	QUANTITY	UNITS	UNIT COST	ITEM COST (2008 $)
Surface Preparation	19.2	Acre	$10,000	$192,000
Landfill Gas System	19.2	Acre	$15,000	$288,000
30 mil Textured LLDPE Geomembrane	837,000	SF	$0.45	$376,650
Drainage Geocomposite	837,000	SF	$0.55	$460,350
Vegetative Soil Layer (24")	62,000	CY	$5.00	$310,000
Erosion Control (Rain Gutters, Diversion Berms, Down Pipes, Drainage Channels, Etc.)	19.2	Acre	$15,000	$288,000
Revegetation	19.2	Acre	$1,500	$28,800
Surveying	19.2	Acre	$2,000	$38,400
			Subtotal:	$1,982,200
Bonds, Mobilization, & Insurance			(4% of Subtotal):	$79,288
			Subtotal:	$2,061,488
			Contingency (10%):	$206,149
			Construction Subtotal:	**$2,267,637**
Engineering	19.2	Acre	$2,000	$38,400
CQA	19.2	Acre	$6,000	$115,200
			TOTAL:	**$2,421,237**

Notes:

1. Assumes closure of 19.2 acres (Phase 5).

TABLE 3.1C: C&D - AREA 1 - CLOSURE COST ESTIMATE[1]

ITEM	QUANTITY	UNITS	UNIT COST	ITEM COST (2008 $)
Surface Preparation	12.9	Acre	$10,000	$129,000
Landfill Gas System	12.9	Acre	$15,000	$193,500
30 mil Textured LLDPE Geomembrane	562,000	SF	$0.45	$252,900
Drainage Geocomposite	562,000	SF	$0.55	$309,100
Vegetative Soil Layer (24")	42,000	CY	$5.00	$210,000
Erosion Control (Rain Gutters, Diversion Berms, Down Pipes, Drainage Channels, Etc.)	12.9	Acre	$15,000	$193,500
Revegetation	12.9	Acre	$1,500	$19,350
Surveying	12.9	Acre	$2,000	$25,800
			Subtotal:	$1,333,150
Bonds, Mobilization, & Insurance			(4% of Subtotal):	$53,326
			Subtotal:	$1,386,476
			Contingency (10%):	$138,648
			Construction Subtotal:	**$1,525,124**
Engineering	12.9	Acre	$2,000	$25,800
CQA	12.9	Acre	$6,000	$77,400
			TOTAL:	**$1,628,324**

Notes:

1. Assumes closure of 12.9 acres (Area 1).

TABLE 3.1D: C&D - AREA 2 - CLOSURE COST ESTIMATE[1]

ITEM	QUANTITY	UNITS	UNIT COST	ITEM COST (2008 $)
Surface Preparation	11.9	Acre	$10,000	$119,000
Landfill Gas System	11.9	Acre	$15,000	$178,500
30 mil Textured LLDPE Geomembrane	519,000	SF	$0.45	$233,550
Drainage Geocomposite	519,000	SF	$0.55	$285,450
Vegetative Soil Layer (24")	39,000	CY	$5.00	$195,000
Erosion Control (Rain Gutters, Diversion Berms, Down Pipes, Drainage Channels, Etc.)	11.9	Acre	$15,000	$178,500
Revegetation	11.9	Acre	$1,500	$17,850
Surveying	11.9	Acre	$2,000	$23,800
			Subtotal:	$1,231,650
Bonds, Mobilization, & Insurance			(4% of Subtotal):	$49,266
			Subtotal:	$1,280,916
			Contingency (10%):	$128,092
			Construction Subtotal:	**$1,409,008**
Engineering	11.9	Acre	$2,000	$23,800
CQA	11.9	Acre	$6,000	$71,400
			TOTAL:	**$1,504,208**

Notes:

1. Assumes closure of 11.9 acres (Area 2 - Cell 1).

TABLE 3.2A: MSW PHASES 1-4A - C&D AREAS 1-2 - POST-CLOSURE COST ESTIMATE[1]

ITEM	QUANTITY	UNIT	UNIT COST	TOTAL (2008 $)
Site Inspection And Record Keeping	80	HR	$75	$6,000
Revegetation (5% Total Area)	5	Acre	$1,500	$7,500
Mowing (once per year)	100	Acre	$100	$10,000
Erosion Control	1	LS	$5,000	$5,000
Gates/Fences	1	LS	$1,000	$1,000
Groundwater/Surface Water Monitoring & Reporting (36 Long-Term Wells/Points - Semi-Annual)	36	Each	$1,000	$72,000
Methane Monitoring & Reporting (Semi-Annual After Year 1)	2	Each	$2,500	$5,000
Leachate Management[2]	1	LS	$45,149	$45,149
			Subtotal:	$151,649
			Contingency (10%):	$15,165
			ANNUAL TOTAL:	**$166,814**
			30-YEAR TOTAL:	**$5,004,417**

Notes:

1. Assumes post-closure of 100 acres (MSW Phases 1-4A and C&D Areas 1 and Area 2 - Cell 1).
2. Leachate treatment based on 100 gal/ac/day x 41.3 acres lined x 365 x $20/1,000 gal. ($30,149/year) plus $5,000/year staff cost plus $3,000/year lab cost plus $2,000/year leachate collection line cleanout costs. Also include $5,000 per year to account for decommissioning leachate facilities (storage lagoon) (half of assumed $300,000 assumed cost) at the end of the post-closure period.

TABLE 3.2B: MSW PHASE 5 - POST-CLOSURE COST ESTIMATE[1]

ITEM	QUANTITY	UNIT	UNIT COST	TOTAL (2008 $)
Site Inspection And Record Keeping	20	HR	$75	$1,500
Revegetation (5% Total Area)	1	Acre	$1,500	$1,500
Mowing (once per year)	20	Acre	$100	$2,000
Erosion Control	1	LS	$5,000	$5,000
Gates/Fences	1	LS	$1,000	$1,000
Groundwater/Surface Water Monitoring & Reporting (17 Long-Term Wells/Points - Semi-Annual)	17	Each	$1,000	$34,000
Methane Monitoring & Reporting (Semi-Annual After Year 1)	2	Each	$2,500	$5,000
Leachate Management[2]	1	LS	$29,016	$29,016
			Subtotal:	$79,016
			Contingency (10%):	$7,902
			ANNUAL TOTAL:	**$86,918**
			30-YEAR TOTAL:	**$2,607,528**

Notes:

1. Assumes post-closure of 19.2 acres (MSW Phase 5).
2. Leachate treatment based on 100 gal/ac/day x 19.2 acres lined x 365 x $20/1,000 gal. ($14,016/year) plus $5,000/year staff cost plus $3,000/year lab cost plus $2,000/year leachate collection line cleanout costs. Also include $5,000 per year to account for decommissioning leachate facilities (storage lagoon) (half of assumed $300,000 assumed cost) at the end of the post-closure period.

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Subject: Re: Johnston County application
From: Pieter Scheer <pieter@rsgengineers.com>
Date: Fri, 16 Jan 2009 16:10:30 -0500
To: Donna Wilson <Donna.Wilson@ncmail.net>

Donna:

See the attached. Let me know if this ties everything together on the C&D.

Also, I received the permit - Thanks!

Pieter

Pieter K. Scheer, P.E.
Principal, Senior Engineer
Richardson Smith Gardner & Associates, Inc.
14 N. Boylan Ave.
Raleigh, NC 27603
Phone: (919) 828-0577 x123
Fax: (919) 828-3899
www.rsgengineers.com

Donna Wilson wrote:
> This language is fine. Please add it to a page in the Continued Operation application for the C&D landfill (.0547 requirements). Please send only the amended page (or two) instead of the whole plan.
> Thanks, Donna
>
> Pieter Scheer wrote:
>> Donna:
>>
>> The County said that waste was last placed on a daily basis in the Area 1 C&D unit on July 17, 2007 (the Area 2 C&D unit opened on July 18, 2007). A number of loads of primarily concrete rubble were placed in Area 1 after July 17, 2007 to fill in areas and level contours. The County does not have information on the exact quantity of this material or dates of placement. However, as I noted before, no waste was placed in Area 1 after June 30, 2008.
>>
>> Please let me know if you need any further clarification.
>>
>> Pieter
>>
>> Pieter K. Scheer, P.E.
>> Principal, Senior Engineer
>> Richardson Smith Gardner & Associates, Inc.
>> 14 N. Boylan Ave.
>> Raleigh, NC 27603
>> Phone: (919) 828-0577 x123
>> Fax: (919) 828-3899
>> www.rsgengineers.com
>>
>> Donna Wilson wrote:
>>> Pieter - As we discussed, I have a few more comments on the Johnston County application:
>>>
>>> 1. The change in volume should be compared to the 19,900,000 cubic yard capacity quoted in the 2006 fact sheet, which is for both the MSW and C&D capacity (18,367,420 cy MSW + 1,487,003 cy C&D = 19,854,423). This was rounded to 19,900,000 in the public notice and fact sheets.
>>> 2. Please clarify in the report that the gross capacity numbers include bottom of waste to top of final cover.
>>> 3. The application for continued operations of the C&D landfill (.0547 requirements) should state when C&D Area 1 stopped

receiving waste, when closure activities began, and when closure activities will be completed.
Thanks, Donna

JC C&DLF Rev. Permit Application 011609.pdf	**Content-Type:** application/pdf **Content-Encoding:** base64

RICHARDSON SMITH GARDNER & ASSOCIATES
Engineering and Geological Services

January 16, 2009

Ms. Donna J. Wilson
Environmental Engineer II
NC DENR - Division of Waste Management
401 Oberlin Road, Suite 150
Raleigh, North Carolina 27605

RE: Johnston County C&D Landfill (Permit No. 51-03)
Application for Continued Operations - Revised

Dear Ms. Wilson:

On behalf of Johnston County, Richardson Smith Gardner & Associates, Inc. (RSG) would like to submit for your review an updated application for the continued operations of Johnston County's active construction and demolition debris (C&D) landfill unit (Area 2) in accordance with 15A NCAC 13B .0547 for existing landfills as of January 1, 2007.

As outlined in the aforementioned rule, the following information was submitted by July 1, 2008:

1. Closure and Post-Closure Plan {.0547 (2)(a)} **(Attached)**
2. Financial Responsibility {.0547 (2)(b)}

Each of these requirements is described below:

In addition, per our prior correspondence (see **attached** letter dated January 12, 2009), the following documents are provided herein as **attachments**:

3. Construction Quality Assurance (CQA) Manual
4. Approved Water Quality Monitoring Plan

Note that for the Area 1 C&D landfill unit, waste was last placed on a daily basis in this unit on July 17, 2007 (the Area 2 C&D unit opened on July 18, 2007). A number of loads of primarily concrete rubble were placed in Area 1 after July 17, 2007 to fill in areas and level contours. The County does not have information on the exact quantity of this material or dates of placement. However, as we discussed previously, no waste was placed in Area 1 after June 30, 2008.

Closure and Post-Closure Plan

Johnston County intends to install a final cover system consisting of the following components (top-down) on C&D units at the site:

- a 24-inch thick vegetative soil layer (including 6 inches of topsoil);
- a drainage geocomposite (with drainage breaks)
- a 30-mil textured LLDPE geomembrane; and
- a 12-inch thick intermediate cover layer.

This final cover system has been demonstrated in prior permit applications to allow less infiltration than the

prescriptive final cover system[1] [2].

A Closure and Post-Closure Plan has been prepared in accordance with .0543(d) and is provided in an **attachment**. Note that this plan addresses both municipal solid waste (MSW) and C&D landfill units at the site. Note also that the attached plan is the same version of that submitted as part of the most recent permit amendment application for the site[3]. Technical specifications, construction quality assurance (CQA) information, and drawings related to the closure of the facility's C&D landfill units were provided as part of previous permit applications for the MSW Phase 4A - Cell 3 landfill unit (covers Area 1 closure)[4] and the C&D Area 2 landfill unit[5]. As noted above, a copy of the CQA Manual is provided as an **attachment**.

Financial Responsibility

As part of the Closure and Post-Closure Plan, estimates have been prepared for closure and post-closure costs (ref. Section 3.0 of the plan) as summarized below:

MSW Phase 4A (Cells 1-3) - Closure Cost	$3,707,126
MSW Phase 5 - Closure Cost	$2,421,237
C&D Area 1 - Closure Cost	$1,628,324
C&D Area 2 (Cell 1) - Closure Cost	$1,504,208
MSW Phases 1-4A & C&D Areas 1-2 - Post-Closure Cost (30 Year)*	$5,004,417
MSW Phase 5 - Post-Closure Cost (30 Year)	$2,607,528
Total:	**$16,872,840** (2008$)

*The post-closure costs for MSW Phases 1-4A and C&D Areas 1 and 2 are combined in that these units are in the same portion of the site.

Johnston County used the above estimated costs in their most recent submittal to demonstrate financial assurance in the form of a local government financial test.

---

[1] Permit Modification Application, Johnston County C&D Landfill Vertical Expansion (Area 1), Johnston County, NC, prepared by G.N. Richardson & Associates, Inc., as revised through August 2005 (approved by NC DWM on 8/1/05).

[2] Permit to Construct Application, Johnston County C&D Landfill - Area 2, Johnston County, NC, prepared by G.N. Richardson & Associates, Inc., as revised through May 2006 (approved by NC DWM on 8/31/06).

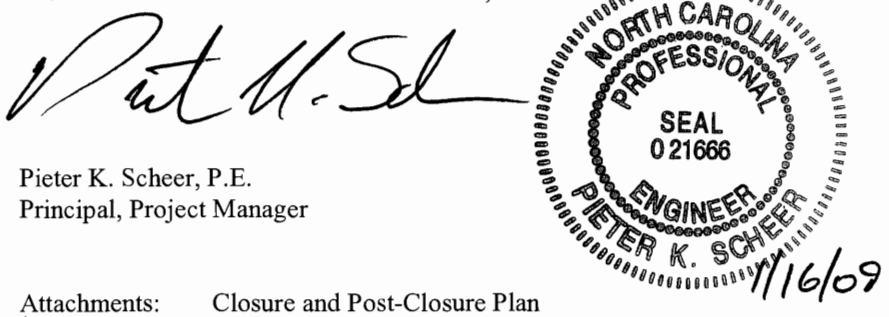
[3] Permit Amendment Application, Johnston County MSW Landfill - Phase 4A - Cell 3, Smithfield, NC, prepared by Richardson Smith Gardner & Associates, Inc., as revised through January 2008 (approved by NC DWM on 1/16/09).

[4] Ibid.

[5] Permit to Construct Application, Johnston County C&D Landfill - Area 2, Johnston County, NC, prepared by G.N. Richardson & Associates, Inc., as revised through May 2006 (approved by NC DWM on 8/31/06).

Should you have any questions or comments on this application, please contact us at your earliest convenience.

Sincerely,
Richardson Smith Gardner & Associates, Inc.



Pieter K. Scheer, P.E.
Principal, Project Manager

Attachments: Closure and Post-Closure Plan
RSG Letter Dated January 12, 2008
CQA Manual
Approved Water Quality Monitoring Plan

cc: Tim Broome, P.E., Johnston County
Haywood Phthisic, Johnston County
Rick Proctor, Johnston County

Closure And Post-Closure Plan

Johnston County Landfill
Smithfield, North Carolina

Prepared for:

Johnston County Department of Public Utilities
Smithfield, NC

June 2008

RICHARDSON SMITH GARDNER & ASSOCIATES
Engineering and Geological Services
14 N. Boylan Avenue
Raleigh, North Carolina 27603

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JOHNSTON COUNTY LANDFILL

CLOSURE AND POST-CLOSURE PLAN

TABLE OF CONTENTS

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SECTION 1.0
CLOSURE PLAN

1.1 OVERVIEW

This plan is intended to serve as a guide for the proposed closure. A formalized Closure Plan for each landfill unit (or incremental portion thereof) will be submitted to the Solid Waste Section of the North Carolina Department of Environment and Natural Resources Division of Waste Management (DWM) for approval prior to beginning closure construction.

1.2 MAXIMUM CLOSURE AREA AND WASTE CAPACITY

The following are the estimated areas and capacity for each landfill unit to be closed under this plan.

Landfill Unit	Closure Area (Acres)	Gross Capacity (CY)[1]	Net (Waste) Capacity (CY/Tons)[1]
MSW Landfill Units			
Phase 4A (Through Cell 3 - Fill Sequence 1)	29.4	2,484,365	2,111,984 CY 1,228,165 Tons
Phase 5	19.2	1,087,199	884,625 CY 514,181 Tons
Total (MSW):	48.6	3,571,564	2,996,609 CY 1,742,346 Tons
C&D Units			
Area 1	12.9 (See Note 2)	572,734	479,645 CY 289,285 Tons
Area 2 (Cell 1)	11.9	451,611	389,897 CY 233,938 Tons
Total (C&D):	24.8	1,027,345	869,542 CY 523,223 Tons

Notes:

1. With the exception of the Phase 4A landfill unit, the volume and tonnage figures assumed for each landfill unit are based on the currently approved Facility Plan. Refer to Section 2.0 (Facility Report) of the Facility and Engineering Plan prepared as part of the Permit to Construct Application for the Johnston County C&D Landfill - Area 2. For Phase 4A, the volume and tonnage figures have been adjusted based on the final design for Cell 3. Refer to Section 2.0 (Quantities) of the Engineering Plan (**Attachment A**).

2. The Area 1 C&D landfill unit has a total area of 16.2 acres but has a reduced closure area due to the overlying Phase 4A - Cell 3 MSW landfill unit.

1.3 FINAL COVER SYSTEM

The final cover system will consist of the following components (top-down):

- a 24-inch thick vegetative soil layer (including 6 inches of topsoil);
- a drainage geocomposite (with drainage breaks)
- a 30-mil textured LLDPE geomembrane; and
- a 12-inch thick intermediate cover layer.

The final cover system will be placed on prepared intermediate cover at a maximum slope of 4H:1V. Surface water control devices will also be incorporated into the final cover of each landfill unit and some units will have a landfill gas (LFG) control system. The final cover surface will be vegetated upon completion of the final cover installation according to the project seeding specifications.

Placement of the vegetative soil layer over the cover geosynthetics must be done with care to avoid damage to these materials. This soil layer should be placed from the bottom up using a small dozer equipped with low ground contact pressure (6 psi or less) tracks. A minimum of 12 inches of soil should be maintained between the dozer tracks and the underlying geosynthetics. The soil buffer should receive no compaction other than that provided by the dozer tracks. Pans or other heavy equipment should not operate on the vegetative soil layer.

Refer to the appropriate permit application for a detailed discussion and details related to the design of the final cover system for each landfill unit.

1.4 LANDFILL GAS SYSTEM

For the MSW landfill units and C&D landfill units overlying MSW units, a landfill gas system is provided in the final cover design. This system includes a system of collection wells placed within the waste to capture the gas and either passively vent or flare the gas via utility flares or, as required, actively collect and flare the gas via header piping and a blower/flare system. The collection wells should be placed before any geosynthetics are placed.

Refer to the appropriate permit application for a detailed discussion and details related to the design of the landfill gas system for each landfill unit.

1.5 SURFACE WATER SYSTEMS

Precipitation falling on the cover will infiltrate into the cover or run off the cover. Short-term the run-off runs down the surface of the intermediate cover. Long-term the run-off is collected in a series of drainage breaks built into the areas covered by final cover. These drainage breaks are provided along side slopes (rain gutters and diversion berms). Water captured by rain gutters or diversion berms is routed toward one of the down pipes. Flow in the down pipes is routed to the base of the landfill and to one of the site sediment basins.

Refer to the appropriate permit application for a detailed discussion and details related to the design of surface water systems for each landfill unit.

