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74-07	3/16/09	DIN 7030

David Garrett & Associates
Engineering and Geology

March 16, 2009

Ms. Donna Wilson
NC DENR Division of Waste Management
Solid Waste Section
401 Oberlin Road
Raleigh, North Carolina, 27611

RE: **Response to Review Comments**
C&D Landfill, Inc. CDLF Phase 2
Pitt County, North Carolina
Solid Waste Permit No. 74-07

Dear Ms. Wilson:

On behalf of Judson Whitehurst and C&D Landfill, Inc., I am pleased to present the following responses to the eighteen comments presented in your letter dated March 9, 2009. Please see the following responses to the eighteen comments presented in order of your letter. Please also find the attached revised Facility Plan (including the Operations Plan and Closure/Post Closure Plan), revisions to selected drawings (see body of responses below), and various deeds and property maps including the recombination map and certified wetlands map (as noted below). I have also revised the Closure Plan originally submitted in June 2008 pursuant to Rule .0547 to be consistent with the Closure/Post Closure Plan (presented herein), and furnished the electronic copies of the February 2009 and November 2008 application submittals. Earlier responses to the thirty-five comments following your March 9, 2009 letter had been submitted as a "redline" (Revision 2) of the application report (Volumes 1 and 2) prior to the March 9, 2009 letter.

Response to March 9, 2009 comments:

1. The applicant signature page is presented herein and shall be placed behind the Executive Summary of the February 2008 report binder.

2. The typo on page 2, pertaining to the Total CDLF Footprint Acreage, has been corrected to say 38 acres (not 48 acres).

3. The following pages are sealed (by David Garrett): Page 33 of the Design Hydro Report (Volume 1), last page of the Monitoring Plan (Section 10), Certification (Section 12).

4. Copies of land deeds for the C&D Landfill, Inc. property (including the recombination) and parcel information for the subject property and adjacent properties are included herein and shall be placed in Appendix 1 immediately behind the tab.

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5. The current, certified wetlands survey (signed by the US Army Corps of Engineers agent) is presented herein and shall be placed in Appendix 3.

6. On-site surface streams have been clearly identified on Drawings E1, E2, and MP-1 (rolled plan set).

7. There is, in fact, no land clearing and yard waste processing area on the premises (this was an error in the text); thus the text in Section 8.1.1 has been corrected.

8. Section 1.4 (paragraph 1) has been corrected to reflect the current status of closure within Phase 1, that is, no areas of Phase 1 have been certified closed as of June 30, 2008 and, thus, the entire Phase 1 area will be closed under Rule .0547.

9. The Gas Venting System has been described in new Section 9.2.1.7 within the Closure/Post Closure Plan. Table 9A has been amended to reflect the cost of installing the passive gas vents – these costs have been translated to the Financial Assurance Calculations (Section 11).

10. Sections 9 and 10 have been amended to reflect the required quarterly sampling for methane for a 30-year post-closure period; the monitoring plan (Section 10) has been further amended to include discrete sampling locations for bar-hole punch tests, shown on Drawing MP-1. Future deviation from these rules will be justified with field data at an appropriate future time, subject to future approval by the Solid Waste Section.

11. Table 1B in the Water Quality Monitoring Plan (Appendix 6) has been modified to include well MW-9A.

12. The number of monitoring wells and surface sampling locations used to estimate the post-closure costs are consistent with the Water Quality Monitoring Plan after completion of Phase 2, i.e., the anticipated number of wells and sampling locations is consistent with Table 1B (see above).

13. Drawing C1 in the .0547 submittal of June 2008 has been corrected to remove superfluous lines that came into question with this comment.

14. The Closure/Post Closure plan under Rule .0547 in June 2008 has been revised to be consistent with the Permit to Construct submittal for Phase 2 (submitted herein).

15. Slope drains shown in the .0547 submittal for Phase 1 and shown in the construction details for both the .0547 submittal (Phase 1) and the Permit to Construct application (Phase 2) have been shown on the final closure plan drawing for Phase 2 (Drawing E2).

16. Directional arrows that indicate the storm water flow patterns around the base of the landfill have been enlarged for better visibility.

17. Electronic copies of the February 2008 and November 2008 submittals are attached.

18. Closure cost estimates presented in Sections 10 and 12 include the items that came into question – refer to the notes following Table 10B (included in the "redline" submittal).

Please contact me if you have any further questions.

Sincerely,

G. David Garrett, P.G., P.E.
Consulting Engineer

EXECUTIVE SUMMARY

C&D Landfill, Inc., is a privately owned and operated disposal facility located south of US 264 in eastern Pitt County, within the Pactolus community (see in-text Figure 1). Phase 1 commenced operations in 2001. Phase 2 is a non-contiguous expansion involving an addition of land to the permitted facility boundary. A Site Suitability evaluation for Phase 2 was prepared under then-current rules, **15A NCAC 13B .0500**, *et seq.*, which was submitted to NC DENR Division of Waste Management for review in early 2003. A hydrogeologic review was completed in 2004, involving one round of responses to review comments documented in September 2004, but the facility plan amendment and engineering plans were never reviewed by the Division due, in part, to pending rule changes and legislative action that delayed the review of many permit applications between 2004 and 2007.

New rules pertaining to C&D landfills were promulgated, i.e., **15A NCAC 13B .0531** *et seq.*, known as the "**2006 C&D Rules**", which require that ongoing facilities after January 2007 conform to the application submittal requirements and operational conditions prescribed by those rules. This is an "existing" facility as of August 31, 2007, with respect to the 2007 Solid Waste Act, and the facility meets the vertical separation requirements of the 2006 C&D Rules, as such the facility and subsequent expansions do not require a synthetic liner – the soil-type requirements prescribed by the 2006 C&D Rules for the upper two (2) feet beneath the base grade do apply for Phase 2.

At present, the Phase 1 is approaching 98 percent of full capacity, and the Owner/Operator desires a permit amendment to include the Phase 2 expansion, in conjunction with a renewal of the Permit to Operate. The Franchise Agreement with Pitt County was renewed in 2003, which identified the footprint expansion and increased waste tonnages, with a term of seven (7) years – the Franchise Agreement is valid and in force relative to the Phase 2 expansion. This document has been prepared to meet the requirements of the 2006 C&D Rules, i.e., the Design Hydrogeologic Evaluation, Engineering Plan, Construction Requirements, Construction Quality Assurance (CQA), Operations Plan, Monitoring Plan, and Financial Assurance. Please note, the .0500 rules required a single hydrogeologic investigation but in practice, a two-part approach was required by Division policy that has now been codified in the 2006 C&D Rules.

The original site characterization study for Phase 2, performed in 2002, included a sufficient number and depth of borings to provide the information for the **Site Suitability Evaluation** (Part 1) and the **Design Hydrogeologic Study** (Part 2); as such, no additional borings were performed since the earlier submittal. Ongoing monitoring of Phase 1 since 2000 provides ample historic data for the evaluation of the long-term seasonal high ground water table. Based on the site characterization study, conditions at Phase 2 are similar to those at Phase 1 with respect to ground water depths, flow directions, and absence of down-gradient ground water users. The data indicate an upward vertical gradient beneath the site and there is a partial confining layer present. Site conditions are present that will facilitate effective monitoring of Phases 1 and 2 as separate CDLF units.

This work is presented in two Volumes: **Volume 1** is the **Design Hydrogeologic Study** (with the **Monitoring Plan**); **Volume 2** is the **Facility, Operations**, and **Closure Plans**.

OWNER/OPERATOR INFORMATION

C&D Landfill, Inc. / EJE Recycling, Inc

Mr. Judson Whitehurst, Owner
Mr. Wayne Bell, General Manager
C&D Landfill, Inc.
802 Recycling Lane
Greenville, North Carolina 27834

Tel 252-752-8274
Fax 252-752-9016

find coord's
PIN #'s

Please refer to the following applicant signature page.

REVISIONS

Previous documents:

x	Part 1 Site Suitability Application C&D Landfill, Inc., Phase 2	November 2002 (Revised September 2004)

This document:

Rev 0	Part 2 Permit to Construct Application C&D Landfill, Inc., Phase 2 (Volumes 1 and 2)	February 2008
Rev 1	Resubmittal of Volumes 1 and 2 in response to 2006 C&D rules	October 2008
Rev 2	Update of Volumes 1 and 2 in response to regulatory Comments	February 12, 2009
Rev 2.1	Update of Volumes 1 and 2 in response to regulatory Comments	March 15, 2009

VOLUME 1 – TABLE OF CONTENTS

REFER TO THE TABLE OF CONTENTS IN VOLUME 2
FOR A GUIDE TO THE ENGINEERING ASPECTS OF THE FACILITY PLAN

FIGURES *Refer to page numbers in text*

TABLES *Refer to the tabbed section that follows Section 1*

DRAWINGS *Refer to the rolled drawing set that accompanies this report*

APPENDICES – VOLUME 1

APPENDICES – VOLUME 2

1.0 BACKGROUND INFORMATION

1.1 Development History

C&D Landfill, Inc. Phase 1 encompasses a 15-acre footprint within a 33-acre facility boundary. The facility is owned and operated by C&D Landfill, Inc., in conjunction with the adjacent EJE Recycling, Inc., both of which family owned business entities that operate from the one location. The C&D Landfill serves portions of multiple counties defined in the franchise agreement. Phase 1 commenced operations in 2001, and a permitted expansion (Phase 1B) was completed in 2002. When completed, Phase 1 will contain an estimated 842,000 cubic yards (421,000 tons) of inert debris. The facility has served as a disaster debris disposal site for the region.

Mixed agricultural, commercial, light industrial and residential properties exist within the community. No significant ground water users or potential sources of contaminants are located in the immediate vicinity, but certain inorganic constituents have been noted at somewhat elevated in the natural background geochemistry. Public water is available in the vicinity of the site, but no public water supply wells or surface water intakes have been identified near the site. The site suitability studies for Phases 1 and 2 identified no conditions that would limit the ongoing use of the site as a C&D disposal facility.

1.2 Existing Facilities

EJE Recycling operates a material recovery facility and a MSW transfer station north of the CDLF units. An office (doubles as a scale house) and equipment maintenance shop are located near the recycling yard. White goods are stored on a paved pad located between the Transfer Station and the CDLF Phase 1 – these materials are sold for scrap metal and removed periodically by EJE. Tires are generally not accepted at the facility; occasional tires from on-site equipment are disposed off-site, like any other consumer's. The Facility Plan map (**Drawing S3**) identifies the relevant waste management facilities.

1.3 Facility Plan Amendment

Phase 2 will encompass a 23-acre new footprint – separate from Phase 1. The expansion involves the addition of 90 acres to the facility boundary, bringing the facility boundary area to 123 acres. Phase 2 will contain an estimated 964,000 cubic yards (482,000 tons) of debris, bringing the total disposed volume to 1,806,000 cubic yards (903,000 tons). The estimated life of Phase 2 is 15 years. This document provides detailed design information pertaining to a Permit to Construct application for the Phase 2A expansion. The following describes the facility before and after the planned expansion.

EXISTING CONDITIONS — C&D Landfill, Inc. (Permit #74-07)

Solid Waste Units Present	MSW Transfer Station, Recycling Facility, CDLF		
Other Activities/Infrastructure	Scales/Office, Alternative Cover Demonstration		
CDLF Unit Footprint Acreage	15 acres		
CDLF Phases/Sub-Phases [1]	**1A**	**1B**	
New Ground Footprint Acreage [1]	8 ac	7 ac	
Final Elevations (Entire Unit) [2]	EL. 124 [5]		
Maximum Waste Thickness [2]	104 feet [5]		
Permitted Side Slope Ratios	3H:1V		
Acreage of Closed Slopes [3]	0		
Facility Boundary Acreage	33 acres		
Total Permitted Capacity [2]	842,000 cy		
Permitted Capacity Remaining	0		

PROPOSED CONDITIONS — Phase 2 is a separate unit from Phase 1

Solid Waste Units Present [4]	Unchanged		
Other Activities/Infrastructure [4]	Unchanged		
New CDLF Unit Footprint Acreage [4]	23 acres		
New CDLF Phases/Sub-Phases [1]	**2A**	**2B**	**2C**
New Ground Footprint Acreage [1]	10 ac	13 ac	9 ac [5]
Interim Capacities (Sub-Phases) [2]	313,044 cy	386,045 cy	299,937 cy
Interim Elevations (Sub-Phases)	EL. 50	EL. 50	EL. 106
New CDLF Unit Capacity [2]	999,063 cy		
Final Elevations (Entire Unit) [2]	EL. 106		
Maximum Waste Thickness [2]	90 feet		
Permitted Side Slope Ratios [4]	3H:1V		
Acreage of Closed Slopes [3]	0		
Facility Boundary Acreage [4]	90 acres		
Total CDLF Footprint Acreage [4]	38 acres		
Total Permitted Capacity [4]	1,841,063 cy		
Permitted Capacity Remaining [4]	999,063 cy		

1 Corresponding to 5-year Operating Capacity
2 Includes Final Cap System and Operational Cover
3 Per Applicable Rules at Time of Closure
4 Subject to Approval of this Application
5 Vertical Expansion – not actual ground disturbance

1.4 Regulatory Requirements

Solid Waste Rules 15A NCAC 13B .0531 *et seq.* became effective January 1, 2007 – these are known as the "**2006 C&D Rules**." Rule .0547 requires that existing CDLF units (i.e., accepted waste prior to January 1, 2007) that wish to continue operating under the "**2006 C&D Rules**" submit an application to depict the proposed long-term development of the site and demonstrate compliance with new rule requirements. This document constitutes said application and is organized in general accordance with the sequence of presentation of topics under **Rules .0531** through **.0547** (with references). Contained in this document are revisions to previous permit documents, including provisions of the "2006 C&D Rules" that must be met, as follows:

(1) Existing C&D units that did not and will not receive solid waste after June 30, 2008 must be closed under the requirements of Rule .0510 (the previous rules).

Design capacity in Phase 1 was not reached by June 30, 2008. Although many of the 3H:1V side slopes had reached final grades and, thus, had received interim soil cover under the old Rule .0510, under which Phase 1 was permitted and operated, no areas of Phase 1 were ready to be certified by June 30, 2008. As such, all of Phase 1 shall be closed under the new Rule .0547, hence making those portions subject to the financial assurance requirements.

(2) Financial Assurance must be demonstrated prior to July 1, 2008 to cover the estimated costs of closure and post-closure for C&D units (typically, a local government test for political subunits of the State, i.e., counties).

The Owners of C&D Landfill, Inc. will furnish an appropriate fiduciary instrument within the specified time frame, based on costs estimates developed elsewhere in this document for Phase 2 and the remaining portions of Phase 1 at the time of closure (as yet to be determined).

(3) A Permit to Construct application for a new phase must contain a comprehensive facility plan for long-range development, including the layout, aerial limits and capacity of various proposed waste management units, along with identification of the anticipated waste stream and criteria for waste acceptance and segregation; an Engineering Plan for the initial phase of development; a Construction Quality Assurance (CQA) plan; an Operation Plan prepared under the "**2006 C&D Rules**" that includes amended monitoring programs (both environmental and waste acceptance monitoring); a Closure and Post-Closure Plan (with cost estimates to facilitate the financial assurance demonstration).

C&D Landfill, Inc., has met the application requirements within this document (presented in later sections). The Facility Plan depicts the Phase 2 expansion; further development of the facility is possible utilizing land to the west of the Phase 2 site, but no formal plans have been derived at this time for further expansion. The Owner understands that further Facility Amendment will require additional Site Suitability characterization and local government approval.

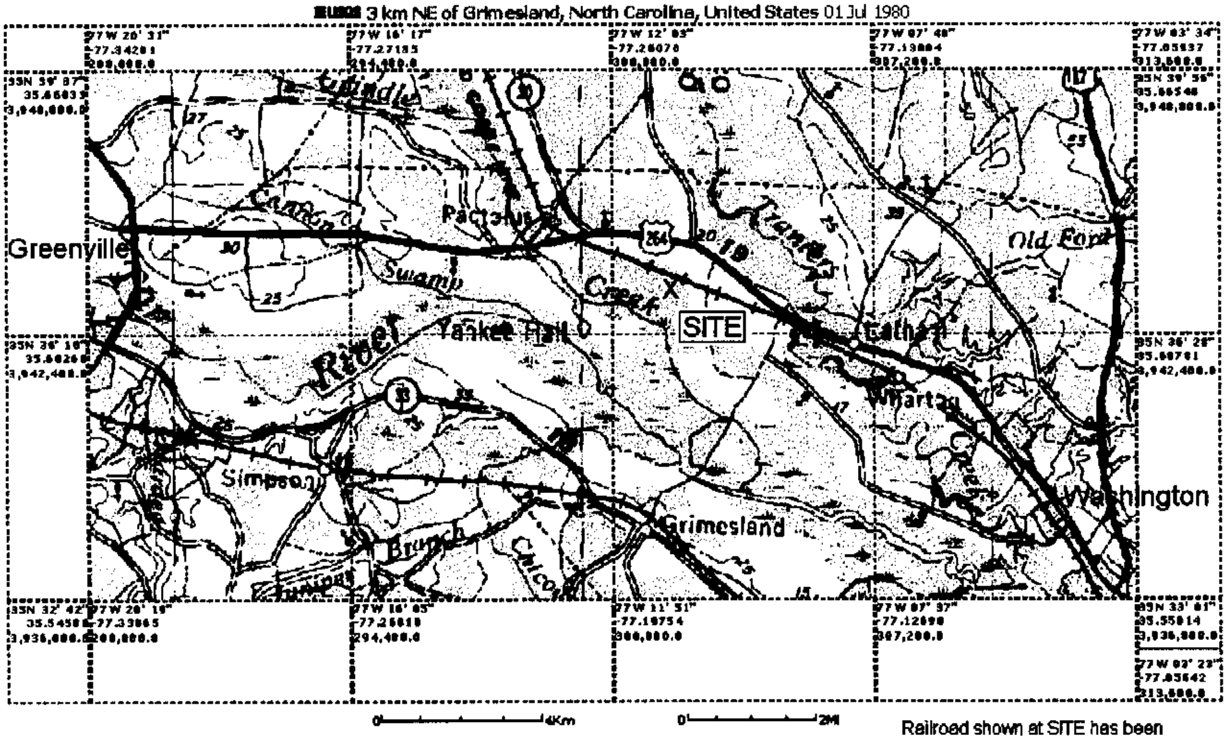

Image courtesy of the U.S. Geological Survey

Railroad shown at SITE has been abandoned and tracks removed

Figure 1 – General Vicinity Map

2.0 PHASE 1 CDLF CLOSURE (15A NCAC 13B .0510)

Phase 1 will receive solid waste after June 30, 2008 and, thus, is subject to the final closure requirements of **Rule .0543**, also applicable to Phase 2. Regulatory final cover requirements for both phases include 18 inches of final cover soil, capable of supporting vegetation, and 18 inches of compacted soil barrier with a field permeability of not more than 1.0×10^{-5} cm/sec. Slope ratios shall be 33% maximum (3H:1V) along side slopes, 5% minimum on upper cap surfaces (post-settlement). The final cover for Phase 1 will be subject to the same CQA requirements described as Phase 2 in **Section 7.0** (Volume 2) and the same financial assurance requirements described in **Section 11.0** (Volume 2) – a separate Closure and Post-Closure Plan was prepared for Phase 1 in June 2008, which has been updated to reflect this document. This information contained herein has been updated from the original submittal of this document (Rev. 0, February 15, 2008).

3.0 CDLF FACILITY PLAN (15A NCAC 13B .0537)

3.1 Regulatory Summary

The "2006 C&D Rules" require a comprehensive facility plan that identifies future development in phases that correspond approximately to 5-year operational capacities. The facility plan must identify and show all relevant permitted Solid Waste units and activities conducted (or proposed) at the site. The grading plan requirements emphasize vertical separation and minimum subgrade soil type requirements. The proposed C&D expansion meets or exceeds the 4-foot minimum vertical separation requirement to groundwater and bedrock, thus no liner or leachate collection system is required under these rules. Subgrade soil types that will be exposed via excavation and used in the compacted fill sections are anticipated to exhibit a mix of finer soil types, e.g., ML, MH, CL, CH, SM and mixed SM-ML classifications, thus subgrade permeability is expected to be low, providing the soils are reworked and compacted (see **Section 6.0**).

3.2 Facility Drawings

3.2.1 Facility Layout

Phase 2 is a separate CDLF unit that will be developed in two sub-phases relative to footprint expansion, with a third sub-phase (vertical expansion) over the other two. Each sub-phase is expected to provide approximately 5 years of operational capacity, based on current waste stream projections. **Drawings E1** and **E2** respectively depict the base grades and final grades for Phase 2. The aerial limits are set to provide a minimum 200-foot buffer to the facility boundary, a 50-foot buffer to jurisdictional water bodies, per the rules that were in effect when the project initiated – this is an "existing" facility relative to the 2007 Solid Waste legislation, hence the original setback requirement applies for jurisdictional waters. **Drawings E3 and E4** show the footprints and estimated interim fill grades for two 5-year sub-phases, 2A and 2B, respectively. A third 5-year sub-phase, 2C, is the vertical expansion over the other two.

The Facility Plan (**Drawing S3**) shows the locations of current and future soil borrow areas and potential future access routes, along with other permitted Solid Waste units and activities (including facility infrastructure) associated with the adjacent MSW Transfer Station and Recycling Facility – at present, these units are considered a separate facility, permitted independently of the CDLF. The Phase 2 footprint contains no identified floodplains or wetlands (adjacent areas with these features will be avoided), unstable areas or cultural resource areas that affect project development.

3.2.2 Operational Sequence

Phase 2A and associated S&EC measures (shown on **Drawing E3**) will be developed in the southern half (approximately) of the Phase 2 footprint. This sub-phase will involve minor grade cuts for reaching the approved base grading plan (see **Drawing E1**). The operational sequence is divided into 5 contiguous cells, each lasting an estimated one year of duration, which extend to an interim elevation that approximates 5 years of capacity. During the operation of Phase 2A, the footprint for Phase 2B – located in the northern half of the Phase 2 footprint – will be used for staging and stockpiling cover soil and "beneficial fill" materials that will be utilized in future construction of Phase 2B. No excavation is planned for Phase 2B – base grade fills up to 4 feet in height are required.

Interim slopes will be maintained at 3H:1V, in accordance with Division of Waste Management requirements, while upper surfaces shall be graded to promote positive drainage, ideally at a 5% slope. Operational procedures are described more fully in the Operations Plan (**Section 8.0**). Exterior slopes will be closed – with simultaneous construction of erosion control benches – in Phase 2A (and other sub-phases) as the slopes come to grade. Interim cover will be placed on exterior slopes until a maximum of 10 acres of slope is ready for final closure (refer to the Final Closure Plan, **Section 9.0**). A future Permit to Construct application for Phase 2B will be submitted to the Division approximately two years prior to the completion of Phase 2A waste placement.

3.3 Facility Report

3.3.1 Waste Stream

The CDLF is permitted and managed separately from the recycling facility and transfer station. This report pertains specifically to the CDLF operation. Scale-house records indicate an average daily C&D disposal tonnage of 200 tons per day, operating 250 days per year, for approximately 50,000 tons per year (100,000 cubic yards per year). The populations served include all or portions of the counties listed below.

SELECTED COUNTY	2000 Pop[1]	2006 Pop[1]	Pop Growth[2]	% Grow	July 2009[3]	% Grow	July 2019[3]	% Grow	July 2029[3]	% Grow
BEAUFORT	44,958	46,346	1,388	3.1%	47,342	5.3%	49,045	9.1%	50,138	11.5%
BERTIE	19,757	19,355	-402	-2.0%	18,945	-4.1%	18,147	-8.1%	17,149	-13.2%
CHOWAN	14,150	14,664	514	3.6%	15,142	7.0%	15,707	11.0%	16,011	13.2%
CRAVEN	91,523	95,558	4,035	4.4%	98,661	7.8%	104,279	13.9%	108,160	18.2%
EDGECOMBE	55,606	52,644	-2,962	-5.3%	51,563	-7.3%	47,811	-14.0%	43,850	-21.1%
GREENE	18,974	20,833	1,859	9.8%	21,378	12.7%	24,057	26.8%	26,728	40.9%
HALIFAX	57,370	55,606	-1,764	-3.1%	54,707	-4.6%	53,321	-7.1%	51,486	-10.3%
HYDE	5,826	5,511	-315	-5.4%	5,426	-6.9%	5,292	-9.2%	5,090	-12.6%
JONES	10,398	10,318	-80	-0.8%	10,512	1.1%	10,680	2.7%	10,766	3.5%

LENOIR	59,619	58,172	-1,447	-2.4%	58,083	-2.6%	57,053	-4.3%	55,711	-6.6%
MARTIN	25,546	24,396	-1,150	-4.5%	24,112	-5.6%	22,968	-10.1%	21,755	-14.8%
NASH	87,385	92,220	4,835	5.5%	94,871	8.6%	103,245	18.1%	111,136	27.2%
NORTHAMPTON	22,086	21,524	-562	-2.5%	21,544	-2.5%	21,330	-3.4%	21,003	-4.9%
PAMLICO	12,934	13,097	163	1.3%	13,236	2.3%	13,702	5.9%	13,930	7.7%
PITT	133,719	146,403	12,684	9.5%	154,430	15.5%	175,690	31.4%	196,602	47.0%
TYRRELL	4,149	4,240	91	2.2%	4,334	4.5%	4,384	5.7%	4,379	5.5%
WASHINGTON	13,723	13,360	-363	-2.6%	13,243	-3.5%	12,589	-8.3%	11,821	-13.9%
WAYNE	113,329	114,930	1,601	1.4%	116,281	2.6%	121,958	7.6%	127,160	12.2%
WILSON	73,811	77,468	3,657	5.0%	79,574	7.8%	85,835	16.3%	91,905	24.5%
	2000 Pop	**2006 Pop**	**Pop Growth**	**% Grow**	**July 2009**	**% Grow**	**July 2019**	**% Grow**	**July 2029**	**% Grow**
MULTI-COUNTY SERVICE AREA	864,863	886,645	21,782	2.5%	903,384	4.5%	947,093	9.5%	984,780	13.9%
STATE OF NORTH CAROLINA	8,046,813	8,860,341	813,528	10.1%	9,348,744	16.2%	10,744,214	33.5%	12,167,409	51.2%

[1]Source data: 2006 Certified County Population Estimates,
North Carolina State Demographics, North Carolina State Data Center,
http://demog.state.nc.us/

[2]All growth is relative to 2000 Census Data

[3]Source data: Projected Annual County Population Totals (for years given),
North Carolina State Demographics, North Carolina State Data Center,
http://demog.state.nc.us/

3.3.2 Landfill Capacity

The volumetric analysis for Phase 2 (see **Appendix 2**) indicates an estimated 999,063 cubic yards of airspace, which includes interim cover soils but excludes final cover. Based on an estimated 50,000 tons of C&D per year with an assumed 3% annual increase in C&D intake, the projected operational life for Phase 2 is between 9 (minimum) and 15 (maximum) years. Since the waste stream and compaction density is expected to vary, the projected operational capacity may vary – based on the current volume projection and waste projection, the airspace should last for two or three 5-year permitting cycles.