1.5.1 Incremental Operation

During much of the life of the landfill, surface run-off will be handled by the intermediate cover system. Operations must strive to provide operational grading that encourages run-off from the intermediate cover to drain to the perimeter channels along the perimeter berms or to areas covered by final cover. Corrugated polyethylene (CPE) piping and temporary soil berms must be installed if required to accomplish this run-off routing.

1.5.2 Required Maintenance

The surface water systems must be inspected annually and immediately after every major storm. Sediment build-up in the drainage features/devices must be cleaned out on a regular basis to promote run-off. Sediments removed can be used as daily or intermediate cover.

1.6 CLOSURE SCHEDULE

Closure activities must begin on the following schedule:

MSW Landfill Units (15A NCAC 13B.1627(c)(5)):

- No later that 30 days after the date on which the MSWLF unit receives the known final receipt of wastes; or
- If the MSWLF unit has remaining capacity and there is a reasonable likelihood that the MSWLF unit will receive additional wastes, no later than one year after the most recent receipt of wastes.

C&D Landfill Units (15A NCAC 13B.0543(c)(5)):

- No later that 30 days after the date on which the C&DLF unit receives the known final receipt of wastes;
- No later than 30 days after the date that a 10 acre or greater area of waste, is within in 15 feet of final design grades; or
- No later than one year after the most recent receipt of wastes, if the C&DLF unit has remaining capacity.

All closure activities shall be completed within 180 days. Exemptions and extensions may be approved by the DWM.

1.7 CLOSURE VERIFICATION

The following procedures will be implemented following closure:

- A Construction Quality Assurance (CQA) report will be submitted to the DWM. This report will describe the observations and tests used before, during, and upon completion of construction to ensure that the construction materials meet the final cover design specifications and the construction and certification requirements. The CQA report will contain as-built drawings.

- A signed certification from a registered Professional Engineer verifying that closure has been completed in accordance with the closure plan will be submitted to the DWM.

- At least one sign notifying all persons of the closing of the landfill (or incremental portions thereof) and that wastes are no longer accepted will be posted. Suitable barriers will be installed as necessary at former access points to prevent new waste from being deposited.

- Within 90 days, a survey plat, prepared by a registered Professional Land Surveyor, indicating the location and dimensions of landfill disposal areas, will be prepared.

- A notation will be recorded on the deed notifying any potential purchaser of the property that the land has been used as a landfill facility and that future use is restricted under the approved closure plan. A copy of the deed notation as recorded will be filed with the operating record.

SECTION 2.0
POST-CLOSURE PLAN

2.1 OVERVIEW

This Post-Closure Plan has been developed to outline steps to be taken to ensure the integrity of the landfill during its post-closure care period. The post-closure care period will last at least 30 years after final closure and, at a minimum, will consist of the following:

- Maintaining the integrity and effectiveness of final cover system;
- Performing groundwater and surface water monitoring;
- Maintaining and operating a gas monitoring system; and
- Maintaining run-on/run-off controls.

No wastes will remain exposed after closure of the landfill. Access to the closed site by the public will not pose a health hazard.

2.2 POST-CLOSURE CONTACT

All correspondence and questions concerning the post-closure care of the unit should be directed to:

Johnston County Department of Public Utilities
Attn: Director
309 E. Market Street
Smithfield, NC 27577
Phone: (919) 209-8333
Fax: (919) 934-7174.

2.3 POST-CLOSURE USE

After filling operations cease at the landfill and the landfill is officially closed in accordance with the Closure Plan, each landfill unit will be maintained as a grassy hill. Johnston County will maintain control of the property and prevent public access to it during the post-closure period.

There may be (an) access road(s) on the final cover to allow proper maintenance during post-closure. Precise location of the access road(s) will be determined as a part of operations. Low ground pressure and rubber tire vehicles will be used for maintenance.

2.4 MAINTENANCE

2.4.1 Repair of Security Control Devices

All security control devices will be inspected and maintained as necessary to ensure access to the site is controlled. Locks, vehicular gates, and fencing will be replaced if functioning improperly. Warning signs will be kept legible at all times and will be replaced if damaged by inclement weather or vandalism.

2.4.2 Erosion Damage Repair

If erosion of the final cover occurs during post-closure, the affected area will be repaired and reseeded as necessary. If necessary, rolled erosion control products (RECPs) will be used to expedite rapid revegetation of slopes and to secure topsoil in place.

2.4.3 Correction of Settlement, Subsidence, and Displacement

Minimum slopes of 5 percent will be maintained after settlement in order to prevent ponding and allow for proper drainage without infiltration. If vertical or horizontal displacement occurs due to differential settlement, cracks will be filled with appropriate material and final cover will be reestablished. Excessive vertical displacement is not anticipated.

2.4.4 Leachate Management System (Lined Units)

In order to maintain the free flow in leachate collection piping, they will be cleared of debris using the manholes or cleanout locations for access. If pipes should crush or buckle within the landfill, leachate will flow through the gravel columns. The leachate collection system (LCS) includes a continuous blanket drain on the base of the landfill which will allow drainage of leachate even in the very unlikely event of total failure of the leachate collection pipes.

2.4.5 Closure of Leachate Storage Lagoon

After closure of the lined landfill units has been achieved, the generation of leachate will eventually curtail. The flow rate immediately after closure should decrease to approximately 100 gallons/acre/day. Toward the end of the 30-year post-closure period, the flow should approach zero, at which time the storage lagoon will not be required. The following procedures will be followed to properly close the leachate storage lagoon:

- Completely drain and remove all liquids, sludges, sediments, etc. from the storage lagoon.
- Disassemble the lagoon, piping, and appurtenances and dispose of the contents in a manner approved by the DWM.

- Sample and analyze the underlying soil for appropriate constituents inherent to leachate. Assess the results for evidence of contaminant migration.

- If contamination of underlying soils is exhibited, perform an assessment as to the degree of contamination and develop remedial actions.

- Obtain approval of the DWM for the assessment and associated remedial measures.

- Perform the remedial actions as necessary to limit any threats to public health and the environment.

- Restore the area to closely match pre-existing conditions in the vicinity of the containment areas. Activities may include: filling, grading, topsoiling, and seeding.

2.4.6 Repair of Run-On/Run-Off Control Structures

All drainage swales, ditches, and perimeter channels will be repaired, cleaned, or realigned in order to maintain their original condition. Any culverts that are damaged will be repaired or replaced.

2.4.7 Landfill Gas System

The landfill gas system will be maintained by the County and operated in accordance with any site air quality permits. Proper operation of the system is verified through testing at the landfill gas monitoring wells.

If gas wells/vents do not function as a result of irregular settlement, accumulation of liquids (condensate, leachate, water), binding or corrosion, additional and/or replacement wells/vents can be installed if necessary in accordance with the current Landfill Gas Management Plan.

2.4.8 Groundwater Monitoring Wells

Procedures outlined in the current Water Quality Monitoring Plan or subsequent revision will take precedence; however, a brief description follows. All groundwater monitoring wells have been installed with concrete pads and protective casings to prevent accidental damage by vehicles and equipment. The wells are also equipped with a locking cap to discourage vandalism. Groundwater wells will be inspected regularly (at the time of sampling) to ensure integrity. Persons inspecting a well should look at the overall condition of the well, for signs of well tampering, and cracking or degradation of the concrete pad. Should a well require replacement, the defective well should be abandoned in accordance with specifications provided in the SAP and a new well installed at a

location that is approved by the DWM.

2.5 MONITORING PLAN

The closed unit will be monitored for a minimum of 30 years. A series of inspections will be scheduled to ensure the integrity and effectiveness of the final cover system, surface water systems, groundwater monitoring system, landfill gas system, and to protect human health and the environment.

2.5.1 Inspection Frequencies

Inspections to be conducted during the post-closure care period will occur regularly as shown in **Table 2.1**.

2.5.2 Quarterly Inspections

Quarterly inspections of the closed site will be conducted by the County. These inspections will include examination of the security control devices for signs of deterioration or vandalism to ensure access to the site is limited to authorized persons. Each disposal area will be checked to ensure the integrity of the final cover system is maintained, erosion damage is repaired, vegetative cover persists, and that cover settlement, subsidence, and displacement are minimal. Drainage swales and channels will be cleared of litter and debris and benchmark integrity will be noted and maintained.

2.5.3 Semi-Annual Inspections

Semi-annual inspections of the site during the post-closure period will be conducted by the County with attention paid to integrity and drainage of the final cover system and condition of the groundwater and gas monitoring systems.

A report of findings will be made to the responsible party, including recommendations for actions deemed necessary to ensure the site continues to meet the closure performance standard.

2.6 ENGINEERING CERTIFICATION

Based on the County's monitoring reports, annual certifications by a registered engineer will be placed in the operating record. They will certify that the closure plan has been followed, noting discrepancies along with the corrective actions undertaken. At the end of the post closure period, the individual certifications will be compiled into a final document and forwarded to the DWM.

TABLE 2.1: POST-CLOSURE INSPECTION FREQUENCIES

INSPECTION ACTIVITY	YEAR 1	YEARS 2-30
Security Control Devices	Quarterly	Quarterly
Vegetative Cover Condition	Quarterly[1]	Quarterly
Surface Water Systems	Quarterly[1]	Quarterly
Erosion Damage	Quarterly[1]	Quarterly
Cover Drainage System	Quarterly[1]	Semi-Annually
Cover Settlement, Subsidence, and Displacement	Quarterly[1]	Semi-Annually
Leachate Management System	Quarterly	Semi-Annually
Landfill Gas System	Quarterly[3]	Semi-Annually[3]
Groundwater Monitoring System	Semi-Annually	Semi-Annually[2]
Benchmark Integrity	Annually	Annually
Leachate Collection Pipe Cleanout	Annually	Annually

Notes:

1. These items will be inspected after each large storm event (i.e. $\geq$ 1 inch in any 24 hours).
2. Or in accordance with groundwater monitoring schedule described in the current Water Quality Monitoring Plan.
3. Or in accordance with the current Landfill Gas Management Plan or air quality permit(s).

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SECTION 3.0
CLOSURE/POST-CLOSURE COST ANALYSIS

3.1 OVERVIEW

The purpose of this section is to provide a written estimate in current dollars of costs associated with all activities specified in the written closure and post-closure plans which have been developed for the MSW and C&D landfill units of the Johnston County Landfill.

3.2 ESTIMATED CLOSURE COSTS

Tables 3.1A, 3.1B, 3.1C, and 3.1D summarize the estimated costs for complete closure of the MSW Phase 4A (Cells 1-3), MSW Phase 5, C&D Area 1, and C&D Area 2 (Cell 1) landfill units, respectively (the maximum area to be closed). The cost estimate for each unit is based on a third party providing the necessary services and includes labor in the unit prices given. The estimated closure costs will be reviewed and updated as required to reflect adjustments for inflation, increased costs in construction or materials, or any other adjustments to the Closure Plan.

3.3 ESTIMATED POST-CLOSURE COSTS

Tables 3.2A and 3.2B summarize the estimated costs for the post-closure care maintenance activities for MSW Phases 1-4A and C&D Areas 1-2[1] and the MSW Phase 5 landfill unit. The cost estimate for each is based on a third party providing the necessary services and includes labor in the unit prices given. The estimated post-closure costs will be reviewed and updated as required to reflect adjustments for inflation, rising costs of anticipated post-closure care, or any other adjustments to the Post-Closure Plan.

[1]The MSW Phases 1-4 units (previously closed), the MSW Phase 4A unit, and the C&D Areas 1 and 2 units are combined in that these units are in the same portion of the site.

TABLE 3.1A: MSW - PHASE 4A - CLOSURE COST ESTIMATE[1]

ITEM	QUANTITY	UNITS	UNIT COST	ITEM COST (2008 $)
Surface Preparation	29.4	Acre	$10,000	$294,000
Landfill Gas System	29.4	Acre	$15,000	$441,000
30 mil Textured LLDPE Geomembrane	1,281,000	SF	$0.45	$576,450
Drainage Geocomposite	1,281,000	SF	$0.55	$704,550
Vegetative Soil Layer (24")	95,000	CY	$5.00	$475,000
Erosion Control (Rain Gutters, Diversion Berms, Down Pipes, Drainage Channels, Etc.)	29.4	Acre	$15,000	$441,000
Revegetation	29.4	Acre	$1,500	$44,100
Surveying	29.4	Acre	$2,000	$58,800
			Subtotal:	$3,034,900
Bonds, Mobilization, & Insurance			(4% of Subtotal):	$121,396
			Subtotal:	$3,156,296
			Contingency (10%):	$315,630
			Construction Subtotal:	**$3,471,926**
Engineering	29.4	Acre	$2,000	$58,800
CQA	29.4	Acre	$6,000	$176,400
			TOTAL:	**$3,707,126**

Notes:

1. Assumes closure of 29.4 acres (Phase 4A).

TABLE 3.1B: MSW - PHASE 5 - CLOSURE COST ESTIMATE[1]

ITEM	QUANTITY	UNITS	UNIT COST	ITEM COST (2008 $)
Surface Preparation	19.2	Acre	$10,000	$192,000
Landfill Gas System	19.2	Acre	$15,000	$288,000
30 mil Textured LLDPE Geomembrane	837,000	SF	$0.45	$376,650
Drainage Geocomposite	837,000	SF	$0.55	$460,350
Vegetative Soil Layer (24")	62,000	CY	$5.00	$310,000
Erosion Control (Rain Gutters, Diversion Berms, Down Pipes, Drainage Channels, Etc.)	19.2	Acre	$15,000	$288,000
Revegetation	19.2	Acre	$1,500	$28,800
Surveying	19.2	Acre	$2,000	$38,400
			Subtotal:	$1,982,200
Bonds, Mobilization, & Insurance			(4% of Subtotal):	$79,288
			Subtotal:	$2,061,488
			Contingency (10%):	$206,149
			Construction Subtotal:	**$2,267,637**
Engineering	19.2	Acre	$2,000	$38,400
CQA	19.2	Acre	$6,000	$115,200
			TOTAL:	**$2,421,237**

Notes:

1. Assumes closure of 19.2 acres (Phase 5).

TABLE 3.1C: C&D - AREA 1 - CLOSURE COST ESTIMATE[1]

ITEM	QUANTITY	UNITS	UNIT COST	ITEM COST (2008 $)
Surface Preparation	12.9	Acre	$10,000	$129,000
Landfill Gas System	12.9	Acre	$15,000	$193,500
30 mil Textured LLDPE Geomembrane	562,000	SF	$0.45	$252,900
Drainage Geocomposite	562,000	SF	$0.55	$309,100
Vegetative Soil Layer (24")	42,000	CY	$5.00	$210,000
Erosion Control (Rain Gutters, Diversion Berms, Down Pipes, Drainage Channels, Etc.)	12.9	Acre	$15,000	$193,500
Revegetation	12.9	Acre	$1,500	$19,350
Surveying	12.9	Acre	$2,000	$25,800
			Subtotal:	$1,333,150
Bonds, Mobilization, & Insurance			(4% of Subtotal):	$53,326
			Subtotal:	$1,386,476
			Contingency (10%):	$138,648
			Construction Subtotal:	**$1,525,124**
Engineering	12.9	Acre	$2,000	$25,800
CQA	12.9	Acre	$6,000	$77,400
			TOTAL:	**$1,628,324**

Notes:

1. Assumes closure of 12.9 acres (Area 1).

TABLE 3.1D: C&D - AREA 2 - CLOSURE COST ESTIMATE[1]

ITEM	QUANTITY	UNITS	UNIT COST	ITEM COST (2008 $)
Surface Preparation	11.9	Acre	$10,000	$119,000
Landfill Gas System	11.9	Acre	$15,000	$178,500
30 mil Textured LLDPE Geomembrane	519,000	SF	$0.45	$233,550
Drainage Geocomposite	519,000	SF	$0.55	$285,450
Vegetative Soil Layer (24")	39,000	CY	$5.00	$195,000
Erosion Control (Rain Gutters, Diversion Berms, Down Pipes, Drainage Channels, Etc.)	11.9	Acre	$15,000	$178,500
Revegetation	11.9	Acre	$1,500	$17,850
Surveying	11.9	Acre	$2,000	$23,800
			Subtotal:	$1,231,650
Bonds, Mobilization, & Insurance			(4% of Subtotal):	$49,266
			Subtotal:	$1,280,916
			Contingency (10%):	$128,092
			Construction Subtotal:	**$1,409,008**
Engineering	11.9	Acre	$2,000	$23,800
CQA	11.9	Acre	$6,000	$71,400
			TOTAL:	**$1,504,208**

Notes:

1. Assumes closure of 11.9 acres (Area 2 - Cell 1).

TABLE 3.2A: MSW PHASES 1-4A - C&D AREAS 1-2 - POST-CLOSURE COST ESTIMATE[1]

ITEM	QUANTITY	UNIT	UNIT COST	TOTAL (2008 $)
Site Inspection And Record Keeping	80	HR	$75	$6,000
Revegetation (5% Total Area)	5	Acre	$1,500	$7,500
Mowing (once per year)	100	Acre	$100	$10,000
Erosion Control	1	LS	$5,000	$5,000
Gates/Fences	1	LS	$1,000	$1,000
Groundwater/Surface Water Monitoring & Reporting (36 Long-Term Wells/Points - Semi-Annual)	36	Each	$1,000	$72,000
Methane Monitoring & Reporting (Semi-Annual After Year 1)	2	Each	$2,500	$5,000
Leachate Management[2]	1	LS	$45,149	$45,149
			Subtotal:	$151,649
			Contingency (10%):	$15,165
			ANNUAL TOTAL:	**$166,814**
			30-YEAR TOTAL:	**$5,004,417**

Notes:

1. Assumes post-closure of 100 acres (MSW Phases 1-4A and C&D Areas 1 and Area 2 - Cell 1).
2. Leachate treatment based on 100 gal/ac/day x 41.3 acres lined x 365 x $20/1,000 gal. ($30,149/year) plus $5,000/year staff cost plus $3,000/year lab cost plus $2,000/year leachate collection line cleanout costs. Also include $5,000 per year to account for decommissioning leachate facilities (storage lagoon) (half of assumed $300,000 assumed cost) at the end of the post-closure period.

TABLE 3.2B: MSW PHASE 5 - POST-CLOSURE COST ESTIMATE[1]

ITEM	QUANTITY	UNIT	UNIT COST	TOTAL (2008 $)
Site Inspection And Record Keeping	20	HR	$75	$1,500
Revegetation (5% Total Area)	1	Acre	$1,500	$1,500
Mowing (once per year)	20	Acre	$100	$2,000
Erosion Control	1	LS	$5,000	$5,000
Gates/Fences	1	LS	$1,000	$1,000
Groundwater/Surface Water Monitoring & Reporting (17 Long-Term Wells/Points - Semi-Annual)	17	Each	$1,000	$34,000
Methane Monitoring & Reporting (Semi-Annual After Year 1)	2	Each	$2,500	$5,000
Leachate Management[2]	1	LS	$29,016	$29,016
			Subtotal:	$79,016
			Contingency (10%):	$7,902
			ANNUAL TOTAL:	**$86,918**
			30-YEAR TOTAL:	**$2,607,528**

Notes:

1. Assumes post-closure of 19.2 acres (MSW Phase 5).
2. Leachate treatment based on 100 gal/ac/day x 19.2 acres lined x 365 x $20/1,000 gal. ($14,016/year) plus $5,000/year staff cost plus $3,000/year lab cost plus $2,000/year leachate collection line cleanout costs. Also include $5,000 per year to account for decommissioning leachate facilities (storage lagoon) (half of assumed $300,000 assumed cost) at the end of the post-closure period.

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RICHARDSON SMITH GARDNER & ASSOCIATES
Engineering and Geological Services

January 12, 2009

Ms. Donna J. Wilson
Environmental Engineer II
NC DENR - Division of Waste Management
401 Oberlin Road, Suite 150
Raleigh, NC 27605

Re: Johnston County C&D Landfill (Permit No. 51-03)
Permit Application - Continued Operations
Response to Review Comments

Dear Ms. Wilson:

Richardson Smith Gardner & Associates, Inc. (RSG) appreciates your review of the above referenced plan. We would like to respond to the comments addressed in your letter dated October 16, 2008 (see **attached** - note comments are near end of letter following those for the Phase 4A Cell 3 MSW landfill unit), as follows. The plan review comments are repeated below in *italics* and our response follows in **bold**.

1. *We have completed a technical review of the Closure and Post-Closure plans and cost estimates for the for the C&D units, in accordance with Rule .0547, and we request that the CQA plan for closure activities and the water monitoring plan be included in the submittal.*

   As referenced in our cover letter dated June 20, 2008, construction quality assurance (CQA) information related to the closure of C&D landfill units was provided as part of the permit application for the MSW Phase 4A - Cell 3 landfill unit. Attached is a copy of the CQA Manual from that submittal.

   The Water Quality Monitoring Plan for the C&D landfill units was submitted and approved as part of the permit application for the Area 2 C&D landfill unit. Attached is a copy of the approved plan.

Please contact me at your earliest convenience with any questions or comments which you may have on this submittal or any further questions or comments you may have on the application.

Sincerely,
Richardson Smith Gardner & Associates, Inc.

Pieter K. Scheer, P.E.
Principal, Project Manager
pieter@rsgengineers.com

Attachments: NC DWM Letter - October 16, 2008
CQA Manual
Approved Water Quality Monitoring Plan

cc: Haywood Phthisic, Johnston County
Tim Broome, P.E., Johnston County
Rick Proctor, Johnston County

NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
Dexter R. Matthews, Director | Division of Waste Management | Michael F. Easley, Governor
William G. Ross Jr., Secretary

October 16, 2008

Mr. Haywood Phthisic, Director
Johnston County Public Utilities Department
P O Box 2263
Smithfield, North Carolina

Re: Application for Permit to Construct Phase 4A, Cell 3, and Review of Closure/Post-Closure Plan for the C&D unit, in accordance with .0547
Johnston County MSW and C&D Landfill
Permit No. 51-03
Johnston County, Doc ID 6031

Dear Mr. Phthisic:

An application for a Permit to Construct for Phase 4A, Cell 3 has been submitted to the Division of Waste Management, Solid Waste Section (Section) on your behalf by your consultant RSG Engineers. In accordance with GS 130A-295.8(e), the Section has reviewed your application and found it to be complete within the meaning of the statute. A determination of completion means that the application includes all required components but does not mean that the required components provide all the information that is required for the Section to make a decision on the application. We have performed a technical review of the submitted application and request the following:

1. Please provide a summary description of the history at the landfill in the application, to include the progression of the phases and vertical expansions, with dates and a brief identification of liners and final covers for the different phases.
2. The property line boundary, from Plat Book 59, Page 437, does not appear to match the property line boundary as shown on drawing S1 (in the area of the NCDOT borrow area). Please clarify.
3. The settlement calculations in the Appendix show the calculated settlement at 7 points. Please provide the calculation of the final slope of the liner between each segment to show positive leachate drainage. Please provide confirmation that the post-settlement bottom elevation of the liner system is a minimum of 4 feet above the seasonal high groundwater table.
4. It appears that the flatter portion of Cell 3 was not included in the original approved plans. Please address why this was changed, and address settlement and differential settlement issues for this flatter portion, to ensure adequate positive drainage of leachate.
5. Please provide calculations that demonstrate that the Cell 4A sump is sized to handle the leachate volumes for cells 1, 2, and 3. Please provide a discussion and detail drawing of how the leachate will be moved from the 2 leachate systems to the sump.

6. Why is the surface water collection on top of the final cover designed to channel all of the surface water under the geomembrane of the final cover? This contradicts the purpose of the final cover system to prevent infiltration of surface water. If there is a leak, how will it be found? If by subsidence, the leak will be present for a long time before it is discovered. Please explain why this design was chosen over a design that involves pipes or drainage channels on top of the final cover. Please address how this would be maintained to prevent clogs from grass, leaves, silt, etc. Please address why this design still leaves exposed pipes on the surface of the landfill for all side slope areas which do not have the geomembrane final cover.
7. Drawing FC1 – Please identify the type of final cover that consists on top of Phase 3 for the strip between Phase 4A cell 2 and the C&D Area 2 cell 2. The entire top of Phase 3 should have a final cover with geomembrane.
8. Please provide at least one cross-section that shows the bottom and top of Phase 3 and 4 MSW areas, the C&D Area 1 and 2 areas, and the Phase 4A areas.
9. In the text, please describe how all the liner components will be connected from cell 1 to cell 3.
10. Drawing FC3 – In text or on the drawing, please explain how the leachate seep collection trenches will be used – in the intermediate cover, after final cover is placed, etc. Leachate outbreaks should not occur through the geomembrane after final cover is placed, as it appears to indicate on the drawing.
11. Please provide a detail drawing of the final cover anchor trench.
12. Drawing detail 2/FC2 – Please clarify where the outlet pipe discharges in relation to Cell 3.
13. Please indicate the locations of the white goods, tire, battery, and waste oil collection areas on the existing conditions drawing.
14. Please include a drawing that shows all future phases, as was in the March 2006 drawings.
15. Operating Plan - Section 2.2.1 - Please correct the reference to the NCAC for the definition of acceptable waste.
16. Operating Plan - Section 2.3.1 – Please correct the reference to the NCAC for the definition of hazardous waste.
17. Operating Plan - Section 2.5.3.2 – Please explain how the geosynthetic rain cover is perforated in a new waste area.
18. Operating Plan – Please incorporate the details and operating plan of the Tarpomatic alternate daily cover.
19. Operating Plan – Please describe the operation and application of the approved spray irrigation system for reclaimed wastewater in the text of the plan, similar to the discussion of the yard waste processing area, and reference the operating plan in the appendix.
20. Operating Plan – Please add discussion of the Bulk Reclaimed Water Transfer Station recently approved on the landfill property. Address site security between the station and the landfill and show the location on the site map.
21. Operating Plan - Please provide a brief discussion of the proposed leachate pond equalization basin modifications.
22. Please provide the actual leachate volumes that have been collected in the leak detection system for Phase 4A, historically and currently.
23. The operating plan should address routine leachate collection line cleaning and inspections. All leachate collection lines shall be designed and constructed to permanently allow cleaning and remote camera inspection. All leachate collection lines shall be cleaned at least once a year, except that the Department may allow leachate collection lines to be cleaned once every

two years if the facility has continuous flow monitoring; and the permit holder demonstrates to the Department that the leachate collection lines are clear and functional based on at least three consecutive annual cleanings. Remote camera inspections of the leachate collection lines shall occur upon completion of construction, at least once every five years thereafter, and following the clearing of blockages.

24. Engineering Plan – Section 2.3.1 - Please clarify what the cut will be in the earthwork cut and fill.
25. Please clarify if the stormwater/leachate separation system will involve welding flaps to the liner.
26. Please provide a copy of the facility plan in this report, updated as needed. The plan should describe the increased capacity, and compare the increase to the capacity in the facility plan that was approved in August 2006.
27. Please include with this application a copy of the approved water quality monitoring plan, following Rule .1623 (b)(3).
28. Closure plan – Please provide a schedule for completing all activities necessary to satisfy the closure criteria in Rule .1627 (c).
29. Please address financial assurance submittal and mechanism in the text of the application. Please update the cost estimates in the application to be consistent with the Closure/Post-closure plan for the C&D units submitted in June 2008. Why has the post-closure costs been reduced from the 2007 submittal ($8,340,528)?

Please submit response to comments as replacement pages to the application report. Only one paper copy is necessary, but an electronic copy is also needed, either sent by email, or on a CD.

We have completed a technical review of the Closure and Post-closure plans and cost estimates for the C&D units, in accordance with Rule .0547, and we request that the CQA plan for closure activities and the water monitoring plan be included in the submittal.

For your reference, the Solid Waste Section rules can be found on the Section's website at http://www.wastenotnc.org/swhome/rule.asp; and the North Carolina General Statutes concerning solid waste are located at http://www.ncleg.net/EnactedLegislation/Statutes/HTML/ByArticle/Chapter_130A/Article_9.html.

If you have any questions or comments, please contact me at (919) 508-8510, or by email at donna.wilson@ncmail.net.

Sincerely,

Donna J. Wilson

Donna J. Wilson
Environmental Engineer
Solid Waste Section

cc: Pieter Scheer Smith, RSG&A
Rick Proctor, Johnston County Solid Waste Manager
Dennis Shackelford, Central Regional Supervisor, DWM
Mary Whaley, Waste Management Specialist, DWM

Construction Quality Assurance Manual

Johnston County Landfill
Smithfield, North Carolina

Prepared for:
Johnston County Department of Public Utilities
Smithfield, NC

June 2007

RICHARDSON SMITH GARDNER & ASSOCIATES
Engineering and Geological Services
14 N. Boylan Avenue
Raleigh, North Carolina 27603

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JOHNSTON COUNTY LANDFILL

CONSTRUCTION QUALITY ASSURANCE MANUAL

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SECTION 1.0
GENERAL

1.1 INTRODUCTION

This Construction Quality Assurance (CQA) Manual has been prepared to provide the Owner, (Design) Engineer, and CQA Engineer the means to govern the construction quality and to satisfy landfill certification requirements under current solid waste management regulations.

More specifically, this CQA Manual addresses the soils and geosynthetics components of the liner, leachate management, and the final cover systems (as applicable) for both the MSW and C&D landfill units at the facility.

The CQA Manual is divided into the following sections:

- Section 1.0 General
- Section 2.0 CQA Documentation
- Section 3.0 Earthwork CQA
- Section 4.0 Soil Liner CQA
- Section 5.0 Geomembrane CQA
- Section 6.0 Leachate Management System CQA
- Section 7.0 Geotextile CQA
- Section 8.0 Drainage Geocomposite CQA
- Section 9.0 Geosynthetic Clay Liner CQA
- Section 10.0 Final Cover System CQA

1.2 DEFINITIONS RELATING TO CONSTRUCTION QUALITY

1.2.1 Construction Quality Assurance (CQA)

In the context of this Manual, Construction Quality Assurance is defined as a planned and systematic program employed by the Owner to assure conformity of the liner, leachate management, and final cover systems installation with the project drawings and the project specifications. CQA is provided by the CQA Engineer as a representative of the Owner and is independent from the Contractor and all manufacturers. The CQA program is designed to provide adequate confidence that items or services meet contractual and regulatory requirements and will perform satisfactorily in service.

1.2.2 Construction Quality Control (CQC)

Construction Quality Control refers to actions taken by manufacturers, fabricators, installers, and/or the Contractor to ensure that the materials and the workmanship meet the requirements of the project drawings and the project specifications. The manufacturer's specifications and quality control (QC) requirements are included in this CQA Manual by

reference only. A complete updated version of each geosynthetic component manufacturer's QC Plan shall be incorporated as part of the Contractor's CQC Plan.

1.2.3 CQA Certification Document

At the completion of construction, a certification document will be prepared by the CQA Engineer and submitted to State Solid Waste Regulators. The certification report will include all QC testing performed by the Geosynthetics Manufacturers, all CQC testing performed by the Geosynthetic Installers, and all CQA testing performed by the CQA Engineer.

1.2.4 Discrepancies Between Documents

The Contractor is instructed to bring discrepancies to the attention of the CQA Engineer who shall then notify the Engineer for resolution. The Engineer has the sole authority to determine resolution of discrepancies existing within the Contract Documents (this may also require the approval of State Solid Waste Regulators). Unless otherwise determined by the Engineer, the more stringent requirement shall be the controlling resolution.

1.3 PARTIES TO CONSTRUCTION QUALITY ASSURANCE

1.3.1 Description of the Parties

The parties to Construction Quality Assurance and Quality Control include the Owner, Engineer, Contractor, Geosynthetics Manufacturer, Geosynthetics Installer, CQA Engineer, Geosynthetics CQA Laboratory, and Soils CQA Laboratory.

1.3.1.1 Owner

The Owner is Johnston County, who owns and/or is responsible for the facility.

1.3.1.2 Engineer

The Engineer is responsible for the engineering design, drawings, and project specifications for the liner, leachate management, and final cover systems. The Engineer is an official representative of the Owner. The Engineer serves as communications coordinator for the project, initiating the meetings outlined in **Section 1.7**. The Engineer will also be responsible for proper resolution of all quality issues that arise during construction. The Engineer is Richardson Smith Gardner & Associates, Inc.

1.3.1.3 Contractor

The Contractor is responsible for the construction of the subgrade, earthwork, and for placement of the liner, leachate management, and final cover systems. The

Contractor is responsible for the overall CQC on the project and coordination of submittals to the CQA Engineer. Additional responsibilities of the Contractor are defined by the project specifications.

1.3.1.4 Geosynthetics Manufacturer

The Geosynthetics Manufacturer(s) is (are) responsible for the production of the geosynthetic components used in landfill construction. The Manufacturer(s) is (are) responsible for Quality Control (QC) during manufacture of the geosynthetic components, certification of the properties of the geosynthetic components, and field installation criteria.

1.3.1.5 Geosynthetics Installer

The Geosynthetics Installer(s) is (are) routinely a subcontractor of the Contractor and is (are) responsible for field handling, storing, placing, seaming, protection of (against wind, etc.), and other aspects of the geosynthetics installations. The Installer may also be responsible for transportation of these materials to the site, and for the preparation and completion of anchor trenches.

1.3.1.6 CQA Engineer

The CQA Engineer is a representative of the Owner, is independent from the Contractor, and is responsible for observing, testing, and documenting activities related to the CQA of the earthworks at the site, and the installation of the soil and geosynthetic components of the liner, leachate management, and final cover systems. The CQA Engineer may make field observations and review submittals for the Engineer and is responsible for notifying the Owner and Engineer of all quality issues that arise during construction. The CQA Engineer is also responsible for issuing a facility certification report, sealed by a Professional Engineer registered in The State of North Carolina.

1.3.1.7 Geosynthetics CQA Laboratory

The Geosynthetics CQA Laboratory is a party, independent from the Owner, that is responsible for conducting tests on conformance samples of geosynthetics used in the liner, leachate management, and final cover systems. The Geosynthetics CQA Laboratory service cannot be provided by any party involved with the manufacture, fabrication, or installation of any of the geosynthetic components. The services of the Geosynthetics CQA Laboratory are coordinated by the CQA Engineer and are paid for by the Owner.

1.3.1.8 Soils CQA Laboratory

The Soils CQA Laboratory is a party, independent from the Owner, that is responsible for conducting geotechnical tests on conformance samples of soils and aggregates used in structural fills and the liner, leachate management, and final cover systems. The services of the Soils CQA Laboratory are coordinated by the CQA Engineer and are paid for by the Owner.

1.3.2 Qualifications of the Parties

The following qualifications are required of all parties involved with the manufacture, fabrication, installation, transportation, and CQA of all materials for the liner, leachate management, and final cover systems. Where applicable, these qualifications must be submitted by the Contractor to the Owner and Engineer for review and approval.

1.3.2.1 Contractor

Qualifications of the Contractor are specific to the construction contract and independent of this CQA Manual.

1.3.2.2 Geosynthetics Manufacturers

Each Geosynthetics Manufacturer must satisfy the qualifications presented in the project specifications.

1.3.2.3 Geosynthetic Installer(s)

The Geosynthetic Installer(s) will be trained and qualified to install the geosynthetics components of the liner, leachate management, and final cover systems. Each Geosynthetics Installer must meet the requirements of the project specifications and be approved by the Engineer.

1.3.2.4 CQA Engineer

The CQA Engineer will act as the Owner's Quality Assurance Representative. The CQA Engineer will perform CQA testing to satisfy the requirements of this CQA Manual and will prepare the CQA certification document. The CQA Engineer will have experience in the CQA aspects of the construction and testing of landfill liner, leachate management, and final cover systems, and be familiar with ASTM and other related industry standards. The activities of the CQA Engineer will be performed under the supervision of a Registered Professional Engineer.

1.3.2.5 Geosynthetics CQA Laboratory

The Geosynthetics CQA Laboratory should be certified by the Geosynthetics Accreditation Institute, will have experience in testing geosynthetics, and be familiar with ASTM, GRI, and other applicable test standards. The Geosynthetics CQA Laboratory will be capable of providing test results within 24 hours or a reasonable time after receipt of samples depending on the test(s) to be conducted, as agreed to at the outset of the project by affected parties, and will maintain that standard throughout the installation.

1.3.2.6 Soils CQA Laboratory

The Soils CQA Laboratory will have experience in testing structural fills, soil liners, and aggregates, and be familiar with ASTM and other applicable test standards. The Soils CQA Laboratory will be capable of providing test results within 24 hours or a reasonable time after receipt of samples depending on the test(s) to be conducted, as agreed to at the outset of the project by affected parties, and will maintain that standard throughout the installation.

1.4 SCOPE OF CONSTRUCTION QUALITY ASSURANCE MANUAL

The scope of this CQA Manual includes the CQA of the soils and geosynthetic components of the liner, leachate management, and final cover systems for the subject facility. The CQA for the selection, evaluation, and placement of the soils is included in the scope.

1.5 UNITS

In this CQA Manual, all properties and dimensions are expressed in U.S. units.

1.6 REFERENCES

The CQA Manual includes references to the most recent version of the test procedures of the American Society of Testing and Materials (ASTM) and/or the Geosynthetic Research Institute (GRI). **Appendix A** contains a list of these procedures.

1.7 CQA MEETINGS

To facilitate the specified degree of quality during installation, clear, open channels of communication are essential. To that end, meetings are critical.

1.7.1 Soil Liner CQA Meeting

Prior to the start of the soil liner system construction a CQA Meeting will be held. This meeting will include all parties then involved, including the Engineer, the CQA Engineer, and the Contractor.

The purpose of this meeting is to begin planning for coordination of tasks, anticipate any problems which might cause difficulties and delays in construction, and, above all, review the CQA Manual to all of the parties involved. It is very important that the rules regarding testing, repair, etc., be known and accepted by all.

This meeting should include all of the activities referenced in the project specifications.

The meeting will be documented by the Engineer and minutes will be transmitted to all parties. The Soil Liner CQA Meeting and the Geosynthetics CQA Meeting may be held as one meeting or separate meetings, depending on the direction of the Engineer.

1.7.2 Geosynthetics CQA Meeting

A CQA Meeting will be held at the site prior to placement of the geosynthetics. At a minimum, the meeting will be attended by the Engineer, the CQA Engineer, the Contractor, and the Geosynthetic Installation Superintendent(s).

The purpose of this meeting is to begin planning for coordination of tasks, anticipate any problems which might cause difficulties and delays in construction, and, above all, review the CQA Manual to all of the parties involved. It is very important that the rules regarding testing, repair, etc., be known and accepted by all.

This meeting should include all of the activities referenced in the project specifications.

The meeting will be documented by the Engineer and minutes will be transmitted to all parties. The Soil Liner CQA Meeting and the Geosynthetics CQA Meeting may be held as one meeting or separate meetings, depending on the direction of the Engineer.

1.7.3 CQA Progress Meetings

Progress meetings will be held between the Engineer, the CQA Engineer, the Contractor, the Geosynthetic Installation Superintendent(s), and representatives from any other involved parties at the frequency dictated in the project specifications or, at a minimum, once per month during active construction. These meetings will discuss current progress, planned activities for the next week, and any new business or revisions to the work. The CQA Engineer will log any problems, decisions, or questions arising at this meeting in his daily or periodic reports. Any matter requiring action which is raised in this meeting will be reported to the appropriate parties. These meetings will be documented by the Engineer and minutes will be transmitted to affected parties.