3.3.3 Special Engineering Features

No seeps, springs, soft ground or other deleterious conditions were identified in the site characterization studies. As such, no special engineering features are required.

4.0 DESIGN HYDROGEOLOGIC STUDY (15A NCAC 13B .0538)

The following sections are adapted from the October 2002 Site Suitability study for Phase 2; that investigation included sufficient test boring and laboratory data to meet the requirements for the Design Hydrologic Study report, discussed below.

4.1 Site Hydrogeologic Report

4.1.1 Local and Regional Geology

The site is located in the central Coastal Plain physiographic and geologic province of North Carolina. Available geologic mapping[1] places the site within the Tertiary (Miocene) age Yorktown Formation, approximately twenty miles west of the Suffolk Scarp – the dividing line between Quaternary age surficial deposits (to the east) and Tertiary age surface deposits (to the west), located at approximately 25 feet above mean sea level. The site is also located approximately twenty-four miles east of the Surry Scarp, which delineates higher ground underlain by Cretaceous (and older) units exposed south and west of Pitt County. The site is located entirely within the Tar-Pamlico River basin, draining south toward Grindle Creek, a major tributary to the Tar River.

Published literature indicates that upland areas throughout the region are underlain by relatively thin Quaternary surficial deposits (not differentiated on the state-wide map).[2] The surficial formation is characterized in the literature as stratified fluvial deposits, containing interlayered low permeability and high permeability horizons. The thickness of the aquifer ranges from 3 to 180 feet (average thickness of 35 feet near the site) – thickening eastward – with an estimated average hydraulic conductivity values ranging up to 29 feet per day. The surficial aquifer is also characterized as exhibiting less than 50 percent sand, hence lower hydraulic conductivity, west of a line that roughly coincides with the Suffolk Scarp. These observations were confirmed by the local area study and site specific reconnaissance, whereas the surficial deposits (deemed the uppermost aquifer) consist of poorly stratified sand and clay layers, which were found to exhibit an average thickness of 12 feet (varying up to 30 feet), underlain by the Yorktown Formation with a distinct fossil-marker bed of turritellas (gastropods) and a color change from tan-white (upper sands) to dark gray-green. On-site field hydraulic conductivity values were measured in the range of 0.028 ft/day to 0.667 ft/day.

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1 North Carolina Geological Map, Scale 1:62,500, NC Geological Survey, 1985.

2 Hydrogeologic Framework of the North Carolina Coastal Plain Aquifer System, U.S. Geological Survey Open File Report 87-690, USGS.

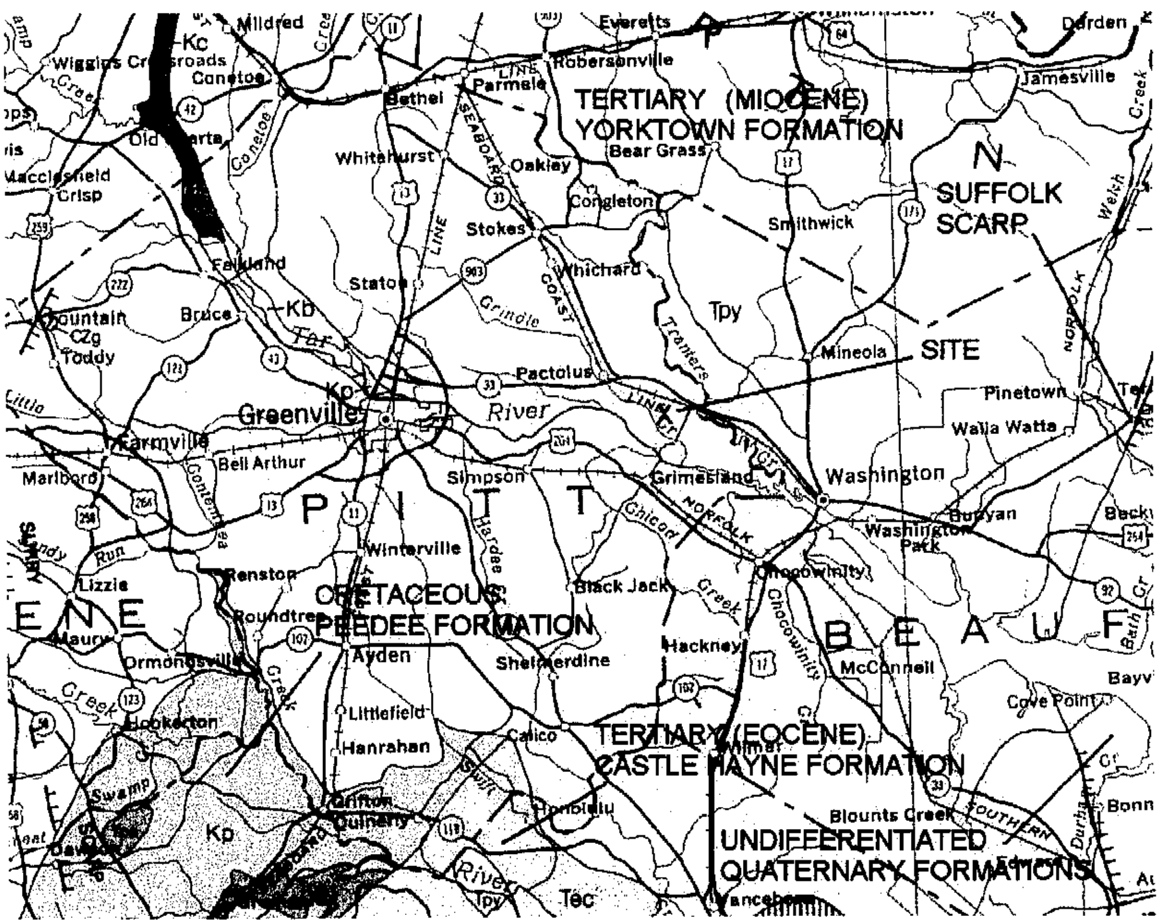

Figure 2 – North Carolina Geologic Map Excerpt

The major regional aquifers beneath the Coastal Plain, near the City of Greenville, NC, include the Yorktown Formation, the deeper Eocene-age Castle Hayne Formation (limestone) and underlying Cretaceous-age units, i.e. the Pee Dee and Black Creek Formations.[3] The Yorktown is characterized as marine sediments varying in thickness to 60 feet (thickest within Pitt County is in the northwest corner). The Castle-Hayne is localized to the southern and eastern portions of Pitt County (and further east) but is represented to be less than 30 feet in thickness everywhere in the county.

The Paleocene-age Beaufort Formation is mentioned in the literature, stratigraphically located between the Castle-Hayne and the deeper Cretaceous units, but the Beaufort does not outcrop. The Pee Dee and Black Creek Formations outcrop along the Tar River approximately eight miles west of the site (in Greenville, NC), and the Cretaceous-age

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3 Brown, P.M., Geology and Ground Water Resources in the Greenville Area, North Carolina, Bulletin Number 73, prepared cooperatively by the North Carolina Department of Conservation and Development and the United States Geological Survey, 1959.

Cape Fear Formation outcrops approximately eight miles further upstream (west of the site). Based on regional data,[4] typical depths of the Cretaceous units in proximity to the site are in excess of 90 feet (see **Table 1B**). All are considered to be viable aquifers with variable water quality.

Basement rocks in the region consist of pre-Mesozoic crystalline rocks of igneous and metamorphic origin, which underlie the sediments of the Coastal Plain near the site at depths in excess of 1000 feet, based on available water well data (see Footnote 4) and published data.[5] West of the Suffolk Scarp the projected surface of the crystalline basement slopes at 0.4% (2000 feet in 90 miles), east of the Suffolk Scarp the surface of the basement slopes at 1.4% (8000 feet in 110 miles), with a maximum depth of 10,000 feet at Hatteras. The basement complex likely resembles the crystalline rocks exposed in the Piedmont, complete with various contacts, jointing, and other tecto-structural features, e.g. folds and faults. Several transform faults in the basement complex have been recognized by characteristic deformation features within the overlying late-Mesozoic and early Tertiary sediments.[6]

These relicts of Triassic-age tectonism (active throughout the Mesozoic era) are strike-slip faults with vertical rotation, oriented approximately with the alignments of the Tar, Neuse and Cape Fear Rivers. The most conspicuous feature produced by these faults, visible on the North Carolina Geologic Map, is the "up-thrown block" that occurs between the Cape Fear and Neuse Rivers (well to the south of the site). Within this area, the Yorktown has been all but eroded away, exposing the older Tertiary and Cretaceous sediments much further east than observed south of the Cape Fear or north of the Neuse. These faults are not active, and the region is not within a Seismic Impact Zone[7].

Heavy ground water extraction by water supply wells in the region has been considered as a probable cause for lowered potentiometric levels within the regional aquifers (noticeable over several decades) and localized ground subsidence.[8] High capacity wells are used to supply drinking for the cities of Greenville and Washington. The Division of

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4 DENR Monitoring Well Database (interactive), North Carolina DENR Division of Water Resources, Ground Water Branch, viewed at web site http://www.dwr.ehnr.state.nc.us.

5 Lawrence and Hoffman, Geology of the Basement Rocks Beneath the North Carolina Coastal Plain, Bulletin 95, North Carolina Geological Survey, 1993.

6 Brown, P.M., and others, Wrench-style Deformation of Rocks of Cretaceous and Paleocene Age, North Carolina Coastal Plain, Special Publication 5, NCGS, Raleigh, NC, 1977.

7 EPA/600/R-95/051, RCRA Subtitle D (258) Seismic Design Guidance for Municipal Solid Waste Landfill Facilities, 1995, including Seismic Intensity Capable Faults Map

8 Land Subsidence Information, NC DENR Division of Water Resources - Ground Water Branch, unpublished, reviewed on-line at www.dwr.ehnr.state.nc.us

Water Resources data do not indicate how far the zone of influence around the wells extends with respect to subsidence, but the subsidence probably extends not more than a few miles from the respective wells. No high capacity production wells are located within two miles of the subject site, based on the findings of the local area study. It is not anticipated that the site could affect these wells, or that the ground water extraction at these locations could affect the site.

Daniels, *et al.*, discusses drainage characteristics and ground water movement within the surficial deposits of the Coastal Plain.[9] By examining in numerous soil samples for the presence of iron-oxide staining (various hues of red and yellow, e.g. goethite) and gley coloration (gray, blue-gray or green-gray pigmentation resulting from reduced iron compounds contained in water-logged soils beneath the surface, often accompanied by the formation of a sticky clay layer), along with various geochemical and pedologic properties, water movement characteristics within certain near surface soil horizons can be determined. Gleyed sands and sand-clay horizons were observed in the drilling and test pits for the subject site, typically at depths of 7 to 12 feet, usually with a sharp near horizontal demarcation with the overlying iron-oxide pigmented soils.

This work suggests that the presence of gley colors relatively near the surface within the Coastal Plain (as in other areas) results from very slow to no movement of water, i.e. "stagnant" ground water conditions. Conditions that produce gleyed beds, whether sand or clay, do not often change, as would be expected with the introduction of oxygen-rich meteoric water from the surface. The implications are that surficial aquifers function independently as reservoirs of infiltrated meteoric water, with relatively shallow discharge to streams and little recharge to the deeper aquifers. As discussed in the Site Suitability Report, the subject site is isolated hydraulically and from human activities. It is not likely that the landfill will affect (or be affected by) regional activities.

4.1.2 Field Reconnaissance

4.1.2.1 Topographic Setting and Drainage – Generally, the land slopes to the south between US 264 (existing near El. 25) and Grindle Creek (existing near El. 10). Site mapping (see **Drawings S2** and **S4**) shows a subtle drainage divide or "rise" (the term "ridge" implies topography too steep for this context) within the center of Phase 2 footprint, in the eastern portion of the site. This feature divides surface flow between

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9 Daniels, R.B., and E.E. Gamble, W.H. Wheeler, J.W. Gilliam, E.H. Whiser, C.W. Welby, Water Movement Surficial Coastal Plain Sediments, Inferred from Sediment Morphology, Technical Bulletin No. 243, North Carolina Agricultural Experiment Station, North Carolina State University, Raleigh, NC, December 1978.

small tributaries located to the east and west of the Phase 2 area. These minor tributaries exhibit distinct channels and a perennial aquifer discharge. Both streams exist in relatively deep swales, several feet lower than the majority of the site. These features are expected to control drainage within the uppermost sandy aquifer. Mean ground elevations within the Phase 2 site occur between El. 16 to El. 18, with maximum ground elevations between El. 19 to El. 20 near the central portions of the site, sloping gently toward the streams where typical elevations occur near El. 12 to 14. The streams are generally incised and channels typically occur 3 to 4 feet lower than the bank; channel widths are typically in the range of 3 to 5 feet, water depths are typically 1 to 3 feet deep.

4.1.2.2 Springs, Seeps and Ground Water Discharge Features

Two on-site streams, situated on the east-to-south and west sides of the Phase 2 footprint originate on the site and converge south of the site. These streams, in turn, converge with larger streams that originate less than a mile east of the site and flow south to Grindle Creek. The streams are fed in part by seeps and springs located along the banks of these features within the property boundary, many of which are too small to discern, which discharge from the uppermost aquifer. Some of the streams could be older man-made drainage features. The smaller upland drainage features are recharged by a fairly small watershed area and could be prone to seasonality. There is apparent "run-on" to the site in the northwest corner (from the US 264 right-of-way) but there is no "run-on" to the Phase 2 footprint area.

An upward vertical gradient exists of the upper and lower aquifers beneath within portions the site, as seen by the piezometer couplets at B-6/6A and B-8/8A (see Table 6). Downward gradients are seen within the central and northern portions of the site, the upward gradients are located near the streams, indicating discharge conditions. Changes in the gradient direction indicate seasonality. These conditions are typical of the region and similar to the Phase 1 site. The Phase 2 site is surrounded on the down gradient side by intercepting streams (not the case with the entirety of Phase 1). Based on the presence of the confining layer – more pronounced in the southern, down gradient portion of the Phase 2 site – it appears that offsite migration within the uppermost aquifer is unlikely.

4.1.3 Test Borings/Piezometers

Test borings and hand auger borings performed in December 2001 and January 2002 are shown on **Figure S5**. The test borings, labeled as the "B" series borings on the site map, were extended to depths varying from 15 to 70 feet, penetrating the several of the major lithologic and hydrologic units mapped in the region. Test boring data are summarized on

Table 1A. The deeper subsurface data were supplemented by three relatively shallow hand auger borings. **Figure S5** also shows site topography and the locations of the hydrogeologic cross sections (discussed later in this text). The soil test borings were sampled with standard penetration test techniques (ASTM D- 1586). Soil samples were visually classified by an experienced geologist, and laboratory testing was performed to confirm the field classifications.

All of the B-series borings were converted to standpipe piezometers for long-term ground water level observation. All test borings were grouted to the surface; some e.g., B-1s/2d, B-5 and B-6, may have application as future monitoring wells (with the installation of locking steel covers). There are 34 piezometers and two surface streams serving as ground water observation points within the 89.5-acre addition to the facility boundary. There are 23 piezometers within/near the Phase 2 footprint, which covers approximately 23 acres. A ground water potentiometric map, discussed in a later section, has been prepared from these data. Test boring records are presented in **Appendix III** of the **October 2002 Site Suitability report**.

4.1.4 Laboratory Geotechnical Testing

4.1.4.1 Laboratory Analysis - Table 2 presents a summary of laboratory test data for the Phase 2 test borings. Laboratory data are presented in **Appendix IV** of the **October 2002 Site Suitability report**. The laboratory test program consists of the following:

Triaxial Shear Strength, CU - undisturbed	D4767-95	2
Triaxial Shear Strength, CU - remolded	D4767-95	2
Flexible wall permeability - undisturbed	D5084	2
Flexible wall permeability - remolded	D5084	2
Standard Proctor Compaction	D698	2
Grain Size w/Hydrometer	D422, D1140	12
Atterberg Limits	D4318	12
Natural Moisture	D2216	12
One-Dimensional Consolidation	D2435	2

The soils were classified in the laboratory according the Unified Soil Classification System (USCS). These descriptions were matched to the boring logs to verify the visual soil classifications. Supplemental laboratory testing included standard Procter moisture-density tests, triaxial-cell hydraulic conductivity tests on undisturbed and remolded samples, triaxial shear strength and one-dimensional consolidation tests.

Soil Descriptions – Within the eastern portion of the site (the proposed CDLF footprint), soils within the upper 5 to 8 feet of the surface are generally classified as low to medium plasticity clayey silt (CL-ML) and silty sand (SM). Occasional pockets of clean well graded sand (SW) were encountered in the near subsurface. Within the western portion of the site, the proposed borrow site, soils generally consist of clean, well graded sands and silty sands, with relatively little clay. These sediments appear to be a relict stream channel, whereas the more clayey soils are likely channel-bank deposits.

Below a typical depth of 12 to 17 feet exists a layer of clayey silt (ML) and plastic clay (CL-CH), which appears to be continuous over the site and varies in thickness to approximately 15 feet, or more. This layer was previously identified as a partial confining layer during the Phase 1 site investigation. Below depths of 35 feet exist layered silty and clayey sands (SM and SM-ML), which locally are cemented. The soils became very clayey (CL and ML) below depths of approximately 50 feet.

Undisturbed Samples – Shelby tube samples were procured from test borings B-1, B-8, and B-10s and subjected to laboratory triaxial permeability, shear strength and consolidation testing. The near-surface soils consist of normally consolidated fluvio-marine sediments, where potential settlement is a concern relative to vertical separation. There appears to be a low likelihood of deep-seated instability and/or excessive settlement. Settlement and stability calculations based on these data are presented in **Appendix 7 (Volume 2)** of this report.

Bulk Samples – Representative bulk samples were procured from the upper 5 feet the surface at test borings B-2 and B-8. These samples were remolded and subjected to laboratory triaxial permeability tests. Permeability values on the order of 6.5×10^{-6} cm/sec were obtained for both samples. The bulk samples are considered to be representative of the shallower soils within the eastern portion of the site.

Effective Porosity – In keeping with Division requirements, the effective porosity was estimated from the grain size distribution analysis using a ternary diagram, originally developed by the US Geological Survey for estimating specific yields in porous aquifers. It has been demonstrated (in the literature) that the specific yield is tied to the effective porosity, the Division has adopted the practice of using specific yield (effective porosity) in the hydraulic gradient calculations (see **Section 4.1.8**). Two sample populations are apparent – the more permeable upper sands exhibit effective porosity values on the range of 7% to 22% (average of 12%), while the less permeable silty clay of the confining unit exhibits effective porosity values in the range of 1% to 5% (average of 3%). The effective porosity calculations are presented in **Appendix 5** and summarized on **Table 2**.

4.1.4.2 Formation Descriptions - The various geologic formations have been discussed in Section 5.0 of the October 2002 Site Suitability report. **Section 4.1.4.4** discusses subunits or layers identified in the near-surface geology that comprises an uppermost aquifer (sand), a partial confining unit (silt-clay), and a deeper regional aquifer (variably silty and partly cemented sand). Depths and permeability characteristics identified in the site specific studies are discussed in the following sections.

4.1.4.3 Field Hydrologic Testing - Table 3 presents a summary of field hydrogeological properties, based on falling head slug tests. Values of assumed total and effective porosity, aquifer thickness and descriptions of the various hydrogeological units based on the laboratory classification data are also presented in Table 3, along with calculated conductivity values. Each piezometer was developed prior to testing using a downhole pump or bailer until clear water was obtained. Static water level measurements were made at the beginning of each slug test. Table 7 presents calculated ground water gradients and velocities at each piezometer.

The slug tests were conducted by placing a pressure transducer at the bottom of the piezometer and allowing a buoyant plastic "slug" of a known volume, placed below the water level in the bore hole casing, to come to equilibrium. The change in piezometric head in response to the "slug" was measured until static equilibrium was re-established. A Hermit 1000C data logger was used to measure the rate of influx until water level equilibrium was achieved. The slug test data was analyzed according to both the Hvorslev and the Bouwer-Rice procedures, using commercially available software. The slug test data and permeability calculations are presented in **Appendix VI** of the **October 2002 Site Suitabilty report.**

4.1.4.4 Hydrogeologic Units – **Table 3** presents the field hydraulic conductivity values (Bouwer-Rice) shown relative to the aquifer units defined for the site. **Table 2** presents laboratory conductivity data for the partial confining unit. Based on these data, the representative depths and conductivity values relative to each unit vary as follows:

Unit	**Unit Description**	**Typical Depths, ft**	**Representative Hydraulic Conductivity (cm/sec)**	**(ft/day)**
AU-1	Surficial Aquifer (Quaternary)	0 - 14	4.79E-04 to 3.25E-03	9.21 to 1.36 Average 5.95
CU-1	Soft Silt-Clay (Yorktown)	14 - 35	3.03E-05 to 2.22E-04	0.63 to 0.09 Average 0.36

AU-2	Dense Silty Sand (Yorktown)*	35 - 50	2.57E-04	0.73
CU-2	Dense Clayey Sand (Beaufort)	50+	5.25E-06	0.015**

* Alternatively identified as Castle Hayne, based on the literature

** Based on the Phase 1 site studies

From these data an order of magnitude difference in conductivity between Aquifer Unit 1 and Confining Unit 1 can be seen. Likewise, an order of magnitude difference can be seen between the lower units. While the difference in conductivity is not large, it is considered significant for modeling the site. The data can be biased due, in part, to the tendency for slug tests to measure hydraulic properties within a relatively narrow zone of influence around the piezometer.

All units exhibit variability with respect to clay content, and it is likely that the upper fluvial sediments are cross-bedded, which potentially leads to "dead-end" pore volumes and decreased effective porosity. Conversely, the upper reaches of the Yorktown have been reworked, which might lead to inconsistencies in measured properties. The "slug" test used to characterize the various formations is prone to influence by localized subsurface conditions, e.g. sand pockets, and piezometer construction, these tests are industry-standard and considered to yield reasonable representative results, sufficient for aquifer characterization and ground water modeling.

4.1.4.5 Dispersivity Characteristics – An important consideration regarding the ability to effectively monitor the site is the nature of the surficial aquifer. A concern revolves around how much dispersion would take place in the shallow and relatively sandy uppermost aquifer should a release of contaminants occur and how closely spaced must the monitoring wells be to detect such a release. This concern was addressed in the **April 2001 Design Hydrogeologic** report for **Phase 1** with respect to the distance of the regional ground water discharge feature (Grindle Creek) beyond the southwest property line. Such is not the case with Phase 2, whereas smaller tributaries provide a localized (on-site) discharge feature for the uppermost aquifer.

Appendix 5 presents a discussion of contaminant transport characteristics, along with an analytical solution to the two-dimensional advection-dispersion equation.[10] This solution assumes uniform, isotropic, and homogenous conditions within the flow regime (Darcy's

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10 Walton, W.C., Principles of Ground Water Engineering, Lewis Publishers, Inc., Chelsea, Michigan, 1991.

law applies). At a given point in space within the flow field (the prospective monitoring well location) and at time zero, the concentration of a solute of interest is assumed to be zero. The mathematical solution assumes no sorption, retardation, or degradation of the solute, e.g. the solute is "conservative" by not reacting with the host media or other solutes in the aquifer system. The model does consider aquifer thickness, porosity, and both longitudinal and transverse diffusion/dispersivity coefficients.

This aquifer system is characterized by lower hydraulic conductivity values than would be expected for a sandy aquifer (10^{-5} cm/sec) and low ground water velocities (0.008 ft/day). The effective hydraulic conductivity is due to cross-bedding and clayey horizons contained within the surficial aquifer. Low velocities are caused by the low conductivity and fairly flat ground water gradients. According to published literature, these conditions place the system in a regime where molecular diffusion is the controlling factor in contaminant transport, rather than mechanical dispersion.[11] The solution verifies that an approximate monitoring well spacing of 300 feet is adequate to detect a potential release of contaminants into the ground water. The **Water Quality Monitoring Plan** presented in **Appendix 6** reflects this analytical solution.