1.7.4 Problem or Work Deficiency Meetings

A special meeting will be held when and if a problem or deficiency is present or likely to occur. At a minimum, the meeting will be attended by the Engineer, the CQA Engineer,

the Contractor, and representatives from any other involved parties. The purpose of the meeting is to define and resolve the problem or work deficiency as follows:

- define and discuss the problem or deficiency;
- review alternative solutions; and
- implement an action plan to resolve the problem or deficiency.

The meeting will be documented by the Engineer and minutes will be transmitted to affected parties.

1.8 CONTROL VERSUS RECORD TESTING

1.8.1 Control Testing

In the context of this CQA Manual, Control Tests are those tests performed on a material prior to its actual use in construction to demonstrate that it can meet the requirements of the project plans and specifications. Control Test data may be used by the Engineer as the basis for approving alternative material sources.

1.8.2 Record Testing

Record Tests are those tests performed during the actual placement of a material to demonstrate that its in-place properties meet or exceed the requirements of the project drawings and specifications.

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SECTION 2.0
CQA DOCUMENTATION

2.1 DOCUMENTATION

An effective CQA plan depends largely on recognition of 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 quality assurance activities. The CQA Engineer will document that quality assurance requirements have been addressed and satisfied.

The CQA Engineer will provide the Owner and Engineer with his daily and weekly progress reports including signed descriptive remarks, data sheets, and logs to verify that required CQA activities have been carried out. These reports will also identify potential quality assurance problems. The CQA Engineer will also maintain at the job site a complete file of project drawings, reports, project specifications, a CQA Manual, checklists, test procedures, daily logs, and other pertinent documents.

2.2 DAILY CQA REPORT

The CQA Engineer's reporting procedures will include preparation of a daily report which, at a minimum, will include the following information, where applicable:

- a unique identifying sheet number for cross referencing and document control;
- date, project name, location, and other identification;
- data on weather conditions;
- a reduced-scale Site Plan showing all proposed work areas and test locations;
- descriptions and locations of ongoing construction;
- descriptions and specific locations of areas, or units, of work being tested and/or observed and documented;
- locations where tests and samples were taken;
- a summary of test results;
- calibrations or recalibrations of test equipment, and actions taken as a result of recalibration;
- off-site materials received, including quality verification documentation;

- decisions made regarding acceptance of units of work, and/or corrective actions to be taken in instances of substandard quality;

- summaries of pertinent discussions with the Contractor and/or Geosynthetic Installers; and

- the CQA Engineer's signature.

The daily report must be completed at the end of each CQA Engineer's shift, prior to leaving the site. This information will be submitted weekly to and reviewed by the Owner and Engineer.

2.3 CQA PROGRESS REPORTS

The CQA Engineer will prepare a summary progress report each week, or at time intervals established at the pre-construction meeting. As a minimum, this report will include the following information, where applicable:

- a unique identifying sheet number for cross-referencing and document control;

- the date, project name, location, and other information;

- a summary of work activities during the progress reporting period;

- a summary of construction situations, deficiencies, and/or defects occurring during the progress reporting period;

- summary of all test results, failures and retests, and

- signature of the CQA Engineer.

The CQA Engineer's progress reports must summarize the major events that occurred during that week. Critical problems that occur shall be communicated verbally to the Engineer immediately as well as being included in the weekly reports. The CQA Engineer's weekly report must be submitted to the Owner and Engineer no later than the Monday following the week reported.

2.4 CQA PHOTOGRAPHIC REPORTING

Photographs will be taken by the CQA Engineer at regular intervals during the construction process and in all areas deemed critical by the CQA Engineer.

These photographs will serve as a pictorial record of work progress, problems, and mitigation activities. These records will be presented to the Engineer upon completion of the project.

In lieu of photographic documentation, videotaping may be used to record work progress,

problems, and mitigation activities. The Engineer may require that a portion of the documentation be recorded by photographic means in conjunction with videotaping.

2.5 DEFICIENCIES

The Owner and Engineer will be made aware of any significant recurring nonconformance with the project specifications. The Engineer will then determine the cause of the non-conformance and recommend appropriate changes in procedures or specification. When this type of evaluation is made, the results will be documented, and any revision to procedures or project specifications will be approved by the Owner and Engineer.

2.6 DESIGN AND/OR PROJECT TECHNICAL SPECIFICATION CHANGES

Design and/or project specification changes may be required during construction. In such cases, the CQA Engineer will notify the Engineer. The Engineer will then notify the appropriate agency, if necessary.

Design and/or project specification changes will be made only with the written agreement of the Engineer, and will take the form of an addendum to the project specifications. All design changes will include a detail (if necessary) and state which detail it replaces in the plans.

2.7 FINAL CQA REPORT

At the completion of each major construction activity at the landfill unit, the CQA Engineer will certify all required forms, observation logs, field and laboratory testing data sheets including sample location plans, etc. The CQA Engineer will also provide a final report which will certify that the work has been performed in compliance with the plans and project technical specifications, and that the supporting documents provide the necessary information.

The CQA Engineer will also provide summaries of all the data listed above with the report. The Record Drawings will include scale drawings depicting the location of the construction and details pertaining to the extent of construction (e.g., depths, plan dimensions, elevations, soil component thicknesses, etc.). All surveying and base maps required for development of the Record Drawings will be done by the Contractor's Construction Surveyor. These documents will be certified by the Contractor and delivered to the CQA Engineer and included as part of the final CQA (Certification) report.

It may be necessary to prepare interim certifications, as allowed by the regulatory agency to expedite completion and review.

At a minimum, the items shown in **Table 2.1** will be included in the Final CQA Report. Note that some items may not be applicable to all projects.

2.8 STORAGE OF RECORDS

All handwritten data sheet originals, especially those containing signatures, will be stored by the CQA Engineer in a safe repository on site. Other reports may be stored by any standard method which will allow for easy access. All written documents will become property of the Owner.

TABLE 2.1A: FINAL CQA REPORT GENERAL OUTLINE (LINER SYSTEM)

1.0 Introduction
2.0 Project Description
3.0 CQA Program
    3.1 Scope of Services
    3.2 Personnel
4.0 Earthwork CQA
5.0 Soil Liner CQA
6.0 GCL CQA
7.0 Geomembrane CQA
8.0 Leachate Management System CQA
9.0 Geotextile CQA
10.0 Drainage Geocomposite CQA
11.0 Summary and Conclusions
12.0 Project Certification

Appendices

Appendix A Design Clarifications and Modifications
Appendix B Piezometer Abandonment (if applicable)
Appendix C Geophysical Investigation (if applicable)
Appendix D Photographic Documentation
Appendix E CQA Reporting
    E1. CQA Reports
    E2. CQA Meeting Minutes
Appendix F Earthwork CQA Data
    F1. CQA Test Results - Control Tests
    F2. CQA Test Results - Record Tests
Appendix G Soil Liner CQA Data
    G1. CQA Test Results - Control Tests
    G2. CQA Test Results - Record Tests
Appendix H Interface Shear Strength Test Data
Appendix I GCL CQA Data
    I1. Manufacturer's Product Data Submittals and Quality Control Certificates
    I2. Geosynthetics Inventory - GCL
    I3. CQA Test Results - Material Control Tests
    I4. GCL Installation Certification

TABLE 2.1A (CONTINUED):

Appendix J	Geomembrane CQA Data
	J1. Manufacturer's Product Data Submittals and Quality Control Certificates
	J2. Geosynthetics Inventory - Geomembrane(s)
	J3. CQA Test Results - Material Control Tests
	J4. Subgrade Acceptance Certificates
	J5. Trial Seam Logs
	J6. Panel Placement Logs
	J7. Panel Seaming Logs
	J8. CQC Test Results - Nondestructive Seam Testing Report Forms
	J9. CQC Test Results - Destructive Seam Testing Report Forms (Field)
	J10. CQA Test Results - Destructive Seam Testing Report Forms (Laboratory)
	J11. Repair Logs
	J12. Geomembrane Installation Certification
Appendix K	Leachate Management System CQA Data
	K1. Manufacturer's Product Data Submittals and Quality Control Certificates
	K2. CQA Test Results - Drainage Aggregate
	K3. CQA Test Results - Protective Cover
	K4. CQC Test Results - Pressure Testing of HDPE Transmission Piping
	K5. Documentation of Pump Start Up
Appendix L	Geotextile CQA Data
	L1. Manufacturer's Product Data Submittals and Quality Control Certificates
	L2. Geosynthetics Inventory - Geotextiles
	L3. CQA Test Results - Material Control Tests
Appendix M	Drainage Geocomposite CQA Data
	M1. Manufacturer's Product Data Submittals and Quality Control Certificates
	M2. Geosynthetics Inventory - Drainage Geocomposite
	M3. CQA Test Results - Material Control Tests
Appendix N	Record Drawings
	N1. Subgrade As-Built
	N2. Soil Liner As-Built
	N3. Geomembrane As-Built(s)
	N4. Leachate Collection Media As-Built
	N5. HDPE Pipe As-Built
	N6. Protective Cover As-Built

TABLE 2.1B: FINAL CQA REPORT GENERAL OUTLINE (FINAL COVER SYSTEM)

1.0 Introduction
2.0 Project Description
3.0 CQA Program
  3.1 Scope of Services
  3.2 Personnel
4.0 Earthwork CQA
5.0 Final Cover System CQA
6.0 Geomembrane CQA
7.0 Geotextile CQA
8.0 Drainage Geocomposite CQA
9.0 Summary and Conclusions
10.0 Project Certification

Appendices

Appendix A Design Clarifications/Modifications
Appendix B Photographic Documentation
Appendix C CQA Reporting
  C1. CQA Reports
  C2. CQA Meeting Minutes
Appendix D Earthwork CQA Data
  D1. CQA Test Results - Control Tests
  D2. CQA Test Results - Record Tests
Appendix E Final Cover System CQA Data
  E1. Manufacturer's Product Data Submittals and Quality Control Certificates
  E2. CQA Test Results - Drainage Aggregate
  E3. CQA Test Results - Vegetative Soil Layer
  E4. CQC Test Results - Pressure Testing of HDPE Piping
Appendix F Interface Shear Strength Test Data
Appendix G Geomembrane CQA Data
  G1. Manufacturer's Product Data Submittals and Quality Control Certificates
  G2. Geosynthetics Inventory - Geomembrane
  G3. CQA Test Results - Material Control Tests
  G4. Subgrade Acceptance Certificates
  G5. Trial Seam Logs
  G6. Panel Placement Logs
  G7. Panel Seaming Logs
  G8. CQC Test Results - Nondestructive Seam Testing Report Forms
  G9. CQC Test Results - Destructive Seam Testing Report Forms (Field)
  G10. CQA Test Results - Destructive Seam Testing Report Forms (Laboratory)
  G11. Repair Logs
  G12. Geomembrane Installation Certification

TABLE 2.1B (CONTINUED):

Appendix H	Geotextile CQA Data
	H1. Manufacturer's Product Data Submittals and Quality Control Certificates
	H2. Geosynthetics Inventory - Geotextiles
	H3. CQA Test Results - Material Control Tests
Appendix I	Drainage Geocomposite CQA Data
	I1. Manufacturer's Product Data Submittals and Quality Control Certificates
	I2. Geosynthetics Inventory - Drainage Geocomposite
	I3. CQA Test Results - Material Control Tests
Appendix J	Record Drawings
	J1 Subgrade As-Built
	J2 Geomembrane As-Built
	J3 HDPE Pipe As-Built
	J4 Vegetative Soil Layer As-Built

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SECTION 3.0
EARTHWORK CQA

3.1 INTRODUCTION

This section of the CQA Manual addresses earthwork (excavation and embankment) and outlines the soils CQA program to be implemented with regard to material approval, subgrade approval, field control and record tests, and resolution of problems.

3.2 EMBANKMENT MATERIAL APPROVAL

All material to be used as compacted embankment shall be approved in advance by the CQA Engineer. Approval is based upon successful completion of CQA control testing outlined below. Such testing can be performed either during excavation and stockpiling or from existing stockpiles prior to use.

3.2.1 Control Tests

The procedure for CQA testing during excavation and stockpiling (including existing stockpiles) is outlined below.

Each load of soil will be examined either at the borrow source or the stockpile area. Any unsuitable material will be rejected or routed to separate stockpiles consistent with its end use. Appropriate entries will be made in the daily log.

During stockpiling operations, control tests, as shown on **Table 3.1**, will be performed by the CQA Engineer prior to placement of any compacted embankment.

3.3 SUBGRADE APPROVAL

The CQA Engineer will verify that the compacted embankment subgrade is constructed in accordance with the project specifications.

3.4 EARTHWORK CONSTRUCTION

3.4.1 Construction Monitoring

A. Earthwork shall be performed as described in the project specifications.

B. Only soil previously approved by the CQA Engineer (see **Section 3.2**) shall be used in construction of the compacted embankment. Unsuitable material will be removed prior to acceptance by the CQA Engineer.

C. All required field density and moisture content tests shall be completed before the overlying lift of soil is placed. The surface preparation (e.g. wetting, drying,

scarification, etc.) shall be completed before the CQA Engineer will allow placement of subsequent lifts.

D. The CQA Engineer will monitor protection of the earthwork during and after construction.

3.4.2 Control Tests

The control tests, as shown on **Table 3.2**, will be performed by the CQA Engineer prior to placement of compacted embankment.

3.4.3 Record Tests

The record tests, as shown on **Table 3.2**, will be performed by the CQA Engineer during placement of compacted embankment.

3.4.3.1 Record Test Failure

Recompaction of the failed area shall be performed and retested until the area meets or exceeds requirements outlined in the specifications.

3.4.4 Judgmental Testing

During construction, the frequency of control and/or record testing may be increased at the discretion of the CQA Engineer when visual observations of construction performance indicate a potential problem. Additional testing for suspected areas will be considered when:

- the rollers slip during rolling operation;
- the lift thickness is greater than specified;
- the fill material is at an improper moisture content;
- fewer than the specified number of roller passes are made;
- dirt-clogged rollers are used to compact the material;
- the rollers may not have used optimum ballast;
- the fill materials differ substantially from those specified; or
- the degree of compaction is doubtful.

3.5 DEFICIENCIES

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies will be documented by the CQA Engineer. The Contractor shall correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer will observe all retests on repaired defects.

TABLE 3.1: CQA TESTING PROGRAM FOR EMBANKMENT MATERIAL APPROVAL

PROPERTY	TEST METHOD	MINIMUM TEST FREQUENCY
CONTROL TESTS:		
Visual Classification	ASTM D 2488	Each Soil
Moisture-Density Relationship	ASTM D 698	5,000 CY per Each Soil

TABLE 3.2: CQA TESTING PROGRAM FOR COMPACTED EMBANKMENT

PROPERTY	TEST METHOD	MINIMUM TEST FREQUENCY
CONTROL TESTS: (See **Table 3.1**)		
RECORD TESTS:		
Lift Thickness	-----	Each Lift
In-Place Density	ASTM D 6938[1]	20,000 ft^2 per lift & 1 per 500 LF/lift of Berms (< 200 ft. base width)
Moisture Content	ASTM D 6938[2]	20,000 ft^2 per lift & 1 per 500 LF/lift of Berms (< 200 ft. base width)

Notes:

1. Optionally use ASTM D 1556, ASTM D 2167, or ASTM D 2937. For every 10 nuclear density tests perform at least 1 density test by ASTM D 1556, ASTM D 2167, or ASTM D 2937 as a verification of the accuracy of the nuclear testing device.
2. Optionally use ASTM D 2216, ASTM D 4643, or ASTM D 4959. For every 10 nuclear moisture tests perform at least 1 moisture test by ASTM D 2216, ASTM D 4643, or ASTM D 4959 as a verification of the accuracy of the nuclear testing device.

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SECTION 4.0
SOIL LINER CQA

4.1 INTRODUCTION

This section of the CQA Manual addresses the soil liner component of the liner system and outlines the soils CQA program to be implemented with regard to material approval, subgrade approval, test fill construction, field and laboratory control and record tests, and resolution of problems.

4.2 SOIL LINER MATERIAL APPROVAL

All material to be used as soil liner shall be approved in advance by the CQA Engineer. Approval is based upon successful completion of CQA control testing outlined below. Such testing can be performed either during excavation and stockpiling or from existing stockpiles prior to use.

4.2.1 Control Tests

The procedure for CQA testing during excavation and stockpiling (including existing stockpiles) is outlined below.

Each load of soil will be examined either at the borrow source or the stockpile area. Any unsuitable material will be rejected or routed to separate stockpiles consistent with its end use. Appropriate entries will be made in the daily log.

During stockpiling operations, control tests, as shown on **Table 4.1**, will be performed by the CQA Engineer prior to placement of any soil liner material.

4.3 SUBGRADE APPROVAL

The CQA Engineer will verify that the soil liner subgrade is constructed in accordance with the project specifications.

4.4 TEST FILL CONSTRUCTION

A test fill meeting the requirements of the project specifications will be constructed using the same construction methods, equipment, and material to be used for the soil liner component. The test fill construction will be conducted prior to or coincide with the beginning of construction of the soil liner component.

Construction equipment and methods will be reviewed by the CQA Engineer prior to test fill placement.

4.4.1 Control Tests

The control tests, as shown on **Table 4.2**, will be performed by the CQA Engineer prior to placement of soil liner material in the test fill.

4.4.2 Record Tests

The record tests, as shown on **Table 4.2**, will be performed by the CQA Engineer during placement of soil liner material in the test fill.

4.4.3 Test Fill Completion

The test fill program is completed when the Contractor has shown that the soil liner constructed using the same construction methods, equipment, and material to be used in construction of the soil liner will satisfy project specifications. No soil liner can be placed until the test fill program is completed.

4.5 SOIL LINER CONSTRUCTION

4.5.1 Construction Monitoring

A. Soil liner shall be placed as described in the applicable section(s) of the project specifications using the construction methods, equipment, and material demonstrated in the test fill construction.

B. Only soil previously approved by the CQA Engineer (see **Section 4.2**) shall be used in construction of the soil liner. Unsuitable material will be removed prior to acceptance by the CQA Engineer.

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

D. The CQA Engineer will monitor protection of the soil liner during and after construction.

E. The liner surface shall be sprinkled with water as needed to prevent desiccation. Should desiccation occur, the last lift shall be reconstructed in accordance with the project specifications. Standing water should not be present on the soil liner.

F. Frost heave or other damage due to freezing shall require lift reconstruction in accordance with the project specifications.

G. The CQA Engineer will inspect the soil liner and certify that it is in accordance with

the project specifications and approved plans prior to the Contractor beginning installation of overlying geosynthetics.

H. The finished soil liner shall be free of all rock protrusions. All cracks and voids shall be filled and the surface made uniform. This shall be accomplished by final dressing of the soil liner with smooth-drum rollers and hand raking. No rubber tired vehicles are permitted on the final dressed surface unless authorized by the CQA Engineer.

I. The surface on which the overlying geosynthetics are to be placed shall be maintained in a firm, clean, and smooth condition and shall be within the acceptable moisture range before and during the geosynthetics installation.

4.5.2 Control Tests

The control tests, as shown on **Table 4.3**, will be performed by the CQA Engineer prior to placement of soil liner material.

4.5.3 Record Tests

The record tests, as shown on **Table 4.3** and as described below, will be performed by the CQA Engineer during placement of soil liner material.

A. Each lift will be checked visually for soil clods, rocks, debris, plant materials and other foreign material. Any such material which does not meet specified requirements shall be identified and removed prior to and during the compaction process.

B. The thickness of the loose lift will be measured at random locations after spreading and leveling is completed. Loose lift thickness should not exceed the depth of penetration of the compaction feet.