4.1.5 Other Investigative Tools

No specialized techniques or other testing methods were required or this investigation, but a number of test pits were excavated in advance of the borings to verify the consistency of soil conditions between Phases 1 and 2, and several hand auger borings, designated by an "A" following the boring number, were used for a detailed evaluation of soil types and ground water flow trends within the uppermost aquifer (**see Table 8**).

4.1.6 Stratigraphic Cross Sections

Drawings X1 and **X2** present generalized subsurface profiles prepared from the test boring and laboratory data, which indicate the hydrogeologic and lithologic units for this site. The stratigraphy at the site has been assigned to hydrogeologic units as follows: two aquifers, upper and lower (Units 1 and 2 Aquifers) and two confining layers, upper and lower (Units 1 and 2 Confining Layers). Typical of the coastal plain, the site stratigraphy within the upper 25 feet beneath the surface is defined by a distinct boundary between recent fluvial sediments (tan-yellow and white cross-bedded sands and clays) and deeper marine sediments (dark green silty sands and clays, often with cemented zones and shell hash).

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11 Fetter, C.W., Contaminant Hydrogeology, Macmillian Publishing Company, New York, 1993.

The uppermost marine sediments have been identified as the Miocene-age Yorktown formation based on the fossil assemblage, yet the presence of glauconite (a dark green-black mica, related to biotite, which forms in deep marine environments)[12] in the deeper sediments suggests other possible formations mapped in the region, e.g., Castle Hayne, Beaufort, Pee Dee, or the Black Creek. Specific studies of index fossils were not performed to distinguish these formations, but a comparative study of water well data in the region (see Footnote 4) indicates that the on-site borings likely encountered the Castle Hayne and/or the Beaufort, in addition to the Yorktown.

Unit 1 Aquifer – Soils within the upper 5 to 8 feet below the surface consist of recent to Pliocene-age fluvial sediments, likely associated with former shorelines and/or estuaries of the Tar River and/or Grindle Creek. Pockets of buff-white, well graded sand (SW), with thicknesses of 15 feet, indicate former channel migration. Correlation of test borings and hand augers to earlier studies for Phase 1 indicates a relatively shallow, tan-yellow clay layer existing at depths between 16 to 24 inches, extending to depths of 36 to 48 inches. Cross-bedding is likely; the clay layer is present at most (but not all) test locations within the eastern portion of the site (not a true confining layer). The clay, sampled at B-2 and B-8, exhibits a laboratory permeability of 10^{-6} cm/sec (**Table 2**).

The silty sands and clean sands within the upper 10 to 14 feet are considered to be the uppermost aquifer. The water table typically occurs at 4 to 7 feet below the ground surface within this unit in the eastern portion of the site (typically shallower within the lower lying western portion of the site). Several piezometers were completed to a depth of 15 feet. Based on these data (Table 3) the hydraulic conductivity for this unit varies on the order of 10^{-3} cm/sec to 10^{-4} cm/sec.

Unit 1 Confining Layer – Below a depth of 12 to 17 feet exist sandy silt grading downward to plastic clay, which collectively vary in thickness from approximately 15 to 25 feet. The top of this layer is distinguished by a dark green-gray color, characteristic of marine sediments, and heavy shell hash, including whole turritellas (a snail-like marine mollusk). These strata represent the top of the Yorktown formation. The clay layer is present in every boring and exhibits a stiff, moist "gumbo" consistency, that is, the clay is easily molded into a thread of less than 1/8-inch diameter and maintains this level of plasticity for repeated remolding over several minutes.

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12 Hurlbut, Jr., C.S., and C. Klein, Manual of Mineralogy (after J.D. Dana), 19th ed., J.W. Wiley & Sons, New York, 1977.

Laboratory permeability testing on relatively undisturbed samples (see **Table 3** and **Appendix IV**), taken at B-1 from a depth of 11 feet and at B-10 from a depth of 14 feet, indicate hydraulic conductivity values of 1.5 x 10^{-7} cm/sec and 4.6 x 10^{-7} cm/sec, respectively. This unit has been identified as the top of the Yorktown Formation – marine clay of Miocene age – which predates the numerous sea level fluctuations associated with glacial activity (elsewhere) during the Pleistocene. The top of the confining unit, marked by the turritella -rich fossil assemblage, appears to be sculpted by channelized water during the multiple estuarine ingresses and regresses of the para-glacial period (see Figure F5). At some borings, there is a sandy transition layer, sometimes with the marker fossils (B-1d), but the clay layer is deeper or absent to the west of the footprint (B-30) and the marker bed is absent. Considering the flat potentiometric gradient and upward vertical gradient (discussed later), vertical ground water migration potential relative to the confining layer is limited.

Unit 2 Aquifer – Below depths of 35 to 45 feet exist relatively dense silty sands and clayey sands (SM and SM-ML), which locally are cemented. These soils contain variable amounts of glauconite (a type of mica found in deep marine sediments, distinguished by a green-black "speckled" color), and scattered pelecypod shell hash (including modern-type clams). The deeper sediments were often cemented, giving firm resistance to the drilling equipment. Occasional cemented shell hash concretions were encountered in the split spoon sampling, some of which resemble the distinctive pelecypod-mold structure of the Castle-Hayne formation. The concretions were not widely encountered and might represent reworked sediments derived from the older formation. A piezometer completed within this unit (MW-1d) indicates in-situ hydraulic conductivity values on the order of 10^{-6} cm/sec, while other piezometers within Phase 1 indicated conductivity values on the order of 10^{-4} to 10^{-5} cm/sec (see **Table 3**). This unit is 25 to 30 feet thick, based on the data.

Unit 2 Confining Layer – The deeper sediments (possible Castle-Hayne or Beaufort) became very clayey below depths of approximately 50 feet, but otherwise resembled the soils described in the overlying aquifer. This unit was encountered in test boring B-1d, extended to a depth of 80 feet. While the actual thickness cannot be determined, piezometer "slug test" data indicate a hydraulic conductivity on the order of 10^{-4} to 10^{-5} cm/sec (see Table 3). An earlier slug test for a nearby piezometer in Phase 1 (B-9) indicated an in-situ conductivity value on the order of 10^{-6} cm/sec. Published data indicates that confining units exist between the Yorktown and Castle Hayne formations and between the Castle

Hayne and the underlying Beaufort formation. Based on the projected depth of the Castle Hayne in this region, and the observation of pelecypod-mold concretions in the split spoon samples, it is likely that the test boring encountered this confining layer. The presence of glauconite (not typically associated with the Castle Hayne) might indicate the deeper Beaufort formation.

4.1.7 Water Table Information

4.1.7.1 Short-Term Water Levels - Table 4 presents a summary of short-term ground water levels observed at the end of drilling of the B-series piezometers and stabilized readings obtained after a period of one to fourteen days after completion of the piezometers.

4.1.7.2 Long-Term Water Levels - Table 5 presents a summary of long-term water level observations at the piezometers and nearby monitoring wells. Data for the B-series piezometers go back to November 2000. This table reflects water level elevation data acquired over a period covering more than one year for on-site data and back to November 2000 for the nearby Phase 1 monitoring well network. These data provide the basis for the ground water potentiometric surface map **(Drawing E1)**, discussed in **Section 4.1.7.3** and shown on the hydrogeologic cross sections (**Drawings X1** and **X2**).

4.1.7.3 Maximum Long-Term Seasonal High Water Table – Historical climatic data from the National Weather Service,[13] discussed in the **October 2002 Site Suitability** report, provides a basis for comparing observations at on-site piezometers with historic data from the Phase 1 monitoring well network to estimate maximum long-term seasonal high water levels. A parameter of interest is the Palmer Hydrological Drought Severity Index (PHDI), compiled for 105 years of weather records. The PHDI represents an overall moisture balance within a region of interest, compiled from multiple weather stations for average precipitation, temperature (PET effects), leaf indices (growing season), wind velocities, and solar radiation. The cyclical data are shown on a time line (see Figure 3), with times of drought shown as negative values and wet times shown as positive. The relative duration of a drought or wet cycle correlates to the availability of moisture to recharge the ground water. Pitt County is located in Region 7 of the North Carolina climate network, which includes the eastern Coastal Plain.

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13 Time Bias Corrected Divisional Temperature-Precipitation-Drought Index, (TD-9640) March 1994, National Oceanic and Atmospheric Administration, periodic updates available on-line at www.ncdc.noaa.gov.

The PMDI data indicate that climatic moisture conditions were near normal to wet or the last several years. Exceptions occur during the latter portion of 1993 and 1994, which experienced prolonged dry spells that classify as moderate drought conditions. Brief dry spells occurred during the latter part of 1997 and the early part of 1999. Mild to moderate wet conditions were experienced during the period from mid-1996 through early 1997, in part contributed to Hurricane Fran and generally high precipitation patterns during that time. Moderate to severe wet conditions resulted from the well documented "el Nino" winter of 1997-98, when record warm temperatures and high rainfall was recorded throughout the southeastern United States.[14] A notable wet spell, more pronounced than "el Nino" – previously considered as a recent climatic standard – occurred in late 2003 through early 2004, which was experienced by the on-site monitoring wells.

14 National Oceanic and Atmospheric Administration, NESDIS Press Release, March 9, 1998.

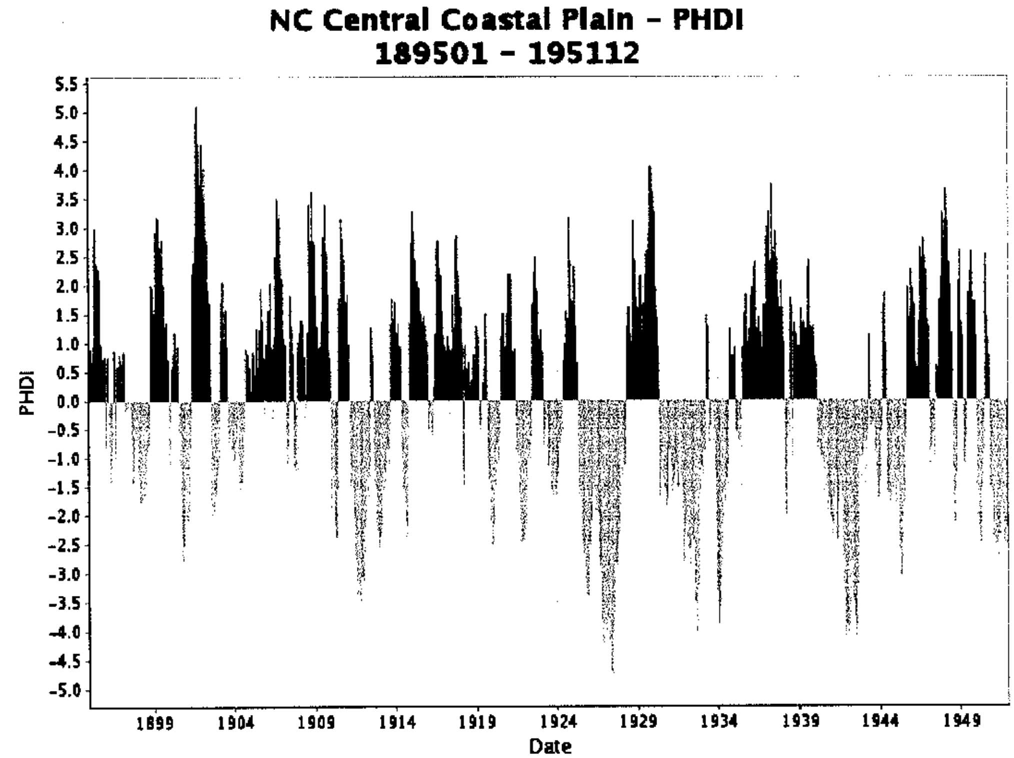

Figure 3A – Palmer Hydrologic Drought Index 1895 – 1951

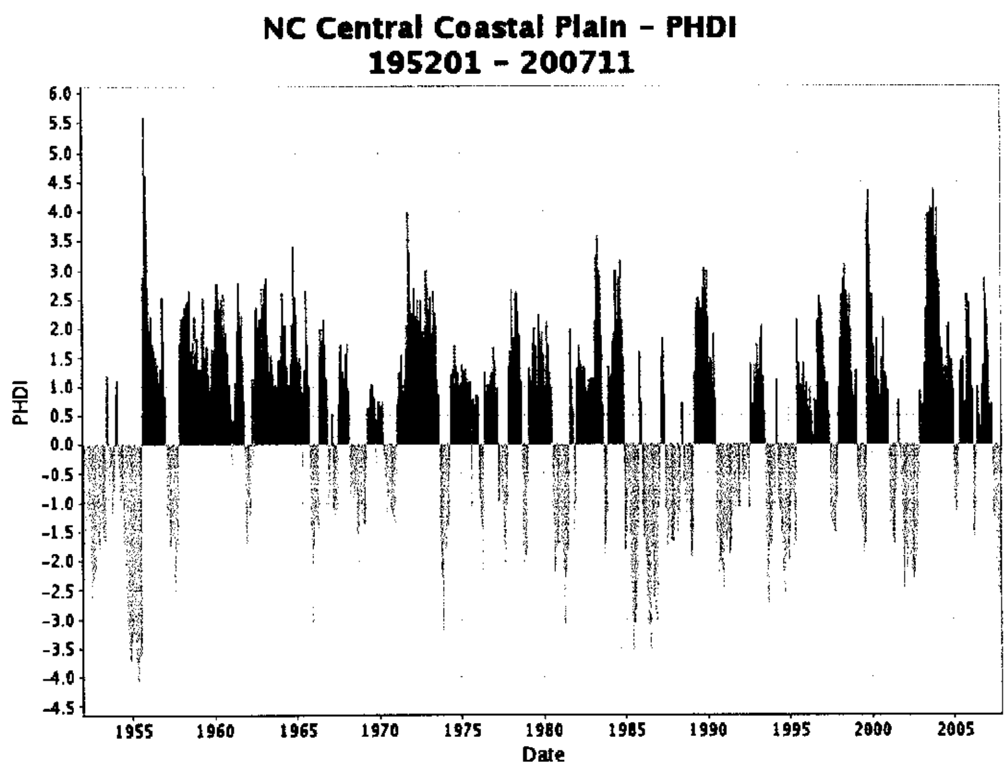

Figure 3B – Palmer Hydrologic Drought Index 1952 - 2007

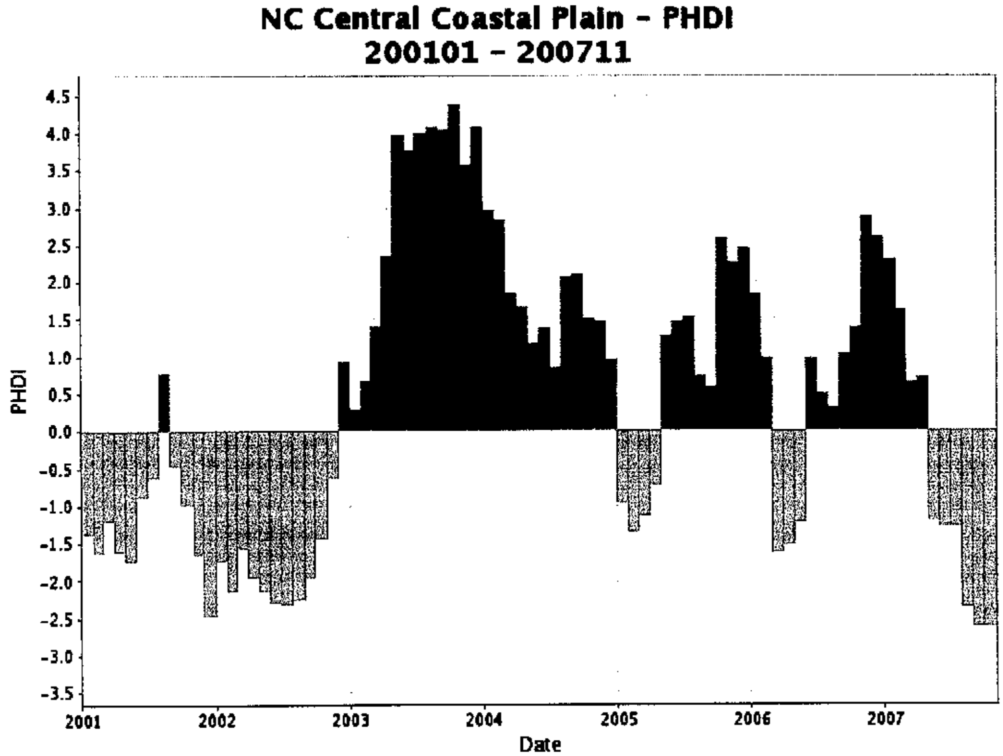

Figure 3C – Palmer Hydrologic Drought Index 2001 - 2007

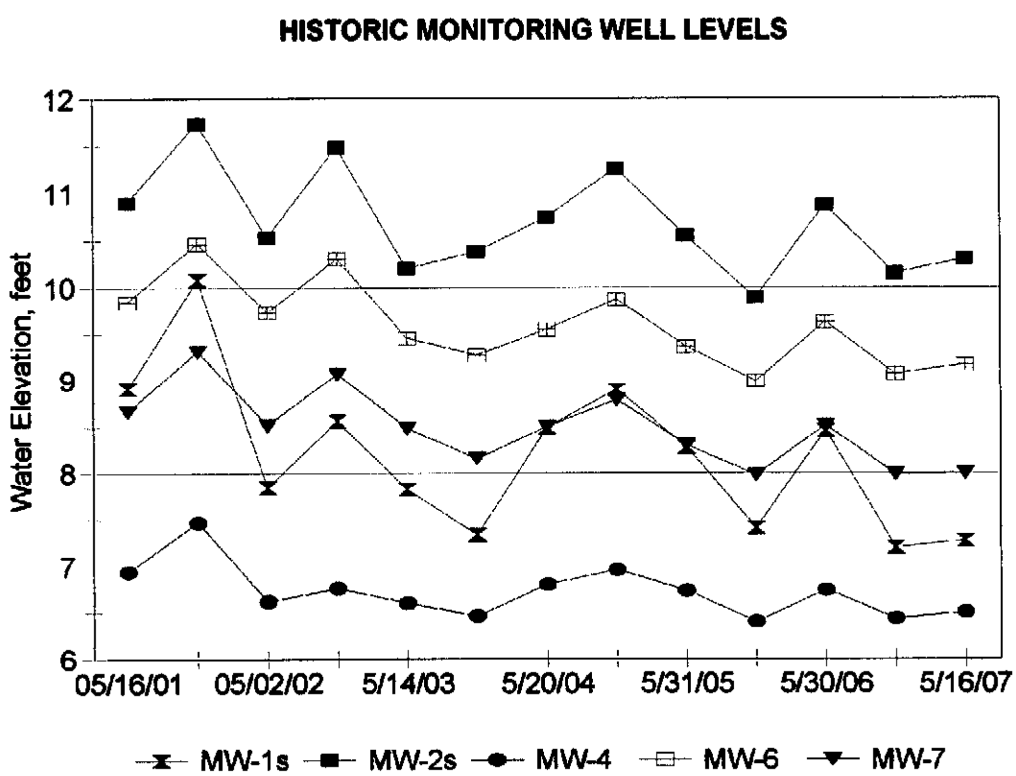

Figure 4 – Monitoring Well Hydrograph 2001 - 2007

Comparison with on-site water level observations indicates a fair correlation between the climatologic trends and the observed water levels. Peak monitoring well levels generally occur during May and November 2001 (Figure 4). The documented state-wide wet spell of 2003-04 (Figure 3C) is reflected by a trough in the monitoring well hydrograph, but the water levels responded over the following year (2004), whereas a peak occurred in the November 2004 observations. Following that, the monitoring wells reflect the general drying of the climate – with normal seasonal fluctuation – as state-wide drought conditions set in. Several factors pertaining to past and recent site development have the potential to affect ground water levels, discussed in **Section 4.1.7.4**.

Test Boring	Hydro Unit	Shallowest Max. Elev.	Deepest Min. Elev.	Observed Difference	Average Difference
MW-1s	AU-1	13.71	10.83	2.88	
MW-2s	AU-1	11.55	9.56	1.99	
MW-4	AU-1	12.02	10.74	1.28	
MW-5	AU-1	11.80	10.47	1.33	
MW-6	AU-1	11.03	9.57	1.46	
MW-7	AU-1	11.42	9.98	1.44	
MW-8	AU-1	11.85	10.63	1.22	
MW-9s	AU-1	12.52	9.11	3.41	1.88
MW-1d	AU-2	12.52	11.12	1.40	
MW-2d	AU-2	9.85	9.11	0.74	
MW-9d	AU-2	10.21	10.21	--	1.07
B-1s	AU-1	16.38	14.38	2.00	
B-2	AU-1	16.04	13.31	2.73	
B-3	AU-1	16.71	12.96	3.75	
B-4	AU-1	17.50	13.86	3.64	
B-5	AU-1	16.76	14.08	2.68	
B-5A	AU-1	19.16	17.03	2.13	
B-6	AU-1	16.99	13.76	3.23	
B-6A	AU-1	16.57	16.04	0.53	
B-7	AU-1	14.33	12.38	1.95	
B-8	AU-1	14.18	11.82	2.36	
B-8A	AU-1	14.00	12.71	1.29	
B-9	AU-1	13.30	11.15	2.15	
B-10	AU-1	14.53	11.71	2.82	
B-12	AU-1	12.62	11.90	0.72	

B-13	AU-1	13.40	12.26	1.14	
B-15s	AU-1	13.25	12.26	0.99	
B-16	AU-1	14.82	12.97	1.85	
B-17s	AU-1	14.65	13.44	1.21	
B-18	AU-1	15.40	13.80	1.60	
B-19	AU-1	15.99	14.22	1.77	
B-20	AU-1	15.25	13.80	1.45	
B-21	AU-1	15.72	13.80	1.92	
B-22	AU-1	14.34	13.08	1.26	
B-23s	AU-1	12.96	9.84	3.12	
B-24	AU-1	14.20	12.95	1.25	
B-25	AU-1	15.33	13.02	2.31	
B-27	AU-1	15.26	13.68	1.58	
B-29	AU-1	14.80	13.26	1.54	1.91
B-11	CU-1	11.91	10.75	1.16	
B-14	CU-1	13.70	12.77	0.93	
B-15d	CU-1	12.05	10.97	1.08	
B-17d	CU-1	13.71	12.56	1.15	
B-23d	CU-1	12.76	11.45	1.31	
B-26	CU-1	14.59	13.68	0.91	
B-28	CU-1	12.76	10.92	1.84	
B-30	CU-1	16.23	13.08	3.15	1.70
B-1d	AU-2	14.59	13.68	0.91	0.91

These data provide a sufficient basis for determining the Maximum Long-Term Seasonal High (MLSH) ground water levels for the site, discussed below. The summary table presents the maximum and minimum water levels observed from May 2001 through November 2007. Considering the monitoring wells, the average difference between the maxima and minima within wells completed in the uppermost aquifer (AU-1) is 1.88 feet, and within the deeper aquifer (AU-2) the difference is 1.07 feet. Within the Phase 2 test borings with piezometers completed in AU-1, the difference in the maxima and minima is 1.85 feet, during a period from December 2001 to June 2002. The difference in test borings with piezometers completed in AU-2 is 0.91 feet. Thus, while the data in Phase 2 cover a shorter time period, the difference in maximum and minimum values is virtually the same in both aquifer units. That, and the correlation with climatic trends, establishes the maximum values observed in Phase 2 during 2001-2003 as representative of the maximum long-term seasonal high water levels, without further adjustment.

4.1.7.4 Factors That Influence Water Table – Conditions at the site are conducive to high infiltration of surface water (upper aquifer recharge) and poor evapotranspiration characteristics. The site is nearly flat and cultivated, and surface depressions result in localized impoundments. Poor drainage originally necessitated the use of shallow drainage ditches to facilitate the former agricultural activities. Man-made influences include shallow drainage ditches (discussed earlier in the context of surface streams) existing to the east, west, and south of the Phase 2 footprint. These features tend to provide stabilizing effect on water level fluctuation, whereas the differences between the maximum and minimum observed water levels are generally less than 2 feet across the site. Changes in land use from agricultural and forest (which promotes high infiltration) to industrial uses (including the landfill, roadways, and appurtenances) tends to reduce infiltration and promote more runoff. This may have an irreversible affect on local ground water levels but not regional ground water.

High ground water conditions persisting into the autumn months are not unusual due to low ET, caused by poor vegetative cover and cover crop wilting. The available data suggest that the upper aquifer is not "flashy", taking weeks or months to fully respond to climatic changes. It should be noted that during the period from 2001 to 2003, heavy beaver activity (surface impoundments) was noted along the tributary to the west of the Phase 2 footprint, which caused higher ground water readings in the western portion of the Phase 2 site than would have occurred due to climatic response. The impoundments have since been removed, but the Phase 2 footprint was not affected by these conditions.

4.1.8 Horizontal and Vertical Flow Dimensions

Drawings X1 and **X2** present generalized hydrogeologic cross-sections that show the horizontal and vertical extent of the uppermost aquifer (AU-1) and ground water flow characteristics. Ground water movement through this formation is unconfined porous media. Recharge within the Phase 2 footprint occurs along most of the surface, with discharge from the surficial aquifer occurring along the on-site streams. A relatively slow horizontal flow occurs in the AU-1 aquifer (ranging 0.002 to 0.737 ft/day, average 0.245 ft/day), due in part to relatively flat gradients that reflect a subdued expression of the surface topography. A partial confining unit (CU-1) provides a lower boundary to the uppermost aquifer, although some slow horizontal flow and recharge to the lower aquifer (AU-2) is expected. Artesian pressures within the deeper aquifer limit potential contaminant migration through the confining layer. The cross sections show a horizontal flow within the deep aquifer, (calculated velocity of 0.075 ft/day). Flow calculations are presented on **Tables 6** and 7. Refer to the following detailed discussion.

Table 6 shows an upward vertical gradient between the upper and lower portions of the unconfined surficial aquifer (AU-1), as seen by the couplets at B-6/6A and B-8/8A. Upward gradients were determined between the upper aquifer (AU-1) and lower aquifer (AU-2) during the site characterization for Phase 1. Data at the couplet B-1s/1d show a downward gradient, which suggests differing conditions in the northern portion of the site – test borings indicate a sandier horizon at the elevation of the silt-clay confining unit detected at other locations. Temporal changes in the gradient direction likely reflect seasonality. The data indicate down ward gradients within the uppermost aquifer over much of the Phase 2, except as noted above.

Table 7 presents horizontal ground water gradient data and velocity calculations for various piezometers, arranged according to Hydrogeologic Units: Aquifer Units (A.U.) And Confining Units (C.U.). Calculated horizontal ground water flow velocities are based on field hydraulic conductivity data at the various piezometers (**Table 3**) and the horizontal gradients developed from the potentiometric contours shown on **Drawing E1**. Ground water velocities vary within the various Hydrogeologic Units, as follows:

Hydrogeologic Unit	**Average Horizontal Ground Water Velocity, ft/day**
A.U. 1	0.245
C.U. 1*	0.0011
A.U. 2	0.075
C.U. 2*	0.0003

*Determined in the Phase 1 site characterization

4.1.9 Ground Water Contour Maps

Drawing E1 shows ground water potentiometric contours based on Maximum Long-Term Seasonal High water level observations discussed in **Section 4.1.7.3**. made in March 2001. Ground water flow is generally toward the south, toward Grindle Creek and its tributaries that flank the higher ground of the site. A local divide surface drainage and ground water flow between the southeast and southwest directions. The potentiometric contours reflect a subdued expression of the surface topography, characteristic of the Coastal Plain. The potentiometric contours make a smooth transition to the unnamed tributaries. There are localized "high areas" in which the water levels are elevated due to variation in subsurface conditions and/or artesian pressure. These areas are reflected as closed contours on the potentiometric map.

4.1.10 Test Location Map

Drawing S5 shows the locations of test borings/piezometers and pre-existing monitoring wells used for this investigation.

4.1.11 Local Well and Water Use Information

A potable well survey conducted in 2000 in conjunction with the Phase 1 site characterization (**Drawing S1**). A handful of domestic wells were identified – most of the region is served by municipal water supply. No down gradient ground water wells or significant ground water users identified within a one-mile radius. A public well exists near the Pactolus cross-roads, some 2 miles west of (and upgradient of) the facility.

4.1.12 Special Geologic Considerations

No unusual geologic features have been determined which would affect the ground water flow or the ability to effectively monitor the site, including faults, mines or dikes. Site conditions appear typical of the North Carolina Coastal Plain region and similar to that determined for the adjacent Phase 1 site. Some consideration should be given to the presence of background metals in the natural geochemistry, discussed below.

Background metals – Some common inorganic constituents have been detected in the monitoring wells for Phase 1, going back to pre-disposal background sampling conducted in 2001. Detected inorganic constituents have been associated with regional background geochemistry, i.e., these are naturally occurring inorganic compounds, the detection of which can be directly attributed to turbidity (suspended and dissolved solids), that have been noted elsewhere in sampling programs in the Coastal Plain. The background sampling event (pre-disposal) of 5/16/01 detected the following constituents:

		Maximum detected concentration, mg/l	2L standard mg/l
Chromium	MW-1d, 1s, 2d, 2s, 4, 7	0.085	0.05
Lead	MW-2s, 4	0.029	0.015
Cobalt	MW-2s	0.019	NA
Vanadium	MW-1d, 2s	0.124	NA
Zinc	MW-1d, 2s	0.099	2.1

Later sampling events have detected concentrations of arsenic and barium, also believed to be associated with background geochemistry (noted during high turbidity events).

The Geochemical Atlas of North Carolina[15] provides graphical summary data for several inorganic constituents, based on the National Uranium Resource Evaluation (NURE) database. These data include stream sediment and ground water samples collected ca. 1970s. Not all inorganic constituents of interest are represented for all regions, but those of potential interest within the Coastal Plain region follow:

Constituent	Ground Water	Stream Sediment
Alkalinity	>3	0.38
Aluminum	440 ppb	64,000 ppm
Bromine	>160 ppb	
Chlorine	30,000 ppb	
Conductivity	>500 umho/cm	>180 umho/cm
Fluorine	200 – 400 ppb	
Iron		200K – 400K ppm
Manganese	200 ppb	250 ppm
Uranium	0.025 ppm	3 ppm
Vanadium	0.062 ppb	45 – 90 ppm

4.1.13 Summary Report

Hydrogeologic conditions at the C&D Landfill, Inc., site are viewed as a short segmented, closed-loop hydrologic cycle, with recharge occurring over a majority of the site and on-site discharge occurring at local streams. Ground water flow is generally toward the south, with the regional discharge feature (Grindle Creek) located beyond the property line to the southwest of Phase 1, but Phase 2 and most of Phase 1 is surrounded by smaller tributaries and deep drainage ditches that drain the uppermost aquifer, i.e., a loose sand layer extending to an average depth of 12 feet (varying to 30 feet in places) that blankets the site above a silt-clay confining unit. There are currently no development or ground water users in the down gradient direction.

The confining layer separates the uppermost aquifer from a deeper regional aquifer (contained within the Yorktown formation). The regional aquifer exhibits mildly artesian pressure that exerts an upward vertical gradient beneath much of the site. Conditions at the site are typical of the Coastal Plain region, except that ground water levels are deeper than would be expected based on local topography. The surficial aquifer is recharged through normal precipitation, ground water migration from the east. Based on an analytical solution to the two-dimensional advection-dispersion equation for contaminant transport, the site can be effectively monitored by a 300-foot well spacing in the uppermost aquifer. Both upper and lower aquifers need to be monitored, although the deeper regional aquifer has been monitored at a reduced frequency.

15 Available on-line at http://www.geology.enr.state.nc.us/NUREgeochem/geochem2.htm

4.2 Design Hydrogeologic Report – CDLF Phase 2

A single hydrogeologic investigation was performed to satisfy the requirements of both the site suitability investigation and the design hydrogeologic evaluation, relative to the Phase 2 expansion, shown on **Drawing S5.** The test boring program described in **Section 4.1.3** indicates 34 piezometers and two surface streams serving as ground water observation points within the 89.5-acre addition to the facility boundary. There are 23 piezometers within/near the Phase 2 footprint, which covers approximately 23 acres.

4.2.1 Ground Water Monitoring System Design

4.2.1.1 Aquifer Characteristics – Site geology has been described as a multiple layer system (**Section 4.1.6**) with an upper sand serving as the uppermost aquifer (Unit AU-1), comprised of Pleistocene fluvial sediments, underlain at depths varying from 12 to 30 feet by deep marine silt-clay that serves as a partial confining layer with thicknesses varying from 10 to 15 feet (Unit CU-1). Hydraulic conductivity values vary on the order of 10^{-3} to 10^{-4} cm/sec within the upper sands and on the order of 10^{-4} to 10^{-5} cm/sec within the partial confining unit. The stratigraphy is considered a "leaky aquifer", whereas the conductivities differ by relatively little (an order of magnitude) and the silt-clay is relatively sandy in places. However, there is an upward vertical gradient, which suggests a degree of confinement due to the silt-clay layer. Beneath the confining layer exists confined, porous silty and clayey sand (AU-2), with conductivity values on the order of 10^{-4} cm/sec, and another confining unit (CU-2) with conductivity values on the order of 10^{-6} cm/sec. The data suggest transitional boundaries between the units. Ground water discharge from the uppermost aquifer (AU-1) occurs along surface streams that surround the Phase 2 site.

4.2.1.2 Relative Point of Compliance – Selection of monitoring well locations for compliance monitoring of the uppermost aquifer is based on an understanding of hydrogeological conditions presented in this report. North Carolina solid waste Rule .1631 (a)(2)(B), pertaining to MSW facilities (extended to CDLFs by Division policy) makes a provision for the relevant point of compliance to be located no more than 150 feet from the waste boundary (relative to a 200 foot buffer) but at least 50 feet within the facility boundary. Division policy has been to require the compliance wells for CDLFs to be located within approximately 75-100 feet of the waste boundary, or approximately half the distance between the edge of waste and the compliance boundary. Based on the site studies, it appears that this spacing for compliance wells is appropriate for this facility. Based on the advection-dispersion calculations performed for Phase 1, a well spacing of no more than 300 feet in the down gradient direction is appropriate.

4.2.1.3 Monitoring Plan Amendments – Based on the foregoing discussion, amendments to the Sampling and Analysis Plan (**Appendix 6**) consist of eight new compliance wells in the uppermost aquifer (AU-1), one of which is a shallow/deep couplet to monitor the deeper aquifer (AU-2), and one upgradient background well in the upper unit (AU-1). No new surface water sampling is proposed. The existing monitoring plan for Phase 1 will be amended with the new wells, which are shown on **Drawing MP1**.

Proposed Well	Nearest Piezometer	Ground Elevation	Top of Yorktown Fm. Confining Unit	Est'd Screen Interval Depth (bgs) and Elev.*	Est'd High Water Elevation (msl)
MW-9A	B-19	19	13.3' (El. 0.9)	5 – 15' (El. 14 to 4)	13.80 to 15.99
MW-10	B-24	14	13.3' (El. 3.4)	5 – 15' (El. 9 to -1)	12.95 to 14.20
MW-11	B-15S	13	15.5' (El. 2.1)	10 – 20' (El. 3 to -7)	12.26 to 13.40
MW-12	B-11	15	10.9' (El. 4.3)	5 – 15' (El. 14 to 1)	10..75 to 11.91
MW-13	B-12	14	17.9' (El. -1.2)	10 – 20' (El. 4 to -6)	11.90 to 12.62
MW-14S	B23S*	13.90	13.0' (El. 0.9)	15 – 20' (El. -1.1 to -6.1)	9.84 to 12.96
MW-14D	B23D*	14.54	12.7' (El. 1.8)	35 – 40' (El. -20.5 to -25.5)	11.45 to 12.76
MW-15	B-17S	15	13.0' (El. 4.0)	5 – 15' (El. 8 to -2)	13.44 to 14.65
MW-17	B-7	16	17.0' (El. 1.3)	10 – 20' (El. 6 to -4)	11.82 to 14.33

*Utilize Existing Borings B-23S and D, although these have 5-foot screens
All others shall have 10-foot screens, situated just below the top of the Yorktown, i.e., drilling depths and screen intervals shall be adjusted as needed during installation. All wells shall be 2" PVC with 0.010" screen slotted screen opening, embedded in filter sand and grouted to surface with locking steel cover. It is writer's intention to bail all wells for pre-sampling purge (no dedicated pumps).

4.2.2 Rock Core Information – Not Applicable

4.2.3 Estimated Long-Term Seasonal High Water Table

Section 4.1.7 provides a detailed description of historic water level data, including wells pertaining to the CDLF. These data were used to estimate a maximum long-term seasonal high potentiometric surface, presented in **Drawing E1**. The potentiometric contours were used, in turn, to verify that a minimum of 4 feet of vertical separation exists to the proposed base grades of CDLF Phase 2.

4.2.4 Bedrock Contour Map – Not Applicable

4.2.5 Hydrogeologic Cross Sections

Drawings X1 and **X2** present generalized hydrogeologic cross-sections that depict the horizontal and vertical extent of the upper most aquifer (Units AU-1) and ground water flow characteristics (discharge areas vs. recharge areas). The cross sections show the vertical separation between the maximum long-term seasonal high potentiometric surface and the proposed CDLF Phase 2 base grades.

4.2.6 Ground Water Flow Regime

A description of ground water flow paths, horizontal and vertical gradients, flow rates, and recharge/discharge areas required by this rule are provided in **Sections 4.1.4.4, 4.1.6, 4.1.8, and 4.2.1.1**. These sections provide a sufficient basis for establishing the ground water monitoring plan amendments.

4.2.7 On-site Soils Report

The CDLF Phase 2 grading plan involves cuts up to 2 – 3 feet below existing ground surfaces – within a relatively small area in the southern end of Phase 2 – and fills on the order of 2 – 4 feet. Much of the base grades will exist near existing ground surfaces. Based on numerous test pits, hand augers, and test borings, soils within the upper 2 feet beneath existing ground surfaces are expected to meet the soil-type requirements (typically SM classifications) of the 2006 C&D Rules. Ample soil resources exist on-site and within adjacent land – over 100 acres with a NCDENR mining permit under the same ownership – available for construction and operations. A close inspection will be required during base grade construction to verify that the required soil types are present within the upper 2 feet beneath finished subgrades (see the **CQA Plan** in **Volume 2**).

4.2.8 Certification

This is to certify that all borings that intersect the water table at this site have been constructed and maintained as permanent monitoring wells or shall be abandoned in accordance with the provisions of 15A NCAC 02C .0113.

Signed ____________________________
Printed ____________________________
Date ______________________________

Not valid unless this document bears the seal of the above-named licensed professional.

VOLUME 2 – TABLE OF CONTENTS

REFER TO THE VOLUME1 TABLE OF CONTENTS FOR A GUIDE TO THE GEOLOGICAL ASPECTS OF THE FACILITY PLAN

TABLES *Refer to the in-text tables referenced by page number*

5.0 ENGINEERING PLAN (15A NCAC 13B .0539)

5.1 Engineering Report

This section of the report describes the physical aspects of the facility design, with emphasis on waste containment and environmental control systems, based on the hydrogeologic data discussed in **Section 4.0**. The design was prepared by a qualified Professional Engineer, who is licensed to practice in North Carolina and is familiar with the requirements of the North Carolina Division of Waste Management (Division) rules. The design of CDLF Phase 2 is set to provide approximately 9 years of capacity, in keeping with rules. Also, in keeping with the intent of the **2006 C&D Rules**, there is no liner or leachate collection system proposed for this facility since the site meets the rule requirements for soil types present within two feet below planned base grades, and there is at least 4 feet of vertical separation between the waste and seasonal high ground water and/or bedrock, (see **Rule .0540 (2)**). The planned base grades and outer slopes will have maximum slope ratios of 3H:1V, which have been demonstrated to be stable.

5.1.1 Analytical Methods

The facility design incorporates elements that are consistent with Division rules and guidelines, as well as sound engineering practice. Various analyses used in the design of the facility include evaluations of soil conditions, i.e., the consistency of subgrade soils and the availability of suitable soils for constructing stable embankments and other earthen structures (discussed below), and ground water characteristics, i.e., flow directions and seasonal water depth fluctuations (discussed in **Section 4.0**). Soil properties testing used to facilitate these evaluations included grain size analysis, shear strength, consolidation, and compaction characteristics (see **Appendix 5**). Stability and settlement of foundation soils were considered in setting base grades, as was outer slope stability for the final cover system (see **Appendix 7**). Other analyses included a detailed evaluation of S&EC and storm water management systems (see **Appendix 8**).

5.1.2 Identified Critical Conditions

Based on the nature of the soils within the Phase 2 footprint and the understanding of geologic conditions within the region (and the site), no inherent foundation stability or long-term settlement problems are anticipated. Some considerations that are both generic to landfills and specific to the on-site soils, learned through practical experience with the construction and operation of Phase 1, are discussed below.

- On-site soils are typically sandy, whereas fine grained soils that meet the soil-type requirements for the upper two (2) feet beneath the base grade elevations are available but often difficult to obtain in the region. Required soil types for the upper two (2) feet of base grades include SM, SC, ML, MH, CL, and CH. Borrow site selection and a field evaluation of the soils during construction (i.e., the CQA program, see Section 7) will be critical to assure the subgrade construction complies with the rule requirements.

- Soil compaction is dependent on both compaction effort (i.e., the right equipment) and working within the correct range of near-optimum moisture (**Section 5.2**).

- Properly compacted embankments are expected to be stable. Outer slope stability (relative to final cover) will also rely on adequate compaction and observation of proper slope ratios, due to the strength considerations.

- Another consideration is significant soil erosivity, which is counteracted with good cover construction practices and vegetative cover. The on-site soils have moderate field capacity and poor nutrient value, which may require additional effort to establish vegetation. These conditions pose operational considerations but require no special design accommodations.

5.1.3 Technical References

Calculations found in **Appendix 7** are referenced within the various analyses.

5.1.4 Location Restriction Demonstrations

The site was granted a Site Suitability determination in accordance with **15A NCAC 13B .0531** *et seq.* based on work completed in 2003-04, i.e., the site characteristics were determined suitable for a C&D landfill. Relative to **Rule .0536** pertaining to C&D landfills, the site has no disqualifying conditions with respect to zoning, setbacks from residences or potable wells, historic or cultural sites, state or nature preserves, 100-year floodplains, wetlands (except as discussed in **Section 3.3.3**), water supply watersheds, or endangered species. Documentation pertaining to these site selection criteria is found in **Appendix II** in the October 2002 **Site Suitability Report**.

5.2 Construction Materials and Practices

Based on the Design Hydrogeologic investigation (see **Section 4.0**), on-site soils available for embankment and subgrade construction consist chiefly of variably silty sand (i.e., Unified Soil Classification System classifications of SM and SM-ML) with silty clay (CL) and clayey silt (ML). These soils meet the requirements for the upper two feet beneath the landfill subgrade referenced in **15A NCAC 13B .0540 (2)** (see **Section 6.0**). The soils exhibit adequate compaction characteristics and shear strength (when properly compacted) to build stable embankments and subgrades that will not undergo excessive settlement – subject to the caveats discussed in **Section 5.1.2** (see above). Some selective use of soils and/or field evaluation will be required to place the correct soil types within the upper two (2) beneath the subgrade elevations.

Good construction practices for embankments and subgrades include compaction using steel-wheel rollers, sheep foot rollers, and/or smooth-drum rollers of sufficient weight – not dozers – making a minimum numbers of passes (typically three to five passes) in two perpendicular directions in order to achieve the desired strength properties for stability. Past experience at the site indicates that material selection (i.e., avoiding soils that are excessively wet or exhibit excess organic debris content) and/or blending soils to negate the effects of wet or slick soils will produce satisfactory results. The targeted compaction criterion is 95% of standard Proctor maximum dry density (**ASTM D-698**). Critical embankment and subgrade areas should be tested to ensure proper compaction in accordance with the criteria outlined in the CQA Plan (**Section 7.0**).

5.3 Design Hydrogeologic Report

Refer to **Section 4.0** of this report.

5.4 Engineering Drawings

Refer to the rolled plan set that accompanies this report. All relevant criteria required by the rules (except as noted) are depicted on the plans.

5.4.1 Existing Conditions

See **Drawings S1 – S5**.

5.4.2 Grading Plan

See **Drawing E1**.

5.4.3 Stormwater Segregation

See **Drawing E1** – while this rule requirement pertains to separation of stormwater runoff from leachate (i.e., a lined landfill), in order to reduce generated leachate volumes, good practices for water management include maintaining slopes with positive drainage (always directed toward approved stormwater control measures), facilitated by an orderly waste placement sequence, shown on this drawing.

5.4.4 Final Cap System

See **Drawing E2** for final contours and **Drawing EC2** for final cover cross-section and details.

5.4.5 Temporary and Permanent S&EC

See **Drawing E1** for temporary sedimentation and erosion control (S&EC) measures and **Drawing EC1** for permanent measures pertaining to the final cover. A separate S&EC plan has been submitted to the Pitt County Planning Department, which has delegated jurisdiction from the NC DENR Division of Land Quality. Minor design revisions to the S&EC plan, if any, resulting from the Pitt County review will be incorporated during construction and shown on "as-built" drawings for the Permit to Operate application.

5.4.6 Vertical Separation

See **Drawing E1** for base grades relative to ground water; also see cross section **Drawings X1 – X2**.

5.4.7 Other Features

This rule pertains to liners and leachate collection systems, if proposed (none are).

5.5 Specific Engineering Calculations and Results

Calculations for settlement and slope stability were performed using site specific data. The calculations can be found in **Appendix** 7, the geotechnical lab data are found in **Appendix** 4. The following is brief description of the analyses and results.

5.5.1 Settlement

Settlement is a concern at unlined landfills for maintaining vertical separation between the bottom of the waste (or base liner) and the maximum long-term seasonal high water table. Settlements of the foundation soils result from time-dependent strain, i.e., a change in thickness within the various soil layers due to the vertical stress (weight of the landfill) applied at the surface, accompanied by drainage of the various soil layers. Vertical stresses beneath landfills gradually increase as the waste becomes thicker over long periods of time; strain-induced settlements within sands and/or well drained silts and clays are relatively short-term, thus long-term settlements are not typically a concern unless thick uniform clay deposits are present (which tend to drain slowly) – such is not the case at the subject landfill.

Settlements were calculated using elastic methods adapted from the US Federal Highway Administration (FHWA) for highway embankments. Ostensibly, a landfill is a large flexible embankment with the highest stresses impinging on the foundation soils near the center. The FHWA settlement calculation is based on the work of Hough (1959) and others, which considers both the material type and overburden depth for determining a "correction factor" for standard penetration test (SPT) values, from which the compressibility and load-induced strain of each soil layer can be evaluated. For sandy soils conventional sampling via Shelby tubes and laboratory consolidation testing is infeasible. For clayey soils, representative Shelby tube samples were acquired and laboratory consolidation tests were performed (see **Section 4.1.4**), and the consolidation data were substituted into the calculations for appropriate soil layers.

A spreadsheet facilitates the settlement calculation (see **Appendix** 7). Initially, the vertical stress increase resulting from varying embankment heights was calculated using an average unit weight of 1000 pounds per cubic yard (37 pcf) and by applying a depth-related "influence factor" based on elastic stress distribution theory. Next a subsurface stress distribution was developed for original and post-construction (final height) conditions, based on the depth and average unit weight of the soil layers, plus the added vertical stresses. The SPT correction factor was applied to determine the compressibility factor and strain within each sand layer. For the clays, consolidation theory was applied to determine the strain in those layers, which was added to the strain in the sand layers to estimate total settlement under a given load. Time-dependent settlement was not considered due to the well drained conditions indicated by the subsurface data.

Assuming fairly uniform subsurface conditions within the footprint – as confirmed by the test borings – a representative subsurface profile was used to estimate the maximum settlements beneath the landfill (at the center), then successive calculations were made to evaluate areas within the footprint where lower stresses will occur, i.e., along side slopes. The variable settlement values were plotted on a map of the footprint (**Appendix 7**), from which it was confirmed that the base grade design, which provides 5 feet of vertical separation (not the minimum required 4 feet), is sufficient to accommodate the anticipated settlement while maintaining the required minimum vertical separation. Differential settlement within the footprint is not a concern. ***For this project, the maximum estimated settlement at the center of the landfill is 0.75 feet.***

5.5.2 Slope Stability

Two primary concerns exist for landfills with respect to slope stability: deep-seated or global stability involving a deep layer in the foundation or along the base of the landfill, which could potentially result in catastrophic slope failure, and veneer stability (sliding of the cover), which can expose the waste but is typically more of a maintenance issue relative to repairs in the event of a failure (veneer stability can also be catastrophic). Subsurface conditions identified at this site are relatively sandy (high strength soils) with interspersed this clay layers with sand seams that are expected to drain readily under the applied embankment loads – only "effective" stresses (i.e., drained conditions) were considered. The site is not earthquake prone, so liquefaction is not a concern. No extremely soft layers that would pose stability concerns were identified by the SPT testing, but the foundation is expected to undergo a strain-hardening strength increase as settlement occurs, i.e., the foundation soils will become even more stable with time.

5.5.2.1 Deep-seated stability – Limit-equilibrium methods, i.e., the STABL-5M model used for this project, evaluate the balance of forces driving a slide (weight of the porous material and contained water) against the forces resisting a slide (shear strength, expressed as cohesion and friction) along a theoretical failure surface, which can be either a circular surface or a series of intersecting planar surfaces. A "static" analysis considers just the weight of the materials and the shear strength (tie-back loads may be considered for reinforced embankments); a "dynamic" analysis might consider external loads, such as linear loads at the top of the embankment (i.e., traffic forces) or additional horizontal loads to represent earthquakes (expressed as a fraction of the normal gravity field, specific to the region of interest). In more advanced routines, the mass above the failure surface is divided into many slices, the driving and resisting forces for each of which are calculated and summed up. This "method of slices" expresses the balance of resisting forces and driving forces as a ratio, e.g., 1.5:1, or simply 1.5, which is the "safety factor." Ratios less than unity (safety factor <1) indicate unstable conditions.

Typical minimum safety factors for maintaining stable embankment conditions throughout the life of a project are 1.5 for static conditions, 1.2 for seismic conditions.

Shear strength inputs to the STABL-5M model were developed from the drilling and laboratory data (see **Section 4.1**). A circular failure surface was used with a Janbu method of slices analysis. A representative soil profile was developed from the drilling data. A side slope ratio of 3H:1V was modeled. The following table shows a summary of the soil strength input values for the representative cross section at the project site.

Soil Layer	Layer Thickness (feet)	Soil Layer Description	Saturated Unit Weight (pcf)	Drained Cohesion (psf)*	Drained Friction Angle (deg)
1	15	Sli. silty-clean sand N = 17	110	0	35
2	25	Silt-Clay N = 3 to 20	125	100	25
3	40	Silty sand N = 100	130	100	35
4	Undefined	Silt-clay N = 10	112	20	15
5	85	Waste	60	20	45

*Apparent cohesion for silty sands and waste is based on retrogression analysis from other projects (past experience). The water table was modeled at a depth of 5 feet below ground surface, i.e., the base of the waste, which reflects seasonal high conditions.