C. Moisture content will be monitored by the CQA Engineer prior to compaction. If the soil is drier than the specified minimum moisture content, water will be added and the lift will be disced to distribute the moisture evenly.

Results of testing will be certified within 7 days of soil liner placement.

4.5.3.1 Record Test Failure

The following procedures shall be used in the event of density or hydraulic conductivity test failure:

A. Failed Density Test: Recompaction of the failed area shall be performed and retested until the area meets or exceeds requirements outlined in the

specifications.

B. Failed Hydraulic Conductivity Test: The area of failure shall be localized and reconstructed in accordance with the project specifications. This area will be retested as outlined within the plan by the CQA Engineer. Optionally, at least five replicate samples shall be obtained and tested by the Contractor in the immediate vicinity of the failed test. If all five samples pass, then the initial failing test will be discounted. However, should the replicate samples confirm the failure of the soil liner to meet specifications, the area of failure shall be localized, reconstructed, and retested as described above.

4.5.4 Judgmental Testing

During construction, the frequency of control and/or record testing may be increased at the discretion of the CQA Engineer when visual observations of construction performance indicate a potential problem. Additional testing for suspected areas will be considered when:

- the rollers slip during rolling operation;
- the lift thickness is greater than specified;
- the fill material is at an improper moisture content;
- fewer than the specified number of roller passes are made;
- dirt-clogged rollers are used to compact the material;
- the rollers may not have used optimum ballast;
- the fill materials differ substantially from those specified; or
- the degree of compaction is doubtful.

4.5.5 Perforations In Soil Liner

All holes shall be patched with compacted soil liner (if allowed by the project specifications) or sodium bentonite compacted and hydrated in the holes.

4.6 DEFICIENCIES

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies will be documented by the CQA Engineer. The Contractor shall correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer will observe all retests on repaired defects.

TABLE 4.1: CQA TESTING PROGRAM FOR SOIL LINER MATERIAL APPROVAL

PROPERTY	TEST METHOD	MINIMUM TEST FREQUENCY
CONTROL TESTS:		
Visual Classification	ASTM D 2488	Each Soil
Moisture Content	ASTM D 2216	2,000 CY per Each Soil
Grain Size Analysis	ASTM D 422	2,000 CY per Each Soil
Atterberg Limits	ASTM D 4318	2,000 CY per Each Soil
Moisture-Density Relationship	ASTM D 698	5,000 CY per Each Soil
Hydraulic Conductivity - Lab Remolded	ASTM D 5084[3]	10,000 CY per Each Soil

TABLE 4.2: CQA TESTING PROGRAM FOR SOIL LINER TEST FILL

PROPERTY	TEST METHOD	MINIMUM TEST FREQUENCY
CONTROL TESTS: (See **Table 4.1**)		
Moisture-Density Relationship	ASTM D 698[4]	1 per lift
Hydraulic Conductivity - Lab Remolded	ASTM D 5084[3,4]	1 per lift
RECORD TESTS:		
Lift Thickness	-----	Each Lift
Atterberg Limits	ASTM D 4318	1 per lift
Grain Size Analysis	ASTM D 422	1 per lift
In-Place Density	ASTM D 2922[1]	3 per lift
Moisture Content	ASTM D 6938[2]	3 per lift
Hydraulic Conductivity - Undisturbed (Shelby Tube)	ASTM D 6938[3]	1 per lift

TABLE 4.3: CQA TESTING PROGRAM FOR SOIL LINER

PROPERTY	TEST METHOD	MINIMUM TEST FREQUENCY
CONTROL TESTS: (See **Table 4.1**)		
RECORD TESTS:		
Lift Thickness	-----	Each Lift
In-Place Density	ASTM D 6938[1]	10,000 ft^2 per lift
Moisture Content	ASTM D 6938[2]	10,000 ft^2 per lift
Hydraulic Conductivity - Undisturbed (Shelby Tube)	ASTM D 5084[3]	80,000 ft^2 per lift

Notes:

1. Optionally use ASTM D 1556, ASTM D 2167, or ASTM D 2937. For every 10 nuclear density tests perform at least 1 density test by ASTM D 1556, ASTM D 2167, or ASTM D 2937 as a verification of the accuracy of the nuclear testing device.
2. Optionally use ASTM D 2216, ASTM D 4643, or ASTM D 4959. For every 10 nuclear moisture tests perform at least 1 moisture test by ASTM D 2216, ASTM D 4643, or ASTM D 4959 as a verification of the accuracy of the nuclear testing device.
3. Maximum effective confining pressure and hydraulic gradient as required by the project specifications. Backpressure as recommended by ASTM D 5084.
4. These tests performed on the test fill may count toward the minimum frequencies established in **Table 4.1**.

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SECTION 5.0
GEOMEMBRANE CQA

5.1 INTRODUCTION

This section of the CQA Manual addresses the geomembrane components of the liner and final cover systems and outlines the CQA program to be implemented with regard to manufacturer and installer approval, material approval, subgrade approval, field and laboratory control and record tests, repairs, and resolution of problems.

5.2 GEOMEMBRANE MANUFACTURER AND INSTALLER APPROVAL

The Contractor shall submit the qualifications of the Geomembrane Manufacturer and the Geomembrane Installer, as described in the specifications, to the CQA Engineer for approval.

5.3 GEOMEMBRANE MATERIAL APPROVAL

5.3.1 Geomembrane Product Data

The CQA Engineer will review the Contractor's submittals for conformance with the project specifications.

5.3.2 Shipment And Storage

During shipment and storage, all geomembrane will be protected as required by the project specifications. The CQA Engineer will observe rolls upon delivery at the site.

5.3.3 Quality Control Certificates

Upon delivery, the CQA Engineer will:

- verify that the Manufacturer's quality control certificates have been provided at the specified frequency and that each certificate identified the rolls or sheets related to it; and

- review the Manufacturer's quality control certificates and verify that the certified properties meet the project technical specifications.

5.3.4 Material Control Tests

Samples for material control tests, as shown on **Table 5.1**, will be obtained by the CQA Engineer at the indicated frequencies upon delivery of the geomembrane. Alternatively, samples may be randomly obtained at the manufacturing site by the CQA Engineer or representatives of the Geosynthetics CQA Laboratory.

Unless otherwise specified, samples will be 3 feet long by the roll or sheet width. The CQA Engineer will mark the machine direction on the samples with an arrow.

All material control tests will be performed by the Geosynthetics CQA Laboratory.

All control test results must be available at the site prior to the deployment of all geomembrane. The CQA Engineer will examine all results from laboratory conformance testing.

5.3.4.1 Material Control Test Failure

The following procedure will apply whenever a sample fails a material control test:

A. The Geomembrane Installer will replace the roll or sheet of geomembrane that is in nonconformance with the project specifications with a roll or sheet that meets project specifications.

B. The Geomembrane Installer will remove conformance samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll or sheet on both sides of the failed roll or sheet. These two samples must both conform to project specifications. If either of these samples fail, then the next numerical roll or sheet will be tested until a passing roll or sheet is found. This additional conformance testing will be at the expense of the Geomembrane Installer. If either of the two closest rolls or sheets fail, the Engineer will dictate the frequency of additional testing.

The CQA Engineer will document actions taken in conjunction with material control test failures.

5.4 GEOMEMBRANE INSTALLATION

5.4.1 Handling

The Geosynthetic Installer will handle all geomembrane in such a manner as required by the project specifications.

5.4.2 Earthwork

5.4.2.1 Surface Preparation

The Geomembrane Installer will certify in writing that the surface on which the geomembrane will be installed meets line and grade, and the surface preparation requirements of the project specifications. The certificate of acceptance will be given to the CQA Engineer prior to commencement of geomembrane installation in the area under consideration. The CQA Engineer will give a copy of this certificate

to the Engineer.

To ensure a timely covering of the subgrade (or soil liner) surface, the Engineer may allow subgrade acceptance in areas as small as one acre. After the supporting soil has been accepted by the Geomembrane Installer, it will be the Geomembrane Installer's responsibility to indicate to the Engineer and CQA Engineer any change in the supporting soil condition that may require repair work. If the CQA Engineer concurs with the Geomembrane Installer, then the Engineer will ensure that the supporting soil is repaired.

5.4.2.2 Anchorage System

The CQA Engineer will verify that anchor trenches have been constructed and backfilled according to project specifications and design drawings.

5.4.3 Geomembrane Placement

5.4.3.1 Field Panel Identification

The CQA Engineer will document that the Geomembrane Installer labels each field panel with an "identification code" (number or letter-number consistent with the layout plan) agreed upon by the Geomembrane Installer and CQA Engineer at the Geosynthetics CQA Meeting (see **Section 1.7.2**).

The Geomembrane Installer will establish a table or chart showing correspondence between roll or sheet numbers and field panel identification codes. This documentation shall be submitted to the CQA Engineer weekly for review and verification. The field panel identification code will be used for all quality control and quality assurance records.

5.4.3.2 Field Panel Placement

5.4.3.2.1 Location: The CQA Engineer will verify that field panels are installed at the location indicated in the Geomembrane Installer's layout plan, as approved or modified in **Section 5.4.3.1**.

5.4.3.2.2 Installation Schedule: The CQA Engineer will evaluate every change in the schedule proposed by the Geomembrane Installer and advise the Engineer on the acceptability of that change.

The CQA Engineer will record the identification code, location, and date of installation of each field panel.

5.4.3.2.3 Placement of Geomembrane: The CQA Engineer will verify that project specification related restrictions on placement of geomembrane are fulfilled. Additionally, the CQA Engineer will verify that the supporting soil has not been damaged by weather conditions.

5.4.3.2.4 Damage: The CQA Engineer will visually observe each panel, after placement and prior to seaming, for damage. The CQA Engineer will advise the Engineer which panels, or portion of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels which have been rejected will be marked and their removal from the work area recorded by the CQA Engineer. Repairs will be made according to procedures described in this section.

As a minimum, the CQA Engineer will document that:

- the panel is placed in such a manner that it is unlikely to be damaged; and
- any tears, punctures, holes, thin spots, etc. are either marked by the Geomembrane Installer for repair or the panel is rejected.

5.4.4 Field Seaming

5.4.4.1 Seam Layout

The Geomembrane Installer will provide the CQA Engineer with a seam layout drawing, i.e., a drawing of the area to be lined showing all expected seams. The CQA Engineer and Engineer will review the seam layout drawing and verify that it is consistent with the accepted state of practice and this CQA Manual.

A seam numbering system compatible with the panel numbering system will be agreed upon at the Geosynthetics CQA Meeting (see **Section 1.7.2**). An on-going written record of the seams and repair areas shall be maintained by the Geomembrane Installer with weekly review by the CQA Engineer.

5.4.4.2 Requirements of Personnel

The Geomembrane Installer will provide the CQA Engineer with a list of proposed seaming personnel and their experience records. This document will be reviewed by the CQA Engineer for compliance with project specifications.

5.4.4.3 Seaming Equipment and Products

Field seaming processes must comply with project specifications. Proposed alternate processes will be documented and submitted to the Engineer and CQA Engineer for their approval. Only seaming apparatus which have been specifically approved by make and model will be used. The CQA Engineer will submit all documentation to the Engineer for his concurrence.

5.4.5 Field Seam Control Tests

5.4.5.1 Trial Seams

A. Prior to production seaming, after four (4) hours of continuous seaming, and/or when significant changes in geomembrane or ambient temperature occurs, the Geomembrane Installer shall perform trial seams to verify that seaming conditions and procedures are adequate. Trial seams shall be performed by each operator of extrusion welders and by the primary operator of each wedge welder using seaming equipment to be used in production seaming.

B. Trial seams shall be made on appropriate sized pieces of identical or equivalent geomembrane material.

C. Hot wedge trial seams shall be approximately 72" x 12" with the seam centered lengthwise. Extrusion fillet trial seams shall be approximately 36" x 12" with the seam centered lengthwise. A minimum of four coupons shall be tested in peel and shear (two each) (ASTM D 6392) by the Geomembrane Installer using a field tensiometer. All coupons shall meet the minimum seam strength requirements as shown in the project specifications.

D. Each trial seam shall be assigned a number and the test results recorded in the appropriate log by the Geomembrane Installer. The CQA Engineer will observe all trial seams and compile all trial seam logs.

5.4.6 Field Seam Record Tests

5.4.6.1 Nondestructive Seam Continuity Testing

The Geomembrane Installer shall test and document all seams continuously over their full length using one of the following nondestructive seam tests. This testing shall be performed simultaneously with geomembrane deployment as the work progresses and not at the completion of all field seaming.

A. Vacuum Testing shall conform to ASTM D 5641 requirements.

B. Air Pressure Testing (for double seam with an enclosed space) shall conform to ASTM D 5820 requirements and the requirements listed in **Table 5.2**.

The CQA Engineer will observe the nondestructive testing on a full time basis to ensure conformance with this CQA Manual and the project specifications.

5.4.6.2 Field Destructive Seam Testing

A. The Geomembrane Installer shall obtain 12" x 30" (or longer as needed) samples of field seams with the seam centered lengthwise, suitable for testing, at an average frequency of one sample per 500 linear feet of seam. The sample shall be cut into two equal-length pieces, one for field destructive seam testing by the Geosynthetics Installer and one given to the CQA Engineer as an archive sample. The date, time, equipment, seam number, and seaming parameters will be marked on each sample and recorded by the CQA Engineer.

B. The Geomembrane Installer shall perform and document field destructive seam testing using a field tensiometer. A minimum of five coupons each will be tested in peel and shear (ASTM D 6392). Coupons shall meet the minimum seam strength requirements as shown in the project specifications.

C. The CQA Engineer or the Owner may require additional random samples to be taken for testing in areas which visually appear defective and not in accordance with the project requirements.

D. All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired in accordance with repair procedures described in this manual.

5.4.6.3 Geosynthetics CQA Laboratory Destructive Testing

A. The Geomembrane Installer shall obtain 12" x 30" (or longer as needed) samples of field seams with the seam centered lengthwise, suitable for testing, at an average frequency of one sample per day to confirm field destructive seam tests. The sample shall be cut into two equal-length pieces, both to be given to the CQA Engineer for laboratory destructive seam testing and as an archive sample. The date, time, equipment, seam number, and seaming parameters will be marked on each sample and recorded by the CQA Engineer.

B. Laboratory destructive test samples will be packaged and shipped to the Geosynthetics CQA Laboratory by the CQA Engineer in a manner that

will not damage the test sample.

C. A minimum of five coupons each will be tested in peel and shear (ASTM D 6392) by the Geosynthetics CQA Laboratory. Coupons shall meet the minimum seam strength requirements as shown in the project specifications.

D. All geomembrane destructive test samples that fail to meet project specifications will be saved and sent to the CQA Engineer for observation.

E. The CQA Engineer will review laboratory test results as soon as they become available.

5.4.6.4 Field Seam Record Test Failure

For noncomplying tests, the CQA Engineer will:

- observe continuity testing of the repaired areas performed by the Geomembrane Installer;
- confirm the record location, date, test unit number, name of tester, and compile the record of testing provided by the Geomembrane Installer;
- provide a walk-through inspection of all impacted seam areas and verify that the areas have been tested in accordance with the CQA Manual and project specifications; and
- verify that the Geomembrane Installer has marked repair areas with the appropriate color-coded marking pencil.

5.4.6.5 Defining Extent of Field Seam Record Test Failure

All defective seam test failures must be bounded by acceptable destructive tests. The CQA Engineer will document repair actions taken in conjunction with all seam test failures.

5.4.7 Repairs & Verification

5.4.7.1 Repair Procedures

A. All repair procedures shall be in accordance with the project specifications. The CQA Engineer will observe all repair procedures.

B. All surfaces shall be clean and dry at the time of the repair.

C. After an extrusion seam is made, no more than ¼ inch of abrasion shall be visible beyond the weld.

5.4.7.2 Repair Verification

A. Each repair shall be numbered and logged by the Geomembrane Installer.

B. Each repair shall be non-destructively tested by the Geomembrane Installer using the methods described above. Repairs which pass non-destructive testing shall be taken as an indication of an adequate repair.

C. Repairs more than 150 feet long may be of sufficient length to require destructive test sampling, at the discretion of the CQA Engineer. A failed test indicates that the repair shall be redone and retested until passing test results are achieved.

5.5 LINER SYSTEM ACCEPTANCE

The geomembrane component of the liner system will be accepted by the Owner when:

- the installation is finished;
- verification of the adequacy of all seams and repairs, including associated testing, is complete;
- CQA Engineer provides the Engineer with a final copy of the nondestructive test documentation, repair information, and as-built drawings, as submitted by the Geomembrane Installer;
- CQA Engineer provides the Engineer with a certification, submitted by the Geomembrane Installer that the geomembrane was installed in accordance with the Geomembrane Manufacturer's recommendations as well as the project drawings and project specifications; and
- all documentation of the installation is completed including the CQA Engineer's final report.

5.6 MATERIALS IN CONTACT WITH GEOMEMBRANES

The quality assurance procedures indicated in this subsection are only intended to assure that the installation of these materials does not damage the geomembrane. All reasonable measures to protect the geomembrane and provide additional quality assurance procedures are necessary to assure that systems built with these materials will be constructed to ensure proper performance.

5.6.1 Soils

Prior to placement, the CQA Engineer will visually confirm that all soil materials to be placed against the geomembrane comply with project specifications. The Geomembrane Installer will provide the CQA Engineer a written surface acceptance certificate in accordance with **Section 5.4.2**. All soil materials shall be placed and compacted in accordance with project specifications.

5.6.2 Sumps and Appurtenances

The CQA Engineer will verify that:

- installation of the geomembrane in appurtenance areas, and connection of the geomembrane to appurtenances have been made according to the project specifications;
- extreme care is taken while seaming around appurtenances since neither nondestructive nor destructive testing may be feasible in these areas; and
- the geomembrane or appurtenances have not been visibly damaged while making connections to appurtenances.

5.7 DEFICIENCIES

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies will be documented by the CQA Engineer. The Contractor shall correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer will observe all retests on repaired defects.

TABLE 5.1: CQA TESTING PROGRAM FOR GEOMEMBRANE MATERIAL APPROVAL

PROPERTY	TEST METHOD	TEST FREQUENCY
Thickness	ASTM D 5199/D 5994	100,000 ft^2 or 1 per Lot[1]
Density	ASTM D 1505/D 792	100,000 ft^2 or 1 per Lot[1]
Carbon Black Content	ASTM D 1603	100,000 ft^2 or 1 per Lot[1]
Carbon Black Dispersion	ASTM D 5596	100,000 ft^2 or 1 per Lot[1]
Tensile Properties:	ASTM D 6693 (Type IV)	
Tensile Strength at Yield		100,000 ft^2 or 1 per Lot[1]
Tensile Strength at Break		100,000 ft^2 or 1 per Lot[1]
Elongation at Yield		100,000 ft^2 or 1 per Lot[1]
Elongation at Break		100,000 ft^2 or 1 per Lot[1]
Tear Resistance	ASTM D 1004	100,000 ft^2 or 1 per Lot[1]

Notes:

1. Whichever provides the larger number of tests.

TABLE 5.2 AIR PRESSURE TEST REQUIREMENTS

MATERIAL	MIN. PRESSURE (PSI)	MAX. PRESSURE DROP (PSI) AFTER 5 MINUTES
30 Mil LLDPE	15	3
$\geq$ 60 Mil HDPE	25	3

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SECTION 6.0
LEACHATE MANAGEMENT SYSTEM CQA

6.1 INTRODUCTION

This section of the CQA Manual addresses the components of the leachate management system including components of the leachate collection system (LCS) (drainage aggregate, collection pipe, protective cover, and geosynthetic rain cover), leak detection system (LDS) (Phase 4A only), and the leachate transmission and storage system (sumps, transmission piping, manholes, valves, etc.). By reference to **Sections 7.0 and 8.0** of this CQA Manual, this section also addresses the geotextiles and drainage geocomposite that are components of the LCS. This section outlines the CQA program to be implemented with regard to material approval, construction monitoring, and resolution of problems.