Based on the analysis presented in Appendix 7, the minimum safety factor for static conditions is 1.55; the minimum safety factor for seismic conditions (2%g) is 1.41.

5.5.2.2 Veneer Stability – Sliding of the final cover (or veneer failure) is dependent on slope angle, material strength, i.e., the interface friction angle and cohesion within the soils and between the soils and synthetic components (if any), and the degree of saturation. Veneer failure occurs when the pore pressures build up along a critical interface in excess of available shear strength. The severity of failure can range from minor sloughing of small areas (maintenance nuisances) to large-scale slides requiring complete replacement of large sections – this type of failure is expensive to repair, especially when synthetic components are involved. The analysis is typically performed for preliminary design conditions to anticipate (and try to avoid) the large-scale failures.

A worse-case scenario involves little (or no) cohesion, as in a geotextile-geomembrane interface, and complete saturation of the soils overlying that interface. Good engineering practice requires a drainage layer (typically a synthetic geonet) whenever a flexible membrane barrier is used, e.g., an alternative final cover that might be considered. The regulatory minimum cover includes 18 inches of vegetative support soil overlying a compacted soil barrier. Given the soils available in the region, the upper 18 inches could include a high permeability sand layer near the base, but the compacted soil barrier (maximum 1 x 10^{-5} cm/sec permeability) may not be readily available. North Carolina Solid Waste regulations allow alternative final covers, subject to approval by the Solid Waste Section, but specific interface testing will be required to verify future designs.

Even when all natural soil covers are used, drainage is still important relative to veneer stability, so a final cover section should include higher permeability sand layer next to the barrier to prevent the soils above the barrier from becoming saturated. Assuming a regulatory minimum cover soil profile is used, the critical interface for veneer stability exists within a low-cohesion sand layer overlying the compacted soil barrier at full saturation on a 3H:1V slope. While a minimum cohesion could be assumed along the sand layer and the compacted soil barrier, the stresses near the base of the sand layer would control stability.

A veneer stability analysis (**Appendix** 7) adapted from Matasovic (1991) was performed to evaluate four conditions: static unsaturated and saturated conditions (with a required safety factor of 1.5) and seismic unsaturated and saturated conditions (with a safety factor of 1.1). For this site, the static (non-seismic) saturated case is the critical condition for design because of the higher required safety factor. The calculations start with the given slope geometry and saturation state, then for a given safety factor the required friction (with or without cohesion) is back-calculated to provide the desired safety factor.

The analysis assumed full saturation of the vegetation support layer (upper cover soil is at field capacity) with a 1-year, 60-minute design storm impinging, resulting in a head of just over 12 inches acting on the base of the upper soil layer. Assuming the deeper compacted soil layer is stronger (due to cohesion) ***a minimum friction angle of 31 degrees is required within the upper soil layer***. Select soils available in the region (including the borrow sites on the premises) are capable of providing this minimum friction angle, combined with the required high permeability for drainage. The CQA program for the final closure should verify the available friction angles for the actual cover components (including alternative cover designs, if these are to be used).

5.5.3 Slope Ratios

Both the deep-seated stability analysis (Section 5.5.2) and the veneer stability analysis (Section 5.5.4) assumed a 3H:1V slope ratio. These analyses demonstrate that stability safety factors meet the minimum acceptable requirement of 1.5 for static (non-seismic) conditions. The use of 3H:1V slope ratios will result in stable slopes, providing that the drainage requirements are accommodated, and assuming proper vegetation maintenance.

5.5.4 Required Soil Volume Calculations

A soil volume analysis performed in part using AutoCAD Digital Terrain Model (DTM) methods is presented in Appendix 7. The following summary is revised for the slightly smaller airspace volume with the revised layout (see Section 3.3.3. The final cover soil volume is the same (assuming 36 inches of cover), as is the base grade fill volume, but the net airspace and intermediate cover have been adjusted. The analysis does not represent an actual earthwork balance, that is, the modest amount of soil cut is not factored into the volume of required borrow.

Total Airspace (includes 3' final cover thickness)	999,063 cy
Final Cover Required (23 ac. x 43,560 x 3' /27 x 1.1 x 1.15)	140,820 cy*
Net Airspace (total minus final cover)	858,243 cy
Intermediate Cover (assume 20% soil)	171,648 cy**
Base Fill Volume (fill depth varies up to 4 feet)	84,285 cy
Required Soil Balance (from adjacent borrow pit)	**396,753 cy**

*Use a slope factor of 1.1 (increases volume determined from plannimetric area) and a 15 percent shrinkage factor from borrow site to field placement (compaction)

**Available cover soils are sand, expect relatively high soil loss into voids

6.0 CONSTRUCTION PLAN REQUIREMENTS (15A NCAC 13B .0540)

This section demonstrates compliance of the facility design for CDLF Phase 1A with the requirements of the **2006 C&D Rules, 15A NCAC 13B .0531 *et seq.*** Reference is made to the construction plan set and various appendices, in which the calculations are presented.

6.1 Horizontal Separation

The following regulatory criteria are addressed in project drawings specified below. Refer to the rolled plan set that accompanies this report.

6.1.1 Property Lines

The minimum setback to property lines is 200 feet (**Drawings E1 and E2**).

6.1.2 Residences and Wells

The minimum setback to residences and wells is 500 feet (**Drawings S1 – S3**).

6.1.3 Surface Waters

The minimum setback to surface waters is 50 feet (**Drawings E1 and E2**).

6.1.4 Existing Landfill Units

The minimum setback to Phase 1 C&D landfill is 100 feet (**Drawing S3**). The Phases are separated by a small stream with associated wetlands – essentially these are separate disposal units for monitoring purposes. The planned expansion (Phase 2) is cross-gradient from Phase 1 relative to local and regional ground water flow. Phase 2 is not expected to impact either operations or monitoring of Phase 1, nor vice-versa.

6.2 Vertical Separation

6.2.1 Settlement

Maximum waste thicknesses are approximately 85 feet; the waste density is approximately 0.5 tons/cubic yard. Foundation soils are very medium stiff, normally consolidated silty sand, sandy silt and/or clayey sand and silt (all marine deposits). Settlement calculations (see **Appendix 7**) indicate maximum post-construction settlements on the order of 0.75 feet (9 inches), or less. Based on the grading plan (**Drawing E1**), settlements of this magnitude will not decrease the vertical separation to less than 4 feet, nor will strains adversely affect the engineered subgrade. Discussion of the assumptions and procedures behind the calculations is presented in **Section 5.5**.

6.2.2 Soil Consistency

Based on the laboratory data (see **Section 4.1.4**), a majority of the on-site soils generally classify as silty sands (SM), silt (ML) or dual classify as sand-silt (SM-ML). A relatively small fraction of the near surface soils consist of low plasticity silty clay (CL), and there are minor high plasticity silty clay (MH-CH) soil types present. These soil types will be present either in-situ or within compacted subgrades, meeting the requirements of **Rule .0540 (2) (b)** for the upper two feet beneath the subgrade. No modification of the soils, i.e., admixtures, will be required to meet this rule requirement, but reworking to blend the soils to a more uniform consistency and proper compaction may be required to mitigate isolated pockets of highly granular soils. For new base grade fill sections, proper soil selection will be required. The soil types shall be documented in the CQA program.

6.3 Survey Control Benchmarks

A permanent benchmark has been established by Burgess Land Surveying, P.A., of Wilson, NC. The benchmark is tied into the North Carolina State Plan (NCSP) coordinate system. The NCSP coordinates of the benchmark are as follows:

N 596,356.5642
E 1,119,904.2133
El. 955.43

6.4 Site Location Coordinates

The latitude and longitude coordinates of the center of the site are approximately:

N 35.3477,
E -81.9504.

6.5 Landfill Subgrade

6.5.1 Subgrade Inspection Requirement

The Owner/Operator shall have the Phase 2 subgrade inspected by a qualified engineer or geologist upon completion of the excavation, in accordance with **Rule .0534 (b)** and **Rule .0539**. Said inspection is required by the Division to verify that subgrade conditions are consistent with expected conditions based on the Design Hydrogeologic Report.

6.5.2 Division Notification

The Owner/Operator shall notify the Division at least 24 hours in advance of the subgrade inspection.

6.5.3 Vertical Separation Compliance

The subgrade inspection shall verify to the Division that the minimum vertical separation requirements are met and that required subgrade soil types are present.

6.6 Special Engineering Features

This section of the rules generally pertains to liners and leachate collection systems, if any are present (none will be).

6.7 Sedimentation and Erosion Control

The sedimentation and erosion control structures described elsewhere in this report (see **Appendix 8**) have been designed to accommodate the 25-year, 24-hour storm event, per the North Carolina Sedimentation Pollution Control Law **(15A NCAC 04)**. A separate plan has been prepared and submitted to the NC DENR Division of Land Resources, Land Quality Section, and is depicted in the construction plan set (see **Drawings E1 and EC3**). Existing sediment basins for Phase 1 shall be cleaned out and upgraded as needed; new sediment basins shall be constructed for Phase 2.

7.0 CONTRUCTION QUALITY ASSURANCE (15A NCAC 13B .0541)

7.1 General Provisions

This Construction Quality Assurance (CQA) Plan has been prepared to provide the Owner, Engineer, and CQA Testing Firm – operating as a coordinated team – the means to govern the construction quality and to satisfy landfill certification requirements. The CQA program includes both a quantitative testing program (by a third-party) and qualitative evaluations (by all parties) to assure that the construction meets the desired criteria for long-term performance. Variations in material properties and working conditions may require minor modification of handling and placement techniques throughout the project. Close communication between the various parties is paramount. It is anticipated that the early stages of the construction activities will require more attention by the CQA team, i.e., the Contractor, Engineer, Owner and CQA Testing Firm.

The requirements of the CQA program (construction oversight and testing) apply to the preparation of the base grades, embankments, and engineered subgrade, as well as the final cover installation. All lines, grades, and layer thicknesses shall be confirmed by topographic surveys performed under the supervision of the Engineer of Record or the CQA Testing Firm, and as built drawings of the base grades and final cover shall be made part of the construction records. Once the base grade and final cover construction is completed, the Engineer shall verify that all surfaces are vegetated within 20 days following completion of final grades. The Engineer shall also verify that interior slopes and base grades of new cells are protected until waste is placed.

7.1.1 Definitions

7.1.1.1 Construction Quality Assurance (CQA) – In the context of this CQA Plan, Construction Quality Assurance is defined as a planned and systematic program employed by the Owner to assure conformity of base grade and embankment construction and the final cover system installation with the project drawings and specifications. CQA is provided by the CQA Testing Firm as a representative of the Owner and is independent from the Contractor and all manufacturers. The CQA program is designed to provide confidence that the items or services brought to the job meet contractual and regulatory requirements and that the final cover will perform satisfactorily in service.

7.1.1.2 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 manufacturer's QC Plan for any Contractor-supplied components shall be incorporated as part of the Contractor's CQC submittal. The Owner and/or the Engineer shall approve the Contractor's QC submittal prior to initial construction. Contractor submittals may be (but us not required to be) incorporated into the final CQA certification document at the Owner's discretion.

7.1.1.3 CQA Certification Document – The Owner and/or the Engineer will prepare a certification document upon completion of construction, or phases of construction. The Owner will submit these documents to the NC DENR Division of Waste Management Solid Waste Section. The CQA certification report will include relevant testing performed by the CQA Testing Firm, including field testing used to verify preliminary test results and/or design assumptions, records of field observations, and documentation of any modifications to the design and/or testing program. An "as-built" drawing (prepared by/for the Owner), showing competed contours, shall be included. The Certification Document may be completed in increments, i.e., as several documents, as respective portions of the final cover are completed. Section 2 discusses the documentation requirements.

7.1.1.4 Discrepancies Between Documents – The Contractor is instructed to bring discrepancies to the attention of the CQA Testing Firm who shall then notify the Owner for resolution. The Owner 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 Owner, the more stringent requirement shall be the controlling resolution.

7.1.2 Responsibilities and Authorities

The parties to Construction Quality Assurance and Quality Control include the Owner, Engineer, Contractor, CQA Testing Firm (i.e., a qualified Soils Laboratory).

7.1.2.1 Owner – The Owner is C&D Landfill, Inc., who operates and is responsible for the facility. The Owner or his designee is responsible for the project and will serve as liaison between the various parties.

7.1.2.2 Engineer – The Engineer (a.k.a. the "Engineer of Rcord") is responsible for the engineering design, drawings, and project specifications, regulatory affairs, and communications coordinator for the construction of the base grades, embankments, engineered subgrade, drainage and final cover systems. The Engineer represents the Owner and coordinates communications and meetings as outlined in **Section 7.3**. The Engineer shall also be responsible for proper resolution of all quality issues that arise during construction. The Engineer shall prepare the CQA certification documents, with input from the Owner, the CQA Testing Firm and the Owner's Surveyor. The Engineer shall be registered in the State of North Carolina.

7.1.2.3 Contractor – The Contractor is responsible for the construction of the subgrade, earthwork, and final cover system. The Contractor is responsible for the overall CQC on the project and coordination of submittals to the Engineer. Additional responsibilities of the Contractor include compliance with 15A NCAC 4, i.e., the North Carolina Sedimentation and Erosion Control rules.

> **Qualifications** – The Contractor qualifications are specific to the construction contract documents and are independent of this CQA Manual.

7.1.2.4 CQA Testing Firm – The CQA Testing Firm (a.k.a. Soils Laboratory) is a representative of the Owner, independent from the Contractor, and is responsible for conducting geotechnical tests on conformance samples of soils and aggregates used in structural fills and the final cover system. Periodic site visits shall be coordinated with the Engineer of Record and the Contractor.

Qualifications – The CQA Testing Firm shall have experience in the CQA aspects of landfill construction and be familiar with ASTM and other related industry 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 construction.

7.1.3 Control vs. Records Testing

7.1.3.1 Control Testing – In the context of this CQA plan, 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.

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

7.1.4 Modifications and Amendment

This document was prepared by the Engineer to communicate the basic intentions and expectations regarding the quality of materials and workmanship. Certain articles in this document may be revised with input from all parties, if so warranted based on project specific conditions. No modifications will be made without the Engineer's approval.

7.1.5 Miscellaneous

7.1.5.1 Units – In this CQA Plan, and through the plans and specifications for this project, all properties and dimensions are expressed in U.S. units.

7.1.5.2 References – This CQA Plan includes references to the most recent version of the test procedures of the American Society of Testing and Materials (ASTM). **Table 7D** at the end of this text contains a list of these procedures.

7.2 Inspection, Sampling and Testing

The requirements of the General Earthwork (perimeter embankments and subgrade) and Final Cover Systems (soil barrier, vegetative cover, storm water management devices) differ with respect to continuous or intermittent testing and oversight. The following two sections are devoted to the specific requirements of each work task.

7.2.1 General Earthwork

This section outlines the CQA program for structural fill associated with perimeter embankments, including sedimentation basins, and general grading of the subgrade. Issues to be addressed include material approval, subgrade approval, field control and record tests, if any, and resolution of problems.

7.2.1.1 Compaction Criteria – All material to be used as compacted embankment shall be compacted to a minimum of **95% of the Standard Proctor Maximum Dry Density (ASTM D-698)**, or as approved by the Engineer or designated QC/QA personnel. Specifically, field observation of the response of soils beneath equipment and the use of a probe rod and/or a penetrometer are other means of determining the adequacy of compaction. Skilled soil technicians working under the supervision of an engineer may make this determination, subject to concurrence by the engineer. Approval is based on visual evaluation for consistency with project specification and objectives. Such material evaluations may be performed either during material handling, i.e., delivery to or upon receipt at the landfill, or from existing stockpiles and/or the soil borrow site. Borrow soils shall be evaluated by the Engineer and QC/QA personnel prior to placement on the work site. All visual inspection and testing shall be documented for the CQA Report.

Where permeability is the key parameter of interest, field and/or lab tests will be used.

7.2.1.2 Testing Criteria – Periodic compaction (moisture-density) testing requirements are imposed on the structural fill, although compaction and testing requirements may not be as stringent as that required for the final cover construction. Initial compaction testing shall be in accordance with the project specifications. The Engineer may recommend alternative compaction testing requirements based on field performance. Additional qualitative evaluations shall be made by the Contractor Superintendent and the Engineer to satisfy the performance criteria for placement of these materials.

CQA monitoring and testing will not be "full-time" on this project. Rather, the CQA Testing Firm will test completed portions of the work at the Contractor's or Owner's request. The CQA Testing Firm may be called upon to test final cover and/or compacted structural fill at any time, ideally scheduling site visits to optimize his efforts. The Engineer will make an inspection at least monthly, more often as needed (anticipated more often in the initial stages of new construction).

7.2.1.3 Material Evaluation – Each load of soil will be examined either at the source, at the stockpile area, or on the working face prior to placement and compaction. Any unsuitable material, i.e., that which contains excess moisture, insufficient moisture, debris or other deleterious material, will be rejected from the working face and routed to another disposal area consistent with its end use. Materials of a marginal natural, i.e., too dry or too wet, may be stockpiled temporarily near the working face for further evaluation by designated QC/QA personnel. The Contractor may blend such materials with other materials (in the event of dryness) or dry the materials (in the event of excess moisture).
Soils designated for the upper 2 feet of subgrade within the cell shall consist of ML, MH, CL, CH, SM and mixed SM-ML classifications – this shall be confirmed with lab testing.

7.2.1.4 Subgrade Approval – Designated QC/QA personnel shall verify that the compacted embankment and/or subgrade are constructed in accordance with the project specifications prior to placing subsequent or overlying materials. These activities include an inspection of the subgrade by a qualified engineer, geologist, or soil technician working under the supervision of an engineer, which will examine and classify the soils within the upper two feet beneath the finished subgrade. This may consist of continual observation during placement with confirmatory sampling and laboratory gradation testing at specified intervals, or there may be an exploratory sampling program at some time near the completion of the subgrade with confirmatory testing at specified intervals. The frequency of visual inspection and testing shall conform to **Table 7A**.

7.2.2 General Earthwork Construction

7.2.2.1 Construction Monitoring – The following criteria apply:

A. Earthwork shall be performed as described in the project specifications. The Construction Superintendent has the responsibility of assuring that only select materials are used in the construction, discussed above.

B. Only materials previously approved by the Engineer or his designee shall be used in construction of the compacted embankment. Unsuitable material will be removed and replaced followed by re-evaluation to the satisfaction of the Engineer and retesting, as may be required.

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

D. The CQA Testing Firm and/or the Engineer shall monitor protection of the earthwork, i.e., from erosion or desiccation during and after construction.

7.2.2.2 Control Tests – The control tests, as shown on **Table 7A**, will be performed by the CQA Testing Firm prior to placement of additional compacted embankment.

7.2.2.3 Record Tests – The record tests, as shown on **Table 7A**, will be performed by the CQA Testing Firm during placement of compacted embankment. The CQA Testing Firm may propose and the Engineer may approve an alternative testing frequency. Alternatively, the Engineer may amend the testing frequency, without further approval from the regulatory agency, based on consistent and satisfactory field performance of the materials and the construction techniques.

7.2.2.4 Record Test Failure – Failed tests shall be noted in the construction report, followed by documentation of mitigation. Soils with failing tests shall be evaluated by the Engineer (or his designee), and the soils shall either be recompacted or replaced, based on the Engineer's judgment. Recompaction of the failed area shall be performed and retested until the area meets or exceeds requirements outlined in the specifications.

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

- Rollers slip during rolling operation;
- Lift thickness is greater than specified;
- Fill material is at an improper moisture content;
- Fewer than the specified number of roller passes is made;
- Dirt-clogged rollers are used to compact the material;
- Rollers may not have used optimum ballast;
- Fill materials differ substantially from those specified; or
- Degree of compaction is doubtful.

7.2.2.6 Deficiencies – The CQA Testing Firm will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. The CQA Testing Firm shall properly document all defects and deficiencies – this shall be more critical on the final cover construction, although this applies to structural fill, as well. The Contractor will correct defects and deficiencies to the satisfaction of the Owner and Engineer. The CQA Testing Firm shall perform retests on repaired defects.

7.2.3 Final Cover Systems

This section outlines the CQA program for piping, drainage aggregate, geotextiles, compacted soil barrier layer, and the vegetative soil layer of the final cover system, as well as the related erosion and sedimentation control activities. Issues to be addressed include material approval, subgrade approval, field control and record tests, if any, and resolution of problems.

7.2.3.1 Material Approval – The Engineer and/or the CQA Testing Firm shall verify that the following materials (as applicable) are provided and installed in accordance with the project drawings, specifications, and this CQA Manual. In general, the Contractor shall furnished material specification sheets to the Engineer for review and approval. In certain cases, materials furnished by the Contractor may need to meet the Owner's requirements, in which case the Owner shall approve of the materials with the Engineer's concurrence. The materials approval process may involve the submittals furnished by the Owner, (for documentation purposes) in the event that the Owner decides to furnish certain materials.

A. <u>High Density Polyethylene (HDPE) Pipe</u>

(1) Receipt of Contractor's submittals on HDPE pipe.

(2) Review manufacturer's submittals for conformity with project specs.

B. Corrugated Polyethylene (CPE) Pipe

(1) Receipt of Contractor's submittals on CPE pipe.

(2) Review manufacturer's submittals for conformity with project specs.

C. Aggregates (Verify for each type of aggregate)

(1) Receipt of Contractor's submittals on aggregates.

(2) Review manufacturer's submittals for conformity with project specs.

(3) Verify aggregates in stockpiles or borrow sources conform to project specifications. Certifications from a quarry will be sufficient.

(4) Perform material evaluations in accordance with **Table 7B**.

D. Vegetative Soil Layer and Drainage Layer

(1) Review manufacturer's submittals for conformity with project specs.

(2) Review contractor's submittals on seed specifications.

(3) Perform material evaluations in accordance with **Table 7C**.

E. Compacted Barrier Layer

(1) Review manufacturer's submittals for conformity with project specs.

(2) Conduct material control tests in accordance with **Table 7C**.

F. Erosion and Sedimentation Control

(1) Review Contractor's submittals on erosion and sedimentation control items (including rolled erosion control products and silt fence).

(2) Review of submittals for erosion and sedimentation control items for conformity to the project specifications.

(3) Perform visual examination of materials for signs of age or deterioration.

7.2.3.2 Final Cover Systems Installation – The CQA Testing Firm, in conjunction with the Engineer, will monitor and document the construction of all final cover system components for compliance with the project specifications. Monitoring for the components of the final cover system includes the following:

- Verify location of all piping;

- Assuring sufficient vertical buffer between field equipment and piping;

- Monitoring thickness and moisture-density of the final cover layers and verification that equipment does not damage the compacted barrier layer or other components; and

- Assuring proper installation of sedimentation and erosion control measures.

7.2.3.3 Deficiencies – The CQA Testing Firm and/or the Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner. The CQA Testing Firm and/or the Engineer shall properly document all defects and deficiencies. The Contractor will correct defects and deficiencies to the satisfaction of the Engineer. The CQA Testing Firm and/or the Engineer shall observe all retests on repaired defects.

7.3 CQA Meetings

Effective communication is critical toward all parties' understanding of the objectives of the CQA program and in resolving problems that may arise that could compromise the ability to meet those objectives. To that end, meetings are essential to establish clear, open channels of communication. The frequency of meetings will be dictated by site conditions and the effectiveness of communication between the parties.

7.3.1 Project Initiation CQA Meeting

A CQA Meeting will be held at the site prior to placement of the compacted barrier layer. At a minimum, the Engineer, the Contractor, and representatives of the CQA Testing Firm and of the Owner will attend the meeting. The purpose of this meeting is to begin planning for coordination of tasks, anticipate any problems that might cause difficulties and delays in construction, and, above all, review the CQA Manual to all of the parties involved.

During this meeting, the results of a prior compaction test pad will be reviewed, and the project specific moisture-density relationships and 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 Engineer shall document the meeting and minutes will be transmitted to all parties.

7.3.2 CQA Progress Meetings

Progress meetings will be held between the Engineer, the Contractor, a representative of the CQA Testing Firm, and representatives from any other involved parties. Meeting frequency will be, at a minimum, once per month during active construction or more often if necessary during critical stages of construction (i.e., initial stages of final cover). These meetings will discuss current progress, planned activities for the next week, and any new business or revisions to the work.

The Engineer will log any problems, decisions, or questions arising at this meeting in his periodic reports. Any matter requiring action, which is raised in this meeting, will be reported to the appropriate parties. The Engineer will document these meetings and minutes will be transmitted to interested parties and to a record file.

7.3.3 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 Engineer, the Contractor, the CQA Testing Firm, and representatives will attend the meeting 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 Engineer will document these meetings and minutes will be transmitted to interested parties and to a record file.

7.4 Documentation and Reporting

An effective CQA plan depends largely on recognition of which construction activities should be monitored and on assigning responsibilities for the monitoring of each required activity. This is most effectively accomplished and verified by the documentation of quality assurance activities. The CQA Testing Firm will provide documentation to address quality assurance requirements. Monitoring will not be continuous and full-time, although the CQA Testing Firm representative (typically this is a Soil Technician) and the Engineer will make frequent and periodic visits to inspect and/or test the work. Both parties shall keep records of their visits and observations.