6.2 LEACHATE MANAGEMENT SYSTEM MATERIAL APPROVAL

The CQA Engineer will verify that the following are provided and installed in accordance with the project drawings, specifications, and this CQA Manual.

6.2.1 Coarse Aggregate (Drainage Aggregate)

A. Receipt of Contractor's submittals on coarse aggregate.

B. Review of submittals for coarse aggregate for conformity to the project specifications.

C. Verify that coarse aggregate in stockpiles or at borrow sources conforms to the project specifications.

D. Conduct material control tests in accordance with **Table 6.1**.

6.2.2 Leachate Collection Media (Drainage Aggregate)

A. Receipt of Contractor's submittals on leachate collection media.

B. Review of submittals for leachate collection media for conformity to the project specifications.

C. Verify that collection media in stockpiles or at borrow sources conforms to the project specifications.

D. Conduct material control tests in accordance with **Table 6.1**.

6.2.3 High Density Polyethylene (HDPE) Pipe

A. Receipt of Contractor's submittals on HDPE pipe.

B. Review of submittals for HDPE pipe for conformity to the project specifications.

6.2.4 Geotextiles (Verify for each type of Geotextile)

The CQA program for geotextiles is presented in **Section 7.0** of this CQA Manual.

6.2.5 Drainage Geocomposite

The CQA program for drainage geocomposite is presented in **Section 8.0** of this CQA Manual.

6.2.6 Protective Cover

A. Review the proposed source of protective cover for conformance with the project specifications.

B. Conduct material control tests in accordance with **Table 6.1**.

6.2.7 Geosynthetic Rain Cover

A. Receipt of Contractor's submittals on Geosynthetic Rain Cover.

B. Review of submittals for Geosynthetic Rain Cover for conformity to the project specifications.

6.2.8 Sumps/Manholes/Leachate Storage

A. Receipt of Contractor's submittals on sumps/manholes/leachate storage.

B. Review of submittals for sumps/manholes/leachate storage for conformity to the project specifications.

6.2.9 Valves

A. Receipt of Contractor's submittals on valves.

B. Review of submittals for valves for conformity to the project specifications.

6.3 LEACHATE MANAGEMENT SYSTEM INSTALLATION

6.3.1 Leachate Collection System (LCS)

The CQA Engineer will allow installation of the LCS to proceed only after he has been provided certification of the installed HDPE geomembrane.

The CQA Engineer will monitor and document the construction of all LCS components for compliance with the project specifications. Monitoring the construction work includes the following:

- monitoring the minimum vertical buffer maintained between field equipment and the geomembrane;
- monitoring that the placement of the LCS components does not fold or damage the geomembrane or other underlying layers; and
- witness and verify the installation of collection piping and gravel columns.

6.3.2 Leachate Transmission and Storage System

The CQA Engineer will monitor and document the construction of all leachate transmission and storage system components for compliance with the project specifications. Monitoring the construction work includes the following:

- witness and verify the installation of transmission piping;
- witness and verify the leak testing of transmission piping; and
- witness and verify the leak testing of manholes, etc. (where applicable).

6.4 DEFICIENCIES

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies will be documented by the CQA Engineer. The Contractor shall correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer will observe all retests on repaired defects.

TABLE 6.1: CQA TESTING PROGRAM FOR LEACHATE MANAGEMENT SYSTEM

COMPONENT	PROPERTY	TEST METHOD	MINIMUM TEST FREQUENCY
CONTROL TESTS:			
Coarse Aggregate:	Gradation	ASTM C 136	5,000 CY
	Carbonate Content	ASTM D 3042	1 per source
Leachate Collection Media:	Gradation	ASTM C 136	5,000 CY
	Permeability[1]	ASTM D 2434	10,000 CY
	Carbonate Content	ASTM D 3042	1 per source
Protective Cover: (Soil Only - See Note 2)	Visual Classification	ASTM D 2488	Each Load
	Grain Size Analysis	ASTM D 422	5,000 CY per Each Soil

Notes:

1. Option for Failed Permeability Test:
   In the case of a failed permeability test value within 20% of the specified value, an additional three tests may be run on the proposed material. If all three tests pass, then the results from the first test can be discounted. Otherwise a different material or material from a different source shall be submitted. The cost for additional testing shall be borne solely by the Contractor.
2. If protective cover consists of additional leachate collection media, perform control tests in accordance with the requirements for leachate collection media.

SECTION 7.0
GEOTEXTILE CQA

7.1 INTRODUCTION

This section of the CQA Manual addresses geotextiles and outlines the CQA program to be implemented with regard to material approval, material control tests, repairs, and resolution of problems.

7.2 GEOTEXTILE MATERIAL APPROVAL

7.2.1 Geotextile Product Data

For each type of geotextile to be used, the CQA Engineer will review the Contractor's submittals for conformance with the project specifications.

7.2.2 Shipment And Storage

During shipment and storage, all geotextiles will be protected as required by the project specifications. The CQA Engineer will observe rolls upon delivery at the site.

7.2.3 Quality Control Certificates

Upon delivery, the CQA Engineer will:

- verify that the Manufacturer's quality control certificates have been provided at the specified frequency and that each certificate identified the rolls related to it; and

- review the Manufacturer's quality control certificates and verify that the certified properties meet the project technical specifications.

7.2.4 Geotextile Material Control Tests

Samples for material control tests, as shown on **Table 7.1**, will be obtained by the CQA Engineer at the indicated frequencies upon delivery of the geotextiles. Alternatively, samples may be randomly obtained at the manufacturing site by the CQA Engineer or representatives of the Geosynthetics CQA Laboratory.

Unless otherwise specified, samples will be 3 feet long by the roll width. The CQA Engineer will mark the machine direction on the samples with an arrow.

All material control tests will be performed by the Geosynthetics CQA Laboratory.

All test results must be available at the site prior to the deployment of all geotextiles. The

CQA Engineer will examine all results from laboratory testing.

7.2.4.1 Material Control Test Failure

The following procedure will apply whenever a sample fails a material control test:

A. The Geosynthetic Installer will replace the roll of geotextile that is in nonconformance with the project specifications with a roll that meets project specifications.

B. The Geosynthetic Installer will remove samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must both conform to project specifications. If either of these samples fail, then the next numerical roll will be tested until a passing roll is found. This additional testing will be at the expense of the Geosynthetic Installer. If either of the two closest rolls fail, the Engineer will dictate the frequency of additional testing.

The CQA Engineer will document actions taken in conjunction with material control test failures.

7.3 GEOTEXTILE INSTALLATION

7.3.1 Handling And Placement

The Geosynthetic Installer will handle and place all geotextiles in such a manner as required by the project specifications.

7.3.2 Seams And Overlaps

All geotextiles will be seamed or overlapped in accordance with project specifications or as approved by the CQA Engineer and Engineer.

7.3.3 Repairs

Any holes or tears in the geotextile will be repaired in accordance with the project specifications. The CQA Engineer will observe any repair.

7.3.4 Placement Of Overlying Materials

All soil materials located on top of a geotextile shall be placed in accordance with the project specifications.

7.4 DEFICIENCIES

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies will be documented by the CQA Engineer. The Contractor shall correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer will observe all retests on repaired defects.

TABLE 7.1: CQA TESTING PROGRAM FOR GEOTEXTILE MATERIAL APPROVAL

PROPERTY	TEST METHOD	TEST FREQUENCY
CONTROL TESTS:		
Tensile Properties	ASTM D 4632	100,000 ft^2 or 1 per Lot[1]
Puncture Resistance	ASTM D 4833	100,000 ft^2 or 1 per Lot[1]
Trapezoidal Tear Strength	ASTM D 4533	100,000 ft^2 or 1 per Lot[1]
Apparent Opening Size (AOS) (Type GT-S Geotextile Only)	ASTM D 4751	100,000 ft^2 or 1 per Lot[1]

Notes:

1. Whichever provides the larger number of tests.
2. CQA testing is not required for geotextiles placed outside of the containment area.

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SECTION 8.0
DRAINAGE GEOCOMPOSITE CQA

8.1 INTRODUCTION

This section of the CQA Manual addresses drainage geocomposite (DGC) and outlines the CQA program to be implemented with regard to material approval, material control tests, repairs, and resolution of problems.

8.2 DGC MATERIAL APPROVAL

8.2.1 DGC Product Data

The CQA Engineer will review the Contractor's submittals for conformance with the project specifications.

8.2.2 Shipment And Storage

During shipment and storage, all DGC will be protected as required by the project specifications. The CQA Engineer will observe rolls upon delivery at the site.

8.2.3 Quality Control Certificates

Upon delivery, the CQA Engineer will:

- verify that the Manufacturer's quality control certificates have been provided at the specified frequency and that each certificate identified the rolls related to it; and

- review the Manufacturer's quality control certificates and verify that the certified properties meet the project technical specifications.

8.2.4 DGC Material Control Tests

Samples for material control tests, as shown on **Table 8.1**, will be obtained by the CQA Engineer at the indicated frequencies upon delivery of the DGC. Alternatively, samples may be randomly obtained at the manufacturing site by the CQA Engineer or representatives of the Geosynthetics CQA Laboratory.

Unless otherwise specified, samples will be 3 feet long by the roll width. The CQA Engineer will mark the machine direction on the samples with an arrow.

All material control tests will be performed by the Geosynthetics CQA Laboratory.

All test results must be available at the site prior to the deployment of all DGC. The CQA

Engineer will examine all results from laboratory testing.

8.2.4.1 Material Control Test Failure

The following procedure will apply whenever a sample fails a material control test:

A. The Geosynthetic Installer will replace the roll of DGC that is in nonconformance with the project specifications with a roll that meets project specifications.

B. The Geosynthetic Installer will remove samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must both conform to project specifications. If either of these samples fail, then the next numerical roll will be tested until a passing roll is found. This additional testing will be at the expense of the Geosynthetic Installer. If either of the two closest rolls fail, the Engineer will dictate the frequency of additional testing.

The CQA Engineer will document actions taken in conjunction with material control test failures.

8.3 DGC INSTALLATION

8.3.1 Handling And Placement

The Geosynthetic Installer will handle and place all DGC in such a manner as required by the project specifications.

8.3.2 Stacking And Joining

When several layers of DGC are stacked, care should be taken to ensure that stacked DGC are placed in the same direction. Stacked DGC will never be laid in perpendicular directions to the underlying DGC (unless otherwise specified by the Engineer). The CQA Engineer will observe the stacking of DGC.

Adjacent rolls of DGC will be joined according to construction drawings and project specifications.

8.3.3 Repairs

Any holes or tears in the DGC will be repaired in accordance with the project specifications. The CQA Engineer will observe any repair.

8.3.4 Placement Of Overlying Materials

All soil materials located on top of DGC shall be placed in accordance with the project specifications.

8.4 DEFICIENCIES

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies will be documented by the CQA Engineer. The Contractor shall correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer will observe all retests on repaired defects.

TABLE 8.1: CQA TESTING PROGRAM FOR DGC MATERIAL APPROVAL

PROPERTY	TEST METHOD	TEST FREQUENCY
CONTROL TESTS:		
Thickness (geonet only)	ASTM D 5199	100,000 ft^2 or 1 per Lot[1]
Density (geonet only)	ASTM D 1505	100,000 ft^2 or 1 per Lot[1]
Ply Adhesion	ASTM D 413/ GRI GC7	100,000 ft^2 or 1 per Lot[1]
Transmissivity	ASTM D 4716[2]	1 per Resin Lot

Notes:

1. Whichever provides the larger number of tests.
2. Conduct tests for transmissivity in accordance with the conditions given in the project specifications.

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SECTION 9.0
GEOSYNTHETIC CLAY LINER (GCL) CQA

9.1 INTRODUCTION

This section of the CQA Manual addresses geosynthetic clay liner (GCL) and outlines the CQA program to be implemented with regard to material approval, material control tests, repairs, and resolution of problems.

9.2 GCL MANUFACTURER AND INSTALLER APPROVAL

The Contractor shall submit the qualifications of the GCL Manufacturer and the GCL Installer, as described in the specifications, to the CQA Engineer for approval.

9.3 GCL MATERIAL APPROVAL

9.3.1 GCL Product Data

The CQA Engineer will review the Contractor's submittals for conformance with the project specifications.

9.3.2 Shipment And Storage

During shipment and storage, GCL will be protected as required by the project specifications. The CQA Engineer will observe rolls upon delivery at the site.

9.3.3 Quality Control Certificates

Upon delivery, the CQA Engineer will:

- verify that the Manufacturer's quality control certificates have been provided at the specified frequency and that each certificate identified the rolls related to it; and
- review the Manufacturer's quality control certificates and verify that the certified properties meet the project technical specifications.

9.3.4 GCL Material Control Tests

Samples for material control tests, as shown on **Table 9.1**, will be obtained by the CQA Engineer at the indicated frequencies upon delivery of the GCL. Alternatively, samples may be randomly obtained at the manufacturing site by the CQA Engineer or representatives of the Geosynthetics CQA Laboratory.

Unless otherwise specified, samples will be 3 feet long by the roll width. The CQA

Engineer will mark the machine direction on the samples with an arrow.

All material control tests will be performed by the Geosynthetics CQA Laboratory.

All test results must be available at the site prior to the deployment of all GCL. The CQA Engineer will examine all results from laboratory testing.

9.3.4.1 Material Control Test Failure

The following procedure will apply whenever a sample fails a material control test:

A. The Geosynthetic Installer will replace the roll of GCL that is in nonconformance with the project specifications with a roll that meets project specifications.

B. The Geosynthetic Installer will remove samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must both conform to project specifications. If either of these samples fail, then the next numerical roll will be tested until a passing roll is found. This additional testing will be at the expense of the Geosynthetic Installer. If either of the two closest rolls fail, the Engineer will dictate the frequency of additional testing.

The CQA Engineer will document actions taken in conjunction with material control test failures.

9.4 GCL INSTALLATION

9.4.1 Handling And Placement

The Geosynthetic Installer will handle and place all GCL in such a manner as required by the project specifications.

9.4.2 Seams And Overlaps

All GCL will be seamed or overlapped in accordance with project specifications or as approved by the CQA Engineer and Engineer.

9.4.3 Repairs

Any holes or tears in the GCL will be repaired in accordance with the project specifications. The CQA Engineer will observe any repair.

9.4.4 Placement Of Overlying Materials

All soil materials located on top of the GCL shall be placed in accordance with the project specifications.

9.5 DEFICIENCIES

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies will be documented by the CQA Engineer. The Contractor shall correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer will observe all retests on repaired defects.

TABLE 9.1: CQA TESTING PROGRAM FOR GCL MATERIAL APPROVAL

PROPERTY	TEST METHOD	TEST FREQUENCY
CONTROL TESTS:		
Hydraulic Conductivity	ASTM D 5084/D 5887	100,000 ft^2 or 1 per Lot[1]
Bentonite Content	ASTM D 5993 (@ 0% moisture)	100,000 ft^2 or 1 per Lot[1]
Peel Strength	ASTM D 6496	100,000 ft^2 or 1 per Lot[1]

Notes:

1. Whichever provides the larger number of tests.

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SECTION 10.0
FINAL COVER SYSTEM CQA

10.1 INTRODUCTION

This section of the CQA Manual addresses the landfill gas (LFG) system, drainage aggregate and piping, and the vegetative soil layer of the final cover system. By reference to **Sections 5.0, 7.0, and 8.0** of this CQA Manual, this section also addresses the geomembrane, geotextiles, and drainage geocomposite that are included in the final cover system. This section outlines the CQA program to be implemented with regard to material approval, construction monitoring, and resolution of problems.

10.2 FINAL COVER SYSTEM MATERIAL APPROVAL

The CQA Engineer shall verify that the following are provided and installed in accordance with the project drawings, specifications, and this CQA Manual.

10.2.1 High Density Polyethylene (HDPE) Pipe

A. Receipt of Contractor's submittals on HDPE pipe.

B. Review of submittals for HDPE pipe for conformity to the project specifications.

10.2.2 Polyvinyl Chloride (PVC) Pipe

A. Receipt of Contractor's submittals on PVC pipe.

B. Review of submittals for PVC pipe for conformity to the project specifications.

10.2.3 Corrugated Polyethylene (CPE) Pipe

A. Receipt of Contractor's submittals on CPE pipe.

B. Review of submittals for CPE pipe for conformity to the project specifications.

10.2.4 LFG System Components

A. Receipt of Contractor's submittals on LFG system components.

B. Review of submittals for LFG system components for conformity to the project specifications.

10.2.5 Aggregates (Verify for each type of aggregate)

A. Receipt of Contractor's submittals on aggregates.

B. Review of submittals for aggregates for conformity to the project specifications.

C. Verify that aggregates in stockpiles or at borrow sources conform to the project specifications.

D. Conduct material control tests in accordance with **Table 10.1**.

10.2.6 Geomembrane

The CQA program for geomembranes is presented in **Section 5.0** of this CQA Manual.

10.2.7 Geotextiles

The CQA program for geotextiles is presented in **Section 7.0** of this CQA Manual.

10.2.8 Drainage Geocomposite

The CQA program for drainage geocomposite is presented in **Section 8.0** of this CQA Manual.

10.2.9 Vegetative Soil Layer

A. Review the proposed source of vegetative soil layer for conformance with the project specifications.

B. Conduct material control tests in accordance with **Table 10.1**.

10.3 FINAL COVER SYSTEM INSTALLATION

The CQA Engineer will monitor and document the construction of all final cover system components for compliance with the project specifications. Monitoring the construction work for the components of the final cover system includes the following:

- verify location and depth of LFG wells;
- verify location of all piping;
- monitoring the minimum vertical buffer maintained between field equipment and geosynthetics/piping; and
- monitoring that the placement of the final cover system components does not fold or damage the geosynthetics or other underlying layers.

10.4 DEFICIENCIES

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies will be documented by the CQA Engineer. The Contractor shall correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer will observe all retests on repaired defects.

TABLE 10.1: CQA TESTING PROGRAM FOR FINAL COVER SYSTEM

COMPONENT	PROPERTY	TEST METHOD	MINIMUM TEST FREQUENCY
CONTROL TESTS:			
Coarse Aggregate:	Gradation	ASTM C 136	5,000 CY
Vegetative Soil Layer:	Visual Classification	ASTM D 2488	Each Load
	Grain Size Analysis	ASTM D 422	5,000 CY
	Atterberg Limits	ASTM D 4318	5,000 CY

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Appendix A

Reference List of Test Methods

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JOHNSTON COUNTY LANDFILL

CQA MANUAL
APPENDIX A: REFERENCE LIST OF TEST METHODS

American Society American Society of Testing and Materials (ASTM):

ASTM C 136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
ASTM D 413	Standard Test Methods for Rubber Property - Adhesion to Flexible Substrate.
ASTM D 422	Standard Test Method for Particle Size Analysis of Soils.
ASTM D 698	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3).
ASTM D 792	Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
ASTM D 1004	Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
ASTM D 1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique.
ASTM D 1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
ASTM D 1603	Standard Test Method for Carbon Black in Olefin Plastics.
ASTM D 2167	Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
ASTM D 2216	Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
ASTM D 2434	Standard Test Method for Permeability of Granular Soils (Constant Head).
ASTM D 2488	Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

ASTM D 2937	Standard Test Method for Density of Soil in Place by the Drive Cylinder Method.
ASTM D 3042	Standard Test Method for Insoluble Residue in Carbonate Aggregates.
ASTM D 4318	Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
ASTM D 4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
ASTM D 4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
ASTM D 4643	Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method.
ASTM D 4716	Standard Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products.
ASTM D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile.
ASTM D 4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
ASTM D 4959	Standard Test Method for Determination of Water (Moisture) Content of Soil by Direct Heating Method.
ASTM D 5084	Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
ASTM D 5199	Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
ASTM D 5596	Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.
ASTM D 5641	Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.
ASTM D 5820	Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes.

ASTM D 5887	Standard Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter.
ASTM D 5993	Standard Test Method for Measuring Mass per Unit of Geosynthetic Clay Liners.
ASTM D 5994	Standard Test Method for Measuring Core Thickness of Textured Geomembrane.
ASTM D 6392	Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.
ASTM D 6496	Standard Test Method for Determining Average Bonding Peel Strength Between the Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners.
ASTM D 6693	Standard Test Method for Determining Tensile Properties of Nonreinforced Flexible Polyethylene and Nonreinforced Polypropylene Geomembranes.
ASTM D 6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

Geosynthetic Research Institute (GRI):

GRI GC7	Determination of Adhesion and Bond Strength of Geocomposites.

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Johnston County Landfill
Proposed C&D Landfill
Water Quality Monitoring Plan

Prepared For:
Johnston County
Department of Public Utilities
Smithfield, North Carolina

The Water Quality Monitoring Plan for this facility has been prepared by a qualified geologist who is licensed to practice in the State of North Carolina. The plan has been prepared based on knowledge of site conditions and familiarity with North Carolina solid waste rules and industry standard protocol. The Plan described herein should provide for the effective detection of a chronic release of hazardous constituents into ground and surface waters of the State, due to, or caused by past activities at the landfill.

Joan A. Smyth 10/27/05

Joan A. Smyth, P.G.
Project Hydrogeologist

NORTH CAROLINA LICENSED SEAL 1369 GEOLOGIST JOAN A SMYTH

October 2005

G.N. Richardson & Associates
Engineering and Geological Services
14 N. Boylan Avenue
Raleigh, North Carolina 27603

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1.0 Introduction

1.1 Plan Background

Johnston County, North Carolina, owns and has sequentially operated four separate, unlined sanitary landfill units since1973 under Solid Waste Facility Permit #51-01, one lined municipal solid waste landfill (Phase 5) under permit 51-02, and one double-lined MSW landfill (Phase 4A) under permit 51-03. The six distinct municipal solid waste disposal units are located on a single property off State Route 210 in Johnston County.

The lined C&D landfill is proposed as a "piggy-back" landfill being constructed over a portion of the sideslope of the unlined Phase 3 MSW landfill. This lined C&D landfill "piggy-back" design is proposed as a part of the presumptive remedy for the unlined Phase 3 MSW landfill. The liner system of the C&D landfill will prevent rainwater infiltration into the soil covered sideslopes of the unlined Phase 3 MSW landfill. This design, in conjunction with the double-lined Phase 4A MSW landfill will provide significant reduction in leachate generation from the Phase 3 landfill.

The lined C&D landfill is located east of Phase 3 and north of Phases 1 & 2. These three phases of unlined landfills have impacted groundwater in this portion of the site. Therefore, this groundwater monitoring plan is more comprehensive than most for C&D landfills in order to provide for monitorability at the C&D landfill site.

C&D Landfill Monitoring Network

GNRA proposes two groundwater monitoring wells located between unlined MSW landfill Phases 1 & 2, (CDMW-1 and CDMW-2), two wells located adjacent to the diabase dikes located in the C&D area (CDMW-3 and CDMW-4), three downgradient nested pairs (CDMW-5/CDMW-5d, and CDMW-8/CDMW-8d and CDMW-9/CDMW9d), a downgradient shallow well (CDMW-6), a side gradient well (CDMW-7).

Additionally, since this is a lined C&D facility, leachate samples from the leachate collection system will be monitored semi-annually for the same Appendix I constituents that ground water is monitored for.

This Water Quality Monitoring Plan (WQMP) has been prepared to meet the field sampling and laboratory analysis requirements of the site. The WQMP details field and laboratory protocols that must be followed to meet the data objectives for the site.

1.2 Purpose & Scope

This WQMP has been designed to insure that accurate and representative field and laboratory results are obtained for all ground and surface water quality monitoring points. The WQMP addresses the following subjects:

- Ground water sample collection
- Surface water sample collection
- Sample preservation and shipment
- Laboratory analytical procedures
- Sample Chain-of-custody control
- Quality assurance/quality control programs

The methods and procedures described in the following sections are intended to facilitate the collection of true and representative samples and test data. Field procedures are presented in **Sections 3.0 through 7.0** in their general order of implementation. Equipment requirements for each field task are presented within the applicable section. Laboratory procedures, quality assurance methods and record keeping requirements are presented in **Sections 7.0 and 8.0**.

Strict adherence to these procedures stipulated in this plan is required. Any variations from these procedures should be throughly documented in the assessment report.

1.3 Sampling Program Overview

The ground water monitoring well designations, completion type, installation information and analytical requirements are included as **Table 1**. The surface water monitoring station designations, locations, sources and sampling frequency are included as **Table 2**.

2.0 Ground Water Sample Collection

This section presents details of the procedures and equipment required to perform ground water field measurements and sampling from monitoring wells during each monitoring event. A description of proposed ground water monitoring well locations and completion details are presented in **Table 1**. Ground water monitoring well locations for each Phase are shown in **Figure 1**.

2.1 Water Level Measurements

Static water level and total depth to the bottom will be measured in each well prior to any purging or sampling activities. Static water level and well depth measurements are necessary to calculate the volume of stagnant water in the well prior to purging. Additionally these measurements provide a field check on well integrity, degree of siltation, and are used to prepare potentiometric maps, calculate aquifer flow velocities and monitor changes in site hydrogeologic conditions.

Upon opening each well, new latex or nitrile surgical gloves will be donned. New gloves will be worn when taking water level measurements at each well. Appropriate measures will be taken during all measurement activities to prevent soils, decontamination supplies, precipitation, and other potential contaminants from entering the well or contacting clean equipment.

An electronic water level indicator will be used to accurately measure depth to ground water in each well and/or piezometer. Ground water depths will be measured to a vertical accuracy of 0.01 feet relative to established wellhead elevations. Each well will have a permanent, easily identified reference point on the lip of the well riser from which all water level measurements will be taken. The elevation of the reference point will be established by a Registered Land Surveyor.

The electronic water level indicator will be constructed of inert materials such as stainless steel and Teflon. Between well measurements the device will be thoroughly decontaminated by washing with non-phosphate soap and triple rinsing with deionized water to prevent cross contamination from one well to another.

The following measurements will be recorded in a dedicated field book prior to sample collection:

- Well Identification
- Depth to static water level and well bottom (to the nearest 0.01 foot)
- Height of water column in the riser (based upon known depth of well)
- Condition of wellhead protective casing, base pad and riser
- Changes in condition of well and surroundings.

2.2 Monitor Well Evacuation

Water accumulated in each well may be stagnant and unrepresentative of surrounding aquifer conditions, and therefore must be removed to insure that fresh formation water is sampled. Each well will be purged of standing water in the well casing following the measurement of the static water level.

New latex or nitrile surgical gloves will be donned for all well purging and sampling activities and whenever handling decontaminated field equipment. Appropriate measures will be taken during all measurement, purging and sampling activities to prevent surface soils, decontamination supplies, precipitation, and other potential contaminants from entering the well or contacting cleaned equipment.

The volume of standing water in the well riser and screen will be calculated immediately before well evacuation during each monitoring event. A standing water volume will be calculated for each well using measured static water level, well depth and well casing diameter according to the following equation:

$$V = (TD - SWL) \times C$$

Where: V = One well volume

TD = Total depth of the well (in feet)

SWL = Static water level (in feet)

C = Volume constant for given well diameter (gallons/foot)

C = 0.163 gal/ft for two-inch wells.

C = 0.653 gal/ft for four-inch wells.

After the volume of standing water within the casing is established, a minimum of three to five well casing volumes of water will be evacuated from each well that is not outfitted with a MicroPurge ™ system.

New, disposable bailers with either double or bottom check-valves will be used to purge each well if the MicroPurge system is not used. Disposable purge bailers will be constructed of fluorocarbon resin (Teflon) suitable for the well and ground conditions. Each bailer will be certified factory-cleaned according to approved EPA protocol and remain sealed in a plastic sleeve until use. A new Teflon-coated stainless steel, inert mono-filament line or nylon cord will be used for each well to retrieve the bailers.

Wells will be purged at a rate that will not cause recharge water to be excessively agitated or cascade through the screen. Care will also be taken to minimize disturbance to the well sidewalls and bottom which could result in the suspension of silt and fine particulate matter. The volume of water purged from each well and the relative rate of recharge will be documents in sampling field notes. Wells which are of very low recharge rates will be purged once until dry. Damaged, dry or low yielding, and high turbidity wells will noted for reconsideration before the next sampling event.

Purge water will be managed to prevent possible soil and surface water contamination. Well site management options may include temporary containment and disposal as leachate or portable activated carbon filtration.

There are several wells on-site that are outfitted with MicroPurge™ pumps. All MicroPurge™ pumps are constructed of stainless steel and teflon components and are equipped with teflon lined

tubing from the pump to the surface of the well. These pumps have been installed to maximize pump efficiency and data reliability.

Wells that are outfitted with the MicroPurge™ system T1200M pumps will be developed until the field parameters of temperature, pH and Conductivity stabilize to within 10%. The use of the MicroPurge low-flow system allows a sample to be collected from a discreet interval of the well, thus limiting the amount of purging necessary. The pumps operate at a flowrate of approximately 200 ml/min during purging. The stabilization of field parameters indicates that water from the formation is being removed. A "Flow Cell - FC4000" is used to continuously monitor the field parameters of the purge water. This cell evaluates the pH, temperature, and conductivity on a constant basis and provides an ongoing continuous readout of the parameter levels. Once three readings taken 3 to 5 minutes apart have stabilized to within 10% of each other, a sample may be immediately collected from the pump. The pumping rate during sampling shall be 100 ml/min.

Durable, non-dedicated equipment to be lowered into the well (such as water level indicators) will be thoroughly decontaminated before each use. Equipment shall be disassembled to the degree practical, washed with (non-phosphate) soapy potable tap water, and triple rinsed using de-ionized water. Detailed equipment decontamination procedures are detailed in **Section 2.6**.

2.3 Ground Water Sample Collection

After purging activities are complete, ground water samples will be collected for laboratory analysis. Additional care commensurate with the importance of this stage will be taken. All monitoring wells should be sampled in as short a time period as possible, generally within 48 hours.

Sampling will occur within 24 hours of the purging of each well and as soon after well recovery as possible. Wells which fail to recharge or produce an adequate sample volume within 24 hours of purging will be sampled and a notation as to the amount of elapsed time since purging will be placed in the "notes" section of the chain of custody sheet and in the field notes for future evaluation. If particular wells are consistently slow in recharging, a remedy should be proposed for the problem.

Field measurements of temperature, pH, specific conductivity and turbidity will be made immediately prior to sampling each monitoring point. The field test specimens will be collected with the sampling bailer and placed in a clean, non-conductive glass or plastic container for observation. The calibration of the pH, temperature, conductivity and turbidity meters will be completed according to the manufacturers' specifications and consistent with Test Methods for Evaluating Solid Waste -Physical/Chemical Methods (SW-846). A pocket thermometer and litmus paper will be available in case of meter malfunction.

Each well outfitted with a dedicated MicroPurge™ pump will be sampled using the pump immediately upon completion of purging. Field measurements of pH, temperature and conductivity will be collected at the time of sample collection. The flowrate of pumping at the time of sampling shall be 100 ml/min or less.

Each well without a dedicated pump will be sampled using a new, factory-cleaned, disposable Teflon bailer with bottom check-valve and sample discharge mechanism. A new segment of Teflon-coated stainless steel wire, inert mono-filament line or nylon cord will be used to lower and retrieve each bailer. The bailer will be lowered into each well to the point of ground water contact, then allowed to fill as it sinks below the water table. Bottom contact will be avoided in order to avoid suspending sediment in the samples. The bailer will be retrieved and emptied in a manner which minimizes sample agitation.

Samples will be transferred directly from the Teflon bailer into a sample container that has been specifically prepared for the preservation and storage of compatible parameters. A bottom emptying device provided will be used to transfer samples from bailer to sample container. The generation air bubbles and sample agitation will be minimized during bailer discharge.

Ground water samples will be collected and contained in the order of volatilization sensitivity. Initially, only purgeable organics and total metals specimens will be collected for laboratory analysis. Subsequently, other analytical methods may required. When collected, the following order of sampling will be observed:

- Initial measurements of pH, temperature, conductivity and turbidity
- Volatile and Purgeable Organics
- Base Neutral and Acid Extractable Organics
- Total Metals
- Final measurements of pH, temperature, conductivity and turbidity

All samples will be collected and analyzed in an **unfiltered** state during all sampling events.

All reusable sampling equipment including water level probes, pH/conductivity meters, interface probes, and filtering pumps which might contact aquifer water or samples will be thoroughly decontaminated between wells by washing with non-phosphate soapy, de-ionized water and triple rinsing with deionized water. Detailed equipment decontamination procedures are detailed in Section 2.6.

2.4 Field Quality Assurance

Field and trip blanks will be prepared, handled and analyzed as ground water samples to ensure cross-contamination has not occurred. One set of trip blanks, as described later in this document, will be prepared before leaving the laboratory to ensure that the sample containers or handling processes have not affected the quality of the samples. One set of field (equipment) blanks will be created in the field at the time of sampling to ensure that the field conditions, equipment, and handling during sampling collection have not affected the quality of the samples. A duplicate ground water sample may be collected from a single well as a check of laboratory accuracy. Blanks and duplicate containers, preservatives, handling, and transport procedures for surface water samples will be identical to those noted for ground water samples.

2.5 Sample Containers

Sample containers will be provided by the laboratory for each sampling event. Containers must be either new and factory-certified analytically clean by the manufacturer, or cleaned by the laboratory prior to shipment for sampling. Laboratory cleaning methods will be based on the bottle type and analyte of interest.

2.6 Equipment Decontamination

All non-dedicated equipment (such as water level meter) that will come in contact with the well casing and water will be decontaminated. The procedure for decontaminating non-dedicated equipment is as follows:

1. Phosphate-free soap and tap water wash
2. Deionized or distilled water rinse
3. Isopropyl alcohol rinse
4. Deionized or distilled water rinse and air dry
5. Aluminum foil wrap with shiny side out

3.0 Surface Water Sample Collection

This section present details of the procedures and equipment required to perform surface water field measurements and sampling from springs, streams and ponds during each monitoring event. A description of proposed surface water monitoring station locations is presented in **Table 2**. The proposed surface water monitoring station locations are shown in **Figure 2**.

3.1 Surface Water Level Observations

Surface water quality analyses are particularly sensitive to site hydrologic conditions and recent precipitation events. Water levels may fluctuate drastically in comparison the ground water table and may result in either diluting or increasing contaminant loadings. The scheduling of sampling events and the interpretation surface water data must take into account climatic, recent weather and sampling station conditions.

Surface water level and sampling station conditions will be observed one day prior to, and during each sampling event. Surface water observations will include the flood stage in streams, seasonal base flow conditions, and confirm location and timing for meaningful surface water quality sampling. The following objective observations will be recorded in a dedicated field book prior to sample collection:

- Sample location designation
- Relative stream water level

- Surface water clarity
- Rate of flow and degree of stagnation
- Physical conditions of sampling station
- Changes in surface monitoring station conditions and surroundings.

Modifications to surface sampling station conditions may be required prior to each sampling event. These modifications may include the removal of surface and submerged debris, slightly deepening the station to allow sample container immersion, or channeling/piping to consolidate local discharge. When modifications are required, sufficient time will be allowed for settlement of suspended solids between the disturbance and sample collection. A minimum settling period of four hours prior to sampling will be observed.

3.2 Surface Water Sample Collection

Surface water samples will be obtained from areas of minimal turbulence and aeration. New latex or nitrile surgical gloves will be donned prior to sample collection. The following procedure will be implemented regarding sampling of surface waters:

1. Put on new latex or nitrile surgical gloves.
2. Hold the bottle in the bottom with one hand, and with the other, remove the cap.
3. Push the sample container slowly into the water and tilt up towards the current to fill. A water depth of six inches is generally satisfactory. Care will be taken to avoid breaching the surface or losing sample preservatives while filling the container.
4. If there is little current movement, the container should be moved slowly, in a lateral, side to side direction, with the mouth of the container pointing upstream.

Temperature, pH, specific conductivity and turbidity will be taken at the start of sampling as a measure of field conditions and check on the stability of the water samples over time. Measurements of temperature, pH, specific conductivity and turbidity will be recorded for all surface water samples. The calibration of the pH, temperature, conductivity , and turbidity meters will be completed at the beginning of each sampling event, according to the manufacturers'

specifications and consistent with Test Methods for Evaluating Solid Waste - Physical/Chemical Methods (SW-846).

Surface water samples will be collected and contained in the order of volatilization sensitivity of the parameters as follows:

- Measurements of pH, temperature, conductivity and Turbidity
- Volatile and Purgeable Organics
- Base Neutral and Acid Extractable Organics
- Total Metals

All surface water samples will be collected in an unfiltered state.

All field meters which might contact surface water samples will be thoroughly decontaminated between stations by washing with non-phosphate soapy, de-ionized water and triple rinsing with deionized water.

One surface water samples will be collected at this site (shown on **Figure 2** and listed in **Table 2**). Samples will be collected directly from the station in the container that has been specifically prepared for the preservation and storage of compatible parameters. Samples will be collected in a manner that assures minimum agitation. Additional blanks and duplicate samples will not be taken with the surface water samples.

Sample containers shall be prepared and provided by the laboratory for each surface water sampling event. Each sample containers' preparation and preservatives shall be the same as those utilized for ground water sampling and addressed previously in Section 2.5.

4.0 Field QA/QC Program

Field Quality Assurance/Quality Control (QA/QC) requires the routine collection and analysis of trip blanks to verify that the handling process has not affected the quality of the samples. Any contaminants found in the trip blanks could be attributed to:

1) interaction between the sample and the container,
2) contaminated source water, or
3) a handling procedure that alters the sample.

The laboratory will prepare a trip blank by filling each type of sample bottle with distilled or deionized water. Trip blanks will be placed in bottles of the specific type required for the analyzed parameters and taken from a bottle pack specifically assembled by the laboratory for each ground water sampling event. Trip blanks will be taken prior to the sampling event and transported with the empty bottle packs. The blanks will be analyzed for volatile and purgeable organics only.

The concentration levels of any contaminants found in the trip blank will be reported but will not be used to correct the ground water data. In the event that elevated parameter concentrations are found in a blank, the analysis will be flagged for future evaluation and possible re-sampling.

All field instruments utilized to measure ground water characteristics will be calibrated prior to entering the field, and recalibrated in the field as required, to insure accurate measurement for each sample. The specific conductivity and pH meter shall be recalibrated utilizing two prepared solutions of known concentration in the range of anticipated values (between 4 and 10). A permanent thermometer, calibrated against a National Bureau of Standards Certified thermometer, will be used for temperature meter calibration. The turbidity meter will be calibrated using Lucite standard blocks provided by the manufacturer.

5.0 Sample Preservation and Shipment

Methods of sample preservation, shipment, and chain-of-custody procedures to be observed between sampling and laboratory analysis are presented in the following sections.

5.1 Sample Preservation

Proper storage and transport conditions must be maintained in order to preserve the integrity of samples between collection and analysis. Wet ice will be used to cool and preserve samples, as directed by the analytical laboratory. Samples will be maintained at a temperature of 4° C. Dry ice is not to be used.