The Soils Technician will visit the site periodically (e.g., once per week) to document activities during placement of the structural fill and during final cover construction. Site visits by the CQA Testing Firm shall be coordinated between the Contractor and the CQA Testing Firm. The Engineer will make monthly site visits during these critical stages to review the work.

The Construction Superintendent or his representative shall be present on-site daily and shall keep a record of the general construction progress, noting specifically any problems or inconsistencies that need to be brought to the Owner's attention. The specifics of the Contractor's records will not be spelled out, but at a minimum, daily or weekly progress records shall be kept and made available to the Owner upon request.

The CQA Testing Firm will provide the Owner (or his designee) with periodic progress reports including signed descriptive remarks, data sheets, and logs to verify that required CQA activities have been carried out. These reports shall also identify potential quality assurance problems. The CQA Testing Firm will also maintain at the job site a complete file of project drawings, reports, project specifications, the CQA Plan, periodic reports, test results and other pertinent documents. The Owner shall furnish a location to keep this record file.

7.4.1 Periodic CQA Reports

The CQA Testing Firm representative's reporting procedures will include preparation of a periodic report that will include the following information, where applicable:

- A unique sheet number for cross referencing and document control;
- Date, project name, location, and other identification;
- Data on weather conditions;
- A 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 (as they become available, in the case of laboratory tests);
- Calibration or recalibration 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 Engineer;
- The Technician's signature.

The periodic report must be completed by the end of each Technician's visit, prior to leaving the site. This information will keep at the Contractor's office and reviewed periodically by the Owner and Engineer. The CQA Testing Firm on a weekly basis should forward copies of the Periodic CQA Reports electronically to the Engineer. Periodic CQA Reports shall be due to the Engineer no later than Noon on the next working day (typically Monday) following the end of a work week (typically Friday). If a periodic visit is postponed or cancelled, that fact should be documented by the CQA Testing Firm and noted in the next periodic report.

7.4.2 CQA Progress Reports

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

- 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;
- A summary of all test results, failures and retests, and
- The signature of the Engineer.

The Engineer's progress reports must summarize the major events that occurred during that week. This report shall include input from the Contractor and the CQA Testing Firm. Critical problems that occur shall be communicated verbally to the Engineer immediately (or as appropriate, depending on the nature of the concern) as well as being included in the Periodic CQA Reports.

7.4.3 CQA Photographic Reporting

Photographs shall be taken by the CQA Testing Firm at regular intervals during the construction process and in all areas deemed critical by the CQA Testing Firm. 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. Electronic photographs are preferred, in which case the electronic photos should be forwarded to the Engineer (the CQA Testing Firm shall keep copies, as well). 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.

7.4.4 Documentation of 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 the Owner and Engineer will approve any revision to procedures or specifications.

7.4.5 Design and/or Technical Specification Changes

Design and/or project specification changes may be required during construction. In such cases, the Contractor will notify the Engineer and/or the Owner. The Owner 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 the Owner, and will take the form of an addendum to the project specifications. All design changes shall include a detail (if necessary) and state which detail it replaces in the plans.

7.5 FINAL CQA REPORT

At the completion of each major construction activity at the landfill unit, or at periodic intervals, the CQA Testing Firm will provide final copies of all required forms, observation logs, field and laboratory testing data sheets, sample location plans, etc., in a certified report. Said report shall include summaries of all the data listed above.

The Engineer will provide one or more final reports, pertinent to each portion of completed work, 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 Engineer will provide Record Drawings, prepared with input from the Owner's Surveyor, which 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 final surveying required for the Record Drawings will be performed by the Owner's Surveyor. The items shown below shall be included in the Final CQA Report(s). Note that some items may not be applicable to all stages of the project.

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 Summary and Conclusions
7.0 Project Certification

Appendices
A Design Clarifications/Modifications
B Photographic Documentation
C CQA Reporting
C1. CQA Reports
C2. CQA Meeting Minutes
D Earthwork CQA Data
D1. CQA Test Results - Control Tests
D2. CQA Test Results - Record Tests
E Final Cover System CQA Data
E1. Manufacturer's Product Data and QC Certificates
E2. CQA Test Results - Drainage Aggregate
E3. CQA Test Results - Vegetative Soil Layer
E4. CQC Test Results - Pressure Testing of HDPE Piping
F Record Drawings
F1. Subgrade As Built
F2. Vegetative Soil Layer As Built

Each CQA report shall bear the signature and seal of the Engineer (or multiple Engineers as applicable), attesting that the construction was completed in accordance with the CQA plan, the conditions of the permit to construct, the requirements of the North Carolina Solid Waste Rules, and acceptable engineering practice.

7.6 STORAGE OF RECORDS

All handwritten data sheet originals, especially those containing signatures, will be stored in a secure location 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.

7.7 PROTECTION OF FINISHED SURFACES

The only relevant systems exposed after construction will be the finished slopes, including both interior and exterior slopes, various drainage systems, and the subgrade,. Ground cover shall be established on all finished surfaces shall to prevent erosion, i.e., seeding of the finished surfaces within 20 days, per NC DENR Division of Land Quality rules, or other measures for preventing erosion (e.g., mulch, rain sheets). Maintenance of finished slopes and subgrade until waste is placed is required. Exterior slopes shall be vegetated in accordance with application sediment and erosion control regulations. The Engineer shall document that the finished surfaces are adequately protected upon completion, and said documentation shall be recorded in the CQA report.

The Owner/Operator shall be responsible for maintaining the finished surfaces, including exterior slope vegetation and drainage conveyances, along with the interior slopes and subgrades. If finished surfaces within the waste disposal area will be required to sit completed for more than 30 days following completion, the Engineer shall examine the finished surfaces prior to waste disposal and the Owner shall be responsible for any necessary repairs, e.g., erosion that might affect embankment integrity or vertical separation with a subgrade. The Engineer shall document any required maintenance or repairs prior to commencing disposal activities, placing said documentation into the Operating Record.

TABLE 7A
CQA TESTING SCHEDULE FOR GENERAL EARTHWORK

PROPERTY	TEST METHOD	MINIMUM TEST FREQUENCY
CONTROL TESTS:		
Consistency Evaluation	ASTM D 2488 (visual)[1]	Each Material
RECORD TESTS:		
Lift Thickness	Direct Measure	Each compacted lift
In-Place Density	ASTM D 2922[2]	20,000 ft^2 per lift
Moisture Content	ASTM D 3017[3]	20,000 ft^2 per lift
Subgrade Consistency within the upper 24 inches[4]	Visual	4 tests per acre
Subgrade Consistency within the upper 24 inches[4]	ASTM D 422 ASTM D 4138	1 test per acre

Notes:

1. To be performed by Contractor Superintendent, Engineer, or CQA Testing Firm. Direct measure shall be facilitated with hand auger borings.
2. 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. ***Minimum required soil density is 95 percent of the standard proctor maximum dry density, which is dependent on the moisture-density characteristic developed for the specific soil during initial construction; lower density or incorrect moisture results in a failed test and the lift must reworked and retested.***

2a. If "beneficial fill" materials are used to construct embankments or structural fill, the Contractor shall spread large particles evenly and fill all voids with finer soil – this is referred to as "choking off" the voids; density testing shall be suspended at the discretion of the Engineer, but judgment testing shall be applied and the use of these materials and evaluation thereof shall be documented as would any other soil placement activity

3. Optionally use ASTM D 2216, ASTM D 4643, or ASTM D 4959. For every 10 nuclear density-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.
4. Subgrade evaluation shall be conducted via continuous inspection with the indicated testing frequency, in order to evaluate the full 24 inch depth, of an intrusive investigation (e.g., hand auger borings) may be performed after portions of the subgrade are completed with the indicated testing frequency – all testing locations, testing types and test results shall be recorded on a site map and made part of the construction record

TABLE 7B
CQA TESTING SCHEDULE FOR DRAINAGE AND FINAL COVER SOIL

COMPONENT	PROPERTY	TEST METHOD	MINIMUM TEST FREQUENCY
RECORD TESTS:			
Coarse Aggregate:	Confirm Gradation	Visual	5,000 CY[1]
Vegetative Soil Layer: (In-Situ Verification)	Visual Classification	ASTM D 2488	1 per acre
	Layer Thickness	Direct measure	Survey[4]

Notes:

1. A quarry certification is acceptable for aggregate from a commercial quarry. If a byproduct is used, i.e., crushed concrete aggregate, the gradation test frequency may be adjusted based on project specific conditions. The Engineer shall approve all materials and alternative test frequencies. ***Materials that do not meet relevant ASTM or ASHTO standard gradation specifications (either may be used at the discretion of the Engineer) shall be rejected.***

TABLE 7C
CQA TESTING SCHEDULE FOR FINAL COVER COMPACTED SOIL BARRIER

PROPERTY	TEST METHOD	MINIMUM TEST FREQUENCY
RECORD TESTS:		
Lift Thickness	Direct measure	Survey[4]
Permeability	ASTM D5084[1]	1 per acre per lift
In-Place Density	ASTM D 2922[2]	4 per acre per lift
Moisture Content	ASTM D 3017[3]	4 per acre per lift

Notes:

1. Optionally use ASTM D6391. ***Maximum allowable soil permeability is 1×10^{-5} cm/sec; higher permeability results in a failed test and the lift must reworked and retested.***
2. 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 device. ***Minimum required density is dependent on the moisture-density-permeability characteristic developed for the specific soil during initial construction; lower density or incorrect moisture may result in higher permeability. Permeability criteria shall govern the determination of a passing test.***
3. Optionally use ASTM D 2216, ASTM D 4643, or ASTM D 4959. For every ten 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.
4. Topographic graphic survey by licensed surveyor

TABLE 7D
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 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 1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
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 2488	Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
ASTM D 2922	Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
ASTM D 2937	Standard Test Method for Density of Soil in Place by the Drive Cylinder Method.
ASTM D 3017	Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
ASTM D 4318	Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
ASTM D 4643	Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method.
ASTM D 4959	Standard Test Method for Determination of Water (Moisture) Content of Soil by Direct Heating Method.
ASTM D5084	Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
ASTM D 5993	Standard Test Method for Measuring Mass per Unit of Geosynthetic Clay Liners.
ASTM D6391	Standard Test Method for Field Measurement of Hydraulic Conductivity Limits of Porous Materials Using Two Stages of Infiltration from a Borehole
ASTM D 6768	Standard Test Method for Tensile Strength of Geosynthetic Clay Liners.

8.0 OPERATION PLAN (15A NCAC 13B .0542)

8.1 General Conditions

This Operations Plan was prepared for C&D Landfill, Inc., Phase 2 to provide landfill personnel with an understanding of relevant rules and how the Design Engineer assumed that the facility would be operated. While deviations from the operation plan outlined here may be acceptable, significant changes should be reviewed and approved by the Design Engineer and/or regulatory personnel.

8.1.1 Facility Description

The landfill entrance is located at 802 Recycling Lane, accessed from US 264. The scales and office are located near the front gate, which is the only means of accessing the site by the public. After crossing the scales, incoming loads are directed either to the Recycling Yard or to the working face of the C&D disposal unit~~. LCID is recycled into mulch within specific areas shown on the Facility Plan Map~~ (see **Drawing S3**).

8.1.2 Geographic Service Area

The current service area authorized by the Pitt County Commissioners includes a multi-county area (see **Section 3.3**). The facility receives C&D from commercial haulers, contractors, and private individuals. The recycling facility and MSW transfer station receive other wastes, which are segregated from the C&D and managed in separate areas. The operator will be responsible for knowing his customer base and waste stream characteristics, such that the approved service area is observed.

8.1.3 Hours of Operation

The landfill is open to the public from 7 AM to 4 PM on Monday – Friday and 7 AM to 12 PM on Saturday. All current operations for the C&D landfill are within those hours.

8.1.4 Personnel Training and Certification

NC DENR Division of Waste Management rules require that a certified Operator be present on-site at all times during operations. As many of the facility staff as practical will receive Operations Specialist training from a credible organization, e.g., SWANA. Certificates will be posted prominently in the scale house, and certifications will be kept up-to-date.

8.1.5 Utilities

Electrical power, water, telephone, and restrooms are provided at the scale house.

8.1.6 Equipment Requirements

The Facility will maintain on-site equipment required to perform the necessary landfill activities. Periodic maintenance of all landfill equipment, and minor and major repair work will be performed at designated maintenance zones outside of the landfill.

8.1.7 Safety

All aspects of the C&D Landfill, Inc., operation were developed with the health and safety of the landfill's operating staff, customers, and neighbors in mind. The Owner or General Manager of the facility is the designated Site Safety Officer and is responsible for the safe operation of the facility in keeping with Occupational Safety and Health Administration (OSHA) requirements. Regular safety meetings with staff (minimum one per month) shall be conducted.

Safety equipment to be provided includes (at a minimum) equipment rollover protective cabs, seat belts, audible reverse warning devices, hard hats, safety shoes, and first aid kits. Landfill personnel will be encouraged to complete the American Red Cross Basic First Aid Course with CPR. Safety for customers will be promoted by the Operator and his staff knowing where the equipment and customer vehicles are moving at all times. Radio communications between the scale house and the field staff will help keep track of the location and movement of customers.

8.2 CONTACT INFORMATION

8.2.1 Emergencies

For fire, police, or medical/accident emergencies dial 911.

A partial listing Emergency and other Useful Contacts, published on the NC DENR Division of Waste Management web site, is provided in **Appendix 9C**.

All correspondence and questions concerning the operation of the C&D Landfill should be directed to the appropriate County staff and/or State personnel listed below.

8.2.2 C&D Landfill, Inc. / EJE Recycling, Inc.

Mr. Judson Whitehurst, Owner
Mr. Wayne Bell, General Manager
C&D Landfill, Inc.
802 Recycling Lane
Greenville, North Carolina 27834

Tel 252-752-8274
Fax 252-752-9016

8.2.3 North Carolina Department of Environment and Natural Resources

Washington Regional Office
943 Washington Square Mall
Washington, NC 27889
Tel. 252/946-6481
Fax 252/975-3716

Division of Waste Management - Solid Waste Section

Eastern Regional Supervisor: Fayetteville Regional Office	Dennis Shackelford dennis.shackelford@ncmail.net	Tel. (910) 433-3300
Environmental Engineer: DWM Central Office	Donna Wilson donna.wilson@ncmail.net	Tel. (919) 508-8487
Waste Management Specialist: Washington Regional Office	Chuck Boyette charles.boyette@ncmail.net	Tel. (252) 946-6481
Waste Management Specialist: Washington Regional Office	Ben Barnes ben.barnes@ncmail.net	Tel. (252) 946-6481
Groundwater Hydrogeologist: DWM Central Office	Jaclynne Drummond jaclynne.drummond@ncmail.net	Tel. (919) 508-8500

Division of Land Resources - Land Quality Section

Regional Engineer: Washington Regional Office	Pat McClain, P.E pat.mcclain@ncmail.net	Tel. (252) 946-6481

Division of Water Quality - Water Quality Section - Storm Water Unit

Regional Engineer: Washington Regional Office	Alton Hodge, Supervisor alton.hodge@ncmail.net	Tel. (252) 946-6481

8.3 Facility Operation Documents

A copy of the approved Facility Plan and construction drawings must be kept on-site at all times. Periodically, the Owner/Operator shall note the location of the active working area on a copy of the drawing, noting areas that have come to final grade and are ready to be closed. The drawings show special waste areas (e.g., asbestos) and the locations of soil borrow and stockpile areas.

Other documents required to be kept on-site at all times include the Engineering Plan, the Permit to Construct, and Permit to Operate, and the Monitoring Plan.

8.4 Waste Acceptance Criteria

8.4.1 Permitted Wastes

C&D Landfill, Inc., shall only accept (for disposal) the following wastes generated within approved areas of service:

- Construction and Demolition Debris Waste: (Waste or debris from construction, remodeling, repair, or demolition operations on pavement or other structures);
- Land Clearing and Inert Debris Waste: (stumps, trees, limbs, brush, grass, concrete, brick, concrete block, uncontaminated soils and rock, untreated and unpainted wood, etc.);
- Other Wastes as approved by the NC DENR Solid Waste Section.

In addition, the special wastes, i.e., asbestos (see **Section 8.3.2**) may also be accepted at this facility. Municipal solid waste (MSW) will be routed to the on-site transfer station.

8.4.2 Asbestos

C&D Landfill, Inc., may dispose of asbestos within a designated area within the normal footprint, only if the asbestos has been processed, packaged and transported in accordance with State and Federal (40 CFR 61) regulations. Handling asbestos requires advance arrangements between the hauler and the landfill and special placement techniques (see (**Section 8.5.3.3**).

8.4.4 Wastewater Treatment Sludge

WWTP sludge may **not** be disposed in the C&D Landfill, per Division rules. WWTP sludge may be used as a soil conditioner to enhance the final cover, upon receipt of permission from the Division, to be applied at agronomic rates.

8.5 Waste Exclusions

No municipal solid waste (MSW), hazardous waste as defined by 15A NCAC 13A .0102, or hazardous waste from conditionally exempt small quantity generators (CESQG waste), or liquid waste will be accepted. No drums or industrial wastes shall be accepted. No tires, batteries, polychlorinated biphenyl (PCB), electronic devices (computer monitors), medical wastes, radioactive wastes, septage, white goods, yard trash, fluorescent lamps, mercury switches, lead roofing materials, transformers, of CCA treated wood shall be disposed. No pulverized or shredded C&D wastes may be accepted.

The Facility will implement a waste-screening program, described in **Section 8.6** below, to control these types of waste. The reader is directed to **Solid Waste Rule .0542 (e)** for further exclusions.

8.6 Waste Handling Procedures

In order to assure that prohibited wastes are not entering the landfill facility, screening programs have been implemented at the landfill. Waste received at both the scale house entrance and waste taken to the working face is inspected by trained personnel. These individuals have been trained to spot indications of suspicious wastes, including: hazardous placards or markings, liquids, powders or dusts, sludges, bright or unusual colors, drums or commercial size containers, and "chemical" odors. Screening programs for visual and olfactory characteristics are an ongoing part of the landfill operation.

8.6.1 Waste Receiving and Inspection

All incoming vehicles must stop at the scale house located near the entrance of the facility, and visitors are required to sign-in. All waste transportation vehicles shall be uncovered prior to entering the scales to facilitate inspection; all incoming loads shall be weighed and the content of the load assessed. The scale attendant shall request from the driver of the vehicle a description of the waste it is carrying to ensure that unacceptable waste is not allowed into the landfill.

Signs informing users of the acceptable and unacceptable types of waste shall be posted at the entrance near the scale house. The attendant shall visually check the vehicle as it crosses the scale. A camera mounted over the scales may facilitate this activity. Any suspicious loads will be pulled aside for a more detailed inspection prior to leaving the scale house area. Loads with unacceptable materials will be required to be recovered (with a tarp) and turned away from the facility. Wastes generated from outside of the service area will be turned away. Once passing the scales, the vehicles containing C&D wastes are routed to the working face. **Vehicles shall be selected for random screening a minimum of three times per week.** The selection of vehicles for screening might be based on unfamiliarity with the vehicle/driver or based on the driver's responses to interrogation about the load content.

Selected vehicles shall be directed to an area of intermediate cover adjacent to the working face where the vehicle will be unloaded and the waste shall be carefully spread using suitable equipment. An attendant trained to identify wastes that are unacceptable at the landfill shall inspect the waste discharged at the screening site. The Operator shall use the **Waste Screening Form** (see **Appendix 9B**) to document the waste screening activities. If no unacceptable waste is found, the load will be pushed to the working face and incorporated into the daily waste cell.

- If unacceptable waste is found, including, the load will be isolated and secured via soil berms, barricades or cordons. Unacceptable wastes that are non-hazardous will be removed from the C&D area and reloaded onto the delivery vehicle for removal from the facility.

- For unacceptable wastes that are hazardous, the Hazardous Waste Contingency Plan outlined in **Section 8.6.3** will be followed.

The hauler is responsible for removing unacceptable waste from the landfill property. The rejection of the load shall be noted on the **Waste Screening Form**, along with the identification of the driver and vehicle. A responsible party to the load generator or hauler shall be notified that the load was rejected. The generator or hauler may be targeted for more frequent waste screening and/or banished from delivering to the facility, depending on the nature of the violation of the waste acceptance policy. If the violation is repetitive or severe enough, State authorities shall be notified.

8.6.2 Disposal of Rejected Wastes

Attempts will be made to inspect waste as soon as it arrives in order to identify the waste hauler; ideally, the hauler can be stopped from leaving the site and the rejected materials reloaded onto the delivery vehicle. Non-allowed materials that are found in the waste during sorting or placement, i.e., after the delivery vehicle has left the site, shall be taken to the on-site Transfer Station.

The Operator shall be responsible for removing any garbage (i.e., food containers), "black bags" or any prohibited wastes that are found in the waste stream, whether during a waste screening inspection or on the working face. Non-authorized materials discovered in the waste stream shall be isolated (e.g., in a dedicated, covered roll-off box) and taken to the nearby Transfer Station at the earliest practical time, no less frequently than once per week.

8.6.3 Waste Disposal Procedures

8.6.3.1 Access – The location of access roads during waste placement will be determined by operations personnel in order to reflect waste placement strategy.

8.6.3.2 General Procedures – Waste transportation vehicles will arrive at the working face at random intervals. There may be a number of vehicles unloading waste at the same time, while other vehicles are waiting. In order to maintain control over the unloading of waste, a limited number of vehicles will be allowed on the working face at a time. The working face superintendent and/or equipment operator(s) will serve as 'spotters' to maintain orderly disposal operations and to minimize the potential of unloading unacceptable waste and to control disposal activity. ***The working face shall be kept to a maximum area of one-half acre at all times.***

Operations at the working face will be conducted in a manner that will encourage the efficient movement of transportation vehicles to and from the working face, and to expedite the unloading of waste. At no time during normal business hours will the working face be left unattended. Scale house and field staff shall be in constant communication regarding incoming loads and the movement of vehicles on the site, irrespective of facility vehicles or private vehicles. It is the responsibility of the working face superintendent to know where each vehicle in the facility is located and what they are doing at all times.

The use of portable signs with directional arrows and portable traffic barricades will facilitate the unloading of wastes to the designated disposal locations. These signs and barricades will be placed along the access route to the working face of the landfill or other designated disposal areas that may be established. The approaches to the working face will be maintained such that two or more vehicles may safely unload side by side. A vehicle turn-around area large enough to enable vehicles to arrive and turn around safely with reasonable speed will be provided adjacent to the unloading area. The vehicles will back to a vacant area near the working face to unload. Upon completion of the unloading operation, the transportation vehicles will immediately leave the working face. Personnel will direct traffic as necessary to expedite safe movement of vehicles.

Waste unloading at the landfill will be controlled to prevent disposal in locations other than those specified by site management. Such control will also be used to confine the working face to a minimum width, yet allow safe and efficient operations. The width and length of the working face will be maintained as small as practical in order to maintain the appearance of the site, control windblown waste, and minimize the amount of required periodic cover.

Normally, only one working face will be active on any given day, with all deposited waste in other areas covered by either periodic or final cover, as appropriate. The procedures for placement and compaction of solid waste include: unloading of vehicles, spreading of waste into 2 foot lifts, and compaction on relatively flat slopes (i.e., 5H: IV max.) using a minimum number of three full passes. Depending on the nature of the wastes and long-term volume analysis of in-situ density, the waste placement geometry and compaction procedures may require adjustment to optimize airspace.

8.6.3.3 Special Wastes: Asbestos Management – Asbestos will arrive at the site in vehicles that contain only the asbestos waste and only after advance notification by the generator and if accompanied by a proper NC DMV transport manifest. Once the hauler brings the asbestos to the landfill, operations personnel will direct the hauler to the designated asbestos disposal area. Operations personnel will prepare the designated disposal area by leveling a small area using a dozer or loader. Prior to disposal, the landfill operators will stockpile cover soil near the designated asbestos disposal area. The volume of soil stockpiled will be sufficient to cover the waste and to provide any berms, etc. to maintain temporary separation from other landfill traffic.

Once placed in the prepared area, the asbestos waste will be covered with a minimum of 18 inches of daily cover soil placed in a single lift. The surface of the cover soil will be compacted and graded using a tracked dozer or loader. The landfill compactor will be prohibited from operating over asbestos disposal areas until at least 18 inches of cover are in-place. The landfill staff will, with record the approximate location and elevation of the asbestos waste once cover is in-place. The Owner/Operator will then review pertinent disposal and location information to assure compliance with regulatory requirements and enter the information into the Operating Record. Once disposal and recording for asbestos waste is completed, the disposal area may be covered with waste. No excavation into designated asbestos disposal areas will be permitted.

8.7 Cover Material

8.7.1 Periodic Cover

At the completion of waste placement each week or sooner if the area of exposed waste exceeds ***one-half acre*** in size, a 6 inch layer of earthen material will be placed over the exposed waste. This periodic cover is intended to control vectors, fire, odors, and blowing debris. Alternative periodic cover may consist of ground LCID, WWTP sludge (with permission from the Division) and/or other non-C&D waste materials, wood ash. Any alternative cover proposed for the facility will require prior approval from the Solid Waste Section before implementing. Additional documentation of Alternative Cover Material use (e.g., when, where and how much) shall be required.

8.7.2 Final Cover

Exterior slopes shall be closed upon reaching final grades in increments throughout the operation of the facility. The permitted final cover for Phase 2 consists of a minimum of 18 inches of compacted soil cover (minimum 10^{-5} cm/sec permeability requirement), overlain by 18 inches of vegetation support soil. An interim soil cover (at least 12 inches in thickness) may be placed on exterior slopes that have attained final grade and left for no more than 20 days without temporary vegetation, until an area of approximately 2 to 3 acres is ready to be closed simultaneously. Alternative final cover designs are allowed by the 2006 C&D rules. Future consideration may be given to alternative covers, in the interest of meeting the permeability requirements for the compacted soil barrier. All future alternative final cover designs shall be submitted for review by the Division.

All final soil cover shall be spread in at least two uniform lifts (maximum of 12 inches before compaction), and all soils shall be compacted by "tracking" with dozers or other equipment. All disturbed soils shall be vegetated with a seed mix that is suitable to climatic conditions (see construction plans) within 20 days following completion of the grading. All seeded areas should be provided with lime, fertilizer and straw mulch. An emulsified tack may be required to prevent wind damage. Other stabilization treatments, e.g., curled wood matting of synthetic slope stabilization blankets may be employed.

Wood mulch may be spread evenly over the final cover surfaces at a maximum thickness of 1 to 2 inches to provide nutrient and for temporary erosion control. This practice does not alleviate the Operator's responsibility for establishing vegetative cover, but the mulch does constitute temporary ground cover in accordance with NC DENR DLQ regulations until vegetation emerges. All final surfaces shall be planted and mulched within 20 days following completion of earthwork, per DLQ regulations. Depending on prevailing moisture conditions at the time of seeding, slopes may require reseeding at more optimal times of the year. The operator shall ensure that all protective measures are functioning prior to placing soil on exterior slopes.

If settlement or erosion occurs after the cover is placed, the cover shall be fortified with additional soil to re-establish grades, followed by revegetation. In the case of extreme settlement (unlikely), the old cover can be stripped and the affected area built up with waste or soil prior to replacing the cover. Long-term post-closure maintenance is phased in incrementally, as such, final cover maintenance (erosion repair, reseeding as needed). The sedimentation and erosion control criteria that govern the final closure (final reclamation) of this facility are performance-based; some trial and error may be required, but the goal is to protect the adjacent water bodies and buffers throughout the operational and post-closure periods.

8.8 Contingency Plan

8.8.1 Unacceptable Waste Contingency

8.8.1.1 Hot Loads Contingency Plan – In the event of a "hot" load attempting to enter the landfill, the scale house staff will turn away all trucks containing waste that is suspected to be hot, unless there is imminent danger to the driver. The vehicle will be isolated away from structures and other traffic and the fire department will be called. The vehicle will not be allowed to unload until the fire is out. If a hot load is detected on the working face, then the load will be treated as a fire condition (see **Section 8.9.2**), whereas the load will be spread as thin as possible and cover soil will be immediately placed on the waste to extinguish the fire. Other traffic will be redirected to another tipping area (away from the fire), or other waste deliveries may be suspended until the fire is out. The fire will be monitored to ensure it does not spread. If the fire cannot be controlled, the fire department will be notified and the area cleared of non-essential personnel.

8.8.1.2 Hazardous Waste Contingency Plan – In the event that identifiable hazardous waste or waste of questionable character is detected at the scales or in the landfill, appropriate protective equipment, personnel, and materials will be employed as necessary to protect the staff and public. Hazardous waste identification may be based on (but not limited to) strong odors, fumes or vapors, unusual colors or appearance (e.g., liquids), smoke, flame, or excess dust. The fire department will be called immediately in the event a hazardous material is detected. An attempt will be made to isolate the wastes in a designated area where runoff is controlled, preferably prior to unloading, and the vicinity will be cleared of personnel until trained emergency personnel (fire or haz-mat) take control of the scene.

Staff will act prudently to protect personnel but no attempt will be made to remove the material until trained personnel arrive. A partial listing of Emergency and Other Useful Contacts is found in **Appendix 9C**. The Owner/Operator is encouraged to compile a list of regional **Hazardous Waste Responders** and disposal firms – these are available on the **NC Division of Waste Management** Hazardous Waste Section web site – and keep it handy in the event of an incident. These firms have the training and equipment to deal with hazardous materials, as needed.

The Operator will notify the Division (see **Section 8.2.3**) that an attempt was made to dispose of hazardous waste at the landfill. If the vehicle attempting disposal of such waste is known, attempts will be made to prevent that vehicle from leaving the site until it is identified (license tag, truck number driver and/or company information) or, if the vehicle leaves the site, immediate notice will be served on the owner of the vehicle that hazardous waste, for which they have responsibility, has been disposed of at the landfill.

The landfill staff will assist the Division as necessary and appropriate in the removal and disposition of the hazardous waste (acting under qualified supervision) and in the prosecution of responsible parties. If needed, the hazardous waste will be covered with on-site soils, tarps, or other covering until such time when an appropriate method can be implemented to properly handle the waste. The cost of the removal and disposing of the hazardous waste will be charged to the owner of the vehicle involved. Any vehicle owner or operator who knowingly dumps hazardous waste in the landfill may be barred from using the landfill or reported to law enforcement authorities. Any hazardous waste found at the scales or in the landfill that requires mitigation under this plan shall be documented by staff using the **Waste Screening Form** provided in **Appendix 9B**. Records of information gathered as part of the waste screening programs will be maintained throughout the operational life of the facility.

8.8.2 Severe Weather Contingency

Unusual weather conditions can directly affect the operation of the landfill. Some of these weather conditions and recommended operational responses are as follows.

8.8.2.1 Ice Storms – In the event that an ice storm hinders access or prevents safe equipment movement or placement of periodic cover, landfill operations shall be suspended until the ice is removed or has melted and access routes are passable.

8.8.2.2 Heavy Rains – Exposed soil surfaces can create a muddy situation in some portions of the landfill during rainy periods. The control of drainage and use of crushed stone (or recycled aggregates) on unpaved roads should provide all-weather access for the site and promote drainage away from critical areas. In areas where the aggregate surface is washed away or otherwise damaged, aggregate should be replaced. Intense rains can affect newly constructed drainage structures such as swales, diversions, cover soils, and vegetation. After such a rain event, inspection by landfill personnel will be initiated and corrective measures taken to repair any damage found before the next rainfall.

8.8.2.3 Electrical Storms – The open area of a landfill is susceptible to the hazards of an electrical storm. If necessary, landfill activities will be temporarily suspended during such an event. To promote the safety of field personnel, refuge will be taken in buildings or in rubber-tire vehicles.

8.8.2.4 Windy Conditions – High winds can create windblown wastes, typically paper and plastic, but larger objects have been known to blow in extreme circumstances. Operations should be suspended if blowing debris becomes a danger to staff, after the working face is secured. The proposed operational sequence minimizes the occurrence of unsheltered operations relative to prevailing winds. If this is not adequate during a particularly windy period, work will be temporarily shifted to a more sheltered area.

When this is done, the previously exposed face will be immediately covered with daily cover. Soil cover shall be applied whenever windblown wastes become a problem. Staff shall patrol the perimeter of the landfill periodically, especially on windy days, to remove windblown litter from tress and adjacent areas. Windscreens of various sorts have been used with mixed success at other facilities in the region. Good planning is essential on the operator's part to be prepared for windy conditions.

8.8.2.5 Violent Storms – In the event of a hurricane, tornado, or severe winter storm warning issued by the National Weather Service, landfill operations should be suspended until the warning is lifted. If safe to do so, exposed waste shall be covered and buildings and equipment shall be secured – if eminent danger to staff is present, personal safety shall take precedence over concerns regarding the waste or equipment.

8.9 Spreading and Compaction of Waste

The working face shall be restricted to the smallest possible area; ideally, the maximum working face area with exposed waste shall be one-quarter to one-half acre. Wastes shall be compacted as densely as practical. Appropriate methods shall be employed to reduced wind-blown debris including (but not limited to) the use of wind fences, screens, temporary soil berms, and periodic cover. Any wind-blown debris shall be recovered and placed back in the landfill and covered at the end of each working day.

8.10 Vector Control

Steps shall be employed to minimize the risk of disease carrying vectors associated with the landfill (e.g., birds, rodents, dogs, mosquitoes). The C&D wastes should be mostly inert and not attractive to animals. Putrescible wasters shall not be allowed; care shall be taken to keep the waste covered in case undetected putrescible wastes are inadvertently admitted. Pools of standing water shall be avoided in and around the disposal area.

8.11 Air Quality Criteria and Fire Control

8.11.1 State Implementation Plan

A demonstration of compliance with the State Implementation Plan (SIP) for air quality under Section 110 of the Clean Air Act is required by the 2006 Solid Waste Rules. Typically, the SIP focuses on industries that require air permits and activities that have regulated emissions that contribute to unhealthy levels of ozone (NOx , SO_4, VOC's), particularly coal combustion (electric power plants) and other "smokestack" industries. Compliance with the spirit of the SIP is demonstrated by the prohibition of combustion of solid waste, the fact that the wastes are generally inert and do not emit sufficient quantities of landfill gas to require active controls (such as flaring), and the current status of the regional attainment. The facility is not currently located in a designated area of non-attainment for ozone and/or fine particle emissions (e.g., VOC's, NOx), designation based on NCDENR Division of Air Quality (DAQ) web site information.

However, on January 20, 2009 the DAQ held a public meeting in Greenville to discuss the possibility of Pitt County being designated as a non-attainment area for ozone. Based on information presented at that meeting, it does not appear that a non-attainment designation would affect existing facilities (more impact might be expected on future industrial location in the region), and the three-year data that lead to this consideration is barely above the US-EPA's current threshold for attainment. State-wide, ozone monitoring data show general improvement since the implementation of the "clean smokestacks" legislation within the last five years, and if the next few months show continued improvement, US-EPA may not impose the non-attainment designation. [1] This leads to a conclusion that the facility is not contributing to an existing non-attainment condition in the local area, nor is it likely to in the future.

Nonetheless, proactive steps that can be taken at the facility include dust control measures (see below) to minimize airborne particle emissions, minimizing the idling time on trucks and equipment, keeping mechanized equipment in good operating condition, and the use of low-sulfur fuels, subject to availability. Adherence to the waste acceptance criteria will minimize VOC emissions. Regular application of periodic cover (in accordance with Solid Waste regulations) will reduce the risk of fires and curtail wind-blown debris; the proper use of vegetative cover will further minimize fugitive emissions of dust and particulates.

8.11.2 Dust Control Air Quality Criteria

Measures shall be taken to control dust from the operations. Dusty wastes shall be covered immediately with soil, and water shall be sprinkled on roads and other exposed surfaces (including operational cover and/or the working face, as needed) to control dust. Disposal activities may need to be suspended during high winds (see **Section 8.8.3.4**).

8.11.3 Fire Control

The possibility of fire within the landfill or a piece of equipment must be anticipated in the daily operation of the landfill. A combination of factory installed fire suppression systems and/or portable fire extinguishers shall be operational on all heavy pieces of equipment at all times. Brush fires of within the waste may be smothered with soil, if combating the fire poses no danger to the staff. The use of water to combat the fire is allowable, but soil is preferable. For larger or more serious fire outbreaks, the local fire department will respond. In the event of any size fire at the facility, the Owner shall contact NC DENR Division Waste Management personnel immediately and complete a **Fire Notification Form (Appendix 9D)**, which will be placed in the Operating Record.

8.12 Access and Safety

8.12.1 Access Control

Access to the C&D Landfill is required for the following reasons:

[1] Tom Mather, Public Information Officer, NC DENR DAQ, personal communication (2-12-09)

1. Prevention of unauthorized and illegal dumping of waste materials,
2. Trespassing, and possible injury resulting from such, is discouraged,
3. The risk of equipment theft or vandalism is greatly reduced.

Access to active areas of the landfill will be controlled by a combination offences and natural barriers, such as the creeks, and strictly enforced operating hours. A landfill attendant will be on duty at all times when the facility is open for public use to enforce access restrictions.

8.12.1.1 Physical Restraints – The site will be accessed by the existing entrance along Laurel Hill Drive. Scales and a scale house are provided near the entrance. All waste will be weighed prior to being placed in the landfill. The entrance gates will be securely locked during non-operating hours.

8.12.1.2 Security – Frequent inspections of gates and fences will be performed by landfill personnel. Evidence of trespassing, vandalism, or illegal operation will be reported to the Owner.

8.12.1.3 All-Weather Access – The on-site roads will be paved or otherwise hardened and maintained for all-weather access.

8.12.1.4 Traffic – The Operator shall direct traffic to a waiting area, if needed, and onto the working face with safe access to an unloading site is available. Once a load is emptied, the delivery vehicle will leave the working face immediately.

8.12.1.5 Anti-Scavenging Policy – The removal of previously deposited waste by members of the public (or the landfill staff) is strictly prohibited by the Division for safety reasons. The Operator shall enforce this mandate and discourage loitering after a vehicle is unloaded. No persons that are not affiliated with the landfill or having business at the facility (i.e., customers) shall be allowed onto or near the working face.

8.12.2 Signage

A prominent sign containing the information required by the Division shall be placed just inside the main gate. This sign will provide information on operating hours, operating procedures, and acceptable wastes. A list of prohibited waste shall be posted on the facility sign. Additional signage will be provided within the landfill complex to distinctly distinguish access routes. Restricted access areas will be clearly marked and barriers (e.g., traffic cones, barrels, etc.) will be used.

8.12.3 Communications

Visual and radio communications will be maintained between the C&D landfill and the landfill scale house and field operators. The scale house has telephones in case of emergency and for the conduct of day-to-day business. Emergency telephone numbers are displayed in the scale house.

8.13 Sedimentation and Erosion Control

Measures depicted in the approved S&EC plan (see construction plans) shall be installed and maintained throughout the operational life of the facility and into the post-closure period (see Section 9.0). Measures to curtail erosion include vegetative cover and woody mulch as ground cover. Measures to control sedimentation include stone check dams in surface ditches, sediment traps and basins. The key to compliance with Sedimentation and Erosion Control rules is vegetative cover. A rule of thumb is that all exposed soils, regardless of whether they are inside or outside the disposal area, should be covered as soon as possible, not to exceed 20 days after any given area is brought to final grade.

8.14 Drainage Control and Water Protection

Coupled with the measures and practices intended to comply with the S&EC rules, steps to protect water quality include diverting surface water ("run-on") away from the disposal area, allowing no impounded water inside the disposal area, and avoiding the placement of solid waste into standing water. The facility is obligated by law not to discharge pollutants into the waters of the United States (i.e. surface streams and wetlands). Any conditions the Operator suspects might constitute a discharge should be brought to the immediate attention of the Engineer, who in turn, may prescribe mitigation and/or may need to contact proper regulatory authorities.

8.15 Survey for Compliance

8.15.1 Height Monitoring

The landfill staff will monitor landfill top and side slope elevations on a weekly basis or as needed to ensure proper slope ratios and to ensure the facility is not over-filled. This shall be accomplished by use of a surveyor's level and a grade rod. When such elevations approach the grades shown on the Final Cover Grading Plan, the final top-of-waste grades will be staked by a licensed surveyor to limit over-placement of waste.

8.15.2 Annual Survey

The working face shall be surveyed on an annual basis to verify slope grades and to track the fill progression. In the event of problems (slope stability, suspected over-filling), more frequent surveys may be required at the request of the Division.

8.16 Operating Record and Recordkeeping

The following related to the C&D landfill shall be maintained in an operating record:

A Waste inspection records (on designated forms); fire notification forms, as needed;

B Daily tonnage records - including source of generation;

C Records of periodic and final cover placement;

D Audit records and regulatory compliance inspection reports;

E Quantity, location of disposal, generator, and special handling procedures employed for all special wastes disposed of at the site;

F List of generators and haulers that have attempted to dispose of restricted wastes;

G Employee training procedures and records of training completed;

H All ground water quality monitoring and surface water quality information including:

1. Monitoring well construction records;
2. Sampling dates and results;
3. Statistical analyses; and
4. Results of inspections, repairs, etc.

I All closure and post-closure information, where applicable, including:

1. Testing;
2. Certification; and
3. Completion records.

J Cost estimates for financial assurance documentation.

K Annual topographic survey of the active disposal phase intended to determine volume consumption.

L Records of operational problems or repairs needed at the facility, e.g., slope maintenance, upkeep of SE&C measures, other structures (excluding equipment)

M Daily rainfall records (via on-site rain gauge).

The Owner or his designee will keep the operating record up to date. Daily logbooks may be used for some items. Records shall be presented upon request to DWM for inspection. A copy of this Operations Manual shall be kept at the landfill and will be available for use at all times.

8.17 ANNUAL REPORTING

Reporting requirements for the C&D Landfill include a summary of waste intake by type and tonnage, and disposal practice. The Division requires an **Annual Report** be submitted, detailing the waste intake in tonnage. New rules for C&D landfills require an annual survey to determine slope, height, and volume (see **Section 8.13**). The reporting requirements include a map prepared by a licensed surveyor.

9.0 CLOSURE AND POST-CLOSURE (15A NCAC 13B .0543)

9.1 Summary of Regulatory Requirements

9.1.1 Final Cap

The final cap design for all phases (both Phase 1 – none of which was closed prior to June 30, 2008 – and Phase 2) shall conform to the minimum requirements of the Solid Waste Rules, i.e., the compacted soil barrier layer shall exhibit a thickness of 18 inches and a field permeability of not more than 1.0 x 10^{-5} cm/sec. The overlying vegetative support layer shall exhibit a thickness of 18 inches. See **Drawing E2** for final contours and **Drawing EC2** for final cover cross-section and details.

9.1.2 Construction Requirements

Final cap installation shall conform to the approved plans (see accompanying plan set), inclusive of the approved Sedimentation and Erosion Control Plan (see **Section 6.7** and **Appendix 8**). **The CQA plan must be followed (see Section 7.0) and all CQA documentation must be submitted to the Division.** Post-settlement surface slopes must not be flatter than 5% (on the upper cap) and not steeper than 25% (on the side slopes). Per the **2006 C&D Rules**, a gas venting system is required for the cap. A passive venting system will be specified, which will consist of a perforated pipe in crushed stone-filled trench – installed just below the final cap soil barrier layer – with a tentative minimum vent spacing of three vents per acre. **Drawing EC3** shows the gas vent system details.

9.1.3 Alternative Cap Design

The **2006 C&D Rules** make a provision for an alternative cap design, to be used in the event that the permeability requirements for the compacted soil barrier layer cannot be met. Past experience indicates that on-site soils may not meet the required field permeability of not more than 1.0 x 10^{-5} cm/sec, as supported by the laboratory data for the soils discussed in **Section 4.0**. Tentative final closure plans have assumed that on-site soils will be used for the compacted barrier layer – alternative cap designs may be researched and submitted for Division approval at a future time.

9.1.4 Division Notifications

The Operator shall notify the Division prior to beginning closure of any final closure activities. The Operator shall place documentation in the Operating Record pertaining to the closure, including the CQA requirements and location and date of cover placement.

9.1.5 Required Closure Schedule

The Operator shall close the landfill in increments as various areas are brought to final grade. The final cap shall be placed on such areas subject to the following:

- No later than 30 days following last receipt of waste;
- No late that 30 days following the date that an area of 10 acres or greater is within 15 feet of final grades;
- No later than one year following the most recent receipt of waste if there is remaining capacity.

Final closure activities **shall be completed within 180 days** following commencement of the closure, unless the Division grants extensions. Upon completion of closure activities for each area (or unit) the Owner shall notify the Division in writing with a **certification by the Engineer** that the closure has been completed in accordance with the approved closure plan and that said documentation has been placed in the operating record.

9.1.6 Recordation

The Owner shall record on the title deed to the subject property that a CDLF has been operated on the property and file said documentation with the Register of Deeds. Said recordation shall include a notation that the future use of the property is restricted under the provision of the approved closure plan.

9.2 Closure Plan

The following is a tentative closure plan for CDLF Phase 2, based on the prescribed operational sequence and anticipated conditions at the time of closure.

9.2.1 Final Cap Installation

9.2.1.1 Final Elevations – Final elevation of the landfill shall not exceed those depicted on Drawing E2 when it is closed, subject to approval of this closure plan. The elevations shown include the final cover. A periodic topographic survey shall be performed to verify elevations.

9.2.1.2 Final Slope Ratios – All upper surfaces shall have at least a 5 percent slope, but not greater than a 10 percent slope. The cover shall be graded to promote positive drainage. Side slope ratios shall not exceed 3H:1V. A periodic topographic survey shall be performed to verify slope ratios.

9.2.1.3 Final Cover Section – The terms "final cap" and "final cover" both apply. The final cover will subscribe to the minimum regulatory requirement for C&D landfills:

- An 18-inch thick compacted soil barrier layer (CSB), i.e., the "infiltration layer," with a hydraulic conductivity not exceeding 1 x 10^{-5} cm/sec,

  overlain by

- An 18-inch thick "topsoil" or vegetated surface layer (VSL),
  i.e., the "erosion layer."

9.2.1.4 Final Cover Installation – All soils shall be graded to provide positive drainage away from the landfill area and compacted to meet applicable permeability requirements (see **Section 7.0**). Suitable materials for final cover soil shall meet the requirements defined above. Care shall be taken to exclude rocks and debris that would hinder compaction efforts. The surface will then be seeded in order to establish vegetation.

Test Pad – Whereas the lab data indicate that the required permeability is attainable, the ability to compact the materials in the field to achieve the required strength and permeability values shall be verified with a field trial involving a test pad, to be sampled with drive tubes and laboratory density and/or permeability testing, prior to full-scale construction. The materials, equipment, and testing procedures should be representative of the anticipated actual final cover construction. The test pad may be strategically located such that the test pad may be incorporated into the final cover.

Compacted Barrier – Materials shall be blended to a uniform consistency and placed in two loose lifts no thicker than 12 inches and compacted by tamping, rolling, or other suitable method – the targeted final thickness is 18 inches minimum. A thicker compacted barrier is acceptable. The cover shall be constructed in sufficiently small areas that can be completed in a single day (to avoid desiccation, erosion, or other damage), but large enough to allow ample time for testing without hindering production. The Contractor shall take care not to over-roll the cover such that the underlying waste materials would pump or rut, causing the overlying soil layers to crack – adequate subgrade compaction within the upper 36 inches of waste materials and/or the intermediate cover soil underlying the final cover is critical. All final cover soils shall be thoroughly compacted through the full depth to achieve the required maximum permeability required by Division regulations of 1.0×10^{-5} cm/sec, based on site-specific test criteria (see below). Compaction moisture control is essential for achieving adequate strength and permeability.

Vegetated Surface Layer – Materials shall be blended and placed in two loose lifts no thicker than 12 inches and compacted by tamping, rolling, or other suitable method – the targeted final layer thickness is 18 inches minimum per the design criteria. A thicker soil layer is acceptable. A relatively high organic content is also desirable. The incorporation of decayed wood mulch or other organic admixtures (WWTP sludge, with advance permission from the Division) is encouraged to provide nutrient and enhanced field capacity. These surface materials are not subject to a permeability requirement, thus no testing will be specified. Care should be taken to compact the materials sufficiently to promote stability and minimize erosion susceptibility, but not to over-compact the materials such that vegetation would be hindered. Following placement and inspection of the surface layer, seed bed preparation, seeding and mulching should follow immediately. The work should be scheduled to optimize weather conditions, if possible.

Inspection and Testing – Soils for the barrier layer are subject to the testing schedule outlined in the **Construction Quality Assurance plan (see Section 7.0)**. The proposed testing program includes a minimum of one permeability test per lift per acre and four nuclear density gauge tests per lift per acre, to verify compaction of the compacted barrier layer. The moisture-density-permeability relationship of the materials has been established by the laboratory testing (discussed elsewhere in this report). The Contractor shall proof roll final cover subgrade materials (i.e., intermediate cover), which consist of essentially the same materials as the compacted barrier layer (without the permeability requirements), to assure that these materials will support the final cover.

9.2.1.5 Final Cover Vegetation – Seedbed preparation, seeding, and mulching shall be performed accordance the specifications provided in the Construction Plans (see **Drawing EC2**), unless approved otherwise (in advance) by the Engineer). In areas to be seeded, fertilizer and lime typically should be distributed uniformly at a rate of 1,000 pounds per acre for fertilizer and 2,000 pounds per acre for lime, and incorporated into the soil to a depth of at least 3 inches by disking and harrowing. The incorporation of the fertilizer and lime may be a part of the cover placement operation specified above. Distribution by means of an approved seed drill or hydro seeder equipped to sow seed and distribute lime and fertilizer at the same time will be acceptable. Please note that the seeding schedule varies by season.

All vegetated surfaces shall be mulched with wheat straw and a bituminous tack. Areas identified as prone to erosion mat be secured with curled-wood excelsior, installed and pinned in accordance with the manufacturer's recommendations. Certain perimeter channels will require excelsior or turf-reinforcement mat (TRM), as specified in the Channel Schedule. Alternative erosion control products may be substituted with the project engineer's prior consent. All rolled erosion control materials should be installed according to the generalized layout and staking plan found in the Construction Plans or the manufacturer's recommendations.

Irrigation for landfill covers is not a typical procedure, but consideration to temporary irrigation may be considered if dry weather conditions prevail during or after the planting. Care should be taken not to over-irrigate in order to prevent erosion. Collected storm water will be suitable for irrigation water. Maintenance of the final cover vegetation, described in the Post-Closure Plan (see below), is critical to the overall performance of the landfill cover system.

9.2.1.6 Documentation – The Owner shall complete an "as-built" survey to depict final elevations and to document any problems, amendments or deviations from the Construction Plan drawings. Records of all testing, including maps with test locations, shall be prepared by the third-party CQA testing firm. All materials pertaining to the closure shall be placed in the Operational Record for the facility. Whereas the closure will be incremental, special attention shall be given to keeping the closure records separate from the normal operational records.