Pre-measured chemical preservatives will be provided in the sample containers provided by the analytical laboratory. Hydrochloric acid will be used as a chemical stabilizer and preservative for volatile and purgeable organic specimens. Nitric acid will be used as the preservative for samples for metals analysis.

Upon collection, samples will be placed on ice in high impact polystyrene coolers and cooled to a temperature of 4°C. Samples will be packed and/or wrapped in plastic bubble wrap to inhibit breakage or accidental spills. Chain-of-Custody control documents will be placed in a waterproof pouch and sealed inside the cooler with the samples for shipping. Tape and/or custody seals shall be placed on the outside of the shipping coolers, in a manner to prevent and detect tampering with the samples.

Samples shall be delivered to the analytical laboratory within a 24-hour period in person or using an overnight delivery service to insure holding times are not exceeded. Shipment and receipt of samples will be coordinated with the laboratory.

Chain-of-Custody control will be maintained from sampling through analysis to prevent tampering with analytical specimens. Chain-of-Custody control procedures for all samples will consist of the following:

1. Chain-of-Custody will originate at the laboratory with the shipment of prepared sample bottles and a sealed trip blank. Identical container kits will be shipped by express carrier to the sampler or site or picked up at the laboratory in sealed coolers.

2. Upon receipt of the sample kit, the sampler will inventory the container kit and check its consistency with number and types of containers indicated in the Chain-of-Custody forms and required for the sampling event.

3. Labels for individual sample containers will be completed in the field, indicating the site, time of sampling, date of sampling, sample location/well number, and preservation methods used for the sample.

4. Collected specimens will be placed in the iced coolers and will remain in the continuous possession of the field technician until shipment or transferral as provided by the Chain-of-Custody form has occurred. If continuous possession can not be maintained by the field technician, the coolers will be temporarily sealed and placed in a secured area.

5. Upon delivery to the laboratory, samples will be given laboratory sample numbers and recorded into a logbook indicating client, well number, and date and time of delivery. The laboratory director or his designee will sign the Chain-of-Custody control forms and formally receive the samples. The field technician, project manager and the laboratory director will work together to insure that proper refrigeration of the samples is maintained.

6. Copies of the complete Chain-of-Custody forms will be placed in the laboratory's analytical project file and attached to the laboratory analysis report upon completion.

Chain-of-Custody forms will be used to transfer direct deliveries from the sampler to the laboratory. A coded, express delivery shipping bill shall constitute the Chain-of Custody between the sampler and laboratory for overnight courier deliveries.

6.0 Field Logbook

The field technician will keep an up-to-date logbook documenting important information pertaining to the technician's field activities. The field logbook will document the following:

- Site Name and Location
- Date and Time of Sampling
- Climatic Conditions During Sampling Event
- Sampling Point/Well Identification Number
- Well Static Water Level
- Height of Water Column in Well
- Purged Water Volume and Well Yield (High or Low)
- Presence of Immiscible Layers and Detection Method
- Observations on Purging and Sampling Event
- Time of Sample Collection
- Temperature, pH, Turbidity, and Conductivity Readings
- Signature of Field Technician.

7.0 Laboratory Analysis

The ground and surface water parameters to be analyzed will be those specified in Table 1. These will include field indicators of water quality (pH, conductivity, temperature and turbidity) and selected purgeable organic as listed in Appendix I and Appendix II of 40 CFR.258 and 15 RCRA metals constituents (total metals analysis). All analytical methods are taken from Test Methods For Evaluating Solid Waste - Physical/Chemical Methods (SW-846) or Methods For the Chemical Analysis of Water and Wastes and will be consistent with DSWM's policies regarding analytical methods and PQLs. Analysis will be performed by a laboratory certified by the North Carolina DENR for the analyzed parameters.

Formal environmental laboratory Quality Assurance/Quality Control (QA/QC) procedures are to be utilized at all times. The owner/operator of the landfill is responsible for selecting a laboratory contractor and insuring that the laboratory is utilizing proper QA/QC procedures. The laboratory must have a QA/QC program based upon specific routine procedures outlined in a written laboratory Quality Assurance/Quality Control Manual. The QA/QC procedures listed in the manual shall provide the lab with the necessary assurances and documentation that accuracy and precision goals are achieved in all analytical determinations. Internal quality control checks shall be undertaken regularly by the lab to assess the precision and accuracy of analytical procedures.

During the course of the analyses, quality control data and sample data shall be reviewed by the laboratory manager to identify questionable data and determine if the necessary QA/QC requirements are being followed. If a portion of the lab work is subcontracted, it is the responsibility of the contracted laboratory to verify that all subcontracted work is completed by certified laboratories, using identical QA/QC procedures.

8.0 Data Evaluation

Copies of all laboratory results and water quality reports for the Johnston County Landfill will be kept at the Johnston County Landfill office. Reports summarizing all ground water quality results and data evaluation will be submitted to the DSWM for each sampling event. Upon receipt of each monitoring event's data, the water quality database of analyses will be updated.

Methods to evaluate the data are taken from North Carolina Solid Waste Rules and the EPA RCRA Ground Water Monitoring Technical Guidance Documents. There is existing ground water impact at the site due to unlined MSW Phases 1 & 2 and Phase 3. Therefore, statistical analyses will be performed for this C&D landfill to determine if contaminant levels are increasing due to possible impact from the C&D landfill. As there is existing impact, intra-well statistical analyses will be performed on laboratory data from ground water samples.

The North Carolina Solid Waste Rules provide several methods for statistical analysis of ground water data. These methods are:

1. Parametric Prediction Intervals
2. Non-Parametric Prediction Intervals
3. Tolerance prediction interval
4. Control chart
5. An alternative statistical test method that meets the performance standards of 40 CFR 258.53 (h)

The choice of appropriate methods for data analysis and presentation, including statistical tests, depends on the type of monitoring, the nature of the data, and the proportion of values in the data set that are below detection limits. The statistical analysis will be conducted separately for each detected organic constituent based on the EPA's Statistical Analysis of Ground Water Monitoring Data at RCRA Facilities, Interim Final Guidance Document (1989) and Addendum to the Interim Final Guidance Document (1992). Any statistical analyses will be performed in general accordance methods outlined in the North Carolina State Regulations 15A NCAC 13B.1632.

9.0 Record Keeping and Reporting

9.1 Sampling Reports

Copies of all laboratory analytical data will be forwarded to the DWM within 45 calendar days of the sample collection date. The analytical data submitted will specify the date of sample collection, the sampling point identification and include a map of sampling locations. Should a significant concentration of contaminants be detected in ground and surface water, as defined in North Carolina Solid Waste Rules, Ground Water Quality Standards, or Surface Water Quality Standards, the owner/operator of the landfill shall notify the DWM and will place a notice in the landfill records as to which constituents were detected.

9.2 Well Abandonment/Rehabilitation

Should wells become irreversibly damaged or require rehabilitation, the DWM shall be notified. If monitoring wells and/or piezometers are damaged irreversibly they shall be abandoned under the direction of the DWM. The abandonment procedure in unconsolidated materials will consist of over-drilling and/or pulling the well casing and plugging the well with an impermeable, chemically-inert sealant such as neat cement grout and/or bentonite clay. For bedrock well completions the abandonment will consist of plugging the interior well riser and screen with an impermeable neat cement grout and/or bentonite clay sealant.

9.3 Additional Well Installations

The data will be analyzed to verify the correct placement of wells and determine locations for future monitoring wells, if necessary. Any additional well installations will be carried out in accordance with DWM directives. If the potentiometric maps reveal that the depths, location, or number of wells is insufficient to monitor potential releases of solid waste constituents from the solid waste management area, new well locations and depths will be submitted to the DWM for approval.

All monitoring wells shall be installed under the supervision of a geologist or engineer who is registered in North Carolina and who will certify to the DWM that the installation complies with the North Carolina Regulations. Upon installation of future wells the documentation for the construction of each well will be submitted by the registered geologist or engineer within 30 days

after well construction. Plans to install MicroPurge™ pumps in any additional well installed on-site shall be submitted to DSWM for approval prior to pump installation.

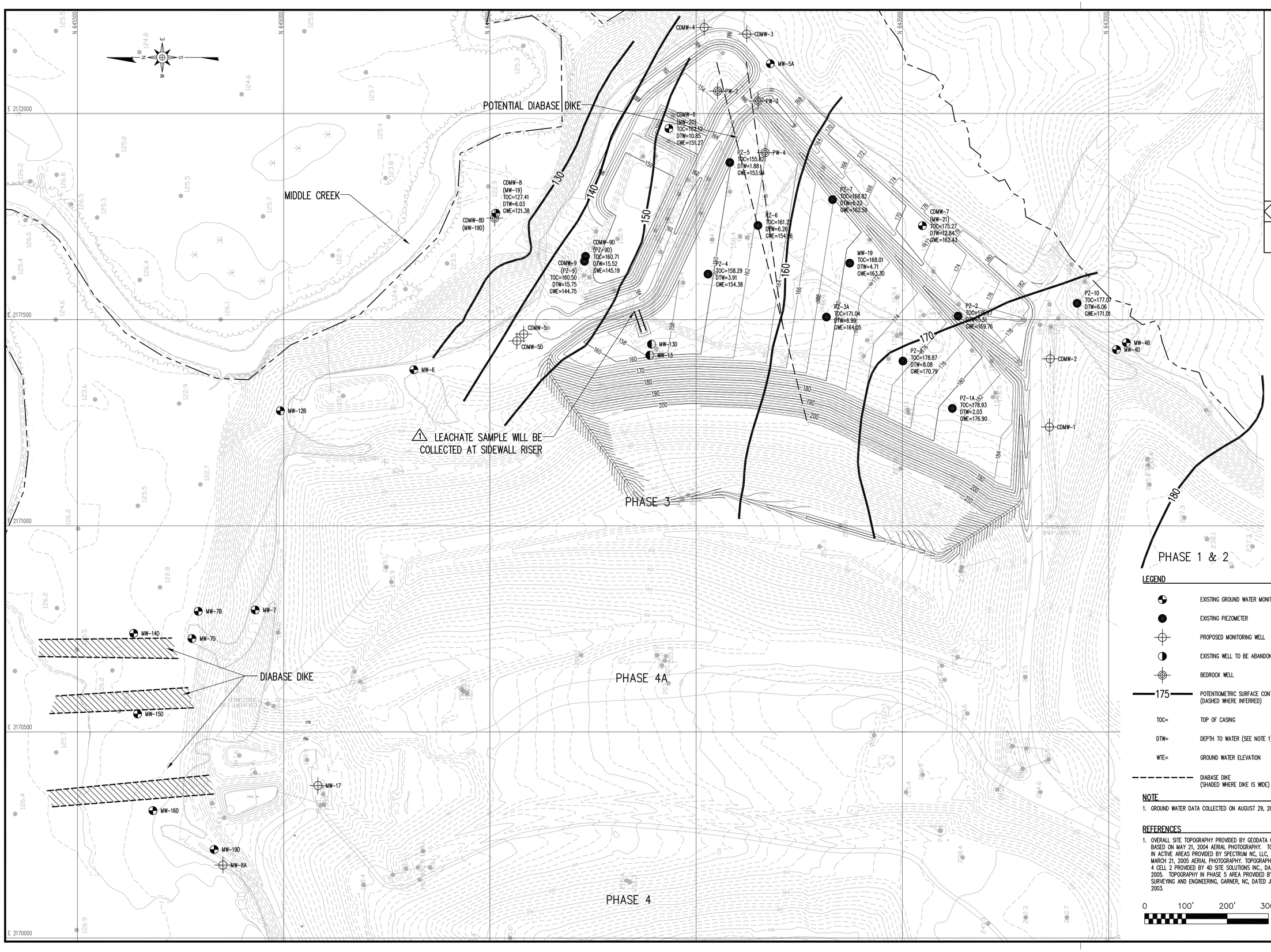
9.4 Implementation Schedule

This program is currently in place and being utilized at the site, with the exception of the addition of MW-8a, MW-14d, MW-15d, MW-16d and MW-17 and the leachate samples. These wells have also been proposed in a letter from GNRA to NCDENR dated July 18, 2001 regarding a recent geophysical evaluation of portions of the site and the proposed installation of additional wells. These well installations will be implemented upon approval from NCDENR.

Table 1
Ground Water Monitoring Well Network
Johnston County Landfill
Johnston County, North Carolina
Proposed C&D Landfill

Monitoring Well	Completion Type	Associated Wells	Screened Interval	Monitoring Program
CDMW-1	Shallow	none	TBD	Appendix I List
CDMW-2	Shallow	none	TBD	Appendix I List
CDMW-3	Shallow	none	TBD	Appendix I List
CDMW-4	Deep	none	TBD	Appendix I List
CDMW-5	Shallow	CDMW-5d	TBD	Appendix I List
CDMW-5d	Shallow	CDMW-5	TBD	Appendix I List
CDMW-6	Shallow	none	TBD	Appendix I List
CDMW-7	Deep	none	TBD	Appendix I List
CDMW-8	Shallow	CDMW-8d	TBD	Appendix I List
CDMW-8d	Deep	CDMW-8	TBD	Appendix I List
CDMW-9	Shallow	CDMW-9d	TBD	Appendix I List
CDMW-9d	Deep	CDMW-9	TBD	Appendix I List

Notes: 1.) Well locations shown on WQMP Figure 1
2.) TBD = To Be Determined



LEGEND

- EXISTING GROUND WATER MONITORING WELL
- EXISTING PIEZOMETER
- PROPOSED MONITORING WELL
- EXISTING WELL TO BE ABANDONED
- BEDROCK WELL
- 175 — POTENTIOMETRIC SURFACE CONTOUR (DASHED WHERE INFERRED)
- TOC= TOP OF CASING
- DTW= DEPTH TO WATER (SEE NOTE 1)
- WTE= GROUND WATER ELEVATION
- DIABASE DIKE (SHADED WHERE DIKE IS WIDE)

NOTE

1. GROUND WATER DATA COLLECTED ON AUGUST 29, 2005.

REFERENCES

1. OVERALL SITE TOPOGRAPHY PROVIDED BY GEODATA CORPORATION, BASED ON MAY 21, 2004 AERIAL PHOTOGRAPHY. TOPOGRAPHY IN ACTIVE AREAS PROVIDED BY SPECTRUM NC, LLC, BASED ON MARCH 21, 2005 AERIAL PHOTOGRAPHY. TOPOGRAPHY OF PHASE 4 CELL 2 PROVIDED BY 4D SITE SOLUTIONS INC., DATED JUNE 2, 2005. TOPOGRAPHY IN PHASE 5 AREA PROVIDED BY SOUTHMND SURVEYING AND ENGINEERING, GARNER, NC, DATED JUNE 16, 2003.

0 100' 200' 300'

NO.	DATE	REVISION
1	2/20/06	ADDED LEACHATE SAMPLE LOCAION CALLOUT

G. N. RICHARDSON & ASSOCIATES, INC.
Engineering and Geological Services
14 N. Boylan Ave. Raleigh, N.C. 27603
ph: 919-828-0577 fax: 919-828-3899
www.gnra.com

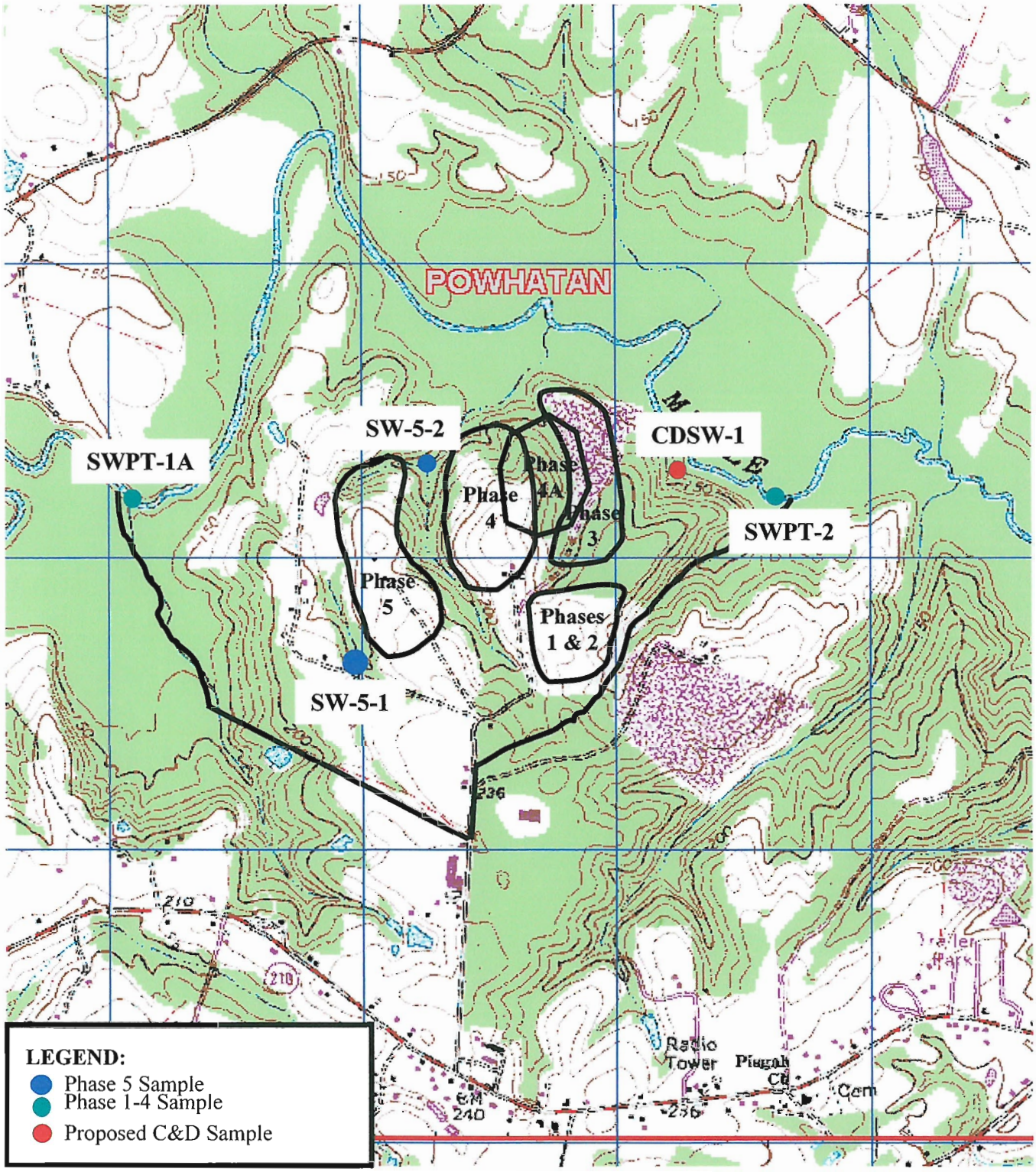
SEAL

SEAL

PROJECT TITLE:
JOHNSTON COUNTY LANDFILL
SMITHFIELD, NORTH CAROLINA

DRAWING TITLE:
POTENTIOMETRIC SURFACE MAP
AUGUST 2005 DATA
WITH PROPOSED
WELL LOCATIONS

DESIGNED BY:	DRAWN BY:
J.A.S.	C.T.J.
CHECKED BY:	PROJECT NO.:
	JOHN-23
SCALE:	DATE:
AS SHOWN	OCT. 2005
FILE NAME	
JOHN-D0385A	
SHEET NO.	DRAWING NO.
	FIG. 1



Surface Water Sampling Locations

Johnston County Landfill

Smithfield, North Carolina

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fax: 919-828-3899

SCALE:	DRAWN BY:	CHECKED BY:	DATE:	PROJECT NO.	FIGURE NO.	FILE NAME
NTS	CJ	JAS	11/3/05	Johnston-23	2	John sw loc.ppt