9.2.1.7 Gas Venting System – Passive gas vents shall be installed incrementally (as portions of the landfill are closed) beneath the final cover as shown in the construction drawings. The vents consist of a slotted pipe embedded in drainage stone, with an inverted slope of approximately 2 to 5 percent (high toward the center), leading to a vertical riser pipe and topped with a vent cap to prevent the entry of water and nesting animals. Vents shall be placed at an average density of three per acre – the field layout will be determined at the time of closure, but typically the vents are arranged in a regular triangular pattern with the trenches oriented parallel to the slope contours.

The slotted pipe is either Schedule 40 PVC or HDPE with cemented slip connections. The pipe is to be installed in a trench excavated through the intermediate cover and/or waste materials to found the trench within the top of the waste. Washed stone with an allowable gradation range of No. 57 to No. 4 shall be placed a minimum of 12 inches thick beneath the pipe to enhance gas transmission and to provide bedding for the pipe. The pipe shall be covered with a minimum of 6 inches of stone prior to pacing the final cover soil. An alternative aggregate, such as crushed concrete, may be substituted subject to meeting the gradation requirements.

The depth of the trench shall allow the full-depth of final cover to be placed above the top of the stone. Soil shall be sloped to promote positive drainage away from the vents. Attention shall be paid to compaction of the cover soils to prevent settling and subsequent ponding of surface water. Each vertical riser shall be made at least 8 feet above finished grades to protect breathing space. The vents shall be posted with "No Smoking" warning signs. Maintenance during post-closure shall consist of periodic inspection and repair or replacement of damaged pipe or vent grates as needed.

9.2.1.8 Slope Drains – A system of drainage swales and pipes, i.e., "slope drains," shall be constructed incrementally along exterior slopes as portions of the landfill come to grade and are closed. Drainage swales shall be graded into the final cover, as shown in the construction plans, referred to as "add-on" or "tack-on" swales, whereas they are not typically graded into the waste itself. Compaction criteria appropriate to the final cover shall be observed (refer to the CQA Plan). The swales shall be vegetated immediately upon completion and maintained as needed to protect them from erosion. Refer to maintenance of the final cover and drainage systems on **Table 9B**.

Solid (non-slotted) corrugated drain pipes shall be placed as shown in the construction plans to convey surface runoff collected from the drainage swales to ditches located at the toes of the slopes. The drain pipes shall be secured in trenches within the 18-inch vegetation support layer (topsoil) of the final cover, above the compacted barrier layer, which shall be backfilled and compacted to prevent settlement and to curtail erosion – there is no specific compaction criteria for the vegetation support layer. Pipe bedding shall be tamped soil that is shaped to "cradle" the pipe below the spring line. Inlets and outlets shall be protected with rip-rap aprons, underlain by non-woven geotextile for erosion control; protruding end sections are acceptable but flared-end sections may be used at the Operator's discretion. Properly buried pipes should require relatively little maintenance except for possible erosion at the ends. Regular inspection of the pipe ends, aprons, and any diversion berms used to direct water to the inlets, with repairs as may be needed, are the major anticipated maintenance requirements (see **Table 9B**).

9.2.2 Maximum Area/Volume Subject to Closure

The largest anticipated area that will require final closure at any one time within the next 5-year period – including all of Phase 1 (15 acres) and Phase 2A (10 acres) – is 25 acres. Intermediate cover shall be used on areas that have achieved final elevations until the final cover is installed. Based on the original permitting for Phase 1 and the volumetric analysis for Phase 2 (**Appendix 3**), the combined volumes of Phase 1 and Phase 2A is 1,119,800 cubic yards (see **Section 1.3**).

9.2.3 Closure Schedule

Refer to the requirements outlined in **Section 9.1.5** (above). Phase 1 is nearing the end of its capacity and will be closed within 180 days of the opening of Phase 2A.

9.2.4 Closure Cost Estimate

The foregoing cost estimate is considered suitable for the **Financial Assurance** requirements (see **Section 11.0**).

TABLE 9A
ESTIMATED FINAL CLOSURE COSTS FOR PHASES 1 and 2A (2009 dollars) [1]

VSL (topsoil)[2] – 25 acres	60,500 c.y.	@	$4 / cubic yard	$242,000
CSB (barrier)[2] – 25 acres	70,000 c.y.	@	$10 / cubic yard	$700,000
Establish Vegetation	25 acres	@	$1,800 per acre	$ 45,000
Storm Water Piping [3]	1200 LF	@	$35.00 / LF	$ 42,000
Erosion Control Stone [3]	100 tons	@	$40.00 / ton	$ 4,000
Gas Vents – 25 ac * 3/ac	75 each	@	$100 each	$ 7,500
Testing and Surveying [4]	Estimated 20 percent of above			$ 208,100
Contingency	Estimated 15 percent of above			$ 156,075
Total Construction Cost (if contracted out)				**$1,404,675**

1 Intended to represent likely third-party construction costs (hired contractor, not the Owner/Operator), based on knowledge of local construction costs for similar projects – these estimates provided to meet NC DENR Division of Waste Management financial assurance requirements; actual costs may be lower for construction by the Owner/Operator; final closure work will be performed incrementally, spreading out the costs over the life of the project.

2 Includes soil work for regulatory requirements of the 2006 C&D Rules, i.e., a minimum of 18 inches of compacted soil barrier (CSB) with max. permeability of 1×10^{-5} cm/sec and 18 inches of vegetation support layer (VSL), or topsoil, with a total soil thickness of 36 inches.

For the compacted soil barrier, use a shrinkage factor of 15%; costs include surface preparation, soil procurement and transport costs, soil placement and compaction, machine/equipment costs, fuel costs

3 Conservative estimate based on similar project history; includes materials and installation

4 Includes Construction document and bidding, construction administrative fee, CQA field monitoring and lab testing, CQA reporting and certification, final survey for as-built drawings, recordation/notation fee

9.3 Post-Closure Plan

9.3.1 Monitoring and Maintenance

9.3.1.1 Term of Post-Closure Care – The facility shall conduct post-closure care for a minimum of 30 years after final closure of the landfill, unless justification is provided for a reduced post-closure care period. The post-closure care period may be extended by the Division if necessary to protect human health and the environment.

9.3.1.2 Maintenance of Closure Systems – Inspections of the final cover systems and sediment and erosion control (S&EC) measures shall be conducted quarterly. Maintenance will be provided during post-closure care as needed to protect the integrity and effectiveness of the final cover. The cover will be repaired as necessary to correct the effects of settlement, subsidence, erosion, or other events. Refer to the **Post Closure Monitoring and Maintenance Schedule** (below).

9.3.1.3 Landfill Gas Monitoring – Gas monitoring will be conducted during the operational period and the post-closure period via bar-hole punch tests at established locations (**Drawing MP-1**), sampling the head-space in monitoring wells with an Organic Vapor Analyzer (OVA), or similar equipment, during routine sampling events and continual monitoring in on-site buildings via a gas detection meter. Solid Waste regulations require quarterly gas monitoring throughout the operational period and for 30 years of post-closure care. The monitoring plan and financial assurance calculations presented herein are based on this premise. However, if no gas is detected consistently for a period of five years, the permittee may apply to the Solid Waste Section for reducing or discontinuing the landfill gas sampling. If gas is detected the Division will be notified and an evaluation of protective measures will be performed.

9.3.1.4 Ground Water Monitoring – Groundwater monitoring will be conducted under the current version of the approved Sampling and Analysis Plan (see **Section 10.2**). This plan will be reviewed periodically and may change in the future. Approximately one year prior to the landfill reaching permitted capacity, the facility will submit post-closure monitoring and maintenance schedules, specific to the ground water monitoring. Procedures, methods, and frequencies will be included in this plan. This future plan, and all subsequent amendments, will be incorporated by reference to this document.

9.3.1.5 Record Keeping – During the post closure period, maintenance and inspection records, i.e., a **Post Closure Record**, shall be kept as a continuation of the **Operating Record** that was kept during the operational period. The Post Closure Record shall include future inspection and engineering reports, as well as documentation of all routine and non-routine maintenance and/or amendments. The Post Closure Record shall include the ground water and gas monitoring records collected for the facility.

9.3.1.6 Certification of Completion – At the end of the post-closure care period the facility manager shall contact the Division to schedule an inspection. The facility manager shall make the Post Closure Record available for inspection. A certification that the post-closure plan has been completed, signed by a North Carolina registered professional engineer, shall be placed in the operating/post closure record. C&D Landfill, Inc. shall maintain these records indefinitely.

TABLE 9B
POST-CLOSURE MONITORING AND MAINTENANCE SCHEDULE

Activity	Frequency Yrs. 1 - 5	Frequency Yrs. 6-15	Frequency Yrs. 16-30
General - Inspect access gates, locks, fences, signs, site security	Quarterly	Quarterly	Quarterly
Maintain access roads, monitoring well access	As needed	As needed	As needed
Final Cover Systems/Stability - Inspect cap and slope cover for erosion, sloughing, bare spots in vegetation, make corrections as needed (1)	Quarterly	Semi-Annually	Annually
Storm Water/Erosion Control Systems - Inspect drainage swales, pipe drains, and sediment basin for erosion, excess sedimentation (1)	Quarterly	Semi-Annually	Annually
Mow cover vegetation and remove thatch	Semi-Annually	Annually	None (2)
Inspect vegetation cover and remove trees	Annually	Annually	Annually
Landfill Gas Monitoring	Quarterly (3)	Quarterly (3)	Quarterly (3)
Ground Water Monitoring System - Check well head security, visibility	Semi-Annually	Semi-Annually	Semi-Annually
Ground Water Monitoring (4)	Semi-Annually	Semi-Annually	Semi-Annually

Notes:

1. Inspect after every major storm event, i.e., 25-year 24-hour design storm
2. Dependent on vegetation type, periodic mowing may be required
3. The Solid Waste Section may be petitioned for discontinuation of gas monitoring if no detections occur in gas sampling locations or on-site buildings
4. See current Ground Water Sampling and Analysis Plan

9.3.2 Responsible Party Contact

C&D Landfill, Inc.
Mr. Judson Whitehurst, Owner
Mr. Wayne Bell, General Manager
C&D Landfill, Inc.
802 Recycling Lane
Greenville, North Carolina 27834 Tel 252-752-8274
Fax 252-752-9016

9.3.3 Planned Uses of Property

Currently, there is no planned use for the landfill area following closure. The closed facility will be seeded with grass to prevent erosion. Any post-closure use of the property considered in the future will not disturb the integrity of the final cover or the function of the monitoring systems unless necessary (and to be accompanied by repairs or upgrades). Future uses shall not increase the potential threat to human health and the environment.

9.3.4 Post-Closure Cost Estimate

The following cost estimate is considered suitable for the **Financial Assurance** requirements. Refer to the 30-year cost projection (see **Section 11.0**).

TABLE 9C
ESTIMATED POST-CLOSURE COSTS FOR PHASES 1 and 2A (in 2009 dollars)

Annual Events	Units		Unit Cost	Cost/ Event	Annual Costs
Reseeding/mulching and erosion repair (Assume 5% of 25 ac., once per year)	1.25	ac.	$1,600	$2,000.00	$2,000.00
Mow final cap (twice per year)	25	ac.	$25	$625.00	$1250.00
Ground Water (semi-annual, 16 wells)*	22	ea.	$400	$8800.00	$17600.00
Surface Water (semi-annual, 3 locations)*	3	ea.	$350	$1,050.00	$2,100.00
Water quality analysis and reporting	1	ea.	$2500	$2500.00	$5000.00
Landfill Gas Monitoring (quarterly)	1	ea.	$3,500	$3,500.00	$7,000.00
Engineering inspection (annual basis)	1	ea.	$3,500	$3,500.00	$3,500.00
Maintain storm water conveyances	1	ea.	$2,000	$2,000.00	$2,000.00
Maintain access roads, gates, buildings	1	ea.	$1,000	$1,000.00	$1,000.00
	Total Estimated Annual Cost				**$41,450.00**

*Appendix I Detection Monitoring (**Section 10.0**)

10.0 MONITORING PLAN
(15A NCAC 13B .0544)

10.1 Summary of Regulatory Requirements

C&D landfills must implement a detection phase monitoring program for ground water and surface water. Normally, this includes an up gradient background well and several down gradient (or cross gradient) compliance wells, along with several strategically placed surface water sampling locations (with up gradient and down gradient coverage). The placement of the wells is to be based on the hydraulic and topographic characteristics of the site, determined in the site investigations (see Section 4.0). Compliance wells are placed at a "review boundary" located approximately half the distance to the "compliance boundary," which is normally established 50 feet inside the facility boundary, or 150 feet from the waste boundary at a C&D landfill.

Detection phase monitoring for all landfills includes semi-annual sampling and analysis for ensuring compliance with North Carolina ground water standards, i.e., **15A NCAC 2L .0300** (the "2L rules"). The detection phase sampling list includes organic constituents on the Appendix 1 list [2] (i.e., volatiles and semi-volatiles that are analyzed by US-EPA Method 8260 and the eight RCRA metals), key indicator parameters (measured in the field), and – new for the **2006 C&D Rules** – several additional constituents (mercury, manganese, sulfate, iron, alkalinity, and total dissolved solids). Assuming no detects of ground water constituents that exceed a 2L standard, the term of detection phase monitoring runs for the operational life of the facility plus the post-closure period (minimum of 30 years beyond closure). Should one or more detected constituents exceed a 2L standard, the facility must undergo an expanded assessment monitoring program to determine the source, extent, and rate of contaminant migration, plus an evaluation of potential human receptors and/or other environmental impacts.

The **Sampling and Analysis Plan** (discussed below and found within **Appendix 6**), considers both present and anticipated future needs of the assessment monitoring program, with respect to surface water sampling and strategic placement of monitoring wells, but the program described herein stands alone for detection phase monitoring for the C&D landfill.

10.2 Ground Water Monitoring

The following discusses the rationale behind planned amendments to the detection phase monitoring program for the C&D landfill, reflected in the **Sampling and Analysis Plan** (see **Appendix 6**). The format of the SAP is consistent with that used for numerous Division-accepted landfill monitoring programs.

10.2.1 Monitoring System Requirements

The Design Hydrogeologic studies (see **Section 4.2**) indicate a radial ground water flow pattern toward the south, southwest, and southeast. This flow pattern reflects surface

[2] 40 CFR Part 258

topography along a gentle ridge, surrounded on three sides by surface streams (i.e., ground water receptors). Based on site topography and hydrogeologic conditions, predominant ground water flow direction to the south (toward Grindle Creek), with loose to medium dense sandy surficial soils serving as the uppermost (unconfined) aquifer (**Unit 1**), which exists above a variably thick, clayey partial confining layer (**Unit 2**). A deeper, regional (confined) aquifer (**Unit 3**) exists beneath the partial confining unit, exhibiting a pronounced upward vertical gradient beneath much of the site.

The placement of wells for the CDLF should focus on the upper sand layer (**Unit 1**), keeping in mind that the regional discharge point (Grindle Creek) is off-site, separated by a distance of several hundred feet. The interstitial land is old-family farm land is not likely to be developed. Regional municipal water is typically supplied to residences and other consumers throughout the area. However, the distance to the off-site ground water discharge point was considered in determining an appropriate monitoring well spacing in the original studies for Phase 1. An advection-dispersion calculation was made to determine a well spacing around the landfill perimeter that would likely intercept a release of contaminants from the landfill.

Applying these principles to the similar geologic conditions at Phase 2, a well spacing of approximately 300 to 400 feet appears appropriate. Please refer to **Section 4.2.1.3 (Volume 1)** for a discussion of new well depths and screen intervals and refer to the **Sampling and Analysis Plan (Appendix 6)** for detailed discussion of sampling and analysis protocols. New wells are shown on Drawing MP-1.

10.2.2 Background Water Quality

Low concentrations of metals also have been detected on occasion at the facility background well, MW-2, including cadmium, lead, and zinc (see **Section 4.1.12**).

10.2.3 Point of Compliance Water Quality

The 2L ground water standards are applicable for the compliance boundary, tempered with background water quality data.

10.2.4 Sampling and Analysis Procedures

Industry accepted protocols (also consistent with Division guidelines)[3] are discussed in the **Sampling and Analysis Plan** (see **Appendix 6**).

10.2.5 Detection-phase Monitoring Parameters

The sampling parameters consist of the **EPA Appendix I** list of organic constituents and metals, modified by the **2006 C&D Rules**.

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[3] NC DENR Division of Waste Management Guidance Document, Ground Water Sampling for Construction and Demolition, Closed or Industrial Landfills, http://www.wastenotnc.org/swhome/enviro_monitoring.asp

10.2.6 Sampling Frequency

The detection phase sampling frequency shall be semi-annually.

10.2.7 Water Level Elevations

During each sampling event, water levels shall be measured from the top-of-casing at each monitoring well.

10.2.8 Reporting

Data analysis and reporting, consistent with Division requirements, are described in the **Sampling and Analysis Plan** (see **Appendix 6**).

10.2.9 Source Demonstration

In the event of the detection of a ground water constituent that exceeds a 2L standard, an evaluation may be made in accordance with Division policy to determine the source, e.g., sampling error, laboratory contamination, extenuating circumstances (improper repairs to a well or incidental spill near a well). Typically, such evaluations are accompanied by re-sampling and, if appropriate, correction of conditions that may have lead to the detection. If such demonstrations cannot be made, the landfill might be considered as the source.

10.2.10 Monitoring Well Design

Wells shall be (and currently are) designed in accordance with **15A NCAC 2C**.

10.2.11 Monitoring Well Layout

The layout takes advantage of topographic features, the shape of the top of the confining unit (as indication of buried former channels), regional flow conditions and access considerations within the generally flat terrain.

10.2.12 Alternative Monitoring Systems

None are proposed at this time.

10.2.13 Assessment Monitoring

Requirements of assessment monitoring, if required, are outlined in **Rule .0545** of the **2006 C&D Rules**. If such conditions exist in the future at the CDLF that requires assessment monitoring, a plan will be prepared for review by the Division. It is not anticipated at this time that future assessment activities will be required.

10.3 Surface Water Monitoring

Surface water monitoring should (and does) focus on the unnamed tributaries shown to be shallow ground water discharge features to the east, west, and south of the Phase 2 footprint. An existing surface sampling location between Phases 1 and 2 (SW-2), shown on **Drawing MP-1**, is sufficient to monitor both CDLF units. The streams that converge near SW-2 emanate adjacent to the Phase 2 footprint – on both sides – and do not present upgradient monitoring opportunities. Actually, this is an ideal monitoring condition, whereas all the surface water monitored in the stream at SW-2 originates on-site.

10.4 Landfill Gas Monitoring and Control Plan

Landfill gas is a by-product from the decomposition of organic waste in a sanitary landfill, including certain C&D wastes. Landfill gas typically includes methane, which can be explosive under certain conditions, and gas has been known to promote the migration of contaminants into ground water. The Solid Waste Rules typically focus on the explosive properties from a public safety standpoint. Normally, gas migrates above the ground water table and is restricted laterally by streams. No pipelines or trenches exist nearby to serve as potential conduits for off-site landfill gas migration at this facility, although the on-site soils are porous and can potentially serve as gas migration pathways. No occupied structures exist nearby that appear to be at risk for gas migration.

The landfill gas management plan for C&D Landfill, Inc. is currently proposed to include monitoring of subsurface soil-gas adjacent to the landfill via bar-hole punch tests and headspace analysis of monitoring wells (see **Drawing MP-1**). Passive landfill gas vents will be installed along with the final cover system at a density of approximately three per acre of final cap surface area – these will not be monitored. A construction detail of these vents is included on **Drawing E2**.

Landfill gas monitoring will be performed during the active life of the landfill and throughout the post-closure care period. Quarterly monitoring will be conducted at all subsurface gas detection locations and in all occupied structures located on the landfill property. The passive gas vents, when installed, are not required to be monitored. Additional sampling may be performed in the future and/or remedial measures will be implemented as required to mitigate a potential gas migration problem.

10.4.1 Regulatory Limits

NCDENR rules require monitoring to the following explosive gas limits:

- 25% of the Lower Explosive Limit (LEL, 5% methane in standard atmosphere), within occupied structures – excluding gas collection/venting structures
- 100% LEL at the facility boundary
- No detectable concentration at off-site occupied structures.

10.4.2 Gas Monitoring Program

Gas monitoring will be conducted along the perimeter boundary of the facility (bar-hole punch tests), at locations shown approximately on **Drawing MP-1**, within occupied structures on the site (scale house), and in the head-space of monitoring wells.

Equipment: A portable combustible gas monitor, e.g., an Organic Vapor Analyzer (OVA) or Photo-Ion Detector (PID), shall be used to measure the concentration of combustible gases at sampling locations in units of percent of lower explosive limit. Lower explosive limit (LEL) means the lowest percent by volume of a mixture of combustible gas in air that will propagate a flame at 25 degrees Celsius and atmospheric pressure. The gas monitor shall be calibrated to methane using the manufacturer's calibration kit and procedure before the monitoring activities begin.

On-site Structures: Gas monitoring in on-site structures will be conducted during regular quarterly monitoring events at the earliest possible time after the structure has been unused (e.g., early morning). The monitoring locations will be in corners along floors and ceilings, at cracks in the floor, and at other areas likely to accumulate gas. Gas monitoring will also be conducted in any confined space requiring the entry of personnel for maintenance or inspection. The monitoring will take place prior to entry by personnel in accordance with OSHA regulations.

Gas Detection Bar-Hole Punch Locations: Gas monitoring in bar-hole punches will consist of punching a hole with a 3-foot probe. Tubing that is open-ended and perforated on the bottom should be placed in the bottom of the hole, taking care not to plug the bottom of the tubing with soil. The peak methane reading should then be recorded for each bar-hole probe location.

Monitoring Well Head-Space: The well heads will be sampled during routing ground water monitoring events.

Record Keeping: The operator will record the date, time, location, sampling personnel, atmospheric temperature, reported barometric pressure, and general weather conditions at the time of sampling, in addition to the concentration of combustible gases (see the example **Landfill Gas Monitoring Field Log** in **Appendix 6**). These monitoring records shall be maintained in the landfill operating record book.

10.4.3 Corrective Action

Prior to initiating corrective action, the monitoring plan may be augmented to include more sampling locations (possibly focusing on occupied structures in the area), permanent probes (in lieu of bar-hole punch tests), and /or more frequent sampling. Corrective action to control gas migration, if any is required, might consist of additional passive venting and/or active gas recovery. The likelihood of such measures ever being required is remote – this issue is addressed in the interest of compliance with the rules.

10.5 Waste Acceptance

Monitoring of the waste intake is addressed in the **Operations Plan** (see **Section 8.0**). The plan calls for routine waste screening and record keeping with respect to waste types, sources, and haulers. Maintaining strict adherence to the waste acceptance criteria is the sure way to maintain compliance with ground water quality criteria.

10.6 Plan Preparation and Certification

This monitoring plan for the C&D Landfill, Inc., disposal units has been prepared by, or under the responsible charge of, one or more North Carolina Licensed Geologists or Professional Engineers. The individual signature and seal below attests to compliance with this rule requirement.

Signed ______________________________

Printed ______________________________

Date ________________________________

Not valid unless this document bears the seal of the above-named licensed professional.

11.0 FINANCIAL ASSURANCE

The **2006 C&D Rules** require that Owners/Operators demonstrate financial assurance for closure and post-closure activities. Typically, for local government-owned facilities, said demonstration is based on a local government test. For private facilities, the posting of a performance bond or insurance policy is typically acceptable to the Division.

Cost estimates for closure and post-closure of CDLF Phases 1 and 2A are presented in **Sections 9.2.4** and **9.3.4**, respectively. The following is a detailed analysis of the closure and post closure costs, based on the preceding, all in 2007 dollars, projected over the anticipated life of the landfill (Phase 2) and 30 years of post-closure care. Please refer to **Tables 11A** and **11B** (following).

Table 11A shows the post-closure costs projected as future values over the 30-year period. Table 11B shows the annual decrease in the annual financial assurance obligation due to the expenditures of prior years, assuming no increased liabilities for unforeseen events, e.g., assessment monitoring. Based on this analysis, maximum post-closure cost liabilities are realized at the time of closure – these liabilities decrease with time and, thus, the amount of the post-closure instrument should be reduced over time. The closure costs will be realized far enough into the future that these costs may be recalculated to account for inflation on a periodic basis (which has not been done here). Thus, the whole financial assurance instrument should be recalculated periodically, say every five years at a minimum, or ideally on an annual basis. The posted amount (bond, insurance, etc.) should be adjusted accordingly on a periodic basis.

SUMMARY OF CLOSURE AND POST-CLOSURE COST

1.	Final Closure Construction (see **Table 9A**)	$1,404,675
2.	Projected Post-Closure Costs (see **Table 9C**)	
	$41,450.00 x 30 years =	$1,243,500
	TOTAL CLOSURE/POST-CLOSURE COST	**$2,648,175**

Upon approval of the financial assurance amount (and issuance of the Permit) by NC DENR Division of Waste Management, Owners/Operators must furnish an acceptable financial assurance instrument (e.g., performance bond, irrevocable letter of credit, insurance policy, other fiduciary instrument) within 30 days of notification of approval. Said documentation shall be furnished by the deadline and will be included as a future amendment to this report (see **Appendix 10**).

12.0 CERTIFICATION

This engineering plan for the C&D Landfill, Inc. Phase 2 disposal unit has been prepared by, or under the responsible charge of, one or more North Carolina Licensed Professional Engineers to meet the requirements of 15A NCAC 13B .0539. The individual signature and seal below attests to compliance with this rule requirement.

Signed ______________________

Printed ______________________

Date ______________________

Not valid unless this document bears the seal of the above-named licensed professional.